

THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 9670 FEET
SAMPLE NUMBER: 1D

PLATE 1

Lithologies:

Major: Dolomitic, very fine- to fine-grained sandstone; slightly argillaceous, silty/sandy dolostone

Minor: Limestone; sandy mudstone

Sedimentary Fabric: Massive to bioturbated; limestone chips exhibit grainstone to packstone textures

Grain Size Range: <0.03mm to 0.20mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; chert; and trace potassium feldspar

Accessory: Heavy minerals (zircon and tourmaline); partially pyritized organic fragments; limestone specific allochems: micritic peloids, micritic intraclasts, echinoderm fragments; and possible benthic foraminifera

Matrix Composition: Predominantly cryptocrystalline to finely crystalline dolomite intermixed with minor detrital clay in sandstone and dolostone; micrite (lime mud) dominates the matrix of packstone textured limestone chips; rare sandy mudstone chips are dominated by detrital clay

Authigenic Clay: None observed

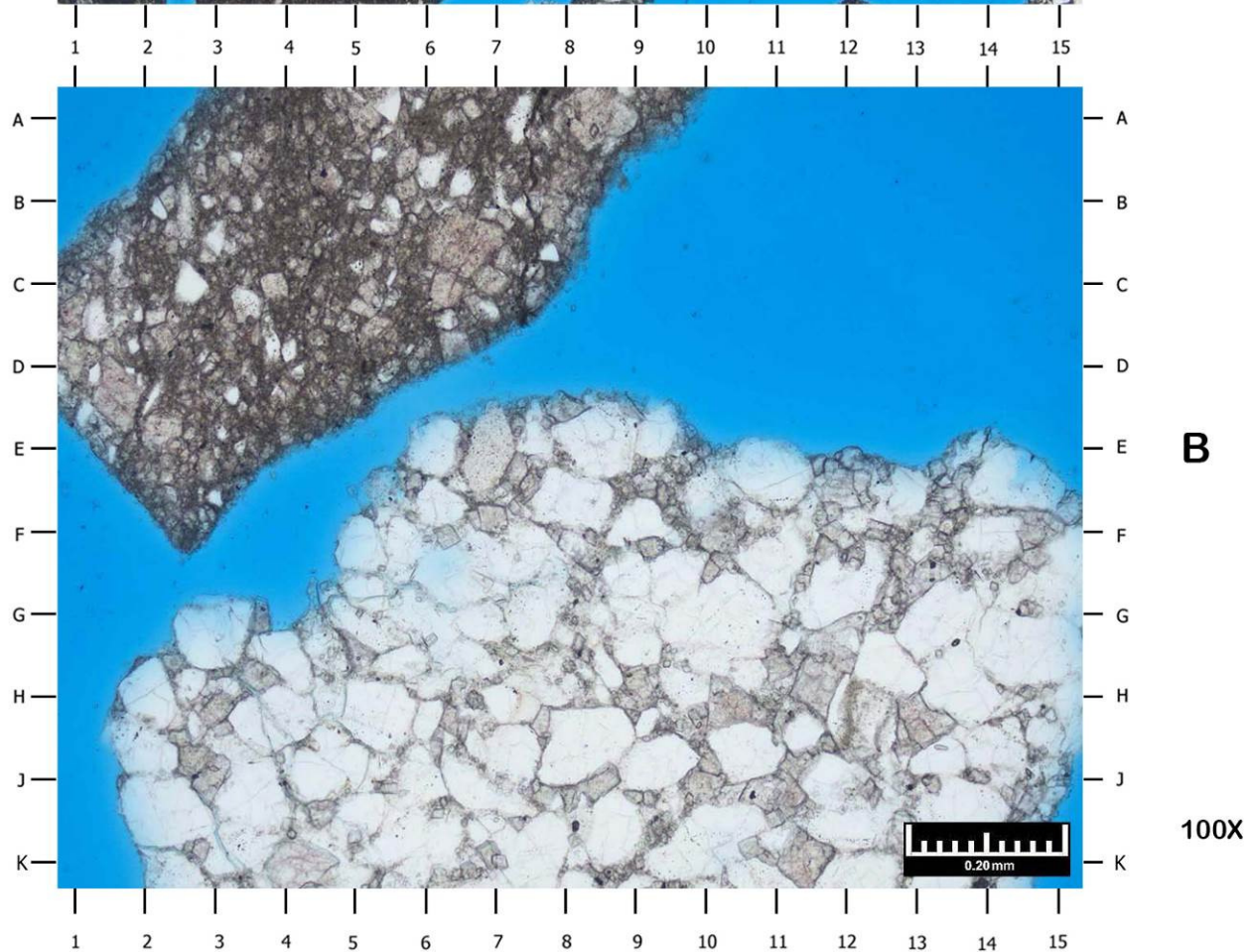
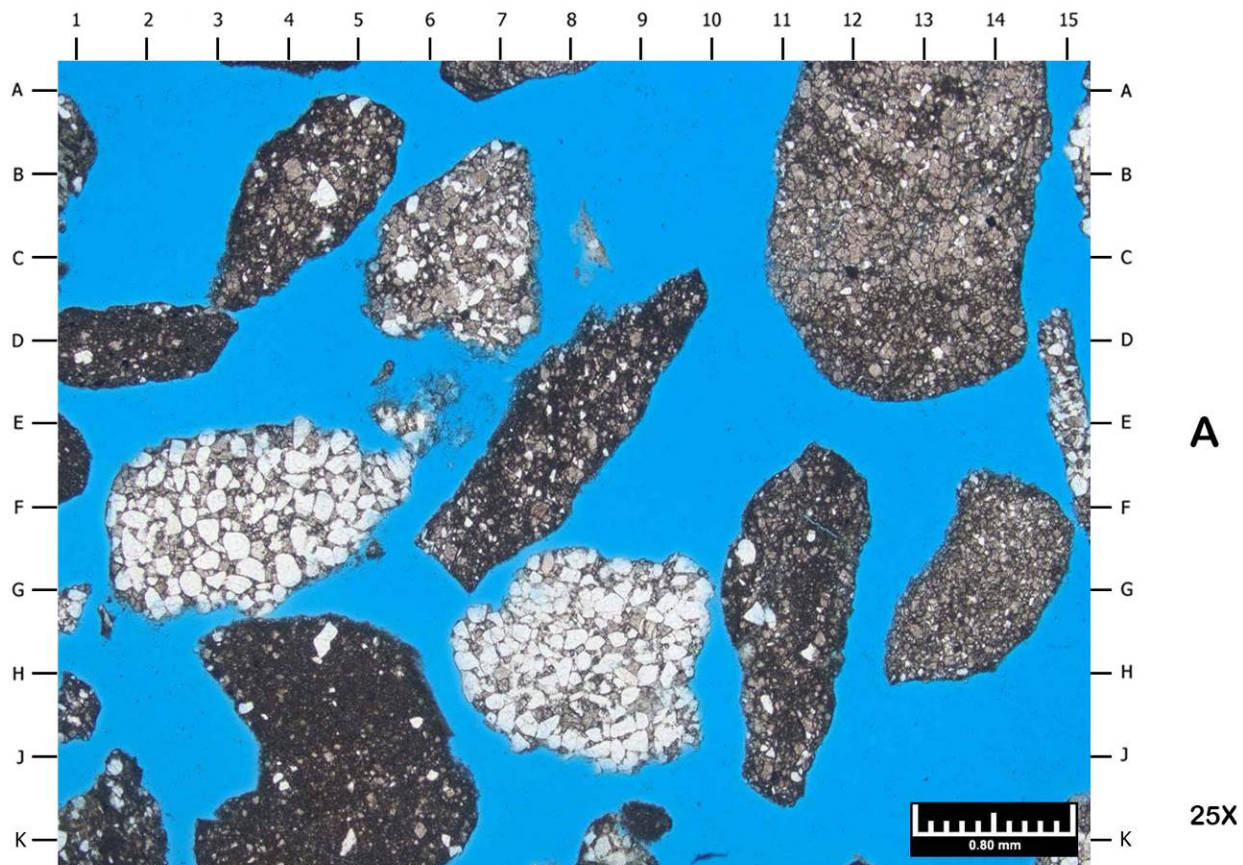
Authigenic Minerals: Common to abundant intergranular dolomite cement (within sandstone chips); dolomicrite precipitating within the matrix and/or replacing precursor matrix material and fine to medium crystalline dolomite precipitating within the matrix and/or replacing unstable grains (sandstone and dolostone chips); quartz overgrowths are minor to locally common within sandstone chips; minor pyrite replacement of unstable particles; limestone specific cements: intergranular sparry calcite cement within lime grainstone chips, patchy sparry calcite replacement/recrystallization of allochems and matrix within limestones, and minor dolomite replacement within some limestone chips

Porosity Types: No naturally occurring porosity is visible using standard petrographic techniques

Magnification: A: 25X B: 100X

A) This low magnification view illustrates the two dominant cuttings lithologies: dolomitic, very fine- to fine-grained sandstone (F3.5, H8) and slightly argillaceous, silty/sandy dolostone (D2, B4.5, C6, AD13, FG14, G11, J5, E8). Although this area of the thin section may give the impression that the dolostone chips are dominant and the sandstone chips are only minor, other areas of the thin section display views where the two lithologies appear more equal or even proportionately weighted toward the sandstone chips.

B) This photomicrograph provides a high magnification view of the area centered near G8 in Photo A. The dolomitic, very fine- to fine-grained sandstone chip illustrated within this view (bottom-center) is dominated by detrital grains of monocrystalline quartz (JK2.5, G10, HJ8.3); a rare chert grain occurs at EF7. Intergranular areas are occluded by a combination of dolomite cement (FG13, K11.4, J3) and quartz overgrowths (G9.5, G5.5). The dolostone contains cryptocrystalline to medium crystalline (BC6.5) dolomite.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 9690 FEET
SAMPLE NUMBER: 2D

PLATE 2

Lithologies:

Major: Dolomitic, very fine- to fine-grained sandstone

Minor: Slightly argillaceous, silty/sandy dolostone; limestone; silty/sandy, dolomitic mudstone

Sedimentary Fabric: Massive to bioturbated (sandstone and dolostone chips); rare vague laminations; limestone chips exhibit mudstone, wackestone, and grainstone textures

Grain Size Range: <0.03mm to 0.30mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; chert; potassium feldspar; and polycrystalline quartz

Accessory: Organic fragments; zircon; limestone specific allochems: micritic peloids, ooids, echinoderm fragments, and micritic intraclasts

Matrix Composition: Predominantly cryptocrystalline to finely crystalline dolomite intermixed with minor detrital clay; rare to minor mudstone chips appear to contain a higher proportion of detrital clay, but are also mixed with dolomicrite; micrite (lime mud) dominates the matrix of lime mudstone to wackestone textured limestone chips

Authigenic Clay: None observed

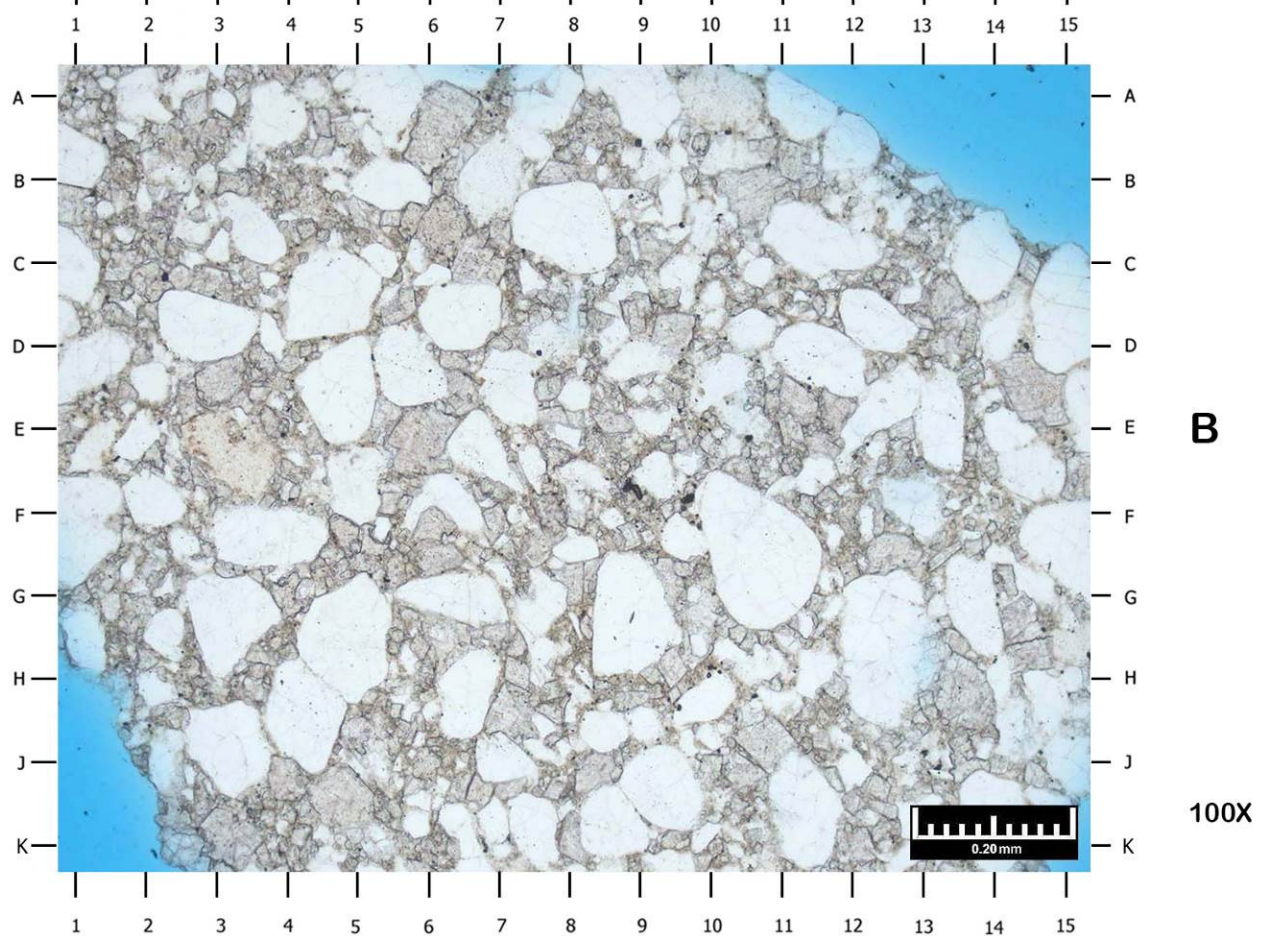
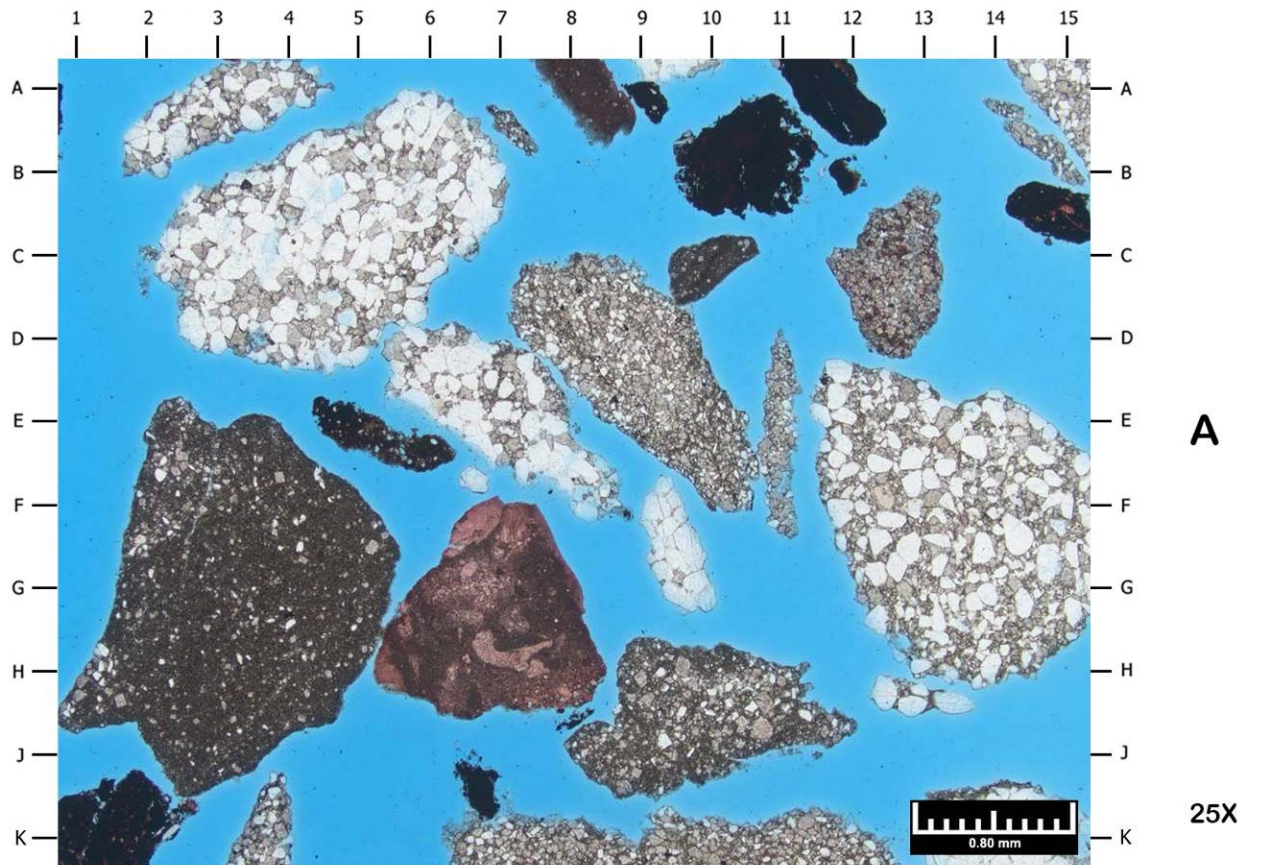
Authigenic Minerals: Common to abundant intergranular dolomite cement (within sandstone chips); dolomicrite precipitating within the matrix and/or replacing precursor matrix material and fine to medium crystalline dolomite precipitating within the matrix and/or replacing unstable grains (sandstone and dolostone chips); quartz overgrowths are minor to locally common within sandstone chips; minor pyrite replacement of unstable particles; limestone specific cements: intergranular sparry calcite cement within lime grainstone chips, patchy sparry calcite replacement/recrystallization of allochems and matrix within limestones, and minor dolomite replacement within limestone chips

Porosity Types: No naturally occurring porosity is visible using standard petrographic techniques

Magnification: A: 25X B: 100X

A) Lithologies pictured within this low magnification view include dolomitic, very fine- to fine-grained sandstone (C4, AB3, E7, FG13.5); slightly argillaceous, silty/sandy dolostone (G3.5, CD12.5, DE9, HJ10, K7-12), and limestone (GH7). An echinoderm fragment occurs at H7 in the limestone chip.

B) This photomicrograph provides a high magnification view of the area centered FG13.5 in Photo A and illustrates the dominant dolomitic, very fine- to fine-grained sandstone lithology. Framework grains are predominantly monocrystalline quartz (CD15, D3, F1, GH3.3, GH5) with rare chert grains (EF3, A10). The largest quartz grain in this view has a measured grain diameter of 0.21mm (FG10.5). The matrix is comprised of cryptocrystalline to medium crystalline dolomite intermixed with minor detrital clay (AB8.3, C13, HJ11.5, A1, H3). Some of the larger, medium-sized dolomite crystals may be occurring as replacement of unstable grains (AB6, EF5.5, JK4.9).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 9715-9720 FEET
SAMPLE NUMBER: 3D

PLATE 3

Lithologies:

Major: Slightly argillaceous, sandy/silty dolostone

Minor: Dolomitic, very fine- to fine-grained sandstone; micritic limestone

Sedimentary Fabric: Massive to bioturbated; mostly euhedral to subhedral, fine to medium crystalline dolomite supported within a mixed dolomicrite and detrital clay matrix (dominant dolostone)

Grain Size Range: <0.02mm to 0.80mm; oversized chert clasts up to 1.20mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Chert; plagioclase feldspar; trace potassium feldspar; and trace mudstone fragments

Accessory: Muscovite; oversized chert clasts; and zircon

Matrix Composition: Dolomicrite intermixed with detrital clay supports larger euhedral dolomite and sand; micrite (cryptocrystalline calcite) occurs only in rare limestone lithology

Authigenic Clay: None observed

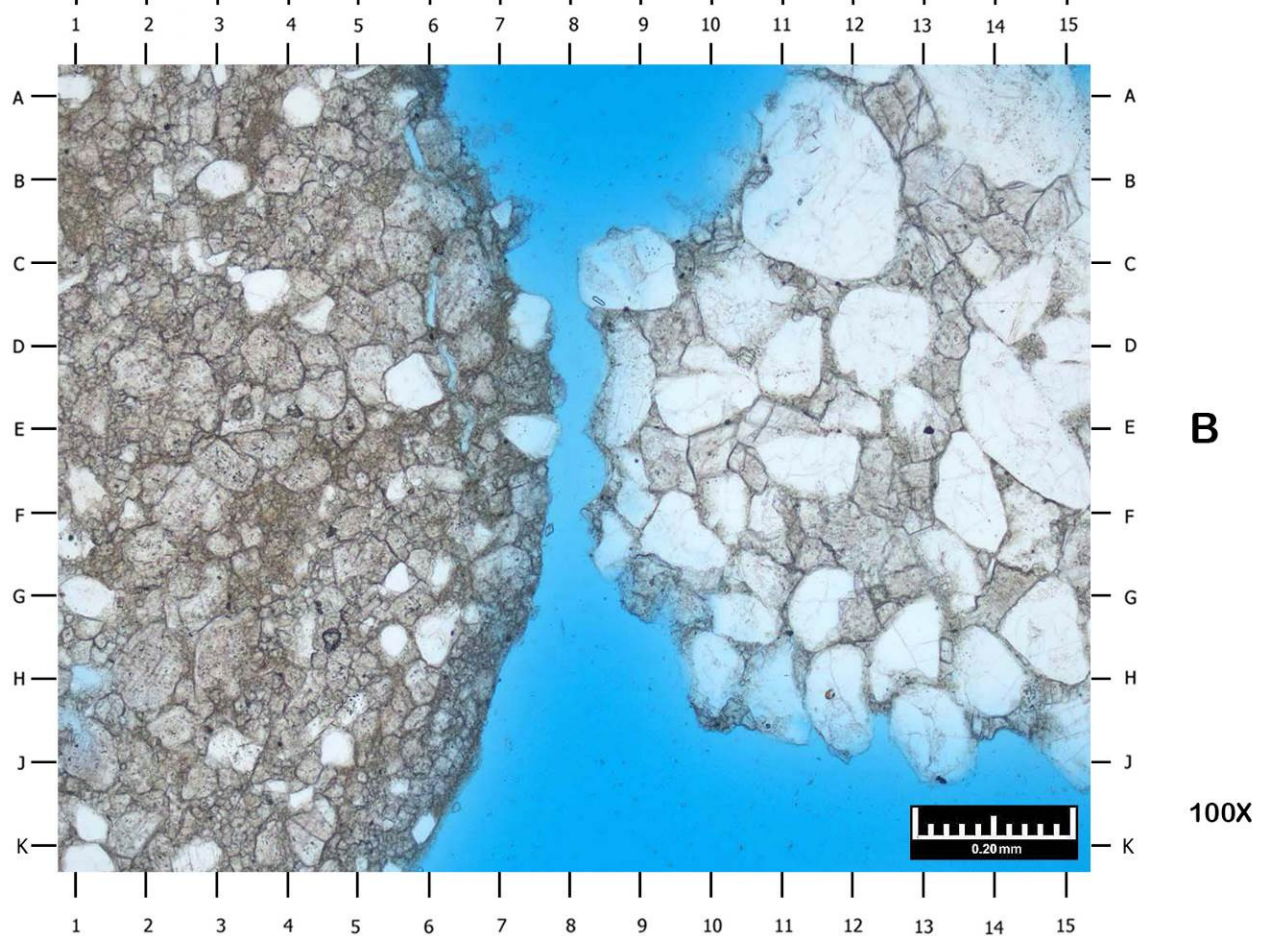
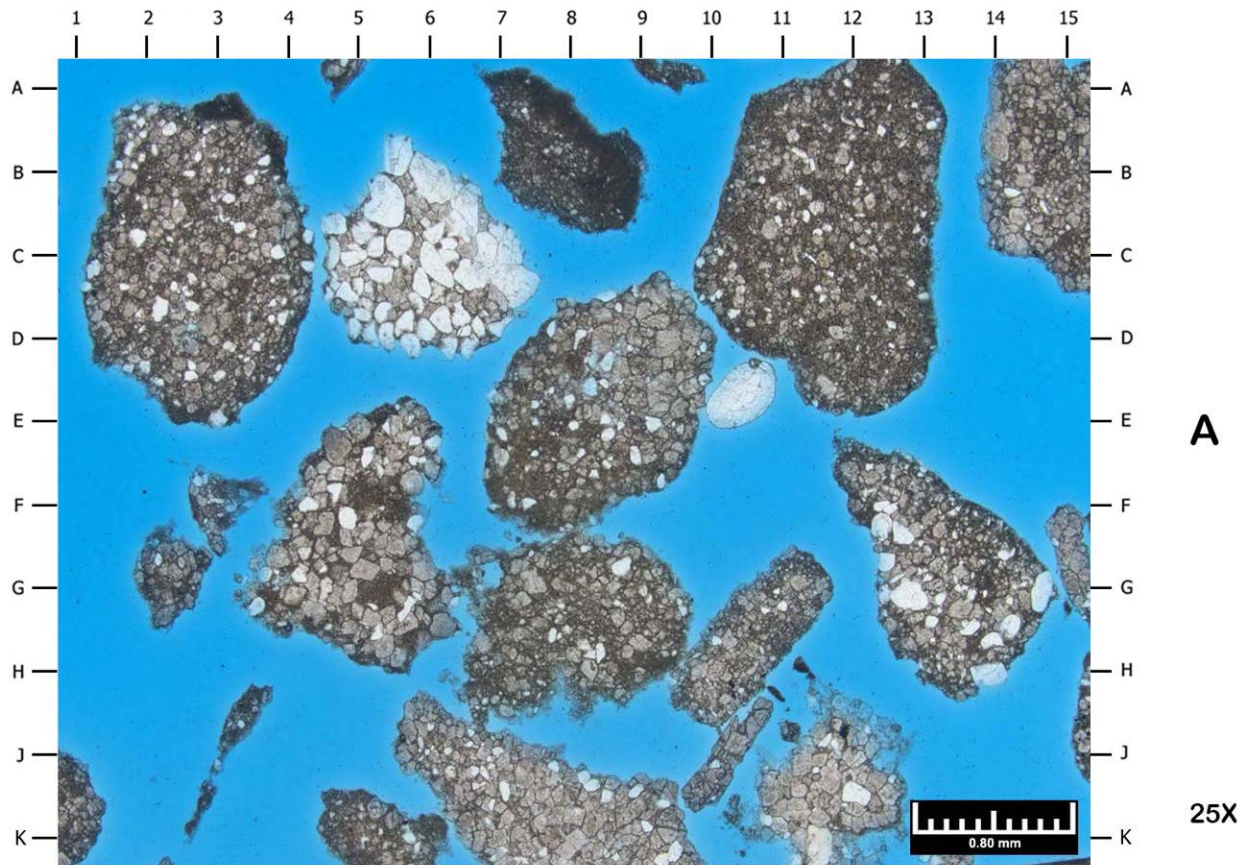
Authigenic Minerals: Dolomicrite precipitating within the matrix and/or replacing precursor matrix material and fine to medium crystalline dolomite precipitating within the matrix and/or replacing unstable grains (within dominant dolostone); minor to locally common intergranular dolomite cement (within sandstone chips); minor pyrite replacement of unstable particles; rare chert replacement of unstable grains/allochems; and rare quartz overgrowths

Porosity Types: No visible natural porosity using standard petrographic techniques; open microfractures are a common artifact of drilling in cuttings

Magnification: A: 25X B: 100X

A) This low magnification view illustrates several of the dominant slightly argillaceous, sandy/silty dolostone chips (C2.5, FG5, BC12, B15, G13.5, GH8, JK8, JK11.8). A minor dolomitic, very fine- to fine-grained sandstone chip occurs at C5.8. The blue epoxy at DE8 within a sandy dolostone chip, represents an area that has been locally thinned due to drilling damage and not natural secondary porosity.

B) This photomicrograph provides a high magnification view of the area centered near C4.4 in Photo A. Detrital grains within both the dolomitic sandstone chip (right) and slightly argillaceous, sandy/silty dolostone chip (left) are predominantly monocrystalline quartz (B11.5, E14, H14, DE9.5, DE5.5, CD3.5, J4.8) with lesser feldspar (K2.8) and chert (FG14.4) grains. Detrital grains are mostly sub-rounded to rounded in sphericity. Intergranular dolomite cement (BC13.2, D13.3, FG12, G14) and rare quartz overgrowths (DE14.5) occlude all visible intergranular areas within the sandstone. In the dolostone chip, fine to medium-sized dolomite crystals (DE2, F2.5, CD5), along with coarse silt to very fine sand grains (DE5.5, B3), are supported by a matrix of dolomicrite intermixed with detrital clay (B1, F3.8).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 10180 FEET
SAMPLE NUMBER: 4D

PLATE 4

Lithologies:

Major: Dolostone

Minor: Silty, pyritic, argillaceous chert (rare lithology); chert/megaquartz (trace lithology)

Sedimentary Fabric: Anhedral to euhedral, mostly finely crystalline to coarsely crystalline dolomite; cryptocrystalline dolomite textures are minor; evidence of burrowing in rare silty, pyritic, argillaceous chert lithology; and trace organic-rich incipient microstylolite

Crystal Size Range: <0.004mm to 1.24mm

Compaction: Moderate

Visual Sorting: N/A

Grains/Allochems:

Major: Silt-sized grains of monocrystalline quartz (within the dominant dolostone, siliciclastic grains are rare overall to locally minor)

Minor: Rare plagioclase feldspar and trace potassium feldspar (silt-sized grains)

Accessory: Rare organic fragments

Matrix Composition: Mostly finely crystalline to coarsely crystalline dolomite; detrital clay observed intermixed with chert in rare chert lithologies; rare localized chert matrix within euhedral dolostone

Authigenic Clay: None observed

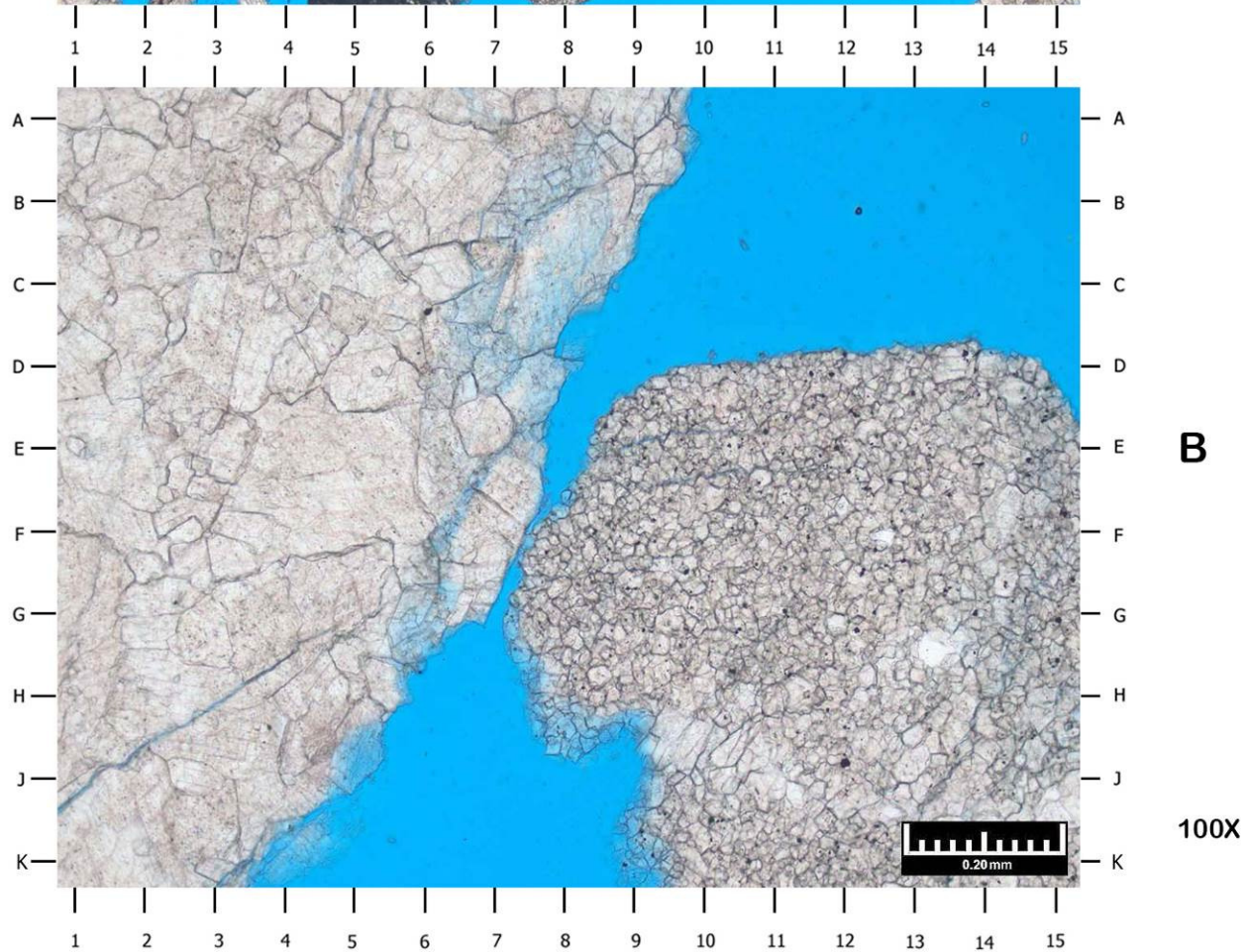
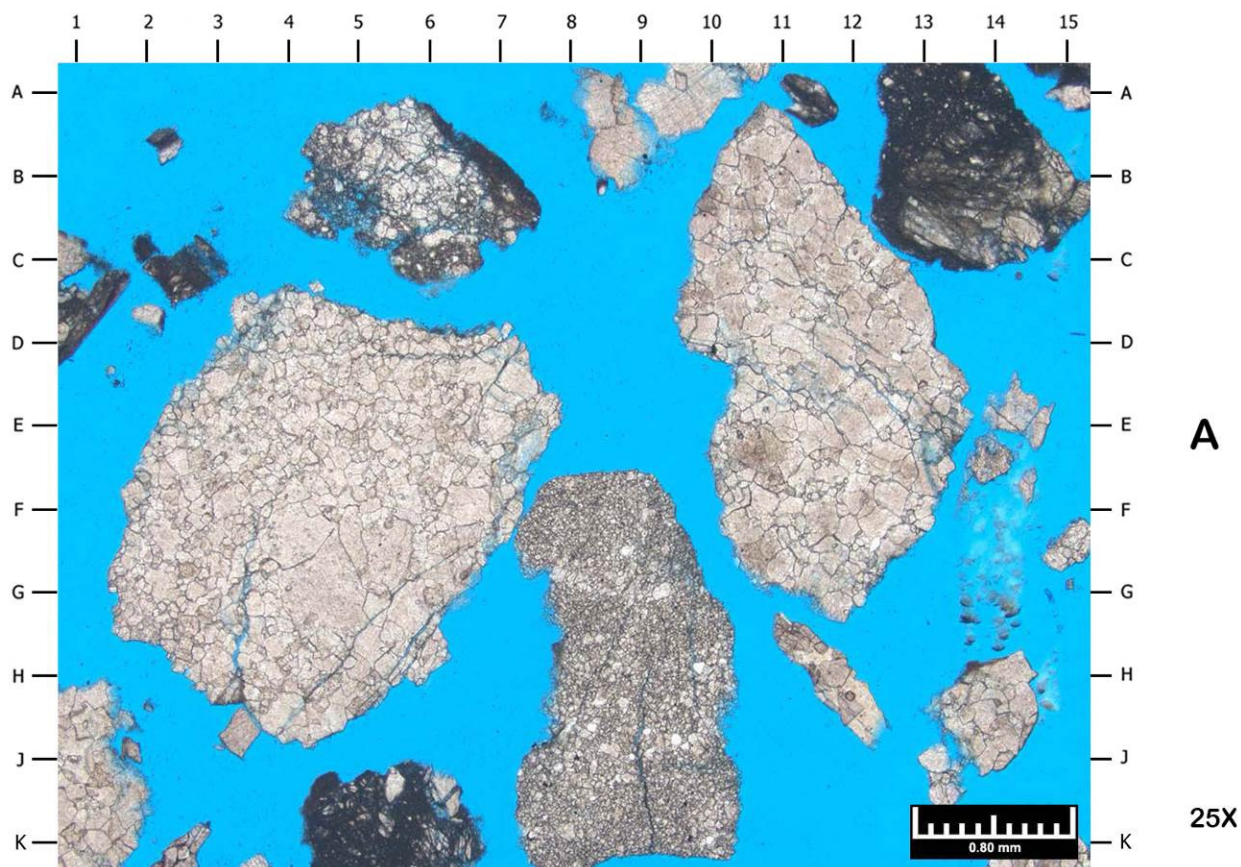
Authigenic Minerals: Very abundant dolomite replacement of precursor substrate; minor pyrite replacement of organic material and other unstable material (locally common within rare chert lithologies); rare amounts of chert occurring as intercrystalline matrix material and/or cement between euhedral dolomite and possible localized chert replacement of dolomite; and trace bitumen occluding intercrystalline spaces

Porosity Types: Trace intercrystalline micropores occurring between dolomite crystals; open microfractures represent artifacts of drilling

Magnification: A: 25X B: 100X

A) The dolostone chips at F4 and DE11.5 are similar; these chips both contain dolomite crystals that vary greatly in size from fine to coarsely crystalline. The very fine to finely crystalline dolostone chip at FK9 contains minor coarse silt grains of monocrystalline quartz (GH9.9, HJ9.6, FG8.9). The original textures of the dolostone chips at K5.5, BC6, and B13.5 have been destroyed by bit-shearing during drilling.

B) This photomicrograph provides a high magnification view of the area centered FG7 in Photo A. Note the difference in crystal size between the fine to coarsely crystalline dolostone (AK1-AB9.5) and the very fine to finely crystalline dolostone (DK9.5-15) chips. Blue epoxy-filled microfractures are artifacts from drilling damage (JK1-GH4.5, FG6.3, BC7.5, EF9.5). A silt-sized grain of monocrystalline quartz occurs at GH13.3.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 10189-10191 FEET
SAMPLE NUMBER: 5D

PLATE 5

Lithologies:

Major: Dolostone

Minor: Trace silty mudstone and trace dolomitic, silty chert

Sedimentary Fabric: Anhedral to euhedral, mostly finely crystalline to coarsely crystalline dolomite; cryptocrystalline dolomite textures are minor; trace organic-rich microstylolites with some pyrite replacement

Crystal Size Range: <0.004mm to 0.75mm

Compaction: Moderate

Visual Sorting: N/A

Grains/Allochems:

Major: Silt-sized grains of monocrystalline quartz (within the dominant dolostone, siliciclastic grains are rare overall to locally minor)

Minor: Rare plagioclase feldspar and trace potassium feldspar (silt-sized grains)

Accessory: Trace organic fragments

Matrix Composition: Mostly finely crystalline to coarsely crystalline dolomite; detrital clay matrix observed in trace mudstone only; rare localized chert matrix between euhedral dolomite

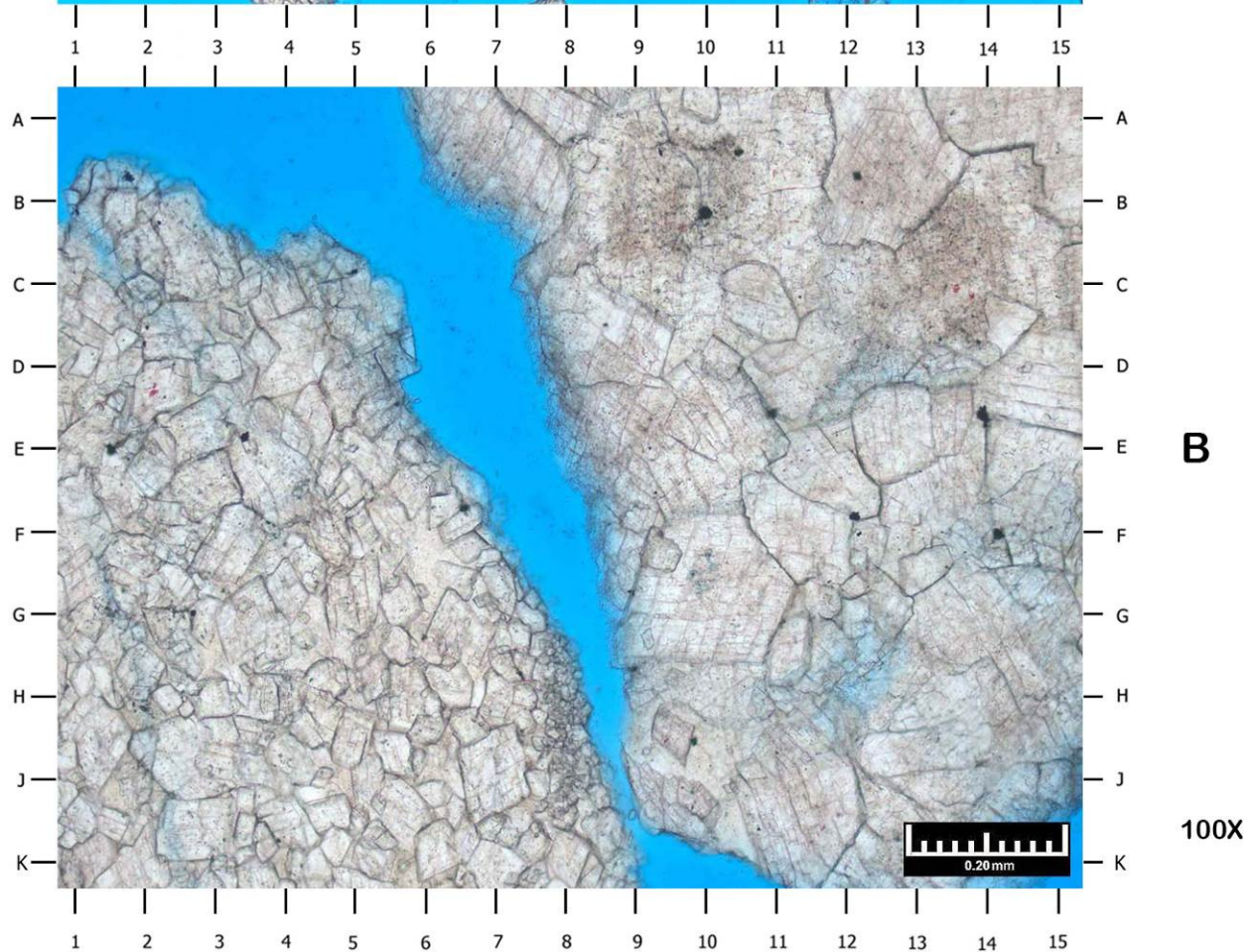
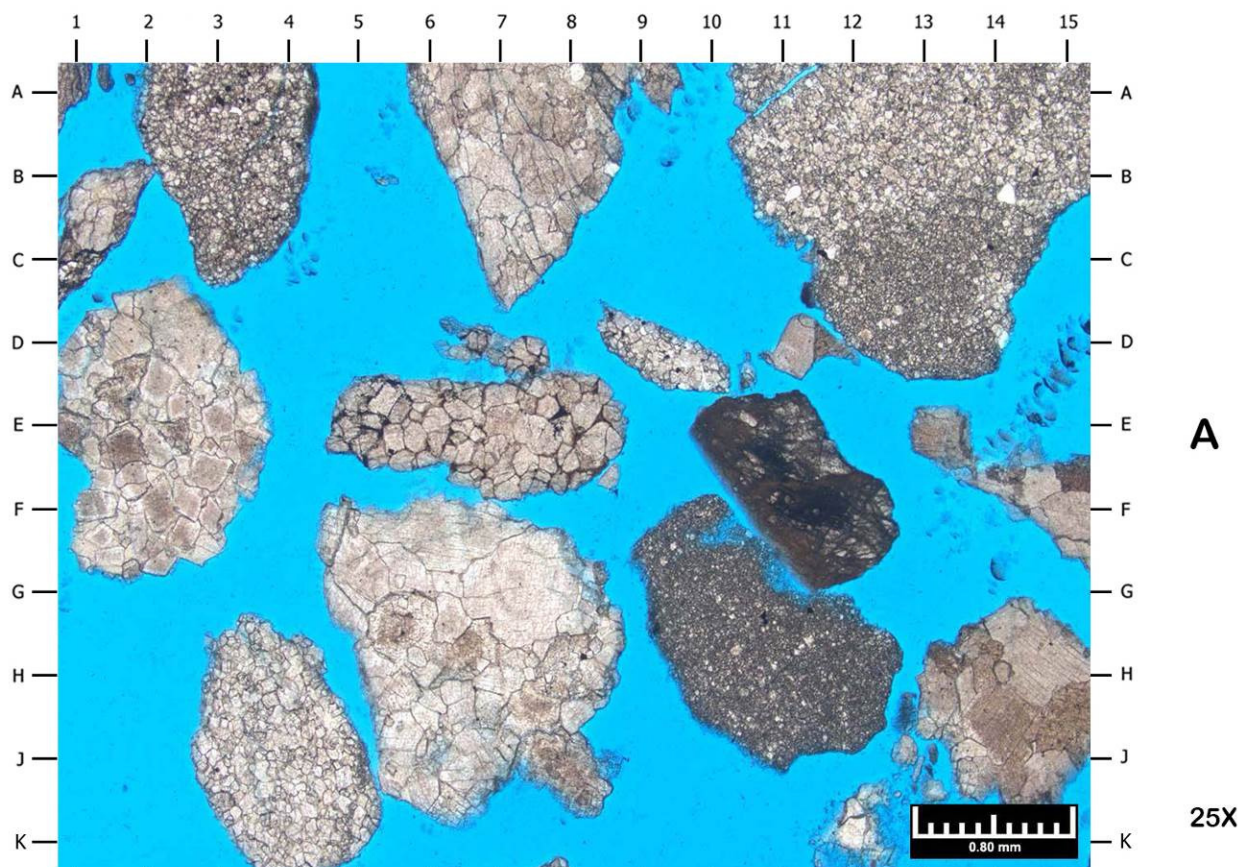
Authigenic Clay: None observed

Authigenic Minerals: Very abundant dolomite replacement of precursor substrate; rare pyrite replacement of organic material and other unstable material; rare amounts of chert occurring as intercrystalline matrix material and/or cement between euhedral dolomite and possible localized chert replacement of dolomite; and trace bitumen occluding intercrystalline spaces

Porosity Types: Trace intercrystalline micropores occurring between dolomite crystals; open microfractures represent artifacts of drilling

Magnification: A: 25X B: 100X

- A) The dolostone chips represented within this low magnification view display a wide range of crystalline textures. The dolostone chip at H11 is dominated by cryptocrystalline to very finely crystalline dolomite. Other visible dolomite crystal sizes include very fine to finely crystalline (AC3, AB11-15); finely crystalline (E5-8); fine to medium crystalline (E2, B7.5); medium crystalline (HJ14); and medium to coarsely crystalline (H6.5). Bitumen locally occludes intercrystalline spaces between dolomite crystals at E5 and E7.8.
- B) This photomicrograph provides a high magnification view of the area centered near HJ5.2 in Photo A and illustrates two dolostone chips. The bottom-left chip is dominated by fine to medium crystalline dolomite (CK1-K9) and the right chip is dominated by medium to coarsely crystalline dolomite (A6-AJ15). Both dolostone chips contain tightly interlocking, anhedral to euhedral dolomite crystals with no visible, naturally occurring, intercrystalline porosity. The zoned dolomite crystal at B8-11.7 displays multiple overgrowth stages. The blue epoxy-filled areas at H12 and BC1.5 are interpreted to be artificial porosity caused by drilling damage. Small pyrite crystals appear as scattered black specks (B10, DE14, F14, DE10.7).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 10200 FEET
SAMPLE NUMBER: 6D

PLATE 6

Lithologies:

Major: Dolostone

Minor: Argillaceous, coarse siltstone (rare lithology); limestone (trace lithology)

Sedimentary Fabric: Anhedral to euhedral, mostly finely crystalline to coarsely crystalline dolomite; cryptocrystalline dolomite textures are minor; trace organic-rich, pyritic microstylolite

Crystal Size Range: <0.004mm to 1.13mm

Compaction: Moderate

Visual Sorting: N/A

Grains/Allochems:

Major: Silt-sized grains of monocrystalline quartz (within the dominant dolostone, siliciclastic grains are rare overall to locally minor)

Minor: Rare plagioclase feldspar and trace potassium feldspar (silt-sized grains)

Accessory: Trace organic fragments

Matrix Composition: Mostly finely crystalline to coarsely crystalline dolomite; detrital clay matrix (probable mixed-layer illite/smectite) observed in rare mudstone only

Authigenic Clay: None observed

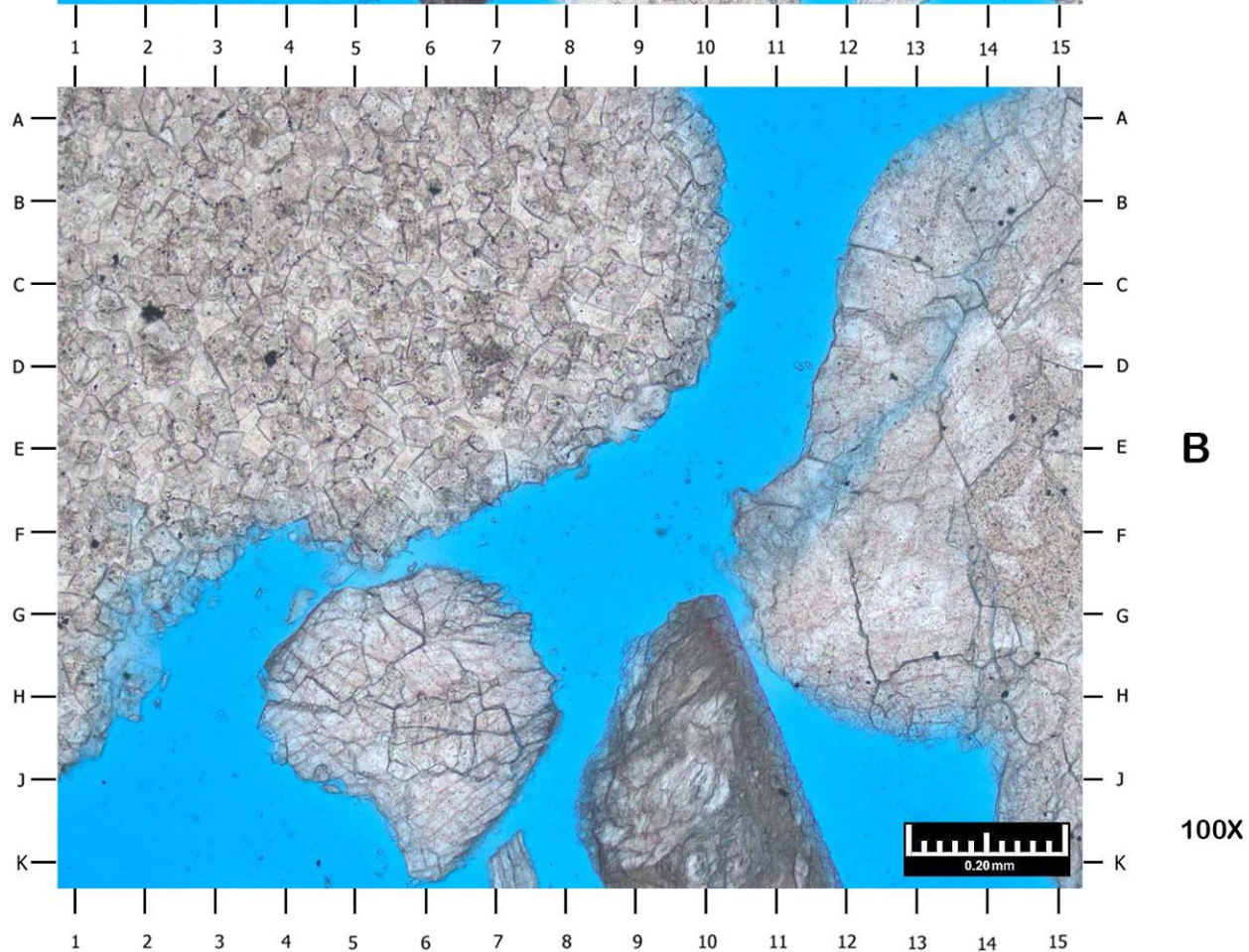
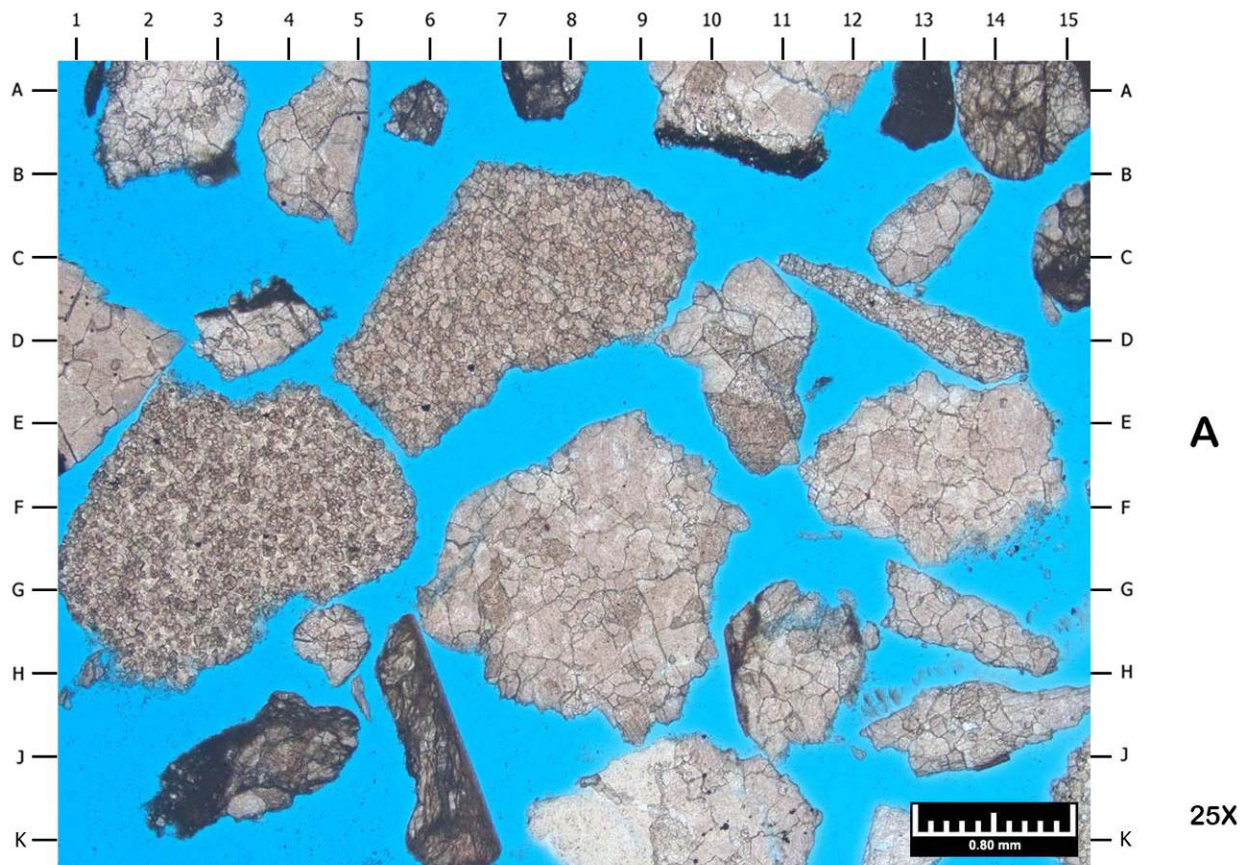
Authigenic Minerals: Very abundant dolomite replacement of precursor substrate; rare pyrite replacement of organic material and other unstable material; trace amounts of authigenic mega-quartz and chert occurring as intercrystalline cement between euhedral dolomite; and trace calcite cement/replacement

Porosity Types: No visible porosity using standard petrographic techniques

Magnification: A: 25X B: 100X

A) This low magnification view illustrates several cutting chips representing finely crystalline dolomite (F3, CD7, D13) and coarsely crystalline dolomite (DE1, B4.5, G8, DE10.5, EF13, K10, H11). Rare to minor silt-sized monocrystalline quartz grains are visible at HJ13.7 and AB10.3.

