Technical Report

Title: ***Petrographic Analysis of DGR-5 and DGR-6 Core***

Document ID: **TR-09-05**

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Revision: **0**

Date: **September 20, 2010**

DGR Site Characterization Document
Intera Engineering Project 08-200

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Document Revision History		
Revision	Effective Date	Description of Changes
0	September 20, 2010	Initial release

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1 Introduction

Intera Engineering Ltd. has been contracted by the Nuclear Waste Management Organization (NWMO) on behalf of Ontario Power Generation (OPG) to implement the Geoscientific Site Characterization Plan (GSCP) for the Bruce nuclear site located near Tiverton, Ontario. The purpose of this site characterization work is to assess the suitability of the Bruce site for the construction of a Deep Geologic Repository (DGR) to store low- and intermediate-level radioactive waste. The GSCP is described by Intera Engineering Ltd. (2006, 2008).

As part of the Phase 2B GSCP, Intera retained Dr. Eva Schandl of GeoConsult, Toronto to undertake petrographic analysis, including microscopic examination and electron microprobe analysis (EMPA), of thin sections of cores collected from angled boreholes DGR-5 and DGR-6. Cores were originally submitted to SGS, Lakefield, Ontario for X-ray diffraction (XRD), Scanning Electron Microscope (SEM) and lithogeochemical analysis, and sections of these cores were also sent to Dr. Schandl. This report summarizes the results of Dr. Schandl's work.

Work described in this Technical Report was completed with data generated from Test Plan TP-09-10 – Laboratory Testing of DGR-5 and DGR-6 Core for Geochemistry and Mineralogy (Intera Engineering Ltd., 2009a). The test plan was prepared following the general requirements of the Intera DGR Project Quality Plan (Intera Engineering Ltd., 2009b).

2 Background

Core samples of 76 and 83 mm diameter were collected during inclined coring of boreholes DGR-5 and DGR-6 at the Bruce nuclear site undertaken from September 2009 to February 2010. Upon core retrieval, all core samples were vacuum sealed within nitrogen-flushed polyethylene and aluminium foil/polyethylene bags following the general preservation and handling requirements of TP-09-02 (Intera Engineering Ltd., 2010a). Ten preserved core samples from DGR-5 and eight from DGR-6 were shipped to SGS Lakefield, Ontario under chain of custody procedures (following procedure DGR P4).

Sample identifiers include the borehole name (e.g., DGR5) and the depth of the mid-point of the sample in metres length along borehole axis (mLBGS). A separate calculation, not performed during this study, converts mLBGS into metres below ground surface (mBGS) so that the data from DGR-5 and DGR-6 in this study can be accurately compared alongside the data from the vertical boreholes DGR-1, DGR-2, DGR-3 and DGR-4.

At SGS, a section of each of the 18 core samples was cut and sent to Dr. Eva Schandl, GeoConsult, Toronto, for petrographic analysis using optical microscopy and EMPA. The principal role of SGS was to analyse the whole rock (1) by XRD to determine mineral concentrations; (2) by lithogeochemical analysis to measure 11 oxides and, in some cases, approximately 50 trace elements; and (3) by SEM and X-ray spectrometry to identify soluble minerals (TR-09-06, Intera Engineering Ltd., 2010b).

The objectives of this petrographic study were:

1. to describe the mineralogy and texture of the individual core sections,
2. to identify evaporite minerals (if present),
3. to determine the presence / abundance of veins and interparticle porosity, and
4. to estimate, where possible, the percentage of clay minerals in the samples.

3 Methods

3.1 Sample Preparation

Polished thin sections were prepared for microscopic study. As one of the objectives of the project was to determine the presence of soluble minerals such as halite, gypsum anhydrite, and celestite in the rocks, oil was used for thin section preparation, instead of water. Although mineral oil was used for preparation of the sections, the final polishing was done with ethylene glycol as the machine is sensitive to oil. While the above method prevented the loss of gypsum, anhydrite and celestite from the thin sections, previous work on DGR samples suggested that halite could have dissolved out of the rocks leaving only its imprint (chevron texture) on the glass (DGR1-456.01 vein, Intera Engineering Ltd., 2009c). Thus, the suite of 18 thin sections was carefully examined for such possible loss but no evidence was found indicating dissolution of halite, however one sample yielded a well-preserved vein of halite (DGR5-605.55).

3.2 Analytical Techniques

The polished thin sections were studied under transmitted and reflected lights, and an ETEC electron microprobe was used to analyze individual minerals and some of the fine-grained matrix in selected samples. The analyses are quantitative where possible, but semi-quantitative to qualitative when analyzing intergrowths of two or more minerals. Due to the small grain size, the oxidation of some samples, and the diffused texture of minerals in some thin sections, it was rarely possible to obtain single grain analysis from the clay minerals in the matrix. In addition, analytical totals may be too low for minerals where the thin sections could not be well polished. Petrographic description of individual rocks includes photomicrographs and microprobe data of selected minerals / domains. Summaries of the microprobe analyses are included in Appendix A and Appendix B for DGR-5 and DGR-6, respectively.

4 Results

In carbonate petrology (e.g., Lucia, 1999), the following terminology is used and followed herein. A packstone is grain supported and contains a fine clay and silt matrix. A grainstone is grain supported but is lacking in mud, whereas a wackestone is primarily mud but contains >10% grains. A mudstone is mostly mud with <10% grains.

4.1 Lithology in DGR-5

The mineralogy and texture of individual DGR-5 samples are described in detail in Appendix A and salient features are demonstrated by photomicrographs. Table 1 is a summary of the various lithologies encountered between 583.40 mLBGS (Georgian Bay Formation) and 764.72 mLBGS (Sherman Fall Formation) in the DGR-5 core. The samples are colour-coded according to their fossiliferous, oxidized, or halite-celestite bearing nature. As shown in Table 1, the stratigraphic section sampled in DGR-5 broadly consists of two distinct sedimentary groupings (Table 1):

1. Calcareous siltstone that grades into calcareous mudstone with depth (583.40 - 699.49 mLBGS) within the Upper Ordovician shale formations, i.e., the Georgian Bay and Blue Mountain Formations.

2. Wackestone (704.99 – 764.72 mLBGS) that contains an abundance of fossil fragments in calcareous mud mixed with illite associated within the underlying Middle Ordovician argillaceous limestone formations, i.e., the Collingwood, Cobourg and Sherman Fall Formations.

At 605.55 mLBGS depth (Georgian Bay Formation), the calcareous mudstone is cross-cut by two small, intersecting halite-celestite veins. Oxidation in the rocks increases with depth between 645.16 and 699.49 mLBGS, i.e., lowermost Georgian Bay and the Blue Mountain Formations. At the deepest part (764.72 mLBGS, Sherman Fall Formation), the wackestone is also weakly oxidized.

4.2 Lithology in DGR-6

Table 2 presents the petrographic interpretation of the eight DGR-6 samples. In the broadest terms these can be subdivided into two distinct sedimentary groupings, much like DGR-5:

1. Oxidized calcareous mudstone-siltstone at depths of 654.58 – 735.40 mLBGS within the Upper Ordovician shale formations.

2. Wackestone from 750.80 to 768.58 mLBGS depth. The wackestone contains fossil fragments in a matrix of calcareous mud + illite ± K-rich clays. These represent the Middle Ordovician argillaceous limestone formations.

As shown in Table 2, the rocks are all oxidized to various extents. The degree of oxidation increases wih depth in the calcareous siltstones and mudstones, but becomes less evident in the wackestones.

Table 1 Summary of Rock Types from Individual Core Samples in DGR-5

Sample #	Rock type	Formation
DGR5-583.40	calcareous siltstone	Georgian Bay
DGR5-605.55	calcareous mudstone (with halite + celestite veins)	Georgian Bay
DGR5-645.16	calcareous mudstone / siltstone	Georgian Bay
DGR5-677.25	calcareous mudstone	Blue Mountain
DGR5-692.35	oxidized calcareous mudstone	Blue Mountain
DGR5-699.49	oxidized calcareous mudstone / siltstone	Blue Mountain
DGR5-704.99	wackestone	Collingwood
DGR5-715.40	wackestone	Cobourg
DGR5-725.33	wackestone	Cobourg
DGR5-764.72	wackestone / packstone – weakly oxidized	Sherman Fall

1. halite-celestite, 2. fossiliferous, 3. oxidized.

Table 2 Summary of Rock Types from Individual Core Samples in DGR-6

Sample #	Rock type	Formation
DGR6-654.58	calcareous siltstone/mudstone	Georgian Bay
DGR6-664.31	calcareous mudstone	Georgian Bay
DGR6-697.67	calcareous mudstone	Blue Mountain
DGR6-717.97	calcareous mudstone	Blue Mountain
DGR6-735.40	calcareous siltstone	Blue Mountain
DGR6-750.80	wackestone (anhydrite)	Cobourg
DGR6-761.76	wackestone+calcareous mudstone/siltst.	Cobourg
DGR6-768.58	wackestone	Cobourg

1. anhydrite, 2. fossiliferous, 3. Oxidized in the mudstones but variably oxidized in the wackestones

4.3 Mineralogy in DGR-5

The mineralogy of individual DGR-5 samples is shown in Appendix A and selected features are demonstrated by the photomicrographs. Table 3 provides estimated percentages of each mineral in the ten DGR-5 samples. Carbonate and illite are the most abundant minerals in the rocks. Illite is often mixed with calcite in the matrix. Other, locally important minerals in some rocks include quartz, K-feldspars and pyrite.

4.3.1 Carbonates

The most common carbonate mineral in the DGR-5 cores is calcite. All fossils consist of pure calcite, and several of the fossil fragments are recrystallized to aggregates of blocky calcite. Some of the recrystallized calcite is a pure end member, but some samples contain up to 1.3 wt% MnO. In the halite vein (DGR5-605.55, Georgian Bay Formation), one calcite grain contains 0.25 wt% Cl.

Dolomite is present is most rocks. It is generally very fine-grained, mostly occurring as single grains and does not form interlocking aggregates. Saddle dolomite was not identified in DGR-5. Dolomites have a wide range of composition, some are nearly pure whereas others are Fe-rich. Because such samples have an Mg:Fe ratio of < 4, the carbonate is identified as ankerite; two samples from the Georgian Bay Formation – DGR5-583.40 and DGR5-645.16 – contain ankerite.

Fossil fragments are abundant in the lowermost four samples that are from the Middle Ordovician limestones. The most common fossils include bryozoa, echinoderms and sponges. Some fossils are partly or completely recrystallized to aggregates of calcite and, in some cases (DGR5-704.99) replaced partly by pyrite. The fragment size varies from <0.5 mm to >1 cm.

4.3.2 Clays

Although illite commonly occurs in a mud-like mixture with calcite, it was also possible to identify single grains, and obtain analyses of pure illite in samples of the Georgian Bay shale DGR5-645.16 and the three Blue Mountain shale samples DGR5-677.25, DGR5-692.35, and DGR5-699.49 (Appendix A). Muscovite is rare and was identified only in sample DGR5-583.40 (Georgian Bay Formation), where it is represented by a few small prism-like grains. Due to the small size of most illite grains and its intercalation with microcrystalline calcite in the calcareous mud matrix, these could be identified only by microprobe analysis. In such analyses, they are reported as a composite ‘calcite - illite matrix’. The percent of SiO_2, Al_2O_3 and K_2O with respect to CaO can be used to approximate the concentration (%) of illite present in the matrix.

4.3.3 Quartz and Feldspars

Quartz is not abundant in the rocks except in the Georgian Bay sample DGR5-583.40 (25%). It mostly occurs as small clasts within the siltstones. Some quartz forms as a narrow rim on the K-feldspars. Orthoclase was identified only in one sample (DGR5-583.40, Georgian Bay Formation). One of the detrital grains of K-feldspar analyzed in this core contained 0.3 wt% Cl. Albite also occurs as fine-grained detrital grains in the two Georgian Bay siltstone samples.

4.3.4 Pyrite

Pyrite is relatively abundant in some DGR-5 cores at 1 – 2%, where these grains often replace the fossils. The small grains occur as aggregates of framboids, or as small, anhedral, angular grains. Some pyrite in a wackestone sample (DGR5-715.40) are rimmed by a dolomite rhomb, while in the Georgian Bay siltstone (DGR5-583.40), pyrite poikiloblasts overgrow the fine-grained matrix.

Table 3 Visually Estimated Mineral Percentages in Individual Samples of DGR-5

Sample Number	***DGR5-583.40***	***DGR5-605.55***	***DGR5-645.16***	***DGR5-677.25***	***DGR5-692.35***	***DGR5-699.49***	***DGR5-704.99***	***DGR5-715.40***	***DGR5-725.33***	***DGR5-764.72***
Rock	***calc-silt***	***calc-mud***	***calc-mud-silt***	***calc-mud***	***oxid-calc-mud***	***oxid.calc-mud-silt***	***wacke***	***wacke***	***wacke***	***wacke-packst oxid***
Carbonate (including fossils)	60	60	25	5	10	25	95	70	80	85
Quartz	25	10	2			10				
Celestite		0.5								
Halite		0.5								
K-feldspar	15									
Albite	X		2							
Illite	X	30	70	60	62	50		10	5	10
Muscovite/sericite	X									
Other Clays										
Apatite							0.1	X		
Rutile	X									
Fe-hydroxide				10	2	15				
Pyrite	X		1	2	1	0.2	5	0.3	0.3	x
Irresolvable matrix				23	25			20	15	5

carbonate = calcite +dolomite, x=trace, calc = calcareous, wacke = wackestone, packst = packstone, silt = siltstone, mud = mudstone, oxid = oxidized

4.4 Mineralogy in DGR-6

The mineralogy of individual DGR-6 samples is shown in Appendix B and selected features are demonstrated by the photomicrographs. Table 4 provides estimated percentages of each mineral in the eight DGR-6 samples.

Carbonate and illite are the most abundant minerals. Illite is commonly mixed with calcite in the matrix. Although K-feldspars were optically not identified, the locally high K_2O concentration in the matrix, coupled with the appropriate stoichiometry for K-feldspars, suggests, that some of the oxidized domains contain very fine-grained K-feldspars. Quartz is less common and is disseminated as minute angular grains within the siltstones and mudstones.

4.4.1 Carbonate

The most common carbonate in the rocks is calcite. Most fossils consist of pure calcite, although some contain a few percent by weight MgO and FeO. Several fossil fragments are recrystallized to aggregates of blocky calcite or dolomite. Very fine-grained calcite is also part of the lime mud matrix, in which it is mixed with illite.

Dolomite is present is most rocks. Generally, it occurs as euhedral or subhedral single grains or in aggregates. In sample DGR6-750.80, euhedral dolomite is vug-filling and is intergrown with anhydrite. Dolomite generally has a wide range in composition; some grains are Fe-free whereas others contain several percent by weight FeO. Carbonate minerals with a Mg:Fe ratio < 4 are known as ankerite, e.g., DGR6-654.58 (Georgian Bay Formation).

Fossil fragments are abundant in the lowermost three samples. The most common fossils are: bryozoa, echinoderms and sponges. Some fossils are partly or completely recrystallized to aggregates of calcite. The fragment size varies from <0.5mm to >1cm.

4.4.2 Illite and Muscovite

Illite occurs within a fine-grained matrix mixed with calcite. It makes up the matrix of the siltstones, mudstones, and even some of the wackestones. Single grain analysis was not possible due to the small grain sized, so most analysis includes variable proportion of carbonates and, possibly, quartz. Muscovite is rare and was identified as small prisms only in sample DGR6-654.58 (Georgian Bay Formation). The percent and ratio of SiO_2, Al_2O_3 and K_2O with respect to CaO, can be used to estimate the percentage of illite in the matrix of individual samples.

4.4.3 Chlorite

Chlorite was positively identified (by electron microprobe) only in one sample (DGR6-654.58, Georgian Bay Formation), where it is interstitial to the illite and to the carbonate-rich matrix. Because of oxidation, optical distinction between chlorite and illite is not possible.

4.4.4 Quartz and Feldspars

Quartz commonly occurs as small angular clasts within the siltstones. The clasts often have resorbed grain boundaries, suggesting disequilibrium. Albite is rare, and where present, it occurs as a small detrital grain (DGR6-654.58; Georgian Bay Formation).

Table 4 Visually Estimated Mineral Percentages in Individual Samples of DGR-6

Sample Number	***DGR6-654.58***	***DGR6-664.31***	***DGR6-697.67***	***DGR6-717.97***	***DGR6-735.40***	***DGR6-750.80***	***DGR6-761.76***	***DGR6-768.58***
Rock	***calc. silt-mudstone***	***calc. mudstone***	***calc. mudstone***	***calc. mudstone***	***calc. siltstone***	***wacke-stone***	***wacke-mud-silt***	***wacke-stone***
Carbonate (including fossils)	32	45	43	45	60	85	55	72
Illite	45	44	30	42	27	15		10
Calcareous mud							30	
K-rich clays							12	15
Muscovite / sericite	x							
Quartz	3		1	x	0.5	x	x	x
Albite	x							
Apatite			x		x	x		x
Anhydrite						x		
Fe-hydroxide	3	10	25	10	12		3	
Pyrite	x	1	1	3	1	x	x	3
Chalcopyrite		x	x	x				
Irresovlalbe matrix	17							

carbonate = calcite+dolomite, x=trace, calc.=calcareous, silt = siltstone, mud = mudstone

4.4.5 Pyrite

Pyrite is relatively abundant in some rocks. In the wackestone samples, the aggregates often replace the fossils or occur as inclusions in the fossils. The small grains are often framboidal and, less commonly, subhedral to euhedral and cube-shaped.

4.5 Porosity and Veins in DGR-5

The DGR-5 samples appear non-porous and do not contain identifiable interparticle pores. Two composite veins were identified in sample DGR5-605.55 (Georgian Bay Formation), where the two small halite + celestite -bearing veins intersect. In the earlier vein, celestite contains a few inclusions of relict calcite, as well as halite that post-dated celestite. The cross-cutting vein consists of only halite.

An empty vein (2 cm long, 0.015 mm wide), which may have originally contained carbonate minerals, cross-cuts the fine-grained matrix in sample DGR5-645.16 (Georgian Bay Formation). Fragmented pyrite was identified in sample DGR5-677.25 (Georgian Bay Formation), which may be from within a vein but also may simply be aligned fragments of pyritized fossils. DGR5-692.35 (Blue Mountain Formation) contains two minute fragmented veins (3mm x 20µm) that are filled by fine-grained material from the matrix.

4.6 Porosity and Veins in DGR-6

For the most part, the porosity of the DGR-6 cores is relatively low and the carbonate aggregates do not contain identifiable interparticle pores.

Veins are rare in the shale samples, with the exception of DGR6-717.97 and DGR6-735.40, both from the Blue Mountain Formation. Most veins in these thin sections are empty. Due to the friable nature of the rocks, the vein material was lost during sample preparation. DGR6-717.97 contains seven veins; their widths range between 0.05 and 0.2 mm, and in length between 1 and 2 cm. There is some evidence of earlier dissolution and replacement, as an irregularly shaped ‘pinch and swell’ vein-like structure consists of fine-grained equigranular pyrite and another vein-like structure consists of fine-grained calcite. The rock also contains a few subrounded domains filled with calcite. The calcareous mudstone, DGR6-735.40, is weakly laminated and contains a network of six inter-connecting veins, having a width of 0.05 - 0.1 mm and length of 1 - 2 cm. As in the previous thin section, they are presently empty.

