**NordAq Energy Inc. Weatherford File No.: HH-61176**

**East Simpson No. 2 (USGS/Husky 1980)**

**Torok Formation**

## Onshore, Alaska

**Conventional Core**

# GENERAL THIN SECTION DESCRIPTION

**SAMPLE DEPTH: 6061.50 FEET**

**SAMPLE NUMBER: 1**

**PLATE 1**

## 

**Porosity (ambient):** 13.1%

**Permeability (to air):** 0.452 mD

**Grain Density:** 2.68 gm/cc

**Lithology:** Fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.40mm

**Average Grain Size:** 0.15mm

**Compaction:** Moderate

**Sorting:** Moderately well

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar, volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, and pyrite

**Porosity Types:** Dominant primary intergranular pores, lesser amounts of secondary

dissolution pores within unstable grains, and micropores associated with

clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates dominant quartz grains (most white grains; AB6,CD3,FG6.5). Lesser amounts of polycrystalline quartz, chert, plagioclase feldspar, volcanic fragments, mudstone rock fragments, and metamorphic fragments are also present. Muscovite mica occurs at JK5.5-6.5.

B) Photo B provides a high magnification view of the area near DE8.5 in Photo A. Porosity consists of primary intergranular pores (blue epoxy; B12.5,DE6H2), secondary dissolution pores (AB1,AB14.5,K12-13), and minor amounts of micropores associated with detrital clay. Cements include quartz overgrowths (AB11.5,GH1), secondary calcite (stained red), and pyrite (black specks; DE1.5,F7.5,EF10.5). Pore-filling kaolinite occurs at HJ6-7.

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6062.00 FEET**

**SAMPLE NUMBER: 2**

**PLATE 2**

**Porosity (ambient):** 14.0%

**Permeability (to air):** 0.343 mD

**Grain Density:** 2.67 gm/cc

**Lithology:** Upper very fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.38mm

**Average Grain Size:** 0.11mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, and pyrite

**Porosity Types:** Dominant primary intergranular pores, minor secondary dissolution

pores within unstable grains, and micropores associated with clay

minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates monocrystalline quartz (most white grains) as the dominant detrital framework grain type. Plagioclase feldspar, polycrystalline quartz, volcanic fragments, mudstone rock fragments, and metamorphic fragments comprise the remaining grain fraction. Partially pyritized organic material (black; CD13.5,DE7,K4) and glauconite (JK9) are also present.

B) Photo B provides a high magnification view of the area near G7 in photo A. Porosity consists of primary intergranular pores (BC2.5,F2,H13,JK9.5) and secondary dissolution pores (B12,GJ5). Quartz overgrowths (A3.5,CD9,JH10) are the dominant cement. Muscovite mica occurs at F7.

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6063.40 FEET**

**SAMPLE NUMBER: 3**

**PLATE 3**

**Porosity (ambient):** 13.8%

**Permeability (to air):** 0.196 mD

**Grain Density:** 2.69 gm/cc

**Lithology:** Very fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated and burrowed

**Grain Size Range:** <0.01mm-0.34mm

**Average Grain Size:** 0.10mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, and pyrite

**Porosity Types:** Dominant primary intergranular pores, lesser amounts of secondary

dissolution pores within unstable grains, and micropores associated with

clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates quartz (mono- and poly-crystalline; B5,F2,H15) as the dominant grain type with lesser amounts of plagioclase feldspar, potassium feldspar, and lithic fragments. Accessory minerals consist of muscovite (G6-7), biotite (JK2.5-3), organic material (black, DE7.5,DE14), and glauconite (BC6.1).

B) Photo B is a high magnification view of the area near EF8 in photo A, which documents quartz overgrowth cement (BC1.5,D2.5,DE13). Secondary calcite occurs at A1.5 replacing a labile grain. Secondary dissolution porosity in the form of partially leached grains occurs at GH4 and HJ11.5.

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6065.50 FEET**

**SAMPLE NUMBER: 4**

**PLATE 4**

**Porosity (ambient):** 14.3%

**Permeability (to air):** 0.173 mD

**Grain Density:** 2.69 gm/cc

**Lithology:** Lower fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated and burrowed

**Grain Size Range:** <0.01mm-0.32mm

**Average Grain Size:** 0.13mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite mica, biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, pyrite, and Fe-dolomite

**Porosity Types:** Dominant primary intergranular pores, lesser amounts of secondary

dissolution of unstable grains, and micropores associated with clay

minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates quartz, plagioclase feldspar, lithic fragments, and organic material (black). The pore system is comprised primarily of intergranular pores (blue epoxy), secondary dissolution pores (DE9.5,F9.5), and micropores associated with clay minerals.

