PETROGRAPHIC STUDY OF TWELVE SAMPLES RECOVERED FROM THE NAHANNI FORMATION AT WELL LOCATION AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0

Northwest Territories Geological Survey
Work Order No. 20A20314

March, 2020

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SERVICE BEYOND ANALYSIS

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EXECUTIVE SUMMARY

The purpose of this study is to describe the observed lithological characteristics, associated reservoir quality and fluid sensitivity of sixteen petrographic samples collected from the Nahanni Formation at well location Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0. Petrographic analyses and interpretations are based on the observation of twelve thin section and SEM samples generated from core; while sixteen Bulk XRD analyses were also completed on these samples (additional four XRD that were not analyzed by thin section or SEM) to confirm mineralogy. An overview of general sample information can be found below within **Table A:**

Sample ID (*)	Depth (ft/m)	Formation	Rock Classification	Analysis (*)	RQ (*)
Location: AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0					
X65	10104.60/3079.88	Nahanni	Dolostone	XRD	N/A
T48, X64, S48	10131.00/3087.93	Nahanni	Dolostone	TS; XRD; SEM	P
T47, X63, S47	10141.80/3091.22	Nahanni	Dolostone	TS; XRD; SEM	P - M
T46, X62, S46	10477.90/3193.66	Nahanni	Dolostone	TS; XRD; SEM	P
T45, X61, S45	10493.30/3198.36	Nahanni	Dolostone	TS; XRD; SEM	P
X60	10497.80/3199.73	Nahanni	N/A	XRD	N/A
T44, X59, S44	10504.60/3201.80	Nahanni	Dolostone	TS; XRD; SEM	P
T43, X58, S43	10725.00/3268.98	Nahanni	Dolostone	TS; XRD; SEM	P - M
X57	10737.70/3272.85	Nahanni	Dolostone	XRD	N/A
T42, X56, S42	10738.90/3273.22	Nahanni	Dolostone	TS; XRD; SEM	P
T41, X55, S41	10742.00/3274.16	Nahanni	Dolostone	TS; XRD; SEM	P

T40, X54, S40	10746.10/3275.41	Nahanni	Dolostone	TS; XRD; SEM	P
T39, X53, S39	10746.20/3275.44	Nahanni	Dolostone	TS; XRD; SEM	P
X52	10749.60/3276.48	Nahanni	Dolostone	XRD	N/A
T38, X51, S38	10956.90/3339.66	Nahanni	Siliceous Dolomitic Shale	TS; XRD; SEM	NR
T37, X50, S37	10961.60/3341.10	Nahanni	Siliceous Dolomitic Shale	TS; XRD; SEM	NR

(*) TS: Detailed thin section analysis with Images; XRD: Bulk X-Ray Analysis; SEM: Scanning Electron Microscope analysis with images; RCA: Routine Core Analysis

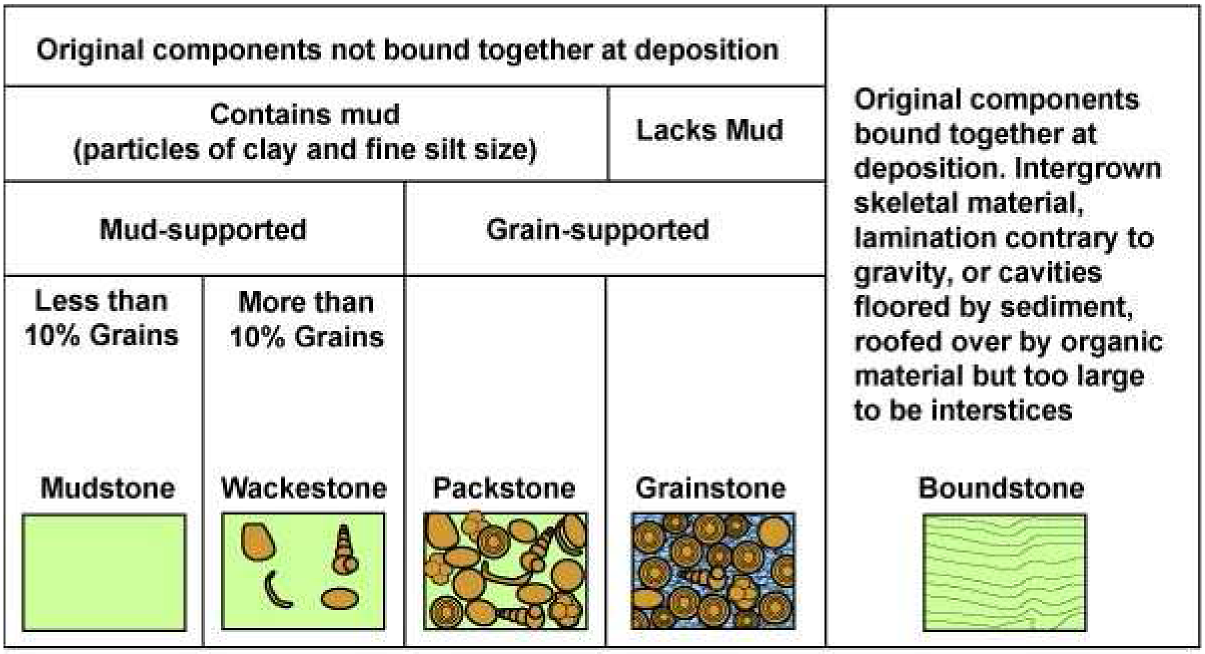
Sample ID: T – thin section sample; X – XRD; S – SEM sample; P – RCA

(*) RQ -Reservoir Quality: NR – Non Reservoir rock; VP – Very Poor; P- Poor; M – Moderate; G- Good

The mineralogy of the ten dolomite samples include mainly dolomite, with only trace to minor organic matter and clays, plus trace pyrite (most sample) and calcite (sample T45 only). Trace drilling mud fines that lines induced fractures and intercrystalline pores in all samples except T45 and T44. Using white card techniques and remnant fabric in plane polarized light indicate that these dolomites were classified dolowackestone to dolopackstone (samples T48, T46, T43, T42 and T40), dolowackestone (samples T47, T41 and T39), dolofloatstone to dolorudstone (sample T45) and dolomite breccia (T44). The allochems in the dolowackestone and dolomudstone carbonates are classified as unidentified bioclasts. However shape, sized and relationship to other features suggest Stromatoporoids, Echinoderms/Crinoid stems and possible plates, highly abraded small bioclasts, bivalves and Brachiopod shell fragments, ostracod debris and small spines (Sponge?) are bioclasts. The high degree of dolomitization makes it impossible to differentiate the bioclastic allochems from the original lime-mud or early calcite cements allochems. Overall the dolomite is divided into two basis types base on crystal size and fabrics. The fine to medium crystalline nonplanar dolomite corresponds mostly to orthochem micrite or microspar and to lesser degree micritized bioclasts is the most abundant type of dolomite in these samples. The less common medium, coarse and very coarse crystalline subhedral to occasional euhedral dolomite cement (also replaced early stage calcite spar cements) occlude voids like leached or intrafossil porosity, interfragmental pores in breccia sample T44 and along burial or tectonic derived fractures. Most of this coarser dolomite has planar fabric but the pore lining and other saddle dolomite rhombs would be considered nonplanar. The organic matter and clays in the dolostone samples are found within the intercrystalline space within the fine crystalline anhedral nonplanar matrix dolomite and within low or high amplitude stylolites. In addition to organic matter or residue the XRD results suggest the clay size material is possibly plagioclase feldspar and quartz and not illite or other clay minerals. The trace pyrite occurs within stylolites, along a few vertical fractures, plus replaces dolomite groundmass (both nonplanar and planar fabrics). The replacement of allochems by chert or polycrystalline quartz occurs in samples T42 and T39. The SEM of sample T48 had euhedral quartz crystal cement along visible porosity. This quartz cement was not detected in the thin section suggest pore occluding quartz cement is highly localized. Trace amounts of calcite occurs as late stage cements along stylolites in sample T45 (XRD of this sample shows the highest amount of calcium carbonate). Calcite was detected in trace amounts by XRD analyses in samples 1 to 9 (see table of sample information), quartz and feldspar detected in all samples. This can be partially explained by the trace amounts of drill mud fines along induced fractures and intercrystalline pores. The drilling mud consist of uphole carbonates (hence the calcite) and clastic minerals (plagioclase feldspar and quartz) fines.

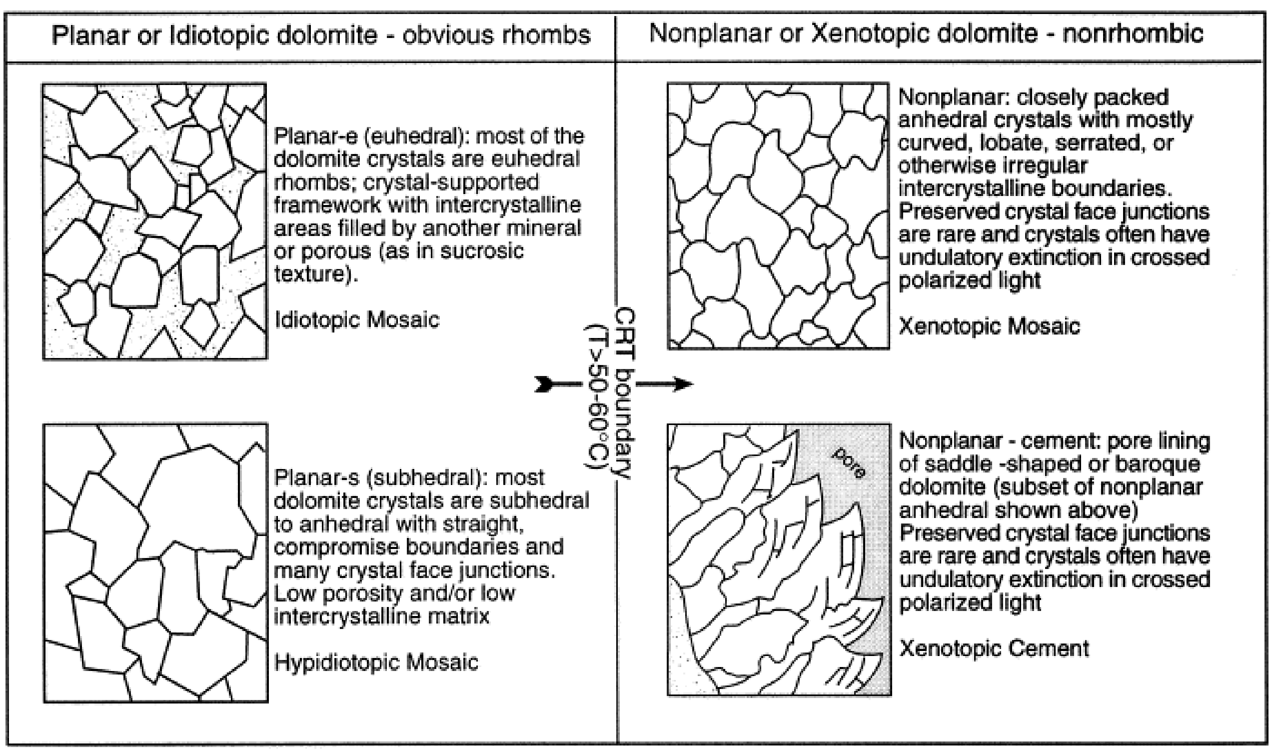
The visible porosity includes intercrystalline (trace to 2%), fracture (trace to 1% except samples T48, T44 and T45), and trace biomoldic (sample T47 only). Micro-intercrystalline porosity occurs only in minor amount in these samples. Most of the horizontal fractures are induced by unloading or coring processes thus should be ignored. Some of smaller horizontal micro-fractures in these dolostones (especially T41 to T39) are derived from possible shear stresses. The vertical fractures are product of extension stress derived from burial and tectonic forces.

Reservoir quality for these ten samples is controlled by depositional environment (i.e. crystal and grain size of the precursor carbonate rock which was mostly lime wackestone to packstone) and diagenesis (i.e. dolomitization, compaction, and cementation). Reservoir quality is considered to be poor to moderate in samples T47 and T43 and poor in the other eight samples.



C. G. St. C. Kendall, 2005 (after Dunham, 1962, AAPG Memoir 1)

For the dolomite crystal fabrics the modified classification proposed by Sibley and Gregg (1987) was used (see the chart below).



Samples 17(T38) and 18(T37)

The two siliceous to dolomitic shale consists of detrital matrix material (42% and 46% - clays, very fine silts and organic matter), with lesser amounts of ferroan dolomite rhombs (20% and 17%), chert (15% and 20%), pyrite (14% and 7%), ferroan calcite (2% and 3%), coarse quartz silts or very fine grained sand (1% both samples), plus fracture cementing chalcedony (6% in sample T38) and polycrystalline quartz (6% in sample T37). Both of these shales have well defined laminations. The laminations in sample T38 have vertical to subvertical dips which is the product of uplifting and folding stresses. In contrast sample T37 has low inclined laminations (approximately 20º). A wide closed vertical to horizontal fracture in sample T38 is first cemented by pyrite, chalcedony and then 3th stage ferroan calcite cements. In sample T37 two subvertical fractures with parallel dips are first stage cemented by polycrystalline quartz and 2nd stage cement is ferroan calcite. Trace pyrite was also seen as cement in fractures in sample T37. These two shale have been significantly silicified and show up as apparent flatten lens or patches of chert and is aligned parallel the laminations. The ferroan dolomite rhombs have subhedral crystal habit and small size (range in size from 10µm to 140µm with average crystal sizes of 50µm and 30µm). This dolomite is precipitated with both the clay rich groundmass in the cherty zones indicating precipitation after silicification has this shale. Pyrite in sample T38 occurs as cement in the large fracture at the base of the thin section and irregular patches of pyrite framboids or spherules replacing clay in rich shale in both samples. The XRD analysis shows the clays in these are dominated by illite, with only minor amounts of kaolinite and chlorite (sample T38 only).

These two siliceous shale samples have no visible porosity (trace micro-porosity is found in association with detrital clays and possible micro-crystalline quartz/chert. These two shale samples are non-reservoir rock due to the total lack of any effective porosity.

The following table summarizes the most important factors that control the reservoir quality of the ten thin section dolostone samples recovered from AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0 location.

Sample ID	**Depth (ft/m)**	**Total Ground-mass (%)**	**Total Cmt (%)**	**Total Porosity (%)**						**Main Porosity controlling factors (*)**	**RQ(*)**
				IP	Int.	Ixl	Bio	Fr	M		
Location: AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0											
T48	10131.00/3087.93	89	9	-	-	TR	-	-	-	Com,Mic,Dc,C, Cht	P
T47	10141.80/3091.22	68	30	-	-	2	TR	TR	-	Com,Mic,Dc,C,F	P-M
T46	10477.90/3193.66	84	15	-	-	TR	-	TR	-	Com,Mic,Dc,C,F	P
T45	10493.30/3198.36	80	18	-	-	1	-	TR	-	Com,Mic,Dc,C,F	P
T44	10504.60/3201.80	54	45	-	-	1	-	-	-	Com,Mic,Dc,C	P
T43	10725.00/3268.98	65	35	-	-	1	-	1	-	Com,Mic,Dc,C,F	P-M
T42	10738.90/3273.22	91	7	-	-	TR	-	-	-	Com,Mic,Dc,C	P
T41	10742.00/3274.16	90	10	-	-	TR	-	TR	-	Com,Mic,Dc,C,F, Cht	P
T40	10746.10/3275.41	94	5	-	-	1	-	1	-	Com,Mic,Dc,C,F	P
T39	10746.20/3275.44	92	7	-	-	TR	-	1	-	Com,Mic,Dc,C,F, Cht	P

Porosity value (%): **IP** – interparticle porosity; **Int** – intraparticle; **Ixl** – intercrystalline; **Bio** – Biomoldic ; **Fr** – fracture porosity; **M** – micro-intercrystalline porosity
Main Porosity controlling factors: **Com –** compaction**;** M**ic** – micrite (calcite or dolomite); **Ms** – micro- and/or pseudospar; **Cc** – calcite cement (druse and spar); **Dc** – dolomite cement**; C** – clays and organics; **Cht** – chert or quartz overgrowths; P**y** – pyrite (replacement and/or cement); **F** – fabric: [**CC** – concavo-convex orthochem contacts; **Styl** – stylolites **S** – sutured orthochem contacts; **Frac** - Fractures]
RQ (*) - reservoir quality: **NR –** non reservoir rock; **P –** poor; **M –** moderate; **G –** good
Total cement (*): includes micro- and pseudospar

The following table summarizes the most important factors that control the reservoir quality of the two siliceous and dolomitic shale thin section samples recovered from AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0 location.

Sample ID	Depth (ft/m)	Total Ground-mass (%)	Total Cmt/ Repl. (%)	Total Porosity (%)						Main Porosity controlling factors (*)	RQ(*)
				IP	Int.	Ixl	Bio	Fr	M		
Location: AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0											
T38	10956.90/3339.66	43	57	-	-	-	-	-	-	C,Cht,F,Dc,Cc,	NR
T37	10961.60/3341.10	47	53	-	-	-	-	-	-	C,Cht,F,Dc,Cc,	NR

Porosity value (%): IP – interparticle porosity; **Int** – intraparticle; **Ixl** – intercrystalline; **Bio** – Biomoldic ; **Fr** – fracture porosity; **M** – micro-intercrystalline porosity
Main Porosity controlling factors: Com – compaction**;** M**ic** – micrite (calcite or dolomite); **Ms** – micro- and/or pseudospar; **Cc** – calcite cement (druse and spar); **Dc** – dolomite cement**; C** – clays and organics; **Cht** – chert or quartz overgrowths; P**y** – pyrite (replacement and/or cement); **F** – fabric: [**CC** – concavo-convex orthochem contacts; **Styl** – stylolites; **Frac** - Fractures]; **Cht**: Siliceous replacement of shale
RQ (*) - reservoir quality: NR – non reservoir rock; **P –** poor; **M –** moderate; **G –** good
Total cement (*): includes micro- and pseudospar

Reservoir problems for the ten dolostone samples recovered from the Nahanni Formation at the Imperial Sun Arrowhead Aurora M-47 300/M-47-6040-12230/0 location, may include the following: **(1)** small sizes of intercrystalline pores and lack of open fractures result in overall poor interconnectivity between pores could restrict the flow of hydrocarbons, **(2)** hydrochloric acid (HCl) treatment of this reservoir has the potential to loosen carbonate fines (dolo-micrite and calcite micrite) that could migrate and block pore throats, plus cause fabric collapse, **(3)** the sensitivity of calcium carbonate to hydrofluoric acid (HF) in regard to precipitation of calcium fluoride scales.

Detailed mineralogical composition of each of the sample are summarized in the tables that can be find in the 'RESULTS' chapter of this report. Following the tabulated data there are images (with descriptions) that show specific features of the samples.

METHODS

Petrographic Microscopy

To prepare the thin section samples, select portions of the core samples were impregnated with blue epoxy, polished and mounted onto a glass slide. After drying of the epoxy the samples were ground down to a total thin section thickness of 30μm. One half of each thin section was then stained with a combination of Alizarin Red (for calcite) and potassium ferricyanide (for ferroan carbonate) to highlight carbonate mineralogy. The dual carbonate stain helps to differentiate the carbonate components within the samples, and affects them as follows: calcite appear pink to red-brown, ferroan calcite shows mauve to blue, ferroan dolomite colors vary from pale blue to turquoise, while non-ferroan dolomite remains unstained. Finally a second glass slide was glued on the samples to protect the polished surface. The prepared thin sections were point counted. The thin sections were examined in plain and cross polarized light conditions and photomicrographs taken at various magnifications (x12.5ppl; x25ppl; x50ppl, x100ppl, and x200ppl) to document structure, porosity, composition and nature of optically resolvable grains and matrix. Each sample has been described separately and the important features of it that includes framework mineralogy, diagenetic minerals and cements, textures, grain size range and average, porosity, etc., and the results are provided in the tabulated format. Annotated images of the thin sections with descriptions show the important aspects that were observed during the thin section examination. These images are placed after the tabulated data.

Bulk XRD Analysis

Sample Preparation: Each sample, consisting of rock fragments, is manually crushed carefully using a mortar and pestle to reduce the size of the fragments. The sample is then ground with a vibratory disc mill (RS200; Retsch) to further reduce crystallite sizes. Finally, the sample is micronized using a planetary ball mill (PQN04; Across International) and scanned for X-ray diffraction analysis.

Quantitative Mineral Phase Analysis: Using the HighScore program, the different mineral phases of the XRD patterns are identified. Once the mineral phases are identified, Rietveld refinements are performed by importing the XRD trace pattern into TOPAS 5. This program (TOPAS 5) is used for Rietveld analysis to quantify the mineralogy. The quantitative mineral phases of all samples are given in **Table 2**.

X-Ray Data Collection and Analysis:

Diffractometer Name:	Bruker D4 Endeavor XRD with a Lynx-Eye detector
Instrumental Parameters:	Radiation Source – Cobalt (Co)
	Generator settings - 40 mA, 35 kV
	Start position [°2θ] - 4
	End position [°2θ] - 80
	Step size [°2θ] - 0.02
	Scan step time [s] - 1
Data Analysis:	ICDD PDF-4 Mineral 2020 powder diffraction database
	X'PERT HighScore Software for mineral identification
	TOPAS Software for quantitative phase analysis
Detection Limit:	0.1 – 0.5 % depending on the type and nature of sample

Combined (Bulk and Clay) XRD Analysis (Samples X51 and X50 only)

Samples were disintegrated, where necessary, and homogenized completely. About 3.0 grams of homogenized subsample was taken from each sample for this analysis. Clay fraction (less than 3µm size) of the samples has been separated from the bulk sample by the centrifuging method. In order to fractionate, samples have been treated in an ultrasonic bath using sodium hexametaphosphate as a deflocculating agent that facilitates complete disintegration of the matrix from the grains. The samples were then centrifuged in two phases. In the first phase, the sample was centrifuged at 600 rpm for 5 minutes that enable coarser particle to settle down at the bottom of the tube. The clay size particles remain in the fluid in suspension, which has been decanted to another tube, and the clay size particles have been collected from this fluid after the second phase of centrifuging at 3000 rpm for 20 minutes. The clay fraction is mounted on a glass slide, dried, ran and placed in a glycol vapor bath for 24 hours in order to identify expandable clays and then ran separate. After placing a separate portion of clay fraction in hydrochloric acid (HCl) for 24 hours and acidized clay fraction was made and ran. Weight fractions are measured for both bulk and clay portions of the sample. The three clays fraction runs were ran between 2° to 40° 2θ(Theta) and one bulk fraction was ran between 4° to 58° 2θ(Theta). The XRD results are summarized and are given in Table 3. The detailed descriptions are as follows:

Note: Bulk and clay XRD analysis does not differentiate between detrital clays, authigenic clays and clays derived from disintegrated framework grains. The quartz in XRD can be quartz, chert, siliceous lithoclast and silt.

Diffractometer Name: XPERT PRO X-RAY DIFFRACTOMETER

Instrumental Parameters: Radiation Source – Copper (Cu)

For Clay Fraction-
- Start position [°2θ]: 4.0
- End position [°2θ]: 40.0
- Step size [°2θ]: 0.03
- Scan step time [s]: 0.5
- Scan type: Continuous
- Generator settings: 40 mA, 45 kV

For Bulk Fraction-
- Start position [°2θ]: 4.0
- End position [°2θ]: 58.0
- Step size [°2θ]: 0.03
- Scan step time [s]: 0.5
- Scan type: Continuous
- Generator settings: 40 mA, 45 kV

Data Analysis: ICDD PDF-4 Mineral 2020 powder diffraction database

X'PERT HighScore for mineral identification

	RIR Method for quantitative Mineral analysis
Detection Limit:	0.5 – 1.0 % depending on the type and nature of sample

SEM Analysis

A representative portion of each sample was adhered onto an aluminum stub specimen mount. The stubs were then sputter-coated with a conductive gold-palladium alloy for detailed Scanning Electron Microscopy (SEM) analysis and imaging. SEM analysis is useful in identifying lithological characteristics such as pore types, framework mineralogy, clay and cement composition, in addition to the potential deportment of clay constituents in relation to pore spaces and pore throats. Energy dispersive X-ray (EDX) was also used in conjunction with SEM observation in order to determine the elemental composition of the observed clay minerals and carbonate mineralogy.

Grain sizes:

The scale for authigenic constituents in carbonates follows the Wentworth division, which is the most useful for dolomites, where transported particles are usually obliterated by replacement and crystal size is one of the few describable characteristic. The carbonate crystal sizes ranges are as follows: very fine crystalline (4 to 16μm), fine (16 to 62 μm), medium (62 to 250 μm), coarse (250-1000 μm), and very coarse crystalline (1000 to 4000 μm). The finest authigenic constituents are called cryptocrystalline (less than 1μm) and aphanocrystalline with the crystal size between 1 and 4 μm.

The following describes a division within the carbonate matrix. Micrite term is used for carbonate mud that consists of 1 to 4 μm diameter crystals and forms as an inorganic precipitate or through breakdown of coarser carbonate grains. Micrite is produced within the basin of deposition and shows little or no evidence of transport (Folk, 1959). Microspar is generally 5 to 20 μm sized calcite produced by recrystallization (neomorphism) of micrite and can be as coarse as 30 μm (Folk, 1965). Microspar is restricted to recrystallization products, not primary precipitates. Calcite fabric crystal size larger than 30 to 50 μm is called a pseudospar.

Abbreviations

The list of common thin section abbreviations in provided in the table below.

NAME	ABBREVIATION	NAME	ABBREVIATION
Anhydrite	Anh	Intraclast Porosity	Intr.
Barite	Ba	Kaolinite	Kao
Bivalves	Biv	K-Feldspar	K-Fld
Bioclasts (indistinct)	Biocl	Laminae	Lam
Burrows/Bioturbation	Bur	Metamorphic Rock Frag.	MRF
Brachiopod	Bra	Muscovite	Musc
Calcite	Cal	Matrix	Mtx
Carbonaceous	Carb	Micro-vuggy pore	Mv
Chert	Cht	Organic material	OM
Chalcedony	Chalc	Ostracods	Os
Concavo-convex	CC	Plutonic Rock Fragments	PRF
Dolomite	Dol	Polycrystalline quartz	PQ
Dolomite Cement	Dc	Pseudo-matrix	P-mtx
Detrital Dolomite	dD	Pyrite	Py
Echinoid/Crinoid	Ech	Quartz	Qtz
Ferroan Dolomite	FeDol	Quartz Cement	Qc
Ferroan Calcite	FeCal	Quartz overgrowths	Ov
Glauconite	Glauc	Sedimentary Rock Frag.	SRF
Grain dissolution pore	GD	Secondary porosity	SP
Horizontal Fracture	HFrac	Sutured grain contact	S
Hematite	Hem	Stylolite	Styl
Illite	Ill	Marcasite	Marc
Intergranular Porosity	IP	Saddle Dolomite	SD
Intercrystalline Porosity	lxl	Vertical Fracture	VFrac
Intraclast	Intraclast		

RESULTS

In this chapter of the report, the twelve samples that were recovered from the Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0 location will be described separately. The images that show specific features of each sample will follow the tabulated sample description. Stratigraphic top of the thin section samples have been marked with an arrow placed in the upper right portion of the thin section.

Stratigraphic Unit: Nahanni Formation

Sample T48 (X64, S48), 10131.00ft/3087.93m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10131.00ft/3087.93m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone (Wacke to Packstone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		99			TR	1
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Detrital grains	Matrix	Pore filling cement	Replacement
		30		1	9	60

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wackestone to packstone that has been eventually totally dolomitized.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divide replacement fabrics by crystal size distribution into unimodal and polymodal, and by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with overall unimodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 1.1) or looking at the scan image of the whole thin section (Figure 1A).
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 99% of dolomite. Other minerals include clays and organics (1%), plus trace pyrite. There are no carbonate clasts, but significant amounts of totally dolomitized bioclasts (30%) were observed. Based on the shape, the bioclasts could possibly be stromatoporoid fragments

	(Amphipora? Or Idiostroma?), echinoid stems and possible plates, spines (brachiopod or sponge?), plus pelecypod and ostracod shell fragments.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material fills locally intercrystalline space that is has been classified as matrix of this sample.
Pore Filling Cements	The pore filling cements occur in moderate to coarse crystalline dolomite healed biomolds and totally occlude all fractures.
Replacement Minerals	Nonplanar fine to medium crystalline dolomite is the main replacement mineral. Trace amount of pyrite appears to replace organic matter within intercrystalline dolomite.
Porosity	There is only a trace amount of intercrystalline pores observed in this sample.

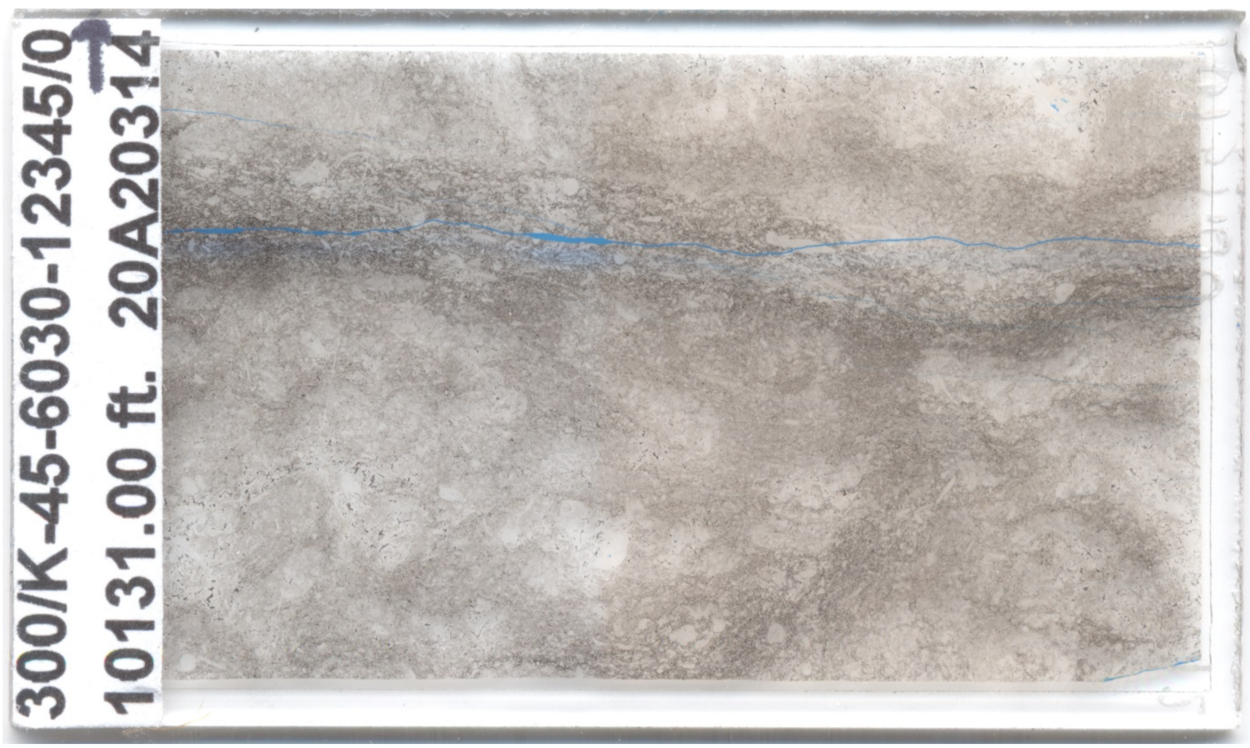


Figure 1A: Thin section scan of sample T48 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone to dolopackstone with fine to coarse crystalline dolomite. The "ghost "of individual bioclasts appear light in this scanned thin section. The horizontal (blue epoxy) fracture has induced origin and should be ignored.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

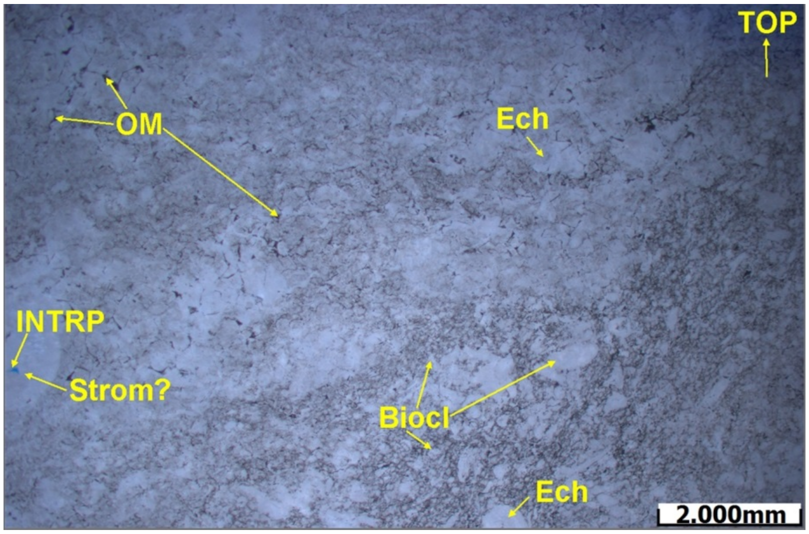


Figure 1.1. Sample T48, 10131.00ft/3087.93m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this dolostone. The bioclasts present are possible echinoid stems (Ech), stromatoporoid (Strom?) and highly fragmatic unidentified fossil debris (Biocl). Rare intercrystalline pores (INTRP) occur within the coarse crystalline dolomite within a larger bioclasts. Also note the irregular distribution of the intercrystalline organic matter and clays (OM). **x12.5 white card ppl**

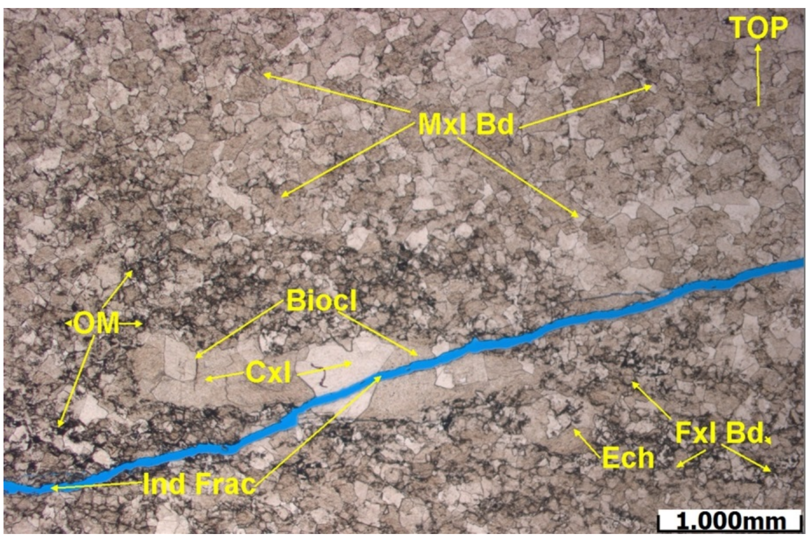


Figure 1.2. Sample T48, 10131.00ft/3087.93m. A low magnification image showing the distribution dolomite crystal size. The fine crystalline dolomite occurs within a zone where intercrystalline organic matter and clays (OM) are common. The medium crystalline dolomite is concentrated in zones were organic matter is rare and coarse crystalline dolomite occurs within large bioclasts (Biocl). Note the faint outline of possible crinoid stem (Ech) within the fine crystalline dolomite. One induced fracture (Ind Frac) bisecting this view should be ignored. **x25ppl**

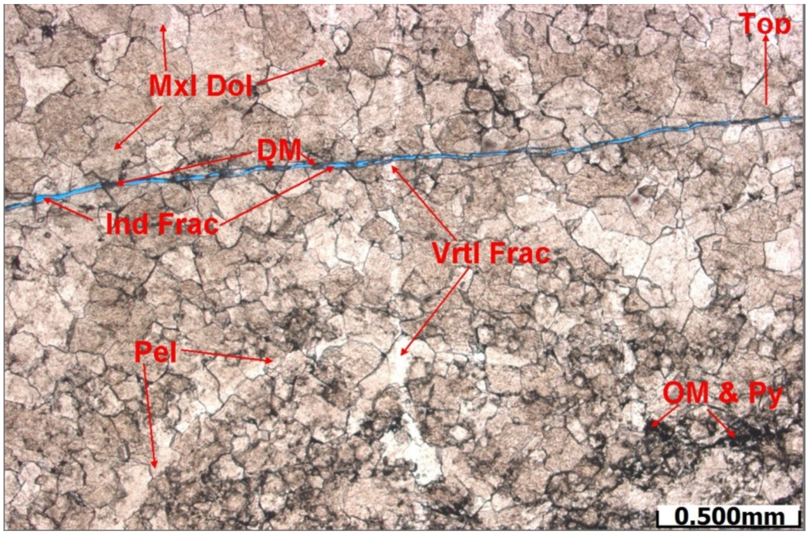


Figure 1.3. Sample T48, 10131.00ft/3087.93m. A moderate magnification image showing a dolomite healed vertical fracture (Vrtl Frac) bisecting a predominately medium crystalline dolomite (Mxl Dol). This same fracture also cuts through a possible pelecypod shell fragment (Pel). Some of the organic matter is partially replaced by pyrite (OM & Py). The induced horizontal fractures (Ind Frac) are partially infilled with drilling mud fines (DM). There is no true visible porosity in this image. **x50ppl**