In sample DGR6-750.80 (Cobourg Formation wackestone) there is evidence for replacement texture. A vug, originally ~3 mm diameter, is presently filled by relatively coarse-grained euhedral dolomite (0.4 mm) and anhydrite (up to 1.0 mm); the aggregates are rimmed by fine-grained dolomite. As the grain size of the euhedral dolomite increases towards the center, which is filled by the coarse-grained anhydrite, it appears that the dolomite and the anhydrite crystallized in an open cavity, perhaps a dissolution cavity. The FeO content of the coarse-grained dolomite is 2.6 wt%, whereas the FeO content of the fine-grained dolomite on the outer rim is 5.2 wt%. Evidently, they represent two distinct generations.

4.7 Texture in DGR-5 and DGR-6

The DGR-5 and DGR-6 core samples are represented by fine-grained shale and carbonate rocks. The largest grains are typically associated with veins and vugs and may be as much as ½ mm in diameter; these could be pyrite or carbonate grains and are often replacement minerals in fossil fragments, e.g., the 2 cm long bryazoan fragment shown in DGR5-764.72 (Sherman Fall Formation). Vug-filling anhydrite and dolomite grains in DGR6-750.80 (Cobourg Formation) are of the order of 1 mm in length. Otherwise, the texture of the rocks is typically microcrystalline, i.e., <0.1 mm.

4.8 Oxidation in DGR-5 and DGR-6

Oxidation is evident in the presence of iron staining of the clay minerals forming the shales (e.g., DGR5-699.49, DGR6-697.67). Both of these Blue Mountain Formation cores are strongly oxidized by ferric oxides and hydroxides that stain illite but also contain pyrite. The Middle Ordovician limestones show only weak oxidation, if any. It is assumed that these iron minerals were early diagenetic products that preceded the formation of the pyrite that is frequently found in the Ordovician shales and limestones.

5 Data Quality and Use

Tables 3 and 4 present the visually-estimated percentage of each mineral in the thin sections from DGR-5 and DGR-6 respectively. However, the percent estimation is approximate due to the very fine-grained nature and the iron-staining of clay minerals and some of the matrix carbonates. Consequently, total percentages of quantified minerals in Tables 3 and 4 may slightly exceed 100%.

It should also be noted that the core sampling was localized and not evenly distributed and therefore may not represent the typical petrographic or diagenetic conditions within any particular formation, i.e., each DGR core may reflect facies changes within the Bruce Paleozoic sequence. Reliable estimation of porosity in these rocks is not possible, because ‘holes’ are created during preparation of the thin sections due to the friable nature of these cores,and potentially due to mineral dissolution, e.g. halite.

6 Conclusions

This Technical Report presents the results of the petrographic analysis of thin sections prepared from ten DGR-5 and eight DGR-6 cores submitted to SGS Lakefield for mineralogical, SEM and lithogeochemical analysis and then forwarded as sliced sections to GeoConsult in Toronto.

A major objective of the petrographic analysis was to identify soluble minerals present, such as gypsum, anhydrite and celestite as well as halite. The most pronounced evidence of soluble minerals was the identification in DGR5-605.55 (Georgian Bay Formation) of cross cutting veins of halite (75%) and celestite (22%) that appear to have replaced the original calcite (3%). Anhydrite was detected with dolomite in a vug in DGR6-750.80 (Cobourg Formation). Apart from these secondary phases, soluble minerals were absent. The cores were mainly fine-grained to microcrystalline in texture, apart from the vein and vug material already noted.

The Georgian Bay and Blue Mountain shales display non-uniform oxidation. Calcareous mudstone and siltstone from the Georgian Bay Formation in DGR-5 showed little evidence of oxidation but were more so in the DGR-6 cores. However, Blue Mountain shales from both DGR-5 and DGR-6 were considerably more oxidized having 10% or more ferric oxide staining.

The Upper Ordovician shales were identified as mudstones and siltstones containing significant amounts of carbonate minerals, thus it is possible that the carbonate interbeds were unintentionally preferentially sampled. For example, four of the 11 Georgian Bay and Blue Mountain samples from DGR-5 and DGR-6 had ≥ 50% estimated carbonate minerals including fossils, i.e., DGR5-583.40, DGR5-605.55, DGR6-735.40 and DGR6-750.80. Typical Georgian Bay and Blue Mountain shales in DGR-3 and DGR-4 have < 10% carbonate minerals when analyzed by x-ray diffraction (Intera Engineering Ltd., 2009d). The principal minerals identified – other than calcite – were illite, quartz, K-feldspars and ferric oxides.

The Middle Ordovician limestones from the Cobourg and deeper formations were identified as wackestones, i.e., muddy rocks containing >10% identifiable grains. The fossil content in all DGR-5 and DGR-6 carbonate rocks was 20-60%. The principal clay mineral was illite at 5-15% abundance. Often there was 10-25% of the thin section that was described as an irresolvable matrix. Some of the carbonate rocks exhibited a weak oxidation, e.g., DGR5-764.72, from the lowermost Sherman Fall Formation.

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APPENDIX A

Petrography (with Photomicrographs) – DGR-5

Ppl = plane polarized light

XN = crossed nicols

Refl. Light = reflected light

Sample Number: DGR5-583.4 **Rock Type: Calcareous siltstone**

Petrographic Description:

A carbonate-rich, calcareous siltstone that consists predominantly of quartz, feldspars, carbonate and clay-size, dark amorphous matrix. The feldspars and quartz are angular grains, some have embayed and sutured grain boundaries, and the feldspars are often rimmed by quartz. A few small laths of muscovite, and minor chlorite are interstitial to the carbonates. Some muscovite is replaced by chlorite. Two carbonate generations co-exist; the earlier carbonate is calcite, some of which are rimmed by anhedral, slightly zoned dolomite. Dolomite makes up a significant part of the rock, and shows evidence of partial dissolution. The grain boundaries are sutured and embayed, and partial dissolution resulted in the break-up of some grains. Dolomite composition differs between the over-growths on calcite, and the 'regular' matrix dolomite. The over-growth dolomite is Fe-rich and contain ca. 1 wt% MnO, whereas both MnO and FeO are much lower in the matrix dolomite.

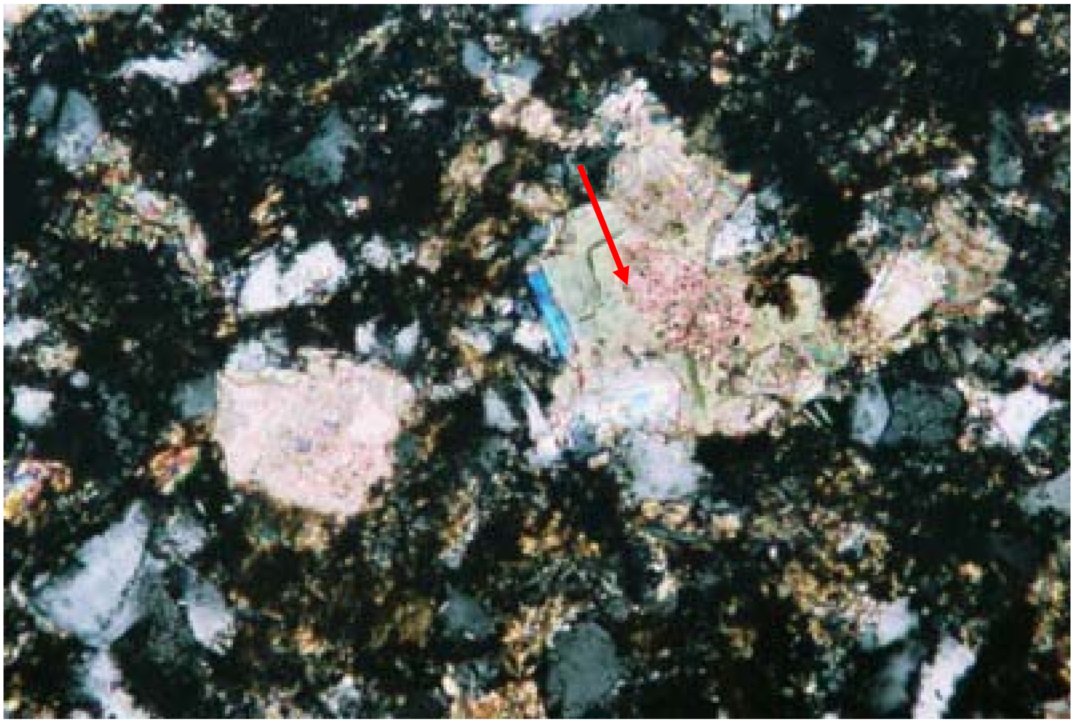
Very fine-grained subhedral / anhedral pyrite crystals are disseminate through the rock, and one, relatively large, round pyrite poikiloblast over-grows a matrix of fine-grained quartz and feldspar.

Detailed mineralogy

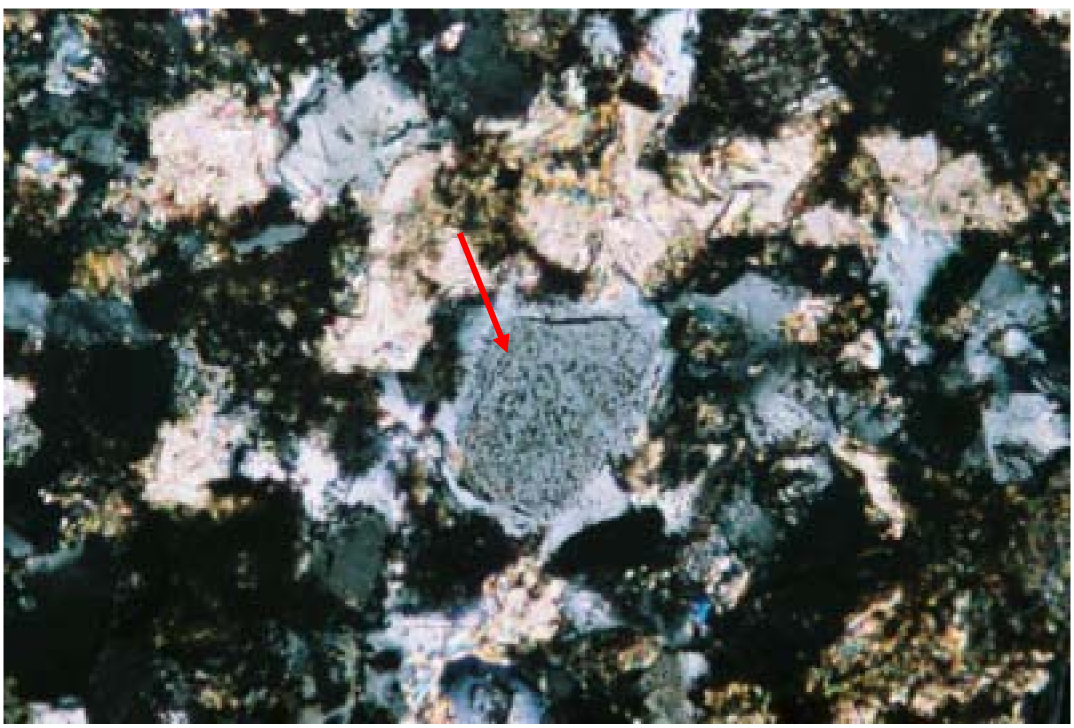
Mineral	%	Grain size(mm)	Comments
Quartz	25	<0.01-0.06	Angular, strained quartz grains are part of the siltstone. Some of the grains are intergrown with the carbonates, and some form a rim on the relatively fresh K-feldspars. Several quartz grains are partly replaced and partly rimmed by anhedral aggregates and single grains of carbonate.
K-feldspars	15	<0.2-0.85	Partly altered orthoclase occur as small clasts interstitial to the carbonates. They are often rimmed by a quartz corona, and the exhibit mottled grain centers.
Muscovite / sericite	trace	variable	Small muscovite laths form a partial rim on second generation carbonates. Some contain ca. 2 % MgO. Fine-grained illite is interstitial to the carbonates and feldspars.
Carbonate	60	<0.1-1.0	Carbonate is the most abundant mineral in the rock. The anhedral grains have sutured and embayed grain boundaries, and many are interstitial to, or over-grow the quartz and feldspars.

Pyrite	trace	variable, minute	One large (0.5mm) pyrite poikiloblast overgrows the rock fabric, and it contains inclusions of quartz and feldspars.

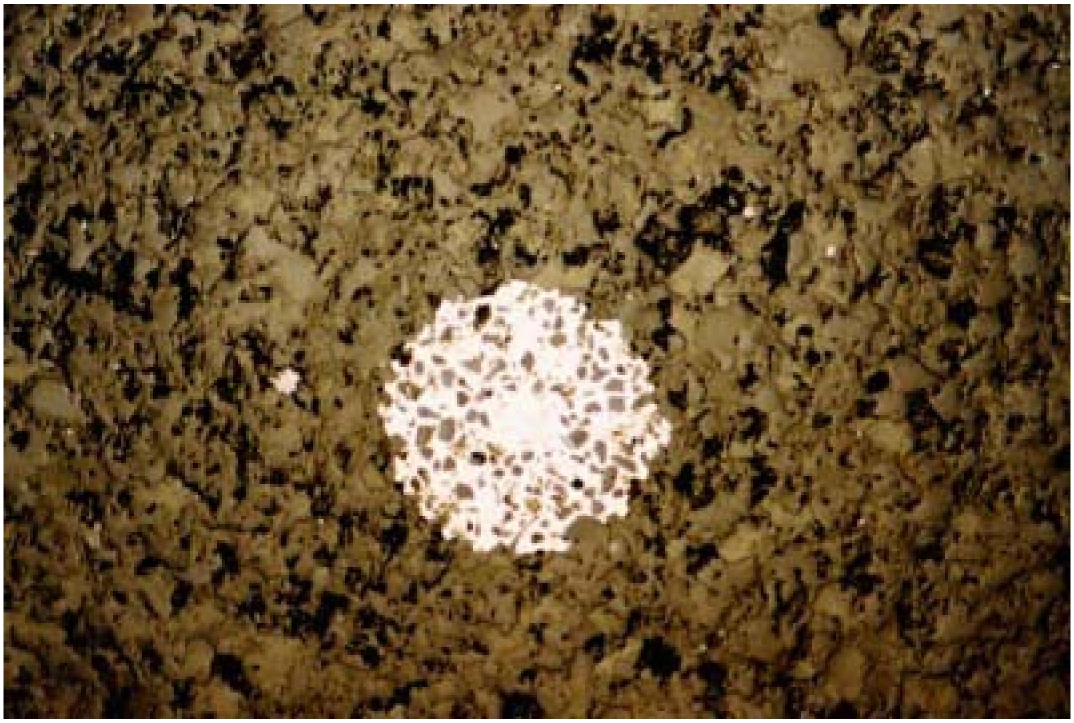
Accessory minerals: plagioclase, rutile, chlorite, illite



A. two carbonate generations. The center calcite (arrow) is overgrown by dolomite. X-axis of photo: 0.45mm. XN.



B. Mottled orthoclase (arrow) is overgrown by a narrow rim of clear quartz. X-axis of photo: 0.45mm. XN.



C. Pyrite poikiloblast in center over-grows existing silicates and carbonates. X-axis of photo: 2.3 mm. Refl. Light.

DGR5-538.4 calcite core
ZAF cycles 4 bc drift= .997

	fac	%el	%ox	stfm
CaO	.92	39.41	55.14	1.988
MgO	.50	.00	.00	.000
FeO	.82	.33	.43	.012
Total		39.74	55.57	2

DGR5-538.4 dolomite rim
ZAF cycles 4 bc drift=1.006

	fac	%el	%ox	stfm
CaO	.91	23.50	32.88	1.191
MgO	.49	7.05	11.69	.590
FeO	.83	5.22	6.71	.190
MnO	.82	.79	1.02	.029
Total		36.56	52.31	2

DGR5-538.4 mucovite
ZAF cycles 6 bc drift=1.007

	fac	%el	%ox	stfm
SiO2	.65	21.35	45.68	5.467
Al2O3	.74	19.24	36.35	5.128
TiO2	.81	.33	.54	.049
FeO	.83	.56	.73	.073
MgO	.64	1.31	2.17	.388
K2O	.85	8.87	10.68	1.631
Total		51.66	96.16	20

DGR5-538.4 large dolomite
ZAF cycles 4 bc drift=1.001

	fac	%el	%ox	stfm
CaO	.91	24.98	34.95	11.858
MgO	.52	9.86	16.34	7.715
FeO	.83	1.25	1.61	.428
Total		36.09	52.91	20

DGR5-538.4 K feldspar
ZAF cycles 5 bc drift=1.005

	fac	%el	%ox	stfm
SiO2	.74	30.12	64.43	11.929
Al2O3	.75	9.89	18.69	4.080
FeO	.83	.87	1.12	.174
K2O	.84	12.98	15.64	3.694
Cl	.76	.30	.30	.095
Total		54.16	100.18	32

DGR5-538.4 large dolomite
ZAF cycles 4 bc drift=1.009

	fac	%el	%ox	stfm
CaO	.91	22.63	31.66	17.293
MgO	.51	10.19	16.89	12.836
FeO	.83	2.99	3.84	1.638
MnO	.81	.42	.54	.234
Total		36.22	52.94	32

Sample Number: DGR5-605.55 **Rock Type: Calcareous mudstone with halite + celestite vein**

Petrographic Description:

A very fine-grained featureless calcareous mudstone that consists predominantly of anhedral, very fine-grained carbonate, illite and lesser quartz. Optical identification of individual minerals is difficult, with the exception of the fine-grained, anhedral carbonates. The matrix carbonates are predominantly dolomite. One dolomite analyzed contains 0.62 wt% SrO, and the interstitial illite contains up to 8 wt% FeO. Minute grains of pyrite framboids occur in aggregates throughout the thin section.

