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Petrochronology of Ultrapotassic Intrusive Rocks and Associated Rare Earth Element-Bearing Carbonatite, Mountain Pass, California

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Petrochronology of Ultrapotassic Intrusive Rocks and Associated Rare Earth Element-Bearing Carbonatite, Mountain Pass, California

A Thesis submitted in partial satisfaction of the

requirements for the degree Master of Science

in Geological Sciences

by

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June 2015

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ABSTRACT

Petrochronology of Ultrapotassic Intrusive Rocks and Associated Rare Earth Element-Bearing Carbonatite, Mountain Pass, California

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The petrogenesis of the rare earth element-bearing carbonatite at Mountain Pass, California remains poorly understood despite the deposit's discovery in the 1950s. Ore-bearing carbonatite dikes and a stock are spatially associated with a suite of ultrapotassic igneous rocks, and, based on geochemical data, the two have been proposed to be genetically related. Such petrologic models are complicated by existing geochronologic constraints indicating that the carbonatite is ~15-25 m.y. younger than the ultrapotassic rocks, leading some authors to favor formation of the ore-bearing carbonatite during a separate, younger event and/or via a different mechanism. New laser ablation split-stream inductively coupled plasma mass spectrometry (LASS-ICPMS) petrochronologic data from 19 ultrapotassic intrusive rocks from Mountain Pass yield titanite and zircon U-Pb ages from 1429 ± 10 to 1385 ± 18 Ma, expanding the U-Pb age range of ultrapotassic rocks in the complex by ~20 m.y. The ages of the youngest ultrapotassic rocks overlap monazite Th-Pb ages from a carbonatite dike and the main carbonatite ore body (1396 ± 16 and 1371 ± 10 Ma, respectively). Epsilon $Hf_{(i)}$ values from zircon in seven ultrapotassic rocks yield consistent

results both within and between samples, with a weighted mean of 1.9 ± 0.2 (MSWD = 0.9), indicating derivation from a shared, isotopically homogeneous source. In contrast, exploratory in-situ Nd isotopic data from titanite in the ultrapotassic rocks are variable ($\varepsilon Nd_{(i)}$ = -3.5 to -12), suggesting secondary alteration and/or contamination from an isotopically enriched source in some samples. The most primitive $\varepsilon Nd_{(i)}$ isotopic signatures do, however, overlap $\varepsilon Nd_{(i)}$ from monazite ($\varepsilon Nd_{(i)}$ = -2.8 ± 0.2) and bastnäsite ($\varepsilon Nd_{(i)}$ = -3.2 ± 0.3) in the carbonatite, indicating derivation from a source with the same Nd isotopic signature. Although carbonatite is the youngest rock type in the intrusive complex based on cross-cutting relationships, at the resolution of the LA-MC-ICPMS technique, Th-Pb monazite ages of carbonatite are not resolvable from titanite and zircon ages in ultrapotassic rocks, eliminating the previously inferred time gap between ultrapotassic and carbonatite magmatism at Mountain Pass. These new geochronologic data combined with whole rock elemental and mineral-scale isotope data imply that the ultrapotassic – carbonatite rocks at Mountain Pass are part of a genetically-related suite that formed via extreme fractional crystallization and/or silicate-carbonatite liquid immiscibility processes.

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I. INTRODUCTION

The Sulphide Queen rare-earth element (REE) mine at Mountain Pass, California is the only significant producer of REE ore in the United States (Long et al., 2010). However, since the discovery and initial development of the Sulphide Queen in the early 1950s (Hewett, 1954), the petrogenesis of the ore body has remained poorly understood. The carbonatite, along with K-rich, mafic to felsic, plutonic rocks (shonkinite, syenite, and granite), make up the Mesoproterozoic Mountain Pass Intrusive Suite (MPIS). Carbonatite has long been recognized as the youngest rock-type in the MPIS in terms of cross-cutting relationships, although one study noted that a cm-scale vein of shonkinite appears to cut carbonatite in at least one location (Olson & Pray, 1954). Based on field relationships and their similar enrichment in incompatible elements such as Sr, Ba, and light rare-earth elements (LREEs), previous workers have inferred that the Sulphide Queen carbonatite magma was derived from the same source as the K-rich silicate rocks and that the intrusive assemblage may represent a single suite of variably evolved alkaline igneous rocks (Woyski, 1980; Castor, 2008). This is broadly compatible with studies from a variety of locations worldwide suggesting that carbonatite and alkali-rich silicate melts can differentiate from the same parental magma, potentially by liquid immiscibility (e.g. Lee & Wyllie, 1998; Wooley, 2003; Panina & Motorina, 2008), extreme fractional crystallization of a CO_2-rich silicate melt (e.g. Bell et al., 1999), or a combination of these processes (e.g. Beccaluva et al., 1992).

In contrast, existing geochronologic data from the MPIS suggest that carbonatite is ~15-25 Ma younger than the K-rich silicate rocks at Mountain Pass, yielding ages of ~1375 Ma and ~1400 Ma, respectively (DeWitt et al., 1987; DeWitt, 2000; Premo et al., 2013). Unfortunately, interpretation and objective assessment of these data is difficult because the ages are derived from different minerals and isotopic systems in each rock type (e.g. zircon and apatite U-Pb, monazite U/Th-Pb, and amphibole and biotite Ar-Ar) and are exclusively reported in conference abstracts that lack data tables, age plots, and contextual information (DeWitt et al., 1987; DeWitt, 2000; Premo et al., 2013). Given that fractional crystallization and liquid immiscibility processes are commonly thought to operate over timescales << 10 Ma (e.g. Schmitt et al., 2010; Williams et al., 1986), the proposed 15-25 Ma age gap is difficult to reconcile with the hypothesis that the carbonatite and the K-rich rocks are derived from the same parental magma or were generated during the same melting event. Thus, current petrogenetic models assert that although geochemically similar, the MPIS is not simply a genetically related differentiated suite of rocks (e.g. Haxel, 2005; Verplanck & Van Gosen, 2011).

This study utilizes laser ablation split-stream inductively coupled plasma mass spectrometry (LASS-ICPMS), x-ray fluorescence (XRF) spectrometry, scanning electron microscopy (SEM), and petrography, within the context of field data to resolve the age and petrogenetic relationships between carbonatite and ultrapotassic igneous rocks in the MPIS. Titanite, zircon, and monazite U/Th-Pb and trace element data from 21 samples from the MPIS suggest that ultrapotassic magmatism occurred in multiple, distinct pulses over ~45 m.y, a longer time interval than previously suggested, and that the latest pulses of ultrapotassic magmatism were synchronous with carbonatite crystallization and REE ore formation. These data force reexamination of existing ore genesis models for the Sulphide Queen carbonatite REE deposit, and indicate that the MPIS is most simply explained as multiple phases of a cogenetic and variably evolved suite of plutonic igneous rocks.

2. BACKGROUND

2.1 Geologic Setting

The Mountain Pass district is located in the Central Mojave Desert of California, about 75 km SSW of Las Vegas, Nevada along Interstate 15 (Fig. 1). The district encompasses a topographic low between the Clark Mountain Range to the north and the Mescal Range to the south, and is primarily underlain by Proterozoic crystalline basement rocks (Fig. 2). Mesozoic volcanic rocks and minor Tertiary andesitic to rhyolitic dikes also crop out locally. Peak- and cliff-forming units along the western edge of the Mountain Pass district include Neoproterozoic through lower Paleozoic limestone, quartzite, and shale, and Mesozoic siliciclastic and felsic volcanic rocks (Evans, 1974). The Proterozoic crystalline rocks compose a ~7 km-wide, fault-bound block, and are juxtaposed against the younger sedimentary and volcanic rocks by the Clark Mountain Fault Complex in the west. The Mesozoic and Proterozoic rocks are autochthonous, and lie in the footwall of a major thrust fault of the Sevier orogeny (Keystone thrust), but are in turn placed against one another by an earlier normal fault that is parallel or sub-parallel to the thrust in the Mountain Pass area (Burchfiel & Davis, 1971; Gans, pers. commun., 2015). In the east and south, the Proterozoic rocks are bound by the inferred Ivanpah Fault, which is obscured

Figure 1 – Modified Google Earth map of Southwestern United States showing location of Mountain Pass (Google Earth, 2013).

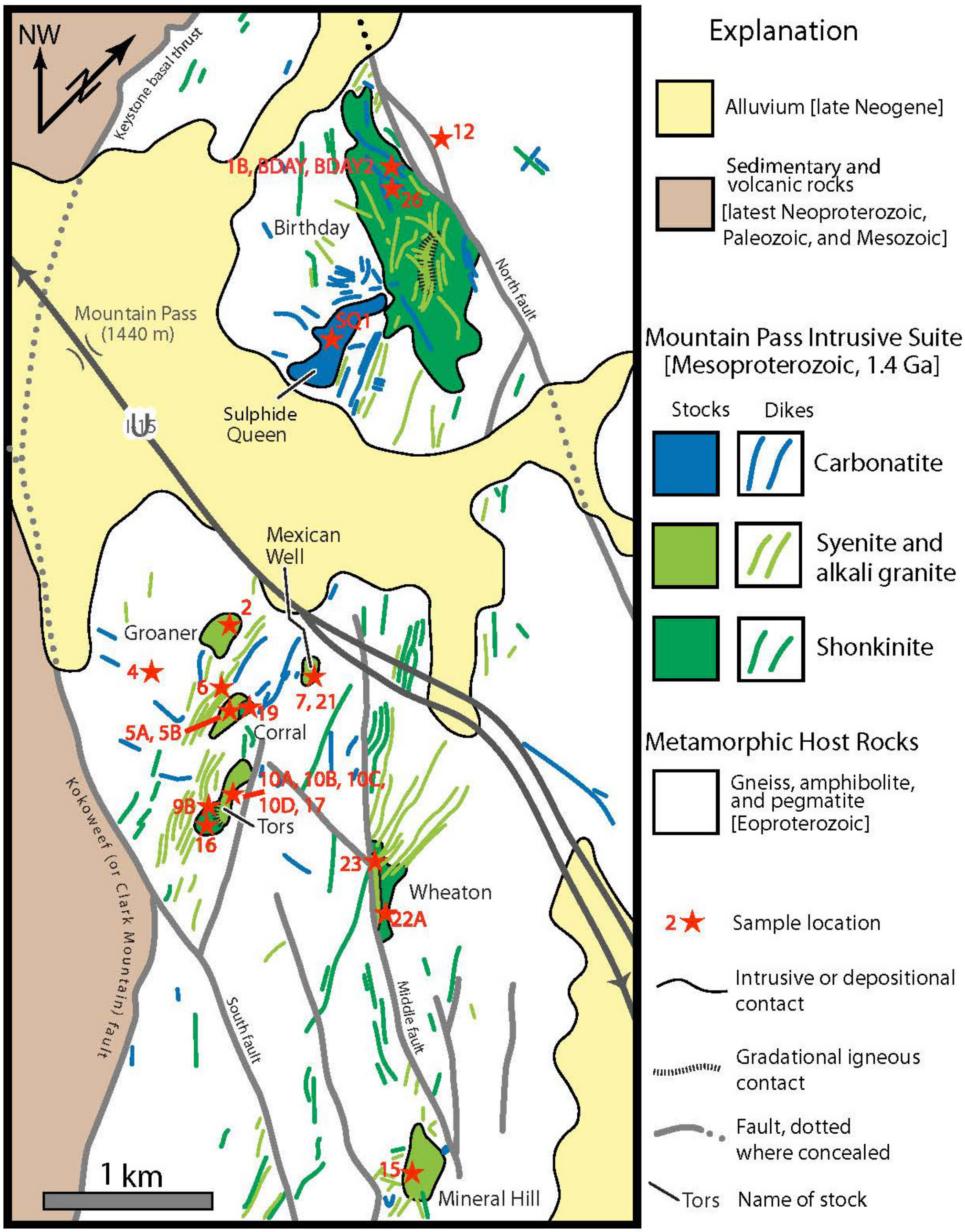


Figure 2 – Generalized geologic map of the Mountain Pass area. Map (without samples) modified from Haxel, 2005, after Olson and Pray, 1954; Olson et al 1954; Burchfiel & Davis, 1971; and Evans, 1971.

by the alluvium of Ivanpah Valley. The structural block that comprises Mountain Pass is cut by several strike-slip faults, none of which place the Proterozoic rocks against units of significantly different age or lithology and either die out or are truncated by the Clark Mountain Fault Complex (Olson et al., 1954). Despite minor local faulting, decimeter- to meter-scale dike emplacement, and minor, localized hydrothermal alteration, the Proterozoic rocks in the district are relatively well-preserved and were not as affected by Cenozoic extension and deformation as neighboring areas in the Mojave Desert (Haxel, 2005).

2.2 History of Discovery and Mining Operations

The Mountain Pass area is a historic mining district for a variety of resources, and has been the site of three major periods of prospecting, discovery, and development. These periods are described in detail in a foreword by D.F. Hewett in the original 1954 United States Geological Survey (USGS) Professional Paper on the Mountain Pass district (Olson et al., 1954), which still stands as perhaps the most thorough description of the field relations and mineralogy of both the metamorphic host rocks and the MPIS. The history of resource discovery and development at Mountain Pass is briefly summarized here:

The cycle of prospecting began in the early 1860s, when notable quantities of gold, silver, lead, and copper ore were extracted from various rock types at small mines in the area. The second wave peaked in 1917, and resulted in the establishment of many small operations in the region that extracted gold, antimony, and lead ore. The mineralization exploited during these periods is thought to be related to Cretaceous faulting and magmatism (Woyski, 1980), and is unrelated to REE mineralization in the MPIS. Both phases were dwarfed by the latest era, which resulted in the establishment of the ongoing, multi-million-dollar rare-earth element mine operation of the Molybdenum Corporation of America (now Molycorp). D.F. Hewitt created the first geologic map of the pass region in 1926, mapping many of the metamorphic rock types that are exposed at Mountain Pass and three syenite bodies south of Interstate 15, but did not observe carbonatite or the shonkinite body that was later discovered ~1.2 km to the north. The Sulphide Queen Gold Mine on Sulphide Queen Hill, for which the rare-earth element orebody is now named, was worked in the early 1940s (Hewitt, 1954).

The third cycle of prospecting at Mountain Pass began in 1949 when H.S. Woodward attempted uranium prospecting in the mine tailings around the area with a Geiger counter. Woodward first discovered radioactive rocks from the locale upon examining specimens collected at the Sulphide Queen mine by the mine's owner. Woodward later searched the area adjacent to the mine and discovered that most of the material on Sulphide Queen Hill was radioactive. Woodward, along with his partner C. Watkins, returned to search the surrounding vicinity shortly thereafter and discovered a ~5-meter-wide carbonatite dike about 4000 feet to the NW of the Sulphide Queen mine that displayed "intense" radioactivity. As it was Woodward's Birthday, the dike was named the Birthday Vein, a claim was staked, and samples of an unknown tan, heavy mineral were collected. The mineral samples later proved to be bastnäsite ([La,Ce,Pr,Nd]CO_3F). A series of claims were staked on dikes and veins in the locale (the Birthday Claims) by several parties, and all were purchased by Molycorp in February 1950. Later that year Sharp and Pray of the USGS (Sharp & Pray, 1952) mapped the Birthday area and noted that the radioactive veins were hosted by shonkinite, a K-rich mafic rock consisting primarily of K-feldspar, clinopyroxene, and biotite. Sharp and Pray were the first to describe the K-rich silicate intrusive rocks of the Mountain Pass Intrusive Suite, and noted that cross-cutting relationships indicated intrusion in the following order: shonkinite, syenite, granite, shonkinite dikes, and carbonatite. In January 1951, Molycorp bought another series of claims on Sulphide Queen Hill that would eventually become the world-famous Mountain Pass REE mine (Hewitt, 1954).

Olson et al. (1954) produced the first geologic map of the Mountain Pass district at a scale of 1:20,000 in 1950, and were the first to describe the large, intrusive, bastnäsite-bearing Sulphide Queen carbonatite stock north of Interstate 15. Although these workers clearly recognized the igneous nature of the carbonatite dikes and the Sulphide Queen based on field relationships and the abundance of REEs, they cautiously referred to it as "carbonate rock." Molycorp began mining operations a few years later, and at the time Mountain Pass was the world's largest known REE deposit (Hewitt, 1954; Olson et al., 1954). The mine was the world's foremost producer of REE commodities until the late 1980s, when Chinese operations surpassed those at Mountain Pass (Verplanck & Van Gosen, 2011).

2.3 Rare Earth Elements and the Importance of the Mountain Pass Deposit

REEs are widely used in a variety of industrial and technological applications, and are in current demand for their unique metallurgical, chemical, catalytic, electrical, magnetic, and optical properties (Verplanck and Van Gosen, 2011). For example: La, Ce, Pr, and Nd are commonly used at catalysts in the automotive and petroleum industries; La, Pr, Nd, Dy, and Tb to produce powerful, relatively lightweight permanent magnets; La, Ce, Pr, Nd, and Sm as alloying elements in metals; La, Ce, and Pr in glass and for glass polishing; and La, Ce, Eu, Y, Tb, and Gd as phosphors (e.g. Long, 2011; Humphries, 2013). Of particular interest to government entities are their uses in technologies such as fighter jet engines, missile guidance systems, antimissile defense systems, satellites, and communication systems

(Humphries, 2013). The majority of the world's REE resources are sourced in China (~95% in 2011), whose decision to restrict exports in 2009 has bolstered global concern over supply shortage (Long et al., 2010; Humphries, 2013). This has led to increased interest in locating, quantifying, and potentially developing domestic REE deposits, among which Mountain Pass is a prime example – most of the world's known economic REE deposits occur in alkaline intrusions and carbonatites, like Mountain Pass (e.g. Orris & Grauch, 2002; Long, 2011; Verplanck & Van Gosen, 2011). An accurate ore genesis model for the Sulphide Queen is therefore a critical aid in the quantification and development of similar deposits in both the U.S. and globally (Berger, 2009; Verplanck & Van Gosen, 2011). However, despite its status as the type example in the United States, the petrogenesis of the REE-bearing Mountain Pass carbonatite remains unclear.

3. GEOLOGIC UNITS AT MOUNTAIN PASS

3.1 Metamorphic Host Rocks

The crystalline basement rocks that underlie most of the Mountain Pass area consist of Paleoproterozoic quartzofeldspathic gneiss and schist, coarse-grained to pegmatitic alkali granite dikes, and minor mafic to ultramafic rocks such as amphibolite, glimmerite, and peridotite (this work; Olson et al., 1954; Haxel, 2005; Castor, 2008; Fig. 2). Feldspar augen gneiss and migmatitic K-feldspar + plagioclase + quartz + biotite ± garnet ± sillimanite gneiss are most common (Figs. 3A & 3B); some gneiss also contains variable amounts of muscovite and hornblende. Local complex folding and garnet-bearing leucosomes (concordant and discordant) are common in the gneiss and schist where textures are migmatitic. Foliation in the gneiss and schist generally strikes north to NW and dips 45-85^0

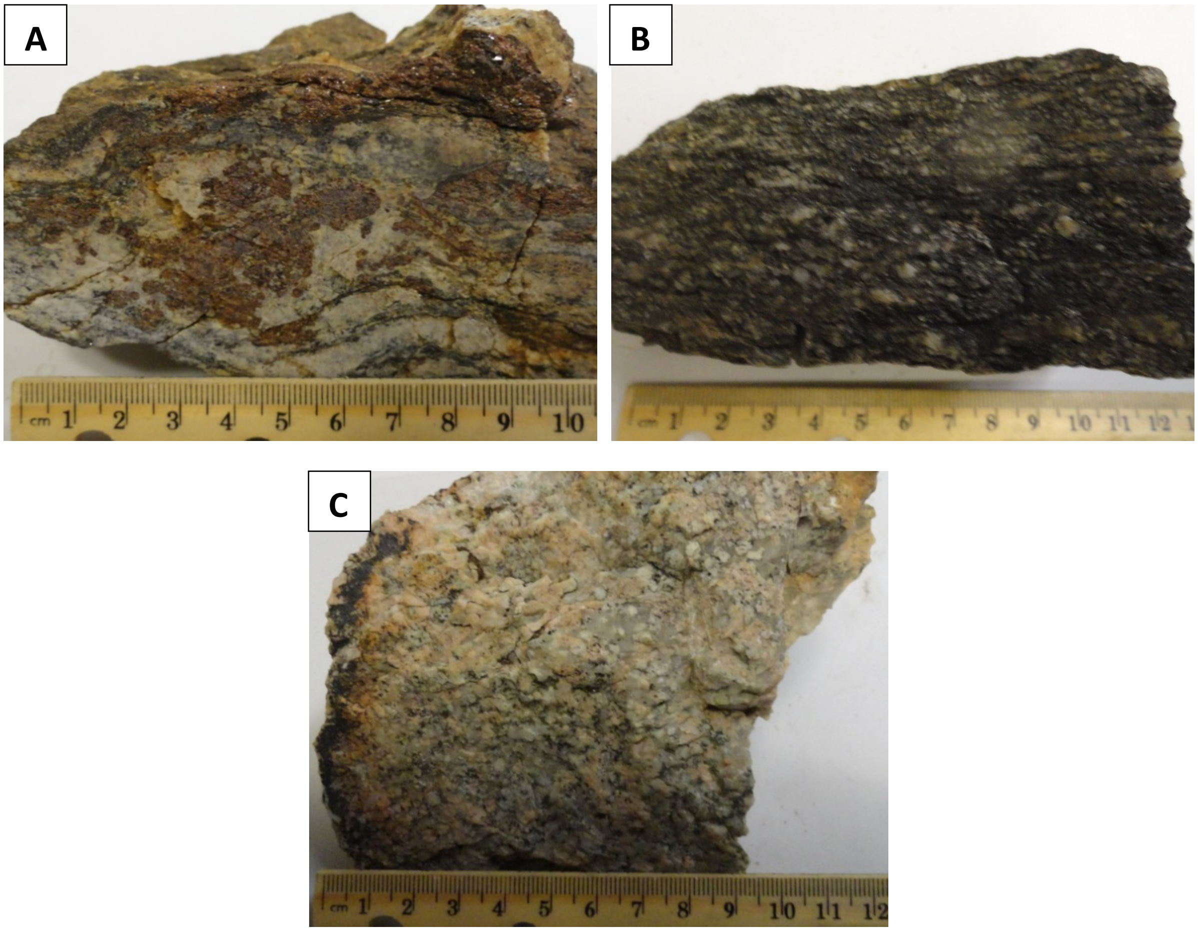


Figure 3 – Examples of typical host rock types at Mountain Pass. **A**. Migmatitic garnet-sillimanite-biotite gneiss from ~300 m SW of Groaner stock (sample MP-P0913-4). **B**. Feldspar augen gneiss from ~360 m NW of Birthday mine (sample MP-P0913-12). **C**. Coarse-grained granite from a m-scale xenolith in syenite at Corral stock (sample MP-P0913-5B).

to the west, and mineral stretching lineations defined by aligned micas, hornblende, and elongated quartz grains dominantly trend west to SW and plunge $50-80^0$ (this work; Olson et al., 1954; Olson & Pray, 1954). Coarse-grained to pegmatitic alkali granite is also common (Fig. 3C), occurring as sub-concordant to discordant dikes in the metamorphic complex that vary widely in orientation. The granite dikes range in thickness from <1 meter to ~40 meters (Olson et al., 1954). Sub-concordant granite pegmatites and dikes in the area are commonly weakly to moderately foliated, and those that cut the regional foliation at a high angle are generally undeformed (this work; Olson et al., 1954). Minor mafic rocks in the area, such as amphibolite and glimmerite, typically occur as concordant lenses or thin layers up to tens of meters long in the host gneiss. In some areas, most notably near faults and intrusive contacts, the host rocks are rusty orange-red to brown, extensively chloritized, and highly friable (this work; Olson et al., 1954; Olson & Pray, 1954).

U-Pb zircon data presented by Barth et al. (2000) from the Baldwin gneiss in the Transverse Ranges, part of the Mojave Crustal Province, were interpreted to indicate several stages of widespread calc-alkaline plutonism, volcanism, and associated sedimentation across the Mojave Province ca. 1.78-1.66 Ga. The latest of these stages is thought to have occurred after significant orogenic thickening, and was interpreted as evidence for the development and accretion of an oceanic arc in the Paleoproterozoic Mojave Province (Barth et al., 2000). McKinney et al. (2015) and Wooden and Miller (1990) report similar zircon ages for these rocks, but the latter workers but also note zircons as old as 2.02 Ga, as young as 1.64 Ga, and the presence of metapelitic rocks in the province. They suggest regional, migmatite-forming metamorphism ~1705 Ma and multiple episodes of pluton emplacement from ~1.76 to ~1.64 Ga. These rocks are widely intruded by 1.45-1.40 Ga granitoids throughout the southwestern U.S. (e.g. Anderson & Bender, 1989; McKinney et al., 2015), including the Mountain Pass Intrusive Suite, but otherwise no mineral ages have been reported from the locality that span the ~1.63 to 1.45 Ga time period.

3.2 Mountain Pass Intrusive Suite

The Paleoproterozoic metamorphic complex in the Mountain Pass district is intruded by hundreds of sub-meter to meter-scale dikes and eight map-scale stocks that compose the Mountain Pass Intrusive Suite. Seven of the stocks consist of shonkinite and/or syenite, one contains significant granite, and one (the Sulphide Queen) consists of carbonatite (Fig. 2).

Gradational forms between shonkinite-syenite and syenite-granite are common. The stocks form ovoid to tabular, sill-like bodies tens to hundreds of meters wide and hundreds of meters long, and occur within a ~7 x 2 km zone in the host gneiss. Nearly all dikes and stocks in the MPIS trend roughly parallel to the regional foliation of the basement rocks (~north to NW), but cut, and are discordant to, foliation on an outcrop scale and are undeformed. The intrusive nature of the alkaline and carbonatite intrusive bodies is also evident by the occurrence of inferred flow structures at contacts (i.e. aligned biotite and/or amphibole), fenitization (alkali-rich fluid alteration) of the host gneiss, and abundant gneiss and granite xenoliths or intrusion breccias around the periphery of the stocks (this work; Olson et al., 1954; Olson & Pray, 1954; Castor, 2008; Fig. 4A). The stocks are typically more fine-grained and contain more xenoliths near contacts with the host rocks, most notably along the westernmost contacts. Dikes are mostly fine-grained or porphyritic, although some coarse-grained dikes are present. Discontinuous syenite pegmatites are common in some areas, most notably the Tors pluton (Fig. 2), but have only been observed in the stocks and not in the host rocks. In general, cross-cutting relationships indicate that the sequence of intrusion in the MPIS was: 1) shonkinite and melanosyenite, 2) syenite, 3) quartz syenite, 4) granite, 5) shonkinite dikes, and 6) carbonatite (e.g. this work; Olson et al., 1954; Haxel, 2005; Castor, 2008; Figs. 4B-4D). However, a cm-scale shonkinite vein appears to cut carbonatite in at least one location (Olson & Pray, 1954; Haxel, 2007). Some shonkinite dikes within syenite are discontinuous, deformed, and back-intruded by fine-grained syenite (Fig. 4E). Magma mingling and mixing textures are common in some areas (e.g. Tors stock), indicating that emplacement of some of the shonkinite and syenite was synchronous (this work; Haxel, 2005; Fig. 4F). The main carbonatite body (Sulphide Queen; Fig. 2) contains

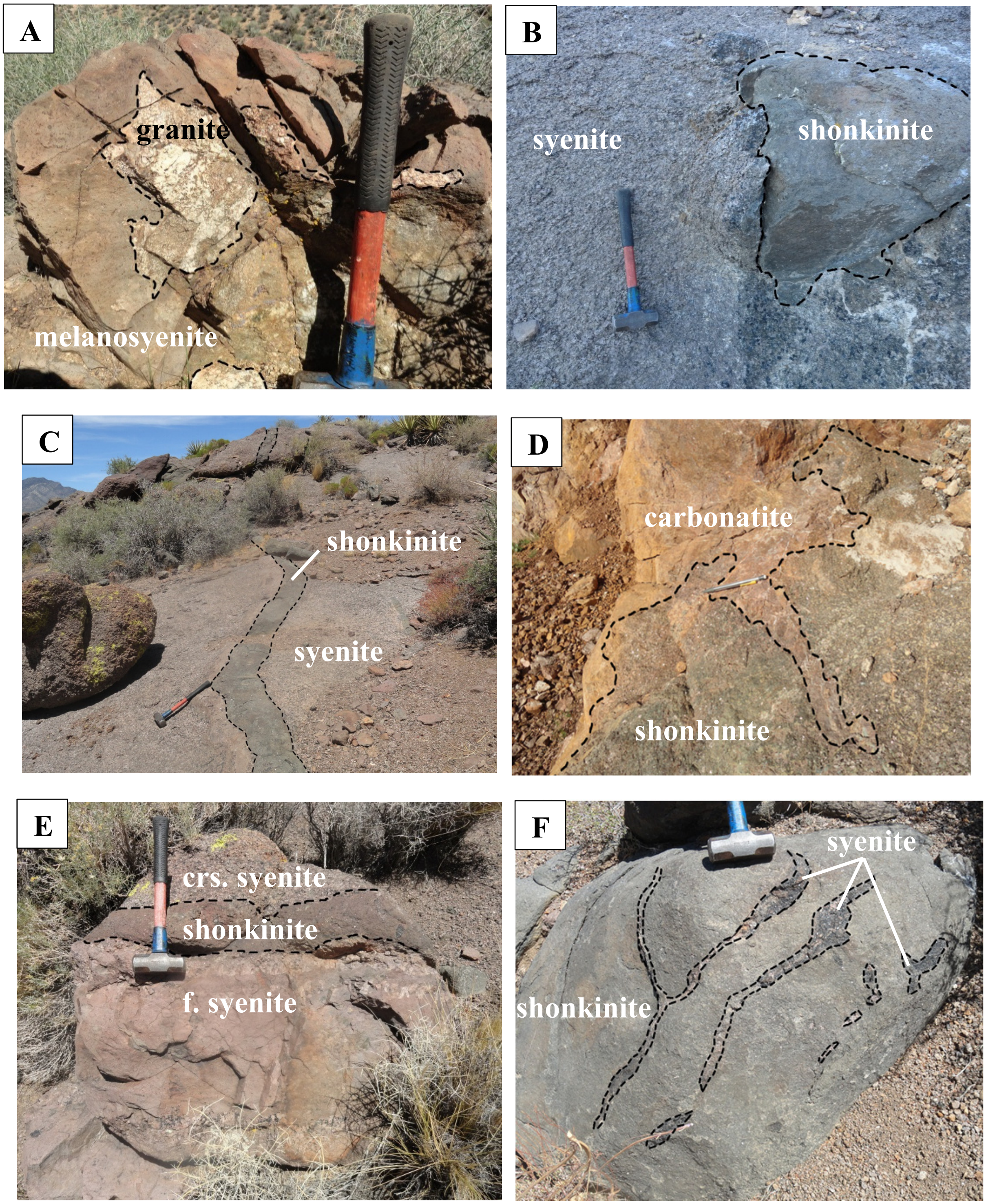


Figure 4 – Examples of cross-cutting relationships within the MPIS. **A**. Granite xenoliths in melanosyenite (MP-P0913-6) at the west edge of Corral stock. **B**. Porphyritic shonkinite enclave (MP-P0913-10A) in coarse syenite (MP-P0913-10B) in Tors stock. **C**. Porphyritic shonkinite dike (MP-P0913-10C) in coarse syenite (MP-P0913-10B) in Tors stock. **D**. Bastnäsite-barite carbonatite dike (MP-L0613-BDAY2; Birthday Vein) that cuts coarse shonkinite (MP-L061313-BDAY) in Birthday stock. **E**. Shonkinite dike that cuts coarse shonkinite and is back-intruded by fine syenite (MP-P0714-17) in Tors stock (ex-situ). **F**. Diffuse syenite inclusions in shonkinite at Tors stock.

fragments of gneiss, shonkinite, syenite, and older carbonatite, the latter of which indicating that carbonatite was not emplaced during a single event (Olson et al., 1954).

Castor (2008) noted that the MPIS lies roughly at the northwestern-most end of a ~300 km belt of ~4 to 150 km^2 alkaline granitoid plutons that extends from southeastern California into southern Nevada and western Arizona (Fig. 5). Ultrapotassic rocks are known only from the western edge of the belt, and have also been found as far south as Rattlesnake Canyon in the Old Woman Mountains and as far north as Mesquite Lake (Fig. 5), indicating that their occurrence at Mountain Pass is not entirely unique (e.g. Gleason et al., 1994). However, the relationship between the various plutons that comprise the belt has not been well-studied outside of the Mountain Pass area (Castor, 2008).

3.2.1 Shonkinite

The most abundant intrusive rock in the study area is coarse-grained shonkinite – a distinctive, dark gray to greenish rock composed of pink to lavender K-feldspar, green clinopyroxene, and lustrous, euhedral, black biotite, with or without black to sky blue amphibole (arfvedsonite/hornblende and riebeckite, respectively; Figs. 6A-6C). Modal abundance of clinopyroxene decreases with increasing amphibole abundance. The rock is better termed a melanosyenite, but the name shonkinite was assigned by Olson et al. (1954) after a rock containing K-feldspar + augite ± olivine ± nepheline ± sodalite described in the Highwood Mountains of Montana by Weed and Pirsson (1895). This name has persisted in the literature, and although not a misnomer is perhaps somewhat misleading. However, to maintain continuity with previous work, shonkinite is used here to describe the most mafic rocks consisting of K-feldspar + biotite + clinopyroxene ± amphibole, and melanosyenite is

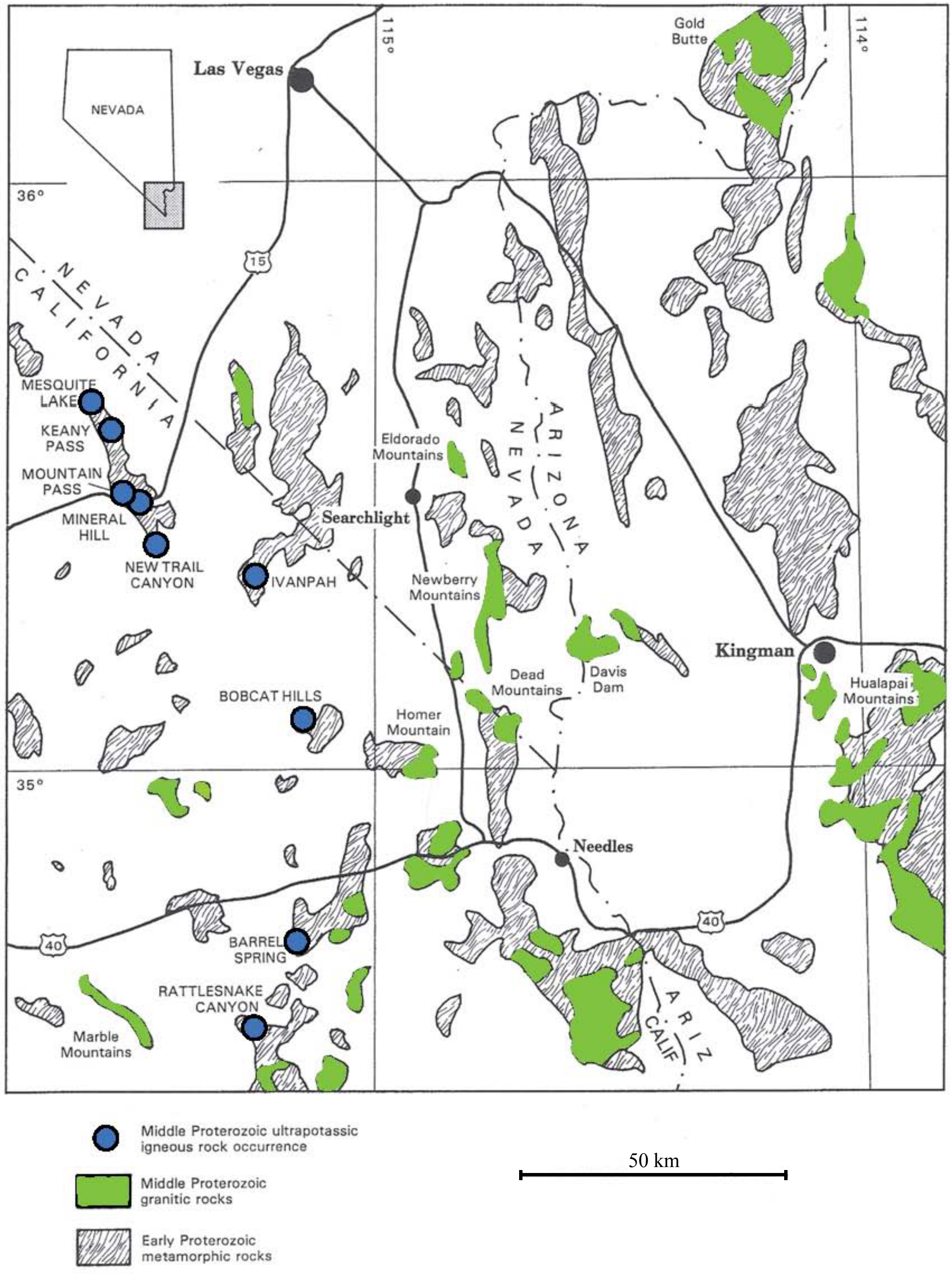


Figure 5 – Map showing location of Mesoproterozoic intrusive rocks in the southwestern U.S. Modified from Castor, 2008.

used for rocks that are transitional from shonkinite-syenite and contain ~40-60% mafic minerals.

Petrographic observations and energy dispersive spectrometry (EDS) show that the K-feldspar in Mountain Pass shonkinite is mostly microcline, the clinopyroxene is mostly diopside with some aegirine and augite, the biotite is commonly phlogopite and ubiquitously Mg-rich, and the amphibole is dominantly K- and Na-rich varieties such as arfvedsonite, magnesio-arfvedsonite, riebeckite, and magnesioriebeckite. Hornblende is also present in some samples. Apatite composes up to ~3% or more of some samples. Sodic plagioclase forms up to ~5% of some samples, and commonly occurs as perthite intergrowths in microcline. Quartz is present in most samples, composing up to 5% (this work; Olson et al., 1954). Olivine has been reported as forming up to ~5% of some shonkinite (Olson et al., 1954; Castor, 2008). Primary accessory minerals in the shonkinite include apatite, zircon, titanite, magnetite, Fe-sulfide (mostly pyrite), Fe-oxides, calcite, and fluorite (detailed mineralogical descriptions are provided in Appendix A).

3.2.2 Syenite, Quartz Syenite, and Granite

Syenite is the second most common intrusive rock type at Mountain Pass, and occurs as a pinkish to purple to brick-red, ridge- and peak-forming, blocky-weathering rock that consists mostly of K-feldspar with variable amounts of biotite, sodic amphibole, sodic plagioclase, quartz, and Fe-oxides (Fig. 6D). Clinopyroxene is sparse, but present (<5%) in some samples. Leucosyenite, quartz syenite, and granite are less common, occurring mostly as dikes and pods in shonkinite or syenite, although the Mineral Hill stock contains significant granite. Mineralogy in these rock types is similar to syenite; they differ only in relative proportions of K-feldspar and quartz. Samples that are ≥ 90% K-feldspar are termed leucosyenite (Fig. 6E), samples with ≥ 5% quartz are termed quartz syenite, and those with ≥ 20% granite. Primary accessory minerals in the syenite, quartz syenite, and granite include apatite, zircon, titanite, magnetite, Fe-sulfide (mostly pyrite), Fe-oxides, fluorite, calcite, and galena (see Appendix A for detailed sample mineralogy).

3.2.3 Carbonatite

Carbonatite at Mountain Pass has been called "an exceedingly strange igneous rock (Castor, 2008)," and is indeed composed of a rather unusual phase assemblage. It varies widely in appearance, but in general is porphyritic with cm-size pink or white barite ($BaSO_4$) phenocrysts in a golden to chocolate brown matrix of calcite, dolomite, quartz, Fe-oxide, and bastnäsite (Figs. 7A-7D). The bastnäsite is mostly fine-grained, but some carbonatite dikes contain crystals up to several cm in length (i.e. Birthday Vein; Fig. 7D). Modal mineralogy in the carbonatite also varies, but virtually all samples contain calcite, dolomite, barite, bastnäsite, strontianite or celestite, Fe-oxide, and quartz. Ankerite, siderite, apatite, synchysite ($Ca[LREE](CO_3)_2F$), parisite ($Ca[LREE]_2(CO_3)_3F_2$), monazite, thorite, an unidentified Th-carbonate, and at least two unidentified REE-bearing phases are also common as accessory, minor, or trace phases in the carbonatite. The Sulphide Queen ore exemplifies this mineralogical variation, but the most common lithology is bastnäsite-barite sövite (calcite-dominated; Castor, 2008). Beforsite (dolomite-dominant) and silicio-carbonatite are also common. Among the carbonatite dikes in the study area, most are calcite-dominated, but some (i.e. Birthday Vein) contain more quartz than carbonate minerals, mostly along contacts with ultrapotassic rocks, and are thus not technically carbonatite in a

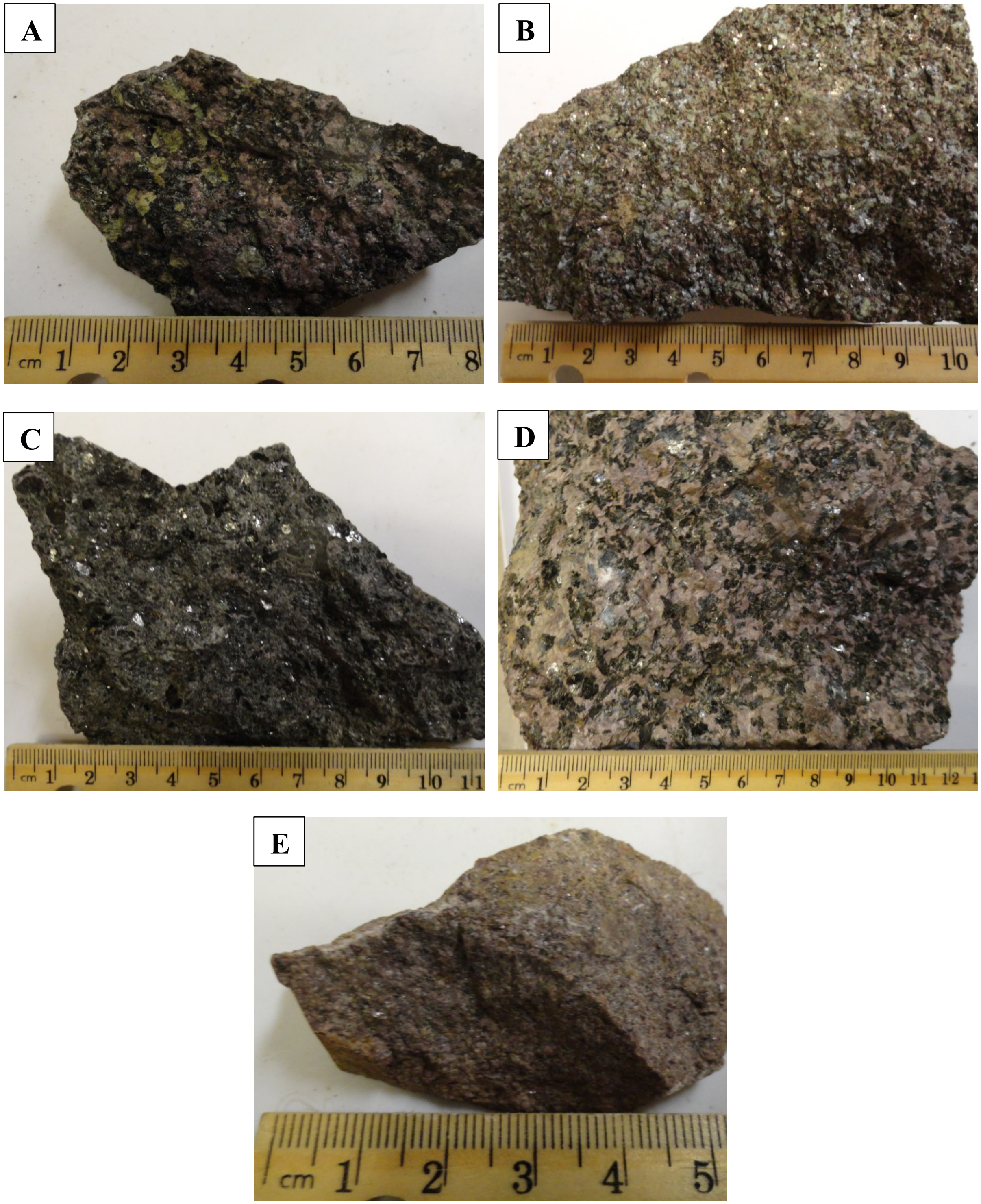


Figure 6 – Representative hand samples of MPIS ultrapotassic rocks. **A**. Coarse biotite shonkinite from Birthday stock with green clinopyroxene, black biotite, and pink to purplish K-feldspar (sample MP-L0613-BDAY). **B**. Medium-grained biotite-riebeckite shonkinite from Wheaton stock with green clinopyroxene, black biotite, blue riebeckite, and purplish K-feldspar (e.g. sample MP-P0913-22A). **C**. Porphyritic biotite shonkinite from Tors stock with biotite phenocrysts (sample MP-P0913-10C). **D**. Coarse biotite-amphibole syenite from Tors stock with black biotite and amphibole and pink to purplish K-feldspar (e.g. sample MP-P0913-10B). **E**. Fine leucosyenite from Corral stock (MP-P0913-5A).

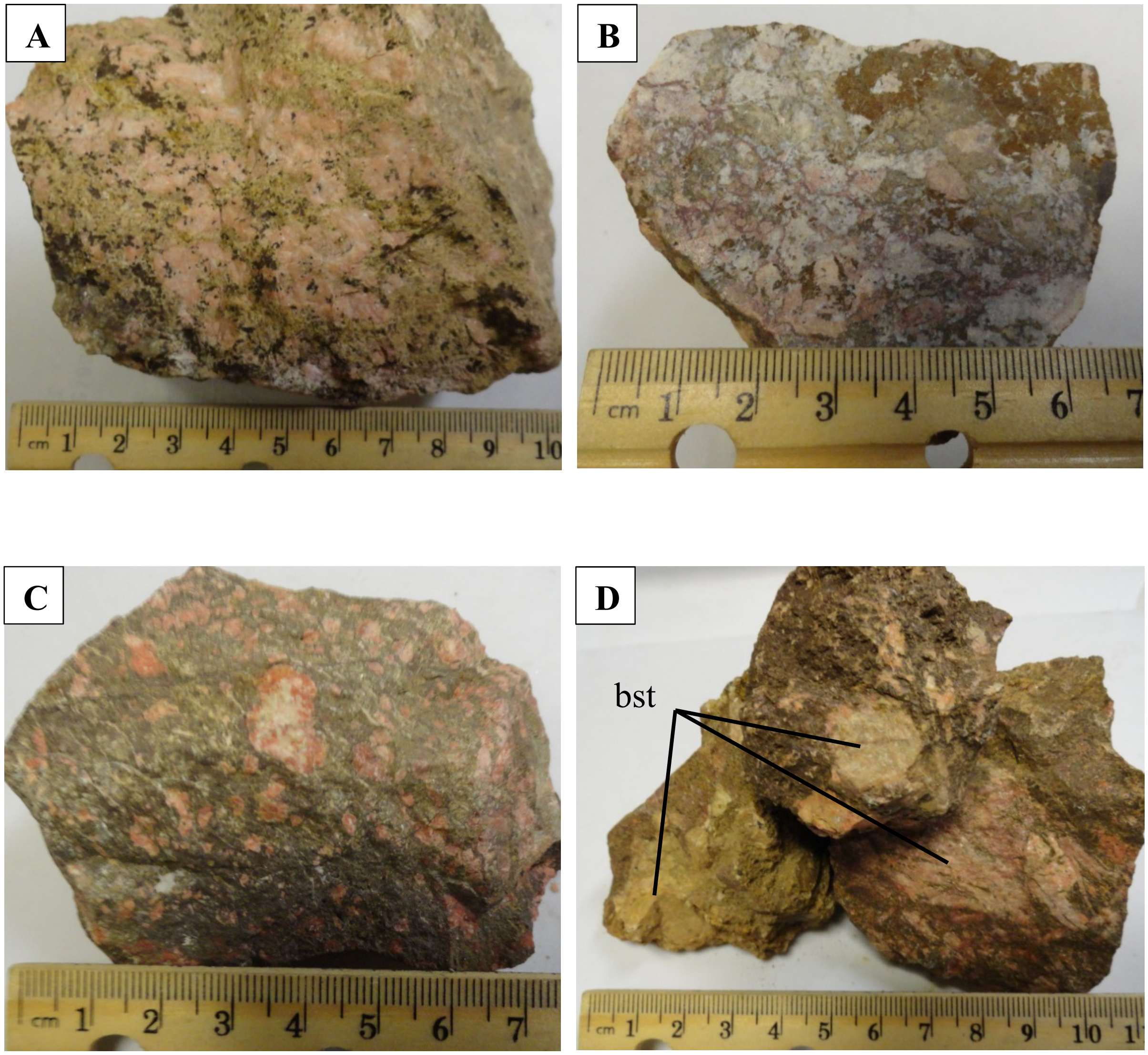


Figure 7 – Hand samples of MPIS carbonatite. **A**. Porphyritic bastnäsite-barite carbonatite from Sulphide Queen stock with pink barite and brown goethite in a tan matrix of primarily calcite, dolomite, bastnäsite, and minor quartz. (sample MP-P0913-SQ1). **B**. Coarse bastnäsite-barite carbonatite from the Birthday Vein with pink barite, tan bastnäsite, brown goethite, and white dolomite, calcite, and quartz (sample MP-L0613-BDAY2). **C**. Porphyritic bastnäsite-barite carbonatite with pink barite in matrix of dolomite, calcite, bastnäsite, quartz, and Fe-oxide and/or goethite. **D**. Cm-scale bastnäsite crystals in carbonatite with fine-grained matrix from Birthday Vein. **bst = bastnäsite**.

strict sense. Some workers have reported significant amounts of other silicate minerals, such as aegirine, biotite, titanite, and thorite (Olson et al., 1954), although only one carbonatite sample in this study contained silicate minerals (sodic amphibole and zircon, sample MP-P0913-1B). (See Appendix A for detailed sample mineralogy).

3.2.4 Secondary Minerals

Accessory phase mineralogy in the alkaline and carbonatite intrusions is diverse, but this diversity is due in large part to secondary alteration, and is not a primary magmatic feature. Stoeser (2013) described a conspicuous, sub-solidus alteration texture in the Mountain Pass ultrapotassic rocks – secondary minerals noted include barite, bastnäsite, parisite, synchysite, calcite, celestite, fluorite, epidote, chlorite, potassium-aluminosilicate (after K-feldspar), and an extensive suite of REE- and Th-bearing carbonates (Stoeser, 2013). Thorite appears to be present as both a primary and secondary mineral. Barite is present as μm-scale inclusions in some primary minerals, but otherwise does not appear to be a primary phase and is present only in veins.

4. SUMMARY OF PREVIOUS GEOCHRONOLOGIC, ISOTOPIC, AND GEOCHEMICAL WORK AT MOUNTAIN PASS

Nearly all workers who have published on the MPIS agree that the carbonatite and alkaline rocks are genetically related based on field relationships and similar geochemical characteristics (e.g. Olson et al., 1954; Woyski, 1980; Haxel, 2005; Haxel, 2007; Castor, 2008). Haxel (2005, 2007), through whole-rock geochemical data and in summary of previous work, invoked a small degree (~0.01-0.1%) of partial melting of highly enriched lithospheric mantle to produce shonkinite magma in order to explain the petrologic relationships in the MPIS. He considered shonkinite the primitive endmember that gave rise to the more silicic rock types (syenite, quartz syenite, granite) in the complex. The relatively high abundance of compatible elements (e.g. Cr, Ni) but distinctively lower contents of Al, Ca, and Na of shonkinite in comparison to other primitive mafic rocks was interpreted to indicate derivation from harzburgitic peridotite that had previously been depleted in Al, Ca, and Na through extraction of basaltic magma (Haxel, 2007). These geochemical characteristics coupled with extreme enrichment in incompatible elements (e.g. K, Ba, LREE) in MPIS rocks require that the depleted source was re-enriched, potentially by metasomatism (Haxel, 2007). However, Haxel (2005, 2007) does not offer a scenario in which the carbonatite is directly derived from shonkinite magma, largely due to the implications of the geochronologic data reported by DeWitt et al. (1987, 2000). On the other hand, Castor (2008) viewed the spatial association and similar geochemistry of the ultrapotassic rocks and carbonatites as “compelling” evidence for a common parental magma.

In spite of the petrologic relationships in the MPIS, the available geochronologic data do not support the notion that the ultrapotassic rocks and carbonatites may have differentiated from a common parental magma. Early attempts to determine ages of the MPIS yielded data that were too imprecise to critically evaluate the absolute timing of the various intrusive phases (Jaffe, 1955; Lanphere, 1964; Appendix B). Jaffe (1955) used alpha-counting and total-lead methods to measure dates of 840 Ma for zircon in shonkinite, and 950 Ma for monazite in carbonatite. Lanphere (1964) measured K-Ar and Rb-Sr dates in biotite ranging from 1440 ± 35 to 1385 ± 35 Ma for shonkinite, and a Th-Pb date in monazite of 1436 ± 71 Ma for carbonatite.

More recent data reported by DeWitt et al. (1987, 2000) and Premo et al. (2013) are sufficiently precise for age comparison between the ultrapotassic rocks and carbonatite, but are difficult to evaluate – they are simply reported as dates with uncertainties in conference abstracts, and additional information necessary to directly compare the dates such as which decay constants were used, which monitor standards were employed, how measurements were collected (e.g. thermal ionization mass spectrometry [TIMS] or secondary ionization mass spectrometry [SIMS]), and what sources of uncertainty are included in the quoted data are not presented. DeWitt et al. (1987, 2000[1]) reported $^{40}Ar/^{39}Ar$ dates of 1400 ± 8 Ma and 1403 ± 7 Ma from phlogopite and arfvedsonite in syenite and shonkinite, respectively; apatite from shonkinite yielded a U-Pb date of 1410 ± 2 Ma; monazite from carbonatite yielded a Th-Pb date of 1375 ± 7 Ma. Zircon from the syenite were reportedly highly discordant with respect to U-Pb, and bastnäsite and parisite from carbonatite contained abundant common Pb; both yielding dates that the authors considered "anomalously young" (~1330 Ma and younger). DeWitt et al. (1987, 2000) interpreted these dates to suggest emplacement of carbonatite ~25 m.y. after crystallization of the ultrapotassic intrusive rocks.

Premo et al. (2013) reported zircon U-Pb SIMS dates from shonkinite, syenite, and granite that overlap from 1410-1422 Ma, supporting the interpretations of DeWitt et al. (1987, 2000), but did not specify whether there was a statistically distinguishable age difference between rock types (Appendix B). Premo et al. (2013) also reported apparent Ti-in-zircon thermometry temperatures ranging between 780 and 933 °C. Gleason et al. (1994)

[1] DeWitt et al. (2000) reported identical dates to those in DeWitt et al. (1987), but it is unclear whether or not these are based on the same dataset.

measured U-Pb TIMS dates of zircon in the Barrel Spring Pluton, an occurrence of ultrapotassic rocks in the Piute Mountains ~90 km SSE of Mountain Pass (Fig. 5), and reported only discordant analyses that gave a single upper intercept age of 1419.2 ± 3.4 Ma.

In addition to age data, S, Pb, Sr, and Nd isotopic data have been reported for the MPIS. However, like the geochronologic data, most of these isotopic data are reported solely in abstracts that do not include data tables, methods, uncertainties, or contextual information. Nevertheless, DeWitt et al. (2000) used S isotopes to suggest either low-temperature crystallization of barite in the carbonatite, or re-equilibration between barite and galena in an oxidizing environment. Premo et al. (2013) reported whole rock $\varepsilon Nd_{(i)}$ values ranging from -1.5 to -6 from the ultrapotassic rocks and carbonatite. In both studies, the authors interpreted Pb, Sr, and Nd isotopes to indicate derivation from a hybrid source, either from enriched lower crust and/or enriched mantle. DeWitt et al. (2000) also noted that only the youngest shonkinite dikes at Mountain Pass have the same Nd isotopic signature as the carbonatite.

Based on their U/Th-Pb data, DeWitt (1987, 2000) and Premo (2013) concluded that, although the various intrusive phases in the MPIS appear to be closely inter-related by other, dominantly petrologic, lines of evidence, the rock types of the MPIS were not contemporaneous. In this study, new geochronologic and geochemical data on ultrapotassic and carbonatite rocks at Mountain Pass indicate previously unrecognized synchroneity in U/Th-Pb dates from accessory minerals in the both ultrapotassic rocks and carbonatite, suggesting up to three temporally distinct phases of magmatism.

5. METHODS

5.1 Overview

In this study, new U/Th-Pb, trace element, isotopic, and textural data are reported from a suite of U- and/or Th-bearing accessory minerals from 23 Mountain Pass shonkinite, syenite, and carbonatite samples and three metamorphic host rock samples. Additionally, whole-rock geochemical data are reported for 14 ultrapotassic rock samples and one carbonatite sample. Zircon, titanite, monazite, apatite, bastnäsite, and rutile were analyzed, but only zircon, titanite, and monazite provided useful age information; thus, only trace element and/or isotopic data are reported for apatite, bastnäsite, and rutile. U/Th-Pb and trace elements were measured simultaneously using laser ablation split-stream inductively coupled plasma mass spectrometry (LASS-ICPMS) at the University of California, Santa Barbara. Zircon data were acquired during seven separate analytical sessions, monazite data over four sessions, rutile data over one session, and titanite, apatite, and bastnäsite data over two sessions each.

5.2 Sample Collection and Selection

3-4 kg of each sample was hammered from relevant outcrops (e.g. Figs. 4A-4E) in fist-sized pieces. Care was taken to collect the least weathered and altered samples, although in some areas (e.g. Mineral Hill and Mexican Well stocks; Fig. 2), alteration is pervasive and not easily avoided. Thin sections of 23 samples were prepared by Spectrum Petrographics. 22 MPIS and three host rock samples were selected for mineral separation and analysis as broadly representative of the MPIS and the gneissic host rocks, based on cross-cutting relationships, lithology, and spatial context (see Appendix C for summary of samples and sample locations).

5.3 Accessory Minerals

5.3.1 Mineral Separation

To prepare for LASS-ICPMS, ~2-3 kg of each sample was first crushed in a jaw crusher to ~1-2 cm. This material was then sieved to isolate particles < 425 μm. For fine-grained rocks, material > 425 μm was then crushed in a disc mill to coarse-sand-sized particles and sieved again. Relatively dense accessory minerals such as titanite and zircon were separated from the < 425 μm fraction of the bulk samples by density separation in a gold pan or Rodgers table, and then in heavy liquid (methylene iodide, ρ=3.32 g/cc). Minerals were subsequently separated by magnetic susceptibility using a Frantz isodynamic separator. Zircon and apatite were typically recovered in the least magnetic fraction, and titanite, rutile, and metamict zircon from the second least magnetic fraction. Monazite and bastnäsite showed moderate magnetic susceptibility and were recovered in the second most magnetic fraction. 30-50 grains of each mineral, if present, was picked by hand under a microscope, mounted in 1-inch diameter epoxy pucks, and polished to a 0.25 μm (titanite, monazite, apatite, bastnäsite) or 1 μm (zircon, rutile) finish.

5.3.2 U/Th-Pb

Backscatter-electron (BSE) and cathodoluminescence (CL) images of the samples were collected in the UCSB Earth Science electron-beam laboratory using scanning electron microscopy (SEM) to provide textural context for LASS-ICPMS spot analysis placement. Additionally, the SEM was used to locate grains of interest in thin sections, identify phases, and study textural relationships.

Mineral analyses were carried out using laser-ablation split-stream inductively coupled mass spectrometry (LASS-ICPMS) at UCSB. Samples were analyzed either in epoxy grain mounts (as described above) or in thin section. UCSB's LASS-ICPMS system combines a Photon Machines 193 nm ArF Excimer laser and Hel-Ex ablation cell with a Nu Instruments HR Plasma high-resolution multi-collector (MC) ICPMS for collecting U-Pb data and an Agilent 7700S quadrupole (Q) ICPMS for collecting major and trace element data. Methods follow those outlined by Kylander-Clark et al. (2013), except that trace elements were measured via Q-ICPMS rather than single-collector ICPMS, and are briefly described here. Different laser run conditions were used for each mineral depending on expected U, Th, and Pb content, varying from 9-40 µm spot size, 3-7 mJ laser power at 75-100%, laser frequency 3-4 Hz, and 80-120 shots per analysis (Appendices N-R, X & Y). Bastnäsite was analyzed using line scans 25 µm wide and 100 µm long, and was ablated with a travel rate of 4 µm/second. Before each ablation period, the laser was fired twice to remove contamination from the surface of the analyte, followed by an eight-second delay to permit sample washout. Ablation rate is typically ~1 µm/10 laser shots, corresponding to a final ablation pit depth of ~8-12 µm (Kylander-Clark et al., 2013). Masses ^{204}Pb+Hg, ^{206}Pb, ^{207}Pb, and ^{208}Pb were measured on ion counters, and ^{232}Th and ^{238}U were measured on Faraday detectors. 20-40 analyses were performed per sample on average, according to the availability of the mineral of interest per sample. Every set of eight sample analyses was bracketed by an analysis of a primary and at least one secondary natural reference material of the same mineral type as the unknowns. Bastnäsite is the only exception, due to the lack of a widely distributed and/or well-characterized bastnäsite reference material; therefore, zircon and monazite were used as reference materials for bastnäsite. Line scans were used rather than spot analyses to analyze bastnäsite in order to avoid problems arising from differences in downhole inter-element fractionation between bastnäsite and the zircon and monazite reference materials.

Raw U/Th-Pb and trace element data were reduced using Igor Pro 6.35A5 data reduction software with the Iolite v2.5 plugin (Paton et al., 2011). In Iolite, baseline signal intensity is subtracted from the analyses, and baseline drift over the run period is modeled after user-selected time-slices in the measured signal waveform. Using the baseline and primary reference material analyses, the measured ratios in the unknowns are corrected for instrument drift, laser-ablation-induced down-hole elemental fractionation, and plasma-induced elemental fractionation. Information about the primary reference materials used is provided in Table 1. External uncertainty was added in quadrature, and was assigned to sample isotopic ratios based on the additional error needed to produce a mean square weighted deviation (MSWD) ~1 in a population (n > 9) of secondary reference material analyses from the same analytical session. Secondary reference materials were treated as unknown samples and used to monitor accuracy and internal reproducibility from run to run, and between analytical sessions. Information about the secondary reference materials used is provided in Table 1, and data collected from the titanite and zircon secondary reference materials is shown below (Figs 8A-8D).

$^{206}Pb/^{238}U$ typically required the addition of ~1-1.5% external error to produce MSWD $\leq$ 1. Additional $^{206}Pb/^{238}U$ variation in isotopically homogeneous secondary reference materials is attributed to counting statistics and variation in signal strength (Spencer et al., 2013). Laser energy has been observed to fluctuate by up to ~3% throughout a run, and likely accounts for some variation in signal strength (Cottle et al., 2012; Kylander-

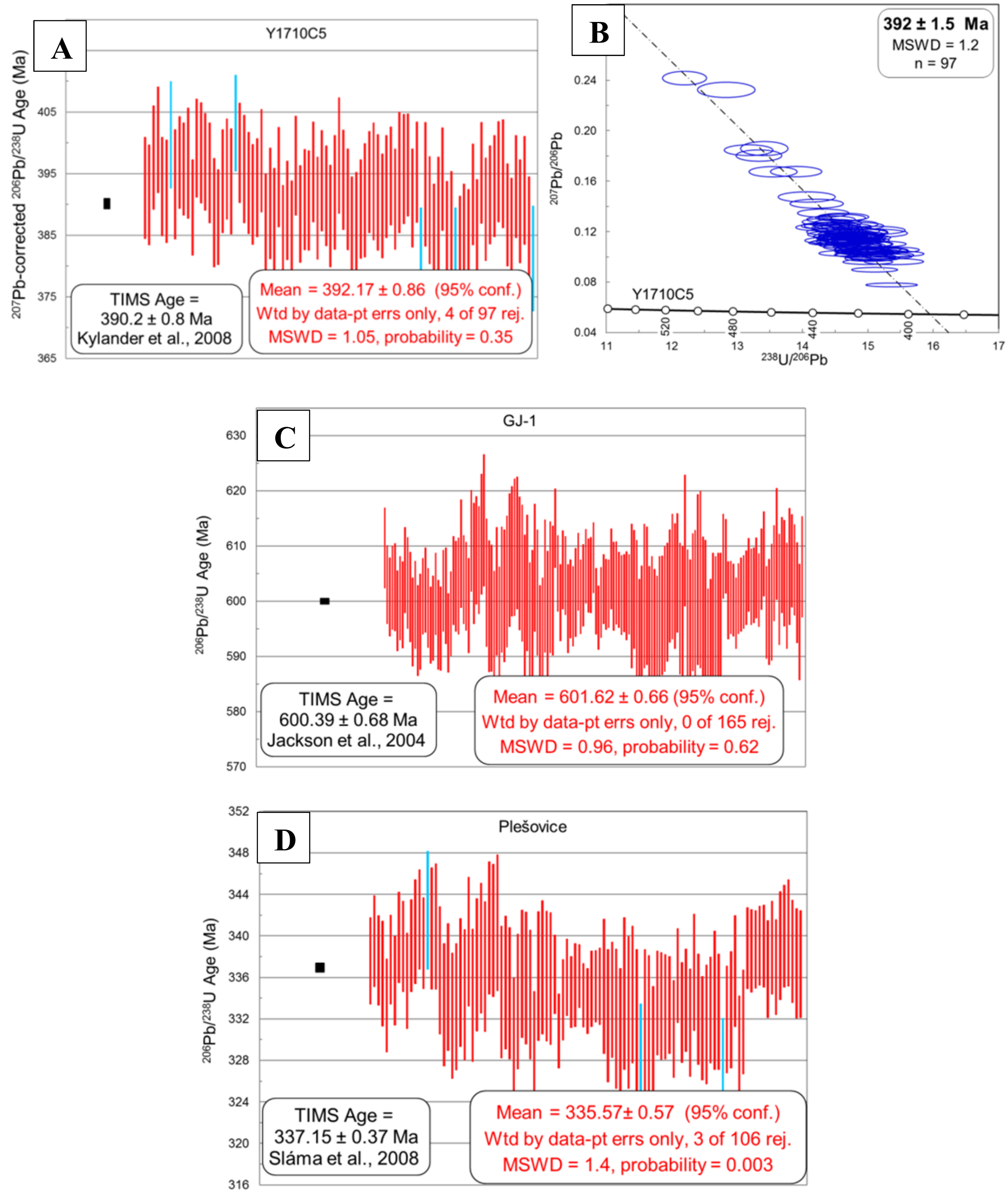


Figure 8 – U-Pb data from titanite and zircon secondary reference materials measured in this study. **A**. Tera-Wasserburg U-Pb Concordia plot of analyses from secondary reference titanite "Y1710C5." **B**. Weighted mean plot of ^{207}Pb-corrected ^{206}Pb/^{238}U dates from secondary reference titanite "Y1710C5." **C**. Weighted mean plot of ^{206}Pb/^{238}U dates from secondary reference zircon "GJ1." **D**. Weighted mean plot of ^{206}Pb/^{238}U dates from secondary reference zircon "Plešovice."

Clark et al., 2013). $^{207}Pb/^{206}Pb$ measurements usually required addition of <1% uncertainty. However, long-term $^{207}Pb/^{206}Pb$ reproducibility for this lab and setup is reportedly 1.5-2% (e.g. Kylander-Clark et al., 2013; Spencer et al., 2013); thus, 1.5% external uncertainty has been added to all unknown $^{207}Pb/^{206}Pb$ ratios to account for long-term accuracy.

To calculate dates and associated uncertainties, U-Pb data were plotted on Tera-Wasserburg diagrams using the Isoplot 4.1.xla plugin for Microsoft Excel (Ludwig, 2012). Titanite ages reported here are U-Pb isochron dates derived from Tera-Wasserburg plots. ^{207}Pb-corrected $^{206}Pb/^{238}U$ dates have also been included for completeness. Zircon dates are U-Pb Concordia dates derived from Tera-Wasserburg plots for samples that yield MSWD < $1+2(2/f)^{1/2}$, where f = n-2 (Wendt & Carl, 1991). For samples that do not yield a Concordia age that meet this criterion, reported ages are weighted means of $^{207}Pb/^{206}Pb$ dates calculated from the corresponding isotopic ratios measured in the sample. Zircon dates were calculated using only data that are < 3% discordant; percent discordance was calculated as the percent difference between the $^{207}Pb/^{206}Pb$ and $^{206}Pb/^{238}U$ dates from the corresponding isotopic ratios measured in the sample.

Due to the low U and high common ^{206}Pb concentrations of all monazite samples measured in this study, U-Pb ratios (and therefore dates) have poor precision and do not generate geologically meaningful U-Pb ages. Thus, all reported monazite ages are common-Pb-corrected $^{208}Pb/^{232}Th$ dates. Correction was applied according to the following steps: **1)** raw ^{232}Th, ^{208}Pb, and ^{204}Pb+Hg signals were corrected for instrumental drift and mass bias in Iolite v2.5 (Paton et al., 2011). **2)** Percent common ^{208}Pb in the ^{208}Pb signal was calculated based on the $^{208}Pb/^{204}Pb$ at an assumed age of 1400 Ma from the Stacy & Kramers (1975) model of Pb evolution (calculated using the “singlestagepbr” function in Isoplot) and the mass-204 signal. It is worth noting that changes up to ~100 Ma in the $^{208}Pb/^{204}Pb$ reference age did not significantly change the final $^{208}Pb/^{232}Th$ date (< 1 Ma). **3)** Radiogenic ^{208}Pb ($^{208}Pb^*$) was calculated by subtracting the common ^{208}Pb from the total measured ^{208}Pb. **4)** Resulting $^{208}Pb^*/^{232}Th$ ratios were used to calculate $^{208}Pb/^{232}Th$ dates using the "agepb8th2" function in Isoplot.

Uncertainties were calculated using the same method as was used to calculate uncertainty for $^{206}Pb/^{238}U$ and $^{207}Pb/^{206}Pb$ ratios as described above, with an additional 1% added in quadrature for uncertainty on the $^{208}Pb/^{204}Pb$ ratio from the Stacy & Kramers (1975) model. Measured $^{208}Pb/^{232}Th$ ratios of the reference materials typically required addition of ~3% uncertainty to achieve MSWD ~1. Data from the monazite secondary reference materials analyzed in this study are shown below (Figs. 9A & 9B). The mass-204 signal used to correct Th-Pb ratios was not corrected for isobaric interference of ^{204}Hg on ^{204}Pb, which may contribute to scatter or inaccuracy in the corrected Th-Pb dates. However, the possible presence of Hg in the Ar gas supply should be accounted for in the background mass-204 signal, unless the Hg is not thoroughly mixed with the Ar and fluctuates throughout the course of an analytical run. Therefore, due to the improbability of Hg presence in the analyte, the effect of neglecting this correction is considered insignificant.

5.3.3 Trace Elements

Zircon "GJ1" was used as the primary trace element reference material for zircon samples, and monazite "Stern" was used as the primary trace element reference material for monazite. SRM NIST610 reference glass was measured in conjunction with titanite, apatite, and rutile at the beginning, middle, and end of each run and used as the primary trace

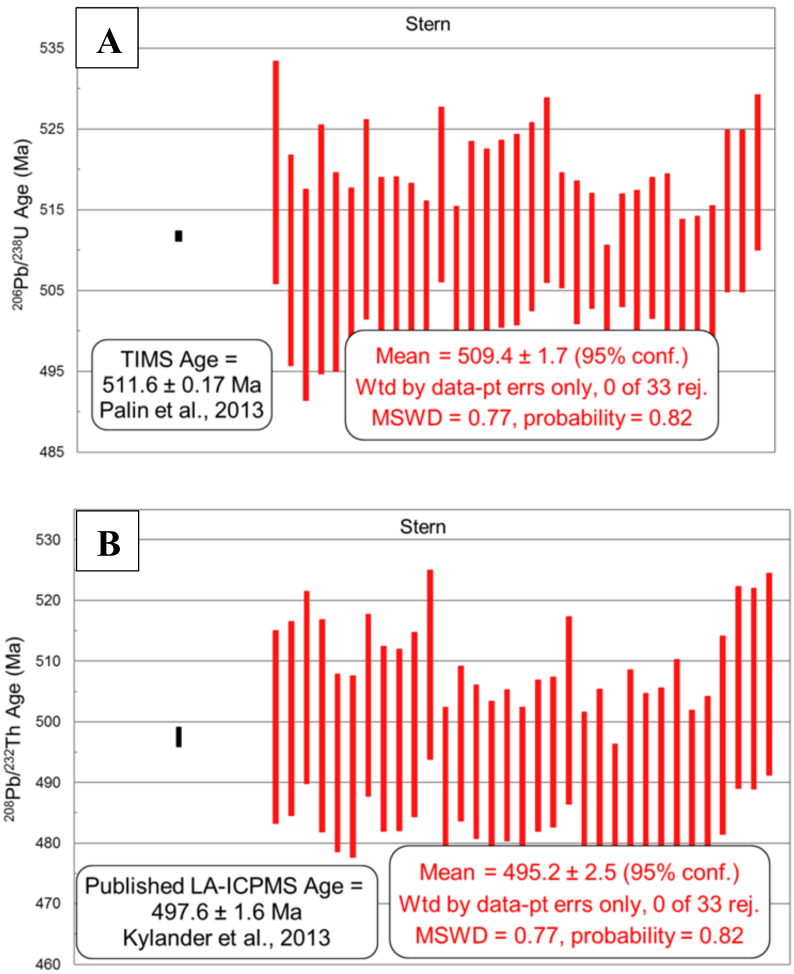


Figure 9 – U-Pb and Th-Pb data from monazite secondary reference material measured in this study. **A**. Weighted mean plot of $^{206}Pb/^{238}U$ dates from secondary reference monazite "Stern." **B**. Weighted mean plot of $^{208}Pb/^{232}Th$ dates from secondary reference monazite "Stern."

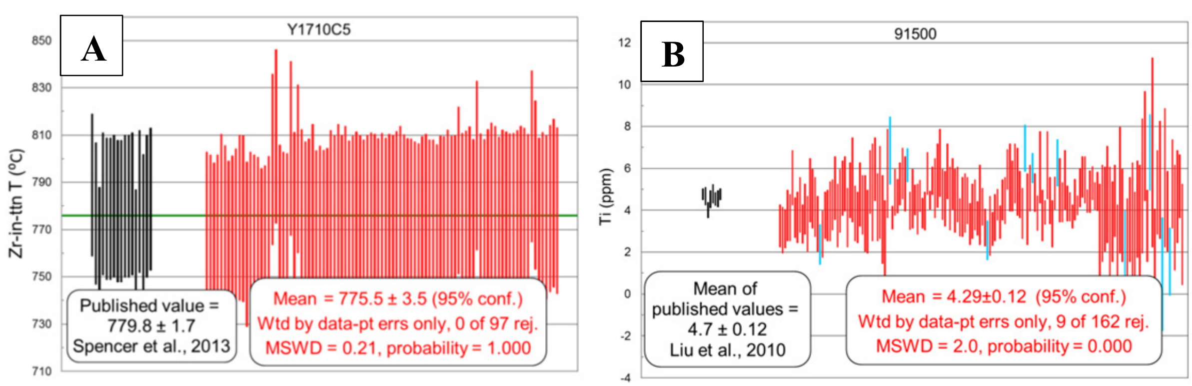


Figure 10 – Trace element data plots from titanite and zircon secondary reference materials for selected elements. **A**. Weighted mean plot of Zr-in-titanite temperatures calculated from measured Zr content in secondary reference titanite "Y1710C5." **B**. Weighted mean plot of Ti content (in ppm) measured in secondary trace element reference zircon "91500."

TABLE 1 – PRIMARY AND SECONDARY GEOCHRONOLOGY REFERENCE MATERIAL INFORMATION

Name	Mineral	ID-TIMS Age (Ma)	Data Type	Author(s)
91500	Zircon	1062.4 +/- 0.4	mean $^{206}Pb/^{238}U$ date	Wiedenbeck et al., 1995; 2004
BLR	Titanite	1047.1 +/- 0.4	mean $^{206}Pb/^{238}U$ date	Aleinikoff et al., 2007
44069	Monazite	425.3 +/- 1.1	mean $^{206}Pb/^{238}U$ date	Aleinikoff et al., 2006
Madagascar	Apatite	486.58 +/- 0.85*	mean $^{206}Pb/^{238}U$ date	Thomson et al., 2012
R10	Rutile	1091.6 +/- 3.5	mean $^{206}Pb/^{238}U$ date	Luvizotto et al., 2009

Secondary Reference Materials

GJ1	Zircon	600.39 +/- 0.68[a]	mean $^{206}Pb/^{238}U$ date	Jackson et al., 2004
Plešovice	Zircon	337.13 +/- 0.37[a]	mean $^{206}Pb/^{238}U$ date	Sláma et al., 2008
Y1710C5	Titanite	390.2 +/- 0.8[a]	mean $^{206}Pb/^{238}U$ date	Kylander-Clark et al., 2008
Stern (a.k.a. Bananeira)	Monazite	511.6 +/- 0.71[a]	mean $^{206}Pb/^{238}U$ date	Palin et al., 2013
Stern (a.k.a. Bananeira)	Monazite	497.6 +/- 1.6[b]	mean $^{208}Pb/^{232}Th$ date	Kylander-Clark et al., 2013
Manangotry	Monazite	555 +/- 7.8[a]	mean $^{206}Pb/^{238}U$ date	Palin et al., 2013
McClure Mountain	Apatite	523.51 +/- 2.07[a]	mean $^{207}Pb/^{235}U$ date	Schoene & Bowring, 2006
Durango	Apatite	31.02 +/- 1.01 (1σ)	mean (U-Th-Sm)/He date	McDowell et al., 2005

* age used to standardize data in this study for reference material for which the ID-TIMS age is reported as > 1 value

[a]ID-TIMS age

[b]LA-ICPMS age, as standardized with "44069" monazite

element reference material. Secondary trace element reference materials used are the same as the primary U-Pb reference materials, except for titanite (Y1710C5 used). Trace element data were reduced using the "trace elements" data reduction scheme in Iolite v2.5 (Paton et al., 2011). Zircon and monazite trace element data were reduced using the "semi-quantitative" standardization method of Iolite. Ca was used as an internal standard for titanite and apatite, and Ti was used as an internal standard for rutile; these values were assumed stoichiometric and were not measured by another method. These standardization schemes reproduced values in the secondary reference materials to within 10% or less for most trace elements (Figs. 10A & 10B). REE plots are normalized to chondrite concentrations of McDonough & Sun (1995). Ti-in-zircon apparent temperatures were calculated using the thermometer of Ferry & Watson (2007), Zr-in-titanite temperatures are calculated using the thermometer of Hayden et al. (2008), and Zr-in-rutile temperatures were calculated using the thermometer of Tomkins et al. (2007). Uncertainties propagated into thermometry temperatures are internal 2 standard error (SE), and were calculated by Iolite. Temperatures quoted here are weighted means calculated by Isoplot 4.1.xla (Ludwig, 2012), or are a range of values from non-single-population groups of analyses. Thermometry data collected from titanite and zircon secondary trace element reference materials are shown below (Figs. 10A & 10B).

5.3.4 Nd Isotopes

The methods presented by Fisher et al. (2011b) for in-situ Nd isotopic analysis by LA-ICPMS were followed for this study, and are summarized here. Only titanite grains that were analyzed for U-Pb geochronology were analyzed for Nd isotopes. All minerals were ablated with 5 mJ laser energy at 100% and shot rate of 6 Hz for each analysis. Laser spot sizes used were 65 µm for titanite, 20 µm for monazite, and 15 µm for bastnäsite. Reference glasses were ablated with a spot size of 40 µm to obtain an optimal signal during monazite and bastnäsite analysis, and at 65 µm during titanite analysis. Samples were ablated for 50 seconds, with a 30-second delay between analyses to allow sample washout. Masses 141-150 were measured on 10 Faraday cups with 1-amu spacing. Data were then reduced using Iolite v2.5 (Paton et al., 2011). The data were carefully screened to detect the presence of inclusions, and portions of analyses that appeared to record measurement of inclusions were rejected during data processing.

During in-situ measurement of Nd isotopes, the isobaric interference on ^{144}Nd by ^{144}Sm has been noted to constitute between 1.5 and 4.6% of the mass-144 signal in LREE-rich minerals (Fisher, 2011b); thus, correcting this interference is vital to obtaining an accurate ^{143}Nd/^{144}Nd ratio. In addition, determination of ^{147}Sm/^{144}Nd in the sample is necessary to accurately calculate the initial ^{143}Nd/^{144}Nd of the sample. In order to make these corrections, instrumental mass bias factors for Sm and Nd must first be determined. “JNdi-1” glass was employed to evaluate Nd isotopic measurements without complication by isobaric interference (^{143}Nd/^{144}Nd = 0.512115 +/- 0.000007; Tanaka et al., 2000). “JNdi-1” doped with Ce, Pr, Sm, Eu, and Gd (“LREE” glass; Fisher et al., 2011b) was employed to provide a homogeneous ^{147}Sm/ ^{144}Nd reference material, and to evaluate Nd isotope measurements where Sm is included. ^{147}Sm/^{149}Sm was used to calculate a Sm mass bias factor, using a natural ^{147}Sm/^{149}Sm ratio of 0.22332 (Dubois et al., 1992). ^{144}Sm interference was then calculated using the measured ^{149}Sm and a natural ^{144}Sm/^{149}Sm ratio of 1.08680 (Isnard et al., 2005). For Nd mass bias determination, a natural ^{146}Nd/^{144}Nd ratio of 0.7219 was used. A canonical ^{145}Nd/^{144}Nd value of 0.348415 (Wasserburg et al., 1981) was used to monitor the accuracy of the Nd mass bias correction. ^{147}Sm/^{144}Nd was calculated using the mass-bias-corrected ^{147}Sm and the interference-corrected ^{144}Nd. Natural reference materials “Trebilcock” monazite (^{143}Nd/^{144}Nd = 0.512616 +/- 0.000011; Fisher et al., 2011b) and “Hondo Canyon” titanite (^{143}Nd/^{144}Nd = 0.512211 +/- 0.000009; Fisher et al., 2011b) were analyzed between every 10-20 unknowns and used to monitor the accuracy of the corrected ^{143}Nd/^{144}Nd and ^{147}Sm/^{144}Nd ratios. Weighted means of results for the reference materials are as follows: Trebilcock monazite – $^{143}Nd/^{144}Nd$ = .512612 ± 0.000008 (2 SE); Hondo Canyon titanite – $^{143}Nd/^{144}Nd$ = 0.512218 ± 0.00001 (2 SE), (Figs. 11A & 11B).

$\varepsilon Nd_{(i)}$ values for the samples were calculated relative to CHUR using present-day values of $^{143}Nd/^{144}Nd$ = 0.512638 and $^{147}Sm/^{144}Nd$ = 0.1967 (Jacobsen & Wasserburg, 1980). Although Jacobsen and Wasserburg (1980) report $^{143}Nd/^{144}Nd$ = 0.511836 for CHUR, the value becomes $^{143}Nd/^{144}Nd$ = 0.512638 when normalized to the commonly used $^{146}Nd/^{144}Nd$ ratio of 0.7219 (Bouvier et al., 2008). Age corrections were applied using the U-Pb ages of the samples interpreted from titanite U-Pb isochrons and zircon U-Pb Concordia plots. Uncertainties on the measured $^{143}Nd/^{144}Nd$ and $^{147}Sm/^{144}Nd$ ratios are propagated in the $\varepsilon Nd_{(i)}$ values.

5.3.5 Hf Isotopes

Methods used in this study follow those used by Hagen-Peter et al. (2015), and are summarized here. Only zircons that were analyzed for U-Pb geochronology and yielded concordant ages were analyzed for Hf isotopes. Ablation spots were placed over the original U-Pb analysis spots in order to obtain Hf compositions that correspond to the measured U-Pb age of the zircon. A laser spot size of 50 μm, 4 mJ laser energy at 100%, and a shot rate of 8 Hz were used for each analysis. Samples were ablated for 50 seconds, with a 20-second delay between analyses to allow washout. Masses 171-180 were measured on 10 Faraday cups with 1-amu spacing. Data were then reduced using Iolite v2.31 (Paton et al., 2011).

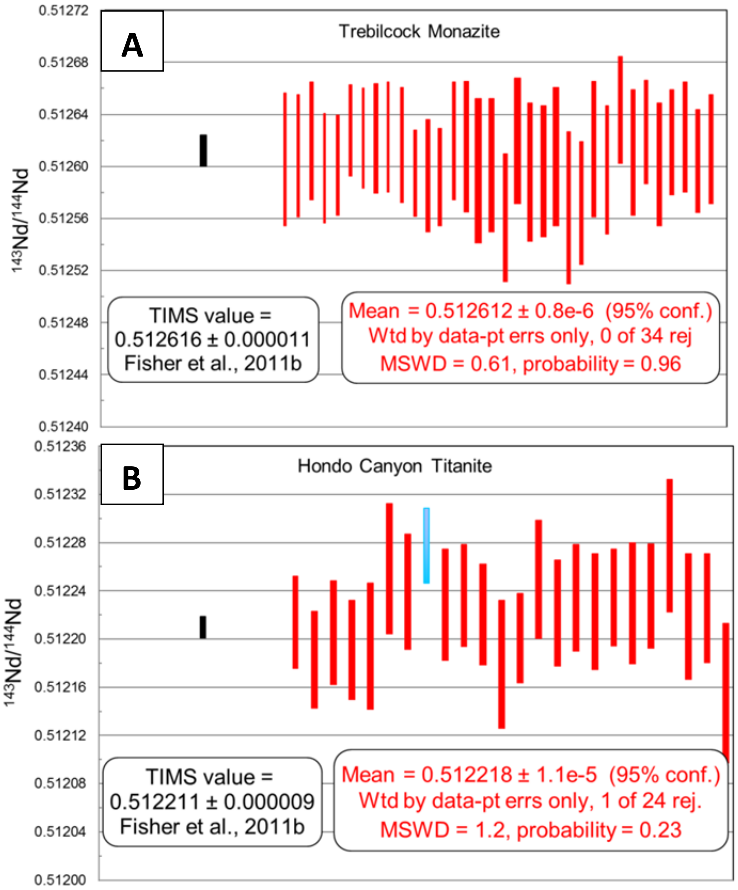


Figure 11 – Nd isotopic data plots from secondary reference materials analyzed for Nd isotopes in this study. **A**. Weighted mean plot of $^{143}Nd/^{144}Nd$ for secondary reference material "Trebilcock monazite." **B**. Weighted mean plot of $^{143}Nd/^{144}Nd$ for secondary reference material "Hondo Canyon titanite."

Three isobars of mass 176 must be taken into account in order to obtain an accurate $^{176}Hf/^{177}Hf$ ratio: ^{176}Yb, ^{176}Lu, and ^{176}Hf. ^{176}Yb correction is the most important, because ^{176}Yb has been noted to contribute ~10% of the total signal at mass 176 (Iizuka & Hirata, 2005). The ^{176}Lu isobar typically has a negligible effect of the corrected $^{176}Hf/^{177}Hf$ ratio, due to the typically low Lu/Hf ratio of zircon (<0.001; Hawkesworth and Kemp, 2006). Natural ratios of $^{176}Yb/^{173}Yb$ = 0.786847 (Thirlwall & Anczkiewicz, 2004) and $^{176}Lu/^{175}Lu$ = 0.02656 (Chu et al., 2002) were used to subtract isobaric interferences of ^{176}Yb and ^{176}Lu on ^{176}Hf. To calculate mass bias for the correction, a natural $^{173}Yb/^{171}Yb$ ratio of 1.123575 (Thirlwall & Anczkiewicz, 2004) was used for Yb, and then used to correct for Yb and Lu mass bias. A natural $^{179}Hf/^{177}Hf$ ratio of 0.7325 (Patchett & Tatsumoto, 1980; 1981) was used to calculate a mass bias factor for Hf. In order to assess the accuracy of the correction method, synthetic reference material zircons "MUN 1" and "MUN 3" ($^{176}Hf/^{177}Hf$ = 0.282140 +/- 0.000005; Fisher et al., 2011a), as well as natural reference material zircons "91500" ($^{176}Hf/^{177}Hf$ = 0.282308 +/- 0.000006; Blichert-Toft, 2008) and "Mud Tank" ($^{176}Hf/^{177}Hf$ = 0.282507 +/- 0.000006; Woodhead and Hergt, 2005) were analyzed concurrently between every five to ten unknown samples. The corrected $^{176}Hf/^{177}Hf$ values obtained were: MUN 1 and MUN 3 = 0.28214 +/- 0.000015; 91500 = 0.28230 +/- 0.000022; 91500 = 0.28230 +/- 0.000022; Mud Tank = 0.28253 +/- 0.000018 (Figs. 12A-12C). Internal uncertainties (2 SE) calculated by Iolite range from 4.5 to 8.5 εHf units, suggesting that the Iolite data reduction scheme overestimated the uncertainties. In addition, weighted means of εHf for the reference material zircons have MSWD<<1, and a more precise external reproducibility (3.5-4.5 εHf units at 2 S.D.) using the uncertainties calculated by Iolite. Thus, in order to avoid disguising possible geologic complexity in the unknown samples with high uncertainties, internal uncertainties on analyses were scaled by a factor of 0.7, such that weighted means of εHf for reference material analyses have MSWD = 1. This factor was then applied to the unknown sample uncertainties. All Hf isotopic data reported here were measured during the same analytical session, and thus the same correction factors and uncertainty estimates were applied to all samples.

$\varepsilon Hf_{(i)}$ values reported here were calculated relative to CHUR, using a present-day $^{176}Hf/^{177}Hf$ of 0.282785 and $^{176}Lu/^{177}Hf$ of 0.0336 (Bouvier et al., 2008). Age correction was applied using the U-Pb Concordia age for samples that yield a Concordia age with MSWD < 2, the mean $^{207}Pb/^{206}Pb$ age for samples that yield a U-Pb Concordia age with MSWD > 2,

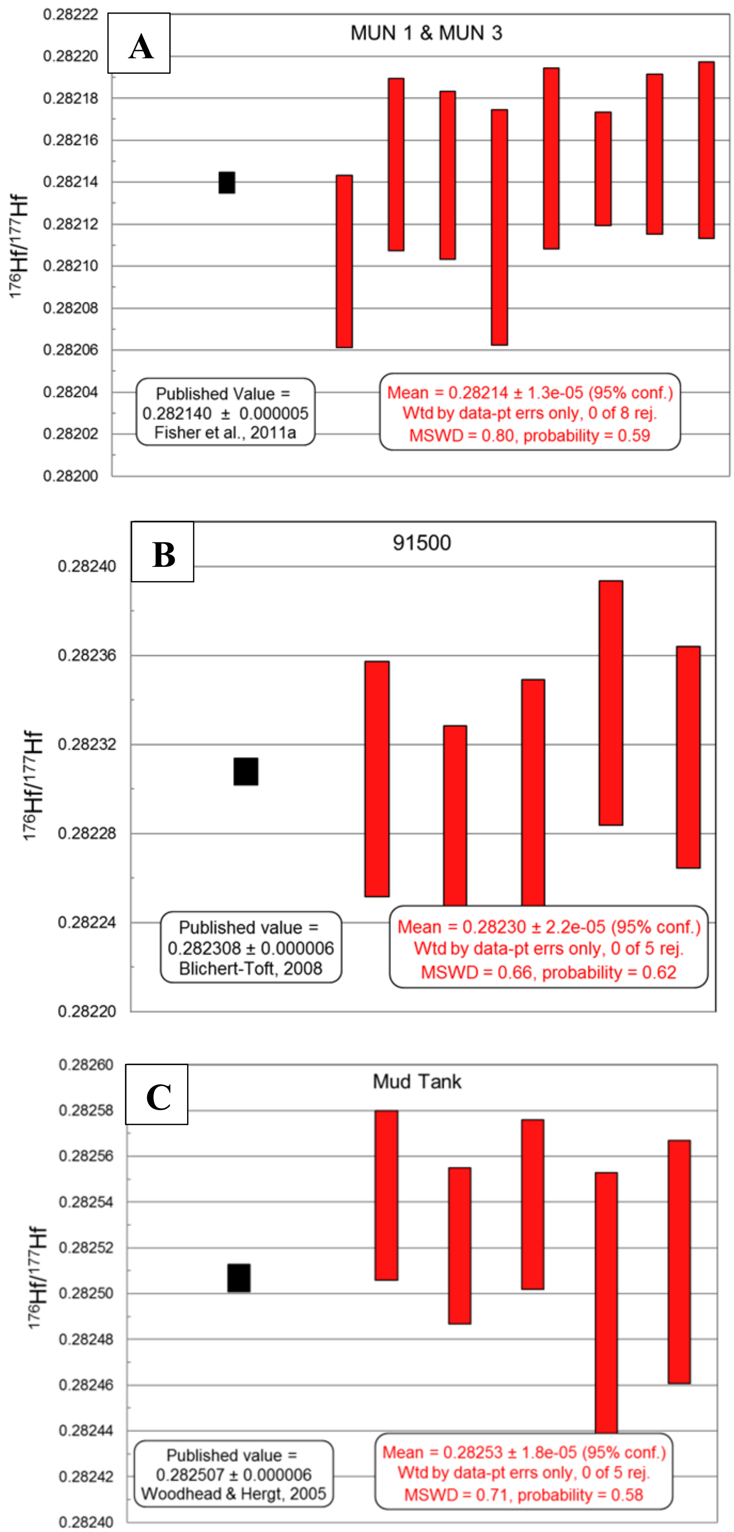


Figure 12 – Hf isotopic data from zircon secondary reference materials analyzed for Hf isotopes in this study. **A**. Weighted mean plot of $^{176}Hf/^{177}Hf$ for synthetic secondary reference zircons "MUN1 and MUN3." **B**. Weighted mean plot of $^{176}Hf/^{177}Hf$ for natural secondary reference zircon "91500." **C**. Weighted mean plot of $^{176}Hf/^{177}Hf$ for secondary reference zircron "Mud Tank."

and λ $^{176}Lu = 1.867x10^{-11}$ yr^{-1} (Scherer et al., 2001; Söderlund et al., 2004). Uncertainties on the corrected $^{176}Hf/^{177}Hf$ and $^{176}Lu/^{177}Lu$ ratios were propagated into the $\varepsilon Hf_{(i)}$ calculations.

Depleted-mantle model ages (T_{DM}) were calculated using the corrected present-day $^{176}Hf/^{177}Hf$ and $^{176}Lu/^{177}Hf$ for each sample. For depleted-mantle parameters, a present-day $^{176}Hf/^{177}Hf$ of 0.28325 was used, a value similar to average MORB (Nowell et al., 1998; Griffin et al., 2000; Griffin et al., 2002), and a present-day $^{176}Lu/^{177}Hf$ value of 0.0384 (Griffin et al., 2000). Two-stage depleted-mantle model ages (T_{DMC}) were calculated using the same depleted mantle parameters and a crustal average $^{176}Lu/^{177}Hf$ of 0.015 (Griffin et al., 2002) for the evolution of the crustal magma source after it separated from the depleted mantle (Hagen-Peter et al., 2015).

5.4 Whole-rock Geochemistry

Samples for whole-rock analysis were selected as representative of the range of rock types in the MPIS, with emphasis on those that contained accessory minerals that produced useful U-Pb age data. ~0.5 to 0.75 kg of the least weathered/altered portions of each sample was first gently hammered into 1-2 cm fragments and powdered in a tungsten carbide (WC) ring mill for 1-2 minutes and thoroughly mixed. More material was powdered for coarse-grained samples to ensure accurate representation of sample mineralogical composition. 3.5 ± 0.0001 grams of each sample was then weighed and combined with 7 ± 0.0001 grams of lithium tetraborate flux for a sample to flux ratio of 2:1, and thoroughly mixed. Sample/flux mixtures were then poured into graphite crucibles and heated at 1000 ^{0}C in a furnace for 30-40 minutes to ensure complete melting. The resulting glass beads were then re-powdered in a WC ring mill to achieve optimal homogenization, and re-fused at 1000 ^{0}C for an additional

30-40 minutes. The final glass bead was polished to a ~15 micron finish, and 2-3 mm chips were then cut from the beads for trace element analysis. The chips were mounted in a 1-inch diameter epoxy puck and polished to a 1 micron finish. Whole-rock major elements were measured via x-ray fluorescence (XRF) spectrometry at Cal Poly Pomona at Pomona, California using a PanAlytical Axios wavelength-dispersive system equipped with a standard set of crystals and a duplex detector for increased accuracy and precision of the transition metals. Instrument calibration and sample preparation methods are the same as those used by the Washington State University Geoanalytical Laboratory.

Whole-rock race elements were measured using laser-ablation quadrupole inductively coupled plasma mass spectrometry (LA-Q-ICPMS) at UCSB. Samples were ablated using line scans 50 μm wide by 250 μm long at a rate of 4 μm/second for ~2 minutes of data each. Three line scans were performed on each sample. USGS whole-rock reference materials Atho-G, BHVO-2, AGV-2, ML3B, StHs 6/80, BCR-2, GOR132, and T-1 were measured at the beginning and end of the analytical session, with Atho-G and AGV-2 measured between every 9 unknowns. Atho-G was used as the primary reference material and AGV-2 as the secondary reference material to assess accuracy of the measurements of each element individually. Three analyses were performed on each sample to assist in the recognition of outliers; the reported values are the arithmetic mean of the three values. LA-Q-ICPMS data were reduced using the “Trace Elements IS” data reduction scheme in Iolite v2.5 (Paton et al., 2011). Ca content was measured by XRF, and was used as the internal elemental standard. Elements reported here were reproduced within less than 10% of the accepted values for AGV-2, except for Cs, Tb, Pb, and U (13.5%, 10.5%, 14.4%, and 10.9% difference from accepted values, respectively; Fig. 13).

6. RESULTS

6.1 Whole-Rock Geochemistry

Whole-rock analyses of 14 ultrapotassic rock samples show enrichment in LREE by ~500x to 1000x chondritic values, and in HREE by ~10x to 50x chondritic values – La/Yb varies from 18 to 174, but for most samples La/Yb = 60 to 100 (Fig. 14). Chondrite-normalized REE patterns thus show a steep LREE to HREE slope, and do not possess a significant Eu anomaly. As previous studies have shown (Haxel, 2005; Castor, 2008), carbonatite from the MPIS is highly enriched in LREE, containing about 500,000x chondritic values (La/Yb ~ 15,000; Fig. 14). In the ultrapotassic rocks, Ti, Fe, Mn, Mg, Ca, and P oxide content decrease with increasing silica content, and Al and Na oxide content increase with increasing silica content (Figs. 15A-15F). K does not show a notable trend (Fig. 15G). Compatible trace elements such as Cr, Ni, and V decrease with increasing silica content (Figs. 16A & 16B). Incompatible trace elements such as Sr, Ba, and LREE also decrease with decreasing silica content (Figs. 16C-16E). The HREE, high-field-strength elements (HFSE, e.g. Zr, Nb, and Ta) and actinides (Th, U) do not show demonstrable trends with silica content, with the exception of Sc (Figs. 16F-16H).

6.2 Titanite Textures, U-Pb, Trace Elements, and Nd Isotopes

Titanite is present in most fresh ultrapotassic rock samples collected at Mountain Pass as transparent, euhedral to subhedral, dark rootbeer brown to golden yellow crystals up to ~2mm (Fig. 17A). Late, interstitial grains are most common in coarse-grained samples, and euhedral matrix grains are typical in fine-grained samples, although euhedral grains also occur in coarse-grained samples (Figs. 17B & 17C). Titanite grains in some samples contain

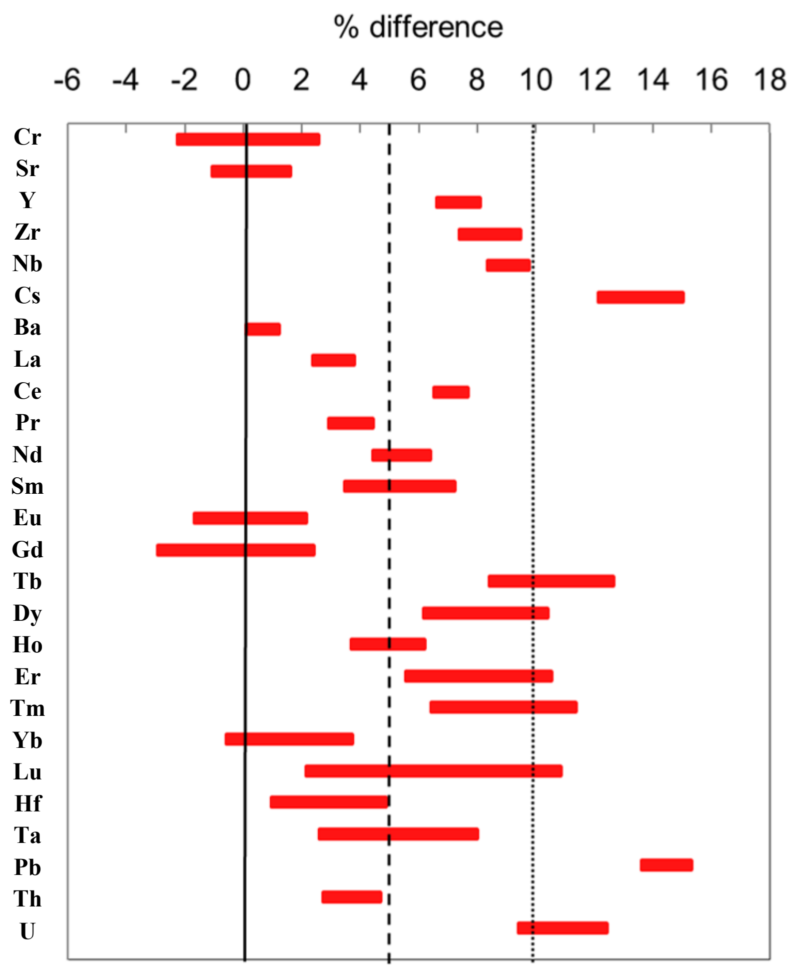


Figure 13 - Percent difference chart for secondary whole-rock trace element standard AGV-2 – percent difference was calculated as the percent difference between values measured in this study by LA-Q-ICPMS and certified values for AGV-2.

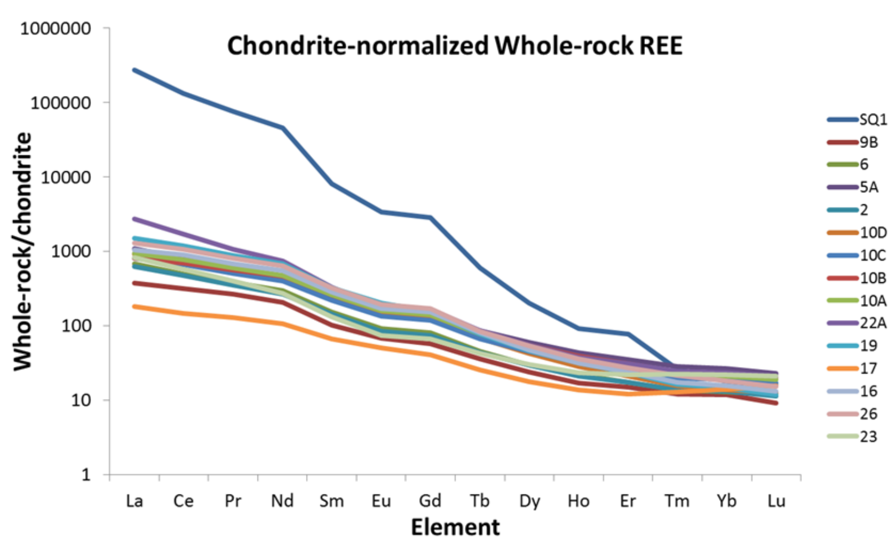


Figure 14 – Chondrite-normalized REE plot for all whole-rock samples analyzed in this study.

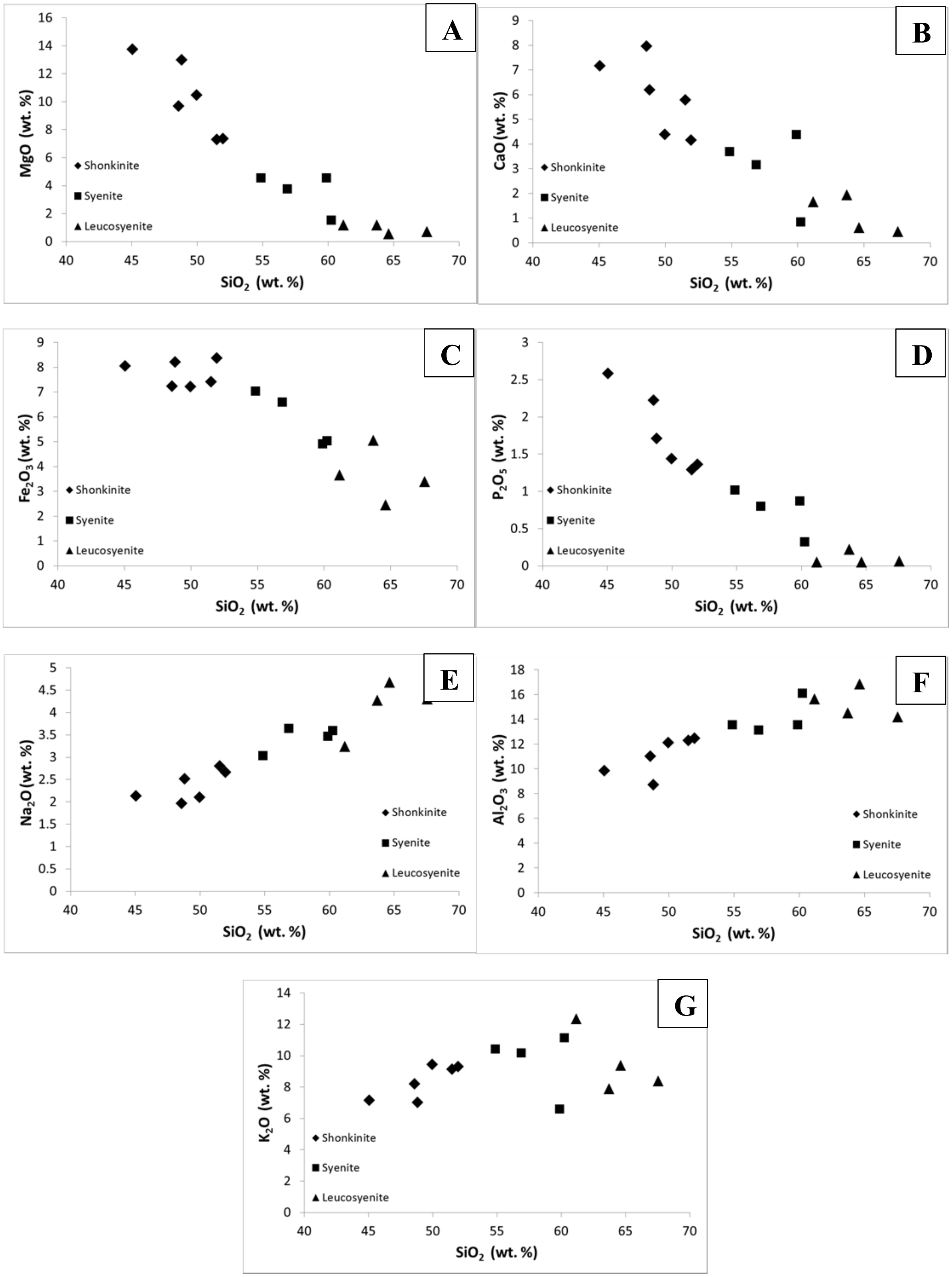


Figure 15 – Major element oxide vs. silica content plots for selected elements from MPIS ultrapotassic rocks. Diamonds are shonkinite, squares are syenite, triangles are leucosyenite.

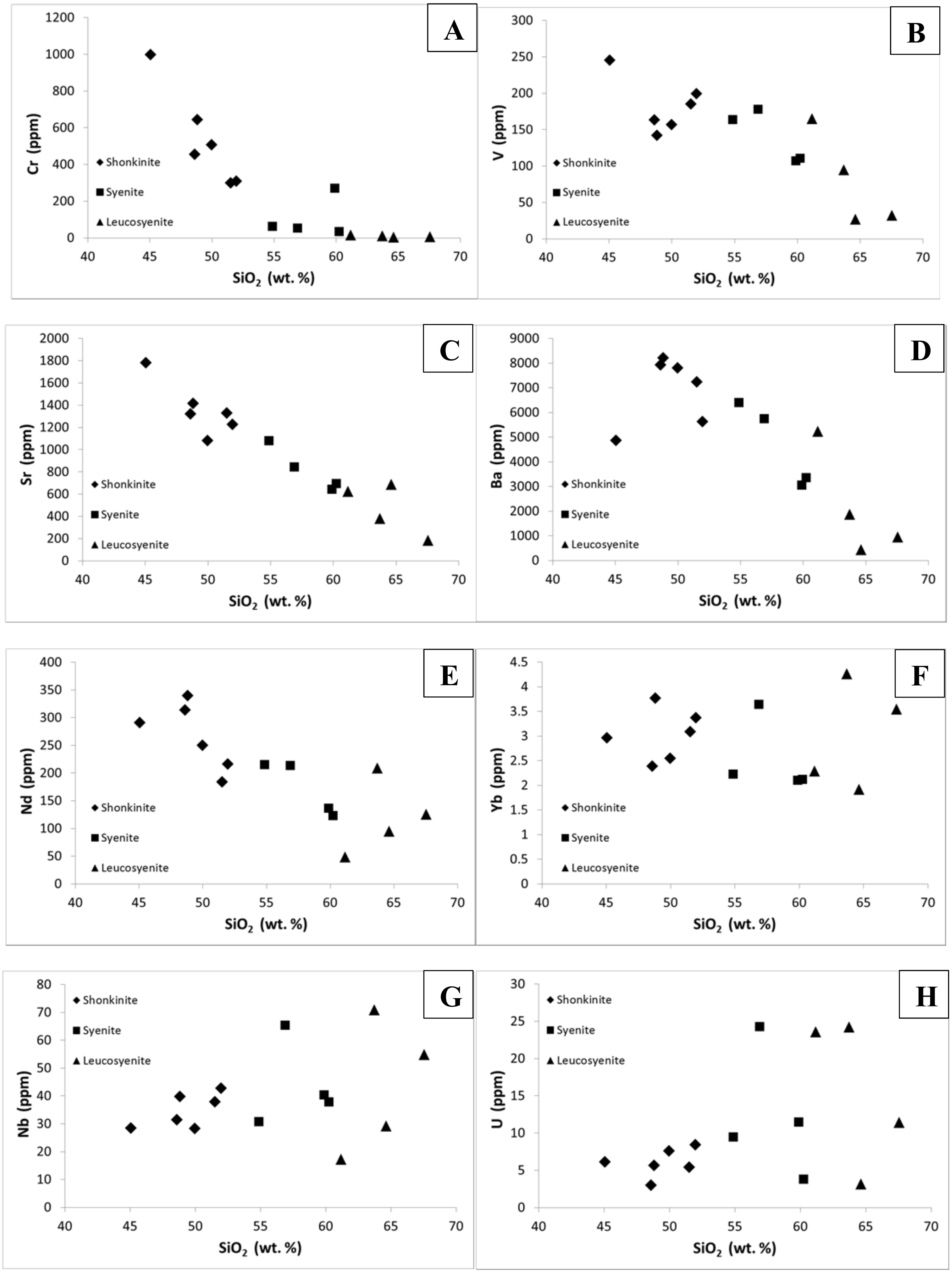


Figure 16 – Whole-rock trace element vs. silica plots for selected elements from MPIS ultrapotassic rocks. Diamonds are shonkinite, squares are syenite, and triangles are leucosyenite.

inclusions of clinopyroxene or apatite (Fig. 17C). Backscatter electron (BSE) imaging reveals no obvious zoning in the majority of samples. However, in some titanite grains (e.g. MP-P0714-19), zoning defined by weak contrast in mean atomic number (Z) is apparent (e.g. Fig. 17D). Monazite inclusions ≤ 2 μm occur in veins in some grains, and are most common in samples that show evidence for alteration and/or contain partially broken-down titanite (Fig. 17E). Where identified, specific zones were targeted for LASS and Nd analysis, but no consistent age or trace element pattern with respect to zonation was observed. Similarly, core and rim regions of grains are indistinguishable in terms of their age, trace element and Nd isotopic composition.

