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Metagenomes from Arctic Soil Microbial Communities from the Barrow Environmental Observatory, Utqiaġvik, AK, USA

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ABSTRACT Here, we report 36 active-layer and 17 permafrost metagenomes from Utqiaġvik, AK, USA. Samples were collected from different topographical features and depths to study Arctic tundra microbiomes.

Increasing global temperatures are affecting Arctic ecosystems more than any other on the planet (1). With accelerated permafrost thaw, vast Arctic soil carbon stocks (2) are expected to become available for microbial decomposition (3) and result in a positive feedback loop. In this study, we investigated the active-layer (AL) soil and permafrost microbiomes from a coastal Arctic tundra location (4).

AL soils and permafrost were collected from the Next Generation Ecosystem Experiments—Arctic (NGEE-Arctic) research site located in the Barrow Environmental Observatory (BEO), Utqiaġvik, AK, USA (4). The BEO landscape is dominated by different polygon types, representing a gradient of permafrost degradation (4, 5). The AL depth varies between 0.35 and 0.45 m (4). In total, 36 AL samples from organic and mineral layers of polygons were collected in two sampling trips in 2012 (Table 1). Presterilized PVC tubes of 3 cm diameter were inserted into soil incrementally (6), sampling the organic and mineral horizons separately. The soil horizons were visually confirmed; the samples were placed into Whirl-Pak (Madison, WI, USA) bags and flash frozen in liquid nitrogen in the field. The samples were transported to the laboratory in a liquid nitrogen dewar and then stored at -80°C . DNA was extracted as previously described (4).

Permafrost cores were collected with a SIPRE soil corer between 2012 and 2014 (7). The corer was augmented with a hydraulic-driven rotary coring platform (Big Beaver; Little Beaver, Inc.) or manually with a gas-powered motor on a 4-m tripod auger. After retrieval, the cores were packed with dry ice in coolers during transport and stored at -25°C in the laboratory. Each permafrost core was first sliced into subsections 10 cm long with a rotary saw in a -18°C room. Then, these subsections were further cut to remove potential surface contaminants via removing the outermost 2 cm using sterile blades on a sonic cutting tool (4). DNA was extracted via the PowerSoil DNA isolation kit (MOBIO, Carlsbad, CA, USA) using 2 g material (Table 1) and quantified using the Qubit double-stranded DNA (dsDNA) high-sensitivity (HS) assay (Invitrogen, Carlsbad, CA, USA).

Metagenomic sequencing was performed at the DOE Joint Genome Institute (JGI). AL soils were submitted for regular DNA library preparation and sequenced using the Illumina HiSeq 2000 platform (2×150 bp; Table 1). Permafrost samples were submitted for low-input DNA library preparation and sequenced using the Illumina HiSeq 2500 platform (2×150 bp; Table 1). BBDuk was used to remove known Illumina adapters, low-quality ($>Q12$) reads, spike-ins or phiX, and reads <51 bp long (8). *De novo* annotation of unassembled and SPAdes-assembled (9) sequences was done in JGI's Integrated Microbial Genomes & Microbiomes (IMG/M) system (10). These data provide a resource to analyze microbial functions across topographical features and at different depths at a changing Arctic tundra site in order to understand and predict future climate trends and threads (11–13).

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TABLE 1 Sample collection and sequencing data^a