B) This photomicrograph provides a high magnification view of the area centered near G5.5 in Photo A. The dolostone in the top-left is dominated by finely crystalline dolomite (AF1-AD10) and the dolostone chip on the right is comprised predominantly of coarsely crystalline dolomite (BH12-15). No intercrystalline porosity is visible between the tightly interlocking, euhedral to anhedral dolomite crystals of these dolostone chips. Small, scattered, framboidal pyrite crystals appear as black specks (D3.7, DE14.4, BC14.3).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 10765-10770 FEET
SAMPLE NUMBER: 7D

PLATE 7

Lithologies:

Major: Dolostone; fine- to medium-grained sandstone
Minor: Dolomitic, fine- to medium-grained sandstone; fine to coarse sand grains (isolated, loose, unconsolidated grains); silty mudstone

Sedimentary Fabric: Massive sandstone chips; mostly anhedral to euhedral, fine- to medium-crystalline dolomite; coarsely-crystalline dolomite is rare

Grain Size Range: 0.03mm to 0.80mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Trace muscovite

Matrix Composition: Predominantly fine- to medium-crystalline dolomite; coarsely-crystalline dolomite is rare; minor detrital clay occurring between dolomite crystals in some dolostone chips; detrital clay is abundant only in rare mudstone chips

Authigenic Clay: None observed

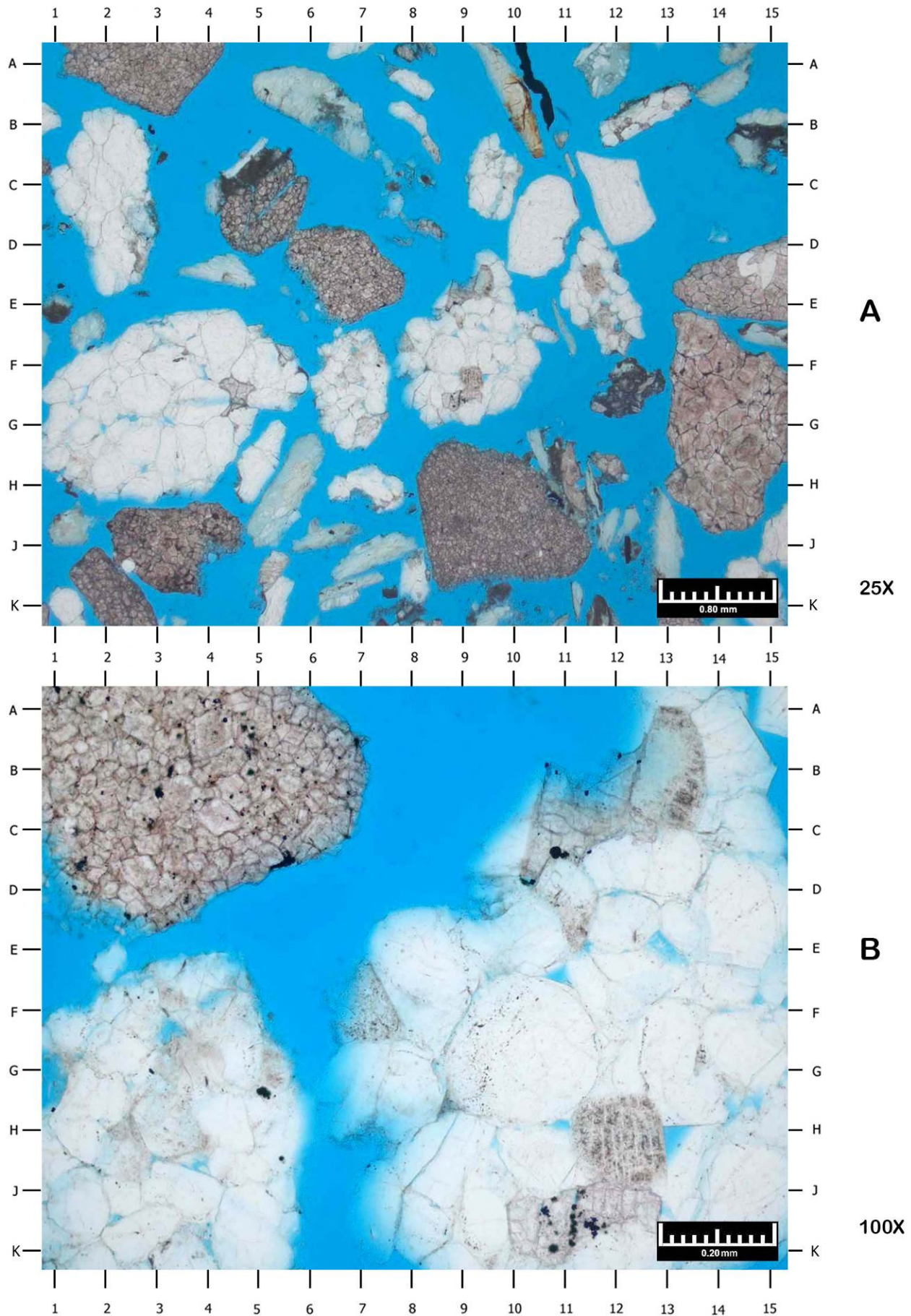
Authigenic Minerals: Very abundant dolomite replacement of precursor matrix in dominant dolostone; rare to locally common intergranular dolomite cement in sandstone; minor dolomite replacement of unstable grains/allocherts; minor to locally common quartz overgrowths and lesser feldspar overgrowths in sandstone chips; rare pyrite replacement of unstable material; and trace localized intercrystalline chert cement occurring between euhedral dolomite

Porosity Types: Minor to common primary intergranular pores and minor secondary intragranular to grain-moldic pores within fine- to medium-grained sandstone chips; no visible porosity within major dolostone chips or minor dolomitic sandstone chips

Magnification: A: 25X B: 100X

A) Lithologies visible in this low magnification view include dolostone (A2.5, CD5, DE6.5, G14, DE14, HJ9.5, J3, K2); fine- to medium-grained sandstone (C2, G2.5, FG6.5, F9, E11.5); and loose/unconsolidated, fine to coarse (CD10.5) sand grains. Damaged chips that were crushed and/or bit-sheared during drilling exhibit a light blue color (AB5.5, A12, AB14, HJ5.4, JK7, J13).

B) This photomicrograph provides a high magnification view of the area centered near E8 in Photo A. A euhedral to subhedral, finely crystalline dolostone chip occurs at BC1-7. The two fine- to medium-grained sandstone chips (FK3, F7-15) visible in this view contain framework grains of monocrystalline quartz (EF8, FG10, JK5) with lesser feldspar grains (H12, G3.8, G5.5, HJ2.5). This sandstone lithology contains minor to common primary intergranular pores (FG3, HJ3.9, JK2.1, JK4, E13, EF10.9, H13, H11). Pore throats are restricted by quartz overgrowths (FG8, F13.3, DE12.8) and feldspar overgrowths (H2.4, HJ4). Minor dolomite cement also occludes intergranular areas (JK10-12.9, C11).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 10780 FEET
SAMPLE NUMBER: 8D

PLATE 8

Lithologies:

Major: Dolostone; fine- to medium-grained sandstone
Minor: Medium to coarse sand grains (isolated, loose, unconsolidated grains); dolomitic, medium-grained sandstone; silty/sandy (tuffaceous?) mudstone

Sedimentary Fabric: Massive sandstone chips; mostly anhedral to euhedral, fine- to medium-crystalline dolomite; coarsely-crystalline dolomite is rare

Grain Size Range: <0.03mm to 0.92mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and trace polycrystalline quartz

Accessory: Rare partially pyritized organic fragments and trace zircon

Matrix Composition: Predominantly fine- to medium-crystalline dolomite; coarsely-crystalline dolomite is rare; rare mudstone chips are likely dominated by mixed-layer illite/smectite

Authigenic Clay: None observed

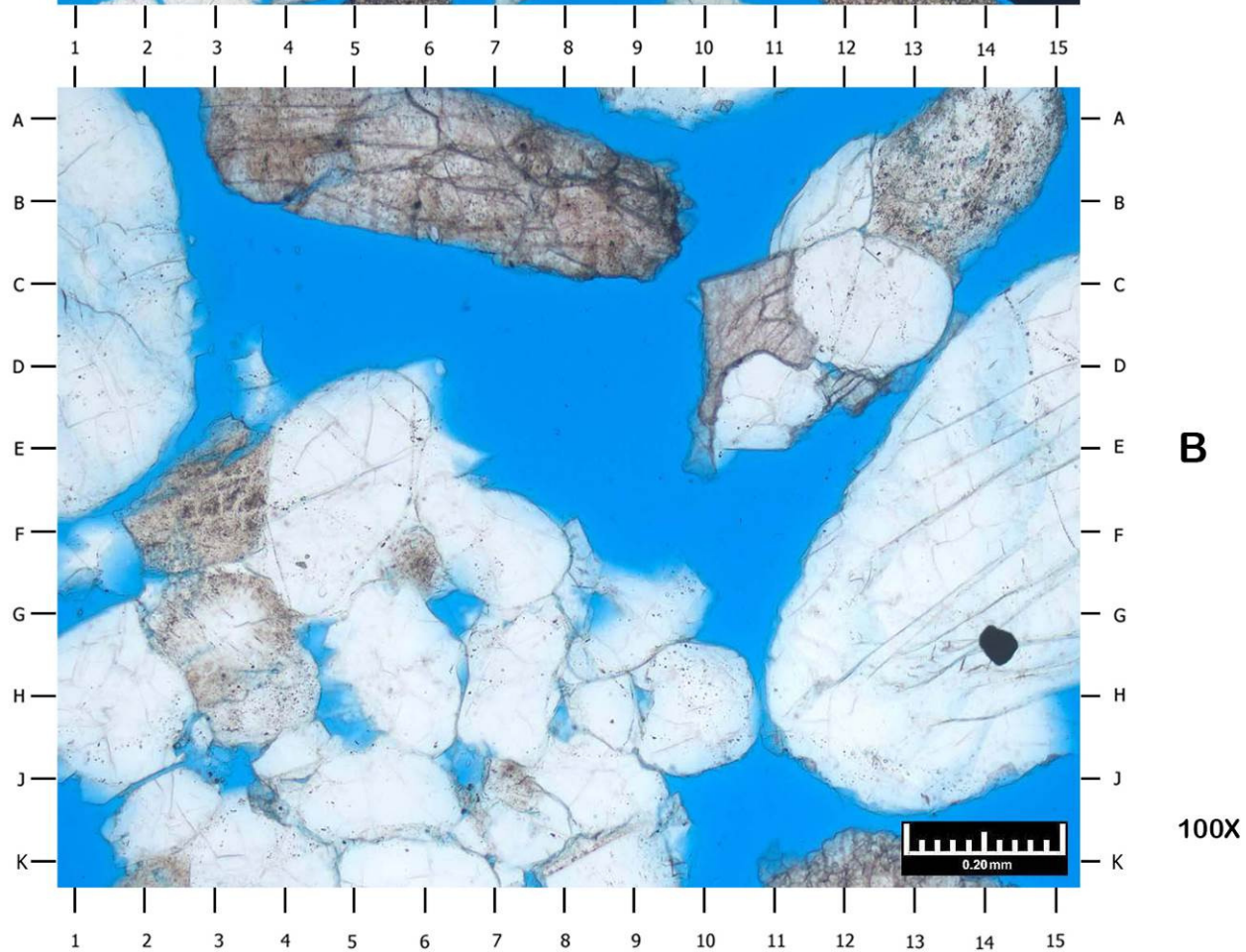
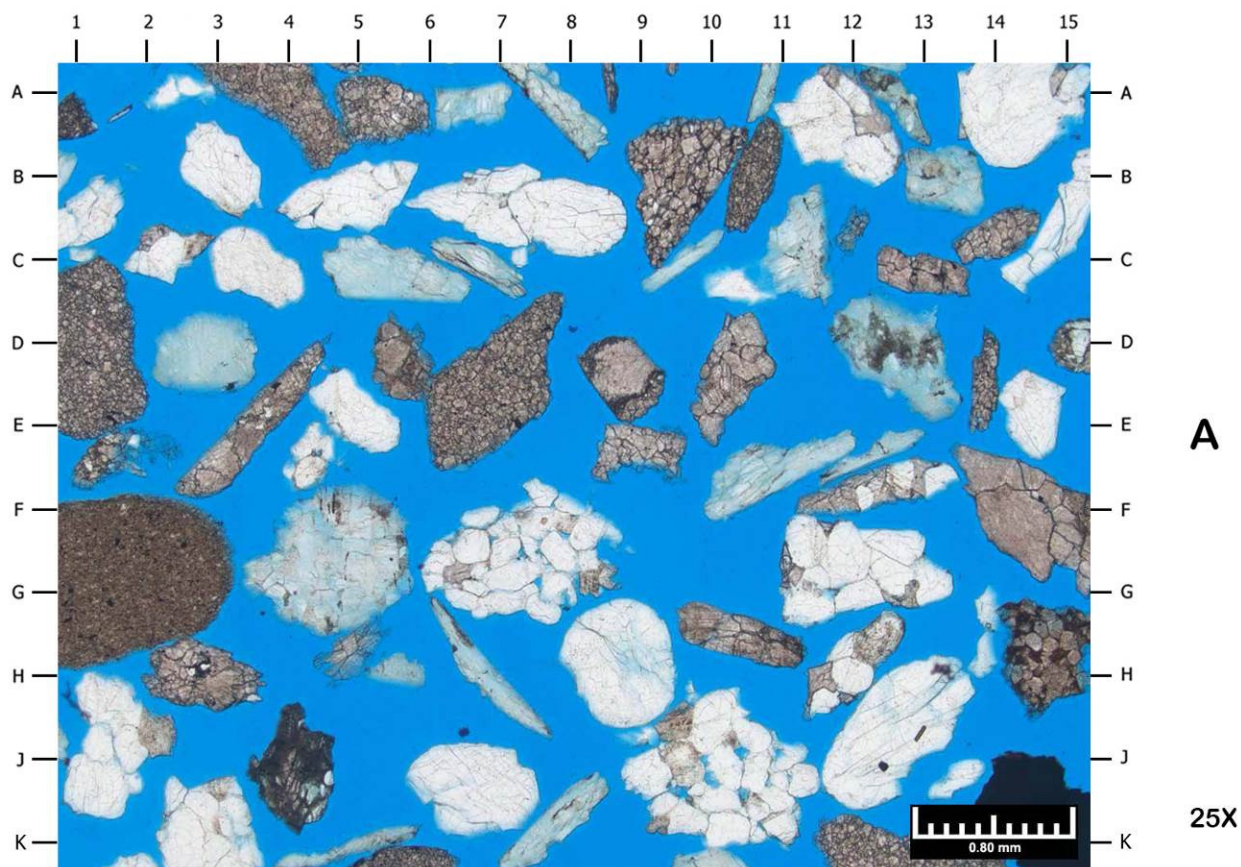
Authigenic Minerals: Very abundant dolomite replacement of precursor matrix in dominant dolostone; rare to locally common intergranular dolomite cement in sandstone; minor dolomite replacement of unstable grains/allocherts; minor to locally common quartz overgrowths and lesser feldspar overgrowths in sandstone chips; rare pyrite replacement of unstable material; and trace localized intercrystalline chert cement occurring between euhedral dolomite

Porosity Types: Dominant sandstone contains minor to common primary intergranular pores and minor secondary intragranular to grain-moldic pores; dominant dolostone contains only trace intercrystalline pores; microporosity within crushed/bit-sheared chips is drilling induced artifact

Magnification: A: 25X B: 100X

A) Lithologies represented within this low magnification view include dolostone (D1, A3.5, DE7, B9.5, K12); fine- to medium-grained sandstone (FG7, J10, FG12, J1.5, K3, AB12); and loose/unconsolidated, medium to coarse sand grains (C3.5, B3, BC5, A14, J12.5, H9, JK7). Several crushed/bit-sheared chips are visible in this view and exhibit a light blue color (DE3, G4.5, D12.5, B13, C5.5). A silty mudstone chip at G1-3 exhibits characteristics of possibly being derived from an altered volcanic ash (tuffaceous?).

B) This photomicrograph provides a high magnification view of the area centered near HJ11 in Photo A. Monocrystalline quartz (C1, F14, EF5, C12, H10) and lesser feldspar grains (F3, GH3.5, FG6, K2) are the dominate grain types. In the sandstone chip in the bottom-left, most pore throats are restricted by quartz overgrowths (FG5, G7, JK2.8, GH8.2) and lesser feldspar overgrowths (FG3), while most primary intergranular pores are preserved (J3, HJ5, G6.6, J6.7, HJ8, H9.2, G8.7). Minor intergranular dolomite cement occurs at CD11.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 10790 FEET
SAMPLE NUMBER: 9D

PLATE 9

Lithologies:

Major: Dolostone

Minor: Fine- to medium-grained sandstone; dolomitic, coarse silt to very fine-grained sandstone; slightly dolomitic very fine-grained sandstone; dolomitic medium-grained sandstone; medium to coarse sand grains (isolated, loose, unconsolidated grains); pyritized dolostone; carbonaceous, slightly pyritic, silty dolostone;

Sedimentary Fabric: Mostly anhedral to euhedral, fine- to medium-crystalline dolomite; euhedral coarsely-crystalline dolomite is rare; massive to bioturbated sandstone chips; trace organic-rich incipient microstylolites and trace organic-/clay-rich laminations

Grain Size Range: <0.03mm to 0.77mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Organic fragments

Matrix Composition: Predominantly fine- to medium-crystalline dolomite; euhedral coarsely-crystalline dolomite is rare; some sandstone chips contains interstitial dolomicrite (possibly intermixed with lesser detrital clay); trace laminations and incipient microstylolites contain detrital clay and organic material

Authigenic Clay: None observed

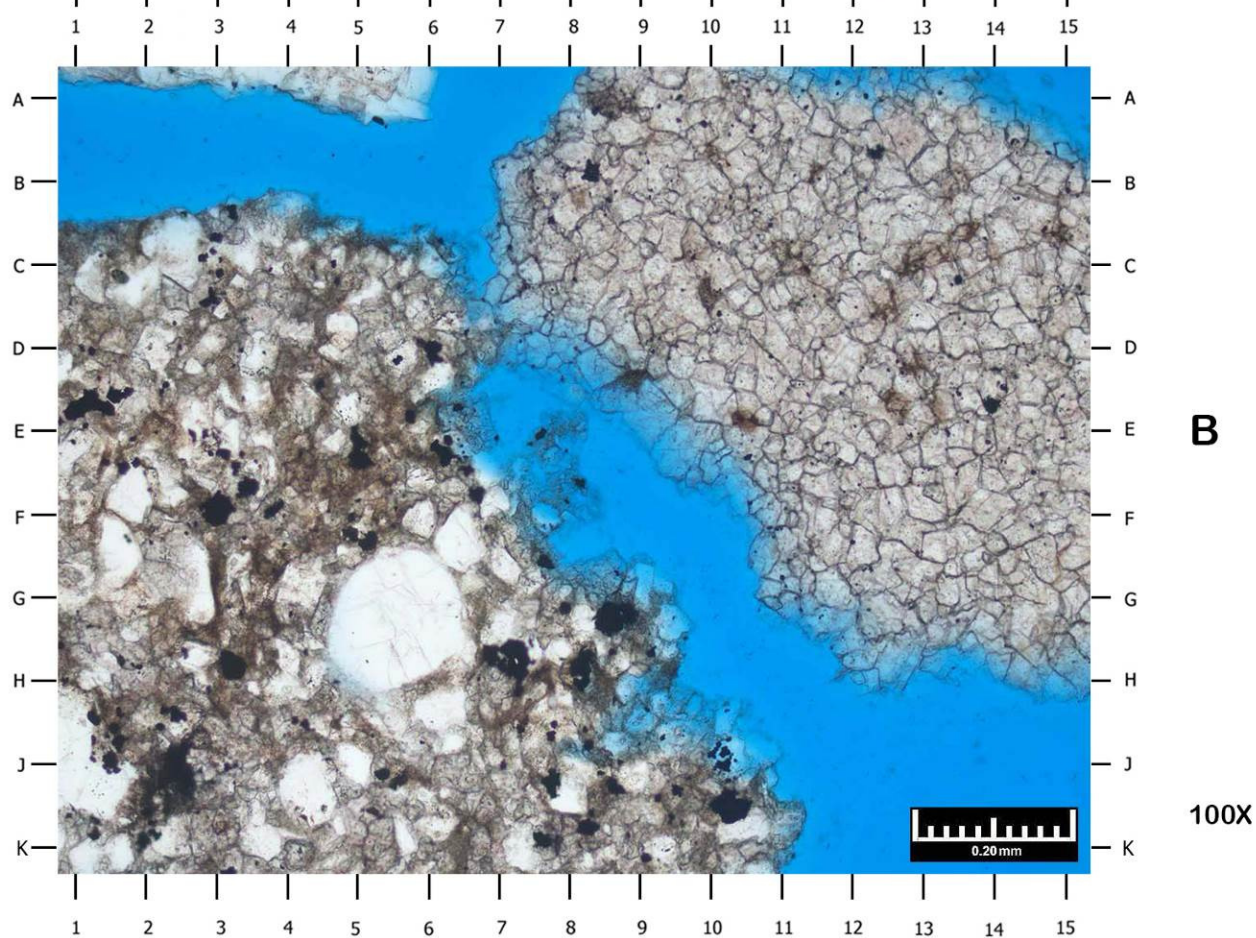
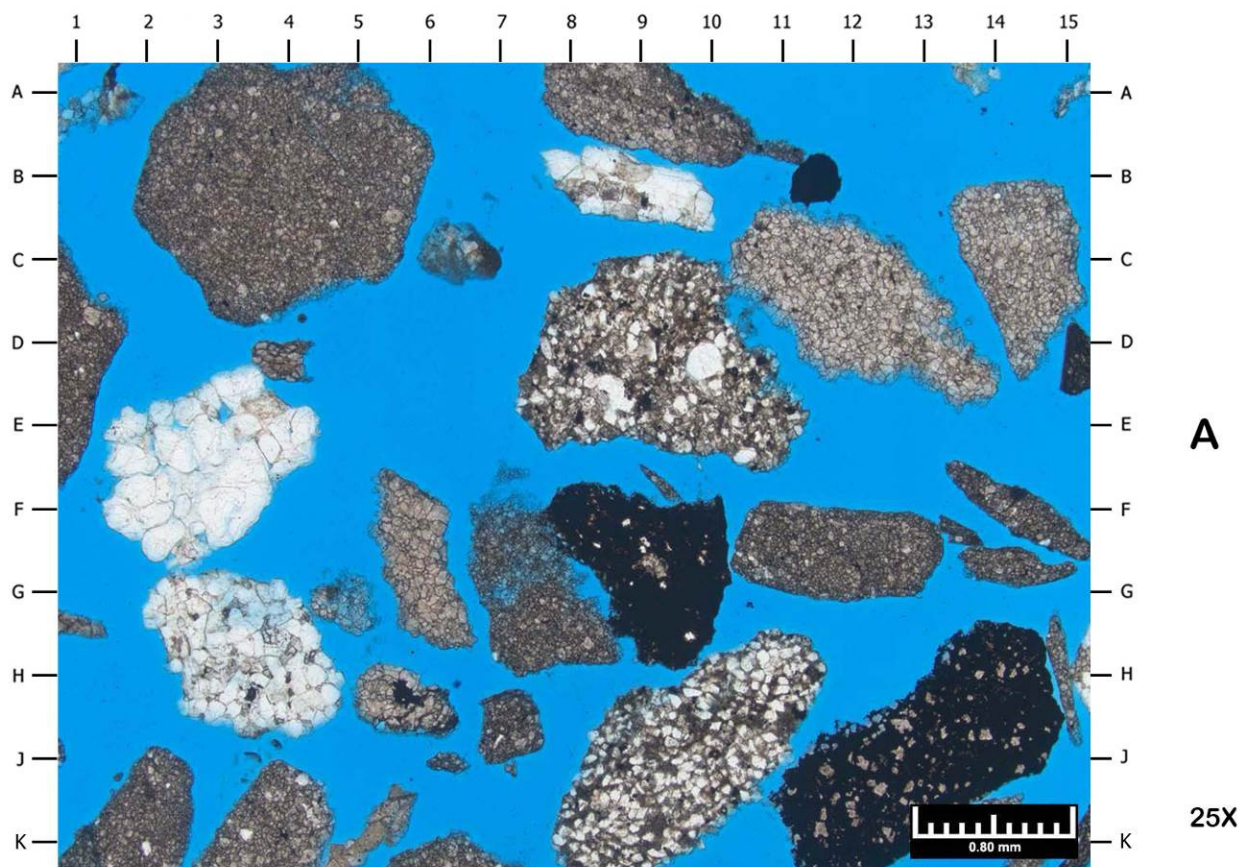
Authigenic Minerals: Very abundant dolomite replacement of precursor matrix in dominant dolostone; minor to locally common intergranular dolomite cement in sandstone; minor dolomite replacement of unstable particles; minor to locally common quartz and feldspar overgrowths in sandstone; minor to locally abundant pyrite replacement; localized chert cement occludes intercrystalline spaces between euhedral dolomite crystals (within rare dolostone chips); and trace bitumen occluding intercrystalline areas

Porosity Types: Minor primary intergranular pores with rare secondary dissolution pores within fine- to medium-grained sandstone chips only; and rare intercrystalline pores (dolostone)

Magnification: A: 25X B: 100X

A) Lithologies pictured within this low magnification view include dolostone (B4, A8.5, C14.5, CD12, FG12, K1.5, K3.5, FG5.5); fine-grained sandstone (EF2.5); dolomitic, coarse silt to very fine-grained sandstone (D9, J9.5); slightly dolomitic very fine-grained sandstone (H3.5); pyritized dolostone (J13); and carbonaceous, slightly pyritic, silty dolostone (G9). The sandstone chip at EF1.5-4 contains locally minor amounts of primary intergranular porosity (E3.2, FG2.9, E2.6).

B) This photomicrograph provides a high magnification view of the area centered near D10.5 in Photo A. A finely crystalline dolomite chip occurs in the top-right and a dolomitic, coarse silt to very fine-grained sandstone chip is pictured in the bottom-left. The siltstone to sandstone chip contains interstitial dolomicrite (EF4.5, D1.5, CD4) occluding the intergranular areas between monocrystalline quartz (GH5.5, FG1.7) and feldspar (G4.3) grains. Minor pyrite replaces unstable particles (black; F3, JK10.2).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 12290 FEET
SAMPLE NUMBER: 10D

PLATE 10

Lithologies:

Major: Dolostone (variably sandy); dolomitic sandstone

Minor: Sandy limestone; silty mudstone; micritic limestone

Sedimentary Fabric: Massive to bioturbated; microcrystalline to medium-crystalline dolomite-replaced fabric (probable precursor sandy limestone); rare organic-rich incipient microstylolites

Grain Size Range: <0.03mm to 0.65mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Dolomitized intraclasts; dolomitized peloids; organic fragments; biotite; muscovite; phosphatic fragments; trace heavy minerals (zircon and tourmaline); and a trace echinoderm fragment

Matrix Composition: Microcrystalline to medium-crystalline dolomite (dominant dolostone); dolomicrite intermixed with detrital clay (localized patches in dolostone and interstitial matrix in some sandstone); abundant detrital clay (minor mudstone only); minor to abundant micrite in minor limestone chips only

Authigenic Clay: None observed

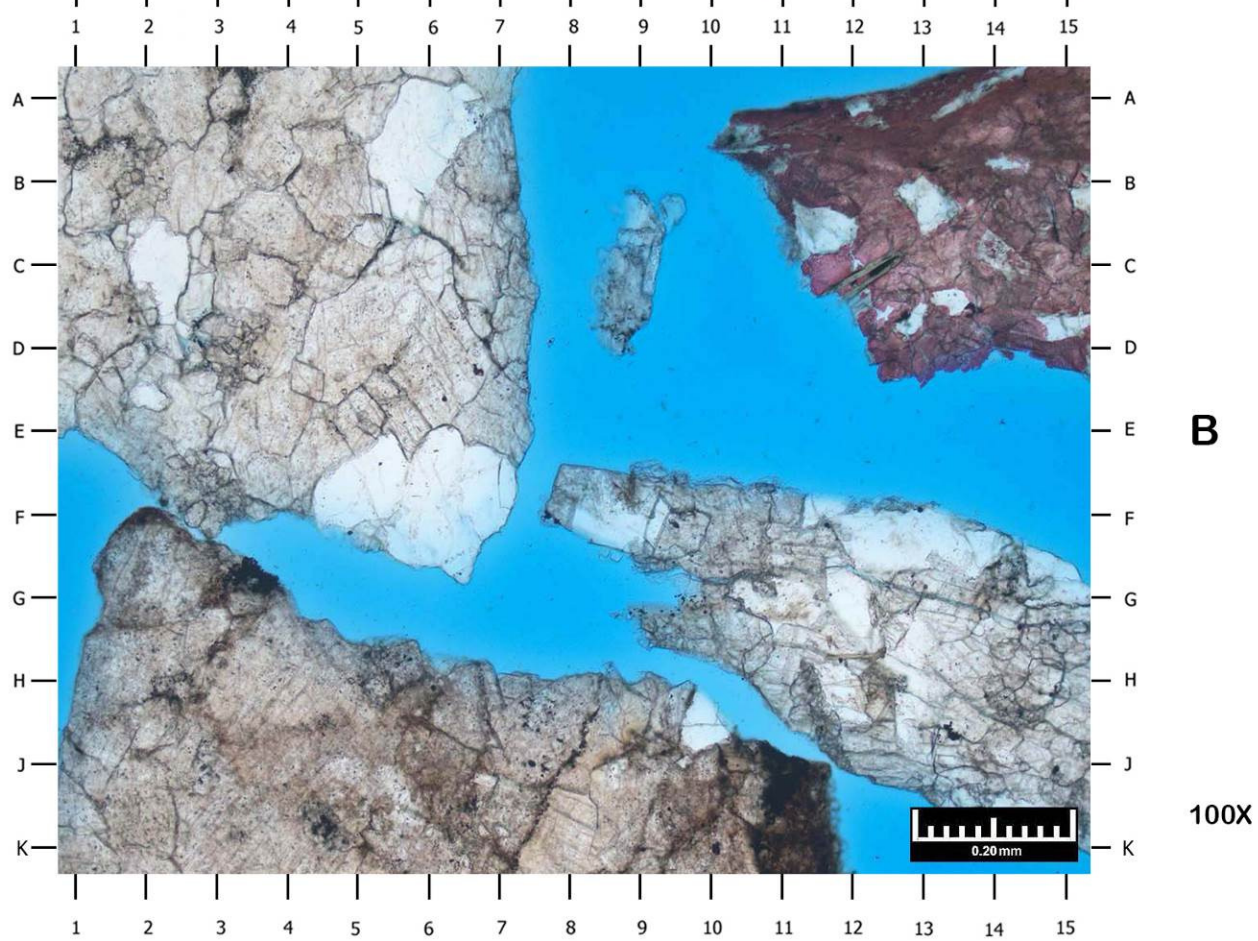
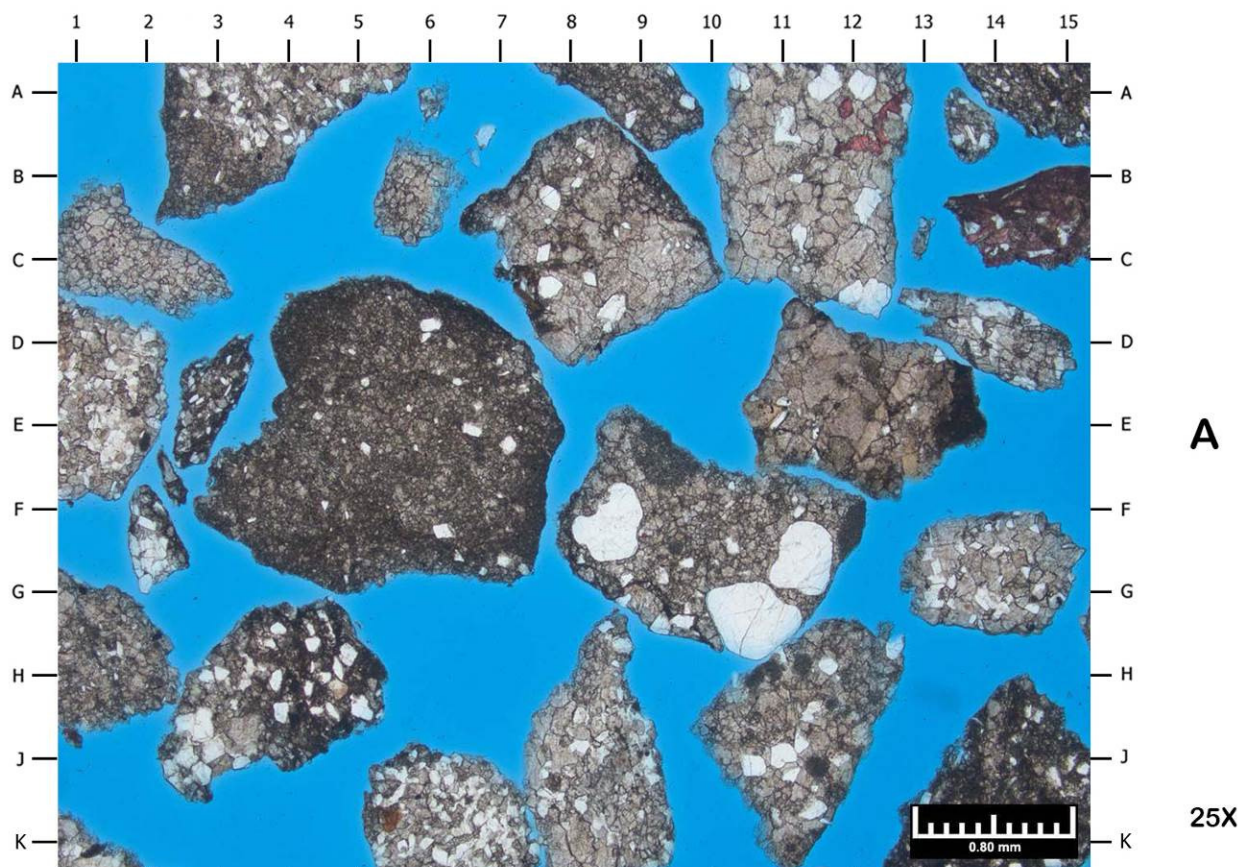
Authigenic Minerals: Very abundant dolomite completely replacing probable precursor limestone fabric; minor to locally common quartz and feldspar overgrowths; minor pyrite occurring as replacement of organic material and other unstable particles; rare calcite occurring as patchy cement or replacement of unstable grains (within dominant dolostone); calcite cement is locally common within rare to minor limestone and calcareous sandstone chips; trace siderite replacement of unstable particles; trace bitumen imbedded between other intergranular cements in minor sandstone chips

Porosity Types: Trace intercrystalline pores; bit-sheared grains and microfractures are drilling induced artifacts

Magnification: A: 25X B: 100X

A) This low magnification view illustrates mostly variably sandy dolostone chips (C8, B11.5, G14, FG10, HJ11, AB3.5, H1.5, J8.5, E12). A dolomitic, very fine-grained sandstone chip occurs at K6 and a sandy limestone chip is visible at BC14.5. Three sub-rounded, medium sand grains (FG11, GH10.8, FG8.5) of monocrystalline quartz are visible within one of the sandy dolostone chips.

B) This photomicrograph provides a high magnification view of the area centered near CD12.5 in Photo A. The mostly recrystallized, sparry calcite fabric of the limestone chip in the top-right has undergone some drilling induced damage due to bit-shearing (AB11-15). Biotite occurs at C12 within the limestone chip. Monocrystalline quartz (EF5, F6, AB6, C2) and feldspar grains (FG13, FG8.5) are supported by a matrix of fine- to medium-crystalline dolomite (AE4, JK1-10, GH11). Restricted intercrystalline pores are faintly visible at BC5.8 and D2.7.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 12300 FEET
SAMPLE NUMBER: 11D

PLATE 11

Lithologies:

Major: Dolostone (variably sandy); dolomitic very fine- to fine-grained sandstone
Minor: Dolomitic, argillaceous, very fine-grained sandstone; calcareous, very fine-grained sandstone; sandy limestone

Sedimentary Fabric: Massive to bioturbated; rare laminations; dolomite-replaced fabric (probable precursor sandy limestone); and trace organic-rich, incipient microstylolites

Grain Size Range: <0.03mm to 0.55mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and dolomitized peloids

Accessory: Dolomitized intraclasts; organic fragments; trace biotite; and trace phosphatic fragments

Matrix Composition: Finely crystalline dolomite with patchy localized areas of dolomicrite (within dolostone); rare to minor detrital clay locally intermixed with dolomicrite

Authigenic Clay: None observed

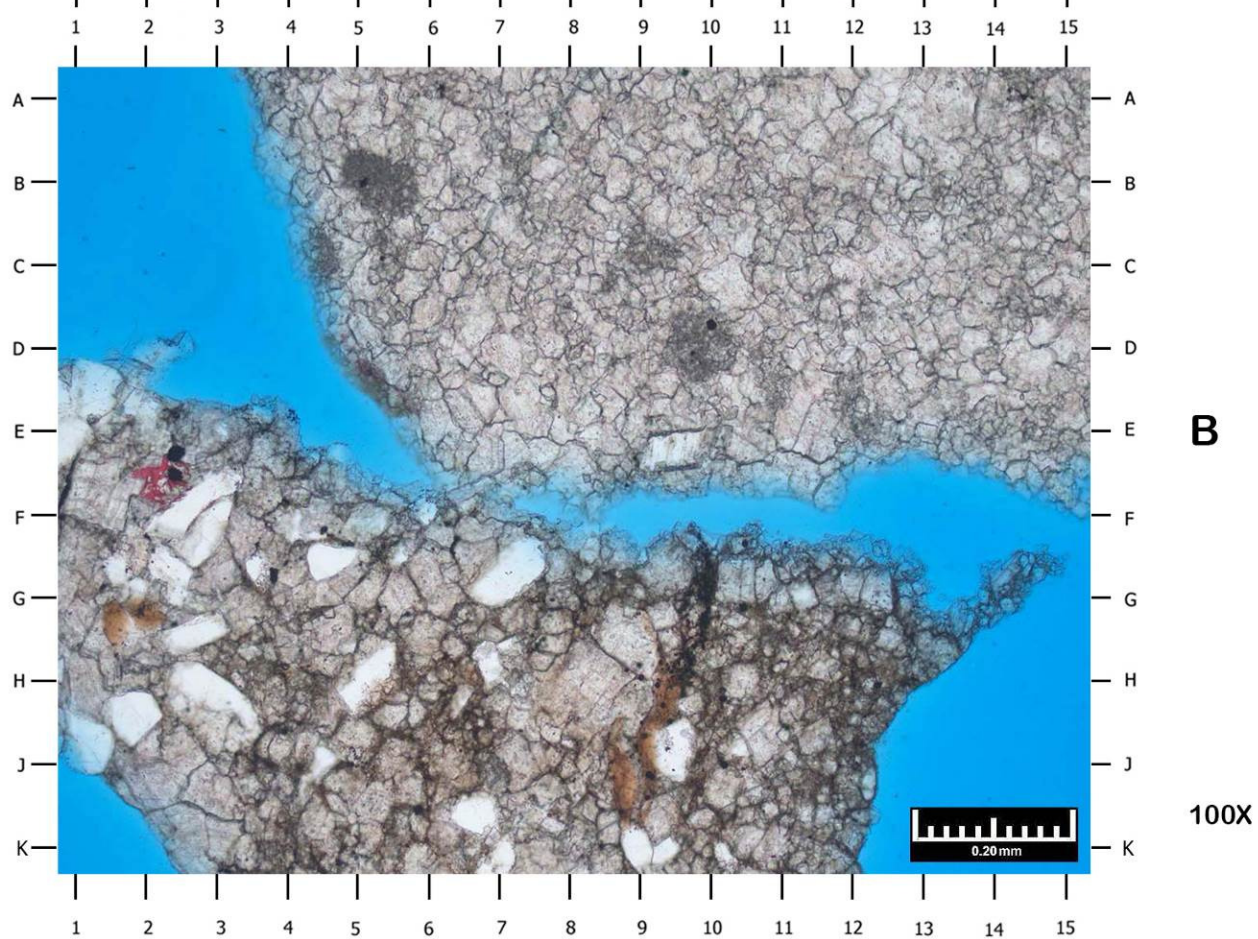
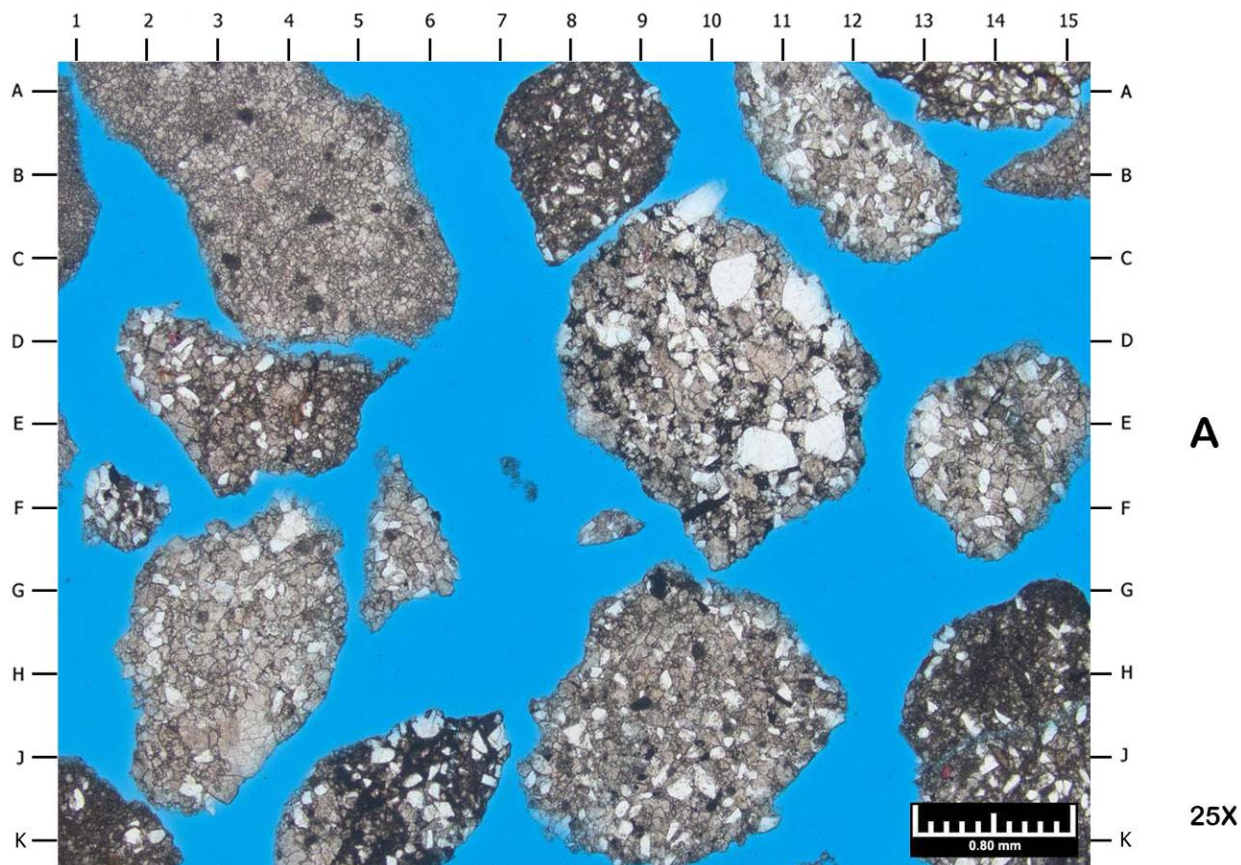
Authigenic Minerals: Very abundant dolomite completely replacing probable precursor limestone fabric; minor to locally common quartz and feldspar overgrowths; minor pyrite occurring as replacement of organic material and other unstable particles; rare calcite occurring as patchy cement or replacement of unstable grains (within dominant dolostone); calcite cement is locally common within rare to minor limestone and calcareous sandstone chips

Porosity Types: Minor intercrystalline pores occurring between dolomite crystals; trace secondary intragranular to grain-moldic pores associated leached and/or altered grains/allochems.