Titanite LASS-ICPMS U-Pb data are plotted on Tera-Wasserburg Concordia diagrams (Fig. 18) and lower intercept dates were calculated from unanchored isochrons (i.e. no upper intercept or theoretical $^{207}Pb/^{206}Pb$ common-lead value is assigned in order to avoid introduction of any systematic bias in the data due to selection of an incorrect $^{207}Pb/^{206}Pb$ common-lead value). Anchoring the upper intercept does not significantly change the calculated lower-intercept age. In 10 samples, analyses consistently yield single-population (i.e. mean square weighted deviation [MSWD] ~1) U-Pb isochrons, which range from 1429 ± 10 to 1385 ± 18 Ma (Figs. 18A & 18B, Appendix D). One sample has relatively little spread in U/Pb and $^{207}Pb/^{206}Pb$ ratios, leading to a relatively imprecise isochron date of 1358 ± 71. Two samples have MSWDs = 1.7, suggesting that they do not represent a single age population and yield apparent "errorchrons" of 1410 ± 17 and 1367 ± 9 (samples MP-P0714-16 and MP-P0714-26; Figs. 18C & 18D). However, subdividing the analyses into two groups based on their relative positions in Tera-Wasserburg U-Pb space gives single-population dates of 1413 ± 16 (n = 25, MSWD = 0.6) and 1395 ± 25 Ma (n = 8, MSWD = 0.2) in MP-

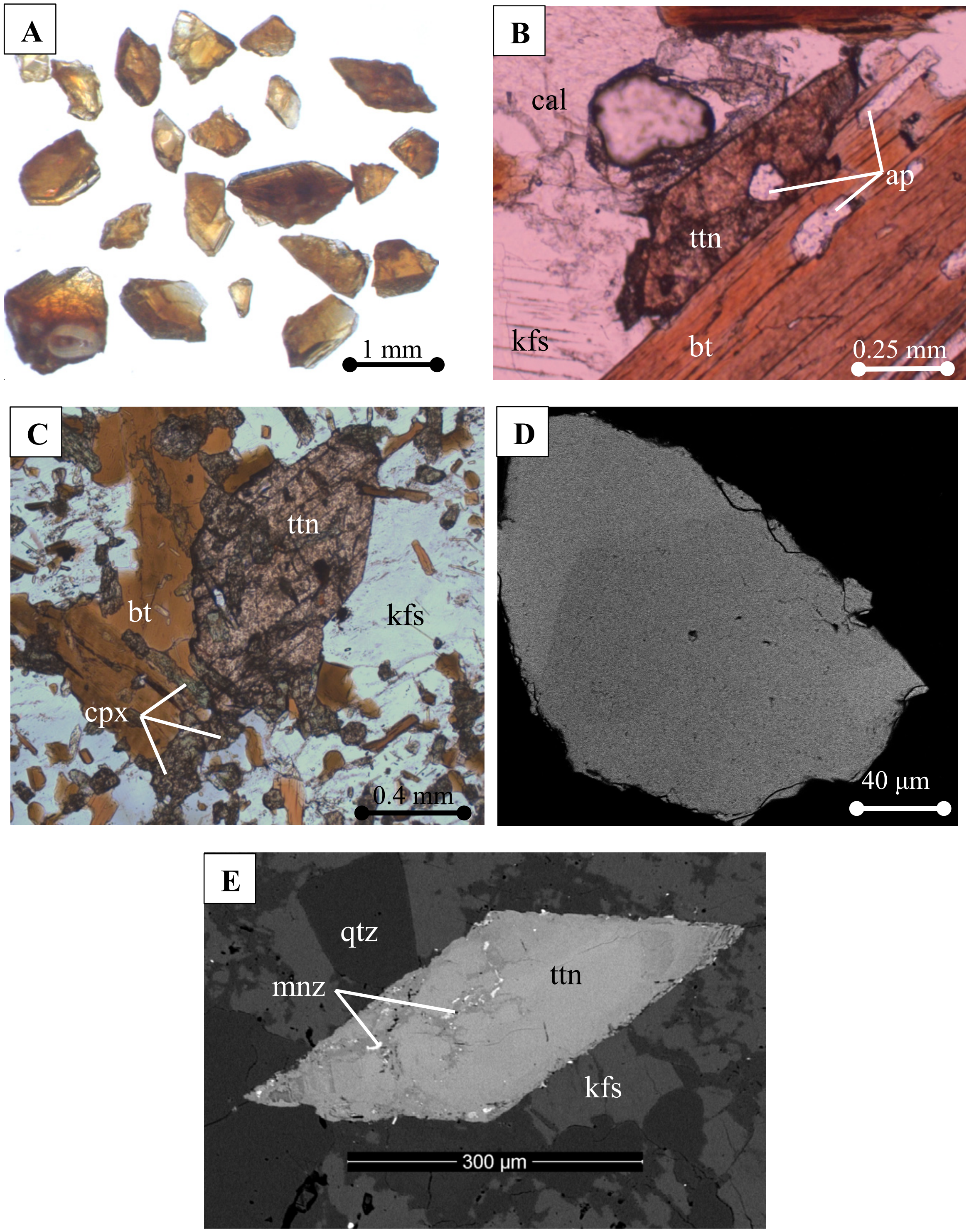


Figure 17 – Examples of typical titanite from MPIS ultrapotassic rocks. **A**. Photomicrograph of titanite grains separated from a sample (MP-P0714-19). **B**. Plane-polarized photomicrograph of euhedral titanite in shonkinite thin section (MP-P0913-19). **C**. Plane-polarized photomicrograph of subhedral titanite in shonkinite thin section (MP-P0913-10C). **D**. Backscatter-electron image of zoned titanite in grain mount (MP-P0714-19). **E**. Backscatter-electron image of titanite grain in leucosyenite thin section with veins containing monazite (MP-P0913-9B). **ap = apatite, bt = biotite, cal = calcite, cpx = clinopyroxene, kfs = K-feldspar, mnz = monazite, qtz = quartz**.

P0714-16, and 1405 ± 16 (n = 8, MSWD = 0.3) and 1363 ± 7 Ma (n= 27, MSWD = 1.0) in MP-P0714-26 (e.g. Fig. 18E). In general, the position of each analysis in Tera-Wasserburg space correlates with U content (Figs. 18A & 18B), suggesting that the degree of discordance in individual analyses is simply a function of relative enrichment in radiogenic Pb vs. the common Pb content.

Chondrite-normalized REE profiles for titanite are characterized by LREE enrichment, a slight positive Ce anomaly, and negative middle REE (MREE) to heavy REE (HREE) slope (Fig. 19, Appendix E). The samples do not show a notable Eu anomaly. Zr-in-titanite temperatures were calculated using the calibration of Hayden et al. (2008) and assuming a pressure (P) of 0.1 ± 0.1 GPa. Previous workers reason that pressure conditions during emplacement of the MPIS were ≤ 0.1 GPa, based on the presence of K-feldspar pseudomorphs after leucite in some samples (e.g. Castor, 2008). They infer that leucite was a primary phase in the samples, which has been experimentally shown to be unstable above ~ 0.1 GPa (Barton & Hamilton, 1978). TiO_2 activity was assumed = 0.8 ± 0.2, and SiO_2 activity = 1 ± 0, based on the presence of minor quartz and apparent lack of primary rutile in most titanite-bearing samples. For samples where quartz was not observed in thin section, SiO_2 activity was assumed 0.9 ± 0.1. Although pressure is not well-constrained, changes in P of ± ~0.1 GPa only change the calculated T by ± 10-20 ^{0}C. Uncertainty in measurement, P, TiO_2 activity, and SiO_2 activity are propagated into the reported temperature uncertainty, of these, the analytical uncertainty in Zr measurement is the largest contribution to uncertainty. Only three samples give single population Zr-in-titanite apparent temperatures (MP-P0913-10C weighted mean = 859 ± 9 ^{0}C, MP-P0714-17 weighted mean = 875 ± 8 ^{0}C, MP-P0714-23 weighted mean = 806 ± 16 ^{0}C; Appendix F). All other samples give a range of apparent

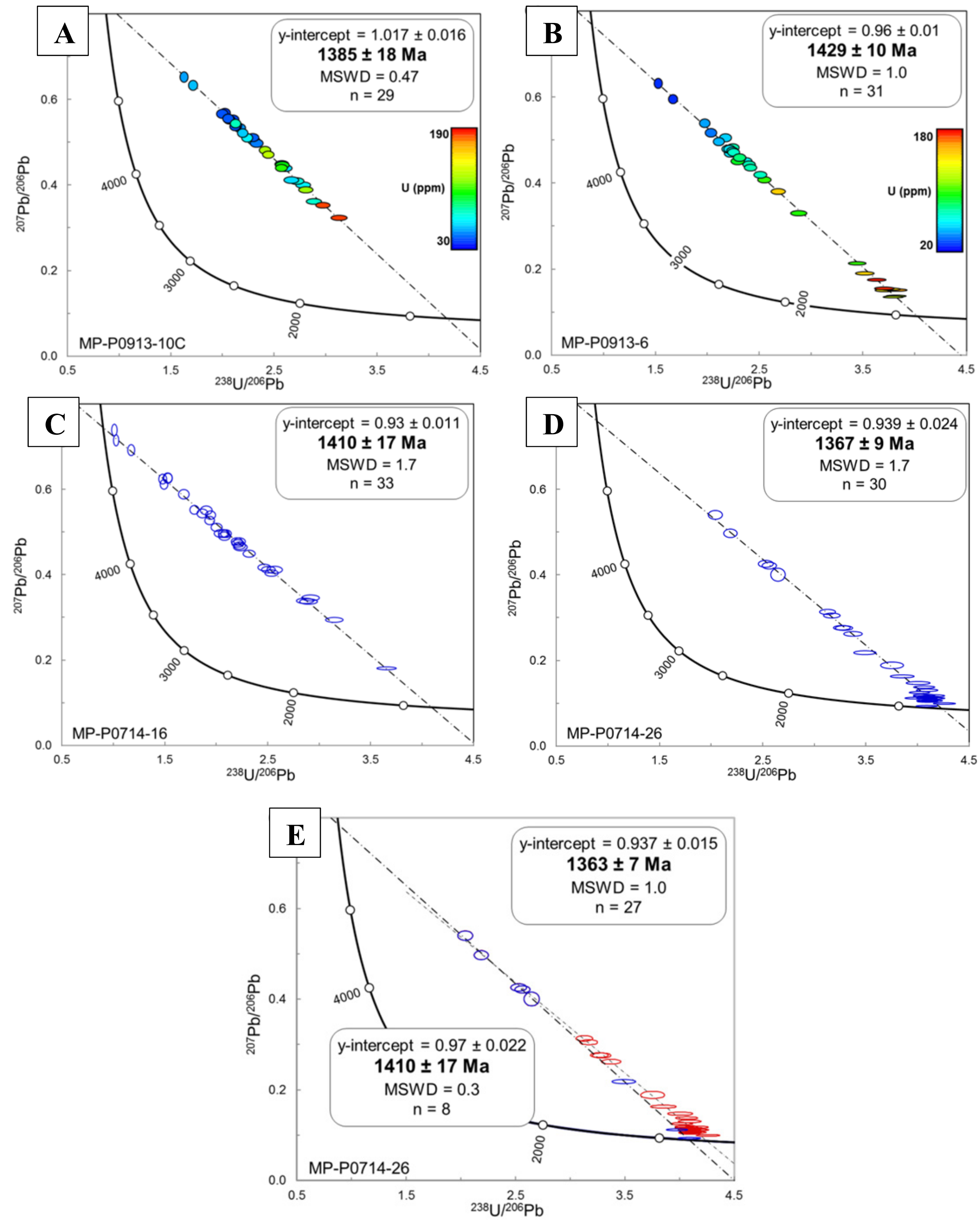


Figure 18 – Representative Tera-Wasserburg Concordia plots of U-Pb analyses from titanite samples. **A**. Sample MP-P0913-10C. Analyses are colored by U content. **B**. Sample MP-P0913-6. Analyses are colored by U content. C. Sample MP-P0714-16 shown without subdividing analyses into separate populations. D. Sample MP-P0714-26 shown without subdividing analyses into separate populations. **E**. Sample MP-P0714-26 subdivided into two age populations.

temperatures between ~950-850 and 700-650 ^{0}C (Fig. 20, Appendix F). There is no apparent correlation observed between apparent Zr-in-titanite temperature and either the trace element pattern or the ^{207}Pb-corrected ^{206}Pb/^{238}U date of individual spots.

In-situ Nd isotopic measurements on titanite from three samples from the Tors stock give single population weighted means of $\varepsilon Nd_{(i)}$: MP-P0913-10B = -4.7 ± 0.4 (MSWD = 1.3, n = 20), MP-P0913-10C = -4 ± 0.4 (MSWD = 0.5, n = 20), MP-P0913-10D = -3.9 ± 0.4 (MSWD = 0.9, n = 19), (e.g. Fig. 21A, Appendix G). These three samples also yield the youngest U-Pb isochron dates in the MPIS.

In contrast, the remaining seven samples give variable intra-sample $\varepsilon Nd_{(i)}$ values ranging from -3.5 to -12 (Fig. 21B). In each case, MSWDs associated with $\varepsilon Nd_{(i)}$ weighted means are significantly greater than 1, suggesting that these data do not form single populations. For four of the seven samples, the majority of analyses (66 of 71 spots) fall in between -3.5 and -7 (e.g. Fig. 21C, Appendix G). The remaining three samples yield the most scattered, and negative, $\varepsilon Nd_{(i)}$ values (as low as -12) (e.g. Figs. 21D & 21E, Appendix G); one of these samples (MP-P0913-5A) also contains abundant xenoliths of host granite and gneiss as well as abundant inherited (~1700-1640 Ma) zircons. The other two samples (MP-P0714-16 and MP-P0714-26) also do not yield single-population U-Pb isochrons, indicating a possible relationship between the disturbance of the U-Pb and Nd isotopic systems. In general, there is no apparent relationship between $\varepsilon Nd_{(i)}$ and position in individual crystals or location of samples in the field area. However, if samples with evidence for U-Pb disturbance are discounted (MP-P0714-16 and MP-P0714-26), there is a trend between $\varepsilon Nd_{(i)}$ and whole-rock silica content suggesting that the cause of spread in $\varepsilon Nd_{(i)}$ in these two samples is different

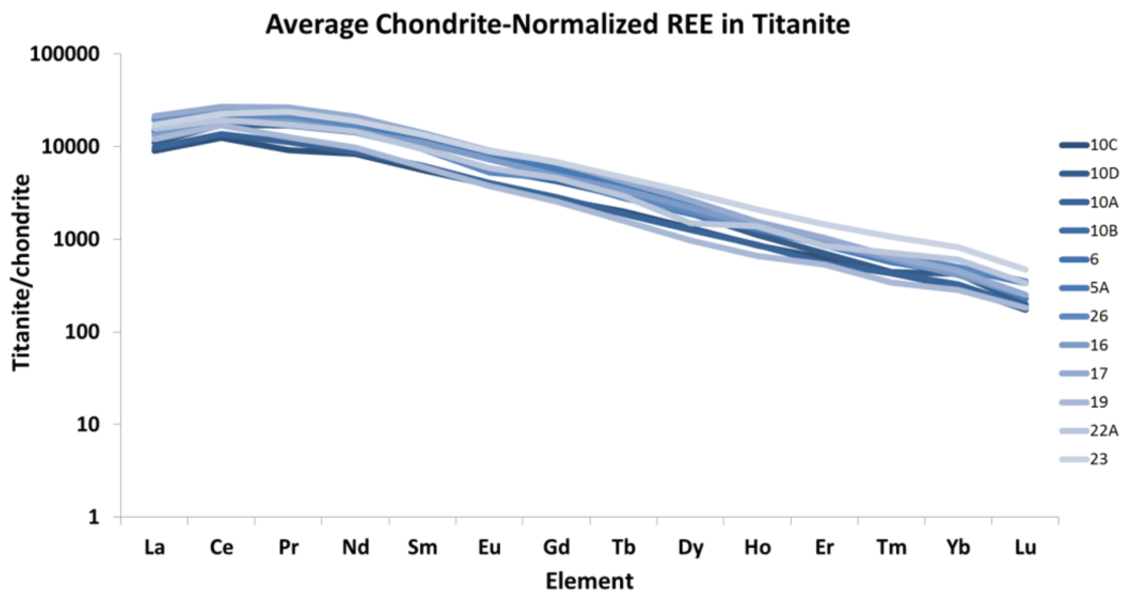


Figure 19 – Average chondrite-normalized REE in titanite from all analyzed samples.

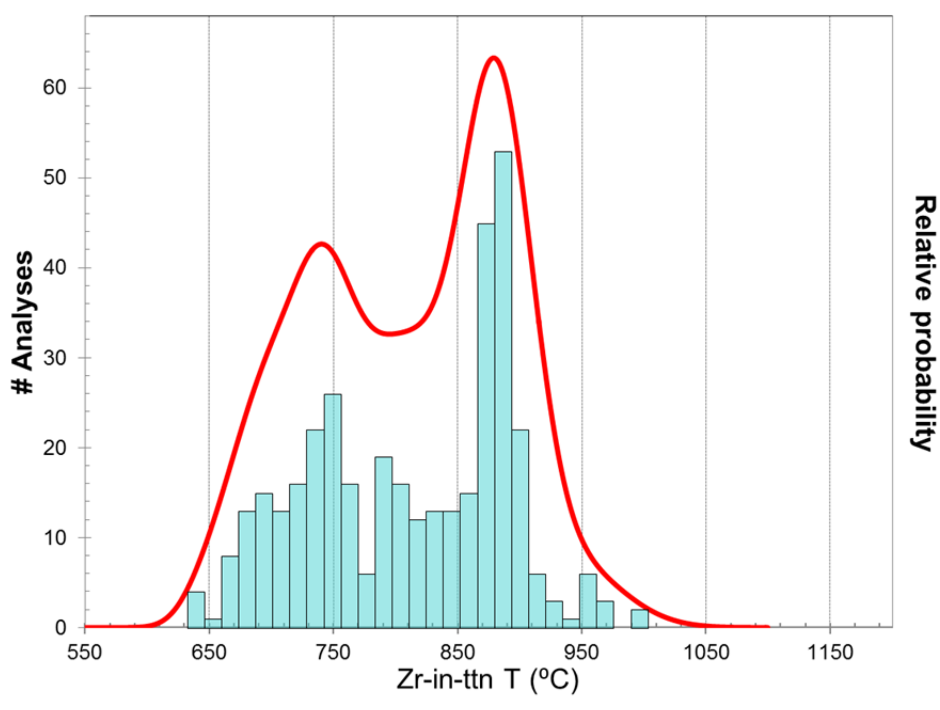


Figure 20 – Probability distribution plot of Zr-in-titanite temperatures for all titanite samples, including those that form single populations.

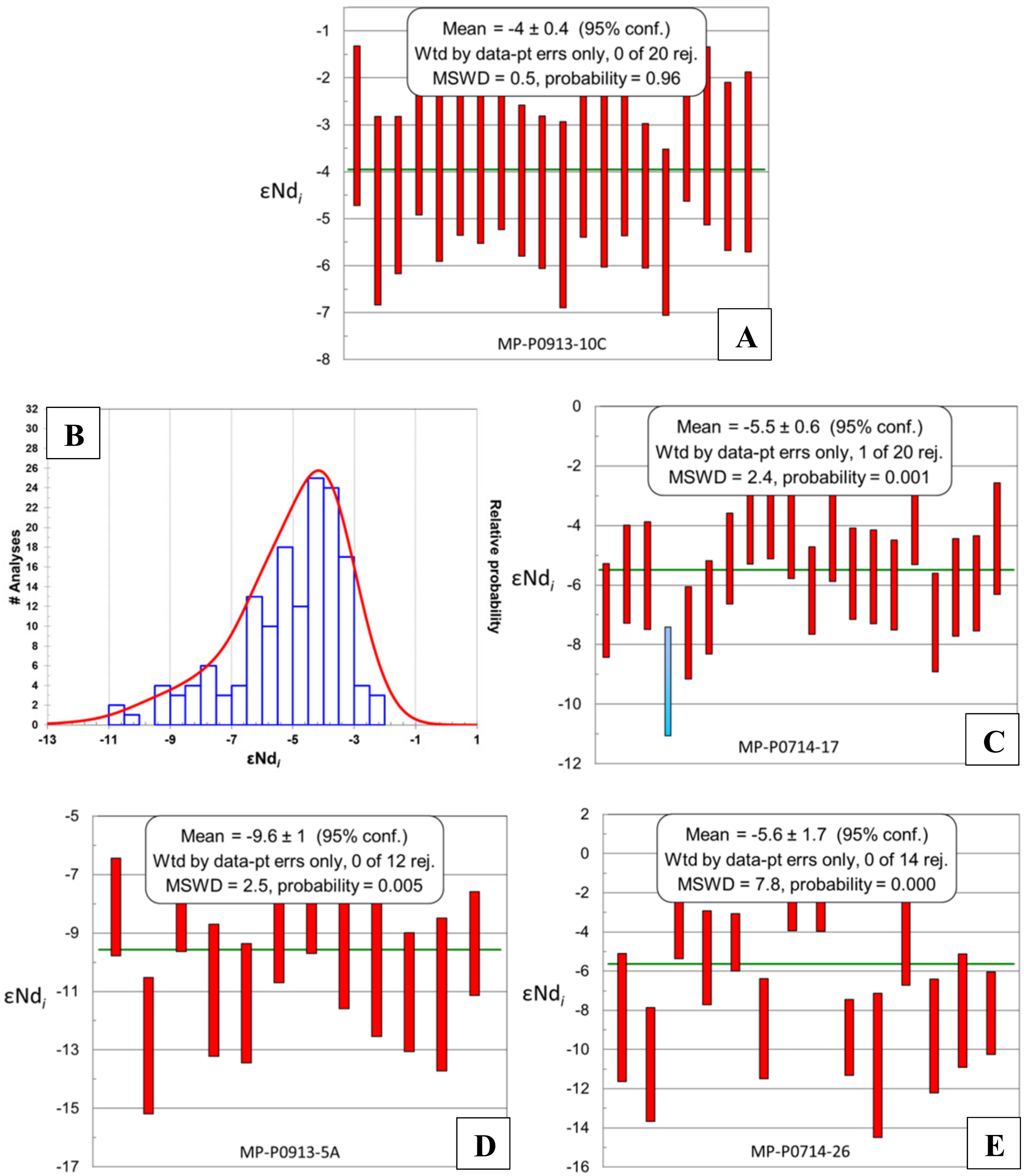


Figure 21 – Representative examples of Nd isotopic data from titanite. **A**. Weighted mean $\varepsilon Nd_{(i)}$ for shonkinite dike sample (MP-P0913-10C). **B**. Probability density plot of $\varepsilon Nd_{(i)}$ for all titanite analyses, including those that form single populations. **C**. Weighted mean $\varepsilon Nd_{(i)}$ for syenite sample, showing moderate scatter in the data (MP-P0714-17). **D**. Weighted mean $\varepsilon Nd_{(i)}$ for syenite sample MP-P0913-5A. **E**. Weighted mean $\varepsilon Nd_{(i)}$ for shonkinite sample, showing significant scatter in the data (MP-P0714-26).

from the majority of samples (Fig. 22). In general, more negative $\varepsilon Nd_{(i)}$ is associated with older U-Pb dates on a sample-by-sample basis.

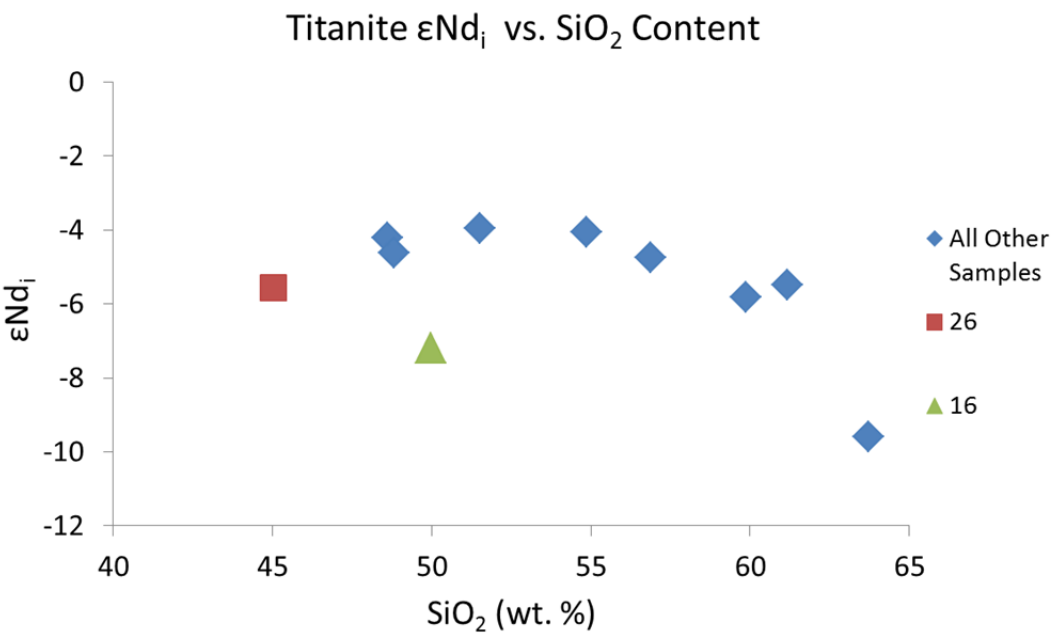


Figure 22 – Scatter plot of mean $\varepsilon Nd_{(i)}$ from titanite versus whole-rock silica content. Each data point is a weighted mean of all titanite Nd analyses from one sample. Uncertainty is not shown, but is typically 0.5-1 εNd unit for each data point.

6.3 Zircon Textures, U-Pb, Trace Elements, and Hf Isotopes

Zircon in Mountain Pass rocks is diverse in morphology. Colorless to brown, elongate or moderately rounded zircons occur exclusively in two fine-grained ultrapotassic rock samples from the Corral stock, which also contain abundant gneissic or granitic xenoliths (Fig. 23A). Metamict, euhedral, pseudo-octahedral, brown-red-pink-white, mostly opaque crystals that vary from ~0.1 mm to 2 mm in diameter are abundant in most samples, including one carbonatite sample (Sample MP-P0913-1B; e.g. Fig. 23B). Most zircons do not luminesce in CL, but some luminesce weakly or contain translucent zones that define irregular, blotchy domains that are CL-bright (Fig. 23C). Transparent to translucent, reddish to pink, euhedral, subhedral, and anhedral crystals were recovered from 15 samples of shonkinite and syenite (Figs. 23D & 23E). Crystal size varies from ~3mm to ~30 μm. Some show typical oscillatory or sector zoning in CL (Fig. 23F), but others show irregular or weak zoning patterns (Figs. 23G & 23H).

Zircon from 14 samples of Mountain Pass shonkinite and syenite are characterized by moderate to high U (1500 to 10,000 ppm), significant radiogenic Pb loss, nearly ubiquitous presence of common Pb, abundant inheritance, high/variable LREE, highly variable Ti-content (~10-450 ppm), and correspondingly variable apparent Ti-in-zircon temperatures (800-1500 ^{0}C). Tera-Wasserburg Concordia diagrams show that most U/Pb data are highly discordant, defining broad arrays that appear to be the result of a mixture of Pb-loss and high/variable common Pb (Figs. 24A & 24B). In general, percent discordance correlates positively with U content, LREE content, and mass-204 signal intensity (a proxy for common Pb content; e.g. Figs. 24C & 24D). Zircon was only present in one carbonatite sample (MP-P0913-1B), but all crystals in the sample are metamict and do not yield meaningful U-Pb data.

A minority of zircon (134 of 700 total analyses, 134 of 436 reported analyses) from six out of 15 MPIS rocks yielded small populations of concordant or near-concordant U-Pb dates. The dates primarily form two clusters; one at ~1460-1400 Ma, and another at 1800-1640 Ma (Figs. 24A & 24B), although one sample additionally yielded sparse analyses from 1600-1430 Ma (Fig. 24B). Elongate or rounded, colorless to brown zircons yield dates >1460 Ma, and pinkish, euhedral to anhedral zircon yield dates <1460 Ma. Mesoproterozoic dates range from 1458 ± 7 to 1407 ± 11 Ma (e.g. Figs. 24E & 24F, Appendix H). Only one sample gave >10 concordant, Mesoproterozoic analyses out of 30-40 (MP-L0613-BDAY), and

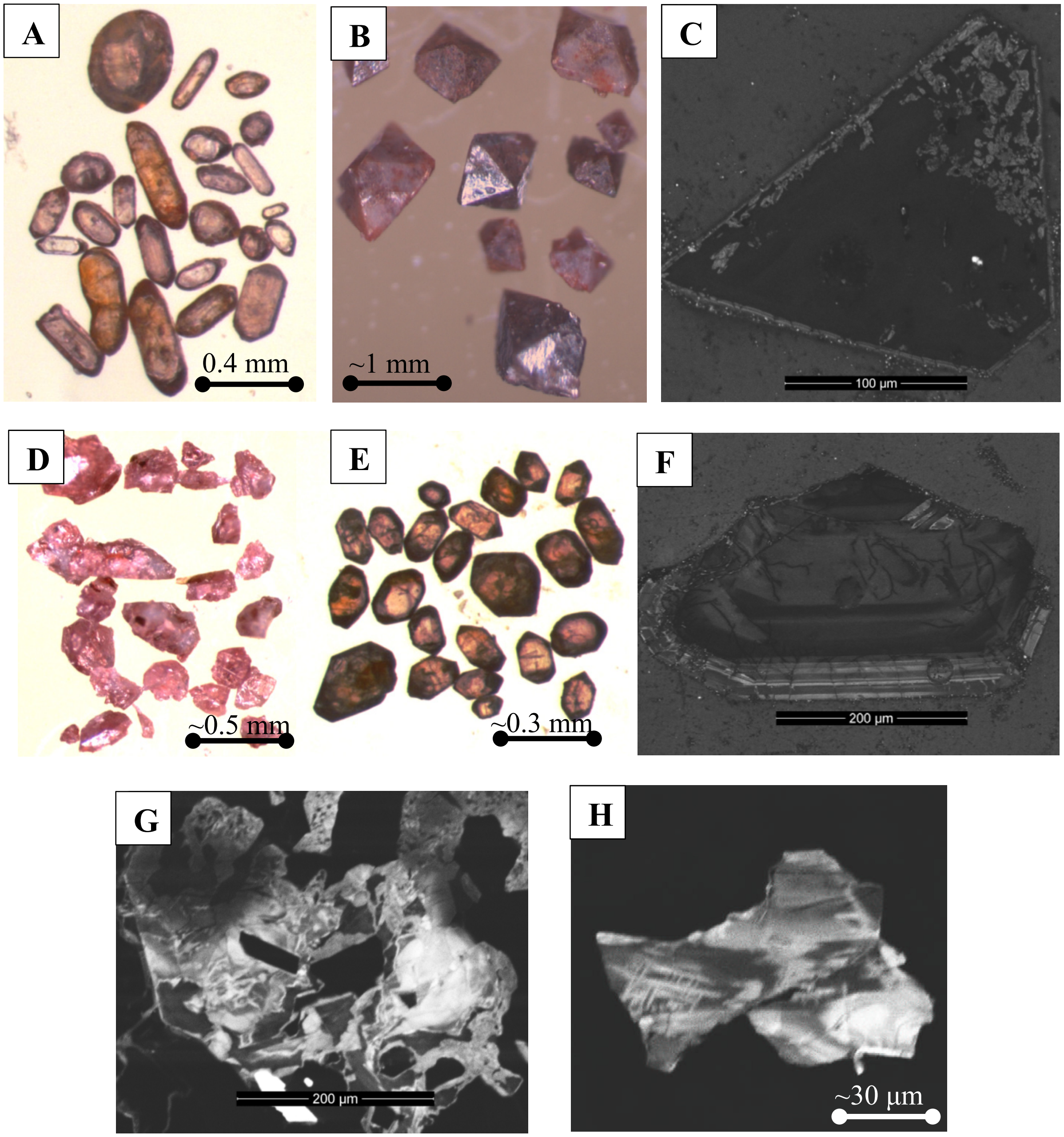


Figure 23 – Examples of typical zircon from MPIS ultrapotassic rocks. **A**. Elongate and rounded, colorless to brown zircon separated from melanosyenite (MP-P0913-6). **B**. Pseudo-octahedral, metamict zircon separated from sample (MP-P0714-22A). **C**. CL image of metamict zircon grain (MP-P0714-22A). **D**. Anhedral, pink zircon separated from sample (MP-P0714-26). **E**. Euhedral, pink to brown zircon separated from sample (MP-P0913-6). **F**. CL image of zircon in grain mount showing oscillatory zoning MP-P0714-26). **G**. CL image of anhedral zircon with irregular zoning pattern in thin section (MP-P0913-10A). **H**. CL image of anhedral zircon in grain mount with irregular zoning pattern (MP-P0913-10C).

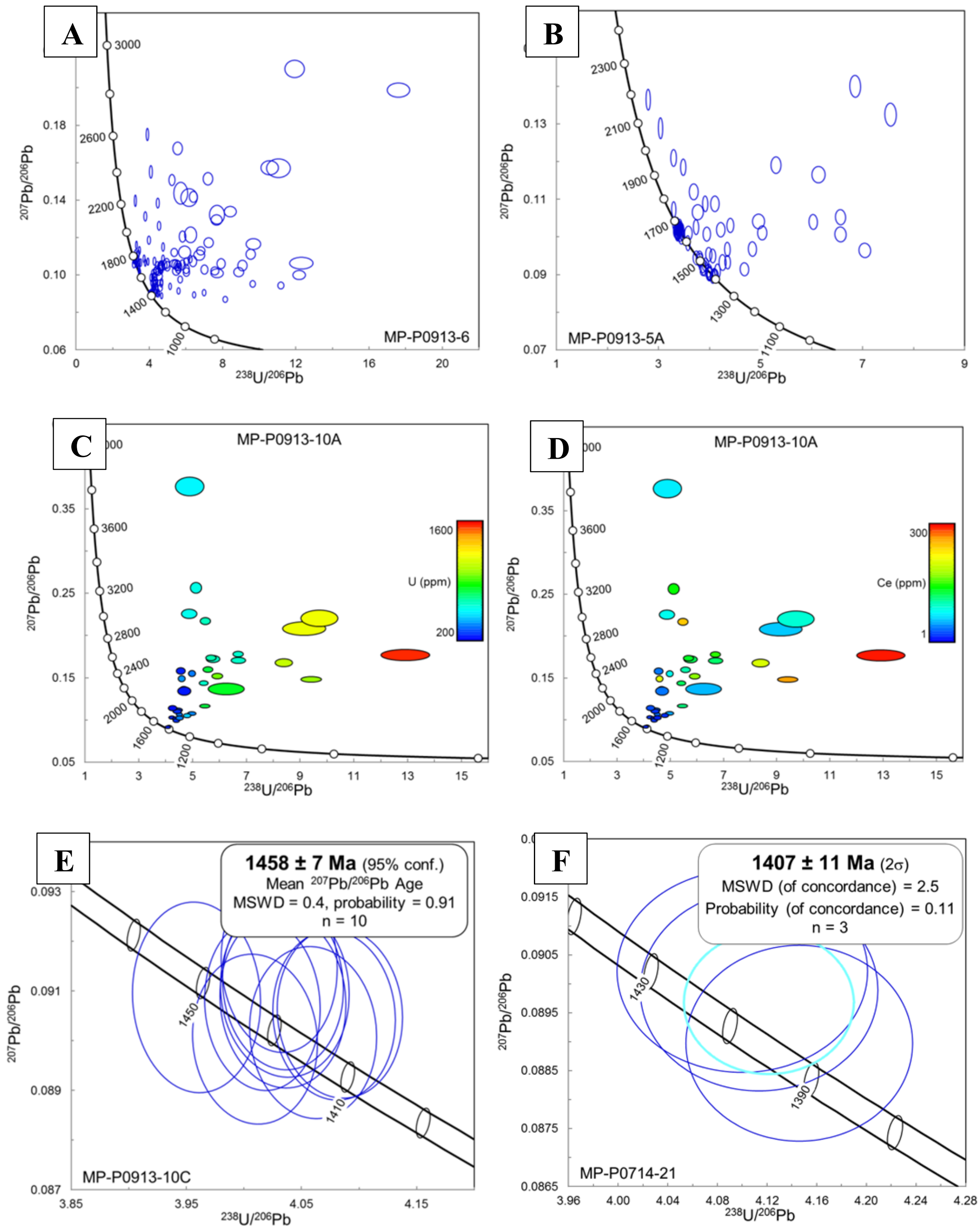


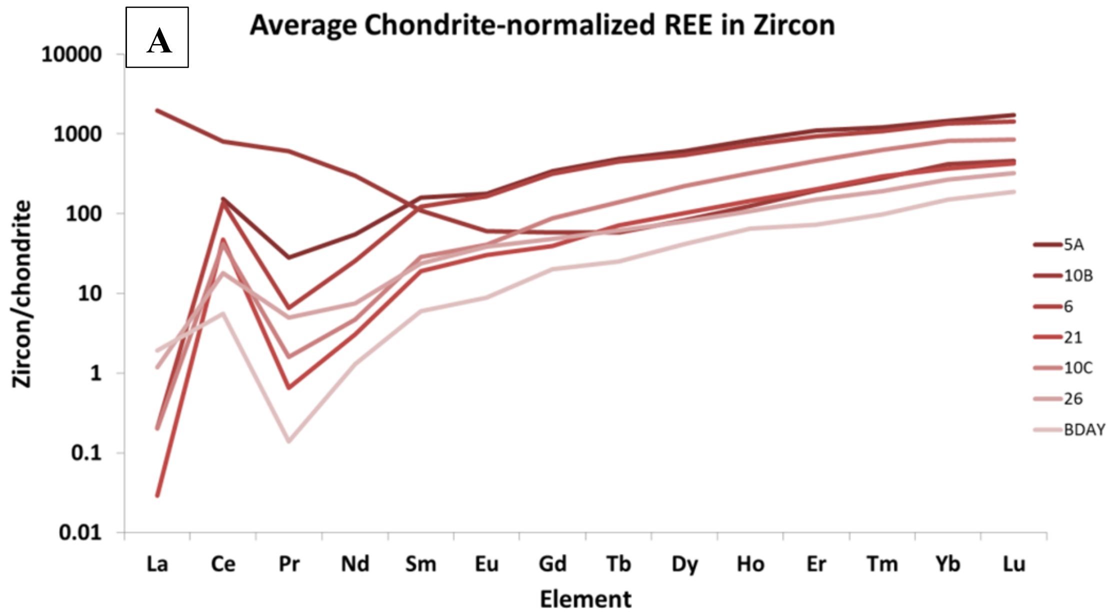
Figure 24 – Representative Tera-Wasserburg Concordia plots of U-Pb analyses from zircon in MPIS ultrapotassic rocks. **A**. Sample MP-P0913-6, showing mostly discordant data and abundant age inheritance. **B**. Sample MP-P0913-5A, showing mostly discordant data and abundant inheritance. **C**. Sample with only discordant analyses (MP-P0913-10A). Analyses are colored by U content. Note higher degree of discordance in high U grains. **D**. Sample with only discordant data (MP-P0913-10A). Analyses are colored by Ce content. Note higher degree of discordance in high Ce grains. **E**. Concordant analyses from sample MP-P0913-10C. **F**. Concordant analyses from sample MP-P0714-21.

yielded a Concordia age of 1425 ± 5 Ma (n = 25; Appendix H). Concordant, Mesoproterozoic dates from four samples overlap titanite ages from the same rocks within uncertainty, but do not overlap the titanite age in one sample. Age patterns within single crystals are not present in any of the samples.

REE patterns in 1800-1640 Ma zircons vary widely from grain to grain, and in general are more variable than Mesoproterozoic zircon in the same rocks. Ti-in-zircon apparent temperatures calculated using the Ti-in-zircon thermometer of Ferry and Watson (2007) predominantly range between ~675 and 775 °C. Zircons that yield concordant and slightly discordant data have similar REE concentration to typical igneous zircon from a variety of igneous rocks (e.g. Belousova, 2002), and yield Ti-in-zircon apparent temperatures from ~600-850 ^{0}C (Figs. 25A & 25B; Appendices I & J). Trace element patterns within single crystals are not present in any of the samples.

Zircon $\varepsilon Hf_{(i)}$ values typically range from 0.5 to 3. Five of seven samples measured yield single populations of analyses (MSWD ~ 1; Fig. 26). Two samples with fewer analyses have higher MSWD due to one to two outlying analyses. Taken as a whole, data from all the samples gives a weighted mean of 1.9 ± 0.2 (MSWD = 0. 9; 7 of 76 analyses rejected; Fig. 26). $\varepsilon Hf_{(i)}$ values > 3 occur in one sample only – a late shonkinite dike, which also yielded the oldest zircon age (1458 ± 7 Ma; mean $^{207}Pb/^{206}Pb$ age), the youngest titanite age (1385 ± 18 Ma), and the most primitive $\varepsilon Nd_{(i)}$ values (weighted mean = -3.9 ± 0.4).

Zircon from three Mountain Pass host rock samples yielded zircon dates from ~1800-1750 Ma (feldspar augen gneiss, MP-P0913-12), ~1780-1635 Ma (coarse-grained alkali granite, sample MP-P0914-5B), and 1800-1650 Ma (garnet-biotite-sillimanite gneiss, sample MP-P0913-4) (e.g. Fig. 27, Appendix K). Discordance is common in the host rock zircons,



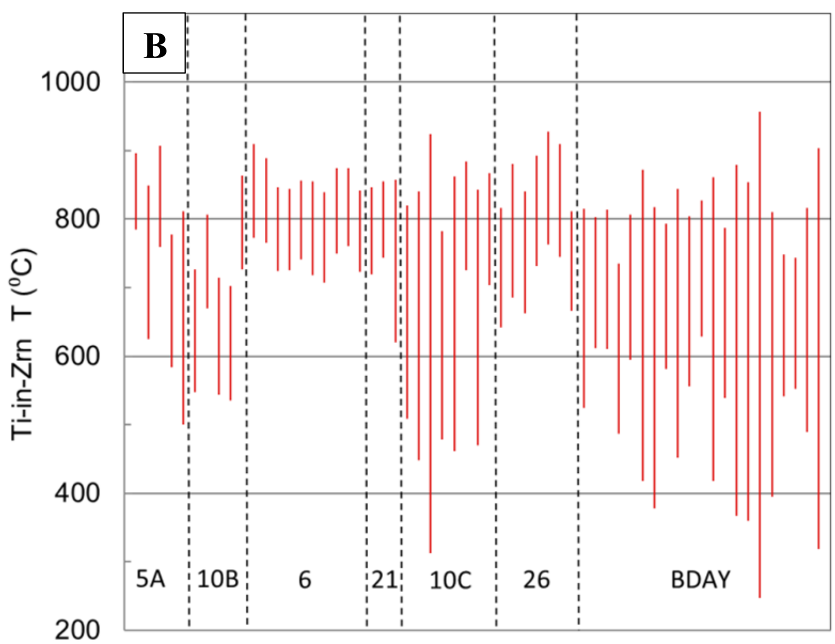


Figure 25 – Selected trace element plots for concordant MPIS zircon. **A**. Average chondrite-normalized REE from all concordant zircon. **B**. Ti-in-zircon apparent temperatures for all concordant zircon. High uncertainties are a product of poor precision as a result of low Ti content in zircon (< 10 ppm).

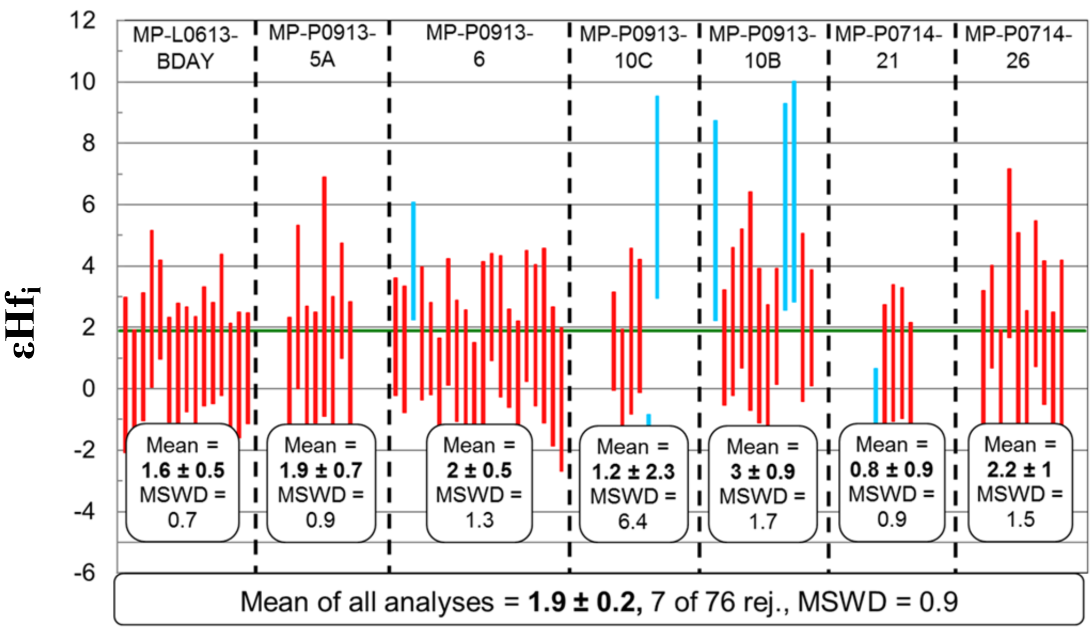


Figure 26 – Weighted mean plot of $\varepsilon Hf_{(i)}$ from all measured MPIS zircon.

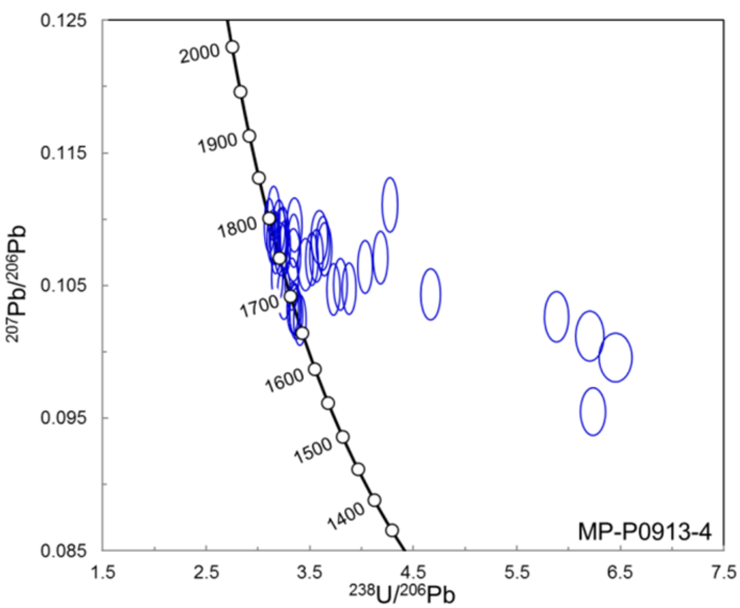


Figure 27 – Tera-Wasserburg U-Pb Concordia plot of analyses from zircon in Mountain Pass metamorphic host rock (garnet-sillimanite-biotite gneiss, MP-P0913-4).

and generally correlates positively with U content and mass-204 signal intensity, but ~50-70% of the zircon analyses are concordant. Chondrite-normalized REE profiles are highly variable, and Ti-in-zircon apparent temperatures mostly range from 650-800 ^{0}C (Appendix K).

6.4 Monazite U/Th-Pb, Trace Elements, and Nd Isotopes

Monazite appears to be a secondary phase in the ultrapotassic rocks, occurring as a trace phase only in altered samples in veins, as inclusions, and as subhedral to anhedral grains in fractures (Fig. 28A). Euhedral grains were found only in one sample that has abundant evidence for secondary alteration (Fig. 28B). In contrast, monazite is a common accessory mineral in carbonatite (≤ 1%), occurring as subhedral or anhedral grains that vary from ~25 to 200 µm in carbonatite sample MP-L0613-BDAY2 (Fig. 28C), and as porous, microcrystalline aggregates from ~50 µm to ~1 mm in carbonatite sample MP-P0913-SQ1 (Figs. 28D & 28E). Based on textural observations alone, it is unclear whether it is primary or secondary phase in the carbonatites.

Monazite from ultrapotassic rocks and carbonatites typically contains 3-50 ppm U and low (typically <5 ppm) radiogenic ^{206}Pb; thus, U-Pb analyses have large uncertainties (up to ~100% or more) and do not generate meaningful U-Pb dates. The monazites do, however, contain significant Th (typically 2,000-20,000 ppm), low common ^{208}Pb (i.e. >85% is thoriogenic) and it is therefore possible to calculate ^{208}Pb/ ^{232}Th dates. In order to calculate ^{208}Pb/ ^{232}Th dates, the Th-Pb analyses were corrected for common Pb; analyses with mass-204 CPS > 100 were rejected in order to minimize the magnitude of the common-Pb correction. Weighted mean, common-lead corrected Th-Pb dates from monazite in

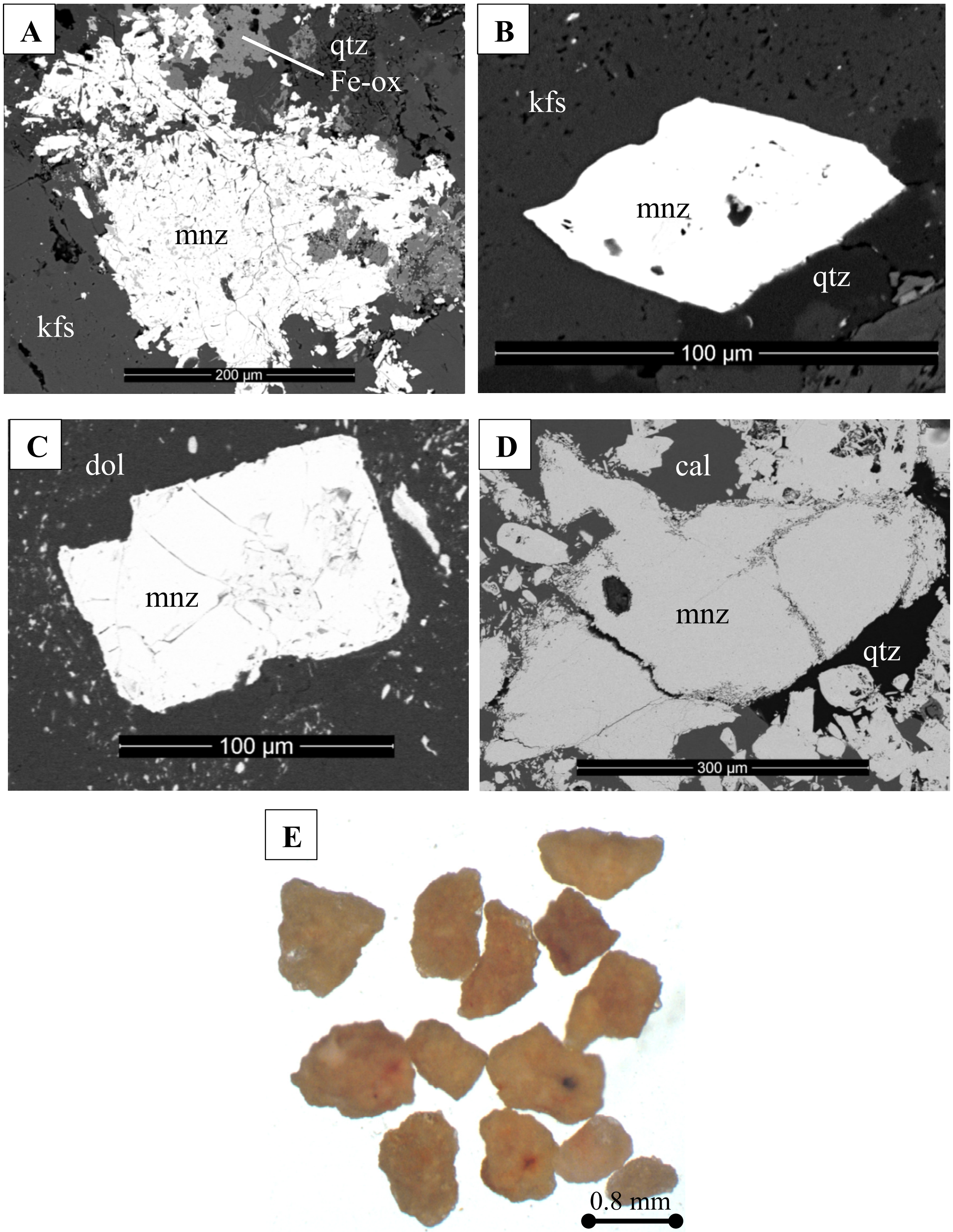


Figure 28 – Examples of monazite from MPIS rocks. **A**. Backscatter-electron image of anhedral monazite in altered syenite (MP-P0913-7). **B**. Backscatter-electron image of euhedral monazite in altered syenite (MP-P0913-2). **C**. Backscatter-electron image of euhedral monazite in carbonatite (MP-L0613-BDAY2). **D**. Backscatter-electron image of anhedral, porous monazite in carbonatite (MP-P0913-SQ1). **E**. Porous monazite grains separated from a carbonatite sample (MP-P0913-SQ1). **cal = calcite, dol = dolomite, Fe-ox = Fe-oxide, kfs = K-feldspar, qtz = quartz.**

ultrapotassic rock samples MP-P0913-2 and MP-P0913-7 are 1376 ± 36 Ma (n = 13, MSWD = 4.5) and 1401 ± 32 Ma (n = 8, MSWD = 1.9), respectively (Fig. 29). The weighted mean Th-Pb date from carbonatite sample MP-L0613-BDAY2 is 1396 ± 16 Ma (n = 23, MSWD = 4.2), whereas carbonatite sample (MP-P0913-SQ1) defines a more narrow range, giving a weighted mean of 1371 ± 10 Ma (n = 46, MSWD = 1.6) (Fig. 29).

Chondrite-normalized REEs in monazite from the ultrapotassic rocks and carbonatite show enrichment in LREE with a steep LREE to HREE slope and a very minor negative Eu anomaly (Fig. 30, Appendix L). Monazite from carbonatite sample MP-P0913-SQ1 show greater depletion in HREE than monazite from the ultrapotassic rocks (Fig. 30). Nd isotopic analysis of monazite from carbonatite sample MP-P0913-SQ1 yielded consistent $\varepsilon Nd_{(i)}$ values, with a weighted mean of -2.8 ± 0.2 (MSWD = 0.8; Fig. 31) within uncertainty of $\varepsilon Nd_{(i)}$ from bastnäsite in the same sample (see below).

U-Pb monazite dates from one host rock sample, a garnet-biotite-sillimanite gneiss (MP-P0913-4), give an mean $^{207}Pb/^{206}Pb$ date of 1693 ± 8 Ma (MSWD = 2.2; Fig. 32A). Chondrite-normalized REEs are similar to those from the Mountain Pass ultrapotassic rocks, but show lower La/Nd ratios and a more pronounced negative Eu anomaly (Fig. 32B).

6.5 Bastnäsite U-Pb and Nd Isotopes

Bastnäsite, the primary REE ore-bearing mineral at Mountain Pass, was observed in three carbonatite samples, and was recovered and analyzed from two. It occurs as tabular or elongate to acicular, subhedral to euhedral, honey-yellow to light brown crystals with resinous to vitreous luster up to ~1 mm in sample MP-P0913-SQ1 (Fig. 33A & 33B), and as anhedral intergrowths with barite in samples MP-P0913-1B and MP-L0613-BDAY2 (Fig.

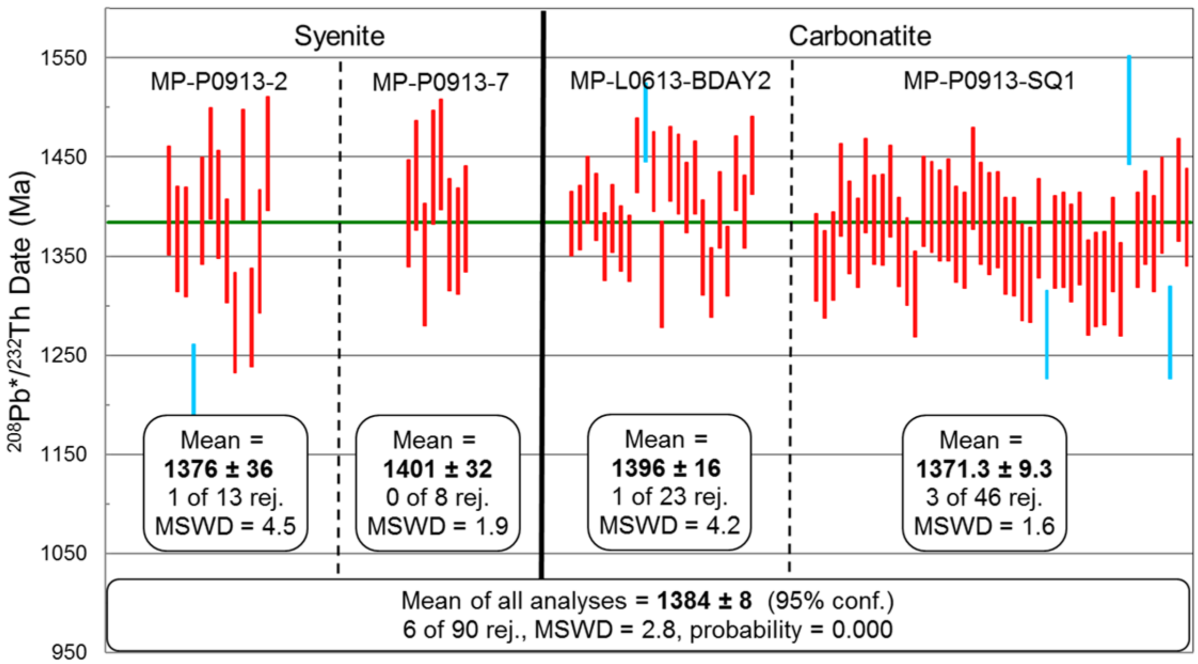


Figure 29 – Weighted mean plots of all common-Pb-corrected Th-Pb dates from monazite from ultrapotassic rocks and carbonatite.

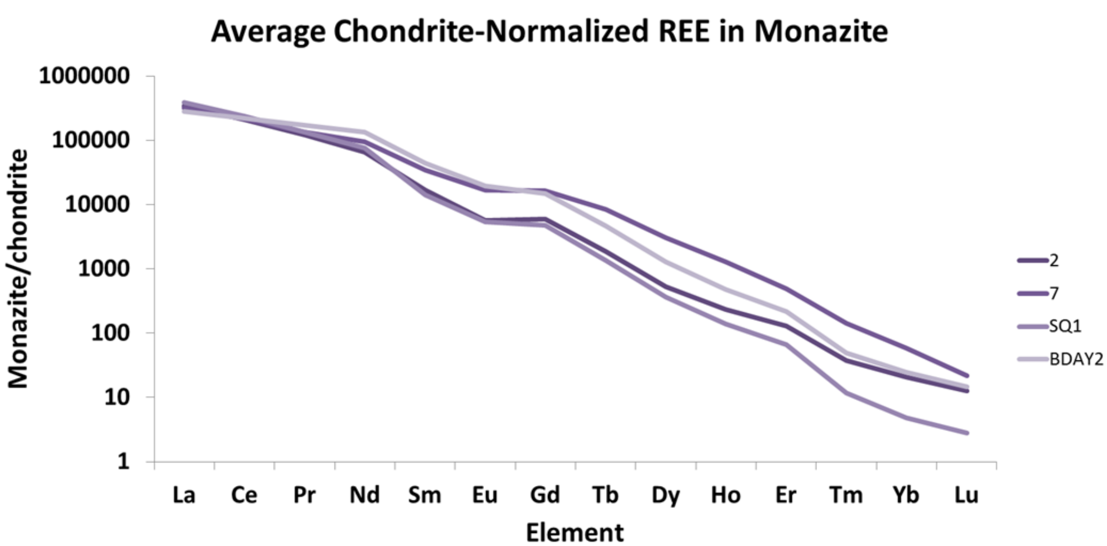


Figure 30 – Average chondrite-normalized REE plot for monazite from ultrapotassic rocks and carbonatite.

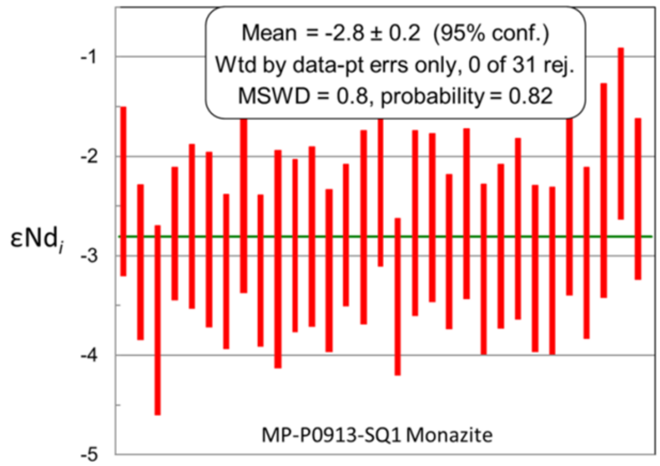


Figure 31 – Weighted mean plot of $\varepsilon Nd_{(i)}$ from monazite from carbonatite (MP-P0913-SQ1).

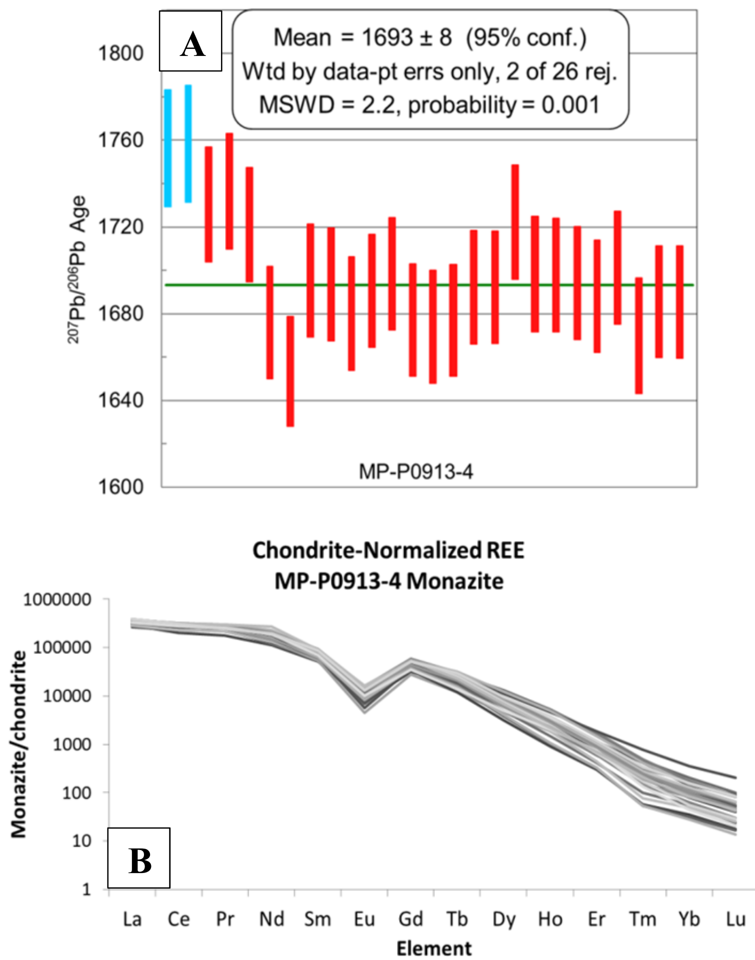


Figure 32 – U-Pb and trace element data from monazite in metamorphic host rocks at Mountain Pass. **A**. Weighted mean 207Pb/206Pb age of monazite from garnet-sillimanite-biotite gneiss (MP-P0913-4). **B**. Chondrite-normalized REE plot from monazite in garnet-sillimanite-biotite gneiss (MP-P0913-4).

33C). It is occasionally intergrown with synchysite/parisite (Fig. 33D). The grains are compositionally heterogeneous and contain abundant inclusions of calcite, barite, and Fe-oxide (hematite?).

Bastnäsite from two carbonatite samples was analyzed for U-Pb and Nd isotopes. Both samples are very low in U (<10 ppm), and have high and variable common-lead contents. Mineralogical heterogeneity (i.e. bastnäsite/barite intergrowths) is a potential cause of variable U and Pb content in sample MP-P0913-1B (e.g. Fig. 33C), but bastnäsite grains from sample MP-P0913-SQ1 are relatively mineralogically homogeneous. The low U combined with the large scatter Pb and U/Pb isotopic ratios suggest that bastnäsite has behaved as an open system with respect to Pb, meaning that reliable dates cannot be calculated. In contrast, Nd isotopic analysis of bastnäsite from sample MP-P0913-SQ1 yield consistent $\varepsilon Nd_{(i)}$ values with a weighted mean of -3.2 ± 0.3 (MSWD = 1.8), overlapping $\varepsilon Nd_{(i)}$ from monazite in the same sample (Fig. 34).

6.6 Apatite U-Pb and Trace Elements

Apatite is ubiquitous in Mountain Pass ultrapotassic rocks as colorless, euhedral, prismatic crystals up to 3 mm long, making up to ~3% of some of the most mafic samples (Figs. 35A & 35B). It is common both as matrix grains and as inclusions in pyroxene and biotite.

Apatite U-Pb data from six ultrapotassic rock samples are predominantly reversely discordant in Tera-Wasserburg U-Pb Concordia space. Due to a combination of low U and high common Pb content, they also yield scattered and imprecise apparent “errorchron” dates between ~1350 and 1450 Ma. Therefore, the apatite U-Pb dates measured in this study are

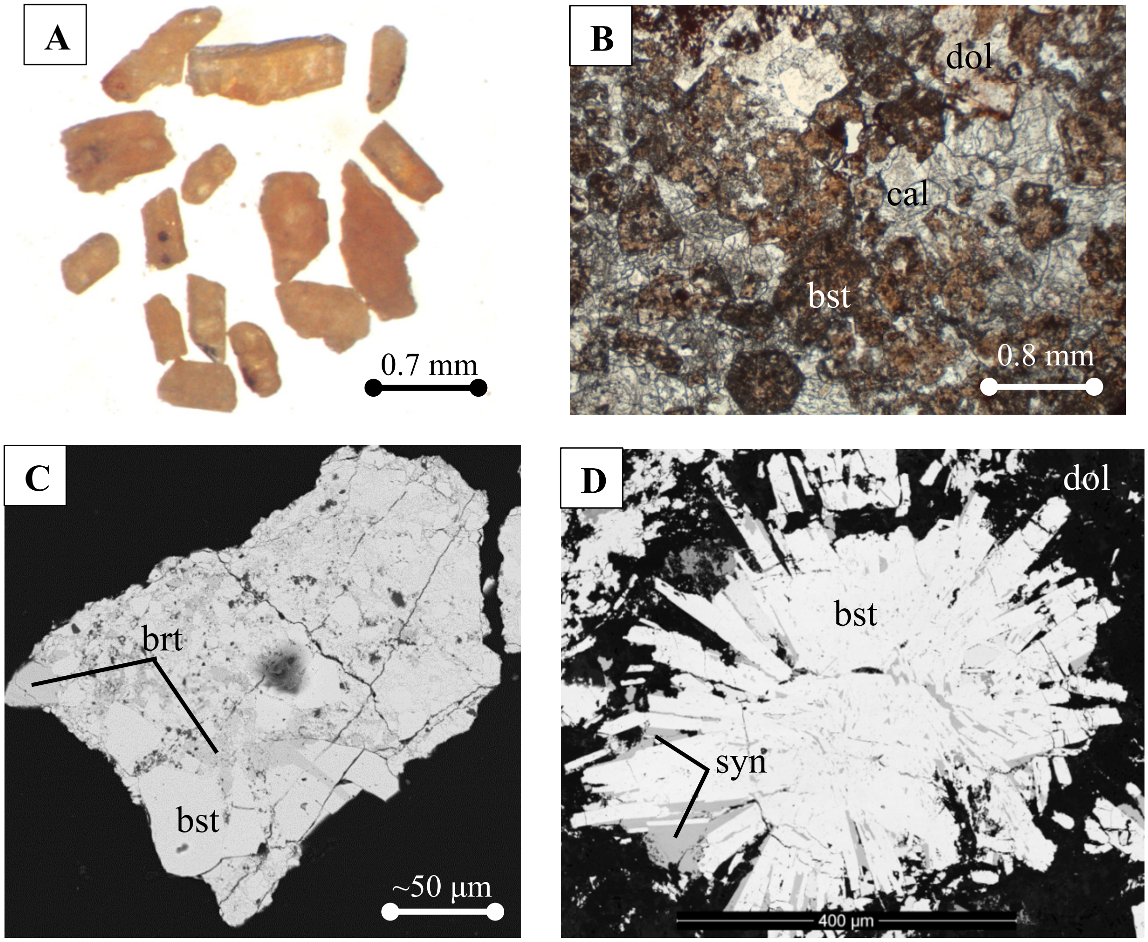


Figure 33 – Examples of bastnäsite in MPIS carbonatite. **A**. Backscatter-electron image of bastnäsite in a matrix of mostly calcite (MP-P0913-SQ1). **B**. Bastnäsite grains separated from a carbonatite sample (MP-P0913-SQ1). **C**. Plane-polarized photomicrograph of bastnäsite in a matrix of calcite and minor dolomite in thin section (MP-P0913-SQ1). **D**. Bastnäsite in grain mount separated from carbonatite sample (MP-P0913-1B). **E**. Intergrowth of bastnäsite and synchysite/parisite in carbonatite (MP-P0913-BDAY2). **brt = barite, bst = bastnäsite, cal = calcite, dol = dolomite, qtz = quartz, syn = synchisite/parisite**.

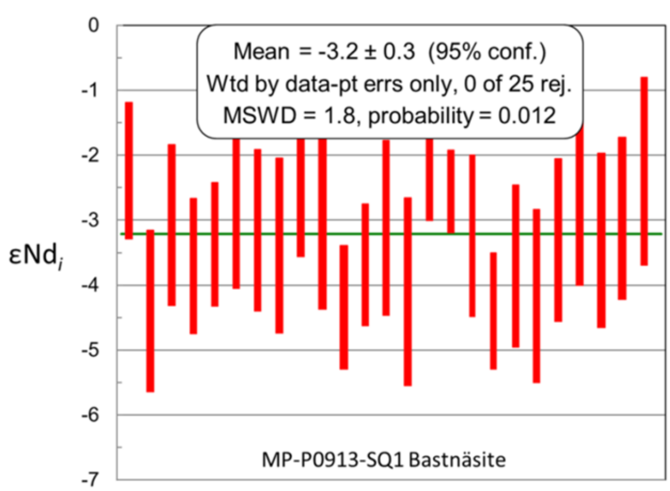


Figure 34 – Weighted mean plot of $\varepsilon Nd_{(i)}$ from bastnäsite from carbonatite (MP-P0913-SQ1).

deemed unreliable and not reported. Chondrite-normalized REEs from Mountain Pass apatite show enrichment in LREE ~10,000x chondritic values with a negative LREE to HREE slope and a slight negative Eu anomaly (Fig. 36, Appendix M).

6.7 Rutile U-Pb and Trace Elements

Rutile occurs as dark reddish-brown, euhedral to subhedral, prismatic to acicular crystals in syenite (Fig. 37A & 37B). It is commonly intergrown with ilmenite. It is most common in samples that do not contain titanite, although three samples of syenite contain both phases. It is most abundant in samples that show abundant evidence for secondary alteration. Despite its euhedral shape in mineral separates from the samples, SEM/BSE imaging of thin sections indicates that rutile is found only as fine- to medium-grained aggregates pseudomorphing primary minerals (Fig. 37C), indicating it is most likely a secondary phase.

Rutile from two syenite samples (MP-P0913-2 and MP-P0913-10B) was analyzed for U-Pb and trace elements. U content in the sample grains is ≤ 3 ppm, and total Pb content typically varies from 3000 to ~60,000 ppm. Sparse grains contain as low as 60 ppm total Pb and as high as 160,000 ppm total Pb. Moreover, the dates calculated from the measured U-Pb ratios have very high uncertainties (up to 100% or more). Thus, U-Pb analyses do not yield meaningful dates and are not reported here.

Euhedral rutile crystals separated from sample MP-P0913-10B are relatively homogeneous in trace element content. Zr-in-rutile temperatures calculated using the calibration of Tomkins et al. (2007) yield a weighted mean temperature of 435 ± 14 ^{0}C (Fig. 38). REE content in the grains is ≤ 40 ppm; most REE comprise < 10 ppm (Appendix Y).

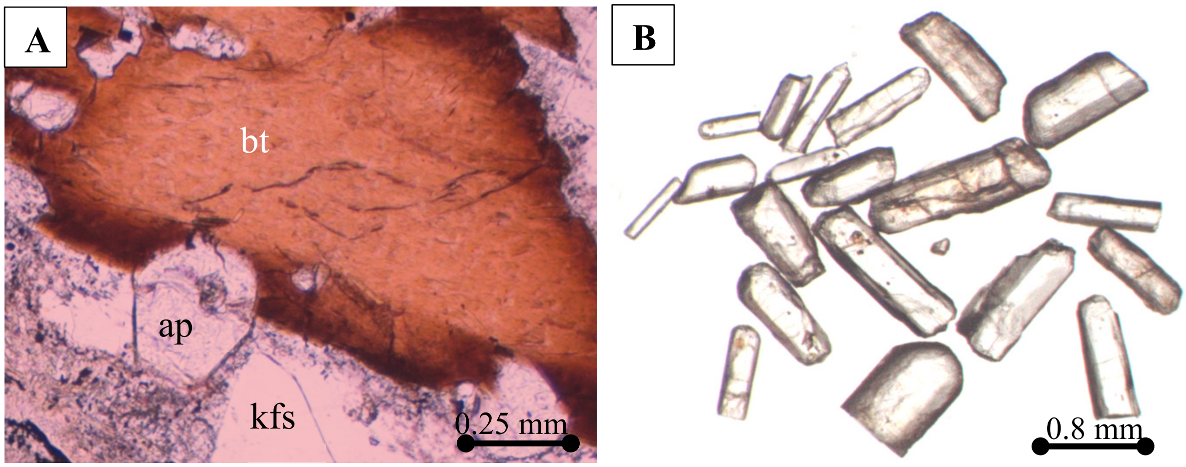


Figure 35 – Examples of typical apatite from MPIS ultrapotassic rocks. **A**. Plane-polarized photomicrograph of apatite in thin section (MP-P0714-26). **B**. Apatite grains separated from sample (MP-P0714-26). **ap = apatite, bt = biotite, kfs = K-feldspar.**

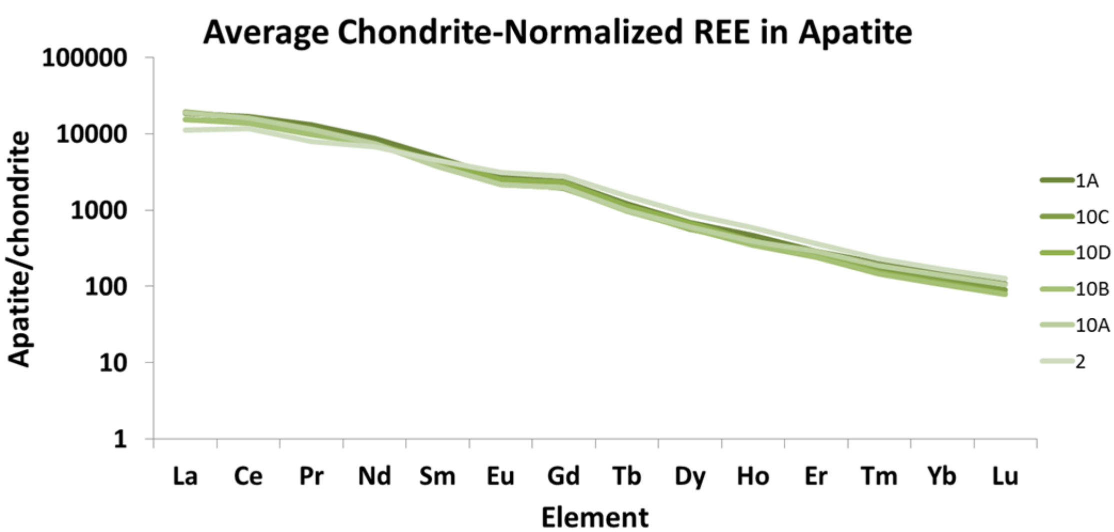


Figure 36 - Average chondrite-normalized REE plot of apatite from ultrapotassic rocks.

Rutile from sample MP-P0913-2 are anhedral, occurring in fine-grained aggregates of quartz, monazite, and ilmenite – Zr content in these grains is highly variable, and yields correspondingly variable Zr-in-rutile temperatures (~1200-425^{0} C) (Fig. 38). REE content in the anhedral grains is also highly variable, ranging from < 1 ppm to tens of thousands ppm (Appendix Y).

6.8 Mineral/Rock Partition Coefficients (K_d)

Partition coefficients (K_d) for selected trace elements were calculated for titanite, zircon, and apatite relative to the bulk rock compositions (Figs. 39A-39C). Titanite and apatite have the highest partition coefficients for the light and middle REEs ($K_d \sim$ 8-40). One titanite sample has higher K_d for the light REEs, but occurs in an apatite-poor rock. Zircon has similar, but generally higher partition coefficients for the HREE (K_d up to 125 for Lu). Partition coefficients for Th and U are similar for titanite and zircon, but are lower for apatite. However, these calculations were made only for zircons that yielded concordant ages – most samples also contain abundant metamict zircon with U content from 1,000 to 10,000 ppm and Th content from hundreds to tens of thousands ppm, indicating that average zircons from the rocks are likely to have much higher K_d for Th and U. Partition coefficients for the HFSE are the highest in titanite, except for Hf.

6.9 Secondary Alteration Textures

A secondary alteration texture similar to that described by Stoeser (2013) is present in MPIS rocks. The textures are abundantly apparent in thin section using SEM, but are subtle when viewed in the petrographic microscope. However, the most pervasively altered samples

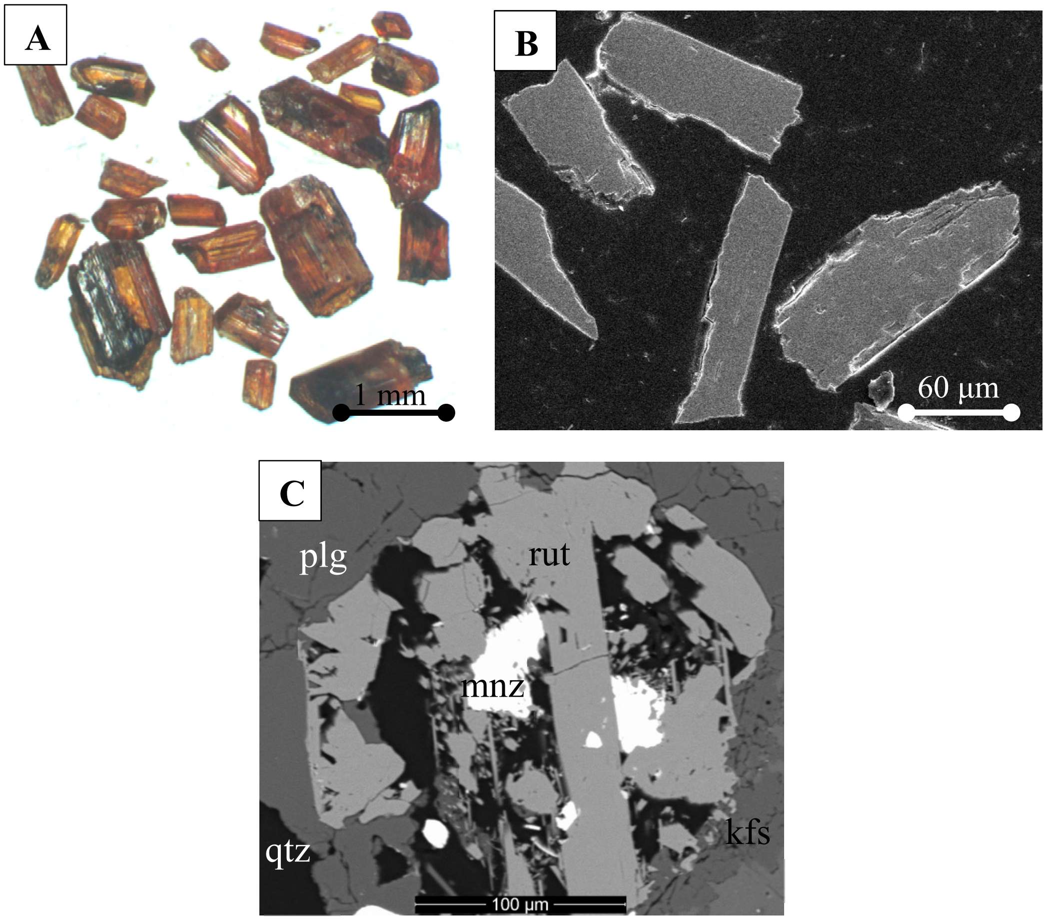


Figure 37 – Typical rutile in MPIS syenite. **A**. Rutile grains separated from syenite sample (MP-P0714-15). **B**. Backscatter-electron image of rutile in grain mount (MP-P0913-2). **C**. Backscatter electron image of anhedral rutile forming aggregate with quartz and monazite in altered sample (MP-P0913-2). **kfs = K-feldspar, mnz = monazite, plg = Na-rich plagioclase, q = quartz, rut = rutile.**

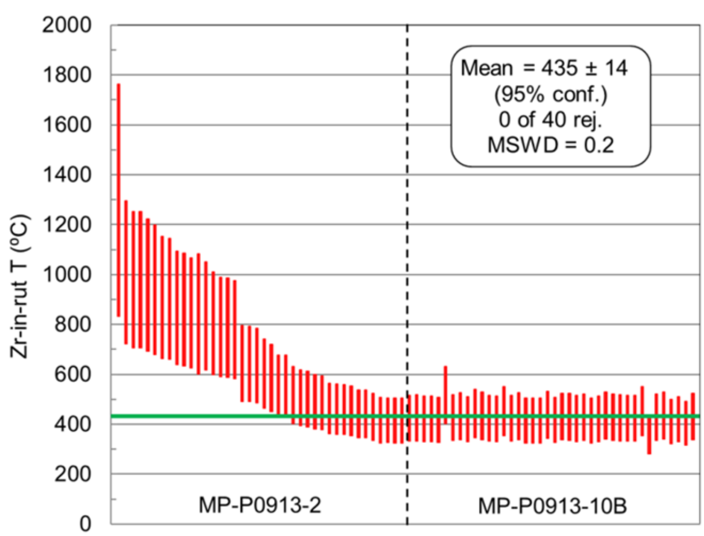


Figure 38 – Zr-in-rutile thermometry data plot. A weighted mean is shown only for the sample on the right (MP-P0913-10B) due to the spread in data from the sample on the left (MP-P0913-2).

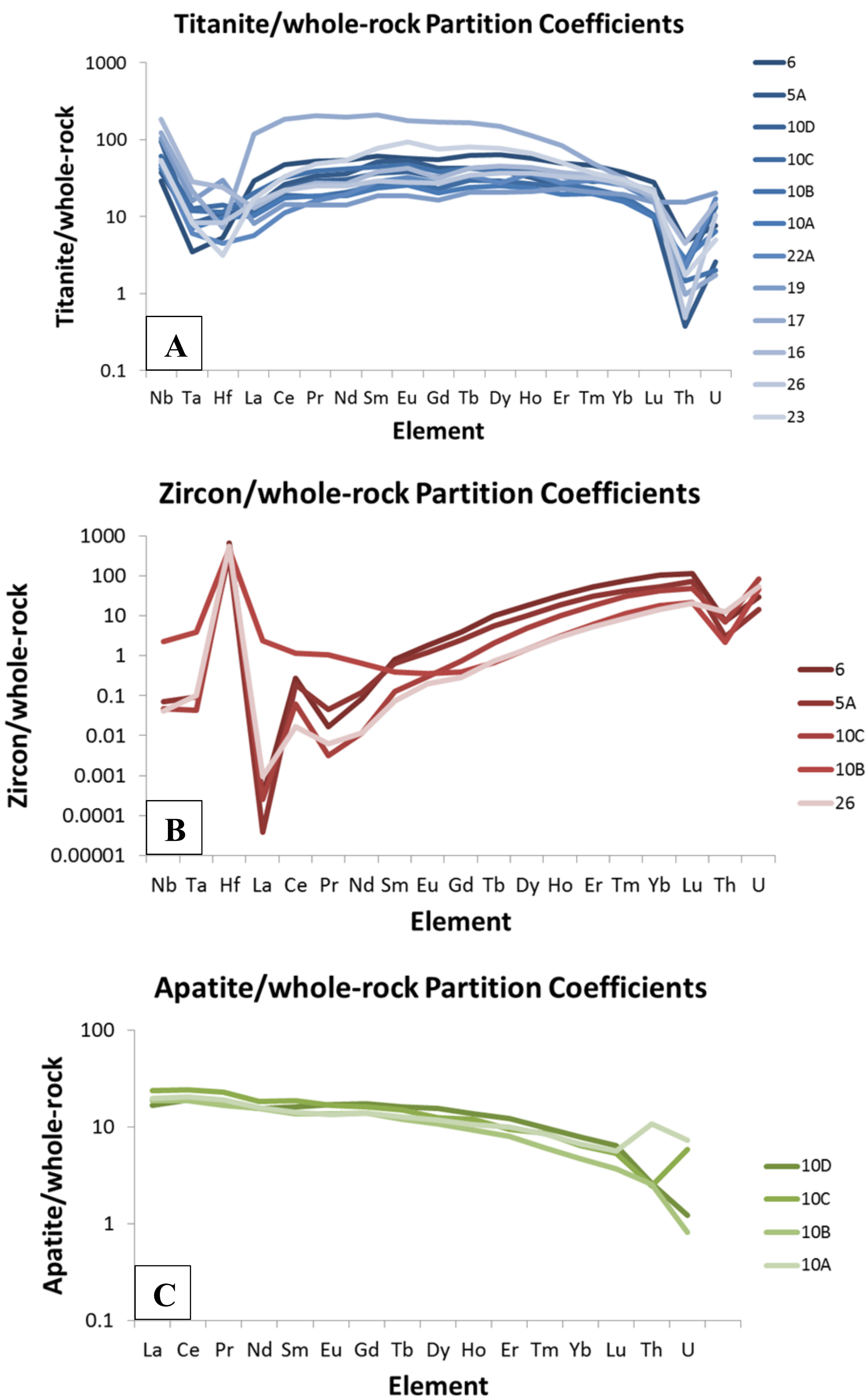


Figure 39 – Mineral/rock partition coefficient plots for selected elements in accessory phases from MPIS ultrapotassic rocks. **A**. Titanite. **B**. Zircon. **C**. Apatite.

show parallel to sub-parallel veins with microcrystalline, high birefringence minerals (primarily in K-feldspar) and cloudy or opaque zones shaped like several primary minerals (e.g. amphibole and titanite) in thin section (Figs. 40A & 40B). SEM-BSE imaging reveals veins containing barite, quartz, Fe-oxide, and REE phases (mostly monazite), and some primary phases are pseudomorphed by anhedral aggregates of the same minerals that form the veins (Fig. 40C). “Skeletal” grains of Fe-oxide are present in some samples, and in some cases contain a core of a spheroidal, unidentified Ca-Al-Mg silicate mineral (Fig. 40D).

The most altered ultrapotassic rock samples do not contain titanite, but contain sphene-shaped aggregates of rutile (?), monazite, ilmenite and quartz (Fig. 41A). Some also contain minor apatite. In one sample, titanite contains reaction fronts and veins of monazite and quartz (?), and coexists with rutile-monazite-quartz aggregates (Figs. 41B & 41C). At least one sample is transitional, and contains titanite grains that appear to be breaking down to rutile, ilmenite, monazite, and quartz (Fig. 41D). Monazite and rutile were found only as secondary phases in pervasively altered ultrapotassic rock samples with no titanite. Rocks from the Groaner, Mexican Well, and Mineral Hill stocks are the most altered, and did not yield titanite, but yielded abundant rutile. In general, coarse-grained samples appear to have been most affected. Zircon is present in both altered and unaltered samples, differing in morphology and degree of U-Pb discordance from sample to sample. Bastnäsite was only observed in carbonatite samples.

Of the three carbonatite samples observed in this study, two show abundant evidence of sub-solidus alteration. Alteration textures in the carbonatite are most apparent as fine-grained aggregates of Fe-oxides and quartz. Quartz appears as porous, concentric-shaped intergrowths with Fe-oxide. Barite, bastnäsite, synchysite/parisite, and celestite or

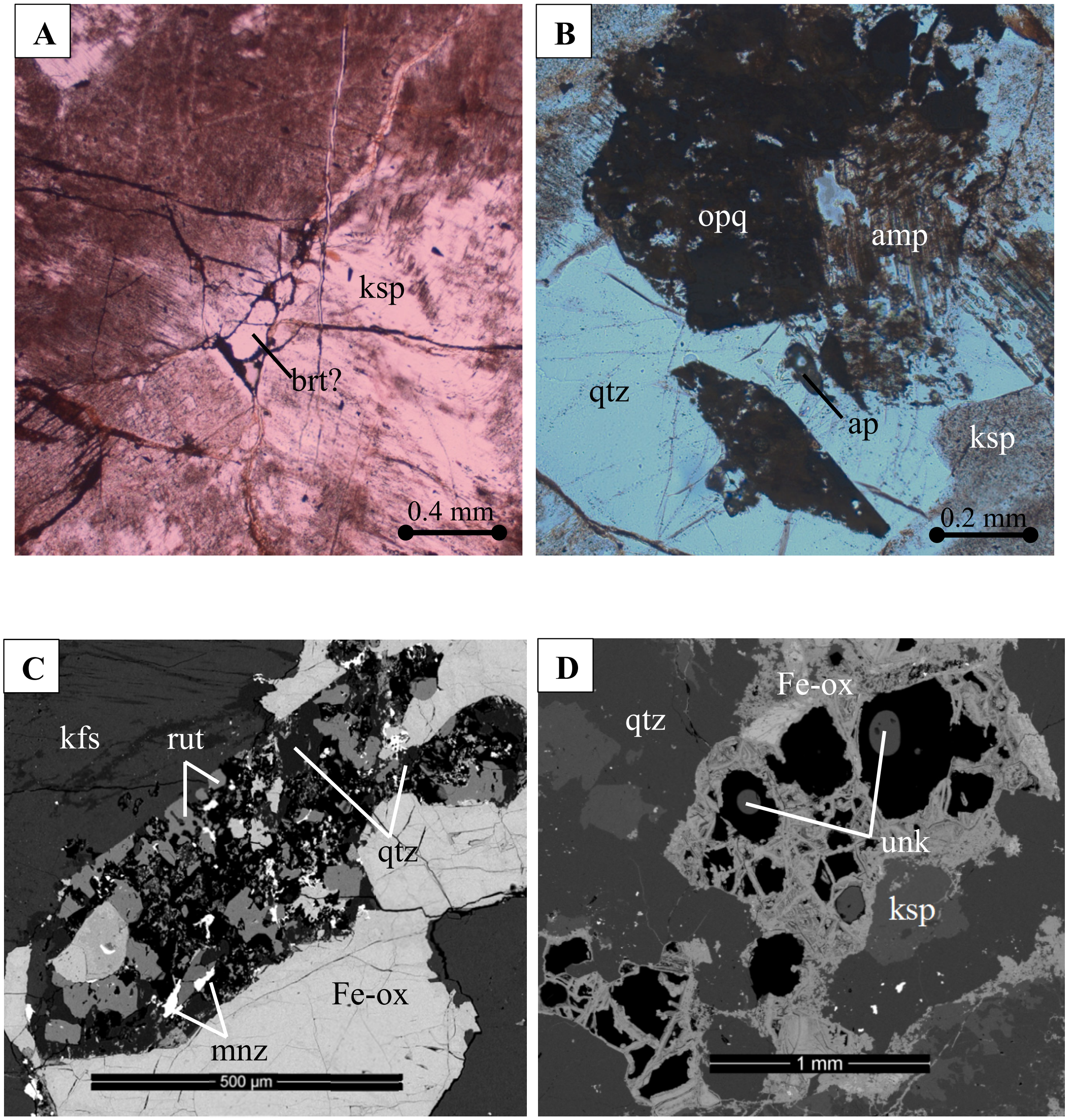


Figure 40 – Alteration textures in MPIS ultrapotassic rocks. **A**. Plane-polarized photomicrograph of veins containing barite and monzite within K-feldspar in thin section (MP-P0913-2). **B**. Plane-polarized photomicrograph of anhedral aggregates of opaque minerals in thin section (MP-P0913-2). **C**. Backscatter-electron image of anhedral aggregate of secondary minerals forming a psuedomorph of a (presumably) primary mineral (MP-P0913-2). **D**. "Skeletal" grains of Fe-oxide containing an unidentified Ca-Al-Mg silicate phase in altered sample (MP-P0913-7). **amp = sodic amphibole, ap = apatite, brt = barite, Fe-ox = Fe-oxide, kfs = K-feldspar, mnz = monazite, opq = opaque minerals, rut = rutile, unk = unknown Ca-Al-Mg silicate mineral.**

strontianite are commonly intergrown within the same crystals (Fig. 41E). Like the veins in ultrapotassic rocks, veins in carbonatite host barite, monazite, quartz, calcite, Fe-oxide, and additionally contain bastnäsite and minor celestite and galena.

Samples with alteration textures were generally avoided for whole-rock XRF analyses, but one ultrapotassic rock sample with pervasive alteration textures (MP-P0913-2) was analyzed to test whether or not alteration is discernable in whole-rock chemistry. However, major and trace element composition in the sample is not markedly different from relatively unaltered samples.

7. DISCUSSION

7.1 Whole-rock Geochemistry and Mineral/Rock Partition Coefficients

Trends observed between whole-rock major element oxides in Mountain Pass shonkinite and syenite are likely due to differences in modal abundance of major and accessory phases. The trends observed between major elements and silica in MPIS rocks, such as increasing Al_2O_3 with increasing silica and lack of trend between K_2O and silica, (Figs. 15A-15G) are common in other ultrapotassic rock occurrences (Foley et al., 1987; Castor, 2008). Decreasing content of Mg and Ca with increasing silica content is probably related to the greater modal abundance of clinopyroxene (Mg, Ca) and apatite (Ca) in low silica samples. Decreasing Fe content with increasing silica is likely a product of decreased abundance of magnetite and clinopyroxene. Lower P is likely due to decreased abundance of apatite in more felsic samples. Ti also decreases with increasing silica, likely due to the high abundance of Ti-bearing biotite in mafic samples, which has been reported by previous studies (Haxel, 2005; Castor, 2008). Increased levels of Al and Na in high-silica samples are

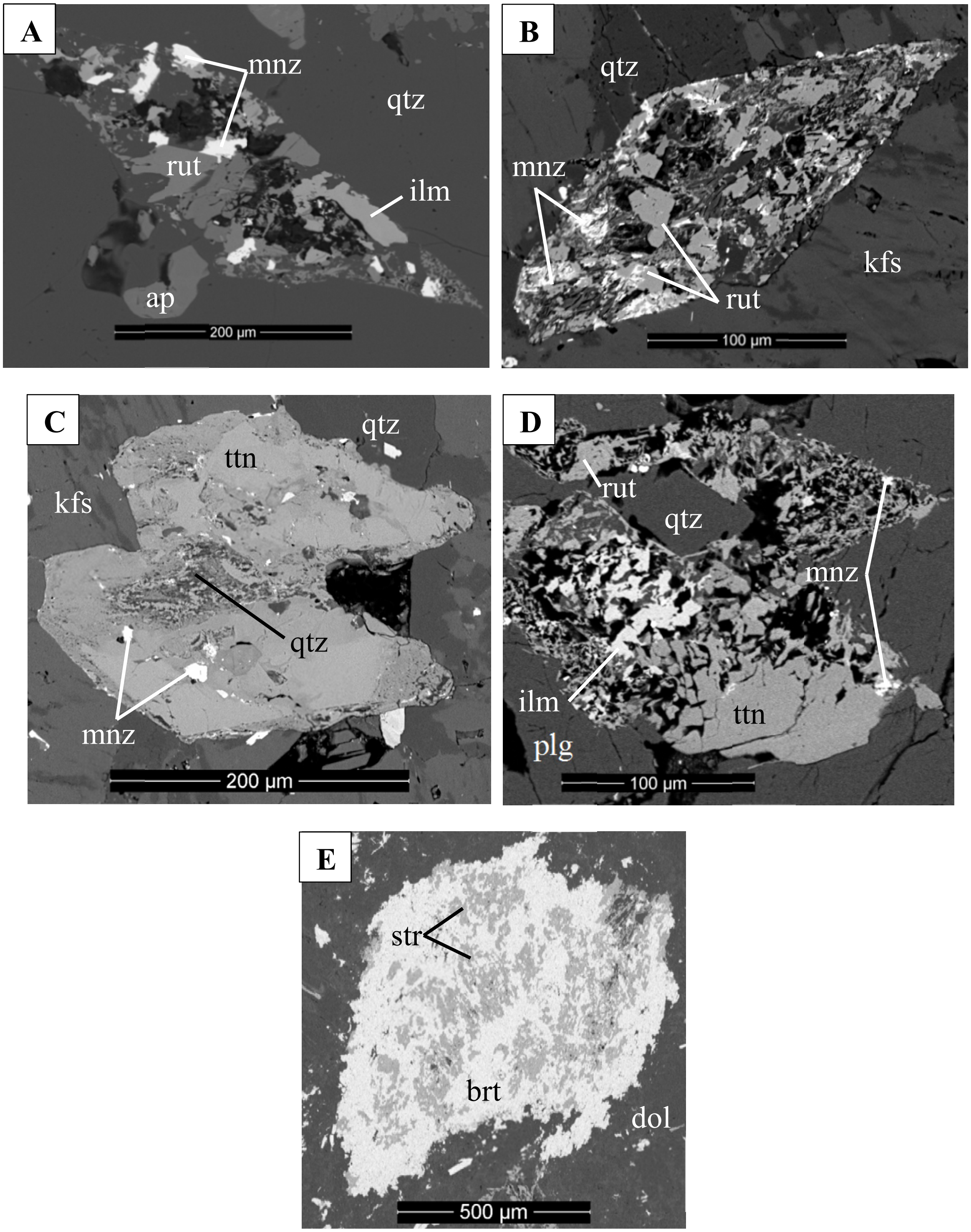


Figure 41 – Examples of alteration textures in accessory phases. **A**. Titanite pseudomorph formed by anhedral grains of rutile, ilmenite, monazite, and quartz with minor apatite (MP-P0913-2) . **B**. Titanite pseudomorph formed by anhedral rutile, monazite, and quartz (MP-P0913-9B). **C**. Titanite with reaction fronts and veins in same sample as titanite pseudomorphs formed by secondary minerals (MP-P0913-9B). **D**. Titanite partially brokend down to secondary minerals (MP-P0913-10B). **E**. Barite and strontianite intergrowth in carbonatite. **Ap = apatite, brt = barite, dol = dolomite, ilm = ilmenite, kfs = K-feldspar, mnz = monazite, plg = Na-rich plagioclase, qtz = quartz, rut = rutile, str = strontianite, ttn = titanite.**

likely due to greater abundances of K-feldspar and plagioclase, the latter of which is mostly absent in mafic samples. K does not show a marked trend, probably because of the high abundance of biotite in mafic samples and K-feldspar in felsic samples. Additionally, the higher abundance of incompatible elements in the mafic samples, most notably Ba, Sr, and LREE, likely reflects high modal percentages of incompatible-element-rich phases in the mafic samples. Apatite measured in this study typically have Sr content in the tens of thousands of ppm range, and is likely the reason for high Sr in lower silica rocks as it is most abundant in these samples. High Ba content is likely due to high Ba biotite, the presence of which was noted by Haxel (2005) and Castor (2008). Chondrite-normalized REE patterns of samples measured in this study are also typical of ultrapotassic rocks, most notably the high LREE to HREE slope and lack of an Eu anomaly (e.g. Foley et al., 1987; Castor, 2008), the latter of which likely indicating that plagioclase fractionation was not an significant factor in the magmatic history of the MPIS – this is not surprising, considering the paucity of plagioclase in the complex.

The higher abundance of LREE in low-silica samples is atypical with respect to most igneous suites, but is common amongst occurrences of ultrapotassic rocks (e.g. Foley et al., 1987). Although the mafic MPIS rocks contain titanite, which is known to incorporate up to ~4 weight percent REE in alkaline igneous rocks (e.g. Vuorinen & Helenius, 2005) and is considered an important REE-sink in silicate melts (e.g. Gromet & Silver, 1983; Sawka et al., 1984), apatite is far more abundant (up to ~3% in samples studied here) and has similar partition coefficients for the REE. Other studies have reported up to 5% apatite in mafic MPIS rocks (Woyski, 1980; Haxel, 2005). Like titanite, apatite has been noted as an important REE carrier in alkaline rocks (e.g. Lingdi and Yangchuan, 1989; Krenn et al., 2012). Moreover, titanite occurs in both mafic and felsic samples, and therefore its relative abundance between rock types does not explain the observed trends in REE. However, the presence of titanite in samples of all compositions is a possible explanation for the lack of trends in the HFSEs from sample to sample, as titanite is often considered an important carrier of HFSEs (e.g. Marks et al., 2008). Like the HFSEs, the HREE, Th, and U content of the samples do not show a trend with major element composition. Zircon has somewhat higher partition coefficients for the HREE, and the highest for Hf, but is also abundant in most samples, regardless of composition. Although titanite and apatite have similar partition coefficients for Th and U compared to concordant zircon, metamict, high-Th and -U zircon is ubiquitous throughout the MPIS. Zircon has been shown to be a significant carrier of HREE and actinides in alkaline rocks (e.g. Žáček et al., 2009). Together, these data indicate that apatite is likely the most important carrier of REE in these rocks, followed by titanite. Titanite is likely the most important carrier of HFSEs, except for Hf, and zircon is the primary carrier of HREE, Hf, and actinides. Monazite also contains abundant REE and Th, but is not present in significant amounts in most samples and is not a primary phase. Rutile contains abundant HFSEs, but is also only present in notable amounts where titanite is absent and appears to only occur as a secondary phase. Apatite, titanite, and zircon are therefore likely to have played the most important roles in controlling the HFSE, REE, and actinide budget of the ultrapotassic magmas as they crystallized.

The secondary alteration textures that are common in the ultrapotassic rocks at Mountain Pass are likely to have affected their whole-rock chemistry, but the effect is difficult to quantify. Nearly all samples appear to have been affected to some degree; thus, there are no samples that may be regarded as an uncontaminated endmember. However, the presence of trends between silica and most major and trace elements in the samples suggests that their compositions have not been significantly altered to the point that they no longer retain their original chemistry. This may indicate that the alteration event simply redistributed elements within the ultrapotassic rocks, rather than removing or adding them. Further work is needed to constrain the effect of the alteration textures on the rocks' chemistry, perhaps by collecting a suite of samples that are both highly altered and minimally altered – highly altered samples were purposely avoided for the purposes of this study, and the true extent of alteration may not be accurately represented in the sample suite presented here.

7.2 Accessory Phase Geochronology and Trace Elements

7.2.1 Titanite

In the ultrapotassic rocks of the MPIS, titanite consistently yields single-population U-Pb dates that range from 1429 ± 10 to 1385 ± 18 Ma (Figs. 18A & 18B, Appendix D). Several lines of evidence indicate that these dates are best interpreted as the igneous crystallization age of each sample: 1) Detailed petrographic observation indicates that unaltered titanite are generally euhedral to subhedral and show interlocking textures with primary igneous minerals (Figs. 17B & 17C), suggesting that it is a primary phase that crystallized directly from a melt; 2) where present, titanite alteration textures suggest that it is primary and has reacted to secondary alteration, rather than grown in response to alteration; 3) chondrite-normalized REE patterns in Mountain Pass titanite are broadly similar to those of titanite from a wide range of igneous rocks (e.g. Bea et al., 1996; Russell, 1994; Mazdab, 2007; Lingdi & Yangchuan, 1989), and whole-rock data indicate LREE enrichment ~1000x chondritic values in Mountain Pass ultrapotassic rocks (Fig. 14), indicating that high LREE in titanite from Mountain Pass ultrapotassic rocks is consistent with crystallization from an LREE-rich melt; 4) Zr-in-titanite thermometry predominantly yields temperatures of 700 ^{0}C and higher, consistent with an igneous origin; and 5) dates obtained from concordant zircon overlap the titanite dates within uncertainty in four of five samples. Taken together, these data suggest that titanite is most likely a primary igneous phase in Mountain Pass ultrapotassic rocks, and has recorded the same igneous crystallization event as zircon.

Assuming a P of ~ 0.1 GPa, Zr-in-titanite temperatures for Mountain Pass titanite are as low as ~650 ^{0}C. Temperatures less than ~700 ^{0}C could be due to a secondary process; however, temperatures below 700 ^{0}C are relatively uncommon, and samples that yield these temperatures also contain grains that yield temperatures up to ~900 ^{0}C. Additionally, the uncertainties associated with the Zr-in-titanite temperatures are on the order of 30-50 ^{0}C, such that the temperature represented may still be ~700 ^{0}C within uncertainty. U-Pb analyses from the same grains do not show significant scatter, i.e. they do not appear to record more than one event. It is possible that the uncertainties of the U-Pb ratios from individual analyses have disguised scatter in the U-Pb data and that the grains record a secondary event in addition to igneous crystallization, but if so, the temporal difference between the two events is not resolvable with these data. Furthermore, Zr diffusion in titanite has been shown to be slower than that of Pb (Cherniak, 2006); therefore, it should be expected that a secondary event pervasive enough to affect the Zr content in the titanite grains should also have had a noticeable effect on the U-Pb ratios of the grains. The cause of variation in Zr content is unclear, but a possible explanation is that titanite crystallized through a range of temperatures as the magma was crystallizing, and they have thus recorded temperatures that reflect both the temperature of the primary magma and the latest stages of cooling through 650 ^{0}C. It is also possible that titanite U-Pb ages therefore also reflect cooling through 650 ^{0}C, but given that titanite and zircon U-Pb ages overlap within uncertainty in all but one sample, the titanite U-Pb ages are still most likely to also reflect igneous crystallization ages.

Two titanite samples measured in this study (MP-P0714-16 and MP-P0714-26) give U-Pb isochrons suggestive of non-analytical scatter between data-points, i.e. compositional or age heterogeneity in grains from the same sample (e.g. Figs. 18C-18E). Titanite is known to preserve multiple intracrystal age domains, which can occur via new titanite growth on existing rims, recrystallization of existing titanite, and/or variable Pb loss (e.g. Mazdab, 2007; Spencer et al., 2013). One of the samples with MSWD = 1.7 gives the youngest age for Mountain Pass rocks. Possible explanations for data scatter include: 1) that some portions of grains are xenocrystic; the oldest age is inherited and the youngest age reflects the age of the rock; 2) all grains have experienced only partial Pb loss, and the isochron gives an 'average' age between 2 events that does not reflect the age of the crystal; or 3) some grains or parts of grains have experienced varying degrees of Pb loss; the oldest age reflects the crystal's age and the youngest records a secondary event or process. Titanite is uncommon in Mountain Pass host rocks and does not record dates >1430 Ma in MPIS rocks; thus, it is unlikely to be inherited from the host rocks. Therefore, the possible presence of multiple age populations within the two samples is more likely to be due to Pb loss or recording of a secondary event. The oldest age components of the samples overlap all other samples ~1425-1380 Ma well within error, thus it is unlikely these titanite grains record only an 'average' date between 2 separate geologic events that is not geologically meaningful. The oldest ages recorded in the crystals are therefore likely reflect the crystallization age of the sample, and may yield a younger “errorchron” date due to the presence of grains that have lost Pb or crystallized later. Interestingly, the grains do not contain well-defined cores or rims when viewed with SEM/BSE, and do not show a systematic age variation between grains or within different zones in single crystals. Furthermore, textures and trace element contents do not systematically differ from samples that give more precisely defined ages. The Pb loss event thus does not appear to have followed a consistent spatial pattern or significantly alter titanite chemistry. The sample for which most grains have been reset (MP-P0714-26) also yields a zircon (mean $^{207}Pb/^{206}Pb$) age of 1434 ± 9 Ma, which overlaps the older titanite age of 1410 ± 17 Ma within uncertainty. In addition, another sample from the same intrusive body (MP-L0613-BDAY; from the Birthday stock) yielded a zircon age of 1425 ± 5 Ma. Thus, the crystallization age of the sample is interpreted to be ~1425 Ma, indicating that most of the grains in the sample have been reset by a second event. For the sample in which 8 analyses record a younger age (MP-P0714-16), the younger age broadly overlaps the older age within uncertainty (1395 ± 25 and 1413 ± 16 Ma, respectively), and the sample did not yield zircon. Rocks nearby gave younger U-Pb ages, and therefore may have disturbed the U-Pb systematics of this sample during emplacement. However, the younger age is imprecisely recorded such that the age of disturbance is poorly constrained, and is not resolvable from the older age component of the sample. Therefore, because there are no U-Pb ages of other phases to compare and these age components widely overlap within uncertainty, the crystallization age of the sample is interpreted to be reflected by the isochron age derived from plotting all analyses together, despite large MSWD (1410 ± 17; MSWD = 1.7).

7.2.2 Zircon

Zircon textural and trace element data from Mountain Pass intrusive rocks indicate that zircon has undergone a potentially complex history. Dates from 1635-1800 Ma are derived from discrete grains that differ from most zircon in MP ultrapotassic rocks, but are similar to host gneiss zircon in their morphology, more variable LREE content, Ti-in-zircon apparent temperatures, and prevalence of U-Pb concordance (~50% of analyses; e.g. Fig. 27, Appendix K). According to these similarities, they are most likely xenocrystic zircon inherited from the host rocks, and will not be considered further.

One sample (MP-P0913-5A) yielded zircon U-Pb analyses that range in age from 1600 to 1430 Ma, in addition to ages 1800-1640 to 1430-1410 Ma. The analyses are from three large, rounded grains, and do not overlap in age with either host rock zircon or most zircon from the ultrapotassic rocks. In addition to being the only grains with ages younger than ~1640 Ma and older than 1450 Ma, the zircons have Th/U ratios < 1, a trait shared with zircons older than 1640 Ma in the sample and zircon from the host rocks. All but one analysis from zircons younger than 1430 Ma in the sample have Th/U > 1.5, a trait shared with zircon from all other MPIS samples except for one (MP-P0913-10B). Apparent mixing of age domains due to sampling multiple zones by LA-ICPMS has been documented in zircon, and typically results in dates between two endmember ages (e.g. Horton & Leech, 2013; Kröner et al., 2014). Therefore, these ages are interpreted as “mixed” ages resulting from sampling of both overgrowths and cores of grains that were inherited from the host rocks, and grains with Th/U < 1 are not included in the age interpretation of this sample.

Concordant zircon ages from four samples overlap the titanite isochron ages from the same rocks (~1425-1400 Ma), and previously reported ages for shonkinite and syenite (DeWitt et al., 1987; DeWitt et al., 2000; Premo et al., 2013) (Fig. 42). For one sample (MP-

P0913-10C), the zircon U-Pb age does not overlap the titanite U-Pb age within uncertainty. However, the sample is from a shonkinite dike that cross-cuts syenite in the Tors stock (e.g. Fig. 4C), and both titanite and zircon from the syenite give a younger age than zircon from the cross-cutting dike. Furthermore, the zircon age of the cross-cutting dike is older than any other age measured in this study (mean $^{207}Pb/^{206}Pb$ age = 1458 ± 7 Ma). Three explanations seem worth considering: 1) the zircons are inherited, and either represent partially reset zircon from a host rock or are inherited from the magma source; 2) the $^{207}Pb/^{206}Pb$ age is anomalously old due to the presence of small amounts of common Pb; or 3) a small sample size has skewed the apparent age, and sampling of more zircons within the sample may yield a younger average age. None of the zircons from the sample yield ages that overlap zircon ages from the host gneiss, and Hf isotopes from the grains are roughly the same as all other zircon from the ultrapotassic rocks, suggesting that they are not inherited from the host rocks. Although the age is defined by only 10 analyses, there is very little age spread amongst the individual analyses, suggesting that the anomalously old age is not due to mixing of age components or an artifact of small sample size. Additionally, explanation of old grains in a younger sample would still require either common Pb presence and/or inheritance/mixing of age domains. Discordant grains from the sample, like zircon from all other samples, contain abundant common Pb. It is therefore likely, at least in part, that the $^{207}Pb/^{206}Pb$ age of the grains is "old" due to the presence of common Pb. However, the possibility that the grains were inherited from the magma source cannot be completely discounted. This seems unlikely, on the basis that no other zircons from MPIS rocks yield analyses of this age. In either case, the age of these zircons is highly unlikely to reflect the crystallization age of the rock, because: 1) it is the only sample in which zircon and titanite ages do not coincide; 2) the ages are older than zircon from any other rock in the MPIS; and 3) the rock crosscuts another rock that yields a younger zircon age.

The near-ubiquity of abundant common Pb content and/or Pb loss in Mountain Pass zircon makes it difficult to deduce the relative influence of each on discordant analyses. Data that do not form clusters in Tera-Wasserburg U-Pb space appear to trend towards older ages if plotted on a Wetherill Concordia diagram (~1420-1450 Ma), and would likely result in an age overestimation if no other data were available (Fig. 43). Analyses that are influenced by common Pb can be corrected, but if the grain has also experienced any Pb loss this results in overcorrection (i.e. the corrected age will be too young). If it is assumed that slightly and moderately discordant analyses are not influenced by common Pb, that only Pb loss has occurred, and that intercept ages defined by trends in discordant data represent the age of the sample, any common Pb in the analysis will lead to an overestimation of the U-Pb age. Given that titanite ages are defined by more data points and overlap concordant zircon ages, it is likely that apparently older zircon ages in some samples are influenced primarily by common Pb, i.e. the zircons are younger than the Discordia intercepts suggest.