B) This high magnification view of the area near E5.5 in photo A documents dominant primary intergranular pores (D12.5,F5.5,J1,JK12.5). Biotite mica occurs at CD3-D7. Fe-dolomite (stained blue) occurs at HJ6.5. Compressed mudstone rock fragments form localized areas of pseudomatrix (DE4,F10,HJ5).

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6067.60 FEET**

**SAMPLE NUMBER: 5**

**PLATE 5**

**Porosity (ambient):** 14.8%

**Permeability (to air):** 0.541 mD

**Grain Density:** 2.68 gm/cc

**Lithology:** Upper very fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.43mm

**Average Grain Size:** 0.12mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite mica, biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, chlorite, and pyrite

**Porosity Types:** Dominant primary intergranular pores, lesser amounts of secondary

dissolution pores within unstable grains, and micropores associated with

clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates a dominant quartz (most white grains) framework grains. Lesser amounts of polycrystalline quartz, chert (A7,B1), plagioclase feldspar, potassium feldspar, lithic fragments, and partially pyritized organic material (black; B13.5,C9J8) are also present. Muscovite mica occurs at DE12 and biotite mica occurs at BC14-15.

B) High magnification view of the area near FG8 in Photo A illustrates primary intergranular pores (blue epoxy; B10,B14,J12) and secondary dissolution pores (CD12.5,EF3,J2). The black specks are pyrite framboids (C3,FG4,J9.5), which occur as a secondary replacement material. Chlorite occurs at EF13-14.5.

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6068.30 FEET**

**SAMPLE NUMBER: 6**

**PLATE 6**

**Porosity (ambient):** 15.4%

**Permeability (to air):** 0.843 mD

**Grain Density:** 2.68 gm/cc

**Lithology:** Fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.50mm

**Average Grain Size:** 0.15mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, pyrite, and Fe-dolomite

**Porosity Types:** Dominant primary intergranular pores, lesser amounts of secondary

dissolution pores, and micropores associated with clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates dominant quartz grains (most white grains), with lesser amounts of chert, plagioclase feldspar, potassium feldspar, volcanic fragments, mudstone rock fragments (B13,FG8), and metamorphic fragments. Secondary calcite (stained red) occurs at FG10.5 as a replacement of a labile lithic fragment.

B) Photo B provides a high magnification view of the area near FG5 in photo A, which documents primary intergranular (C4,EF3,H11) and secondary dissolution pores (D10.5,DE12.5,G4.5). Pore-filling kaolinite, which was derived from an altered feldspar, occurs at HJ7-9. Muscovite mica occurs at E10 and J9-H11.

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6069.20 FEET**

**SAMPLE NUMBER: 7**

**PLATE 7**

**Porosity (ambient):** 14.5%

**Permeability (to air):** 0.391 mD

**Grain Density:** 2.68 gm/cc

**Lithology:** Lower fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Slightly bioturbated and burrowed

**Grain Size Range:** <0.01mm-0.15mm

**Average Grain Size:** 0.13mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, pyrite, and Fe-dolomite

**Porosity Types:** Dominant primary intergranular pores, lesser amounts of secondary

dissolution pores, and micropores associated with clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates dominant quartz grains (most white grains) and various lithic fragments primarily cemented by quartz overgrowths. Secondary calcite (stained red) and Fe-dolomite (stained blue) are also present as a replacement of less stable grains and matrix material.

B) Photo B provides a high magnification view of the area near E8 in photo A, which documents primary intergranular pores (AB6.5,EF7.5,G7) and secondary dissolution pores (F4.5,FG1,J12). Secondary calcite (stained red) occurs at JK10 and Fe-dolomite (stained blue) occurs at F11.5. Kaolinite occurs at HJ3.5.