Magnification: A: 25X B: 100X

A) This low magnification photomicrograph illustrates several variably sandy dolostone cuttings chips (BC4, E3.5, H3, DE10, EF14, J9.5, HJ14, K1, JK5.5, B12); a few of these dolomitic chips may be considered borderline dolomitic, very fine-grained sandstone (A14). Grain sorting varies between individual sandy dolostone chips; the sand grains in some chips appear moderately sorted (A14, J9.5) and then in others, poorly sorted (DE10).

B) This photomicrograph provides a high magnification view of the area centered near D4 in Photo A. In the bottom dolostone chip, common detrital grains of monocrystalline quartz (HJ2, FG4.8, JK6.8) and feldspar (FG7, F2.5) are supported by a dolomite matrix. A biotite fragment occurs at H9.4 to J9. The upper-right dolostone chip contains several dolomitic peloids (B5.4, D9.8, C9) and a feldspar grain at EF9. Calcite partially replaces an unstable grain at EF2 (stained red).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 12310 FEET
SAMPLE NUMBER: 12D

PLATE 12

Lithologies:

Major: Dolostone (variably sandy); dolomitic very fine- to fine-grained sandstone
Minor: Dolomitic, fine- to medium-grained sandstone; dolomitic, coarse siltstone; sandy limestone; calcareous, very fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; completely replaced by finely crystalline, euhedral to subhedral dolomite (probable precursor sandy limestone); rare laminations; minor organic-rich microstylolites

Grain Size Range: <0.03mm to 0.56mm

Compaction: Moderate to high

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and dolomitized peloids

Accessory: Dolomitized intraclasts; rare organic fragments; rare biotite; trace muscovite; trace zircon; and trace glauconite

Matrix Composition: Finely crystalline dolomite and lesser dolomicrite (within dominant dolostone); rare detrital clay associated with rare laminations and microstylolites; and trace micrite in limestone chips

Authigenic Clay: Trace undifferentiated pore-filling clay in rare sandstone chips and occurring as trace grain replacement

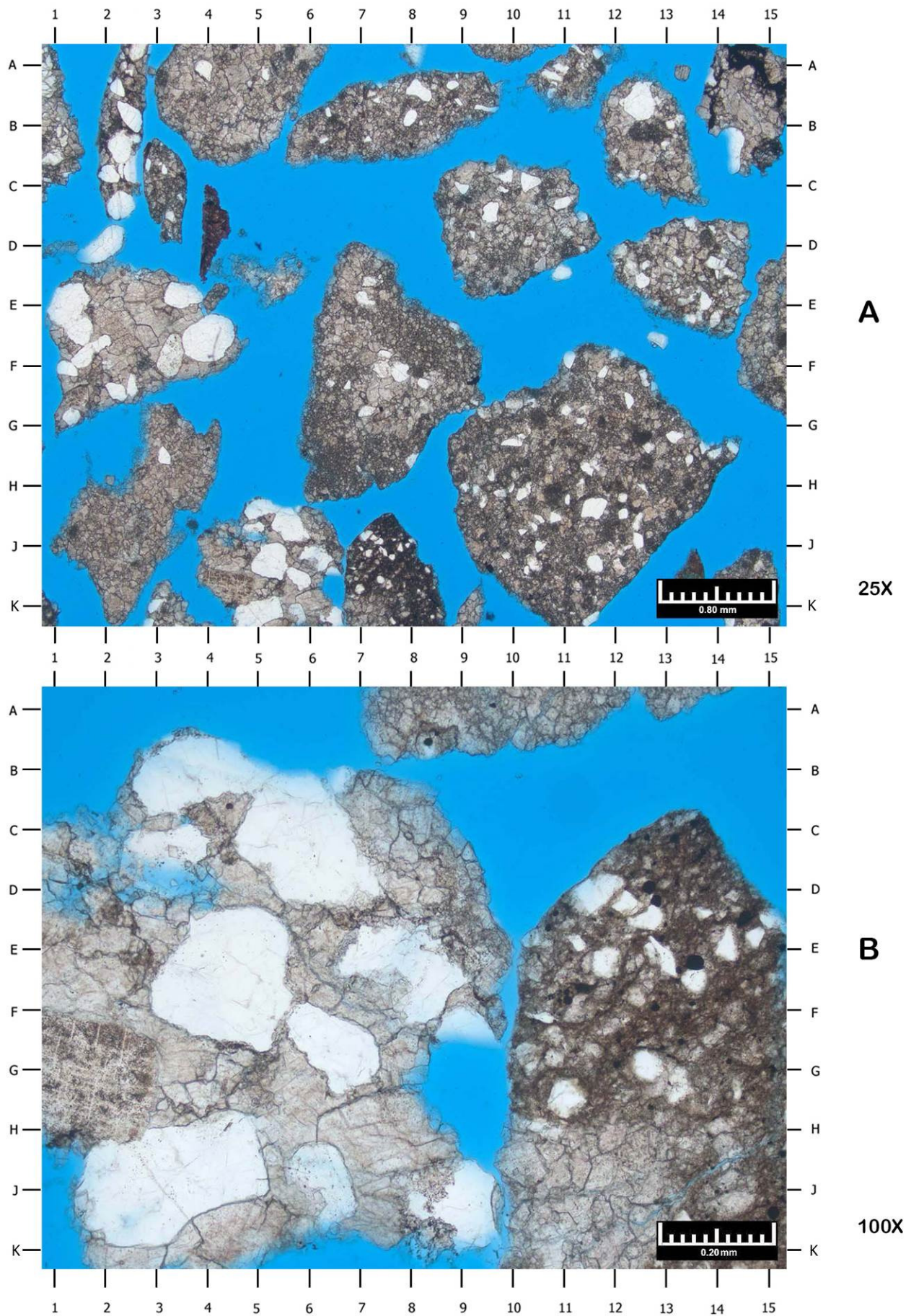
Authigenic Minerals: Very abundant dolomite completely replacing probable precursor limestone fabric; minor to locally common quartz and feldspar overgrowths; minor pyrite occurring as replacement of organic material (mostly along microstylolites) and other unstable particles; rare calcite occurring as patchy cement or replacement of unstable grains (within dominant dolostone); calcite cement is locally common within rare to minor limestone and sandstone chips

Porosity Types: Rare intercrystalline pores occurring between dolomite crystals and trace secondary intragranular pores associated with leached feldspar grains; fractures in cuttings are a common drilling induced artifact

Magnification: A: 25X B: 100X

A) This low magnification view illustrates several variably sandy dolostone chips (AB4.5, J2.5, FG7.5, H11, DE13.5, CD10, B7.5); a few of these dolomitic chips may be considered borderline dolomitic sandstone (BC2.5, JK5.5). A possible organic-rich microstylolite is visible at AB14.5.

B) This photomicrograph provides a high magnification view of the area centered near JK6 in Photo A. Detrital grains visible in this view are predominantly monocrystalline quartz (B3.5, CD6, EF4, J3, J9.2, E14, G12.8) with lesser amounts of feldspar grains (G2). These detrital grains are supported by a completely dolomite-replaced matrix (EF1-2, GH4-6, HJ7.5, CD8, EF6). The darker matrix material at EG11-15 appears to be predominantly dolomicrite, but may also be intermixed with some detrital clay. Small framboidal pyrite crystals (black; EF13.5, F12.8, D12.7, F11) occur within the dolomicrite matrix.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 12320 FEET
SAMPLE NUMBER: 13D

PLATE 13

Lithologies:

Major: Dolostone (variably sandy)

Minor: Dolomitic, very fine- to medium-grained sandstone; mudstone (variably silty/sandy); sandy limestone; and calcareous, very fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; completely replaced by finely crystalline, euhedral to subhedral dolomite (probable precursor sandy limestone); organic material concentrated along rare to minor discontinuous, thin, wispy laminations and/or possible incipient microstylolites

Grain Size Range: <0.03mm to 0.58mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Grains/Allochems:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and dolomitized peloids

Accessory: Dolomitized ooids; dolomitized intraclasts

Matrix Composition: Finely crystalline dolomite (dominant dolostone); detrital clay dominates minor mudstone chips; and micrite within minor limestone chips

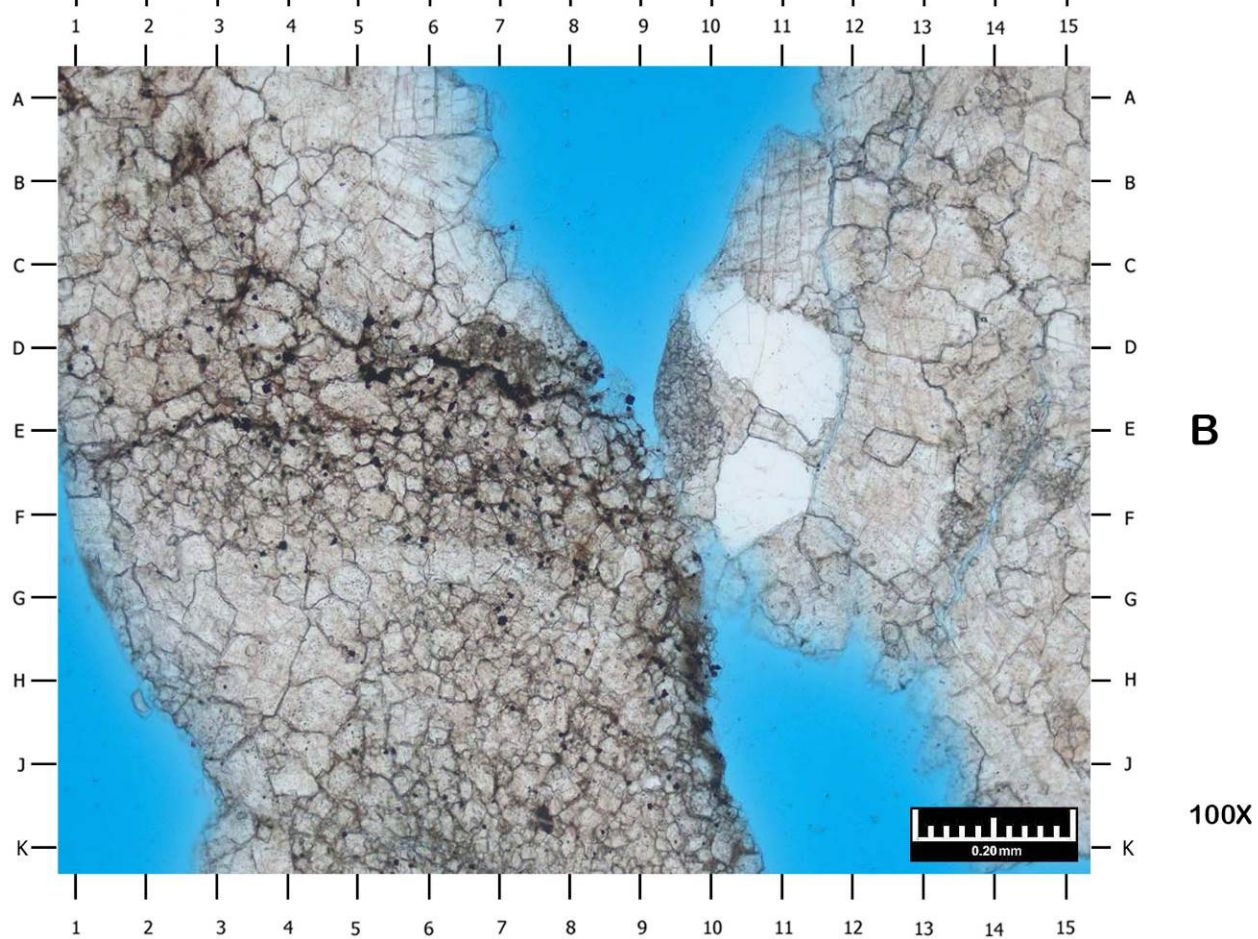
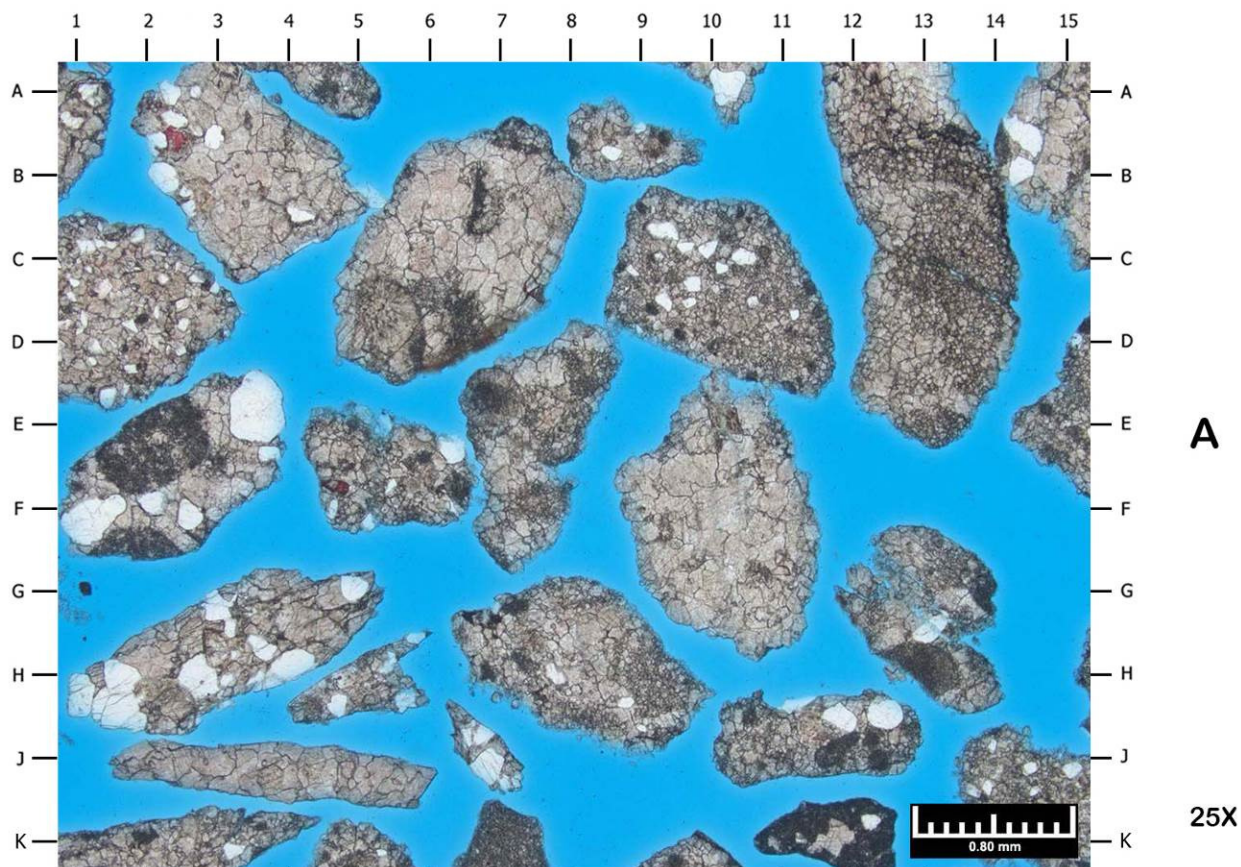
Authigenic Clay: No visible authigenic clay

Authigenic Minerals: Very abundant dolomite completely replacing probable precursor limestone fabric; minor quartz and feldspar overgrowths; minor pyrite occurring as replacement of organic material (mostly along microstylolites) and other unstable particles; rare calcite occurring as patchy cement or replacement of unstable grains (within dominant dolostone); calcite cement is locally common within rare to minor limestone and sandstone chips

Porosity Types: Rare intercrystalline pores occurring between dolomite crystals; trace secondary intragranular pores associated with partially leached feldspar grains; fractures and bit-sheared cuttings are common drilling induced artifacts

Magnification: A: 25X B: 100X

- A) This low magnification photomicrograph illustrates several variably sandy dolostone cuttings chips (CD1-2, C6.5, B3.5, CD10, C13, AB15, GH3.5, H8, J11.5, K2). Dolomitized peloids (J12.4), intraclasts (CD13.5, D5.5, EF2), and ooids (DE7) are indications of a precursor limestone origin before dolomite replacement.
- B) This photomicrograph provides a high magnification view of the area centered near B13.9 in Photo A. Monocrystalline quartz grains occur at D11 and F10.5. A localized concentration of organic material occurs compacted between dolomite crystals at DE5-8; micro-sized pyrite crystals (black specks; EF6.5, DE7.5) also occur distributed around the same area. Localized areas of microcrystalline dolomite likely represent dolomitized peloids and/or other dolomite-replaced allochems (DE9.5, F13.5, J15, HK5-9).



Cabot Oil & Gas Corporation
Cabot No. 50
UWI/API#: 4707901538
Putnam County, West Virginia
Maryville Limestone Formation
Cuttings

WFT File No.: HH-73588

THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 12330 FEET
SAMPLE NUMBER: 14D

PLATE 14

Lithologies:

Major: Variably sandy dolostone

Minor: Dolomitic, very fine- to fine-grained sandstone; limestone (variably sandy/dolomitic)

Sedimentary Fabric: Massive to bioturbated; completely replaced by finely crystalline, euhedral to subhedral dolomite (probable precursor sandy limestone); minor organic-rich microstylolites

Grain Size Range: 0.03mm to 0.47mm

Compaction: Moderate to high

Visual Sorting: Moderate

Grains/Allochems:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Dolomitized peloids and dolomitized intraclasts

Matrix Composition: Finely crystalline dolomite; rare detrital clay occurs in localized patches occluding intercrystalline spaces and concentrated along microstylolites

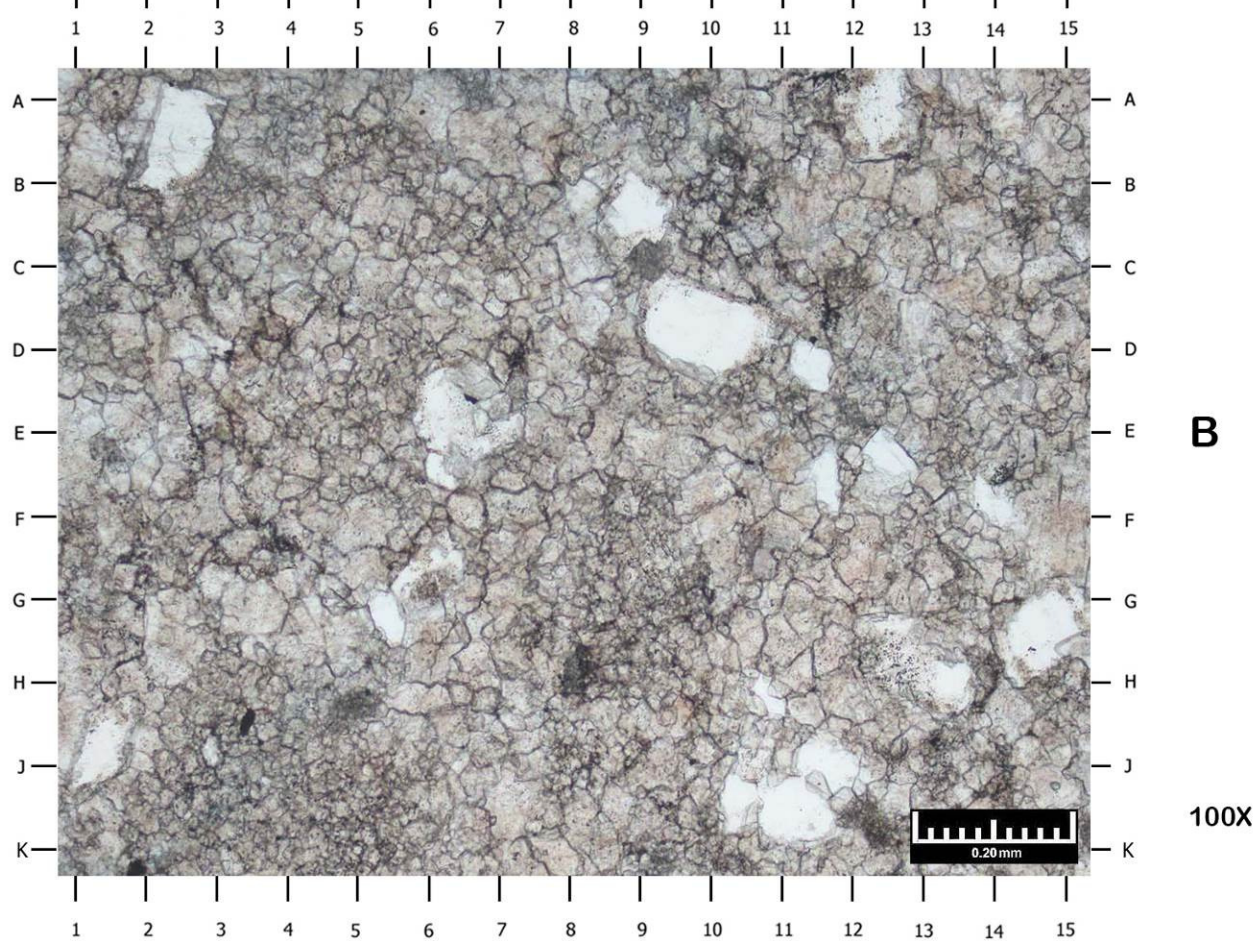
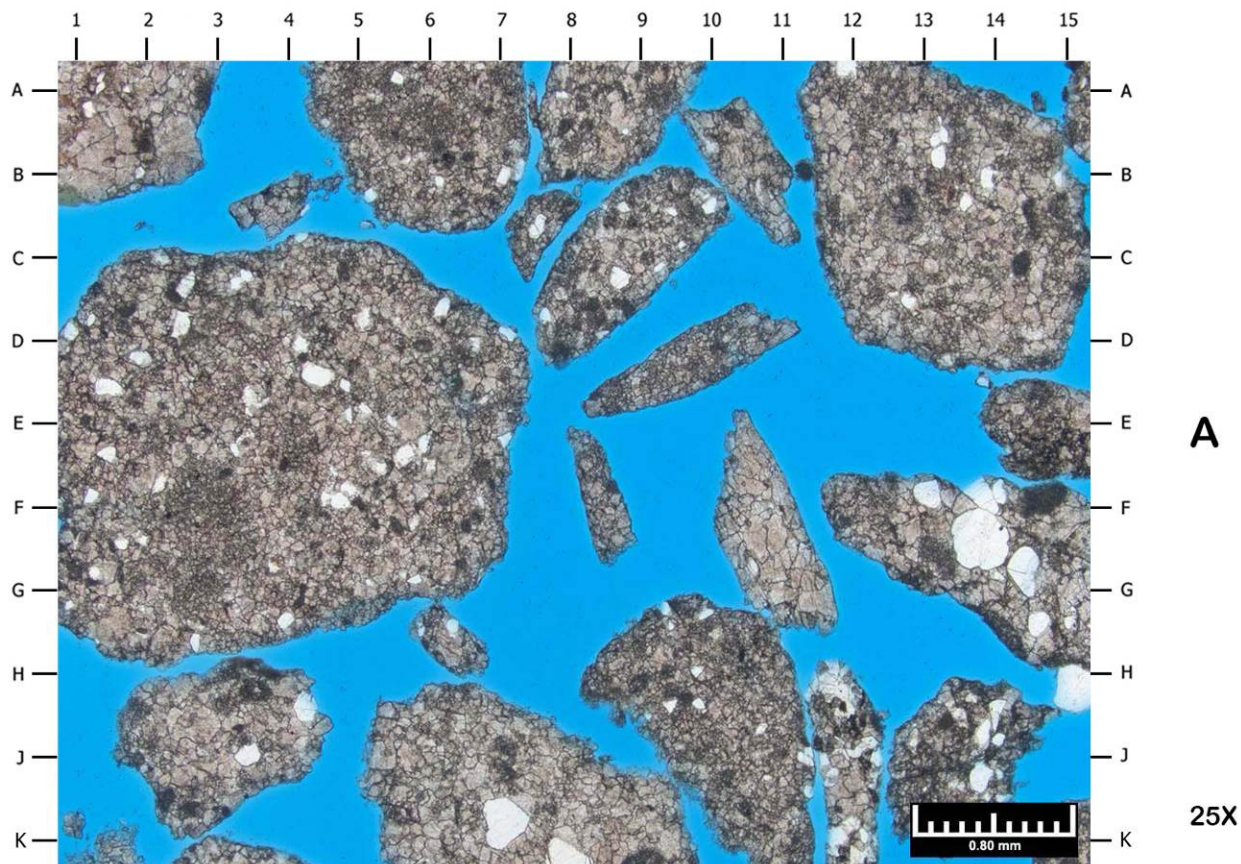
Authigenic Clay: None observed

Authigenic Minerals: Very abundant dolomite completely replacing probable precursor limestone fabric; minor quartz and feldspar overgrowths; minor pyrite occurring as replacement of organic material (mostly along microstylolites) and other unstable particles; rare calcite occurring as patchy cement or replacement of unstable grains

Porosity Types: Trace secondary intragranular pores associated with leached grains and trace intercrystalline pores occurring between dolomite crystals

Magnification: A: 25X B: 100X

- A) This low magnification view illustrates several variably sandy dolostone cuttings chips (EF3.5, AB2, AB6, BC13, AB8.5, J3, JK7, HJ10.5, FG12-15, J13.5). Detrital grains within this view are mostly sub-rounded to rounded in sphericity and are mostly very fine- to fine-grained in size; a few grains that fall into a medium-grained size class are also present (FG13.7; 0.30mm).
- B) This photomicrograph provides a high magnification view of the area centered near E3.5 in Photo A. In this view, tightly interlocking, euhedral to subhedral, finely crystalline dolomite (C1-8, AB4-11, G11-14) supports detrital grains of monocrystalline quartz (CD10, JK11, GH14.5) and feldspar (AB2.5, AB12.4). Granular-shaped areas of microcrystalline dolomite or localized clusters of smaller-sized dolomite crystals likely represent dolomitized peloids and/or intraclasts (FH9, JK2-6).



Cabot Oil & Gas Corporation
Cabot No. 50
UWI/API#: 4707901538
Putnam County, West Virginia
Maryville Limestone Formation
Cuttings

WFT File No.: HH-73588

THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 12340 FEET
SAMPLE NUMBER: 15D

PLATE 15

Lithologies:

Major: Variably sandy dolostone

Minor: Dolomitic very fine- to fine-grained sandstone; variably silty/sandy mudstone; sandy limestone

Sedimentary Fabric: Massive to bioturbated; completely replaced by finely crystalline, euhedral to subhedral dolomite (probable precursor sandy limestone); minor organic-rich microstylolites

Grain Size Range: 0.03mm to 0.37mm

Compaction: Moderate to high

Visual Sorting: Moderate

Grains/Allochems:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and dolomitized peloids

Accessory: Dolomitized undifferentiated fossil fragments; dolomitized intraclasts; and trace zircon

Matrix Composition: Finely crystalline dolomite; trace detrital clay concentrated along microstylolites

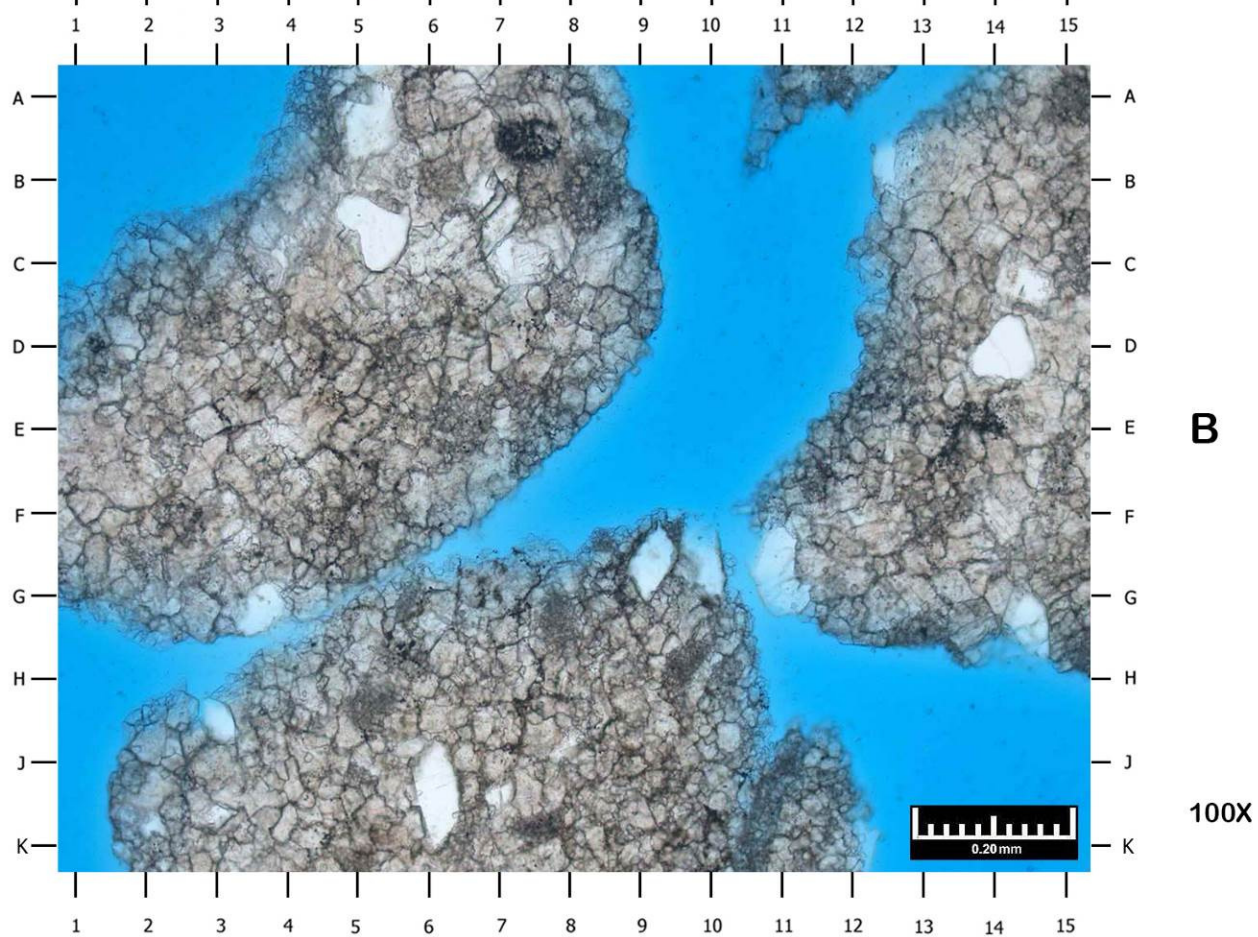
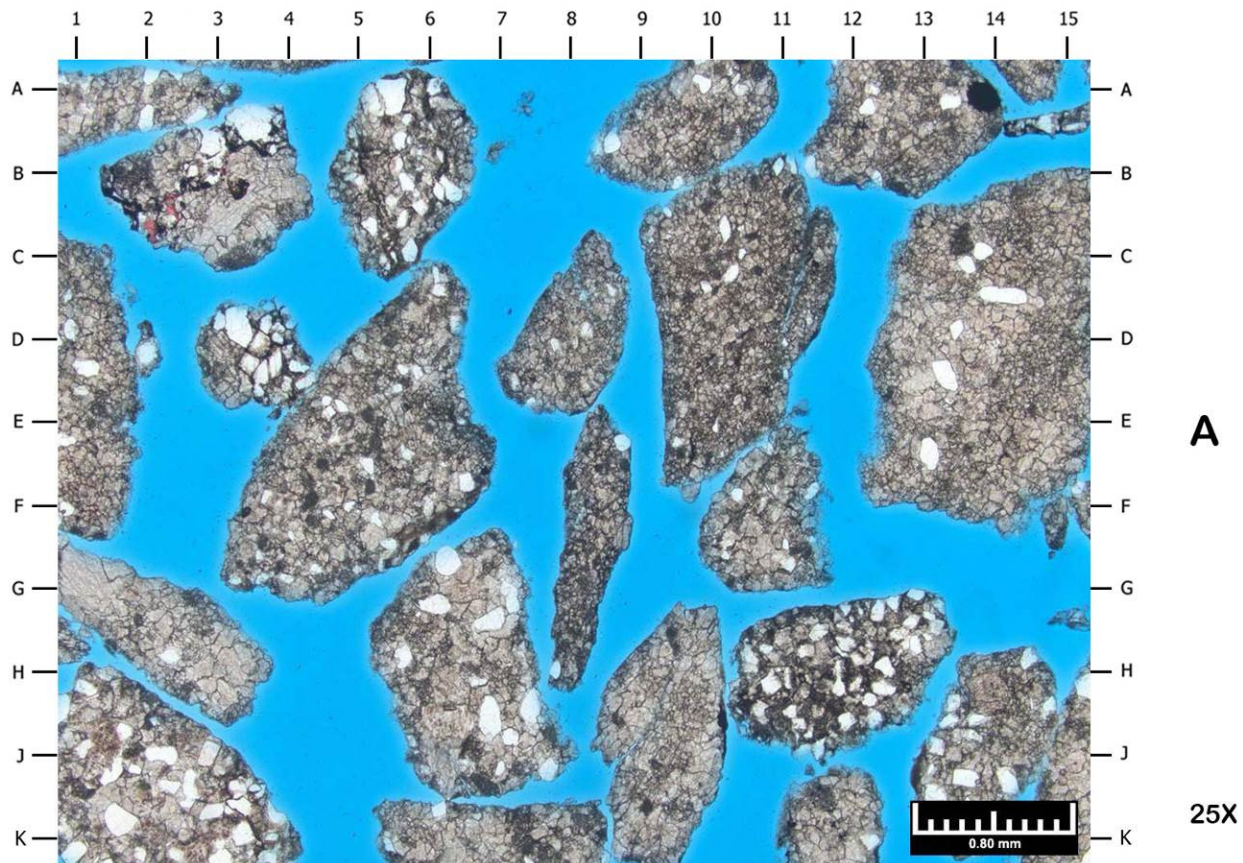
Authigenic Clay: None observed

Authigenic Minerals: Very abundant dolomite completely replacing probable precursor limestone fabric; minor quartz and feldspar overgrowths; minor pyrite occurring as replacement of organic material (mostly along microstylolites) and other unstable particles; rare calcite occurring as patchy cement or replacement of unstable grains

Porosity Types: No visible pores using standard petrographic techniques

Magnification: A: 25X B: 100X

- A) Almost all visible cuttings chips represent variably sandy dolostone (DE1, BC3, AB1.5, EF5, D14, A13, AB10, D10.5). Some dolomitic chips contain sufficient sand content to be considered borderline dolomitic sandstone (D3.5, H12, JK2.5). The dolostone chip at HJ9.3 contains no visible sand grains. An organic-rich microstylolite is visible at BC2-AB3.5.
- B) This photomicrograph provides a high magnification view of the area centered near AB11 in Photo A. The three cuttings chips in this view are comprised predominantly of tightly interlocking, euhedral to subhedral dolomite crystals (E1-6, HJ6-9, F12-15, B13-15) that support siliciclastic detrital grains of quartz (BC5.2, D14) and feldspar (JK6, FG9, C6). Remnant dolomitized peloids composed of microcrystalline dolomite are also faintly visible (A15, B8.3, E6.5, HJ5.2, GH8).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13095-13100 FEET
SAMPLE NUMBER: 16D

PLATE 16

Lithologies:

Major: Dolomitic, very fine- to medium-grained sandstone; limestone
Minor: Dolostone (variably calcareous); medium to coarse sand grains (isolated, loose, unconsolidated grains); sandy/silty mudstone

Sedimentary Fabric: Massive to bioturbated; limestone chips are mostly peloidal grainstone in texture with lesser lime mudstone

Grain Size Range: 0.03mm to 1.03mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and chert

Accessory: Peloids; partially recrystallized ooids with radiating crystal structure; intraclasts; and trace zircon

Matrix Composition: Minor to locally abundant micrite (limestone chips); minor to locally common dolomicrite (sandstone and dolomite chips); minor detrital clay within some sandstone chips to abundant detrital clay within mudstone chips

Authigenic Clay: Undifferentiated authigenic clay imbedded between other intergranular cement and occurring as grain replacement and possible localized recrystallization of precursor detrital clay

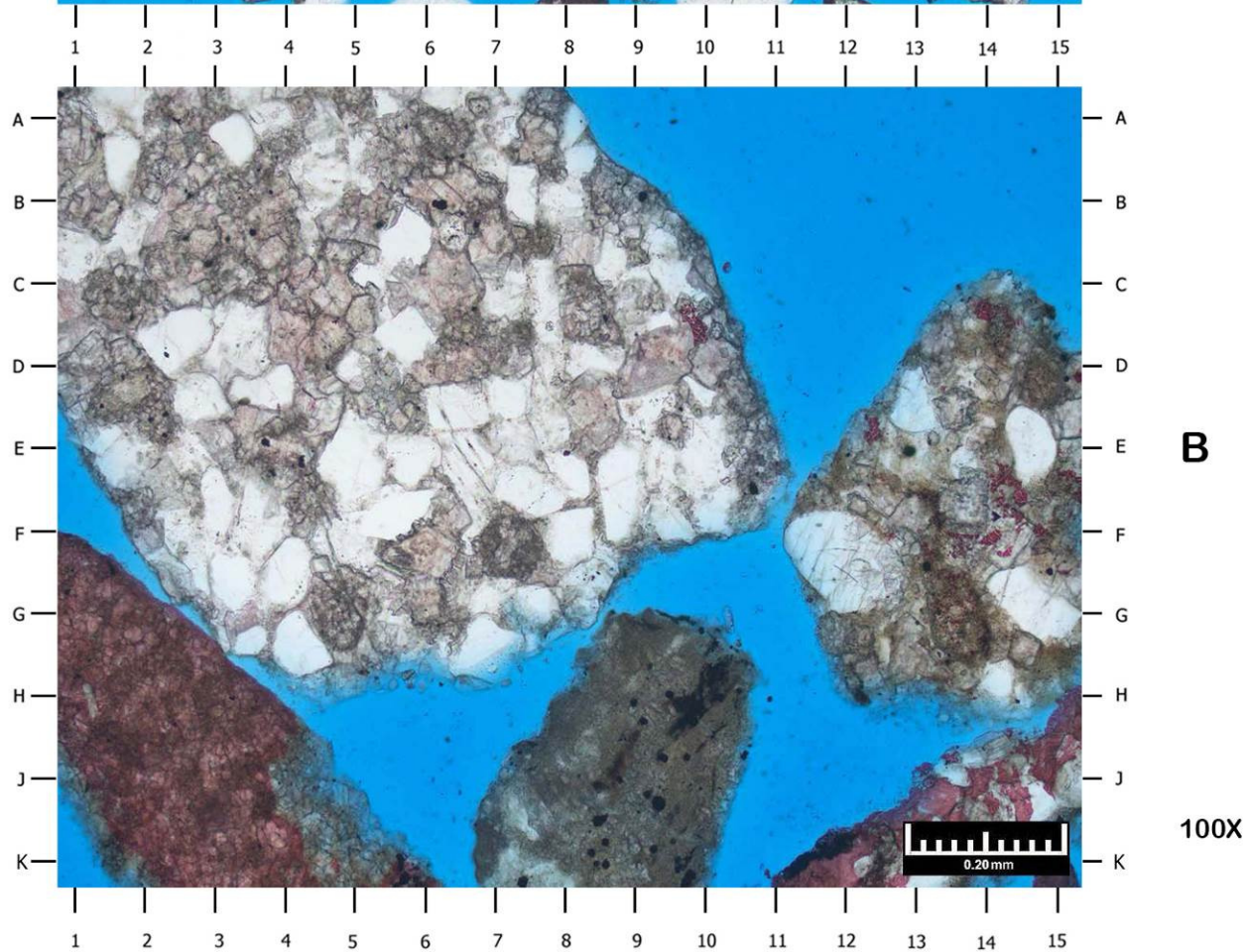
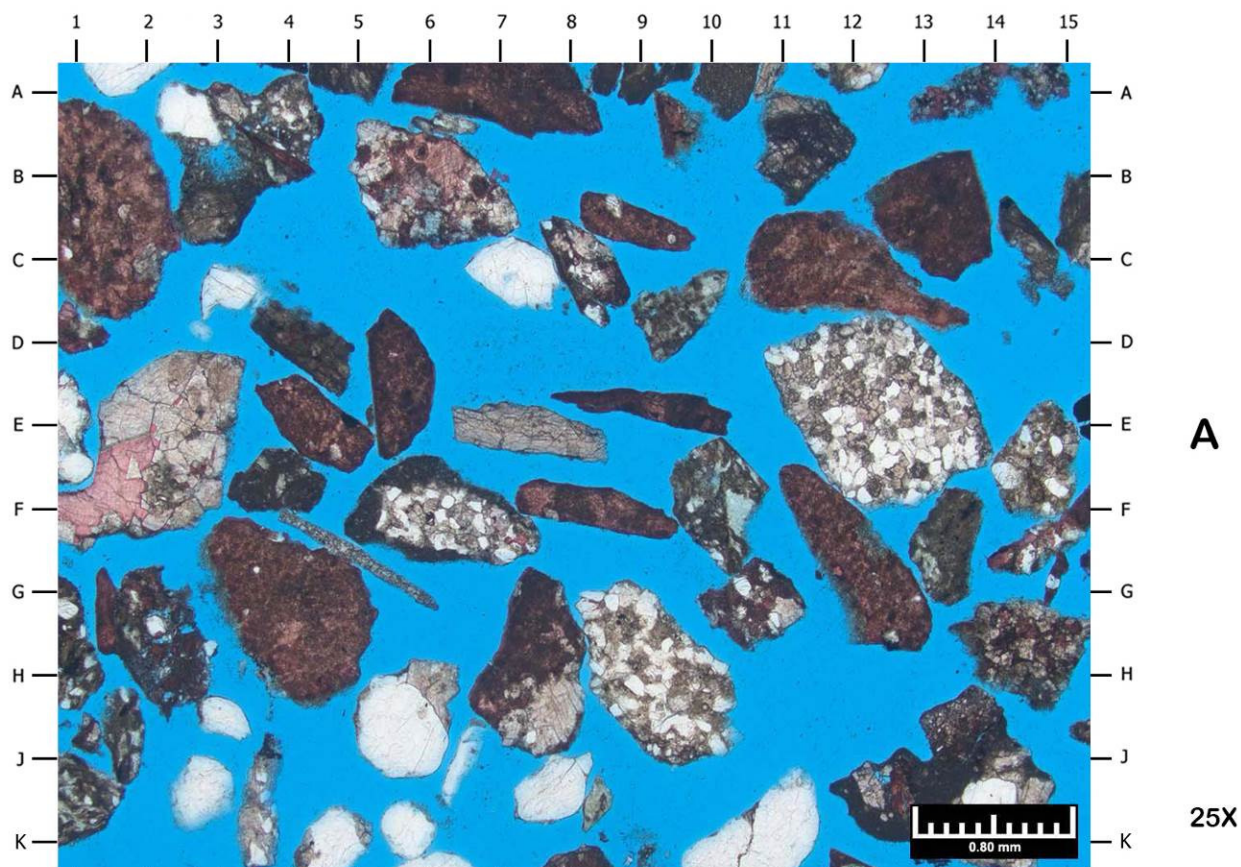
Authigenic Minerals: Abundant dolomite occurring as intergranular cement and replacement of unstable grains (within sandstone chips); quartz and feldspar overgrowths are minor to locally common within sandstone chips; dolomite completely replaces precursor matrix and grains/allochans within dolostone chips; intergranular sparry calcite cement is rare within sandstone chips, but is common to abundant within limestone (grainstone) chips; patchy sparry calcite replacement/recrystallization of precursor matrix within limestone; rare to minor calcite is also present within some dolostone chips; pyrite and siderite occur as trace to rare replacements of unstable particles

Porosity Types: Trace secondary intragranular micropores associated with partially leached/altered grains; trace intercrystalline pores occurring between dolomite crystals; and bit-sheared grains and fractures are common drilling induced artifacts

Magnification: A: 25X B: 100X

A) The dominant lithologies represented within this view include limestone (GH4, BC1.5, A7, BC13, C11.5, G12.5, GH4.3, E4, DE5.5) and dolomitic, very fine- to fine-grained sandstone. Other dolomitic sandstone chips containing a higher proportion of medium to coarse sand grains (HJ5.5, K10.5) are also common, but poorly represented within this view. Calcareous dolostone occurs at E2 and B6 and dolostone occurs at E7. The dolomitic sandstone chip at F6 is coated with a dark rind of dolomitic drilling mud debris (F5).