| Soil type | Soil horizon | Sampling date | | Polygon | Depth (cm) | No. of reads | Avg GC% | Coordinates (°N, °W) | SRA accession no. | JGI taxon object identification no. |
|-----------|--------------|---------------|------|---------|------------|--------------|---------|----------------------|-------------------|-------------------------------------|
| | | Mo | Yr | | | | | | | |
| AL | Organic | July | 2012 | HC-Rep1 | 7.5 | 6.9E+07 | 62.9 | 71.2, 156.4 | SRX1987651 | 3300001405 |
| AL | Organic | July | 2012 | HC-Rep2 | 7.5 | 1.0E+08 | 63.9 | 71.2, 156.4 | SRX1987654 | 3300001418 |
| AL | Organic | July | 2012 | HC-Rep3 | 7.5 | 7.0E+07 | 63.3 | 71.2, 156.4 | SRX1987657 | 3300001384 |
| AL | Mineral | July | 2012 | HC-Rep1 | 37 | 7.0E+07 | 61.6 | 71.2, 156.4 | SRX1987652 | 3300001409 |
| AL | Mineral | July | 2012 | HC-Rep2 | 37 | 7.1E+07 | 61.6 | 71.2, 156.4 | SRX1987653 | 3300001406 |
| AL | Mineral | July | 2012 | HC-Rep3 | 37 | 6.8E+07 | 61.6 | 71.2, 156.4 | SRX1987658 | 3300001401 |
| AL | Organic | July | 2012 | FC-Rep1 | 10 | 6.8E+07 | 61.8 | 71.2, 156.6 | SRX1987241 | 3300001414 |
| AL | Organic | July | 2012 | FC-Rep2 | 10 | 7.3E+07 | 58.6 | 71.2, 156.6 | SRX1987457 | 3300001416 |
| AL | Organic | July | 2012 | FC-Rep3 | 10 | 7.1E+07 | 62.3 | 71.2, 156.6 | SRX1987459 | 3300001399 |
| AL | Mineral | July | 2012 | FC-Rep1 | 39 | 8.7E+07 | 62.2 | 71.2, 156.6 | SRX1987242 | 3300006055 |
| AL | Mineral | July | 2012 | FC-Rep2 | 39 | 7.3E+07 | 62.0 | 71.2, 156.6 | SRX1987240 | 3300001396 |
| AL | Mineral | July | 2012 | FC-Rep3 | 39 | 8.0E+07 | 60.7 | 71.2, 156.6 | SRX1987244 | 3300001397 |
| AL | Organic | July | 2012 | LC-Rep1 | 15 | 7.3E+07 | 61.4 | 71.1, 156.4 | SRX1987639 | 3300001413 |
| AL | Organic | July | 2012 | LC-Rep2 | 15 | 6.8E+07 | 58.3 | 71.1, 156.4 | SRX1987638 | 3300001411 |
| AL | Organic | July | 2012 | LC-Rep3 | 15 | 7.7E+07 | 51.1 | 71.1, 156.4 | SRX1987646 | 3300001415 |
| AL | Mineral | July | 2012 | LC-Rep1 | 45 | 6.7E+07 | 55.4 | 71.1, 156.4 | SRX1987460 | 3300001410 |
| AL | Mineral | July | 2012 | LC-Rep2 | 45 | 7.1E+07 | 60.0 | 71.1, 156.4 | SRX4917243 | 3300001404 |
| AL | Mineral | July | 2012 | LC-Rep3 | 45 | 6.9E+07 | 58.8 | 71.1, 156.4 | SRX1987640 | 3300001400 |
| AL | Organic | Sept | 2012 | HC-Rep1 | 7.5 | 5.9E+07 | 61.5 | 71.1, 156.4 | SRX1987694 | 3300001454 |
| AL | Organic | Sept | 2012 | HC-Rep2 | 7.5 | 7.2E+07 | 59.6 | 71.2, 156.4 | SRX1987695 | 3300001403 |
| AL | Organic | Sept | 2012 | HC-Rep3 | 7.5 | 5.6E+07 | 58.1 | 71.2, 156.4 | SRX1987724 | 3300001449 |
| AL | Mineral | Sept | 2012 | HC-Rep1 | 37 | 6.8E+07 | 61.1 | 71.2, 156.4 | SRX1987692 | 3300001452 |
| AL | Mineral | Sept | 2012 | HC-Rep2 | 37 | 7.3E+07 | 59.1 | 71.2, 156.4 | SRX1987693 | 3300001408 |
| AL | Mineral | Sept | 2012 | HC-Rep3 | 37 | 7.3E+07 | 58.6 | 71.2, 156.4 | SRX1987723 | 3300001398 |
| AL | Organic | Sept | 2012 | FC-Rep1 | 10 | 7.2E+07 | 61.2 | 71.2, 156.6 | SRX1987660 | 3300001407 |