Zircons that contain >1000 ppm commonly appear metamict and occur in the same samples as non-metamict zircon, but are higher in LREE and Ti. Recrystallization of metamict zircon is commonly thought to occur via interaction with a fluid (Mezger & Krogstad, 2004) and is occasionally associated with elevated LREE contents (e.g. Kusiak et al., 2009; Yudovskaya et al., 2013). The pervasive alteration texture that characterizes some samples is evident in large part by veins and pseudomorphs of primary phases by secondary minerals, and independently suggests that primary minerals interacted with/reacted to a fluid at some point in their history. Zircon in many samples forms anhedral crystals with

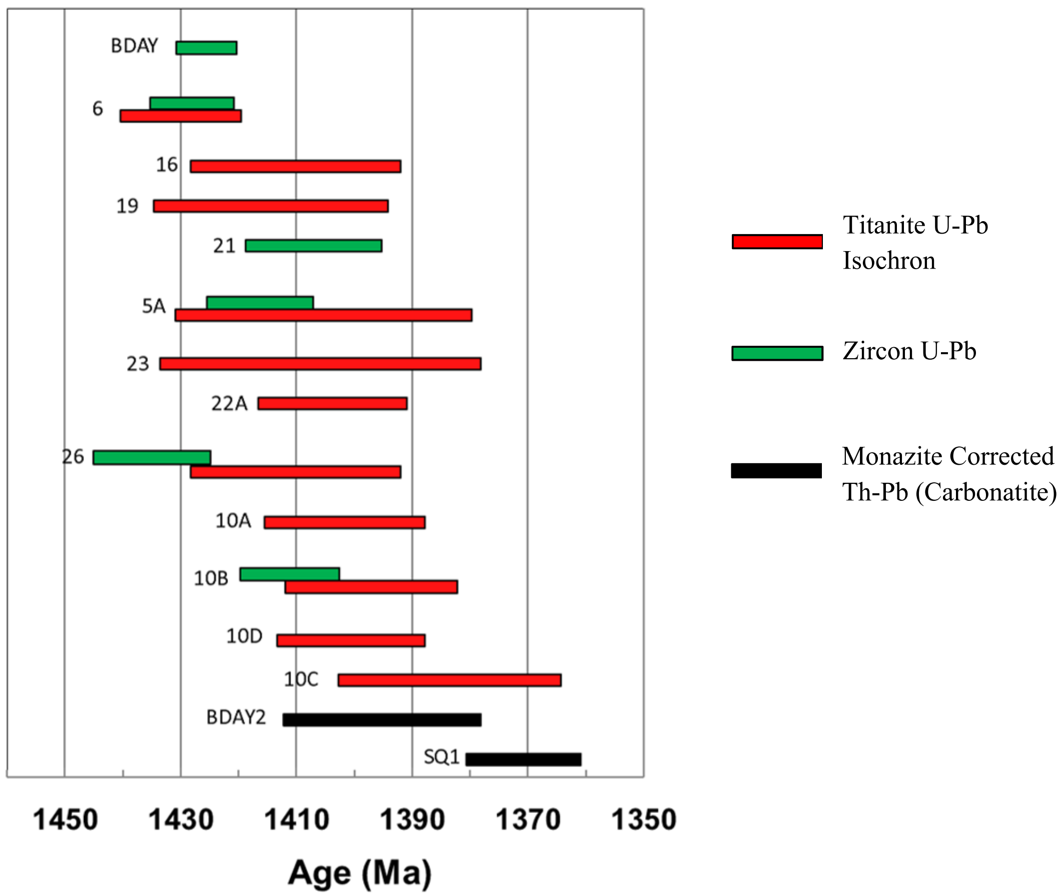


Figure 42 – Plot of titanite, zircon, and monazite dates from all samples measured in this study. Each date and associated uncertainty is from all analyses interpreted as age (e.g. Tera-Wasserburg Concordia age, intercept age, etc.) of a specific mineral in a single rock sample.

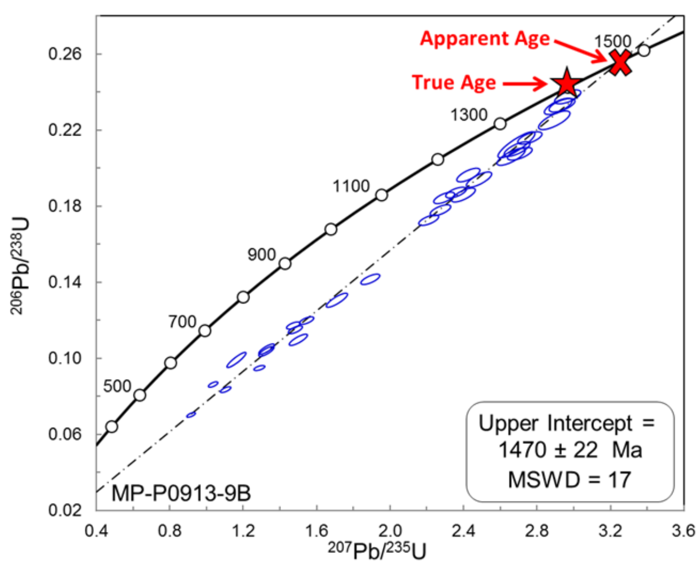


Figure 43 – Wetherill Concordia plot for zircon from leucosyenite sample MP-P0913-9B illustrating the likelihood of age overestimation if age interpretations are made from discordant zircon U-Pb data.

irregularly-shaped zoning visible in CL (e.g. Fig. 23G), which is especially pervasive along fractures and at grain boundaries, suggesting that some of the zircon also interacted with a fluid. It is thus likely that pervasive Pb loss, high common Pb content, and high LREE element content in Mountain Pass zircon is the result of interaction of primary, high-U zircon with a fluid. It might be expected that zircon would record the timing of this event, and that the possible Pb loss observed in titanite would have occurred as a result of the same event. However, all discordant zircon data trend either toward the $^{207}Pb/^{206}Pb$ composition of common Pb, or toward Phanerozoic ages. Zircon from Mountain Pass host rocks yield similar arrays in discordant data, but are mostly characterized by partial Pb loss and do not contain abundant common Pb. These data indicate that Pb loss ~1380-1350 Ma is not recorded by zircon, so it is unclear whether the possible Pb loss in titanite is related to the same event. Although the Pb loss event that affected nearly all Mountain Pass zircons may be an important detail in the chemical evolution of these rocks, it is defined only by inconsistent, discordant zircon data, and further work is needed to constrain the timing and nature of the event.

Analytical effects could also contribute to the apparent minor discordance observed in some Mountain Pass zircon. The time-dependent change in measured inter-element ratios of natural zircons has been shown to vary between reference materials and samples when measured by LA-ICPMS (e.g. Marillo-Sialer et al., 2014), due to difference in ablation rate. The high U and trace element content in Mountain Pass zircons increases the likelihood that they have different physical characteristics (i.e. lattice defects) compared to the zircon standard reference materials used in this study, causing a difference in ablation rate and hence measured inter-element ratio. Laser-ablation- and plasma-induced U/Th-Pb fractionation is modeled from repeat measurements of the primary reference materials, and thus a difference in ablation rate can result in inaccurate correction of raw U/Th-Pb ratios measured in the sample. However, it is worth noting that DeWitt et al. (1987) also reported abundant common Pb and Pb loss in zircon from the ultrapotassic rocks at Mountain Pass, suggesting that it is a geologic feature amongst zircon in the MPIS rather than an analytical effect.

7.2.3 Monazite

Low U, high common Pb monazite in Mountain Pass intrusive rocks does not generate a geologically meaningful U-Pb age due to a low relative proportion of radiogenic Pb. Th-Pb ages from monazite are quite variable in three out of the four samples that yielded monazite, ranging from ~1420 to 950 Ma. Monazite in the ultrapotassic rocks is likely a secondary phase – it occurs only in samples with other evidence for alteration (i.e. monazite-bearing veins and titanite pseudomorphs with monazite). It has been suggested that MPIS rocks were affected by a hydrothermal event soon after their emplacement (Premo et al., 2013; Stoeser, 2013), which could explain the variability in Th-Pb ages measured in monazite and suggests that monazite growth in the ultrapotassic rocks is likely hydrothermal. The monazites have REE similar to wide range of igneous rocks (e.g. Bea et al., 1996), although this is not corroborated by textural evidence. The origin of monazite in carbonatite is unclear from textural relationships; however, it has roughly the same trace element content, U/Th-Pb systematics, and range of Th-Pb dates as monazite in the ultrapotassic rocks, indicating that monazite in both rock types may be genetically related. However, it is unclear whether the secondary alteration event is related to carbonatite magmatic activity or if it is a later event that disturbed the Th-Pb systematics of primary, igneous monazite in carbonatite.

It is likely that Th-Pb dates younger than ~1350 are the result of Pb loss, given that they are restricted to less than half of the analyses, and that they are distinctly younger than ages measured by other workers (DeWitt et al., 1987; DeWitt et al., 2000; Premo et al., 2013). These data somewhat resemble those reported for bastnäsite and parisite by DeWitt et al. (1987), which yielded Th-Pb dates of ~1332 ± 7 Ma and younger. DeWitt et al. (2000) suggested that barite in the carbonatite re-equilibrated in low-temperature conditions on the basis of S isotopes, independently indicating that at least some carbonatite has undergone sub-solidus alteration, which may account for open-system behavior and Pb loss in monazite. It is likely that ages ~1370 and older have also been affected by Pb loss, suggesting that the oldest Th-Pb ages may represent the timing of monazite crystallization, but there are no other constraints on the true crystallization age. Older dates may also be the result of small amounts of common Pb that were not accounted for by the correction scheme applied to the Th-Pb ratios of the samples, but this possibility is discounted if only on the basis that there are no data to accurately evaluate whether or not all common Pb was properly corrected for. If ages younger than ~1340 Ma are rejected, the mean Th-Pb dates approach 1405 Ma for one carbonatite sample and 1380 Ma for the other, but MSWD of the mean is still > 1 and there is no significant evidence to justify their exclusion other than their younger dates. The same is true of monazite Th-Pb ages from the ultrapotassic rocks, except that there are fewer analyses upon which to base the age interpretation.

In the absence of other data to evaluate the meaning of the Th-Pb monazite dates, the monazite crystallization ages of carbonatite samples MP-L0613-BDAY2 and MP-P0913-

SQ1 are inferred to be ~1400 Ma and ~1380 Ma, respectively. Although imprecisely defined, the ages of monazite in the ultrapotassic rocks are inferred to lie within this range, and are interpreted as being related either to a late-stage fluid or carbonatite emplacement, rather than igneous crystallization of the ultrapotassic rocks. The idea that monazite in the ultrapotassic rocks is related to carbonatite emplacement is supported by the high concentrations of Ba and LREE in veins, and by the reported presence of minerals in the veins that are also present in the carbonatite (e.g. bastnäsite, parisite, calcite; Stoeser, 2013). However, it is also possible that remobilization of highly incompatible elements (i.e. Ba, LREE) already present in the rocks by an unrelated hydrothermal event could also have occurred.

The U-Th-Pb monazite age reported from Mountain Pass carbonatite by DeWitt et al. (1987, 2000) is within the range measured in this study, but is more precise (1375 ± 7 Ma). This could indicate that monazite has been an open system to Th-Pb in some carbonatite, and more precisely records the age of primary igneous monazite closure/crystallization in some samples. Regardless, monazite Th-Pb ages are inconsistent with a 15-25 Ma hiatus between ultrapotassic and carbonatite magmatism at Mountain Pass. The variability in Th-Pb ages presents significant difficulty in assigning ages to the carbonatite samples, and data from this study are insufficiently precise to postulate a younger age for carbonatite relative to the ultrapotassic rocks. In other words, there is no reason to infer that the carbonatite is younger based on these data (Fig. 42).

7.2.4 Bastnäsite

U-Pb and Th-Pb ages from the bastnäsite are anomalously young when compared to monazite from the same rocks (< 1300 Ma), suggesting that bastnäsite has either behaved as an open system, or is not magmatic and grew as a result of hydrothermal activity that post-dates magmatism by 80 Ma or more. However, because $\varepsilon Nd_{(i)}$ is the same in bastnäsite and monazite, they are likely to have grown from the same fluid or melt. DeWitt et al. (1987, 2000) also reported open-system behavior in bastnäsite with respect to U and Pb, indicating that open-system behavior is not unique to bastnäsite samples analyzed in this study. Because bastnäsite data do not provide useful age information, they will not be considered further for age interpretation.

7.2.5 Apatite

Apatite U-Pb data from Mountain Pass samples are problematic – most analyses are reversely discordant, the data do not form single-populations, y-intercepts in Tera-Wasserburg U-Pb space are anomalously low, and the concurrently measured secondary reference material did not reproduce its TIMS age within uncertainty. Reverse discordance in Mountain Pass apatite is most likely due to low U relative to Pb content in the sample grains, resulting in a common-Pb-dominated Pb isotopic signature and causing the analyses to plot near the $^{207}Pb/^{206}Pb$ composition of common Pb in Tera-Wasserburg U-Pb space.

Low $^{207}Pb/^{206}Pb$ y-intercepts in Tera-Wasserburg space indicate apparently highly radiogenic common lead ($^{207}Pb/^{206}Pb$ of ~0.46 to 0.49) in both the samples and secondary reference material. It is therefore suspected that the $^{207}Pb/^{206}Pb$ measurements have not been properly corrected by the primary reference material. This discrepancy may be due to variable common Pb content in the primary reference material, which is not accounted for by the data reduction scheme used to process the data, “UPb geochronology3” in Iolite v2.5 (Paton et al., 2011). Although a data reduction scheme for Iolite exists to circumvent this issue (VizualAge_UcomPbine; Chew et al., 2013), it requires measurement of ^{202}Hg for isobaric correction of ^{204}Hg interference on ^{204}Pb, and ^{202}Hg was not measured. Furthermore, the reference materials and the unknown samples may differ significantly in F and OH content, and matrix effects between fluor- and hydroxyl-apatite during laser ablation have not been well studied. Therefore, these data have not been included in the results or age interpretations of this study due the likelihood that they are unreliable with respect to the lack of reproducibility in the analytical reference materials, the possibility of unaccounted-for matrix effects, and the reasons discussed above indicating that the isotopic ratios were likely not accurately corrected.

Despite problems with U-Pb geochronology of MPIS apatite, the chondrite-normalized REEs from the grains are similar to apatite from other alkaline igneous rocks (e.g. Lingdi & Yangchuan, 1989; Morteani & Preinfalk, 1996). This suggests that apatite was likely an important REE-sink in the ultrapotassic magmas that formed the MPIS (discussed in detail above).

7.2.6 Rutile

The low U and high Pb content in rutile from Mountain Pass ultrapotassic rocks make it unsuitable for U-Pb geochronology. Dates derived from these data have uncertainties of 100% or more, which therefore do not provide useful age constraints. Zr-in-rutile temperatures derived from the grains yield highly variable temperatures in one sample, and consistent temperatures in the other. Variable Zr content is associated with grains that were measured in thin section, which also have variable but mostly high REE content (Appendix Y). Because these grains occur in fine-grained aggregates that also include quartz, ilmenite, and monazite, it is likely that the apparently variable Zr contents of the grains is due to inadvertent sampling of multiple phases by laser ablation. Only two dimensions are observable in thin section, so it is possible that the laser completely penetrated the small rutile grains and sampled other phases in the third dimension (e.g. monazite or relict titanite). The low Zr-in-rutile temperatures derived from the other sample grains, which were ablated in a grain mount, are inconsistent with magmatic processes (435 ± 14 ^{0}C). Moreover, textural evidence in thin section suggests that rutile occurs only as a secondary mineral in the ultrapotassic rocks. These data together suggest that the growth of rutile is the result of secondary alteration, which occurred at a low temperature on the order of 435 ^{0}C. However, it is not known with certainty if the "rutile" grains are, in fact, rutile. Although the crystal habit resembles rutile, they may also be another Ti-oxide phase, such as anatase – rutile is generally thought of as a high-T, moderate-P phase (e.g. Hanaor and Sorrell, 2011), which is not consistent with temperatures of ~435 ^{0}C. EBSD of the grains is needed to establish their identity in order to determine whether use of the Zr-in-rutile geothermometer is warranted. The Zr-in-rutile data are thus tentatively inferred to indicate low temperature alteration of the ultrapotassic rocks at Mountain Pass.

7.3 Mineral-scale Nd and Hf Isotopes

7.3.1 Nd Isotopes

$\varepsilon Nd_{(i)}$ values from titanite in the ultrapotassic rocks at Mountain Pass are variable, but most overlap whole rock values reported by Premo et al. (2013) of -1.5 to -6. Values lower than -7 occur in five samples, although two of these only yielded one analysis with $\varepsilon Nd_{(i)}$ less than -7. The most primitive $\varepsilon Nd_{(i)}$ values are approximately -3.5, and are seemingly different from $\varepsilon Nd_{(i)}$ values of about -2.5 to -3.5 from monazite and bastnäsite in carbonatite. However, most overlap within uncertainty, and the analyses give a weighted mean of -3 ± 0.1 with MSWD = 1.1 (4 of 76 analyses rejected) if monazite and bastnäsite $\varepsilon Nd_{(i)}$ from carbonatite are plotted with $\varepsilon Nd_{(i)}$ from the ultrapotassic rock sample with the most consistent $\varepsilon Nd_{(i)}$ (Fig. 44). These isotopic signatures may therefore be considered a single population. Furthermore, despite the variability of $\varepsilon Nd_{(i)}$ in most ultrapotassic rock samples, most yielded several analyses with $\varepsilon Nd_{(i)}$ as high as -3.5, indicating that at least some have also recorded this primitive signature. $\varepsilon Nd_{(i)}$ of the carbonatite is therefore not resolvable from $\varepsilon Nd_{(i)}$ of the most primitive $\varepsilon Nd_{(i)}$ signatures of the ultrapotassic rocks, lending credence to the idea that they are derived from the same source.

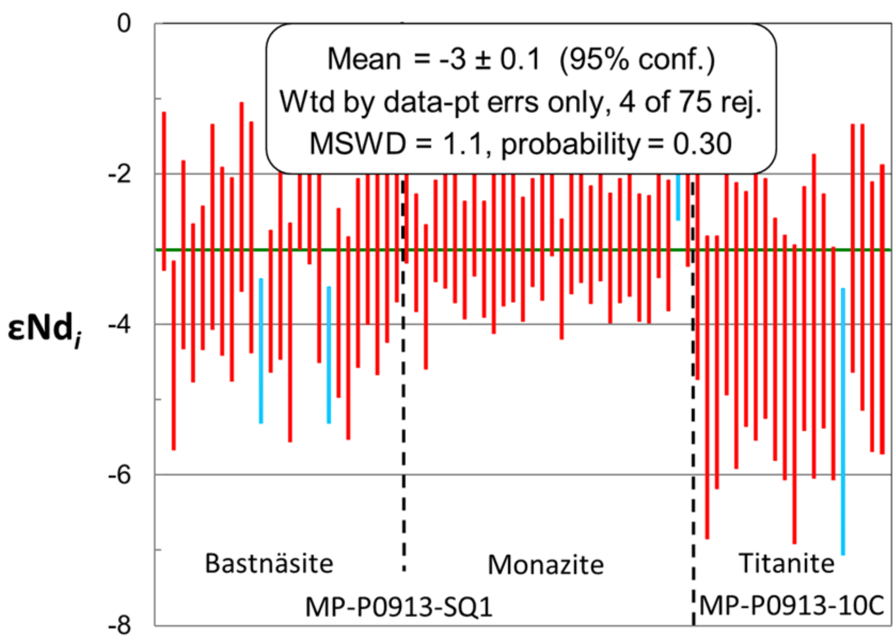


Figure 44 – Weighted mean plot of $\varepsilon Nd_{(i)}$ from monazite and bastnäsite from carbonatite (MP-P0913-SQ1) and titanite from shonkinite (MP-P0913-10C).

As reported by DeWitt et al. (2000), the carbonatite Nd isotopic signature is shared primarily by the youngest shonkinite dikes, but additionally by syenite in the Tors area (samples MP-P0913-10B and MP-P0913-10D; Appendix G), suggesting that these rocks are closely related and were potentially derived from a common magma.

The variability of $\varepsilon Nd_{(i)}$ to values as low as -12 suggest that the Nd isotopic signature of some titanite has been influenced by either magma contamination or secondary alteration. The presence of $\varepsilon Nd_{(i)}$ values lower than about -6 in titanite from ultrapotassic rock samples could potentially be explained by assimilation of crustal material, most likely either the host rocks exposed at Mountain Pass or unexposed basement rocks of the Mojave Province. One sample (MP-P0913-5A) only yielded $\varepsilon Nd_{(i)}$ -7.9 and lower, but contains abundant xenoliths of host granite and gneiss and abundant inherited zircon grains. This suggests that the Nd isotopic signature of the sample has been contaminated by the host rocks it intruded, and that it has not retained any of its primary signature. At the present time, no Nd isotopic data are known to exist for Paleoproterozoic Mojave basement rocks in the vicinity of Mountain Pass that corroborate this hypothesis; moreover, Nd isotopic data were not obtained by the present study. However, if the two samples with evidence for disturbance of U-Pb systematics (MP-P0714-16 and MP-0714-26) are interpreted as being disturbed by a different process (discussed below) and discounted, there is a trend in which higher silica samples have lower $\varepsilon Nd_{(i)}$ (Fig. 22), suggesting that lower $\varepsilon Nd_{(i)}$ may be due to crustal contamination of the primary ultrapotassic magmas.

A post-magmatic alteration event could also be the source of Nd isotopic variation. Two samples that yielded multiple populations of U-Pb analyses gave the most variable and some of the lowest $\varepsilon Nd_{(i)}$ values (MP-P0714-16 and MP-0714-26; e.g. Fig. 21E, Appendix

G) – both yielded $\varepsilon Nd_{(i)}$ as low as -10.7. This suggests that some titanite grains from these samples recorded $\varepsilon Nd_{(i)}$ of the fluid they interacted with after crystallization, and that the variability in Nd isotopes of the grains does not reflect the primary Nd isotopic signature of the samples, nor does it record magma contamination. ^{207}Pb-corrected $^{206}Pb/^{238}U$ ages of the grains do not show any correlation with $\varepsilon Nd_{(i)}$, lending difficulty to evaluating this as a plausible explanation. However, the occurrence of spread in U-Pb data in conjunction with spread in $\varepsilon Nd_{(i)}$ suggests that the disturbance of these two systems is likely related. Additionally, the lack of relationship between $\varepsilon Nd_{(i)}$ and silica content in these two samples alone suggests that they have potentially undergone a different history than the majority of the analyzed samples.

Titanite Nd isotopic data reported here are interpreted to indicate derivation of Mountain Pass ultrapotassic rocks and carbonatite from the same source, crustal contamination of at least some of the ultrapotassic magmas by at least one crustal contaminant, and alteration of the Nd isotopic signature of some samples by secondary fluid alteration. Further work is needed to constrain the nature of the altering fluid, and to determine whether or not the Paleoproterozoic metamorphic rocks exposed in the Mountain Pass area and/or a hydrothermal fluid are plausible sources of contamination for the ultrapotassic rocks.

7.3.2 Hf Isotopes

Hf isotopic data from zircons in the ultrapotassic rocks at Mountain Pass are remarkably consistent, especially in light of the variation in Nd isotopic data from titanite in the same samples. There are no systematic differences in $\varepsilon Hf_{(i)}$ between samples, providing evidence for the hypothesis that the ultrapotassic magmas were all derived from a common source, despite the temporal range. The mean $\varepsilon Hf_{(i)}$ of zircons from the samples analyzed in this study (2.8 ± 0.2) is overlapped by $\varepsilon Hf_{(i)}$ of zircon from the 1.42 Ga Barrel Spring Pluton and ~1.4 Ga granitoids throughout the Mojave Desert (Wooden et al., 2012). However, the authors who reported these values also report a wide range in $\varepsilon Hf_{(i)}$ for the same suite of rocks, and a similar range for Paleoproterozoic rocks throughout the Mojave Desert as well (Wooden et al., 2012). Thus, this is not an especially helpful comparison concerning the source of the Mountain Pass intrusive rocks. It might be expected that if some of the ultrapotassic magmas were contaminated by crustal material, as Nd isotopes from titanite suggest, the contamination would be recorded in the Hf isotopic signature of zircon. This could be explained by either low Hf content in the contaminant, or similar Hf isotopic composition of the MPIS and the host rocks. Similar Hf isotopic composition would suggest that the host rocks plot far above the $\varepsilon Hf_{(i)}/\varepsilon Nd_{(i)}$ terrestrial array of Vervoort et al. (1999) (i.e. they would have $\varepsilon Hf_{(i)}$ ~2 and $\varepsilon Nd_{(i)}$ ~ -10), and is therefore an unlikely explanation. Another possibility is that zircon crystallized earlier than titanite, and thus may not have been exposed to contamination as long as titanite. However, thermometry of the two phases indicates overlap in crystallization temperatures, although Ti-in-zircon thermometry is hindered by smaller sample sizes and higher measurement uncertainties (e.g. Fig. 25B) and therefore may not accurately reflect the relative crystallization temperatures of the two phases.

8. CONCLUSIONS

Titanite and zircon from 20 ultrapotassic rocks of the MPIS yield U-Pb ages from ~1425-1385 Ma, and ~1425-1407 Ma, respectively, and suggest up to three phases of magmatism (~1425 Ma, ~1405 Ma, and ~1380 Ma; Fig. 42). Monazite Th-Pb ages from carbonatite are approximately 1400-1375 Ma (Fig. 42). Ti-in-zircon and Zr-in-titanite apparent temperatures overlap at ~700-850^0 C. Trace element and textural data indicate that titanite grew as an igneous phase in Mountain Pass rocks, and is interpreted to have recorded the same igneous event as zircon. Titanite from two samples likely underwent Pb loss as a result of secondary alteration. Zircon sparsely records both igneous crystallization ca. 1430-1407 Ma. Secondary fluid alteration and high U-content is the likely cause of abundant discordance observed in Mountain Pass zircons. Monazite common-Pb-corrected Th-Pb ages from carbonatite overlap with titanite and zircon ages. Zr-in-rutile data suggest a low-temperature (~435 ^{0}C) alteration event that destabilized titanite and resulted in the growth of rutile, monazite, and ilmenite in the ultrapotassic rocks. Hf isotopic data from zircon in the ultrapotassic rocks are consistent, yielding a mean $\varepsilon Hf_{(i)}$ of 1.8 ± 0.2, and indicating derivation from a common source. Nd isotopic data from titanite in the ultrapotassic rocks are variable ($\varepsilon Nd_{(i)}$ = -3.5 to -12), suggesting secondary alteration or crustal contamination of some samples, but the most primitive values overlap $\varepsilon Nd_{(i)}$ from monazite and bastnäsite in the carbonatite. Whole-rock data indicate that titanite, zircon, and apatite are likely the most important carriers of HFSE, actinides, and REE in the ultrapotassic rocks, respectively. Data from this study effectively eliminate the purported 25 Ma time gap between ultrapotassic and carbonatite magmatism, and indicate that carbonatite and ultrapotassic rocks younger than ~1410 Ma should be considered cogenetic igneous assemblages that have evolved and differentiated.

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APPENDIX A – SAMPLE MINERALOGY

MP-L0613-BDAY – coarse-grained biotite shonkinite (Birthday stock)
(no thin section)

30%	K-feldspar	
30%	biotite	
25%	diopside	euhedral, simple twins common
2%	sodic amphibole	
Accessory	zircon	
Accessory	apatite	
Notes:		

MP-L0613-BDAY2 – Coarse-grained bastnäsite-barite carbonatite (Birthday Vein)

25%	barite	
10%	bastnäsite	
~10%	quartz	
~30%	dolomite	
~10%	calcite	
10%	goethite and/or hematite	
~5%	synchysite/parisite	
1-2%	celestite	
Accessory	fluorite	
Accessory	monazite	
Notes:		

MP-P0913-SQ1 – porphyritic bastnäsite-barite carbonatite (Sulphide Queen Mine)

30-35%	bastnäsite	euhedral-subhedral matrix grains, up to ~1 mm
20%	barite	euhedral, pink phenocrysts up to ~2 cm
35%	calcite	matrix, some Sr-rich
~7%	dolomite	matrix, rimmed by hematite(?)
~3%	quartz	matrix, heterogeneous distribution
Accessory	apatite	
Accessory	monazite	polycrystalline, porous grains up to 1 mm
Accessory	synchisite/parisite	
Trace	Fe-oxide (hematite?)	
Trace	rutile(?)	
Notes: polycrystalline, porous quartz blebs up to 1 cm; no fluid alteration textures observed		

MP-P0913-1A – coarse-grained biotite shonkinite (Birthday stock)

35%	K-feldspar	
35%	biotite	
25%	clinopyroxene	mostly diopside
3%	sodic amphibole	
1%	apatite	euhedral
Accessory	zircon	anhedral, commonly w/ thorite inclusions
Accessory	quartz	
Accessory	oxides	
Accessory	hematite	
Trace	barite	in veins primarily
Trace	baddeleyite	
Trace	pyrite	
Trace	Th-carbonate	in veins primarily
Notes:		

MP-P0913-1B – porphyritic bastnäsite-barite carbonatite (Birthday Vein)

20%	barite	subhedral-anhedral phenocrysts up to ~1 cm/ commonly intergrown w/ bastnäsite
30%	quartz	matrix
20%	calcite	matrix
15%	Fe-oxide	hematite and/or goethite
~7-10%	bastnäsite	euhedral, up to ~0.5 cm, commonly intergrown w/barite
~5%	dolomite	euhedral rhombs
Accessory	zircon	metamict
Accessory	synchysite/parisite	
Accessory	sodic amphibole	
Accessory	Fe-Mn oxide	
Trace	Ti-oxide (rutile?)	
Trace	celestite	
Trace	fluorite	
Notes: fluid-altered - anhedral quartz and hematite, abundant veins, silicified?		

MP-P0913-2 – coarse-grained amphibole syenite (Groaner stock)

80%	K-feldspar	euhedral, up to ~0.5 x 2 cm
7-8%	sodic amphibole	subhedral-anhedral, up to 1 cm, some pseudomorphed by oxides, inclusion-rich
5%	Fe-oxide	euhedral
1%	plagioclase	An_{10} or An_{25} (from Michel-Levy method)
1-2%	quartz	interstitial
≤1%	biotite	anhedral, up to 1 mm
accessory	apatite	euhedral, up to ~2 cm
accessory	monazite	anhedral aggregates or single grains up to ~0.1 mm, also in veins
accessory	rutile	
accessory	ilmenite	
accessory	zircon	anhedral, up to 1 mm
trace	barite	anhedral, in veins
Notes: rusty coating on fracture surfaces; fluid-altered - abundant veins; anhedral rutile, monazite, apatite, quartz, ilmenite pseudomorphs after titanite		

MP-P0913-5A – fine-grained leucosyenite (Corral stock)

70-75%	K-feldspar	euhedral
15%	oxides	euhedral
5%	sodic amphibole	interstitial, anhedral, inclusion-rich
5%	quartz	interstitial
1%	plagioclase	sodic
Accessory	apatite	
Accessory	titanite	euhedral, subhedral, and anhedral
Accessory	zircon	aggregates; anhedral
Accessory	calcite	euhedral, isolated matrix grains
Accessory	pyrite	
Accessory	fluorite	
Trace	rutile(?)	
Trace	chlorite(?)	
Notes: abundant veins		

MP-P0913-6 – porphyritic biotite melanosyenite (dike W of Corral stock)

50%	K-feldspar	matrix
25%	clinopyroxene	matrix, some w/ sieve texture
20%	biotite	equant phenocrysts
1-2%	apatite	
Accessory	titanite	subhedral-anhedral, mostly associated w/ reacting biotite phenocrysts
Accessory	plagioclase	sodic
Accessory	zircon	abundant, wide range of colors/sizes/shapes
Accessory	amphibole	pale green in thin section
Accessory	Fe-oxide	some have Fe-sulfide cores
Accessory	fluorite	inclusions in biotite
Accessory	epidote(?)	
Trace	REE+Al silicate (allanite?)	
Notes: flow alignment of elongate grains, abundant quartz and zircon xenocrysts		

MP-P0913-7 – coarse-grained syenite (Mexican Well stock)

~75%	K-feldspar	euhedral, up to ~0.5 x 2 cm
10%	hematite	interstitial, "skeletal" grains, in veins
5%	quartz	interstitial, in veins
2%	plagioclase	sodic
Accessory	zircon	anhedral grains up to 1 mm
Accessory	monazite	euhedral-subhedral, inclusions in K-feldspar, in veins
Trace	barite	inclusions in K-feldspar, in veins
Trace	Ca-Mg-Na silicate	ovoid grains in Fe-oxide
Notes: pervasively fluid-altered, abundant veins and inclusions in K-feldspar		

MP-P0913-9B – fine-grained leucosyenite (Tors stock)

85%	K-feldspar	euhedral, up to ~0.2 x 1 cm
7%	oxides (hematite?)	
7%	quartz	
Accessory	biotite	
Accessory	sodic amphibole	anhedral, inclusion-rich
Accessory	apatite	
Accessory	zircon	euhedral
Accessory	titanite	euhedral, some pseudomorphed by microcrystalline aggregates
Accessory	plagioclase	An_{10} or An_{25} (from Michel-Levy method)
Trace	monazite	anhedral aggregates
Trace	rutile	anhedral aggregates
Notes: abundant veins; quartz-rutile-monazite pseudomorphs after titanite		

MP-P0913-10A – porphyritic biotite shonkinite (Tors stock)

35%	biotite	phenocrysts up to ~0.5 cm
45%	K-feldspar	matrix, glomerocrysts up to 1 cm common (~1% of rock)
~7%	sodic amphibole	blue-violet in PPL, anhedral, inclusion-rich; some w/ hornblende rim ~0.1 mm thick, phenocrysts commonly rimmed by biotite
~7%	diopside	
2%	apatite	euhedral, up to ~1 cm long
Accessory	zircon	anhedral, thorite inclusions common, interstitial, aggregates up to ~2 mm
Accessory	plagioclase	sodic
Accessory	oxides	
Accessory	titanite	
Accessory	calcite	euhedral, isolated matrix grains
Trace	thorite	mostly as inclusions in zircon
Trace	monazite	in veins
Trace	barite	in veins or as inclusions
Notes:		

MP-P0913-10B – coarse-grained amphibole-biotite syenite (Tors stock)

60%	K-feldspar	euhedral, up to ~0.5 x 2 cm
15%	biotite	
20%	sodic amphibole	
1%	apatite	
1-2%	quartz	
Accessory	zircon	abundant, mostly metamict
Accessory	titanite	some breaking down to rutile, ilmenite, monazite, quartz
Accessory	rutile	most abundant near anhedral/inclusion-rich biotite and amphibole
Accessory	plagioclase	
Accessory	apatite	
Accessory	calcite	
Accessory	oxides	
Trace	ilmenite	
Trace	monazite	in veins, near reacting titanite
Trace	barite	in veins
Notes:		

MP-P0913-10C – porphyritic biotite shonkinite (Tors stock)

30%	biotite	phenocrysts up to 0.5 cm, some = glomerocrysts w/ bluish mica in core
50%	K-feldspar	matrix, glomerocrysts up to 1 cm common (~1% of rock)
15%	clinopyroxene	some phenocrysts up to ~0.5 cm (~1% of rock)
5%	sodic amphibole	anhedral, inclusion-rich, some hornblende
2%	apatite	
Accessory	zircon	anhedral, interstitial, mostly metamict
Accessory	titanite	euhedral-subhedral, up to ~2 mm, interstitial, common biotite or cpx inclusions, abundant (~0.5%)
Accessory	oxides (hematite?)	
Accessory	quartz	
Trace	pyrite	
Trace	allanite	
Trace	barite	in veins, as inclusions
Trace	monazite	in veins
Notes:		

MP-P0913-10D – coarse-grained amphibole-biotite syenite (Tors stock) (no thin section)

55%	K-feldspar	euhedral, up to ~0.2 x 1 cm
5-7%	sodic amphibole	
35%	biotite	
2%	quartz	
Accessory	zircon	
Accessory	titanite	
Accessory	oxides (hematite?)	
Accessory	apatite	
Trace	thorite	
Notes: very friable		

MP-P0714-15 – medium-grained quartz syenite (Mineral Hill stock)

50%	K-feldspar	euhedral, up to ~0.2 x 1 cm
30%	sodic amphibole	some hornblende, up to ~0.25 cm
10%	quartz	
5%	plagioclase	
2%	biotite	commonly rimmed by smaller amphibole grains
Accessory	zircon	euhedral, up to ~1 mm
Accessory	rutile	
Accessory	fluorite	
Accessory	oxides (hematite?)	
Accessory	apatite	
Trace	thorite	
Notes: veins common, fluid-altered		

MP-P0714-16 – medium-grained biotite shonkinite (Tors stock)

30%	K-feldspar	
30%	diopside	euhedral-subhedral, simple twins common, amphibole rims or sections common
35%	biotite	
~4%	hornblende	
~1%	sodic amphibole	
1%	apatite	euhedral, up to 1 mm
Accessory	quartz	
Accessory	zircon	
Trace	oxides	
Trace	thorite	
Notes:		

MP-P0714-17 – fine-grained leucosyenite (Tors stock)

85%	K-feldspar	
7%	amphibole	glomerocrysts up to ~1 cm common, needle-shaped, sodic amphibole and hornblende
3%	clinopyroxene	
1%	calcite	matrix, interlocking texture, often associated w/ quartz
1%	quartz	matrix
Accessory	biotite	
Accessory	zircon	
Accessory	rutile	
Accessory	plagioclase	
Accessory	oxides	
Accessory	apatite	
Notes:		

MP-P0714-19 - coarse-grained biotite shonkinite (Corral stock)

35%	K-feldspar	
20%	diopside	
30%	biotite	
10%	hornblende	
2-3%	apatite	euhedral, up to ~1 mm
Accessory	zircon	
Accessory	titanite	abundant (~0.5%), up to ~1.5 mm
Accessory	oxides (hematite?)	
Accessory	calcite	
Accessory	plagioclase	
Accessory	rutile(?)	
Accessory	quartz	
Notes: equigranular; friable with rusty to white mineralization along fracture surfaces		

MP-P0714-21 – medium-grained biotite-amphibole melanosyenite (Mexican Well stock)

50%	K-feldspar	
25%	chloritized biotite	sieve texture common
20%	sodic amphibole	some hornblende
2%	quartz	
2%	apatite	
≤1%	zircon	anhedral, up to ~2 mm
Accessory	oxides	
Notes: friable, weathered sample		

MP-P0714-22A – medium-grained biotite-amphibole shonkinite (Wheaton stock)

25%	K-feldspar	
35%	biotite	
40%	sodic amphibole	abundant biotite inclusions, some clinopyroxene inclusions, forms some fibrous/sub-radiating masses, some hornblende
1%	diopside	mostly as relict cores or sections in amphibole
1-2%	apatite	
Accessory	oxides	
Accessory	zircon	
Accessory	titanite	
Notes:		

MP-P0714-23 – fine-grained quartz syenite (Wheaton stock)

80%	K-feldspar	
15%	quartz	
3%	oxides	
Accessory	zircon	abundant, up to 0.5 mm, metamict
Accessory	titanite	
Accessory	thorite	
Accessory	plagioclase	
Accessory	apatite	
Accessory	sodic amphibole	
Accessory	rutile or hematite?	
Notes:		

MP-P0714-26 – coarse-grained biotite shonkinite (Birthday stock)

25%	K-feldspar	
40%	biotite	
30%	diopside	euhedral, simple twins common
3%	apatite	
1%	hornblende	sparse sodic amphibole, common fibrous to microcrystalline masses
≤1%	magnetite	
Accessory	zircon	
Accessory	titanite	
Accessory	quartz	mostly as inclusions
Notes: oxides and microcrystalline amphibole pseudomorphs after clinopyroxene common		

<u>HOST ROCKS</u>

MP-P0913-4 –coarse-grained, migmatitic garnet-sillimanite-biotite gneiss (SW of Groaner stock)

20%	K-feldspar	
~10%	garnet	up to ~4 cm
35%	biotite	anhedral, breaking down to sillimanite
20%	quartz	
15%	sillimanite	mostly associated w/ biotite
1%	oxides	euhedral, associated w/ biotite and sillimanite
Accessory	plagioclase	
Accessory	zircon	abundant
Accessory	monazite	abundant
Accessory	apatite	
Accessory	hematite	
Accessory	rutile(?)	
Notes: migmatitic, modal mineralogy varies widely on scale of hand sample		

MP-P0913-5B – coarse-grained alkali granite (Corral stock)

55%	K-feldspar	sparse myermekite, highly sericitized
35%	quartz	
~10%	plagioclase	highly sericitized
1%	chlorite	
Accessory	zircon	
Accessory	oxides	
Notes: partially fenitized? – meter-scale inclusion in syenite		

MP-P0913-12 – schistose augen gneiss (North of Birthday stock)

35-40%	biotite	up to ~85% of rock in places (schistose), commonly partially chloritized
25%	K-feldspar	porphyroclasts up to ~0.5 cm, some porphyroclasts = aggregates
35%	quartz	oscillatory extinction common
1%	hornblende	
1%	plagioclase	highly sericitized
Accessory	zircon	
Accessory	apatite	
Accessory	titanite	abundant (~0.5% of rock), sub-rounded matrix grains and "trains" of euhedral-subhedral grains in foliation planes w/biotite
Accessory	oxides (hematite?)	
Notes: chloritized zones along foliation planes		

APPENDIX B – TABLE OF GEOCHRONOLOGIC DATA FROM PREVIOUS STUDIES

Author (year)	Rock Type	Mineral	Method	Age (Ma)
Jaffe (1955)	Shonkinite	Zircon	alpha-counting and total-lead	840
	Carbonatite	Monazite	alpha-counting and total-lead	950
Lanphere (1964)	Shonkinite	Biotite	K-Ar	1440 ± 35, 1385 ± 35
	Shonkinite	Biotite	Rb-Sr	1415 ± 80 , 1380 ± 50
	Carbonatite	Monazite	Th-Pb	1436 ± 71
DeWitt et al. (1987, 2000)	Shonkinite	Apatite	U-Pb	1410 ± 2
	Shonkinite	Phlogopite	Ar-Ar	1400 ± 8
	Syenite	Arfvedsonite	Ar-Ar	
	Carbonatite	Monazite	Th-Pb	1375 ± 7
Premo et al. (2013)	Shonkinite	Zircon	U-Pb	1410-1422
	Syenite	Zircon	U-Pb	1410-1422
	Granite	Zircon	U-Pb	1410-1422

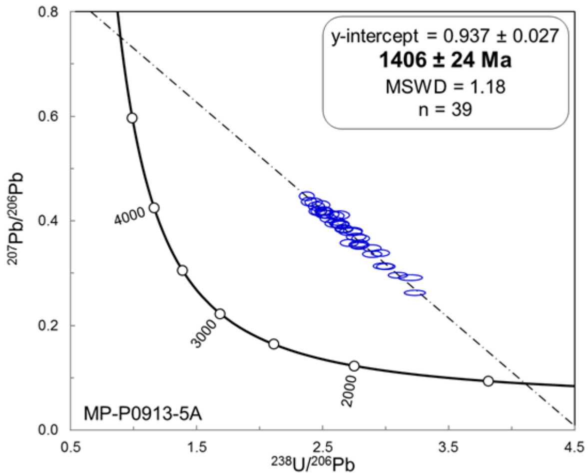
Appendix C – Sample Summary and Sample Location Table

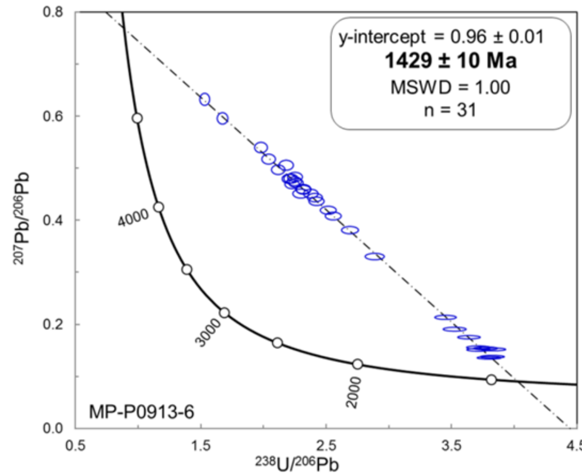
Sample	Rock Type	Location	Coordinates	Field Context	Titanite Age (Ma)	Zircon Age (Ma)	Monazite Th/Pb Age (Ma)
MP-L0613-BDAY	biotite shonkinite	Birthday mine	35°29'20.98" N, 115°32'10.56" W	massive body	—	1425 +/- 5	—
MP-L0613-BDAY2	bastnaesite-barite carbonatite	Birthday mine	35°29'20.98" N, 115°32'10.56" W	dike in shonkinite	—	—	1396 +/- 16*
MP-P0913-SQ1	bastnaesite-barite carbonatite	Sulphide Queen (from parking lot)	35°28'10.93" N, 115°31'46.60" W	massive body (?)	—	—	1371 +/- 10
MP-P0913-1A	biotite shonkinite	Birthday mine	35°29'20.81" N, 115°32'10.60" W	massive body	—	—	—
MP-P0913-1B	bastnaesite-barite carbonatite	Birthday mine	35°29'20.98" N, 115°32'10.56" W	dike in shonkinite	—	discordant	—
MP-P0913-2	amphibole syenite	Groaner stock	35°27'53.24" N, 115°31'21.42" W	massive body	—	discordant	~1376 +/- 36*
MP-P0913-4	garnet-biotite-sillimanite gneiss	~170 m SW of Groaner stock	35°27'44.80" N, 115°31'25.51" W	host rock	—	~1650-1800	1693 +/- 8 ($^{207}Pb/^{206}Pb$ age average)
MP-P0913-5A	leucosyenite	Corral stock	35°27'43.66" N, 115°31'13.61" W	massive body	1406 +/- 24	1416 +/- 9	—
MP-P0913-5B	granite	Corral stock	35°27'43.66" N, 115°31'13.61" W	m-scale host rock xenolith	—	~1630-1800	—
MP-P0913-6	biotite melanosyenite	dike ~50 m west of Corral stock	35°27'43.86" N, 115°31'17.51" W	dike in host rock	1423 +/- 7	1426 +/- 7	—
MP-P0913-7	syenite	Mexican Well stock	35°27'57.88" N, 115°30'57.98" W	massive body	—	discordant	1401 +/- 32*
MP-P0913-9B	leucosyenite	dike @ west edge of Tors stock	35°27'21.24" N, 115°30'52.63" W	dike in host rock	—	discordant	—

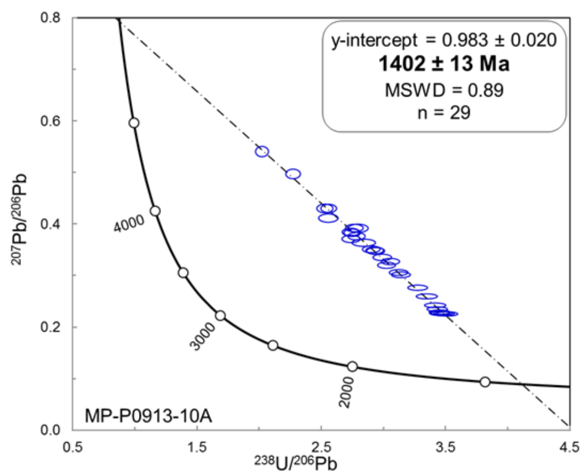
Sample	Rock Type	Location	Coordinates	Field Context	Titanite Age (Ma)	Zircon Age (Ma)	Monazite Th/Pb Age (Ma)
MP-P0913-10A	biotite shonkinite	Tors stock	35°27'22.84" N, 115°30'50.97" W	enclave in syenite	1402 +/- 13	discordant	—
MP-P0913-10B	biotite-amphibole syenite	Tors stock	35°27'22.84" N, 115°30'50.97" W	massive body	1398 +/- 14	1411 +/- 8	—
MP-P0913-10C	biotite shonkinite	Tors stock	35°27'22.89" N, 115°3'51.03" W	dike in syenite	1385 +/- 18	1458 +/- 7	—
MP-P0913-10D	biotite-amphibole syenite	Tors stock	35°28'10.93" N, 115°31'46.60" W	enclave in shonkinite	1401 +/- 12	—	—
MP-P0913-12	feldspar augen gneiss	host rock ~ 360 m NNW of Birthday mine	35°29'32.40" N, 115°32'06.62" W	host rock	—	~1750-1825	—
MP-P0714-15	quartz syenite	Mineral Hill stock	35°27'05.76" N, 115°29'23.20" W	massive body	—	discordant	—
MP-P0714-16	biotite shonkinite	Tors stock	35°27'19.84" N, 115°30'51.56" W	massive body	1410 +/- 17	—	—
MP-P0714-17	leucosyenite	Tors stock	35°27'23.88" N, 115°30'51.46" W	dike intruding shonkinite dike in syenite	1358 +/- 71	—	—
MP-P0714-19	biotite shonkinite	Corral stock	35°27'44.03" N, 115°31'08.23" W	massive body	1414 +/- 19	discordant	—
MP-P0714-21	biotite-amphibole melanosyenite	Mexican Well stock	35°27'58.71" N, 115°30'57.98" W	enclave in syenite	—	1407 +/- 11	—
MP-P0714-22A	biotite-amphibole shonkinite	Wheaton stock	35°27'38.26" N, 115°30'09.56" W	massive body	1404 +/- 12	—	—
MP-P0714-23	leucosyenite	Wheaton stock	35°27'41.49" N, 115°30'16.45" W	massive body	1406 +/- 26	discordant	—
MP-P0714-26	biotite shonkinite	Birthday stock	35°29'18.40" N, 115°32'11.39" W	massive body	1410 +/- 17	1434 +/- 10	—

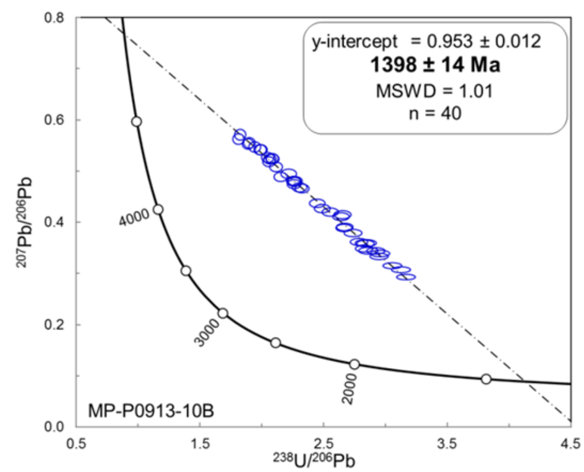
* - MSWD >> 1

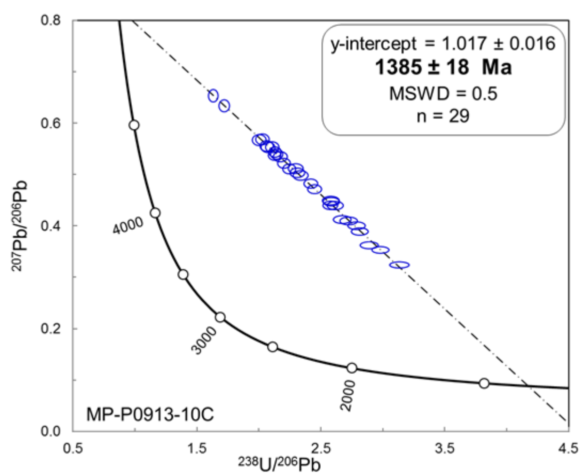
APPENDIX D - TITANITE URANIUM-LEAD CONCORDIA PLOTS

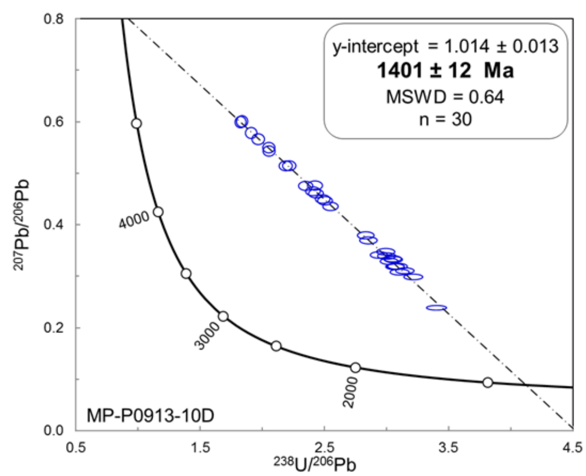


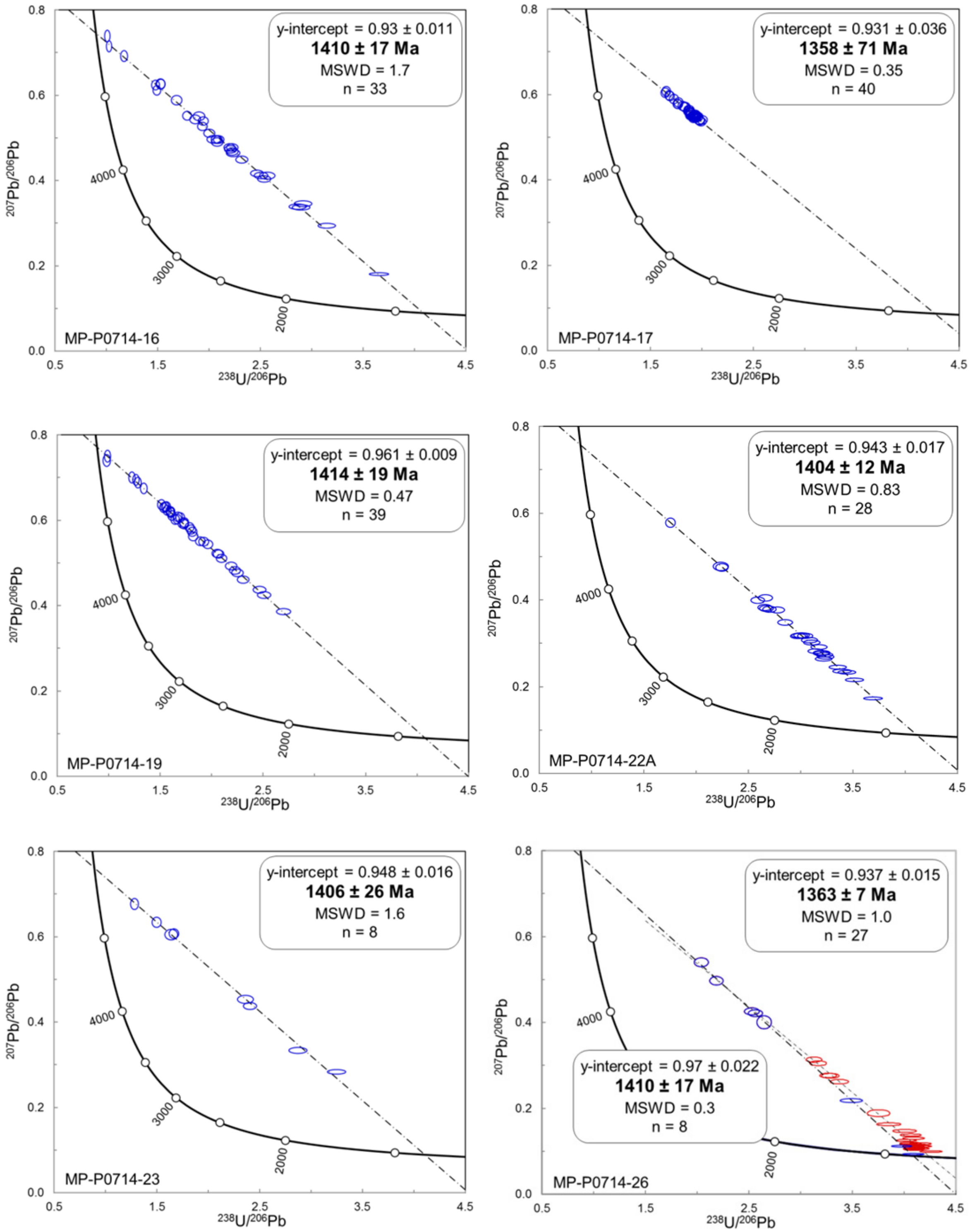




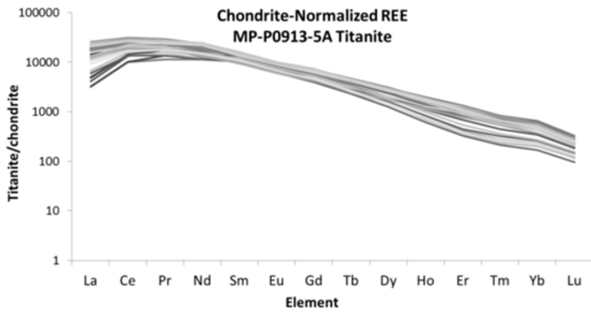


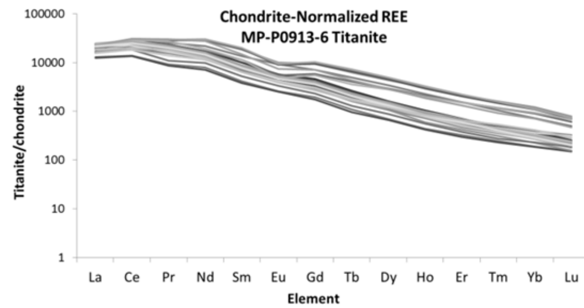


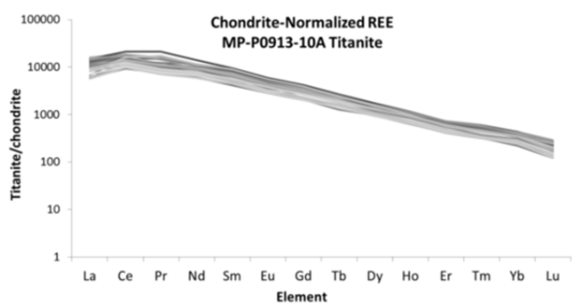


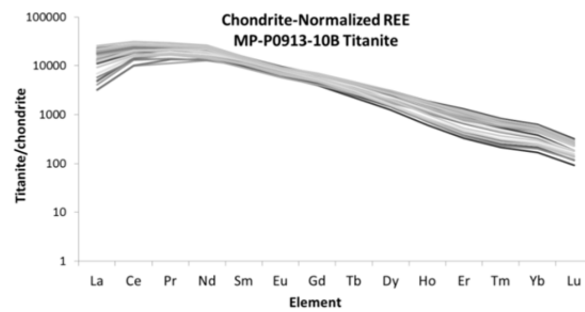

y-intercept = 0.93 ± 0.011
1410 ± 17 Ma
MSWD = 1.7
n = 33
MP-P0714-16
y-intercept = 0.931 ± 0.036
1358 ± 71 Ma
MSWD = 0.35
n = 40
MP-P0714-17
y-intercept = 0.961 ± 0.009
1414 ± 19 Ma
MSWD = 0.47
n = 39
MP-P0714-19
y-intercept = 0.943 ± 0.017
1404 ± 12 Ma
MSWD = 0.83
n = 28
MP-P0714-22A
y-intercept = 0.948 ± 0.016
1406 ± 26 Ma
MSWD = 1.6
n = 8
MP-P0714-23
y-intercept = 0.937 ± 0.015
1363 ± 7 Ma
MSWD = 1.0
n = 27
y-intercept = 0.97 ± 0.022
1410 ± 17 Ma
MSWD = 0.3
n = 8
MP-P0714-26
$^{207}Pb/^{206}Pb$
$^{238}U/^{206}Pb$
4000
3000
2000

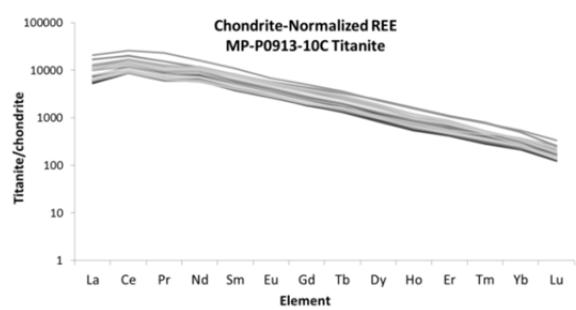
APPENDIX E – TITANITE – CHONDRITE-NORMALIZED REE PLOTS

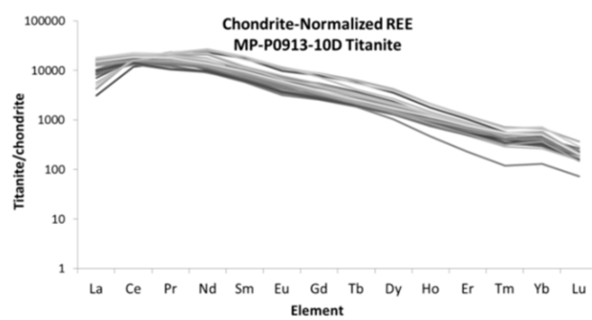


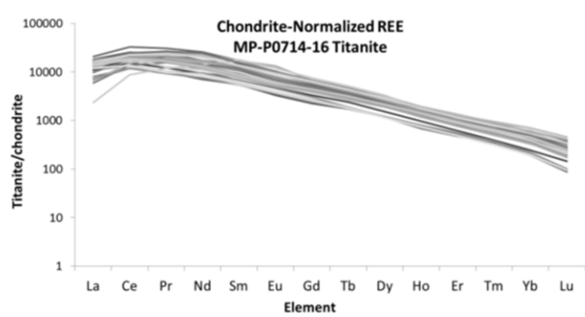


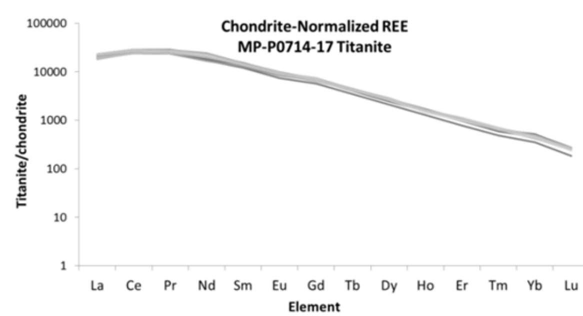


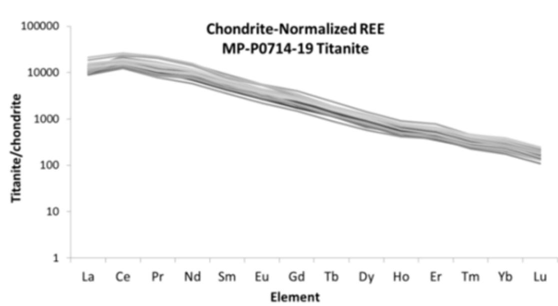


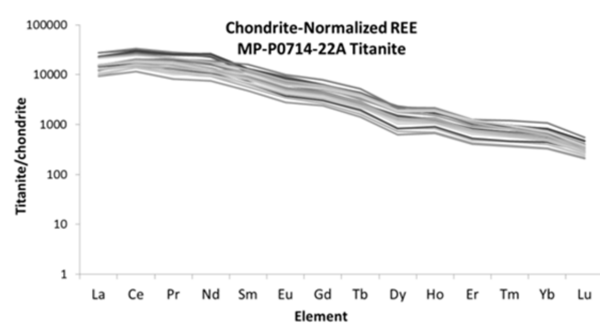


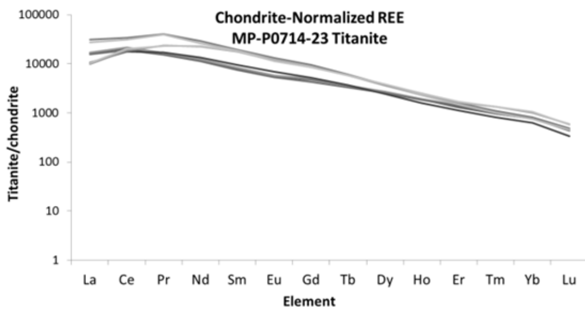


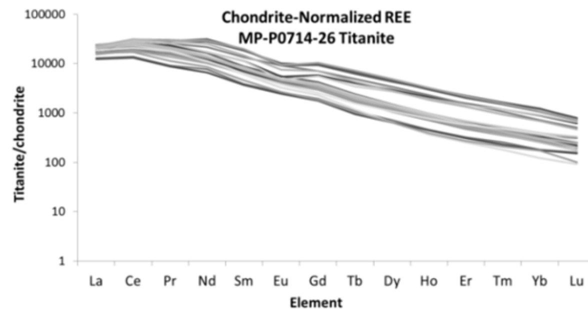




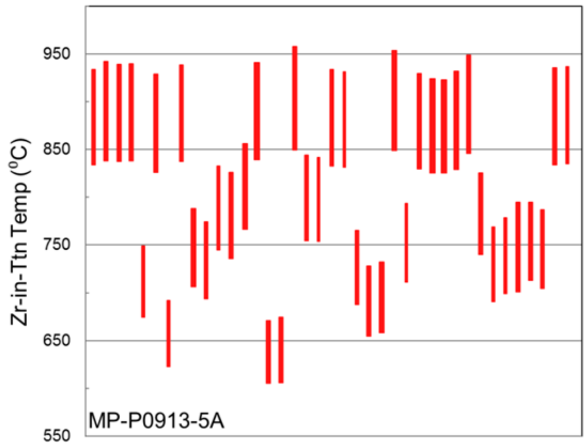


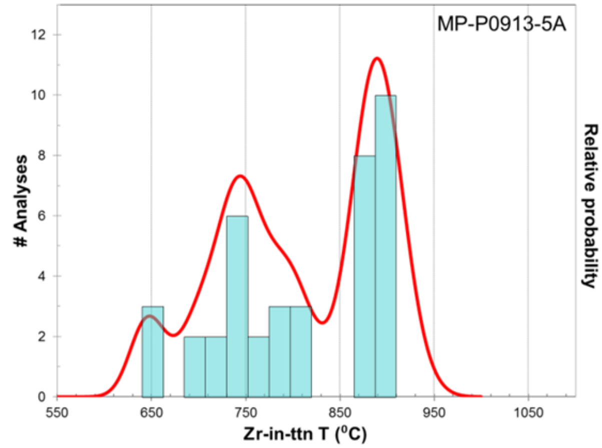


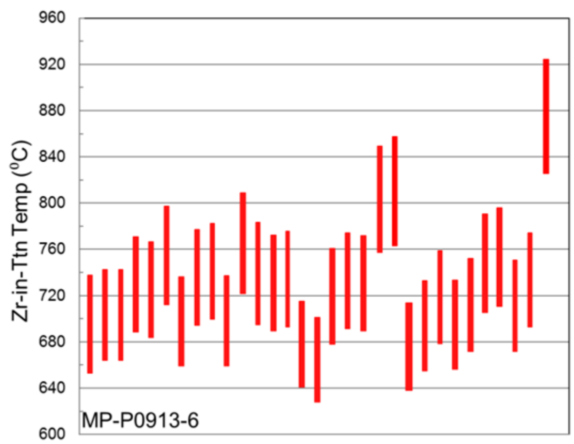

Chondrite-Normalized REE
MP-P0714-23 Titanite
Titanite/chondrite
100000
10000
1000
100
10
1
La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Element

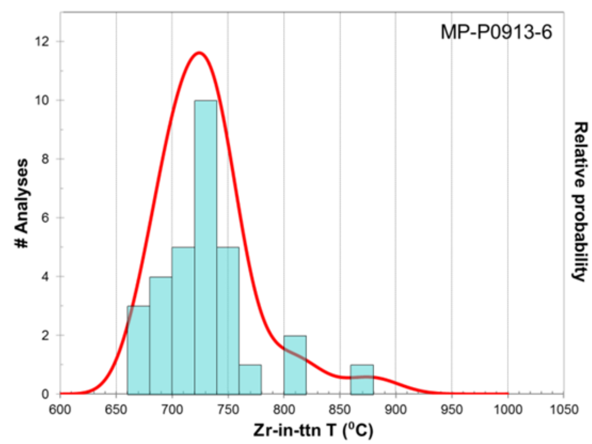

Chondrite-Normalized REE
MP-P0714-26 Titanite
Titanite/chondrite
100000
10000
1000
100
10
1
La Ce Pr Nd Sm Eu Gd Tb Dy Ho Er Tm Yb Lu
Element

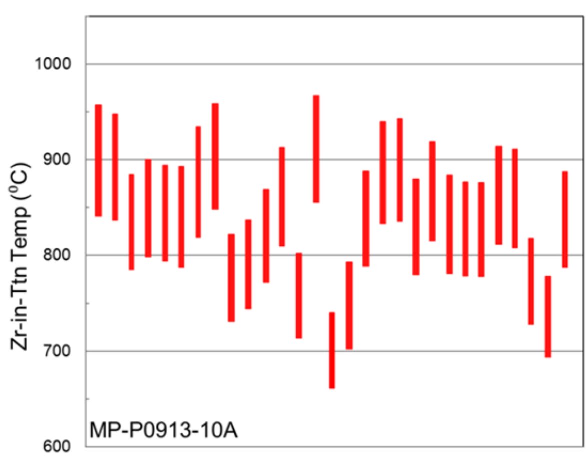
APPENDIX F – TITANITE THERMOMETRY DATA PLOTS

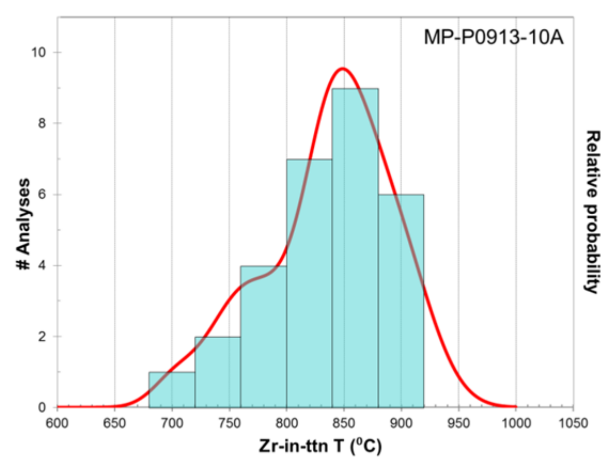


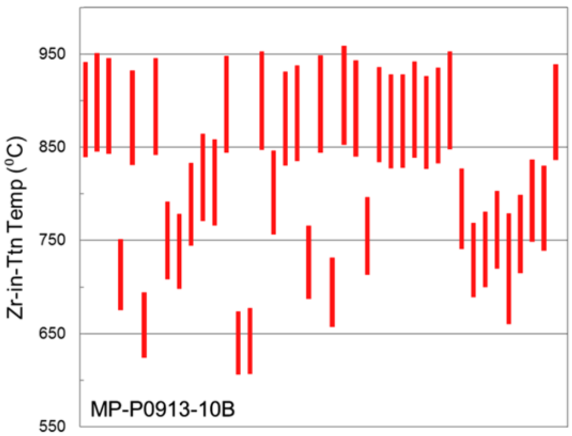


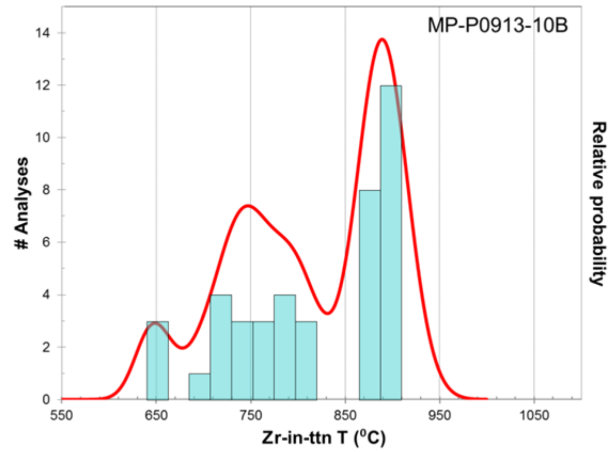


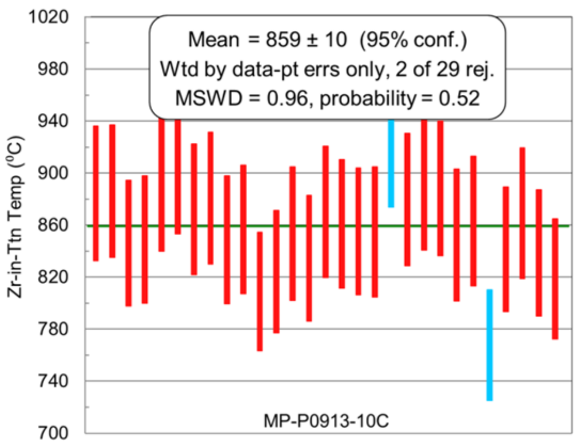


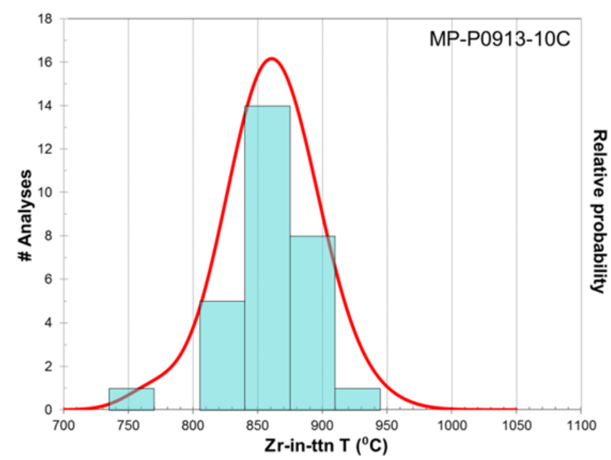


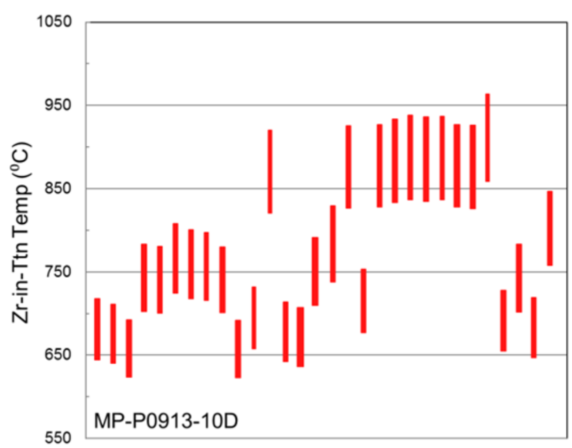


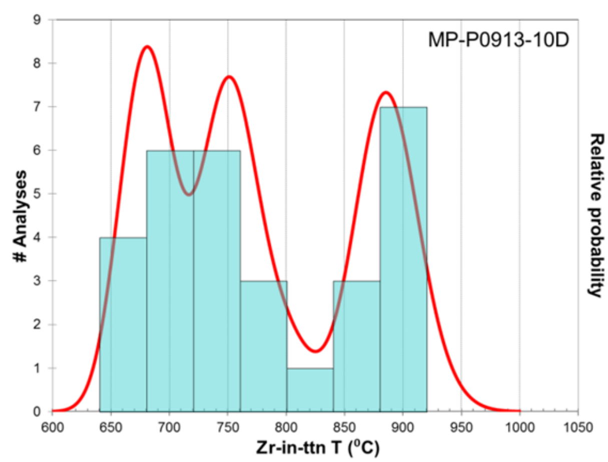

Zr-in-Ttn Temp (°C)
950
850
750
650
550
MP-P0913-10B

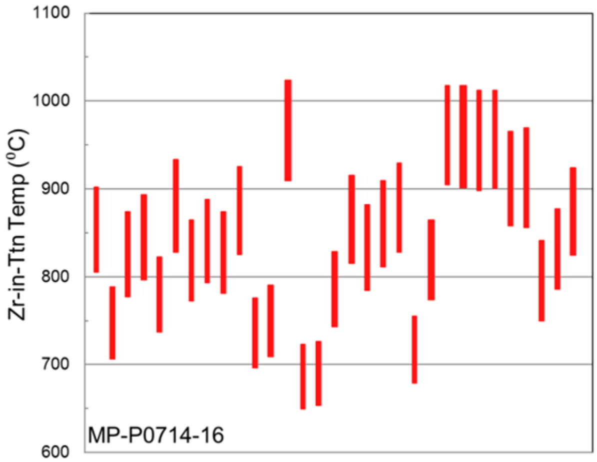

MP-P0913-10B
Analyses
Relative probability
Zr-in-ttn T (°C)
550
650
750
850
950
1050

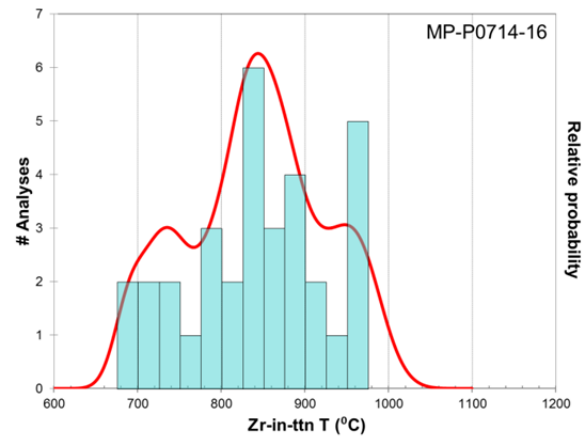

Mean = 859 ± 10 (95% conf.)
Wtd by data-pt errs only, 2 of 29 rej.
MSWD = 0.96, probability = 0.52
Zr-in-Ttn Temp (°C)
MP-P0913-10C

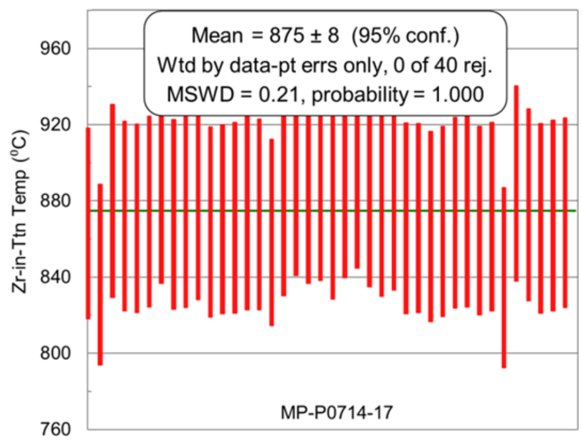

MP-P0913-10C
Analyses
Relative probability
Zr-in-ttn T (°C)

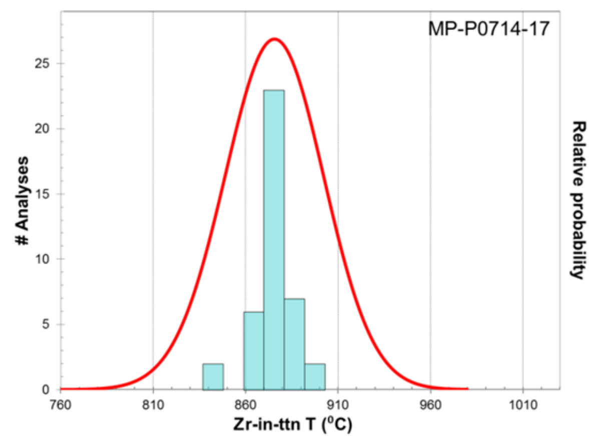

Zr-in-Ttn Temp (°C)
1050
950
850
750
650
550
MP-P0913-10D

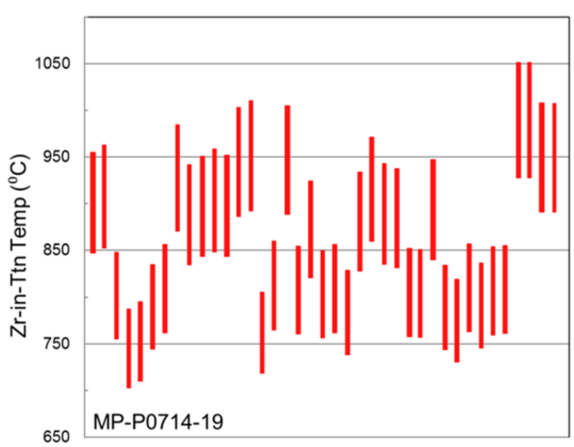

MP-P0913-10D
Analyses
Relative probability
Zr-in-ttn T (°C)

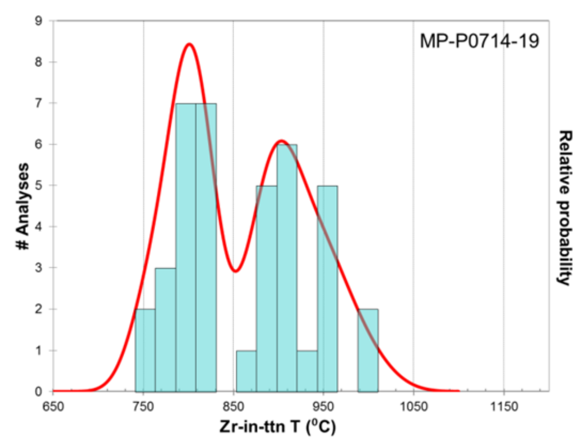

Zr-in-Ttn Temp (°C)
MP-P0714-16

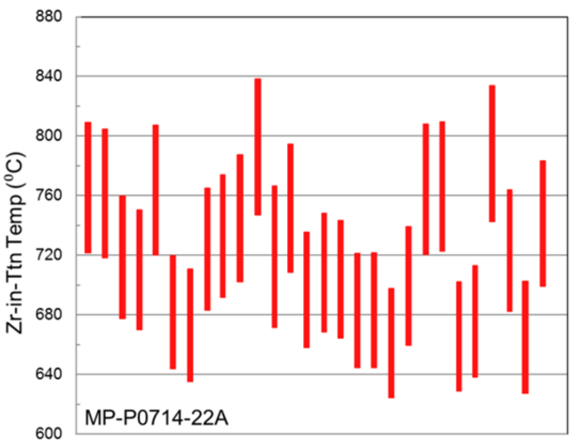

MP-P0714-16
Analyses
Relative probability
Zr-in-ttn T (°C)

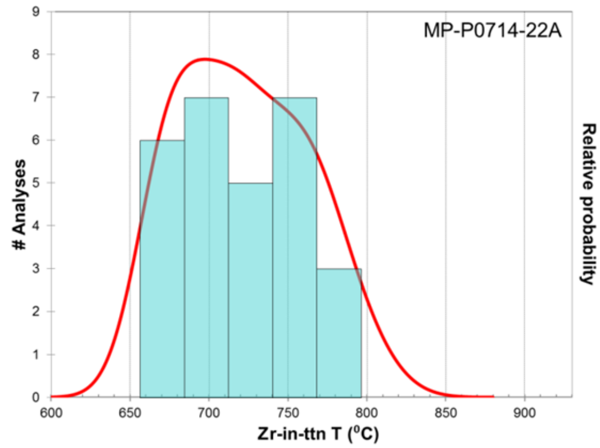

Mean = 875 ± 8 (95% conf.)
Wtd by data-pt errs only, 0 of 40 rej.
MSWD = 0.21, probability = 1.000
Zr-in-Ttn Temp (°C)
MP-P0714-17

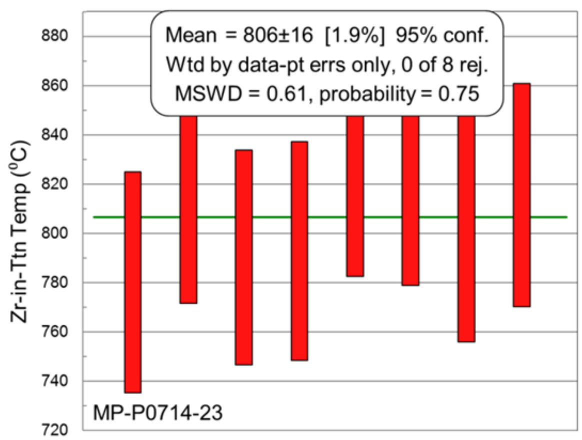

MP-P0714-17
Analyses
Relative probability
Zr-in-ttn T (°C)

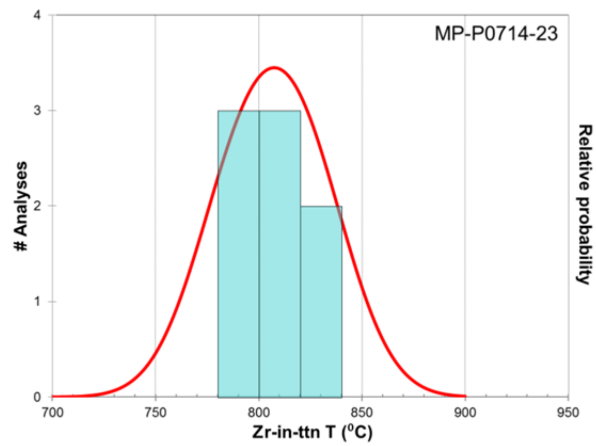

Zr-in-Ttn Temp (°C)
MP-P0714-19

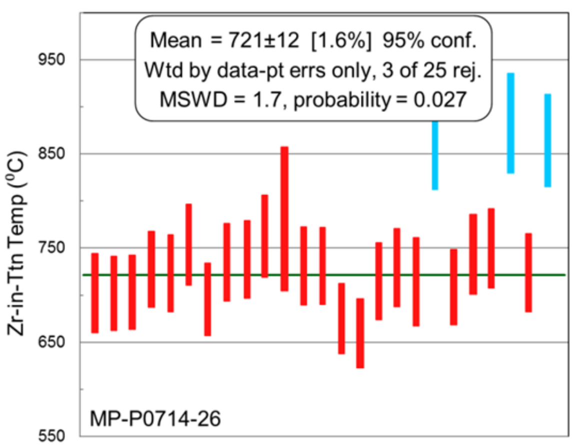

MP-P0714-19
Analyses
Relative probability
Zr-in-ttn T (°C)

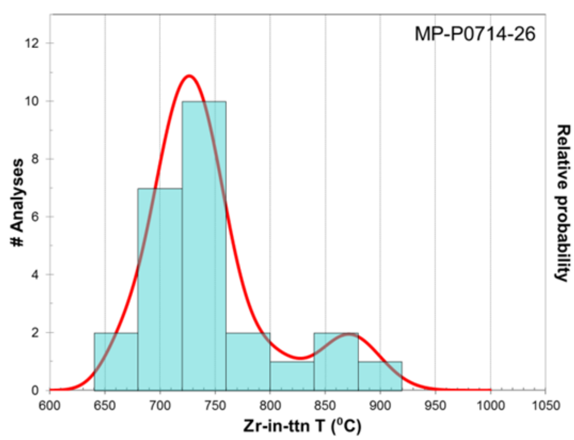

Zr-in-Ttn Temp (°C)
880
840
800
760
720
680
640
600
MP-P0714-22A


MP-P0714-22A
Analyses
Relative probability
Zr-in-ttn T (°C)
600
650
700
750
800
850
900

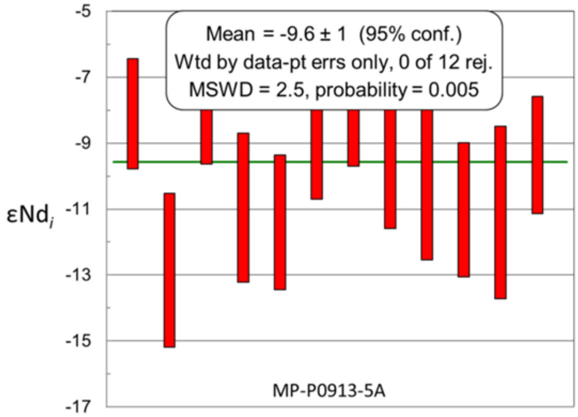

Mean = 806±16 [1.9%] 95% conf.
Wtd by data-pt errs only, 0 of 8 rej.
MSWD = 0.61, probability = 0.75
Zr-in-Ttn Temp (°C)
880
860
840
820
800
780
760
740
720
MP-P0714-23

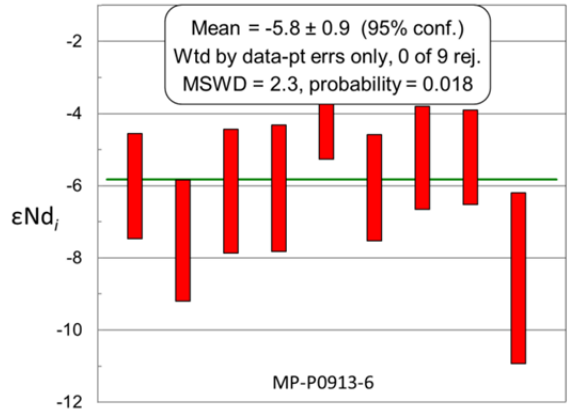

MP-P0714-23
Analyses
Relative probability
Zr-in-ttn T (°C)
700
750
800
850
900
950

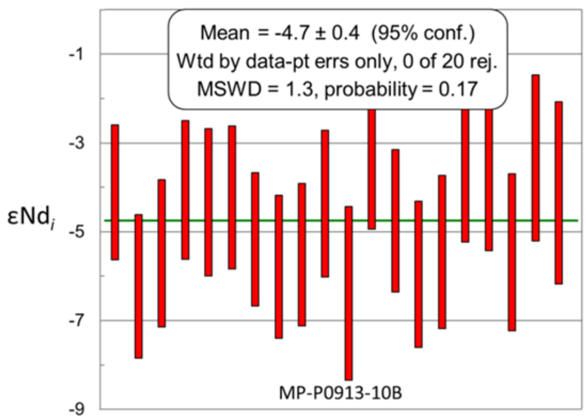

Mean = 721±12 [1.6%] 95% conf.
Wtd by data-pt errs only, 3 of 25 rej.
MSWD = 1.7, probability = 0.027
Zr-in-Ttn Temp (°C)
950
850
750
650
550
MP-P0714-26

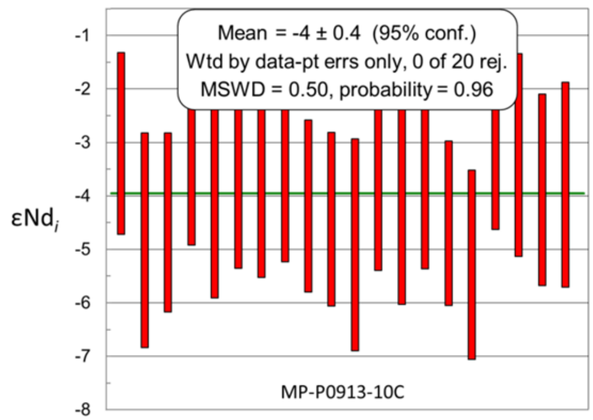

MP-P0714-26
Analyses
Relative probability
Zr-in-ttn T (°C)
600
650
700
750
800
850
900
950
1000
1050

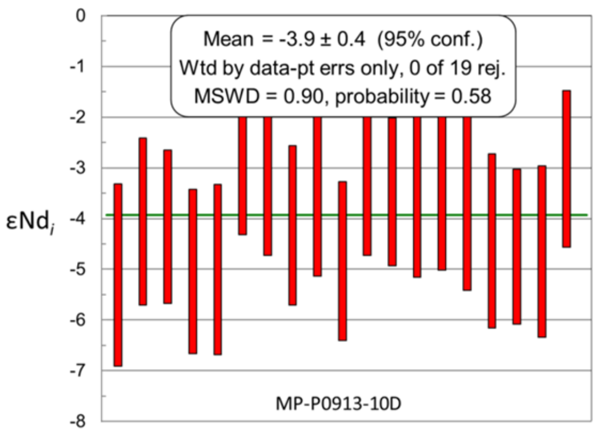
APPENDIX G – TITANITE NEODYMIUM ISOTOPIC DATA PLOTS

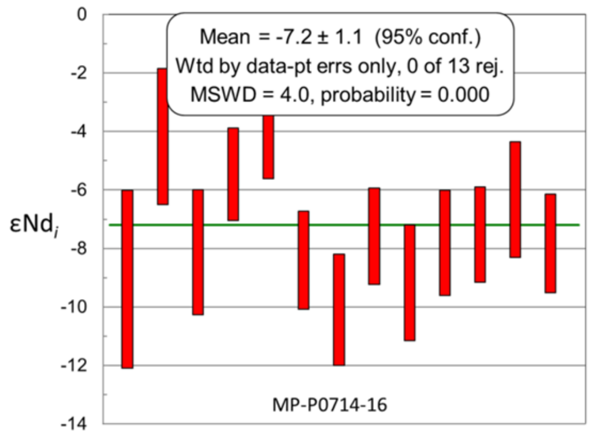


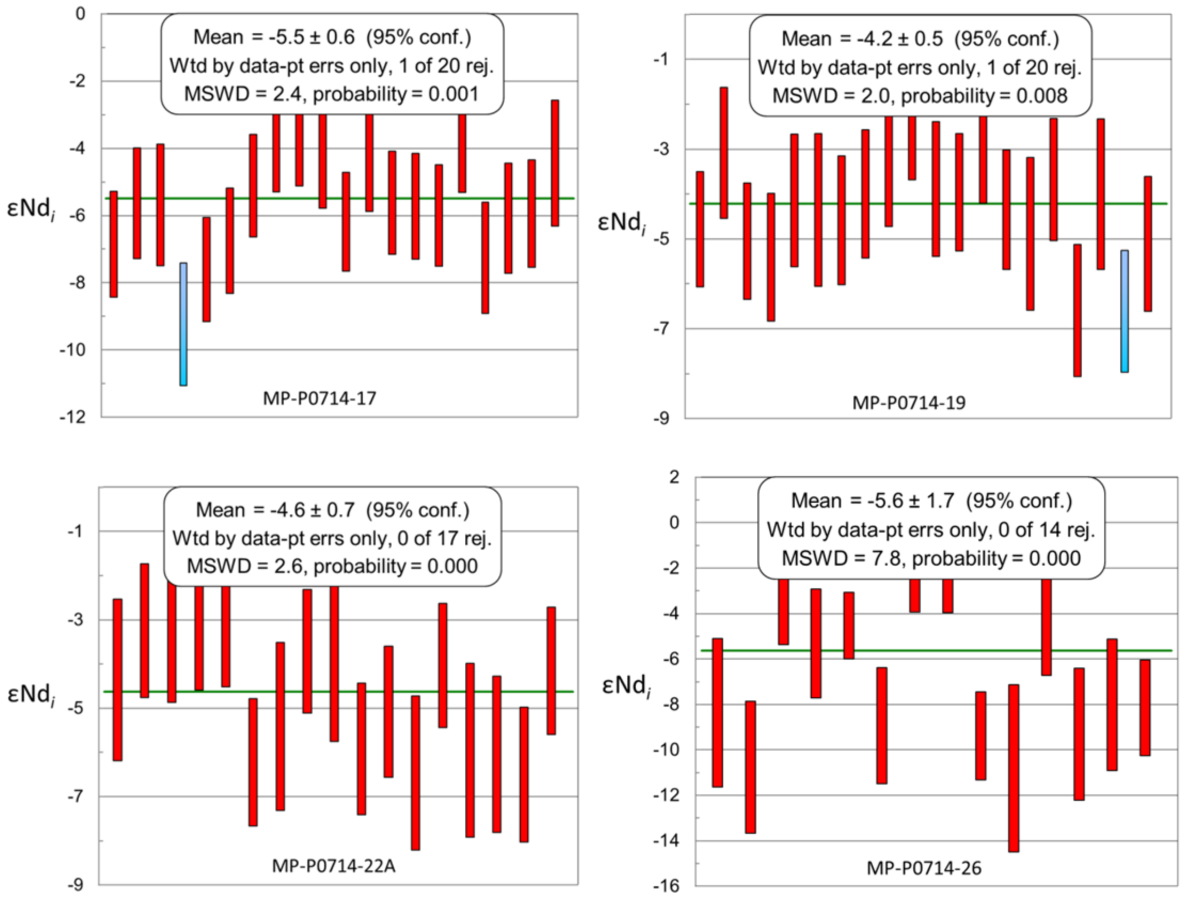




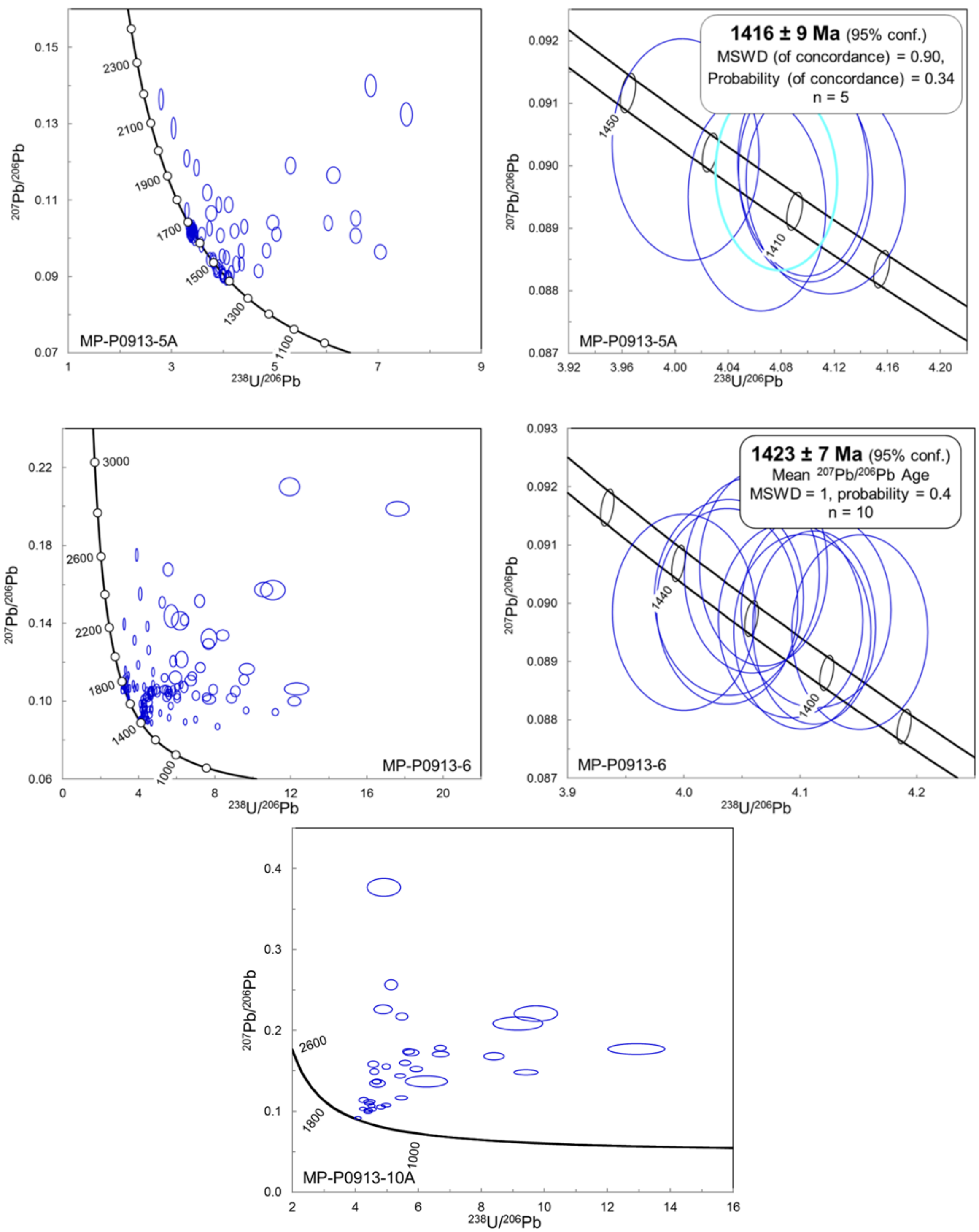


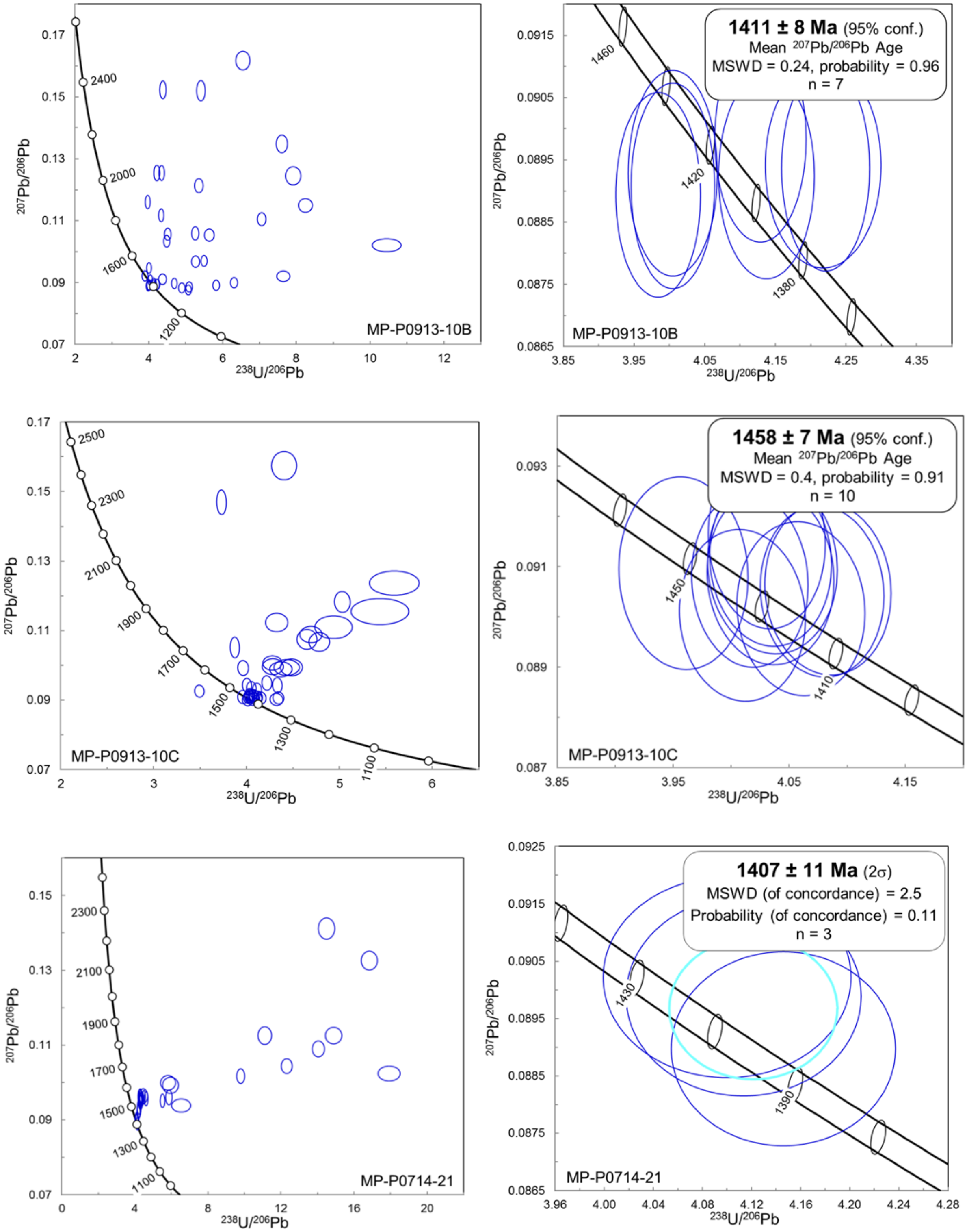




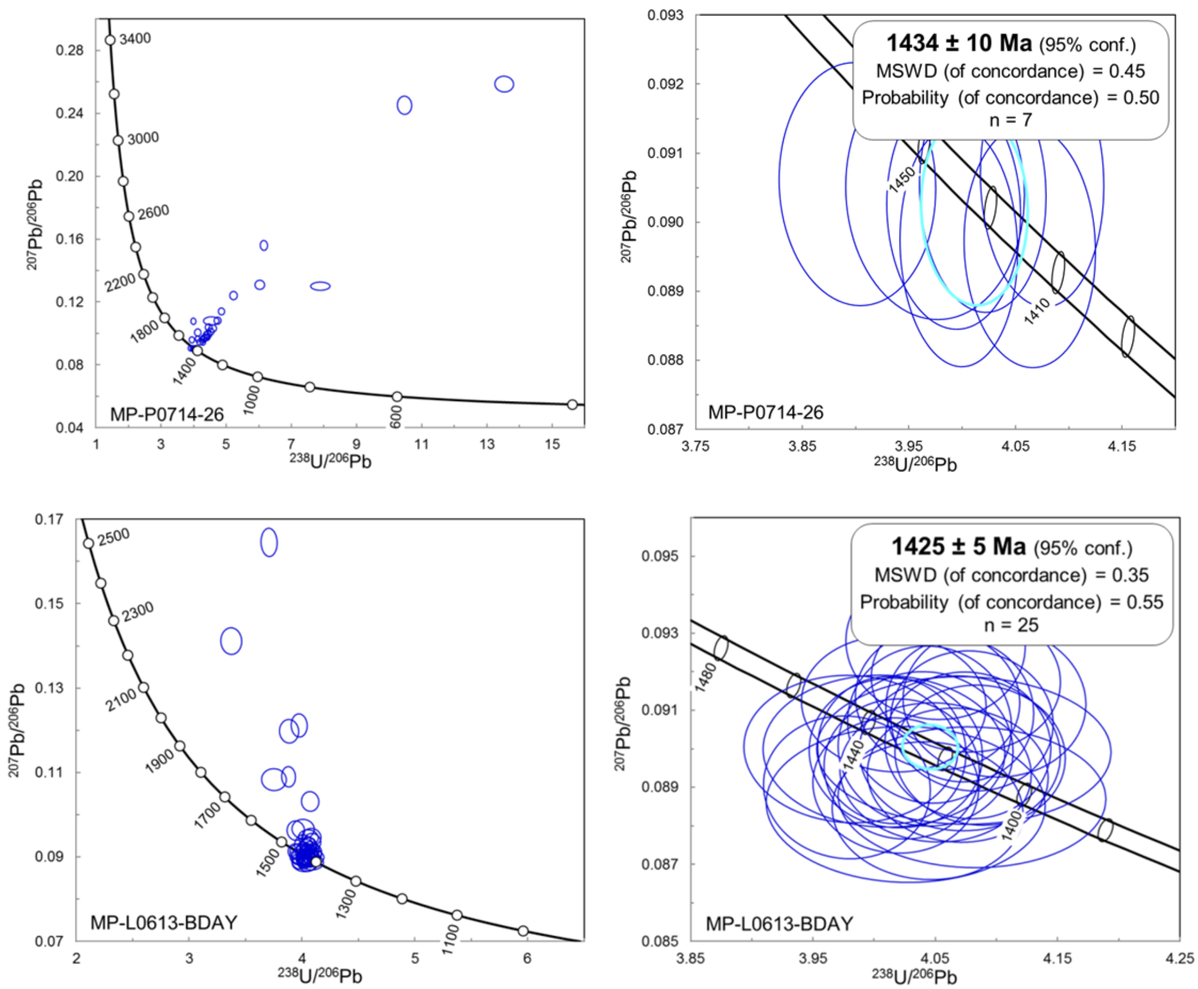

Mean = -5.5 ± 0.6 (95% conf.)
Wtd by data-pt errs only, 1 of 20 rej.
MSWD = 2.4, probability = 0.001
εNd$_i$
MP-P0714-17
Mean = -4.2 ± 0.5 (95% conf.)
Wtd by data-pt errs only, 1 of 20 rej.
MSWD = 2.0, probability = 0.008
εNd$_i$
MP-P0714-19
Mean = -4.6 ± 0.7 (95% conf.)
Wtd by data-pt errs only, 0 of 17 rej.
MSWD = 2.6, probability = 0.000
εNd$_i$
MP-P0714-22A
Mean = -5.6 ± 1.7 (95% conf.)
Wtd by data-pt errs only, 0 of 14 rej.
MSWD = 7.8, probability = 0.000
εNd$_i$
MP-P0714-26

APPENDIX H – ZIRCON URANIUM-LEAD CONCORDIA PLOTS

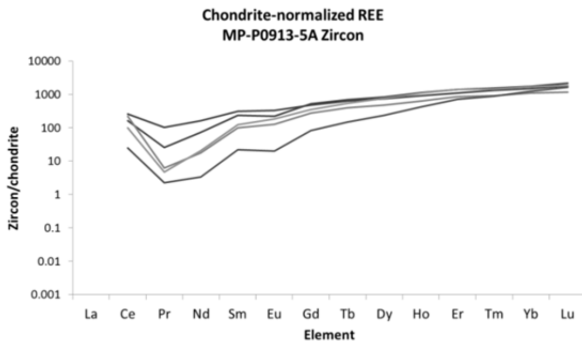


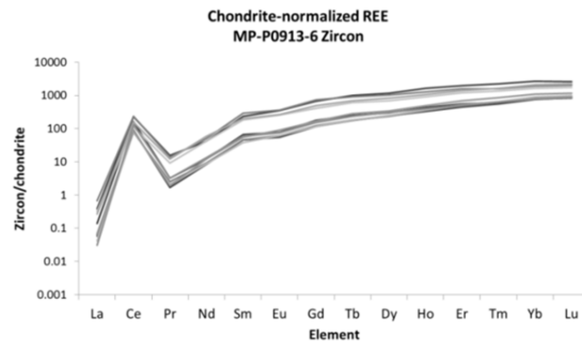


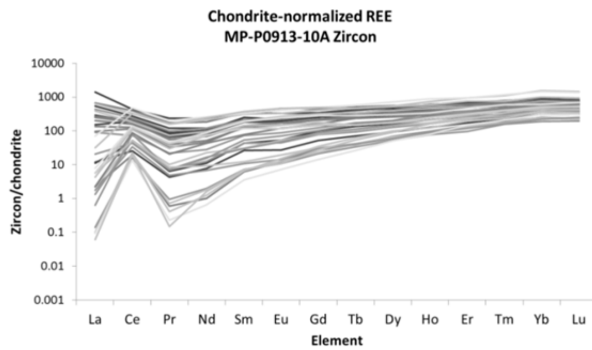
MP-P0913-10B
1411 ± 8 Ma (95% conf.)
Mean 207Pb/206Pb Age
MSWD = 0.24, probability = 0.96
n = 7
MP-P0913-10C
1458 ± 7 Ma (95% conf.)
Mean 207Pb/206Pb Age
MSWD = 0.4, probability = 0.91
n = 10
MP-P0714-21
1407 ± 11 Ma (2σ)
MSWD (of concordance) = 2.5
Probability (of concordance) = 0.11
n = 3
207Pb/206Pb
238U/206Pb

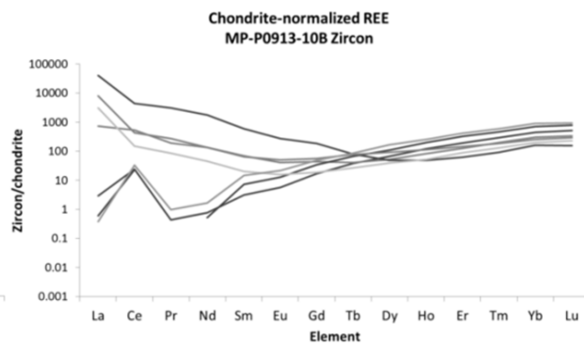

MP-P0714-26
1434 ± 10 Ma (95% conf.)
MSWD (of concordance) = 0.45
Probability (of concordance) = 0.50
n = 7
MP-L0613-BDAY
1425 ± 5 Ma (95% conf.)
MSWD (of concordance) = 0.35
Probability (of concordance) = 0.55
n = 25
$^{238}U/^{206}Pb$
$^{207}Pb/^{206}Pb$

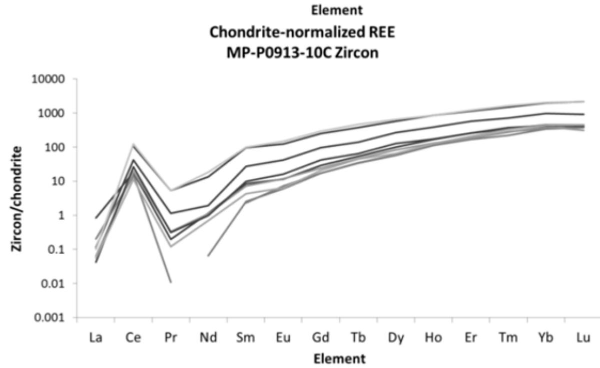
APPENDIX I – ZIRCON – CHONDRITE-NORMALIZED REE PLOTS