B) This photomicrograph provides a high magnification view of the area centered near EF13 in Photo A. Detrital grains within the sandstone are predominantly monocrystalline quartz (E14.5, FG4, AB1.6) and feldspar (EF6.5). Dolomite cement occludes most intergranular areas (E3.5, FG6, D9.2).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13100-13105 FEET
SAMPLE NUMBER: 17D

PLATE 17

Lithologies:

Major: Dolomitic, fine- to medium-grained sandstone to sandy dolostone
Minor: Dolomite; limestone; medium to very coarse sand grains (isolated, loose, unconsolidated grains)

Sedimentary Fabric: Massive to bioturbated; limestone chips exhibit mostly lime grainstone texture

Grain Size Range: 0.03mm to 1.06mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Peloids; intraclasts; and ooids

Matrix Composition: Minor to locally common micrite within limestone chips; dolomite completely replaces precursor matrix in dolostone chips

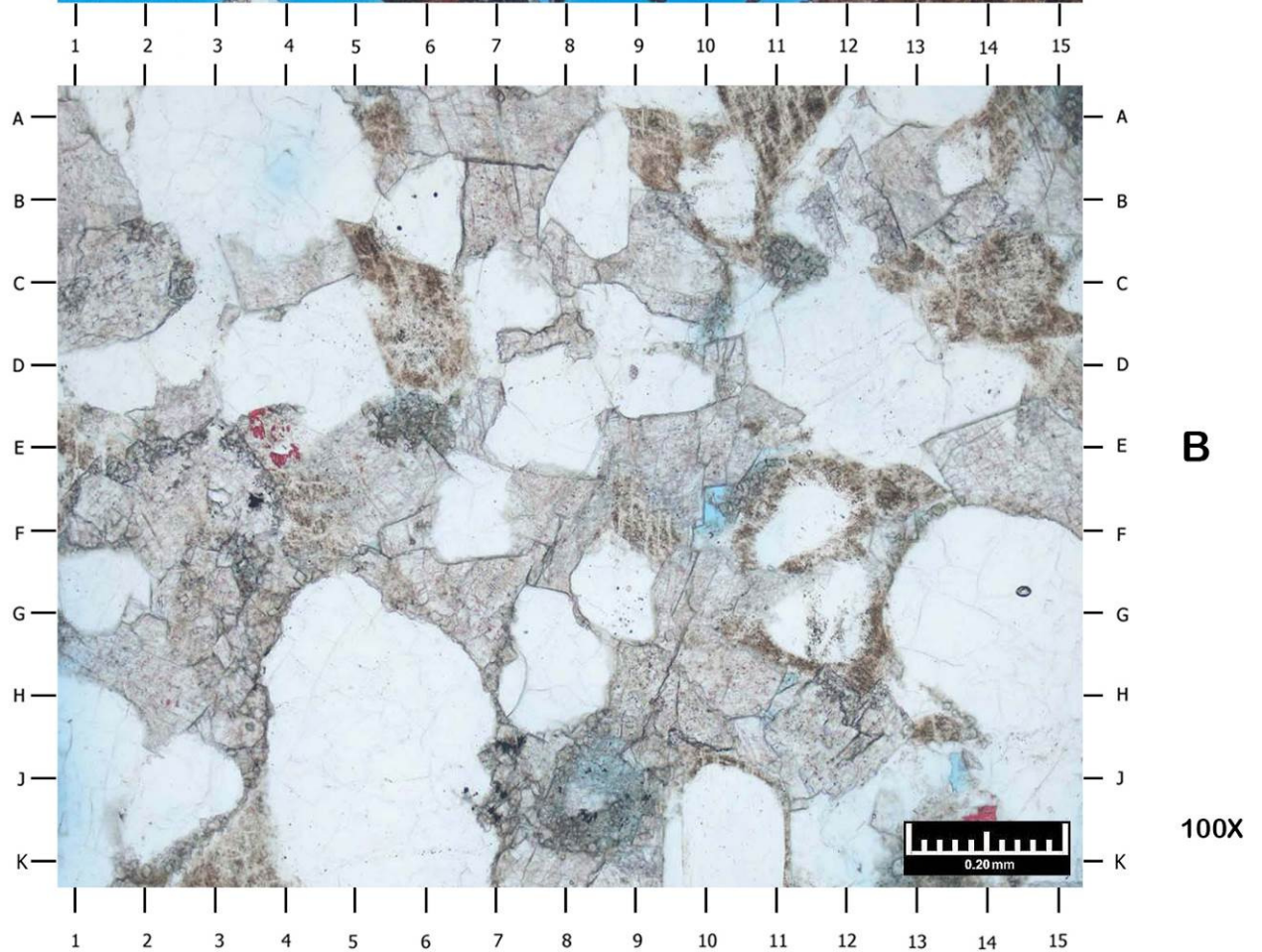
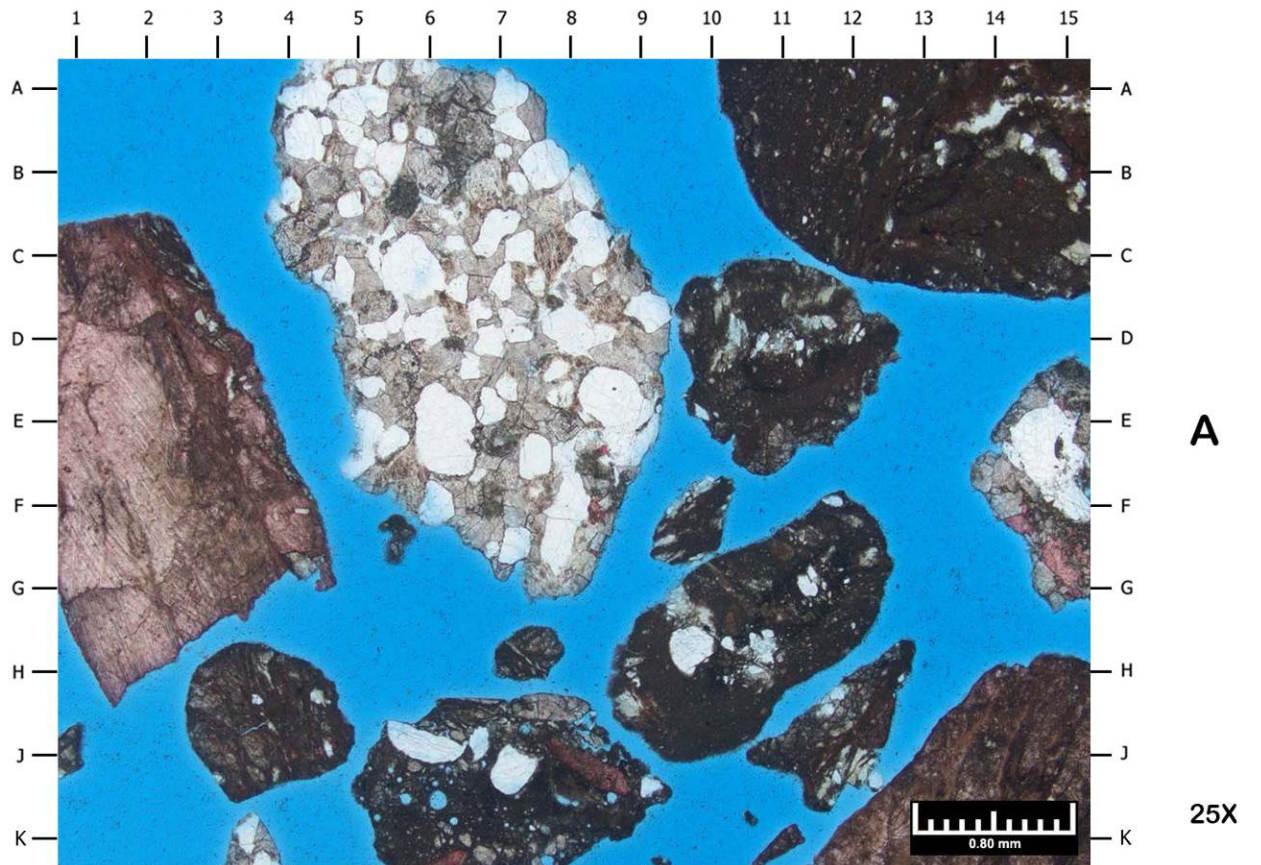
Authigenic Clay: Trace undifferentiated clays imbedded between grain-binding cements and partially replacing unstable grains

Authigenic Minerals: Abundant dolomite occurs as intergranular cement and replacement of unstable grains within the dominant sandstone lithology; quartz and feldspar overgrowths are minor to locally common within sandstone chips; dolomite completely replaces precursor matrix and grains/allochments within dolostone chips; sparry calcite cement is rare within the dominant sandstone, but is common to abundant within limestone chips; rare to minor calcite is also present within some dolostone chips; pyrite and siderite occur as trace to rare replacements of unstable particles

Porosity Types: Rare to minor primary intergranular pores, minor secondary intragranular micropores associated with partially leached/altered grains, trace possible secondary grain-moldic pores (could be plucked grains) occur within the dominant sandstone; no visible pores within limestone or dolostone chips; damaged/bit-sheared chips and induced fractured are common artifacts of drilling

Magnification: A: 25X B: 100X

- A) Dolomitic, fine- to medium-grained sandstone cuttings chips occur at AF6 and EF15. Limestone chips occur at EF2 and J14. The matrix material of the remaining sandy dolostone chips in this low magnification view has been crushed by bit-shearing during drilling (B11-15, DE11, GH10.5, HJ3.5, JK6.5).
- B) This photomicrograph provides a high magnification view of the dominant sandstone lithology and illustrates the area centered near D7 in Photo A. Framework grains are predominantly monocrystalline quartz (A3, D12, G14, HJ5.5, K10.5) and feldspar (C14, CD5.5, A11, F11.5, G12). Intergranular cements include dolomite (E14, H10.5, AB7, GH3), quartz overgrowths (D10.8, FG2, D8, K9.5), and feldspar overgrowths (BC5, F12.5, GH12.5, D15). Restricted primary intergranular pores occur at J13.7 and F10. An unstable grain at J8.5 is partially replaced by microcrystalline dolomite and contains secondary intragranular microporosity.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13105-13110 FEET
SAMPLE NUMBER: 18D

PLATE 18

Lithologies:

Major: Sandy dolostone to dolomitic, very fine- to medium-grained sandstone
Minor: Limestone; dolostone; medium to very coarse sand grains (isolated, loose, unconsolidated grains)

Sedimentary Fabric: Massive to bioturbated; limestone chips exhibit mostly a grainstone texture with a few lime mudstone textured chips also present; trace organic-rich incipient microstylolite; trace calcite-filled fracture within a limestone chip

Grain Size Range: <0.03mm to 1.20mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Micritic peloids and intraclasts (limestone only); trace biotite; and trace zircon

Matrix Composition: Rare dolomicrite occurs within some sandstone chips; minor micrite within limestone chips; trace detrital clay within some sandstone chips; dolomite completely replaces precursor matrix in dolostone chips

Authigenic Clay: Trace undifferentiated clays imbedded between grain-binding cements and partially replacing unstable grains

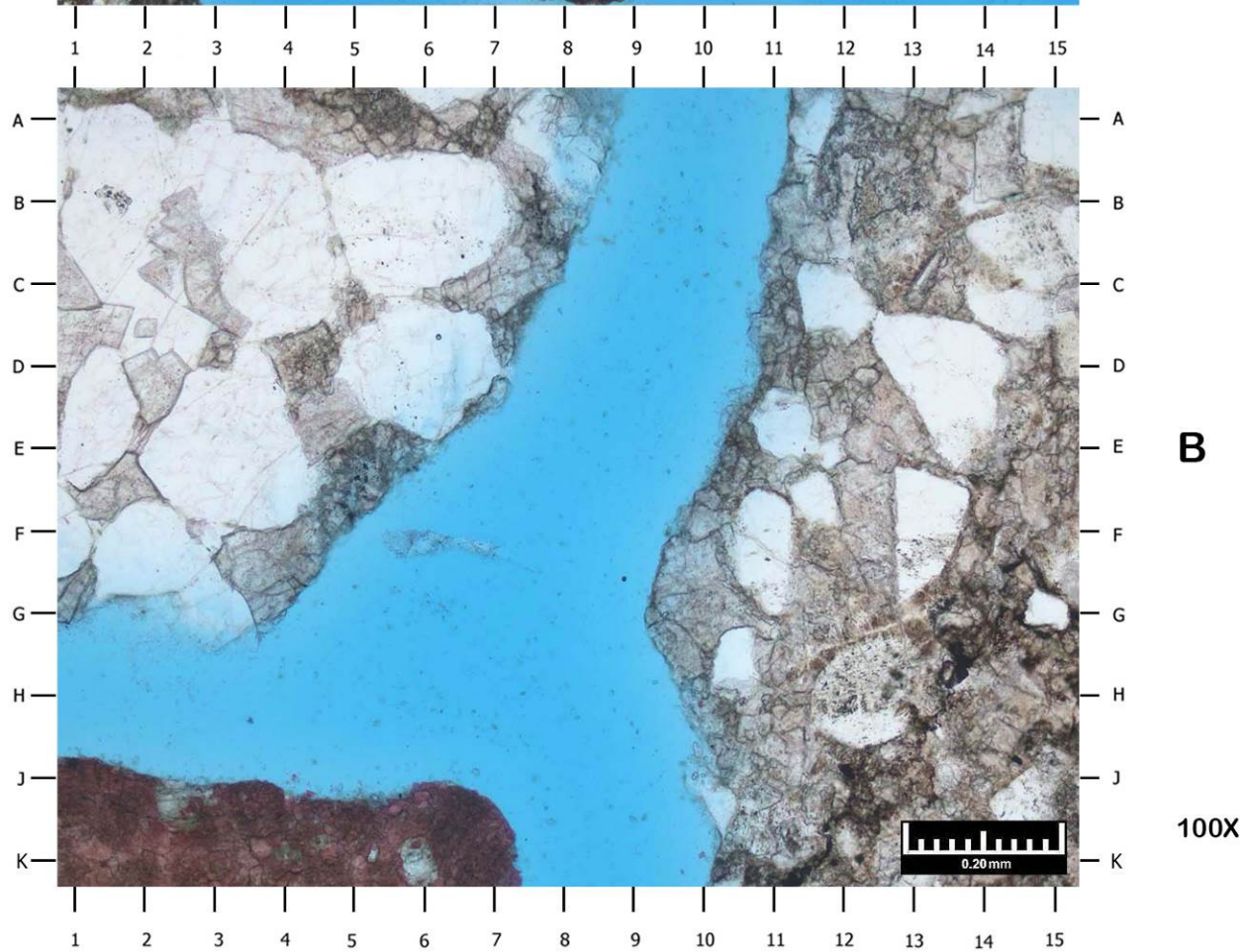
Authigenic Minerals: Abundant dolomite occurs as intergranular cement and replacement of unstable grains within the dominant sandstone lithology; quartz and feldspar overgrowths are minor to locally common within sandstone chips; dolomite completely replaces precursor matrix and grains/allocherts within dolostone chips; sparry calcite cement is rare within the dominant sandstone, but is common to abundant within limestone chips; rare to minor calcite is also present within some dolostone chips; pyrite and siderite occur as trace to rare replacements of unstable particles

Porosity Types: Rare secondary intragranular pores and rare intercrystalline pores between euhedral pore-filling dolomite; fractures and bit-sheared grains are common artifacts of drilling

Magnification: A: 25X B: 100X

A) This low magnification view illustrates the dominant sandy dolostone to dolomitic, very fine- to medium-grained sandstone lithology (BC12, DE4, E11.5, FG9.5, H13.5), along with minor limestone chips (G4.5, J7.5). A calcite replaced grain occurs at GH8.7 (stained red).

B) This photomicrograph provides a high magnification view of the area centered near G11 in Photo A. Detrital grains within this view include monocrystalline quartz (BC6, E3.5, DE13.5) and feldspar (BC14.5, F13, GH12.5). Intergranular areas are occluded by mostly dolomite cement (A4.5, CD1, FG4, E12.5), with lesser amounts of quartz overgrowths (CD2, C4.9) and feldspar overgrowths (GH13, BC13.7).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13110-13115 FEET
SAMPLE NUMBER: 19D

PLATE 19

Lithologies:

Major: Dolomitic, fine- to medium-grained sandstone

Minor: Oolitic/peloidal limestone; dolostone

Sedimentary Fabric: Massive sandstone; limestone chips mostly exhibit oolitic, peloidal grainstone texture; trace organic-rich microstylolite

Grain Size Range: 0.05mm to 0.92mm

Compaction: Moderate to high

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Ooids and peloids (within limestone only); dolomitic intraclasts; and trace tourmaline

Matrix Composition: No detrital clay or micrite was observed within dominant sandstone; minor micrite within limestone chips; dolomite completely replaces precursor matrix in dolostone chips

Authigenic Clay: Trace undifferentiated clays imbedded between grain-binding cements and partially replacing unstable grains

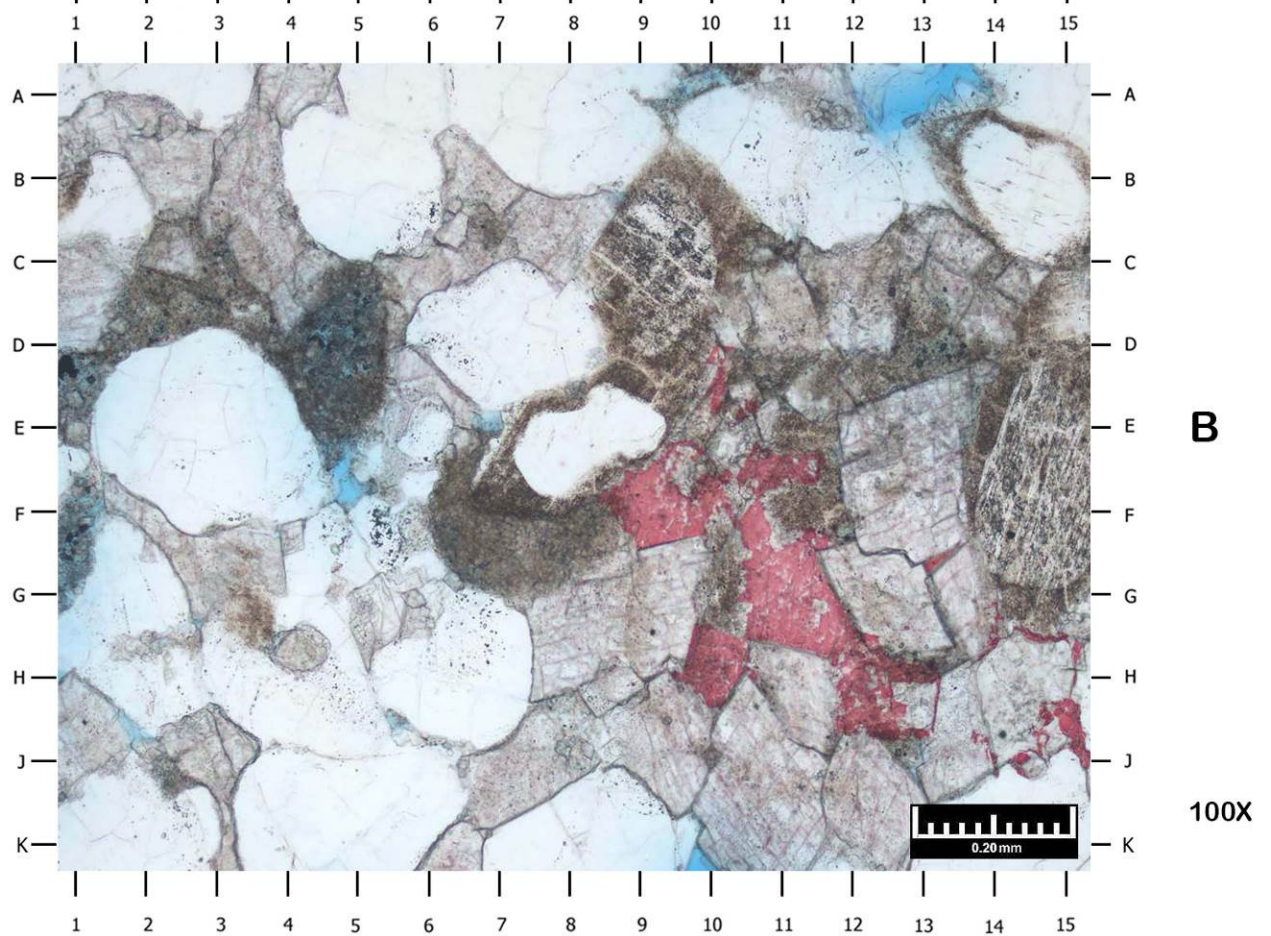
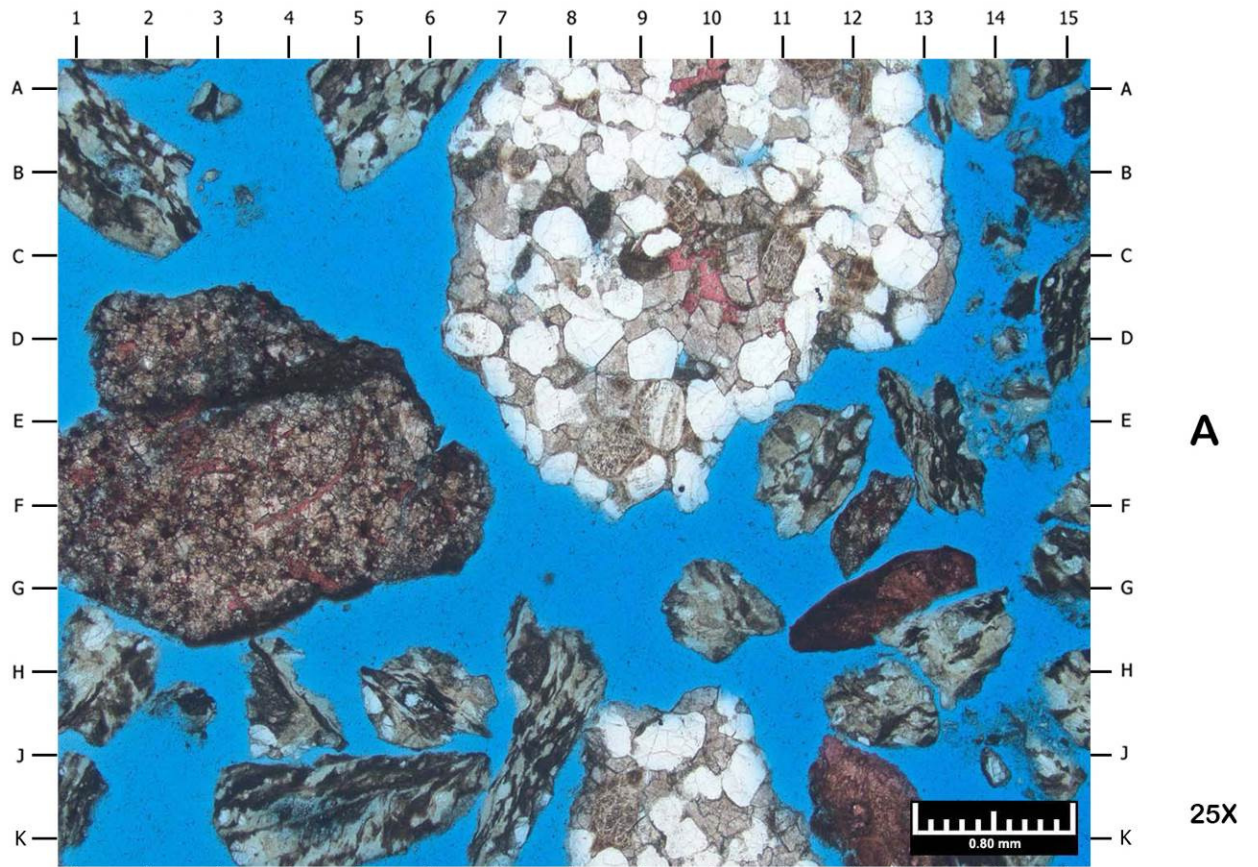
Authigenic Minerals: Abundant dolomite occurs as intergranular cement and replacement of unstable grains within the dominant sandstone lithology; quartz and feldspar overgrowths are minor to locally common within sandstone chips; dolomite completely replaces precursor matrix and grains/allocherts within dolostone chips; sparry calcite cement is rare within the dominant sandstone, but is common to abundant within limestone chips; rare to minor calcite is also present within some dolostone chips; pyrite and siderite occur as trace to rare replacements of unstable particles

Porosity Types: Rare to minor primary intergranular pore, rare to minor intercrystalline pores occurring between euhedral pore-filling dolomite, rare to minor secondary pores, and minor secondary micropores associated with altered/replaced grains occur within the dominant sandstone; rare intercrystalline pores and secondary moldic pores occur within dolostone chips; no visible porosity within limestone chips; common bit-sheared chips are artifacts of drilling

Magnification: A: 25X B: 100X

A) Dolomitic, fine- to medium-grained sandstone cuttings chips represent the dominant lithology (C7-13, JK9.5). Dolostone (F1-6) and limestone (G12.5, JK12) represent minor lithologies. Common amounts of chips within this interval have been damaged by bit shearing during drilling (JK4.5, B1.5, AB5.5, EF11, HJ6, GH10, GH13.5, EF11)

B) This photomicrograph provides a high magnification view of the dominant sandstone lithology and of the area centered near C9.3 in Photo A. Intergranular areas between framework grains of monocrystalline quartz (E2.5, JK4.5) and feldspar (EF15, BC14.5) are occluded by dolomite (B2-4, GH8.5), quartz overgrowths (AB5, GH5), feldspar overgrowths (B13.4, BC10), and calcite (stained red; G11). Primary intergranular pores (EF5, K9.9, E6.5, JK2) and a secondary pore (A13) are visible within this view.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13120 FEET
SAMPLE NUMBER: 20D

PLATE 20

Lithologies:

Major: Dolomitic, fine- to coarse-grained sandstone
Minor: Dolostone; limestone (variably sandy); dolomitic very fine-grained sandstone; sandy/silty dolostone; medium to coarse sand grains (isolated, loose, unconsolidated grains)

Sedimentary Fabric: Massive to bioturbated sandstone; oolitic/peloidal grainstone to lime mudstone texture in limestone chips; trace organic-rich, incipient microstylolites

Grain Size Range: <0.03mm to 1.05mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Ooids, peloids, and intraclasts (calcareous and dolomitized); and organic fragments

Matrix Composition: No detrital clay observed within dominant sandstone; minor to locally common micrite within limestone chips

Authigenic Clay: Trace to rare undifferentiated clay imbedded between grain-binding cements and occurring as a rare grain replacement

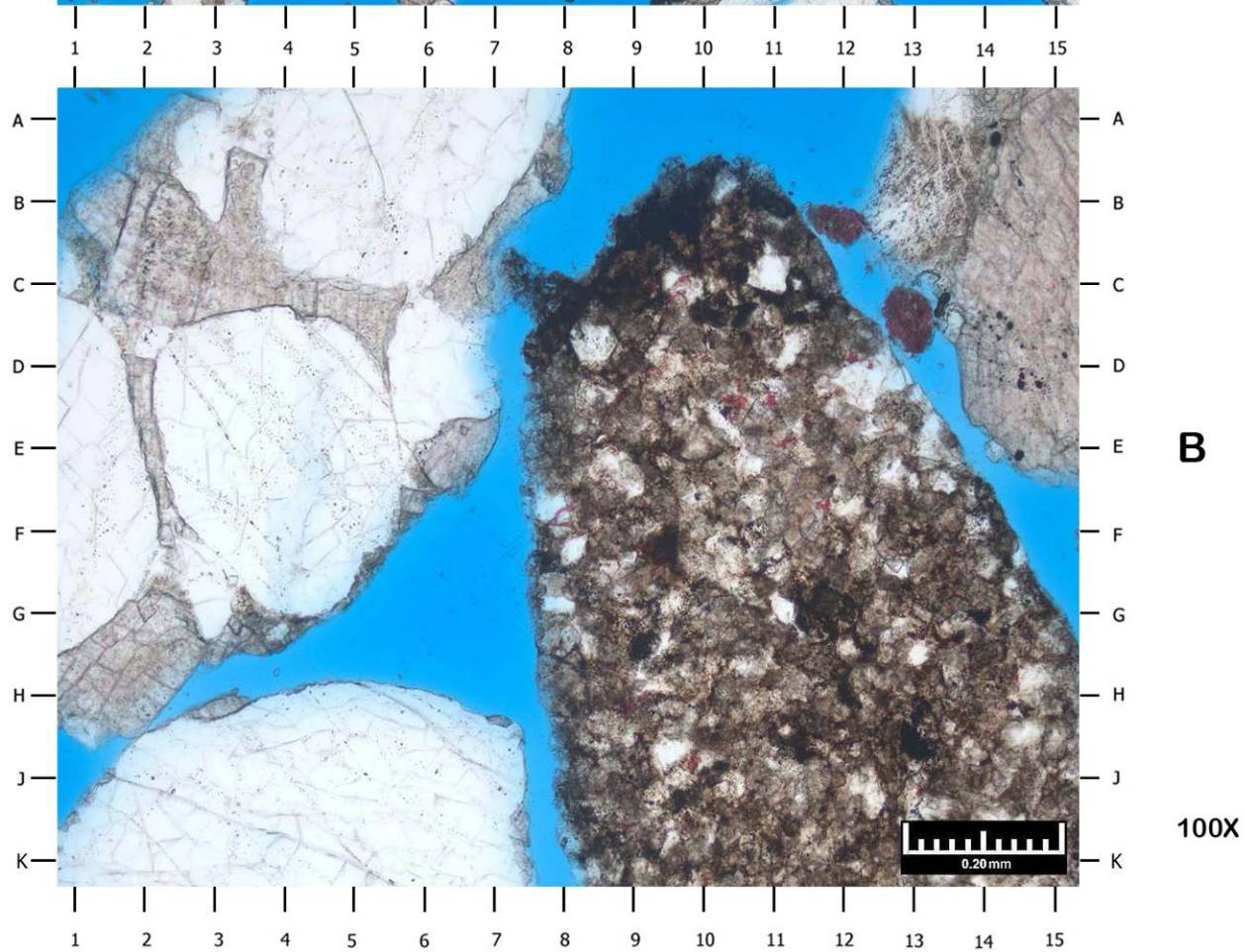
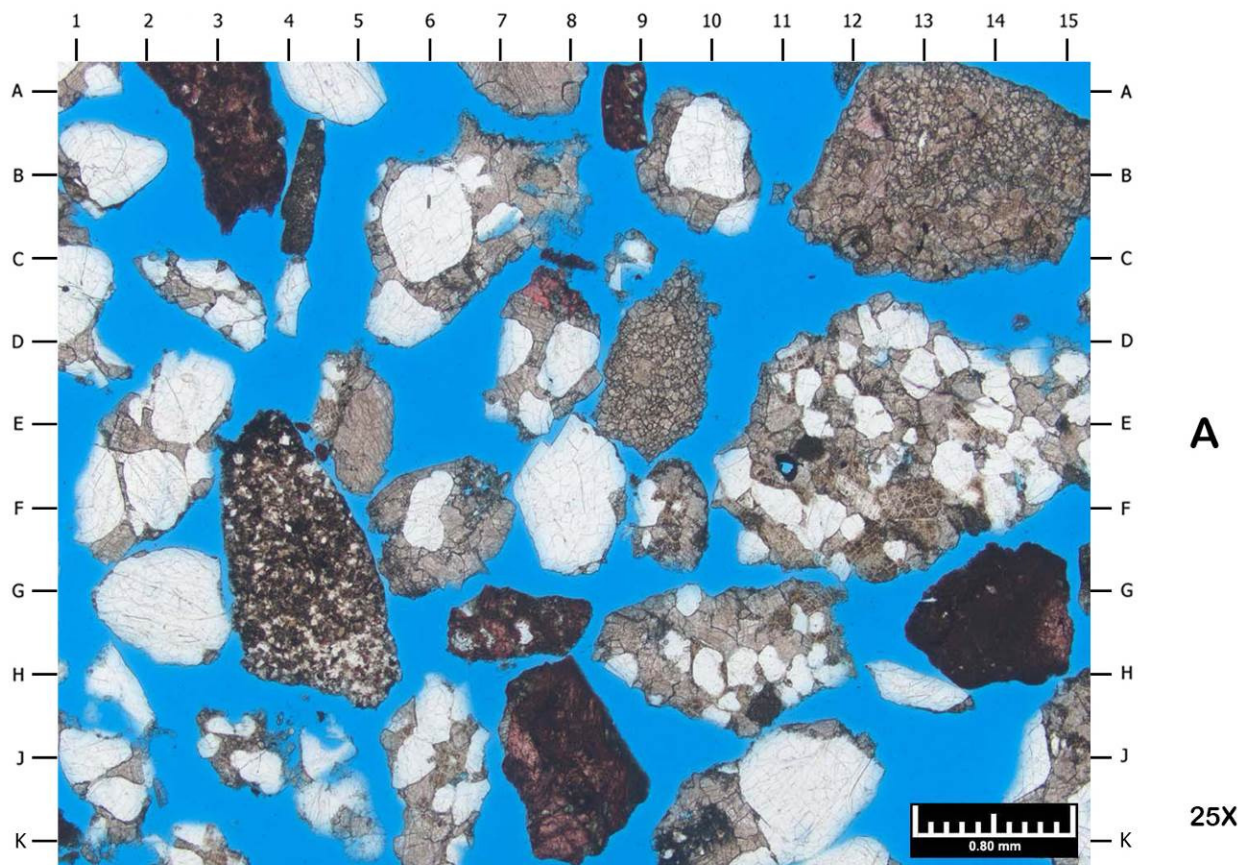
Authigenic Minerals: Dolomite, quartz overgrowths, and feldspar overgrowths occlude intergranular spaces within dominant sandstone; dolomite replacement of unstable grains/allochems and replacement of precursor matrix within dolostone chips; calcite occurs as intergranular cement within lime grainstone chips, as replacement and/or recrystallization of grains, allochems, and matrix material (mostly within limestone chips); calcite is rare to minor within the dominant sandstone; and rare pyrite replacement of unstable particles

Porosity Types: Dominant sandstone contains minor primary intergranular pores, minor secondary pores, and minor intercrystalline pores occurring between pore-filling dolomite crystals; rare intercrystalline pores within dolostone; limestone chips contain no visible porosity; bit-sheared grains and fractures are common artifacts of drilling

Magnification: A: 25X B: 100X

A) Lithologies illustrated within this low magnification view include dolomitic, fine- to medium grained sandstone (E11-15, GH10.5, EF2, C6.5, J6, JK10.5, J15, DE7.5, CD1); dolostone (B12-15, DE9); sandy/silty dolostone (FG4); limestone (AB3, J8, GH14, GH7.5); and loose, unconsolidated medium to coarse sand grains (G2.5, F8). A secondary pore (blue epoxy), lined by pyrite (black) occurs at EF11.

B) This photomicrograph provides a high magnification view of the area centered near F3 in Photo A. The dominant, fine- to coarse-grained sandstone (top-left) contains monocrystalline quartz (EF1, EF4, B5.5, DE6.5) and feldspar grains (not pictured) that are rounded to sub-rounded in sphericity. Dolomite (C2-4, H2) and quartz overgrowths (AB3.5, CD2, EF5.7) occlude intergranular pores within this view. The isolated coarse sand grain at K4 has a measured diameter of 0.72mm. The sandy/silty dolostone chip contains coarse silt to very fine sand grains of monocrystalline quartz (C11, D8.3) and feldspar (FG8.4, GH14.8).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13120-13125 FEET
SAMPLE NUMBER: 21D

PLATE 21

Lithologies:

Major: Dolomitic, fine- to coarse-grained sandstone
Minor: Dolostone; limestone (variably sandy and dolomitic); dolomitic very fine-grained sandstone; medium to coarse sand grains (isolated, loose, unconsolidated grains)

Sedimentary Fabric: Massive to bioturbated sandstone; oolitic/peloidal grainstone to lime mudstone texture in limestone chips

Grain Size Range: <0.03mm to 0.97mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz
Minor: Plagioclase feldspar and potassium feldspar
Accessory: Micritic peloids (limestone) and recrystallized ooids with radial crystal structure (limestone and dolostone)

Matrix Composition: No detrital clay observed within dominant sandstone; minor to locally common micrite within limestone chips

Authigenic Clay: Trace to rare undifferentiated clay imbedded between grain-binding cements and occurring as a rare grain replacement

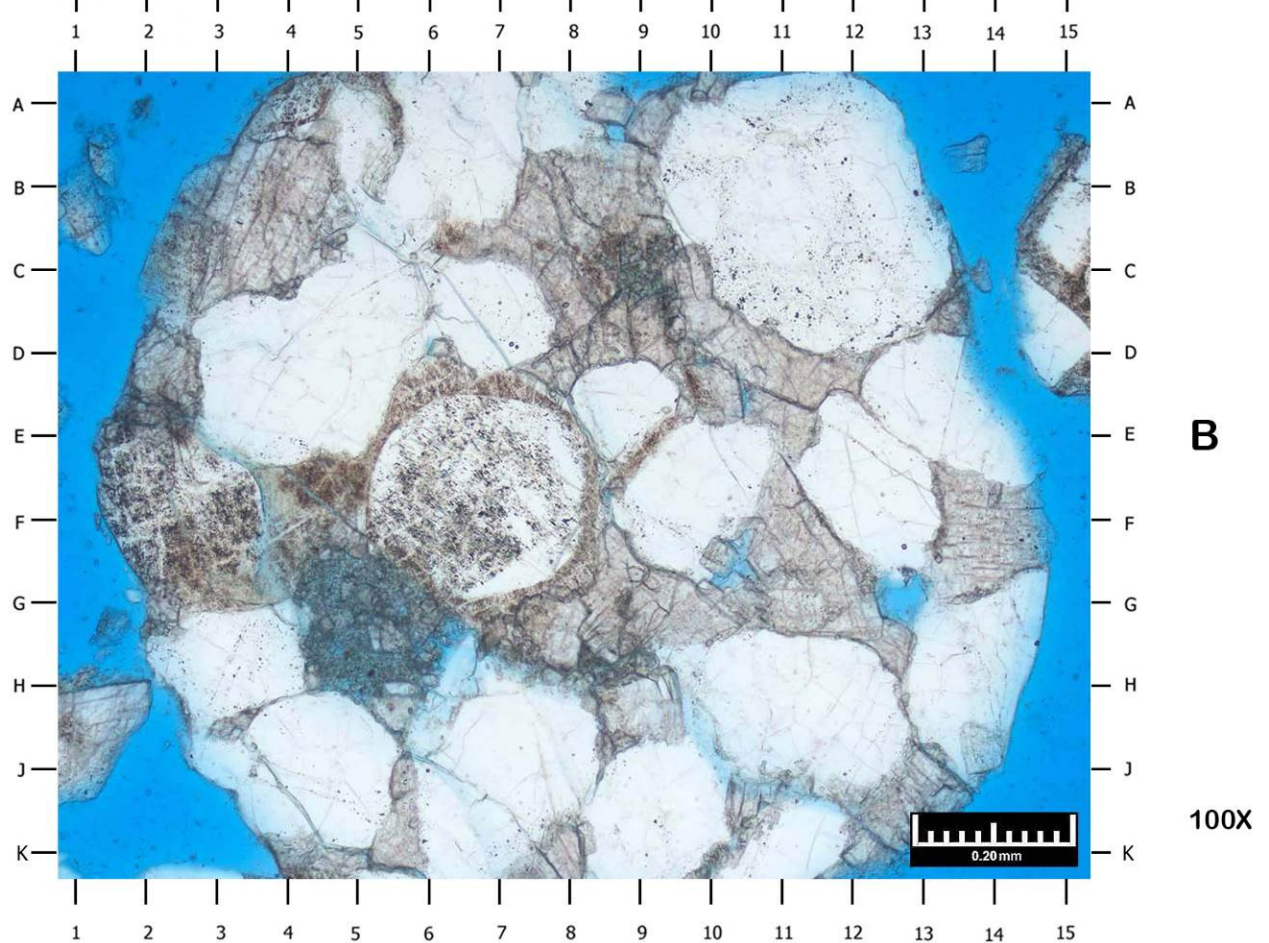
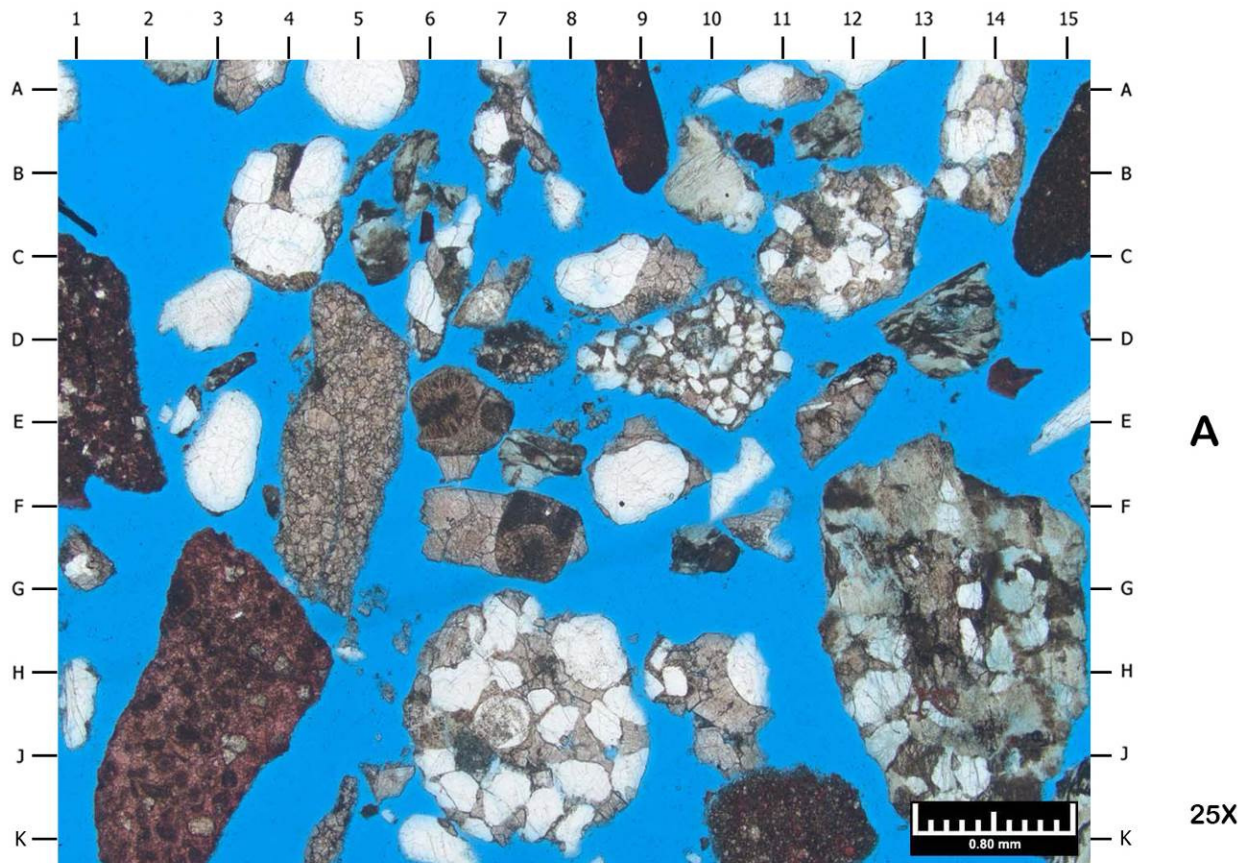
Authigenic Minerals: Dolomite, quartz overgrowths, and feldspar overgrowths occlude intergranular spaces within dominant sandstone; dolomite replacement of unstable grains/allochems and replacement of precursor matrix within dolostone chips; calcite occurs as intergranular cement within lime grainstone chips, as replacement and/or recrystallization of grains, allochems, and matrix material (mostly within limestone chips); calcite is rare to minor within the dominant sandstone; and rare pyrite replacement of unstable particles

Porosity Types: Minor secondary intragranular pores and minor primary intergranular pores partially restricted by grain-binding cements within the dominant sandstone lithology; fractures and bit-sheared cuttings are common drilling induced artifacts

Magnification: A: 25X B: 100X

A) Lithologies visible in this low magnification view include dolomitic, fine- to coarse-grained sandstone (BC4, HJ7.5, AB14, C9, H10, BC12); dolostone (EF5, FG6.5, E6.5, K11, B15); limestone (H3, DE1, AB9); dolomitic, very fine-grained sandstone (D10); and isolated, unconsolidated, medium to coarse sand grains (EF3, CD2.5). The cutting chip at GH12-15 is damaged due to bit shearing during drilling. Dolomitized ooids with radial crystal structure are visible at E6 and FG7.3.

B) This photomicrograph provides a high magnification view of the area centered HJ7.5 in Photo A and illustrates the dominant sandstone lithology. Dolomite (BC8, G11, F14), quartz overgrowths (BC5.5, CD6), and feldspar overgrowths (DE6, G7) act as grain-binding cements between framework grains of monocrystalline quartz (DE4, B6.5, B11, DE13, H13.5, HJ11.5, J5, J7.5) and feldspar (F2.5, EF6.5). Remnant primary intergranular porosity (G13, FG10.2, DE10.3) occurs between cementing dolomite crystals. Secondary porosity occurs within leached and/or altered grains (GH5).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13130 FEET
SAMPLE NUMBER: 22D

PLATE 22

Lithologies:

Major: Limestone (variably sandy); slightly feldspathic, dolomitic, very fine- to fine-grained sandstone

Minor: Dolostone (variably sandy); dolomitic limestone; slightly carbonaceous/cherty, very fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; slightly laminated; predominantly sandy, peloidal lime grainstone with lesser wackestone to packstone also present

Grain Size Range: <0.03mm to 0.25mm (sand portion)

Compaction: Moderate

Visual Sorting: Poor to moderate (sand portion)

Grains/Allochems:

Major: Monocrystalline quartz and micritic peloids

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Organic fragments; recrystallized/altered, undifferentiated fossil fragments; and trace biotite/muscovite

Matrix Composition: Minor to locally common micrite within some limestone chips; trace detrital clay lamination intermixed with dolomicrite

Authigenic Clay: Trace chlorite within sandstone chips only

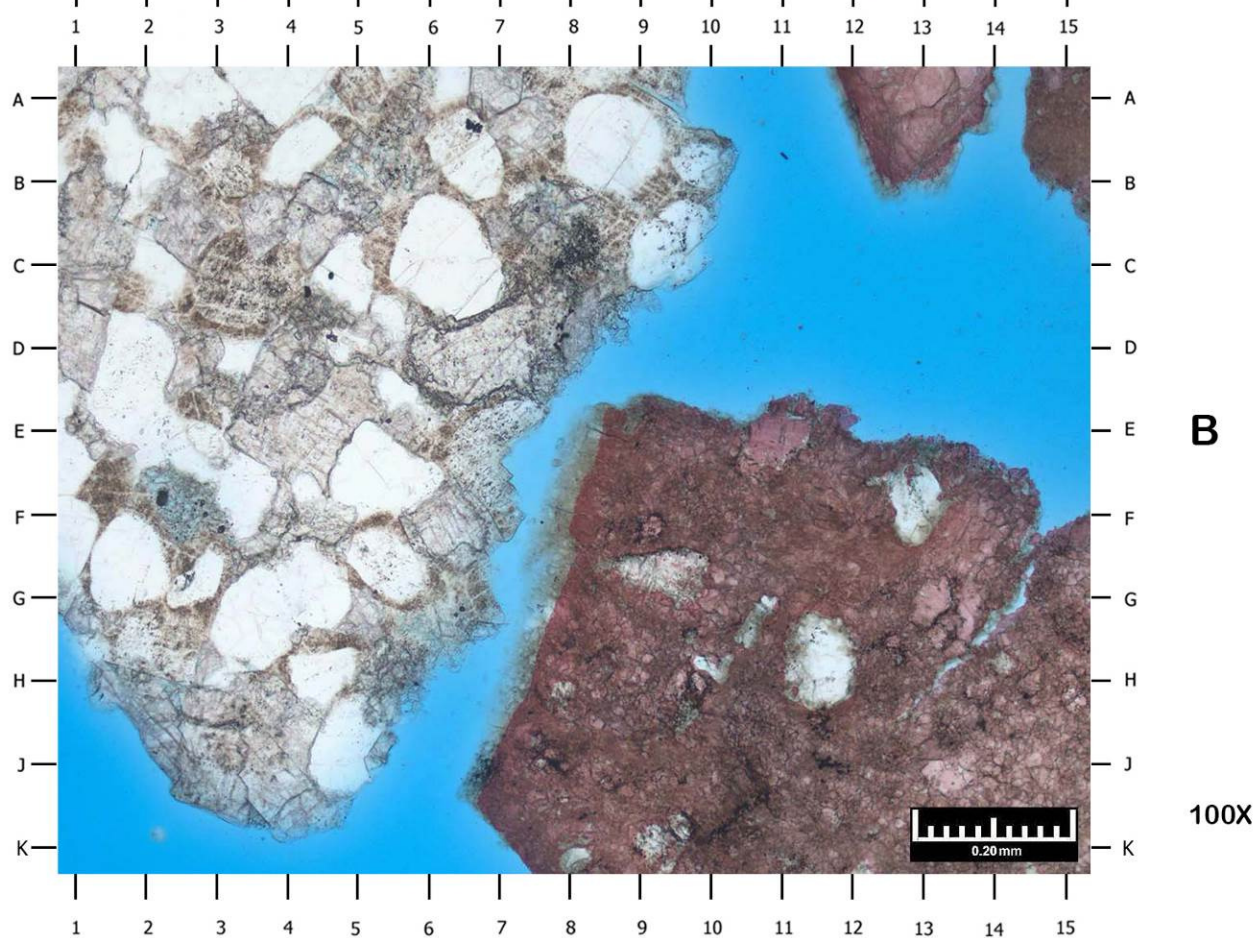
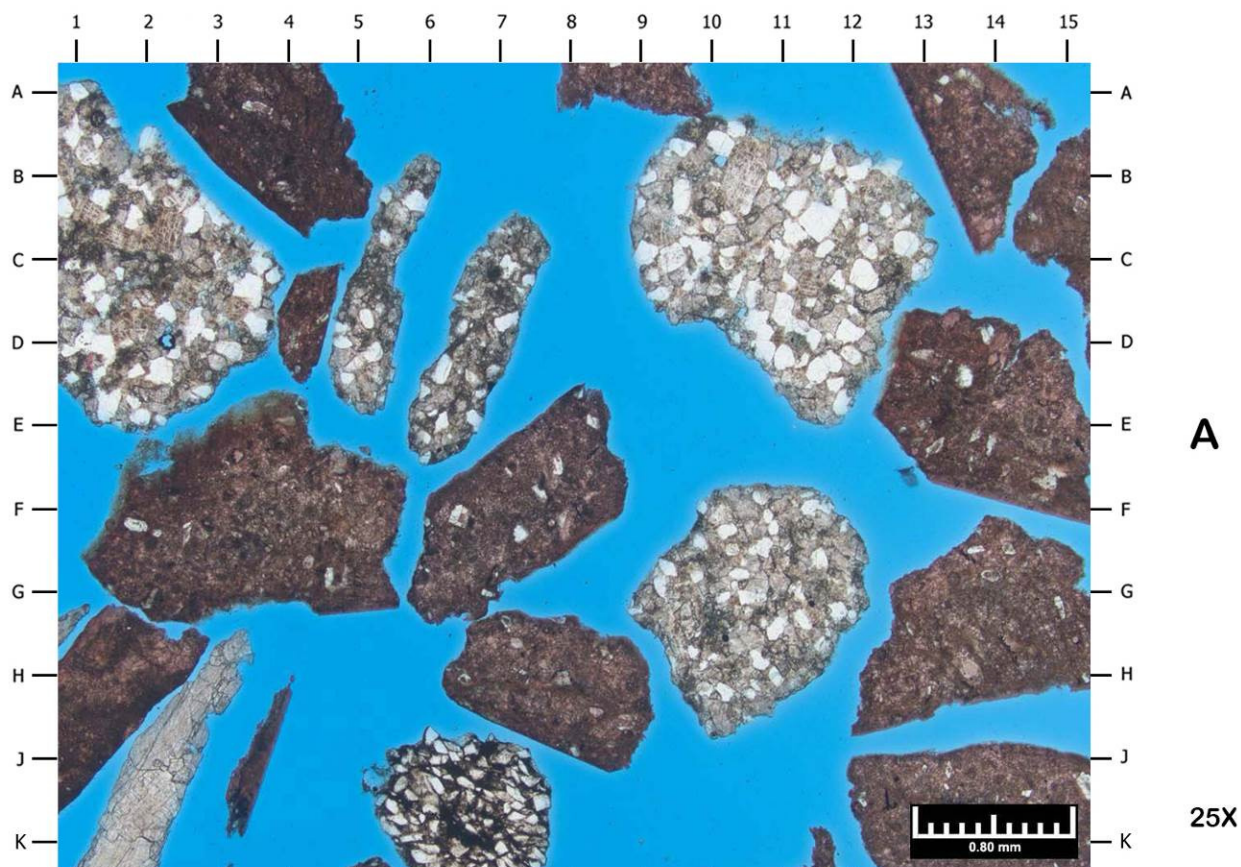
Authigenic Minerals: Major limestone contains common sparry calcite intergranular cement, calcite replacement of grains/allochems, minor patchy calcite replacement/recrystallization of precursor matrix material, minor dolomite replacement of allochems/grains; minor sandstone chips contain dolomite cement, dolomite replacement of unstable feldspar grains, quartz overgrowths, and feldspar overgrowths; minor pyrite replacement of organic material and other unstable particles; and rare siderite grain/allochem replacement

Porosity Types: The major limestone lithology contains no visible porosity; the minor sandstone lithology contains rare to minor secondary intragranular pores and rare to minor primary intergranular pores restricted by dolomite cement; fractures and bit-sheared chips are drilling induced artifacts

Magnification: A: 25X B: 100X

A) The dominant lithology within this depth interval is variably sandy limestone (F3.5, H1.5, H8, JK14, GH14, E14, BC15, AB13.5, A9) that exhibits a mostly peloidal grainstone texture. The next most prevalent lithology is slightly feldspathic, dolomitic, very fine- to fine-grained sandstone (C2, C11, G10.5, D7, CD5). Other minor visible lithologies include a slightly carbonaceous/cherty, very fine-grained sandstone chip (JK6.5) and a dolostone chip (JK2).