| AL | Organic | Sept | 2012 | FC-Rep2 | 10 | 6.0E+07 | 61.3 | 71.2, 156.6 | SRX1987666 | 3300001383 |
| AL | Organic | Sept | 2012 | FC-Rep3 | 10 | 8.1E+07 | 61.6 | 71.2, 156.6 | SRX1987663 | 3300001417 |
| AL | Mineral | Sept | 2012 | FC-Rep1 | 39 | 7.6E+07 | 62.7 | 71.2, 156.6 | SRX1987659 | 3300001394 |
| AL | Mineral | Sept | 2012 | FC-Rep2 | 39 | 6.1E+07 | 60.9 | 71.2, 156.6 | SRX1987665 | 3300001385 |
| AL | Mineral | Sept | 2012 | FC-Rep3 | 39 | 8.7E+07 | 61.6 | 71.2, 156.6 | SRX1987664 | 3300001402 |
| AL | Organic | Sept | 2012 | LC-Rep1 | 15 | 5.1E+07 | 56.7 | 71.1, 156.4 | SRX1987671 | 3300001424 |
| AL | Organic | Sept | 2012 | LC-Rep2 | 15 | 6.0E+07 | 60.6 | 71.1, 156.4 | SRX1987675 | 3300001427 |
| AL | Organic | Sept | 2012 | LC-Rep3 | 15 | 6.7E+07 | 61.2 | 71.1, 156.4 | SRX1987696 | 3300001429 |
| AL | Mineral | Sept | 2012 | LC-Rep1 | 45 | 5.6E+07 | 53.1 | 71.1, 156.4 | SRX1987674 | 3300001453 |
| AL | Mineral | Sept | 2012 | LC-Rep2 | 45 | 5.3E+07 | 59.5 | 71.1, 156.4 | SRX1987672 | 3300001423 |
| AL | Mineral | Sept | 2012 | LC-Rep3 | 45 | 6.0E+07 | 60.3 | 71.1, 156.4 | SRX1987677 | 3300001428 |
| PERM | Mineral | April | 2012 | FC | 55 | 3.6E+08 | 55.1 | 71.3, 156.6 | SRX2901267 | 3300006950 |
| PERM | Mineral | April | 2012 | FC | 151 | 1.1E+08 | 48.7 | 71.3, 156.6 | SRX2901268 | 3300006636 |
| PERM | Mineral | April | 2012 | FC | 183 | 9.2E+07 | 63.1 | 71.3, 156.6 | SRX2901418 | 3300006635 |
| PERM | Mineral | June | 2013 | FC | 76 | 1.0E+08 | 55.4 | 71.1, 156.3 | SRX2910105 | 3300006619 |
| PERM | Mineral | May | 2013 | LC | 258 | 1.0E+08 | 56.9 | 71.2, 156.4 | SRX2901419 | 3300006640 |
| PERM | Mineral | June | 2013 | FC | 292 | 3.4E+08 | 55.2 | 71.1, 156.3 | SRX2910045 | 3300006949 |
| PERM | Mineral | April | 2014 | HC | 23 | 1.1E+08 | 59.4 | 71.1, 156.6 | SRX2900831 | 3300006638 |
| PERM | Mineral | April | 2014 | FC | 36 | 1.1E+08 | 59.4 | 71.2, 156.4 | SRX2899914 | 3300006795 |
| PERM | Mineral | Sept | 2014 | HC | 44 | 2.8E+08 | 51.5 | 71.2, 156.3 | SRX2895659 | 3300006972 |
| PERM | Mineral | April | 2014 | HC | 238 | 2.8E+08 | 54.4 | 71.1, 156.6 | SRX2900872 | 3300006936 |
| PERM | Mineral | April | 2014 | FC | 243 | 1.5E+08 | 59.4 | 71.2, 156.4 | SRX2899913 | 3300006642 |
| PERM | Mineral | April | 2014 | HC | 255 | 1.2E+08 | 57.1 | 71.1, 156.4 | SRX2916185 | 3300006792 |
| PERM | Mineral | Sept | 2014 | HC | 357 | 3.0E+08 | 55.3 | 71.2, 156.3 | SRX2896615 | 3300009010 |

^a AL, active layer; PERM, permafrost; HC, high center polygon; FC, flat center polygon; LC, low center polygon; rep, replicate.

Data availability. The sequences were deposited at the National Center for Biotechnology Information (NCBI) database under the SRA accession numbers listed in Table 1. The sequences and annotations are available under JGI IMG/M proposal ID 1044. A summary of the scaffolds and genes can be found at <https://doi.org/10.6084/m9.figshare.20164358.v1>.

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