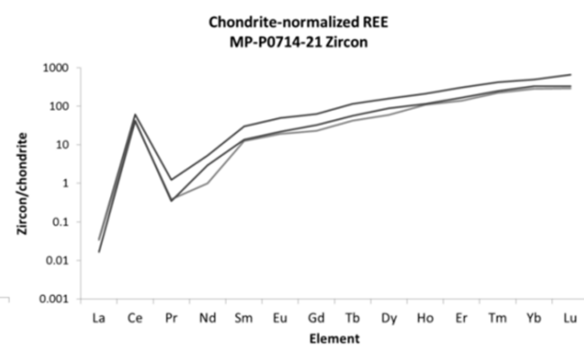


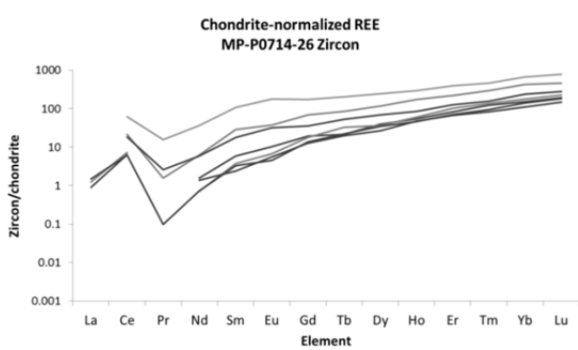


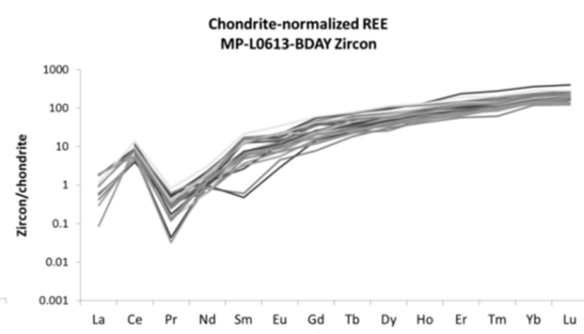




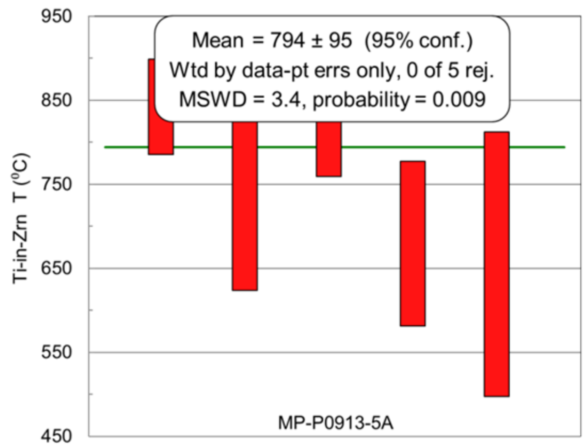


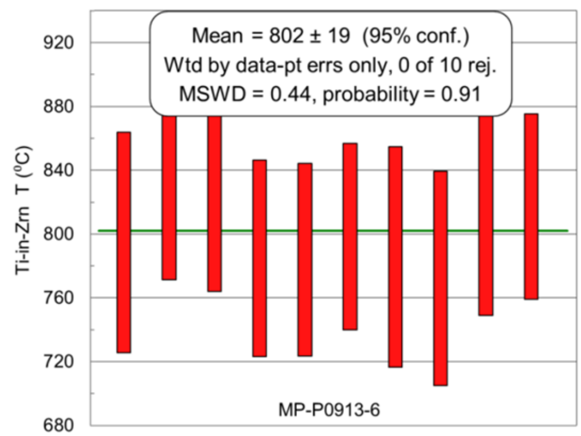


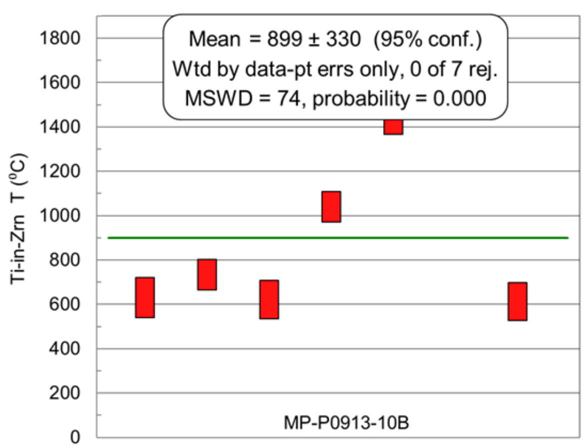


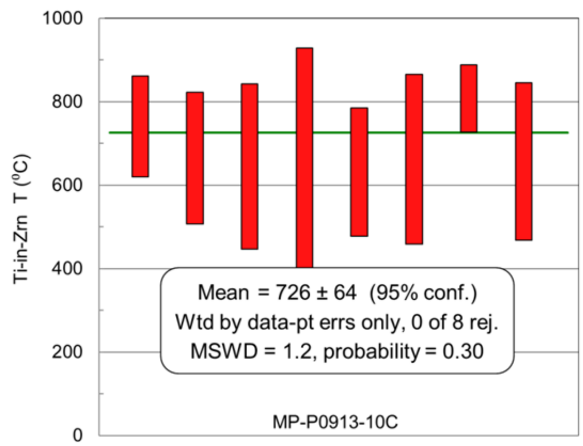


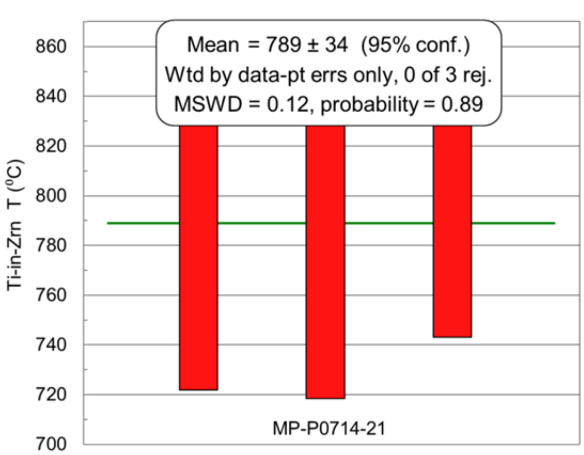
APPENDIX J – ZIRCON THEMOMETRY DATA PLOTS

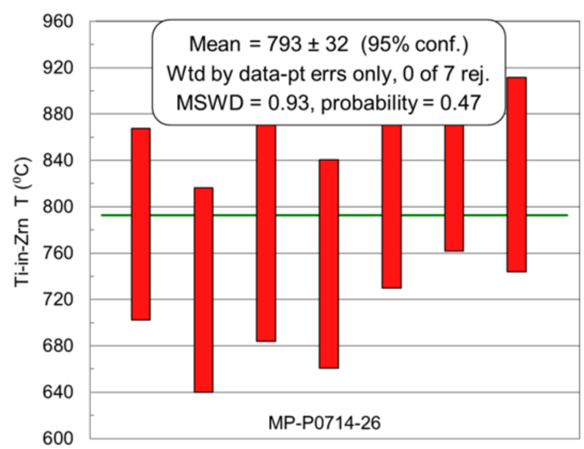


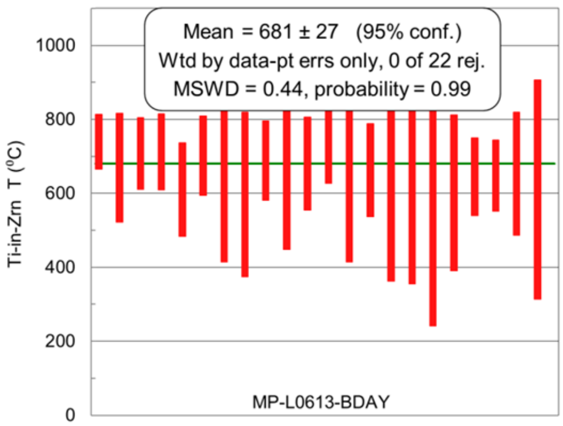


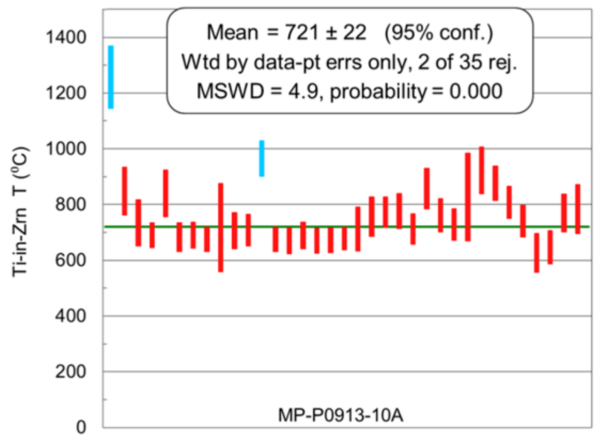






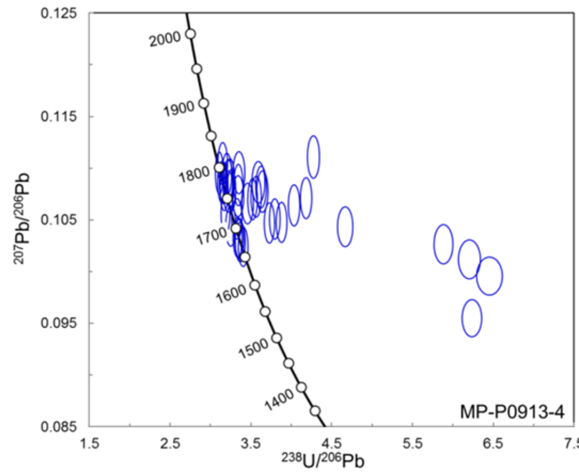


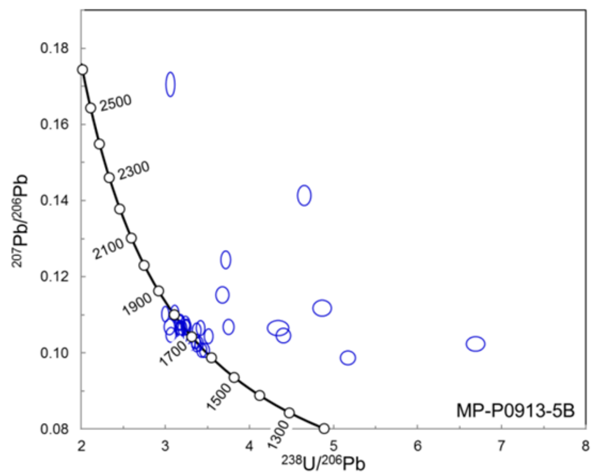

Mean = 681 ± 27 (95% conf.)
Wtd by data-pt errs only, 0 of 22 rej.
MSWD = 0.44, probability = 0.99
Ti-in-Zrn T (⁰C)
1000
800
600
400
200
0
MP-L0613-BDAY

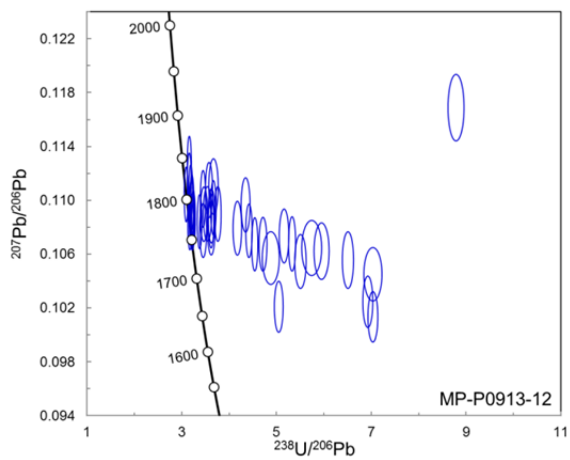

Mean = 721 ± 22 (95% conf.)
Wtd by data-pt errs only, 2 of 35 rej.
MSWD = 4.9, probability = 0.000
Ti-in-Zrn T (⁰C)
1400
1200
1000
800
600
400
200
0
MP-P0913-10A

APPENDIX K – HOST ROCK ZIRCON GEOCHRONOLOGIC, REE, AND THERMOMETRY DATA PLOTS

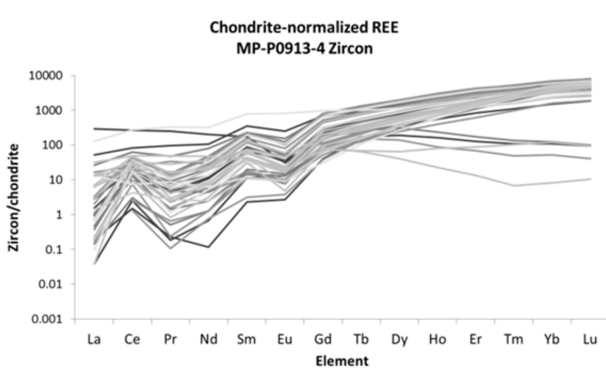
Zircon U-Pb Geochronology

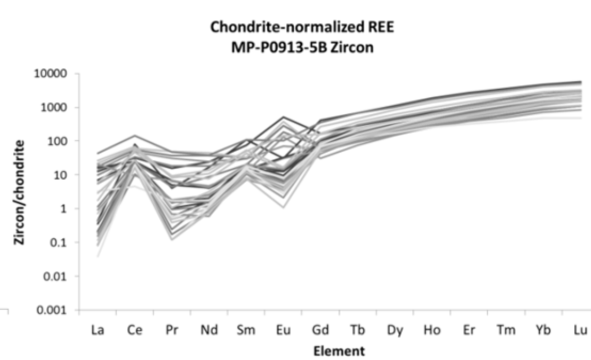


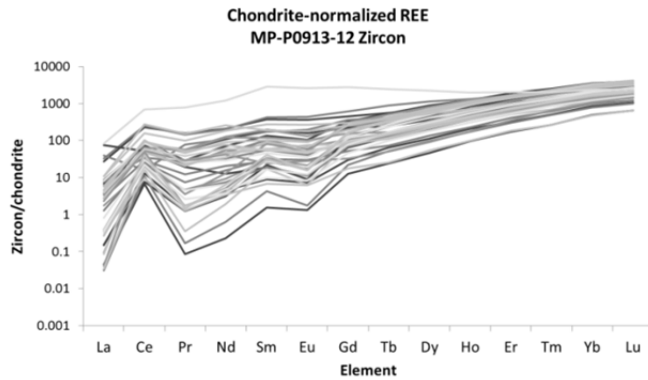




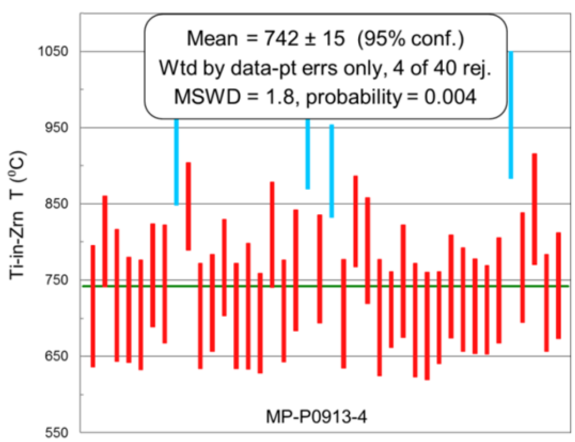
Zircon - Chondrite-Normalized REE

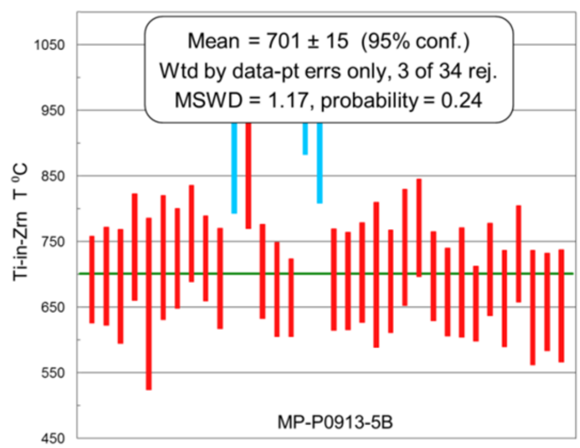


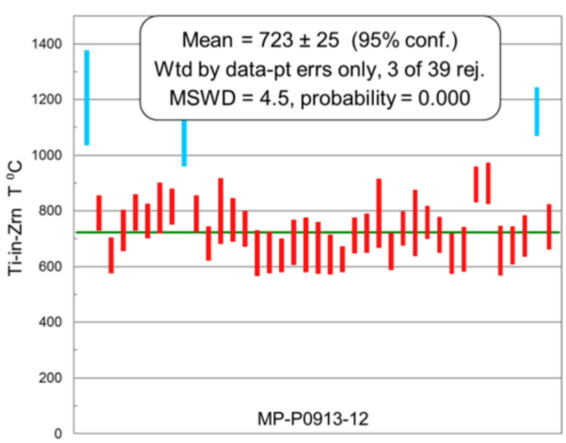


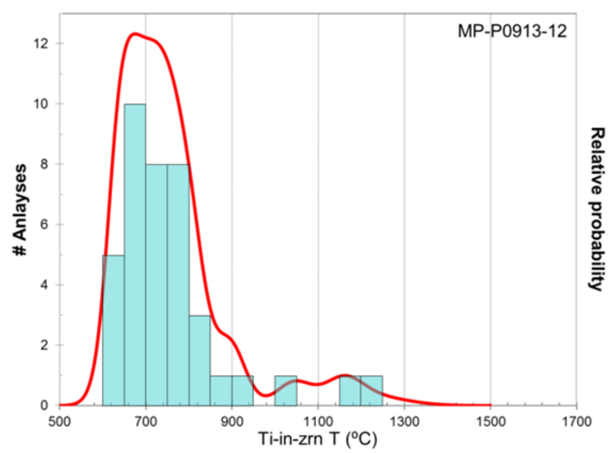


Zircon Thermometry

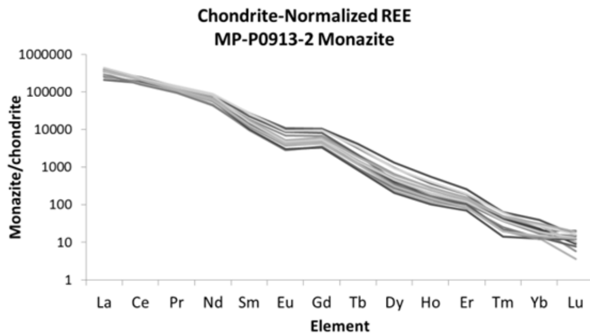


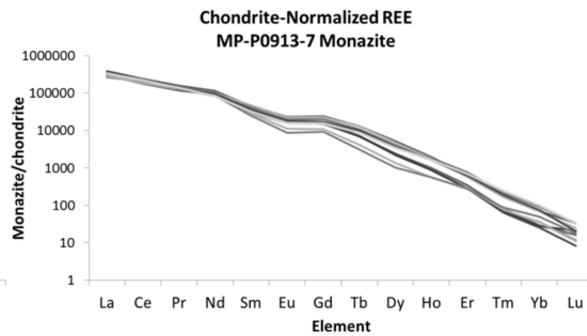


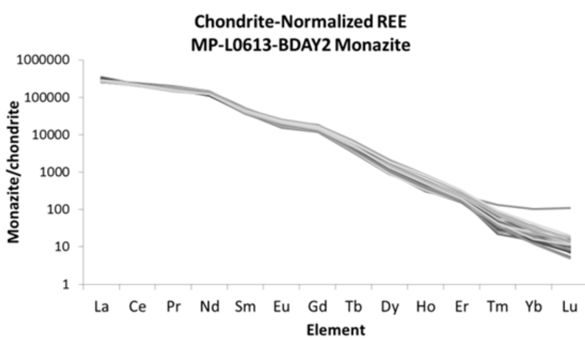


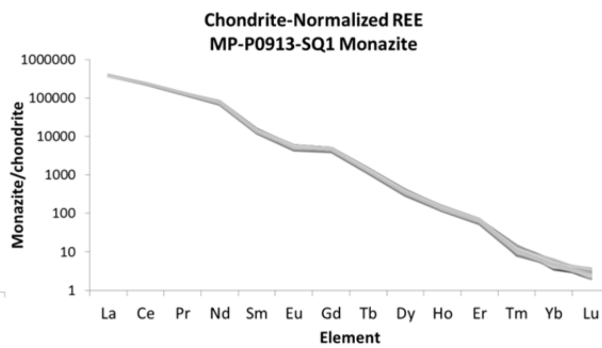


APPENDIX L – MONAZITE – CHONDRITE-NORMALIZED REE PLOTS

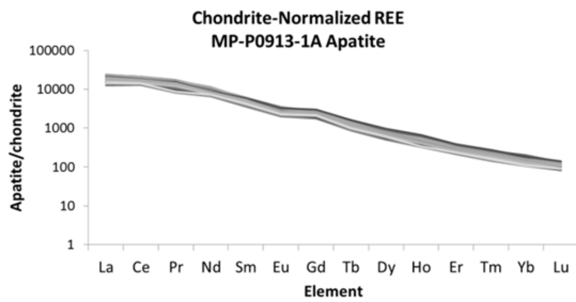


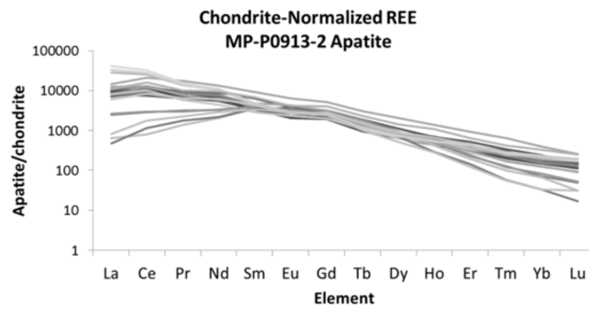


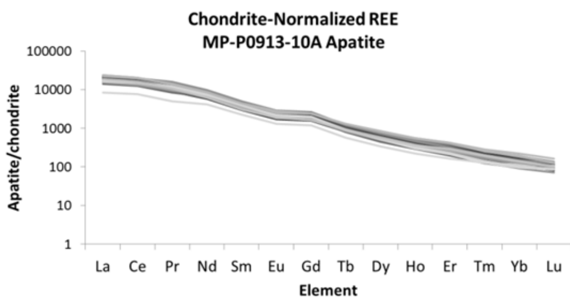


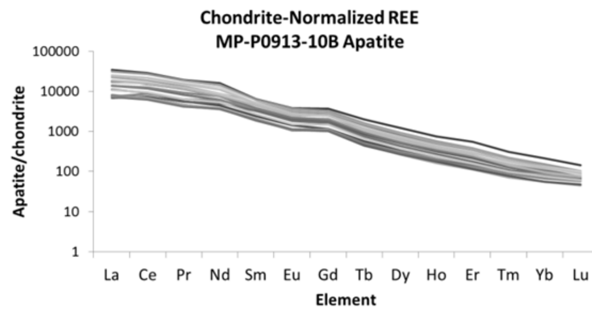


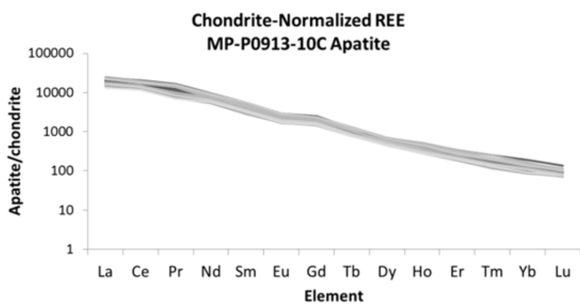
APPENDIX M – APATITE – CHONDRITE-NORMALIZED REE PLOTS

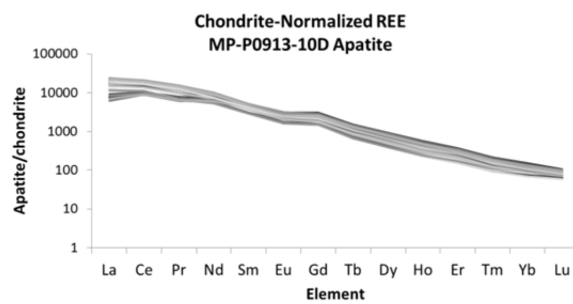












APPENDIX N - TITANITE URANIUM-LEAD DATA TABLE

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES					
Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-5A titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		27.2	120	53.2	2.23	0.3901	1.63	20.53	2.76	0.3789	2.23	0.807	3871	63.1	2073	46.2	1410	41.7
2		20.4	81	34.1	2.34	0.4267	1.53	24.11	2.64	0.4082	2.15	0.815	4006	61.3	2208	47.5	1417	44.7
3		31.2	158	60.7	2.57	0.3799	1.53	19.21	3.14	0.3675	2.75	0.874	3831	58.5	2019	55.5	1393	45.4
4		30.7	155	55.1	2.78	0.3826	1.54	19.86	2.67	0.3747	2.18	0.816	3842	59.3	2053	44.7	1413	40.3
5		33.8	154	76.6	1.98	0.35037	1.52	17.43	2.56	0.3587	2.05	0.804	3709	56.4	1978	40.6	1431	36.7
6		29.4	127	84.9	1.48	0.3124	1.54	14.51	2.68	0.3354	2.20	0.819	3533	54.4	1866	41.0	1425	35.6
7		32.1	122	58.8	2.04	0.4131	1.54	22.76	2.57	0.3992	2.05	0.799	3957	61.1	2167	44.5	1422	42.5
8		27.2	135	41.4	3.17	0.4295	1.58	23.87	2.80	0.4021	2.31	0.826	4016	63.4	2180	50.4	1389	45.9
9		27.0	99	73.0	1.34	0.34654	1.52	16.59	2.54	0.3458	2.03	0.801	3692	56.1	1916	39.0	1390	35.1
10		27.4	144	87.9	1.63	0.2887	1.55	12.58	2.89	0.3129	2.44	0.845	3411	52.8	1756	42.9	1381	36.3
11		30.5	106	61.9	1.69	0.4136	1.54	22.32	3.01	0.3923	2.59	0.860	3959	60.9	2135	55.3	1397	46.9
12		30.0	120	55.7	2.10	0.4166	1.53	23.39	2.57	0.4049	2.07	0.804	3970	60.6	2193	45.3	1433	43.3
13		32.7	101	101.9	0.99	0.33775	1.53	15.79	2.51	0.3381	2.00	0.795	3653	55.7	1879	37.6	1379	33.9
14		24.7	123	70.2	1.76	0.31265	1.52	14.372	2.51	0.3332	2.00	0.797	3534	53.6	1855	37.1	1415	33.1
15		26.4	116	39.8	2.90	0.44734	1.52	25.98	2.55	0.4212	2.05	0.804	4076	61.8	2268	46.4	1403	46.0
16		26.7	108	48.9	2.21	0.41863	1.51	23.02	2.54	0.3981	2.04	0.804	3977	60.2	2162	44.2	1404	42.4
17		60.4	160	144.6	1.10	0.3962	1.66	20.97	3.07	0.3846	2.58	0.841	3895	64.6	2099	54.1	1415	46.1
18		33.9	124	92.0	1.36	0.35553	1.52	17.52	2.80	0.3586	2.36	0.840	3731	56.7	1977	46.6	1418	40.0
19		32.5	122	81.4	1.50	0.35715	1.52	18.21	2.64	0.3689	2.16	0.818	3738	56.8	2026	43.8	1454	39.0
20		24.4	81	55.8	1.46	0.3945	1.55	20.66	2.82	0.3798	2.36	0.835	3888	60.4	2077	49.0	1402	42.9
21		22.1	71	44.2	1.62	0.4181	1.56	22.89	2.61	0.3971	2.09	0.802	3975	62.0	2157	45.2	1402	42.9
22		27.4	94	65.4	1.44	0.381	1.52	19.16	2.71	0.3649	2.24	0.827	3836	58.4	2007	44.9	1381	39.7
23		19.1	59	38.5	1.53	0.4182	1.53	23.05	2.65	0.3993	2.16	0.816	3976	60.9	2168	46.8	1409	43.6
24		18.1	59	34.5	1.68	0.4181	1.62	23.44	2.85	0.4061	2.35	0.822	3975	64.6	2199	51.6	1433	46.5
25		32.1	151	105.3	1.43	0.29686	1.51	13.189	2.52	0.3229	2.02	0.800	3454	52.2	1805	36.4	1406	32.2
26		25.0	94	42.1	2.24	0.4357	1.53	24.74	2.78	0.4118	2.32	0.836	4037	61.6	2225	51.7	1405	47.0
27		24.7	93	53.9	1.70	0.3864	1.52	19.92	2.54	0.3747	2.04	0.803	3857	58.5	2053	41.9	1404	38.9
28		23.4	84	50.2	1.67	0.39294	1.51	20.47	2.56	0.3784	2.07	0.807	3882	58.8	2070	42.8	1401	39.8
29		30.7	117	77.6	1.50	0.35819	1.51	17.64	2.50	0.3584	1.99	0.796	3742	56.6	1976	39.3	1411	36.1
30		26.2	113	50.9	2.16	0.41023	1.52	21.71	2.63	0.3843	2.14	0.816	3947	59.9	2098	44.9	1378	41.6
31		23.3	84	49.2	1.70	0.39994	1.51	21.1	2.54	0.3832	2.05	0.804	3909	59.1	2093	42.8	1400	40.2
32		20.0	137	57.6	2.36	0.26336	1.53	11.2	2.62	0.3094	2.12	0.810	3267	50.1	1739	36.8	1418	32.2
33		27.3	120	63.7	1.90	0.3681	1.54	18.05	2.56	0.357	2.04	0.800	3784	58.1	1970	40.3	1383	36.8
34		29.0	94	63.2	1.49	0.4124	1.59	21.52	2.91	0.3796	2.44	0.837	3955	63.0	2076	50.6	1357	44.2
35		26.6	107	51.7	2.08	0.4061	1.56	21.94	2.63	0.3929	2.12	0.806	3932	61.2	2138	45.3	1419	42.3

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES					
Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-5A titanite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
36		30.0	119	50.1	2.39	0.43854	1.51	25.19	2.57	0.4181	2.08	0.808	4047	61.2	2254	46.8	1418	45.5
37		30.0	145	75.1	1.95	0.3388	1.55	16.05	2.64	0.3457	2.14	0.810	3657	56.6	1916	41.0	1407	36.2
38		28.4	135	61.5	2.21	0.3712	1.54	18.43	2.76	0.3616	2.29	0.829	3796	58.5	1991	45.5	1392	39.8
39		29.8	116	55.5	2.08	0.414	1.54	22.6	2.66	0.3969	2.17	0.817	3961	60.9	2156	46.9	1412	43.4
MP-P0913-6 titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		40.3	175	49.5	3.55	0.5027	1.55	31.99	2.66	0.4586	2.16	0.812	4249	65.9	2435	52.6	1390	39.4
2		45.3	247	59.2	4.16	0.45142	1.52	26.18	2.51	0.4207	2.00	0.797	4090	62.0	2265	45.3	1417	34.7
3		53.0	291	71.3	4.08	0.44319	1.51	25.39	2.53	0.415	2.03	0.803	4063	61.2	2240	45.5	1420	34.7
4		68.3	419	99.2	4.21	0.40812	1.51	22.02	2.53	0.3912	2.03	0.803	3939	59.3	2130	43.2	1429	33.2
5		43.4	211	53.5	3.93	0.4717	1.53	29.08	2.57	0.4491	2.07	0.804	4155	63.5	2393	49.6	1451	37.7
6		110.3	1219	177.0	6.90	0.17531	1.51	6.639	2.53	0.2748	2.02	0.801	2609	39.5	1566	31.7	1428	28.3
7		43.6	211	54.1	3.91	0.47983	1.51	30.03	2.54	0.454	2.04	0.804	4180	63.0	2415	49.3	1443	37.6
8		85.9	949	142.9	6.66	0.15106	1.51	5.609	2.55	0.2692	2.05	0.805	2358	35.7	1538	31.6	1441	28.8
9		83.9	947	160.8	5.90	0.15221	1.51	5.458	2.55	0.2607	2.05	0.804	2371	35.9	1495	30.6	1395	27.8
10		48.9	290	69.5	4.20	0.41797	1.51	22.98	2.56	0.3974	2.06	0.807	3975	60.0	2159	44.5	1426	33.9
11		59.4	492	44.2	11.20	0.45881	1.51	27.27	2.55	0.4312	2.05	0.804	4114	62.3	2313	47.4	1431	36.1
12		69.3	365	89.2	4.12	0.4522	1.57	27.09	2.76	0.4353	2.27	0.822	4092	64.3	2331	52.9	1462	39.3
13		94.1	1003	147.7	6.78	0.1904	1.61	7.459	2.66	0.2837	2.13	0.798	2746	44.1	1611	34.2	1445	30.2
14		87.5	989	146.0	6.77	0.153	1.51	5.624	2.53	0.2651	2.03	0.802	2380	36.0	1517	30.8	1417	28.0
15		34.3	94	26.7	3.53	0.6325	1.51	56.99	2.59	0.6534	2.10	0.811	4584	69.3	3244	68.0	1417	55.6
16		28.4	73	26.4	2.77	0.5954	1.51	49.12	2.57	0.5978	2.08	0.810	4497	67.9	3023	63.0	1442	50.1
17		37.7	159	45.9	3.47	0.4979	1.51	32.39	2.57	0.4724	2.08	0.809	4235	64.1	2496	51.9	1445	39.4
18		60.7	686	117.1	5.87	0.13786	1.52	4.967	2.55	0.2614	2.05	0.803	2201	33.5	1498	30.7	1423	28.3
19		63.7	721	123.2	5.88	0.13648	1.51	4.927	2.56	0.2632	2.06	0.806	2183	33.1	1507	31.1	1435	28.7
20		72.8	333	149.7	2.22	0.38206	1.51	19.54	2.55	0.3718	2.05	0.806	3840	57.9	2040	41.9	1423	32.3
21		66.1	395	72.2	5.49	0.48209	1.51	29.61	2.63	0.4443	2.15	0.818	4187	63.4	2372	51.1	1406	38.0
22		31.6	123	36.7	3.38	0.5182	1.51	34.98	2.65	0.4901	2.18	0.821	4294	65.0	2573	56.0	1433	41.8
23		41.6	188	53.4	3.54	0.48186	1.51	29.85	2.56	0.4509	2.06	0.806	4187	63.4	2401	49.5	1427	37.6
24		46.6	293	96.9	3.02	0.3327	1.54	15.78	2.66	0.3464	2.17	0.816	3630	55.8	1919	41.6	1438	32.7
25		52.8	281	61.5	4.58	0.47583	1.51	29.16	2.56	0.4451	2.06	0.808	4168	62.8	2375	49.1	1427	37.1
26		39.3	149	43.0	3.47	0.5386	1.53	37.61	2.61	0.5052	2.12	0.810	4350	66.5	2638	55.8	1410	42.5
27		103.1	1131	174.9	6.47	0.15656	1.57	5.778	2.60	0.2693	2.07	0.796	2419	38.0	1538	31.8	1432	28.9
28		86.3	922	99.4	9.31	0.21349	1.52	8.527	2.54	0.2897	2.03	0.802	2932	44.5	1641	33.4	1432	28.8
29		52.9	296	72.0	4.11	0.43585	1.51	24.85	2.54	0.4128	2.04	0.803	4038	61.1	2230	45.5	1432	34.8
30		52.6	257	67.7	3.80	0.47042	1.51	28.81	2.56	0.4427	2.07	0.807	4151	62.7	2365	48.9	1435	37.0

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES					
Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-6 titanite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
31		83.8	605	79.0	7.63	0.4611	1.56	27.39	2.66	0.4317	2.16	0.810	4121	64.4	2315	49.9	1426	37.5
MP-P0913-10A titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
1		39.5	353	39.2	8.94	0.3649	1.59	17.65	3.15	0.3519	2.73	0.864	3770	59.9	1945	53.0	1404	41.2
2		40.1	363	35.0	10.36	0.3696	1.58	18.68	2.70	0.365	2.20	0.812	3790	59.8	2007	44.1	1443	36.1
3		53.4	546	79.6	6.79	0.23505	1.51	9.432	2.48	0.2913	1.97	0.793	3087	46.6	1649	32.4	1406	28.0
4		68.2	696	100.2	6.91	0.22898	1.51	9.153	2.48	0.2898	1.97	0.794	3045	45.9	1642	32.3	1410	28.0
5		67.8	697	96.6	7.12	0.2275	1.51	9.066	2.47	0.2896	1.95	0.790	3035	46.0	1641	32.1	1412	27.8
6		61.1	628	90.4	6.93	0.2261	1.52	9.021	2.58	0.2886	2.08	0.807	3025	46.0	1636	34.0	1410	29.4
7		32.7	296	28.9	10.08	0.3923	1.67	19.32	2.88	0.3576	2.35	0.815	3880	64.9	1972	46.3	1365	37.3
8		38.1	360	32.6	11.00	0.3763	1.59	18.65	2.59	0.3593	2.05	0.789	3817	60.7	1980	40.5	1407	33.9
9		17.1	81	54.9	1.46	0.30664	1.51	13.51	2.49	0.3203	1.97	0.794	3504	52.9	1793	35.4	1398	29.7
10		17.1	77	59.0	1.31	0.30242	1.52	13.24	2.50	0.3184	1.98	0.792	3483	53.0	1783	35.2	1399	29.6
11		12.5	22	35.8	0.62	0.386	1.60	19.36	2.63	0.3653	2.08	0.792	3855	61.9	2009	41.8	1407	34.9
12		35.2	338	30.1	11.19	0.349	1.54	16.33	2.54	0.3405	2.02	0.795	3703	57.0	1891	38.1	1394	31.8
13		47.7	283	81.5	3.46	0.3858	1.54	19.22	2.52	0.3638	1.99	0.790	3855	59.5	2002	39.9	1402	33.6
14		37.1	360	34.9	10.27	0.31966	1.53	14.59	2.47	0.3306	1.94	0.785	3568	54.6	1843	35.8	1415	30.2
15		8.3	20	18.3	1.07	0.4335	1.54	23.18	2.54	0.3907	2.02	0.796	4030	62.0	2128	43.0	1386	36.6
16		25.6	132	59.8	2.16	0.3509	1.55	16.68	2.53	0.3446	2.00	0.791	3711	57.3	1910	38.2	1406	32.0
17		25.6	198	18.9	10.56	0.4969	1.53	30.17	2.61	0.44	2.12	0.810	4232	64.9	2353	49.8	1381	43.0
18		67.8	663	86.6	7.72	0.25924	1.53	10.69	2.58	0.2986	2.08	0.805	3242	49.6	1686	35.0	1395	29.7
19		35.7	345	33.8	10.14	0.33695	1.52	15.46	2.55	0.3344	2.05	0.804	3649	55.5	1861	38.2	1395	31.7
20		46.5	431	80.6	5.35	0.27644	1.52	11.637	2.50	0.3053	1.98	0.792	3343	50.9	1719	34.0	1393	28.8
21		35.3	320	38.5	8.28	0.3487	1.60	16.42	2.54	0.3414	1.98	0.778	3701	59.1	1895	37.5	1398	31.6
22		28.5	238	24.1	9.90	0.4132	1.62	22.2	2.98	0.3912	2.50	0.840	3958	64.0	2130	53.3	1437	42.1
23		54.9	554	86.5	6.40	0.22714	1.52	8.931	2.48	0.2867	1.96	0.789	3032	46.2	1626	31.8	1399	27.6
24		49.6	490	75.5	6.50	0.24291	1.52	9.779	2.55	0.2927	2.05	0.805	3139	47.6	1656	34.0	1398	29.1
25		31.6	262	25.5	10.31	0.4316	1.61	23.46	2.66	0.3954	2.12	0.796	4023	64.7	2150	45.5	1407	38.3
26		38.5	276	25.9	10.67	0.5412	1.53	36.86	2.60	0.4944	2.11	0.810	4358	66.5	2592	54.6	1409	49.2
27		10.9	29	28.5	1.02	0.3923	1.53	19.56	2.61	0.3616	2.11	0.811	3880	59.2	1991	42.1	1380	34.6
28		20.8	113	55.2	2.03	0.32942	1.51	14.77	2.50	0.3273	1.99	0.796	3614	54.7	1827	36.4	1382	30.4
29		58.1	598	90.3	6.63	0.22662	1.51	8.855	2.50	0.2847	1.99	0.796	3028	45.8	1616	32.1	1390	27.8

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES					
Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-10B titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		71.6	533	55.6	9.60	0.4909	1.52	31.3	2.55	0.4644	2.05	0.804	4214	63.9	2461	50.5	1432	39.7
2		48.5	344	31.7	10.89	0.5565	1.52	40.27	2.51	0.5261	2.01	0.798	4398	66.7	2727	54.7	1393	45.0
3		75.1	581	63.3	9.20	0.46847	1.51	27.63	2.49	0.4299	1.98	0.795	4145	62.5	2307	45.7	1391	36.1
4		15.0	36	38.5	0.94	0.39242	1.52	20.13	2.50	0.3753	1.98	0.794	3880	58.9	2056	40.7	1405	32.1
5		56.4	423	42.5	9.97	0.51215	1.51	33.12	2.50	0.4726	2.00	0.798	4277	64.5	2497	49.9	1392	39.9
6		9.6	23	28.4	0.81	0.3653	1.53	17.9	2.56	0.3589	2.05	0.802	3772	57.7	1979	40.6	1408	32.0
7		56.9	364	38.8	9.40	0.57508	1.51	43.12	2.53	0.5476	2.03	0.802	4446	67.1	2817	57.2	1383	47.3
8		12.3	25	32.6	0.76	0.395	1.55	20.17	2.57	0.3743	2.05	0.798	3890	60.2	2051	42.1	1395	32.9
9		10.7	23	33.4	0.69	0.36383	1.52	17.41	2.53	0.3522	2.02	0.798	3766	57.3	1947	39.3	1386	31.0
10		15.5	78	18.4	4.26	0.4992	1.53	30.75	2.78	0.4508	2.32	0.834	4239	65.0	2401	55.7	1368	41.3
11		30.9	160	67.6	2.37	0.3599	1.56	17.44	2.91	0.3519	2.46	0.845	3749	58.4	1945	47.9	1394	36.4
12		28.0	139	59.7	2.32	0.3546	1.53	16.99	2.57	0.3535	2.07	0.805	3727	56.9	1953	40.4	1412	31.9
13		52.4	350	36.9	9.49	0.55908	1.51	40.36	2.52	0.5292	2.01	0.800	4405	66.5	2740	55.1	1393	45.3
14		8.1	15	18.3	0.82	0.4308	1.56	23.64	2.61	0.4017	2.10	0.803	4020	62.6	2179	45.8	1401	35.4
15		8.3	15	19.5	0.79	0.425	1.57	22.67	2.65	0.3915	2.13	0.806	4000	62.6	2131	45.5	1381	35.0
16		75.7	612	63.7	9.63	0.4733	1.56	27.99	2.61	0.4336	2.09	0.802	4160	64.8	2324	48.6	1390	37.8
17		10.9	20	23.2	0.86	0.441	1.52	24.61	2.60	0.4083	2.11	0.810	4055	61.8	2209	46.5	1396	35.8
18		64.3	509	51.5	9.91	0.48485	1.51	29.4	2.51	0.4434	2.01	0.799	4196	63.4	2368	47.6	1387	37.5
19		62.4	448	48.3	9.26	0.52284	1.51	34.72	2.51	0.4857	2.00	0.799	4307	65.0	2554	51.2	1396	41.1
20		22.9	105	70.5	1.49	0.31748	1.52	14.22	2.53	0.3272	2.03	0.801	3558	53.9	1826	37.0	1389	29.7
21		50.6	348	31.8	10.96	0.5666	1.52	42.8	2.59	0.5517	2.10	0.810	4425	67.1	2835	59.4	1423	48.1
22		14.3	33	50.6	0.65	0.3337	1.53	15.59	2.56	0.3391	2.05	0.801	3634	55.6	1884	38.6	1402	30.8
23		76.9	596	62.7	9.47	0.48134	1.51	29.19	2.51	0.4419	2.01	0.800	4185	63.2	2361	47.5	1392	37.4
24		70.5	551	58.1	9.49	0.47709	1.51	28.93	2.52	0.4421	2.02	0.801	4172	63.0	2362	47.7	1405	37.4
25		15.9	42	48.8	0.86	0.3482	1.58	16.6	2.75	0.3494	2.25	0.819	3699	58.4	1933	43.5	1411	34.0
26		71.5	576	57.2	10.12	0.483	1.52	29.19	2.57	0.4405	2.08	0.807	4190	63.7	2355	48.9	1383	38.0
27		50.8	368	35.9	10.25	0.5458	1.51	37.6	2.54	0.5032	2.04	0.803	4370	66.1	2630	53.6	1370	43.2
28		50.9	351	35.2	9.99	0.54772	1.51	38.82	2.51	0.5145	2.01	0.800	4375	66.0	2678	53.9	1393	43.9
29		58.7	422	43.8	9.67	0.52547	1.51	34.95	2.49	0.4841	1.99	0.796	4314	65.1	2547	50.6	1383	40.8
30		61.6	439	46.3	9.50	0.5281	1.51	35.44	2.53	0.488	2.02	0.801	4322	65.3	2564	51.9	1385	41.6
31		60.2	429	46.8	9.20	0.52396	1.51	34.58	2.51	0.4788	2.01	0.799	4310	65.1	2524	50.7	1373	40.6
32		59.3	395	45.3	8.74	0.54246	1.51	37.44	2.54	0.5013	2.04	0.804	4361	65.7	2621	53.4	1375	42.9
33		64.9	426	177.8	2.42	0.29269	1.51	12.761	2.47	0.3158	1.96	0.793	3432	51.7	1771	34.7	1393	28.4
34		25.2	125	77.9	1.61	0.30825	1.52	13.557	2.51	0.3199	2.00	0.796	3512	53.4	1791	35.8	1378	29.0
35		12.4	151	29.5	1.17	0.412	1.56	21.56	2.64	0.3769	2.14	0.809	3953	61.5	2063	44.1	1363	33.9
36		10.9	30	27.9	1.08	0.3827	1.55	19.09	2.65	0.3652	2.15	0.812	3842	59.6	2008	43.2	1391	33.5
37		12.3	39	28.1	1.41	0.4124	1.52	21.46	2.58	0.3786	2.08	0.807	3955	60.3	2071	43.1	1368	33.3
38		16.5	50	51.2	0.98	0.34539	1.53	16.24	2.58	0.3422	2.08	0.806	3687	56.3	1899	39.5	1389	31.2

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES					
Spot	**Comm.**	**Pb ppm**	**Th ppm**	**U ppm**	**Th/U**	**^{207}Pb/^{206}Pb**	**2σ %**	**^{207}Pb/^{235}U**	**2σ %**	**^{206}Pb/^{238}U**	**2σ %**	**Rho**	**^{207}Pb/^{206}Pb Age**	**2σ abs**	**^{206}Pb/^{238}U Age**	**2σ abs**	**^{207}Pb-corrected ^{206}Pb/^{238}U Age**	**2σ abs**
MP-P0913-10B titanite CONT'D (spot size = 40 μm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
39		16.0	50	49.8	1.00	0.3419	1.53	15.81	2.65	0.3382	2.16	0.816	3671	56.3	1880	40.7	1381	31.9
40		61.0	453	45.6	9.96	0.52431	1.51	34.73	2.49	0.4799	1.98	0.794	4311	65.2	2529	50.0	1375	40.4
MP-P0913-10C titanite (spot size = 40 μm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
1		30.1	166	61.9	2.64	0.4358	1.52	23.19	2.55	0.3824	2.04	0.802	4037	61.4	2089	42.7	1383	33.9
2		32.5	197	66.2	2.92	0.3964	1.53	19.81	2.56	0.3587	2.06	0.804	3895	59.4	1978	40.8	1385	32.3
3		23.7	104	39.0	2.65	0.5671	1.51	38.66	2.67	0.493	2.20	0.823	4426	67.0	2586	56.8	1380	45.5
4		25.5	110	41.7	2.61	0.5623	1.55	39.06	2.76	0.4994	2.28	0.827	4413	68.4	2613	59.6	1412	47.1
5		28.1	153	55.1	2.75	0.4463	1.52	24.02	2.64	0.3876	2.16	0.817	4073	61.9	2113	45.6	1376	35.5
6		38.6	231	74.6	3.07	0.4073	1.52	20.74	2.61	0.3671	2.12	0.812	3936	60.0	2017	42.7	1392	33.6
7		35.7	178	65.3	2.72	0.5012	1.52	30.06	2.59	0.4329	2.10	0.811	4245	64.3	2321	48.8	1389	38.8
8		51.0	279	102.1	2.73	0.44484	1.51	23.86	2.59	0.387	2.10	0.811	4068	61.6	2111	44.4	1378	34.8
9		24.7	114	40.3	2.83	0.5528	1.54	36.21	2.61	0.4745	2.11	0.807	4389	67.7	2505	52.8	1371	43.2
10		23.6	107	39.6	2.68	0.5527	1.52	36.81	2.66	0.4825	2.19	0.821	4388	66.8	2540	55.6	1393	44.4
11		58.2	348	182.8	1.90	0.3231	1.51	14.26	2.54	0.3191	2.05	0.804	3585	54.2	1787	36.5	1378	29.6
12		41.2	161	57.0	2.81	0.6325	1.52	50.83	2.53	0.5815	2.03	0.801	4584	69.5	2957	59.9	1391	53.8
13		25.3	123	47.5	2.61	0.4999	1.55	29.41	2.62	0.428	2.11	0.806	4241	65.6	2299	48.5	1377	38.6
14		26.2	134	43.6	3.09	0.5112	1.53	30.71	2.63	0.4353	2.14	0.813	4274	65.3	2331	49.8	1370	39.5
15		25.7	110	42.4	2.62	0.5547	1.52	37.16	2.60	0.485	2.12	0.813	4394	66.7	2551	54.0	1394	44.0
16		47.0	269	122.2	2.23	0.3881	1.52	19.07	2.49	0.3554	1.98	0.792	3864	58.8	1962	38.8	1390	31.2
17		28.1	126	50.8	2.51	0.5325	1.52	33.94	2.62	0.4603	2.14	0.815	4334	65.9	2443	52.2	1387	41.8
18		33.3	196	61.9	3.21	0.41205	1.52	21.28	2.67	0.3742	2.19	0.823	3954	60.0	2051	45.0	1407	35.0
19		39.0	252	76.9	3.31	0.3611	1.53	17.29	2.57	0.346	2.06	0.803	3754	57.5	1917	39.6	1411	31.7
20		52.8	285	107.7	2.67	0.4378	1.53	23.56	2.43	0.3882	1.89	0.777	4044	61.8	2116	39.9	1398	32.8
21		62.1	312	124.5	2.56	0.4809	1.52	27.5	2.41	0.4134	1.88	0.778	4184	63.5	2232	41.9	1379	34.9
22		66.2	343	129.9	2.67	0.46914	1.51	26.55	2.41	0.4083	1.87	0.778	4147	62.7	2209	41.4	1391	34.3
23		37.7	189	66.3	2.88	0.5079	1.53	31.39	2.44	0.4455	1.91	0.780	4264	65.2	2377	45.3	1410	38.2
24		27.4	134	43.0	3.16	0.5392	1.52	34.73	2.44	0.4665	1.90	0.782	4352	66.1	2470	47.0	1387	40.4
25		41.1	176	182.1	0.98	0.35225	1.51	16.345	2.42	0.3355	1.90	0.783	3717	56.1	1866	35.4	1387	28.9
26		24.5	115	41.4	2.80	0.5378	1.52	34.88	2.47	0.4703	1.95	0.788	4348	66.1	2487	48.4	1401	41.0
27		32.7	155	58.6	2.66	0.5212	1.52	32.69	2.44	0.4541	1.91	0.783	4302	65.3	2415	46.1	1400	39.0
28		53.5	267	80.4	3.36	0.54294	1.51	35.2	2.46	0.4694	1.94	0.789	4362	65.9	2483	48.2	1384	40.9
29		40.6	156	52.8	2.98	0.6534	1.53	55.24	2.47	0.613	1.94	0.787	4631	70.6	3084	60.0	1387	57.1

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-10D titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
1		8.0	10	34.5	0.30	0.4774	1.54	27.09	2.55	0.4125	2.03	0.798	4173	64.1	2228	45.3	1382	35.2
2		14.2	38	91.9	0.41	0.34826	1.52	16.01	2.50	0.334	1.99	0.794	3699	56.2	1859	36.9	1388	29.4
3		13.4	33	77.5	0.42	0.3801	1.52	18.47	2.46	0.353	1.93	0.786	3832	58.4	1950	37.7	1396	29.9
4		29.9	111	196.4	0.56	0.3117	1.51	13.61	2.45	0.3177	1.93	0.786	3529	53.5	1780	34.3	1392	27.9
5		44.5	193	283.1	0.68	0.29947	1.51	12.81	2.45	0.311	1.93	0.788	3467	52.3	1747	33.8	1387	27.6
6		46.1	189	251.3	0.74	0.33365	1.51	15	2.44	0.3272	1.92	0.787	3634	54.8	1826	35.1	1389	28.3
7		42.4	158	267.0	0.58	0.32081	1.51	14.313	2.41	0.3255	1.88	0.780	3574	54.0	1818	34.2	1407	27.9
8		42.9	200	197.5	1.01	0.3308	1.51	15.02	2.46	0.331	1.94	0.789	3621	54.7	1845	35.8	1410	28.9
9		44.3	204	190.9	1.06	0.34354	1.52	16.02	2.45	0.3403	1.92	0.785	3679	55.8	1890	36.3	1422	29.2
10		10.0	18	47.7	0.38	0.4397	1.52	23.57	2.50	0.3923	1.98	0.792	4051	61.8	2135	42.2	1405	33.0
11		12.7	20	54.9	0.35	0.4682	1.52	26.63	2.51	0.4153	2.00	0.796	4144	63.1	2241	44.8	1413	35.0
12		37.3	178	60.3	2.91	0.5461	1.51	36.46	2.46	0.4867	1.94	0.789	4371	66.0	2558	49.6	1420	40.3
13		19.3	36	86.5	0.41	0.45228	1.51	24.96	2.46	0.4022	1.94	0.789	4093	61.9	2181	42.3	1409	33.3
14		12.0	30	162.8	0.19	0.24088	1.52	9.679	2.46	0.2939	1.94	0.787	3126	47.5	1662	32.2	1417	27.4
15		32.4	120	213.8	0.56	0.31092	1.52	13.68	2.53	0.322	2.03	0.801	3526	53.5	1801	36.5	1412	29.5
16		44.0	199	230.0	0.85	0.32175	1.51	14.26	2.57	0.3238	2.08	0.809	3578	54.1	1810	37.7	1398	30.2
17		42.5	192	63.5	3.01	0.5806	1.51	41.73	2.49	0.5233	1.98	0.794	4460	67.5	2715	53.7	1414	44.1
18		10.1	17	68.7	0.24	0.37171	1.52	17.86	2.53	0.3503	2.02	0.799	3798	57.8	1938	39.1	1403	30.8
19		50.1	259	93.2	2.77	0.47683	1.51	27.91	2.51	0.4256	2.00	0.798	4171	63.0	2288	45.7	1425	35.7
20		51.3	249	89.6	2.77	0.5168	1.51	32.41	2.48	0.4569	1.97	0.794	4290	64.7	2428	47.9	1416	38.0
21		45.5	223	79.4	2.79	0.51697	1.51	32.01	2.49	0.451	1.98	0.795	4290	64.9	2402	47.5	1398	37.6
22		58.0	322	110.9	2.90	0.44844	1.52	24.59	2.46	0.3992	1.94	0.788	4080	61.8	2167	42.1	1408	33.1
23		30.0	133	50.3	2.64	0.5506	1.52	36.93	2.47	0.4871	1.95	0.790	4383	66.4	2560	50.0	1408	40.6
24		39.7	176	53.3	3.33	0.6008	1.51	45.07	2.52	0.544	2.01	0.799	4510	68.2	2802	56.4	1402	46.4
25		40.9	184	54.5	3.39	0.6011	1.51	45.29	2.49	0.5479	1.98	0.794	4511	68.3	2819	55.8	1411	46.5
26		49.9	220	77.3	2.86	0.5661	1.52	39.68	2.59	0.5082	2.09	0.808	4423	67.4	2651	55.4	1419	43.7
27		15.8	43	104.7	0.42	0.3392	1.52	15.59	2.50	0.3332	1.99	0.795	3659	55.5	1855	36.9	1403	29.5
28		26.8	91	172.6	0.53	0.31892	1.51	14.33	2.49	0.326	1.98	0.795	3565	54.0	1820	36.1	1413	29.2
29		10.7	15	47.3	0.32	0.462	1.53	26.12	2.51	0.4111	1.99	0.794	4124	62.9	2222	44.2	1415	34.6
30		59.6	276	273.2	1.02	0.33344	1.51	15.11	2.44	0.3281	1.92	0.787	3633	54.8	1831	35.2	1393	28.3
MP-P0714-16 titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		166.4	743	158.3	4.62	0.5534	1.53	42.6	2.53	0.5596	2.01	0.796	4390	67.2	2867	57.7	1444	47.8
2		98.1	391	152.5	2.59	0.44998	1.51	26.71	2.56	0.4312	2.08	0.809	4085	61.5	2313	48.0	1420	37.0
3		166.1	826	175.8	4.66	0.5095	1.52	35.19	2.68	0.4994	2.21	0.824	4269	64.8	2613	57.7	1439	43.9
4		162.7	749	171.0	4.38	0.4959	1.54	33.45	3.12	0.4884	2.72	0.870	4229	65.1	2566	69.8	1453	48.6

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
						MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**					
MP-P0714-16 titanite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
5		212.6	844	85.9	9.84	0.71557	1.50	96.09	2.54	0.9747	2.04	0.806	4762	71.5	4390	89.7	1433	91.8
6		85.8	399	106.8	3.76	0.4728	1.52	29.54	2.67	0.4526	2.20	0.822	4159	63.3	2409	52.9	1419	40.0
7		110.0	675	150.4	4.51	0.41666	1.51	23.31	2.57	0.4054	2.08	0.810	3970	59.8	2196	45.6	1427	35.2
8		186.9	1065	184.9	5.76	0.4895	1.64	32.53	2.81	0.481	2.27	0.810	4210	69.2	2534	57.6	1452	44.2
9		136.0	608	187.9	3.27	0.4659	1.53	28.69	2.88	0.4477	2.43	0.846	4137	63.5	2387	58.1	1425	42.2
10		86.6	534	121.8	4.40	0.4118	1.52	22.66	2.66	0.399	2.18	0.821	3953	60.1	2166	47.3	1418	36.0
11		53.3	203	66.0	3.08	0.4958	1.51	33	2.59	0.4822	2.11	0.812	4229	64.0	2539	53.5	1435	41.5
12		92.1	293	137.7	2.13	0.47716	1.50	29.96	2.51	0.4548	2.00	0.800	4172	62.8	2419	48.5	1413	38.1
13		85.7	463	139.2	3.31	0.4113	1.65	22.11	2.91	0.3896	2.40	0.824	3951	65.1	2123	50.9	1387	38.2
14		27.6	131	34.4	3.83	0.47689	1.51	29.58	2.55	0.4492	2.05	0.805	4171	63.1	2394	49.2	1397	38.2
15		19.7	45	11.0	4.09	0.6943	1.53	81.4	2.82	0.853	2.36	0.839	4719	72.2	3979	94.1	1380	81.3
16		25.4	73	19.6	3.74	0.6232	1.53	56.4	2.69	0.6534	2.20	0.821	4563	70.0	3244	71.5	1376	59.1
17		27.4	198	152.8	1.29	0.17998	1.52	6.813	2.60	0.2736	2.11	0.812	2653	40.2	1560	32.9	1408	29.2
18		6.1	8	22.3	0.36	0.3427	1.63	16.35	2.91	0.343	2.41	0.828	3675	60.0	1903	45.9	1383	35.4
19		118.4	746	169.0	4.44	0.4027	1.53	21.95	2.58	0.3942	2.08	0.805	3919	59.9	2144	44.5	1425	34.5
20		37.4	84	16.9	5.03	0.7346	1.51	101	2.63	0.991	2.15	0.818	4800	72.7	4443	95.6	1331	95.8
21		45.8	352	95.9	3.68	0.2916	1.59	12.89	2.72	0.3178	2.21	0.813	3426	54.3	1780	39.4	1392	31.8
22		69.5	67	116.2	0.58	0.49394	1.51	32.68	2.52	0.4776	2.01	0.801	4223	63.7	2519	50.7	1428	40.1
23		167.2	909	147.0	6.18	0.52527	1.50	37.55	2.50	0.5167	1.99	0.798	4314	64.9	2687	53.5	1434	43.3
24		63.3	288	41.0	7.02	0.6092	1.52	56.55	2.55	0.6704	2.05	0.804	4530	68.7	3310	67.9	1473	58.8
25		88.0	488	72.7	6.72	0.5496	1.52	39.94	2.89	0.5258	2.46	0.851	4380	66.4	2726	67.0	1373	48.4
26		88.1	488	70.7	6.93	0.542	1.55	40.19	2.80	0.5362	2.33	0.832	4360	67.5	2770	64.4	1427	48.6
27		80.5	339	53.8	6.31	0.6247	1.53	56.61	2.82	0.6548	2.37	0.841	4567	69.8	3250	77.1	1373	60.2
28		77.9	356	57.5	6.19	0.5862	1.55	48.19	2.94	0.5938	2.51	0.851	4474	69.2	3007	75.4	1401	55.5
29		72.5	425	153.7	2.76	0.3364	1.53	16.05	2.88	0.3453	2.44	0.848	3647	55.8	1914	46.7	1406	36.0
30		71.1	416	144.3	2.88	0.33726	1.51	16.32	2.83	0.3493	2.40	0.846	3650	55.2	1933	46.3	1420	35.7
31		76.9	237	118.9	2.00	0.46561	1.51	29	2.56	0.4493	2.06	0.806	4136	62.6	2394	49.4	1431	38.3
32		116.8	505	118.0	4.29	0.5364	1.51	38.28	2.54	0.5144	2.05	0.805	4345	65.5	2678	54.8	1390	43.7
33		82.1	352	52.6	6.71	0.62293	1.51	58.2	2.60	0.6762	2.12	0.815	4562	68.8	3332	70.7	1424	60.0
MP-P0714-17 titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		61.7	411	41.8	9.84	0.55764	1.51	41.03	2.58	0.5328	2.09	0.810	4401	66.4	2755	57.5	1365	81.5
2		46.9	278	28.9	9.64	0.602	1.51	50.69	2.59	0.6083	2.10	0.812	4513	68.2	3066	64.5	1373	99.7
3		61.9	421	43.6	9.68	0.54361	1.51	38.86	2.55	0.5163	2.06	0.807	4364	65.8	2686	55.3	1372	77.2
4		61.8	415	42.5	9.80	0.5458	1.51	39.63	2.55	0.5241	2.05	0.806	4370	66.0	2719	55.9	1384	78.6
5		63.1	422	43.5	9.72	0.546	1.51	39.72	2.56	0.5248	2.06	0.807	4370	66.0	2722	56.1	1385	78.7

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
						MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**					
MP-P0714-17 titanite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
6		61.8	411	42.6	9.67	0.54936	1.51	40.18	2.58	0.5291	2.09	0.811	4379	66.1	2740	57.2	1384	79.9
7		51.0	316	32.7	9.63	0.5754	1.51	45.05	2.56	0.5657	2.06	0.806	4447	67.3	2892	59.6	1379	88.8
8		67.6	420	43.6	9.66	0.5754	1.51	45.23	2.53	0.5673	2.03	0.803	4447	67.2	2899	58.9	1383	88.9
9		63.4	429	44.7	9.61	0.5473	1.51	38.96	2.55	0.5133	2.05	0.805	4374	66.2	2673	54.9	1351	77.2
10		53.2	315	32.0	9.81	0.604	1.51	50.7	2.54	0.6049	2.05	0.804	4518	68.3	3052	62.5	1357	99.3
11		52.9	319	32.5	9.82	0.5956	1.51	48.68	2.56	0.5918	2.07	0.807	4497	68.0	2999	62.0	1362	95.9
12		61.3	421	42.3	9.99	0.54703	1.51	39.21	2.54	0.5176	2.04	0.803	4373	66.0	2691	54.8	1363	77.7
13		61.3	422	42.6	9.93	0.54726	1.51	39.18	2.52	0.5185	2.02	0.802	4374	66.0	2695	54.5	1365	77.8
14		53.4	349	36.3	9.69	0.5714	1.53	42.98	2.77	0.5453	2.31	0.835	4437	67.7	2808	65.0	1346	86.4
15		52.8	347	34.6	10.04	0.5681	1.51	42.88	2.55	0.5451	2.06	0.806	4428	66.9	2807	57.7	1357	84.7
16		61.5	416	41.4	10.10	0.5522	1.51	40.35	2.52	0.5287	2.02	0.801	4387	66.2	2738	55.3	1373	79.9
17		61.2	407	44.9	9.07	0.5388	1.51	37.77	2.55	0.5068	2.06	0.806	4351	65.8	2645	54.4	1363	75.2
18		63.5	405	47.1	8.64	0.5437	1.52	39.08	2.56	0.5207	2.06	0.805	4364	66.2	2704	55.6	1383	77.8
19		61.3	410	43.8	9.39	0.54844	1.51	39.15	2.54	0.5168	2.04	0.805	4377	66.0	2688	54.9	1356	77.8
20		60.4	403	43.1	9.36	0.5517	1.51	39.47	2.58	0.5171	2.09	0.810	4386	66.4	2689	56.2	1346	78.5
21		62.8	444	45.3	9.82	0.53577	1.51	37.16	2.52	0.5023	2.02	0.802	4343	65.5	2626	53.1	1362	74.0
22		65.1	409	43.3	9.48	0.5799	1.52	45.27	2.58	0.5644	2.08	0.808	4458	67.7	2887	60.1	1359	89.4
23		59.5	390	42.6	9.21	0.55914	1.51	40.92	2.53	0.5303	2.03	0.803	4405	66.4	2745	55.7	1353	81.1
24		57.7	393	39.2	10.08	0.5628	1.51	41.33	2.51	0.5319	2.01	0.800	4415	66.7	2752	55.3	1344	81.8
25		62.0	424	43.6	9.77	0.5473	1.51	38.53	2.55	0.5098	2.06	0.806	4374	66.1	2658	54.6	1343	76.7
26		61.3	418	43.6	9.63	0.54867	1.51	39.05	2.55	0.5156	2.05	0.806	4378	66.0	2683	55.1	1353	77.7
27		51.9	322	31.5	10.26	0.598	1.51	49.09	2.51	0.595	2.01	0.799	4503	68.1	3012	60.5	1359	96.6
28		60.1	429	43.3	9.94	0.54062	1.51	37.23	2.54	0.4993	2.04	0.804	4356	65.8	2613	53.3	1338	74.3
29		67.2	429	41.8	10.31	0.5885	1.53	47.06	2.61	0.5788	2.12	0.811	4480	68.4	2946	62.4	1360	93.1
30		63.2	412	41.3	9.99	0.5751	1.51	43.57	2.58	0.5512	2.09	0.810	4446	67.3	2832	59.2	1346	86.7
31		61.4	426	43.0	9.93	0.5521	1.52	39.26	2.55	0.5161	2.05	0.804	4387	66.5	2685	55.1	1342	78.3
32		62.3	429	43.8	9.81	0.5487	1.51	38.95	2.58	0.5151	2.09	0.810	4378	66.2	2681	56.1	1351	77.8
33		63.1	432	43.9	9.86	0.552	1.51	39.27	2.54	0.5174	2.04	0.803	4386	66.3	2690	54.8	1346	78.3
34		63.6	433	44.2	9.84	0.54811	1.51	39.21	2.56	0.52	2.06	0.807	4376	66.1	2701	55.8	1366	78.3
35		48.7	338	31.4	10.76	0.5656	1.51	41.55	2.59	0.534	2.11	0.813	4422	66.8	2761	58.2	1339	82.9
36		62.1	411	46.6	8.90	0.54108	1.51	37.55	2.51	0.5055	2.01	0.800	4357	65.7	2640	53.0	1352	75.1
37		60.9	397	41.8	9.53	0.56065	1.51	40.75	2.56	0.5304	2.07	0.808	4409	66.5	2745	56.9	1348	81.5
38		60.8	395	40.9	9.67	0.56458	1.51	41.43	2.55	0.5354	2.06	0.807	4419	66.6	2766	56.9	1346	82.7
39		61.6	421	43.2	9.78	0.54958	1.51	38.67	2.54	0.5146	2.05	0.805	4380	66.0	2678	54.8	1347	77.6
40		61.1	402	42.0	9.60	0.55853	1.51	40.56	2.52	0.5307	2.02	0.801	4404	66.4	2747	55.4	1356	81.0

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0714-19 titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		97.2	700	51.6	13.41	0.6021	1.51	50.37	2.57	0.6072	2.08	0.810	4513	68.0	3061	63.8	1441	49.9
2		117.2	965	62.3	15.34	0.56326	1.51	42.56	2.55	0.5489	2.06	0.808	4416	66.5	2823	58.2	1443	44.7
3		18.8	96	6.3	14.93	0.7438	1.53	104.1	3.39	1.02	3.02	0.892	4818	73.7	4536	137.2	1464	96.0
4		57.6	328	63.5	5.15	0.49365	1.51	31.03	2.58	0.4565	2.09	0.811	4222	63.7	2426	50.8	1411	37.8
5		61.8	353	71.0	4.94	0.47788	1.51	29.2	2.56	0.4441	2.07	0.808	4174	62.9	2371	49.0	1419	36.6
6		78.4	487	108.8	4.45	0.4248	1.51	23.33	2.60	0.3982	2.12	0.814	3999	60.3	2162	45.7	1412	34.2
7		104.6	791	93.9	8.40	0.4614	1.51	27.55	2.53	0.4334	2.03	0.803	4122	62.2	2323	47.2	1432	35.6
8		80.9	527	40.0	13.18	0.62884	1.51	56.61	2.57	0.6518	2.08	0.810	4576	69.0	3238	67.3	1431	53.9
9		109.6	763	52.3	14.82	0.62004	1.51	53.33	2.53	0.6235	2.04	0.804	4556	68.6	3126	63.7	1407	51.1
10		115.8	798	53.9	15.11	0.62353	1.50	54.83	2.55	0.6378	2.06	0.808	4564	68.7	3183	65.6	1423	52.5
11		74.8	470	34.2	14.05	0.63538	1.51	58.04	2.56	0.6611	2.07	0.808	4591	69.2	3274	67.7	1424	54.7
12		74.0	479	35.1	14.07	0.6299	1.51	56.2	2.59	0.6456	2.11	0.813	4579	69.1	3214	67.8	1414	53.7
13		95.4	640	49.8	13.24	0.60672	1.51	50.12	2.58	0.5977	2.10	0.812	4524	68.1	3023	63.4	1401	49.3
14		97.8	640	48.4	13.69	0.61701	1.51	53.14	2.54	0.6237	2.04	0.805	4549	68.5	3127	63.9	1419	51.1
15		74.8	331	67.9	5.07	0.55051	1.51	40.17	2.53	0.5288	2.03	0.803	4383	66.0	2739	55.6	1435	42.8
16		115.8	662	103.4	6.66	0.5203	1.51	35.04	2.56	0.4864	2.07	0.809	4300	64.7	2557	52.9	1418	39.8
17		101.6	724	51.3	14.62	0.60262	1.51	49.35	2.56	0.5899	2.07	0.808	4514	67.9	2991	61.8	1399	48.3
18		115.2	753	177.0	4.39	0.38415	1.51	19.71	2.59	0.3703	2.10	0.812	3848	58.1	2032	42.7	1413	32.5
19		129.6	1081	64.8	17.08	0.54921	1.51	39.43	2.54	0.5199	2.04	0.805	4379	66.0	2701	55.2	1416	42.2
20		24.3	94	9.0	10.70	0.7477	1.53	104.7	2.91	1.012	2.47	0.851	4825	73.8	4511	111.5	1427	92.3
21		109.8	672	144.6	4.71	0.43518	1.51	24.44	2.56	0.4054	2.07	0.807	4035	60.9	2196	45.4	1410	34.1
22		100.0	565	96.9	5.86	0.51851	1.50	34.73	2.54	0.4835	2.04	0.805	4295	64.6	2545	51.9	1415	39.2
23		123.7	1072	55.1	19.52	0.5702	1.51	43.61	2.57	0.5518	2.08	0.810	4434	66.8	2835	59.0	1426	45.1
24		86.5	594	45.6	12.97	0.61045	1.51	52.21	2.52	0.6194	2.02	0.802	4533	68.3	3110	62.9	1436	50.5
25		80.6	553	39.9	13.66	0.6287	1.51	55.81	2.55	0.6404	2.05	0.806	4576	69.0	3193	65.6	1408	52.8
26		82.1	573	41.2	13.69	0.6183	1.51	53.76	2.54	0.6274	2.05	0.805	4552	68.6	3142	64.4	1422	51.5
27		18.9	120	11.6	10.11	0.5901	1.57	47.44	2.85	0.5805	2.38	0.835	4484	70.3	2953	70.2	1424	51.0
28		69.7	355	52.1	6.74	0.59399	1.51	47.32	2.53	0.5767	2.03	0.802	4493	67.8	2938	59.6	1401	46.9
29		127.2	1086	70.1	15.31	0.54099	1.51	38.19	2.51	0.5093	2.01	0.800	4357	65.7	2656	53.3	1415	41.0
30		127.3	848	128.6	6.55	0.47955	1.51	29.88	2.50	0.449	1.99	0.796	4180	63.2	2393	47.5	1429	36.2
31		118.8	735	113.1	6.47	0.50845	1.50	33.59	2.50	0.4769	2.00	0.799	4266	64.2	2516	50.4	1427	38.4
32		77.8	413	35.6	11.56	0.69236	1.51	75.79	2.52	0.791	2.02	0.802	4715	71.0	3760	76.1	1406	67.1
33		69.1	282	37.1	7.58	0.6854	1.51	73.94	2.52	0.7789	2.02	0.802	4700	70.9	3716	75.2	1420	65.8
34		79.1	484	30.4	15.85	0.696	1.52	78.84	2.55	0.8162	2.06	0.804	4722	71.7	3850	79.1	1430	69.9
35		100.3	699	40.8	17.07	0.6723	1.51	69.39	2.51	0.7458	2.01	0.799	4673	70.4	3595	72.1	1424	62.4
36		104.3	741	56.9	12.95	0.60019	1.51	49.86	2.51	0.5998	2.01	0.800	4508	67.9	3031	60.9	1431	48.6
37		100.9	738	57.8	12.76	0.58766	1.51	47	2.53	0.5768	2.03	0.804	4478	67.4	2938	59.8	1424	46.9
38		85.2	664	47.5	13.96	0.58051	1.51	45.08	2.50	0.56	2.00	0.799	4460	67.2	2869	57.4	1410	45.2

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
						MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**					
MP-P0714-19 titanite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
39		84.5	664	47.5	13.88	0.57529	1.51	44.29	2.52	0.5554	2.03	0.802	4447	67.0	2850	57.7	1417	45.0
MP-P0714-22A titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		62.9	468	284.9	1.63	0.2148	1.51	8.466	2.53	0.2845	2.03	0.802	2942	44.4	1615	32.7	1400	28.4
2		59.3	467	197.6	2.33	0.24417	1.51	10.075	2.53	0.2981	2.03	0.802	3147	47.5	1683	34.1	1407	29.1
3		34.2	245	101.5	2.38	0.27324	1.51	11.685	2.53	0.3098	2.03	0.802	3325	50.3	1741	35.3	1402	29.6
4		39.1	221	128.7	1.69	0.2909	1.51	12.657	2.50	0.3149	1.99	0.797	3422	51.7	1766	35.2	1388	29.4
5		43.0	262	151.7	1.70	0.26909	1.52	11.448	2.53	0.3088	2.02	0.798	3301	50.3	1736	35.0	1406	29.5
6		32.6	134	70.4	1.89	0.40456	1.52	20.96	2.58	0.3755	2.08	0.808	3926	59.6	2057	42.8	1367	34.9
7		22.4	101	51.8	1.92	0.37746	1.51	18.72	2.52	0.3601	2.02	0.801	3822	57.7	1984	40.1	1377	32.9
8		21.6	155	81.0	1.90	0.23622	1.55	9.58	2.64	0.2945	2.14	0.810	3095	47.9	1665	35.6	1406	30.4
9		38.2	238	166.1	1.44	0.2337	1.51	9.348	2.53	0.2905	2.02	0.800	3078	46.6	1645	33.3	1393	28.5
10		44.5	297	137.2	2.19	0.26496	1.52	11.314	2.53	0.3106	2.03	0.801	3276	49.6	1745	35.4	1422	29.8
11		40.8	279	102.6	2.76	0.28249	1.52	12.37	2.47	0.318	1.95	0.789	3377	51.3	1781	34.7	1419	29.3
12		24.4	107	49.3	2.21	0.38036	1.52	19.63	2.53	0.3742	2.02	0.800	3833	58.3	2051	41.5	1422	34.2
13		34.3	182	94.2	1.96	0.3188	1.57	14.38	2.52	0.3287	1.97	0.781	3564	56.0	1834	36.1	1387	30.1
14		22.5	101	46.0	2.24	0.37974	1.51	19.328	2.46	0.3702	1.94	0.788	3831	57.9	2032	39.4	1409	32.9
15		16.4	72	161.9	0.45	0.17364	1.51	6.464	2.50	0.2708	1.99	0.796	2593	39.3	1546	30.8	1407	27.6
16		23.4	131	59.4	2.23	0.31884	1.51	14.67	2.56	0.3345	2.06	0.806	3564	54.0	1862	38.4	1410	31.6
17		30.7	121	66.5	1.82	0.38457	1.51	19.86	2.55	0.3763	2.06	0.807	3850	58.1	2061	42.5	1419	34.7
18		23.5	89	48.1	1.84	0.4015	1.51	21.27	2.57	0.3862	2.07	0.808	3915	59.3	2107	43.7	1413	35.7
19		16.7	31	18.1	1.69	0.5801	1.52	45.45	2.64	0.5701	2.16	0.817	4459	67.7	2911	62.7	1398	56.9
20		27.9	176	72.2	2.42	0.3081	1.63	13.74	2.62	0.3242	2.05	0.782	3511	57.4	1812	37.1	1391	30.9
21		33.0	178	90.3	1.96	0.31997	1.51	14.6	2.54	0.3324	2.04	0.805	3570	53.8	1851	37.8	1399	31.1
22		31.2	189	75.7	2.48	0.3185	1.51	14.68	2.52	0.3361	2.02	0.801	3563	53.8	1869	37.8	1418	31.2
23		13.1	50	35.9	1.38	0.34954	1.52	16.84	2.54	0.3507	2.03	0.800	3705	56.4	1940	39.4	1406	32.3
24		15.2	41	24.6	1.68	0.4769	1.52	29.16	2.65	0.4452	2.16	0.817	4171	63.6	2376	51.4	1402	42.5
25		49.7	266	174.7	1.52	0.27846	1.51	11.933	2.52	0.3125	2.03	0.802	3354	50.5	1754	35.5	1403	29.7
26		31.4	161	113.0	1.43	0.27958	1.51	11.993	2.54	0.3124	2.04	0.804	3361	50.7	1754	35.7	1400	29.9
27		14.0	40	21.7	1.89	0.4809	1.66	29.45	3.14	0.4473	2.67	0.850	4184	69.4	2385	63.7	1397	48.5
28		27.2	175	71.2	2.46	0.30328	1.51	13.4	2.57	0.3219	2.08	0.809	3487	52.7	1800	37.4	1392	30.8
MP-P0714-23 titanite (spot size = 30 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%																		
1		35.9	206	21.5	9.62	0.6036	1.68	50.9	3.53	0.61	3.11	0.879	4517	76.0	3072	95.5	1411	69.5

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0714-23 titanite CONT'D (spot size = 30 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%																		
2		36.5	217	22.7	9.57	0.6104	1.53	50.27	2.75	0.6003	2.28	0.831	4533	69.2	3033	69.3	1363	60.3
3		36.3	196	21.2	9.26	0.6398	1.54	58.39	2.87	0.668	2.42	0.844	4601	70.8	3301	79.8	1384	69.5
4		40.4	193	19.7	9.85	0.6809	1.57	72.8	2.91	0.78	2.44	0.841	4691	73.7	3720	90.9	1400	84.4
5		37.9	346	24.7	14.11	0.4548	1.72	26.47	3.20	0.4235	2.70	0.843	4101	70.4	2278	61.4	1403	46.2
6		35.8	328	23.8	13.88	0.4388	1.53	25.09	2.67	0.4157	2.19	0.820	4048	61.9	2243	49.0	1421	39.1
7		26.0	134	62.4	2.16	0.3352	1.73	16.02	3.05	0.3482	2.51	0.823	3641	63.0	1928	48.3	1432	38.5
8		25.9	147	82.7	1.78	0.2795	1.55	12.03	2.73	0.3079	2.25	0.823	3360	52.1	1732	38.9	1383	32.0
MP-P0714-26 titanite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
1		5.2	8	7.5	1.02	0.5393	1.57	36.52	3.17	0.4902	2.76	0.869	4352	68.3	2574	71.0	1329	51.5
2		44.5	9	110.6	0.08	0.402	3.12	20.86	3.80	0.3777	2.18	0.572	3917	122.2	2067	45.0	1376	44.6
3	old	1.2	1	11.4	0.05	0.2181	1.69	8.62	3.05	0.2865	2.53	0.832	2967	50.2	1625	41.2	1411	35.5
4		1.0	1	12.7	0.18	0.1876	3.39	6.93	4.16	0.2664	2.42	0.581	2721	92.2	1524	36.9	1360	33.8
5		1.1	6	88.1	0.07	0.0992	1.55	3.214	2.58	0.2347	2.07	0.799	1609	25.0	1360	28.1	1340	26.8
6		3.8	28	88.3	0.31	0.11632	1.54	3.924	2.53	0.2463	2.01	0.794	1900	29.2	1421	28.5	1376	26.8
7		3.7	35	71.8	0.49	0.10629	1.57	3.58	2.59	0.2442	2.05	0.794	1737	27.3	1410	28.9	1381	27.5
8		4.1	34	91.4	0.38	0.11301	1.59	3.803	2.60	0.2443	2.05	0.791	1848	29.4	1410	29.0	1371	27.3
9		3.3	23	58.4	0.40	0.12508	1.55	4.292	2.55	0.2488	2.02	0.793	2030	31.5	1433	28.9	1375	27.0
10		1.2	4	48.7	0.08	0.1158	1.61	3.851	2.65	0.2432	2.10	0.795	1892	30.4	1404	29.6	1360	27.8
11		6.4	13	15.2	0.88	0.4221	1.53	22.68	2.70	0.3901	2.22	0.823	3990	61.1	2125	47.2	1368	36.9
12		6.4	6	11.4	0.58	0.4977	1.64	31.36	2.94	0.4574	2.44	0.830	4234	69.4	2430	59.3	1368	46.0
13		4.0	5	24.9	0.17	0.2615	1.72	10.71	2.77	0.2963	2.17	0.784	3256	56.0	1674	36.3	1363	30.4
14		3.7	37	85.9	0.43	0.10603	1.53	3.529	2.53	0.2415	2.01	0.795	1732	26.6	1396	28.1	1367	26.7
15		12.1	40	55.7	0.72	0.277	1.61	11.57	2.63	0.3042	2.08	0.792	3346	53.8	1713	35.7	1367	29.6
16		0.9	2	35.1	0.05	0.1172	1.77	3.898	2.73	0.2405	2.07	0.761	1914	33.9	1390	28.8	1344	27.1
17		1.4	5	48.9	0.10	0.11835	1.68	4.03	2.68	0.2461	2.08	0.778	1931	32.5	1419	29.6	1372	27.8
18		4.4	40	121.0	0.33	0.10448	1.52	3.506	2.53	0.244	2.02	0.799	1705	26.0	1409	28.5	1383	27.1
19	old	22.0	258	89.9	2.86	0.11195	1.55	3.883	2.53	0.2515	2.00	0.791	1831	28.4	1447	29.0	1413	27.4
20	old	7.5	78	406.2	0.19	0.09338	1.53	3.149	2.58	0.2445	2.07	0.803	1496	22.9	1411	29.2	1404	28.0
21		3.8	34	84.6	0.40	0.11134	1.54	3.706	2.61	0.2405	2.11	0.807	1821	28.1	1390	29.3	1353	27.7
22		5.1	11	10.8	1.03	0.4257	1.56	23.22	2.81	0.3954	2.34	0.832	4002	62.4	2150	50.3	1377	38.8
23		5.2	34	82.8	0.41	0.13712	1.61	4.671	2.62	0.246	2.07	0.789	2191	35.3	1419	29.3	1341	27.0
24		0.7	2	21.8	0.08	0.1304	1.80	4.394	2.76	0.2443	2.09	0.757	2103	37.9	1410	29.4	1343	27.3
25		0.8	3	41.1	0.09	0.11046	1.65	3.708	2.65	0.2414	2.07	0.782	1807	29.9	1395	28.9	1359	27.3
26		0.7	1	15.1	0.17	0.1479	1.97	5.07	3.08	0.2496	2.36	0.767	2322	45.9	1438	33.9	1342	31.0
27		0.7	1	12.5	-1.00	0.1625	1.76	5.831	3.01	0.2596	2.45	0.812	2482	43.7	1489	36.4	1369	32.8

Spot	Comm.	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs	^{207}Pb-corrected $^{206}Pb/^{238}U$ Age	2σ abs
MP-P0714-26 titanite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 100%)																		
28		9.5	22	39.0	0.58	0.3123	1.57	13.82	2.56	0.3197	2.02	0.791	3532	55.3	1790	36.2	1360	29.6
29		12.5	60	50.9	1.14	0.2761	1.57	11.67	2.58	0.3061	2.04	0.793	3341	52.5	1723	35.2	1377	29.3
30		10.2	31	42.0	0.73	0.30599	1.53	13.27	2.58	0.3155	2.07	0.804	3501	53.7	1769	36.6	1356	29.9

APPENDIX O - ZIRCON URANIUM-LEAD DATA TABLE

								MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-5A zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
1	N		20.61	127	663	1207	0.55	0.10834	1.56	3.654	2.28	0.2436	1.66	0.730	1772	28	1407	23
2	N		18.09	64	311	1098	0.29	0.1028	1.54	3.33	2.24	0.237	1.62	0.725	1675	26	1372	22
3	N	inherited	2.01	52	65	242	0.27	0.10082	1.54	4.122	1.96	0.2959	1.21	0.619	1639	25	1672	20
4	N	inherited	2.12	83	105	332	0.32	0.10158	1.52	4.19	1.97	0.2991	1.25	0.635	1653	25	1688	21
5	N	inherited	0.20	75	92	281	0.34	0.10166	1.53	4.108	1.96	0.2917	1.22	0.624	1655	25	1651	20
6	N		3.43	83	97	289	0.32	0.10105	1.54	3.883	2.29	0.2789	1.69	0.741	1643	25	1587	27
7	N	inherited	1.85	47	56	298	0.19	0.10009	1.53	4.061	2.07	0.2926	1.39	0.673	1626	25	1656	23
8	N	inherited	1.70	46	59	204	0.29	0.10118	1.54	4.128	2.07	0.2962	1.38	0.667	1646	26	1674	23
9	N	inherited	1.91	53	68	255	0.27	0.10139	1.52	4.158	1.93	0.2977	1.19	0.615	1650	25	1681	20
10	N	inherited	0.45	72	94	234	0.41	0.10219	1.53	4.125	1.93	0.2928	1.17	0.609	1664	26	1657	19
11	N	inherited	0.42	69	87	224	0.39	0.10238	1.53	4.18	1.95	0.2964	1.21	0.620	1668	26	1675	20
12	N	inherited	0.35	68	88	222	0.40	0.10195	1.53	4.124	1.97	0.2946	1.24	0.628	1660	26	1666	21
13	N	inherited	1.68	87	110	394	0.28	0.10117	1.52	4.114	2.01	0.2961	1.31	0.651	1646	25	1673	22
14	N	mixed age	0.22	3	5	80	0.07	0.09089	1.63	3.119	2.04	0.2503	1.23	0.602	1444	24	1441	18
15	N	inherited	1.18	3	5	84	0.16	0.09995	1.61	3.999	2.13	0.2899	1.40	0.656	1623	26	1642	23
16	N	mixed age	0.42	4	6	88	0.06	0.09461	1.59	3.476	2.16	0.267	1.47	0.679	1520	24	1527	22
17	N	mixed age	0.66	7	11	136	0.07	0.09022	1.58	3.104	2.08	0.25	1.35	0.648	1430	23	1440	19
18	N	mixed age	0.39	7	10	188	0.05	0.09067	1.55	3.152	2.01	0.2511	1.28	0.638	1440	23	1445	19
19	N	mixed age	0.76	4	6	79	0.10	0.09221	1.61	3.261	2.07	0.2584	1.29	0.625	1472	24	1483	19
20	N	mixed age	0.06	4	6	98	0.06	0.09384	1.60	3.422	2.12	0.2629	1.39	0.657	1505	24	1506	21
21	N	mixed age	0.01	5	8	127	0.07	0.09378	1.57	3.397	2.01	0.2625	1.26	0.626	1504	24	1504	19
22	N		48.50	108	214	1747	0.12	0.11575	1.53	2.619	2.31	0.163	1.73	0.748	1892	29	974	17
23	N		42.46	83	181	1312	0.14	0.11874	1.52	3.096	2.14	0.1886	1.52	0.707	1937	30	1115	17
24	N	inherited	0.55	42	54	879	0.06	0.10159	1.51	4.077	1.98	0.2903	1.27	0.643	1653	25	1644	21
25	N		12.57	176	105	799	0.13	0.11994	1.52	5.06	2.06	0.3034	1.39	0.675	1955	30	1710	24
26	N		10.43	133	181	478	0.38	0.10015	1.52	3.52	2.15	0.2534	1.52	0.707	1627	25	1457	22
27	N		28.47	108	221	940	0.24	0.10057	1.52	2.769	2.11	0.1987	1.47	0.695	1635	25	1169	17
28	N		29.59	375	628	1264	0.51	0.10322	1.53	2.894	2.48	0.2016	1.96	0.788	1683	26	1185	23
29	N		15.40	71	71	752	0.10	0.11787	1.51	4.689	1.95	0.287	1.23	0.631	1924	29	1628	20
30	N		14.44	108	326	693	0.47	0.11053	1.55	4.184	2.49	0.271	1.95	0.784	1808	28	1547	30
31	N		12.75	95	493	954	0.51	0.10648	1.55	3.898	2.82	0.2653	2.36	0.837	1740	27	1518	36
32	N	inherited	0.90	14	17	599	0.03	0.10312	1.51	4.289	1.92	0.3007	1.18	0.616	1681	26	1696	20
33	N		20.93	44	170	1202	0.14	0.10242	1.51	3.224	1.97	0.2269	1.26	0.641	1668	25	1319	17
34	N	inherited	0.19	30	88	950	0.09	0.1029	1.51	4.236	1.95	0.2975	1.23	0.632	1677	26	1680	21
35	N	mixed age	1.02	3	4	55	0.09	0.09212	1.69	3.297	2.22	0.2588	1.44	0.649	1470	25	1485	21
36	N	mixed age	0.26	6	9	127	0.50	0.09209	1.56	3.257	2.04	0.255	1.30	0.640	1469	23	1465	19
37	N		71.81	82	202	1566	0.13	0.10346	1.56	2.377	1.97	0.1658	1.12	0.609	1700	27	990	11
38	N		15.01	715	1203	606	1.99	0.09141	1.55	2.691	2.19	0.2135	1.48	0.704	1469	23	1248	18
39	Y		0.05	871	1439	479	3.02	0.08993	1.604	3.105	2.009	0.2495	1.129	0.602	1438	23	1437	16
40	N		9.88	95	105	159	0.68	0.13586	1.658	6.723	2.122	0.3574	1.25	0.624	2188	36	1971	25

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	^{207}Pb/^{206}Pb	2σ %	^{207}Pb/^{235}U	2σ %	^{206}Pb/^{238}U	2σ %	Rho	^{207}Pb/^{206}Pb Age	2σ abs	^{206}Pb/^{238}U Age	2σ abs
								MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**			
MP-P0913-5A zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
41	N	inherited	0.80	64	88	284	0.31	0.10222	1.566	4.147	1.936	0.2944	1.051	0.588	1678	26	1665	18
42	Y		1.58	1067	1767	501	3.54	0.08962	1.53	3.022	1.883	0.244	1.007	0.583	1431	22	1409	14
43	Y		1.87	351	554	229	2.43	0.08959	1.578	3.006	2.025	0.2431	1.192	0.627	1431	23	1404	17
44	N		44.86	414	955	514	1.87	0.10115	1.617	2.114	2.172	0.1523	1.383	0.668	1659	27	915	13
45	N		12.38	115	60	359	0.17	0.1288	1.766	5.845	2.146	0.329	1.14	0.568	2094	37	1835	21
46	N		47.34	98	294	1903	0.15	0.10553	1.567	2.21	2.046	0.1523	1.24	0.643	1737	27	915	11
47	N		62.56	324	475	1700	0.28	0.1325	1.879	2.42	2.285	0.1325	1.224	0.569	2144	40	803	10
48	N		60.70	434	1208	1905	0.64	0.1397	1.694	2.816	2.16	0.1459	1.266	0.620	2236	38	879	11
49	N		14.90	148	307	604	0.51	0.09638	1.598	3.065	1.956	0.2299	1.04	0.577	1569	25	1335	14
50	N		11.31	290	486	376	1.3	0.09313	1.583	2.955	1.944	0.2297	1.041	0.580	1504	24	1334	14
51	N		9.68	727	1207	460	2.68	0.0933	1.844	3.02	2.314	0.235	1.33	0.605	1508	28	1362	18
52	Y		0.05	220	343	230	1.53	0.08906	1.579	3.035	1.942	0.2462	1.043	0.582	1419	22	1420	15
53	N		6.83	85	157	455	0.35	0.09543	1.576	3.3	2.062	0.2509	1.257	0.645	1550	24	1444	18
54	N	mixed age	0.82	69	91	299	0.3	0.09823	1.665	3.793	1.989	0.2797	0.997	0.547	1604	27	1591	16
55	N		3.37	123	154	322	0.48	0.10732	1.591	4.483	1.952	0.3031	1.043	0.579	1768	28	1708	18
56	N		45.34	1040	2870	912	3.19	0.0963	1.62	1.888	2.144	0.142	1.335	0.655	1567	25	857	11
57	N		18.28	300	440	976	0.45	0.10899	1.566	3.831	1.949	0.2554	1.075	0.595	1796	28	1467	16
58	N	inherited	1.31	79	111	255	0.44	0.10106	1.565	4.015	1.911	0.2885	1.007	0.574	1657	26	1635	16
59	N	inherited	1.23	62	83	201	0.42	0.10179	1.581	4.106	1.932	0.2914	1.02	0.574	1670	26	1650	17
60	N	mixed age	0.14	4	5	70	0.06	0.09164	1.817	3.239	2.363	0.2562	1.446	0.639	1474	27	1472	21
61	Y	mixed age	0.35	12	19	240	0.08	0.09035	1.558	3.125	1.912	0.2504	1.02	0.580	1447	23	1442	15
62	N	inherited	0.25	71	93	223	0.42	0.10265	1.566	4.214	1.916	0.2978	1.015	0.577	1686	26	1682	17
63	N		7.87	160	261	668	0.39	0.09498	1.586	3.223	2.044	0.2462	1.212	0.630	1541	24	1420	17
64	N	inherited	9.09	163	203	499	0.41	0.10251	1.58	3.787	2	0.2677	1.146	0.613	1683	27	1530	18
65	N	inherited	2.18	67	89	402	0.22	0.103	1.549	4.144	1.889	0.2925	0.989	0.572	1692	26	1655	16
66	N	inherited	0.92	60	81	345	0.23	0.10214	1.548	4.144	1.895	0.2937	1.003	0.577	1677	26	1661	17
67	N	inherited	0.51	64	84	240	0.34	0.1022	1.548	4.159	1.911	0.2953	1.033	0.587	1678	26	1669	17
68	Y		2.00	309	489	299	1.59	0.08994	1.565	3.028	1.896	0.24412	0.979	0.565	1438	22	1409	14
69	N		5.11	292	454	325	1.37	0.09126	1.737	3.015	2.087	0.2406	1.072	0.554	1466	25	1391	15
70	N	inherited	1.10	60	80	312	0.25	0.10225	1.575	4.124	1.91	0.2935	0.989	0.566	1679	26	1660	16
71	N	inherited	0.70	51	68	229	0.29	0.10213	1.59	4.147	1.947	0.2944	1.034	0.577	1677	27	1665	17
72	N	inherited	0.96	48	63	364	0.17	0.10187	1.548	4.12	1.904	0.2926	1.019	0.582	1672	26	1656	17
73	N	inherited	0.74	59	78	231	0.32	0.10295	1.557	4.225	1.91	0.2972	1.016	0.579	1691	26	1679	17
74	N		23.15	341	658	364	1.73	0.09679	1.635	2.757	2.17	0.2066	1.358	0.657	1577	26	1212	16
MP-P0913-6 zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
1	N		46.23	269	571	681	0.85	0.109	1.53	2.398	1.93	0.1602	1.17	0.607	1783	27.5	959	11.2
2	N	inherited	4.25	421	477	695	0.69	0.10975	1.53	4.6	1.86	0.3053	1.05	0.567	1795	27.7	1719	18.1
3	N		11.66	798	1211	600	2.06	0.09374	1.56	2.946	2.13	0.2285	1.45	0.680	1503	23.7	1328	19.2
4	N		4.24	1059	1521	626	2.44	0.09152	1.51	3.029	1.90	0.2415	1.15	0.604	1457	22.3	1396	16.0

								MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-6 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
5	N		10.45	766	1205	632	1.93	0.09115	1.53	2.79	1.88	0.2229	1.10	0.586	1450	22.3	1298	14.3
6	N	inherited	58.69	167	623	1522	0.42	0.09565	1.53	1.362	1.99	0.1037	1.27	0.639	1541	23.8	637	8.1
7	N		3.99	379	506	471	1.08	0.09186	1.59	3.042	2.66	0.2435	2.13	0.801	1465	23.5	1406	30.0
8	N		10.28	348	521	424	1.25	0.09613	1.63	3.177	2.32	0.2406	1.65	0.711	1550	25.5	1391	23.0
9	N	inherited	37.20	35	39	820	0.05	0.10495	1.53	2.615	2.01	0.1815	1.31	0.648	1713	26.5	1076	14.0
10	N		37.27	286	375	421	0.92	0.12663	1.55	3.845	2.26	0.2208	1.65	0.730	2052	31.9	1287	21.2
11	N		62.43	338	609	1301	0.48	0.1305	1.76	2.327	3.67	0.1304	3.22	0.878	2105	37.3	791	25.5
12	N	inherited	20.29	178	318	582	0.55	0.10248	1.53	3.222	3.15	0.2291	2.75	0.874	1670	25.8	1331	36.6
13	N		5.37	652	952	857	1.13	0.0922	1.53	3.036	1.82	0.2409	0.99	0.546	1472	22.7	1392	13.8
14	Y		1.60	774	1097	505	2.21	0.09088	1.51	3.074	1.91	0.2464	1.17	0.610	1444	22.1	1421	16.6
15	N	inherited	2.69	27	29	303	0.10	0.1039	1.55	4.146	1.91	0.2913	1.11	0.580	1695	26.5	1649	18.3
16	N	inherited	1.45	29	55	552	0.10	0.1064	1.51	4.451	1.87	0.3042	1.10	0.590	1739	26.5	1713	18.9
17	N		19.06	975	1820	576	3.20	0.0963	1.57	2.832	2.16	0.2152	1.48	0.684	1554	24.7	1257	18.6
18	N		34.43	857	1837	714	2.60	0.08972	1.52	1.913	1.87	0.1552	1.09	0.583	1420	21.8	931	10.2
19	N	inherited	23.74	395	745	882	0.84	0.1053	1.55	3.269	2.36	0.2254	1.78	0.756	1720	26.8	1311	23.4
20	N	inherited	0.39	131	144	245	0.55	0.10813	1.53	4.715	1.88	0.3167	1.10	0.586	1768	27.2	1775	19.6
21	N		13.94	516	843	439	1.95	0.09562	1.53	2.999	1.92	0.2281	1.16	0.602	1540	23.8	1326	15.3
22	N		40.16	818	2059	770	2.69	0.09078	1.54	1.787	1.92	0.1431	1.15	0.598	1442	22.4	863	9.9
23	N		19.99	811	1388	574	2.45	0.09689	1.52	2.847	1.92	0.2142	1.17	0.609	1565	24.0	1252	14.6
24	Y		0.88	981	1413	501	2.85	0.09068	1.52	3.076	2.00	0.2476	1.30	0.648	1440	22.1	1427	18.5
25	N		5.38	1183	1759	706	2.48	0.09112	1.52	2.97	1.98	0.2368	1.27	0.641	1449	22.2	1371	17.4
26	Y		1.48	578	816	458	1.80	0.09065	1.52	3.071	1.88	0.2458	1.10	0.588	1439	22.1	1418	15.7
27	N	inherited	4.87	108	120	229	0.54	0.11156	1.53	4.743	2.16	0.3088	1.53	0.708	1825	28.1	1736	26.6
28	N		11.30	161	176	425	0.41	0.11303	1.53	4.515	2.03	0.2894	1.34	0.658	1849	28.5	1640	21.9
29	N	inherited	1.54	323	367	291	1.28	0.10889	1.52	4.668	1.91	0.3123	1.16	0.608	1781	27.3	1753	20.4
30	N	inherited	1.09	59	65	413	0.15	0.10627	1.53	4.452	1.90	0.305	1.13	0.594	1736	26.8	1717	19.4
31	Y		2.26	264	378	256	1.49	0.08996	1.52	2.973	1.91	0.2409	1.15	0.603	1425	21.9	1392	16.0
32	N		10.28	358	553	343	1.62	0.09393	1.52	3.012	1.96	0.2331	1.25	0.634	1507	23.1	1352	16.8
33	N		21.61	79	53	123	0.44	0.1392	1.81	5.955	2.29	0.3092	1.41	0.617	2217	40.3	1738	24.6
34	N	inherited	1.13	40	42	147	0.29	0.10748	1.65	4.63	2.70	0.3171	2.14	0.791	1757	29.2	1777	38.0
35	N	inherited	0.07	71	78	203	0.39	0.11013	1.54	4.894	2.01	0.3224	1.29	0.642	1802	28.0	1803	23.3
36	N		10.08	129	160	357	0.45	0.1164	1.55	4.851	1.97	0.3035	1.21	0.616	1902	29.7	1710	20.7
37	N		25.24	80	229	595	0.39	0.11869	1.53	4.115	2.32	0.2516	1.74	0.750	1937	29.8	1448	25.2
38	N		8.18	563	853	424	2.04	0.09329	1.67	3.03	2.21	0.2369	1.45	0.654	1494	25.2	1372	19.8
39	N		33.58	965	1869	695	2.81	0.09739	1.57	2.369	2.42	0.176	1.84	0.762	1575	24.9	1046	19.3
40	N	inherited	5.80	128	152	891	0.17	0.10681	1.53	4.267	1.97	0.2903	1.25	0.632	1746	26.9	1644	20.5
41	N		29.03	111	109	208	0.53	0.13275	1.57	4.793	2.34	0.2647	1.73	0.741	2135	33.7	1515	26.3
42	N		12.10	300	438	215	2.06	0.09891	1.76	3.318	2.19	0.2442	1.31	0.597	1604	28.5	1410	18.4
43	N		30.87	225	407	226	1.81	0.10909	1.60	3.155	2.03	0.2107	1.26	0.618	1784	28.7	1234	15.5
44	N		34.75	343	583	263	2.25	0.11562	1.62	3.339	2.03	0.2106	1.22	0.601	1890	30.8	1233	15.0
45	N	inherited	7.61	72	126	646	0.18	0.10677	1.57	4.175	2.06	0.2839	1.33	0.644	1745	27.7	1612	21.4
46	N		23.04	114	237	1041	0.20	0.10772	1.67	3.461	2.17	0.2338	1.39	0.640	1761	29.6	1355	18.8

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
								MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**			
MP-P0913-6 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
47	N		7.29	297	443	261	1.72	0.0924	1.52	3.005	1.94	0.2362	1.20	0.618	1476	22.7	1368	16.4
48	N	inherited	8.98	73	74	571	0.08	0.11188	1.53	4.526	2.08	0.2946	1.41	0.677	1830	28.2	1666	23.5
49	N		41.27	175	202	797	0.25	0.1555	1.78	5.24	2.41	0.245	1.63	0.674	2407	43.2	1414	23.0
50	N		43.42	169	228	451	0.51	0.17523	1.55	6.205	2.08	0.257	1.39	0.670	2608	40.5	1476	20.6
51	N	inherited	3.70	86	101	175	0.59	0.10779	1.54	4.48	2.00	0.3009	1.27	0.637	1762	27.4	1697	21.6
52	N	inherited	38.42	61	89	1116	0.08	0.10557	1.51	2.604	1.98	0.1789	1.27	0.644	1724	26.3	1062	13.5
53	N		40.95	289	287	745	0.39	0.13864	1.57	4.28	2.18	0.2242	1.51	0.694	2210	34.8	1305	19.7
54	Y		0.14	211	290	241	1.22	0.09001	1.53	3.072	1.96	0.2477	1.23	0.627	1426	22.0	1428	17.5
55	Y		0.96	267	357	245	1.47	0.09002	1.53	3.097	1.98	0.25	1.25	0.634	1426	22.0	1440	18.0
56	N		13.50	33	111	995	0.11	0.10882	1.53	4.039	1.97	0.2695	1.25	0.634	1780	27.4	1540	19.3
57	N		37.39	44	81	1030	0.06	0.10706	1.73	2.706	4.76	0.1851	4.43	0.932	1750	30.5	1096	48.6
58	N		24.02	830	1541	677	2.30	0.09419	1.52	2.524	1.89	0.1949	1.12	0.592	1512	23.2	1149	12.8
59	N		12.90	355	548	348	1.59	0.09424	1.52	2.935	1.93	0.2266	1.20	0.620	1513	23.1	1318	15.8
60	N		11.01	809	1486	674	2.22	0.08916	1.51	2.628	1.82	0.2143	1.02	0.561	1408	21.5	1253	12.8
61	N		8.07	753	1264	546	2.36	0.08964	1.51	2.773	2.26	0.2239	1.67	0.741	1418	21.7	1303	21.8
62	N	inherited	16.37	59	183	715	0.26	0.10719	1.51	3.768	1.84	0.255	1.05	0.572	1752	26.6	1465	15.4
63	N	inherited	2.19	54	73	687	0.02	0.10367	1.51	4.199	1.84	0.2922	1.05	0.573	1691	25.7	1654	17.4
64	N	inherited	13.01	77	188	528	0.36	0.10664	1.51	3.894	1.80	0.2649	0.98	0.543	1743	26.5	1516	14.8
65	N	inherited	0.89	134	185	381	0.49	0.10146	1.51	4.038	1.83	0.2887	1.03	0.565	1651	25.1	1636	16.9
66	N	inherited	0.79	130	181	356	0.51	0.10195	1.51	4.084	1.77	0.2908	0.93	0.527	1660	25.2	1647	15.4
67	N	inherited	1.13	27	37	176	0.21	0.10129	1.52	4.01	1.80	0.2873	0.96	0.534	1648	25.3	1629	15.7
68	Y		0.92	279	428	199	2.17	0.0896	1.53	3.013	1.99	0.2431	1.28	0.642	1417	21.9	1404	17.9
69	Y		0.54	454	728	247	2.97	0.08966	1.52	3.023	1.96	0.2444	1.24	0.631	1418	21.8	1411	17.5
70	N	inherited	0.63	97	123	536	0.23	0.10701	1.50	4.562	1.82	0.3092	1.02	0.562	1749	26.5	1738	17.8
71	N	inherited	5.65	171	257	797	0.32	0.1087	1.56	4.449	2.08	0.2969	1.37	0.660	1778	28.0	1677	23.0
72	N	inherited	1.85	136	170	793	0.22	0.10729	1.51	4.53	1.82	0.3058	1.03	0.563	1754	26.6	1721	17.7
73	N		7.29	743	1211	546	2.23	0.09331	1.51	3.083	1.83	0.2395	1.03	0.562	1494	22.8	1385	14.2
74	Y		0.81	978	1538	589	2.63	0.08955	1.51	3.004	1.84	0.2432	1.05	0.570	1416	21.6	1404	14.7
75	N		45.15	770	2470	1057	2.36	0.08708	1.52	1.473	1.98	0.1228	1.27	0.641	1362	20.9	747	9.5
76	N		3.21	735	1174	374	3.09	0.08991	1.52	2.967	2.00	0.2381	1.30	0.649	1424	21.9	1378	17.9
77	N		63.49	717	2929	844	3.49	0.09428	1.61	1.164	2.02	0.08943	1.22	0.602	1514	24.6	553	6.7
78	N		3.70	752	1177	471	2.51	0.08992	1.51	2.944	1.85	0.2368	1.06	0.575	1424	21.8	1371	14.6
79	N		27.39	609	1253	331	3.82	0.09172	1.52	2.256	1.96	0.1788	1.23	0.627	1462	22.5	1061	13.0
80	Y		0.32	319	486	195	2.51	0.08937	1.52	3.009	1.92	0.2438	1.17	0.611	1412	21.7	1408	16.5
81	N		43.23	372	605	329	1.85	0.10707	1.66	2.457	2.39	0.1665	1.71	0.717	1750	29.3	994	17.0
82	N		7.17	326	548	206	2.67	0.08974	1.52	2.817	1.91	0.2267	1.16	0.607	1420	21.8	1318	15.3
83	N		51.59	638	986	766	1.28	0.1206	2.83	2.68	5.16	0.16	4.31	0.835	1978	50.6	958	43.2
84	N		18.69	610	961	537	1.81	0.0982	1.87	3.07	4.89	0.224	4.52	0.924	1604	35.0	1304	61.4
85	N		46.18	590	1129	823	1.39	0.106	2.20	2.319	3.39	0.1567	2.59	0.762	1745	40.3	939	27.3
86	N		70.90	576	2425	1368	1.81	0.1053	2.42	1.192	4.88	0.0813	4.24	0.868	1733	44.5	504	22.4
87	N		45.27	828	1447	774	1.92	0.1116	2.41	2.611	5.15	0.1688	4.56	0.884	1839	43.6	1006	47.8
88	N		27.04	991	1531	572	2.71	0.1041	1.95	3.085	3.16	0.2136	2.49	0.787	1712	36.0	1249	35.2

								MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-6 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
89	N		36.23	1088	1801	743	2.44	0.1046	1.83	2.699	3.12	0.1854	2.53	0.810	1721	33.7	1097	31.3
90	N		29.78	1100	1724	641	2.71	0.1054	2.07	3.018	3.25	0.2078	2.51	0.771	1735	38.0	1218	34.5
91	N		15.33	262	357	274	1.33	0.09721	1.76	3.078	3.18	0.2312	2.65	0.832	1585	33.0	1342	39.7
92	N		14.76	253	341	246	1.39	0.09698	1.79	3.1	2.95	0.2322	2.35	0.796	1580	33.5	1347	36.3
93	N		76.88	964	2431	1422	1.72	0.1553	2.60	1.96	5.46	0.0905	4.80	0.879	2417	44.2	559	27.8
94	N		66.90	717	2200	989	2.26	0.1165	2.03	1.66	3.93	0.1033	3.36	0.856	1916	36.5	634	22.9
95	N		68.77	751	3077	1174	2.69	0.0996	1.99	1.132	3.04	0.0821	2.30	0.757	1630	37.0	509	13.5
96	N		48.98	796	1840	848	2.16	0.1027	1.96	2.025	2.96	0.1427	2.22	0.749	1687	36.3	861	22.2
97	N		56.56	1102	2445	849	2.89	0.1169	1.82	2.235	3.43	0.1382	2.91	0.848	1922	32.6	835	26.7
98	N		54.05	840	1176	707	1.70	0.1421	3.31	3.47	6.35	0.1751	5.41	0.853	2265	57.2	1041	58.0
99	N		38.16	891	1628	768	2.11	0.1045	2.08	2.558	3.17	0.1791	2.39	0.755	1719	38.2	1063	29.1
100	N		25.19	523	757	609	1.25	0.1036	2.08	3.144	3.14	0.2183	2.35	0.748	1703	38.5	1274	34.4
101	N		51.46	349	711	446	1.59	0.11055	1.60	2.287	3.18	0.1469	2.75	0.864	1822	29.1	884	27.0
102	N		64.06	759	2282	987	2.31	0.1087	1.98	1.607	2.97	0.1049	2.21	0.745	1791	36.1	644	16.6
103	N		47.33	836	1406	753	1.87	0.1184	2.02	2.861	3.24	0.1721	2.54	0.783	1945	36.2	1024	29.3
104	N		26.52	865	1288	674	1.92	0.1044	2.01	3.129	3.01	0.216	2.24	0.744	1717	37.0	1262	32.9
105	N		40.20	895	1947	863	2.29	0.1011	1.85	2.327	3.03	0.1661	2.39	0.791	1658	34.4	991	27.1
106	N		39.77	1039	2029	813	2.52	0.1036	2.08	2.504	2.99	0.1723	2.15	0.718	1703	38.5	1026	25.9
107	N		25.17	785	1155	600	1.94	0.1029	1.90	3.124	2.87	0.2166	2.15	0.749	1690	35.1	1265	31.9
108	N		58.43	935	2835	1006	2.83	0.101	1.98	1.577	3.19	0.1126	2.50	0.784	1656	36.7	688	19.5
109	N		60.87	868	2691	1181	2.28	0.1047	2.21	1.595	3.18	0.1101	2.29	0.719	1722	40.7	674	17.8
110	N		34.01	486	814	617	1.32	0.1003	1.92	2.58	3.59	0.183	3.03	0.845	1643	35.7	1084	35.9
111	N		37.62	1064	1991	775	2.62	0.1042	2.08	2.606	3.76	0.1802	3.13	0.833	1714	38.3	1069	36.4
112	N		40.49	1055	2174	826	2.63	0.1017	1.97	2.369	3.01	0.1664	2.27	0.756	1669	36.5	993	26.1
113	N		50.34	465	911	779	1.17	0.1093	2.03	2.268	4.16	0.1487	3.63	0.873	1801	37.0	894	34.6
114	N		30.53	998	1608	701	2.32	0.1034	2.02	2.899	3.21	0.2008	2.49	0.777	1699	37.3	1181	33.3
115	N		26.05	531	744	610	1.23	0.1037	1.95	3.063	2.88	0.2158	2.11	0.734	1705	36.1	1261	31.4
116	N		55.89	833	2136	1014	2.15	0.1057	2.06	1.847	3.11	0.1263	2.32	0.748	1740	37.9	767	20.5
117	N		51.72	863	2244	1014	2.25	0.0997	1.92	1.808	4.09	0.1299	3.61	0.883	1632	35.8	788	30.3
118	N		25.66	761	1109	632	1.78	0.1038	2.02	3.103	3.28	0.2173	2.58	0.788	1706	37.2	1269	36.8
119	N		56.48	286	370	1312	0.29	0.139	2.75	3.16	6.57	0.1621	5.96	0.908	2227	47.6	969	59.2
120	N		63.18	986	1877	1001	1.90	0.1323	3.11	2.37	5.36	0.13	4.36	0.815	2141	54.4	789	36.0
121	N		51.68	861	2383	868	2.82	0.10098	1.71	1.86	2.93	0.132	2.38	0.812	1656	31.7	800	21.8
122	N		22.43	679	967	504	1.94	0.1017	1.85	3.128	3.10	0.2222	2.49	0.802	1669	34.3	1295	36.5
123	N		21.52	354	472	360	1.33	0.1026	1.96	3.211	3.26	0.2275	2.60	0.798	1685	36.3	1322	38.6
124	N		14.52	254	348	280	1.26	0.09758	1.81	3.204	3.21	0.2348	2.65	0.826	1592	33.8	1361	40.3
125	N		31.71	769	1145	586	1.97	0.1057	2.06	2.961	3.33	0.2022	2.62	0.785	1740	37.9	1188	34.9
126	N		87.33	1209	3800	2580	1.45	0.19851	1.56	1.557	3.25	0.0568	2.85	0.877	2814	44.2	356	10.2
127	N		82.23	1583	3517	2448	1.39	0.2122	1.80	2.428	4.06	0.0838	3.64	0.897	2922	52.7	519	18.9
128	N		76.03	431	934	891	1.02	0.1579	1.96	2.052	4.18	0.0946	3.69	0.883	2433	48.0	583	21.5
129	N		16.75	641	909	609	1.49	0.10073	1.63	3.282	3.06	0.2353	2.59	0.847	1638	26.8	1363	35.3
130	N		57.79	1263	1901	900	2.13	0.1677	1.66	4.17	4.18	0.1804	3.83	0.918	2535	42.3	1070	41.0

