Appendix B

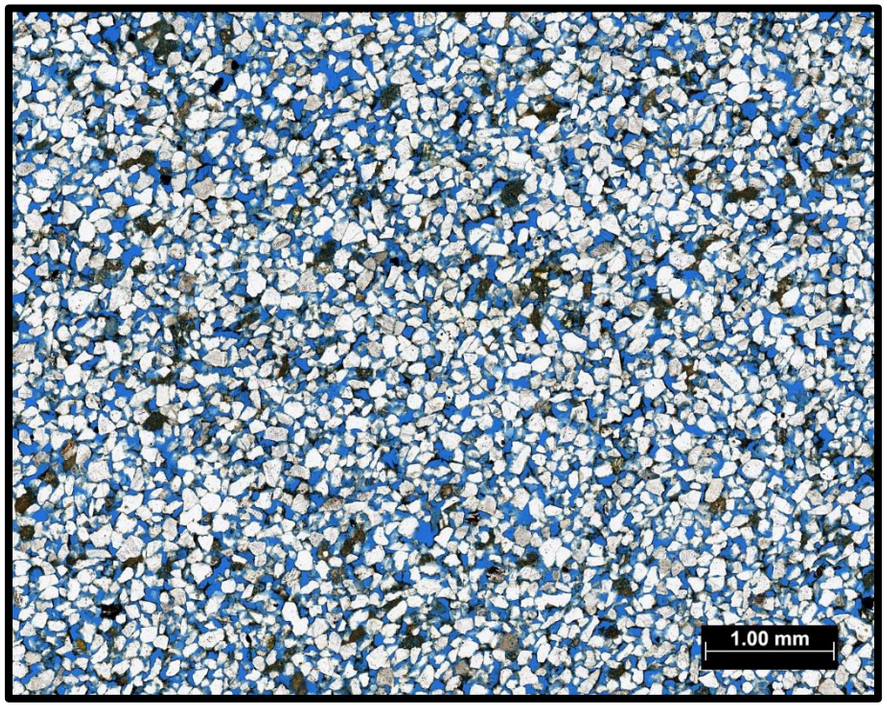
Stratum Laboratory Thin Sections and Analysis on Hosston Core Samples

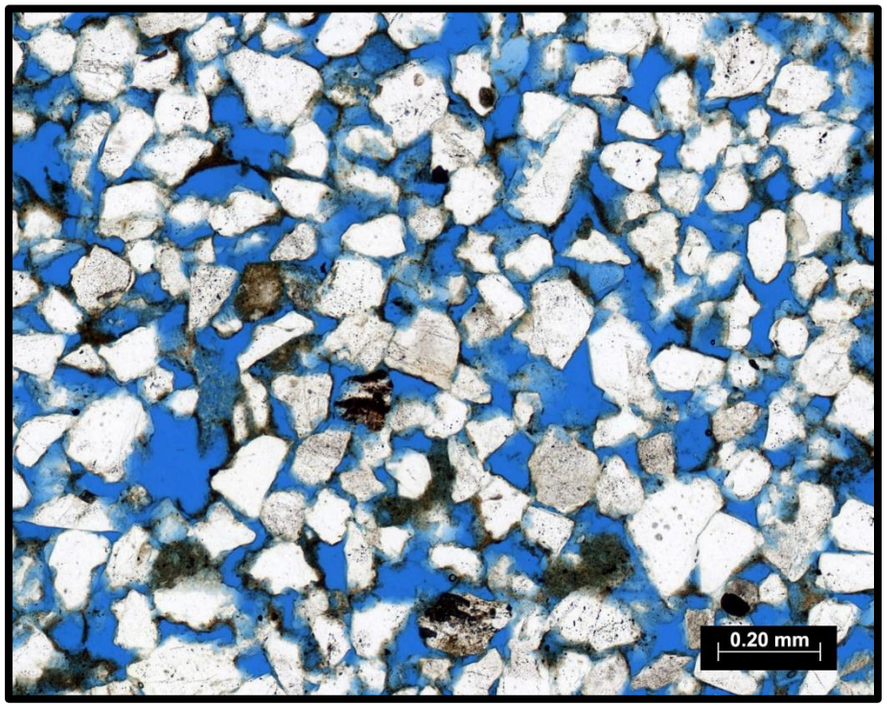
Geostock Sandia

Geostock Sandia
Hosston (03-139-03544)

3929.20 feet
Sample # 1-2H-ET
Fine-grained sandstone
Hosston formation

Project # HH-111673
Conventional Core





ROCK NAME (Folk): Sublitharenite
SEDIMENTARY FABRIC: Faintly laminated
GRAIN SIZE RANGE*: Clay to 0.350 mm (medium sand)
AVERAGE GRAIN SIZE*: 0.150 mm (fine sand)
ROUNDNESS*: Subangular to rounded
SORTING*: Moderate
COMPACTION: Low
*Sand/silt portion only

FRAMEWORK GRAINS/ALLOCHEMS:

MAJOR (GRAINS/ALLOCHEMS):
Monocrystalline quartz (57.0%)

MINOR/ACCESSORY:
Polycrystalline quartz (3.3%); mudstone fragments (3.3%); pseudomatrix (1.1%); potassium feldspar (0.7%); chert (0.7%; including microporous varieties); plagioclase feldspar (0.3%); metamorphic rock fragments (0.3%; schist, micaceous fragments); siltstone fragments (0.3%); trace amounts of plutonic rock fragments, muscovite mica, and heavy minerals (zircon, tourmaline, rutile, opaques)

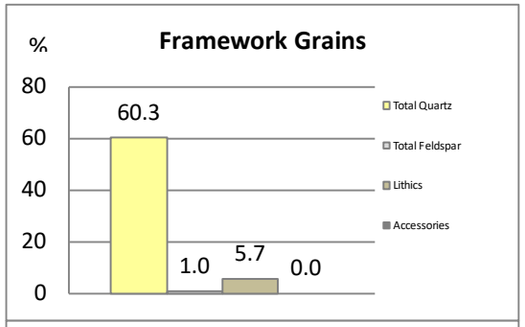
MATRIX:
Minor amounts of pore-filling (3.0%) and grain-coating/pore-lining (5.7%) clays likely consist of detrital illite and intermixed illite/smectite clays.

