

Lawrence Berkeley National Laboratory

Recent Work

Title

IRIDIUM IN SPRING WATERS AND SUMMIT CRATER LAKE OF MT. HOOD, OREGON

Permalink

<https://escholarship.org/uc/item/0cg853sm>

Author

Bowman, H.

Publication Date

1981-04-01



Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA, BERKELEY

EARTH SCIENCES DIVISION

Submitted to Science

RECEIVED
LAWRENCE
BERKELEY LABORATORY
JUN 17 1981
LIBRARY
DOCUMENT

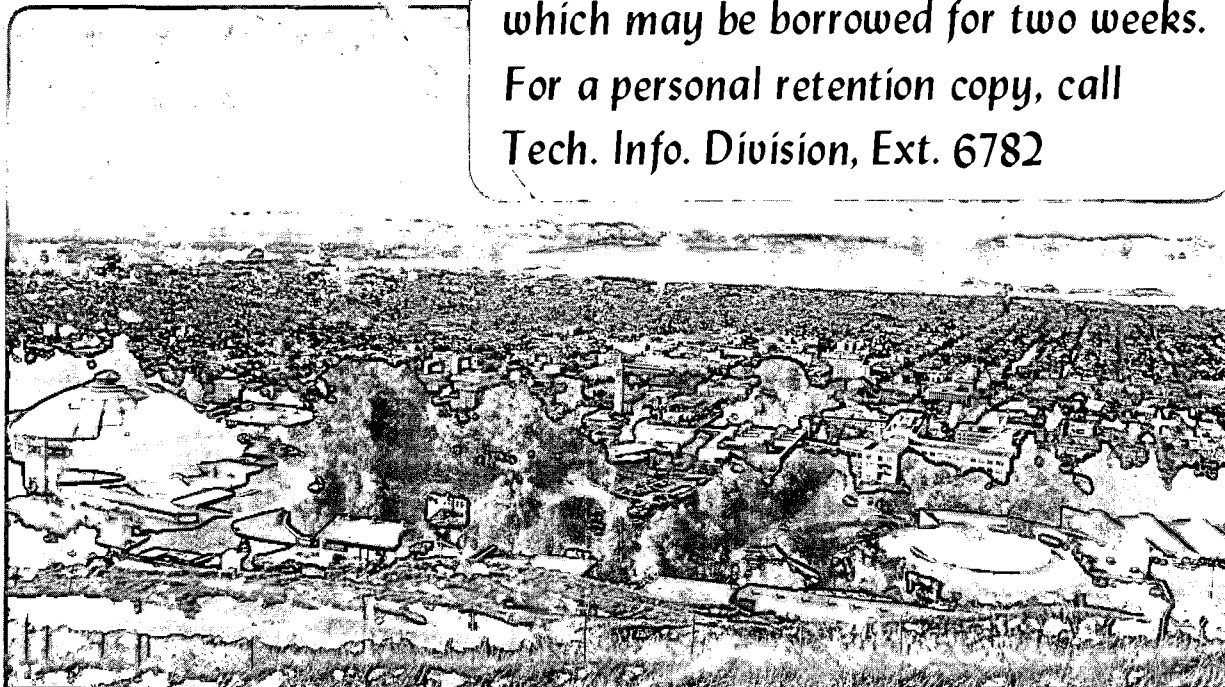
IRIDIUM IN SPRING WATERS AND SUMMIT CRATER LAKE OF
MT. HOOD, OREGON

H. Bowman, H. Wollenberg, F. Asaro, and R.G. Bowen

March 1981

TWO-WEEK LOAN COPY

*This is a Library Circulating Copy
which may be borrowed for two weeks.
For a personal retention copy, call
Tech. Info. Division, Ext. 6782*



*LBL-12345
es*

*bfa
es*

DISCLAIMER

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

IRIDIUM IN SPRING WATERS AND SUMMIT CRATER LAKE OF MT. HOOD, OREGON

H. Bowman, H. Wollenberg, F. Asaro, and R. G. Bowen*
Earth Sciences Division, Lawrence Berkeley Laboratory
University of California
Berkeley, California 94720

*Consultant to the State of Oregon.
Department of Geology and Mineral Industries
Portland, Oregon 97210

This work was supported by the Assistant Secretary for Resource Applications,
Office of Industrial and Utility Applications and Operations, Geothermal Energy
Division of the U. S. Department of Energy under Contract No. W-7405-ENG-48.