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
								MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**			
MP-P0913-6 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
131	N		58.28	621	1031	904	1.15	0.1414	1.69	3.053	3.28	0.1562	2.81	0.857	2244	38.1	936	26.3
132	N		10.87	560	815	579	1.42	0.09478	1.53	3.08	2.71	0.2343	2.24	0.825	1524	23.5	1358	30.4
133	N		15.80	629	914	611	1.53	0.09891	1.58	3.193	2.86	0.2328	2.39	0.834	1604	25.5	1350	32.2
134	N		66.25	456	1116	892	1.27	0.1336	1.71	2.193	3.62	0.1188	3.19	0.881	2146	36.9	724	23.1
135	N		64.30	615	1325	801	1.71	0.1504	1.80	2.9	3.48	0.1389	2.98	0.856	2350	42.6	839	25.0
136	N		40.02	766	1180	800	1.52	0.11256	1.59	2.885	3.20	0.1867	2.78	0.867	1841	29.6	1104	30.7
137	N		51.72	758	1126	680	1.71	0.14919	1.61	3.972	3.04	0.1911	2.58	0.847	2337	37.9	1128	29.1
MP-P0913-10A zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 5 mJ at 100%)																		
1	N		64.25	685	855	573	1.49	0.2543	2.01	6.89	3.82	0.1948	3.25	0.851	3212	64.8	1148	37.3
2	N		56.56	404	694	776	0.88	0.1594	1.65	3.952	3.11	0.1793	2.63	0.847	2449	40.6	1064	28.0
3	N		60.32	493	884	625	1.44	0.1742	1.92	4.124	3.99	0.1733	3.50	0.876	2598	50.2	1031	36.1
4	N		57.62	1031	1798	960	1.88	0.1523	1.73	3.54	3.27	0.1686	2.78	0.849	2372	41.1	1005	27.9
5	N		59.51	779	1494	654	2.28	0.17247	1.58	4.221	3.13	0.1759	2.70	0.864	2582	41.0	1045	28.3
6	N		65.88	526	1140	608	1.84	0.17766	1.58	3.67	2.79	0.1493	2.29	0.823	2631	41.8	898	20.6
7	N		72.16	829	2500	1003	2.42	0.1494	1.81	2.17	3.76	0.1062	3.30	0.877	2339	42.4	651	21.5
8	N		33.06	402	674	372	1.74	0.10801	1.69	2.983	3.05	0.2011	2.54	0.832	1766	30.1	1182	30.0
9	N		50.89	306	692	352	1.86	0.1552	1.78	4.298	2.83	0.2008	2.20	0.776	2404	43.1	1181	26.0
10	N		51.87	559	1062	616	1.62	0.14359	1.58	3.662	3.03	0.1846	2.59	0.854	2271	36.0	1093	28.3
11	N		63.41	936	2004	636	2.89	0.2168	1.63	5.47	3.29	0.1826	2.86	0.868	2957	48.5	1082	30.9
12	N		71.39	773	4430	1086	3.65	0.168	2.24	2.76	3.89	0.1191	3.18	0.817	2538	57.2	726	23.1
13	N		26.23	338	565	346	1.49	0.10717	1.57	3.264	2.58	0.2218	2.04	0.792	1752	27.8	1292	26.4
14	N		29.28	233	393	294	1.25	0.1132	1.84	3.48	3.79	0.225	3.31	0.875	1851	34.2	1309	43.4
15	N		43.07	836	1971	773	2.44	0.11665	1.62	2.945	3.32	0.1831	2.90	0.873	1906	31.1	1085	31.4
16	N		18.65	191	340	246	1.32	0.10308	1.54	3.355	2.66	0.236	2.17	0.817	1680	26.0	1367	29.7
17	N		2.97	214	287	241	1.16	0.09153	1.54	3.103	2.62	0.2451	2.12	0.809	1458	22.7	1414	30.0
18	N		65.05	639	1363	620	2.17	0.171	1.63	3.512	3.67	0.1492	3.29	0.896	2567	42.1	897	29.5
19	N		42.99	919	1754	698	2.50	0.1371	1.81	4.03	3.11	0.2136	2.53	0.813	2191	40.0	1249	31.6
20	N		47.08	241	353	240	1.45	0.1551	2.02	4.78	3.69	0.2191	3.09	0.837	2415	34.3	1278	43.0
21	N		57.03	812	1202	805	1.48	0.1391	4.09	3.02	9.69	0.16	8.78	0.906	2229	71.0	958	85.0
22	N		77.13	1024	2080	1182	1.71	0.2108	3.22	3.14	7.78	0.1092	7.09	0.911	2923	52.1	669	48.2
23	N		20.91	156	186	238	0.77	0.1017	1.85	3.174	3.16	0.227	2.56	0.811	1669	34.3	1320	38.1
24	N		81.63	924	3618	1559	2.33	0.175	3.08	1.89	6.50	0.0774	5.73	0.881	2618	51.2	481	28.3
25	N		42.70	425	550	358	1.53	0.1359	1.78	4.04	2.98	0.2145	2.39	0.802	2188	31.0	1254	34.3
26	N		27.78	226	267	252	1.06	0.1102	1.85	3.42	3.35	0.2254	2.80	0.833	1816	33.7	1311	40.6
27	N		43.18	214	236	229	1.03	0.1361	2.98	3.95	5.18	0.2128	4.24	0.818	2191	51.8	1245	55.3
28	N		26.54	172	262	219	1.21	0.1124	2.19	3.69	3.67	0.2347	2.94	0.801	1852	39.7	1360	43.9
29	N		45.60	146	187	385	0.45	0.1478	2.02	4.47	3.14	0.2174	2.40	0.766	2333	34.6	1269	34.8
30	N		79.06	804	1949	1190	1.68	0.2232	3.56	3.13	6.79	0.1028	5.78	0.852	3016	57.2	631	37.4
31	N		18.12	240	326	261	1.27	0.0987	1.93	3.118	3.04	0.2272	2.35	0.773	1613	36.0	1321	35.7

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-10A zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 5 mJ at 100%)																		
32	N		23.54	63	77	359	0.22	0.1027	1.96	3.131	3.21	0.2213	2.54	0.791	1687	36.3	1290	36.9
33	N		29.07	106	147	456	0.33	0.1045	1.95	3.023	3.06	0.208	2.37	0.772	1719	35.9	1219	33.1
34	N		69.20	921	496	522	0.97	0.3919	2.41	10.6	9.17	0.204	8.85	0.965	3889	36.3	1198	107.2
35	N		60.42	624	562	559	1.03	0.2266	2.00	6.39	5.32	0.205	4.93	0.927	3040	32.1	1203	61.4
MP-P0913-10B zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
1	Y		0.61	83	131	924	0.14	0.08905	1.51	2.974	2.02	0.2417	1.34	0.663	1405	21.5	1397	18.7
2	N		34.38	506	829	1145	0.72	0.10487	1.68	2.777	2.26	0.1902	1.51	0.667	1712	29.0	1123	16.9
3	N		28.49	485	983	1080	0.90	0.09707	1.58	2.534	2.34	0.1899	1.73	0.738	1569	25.0	1122	19.4
4	N		13.00	288	577	927	0.61	0.08785	1.52	2.488	2.12	0.2044	1.48	0.698	1379	21.2	1200	17.8
5	N		25.10	317	430	857	0.49	0.1056	1.52	3.228	2.23	0.2217	1.63	0.730	1725	26.5	1292	21.0
6	N		5.61	542	782	971	0.80	0.0948	1.52	3.263	2.01	0.2498	1.32	0.655	1524	23.3	1439	18.9
7	N		15.87	212	441	1172	0.37	0.0879	1.52	2.383	2.01	0.1972	1.32	0.656	1380	21.1	1161	15.3
8	N		23.81	448	535	638	0.82	0.11649	1.52	4.032	2.05	0.252	1.37	0.668	1903	29.2	1450	19.9
9	Y		1.35	244	367	926	0.40	0.08969	1.51	3.074	1.99	0.2497	1.29	0.648	1419	21.7	1438	18.5
10	Y		2.44	96	144	999	0.15	0.08929	1.51	3.078	1.95	0.251	1.23	0.631	1410	21.5	1445	17.8
11	Y		1.92	333	510	643	0.80	0.08932	1.52	3.067	1.94	0.2497	1.20	0.622	1411	21.6	1438	17.3
12	N		32.69	421	414	727	0.58	0.12581	1.66	4.102	2.29	0.2372	1.59	0.692	2040	34.0	1373	21.8
13	N		31.32	629	1179	1143	1.07	0.09718	1.52	2.434	1.97	0.182	1.26	0.639	1571	24.0	1079	13.6
14	N		62.10	652	688	2095	0.33	0.1248	1.92	2.17	2.90	0.1264	2.17	0.749	2026	39.2	768	16.7
15	N		63.28	750	947	1728	0.57	0.1355	1.74	2.445	2.39	0.1315	1.64	0.685	2170	38.0	797	13.1
16	N		26.70	203	607	563	1.14	0.11169	1.53	3.555	2.01	0.2307	1.31	0.651	1827	28.1	1339	17.6
17	N		34.50	289	888	484	1.92	0.12579	1.59	3.98	2.12	0.2301	1.41	0.665	2040	32.6	1336	18.9
18	N		27.13	403	830	1272	0.68	0.08894	1.52	2.11	2.00	0.1717	1.30	0.649	1403	21.5	1022	13.2
19	N		33.18	366	806	1317	0.63	0.08976	1.53	1.966	1.98	0.1585	1.26	0.635	1420	22.0	949	12.0
20	N		64.03	618	1396	3550	0.41	0.10082	1.68	1.347	3.49	0.0957	3.06	0.877	1639	27.7	590	18.0
21	N		60.69	584	837	2284	0.38	0.11494	1.59	1.923	2.46	0.1213	1.88	0.763	1879	30.1	739	13.9
22	N		12.51	2261	4360	404	11.19	0.08998	1.53	2.638	2.01	0.2132	1.30	0.648	1425	22.0	1247	16.2
23	N		16.75	80	93	925	0.09	0.08833	1.52	2.399	2.12	0.1964	1.48	0.698	1390	21.3	1157	17.1
24	N		45.89	827	1303	3075	0.44	0.09191	1.53	1.66	2.45	0.1308	1.91	0.780	1466	22.7	793	15.1
25	N		52.75	1179	1208	2798	0.44	0.1106	1.56	2.159	2.06	0.1417	1.34	0.650	1809	28.5	855	11.4
26	Y		1.27	538	778	1604	0.51	0.08961	1.51	3	1.98	0.2422	1.28	0.647	1417	21.6	1399	17.9
27	N		22.80	623	873	1325	0.68	0.10323	1.53	3.18	2.15	0.2231	1.51	0.703	1683	25.9	1299	19.6
28	Y		2.51	487	714	1603	0.46	0.08918	1.51	2.923	2.19	0.2371	1.59	0.725	1408	21.4	1373	21.8
29	Y		2.43	126	199	1161	0.18	0.08908	1.51	2.919	1.93	0.2369	1.21	0.624	1406	21.4	1372	16.5
30	N	old	0.31	248	370	797	0.47	0.09029	1.52	3.101	2.00	0.2476	1.29	0.648	1432	22.0	1427	18.5
31	N		38.61	400	638	1178	0.55	0.10511	1.55	2.577	2.47	0.1774	1.92	0.776	1716	26.9	1054	20.2
32	N		43.87	613	560	815	0.70	0.15154	1.55	4.795	2.25	0.2283	1.63	0.725	2363	36.7	1327	21.6
33	N		62.94	729	919	1301	0.72	0.16172	1.53	3.406	2.85	0.1527	2.40	0.844	2474	38.0	917	22.0
34	N		7.68	643	983	1664	0.59	0.09068	1.52	2.874	2.51	0.2288	2.01	0.797	1440	22.1	1329	26.7

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-10B zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																		
35	N	old	0.35	561	793	1404	0.57	0.09213	1.52	3.264	2.30	0.2569	1.73	0.752	1470	22.5	1475	25.5
36	N		44.09	522	468	1187	0.40	0.12135	1.54	3.125	2.37	0.1868	1.79	0.759	1976	30.7	1105	19.8
37	N		53.90	681	489	1069	0.46	0.1524	1.76	3.874	2.49	0.1848	1.76	0.708	2373	42.0	1094	19.3
MP-P0913-10C zircon (spot size = 20 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
1	N		59.78	902	307	350	0.88	0.4056	1.60	15.51	2.97	0.2785	2.51	0.844	3941	24.0	1585	44.9
2	N		17.50	232	341	206	1.66	0.1003	1.67	3.245	2.58	0.2338	1.97	0.763	1643	31.0	1355	32.2
3	N		16.46	64	86	211	0.41	0.0991	1.87	3.207	2.86	0.2335	2.17	0.758	1621	34.8	1354	34.5
4	N		34.75	50	55	388	0.14	0.1107	2.42	3.1	4.12	0.2026	3.33	0.809	1824	43.9	1190	42.7
5	N		16.97	69	95	239	0.41	0.09809	1.79	3.121	2.87	0.2289	2.25	0.784	1602	33.4	1330	34.8
6	N		30.01	657	996	494	2.02	0.1063	2.06	3.077	2.80	0.2091	1.90	0.679	1750	37.8	1225	28.4
7	N		20.47	79	107	245	0.43	0.0998	1.99	3.058	2.95	0.2231	2.18	0.739	1634	37.0	1299	33.1
8	N		46.06	168	94	329	0.28	0.1581	2.13	4.93	3.30	0.2271	2.52	0.763	2448	36.2	1320	37.6
9	N		18.80	82	107	239	0.45	0.0989	1.87	3.093	3.15	0.2257	2.54	0.805	1617	34.8	1313	37.6
10	N		29.75	691	1036	509	2.03	0.1086	2.17	3.188	2.88	0.2151	1.90	0.659	1789	39.6	1257	29.1
11	N		56.64	760	822	420	1.97	0.2166	1.74	6.57	4.00	0.2207	3.60	0.901	2967	28.0	1287	49.4
12	N		47.92	216	244	388	0.62	0.1248	2.31	3.05	4.55	0.1789	3.92	0.861	2039	41.0	1062	43.9
13	N		55.29	539	330	328	1.01	0.2632	2.39	9.38	4.98	0.255	4.37	0.877	3277	37.6	1465	66.9
14	N		30.21	799	1206	525	2.30	0.1084	1.76	3.199	2.73	0.2131	2.09	0.765	1786	32.1	1246	30.9
15	N		43.89	297	377	699	0.54	0.1182	2.66	2.93	5.38	0.184	4.67	0.869	1942	47.7	1090	52.9
16	N		27.38	107	114	239	0.48	0.1122	1.95	3.582	2.99	0.2313	2.27	0.759	1848	35.3	1342	35.3
17	N		7.80	1328	2035	757	2.73	0.09052	1.58	2.878	1.98	0.2303	1.11	0.602	1450	23.0	1337	14.9
18	N		3.94	729	1107	539	2.09	0.09092	1.54	3.039	1.88	0.24259	0.97	0.568	1459	22.5	1401	13.6
19	Y		0.63	981	1555	648	2.42	0.0903	1.55	3.096	1.95	0.2494	1.11	0.609	1446	22.4	1437	15.9
20	Y		2.70	78	116	434	0.27	0.09144	1.60	3.132	1.94	0.2481	1.02	0.571	1470	23.5	1430	14.6
21	N		34.05	524	606	297	2.04	0.147	1.98	5.431	2.32	0.2681	1.12	0.520	2324	46.0	1532	17.2
22	N		39.77	764	907	1336	0.68	0.1182	2.08	3.241	2.54	0.1988	1.39	0.573	1942	40.4	1170	16.2
23	N		3.39	251	374	759	0.49	0.09117	1.53	3.087	1.88	0.2451	1.01	0.582	1464	22.4	1414	14.2
24	Y		1.48	352	547	698	0.79	0.09079	1.56	3.115	1.91	0.249	1.02	0.580	1456	22.7	1434	14.6
25	N		6.35	138	204	367	0.55	0.0929	1.61	3.119	1.93	0.24317	0.96	0.549	1500	24.2	1404	13.5
26	N		5.65	150	200	365	0.55	0.09412	1.76	3.245	2.07	0.2497	1.00	0.528	1524	26.8	1438	14.4
27	N		10.74	346	505	685	0.74	0.09481	1.82	3.104	2.13	0.2371	1.03	0.525	1538	27.9	1373	14.2
28	N		7.43	103	156	342	0.46	0.09054	1.60	2.877	2.11	0.2314	1.31	0.653	1451	23.2	1343	17.6
29	N		3.13	127	196	337	0.58	0.09044	1.59	3.024	1.92	0.24296	0.98	0.558	1449	23.0	1403	13.7
30	N		4.60	72	109	438	0.25	0.09089	1.56	3.006	1.92	0.2406	1.03	0.583	1458	22.7	1391	14.3
31	N		11.92	123	178	343	0.52	0.094	1.90	3.001	2.19	0.2309	1.00	0.497	1522	29.0	1340	13.4
32	Y		2.43	124	186	353	0.53	0.09117	1.58	3.11	1.99	0.2478	1.13	0.610	1464	23.1	1428	16.2
33	Y		2.72	77	117	315	0.38	0.09064	1.55	3.058	1.94	0.2449	1.09	0.604	1453	22.5	1413	15.4
34	N		14.23	136	152	352	0.43	0.105	2.35	3.743	2.60	0.2582	1.03	0.430	1728	40.6	1482	15.3
35	N		5.77	506	780	379	2.01	0.09343	1.62	3.181	1.98	0.2468	1.06	0.580	1510	24.4	1423	15.1

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	MEASURED ISOTOPIC RATIOS $^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	APPARENT ISOTOPIC AGES $^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-10C zircon CONT'D (spot size = 20 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
36	Y	old	0.34	110	159	129	1.22	0.09089	1.72	3.165	2.12	0.2526	1.15	0.580	1458	25.1	1453	16.7
37	N		9.10	652	844	959	0.87	0.0924	1.55	3.655	2.01	0.2864	1.21	0.638	1489	23.0	1625	19.6
38	N		3.10	155	233	449	0.52	0.09122	1.55	3.092	1.91	0.2461	1.02	0.584	1465	22.7	1419	14.5
39	N		3.54	150	226	396	0.57	0.09082	1.57	3.047	1.95	0.2433	1.07	0.593	1457	22.8	1405	15.0
40	N		3.23	103	154	312	0.49	0.09149	1.60	3.113	2.00	0.2468	1.11	0.596	1471	23.6	1423	15.8
41	Y		2.85	145	215	383	0.57	0.09081	1.54	3.06	1.92	0.2452	1.07	0.600	1456	22.4	1415	15.1
42	Y		2.22	207	303	430	0.73	0.09104	1.58	3.104	1.98	0.2479	1.11	0.601	1461	23.1	1429	15.8
43	N		10.69	111	142	291	0.50	0.09937	1.77	3.454	2.18	0.2524	1.20	0.584	1626	28.8	1452	17.4
44	Y		2.59	1025	1537	631	2.49	0.09131	1.54	3.115	1.92	0.2479	1.06	0.598	1467	22.6	1429	15.2
45	Y		2.00	146	214	307	0.72	0.09048	1.57	3.062	1.97	0.2463	1.11	0.606	1449	22.7	1421	15.8
MP-P0714-21 zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 5 mJ at 100%)																		
1	N		70.36	970	4677	710	6.58	0.10339	1.56	1.169	2.52	0.0812	1.98	0.785	1699	28.8	504	12.0
2	N		38.47	1001	2419	611	3.99	0.09951	1.80	2.3	6.26	0.168	5.99	0.958	1628	33.5	1002	61.5
3	N		14.14	1215	2094	494	4.22	0.09527	1.63	3.015	2.55	0.2286	1.97	0.770	1547	30.7	1328	31.5
4	N		12.88	1188	2002	461	4.28	0.09505	1.66	3.039	2.38	0.2316	1.70	0.716	1543	31.3	1344	29.0
5	N		82.58	1434	9120	1121	8.14	0.13194	1.57	1.086	2.65	0.0594	2.14	0.806	2137	27.5	372	9.4
6	N		13.30	983	1578	328	4.78	0.09589	1.67	3.097	2.74	0.2331	2.17	0.793	1559	31.4	1352	34.4
7	N		75.21	1094	6160	804	7.69	0.10866	1.60	1.07	2.53	0.0712	1.96	0.773	1790	29.3	444	10.5
8	N		12.21	1020	1648	341	4.82	0.09473	1.65	3.06	2.73	0.2325	2.18	0.798	1536	31.0	1349	34.4
9	N		37.99	1094	2363	589	3.99	0.10075	1.60	2.37	6.07	0.172	5.86	0.965	1651	29.8	1024	61.5
10	N		14.65	998	1623	392	4.11	0.09608	1.71	3.024	2.69	0.2297	2.08	0.772	1563	32.1	1334	32.9
11	N		13.40	950	1502	387	3.84	0.09604	1.72	3.095	2.50	0.2333	1.81	0.725	1562	32.3	1353	30.4
12	N		62.38	971	3923	699	5.56	0.10161	1.58	1.432	2.40	0.1021	1.81	0.752	1667	29.3	627	14.1
13	N		12.28	853	1388	412	3.35	0.09473	1.62	3.032	2.59	0.2323	2.02	0.780	1536	30.5	1348	32.6
14	Y		2.80	225	351	123	2.87	0.09044	1.58	3.034	2.56	0.2439	2.01	0.786	1449	30.2	1408	33.9
15	N		77.36	811	4512	871	5.24	0.11252	1.62	1.043	2.96	0.0672	2.48	0.838	1854	29.3	420	11.8
16	Y		2.67	146	227	101	2.23	0.09015	1.58	3.013	2.47	0.2431	1.90	0.769	1442	30.2	1404	32.6
17	N		19.44	1340	2440	466	5.21	0.09645	1.62	2.858	2.43	0.2166	1.80	0.743	1570	30.5	1265	28.3
18	N		10.72	1032	1649	359	4.60	0.09444	1.63	3.039	2.58	0.2359	1.99	0.773	1531	30.8	1366	32.7
19	Y		2.58	110	176	79	2.26	0.08961	1.55	2.959	2.38	0.2412	1.80	0.757	1431	29.7	1394	31.2
20	N		35.89	1076	2499	655	3.89	0.09719	1.69	2.258	3.02	0.1705	2.50	0.829	1584	31.7	1016	28.8
21	N		4.06	463	746	204	3.67	0.09109	1.56	3.029	2.24	0.2429	1.60	0.716	1462	29.7	1403	29.2
22	N		7.44	1129	1942	389	5.04	0.09234	1.56	3.023	2.29	0.238	1.67	0.729	1488	29.7	1377	29.3
23	N		81.08	972	4955	1045	4.78	0.14287	1.65	1.343	3.05	0.069	2.56	0.841	2275	28.5	430	12.4
24	N		40.10	1060	3450	710	4.81	0.09458	1.54	1.98	6.75	0.153	6.57	0.974	1533	29.1	918	61.6
25	N		79.21	955	6305	1008	6.39	0.10259	1.59	0.788	3.20	0.0558	2.78	0.868	1685	29.4	350	10.8
26	N		70.20	1168	5561	799	7.11	0.11327	1.74	1.397	3.26	0.09	2.76	0.846	1866	31.4	556	17.0
27	N		17.43	1437	2753	572	4.93	0.09643	1.56	2.949	2.13	0.2225	1.44	0.677	1570	29.4	1296	25.4
28	N		13.00	1118	1830	466	4.01	0.09543	1.63	3.04	2.60	0.2325	2.02	0.777	1550	30.8	1349	32.6

								MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**			
Spot	***used in age interp. (Y/N)**	**Comments**	**% discordance**	**Pb ppm**	**Th ppm**	**U ppm**	**Th/U**	**$^{207}Pb/^{206}Pb$**	**2σ %**	**$^{207}Pb/^{235}U$**	**2σ %**	**$^{206}Pb/^{238}U$**	**2σ %**	**Rho**	**$^{207}Pb/^{206}Pb$ Age**	**2σ abs**	**$^{206}Pb/^{238}U$ Age**	**2σ abs**
MP-P0714-21 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 5 mJ at 100%)																		
29	N		15.87	827	1510	355	4.37	0.09549	1.67	2.98	4.69	0.2242	4.38	0.934	1551	31.4	1305	59.8
30	N		8.58	602	956	254	3.84	0.09294	1.62	3.02	2.47	0.2369	1.87	0.754	1500	30.8	1372	31.4
31	N		30.38	933	2053	547	3.83	0.09512	1.58	2.378	2.47	0.1813	1.90	0.768	1544	29.8	1075	24.9
32	N		11.80	1214	2045	491	4.31	0.09467	1.60	3.055	2.39	0.2335	1.77	0.743	1535	30.1	1354	30.0
MP-P0714-26 zircon (spot size = 20 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
1	N		22.03	321	526	338	1.57	0.10098	1.79	3.089	2.64	0.2215	1.94	0.734	1656	33.3	1291	30.3
2	N		23.36	818	1294	466	2.82	0.1036	1.71	3.213	2.60	0.2242	1.96	0.753	1703	31.5	1305	30.9
3	N		14.94	338	511	204	2.52	0.1005	1.86	3.364	2.72	0.2425	1.98	0.730	1647	34.5	1401	33.4
4	N		30.68	741	1254	493	2.56	0.10829	1.73	3.151	2.53	0.2113	1.84	0.728	1784	31.6	1237	28.1
5	N		53.44	704	1402	551	2.56	0.1312	1.84	2.995	2.71	0.1659	2.00	0.735	2127	32.3	990	23.7
6	N		15.39	424	632	229	2.78	0.09743	1.74	3.099	2.61	0.2317	1.94	0.745	1589	32.6	1344	31.6
7	N		16.63	505	782	282	2.77	0.09712	1.72	3.054	2.47	0.227	1.77	0.718	1583	32.2	1320	29.2
8	N		26.96	915	1584	374	4.21	0.1068	1.99	3.28	4.76	0.2203	4.32	0.908	1759	36.5	1284	58.1
9	N		24.75	467	698	501	1.40	0.103	1.84	3.106	2.79	0.2182	2.09	0.751	1692	34.0	1273	31.5
10	N		63.41	476	1140	769	1.49	0.1296	1.64	2.274	3.49	0.1268	3.08	0.883	2105	28.8	770	25.8
11	N		19.66	457	672	341	1.99	0.0999	1.92	3.093	2.98	0.2259	2.28	0.765	1636	35.8	1314	34.7
12	N		44.36	807	1443	608	2.40	0.1243	1.74	3.277	2.51	0.1915	1.81	0.721	2032	30.9	1130	25.4
13	N		9.71	187	4414	150	1.83	0.0943	1.60	3.109	2.60	0.2384	2.05	0.788	1528	30.2	1379	33.7
14	N		13.07	164	275	234	1.01	0.09571	1.70	3.092	2.63	0.2332	2.01	0.764	1556	31.9	1352	32.6
15	N		11.59	117	237	194	0.88	0.09451	1.69	3.044	2.34	0.2336	1.62	0.690	1532	31.9	1354	28.3
16	N		18.59	371	172	378	1.49	0.0993	1.81	3.101	2.59	0.2275	1.85	0.716	1624	33.7	1322	30.1
17	N		15.20	121	563	262	0.67	0.09661	1.75	3.088	2.63	0.2297	1.96	0.746	1573	32.8	1334	31.5
18	N		6.10	273	416	202	2.05	0.09557	1.68	3.354	2.42	0.2536	1.68	0.719	1553	26.1	1458	24.5
19	Y		0.79	207	350	223	1.56	0.0896	1.60	3.042	2.07	0.2461	1.24	0.636	1431	22.8	1419	17.6
20	N		81.43	1174	5290	728	7.23	0.2458	1.93	3.228	2.62	0.0955	1.72	0.676	3169	61.3	588	10.1
21	Y		2.59	177	301	277	1.09	0.09067	1.66	3.066	2.07	0.2454	1.16	0.599	1453	24.1	1416	16.4
22	N		60.01	804	2044	624	3.24	0.1564	1.66	3.495	2.26	0.1625	1.48	0.680	2429	40.2	971	14.3
23	Y		0.36	228	376	249	1.51	0.08982	1.59	3.093	2.00	0.2502	1.13	0.605	1436	22.9	1441	16.2
24	Y		1.39	162	263	267	0.98	0.09068	1.59	3.103	2.04	0.2488	1.21	0.629	1454	23.1	1433	17.3
25	N		36.05	892	1631	727	2.25	0.11485	1.59	3.24	2.32	0.2061	1.63	0.727	1891	30.1	1209	19.7
26	N		19.57	722	1025	819	1.24	0.10887	1.53	3.723	2.23	0.2506	1.56	0.727	1794	27.5	1443	22.5
27	Y		1.41	804	1319	441	3.02	0.09112	1.57	3.115	2.08	0.2505	1.29	0.653	1463	23.0	1442	18.5
28	Y		1.51	988	1511	405	3.72	0.09147	1.68	3.138	2.45	0.2516	1.72	0.726	1470	24.8	1448	25.0
29	N		85.91	665	2760	782	3.54	0.2611	1.59	2.635	2.40	0.0739	1.74	0.748	3265	52.0	460	8.0
30	N		12.04	1272	2045	589	3.51	0.09771	1.58	3.233	2.13	0.2428	1.37	0.673	1594	25.2	1402	19.2
31	Y		0.69	802	1216	449	2.73	0.09108	1.59	3.2	2.25	0.2563	1.54	0.710	1462	23.2	1472	22.7

Spot	*used in age interp. (Y/N)	Comments	% discordance	Pb ppm	Th ppm	U ppm	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
								MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
MP-L0613-BDAY zircon (spot size = 20 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
1	Y		1.52	196	306	90	3.45	0.09	1.83	3.045	2.50	0.2457	1.65	0.683	1439	26.3	1417	23.4
2	N		4.72	150	231	94	2.46	0.09248	1.79	3.146	2.34	0.2463	1.45	0.646	1491	26.7	1421	20.6
3	N		3.09	217	342	190	1.81	0.09065	1.63	3.046	2.21	0.2439	1.43	0.675	1453	23.7	1408	20.1
4	N	old	0.35	127	180	146	1.25	0.09114	1.67	3.191	2.22	0.2536	1.39	0.659	1463	24.4	1458	20.3
5	N		3.88	135	199	132	1.52	0.0926	2.21	3.187	2.76	0.2492	1.60	0.601	1493	33.0	1436	23.0
6	Y		0.02	144	221	125	1.78	0.08937	1.82	3.07	2.36	0.2474	1.45	0.639	1426	25.9	1426	20.6
7	N		16.46	223	307	171	1.81	0.1075	1.82	3.873	2.27	0.2577	1.30	0.601	1771	32.2	1479	19.2
8	N	old	1.18	119	185	125	1.48	0.09058	1.66	3.148	2.20	0.249	1.38	0.657	1452	24.1	1434	19.8
9	Y		1.63	160	248	103	2.43	0.08965	1.75	3.069	2.34	0.244	1.49	0.664	1432	25.1	1409	21.0
10	Y		2.22	133	205	95	2.14	0.09041	1.67	3.106	2.32	0.2454	1.55	0.694	1448	24.2	1416	22.0
11	N		3.94	138	215	151	1.44	0.09142	1.76	3.155	2.37	0.2445	1.52	0.669	1469	25.8	1411	21.5
12	Y		2.43	111	168	122	1.39	0.09094	1.74	3.157	2.32	0.2469	1.48	0.664	1459	25.4	1424	21.1
13	Y		0.29	195	298	128	2.34	0.08943	1.63	3.106	2.16	0.2468	1.36	0.658	1427	23.3	1423	19.3
14	Y		0.89	102	157	124	1.27	0.08957	1.67	3.083	2.11	0.2457	1.21	0.611	1430	23.9	1417	17.2
15	N		26.25	141	188	87	2.16	0.1196	1.85	4.203	2.40	0.2516	1.46	0.636	1963	36.4	1448	21.2
16	N		14.91	123	183	182	1.00	0.1015	1.85	3.493	2.45	0.2456	1.55	0.656	1665	30.8	1417	22.0
17	Y		1.55	109	163	116	1.41	0.09039	1.84	3.089	2.32	0.2472	1.35	0.612	1448	26.6	1425	19.3
18	Y		2.13	187	289	191	1.52	0.09027	1.64	3.066	2.15	0.2451	1.33	0.650	1445	23.6	1414	18.8
19	N		4.57	264	415	151	2.80	0.09265	1.66	3.148	2.13	0.2474	1.27	0.627	1494	24.8	1426	18.0
20	Y		0.73	156	238	148	1.64	0.09017	1.66	3.067	2.15	0.2486	1.29	0.635	1443	23.9	1432	18.5
21	Y		1.59	172	268	103	2.62	0.08995	1.73	3.047	2.24	0.2453	1.36	0.637	1438	24.8	1415	19.2
22	Y		2.62	173	268	168	1.60	0.09052	1.65	3.031	2.21	0.2447	1.39	0.662	1450	24.0	1412	19.7
23	Y		0.68	132	201	86	2.38	0.09021	1.77	3.085	2.32	0.2489	1.44	0.649	1444	25.5	1434	20.7
24	N		16.26	553	738	311	2.38	0.1105	1.96	3.982	3.12	0.2666	2.39	0.778	1821	35.8	1525	36.4
25	Y		0.01	94	141	119	1.19	0.0898	1.73	3.09	2.17	0.2491	1.23	0.602	1435	24.9	1435	17.7
26	Y		0.93	383	569	279	2.05	0.09041	1.58	3.13	2.25	0.249	1.54	0.710	1448	22.9	1434	22.0
27	N		6.65	100	148	100	1.48	0.09361	1.78	3.198	2.49	0.2449	1.69	0.700	1514	27.0	1413	23.9
28	N		24.90	117	152	102	1.51	0.1199	1.90	4.251	2.65	0.2574	1.80	0.697	1968	37.4	1478	26.5
29	N		6.05	209	299	125	2.40	0.0955	1.96	3.364	2.57	0.2535	1.62	0.650	1552	30.4	1458	23.5
30	N		6.72	117	169	186	0.91	0.09414	1.63	3.215	2.46	0.2466	1.78	0.747	1525	24.9	1422	25.4
31	N	old	0.92	54	74	101	0.73	0.09095	1.76	3.159	2.55	0.2512	1.79	0.724	1459	25.7	1446	25.9
32	Y		1.13	154	228	75	3.05	0.09067	1.79	3.094	2.73	0.2495	2.02	0.755	1453	26.1	1437	29.0
33	N		9.45	224	341	129	2.65	0.0973	1.94	3.323	2.83	0.2494	2.02	0.728	1587	30.8	1437	29.0
34	Y		0.34	254	379	162	2.33	0.08998	1.61	3.056	2.17	0.2489	1.38	0.668	1439	23.2	1434	19.8
35	Y		0.29	168	244	101	2.43	0.09011	1.74	3.117	2.54	0.2512	1.79	0.728	1442	25.0	1446	25.9
36	Y		2.47	72	110	110	1.01	0.09061	1.74	3.045	3.01	0.2455	2.41	0.816	1452	25.3	1416	34.2
37	Y		0.99	263	378	149	2.56	0.08969	1.70	3.085	2.25	0.2514	1.40	0.653	1433	24.4	1447	20.3
38	Y		1.00	111	166	167	1.00	0.08994	1.65	3.043	2.32	0.2469	1.58	0.704	1438	23.7	1424	22.5
39	N		3.08	150	225	137	1.64	0.09105	1.72	3.054	2.29	0.2455	1.45	0.661	1461	25.2	1416	20.6
40	N		26.33	165	146	286	0.52	0.1428	1.83	5.77	2.93	0.2965	2.25	0.781	2274	41.6	1675	37.6
41	Y		1.82	318	486	244	1.99	0.09023	1.59	3.027	2.22	0.2458	1.48	0.697	1444	23.0	1418	21.0
42	N		39.30	176	183	114	1.62	0.1668	1.66	6.118	2.33	0.2697	1.58	0.702	2538	42.2	1541	24.3

								MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	***used in age interp. (Y/N)**	**Comments**	**% discordance**	**Pb ppm**	**Th ppm**	**U ppm**	**Th/U**	**$^{207}Pb/^{206}Pb$**	**2σ %**	**$^{207}Pb/^{235}U$**	**2σ %**	**$^{206}Pb/^{238}U$**	**2σ %**	**Rho**	**$^{207}Pb/^{206}Pb$ Age**	**2σ abs**	**$^{206}Pb/^{238}U$ Age**	**2σ abs**
MP-L0613-BDAY zircon CONT'D (spot size = 20 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																		
43	Y		0.41	98	152	82	1.85	0.0899	1.87	3.033	3.01	0.2484	2.32	0.784	1437	26.8	1431	33.1
44	Y		0.64	262	408	147	2.79	0.08925	1.68	2.999	2.80	0.2451	2.19	0.799	1423	23.9	1414	31.0
45	Y		0.09	142	221	132	1.68	0.0893	1.65	3.014	2.33	0.2473	1.58	0.703	1424	23.5	1426	22.5

APPENDIX P - HOST ROCK ZIRCON URANIUM-LEAD DATA TABLE

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	% discordance	Pb (ppm)	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-4 zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																
1	0.31	6	7	364	0.01	0.10356	1.53	4.245	2.04	0.2982	1.35	0.662	1689	26.0	1684	22.7
2	40.78	220	347	2110	0.17	0.10022	1.52	2.249	2.35	0.1612	1.79	0.762	1628	25.0	964	17.3
3	38.89	178	285	1908	0.15	0.09717	1.54	2.112	2.21	0.1604	1.59	0.718	1571	24.4	960	15.2
4	0.24	212	222	484	0.47	0.10875	1.52	4.769	2.06	0.3183	1.40	0.678	1779	27.2	1783	24.9
5	1.76	148	172	490	0.35	0.10598	1.52	4.573	2.05	0.314	1.38	0.674	1731	26.4	1762	24.4
6	39.35	165	228	2296	0.10	0.10252	1.51	2.406	2.22	0.17	1.62	0.732	1670	25.4	1013	16.5
7	10.03	258	336	900	0.38	0.1044	1.52	3.872	2.07	0.2682	1.41	0.680	1704	26.1	1533	21.6
8	42.59	24	60	2631	0.02	0.09974	1.51	2.128	2.52	0.155	2.02	0.801	1619	24.6	930	18.8
9	11.32	832	1214	1316	0.93	0.10836	1.53	4.114	2.12	0.2758	1.47	0.694	1772	27.2	1571	23.1
10	0.07	7	7	750	0.01	0.10814	1.52	4.695	1.99	0.3156	1.29	0.647	1768	27.0	1770	22.8
11	0.23	474	546	907	0.61	0.10972	1.51	4.857	1.99	0.3216	1.30	0.651	1795	27.3	1799	23.3
12	4.79	570	710	1107	0.65	0.10839	1.51	4.468	2.06	0.299	1.40	0.680	1773	26.9	1688	23.6
13	0.81	304	357	720	0.51	0.10761	1.51	4.614	2.18	0.3106	1.57	0.721	1759	26.8	1745	27.4
14	0.45	5	6	539	0.01	0.10329	1.51	4.271	2.04	0.2998	1.37	0.671	1684	25.7	1692	23.2
15	0.61	9	11	458	0.02	0.10262	1.51	4.238	2.03	0.2979	1.35	0.666	1672	25.5	1682	22.7
16	2.59	472	582	924	0.64	0.10891	1.51	4.634	2.07	0.3086	1.42	0.686	1781	27.1	1735	24.7
17	13.66	233	282	1212	0.24	0.10498	1.51	3.724	2.07	0.2578	1.41	0.682	1714	26.1	1480	20.9
18	5.23	671	806	1265	0.65	0.1087	1.52	4.508	2.34	0.2984	1.79	0.762	1778	27.2	1685	30.1
19	1.97	729	869	1210	0.73	0.10935	1.51	4.712	2.14	0.3123	1.51	0.709	1789	27.2	1753	26.5
20	0.28	139	176	290	0.61	0.1018	1.52	4.148	2.09	0.2938	1.44	0.687	1657	25.4	1662	23.9
21	11.56	910	1182	1527	0.78	0.10954	1.52	4.17	2.37	0.2784	1.82	0.768	1792	27.4	1585	28.8
22	7.24	62	86	621	0.14	0.10643	1.52	4.191	2.06	0.2841	1.39	0.675	1739	26.6	1613	22.4
23	20.02	661	1080	1337	0.81	0.10586	1.51	3.531	2.05	0.2391	1.38	0.674	1729	26.4	1383	19.1
24	8.64	691	950	1117	0.85	0.10686	1.51	4.149	2.11	0.2806	1.48	0.701	1747	26.5	1596	23.6
25	0.59	6	7	712	0.03	0.10778	1.51	4.734	2.03	0.3162	1.35	0.667	1762	26.9	1773	24.0
26	1.28	462	544	683	0.80	0.11013	1.51	4.833	2.17	0.3174	1.55	0.715	1802	27.5	1778	27.5
27	26.14	64	95	1545	0.06	0.10396	1.51	3.083	2.25	0.2143	1.66	0.741	1696	25.8	1253	20.8
28	2.06	46	54	461	0.11	0.10395	1.52	4.429	2.19	0.3077	1.58	0.721	1696	26.0	1731	27.4
29	1.65	252	306	661	0.46	0.10853	1.51	4.661	2.07	0.3107	1.42	0.683	1775	27.1	1746	24.7
30	3.17	205	254	731	0.35	0.10674	1.51	4.428	2.29	0.2993	1.72	0.752	1744	26.6	1689	29.1
31	11.99	723	705	1493	0.47	0.11374	1.52	5.996	2.07	0.3811	1.40	0.679	1860	28.4	2083	29.2
32	11.67	20	36	758	0.04	0.10466	1.52	3.818	2.08	0.2635	1.42	0.684	1708	26.1	1509	21.5
33	0.15	75	96	339	0.29	0.10305	1.52	4.211	2.14	0.2969	1.51	0.705	1680	25.8	1677	25.3
34	17.85	121	158	1138	0.13	0.10643	1.53	3.637	2.10	0.2479	1.44	0.687	1739	26.7	1429	20.6
35	11.23	165	211	1060	0.20	0.10785	1.52	4.079	2.18	0.2746	1.56	0.717	1763	27.0	1565	24.4

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	% discordance	Pb (ppm)	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-4 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																
36	25.29	298	1186	1391	0.85	0.11099	1.51	3.584	2.08	0.234	1.43	0.688	1816	27.6	1357	19.4
37	6.25	209	273	874	0.31	0.10695	1.51	4.25	2.30	0.2892	1.74	0.755	1748	26.6	1639	28.5
38	2.63	788	1024	1229	0.83	0.10845	1.51	4.565	2.03	0.3069	1.35	0.667	1774	27.0	1727	23.4
39	1.89	46	42	788	0.05	0.10583	1.52	4.358	2.19	0.3007	1.58	0.720	1729	26.5	1696	26.8
40	8.62	949	1017	1727	0.59	0.1127	1.51	5.631	2.16	0.3639	1.55	0.718	1843	27.9	2002	31.1
MP-P0913-5B zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																
1	1.25	177	207	949	0.22	0.10932	1.51	4.693	2.03	0.3148	1.36	0.667	1788	27.3	1766	24.0
2	1.07	135	158	795	0.20	0.10738	1.51	4.585	2.04	0.3089	1.37	0.672	1755	26.8	1737	23.8
3	4.95	194	238	636	0.38	0.10619	1.53	4.709	2.21	0.3261	1.60	0.722	1735	26.7	1821	29.1
4	45.62	114	167	2122	0.08	0.10156	1.53	2.11	2.04	0.1495	1.35	0.660	1653	25.6	899	12.1
5	29.92	66	119	1441	0.08	0.1002	1.52	2.632	2.07	0.1934	1.41	0.681	1628	24.9	1141	16.1
6	12.78	117	99	930	0.11	0.10696	1.52	3.927	2.08	0.2666	1.41	0.680	1748	26.9	1525	21.5
7	2.31	1299	1753	2055	0.84	0.11094	1.51	5.067	1.91	0.3335	1.17	0.613	1815	27.6	1857	21.7
8	5.34	125	119	1029	0.12	0.10702	1.51	4.298	1.94	0.2926	1.22	0.627	1749	26.6	1656	20.2
9	5.93	195	247	1144	0.22	0.10519	1.52	4.096	1.94	0.2846	1.21	0.624	1718	26.2	1616	19.5
10	0.84	177	219	907	0.25	0.10484	1.51	4.406	1.91	0.3067	1.17	0.614	1712	26.0	1726	20.2
11	20.88	189	145	844	0.17	0.12034	1.53	4.32	2.31	0.2719	1.72	0.747	1961	30.3	1552	26.8
12	24.74	150	113	517	0.22	0.12595	1.53	4.616	1.99	0.269	1.27	0.637	2042	31.5	1537	19.5
13	1.31	339	298	1454	0.21	0.1114	1.51	4.898	1.98	0.3215	1.27	0.645	1822	27.7	1798	22.9
14	0.74	73	93	496	0.19	0.10282	1.52	4.152	1.93	0.2941	1.19	0.618	1676	25.6	1663	19.8
15	0.49	218	275	522	0.54	0.10107	1.52	4.006	2.05	0.2886	1.37	0.672	1644	25.1	1636	22.5
16	29.34	655	201	917	0.22	0.17254	1.53	7.686	2.07	0.3269	1.40	0.674	2582	39.7	1825	25.5
17	44.90	1695	2036	2834	0.73	0.14435	1.53	4.19	2.07	0.215	1.40	0.674	2280	35.1	1256	17.6
18	0.93	183	209	756	0.28	0.10717	1.51	4.628	2.02	0.3153	1.33	0.661	1752	26.7	1768	23.6
19	3.53	112	133	667	0.21	0.10631	1.51	4.33	1.96	0.2966	1.26	0.640	1737	26.4	1676	21.1
20	0.06	358	386	1007	0.39	0.1084	1.51	4.702	2.10	0.316	1.45	0.692	1773	27.0	1772	25.7
21	3.62	121	121	626	0.20	0.10804	1.59	4.833	2.32	0.3281	1.69	0.729	1767	28.2	1831	31.0
22	0.42	295	364	651	0.57	0.10102	1.51	4.047	2.06	0.2914	1.39	0.678	1643	25.0	1650	23.0
23	34.44	171	105	2014	0.05	0.11249	1.55	3.168	2.40	0.2056	1.84	0.766	1840	28.6	1206	22.2
24	23.00	76	88	1343	0.07	0.10502	1.51	3.274	2.20	0.2271	1.60	0.726	1715	26.1	1320	21.1
25	1.80	94	110	584	0.19	0.10294	1.51	4.286	2.02	0.3031	1.34	0.663	1678	25.6	1708	22.8
26	22.38	376	564	899	0.64	0.10552	1.54	3.384	2.84	0.2304	2.39	0.841	1723	26.7	1338	32.0
27	1.20	115	134	625	0.22	0.10711	1.51	4.532	2.01	0.3075	1.33	0.660	1751	26.7	1730	23.0
28	1.51	127	150	614	0.25	0.10673	1.51	4.615	2.00	0.3158	1.31	0.654	1744	26.6	1771	23.2

Spot	% discordance	Pb (ppm)	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
						MEASURED ISOTOPIC RATIOS							**APPARENT ISOTOPIC AGES**			
MP-P0913-5B zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 100, laser energy = 3 mJ at 75%)																
29	0.60	315	379	425	0.90	0.10227	1.52	4.18	2.07	0.2966	1.40	0.678	1666	25.6	1676	23.5
30	0.03	102	124	296	0.42	0.10313	1.53	4.226	1.99	0.2976	1.28	0.641	1681	26.0	1681	21.5
31	0.56	129	154	591	0.26	0.10677	1.51	4.538	2.03	0.3086	1.35	0.665	1745	26.6	1735	23.4
32	1.69	127	147	562	0.27	0.10641	1.51	4.634	1.94	0.3153	1.22	0.628	1739	26.5	1768	21.6
33	1.22	92	109	524	0.21	0.10654	1.51	4.609	2.05	0.3141	1.38	0.675	1741	26.5	1762	24.4
34	0.57	86	101	510	0.20	0.10668	1.51	4.586	2.02	0.3123	1.34	0.663	1743	26.6	1753	23.5
MP-P0913-12 zircon (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)																
1	11.55	72	105	477	0.22	0.10864	1.51	4.139	2.26	0.2758	1.68	0.742	1777	27.1	1571	26.3
2	45.31	133	571	725	0.77	0.10344	1.63	2.237	2.20	0.1537	1.48	0.672	1687	27.7	922	13.6
3	2.51	48	53	248	0.21	0.10964	1.52	4.714	1.87	0.3113	1.09	0.583	1793	27.4	1749	19.1
4	39.47	178	448	684	0.65	0.10485	1.57	2.557	3.40	0.1742	3.01	0.887	1712	27.1	1036	31.2
5	6.55	51	66	192	0.33	0.1075	1.52	4.307	2.31	0.2899	1.73	0.752	1757	26.9	1642	28.5
6	1.43	47	57	175	0.32	0.10823	1.52	4.637	1.98	0.3105	1.27	0.642	1770	27.1	1745	22.2
7	10.82	89	120	459	0.26	0.10787	1.51	4.109	2.36	0.2761	1.81	0.767	1764	26.9	1573	28.4
8	9.67	113	144	379	0.37	0.10863	1.52	4.244	2.57	0.2824	2.07	0.807	1777	27.1	1605	33.2
9	13.00	147	210	598	0.35	0.10933	1.51	4.115	1.98	0.2727	1.27	0.644	1788	27.3	1556	19.8
10	3.49	58	61	123	0.50	0.11244	1.53	4.919	1.92	0.3167	1.15	0.601	1839	28.4	1775	20.5
11	63.35	176	158	1422	0.11	0.1161	1.73	1.834	2.34	0.1138	1.57	0.672	1897	33.0	695	10.9
12	49.53	145	297	1138	0.26	0.10417	1.55	2.049	2.71	0.1422	2.22	0.820	1700	26.6	858	19.1
13	2.13	90	99	376	0.24	0.10947	1.52	4.708	2.17	0.3121	1.55	0.714	1791	27.4	1752	27.1
14	37.31	85	160	733	0.22	0.10522	1.55	2.642	2.37	0.1817	1.79	0.756	1718	26.9	1077	19.3
15	26.27	83	151	632	0.24	0.10661	1.52	3.242	1.92	0.2203	1.18	0.615	1742	26.6	1284	15.2
16	0.91	27	31	227	0.14	0.10818	1.52	4.669	1.96	0.3122	1.24	0.633	1769	27.0	1753	21.8
17	34.79	115	199	889	0.22	0.10726	1.53	2.87	2.21	0.1939	1.60	0.725	1753	27.0	1143	18.3
18	29.78	73	332	903	0.36	0.10203	1.52	2.79	2.13	0.1982	1.49	0.699	1661	25.5	1167	17.3
19	8.65	57	64	304	0.21	0.10997	1.57	4.404	2.06	0.2901	1.34	0.648	1799	28.5	1643	21.9
20	12.13	63	67	405	0.17	0.11072	1.52	4.273	2.30	0.2798	1.72	0.749	1811	27.8	1592	27.4
21	30.29	143	283	592	0.50	0.10566	1.52	2.988	3.37	0.205	3.01	0.893	1726	26.4	1203	36.2
22	0.15	41	44	231	0.19	0.10835	1.51	4.712	1.91	0.3155	1.16	0.606	1772	27.0	1769	20.4
23	2.41	211	246	400	0.62	0.10872	1.52	4.624	1.90	0.3086	1.15	0.603	1778	27.2	1735	19.9
24	21.58	205	369	698	0.51	0.10811	1.52	3.567	2.33	0.2397	1.77	0.759	1768	27.1	1386	24.6
25	8.41	78	103	352	0.28	0.1092	1.52	4.336	2.39	0.2886	1.84	0.770	1786	27.4	1636	30.0
26	0.18	88	96	327	0.29	0.11073	1.51	4.926	1.85	0.3235	1.07	0.576	1811	27.6	1808	19.3
27	28.84	108	180	802	0.22	0.10675	1.53	3.123	2.11	0.2122	1.45	0.688	1745	26.9	1242	18.0

MP-P0913-12 zircon CONT'D (spot size = 25 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)

						MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	**% discordance**	**Pb (ppm)**	**Th (ppm)**	**U (ppm)**	**Th/U**	**$^{207}Pb/^{206}Pb$**	**2σ %**	**$^{207}Pb/^{235}U$**	**2σ %**	**$^{206}Pb/^{238}U$**	**2σ %**	**Rho**	**$^{207}Pb/^{206}Pb$ Age**	**2σ abs**	**$^{206}Pb/^{238}U$ Age**	**2σ abs**
28	14.80	39	43	615	0.07	0.1092	1.53	3.997	2.16	0.266	1.52	0.706	1786	27.5	1522	23.2
29	48.09	271	830	1298	0.63	0.10154	1.51	1.987	1.94	0.1422	1.21	0.624	1652	25.2	858	10.4
30	47.95	139	323	1439	0.22	0.1026	1.52	2.04	1.97	0.1444	1.25	0.635	1672	25.7	870	10.9
31	2.65	31	30	203	0.15	0.11057	1.52	4.784	1.88	0.3138	1.11	0.589	1809	27.7	1761	19.5
32	11.72	75	107	372	0.29	0.10901	1.51	4.132	1.99	0.2763	1.29	0.649	1783	27.2	1574	20.3
33	25.51	132	209	626	0.34	0.10809	1.51	3.363	1.95	0.2264	1.23	0.633	1767	26.9	1317	16.2
34	42.30	154	444	701	0.62	0.10633	1.62	2.462	2.73	0.1681	2.20	0.805	1737	28.3	1002	22.0
35	14.63	239	304	1164	0.26	0.11136	1.52	4.173	2.68	0.2726	2.21	0.823	1822	27.9	1555	34.3
36	5.69	72	92	495	0.18	0.10855	1.51	4.429	1.90	0.2963	1.15	0.604	1775	27.1	1674	19.2
37	2.81	455	545	897	0.60	0.11167	1.52	4.868	1.88	0.3168	1.10	0.587	1827	28.0	1776	19.6
38	25.73	62	201	676	0.29	0.10998	1.51	3.479	2.31	0.2301	1.75	0.758	1799	27.3	1336	23.4
39	36.49	92	184	897	0.21	0.10692	1.55	2.763	1.93	0.1877	1.14	0.594	1748	27.3	1110	12.7

APPENDIX Q - MONAZITE THORIUM-LEAD DATA TABLE

Spot	U ppm	Th ppm	Pb ppm	Th/U	204 CPS	%^{208}Pb comm.	^{206}Pb/^{204}Pb	2SE %	^{208}Pb/^{204}Pb	2SE %	^{208}Pb/^{206}Pb	2SE %	^{207}Pb/^{206}Pb	2SE %	^{206}Pb/^{238}U	2SE %	Rho	^{208}Pb/ ^{232}Th	2SE %	^{208}Pb/^{232}Th Date (Ma)	2SE abs.	^{208}Pb*/^{232}Th	2SE %	^{208}Pb*/^{232}Th Date (Ma)	2SE abs.
MP-P0913-2 monazite (spot size = 9 μm, shot frequency = 3 Hz, shot count = 80, laser energy = 4 mJ @ 100%)																									
1	23.3	8323	816.6	365	21	0.32	63	58.7	6300	58.7	98.0	0.96	0.1452	2.98	0.331	25.2	0.993	0.0722605	3.75	1410	53	0.0720292	3.88	1406	55
2	35.4	8230	786	246	37	0.58	47	104	3600	103	74.5	1.27	0.1146	2.39	0.4	95	1.000	0.0703829	3.73	1375	51	0.0699737	3.86	1367	53
3	13.2	6490	618	465	26	0.51	37	64.9	4200	66.7	112.1	2.35	0.2099	3.05	0.24	62.5	0.999	0.0701801	3.92	1371	54	0.0698200	4.05	1364	55
4	24.2	17210	1454	735	82	0.67	63	46	8100	43.2	131.4	1.97	0.3506	2.58	0.408	20	0.992	0.0622879	3.76	1221	46	0.0618685	3.89	1213	47
5	23.5	12150	1181	532	23	0.23	280	85.7	45000	84.4	157.3	0.91	0.1682	2.21	0.27	111	1.000	0.0716524	3.73	1399	52	0.0714849	3.87	1396	54
6	11.2	7690	779	769	67	1.01	33.8	21	4900	20.4	148.0	0.95	0.4308	2.25	0.22	105	1.000	0.0747620	3.76	1457	55	0.0740073	3.89	1443	56
7	10.1	7700	753	813	26	0.41	13	115	2900	86.2	217.9	3.27	0.226	3.12	0.14	85.8	0.999	0.0721141	3.71	1407	52	0.0718209	3.85	1402	54
8	24.6	8050	538	334	55	1.18	200	110	15000	113	72.5	2.03	0.274	4.22	0.289	18.9	0.976	0.0492147	4.08	971	40	0.0486323	4.20	960	40
9	20.9	7950	568.9	389	96	1.89	32.1	10.6	2340	12.0	71.0	2.41	0.418	3.37	0.41	34.2	0.995	0.0527438	3.96	1039	41	0.0517452	4.09	1020	42
10	23.3	13770	1298	602	25	0.21	30	367	40000	42.5	148.7	0.97	0.1707	2.63	0.387	24.9	0.994	0.0694918	3.70	1358	50	0.0693443	3.84	1355	52
11	18.6	8520	759	465	17	0.24	13	446	1100	600	107.8	1.40	0.203	2.28	0.28	32.2	0.998	0.0656806	3.78	1286	49	0.0655203	3.91	1283	50
12	10.2	4072	411	413	17	0.45	29	76	2600	76.9	93.0	0.93	0.2562	2.34	0.07	285.7	1.000	0.0742845	3.73	1448	54	0.0739520	3.86	1442	56
13	39.5	9248	831	236	28	0.37	140	121	90000	12.2	63.1	1.07	0.1437	2.28	0.238	5.25	0.917	0.0660486	3.71	1293	48	0.0658065	3.85	1288	50
14	28.1	6670	635	232	53	0.91	67	49.3	4200	50	62.9	1.83	0.1308	2.91	0.268	11.1	0.967	0.0699413	4.47	1366	61	0.0693076	4.58	1354	62
15	29.1	6520	671	224	84	1.35	55.5	13	3370	13.4	60.0	2.40	0.1469	2.14	0.309	9.40	0.975	0.0755474	3.81	1472	56	0.0745270	3.94	1453	57
MP-P0913-7 monazite (spot size = 9 μm, shot frequency = 3 Hz, shot count = 80, laser energy = 4 mJ @ 100%)																									
1	22.3	528	41.15	22	34	10.77	65	44.6	320	46.9	6.2	2.37	0.2131	4.33	0.224	29.1	0.989	0.0579865	4.03	1139	46	0.0517424	4.15	1020	42
2	12	1134	86.5	90	16	2.42	21	90.5	410	107	23.0	4.61	0.1628	4.02	0.18	66.7	0.998	0.0567479	3.70	1116	41	0.0553745	3.83	1089	42
3	8.2	1844	140.5	222	26	2.36	11	127	500	114	43.0	2.54	0.3216	3.26	0.12	150	1.000	0.0566618	3.68	1114	41	0.0553263	3.81	1088	41
4	18.3	182	14.55	10	7	6.14	7	214	21	243	3.3	1.43	0.0788	5.12	0.18	88.9	0.998	0.0594038	4.37	1166	51	0.0557581	4.49	1097	49
5	54.9	10690	1051	186	86	1.13	66.1	9.83	3920	11.5	56.9	1.20	0.1266	2.11	0.243	5.91	0.942	0.0723068	3.71	1411	52	0.0714905	3.84	1396	54
6	10.4	8470	852	870	44	0.72	14	114	3500	111	236.1	1.32	0.1922	3.33	0.05	280	1.000	0.0740359	3.71	1444	54	0.0735042	3.85	1434	55
7	27.6	13030	1227	459	77	0.86	38	111	3500	123	96.2	3.37	0.272	6.02	0.45	35.6	0.986	0.0693490	4.45	1355	60	0.0687495	4.56	1344	61
8	24.6	9460	952	351	12	0.18	42	112	4900	108	111.1	1.33	0.1009	3.70	0.294	20.9	0.985	0.0740883	3.82	1445	55	0.0739539	3.95	1442	57
9	9.8	6390	648.5	629	9	0.19	15	153	2500	160	185.1	1.31	0.2432	3.01	0.15	167	1.000	0.0747732	3.68	1457	54	0.0746337	3.82	1455	56
10	28.6	7600	731	266	40	0.75	59	44.1	4500	44.44	78.4	1.65	0.1902	4.50	0.253	32.9	0.991	0.0708701	3.97	1384	55	0.0703398	4.09	1374	56
11	31	8120	784	253	92	1.60	48.3	14.3	2780	14.39	57.8	1.39	0.2956	2.13	0.39	24.5	0.996	0.0711362	3.76	1389	52	0.0700005	3.89	1368	53
12	31.8	8480	832	267	96	1.55	52.4	13.5	3120	14.42	58.8	1.47	0.3035	2.18	0.4	15.2	0.990	0.0723074	3.69	1411	52	0.0711898	3.82	1390	53
MP-P0913-SQ1 monazite (spot size = 9 μm, shot frequency = 3 Hz, shot count = 80, laser energy = 4 mJ @ 100%)																									
1	5.8	2660	262.9	402	225	12.47	17.71	4.18	293	4.44	756.4	1.36	0.8188	1.92	0.54	172	1.000	0.0789458	3.10	1536	48	0.0690986	3.26	1350	44
2	3.5	2962	282.9	787	205	10.59	19.5	5.64	350	4.86	854.0	3.42	0.7726	1.95	0.33	239	1.000	0.0762802	3.11	1486	46	0.0681987	3.27	1333	44
3	4.1	2678	264.4	599	222	12.23	18.73	3.68	294	3.74	772.8	2.01	0.8085	1.88	1.4	85.7	1.000	0.0788220	3.11	1533	48	0.0691824	3.27	1352	44
4	7.1	4920	460	654	79	2.51	25.3	11.5	1540	12.3	2979.7	2.12	0.599	2.54	0.64	61.0	0.999	0.0745828	3.13	1454	45	0.0727075	3.28	1419	47
5	8.3	4287	414.7	503	240	8.43	19.98	4.55	459	10	1107.4	8.64	0.727	3.04	1.3	76.9	0.999	0.0772163	3.22	1503	48	0.0707053	3.38	1381	47
6	11.1	5210	484	465	189	5.69	21.7	4.61	645	6.51	1536.1	3.84	0.6705	1.94	1.32	23.5	0.997	0.0740804	3.13	1444	45	0.0698684	3.28	1365	45
7	8.4	3820	383.5	472	234	8.91	19.18	3.96	405	4.94	1176.5	2.00	0.7392	1.76	0.72	72.2	1.000	0.0800680	3.15	1557	49	0.0729358	3.31	1423	47
8	3.8	3462	342.5	952	232	9.89	19.85	4.13	369	4.07	1051.5	2.94	0.7511	2.03	1.1	155	1.000	0.0789222	3.08	1535	47	0.0711146	3.24	1389	45
9	7.4	2913	280.8	442	144	7.46	22	5.45	479	6.05	1212.1	1.58	0.6667	1.98	0.55	81.8	1.000	0.0768411	3.13	1496	47	0.0711089	3.28	1388	46
10	3.4	2395	242.8	855	169	10.16	17.84	5.33	360	5.56	1128.7	1.24	0.7772	1.97	0.16	475	1.000	0.0808324	3.10	1571	49	0.0726185	3.25	1417	46
11	4.1	4624	443.2	1087	257	8.46	21.85	2.88	428	2.80	1077.6	1.19	0.6812	1.73	2.1	71.4	1.000	0.0763964	3.11	1488	46	0.0699301	3.27	1366	45
12	3.5	3155	309.9	909	257	12.10	17.86	3.53	300	4.33	900.9	2.25	0.8062	1.96	1	100	1.000	0.0783325	3.10	1524	47	0.0688546	3.26	1346	44
13	6.4	2726	254.4	446	169	9.70	26.5	5.28	377	5.84	756.4	2.04	0.5913	2.29	2.9	65.5	0.999	0.0743547	3.13	1450	45	0.0671442	3.28	1314	43
14	7	2556	267.2	417	245	13.40	19.58	4.03	267	4.49	700.8	1.89	0.7444	1.86	2.4	83.3	1.000	0.0832388	3.07	1616	50	0.0720867	3.23	1407	45
15	3.4	3468	329	1031	112	4.98	21.4	6.07	726	6.47	1746.1	1.54	0.6843	2.07	1.2	150	1.000	0.0755641	3.11	1472	46	0.0717997	3.26	1401	46
16	3.6	4280	411	1370	188	6.67	18.17	4.57	542	4.98	1507.4	1.43	0.7697	1.85	-0.25	252	1.000	0.0764155	3.12	1488	46	0.0713182	3.27	1392	46
17	4.7	3020	299.7	641	190	9.27	20	4.20	405	6.67	1025.6	3.59	0.683	2.46	0.2	500	1.000	0.0789530	3.52	1536	54	0.0716366	3.66	1398	51

MP-P0913-SQ1 monazite CONT'D (spot size = 9 μm, shot frequency = 3 Hz, shot count = 80, laser energy = 4 mJ @ 100%)

Spot	U ppm	Th ppm	Pb ppm	Th/U	204 CPS	%^{208}Pb comm.	^{206}Pb/^{204}Pb	2SE %	^{208}Pb/^{204}Pb	2SE %	^{208}Pb/^{206}Pb	2SE %	^{207}Pb/^{206}Pb	2SE %	^{206}Pb/^{238}U	2SE %	Rho	^{208}Pb/ ^{232}Th	2SE %	^{208}Pb/^{232}Th Date (Ma)	2SE abs.	^{208}Pb*/^{232}Th	2SE %	^{208}Pb*/^{232}Th Date (Ma)	2SE abs.
18	2.3	2565	255.8	1176	199	11.32	16.8	4.40	323	5.26	1006.0	2.21	0.8047	1.85	-0.46	185	1.000	0.0793103	3.37	1543	52	0.0703300	3.52	1374	48
19	7.5	2964	289.3	410	195	9.82	19.42	3.60	374	4.55	1010.1	1.52	0.7396	1.92	0.65	86.2	1.000	0.0776334	3.39	1511	51	0.0700107	3.53	1368	48
20	16	2805	285.4	182	185	9.44	22.41	3.93	380	3.95	932.0	1.40	0.6615	2.00	0.785	12.6	0.988	0.0809641	3.43	1574	54	0.0733219	3.57	1430	51
21	4.6	2378	245.3	588	217	12.91	19.38	3.51	280	3.93	803.9	1.13	0.7612	1.90	0.5	460	1.000	0.0820379	3.54	1594	56	0.0714431	3.68	1395	51
22	11	2789	268.3	262	134	7.30	24.5	5.31	501	5.19	1124.9	2.81	0.6041	2.01	0.71	64.8	1.000	0.0764777	3.55	1490	53	0.0708986	3.68	1384	51
23	6.3	2761	262.7	476	109	6.03	18.3	7.10	617	7.13	1821.5	2.00	0.713	2.19	-0.06	1217	1.000	0.0756606	3.34	1474	49	0.0710991	3.48	1388	48
24	8.9	3330	318.5	431	178	8.14	22	5.45	441	7.26	1092.9	5.36	0.636	2.33	0.31	181	1.000	0.0758980	3.40	1479	50	0.0697168	3.54	1362	48
25	9.8	2472	233.9	269	115	7.16	20.8	6.73	518	7.53	1338.7	1.61	0.6725	1.96	0.61	90.2	1.000	0.0750551	3.48	1463	51	0.0696811	3.62	1362	49
26	8.7	2671	255.9	324	177	10.10	19.4	4.23	360	5.56	985.2	2.17	0.7468	2.00	0.83	74.7	1.000	0.0759826	3.47	1480	51	0.0683065	3.61	1336	48
27	6.8	2908	267.8	463	123	6.69	20.3	5.91	538	6.51	1398.6	3.50	0.731	2.17	0.55	105	1.000	0.0730716	3.43	1425	49	0.0681827	3.57	1333	48
28	10.4	2702	261.2	270	142	7.90	19.68	4.93	446	4.93	1206.3	2.05	0.7128	2.04	0.71	52.1	0.999	0.0767212	3.46	1494	52	0.0706578	3.60	1380	50
29	10.3	3009	268	319	147	8.01	19.3	5.70	464	5.82	1240.7	2.11	0.7442	1.94	0.08	1188	1.000	0.0706568	3.33	1380	46	0.0649989	3.48	1273	44
30	5.1	3530	328.9	752	120	5.31	22.3	6.28	700	6.71	1618.1	2.10	0.694	2.33	0.27	226	1.000	0.0738495	3.23	1440	47	0.0699283	3.38	1366	46
31	15.6	3850	365	274	169	6.75	24.6	4.47	540	5.74	1091.7	2.51	0.62	2.24	0.97	20.7	0.994	0.0750997	3.34	1464	49	0.0700280	3.49	1368	48
32	8.8	3214	301.9	397	140	6.78	19.9	5.53	547	5.48	1353.2	1.76	0.716	2.19	0.19	321	1.000	0.0743892	3.49	1450	51	0.0693464	3.63	1355	49
33	4.6	3523	335.1	833	159	6.92	19.5	5.64	524	5.92	1324.5	2.12	0.7666	1.94	0.33	188	1.000	0.0753224	3.23	1468	47	0.0701068	3.38	1370	46
34	5.4	3098	294.2	625	208	10.29	18.84	4.25	342	4.68	879.5	1.93	0.77	2.12	0.6	183	1.000	0.0752413	3.48	1466	51	0.0674982	3.62	1320	48
35	10.3	3803	354	394	192	7.91	21.3	4.69	463	4.97	1051.2	0.95	0.7104	1.83	1.13	35.4	0.999	0.0737427	3.42	1438	49	0.0679093	3.56	1328	47
36	3.1	3004	288.1	1515	208	10.51	18.11	3.92	344	4.36	944.3	1.79	0.8117	1.85	0.23	430	1.000	0.0759793	3.39	1480	50	0.0679959	3.54	1330	47
37	4.4	3560	333.4	719	136	5.95	19.73	4.97	614	7.17	1540.8	4.16	0.744	2.06	0.3	250	1.000	0.0742035	3.33	1447	48	0.0697909	3.48	1364	47
38	6.8	3477	327.7	568	217	9.63	18.77	4.79	374	5.35	969.9	1.94	0.782	2.02	1.12	72.3	1.000	0.0745703	3.42	1454	50	0.0673868	3.56	1318	47
39	25.5	5670	574	198	112	2.84	35.9	8.36	1290	9.30	1560.1	2.18	0.434	2.78	0.423	11.19	0.970	0.0792327	3.50	1541	54	0.0769787	3.64	1499	55
40	8.1	3356	322	372	149	6.73	20.6	4.85	543	4.79	1162.8	2.09	0.721	2.18	0.5	220	1.000	0.0751116	3.34	1464	49	0.0700539	3.48	1369	48
41	3	3414	339.3	1053	197	8.43	19.53	3.84	433	5.31	947.9	4.17	0.7509	1.97	1.1	136	1.000	0.0777785	3.24	1514	49	0.0712244	3.39	1391	47
42	2.7	4053	402.5	1299	280	10.10	19.74	3.50	359	3.90	796.2	1.27	0.7739	1.79	2.2	59.1	1.000	0.0776693	3.38	1512	51	0.0698230	3.53	1364	48
43	3	3461	356.9	1190	268	10.93	17.77	4.22	325	4.31	818.3	2.05	0.8131	1.85	-0.3	833	1.000	0.0806892	3.29	1568	52	0.0718722	3.44	1403	48
44	8.3	2955	270.4	312	169	9.06	23.1	5.63	420	6.19	817.7	2.13	0.6728	1.88	1.3	100	1.000	0.0715809	3.51	1397	49	0.0650965	3.65	1275	47
45	4.1	3334	345.8	629	248	10.41	21.03	4.09	340	4.41	745.2	1.79	0.6866	1.95	-	-	-	0.0811520	3.49	1577	55	0.0727027	3.63	1419	51
46	9.7	3562	346.3	337	151	6.34	25.4	5.91	595	6.05	1108.6	1.22	0.6383	2.08	0.42	110	1.000	0.0760524	3.39	1482	50	0.0712326	3.54	1391	49

MP-L0613-BDAY2 monazite (spot size = 9 μm, shot frequency = 3 Hz, shot count = 80, laser energy = 4 mJ @ 100%)

Spot	U ppm	Th ppm	Pb ppm	Th/U	204 CPS	%^{208}Pb comm.	^{206}Pb/^{204}Pb	2SE %	^{208}Pb/^{204}Pb	2SE %	^{208}Pb/^{206}Pb	2SE %	^{207}Pb/^{206}Pb	2SE %	^{206}Pb/^{238}U	2SE %	Rho	^{208}Pb/ ^{232}Th	2SE %	^{208}Pb/^{232}Th Date (Ma)	2SE abs.	^{208}Pb*/^{232}Th	2SE %	^{208}Pb*/^{232}Th Date (Ma)	2SE abs.
1	2.7	7570	758	3030	58	0.57	13	92.3	4900	102	548.2	2.36	0.457	3.41	-0.14	143	1.000	0.0712896	2.11	1392	29	0.0708861	2.34	1384	32
2	3.2	6790	690	2174	101	1.19	11.3	17.7	4090	23	329.2	2.37	0.586	2.54	0.14	78.6	0.999	0.0720522	2.11	1406	30	0.0711938	2.34	1390	32
3	10.1	7730	803	781	103	1.13	18	66.7	5800	67.2	301.9	1.84	0.604	2.49	0.08	238	1.000	0.0735227	2.13	1434	31	0.0726893	2.35	1418	33
4	6.5	16290	1670	2364	85	0.54	18.5	28.6	7000	28.6	378.4	1.25	0.3733	2.91	0.51	106	1.000	0.0721462	2.18	1408	31	0.0717564	2.40	1401	34
5	7.7	17210	1717	2128	132	0.85	13.3	12.8	4830	13.5	367.8	1.99	0.533	2.55	0.37	40.6	0.998	0.0702324	2.29	1372	31	0.0696363	2.50	1361	34
6	12.3	24100	2448	1880	111	0.51	27	37	9300	34.4	391.7	2.86	0.392	3.18	0.36	38.9	0.997	0.0715405	2.23	1397	31	0.0711766	2.44	1390	34
7	1.9	12940	1263	6536	63	0.31	14.8	18.2	13700	18.2	925.9	1.48	0.444	3.29	0.05	520	1.000	0.0702935	2.15	1373	30	0.0700782	2.37	1369	32
8	7.5	15700	1516	2198	142	0.57	14.5	8.97	6680	8.83	464.3	1.67	0.616	2.21	0.54	61.1	0.999	0.0699356	2.22	1366	30	0.0695396	2.44	1359	33
9	5.2	2161	227	420	98	2.70	14.7	15	1500	14.7	102.8	1.44	0.64	2.40	0.35	88.6	1.000	0.0766066	2.40	1492	36	0.0745349	2.60	1453	38
10	4.9	3490	370	719	89	1.52	16.3	17.2	2920	18.8	170.0	1.21	0.598	2.51	0.14	393	1.000	0.0774880	2.47	1508	37	0.0763114	2.66	1486	40
11	3.1	9310	939	3333	29	0.20	9.5	65.3	8700	70.1	1008.1	2.82	0.361	4.42	0.04	275	1.000	0.0738254	2.60	1440	38	0.0736773	2.79	1437	40
12	5.7	19560	1830	3448	107	0.39	22.4	38.4	12400	40.3	541.7	2.38	0.467	3.54	0.24	313	1.000	0.0684358	3.89	1338	52	0.0681706	4.01	1333	54
13	5.6	12840	1305	2252	88	0.45	19.7	15.2	9900	16.2	498.5	1.25	0.515	2.45	0.34	221	1.000	0.0744085	2.41	1451	35	0.0740742	2.61	1444	38
14	4.3	11270	1136	2500	67	0.39	18.8	17.6	10900	17.4	576.0	1.44	0.4625	2.58	-0.14	429	1.000	0.0738226	2.60	1440	37	0.0735315	2.78	1434	40
15	26.2	8870	889	355	203	1.54	11.95	5.69	2390	6.69	196.5	6.09	0.694	2.08	0.19	8.48	0.971	0.0734203	2.28	1432	33	0.0722904	2.49	1411	35
16	8	8080	815	1087	122	1.02	13.4	18.7	4570	19.5	326.8	6.21	0.582	2.98	0.26	50	0.998	0.0740916	2.37	1445	34	0.0733387	2.57	1431	37
17	23.6	10560	1012	448	155	1.05	14.5	15.9	3750	16	246.9	3.21	0.686	2.53	0.203	13.3	0.982	0.0703254	3.37	1374	46	0.0695874	3.51	1360	48
18	37.2	16540	1538	441	153	0.69	15.2	11.2	6600	22.7	352.1	14.08	0.587	4.36	0.135	13.4	0.951	0.0681985	2.45	1333	33	0.0677256	2.64	1325	35
19	10	20530	2006	1949	62	0.22	22	72.7	16000	68.8	721.5	1.37	0.381	3.02	0.29	29.7	0.995	0.0717592	2.55	1401	36	0.0716045	2.74	1398	38
20	52.6	16050	1526	309	282	1.29	13.22	4.99	2800	8.21	212.3	5.73	0.678	2.32	0.158	8.29	0.963	0.0697831	2.36	1363	32	0.0688796	2.56	1346	35
21	12.7	4590	466	373	130	1.32	23.6	6.36	2810	6.76	117.1	0.80	0.3244	2.06	0.393	13.8	0.989	0.0745537	2.41	1453	35	0.0735687	2.61	1435	37
22	27.9	5720	573.4	195	42	0.35	20	240	60000	23.3	274.7	4.95	0.3513	2.43	0.1176	8.06	0.958	0.0717736	2.41	1401	34	0.0715191	2.61	1396	36
23	105	3644	288	31	279	5.05	17.04	3.93	695	5.32	40.6	2.07	0.5643	1.95	0.1233	5.29	0.938	0.0558780	3.11	1099	34	0.0530557	3.27	1045	34
24	234	2673	191.1	11	290	8.09	16.43	3.65	508	11.6	25.6	13.30	0.602	1.92	0.089	16.9	0.994	0.0504808	6.64	995	66	0.0463985	6.72	917	62
25	215	4550	350	20	129	1.99	25.1	14.7	2120	17.9	80.6	4.11	0.4443	2.58	0.0359	8.14	0.953	0.0543295	3.77	1069	40	0.0532483	3.90	1049	41

MP-L0613-BDAY2 monazite CONT'D (spot size = 9 μm, shot frequency = 3 Hz, shot count = 80, laser energy = 4 mJ @ 100%)

Spot	U ppm	Th ppm	Pb ppm	Th/U	204 CPS	%^{208}Pb comm.	^{206}Pb/^{204}Pb	2SE %	^{208}Pb/^{204}Pb	2SE %	^{208}Pb/^{206}Pb	2SE %	^{207}Pb/^{206}Pb	2SE %	^{206}Pb/^{238}U	2SE %	Rho	^{208}Pb/ ^{232}Th	2SE %	^{208}Pb/^{232}Th Date (Ma)	2SE abs.	^{208}Pb*/^{232}Th	2SE %	^{208}Pb*/^{232}Th Date (Ma)	2SE abs.
26	11	3745	398.9	327	84	1.15	32	37.5	4600	37	144.1	2.16	0.4651	2.47	0.57	57.9	0.999	0.0754135	2.49	1470	37	0.0745484	2.69	1453	39

APPENDIX R - HOST ROCK MONAZITE URANIUM-LEAD DATA TABLE

					MEASURED ISOTOPIC RATIOS							APPARENT ISOTOPIC AGES			
Spot	Pb (ppm)	Th (ppm)	U (ppm)	Th/U	$^{207}Pb/^{206}Pb$	2σ %	$^{207}Pb/^{235}U$	2σ %	$^{206}Pb/^{238}U$	2σ %	Rho	$^{207}Pb/^{206}Pb$ Age	2σ abs	$^{206}Pb/^{238}U$ Age	2σ abs
MP-P0913-4 monazite (spot size = 9 µm, shot frequency = 3 Hz, shot count = 80, laser energy = 3 mJ at 75%)															
1	5530	49500	7430	5.96	0.10741	1.51	4.179	2.99	0.2836	2.58	0.862	1756	26.6	1611	41.5
2	6010	53600	8040	5.94	0.10753	1.52	4.183	3.02	0.2814	2.61	0.865	1758	26.7	1600	41.8
3	6960	61500	5062	10.85	0.10592	1.51	4.186	3.01	0.2862	2.60	0.865	1730	26.2	1624	42.3
4	6740	59400	9180	5.85	0.10627	1.52	4.188	3.07	0.2868	2.67	0.870	1736	26.3	1627	43.5
5	6510	58000	10050	5.24	0.10539	1.51	4.139	3.11	0.2842	2.72	0.874	1721	26.0	1614	43.8
6	6930	63300	4810	12.03	0.10287	1.52	4.045	3.07	0.2838	2.66	0.868	1677	25.6	1612	42.9
7	6690	60300	7220	7.83	0.10165	1.52	3.916	3.04	0.2788	2.64	0.867	1654	25.1	1587	41.8
8	6870	60400	9360	6.13	0.10395	1.51	4.125	3.04	0.2869	2.64	0.867	1696	25.6	1627	42.9
9	5840	50700	4720	10.92	0.10385	1.52	4.095	3.10	0.2875	2.71	0.872	1694	25.7	1630	44.1
10	8120	69700	2571	27.82	0.10311	1.54	4.119	3.05	0.2877	2.64	0.864	1681	25.8	1631	43.0
11	7090	61700	5300	12.11	0.10369	1.52	4.146	3.01	0.2883	2.60	0.863	1691	25.7	1634	42.5
12	7810	67500	10420	6.91	0.10412	1.51	4.188	3.07	0.292	2.68	0.871	1699	25.7	1653	44.2
13	8070	70600	3523	21.50	0.10294	1.53	4.175	3.08	0.2934	2.67	0.868	1678	25.6	1660	44.4
14	7510	65200	3399	20.86	0.10277	1.53	4.212	3.03	0.297	2.62	0.863	1675	25.6	1678	43.9
15	8090	70400	7220	11.07	0.10293	1.52	4.151	3.19	0.2921	2.81	0.880	1678	25.4	1653	46.4
16	8120	69400	8040	9.63	0.10377	1.53	4.291	3.13	0.2998	2.73	0.872	1693	25.9	1692	46.2
17	8210	70400	8560	9.39	0.10378	1.51	4.202	3.07	0.2925	2.68	0.871	1693	25.6	1655	44.3
18	8910	78400	10270	7.88	0.10546	1.51	4.216	3.19	0.2901	2.81	0.881	1722	26.0	1643	46.2
19	8810	77700	4320	18.01	0.10411	1.55	4.22	3.88	0.288	3.55	0.917	1699	26.3	1633	58.0
20	8520	76700	7500	10.24	0.10409	1.52	4.196	3.32	0.2922	2.95	0.889	1698	25.8	1654	48.8
21	8290	73400	9170	7.94	0.10388	1.51	4.187	3.16	0.2907	2.77	0.878	1695	25.6	1646	45.6
22	8690	77100	9430	8.07	0.10354	1.51	4.168	3.11	0.2911	2.72	0.874	1689	25.5	1648	44.8
23	8400	75000	14970	4.88	0.10428	1.51	4.172	3.16	0.2888	2.78	0.878	1702	25.7	1637	45.5
24	9240	80500	4390	17.94	0.10254	1.57	4.355	2.91	0.3023	2.46	0.843	1671	26.2	1704	41.8
25	8550	75100	10640	6.95	0.10341	1.51	4.201	2.88	0.294	2.45	0.852	1686	25.4	1663	40.8
26	7320	63300	16310	3.83	0.1034	1.51	4.18	2.89	0.2924	2.47	0.853	1686	25.5	1655	40.8

APPENDIX S - TITANITE TRACE ELEMENT DATA TABLE

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
MP-P0913-5A titanite																													
1		936	126500	193	10	269000	523	109.0	28600	6190	2260	3100	4060	13420	1830	6450	1640	402	1028	138.4	630	93.7	177.0	18.7	90.8	6.7	356.0	334.0	N/M
2		1014	126600	191	13	273000	782	126.4	41900	5810	2090	1600	4300	14500	2150	9080	2000	496	1336	153.1	641	86.3	159.6	15.6	76.6	6.2	421.0	234.0	N/M
3		928	130100	187	11	288000	521	40.3	37400	6930	2272	3550	4370	14000	1890	6480	1700	424	1130	137.0	637	99.4	189.0	18.5	91.5	6.9	390.0	368.0	N/M
4		845	124200	197	11	275000	485	41.9	39500	6190	2290	3420	4340	13730	1990	6640	1720	414	1090	136.2	625	90.5	186.0	18.6	94.6	7.1	390.0	367.0	N/M
5		1037	135400	119	2.4	287000	724	112.0	38900	699	779	4780	2980	12090	1821	6120	1476	338	787	82.2	308	33.7	53.0	5.3	26.8	2.3	81.5	25.7	N/M
6		942	126000	169	11	273000	665	135.0	55400	5940	2230	2220	4240	14400	1980	6960	1790	452	1157	140.0	671	94.0	177.0	17.8	85.3	6.7	324.0	274.0	N/M
7		850	139200	89	2.4	271000	557	82.7	49100	474	1941	2230	982	8100	1640	6590	2090	540	1287	149.6	652	83.2	146.0	14.5	87.0	6.8	56.9	14.9	N/M
8		894	128800	221	12	290000	685	100.7	68900	7120	1908	2020	4820	16320	2293	9700	2068	498	1295	151.6	650	88.2	158.8	14.4	71.1	5.7	442.0	308.0	N/M
9		734	140600	104	3.1	282500	494	58.5	65600	565	1678	2120	1126	8780	1608	6380	2012	503	1180	134.5	575	73.1	124.6	13.7	73.8	6.0	256.0	14.6	N/M
10		821	122000	91	3.4	287000	504	65.6	104700	534	2240	2970	1180	8680	1650	6630	2180	498	1310	158.0	736	94.0	170.0	18.0	100.1	7.9	190.0	16.8	N/M
11		984	130000	96	4.9	279000	724	143.7	130000	1092	1627	1740	2990	11860	1870	7590	2020	491	1128	134.0	580	75.5	129.3	13.4	59.2	4.8	164.0	209.0	N/M
12		1011	141000	114	4.1	295000	776	149.0	134500	1080	1664	1960	2930	12330	1980	7080	2020	469	1234	139.4	591	72.0	132.0	13.5	60.7	4.8	163.0	219.0	N/M
13		952	130800	145	5.6	310000	759	168.0	139000	2660	1346	2250	3000	12690	1839	6610	1732	424	1047	117.4	493	60.0	109.3	10.9	54.8	4.6	161.4	227.0	N/M
14		960	123700	225	13	273000	653	98.2	161300	6250	1899	1868	4710	15620	2260	9040	2040	490	1275	150.2	658	87.0	158.0	15.0	71.3	6.2	468.0	312.0	N/M
15		850	137900	78	2.6	298000	664	108.0	150600	399	1871	994	747	6080	1045	5230	1695	428	1085	131.0	583	74.2	137.2	15.1	75.6	6.6	32.8	5.4	N/M
16		816	138100	73	2.6	301000	703	106.0	159000	408	1920	1070	767	6230	1250	5420	2130	516	1300	157.0	662	84.7	152.0	14.5	75.4	6.5	29.7	4.4	N/M
17		990	132000	227	15	342000	586	79.0	162300	7250	2490	3180	5050	16580	2260	8620	2040	481	1223	158.6	728	107.0	213.0	20.4	105.0	8.0	445.0	426.0	N/M
18		941	147000	86	5.8	289100	678	141.9	171000	792	1021	1570	1446	8260	1410	5420	1500	359	876	92.8	370	43.4	68.1	6.8	37.4	3.4	227.0	23.7	N/M
19		981	147000	107	5.7	297700	633	113.4	161100	797	1098	1530	1410	8190	1260	5170	1509	386	915	95.5	394	45.7	71.4	8.0	41.5	3.6	221.0	22.1	N/M
20		997	128400	234	11	306000	659	66.6	117300	7390	2030	2390	5400	18000	2520	10200	2270	546	1340	160.0	682	93.3	169.0	16.4	77.8	6.5	370.0	345.0	N/M
21		885	124800	230	12	309000	660	61.7	111100	6720	2040	2350	5510	17300	2450	9810	2190	527	1319	154.3	714	90.6	160.0	15.7	78.0	5.9	357.0	342.0	N/M
22		960	136000	134	3.4	321000	348	36.5	89400	4500	1659	2750	3410	11710	1790	5780	1480	354	898	103.4	469	64.8	128.8	14.8	84.7	7.0	39.3	42.7	N/M
23		1151	138600	93	2.4	326000	677	144.6	69300	650	900	4990	2620	11140	1749	5850	1486	355	860	88.9	358	39.8	64.6	6.2	34.8	2.9	39.0	19.2	N/M
24		1152	124200	93	2.7	329000	669	129.6	70800	683	923	4880	2660	11070	1720	5990	1464	365	905	90.8	369	42.0	62.5	6.1	34.6	3.0	36.4	18.7	N/M
25		845	129700	182	12	333000	459	102.6	66500	6500	2130	3700	4180	13650	1970	6450	1700	408	1105	135.6	652	90.6	174.4	17.6	87.9	6.3	517.0	392.0	N/M
26		1050	137700	115	4.5	339000	750	153.0	64900	675	878	4000	3080	13130	1940	6490	1596	380	908	99.3	361	38.2	57.9	5.7	32.5	2.9	253.0	17.7	N/M
27		893	123100	212	11	322000	592	106.4	45200	6940	2340	2680	6090	19090	2700	10880	2240	518	1396	168.5	756	100.2	185.2	19.3	94.5	7.2	319.0	340.0	N/M
28		1024	120100	193	11	338300	702	114.5	49900	6060	2061	1814	4340	14730	2133	8140	1951	480	1285	152.4	649	91.1	173.4	16.6	80.2	6.6	344.0	278.3	N/M
29		882	125900	206	11	334000	679	90.7	35700	7070	1988	2160	5130	17350	2414	10020	2034	500	1279	151.8	653	89.1	164.7	15.9	77.1	5.9	305.3	341.0	N/M
30		930	116000	213	12	336000	735	63.4	35000	7210	2060	2230	5120	17100	2450	10500	2190	520	1310	160.0	688	89.3	165.0	15.2	77.2	6.1	337.0	346.0	N/M
31		851	122800	208	14	337000	669	76.4	33400	7210	1980	2260	5290	17700	2460	10660	2130	516	1366	159.0	660	85.8	154.8	15.0	73.7	5.7	448.0	365.0	N/M
32		845	123100	143	4.7	341000	464	70.4	26700	5160	1799	3970	3770	12650	1805	6250	1510	364	940	110.3	497	69.5	151.1	16.2	84.9	6.5	82.6	61.8	N/M
33		994	122900	118	3.1	338000	342	54.8	24700	4280	1479	2610	3130	11300	1587	6150	1373	334	835	95.9	425	63.0	123.0	14.3	76.9	6.3	36.9	61.0	N/M
34		1028	133300	102	4.2	343000	350	56.0	25400	4690	1681	2840	3110	11700	1710	6140	1449	360	846	94.6	425	61.8	125.0	14.4	81.3	6.6	41.0	73.2	N/M
35		884	133900	89	3.8	335000	633	74.0	23220	812	1200	2119	1590	9520	1657	6920	1750	420	1042	113.5	456	53.4	86.0	8.8	43.8	3.8	170.0	32.5	N/M
36		914	133700	93	4.4	337000	637	99.0	23000	724	898	2298	2230	10290	1651	6750	1590	383	909	94.2	354	40.7	60.0	6.4	35.8	3.3	216.0	31.8	N/M
37		1006	134200	124	3.8	354000	564	66.3	24580	1235	2030	4110	3070	13840	2240	11130	2370	566	1460	159.0	665	84.2	142.0	14.0	69.3	5.3	173.0	83.0	N/M
38		938	127000	205	11	316000	598	90.3	23200	7350	2090	2380	5010	15960	2200	10170	2010	508	1238	153.0	647	94.3	171.3	16.7	75.0	6.0	346.0	351.0	N/M
39		1008	126600	211	12	329000	613	95.9	24800	7400	2230	2400	5330	16890	2440	11210	2180	517	1374	160.2	693	100.2	182.4	16.5	80.9	6.6	358.0	366.0	N/M
MP-P0913-6 titanite																													
1		2960	133000	119	5.4	267000	1160	16.8	20000	673	1190	550	3690	11860	1490	5190	1030	244	651	62.2	273	44.5	81.7	9.7	53.4	4.8	29.6	14.0	N/M
2		3160	138100	141	5.9	284000	1223	25.2	20170	803	1115	600	5100	14690	1804	5890	1055	249	645	65.8	286	44.3	88.1	10.0	58.7	6.1	35.5	16.3	N/M
3		3030	140900	166	6.5	275000	1234	12.4	20590	870	1420	709	5660	16440	2126	7260	1306	309	835	87.0	368	53.3	107.7	11.9	63.9	6.3	39.2	21.9	N/M
4		2860	145900	192	5.9	264000	883	7.6	21850	846	1497	1204	5450	17430	2151	7830	1491	324	914	94.3	394	57.3	113.6	11.8	61.7	6.0	54.0	66.2	N/M
5		3120	139100	128	6.8	270000	1056	32.8	19300	788	1143	564	5280	14340	1704	5990	1061	241	606	66.2	275	42.9	85.8	10.3	54.6	5.7	90.1	26.5	N/M
6		7390	138500	322	16	265000	895	152.0	20890	324	4180	3100	5150	18800	2770	12910	2710	564	1863	223.0	1055	169.0	337.0	39.6	196.7	19.4	72.3	241.0	N/M
7		2900	132200	132	5.6	266000	1018	52.0	18630	757	1182	623	4440	13180	1695	6070	1113	254	673	72.2	294	45.9	85.9	9.4	48.4	4.9	36.9	23.8	N/M
8		12100	142800	270	20	255800	757	68.6	21330	154	4280	1629	4560	17500	2649	13620	2850	510	1990	248.0	1149	173.5	345.0	38.7	196.0	18.9	48.4	136.0	N/M
9		10450	147200	268	16	261700	540	9.9	17860	100	3260	3510	4540	15670	2160	7880	1688	306	1161	144.9	725	113.6	246.0	28.8	145.2	15.1	74.4	253.8	N/M

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
MP-P0913-6 titanite CONT'D																													
10		3320	135300	137	6.8	263000	1293	54.1	18200	770	1161	570	5690	15400	1700	5990	1084	256	635	68.4	288	45.0	92.2	10.3	57.4	6.0	34.5	17.5	N/M
11		4130	139900	231	11	270000	715	69.4	24200	1451	3020	907	5210	17830	2364	9990	1986	514	1399	176.5	836	123.9	243.1	25.9	117.1	12.3	57.5	70.4	N/M
12		3870	140400	138	6.4	267000	829	16.6	20870	765	1192	1203	4460	13950	1783	6020	1143	260	734	75.7	333	48.7	90.1	10.6	49.3	5.5	49.4	46.0	N/M
13		12100	130700	229	19	257000	717	73.2	20750	154	4160	1486	4370	16910	2620	13260	2840	506	1850	233.6	1098	159.6	325.0	36.5	174.3	17.2	48.7	129.5	N/M
14		11490	128200	267	20	252300	715	69.5	20880	155	4450	1640	4390	16980	2711	13740	2930	523	2056	259.2	1202	177.9	354.0	38.4	177.3	18.0	50.8	134.7	N/M
15		3300	128500	127	5.6	265000	1202	22.1	17740	724	689	292	3040	8540	858	3620	608	144	383	39.0	169	24.0	51.5	6.1	30.3	3.8	30.4	7.1	N/M
16		3530	128600	122	6.3	261000	1250	55.3	17400	686	594	242	2960	8300	805	3210	567	141	345	34.6	162	22.9	47.9	5.7	29.6	3.7	23.3	5.5	N/M
17		3150	135600	119	6.5	276000	1182	34.0	18570	711	994	539	3970	11700	1420	5410	960	224	595	60.6	262	39.4	75.0	8.7	44.0	4.9	52.0	26.6	N/M
18		10800	138400	215	17	251000	1117	123.2	19900	273	1385	874	4780	15880	1930	6760	1265	270	793	83.2	360	53.7	111.1	12.7	64.7	8.1	64.0	80.1	N/M
19		10280	141300	234	16	261700	1028	94.9	19600	239	1413	876	4800	15300	1942	6890	1250	260	735	80.3	366	51.5	107.7	12.5	60.9	8.1	57.1	73.9	N/M
20		3100	145600	176	8.1	259600	789	8.4	21500	1053	1095	1730	5870	17220	2015	7190	1209	261	716	73.3	317	43.5	83.0	9.2	43.3	4.4	142.3	63.2	N/M
21		3380	147000	151	9.2	259000	831	4.7	20900	958	829	1770	4740	14500	1800	6000	1066	222	574	57.7	259	32.7	67.0	7.6	36.5	3.9	175.0	181.0	N/M
22		3300	127200	120	6.4	277000	1363	46.8	18350	700	794	292	4000	11220	1005	4490	771	186	463	46.9	217	30.6	59.8	6.7	37.2	4.6	26.2	6.6	N/M
23		2770	133600	109	6.2	278000	1109	15.6	19700	710	1331	643	3890	12610	1646	6080	1188	284	759	82.7	369	51.8	98.9	10.6	50.7	5.5	32.0	37.3	N/M
24		3950	134400	166	8.8	268000	1380	40.7	19330	734	1183	606	5430	13550	1520	5570	935	235	611	63.9	313	43.4	93.4	11.2	58.2	7.6	46.3	10.6	N/M
25		2680	142000	144	5.8	263000	1110	19.3	18600	824	1320	658	5320	16170	1920	6870	1290	293	800	79.4	376	51.9	100.8	11.1	53.5	5.3	33.5	25.7	N/M
26		2852	130400	137	6.1	254000	1059	14.3	18800	710	1045	509	3650	11200	1280	5150	945	220	614	64.9	292	41.7	80.5	9.2	47.1	4.9	56.8	20.3	N/M
27		9990	145200	403	13	267000	533	52.0	17900	90	2970	3060	5160	17830	2527	8790	1680	270	1077	129.4	689	108.3	241.0	29.2	150.9	16.7	83.2	290.0	N/M
28		7630	131000	298	13	277000	967	411.0	19200	350	2670	1440	5390	19020	2700	12600	2180	421	1420	155.5	708	101.7	211.0	22.8	112.5	11.5	58.3	123.8	N/M
29		3040	138900	153	5.9	271000	1149	29.9	18820	813	1230	818	5250	15580	1870	6710	1165	277	737	76.9	344	46.6	93.9	11.0	53.3	5.9	36.7	25.3	N/M
30		3140	140300	147	6.4	266000	1015	21.2	18900	863	1197	1146	5090	15030	1854	6660	1147	260	711	73.9	321	44.8	94.2	9.9	45.9	4.9	82.0	71.0	N/M
31		3410	131700	225	15	250300	770	2.9	21800	1129	1293	2770	4290	12230	1650	5620	939	219	538	60.4	292	45.3	103.3	13.1	66.6	7.1	381.0	242.9	N/M
MP-P0913-10A titanite																													
1		3420	112000	1102	N/M	168000	800	17.1	6700	2150	1270	2250	3260	10000	1065	4430	990	243	603	74.0	364	53.4	110.0	13.0	67.0	6.0	337.0	164.0	0.49
2		3350	110000	1360	N/M	157000	712	19.5	7080	2050	1200	1350	2940	9390	982	3830	847	220	567	71.0	324	54.7	99.7	12.6	61.9	6.2	308.0	140.0	0.72
3		2060	124800	104	N/M	167000	552	138.0	6480	2760	845	1520	1442	5780	695	2790	642	159	399	51.1	229	36.4	68.9	8.4	38.0	3.0	126.2	21.7	0.00
4		1802	110200	88	N/M	169000	494	67.3	6010	2750	808	3240	1370	6090	668	2750	622	162	408	46.6	237	35.6	69.1	7.9	36.2	3.0	155.6	73.0	0.07
5		1890	106400	102	N/M	173200	501	97.5	6120	2810	823	2680	1439	6210	699	2790	675	167	416	49.9	236	36.2	66.8	7.9	36.7	3.1	127.0	49.5	0.09
6		1870	116000	109	N/M	170000	509	92.0	6210	2620	804	2380	1370	5940	674	2750	665	164	427	48.4	233	34.3	67.1	8.0	37.7	3.1	121.0	37.6	0.00
7		4070	113000	150	N/M	165600	761	27.4	7900	1740	1040	1210	2660	8300	926	3790	850	205	542	67.5	297	46.3	88.0	11.3	56.5	5.1	257.0	144.0	0.98
8		5030	113000	186	N/M	167400	754	8.0	8600	1700	1413	1341	3770	11540	1500	4860	1076	267	678	83.7	405	62.4	117.6	14.9	70.2	7.2	326.0	128.2	0.39
9		877	127600	77	N/M	185900	348	82.0	4950	3840	1257	2420	2980	10640	1360	5290	1189	285	698	82.5	372	53.1	105.2	13.0	67.1	5.1	165.0	10.2	0.05
10		809	127500	84	N/M	174900	326	60.1	4960	3750	1560	2160	3590	13060	1950	6440	1399	332	836	96.4	423	63.4	113.4	14.6	70.3	5.7	218.0	10.3	0.21
11		719	126500	95	N/M	181000	367	99.8	5380	512	1163	1005	1610	9720	1576	5350	1249	296	727	84.0	364	53.8	86.7	11.0	56.0	5.3	479.0	3.9	1.74
12		4030	122600	189	N/M	173500	888	29.4	7910	1670	1342	1252	3400	11440	1410	4920	1145	290	688	83.8	386	61.6	113.3	14.2	66.3	6.5	175.0	124.6	0.30
13		875	121900	94	N/M	172600	441	108.5	4750	3600	1241	5340	2410	9540	1370	5010	1218	296	754	87.9	391	55.6	101.3	11.7	54.8	4.1	59.6	140.4	0.05
14		5320	121400	175	N/M	155100	877	17.4	10310	1600	1091	1254	3690	10370	1066	3820	747	226	444	58.1	271	45.4	85.2	10.9	57.9	6.0	268.0	82.0	0.32
15		927	147000	72	N/M	196000	556	168.0	6880	727	1261	667	1369	8210	1147	5330	1343	314	771	93.2	391	56.3	99.5	11.2	57.5	4.6	90.0	3.6	0.45
16		951	121900	64	N/M	173000	402	94.0	4950	3670	1088	2540	2230	8390	1018	4310	1024	250	613	72.3	330	47.9	95.4	11.5	54.1	4.2	48.5	22.1	0.16
17		2810	114000	115	N/M	161100	744	25.9	7060	1958	816	963	1670	6200	710	2990	710	174	448	53.0	246	37.2	66.3	8.1	37.7	3.6	124.6	103.9	0.38
18		1730	117900	108	N/M	168700	539	47.8	6540	2920	912	4470	1930	6880	746	3060	741	177	463	55.7	256	40.8	76.3	8.8	45.1	3.8	300.0	353.0	0.11
19		4350	130500	265	N/M	172200	850	16.8	8860	1840	1350	1409	3500	11060	1324	4810	1059	268	648	82.3	396	61.0	114.7	13.8	68.8	6.7	272.0	131.1	0.48
20		1379	116300	86	N/M	171000	418	82.3	5620	3500	864	2780	1970	6870	786	3310	740	183	457	56.4	257	39.4	76.4	8.7	42.9	3.5	161.0	43.6	0.05
21		2650	127500	133	N/M	180000	766	5.5	7420	2407	1138	1940	2620	8600	994	4140	955	240	579	71.7	325	52.2	97.3	11.3	57.0	4.9	205.0	191.0	0.12
22		2990	144000	1930	N/M	177000	803	21.0	7240	2240	1060	1440	2620	8180	975	4170	943	238	580	69.3	304	46.5	86.8	9.2	49.9	4.3	140.0	134.0	0.77
23		1990	123000	84	N/M	163000	514	89.8	7680	2650	841	1960	1445	6120	683	2730	645	159	400	49.1	231	34.8	65.8	7.8	39.2	3.1	125.3	28.5	0.17
24		2070	127900	80	N/M	180000	570	120.5	8120	3030	886	1366	1660	6390	715	3090	670	168	398	51.4	228	36.3	69.7	8.1	39.2	3.0	138.8	25.1	0.21
25		2910	132000	181	N/M	167000	813	49.0	8990	1990	1050	1296	2320	7900	868	3690	831	213	526	65.6	316	50.9	92.4	10.4	56.2	5.1	189.0	129.7	0.14
26		2180	123000	128	N/M	168000	663	30.6	7720	2310	1118	1800	2200	7550	836	3490	850	211	542	67.8	321	51.0	95.6	11.3	56.8	5.0	172.4	195.8	0.15
27		712	119600	274	N/M	176000	391	89.0	6190	831	1245	897	1940	9740	1618	5340	1329	310	781	86.9	383	54.4	90.8	10.9	55.0	4.9	308.0	5.2	1.30
28		950	124400	58	N/M	179000	406	88.6	5850	3660	1086	2620	2219	8620	1020	4330	1030	244	617	74.4	332	49.6	93.4	11.6	54.8	4.3	40.4	19.7	0.06

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
MP-P0913-10A titanite CONT'D																													
29		1840	109900	85	N/M	156000	531	94.0	9020	2710	830	2420	1356	5930	655	2740	669	160	417	48.6	237	36.1	66.2	8.3	39.1	3.1	121.1	49.0	0.07
MP-P0913-10B titanite																													
1		947	127100	199	11	278000	514	115.6	13260	6140	2280	2980	4100	13500	1890	6810	1650	407	1112	140.2	660	95.6	183.0	18.9	92.6	6.9	372.0	340.0	N/M
2		1022	126400	206	14	276000	785	132.2	18000	6040	2082	1570	4370	14730	2190	9950	2010	508	1344	153.4	655	90.4	168.0	15.5	77.8	6.2	423.0	235.0	N/M
3		881	125800	196	11	283000	504	45.2	14060	6460	2282	3310	4400	13540	1977	7080	1744	426	1108	136.6	632	95.4	187.1	18.4	93.9	7.0	390.0	369.0	N/M
4		1043	131800	132	2.5	290000	727	108.1	12180	697	772	4460	2960	11980	1815	6640	1469	338	795	81.3	307	33.9	52.8	5.3	26.8	2.2	81.3	25.8	N/M
5		981	124600	177	11	294000	654	124.1	15400	6000	2240	2080	4250	14710	1990	7570	1774	467	1167	143.9	687	97.2	179.0	18.3	84.1	7.0	319.0	273.0	N/M
6		851	136300	101	2.5	274000	560	78.6	11810	474	1933	2070	984	8080	1654	7250	2090	539	1290	149.9	651	83.4	146.0	14.6	87.1	6.8	57.1	14.9	N/M
7		895	126100	228	13	293000	689	94.1	14490	7120	1901	1873	4830	16280	2314	10730	2074	497	1298	151.8	648	88.5	159.1	14.4	71.1	5.7	444.0	309.0	N/M
8		734	137900	114	3.2	283900	496	53.7	12090	566	1672	1960	1128	8760	1623	7090	2017	503	1182	134.7	574	73.3	124.8	13.7	73.8	5.9	257.0	14.7	N/M
9		870	132000	101	3.2	281800	511	54.1	12260	532	2290	2720	1195	8630	1740	7810	2280	528	1368	165.0	743	99.5	175.3	18.7	101.7	7.9	197.0	17.9	N/M
10		1026	135300	118	4.5	280000	765	134.8	13920	1045	1631	1706	2970	12170	1950	8400	2050	475	1175	139.7	591	73.5	131.6	13.5	61.1	4.6	164.3	215.0	N/M
11		933	127900	136	5.7	292000	764	144.0	12600	2550	1250	1928	2820	12380	1810	6990	1679	427	983	115.0	469	58.4	104.0	10.7	52.4	4.4	160.6	233.0	N/M
12		990	134100	163	5.6	292900	779	164.0	13430	2635	1460	2080	3250	12790	1923	8390	1809	422	1124	120.9	500	61.6	112.0	11.1	54.8	4.5	159.0	220.7	N/M
13		966	121000	222	13	270000	653	88.8	14220	6240	1884	1687	4710	15570	2290	10270	2038	485	1301	151.4	657	86.4	159.1	14.9	71.0	6.1	465.0	310.0	N/M
14		855	136800	76	2.5	287000	666	99.0	13000	399	1863	903	747	6060	1056	5940	1697	427	1087	131.0	581	74.3	137.2	15.0	75.3	6.6	32.8	5.4	N/M
15		819	136400	70	2.5	287000	706	97.6	13300	408	1910	973	767	6200	1260	6160	2130	514	1300	157.0	659	84.8	152.0	14.5	75.1	6.5	29.7	4.4	N/M
16		896	124800	219	13	292000	584	95.0	13070	7110	2445	2790	5020	16340	2263	10140	2046	487	1266	158.8	763	103.0	208.3	20.6	100.1	7.7	406.0	418.0	N/M
17		933	142500	89	5.5	274500	641	117.1	14090	799	1045	1396	1389	8120	1310	5920	1494	363	879	94.6	368	44.4	68.7	7.3	38.9	3.4	221.0	22.4	N/M
18		940	125000	188	11	288800	633	117.1	13970	6040	2338	2260	4610	15830	2111	7860	1840	456	1232	156.9	707	98.9	197.8	19.1	93.0	7.2	312.0	312.9	N/M
19		933	126400	233	11	279000	671	62.4	14560	7220	2019	2139	5490	17200	2480	11460	2270	546	1353	156.0	699	93.4	166.8	16.1	75.8	6.0	357.0	348.0	N/M
20		1020	135500	127	3.2	286000	368	33.5	12400	4450	1621	2520	3410	11850	1770	6630	1494	350	916	101.7	461	66.4	129.3	15.4	84.3	7.0	39.1	41.7	N/M
21		972	117700	203	14	267500	765	87.5	17220	5780	1860	1496	4240	14890	2226	10710	2071	502	1292	154.0	689	91.4	154.6	14.9	71.8	5.6	424.0	245.0	N/M
22		1158	129800	93	2.3	289100	677	131.1	11700	650	903	4560	2650	11110	1755	6580	1473	355	861	90.1	360	40.1	64.1	6.2	34.6	2.9	36.6	19.2	N/M
23		846	128500	179	12	290000	460	99.0	12340	6510	2130	3410	4180	13610	1990	7230	1703	407	1107	135.6	651	90.6	174.4	17.6	87.4	6.2	516.0	392.0	N/M
24		921	120100	194	11	281000	586	86.7	12940	6720	2310	2830	5030	15300	2040	8640	1880	445	1263	150.0	682	98.3	183.1	19.1	95.2	7.2	368.0	382.0	N/M
25		1058	136000	125	4.0	296000	780	155.0	14970	675	907	3800	3140	13260	2000	7390	1640	370	933	102.0	381	39.0	58.5	5.8	32.1	2.9	259.0	17.9	N/M
26		892	123300	210	11	269900	596	104.0	13110	6970	2350	2520	6160	19140	2740	11990	2260	520	1408	169.1	758	101.1	187.4	19.4	95.1	7.2	321.0	345.0	N/M
27		1027	119600	188	11	280500	704	112.2	15330	6060	2058	1702	4340	14690	2151	8910	1954	478	1287	152.4	650	91.2	173.3	16.6	79.7	6.5	344.0	278.0	N/M
28		950	122300	165	10	275000	679	108.5	14440	6240	1954	1652	4340	14920	2100	9370	1873	446	1221	140.8	645	85.6	155.8	15.2	74.4	5.9	326.0	255.2	N/M
29		938	120700	181	12	277000	621	94.5	14020	6660	2177	2220	4840	16020	2296	10220	1977	488	1283	157.6	715	94.1	168.9	16.9	82.1	6.3	403.0	328.0	N/M
30		891	124300	201	11	274000	688	88.9	13310	7100	1977	2034	5140	17030	2400	10780	2029	496	1278	151.6	656	87.7	165.1	15.9	78.1	6.0	303.8	340.0	N/M
31		901	117900	180	11	274000	704	61.5	13310	7130	2030	2090	5140	17300	2430	11050	2110	509	1334	152.0	678	91.7	165.4	15.9	78.2	6.0	349.0	348.0	N/M
32		868	122000	199	13	273000	671	75.4	13630	7220	1980	2150	5290	17700	2480	11390	2140	513	1368	159.0	661	85.9	154.7	15.0	73.2	5.7	447.0	364.0	N/M
33		875	124200	135	4.3	281000	473	69.4	11700	5170	1809	3840	3780	12670	1778	6820	1556	364	945	111.9	504	73.4	152.3	16.4	84.9	6.5	84.3	62.2	N/M
34		983	121900	110	2.4	274000	338	55.7	11780	4250	1470	2500	3140	11200	1581	6370	1360	328	826	95.9	429	61.4	121.9	14.2	75.7	6.2	36.3	57.6	N/M
35		865	130800	82	3.6	276900	642	77.1	11510	764	977	2180	1630	9360	1559	6640	1665	381	956	101.1	377	42.2	65.5	6.6	37.2	3.3	227.0	30.1	N/M
36		924	136100	87	2.8	277000	633	65.8	12670	864	1550	1925	1632	9730	1810	7820	2010	474	1161	139.0	563	68.4	112.6	11.6	56.7	4.4	84.0	34.8	N/M
37		885	134700	90	3.7	281000	609	77.7	12320	770	964	2210	2200	10140	1672	7150	1660	403	982	100.9	373	42.2	64.6	6.7	38.6	3.6	225.0	35.0	N/M
38		933	137000	119	4.5	293000	564	73.6	12860	1051	1109	4560	2950	12790	2020	8970	1880	449	1064	112.7	400	46.5	75.1	7.7	42.1	3.9	340.0	39.9	N/M
39		916	126400	115	4.4	287000	579	63.7	12190	1054	1330	4150	2860	12530	2064	9950	1960	474	1132	124.2	492	55.5	84.8	9.1	47.7	4.4	313.0	43.7	N/M
40		972	128800	211	11	279000	616	93.8	13160	7480	2140	2380	5110	16490	2320	10880	2120	512	1324	158.5	675	98.1	179.2	16.7	78.0	6.3	355.0	352.0	N/M
MP-P0913-10C titanite																													
1		3680	140000	128	N/M	196000	1000	152.0	15520	2460	879	1205	1547	6230	665	3150	672	182	432	58.0	252	38.3	80.3	9.1	47.0	4.2	261.0	136.6	0.12
2		4490	139000	139	N/M	174000	1128	93.0	17300	1660	1096	1255	1817	7120	811	3830	849	220	526	71.0	314	46.3	97.4	11.2	58.6	5.6	299.0	170.0	0.36
3		2980	124800	74	N/M	186200	727	91.0	11440	2590	725	1020	1266	5480	581	2700	575	158	377	46.8	206	29.2	69.4	7.2	35.9	3.1	163.0	84.0	0.12
4		3090	118700	62	N/M	204000	746	97.6	12400	2500	787	1071	1262	5410	560	2720	560	151	369	48.3	222	31.8	70.1	7.3	35.2	3.0	169.0	86.1	0.65