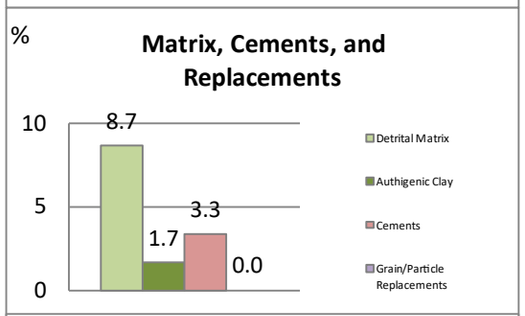
DIAGENESIS:

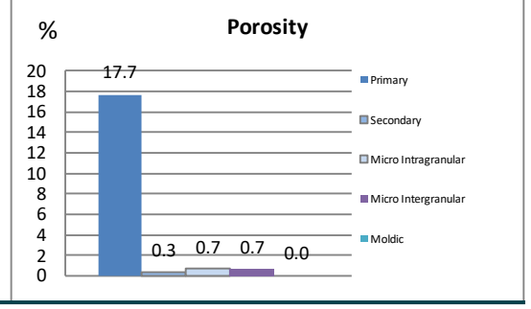
MAJOR:
Quartz – 3.0%; Minor amounts of incipient to moderately well-developed quartz overgrowths precipitate on host grains.

MINOR/ACCESSORY:
Illite/Chlorite – 1.7%; Minor amounts of authigenic illite/chlorite as grain-coating/pore-lining clays.
Illite/Sericite – Trace replacement of susceptible feldspar and lithic grains.
Pyrite – Trace pyrite framboids as pore-lining/grain-coating cement and replacement of clays and susceptible grains.

ØHe: 30.9% **Kl:** 683mD
Grain density: 2.64 gm/cc







PORE TYPES:

Observed pore types include common intergranular pores (17.7%), intergranular micropores (0.7%), secondary intragranular pores (0.3%), intragranular micropores (0.7%), and trace grain fracture pores.

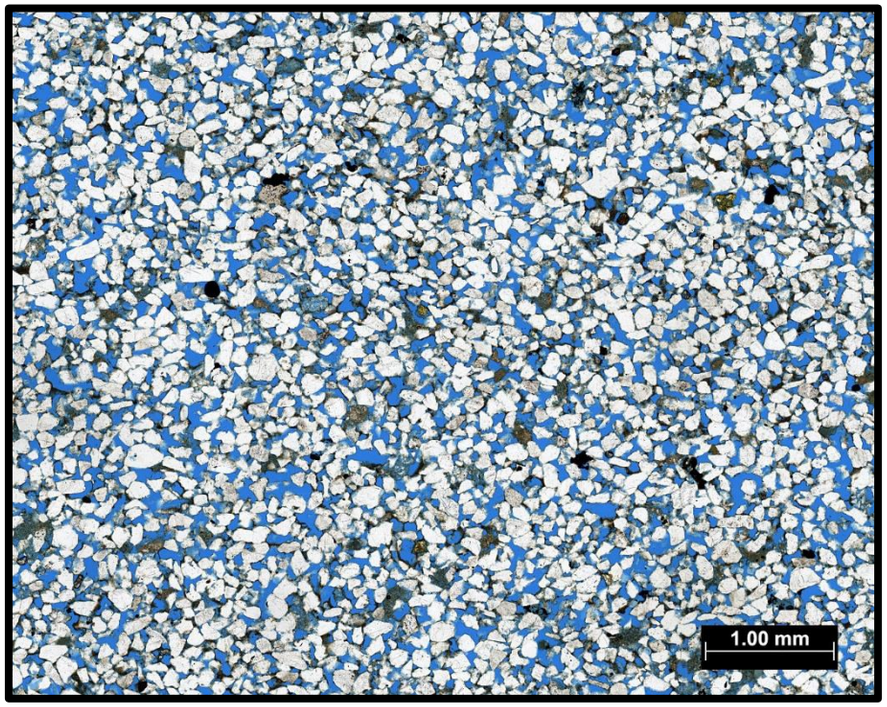
PETROGRAPHIC SUMMARY:

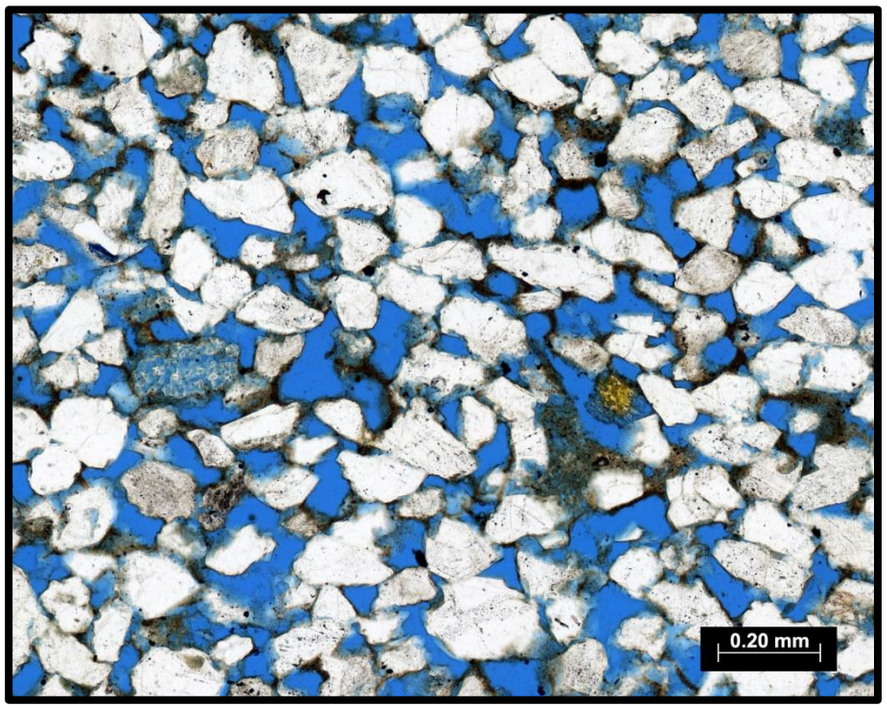
This moderately sorted, fine-grained sandstone is classified by Folk as sublitharenite. The fabric is faintly laminated with most grains displaying preferential orientation along the long axis. Detrital framework grains consist of abundant very fine to medium sand-sized monocrystalline quartz, minor polycrystalline quartz, rare feldspars, minor lithic fragments, mudstone fragments, and trace muscovite mica and heavy minerals. Minor amounts of detrital illitic and illitic/smectitic clays locally occlude intergranular pores, coat grains/line pore walls, and bridge pore throats. Authigenic quartz overgrowth cement locally precipitates on host detrital quartz grains where grain-coating clays are absent or discontinuous. Trace amounts of framboidal pyrite occurs disseminated throughout the fabric as a replacive phase of susceptible grains and clays. Visible pore types consist primarily of intergranular pores/micropores and minor secondary intragranular pores/micropores associated with partially leached feldspar grains and microporous chert grains. Interconnectivity is expected to be good with local permeability restrictions resulting from pore-bridging clays and grain-to-grain contacts (point and long contacts).

Geostock Sandia
Hosston (03-139-03544)

3938.40 feet
Sample # 1-4H-ET
Fine-grained sandstone
Hosston formation

Project # HH-111673
Conventional Core





ROCK NAME (Folk): Subarkose
SEDIMENTARY FABRIC: Faintly laminated
GRAIN SIZE RANGE*: Clay to 0.310 mm (medium sand)
AVERAGE GRAIN SIZE*: 0.240 mm (upper fine sand)
ROUNDNESS*: Subangular to rounded
SORTING*: Moderate
COMPACTION: Low
*Sand/silt portion only

FRAMEWORK GRAINS/ALLOCHEMS:

MAJOR (GRAINS/ALLOCHEMS):
Monocrystalline quartz (50.0%)

MINOR/ACCESSORY:
Polycrystalline quartz (5.0%); potassium feldspar (1.0%); mudstone fragments (1.0%); plagioclase feldspar (0.3%); muscovite mica (0.3%); heavy minerals (0.3%; zircon, tourmaline, rutile, opaques); trace amounts of metamorphic rock fragments (schist), siltstone fragments, chert (including microporous varieties), and pseudomatrix

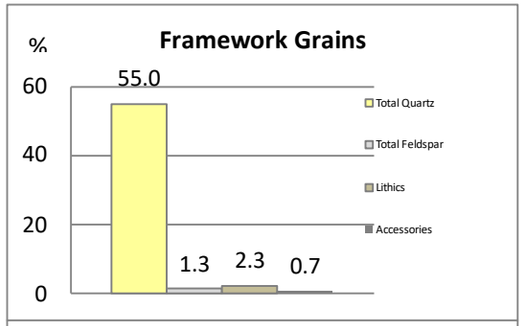
MATRIX:
Minor amounts of pore-filling (4.0%) and grain-coating/pore-lining (8.0%) clays likely consist of detrital illite and intermixed illite/smectite clays.

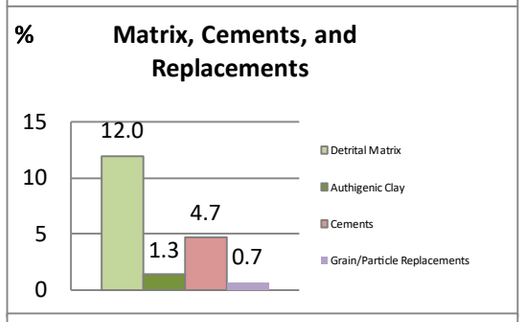
DIAGENESIS:

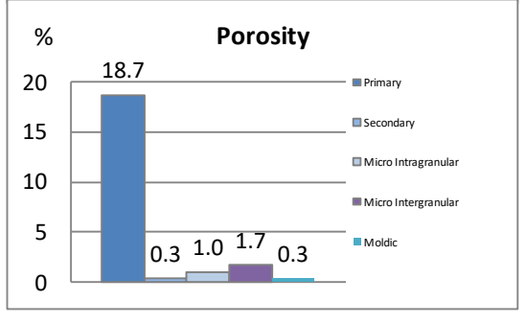
MAJOR:
Quartz – 4.7%; Minor amounts of incipient to moderately well-developed quartz overgrowths precipitate on host grains.

MINOR/ACCESSORY:
Chlorite – Trace amounts as grain replacement.
Ferroan Dolomite – Stained blue; trace amounts as localized pore-filling cement
Illite/Chlorite – 1.0%; rare amounts of authigenic illite/chlorite as grain-coating/pore-lining clays.
Illite/Sericite – Trace replacement of susceptible feldspar and lithic grains.
Kaolinite – 0.3%; Rare amounts of pore-filling booklets.
Pyrite – Trace pyrite framboids as pore-lining/grain-coating cement and replacement of clays and susceptible grains.
Ti/Fe-oxides – Trace amounts as replacement of susceptible grains.

ØHe: 31.3% **Kl:** 704mD
Grain density: 2.65 gm/cc







PORE TYPES:

Observed pore types include common intergranular pores (18.7%), intergranular micropores (1.7%), secondary intragranular pores (0.3%), intragranular micropores (1.0%), and grain moldic pores (0.3%).