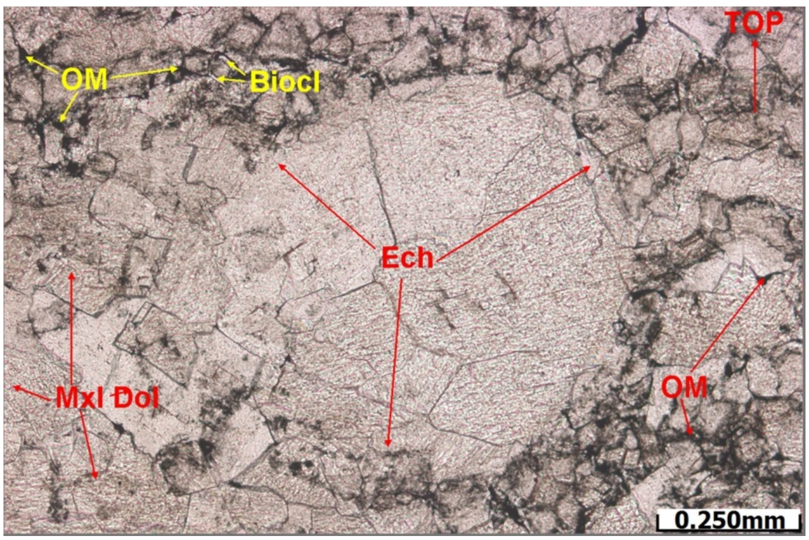


Figure 1.4. Sample T48, 10131.00ft/3087.93m. A high magnification view showing the outline of probable crinoids stem (Ech) replaced by very coarse crystalline dolomite. Rare small possible ostrocod shell debris (Biocl) occurs in association with the intercrystalline organic matter (OM). The majority of dolomite in this image is medium crystalline (Mxl Dol) and has nonplanar fabric. **x100ppl**

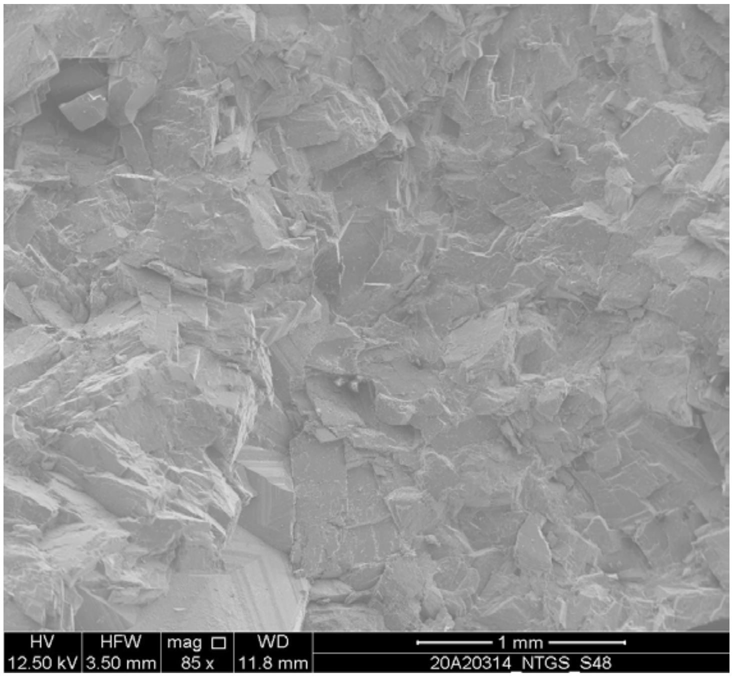


Figure 1.5. Sample S48, 10131.00ft/3087.93m. Low magnification scanning electron microscope (SEM) image showing the overall crystal fabric of the rhombic dolomite. **x85**

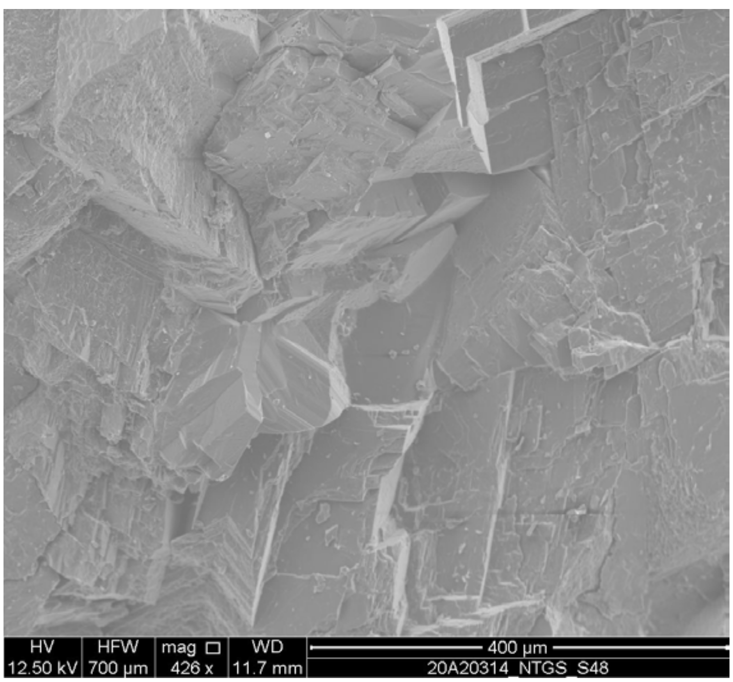


Figure 1.6. Sample S48, 10131.00ft/3087.93m. Low magnification scanning electron microscope (SEM) image showing that the replacement crystal fabric predominately consists of tightly inter locking sub- to euhedral dolomite; therefore, porosity is generally poor. **x426**

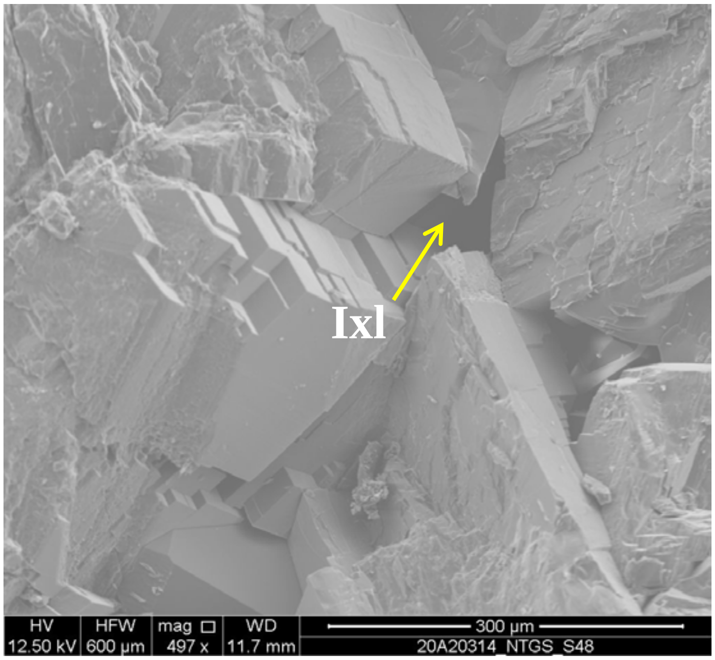


Figure 1.7. Sample S48, 10131.00ft/3087.93m. Low magnification scanning electron microscope (SEM) image highlighting an intercrystalline pore space measuring ~150µm. Porosity in this sample consists of rare isolated pore spaces. **x497**

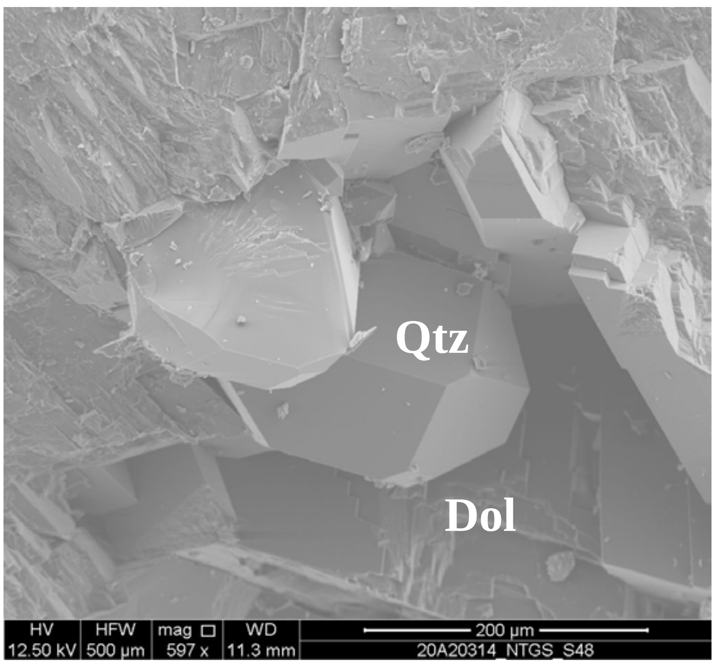


Figure 1.8. Sample S48, 10131.00ft/3087.93m. Low magnification scanning electron microscope (SEM) image highlighting euhedral secondary quartz cement (Qtz). Dol: dolomite. **x597**

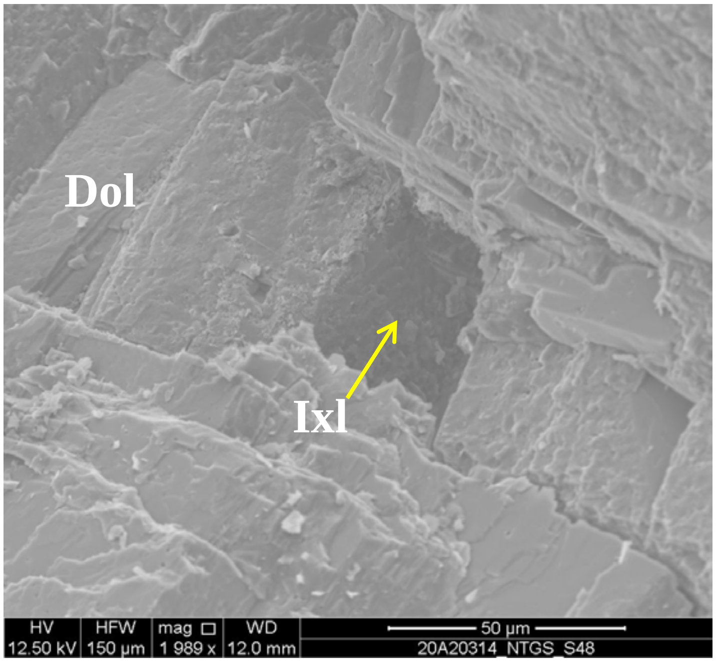


Figure 1.9. Sample S48, 10131.00ft/3087.93m. Scanning electron microscope (SEM) image showing an isolated intercrystalline pore space measuring ~30µm. Dol: medium crystalline dolomite. **x1989**

Sample T47 (X63, S47), 10141.80ft/3091.22m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample Type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10141.80ft/3091.22m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor to Moderate
Classification	Dolostone (Mud- to Wackestone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		98	TR		TR	2
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Detrital grains	Matrix	Pore filling cement	Replacement
		15		2	30	53

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-mudstone to wackestone that has been eventually totally dolomitized. Formation of low amplitude stylolites typically occurs during burial diagenesis (chemical compaction). The fact that these stylolites have dips approaching vertical (approximately 60º) indicate significant tectonic movement of this rock after deposition and dolomitization.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divide replacement fabrics by crystal size distribution into unimodal and polymodal, and by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with both unimodal and polymodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed and only locally is mimic original fabric (see whole thin section – Figure 1A) preserved. Thin to wide width fractures totally to partially occlude by dolomite cement.
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 98% of dolomite. Other minerals include clays and organics (2%), plus trace pyrite and drilling mud. There are no carbonate clasts, but moderate amounts of totally dolomitized bioclasts (15%) were observed. Based on the shape, the bioclasts could possibly be stromatoporoid fragments (Amphipora? Or Idiostroma?), echinoid stems, and possible plates, spines (sponge or echinoid?), plus indistinct very fine grained fossil debris.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material that is incorporated into high amplitude stylolites and as local intercrystalline fill.
Pore Filling Cements	The pore filling cements within this sample are associated with healed fractures and rarely totally occluded bioclasts. The fractures have been infilled by coarse crystalline non-ferroan

	dolomite and in rare cases the dolomite is ferroan in nature. Trace amounts of drill mud fines fill induced fractures.
Replacement Minerals	Nonplanar fine to medium crystalline dolomite is the main replacement mineral. Trace amount of pyrite appears to replace organic matter within intercrystalline dolomite and occludes intercrystalline porosity.
Porosity	There are minor amounts of the intercrystalline porosity (2%) within the coarse crystalline dolomite cements within large fractures or bioclasts. The small vertical to near vertical fractures are locally partially open and thus the rock contains trace amounts of fracture porosity.

Figure 2A: Thin section scan of sample T47 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolomudstone to dolowackestone with fine to medium crystalline dolomite. The "ghost "of individual bioclasts appear light in this scanned thin section. The white colour denoted coarse crystalline dolomite which occluded large fractures and possible bioclastic voids in this carbonate. The horizontal (blue epoxy) fracture has induced origin and should be ignored.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

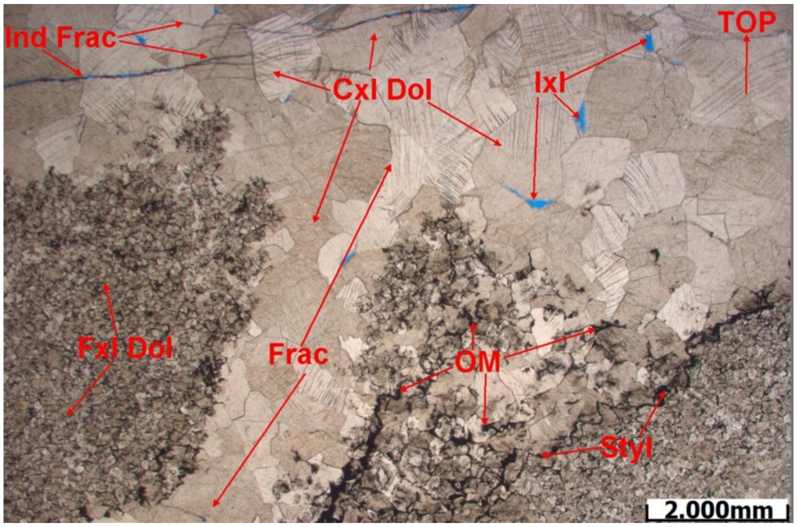


Figure 2.1. Sample T47, 10141.80ft/3091.22m. Very low magnification image of the thin section showing wide width fractures (Frac) occluded with coarse to very coarse crystalline planar dolomite cement (Cxl Dol). Small amounts of intercrystalline porosity (Ixl) occur in this planar dolomite cement. These fractures are surrounded by groundmass of fine crystalline dolomite (Fxl Dol). Organic matter (OM) occurs in the stylolites (Styl) on the right side of the fracture and locally within the intercrystalline space of the groundmass dolomite. The horizontal microfractures (Ind Frac) have an induced source. **x12.5ppl**

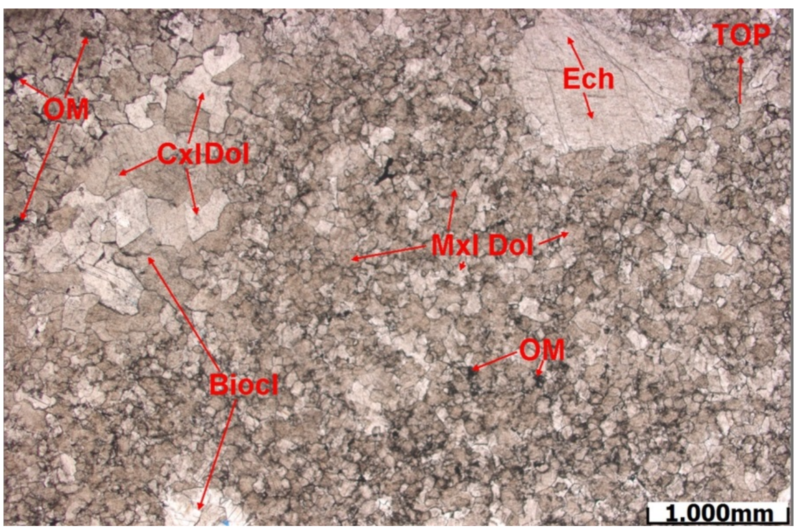


Figure 2.2. Sample T47, 10141.80ft/3091.22m. Low magnification image of the "groundmass" dolomite with coarse crystalline replaced indistinct bioclasts (Biocl) or echinoid plates (Ech) floating in matrix of fine crystalline dolomite (Mxl Dol). Minor amounts of organic matter and clays (OM) occur between the crystals of the fine anhedral nonplanar dolomite. **x25 ppl**

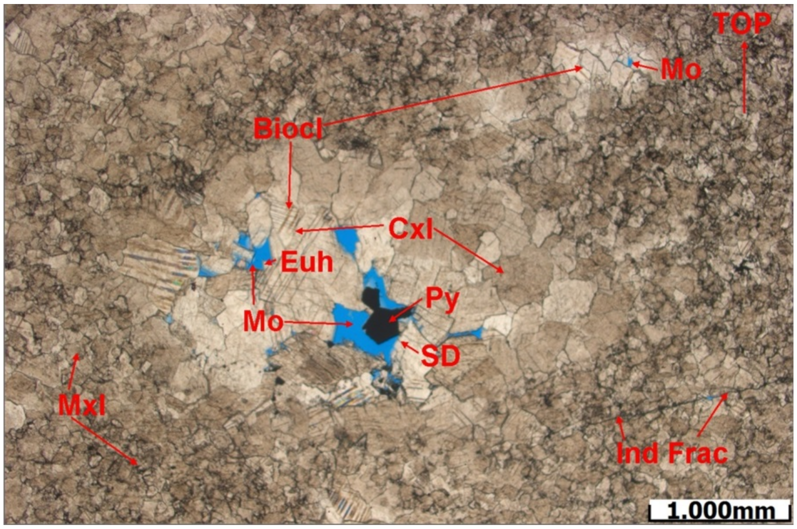


Figure 2.3. Sample T47, 10141.80ft/3091.22m. Low magnification view highlighting remnant biomoldic pores (Mo) highly cemented by euhedral (Euh) and sometimes well-formed saddle (SD) dolomite rhombs. A late stage euhedral pyrite crystal (Py) with a cubic habit occludes remnant biomoldic porosity after the euhedral dolomite. The surrounding dense anhedral replacement dolomite has fine to medium crystal size (Mxl). The small open horizontal fracture (Ind Frac) has an induced origin. **x25ppl**

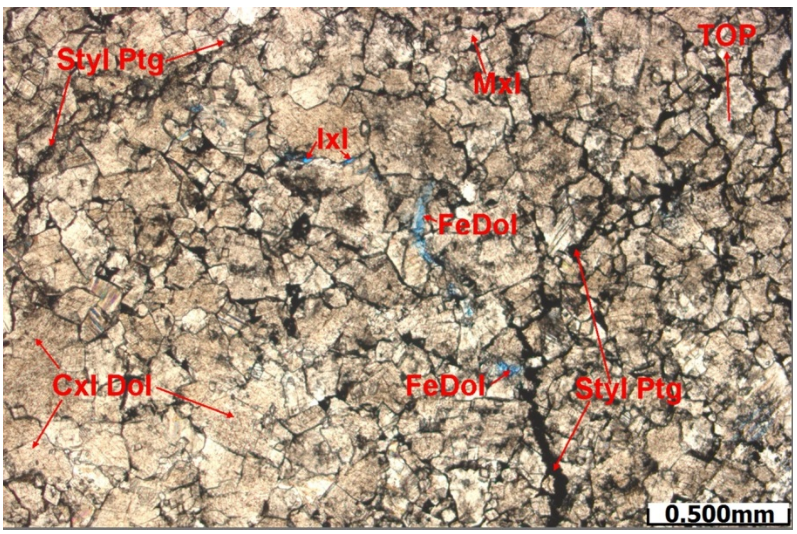


Figure 2.4. Sample T47, 10141.80ft/3091.22m. Moderate magnification view of organic matter rich stylolite partings (Styl) striking at vertical to sub-vertical angles to the horizontal bedding plane. These stylolite partings bisect medium (Mxl) to coarse crystalline (Cxl Dol) anhedral dolomite with nonplanar, closely packed dolomite crystals. A small vertical fracture is partially healed by ferroan dolomite (FeDol). Only rare intercrystalline pores (Ixl) are found within this dense nonplanar dolomite. **x50ppl**

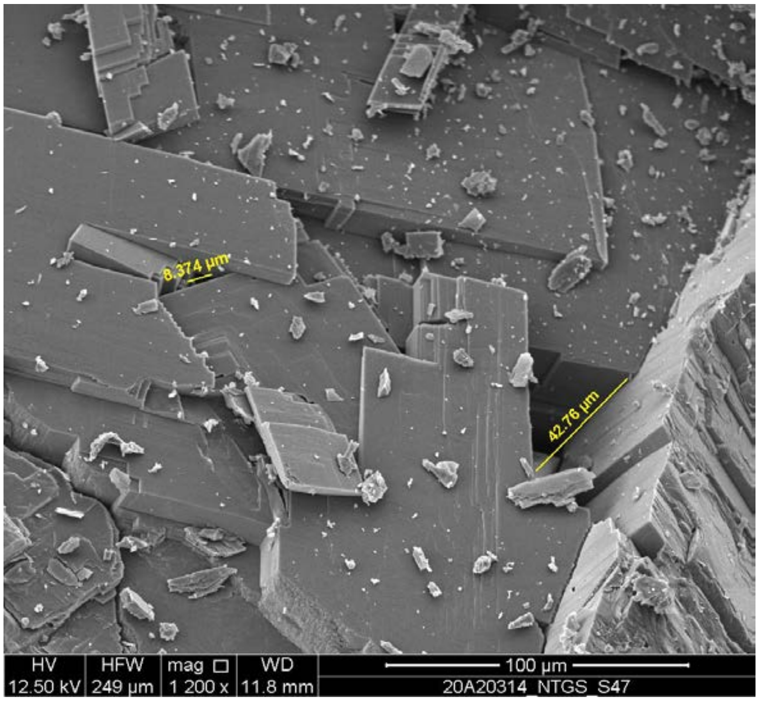


Figure 2.5. Sample S47, 10141.80ft/3091.22m. High magnification scanning electron microscope (SEM) image highlighting an intercrystalline pore space measuring at 8.374µm and 42.76 µm. Porosity in this sample consists of rare isolated pore spaces. **x1200**

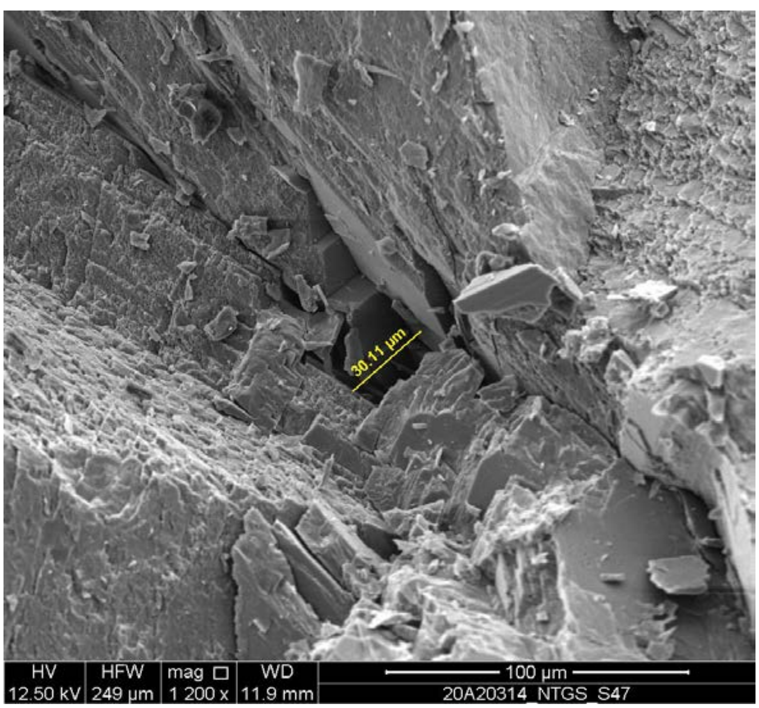


Figure 2.6. Sample S47, 10141.80ft/3091.22m. High magnification scanning electron microscope (SEM) image highlighting an intercrystalline pore space measuring at 30.11µm. Porosity in this sample often consists of isolated pores. **x1200**

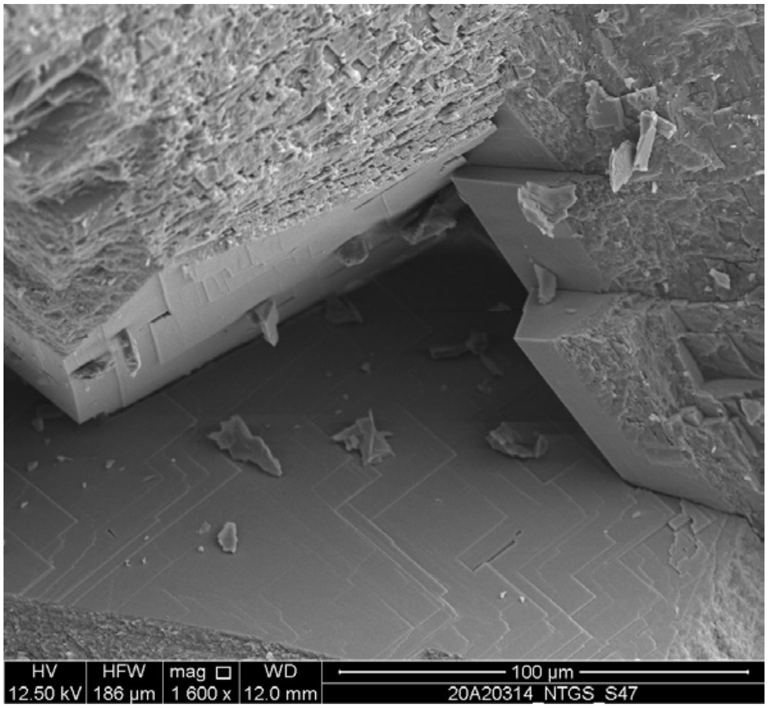


Figure 2.7. Sample S47, 10141.80ft/3091.22m. High magnification scanning electron microscope (SEM) image showing a remnant pore (fracture or biomold?) occluded with euhedral zoned dolomite cement. **x1600**

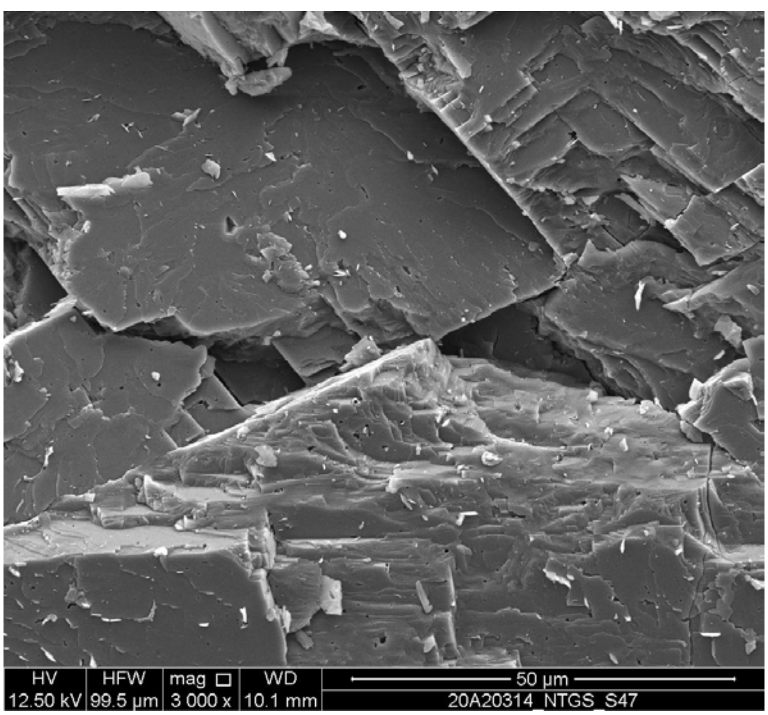


Figure 2.8. Sample S47, 10141.80ft/3091.22m. High magnification scanning electron microscope (SEM) image highlighting coarse crystalline subhedral dolomite rhombs that are pitted with isolated micro-pores (≤ 5μm). No intercrystalline pores are observed in the tightly packed dolomite of this image. **x3000**

Sample T46 (X62, S46), 10477.90ft/3193.66m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample Type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10477.90ft/3193.66m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone (Wacke- to Packstone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	**Calcite**	**Dolomite**	**Drilling Mud**	**Quartz/Cht**	**Pyrite**	**Clays & organics**
		99	TR		TR	1
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	**Bioclasts**	**Detrital grains**	**Matrix**	**Pore filling cement**	**Replacement**
		40		1	15	44

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wackestone to packstone that has been eventually totally dolomitized. Formation of low amplitude stylolites typically occurs during burial diagenesis (chemical compaction). These stylolites have dips approaching horizontal to sub-horizontal (dip ranging 10º to 30º) due to tectonic movement of this rock after deposition and dolomitization.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divides the replacement fabrics by crystal size distribution are by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with both unimodal and polymodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 3.1) or looking at the scan image of the whole thin section (Figure 3A).
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 99% of dolomite. Other minerals include clays and organics (1%), plus trace pyrite and drilling mud. There are no carbonate clasts, but significant amounts of totally dolomitized bioclasts (40%) were observed. Based on the shape, the bioclasts could possibly be stromatoporoid fragments (Amphipora? Or Idiostroma?), echinoid stems, and possible plates, spines (echinoderm or brachiopods), plus indistinct very fine grained fossil debris.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material is incorporated into low amplitude stylolites and as local intercrystalline fill.
Pore Filling Cements	The pore filling cements within this sample are associated almost totally with occluded bioclasts and fractures. The bioclasts and fractures have been infilled by coarse to very coarse crystalline dolomite. Trace amounts of drill mud fines fill induced fractures and

	intercrystalline pores within coarse crystalline dolomite.
Replacement Minerals	Nonplanar fine to medium crystalline dolomite is the main replacement mineral. Trace amount of pyrite appears to replace organic matter within intercrystalline dolomite.
Porosity	There is a trace amount of the vertical to near vertical fracture and intercrystalline porosity.

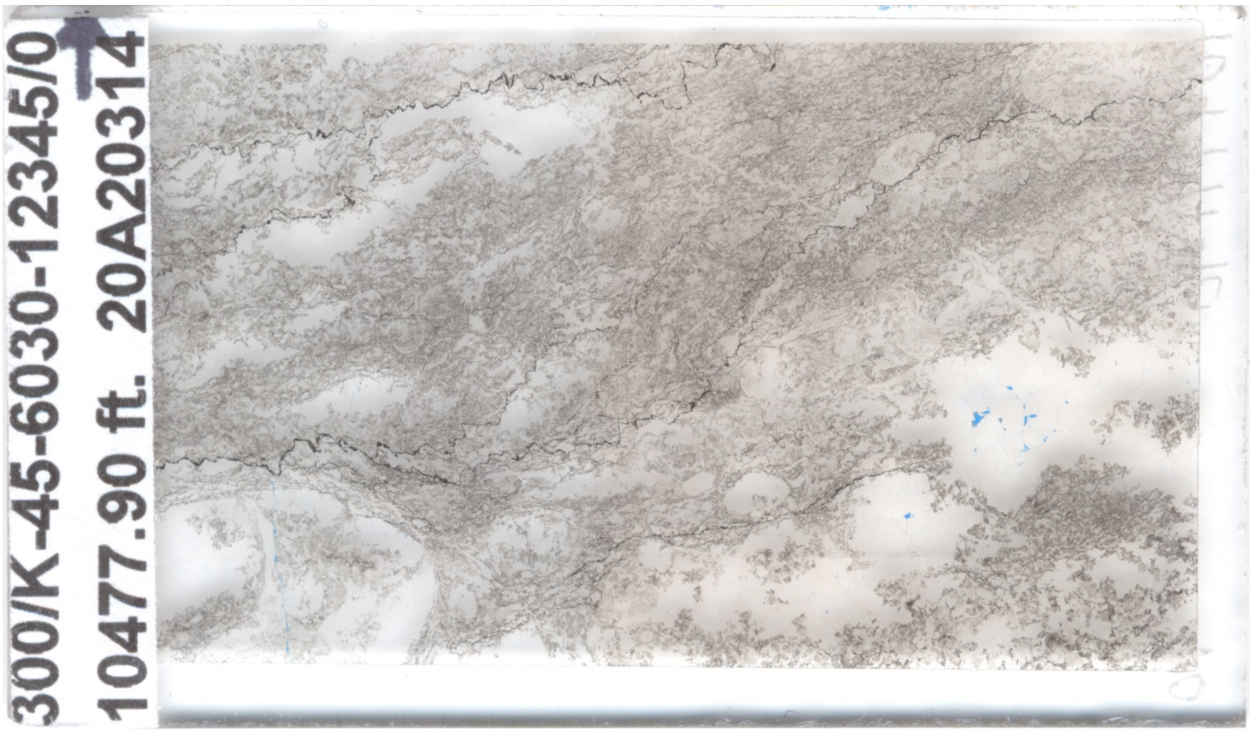


Figure 3A: Thin section scan of sample T46 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone to dolopackstone with fine to medium crystalline dolomite. The “ghost “of individual bioclasts appear light in this scanned thin section. The white colour denoted course to very coarse crystalline dolomite which fills bioclast ghosts and lesser amounts in fractures. The blue epoxy represents remnant intercrystalline porosity in healed bioclasts.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

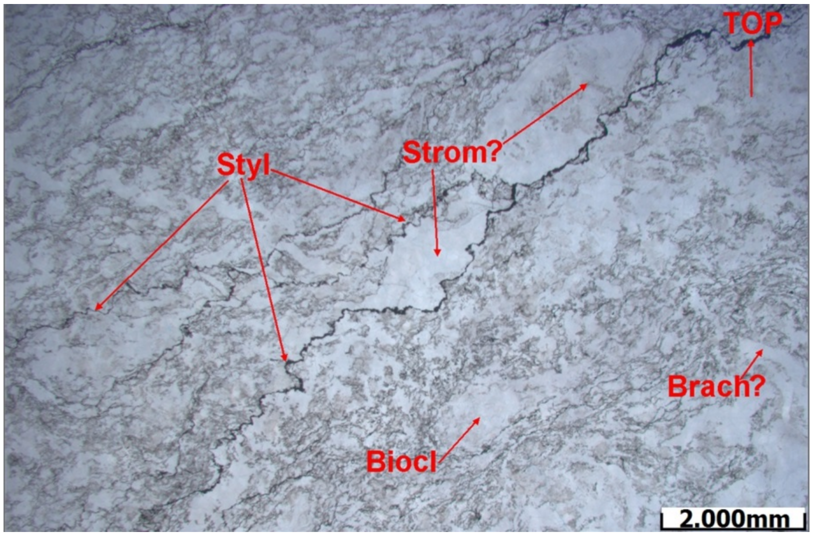


Figure 3.1. Sample T46, 10477.90ft/3193.66m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this dolostone. The bioclasts present are possible stromapora (Strom?), brachiopod shells (Brach?), echinoid stems, spines (Brachiopod and echinoid?) and indistinct fossil debris (Biocl). Note the sub-vertical dipping parallel set of stylolites (Styl) that bound and encircle the abovementioned bioclasts. Most the organic matter and clays in this samples are found in the stylolites.**x12.5ppl white card ppl**

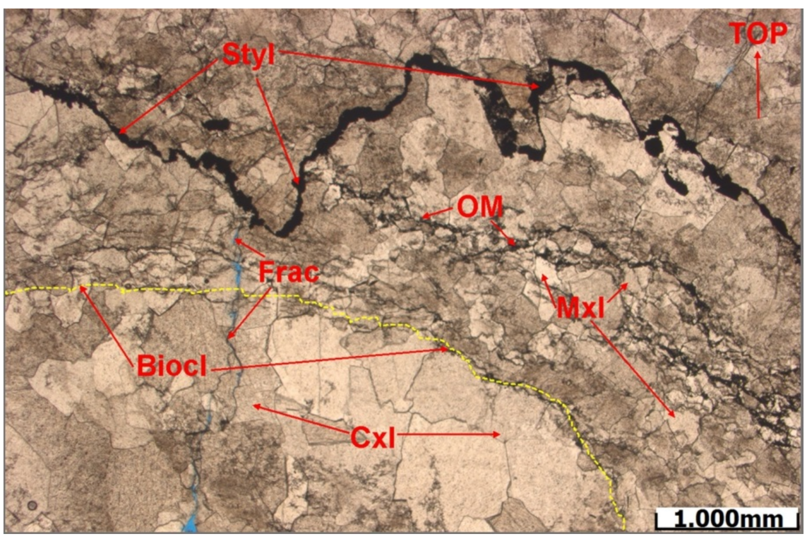


Figure 3.2. Sample T46, 10477.90ft/3193.66m. Low magnification image of the dolowacke to packstone showing the outline of a larger indistinct bioclast (Biocl) consisting of coarse crystalline (Cxl) planar dolomite. Local wispy organic matter and clays partings (OM) occur in the medium crystalline dolomite (Mxl) that surrounds the larger bioclast. The high amplitude stylolites (Styl) consist of organic residue and minor amounts of pyrite. One open vertical fracture (Frac) terminates at the stylolite. **x25ppl**