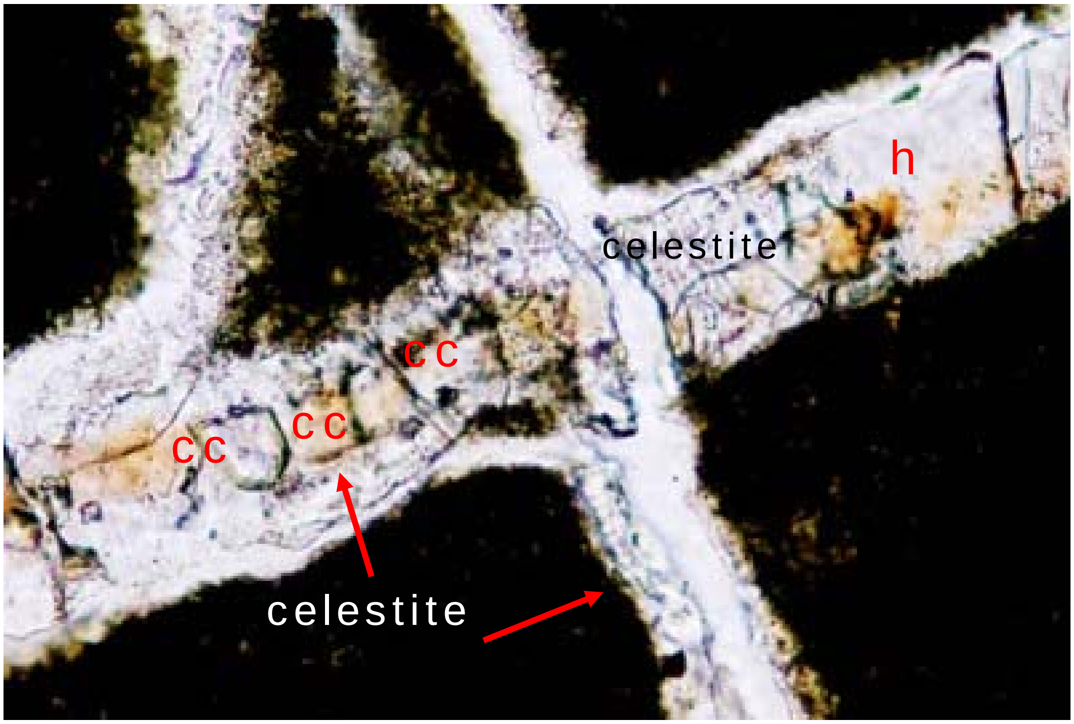
The rock is cross-cut by two veins perpendicular to one another. The veins consist of halite, celestite and lesser carbonate. The two veins have a cross-cutting relationship, where the composite vein is cross-cut by a somewhat narrower halite vein. The original veins consisted of calcite, which was partly replaced by relatively coarse-grained halite, and partly by celestite. A few grains of anhedral calcite occur as inclusions in halite and in celestite. The calcite composition is heterogeneous, one grain contains 0.25 wt% Cl, and another grain is Cl-free, but contains 1.4 wt% MnO. Textural evidence suggests that some of the Ba-rich celestite in one of the veins was replaced by halite. However, in other parts of the vein, the paragenetic relationship between halite and celestite is ambiguous.

Vein size: 3.0 cm x 0.16 mm (75 % halite + 25% celestite + trace carbonate)
Vein size: 1.5 cm x 0.12 mm (100% halite + trace carbonate)

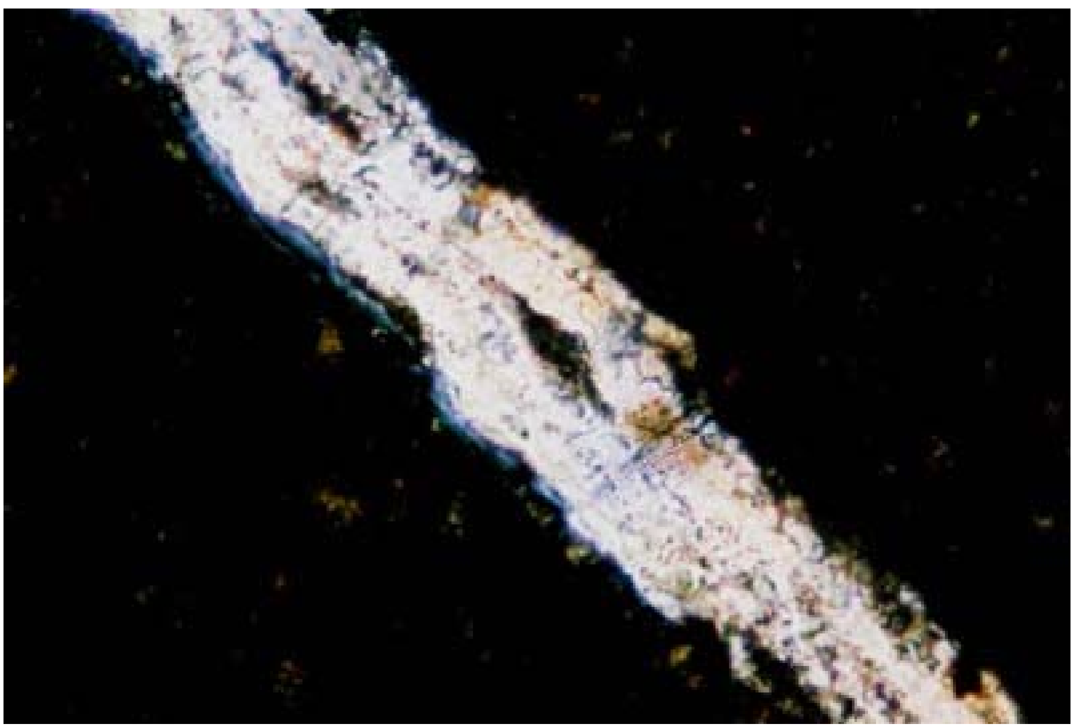
Note: parts of the veins were removed during thin section preparation due to the softness of the minerals.

Matrix	**%**
Carbonate	60
Illite	30
Quartz	10
Pyrite	0.1

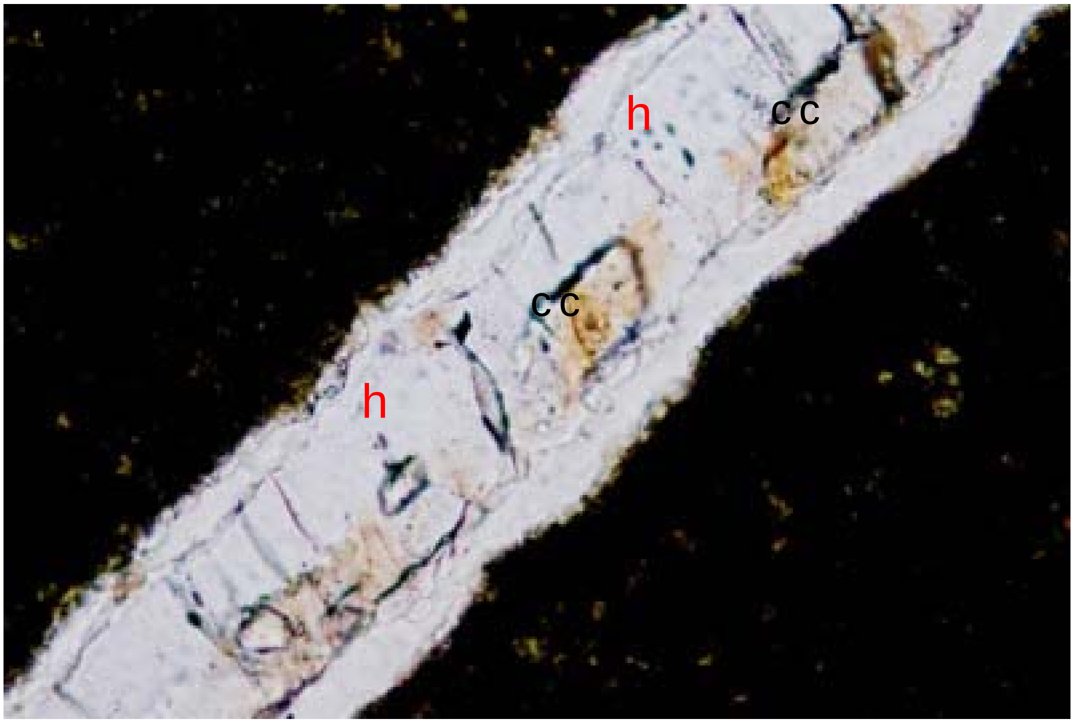
Vein	**%**
Halite	75
Celestite	22
Calcite	3



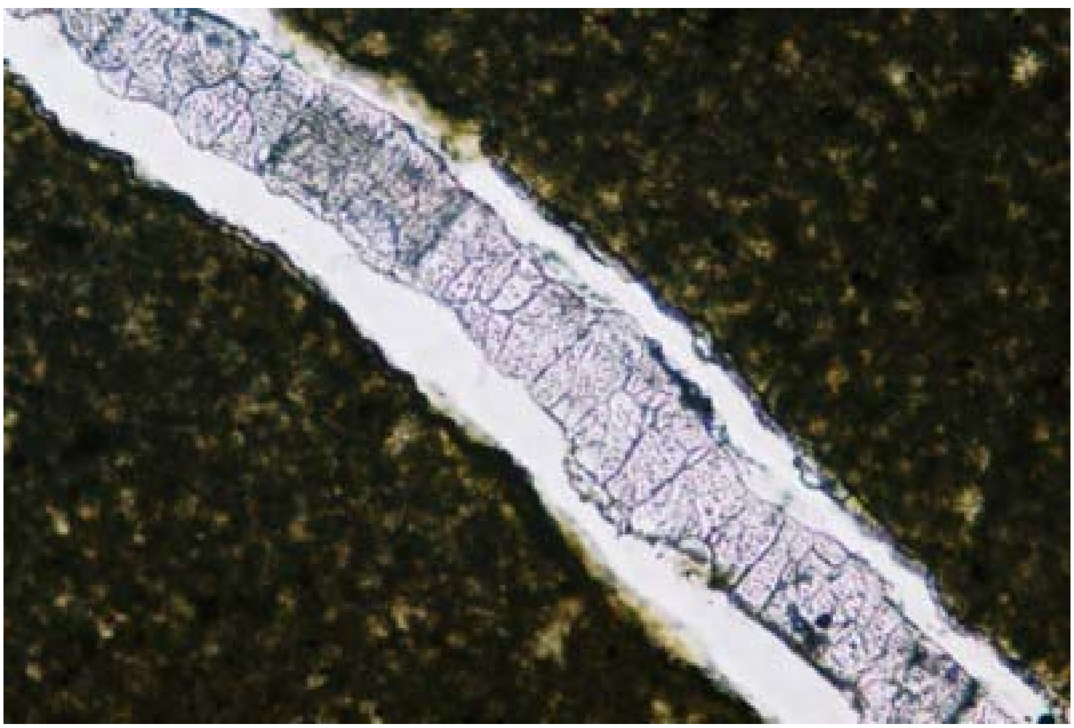
A. Composite vein consisting of halite (h), celestite and calcite (cc).
X-axis of photo: 0.45mm. Ppl.



B. Celestite vein. X-axis of photo: 0.45mm. Ppl.



C. Halite vein with inclusions of calcite. X-axis of photo: 0.45mm. Ppl.


D. Halite vein that cross-cuts the composite vein. X-axis of photo: 0.45mm. Ppl.

DGR5-605.55 halite in Vein
ZAF cycles 5 bc drift= .964

	fac	%el	stfm
Cl	.90	59.83	19.182
Na	.65	38.67	12.396
S	.92	.00	.000
Total		98.50	1

DGR5-605.55 calcite in vein
ZAF cycles 4 bc drift= .969

	fac	%el	%ox	stfm
CaO	.92	39.33	55.03	.980
GeO2	.54	.00	.00	.000
MnO	.80	1.09	1.40	.020
Total		40.42	56.44	1

DGR5-605.55 halite vein
ZAF cycles 5 bc drift= .969

	fac	%el	stfm
Cl	.90	59.40	.017
Na	.65	38.64	.017
Total		98.04	1

DGR5-605.55 celestite in vein
ZAF cycles 5 bc drift= .972

	fac	%el	%ox	stfm
SrO	.81	38.02	44.96	.896
BaO	.74	16.50	18.43	.248
SO3	.60	14.79	36.92	.952
Total		69.31	100.30	4

DGR5-605.55 celestite vein margin
ZAF cycles 5 bc drift= .972

	fac	%el	%ox	stfm
SrO	.83	37.63	44.50	.901
BaO	.73	11.22	12.53	.172
SO3	.60	14.90	37.22	.976
Total		63.75	94.24	4

DGR5-605.55 celestite in vein
ZAF cycles 5 bc drift= .974

	fac	%el	%ox	stfm
SrO	.82	36.58	43.26	.826
BaO	.73	13.15	14.68	.189
SO3	.61	16.11	40.23	.995
Total		65.84	98.17	4

DGR5-605.55 halite in vein
ZAF cycles 6 bc drift= .978

	fac	%el	stfm
Na	.66	39.30	.017
Cl	.90	59.91	.017
Total		99.21	1

DGR5-605.55 calcite in vein
ZAF cycles 4 bc drift= .975

	fac	%el	%ox	stfm
CaO	.92	40.04	56.02	3.955
MnO	.80	.38	.49	.027
FeO	.82	.24	.31	.017
SrO	.81	.00	.00	.000
Cl	.94	.25	.25	.028
Total		40.91	57.07	4

DGR5-605.55 halite vein
ZAF cycles 5 bc drift= .970

	fac	%el	stfm
Na	.64	37.12	.016
Cl	.90	60.10	.017
Total		97.22	1

DGR5-605.55 halite vein
ZAF cycles 5 bc drift= .977

	fac	%el	stfm
Na	.65	37.63	.016
Cl	.90	60.21	.017
Total		97.84	1

DGR5-605.55 dolomite in matrix
ZAF cycles 4 bc drift= .974

	fac	%el	%ox	stfm
CaO	.90	22.66	31.71	.522
MgO	.53	12.42	20.59	.472
SrO	.73	.52	.62	.006
Total		35.60	52.92	1

DGR5-605.55 micaceous matrix
ZAF cycles 5 bc drift= .976

	fac	%el	%ox	stfm
SiO2	.69	20.46	43.76	.319
Al2O3	.67	10.07	19.02	.163
CaO	.84	.28	.39	.003
MgO	.56	1.82	3.02	.033
FeO	.84	6.35	8.17	.050
MnO	.83	.00	.00	.000
K2O	.86	5.52	6.64	.062
Total		44.49	81.01	1

DGR5-605.55 micaceous matrix
ZAF cycles 5 bc drift= .976

	fac	%el	%ox	stfm
SiO2	.69	22.37	47.85	.323
Al2O3	.68	10.56	19.95	.159
CaO	.83	.72	1.01	.007
MgO	.57	2.06	3.42	.034
FeO	.84	6.08	7.82	.044
MnO	.83	.00	.00	.000
K2O	.86	5.92	7.13	.061
Total		47.71	87.18	1

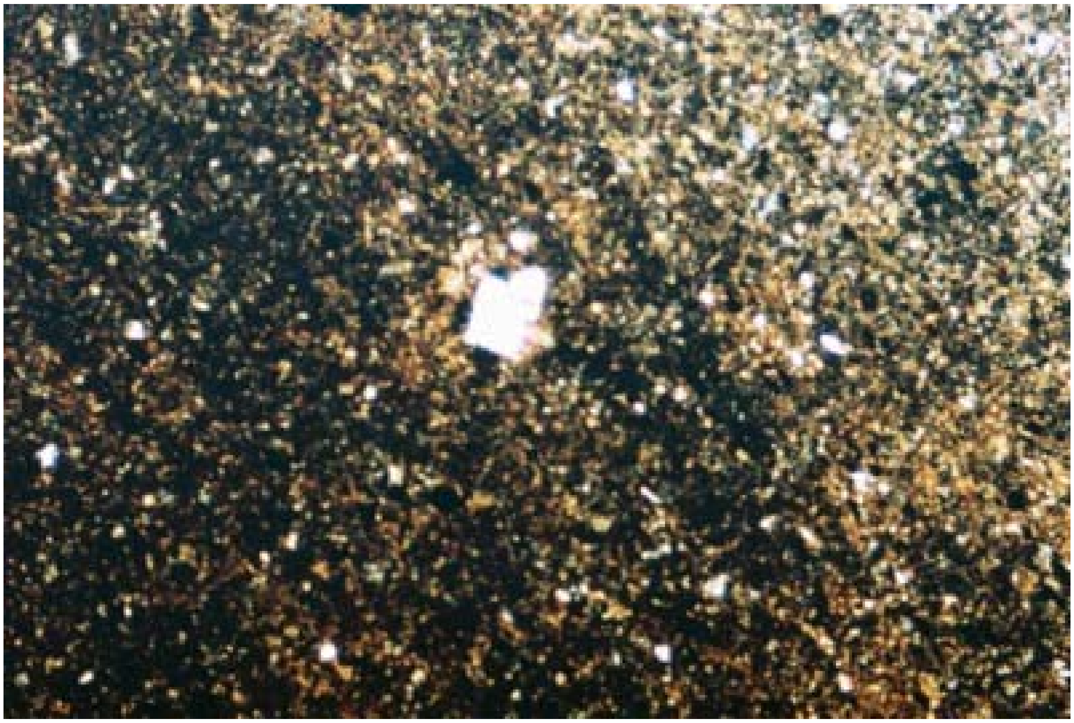
Sample Number: DGR5-645.16 **Rock Type: calcareous mudstone / siltstone (weakly oxidized)**

Petrographic Description:

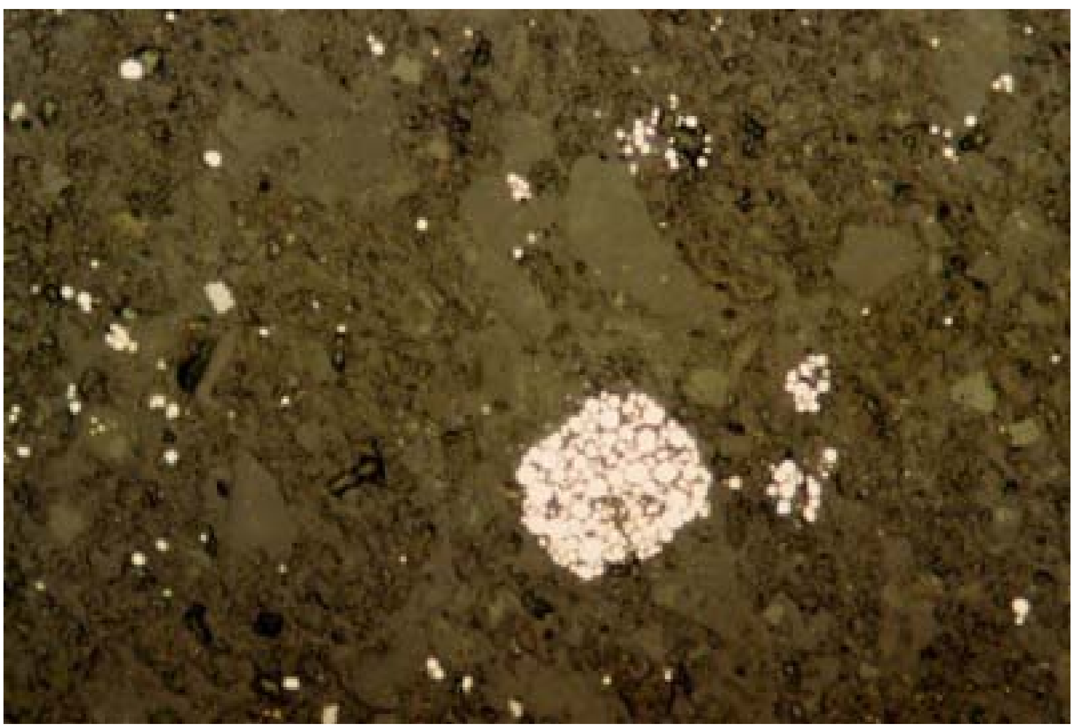
The rock consists of very fine-grained, clayey, somewhat oxidized matrix with minute inclusions of anhedral albite, quartz and carbonate. Small to medium-size clasts in the matrix are dolomite, and some silicates are rimmed by dolomite. A 2 cm long and 0.015mm wide slightly anastomosing vein cross-cuts the matrix. Vein filling has been removed during grinding of the thin section (due to softness of the core), but minute fragments included in the vein suggest that it was probably a carbonate vein. Individual minerals in the rock are difficult to distinguish by optical means due to the clayey, amorphous nature of the matrix. When the amorphous matrix is spot-checked by electron microprobe, it generally gives an illite composition. This would suggest a predominantly illite matrix.