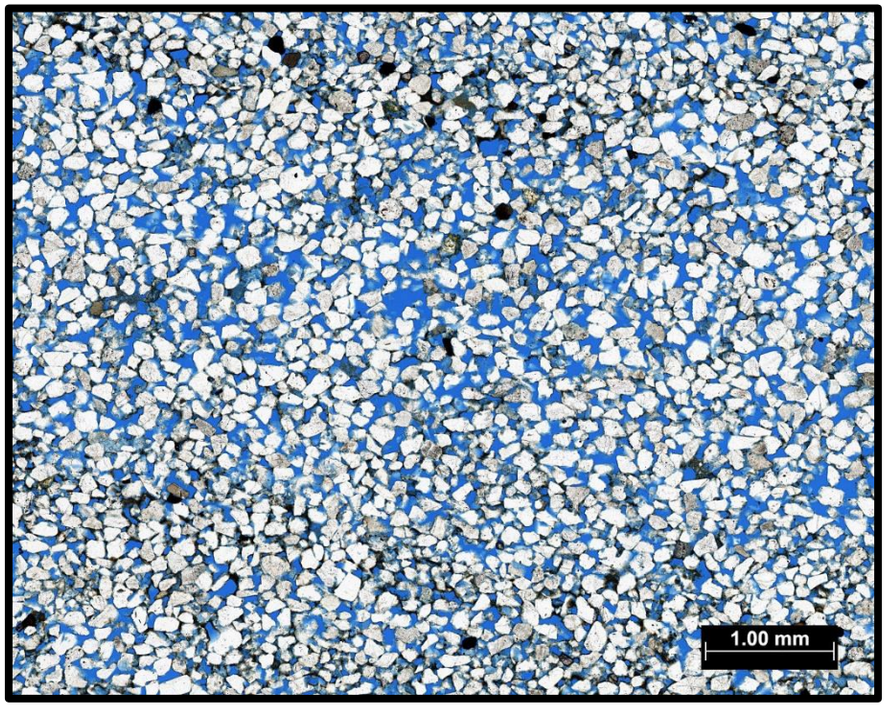
PETROGRAPHIC SUMMARY:

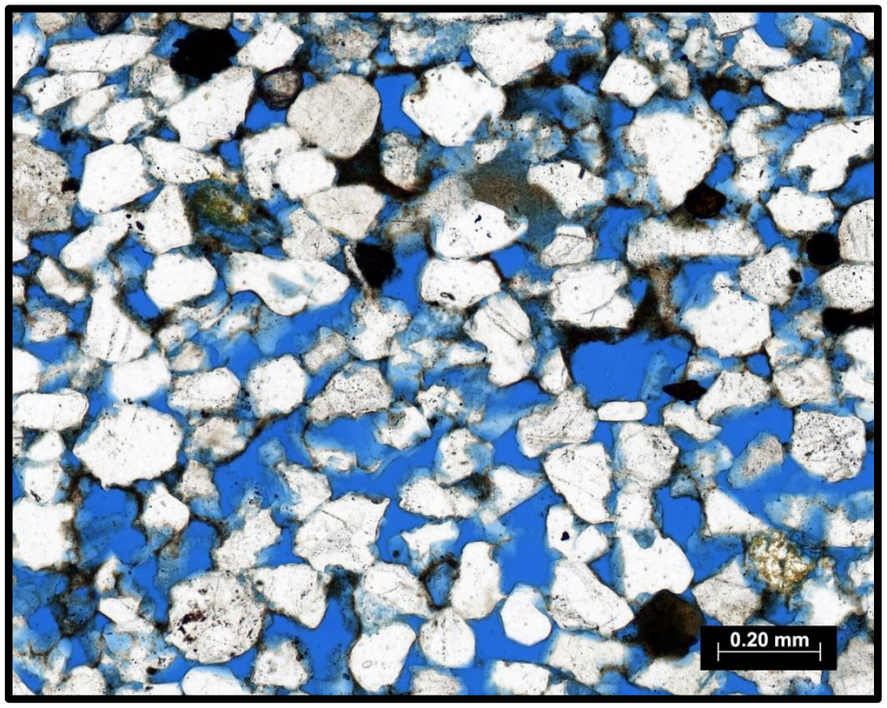
This moderately sorted, fine-grained sandstone is classified by Folk as subarkose. This sample exhibits a faintly laminar fabric with most grains displaying preferred orientation along the long axis. Detrital framework grains include abundant silt to medium sand-sized monocrystalline quartz, minor polycrystalline quartz, feldspars, lithic fragments, mudstone and siltstone fragments, and trace to rare amounts of chert, muscovite mica, and heavy minerals. Detrital matrix clays consist of minor pore-filling, grain-coating/pore-lining, and pore-bridging illite and intermixed illite/smectite clays. Incipient to moderately-well developed quartz overgrowth cement nucleates on host quartz grains where grain-coating clays are absent or discontinuous. Authigenic clays include rare amounts of intermixed illite/chlorite as grain coats, illite/sericite as a grain-replacive phase of susceptible feldspars, and trace pore-filling kaolinite booklets. Trace amounts of pyrite and iron oxides are also grain-replacive phases. Visible pore types include common intergranular pores/micropores and minor secondary intragranular pores/micropores associated with partially leached feldspars. A good reservoir quality is expected with minimal obstruction occurring from pore throat-bridging clays and point to long grain contacts.