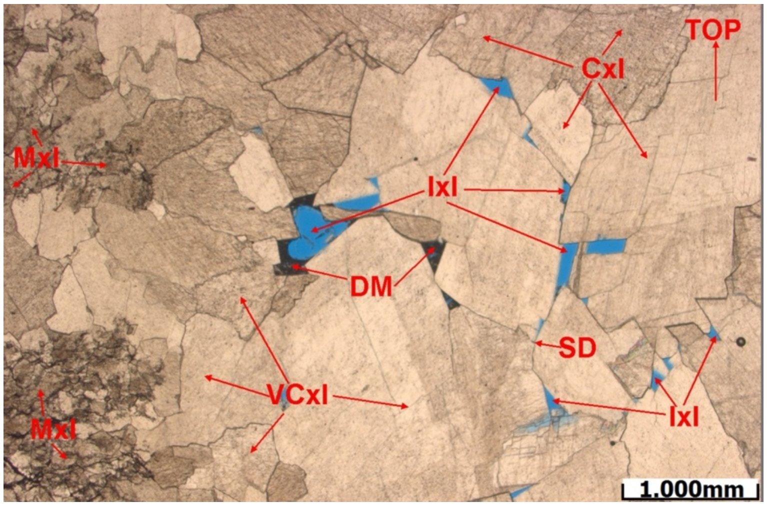


Figure 3.3. Sample T46, 10477.90ft/3193.66m. A moderate image showing remnant intercrystalline pores (Ixl) within leached or re-crystallized bioclast consisting of coarse (Cxl) to very coarse (VCxl) sub- euhedral rhombs with local saddle dolomite crystal (SD) terminations. These intercrystalline pores are locally filled with drilling mud fines (DM). Dense medium crystalline groundmass dolomite (Mxl) surrounds the bioclasts.
x50ppl

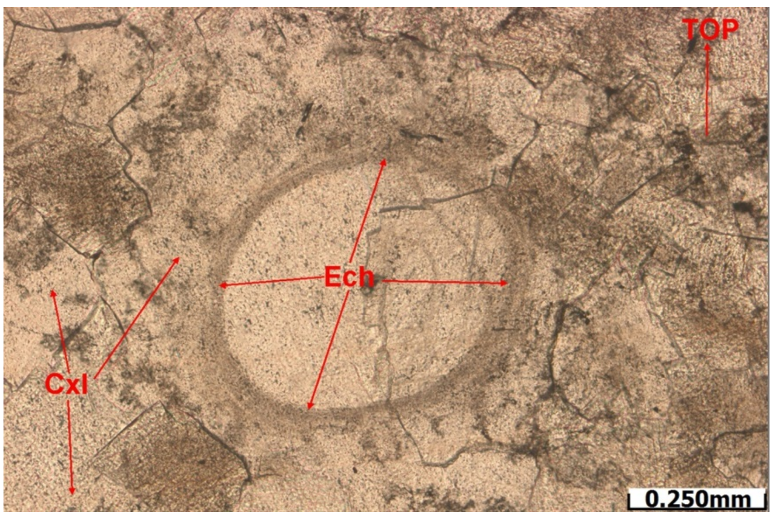


Figure 3.4. Sample T46, 10477.90ft/3193.66m High magnification image of the sample showing the outlines of cross section of crinoid stem (Ech) surrounded by non-porous nonplanar coarse crystalline dolomite crystals. The dark patches in this generally anhedral dolomite represent the ghosts of indistinct bioclasts. **x100ppl**

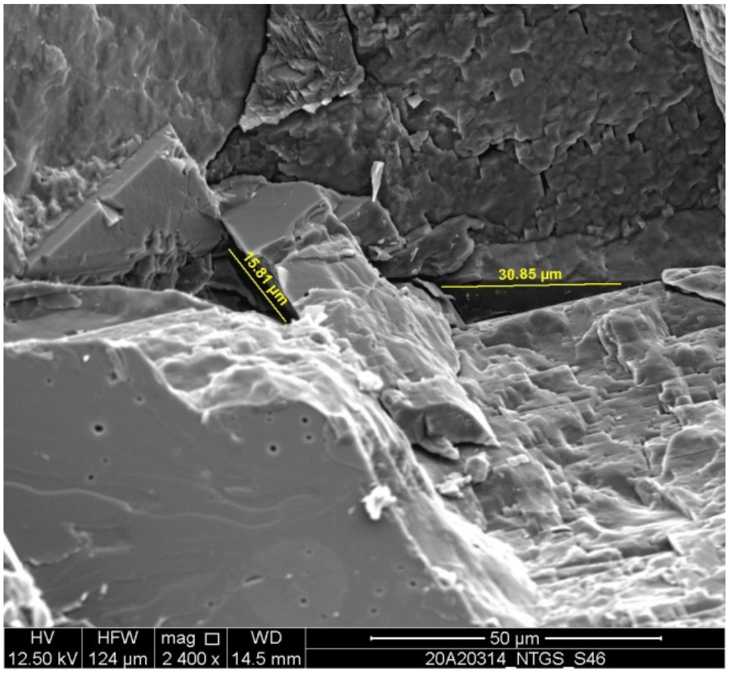


Figure 3.5. Sample S46, 10477.90ft/3193.66m. High magnification scanning electron microscope (SEM) image highlighting coarse crystalline subhedral to locally euhedral dolomite rhombs. The long axis of the two intercrystalline pores in this image is 15.81µm and 30.85µm. **x2400**

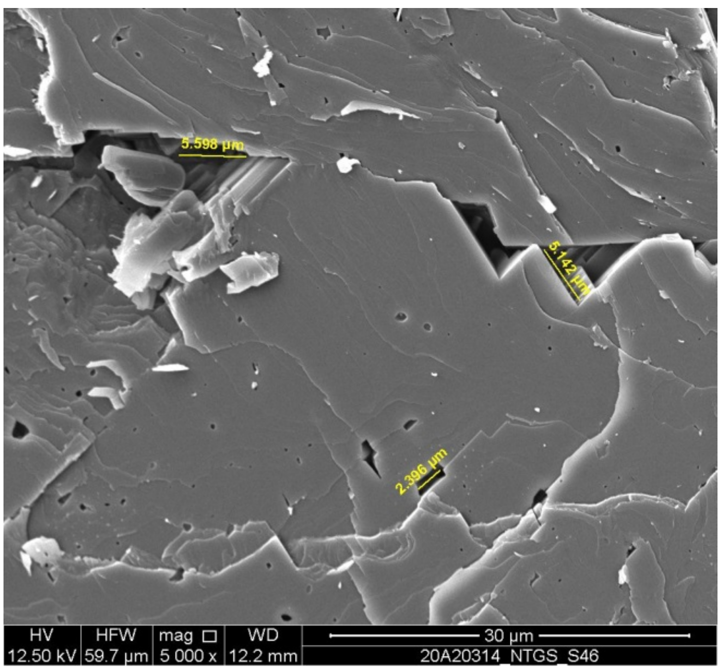


Figure 3.6. Sample S46, 10477.90ft/3193.66m. Very high magnification scanning electron microscope (SEM) image highlighting the small size of intercrystalline (5.598µm and 5.142 µm) and intracrystalline (2.396µm) pore space. **x5000**

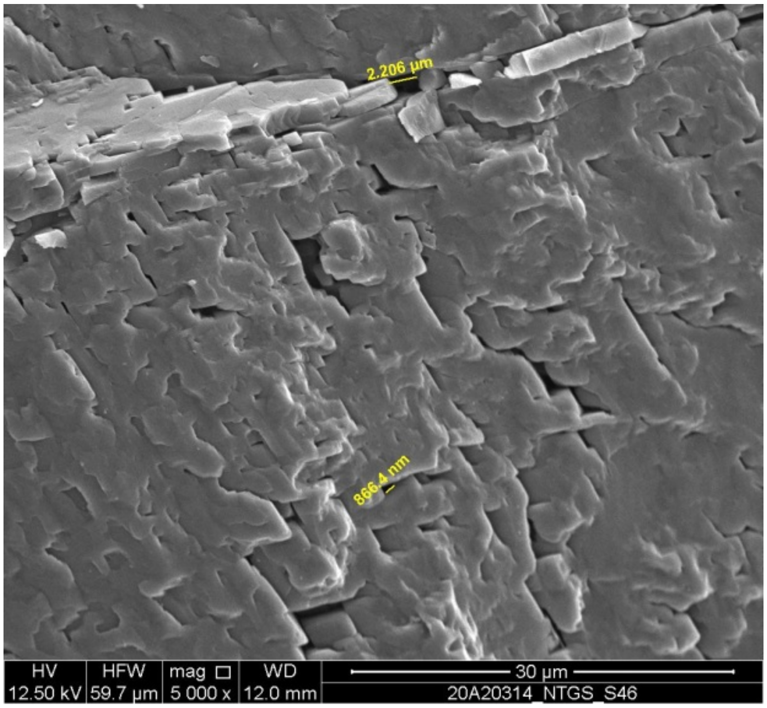


Figure 3.7. Sample S46, 10477.90ft/3193.66m. Very high magnification scanning electron microscope (SEM) image highlighting the very small size of micro-intercrystalline pores (2.206µm and 866.4nm). **x5000**

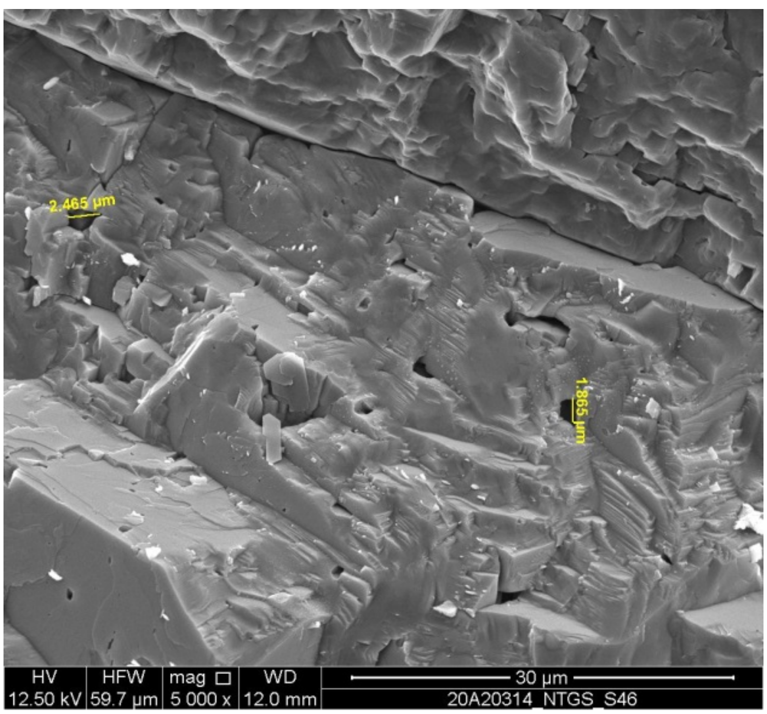


Figure 3.8. Sample S46, 10477.90ft/3193.66m. Very high magnification scanning electron microscope (SEM) image highlighting the very small size of micro-intracrystalline (2.465µm and 1.865µm) pores within a dolomite rhomb. **x5000**

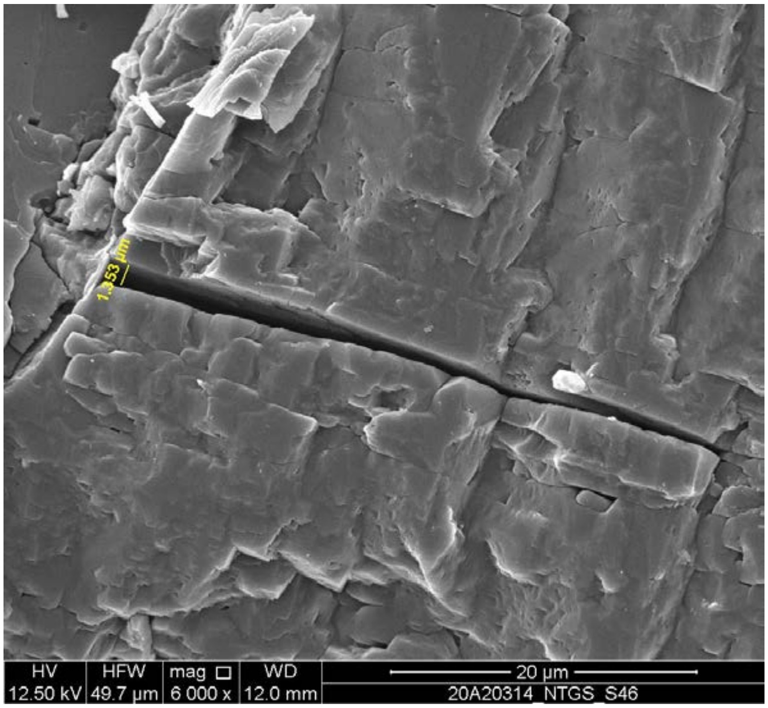


Figure 3.9. Sample S46, 10477.90ft/3193.66m. Very high magnification scanning electron microscope (SEM) image highlighting the width (1.353µm) of an intercrystalline pore between two dolomite rhombs. **x6000**

Sample T45 (X61, S45), 10493.30ft/3198.36m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10493.30ft/3198.36m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone (Dolomudstone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	**Calcite**	**Dolomite**	**Drilling Mud**	**Quartz/Cht**	**Pyrite**	**Clays & organics**
		98			TR	2
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	**Bioclasts**	**Detrital grains**	**Matrix**	**Pore filling cement**	**Replacement**
				2	18	80

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-mudstone that after burial compaction formed local boudinage structures in this carbonate. Afterward this mudstone was totally dolomitized. Formation of high amplitude stylolites typically occurs during burial diagenesis (chemical compaction). These stylolites have dips approaching horizontal to sub-horizontal (angle ranging 10º to 20º). The sub-vertical fractures that bisect boudinage bedding and are healed with coarse dolomite.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) classified the replacement fabrics by crystal size distribution are by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with both unimodal and polymodal crystal size. Visible burial induced boudinage structure is preserved after dolomitization. Due to the dolomitization, the precursor mudstone texture was highly destroyed and only locally is mimic original fabric (see whole thin section – Figure 4A) preserved. Thin to wide width fractures are totally to partially occluded by dolomite cement.
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 98% of dolomite. Other minerals include clays and organics (2%), plus trace pyrite. There are no carbonate clasts observed.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material is incorporated into intercrystalline fill and local high amplitude stylolites.
Pore Filling Cements	The pore filling dolomite cements within this sample are associated with almost totally occluded bioclasts and fractures. The bioclasts and fractures have been infilled by coarse to very coarse crystalline dolomite. Trace amounts of calcite cement is associated with dissolution pores near the stylolites.

Replacement Minerals	Nonplanar medium crystalline dolomite is the main replacement mineral. Trace amount of pyrite appears to replace organic matter within intercrystalline dolomite
Porosity	There is a minor amount of the local intercrystalline (1%) pores within the coarse crystalline dolomite cements within bioclasts and trace vertical to near vertical fractures porosity.

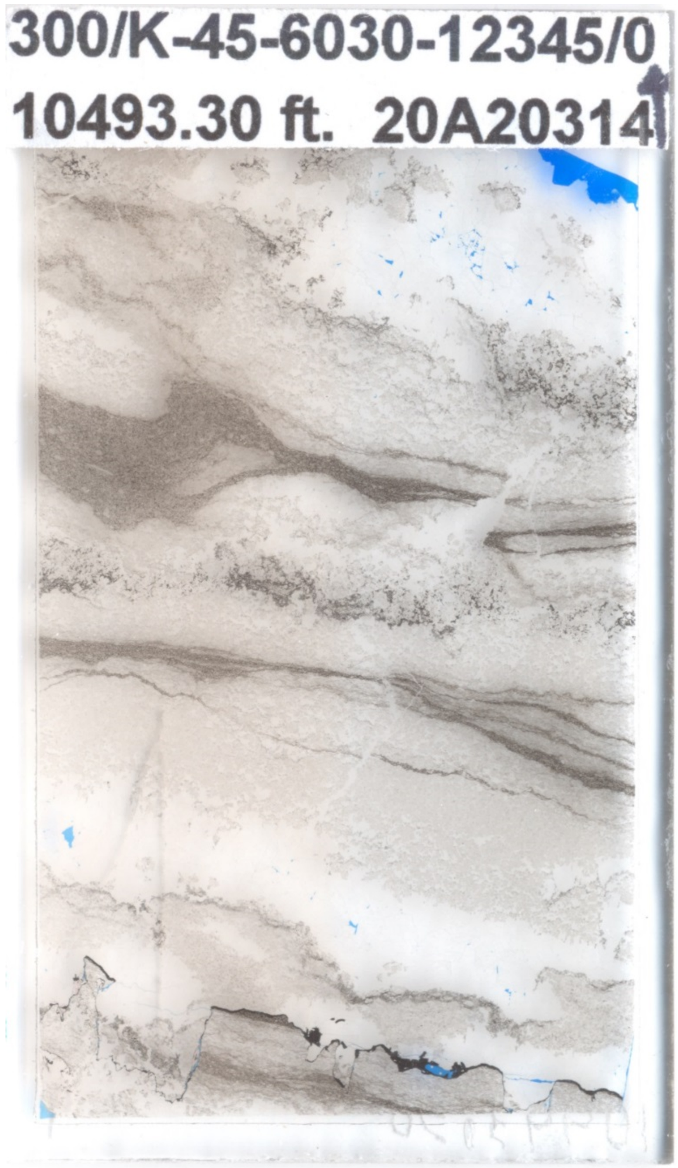


Figure 4A: Thin section scan of sample T45 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolomudstone with inclined and local boudinage (top portion of the thin section) bedding. A high amplitude stylolite occurs at base of the thin section and is associated with dissolution enlarge vertical fractures. Vertical fractures also bisect the inclined bedding plane of this dolostone. The white colour denoted coarse to very coarse crystalline dolomite and local blue is visible porosity.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

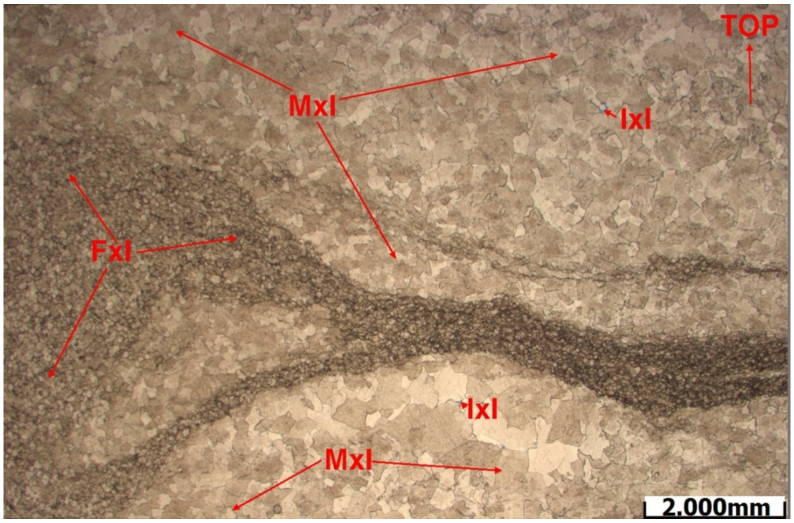


Fig 4.1. Sample T45, 10493.30ft/3198.36m. Very low magnification overview image highlights the boudinage structure in that the denser medium crystalline dolomite (Mxl) beds squeeze the more labile fine crystalline dolomite (Fxl) resulting into "sausage shaped boudins". These structures where made upon shallow burial prior to dolomitization. Trace amounts of intercrystalline porosity (Ixl) occur in medium crystalline dolomite. **x12.5ppl**

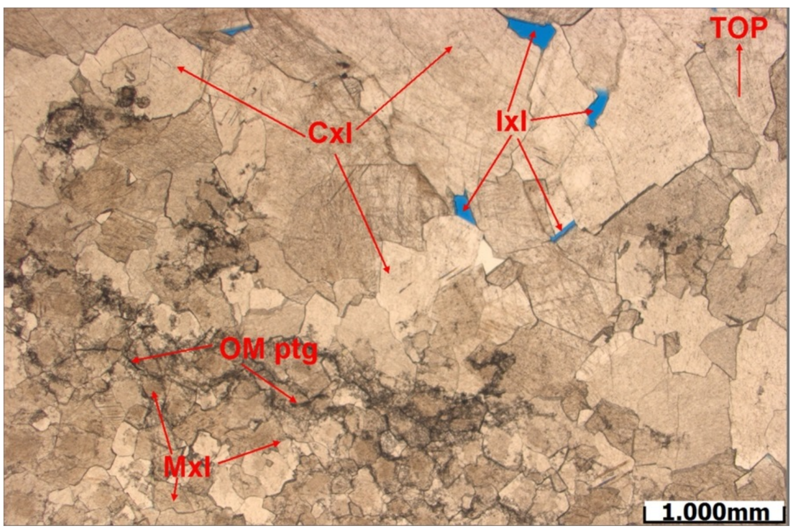


Figure 4.2. Sample T45, 10493.30ft/3198.36m. Low magnification image shows the intercrystalline pores (Ixl) within coarse crystalline subhedral planar dolomite. Local wispy organic matter partings (OM ptg) separate the above mentioned dolomite from the medium crystalline anhedral nonplanar dolomite (Mxl). **x25ppl**

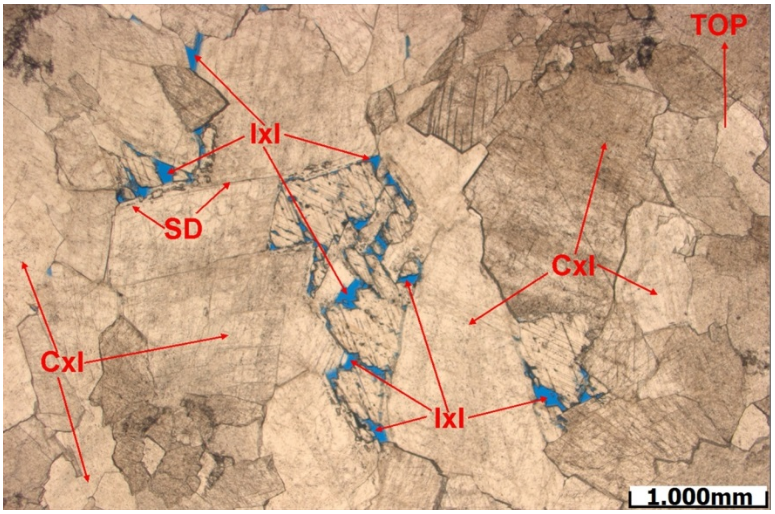


Figure 4.3. Sample T45, 10493.30ft/3198.36m. Low magnification image shows a local intercrystalline porosity (Ixl) within coarse to very coarse crystalline euhedral dolomite (Cxl) with its often saddle dolomite (SD) morphology. Local dissolution has altered the crystal termination of some the dolomite rhombs bounding this porosity. **x25ppl**

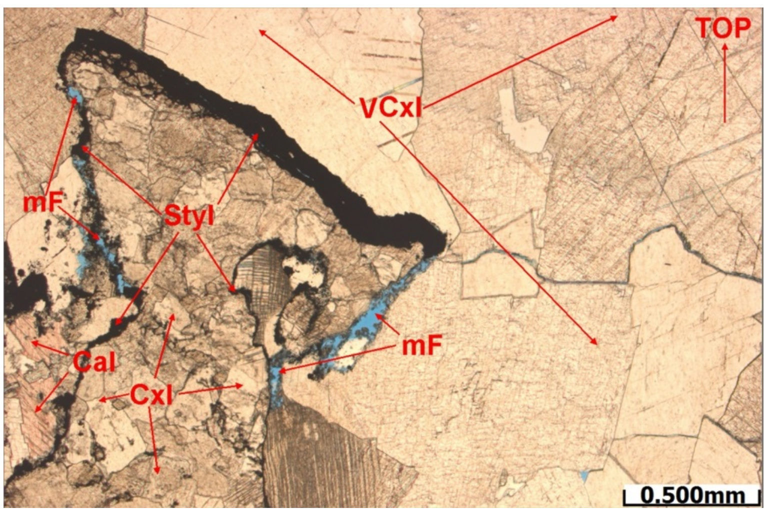


Figure 4.4. Sample T45, 10493.30ft/3198.36m. Moderate magnification image showing a high amplitude stylolite (Styl) separating very coarse dolomite (VCxl) from coarse crystalline dolomite (Cxl). Dissolution has enlarged micro-fractures/tension gashes (mF) associated with this stylolite. Leach porosity along the stylolite has been totally occluded by calcite cement (Cal). The stylolite consists of black organic residue, possible siliceous very fine silts and trace pyrite. **x50ppl**

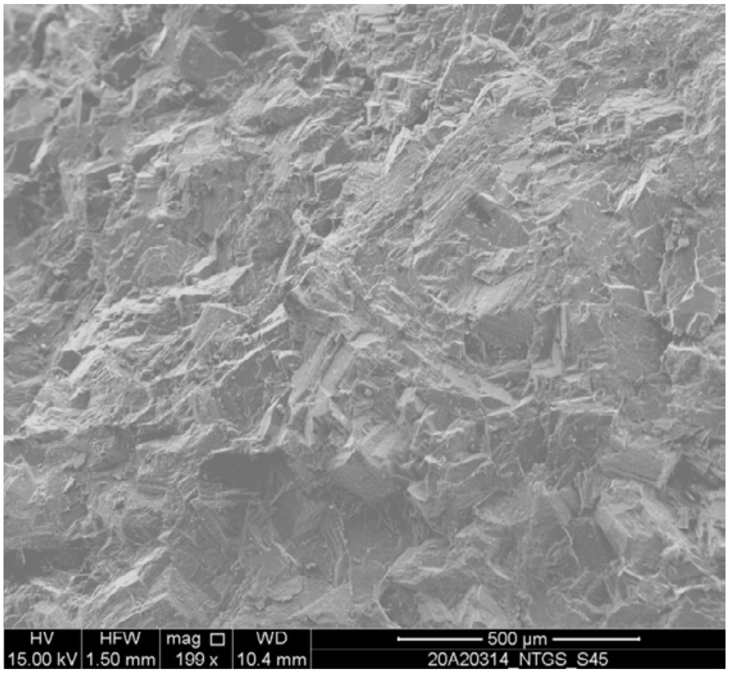


Fig 4.5. Sample S45, 10493.30ft/3198.36m. Low magnification scanning electron microscope (SEM) image showing a portion of the sample that conisists predominately of sub- to euhedral fine crystalline dolomite. Porosity in not visible in assoiciation with the interlocking crystal fabric, while isolated intercrystalline pores are predominately associated with relatively coarse dolomite as shown in the subsequent images. **x199**

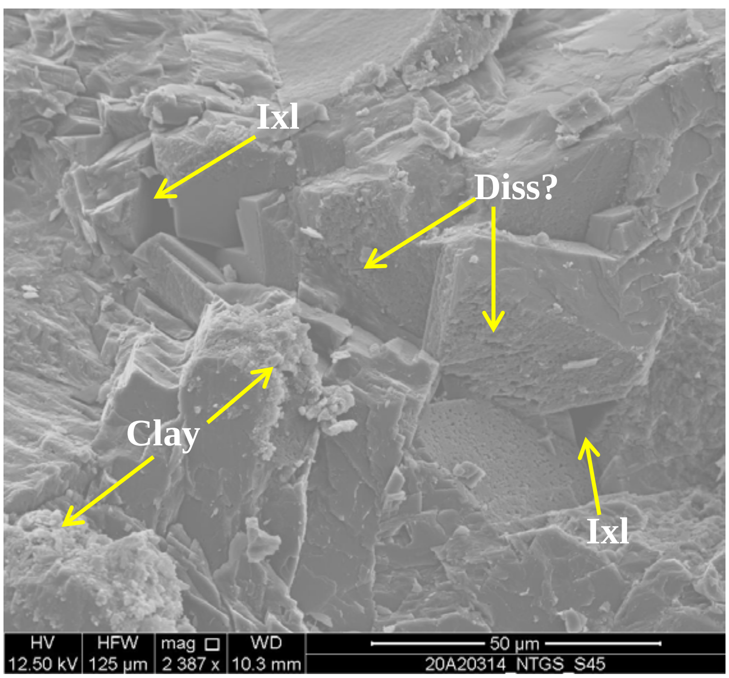


Figure 4.6. Sample S45, 10493.30ft/3198.36m. Moderate magnification scanning electron microscope (SEM) view showing an intercrystalline pore space (Ixl) measuring ~10-20µm. Note that some of the dolomitic crystal faces show possible dissolution textures (Diss?) and clay coatings (Clay). **x2387**

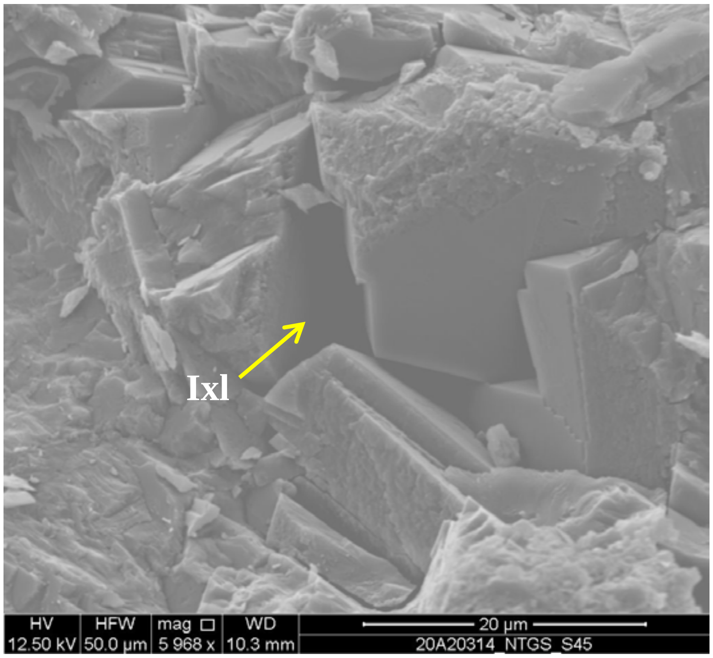


Figure 4.7. Sample S45, 10493.30ft/3198.36m. High magnification view an intercrystalline pore space (Ixl) as shown in Figure 4.6. **x5968**

Sample T44 (X59, S44), 10504.60ft/3201.80m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample Type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10504.60ft/3201.80m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone (Float- Rudstone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		99				1
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Detrital grains	Matrix	Pore filling cement	Replacement
	54			1	45	

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely a collapse breccia (floatstone and rudstone). The original lime-mud intraclasts were dolomitized and further disrupted by high amplitude stylolites. The inter-clastic space in this breccia is cement/filled with coarse crystalline dolomite (probably replacing calcite spar cement).
Textures	Based on the mineralogy and proportion between framework components (carbonate clasts) and cement sample was classified as a floatstone to rudstone. For crystal texture of the cement is planar and coarse crystalline and the intraclasts are nonplanar and generally fine crystalline.
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 99% of dolomite. Other minerals include minor amounts of clays and organics (1%). Dolostone intraclasts (54%) are the most abundant component of this dolomite.
Detrital Grains & Other Non-Carbonate Grains	There are no clastic detrital grains in this sample.
Matrix	The organic material and clays occurs within intercrystalline space of the fine crystalline intraclasts and in stylolites.
Pore Filling Cements	The pore filling dolomite cements within this sample are associated with almost totally occluded interfragmental space.
Replacement Minerals	The original fine crystalline intraclasts were derived by replaced of organic lime-mud intraclasts and the coarse crystal dolomite probably replaced the original calcite spar cement and/or micrite.
Porosity	This sample has minor amounts of intercrystalline porosity (1%) that occurs solely in the coarse crystalline dolomite.