Pyrite is relatively abundant in the rock. It occurs as tiny framboids, some of which are partly recrystallized to subhedral grains. They generally occur in clusters of various sizes. Much of the pyrite is a replacement after carbonate (?).

Mineral	**%**
Illite	70
Carbonate	25
Quartz	2
Albite	2
Pyrite	1



A. Small Fe-rich dolomite grain (in center) of fine-grained illite-rich matrix. X-axis of photo: 2.3 mm. Ppl.



B. Aggregate of pyrite framboids. X-axis of photo: 0.45 mm. Refl. Light.

DGR5-645.16 albite
ZAF cycles 7 bc drift=1.041

	fac	%el	%ox	stfm
SiO2	.71	31.69	67.79	11.885
Al2O3	.71	10.48	19.80	4.091
CaO	.83	.48	.67	.125
K2O	.83	1.08	1.31	.292
Na2O	.50	7.94	10.70	3.639
Total		51.67	100.27	32

DGR5-645.16 illite matrix
ZAF cycles 5 bc drift=1.023

	fac	%el	%ox	stfm
SiO2	.70	23.39	50.05	10.920
Al2O3	.69	10.20	19.27	4.956
MgO	.59	1.96	3.25	1.057
FeO	.84	3.28	4.22	.770
K2O	.85	5.36	6.45	1.796
Total		44.19	83.24	32

DGR5-645.16 illite matrix
ZAF cycles 5 bc drift=1.035

	fac	%el	%ox	stfm
SiO2	.70	25.72	55.03	11.245
Al2O3	.68	9.59	18.12	4.366
MgO	.59	2.37	3.93	1.196
FeO	.84	5.08	6.54	1.118
K2O	.85	4.11	4.96	1.292
Total		46.88	88.57	32

DGR5-645.16 illite matrix
ZAF cycles 5 bc drift=1.039

	fac	%el	%ox	stfm
SiO2	.71	26.18	56.00	11.289
Al2O3	.70	10.09	19.07	4.531
MgO	.60	2.30	3.81	1.145
FeO	.84	3.40	4.37	.737
K2O	.84	4.78	5.76	1.482
Total		46.75	89.01	32

DGR5-645.16 dolomite rhomb
ZAF cycles 4 bc drift=1.033

	fac	%el	%ox	stfm
CaO	.91	23.65	33.09	19.061
MgO	.48	6.75	11.19	8.963
FeO	.84	5.68	7.30	3.284
MnO	.82	1.18	1.52	.693
Total		37.25	53.11	32

DGR5-645.16 dolomite rhomb
ZAF cycles 4 bc drift=1.030

	fac	%el	%ox	stfm
CaO	.91	24.61	34.43	19.801
MgO	.48	6.19	10.27	8.214
FeO	.84	5.87	7.56	3.392
MnO	.82	1.01	1.31	.594
Total		37.68	53.56	32

DGR5-645.16 dolomite rim

ZAF cycles 4 bc drift=1.022

	fac	%el	%ox	stfm
CaO	.91	23.37	32.70	18.120
MgO	.50	8.76	14.53	11.202
FeO	.83	4.46	5.74	2.482
MnO	.82	.35	.45	.196
Total		36.94	53.42	32

Sample Number: DGR5-677.25 **Rock Type: Calcareous mudstone (partly oxidized)**

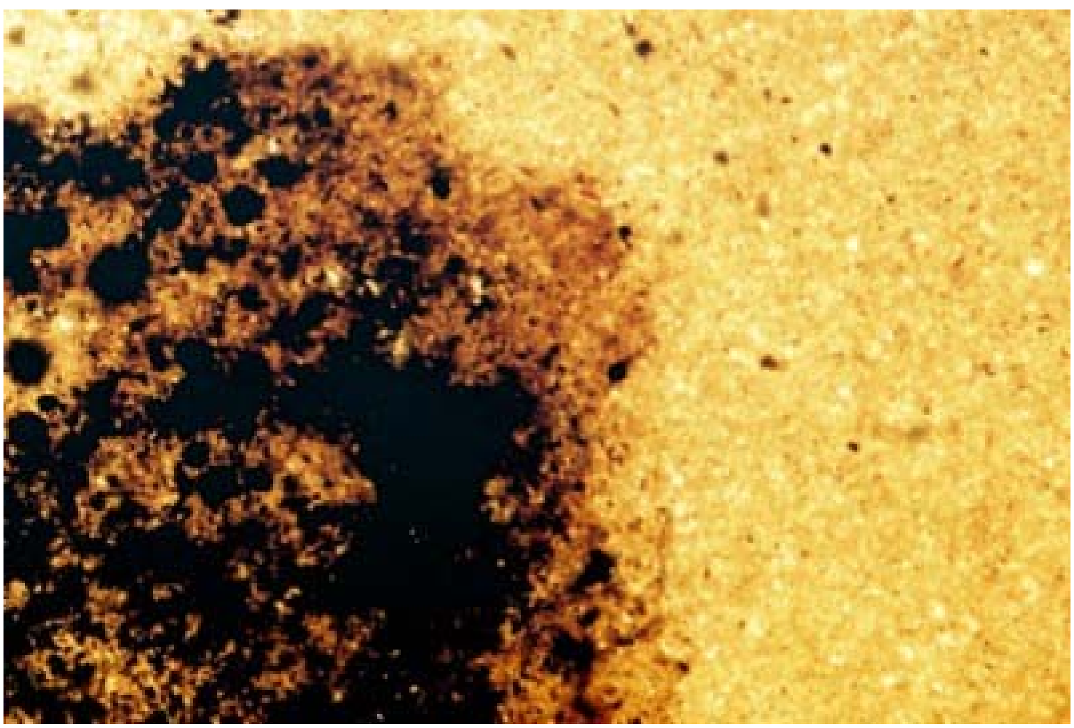
Petrographic Description:

The mineralogy and texture of the rock is comparable to the previous sample (DRG5-645.16), except it is more oxidized, and it contains more pyrite. Slumping and filling of depressions and veins by detrital material is suggested by the texture of the thin section, where the scoured vein-like features are filled by the same fine-grained material the matrix is made up of (illite and lesser carbonates). It also contains slightly circular fragments of similar mineralogy as the rest of the matrix (pyrite-rich mud ball?). Much of the matrix is made of very fine-grained illite, framboidal to subhedral pyrite, and lesser calcite. Just as in the previous two samples, the mineralogy is difficult to identify optically, due to the oxidized, clayey texture of the rock. Illite is probably the most abundant mineral, the carbonate in the rock is calcite.

Pyrite is abundant in the rock. It occurs as replacement after fragments of fossils, as small framboids, and as large circular grains that represent recrystallized fine-grained aggregates. Sulfidation was important in this sample.

Mineral	%
Illite	60
Fe-hydroxide	10
Carbonate	5
Pyrite	2
Irresolvable matrix	23

A. Fine-grained aggregates and single grains of pyrite in mudstone. X-axis of photo: 2.3mm. Refl. Light.



B. Pyrite-rich (black) oxidized domain in sediment. X-axis of photo: 2.3mm. Ppl.

DGR5-677.25 illite matrix
ZAF cycles 6 bc drift=1.037

	fac	%el	%ox	stfm
SiO2	.71	29.04	62.13	11.555
Al2O3	.72	10.91	20.62	4.521
MgO	.62	1.87	3.10	.859
FeO	.83	2.19	2.82	.439
K2O	.84	5.66	6.82	1.618
Total		49.68	95.50	32

DGR5-677.25 illite matrix
ZAF cycles 6 bc drift=1.041

	fac	%el	%ox	stfm
SiO2	.71	28.53	61.04	11.552
Al2O3	.70	9.82	18.56	4.140
MgO	.61	2.88	4.78	1.349
FeO	.84	3.83	4.92	.779
K2O	.84	3.83	4.62	1.115
Total		48.90	93.91	32

DGR5-677.25 illite matrix
ZAF cycles 6 bc drift=1.039

	fac	%el	%ox	stfm
SiO2	.69	25.27	54.07	10.449
Al2O3	.70	12.55	23.72	5.404
MgO	.61	2.85	4.73	1.361
FeO	.84	3.25	4.18	.675
K2O	.84	6.46	7.78	1.919
Total		50.39	94.48	32

DGR5-677.25 calcite
ZAF cycles 4 bc drift=1.015

	fac	%el	%ox	stfm
CaO	.92	36.15	50.59	31.677
MgO	.49	.00	.00	.000
FeO	.82	.51	.66	.323
Total		36.67	51.25	32

Sample Number: DGR5-692.35 Rock Type: Calcareous mudstone (oxidized)

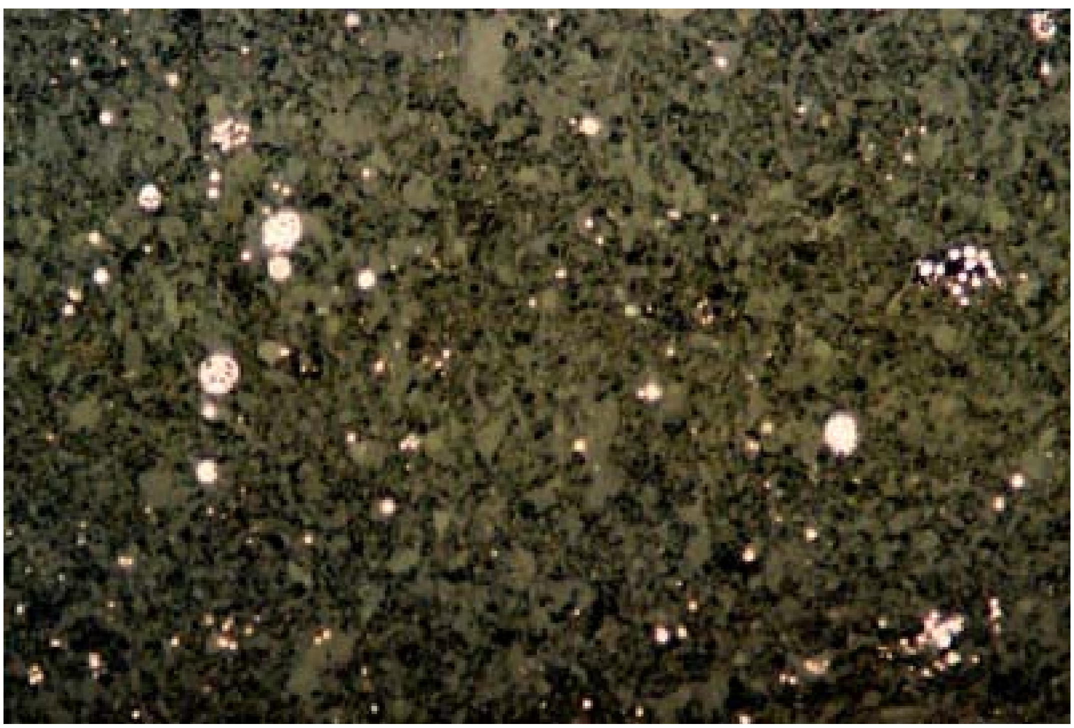
Petrographic Description:

Very fine-grained, slightly oxidized, calcareous mudstone that is otherwise featureless. As in previous samples, the optical identification of distinct minerals is difficult due to the friable nature of the rock, the abundance of nearly amorphous clays, and oxidation that over-printed the minerals. Microprobe analysis, combined with petrography identified two major phases; illite and calcite. Much of the matrix consists of Fe-Mg-rich illite, lesser calcite, which occurs as part of the matrix and as small clasts and aggregates within the fine-grained matrix. Two minute veinlets were identified (3 mm long and ca 20 μm wide), both of which are filled by fine-grained quartz, carbonate and illite derived from the matrix. One relatively wide vein-like sinuous structure (3mm x 0.3mm) is filled by the same minerals that compose the matrix. It appears to be more like a scour mark than an original vein.

Pyrite is relatively abundant. It occurs as small, discrete framboids, and as aggregates made up of small framboids.

Mineral	%
Illite	62
Carbonate	10
Fe-hydroxide	2
Pyrite	1
Irresolvable matrix	25


A. Small, fragmented veinlet in mudstone. X-axis of photo: 2.3 mm. Ppl.


B. Small pyrite framboids in matrix. X-axis of photo: 0.45mm. Refl. Light.

DGR5-692.35 illite matrix
ZAF cycles 6 bc drift=1.033

	fac	%el	%ox	stfm
SiO_2	.68	25.07	53.63	10.380
Al_2O_3	.68	11.62	21.95	5.008
MgO	.60	4.11	6.81	1.966
FeO	.84	4.53	5.83	.944
K_2O	.84	5.48	6.60	1.630
Total		50.81	94.82	32

DGR5-692.35 calcite in matrix
ZAF cycles 4 bc drift=1.031

	fac	%el	%ox	stfm
CaO	.92	39.41	55.15	31.379
MgO	.50	.27	.45	.358
FeO	.82	.46	.59	.263
Total		40.15	56.19	32

DGR5-692.35 illite matrix
ZAF cycles 6 bc drift=1.024

	fac	%el	%ox	stfm
SiO_2	.67	24.22	51.80	9.844
Al_2O_3	.70	14.21	26.85	6.013
MgO	.61	2.68	4.45	1.260
FeO	.84	4.45	5.73	.910
K_2O	.84	7.68	9.25	2.243
Total		53.24	98.07	32

DGR5-692.35 illite matraix
ZAF cycles 6 bc drift=1.022

	fac	%el	%ox	stfm
SiO_2	.69	25.60	54.76	10.563
Al_2O_3	.70	12.17	23.00	5.231
MgO	.61	2.66	4.41	1.268
FeO	.84	3.78	4.86	.784
K_2O	.84	6.58	7.92	1.950
Total		50.79	94.96	32

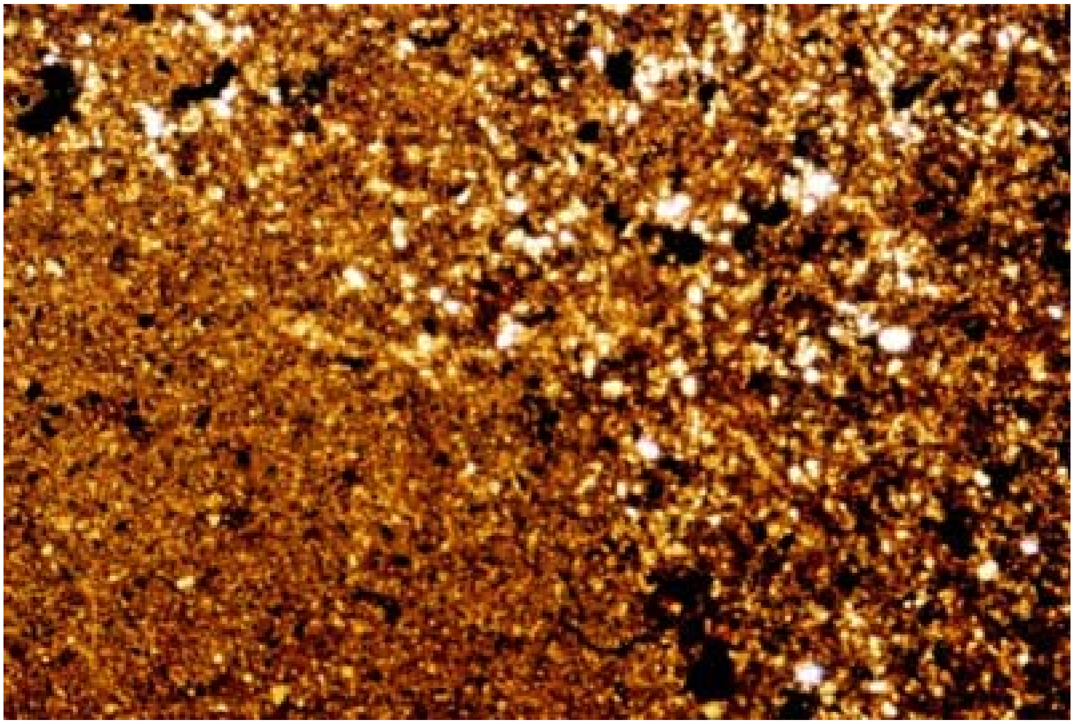
Sample Number: DGR5-699.49 **Rock Type: Oxidized calcareous mudstone / siltstone**

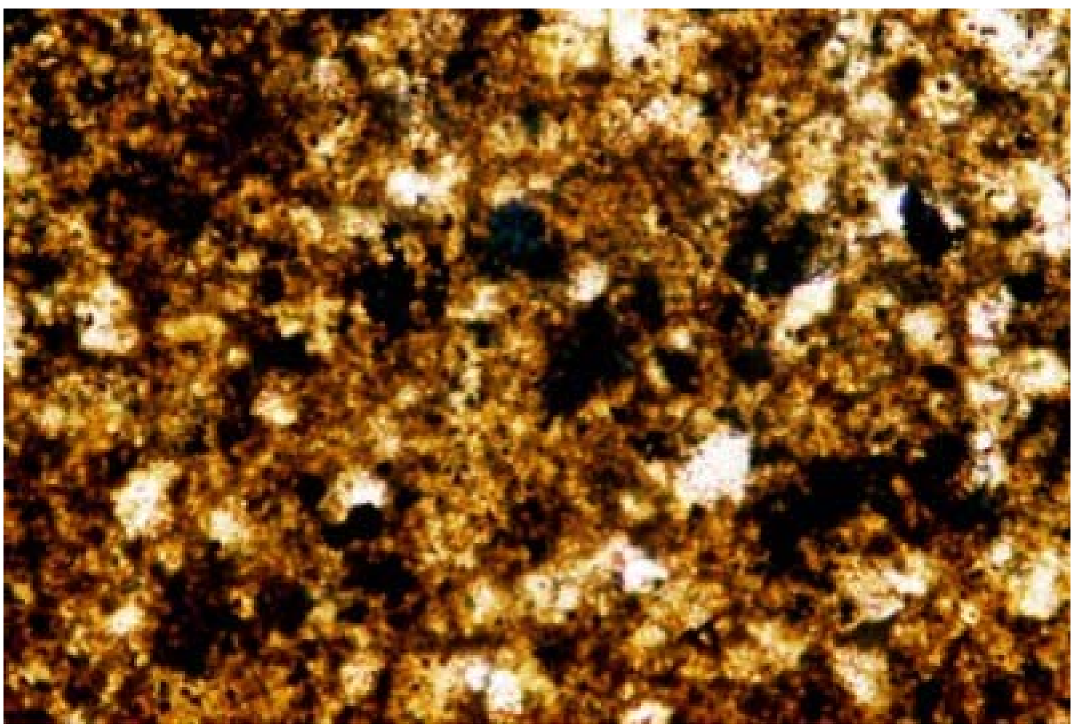
Petrographic Description:

A very fine-grained and highly oxidized rock that contains small clots of slightly more coarse-grained sediment fragments than the matrix. These fragments consist predominantly of carbonate, quartz and lesser illite. They have higher proportion of carbonate and quartz than the nearly microcrystalline matrix. The carbonate and quartz clasts are anhedral, and illite is interstitial to both minerals. A few grains of illite occur as small needles that over-grow the fine-grained matrix. These represent a second generation of micas. The texture of the fine-grained matrix in the rock is comparable to the texture and mineralogy of the previous calcareous mudstones. The only significant difference is, the higher degree of oxidation. Small fragments that appear to be oxyhydroxide are disseminated through the rock and over-grow some of the minerals.