IRIDIUM IN SPRING WATERS AND SUMMIT CRATER LAKE OF MT. HOOD, OREGON

H. Bowman, H. Wollenberg, F. Asaro, and R. G. Bowen*

During a hydrogeochemical study of the Mt. Hood volcano in Oregon, the platinum-group element iridium was detected in three out of approximately thirty natural water sources on or near the mountain. Prior to this study iridium had apparently not been detected in terrestrial waters. The element iridium is of special interest because of its apparent association with the Cretaceous-Tertiary boundary on a world-wide basis (Alvarez et al., 1980). The present study (described in detail by Wollenberg et al., 1979) was part of a program to assess the geothermal potential of Mt. Hood, and was carried out under the direction of the Oregon Department of Geology and Mineral Industries with support from the U. S. Department of Energy.

SETTING

Mt. Hood is located 80 km east of Portland, Oregon, along the linear trend of most of the Cascade volcanoes of California, Oregon, and Washington. The geologic setting of Mt. Hood was described in detail by Wise (1969). The mountain is a composite andesitic stratovolcano, mainly Pleistocene in age, rising approximately 2500 m above the surrounding terrain. Its eruptive history is similar to that of many other Cascade volcanoes. The most recent major eruption took place about 220 years ago. At that time a series of hot avalanches cascaded down the west and east sides of the mountain, carrying

*R. G. Bowen: Consultant to the State of Oregon, Department of Geology and Mineral Industries.

incandescent debris several miles downslope into the adjacent valleys. Mt. Hood today has 90-95°C fumaroles near its summit, a partially frozen summit crater lake, and a warm spring area, Swim Spring, on its south flank.

SAMPLING

During this study over 40 water samples were collected and filtered in the field and analyzed at Lawrence Berkeley Laboratory (LBL) by x-ray fluorescence and neutron activation analysis (NAA). The locations of the water sources containing iridium are shown in Figure 1. The warm spring area was sampled at different times of the year to test for seasonal chemical variation.

SAMPLE PREPARATION AND ANALYSES

A 500-ml water sample is evaporated to dryness in a cleaned Nalgene container at a temperature of 60-80°C. The residue from the bottom of the container is used as an abrasive to scrape residue from the walls (with a toothbrush). The total residue is then weighed. A 100-mg sample of the residue is mixed with 50 mg of cellulose binder, and the mixture is compressed into a pill 1.00 cm in diameter at a pressure of about 25,000 psi. In the normal NAA regime each pill is encapsulated in polyethylene foil and irradiated with standards for 10-18 minutes in the small U.C. Berkeley research reactor at a flux of about 2×10^{11} n/s-cm². All pills are essentially the same size, and the standards and unknowns are rotated in such a way that all samples receive exactly the same neutron dose. After irradiation each sample is counted twice, and 11 elements are measured in these counts. Several weeks

later the pills are removed from the polyethelene wrappers and rewrapped in 0.001-in. aluminum foil (99.9999% pure). These samples and a multielement standard, Standard Pottery (Perlman and Asaro, 1971), are irradiated for 8 hr at a flux of about 2.7×10^{13} n/sec-cm². They are counted at about 1 week and 4 weeks after the irradiation with a 1-cc intrinsic Ge gamma-ray detector and again at about 3 weeks after the irradiation with a 7-cc intrinsic Ge detector. About 39 elements are measured in these counts. The sensitivity for measurement of iridium with the 7-cc detector is about 0.5 to 1 ppb in the evaporated residue, which leads to sensitivities of about 10^{-13} g Ir/g H₂O in water containing a few parts in 10,000 of residue.