Figure 5A: Thin section scan of sample T44 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolo-floatstone to rudstone with fine crystalline dolomite intraclasts floating coarse to very coarse crystalline dolomite cement/fill. The minor intercrystalline porosity shows up as blue epoxy and one late stage high amplitude horizontal stylolite bisects this dolomite.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

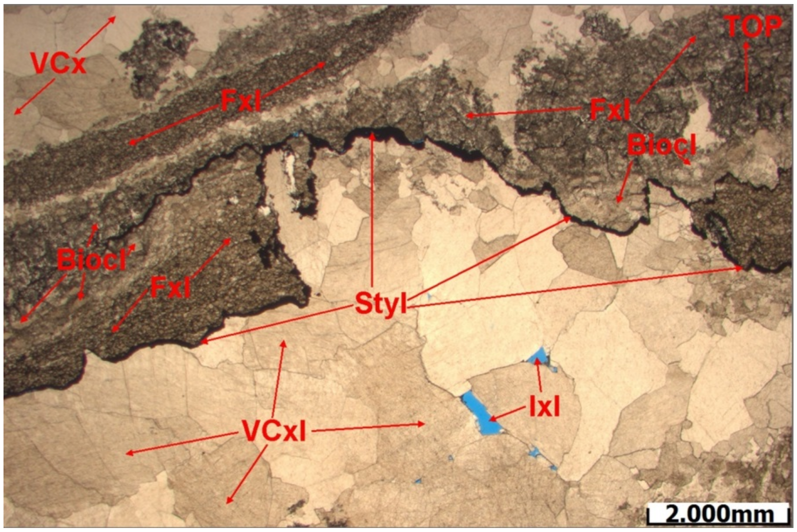


Figure 5.1. Sample T44, 10504.60ft/3201.80m. Very low magnification image of the thin section showing a stylolite (Styl) consisting of organic residue separating a fine crystalline dolomite (Fxl) intraclasts from a very coarse dolomite (VCxl) crystal cement. Minor amounts of intercrystalline pores (Ixl) occur in very coarse crystalline cement. The presence of minor floating bioclastic debris (Biocl) within the fine crystalline intraclasts indicates the intraclasts were deposited as a wackestone. The upper boundary of the dolomite intraclast is also filled with very coarse crystalline dolomite (VCx). **x12.5ppl**

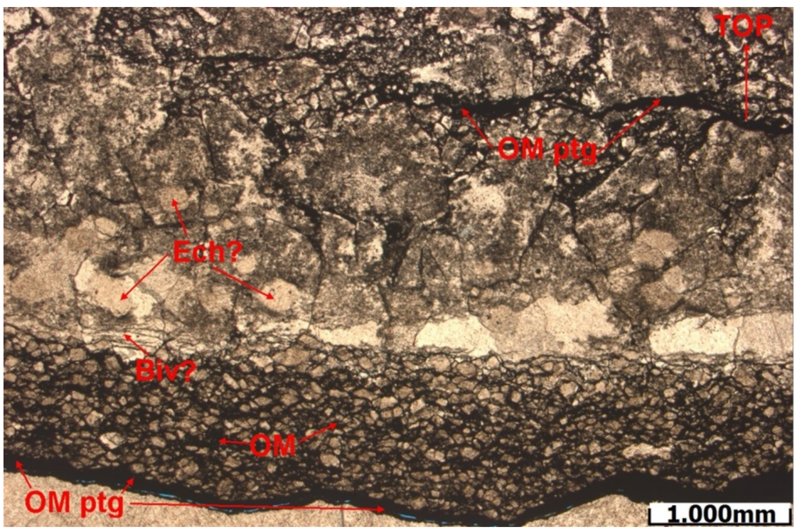


Figure 5.2. Sample T44, 10504.60ft/3201.80m. A low magnification image shows organic matter (OM) rich section of the fine crystalline dolomite intraclasts. The organic matter occurs as intercrystalline fill or as horizontal partings (OM ptg). The "ghosts" of possible echinoid stems or plates (Ech?) and bivalve shells (Biv?) are visible in the dolowackestone seen in this image. **x25ppl**

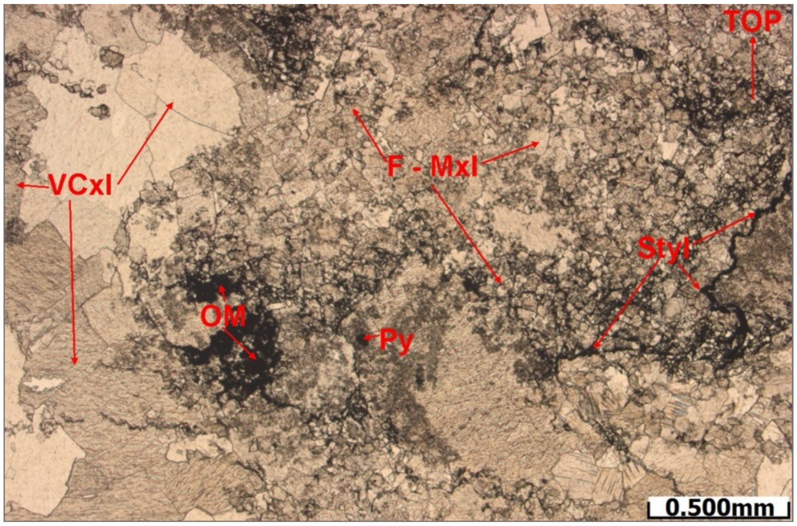


Figure 5.3. Sample T44, 10504.60ft/3201.80m. Moderate magnification image showing vertical dipping irregular stylolite (Styl) cutting through an anhedral fine to medium crystalline (F – Mxl) dolowackestone rich in organic matter (OM) and occasionally replaced by small pyrite framboids (Py). This dolowackestone occurs as intraclasts surrounded by coarse to very coarse crystalline subhedral planar dolomite (VCxl) crystal cement. **x50ppl**

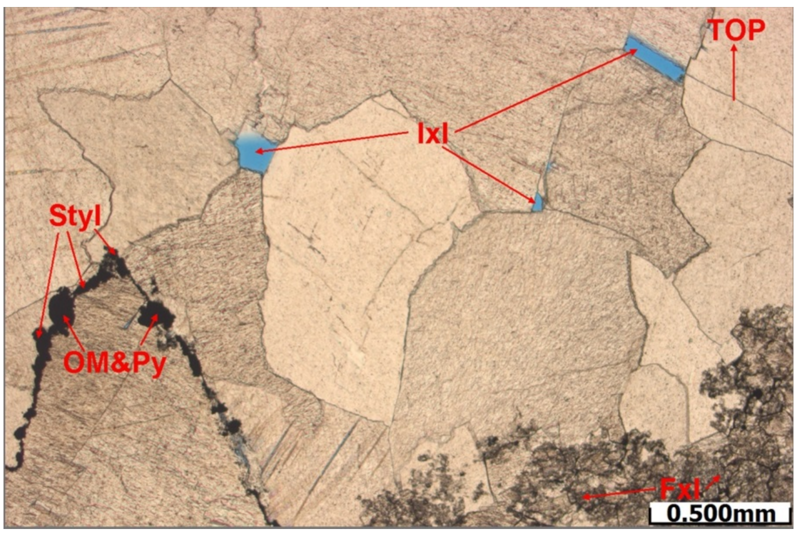


Figure 5.4. Sample T44, 10504.60ft/3201.80m. A second moderate magnification image showing isolated intercrystalline pores (Ixl) within the very coarse crystalline subhedral saddle dolomite cement. A late stage high amplitude stylolite (Styl) filled with organic residue and local pyrite framboids (OM&Py) bisects the very coarse crystalline dolomite cement. The lower right hand corner of this image shows the boundary between the fine crystalline dolomite intraclasts (Fxl) and the very coarse crystalline dolomite. **x50xpl**

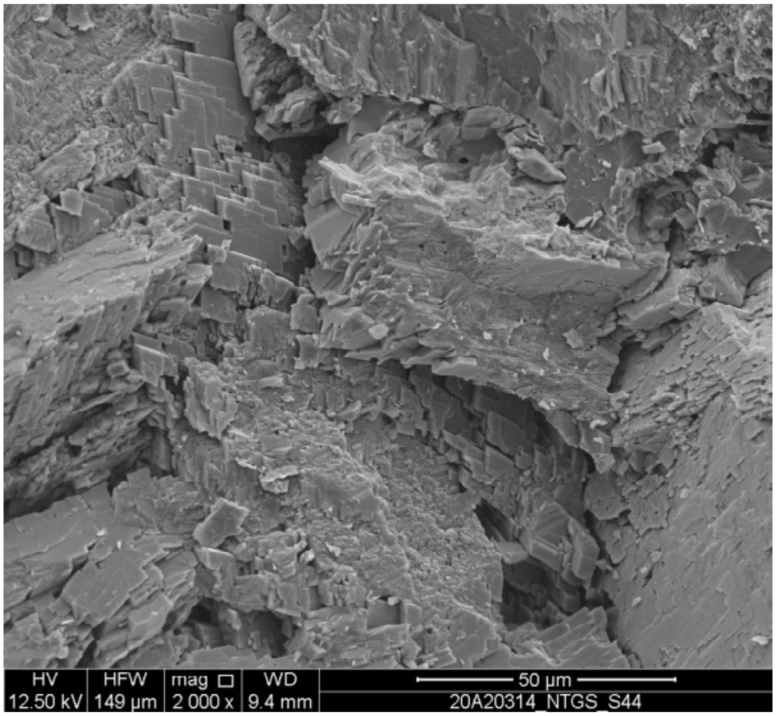


Figure 5.5. Sample S44, 10504.60ft/3201.80m. High magnification scanning electron microscope (SEM) image highlighting euhedral saddle dolomite rhombs occluding the pore space. Micro-intercrystalline pores occur in small amounts within the saddle dolomite cement. **x2000**

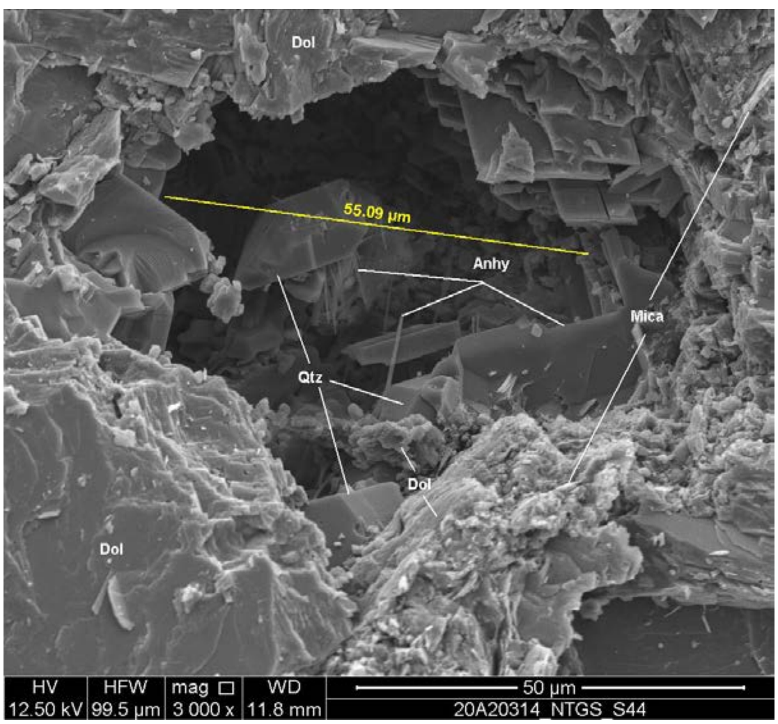


Figure 5.6. Sample S44, 10504.60ft/3201.80m. High magnification scanning electron microscope (SEM) image highlighting a micro-vug pore with the diameter of 55.09µm. This porosity is partially occluded by euhedral quartz crystals and thin filaments of calcium sulfate/anhydrite (Anhy). Dolomite fines (Dol) derived from the surrounding matrix occurs loose in this pore. Micro-mica (Mica) is found within fine crystalline groundmass dolomite. **x3000**

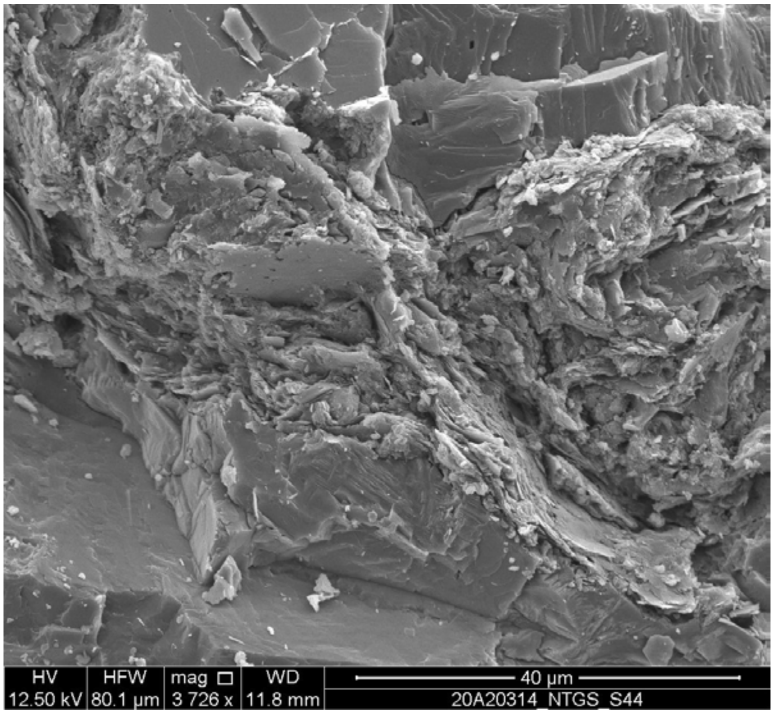


Figure 5.7. Sample S44, 10504.60ft/3201.80m. High magnification scanning electron microscope (SEM) image showing clays/mica compacted between dolomite rhombs. The morphology suggests illite and/or muscovite mica. **x3727**

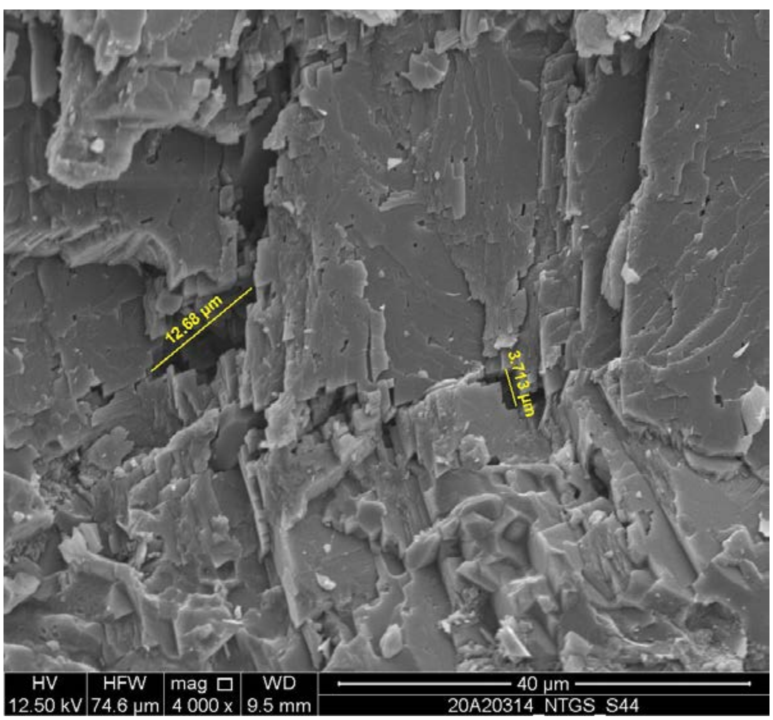


Figure 5.8. Sample S44, 10504.60ft/3201.80m. High magnification scanning electron microscope (SEM) image highlighting coarse crystalline subhedral to locally corroded anhedral dolomite rhombs. The two intercrystalline pores in this image have diameter of 12.68µm and 3.713µm. **x4000**

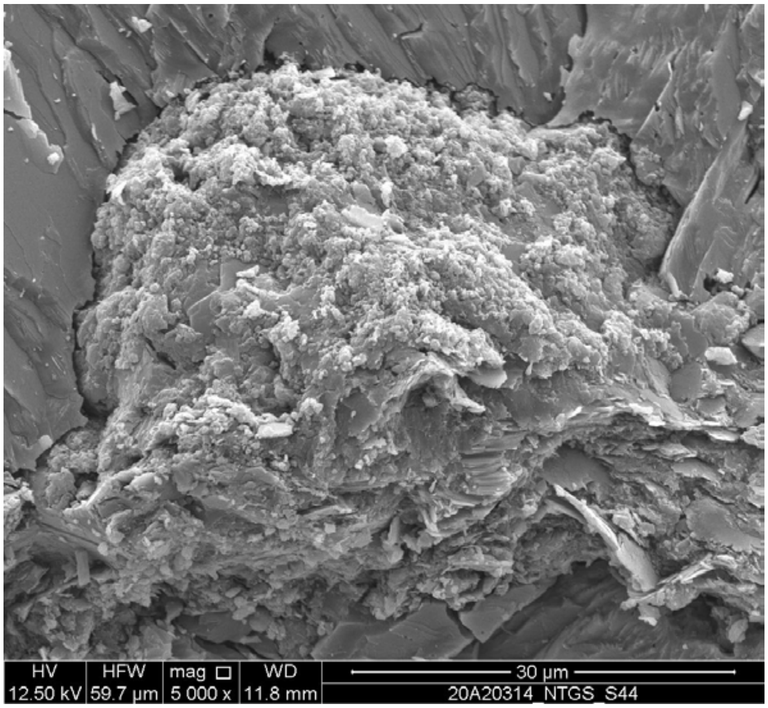


Figure 5.9. Sample S44, 10504.60ft/3201.80m. Very high magnification scanning electron microscope (SEM) image highlighting stylolite parting consisting of organic matter, dolomite and illite/muscovite clays. Note the dense coarse dolomite in top portion of this SEM image. **x5000**

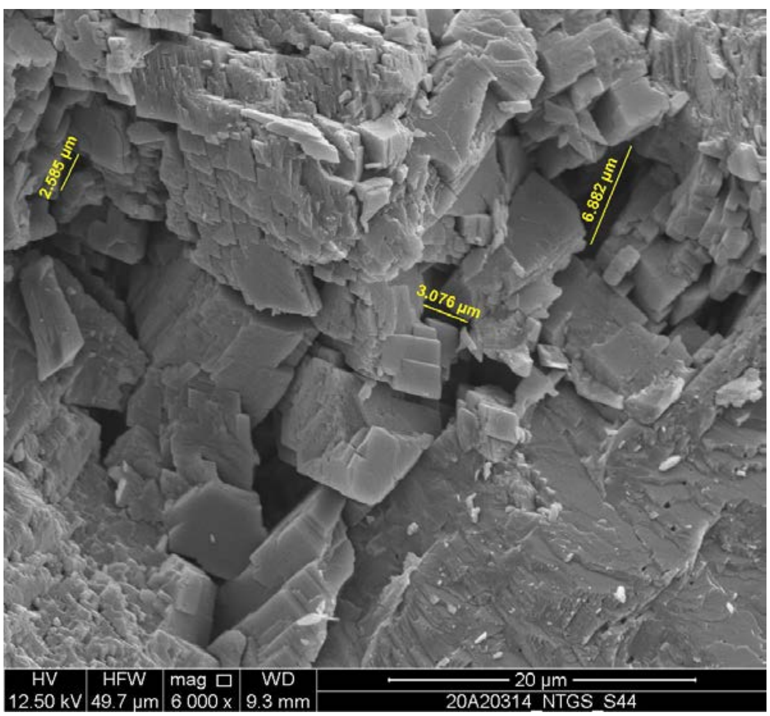


Figure 5.10. Sample S44, 10504.60ft/3201.80m. Very high magnification scanning electron microscope (SEM) image highlighting intercrystalline pores within euhedral dolomite rhombs The intercrystalline pores are “clean” and open at long axis diameters of 6.882µm, 3.076µm, and 2.585 µm. **x6000**

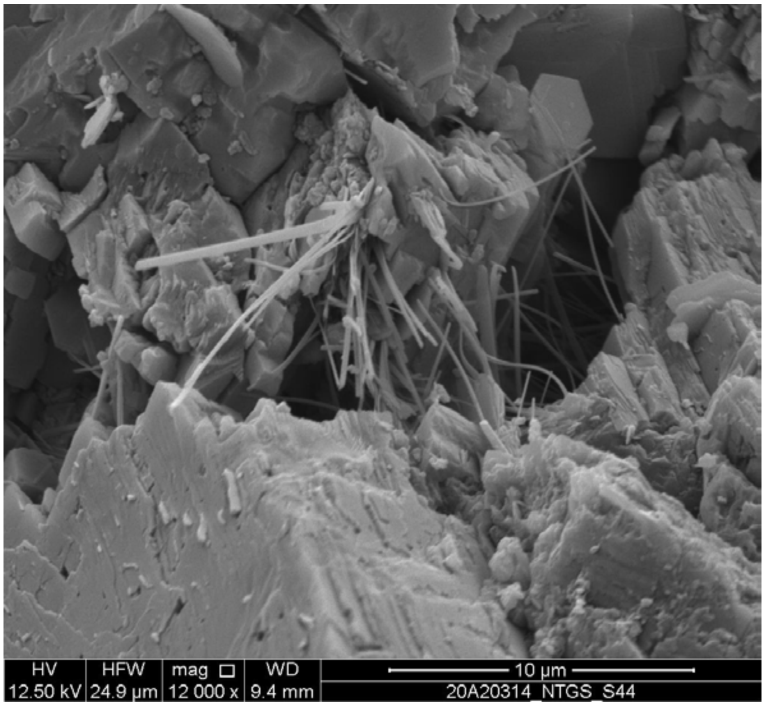


Figure 5.11. Sample S44, 10504.60ft/3201.80m. Very high magnification scanning electron microscope (SEM) image highlighting thin filaments of calcium sulfate/anhydrite bridging an intercrystalline pore. Additional very small dolomite fines and clays coat the surface of dolomite crystals. **x12000**

Sample T43(X58, S43), 10725.00ft/3268.98m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample Type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10725.00ft/3268.98m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor to Moderate
Classification	Dolostone (Wacke- Packstone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		100	TR			TR
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Detrital grains	Matrix	Pore filling cement	Replacement
		20		TR	35	45

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wacke to packstone that has been totally dolomitized. Possible dissolution resulted in the creation of significant amount of void space that was cemented by probable calcite spar that was later transformed to dolomite. Sub-vertical fractures occluded to heal by coarse crystalline dolomite suggest to tectonic stress of this rock after deposition and dolomitization.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divides the replacement fabrics by crystal size distribution by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with both unimodal and polymodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 6.1) or looking at the scan image of the whole thin section (Figure 6A).
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 100% dolomite with only trace amounts of organic matter and clay. Local occurring totally dolomitized bioclasts (20%) were observed. Based on the shape, these bioclasts appear to be mostly echinoid stems and possible plates, spines (echinoid?), plus indistinct very fine grained fossil debris.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Trace amounts of clays and organic material is incorporated into low amplitude stylolites and as local intercrystalline fill. Drilling mud fines coat remnant intercrystalline pores.
Pore Filling Cements	The coarse to very coarse pore filling dolomite cements within this sample are associated with healed fractures and replacement of void filling possible calcite spar. The fractures have been infilled by coarse to very coarse crystalline dolomite.
Replacement Minerals	Nonplanar medium crystalline dolomite is the main replacement mineral.

Porosity	This sample has minor amounts of intercrystalline porosity (1%) that occurs solely in the coarse crystalline dolomite and minor amounts of partially open fracture porosity (1%).

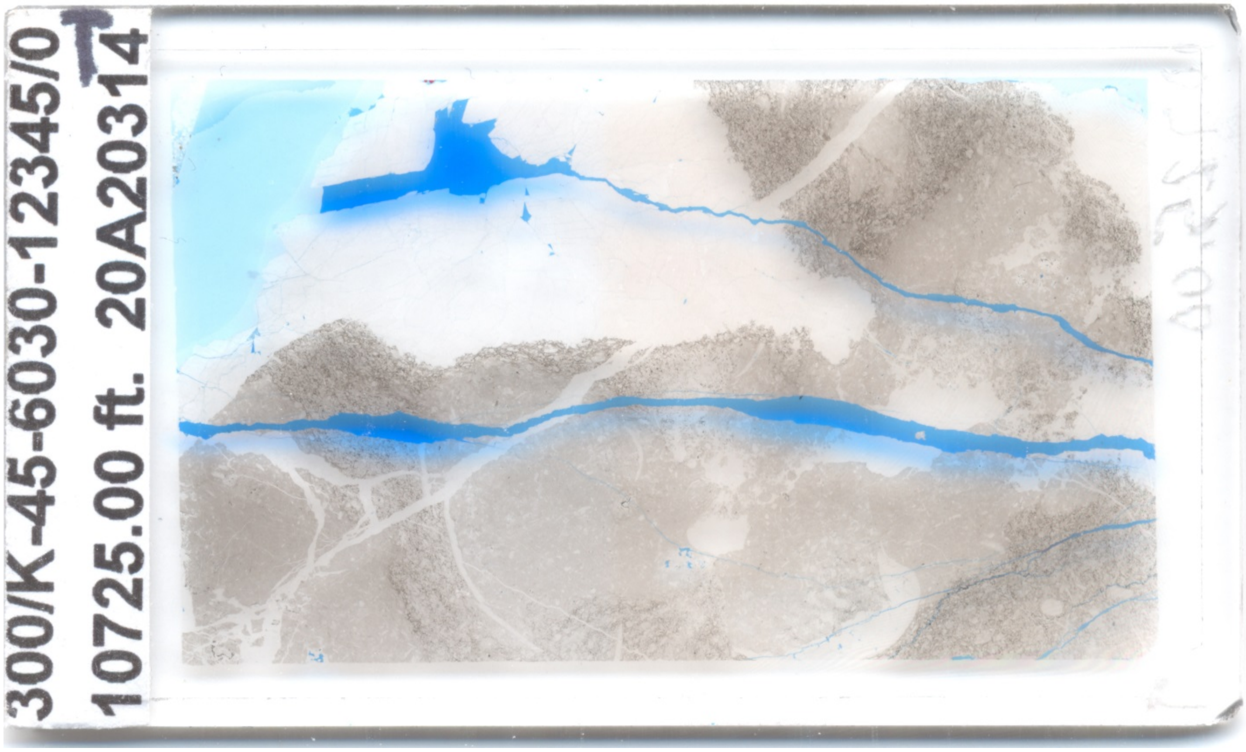


Figure 6A: Thin section scan of sample T43 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone to dolopackstone with medium crystalline dolomite groundmass. The "ghost "of individual bioclasts are difficult to see in this scanned thin section. The white colour denoted coarse to very coarse crystalline dolomite which fills bioclast ghosts, a possible dissolution void and numerous fractures. The blue epoxy represents horizontal induced fractures that should be ignored.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

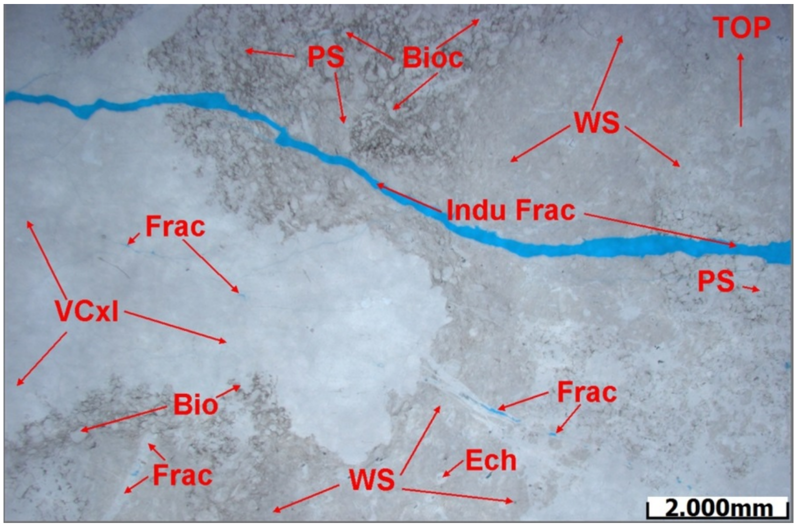


Figure 6.1. Sample T43, 10725.00ft/3268.98m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this dolostone. The bioclasts present are indistinct fossil debris (Biocl) and possible echinoderm stems and spines (Ech). Note the partially open sub-vertical to vertical dipping fractures (Frac) cut through both very coarse crystalline dolomite (VCxl) and fine to medium crystalline dolowackestone (WS). Zones of densely packed bioclasts evident in this white card image are classified as dolopackstone (PS). One coring induced horizontal fracture (Indu Frac) bisects the thin section in this image. **x12.5ppl white card ppl**

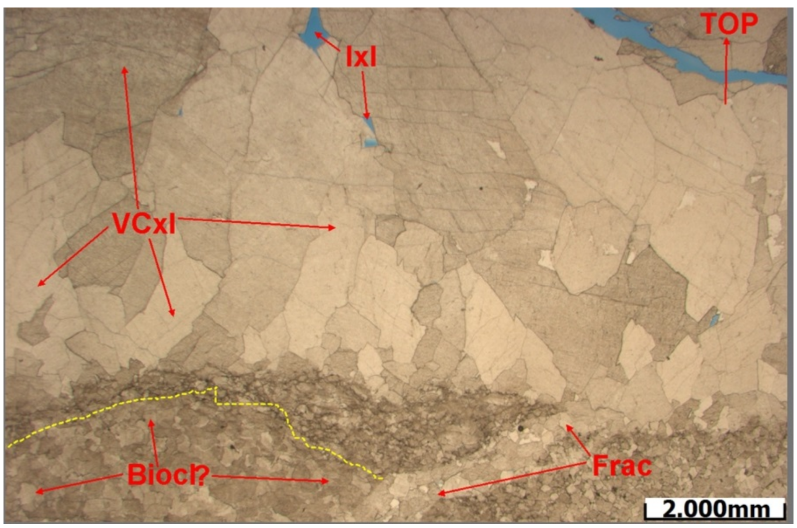


Figure 6.2. Sample T43, 10725.00ft/3268.98m. A second very low magnification overview (this time in plane polarized light) highlighting the presence of isolated intercrystalline pores (Ixl) within the planar subhedral dolomite rhombs. The yellow dash line outlines the shadow of possible bioclast (Biocl?). A sub-vertical coarse crystalline dolomite healed fracture (Frac) bisects the groundmass medium crystalline and the above mentioned very coarse dolomite. **x12.5ppl**

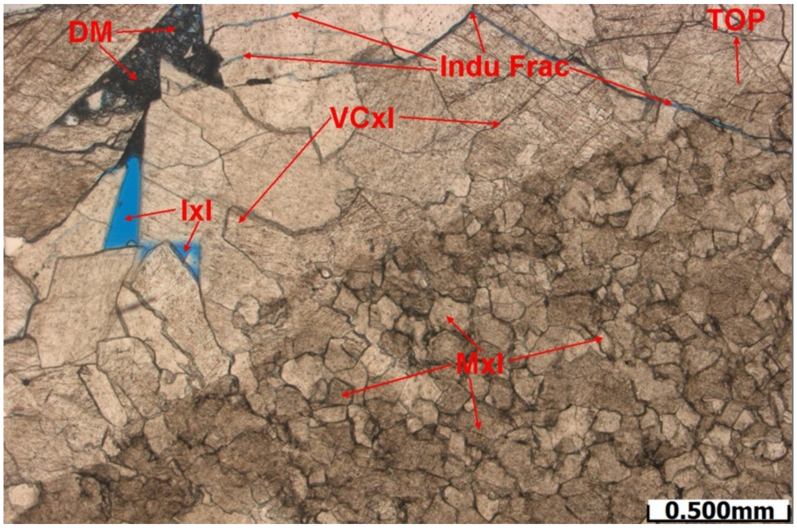


Figure 6.3. Sample T43, 10725.00ft/3268.98m. Moderate magnification image of the sample focuses on boundary between medium crystalline replacement dolomite (Mxl) and very coarse crystalline subhedral planar dolomite cements. The local intercrystalline pores (Ixl) in the very coarse crystalline dolomite are locally plugged with drilling mud fines (DM). Hair-like most likely induced fractures (Indu Frac) cut through the subhedral dolomite rhombs of the coarser crystalline dolomite. Trace amounts of organic matter (dark material between rhombs) are found between anhedral crystals in the medium crystalline replacement dolomite (Mxl). **x50ppl**

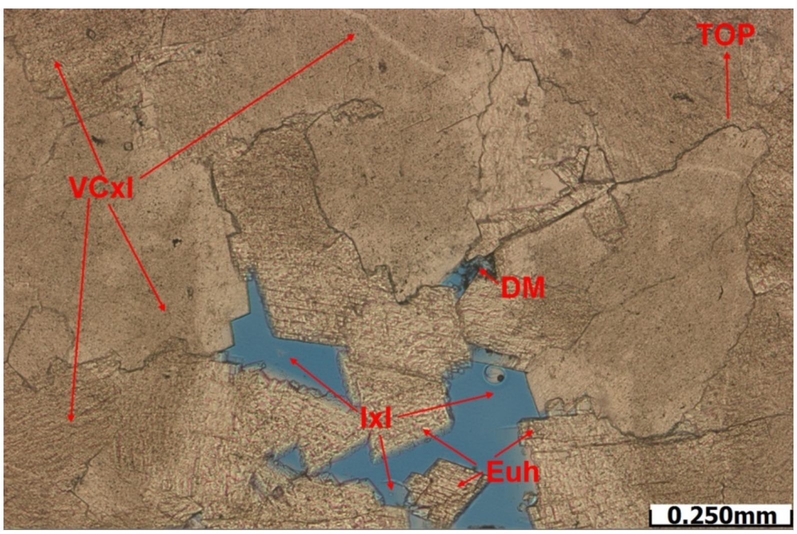


Figure 6.4. Sample T43, 10725.00ft/3268.98m. High magnification image showing that intercrystalline porosity (Ixl) within very coarse crystalline dolomite (VCxl) appears to be isolated and poorly connected to other pores. Euhedral crystal terminations (Euh) occur along dolomite bounding the pores in this dolomite. Minor drilling mud fines (DM) occur in one of these intercrystalline pores. **x100ppl**

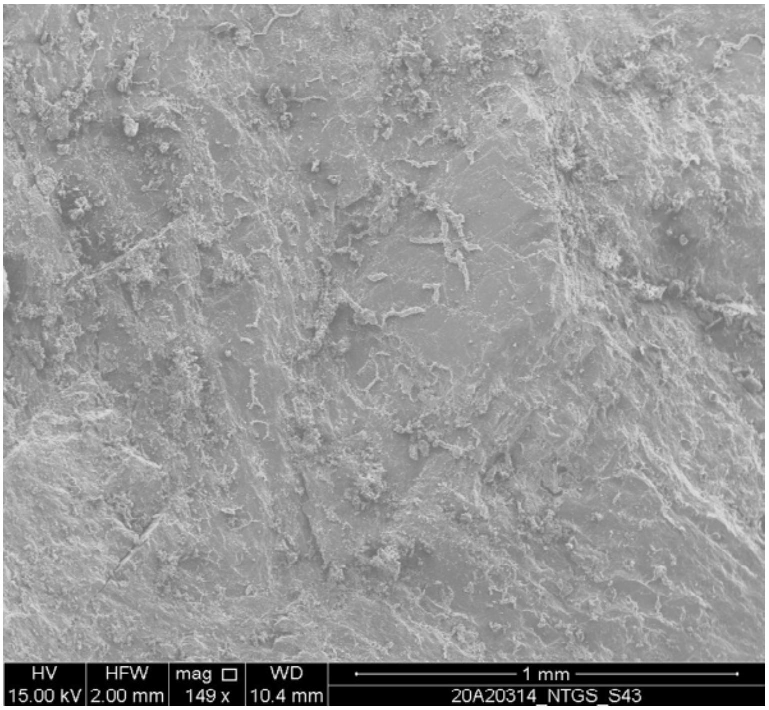


Figure 6.5. Sample S43, 10725.00ft/3268.98m. A low magnification scanning electron microscope (SEM) image of a portion of the sample which consists of coarse to very coarse crystalline dolomite. Crystal boundaries are poorly defined. No visible porosity. **x149**

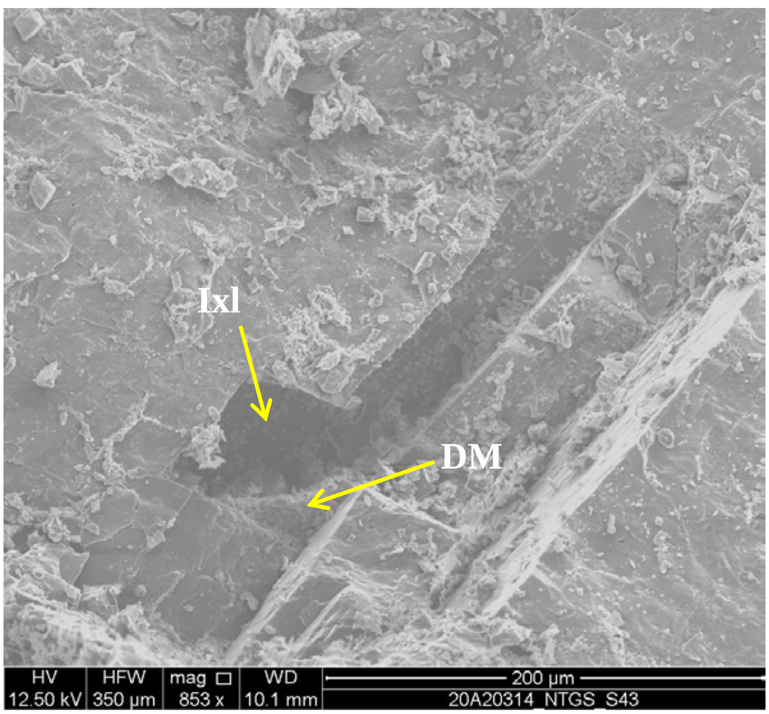


Figure 6.6. Sample S43, 10725.00ft/3268.98m. Low magnification scanning electron microscope (SEM) showing an elongate intercrystalline pore space (Ixl) that is partly occluded by probable drilling mud fines (DM). Dol: dolomite. **x853**

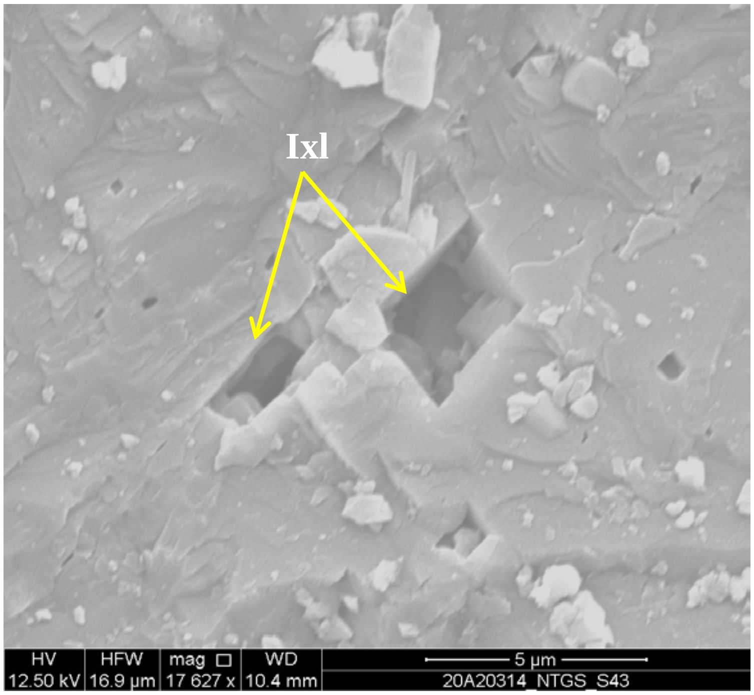


Figure 6.7. Sample S43, 10725.00ft/3268.98m. Very high magnification scanning electron (SEM) image of an isolated micro-intercrystalline (<5µm) pore spaces (Ixl). **x17627**

Sample T42 (X56, S42), 10738.90ft/3273.22m

<table>
<tr><td>Well Name</td><td>Amoco CDA PANAM Pointed Mountain K-45</td><td>Location</td><td>300/K-45-6030-12345/0</td></tr>
<tr><td>Sample Type</td><td>Thin section/SEM grain mount from a core sample</td><td>Depth (m)</td><td>10738.90ft/3273.22m</td></tr>
<tr><td>Stratigraphic Unit</td><td>Nahanni Formation</td><td>Reservoir Quality</td><td>Poor</td></tr>
<tr><td>Classification</td><td>Dolostone (Wacke- Packstone)</td><td>Stain type</td><td>½ Dual Carbonate</td></tr>
<tr><td colspan="4">MINERALOGY</td></tr>
</table>

<table>
<tr><td></td><td colspan="6">Total Bulk mineralogy</td></tr>
<tr><td rowspan="5">Thin Section Point counting (%)</td><td>Calcite</td><td>Dolomite</td><td>Drilling Mud</td><td>Quartz/Cht</td><td>Pyrite</td><td>Clays & organics</td></tr>
<tr><td></td><td>98</td><td>TR</td><td>1</td><td>TR</td><td>1</td></tr>
<tr><td colspan="6">Framework, Matrix, Cement, and Replacement</td></tr>
<tr><td>Carbonate clasts</td><td>Bioclasts</td><td>Cht</td><td>Matrix</td><td>Pore filling cement</td><td>Replacement</td></tr>
<tr><td></td><td>42</td><td></td><td>1</td><td>7</td><td>49</td></tr>
</table>

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wacke to packstone that has been eventually totally dolomitized. Sub-vertical to vertical fractures are healed by coarse crystalline dolomite suggest to tectonic stress of this rock after deposition and dolomitization.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divides the replacement fabrics by crystal size distribution are by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with mostly unimodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 7.1) but less so when looking at the scan image of the whole thin section (Figure 7A).
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 98% dolomite with minor amounts of chert (1%), organic matter and clay (1%), plus trace pyrite and drilling mud fines. Irregularly distributed dolomitized bioclasts (42%) were observed. Based on the shape, these bioclasts appear to be mostly indistinct very fine grained fossil debris, with minor amounts echinoderms stems and large bioclasts (stromatoporoids?).
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material is incorporated into intercrystalline fill and in rare low amplitude stylolites. Trace drilling mud fines coat remnant intercrystalline and horizontal induced fractures.
Pore Filling Cements	The coarse to very coarse pore filling dolomite cements (7%) within this sample are associated with healed fractures and cemented/replaced leached bioclasts.
Replacement Minerals	The original micrite of these wackestone to packstone has been replaced by fine to medium crystalline anhedral dolomite (49%). Minor amounts of chert (1%) has replaced or cemented a few larger bioclasts (Figures 7.3 and 7.4), plus trace pyrite are replace dolomite.
Porosity	The collected sample has only trace amounts of intercrystalline porosity.