Fine-grained pyrite framboids are disseminated through the rock. The minute framboids also occur in aggregates that partly replace, what appear to be carbonate clasts.

Mineral	%
Illite	50
Carbonate	25
Quartz	10
Fe-hydroxide	15
Pyrite	0.2


A. Oxidized mudstone / siltstone. Note the change in grain size between domains.
X-axis of photo: 2.3mm. Ppl.


B. Oxidized rock with inclusions of carbonate (white) and pyrite (black).
X-axis of photo: 0.45mm. Ppl.

DGR5-699.49 illite matrix
ZAF cycles 6 bc drift= .971

	fac	%el	%ox	stfm
SiO2	.68	24.58	52.59	10.154
Al2O3	.70	13.51	25.52	5.809
MgO	.61	2.77	4.60	1.323
FeO	.84	3.15	4.06	.655
K2O	.84	6.74	8.12	2.001
Total		50.76	94.90	32

DGR5-699.46 illite matrix
ZAF cycles 6 bc drift=1.024

	fac	%el	%ox	stfm
SiO2	.68	23.10	49.43	10.034
Al2O3	.68	12.68	23.95	5.732
MgO	.60	2.95	4.89	1.481
FeO	.84	4.59	5.90	1.002
K2O	.85	5.45	6.56	1.699
Total		48.77	90.74	32

DGR5-699.49 illite matrix
ZAF cycles 6 bc drift=1.036

	fac	%el	%ox	stfm
SiO2	.67	24.12	51.61	10.177
Al2O3	.66	11.47	21.67	5.037
MgO	.57	3.39	5.62	1.654
FeO	.84	8.99	11.56	1.906
K2O	.85	3.49	4.20	1.057
Total		51.46	94.66	32

Sample Number: DGR5-704.99 **Rock Type: Wackestone**

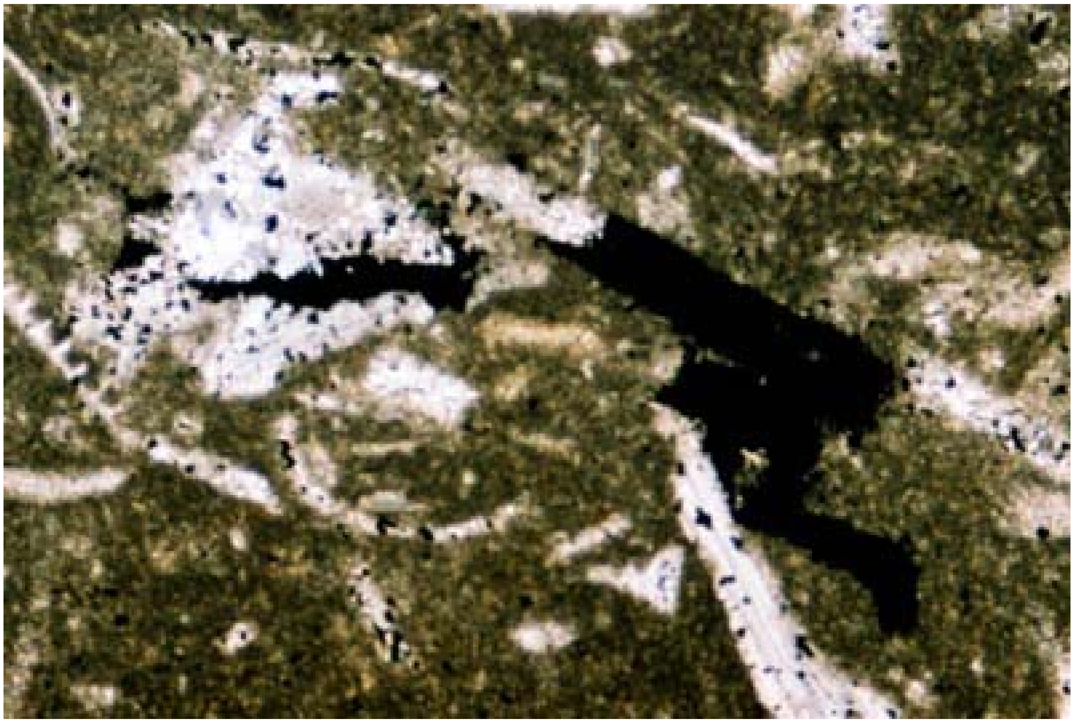
Petrographic Description:

A medium-grained, partly recrystallized wackestone that consists of crinoids and bryozoan fragments set in fine-grained matrix of carbonate (limey mudstone). Approximately 20% of the fossils recrystallized to blocky aggregates of calcite, which in turn, are partly replaced by aggregates of fine-grained pyrite. Most replacement calcite are pure, only some contain 0.5 wt% MgO, whereas the fine-grained matrix carbonate is generally pure calcite, but may contain up to 1 wt% FeO and 0.5 wt% MgO. Intergranular pore space was not observed in the recrystallized carbonates. Most fossils are partly recrystallized at the grain boundaries, and they are rimmed by very fine-grained aggregates of calcite. Partial recrystallization of the matrix is observed in several domains.

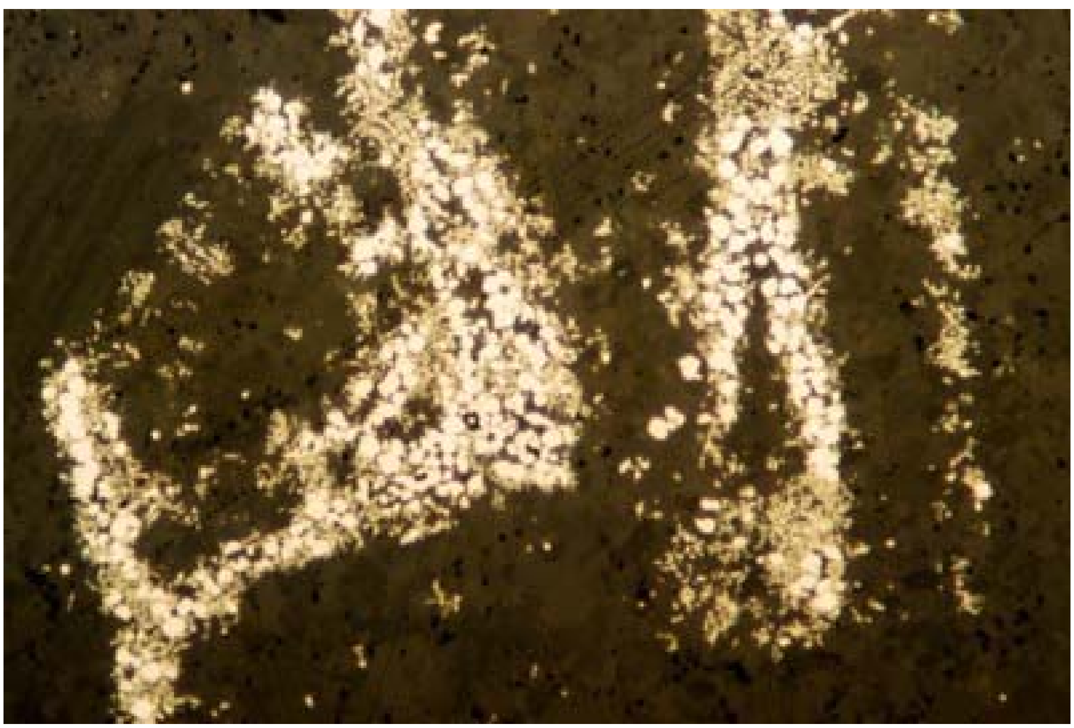
An interesting feature in the rock is, the presence of small, anhedral fragments of brown (Fe-stained?) apatite. The one apatite analyzed by electron microprobe, contains 0.39 wt% Cl and 0.6 wt% SO3. The anhedral grains are rimmed by a mixture of fine-grained calcite and Fe-stained muscovite. The size of the apatite fragments ranges between <0.1-0.2 mm. Although the morphology and color of the grains are comparable to the apatite previously identified in sample DGR4-740.82, they are not hydrated, nor are they associated with recrystallized carbonates and with graphite. About 2 dozens of such small, anhedral grains were identified in the thin section.

Pyrite is abundant in the rock. It represents a late mineral, partly replacing the recrystallized fossils. Minute grains also occur as small inclusions (or over-print?) in some of the fossil fragments. Several domains in the rock consist of aggregates of small pyrite framboids.

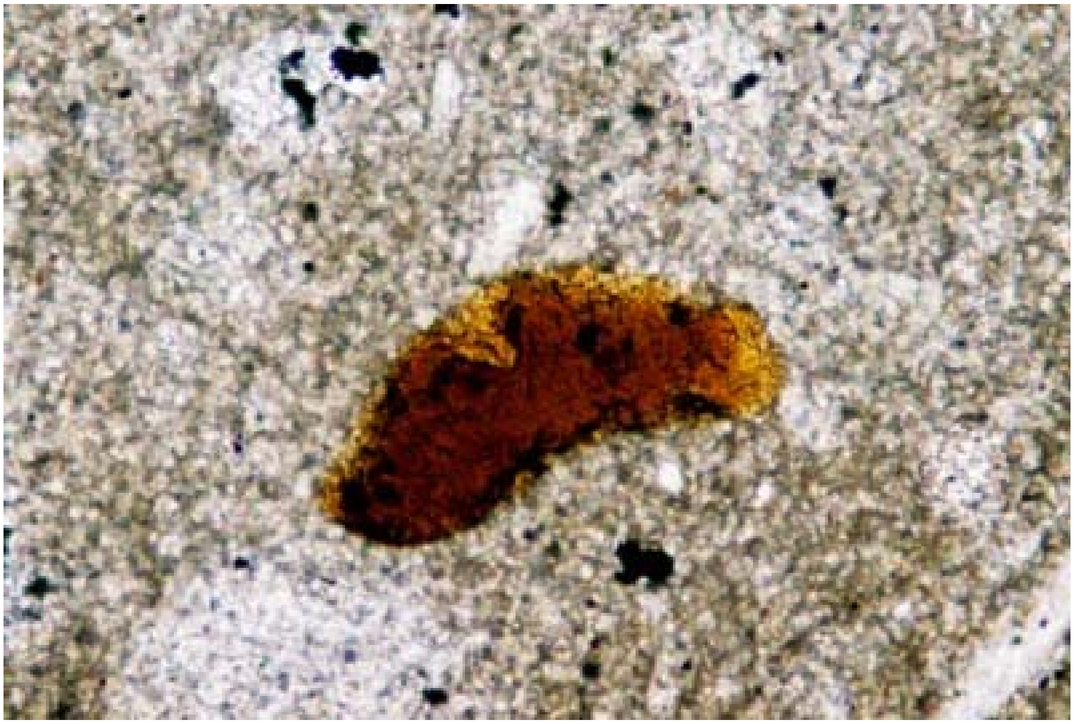
Mineral	%
Fossils (calcite)	20
Recryst. Fossils (calcite)	5
Matrix calcite	70
Pyrite	5
Apatite	0.1
Muscovite	trace



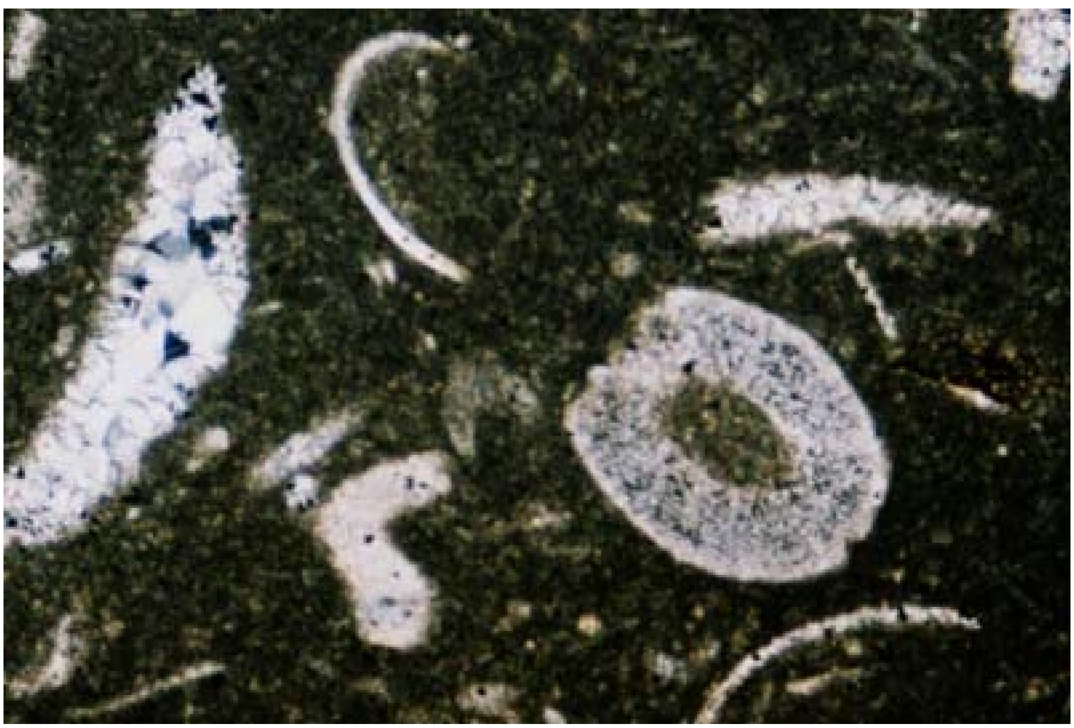
A. Black pyrite replaces carbonate-altered fossil fragments.
X-axis of photo: 2.3mm. XN.



B. Fossils are partly replaced by fine-grained pyrite.
X-axis of photo: 0.45mm. Refl. Light.



C. Fe-stained anhedral apatite is rimmed by fine-grained mixture of calcite and muscovite. X-axis of photo: 0.45mm. Ppl.



D. Fragments of echinoderm in fine-grained matrix of wackestone.
X-axis of photo: 2.3mm. XN.

DGR5-704.99 brown anhedral apatite
ZAF cycles 4 bc drift= .887

	fac	%el	%ox	stfm
CaO	.88	39.01	54.58	.391
P2O5	.87	18.52	42.43	.240
SO3	.77	.24	.60	.003
Cl	.83	.39	.39	.004
Total		58.16	98.00	1

DGR5-704.99 calcite + muscovite rim on apatite
ZAF cycles 4 bc drift= .952

	fac	%el	%ox	stfm
CaO	.91	39.09	54.69	.781
SiO2	.76	2.68	5.74	.076
Al2O3	.64	1.19	2.25	.035
K2O	1.04	1.24	1.49	.025
Total		44.19	64.16	1

DGR5-704.99 calcite + muscovite rim on apatite
ZAF cycles 4 bc drift= .952

	fac	%el	%ox	stfm
CaO	.91	39.10	54.71	.772
SiO2	.75	2.69	5.75	.076
Al2O3	.64	1.23	2.33	.036
MgO	.51	.30	.50	.010
FeO	.82	.00	.00	.000
K2O	1.04	1.24	1.49	.025
Total		44.56	64.78	1

DGR5-704.99 'blocky' replacement calcite in aggregate
ZAF cycles 4 bc drift= .979

	fac	%el	%ox	stfm
CaO	.92	42.30	59.18	.988
MgO	.50	.32	.53	.012
FeO	.82	.00	.00	.000
Total		42.62	59.71	1

DGR5-704.99 'blocky' replacement carbonate
ZAF cycles 4 bc drift= .982

	fac	%el	%ox	stfm
CaO	.92	42.62	59.63	1.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		42.62	59.63	1

DGR5-704.99 fine grained carbonate matrix
ZAF cycles 4 bc drift= .982

	fac	%el	%ox	stfm
CaO	.92	42.62	59.63	1.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		42.62	59.63	1

DGR5-704.99 fine grained carbonate matrix

ZAF cycles 4 bc drift= .988

	fac	%el	%ox	stfm
CaO	.92	40.29	56.38	.972
MgO	.49	.35	.58	.014
FeO	.82	.79	1.02	.014
Total		41.43	57.98	1

Sample Number: DGR5-715.40 **Rock Type: Wackestone**

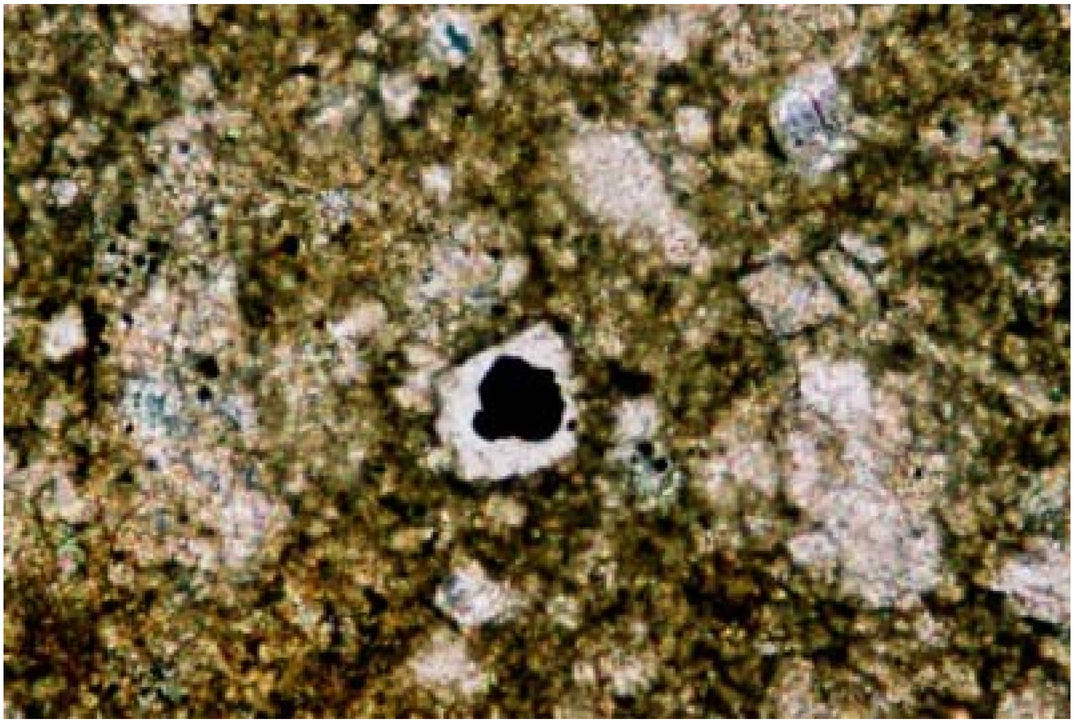
Petrographic Description:

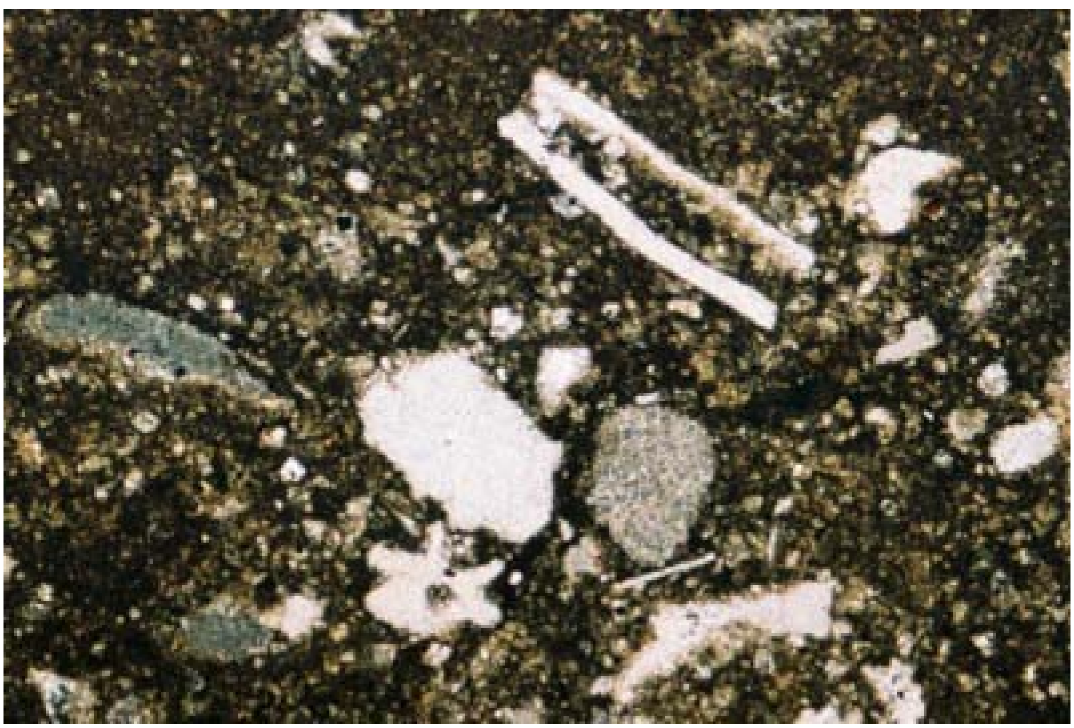
A wackestone that consists of several rock fragments. Although all fragments contain variable proportions of very fine-grained to fine-grained matrix consisting of calcite, some of which are mixed with minor illite, there are significant differences in various domains between grain size of the matrix and the extent of recrystallization (and break-down) of the fossil fragments. This suggests that the sample consists of a chaotic mixture of rock fragments. Secondary dolomite occurs in the rock as small rhombs, some of which over-grow pre-existing fine-grained pyrite (see photomicrograph). The matrix in some domains (where recrystallization is extensive), consists almost entirely of fine-grained, euhedral secondary dolomite, whereas in other domains, it consists of microcrystalline, mud-size calcite and illite – and dolomite is absent. In the latter, individual minerals are micron size. Although optically unidentifiable, microprobe analysis obtained from the fine-grained matrix, revealed the intergrowth of calcite and illite (Appendix). Small (0.3mm) anhedral grains that resemble the Fe-stained apatite in sample DGR5-704.99 are interstitial to some of the matrix.

The fossils that consist mostly of fragments derived from echinoderms, bryozoan and sponges range in size from <0.5 mm to >3.5 mm. Most have sutured grain boundaries, and their texture suggests an advanced stage of dissolution. Some recrystallized in the center to blocky aggregates of calcite, whereas others are dissolved into the mud-like matrix of calcite and illite.

Fine-grained pyrite occurs in aggregates and as single grains. Some are included in secondary dolomite, suggesting their original presence in the rock. Their morphology is different from the previous rocks, as most are subhedral, angular grains and not framboids. This implies that they are probably detrital and not diagenetic in origin.

Mineral	**%**
Calcite (matrix)	30
Dolomite	10
Fossils	30
Illite	10
Irresolvable	20
Apatite	trace
Pyrite	0.3


A. Pyrite (black) is included in late dolomite rhomb. Rest of the matrix consists of calcite and dolomite. X-axis of photo: 2.3mm. XN.


B. Fossil fragments in fine-grained matrix of illite and calcite in wackestone. X-axis of photo: 2.3mm. XN.

DGR5-715.4 dolomite rhomb
ZAF cycles 4 bc drift= .935

	fac	%el	%ox	stfm
CaO	.91	24.35	34.06	.577
MgO	.51	9.46	15.68	.370
FeO	.83	2.74	3.52	.047
SrO	.74	.59	.69	.006
Total		37.13	53.97	1

DGR5-715.4 illite/calcite matrix
ZAF cycles 5 bc drift= .969

	fac	%el	%ox	stfm
SiO2	.74	12.32	26.36	.234
Al2O3	.67	5.45	10.30	.108
K2O	.94	4.74	5.71	.065
FeO	.83	.55	.71	.005
MgO	.55	.87	1.45	.019
CaO	.87	23.60	33.02	.314
Total		47.54	77.55	1

DGR5-715.4 dolomite rhomb
ZAF cycles 4 bc drift= .973

	fac	%el	%ox	stfm
CaO	.91	25.57	35.77	.595
MgO	.51	9.43	15.64	.362
FeO	.83	2.44	3.14	.041
MnO	.81	.00	.00	.000
SrO	.74	.28	.33	.003
Total		37.71	54.87	1

Sample Number: DGR5-725.33 **Rock Type: Wackestone**

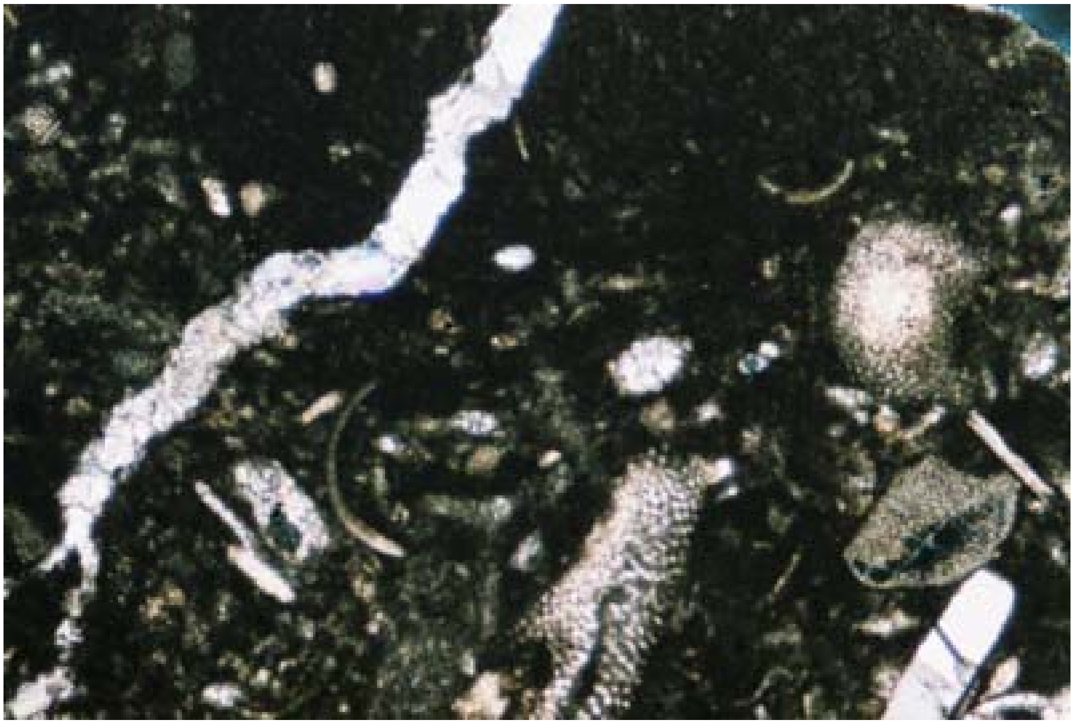
Petrographic Description:

The rock is comparable in grain size and mineralogy to the previous sample 715.40, but having a higher proportion of fossil to the matrix. The matrix ranges from mud-size particles that consist of intergrowth of calcite and illite, to recrystallized rhombs of dolomite. Illite is less abundant than in the previous rock, as suggested by the significantly lower concentration of SiO_2, Al_2O_3 and K_2O (Appendix). The dolomite rhombs contain some FeO, but the carbonate that crystallized after the breakdown of the fossils, is always pure calcite. A 3 mm long and ca. 0.01 mm wide calcite vein cross-cuts the rock matrix.

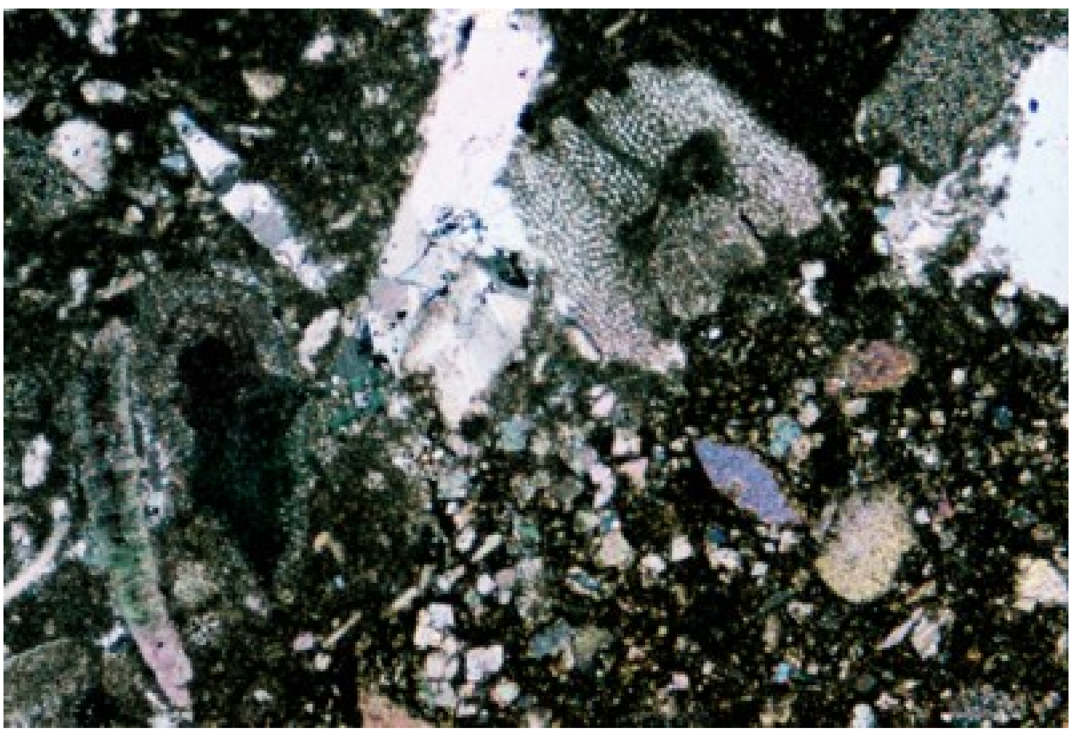
The fossils are relatively large fragments of echinoderms, bryozoan and sponges. Some have sutured selvages, due to partial dissolution, and also to partial recrystallization. The recrystallized selvages consist of very fine-grained, granular calcite, which often engulf part of the fossil. Such replacement takes place from rim to core, and is different from the replacement of fossils in the center by aggregates of relatively coarse-grained, blocky calcite. The complete replacement of fossil fragments is always by the blocky, interlocking calcite aggregates.

Fine-grained, mostly blocky pyrite occurs as inclusions in some of the fossils, but also as part of the matrix. They appear to replace the early carbonates. Some occur as minute veinlets that partly replace small fossil fragments.

Mineral	%
Calcite	20
Dolomite (2nd generation)	20
Fossils (calcite)	40
Illite	5
Pyrite	0.3
Irresolvable matrix	15



A. Small calcite vein in fossil-rich domain of wackestone. X-axis of photo: 2.3mm. XN.



B. Fossil-rich fragments and minute grains of dolomite rhombs in fine-grained matrix of clay-size calcite + illite. X-axis of photo: 2.3mm. XN.

DGR5-725.33 CALCITE VEIN
ZAF cycles 4 bc drift= .900

	fac	%el	%ox	stfm
CaO	.92	41.70	58.35	2.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		41.70	58.35	2

DGR5-725.33 dolomite rhomb
ZAF cycles 4 bc drift= .985

	fac	%el	%ox	stfm
CaO	.91	24.29	33.98	1.163
MgO	.52	9.99	16.57	.789
FeO	.83	1.42	1.83	.049
Total		35.70	52.38	2

DGR5-725.33 calcite after fossil
ZAF cycles 4 bc drift= .986

	fac	%el	%ox	stfm
CaO	.92	42.40	59.32	2.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		42.40	59.32	2

DGR5-725.33 calcite/illite matrix
ZAF cycles 4 bc drift= .986

	fac	%el	%ox	stfm
CaO	.90	35.14	49.16	1.270
SiO2	.75	4.71	10.08	.243
Al2O3	.64	2.07	3.91	.111
MgO	.52	.42	.70	.025
FeO	.82	.26	.33	.007
K2O	1.01	2.43	2.93	.090
Total		45.03	67.12	2

DGR5-725.33 calcite/illite matrix
ZAF cycles 4 bc drift= .991

	fac	%el	%ox	stfm
CaO	.89	25.78	36.07	.742
SiO2	.71	8.88	19.00	.365
Al2O3	.62	4.45	8.41	.190
MgO	.51	2.58	4.28	.122
FeO	.83	5.56	7.16	.115
K2O	.96	.45	.54	.013
Total		47.71	75.47	2

DGR5-725.33 calcite/illite matrix
ZAF cycles 4 bc drift= .993

	fac	%el	%ox	stfm
CaO	.91	37.31	52.20	1.456
SiO2	.75	2.85	6.10	.159
Al2O3	.63	1.69	3.20	.098
MgO	.51	.77	1.28	.050
FeO	.82	.52	.66	.014
K2O	1.03	.78	.94	.031
Total		43.92	64.38	2

Sample Number: DGR5-764.72 **Rock Type: Wackestone / packstone (weakly oxidized)**

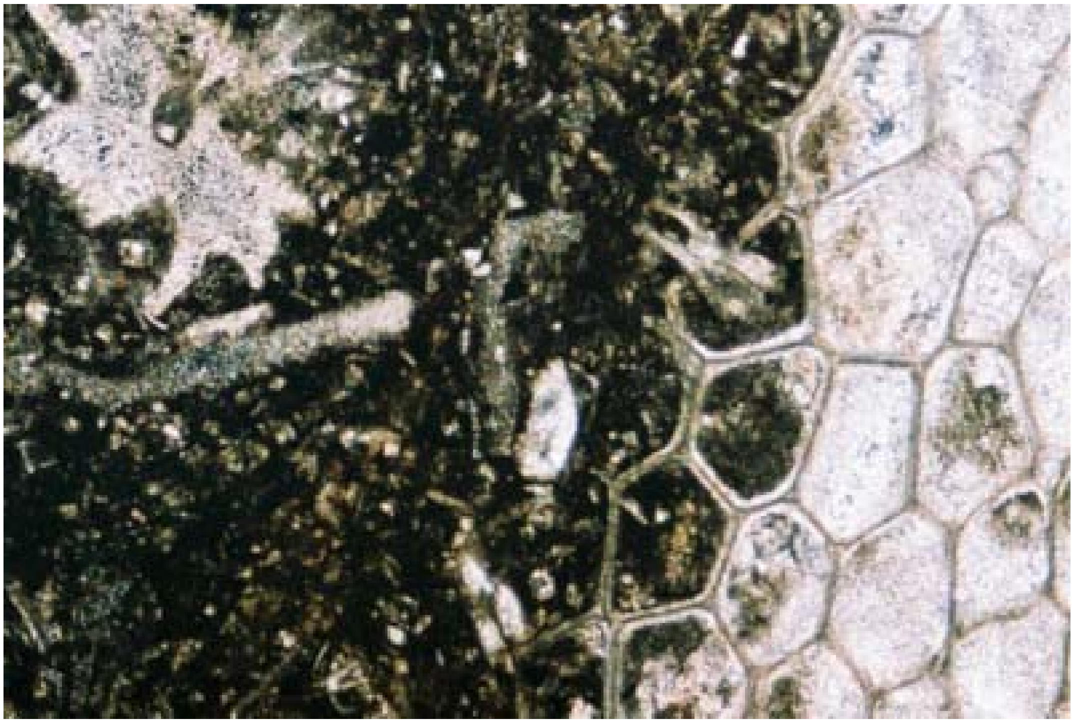
Petrographic Description:

A partly oxidized rock. Approximately ¼ of the thin section is covered by a 2 cm long partly recrystallized bryozoan fragment. The individual apertures of this large fossil fragment are recrystallized to aggregates of pure calcite, and some are filled by limey mud that consists of microcrystalline calcite and illite. Similar to the previous wackestones, the thin section contains fragments of echinoderms, bryozoan and sponges, a few of which are partly recrystallized to aggregates of blocky calcite. The matrix of the rock is variable, ranging from mud-size particles to fine-grained calcite and recrystallized euhedral rhombs of dolomite. The different grain size of carbonates in the matrix suggests the derivation of the matrix from more than one source. The overall mineralogy of the matrix consists of approximately ⅓ of calcite, and ⅔ of illite. The fossil fragments, apart from the bryozoan fragments, are relatively fine-grained, and together with the matrix, they show evidence of soft-sediment deformation (flow texture). A few small domains in the thin section consist of aggregates of fine-grained calcite.

The most abundant fossil fragments are partly recrystallized bryozoan, which were buried by limey, illite-rich mudstone. The center part of a few skeletal bryozoan fragments consist predominantly of limey mudstone (with illite). Several of the fossils have sutured, partly recrystallized grain boundaries, and are rimmed by very fine-grained granular calcite.

Fine-grained pyrite occurs as minute framboids and as angular, anhedral grains which are included in the fossil fragments and in the matrix. Some of the small recrystallized fossil fragments are rimmed by fine-grained pyrite.

Minerals	**%**
Calcite (matrix + aggr.)	20
Dolomite	5
Fossils (partly recrystall.)	60
Illite	10
Pyrite	trace
Irresolvable matrix	5



A. Very large bryozoan fragment is partly recrystallized to aggregates of calcite in individual apertures, and some sections are filled by fine-grained limey mud consisting of calcite and illite. X-axis of photo: 2.3mm. XN.