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
MP-P0913-10C titanite CONT'D																													
5		3670	139900	136	N/M	184000	978	63.0	14100	2210	964	1360	1730	7050	779	3530	766	204	471	60.8	271	39.9	79.1	8.9	46.7	4.2	307.0	186.0	0.24
6		3880	124300	153	N/M	199000	941	57.0	13240	2340	1133	1820	2660	8420	907	4250	919	237	562	73.5	331	49.0	108.3	11.6	59.9	6.0	411.0	272.0	0.32
7		3230	135400	73	N/M	191000	618	99.0	13140	2600	1020	1750	1430	5420	587	2720	586	159	383	55.3	255	38.6	92.2	9.6	46.9	3.8	203.0	146.0	0.02
8		2900	144100	82	N/M	184000	542	95.0	12800	2770	1058	2510	1516	5740	589	2650	584	156	378	55.7	260	42.2	89.5	10.4	47.0	3.4	215.0	169.0	BDL
9		2880	122500	82	N/M	197000	745	112.0	12740	2540	768	1072	1437	5900	625	3150	645	167	409	50.9	231	31.6	72.6	7.7	38.6	3.6	171.0	102.2	0.50
10		2800	121100	79	N/M	184000	759	92.1	12010	2510	739	1067	1367	5560	586	2870	600	157	361	49.6	213	29.5	66.5	6.9	34.4	3.1	200.0	117.5	0.05
11		1253	123300	112	N/M	191000	433	93.0	9320	4730	1328	9640	2920	9960	1180	4830	1147	288	724	92.2	408	55.8	107.9	11.2	49.4	3.8	115.9	393.0	0.13
12		1467	117200	113	N/M	186800	426	94.0	11950	3110	1364	1510	2520	8790	943	4490	1076	276	734	98.6	458	65.8	138.0	13.2	56.5	5.1	116.7	143.9	1.49
13		3180	122900	88	N/M	190000	858	159.0	14100	2550	811	930	1390	5600	592	2970	614	167	390	51.3	233	34.0	74.9	7.7	39.3	3.5	157.0	88.5	0.21
14		2830	109500	108	N/M	191000	735	75.3	12100	2420	766	1150	1452	6240	654	3150	653	171	430	52.9	247	33.9	73.2	8.0	36.8	3.7	146.0	114.5	0.18
15		3010	147000	120	N/M	201000	705	79.0	13520	2970	830	1500	1570	6580	689	3180	612	174	398	50.9	236	33.7	71.1	7.7	37.6	3.3	226.0	156.0	0.07
16		2420	130700	97	N/M	187000	524	145.0	12640	3360	1069	6490	2360	7470	816	3620	811	206	496	68.5	296	42.1	86.6	10.0	44.0	3.3	191.0	340.0	0.01
17		3230	132700	70	N/M	207000	705	110.0	14640	2860	824	1292	1465	5620	594	2850	615	167	406	51.9	236	36.0	78.8	8.3	39.5	3.5	176.0	90.8	0.00
18		3730	119600	115	N/M	196000	870	31.1	14700	2190	1284	1670	2740	9040	969	4880	1033	265	657	83.6	381	53.0	117.7	11.6	60.3	5.7	205.0	149.1	0.28
19		6300	128700	175	N/M	171800	823	23.0	24400	1690	2030	1370	4940	15900	2130	7340	1620	380	991	130.6	563	85.0	169.0	18.7	87.2	8.2	658.0	181.0	0.51
20		2600	128900	75	N/M	195000	460	99.9	14550	2970	986	2710	1484	5830	592	2610	593	156	382	57.4	274	42.2	88.2	10.9	45.0	3.4	236.0	174.0	0.07
21		1273	129000	130	N/M	188000	296	108.0	12220	4940	2470	4010	4030	12290	1430	5230	1212	318	873	124.5	569	86.6	171.0	19.0	79.1	6.2	298.0	327.0	0.05
22		1246	128000	120	N/M	187000	291	106.0	12750	4680	2540	3730	3950	12420	1421	5260	1192	320	830	119.7	589	87.8	175.0	19.8	79.7	6.3	292.0	311.0	0.17
23		2570	132000	107	N/M	192000	694	127.0	13920	3220	935	3810	2360	7480	775	3800	787	209	492	67.2	272	39.2	83.1	8.8	41.9	3.5	184.0	164.0	0.06
24		2970	144000	84	N/M	208000	766	106.7	16200	2980	845	1291	1910	6630	719	3320	701	179	408	58.0	242	35.1	76.0	8.6	40.5	3.4	234.0	173.2	0.05
25		1052	120200	70	N/M	205000	531	147.0	11750	3800	1238	5470	2440	9360	1067	5370	1212	310	768	94.1	412	56.0	126.4	12.7	53.2	4.5	85.6	121.9	0.19
26		3480	134900	78	N/M	212000	912	162.0	18900	2870	864	957	1550	6260	645	3220	663	183	435	56.0	255	35.7	76.1	8.5	40.4	3.8	181.0	102.4	0.04
27		3160	141200	84	N/M	190000	715	101.0	18600	2660	867	1460	1434	5450	591	2760	600	165	380	54.5	241	36.9	82.2	9.3	42.7	3.7	213.0	122.5	0.07
28		1740	123300	154	N/M	210000	414	81.0	13100	3650	1410	2910	3120	10510	1190	5100	1140	291	773	102.0	449	64.1	134.0	12.9	57.3	5.1	152.0	313.0	0.19
29		1630	122200	113	N/M	214000	447	130.0	16300	3640	1406	1318	2630	9320	1028	4910	1159	297	802	108.1	476	65.7	134.0	12.8	55.6	4.5	136.6	141.5	0.23
MP-P0913-10D titanite																													
1		692	111500	49	N/M	169000	594	31.1	19800	362	1430	2080	734	7180	1320	5570	1790	388	1094	132.2	574	68.3	109.5	10.3	47.6	4.7	66.0	94.7	1.12
2		766	113600	74	N/M	166000	341	63.2	17780	2790	1103	1309	1900	8800	1133	4400	1049	231	661	82.0	357	47.4	90.7	9.9	53.5	5.0	14.2	15.0	0.18
3		757	125400	71	N/M	181200	294	81.3	20200	2180	1790	1387	1663	9830	1623	5770	1550	346	944	130.6	551	71.8	131.2	12.4	59.8	5.0	10.8	22.5	0.25
4		617	111300	76	N/M	159200	265	23.4	14160	3750	1149	2990	2470	11190	1600	4700	1026	215	619	74.5	345	46.4	89.1	9.7	52.4	5.0	56.2	45.0	0.24
5		684	117400	91	N/M	177000	384	54.0	17100	3600	1680	2770	2390	11020	1639	5100	1199	247	769	99.7	466	64.7	122.1	12.9	69.2	6.5	40.3	43.3	0.25
6		681	112800	98	N/M	178000	400	47.8	17040	3730	1310	3450	2450	10700	1567	4750	1043	220	646	86.0	407	53.7	101.0	11.0	55.9	5.3	68.5	47.7	0.03
7		672	118200	91	N/M	184000	369	28.6	16000	3840	1330	3050	2370	10600	1480	4630	1059	209	637	85.0	382	50.9	101.2	11.1	58.2	5.6	59.1	43.7	0.05
8		870	117700	90	N/M	177000	453	55.7	15300	3100	1188	4710	2019	9050	1088	4200	914	195	549	77.6	357	46.2	86.8	8.7	47.0	3.9	59.2	60.9	0.02
9		818	110000	84	N/M	173100	442	40.3	14290	3130	1236	4480	1980	9120	1163	4120	950	199	576	80.0	359	44.6	83.0	8.4	47.1	3.9	45.1	77.4	0.01
10		950	112800	58	N/M	183000	640	11.8	16200	578	3050	3470	1010	10820	2160	10620	2590	546	1549	203.0	873	97.7	164.0	13.9	74.9	5.7	21.0	8.1	0.97
11		883	124600	95	N/M	188500	573	41.5	14830	643	663	8270	2360	11670	1741	5500	1088	214	574	66.7	256	25.1	36.6	2.9	21.1	1.8	51.6	86.5	0.49
12		1215	108300	141	N/M	162000	586	34.1	16500	4730	1204	1530	3270	12550	1710	5380	1083	225	636	81.2	358	45.7	77.5	7.2	42.2	3.8	288.0	218.0	0.02
13		687	113700	83	N/M	177000	274	34.0	12660	3850	1334	2100	2190	9730	1444	4890	1012	213	585	80.2	322	41.0	79.6	8.1	49.2	4.0	14.3	22.6	0.06
14		1012	118000	100	N/M	192000	746	7.6	18680	525	4360	5740	1044	10500	2130	11330	2820	615	1738	229.0	1044	114.6	191.0	17.6	107.0	8.9	25.7	60.6	3.72
15		789	99990	70	N/M	171600	368	55.6	12100	4020	1443	2920	2092	8010	968	4190	857	181	508	67.2	312	40.4	87.3	8.5	55.1	4.6	70.9	38.9	0.05
16		1053	116000	86	N/M	171000	466	92.0	13800	3830	1540	4360	2350	8590	977	4360	920	203	536	71.6	326	44.6	89.0	8.4	53.2	4.0	107.4	60.3	0.12
17		923	108400	143	N/M	160000	534	71.4	14200	6490	2730	1413	3730	13070	1875	7920	1461	319	871	111.2	506	63.7	113.7	10.0	65.9	4.8	313.0	218.0	0.04
18		1231	118100	68	N/M	187000	659	4.6	16400	738	5260	3670	1197	10360	2102	12350	2810	653	1686	197.5	940	112.8	185.0	16.6	116.1	7.1	75.2	24.4	1.58
19		1227	114900	123	N/M	166000	458	51.0	12590	6060	2310	2520	3100	9640	1260	5040	1039	240	631	80.7	383	53.8	105.2	10.2	71.8	4.6	236.0	213.0	0.08
20		1127	117600	120	N/M	166700	399	43.9	11310	6920	2830	2660	3350	10480	1445	5590	1140	268	692	97.3	441	62.9	121.0	11.1	81.9	5.2	294.0	278.0	0.11
21		1251	118300	129	N/M	170000	456	59.3	12530	7430	2760	2160	3560	10890	1535	5860	1275	303	747	101.6	470	66.0	126.4	12.1	87.4	5.5	311.0	257.0	0.20
22		1395	114000	114	N/M	166200	416	49.0	11260	6950	2570	2880	3480	10500	1463	5850	1174	276	700	90.1	418	57.6	120.1	12.0	86.2	5.3	270.0	264.0	0.06
23		2350	118200	138	N/M	164000	681	49.1	17430	6000	1937	1046	3870	11950	1738	6820	1375	299	724	84.4	339	45.8	83.6	7.8	58.6	3.6	301.0	187.5	0.06
24		1392	118700	156	N/M	167000	625	122.0	14200	7800	3270	1141	4240	13760	1980	10050	1790	446	1056	121.0	536	75.1	130.5	12.3	87.8	4.8	300.0	200.0	0.17
25		1352	113700	152	N/M	158200	618	110.0	13990	7300	3210	1099	4150	12860	1880	9420	1720	424	1071	118.0	524	70.2	130.3	12.3	84.1	4.8	284.0	201.0	0.01

MP-P0913-10D titanite CONT'D

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
26		1101	119400	165	N/M	176000	439	69.0	10510	8030	3320	2120	4270	13000	1790	7740	1640	382	945	113.5	509	71.6	137.0	13.7	95.0	5.0	395.0	302.0	0.34
27		1275	121800	87	N/M	173000	340	52.6	12830	4680	2100	1288	2950	9860	1470	6200	1369	318	728	83.2	363	53.2	107.1	12.2	85.3	5.1	12.0	14.3	0.17
28		1197	125300	85	N/M	181000	332	34.0	10980	5370	1930	2150	2960	9510	1351	5650	1201	294	666	76.3	347	54.7	109.5	12.6	89.8	5.1	34.0	35.4	0.11
29		1405	131700	82	N/M	190000	558	7.2	10810	811	3290	5160	1353	9630	1920	12050	2460	648	1450	149.0	659	80.3	142.6	13.0	83.4	4.8	32.5	32.6	1.16
30		1050	116700	104	N/M	158500	384	91.0	10520	5510	1930	4650	3570	11450	1656	6350	1404	341	788	92.6	415	63.7	121.7	13.4	79.9	5.1	88.6	87.7	0.09

MP-P0714-16 titanite

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
1		886	123100	310	9.1	278000	893	331.0	14290	2590	1960	5160	4320	15290	2158	6660	1630	389	1009	126.3	531	77.8	154.6	15.6	75.4	7.1	360.0	309.0	N/M
2		1364	125800	178	6.0	280000	1162	583.0	16830	1610	2060	3880	3760	15020	2224	7760	1850	439	1092	136.0	586	83.1	159.8	17.2	76.7	8.0	86.0	206.0	N/M
3		1005	119200	265	8.2	279000	777	389.0	16100	2940	1760	6400	3380	12340	1833	5880	1700	394	979	122.0	547	74.8	146.9	14.0	62.0	6.2	242.0	683.0	N/M
4		1130	133100	279	9.1	286000	899	408.0	17800	2940	2035	6140	3740	13720	2160	6790	1788	441	1080	140.0	570	80.8	161.0	16.3	68.0	6.5	265.0	592.0	N/M
5		1020	134000	320	7.9	291000	1580	2720.0	16580	1779	2330	4190	4880	20100	2850	11650	2510	579	1340	164.0	698	93.2	183.5	18.4	82.8	9.5	150.1	129.4	N/M
6		1003	135000	137	10	284000	711	519.0	17700	3000	1634	7610	3060	10810	1510	5220	1393	371	801	103.8	481	64.5	124.1	12.6	53.1	4.8	354.0	214.0	N/M
7		988	130600	173	7.7	274000	719	545.0	16500	2832	1749	7890	3350	11600	1831	5780	1559	389	929	118.4	500	70.3	130.1	14.0	57.1	5.6	197.0	447.0	N/M
8		913	127800	193	8.1	266000	542	554.0	16900	3280	1790	6740	3320	12700	1910	6190	1650	395	947	125.3	559	74.7	141.3	14.2	57.2	5.5	291.0	433.0	N/M
9		1090	140000	238	7.8	299000	743	365.0	17800	3000	1945	5340	4130	14780	2166	6520	1850	429	1012	133.2	525	73.6	141.0	14.4	55.3	5.9	217.0	290.0	N/M
10		973	131600	163	12	266300	604	322.0	17260	3630	1308	7300	2640	9420	1129	4230	1135	266	666	85.7	377	52.8	98.4	9.6	38.8	3.6	331.0	200.7	N/M
11		1250	138700	120	4.0	287000	945	460.0	17110	922	2250	3630	2310	11450	1955	6720	2170	546	1195	155.8	675	89.4	173.0	18.8	86.4	8.0	64.0	329.0	N/M
12		1099	137000	218	6.0	280000	963	638.0	19800	1740	2630	6980	3440	14300	2290	10050	2350	579	1312	181.0	775	106.0	215.0	22.6	96.9	10.1	84.4	407.0	N/M
13		873	127000	109	22	251000	460	473.0	15560	4320	1077	9110	2620	8310	918	3250	816	188	447	62.4	287	37.6	75.5	8.4	30.8	2.2	1034.0	204.0	N/M
14		1480	134100	164	4.9	280000	1216	136.6	21500	590	2600	3310	3050	14210	2500	10830	2510	737	1353	171.0	735	101.1	200.0	21.5	98.6	9.7	10.1	41.6	N/M
15		1413	137000	71	5.2	258500	985	237.2	19190	504	1817	1009	1404	8430	1450	5590	1536	445	914	118.1	507	70.2	139.9	15.6	69.1	6.9	21.6	20.3	N/M
16		1274	139700	111	6.7	277000	881	245.0	19120	691	2330	2660	2590	11620	2108	7780	2080	567	1135	142.2	619	89.0	175.4	19.2	88.1	8.6	68.3	69.4	N/M
17		1080	132800	102	8.7	270000	428	238.8	13130	3750	1110	2900	1890	7280	860	3460	804	202	492	65.5	294	43.8	88.0	9.2	35.0	2.5	255.0	18.8	N/M
18		650	148000	82	6.4	287000	728	910.0	12000	373	2300	1940	556	5420	1110	6490	2620	667	1510	184.0	817	97.0	165.0	15.5	61.1	5.4	173.0	41.1	N/M
19		962	136000	237	11	275000	865	613.0	14870	3270	2070	4240	4240	14950	2113	7250	1720	414	1025	125.7	554	81.1	167.0	16.3	71.5	6.9	342.0	260.9	N/M
20		1460	130600	72	5.1	245000	1124	306.0	20300	610	2466	1198	1579	9370	1770	7240	1950	529	1146	155.0	708	102.5	206.0	23.3	113.6	11.1	37.9	15.1	N/M
21		992	131000	111	13	273000	448	235.0	10640	3010	958	3370	1690	7270	929	4330	1001	257	599	68.1	287	43.1	80.2	8.3	33.4	2.3	381.0	245.0	N/M
22		1160	145100	193	18	284000	1079	898.0	17720	1692	2320	5680	3950	15110	2440	11300	2260	562	1302	162.0	702	93.3	175.8	18.2	85.7	8.0	58.6	350.0	N/M
23		901	124500	324	14	270200	643	425.0	14190	3460	2035	7000	3260	12370	1954	7890	1920	436	1165	141.1	629	85.8	163.0	15.6	73.2	6.5	228.0	771.0	N/M
24		883	126200	181	22	264000	858	513.0	17590	5060	1650	2350	3250	10930	1627	5880	1461	340	876	108.9	518	73.8	141.9	14.4	61.0	5.1	491.0	219.0	N/M
25		801	131300	194	25	266000	592	329.0	13570	7220	2120	4950	4200	12480	1500	5490	1165	300	796	109.4	540	79.7	152.8	16.6	70.3	6.1	629.0	330.0	N/M
26		740	125000	159	24	255000	558	280.6	12210	6450	1870	4690	3750	11320	1168	5050	1095	288	768	105.0	522	76.0	149.0	15.8	71.7	5.9	601.0	305.0	N/M
27		752	118900	171	24	243000	578	283.0	12600	6430	1510	3350	3560	11380	1660	5570	1177	290	762	96.9	461	65.1	121.1	12.3	54.5	4.2	651.0	290.0	N/M
28		733	127300	194	24	258000	575	259.0	12800	6590	1570	3430	4100	12820	1680	6340	1302	331	833	108.2	486	70.4	126.2	13.5	57.2	4.6	690.0	335.0	N/M
29		1010	138000	149	16	255000	539	446.0	13700	5810	1030	8300	2880	8500	920	4040	860	216	529	68.0	281	39.4	77.9	7.8	31.9	2.4	584.0	86.0	N/M
30		1014	128300	132	18	261000	556	432.0	12800	5420	1120	8300	2790	8200	910	4050	823	211	514	63.9	285	41.0	77.8	7.8	30.9	2.3	593.0	82.3	N/M
31		1126	135000	220	7.3	268000	940	812.0	16100	2570	2230	6150	3390	13500	2110	9370	2050	537	1283	157.2	678	99.2	180.0	18.9	101.7	8.4	158.0	310.0	N/M
32		1011	128000	314	10	268000	729	781.0	16000	3040	2355	6650	3820	13730	2180	9170	2010	507	1266	153.4	715	95.0	182.9	19.4	87.6	8.4	263.0	566.0	N/M
33		815	120500	156	11	245600	707	537.0	15270	2480	1925	3620	3690	11370	1559	5850	1267	332	872	114.5	521	76.6	149.2	15.2	69.9	5.9	500.0	307.4	N/M

MP-P0714-17 titanite

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
1		895	127700	193	8.4	274000	645	64.2	15200	6740	2102	2160	5430	17500	2520	10210	2106	507	1349	150.4	672	92.4	167.0	16.5	78.9	6.4	292.0	329.0	N/M
2		856	133100	168	5.6	280000	496	67.2	13490	5650	1565	1774	4560	14710	2180	7780	1788	418	1141	123.5	515	69.7	125.6	11.9	56.4	4.5	202.4	281.6	N/M
3		917	123800	195	8.8	266000	681	76.4	15250	6240	1976	2127	5290	16760	2430	10420	2093	493	1369	152.0	661	89.7	160.2	15.4	76.6	6.2	345.0	332.0	N/M
4		943	122900	183	7.7	266000	648	63.0	14810	6350	2030	2190	5390	16510	2450	10110	2112	501	1357	150.0	646	91.4	170.4	16.7	77.5	6.3	309.0	322.0	N/M
5		915	131500	165	7.8	268500	639	61.6	14550	6340	1974	2204	5380	17120	2453	10100	2000	488	1355	151.2	628	88.1	159.4	16.2	77.8	6.2	308.0	326.0	N/M

MP-P0714-17 titanite CONT'D

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
6		948	128000	163	8.5	275000	686	58.5	15160	6420	2090	2270	5530	17580	2630	11020	2207	529	1423	157.8	666	92.4	170.2	15.6	83.2	6.3	326.0	336.0	N/M
7		1058	131400	178	9.2	279600	723	77.9	16020	5590	1980	1810	4790	15660	2380	9600	2100	511	1424	154.1	662	89.0	167.4	16.0	80.8	6.2	442.0	284.7	N/M
8		874	120400	171	7.3	260800	610	58.5	13570	5990	2023	2240	5320	16370	2380	9570	1990	485	1361	147.7	638	85.3	161.7	15.6	72.5	5.8	304.0	320.0	N/M
9		910	120700	168	8.3	255000	613	63.3	13560	6070	2060	2210	5260	17200	2370	9510	2050	503	1371	152.2	672	89.0	166.0	16.0	80.7	6.6	315.0	331.0	N/M
10		983	129800	152	8.5	276000	685	62.5	14740	5640	1880	1787	4680	15550	2320	9560	2120	512	1379	149.1	633	82.6	161.5	15.5	70.1	6.2	350.0	274.6	N/M
11		968	121800	150	7.5	265000	643	65.4	13930	5090	1842	1862	4390	14740	2195	8250	1925	472	1309	144.3	608	82.6	155.8	14.6	72.4	6.0	310.0	265.0	N/M
12		964	131500	165	8.2	267200	663	60.7	13260	6150	2099	2130	5340	17230	2580	10550	2084	524	1403	162.7	678	89.3	167.5	16.8	77.9	6.3	288.0	344.0	N/M
13		972	124400	162	8.1	262000	629	61.2	12580	5770	2090	2140	5360	16720	2440	8730	2010	481	1421	155.8	655	87.3	169.0	16.9	74.8	6.4	304.0	327.0	N/M
14		979	134000	140	8.1	266000	675	69.0	14010	5140	1980	1790	4760	15900	2430	9250	2000	504	1330	159.0	700	86.9	164.0	16.5	75.0	6.4	311.0	277.0	N/M
15		1001	128100	163	8.3	272000	702	71.6	14020	5180	1943	1800	4820	15800	2310	8810	2079	505	1409	152.7	664	85.0	169.1	16.0	75.5	6.3	305.0	256.0	N/M
16		935	124700	154	7.2	270000	633	63.3	12350	5450	1919	2140	5320	16770	2470	9430	2088	507	1342	148.0	641	86.3	163.7	16.0	71.1	6.0	253.0	315.0	N/M
17		934	124400	143	9.1	260000	683	67.7	11650	5370	1945	2249	5100	17470	2562	9910	2243	522	1466	155.2	676	86.5	164.8	16.7	74.1	6.5	327.0	322.3	N/M
18		924	124100	163	10	255900	676	66.2	11450	5540	2040	2300	5250	17100	2630	10110	2220	521	1479	158.4	670	86.8	166.3	16.5	72.7	6.5	385.0	343.0	N/M
19		938	125200	154	9.2	253500	663	85.1	11200	5520	1910	2110	5390	17100	2480	9640	2212	544	1394	151.7	648	82.6	165.9	15.1	69.8	6.2	360.0	343.0	N/M
20		908	124300	164	11	263000	674	86.7	10890	5580	2022	2240	5200	16940	2510	10080	2200	532	1424	157.3	653	85.9	166.0	16.6	72.6	6.1	371.0	340.0	N/M
21		893	119500	154	8.9	258000	666	82.5	10440	5530	2003	2177	5250	17520	2557	10030	2160	532	1398	154.5	686	87.3	168.2	16.6	73.5	6.3	304.0	322.0	N/M
22		936	125300	167	10	257200	682	83.8	11120	5700	1961	2210	5330	16930	2570	10090	2210	526	1408	154.7	666	83.9	168.5	15.8	69.7	6.3	361.0	344.0	N/M
23		916	126000	170	11	261500	646	85.4	11080	5540	1911	2230	5210	17650	2626	10010	2281	531	1413	156.3	654	82.6	158.5	15.4	71.2	5.9	404.0	356.6	N/M
24		932	123900	153	9.4	262100	642	90.7	10550	5500	2003	2110	5100	16680	2530	9560	2143	530	1399	149.4	663	80.6	160.2	15.7	74.2	6.1	345.0	332.4	N/M
25		954	124600	161	9.4	258400	654	88.5	10350	5690	1984	2191	5380	17460	2650	9610	2190	534	1409	154.9	658	81.6	169.6	15.9	69.9	6.3	306.0	334.0	N/M
26		909	126000	175	10	262000	686	87.2	10050	5880	1910	2210	5150	17630	2524	9540	2183	524	1426	152.6	645	81.4	162.6	16.0	68.5	5.9	327.0	346.0	N/M
27		957	128900	161	8.2	272000	656	62.6	10670	5210	1970	1811	4300	15120	2172	7650	1920	489	1261	151.6	659	79.6	162.7	15.8	71.8	6.4	268.0	278.0	N/M
28		925	126200	166	7.9	254000	636	73.9	9820	5600	2076	2189	4900	16460	2410	9420	2149	513	1363	159.7	679	85.0	175.4	16.5	75.3	6.6	260.0	320.0	N/M
29		946	123500	155	7.7	255000	630	65.5	10070	5540	2016	2280	5040	16200	2400	8850	2080	508	1311	155.3	664	83.8	171.0	16.5	70.8	6.2	248.0	326.0	N/M
30		939	126000	157	7.8	258000	613	72.0	9510	5510	2030	2150	4860	16250	2450	9360	2130	526	1355	155.0	681	83.9	169.7	17.0	75.9	6.5	268.0	325.0	N/M
31		966	125100	163	7.8	257000	603	78.5	9910	5740	2084	2200	4950	15930	2420	9280	2020	479	1356	154.1	662	84.9	168.0	16.9	74.7	6.3	267.0	335.0	N/M
32		969	125200	165	8.2	252600	608	74.0	9760	5710	1925	2250	5100	16530	2414	9480	2078	500	1324	149.4	669	82.2	171.4	16.3	75.2	6.2	279.8	341.0	N/M
33		957	124400	179	8.3	262000	628	74.1	10540	6340	2040	2160	5240	16560	2500	9920	2110	497	1319	155.6	672	82.4	167.7	16.9	71.3	6.3	272.0	336.0	N/M
34		904	123100	178	8.6	262500	650	71.8	10620	6190	2022	2211	5010	16810	2460	9940	2119	508	1310	152.4	662	83.3	168.8	16.5	72.5	6.2	276.0	325.0	N/M
35		1083	122600	162	6.9	262000	805	98.0	14080	5220	1893	1352	4420	14900	2237	9510	2092	488	1334	151.8	638	85.3	160.1	15.9	67.1	6.2	202.7	205.0	N/M
36		927	125500	193	11	253000	652	75.7	11420	6540	1980	2342	5470	17430	2496	10300	2180	533	1382	158.7	672	83.1	158.2	15.9	70.6	5.8	345.0	334.5	N/M
37		941	123500	188	8.7	257000	646	73.9	11410	6410	1970	2199	5280	16930	2507	10260	2183	523	1297	151.1	649	82.2	158.0	16.7	69.7	6.1	312.0	337.0	N/M
38		939	123000	186	9.1	263000	659	68.3	12010	6740	1969	2063	5280	16900	2510	10130	2140	534	1315	154.9	640	80.0	161.3	15.8	72.7	6.1	291.0	333.0	N/M
39		931	129000	188	8.8	266000	660	70.6	12250	6770	2105	2320	5500	17570	2539	10650	2116	524	1319	157.3	683	88.3	178.4	17.1	75.1	6.1	284.0	331.0	N/M
40		943	123700	199	10	256700	640	69.3	12780	6830	1897	2135	5250	17170	2540	10670	2170	525	1343	158.7	658	87.1	167.9	15.7	77.3	6.3	297.0	334.0	N/M

MP-P0714-19 titanite

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
1		1330	123200	261	14	282100	807	430.0	11730	3526	833	5060	2790	9070	967	4010	796	184	459	52.3	209	33.5	70.6	8.5	43.6	4.2	465.0	411.0	N/M
2		1141	116900	248	14	291000	803	394.0	11210	3460	818	5300	2962	9700	1096	4320	831	195	468	54.0	218	33.5	70.7	7.2	40.9	4.0	499.0	416.0	N/M
3		1582	120600	101	5.3	318000	985	328.0	13770	625	847	257	2490	9780	1124	4640	938	215	523	56.6	211	32.9	69.9	7.1	43.4	4.6	103.4	1.6	N/M
4		1748	120900	150	4.5	310000	1091	332.0	13470	1870	698	756	2253	8750	913	3760	778	194	387	44.8	171	27.2	58.6	6.0	34.4	3.5	35.3	5.8	N/M
5		1740	121700	150	5.6	327000	1134	328.0	13410	2002	704	830	2290	8490	925	3860	718	188	408	44.8	170	26.6	56.6	6.0	33.8	3.5	40.3	6.3	N/M
6		1522	129100	185	6.7	352000	1030	240.1	11700	2520	680	1668	2470	9030	967	3680	727	188	392	42.3	162	26.9	59.9	6.1	34.4	3.5	80.7	18.0	N/M
7		1609	126900	206	8.4	347000	1043	421.0	11780	2680	793	2560	2500	9260	1017	4250	877	203	468	50.1	200	31.6	68.4	6.9	38.0	3.6	111.3	55.0	N/M
8		1507	119500	268	19	331000	1008	348.0	11420	3150	982	3720	2610	9920	1113	4410	933	216	523	65.5	254	43.6	94.7	9.4	53.4	5.4	568.0	359.0	N/M
9		921	121400	233	11	398000	897	199.7	10260	3770	829	5260	2740	9310	916	3130	626	149	346	41.9	170	29.9	70.9	7.9	44.5	4.3	309.3	405.0	N/M
10		978	125900	263	13	407000	887	194.1	10410	3970	847	5980	2920	9800	931	3200	641	152	342	43.0	182	31.7	77.5	8.1	45.8	4.6	361.0	481.0	N/M
11		1578	123600	227	15	388000	1281	371.0	13290	3010	1000	2880	2385	9650	1008	4094	906	194	520	61.9	243	40.8	93.6	9.8	55.0	5.3	354.0	238.7	N/M
12		1567	118100	211	16	412000	1352	418.0	13210	3140	986	2910	2410	9380	1046	4070	910	196	540	63.6	250	41.4	95.1	9.5	52.4	5.4	337.0	238.9	N/M
13		1252	123300	267	20	409000	1088	282.0	11230	3750	1038	4690	3190	11680	1500	4810	997	214	576	68.5	269	42.7	101.3	9.4	56.4	5.4	595.0	474.0	N/M
14		1295	118200	279	21	403000	1192	315.0	11530	4070	1085	4870	3300	11570	1340	4794	1000	217	580	68.7	272	42.3	99.6	9.8	54.3	5.5	624.0	489.0	N/M
15		1699	123600	152	5.9	420000	1447	534.0	15500	2120	909	988	2430	9960	1070	4280	931	207	539	58.6	225	35.0	83.4	7.8	43.4	4.3	56.3	5.3	N/M

MP-P0714-19 titanite CONT'D

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
16		1415	120100	200	7.6	459000	1231	349.0	12930	3010	982	2830	3320	12630	1555	5020	1084	230	577	63.5	238	37.4	93.2	7.9	46.1	4.6	166.3	26.1	N/M

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
17		1242	117900	234	20	421000	1291	457.0	11640	3680	959	4930	2827	10460	1157	4210	912	196	517	59.8	249	40.2	100.3	9.3	52.1	5.2	560.0	385.3	N/M
18		1693	133300	212	8.1	469000	1497	583.0	14580	2990	981	3360	2588	11050	1270	4850	1030	232	604	67.9	269	41.3	92.9	8.5	49.3	4.6	120.4	62.2	N/M
19		1223	120400	229	11	438000	1239	594.0	13440	3400	726	5880	2210	8460	858	3330	711	149	406	44.1	171	28.0	67.8	6.2	34.2	3.3	303.0	176.4	N/M
20		1370	124300	94	5.6	436000	1414	432.0	15780	792	1020	577	2330	11260	1473	5070	1074	244	621	67.5	262	40.6	94.1	8.6	48.8	4.7	124.4	3.2	N/M
21		1505	130100	205	7.0	437000	1342	622.0	15420	2850	918	3480	2470	10190	1035	4390	907	209	539	61.3	243	37.2	91.6	8.5	44.8	4.4	140.8	48.8	N/M
22		1756	125000	173	7.4	434000	1732	678.0	17460	2900	871	2053	2520	9860	1002	4110	849	194	471	51.6	212	33.4	81.8	7.2	40.4	4.1	74.2	18.2	N/M
23		1281	119600	209	10	409000	1239	242.0	13170	3160	602	4700	2120	7540	733	2652	524	123	295	33.0	142	22.8	59.6	6.2	31.2	3.2	339.0	258.0	N/M
24		1354	124700	234	16	430000	1570	584.0	15960	3470	923	4240	2640	9980	1005	4090	870	196	514	59.9	252	38.5	95.4	8.9	49.5	4.7	492.0	374.0	N/M
25		1508	124400	243	14	402000	1693	579.0	20000	3500	982	2970	2690	10320	1069	4140	908	210	533	63.7	275	39.9	100.0	9.8	54.8	5.0	320.0	264.9	N/M
26		1543	122000	225	14	406000	1789	557.0	20440	3540	970	3210	2755	10500	1053	4210	900	215	563	64.1	272	41.5	106.3	10.2	51.3	5.0	337.0	285.0	N/M
27		1830	127100	100	5.4	402000	1820	356.0	19760	702	1278	606	2960	14000	1951	6850	1363	311	797	85.6	353	49.7	124.6	11.3	57.9	5.4	92.4	2.5	N/M
28		2137	117900	173	7.9	368000	1396	497.0	18960	2732	629	2280	2120	8120	820	3400	670	165	392	41.5	176	23.6	60.6	5.7	28.4	2.7	87.1	69.6	N/M
29		1150	121800	218	13	368000	1292	464.0	17120	3530	741	5850	2520	8700	859	3460	681	165	415	44.1	203	27.6	72.8	6.7	36.1	3.2	415.0	354.0	N/M
30		1409	121600	211	5.6	371000	1301	464.0	18050	3130	1050	4240	3260	11880	1523	5340	1098	254	619	69.7	300	41.3	106.0	9.7	50.8	4.7	118.8	107.7	N/M
31		1430	125700	179	5.5	382000	1453	345.0	19200	3090	1016	3508	3292	12460	1554	5370	1041	249	603	63.0	278	37.8	98.1	9.2	48.4	4.8	82.8	57.1	N/M
32		1668	119000	146	8.5	352000	1533	700.0	20270	2264	841	1527	3450	11870	1513	5160	959	247	538	56.2	243	32.8	78.3	7.4	40.1	3.7	70.7	12.8	N/M
33		1935	123100	157	9.1	355000	1550	718.0	21950	2690	674	1369	2855	9540	993	4260	763	205	418	44.9	193	27.3	63.9	6.4	33.5	3.2	47.0	12.0	N/M
34		1634	123300	136	7.7	340000	1423	642.0	19800	2180	980	1560	4400	14630	1890	6400	1142	300	614	63.7	278	37.9	89.9	8.5	42.1	4.2	78.2	14.7	N/M
35		1723	122200	205	8.6	332500	1533	537.0	20360	2690	1053	1921	5040	16100	2060	7190	1201	313	682	69.0	311	40.0	91.6	8.7	43.9	4.4	70.8	21.9	N/M
36		1360	120900	282	27	311000	993	333.0	18210	4560	1096	5560	3850	11780	1380	5300	1014	238	591	68.1	307	44.4	108.7	11.3	63.5	6.1	908.0	541.0	N/M
37		1286	121000	255	28	302200	989	337.0	18080	4250	1036	5170	3670	11080	1298	4950	959	237	586	66.1	306	42.6	102.6	11.1	61.2	5.9	924.0	512.0	N/M
38		1639	120400	228	19	291700	1118	367.0	21810	3630	994	3500	3146	9600	1032	4340	847	211	532	61.4	277	41.7	97.8	10.7	57.5	5.8	599.0	324.2	N/M
39		1632	120700	207	21	287600	1102	468.0	20910	3530	1001	3428	3047	9620	1038	4500	852	221	553	63.0	291	41.6	95.9	11.5	59.8	5.8	626.0	317.9	N/M
MP-P0714-22A titanite																													
1		—	123400	241	5.7	247900	731	300.0	17400	2132	3070	3290	6540	19320	2542	10380	1729	458	1089	124.6	516	92.4	187.1	24.1	129.8	11.4	44.9	64.2	N/M
2		2334	121800	223	5.4	249000	728	373.0	16350	2090	2712	3100	6550	20270	2590	11490	1735	418	1088	117.2	457	82.6	156.2	21.2	117.3	10.1	47.8	74.8	N/M
3		2370	118400	134	6.0	224500	717	838.0	15990	1341	2130	1201	3560	11870	1683	6220	1263	308	825	95.3	371	68.2	134.0	17.4	100.4	9.0	29.5	21.3	N/M
4		2390	123400	106	5.3	229000	712	201.2	14840	1271	2230	1156	3500	11580	1528	5620	1132	305	741	87.2	353	66.6	127.7	17.6	96.5	8.2	16.7	15.2	N/M
5		1720	126900	186	4.2	243000	327	565.0	13200	3150	3180	5150	5490	16490	2270	10900	1957	509	1272	149.4	579	103.6	174.5	20.2	95.8	6.5	63.0	531.0	N/M
6		1820	131000	114	3.1	235100	692	1124.0	12820	756	2320	1347	2850	11400	1748	7090	1627	387	1038	121.1	436	84.8	146.8	19.9	109.2	9.3	22.4	33.6	N/M
7		2040	127000	107	3.2	228500	647	1140.0	12780	728	1810	774	3020	10670	1545	6030	1260	280	766	88.4	315	59.8	109.3	14.8	85.8	7.5	15.3	17.9	N/M
8		2609	120700	133	4.0	217900	619	703.0	15980	2127	3140	1830	3390	10640	1526	5930	1414	354	1019	124.7	476	96.6	171.1	20.9	104.0	8.0	58.1	65.9	N/M
9		1657	131500	158	4.2	219200	443	582.0	12370	1335	3070	5150	3660	12360	1811	7900	1894	456	1225	159.1	551	112.5	187.0	23.8	118.1	9.4	48.0	517.0	N/M
10		2370	136200	210	4.7	212900	699	846.0	14680	1130	2850	2570	5490	18030	2409	12050	1936	468	1231	141.8	466	95.9	169.5	23.0	134.9	11.6	69.9	117.7	N/M
11		2181	136300	179	7.6	208000	576	1085.0	13110	1850	2182	2160	5290	16270	1991	7370	1448	345	908	103.8	337	69.9	119.5	17.8	102.3	9.5	183.6	90.2	N/M
12		2109	131700	137	6.0	201700	575	1695.0	11990	1256	1431	867	3070	9820	1090	4710	955	221	624	67.0	209	45.8	78.2	11.3	64.8	6.0	47.0	25.3	N/M
13		2124	125500	140	5.3	198200	527	754.0	12910	1390	2150	1670	3490	11510	1500	6190	1357	309	872	99.2	333	73.2	123.6	16.8	91.1	8.4	71.6	62.0	N/M
14		2150	124600	122	4.4	208000	584	983.0	11450	1237	1261	816	2990	9140	955	4260	832	193	526	58.3	180	38.3	68.1	9.4	54.3	5.4	20.2	17.8	N/M
15		1579	138100	117	3.2	207000	265	402.0	13010	609	3340	3970	2870	12250	1941	8680	2350	555	1573	187.0	546	117.1	202.0	29.4	174.1	13.5	24.0	71.6	N/M
16		2166	122200	127	5.6	194600	735	950.0	13560	1214	1542	663	3480	10090	1220	4950	993	213	605	71.1	206	49.3	84.3	11.5	71.6	7.1	26.0	16.6	N/M
17		2007	135600	108	3.5	210400	713	561.0	14290	827	2070	1114	2920	10090	1494	5760	1373	307	865	104.5	313	72.8	118.7	16.2	94.4	8.4	18.0	23.3	N/M
18		2049	136700	104	3.9	212000	776	743.0	15200	798	1896	593	3090	9810	1280	5310	1178	250	742	83.1	253	57.2	102.3	13.9	82.7	7.3	20.2	15.4	N/M
19		1730	125600	112	2.6	210700	579	464.0	11060	610	1146	321	2190	7140	759	3450	710	156	475	51.9	155	36.5	64.6	9.0	52.5	5.2	17.6	8.2	N/M
20		2130	133000	104	4.5	191600	751	1939.0	14810	948	2030	875	3040	9660	1311	5130	1289	275	804	94.0	298	70.1	123.6	16.3	93.4	8.8	28.2	19.5	N/M
21		2083	127200	125	5.7	216700	604	695.0	14390	1500	2206	1748	3720	10950	1464	5790	1318	282	866	100.2	304	68.4	123.1	15.8	93.7	8.4	118.0	59.5	N/M
22		2126	126300	129	7.1	206900	588	863.0	14700	1414	1930	1917	3730	11370	1515	5760	1321	285	834	91.5	291	65.1	114.1	14.7	83.8	8.1	110.7	133.6	N/M
23		1821	133500	99	2.3	215000	472	606.0	13790	532	3300	632	2328	8700	1310	5720	1674	372	1160	143.7	488	110.0	194.6	23.7	119.5	8.4	22.7	20.9	N/M
24		1948	128900	97	2.8	221900	652	765.0	14310	600	1866	419	2489	8370	923	4520	1043	233	696	81.5	268	60.9	109.6	14.3	79.5	6.4	44.5	17.6	N/M
25		1550	132500	201	5.4	233300	415	292.0	13620	3320	2920	5230	5100	14970	2012	8150	1874	433	1202	146.3	488	100.3	176.2	20.2	98.4	7.5	72.6	297.0	N/M
26		2229	126800	118	4.4	229300	615	648.0	14780	1418	3350	1763	3640	11250	1550	5800	1484	343	1053	133.7	459	100.7	197.1	23.4	115.2	9.4	31.0	27.4	N/M
MP-P0714-22A titanite CONT'D																													
27		1920	117200	127	3.5	251000	731	824.0	14550	590	1940	312	2540	8380	1003	4350	990	230	670	81.0	296	59.0	115.0	14.2	77.0	6.7	25.3	8.8	N/M
28		2200	127300	116	5.5	247500	733	1147.0	14690	1230	1811	1617	3740	12040	1687	6080	1274	277	784	88.6	339	61.8	122.2	15.1	83.3	7.9	58.4	74.3	N/M

Spot	Comm.	Al	Si	P	Sc	Ti	V	Cr	Fe	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W
MP-P0714-23 titanite																													
1		2880	121000	180	17	313000	474	BDL	26200	4360	2770	1590	3930	12700	1530	5510	1174	313	950	131.0	645	102.7	208.0	24.1	121.7	10.9	69.0	68.6	N/M
2		2910	122000	217	19	342000	460	BDL	25700	4550	2940	1970	4070	13200	1560	5690	1252	326	992	129.0	675	104.6	228.0	25.8	128.4	11.5	128.6	98.7	N/M
3		2650	123600	146	12	310000	409	BDL	23600	4660	2910	1960	3730	11690	1417	5160	1115	303	857	119.3	624	99.9	222.3	23.7	124.2	10.7	86.9	109.0	N/M
4		2460	115400	170	13	300000	360	BDL	20800	4750	2580	1850	2510	10830	1570	6180	1422	392	1027	133.1	605	86.3	180.6	20.1	101.1	8.3	99.8	86.3	N/M
5		5730	136400	316	32	328000	725	BDL	20690	1880	3470	1172	7490	20800	3750	13400	2890	738	1890	218.0	936	127.2	252.2	27.1	131.3	11.8	130.3	83.5	N/M
6		5220	128200	271	27	311000	673	1.3	18570	1670	3410	1053	6450	19290	3690	12140	2760	678	1758	208.1	893	125.6	239.0	25.0	120.0	11.1	126.1	77.2	N/M
7		2040	156000	174	7.0	317000	1030	458.0	14000	767	3690	6180	2350	11340	2190	10400	2650	657	1690	213.0	903	136.0	262.0	33.1	163.0	14.6	152.0	246.0	N/M
8		7100	162000	169	7.6	324000	1020	455.0	18200	782	3620	7380	2440	12400	2130	10500	2680	633	1720	209.0	941	136.6	271.0	32.9	171.0	14.3	177.0	302.0	N/M
MP-P0714-26 titanite																													
1		2900	127800	106	6.0	278000	1075	14.6	40600	726	1230	653	3950	12250	1570	5480	1078	264	682	68.3	292	44.7	89.0	10.1	52.7	4.9	33.5	17.9	N/M
2		3140	137200	124	6.3	282000	1231	27.6	39100	791	1100	605	5110	14740	1795	5980	1049	249	638	64.1	281	44.1	88.3	10.0	56.8	6.0	35.3	16.3	N/M
3	old	3010	140600	155	6.9	271000	1233	12.7	40600	868	1419	726	5660	16490	2137	7460	1305	312	834	87.1	370	53.3	108.0	11.9	63.5	6.3	39.4	22.1	N/M
4		3130	134600	120	7.0	256000	1060	31.9	36200	786	1141	574	5010	13780	1653	6090	1017	240	598	63.7	273	40.0	82.8	9.6	53.4	5.4	87.8	23.8	N/M
5		7370	138400	326	17	255000	895	151.4	41300	323	4180	3180	5150	18900	2790	13220	2700	568	1861	223.0	1062	169.0	338.0	39.7	194.9	19.5	72.8	242.0	N/M
6		2880	131300	128	5.9	251000	1024	51.0	36000	752	1178	643	4410	13120	1694	6200	1108	260	670	72.3	295	45.9	85.5	9.4	47.7	4.9	36.2	24.3	N/M
7		12270	141900	274	21	238300	736	68.7	41900	154	4330	1698	4540	17600	2660	14230	2880	516	2020	250.0	1182	174.2	358.0	40.0	196.0	18.9	50.3	136.5	N/M
8		N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
9		N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
10		10460	147300	279	16	236900	541	9.2	32000	100	3260	3660	4550	15720	2170	7870	1686	309	1159	145.2	729	113.7	247.0	28.9	143.1	15.2	75.1	255.4	N/M
11		4130	139500	241	11	242500	716	68.0	41800	1447	3020	950	5220	17880	2378	9860	1983	519	1397	176.7	840	124.1	243.9	26.0	115.2	12.4	58.1	70.9	N/M
12		3750	140400	174	7.7	236000	849	15.4	36000	768	1222	1322	4530	13800	1796	6020	1172	264	721	74.9	331	47.4	91.6	10.5	49.1	5.9	79.0	45.6	N/M
13		11730	126400	265	19	221000	697	68.2	34470	159	4120	1565	4360	16980	2617	12970	2810	512	1855	233.0	1100	160.6	322.0	36.5	168.8	17.6	47.8	128.6	N/M
14		11480	127000	276	20	224100	715	67.5	34000	154	4440	1730	4390	17020	2725	13320	2920	527	2053	259.4	1205	178.1	355.0	38.5	173.9	18.1	51.3	135.5	N/M
15		3150	125100	137	5.7	231000	1210	19.8	26800	740	724	310	3040	8490	853	3490	571	147	382	39.2	174	24.7	51.9	6.3	29.2	3.8	31.5	7.4	N/M
16		3480	128100	123	6.2	233000	1209	49.6	24500	679	605	261	2910	8160	810	3050	548	137	349	34.5	158	24.3	49.7	5.7	28.5	3.7	23.1	5.6	N/M
17		3150	134700	117	6.3	243900	1182	31.5	27200	707	991	576	3970	11720	1430	5090	957	226	594	60.6	262	39.4	75.2	8.7	43.0	4.9	52.6	26.8	N/M
18		10720	138700	219	16	223000	1117	120.3	28300	271	1374	923	4880	15780	1920	6280	1233	271	786	83.0	357	52.3	109.6	12.8	63.3	8.1	64.1	80.1	N/M
19	old	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
20	old	3110	147000	180	7.7	231700	790	6.0	29300	1047	1078	1820	5760	17040	1967	6440	1155	260	705	71.7	308	42.6	80.3	8.9	40.6	4.3	136.3	63.6	N/M
21		3880	131300	168	8.0	242000	1419	37.0	23300	719	1200	617	5590	13680	1529	4930	924	233	594	62.9	301	43.3	88.7	11.0	56.5	7.5	48.5	11.4	N/M
22		N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
23		N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M	N/M
24		3570	134200	503	14	239000	753	3.4	25600	1013	538	2680	5160	14350	1729	4990	890	184	460	42.0	159	19.9	40.7	4.4	19.6	2.3	299.0	95.7	N/M
25		2849	129700	135	5.5	238000	1059	11.3	21300	707	1041	534	3660	11220	1280	4660	943	222	613	65.0	292	41.7	80.8	9.2	46.2	4.9	57.5	20.5	N/M
26		10250	149000	401	13	255000	560	47.4	19640	90	2930	3360	5130	18000	2410	7780	1688	270	1095	125.6	674	104.6	231.0	29.3	146.0	16.0	81.7	302.0	N/M
27		7620	130300	308	12	263000	967	409.0	21400	348	2660	1500	5400	19040	2690	11510	2180	426	1416	155.6	707	101.7	212.0	22.8	110.5	11.5	59.1	124.9	N/M
28		3300	127900	226	17	237700	725	BDL	24770	937	564	2780	3900	10460	1060	3950	676	149	370	37.5	157	21.5	43.1	5.2	27.6	2.4	456.0	189.8	N/M
29		3230	151600	132	6.0	258000	1071	18.9	22100	834	1186	1140	5030	15120	1860	6270	1174	263	715	75.2	331	45.4	97.1	10.2	47.4	4.9	73.0	68.1	N/M
30		3580	139500	222	13	247900	785	1.2	24740	1091	1110	2860	4380	12820	1644	5160	908	210	514	56.1	267	41.9	91.5	11.7	60.2	6.5	358.0	248.0	N/M

BDL = below detection limit
N/M = not measured

APPENDIX T - ZIRCON TRACE ELEMENT DATA TABLE

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
									MP-P0913-5A zircon													
1	N		175000	118	679	10.3	54.9	63.2	9.47	56.3	29.8	9.38	62.2	15.4	102.3	23	63.8	9.48	53.7	6.86	13330	1.57
2	N		140000	125	720	5.7	21.8	30.6	4.9	26.9	16.2	6.1	41.1	11.91	101.6	23.9	71.4	10.11	78.2	11.1	11990	1.67
3	N	inherited	143100	106	186	1.06	0.00057	2.55	0.022	0.35	2.28	0.062	12.2	3.2	23.4	5.39	18.2	2.98	21	3.89	12980	1.19
4	N	inherited	157800	103	351	1.1	0.043	3.51	0.064	1.39	3.65	0.257	25.6	6.01	44.6	11.29	37.9	6.19	45.7	6.87	13200	0.81
5	N	inherited	152100	89	285	1.25	0.26	3.35	0.076	1.13	3.89	0.243	23.1	5.53	42.3	10.1	31.5	4.86	35	5.71	13240	1.27
6	N		148400	122	209	1.73	3.1	5.7	0.147	1.26	2.65	0.56	13	3.33	31	6.5	23.8	3.35	25.6	3.83	12680	1.12
7	N	inherited	154600	88	197	0.85	0.0004568	2.38	0.037	0.29	1.79	0.116	11.1	3.31	28.8	5.9	21.2	3.37	24.1	4.39	13740	1.02
8	N	inherited	144800	83	143.4	0.63	0.0004272	2.11	0.021	0.53	1.37	0.148	10	2.59	20.9	4.77	14.7	2.4	18.2	3	12830	1.12
9	N	inherited	151200	86	159.9	1.15	0.0003987	2.45	0.03	0.57	2.16	0.039	12.9	3.07	22.8	5.66	17	2.75	20.5	3.13	13550	1.12
10	N	inherited	149900	71	207	0.75	0.049	2.84	0.029	1.06	3.76	0.06	17.2	4.37	31.1	6.97	21.5	3.21	22.2	3.69	13020	0.79
11	N	inherited	158300	69.8	268	0.75	0.044	3.03	0.089	1.51	4.42	0.254	22.5	5.46	38.2	8.11	25.2	3.62	27	3.69	13260	1.43
12	N	inherited	155400	82	232	1.1	0.13	2.78	0.094	0.94	4.88	0.268	21.1	5.59	37.9	7.98	23.4	3.6	25.7	3.88	13330	1.11
13	N	inherited	159700	91	363	1.05	0.0001255	3.52	0.017	1.21	4.9	0.28	26.2	6.41	51.7	12	39.1	5.82	49.3	7.47	12910	1.12
14	N	mixed age	157000	58	74.2	1.68	0.044	3.55	0.058	0.78	1.41	0.99	6.2	1.41	9.46	2.46	7.28	1.14	8.7	1.46	10460	1.77
15	N	inherited	150300	44.4	90.1	1.97	BDL	3.58	0.058	0.96	2.07	1.1	7.5	1.59	14.1	3.09	8.64	1.41	11.12	1.91	10580	2.05
16	N	mixed age	151100	55	205	3.33	0.08	4.6	0.045	0.71	1.76	0.86	6.9	2.24	22.3	7.17	28.9	5.28	55.2	11.86	9930	1.99
17	N	mixed age	150700	126	616	5.93	0.73	13.6	0.094	1.43	2.88	0.59	13.12	3.9	54.6	20.7	98.5	20.24	201.8	39.3	10290	5.91
18	N	mixed age	158000	52	130.8	4.91	BDL	10.01	0.179	2.6	3.53	1	8.9	1.78	15.4	4.27	14.12	2.41	17.6	2.72	11540	6.2
19	N	mixed age	157000	130	803	5.13	0.14	7.5	0.116	1.71	2.52	0.52	16.6	5.49	69.3	26.3	121.4	25.51	249.5	45.1	10300	4.26
20	N	mixed age	157000	121	680	6.34	0.7	8.24	0.04	1.3	2.07	0.39	12.9	4.24	61	23.9	107.1	22.3	218.4	42.5	10420	6.53
21	N	mixed age	154600	108	737	6.48	BDL	7.98	0.081	0.96	1.87	0.46	14.2	4.9	60.3	23.5	109.4	23.2	226	45.6	10470	6.8
22	N		198000	181	1360	22.3	46.6	76.8	8.7	61.2	53.5	16.2	72.3	16.9	148.7	42.2	190.4	45.5	470	90.5	15200	7.9
23	N		158000	171	1151	17.2	41.3	55.3	8.41	45.2	35	10.02	56.1	11.78	107.2	37.5	174.8	38.3	415	83.3	14250	7.79
24	N	inherited	184000	100	264	0.68	0.26	1.55	0.056	0.84	3.2	0.229	24.8	7.22	49.8	8.7	18	1.97	14.4	2.2	15000	0.98
25	N		174200	91	222	1.7	2.66	2.97	0.361	2.4	3.13	0.51	19.5	5.31	36.4	6.89	14.7	2.06	11.65	1.54	15370	0.48
26	N		174000	229	1720	3.41	11	13.5	1.33	8.9	12.1	2.13	41.7	13.1	159	53.8	260	51.8	479	88.7	13360	1.52
27	N		178800	296	1830	8.38	58.4	45.6	7.54	44.6	34.7	9.17	59.8	16.2	178	64	301	65.4	681	125.1	14270	2.31
28	N		192000	190	1740	3.99	4.7	41.8	0.66	5.94	6.7	1.87	36.4	11.8	150	56.9	269	58.7	579	112	11420	4.3
29	N		182600	193	937	1.65	0.18	5.91	0.027	0.67	1.95	0.221	17.3	5.94	85.2	33.46	163.4	38.9	402	77.8	13410	1.92
30	N		180000	57	426	6.6	22.4	31.8	4.59	28.3	17.6	5.9	37.5	8.62	63.5	14	38.3	5.35	37.4	4.62	14280	2.1
31	N		145600	88	690	11.8	60	76	12.9	71	36	14.3	67	14	115	22.5	64	8.4	59.3	7.5	13600	3.29
32	N	inherited	159300	81.8	370	0.59	BDL	0.9	0.009	0.16	1.09	0.212	14	5.11	52.9	11.34	32.8	4.2	30.8	4.25	13710	1.59
33	N		177000	104	527	3.49	10.7	10.2	1.32	10.5	7.6	2.82	25.9	7.92	70.1	16.06	45.5	6.22	49.5	7.51	13820	2.06
34	N	inherited	160400	87	452	2.59	2.2	4.44	0.59	3.78	3.58	0.78	17	6.96	61.8	14.2	40.6	5.58	42.5	6.97	13150	1.85
35	N	mixed age	151100	45	361	3.16	BDL	4.87	0.053	0.58	1.62	0.57	7.1	2.75	31.6	11.92	54.9	10.16	108	22.76	9460	2.83
36	N	mixed age	156500	6	47.7	1.2	BDL	9.56	0.071	0.61	1.68	1.3	4.2	1.01	6.98	1.36	4.65	0.46	5.66	0.84	11940	0.78
37	N		18000	122	800	4.4	BDL	18	1.37	11.3	6.5	3.44	19	5.94	62.3	25.1	119.3	24.6	232	53.1	12130	5.64
38	N		17630	135	1750	6.33	BDL	100.1	4.37	40.7	33.6	12.5	91.6	22.9	181	56.4	227	36.3	291	52.2	9310	2.19
39	Y		17700	129	1870	3.28	BDL	100.4	2.37	33.9	35	12.42	104	25	204	62	227.9	38.2	282	53	10490	1.48

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-P0913-5A zircon CONT'D																						
40	N		16400	82	244	1.08	BDL	3.79	0.051	1.78	3.5	0.39	17.9	4.88	35.6	7.94	25.9	4.23	30.9	4.9	15400	1.63
41	N	inherited	16900	200	1472	2.42	BDL	127	1.35	18.6	22.7	8.6	64.4	16.2	160	45.9	180	29	237	51.4	9370	1.31
42	Y		16700	54	1007	3.15	BDL	136.6	0.57	8.1	14.9	7.19	54	14.5	116.5	34	135.7	22.7	175.4	29	8850	1.72
43	Y		17500	62.7	1615	11.8	BDL	160.3	9.58	73.6	46.5	18.8	96.5	22.99	181	50.5	177	32.44	239	44.3	8900	1.65
44	N		17290	218	1524	1.18	BDL	2.39	0.176	1.77	4.6	0.79	20.6	8.68	117	46.1	207	41.2	351	75.9	13500	1.2
45	N		19200	168	1261	14.6	BDL	58.5	4.18	35.4	29.2	10.1	45.1	9.76	101	35	196	48	533	115.2	17070	38.7
46	N		17130	60.3	1870	7.5	BDL	52	2.7	27.1	37	13.8	74	19.2	202	65.7	270	47.3	424	79.4	9550	2.2
47	N		17610	240	1620	14	BDL	53	7.4	49.2	30.7	8.5	43	13.9	145	45.4	163	27.9	214	41.3	16800	4.5
48	N		18900	95	718	6.96	BDL	41.8	3.52	22.9	12.2	3.52	26.1	6.24	66	26.3	121.1	25.5	231	49.1	11910	5.34
49	N		17400	56	1130	5.44	BDL	112	0.65	7.3	11.3	5.3	46.8	12.1	115	38.5	131	23.6	228	37.4	9010	2.86
50	N		18800	54.5	1750	5.08	BDL	233	0.97	13.5	23.9	11.62	79.9	22.6	202	57	200	33.9	272	45.9	7920	1.59
51	N		17800	33.9	822	2.71	BDL	88.8	0.202	4.6	7.7	3.64	30.2	9.07	82.2	25.5	109.9	19.1	160	26.4	8650	1.32
52	Y		16600	92.5	717	4.48	BDL	15	0.206	1.54	3.3	1.12	16.2	5.42	58.2	23.1	115	21.6	199	39.8	9230	3.51
53	N		17630	68	432	2.92	BDL	6.93	0.126	0.89	0.75	0.49	7.5	2.48	38.6	14.3	76	16.9	186	37.6	11970	4.44
54	N	mixed age	18000	94	899	3.79	BDL	7.66	0.09	1.07	1.91	0.64	14.9	5.91	72.5	30.5	153	30.2	287	61.5	10860	4.82
55	N		14500	159	1700	23.4	BDL	323	12.6	107	87	32.9	169	34.2	210	49.8	169	26.7	204	39.6	5260	2.87
56	N		17600	111	2530	9.5	BDL	239	5.5	68	78	30	167	37.4	298	72.8	280	44.4	325	66	5980	3.95
57	N		20200	39	502	2	BDL	48.7	0.073	0.93	1.81	0.82	6.9	2.27	29.2	12.9	73.5	18.6	220	54	11470	1.79
58	N	inherited	17880	67.2	303	1.188	0.004	3.47	0.048	1.13	5.46	0.29	21.9	5.91	42.9	9.97	30.4	4.09	29.3	3.92	14710	1.2
59	N	inherited	17400	70	185	1.22	BDL	2.94	0.038	1.32	4.48	0.24	16.9	4.14	29.3	6.04	19.4	2.9	19.4	3.24	15210	1.42
60	N	mixed age	17800	122	829	4.11	BDL	8.61	0.126	1.55	2.51	0.71	15.5	5.82	70.1	26.1	121	24.8	234.5	47.4	10620	4.48
61	Y	mixed age	18200	55	149	2.85	BDL	12.4	0.166	1.88	3.99	0.92	13.7	3.2	23.4	5.43	17.3	2.72	23.3	3.51	11390	4.47
62	N	inherited	19300	80.1	291	1.35	BDL	3.04	0.069	1.87	5.33	0.49	23.5	5.76	44.4	9.26	29.4	4.87	26.7	4.39	14860	1.33
63	N		18700	66.7	620	5.9	BDL	32	2.2	15.3	13.9	4.6	25.8	8	56	15.2	81.7	16.5	171	35.9	10960	4.04
64	N	inherited	18800	60.1	402	3.22	BDL	16.4	0.261	2.68	2.9	0.91	10.1	3.08	32.6	13.9	65.5	13.6	153	32.5	11370	4.12
65	N	inherited	18400	83.5	400	1.27	BDL	2.98	0.052	0.78	4.24	0.228	25	6.42	49	12.9	44.8	6.85	54.4	8.5	14500	1.78
66	N	inherited	19100	74.4	280	1.18	BDL	2.45	0.062	0.54	1.82	0.363	17.8	4.21	37	8.97	33.3	4.81	34.2	5.93	13840	1.21
67	N	inherited	18980	70.5	238	1.18	0.0233	3.11	0.056	1.38	2.24	0.312	17.8	4	31.3	7.1	24.2	4.03	26.2	4.14	15140	1.45
68	Y		18800	66	1670	2.86	BDL	60.8	0.43	9.3	18.4	10.43	70.3	19.7	187	59.9	225	35.7	272	45.6	8130	1.91
69	N		18720	62.7	1398	4.1	BDL	89.5	0.32	6.5	11.8	6.79	53.3	15.25	163.5	46.2	177	34.1	277	44.3	7960	2.19
70	N	inherited	19000	84.8	317.4	1.21	BDL	2.68	0.024	0.92	3.19	0.406	21.6	5.45	41.3	10.81	35.2	5.62	41.8	6.54	13810	1.61
71	N	inherited	17800	76.1	166.3	1.21	BDL	2.69	BDL	0.6	2.35	0.21	12.7	2.88	22.9	5.37	17.8	2.89	20	3.6	15210	1.38
72	N	inherited	19500	84.8	351	1.47	BDL	2.02	BDL	0.65	3.45	0.277	21.1	6.08	49.4	12.2	41.3	6.35	40.1	7.42	14260	1.68
73	N	inherited	18700	67	268	1	0.007	2.53	0.037	1.14	4.4	0.29	21.8	5.03	43	10.1	30.6	4.97	31.4	5.65	14570	1.25
74	N		17500	59.9	1700	4.49	BDL	65.8	1.244	16.2	22.5	11.9	83.4	22.4	217	61.9	250	40.9	307	49.8	7910	1.59
MP-P0913-6 zircon																						
1	N		157000	199.8	N/M	7.21	0.55	36.5	0.99	7.71	8.14	1.46	36.3	10.48	119	45.3	195	39.2	357	59.5	11610	N/M
2	N	inherited	169000	419	N/M	4.31	0.053	20.99	0.253	3.03	9.3	0.89	46.6	16.66	180.1	70.8	297	61.2	572	99.9	11770	N/M

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
								MP-P0913-6 zircon CONT'D														
3	N		162200	780	N/M	4.74	19	240	18	63	27	8.2	59	13.1	97.7	29	104.4	17.4	147	22	9300	N/M
4	N		160000	97	N/M	2.5	0.131	101.2	2.31	21.8	34.7	16.3	124.1	28.3	224	66.1	223	37.1	290.8	45.2	9480	N/M
5	N		150800	85.8	N/M	3.69	0.38	103.3	0.54	5.78	10.2	4.68	37.5	10.35	84.6	27.7	98.2	17.32	142.3	21.8	9960	N/M
6	N	inherited	160000	321	N/M	8.75	0.05	37.4	0.298	4.17	10.22	2.44	58.3	19.2	204	80.9	352	72.7	692	118.8	10410	N/M
7	N		162000	181	N/M	3.5	1.2	58	3	19	11	4.1	36.1	7.9	73.9	24.3	87	15.49	150	23.8	10000	N/M
8	N		149000	164	N/M	3.7	1.18	44	2.4	14.3	9.8	3.36	35.3	7.93	69.4	22.7	87.6	17	143	23.1	10650	N/M
9	N	inherited	148000	46.9	N/M	0.64	0.196	8.5	0.526	2.28	1.16	0.46	3.68	1.16	15.58	7.07	40.2	10.19	119.5	23.7	14030	N/M
10	N		152800	86	N/M	2.32	4.07	56.7	4.16	19.6	8.66	3.68	17.8	3.91	37.7	15.4	80	18.9	245	47.3	9020	N/M
11	N		171000	115	N/M	4.46	12.2	104	7.7	45	22.6	9.48	39.5	8.73	73	25.3	121	25.6	267	52.4	12260	N/M
12	N	inherited	163000	72	N/M	0.98	0.38	13.6	0.41	3.1	3	1.45	13.1	3.89	37.3	14.43	68.7	15.3	164	34.4	11440	N/M
13	N		157000	93.6	N/M	14.62	0.0253	123.4	0.339	4.27	10.8	5.69	51.1	16.74	162.5	57	229.8	42.9	362	58.2	9550	N/M
14	Y		150000	108	N/M	4.18	0.093	139	1.44	18.9	34.9	19.5	134.8	35.9	291	90.7	318	55.4	430	65.1	7980	N/M
15	N	inherited	158000	125	N/M	1.016	0.0091	1.56	0.028	0.47	2.06	0.241	12.9	4.03	30.2	7.88	26.9	4.55	36.6	5.25	13230	N/M
16	N	inherited	154300	177	N/M	1.27	0.171	4.34	0.211	1.75	2.03	0.364	13.56	5.85	63.6	22.9	104	24.7	249	49	13780	N/M
17	N		174700	150	N/M	5.51	0.2	159	0.79	10.8	19.5	9.62	68.5	16.2	132.4	43.2	140.5	25.8	196	30.1	9350	N/M
18	N		156000	183	N/M	8.7	0.096	136.8	1.362	22.1	27	11.53	92.3	23.6	187.3	58	201.4	33.4	263	41.3	9890	N/M
19	N	inherited	178000	178	N/M	6.49	0.048	38.5	0.512	9.23	20.2	2.65	96.4	29.7	312	121	511	96.9	854	160.1	9850	N/M
20	N	inherited	166000	69	N/M	1.16	0.0121	15.4	0.091	2.26	4.8	0.89	26.8	8.1	89	34.8	153	30.3	279	49.9	11160	N/M
21	N		162000	71.6	N/M	4.28	1.011	96	1.02	10.26	10.47	5.39	35.5	8.31	68.7	20.6	74	13.3	107.9	17.7	8730	N/M
22	N		174100	117	N/M	5.88	0.106	156.1	0.79	14.4	24.4	11.7	80.2	18.3	144	42.9	153.2	25.9	200	30.9	8580	N/M
23	N		161200	120	N/M	5.23	1.13	157	1.71	16.9	17.8	7.31	58.1	13.01	95.8	30.7	101.9	18.9	152	23.43	9000	N/M
24	Y		164000	92	N/M	3.27	0.158	143.6	1.3	23.2	43.7	20.3	145.1	32.9	254	70.2	252	39.3	312	50.4	8330	N/M
25	N		150900	84.2	N/M	2.71	0.131	109.7	1.3	20	31.1	13.8	120.9	28.1	226.4	67.9	236.2	38.3	310.4	51.7	8790	N/M
26	Y		158100	77	N/M	2.72	0.033	99.4	0.304	5.63	9.96	4.41	36	9.01	74.3	23.6	89.1	15.05	127.4	20.7	9110	N/M
27	N	inherited	151000	92.4	N/M	1.72	0.11	18	0.153	1.51	3.02	0.594	13.6	4.9	51.1	20.7	96.3	20.56	195.7	36.6	9310	N/M
28	N		156600	151	N/M	3.39	0.77	30.1	0.85	7.5	6	1.69	23.8	7.76	86.7	36.2	171	35.8	348	62.8	9630	N/M
29	N	inherited	152000	190	N/M	3.83	0.021	86.7	0.185	3.48	7.95	1.096	32.3	10.62	112.6	43.3	202	40.5	362	66.7	11180	N/M
30	N	inherited	167700	66.4	N/M	1.23	0.03	8.74	0.0322	0.63	0.93	0.288	5.33	1.97	23.9	11.1	52.2	13.11	128.8	25.8	13990	N/M
31	Y		153000	106.4	N/M	2.03	0.0151	55.2	0.16	3.86	6.88	3.07	22.9	6.42	59.4	18	71.4	13.84	120.6	21.2	9190	N/M
32	N		151000	114.4	N/M	3.56	0.64	74.4	1	8.4	10.06	3.66	29.2	7.89	63.2	21.6	87.1	16.06	142	25.8	9520	N/M
33	N		168000	128	N/M	1.23	0.08	4.6	0.095	0.89	2.91	0.172	12.7	4.02	31.7	9.93	32.1	5.69	41.1	5.77	13500	N/M
34	N	inherited	162000	107	N/M	0.87	0.022	2.99	0.019	0.64	2.26	0.204	11.14	3.7	32	8.7	28.5	4.69	34.4	5.14	13500	N/M
35	N	inherited	153000	163.5	N/M	2.51	0.049	12.75	0.203	2.72	5.09	0.356	25.6	9.36	112.5	42.7	201.7	42.4	366	64	10260	N/M
36	N		168000	97.9	N/M	4.4	0.647	34.5	1.361	9.3	5.32	0.85	15.3	4.79	53.4	21.8	96.3	20.5	192	30.2	12000	N/M
37	N		155000	206	N/M	3.59	2.22	65.6	5.16	30.9	11.7	2.89	16.8	4.57	47.7	16.02	75.5	15.2	149	22.6	14980	N/M
38	N		171000	85	N/M	3.32	0.48	138	1.32	8.9	12.6	6.06	45.1	11.86	107	33	124.5	22.24	183	29.7	8950	N/M
39	N		159000	138	N/M	7.19	3.1	309	6	46.3	58.9	24.7	167.6	39.1	331	99.8	342	60.1	463	74.5	7530	N/M
40	N	inherited	151000	314	N/M	4.42	0.0041	7.2	0.043	0.8	3.56	0.492	28.6	11.11	128.9	48.5	227.5	46	453	81.7	13080	N/M
41	N		153000	192	N/M	3.84	1.296	31.3	2.86	14.6	11	2.46	47.3	14.9	174	65.8	287	55.7	499	82	9910	N/M
42	N		149000	104	N/M	4.3	0.28	60.4	0.8	5.1	7.17	5.06	38	12.04	127	41.4	178.8	35.2	303	45.9	6930	N/M
43	N		163000	99.8	N/M	4.54	1.07	53.4	2.07	9.37	7.35	4.07	27.6	8.41	95.9	32.7	137	26.6	231	38.1	6730	N/M

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
									MP-P0913-6 zircon CONT'D													
44	N		149000	109	N/M	4.02	1.36	74.2	2.87	12.6	10.14	5.96	35.3	10.3	88.3	29.3	115.4	20.34	180.7	28.3	6440	N/M
45	N	inherited	155500	118	N/M	2.26	0.5	10.6	0.95	4.1	6.5	1.53	27.9	7.39	55.7	13.15	41.4	6.67	50.7	6.68	13230	N/M
46	N		158000	196	N/M	4.15	1.21	26	2.5	11.8	12.9	3.2	50.5	13.44	101	24.9	79.5	11.19	88.7	13.3	12360	N/M
47	N		164000	122	N/M	3	0.331	53.9	0.872	5.76	7.44	2.84	28.7	7.61	66.5	21.1	81.8	15.62	131.5	22	10780	N/M
48	N	inherited	152000	164	N/M	1.68	0.127	10.2	0.159	0.83	0.97	0.288	6.15	2.95	43.4	19	106.4	29.6	328	60.7	13040	N/M
49	N		160000	142.1	N/M	12.6	2.18	53.2	3.62	17.8	13	4.2	30	8.18	83.5	33.7	163	35	358	72	11510	N/M
50	N		147000	1260	N/M	11.98	5.04	79.6	7.91	46.3	36.8	5.04	43.1	8.2	71.4	22.08	97.6	19.69	188	34.7	11580	N/M
51	N	inherited	150200	164	N/M	8.1	0.025	7.27	0.097	1.87	4.31	0.75	31.3	11.5	141	53.3	231	44.3	402	71	10250	N/M
52	N	inherited	152800	208	N/M	7.2	0.151	21.2	0.97	9.5	8.66	2.12	15.8	5.59	68.3	27.38	140.2	33.9	348	62.1	14310	N/M
53	N		167000	159	N/M	11.5	1.53	37.9	1.9	17.13	17.04	5.07	37.8	10.45	106.9	39.1	178	39.3	384	68.9	10850	N/M
54	Y		143200	66.7	N/M	2.04	0.0138	47.4	0.234	4.24	6.9	3.56	24.9	6.61	58.1	19.2	78.6	15.63	144	22.74	7900	N/M
55	Y		159000	78	N/M	2.33	0.01	48.9	0.194	3.99	5.74	3.5	23.3	6.57	62.6	20.37	83.3	15.98	146.4	24.3	8340	N/M
56	N		153400	148.9	N/M	2.03	1.36	22.7	1.56	11.21	9	2.79	23.3	8.2	65.8	12.64	26.4	2.94	16.8	2.27	14290	N/M
57	N		153200	172	N/M	3.22	0.76	11.9	0.51	8.8	11.8	4.3	30.1	10.1	95	22.6	64.4	9.4	67.3	10.4	14450	N/M
58	N		160000	82	N/M	6.19	0.546	137.9	1.329	15.6	18.07	7.09	49.8	11.25	95.8	26.4	97.5	17.04	128.2	21.61	9640	N/M
59	N		155000	138.6	N/M	9.22	0.614	125.8	1.36	13.24	14.78	6.5	48.4	12.06	105	33.1	136.1	26.6	245	38.9	9200	N/M
60	N		164500	82.2	N/M	8.12	0.048	213.8	0.697	15.3	24.8	12.4	102.1	28.4	240	73.6	279.9	50.2	386	62.7	10410	N/M
61	N		165600	74.8	N/M	6.69	0.145	204	0.93	16.8	19.57	9.69	73.4	20.53	166.9	51	194.8	35.7	269	46.5	10040	N/M
62	N	inherited	157000	179	N/M	2.98	1.16	26.5	1.6	15.8	9	1.65	32.4	10.62	92.2	27.8	99.8	18.2	140.4	22.2	16470	N/M
63	N	inherited	155000	87.3		1.51	0.0079	3.94	0.0236	0.69	2.67	0.384	18.6	5.86	52.3	16.21	52.8	8.26	56.7	8.58	15470	N/M
64	N	inherited	154900	94.4	N/M	2.68	0.577	20.99	0.97	11.3	7.12	1.54	25	6.41	55.3	15.1	49	7.68	55.5	7.9	14830	N/M
65	N	inherited	158700	221.9	N/M	1.93	0.0101	7.3	0.056	2.36	9.9	0.76	61.9	19.6	170	52.5	190.5	33.6	254	42.1	14430	N/M
66	N	inherited	152000	223	N/M	1.69	0.0251	6.58	0.073	2.46	9.63	0.784	59.7	18.96	161.2	51.8	188	32.7	257	43.8	15130	N/M
67	N	inherited	155000	115.3	N/M	1.08	0.0077	1.81	0.0218	1.04	3.49	0.27	22.6	6.97	57.5	16.56	56.5	9.1	72.5	11.25	15170	N/M
68	Y		156700	115.1	N/M	3.75	0.0162	53.5	0.18	5.62	8.26	5.16	33.9	10.11	84	26.6	111.1	21.2	175	28.6	8610	N/M
69	Y		162300	102	N/M	3.45	0.077	69	0.85	19	27.1	14.5	82.8	21.9	170	50.6	191.5	34.1	265	43.6	8310	N/M
70	N	inherited	156500	100	N/M	1.53	0.0057	5.97	0.0168	0.75	2.8	0.307	19.2	7.5	70.2	24.6	96.7	19.13	164.2	29.9	14500	N/M
71	N	inherited	162300	195	N/M	2.74	0.63	30	0.99	12.4	7.4	1.33	35.3	13	138	43.9	192	36.4	328	58	14230	N/M
72	N	inherited	164000	114	N/M	2.15	0.0045	7.72	0.038	1.18	3.48	0.316	22	8.01	82.8	27.5	105.3	20.2	183.1	34.3	13920	N/M
73	N		168200	138	N/M	5.68	0.404	103.8	0.89	14.83	13.3	6.4	41.4	11.56	95.5	30.35	118.5	22.8	200	32.2	9260	N/M
74	Y		165500	117.6	N/M	4.77	0.064	97.8	1.132	27.1	30	15.07	97.2	25.25	203.1	59.1	221.8	41	341	55.1	8810	N/M
75	N		165300	96.7	N/M	18	0.272	215.3	1.038	18.1	23.7	13.83	98	26.76	223.9	67.1	246.3	42.5	318	49.1	10110	N/M
76	N		168100	77.4	N/M	3.7	0.076	142	1.56	32.8	42.3	20.7	139	34.9	271	74.4	265	43.6	352	53.6	8170	N/M
77	N		175100	94.8	N/M	6.9	1.24	205	2.83	51.3	71.5	33.1	222.1	51.3	405	104.6	363	60.4	470	72.6	9400	N/M
78	N		162500	84.6	N/M	3.4	0.0317	130.9	0.548	11.02	14.3	6.65	50.2	12.96	107.3	31.1	116.5	19.4	163	25.82	9310	N/M
79	N		150000	107	N/M	5.4	0.047	122	0.685	12.7	16.4	8.07	57.6	14.8	123.3	33.2	123.7	21.9	189	28	8190	N/M
80	Y		154800	79.9	N/M	2.82	0.0074	79.9	0.303	6.2	8.81	4.26	30.8	8.47	76	21.4	81	15.52	126.6	20.95	9900	N/M
81	N		163000	71.4	N/M	10.9	0.67	85	1.45	17.5	16	7.39	39.1	10.32	88.1	25.4	92.6	16.96	147.7	24.4	7870	N/M
82	N		158000	64.7	N/M	2.56	0.0061	65.7	0.264	5.77	8.81	4.13	29.5	7.99	75.8	21.1	82.3	15.54	129.7	21.1	8020	N/M
83	N		185000	66	869	3.03	0.36	83	0.79	8.9	13.6	5.85	47.1	11.5	94	26.5	111	20	190	27.5	7750	2.53
84	N		169000	72	907	4.34	1.4	103	1.43	14	14.9	4.82	45.4	11.5	98	29.2	127	21.6	209	29.9	9190	2.84

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
								MP-P0913-6 zircon CONT'D														
85	N		160400	118	1610	17.8	2.78	192	1.73	15.5	18.5	7.8	67.6	17.1	179	51.8	209	42.8	322	54.2	8030	6.4
86	N		171000	80	1420	4.8	3.96	141.7	3.2	27.2	30.2	11.8	95	20.1	190	49.5	156	28.1	211	36.9	8700	2.47
87	N		141000	51	1224	3.2	1.5	79	2.05	17.8	22.6	10.3	80	16.6	155	39.3	167	32.7	226	33.2	8100	2.2
88	N		157000	86	1860	4.03	0.66	123	1.39	18.8	32.1	16.4	114	30.1	226	71.2	210	36.1	410	41.4	8100	3.8
89	N		166000	94	2040	3.45	0.44	115	1.27	17.8	34.3	18.1	144	28.9	216	72.3	211	38.2	325	43.2	7750	3.58
90	N		167000	76	1651	3.36	0.86	116.7	1.92	24.5	39.6	18.6	136.4	27.4	205	63.7	216	34.8	299	44.5	7900	2.76
91	N		176000	72	1830	2.21	0.48	113.4	1.42	22.1	39.1	18.1	135	27.6	243	58.5	207	40.1	333	46.7	7400	2.04
92	N		161000	83	455	1.86	0.045	41.6	0.211	3.9	5.82	3.39	24.2	5.53	47.6	15.5	62.4	12.6	109	18	7990	1.83
93	N		182000	54.6	416	1.56	BDL	37.5	0.175	3.15	4.37	2.27	19.3	4.99	46.5	14.2	57.8	10	116	13.5	7640	1.47
94	N		171000	99	1037	8.4	BDL	226	6.72	52	27.9	13.8	68.1	13.8	114	33.3	127	26.8	185	28.9	8100	3.4
95	N		176000	58	939	6.07	BDL	188	3.01	21.8	18.2	6.98	52.2	12.1	107	29.1	108	22.5	173	20.1	7130	2.2
96	N		163000	99.6	1175	7.04	BDL	206	0.654	8.3	19.6	10.5	76.8	16	154	44.3	152.6	25.9	256	33.7	7980	4.72
97	N		135000	79	1117	5.85	BDL	160	0.573	7.3	12.8	7.44	65.1	15.3	124	37.2	143.6	24.4	234	30.3	8320	3.06
98	N		134000	77.2	2240	5.7	BDL	162	1.86	29.7	57.5	28.1	180	42.6	318	87.6	272	42.2	416	55.7	8060	3.4
99	N		172000	86	850	3.45	BDL	111	2.35	16.6	13.5	6.75	54	11.4	87	26.2	103	16.2	218	19.6	7880	1.76
100	N		169000	61	1700	4.16	BDL	127	1.023	15	21.6	11.2	85.5	24.5	180	59.1	189.9	38.8	321	40.1	7820	2.89
101	N		157000	68	536	2.56	BDL	68.9	0.128	4.21	6.6	3.09	29.1	6.62	56.9	18.2	73.3	12.6	141	16.9	9120	2.77
102	N		171000	105	1110	6.7	BDL	109	3.2	29	27	12	71	16.1	120	40.9	119	25.8	264	35.4	7640	2.36
103	N		155200	167	1450	16.5	BDL	223	3.19	28.1	36.9	16.4	95.5	21.3	173	53.2	177	34.8	294	45.5	6880	5.27
104	N		152000	82	882	5.09	BDL	168	4.98	38.4	25.6	10.13	72.8	12.4	114	34.4	110.8	22.5	175	27.3	7940	2.71
105	N		175000	63	575	2.28	BDL	83.8	0.37	4.89	9.5	3.89	33	7.06	62.3	20.4	68.3	12.4	116.7	15.4	9080	1.35
106	N		158000	73	2020	4.73	BDL	162	1.41	19.2	39.4	15.4	125	29.5	233	77.6	236	43.5	367	55.3	7990	2.78
107	N		159000	66	1360	3.49	BDL	157	1.11	17.4	30	12.2	100	21.7	177	51.3	148	26.8	251	35.5	7780	2.04
108	N		142000	59	679	3	BDL	98	0.475	7.3	12	4.2	36.7	8.66	80.4	23.3	79	15.4	137	17	8830	2.3
109	N		164000	129	2760	5.29	BDL	191	1.97	27.6	49.7	24.9	159	38.9	341	102	297	56.9	441	72.2	7590	3.64
110	N		171000	105	1820	6.41	BDL	170	1.13	17.4	30	12.9	107	24.3	213	55	215	35.6	303	46.8	8510	4.2
111	N		160000	60	720	2.98	BDL	71.9	0.489	6.75	7.5	3.81	33.8	7.6	75	21.9	82.8	14.7	150	23.8	8660	1.99
112	N		167000	65.8	1900	2.87	BDL	106	1.76	20	34.6	16.2	139	27.9	230	64	219	37.2	310	38.4	8170	2.37
113	N		145000	73	1930	3.06	BDL	136	1.59	23.7	42.6	15.9	131.3	28	234	65	197	34.3	314	44.2	8840	2.35
114	N		149000	69	785	6.5	BDL	117	1.91	12.3	10.5	5.17	37.5	10.1	77.3	21.8	86	15.9	158	21.4	8930	3.14
115	N		149000	100	1034	3.82	BDL	150	0.74	10.4	16.7	7.48	63.8	13.5	120	30.4	132	20.3	175	24.8	7970	2.23
116	N		159000	87	856	3.47	BDL	69.2	0.42	4.89	8.7	3.88	34.8	8.3	74.2	24.1	95.3	20.1	199	29.8	7410	2.83
117	N		147000	146	1501	9.8	BDL	158	1.48	14	19.1	8.5	73.5	20	167	45.6	182	35	295	40.5	8620	5.6
118	N		155000	72	1450	4.68	BDL	138.7	0.81	11.9	24.8	9.3	99	21.52	176	49.9	161	29.4	235	37.5	8710	2.61
119	N		142000	65	647	2.87	BDL	96.6	0.34	5.56	8.8	3.9	32.8	8.19	68.5	19	79.7	13	121	16.8	8450	1.86
120	N		136000	65.1	1780	6.3	BDL	128	3.06	35.1	42.4	15.7	137	30.8	205	56.2	203	31.2	286	44.4	8860	2.22
121	N		156000	61	2100	3.8	BDL	152	2.16	27.7	40.4	17.4	131.3	33.8	276	67.7	256	40.6	338	43	8310	2.5
122	N		139000	60	709	2.48	BDL	105	0.427	6.1	9.8	4.69	39.3	7.25	77.2	20.3	70.8	13.2	112	15.6	8700	1.77
123	N		138900	74	608	2.16	BDL	51.9	0.55	5.2	7.2	3.38	28.9	7.88	70.4	18.8	76.1	14.1	143	22.8	8060	2.18
124	N		131000	55	315	1.03	BDL	44.7	0.117	1.68	3.21	1.61	16.2	4.06	35.2	9.84	45.9	7.15	62	9.1	8800	1.27
125	N		167000	72	868	3.55	BDL	130	1.38	15.1	16.3	6.2	47	11.5	98.4	24.7	86.3	16.3	132	19.7	8570	1.64

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-P0913-6 zircon CONT'D																						
126	N		103000	131	1250	N/M	83	209	8.8	83	86	40	124	21.9	148	36.7	141	23.9	205	32.6	7600	N/M
127	N		175000	430	1250	N/M	137	298	16.25	103.2	63	25.9	105	20.6	162	41.7	148.4	28.3	252	36.9	9400	N/M
128	N		110000	119	700	N/M	28	112	5.5	41	34	12.5	60	10.2	80	22.3	81	15.4	118	20.4	7120	N/M
129	N		146000	65.9	604	N/M	1.49	70.5	0.79	7.1	7.5	4.21	29.7	7.15	63.1	19	73.9	13.7	125	20	8270	N/M
130	N		149000	2380	1207	N/M	350	738	73.7	298	66.6	19.5	126.7	21.9	164	41.5	143	23.91	213	30.4	7300	N/M
131	N		142000	58	439	N/M	12.9	89	3.2	21.6	13.8	6.1	28.9	6.6	47.6	13.8	50.5	10.5	97.6	15.5	8200	N/M
132	N		133000	60.7	735	N/M	0.547	66.8	0.542	7.27	8.09	4.22	36.1	8.62	74.1	22.4	87.8	17.8	149.6	24.78	8430	N/M
133	N		124500	57.1	688	N/M	0.55	67.2	0.651	7.08	8.86	4.1	35.1	8.72	71.9	21.1	80.4	14.8	124.7	21.3	9190	N/M
134	N		123000	62.7	650	N/M	8.1	98	2.77	26.2	18.6	6.8	39.5	8.3	65	19.3	69	13.3	119	17.5	7700	N/M
135	N		89000	7900	907	N/M	704	1140	119	540	115	20.9	118	19.4	120	29.9	95	16.77	137	22.2	8100	N/M
136	N		167000	61.1	709	N/M	4.05	111	2.13	18.7	14.9	4.77	39.9	9.08	77.4	24.8	86.9	16.4	145	20.5	9030	N/M
137	N		153000	61.4	665	N/M	6.03	102.1	2.85	20	15.3	5.77	34	8.34	65.6	22.2	77	16.4	124	19.8	8780	N/M
MP-P0913-10A zircon																						
1	N		164000	21.2	720	N/M	61	138	8.1	47	37	12.5	53	10	91	23	83	13.8	116	17.3	5860	N/M
2	N		191000	19.3	556	N/M	47.6	98	5.84	37.1	27.6	9.8	41.4	8.38	68	17.9	61.2	11.9	94.8	15	5170	N/M
3	N		185000	26.9	642	N/M	69.3	118.2	7.4	47.6	29.2	11.4	51.1	9.43	72.5	19.4	77.5	13.42	126.1	18.6	5800	N/M
4	N		183000	106	820	N/M	129	169	11	55	31.7	12.4	53.1	11.87	103	26.2	85.2	15.9	115	16.8	8600	N/M
5	N		183000	23.4	886	N/M	63.6	129.27	6.83	43.8	30.5	11.7	67.9	14.5	120.8	30.5	101.3	17.1	132	21	7600	N/M
6	N		187000	18.9	707	N/M	102	146.9	9.16	55.2	31.2	10.92	53.5	10.98	87.3	23	75.8	13.4	100.8	14.5	6370	N/M
7	N		165000	27.5	976	N/M	334	264	21.7	107	50	18.5	67	15.5	116	33.2	110	19.1	147	20	8400	N/M
8	N		172000	26	494	N/M	21.6	44.3	2.05	12.9	10.93	4.9	24.5	6.27	50.1	18.2	57.8	10.78	95.3	12.5	10810	N/M
9	N		167100	29	533	N/M	32	77	3.68	23.6	18	6.6	32.6	8.4	64.3	15.8	53	9.1	72	11.2	8210	N/M
10	N		198000	29.9	760	N/M	36.6	116	6.33	37.2	26.9	11.08	49.2	12.3	92	23.3	81	14.8	129	16.4	8500	N/M
11	N		178000	33.4	940	N/M	157	246	16	84	51	26.5	87	18.6	139	31.1	94	14.8	127	18.9	8580	N/M
12	N		147000	34.8	1215	N/M	151	200	14.7	98	45.7	18.8	82.2	16.8	133	40.4	152	27	248	35.7	5870	N/M
13	N		186000	28.6	366	N/M	2.66	28.5	0.597	5.1	6.44	2.99	19.9	4.88	40.5	11.91	43.3	7.85	68.8	9.41	10800	N/M
14	N		197500	24.2	277	N/M	4.94	26.4	0.65	5.7	6.38	2.55	15.5	3.41	31.2	8.8	35.6	6.66	58.9	8.18	8480	N/M
15	N		199000	33.5	667	N/M	59	109	5.1	31	21	9.8	42.3	9.4	86	20.7	77.9	16.7	120	16.2	10300	N/M
16	N		193000	22.8	216	N/M	2.77	15.71	0.395	3.55	3.91	1.531	10.3	2.58	23.07	6.92	27.9	5.65	49.8	7.41	9440	N/M
17	N		202000	20.1	173.7	N/M	0.53	12	0.055	0.46	0.91	0.68	5.67	1.44	17	5.33	22.7	4.6	39.8	5.59	9950	N/M
18	N		187000	30	770	N/M	91	113	6.7	44.1	30.2	14.9	64.3	12.2	99	25.5	80.6	14	119	16.58	6000	N/M
19	N		197000	35.9	680	N/M	22.6	70.2	3.05	21.1	19.7	8.4	44.6	9.53	79.4	22	76.6	13.5	112	15.4	9990	N/M
20	N		135000	26.2	358	3.94	0.52	32	0.94	10.4	4.58	3	16.4	3.81	35.5	9.4	40.4	7.1	59	8.8	7510	1.65
21	N		143000	40.4	470	5.63	0.151	48.9	0.65	7.1	8	3.95	20.7	5.77	43.2	13.6	55.7	10.94	86	11.1	9470	9.06
22	N		164000	31.4	487	4.84	0.53	53.1	1.93	20	11.5	6.8	29.5	5.6	48.3	14.6	52.9	11.2	103	14.7	9410	4.8
23	N		131000	34.2	123	0.92	0.033	9.54	0.089	0.91	1.06	0.6	4.24	1.22	13	4.24	15.5	3.86	31	4.75	6540	1.02
24	N		140000	39.5	1400	17.2	16.6	295	19	119	49.4	23.3	99.7	20.6	177	48.6	153	29.3	235	33.8	8020	11.2
25	N		159000	46	346	3.47	0.315	32	0.68	7.66	4.42	2.66	17.3	4	36	11.6	43.4	7.35	68.9	9.6	9010	4.42

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
									MP-P0913-10A zircon CONT'D													
26	N		158000	33.2	166	1.22	0.024	13.1	0.067	0.82	1.01	0.72	4.6	1.474	15.2	5.02	21.7	4.26	38.2	5.47	8290	2.74
27	N		172000	43.4	141.5	1.57	1.35	31	0.79	4.2	1.8	1.1	6.3	1.497	16.4	4.64	18.9	5.08	39.5	5.74	7000	1.85
28	N		142000	35	169	2.2	0.42	20.7	0.448	3.1	1.62	0.81	6	1.48	14.5	5	19.3	3.97	35.8	6.23	7890	2.73
29	N		143000	90	984	13.6	7.55	205	15.3	110	54.8	25.9	97.6	16.5	128	32.6	120	19	159	22.9	6560	2.47
30	N		167000	38.2	681	5.19	1.89	86	4.33	40	28.2	13.6	56	10.2	74.9	18.8	73.6	14.8	99.9	16.8	7930	3.14
31	N		160000	33.5	225	1.11	0.0235	13.9	0.038	0.57	0.98	0.85	7	2.25	24.6	6.83	31.4	5.81	61	7.8	10070	3.81
32	N		144000	31.4	159	0.734	0.0221	8.6	0.021	0.3	0.52	0.41	2.82	0.94	12.5	4.42	23.6	5.19	49.8	7.34	6560	0.134
33	N		158000	38.6	277	1.04	0.0143	12.1	0.014	0.73	1.06	0.61	5.4	1.93	22.2	8.8	35.9	8.32	76	13.5	6170	0.27
34	N		128000	40	427	1.78	1.01	66	2.77	33	21.5	8.4	35.2	5.37	44.6	11.3	47.3	9.95	69.1	10.4	6200	0.47
35	N		167000	31	426	2.42	1.33	77	3.88	34.8	17.5	6.5	30.5	5.28	44.6	13.5	51.3	10.09	82	13.1	6300	0.62
									MP-P0913-10B zircon													
1	Y		176600	22	219.5	0.92	0.7	14.6	0.04	0.35	0.46	0.32	3.38	1.35	16.5	6.52	31.2	7.14	71.7	12.5	7650	0.23
2	N		185000	63	327	328	1030	185	16.9	46.9	9.8	3.96	19.4	4.79	37.1	10.7	37.9	7.36	65.9	10.88	14400	225
3	N		167000	51	455	339	828	169	16.05	47.7	14.1	5.19	25.7	6.5	54	14.5	52.3	9.4	85	13.3	14310	233
4	N		175000	53	220	118	3030	539	46.5	158	31.6	8.3	25.6	3.41	23.3	5.5	22.8	5.53	63.2	10.93	17320	60.3
5	N		169000	64	365	110	315	122	6.98	18	8.6	4.01	19.8	5.1	41.3	10.34	38.9	7.17	62.5	10.19	12960	60.2
6	N		180000	69	90.9	426	2104	277	25.1	67.2	9.5	2.15	5.78	1	7.99	2.16	10.3	2.44	24.4	4.1	18140	175.6
7	N		178300	40	677	8.34	28	57.1	4.04	18.6	10.4	4.9	23.9	6.11	63.7	18.5	83.9	16.8	141.2	21.7	7280	0.24
8	N		167000	71	348	1140	5550	1030	94	238	28.2	7.8	16.3	2.54	22.3	7.16	38.2	9.8	103	16.3	11230	152
9	Y		169000	39	164.2	13.5	174	324	17.95	62.1	10.1	2.28	8.8	1.48	12.7	4.5	20.4	4.94	48.2	8.35	12560	4.23
10	Y		166000	26	369	0.63	0.14	14.33	BDL	0.24	1.06	0.73	6.77	2.38	26.8	10.97	51.9	11.29	112.7	19.4	6000	BDL
11	Y		164000	30	106.2	91.2	9750	2730	285	808	87.3	15.4	37	2.85	12	2.65	10.1	2.24	25.5	3.89	18700	28.3
12	N		162000	43	153.6	562	1473	249	22.4	56.8	8.1	2	9.4	1.78	14.2	4.11	16.3	3.22	35.7	5.06	15320	72.8
13	N		157000	14	422	44.7	48.9	97.1	7.89	20.1	8.51	3.09	15.3	4.65	44	12.26	46	9.09	83.8	12.73	16280	41.2
14	N		185000	19	1130	31.4	318	210	15.9	66	24.7	12.8	51.6	15	139	35.3	136	25.2	245	43	15450	9.9
15	N		150000	13	1041	36.5	239	195	16.51	62.8	28	12.49	55.4	14.26	128.2	32.5	121	24.8	206	34.5	13480	16.5
16	N		163000	11	233	20.3	66	57	3.19	12.3	9.7	4.38	17.3	4.35	32.1	7.44	20.7	2.81	23.8	3.44	14110	8.8
17	N		149000	20	247	61	135	51.3	3.7	15.5	10.3	4.08	18.7	4.46	35.6	7.85	21.3	3.59	29	3.71	13330	66
18	N		162000	12	207	789	1221	324	31.6	91.9	13.5	3.23	11	2.02	16.6	4.72	20.2	5.42	60.3	9.76	11810	179.8
19	N		160500	21.8	344	512	531	142.9	12.82	50.7	19.1	6.3	19.4	4.11	32.9	7.98	33.3	7.89	82.3	14.8	9310	106.1
20	N		199000	82	582	1089	8810	7110	487	1539	201.1	57	125.6	13.8	64.3	15.6	54.6	10.2	79.9	13.3	15280	167
21	N		161000	73	458	864	10110	3610	331	916	110.4	31	70.7	8.4	55.7	11.7	40.5	7.13	63.7	9.6	12280	128
22	N		166200	56	1700	284	82.8	263	29.2	133.2	57.8	19.8	80.5	18.02	148.6	38.4	156.4	32	284	39.3	13130	155.8
23	N		166800	28	418	9.2	26.8	43.3	2.17	11.9	4.99	2.34	11.8	2.73	32.2	11.97	54.7	11.38	112.2	19.3	10850	13.1
24	N		190000	51	300	602	1492	66	4.29	8.2	2.78	1.38	6.2	1.72	19.9	6.62	35.1	8	89.8	13.74	15160	310
25	N		172000	34	510	359	2830	666	60.3	153	17.5	4.03	16.6	4.08	40.1	12.22	53.6	12.08	118.3	18.98	13130	228
26	Y		166000	75	203	585	1890	264	25.6	61	9.5	2.81	11.1	2.73	22.9	6.1	22.9	4.65	41.2	7.23	13650	137.3
27	N		170500	62	192	1287	2560	434	39.7	105.7	14.6	4.07	11.2	2.04	18.8	5.49	22.2	4.47	43.8	6.82	13520	210

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-P0913-10B zircon CONT'D																						
28	Y		180000	56	111.2	366	740	93	7.9	20.7	3	0.9	3.8	0.95	9.6	2.88	14.1	3.23	31.8	5.61	13700	154
29	Y		175000	21	484	1.64	0.09	20.34	0.089	0.76	2.18	1.23	9.7	3.11	41.3	14.02	67.8	14.85	145.3	22.8	5920	BDL
30	N	old	185000	47	152.7	12.7	203	326	20.7	64.6	10.01	2.38	8.4	1.43	12.3	4.1	19.2	4.35	46.4	7.85	12900	3.76
31	N		173000	66	257	306	532	128	9.6	25	4.9	2.7	6.5	2.214	21.9	6.6	26.4	5.7	56.8	8.4	12740	176
32	N		193000	62	322	695	1334	300	25.5	76.9	17	6.24	24.4	5.67	46.9	11.3	36.2	5.72	50.7	7.16	16280	88.8
33	N		167100	51	990	264	2620	1500	131	436	90	29.3	88.9	19.5	144	31	107	16.1	133	19	14060	54.4
34	N		200000	39	210	830	2930	411	41	95	12.5	3.91	9	2.42	21	6.27	23	4.88	43	8.07	14000	199
35	N	old	178000	56	159.5	587	1540	217	20.5	49	7	2.27	8.1	2.02	16.7	4.17	16	3.16	36.1	5.57	13070	166
36	N		183000	59	857	70.6	2940	1763	136.5	425	71	19.2	58.1	12.2	97	26.6	97.5	18.2	164	26.5	14500	20
37	N		164000	24	698	47.4	7680	1220	118.9	259	33.9	12.2	44.6	10.2	89	26.6	98	16.77	151	25.3	13590	15
MP-P0913-10C zircon																						
1	N		132000	18.88	269	34.7	0.643	25.7	1.7	14.8	4.7	2.09	9.9	2.24	18.9	7.68	28.1	6.43	53.2	7.07	5840	0.27
2	N		170000	29.7	366	0.47	0.04	20.5	0.137	2.33	3.3	1.88	13.9	3.56	37.3	12.1	53.8	10.7	97	16.1	6710	0.35
3	N		155000	22.5	178	0.9	0.0095	7.7	0.012	0.3	0.61	0.43	3.6	1.42	15.9	5.59	23.5	6	47.2	7.65	6610	0.28
4	N		158000	24.2	158	1.67	0.024	9.3	0.046	0.38	0.42	0.244	3.3	0.97	11	4.43	22.6	5.8	50.5	8.19	5990	0.2
5	N		159000	22	125	0.316	0.0114	5.86	0.018	0.3	0.48	0.3	2.24	0.74	11	3.62	16.5	3.92	35.8	5.99	6780	0.047
6	N		163000	27.2	1058	2.42	0.263	48.7	0.339	4.3	5.19	4.63	34.3	10.1	115	40	155	31.4	235	40.5	6830	0.72
7	N		130000	24	181	1.08	0.396	11.7	0.133	0.72	0.53	0.46	3.4	1.03	14.9	5.07	26.2	5.38	53	7.4	6950	0.6
8	N		162000	21.2	155.8	1.07	0.314	22.2	0.97	7.9	2.77	1.42	5.12	0.92	13.1	5	19.9	5.12	49	6.84	6540	0.54
9	N		155000	22.6	219	1.3	0.0133	10.2	0.0094	0.25	0.64	0.46	4.82	0.99	16.7	5.19	27.4	5.23	50.5	7.99	6250	0.22
10	N		162000	31.3	1090	1.83	0.0278	55.6	0.335	5.05	8.5	6.21	42.9	11.1	108	37.1	148.7	33.5	267	38.7	6610	1.06
11	N		179000	31.2	945	2.23	0.401	74.3	1.38	17.9	16	7.87	41.2	9.36	89.9	26.6	121.7	23	204	36.5	6470	1.02
12	N		134000	30.5	321	32	1.3	68.2	2.75	18.3	6.7	2.94	14.3	3.24	33	9.3	49.1	8	65.8	9.9	5690	1.17
13	N		168000	28	415	37.5	1.45	59.8	2.61	19.7	6.6	3.96	14.1	3.15	34	11.69	47	9.3	75	12.2	5920	0.33
14	N		158000	34.8	1490	2.91	0.067	64.9	0.243	3.43	7.1	5.92	45.8	14	143	46.3	206	40.6	315	47.3	5950	1.22
15	N		164000	32.8	340	5	0.19	23.5	0.26	1.61	2.07	1.27	8.4	3.02	30.2	11.37	45.1	9.7	74.4	10.22	7760	0.87
16	N		135500	26	194	6.8	0.155	13.6	0.36	2.7	1.39	0.63	4.7	1.21	14.7	4.93	25	4.93	47.1	6.7	6150	0.27
17	N		19000	25	1360	2.36	BDL	93.6	2.42	28.6	20.7	10	59.4	15.7	137	41.6	177	33.8	274	40.7	7020	1.6
18	N		18000	33.3	1240	2.64	BDL	49.2	0.25	4.48	6.06	3.83	32.6	11.2	120.5	38.9	168	32.6	277	46.8	7360	1.35
19	Y		17950	26	1513	2.07	BDL	65.4	0.5	6.1	14.07	6.89	50.5	13.52	143.7	46.4	180	37.4	314	53.9	6690	0.97
20	Y		17100	30.3	196	1.02	BDL	9.8	0.001	BDL	0.34	0.41	3.39	1.23	13.9	6.19	26.5	5.42	54.2	9.1	8720	0.34
21	N		17400	26.1	615	1	BDL	29.4	0.133	2.66	4.16	2.85	20.6	5.93	57	19.5	81.4	16.45	141.8	26.5	6740	0.65
22	N		18900	22	954	9.44	43.8	84	3.39	23.6	11.2	5.93	33.3	8.7	95	27	132	25.3	201	29	8010	0.81
23	N		17100	27.1	366	2.29	BDL	21.6	BDL	0.1	1.61	0.81	7.2	2.61	31.3	9.56	47.3	9.39	88.4	14.4	9350	0.6
24	Y		18260	24.7	734	2.75	0.027	25.4	0.105	0.89	4	2.34	19	4.97	64.8	20.9	93.3	17.4	155	22.3	8530	0.62
25	N		18000	19.3	226	2.31	0.651	14	0.142	0.93	0.75	0.67	4.5	1.38	15.4	5.71	23.9	5.69	44.3	6.1	7100	0.52
26	N		17600	17	251.1	1.75	0.039	12.03	0.053	0.06	0.35	0.51	5.39	1.86	18.4	6.89	28.3	6.01	52.4	7.03	6950	0.38
27	N		20000	31	365	6.3	0.77	23	0.159	2.3	0.6	1.12	8.5	2.79	25.7	8.9	47.8	9.5	75.6	10.78	7040	0.79

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-P0913-10C zircon CONT'D																						
28	N		16500	32.1	252	9.28	0.59	21.7	0.66	8.2	3.3	1.23	8.2	2	22.7	8.23	36.9	7.77	62.4	8.7	7080	0.45
29	N		17400	29.8	215	1.59	0.104	10.8	0.043	0.31	1.15	0.48	4.6	1.23	16.3	6.74	30.2	6.45	48.4	7.75	7170	0.43
30	N		17400	35.3	155.4	0.92	0.153	7.99	0.051	1.11	0.56	0.31	2.48	1.04	11.2	4.32	23.1	4.86	46	6.7	6850	0.27
31	N		17700	26	308	8.49	0.71	20.1	0.496	3.07	2.79	1.35	5.9	2.1	25.7	8.46	37.5	7.64	69.5	9.8	7610	0.43
32	Y		17490	30.4	273	1.58	0.199	11.21	0.018	0.52	1.25	0.64	5.7	1.93	24.4	9.03	41.5	8.36	71.5	11.2	8690	0.63
33	Y		17800	30.5	180	1.25	0.048	8.87	BDL	0.03	0.38	0.34	3.4	1.24	14.5	6.12	29.4	7.06	56.2	9.4	6070	0.42
34	N		15300	30	164.1	1.2	BDL	9.82	0.022	BDL	0.43	0.16	4.3	1.3	11.2	3.83	19.5	5.77	46.9	5.8	8080	0.65
35	N		18700	32.6	589	1.22	0.013	30	0.182	2.5	4.66	2.69	21.9	5.62	63.1	21.1	79.3	17	135	22.5	6880	0.51
36	Y	old	17300	28	187	0.68	0.031	9.92	0.047	0.67	0.57	0.66	5.6	1.38	18.1	5.26	25.8	5.73	46.1	8.2	7400	0.51
37	N		14100	7.8	409	4.11	0.025	25.2	0.076	0.79	1.31	1.17	10.3	3.8	31.6	11.4	49.2	9.18	85	12.1	5800	1.12
38	N		17500	18.5	233	2.08	0.008	12.67	BDL	0.45	0.55	0.55	5.4	1.83	20.9	7.51	33.3	6.67	57	8.53	8440	0.5
39	N		15500	17	212.4	4.03	0.046	13.69	0.053	1.07	1.04	0.41	4.3	1.24	17.6	5.54	27.3	5.87	52.5	6.63	7390	0.61
40	N		17700	4	223	1.54	0.038	9.6	0.038	0.28	0.07	0.23	4.71	1.42	18.4	7.03	25.8	6.1	54.8	8.27	8480	0.54
41	Y		16300	11	239	1.77	0.015	12.06	0.031	0.51	1.08	0.67	4.8	1.65	20.4	7.24	29.5	6.82	64	7.7	7170	0.46
42	Y		16690	21.3	382	2.65	0.01	16.3	0.029	0.45	1.46	0.9	8.3	2.33	30.9	9.6	41.1	9.3	67.7	10.23	6940	0.69
43	N		17190	14	175	0.87	BDL	6.91	BDL	0.47	0.69	0.44	2	1.18	12.5	5.32	24.4	5.8	39.3	5.7	7480	0.57
44	Y		17180	29	1565	2.58	0.024	74.5	0.501	8.3	14.7	8.3	58.9	16.83	162.2	47.5	195	40.1	328	53.3	7100	1.01
45	Y		18000	19	226	0.71	0.013	7.1	0.011	0.32	0.64	0.36	4.1	1.59	16	7.01	33.1	8.05	71.2	11.2	7110	0.21
MP-P0714-21 zircon																						
1	N		194000	114	2690	6.29	0.71	228	4.02	69.3	75.8	35.9	184	41.3	347	92.9	344	59.3	476	80.5	8160	4.53
2	N		159000	104	1028	8.3	0.15	113	0.576	11.5	14.1	9	45.1	12.7	112	33	131	25.7	198	36.6	9890	5.9
3	N		183000	102.7	1227	6.24	0.093	143.3	0.66	13	20.3	11.7	57.1	16.5	138.3	39.2	147.7	31.3	253	43.8	8180	4.2
4	N		197000	83	1252	4.95	0.134	105.5	0.842	18.4	21	12.6	66.8	16.7	152	44.7	167	31.4	237	39.4	8980	3.01
5	N		184000	152	2250	14	0.58	474	3.7	81.7	68.9	36.6	163	36.8	299	82.2	267	47.1	361	58.4	6960	5.52
6	N		191000	79	1378	3.72	0.179	110.2	1.095	24	26.4	13.3	69.9	18.2	163	45.6	164	32.5	265	39.8	6890	2.13
7	N		182000	137	2090	10.34	0.323	306	1.96	45.9	51.3	29.5	137.4	32.9	267	74.2	256	45	332	61.9	7060	4.63
8	N		174000	94	1570	3.4	0.223	112.2	1.55	33.4	37.3	18.4	89.2	21.7	176.1	53.7	207	38.2	265	46.1	7440	2.37
9	N		175000	120	1250	6.3	0.06	153	0.464	12.4	21.4	10.7	65	16.9	153	45.5	177	33.6	283	48.4	7650	3.87
10	N		172000	89	1114	4.11	0.058	114	0.456	16	18.2	10.5	58.5	14.3	128.5	39.7	142	28.8	208	42.6	6740	3.06
11	N		176000	109	922	4.4	0.053	108.5	0.38	10.3	15	8.91	50.9	13.1	117.1	36	134.4	23.5	189	37.9	7850	2.42
12	N		176000	122	1694	8.4	0.108	194	0.627	19.5	28.2	15.9	83.7	22.5	197	54.9	222.1	39.6	320	52.5	8370	4.39
13	N		182000	68	541	3.14	0.029	45.3	0.216	6.1	7.5	4.8	23.8	5.94	57.9	16.3	67.2	13.8	114.6	23.8	9990	3.41
14	Y		179000	53.5	334	1.17	0.0085	37.7	0.114	2.41	4.49	2.81	12.7	4.18	38.7	11.5	48.6	10.35	80	16.1	8740	0.94
15	N		182000	125	1790	11.4	0.137	208	0.65	18.7	27.9	15	79.4	22.6	196	60.8	212	41.4	324	59.6	8720	5.6
16	Y		167000	40.1	166.9	1.3	0.0081	24.6	0.036	0.46	1.88	1.09	4.6	1.52	14.6	6.06	22.5	5.59	45.5	7.21	8660	0.98
17	N		171000	76.3	566	3.15	0.0236	62.3	0.2	7.17	10.2	5.1	24.1	7.49	67.2	20.5	74.1	13.9	117.8	22.1	10260	3.01
18	N		174000	84	915	3.6	0.039	98.5	0.282	10.5	14.2	7.74	50.7	11	115.1	31.3	122.9	23.9	196	35.2	8190	2.72
19	Y		162000	53	194.2	0.85	0.0039	25.7	0.032	1.34	2.01	1.25	6.4	2.06	21.6	6.29	26.9	6.09	53.9	8.2	8470	0.65