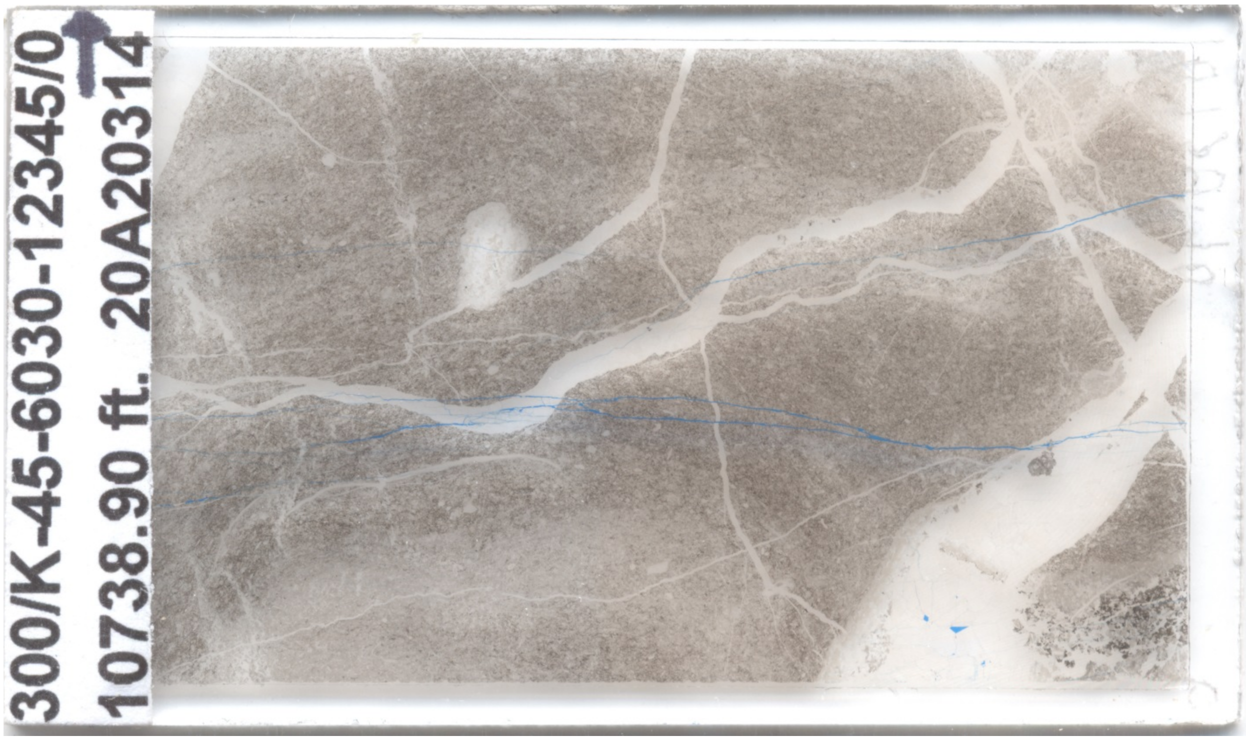


Figure 7A: Thin section scan of sample T42 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone to dolopackstone with fine to medium crystalline dolomite. The “ghost “of individual bioclasts are difficult to see in this scanned thin section. The white colour denoted coarse to very coarse crystalline dolomite which fills bioclast ghosts and numerous fractures. The blue epoxy represents horizontal induced fractures that should be ignored since they not found downhole.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

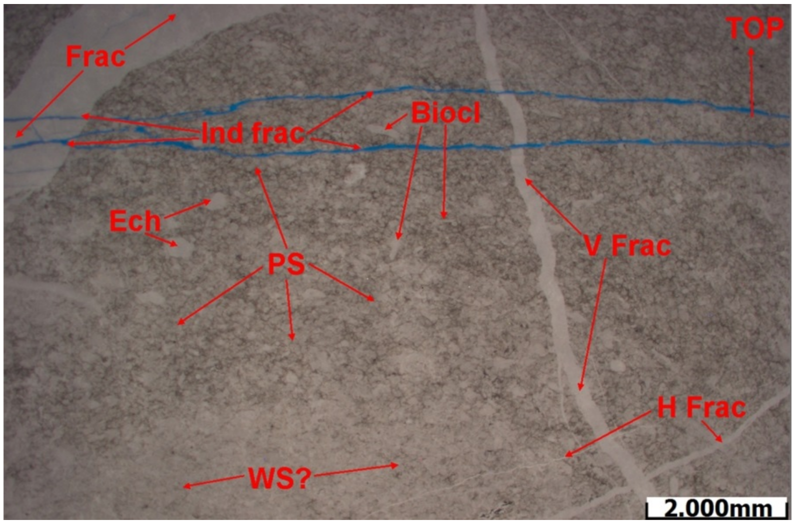


Figure 7.1. Sample T42, 10738.90ft/3273.22m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this probable dolowackestone (WS?) to dolopackstone (PS). The bioclasts present are indistinct fossil debris (Biocl) and echinoderm stems (Ech). Note the dolomite cemented vertical (VFrac), subhorizontal (Frac), and horizontal (HFrac) fractures that bisect this dolomite. **x12.5 white card ppl**

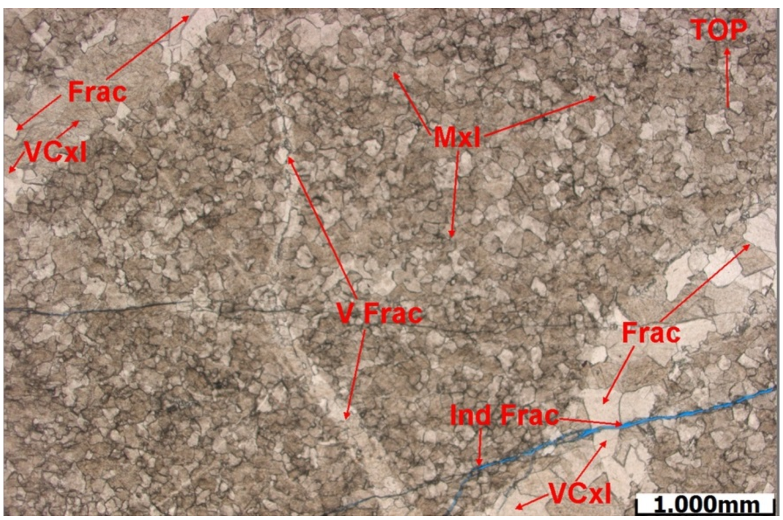


Figure 7.2. Sample T42, 10738.90ft/3273.22m. Low magnification image of the sample in plane polarized light shows the conjuncture of two sets of very coarse crystalline healed fractures bisecting the medium crystalline dolomite (Mxl) groundmass. The more vertical dipping fracture (V Frac) intersects the large sub-horizontal dipping fractures (Frac) at an orthogonal angle. The horizontal dipping induced fractures (Ind Frac) cut through both groundmass and fracture occluding dolomite. **x25ppl**

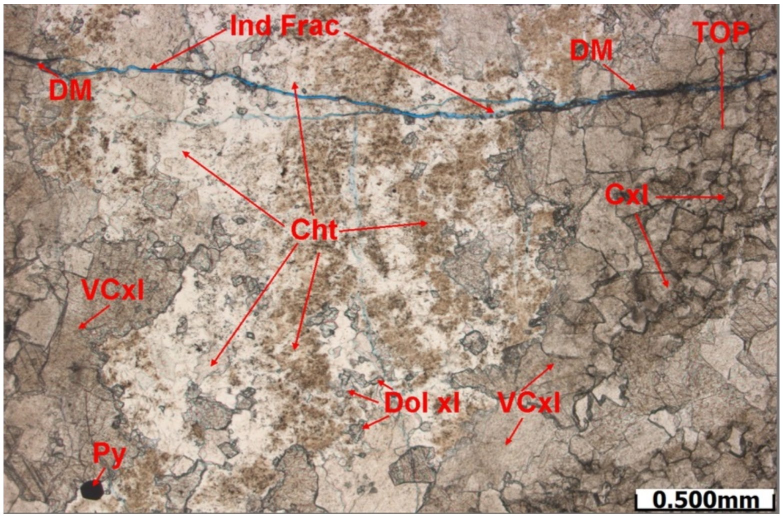


Figure 7.3. Sample T42, 10738.90ft/3273.22m. One moderate magnification image focusing on patch of the dolostone that is partially replaced by chert (Cht). This chert may have replaced a bioclast prior to complete dolomitization. Please note the small euhedral dolomite rhombs (Dol xl) that grown within the chert. Very coarse (VCxl) and coarse (Cxl) crystalline dolomite groundmass surrounds this chert. Note the one pyrite inclusion (Py) with a cubic habit replacing dolomite. The induced fracture (Ind Frac) at the top of image is partially filled with drilling mud fines (DM). **x50ppl**

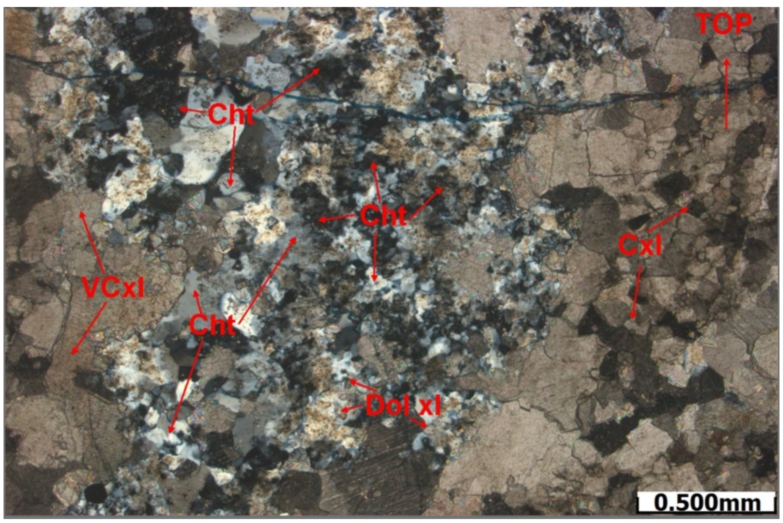


Figure 7.4. Sample T42, 10738.90ft/3273.22m. The same moderate magnification image as Figure 7.3 but in cross polarized light focusing on patch of the dolostone that is partially replaced by chert (Cht). The chert consists of micro to fine crystalline polycrystalline quartz. Note the difference between the dull brown birefringence of the dolomite crystals (Dol xl) and white to black colour of the poly- to microcrystalline quartz of the chert/quartz. The surrounding very coarse (VCxl) to coarse (Cxl) crystalline dolomite clearly show the nonplanar nature of this generally subhedral carbonate. **x50xpl**

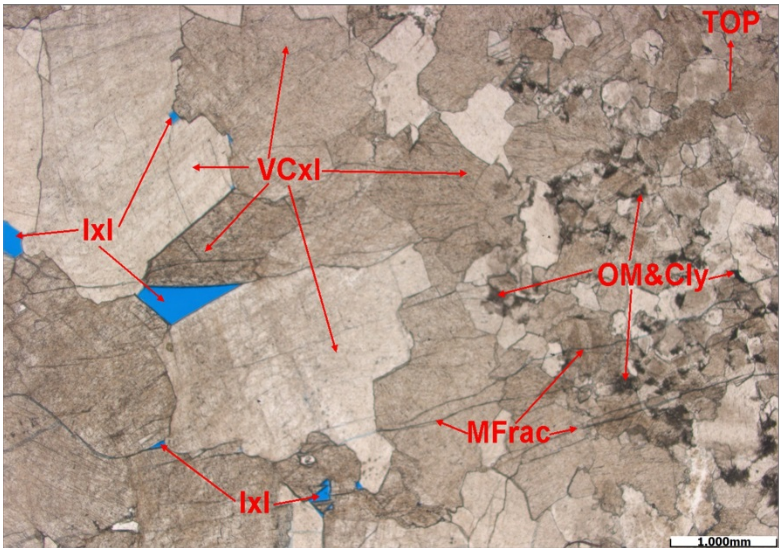


Figure 7.3. Sample T42, 10738.90ft/3273.22m. A low magnification image showing the only zone of this thin section were intercrystalline porosity (Ixl) was detected. This porosity was found within a thick fracture consisting of coarse to fine crystalline very crystalline dolomite (VCxl). Difference between the cloudy brown birefringence of this dolomite may be a shear stress feature. Also note organic matter and clays (OM&Cly). With surrounding very coarse (VCxl) to coarse (Cxl) crystalline dolomite clearly show the planar nature and this generally subhedral carbonate. **x50ppl**

Figure 7.4. Sample T42, 10738.90ft/3273.22m. The same moderate magnification image as Figure 7.3 but this was in cross polarized light. focusing on a patch of the dolostone that is partially replaced by chert (Cht). The fracture is almost completely occluded with euhedral polycrystalline quartz. Note the horizontal dipping micro-fractures (MFrac) crossing the dolomite crystals (Dol xl) and the white to black colour of the poly- to microcrystalline quartz of the chert. The medium crystalline groundmass bordering the previously mentioned fracture. **x25ppl**

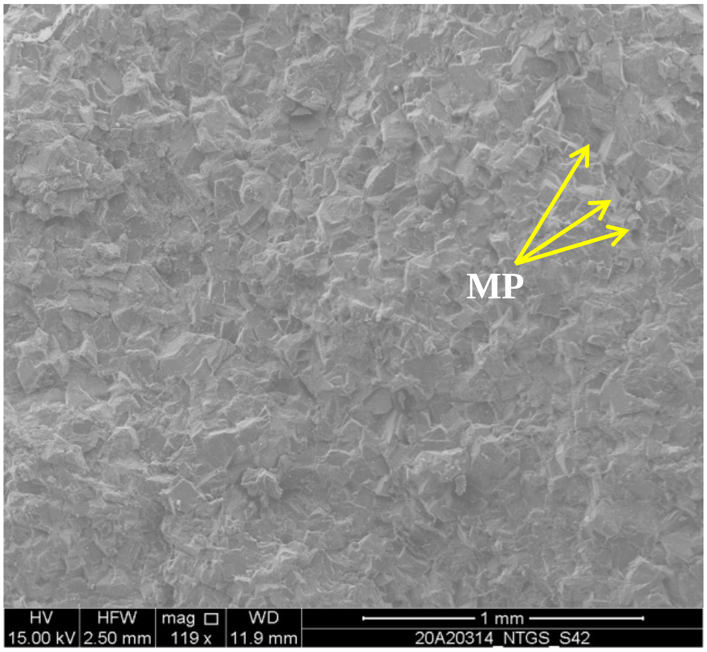


Figure 7.6. Sample S42, 10738.90ft/3273.22m. Low magnification scanning electron microscope (SEM) image showing a portion of the groundmass that is dominated by medium crystalline dolomite rhombs. Porosity within this view consists of scattered micropores that may represent a predominately closed microfracture. **x119**

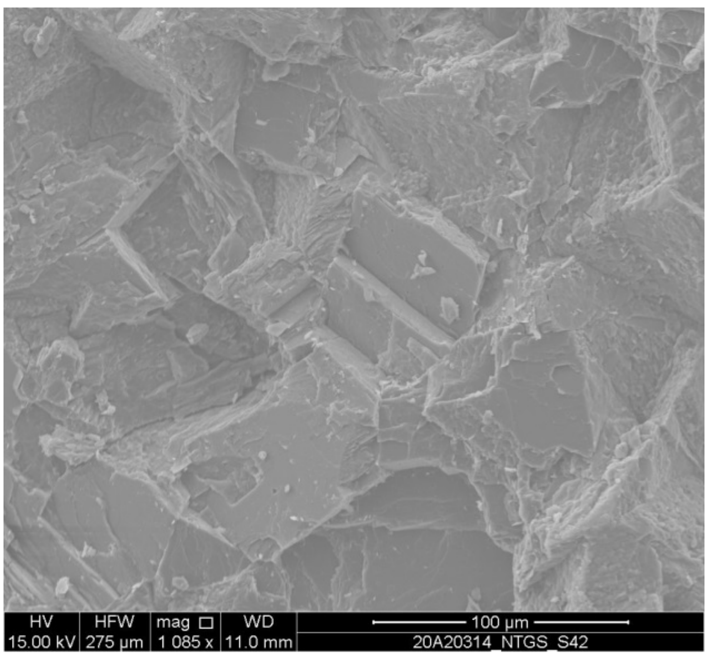


Figure 7.7. Sample S42, 10738.90ft/3273.22m. Moderate magnification scanning electron microscope (SEM) image showing details of the medium crystalline dolomitic groundmass. Porosity is poorly preserved due to the tightly interlocking crystal fabric. **x1085**

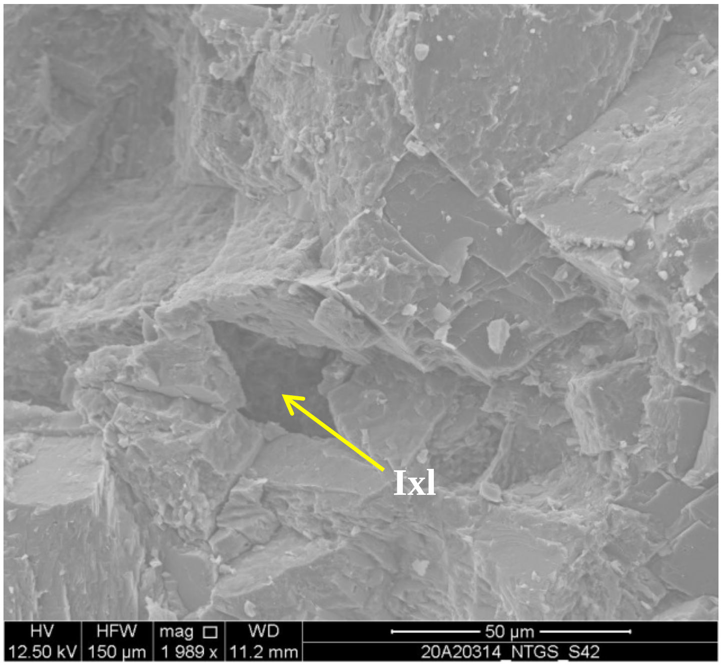


Figure 7.8. Sample S42, 10738.90ft/3273.22m. Moderate magnification scanning electron microscope (SEM) image showing an intercrystalline pore space (Ixl). Isolated pores within this sample appear poorly connected. **x1989**

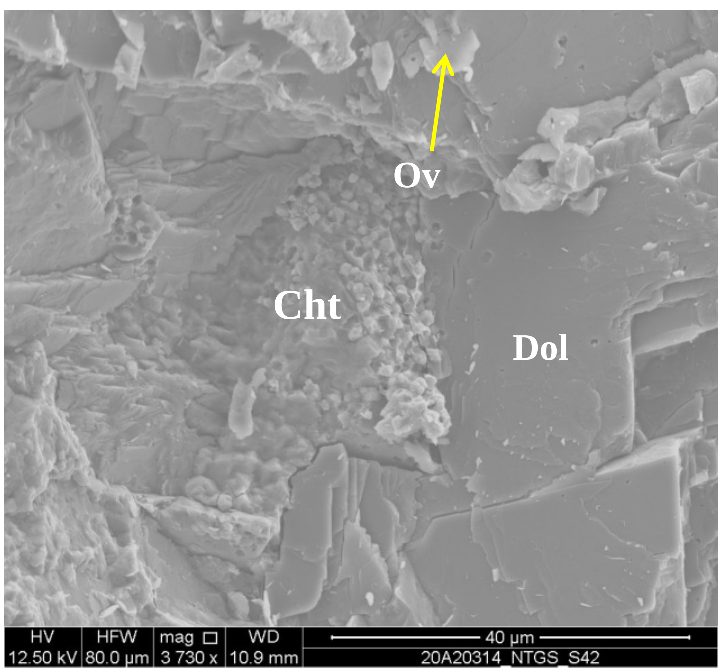


Figure 7.9. Sample S42, 10738.90ft/3273.22m. Moderate magnification scanning electron microscope (SEM) image highlighting localized chert replacement (Cht). No visible microporosity is associated with the tightly packed crystallites. Minute overgrowths (Ov) are noted on some crystal surfaces. Dol: dolomite. **x3730**

Sample T41 (X55, S41), 10742.00ft/3274.16m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample Type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10742.00ft/3274.16m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone (Wackestone)	**Stain type**	½ Dual carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		100	TR		TR	TR
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Detrital grains	Matrix	Pore filling cement	Replacement
	3	15		TR	10	72

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wackestone that has been eventually totally dolomitized. Sub-vertical to vertical fractures are healed by coarse crystalline dolomite suggest tectonic stress on this rock after deposition, but prior late stage dolomitization.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divides the replacement fabrics by crystal size distribution are by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows nonplanar fabrics, with mostly unimodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 8.1) but less so when looking at the scan image of the whole thin section (Figure 8A).
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 100% dolomite with trace amounts of organic matter and clay, pyrite and drilling mud. Moderate amounts of dolomitized bioclasts (15%) and minor intraclasts (3%) were observed evenly distributed throughout the groundmass for this dolostone. Based on the shape, these bioclasts appear to be mostly indistinct very fine grained fossil debris, ostracod and other small bivalve fragments, plus echinoderms stems and larger bioclasts.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Trace amounts of clays and organic material is incorporated into intercrystalline fill and in low amplitude stylolites.
Pore Filling Cements	The coarse to very coarse pore filling dolomite cements (10%) within this sample are associated with healed fractures and cemented/replaced leached bioclasts.
Replacement Minerals	The original micrite of these wackestone has been replaced by fine to medium crystalline primary anhedral dolomite (72%). Trace pyrite replaces dolomite which is often associated with organic matter.

Porosity	The collected sample has trace intercrystalline and fracture porosity.

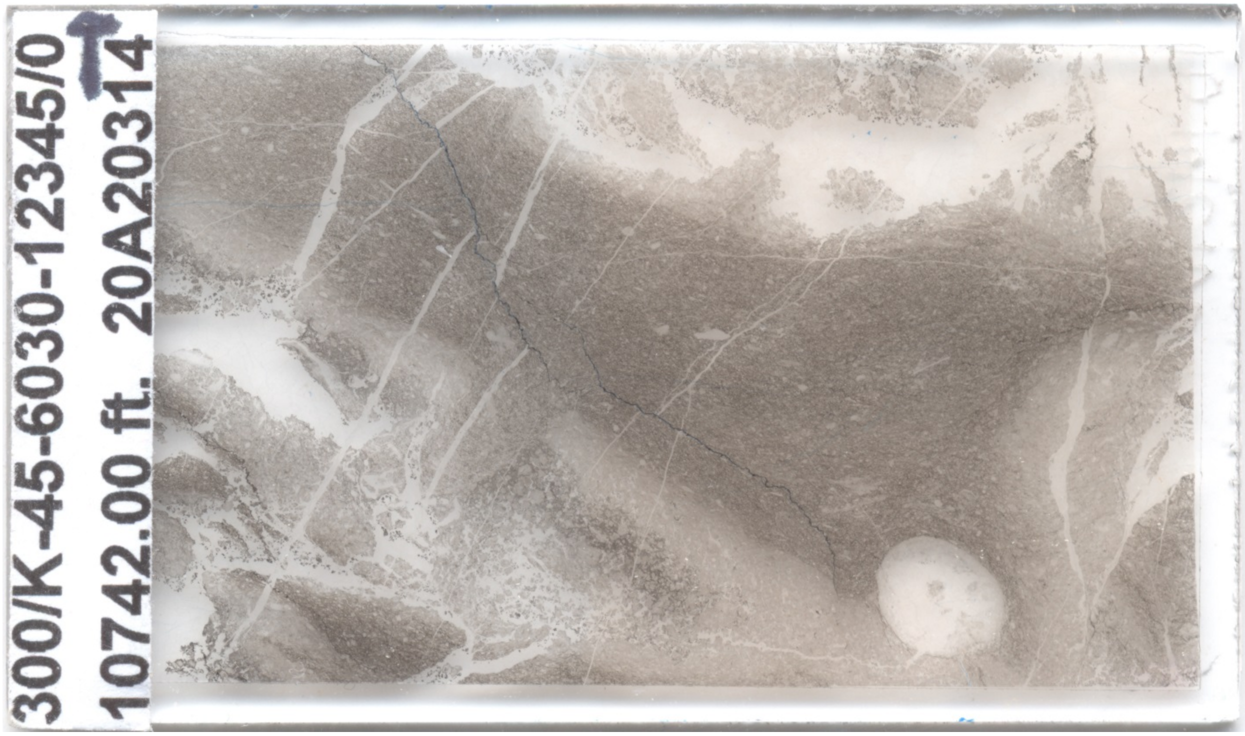


Figure 8A: Thin section scan of sample T41 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone consisting mostly of fine to medium crystalline dolomite. The "ghost "of individual bioclasts are difficult to see in this scanned thin section. The white colour denoted coarse to very coarse crystalline dolomite which fills bioclast ghosts and numerous fractures. A sub-vertical stylolite cuts through the middle of this thin section.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

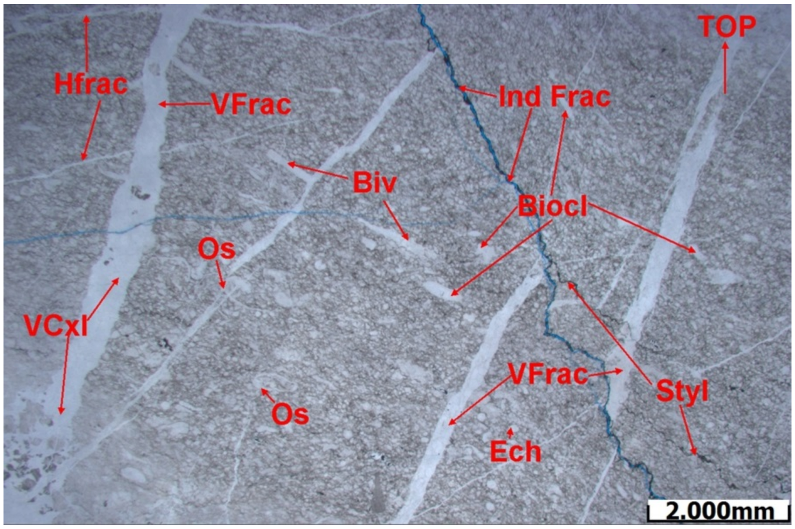


Figure 8.1. Sample T41, 10742.00ft/3274.16m. Figure 7.1. Sample T42, 10738.90ft/3273.22m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this probable dolowackestone (WS?). The bioclasts present are echinoderm stems and spines (Ech), bivalve shell fragments (Biv), ostracods shells (Os) and indistinct bioclasts (Biocl). Note the dolomite cemented vertical (VFrac) and horizontal (HFrac) fractures that bisect this dolomite. In addition a low amplitude stylolite (Styl) bisects this dolostone and a portion of is unloaded along its trace thus forming an induced fracture (Ind Frac). **x12.5 white card ppl**

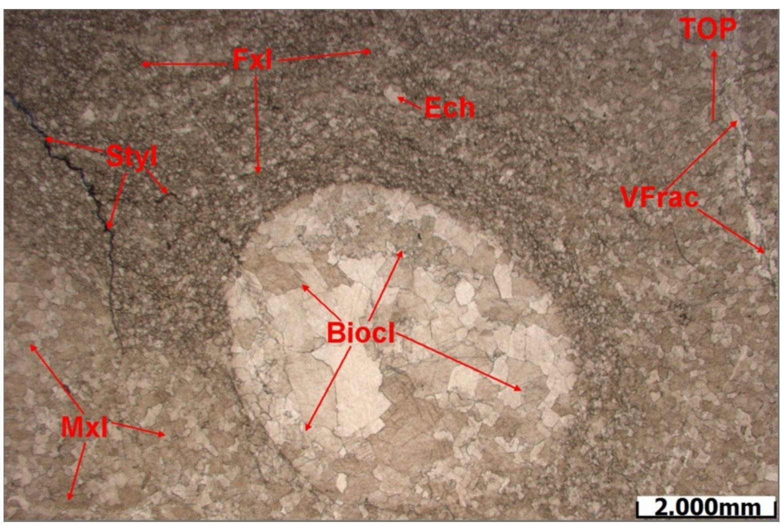


Figure 8.2. Sample T41, 10742.00ft/3274.16m. A second very low magnification image shot in plane polarized light show a relatively large bioclast ghost (Biocl) cemented or replaced by very crystalline dolomite. The internal structure of this fossil is totally recrystallized or replaced so no internal structure is preserved. Small broken-up echinoid debris (Ech) occurs floating in the fine crystalline dolomite groundmass. A vertical fracture (VFrac) with minor amounts of open porosity cuts through the fine crystalline dolomite as well. A wispy stylolite (Styl) separates the previously mentioned fine crystalline dolomite from the medium crystalline dolomite in the lower left-hand corner of this image. **x12.5ppl**

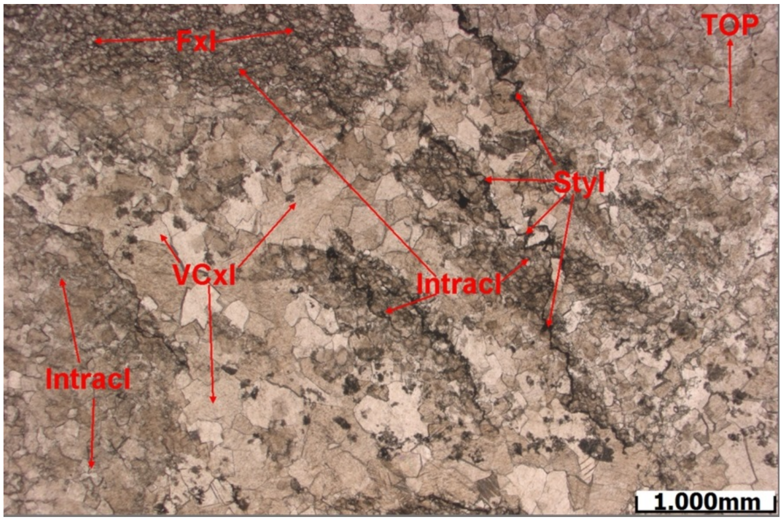


Figure 8.3. Sample T41, 10742.00ft/3274.16m. Low magnification image focuses on local intraclasts (Intracl) in the lower left hand corner of the thin section (see Figure 8A) that float in very coarse crystalline dolomite cement (VCxl). These apparent intraclasts may actually be local gouge fill floating in the very coarse crystalline cemented vertical fracture. These intraclasts consists of fine crystalline dolomite mixture with minor amounts of organic matter and clays. A vertical dipping stylolite (Styl) is parallel to the strike of the large closed fracture. **x25ppl**

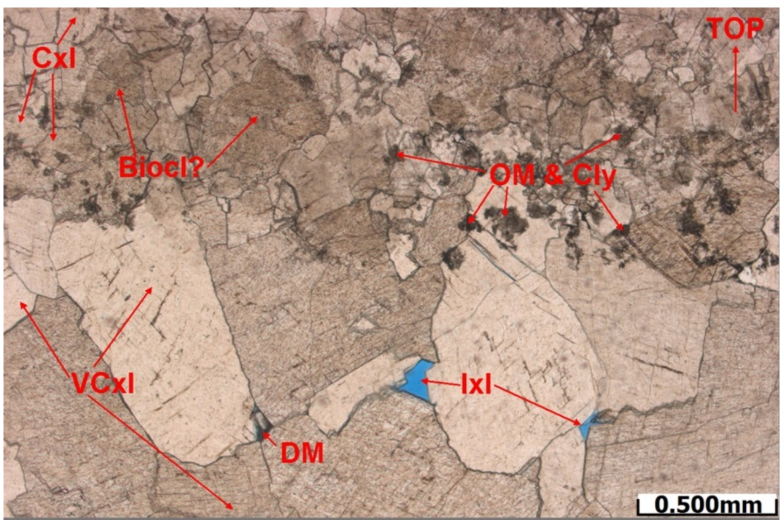


Figure 8.4. Sample T41, 10742.00ft/3274.16m. Moderate magnification image shows minor amounts of intercrystalline porosity (Ixl) within very coarse crystalline dolomite (VCxl) with rounded euhedral saddle dolomite rhombic habit. One small intercrystalline pore is filled with drilling mud fines (DM). The coarse crystalline dolomite (Cxl) in the upper right hand corner of the image shows the “shadow” of indistinct bioclast (Biocl?). The dolomite also appears to in enclosed peloid shape organic matter and clays (OM & Cly). **x50ppl**

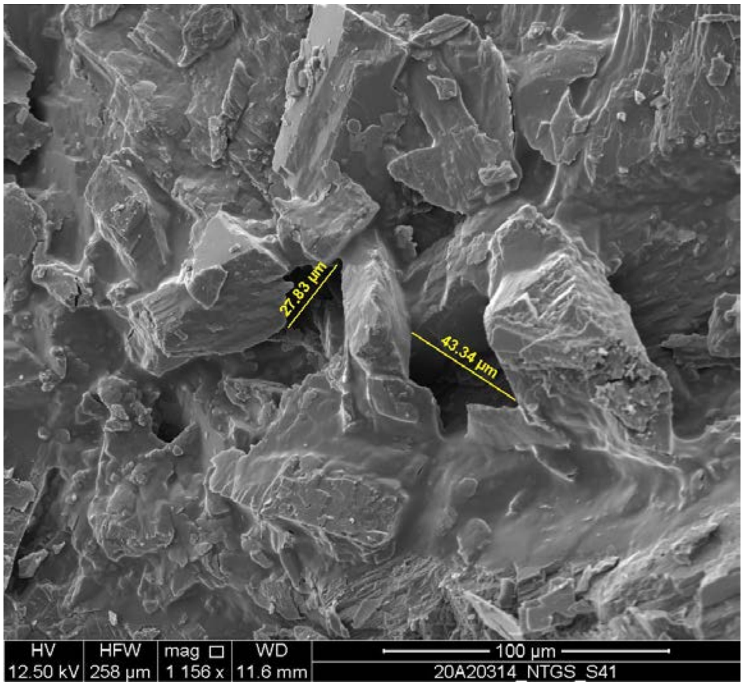


Figure 8.5. Sample S41, 10742.00ft/3274.16m. Moderate magnification scanning electron microscope (SEM) image highlighting relatively large intercrystalline pores with the diameters of 43.34µm and 27.83µm. These pores are partially filled with non-crystalline organic matter (residue hydrocarbon?). **x1156**

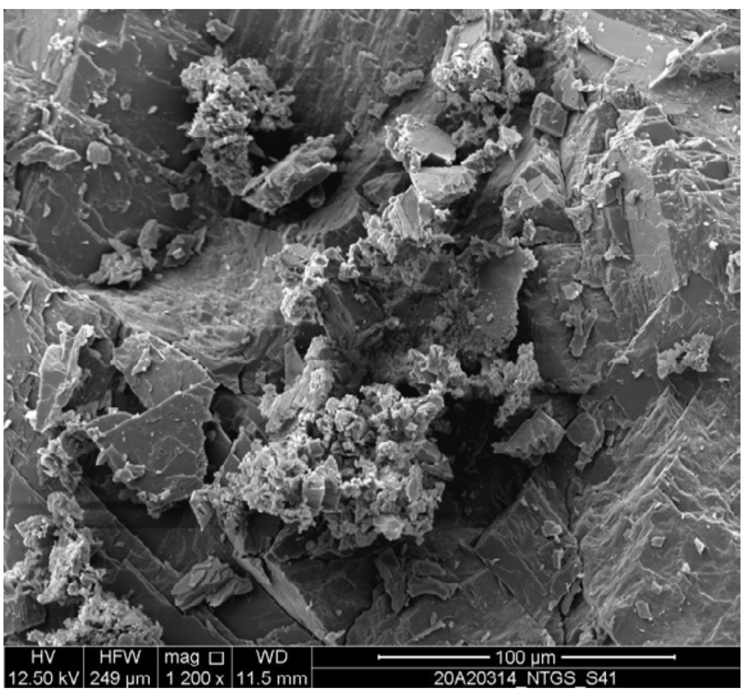


Figure 8.6. Sample S41, 10742.00ft/3274.16m. Moderate magnification scanning electron microscope (SEM) image highlighting drilling muds that consist of uphole carbonate and clastic mineral fines. **x1200**

Sample T40 (X54, S40), 10746.10ft/3275.41m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10746.10ft/3275.41m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone (Wacke- to Packstone)	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		99	TR		TR	1
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Detrital grains	Matrix	Pore filling cement	Replacement
		45		1	5	49

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wackestone to packstone that has been eventually totally dolomitized. Sub-vertical to vertical fractures are healed by coarse crystalline dolomite suggest tectonic stresses on this rock after deposition but prior late stage dolomitization (i.e. fracture cement).
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) also divides the replacement fabrics by crystal size distribution are by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows mostly nonplanar fabrics, with mostly unimodal crystal size. Due to the dolomitization, the precursor rock texture was highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 9.1) and the scan image of the whole thin section (Figure 9A).
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains dolomite (99%), with minor amounts of organic matter and clay (1%), plus trace pyrite and drilling mud. Significant amounts of dolomitized bioclasts (45%) were observed irregular distributed throughout the groundmass for this dolostone (large bioclasts are more common on lower half of the thin section). Based on the shape, these bioclasts appear to be stromatoporoids, echinoderms stem and spines, plus indistinct small bioclast particles.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material is incorporated into intercrystalline fill and in low to high amplitude stylolites and rare carbonaceous partings. Trace drilling mud fines line induced fractures.
Pore Filling Cements	The coarse to very coarse pore filling dolomite cements (5%) within this sample are associated with healed fractures and cemented/replaced leached bioclasts. Trace amounts of the ferroan dolomite heal a few of the vertical fractures.
Replacement	The original micrite of these dolostone has been replaced by medium to coarse crystalline

Minerals	primary anhedral dolomite (59%). Trace pyrite replaces dolomite which is often associated with organic matter.
Porosity	Minor amounts of intercrystalline (1%) and partially open fractures (1%) porosity was detected.