B) This photomicrograph provides a high magnification view of the area centered near D12.5 in Photo A. The dominant variably sandy limestone lithology contains no visible porosity (H8-15, A13, A15). However the dominant sandstone chips contain rare to minor secondary intragranular pores (F2.5, B5) within partially leached feldspar grains. Monocrystalline quartz (BC6.2, EF5.5) and feldspar (CD3, AB8.5) grains are cemented by dolomite (EF4, FG6.3), quartz overgrowths (GH4.2), and feldspar overgrowths (BC8.5).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13310 FEET
SAMPLE NUMBER: 23D

PLATE 23

Lithologies:

Major: Dolomitic, very fine-grained sandstone
Minor: Dolostone (variably sandy/silty); sandy, peloidal limestone; dolomitic limestone; sandy/silty mudstone; siltstone

Sedimentary Fabric: Bioturbated to massive; laminated; minor limestone chips exhibit a sandy, peloidal grainstone texture with lesser wackestone to packstone textures also present

Grain Size Range: <0.03mm to 0.76mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz
Minor: Plagioclase feldspar; potassium feldspar; and micritic peloids (limestone only)
Accessory: Organic fragments; muscovite/biotite; undifferentiated, recrystallized/altered fossil fragments; and trace zircon

Matrix Composition: Minor to common detrital clay in sandstone chips; abundant detrital clay in mudstone chips; minor to locally abundant micrite in limestone chips

Authigenic Clay: Rare to minor chlorite imbedded between other intergranular cements; minor chlorite occurring as replacement of unstable grains

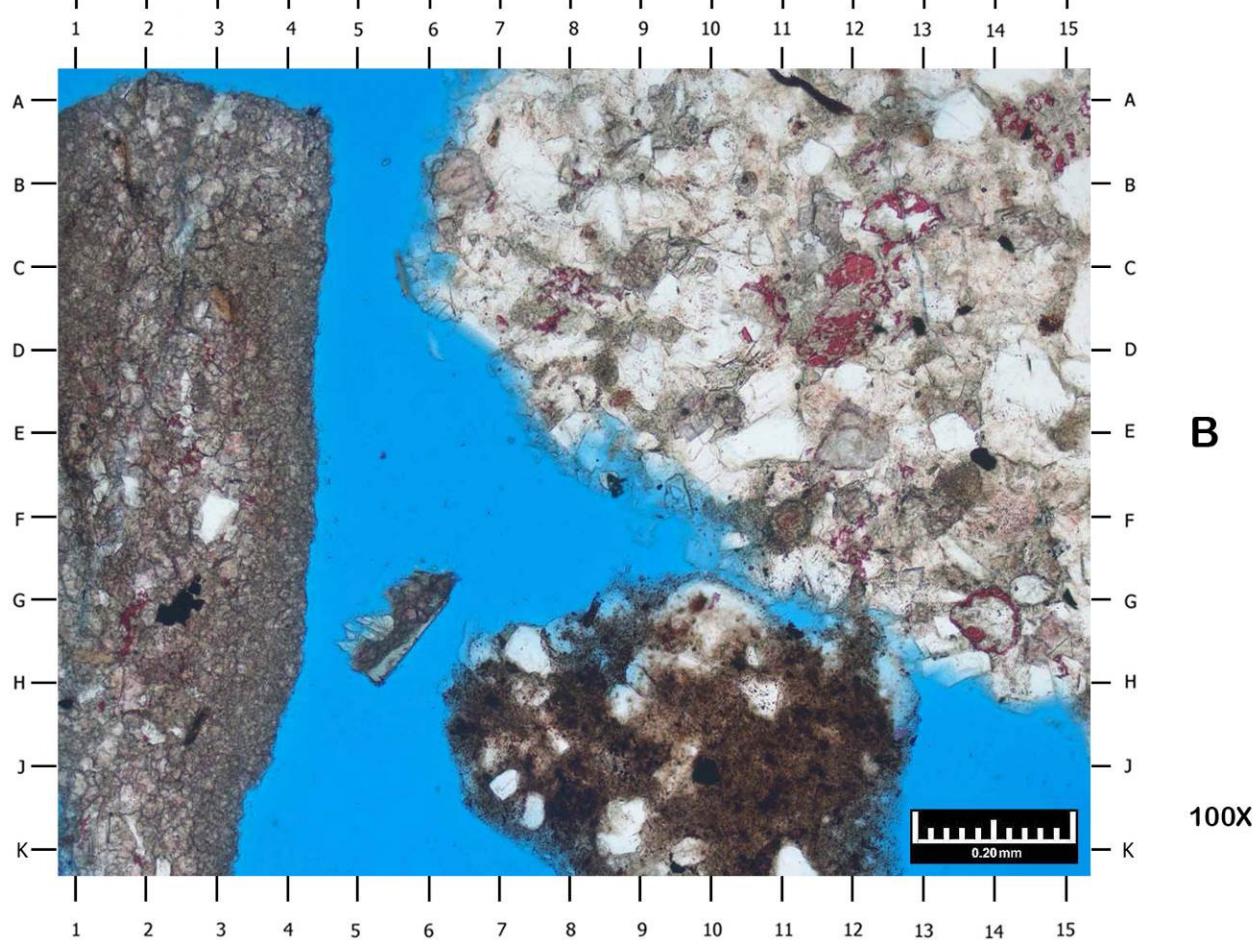
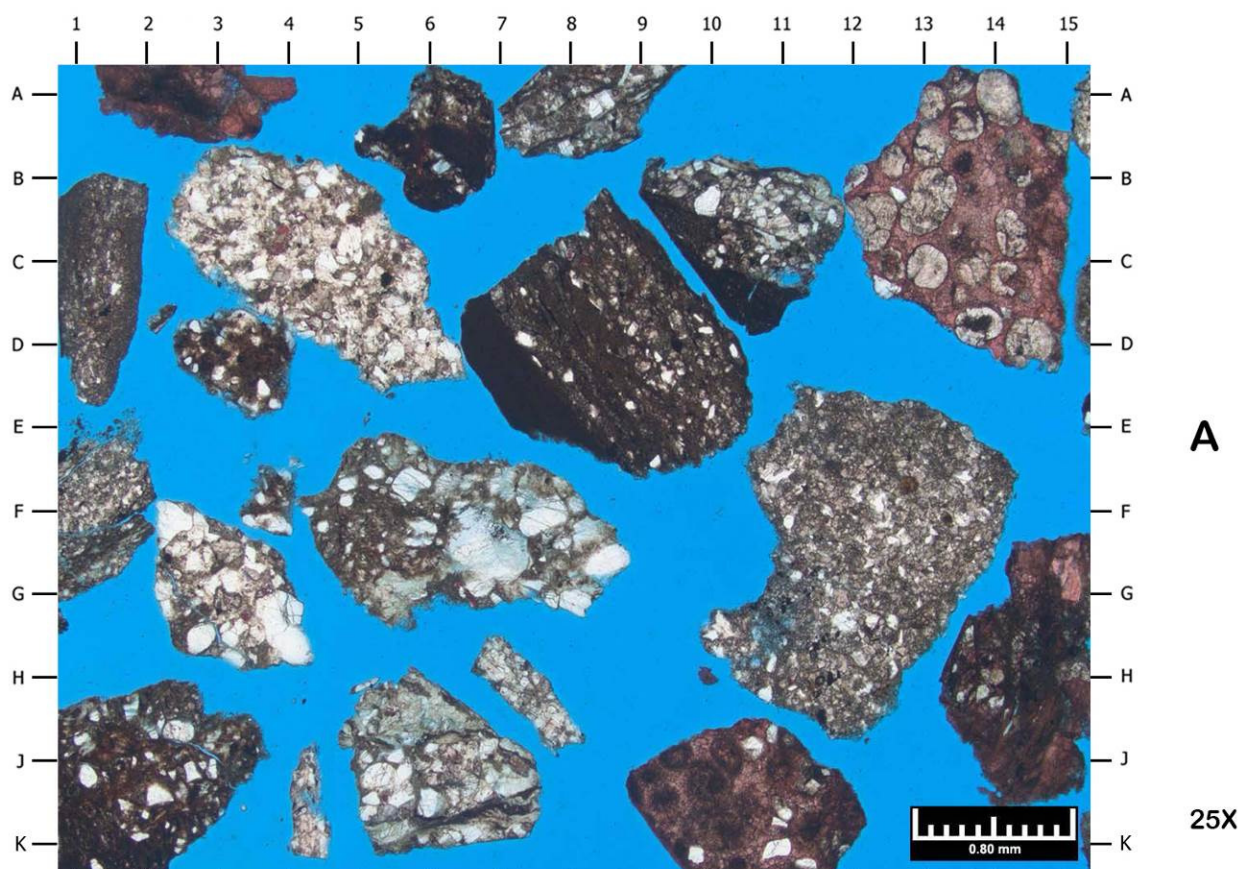
Authigenic Minerals: Dolomite and microcrystalline dolomite occurring as replacement of unstable grains, as intergranular cement, and as replacement of precursor matrix material within dolostone chips; common quartz overgrowth and feldspar overgrowth cement; calcite occurring as minor replacement of unstable grains and rare intergranular cement (within dominant sandstone), common intergranular cement (only within lime grainstone chips), and as localized replacement/recrystallization of precursor matrix (limestone chips); minor pyrite replacement of organic material and other unstable particles; and rare siderite replacement of unstable particles;

Porosity Types: No naturally occurring pores were observed using standard petrographic techniques; possible microporosity/nanoporosity associated with pore-filling chlorite and altered grains (cannot be verified without additional SEM analysis); numerous fractures and bit-sheared chips are induced artifacts from drilling

Magnification: A: 25X B: 100X

A) Lithologies represented within this low magnification view include dolomitic, very fine-grained sandstone (C4, G3, FG6, J6); variably silty/sandy dolostone (C1, F1.5, FG12.5); variably silty/sandy mudstone (D8.5, JK2, DE3); sandy, peloidal limestone (JK10.5); and dolomitic limestone (BC13.5).

B) This photomicrograph provides a high magnification view of the area centered near CD2.5 in Photo A. Detrital grains are predominantly monocrystalline quartz (E13.3, GH7.5, JK7, K11) and feldspar (DE14.2, DE10.5, A13). The dolostone chip is dominated by microcrystalline to finely-crystalline dolomite (AK2). The matrix of the silty/sandy mudstone chip at HJ7-12 contains detrital clay intermixed with microcrystalline dolomite. Intergranular areas within the dominant dolomitic, very fine-grained sandstone chip (top-right) are occluded by dolomite (C9, E9.5), quartz (AB6.9) and feldspar (E13.8) overgrowths, and calcite (C12, G14).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13385-13390 FEET
SAMPLE NUMBER: 24D

PLATE 24

Lithologies:

Major: Slightly feldspathic, dolomitic, very fine- to medium-grained sandstone
Minor: Dolostone; limestone (variably sandy); calcareous sandstone; medium- to coarse sand grains (isolated, loose, disaggregated grains)

Sedimentary Fabric: Massive to bioturbated

Grain Size Range: <0.03mm to 0.65mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Common plagioclase feldspar; minor to common potassium feldspar

Accessory: Trace tourmaline; peloids and intraclasts (within minor limestone chips only)

Matrix Composition: Minor to locally common detrital clay within some sandstone chips; micrite within minor limestone chips

Authigenic Clay: Rare to minor pore-filling chlorite occurs imbedded between other intergranular cements chlorite also occurs as a rare to minor grain replacement

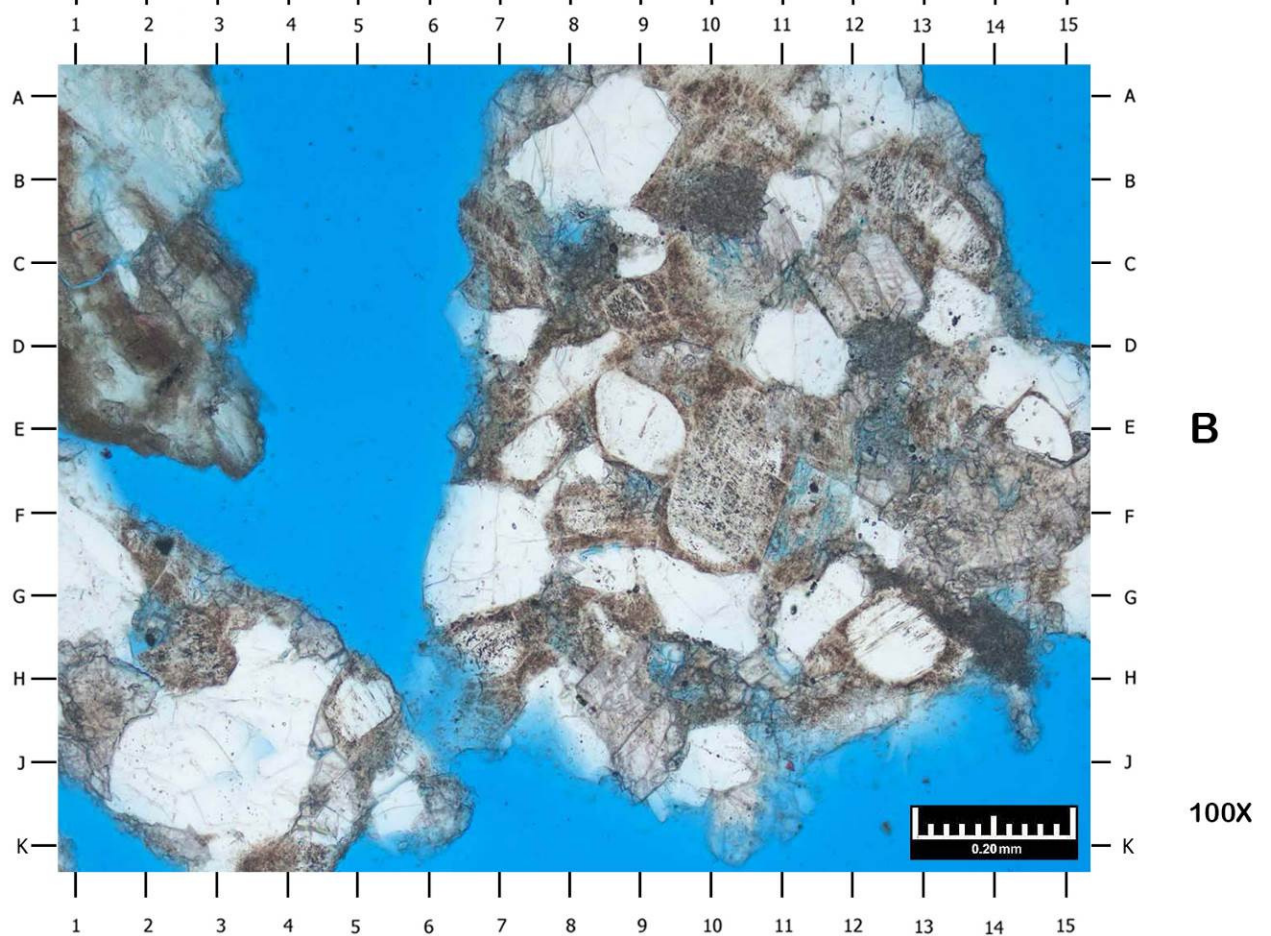
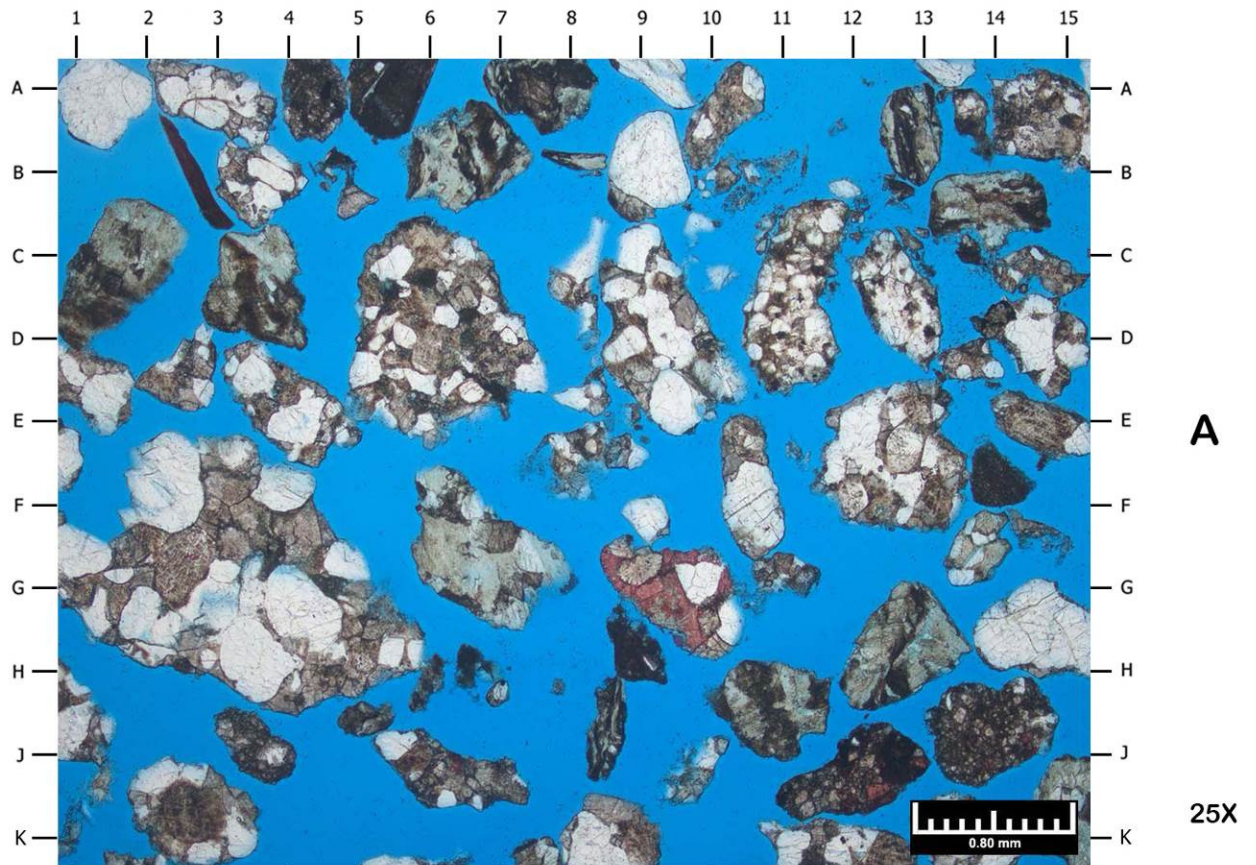
Authigenic Minerals: Common dolomite occurring as intergranular cement and replacement of unstable grains/allochams; minor to locally common quartz overgrowth and feldspar overgrowth cement; minor calcite cement and replacement of unstable grains/allochams; rare to minor pyrite replacement of unstable particles; rare siderite replacement of unstable grains

Porosity Types: Minor secondary intragranular pores associated with leached feldspar grains; minor restricted primary intergranular pores in localized areas of incomplete cementation; possible microporosity/nanoporosity associated with pore-filling chlorite; fractures and bit-sheared cuttings are common artifacts of drilling

Magnification: A: 25X B: 100X

A) Slightly feldspathic, dolomitic, very fine- to medium grains sandstone is the dominant lithology within this depth interval (CD6, G3, D9, CD11, EF12.5, A3, JK2.5, K8.5, K12). A calcareous sandstone chip occurs at G9.5. Several damaged, bit-sheared chips are also visible within this low magnification view (BC14, AB13, B6.5, H12.5, HJ11, FG7, C1.5).

B) This photomicrograph provides a high magnification view of the area centered near D5.5 in Photo A and illustrates two chips from the dominant lithology. Detrital grains are predominantly monocrystalline quartz (FG7, G10, B8.5, D11, J3, G1) with common to abundant feldspar grains also present (F10, HJ5, EF7.5, BC13.3, CD9, E9, GH12.5). Dolomite occludes some intergranular areas (H11, HJ1.5) and replaces unstable grains (F14, BC10). Quartz overgrowths (DE14.5, G11.3, GH1.8, JK3.5, BC11.3) and feldspar overgrowths (B9.5, FG9.5, FG8, J5, GH7.5) occlude most of the remaining intergranular pore space. Visible pore types include secondary intragranular pores (F11.3, C10) and primary intergranular pores (BC8, GH2, FG8.5, EF9).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13390-13395 FEET
SAMPLE NUMBER: 25D

PLATE 25

Lithologies:

Major: Variably sandy limestone

Minor: Dolostone to sandy dolostone; silty/sandy mudstone; slightly pyritic, calcareous very fine-grained sandstone

Sedimentary Fabric: Bioturbated; laminated; sandy, peloidal lime grainstone with lesser possible recrystallized wackestone to packstone; organic-rich/pyritic, incipient microstylolites

Grain Size Range: <0.03mm to 0.40mm (sand portion)

Compaction: Moderate to high

Visual Sorting: Moderate (sand portion)

Framework Grains:

Major: Monocrystalline quartz and micritic peloids

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Minor organic fragments; rare intraclasts; undifferentiated, recrystallized, calcareous fossil fragments; and trace muscovite

Matrix Composition: Minor to common micrite in limestone chips; abundant detrital clay in minor mudstone chips; minor detrital clay in rare sandstone chips; detrital clay concentrated along minor laminations

Authigenic Clay: None observed

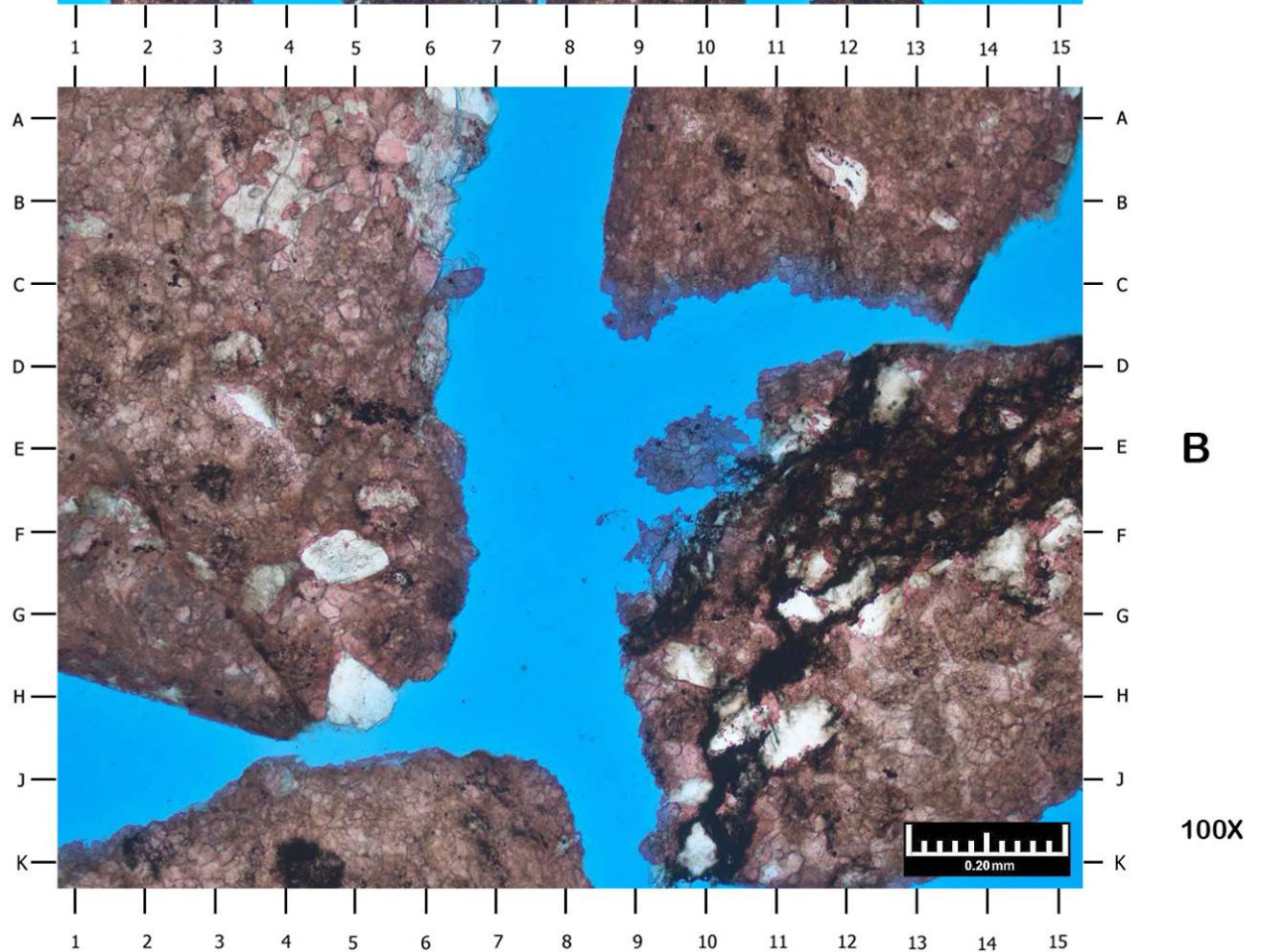
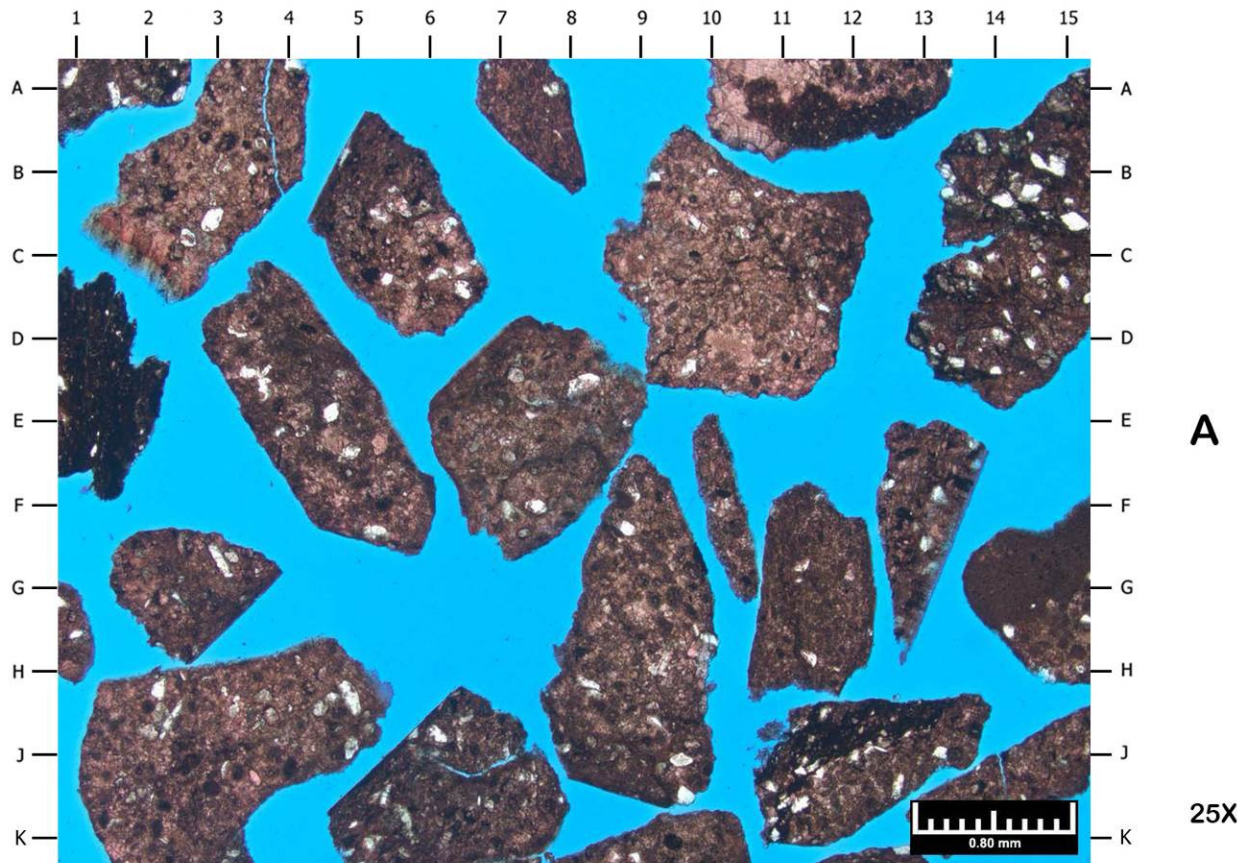
Authigenic Minerals: Sparry calcite occurring as intergranular cement, localized replacement/recrystallization of precursor matrix, and replacement of grains/allochems; minor dolomite grain/allochem replacement within limestone and minor dolostone chips contain abundant dolomite cement; minor to locally common pyrite occurring as replacement of organic material and other unstable particles

Porosity Types: No naturally occurring pores were observed using standard petrographic techniques; fractures and bit-sheared grains are drilling induced artifacts

Magnification: A: 25X B: 100X

A) This low magnification view documents several cuttings chips from the dominant variably sandy limestone lithology (B3, C10, BC14.5, E4, J2.5, JK6, GH9, J12, G15). The main texture of these limestone chips is sandy, peloidal grainstone. A sandy, silty mudstone chip that is also slightly pyritic and carbonaceous occurs at DE1.

B) This photomicrograph provides a high magnification view of the area centered near HJ10.5 in Photo A. Visible detrital grains/allochems include partially recrystallized micritic peloids (HJ13.3, D1.2, AB2.5, EF3.8), monocrystalline quartz (FG5, H5, G11.5), and feldspar (HJ10.5, F15). Most intergranular areas are occluded by sparry calcite cement (BC2, H14.3, HJ12.8, AB2). Partially pyritized organic material and detrital clay occur concentrated along a lamination and/or possible incipient microstylolite at JK10.3 to DF15.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13400 FEET
SAMPLE NUMBER: 26D

PLATE 26

Lithologies:

Major: Variably sandy limestone

Minor: Dolomitic, medium-grained sandstone to sandy dolostone; dolostone; argillaceous, fine- to medium-grained sandstone; medium- to coarse sand grains (isolated, loose, disaggregated grains); slightly argillaceous/calcareous, dolomitic very fine-grained sandstone; and trace silty/sandy mudstone

Sedimentary Fabric: Mostly sandy, peloidal, lime grainstone; euhedral to subhedral dolomite; massive to bioturbated; slightly laminated; trace organic-rich microstylolite

Grain Size Range: <0.03mm to 0.55mm

Compaction: Moderate to high

Visual Sorting: Moderate

Grains/Allochems:

Major: Monocrystalline quartz and micritic peloids

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Organic fragments and trace zircon

Matrix Composition: Minor detrital clay in sandstone chips; minor to common micrite in limestone chips; abundant detrital clay in trace mudstone chips

Authigenic Clay: Rare to minor chlorite/illite recrystallization of detrital matrix clays; rare pore-filling chlorite imbedded between other intergranular cements; and rare to minor chlorite/illite grain replacement

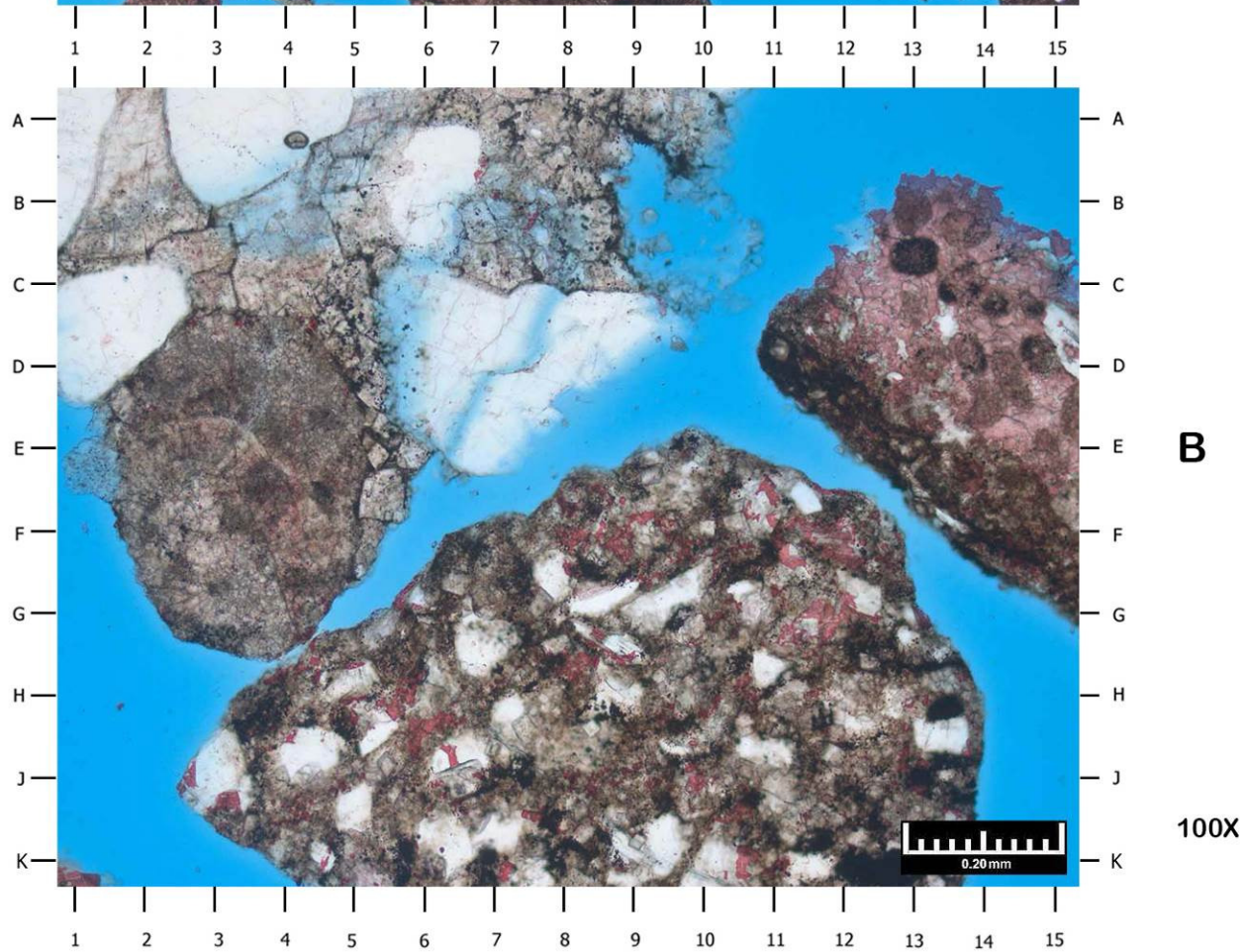
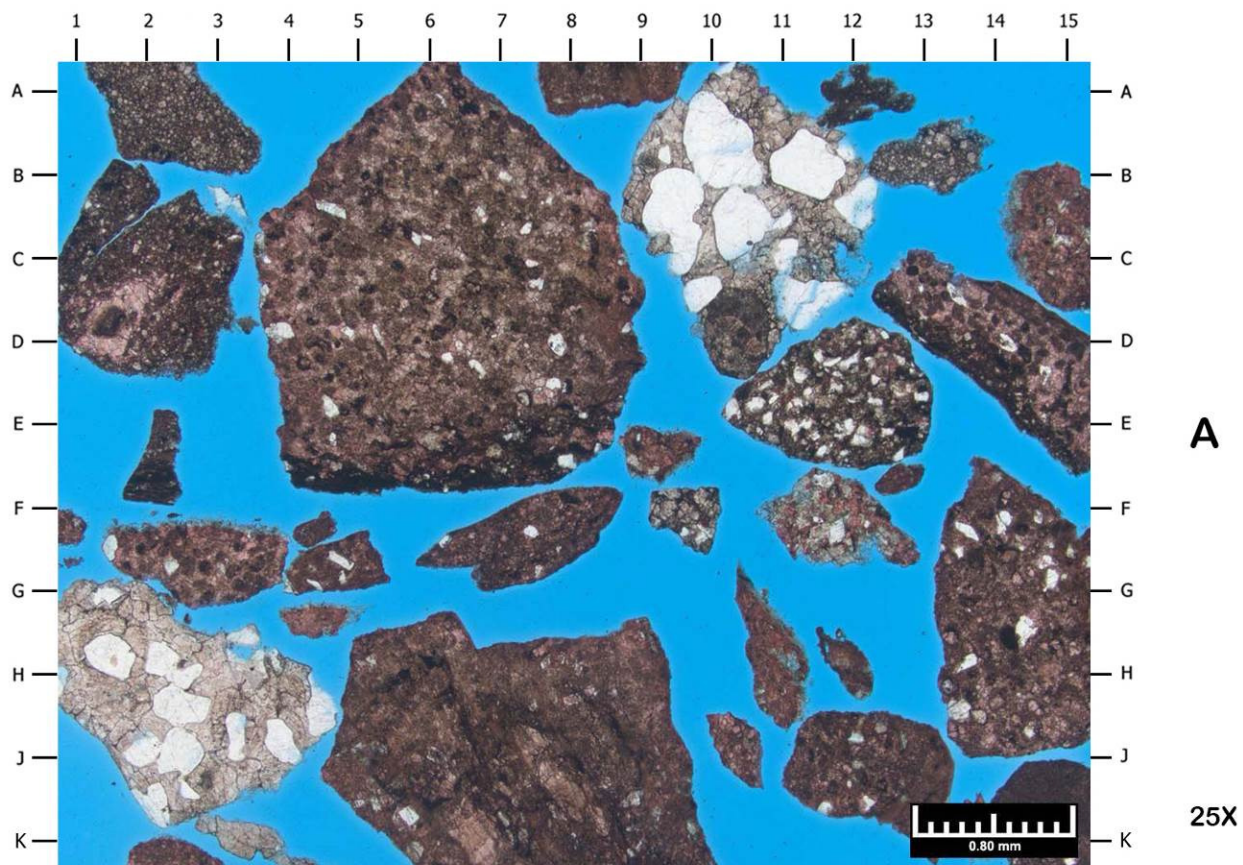
Authigenic Minerals: Abundant sparry calcite intergranular cement (limestone chips) and grain/allochem replacement; common to abundant dolomite cement and grain/matrix replacement (sandstone and dolostone); minor pyrite replacement of unstable particles; and trace bitumen occluding intercrystalline areas within dolostone

Porosity Types: No naturally occurring pores were observed using standard petrographic techniques; fractures and bit-sheared grains are drilling induced artifacts

Magnification: A: 25X B: 100X

A) Variably sandy, peloidal, limestone with a grainstone texture is the dominant lithology at this depth interval (CD2, CD6, A2, FG2.5, J7.5, BC15, GH14.5, J12, D14). Dolomitic medium-grained sandstone to borderline sandy dolostone chips are pictured at HJ2.5 and BC10.5. A slightly argillaceous/calcareous, dolomitic very fine-grained sandstone chip occurs at DE12.

B) This photomicrograph provides a high magnification view of the area centered near CD12 in Photo A and represent cuttings chips from three different lithologies. The sandy dolostone chip in the top-left contains rounded to sub-rounded grains of monocrystalline quartz (AB3.5, CD1.5, D7) with dolomite cement occluding the intergranular areas (B2, C4, AC7.5). The limestone chip at D13.5 represents the dominant lithology and contains intergranular sparry calcite cement between quartz grains (CD15) and micritic peloids (D14.2, B13). The intergranular areas within the very fine-grained sandstone chip at bottom-center are occluded by a combination of undifferentiated clay imbedded within dolomite (H11, J12) and calcite (stained red; HJ6, G11.8) intergranular cements; clusters of microcrystalline pyrite are also present (black; K12.5, K7).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13445-13450 FEET
SAMPLE NUMBER: 27D

PLATE 27

Lithologies:

Major: Calcareous, very fine- to fine-grained sandstone; argillaceous, very fine- to fine-grained sandstone (variably calcareous and dolomitic)
Minor: Dolomitic, very fine- to medium-grained sandstone; limestone (variably sandy); mudstone (variably silty/sandy); medium- to coarse sand grains (isolated, loose, disaggregated grains); and crystalline dolostone

Sedimentary Fabric: Bioturbated to massive; laminated; sandy grainstone with lesser wackestone/packstone (minor limestone only)

Grain Size Range: <0.03mm to 0.57mm

Compaction: Moderate

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and micritic peloids

Accessory: Minor organic fragments; rare undifferentiated, recrystallized calcareous fossil fragments; and trace biotite/muscovite

Matrix Composition: Rare to minor detrital clay in sandstone chips; abundant detrital clay in mudstone chips; minor to common micrite in limestone chips

Authigenic Clay: Rare to minor pore-filling chlorite imbedded between other intergranular cements and chlorite/illite occurring as rare to minor grain replacement; possible recrystallization of detrital clay

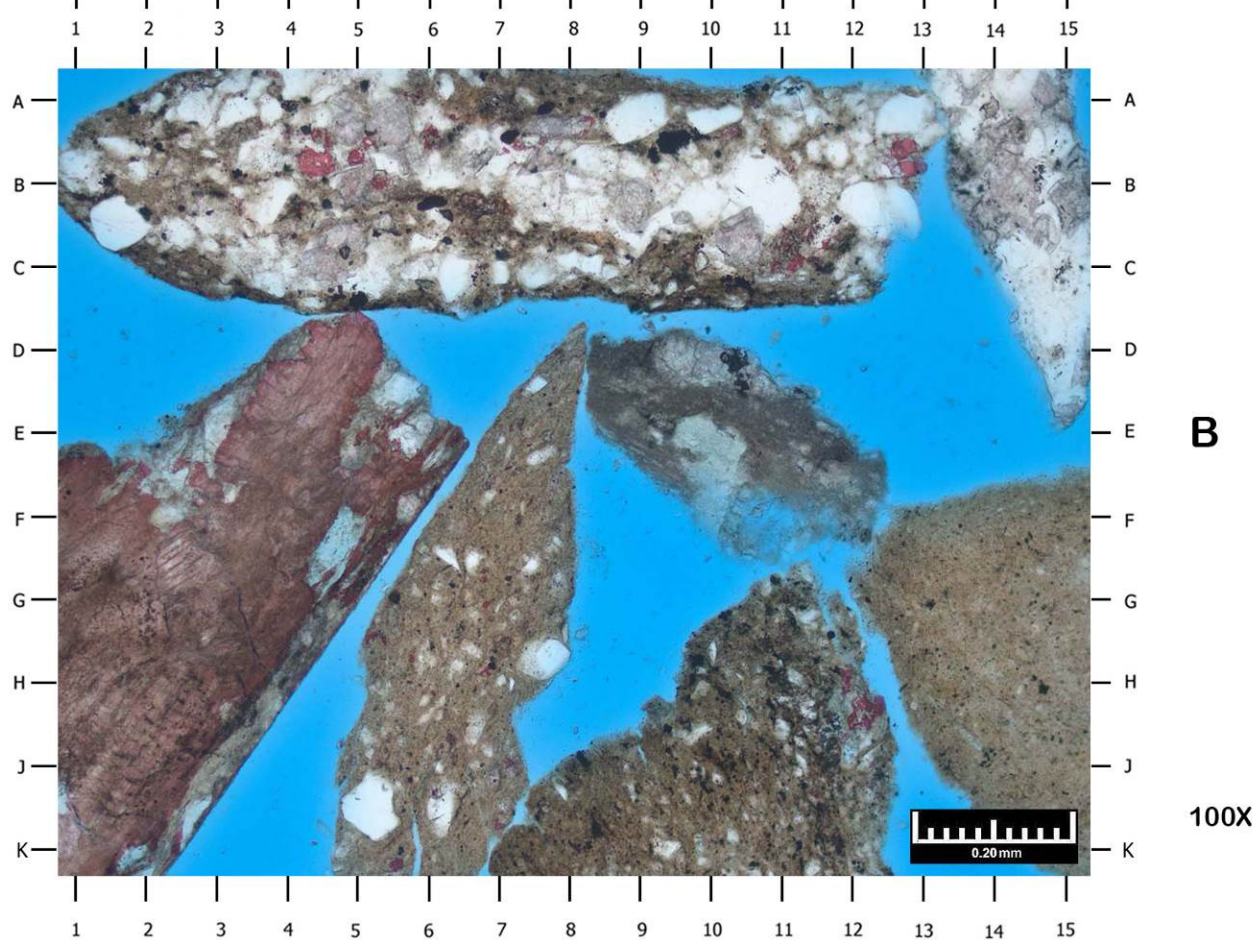
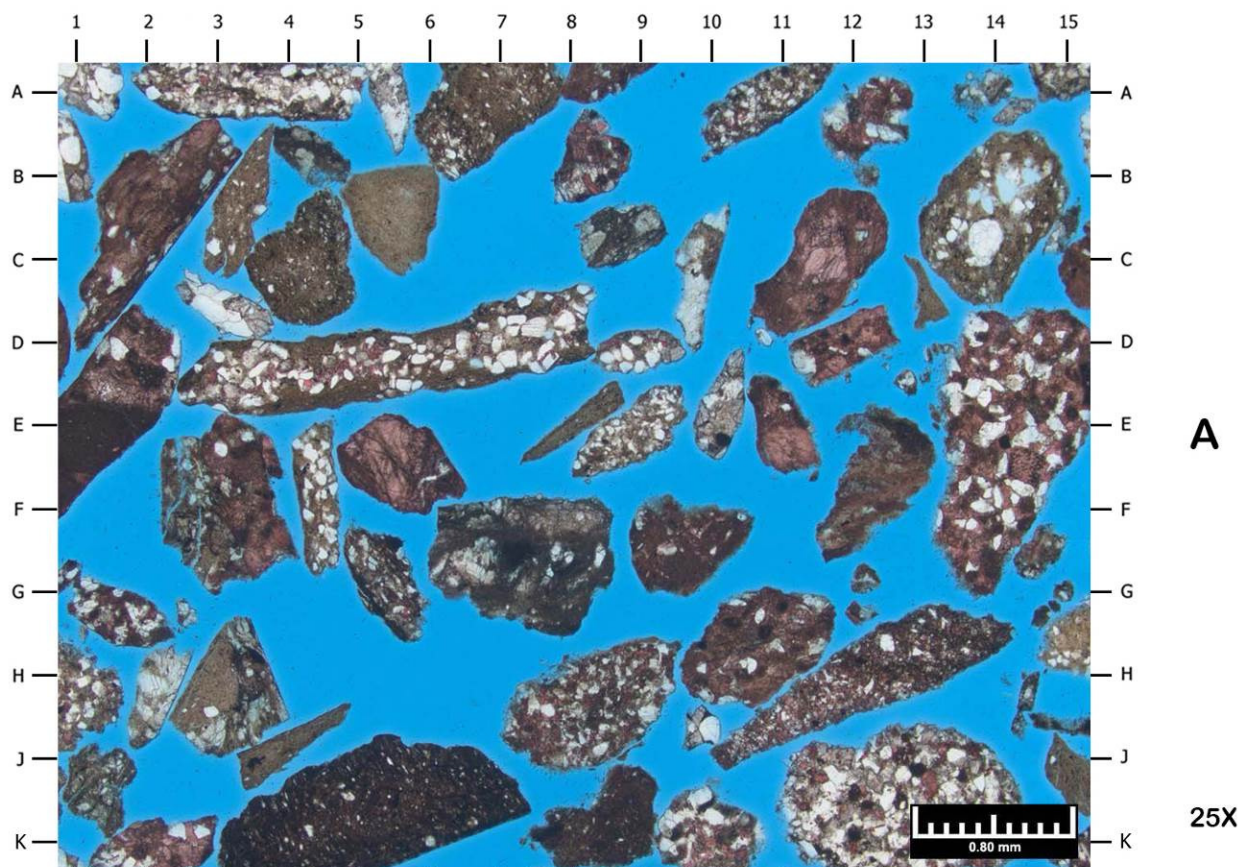
Authigenic Minerals: Common sparry calcite intergranular cement (within dominant sandstone and rare lime grainstone) and calcite occurring as replacement/recrystallization of grains/allochments and matrix (within limestone); minor to locally common dolomite occurring as intergranular cement and replacement of unstable grains/allochments; minor to locally common quartz overgrowth and feldspar overgrowth cement; rare to minor pyrite replacement of unstable particles; and trace siderite replacement

Porosity Types: Trace secondary intragranular micropores associated with altered feldspar grains; fractures and bit-sheared grains are drilling induced artifacts

Magnification: A: 25X B: 100X

A) Lithologies visible in this low magnification view include calcareous, very fine- to fine-grained sandstone (E14.5, HJ8.5); argillaceous, very fine- to fine-grained sandstone (variably calcareous/dolomitic; DE3-8, A3.5, JK12.5); limestone (variably sandy; BC2, F3, GH10.5, C11.5); and mudstone (variably silty/sandy; BC14, JK5, C4, A7, BC3.3, BC5.5, HJ3).