Geostock Sandia
Hosston (03-139-03544)

3945.60 feet
Sample # 1-6H-ET
Fine-grained sandstone
Hosston formation

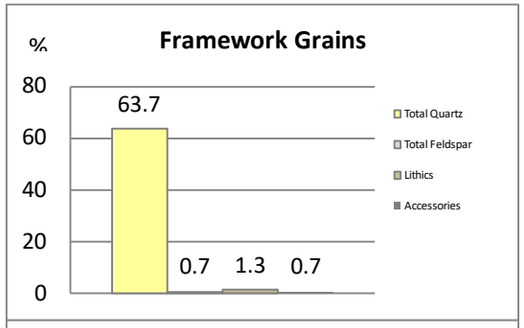
Project # HH-111673
Conventional Core

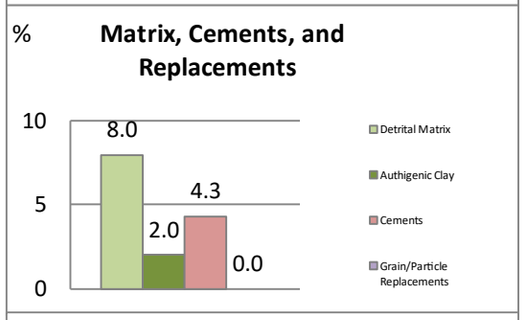


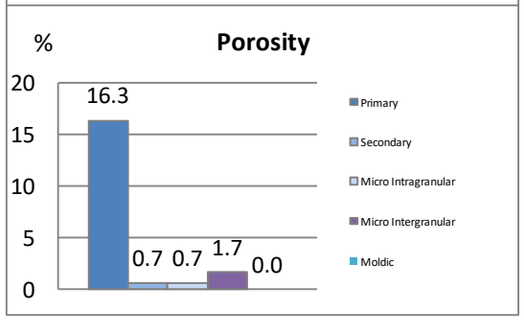


ROCK NAME (Folk): Quartzarenite
SEDIMENTARY FABRIC: Laminated
GRAIN SIZE RANGE*: Clay to 0.350 mm (medium sand)
AVERAGE GRAIN SIZE*: 0.150 mm (fine sand)
ROUNDNESS*: Subrounded to rounded
SORTING*: Moderate
COMPACTION: Low to moderate
*Sand/silt portion only

ØHe: 27.5% **Kl:** 273mD
Grain density: 2.65 gm/cc







FRAMEWORK GRAINS/ALLOCHEMS:

MAJOR (GRAINS/ALLOCHEMS):
Monocrystalline quartz (60.3%)

MINOR/ACCESSORY:
Polycrystalline quartz (3.0%); potassium feldspar (0.7%); heavy minerals (0.7%; zircon, tourmaline, rutile, opaques); metaquartzite (0.3%); mudstone fragments (0.3%); plutonic rock fragments (0.3%); metamorphic rock fragments (0.3%; schist); siltstone fragments (0.3%); trace amounts of plagioclase feldspar, chert, and muscovite mica

MATRIX:
Minor amounts of pore-filling (2.3%) and grain-coating/pore-lining (5.7%) clays likely consist of detrital illite and intermixed illite/smectite clays.

DIAGENESIS:

MAJOR:
Quartz – 4.7%; Minor amounts of moderately well-developed quartz overgrowths precipitate on host grains.

MINOR/ACCESSORY:
Ferroan dolomite – Stained blue; trace replacement of clay particles.
Illite/Chlorite – 1.0%; rare amounts of authigenic illite/chlorite as grain-coating/pore-lining clays.
Illite/Sericite – Trace replacement of susceptible feldspar and lithic grains.
Kaolinite – 0.6%; Rare amounts of pore-filling booklets and *in situ* alteration of feldspars.
Non-ferroan calcite – Stained red; trace amounts of localized pore-filling cement and replacement of susceptible grains.
Pyrite – Trace pyrite framboids as pore-lining/grain-coating cement and replacement of clays and susceptible grains.
Ti/Fe-oxides – Trace amounts as replacement of susceptible grains.

PORE TYPES:

Observed pore types include common intergranular pores (16.3%), intergranular micropores (0.7%), secondary intragranular pores (0.3%), intragranular micropores (0.3%), and trace grain moldic pores.

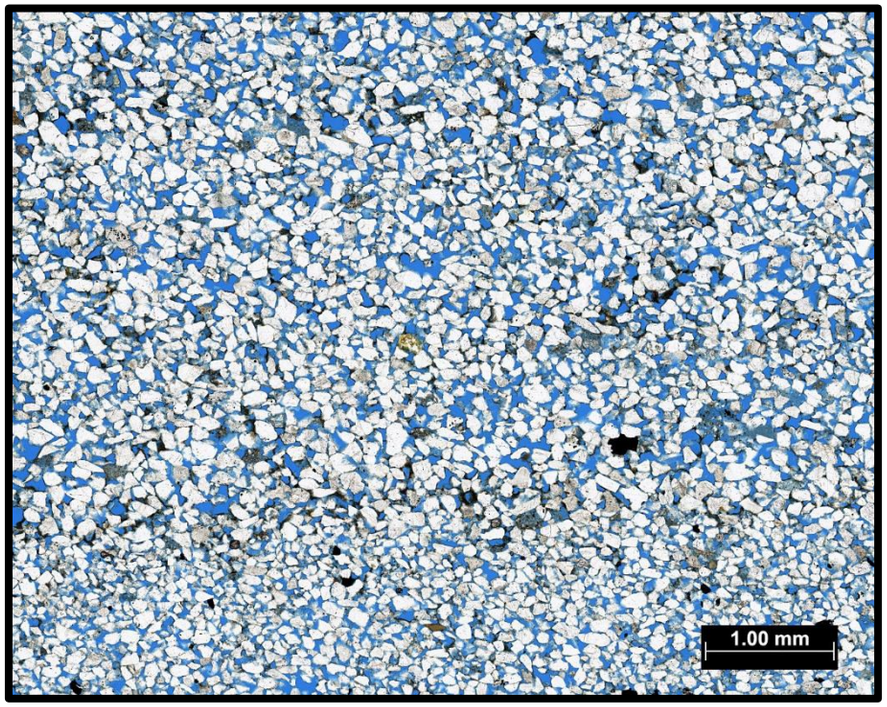
PETROGRAPHIC SUMMARY:

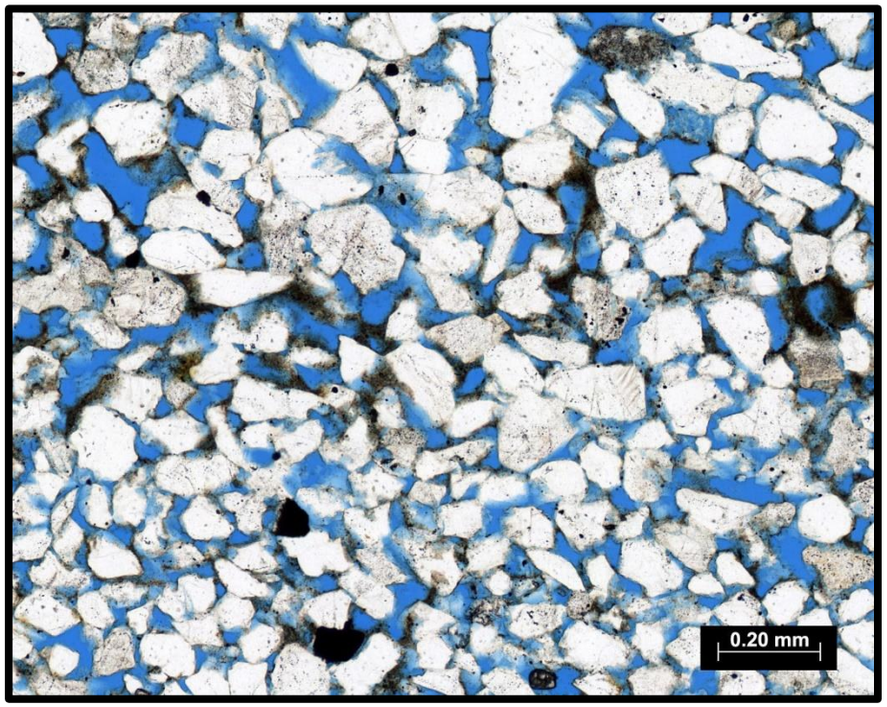
This moderately sorted, fine-grained sandstone is classified by Folk as quartzarenite. The fabric displays discreet laminations alternating between thin, slightly clay-rich layers with moderate levels of compaction and pore-dominated layers with lower compaction and better pore interconnectivity. Framework grains consist of very fine to medium sand-size grains of detrital monocrystalline quartz, with lesser amounts of polycrystalline quartz, feldspars, various lithic fragments, and trace to rare amounts of muscovite mica, chert, and heavy minerals. Detrital clays are observed throughout the fabric, but as mentioned before, locally appear more common in thin laminations. These clays consist of illitic and illitic/smectitic clays occurring as pore-filling, grain-coating/pore-lining, and bridging material. Quartz overgrowth cement is more apparent in "cleaner" laminations where grain-coating clays are either absent or poorly developed. Visible pore types include common intergranular pores/micropores, and secondary intragranular and grain moldic pores associated with dissolved feldspar grains. Interconnectivity is expected to be locally obstructed by clay-rich laminations and moderate grain-to-grain contacts.

Geostock Sandia
Hosston (03-139-03544)

3946.30 feet
Sample # 1-8H-ET
Very fine-grained sandstone
Hosston formation

Project # HH-111673
Conventional Core





ROCK NAME (Folk): Sublitharenite
SEDIMENTARY FABRIC: Laminated
GRAIN SIZE RANGE*: Clay to 0.300 mm (medium sand)
AVERAGE GRAIN SIZE*: 0.120 mm (upper very fine sand)
ROUNDNESS*: Subrounded to rounded
SORTING*: Moderate
COMPACTION: Low to moderate
*Sand/silt portion only

FRAMEWORK GRAINS/ALLOCHEMS:

MAJOR (GRAINS/ALLOCHEMS):
Monocrystalline quartz (60.7%)

MINOR/ACCESSORY:
Polycrystalline quartz (2.0%); chert (1.0%) plagioclase feldspar (0.7%); mudstone fragments (0.7%); metaquartzite (0.3%); potassium feldspar (0.3%); plutonic rock fragments (0.3%); siltstone fragments (0.3%); pseudomatrix (0.3%); trace metamorphic rock fragments (schist, micaceous fragments), muscovite mica, and heavy minerals (zircon, opaques)

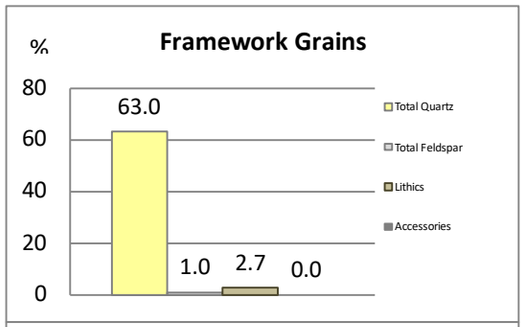
MATRIX:
Minor amounts of pore-filling (4.3%) and grain-coating/pore-lining (5.3%) clays likely consist of detrital illite and intermixed illite/smectite clays.

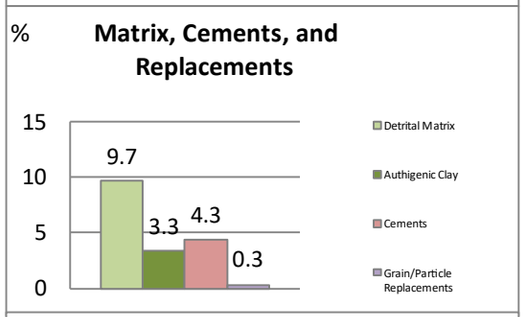
DIAGENESIS:

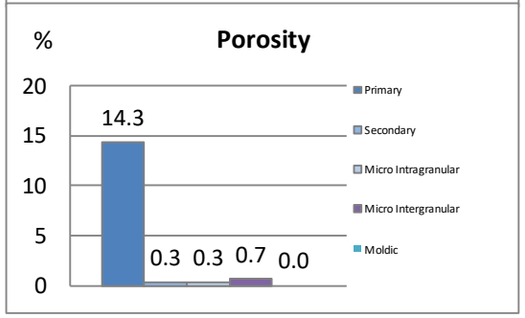
MAJOR:
Quartz – 4.0%; Minor amounts of incipient to moderately well-developed quartz overgrowths precipitate on host grains.