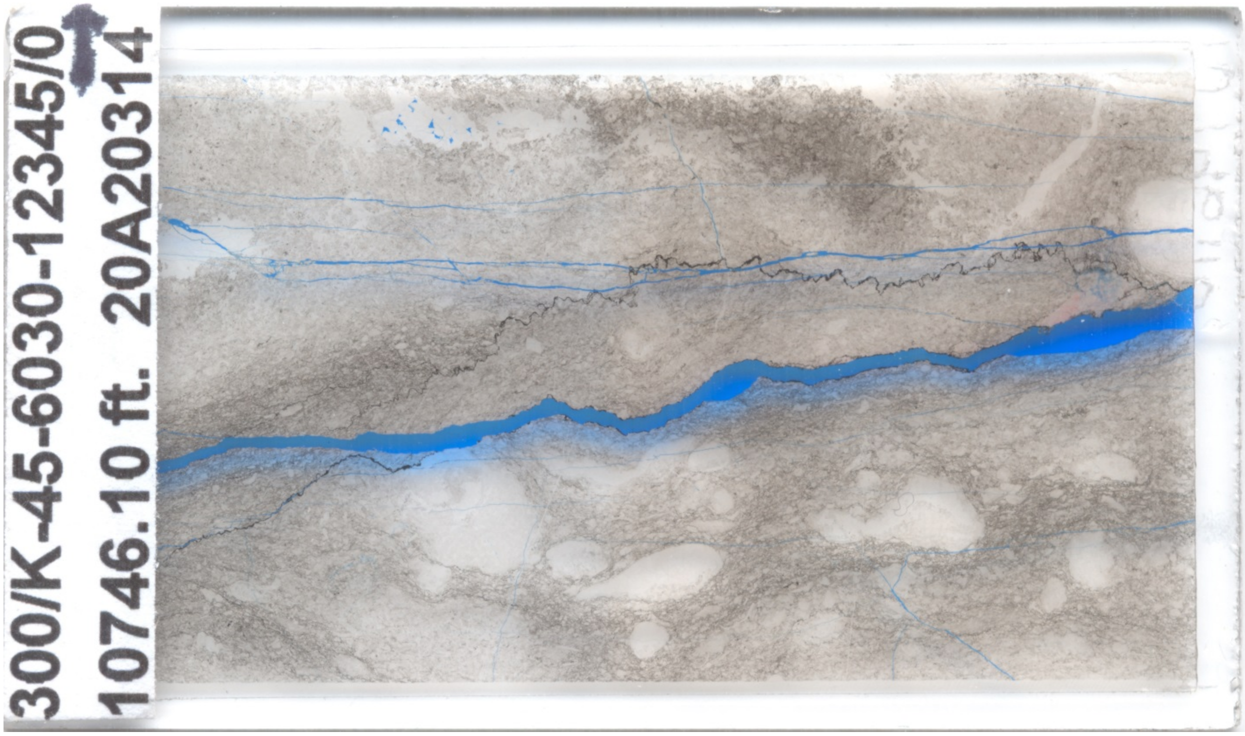


Figure 9A: Thin section scan of sample T40 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone to dolopackstone consisting of fine to very crystalline dolomite. The visible "ghost "of individual bioclasts in this thin section scan consist of possible stromatoporoids (large bioclasts) and echinoderm stems, spines and plates. Slightly inclined moderate amplitude stylolites are filled with organic residue and the unloading along them is the source of a large induced fracture (blue epoxy). The white colour denoted coarse to very coarse crystalline dolomite which fills bioclast ghosts and numerous fractures.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

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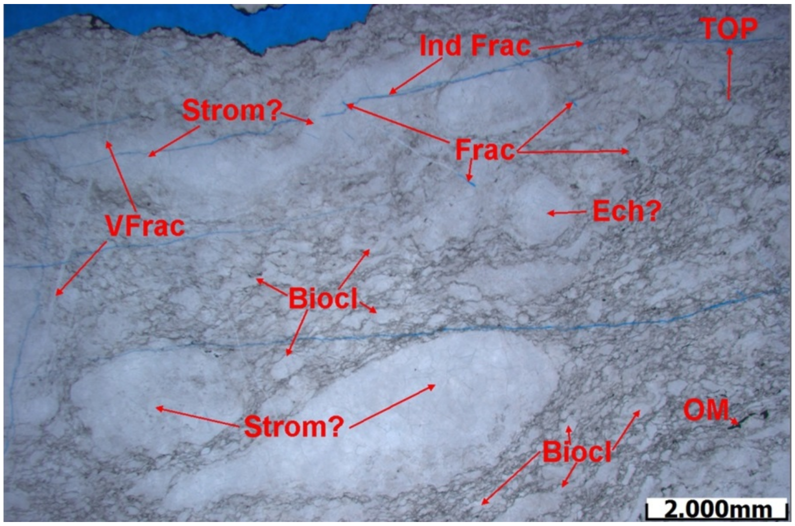

Figure 9.1. Sample T40, 10746.10ft/3275.41m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this probable dolopackstone. The bioclasts present are echinoderm stems and plates (Ech?), probable stromatoporoids (Strom?) and indistinct small bioclast fragments (Biocl). Trace organic matter parting was detected using the white card technique. Note the dolomite cemented sub-vertical (Frac) fracture that bisects the fabric of this dolostone and terminates at a stylolite (blue epoxy shows where its stylolite unloaded during coring). Induced fracture (Ind Frac) shows no mineralization along its trace. **x12.5 white card ppl**

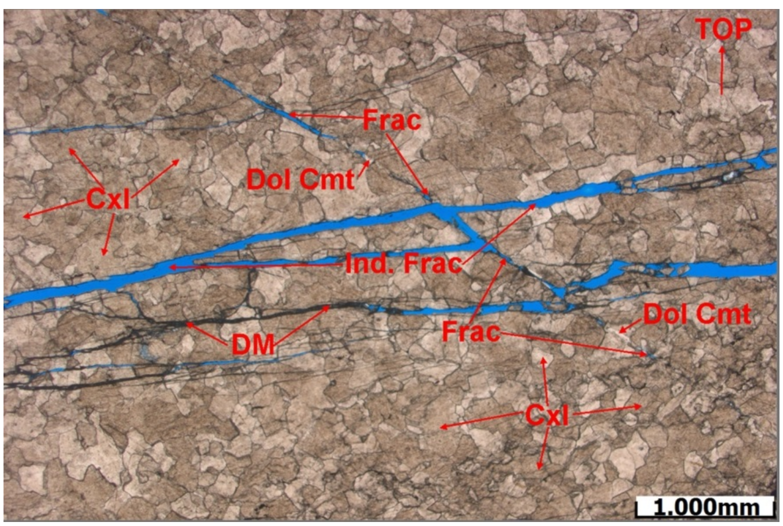

Figure 9.2. Sample T40, 10746.10ft/3275.41m. Low magnification image in plane polarized of sub-vertical fracture (Frac) that is partially occluded by dolomite cement (Dol Cmt) and bisects a set on horizontal induced fractures (Ind. Frac). Drilling mud fines (MD) are locally found along these induced fractures. The nonplanar tightly packed coarse crystalline dolomite (Cxl) shows no shadows of the allochems detected using the white card technique. **x25ppl**

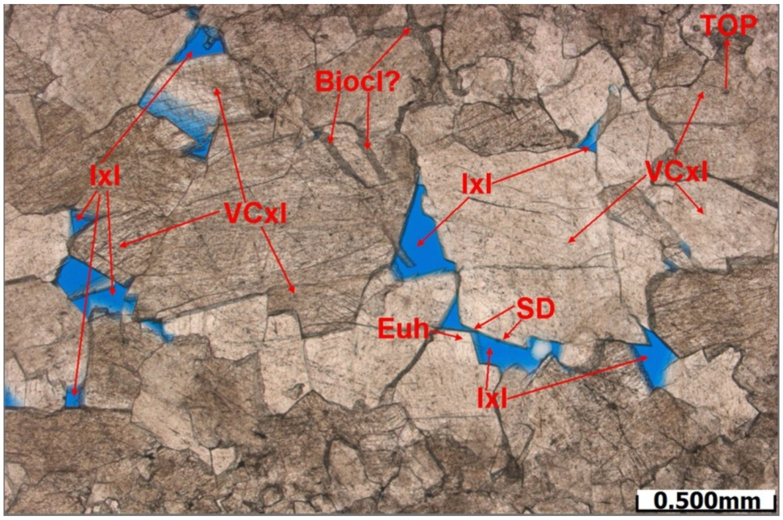

Figure 9.3. Sample T40, 10746.10ft/3275.41m. Moderate magnification image focuses on the presence intercrystalline porosity (Ixl) formed between very course crystalline euhedral (Euh) and saddle dolomite (SD) rhombs. In addition see the "ghost" of indistinct branching bioclast (Biocl?) within a very coarse crystalline dolomite rhombs. **x50ppl**

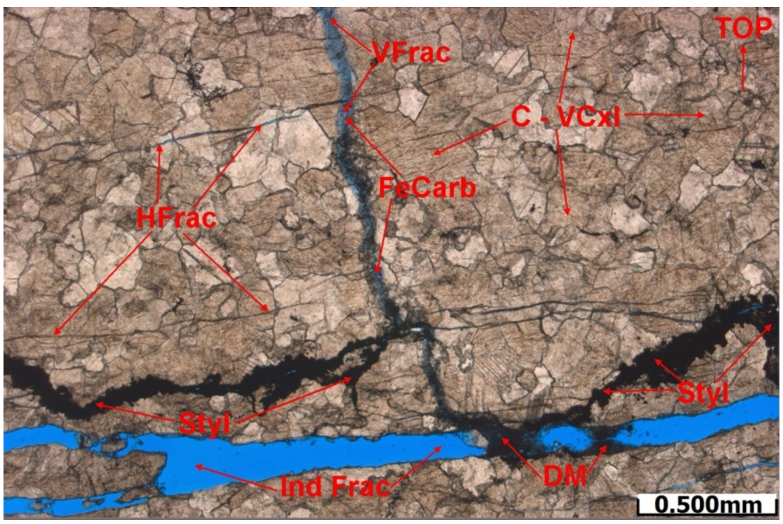

Figure 9.4. Sample T40, 10746.10ft/3275.41m. Moderate magnification image showing vertical fracture (VFrac) partially occluded by ferroan carbonate (FeCarb) that terminates at carbonaceous residue filled stylolite (Styl). This ferroan carbonate in this fracture is most likely dolomite. In addition to previously mentioned stylolite and vertical fracture and horizontal possible shear stress fractures (HFrac) cut across the coarse to very coarse crystalline dolomite (C – VCxl). The base of the image shows an induced unloading fracture (Ind Frac) that is partially filled with drilling mud fines (DM). **x50ppl**

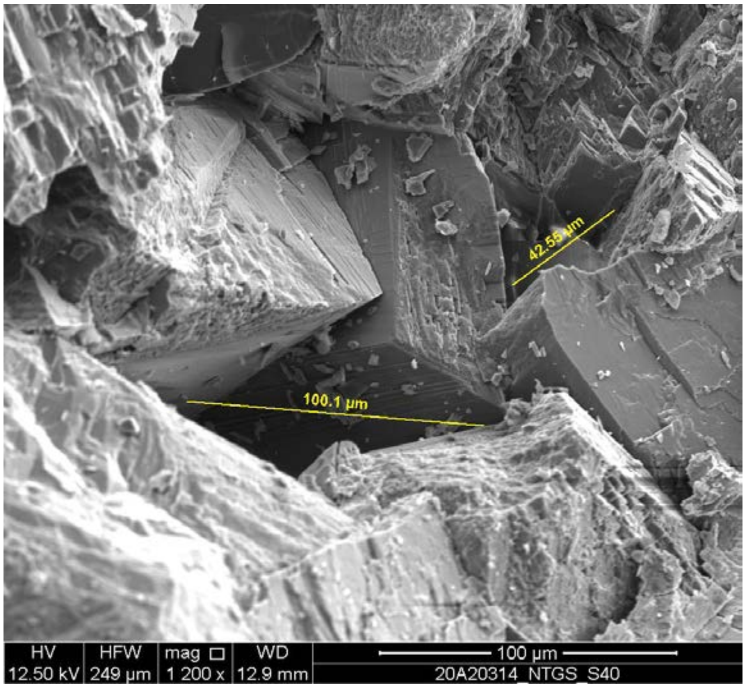

Figure 9.5. Sample S40, 10746.10ft/3275.41m. Moderate magnification scanning electron microscope (SEM) image highlighting relatively large intercrystalline pores with long axis diameters of 100.1µm and 42.55µm. These pores are found with euhedral coarse crystalline dolomite rhombs with saddle dolomite crystal terminations. **x1200**

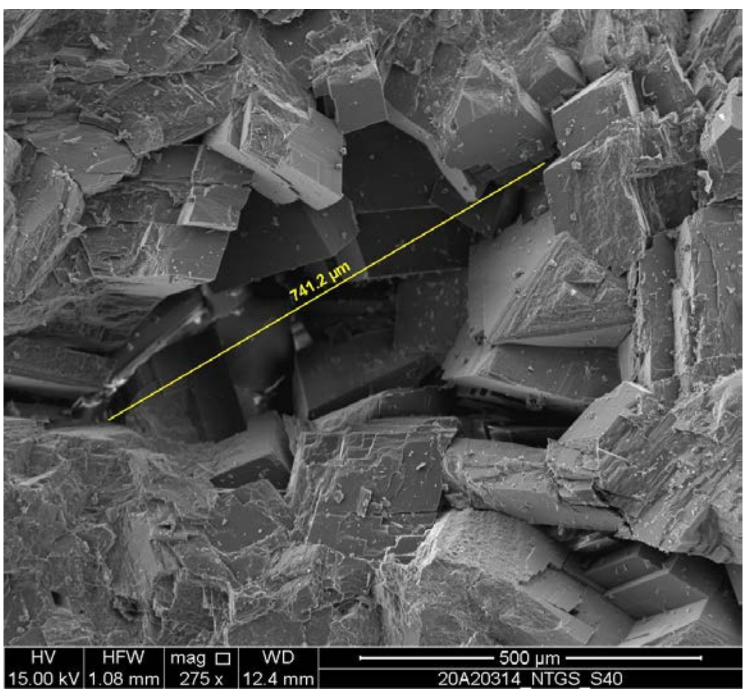

Figure 9.6. Sample S40, 10746.10ft/3275.41m. Low magnification scanning electron microscope (SEM) image highlighting the patch (741.2µm) of well-made euhedral dolomite rhombs with sharp crystal terminations. **x275**

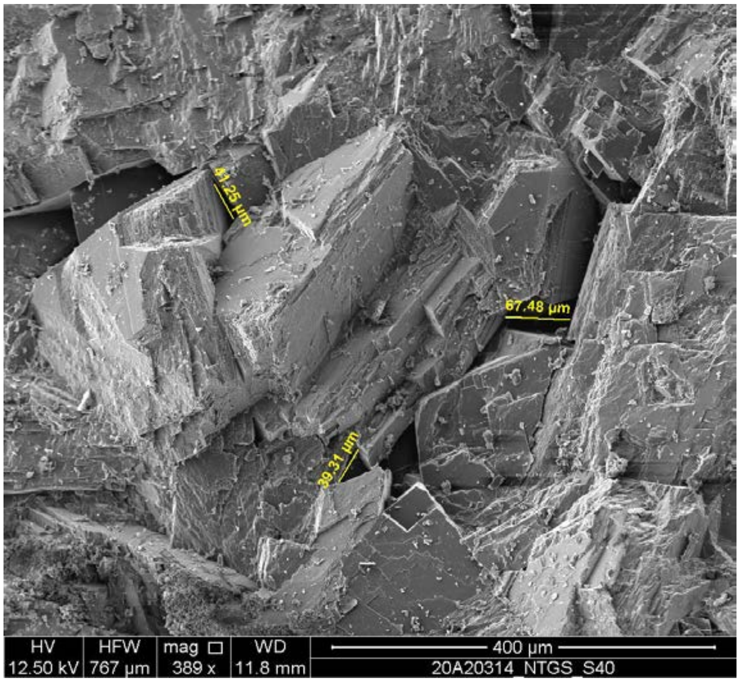

Figure 9.7. Sample S40, 10746.10ft/3275.41m. Low magnification scanning electron microscope (SEM) image highlighting intercrystalline pores with long axis diameters of 67.48µm, 41.25µm, and 39.31µm. These dolomite rhombs have euhedral habit and local saddle morphology. **x389**

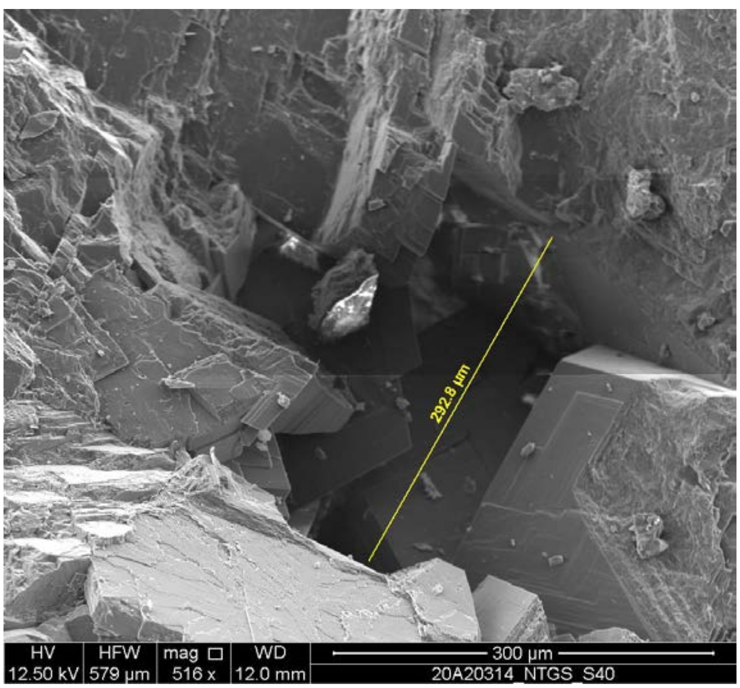

Figure 9.8. Sample S40, 10746.10ft/3275.41m. Moderate magnification scanning electron microscope (SEM) image highlighting vug (292.8µm) rims by well-made euhedral saddle dolomite rhombs. **x516**

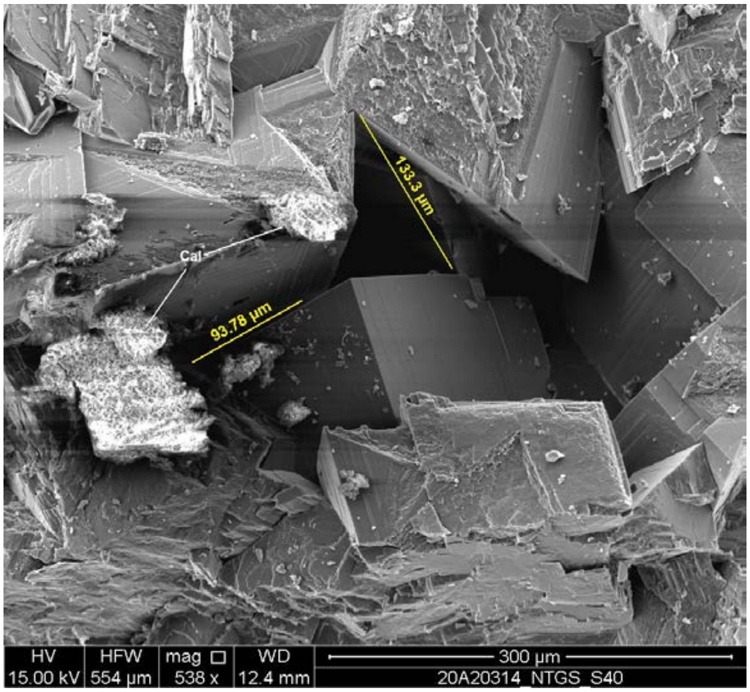

Figure 9.9. Sample S40, 10746.10ft/3275.41m. Moderate magnification scanning electron microscope (SEM) image highlighting intercrystalline pores with diameters of 133.3µm and 93.78µm. These dolomite rhombs have euhedral habit and locally show zoned growth patterns. A loose particle of calcite (Cal) is an uphole material found within drilling mud fines. **x538**

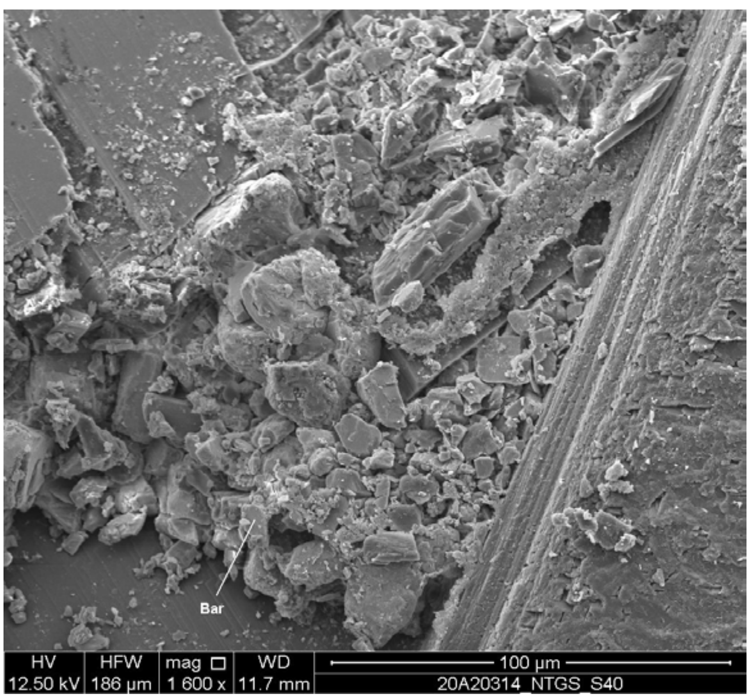

Figure 9.10. Sample S40, 10746.10ft/3275.41m. High magnification scanning electron microscope (SEM) image highlighting the mineralogy of drill mud fines probably deposited along induced fractures. The drill mud fines of abraded crystals of uphole carbonates, clastic and barite (Bar) which is weight component of drilling mud. **x1600**

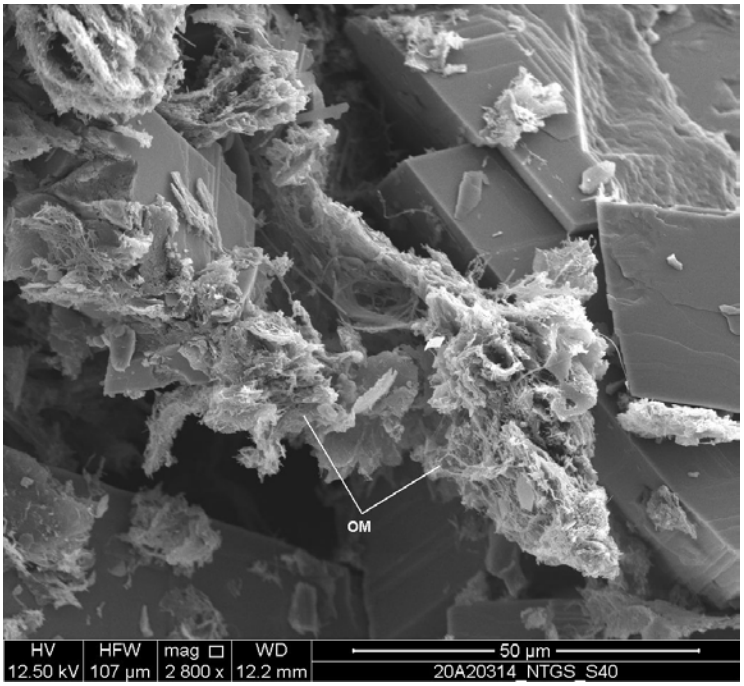

Figure 9.11. Sample S40, 10746.10ft/3275.41m. High magnification scanning electron microscope (SEM) image highlighting the composition of carbonaceous residue (OM) within a stylolite trace. Also note the well-formed, euhedral saddle dolomite that borders the above mentioned carbonaceous debris. **x2800**

Sample T39 (X53, S39), 10746.20ft/3275.44m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10746.20ft/3275.44m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Poor
Classification	Dolostone	**Stain type**	½ Dual Carbonate

MINERALOGY

	Total Bulk mineralogy					
Thin Section Point counting (%)	Calcite	Dolomite	Drilling Mud	Quartz/Cht	Pyrite	Clays & organics
		99		TR	TR	1
	Framework, Matrix, Cement, and Replacement					
	Carbonate clasts	Bioclasts	Cht	Matrix	Pore filling cement	Replacement
		12	TR	1	7	80

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	At the time of deposition, the sample was most likely lime-wackestone that has been totally dolomitized. Numerous subvertical to vertical fractures are healed to partially cemented with coarse crystalline dolomite suggesting tectonic stresses of this rock after deposition but prior late stage dolomitization.
Textures	Dolomite fabrics were classified as planar and nonplanar (Sibley & Gregg, 1987) based on the nature of crystal boundaries. Sibley and Gregg (1987) divides the replacement fabrics by crystal size distribution are by degree of preservation of precursor fabric into mimic (fabric-preserving) and nonmimic (fabric destroying) varieties. This sample shows mostly nonplanar fabrics, with mostly unimodal crystal size. Due to the dolomitization, the precursor rock texture is highly destroyed but still mimic original fabric when viewed using the white card technique (Figure 10.1). The scan image of the whole thin section (Figure 10A) shows the morphology and abundance of the fracture system in this sample.
Framework (Carbonate clasts, Bioclasts)	Petrographic Summary Table 1 shows detailed mineralogy of the sample. This sample contains 99% dolomite with minor amounts of organic matter and clay (1%), and trace pyrite and chert. Moderate amounts of dolomitized bioclasts (12%) were observed irregular distributed throughout the groundmass for this dolostone. Based on the shape, these bioclasts appear to be bivalve and ostracod shell fragments, echinoderms stem and spines and indistinct bioclast particles.
Detrital Grains & Other Non-Carbonate Grains	There are no detrital grains in this sample.
Matrix	Minor amounts of clays and organic material is incorporated into intercrystalline fill and in low to high amplitude stylolites.
Pore Filling Cements	The coarse to very coarse pore filling dolomite cements (7%) within this sample are associated mostly with healed fractures.
Replacement Minerals	The original micrite of this dolostone has been replaced by medium crystalline primary nonplanar anhedral dolomite (80%). Trace pyrite replaces dolomite crystals.

Porosity	The collected sample has minor amount of partially open fracture porosity (1%) and trace intercrystalline pores. The blue epoxy filled large fractures in the below scan thin section are induced and should be ignored.

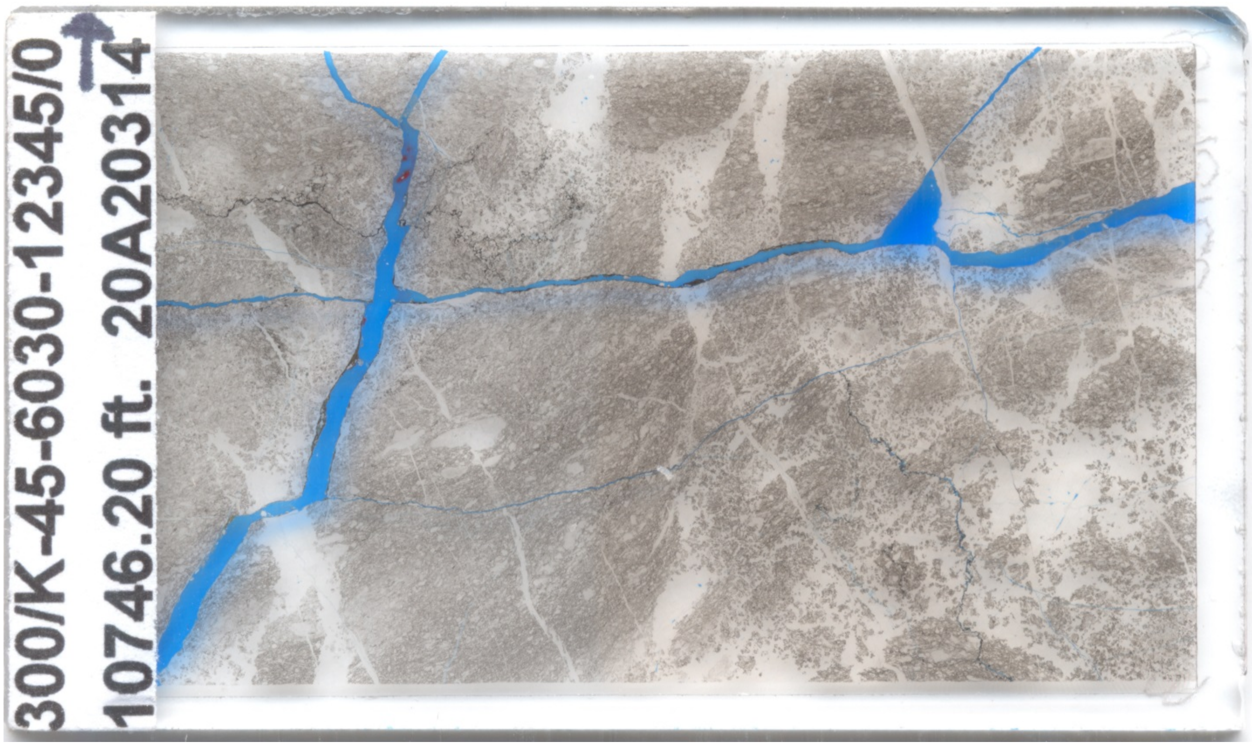

Figure 10A: Thin section scan of sample T39 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as dolowackestone consisting of fine to very crystalline dolomite. The visible “ghost “of individual bioclasts in this thin section scan consist of possible echinoderm stems and spines, bivalve and ostracod shell fragments and indistinct fossil debris (the few larger ones may be stromatoporoids). Horizontal to vertical low amplitude stylolites are filled with organic residue and possible clays or clastic material. The white colour denoted coarse to very coarse crystalline dolomite which fills to partially fill vertical to sub-horizontal fractures.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

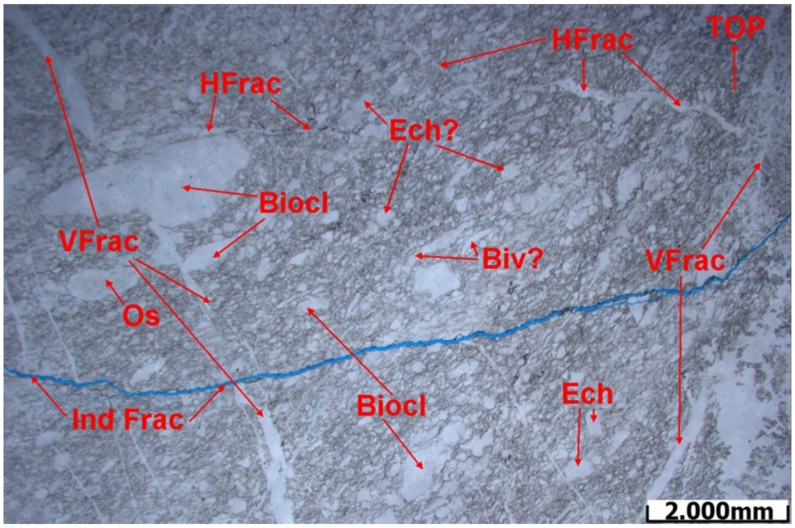

Figure 10.1. Sample T39, 10746.20ft/3275.44m. A very low magnification overview was taken using the white card technique to enhance the visibility of the allochems in this probable dolowackestone. The bioclasts present are echinoderm stems and spines (Ech), possible bivalve shell fragments (Biv?), very crystalline healed possible ostracod (Os) and large (possible stromatoporoid?) and small indistinct fossil fragments (Biocl). Both vertical (VFrac) and horizontal (HFrac) are mostly healed with coarse crystalline dolomite. A horizontal dipping induced fracture (Ind Frac) shows no mineralization along its trace. **x12.5 white card ppl**

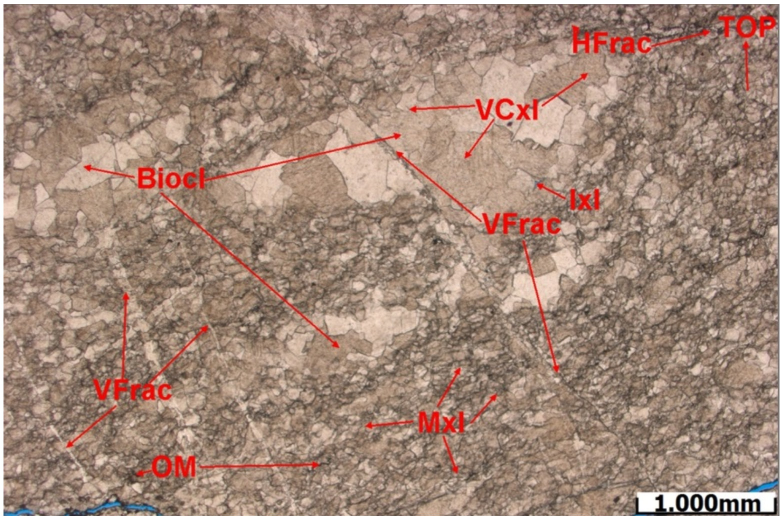

Figure 10.2. Sample T39, 10746.20ft/3275.44m. Low magnification image of the sample in plane polarized light showing the “ghost” of bioclasts (Biocl) filled with planar, coarse to very coarse subhedral dolomite rhombs. These bioclasts could be stromatoporoid, healed whole pelecypods/brachiopods or echinoid debris. Partially open vertical fractures (VFrac) with dolomite mineralization cut through the fabric of this dolostone. Trace amounts of organic matter (OM) occur between crystals in the medium crystalline dolomite (Mxl) groundmass. **x25ppl**

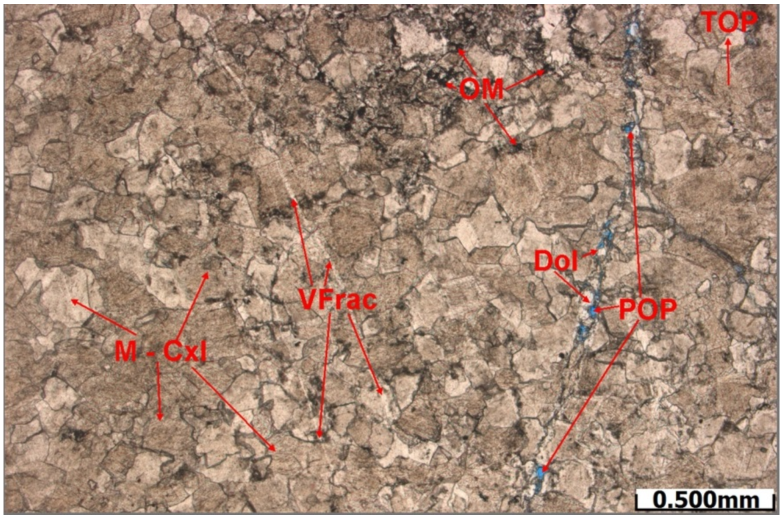

Figure 10.3. Sample T39, 10746.20ft/3275.44m. Moderate magnification image focuses on the totally healed (VFrac) to partially open (POP) vertical fractures that are mineralized with dolomite cement (Dol). The intercrystalline organic matter and clays (OM) occur in isolated patches in the medium to coarse crystalline (M – Cxl) groundmass dolomite. **x50ppl**