DGR5-764.72 matrix mixture: illite + calcite
ZAF cycles 5 bc drift= .999

	fac	%el	%ox	stfm
CaO	.85	15.54	21.75	5.398
SiO2	.72	19.06	40.77	9.444
Al2O3	.68	7.26	13.72	3.746
MgO	.58	1.91	3.18	1.096
FeO	.83	1.42	1.83	.355
K2O	.90	3.60	4.34	1.282
Total		48.80	85.59	32

DGR5-764.72 calcite after fossil
ZAF cycles 4 bc drift=1.015

	fac	%el	%ox	stfm
CaO	.92	41.10	57.50	32.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
SrO	.81	.00	.00	.000
Total		41.10	57.50	32

DGR5-764.72 dolomite rhomb

ZAF cycles 4 bc drift=1.012

	fac	%el	%ox	stfm
CaO	.91	24.92	34.87	19.515
MgO	.51	8.70	14.42	11.229
FeO	.83	2.24	2.88	1.257
SrO	.75	.00	.00	.000
Total		35.85	52.17	32

DGR5-764.72 matrix: illite + calcite

ZAF cycles 5 bc drift=1.010

	fac	%el	%ox	stfm
CaO	.84	10.59	14.82	3.729
SiO2	.72	19.14	40.94	9.616
Al2O3	.68	8.32	15.73	4.355
MgO	.58	1.88	3.12	1.092
FeO	.83	1.80	2.32	.456
K2O	.88	5.31	6.39	1.915
Cl	.80	.30	.30	.118
Total		47.34	83.62	32

APPENDIX
DGR-5 Microprobe Analysis of Selected Minerals

DGR5-538.4 calcite core
ZAF cycles 4 bc drift= .997

	fac	%el	%ox	stfm
CaO	.92	39.41	55.14	1.988
MgO	.50	.00	.00	.000
FeO	.82	.33	.43	.012
Total		39.74	55.57	2

DGR5-538.4 dolomite rim
ZAF cycles 4 bc drift=1.006

	fac	%el	%ox	stfm
CaO	.91	23.50	32.88	1.191
MgO	.49	7.05	11.69	.590
FeO	.83	5.22	6.71	.190
MnO	.82	.79	1.02	.029
Total		36.56	52.31	2

DGR5-538.4 mucovite
ZAF cycles 6 bc drift=1.007

	fac	%el	%ox	stfm
SiO2	.65	21.35	45.68	5.467
Al2O3	.74	19.24	36.35	5.128
TiO2	.81	.33	.54	.049
FeO	.83	.56	.73	.073
MgO	.64	1.31	2.17	.388
K2O	.85	8.87	10.68	1.631
Total		51.66	96.16	20

DGR5-538.4 large dolomite
ZAF cycles 4 bc drift=1.001

	fac	%el	%ox	stfm
CaO	.91	24.98	34.95	11.858
MgO	.52	9.86	16.34	7.715
FeO	.83	1.25	1.61	.428
Total		36.09	52.91	20

DGR5-538.4 K feldspar
ZAF cycles 5 bc drift=1.005

	fac	%el	%ox	stfm
SiO2	.74	30.12	64.43	11.929
Al2O3	.75	9.89	18.69	4.080
FeO	.83	.87	1.12	.174
K2O	.84	12.98	15.64	3.694
Cl	.76	.30	.30	.095
Total		54.16	100.18	32

DGR5-538.4 large dolomite
ZAF cycles 4 bc drift=1.009

	fac	%el	%ox	stfm
CaO	.91	22.63	31.66	17.293
MgO	.51	10.19	16.89	12.836
FeO	.83	2.99	3.84	1.638
MnO	.81	.42	.54	.234
Total		36.22	52.94	32

DGR5-605.55 halite in Vein
ZAF cycles 5 bc drift= .964

	fac	%el	stfm
Cl	.90	59.83	19.182
Na	.65	38.67	12.396
S	.92	.00	.000
Total		98.50	1

DGR5-605.55 calcite in vein
ZAF cycles 4 bc drift= .969

	fac	%el	%ox	stfm
CaO	.92	39.33	55.03	.980
GeO2	.54	.00	.00	.000
MnO	.80	1.09	1.40	.020
Total		40.42	56.44	1

DGR5-605.55 halite vein
ZAF cycles 5 bc drift= .969

	fac	%el	stfm
Cl	.90	59.40	.017
Na	.65	38.64	.017
Total		98.04	1

DGR5-605.55 celestite in vein
ZAF cycles 5 bc drift= .972

	fac	%el	%ox	stfm
SrO	.81	38.02	44.96	.896
BaO	.74	16.50	18.43	.248
SO3	.60	14.79	36.92	.952
Total		69.31	100.30	4

DGR5-605.55 celestite vein margin
ZAF cycles 5 bc drift= .972

	fac	%el	%ox	stfm
SrO	.83	37.63	44.50	.901
BaO	.73	11.22	12.53	.172
SO3	.60	14.90	37.22	.976
Total		63.75	94.24	4

DGR5-605.55 celestite in vein
ZAF cycles 5 bc drift= .974

	fac	%el	%ox	stfm
SrO	.82	36.58	43.26	.826
BaO	.73	13.15	14.68	.189
SO3	.61	16.11	40.23	.995
Total		65.84	98.17	4

DGR5-605.55 halite in vein
ZAF cycles 6 bc drift= .978

	fac	%el	stfm
Na	.66	39.30	.017
Cl	.90	59.91	.017
Total		99.21	1

DGR5-605.55 calcite in vein
ZAF cycles 4 bc drift= .975

	fac	%el	%ox	stfm
CaO	.92	40.04	56.02	3.955
MnO	.80	.38	.49	.027
FeO	.82	.24	.31	.017
SrO	.81	.00	.00	.000
Cl	.94	.25	.25	.028
Total		40.91	57.07	4

DGR5-605.55 halite vein
ZAF cycles 5 bc drift= .970

	fac	%el	stfm
Na	.64	37.12	.016
Cl	.90	60.10	.017
Total		97.22	1

DGR5-605.55 halite vein
ZAF cycles 5 bc drift= .977

	fac	%el	stfm
Na	.65	37.63	.016
Cl	.90	60.21	.017
Total		97.84	1

DGR5-605.55 dolomite in matrix
ZAF cycles 4 bc drift= .974

	fac	%el	%ox	stfm
CaO	.90	22.66	31.71	.522
MgO	.53	12.42	20.59	.472
SrO	.73	.52	.62	.006
Total		35.60	52.92	1

DGR5-605.55 micaceous matrix
ZAF cycles 5 bc drift= .976

	fac	%el	%ox	stfm
SiO2	.69	20.46	43.76	.319
Al2O3	.67	10.07	19.02	.163
CaO	.84	.28	.39	.003
MgO	.56	1.82	3.02	.033
FeO	.84	6.35	8.17	.050
MnO	.83	.00	.00	.000
K2O	.86	5.52	6.64	.062
Total		44.49	81.01	1

DGR5-605.55 micaceous matrix
ZAF cycles 5 bc drift= .976

	fac	%el	%ox	stfm
SiO2	.69	22.37	47.85	.323
Al2O3	.68	10.56	19.95	.159
CaO	.83	.72	1.01	.007
MgO	.57	2.06	3.42	.034
FeO	.84	6.08	7.82	.044
MnO	.83	.00	.00	.000
K2O	.86	5.92	7.13	.061
Total		47.71	87.18	1

DGR5-645.16 albite

ZAF cycles 7 bc drift=1.041

	fac	%el	%ox	stfm
SiO2	.71	31.69	67.79	11.885
Al2O3	.71	10.48	19.80	4.091
CaO	.83	.48	.67	.125
K2O	.83	1.08	1.31	.292
Na2O	.50	7.94	10.70	3.639
Total		51.67	100.27	32

DGR5-645.16 illite matrix
ZAF cycles 5 bc drift=1.023

	fac	%el	%ox	stfm
SiO2	.70	23.39	50.05	10.920
Al2O3	.69	10.20	19.27	4.956
MgO	.59	1.96	3.25	1.057
FeO	.84	3.28	4.22	.770
K2O	.85	5.36	6.45	1.796
Total		44.19	83.24	32

DGR5-645.16 illite matrix
ZAF cycles 5 bc drift=1.035

	fac	%el	%ox	stfm
SiO2	.70	25.72	55.03	11.245
Al2O3	.68	9.59	18.12	4.366
MgO	.59	2.37	3.93	1.196
FeO	.84	5.08	6.54	1.118
K2O	.85	4.11	4.96	1.292
Total		46.88	88.57	32

DGR5-645.16 illite matrix
ZAF cycles 5 bc drift=1.039

	fac	%el	%ox	stfm
SiO2	.71	26.18	56.00	11.289
Al2O3	.70	10.09	19.07	4.531
MgO	.60	2.30	3.81	1.145
FeO	.84	3.40	4.37	.737
K2O	.84	4.78	5.76	1.482
Total		46.75	89.01	32

DGR5-645.16 dolomite rhomb
ZAF cycles 4 bc drift=1.033

	fac	%el	%ox	stfm
CaO	.91	23.65	33.09	19.061
MgO	.48	6.75	11.19	8.963
FeO	.84	5.68	7.30	3.284
MnO	.82	1.18	1.52	.693
Total		37.25	53.11	32

DGR5-645.16 dolomite rhomb
ZAF cycles 4 bc drift=1.030

	fac	%el	%ox	stfm
CaO	.91	24.61	34.43	19.801
MgO	.48	6.19	10.27	8.214
FeO	.84	5.87	7.56	3.392
MnO	.82	1.01	1.31	.594
Total		37.68	53.56	32

DGR5-645.16 dolomite rim
ZAF cycles 4 bc drift=1.022

	fac	%el	%ox	stfm

CaO	.91	23.37	32.70	18.120
MgO	.50	8.76	14.53	11.202
FeO	.83	4.46	5.74	2.482
MnO	.82	.35	.45	.196
Total		36.94	53.42	32

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DGR5-677.25 illite matrix
ZAF cycles 6 bc drift=1.037

	fac	%el	%ox	stfm
SiO2	.71	29.04	62.13	11.555
Al2O3	.72	10.91	20.62	4.521
MgO	.62	1.87	3.10	.859
FeO	.83	2.19	2.82	.439
K2O	.84	5.66	6.82	1.618
Total		49.68	95.50	32

DGR5-677.25 illite matrix
ZAF cycles 6 bc drift=1.041

	fac	%el	%ox	stfm
SiO2	.71	28.53	61.04	11.552
Al2O3	.70	9.82	18.56	4.140
MgO	.61	2.88	4.78	1.349
FeO	.84	3.83	4.92	.779
K2O	.84	3.83	4.62	1.115
Total		48.90	93.91	32

DGR5-677.25 illite matrix
ZAF cycles 6 bc drift=1.039

	fac	%el	%ox	stfm
SiO2	.69	25.27	54.07	10.449
Al2O3	.70	12.55	23.72	5.404
MgO	.61	2.85	4.73	1.361
FeO	.84	3.25	4.18	.675
K2O	.84	6.46	7.78	1.919
Total		50.39	94.48	32

DGR5-677.25 calcite
ZAF cycles 4 bc drift=1.015

	fac	%el	%ox	stfm
CaO	.92	36.15	50.59	31.677
MgO	.49	.00	.00	.000
FeO	.82	.51	.66	.323
Total		36.67	51.25	32

DGR5-692.35 illite matrix
ZAF cycles 6 bc drift=1.033

	fac	%el	%ox	stfm
SiO2	.68	25.07	53.63	10.380
Al2O3	.68	11.62	21.95	5.008
MgO	.60	4.11	6.81	1.966
FeO	.84	4.53	5.83	.944
K2O	.84	5.48	6.60	1.630
Total		50.81	94.82	32

DGR5-692.35 calcite in matrix
ZAF cycles 4 bc drift=1.031

	fac	%el	%ox	stfm
CaO	.92	39.41	55.15	31.379
MgO	.50	.27	.45	.358
FeO	.82	.46	.59	.263
Total		40.15	56.19	32

DGR5-692.35 illite matrix
ZAF cycles 6 bc drift=1.024

	fac	%el	%ox	stfm
SiO2	.67	24.22	51.80	9.844
Al2O3	.70	14.21	26.85	6.013
MgO	.61	2.68	4.45	1.260
FeO	.84	4.45	5.73	.910
K2O	.84	7.68	9.25	2.243
Total		53.24	98.07	32

DGR5-692.35 illite matraix
ZAF cycles 6 bc drift=1.022

	fac	%el	%ox	stfm
SiO2	.69	25.60	54.76	10.563
Al2O3	.70	12.17	23.00	5.231
MgO	.61	2.66	4.41	1.268
FeO	.84	3.78	4.86	.784
K2O	.84	6.58	7.92	1.950
Total		50.79	94.96	32

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DGR5-699.49 illite matrix
ZAF cycles 6 bc drift= .971

	fac	%el	%ox	stfm
SiO2	.68	24.58	52.59	10.154
Al2O3	.70	13.51	25.52	5.809
MgO	.61	2.77	4.60	1.323
FeO	.84	3.15	4.06	.655
K2O	.84	6.74	8.12	2.001
Total		50.76	94.90	32

DGR5-699.46 illite matrix

ZAF cycles 6 bc drift=1.024

	fac	%el	%ox	stfm
SiO2	.68	23.10	49.43	10.034
Al2O3	.68	12.68	23.95	5.732
MgO	.60	2.95	4.89	1.481
FeO	.84	4.59	5.90	1.002
K2O	.85	5.45	6.56	1.699
Total		48.77	90.74	32

DGR5-699.49 illite matrix

ZAF cycles 6 bc drift=1.036

	fac	%el	%ox	stfm
SiO2	.67	24.12	51.61	10.177
Al2O3	.66	11.47	21.67	5.037
MgO	.57	3.39	5.62	1.654
FeO	.84	8.99	11.56	1.906
K2O	.85	3.49	4.20	1.057
Total		51.46	94.66	32

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DGR5-704.99 brown anhedral apatite

ZAF cycles 4 bc drift= .887

	fac	%el	%ox	stfm
CaO	.88	39.01	54.58	.391
P2O5	.87	18.52	42.43	.240
SO3	.77	.24	.60	.003
Cl	.83	.39	.39	.004
Total		58.16	98.00	1

DGR5-704.99 calcite + muscovite rim on apatite

ZAF cycles 4 bc drift= .952

	fac	%el	%ox	stfm
CaO	.91	39.09	54.69	.781
SiO2	.76	2.68	5.74	.076
Al2O3	.64	1.19	2.25	.035
K2O	1.04	1.24	1.49	.025
Total		44.19	64.16	1

DGR5-704.99 calcite + muscovite rim on apatite

ZAF cycles 4 bc drift= .952

	fac	%el	%ox	stfm
CaO	.91	39.10	54.71	.772
SiO2	.75	2.69	5.75	.076
Al2O3	.64	1.23	2.33	.036
MgO	.51	.30	.50	.010
FeO	.82	.00	.00	.000
K2O	1.04	1.24	1.49	.025
Total		44.56	64.78	1

DGR5-704.99 'blocky' replacement calcite aggregate
ZAF cycles 4 bc drift= .979

	fac	%el	%ox	stfm
CaO	.92	42.30	59.18	.988
MgO	.50	.32	.53	.012
FeO	.82	.00	.00	.000
Total		42.62	59.71	1

DGR5-704.99 'blocky' replacement carbonate
ZAF cycles 4 bc drift= .982

	fac	%el	%ox	stfm
CaO	.92	42.62	59.63	1.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		42.62	59.63	1

DGR5-704.99 fine grained carbonate matrix
ZAF cycles 4 bc drift= .982

	fac	%el	%ox	stfm
CaO	.92	42.62	59.63	1.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		42.62	59.63	1

DGR5-704.99 fine grained carbonate matrix
ZAF cycles 4 bc drift= .988

	fac	%el	%ox	stfm
CaO	.92	40.29	56.38	.972
MgO	.49	.35	.58	.014
FeO	.82	.79	1.02	.014
Total		41.43	57.98	1

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DGR5-715.4 dolomite rhomb
ZAF cycles 4 bc drift= .935

	fac	%el	%ox	stfm
CaO	.91	24.35	34.06	.577
MgO	.51	9.46	15.68	.370
FeO	.83	2.74	3.52	.047
SrO	.74	.59	.69	.006
Total		37.13	53.97	1

DGR5-715.4 illite/calcite matrix
ZAF cycles 5 bc drift= .969

	fac	%el	%ox	stfm
SiO2	.74	12.32	26.36	.234
Al2O3	.67	5.45	10.30	.108
K2O	.94	4.74	5.71	.065
FeO	.83	.55	.71	.005
MgO	.55	.87	1.45	.019
CaO	.87	23.60	33.02	.314
Total		47.54	77.55	1

DGR5-715.4 dolomite rhomb
ZAF cycles 4 bc drift= .973

	fac	%el	%ox	stfm
CaO	.91	25.57	35.77	.595
MgO	.51	9.43	15.64	.362
FeO	.83	2.44	3.14	.041
MnO	.81	.00	.00	.000
SrO	.74	.28	.33	.003
Total		37.71	54.87	1

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DGR5-725.33 CALCITE VEIN
ZAF cycles 4 bc drift= .900

	fac	%el	%ox	stfm
CaO	.92	41.70	58.35	2.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		41.70	58.35	2

DGR5-725.33 dolomite rhomb
ZAF cycles 4 bc drift= .985

	fac	%el	%ox	stfm
CaO	.91	24.29	33.98	1.163
MgO	.52	9.99	16.57	.789
FeO	.83	1.42	1.83	.049
Total		35.70	52.38	2

DGR5-725.33 calcite after fossil
ZAF cycles 4 bc drift= .986

	fac	%el	%ox	stfm
CaO	.92	42.40	59.32	2.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		42.40	59.32	2

DGR5-725.33 calcite/illite matrix
ZAF cycles 4 bc drift= .986

	fac	%el	%ox	stfm
CaO	.90	35.14	49.16	1.270
SiO2	.75	4.71	10.08	.243
Al2O3	.64	2.07	3.91	.111
MgO	.52	.42	.70	.025
FeO	.82	.26	.33	.007
K2O	1.01	2.43	2.93	.090
Total		45.03	67.12	2

DGR5-725.33 calcite/illite matrix
ZAF cycles 4 bc drift= .991

	fac	%el	%ox	stfm
CaO	.89	25.78	36.07	.742
SiO2	.71	8.88	19.00	.365
Al2O3	.62	4.45	8.41	.190
MgO	.51	2.58	4.28	.122
FeO	.83	5.56	7.16	.115
K2O	.96	.45	.54	.013
Total		47.71	75.47	2

DGR5-725.33 calcite/illite matrix

ZAF cycles 4 bc drift= .993

	fac	%el	%ox	stfm
CaO	.91	37.31	52.20	1.456
SiO2	.75	2.85	6.10	.159
Al2O3	.63	1.69	3.20	.098
MgO	.51	.77	1.28	.050
FeO	.82	.52	.66	.014
K2O	1.03	.78	.94	.031
Total		43.92	64.38	2

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DGR5-764.72 matrix mixture: illite + calcite

ZAF cycles 5 bc drift= .999

	fac	%el	%ox	stfm
CaO	.85	15.54	21.75	5.398
SiO2	.72	19.06	40.77	9.444
Al2O3	.68	7.26	13.72	3.746
MgO	.58	1.91	3.18	1.096
FeO	.83	1.42	1.83	.355
K2O	.90	3.60	4.34	1.282
Total		48.80	85.59	32