MINOR/ACCESSORY:
Ferroan calcite – Stained mauve; rare amounts of localized pore-filling cement and grain replacement.
Illite/Chlorite – 2.0%; Minor amounts of authigenic illite/chlorite as grain-coating/pore-lining and pore-filling clays.
Illite/Sericite – 0.7%; Rare replacement of susceptible feldspar and lithic grains.
Kaolinite – 0.7%; Rare amounts of pore-filling booklets and *in situ* alteration of feldspars.
Pyrite – Trace pyrite framboids as pore-lining/grain-coating cement and replacement of clays and susceptible grains.

ØHe: 28.1% **Kl:** 296mD
Grain density: 2.64 gm/cc







PORE TYPES:

Observed pore types include common intergranular pores (14.3%), intergranular micropores (0.7%), secondary intragranular pores (0.3%), intragranular micropores (0.3%), and trace grain moldic pores.

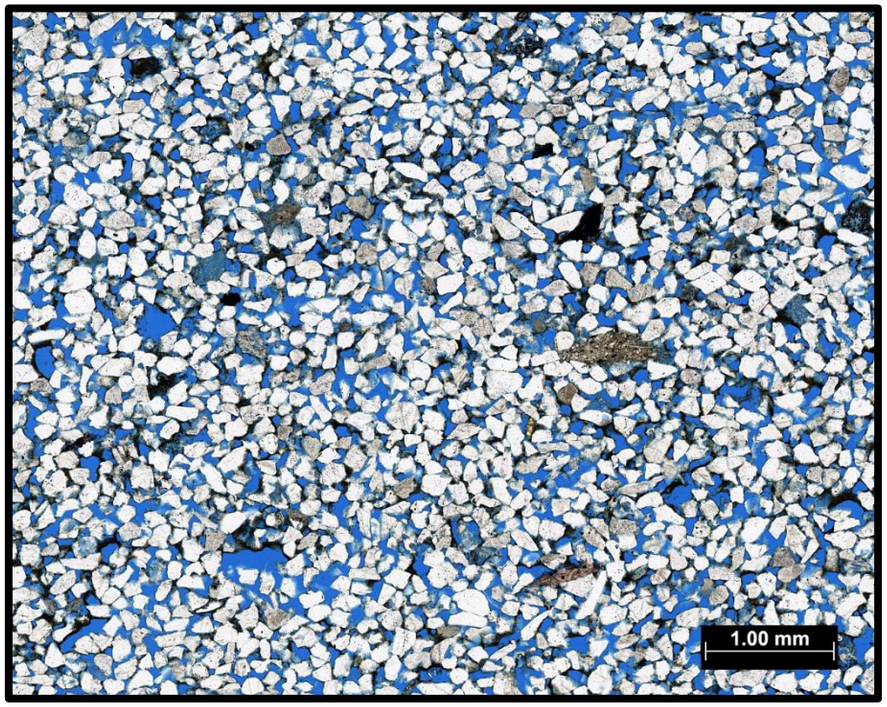
PETROGRAPHIC SUMMARY:

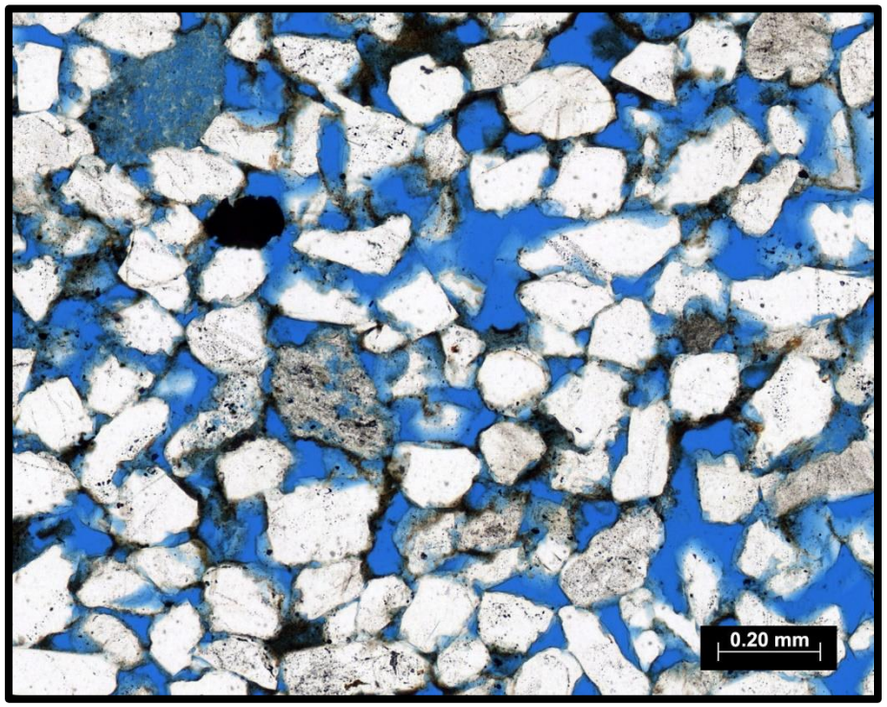
This moderately well sorted, very fine-grained sandstone is classified by Folk as sublitharenite. The fabric is laminated as observed in discreet variances in grain size (coarse silt to very fine sand vs. fine sand), heavy mineral lags, and most grains displaying preferential orientation along the long axis. Framework grains are comprised of abundant monocrystalline quartz, with lesser amounts of polycrystalline quartz, feldspars, various lithic fragments, chert, and trace amounts of muscovite mica and heavy minerals. Minor amounts of detrital illite and illite/smectite occur as pore-filling, pore throat-bridging, and grain-coating/pore-lining clays. Quartz overgrowth cement nucleates on host detrital quartz grains where grain-coating clays are absent or discontinuous. Trace to rare cement and grain-replacive phases include ferroan calcite, framboidal pyrite, and kaolinite as *in situ* replacement of feldspar grains. Visible pore types include common intergranular pores/micropores and secondary intragranular and grain moldic pore associated with dissolved feldspars. Interconnectivity is expected to be locally restricted by pore-bridging clays and laminations with more frequent amounts of grain contacts (point and long).