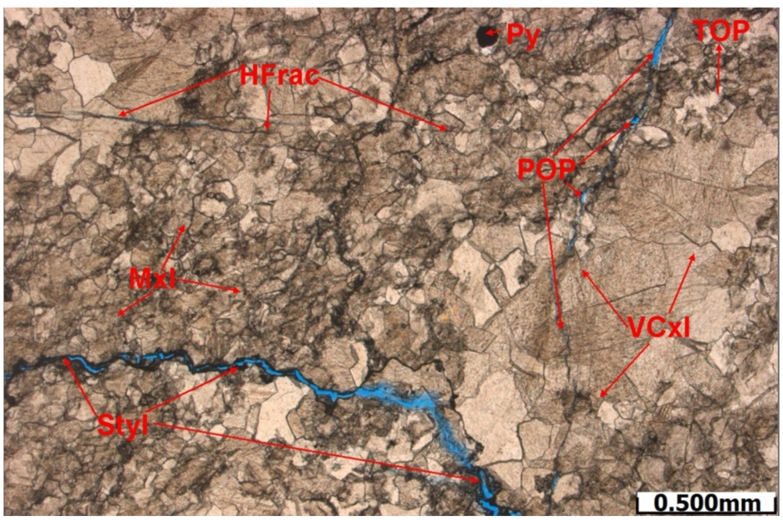

Figure 10.4. Sample T39, 10746.20ft/3275.44m. A second moderate magnification image focuses on the partially open vertical fracture (POP) that bisect the very coarse (VCxl) to medium crystalline (Mxl) fabric of this dolostone. The unloading along stylolite (Styl) is induced feature that should be ignored. Note the discontinuous horizontal micro-fractures (HFrac) that cuts through the fabric of this dolomite. These horizontal micro-fractures maybe a product of shear stresses and are thus not induced fractures. **x50ppl**

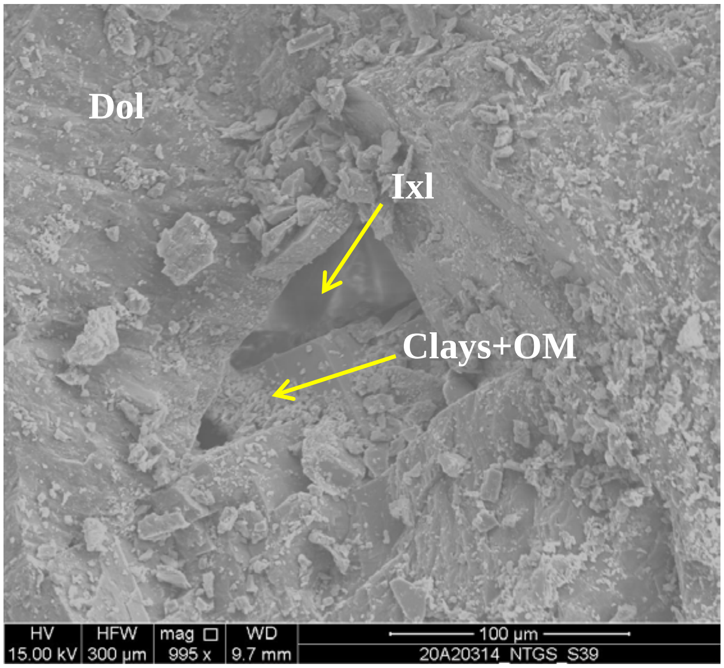

Figure 10.5. Sample S39, 10746.20ft/3275.44m. Scanning electron microscope (SEM) image showing medium to coarse crystalline dolomite (Dol) that makes up a significant portion of the sample. Loose debris surrounding the angular intercrystalline pore (Ixl), measuring ~100µm, consists of clay minerals with an indistinct morphology, in addition to very fine organic material (Clays+OM). **x995**

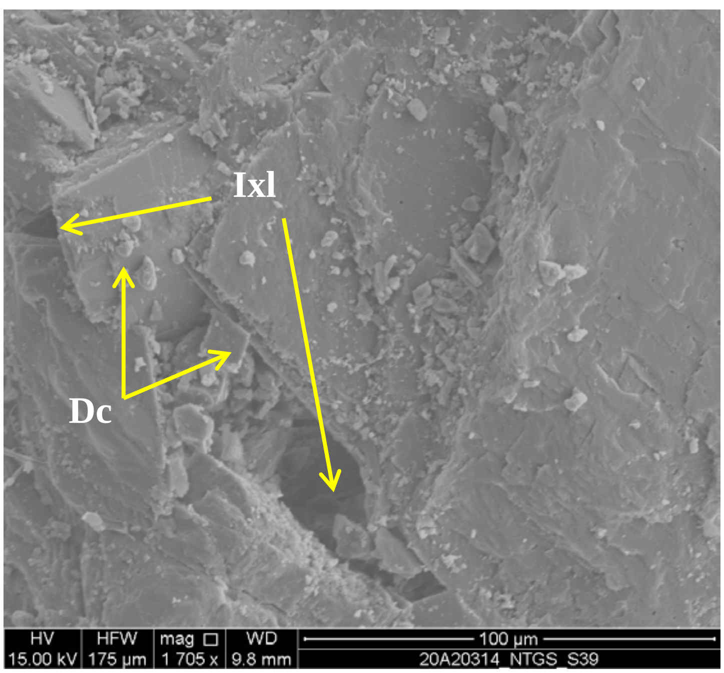

Figure 10.6. Sample S39, 10746.20ft/3275.44m. Low magnification scanning electron microscope image (SEM) highlighting localized intercrystalline porosity (Ixl), that likely represents partially open fracture porosity as noted in thin section. Very fine to medium euhedral dolomite cements (Dc) has precipitated in the microfracture. **x1705**

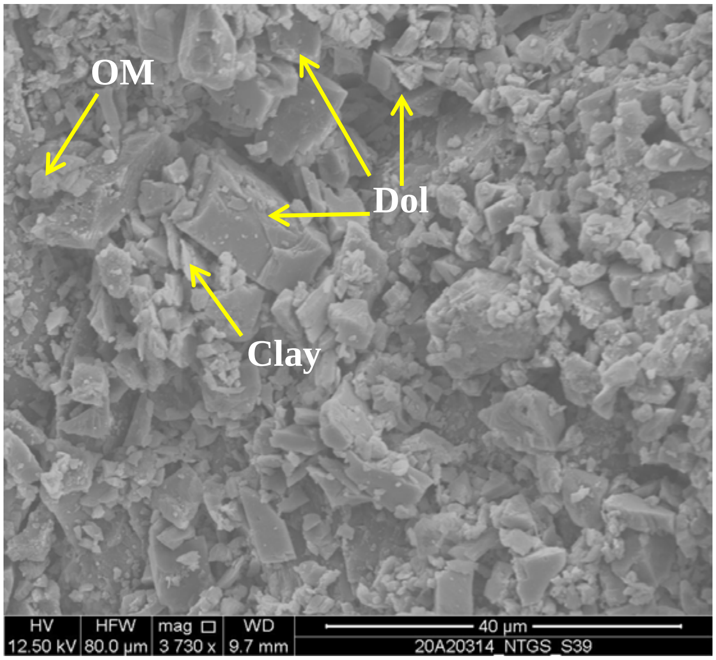

Figure 10.7. Sample S39, 10746.20ft/3275.44m. High magnification scanning electron (SEM) image highlighting a portion of matrix which consists of sub- to euhedral rhombic dolomite (Dol), which ranges in size from aphanocrytalline (<4µm) to very fine crystalline, plus lesser amounts of clays (Clay) and organic matter (OM). **x3730**

Sample T38 (X51, S38), 10956.90ft/3339.66m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10956.90ft/3339.66m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Non-Reservoir Rock
Classification	Siliceous Dolomitic Shale	**Stain type**	½ Dual Carbonate

MINERALOGY

Thin Section Point counting (%)	Qtz	Fld	K-Fld	Cht	Rock Frag.	Mica	HM	Glau	OM
	1					TR			
	Mtx/ P-mtx	**PQ (Cem)**	**Cht (Replace)**	**Chalc**	**FeCal**	**Dol**	**FeDol**	**Sid**	**Py**
	42		15	6	2		20		14

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	The sample has vertical to subvertical laminations that are folded and altered by significant tectonic movement of this rock during uplift and tectonic stresses. The base of this thin section shows wide fracture surface occluded by chalcedony, pyrite and ferroan carbonate (both calcite and dolomite).
Biogenic structures	Not observed.
Textures	This shale has well defined vertical to sub-vertical laminated fabric that been tipped and folded by tectonic stresses.
Mineralogy (Framework and accessory grains)	The minor framework grains (1%) visible in thin section are fine to coarse silt sized quartz. Significant amounts of ferroan dolomite (20%) and replacement chert (15%) occur within the fabric of this laminated shale. A large wide sub-vertical fracture occluded with pyrite, chalcedony, and ferroan carbonate (both calcite and dolomite) occurs at the base of this thin section.
Matrix/ Pseudo-matrix	The matrix (42%) appears dark brown, which suggests high organic content. Based on the optical properties it was concluded that the matrix is of detrital origin but has been significantly replaced by chert (15%). The XRD results indicate matrix clay is dominated by illite; but minor amounts kaolinite and chlorite are also present. Minute muscovite mica also occurs in the groundmass of this shale.
Authigenic Clays	No authigenic clay minerals were detected so all the clays minerals are detrital origin.
Diagenetic minerals/ Diagenesis	The matrix, in addition to replacement siliceous chert, has been partially replaced by ferroan dolomite (20%) and pyrite (14% in groundmass and fracture). Chert occurs in elongate, discontinuous lenses that align with the depositional lamination structure. Ferroan dolomite occur as fine to coarse crystalline subhedral sub- to euhedral rhombs and the pyrite occurs as scattered irregular distributed blebs or framboids. The wide vertical fracture at the base of thin section is occluded by initial pyrite, followed by moderate amounts of ferroan dolomite along the surface of fracture with late-stage chalcedony occluding remaining fracture porosity. The ferroan calcite in the fracture probably precipitated in voids within the chalcedony cement.
Porosity	No visible porosity.

Figure 11A: Thin section scan of sample T38 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as silicified dolomitic shale with vertical to subvertical dipped and folded laminations. The lower portion show large vertical to horizontal fractures and voids occluded with pyrite, chalcedony and ferroan carbonate (calcite and dolomite).

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

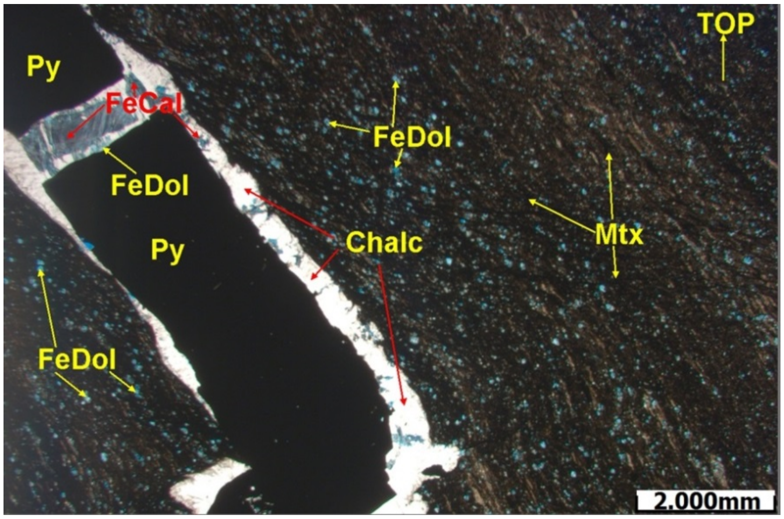

Figure 11.1. Sample T38, 10956.90ft/3339.66m. Very low magnification overview of a sub-vertical laminated siliceous shale (Mtx) bisected by thick fracture occluded with pyrite (Py), chalcedony (Chalc), ferroan calcite (FeCal), and ferroan dolomite (FeDol). Numerous medium to coarse crystalline ferroan dolomite rhombs (FeDol) have precipitated with the matrix of this siliceous shale. **x12.5ppl**

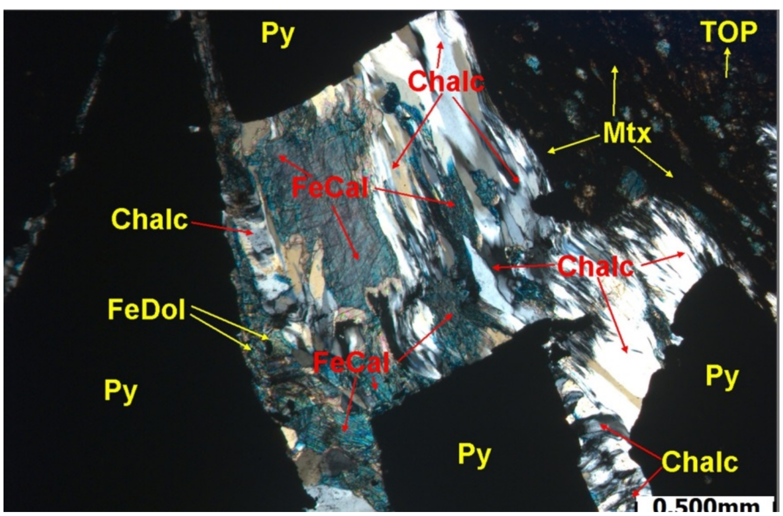

Figure 11.2. Sample T38, 10956.90ft/3339.66m. Moderate magnification image in cross polarized light of the wide fracture mention in Figure 11.1. Note the stretched, fibrous and polycrystalline morphology of the chalcedony; which range from white to grey to black birefringence in cross polarized light. The ferroan dolomite (FeDol) locally rims the apparent pyrite "gouge" with this fracture/fault. Late stage ferroan calcite (FeCal) appears to have formed within the chalcedony. The upper right hand corner of this image show the groundmass of shale (Mtx) this structural feature bisects. **x50xpl**

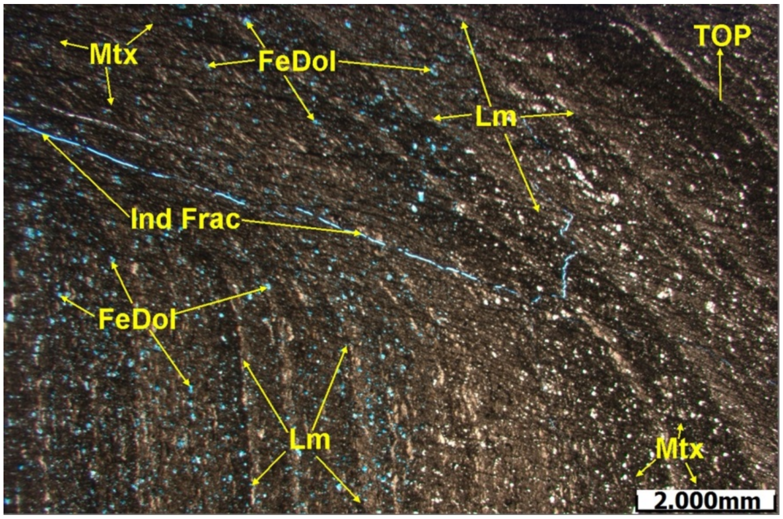

Figure 11.3. Sample T38, 10956.90ft/3339.66m. Very low magnification image focuses where the vertical dipping laminations (Lm – lower half of image) and fold to sub-vertical dipping laminations (Lm – upper half of image). These non-horizontal laminations confirm the complex tectonic history of this shale sample. Also note the even distribution of the ferroan dolomite rhombs (FeDol) in this laminated shale (the ferroan dolomite is not stained turquoise blue on the non-stained right side of the image). A coring induced fracture (Ind Frac) bisects the groundmass of this shale (Mtx). **x12.5ppl**

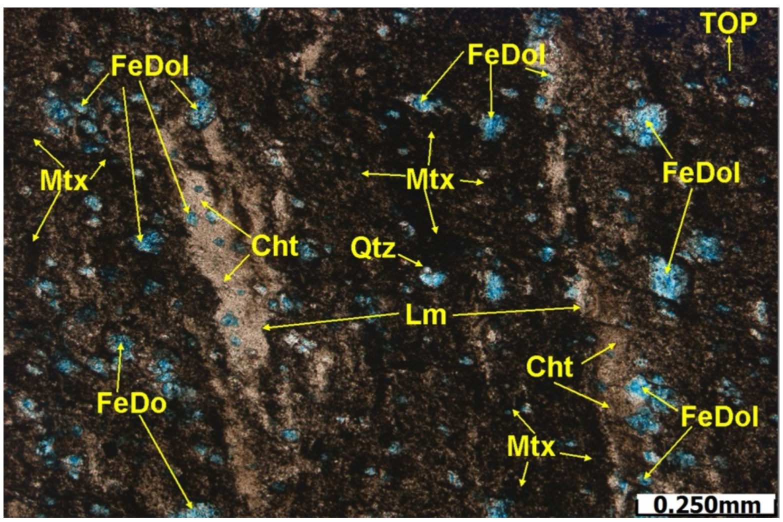

Figure 11.4. Sample T38, 10956.90ft/3339.66m. High magnification image focuses on the lenticular morphology of replacement chert (Cht) which runs parallel vertical dipping bedding plane/laminations (Lm). Ferroan dolomite rhombs (FeDol) have precipitated within both the matrix of the non-altered shale (Mtx) and in previous mentioned chert indicating this dolomite was precipitated late in the diagenetic history of sample. Minor medium silt sized quartz (Qtz) is also found in the shale. **x100ppl**

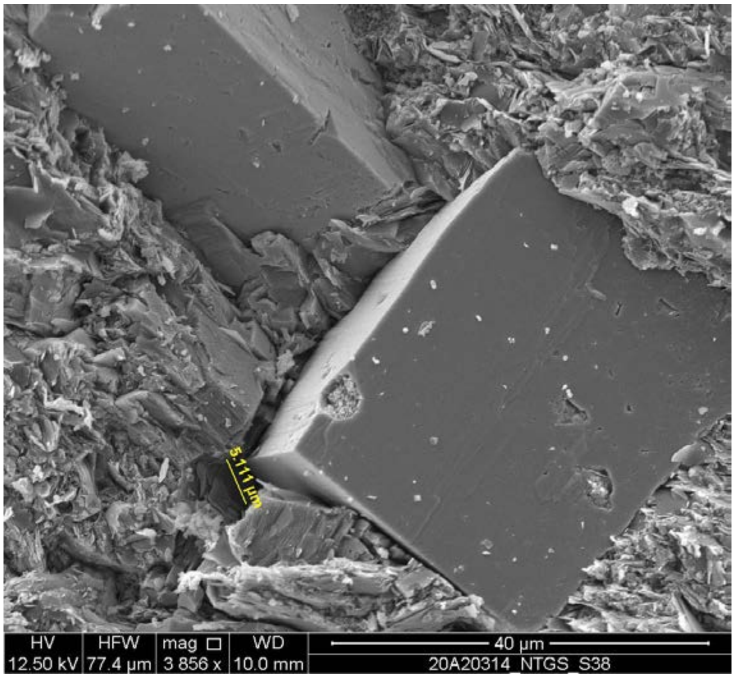

Figure 11.5. Sample S38, 10956.90ft/3339.66m. High magnification scanning electron microscope (SEM) image highlighting euhedral, cubic pyrite grown within dense siliceous and illitic groundmass. A gap between the pyrite cubes and shale groundmass was measured as 5.111µm. **x3856**

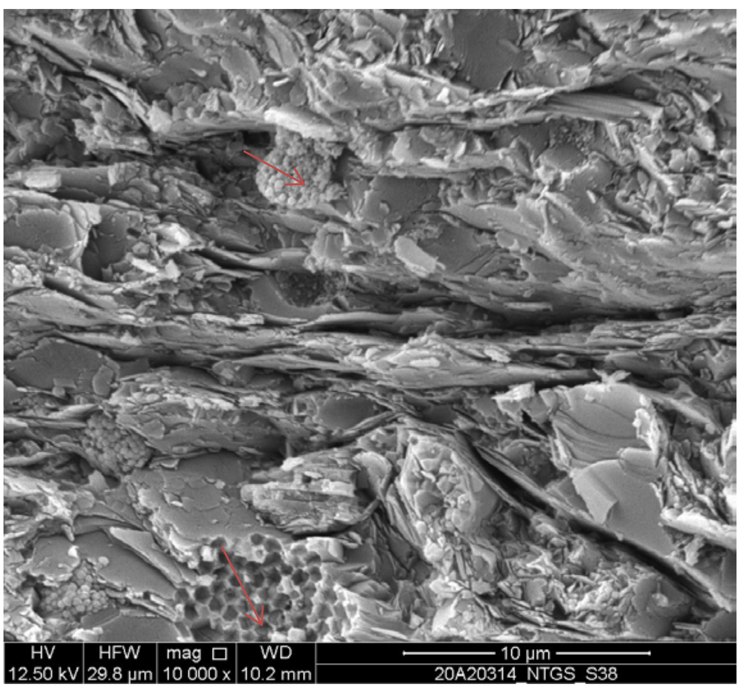

Figure 11.6. Sample S38, 10956.90ft/3339.66m. Very high magnification scanning electron microscope (SEM) image highlighting flakey morphology of the illite/micro-mica that occurs in non-siliceous portion of this shale. Two very small pyrite framboids (red arrow) and plucked impression of one (red arrow) occurs within illite/mica groundmass of this shale. **x10000**

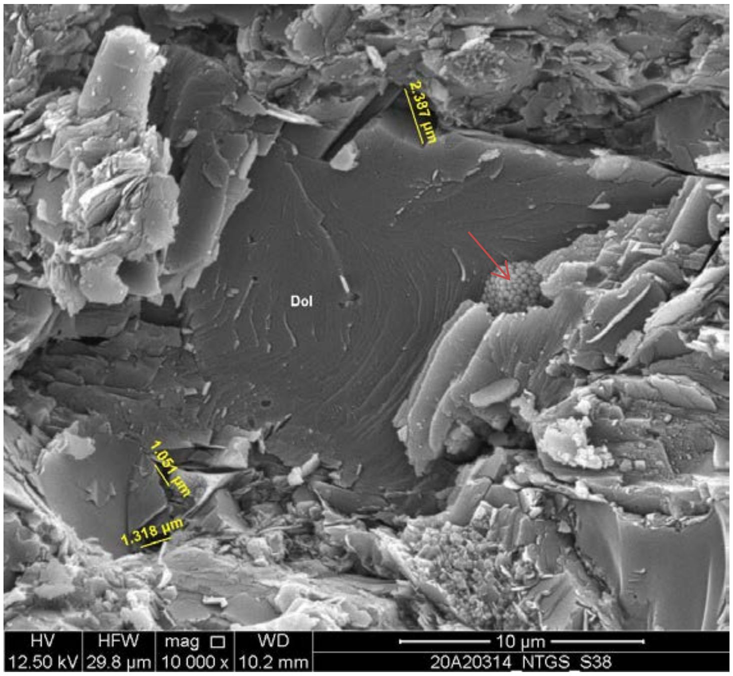

Figure 11.7. Sample S38, 10956.90ft/3339.66m. Very high magnification scanning electron microscope (SEM) image highlighting subhedral dolomite rhomb (Dol) grown with the flaky illite/micro-mica groundmass of this shale. The dolomite rhomb has measured gap with the shale groundmass ranging from 1.051 to 2.387µm. Well-formed very small pyrite framboid (red arrow) also occurs in this image. **x10000**

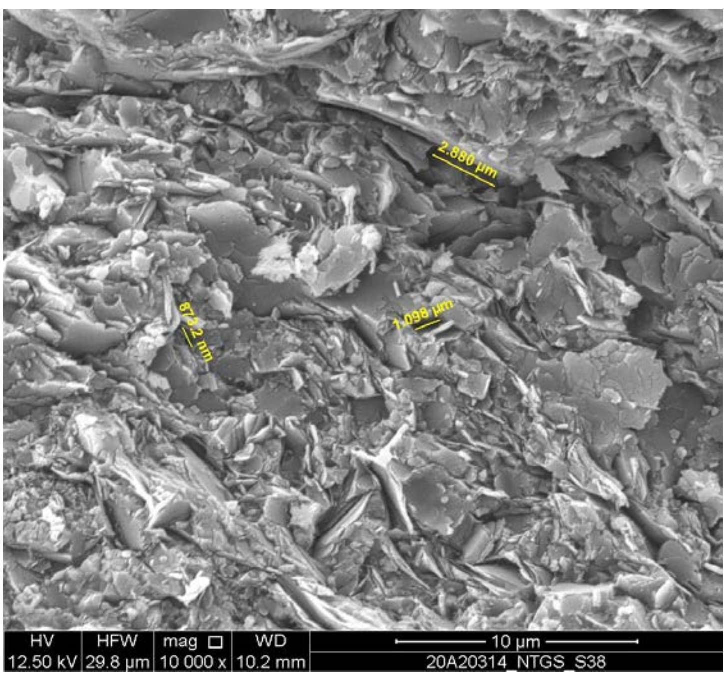

Figure 11.8. Sample S38, 10956.90ft/3339.66m. Very high magnification scanning electron microscope (SEM) image highlighting flaky morphology of the illite/micro-mica that occurs in non-siliceous portion of this shale. The long axis micro-pores within this illite/micro-mica range in size from 2.88µm to 873.2nm. **x10000**

Sample T37 (X50, S37), 10961.60ft/3341.10m

Well Name	Amoco CDA PANAM Pointed Mountain K-45	**Location**	300/K-45-6030-12345/0
Sample Type	Thin section/SEM grain mount from a core sample	**Depth (m)**	10961.60ft/3341.10m
Stratigraphic Unit	Nahanni Formation	**Reservoir Quality**	Non-Reservoir Rock
Classification	Siliceous and Dolomitic Shale	**Stain type**	½ Dual carbonate stain

MINERALOGY

Thin Section Point counting (%)	Qtz	Fld	K-Fld	Cht	Rock Frag.	Mica	HM	Glau	OM
	1					TR			
	Mtx/ P-mtx	**PQ (Cem)**	**Cht (Replace)**	**Chalc (Cem)**	**FeCal**	**Dol**	**FeDol**	**Sid**	**Py**
	46	6	20		3		17		7

ADDITIONAL FEATURES and OTHER COMMENTS

Depositional	The sample appears to be deposited as well laminated mudstone that has a slightly inclined bedding plane (mild tilting lamination to tectonic forces?).
Biogenic structures	Not observed.
Textures	This shale has well defined inclined laminated fabric.
Mineralogy (Framework and accessory grains)	One isolated lens of dolomite cemented quartz sandstone (1%) occurs parallel to the inclined bedding plane. Significant amounts of replacement chert (20%) and ferroan dolomite (17%) occur within the fabric of this laminated shale.
Matrix/ Pseudo-matrix	The matrix (46%) appears dark brown, which suggests high organic content. Based on the optical properties it was concluded that the matrix is of detrital origin but has been significantly replaced by chert (20%). The XRD results indicate matrix clay is dominated by illite with minor amounts of kaolinite. Minute muscovite mica also occurs in the groundmass of this shale.
Authigenic Clays	No authigenic clay minerals were detected so all the clays minerals are detrital origin.
Diagenetic minerals/ Diagenesis	The matrix, in addition to replacement siliceous chert, has been partially replaced by ferroan dolomite (17%) and pyrite (7%). Chert occurs in elongate, discontinuous lenses that align with the depositional structure. Ferroan dolomite occur as fine to coarse crystalline subhedral sub- to euhedral rhombs and the pyrite occurs as scattered irregular distributed blebs or framboids. The vertical to sub-vertical fracture that bisect this shale are healed by first stage polycrystalline quartz (6%) and a later stage ferroan calcite (3%). Pyrite (7%) occurs as irregularly distributed framboids and spheres within groundmass of this shale.
Porosity	No visible porosity.

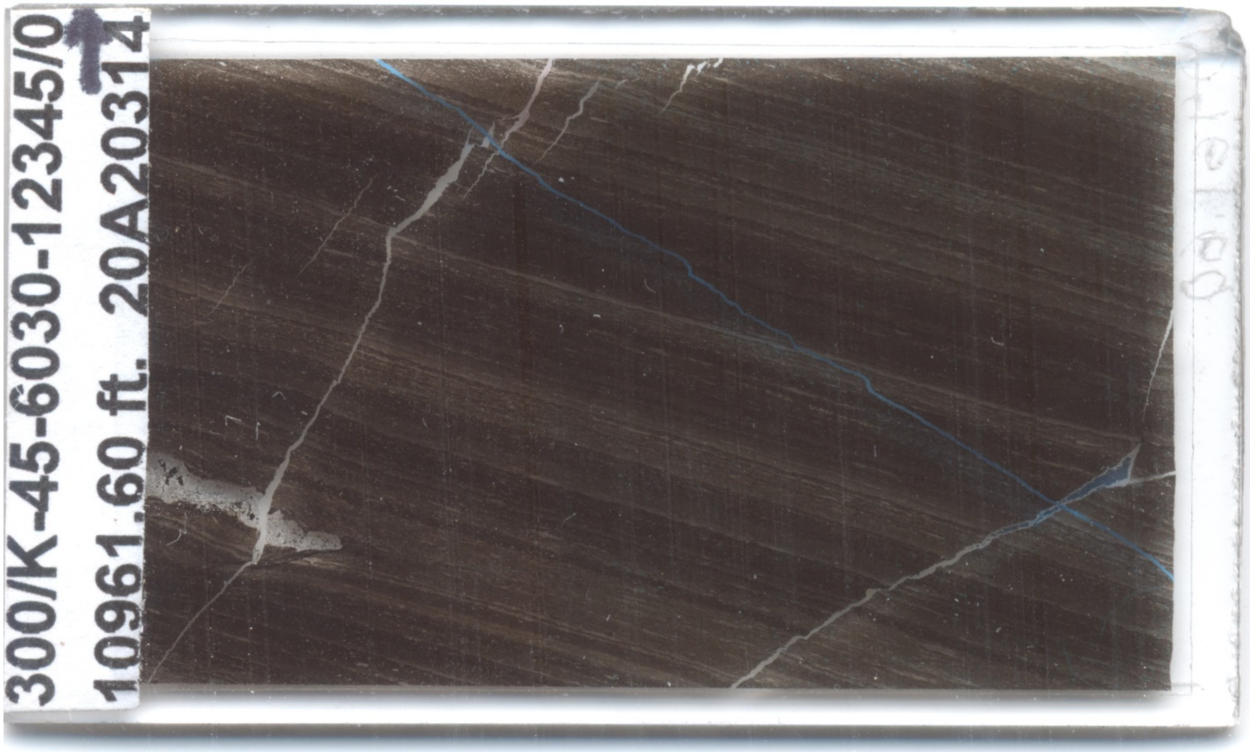

Figure 11A: Thin section scan of sample T37 collected from the Nahanni Formation at the 300/K-45-6030-12345/0 location. The sample is classified as silicified dolomitic shale with inclined laminations (approximately 20%). One dolomite cemented lens of very fine grained quartz sandstone (light colour) occurs in the lower left hand side of the thin section. Several sub-vertical dipping fractures cemented by polycrystalline quartz and ferroan calcite occur at orthogonal angle to inclined bedding plane.

Annotated microphotographs of the thin section and SEM sample with descriptions can be found below.

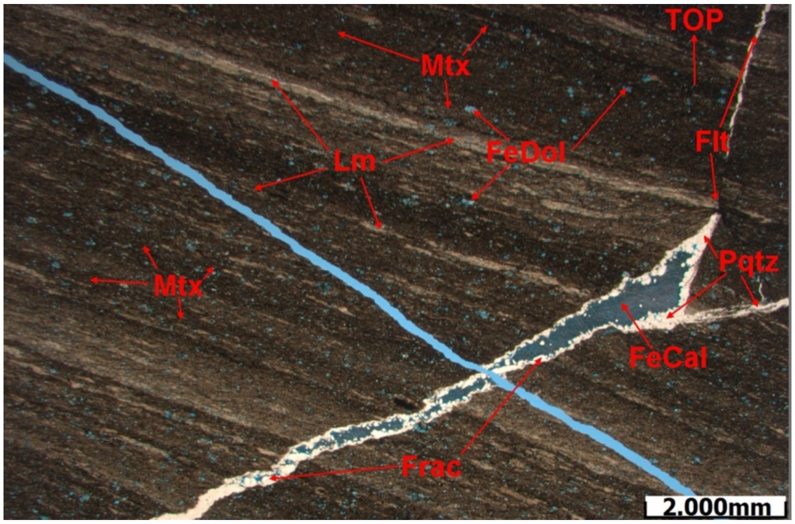

Figure 12.1. Sample T37, 10961.60ft/3341.10m. Very low magnification overview of this inclined laminated (Lm) shale (Mtx) bisected by sub-vertical fracture (Frac) that is occluded by 1st stage polycrystalline quartz (PQ) and 2nd stage ferroan calcite (FeCal). In addition the shifting of the laminations along this fracture suggests lateral displacement indicating is actually fault (Flt). The medium to dark brown detrital argillaceous matrix (Mtx) of this shale has moderate amounts of small ferroan dolomite rhombs (FeDol) formed in its groundmass. **x12.5ppl**

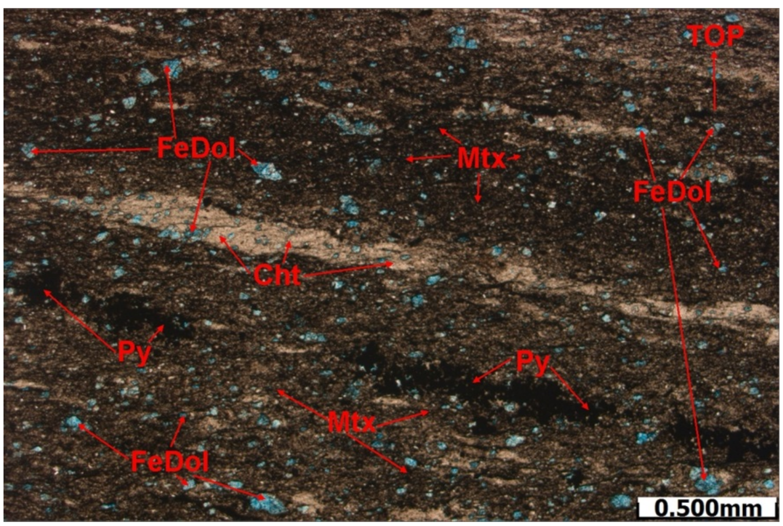

Figure 12.2. Sample T37, 10961.60ft/3341.10m. Moderate magnification image of the sample showing the diagenetic alteration of this shale. Lenticular partings of chert (Cht) occur parallel to the bedding and the elongated pyrite framboids (Py) replace the detrital matrix clays (Mtx). Late stage ferroan dolomite (FeDol) is found precipitated within matrix clays and diagenetic chert. **x50ppl**

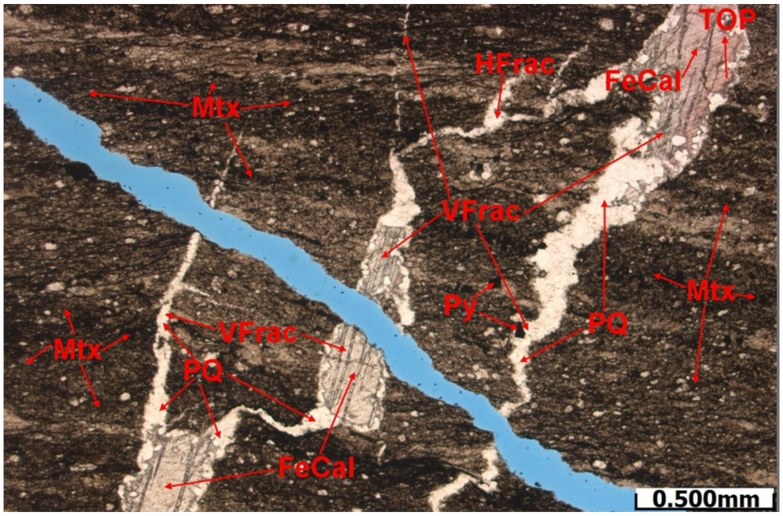

Figure 12.3. Sample T37, 10961.60ft/3341.10m. A second moderate magnification image focuses on vertical fractures (VFrac) bisecting the groundmass of this siliceous shale (Mtx). The 1st stage polycrystalline quartz (PQ) line to completely heal these vertical fractures, while the 2nd stage ferroan calcite (FeCal) cement occludes the remaining fracture porosity. It should be noted that these fractures in the image are in the non-stain portion of the slide thus not stained blue. Minor pyrite cubes (Py) occur within the shale groundmass and as cement in the fracture. **x50ppl**

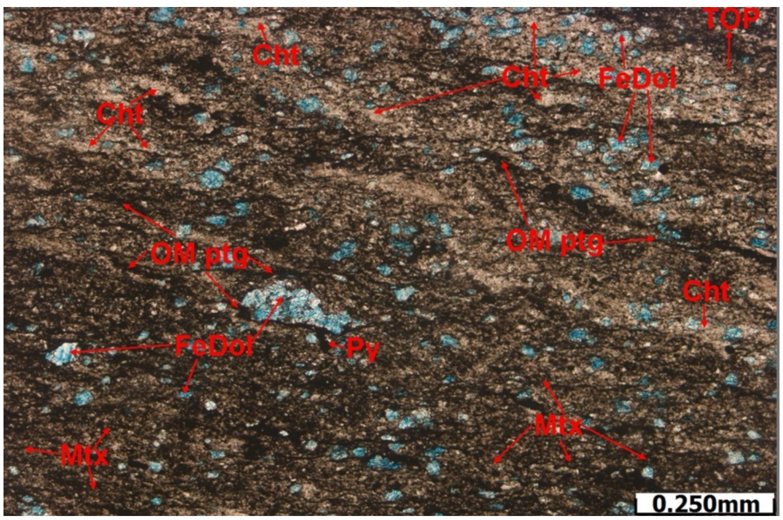

Figure 12.4. Sample T37, 10961.60ft/3341.10m. A high magnification image showing organic matter partings (OM ptg) aligned parallel to the inclined bedding plane of this shale. Siliceous replacement of the shale highlighted by abundance of diagenetic chert (Cht). Minor amount of pyrite (Py) is seen replacing the coaly partings. Very fine to medium crystalline subhedral ferroan dolomite (FeDol) is precipitated within the clay rich and chert replaced zone of this shale. **x100ppl**