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## Onshore, Alaska

**Conventional Core**

# GENERAL THIN SECTION DESCRIPTION

**SAMPLE DEPTH: 6070.60 FEET**

**SAMPLE NUMBER: 8**

**PLATE 8**

**Porosity (ambient):** 14.2%

**Permeability (to air):** 0.287 mD

**Grain Density:** 2.68 gm/cc

**Lithology:** Lower fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.33mm

**Average Grain Size:** 0.13mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and

heavy mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, and pyrite

**Porosity Types:** Primary intergranular pores, minor secondary dissolution of unstable grains, and micropores associated with clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A provides a general overview of this moderately sorted, lower fine-grained, lithic-rich sandstone. The pore system (blue epoxy) is comprised of dominant intergranular pores. Lesser amounts of secondary dissolution pores and micropores associated with clay minerals contribute to overall porosity.

B) A high magnification view of the area near DE6 in photo A illustrates primary intergranular pores (BC11) and secondary dissolution pores (AB1.5,B15,E7.5,G4). Secondary pyrite framboids (black specks) occur at A4, DE7.5, and J4.5. Calcite (stained red) replacing a labile lithic fragment occurs at CD11.5.

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## Onshore, Alaska

**Conventional Core**

**GENERAL THIN SECTION DESCRIPTION**

**SAMPLE DEPTH: 6072.70 FEET**

**SAMPLE NUMBER: 9**

**PLATE 9**

**Porosity (ambient):** 14.5%

**Permeability (to air):** 0.348 mD

**Grain Density:** 2.67 gm/cc

**Lithology:** Upper very fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.32mm

**Average Grain Size:** 0.12mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar,

volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite and biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, kaolinite, illite, and pyrite

**Porosity Types:** Primary intergranular pores, minor secondary dissolution of unstable grains, and micropores associated with clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates dominant quartz (most white grains) with lesser amounts of feldspars, lithic fragments, and partially pyritized organic material (black), as the main constituents. Accessory grains include muscovite mica (AB9.5-10), biotite mica (G7-7.5), glauconite (not pictured), and zircon.

B) A high magnification view of the area near C6.5 in photo A documents primary intergranular pores (EF14,F11,J10) and secondary dissolution pores (AB11.5,DE9.5,EF2.5). Quartz overgrowths (BC2.5,D15,GH10.5,JK9.5) are the primary cement documented.

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## Onshore, Alaska

**Conventional Core**

# GENERAL THIN SECTION DESCRIPTION

**SAMPLE DEPTH: 6075.40 FEET**

**SAMPLE NUMBER: 10**

**PLATE 10**

**Porosity (ambient):** 15.8%

**Permeability (to air):** 0.567 mD

**Grain Density:** 2.67 gm/cc

**Lithology:** Fine-grained, lithic-rich sandstone

**Sedimentary Fabric:** Vaguely bioturbated

**Grain Size Range:** <0.01mm-0.39mm

**Average Grain Size:** 0.15mm

**Compaction:** Moderate

**Sorting:** Moderate

## Framework Grains:

**Major:** Monocrystalline quartz

**Minor:** Polycrystalline quartz, chert, plagioclase feldspar, potassium feldspar, volcanic fragments, mudstone fragments, and metamorphic fragments

**Accessory:** Muscovite mica, biotite mica, organic material, glauconite, and heavy

mineral zircon

**Clay Content:**

**Detrital Matrix:** Minor to trace amounts (visual estimate)

**Authigenic Clay:** Minor amounts (visual estimate)

**Cement Types:** Quartz overgrowths, calcite, pyrite, kaolinite, illite, and Fe-dolomite

**Porosity Types:** Primary intergranular pores, minor secondary dissolution pores within

unstable grains, and micropores associated with clay minerals

**Reservoir Quality:** Good (based on visual estimation of thin section porosity)

**Magnification:** A: 50X B: 200X

A) Photo A illustrates dominant quartz grains (most white grains; A10,E4.5,HJ6). Lesser amounts of polycrystalline quartz, plagioclase feldspar, potassium feldspar, volcanic fragments, mudstone rock fragments, and metamorphic fragments are also present. Iron-rich dolomite (stained blue) occurs at B4 as a replacement of a less stable grain.

B) Photo B provides a high magnification view of the area near EF8 in Photo A. Porosity consists of primary intergranular pores (blue epoxy; B1-2,BC12,CD4), secondary dissolution pores (B7.5,G14,K5-7), and minor amounts of micropores associated with clay minerals. Cements include quartz overgrowths (AB10,C2,J14.5), secondary calcite (stained red; not pictured), Fe-dolomite (stained blue; BC4), and pyrite (black specks; H11).