B) This photomicrograph provides a high magnification view of the area centered near B3.5 in Photo A. The mudstone chips at EK6, JK8-12, and GH13-15 are dominated by illitic detrital clay. The argillaceous sandstone at B1-12 contains minor to common detrital clay matrix; authigenic minerals present within this sandstone chip include dolomite (C4.5, BC9, C10.5), calcite (stained red; B4.4, AB12.9), quartz overgrowths (BC10.2, B8), and pyrite (black; AB9.5, AB7.2). The recrystallized limestone chip at K1-D5 is damaged/bit-sheared. Detrital grains pictured include quartz (BC1.5, JK5) and feldspar (B11, GH7.5).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13450-13455 FEET
SAMPLE NUMBER: 28D

PLATE 28

Lithologies:

Major: Dolomitic, very fine- to medium-grained sandstone
Minor: Argillaceous, very fine- to medium-grained sandstone; limestone (variably sandy and dolomitic); silty/sandy mudstone; medium- to coarse sand grains (isolated, loose, disaggregated grains)

Sedimentary Fabric: Massive to bioturbated; slightly laminated; rare limestone exhibits a grainstone texture

Grain Size Range: <0.03mm to 0.60mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Micritic peloids (minor limestone chips only); trace muscovite/biotite; and trace zircon

Matrix Composition: Minor undifferentiated interstitial detrital clay (within minor sandstone); abundant detrital clay (within mudstone chips only); minor to locally common micrite (within minor limestone only)

Authigenic Clay: Rare to minor pore-filling chlorite imbedded between other intergranular cements and rare to minor chlorite/illite replacement of unstable grains

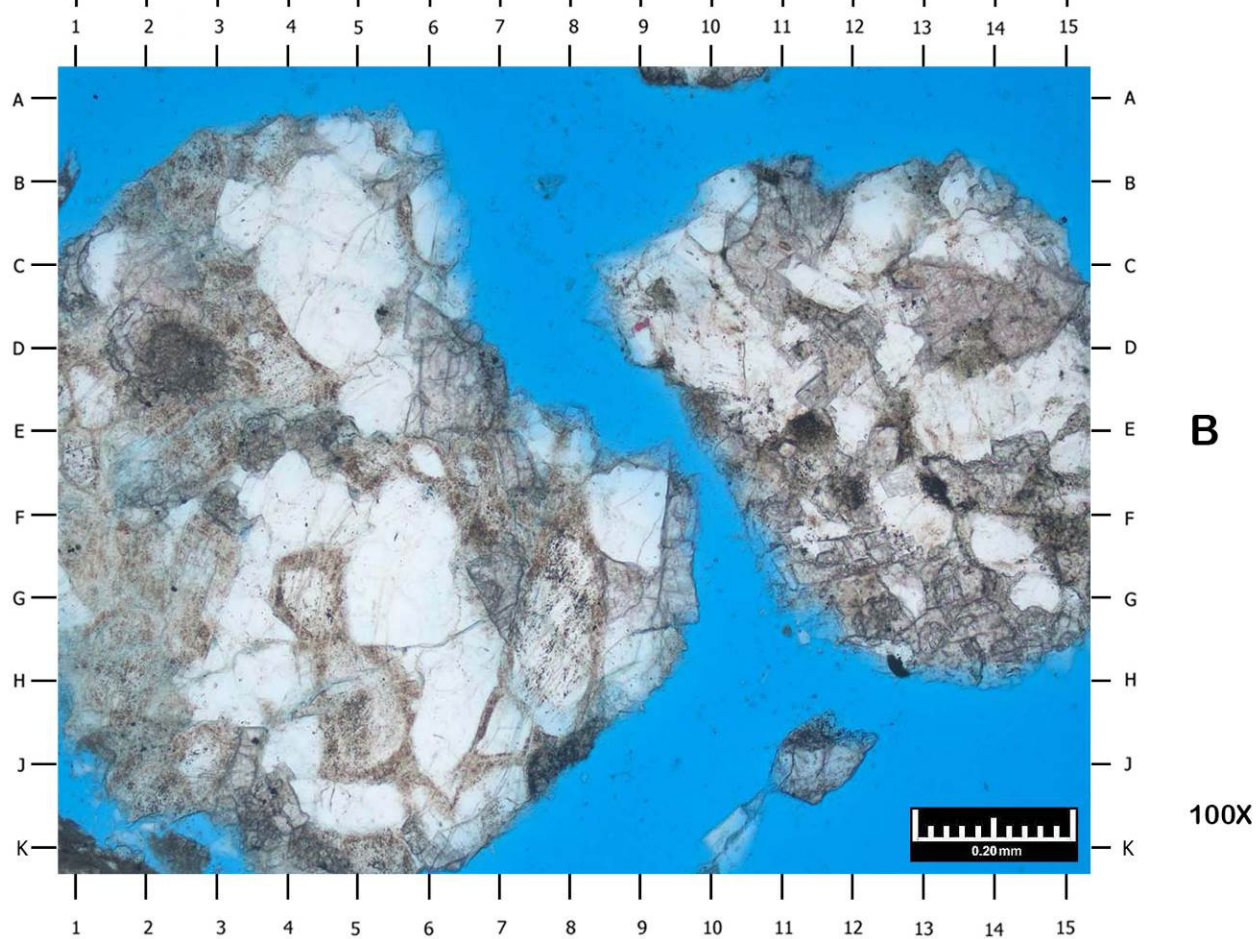
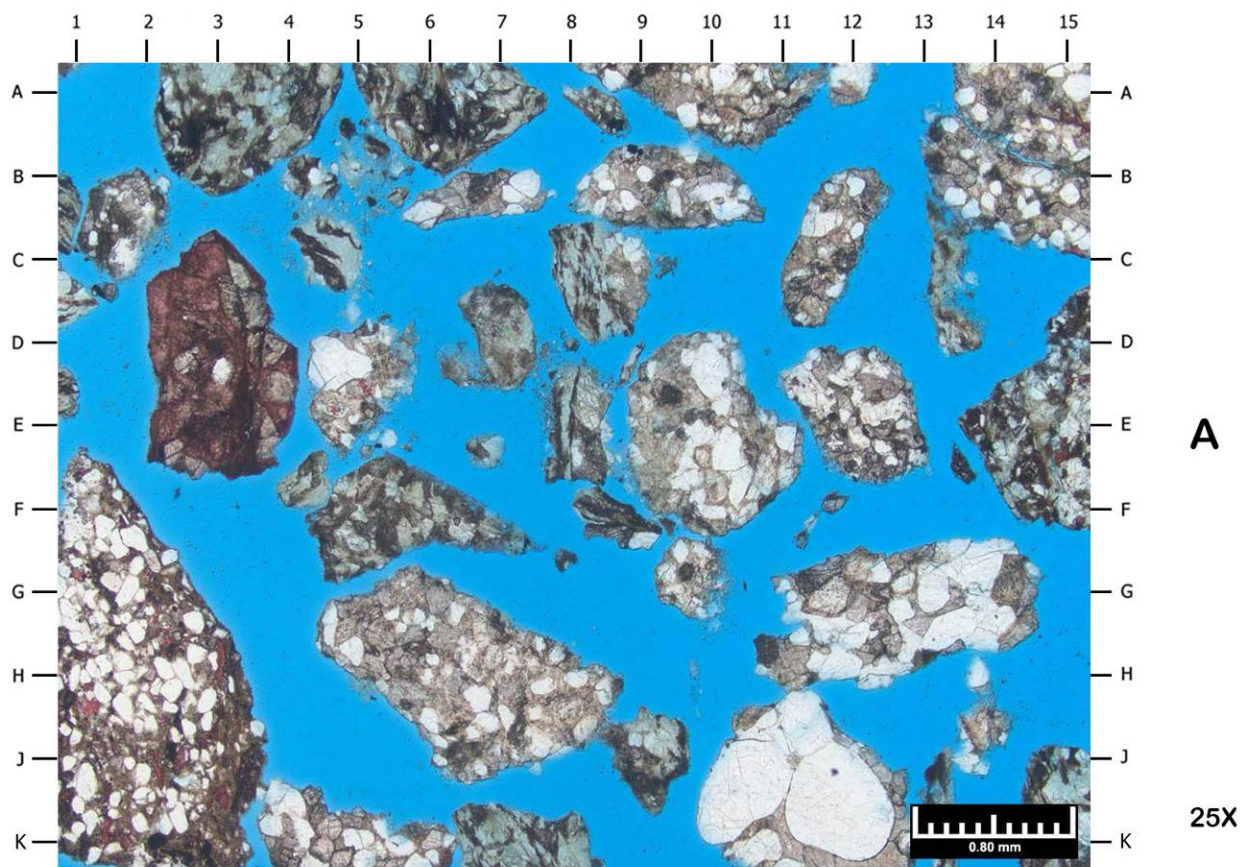
Authigenic Minerals: Common dolomite occurring as intergranular cement and replacement of unstable grains; minor to locally common quartz overgrowth and feldspar overgrowth cement; rare sparry calcite cement/replacement within sandstone to locally abundant recrystallization/replacement of precursor matrix (limestone only); rare to minor pyrite replacement of unstable particles; and trace siderite replacement of unstable grains

Porosity Types: Rare secondary intragranular pores; rare restricted primary intergranular pores in areas of incomplete cementation; possible microporosity associated with pore-filling chlorite; numerous fractures, cracked grains, and bit-sheared/damaged chips represent drilling induced artifacts

Magnification: A: 25X B: 100X

A) The dominant dolomitic sandstone chips mostly exhibit a grain size range of very fine- to medium-grained sand (A10, B14.5, E12, E10, HJ6.5, K5, G13), but a few dolomitic sandstone chips contain coarse sand grains (JK10.5, JK12). Other minor lithologies represented in this low magnification view include argillaceous, fine-grained sandstone (H2) and dolomitic limestone (DE3). Sandstone chips that were damaged by bit-shearing during drilling are also present (AB3, AB6, C4.5, F5, C8.5, E8, K7.5).

B) This photomicrograph provides a high magnification view of the area centered near E11 in Photo A and illustrates dolomitic sandstone chips from the dominant lithology. Dolomite (D11.5, C10.8, EF14, B5.5, DE6.5), quartz overgrowths (D5.5, GH6, F5), and feldspar overgrowths (J5.5, FG4.5, DE4.2) occlude the intergranular areas between framework grains of monocrystalline quartz (C4.5, FG5.5, HJ6.3, FG14) and feldspar (GH8, HJ5, G4.5, G3, CD9.5). Dolomite also replaces unstable feldspar grains (DE2.5, CD14, F7).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13455-13460 FEET
SAMPLE NUMBER: 29D

PLATE 29

Lithologies:

Major: Dolomitic, very fine- to coarse-grained sandstone
Minor: Limestone (variably sandy/silty); mudstone (variably silty/sandy); medium- to coarse sand grains (isolated, loose, disaggregated grains); crystalline dolostone (variably sandy); and slightly argillaceous very fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; trace organic-rich microstylolites

Grain Size Range: <0.03mm to 0.72mm

Compaction: Moderate to high

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; altered mudstone fragments; and trace polycrystalline quartz

Accessory: Rare organic fragments; trace muscovite; and trace biotite

Matrix Composition: Minor undifferentiated detrital clay within some minor sandstone chips

Authigenic Clay: Pore-filling chlorite imbedded between other intergranular cement; chlorite/illite grain replacement

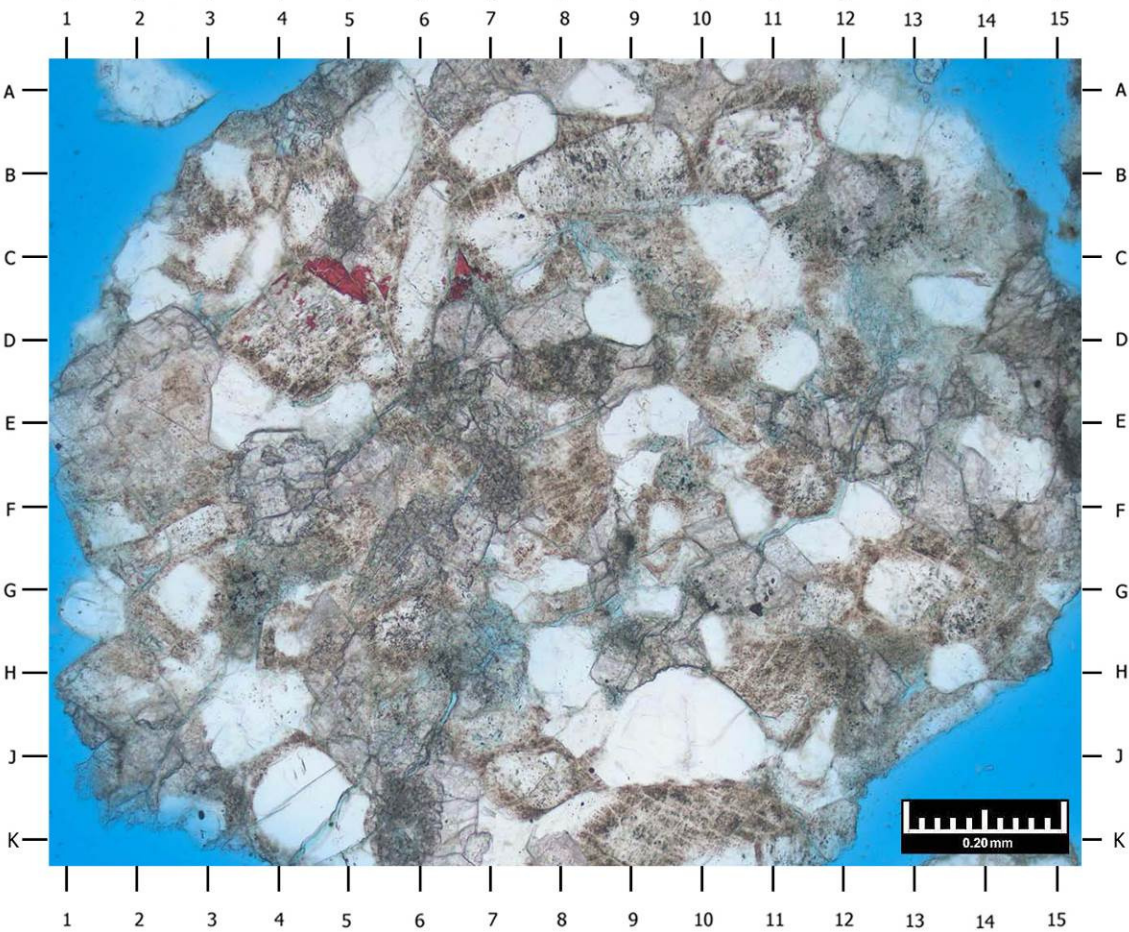
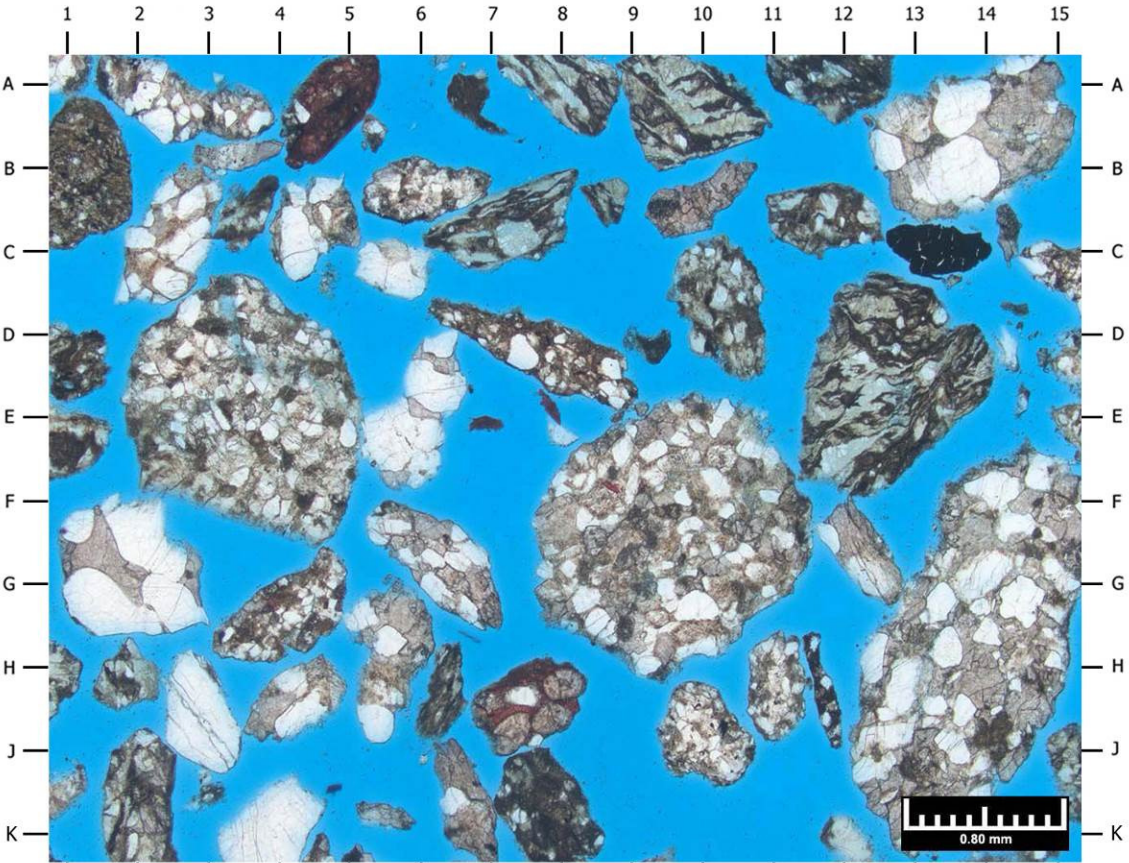
Authigenic Minerals: Common to locally abundant dolomite occurring as intergranular cement and replacement of unstable grains and precursor matrix material; minor to locally common quartz overgrowth and feldspar overgrowth cement; rare to minor calcite occurring as cement and grain replacement (within dominant lithology), common calcite recrystallization of matrix within minor limestone chips; minor pyrite replacement of unstable particles; trace bitumen occluding intergranular areas; and trace siderite grain replacement

Porosity Types: Rare secondary intragranular pores; rare restricted primary intergranular pores in areas of incomplete cementation; trace intercrystalline pores occurring between euhedral dolomite; and possible microporosity associated with pore-filling chlorite

Magnification: A: 25X B: 100X

A) The dominant dolomitic sandstone lithology (C2.2, AB2.2, AB13.5, G1.5, HJ4, G6, FG9, AB14, GH14) varies considerably in grain size; the average grain size within individual dolomitic sandstone chips varies from very fine grained (E3.5) to medium grained (H13.5) to coarse grained (G2). A dolomitic limestone chip occurs at HJ7.5 and another limestone chip occurs at AB5. The sandy/silty chips at GH4, DE8, J10, HJ11, and C15 contain matrix detrital clay.

B) This photomicrograph provides a high magnification view of the centered near FG9.5 in Photo A. Monocrystalline quartz (J9.5, HJ3.5, D9, H8, F12.5) and feldspar (D4, B8.5, B11, H11, K9.5, JK4.5) are the dominant grain types present. Most intergranular areas are occluded by a combination of dolomite cement (G11, F13, JK6.5), quartz overgrowths (E4, J8.7), feldspar overgrowths (B6.2, BC5.5, AB8.3, GH2.5) and rare calcite (stained red; CD4.5, CD6.5). Dolomite also replaces of unstable grains (E2, HJ5.5, JK5.9, E7.5). Rare primary intergranular pores (CD2.7, EF10.2, H13) and rare secondary intragranular pores (BC8.3) are faintly visible.



Cabot Oil & Gas Corporation
Cabot No. 50
UWI/API#: 4707901538
Putnam County, West Virginia
Belgrove Sandstone Formation
Cuttings

WFT File No.: HH-73588

THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13470-13475 FEET
SAMPLE NUMBER: 30D

PLATE 30

Lithologies:

Major: Sandy, peloidal limestone
Minor: Dolostone; dolomitic, very fine- to fine-grained sandstone; silty, calcareous mudstone; dolomitic limestone

Sedimentary Fabric: Predominantly sandy, peloidal grainstone; minor patchy packstone to wackestone; bioturbated; vague laminations; and rare incipient organic-rich microstylolites

Grain Size Range: <0.03mm to 0.21mm (sand portion only)

Compaction: Moderate

Visual Sorting: Moderate (sand portion only)

Grains/Allochems:

Major: Micritic peloids and monocrystalline quartz
Minor: Plagioclase feldspar and potassium feldspar
Accessory: Organic fragments and undifferentiated calcareous fossil fragments

Matrix Composition: Minor to locally common micrite; detrital clay present only within rare mudstone chips

Authigenic Clay: None observed

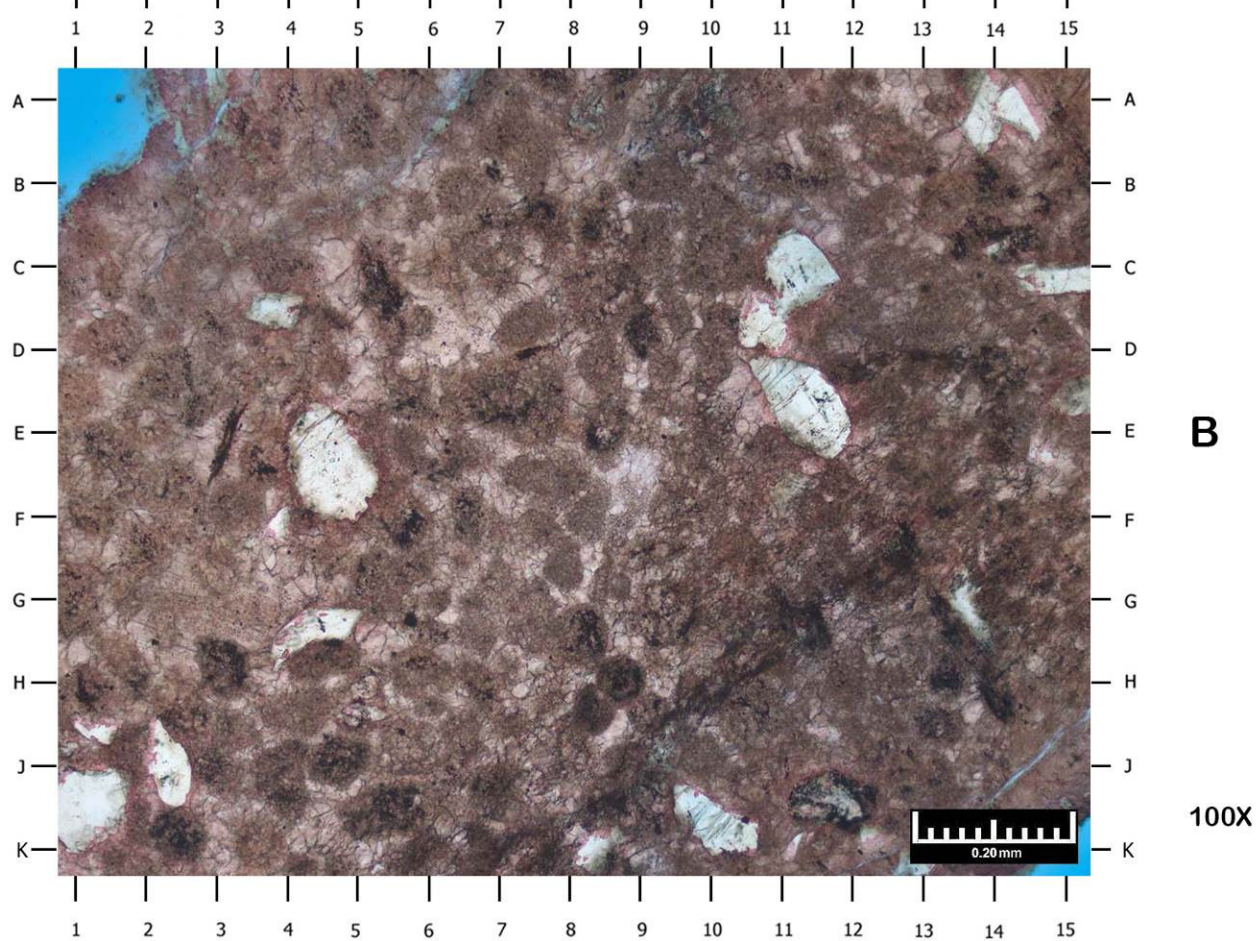
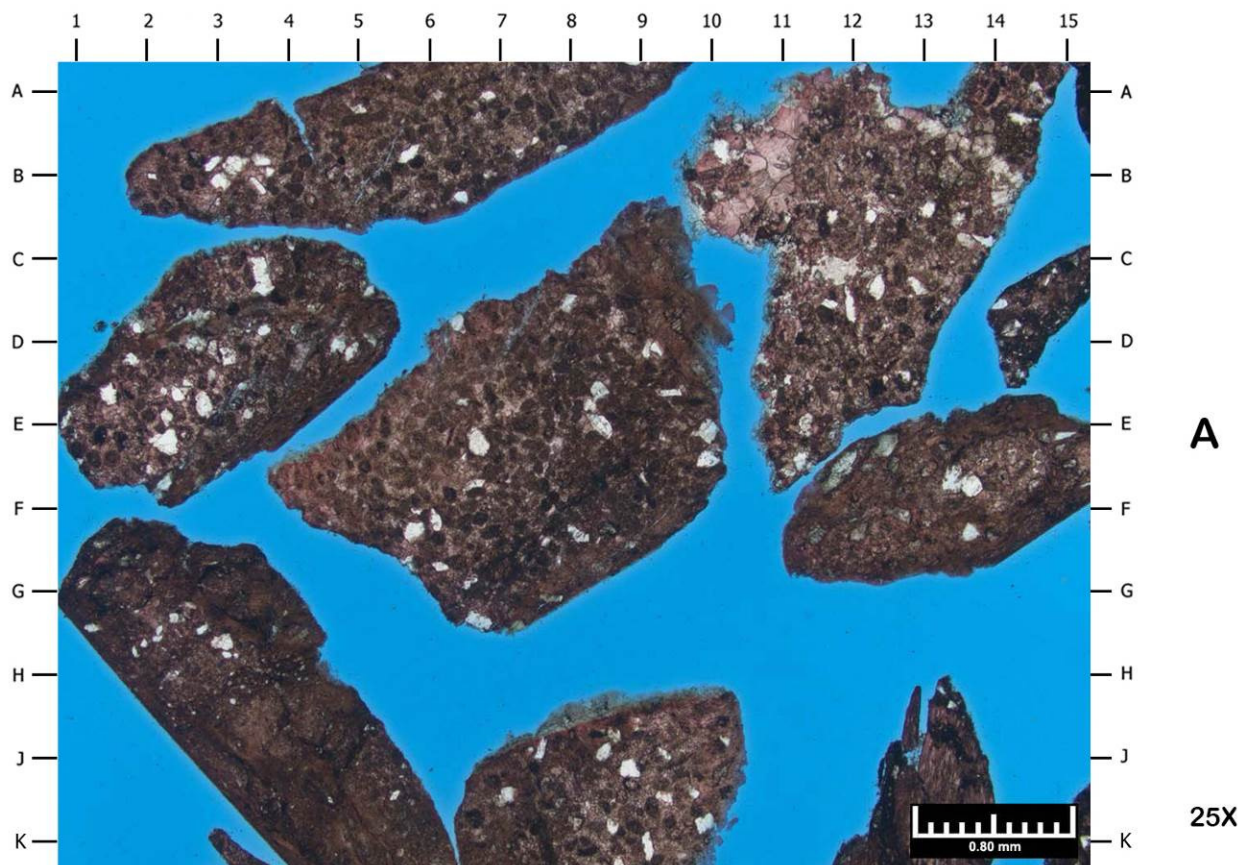
Authigenic Minerals: Abundant sparry calcite occurring as intergranular cement and as patchy replacement/recrystallization of precursor matrix and unstable grains/allochems; minor to locally common dolomite occurring as replacement of unstable grains/allochems and precursor matrix; rare to minor pyrite replacement of unstable particles; and dolomite intergranular cement within rare sandstone chips only

Porosity Types: No naturally occurring pores were observed using standard petrographic techniques; fractures and sheared/damaged grains are artifacts of drilling

Magnification: A: 25X B: 100X

A) These limestone chips predominantly exhibit a sandy, peloidal grainstone texture (DE3, AB6, E7, BC12, JK8.5). Limestone chips dominated by micritic matrix are less common (HJ4, EF12.5, K13).

B) This photomicrograph provides a high magnification view of the area centered near EF7 in Photo A. Sparry calcite cement (D6.3, EF8.5, A12.5, CD4.7, JK4.5) occludes most intergranular areas between micritic peloids (D1.5, G1, DE7, HJ4.2) and siliciclastic grains of monocrystalline quartz (EF4.5, JK1.2, J2.5) and feldspar (DE11, JK10).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13495-13500 FEET
SAMPLE NUMBER: 31D

PLATE 31

Lithologies:

Major: Sandy limestone to borderline calcareous, very fine-grained sandstone
Minor: Dolostone (variably sandy); mudstone (variably silty/sandy); slightly argillaceous, very fine-grained sandstone; and coarse sand grains (isolated, loose, disaggregated grains)

Sedimentary Fabric: Predominantly sandy lime grainstone with lesser sandy lime packstone; bioturbated to vaguely laminated

Grain Size Range: <0.03mm to 0.74mm (sand portion only)

Compaction: Moderate

Visual Sorting: Moderate (sand portion only)

Grains/Allochems:

Major: Monocrystalline quartz

Minor: Micritic peloids; plagioclase feldspar; potassium feldspar; and trace polycrystalline quartz

Accessory: Trace biotite and trace muscovite

Matrix Composition: Common to abundant micrite matrix is present in some limestone cuttings; detrital clay is dominant only in minor mudstone chips; rare sandstone chips contain minor interstitial detrital clay

Authigenic Clay: Trace undifferentiated authigenic clay imbedded between other pore-filling cements only within rare sandstone chips and also present as rare grain replacement

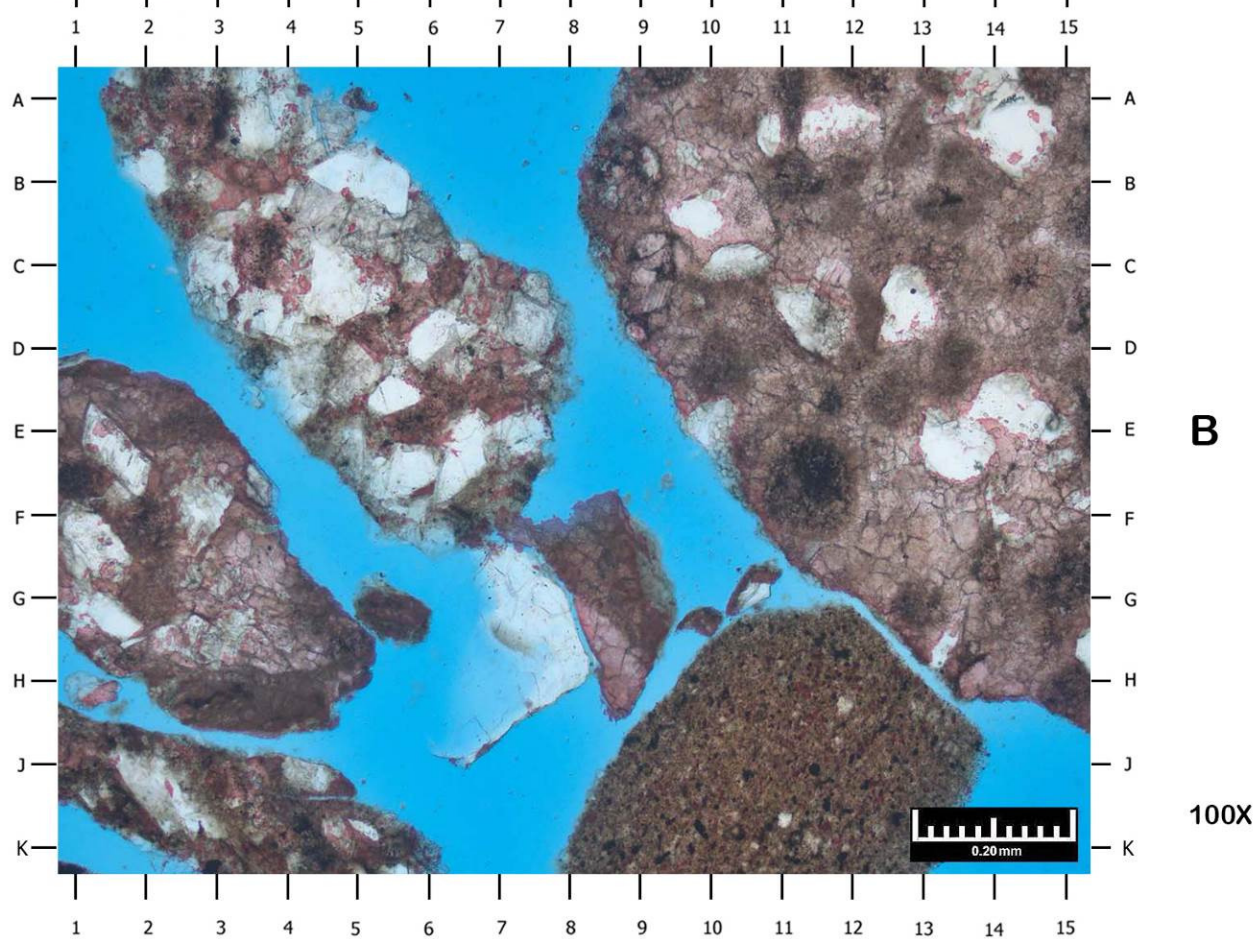
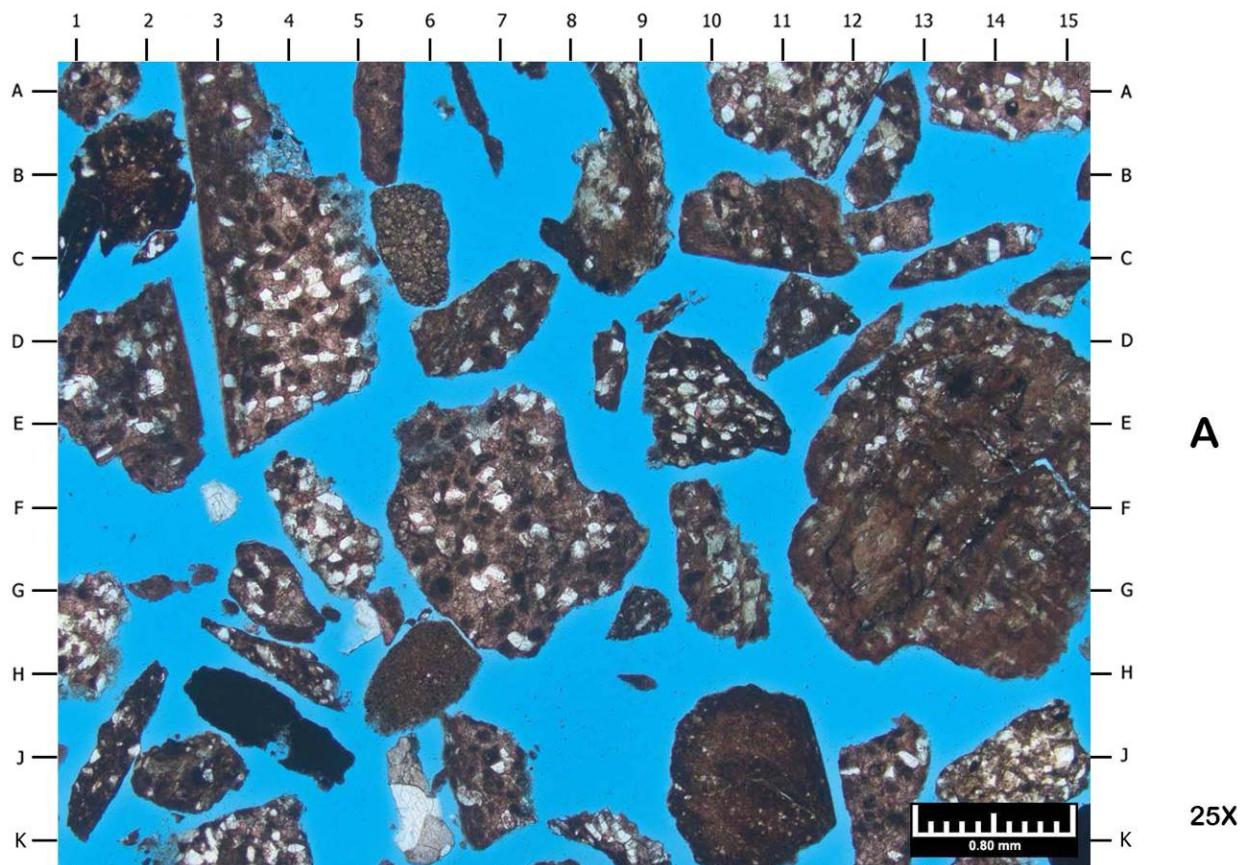
Authigenic Minerals: Abundant sparry calcite cement occluding intergranular areas between sand and peloids; sparry calcite also occurs as patchy recrystallization of precursor micrite matrix; dolomite cement/replacement is present in dolostone and rare sand lithologies; minor pyrite occurring as replacement of unstable particles

Porosity Types: No naturally occurring pores were observed using standard petrographic techniques; numerous cracks and sheared/damaged grains are artifacts of drilling

Magnification: A: 25X B: 100X

A) The dominant sandy limestone chips (F13.5, JK12.4, DE1.5, B2, BC10.5, JK7, FG7) also contain patchy, localized areas of borderline calcareous, very fine-grained sandstone (A14, E9.5, D4, FG4, J14.5). Other lithologies represented in this low magnification view include dolostone (C5.5) and mudstone (H6, JK10.5).

B) This photomicrograph provides a high magnification view of the area centered near G5.5 in Photo A. In the dominant lithology sparry calcite cement (FG12.5, FG3, AB9.5, B3.5) occludes intergranular areas between grains of monocrystalline quartz (AB14, DE14, EF13, CD4.5, D6), plagioclase feldspar (EF6.4, EF1.7), and micritic peloids (EF11, D13.5, B13.5, G2, B11.2). A mudstone chip dominated by detrital clay matrix is pictured at J9-13.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13525-13530 FEET
SAMPLE NUMBER: 32D

PLATE 32

Lithologies:

Major: Crystalline dolostone

Minor: Dolomitic limestone; slightly sandy limestone; slightly sandy mudstone; dolomitic very fine- to fine-grained sandstone; dolomitic mudstone; calcareous dolostone; very fine-grained sandstone; and coarse sand grains (isolated, loose, disaggregated grains)

Sedimentary Fabric: Slightly sucrosic, euhedral to subhedral dolomite (within dominant dolostone lithology)

Grain Size Range: <0.03mm to 0.95mm (sand portion only)

Compaction: Moderate

Visual Sorting: Moderate (sand portion only)

Grains/Allochems:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; chert; and polycrystalline quartz

Accessory: Rare partially pyritized organic fragments

Matrix Composition: Dominant dolostone lithology contains no remaining detrital matrix; minor recrystallized limestones contain trace remnant micrite; rare sandstone chips contain minor interstitial detrital clay

Authigenic Clay: None within dominant lithology; trace amounts of undifferentiated authigenic clay imbedded between intergranular cements within rare sandstone chips and occurring as trace grain replacement

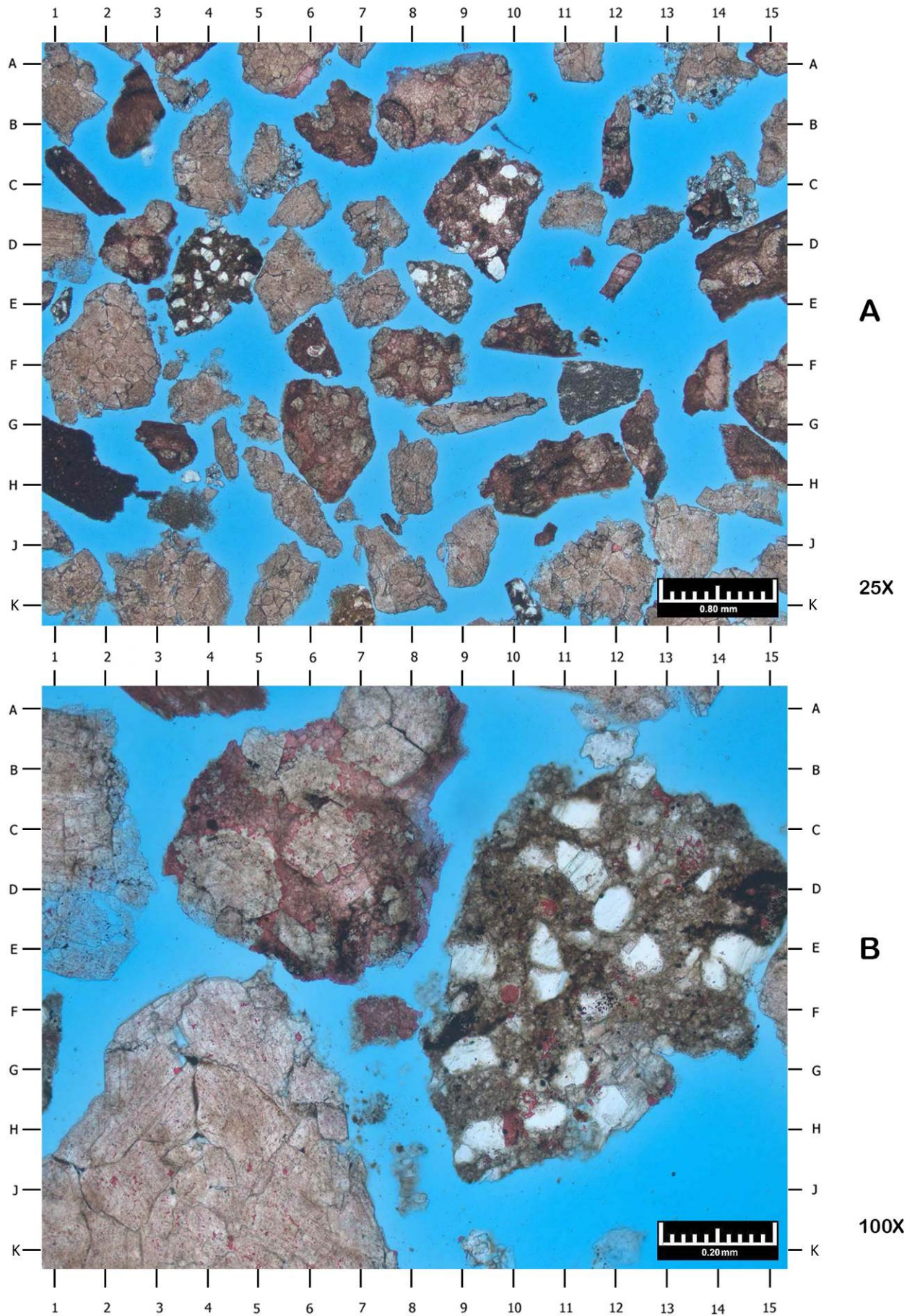
Authigenic Minerals: Euhedral to subhedral dolomite and trace dolomicrite completely replacing precursor matrix; dolomite replacement of grains/allochems; sparry calcite replacement/recrystallization of matrix within limestones; calcite replacement of grains/allochems; dogtooth spar radiating from replaced grains/allochems to occlude interparticle areas within limestones; sparry calcite occluding intercrystalline areas between dolomite crystals; and rare to minor pyrite replacement of unstable particles

Porosity Types: Minor to common intercrystalline pores associated with slightly sucrosic dolomite with some rare vuggy secondary pore development

Magnification: A: 25X B: 100X

A) Crystalline dolostone dominates this low magnification view (AB8.5, F2, AB1.3, BC4, JK11.5, J13.3, JK3, JK8, DE5.5). Other minor lithologies also pictured within the low magnification view include dolomitic limestone (GH6.5, F8, B6.5, FG15); slightly sandy limestone (CD9.5); and dolomitic, very fine-grained sandstone (DE4).

B) This photomicrograph provides a high magnification view of the area centered near E3 in Photo A. Intercrystalline pores (FG3.7, GH5.7, HJ3.9) occur between euhedral to subhedral dolomite crystals within the dominant dolostone lithology at FK4. Sparry calcite cement (stained red; BC4.5, DE6, BC7) occludes intergranular areas between dolomite-replaced grains (D4, AB7.5, CD6, B5). The dolomitic, very fine-grained sandstone (CH12) is a rare lithology within this depth interval; dolomicrite (D10, DE13, GH9.5) occludes the intergranular areas between framework grains of monocrystalline quartz (BC11, DE12, E14) and lesser plagioclase feldspar (CD11.4).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13530-13535 FEET
SAMPLE NUMBER: 33D

PLATE 33

Lithologies:

Major: Partially recrystallized micritic limestone (variably sandy/silty)
Minor: Dolostone; mudstone (variably sandy/silty); slightly calcareous, sandy dolostone; very fine- to medium-grained sandstone

Sedimentary Fabric: Partially recrystallized lime mudstone (dominant); grainstone (minor); bioturbated; possible rip-up clasts and/or possible disturbed hard ground

Grain Size Range: <0.03mm to 0.38mm (sand portion)

Compaction: Moderate

Visual Sorting: Moderate (sand portion)

Grains/Allochems:

Major: Monocrystalline quartz and micritic peloids

Minor: Plagioclase feldspar; potassium feldspar; and chert

Accessory: Possible rip-up clasts; foraminifera; and trace biotite

Matrix Composition: Predominantly partially recrystallized micrite; detrital clay (associated with mudstones and some possible rip-up clasts)

Authigenic Clay: None observed in dominant limestone lithology; trace undifferentiated authigenic clay in rare sandstone lithologies

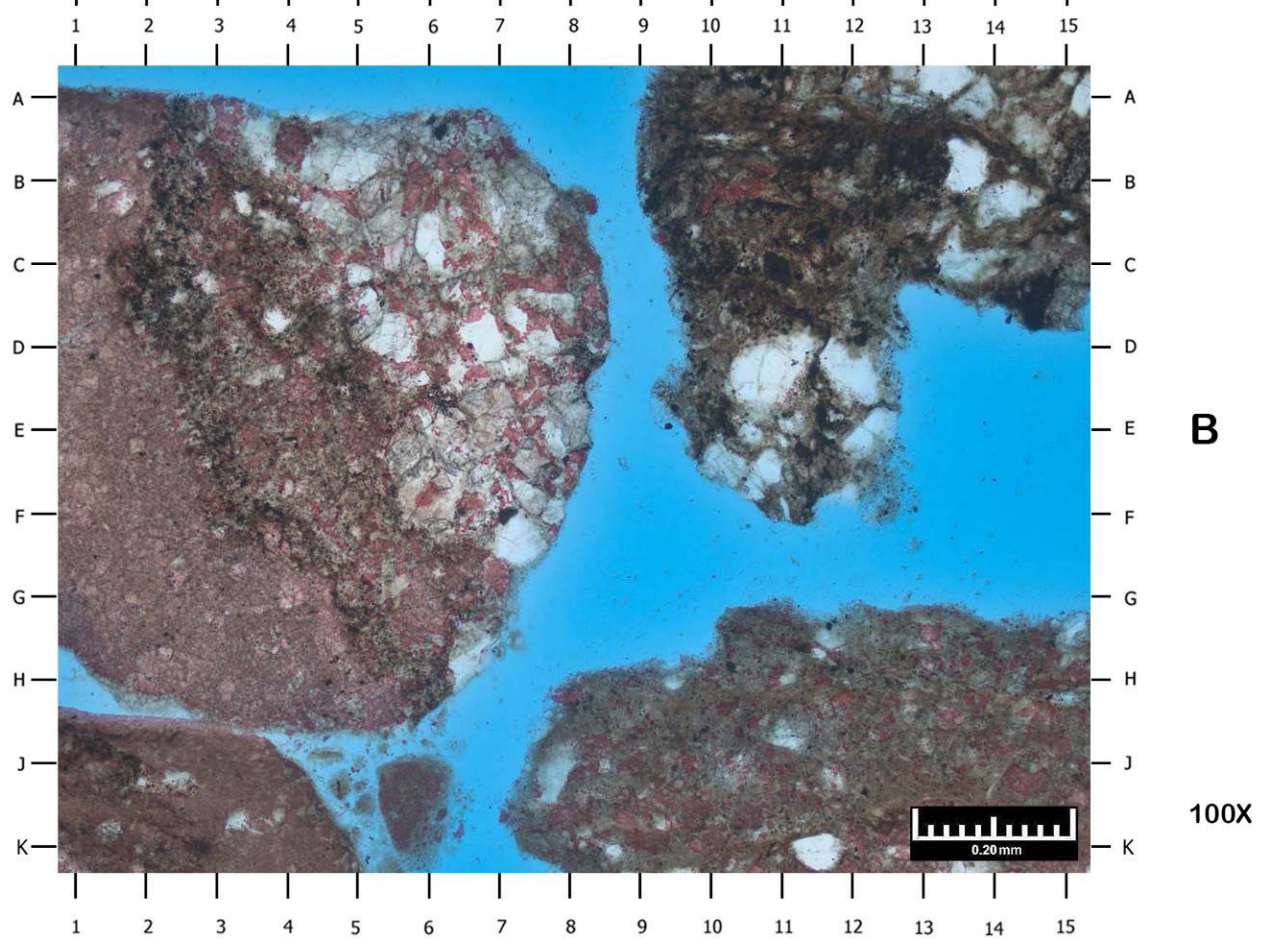
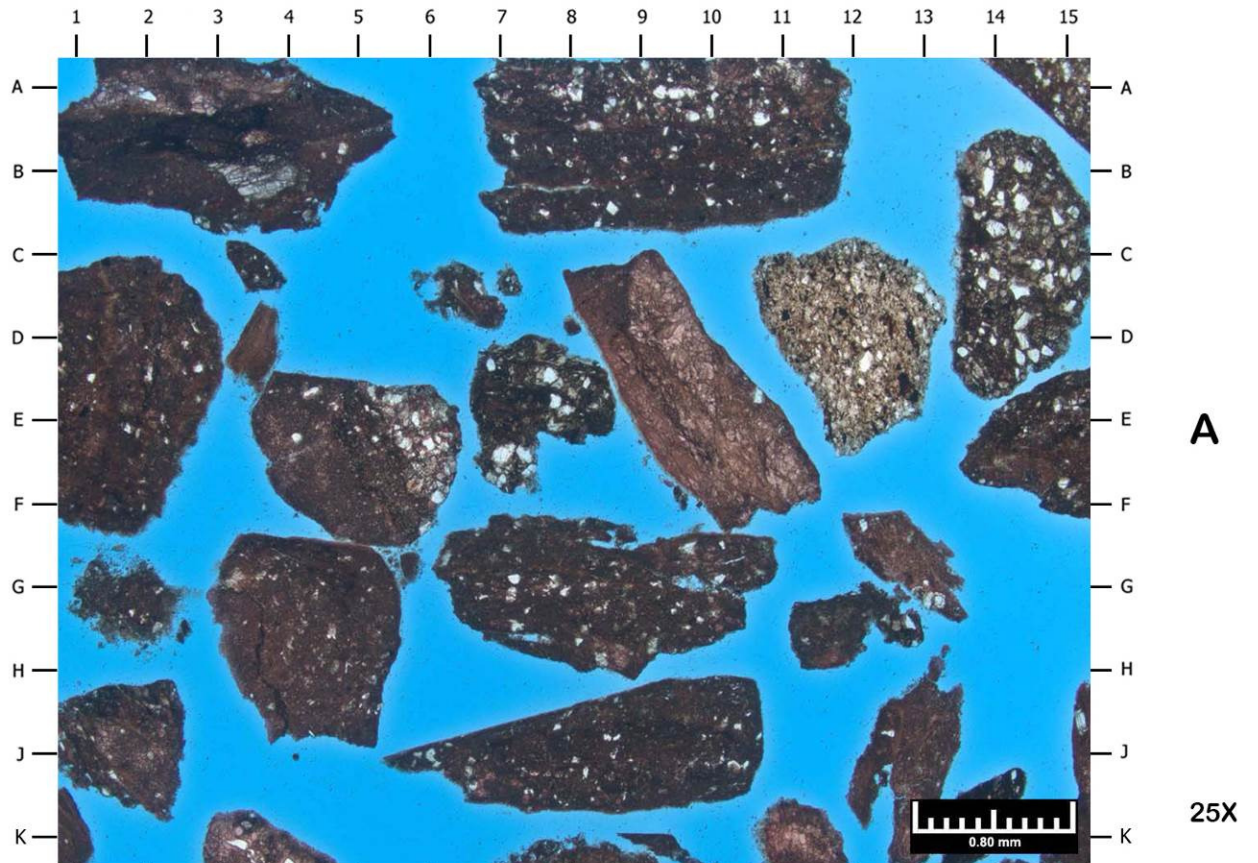
Authigenic Minerals: Microspar to sparry calcite occurring as patchy recrystallization/replacement of micritic matrix; intergranular sparry calcite cement within minor grainstone are rare sandstone; minor dolomite replacement of matrix and unstable grains/allochems; minor pyrite replacement of organic material and other unstable particles; trace siderite replacement of labile particles; and quartz overgrowths mostly within rare sandstone lithologies

Porosity Types: Microporosity is possible within the dominant micritic matrix, but no pores could be directly observed within the dominant lithology using standard thin section techniques; trace intergranular porosity was detected within one medium-grained sandstone chip

Magnification: A: 25X B: 100X

A) The dominant limestone lithology pictured in Photo A has a variably sandy/silty lime mudstone texture (DE1.5, GH4.5, J8.5, EF14.5, AB9, EF4.5). Several limestone chips exhibit patchy areas of sparry calcite replacement/recrystallization (D9.5, EF10.5). Other rare to minor lithologies pictured include silty/sandy mudstone (D12) and slightly calcareous, dolomicritic, very fine-grained sandstone (C14.5).