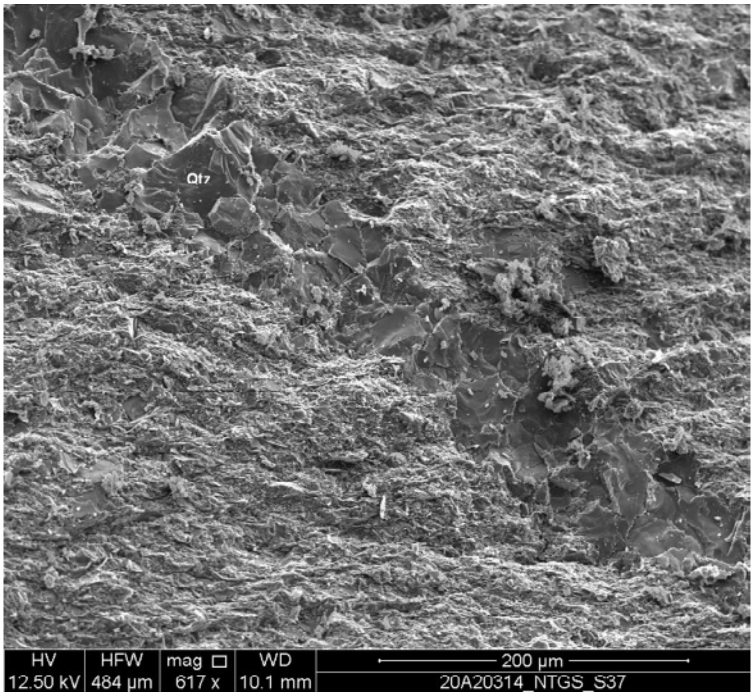

Figure 12.5. Sample S37, 10961.60ft/3341.10m. Moderate magnification scanning electron microscope (SEM) image highlighting showing quartz cemented fracture (Qtz) bisecting the groundmass shale. **x617**

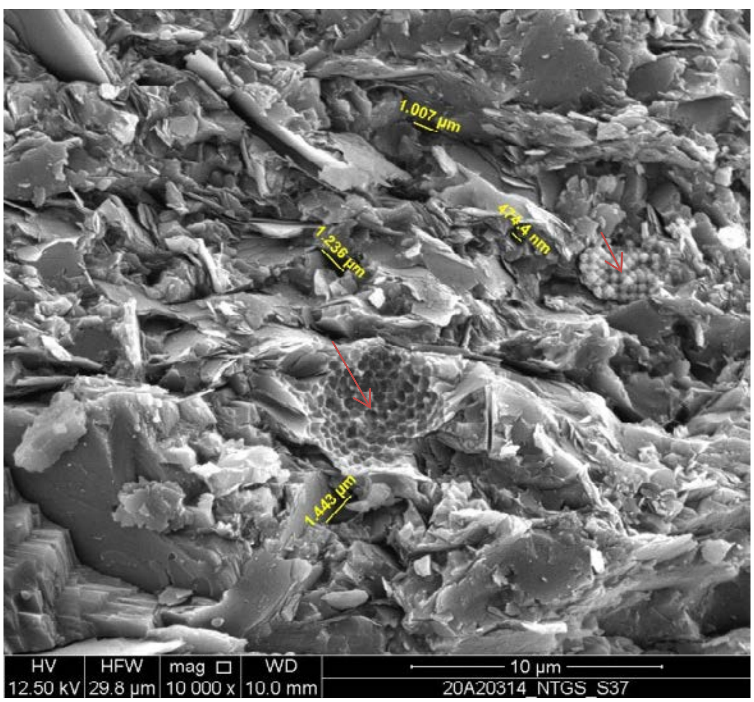

Figure 12.6. Sample S37, 10961.60ft/3341.10m. Very high magnification scanning electron microscope (SEM) image highlighting flaky morphology of the illite/micro-mica. Micro-pores within flaky illitic clays have long axis ranging in size from 1.236µm to 474.4nm. Small pyrite framboids (red arrows) occur in whole or are impressions in the groundmass of this shale. The long axis micro-pores within this illite/micro-mica range in size from 2.88µm to 873.2nm. **x10000**

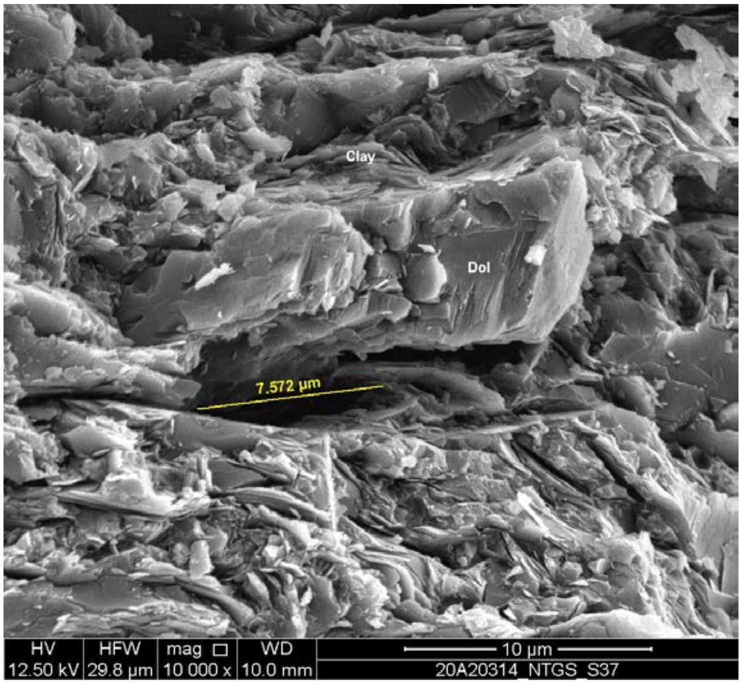

Figure 12.7. Sample S37, 10961.60ft/3341.10m. Very high magnification scanning electron microscope (SEM) image showing subhedral dolomite rhomb (Dol) embedded in flaky illite/micro-mica (Clay) rich shale groundmass. The long axis pore between the dolomite and shale groundmass was measured at 7.572µm. **x10000**

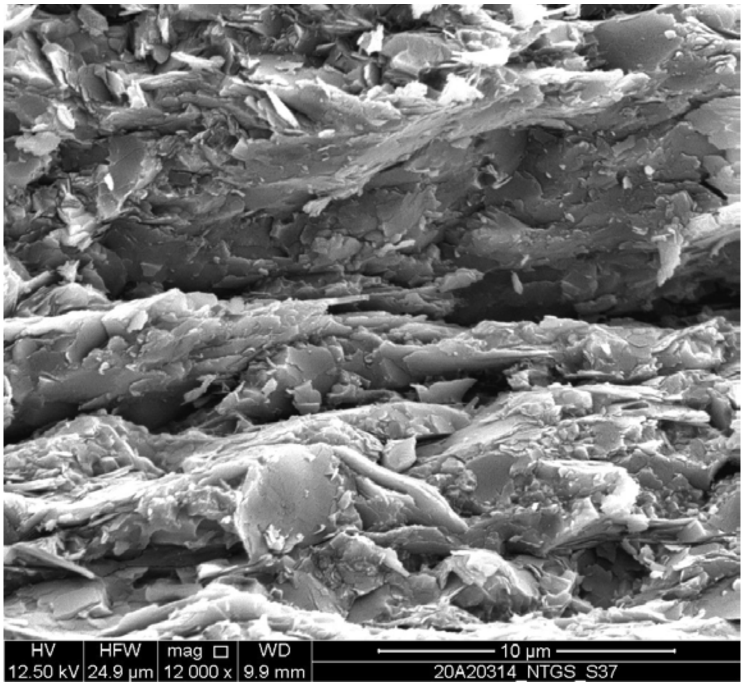

Figure 12.8. Sample S37, 10961.60ft/3341.10m. Very high magnification scanning electron microscope (SEM) image showing micro-porosity between flaky illite/mica being locally occluded by siliceous minerals. **x12000**

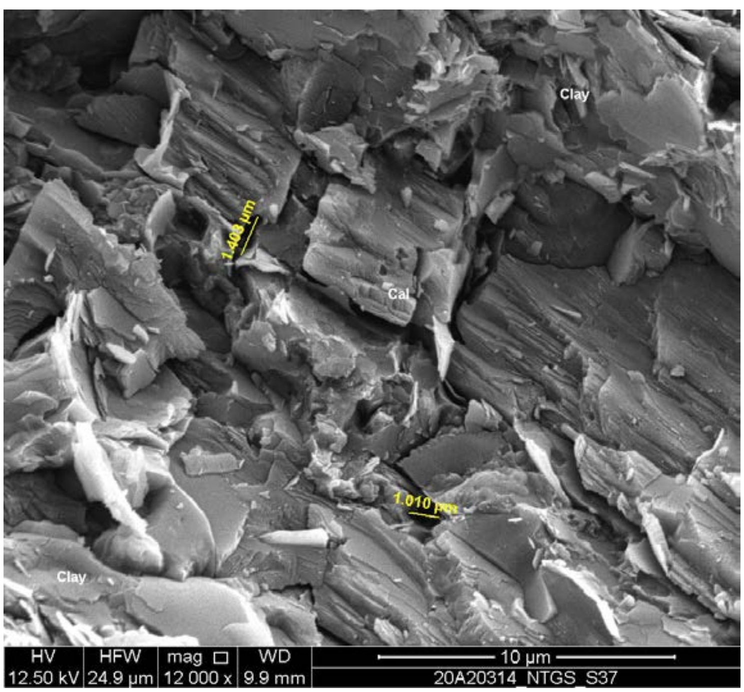

Figure 12.9. Sample S37, 10961.60ft/3341.10m. Very high magnification scanning electron microscope (SEM) image showing the subhedral morphology of the ferroan calcite (Cal) that occludes fractures that bisect this shale. The flaky illite/mica (clay) groundmass of this shale borders this calcite cement fracture. Micro-pores ranging between 1.010µm to 1.403µm occur at this boundary between shale and calcite cement fractures. **x12000**

SUMMARY OF PORE SYSTEM, MAIN POROSITY CONTROLS AND RESERVOIR QUALITY

The reservoir quality of sediments is modified by diagenetic processes. Some diagenetic processes are directly related to the physical nature of the sediment, and the resulting geometries can be directly related to sedimentation patterns. Other diagenetic processes involve the interaction of sediment with flowing interstitial water. Diagenetic features observed at this location include: onset of compaction, micritization of framework grains, dolomitization, and dissolution of dolomite, cementation of pores (coarse to very coarse crystalline dolomite), partial replacement of dolomite cements with late pyrite), pressure solution (stylolites), authigenic silica replacements/cement and possible pyrobitumen. Dolomitization is a diagenetic process that leads to dissolution of calcium carbonate and precipitation of dolomite. Dolomitization can change the rock fabric and petrophysical properties of the precursor limestone, because dolomite crystals are commonly larger than the replaced limestone particles. Dolomite cement occurs as subhedral to euhedral usually medium to very coarse crystalline rhombohedral cement that occludes biomolds, micro-vugs, intercrystalline and fracture pores. The pervasive replacement dolomitization is the main diagenetic feature observed in dolostone samples. Diagenetic features developed prior to dolomitization have mostly been obliterated during the pervasive dolomitization. Some un-dolomitized calcite allochems were partly dissolved and dissolution pores and/or micro-vugs were filled with dolomite cement, megaquartz (Figure 1.8), chert (see Figures 7.3 and 7.4) and filaments calcium sulfate (Figure 5.11). Dolomite cement systematically grows on dolomite crystal faces, reducing reservoir quality. Chemical compaction (pressure solution) in the form of stylolites also occurred post primary dolomitization. Chemical compaction is evidenced through pressure solution features like micro-stylolites. Insoluble bituminous organic matter and possible clays are found along these micro-stylolites. The often vertical dipping nature of the stylolites suggests possible tilting of rock during tectonic movement and stresses. Most of dolostone samples have healed to partial open fracture (mostly vertical and subvertical) with mineralization cement dominated by dolomite, with trace of ferroan calcite, pyrite and quartz. The lower dolostone samples T42, T40 and T39 have hair-like horizontal open fractures that may be product of tectonic shear stresses. The two siliceous dolomitic shale samples with laminated fabric have vertical dip and folded morphology in sample T38 and inclined dip (approximately 20º) suggesting mild to intensive uplift and folding due to tectonic stresses. The fractures in this shale are cemented with polycrystalline quartz or chalcedony, ferroan calcite and in case T39 significant pyrite. All the diagenetic features are not necessarily present in every sample.

Nahanni Formation

Total twelve samples were recovered from the Nahanni Formation at the Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0 location. Samples T48 to T39 are dolostones, while samples T38 and T37 are siliceous-dolomitic shales.

Dolostone

All ten dolostone samples comprise primarily dolomite, plus small amounts of organic matter and clays (within intercrystalline groundmass and stylolites), insignificant pyrite, quartz (chert and quartz cement), calcite and formation damage in regards to trace drillings mud fines in most samples. The visible porosity in these ten samples includes trace to minor (1% to 2%) intercrystalline pores. Note partially open fracture pores (trace to 1%) occur in all samples but T48 and T42, plus remnant biomoldic pores where observed in T48 and T47. The porosity reducing factors include dolomitization, compaction, plus minor chert or quartz, pyrite and calcite.

Reservoir quality is controlled mainly by diagenetic events (i.e. dolomitization, dissolution, compaction, cementation [mostly euhedral dolomite] and pyrobitumen) and to a lesser extent the depositional environment (i.e. the original carbonate texture influences dolomite crystal size which correlates to the size and efficiency of the intercrystalline and micro-vuggy pores). Reservoir quality for these dolostone samples is assessed as poor to moderate (samples T47 and T43) and poor for the other 8 samples.

The following table summarizes the most important factors that control the reservoir quality of the ten thin section dolostone samples recovered from AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0 location.

Sample ID	Depth (ft/m)	Total Ground-mass (%)	Total Cmt (%)	Total Porosity (%)						Main Porosity controlling factors (*)	RQ(*)
				IP	Int.	Ixl	Bio	Fr	M		
Location: AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0											
T48	10131.00/3087.93	89	9	-	-	TR	-	-	-	Com,Mic,Dc,C, Cht	P
T47	10141.80/3091.22	68	30	-	-	2	TR	TR	-	Com,Mic,Dc,C,F	P-M
T46	10477.90/3193.66	84	15	-	-	TR	-	TR	-	Com,Mic,Dc,C,F	P
T45	10493.30/3198.36	80	18	-	-	1	-	TR	-	Com,Mic,Dc,C,F	P
T44	10504.60/3201.80	54	45	-	-	1	-	-	-	Com,Mic,Dc,C	P
T43	10725.00/3268.98	65	35	-	-	1	-	1	-	Com,Mic,Dc,C,F	P-M
T42	10738.90/3273.22	91	7	-	-	TR	-	-	-	Com,Mic,Dc,C	P
T41	10742.00/3274.16	90	10	-	-	TR	-	TR	-	Com,Mic,Dc,C,F, Cht	P
T40	10746.10/3275.41	94	5	-	-	1	-	1	-	Com,Mic,Dc,C,F	P
T39	10746.20/3275.44	92	7	-	-	TR	-	1	-	Com,Mic,Dc,C,F, Cht	P

Porosity value (%): **IP** – interparticle porosity; **Int** – intraparticle; **Ixl** – intercrystalline; **Bio** – Biomoldic ; **Fr** – fracture porosity; **M** – micro-intercrystalline porosity
Main Porosity controlling factors: **Com –** compaction**;** M**ic** – micrite (calcite or dolomite); **Ms** – micro- and/or pseudospar; **Cc** – calcite cement (druse and spar); **Dc** – dolomite cement**; C** – clays and organics; **Cht** – chert or quartz overgrowths; P**y** – pyrite (replacement and/or cement); **F** – fabric: [**CC** – concavo-convex orthochem contacts; **S** – stylolite; **Frac** - Fractures]
RQ (*) - reservoir quality: **NR –** non reservoir rock; **P –** poor; **M –** moderate; **G –** good
Total cement (*): includes micro- and pseudospar

The following table summarizes the most important factors that control the reservoir quality of the two siliceous and dolomitic shale thin section samples recovered from AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0 location. Note these two shale samples are not reservoir rock.

Sample ID	Depth (ft/m)	Total Ground-mass (%)	Total Cmt/ Repl. (%)	Total Porosity (%)						Main Porosity controlling factors (*)	RQ(*)
				IP	Int.	Ixl	Bio	Fr	M		
Location: AMOCO CDA PANAM POINTED MOUNTAIN K-45 300/K-45-6030-12345/0											
T38	10956.90/3339.66	43	57	-	-	-	-	-	-	C,Cht,F,Dc,Cc,	NR
T37	10961.60/3341.10	47	53	-	-	-	-	-	-	C,Cht,F,Dc,Cc,	NR

Porosity value (%): **IP** – interparticle porosity; **Int** – intraparticle; **Ixl** – intercrystalline; **Bio** – Biomoldic ; **Fr** – fracture porosity; **M** – micro-intercrystalline porosity
Main Porosity controlling factors: **Com –** compaction**;** M**ic** – micrite (calcite or dolomite); **Ms** – micro- and/or pseudospar; **Cc** – calcite cement (druse and spar); **Dc** – dolomite cement**; C** – clays and organics; **Cht** – chert or quartz overgrowths; P**y** – pyrite (replacement and/or cement); **F** – fabric: [**CC** – concavo-convex orthochem contacts; **Styl –** stylolites; **Frac** - Fractures]; Cht: Siliceous replacement of shale
RQ (*) - reservoir quality: **NR –** non reservoir rock; **P –** poor; **M –** moderate; **G –** good
Total cement (*): includes micro- and pseudospar

Reservoir problems for the ten dolostone samples recovered from the Nahanni Formation at the Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0 location may include the following: **(1)** rare and small sizes of intercrystalline and micro-vuggy pores, plus overall poor could restrict the flow of hydrocarbons. The few natural partially open fractures several of this samples locally improves interconnectivity between pores, **(2)** hydrochloric acid (HCl) treatment of this reservoir has the potential to loosen carbonate fines (calcite micrite) that could migrate and block pore throats, plus cause fabric collapse, **(3)** the sensitivity of calcium carbonate to hydrofluoric acid (HF) in regard to precipitation of calcium fluoride scales.

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DATA TABLES

TABLE 1
Petrographic Summary of ten Dolomite Samples from the Nahanni Fm. at the Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0

Sample ID Depth (ft) Rock Type		T48 10131.0 Dol	T47 10141.8 Dol	T46 10477.9 Dol	T45 10493.3 Dol	T44 10504.6 Dol	T43 10725.0 Dol
Mineralogy	*Calcite*	-	-	-	TR	-	-
	Dolomite	99	98	99	98	99	100
	Anhydrite	-	-	-	-	-	-
	Quartz	-	-	-	.	TR	-
	Chert	-	-	-	-	-	-
	Gypsum	-	-	-	-	-	-
	Pyrite and Heavy Minerals	TR	TR	TR	TR	-	-
	Drilling Mud	-	TR	TR	-	-	-
	Clays & Organic	1	2	1	2	1	TR
Total Rock Volume (%)		**100**	**100**	**100**	**100**	**100**	**100**
Carbonate Clasts	*Peloids*	-	-	-	-	-	-
	Intraclasts	-	-	-	-	54	-
	Total:	**0**	**0**	**0**	**0**	**54**	**0**
Bioclasts/Fauna	*Pelecypods*	-	-	-	-	-	-
	Foraminifers	-	-	-	-	-	-
	Corals	-	-	-	-	-	-
	Ostracods	-	-	-	-	-	-
	Echinoderms	-	-	-	-	-	-
	Unidentified	30	15	40	-	-	20
	Total:	**30**	**15**	**40**	**0**	**0**	**20**
Detrital Grains	*Quartz*	-	-	-	-	-	-
	Feldspar	-	-	-	-	-	-
	Chert	-	-	-	-	-	-
	Total:	**0**	**0**	**0**	**0**	**0**	**0**
Matrix	*Micrite*	-	-	-	-	-	-
	Dolomite	-	-	-	-	-	-
	Clay and Organics	1	2	1	2	1	TR
	Drilling Mud	-	TR	TR	-	-	TR
	Total:	**1**	**2**	**1**	**2**	**1**	**TR**
Pore Filling Cement	*Calcite*	-	-	-	TR	-	-
	Ferroan Calcite	-	-	-	-	-	-
	Dolomite	9	30	15	18	45	35
	Ferroan Dolomite	-	TR	-	-	-	-
	Quartz/Chert	TR	-	-	-	-	-
	Pyrite	-	-	-	-	-	-
	Total:	**9**	**30**	**15**	**18**	**45**	**35**
Replacement	*Calcite*	-	-	-	-	-	-
	Dolomite	60	53	44	80	-	45
	Anhydrite	-	-	-	-	-	-
	Chert	-	-	-	-	-	-
	Pyrite	TR	TR	TR	TR	-	-
	Total:	**60**	**53**	**44**	**80**	**0**	**45**
Total Rock Volume (%)		**100**	**100**	**100**	**100**	**100**	**100**
Crystal Texture (Matrix)		-	-	-	-	-	-
Crystal Texture (Cement)		-	-	-	-	-	-
Crystal Texture (Cement)		-	-	-	-	-	-
Structure/Fabric		Frac	Styl, Frac	Styl, Frac	Styl, Frac, Boud	Styl	Styl, Frac
Ratio Matrix/Clasts		-	-	-	-	-	-
Original Texture		WS - PS	WS	WS - PS	MS	FS - RS	WS - PS
Porosity	*Interparticle*	-	-	-	-	-	-
	Intraparticle	-	-	-	-	-	-
	Intercrystalline	TR	2	TR	1	1	1
	Biomoldic	TR	TR	-	-	-	-
	Vuggy	-	-	-	-	-	-
	Fractures	-	TR	TR	TR	TR	1
	Microporosity	-	-	-	-	-	-
	Total TS Porosity (%)	**0**	**2**	**0**	**1**	**1**	**2**
Petrophysical Results	*Core Porosity (%)*	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
	Gas Permeability (mD)	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**	**N/A**
Reservoir Quality		**P**	**P -M**	**P**	**P**	**P**	**P -M**

TABLE 1 (continued)
Petrographic Summary of ten Dolomite Samples from the
Nahanni Fm. at the Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0

Sample ID Depth (ft) Rock Type		T42 10738.9 Dol	T41 10742.0 Dol	T40 10746.1 Dol	T39 10746.2 Dol		
Mineralogy	*Calcite*	-	-	-	-		
	Dolomite	98	100	99	99		
	Anhydrite	-	-	-	-		
	Quartz	-	-	-	.		
	Chert	1	-	-	TR		
	Gypsum	-	-	-	-		
	Pyrite and Heavy Minerals	TR	TR	TR	TR		
	Drilling Mud	TR	TR	TR	-		
	Clays & Organic	1	TR	1	1		
Total Rock Volume (%)		**100**	**100**	**100**	**100**		
Carbonate Clasts	*Peloids*	-	-	-	-		
	Intraclasts	-	3	-	-		
	Total:	**0**	**3**	**0**	**0**		
Bioclasts/Fauna	*Pelecypods*	-	-	-	-		
	Foraminifers	-	-	-	-		
	Corals	-	-	-	-		
	Ostracods	-	-	-	-		
	Echinoderms	-	-	-	-		
	Unidentified	42	15	45	12		
	Total:	**42**	**15**	**45**	**12**		
Detrital Grains	*Quartz*	-	-	-	-		
	Feldspar	-	-	-	-		
	Chert	-	-	-	-		
	Total:	**0**	**0**	**0**	**0**		
Matrix	*Micrite*	-	-	-	-		
	Dolomite	-	-	-	-		
	Clay and Organics	1	TR	1	1		
	Drilling Mud	TR	TR	TR	-		
	Total:	**1**	**TR**	**1**	**1**		
Pore Filling Cement	*Calcite*	-	-	-	-		
	Ferroan Calcite	-	-	-	-		
	Dolomite	7	10	5	7		
	Ferroan Dolomite	-	-	TR	-		
	Quartz/Chert	-	-	-	-		
	Pyrite	-	-	-	-		
	Total:	**7**	**10**	**5**	**7**		
Replacement	*Calcite*	-	-	-	-		
	Dolomite	49	72	49	80		
	Anhydrite	-	-	-	-		
	Chert	1	-	-	TR		
	Pyrite	TR	TR	TR	TR		
	Total:	**50**	**72**	**49**	**80**		
Total Rock Volume (%)		**100**	**100**	**100**	**100**		
Crystal Texture (Matrix)		-	-	-	-		
Crystal Texture (Cement)		-	-	-	-		
Structure/Fabric		Styl, Frac	Styi, Frac, Flt	Styl, Frac	Styl, Frac		
Ratio Matrix/Clasts		-	-	-	-		
Original Texture		WS - PS	WS	WS - PS	WS		
Porosity	*Interparticle*	-	-	-	-		
	Intraparticle	-	-	-	-		
	Intercrystalline	TR	TR	1	TR		
	Biomoldic	-	-	-	-		
	Vuggy	-	-	-	-		
	Fractures	-	TR	1	1		
	Microporosity	-	-	-	-		
	Total TS Porosity (%)	**TR**	**TR**	**2**	**1**		
Petrophysical Results	*Core Porosity (%)*	**N/A**	**N/A**	**N/A**	**N/A**		
	Gas Permeability (mD)	**N/A**	**N/A**	**N/A**	**N/A**		
Reservoir Quality		**P**	**P**	**P**	**P**		

LIST OF ABBREVIATIONS (CARBONATES)

SKELETAL GRAINS

Bry - BRYOZOAN
Ech - ECHINODERMS
Bra - BRACHIOPODS
Os - OSTRACODS
Cal - CALCISPHERES
Moll - MOLLUSKS
Plcy - PELECYPODS
Biv - BIVALVES
For - FORAMINIFERA
Strom - STROMATOPOROIDS
Cor - CORALS
Ga - GASTROPODS
Biocl - BIOCLASTS

OTHER GRAINS

Pel - PELOIDS
Ooi - OOIDS

ORIGINAL TEXTURE

GS - GRAINSTONE
PS - PACKSTONE
WS - WACKESTONE
MS - MUDSTONE
FS - FLOATSTONE
RS - RUDSTONE

CRYSTAL TEXTURE

Euh - EUHEDRAL
Sub - SUBHEDRAL
Anh - ANHEDRAL

CRYSTAL SIZE

Cxl - COARSE CRYSTALLINE
Mxl - MEDIUM CRYSTALLINE
Fxl - FINE CRYSTALLINE
Vfxl - VERY FINE CRYSTALLINE

CEMENT TYPES

Syn - SYNTAXIAL OVERGROWTHS
Blo - BLOCKY
Poik - POIKILOTOPIC
Dru - DRUSY
SD - SADDLE DOLOMITE
Lath - ANHYDRITE LATHS
Grm - GROUNDMASS
Iso - ISOPACHOUS RIMS
Spa - SPARITE

POROSITY TYPES

Mixl - MICRO-INTERCRYSTALLINE
Ixl - INTERCRYSTALLINE
Mo - BIOMOLDIC
mV - MICROVUGGY
mF - MICROFRACTURE
IG - INTERGRANULAR
IP - INTERPARTICLE
INTRP - INTRAPARTICLE

QUALITY

G - GOOD
M - MODERATE
P - POOR

TABLE 2
Petrographic Summary of two Silicecous and Carbonate-rich Shale Samples from the Nahanni Fm. at the Amoco CDA PANAM Pointed Mountain K-45 300/K-45-6030-12345/0

Sample ID Depth (ft) Rock Type				**T38 10956.90 Sil & Dol Sh**	**T37 10961.60 Sil & Dol Sh**		
Quartz	*Monocrystalline*			1	1		
	Polycrystalline			-	-		
	Total			**1**	**1**		
Feldspar	*Potassium Feldspar*			-	-		
	Plagioclase			-	-		
	Total (or Fld not classified)			**0**	**0**		
Rock Fragments	*Chert*			-	-		
	Sedimentary Rock Fragments			-	-		
	Volcanic Rock Fragments			-	-		
	Metamorphic Rock Fragments			-	-		
	Plutonic Rock Fragments			-	-		
	Detrital Calcite			-	-		
	Detrital Dolomite			-	-		
	Total			**0**	**0**		
Accessories	*Mica*			TR	TR		
	Heavy Minerals			-	-		
	Glauconite			-	-		
	Organic Matter			-	-		
	Pelecypods			-	-		
	Foraminifera			-	-		
	Total			**0**	**0**		
Matrix	*Micrite (Calcite/Dolomite)*			-	-		
	Clays & Organic			42	46		
	Total			**42**	**46**		
Authigenic Clays	*Kaolinite*			-	-		
	Illite			-	-		
	Chlorite			-	-		
	Smectite			-	-		
	Unidentified			-	-		
	Total			**0**	**0**		
Cements/ Replacement	*Chert*			15	20		
	Chalcodony			6	-		
	Polycrystalline			-	6		
	Ferroan Calcite			2	3		
	Dolomite			-	-		
	Ferroan Dolomite			20	17		
	Anhydrite			-	-		
	Siderite			-	-		
	Pyrite			14	7		
	Residual Hydrocarbon			-	-		
	Total			**57**	**53**		
Total Rock Volume (%)				**100**	**100**		
Structures				Folded Lm, Frac	Incl. Lm, Frac		
Textures	*Grain Size Average of Dol xl*			50µm	30µm		
	Grain Size Range of Dol xl			10-140µm	10-120µm		
	Sorting			N/A	N/A		
	Roundness			N/A	N/A		
Diagenesis	*Compaction*			XX	XX		
	Grain Fabric			M	M		
	Cementation			Cem	Cem		
	Dissolution			N/A	N/A		
Visible Porosity	*Intergranular*			-	-		
	Dissolution (unclassified)			-	-		
	Grain Dissolution			-	-		
	Cement Dissolution			-	-		
	Total Visible Porosity (%)			**0**	**0**		
Petrophysical Results	*Core Porosity (%)*			**N/A**	**N/A**		
	Gas Permeability (mD)			**N/A**	**N/A**		
Reservoir Quality				**Non-Reservoir**	**Non-Reservoir**		

Structures: **Mss**-massive, **Lm**-laminae; **Xlm**-cross laminae; **Xb**-cross bedded; **Bd**-bedded; **Frac**- fracture
Compaction: **X**-slightly; **XX**-moderately; **XXX**-highly
Grain Fabric: **G**-grain supported; **M**-matrix supported; **C**-cement supported; **P**-point contacts; **F**-flat contacts; **CC-**concavo-convex contacts; **S-**sutured contacts
Cementation: **Cem**-completely cemented; **NCem**-non-cemented; **PCem**-partly cemented
Dissolution: **Cor**-corroded surfaces; **GD**-grain dissolution; **GR**-grain replacement; **CCD**-complete cement dissolution; **SCD**-selective cement dissolution

LIST OF ABBREVIATIONS (SANDSTONES)

ROCK TYPE

QA – QUARTZARENITE

SA – SUBARKOSE

SL – SUBLITHARENITE

AR – ARKOSE

LA – LITHIC ARKOSE

FL – FELDSPATHIC LITHARENITE

LR – LITHARENITE

SORTING

VW – VERY WELL SORTED

W – WELL SORTED

M – MODERATELY SORTED

P – POORLY SORTED

GRAIN SIZE

P – PEBBLE

GR – GRANULE

vcU – UPPER VERY COARSE

vcL – LOWER VERY COARSE

cU – UPPER COARSE

cL – LOWER COARSE

mU – UPPER MEDIUM

mL – LOWER MEDIUM

fU- UPPER FINE

fL – LOWER FINE

vfU – UPPER VERY FINE

vfL – LOWER VERY FINE

slt – SILT

RESERVOIR QUALITY

VG – VERY GOOD

G – GOOD

M – MODERATE

F - FAIR

P – POOR

ROUNDNESS

WR – WELL ROUNDED

R – ROUNDED

SR – SUBROUNDED

SA – SUBANGULAR

A - ANGULAR

AGAT® Laboratories

Well Name: Amoco CDA PANAM Pointed Mountain K-45
Well ID: 300/K-45-6030-12345/0
NT WID # N361

Table 3: Results of quantitative mineral analysis (relative weight %) of X-ray diffraction data for 14 (fourteen) samples using Rietveld method

Geology ID	Depth (ft)	Depth (m)	Core & Box #	NTGS Sample Type & #	**Calcite**	**Dolomite**	**Ankerite**	**Siderite**	**Quartz**	**Plagioclase feldspar**	**Potassium feldspar**	**Muscovite/ Illite**	**Total**
1	10104.60	3079.88	1 & 4 of 12 R	X65	0.9	97.8			1.0	0.3			100.0
2	10131.00	3087.93	1 & 9 of 12 L	T48, X64, S48	0.1	97.4			1.4	1.1			100.0
3	10141.80	3091.22	2 & 1 of 7 L	T47, X63, S47	0.1	99.4			0.2	0.3			100.0
4	10477.90	3193.66	3 & 1 of 9 L	T46, X62, S46	0.1	99.3			0.3	0.3			100.0
5	10493.30	3198.36	3 & 5 of 9 R	T45, X61, S45	2.2	97.1			0.3	0.4			100.0
6	10497.80	3199.73	3 & 6 of 9 R	X60	0.2	98.1			1.3	0.4			100.0
7	10504.60	3201.80	3 & 8 of 9 R	T44, X59, S44	0.1	98.9			0.7	0.3			100.0
8	10725.00	3268.98	4 & 2 of 8 R	T43, X58, S43	0.1	99.4			0.2	0.3			100.0
9	10737.70	3272.85	4 & 5 of 8 R	X57	0.2	57.2			42.5	0.1			100.0
10	10738.90	3273.22	4 & 5 of 8 L	T42, X56, S42		94.1			5.5	0.4			100.0
11	10742.00	3274.16	4 & 6 of 8 L	T41, X55, S41		99.2			0.4	0.4			100.0
12	10746.10	3275.41	4 & 7 of 8 L	T40, X54, S40		99.6			0.1	0.3			100.0
13	10746.20	3275.44	4 & 8 of 8 R	T39, X53, S39		99.3			0.2	0.5			100.0
14	10749.60	3276.48	4 & 8 of 8 L	X52		99.3			0.2	0.5			100.0

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Table 4 - Summary of XRD Analysis

Company: Northwest Territories Geological Survey — **Work Order No. 20A20314**

Location: Amoco CDA PANAM Pointed Mountain K-45; 300/K-45-6030-12345/0; N361 — **March, 2020**

SAMPLE ID.	TYPE OF ANALYSIS	WEIGHT %	Qtz	Plag	K-Feld	Cal	Dol	Anhy	Pyr	Musc	Bar	Sider	Kaol (CLAYS)	Chl (CLAYS)	Ill (CLAYS)	ML (CLAYS)	Smec (CLAYS)	Total Clay
15	BULK FRACTION:	83.17	64	2	0	0	14	0	11	0	0	0	2	0	7	0	0	9
10956.90 ft	CLAY FRACTION:	16.83	18	0	0	0	5	0	3	0	0	0	8	4	62	0	0	74
T38, X51, S38	BULK & CLAY	100	56	2	0	0	12	0	10	0	0	0	3	1	16	0	0	20
16	BULK FRACTION:	85.99	66	2	0	0	10	0	12	1	0	0	1	0	8	0	0	9
10961.60 ft	CLAY FRACTION:	14.01	35	0	0	0	7	0	2	0	0	0	10	0	46	0	0	56
T37, X50, S37	BULK & CLAY	100	61	2	0	0	10	0	10	1	0	0	3	0	13	0	0	16

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XRD LEGEND

- XRD Analysis is semi-quantitative (approx. 10% at best) and identifies only crystalline substances; amorphous (non-crystalline) substances will not be detected.
- Bulk Fraction – greater than 3 micron size fraction.
- Clay Fraction – less than 3 micron size fraction.
- Bulk and Clay – mathematical recalculation including the bulk and clay fraction representing the whole sample.
- Total Clay – sum of the clay minerals (may include authigenic and matrix clays plus clays in rock fragments).

ABBREVIATIONS

Amp - Amphiboles	Dol - Dolomite	Marc - Marcasite	Pr - Pure (95 – 100%)
Ana - Analcime	Gyp - Gypsum	ML* - Illite-Smectite	NPr - Near Pure (90 – 95%)
Anhy- Anhydrite	Hal - Halite	ML** - Corrensite (chlorite-smectite)	Abnt - Abundant (60 – 90%)
Ank - Ankerite	Hem - Hematite	Plag - Plagioclase Feldspar	Com - Common (30 – 60%)
Apa - Apatite	Ill - Illite	Pyr - Pyrite	Mnr - Minor (10 – 30%)
Bar - Barite	Kaol - Kaolinite	Qtz - Quartz	Rre - Rare (1 – 10%)
Cal - Calcite	K-feld- Potassic Feldspar	Sid - Siderite	Tr - Trace; detectable, but not measurable (0 – 1%)
Chl - Chlorite	Mack - Mackinawite	Smec - Smectite (montmorillonite)	
Phos – Phosphate	Musc - Muscovite		