**Supplement Item S2**

**A) Sample location information**

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| --- | --- | --- | --- | --- | --- |
| **Sample** | **IGSN** | **Latitude** | **Longitude** | **Map unit Trettin (1998)** | **Map unit (revised)** |
|  |  |  |  |  |  |
| 17-02 | IEMCC0014 | 82.224647 | -82.632905 | Kulutingwak Fm. | Kulutingwak Fm. |
| 17-14 | IEMCC001G | 82.222702 | -82.628091 | Kulutingwak Fm. | fault block of Pearya Succession 1 in Kulutingwak Fm. (Type B) |
| 17-16 | IEMCC001I | 82.221169 | -82.625859 | Kulutingwak Fm. | Kulutingwak Fm. |
| 17-18 | IEMCC001K | 82.243837 | -82.534269 | Pearya, Succession I | Kulutingwak Fm. (fault block in Pearya basement) |
| 17-20 | IEMCC001M | 82.244093 | -82.538008 | Pearya, Succession I | Pearya, Succession II |
| 17-39 | IEMCC0025 | 82.092931 | -81.623002 | Danish River Fm. | Danish River Fm. |
| 17-55 | IEMCC002C | 82.189649 | -82.792365 | Kulutingwak Fm. | fault block of Danish River Fm. in Kulutingwak Formation (Type B) |
| 17-60 | IEMCC002H | 82.196168 | -82.457822 | Danish River Fm. | Danish River Fm. |
| 17-80 | IEMCC0031 | 82.225029 | -82.685474 | Pearya, Succession I | Pearya, Succession II |
| KF17-125 | 10.58052/IEJVS001V | 82.051949 | -81.318441 | Osv, correlated with Kulutingwak Fm. | fault block of Danish River/Lands Lokk Fm. in Kulutingwak Fm. (Type B) |
| KF17-128 | 10.58052/IEJVS001W | 82.05302 | -81.321838 | Osv, correlated with Kulutingwak Fm. | Fire Bay assemblage |
| KF17-129 | 10.58052/IEJVS001X | 82.05302 | -81.321838 | Osv, correlated with Kulutingwak Fm. | Fire Bay assemblage |
| KF17-217 | 10.58052/IEJVS001Y | 81.999305 | -81.41617 | Lands Lokk Fm. | Lands Lokk Fm. |
| 04LB17 |  | 82.033239 | -82.863703 | Kulutingwak Fm. | fault block of Danish River/Lands Lokk Fm. in Kulutingwak Fm. (Type B) |
| VP17-04b |  | 82.036133 | -82.834783 | Kulutingwak Fm. | Kulutingwak Fm. |
| VP17-05b |  | 82.037167 | -81.478733 | Osv, correlated with Kulutingwak Fm. | Fire Bay assemblage |

**B) Additional sample description material**

***Petersen Bay fault zone – Pearya terrane***

**Sample 17-18:** The sample consists of fine- to medium-grained quartz and calcite with minor biotite and white mica. A penetrative foliation is defined by quartz and carbonate compositional layers and the alignment of mica. Quartz displays some undulose extinction, but many grains have polygonal subgrain boundaries. Calcite is sparry and granular. Zircon is 40 to 200 μm in maximum dimension, equant to elongate, and rounded to subangular in shape. Grains appear unzoned or define faint to well-developed oscillatory zoning. Oscillatory zoning is typically truncated at the grain boundaries, consistent with a detrital origin. Some grains have 1–3 μm CL-dark to CL-intermediate rims.

**Sample 17-20**: The sample consists of 10- to 20-cm-thick quartzite layers with minor feldspar, biotite, chlorite, and white mica separated by <2-cm-thick biotite-rich interlayers. Quartz has embayed subgrain boundaries indicating high-T grain boundary migration recrystallization. Some quartz ribbons have aspect ratios of approximately 6:1. Fine- to medium-grained white mica is aligned with the foliation defined by compositional layering and grain shape preferred orientation of quartz. Chlorite is locally intergrown with medium- to coarse-grained biotite. The detrital zircon is 50 to 200 μm long and variable in morphology, from sub-equant to elongate and subrounded to euhedral. Most grains have well developed oscillatory zoning with clear core-rim relationships defined by 1–20 μm CL-intermediate rims.

**Sample 17-80:** The sample consists of quartzofeldspathic layers, 2 – 5 cm in thickness, within biotite gneiss. Abundant feldspar and quartz augen in the biotite gneiss are interpreted as deformed leucosome. Medium- to fine-grained aggregates of chlorite and biotite are compositionally interlayered with fine-grained quartz and intruded by very coarse-grained quartz and feldspar leucosomes. Euhedral white mica is medium- to coarse-grained and occurs as aggregates that cut the foliation. Zircon is elongate and subrounded to euhedral. Most grains exhibit well developed oscillatory zoning that is overprinted by recrystallized CL-bright areas and 1- to 5-µm-thick rims.

***Petersen Bay fault zone – Petersen Bay Assemblage***

**Sample 17-02:** The sample of mylonitic psammite contains abundant quartz with minor white mica and calcite. A strong foliation is defined by compositional layering, alignment of fine-grained white mica, and grain size variation between coarser-grained quartz and a fine-grained matrix. A few coarse white mica grains are euhedral, but most are subhedral to anhedral. Zircon is 40 to 200 μm in maximum dimension, equant to elongate and rounded to subangular. Most grains display fine to coarse oscillatory zoning that is truncated at grain boundaries. Zones of internal and rim recrystallization or growth are common.