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
									MP-P0714-21 zircon CONT'D													
20	N		183000	90.1	1128	6.99	0.169	102.1	0.61	17.5	20.1	11.5	46.1	14.1	120.8	36	142	27.5	253	41.5	11850	4
21	N		186000	73	495	1.62	0.009	56.4	0.18	5.2	8.1	4.14	20.5	6.09	57.2	16	60.1	12	103.5	18.2	8720	1.42
22	N		177700	101	1830	3.84	0.112	129.9	1.25	32.5	43.5	20.2	97.6	22.7	194	61.4	214	42.2	371	53.5	8170	2.9
23	N		188000	134	2220	13.1	2.32	280	5.01	100	88	36.7	159	31.6	253	70.7	279	47.7	415	63	9810	8.6
24	N		199500	98	1560	9.6	0.046	147	0.419	13.5	19.8	9.5	53.8	17.7	167	54.2	202	39.6	353	51.9	9370	4.8
25	N		217000	139	1414	7.15	0.059	211	0.633	26.4	40.4	18.6	88	21.9	172	46.1	181	35.1	288	44.7	8860	4.75
26	N		200000	149	3500	9.38	0.95	358	4.63	110.2	115.7	48.7	208	53.8	411	107.8	383	71.2	614	93	8330	5.6
27	N		185000	104	1707	6.02	0.518	192.5	2.1	58.4	54.5	23	91.3	24.2	202	52.2	202.7	36.9	329	48.6	8560	2.75
28	N		186000	100	1350	5.75	0.043	131	0.546	17.4	24	11.9	60.4	17.11	142	42.6	178	28.4	269	39.9	7920	3.45
29	N		165000	68	954	7.3	2.1	116	3.5	50	29	10.2	40	11	102	26.8	116	23.5	180	32.1	9970	2.29
30	N		169000	79	680	2.23	0.04	69.4	0.215	6.97	9.5	5.25	25.8	8.44	75.9	22.3	80	16.9	147	23.1	7480	1.38
31	N		182000	66	1110	7.6	0.055	101.7	0.46	10.2	13.6	9.1	43.3	12.2	116.6	38	144	28	278	35.8	9160	3.93
32	N		172000	112	1542	6.15	0.076	160.3	0.78	21.3	24.3	16.4	73.1	17.7	165	46.6	192	35.4	336	49	8130	4.3
									MP-P0714-26 zircon													
1	N		166000	59.2	131.7	1.39	0.226	13.44	1	8.8	4.26	3.2	9.4	1.77	13.7	4.56	14.5	3.31	27.7	5.17	4720	2.83
2	N		171000	73.2	310	1.72	0.105	10.9	0.57	6.59	6.04	3.46	16.1	3.95	33.5	9.7	37.2	7.85	65.8	13.5	4980	1.97
3	N		163000	68	195	1.01	0.175	16.5	0.59	6.4	4.08	2.6	11	2.37	19.1	5.78	24.7	4.44	45	8.3	4850	1.15
4	N		149000	67.2	198	1.87	0.176	16.2	0.639	7.3	4	3.11	13.7	2.95	25.2	6.46	27.3	4.66	38.1	7.44	6150	3.19
5	N		165000	53.5	250	1.39	0.735	23.6	1.47	12.2	6.07	3.27	14.8	2.92	28.8	7.95	32.3	6.47	63	10.6	6210	3.2
6	N		159000	112	339	0.75	0.039	11.95	0.191	2.78	5.04	2.52	15.4	3.64	31.9	11.6	40.6	8.84	75	14.9	6990	1.57
7	N		166000	111	330	0.98	0.0166	10.36	0.175	2.63	4.15	2.43	15.6	3.81	31.6	10.64	38.6	8.8	70.2	13.5	6550	1.52
8	N		129900	114	602	2.94	0.72	46.9	2.41	26.8	18.5	12	44.8	8.2	67.6	19.4	75.7	13.8	108	21.4	7030	2.23
9	N		164000	65	123.7	1.02	0.0049	5.1	0.042	0.7	1.07	0.75	5.3	1.42	13	3.9	16.1	3.63	29.8	5.71	6050	1.44
10	N		178000	61.7	479	1.56	1.69	51.9	3.59	27.6	10.3	7.86	26.4	6.49	54.9	15.7	60.6	12.1	96.3	17.9	8670	2.39
11	N		168000	47.6	99.9	1.33	0.0103	4.92	0.046	0.57	0.88	0.55	3.4	0.94	10.8	2.89	13.5	2.97	21.9	4.41	6640	2.23
12	N		172000	82	219	1.35	0.334	19.8	0.97	9.6	6.27	2.64	15.1	2.77	25.2	5.91	25.4	4.78	43.8	7.85	5090	1.72
13	N		145800	68.9	292	1.58	0.035	6.96	0.201	2.89	4.16	2.53	15.5	3.63	30.4	9.3	38.6	6.43	64.7	12.1	5780	4.24
14	N		155000	49	89.1	0.56	0.0132	4.69	0.038	0.64	0.56	0.47	2.95	0.933	8.9	2.64	12.3	2.86	23.6	5.22	6660	1.01
15	N		151000	43.9	67.9	0.55	0.0037	3.15	0.029	0.27	0.28	0.33	1.53	0.63	7.2	2.07	8.6	1.79	20.6	3.72	6550	1.21
16	N		151000	36.6	77.7	0.359	0.0073	3.94	0.029	0.2	0.44	0.226	1.95	0.6	6.41	2.23	10.5	2.42	22.7	3.9	8210	0.66
17	N		167000	58	126.2	1.08	0.0094	4.85	0.06	0.89	1.74	0.84	6	1.52	13.8	4.57	18.6	3.99	31.4	6.2	5510	2.25
18	N		16500	34	89.1	0.99	BDL	21	0.78	8.1	3.89	3.69	5.6	1.11	9.6	3.12	11.3	2.17	22.6	3.92	6030	0.81
19	Y		18300	50	95.9	1.03	0.21	3.91	BDL	0.72	0.87	0.57	3.8	0.77	9.6	2.96	13.3	2.98	24.5	4.72	5530	1.21
20	N		20500	122	978	2.78	BDL	281	22.9	125	49.9	37.8	78	12.6	102.8	29	98.5	16.7	148	24.2	6930	1.81
21	Y		17500	45.4	101	0.74	0.29	4.41	BDL	0.32	0.56	0.38	3.54	1.17	8.9	3.3	16.4	3.33	28.7	5.49	8180	0.66
22	N		17400	73	333	3.38	BDL	358	24.8	144	50	26.6	43.4	5.1	42.4	11.31	34.3	6.82	62.9	10.8	6420	2.11
23	Y		18590	51.4	72.7	1.05	BDL	3.46	BDL	0.63	0.35	0.315	2.52	0.72	6.56	2.57	10.5	2.04	17.6	3.62	6440	1.68
24	Y		18200	49	81.7	0.58	0.35	3.79	0.009	0.33	0.48	0.251	2.73	0.79	8.34	2.5	11.1	2.34	22.6	4.43	7170	0.5

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-P0714-26 zircon CONT'D																						
25	N		18100	69	190.7	1.59	BDL	18	0.56	5.8	6.9	2.83	13.1	2.38	19.9	6.07	24	3.96	36.2	6.33	4730	1.99
26	N		18100	59.5	144	1.059	BDL	5.8	0.051	0.72	1.36	0.76	5.6	1.58	12.5	4.79	20.9	3.49	41.4	7.94	7790	0.63
27	Y		17700	74	297	1.44	BDL	13.05	0.145	2.79	4.2	2.09	13.5	3.06	28.3	9.36	35.3	7.22	67.4	11.2	6970	1.13
28	Y		19680	85.5	508	2.1	BDL	38.1	1.46	16.4	15.7	9.84	34	7.26	59	16	63	11.2	106.2	19.2	7360	1.47
29	N		16000	64	324	3.19	BDL	337	28.9	158	34.5	26.9	42.8	5.26	37.2	8.9	38.3	6.9	60	9.8	5000	2.44
30	N		19250	65	353	2.12	BDL	10.06	0.342	4.53	6.4	3.33	21.3	4.28	38	11.61	42.6	8.46	75.6	14.4	5770	1.85
31	Y		16440	64.5	168	1.28	BDL	11.1	0.24	2.66	2.62	1.8	7.1	1.89	16.9	4.58	19.8	3.78	38.3	6.77	4700	1.59
MP-L0613-BDAY zircon																						
1	Y		17100	42	153	0.59	BDL	7.03	0.045	1.02	2.06	1	7.6	1.75	17.5	4.84	21.3	2.98	29.6	5.36	6450	0.72
2	N		17800	40.2	129	0.49	0.36	4.85	0.028	0.76	1.38	0.71	7.2	1.56	13.8	4.32	16.3	3.13	32.8	4.98	5770	0.54
3	N		15540	34.6	160	0.56	BDL	3.52	0.037	0.37	1.74	0.65	4.79	1.68	15.8	5.09	23.4	3.49	32.7	5.8	5490	0.67
4	N	old	16300	33	91.3	0.411	BDL	2.99	0.005	0.25	0.33	0.32	3.62	0.98	10.2	3.05	15.2	2.75	24.5	4.63	7470	0.28
5	N		17900	41	110	0.65	BDL	3.21	0.057	1.1	1.43	0.83	5.4	1.29	14.2	3.87	16.4	3.11	28.8	5.13	6620	0.72
6	Y		15800	39.2	106.8	0.63	BDL	2.93	0.033	0.29	0.72	0.43	3.99	1.05	9.6	3.69	14.9	2.86	23.3	4.06	6750	0.69
7	N		16690	35	97.7	0.67	BDL	4.95	0.074	0.9	1.63	0.71	5.1	1.08	9.7	2.87	12.3	2.09	17.5	4.15	6100	0.48
8	N	old	15930	48	58.7	0.51	BDL	2.76	0.001	0.37	0.12	0.158	1.53	0.524	5.66	1.73	6.6	1.38	15.4	2.65	7170	0.45
9	Y		16650	60.2	241	0.5	BDL	5.48	0.051	0.98	1.78	1.16	11.1	2.64	23.2	7.35	38.2	6.77	58.4	9.9	7360	0.96
10	Y		17330	47.7	97.7	0.45	BDL	5.3	0.052	0.58	0.97	0.54	4.69	1.24	12	3.68	13.41	2.52	21.5	3.94	6940	0.52
11	N		16300	43	82.7	0.5	0.52	3.15	0.03	0.2	0.04	0.39	2.5	0.95	7.6	2.64	11.2	2.34	20.3	4.1	6310	0.45
12	Y		17500	41.9	72.5	0.37	0.1	2.57	0.029	0.38	0.09	0.25	1.54	0.65	7.4	2.3	9.11	1.5	19.1	2.97	5970	0.558
13	Y		17000	45	117.9	0.5	0.02	5.81	0.058	0.76	1.09	0.74	4.51	1.5	13.1	3	16	2.4	20.8	2.97	8170	0.5
14	Y		16500	29	82.9	0.35	0.14	2.44	0.028	0.44	0.07	0.16	2.9	0.86	6.4	2.96	12.2	2.39	23.1	4.04	7780	0.25
15	N		18600	46	102.9	0.44	BDL	6.2	0.033	0.69	1.73	0.86	4.39	1.31	11.2	2.99	12.1	2.71	18.9	3.48	7860	0.36
16	N		16720	29	143.8	0.72	BDL	7.58	0.176	1.11	1.66	0.69	5.2	1.46	11.8	4.87	18.1	3.01	33.9	6.1	5370	0.59
17	Y		15460	36.8	95.4	0.31	0.13	2.75	BDL	0.5	BDL	0.43	4.2	0.87	10.5	3.11	10.9	2.44	23.7	3.88	6870	0.56
18	Y		17700	42.4	96.8	0.57	BDL	3.72	0.004	0.42	0.83	0.58	4.9	1.18	12.2	3.21	14.7	2.83	25.4	5	6130	0.23
19	N		16810	51.6	183	0.44	BDL	5.86	BDL	0.92	2.82	1.19	9	1.94	20.3	5.56	22.3	3.6	37.2	6.35	7750	0.57
20	Y		17300	34.1	99.4	0.6	BDL	3.17	0.004	0.57	0.39	0.64	3.3	1.05	11.6	3.37	14.1	3.21	24.8	4.27	6210	0.48
21	Y		15400	40.3	218	0.31	BDL	6.37	0.029	0.88	2.55	1.14	9.4	2.51	25.6	6.45	23.8	4.58	37.6	6.86	7680	0.34
22	Y		16700	39	140.9	0.5	BDL	3.24	0.012	0.29	1.13	0.6	4.7	1.5	13.2	4.11	18.6	3.93	33.9	5.8	7050	0.44
23	Y		15750	43.7	159.8	0.53	0.42	5.41	0.016	0.5	1.87	0.78	7.2	1.46	17.1	5.42	17.9	3.25	28.9	4.48	6780	0.51
24	N		14000	45	153	0.56	BDL	8.76	0.138	2.35	1.7	1.1	6.3	2.26	15.7	4.9	20	4.28	30.5	5.7	4730	0.76
25	Y		14900	29.5	92.3	0.326	BDL	2.99	BDL	0.58	0.47	0.31	3.12	1.03	8.83	2.56	11.9	2.44	27.3	4.1	8260	0.2
26	Y		17500	56.7	158.6	0.5	BDL	5.07	0.023	0.69	0.79	0.72	7	2	15.6	5.12	20.7	3.77	36.1	6.62	6100	0.31
27	N		17800	33.2	73.1	0.38	BDL	2.81	BDL	0.2	0.2	0.32	3.27	0.81	6.7	2.43	9.9	1.77	17.8	3.13	5010	0.25
28	N		15400	35.4	66.8	0.313	BDL	2.91	0.029	0.74	BDL	0.46	2.8	0.78	8.7	2.08	8	1.67	13.9	2.96	5570	0.32
29	N		14880	43.4	124	0.22	BDL	4.32	0.04	0.51	1.29	0.7	6.21	1.43	14	3.84	16	2.77	27.3	3.88	5700	0.51
30	N		14000	21.9	130.4	0.39	BDL	4.86	0.044	0.37	0.67	0.3	3.67	1.23	12.3	3.99	18.7	3.24	32.2	5.8	5900	0.55

Spot	*used in age interp. (Y/N)	Comments	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-L0613-BDAY zircon CONT'D																						
31	N	old	15450	9	70.5	0.271	BDL	2.55	0.029	0.34	0.5	0.203	1.9	0.65	6.6	2.4	10.7	2.21	17.8	3.4	7550	0.6
32	Y		17300	41	128.3	0.35	BDL	5.59	0.036	0.46	1.1	0.63	5.19	1.31	15.1	4.57	16.6	2.97	27.3	4.28	4740	0.97
33	N		16670	46	191	0.41	0.14	4.9	0.09	1	1.89	0.92	7.5	2.39	20	6.16	24.4	4.52	37.5	6.8	6850	0.25
34	Y		15250	64.6	170	0.177	0.22	5.63	0.025	0.98	1.97	1.26	6.8	2.23	18.1	5.25	21.8	4.28	31.9	6.22	6410	0.34
35	Y		15700	43	155.2	0.31	BDL	5.54	0.0377	0.88	2.04	1.19	8.7	1.93	16.8	5.49	23.1	3.47	32.6	5.56	6540	0.55
36	Y		14680	21.4	96.5	0.29	BDL	3.95	0.028	0.56	0.92	0.41	2.37	0.8	9.5	2.91	13.7	2.79	24.5	4	6560	0.34
37	Y		16600	53	148.9	0.438	BDL	5.63	0.034	0.81	1.82	1.24	4.54	1.59	15.6	4.4	19.3	3.12	28.2	5.22	6660	0.36
38	Y		16910	30.9	79.9	0.33	0.23	4.75	BDL	0.29	0.54	0.42	2.5	0.81	6.27	2.72	10.2	2.31	22.4	3.35	7270	0.38
39	N		15230	30	110.1	0.47	0.41	2.93	BDL	0.39	0.79	0.47	2.62	1.18	11.74	3.12	13.7	2.23	21.9	4.37	6530	0.43
40	N		15520	146	847	3.46	BDL	16.6	0.147	2.8	7.6	1.92	20.9	5.92	72.8	24.7	119	24.7	235	47.3	12480	3.1
41	Y		16700	51	138.5	0.55	0.43	4.72	0.011	0.59	2.39	0.87	5	1.82	13.8	4.37	18.7	3.24	33.7	5.4	6320	0.34
42	N		16900	42	102.1	0.51	0.32	4.09	0.034	0.75	1.9	0.87	3.9	0.91	10.3	3.11	11.7	2.73	27.3	3.49	7050	0.5
43	Y		18300	27	92.1	0.39	0.07	3.36	0.003	0.56	0.93	0.59	3.37	0.99	8.2	2.99	11.8	2.07	22.4	3.46	6260	0.14
44	Y		16900	46	241	0.43	0.28	8.4	0.077	1.37	3.16	1.95	11.9	2.83	27.6	7.29	30.6	4.93	45.9	6.93	7810	0.56
45	Y		16400	27.5	110.5	0.4	0.453	3.43	0.013	0.59	0.88	0.5	4	0.91	10.2	3.54	11.7	2.42	24.3	4.63	6490	0.73

BDL = below detection limit
N/M = not measured

APPENDIX U - HOST ROCK ZIRCON TRACE ELEMENT DATA TABLE

Spot	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
										MP-P0913-4 zircon										
1	172000	176	285	0.78	0.009	1.58	0.017	0.31	1.69	0.73	16.4	6.24	46.5	8.81	20.1	2.67	17.47	2.3	13340	2.66
2	172000	434	2540	7.6	0.109	10.07	0.73	6	13.6	2.26	53.8	18.9	233	84	406	94.6	946	171.7	12030	21.4
3	163000	395	2190	6.6	0.24	8	0.47	6.06	9.3	2.15	45.5	15.6	191	74.6	372	85.3	885	159	10870	22.9
4	173000	460	881	3.15	69	162	23	91	26	1.75	34.1	8.7	86.1	30.2	132	26.9	239	45.3	10410	3.23
5	178000	262	1249	3.03	0.265	8.03	0.132	1.11	2.43	0.43	21.2	8.54	108.1	40.7	199	39.3	369	63.3	12110	4.22
6	185500	324	1379	7.46	0.22	5.91	0.143	2.16	2.63	0.57	21.1	7.54	114.3	48.8	252	62.7	642	116.6	12780	22.6
7	186000	368	2090	5.78	0.37	9.51	0.401	5	10.2	2.33	58.7	16.66	187.4	72.9	321	72.9	727	136.2	11500	10.2
8	181000	415	1650	3.15	3.9	14.8	3.12	13.2	10.1	2.83	23.2	8.42	113	53.5	298	85.1	1008	197.5	15100	13.4
9	183000	253	3300	8	6.2	38.6	4.4	37	34.2	8.5	134	35.3	363	121.7	512	99.4	876	151.7	8490	5.3
10	175000	432	1420	1.63	0.045	0.92	0.021	0.054	0.34	0.151	8.1	5.7	92.9	47.3	286	79.6	951	186.3	13900	4.82
11	183500	97	2800	3.18	0.089	13.43	0.84	9.7	17.5	2.93	90.9	27.7	297.7	102.8	422	85.3	755	132.1	9900	3.24
12	187000	122	3130	5.3	1.47	19.3	1.12	11.16	18.6	3.28	96.9	28	301	109	443	89.4	781	138.6	9470	3.79
13	178900	164	2050	3.35	0.69	12.4	0.4	5.51	12.41	1.85	63.3	18.3	203.7	76.2	317	65.3	558	98.9	10230	4
14	184000	146	175	0.57	BDL	1.54	0.06	0.57	2.36	0.53	16.6	5.48	34.7	4.8	10.9	1.2	8.32	1	13920	2.28
15	192000	158	408	0.83	0.034	1.9	0.047	0.59	2.97	0.84	28.6	11.05	76.2	12.75	27.6	3.38	19.6	2.41	13320	2.28
16	172000	285	3200	5.2	12.2	50.6	9	48.4	52.4	14.3	136.5	34.2	334	115.5	452	91.7	802	137	9030	4.2
17	180000	238	1614	4.05	BDL	8.72	0.215	2.78	6.35	1.09	38.1	12.74	149.1	57	256	60.9	584	105.4	12340	7.7
18	192000	346	2990	8.84	0.179	28.1	0.6	9	19.9	3.31	95.9	28.2	311	109.1	453	84.9	748	124.5	9400	5.4
19	171000	161	4410	6.5	0.225	24.4	1.42	21.8	34.1	6.84	160.5	47.4	489	164.4	676	125.4	1099	188.5	8620	4.8
20	188000	37	38.8	0.94	0.043	10.79	0.226	3.04	6.21	0.48	16.6	2.32	10.1	1.22	2.16	0.168	1.3	0.259	14110	1.57
21	186000	284	4510	9.72	0.49	28.3	1.38	18.1	34	5.69	159	45.6	479	160.5	658	130.4	1136	195.3	8790	8.9
22	172000	252	965	4.02	3.19	5.96	0.44	2.04	2.13	0.74	12.7	4.61	69.8	32	174.4	47.3	533	107.1	12500	5.32
23	183200	186	3080	8.06	0.8	26.4	1.3	12.6	23.3	4.46	104.1	31.6	324	113	469	92.3	823	140.6	8680	7.6
24	178700	134	2120	6.67	0.14	17.87	0.49	6.07	11	2.26	65.4	18.9	208.6	75.9	295	59.5	520	90.7	8500	5.04
25	190900	475	1401	1.14	BDL	0.81	0.01	0.35	0.47	0.211	7.68	4.98	86.7	44.5	259	75.5	904	173.6	13900	3.95
26	179000	119	1289	4.33	1.64	29	1.44	10	11.3	2.63	41.5	11.51	119	43.5	192	39.3	369	62.9	9920	2.87
27	187900	346	1268	7	7.5	30.3	4.52	21.5	6.2	1.12	15.2	5.6	91.3	43.1	229	64.6	771	148.6	13990	20.7
28	178000	163	623	0.89	0.036	4.62	0.022	0.59	1.67	0.53	10.5	4.82	59.3	21.4	97.8	24.1	257	47.8	12140	1.59
29	172500	107	1850	2.88	0.054	9.26	0.225	3.76	8.64	1.23	50.3	15.85	173	67.5	284	54.8	513	91	10480	3.6
30	191600	89	1295	7.38	0.024	11.12	0.105	2.45	4.63	0.99	30.6	9.68	107.5	42.8	198	41.7	413	74.7	10030	7.6

Spot	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
MP-P0913-4 zircon CONT'D																				
31	183000	120	1608	13.44	0.7	17.61	0.51	3.9	6.4	0.99	34.7	12.19	144.5	54.1	256.1	55.6	508	88.1	11260	16.6
32	191000	303	1005	2.68	3.31	4.54	0.8	2.86	1.75	0.52	6.2	3.91	66.2	32.9	197.1	56	649	126.3	14700	9.6
33	188000	80	132.1	1.04	BDL	6.22	0.077	1.45	4.6	0.276	14.5	2.46	16.08	4.37	14.06	2.51	19.2	2.32	13990	3.13
34	192000	318	1153	3.99	3.32	20.3	2.62	17	10.9	0.99	18.9	6.12	87.5	38.6	214	56.4	646	126.8	13230	14.3
35	187000	393	1570	4.75	3.11	12.94	1.57	9	8.3	2.49	29.1	10.66	128.8	55.7	284	73.9	819	155.2	13660	8.1
36	186000	550	2060	14	29.8	169	30.9	148.7	117.4	45.6	191.6	36.5	276.8	80.6	336	77.6	776	142.8	12160	30
37	187000	185	1479	9.2	1.54	12.02	0.37	4.04	5.41	0.92	30.5	9.7	122.7	49.4	248	58	591	109.9	10140	13.8
38	186000	353	3960	8.12	0.178	23.7	0.98	14.9	29.4	6.11	134	38.2	423	142.6	599	113.4	977	169.8	9020	6
39	176000	382	1170	1.5	0.34	2.6	0.26	1.11	1.72	0.5	12.4	5.71	87	41.1	232	66.7	775	148.9	14100	4.65
40	184300	135	2490	11.9	0.009	21.8	0.275	3.5	9.6	1.34	57.8	21	235	86	389	77.8	677	117.1	10750	9.5
MP-P0913-5B zircon																				
1	163600	109	892	2.68	BDL	17.1	0.095	0.7	2.07	0.39	17.8	6.49	74.5	27.1	121.3	25.7	225	45	12330	6.1
2	177000	84	702	3.39	0.051	10.28	0.016	0.39	1.07	0.211	11.4	4.76	55.5	21.4	105.9	25.8	238	45.4	14140	6.69
3	169000	123	1003	3.89	0.084	14.1	0.052	0.77	2.94	0.54	19.1	7.36	81.6	33.1	135.2	30	299	57.2	12080	6.4
4	183500	201	1336	4.78	2.97	19.2	1.45	10.9	11	29	33.1	10.1	112	41.2	186	43	400	77.8	17700	10.9
5	157000	221	1270	6.2	0.02	6.49	0.143	0.74	1.64	0.98	15.7	7.4	96.7	41.4	187.6	42.3	385	75	14300	10.1
6	182000	81	465	2.47	1.31	13.9	0.6	2.16	1.83	7.48	6.1	2.7	36.4	14.58	78.8	19.2	189	38.5	16700	4.4
7	173800	227	2830	9.5	0.103	48.6	0.37	7.5	16.2	1.73	80.7	24.6	267	100.5	436	88.3	763	136.6	10040	6.9
8	182000	82	684	3.37	3.31	29.1	2.89	11.27	4.46	3.98	11.7	4.28	56.9	22.5	114.2	24.4	267	50.1	14040	6.4
9	158000	98	733	4.75	2.34	20.9	1.67	8.4	4.51	16.1	14.8	4.47	56	23.3	113.6	28.3	274	57.2	14730	9.6
10	171000	139	1143	4.09	0.049	14.48	0.151	0.94	3.08	0.73	21	8.19	100.1	38.4	162.4	34.1	321.9	58.1	12690	9.2
11	192000	98	653	3.3	4.22	34.3	3.46	17.2	4.9	15.9	13	4.07	59.5	22.9	110.1	27.1	270	50.2	15100	9.9
12	162000	70	563	2.57	5.17	37.7	4.56	20.1	4.8	21.3	11.1	4.43	46.9	20.2	90.3	20.4	222	37.6	13830	5.1
13	166000	90	820	6.15	1.66	14.34	0.46	1.92	2.05	0.71	14.6	5.29	67.2	28.5	122.9	30.8	322	68.9	15890	10.3
14	169500	56	512	1.4	0.045	11.05	0.137	1.21	1.74	1.72	10.5	4.07	46.1	16.6	71.8	14.34	138.7	27.3	12070	4.4
15	175900	76	423	2.14	BDL	13.08	0.023	0.8	2.15	0.36	11	3.38	37.5	14.1	65.1	14.64	144.3	26.8	14630	3.78
16	151000	156	908	3.68	3.86	15.4	0.63	1.84	2.13	1.82	14.4	6.39	79.3	31.2	141.2	30.9	293	57.1	13430	6.7
17	204000	262	2620	13.6	10.4	87.6	4.4	17.4	15.9	5.71	69.4	23.9	247	91.3	390	80.7	697	125.2	10930	11.6

Spot	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
18	172700	140	1022	3.52	0.17	13	0.044	0.46	2.19	0.241	18	6.93	89	34.3	157.2	33.7	330	63.5	12970	7.29

MP-P0913-5B zircon CONT'D

19	176000	134	785	4.71	0.27	14.7	0.41	3.96	3	10.43	13.7	5.21	66.2	27.4	119.7	27.3	275	49.5	13250	6.33
20	162100	183	1566	4.28	1.42	28	0.85	3.5	6.5	0.84	33.8	13.11	151.2	53.2	233	48.7	460	80.6	11790	6.8
21	169000	118	655	3.61	0.22	9.71	0.17	1.13	1.7	0.24	8.3	4.23	58.8	21.4	98.4	21.4	204	37	12490	4.6
22	154000	108	437	3.2	0.036	16.7	0.088	0.54	1.6	0.213	11.3	3.63	38.4	14.54	62.7	15	137	27.2	13420	2.75
23	181000	255	1550	2.86	4.86	5.71	0.64	1.96	2.95	0.84	22.1	10.8	122	42.6	171	34.6	327	52.4	16800	8.3
24	173000	186	1010	1.72	0.76	2.79	0.157	0.8	2.32	0.27	16.1	7.94	86.7	30	133.7	29.4	264	47.1	15450	4.9
25	162800	73	424	1.7	0.098	9.49	0.065	0.27	1.92	0.317	10.2	3.37	39.3	14.14	61.7	12.29	114.4	20.65	11110	3.5
26	180000	112	1060	1.64	0.42	34.9	0.85	6.4	7.4	8	31	8.5	98	33.8	155	35.2	380	69.2	9980	2.07
27	162000	119	823	3.26	0.028	11.11	0.036	0.34	1.73	0.218	13.2	4.9	64.7	27.2	128.1	29.6	296	54.2	13850	5.2
28	168700	103	873	3.63	0.036	10.79	0.011	0.36	1.57	0.12	13.9	5.5	71.2	27.3	134	32.1	309	56.2	13260	7.1
29	161100	97	561	3.2	0.68	16.9	0.1	1.45	2.83	0.42	14.7	4.82	50.7	18.42	77.1	17.19	156.9	27.9	12500	3.29
30	161000	83	394	1.55	BDL	12.37	0.052	0.62	2.61	0.46	14.3	4.59	42.9	14.18	50.7	9.63	77.7	11.95	12100	2.85
31	169000	205	2250	10.7	6.3	42.7	0.76	4.99	8	0.95	52.8	16.7	203	75.9	329	69.9	646	115.6	10670	10.4
32	173000	128	867	3.57	0.009	12.4	0.011	0.54	2.16	0.15	13.2	5.72	72.3	27.4	132.5	29.9	292	56.6	12590	5.98
33	172300	126	609	3.91	0.019	9.88	0.011	0.36	1.14	0.06	10.7	4.07	52.8	20.8	95.2	20.1	207	38.1	12880	6.5
34	162600	124	636	3.98	BDL	8.89	BDL	0.46	1.23	0.187	10.6	4.22	51.9	20.96	96.1	22.4	218	40.6	12570	7.8

MP-P0913-12 zircon

1	155000	125	N/M	4.77	6.4	142	14.5	95	56	20.7	90	20.3	171	48	176	31.4	265	50.9	11970	N/M
2	155000	57.8	N/M	3.92	2.04	48	2.56	21.7	15.1	3.34	45.9	13.3	139	46.7	195.2	43.9	379	66.5	11540	N/M
3	152000	40.2	N/M	1.56	0.035	7.93	0.147	2.09	1.31	0.406	5.99	2.32	27.5	11.34	50.6	12.7	138	26.2	10900	N/M
4	146000	111	N/M	4.65	0.91	55.6	2.68	31.9	20.1	5.93	66.5	19.8	217	68.8	305	61.8	566	100	9740	N/M
5	154700	161	N/M	1.57	9.4	9.93	7.2	50.6	25.5	11.07	73.3	15.05	140.3	39.2	140.3	26.1	209	37.2	9110	N/M
6	165000	55.1	N/M	1.202	0.41	10.4	0.44	4.3	4.44	1.21	17.5	5.61	62.7	21.8	95.8	21	188.9	34.8	9520	N/M
7	149000	71.9	N/M	2.66	1.61	44.7	5	50	29.1	9	43.6	8.9	90	28.4	131.2	27.7	262	52.7	11090	N/M
8	144900	83	N/M	2.07	1.44	49	5.3	58	28.9	7.5	49.5	10.2	108	36.8	162	37.3	348	61.5	10880	N/M
9	153000	250	N/M	4	7.81	154	13.3	92.1	61.9	24.4	120.3	32	276	72	259	48.8	411	68.7	10530	N/M
10	152300	244	N/M	1.442	0.036	4.74	0.116	1.45	3.25	0.51	23.5	8.52	117.7	45.4	200.3	45	434	76.5	11460	N/M

Spot	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
11	148400	78.3	N/M	9.29	1.8	21.6	2.47	14.9	8.1	2.27	19.6	5.85	71.2	27.4	143.2	33.7	348	73.4	12250	N/M
12	160000	142.9	N/M	4.54	1.33	57	4.3	41	15.1	5.1	39	12.35	149.7	54.5	247	55.5	532	95.9	10920	N/M

MP-P0913-12 zircon CONT'D

Spot	Si	P	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta
13	143300	94	N/M	1.98	18	32	1.8	5.7	2.8	0.65	13	4.5	51	20.3	97	23.2	236	43.2	10590	N/M
14	152200	155	N/M	2.75	0.85	29.2	2.06	25.4	11.99	3.86	21.02	5.74	61.6	22.69	118.7	26.2	267	52.9	11430	N/M
15	151100	90	N/M	2.75	0.66	17.9	1.14	9.5	4	0.99	13.92	4.7	60.2	23.5	114.4	27.1	268	54.7	11350	N/M
16	146900	36.2	N/M	1.12	0.011	4.19	0.008	0.104	0.231	0.074	2.51	0.86	11.35	5.3	27.3	6.64	79	16.1	10320	N/M
17	148000	111	N/M	2.95	0.302	14.3	0.42	3.38	2.88	0.62	13.5	4.87	60.9	24.17	115.8	26.9	276	50.6	12180	N/M
18	153500	52.5	N/M	3.51	0.65	30.4	1.94	21.5	9.1	2.76	15	4.3	53.1	20.4	95.5	22.5	240	46.4	11390	N/M
19	147000	51.8	N/M	1.46	0.093	15.6	0.69	7.1	4.7	1.7	10.3	2.6	33.1	12.46	65.1	15.16	161.1	29.9	12090	N/M
20	141900	2250	N/M	2.02	1.08	28	2.8	20.5	8.6	4.3	15.9	4.12	44.7	17.2	82	17.2	182	35.6	11520	N/M
21	152300	83	N/M	4.7	0.01	29.7	0.155	2.34	4.95	1.18	27.1	8.77	100.7	39.4	185	43.1	415	80	9590	N/M
22	141000	46.5	N/M	1.18	0.007	6.7	0.016	0.29	0.63	0.1	4.39	1.89	23.4	9.58	48.8	12.26	127	24.3	11380	N/M
23	153100	128.3	N/M	2.6	0.022	19.4	0.334	5.92	12.07	2.83	60.7	18.3	200	68.7	268	57.6	502	82.8	8870	N/M
24	158000	92	N/M	3.76	1.95	52.1	2.48	13.2	6.8	1.94	26.4	8.39	101.5	34.8	159.8	35.4	358	62.5	10410	N/M
25	160000	71	N/M	1.94	0.8	40	5	55	17.9	5.7	31.7	6	67.3	23.6	105.5	24.9	225	42.6	10560	N/M
26	153000	106	N/M	2.86	0.008	10.14	0.033	0.87	2.56	0.357	17.6	5.98	80.8	32	143.3	31.4	294.5	54.1	11140	N/M
27	150000	76	N/M	1.98	1.13	57.2	4.79	35.4	8	2.91	16.76	5.18	60.6	23.1	109.5	26.5	260	51.1	12170	N/M
28	152000	63.3	N/M	1.56	0.55	32.7	2.65	19.2	3.61	1.56	6.5	1.85	22.3	9.86	56.3	15.98	173.6	35.6	11560	N/M
29	147000	136	N/M	8.51	1.06	63.3	2.15	15.7	13.4	3.67	52.2	15.72	177.6	62	260	54.3	501	90.6	10180	N/M
30	152200	107	N/M	7.84	0.19	18.6	0.42	3	4.08	1.09	23	9.8	121.5	49.8	242.2	54.7	536.5	104	12510	N/M
31	148000	47.2	N/M	1.009	0.085	5.8	0.119	1.58	1.01	0.352	3.49	0.93	13.27	5.44	29.3	6.51	77.1	16.2	8580	N/M
32	152900	68	N/M	2.08	0.073	11.55	0.146	2.2	1.46	0.47	9.24	3.55	44.2	17.1	85	21.1	200	40.5	11570	N/M
33	156600	134	N/M	3.8	2.56	96.6	9.33	85	41.1	15.1	59.7	14.31	131	39.5	160.5	33.9	311	53.7	10380	N/M
34	152500	144	N/M	9.54	2.6	167	14.1	117	28.1	10.2	52	14	161	54.7	246	50.3	465	80.5	10610	N/M
35	175000	69.8	N/M	2.65	0.064	12.77	0.161	1.85	4.66	0.88	31.7	12.18	154.5	55.9	256.9	59.2	562	102.2	12780	N/M
36	153000	83	N/M	3.01	0.088	13.74	0.241	1.67	2.46	0.69	15.27	5.99	73.8	29.5	145	33	333	65.6	12500	N/M
37	160000	154	N/M	3.34	0.02	25.1	0.137	2.92	6.07	0.9	32.9	11.56	141	51.6	227.3	48.7	433	78	9570	N/M
38	149600	487	N/M	4.09	19.7	426	72.8	553	418	146	559	88.5	542	108	325	50.3	377	60.5	10850	N/M
39	171000	73.9	N/M	4.08	0.94	36	3.53	27.6	8.5	2.62	19.4	5.66	67.2	24.9	120.2	27.9	277	52.6	12960	N/M

BDL = below detection limit

N/M = not measured

APPENDIX V - MONAZITE TRACE ELEMENT DATA TABLE

Spot	Si	P	Ca	Sr	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
									MP-P0913-2 monazite										
1	BDL	90300	6100	1230	1030	61100	115000	10600	35600	4030	602	2090	149	324	30.1	41	1.56	6.25	0.38
2	BDL	91900	3510	713	562	66500	106000	10700	31100	2800	384	1320	77.2	162	15.4	25	1.2	3.64	0.145
3	BDL	86200	3940	838	736	50300	107200	12000	38300	4070	575	1990	116	232	20.3	30	1.02	3.3	0.5
4	BDL	106000	8650	1880	399	83000	132000	11500	27000	2130	272	1030	54.5	101	11.1	19.3	1.04	3.7	0.22
5	BDL	111000	5670	1160	341	87500	142000	11240	25600	1785	243	948	46.5	87.4	9.2	17.1	0.91	2.8	0.36
6	BDL	121000	14000	2990	244	99000	139000	11000	21200	1430	160	682	30.6	57.1	6.32	13.9	0.63	2.08	0.09
7	BDL	118000	4880	1050	348	86800	152400	12880	37900	3320	489	1600	75.6	109.2	8.27	16.2	0.53	2.24	0.19
8	BDL	92000	7700	1760	459	63900	104000	9500	20400	1850	241	980	54.5	124	13.1	21.3	1.2	4.4	0.249
9	BDL	83600	9500	2160	278	70400	96600	8700	20400	1488	162	699	33.7	69	7.4	13.1	0.62	2.08	0.296
10	BDL	98000	6100	1160	199	90900	139000	10940	27800	1490	171	661	30.5	51.6	5.68	11.2	0.35	2.04	0.296
11	BDL	102800	5430	1094	292	93000	135000	10700	27200	1770	212	859	43.2	77.3	7.5	14.1	0.5	1.95	0.39
12	BDL	104200	8060	1530	768	74700	141000	13400	40500	4020	527	1900	125	231	22.1	31.1	1.5	4.4	0.4
13	BDL	111000	6710	1140	555	87800	127000	10800	31500	2590	294	1209	67.7	149.4	16	24.4	1.22	5.12	0.46
14	BDL	114000	4730	920	388	105200	146000	12000	37000	2350	264.8	1069	50.6	112	10.8	19.3	0.93	3	0.32
15	BDL	102000	4520	865	317	87000	131000	10600	27400	1940	227	860	43.5	78.3	8.32	13.36	0.477	2.33	0.31
									MP-P0913-7 monazite										
1	BDL	98000	2530	684	2410	70000	120000	11660	44500	5240	973	3090	255	532	47.2	45.8	1.55	4.1	0.2
2	BDL	108000	4000	1114	2530	62100	126000	12750	42500	5000	970	2960	253	589	54.1	55.5	1.78	5.7	0.29
3	BDL	108000	3790	1096	2490	65500	123000	12200	40300	4450	886	3030	252	579	53.4	55.6	2.02	4.62	0.4
4	BDL	108000	3410	981	2240	70000	110600	11060	41300	4960	980	3280	261	576	47.3	45.7	1.77	4.5	0.51
5	BDL	115000	3300	688	3510	69700	132000	12300	44600	5770	1110	3980	387	993	99	122	5.35	14.6	0.82
6	BDL	124000	5030	1126	1570	72000	133000	12000	43100	4140	628	2130	151	332	30	45.7	1.88	5.5	0.273
7	BDL	121000	3900	930	3090	86700	145100	14600	51700	6500	1315	4750	479	1280	105	100	4.63	11.3	0.83
8	1120	125000	3370	649	3150	67800	115000	11900	46800	6920	1280	4560	473	1178	95.5	92	4.12	10.8	0.6
9	BDL	117000	7030	1540	1254	77400	145000	12700	39300	3700	495	1820	113.1	253	30.7	43.9	2.14	7.9	0.44
10	BDL	150000	2920	549	3270	92100	146000	12800	44300	5380	1000	3400	365	904	87.6	100	4.67	12.2	0.49
11	BDL	137000	2620	582	3160	79000	140000	12180	38300	4590	900	3190	320	840	92	113	6.08	15.6	0.79
12	BDL	141000	2770	653	3550	79800	135000	12700	38000	4690	906	3070	317	842	88	111	6	16	0.84

Spot	Si	P	Ca	Sr	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
MP-P0913-SQ1 monazite																			
1	N/M	124800	3460	940	223.2	90300	142800	11930	32990	2069	298.6	911	47.5	90.6	7.39	10.65	0.337	0.77	0.07
2	N/M	125300	3245	937	221.8	90400	145200	12580	34550	2159	312.5	972	49.4	91.7	7.92	10.52	0.268	0.92	0.065
3	N/M	130300	3310	974	220.8	92000	145200	12270	33800	2091	321	948	49.1	90	7.62	10.25	0.315	0.86	0.056
4	N/M	124900	2710	876	209	92100	149400	12900	34810	2175	329.8	992	49.1	88.4	7.22	9.83	0.276	0.59	0.085
5	N/M	128700	3040	989	196.7	91400	143300	12310	34540	2003	288.5	887	44.8	81	6.73	9.54	0.268	0.76	0.054
6	N/M	127800	2940	960	208.3	88000	147200	12740	35630	2129	309.2	943	48.1	86.1	7.23	9.87	0.3	0.64	0.062
7	N/M	129000	2681	917	205.4	90000	145500	12540	34480	2110	326.4	975	48.8	87.5	7.09	10.3	0.296	0.57	0.063
8	N/M	131100	3180	1008	190.9	90600	144900	11950	31910	1800	266	847	41.9	76.1	6.58	9.55	0.256	0.6	0.082
9	N/M	127800	3380	1054	237.5	92900	147000	12790	35000	2150	313.5	967	50.7	94.4	8.14	11.03	0.304	0.77	0.074
10	N/M	128600	3620	1081	244.7	90600	143300	12630	34550	2119	321	974	51.4	96	8.48	11.51	0.287	0.92	0.066
11	N/M	129400	3259	1015	218.9	87800	146400	12850	35900	2148	317	970	50.6	89.6	7.53	10.37	0.196	0.71	0.063
12	N/M	126400	3090	951	247.2	91300	144000	12720	35000	2196	324	981	52.3	97.9	8.33	11.18	0.369	0.79	0.091
13	N/M	129600	3250	1013	242.9	90100	144400	13000	36220	2257	326.5	1018	53.8	102.4	8.28	10.85	0.35	0.98	0.071
14	N/M	128200	3120	950	246.8	89600	139900	12230	34500	2140	321.1	975	51.96	95.3	8.12	11.33	0.349	0.89	0.085
15	N/M	124700	2900	888	199.2	90200	145500	12480	35040	2060	285.6	887	44.5	81	7.03	10.47	0.304	0.64	0.061
16	N/M	124500	3040	950	190.7	92000	143100	12250	32330	1970	281.7	858	43.3	79.1	6.18	9.75	0.269	0.73	0.049
17	N/M	131000	3430	1020	210	92800	144400	12230	33480	1988	292.8	913	47.1	86.1	7.29	10.34	0.26	0.69	0.065
18	N/M	127200	3530	1015	237.2	85000	138800	12480	33600	2132	320	945	51.1	96.6	7.86	11.13	0.33	0.88	0.063
19	N/M	130200	3110	920	216.2	92300	141700	12460	34010	2094	305.7	935	47	88.1	7.51	10.52	0.318	0.82	0.065
20	N/M	129100	2980	881	241.5	89400	143500	12860	36200	2269	333	1001	53.6	96.4	8.22	11.6	0.313	0.78	0.081
21	N/M	126900	2869	814	238.8	89000	147600	12940	37700	2360	324.4	969	52.1	96.2	7.82	11.11	0.264	0.88	0.063
22	N/M	126100	3003	918	247.5	91500	145100	12780	35830	2219	328.7	1010	53.7	100.8	7.96	11.25	0.331	0.8	0.072
23	N/M	133100	3096	928	219.7	89500	147100	12560	35180	2113	305	915	48.7	88.1	7.1	10.49	0.28	0.79	0.061
24	N/M	129000	3380	990	221	90200	144700	12520	34100	2159	293	915	46.9	86.2	7.37	10.61	0.257	0.63	0.086
25	N/M	119000	2900	848	181.2	87900	138700	11240	30900	1774	243.3	775	39.6	71.1	6.1	8.44	0.202	0.7	0.069
26	N/M	126400	3640	1002	252.3	91800	142400	12350	35500	2190	319.4	986	53.3	98.2	8.39	11.42	0.295	1.03	0.072
27	N/M	129600	3501	980	253.3	93200	145200	12420	35310	2202	330.2	1009	53.4	95	8.15	10.83	0.329	0.73	0.072
28	N/M	125700	3110	898	213.9	90200	143000	12400	34290	2152	306.9	936	49.3	88.3	7.03	10.37	0.292	0.67	0.063
29	N/M	129600	2920	824	213.8	88600	141400	12630	34900	2101	297.4	949	47.5	88.4	7.53	10.74	0.286	0.92	0.048
30	N/M	127400	3287	926	239.2	96800	149900	12690	34360	2008	292.6	902	49	90	7.91	10.76	0.268	0.66	0.063
31	N/M	134100	3690	1002	229	92000	150800	12390	34960	2090	300.6	942	49.1	89.3	7.76	10.45	0.324	0.74	0.081
32	N/M	126200	3260	927	214.1	89900	146800	12370	33900	2009	291	894	47.5	81.9	7.28	10.89	0.275	0.68	0.063
33	N/M	128500	3329	927	206.6	95900	150500	12230	34100	1952	282.5	871	44.85	80.2	7	9.97	0.263	0.74	0.056
34	N/M	124400	3294	926	226.8	92400	146600	12310	34800	2126	298.8	928	47.2	87.7	7.5	10.68	0.274	0.83	0.074

Spot	Si	P	Ca	Sr	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
MP-P0913-SQ1 monazite CONT'D																			
35	N/M	127200	3300	926	232.1	92500	146800	12780	35830	2233	319	956	49.3	90.4	7.96	10.85	0.313	0.871	0.086
36	N/M	128500	2849	847	221.7	92400	148400	12780	37000	2238	322	964	51.1	92.6	7.81	10.88	0.297	0.79	0.065
37	N/M	127600	3440	992	215.4	91300	147300	12090	33240	1968	289.6	879	46.6	85	6.89	9.59	0.238	0.71	0.055
38	N/M	128200	3005	926	221.1	87500	145100	12460	36430	2220	310.2	969	50.3	92.7	7.68	10.44	0.295	0.84	0.061
39	N/M	128900	3370	1045	228.7	95100	151900	13080	36600	2202	314.3	947	47.7	91.3	7.54	10.69	0.274	0.81	0.086
40	N/M	130000	2839	865	204.4	93300	145300	12550	34480	2030	275.6	903	45.1	85	7.31	10.05	0.279	0.77	0.064
MP-L0613-BDAY2 monazite																			
1	BDL	126400	5850	705	633	67700	134100	15630	59100	6520	1003	3150	173	283	21.7	34.2	0.75	3.27	0.22
2	BDL	122000	6050	679	627	70000	137100	15770	61900	6870	1054	3060	153.7	281	20.5	34.2	0.89	2.7	0.183
3	BDL	123000	6110	733	618	68800	134100	15450	59200	6630	997	3170	165.7	273.9	21.3	33.7	0.76	2.69	0.27
4	BDL	117600	8800	1009	838	66500	126200	15440	58100	6680	1099	3250	180.8	351	26.8	37.9	1.08	3.43	0.249
5	2300	117600	10500	1073	522	66800	130900	14800	56100	6020	950	2660	138.2	238	16.76	30.6	0.54	2.36	0.186
6	BDL	124800	14000	1470	923	61500	135100	16230	65300	7710	1278	3740	216	383	31.6	40.4	1.27	3.99	0.205
7	BDL	128700	6370	859	633	60900	137700	16900	65200	7480	1083	2910	152	264	20.2	31.1	0.7	2.44	0.234
8	1100	122100	11930	1499	775	61600	133900	15810	58200	6020	1029	2960	171.2	321	25.7	32.2	1.02	3.3	0.34
9	3200	125800	8700	1184	953	82500	136500	14460	51900	5320	996	2890	187.1	387	32.2	37.3	1.56	3.57	0.237
10	100	127700	9300	1254	949	75500	138500	15240	51500	5790	1037	2970	182	379	32	37.3	1.16	3.34	0.173
11	200	136800	4730	521	491	62500	145200	17290	68300	6650	1043	2840	140	255	17.9	25.1	0.75	2.03	0.136
12	BDL	135000	10500	1402	647	68900	150500	19000	67100	6940	1141	3160	171	322	24.5	31.5	1.07	3.5	0.28
13	BDL	131600	8440	1196	696	60700	133900	16370	64700	6560	1057	2880	167	298	24.1	31.1	1.01	2.76	0.197
14	BDL	122400	7090	1033	555	62000	137200	16900	63900	6330	1004	2910	142.1	263	20.9	27.3	0.94	2.03	0.215
15	900	125400	6700	936	531	63100	143000	16300	64100	6340	950	2740	134.4	244	18.6	28.2	0.84	3.19	0.38
16	BDL	130400	4980	782	552	61900	140500	17630	64800	6610	1055	2800	145.3	271	19.1	25.7	0.72	2.3	0.181
17	1100	104000	11500	1361	676	60800	132000	14200	55700	5620	863	2380	121	215	21.5	37.9	3.32	16.6	2.66
18	3200	123500	8850	1282	538	66700	133000	17100	64700	6710	996	2570	134.1	221	17.5	26.1	0.93	4.02	0.32
19	BDL	127400	10230	1522	582	67300	131400	16680	63400	7010	1001	2780	143	271	21.1	29.9	0.92	1.94	0.12
20	1100	126300	9150	1300	856	66700	137000	15950	60300	7530	1159	3120	187	348	30.6	36.5	1.45	5.9	0.351
21	400	122300	9450	1251	1403	66500	132900	15330	60800	7200	1451	3610	249	528	45.9	52.5	1.86	4.2	0.34
22	2140	129600	4020	498	577	61600	133900	15480	59400	6310	1050	2590	140	261	20.3	26.3	0.65	3.04	0.205
23	BDL	126800	11600	1444	1247	61300	127100	14260	58500	6730	1391	3450	229	447	41.1	46.1	2.08	5.51	0.42

Spot	Si	P	Ca	Sr	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
24	600	122200	16400	2150	1385	67400	134400	14440	56800	6500	1314	3270	221	464	44.2	52.1	2.33	6.74	0.49
25	800	118200	9000	1164	894	61600	125500	13510	56300	5780	1167	2810	169.1	376	31.9	39	1.9	4.71	0.45
MP-L0613-BDAY2 monazite CONT'D																			
26	BDL	123800	7110	916	777	68100	129400	14400	56000	6310	1183	2830	179	321	26.5	31.1	1.06	2.57	0.28

BDL = below detection limit
N/M = not measured

APPENDIX W - HOST ROCK MONAZITE TRACE ELEMENT DATA TABLE

Spot	Si	P	Ca	Sr	Y	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
MP-P0913-4 monazite																			
1	2300	149000	13300	31.9	7350	68300	125100	16200	52000	7500	428	6250	610	1758	143	109.2	5.89	16.1	1.32
2	5100	154000	11600	37	7360	76900	162000	21900	55600	8980	504	7500	768	2000	159	133	6.29	20.7	1.37
3	3200	166000	10800	33.7	5140	67800	147000	20700	57100	8900	391	7140	610	1460	117	95.3	5	19.3	1.27
4	1900	144000	12300	37.2	7050	71300	146000	22200	58900	9400	570	8940	842	2070	160	113.9	4.81	12.9	0.99
5	4700	153000	10500	32.6	13500	70300	159000	20800	61300	9490	620	8490	1000	3210	292	260	11.2	33.2	2.42
6	4700	166000	9200	22.7	4750	66500	163000	20700	61200	7760	253	5500	423	1147	99.9	97	3.68	13.9	1.05
7	7400	166000	10600	23	8000	82000	167000	23100	63000	9500	316	7480	686	1870	173	184	10.4	23.1	2.21
8	4900	160000	13800	33.8	7380	73900	165000	22700	63900	10400	567	9570	821	2000	169	163	7.47	28.3	2.09
9	3000	138000	9000	26.6	3500	61400	139000	20900	59600	9210	516	8020	602	1226	81.5	66.2	2.44	8.8	0.59
10	9000	151000	10200	33.9	2290	72000	152000	22800	69800	9400	429	6710	429	768	50.2	48.2	1.4	5.7	0.43
11	4400	173000	12100	32	5080	72300	169000	19800	60300	10000	577	9300	786	1570	113.4	99.2	3.66	10.2	0.73
12	5900	160000	13300	35.2	3950	68700	141400	19700	60300	10020	554	8680	769	1540	102	70.4	1.89	7.8	0.63
13	1400	153000	10800	37.3	2340	79700	163000	22900	67000	9200	436	7210	553	940	56.9	51.5	1.32	4.9	0.41
14	2800	136000	12300	33.7	2360	77400	159000	22800	70700	9220	463	7310	561	1004	58.4	53	1.32	4.5	0.33
15	BDL	154000	9600	26.8	12100	76600	161000	24100	83000	10100	712	8700	900	2780	284	276	12	28	2
16	BDL	147000	12300	35.9	10400	78000	159000	24900	80000	10100	778	9400	940	2700	254	293	18.8	57	5
17	BDL	159000	11000	34.9	4890	89700	195000	26600	82400	12760	766	10310	919	1870	129	111	3.61	13.2	1.11
18	BDL	175000	11800	43.1	5550	81000	185000	23200	96000	12260	918	10220	948	1940	135	104.4	4.2	8.9	0.7
19	50000	172000	9800	36.3	4620	76500	164000	23800	67100	10400	714	8600	750	1487	122	113	5.82	18.4	1.54
20	BDL	213000	12600	39	7870	87000	186000	27800	106000	13600	888	11700	1042	2280	178	162	6.76	21	1.61
21	30000	215000	12700	40.8	6220	87700	198000	27700	97000	13500	797	11510	1056	2090	155	134	4.76	14.4	1
22	BDL	212000	11600	38.3	6330	93000	190000	26500	91000	13200	870	11740	1113	2280	165	144	6.07	16.1	1.16
23	BDL	175000	12600	44.8	10840	83700	186000	25400	83000	11850	790	10740	1135	3060	267	240	10.2	24.3	2
24	11000	179000	11900	29.3	4370	78000	173000	23800	86900	10200	562	6900	506	1220	112	118	3.3	7.1	0.51
25	20000	186000	13200	35	4830	92200	191000	27400	125000	13330	894	10600	827	1690	119	111.9	5.14	13.2	1.07
26	13000	212000	11200	37.1	8370	91000	187000	23100	88000	13000	746	10370	1073	2320	208	189	8.35	24.9	2.06

BDL = below detection limit

APPENDIX X - APATITE TRACE ELEMENT DATA TABLE

MP-P0913-1A apatite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 120, laser energy = 3 mJ at 75%)

Spot	Al	P	Ti	V	Cr	Fe	Sr	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Th	U
1	BDL	104800	0.9	4.62	26.8	1251	15700	589	4.91	0.036	3580	8930	883	3430	621	134.9	417	38.3	159.3	22.8	44.1	4.63	20.4	2.27	0.04	BDL	0.022	1057	127
2	0.05	104100	0.64	4.35	6.5	1410	18320	461	4.02	0.072	2980	7820	752	3030	521	111.6	348	31.3	125.8	18.19	33.9	3.57	17.3	2.03	BDL	0.009	0.036	981.7	96.69
3	0.1	109400	0.28	22.29	16.1	1821	21400	770	16.1	0.075	4630	11430	1439	4650	846	180.2	529	50.9	184.3	28.6	52.2	5.73	26.7	2.9	0.04	0.0069	BDL	910	120.7
4	0.42	104600	0.99	4.67	11.5	1340	15570	541	5.16	0.069	3370	8630	825	3410	592	127.4	394	35.8	140.9	20.9	39	4.04	18.05	2.31	0.025	BDL	0.028	1055	93.52
5	BDL	107800	0.16	16.5	18.2	1960	26500	707	21.5	0.057	5070	11910	1451	4480	805	165.2	500	48.3	173.9	27.2	47.6	5.28	25.7	2.92	0.139	0.018	0.04	1051	67.25
6	BDL	111000	1.07	22.6	17.8	1880	27100	799	24.1	0.076	5580	12610	1559	4870	856	180	533	50.8	182	28.2	52	5.63	27.8	3.37	0.087	BDL	0.044	1053	58.29
7	0.1	124600	1.61	30.7	41.7	780	19800	852	26.2	0.055	5530	12830	1559	4980	889	196	521	51.8	184	28.7	52.9	5.87	28.5	3.14	0.141	0.0028	BDL	529.2	53.86
8	0.35	122600	0.47	8.06	30.1	830	13940	871	5.58	0.131	5280	12310	1549	4740	878	193	544	57.7	201.8	31.8	59.9	6.17	30.2	2.86	BDL	0.009	BDL	1419	153.7
9	0.36	106400	0.36	5.01	42.8	796	12650	847	2.69	0.065	4780	11150	1430	4440	861	186	530	55.3	207	32.8	61.3	6.43	32.1	3.28	0.098	BDL	0.065	337.8	180.5
10	0.1	94200	0.82	9.21	32.1	530	20840	544	11.56	0.041	3610	8650	868	3430	606	131.7	379	35.5	135	20.2	39.2	3.91	18.2	2.03	0.054	BDL	0.009	1478	91.6
11	0.38	94500	1.05	10.3	25.1	558	20260	582	8.9	0.041	3870	9060	996	3550	624	139.9	411	39	150.2	22.5	43.3	4.21	20.5	2.42	0.051	0.01	BDL	1463	93.8
12	0.01	101400	0.52	6.76	47	734	15800	711	6.63	0.15	4660	11100	1450	4160	824	174.7	520	49.6	192.7	28.9	51.6	5.48	25.3	2.69	0.039	BDL	BDL	3387	161.7
13	0.57	100200	0.23	8.04	37.2	709	16390	606	11.77	0.04	4400	10120	1334	3900	756	151.2	467	43.8	161.6	24.6	43.8	4.56	21	2.33	0.052	0.01	0.038	1316	70.39
14	BDL	85800	0.87	30.4	16.1	598	25200	728	18.7	0.022	5400	12780	1548	5150	842	178.6	556	48.1	190.5	27.8	49.3	5.44	25.3	3.06	0.121	0.008	0.042	1186	65.8
15	0.81	80600	10	25.9	23.1	640	26500	659	20.7	0.069	5170	11350	1458	4010	759	156.4	468	40.3	166.4	25	42.1	4.89	24.9	2.9	0.067	0.014	0.018	946	62.8
16	5.93	100200	0.26	5.89	28.8	530	13400	858	5.55	0.098	4160	10190	1376	4070	870	181	589	57.8	236	36.7	61.9	6.8	30	3.41	BDL	0.027	0.01	1546	184.7
17	3.47	90000	0.67	17.78	29.6	435	25900	601	22.7	0.038	4500	9950	1280	3730	713	138.3	463	40.8	166.6	24.4	42.2	4.75	21.6	2.66	0.065	BDL	0.04	5336	163.9
18	BDL	93300	0.49	8.39	22.8	553	21040	550	17.1	0.034	3920	9070	1155	3360	652	134.9	434	37	157	22.15	39.4	4.14	19.68	2.25	0.037	0.0067	0.008	2200	112.5
19	1.18	115200	0.52	8.07	45.2	691	13230	685	11	0.057	4080	9440	1215	3510	704	132.1	461	42.4	176.9	25.3	45.8	5.2	23.77	2.79	0.036	BDL	BDL	2376	142.6
20	0.37	116400	0.22	7.73	42.1	688	15640	582	3.25	0.068	4060	9060	1129	3370	667	137.1	434	38.8	158.7	22.34	39.8	4.61	20.1	2.16	BDL	BDL	0.008	1530	96.8
21	0.36	120300	0.53	8.67	33.3	676	12240	701	2.4	0.087	4250	10050	1319	3810	787	146.1	510	46.3	195	27.9	50.1	5.46	25.8	2.86	0.04	0.0036	BDL	415.5	96.74
22	0.38	109400	0.59	4.31	31.9	409	18600	518	4.73	0.067	3360	8220	782	3210	572	122.8	394	34.7	138.7	18.4	35.8	3.62	17.4	2.1	0.024	0.0025	BDL	2895	158.9
23	0.26	114700	1.99	27	28.6	960	20000	666	16.1	0.067	4600	10540	1310	3840	746	148.9	452	41.9	166.8	23.2	42.3	4.86	21.7	2.61	0.037	0.018	0.026	2538	124.3
24	1.12	115600	1.3	6.4	28.5	760	17690	542	5.54	0.054	3470	8630	812	3260	616	128.8	420	35.8	149.9	18.7	37.2	3.91	17.7	2.23	0.05	BDL	0.026	3046	153.1

MP-P0913-2 apatite (spot size = 19 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 4 mJ at 100%)

Spot	Al	P	Ti	V	Cr	Fe	Sr	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Th	U
1	5.1	127000	181	4.97	BDL	490	9200	648	1.76	0.096	2500	8000	794	3390	584	127	392	44	168	24.7	45.8	4.7	23.7	2.77	0.33	0.08	N/M	41.3	1.58
2	0.2	113500	136	4.56	BDL	318	8860	699	1.45	0.049	2610	7750	858	3600	582	131	419	45.7	184	28.1	48.1	4.68	25.6	3.24	0.13	BDL	N/M	87.5	3.69
3	2.1	111100	112	1.98	BDL	300	9620	980	0.3	0.01	1900	4510	592	2500	496	128	436	49.2	213	38.6	67	7.4	30	3.25	0.21	BDL	N/M	47.1	1.04
4	2.6	121000	134	3.35	23	1010	6710	825	0.98	0.17	2330	6290	820	3050	672	163	484	55	223	32.5	60.2	5.5	30.8	3.76	0.54	BDL	N/M	22.6	0.38
5	8300	121900	434	165	BDL	37100	11100	1890	60	1.03	3470	12900	1620	6130	1349	361	1018	110	505	76.4	151	15.7	62.9	6.33	5.5	BDL	N/M	141.8	12.7
6	2060	106000	211	55	4.7	15900	6610	906	270	1.1	1680	6700	876	4050	956	213	629	67.1	279	37.6	83	8.5	38.8	3.71	3.6	BDL	N/M	57.3	12.7
7	3510	109900	163	19.9	4.6	2530	9470	846	0.85	0.071	1680	5670	640	3030	641	154	528	56.6	219	34.2	59.6	5.61	28.5	3.1	0.31	BDL	N/M	23.3	4.27
8	0.6	105000	152	3.29	1.4	120	8900	589	0.66	0.011	2180	6440	686	2900	497	117	384	34.9	157	23.4	48.8	4.93	24.6	3.19	0.055	BDL	N/M	22.6	3.62
9	4240	97800	149	4.08	BDL	890	7550	749	1.52	0.028	1990	6920	809	3540	647	132.4	532	51	187.4	31.1	59	5.75	24.8	3.19	0.32	BDL	N/M	110.4	2.07
10	43	107000	146	3.4	1.5	390	9500	720	0.18	BDL	1930	6150	536	2050	422	131	400	38.9	157	25.3	45	4.42	20.9	2.15	BDL	0.005	N/M	24	4.5
11	0.7	94700	167	0.83	BDL	240	6200	734	0.026	BDL	580	1790	294	1470	606	181	612	65.8	227	26.8	36.7	3.17	11.5	1.23	0.05	BDL	N/M	3.4	1.37
12	256	73200	35.7	2.32	25	1340	12800	655	1.16	0.079	151	487	128.7	936	534	185	576	60.6	203	22.9	31	2.45	10.9	0.78	BDL	0.001	N/M	1.6	0.35
13	34.8	93600	105.9	1.34	16.1	250	7610	872	0.12	0.066	620	1840	277	1530	573	192	603	66.6	226	28	39.3	2.95	13.2	1.28	0.02	BDL	N/M	11.7	0.09
14	1.5	88000	131	0.113	3.2	120	19900	557	0.017	0.015	111	712	165	1010	522	206	557	54.8	172	16	22.8	1.42	5.3	0.411	0.1	0.008	N/M	0.4	0.63
15	0.8	109000	140	2.9	16.1	70	8900	764	0.37	BDL	2980	7800	714	2680	725	243	628	53.3	194	26.7	49.1	4.16	19.7	2.29	0.08	0.066	N/M	66.9	2.7
16	10	97100	140	8.43	BDL	320	17800	920	1.43	0.009	9900	19600	1430	5060	720	162	503	39.9	181	29.8	68.9	6.9	37.4	4.47	0.27	0.07	N/M	233	9.2
17	1.8	105000	161	5.92	BDL	80	13500	822	1.2	0.05	6760	15360	1270	4690	683	162	513	45.9	200	30.8	58.3	6.57	31.3	4.07	BDL	0.006	N/M	301.1	16.93
18	2.44	98000	144	7.43	BDL	190	12500	823	1.24	0.054	7800	16800	1330	4750	660	157	491	42.1	177	29.3	66.4	6.7	35.7	4.32	BDL	BDL	N/M	314	17.5
19	BDL	106000	168	0.34	BDL	40	3230	423	0.016	0.028	196	1091	206.9	1310	502	161	476	36.9	130	15.2	19.6	1.38	5.3	0.76	0.13	0.016	N/M	1.5	0.06
20	2.2	99000	132	3.68	BDL	170	11300	1580	0.77	0.036	2630	9830	936	4390	1000	233	795	83	355	58.4	102.7	10.25	52.3	6.16	BDL	BDL	N/M	159.3	6.9
21	1.8	110000	150	2.18	BDL	260	8010	990	0.529	0.03	1430	5090	589	2860	628	153	549	55.2	222	36.5	71.4	6.25	37.2	4.75	0.19	BDL	N/M	32.4	1.46

Spot	Al	P	Ti	V	Cr	Fe	Sr	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Th	U
MP-P0913-10A apatite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 120, laser energy = 3 mJ at 75%)																													
1	0.03	74800	1.09	22.9	26.2	131	29000	695	6.83	0.098	5150	11290	1138	3460	550	123.9	379	38.4	165.7	24.2	55.2	5.77	27.8	2.91	0.033	0.0058	1.6	1225	95.3
2	1.33	78800	0.99	31	16	145	23800	695	10.33	0.086	4750	10780	1130	3470	546	126.4	396	39.7	169.5	25.2	56.2	5.64	29.2	3.17	0.081	0.008	0.83	1252	51.95
3	3.28	80900	0.95	22.5	24.4	171	23200	480	10.16	0.058	4030	8400	838	3150	504	109.3	359.3	32.8	130.6	18.48	38.3	3.94	18.3	1.99	0.008	0.015	0.127	893	33.05
4	0.96	75700	1.45	24.5	7.7	141	25800	555	8.21	0.068	4080	8710	827	2690	434	95.7	307	29.6	129.7	19.37	43.1	4.48	22.4	2.37	BDL	0.0054	1.01	1339	54.89
5	5	76900	0.92	23.5	12.1	200	26400	626	8.78	0.068	4200	8800	841	2840	462	102.8	333	33.2	145.4	22	48	4.9	24.6	2.76	0.078	BDL	1.42	1215	48.72
6	0.43	74500	0.34	3.31	5.7	98	30900	578	1	0.092	4700	9860	1055	3210	492	104.1	353	33.9	137.9	20.6	45.5	4.63	23.3	2.46	BDL	BDL	4.57	369.4	74.55
7	BDL	86800	1.61	27	4.5	381	24100	593	13	0.047	5120	11640	1295	4340	694	144.7	479	43.1	165.7	22.9	48.2	4.73	22.1	2.8	0.09	BDL	BDL	414.4	28.52
8	0.31	90200	1.44	31.7	8.1	374	20100	452	13.17	0.032	3840	8870	859	3420	540	120.6	384	31.8	119.6	16.8	33.8	3.39	16.5	2.26	0.082	0.0035	0.027	521.2	24.85
9	0.63	84200	0.85	28.9	10.4	440	18610	417	11.66	0.042	3380	7740	780	2990	510	109.5	350	28.9	111.4	16.02	31.5	3.04	15.61	2.16	0.018	0.0086	BDL	483.1	19.57
10	0.56	73500	0.18	15.32	2.8	207	29200	682	5.22	0.157	5510	11360	1137	3400	525	118	382	38.3	167.9	25.3	56.5	5.69	26.2	2.71	0.049	0.011	0.01	5574	247.1
11	1.23	74000	0.45	28.9	5.5	164	27800	747	9.18	0.133	5180	11160	1173	3470	548	128.3	397	40.1	175	26.5	60.1	6.29	30.2	3.35	0.041	0.009	0.98	2970	118.2
12	0.45	76100	0.34	27.5	3.4	239	25400	537	11.38	0.06	4650	10840	1195	3950	622	132.8	434	37.6	151.4	21.2	43.1	4.12	20.3	2.37	0.152	0.012	0.39	640	30.57
13	1.44	80900	1.12	27.7	5.5	282	23900	532	11.1	0.037	4620	10300	1144	3680	608	128.1	413	36.2	150	19.7	40.9	3.96	19.9	2.29	0.116	0.0028	0.26	695	30.13
14	0.35	75200	0.74	16.95	12.1	201	31200	783	6.38	0.215	5610	12430	1305	3880	635	140.1	463	45.3	198.8	28.9	64.6	6.41	29.8	3.25	0.097	BDL	1.59	2202	133.8
15	0.09	78600	0.92	21.4	1.6	245	23900	595	10.06	0.044	4560	10350	1180	3600	582	119.5	424	37.8	161.9	22.8	47.5	4.6	23	2.88	0.167	BDL	1.43	778	43.64
16	BDL	85300	1.09	23.3	1.7	178	25800	612	9.47	0.053	4840	10670	1208	3830	598	124.7	419	37.7	161	22.6	47.5	4.55	22.37	2.58	0.079	0.0027	1.87	910.2	53.83
17	0.28	85800	1.38	29.4	BDL	537	20440	634	15.55	0.049	5170	12060	1462	4440	744	160.2	531	44.9	177.3	25	51.2	4.94	23.6	3.03	0.111	0.0057	0.05	886	44.99
18	BDL	91100	1.71	21.59	16.4	333	16600	337	11.38	0.035	1990	4650	470	1900	333	73	236	20.56	82.3	12.22	26.3	3.15	17.9	2.61	0.072	0.0068	0.07	381.7	23.73
19	0.15	90200	1.61	23.4	14.2	228	17690	427	12	0.041	3830	8980	965	3290	572	115.8	387	31.6	123.2	17.2	33.8	3.23	14.6	1.76	0.052	BDL	0.063	524.1	27.01
20	0.51	91200	1.09	21.56	4.9	187	18260	523	9.21	0.051	4390	10190	1163	3520	571	116.9	375	32.3	133.7	19.3	40.9	4.01	19.7	2.54	0.035	BDL	0.07	442.8	25.74
21	16.8	82200	1.34	22.81	21.7	356	20830	444	10.96	0.051	3730	8110	902	3080	525	112.7	370	30.8	124	17.43	34.1	3.32	16.57	2.09	0.118	BDL	0.083	381.4	19.06
22	BDL	76000	1.4	22.5	4.9	204	23200	511	10.34	0.052	4210	9840	1084	3420	539	113.7	384	34.3	138.1	19.44	40.4	4.05	20.39	2.35	0.052	BDL	0.29	904	46.62
23	BDL	76700	0.93	21.79	5.2	173	24900	563	9.3	0.054	4190	9400	1032	3140	520	114.6	362	33.1	142.7	20.2	42.6	4.58	21	2.48	0.04	BDL	0.72	1052	54.38
24	0.34	83900	0.94	22.2	10.5	731	22000	443	11.63	0.036	3970	9210	1081	3430	588	122.6	397	32.6	126.4	16.6	34.6	3.13	15.8	2.13	0.054	0.0084	0.029	419.7	22.72
25	0.47	75900	0.61	38.8	0.5	138	26200	815	12.5	0.115	5690	12330	1326	3890	636	149.8	478	47.5	204.3	30.3	68	7.05	35.3	4	0.128	0.009	1.97	2660	95.85
26	BDL	83700	0.7	21.27	3.8	473	22300	448	9.49	0.038	3850	9250	1034	3330	574	117.7	387	32.5	129.7	17.7	36.3	3.42	16.4	2.2	0.06	BDL	0.05	245.7	18.41
27	1.58	78900	0.93	22.4	BDL	122	27200	597	7.72	0.081	4480	9540	999	2870	459	106.1	323	31.4	136.7	19.94	47	4.89	22.8	2.56	0.035	0.007	1.41	1731	78.96
28	0.46	78900	0.55	24.8	BDL	208	27700	764	11.4	0.201	5510	12250	1314	3990	663	157	474	46.7	211.6	29.9	66.3	6.23	31.1	3.17	0.078	0.0057	0.368	5090	183.2
MP-P0913-10B apatite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 120, laser energy = 3 mJ at 75%)																													
1	0.84	73400	1.87	13.97	26.8	386	25400	349	7.7	0.024	2658	5610	524	1998	350	79.7	230	20.4	82.4	12.04	24	2.5	11.75	1.67	0.061	0.021	0.092	231.6	12.42
2	1.03	85800	2.35	15.04	22.6	535	16400	282	8.08	0.0042	1832	4170	400	1620	292	59	207	16.91	67.1	10.1	20.8	2.16	10.77	1.405	0.068	BDL	0.012	216.9	14.05
3	0.49	86300	0.79	4.85	20.5	239	16100	489	2.92	0.0105	1620	4610	504	2290	486	114.2	345	31.1	124.2	17.5	34	3.17	14.59	1.71	BDL	BDL	0.038	134.8	7.34
4	0.55	69900	0.62	7.99	12.4	211	27400	1315	3.9	0.202	8170	17510	1801	7360	952	212	729	72.6	299	40.8	88.6	7.75	34.6	3.53	0.064	0.008	0.44	2928	111.4
5	0.32	74000	1.61	19.08	22.3	456	24200	392	10.3	0.043	3260	7240	753	2800	488	102.4	324	26.9	107.8	14.83	28.6	2.7	13.22	1.49	0.021	0.0056	BDL	430.7	18.11
6	0.7	83500	1.69	14.95	18.6	546	19600	258	7.83	0.049	1908	4180	410	1686	277	61.9	205.3	16.46	65.9	8.87	18.1	1.74	8.95	1.108	0.033	BDL	BDL	169.1	9.97
7	0.12	82700	1.38	15.59	16.1	529	19800	266	8.63	0.036	1862	4190	427	1685	282	63.8	203.2	16.31	67.9	9.63	18.9	1.93	9.07	1.185	0.031	BDL	BDL	185.2	11.22
8	26.2	81600	1.64	17.9	21.9	488	18900	310	8.96	0.052	1841	4160	420	1735	304	65.5	224	18.5	75.8	11.31	22.6	2.51	14.4	1.77	0.027	0.012	0.094	263.3	12.87
9	25.8	75800	1.66	16.88	20.2	527	18300	302	9.33	0.03	1719	3790	388	1669	285	62.4	210.2	17.63	71	10.72	23.1	2.6	15	2.11	0	BDL	0.009	264	13.36
10	0.12	69700	0.62	24.4	BDL	240	30100	467	9.36	0.023	4200	9220	1076	3390	528	122.4	384	33	131.2	17.85	37.5	3.59	18	2.01	0.044	BDL	0.018	511	21.28
11	0.02	94500	1.17	3.17	15	82	9190	589	0.92	0.024	1750	5280	586	2720	539	125.2	415	37.8	141.7	20	40.2	3.36	16	1.8	BDL	0.025	0.79	58	5.83
12	0.32	83800	1.83	20.7	8.5	583	17800	348	10.96	0.047	2510	5880	588	2430	401	85.3	297	24	91.8	12.68	25.5	2.46	12.04	1.51	0.035	0.0039	0.033	287.4	14.34
13	BDL	79300	0.73	9.65	7.2	199	19500	691	3.77	0.046	3280	7670	860	3410	704	162.7	549	51.4	198	25.8	51.2	4.41	19.5	2.24	0.007	BDL	0.46	342.7	13.8
14	0.04	64800	1.34	17.51	1.2	148	30200	547	8.66	0.029	4290	9460	1044	3360	563	126	395	36.6	149.4	19.4	40.4	3.73	18.1	1.85	0.091	0.009	0.098	403.1	16.6
15	0.26	74100	0.85	15.2	3.4	206	26600	963	5.66	0.114	7460	16300	1740	6740	906	205	650	58.3	232	30.7	61.6	5.42	24.5	2.55	0.042	0.0031	0.23	423	14.9
16	0.41	70000	0.72	22.47	1.2	254	29100	496	10.1	0.034	4110	9530	1064	3540	569	124.3	383	33.5	129.6	18.5	37.9	3.47	17.33	1.96	0.054	BDL	0.054	437.9	18.18
17	0.52	79500	0.27	5.06	BDL	154	21400	851	2.02	0.12	5280	11590	1234	3980	780	185	578	55.4	222	28.4	57	5.09	22.76	2.03	0.01	0.015	0.27	1121	37.49
18	2.13	84900	0.61	6.56	BDL	166	17220	708	2.7	0.056	3710	9580	1127	3810	695	154.5	495	44.8	180.5	24.7	50.2	4.33	20.3	2.02	0.008	0.015	0.85	152.9	12.57
19	14.9	70900	1.54	12.61	BDL	360	29600	587	4.93	0.013	4360	9920	1096	3570	645	141	503	40.1	164	20.7	41.2	3.61	15.8	1.86	0.049	0.008	0.102	192	7.9
20	0.8	65500	0.44	25.42	BDL	215	32900	662	10.71	0.08	5910	13300	1463	5890	756	159.4	499	44.9	177.2	23.8	47.6	4.31	21	2.43	0.073	0.01	0.069	683.6	23.25
21	0.34	69200	0.85	21.2	BDL	191	35400	660	9.45	0.048	5790	13240	1415	5030	723	155.7	488	43.3	171.7	23.5	46.8	4.51	20.8	2.26	0.026	BDL	0.087	562.6	21.98

Spot	Al	P	Ti	V	Cr	Fe	Sr	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Th	U
MP-P0913-10C apatite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 120, laser energy = 3 mJ at 75%)																													
1	0.43	109700	1.65	29.1	35.9	511	18600	572	15.3	0.05	4780	10700	1344	3950	712	150	465	41.4	151.2	22.4	39.5	4.11	19	2.29	0.107	0.003	0.029	197.3	32.71
2	0.29	101100	1.09	27.9	30.2	691	22460	533	10.88	0.036	4390	10020	1222	3460	622	131.8	403	36.5	134.8	19.67	35.2	3.65	17.38	1.9	0.008	0.006	0.064	124.2	16.72
3	0.29	100000	0.64	28	29.5	491	21200	534	10.7	0.025	4180	9550	975	3400	607	129.6	390	34	129.2	17.97	35.7	3.53	16.57	2.11	0.066	0.011	0.041	124.4	17.58
4	0.33	103100	1.07	23.79	23.3	195	22070	497	11.69	0.037	4010	8890	923	3320	562	126.4	374	34	125.6	18.05	34.2	3.21	16.3	1.96	0.078	0.00000192	0.061	109.4	20.67
5	0.29	91100	0.6	12.34	13.4	231	28800	646	4.56	0.111	4910	10220	1082	2810	483	107.9	328	33.4	140.1	23.4	45.5	5.04	23.1	2.29	0.017	0.000000654	0.281	354.9	83.3
6	0.26	98200	1.44	20.68	22	551	23100	475	10.45	0.055	4210	9210	958	3300	575	128.2	356	31.6	117	16.19	32	3.22	14.75	1.73	0.064	BDL	BDL	58.24	13.8
7	0.35	103100	0.66	28.9	17.3	464	20540	580	13.22	0.044	5450	12390	1530	4330	800	160.2	498	43.7	159	24.2	41.8	4.43	19.9	2.07	0.101	0.0028	0.031	250.2	39.28
8	0.43	108500	0.97	28.4	10.1	575	20100	553	14	0.05	5180	11730	1473	4030	750	153.5	457	40.8	153.2	22.4	39.8	4.04	17.8	2.12	0.102	0.0032	0.077	210.5	34.54
9	0.36	109600	1.02	25.1	32.3	342	21700	527	8.47	0.049	4510	9870	1042	3340	563	121.8	363	34.9	130.1	20	37.8	3.85	17.91	2.04	0.009	0.01	0.3	123.8	23.81
10	0.84	112500	1.24	23.6	19.4	433	22800	523	10.96	0.025	4820	10550	1229	3680	626	132.3	399	37.7	138.1	20.5	35.3	3.59	17.3	1.91	0.071	0.0043	0.075	106.4	21.57
11	0.81	97400	1.95	23.25	16.2	203	22300	461	10.4	0.019	3620	7790	703	2770	467	106.6	313	28.6	114.4	17.3	33.7	3.57	17.83	2.18	0.016	BDL	BDL	143	24.32
12	0.35	95000	1.11	33.7	11	220	20700	532	8.67	0.036	3810	7850	670	2456	412	96	284	28.2	123.5	18.9	41.4	4.57	23.81	2.83	BDL	0.0031	0.074	311.3	41.82
13	0.4	104400	1.08	34.1	4.6	206	21700	710	11.86	0.105	4840	9940	925	3100	511	121.9	355	37.4	158.6	26	54.5	6.17	30.9	3.33	0.073	0.014	0.077	679.1	80.18
14	0.32	97100	0.29	11.67	10.5	77	25970	676	3.54	0.23	4440	9400	837	2795	474	109.2	343	35.7	149.8	23.4	48.9	5.19	24.6	2.49	0.014	0.009	0.105	448.9	98.2
15	0.39	97300	0.76	16.11	10	314	21500	461	7.03	0.042	3920	8680	823	3000	512	111	324	30.3	117.3	17.21	34.6	3.43	17.7	2.18	0.025	BDL	0.022	78.2	19.49
16	0.17	115600	0.6	18.3	0.9	688	23300	541	9.27	0.055	4630	9940	1163	3490	601	131.6	376	36.3	132	19.7	37.9	4.13	19.9	2.28	0.056	0.0034	0.012	60.58	17.7
17	0.56	115400	1.32	26.3	43.8	539	22500	669	12.34	0.042	5730	12060	1418	4170	789	162	466	47.2	169	25.6	46.6	4.88	21.3	2.45	0.051	BDL	BDL	130.9	22.26
18	0.83	122400	240	32.6	45.2	1210	22500	688	67	8.2	5510	11570	1405	4190	773	158.6	460	45.9	168	25.9	46.5	4.9	23	2.49	0.71	0.27	1.49	188.1	36.51
19	0.35	115500	1.61	41	33.4	485	22500	532	12.48	0.038	5140	10490	1269	3760	675	137.4	408	38.9	131.3	19.5	35.8	3.79	17.7	1.81	0.07	BDL	0.044	135.2	15.43
20	0.16	112600	0.82	43	20.5	424	22200	543	13.12	0.052	5280	10590	1291	3750	667	137.9	403	38.4	135	20.17	36.7	3.82	17.93	1.99	0.148	0.01	BDL	159.4	17.98
21	0.42	100800	1.08	23.46	24.3	930	19400	413	11.72	0.054	3480	7660	724	2890	506	111.1	340	29	110.7	15.25	29.4	2.83	13.83	1.83	0.124	BDL	0.066	101	19.29
22	0.13	95900	1.42	17.6	20.8	96	22900	461	7.01	0.045	3570	7610	671	2530	455	94.9	304	29.7	118.5	18.4	37.2	4.06	19.1	1.94	0.043	0.0061	0.027	199.5	39.28
23	0.41	99200	0.42	26.3	41.1	902	19000	612	14.85	0.067	5180	11100	1368	3910	757	148.6	450	45.6	166.5	26	44.6	5.08	24.6	2.7	0.147	0.0061	0.064	110.4	19.23
24	0.59	87000	1.69	19.36	24	286	18780	396	8.98	0.045	3180	7130	654	2600	469	95.4	305	28	108.5	15.65	30.9	3.15	14.6	1.88	0.09	0.0065	0.083	151.1	27.77
25	0.47	93200	1.53	20.29	25.2	514	20810	489	10.72	0.039	4290	9100	903	3330	571	124.5	347	32.7	124.9	18.7	36.3	3.65	19	2.14	0.087	0.0029	0.02	190.4	35.56
26	0.07	84700	0.37	20.91	28.9	298	18550	434	10.26	0.038	3830	8320	790	2940	513	110.7	332	31.1	118.9	17.08	33.3	3.59	17.3	1.92	0.078	0.003	BDL	90.5	16.6
27	0.06	95800	1.73	32.7	24.5	617	18770	640	15.4	0.066	5480	11630	1431	4210	809	152.2	464	46.4	175	27	48.5	5.12	24.8	2.77	0.072	0.0064	0.12	78	21.79
28	0.37	85300	0.74	11.91	20.1	429	28800	805	4.47	0.16	5520	11150	1266	3230	618	130.9	398	42.9	166.5	28.4	53.6	6.23	26	2.61	0.069	BDL	1.61	95.2	21.61
29	0.61	92800	1.69	28.6	25.9	720	20330	601	16.28	0.048	5320	11240	1428	4010	806	161.7	469	44	165.2	24.34	43	4.75	21.7	2.56	0.062	0.0061	0.068	267.4	40.1
MP-P0913-10D apatite (spot size = 40 µm, shot frequency = 4 Hz, shot count = 120, laser energy = 3 mJ at 75%)																													
1	0.39	77800	0.62	2.69	23.6	135	19100	759	1.14	0.035	1686	5400	640	2950	664	156.9	492	47.2	197	28.4	56.1	5.36	25	2.62	0.027	BDL	0.45	45.3	7.23
2	0.42	64100	0.87	16.31	15.6	211	31900	423	9.51	0.055	3830	8410	922	2730	448	112.2	307	27.3	113.4	15.6	33	3.32	15.9	1.81	0.069	BDL	0.24	173.9	13.39
3	49.5	86700	3.5	1.516	8.5	220	14580	838	1.14	0.095	2154	6410	729	3180	722	163	549	53.9	228.4	31.1	58.9	5.25	23.5	2.3	0.02	0.009	0.189	235.2	7.87
4	25.4	67700	0.17	16.67	9.4	182	28100	622	6.46	0.04	4610	11200	1242	3990	713	165.1	524	48.7	189.8	25.2	50	4.46	20.4	2.17	0.058	BDL	0.22	208.7	11.6
5	0.36	68700	1.2	24.9	9.7	288	29800	476	12.74	0.032	4300	10150	1166	3790	618	135.3	418	34.2	141.6	19	36.9	3.43	17.3	2.01	0.089	0.0058	0.144	267.7	14.82
6	2.71	69800	0.61	18.58	11.1	220	30300	586	5.85	0.054	5120	12030	1332	4300	723	172.2	508	45.5	178.4	22.7	45.1	4.09	18.1	2.07	0.018	0.0033	0.96	183	10.38
7	0.67	72600	1.48	20.3	15.9	308	26200	356	9.98	0.044	2873	6820	629	2540	437	95.8	302	24.4	101.3	13.25	25.4	2.3	12.04	1.52	0.055	BDL	BDL	158.8	9.75
8	0.34	67300	0.93	22.64	5.8	243	33000	464	10.45	0.039	4630	10880	1178	3720	606	137.1	421	35.8	141.2	18.4	37.4	3.33	16.8	1.89	0.047	0.0085	0.133	232.2	13.43
9	0.15	83200	0.56	1.61	0.4	109	12520	762	0.75	0.037	1870	5700	609	2890	727	175	606	55.2	228	28.3	51	4.37	17.8	1.66	0.008	BDL	0.21	164.2	7.57
10	0.68	86600	0.35	2.34	BDL	140	10790	668	1.11	0.039	1900	5490	571	2720	689	174.7	584	53.9	204	25	43.4	3.44	14.7	1.56	0.039	BDL	0.35	259.2	10.94
11	0.32	64100	1.08	20.61	1.7	159	35700	557	9.54	0.069	5160	11810	1254	3880	657	151.2	463	39.6	158.5	20.8	41.8	3.7	19.6	2.1	0.112	BDL	0.24	242.9	14.18
12	0.2	69600	0.78	21.98	BDL	223	29200	453	10.66	0.029	3990	9760	1060	3410	569	125.7	396	33.8	132.1	16.98	34.2	3.29	16.12	1.89	0.123	BDL	0.079	217.4	13.2
13	0.39	64300	0.25	3.11	0.9	47	36300	575	1.27	0.06	5560	12020	1145	3540	562	121.6	402	36.5	153.5	20.93	46	4.8	22.4	2.27	0.039	0.0056	1.48	177.8	39.95
14	0.33	65500	1.58	20.3	1	231	33100	506	9.87	0.049	4940	11590	1282	3980	651	142.7	452	39.4	157.6	20.2	41.6	3.73	18	2.15	0.149	BDL	0.166	210	13.17
15	0.31	87600	0.3	4.49	BDL	99	10220	631	1.77	0.038	1450	5400	584	2940	714	168	564	51.6	204	24.9	45.5	3.89	17.36	1.98	0.011	0.011	0.74	38.83	3.54
16	1.28	76900	0.5	10.29	5	160	20800	597	3.24	0.03	3570	8890	912	3480	692	157.4	505	44.5	178.9	21.9	41.1	3.44	16.6	1.84	0.042	BDL	0.69	67.5	5.71
17	0.73	71400	0.18	13.79	0.9	83	26200	710	4.07	0.069	5000	11520	1238	4120	769	176	551	49.7	207	27	53.7	4.63	21.4	2.38	0.057	BDL	0.56	188.1	13.4
18	BDL	70700	1.19	16.95	10.8	353	24700	345	7.99	0.016	2880	7040	635	2460	421	92.2	284	23.81	94.8	12.38	24.6	2.29	11.28	1.48	0.096	BDL	0.027	69.54	5.62
19	10.95	79900	1.15	21.08	15	360	21800	366	12.77	0.025	2738	6690	607	2410	422	90.4	303	24.3	96.1	13.17	28	2.73	14.6	1.95	0.079	0.0058	0.114	142	12.76
20	BDL	74900	1.39	22.81	17.1	480	24500	423	11.46	0.03	3590	8380	898	3230	545	116.3	365	30.9	120.9	16	31.8	2.96	14.1	1.776	0.017	BDL	0.01	168.8	11.46
21	0.34	68600	0.67	24.1	4	184	30800	632	10.48	0.06	5590	12840	1459	4610	761	169.8	526	46.5	189.6	24.3	49.7	4.52	21.2	2.48	0.126	0.02	1.2	282.2	17.14
22	0.25	91400	0.77	3.26	10	168	9740	598	1.06	0.037	2000	5800	638	2990	697	162	549	47.4	186	24.2	45	3.58	15.7	1.84	BDL	BDL	0.63	109.3	9.25

Spot	Al	P	Ti	V	Cr	Fe	Sr	Y	Zr	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	W	Th	U
MP-P0913-10D apatite CONT'D (spot size = 40 µm, shot frequency = 4 Hz, shot count = 120, laser energy = 3 mJ at 75%)																													
23	0.51	85400	0.74	3.53	9.6	132	10990	723	1.56	0.027	1650	5410	585	2740	624	148.6	508	47.2	192.4	26.1	48.7	4.19	17.1	1.95	0.009	0.0031	0.62	37.1	3.73
24	0.45	62800	0.64	15.79	BDL	154	30900	574	7.09	0.027	4600	10330	1149	3430	591	137	418	38.7	157.2	20.4	42.2	3.84	17.6	2.03	0.047	0.0089	1.25	119.4	8.42
25	0.33	63000	0.95	20.95	BDL	162	32000	582	7.94	0.048	5110	11670	1295	4040	670	145.3	464	39.9	161	21.8	42.6	4.05	18.1	2.12	0.156	0.0062	0.56	188.6	11.29

BDL = below detection limit
N/M = not measured

APPENDIX Y - RUTILE TRACE ELEMENT DATA TABLE

MP-P0913-2 rutile (spot size = 31 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 7 mJ at 100%)

Spot	Al	Si	P	Ca	V	Cr	Fe	Ni	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Pb	U
1	43.4	7100	83	220	2060	19	6910	0.36	39.9	86	11870	27.2	87	13.1	63	19.2	5.1	22.2	4.2	25.2	5	11.9	1.33	6.3	0.6	191	591	18500	4.7
2	590	11800	211	144000	4540	33.3	275000	2	38600	21200	5340	19100	21200	845	2680	2930	1183	4370	899	4960	860	1790	207	1050	85	363	357	BDL	175.7
3	16	8500	78	2700	166	9.6	6200	0.27	290	160	8400	160	260	22	78	30	12	37	7.9	47	8	19	2.4	14	1.1	185	426	5500	BDL
4	94	6800	146	5780	266	15.8	14910	BDL	1340	1070	7350	552	680	47	136	94	40.7	142	39	244	46.7	116	13.9	79.5	7.6	212.3	375	BDL	13.71
5	490	28300	23500	10320	1818	18.5	13320	2.2	800	4400	10640	32000	57400	12400	50400	7050	1490	3730	400	1190	150	249	23.6	125	14.4	326	616	347100	77.3
6	59	4980	620	470	974	21.1	4550	0.88	15.6	70	9480	230	3800	82	410	74	28	35	4.9	18.2	2.1	4.8	0.33	2.9	0.25	205	598	56700	1.4
7	400	30000	3200	16500	484	11.3	4320	1.7	360	4500	4960	3500	11900	1680	5100	1090	218	650	104	750	320	970	140	850	85	1800	478	18600	2.63
8	43	6100	220	10	515	10.4	2520	0.74	15	45	4410	69	280	16	56	14	3.7	14	0.92	8.7	1.26	3.1	0.57	2.1	0.27	396	522	59900	1.12
9	260	6280	226	340	357	19.6	3880	1.4	12.8	110	7130	47	208	22	76	15.8	4.1	10.9	1.19	7.5	1.9	5.9	0.65	5.5	0.63	340	552	42800	1.01
10	16.8	6670	96	300	168	11.1	2400	BDL	17.7	15.8	6660	14	46	15	40	10.1	2.1	6.9	0.93	4.84	0.8	1.75	0.239	1.27	0.134	210	427	14300	BDL
11	109	7700	295	1460	187	17.5	5900	1.95	84	42	7450	159	590	77	230	52	10.7	35	3.4	10.3	1.69	3.2	0.87	2.15	0.216	158.7	594	129100	0.97
12	1600	16500	86	6500	580	14.6	7200	0.67	23.9	82	10210	47	260	48	250	68	16.5	46	5.5	25	3.8	8.4	0.92	4.5	0.45	137	749	6760	0.59
13	24.1	4230	66.1	240	2750	8.9	3310	0.43	27.6	3.46	2350	9.5	32	4.61	20.4	5.57	1.25	3.35	0.41	0.81	0.169	0.24	0.011	0.152	0.033	6.3	317	51800	0.33
14	57	4600	104	268	2500	13.6	4830	0.85	46.4	7.9	2720	16.9	41.1	5.17	28.6	9.3	2.32	6.8	0.64	3	0.496	1.05	0.109	0.62	0.13	9.88	218	75800	0.65
15	220	5410	82.3	140	1640	11.9	101000	2.83	15.5	3	1590	3.56	18	1.09	4.49	0.89	0.36	1.16	0.165	0.85	0.109	0.32	BDL	0.22	0.077	2.65	157	56500	0.12
16	5.1	3940	49	7	1219	6.6	5600	BDL	6.77	1.99	6260	3.9	12.9	2.08	8.16	1.98	0.52	1.48	0.183	0.56	0.119	0.102	0.012	0.11	0.032	2.4	141.2	2130	0.14
17	58	5010	78	58	2940	11.6	17700	0.75	17.6	7.65	25400	13.3	45.4	6.5	26.3	8.2	2.11	5.36	0.64	2.31	0.33	0.97	0.076	0.62	0.077	8.79	305	31200	0.79
18	1.37	4810	49	BDL	1070	5.2	4180	0.22	5.9	0.66	3890	0.22	0.279	0.05	0.25	0.23	0.044	0.3	0.014	0.17	0.008	0.024	0.009	0.007	0.014	8.02	58.4	3020	0.03
19	1.6	5540	63	17	1086	13.1	5160	0.33	6.37	0.72	3010	0.46	1.18	0.181	0.68	0.17	0.074	0.092	0.039	0.16	0.014	BDL	0.016	0.06	0.0115	20.2	204	2930	0.38
20	62	5120	129	70	1730	5.5	8400	0.39	7.91	6.5	9830	120	38	14	54	8.8	2.2	9.5	0.75	3.4	0.42	0.9	0.16	0.67	0.116	38.4	347	3400	0.31
21	22.9	14400	1240	BDL	1192	21.1	7300	0.24	29	7.5	6380	630	1680	240	860	120	26	45	2.19	3.4	0.341	0.538	0.066	0.206	0.034	70.3	437	12870	0.62
22	127.2	12410	2090	870	1600	8.2	14000	0.55	179	177	16160	1380	8600	1470	5500	722	106	338	29.4	91.7	10.76	18.55	1.42	7.23	0.78	124.8	386	160600	3.92
23	98	6700	122	160	2020	8	10070	0.27	48	73	12700	165	1270	193	897	107	16.5	47.4	4.57	21.5	3.9	8.5	1.26	7.3	1.03	240	646	68200	1.38
24	13.4	4860	120	20	1570	6.9	4450	0.11	24	7.58	3960	40.7	259	53.4	247	19.1	3.2	7.9	0.71	2.94	0.386	0.79	0.074	0.41	0.054	15.5	340	16300	0.63
25	320	7520	500	620	685	9.9	4230	0.32	28	70	6990	410	760	84	310	74	13	36	4.3	19	3.5	6.7	1.03	2.5	0.34	216	440	13200	0.58
26	9.7	6530	84	3100	279	8.3	2630	BDL	35	190	5280	1900	5100	760	2800	500	101	230	19	58	7	10.3	0.63	1.8	0.134	157	316	10830	0.12
27	57	7700	77	233	395	11.7	3700	BDL	12.4	59	5900	1.07	7.46	0.89	2.27	1.65	0.61	2.2	1.2	14	4.3	20	2.3	15	1.5	367	492	45000	0.72
28	4.16	3840	77.5	BDL	2060	5.5	9990	BDL	10.6	10.2	13600	21.7	49.7	6.7	30.3	8.8	2.46	7.6	0.97	3.89	0.52	1.27	0.198	0.52	0.115	3.3	483	5200	0.56
29	100	4800	75	80	2060	5.9	28000	0.65	18	10.9	7150	18	44	5.6	22	7.5	2.2	6.2	1.04	4.5	0.72	1.8	0.18	0.72	0.109	1.64	445	2770	0.32
30	2.02	4440	62.7	BDL	1421	7.1	8430	0.07	6.77	1.49	10390	5.5	13.1	1.61	7.5	2	0.6	1.21	0.153	0.54	0.061	0.058	0.014	BDL	0.025	1.61	153	865	0.08
31	10.8	4110	58	13	1190	12.1	5140	0.58	6.7	2.2	5240	7.2	19	2.44	9.7	2.9	0.8	2.4	0.202	0.77	0.036	0.27	0.038	0.02	0.034	3.47	103	9900	BDL
32	7.3	3630	57	18	914	3.9	4830	0.02	26.5	6.47	2860	4.44	12.3	1.81	9.4	3.28	1.29	3.79	0.45	2.08	0.408	0.62	0.095	0.4	0.105	2.28	130	4300	0.05
33	0.84	4120	58	31	1006	8.4	4478	0.14	6.22	1.65	3410	4.8	11	1.53	5.3	1.79	0.52	0.78	0.19	0.56	0.073	0.036	0.024	0.037	0.026	1.91	272	1240	0.34
34	1.18	4940	66	93	1146	9.7	6460	0.2	9.79	3.1	6260	15.1	47.1	6.77	35.9	14.8	4.52	8.8	0.85	2.18	0.103	0.198	0.026	0.025	0.019	3.94	262	2640	0.04
35	2.26	4810	49.6	90	777	8.2	6110	0.47	7.96	1.94	4100	51.6	318	55.4	255	31.4	4.13	8.7	0.36	0.89	0.078	0.19	0.022	0.086	0.02	24.1	402	4440	0.03
36	2.9	3700	52.7	3	1580	8.7	9010	0.29	6.4	2.61	7150	4.4	14.1	2.2	10.5	2.7	0.75	1.87	0.28	1.07	0.105	0.23	0.009	0.1	0.032	0.98	550	1299	0.22
37	2.98	3730	60	8	1190	8.1	10190	0.52	5.59	0.7	12600	1.89	11.1	2.11	10.6	2.57	0.55	0.87	0.089	0.204	BDL	0.046	0.013	0.021	0.035	88	807	147	0.07
38	0.6	3240	52	73	1080	7.2	5600	0.07	5.33	0.37	4820	0.54	2	0.33	1.2	0.46	0.121	0.13	0.022	0.016	0.015	0.056	BDL	0.03	0.0076	3.06	194	67	0.03
39	1.38	3430	51.9	76	1112	7.1	6900	0.46	4.91	0.36	5570	0.011	BDL	0.021	BDL	0.05	0.015	BDL	0.0063	BDL	0.003	0.05	0.007	0.026	0.014	29.8	21.8	18.6	0.39
40	1.66	2650	65.4	120	1850	4.8	11150	0.15	6.09	0.71	15100	1.63	5	0.93	5.2	1.46	0.28	0.79	0.028	0.28	0.028	0.005	0.022	0.022	0.009	10.8	64.5	1030	BDL

MP-P0913-10B rutile (spot size = 31 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 7 mJ at 100%)

Spot	Al	Si	P	Ca	V	Cr	Fe	Ni	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Pb	U
1	1.92	5460	66	BDL	154	318	5070	0.19	5.4	0.62	2680	0.39	0.83	0.203	0.74	BDL	0.074	0.2	0.024	0.19	0.002	0.094	BDL	0.097	0.014	2.27	53.1	292	0.28
2	2.9	6260	61.4	90	171.5	341	5220	0.02	6.53	0.718	2800	1	1.84	0.296	1.1	0.44	0.135	0.59	0.078	0.161	0.011	0.031	0.011	0.086	0.0125	2.25	54.5	977	0.45
3	1.16	5880	59	63	159	304	5020	0.06	6.04	0.49	2820	0.212	0.87	0.119	0.84	0.34	0.062	0.21	0.023	0.32	0.017	0.083	0.003	0.04	0.0078	2.29	54.9	372	0.56
4	1.8	5800	64	14	288	39.3	8800	0.19	7.05	1.64	6920	4.2	12.9	1.61	9.1	3.9	1.03	2.2	0.32	0.61	0.061	0.133	0.003	0.022	0.014	0.98	241	2350	0.36
5	1.27	5280	48	80	221	67	8060	0.16	5.6	0.59	3290	0.95	2.39	0.368	1.49	0.82	0.26	0.63	0.126	0.21	0.008	0.067	0.0129	0.047	0.013	0.97	159	678	0.4
6	13.1	5190	80.2	100	4660	27.9	81900	1.29	5.5	0.52	139600	0.23	0.53	0.053	0.42	0.14	0.084	0.29	0.019	0.13	0.01	0.14	0.018	0.001	0.017	8.53	8150	206	1.24
7	3.48	3880	45.4	30	689	16.9	9730	0.23	6.36	1.76	9670	4.9	13.5	2.08	11.1	4.67	1.05	3.7	0.307	1.2	0.063	0.133	0.015	0.07	0.019	1.221	276	2420	0.16
8	4.21	4150	54	119	759	20.6	10400	0.32	8.32	3.09	10430	5.77	15.9	2.56	13.1	5.13	1.37	5.5	0.46	1.39	0.121	0.199	0.028	0.044	0.0043	1.46	296	3500	0.45
9	1.18	4050	57	BDL	175	9.7	6280	BDL	5.54	0.49	2350	0.032	0.053	0.018	0.15	0.28	0.013	0.39	0.013	0.16	0.011	0.048	BDL	BDL	0.017	1.02	224	204	0.17
10	14.3	4960	65	62	218	12.8	8400	0.26	14.5	5.2	4700	15.7	45	7.2	33	15.8	5	11.3	1.14	2.7	0.323	0.55	0.011	0.12	0.018	1.57	92	11980	1.24
11	2	4880	59.5	BDL	453	50.1	7500	BDL	6.52	1.52	4900	1.91	4	0.89	4.1	1.99	0.34	0.99	0.19	0.65	0.061	0.149	0.006	0.005	0.0034	1.63	122	1610	0.46
12	1.49	4710	61	BDL	526	22.2	9070	BDL	6.69	1.01	7470	1.98	7.3	0.97	5.1	1.85	0.65	1.51	0.139	0.33	0.035	0.103	0.014	0.033	0.0061	1.36	110.2	808	0.17
13	2.34	4550	52	62	392	21.5	13900	BDL	7.4	1.45	5700	3.8	9.7	1.55	7.2	3.3	1.02	3	0.28	0.66	0.062	0.166	BDL	0.018	0.004	1.04	147	2090	0.25

Spot	Al	Si	P	Ca	V	Cr	Fe	Ni	Sr	Y	Nb	La	Ce	Pr	Nd	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu	Hf	Ta	Pb	U
MP-P0913-10B rutile CONT'D (spot size = 31 µm, shot frequency = 4 Hz, shot count = 80, laser energy = 7 mJ at 100%)																													
14	20.7	4570	59	72	574	15.2	10700	0.15	14	6.56	7230	14.8	40.1	6.2	33.1	14.7	4.49	12.3	1.35	3.7	0.44	0.45	0.019	0.058	0.051	2.62	279	8150	0.47
15	2.49	3900	49	BDL	434	14.5	10100	BDL	6.26	1.21	5870	3.46	10.5	1.46	8.6	3.92	0.89	2.45	0.212	0.66	0.074	0.061	0.008	BDL	0.0036	1.42	206	1596	0.28
16	3.06	3610	54.6	BDL	1045	24.1	15670	0.17	6.66	1.55	21230	3.5	7.7	1.15	6.2	3.2	0.58	1.8	0.214	0.67	0.071	0.16	0.005	BDL	0.017	1.8	512	1247	0.27
17	1.41	3860	41	53	93.8	19.7	5910	BDL	6.29	0.7	2890	0.37	0.52	0.073	0.46	0.19	0.031	BDL	0.032	0.061	0.015	BDL	BDL	BDL	0.025	0.86	137.6	206	0.69
18	1.58	4130	50	BDL	83.4	15.4	7420	0.1	5.44	0.53	2820	0.023	0.037	BDL	0.1	BDL	0.039	0.064	BDL	BDL	0.023	0.032	BDL	BDL	0.017	0.95	123.7	126	0.12
19	0.89	4860	43	160	136	19.5	6180	BDL	5.65	0.605	2730	0.1	0.46	0.089	0.57	0.18	0.038	0.21	0.033	0.2	0.0052	0.11	BDL	BDL	0.0017	0.95	94.3	238	0.04
20	1.38	4520	56	200	348	140.5	8790	0.05	7.09	1.9	7070	2.7	7.1	1.34	7.5	3.7	1	2.8	0.43	0.92	0.077	0.122	BDL	0.045	0.027	1.98	291	1409	0.06
21	3.7	4250	49	218	333	98.8	6350	0.45	8.3	1.84	3340	4.97	18.6	2.59	16	6.7	1.7	4.6	0.46	0.8	0.098	0.04	BDL	0.071	0.019	1.1	143	3360	BDL
22	4.2	4090	48	203	381	295	8010	0.24	8.67	3.74	6000	6.5	18.2	2.74	16.8	8.4	2.25	6.8	0.81	1.83	0.135	0.163	0.014	0.069	0.036	1.56	250	3070	0.45
23	2.1	3670	56	160	371	41.2	6160	BDL	6.76	1.63	4030	4.4	13.6	2.04	9.1	3.2	1.33	3	0.31	0.66	0.102	0.13	0.021	0.088	0.031	1.66	345	2190	0.2
24	2.4	3740	62	170	415	43.1	11000	0.11	6.68	1.14	4200	2.27	7.3	1.01	5.1	2.66	0.65	2	0.197	0.54	0.035	0.059	BDL	0.126	BDL	1.19	359	1530	0.43
25	5.3	3790	59.7	76	201	26	25300	0.18	9.93	3.78	3650	6.8	18.9	3.1	19.1	9.5	2.91	6.5	0.91	2.41	0.213	0.3	0.021	0.041	0.032	1.52	135	3520	0.37
26	1.55	4330	50	113	163	36.8	10100	0.2	5.04	0.77	2520	0.89	2.29	0.42	2	1.03	0.253	0.74	0.112	0.129	0.038	0.084	0.01	0.004	0.034	0.93	85.6	629	0.09
27	1.14	4530	46	80	157	29.1	5560	BDL	5.78	0.7	2600	0.93	3	0.39	2.4	0.93	0.29	0.67	0.074	0.34	0.044	BDL	0.005	0.011	0.017	0.82	86.2	636	BDL
28	6.4	4150	50	66	247	137	7600	0.1	9.7	3.3	2860	4.4	13.2	2.5	13	5.7	1.8	5.6	0.49	1.7	0.149	0.14	0.037	0.078	0.026	1.69	158.3	1527	0.46
29	7.7	3990	53.2	208	160.9	99.1	4750	0.01	10.8	3.7	2710	9.8	31	4.7	26.9	11.9	3	10.1	0.96	2.6	0.138	0.4	0.0043	0.048	0.025	1.85	180	4250	0.13
30	0.97	3540	54.3	80	249	122	4720	0.24	5.54	0.532	1690	0.022	0.04	BDL	0.18	0.12	BDL	BDL	0.021	0.084	0.025	0.016	BDL	BDL	0.017	0.64	44	165	0.09
31	0.88	3290	54	127	260	136	4350	0.17	5.56	0.58	1670	0.47	0.78	0.094	0.31	0.024	0.028	0.027	0.017	0.088	BDL	0.079	0.018	BDL	0.028	0.75	39.8	234	0.37
32	1.39	2920	47	88	200.6	9	6190	0.09	5.87	0.94	2130	0.77	2.7	0.329	1.77	1.11	0.27	0.73	0.136	0.31	BDL	0.092	BDL	BDL	0.016	0.86	44.7	755	0.4
33	24.2	3730	62	78	323	11	110000	1.03	21.4	8.7	5060	22.7	62	8.4	45	21.2	5.7	15	1.71	5.3	0.47	0.52	0.038	0.13	0.059	2.26	112	13300	2.64
34	0.7	3540	49.6	109	205.6	7	3690	0.2	5.5	0.61	1510	0.58	2.25	0.36	2.14	0.34	0.184	0.63	0.053	0.091	0.016	0.093	0.003	BDL	0.013	0.133	30.5	706	0.33
35	1.49	3800	59.1	109	419	353	5260	0.04	6.29	0.57	4970	1.11	3.2	0.48	1.9	0.71	0.24	0.79	0.109	0.176	0.022	0.07	BDL	BDL	0.0041	1.87	96	284	0.04
36	3.2	3950	52	90	367	43.8	5800	BDL	7.7	1.36	5090	4.1	12.2	1.95	9.6	3.2	1.04	2.72	0.26	0.61	0.056	0.091	BDL	BDL	0.023	2.31	183	1830	0.36
37	1.23	3730	55.1	74	285	42.2	8050	0.11	5.81	0.53	7390	0.52	1.32	0.2	0.84	0.35	0.097	0.22	0.016	0.085	0.02	0.054	BDL	BDL	0.0103	1.1	477	243	0.28
38	1.83	3430	58	BDL	317	27.6	6440	BDL	5.65	0.43	8230	0.205	0.78	0.11	0.188	0.21	0.074	0.042	0.012	0.049	0.011	0.071	0.018	0.004	0.017	1.59	365	198.6	0.19
39	1.12	3200	56	BDL	337	34.1	5810	0.06	5.31	0.37	4050	0.026	0.14	0.058	0.16	0.033	0.041	BDL	0.017	BDL	0.027	0.017	BDL	0.013	0.013	1.25	145.2	129.5	0.23
40	3.86	2980	57.4	18	754	41.1	15300	0.51	6.89	1.81	16700	2.69	8.1	1.42	6.2	3.28	0.65	1.79	0.299	0.92	0.118	0.153	BDL	BDL	BDL	1.39	495	7000	0.38