If iridium is chemically removed from water or from its evaporated residue (either before or after a neutron irradiation), better sensitivities can be obtained. This procedure, however, introduces an uncertainty related to the efficiency of the chemical separation. In post-irradiation chemistry, for example, there can be an uncertainty as to the extent of equilibrium between iridium in the unknown and in the carrier used to determine the chemical efficiency. In order to avoid these uncertainties and still improve the sensitivity, we employed an NAA measurement technique used to obtain a limit on the amount of iridium in sea water (Alvarez et al., 1980). In this procedure a 128-cc Li-doped Ge detector is used to count the 316 and 468 Kev gamma rays of 74.17-day ¹⁹²Ir for several days some months after the irradiation. There is a substantial background radiation from the continuous Bremstrahlung radiation of 14.28-day ³²P. This radiation arises from the ³¹P(n,γ)³²P reaction and (with smaller neutron cross section) from the reaction ³²S(n,p)³²P. As long

as ^{32}P is contributing a predominant part of the background, the longer one waits before counting a sample the better will be the background counting statistics (in the Ir peak region) for a given length of count. For one sample of Mt. Hood water, MH-43, a preliminary count of 1502 min was made 33 days after the irradiation. From this count it was estimated that the most efficient analysis would be made 2 months later, and a 7086-min count was made 94 days after the irradiation. The results are summarized in Table 1, and part of the gamma ray spectrum of the 7086-min count is shown in Figure 2. The best value for the iridium abundance in the residue was 0.074 ± 0.007 ppb, which corresponds to an abundance of $55 \pm 5 \times 10^{-15}$ g Ir/g water.

Table 1. Iridium abundance data for Mt. Hood water sample MH-43A (location A, Fig. 1, collected on October 5, 1978)

	Parts-per-billion (ppb) iridium in evaporated residue	
	316 kev	468 kev
Normal NAA regime (28 days after irradiation, 60-min count, 7-cc Ge detector)	< 1.8	< 5
Special NAA counting regime (128-cc Ge-Li detector):		
33 days after irradiation (1502-min count)	0.064 ± 0.032	0.061 ± 0.039
94 days after irradiation (7086-min count)	0.077 ± 0.009	0.072 ± 0.014

Best abundance of iridium in residue = 0.074 ± 0.007 ppb.
 Abundance of evaporated residue = 7.49×10^{-4} g residue/g H_2O .
 Abundance of iridium in water = $(55 \pm 5) \times 10^{-15}$ g Ir/g H_2O .

RESULTS

Iridium was first detected in a high-iron-content cold spring on the southern flank of Mt. Hood (location C in Fig. 1). It was then detected in Swim Spring in the samples collected in February and October of 1978 and in a sample obtained in the summer of 1977 from the summit crater lake (location B).

The results for seven of the best determined chemical elements in waters from five separate orifices in the Swim Springs area are shown in Figure 3 and the location of the orifices in Figure 4. The plots of six of these elements against sodium concentrations suggest a linear correlation between the elemental abundances. These results, along with water temperature data, suggest that at least two separate water sources are mixed together in differing proportions to produce the spring waters in the warm spring area.

Iridium contents are shown in Table 2. The iridium concentration in one of the warm spring orifices varied from 7×10^{-12} g/g in the winter sampling period to 5.5×10^{-14} g/g in a sample collected in the following October. The average major-element content of this spring water varied about 20% for the same period, with the higher concentrations also occurring during the winter.

Iridium was also detected in the summit crater lake at the level of 4×10^{-13} g/g in a sample collected August 30, 1977, and was found to be less than 1×10^{-13} g/g in a sample collected on October 10, 1978.

The presence of iridium in the waters associated with the volcano raises the question of the iridium content of the volcanic rock. However, the presence of iridium above the detectability limit (0.003 parts per million)

Table 2. Iridium abundances in Mt. Hood waters.

Location	Date	Iridium (g/g)
A. Swim Spring, orifice	February 22, 1978	7×10^{-12}
	October 5, 1978	5.5×10^{-14}
B. Lake, summit crater fumarole area	August 30, 1977	4×10^{-13}
	October 10, 1978	$< 1 \times 10^{-13}$
C. Fe-rich cold spring	June 2, 1977	3.1×10^{-13}

was not detected by standard neutron activation analyses of rock samples collected from the summit fumarole area or from elsewhere on the mountain (Wollenberg et al., 1979). Special counting procedures similar to those described above should improve significantly our sensitivity for detecting iridium in these rock samples.