B) This photomicrograph provides a high magnification view of the area centered near EF6.5 in Photo A and illustrates three micritic limestone chips (AG1-7, JK1-4, JK7.5-GK15). The matrix of the chip in the top-right contains a combination of dolomicrite, organic material, and possible clay; however this chip appears to have been damaged during drilling. Siliciclastic grains are predominantly monocrystalline quartz (DE10.5, K11.5, B13.5, FG7) with lesser amounts of feldspar also present (D5.3). Dolomite grain replacement occurs at EF6 and C6.5.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13540 FEET
SAMPLE NUMBER: 34D

PLATE 34

Lithologies:

Major: Dolomitic, very fine- to fine-grained sandstone to sandy dolostone
Minor: Dolostone; partially recrystallized micritic limestone (variable silt/sand content); mudstone (variable silt/sand content); coarse sand grains (isolated, loose, disaggregated grains)

Sedimentary Fabric: Bioturbated

Grain Size Range: <0.03mm to 1.09mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Minor plagioclase feldspar; rare potassium feldspar; trace chert; and trace polycrystalline quartz

Accessory: Trace undifferentiated fossil fragments (calcareous and dolomitized); trace biotite; and trace heavy minerals (zircon)

Matrix Composition: Dolomicrite within dominant sandstone to dolostone; rare to minor detrital clay within sandstones and variable minor lithologies; abundant detrital clay only within minor mudstone lithology; micritic lime mud (limestone only)

Authigenic Clay: Minor chlorite imbedded between other intergranular cements and occurring as grain replacement

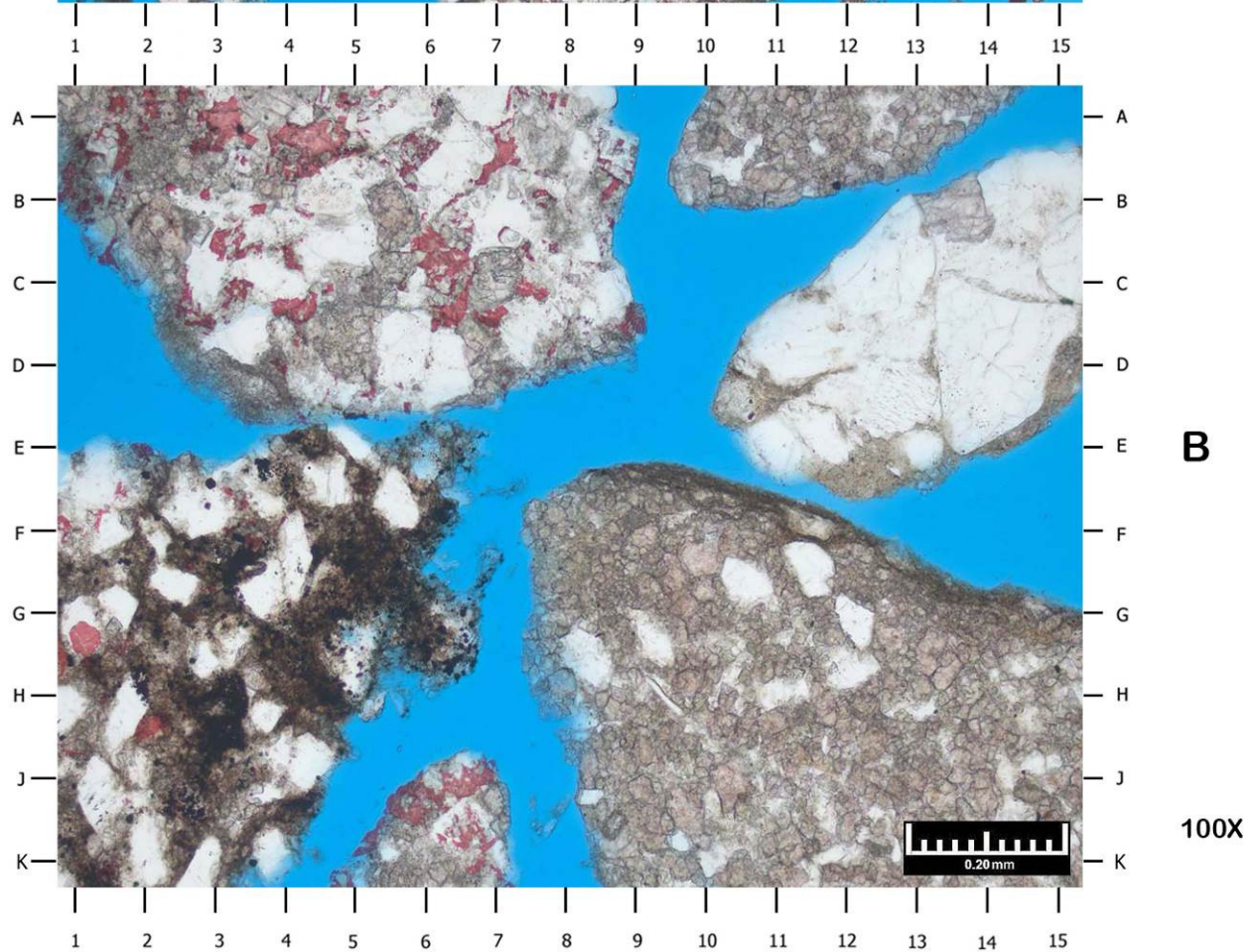
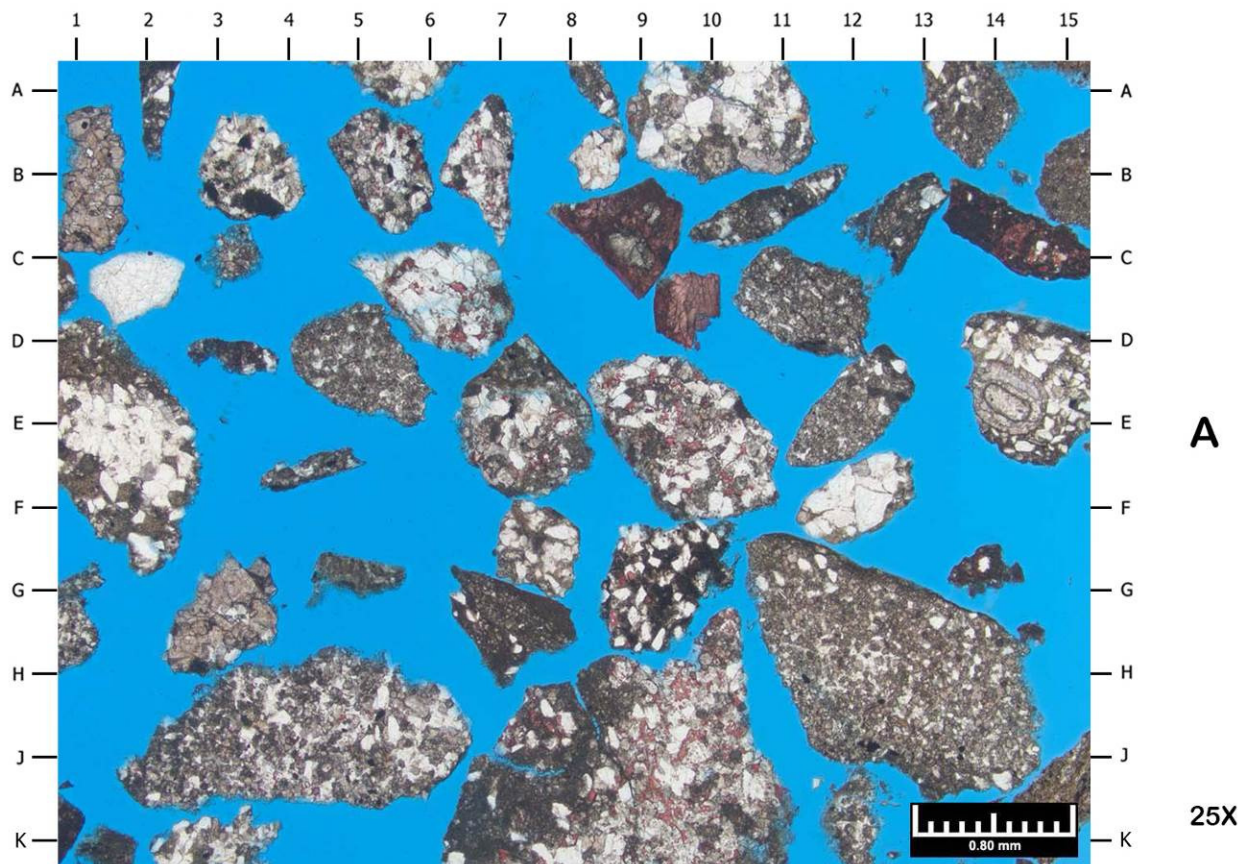
Authigenic Minerals: Common to abundant dolomite occurring as intergranular cement, recrystallization of precursor matrix, and replacement of unstable grains/allochems; minor to locally abundant calcite occurring as sparry intergranular cement, recrystallization of matrix micrite, and replacement of unstable grains/allochems; minor to locally common quartz overgrowth cement; and rare to minor siderite and pyrite replacement of unstable particles

Porosity Types: No visible naturally occurring porosity within the dominant lithology; trace intercrystalline pores within rare dolostone chips; pseudo porosity associated with fractures and sheared/damaged grains are drilling induced artifacts

Magnification: A: 25X B: 100X

A) The dominant lithology varies between dolomitic, very fine- to fine-grained sandstone to sandy dolostone (E1-2, J2-6, JK8.5, H13, DE14.5, E9.5, GH7, E11.5, AB10). Other minor lithologies visible in this low magnification view include dolostone (B1.2), and limestone (C14, C9, CD9.5). An isolated monocrystalline quartz grain at CD2 has a measured grain diameter of 0.50mm.

B) This photomicrograph provides a high magnification view of the area centered near FG10 in Photo A. Framework grains are predominantly monocrystalline quartz (D14, D5.5, EF5.5, C12.3) with lesser amounts of feldspar grains (DE12.2, CD11, EF4.8, EF2.5). Dolomite ranges from intergranular cement (BC4.5, D15) to grain supporting, crystalline matrix (A11.5, J9-13). Minor sparry calcite is also present as intergranular cement (AB7) and grain replacement (C6.2, JK6.5). The matrix of the sandstone in the bottom-left contains dolomicrite intermixed with low amounts of organic material and microcrystalline pyrite.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13560 FEET
SAMPLE NUMBER: 35D

PLATE 35

Lithologies:

Major: Slightly calcareous to dolomitic, very fine- to medium-grained sandstone
Minor: Slightly calcareous, sandy dolostone; sandy/silty limestone; sandy/silty mudstone; micritic limestone; crystalline dolostone; and rare very fine- to fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; possible bimodal grain size distribution in the dominant sandstone lithology; vague laminations visible in a few chips of minor lithology

Grain Size Range: <0.03mm to 0.96mm

Compaction: Moderate

Visual Sorting: Moderate to very poor (bimodal?)

Framework Grains:

Major: Monocrystalline quartz

Minor: Minor to common (visual est.) plagioclase feldspar; rare potassium feldspar; and trace polycrystalline quartz

Accessory: Trace biotite; trace zircon; calcareous fossil fragments (minor limestone lithology only)

Matrix Composition: Microcrystalline dolomite (dolomicrite); microcrystalline calcite (micrite); detrital clay

Authigenic Clay: Trace pore-filling chlorite and kaolinite (within rare, clean (vfg-fg) sandstone chips)

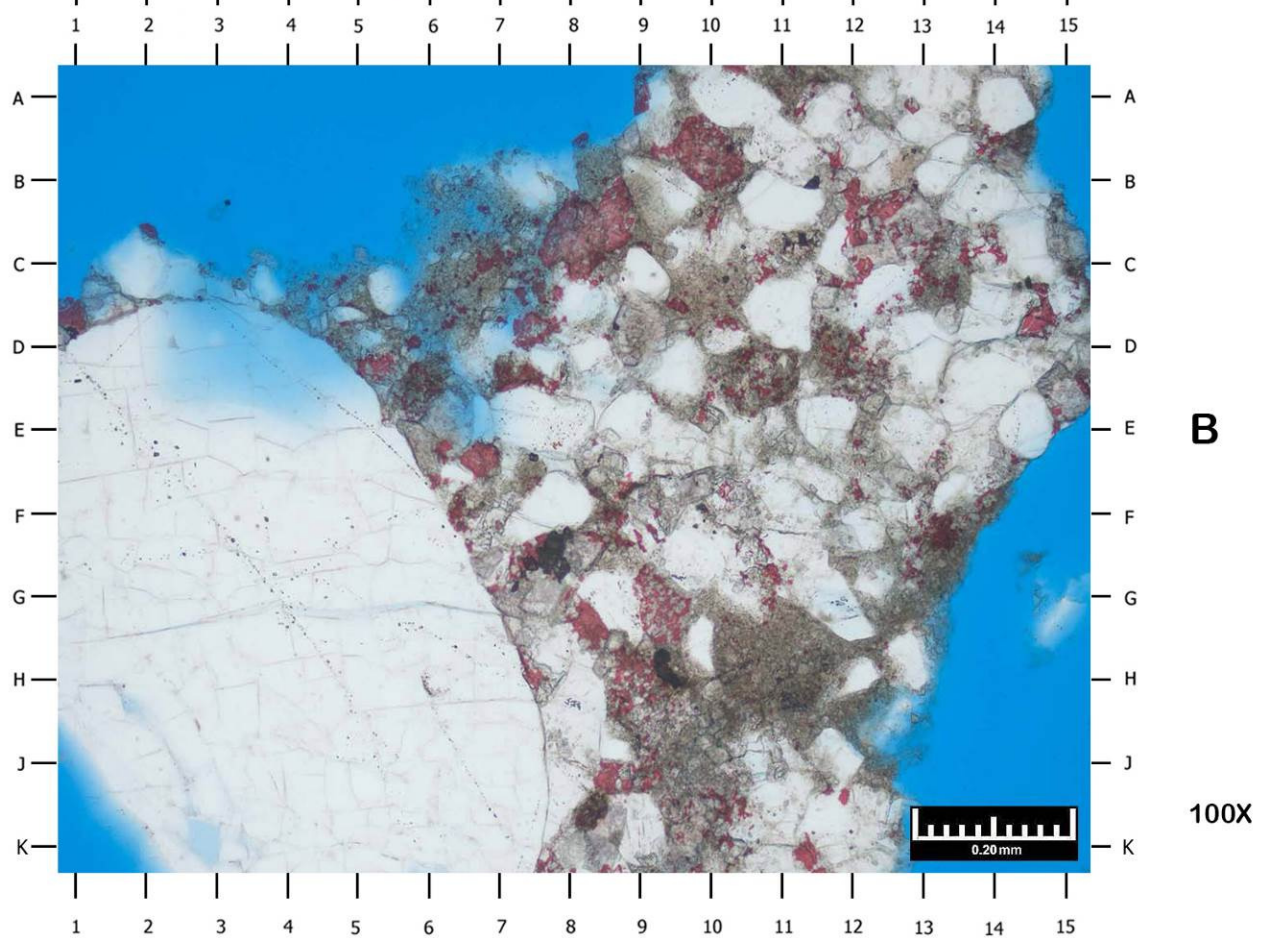
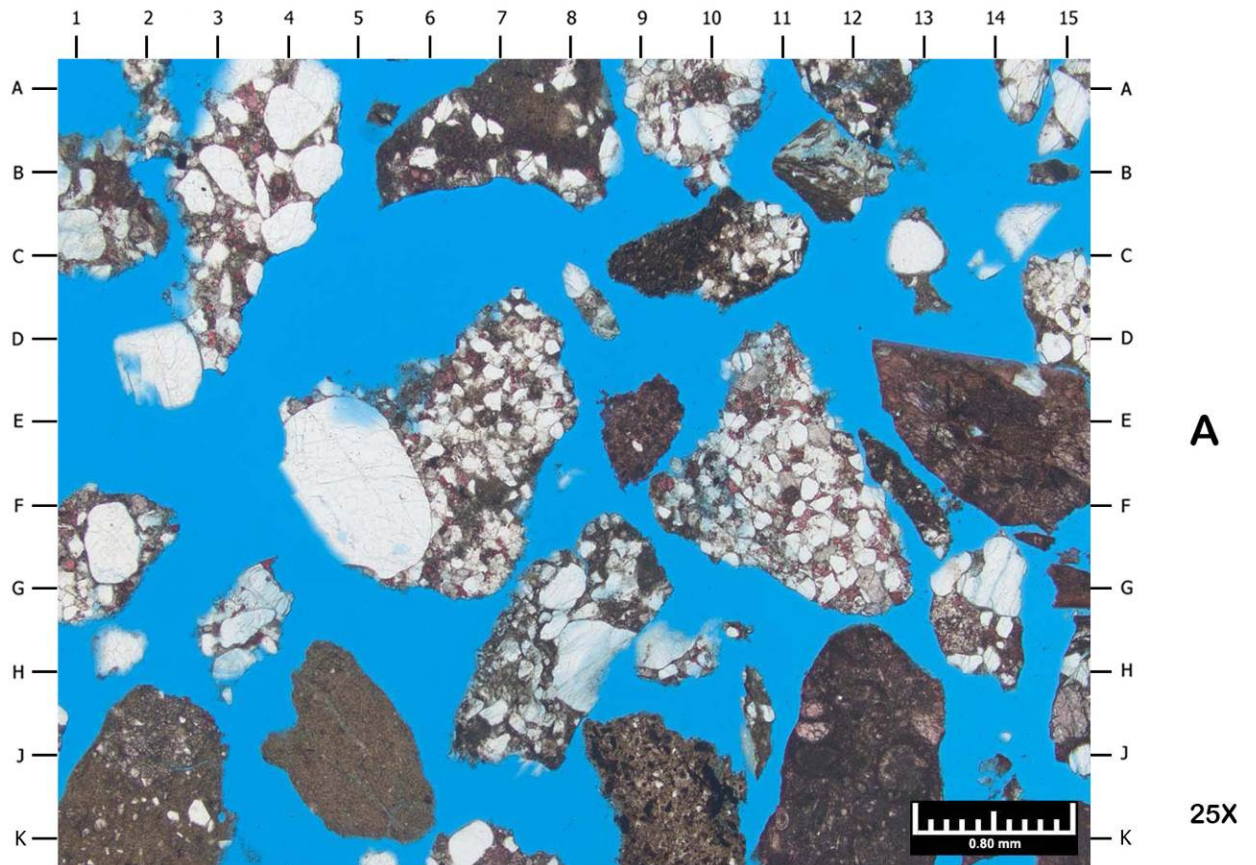
Authigenic Minerals: Common to locally abundant calcite and dolomite occurring as intergranular cement, replacement of unstable grains and recrystallization/replacement of precursor matrix material; minor quartz overgrowths; and rare pyrite and siderite replacement of unstable particles

Porosity Types: The dominant slightly calcareous to dolomitic sandstone lithology contains no visible naturally occurring pores; a rare lithology of quartz-cemented, very fine to fine-grained sandstone contains primary intergranular pores, secondary pores, and micropores associated with pore-filling kaolinite; numerous fractures and sheared grains represent drilling induced artifacts

Magnification: A: 25X B: 100X

A) Slightly calcareous to dolomitic, very fine- to medium-grained sandstone represents the dominant lithology within this cuttings depth interval (BC3.5, FG1.5, GH3.5, EF6, F10.5, GH13.8, K7). Other minor lithologies represented within this view include mudstone (variably sandy/silty; JK2, J5, JK9.5), micritic limestone (HK12, E14, EF9), and sandy dolostone (AB6-8).

B) This photomicrograph provides a high magnification view of the area centered near EF6 in Photo A and illustrates the dominant lithology within this depth interval. This cuttings chip contains a single, rounded, coarse sand grain of monocrystalline quartz (0.96mm diameter; DK4). The remaining sand content is predominantly very fine grained. This sandstone lithology may exhibit a bimodal grain size distribution. Monocrystalline quartz is the dominant grain type (E14.5, A14, F7.5) with lesser feldspar grains also represented (E9.3, BC10). Intergranular areas are occluded by a combination of dolomicrite (J9.9, G123), sparry calcite cement (stained red; GH8.5, CD14.5, DE7, GH8.3), intergranular dolomite cement (G7.8, DE15), and quartz overgrowths (J8, CD8.7, EF7.8, EF8.7). Calcite (AB10, BC8.5) and dolomite (J10) also occur as replacement of unstable grains.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 13560-13565 FEET
SAMPLE NUMBER: 36D

PLATE 36

Lithologies:

Major: Calcareous to dolomitic, fine- to medium-grained sandstone
Minor: Crystalline dolostone; sandy/silty dolostone; sandy/silty mudstone; sandy/silty limestone; slightly dolomitic, slightly argillaceous, very fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; possible laminations in some minor lithologies

Grain Size Range: <0.03mm to 0.90mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Minor to common plagioclase feldspar and rare potassium feldspar

Accessory: Trace biotite and trace heavy minerals (zircon and tourmaline)

Matrix Composition: Microcrystalline dolomite and micritic calcite (within dominant sandstone); minor detrital clay within some sandstone lithologies; abundant detrital clay within minor mudstone chips

Authigenic Clay: Rare to minor chlorite recrystallization of precursor detrital clay and trace grain replacement

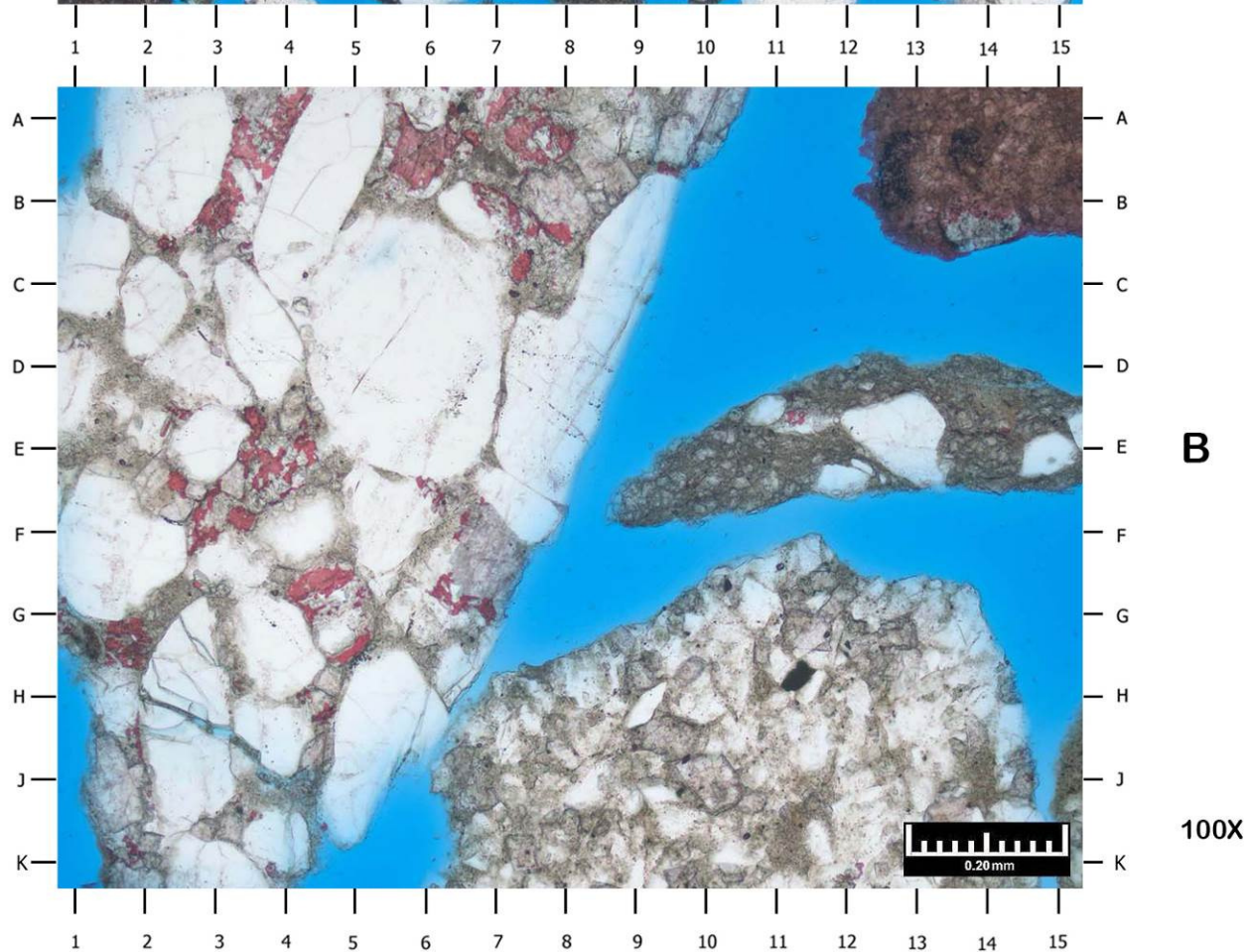
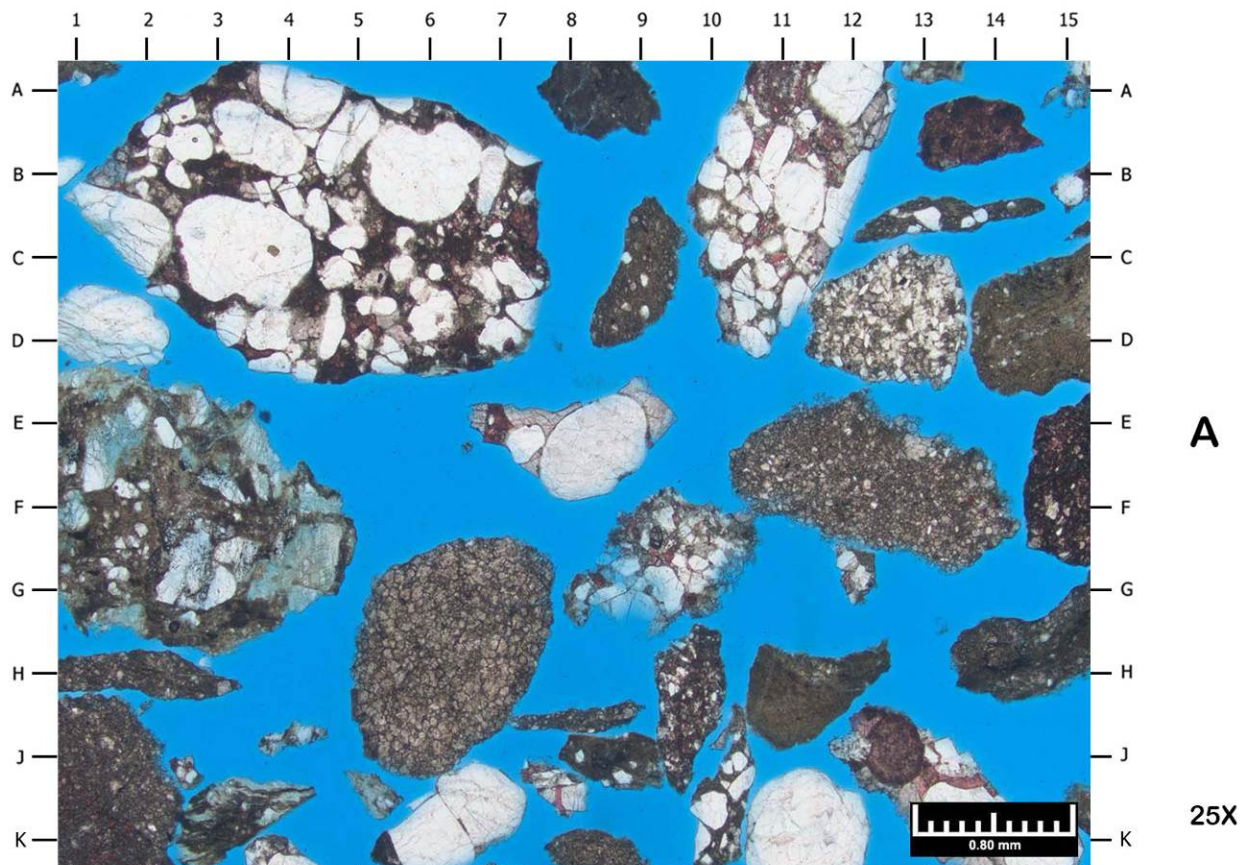
Authigenic Minerals: Dolomite and calcite replacement/recrystallization of matrix; dolomite and sparry calcite intergranular cement; dolomite and calcite replacement of unstable grains/allocherts; minor quartz overgrowths; and rare siderite and pyrite replacement of unstable particles

Porosity Types: No naturally occurring pores could be identified; numerous fractures and sheared grains represent drilling induced artifacts

Magnification: A: 25X B: 100X

A) Calcareous to dolomitic, fine- to medium-grained sandstone represents the dominant lithology within this depth interval (BC2-7, BC11, JK6, JK10, EF8). Other minor lithologies pictured in this low magnification view include crystalline dolostone (H6, EF12); silty/sandy mudstone (CD14.5, JK1.5, CD9, BC13); and slightly argillaceous, slightly dolomitic, very fine-grained sandstone (D12.5). A rounded, monocrystalline quartz grain at K11-12 has a measured grain diameter of 0.67mm and was likely plucked from the dominant lithology.

B) This photomicrograph provides a high magnification view of the area centered near C12 in Photo A. The cuttings chip on the left (AK2-AB10) represents the dominant sandstone lithology. Detrital grains are predominantly monocrystalline quartz (AB2, D5.5, FG1.5) with minor plagioclase feldspar (JK4) also present. Framework grains within the dominant lithology are rounded to sub-rounded and poorly sorted. Dominant intergranular cements include dolomite (AB8.5, FG7), calcite (stained red; A4, AB6, FG4.5), and quartz overgrowths (C4.3). Minor amounts of detrital clay are also present within the matrix (CD1.5, C7.5, G2.5, J13.9).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14210 FEET
SAMPLE NUMBER: 37D

PLATE 37

Lithologies:

Major: Slightly argillaceous, very fine- to fine-grained sandstone
Minor: Calcareous, very fine- to fine-grained sandstone; sandy/silty limestone; mudstone; recrystallized limestone; and dolostone

Sedimentary Fabric: Massive to bioturbated

Grain Size Range: <0.03mm to 0.43mm

Compaction: Moderate

Visual Sorting: Poor to moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; glauconite; carbonate grains/recrystallized fossil fragments; and trace chert

Accessory: Phosphatic fragments; biotite; and trace heavy minerals (zircon and tourmaline)

Matrix Composition: Minor to locally common interstitial detrital clay; abundant detrital clay within minor mudstone lithology; recrystallized micrite within some limestone chips

Authigenic Clay: Chlorite mixed with lesser illite occluding intergranular areas, occurring as possible recrystallization of precursor detrital clay, and rare replacement of unstable grains

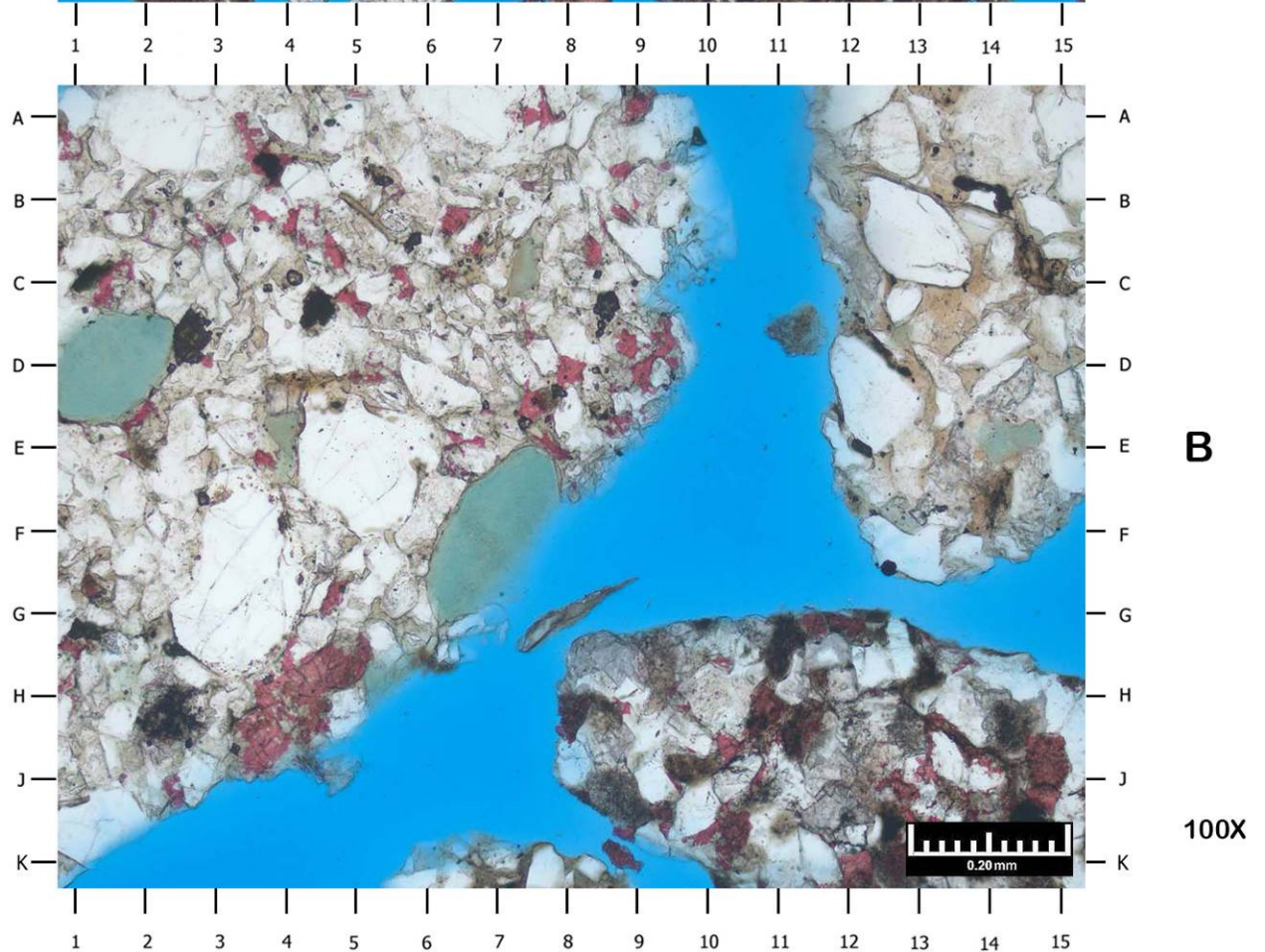
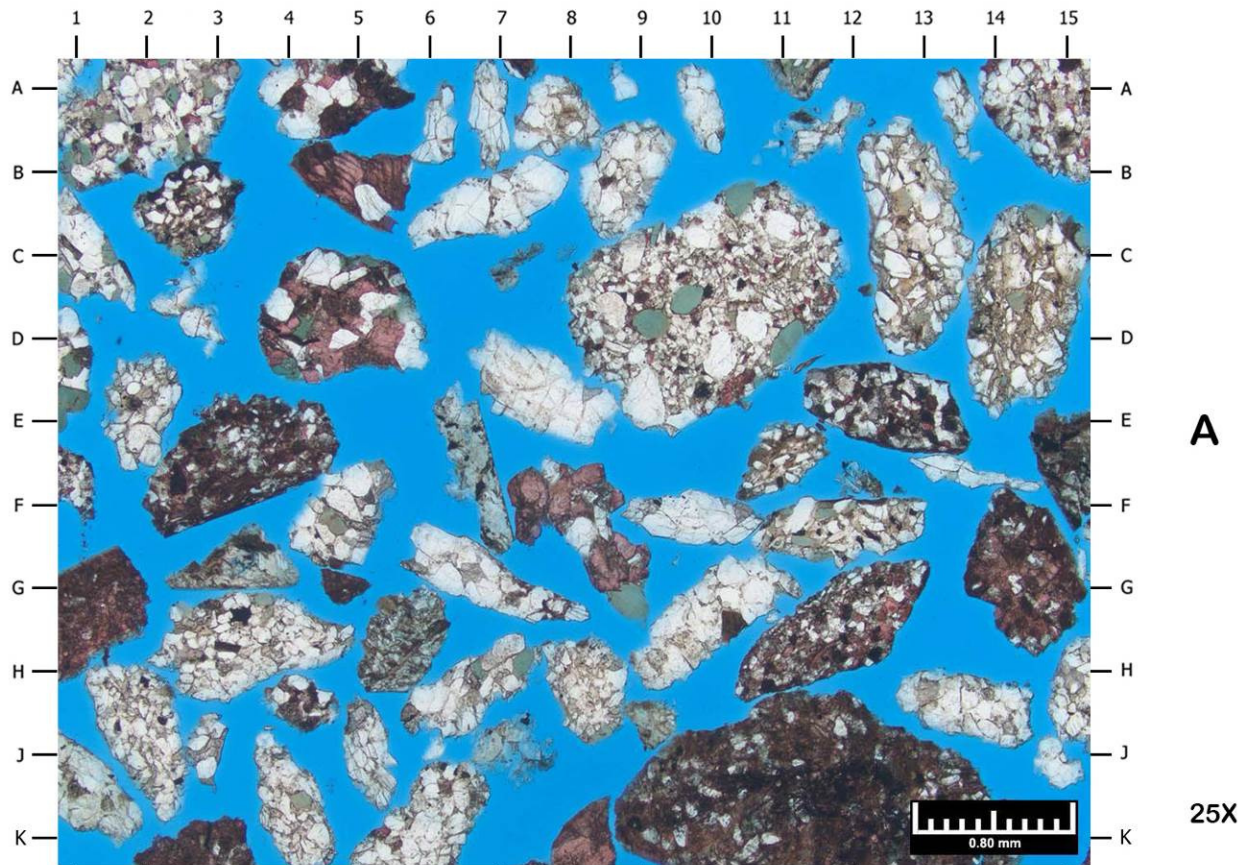
Authigenic Minerals: Calcite occurring intergranular cement, replacement of unstable grains/allochems, and as recrystallization of limestone chips; quartz overgrowths; dolomite occurring as intergranular cement and replacement of labile grains; feldspar overgrowths; rare siderite and pyrite replacement of unstable grains/allochems

Porosity Types: Minor secondary intragranular micropores associated with altered glauconite and other unstable grains; rare microporosity associated with pore-filling chlorite; primary pore space is predominantly occluded by authigenic cements with only trace primary pores remaining

Magnification: A: 25X B: 100X

A) Lithologies pictured in this low magnification view include slightly argillaceous, very fine- to fine grained sandstone (A15, BC12.5, CD14.5, CD10, FG12, AB2, HJ2, GH3, JK4, K6, GH10, G6D1, C1); calcareous, very fine- to fine-grained sandstone (A4.5, GH11.5, E12); sandy/silty limestone (B5, D4.5, EF3, G14, JK11); and recrystallized limestone (GH1, K2.5).

B) This photomicrograph provides a high magnification view of the area centered near D11 in Photo A. The poorly sorted sandstone chip at AK2 to AE9 contains individual detrital grains ranging in size from coarse silt to medium-grained sand (G3.5). Grain types visible in this view include monocrystalline quartz (EF5, FG3.5, BC13, DE12.2), feldspar (AB12.6, BC9, A8, H10.3), glauconite (D1.5, F7, C7.4, E14, E4), chert (CD13.2, A13.2), and biotite (B5, B12.7). Authigenic minerals include calcite cement/replacement (stained red; HJ4, A9, D8, J14.8), dolomite cement/replacement (JK12, GH8-10), and quartz overgrowths (G2.7, E5.8). Interstitial detrital clay also occludes intergranular areas (DE13, C13.8, DE4).



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14215-14220 FEET
SAMPLE NUMBER: 38D

PLATE 38

Lithologies:

Major: Sandy to silty limestone; calcareous very fine-grained sandstone; slightly dolomitic, very fine- to fine-grained sandstone

Minor: Silty, sandy mudstone; partially recrystallized limestone; slightly argillaceous very fine-grained sandstone

Sedimentary Fabric: Massive to bioturbated; laminated

Grain Size Range: <0.03mm to 0.27mm

Compaction: Moderate

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and recrystallized peloids (limestone only)

Accessory: Glauconite; phosphatic fragments; trace biotite; and trace zircon

Matrix Composition: Rare to locally common detrital clay within sandstones; partially recrystallized micrite within limestones; abundant detrital within minor mudstone lithology

Authigenic Clay: Minor to locally common chlorite/illitic clay occluding intergranular spaces, replacing labile grains, and occurring as possible recrystallization of precursor detrital clay

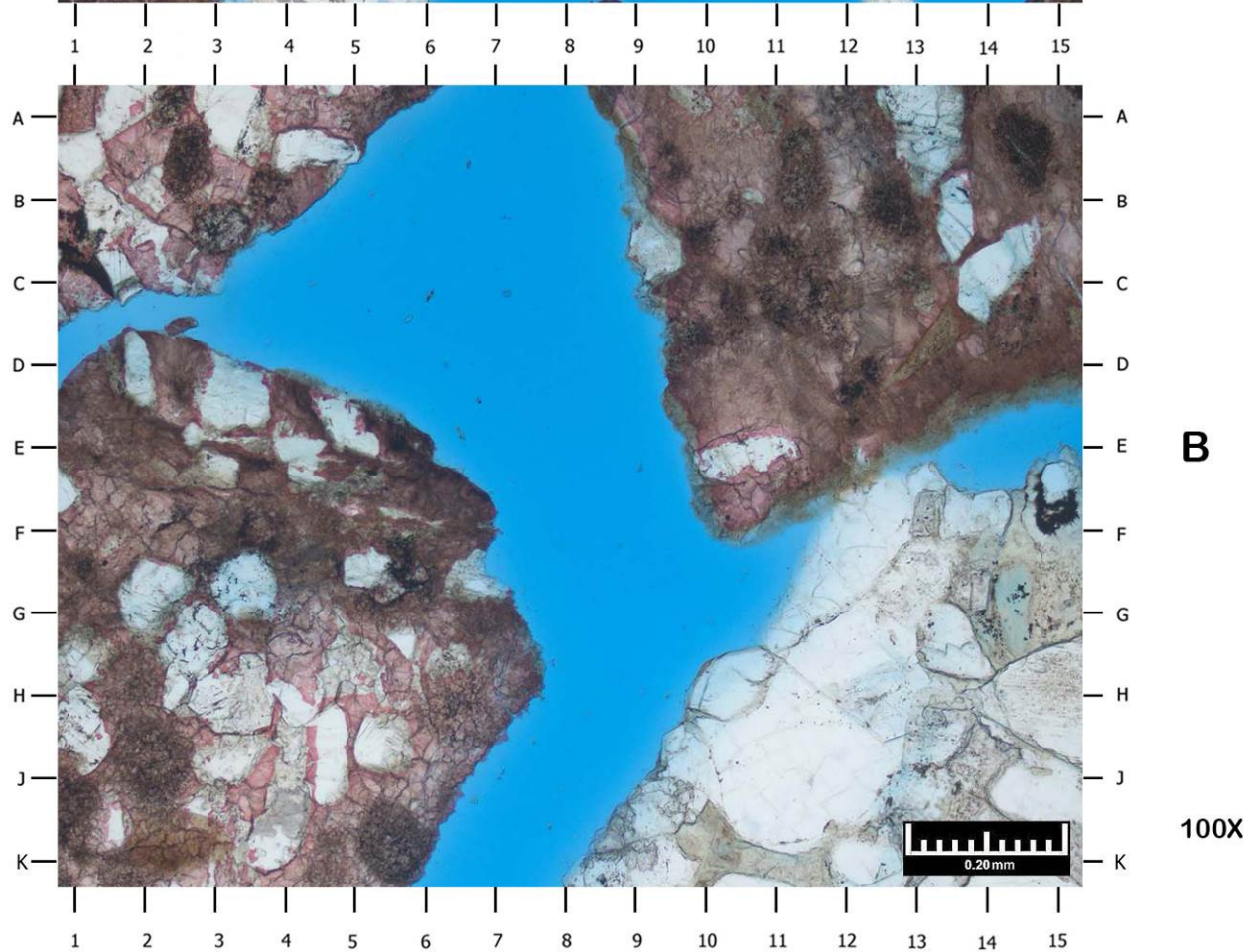
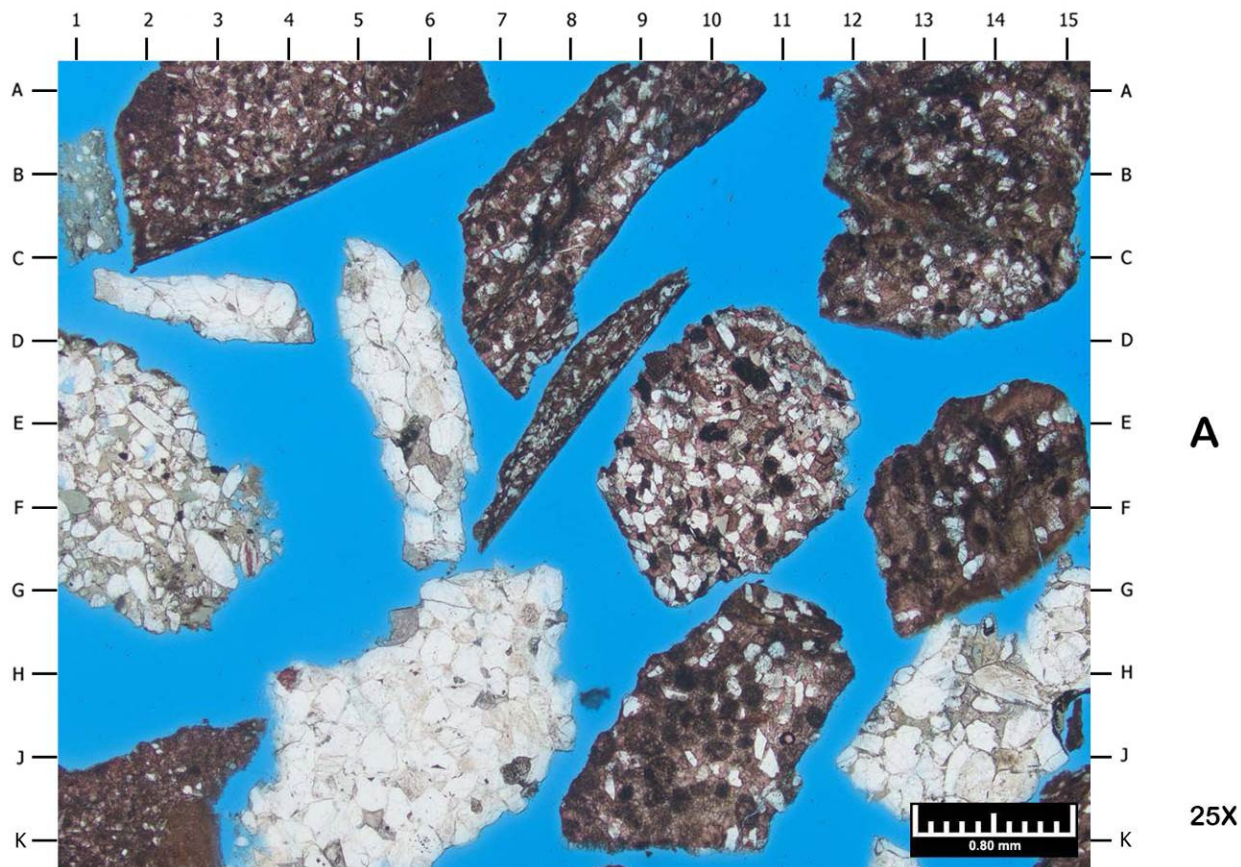
Authigenic Minerals: Calcite occurring as sparry intergranular cement, recrystallization of micrite (limestones only), and as replacement of unstable grains/allochams; quartz overgrowths and lesser feldspar overgrowth cement; dolomite occurring mostly as intergranular cement and in lesser amounts as replacement; and rare pyrite and siderite replacement of unstable grains/allochams

Porosity Types: Rare secondary intragranular micropores associated with altered glauconite and other unstable/altered grains; rare microporosity associated with pore-filling chlorite; primary pore space is predominantly occluded by authigenic cements with only trace primary pores remaining

Magnification: A: 25X B: 100X

A) Lithologies pictured within this low magnification view include sandy to silty limestone (AB4, BC8, F13.5, J9.5, K2, B13.5), calcareous very fine-grained sandstone (EF10), slightly dolomitic, very fine- to fine-grained sandstone (J5.5, HJ13.5, E5.5, CD3), and slightly argillaceous, very fine-grained sandstone (EF1.5). The slightly argillaceous, very fine-grained sandstone chip at EF1.5 is dominated by intergranular chlorite occurring as possible recrystallization of precursor detrital clay; although this is a minor lithology within this depth interval, it exhibits the best reservoir potential. A glauconite grain occurs at F1.2 and a primary intergranular pore occurs at DE1.