BDL = below detection limit

APPENDIX Z - NEODYMIUM ISOTOPE DATA TABLE

Spot	^{146}Nd (V)	Total Nd	% ^{144}Sm	^{143}Nd/ ^{144}Nd	2SE	^{143}Nd/^{144}Nd std corr'd	2SE	^{145}Nd/ ^{144}Nd	2SE	^{147}Sm/ ^{144}Nd	2SE	^{147}Sm/^{144}Nd std corr'd	2SE	2SE prop.	β (Sm)	β (Nd)	Age (Ma)	εNd_i	2SE
								MP-P0913-SQ1 Bastnäsite											
1	1.89	8.12	1.0404	0.511035	0.000049	0.511140695	0.000049	0.348386	0.0000345	0.05048	0.00019	0.044186868	0.00019	0.002217498	-1.277	-1.4219	1380	-2.2436	1.037
2	1.92	8.25	1.0009	0.51091	0.00006	0.511015669	0.00006	0.348385	0.0000345	0.04856	0.00012	0.042506227	0.00012	0.002128696	-1.262	-1.4134	1380	-4.3927	1.234
3	1.739	7.45	0.9298	0.51095	0.00006	0.511055677	0.00006	0.348412	0.000041	0.04512	0.00027	0.039495077	0.00027	0.001993126	-1.272	-1.417	1380	-3.0751	1.227
4	1.78	7.63	0.9409	0.510922	0.0000495	0.511027672	0.0000495	0.348378	0.0000345	0.04565	0.00025	0.039959004	0.00025	0.00201353	-1.273	-1.4117	1380	-3.7057	1.033
5	1.87	8.03	0.9883	0.510957	0.000044	0.511062679	0.000044	0.348401	0.0000295	0.04794	0.00036	0.04196352	0.00036	0.002128836	-1.269	-1.4301	1380	-3.3762	0.941
6	1.84	7.88	0.985	0.51099	0.000065	0.511095686	0.000065	0.348387	0.000021	0.0478	0.0011	0.041840973	0.0011	0.002363613	-1.277	-1.4165	1380	-2.7083	1.34
7	1.92	8.22	0.9676	0.51096	0.00006	0.511065679	0.00006	0.348403	0.000036	0.04693	0.00018	0.041079432	0.00018	0.002061844	-1.24	-1.4152	1380	-3.1605	1.23
8	1.916	8.22	0.9988	0.51096	0.000065	0.511065679	0.000065	0.348428	0.0000235	0.04845	0.00022	0.04240994	0.00022	0.002131879	-1.304	-1.4398	1380	-3.3966	1.327
9	1.551	6.65	0.959	0.511	0.00006	0.511105688	0.00006	0.348422	0.0000425	0.04653	0.00073	0.040729298	0.00073	0.002163351	-1.266	-1.4085	1380	-2.3152	1.236
10	2.003	8.58	0.9501	0.51097	0.000075	0.511075681	0.000075	0.348421	0.000041	0.04615	0.00029	0.040396671	0.00029	0.002040546	-1.221	-1.4142	1380	-2.8436	1.512
11	1.82	7.81	1.0028	0.510914	0.000044	0.51101967	0.000044	0.348392	0.0000305	0.04868	0.00026	0.042611267	0.00026	0.002146369	-1.288	-1.4053	1380	-4.333	0.942
12	1.823	7.82	1.0138	0.510951	0.000043	0.511056678	0.000043	0.348371	0.0000285	0.04916	0.00022	0.043031427	0.00022	0.00216279	-1.246	-1.4231	1380	-3.6832	0.925
13	1.722	7.39	0.988	0.51097	0.000065	0.511075681	0.000065	0.348385	0.000028	0.04792	0.00051	0.041946013	0.00051	0.002158418	-1.268	-1.4186	1380	-3.1185	1.329
14	1.92	8.23	0.989	0.51092	0.00007	0.511025671	0.00007	0.348357	0.0000395	0.0479	0.001	0.041928506	0.001	0.002322714	-1.235	-1.4202	1380	-4.0944	1.431
15	2.01	8.63	1.0119	0.511028	0.000038	0.511133693	0.000038	0.348424	0.000021	0.04907	0.00032	0.042952647	0.00032	0.002171342	-1.229	-1.4127	1380	-2.1616	0.838
16	1.68	7.23	1.0073	0.511006	0.0000255	0.511111689	0.0000255	0.348408	0.0000305	0.04887	0.00016	0.04277758	0.00016	0.002144855	-1.28	-1.4142	1380	-2.5613	0.628
17	1.864	8	1.0045	0.51097	0.00006	0.511075681	0.00006	0.348405	0.0000335	0.04874	0.00032	0.042663787	0.00032	0.002157057	-1.27	-1.4239	1380	-3.2459	1.235
18	1.99	8.52	0.9953	0.510908	0.000041	0.511013669	0.000041	0.348387	0.0000275	0.04828	0.00047	0.042261133	0.00047	0.002164696	-1.24	-1.4047	1380	-4.3883	0.89
19	1.81	7.75	1.0135	0.51095	0.00006	0.511055677	0.00006	0.348414	0.0000345	0.04916	0.00028	0.043031427	0.00028	0.002169714	-1.253	-1.4133	1380	-3.7027	1.236
20	1.93	8.25	0.9708	0.51091	0.000065	0.511015669	0.000065	0.348396	0.000026	0.04708	0.00025	0.041210732	0.00025	0.002075647	-1.256	-1.4097	1380	-4.1628	1.325
21	1.937	8.31	1.0132	0.51097	0.00006	0.511075681	0.00006	0.348361	0.000034	0.04915	0.00026	0.043022674	0.00026	0.002166789	-1.277	-1.4302	1380	-3.3096	1.236
22	1.82	7.81	0.9526	0.51098	0.000065	0.511085684	0.000065	0.348417	0.0000395	0.04624	0.00027	0.040475451	0.00027	0.002041704	-1.297	-1.4289	1380	-2.6618	1.323
23	1.93	8.29	1.041	0.51098	0.000065	0.511085684	0.000065	0.348421	0.0000375	0.05045	0.00013	0.044160608	0.00013	0.002211854	-1.242	-1.4209	1380	-3.3158	1.332
24	1.99	8.53	0.9709	0.51097	0.00006	0.511075681	0.00006	0.348371	0.000032	0.04707	0.00026	0.041201979	0.00026	0.002076441	-1.257	-1.4242	1380	-2.9865	1.231
25	1.922	8.25	1.0305	0.51103	0.00007	0.511135694	0.00007	0.348389	0.000043	0.04998	0.00014	0.043749201	0.00014	0.002191936	-1.264	-1.4321	1380	-2.2638	1.424
								MP-P0913-SQ1 Monazite											
1	1.537	6.59	1.0129	0.511105	0.000037	0.511167886	0.000037	0.34842	0.00002	0.049067	0.000076	0.047754008	0.000076	0.00238891	-1.406	-1.629	1380	-2.3444	0.839
2	1.533	6.57	1.0132	0.511069	0.000033	0.511131881	0.000033	0.348405	0.000024	0.049064	0.000066	0.047751089	0.000066	0.002388466	-1.4	-1.6267	1380	-3.0486	0.773
3	1.507	6.46	1.0042	0.511036	0.000043	0.511098877	0.000043	0.348385	0.000026	0.048656	0.000065	0.047354006	0.000065	0.002368592	-1.405	-1.6213	1380	-3.6242	0.941
4	1.518	6.51	1.0042	0.51108	0.000026	0.511142882	0.000026	0.348412	0.000022	0.048656	0.000095	0.047354006	0.000095	0.002369605	-1.406	-1.6256	1380	-2.7628	0.66
5	1.508	6.46	0.9964	0.51108	0.000036	0.511142882	0.000036	0.348404	0.000021	0.048255	0.000063	0.046963737	0.000063	0.002349032	-1.405	-1.6223	1380	-2.6935	0.819
6	1.531	6.56	1.0049	0.511077	0.000039	0.511139882	0.000039	0.348394	0.000021	0.04868	0.00014	0.047377364	0.00014	0.002373002	-1.407	-1.6223	1380	-2.8257	0.872
7	1.504	6.45	0.9962	0.511057	0.000033	0.51111988	0.000033	0.348414	0.000019	0.04825	0.00014	0.046958871	0.00014	0.002352114	-1.392	-1.6193	1380	-3.143	0.769
8	1.532	6.57	1.0073	0.511096	0.000039	0.511158884	0.000039	0.348388	0.000024	0.048826	0.00008	0.047519457	0.00008	0.002377319	-1.411	-1.6188	1380	-2.4789	0.872
9	1.524	6.53	1.0016	0.51106	0.000032	0.51112288	0.000032	0.348414	0.000022	0.048531	0.00009	0.047232351	0.00009	0.002363332	-1.405	-1.6183	1380	-3.1328	0.754
10	1.511	6.47	0.9999	0.511065	0.000051	0.511127881	0.000051	0.348402	0.000024	0.048441	0.000098	0.04714476	0.000098	0.002359274	-1.405	-1.6192	1380	-3.0193	1.083
11	1.519	6.51	1.0189	0.51108	0.000038	0.511142882	0.000038	0.348403	0.000024	0.049362	0.000095	0.048041114	0.000095	0.002403934	-1.404	-1.617	1380	-2.8847	0.858
12	1.506	6.46	1.0177	0.511084	0.00004	0.511146883	0.00004	0.348408	0.000017	0.0493	0.00013	0.047980773	0.00013	0.002402558	-1.401	-1.6166	1380	-2.7957	0.892
13	1.521	6.52	1.0212	0.511068	0.000035	0.511130881	0.000035	0.348397	0.00002	0.04945	0.00014	0.04812676	0.00014	0.002410407	-1.383	-1.615	1380	-3.1349	0.808
14	1.513	6.49	1.0086	0.511081	0.000029	0.511143883	0.000029	0.348409	0.000022	0.048878	0.000098	0.047570066	0.000098	0.002380521	-1.412	-1.6182	1380	-2.7816	0.708
15	1.54	6.61	1.0247	0.511092	0.000044	0.511154884	0.000044	0.348423	0.000028	0.049666	0.000074	0.04833698	0.000074	0.002417982	-1.409	-1.6171	1380	-2.7023	0.962
16	1.527	6.54	0.9839	0.511098	0.000038	0.511160885	0.000038	0.34842	0.000023	0.047649	0.000094	0.046373953	0.000094	0.002320602	-1.404	-1.6262	1380	-2.2365	0.85
17	1.428	6.12	0.976	0.511036	0.000034	0.511098877	0.000034	0.348418	0.000025	0.04732	0.00012	0.046053757	0.00012	0.002305812	-1.419	-1.6271	1380	-3.3935	0.781
18	1.497	6.41	0.9804	0.511075	0.000042	0.511137882	0.000042	0.348406	0.000023	0.0475	0.00011	0.04622894	0.00011	0.002314063	-1.419	-1.6264	1380	-2.661	0.919

Spot	^{146}Nd (V)	Total Nd	% ^{144}Sm	^{143}Nd/ ^{144}Nd	2SE	^{143}Nd/^{144}Nd std corr'd	2SE	^{145}Nd/ ^{144}Nd	2SE	^{147}Sm/ ^{144}Nd	2SE	^{147}Sm/^{144}Nd std corr'd	2SE	2SE prop.	β (Sm)	β (Nd)	Age (Ma)	εNd_i	2SE
MP-P0913-SQ1 Monazite CONT'D																			
19	1.495	6.4	0.9917	0.511083	0.000037	0.511145883	0.000037	0.348391	0.000022	0.048072	0.000075	0.046785634	0.000075	0.002340484	-1.417	-1.6257	1380	-2.6032	0.835
20	1.499	6.42	0.9792	0.51106	0.000033	0.51112288	0.000033	0.348398	0.000018	0.047434	0.000062	0.046164706	0.000062	0.002309068	-1.416	-1.6214	1380	-2.9433	0.765
21	1.456	6.24	0.9718	0.511076	0.000038	0.511138882	0.000038	0.348413	0.000025	0.04708	0.00014	0.045820179	0.00014	0.002295283	-1.397	-1.6217	1380	-2.5689	0.848
22	1.452	6.22	0.9718	0.511048	0.000038	0.511110879	0.000038	0.348411	0.000026	0.04708	0.00013	0.045820179	0.00013	0.002294694	-1.403	-1.6178	1380	-3.1171	0.848
23	1.454	6.23	0.9749	0.511061	0.000036	0.51112388	0.000036	0.348396	0.000022	0.04723	0.00011	0.045966165	0.00011	0.002300939	-1.408	-1.6169	1380	-2.8885	0.814
24	1.452	6.22	0.9759	0.51107	0.000041	0.511132881	0.000041	0.348393	0.000021	0.047257	0.000099	0.045992442	0.000099	0.002301752	-1.412	-1.6154	1380	-2.7169	0.901
25	1.416	6.06	0.9632	0.511045	0.000037	0.511107878	0.000037	0.348409	0.000021	0.0467	0.00012	0.045450347	0.00012	0.002275683	-1.43	-1.6136	1380	-3.1102	0.829
26	1.552	6.65	0.9778	0.51105	0.000037	0.511112879	0.000037	0.348404	0.000025	0.047386	0.00007	0.04611799	0.00007	0.002306962	-1.403	-1.6144	1380	-3.1308	0.832
27	1.575	6.75	0.9838	0.511091	0.000046	0.511153884	0.000046	0.348395	0.00003	0.047708	0.000074	0.046431374	0.000074	0.002322748	-1.431	-1.616	1380	-2.3837	0.99
28	1.543	6.61	0.9874	0.511063	0.000038	0.51112588	0.000038	0.348405	0.000018	0.04785	0.00015	0.046569574	0.00015	0.002333305	-1.406	-1.6135	1380	-2.9564	0.851
29	1.568	6.72	0.9818	0.511121	0.000038	0.511183888	0.000038	0.34841	0.000021	0.04757	0.0001	0.046297067	0.0001	0.002317012	-1.406	-1.6169	1380	-1.7726	0.85
30	1.617	6.93	0.9843	0.511089	0.000035	0.511151884	0.000035	0.348402	0.000018	0.047696	0.000071	0.046419695	0.000071	0.00232207	-1.386	-1.6146	1380	-2.4208	0.8
MP-P0913-5A Titanite																			
1	1.663	7.46	3.388	0.511836	0.000039	0.511880981	0.000039	0.348414	0.000021	0.16425	0.00064	0.160089719	0.00064	0.008030031	-1.5432	-1.7297	1420	-8.1331	1.654
2	1.587	7.33	4.903	0.512265	0.000045	0.512310019	0.000045	0.348421	0.000027	0.2377	0.0012	0.231679308	0.0012	0.011645954	-1.5836	-1.7585	1420	-12.81	2.302
3	1.766	7.9	3.174	0.511745	0.000036	0.511789973	0.000036	0.34842	0.000019	0.1539	0.0017	0.150001874	0.0017	0.007690345	-1.5944	-1.7774	1420	-8.0722	1.572
4	1.285	5.88	4.439	0.512156	0.000058	0.512201009	0.000058	0.348411	0.000027	0.21523	0.00068	0.209778449	0.00068	0.010510942	-1.5652	-1.7427	1420	-10.944	2.231
5	0.898	4.06	3.759	0.511834	0.00006	0.511878981	0.00006	0.348411	0.00003	0.1823	0.0013	0.177682532	0.0013	0.008978736	-1.579	-1.7557	1420	-11.386	2.017
6	1.533	6.87	3.305	0.511757	0.000035	0.511801974	0.000035	0.348409	0.000021	0.1603	0.0035	0.156239769	0.0035	0.008560208	-1.5739	-1.7548	1420	-8.9767	1.707
7	1.49	6.7	3.422	0.511863	0.000051	0.511907983	0.000051	0.348414	0.000023	0.1659	0.0016	0.161697927	0.0016	0.008241696	-1.5526	-1.7424	1420	-7.8983	1.806
8	1.224	5.58	4.014	0.512059	0.000074	0.512104001	0.000074	0.348427	0.000032	0.1945	0.0046	0.189573518	0.0046	0.010535905	-1.571	-1.7706	1420	-9.1524	2.409
9	1.171	5.31	3.879	0.511955	0.00009	0.511999991	0.00009	0.348408	0.000043	0.1881	0.0019	0.183335624	0.0019	0.009361617	-1.591	-1.7615	1420	-10.049	2.455
10	1.481	6.73	3.996	0.511958	0.000047	0.512002992	0.000047	0.348418	0.000023	0.1938	0.0024	0.188891249	0.0024	0.00974473	-1.5917	-1.7546	1420	-11.005	2.004
11	1.129	5.15	4.16	0.512024	0.000069	0.512068997	0.000069	0.348385	0.000029	0.2015	0.0069	0.196396216	0.0069	0.012001612	-1.594	-1.7654	1420	-11.084	2.575
12	1.438	6.52	3.286	0.511728	0.000044	0.511772971	0.000044	0.348402	0.000019	0.1593	0.0032	0.155265098	0.0032	0.008396912	-1.5831	-1.762	1420	-9.3664	1.759
MP-P0913-6 Titanite																			
1	1.047	4.62	2.464	0.511538	0.000047	0.511582955	0.000047	0.34841	0.000024	0.1195	0.0015	0.11647319	0.0015	0.006013735	-1.492	-1.6725	1420	-6.0008	1.433
2	1.77	7.94	3.327	0.511842	0.000039	0.511886981	0.000039	0.348401	0.000023	0.1613	0.0017	0.15721444	0.0017	0.008042447	-1.4758	-1.6716	1420	-7.4905	1.656
3	1.616	7.22	3.096	0.511809	0.000052	0.511853979	0.000052	0.348409	0.000023	0.15009	0.00096	0.146288377	0.00096	0.007377149	-1.4865	-1.6711	1420	-6.1409	1.689
4	1.648	7.42	3.534	0.512005	0.000039	0.512049996	0.000039	0.348415	0.000022	0.1712	0.0018	0.166863683	0.0018	0.008535146	-1.4219	-1.6309	1420	-6.0616	1.736
5	1.572	7.05	3.326	0.512038	0.000039	0.512082999	0.000039	0.348395	0.000022	0.16118	0.00089	0.157097479	0.00089	0.007905134	-1.4239	-1.6243	1420	-3.6317	1.633
6	1.127	4.99	2.643	0.511612	0.000044	0.511656961	0.000044	0.348418	0.000023	0.1279	0.0014	0.124660427	0.0014	0.006388314	-1.486	-1.6651	1420	-6.0475	1.45
7	1.189	5.26	2.634	0.511652	0.000041	0.511696965	0.000041	0.348411	0.000022	0.1277	0.0013	0.124465493	0.0013	0.006357605	-1.454	-1.6497	1420	-5.2287	1.412
8	1.483	6.57	2.722	0.511691	0.000026	0.511735968	0.000026	0.348404	0.000018	0.13194	0.00093	0.128598098	0.00093	0.006496813	-1.48	-1.6668	1420	-5.22	1.291
9	2.137	9.68	3.83	0.512011	0.000084	0.512055996	0.000084	0.348398	0.000039	0.18566	0.00083	0.180957426	0.00083	0.009085861	-1.455	-1.6428	1420	-8.5184	2.336
MP-P0913-10B Titanite																			
1	1.163	5.2	3.115	0.511926	0.000033	0.511970989	0.000033	0.348409	0.000019	0.151	0.0013	0.147175328	0.0013	0.007472713	-1.432	-1.6231	1405	-4.108	1.497
2	1.412	6.34	3.351	0.511922	0.000035	0.511966988	0.000035	0.348411	0.000022	0.16238	0.00097	0.158267084	0.00097	0.007972583	-1.437	-1.6371	1405	-6.1907	1.595
3	1.393	6.25	3.32	0.511946	0.00004	0.511990991	0.00004	0.348399	0.000019	0.1609	0.0015	0.156824571	0.0015	0.007983412	-1.4447	-1.6445	1405	-5.4602	1.641
4	1.218	5.44	3.09	0.511918	0.000039	0.511962988	0.000039	0.348397	0.000021	0.1498	0.0012	0.146005723	0.0012	0.007398255	-1.4179	-1.6188	1405	-4.0533	1.54
5	1.269	5.688	3.2751	0.511984	0.000043	0.512028994	0.000043	0.348419	0.000032	0.15868	0.00041	0.154660802	0.00041	0.007743901	-1.434	-1.6471	1405	-4.3252	1.633

Spot	^{146}Nd (V)	Total Nd	% ^{144}Sm	^{143}Nd/ ^{144}Nd	2SE	^{143}Nd/^{144}Nd std corr'd	2SE	^{145}Nd/ ^{144}Nd	2SE	^{147}Sm/ ^{144}Nd	2SE	^{147}Sm/^{144}Nd std corr'd	2SE	2SE prop.	β (Sm)	β (Nd)	Age (Ma)	εNd_i	2SE
								MP-P0913-10B Titanite CONT'D											
6	1.261	5.63	3.092	0.511909	0.000045	0.511953987	0.000045	0.34842	0.000023	0.14973	0.00066	0.145937496	0.00066	0.007326662	-1.415	-1.6146	1405	-4.2172	1.59
7	1.097	4.91	3.174	0.511898	0.000028	0.511942986	0.000028	0.348418	0.000018	0.1538	0.0012	0.149904407	0.0012	0.007590674	-1.425	-1.6159	1405	-5.1494	1.477
8	1.097	4.92	3.251	0.511901	0.000037	0.511945987	0.000037	0.348407	0.000026	0.1576	0.0013	0.153608157	0.0013	0.007789651	-1.4124	-1.6098	1405	-5.7599	1.583
9	1.301	5.83	3.27	0.511923	0.000036	0.511967989	0.000036	0.348429	0.000022	0.1585	0.0014	0.154485361	0.0014	0.007850116	-1.4345	-1.6314	1405	-5.4877	1.584
10	1.225	5.48	3.208	0.511953	0.000044	0.511997991	0.000044	0.348413	0.000023	0.1554	0.0013	0.151463881	0.0013	0.007683962	-1.4268	-1.6355	1405	-4.3544	1.634
11	1.129	5.14	4.093	0.512237	0.000041	0.512282016	0.000041	0.348422	0.00002	0.1983	0.0012	0.193277268	0.0012	0.009738083	-1.4128	-1.6171	1405	-6.3503	1.934
12	1.229	5.49	3.0996	0.511954	0.000035	0.511998991	0.000035	0.34842	0.00002	0.15028	0.00042	0.146473565	0.00042	0.007335711	-1.4095	-1.6115	1405	-3.433	1.492
13	1.155	5.17	3.258	0.511955	0.000037	0.511999991	0.000037	0.348415	0.000022	0.1578	0.0012	0.153803091	0.0012	0.007783218	-1.4086	-1.6186	1405	-4.738	1.582
14	1.018	4.57	3.295	0.511913	0.000041	0.511957988	0.000041	0.348384	0.000021	0.15985	0.00055	0.155801167	0.00055	0.00780945	-1.433	-1.6123	1405	-5.9213	1.624
15	1.312	5.89	3.35	0.511961	0.000046	0.512005992	0.000046	0.348402	0.000021	0.1624	0.0013	0.158286578	0.0013	0.008020387	-1.4294	-1.619	1405	-5.4307	1.706
16	1.122	5.02	3.1478	0.511961	0.000036	0.512005992	0.000036	0.348444	0.00002	0.15256	0.00017	0.148695815	0.00017	0.007436734	-1.3977	-1.6023	1405	-3.6976	1.517
17	1.128	5.045	3.019	0.511902	0.000051	0.511946987	0.000051	0.348402	0.000024	0.1463	0.0013	0.142594374	0.0013	0.007247268	-1.408	-1.6174	1405	-3.7501	1.647
18	1.269	5.72	3.59	0.512065	0.000042	0.512110001	0.000042	0.34842	0.000024	0.174	0.00057	0.169592762	0.00057	0.008498774	-1.4101	-1.5995	1405	-5.4377	1.742
19	1.157	5.213	3.53	0.512145	0.000045	0.512190008	0.000045	0.348429	0.000025	0.171	0.0033	0.166668749	0.0033	0.008963045	-1.3767	-1.5838	1405	-3.3431	1.844
20	1.363	6.08	3.0575	0.511901	0.000079	0.511945987	0.000079	0.348417	0.000036	0.14826	0.00034	0.144504729	0.00034	0.007233232	-1.418	-1.6136	1405	-4.1149	2.025
								MP-P0913-10C Titanite											
1	0.4282	1.905	2.892	0.511893	0.000059	0.511937986	0.000059	0.348429	0.000038	0.14011	0.00054	0.13656116	0.00054	0.006849378	-1.399	-1.618	1380	-3.0301	1.677
2	0.4383	1.952	2.923	0.511815	0.000079	0.511859979	0.000079	0.348375	0.000038	0.1416	0.0011	0.13801342	0.0011	0.006987794	-1.409	-1.6166	1380	-4.8148	1.982
3	0.617	2.757	3.126	0.511919	0.000051	0.511963988	0.000051	0.348428	0.000031	0.15147	0.00062	0.147633423	0.00062	0.007407663	-1.423	-1.6263	1380	-4.486	1.651
4	0.576	2.572	3.0983	0.511967	0.000047	0.512011992	0.000047	0.34839	0.000032	0.15012	0.00032	0.146317617	0.00032	0.007322876	-1.408	-1.6237	1380	-3.3128	1.592
5	0.787	3.5	2.9464	0.511867	0.000072	0.511911984	0.000072	0.348437	0.000035	0.14279	0.00036	0.139173279	0.00036	0.00696797	-1.425	-1.6246	1380	-4.0026	1.875
6	0.63	2.79	3.025	0.511913	0.000044	0.511957988	0.000044	0.348415	0.000033	0.14674	0.00073	0.143023229	0.00073	0.007188325	-1.423	-1.617	1380	-3.7853	1.539
7	0.383	1.704	2.875	0.511852	0.000067	0.511896982	0.000067	0.348415	0.000033	0.1394	0.001	0.135869144	0.001	0.006866663	-1.403	-1.6064	1380	-3.7099	1.79
8	0.567	2.522	2.8853	0.511859	0.000051	0.511903983	0.000051	0.348391	0.000024	0.13982	0.00016	0.136278506	0.00016	0.006815804	-1.394	-1.6003	1380	-3.6455	1.568
9	0.555	2.473	2.947	0.511858	0.00005	0.511902983	0.00005	0.348411	0.000033	0.1428	0.001	0.139183025	0.001	0.007030632	-1.418	-1.6206	1380	-4.1806	1.586
10	0.527	2.344	2.87	0.511813	0.000053	0.511857979	0.000053	0.348425	0.000033	0.1391	0.0012	0.135576743	0.0012	0.006884231	-1.42	-1.616	1380	-4.4215	1.603
11	0.377	1.681	2.933	0.511816	0.000077	0.511860979	0.000077	0.348381	0.000035	0.1422	0.0011	0.138598223	0.0011	0.007016671	-1.412	-1.601	1380	-4.899	1.955
12	0.4175	1.853	2.751	0.511795	0.000056	0.511839977	0.000056	0.348418	0.000043	0.13335	0.00017	0.129972384	0.00017	0.006500842	-1.405	-1.5859	1380	-3.7793	1.591
13	0.398	1.77	2.859	0.511836	0.000089	0.511880981	0.000089	0.348389	0.000046	0.13855	0.00086	0.135040673	0.00086	0.006806582	-1.386	-1.5959	1380	-3.8761	2.12
14	0.4826	2.151	2.978	0.511891	0.000044	0.511935986	0.000044	0.348475	0.000026	0.1444	0.001	0.140742499	0.001	0.007107822	-1.418	-1.591	1380	-3.8113	1.527
15	0.833	3.71	2.941	0.511839	0.000044	0.511883981	0.000044	0.348418	0.000025	0.1425	0.0011	0.138890624	0.0011	0.00703111	-1.402	-1.6065	1380	-4.5006	1.516
16	0.659	2.948	3.153	0.511891	0.000054	0.511935986	0.000054	0.348418	0.000025	0.1528	0.0024	0.148929736	0.0024	0.007823693	-1.406	-1.6136	1380	-5.2642	1.745
17	0.4624	2.056	2.8478	0.511876	0.000056	0.511920984	0.000056	0.348384	0.000032	0.13798	0.00034	0.134485111	0.00034	0.006732846	-1.393	-1.5868	1380	-2.9944	1.622
18	0.475	2.116	2.919	0.511894	0.000072	0.511938986	0.000072	0.348402	0.000029	0.14146	0.00074	0.137876966	0.00074	0.006933451	-1.388	-1.5926	1380	-3.244	1.871
19	0.4079	1.821	2.852	0.511833	0.000066	0.511877981	0.000066	0.348419	0.000039	0.13824	0.00072	0.134738525	0.00072	0.006775292	-1.392	-1.5869	1380	-3.8812	1.765
20	0.367	1.63	2.7958	0.511813	0.000076	0.511857979	0.000076	0.348382	0.000044	0.13543	0.00015	0.1319997	0.00015	0.006601689	-1.371	-1.5746	1380	-3.7867	1.894
								MP-P0913-10D Titanite											
1	1.367	6.18	3.726	0.512142	0.000039	0.512187008	0.000039	0.348409	0.000018	0.18056	0.00095	0.175986604	0.00095	0.008850464	-1.4036	-1.6131	1405	-5.0856	1.772
2	1.036	4.604	2.806	0.511794	0.000056	0.511838977	0.000056	0.348398	0.000034	0.13599	0.00053	0.132545516	0.00053	0.006648435	-1.398	-1.5979	1405	-4.0486	1.626
3	1.561	7.01	3.4	0.511896	0.000048	0.511940986	0.000048	0.348421	0.000022	0.16484	0.00048	0.160664775	0.00048	0.008047566	-1.4419	-1.6272	1405	-7.133	1.731
4	1.117	4.985	3.0581	0.511899	0.000037	0.511943986	0.000037	0.348411	0.00002	0.148208	0.000073	0.144454046	0.000073	0.007223071	-1.4072	-1.6074	1405	-4.1449	1.493
5	1.369	6.12	3.174	0.511905	0.000042	0.511949987	0.000042	0.348401	0.000021	0.15383	0.00095	0.149933647	0.00095	0.007556636	-1.4137	-1.6192	1405	-5.0176	1.594
6	1.136	5.09	3.262	0.511945	0.000045	0.511989991	0.000045	0.348432	0.000022	0.15808	0.00086	0.154075999	0.00086	0.007751654	-1.41	-1.6127	1405	-4.9831	1.655
7	0.976	4.328	2.7317	0.511824	0.000046	0.51186898	0.000046	0.348422	0.000023	0.13237	0.00016	0.129017206	0.00016	0.006452844	-1.3813	-1.5945	1405	-2.8236	1.473

Spot	^{146}Nd (V)	Total Nd	% ^{144}Sm	^{143}Nd/ ^{144}Nd	2SE	^{143}Nd/^{144}Nd std corr'd	2SE	^{145}Nd/ ^{144}Nd	2SE	^{147}Sm/ ^{144}Nd	2SE	^{147}Sm/^{144}Nd std corr'd	2SE	2SE prop.	β (Sm)	β (Nd)	Age (Ma)	εNd_i	2SE
MP-P0913-10D Titanite CONT'D																			
8	1.074	4.77	2.8011	0.511834	0.000045	0.511878981	0.000045	0.348435	0.000023	0.13574	0.00029	0.132301848	0.00029	0.006621446	-1.399	-1.6062	1405	-3.2214	1.486
9	0.738	3.286	2.897	0.51183	0.000047	0.51187498	0.000047	0.348442	0.000023	0.14042	0.00095	0.136863308	0.00095	0.006908792	-1.394	-1.5953	1405	-4.124	1.551
10	0.881	3.924	2.9499	0.511883	0.000049	0.511927985	0.000049	0.348425	0.000028	0.142926	0.000087	0.139305834	0.000087	0.006965835	-1.392	-1.6008	1405	-3.5278	1.583
11	1.256	5.6	2.988	0.511834	0.000043	0.511878981	0.000043	0.348411	0.000026	0.1448	0.0011	0.141132367	0.0011	0.007141839	-1.409	-1.6077	1405	-4.8172	1.541
12	1.0652	4.828	3.85	0.512309	0.000042	0.512354022	0.000042	0.34842	0.00002	0.18654	0.00058	0.181815137	0.00058	0.00910924	-1.3839	-1.5935	1405	-2.8694	1.84
13	1.059	4.726	3.0369	0.511924	0.000032	0.511968989	0.000032	0.348402	0.000023	0.14716	0.00021	0.143432591	0.00021	0.007174704	-1.4006	-1.6073	1405	-3.4708	1.44
14	1.255	5.6	3.0081	0.511929	0.000078	0.511973989	0.000078	0.348419	0.000032	0.14579	0.00032	0.142097292	0.00032	0.007112067	-1.403	-1.6059	1405	-3.1316	1.996
15	0.671	2.988	2.908	0.51187	0.000048	0.511914984	0.000048	0.348407	0.000027	0.14093	0.0006	0.137360391	0.0006	0.006894178	-1.393	-1.5922	1405	-3.4307	1.56
16	1.345	6.055	3.483	0.512117	0.000058	0.512162006	0.000058	0.348426	0.000022	0.1688	0.0012	0.164524473	0.0012	0.008313288	-1.395	-1.5975	1405	-3.5038	1.883
17	1.037	4.68	3.651	0.512143	0.000032	0.512188008	0.000032	0.34843	0.000023	0.1769	0.0012	0.172419308	0.0012	0.008704082	-1.39	-1.5849	1405	-4.4214	1.693
18	0.757	3.38	2.999	0.511853	0.000039	0.511897982	0.000039	0.348406	0.000026	0.1453	0.0012	0.141619703	0.0012	0.007181946	-1.39	-1.5971	1405	-4.5333	1.506
19	0.902	4.05	3.345	0.512	0.000035	0.512044995	0.000035	0.348405	0.000022	0.1622	0.0029	0.158091644	0.0029	0.008419764	-1.4	-1.5893	1405	-4.6319	1.669
20	0.793	3.533	2.9635	0.511915	0.000043	0.511959988	0.000043	0.34841	0.000025	0.14361	0.00021	0.139972509	0.00021	0.007001775	-1.386	-1.5885	1405	-3.0218	1.52
MP-P0714-16 Titanite																			
1	0.7842	3.656	5.26	0.51261	0.00008	0.512655049	0.00008	0.348428	0.000029	0.2548	0.0068	0.248346183	0.0068	0.014157315	-1.498	-1.6932	1405	-8.9992	3
2	0.925	4.16	3.507	0.512094	0.000088	0.512139004	0.000088	0.34839	0.000051	0.1702	0.0013	0.165889012	0.0013	0.008395708	-1.501	-1.6984	1405	-4.2007	2.296
3	1.794	8.06	3.408	0.51185	0.000077	0.511894982	0.000077	0.348412	0.000034	0.1652	0.0013	0.161015657	0.0013	0.008155066	-1.537	-1.7287	1405	-8.097	2.108
4	1.545	6.92	3.233	0.511908	0.000036	0.511952987	0.000036	0.348401	0.000022	0.1567	0.001	0.152730953	0.001	0.007701744	-1.5073	-1.7017	1405	-5.4644	1.56
5	1.052	4.686	2.977	0.511868	0.000045	0.511912984	0.000045	0.348409	0.000023	0.14427	0.00065	0.140615792	0.00065	0.007060772	-1.5	-1.7093	1405	-4.0582	1.551
6	1.387	6.23	3.416	0.51184	0.000039	0.511884981	0.000039	0.348391	0.000025	0.16562	0.0006	0.161425019	0.0006	0.008093522	-1.5301	-1.7186	1405	-8.3668	1.65
7	1.648	7.47	3.911	0.511971	0.000043	0.512015993	0.000043	0.348406	0.00002	0.18963	0.00067	0.18482687	0.00067	0.009265599	-1.5214	-1.7033	1405	-10.031	1.874
8	1.33	5.96	3.316	0.511837	0.000039	0.511881981	0.000039	0.348398	0.000019	0.1607	0.0014	0.156629637	0.0014	0.007955634	-1.5291	-1.7262	1405	-7.5589	1.628
9	1.312	5.93	3.737	0.511941	0.000057	0.51198599	0.000057	0.348414	0.000022	0.18113	0.0008	0.176542167	0.0008	0.008863286	-1.561	-1.751	1405	-9.1212	1.952
10	1.154	5.17	3.269	0.511806	0.000054	0.511850978	0.000054	0.348411	0.000024	0.1585	0.0013	0.154485361	0.0013	0.0078329	-1.539	-1.7375	1405	-7.7784	1.767
11	1.339	6	3.306	0.511836	0.000038	0.511880981	0.000038	0.348392	0.000028	0.16026	0.00076	0.156200782	0.00076	0.00784693	-1.5363	-1.7225	1405	-7.501	1.601
12	1.578	7.11	3.531	0.511994	0.000063	0.512038995	0.000063	0.348439	0.000024	0.17112	0.00087	0.166785709	0.00087	0.008384544	-1.5178	-1.717	1405	-6.3205	1.954
13	0.9066	4.066	3.325	0.511828	0.000043	0.51187298	0.000043	0.348435	0.000024	0.16105	0.00075	0.156970772	0.00075	0.007884292	-1.534	-1.7224	1405	-7.7968	1.655
MP-P0714-17 Titanite																			
1	1.77	7.94	3.3066	0.511877	0.000036	0.511921985	0.000036	0.348413	0.000017	0.16027	0.00026	0.156210529	0.00026	0.007814853	-1.477	-1.6713	1380	-6.8304	1.556
2	1.18	5.275	3.147	0.51187	0.000048	0.511914984	0.000048	0.348437	0.000019	0.15251	0.00057	0.148647081	0.00057	0.007454179	-1.487	-1.6814	1380	-5.6252	1.623
3	1.662	7.44	3.174	0.511879	0.00006	0.511923985	0.00006	0.348422	0.000029	0.1538	0.0011	0.149904407	0.0011	0.007575508	-1.452	-1.6543	1380	-5.6721	1.785
4	1.901	8.56	3.527	0.511852	0.00005	0.511896982	0.00005	0.348419	0.000022	0.171	0.0018	0.166668749	0.0018	0.008525619	-1.4835	-1.6705	1380	-9.1759	1.802
5	1.925	8.64	3.3248	0.511847	0.000032	0.511891982	0.000032	0.348409	0.000017	0.16113	0.00032	0.157048746	0.00032	0.007858955	-1.4916	-1.6867	1380	-7.5665	1.529
6	1.799	8.06	3.268	0.511866	0.000035	0.511910984	0.000035	0.348406	0.000019	0.1584	0.0012	0.154387894	0.0012	0.007812109	-1.4644	-1.6601	1380	-6.7223	1.546
7	1.424	6.36	3.113	0.511882	0.000037	0.511926985	0.000037	0.348424	0.00002	0.1509	0.0011	0.147077861	0.0011	0.007435707	-1.4386	-1.6392	1380	-5.1118	1.505
8	1.377	6.13	2.9586	0.511878	0.000034	0.511922985	0.000034	0.34842	0.000018	0.14335	0.00015	0.139719094	0.00015	0.006987565	-1.4313	-1.637	1380	-3.8842	1.407
9	1.51	6.73	2.9956	0.511918	0.000059	0.511962988	0.000059	0.348409	0.000031	0.14516	0.00019	0.141483249	0.00019	0.007076714	-1.432	-1.6408	1380	-3.4142	1.706
10	1.379	6.15	3.019	0.511883	0.00004	0.511927985	0.00004	0.348392	0.000022	0.1461	0.0011	0.14239944	0.0011	0.007204443	-1.4427	-1.6416	1380	-4.2619	1.499
11	1.711	7.65	3.144	0.511841	0.000031	0.511885981	0.000031	0.348404	0.000022	0.15235	0.00046	0.148491134	0.00046	0.007438793	-1.4414	-1.6488	1380	-6.1652	1.453
12	1.499	6.7	3.131	0.511933	0.000047	0.511977989	0.000047	0.348414	0.000027	0.1517	0.0012	0.147857598	0.0012	0.007489638	-1.4461	-1.66	1380	-4.2518	1.617
13	1.606	7.18	3.168	0.51188	0.000037	0.511924985	0.000037	0.348407	0.000018	0.15355	0.00058	0.149660739	0.00058	0.007505481	-1.4635	-1.6601	1380	-5.6093	1.516
14	1.542	6.9	3.156	0.51187	0.00004	0.511914984	0.00004	0.348419	0.000023	0.153	0.0013	0.14912467	0.0013	0.007568713	-1.4672	-1.6679	1380	-5.71	1.555
15	1.499	6.71	3.197	0.511873	0.000032	0.511917984	0.000032	0.348402	0.000021	0.15491	0.00087	0.150986292	0.00087	0.00759928	-1.443	-1.6474	1380	-5.9816	1.487
16	1.381	6.15	2.9673	0.511883	0.000038	0.511927985	0.000038	0.34841	0.000027	0.1438	0.00017	0.140157696	0.00017	0.007009946	-1.434	-1.6383	1380	-3.8641	1.449

Spot	^{146}Nd (V)	Total Nd	% ^{144}Sm	^{143}Nd/ ^{144}Nd	2SE	^{143}Nd/^{144}Nd std corr'd	2SE	^{145}Nd/ ^{144}Nd	2SE	^{147}Sm/ ^{144}Nd	2SE	^{147}Sm/^{144}Nd std corr'd	2SE	2SE prop.	β (Sm)	β (Nd)	Age (Ma)	εNd_i	2SE
MP-P0714-17 Titanite CONT'D																			
17	1.771	7.95	3.363	0.511881	0.00004	0.511925985	0.00004	0.348408	0.000019	0.163	0.0015	0.158871381	0.0015	0.008083953	-1.4856	-1.6779	1380	-7.2243	1.634
18	1.649	7.37	3.173	0.51186	0.000046	0.511904983	0.000046	0.348402	0.000025	0.15389	0.00071	0.149992127	0.00071	0.00753314	-1.447	-1.6534	1380	-6.0597	1.612
19	1.721	7.71	3.277	0.51191	0.000038	0.511954987	0.000038	0.348425	0.000021	0.1588	0.0011	0.154777762	0.0011	0.007816674	-1.4701	-1.6723	1380	-5.9301	1.574
20	1.614	7.19	2.995	0.511866	0.000069	0.511910984	0.000069	0.348407	0.000039	0.14524	0.00065	0.141561223	0.00065	0.007107844	-1.448	-1.646	1380	-4.446	1.848
MP-P0714-19 Titanite																			
1	0.764	3.37	2.466	0.511609	0.000035	0.511653961	0.000035	0.348402	0.000025	0.11952	0.00086	0.116492683	0.00086	0.005887781	-1.487	-1.6823	1405	-4.7696	1.266
2	0.853	3.751	2.315	0.511629	0.000053	0.511673963	0.000053	0.348408	0.000029	0.11219	0.00067	0.109348345	0.00067	0.005508317	-1.452	-1.6459	1405	-3.087	1.438
3	0.954	4.206	2.455	0.511591	0.000037	0.511635959	0.000037	0.348435	0.000026	0.11898	0.00049	0.115966361	0.00049	0.005818985	-1.44	-1.6468	1405	-5.0269	1.277
4	0.822	3.624	2.451	0.511571	0.000047	0.511615958	0.000047	0.348428	0.000027	0.11878	0.00073	0.115771427	0.00073	0.00583442	-1.474	-1.6734	1405	-5.3832	1.399
5	0.878	3.87	2.368	0.511599	0.000053	0.51164396	0.000053	0.348431	0.000031	0.11478	0.00083	0.111872743	0.00083	0.005654881	-1.467	-1.6615	1405	-4.1305	1.456
6	0.942	4.17	2.64	0.511707	0.000062	0.51175197	0.000062	0.348404	0.000026	0.128	0.0014	0.124757894	0.0014	0.006393069	-1.496	-1.6911	1405	-4.3446	1.676
7	0.625	2.749	2.292	0.511543	0.000052	0.511587955	0.000052	0.348389	0.000036	0.11105	0.00073	0.10823722	0.00073	0.005460873	-1.471	-1.6764	1405	-4.5699	1.418
8	0.621	2.724	2.1754	0.511522	0.000054	0.511566953	0.000054	0.348403	0.000037	0.10545	0.00035	0.102779062	0.00035	0.005150858	-1.439	-1.667	1405	-3.9947	1.409
9	0.922	4.06	2.3408	0.511639	0.000064	0.511683964	0.000064	0.348385	0.00004	0.11343	0.00014	0.110556937	0.00014	0.005529619	-1.458	-1.6531	1405	-3.1096	1.603
10	0.7223	3.177	2.3027	0.511663	0.000048	0.511707966	0.000048	0.34839	0.000026	0.11159	0.00039	0.108763542	0.00039	0.005452144	-1.435	-1.6401	1405	-2.3157	1.362
11	0.787	3.475	2.53	0.511682	0.000051	0.511726967	0.000051	0.348417	0.000019	0.12261	0.0008	0.119504417	0.0008	0.006028537	-1.484	-1.6827	1405	-3.8847	1.478
12	0.847	3.736	2.4533	0.511645	0.000038	0.511689964	0.000038	0.348401	0.000021	0.1189	0.00032	0.115888387	0.00032	0.005803249	-1.475	-1.6789	1405	-3.9556	1.286
13	0.861	3.78	2.233	0.511615	0.000061	0.511659962	0.000061	0.348435	0.000031	0.10824	0.0001	0.105498394	0.0001	0.005275867	-1.468	-1.6613	1405	-2.6654	1.528
14	0.862	3.81	2.544	0.511665	0.000037	0.511709966	0.000037	0.348426	0.000024	0.12328	0.00078	0.120157447	0.00078	0.006058294	-1.468	-1.6694	1405	-4.3355	1.313
15	0.486	2.133	2.231	0.511501	0.00007	0.511545951	0.00007	0.348397	0.000033	0.1081	0.0011	0.10536194	0.0011	0.005381714	-1.474	-1.6714	1405	-4.8726	1.68
16	0.5634	2.473	2.2048	0.51155	0.000049	0.511594956	0.000049	0.348407	0.000025	0.10677	0.00022	0.104065628	0.00022	0.00520793	-1.443	-1.6589	1405	-3.679	1.344
17	1.041	4.615	2.728	0.511632	0.000041	0.511676963	0.000041	0.348377	0.000018	0.1322	0.0017	0.128851512	0.0017	0.006663091	-1.473	-1.6695	1405	-6.5527	1.447
18	0.893	3.95	2.658	0.511732	0.00006	0.511776972	0.00006	0.348426	0.000033	0.1288	0.0015	0.125537631	0.0015	0.006453622	-1.458	-1.6621	1405	-3.996	1.655
19	0.847	3.75	2.625	0.511586	0.000037	0.511630959	0.000037	0.348395	0.000024	0.12721	0.00066	0.123987904	0.00066	0.006234429	-1.471	-1.6739	1405	-6.5743	1.339
20	0.775	3.42	2.435	0.511579	0.000053	0.511623958	0.000053	0.348387	0.000024	0.11803	0.00097	0.115040424	0.00097	0.005833236	-1.498	-1.679	1405	-5.0945	1.479
MP-P0714-22A Titanite																			
1	0.777	3.499	3.521	0.512091	0.000048	0.512136003	0.000048	0.34842	0.000024	0.1707	0.0018	0.166376348	0.0018	0.008511329	-1.457	-1.6535	1405	-4.3475	1.802
2	0.987	4.4	2.9459	0.511896	0.000041	0.511940986	0.000041	0.348401	0.000022	0.14278	0.00013	0.139163532	0.00013	0.006959391	-1.456	-1.6504	1405	-3.2475	1.492
3	1.098	4.89	2.9041	0.511871	0.000042	0.511915984	0.000042	0.348424	0.000024	0.14069	0.00021	0.137126469	0.00021	0.006859539	-1.444	-1.6525	1405	-3.3689	1.487
4	0.854	3.78	2.597	0.511755	0.000053	0.511799974	0.000053	0.348401	0.000021	0.1259	0.0013	0.122711085	0.0013	0.006271764	-1.421	-1.6289	1405	-3.0349	1.537
5	0.909	4.027	2.641	0.511769	0.00004	0.511813975	0.00004	0.3484	0.000021	0.12797	0.00083	0.124728654	0.00083	0.006291422	-1.432	-1.6352	1405	-3.1254	1.38
6	1.571	6.98	2.803	0.511683	0.000037	0.511727967	0.000037	0.348406	0.000016	0.1358	0.0013	0.132360328	0.0013	0.00674449	-1.462	-1.6649	1405	-6.1883	1.418
7	1.286	5.71	2.846	0.51174	0.000072	0.511784972	0.000072	0.348401	0.000033	0.1376	0.0015	0.134114736	0.0015	0.006871456	-1.442	-1.6626	1405	-5.3894	1.878
8	0.984	4.348	2.5338	0.511692	0.000044	0.511736968	0.000044	0.348389	0.000018	0.12275	0.00011	0.119640871	0.00011	0.005983055	-1.425	-1.6365	1405	-3.7135	1.382
9	1.019	4.51	2.693	0.511749	0.000068	0.511793973	0.000068	0.348391	0.000035	0.13047	0.00052	0.127165331	0.00052	0.006379495	-1.428	-1.6512	1405	-3.9573	1.761
10	1.456	6.469	2.831	0.511711	0.00004	0.51175597	0.00004	0.34843	0.000024	0.1372	0.0016	0.133724868	0.0016	0.006875016	-1.4532	-1.6524	1405	-5.8867	1.469
11	0.815	3.61	2.649	0.511674	0.000046	0.511718967	0.000046	0.348399	0.000024	0.1284	0.0014	0.125147762	0.0014	0.006412091	-1.445	-1.6484	1405	-5.0611	1.468
12	1.002	4.46	2.899	0.511713	0.00006	0.51175797	0.00006	0.348417	0.000028	0.1405	0.0014	0.136941282	0.0014	0.006988726	-1.463	-1.6671	1405	-6.4287	1.725
13	0.914	4.04	2.593	0.511702	0.000042	0.511746969	0.000042	0.348399	0.000026	0.12565	0.00048	0.122467417	0.00048	0.006142155	-1.4427	-1.6486	1405	-4.0285	1.381
14	1.004	4.53	3.699	0.512088	0.000056	0.512133003	0.000056	0.34842	0.000027	0.1793	0.0013	0.174758519	0.0013	0.008834102	-1.4684	-1.6646	1405	-5.9209	1.937
15	1.384	6.26	3.773	0.512115	0.000034	0.512160005	0.000034	0.348407	0.000016	0.18282	0.00062	0.178189361	0.00062	0.008931015	-1.4646	-1.6711	1405	-6.0123	1.746
16	1.279	5.7	3.005	0.511757	0.000038	0.511801974	0.000038	0.348426	0.000019	0.1456	0.0014	0.141912104	0.0014	0.0072324	-1.448	-1.6536	1405	-6.4656	1.504
17	1.054	4.67	2.722	0.511751	0.000042	0.511795973	0.000042	0.348403	0.000023	0.13177	0.00052	0.128432404	0.00052	0.00644264	-1.428	-1.6417	1405	-4.1471	1.425

Spot	^{146}Nd (V)	Total Nd	% ^{144}Sm	^{143}Nd/ ^{144}Nd	2SE	^{143}Nd/^{144}Nd std corr'd	2SE	^{145}Nd/ ^{144}Nd	2SE	^{147}Sm/ ^{144}Nd	2SE	^{147}Sm/^{144}Nd std corr'd	2SE	2SE prop.	β (Sm)	β (Nd)	Age (Ma)	εNd_i	2SE
								MP-P0714-26 Titanite											
1	0.366	1.719	5.71	0.512851	0.000092	0.51289607	0.000092	0.34845	0.000037	0.2767	0.0057	0.269691478	0.0057	0.0146398	-1.445	-1.6313	1425	-8.3273	3.232
2	0.322	1.517	5.972	0.512847	0.000061	0.51289207	0.000061	0.348423	0.000041	0.2895	0.0015	0.282167268	0.0015	0.014187879	-1.453	-1.6355	1425	-10.692	2.862
3	0.585	2.59	2.5826	0.511693	0.000046	0.511737968	0.000046	0.348414	0.000028	0.1252	0.00047	0.122028815	0.00047	0.006119516	-1.411	-1.5943	1425	-3.9327	1.438
4	0.739	3.42	4.953	0.512671	0.00005	0.512716054	0.00005	0.348403	0.000027	0.2401	0.0012	0.234018518	0.0012	0.011762299	-1.4313	-1.6279	1425	-5.3125	2.368
5	0.858	3.78	2.45	0.511603	0.00005	0.51164796	0.00005	0.348388	0.000027	0.11873	0.00069	0.115722693	0.00069	0.005827131	-1.423	-1.6228	1425	-4.5389	1.449
6	0.566	2.64	5.41	0.51269	0.000044	0.512735056	0.000044	0.34841	0.000037	0.2622	0.0022	0.255558748	0.0022	0.012965943	-1.46	-1.6667	1425	-8.8889	2.528
7	0.597	2.635	2.468	0.511717	0.000047	0.51176197	0.000047	0.348425	0.000034	0.1197	0.0023	0.116668124	0.0023	0.006270457	-1.464	-1.6481	1425	-2.4802	1.472
8	0.4478	1.991	2.871	0.511913	0.000058	0.511957988	0.000058	0.348387	0.000035	0.1391	0.0043	0.135576743	0.0043	0.008027617	-1.433	-1.6362	1425	-2.1087	1.859
9	1.998	9.06	3.885	0.511994	0.000038	0.512038995	0.000038	0.348416	0.00002	0.1884	0.0027	0.183628025	0.0027	0.009570169	-1.4471	-1.6181	1425	-9.3308	1.905
10	0.1815	0.871	7.01	0.5133	0.0001	0.51334511	0.0001	0.348536	0.000065	0.3394	0.002	0.330803353	0.002	0.016660647	-1.438	-1.6248	1425	-10.738	3.628
11	0.1923	0.893	5.1679	0.512842	0.000095	0.512887069	0.000095	0.348442	0.000071	0.2503	0.00038	0.243960163	0.00038	0.012203926	-1.386	-1.6066	1425	-3.7868	2.909
12	0.376	1.75	5.326	0.512636	0.000086	0.512681051	0.000086	0.348388	0.000053	0.2583	0.0016	0.251757531	0.0016	0.012689154	-1.449	-1.6189	1425	-9.2494	2.871
13	0.397	1.87	5.961	0.512981	0.000061	0.513026082	0.000061	0.348454	0.000043	0.28897	0.0009	0.281650692	0.0009	0.014111264	-1.429	-1.6196	1425	-7.9742	2.849
14	1.175	5.37	4.294	0.512236	0.000047	0.512281016	0.000047	0.348394	0.000022	0.20807	0.00091	0.202799805	0.00091	0.010180742	-1.4259	-1.6294	1425	-8.1069	2.081

APPENDIX AA - ZIRCON HAFNIUM ISOTOPE DATA TABLE

Spot	Hf beam (V)	βHf	βYb	$^{176}Hf/^{177}Hf$	±2σ	$^{176}Lu/^{177}Hf$	±2σ	$^{176}Yb/^{177}Hf$	analysis age	$^{176}Hf/^{177}Hf_{(i)}$	εHf	±2σ	propagated 2σ	T_{DM}	T_{DM}^{C} 2-stage
							MP-L0613-BDAY zircon								
1	4.7	-1.45	-2.03	0.281914	0.000063	0.000143	0.000016	0.007	1425	0.281910	1.1	2.2	2.3	1837	2088
2	5.9	-1.45	-1.76	0.281904	0.000043	0.000097	0.000003	0.005	1425	0.281901	0.8	1.5	1.7	1849	2107
3	6.1	-1.46	-1.96	0.281930	0.000051	0.000159	0.000002	0.008	1425	0.281926	1.7	1.8	1.9	1816	2055
4	7.2	-1.44	-1.62	0.281969	0.000064	0.000087	0.000002	0.004	1425	0.281967	3.1	2.3	2.4	1761	1966
5	7.2	-1.45	-2.07	0.281970	0.000037	0.000151	0.000005	0.008	1425	0.281966	3.1	1.3	1.5	1762	1967
6	6.1	-1.45	-1.96	0.281917	0.000040	0.000082	0.000002	0.004	1425	0.281915	1.3	1.4	1.6	1831	2078
7	6.0	-1.45	-1.84	0.281917	0.000053	0.000075	0.000000	0.004	1425	0.281915	1.3	1.9	2.0	1831	2078
8	6.2	-1.45	-1.88	0.281927	0.000040	0.000135	0.000002	0.007	1425	0.281923	1.6	1.4	1.6	1819	2060
9	5.7	-1.44	-2.05	0.281910	0.000049	0.000110	0.000002	0.005	1425	0.281907	1.0	1.7	1.9	1841	2095
10	5.7	-1.45	-1.93	0.281938	0.000047	0.000125	0.000001	0.006	1425	0.281935	2.0	1.7	1.8	1804	2035
11	6.8	-1.44	-1.96	0.281933	0.000038	0.000150	0.000003	0.008	1425	0.281929	1.8	1.3	1.5	1812	2048
12	6.7	-1.45	-1.90	0.281957	0.000057	0.000139	0.000001	0.007	1425	0.281953	2.6	2.0	2.1	1779	1995
13	7.1	-1.45	-1.88	0.281909	0.000043	0.000070	0.000001	0.003	1425	0.281907	1.0	1.5	1.7	1841	2095
14	5.5	-1.45	-2.15	0.281914	0.000050	0.000139	0.000002	0.007	1425	0.281910	1.1	1.8	1.9	1837	2088
15	7.1	-1.45	-1.98	0.281918	0.000043	0.000085	0.000002	0.004	1425	0.281916	1.3	1.5	1.7	1830	2076
							MP-P0913-5A zircon								
1	7.3	-1.46	-1.98	0.281927	0.000049	0.000562	0.000007	0.029	1420	0.281912	1.0	1.7	1.9	1835	2088
2	5.2	-1.46	-1.96	0.282021	0.000067	0.001744	0.000072	0.090	1420	0.281974	3.3	2.4	2.5	1751	1953
3	9.6	-1.49	-1.99	0.281958	0.000059	0.001699	0.000086	0.067	1420	0.281912	1.1	2.1	2.2	1834	2087
4	6.8	-1.46	-1.98	0.281939	0.000043	0.000631	0.000012	0.034	1420	0.281922	1.4	1.5	1.7	1821	2066
5	8.1	-1.46	-2.01	0.282020	0.000100	0.001380	0.000120	0.061	1420	0.281983	3.6	3.5	3.6	1739	1934
6	6.7	-1.46	-1.99	0.281956	0.000055	0.001173	0.000021	0.057	1420	0.281924	1.5	2.0	2.1	1818	2060
7	6.8	-1.46	-1.98	0.282003	0.000045	0.000872	0.000023	0.043	1420	0.281980	3.5	1.6	1.7	1743	1941
8	6.5	-1.44	-1.94	0.281928	0.000063	0.000572	0.000028	0.030	1420	0.281913	1.1	2.2	2.3	1834	2086

Spot	Hf beam (V)	βHf	βYb	$^{176}Hf/^{177}Hf$	±2σ	$^{176}Lu/^{177}Hf$	±2σ	$^{176}Yb/^{177}Hf$	analysis age	$^{176}Hf/^{177}Hf_{(i)}$	εHf	±2σ	propagated 2σ	T_{DM}	$T_{DM}{}^{C}$ 2-stage
MP-P0913-6 zircon															
1	7.2	-1.45	-2.02	0.281963	0.000046	0.000559	0.000020	0.031	1420	0.281948	2.3	1.6	1.8	1786	2009
2	8.3	-1.46	-2.00	0.281949	0.000050	0.000431	0.000023	0.022	1420	0.281937	2.0	1.8	1.9	1800	2032
3	6.2	-1.47	-1.97	0.282046	0.000046	0.001227	0.000025	0.062	1420	0.282013	4.6	1.6	1.8	1698	1868
4	7.7	-1.44	-1.98	0.281976	0.000053	0.000934	0.000016	0.046	1420	0.281951	2.4	1.9	2.0	1782	2003
5	9.4	-1.44	-1.99	0.281952	0.000034	0.000530	0.000011	0.024	1420	0.281938	2.0	1.2	1.4	1800	2032
6	7.8	-1.44	-1.94	0.281913	0.000044	0.000549	0.000024	0.027	1420	0.281898	0.6	1.6	1.7	1853	2117
7	8.3	-1.43	-1.98	0.281972	0.000050	0.000422	0.000006	0.023	1420	0.281961	2.8	1.8	1.9	1769	1982
8	6.5	-1.45	-1.94	0.281949	0.000048	0.000806	0.000022	0.034	1420	0.281927	1.6	1.7	1.8	1814	2054
9	6.6	-1.45	-1.98	0.281930	0.000050	0.000482	0.000004	0.023	1420	0.281917	1.2	1.8	1.9	1828	2076
10	6.0	-1.46	-2.02	0.281905	0.000053	0.000702	0.000035	0.032	1420	0.281886	0.1	1.9	2.0	1869	2143
11	6.6	-1.45	-1.97	0.281965	0.000068	0.000873	0.000052	0.044	1420	0.281942	2.1	2.4	2.5	1795	2023
12	6.3	-1.46	-1.91	0.281986	0.000041	0.000461	0.000008	0.022	1420	0.281974	3.2	1.5	1.6	1751	1954
13	5.8	-1.46	-1.96	0.281986	0.000057	0.001088	0.000031	0.054	1420	0.281957	2.6	2.0	2.1	1774	1990
14	6.4	-1.46	-1.93	0.281944	0.000037	0.000536	0.000016	0.027	1420	0.281930	1.7	1.3	1.5	1811	2049
15	5.9	-1.45	-1.95	0.281926	0.000060	0.001036	0.000059	0.052	1420	0.281898	0.6	2.1	2.2	1853	2117
16	5.6	-1.45	-1.96	0.281988	0.000052	0.000825	0.000004	0.044	1420	0.281966	3.0	1.8	2.0	1762	1971
17	6.2	-1.46	-1.92	0.281968	0.000057	0.000701	0.000053	0.036	1420	0.281949	2.4	2.0	2.1	1784	2007
18	4.8	-1.46	-1.97	0.282002	0.000072	0.001971	0.000030	0.099	1420	0.281949	2.4	2.6	2.7	1785	2007
19	6.9	-1.43	-1.93	0.281928	0.000056	0.000510	0.000021	0.025	1420	0.281914	1.1	2.0	2.1	1831	2082
20	6.0	-1.46	-1.99	0.281914	0.000058	0.000739	0.000026	0.037	1420	0.281894	0.4	2.1	2.2	1859	2126
MP-P0913-10B zircon															
1	10.9	-1.46	-1.97	0.281959	0.000037	0.000224	0.000023	0.012	1405	0.281953	2.2	1.3	1.5	1779	2008
2	15.4	-1.44	-2.08	0.281924	0.000036	0.000076	0.000005	0.004	1405	0.281922	1.1	1.3	1.5	1821	2075
3	5.1	-1.44	-1.93	0.281977	0.000068	0.000572	0.000009	0.031	1405	0.281962	2.5	2.4	2.5	1767	1989
4	11.4	-1.44	-2.02	0.281970	0.000053	0.000140	0.000005	0.006	1405	0.281966	2.6	1.9	2.0	1761	1979
5	7.3	-1.43	-2.01	0.281865	0.000033	0.000510	0.000034	0.023	1405	0.281851	-1.4	1.2	1.4	1916	2228
6	11.5	-1.48	-1.94	0.282093	0.000084	0.000626	0.000090	0.025	1405	0.282076	6.5	3.0	3.1	1613	1740

Spot	Hf beam (V)	βHf	βYb	$^{176}Hf/^{177}Hf$	±2σ	$^{176}Lu/^{177}Hf$	±2σ	$^{176}Yb/^{177}Hf$	analysis age	$^{176}Hf/^{177}Hf_{(i)}$	εHf	±2σ	propagated 2σ	T_{DM}	T_{DM}^{C} 2-stage
							MP-P0913-10C zircon								
1	5.3	-1.46	-1.96	0.282075	0.000083	0.001713	0.000053	0.075	1451	0.282028	5.9	2.9	3.0	1678	1817
2	7.2	-1.47	-1.96	0.281927	0.000045	0.000262	0.000003	0.012	1451	0.281920	2.0	1.6	1.7	1824	2051
3	7.3	-1.43	-1.97	0.281987	0.000060	0.001637	0.000018	0.073	1451	0.281942	2.8	2.1	2.2	1794	2003
4	8.2	-1.46	-1.96	0.281970	0.000056	0.000315	0.000019	0.017	1451	0.281961	3.5	2.0	2.1	1768	1961
5	7.3	-1.44	-1.97	0.281966	0.000091	0.000242	0.000010	0.014	1451	0.281959	3.4	3.2	3.3	1771	1966
6	7.3	-1.46	-1.94	0.281928	0.000063	0.000249	0.000002	0.012	1451	0.281921	2.1	2.2	2.3	1822	2049
7	6.3	-1.46	-1.96	0.281911	0.000049	0.000278	0.000015	0.014	1451	0.281903	1.5	1.7	1.9	1846	2087
8	7.8	-1.45	-1.95	0.281944	0.000045	0.000231	0.000005	0.013	1451	0.281938	2.7	1.6	1.7	1800	2013
9	5.1	-1.49	-1.97	0.282053	0.000086	0.000479	0.000046	0.022	1451	0.282040	6.3	3.1	3.1	1662	1791
10	6.7	-1.46	-1.89	0.282062	0.000092	0.000334	0.000047	0.017	1451	0.282053	6.8	3.3	3.3	1644	1763
11	7.5	-1.47	-1.96	0.281959	0.000069	0.000495	0.000012	0.023	1451	0.281945	2.9	2.4	2.5	1789	1996
12	7.0	-1.45	-1.97	0.281942	0.000045	0.000203	0.000012	0.012	1451	0.281936	2.6	1.6	1.7	1802	2015
							MP-P0714-21 zircon								
1	6.1	-1.45	-1.98	0.281888	0.000042	0.000250	0.000011	0.012	1405	0.281881	-0.4	1.5	1.7	1876	2163
2	5.4	-1.46	-1.95	0.281928	0.000064	0.000477	0.000004	0.023	1405	0.281915	0.8	2.3	2.4	1830	2089
3	5.3	-1.45	-1.98	0.281973	0.000055	0.001211	0.000024	0.059	1405	0.281941	1.7	2.0	2.1	1796	2034
4	6.1	-1.45	-2.02	0.281951	0.000052	0.000375	0.000005	0.019	1405	0.281941	1.7	1.8	2.0	1795	2034
5	5.5	-1.45	-1.98	0.281933	0.000050	0.000749	0.000027	0.038	1405	0.281913	0.7	1.8	1.9	1833	2094
							MP-P0714-26 zircon								
1	3.3	-1.44	-1.92	0.281915	0.000072	0.000227	0.000003	0.011	1425	0.281909	1.1	2.6	2.7	1839	2091
2	4.3	-1.47	-1.78	0.281968	0.000039	0.000263	0.000003	0.012	1425	0.281961	2.9	1.4	1.6	1769	1978
3	3.8	-1.46	-1.95	0.281902	0.000055	0.000410	0.000003	0.019	1425	0.281891	0.4	2.0	2.1	1863	2130
4	2.5	-1.45	-1.78	0.282032	0.000069	0.000617	0.000036	0.030	1425	0.282015	4.8	2.4	2.5	1695	1860
5	2.7	-1.45	-1.84	0.281967	0.000079	0.000573	0.000041	0.027	1425	0.281952	2.6	2.8	2.9	1781	1999
6	4.3	-1.46	-2.04	0.281909	0.000059	0.000196	0.000005	0.009	1425	0.281904	0.9	2.1	2.2	1846	2102
7	5.1	-1.46	-1.94	0.281994	0.000059	0.000498	0.000017	0.024	1425	0.281981	3.6	2.1	2.2	1742	1936

Spot	Hf beam (V)	βHf	βYb	$^{176}Hf/^{177}Hf$	±2σ	$^{176}Lu/^{177}Hf$	±2σ	$^{176}Yb/^{177}Hf$	analysis age	$^{176}Hf/^{177}Hf_{(i)}$	εHf	±2σ	propagated 2σ	T_{DM}	T_{DM}^{C} 2-stage
8	4.9	-1.46	-1.85	0.281952	0.000058	0.000166	0.000001	0.008	1425	0.281948	2.4	2.1	2.2	1787	2007
9	3.1	-1.45	-2.01	0.281911	0.000057	0.000246	0.000001	0.012	1425	0.281904	0.9	2.0	2.1	1845	2101
MP-P0714-26 zircon CONT'D															
10	4.6	-1.46	-2.23	0.281933	0.000077	0.000113	0.000002	0.005	1425	0.281930	1.8	2.7	2.8	1810	2045

APPENDIX BB - TITANITE THERMOMETRY DATA TABLE

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
		MP-P0913-5A titanite			
1		7800	370	887	50
2		8520	630	894	52
3		8260	410	892	51
4		8340	430	893	51
5		510	16	714	37
6		7190	620	881	51
7		177	10	659	34
8		8210	370	891	51
9		956	69	749	41
10		766	62	736	40
11		1900	150	790	44
12		1700	200	784	45
13		2770	160	815	45
14		8500	370	894	51
15		119	7	641	33
16		125	13	643	34
17		10100	920	907	54
18		2300	220	803	46
19		2230	150	801	44
20		7700	460	887	51
21		7540	380	885	50
22		677	22	729	38
23		351	22	694	37
24		376	23	697	37
25		9790	570	905	52
26		1058	75	755	41
27		7450	270	884	50
28		6910	280	878	50
29		6830	140	878	49
30		7440	680	884	52
31		9310	500	901	52
32		1748	76	785	43
33		707	40	732	39
34		830	42	741	40
35		970	190	750	47
36		1078	74	756	41
37		942	74	748	41
38		7920	380	889	51
39		8070	400	890	51
		MP-P0913-6 titanite			
1		373	58	697	42
2		434	25	705	39
3		435	27	705	39
4		705	34	732	41
5		649	47	727	41
6		1088	56	757	43

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^0C)	2σ abs
		MP-P0913-6 titanite CONT'D			
7		390	18	699	39
8		783	37	737	41
9		857	26	743	41
10		396	26	700	39
11		1298	63	767	44
12		830	100	741	44
13		719	45	733	41
14		767	29	736	41
15		267	14	680	37
16		205	12	667	36
17		581	53	721	41
18		746	43	735	41
19		717	30	732	41
20		2420	110	806	46
21		2700	190	813	48
22		257	21	678	38
23		365	27	696	39
24		577	37	720	40
25		370	19	697	38
26		509	34	714	40
27		966	54	750	42
28		1062	39	755	42
29		502	19	713	39
30		755	70	735	40
31		6830	350	878	50
		MP-P0913-10A titanite			
1		10600	1300	903	59
2		9690	810	896	56
3		4390	290	839	50
4		5370	380	853	52
5		5000	250	848	51
6		4660	550	843	53
7		7800	1200	880	58
8		11170	600	907	56
9		1750	110	779	45
10		2190	120	793	46
11		3500	230	823	49
12		6360	300	865	52
13		1299	88	761	44
14		12340	440	915	56
15		467	22	703	39
16		1090	140	750	46
17		4560	190	841	50
18		8960	410	890	54
19		9310	390	893	54
20		4030	260	833	50
21		6850	370	870	53
22		4210	490	836	52

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
MP-P0913-10A titanite CONT'D					
23		3870	240	830	49
24		3850	260	830	50
25		6470	310	866	52
26		6100	290	862	52
27		1649	86	775	45
28		880	37	738	42
29		4470	260	840	50
MP-P0913-10B titanite					
1		8070	260	890	50
2		8940	610	898	52
3		8500	270	894	51
4		518	14	715	37
5		7200	350	882	50
6		182	10	661	34
7		8440	380	893	51
8		984	71	751	41
9		807	41	739	39
10		1860	130	789	44
11		2900	220	818	46
12		2680	180	813	45
13		8690	400	896	51
14		121	7	642	33
15		127	14	644	35
16		9180	560	900	52
17		2270	120	802	44
18		7090	230	880	50
19		7670	310	886	50
20		656	23	728	38
21		8740	370	896	51
22		361	17	695	36
23		9830	570	905	52
24		8220	390	891	51
25		1074	63	756	41
26		7510	290	885	50
27		6850	280	878	50
28		6870	210	878	49
29		8070	360	890	51
30		6720	140	876	49
31		7450	430	884	50
32		9170	500	900	52
33		1729	57	785	42
34		684	37	730	39
35		1195	50	762	41
36		580	210	721	58
37		1107	73	758	41
38		1980	110	793	43
39		1740	190	785	45
40		7810	310	888	50
MP-P0913-10C titanite					

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
1		7490	530	884	51
2		7660	360	886	50
3		4440	300	847	48
4		4620	360	850	48
5		8360	690	893	52
6		9990	620	906	52
7		6370	380	872	50
8		7140	390	881	50
9		4600	380	849	49
10		5160	360	857	49
11		2580	180	810	45
12		3240	230	825	46
13		4930	560	854	51
14		3760	330	835	48
15		6210	420	871	50
16		5460	310	861	49
17		5040	290	856	48
18		5000	440	855	49
19		13400	1200	930	56
20		7040	400	880	50
21		8330	480	892	51
22		7870	520	888	51
23		4840	510	853	50
24		5630	390	864	49
25		1349	84	769	42
26		4160	240	842	47
27		6110	410	869	50
28		4000	330	839	48
29		2980	170	820	45

MP-P0913-10D titanite

1		283	24	683	36
2		259	14	678	35
3		182	10	661	34
4		900	59	745	40
5		859	60	743	40
6		1330	77	768	42
7		1187	82	762	42
8		1135	58	759	41
9		861	39	743	40
10		179	13	660	35
11		376	24	697	37
12		6530	410	874	50
13		274	15	681	36
14		242	14	675	35
15		1023	59	753	41
16		1800	230	787	46
17		7050	380	880	50
18		552	28	718	38

MP-P0913-10D titanite CONT'D

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
19		7220	350	882	50
20		7810	440	888	51
21		8190	580	891	52
22		8020	560	890	51
23		8100	440	890	51
24		7140	400	881	50
25		7010	490	880	51
26		11120	640	915	53
27		350	16	694	36
28		893	73	745	41
29		298	16	685	36
30		2380	130	805	44
		MP-P0714-16 Titanite			
1		5120	290	857	48
2		960	82	749	41
3		3360	400	828	49
4		4510	400	848	49
5		1650	69	782	42
6		7430	850	884	53
7		3000	210	820	46
8		4140	250	842	47
9		3450	210	829	46
10		6820	450	878	50
11		791	46	738	40
12		986	71	751	41
13		22000	1200	971	58
14		314	25	688	37
15		338	14	692	36
16		1810	100	787	43
17		6000	530	868	50
18		3740	390	835	49
19		5480	390	862	49
20		580	34	721	38
21		7090	450	880	50
22		558	31	719	38
23		3060	140	821	45
24		12810	890	926	54
25		20710	820	966	57
26		20200	1800	963	59
27		19100	1500	959	58
28		19300	1000	960	57
29		11200	1000	915	54
30		11300	1600	916	58
31		2110	220	797	46
32		3620	130	833	46
33		6610	360	875	50
		MP-P0714-17 Titanite			
1		6020	370	868	49

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
2		4150	170	842	47
3		7070	370	880	50
4		6350	280	872	49
5		6250	170	871	49
6		6550	300	875	49
7		7850	410	888	51
8		6420	240	873	49
9		6550	330	875	50
10		6940	300	879	50
11		6090	350	869	49
12		6210	240	871	49
13		6280	360	871	49
14		6650	700	876	52
15		6420	310	873	49
16		5650	200	864	48
17		7130	270	881	50
18		8290	340	892	51
19		7830	360	888	50
20		8020	370	890	51
21		6940	250	879	50
22		8170	350	891	51
23		8760	380	896	51
24		7620	260	886	50
25		7140	380	881	50
26		7490	460	884	51
27		6250	360	871	49
28		6260	270	871	49
29		5900	360	867	49
30		6110	340	869	49
31		6510	300	874	49
32		6590	400	875	50
33		6150	250	870	49
34		6330	200	872	49
35		4050	150	840	47
36		7990	370	889	51
37		6880	320	878	50
38		6250	300	871	49
39		6370	320	872	49
40		6510	240	874	49

MP-P0714-19 Titanite

1		9760	300	905	54
2		10390	340	909	55
3		2330	110	803	46
4		925	40	747	42
5		1048	37	754	42
6		1923	64	791	45
7		2620	150	811	47

MP-P0714-19 Titanite CONT'D

8		13700	720	931	57
9		8090	230	890	53

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^0C)	2σ abs
10		9320	340	901	54
11		9970	590	906	55
12		9370	470	901	54
13		16850	990	948	59
14		18220	970	955	59
15		1224	55	764	43
16		2720	120	814	47
17		17290	480	950	58
18		2540	130	809	47
19		6510	210	874	52
20		2370	100	805	46
21		2600	150	811	47
22		1734	91	785	45
23		7310	350	883	53
24		11360	510	916	56
25		8120	370	890	53
26		7700	330	887	53
27		2460	170	807	47
28		2400	140	805	47
29		8620	330	895	54
30		1907	52	791	45
31		1518	60	777	44
32		2630	100	811	47
33		1953	75	792	45
34		2500	150	808	47
35		2560	120	810	47
36		28300	1200	993	62
37		28200	910	993	62
38		17840	760	953	59
39		17760	550	953	58
		MP-P0714-22A titanite			
1		1453	71	767	44
2		1364	46	764	44
3		636	48	720	41
4		545	33	712	40
5		1415	80	766	44
6		317	12	683	38
7		266	16	674	37
8		704	35	726	41
9		829	28	735	41
10		1028	67	747	43
11		2263	90	795	46
12		640	130	720	47
13		1150	52	754	43
14		423	21	698	39
15		531	24	710	40
		MP-P0714-22A titanite CONT'D			
16		483	31	705	40
17		324	19	684	38
18		325	21	684	38

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
19		209	12	662	37
20		446	33	701	40
21		1427	79	766	44
22		1468	51	768	44
23		229	10	667	37
24		280	11	677	37
25		2100	110	790	46
26		694	19	725	41
27		227	19	666	37
28		953	46	743	42
		MP-P0714-23 titanite			
1		1620	180	781	45
2		2870	140	817	45
3		1900	110	790	43
4		1980	150	793	44
5		3410	120	829	46
6		3250	200	825	46
7		2370	330	805	48
8		2810	130	816	45
		MP-P0714-26 Titanite			
1		432	57	705	42
2		425	27	704	39
3	old	431	27	705	39
4		629	40	725	41
5		1069	55	755	43
6		380	18	698	38
7		781	36	737	41
8		N/M	N/M	N/M	N/M
9		N/M	N/M	N/M	N/M
10		828	25	741	41
11		1247	61	765	43
12		1710	770	784	77
13		728	50	733	41
14		733	28	734	41
15		255	17	678	37
16		188	15	662	37
17		549	50	718	41
18		701	39	731	41
19	old	N/M	N/M	N/M	N/M
20	old	2260	28	802	46
21		538	110	717	47
22		N/M	N/M	N/M	N/M
		MP-P0714-26 Titanite CONT'D			
23		N/M	N/M	N/M	N/M
24		5820	230	866	51
25		484	33	711	40
26		908	66	746	43

Spot	Comm.	Zr (ppm)	2SE abs	Zr-in-Ttn T (^{0}C)	2σ abs
27		1016	37	752	42
28		7710	280	887	53
29		642	49	726	41
30		5980	440	868	50

N/M = not measured

APPENDIX CC - ZIRCON THERMOMETRY DATA TABLE

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
		MP-P093-5A zircon			
1	N	18.7	3.8	832	75
2	N	9.6	3.9	763	105
3	N	6.8	1.7	731	71
4	N	7.5	1.7	740	68
5	N	6.8	1.5	731	66
6	N	5.5	1.7	712	78
7	N	6	1.6	720	72
8	N	6.6	1.7	728	72
9	N	6.7	2.2	730	85
10	N	6.7	1.6	730	69
11	N	6.7	1.7	730	71
12	N	9.7	2	764	67
13	N	7.6	1.8	741	70
14	N	6.3	1.9	724	79
15	N	9.6	1.9	763	66
16	N	5.3	1	709	58
17	N	6.1	1.6	721	72
18	N	4.8	1.5	700	77
19	N	7.1	1.7	735	70
20	N	9.7	1.9	764	66
21	N	8.3	2.5	749	83
22	N	15.3	2.6	811	66
23	N	17.4	2.2	825	60
24	N	6.8	1.3	731	61
25	N	7.1	2.3	735	85
26	N	6.5	1.9	727	78
27	N	13.4	3.2	797	78
28	N	8.2	3.2	748	99
29	N	6.6	2.2	728	85
30	N	14.4	5.7	804	111
31	N	17.1	5.8	823	102
32	N	3.4	1.5	671	94
33	N	7.9	2.6	745	87
34	N	4.2	1.3	689	75
35	N	6.4	1.4	725	65
36	N	4.7	1.5	698	78
37	N	6.7	3.2	730	113
38	N	18.1	3.7	829	75
39	Y	20.2	1.9	841	56
40	N	7.8	4.3	744	130
41	N	15.2	3.5	810	78
42	Y	7.3	3.4	737	112
43	Y	18.8	3.7	833	74
44	N	5.4	2.7	710	113
45	N	10.2	6	769	145
46	N	7	2.6	734	93
47	N	20.2	5.3	841	89
48	N	13.3	2.3	796	65

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
			MP-P093-5A zircon CONT'D		
49	N	12.9	6.7	793	136
50	N	12.8	2.7	792	72
51	N	7.1	2.5	735	90
52	Y	3.8	1.7	680	97
53	N	6.3	2.9	724	108
54	N	7.3	2.7	737	94
55	N	41.1	6.6	927	77
56	N	16.7	4.6	820	88
57	N	3.9	2.6	683	136
58	N	3.6	2.5	676	139
59	N	5.7	2.6	715	105
60	N	7.3	1.9	737	74
61	Y	6.8	3.6	731	123
62	N	7.1	2.9	735	100
63	N	8.9	2.4	756	78
64	N	6.2	3	722	112
65	N	6	3.5	720	131
66	N	6.9	2.2	732	83
67	N	8.6	2.2	753	75
68	Y	2.8	2.3	656	155
69	N	3.5	2.1	674	122
70	N	7.4	2.7	739	93
71	N	5.9	3.3	718	126
72	N	8.6	1.9	753	69
73	N	6.3	2.7	724	102
74	N	2.5	2.8	647	204
			MP-P0913-6 zircon		
1	N	25.7	3.4	869	71
2	N	5.8	1.6	717	76
3	N	28.6	6	881	87
4	N	17.1	3.4	823	77
5	N	15.8	2.6	814	70
6	N	4.6	1.1	696	68
7	N	28	24	879	249
8	N	27.7	8.6	878	109
9	N	6.3	1.1	724	61
10	N	21.9	3.8	850	76
11	N	15.73	0.57	814	51
12	N	6.2	2.3	722	93
13	N	13.4	2.5	797	72
14	Y	13.2	2.2	795	68
15	N	4.7	1.4	698	77
16	N	8.1	1.2	747	60
17	N	27.8	3.1	878	68
18	N	27.8	2.5	878	64
19	N	10.9	2.1	776	70
20	N	3.7	1.6	678	96

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
		MP-P0913-6 zircon CONT'D			
21	N	22.4	2.2	853	63
22	N	22.5	2.6	853	66
23	N	26.5	2.1	872	62
24	Y	20.2	2.8	841	69
25	N	17.5	2.2	825	65
26	Y	17.8	1.9	827	62
27	N	11.2	1.2	779	57
28	N	18.2	2.8	829	70
29	N	5.9	1.6	718	76
30	N	9	1.9	757	71
31	Y	12	1.5	785	61
32	N	16.9	2.4	821	67
33	N	6.6	1.4	728	68
34	N	5.5	2.4	712	103
35	N	4	0.88	685	63
36	N	16.9	2.4	821	67
37	N	36.9	2.6	913	64
38	N	19.3	2.7	836	68
39	N	26.9	1.7	874	60
40	N	10.6	2.2	773	72
41	N	19.6	1.9	838	62
42	N	11	2.5	777	76
43	N	15.3	1.8	811	62
44	N	24.7	2.8	864	67
45	N	7.6	2.7	741	94
46	N	13.2	3.3	795	83
47	N	21.6	4	849	78
48	N	5.6	1.1	713	63
49	N	11.5	1.6	781	62
50	N	9.8	1.5	765	63
51	N	11.1	2.2	778	71
52	N	10.1	1.8	768	67
53	N	11.4	2	780	68
54	Y	11.9	1.4	785	60
55	Y	13.7	1.3	799	58
56	N	6.43	0.95	726	58
57	N	7.3	1.1	737	59
58	N	20.3	1.5	842	59
59	N	22	1.9	851	61
60	N	16.5	2.1	819	64
61	N	30.1	7.7	888	98
62	N	18	2.1	828	64
63	N	2.76	0.61	655	60
64	N	11.5	1.7	781	64
65	N	3.57	0.96	675	69
66	N	4.46	0.41	694	48
67	N	2.49	0.86	647	76
68	Y	12.1	2.1	786	68
69	Y	10.6	1.8	773	66
70	N	3.31	0.48	669	52

MP-P0913-6 zircon CONT'D

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
71	N	8	2.9	746	96
72	N	1.64	0.45	616	62
73	N	20.9	2.4	845	65
74	Y	15.5	1.8	812	62
75	N	13.97	0.87	801	53
76	N	12.7	1.8	791	64
77	N	22.6	2.1	854	63
78	N	18	1.3	828	57
79	N	18.2	2.9	829	71
80	Y	16.3	1.3	817	57
81	N	14.9	0.99	808	55
82	N	15.4	2.4	811	68
83	N	8.85	0.84	755	54
84	N	12.6	2.3	790	70
85	N	16.3	2.5	817	69
86	N	18.7	5.5	832	98
87	N	13.7	2.2	799	68
88	N	15.3	3.3	811	79
89	N	14.1	2.9	802	76
90	N	17.1	1.5	823	59
91	N	14	1.4	801	59
92	N	10.8	1.8	775	66
93	N	10	1	767	55
94	N	40.2	3.6	924	69
95	N	23.6	5.4	859	88
96	N	15	1.5	809	59
97	N	13.4	1.6	797	61
98	N	21.2	1.3	846	57
99	N	28.8	1.7	882	60
100	N	13.8	2.6	800	72
101	N	8.6	1.1	753	58
102	N	16.2	2.9	817	73
103	N	25.7	3	869	68
104	N	34.4	3.3	904	68
105	N	14.1	1.7	802	62
106	N	12	1.9	785	66
107	N	18.6	2.2	832	64
108	N	15.4	1.4	811	58
109	N	17.4	1.9	825	62
110	N	16.6	1.8	819	62
111	N	10.61	0.85	773	53
112	N	15.6	1.9	813	63
113	N	15.7	1	813	55
114	N	11.7	1	783	55
115	N	15.9	1.6	815	60
116	N	14.7	1.6	806	60
117	N	12.7	1.5	791	60
118	N	12.9	1.7	793	62
119	N	12.8	1.2	792	57
120	N	17	1.4	822	58

MP-P0913-6 zircon CONT'D

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
121	N	12.7	2.2	791	69
122	N	13.7	2.3	799	69
123	N	11.6	1.7	782	64
124	N	9	1.2	757	59
125	N	16.1	1.2	816	56
126	N	27.8	5.2	878	82
127	N	8.3	1	749	57
128	N	28.8	6.6	882	92
129	N	3.84	0.29	681	45
130	N	12.67	0.61	791	51
131	N	8.8	1.9	755	71
132	N	3.669	0.086	678	40
133	N	3.74	0.26	679	44
134	N	4.52	0.51	695	50
135	N	19	2.2	834	64
136	N	7.55	0.45	740	48
137	N	14.4	8.9	804	163
138	N	4.61	0.34	697	46

MP-P0913-10A zircon

1	N	327	33	1253	110
2	N	24	5.2	849	85
3	N	8	2.3	736	82
4	N	4.92	0.22	693	44
5	N	22.3	4.7	840	83
6	N	4.51	0.5	686	50
7	N	4.87	0.29	692	45
8	N	4.1	0.21	678	44
9	N	6.7	4.7	720	155
10	N	5.9	1.2	709	65
11	N	6	0.84	710	56
12	N	60.6	1.5	965	63
13	N	4.08	0.16	678	42
14	N	3.89	0.29	674	45
15	N	4.87	0.36	692	47
16	N	3.86	0.21	673	44
17	N	3.94	0.2	675	43
18	N	4.267	0.081	681	40
19	N	6.3	1.8	715	78
20	N	10.1	2	758	70
21	N	11.92	0.87	774	54
22	N	12.4	1.6	778	62
23	N	6.31	0.76	715	54
24	N	26	3.5	858	71
25	N	10.7	1.3	764	59
26	N	7.54	0.91	731	56
27	N	20	11	828	155
28	N	44.1	6.9	922	83

MP-P0913-10A zircon CONT'D

29	N	30.7	1.8	877	61

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
30	N	16.7	1.2	809	57
31	N	8.55	0.95	742	56
32	N	2.19	0.67	629	69
33	N	2.88	0.6	650	58
34	N	11.6	1.9	772	66
35	N	13.2	3.6	784	86

MP-P093-10B zircon

1	Y	2.2	1	638	90
2	N	1130	91	1601	124
3	N	754	56	1481	109
4	N	38.7	4.5	919	67
5	N	309	24	1263	89
6	N	2220	110	1844	130
7	N	9.3	2.5	760	78
8	N	1022	43	1570	102
9	Y	7.4	1.7	739	68
10	Y	1.96	0.86	629	86
11	Y	91.8	6.8	1042	69
12	N	1615	88	1722	122
13	N	23.8	4.2	860	73
14	N	19.5	4.4	837	80
15	N	36.8	3.4	913	62
16	N	21	13	845	174
17	N	141	26	1112	107
18	N	75.5	6.1	1012	68
19	N	44.5	3.8	937	62
20	N	323	32	1273	98
21	N	449	28	1348	91
22	N	22.1	2.2	851	58
23	N	2.13	0.79	635	76
24	N	1942	75	1791	118
25	N	1470	110	1689	130
26	Y	693	32	1458	94
27	N	945	38	1546	99
28	Y	1155	79	1608	119
29	Y	1.71	0.75	619	84
30	N	11.1	1.5	778	57
31	N	729	63	1472	113
32	N	1840	100	1770	126
33	N	139	15	1110	84
34	N	735	49	1474	105
35	N	947	39	1547	99
36	N	65	12	990	91
37	N	60	13	978	98

MP-P0913-10C zircon

1	N	9.65	0.82	764	48
2	N	6.86	0.73	732	49

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
3	N	1.56	0.68	612	82
4	N	1.22	0.58	595	85
5	N	1.75	0.51	621	63
6	N	9.71	0.81	764	48
7	N	2.02	0.73	631	74
8	N	2	0.78	630	78
9	N	2.25	0.52	639	57
10	N	10.1	1	768	51
11	N	12.7	1.4	791	54
12	N	8.9	1.3	756	57
13	N	10.2	1.5	769	58
14	N	11.9	1.1	785	51
15	N	2.9	1.2	659	87
16	N	3.16	0.89	666	67
17	N	13.1	4.8	794	103
18	N	13.3	2.7	796	71
19	Y	7.4	3.7	739	119
20	Y	BDL	—	—	—
21	N	7.4	1.9	739	73
22	N	1.2	1.2	594	163
23	N	2.1	1.7	634	146
24	Y	3.1	2.5	664	155
25	N	2.1	4.3	634	355
26	N	3.6	2.3	676	129
27	N	4.3	3.4	691	161
28	N	6	2.6	720	102
29	N	1.2	3.5	594	460
30	N	0.3	1.9	509	808
31	N	6.9	2.4	732	89
32	Y	2.4	2.6	644	196
33	Y	1.7	3.1	619	306
34	N	3.4	3	671	172
35	N	10.3	3.4	770	92
36	Y	6.6	3.8	728	131
37	N	3.7	5.2	678	271
38	N	3.6	3.3	676	179
39	N	4.5	2	695	99
40	N	BDL	—	—	—
41	Y	2	1.7	630	152
42	Y	3	3.2	661	201
43	N	0.9	3	575	502
44	Y	14.5	3.5	805	79
45	Y	2.8	2.8	656	187
		MP-P0714-21 zircon			
1	N	18.4	1.2	831	50
		MP-P0714-21 zircon CONT'D			
2	N	13.7	1.2	799	51
3	N	14.2	1.5	803	54
4	N	10.83	0.72	775	47

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
5	N	28.6	3.5	881	65
6	N	14.8	1.2	807	51
7	N	23.7	1.7	859	54
8	N	11.9	1	785	50
9	N	16	2.1	815	60
10	N	18	2.1	828	59
11	N	15.5	1.7	812	56
12	N	20.9	1.5	845	52
13	N	21.7	2.2	849	58
14	Y	11.6	1.7	782	59
15	N	25.2	3.2	866	64
16	Y	11.7	2	783	63
17	N	22.9	1.3	855	51
18	N	23.1	2.2	856	57
19	Y	13.8	1.6	800	56
20	N	24.2	1.9	862	55
21	N	21.7	2.3	849	59
22	N	22.8	2.5	855	60
23	N	40.4	5.6	925	72
24	N	22.8	3.9	855	71
25	N	34.3	2.3	904	56
26	N	31.5	2.1	893	55
27	N	31.4	1.9	893	54
28	N	20.7	2	844	56
29	N	17	5.2	822	95
30	N	17.5	2.5	825	63
31	N	17	1.3	822	51
32	N	21.9	1.9	850	55

MP-P0714-26 zircon

1	N	13.5	1.1	798	56
2	N	18.7	2	832	63
3	N	18.5	1.8	831	61
4	N	20.6	1.7	843	60
5	N	17.1	1.2	823	56
6	N	23.8	2	860	62
7	N	21.3	1.4	847	58
8	N	23.4	3.1	858	69
9	N	11.37	0.63	780	51
10	N	13.2	1.7	795	62
11	N	15.9	1	815	55
12	N	21.1	1.8	846	61
13	N	16	1.6	815	60
14	Y	14.01	0.62	801	51
15	N	9.3	1.2	760	59

MP-P0714-26 zircon CONT'D

16	Y	6.5	0.62	727	51
17	N	11.9	1.3	785	58
18	N	23	11	856	145
19	Y	12	3	785	82

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
20	N	41.9	5.5	929	77
21	N	6.7	2.2	730	87
22	N	32.9	4.9	899	77
23	N	11.7	3.9	783	97
24	N	8.5	2.7	752	89
25	N	17.7	2.8	826	70
26	N	7.7	3.9	742	123
27	N	15.5	3.5	812	81
28	N	20.9	4.4	845	82
29	N	41.9	5.8	929	79
30	N	16.8	3.2	821	75
31	N	17.9	4	828	83
		MP-L0613-BDAY zircon			
1	Y	8.2	1.9	738	73
2	N	4.8	3.8	691	163
3	N	0.6	1.4	543	327
4	N	2	2	623	174
5	N	BDL	—	—	—
6	Y	3.7	2.7	670	145
7	N	3.1	1.7	656	110
8	N	1.6	2.7	607	277
9	Y	5.8	2.3	707	96
10	Y	6.1	2.6	712	102
11	N	2.3	1.4	633	115
12	Y	1.7	1.2	611	124
13	Y	5.4	2.5	701	106
14	Y	2.7	3.4	645	228
15	N	5.2	2.3	698	102
16	N	BDL	—	—	—
17	Y	1.4	1.9	598	220
18	Y	BDL	—	—	—
19	N	3.2	2.5	658	150
20	Y	4.6	2.2	688	106
21	Y	2.8	3	648	197
22	Y	4.2	2.5	680	124
23	Y	7.3	2.9	728	100
24	N	5.6	5.5	704	204
25	Y	0.3	2.1	503	880
26	Y	2.5	3.1	639	221
27	N	4.8	1.8	691	89
28	N	6.1	1.4	712	69
29	N	7.6	1.9	731	75
30	N	3.5	2.5	665	141
		MP-L0613-BDAY zircon CONT'D			
31	N	4.4	1.9	684	97
32	Y	3.4	2.1	663	124
33	N	2.4	1.5	636	118
34	Y	2	3	623	256
35	Y	1.6	2.4	607	247

Spot	*used in age interp. (Y/N)	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
36	Y	1.5	3.3	602	355
37	Y	1.5	1.9	602	208
38	Y	2.7	1.4	645	103
39	N	2	1.5	623	134
40	N	5.2	1.7	698	82
41	Y	0.1	1.7	448	1840
42	N	1.9	2.3	619	207
43	Y	2.8	1.3	648	95
44	Y	3	2.6	653	163
45	Y	1.7	3	611	292

BDL = below detection limit

APPENDIX DD - HOST ROCK ZIRCON THERMOMETRY DATA TABLE

Spot	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
		MP-P0913-4 zircon		
1	5.8	1.8	717	79
2	14	1.9	801	59
3	6.8	2.3	731	87
4	5.5	1.4	712	69
5	5.1	1.4	705	72
6	9	1.9	757	67
7	8	2.2	746	77
8	44.8	9.1	938	89
9	21.4	2.1	848	57
10	5	1.3	704	69
11	6.1	1.3	721	64
12	10	1.8	767	63
13	5	1.3	704	69
14	5.8	1.9	717	82
15	4.5	1.1	695	65
16	15.2	2.8	810	69
17	5.4	1.3	710	67
18	9.6	2.6	763	79
19	42.5	3.4	931	61
20	9.8	2.2	765	71
21	31.6	3	894	60
22	5.2	1.4	707	71
23	17.9	2.2	828	60
24	12.5	2.5	790	69
25	4.9	1.5	702	76
26	5.52	0.69	712	50
27	8.3	2.1	749	74
28	4.7	1.4	698	74
29	4.3	1.2	691	70
30	4.9	1	702	60
31	7.7	1.7	742	67
32	6.4	1.5	725	68
33	5.8	1.2	717	62
34	5.5	1	712	58
35	7.3	1.7	737	69
36	55.5	9.1	967	83
37	10	2.3	767	72
38	20.7	3.8	844	73
39	6.1	1.3	721	64
40	7.8	1.8	744	69
		MP-P0913-5B zircon		
1	4.4	1.1	693	66
2	4.7	1.4	698	74
3	3.9	1.5	683	86
4	7.7	2.3	742	81
5	2.8	1.9	656	131

Spot	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs

MP-P0913-5B zircon CONT'D

Spot	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
6	6.5	2.5	727	94
7	6.4	1.8	725	76
8	9.6	2.3	763	73
9	6.4	1.4	725	65
10	4.5	1.4	695	76
11	29.3	7	884	90
12	22.7	5.2	854	83
13	5.1	1.4	705	72
14	3.7	1.1	678	71
15	3.15	0.71	665	59
16	49.3	5.2	951	68
17	29.7	5.3	886	76
18	4.4	1.4	693	77
19	4.3	1.3	691	74
20	5	1.5	704	76
21	4.8	2.4	700	110
22	4.3	1.4	691	78
23	7.7	2.6	742	88
24	10.5	2.5	772	74
25	4.7	1.2	698	67
26	3.51	0.95	674	67
27	4.2	1.5	689	83
28	2.82	0.61	657	57
29	5.3	1.4	709	70
30	3.1	1	664	73
31	6.9	1.8	732	73
32	2.6	1.1	650	87
33	2.91	0.97	659	74
34	2.7	1.1	653	85

MP-P0913-12 zircon

Spot	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
1	236	72	1208	169
2	13	2	794	62
3	2.37	0.64	643	63
4	6.9	1.8	732	73
5	13.4	2.2	797	64
6	9.8	1.6	765	60
7	15.5	4.5	812	90
8	16.3	2.4	817	63
9	93	11	1044	80
10	12.8	2.2	792	65
11	3.99	0.85	684	59
12	14	5.9	801	116
13	10.2	2.6	769	77
14	7.3	1.4	737	62
15	2.6	1	650	81
16	2.66	0.88	652	73
17	2.34	0.56	642	58
18	4.2	1.4	689	79

Spot	Ti (ppm)	2SE abs	Ti-in-Zrn T ^{0}C	2σ abs
		MP-P0913-12 zircon CONT'D		
19	3.8	1.7	680	97
20	3.3	1.4	669	91
21	2.41	0.76	644	69
22	1.94	0.29	628	45
23	5.6	1.2	713	63
24	6.2	1.5	722	68
25	13	5.9	794	122
26	2.82	0.76	657	64
27	7.4	1.3	739	60
28	9.1	4.3	758	118
29	9.4	1.4	761	58
30	5.7	1.2	715	62
31	2.53	0.8	648	70
32	3.1	1.1	664	78
33	32.3	3.4	896	63
34	33.6	5.1	901	72
35	2.9	1.2	659	87
36	3.7	1	678	67
37	5.5	1.5	712	72
38	182	18	1158	86
39	7.9	2.3	745	80

APPENDIX EE - RUTILE THERMOMETRY DATA TABLE

Spot	Zr (ppm)	2SE abs	Zr-in-Rut T (^{0}C)	2σ abs
		MP-P0913-2 rutile		
1	1970	170	784	193
2	8890	430	982	269
3	3490	280	852	218
4	4060	250	871	225
5	7790	450	961	261
6	3880	120	865	222
7	45000	35000	1297	460
8	10700	1200	1011	282
9	6900	1500	943	255
10	5320	570	907	239
11	2460	350	810	203
12	2180	190	796	197
13	53.7	7.9	496	106
14	74	7.9	515	110
15	14.7	1.7	427	89
16	30.6	2.3	464	98
17	57.8	5.6	500	107
18	69.5	7.1	511	109
19	154	11	562	123
20	303	15	612	137
21	454	52	644	147
22	2110	320	792	196
23	3400	2700	848	238
24	154	15	562	123
25	5510	560	912	241
26	3190	240	840	213
27	8930	650	982	270
28	34.1	3.6	470	99
29	19.1	4.6	440	93
30	23.9	1.4	451	94
31	36.3	4.3	474	100
32	14.4	1.1	426	89
33	24.6	1.8	453	95
34	14.69	0.55	427	89
35	239	18	594	132
36	14.2	2.5	425	89
37	482	72	649	149
38	33.4	1.5	469	99
39	493	51	651	149
40	89.5	7.8	527	113
		MP-P0913-10B rutile		
1	17.1	1	434	91
2	17.6	1.2	436	91
3	16.5	1.6	433	90
4	16.5	1	433	90

Spot	Zr (ppm)	2SE abs	Zr-in-Rut T (^{0}C)	2σ abs
		MP-P0913-10B rutile CONT'D		
5	14.8	1	427	89
6	88	8.2	526	113
7	18.2	1.1	437	91
8	20.3	1.9	443	93
9	15.9	1.2	431	90
10	24.6	4.5	453	95
11	20.8	2.8	444	93
12	17.1	1.2	434	91
13	16.65	0.58	433	90
14	29.3	2.1	462	97
15	17.4	1.2	435	91
16	20.8	1.5	444	93
17	14.67	0.7	427	89
18	14.27	0.53	426	88
19	14.24	0.75	425	88
20	22.4	2.8	448	94
21	14.93	0.99	428	89
22	19.9	1.7	442	92
23	19.2	1.7	440	92
24	16.9	2.4	434	91
25	19	2.2	440	92
26	14.6	1.5	427	89
27	16.1	1.2	431	90
28	21.5	2.3	446	93
29	18.3	2.3	438	91
30	17.9	1.2	437	91
31	17.4	1.1	435	91
32	17.11	0.93	434	91
33	30	4.8	463	98
34	4.25	0.4	372	77
35	19.1	1.4	440	92
36	21.4	2.3	446	93
37	12.87	0.74	421	87
38	16	1.3	431	90
39	11.68	0.86	416	86
40	19.5	1.1	441	92

APPENDIX FF - WHOLE-ROCK DATA TABLE

Sample	MP-PO913-2	MP-PO913-5A	MP-PO913-6	MP-PO913-9B	MP-PO913-10A	MP-PO913-10B	MP-PO913-10C
SiO_2	60.23	63.71	59.88	64.64	51.96	56.87	51.52
TiO_2	0.57	0.54	0.83	0.41	1.18	0.81	1.13
Al_2O_3	16.1	14.51	13.54	16.84	12.45	13.12	12.26
Fe_2O_3	5.04	5.06	4.92	2.46	8.36	6.59	7.42
MnO	0.07	0.02	0.07	0.01	0.11	0.06	0.1
MgO	1.52	1.2	4.55	0.54	7.36	3.77	7.3
CaO	0.85	1.94	4.39	0.61	4.16	3.17	5.78
Na_2O	3.6	4.27	3.47	4.68	2.66	3.65	2.8
K_2O	11.13	7.89	6.59	9.38	9.29	10.17	9.13
P_2O_5	0.32	0.22	0.87	0.05	1.36	0.8	1.29
Rb	444	347	228	446	658	568	604
Sc	3	4	12	0	22	13	20
V	111	95	107	27	199	178	185
Ni	10	4	72	0	106	64	99
Ga	17	22	17	19	17	17	16
Cu	53	38	64	38	75	100	161
Zn	119	78	111	45	183	106	141
Cr	35.2	11.9	271.0	4.7	309.0	53.4	299.3
Sr	697	381	645	687	1228	846	1326
Y	32.5	67.7	34.0	25.9	57.2	56.8	50.9
Zr	508	1176	496	530	845	946	644
Nb	37.9	70.9	40.4	29.3	42.8	65.5	37.9
Cs	3.2	2.7	3.0	2.4	15.8	7.0	13.6
Ba	3356	1874	3054	437	5622	5753	7241
La	148.5	259.6	160.4	88.8	224.6	190.3	191.2
Ce	289.4	492.3	307.5	195.2	481.5	430.9	407.4
Pr	32.6	56.8	36.0	24.7	55.4	52.4	46.8
Nd	123.0	209.4	136.8	94.6	216.4	213.6	183.6
Sm	21.2	36.2	22.9	15.3	39.0	41.3	32.7
Eu	4.79	8.28	5.15	3.84	8.99	9.34	7.67
Gd	14.8	26.8	16.2	11.5	27.9	29.6	23.6
Tb	1.59	3.11	1.64	1.31	2.82	3.07	2.42
Dy	7.30	14.73	7.35	5.92	12.52	13.72	11.12
Ho	1.146	2.359	1.194	0.942	2.021	2.125	1.754
Er	2.82	5.65	2.82	2.38	4.59	4.95	4.14
Tm	0.341	0.707	0.338	0.301	0.541	0.589	0.488
Yb	2.12	4.27	2.10	1.92	3.37	3.65	3.08
Lu	0.279	0.569	0.296	0.226	0.464	0.514	0.417
Hf	11.2	26.5	12.8	11.9	19.8	24.2	15.6
Ta	27.6	22.3	22.9	11.3	12.5	16.1	13.8
Pb	154.0	60.8	87.1	36.1	91.1	57.0	255.7
Th	45.8	301.9	100.6	42.8	120.2	184.3	74.0
U	3.8	24.3	11.5	3.1	8.4	24.3	5.4

Sample	MP-PO913-10D	MP-P0714-16	MP-P0714-17	MP-P0714-19	MP-PO913-22A	MP-PO714-23	MP-P0714-26
SiO_2	54.86	49.97	61.18	48.6	48.82	67.55	45.07
TiO_2	0.85	1.37	0.16	1.67	1.81	0.56	2.33
Al_2O_3	13.55	12.11	15.62	11.01	8.69	14.18	9.82
Fe_2O_3	7.04	7.22	3.66	7.24	8.2	3.4	8.05
MnO	0.07	0.07	0.04	0.07	0.17	0	0.06
MgO	4.54	10.48	1.17	9.68	12.98	0.7	13.74
CaO	3.7	4.39	1.66	7.96	6.19	0.45	7.17
Na_2O	3.04	2.1	3.24	1.96	2.51	4.3	2.13
K_2O	10.43	9.44	12.35	8.2	7.02	8.4	7.14
P_2O_5	1.02	1.44	0.05	2.22	1.71	0.06	2.58
Rb	652	652	679	277	364	329	435
Sc	15	16	5	22	20	0	21
V	164	157	165	163	142	32	245
Ni	105	478	0	207	396	0	475
Ga	20	17	20	16	16	22	17
Cu	147	95	47	136	30	29	77
Zn	132	133	46	130	194	37	112
Cr	63.8	506.4	16.8	455.4	644.4	7.3	998.7
Sr	1079	1082	626	1322	1417	183	1783
Y	44.4	50.7	22.8	47.7	63.1	39.1	58.4
Zr	420	516	1235	420	423	1124	492
Nb	30.8	28.2	17.3	31.4	39.7	54.9	28.4
Cs	10.7	11.9	6.0	7.6	6.9	2.6	7.8
Ba	6402	7793	5243	7926	8214	943	4863
La	217.2	248.5	42.8	354.8	655.3	197.1	307.0
Ce	464.1	555.5	90.9	722.4	1056.5	356.0	661.4
Pr	54.4	63.4	11.9	82.6	100.0	37.2	74.5
Nd	215.1	250.1	48.9	313.5	339.5	125.4	291.2
Sm	38.5	42.6	10.0	47.9	49.3	19.4	48.3
Eu	8.32	9.56	2.87	11.43	10.10	4.17	10.89
Gd	26.2	30.4	8.1	31.1	33.6	13.4	33.9
Tb	2.49	2.90	0.92	2.80	3.14	1.54	3.05
Dy	10.58	11.81	4.36	11.47	13.51	7.48	13.27
Ho	1.560	1.727	0.756	1.720	2.048	1.296	1.963
Er	3.40	3.85	1.96	3.75	4.95	3.56	4.38
Tm	0.384	0.435	0.322	0.408	0.600	0.553	0.529
Yb	2.22	2.55	2.29	2.38	3.77	3.55	2.96
Lu	0.310	0.328	0.384	0.295	0.521	0.519	0.380
Hf	11.9	13.4	43.1	10.0	10.9	26.2	11.7
Ta	13.3	10.1	14.9	12.6	14.5	15.4	11.3
Pb	83.4	45.6	687.0	75.8	23.4	28.3	45.5
Th	64.3	100.3	407.6	39.6	81.3	104.9	58.8
U	9.5	7.6	23.6	3.0	5.7	11.4	6.1

Sample	MP-PO913-SQ1 [A]
SiO_2	0
TiO_2	0
Al_2O_3	0.04
Fe_2O_3	1.39
MnO	0
MgO	3.42
CaO	18.71
Na_2O	0.82
K_2O	0.07
P_2O_5	0.8
Rb	0
Sc	0
V	0
Ni	44
Ga	0
Cu	222
Zn	65
Cr	3.9
Sr	15270
Y	156.4
Zr	3.2
Nb	20.9
Cs	0.0
Ba	162500
La	65150.0
Ce	82050.0
Pr	7116.7
Nd	20716.7
Sm	1200.0
Eu	192.5
Gd	569.5
Tb	21.57
Dy	50.07
Ho	5.065
Er	12.42
Tm	0.645
Yb	2.89
Lu	0.388
Hf	6.7
Ta	13.3
Pb	67.9
Th	353.3
U	54.2

[A] "Nominal" Values