CONCLUSIONS

Iridium, one of the platinum-group elements, has been detected for the first time in terrestrial water sources. During the hydrogeochemical study of Mt. Hood, Oregon, iridium was detected in the summit crater lake and in both a warm and cold spring on the southern flank of the volcano. The platinum-group elements are generally associated with basic to ultrabasic igneous terranes. Therefore, it is surprising to find iridium associated with a volcano composed predominantly of andesite. The seasonal variation (February to October) in iridium abundance was found to be quite large ($>10^2$) in water from one of the warm spring orifices. This iridium variation is probably not related to the

seasonal variations in major-element abundances detected in this warm spring area. Those variations are relatively small (<20%), and are probably due to dilution effects that occur during the spring and summer thaw of the snow pack.

ACKNOWLEDGMENT

This work was supported by the Assistant Secretary for Resource Applications, Office of Industrial and Utility Applications and Operations, Geothermal Energy Division of the U. S. Department of Energy under Contract No. W-7405-ENG-48.

REFERENCES CITED

- Alvarez, L. W., Alvarez, W., Asaro, F., and Michel, H. V., 1980. Extraterrestrial cause for the Cretaceous-Tertiary extinction. *Science*, v. 208, p. 1095-1108.
- Perlman, I., and Asaro, F., 1971. Pottery analysis by neutron activation. In R. H. Brill (ed.), *Science and Archaeology*. Cambridge, Mass., MIT Press, p. 182-195.
- Wise, W. S., 1969. Geology and petrology of the Mt. Hood area: A study of High Cascade volcanism. *Geol. Soc. Am. Bull.*, v. 80, p. 969-1006.
- Wollenberg, H. A., Bowen, R. G., Bowman, H. R., and Strisower, B., 1979. Geochemical studies of rocks, water, and gases at Mt. Hood, Oregon. Berkeley, Lawrence Berkeley Laboratory, LBL-7092.

FIGURE CAPTIONS

Figure 1. Map of Mt. Hood area showing the location of water sources which contain iridium. A - Swim Spring; B - Summit crater lake fumarole area; C - Fe-rich cold spring. [XBC 784-644]

Figure 2a and 2b. Partial gamma-ray spectrum of the neutron irradiated evaporated residue from Mt. Hood water sample MH-43A. Length of gamma ray count equals 7086 min (94 days after the irradiation). The spectrum was taken with a 128-cc Ge-Li detector. The iridium abundance is $(55 \pm 5) \times 10^{-15}$ grams of Ir per gram of water. This neutron irradiation was the second one done on the sample, and it was made to take advantage of recent improvements in iridium measurement techniques. Ag was an impurity introduced by a sample holder in the counting of the sample after the first irradiation. ^{51}Cr arose from a minute Cr impurity introduced into the sample by a tool-steel die in the sample preparation procedure. ^{140}La was a decay product from the fission of ^{235}U in the sample during neutron irradiation. ^{228}Ac was a natural radioactivity in equilibrium with ^{232}Th , and its gamma rays were part of the background in the lead-lined counting chamber. Ba, Cs, Eu, Ir, and Sr radioactivities and possibly those of Hf and Tb were due to the presence of those elements in the water. [2a = XBL 812-8072, 2b = XBL 812-8073]

Figure 3. Chemical variations in warm spring waters at Mt. Hood, Oregon. [XBL 789-2699]

Figure 4. The distribution of water sources at Swim Spring. [XBL 788-2660A]