B) This photomicrograph provides a high magnification view of the area centered near G12 in Photo A. Sparry calcite cement (stained red; AB2, J3.3, GH4) occludes intergranular areas between grains of quartz (J4.5, DE3, AB1), feldspar (C1.5, A3), and recrystallized peloids (J2, G1, JK5.5, AB2.7) within the calcareous, sandy chips. Intergranular areas within the sandstone at K9 to FK15 are occluded by a combination of quartz overgrowths (HJ9.5, GH11), dolomite (J13.8), and partially recrystallized detrital chloritic/illitic clay (JK10-K11.5, FG14.5). A bitumen-filled secondary pore, rimed by chlorite, occurs at EF14.8.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14230 FEET
SAMPLE NUMBER: 39D

PLATE 39

Lithologies:

Major: Argillaceous very fine- to fine-grained sandstone; slightly dolomitic very fine- to fine-grained sandstone; calcareous coarse siltstone to very fine-grained sandstone
Minor: Sandy/silty limestone; silty mudstone; crystalline dolostone; micritic limestone

Sedimentary Fabric: Massive to bioturbated; laminated

Grain Size Range: <0.03mm to 0.43mm

Compaction: Moderate

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and mudstone fragments

Accessory: Glauconite and phosphatic fragments

Matrix Composition: Minor to common interstitial detrital clay within most sandstone; abundant grain-supporting detrital clay matrix within minor mudstone lithology

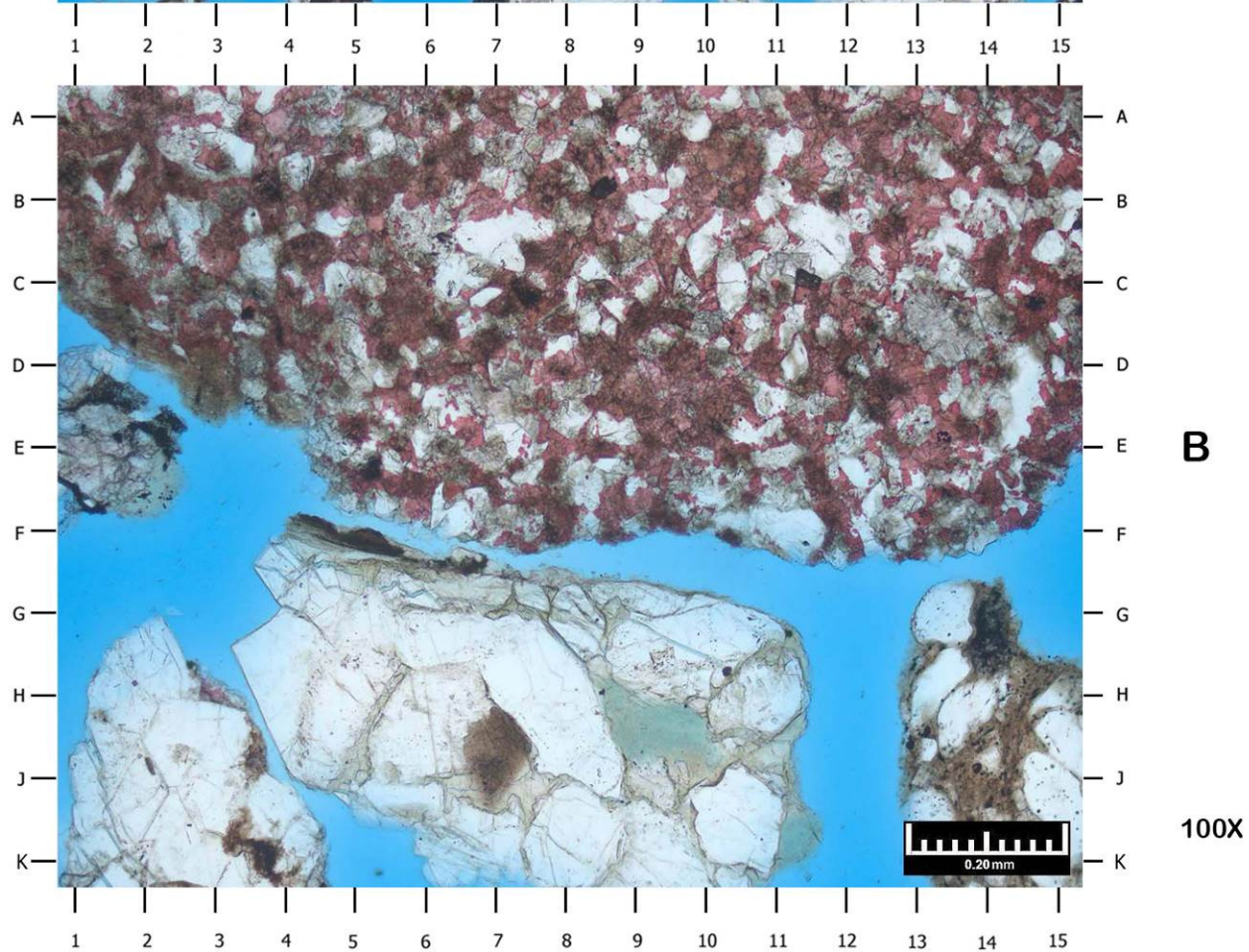
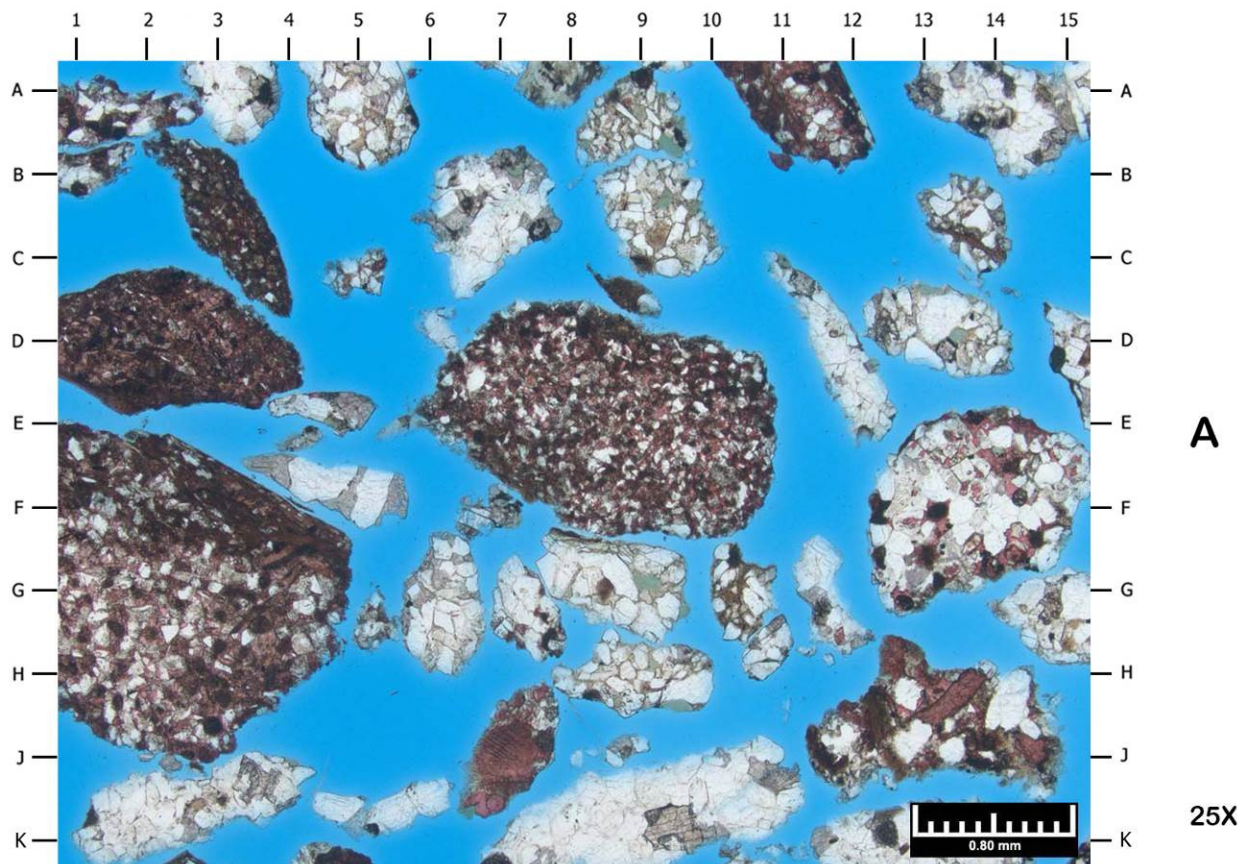
Authigenic Clay: Pore-filling chlorite and grain replacement, and possible chlorite recrystallization of detrital matrix clays

Authigenic Minerals: Common quartz overgrowths; minor to common dolomite occurring as intergranular cement and replacement of unstable grains; minor to locally abundant sparry calcite occurring as intergranular cement, replacement of labile grains, recrystallization of precursor lime matrix (minor limestone lithology only); minor pyrite replacement of organic material and other unstable particles; trace siderite replacement of unstable particles

Porosity Types: Rare secondary intragranular pores; microporosity associated with altered glauconite grains; and no visible intergranular pores

Magnification: A: 25X B: 100X

- A) Lithologies pictured within this low magnification view include calcareous, coarse siltstone to very fine-grained sandstone (G1-4, DE6-10.5); slightly dolomitic, very fine- to fine grained sandstone (AB5, BC7, K9, JK2.5); argillaceous very fine- to fine-grained sandstone (G10.5, BC9, BC13.5), and sandy/silty limestone (HJ13, A11, BC3, D2). Dolomite cement occurs at JK9.5, JK3.5, AB5.3, at BC6.3; calcite is stained red.
- B) This photomicrograph provides a high magnification view of the area centered near F8.5 in Photo A and illustrates the three dominant lithologies. Detrital grains are predominantly monocrystalline quartz (JK10.5, G13.5, JK15) and feldspar (JK4, BC11.5, HJ6). Glauconite (HJ9.5, JK11.1) and phosphatic fragments (J7) are also present as accessory grains. Sparry calcite (stained red; B13, BC3, DE9.5) occludes intergranular areas and replaces unstable grains. Quartz overgrowths (HJ2.2, JK8.7) and authigenic chlorite (J9.9, HJ5, GH11) occlude intergranular areas within some sandstone chips. Detrital clay matrix is present within the cutting chip at J14.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14310 FEET
SAMPLE NUMBER: 40D

PLATE 40

Lithologies:

Major: Slightly dolomitic, very fine- to fine-grained sandstone

Minor: Sandy/silty limestone; silty mudstone

Sedimentary Fabric: Massive to bioturbated; slightly laminated

Grain Size Range: <0.03mm to 0.44mm

Compaction: Moderate

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar (including microcline with cross-hatch twinning); chert; and mudstone fragments

Accessory: Phosphatic fragments; trace zircon and tourmaline

Matrix Composition: Minor interstitial detrital clay and trace clay laminations

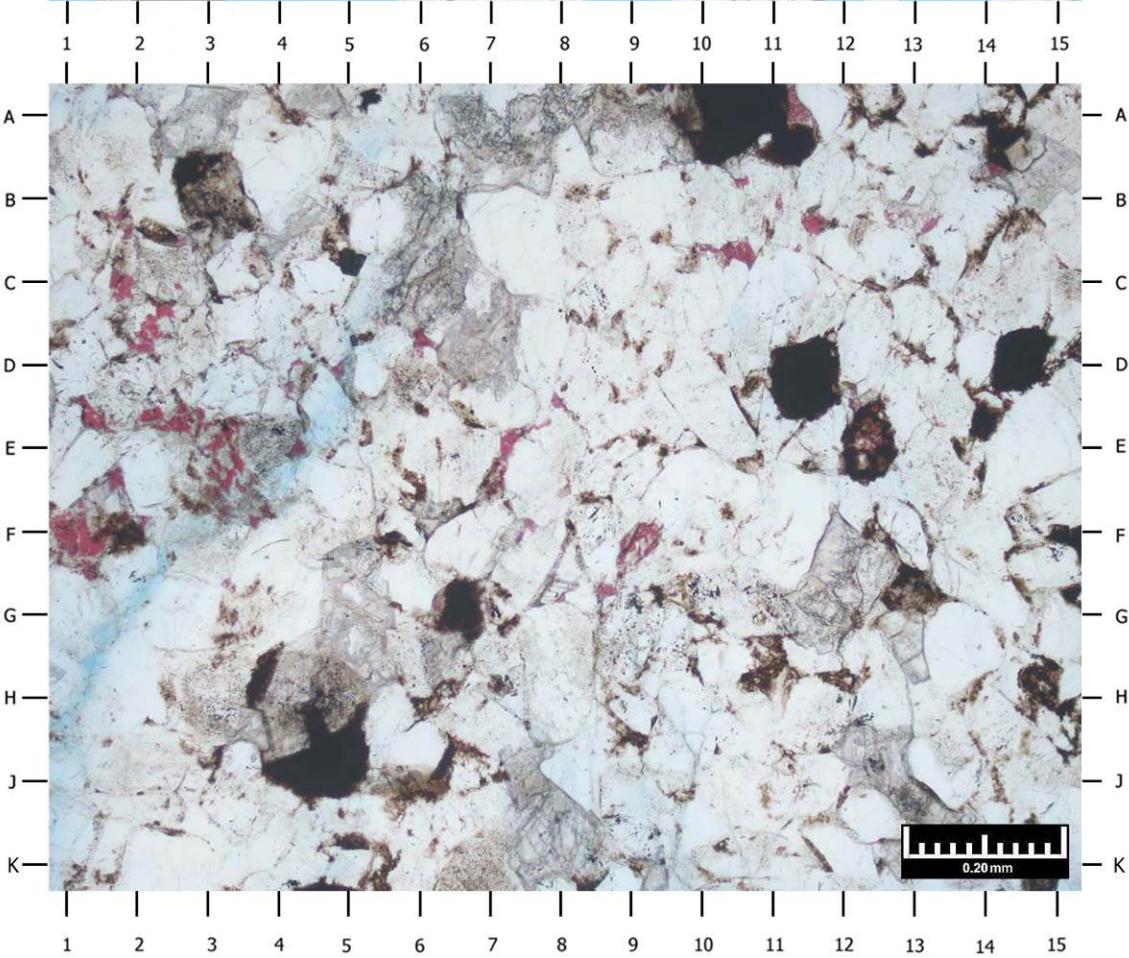
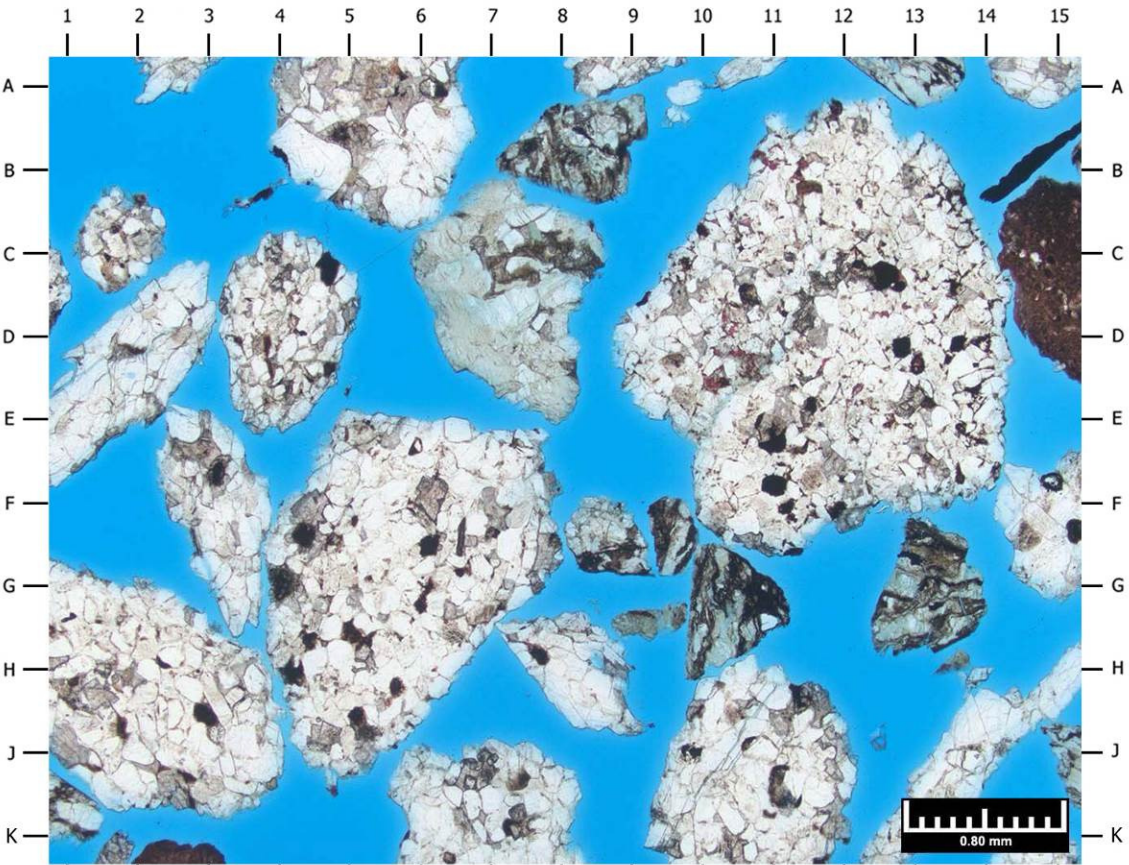
Authigenic Clay: Pore-filling/pore-lining chlorite and possible chlorite recrystallization of detrital matrix

Authigenic Minerals: Common quartz overgrowths; minor to common dolomite occurring as intergranular cement and as replacement of unstable grains/allocherts; minor to common calcite occurring as intergranular cement and as replacement of unstable particles; minor pyrite replacement of organic material and other unstable particles; rare pore-filling bitumen; and trace siderite replacement of unstable particles

Porosity Types: Trace secondary grain-moldic pores; bitumen and authigenic chlorite are observed occluding intergranular spaces, but no open intergranular macro pores are observed; microporosity associated with authigenic chlorite is probable

Magnification: A: 25X B: 100X

- A) Several cutting chips from the dominant slightly dolomitic, very fine- to fine-grained sandstone lithology are represented in this low magnification view (HJ2, G5.5, D12, AB5, D4, F3, JK10.5, K7, FG15). A silty/sandy limestone chip is visible at C15. Several chips damaged by bit shearing are also visible within this view (CD7, B8, G13, G10.5, AB8, A13).
- B) This photomicrograph provides a high magnification view of the area centered near D12 in Photo A. Monocrystalline quartz (BC7, GH13.8, E14.5, JK12.5, HJ6) with lesser feldspar grains (EF6.5, FG7.5, HJ14.5) are the dominant grain types present. Intergranular areas are occluded by a combination of quartz overgrowth cement (EF14, HJ8.7, BC9.5), dolomite cement (AB7, FG12, J13, K7.5), calcite cement (stained red; F1, C1.7, BC10.5), and bitumen (AB14.3, H14.5, J6). Calcite replaces an unstable grain at EF3. The microfracture at K1 to DE5 was artificially induced during drilling.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14315-14320 FEET
SAMPLE NUMBER: 41D

PLATE 41

Lithologies:

Major: Slightly argillaceous, slightly dolomitic, very fine- to fine-grained sandstone
Minor: Very fine- to fine-grained sandstone; calcareous siltstone; sandy limestone; silty mudstone; crystalline dolostone; argillaceous, sandy dolostone

Sedimentary Fabric: Massive to bioturbated; slightly laminated

Grain Size Range: <0.03mm to 0.31mm

Compaction: Moderate

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar Mudstone fragments; and chert grains

Accessory: Tourmaline and phosphatic fragments

Matrix Composition: Minor to common interstitial detrital clay (most chips); abundant detrital clay (within minor mudstone chips)

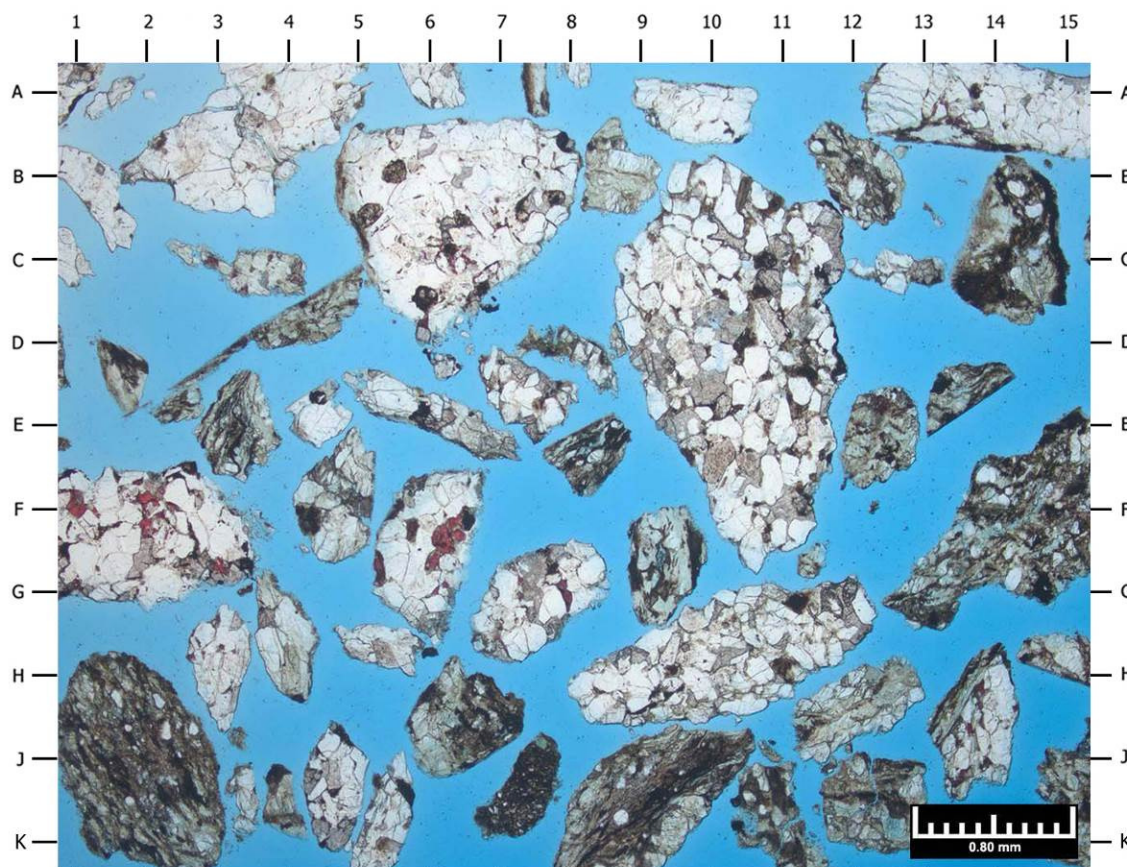
Authigenic Clay: Minor pore-filling chlorite; possible chlorite recrystallization of detrital clay; chlorite/illite grain replacement

Authigenic Minerals: Minor to common dolomite occurring as intergranular cement and replacement of unstable grains; minor to common quartz overgrowths and lesser feldspar overgrowths cement; minor to locally common calcite occurring as intergranular cement and replacement of unstable grains; rare to minor pyrite replacement of unstable particles; sparry calcite recrystallization/replacement of precursor matrix (minor limestone chips only)

Porosity Types: Trace secondary intragranular pores; possible microporosity associated with authigenic pore-filling chlorite

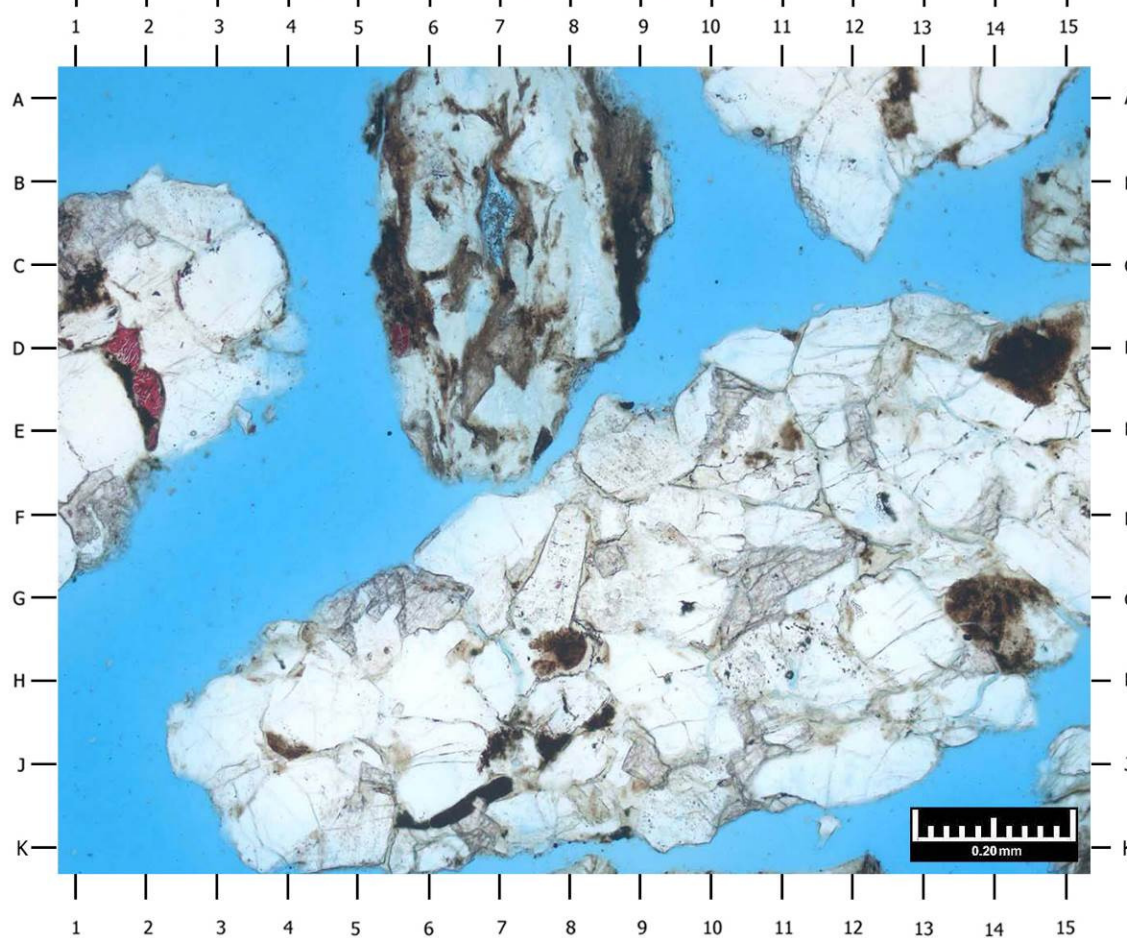
Magnification: A: 25X B: 100X

- A) This low magnification photomicrograph represents several cutting chips from the dominant slightly argillaceous, slightly dolomitic very fine- to fine-grained sandstone (BC6, D10, H10, FG2, FG6, GH7, AB3.5). Many damaged, bit-sheared cutting chips are also pictured within this view (C14, F14, J2, JK9, G9, E3, E12).
- B) This photomicrograph provides a high magnification view of the area centered near GH9.5 in Photo A. Detrital grains include monocrystalline quartz (B12, A11, CD3, HJ4.5), feldspar (G7.5, GH10.8, GH9, E8.5), and mudstone fragments (D14.5, GH14, H8). Intergranular spaces have been completely restricted by a combination of quartz overgrowths (CD2, HJ3.8, HJ5.3), dolomite (GH6, HJ9, J10.5, FG10.5, DE10), calcite (stained red; DE2), and detrital clay (A12.7, AB13.5, EF14.8). The bluish grains in the cutting chip at AE7 have been crushed by bit shearing during drilling and do not represent natural microporosity.



A

25X



B

100X

THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14330 FEET
SAMPLE NUMBER: 42D

PLATE 42

Lithologies:

Major: Slightly calcareous/dolomitic, very fine- to fine-grained sandstone
Minor: Argillaceous, very fine-grained sandstone; calcareous, very fine-grained sandstone; recrystallized limestone

Sedimentary Fabric: Massive; bioturbated

Grain Size Range: <0.03mm to 0.35mm

Compaction: Moderate

Visual Sorting: Moderate

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar and potassium feldspar

Accessory: Phosphatic fragments; mica/biotite; and zircon

Matrix Composition: Minor to common interstitial detrital clay

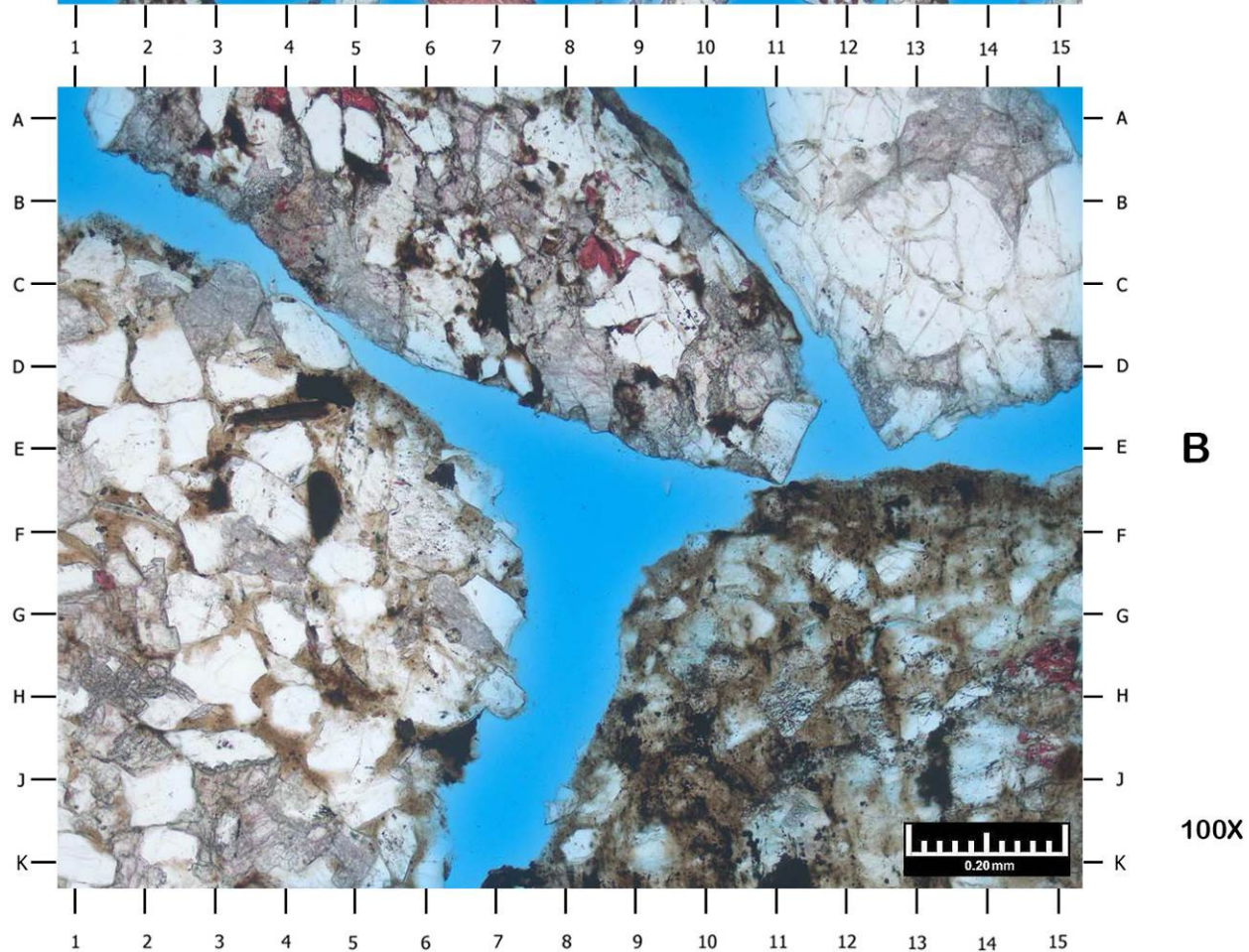
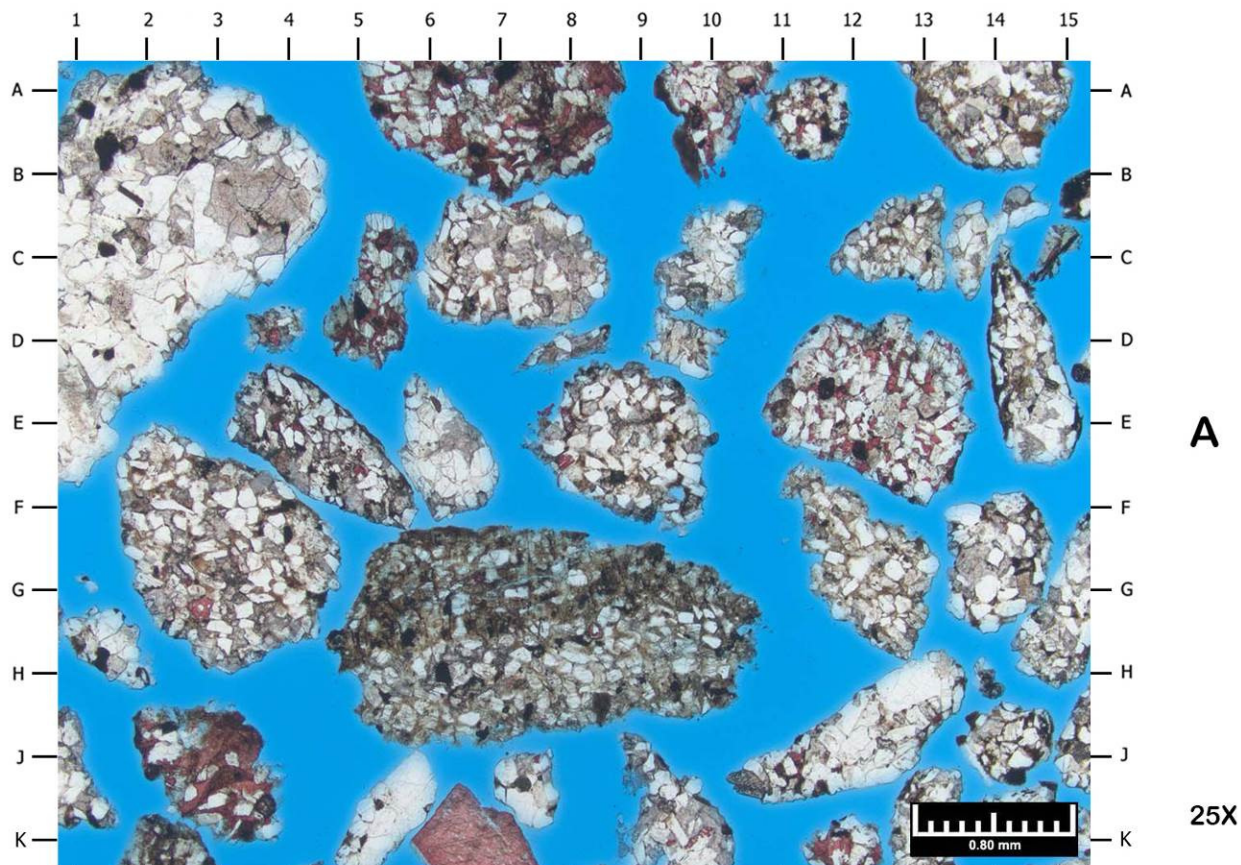
Authigenic Clay: Minor authigenic pore-filling chlorite and possible recrystallization of detrital clay

Authigenic Minerals: Minor to common dolomite occurring as intergranular cement and replacement of unstable grains; minor to common calcite occurring as intergranular cement and replacement of unstable grains; minor quartz overgrowths; rare to minor pyrite replacement of organic material and other unstable particles; trace siderite replacement of unstable grains; and trace pore-filling bitumen

Porosity Types: Possible microporosity associated with authigenic, pore-filling chlorite

Magnification: A: 25X B: 100X

- A) Cutting chips represented in this low magnification view are predominantly calcareous (AB7, E12) to dolomitic (C7, FG3) very fine-grained sandstone. A dolomitic fine-grained sandstone chip occurs at BC1-4. Argillaceous, very fine-grained sandstone chips are pictured at GH7.5, DE14.5, and A14.
- B) This photomicrograph provides a high magnification view of the area centered at FG5 in Photo A. Detrital grains include monocrystalline quartz (CD13, B15, E2, AB4.5), plagioclase feldspar (EF3.5, EF5, CD9.7), potassium feldspar (EF5, F6), and biotite mica (EF2). Intergranular areas are occluded by a combination of detrital clay (HJ4, F1.5, E3), dolomite cement (A14, CD3, K2, D8), quartz overgrowths (CD14, CD9.5, BC13.2), calcite cement (stained red; A5, BC8.3), and bitumen (AB3.3, BC6, CD7). Minor pyrite occurs as replacement of unstable particles (F4.5, DE4, DE4.5). The argillaceous sandstone chip at FK9-15 has been damaged by bit shearing of grains and some drilling mud invasion.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14340 FEET
SAMPLE NUMBER: 43D

PLATE 43

Lithologies:

Major: Slightly argillaceous/calcareous/dolomitic, very fine-grained sandstone; slightly carbonaceous very fine-grained sandstone; calcareous very fine-grained sandstone
Minor: Dolostone; silty, sandy limestone; dolomitic, medium-grained sandstone (poorly sorted)

Sedimentary Fabric: Laminated to massive (possible bioturbation)

Grain Size Range: <0.03mm to 0.66mm

Compaction: Moderate

Visual Sorting: Moderate to well (most cuttings); poorly sorted (minor lithology)

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar; and mudstone fragments

Accessory: Organic fragments; phosphatic fragments; zircon; and tourmaline

Matrix Composition: Minor interstitial detrital clay

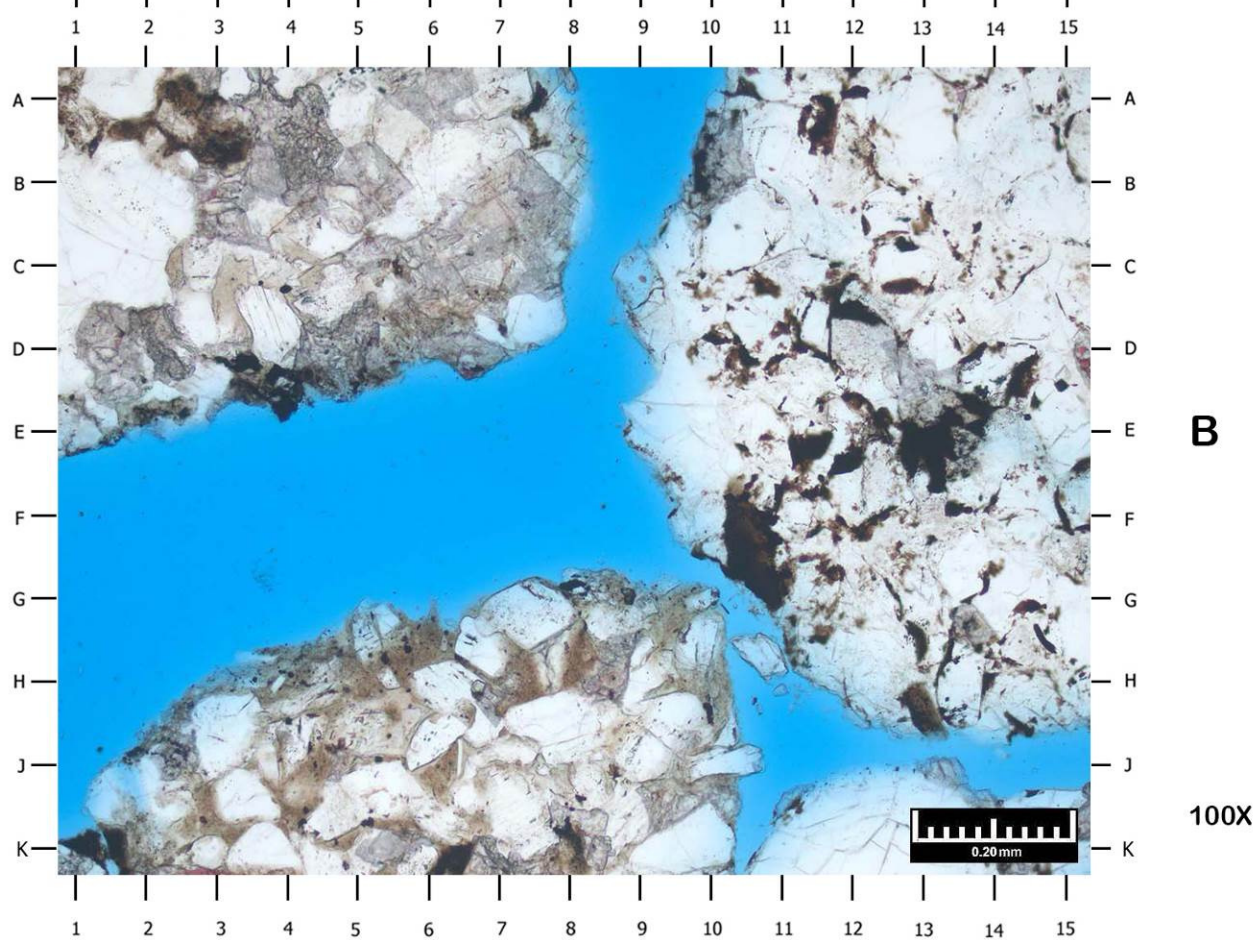
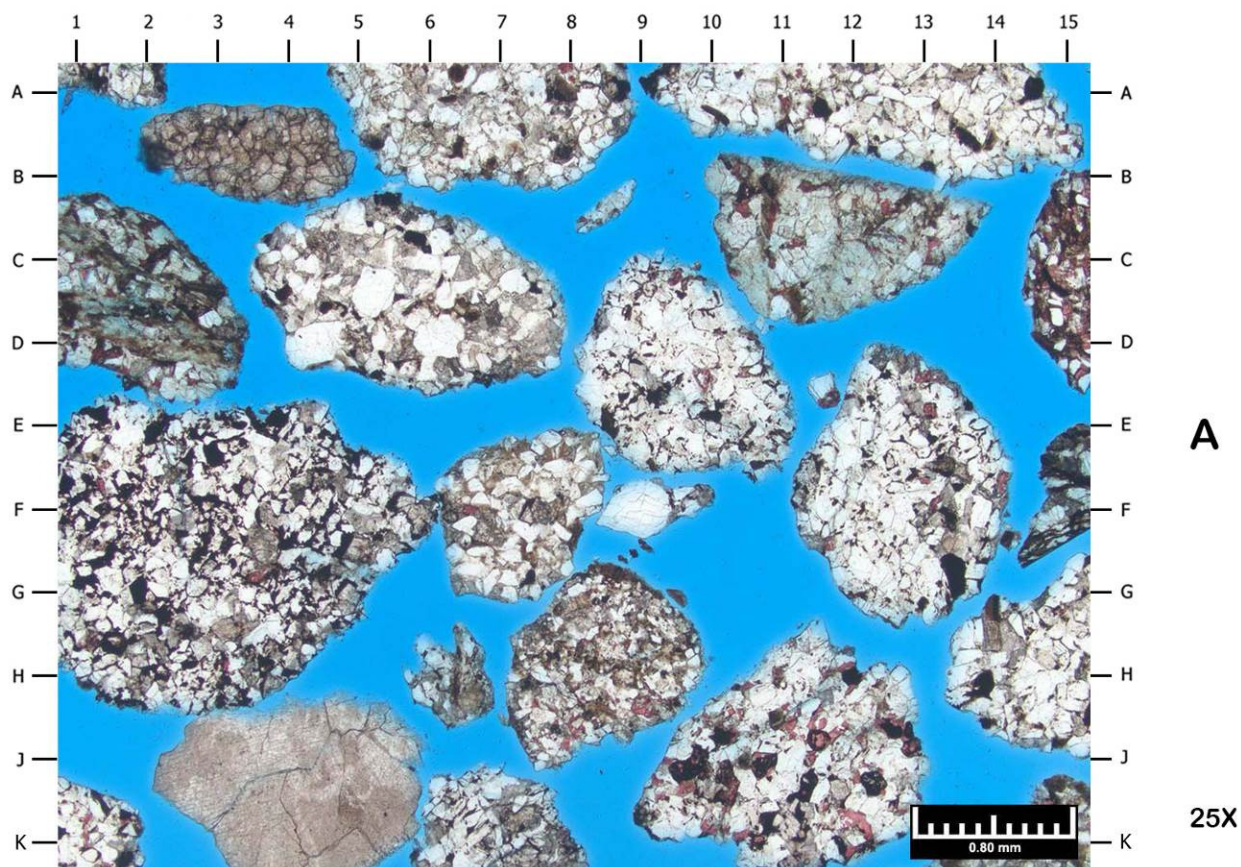
Authigenic Clay: Minor undifferentiated clays occurring as partial replacement of unstable grains

Authigenic Minerals: Quartz overgrowths; feldspar overgrowths; intergranular calcite cement and replacement of unstable grains; dolomite cement and replacement of unstable grains; bitumen occluding intergranular spaces; sparry calcite recrystallization of matrix within limestone chips; rare to minor pyrite replacement of unstable particles; trace siderite replacement of unstable particles

Porosity Types: No visible pores using standard petrographic techniques

Magnification: A: 25X B: 100X

- A) Very fine-grained sandstone is the dominant lithology pictured in this low magnification view. The sandstone chips at CD15, J11, and H8.5 contain minor to common amounts of calcite cement occluding intergranular spaces. The chip at FG1-5 contains common bitumen occluding intergranular areas. Dolostone chips occur at AB3.5 and JK4. The chips at BC11.5 and CD1.5 exhibit extensive damage from broken/crushed grains induced by drill bit shearing.
- B) This photomicrograph provides a high magnification view of the area centered near DE7.5 in Photo A. Intergranular areas within these sandstone chips are occluded by a combination of interstitial detrital clay (JK3, J6, H7.3), dolomite cement (BC3, A6, JK9.4), quartz overgrowths (AB11, B13.5), and pore-filling bitumen (D10.2, CD11.8, E13, E12). A portion of the pore-filling detrital clay in some of the cuttings may be artificially derived from drilling mud invasion.



THIN SECTION DESCRIPTION – GENERAL
SAMPLE DEPTH: 14380 FEET
SAMPLE NUMBER: 44D

PLATE 44

Lithologies:

Major: Calcareous, very fine-grained sandstone to calcareous coarse siltstone; dolomitic, very fine-grained sandstone; very fine- to medium-grained sandstone
Minor: Sandy limestone to limestone; silty, sandy mudstone to calcareous mudstone; argillaceous, very fine-grained sandstone

Sedimentary Fabric: Laminated to bioturbated; partially to completely recrystallized limestone cuttings

Grain Size Range: <0.03mm to 0.44mm

Compaction: Moderate

Visual Sorting: Moderate to well

Framework Grains:

Major: Monocrystalline quartz

Minor: Plagioclase feldspar; potassium feldspar (including microcline); chert; and mudstone fragments

Accessory: Phosphatic fragments; organic fragments; echinoderm fragments; other undifferentiated calcareous skeletal fragments; and trace zircon

Matrix Composition: Minor to common detrital clay within some sandstone cuttings; minor detrital clay in some limestone cuttings; abundant detrital clay within mudstone cuttings; partially recrystallized micrite (limestone cuttings)

Authigenic Clay: Trace pore-filling chlorite in some sandstone chips

Authigenic Minerals: Common quartz overgrowth cement (sandstone only); intergranular calcite cement; intergranular dolomite cement; calcite recrystallization and/or replacement of grains/allochems; dolomite replacement of grains/allochems; feldspar overgrowth cement; rare to minor pyrite replacement of organics and other unstable particles; rare pore-filling bitumen within some sandstone chips; and trace siderite replacement of unstable particles

Porosity Types: No visible pores using standard petrographic techniques

Magnification: A: 25X B: 100X

A) Lithologies represented in this low magnification view of cutting chips include very fine- to medium-grained sandstone (CD8, G4.5, K11); calcareous coarse siltstone to very fine-grained sandstone (C12.5, BC4.5, EF3.4, F1.5, B2, J2, EF10, J13); sandy limestone (A13, EF12.5, G9.5, K9); limestone (H6.5, HJ9, E15); and silty, calcareous mudstone (G15).

B) This photomicrograph provides a high magnification view of the area centered near EF10 in Photo A. Intergranular areas within the sandstone chips are occluded by a combination of quartz overgrowth cement (AB1.3, D1, DE8), calcite cement (stained red; AB10.5, F7, CD8.5), dolomite cement (D4.5, A2, C4, G8.5, AB8.6), and detrital clay (AB5, DE1.8). Detrital grains are predominantly monocrystalline quartz (AB5.5, EF2.5, JK4, DE11.5) with lesser amounts of feldspar (C2, BC1.8, D10, DE10.4, CD6). The grain at C4.5 is rimmed by siderite crystals. The sandy limestone chips at JK2-9, AG14.5, and K13 are mostly recrystallized to sparry calcite.