Geostock Sandia
Hosston (03-139-03544)

3954.00 feet
Sample # 1-12H-ET
Fine-grained sandstone
Hosston formation

Project # HH-111673
Conventional Core





ROCK NAME (Folk): Subarkose
SEDIMENTARY FABRIC: Faintly laminated
GRAIN SIZE RANGE*: Clay to 0.770 mm (coarse sand)
AVERAGE GRAIN SIZE*: 0.180 mm (upper fine sand)
ROUNDNESS*: Subangular to rounded
SORTING*: Moderate
COMPACTION: Low to moderate
*Sand/silt portion only

FRAMEWORK GRAINS/ALLOCHEMS:

MAJOR (GRAINS/ALLOCHEMS):
Monocrystalline quartz (60.0%)

MINOR/ACCESSORY:
Polycrystalline quartz (5.0%); potassium feldspar (1.0%); chert (1.0%; including microporous varieties); plagioclase feldspar (0.7%); skeletal debris (0.7%; bivalve shell fragments); plutonic rock fragments (0.3%); metamorphic rock fragments (0.3%); pseudomatrix (0.3%); heavy minerals (0.3%; zircon, epidote, opaques); trace mudstone fragments and muscovite mica

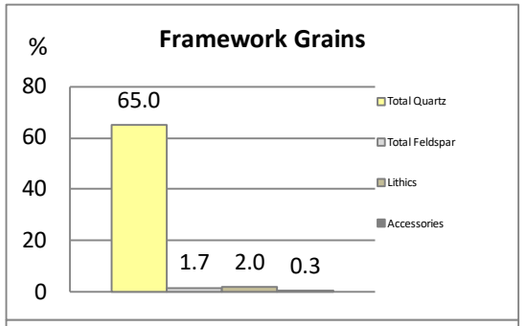
MATRIX:
Minor amounts of pore-filling (3.7%) and grain-coating/pore-lining (5.0%) clays likely consist of detrital illite and intermixed illite/smectite clays.

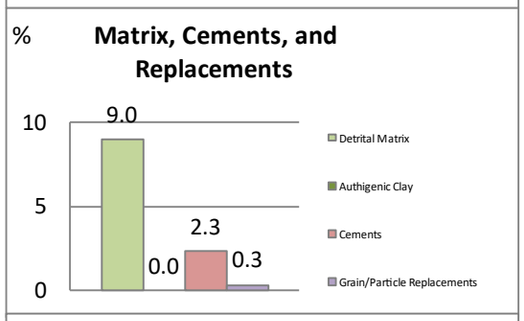
DIAGENESIS:

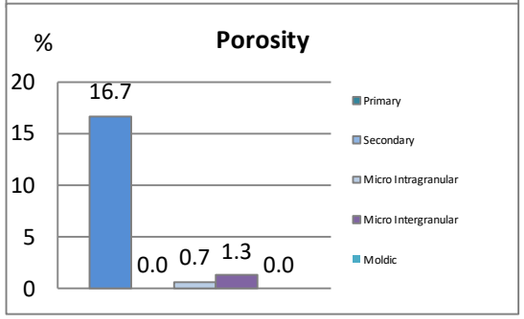
MAJOR:
Quartz – 2.3%; Minor amounts of incipient to moderately well-developed quartz overgrowths precipitate on host grains.

MINOR/ACCESSORY:
Ferroan dolomite – Stained blue; trace pore-filling cement
Illite/Chlorite – Trace amounts of authigenic illite/chlorite as grain-coating/pore-lining and pore-filling clays.
Illite/Sericite – Trace replacement of susceptible feldspar and lithic grains.
Kaolinite – Trace amounts of *in situ* alteration of feldspars.
Non-ferroan calcite – Stained red; trace amounts of localized pore-filling cement and replacement of susceptible grains and fossil fragments.
Pyrite – 0.3%; Rare pyrite framboids as pore-lining/grain-coating cement and replacement of clays and skeletal debris.

ØHe: 28.4% **Kl:** 413mD
Grain density: 2.64 gm/cc







PORE TYPES:

Observed pore types include common intergranular pores (14.3%), intergranular micropores (1.3%), secondary intragranular pores (trace), and intragranular micropores (0.7%).

PETROGRAPHIC SUMMARY:

This moderately sorted, fine-grained sandstone is classified by Folk as subarkose. The fabric displays a faintly laminar texture highlighted by elongate skeletal fragments and most grains displaying a preferred orientation along the long axis. Framework grains consist of abundant fine to medium sand-sized grains of monocrystalline quartz, with minor amounts of polycrystalline quartz, feldspars, bivalve shell fragments, various lithic fragments, chert, and trace amounts of muscovite mica and heavy minerals. Detrital clays consist of illite and intermixed illite/smectite occurring as pore-filling, grain-coating/pore-lining, and pore-throat bridging clays. Quartz overgrowths are the dominant cement type and noted on host quartz grains where grain-coating clays are absent or poorly developed. Rare grain/allochem-replacive phases include pyrite framboids and non-ferroan calcite. Visible pore types include common intergranular pores/micropores and secondary intragranular pores/micropores associated with partially leached grains. Reservoir quality is expected to be good with minimal interconnectivity restrictions expected from pore-bridging detrital clays and minor grain contacts (point and long contacts).