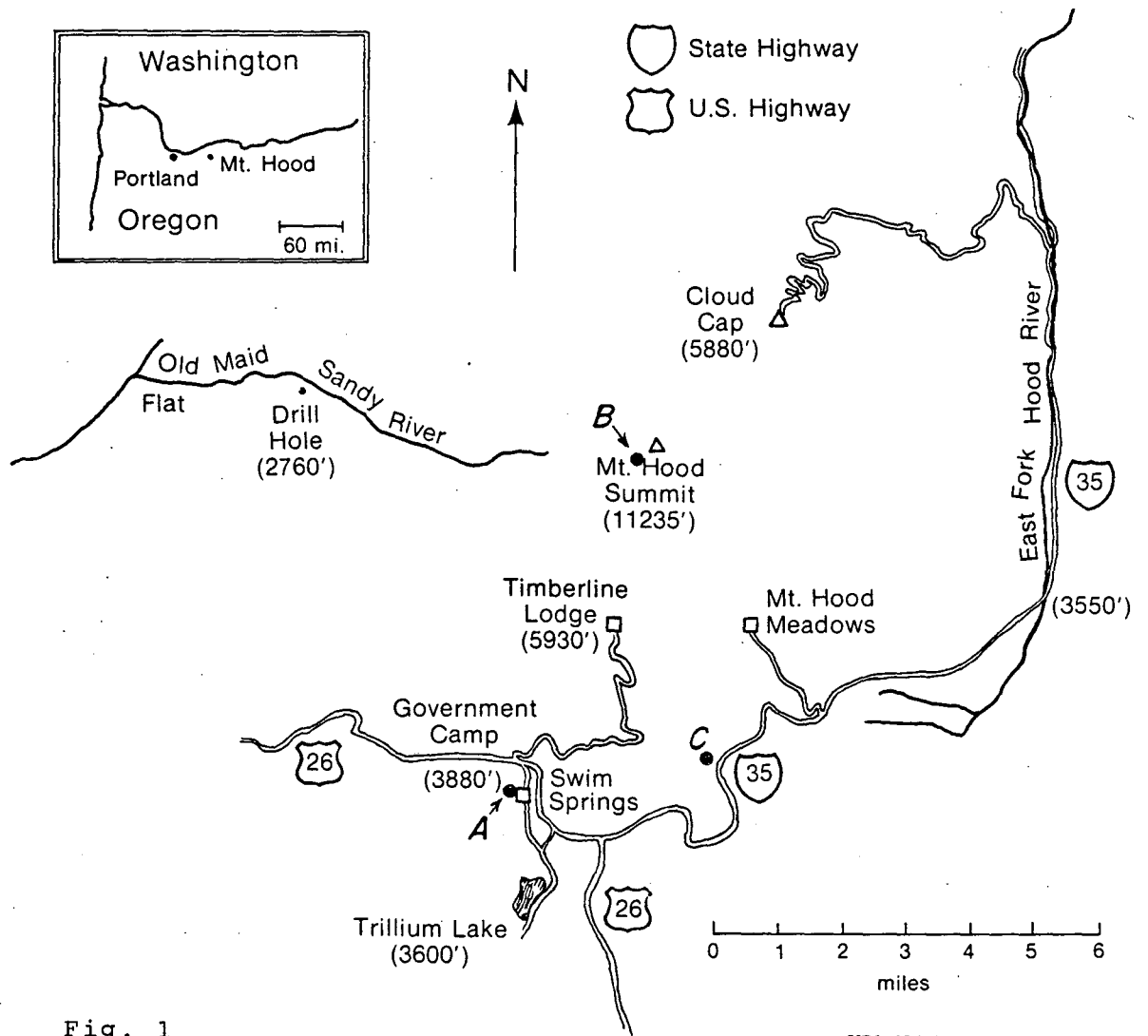
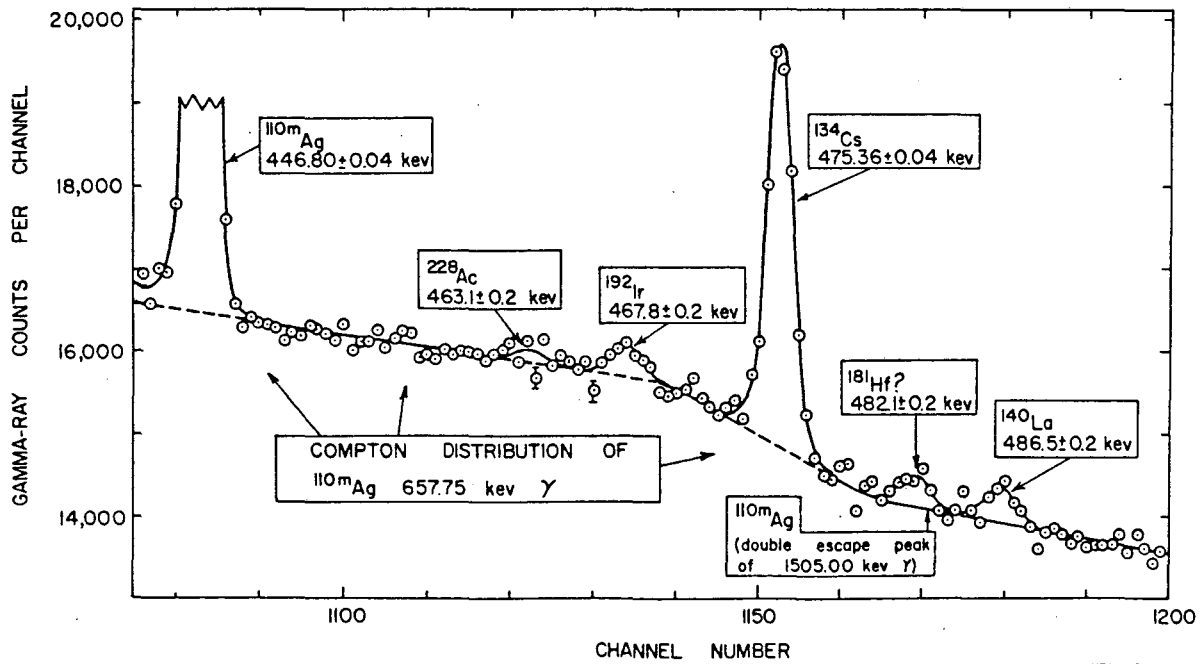