**Sample 17-14:** The felsic metaigneous sample consists of quartz, biotite, and feldspar with minor chlorite. A weak foliation is defined by grain shape preferred orientation of biotite. Quartz displays some subgrain development, which is obscured by recrystallized grains with polygonal boundaries. Zircon from this sample is mainly euhedral and elongate with maximum dimensions of 50 to 300 μm. Most grains display oscillatory zoning and approximately 50% of grains have complex zonation patterns or rim development.

**Sample 17-16:** The sample consists of amphibole, quartz, calcite, biotite, and feldspar. Poikiloblastic, coarse-grained amphibole contains quartz and feldspar of varying size and shape is characteristic. Grain-shape preferred orientation of medium- to coarse-grained biotite forms a weak foliation. Coarse-grained sparry calcite overgrows other minerals in the matrix. Zircon is 30 to 210 μm in length, equant to elongate and mainly rounded to subangular with a few euhedral laths. The grains have well-developed to faint oscillatory zoning. Up to 60% of grains have thin, CL-yellow rims attributed to metamorphic overgrowth.

**Sample 17-55:** The sample of sandstone consists of quartz, calcite, biotite, and rare white mica. A moderate foliation is defined by grain shape preferred orientation of biotite. Rare, coarse white mica is not aligned with the foliation. Fine- to medium-grained quartz displays some subgrain development and undulose extinction but is partially obscured by quartz with polygonal subgrain boundaries. Detrital zircon is 50–200 μm in maximum dimension, equant to elongate and euhedral to rounded. Most grains have well developed faint oscillatory zoning in CL images with complex core-rim relationships. Approximately 40% of grains have thin (1–3 µm), CL-yellow metamorphic rims.

***Petersen Bay fault zone – Danish River Formation***

**Sample 17-60:** Metasandstone layers at this locality consist of quartz, carbonate, and white mica with interlayered lenses of finer-grained calcite and white mica. A moderate foliation is defined by alignment of white mica, compositional layers of quartz and calcite, sigmoidal quartz aggregates and stretched quartz grains with aspect ratios of 3:1. Detrital zircon is highly variable in size and morphology, 30–250 μm in maximum dimension, equant to elongate and rounded to euhedral in shape. Zircon grains show well developed oscillatory zoning, coarse zoning, or faint zoning produced by recrystallization. Many grains have thin to thick (1–30 µm) CL-bright to -dark rims.

***Kulutingwak Fiord fault zone (KFFZ)***

**Sample 04LB17:** The sandstone displays normal graded bedding and planar cross-stratification in outcrop and is moderately to poorly sorted with the coarsest grains consisting of mono- to polycrystalline quartz, feldspar, and lithic fragments of quartzite and mica schist. Zircon is 50-150 µm long, equant to elongate and subangular to subrounded. The grains typically display oscillatory zoning.

**Sample VP17-04b:** The sample was collected from subcrop of altered metavolcanic rock composed of amphibole, fine-grained plagioclase, quartz, and Fe-Ti oxides. Fractures filled with secondary calcite are common. Zircon ranges in length from ca. 50–200 µm, with typical oscillatory zoning. A few grains show greater internal CL complexities; these were avoided during analysis.

**Sample 17-39:** The sandstone is dominated by quartz and white mica. Zircon is 20–350 µm long, equant to elongate, and subrounded to rounded with well-preserved to faint oscillatory zoning. Approximately 30% of the grains have irregularly shaped CL-white rims.

***Emma Fiord fault zone (EFFZ)***

**Sample KF17-125:** The sample is an immature lithic arenite with quartz, calcite, biotite, and white mica in a fine-grained quartz-calcite matrix. Quartz is medium- to very fine-grained with angular grain boundaries. Fine-grained biotite and white mica are randomly dispersed throughout the matrix. Detrital zircon is 50 to 500 µm in maximum dimension and varies in shape from equant to elongate and from rounded grains to euhedral laths with most subrounded. Most grains have well developed oscillatory zoning that is truncated at the margins of rounded equant grains. Approximately 30% of the grains have irregular CL-white metamorphic rims, and a few grains are dark in CL, presumably due to high U content.

**Sample KF17-128:** Polymict clasts dominated by quartz, feldspar, calcite, volcanic glass, and lithic fragments are supported in a fine-grained calcite mud matrix. Quartz clasts are the most abundant, with some clasts displaying significant stretching (4:1) and others relatively undeformed. Zircon is either euhedral or forms angular fragments. The grains show oscillatory zoning and approximately 60% are extremely dark in CL with U ranging from 3000 to 7000 ppm.

**Sample KF17-129:** The was collected from sandstone that is strongly altered and consists of calcite, plagioclase, quartz, Fe-Ti oxide aggregates, and white mica. Clasts of quartz, feldspar, and volcanic glass are aligned parallel to a foliation defined by compositional layering of Fe-Ti oxide aggregates and the fine-grained quartz-calcite matrix. Clasts are altered and matrix calcite commonly overgrows the fabric. Zircon is 20–300 µm in maximum dimension, equant to elongate and dominantly euhedral. Roughly 50% of the grains are CL-dark and the remainder have well developed oscillatory zoning.

**Sample VP17-05b:** In thin-section, plagioclase occurs in clusters, as individual phenocrysts, and as a comminuted microcrystalline groundmass, along with secondary calcite. Zircon is 30–100 μm long and generally euhedral with simple oscillatory and sector zoning.

**Sample KF17-217:** The sample is a quartz-feldspar pebble conglomerate with minor white mica and calcite. Some quartz pebbles show extensive subgrain development with bulging recrystallization textures or are extremely stretched (5:1), while others exhibit undulose extinction or are undeformed. Zircon is 30 to 300 μm long and varies in shape from rounded to euhedral. The grains have fine to coarse oscillatory zoning or complex internal domains with no apparent zoning. Approximately 60% have 1- to 10-µm-thick CL-bright rims.