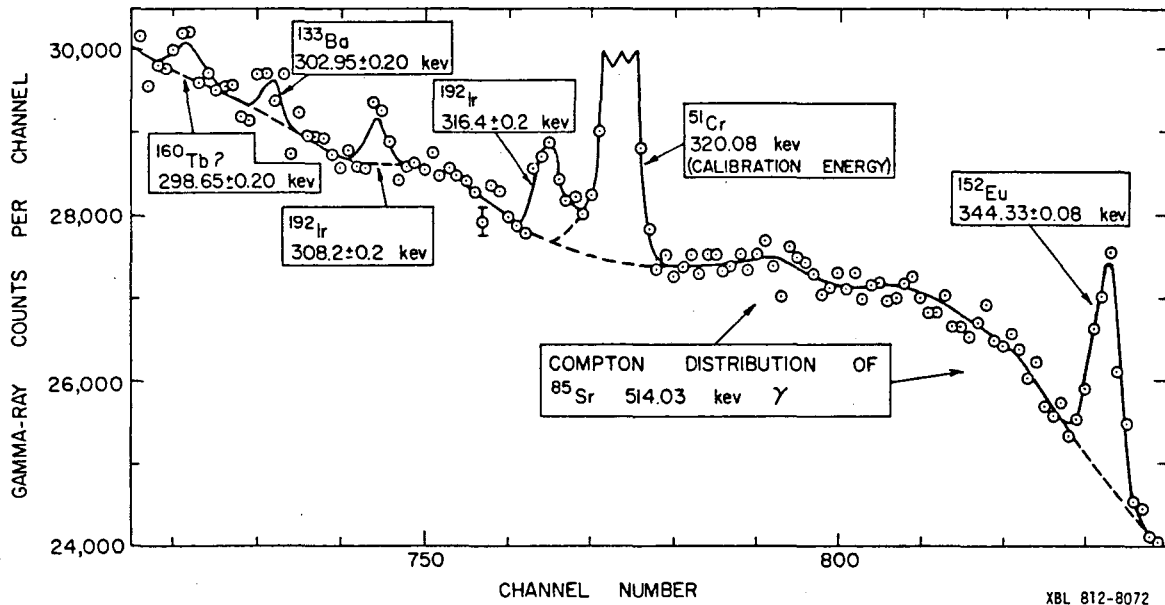


Fig. 1

XBL 784-644



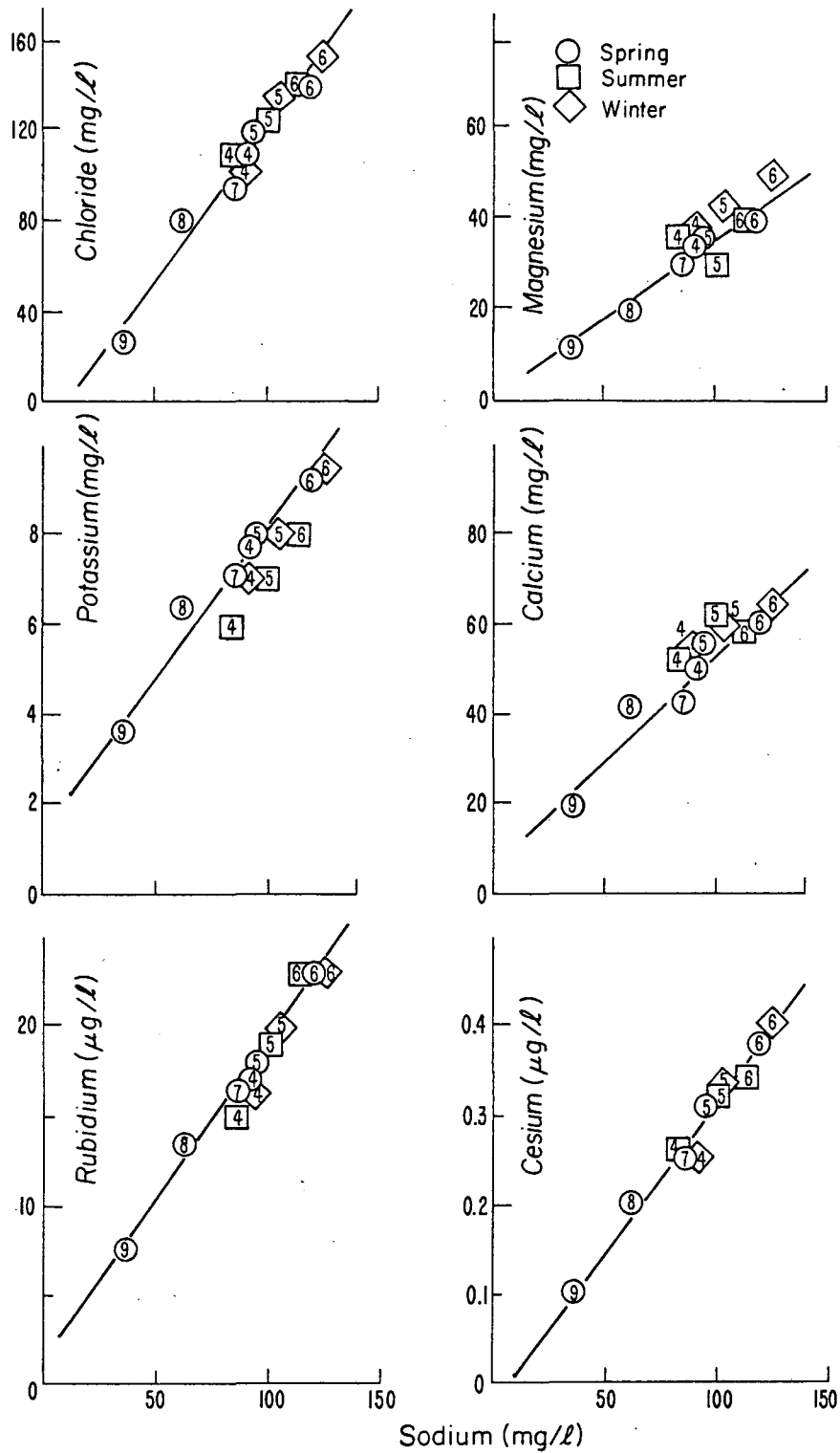
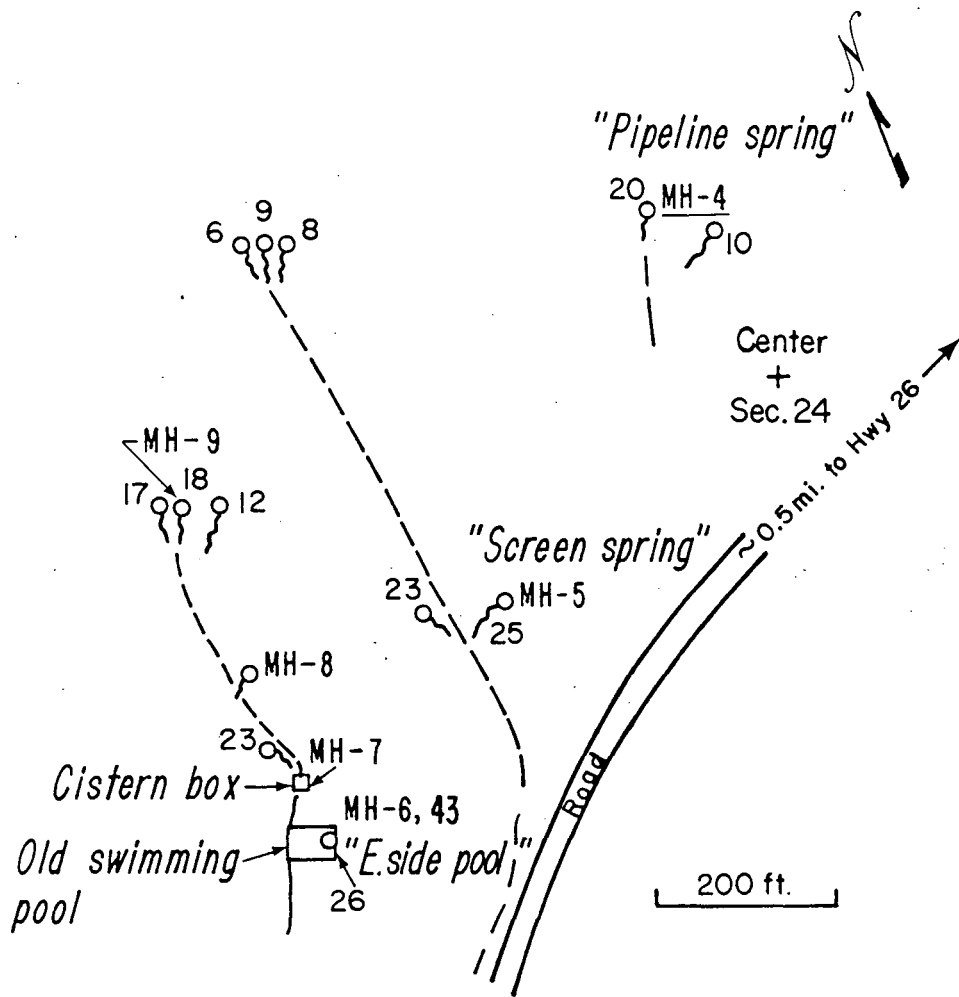


Fig. 3

XBL 789-2699



Legend:
 ○¹⁵ Spring location with temperature (°C)
 MH-7 Sample number
 - - - - - Stream

Fig. 4

XBL 788-2660A

Submitted to Science

IRIDIUM IN SPRING WATERS AND SUMMIT CRATER LAKE OF
MT. HOOD, OREGON

H. Bowman, H. Wollenberg, F. Asaro, and R.G. Bowen

March 1981

This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

TECHNICAL INFORMATION DEPARTMENT
LAWRENCE BERKELEY LABORATORY
UNIVERSITY OF CALIFORNIA
BERKELEY, CALIFORNIA 94720

A RCO OSTI CDL