DGR5-764.72 calcite after fossil

ZAF cycles 4 bc drift=1.015

	fac	%el	%ox	stfm
CaO	.92	41.10	57.50	32.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
SrO	.81	.00	.00	.000
Total		41.10	57.50	32

DGR5-764.72 dolomite rhomb

ZAF cycles 4 bc drift=1.012

	fac	%el	%ox	stfm
CaO	.91	24.92	34.87	19.515
MgO	.51	8.70	14.42	11.229
FeO	.83	2.24	2.88	1.257
SrO	.75	.00	.00	.000
Total		35.85	52.17	32

DGR5-764.72 matrix: illite + calcite

ZAF cycles 5 bc drift=1.010

	fac	%el	%ox	stfm
CaO	.84	10.59	14.82	3.729
SiO2	.72	19.14	40.94	9.616
Al2O3	.68	8.32	15.73	4.355
MgO	.58	1.88	3.12	1.092
FeO	.83	1.80	2.32	.456
K2O	.88	5.31	6.39	1.915
Cl	.80	.30	.30	.118
Total		47.34	83.62	32

APPENDIX B

Petrography (with Photomicrographs) – DGR-6

Ppl = plane polarized light

XN = crossed nicols

Refl. Light = reflected light

Sample Number: 654.58 **Rock Type: Oxidized calcareous siltstone / mudstone**

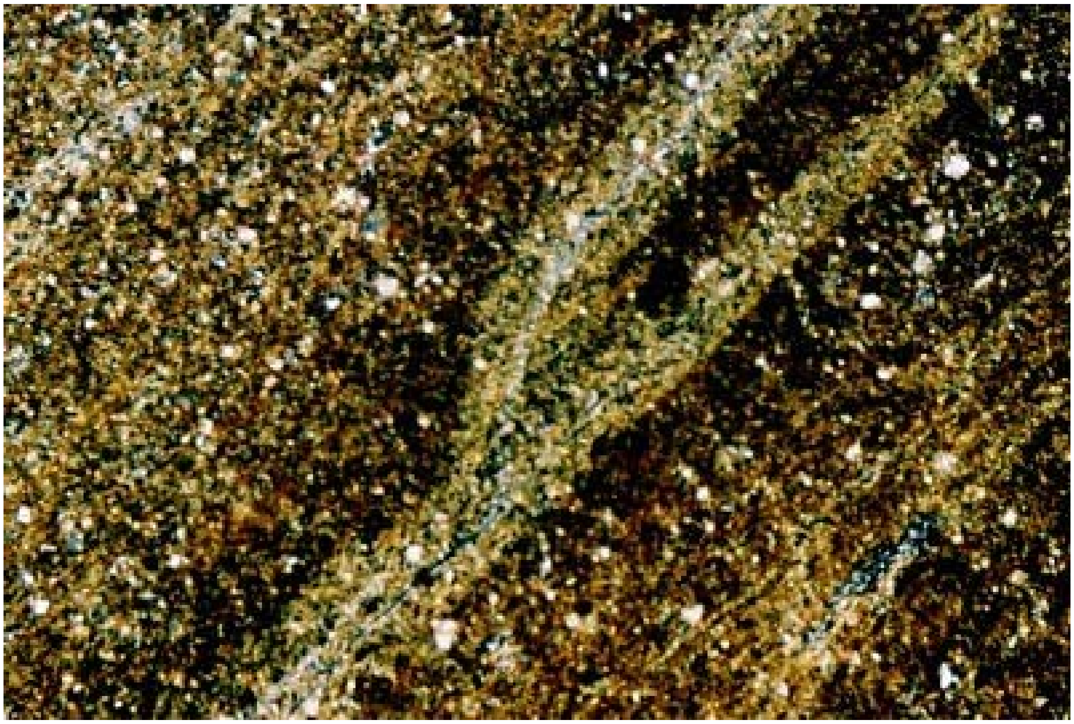
Petrographic Description:

Oxidized calcareous rock that consists of very fine-grained matrix of illite, mixed with minor chlorite, anhedral minute grains of calcite, impure calcite, Fe-dolomite, and framboids of minute grains and aggregates of pyrite. Minor chlorite is interstitial to the matrix carbonates. In terms of texture, it is a featureless rock that contains <0.05mm wide ‘veinlets’ that appear to be scoured and filled by microcrystalline aggregates of illite and carbonate that are undistinguishable from the rest of the matrix. Most of these poorly defined ‘veinlets’ are parallel, discontinuous and <1mm long, and may have been superimposed on the thin section during preparation. Euhedral / subhedral carbonate rhombs (<0.05 mm) are disseminated through the thin section. Some have resorbed grain boundaries, suggesting disequilibrium. Other clasts in the microcrystalline matrix include a few grains of quartz, albite, and slender needles of muscovite.

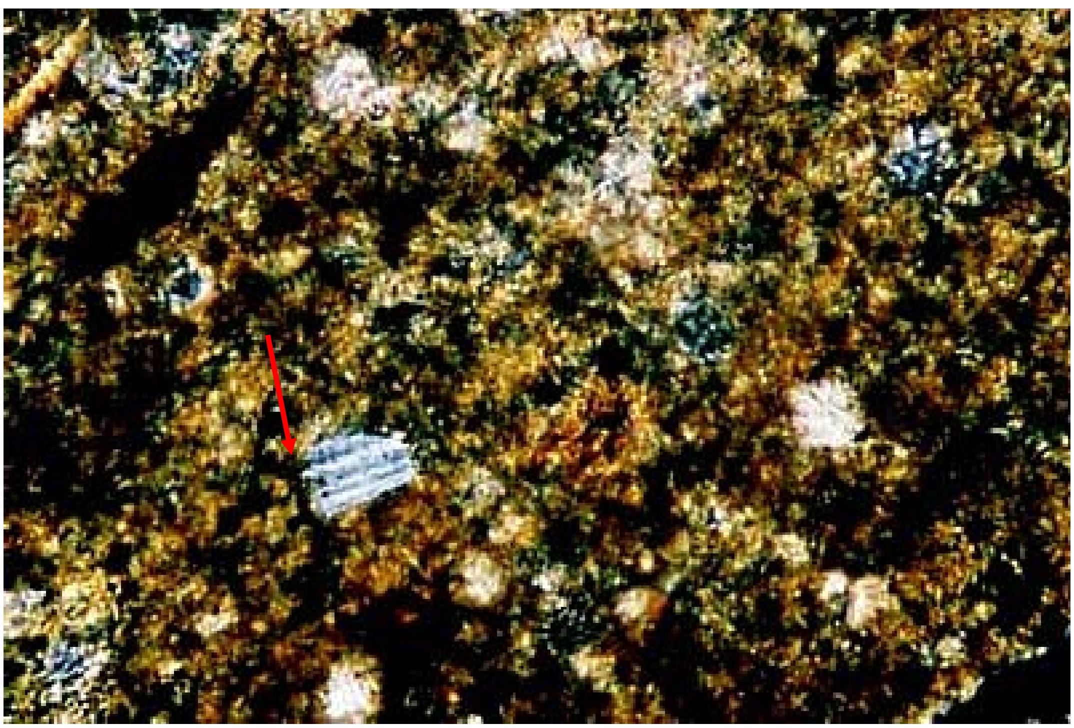
Somewhat larger, subhedral grains of Fe-rich dolomite are interstitial to the matrix. Most are small, anhedral grains, and some occur in aggregates.

Very fine-grained aggregates of pyrite are interstitial to the matrix. Most occur in aggregates and form a rim on relict fragments of carbonate.

Mineral	%	Grain size (mm)
Carbonate	32	<0.05-0.08
Matrix (illite + calcite + chlorite)	45+15+2	
Quartz	3	0.05-0.8
Fe-hydroxide	3	
Pyrite	trace	
Muscovite	trace	
Albite	trace	0.08



A. Typical ‘vein’ that is either empty, or filled by material similar to the matrix.
X-axis of photo: 2.3mm. Ppl.



B. Small albite clast (arrow) and several small Fe-dolomite (light) in illite-calcite-chlorite matrix. X-axis of photo: 0.45mm. XN.
(note: green areas are not chlorite, only scraping on glass)

DGR6-654.58 impure carbonate
ZAF cycles 4 bc drift= .969

	fac	%el	%ox	stfm
CaO	.92	26.73	37.40	22.739
MgO	.49	4.53	7.50	6.347
FeO	.83	4.06	5.22	2.476
MnO	.81	.71	.91	.439
Total		36.02	51.04	32

DGR6-654.58 calcite
ZAF cycles 4 bc drift= .968

	fac	%el	%ox	stfm
CaO	.92	35.78	50.06	30.108
MgO	.49	.91	1.51	1.264
FeO	.82	.73	.94	.439
MnO	.80	.31	.40	.189
Total		37.73	52.91	32

DGR6-654.58 chlorite
ZAF cycles 5 bc drift= .962

	fac	%el	%ox	stfm
SiO2	.62	12.64	27.04	6.290
Al2O3	.57	9.52	18.00	4.935
FeO	.86	19.88	25.58	4.977
MgO	.48	5.29	8.76	3.039
Total		47.33	79.38	28

DGR6-654.58 chlorite
ZAF cycles 5 bc drift= .959

	fac	%el	%ox	stfm
SiO2	.62	12.64	27.04	6.231
Al2O3	.56	9.69	18.31	4.972
FeO	.86	20.27	26.08	5.027
MgO	.48	5.36	8.88	3.051
Total		47.96	80.32	28

DGR6-654.58 Fe-dolomite
ZAF cycles 4 bc drift= .956

	fac	%el	%ox	stfm
CaO	.91	23.82	33.33	16.147
MgO	.49	7.88	13.07	8.809
FeO	.83	5.66	7.28	2.752
MnO	.82	.59	.77	.294
Total		37.95	54.44	28

DGR6-654.58 matrix clay
ZAF cycles 5 bc drift= .953

	fac	%el	%ox	stfm
SiO2	.71	23.33	49.92	11.392
Al2O3	.67	8.03	15.18	4.084
TiO2	.84	.18	.29	.051
FeO	.84	5.96	7.66	1.462
MgO	.56	1.60	2.66	.904
K2O	.85	3.54	4.26	1.242
Cl	.77	.14	.14	.053
Total		42.78	80.11	32

Sample Number: 664.31 **Rock Type: Oxidized calcareous mudstone**

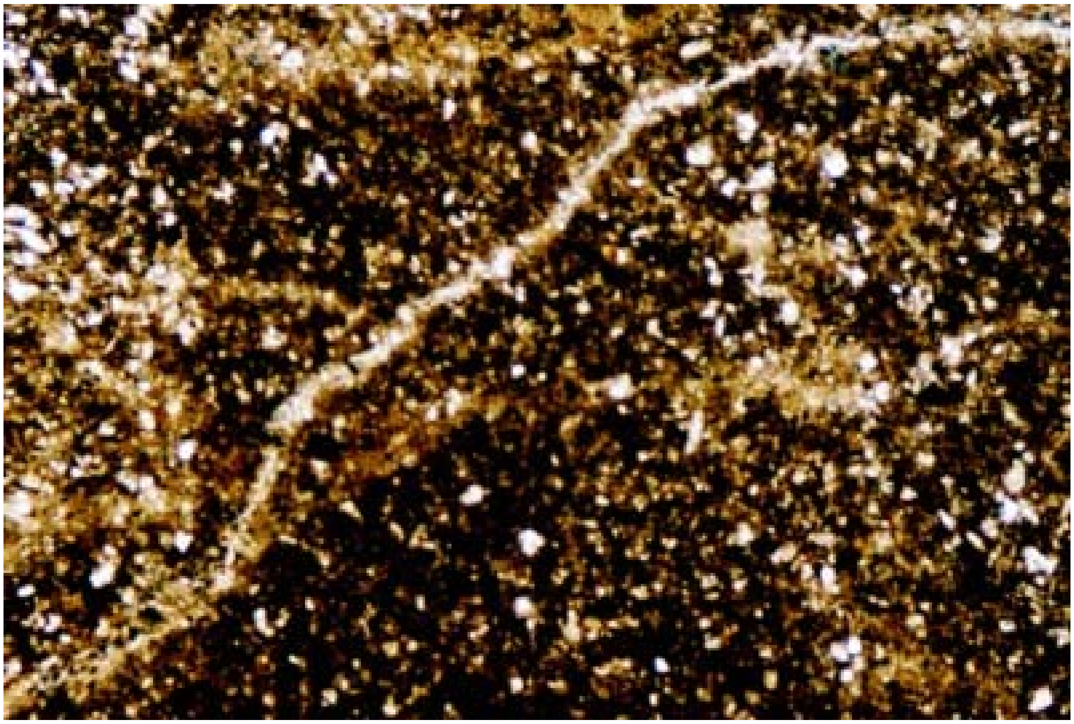
Petrographic Description:

The rock is a somewhat more coarse-grained variety of the previous sample (DGR6-654.58). An oxidized rock, it appears to consist predominantly of fine-grained carbonate, ca. equal amount of interstitial illite, and disseminated, partly recrystallized pyrite. Fine- grained anhedral / subhedral carbonate makes up a significant part of the matrix. Small clasts, consisting of angular quartz, and predominantly of dolomite rhombs are disseminated through the thin section. As in the previous sample, the carbonate rhombs have resorbed grain boundaries, suggesting disequilibrium. Veins are absent, with the exception of a narrow (<0.05mm), 3mm long veinlet that is partly filled by fine-grained carbonate and illite. A soft, poorly consolidated rock with numerous super-imposed scour marks on the thin section.

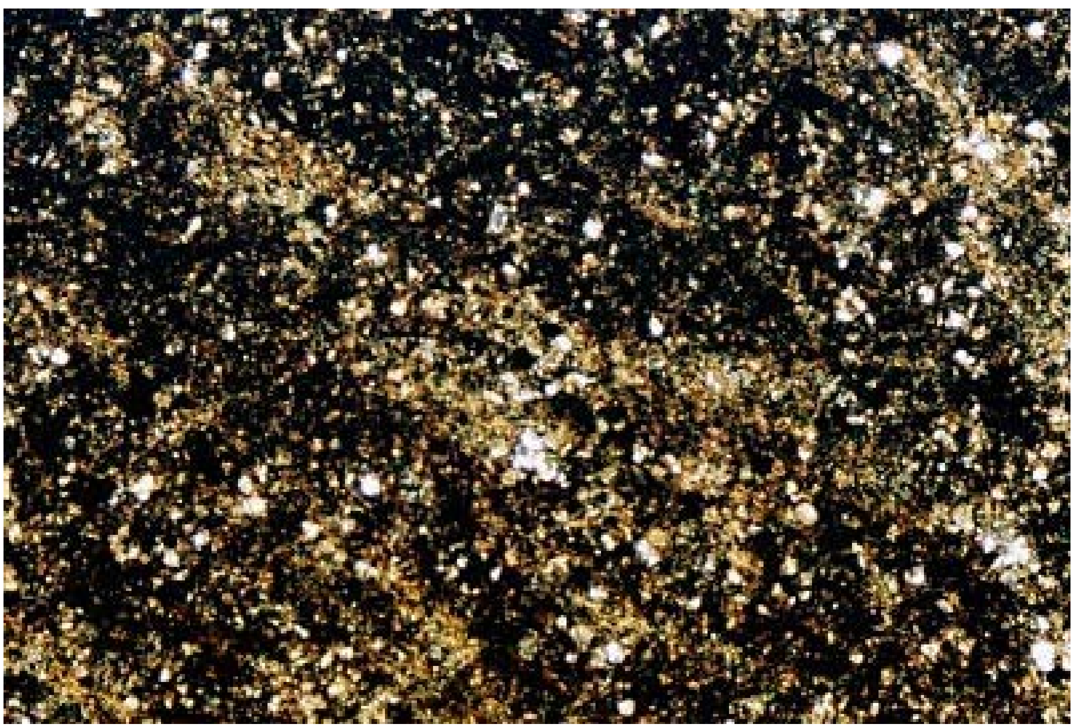
Significant part of the matrix consists of very fine-grained, Fe-stained illite, some of which contain >3% Na_2O. Single grain analysis in not possible, due to the small grain size, and the analyses below probably also include some of the fine-grained matrix quartz.

Pyrite is relatively abundant, and the small grains occur mostly as partly recrystallized framboids, forming aggregates. A few small grains of anhedral chalcopyrite grains were identified in the fine-grained matrix.

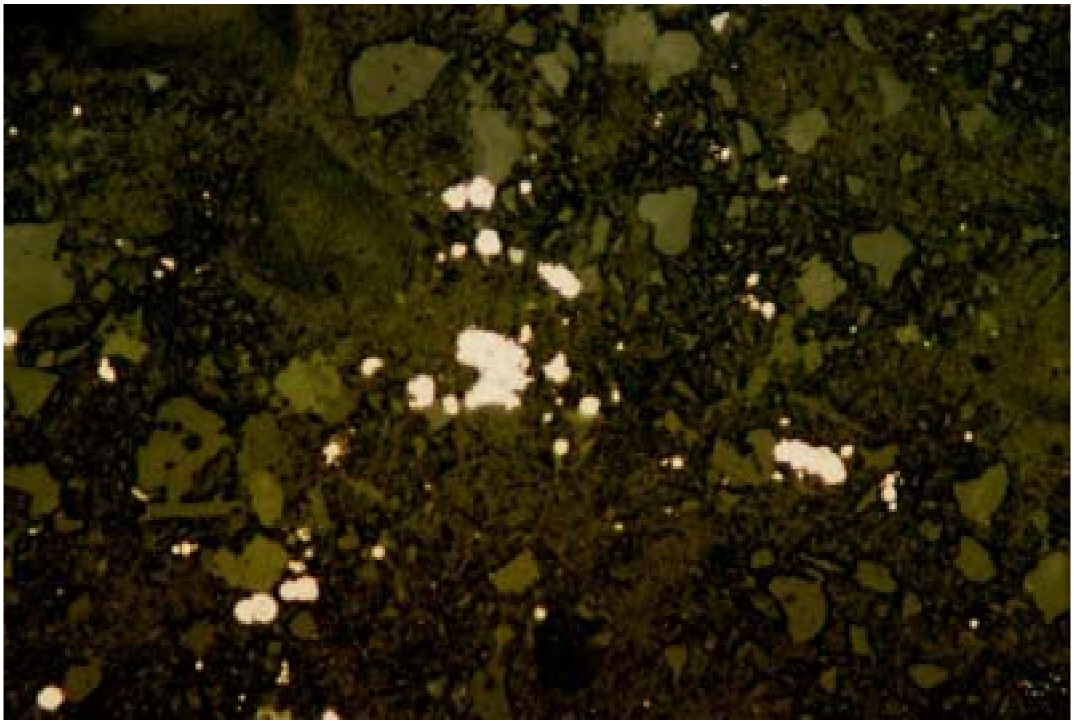
Mineral	%	Grain size (mm)
Carbonate	45	<0.05-0.1
Illite	44	
Fe-hydroxide	10	
Quartz	1	av. 0.08
Pyrite	1	<0.05
Chalcopyrite	trace	



A. Small vein contains fragments of minute calcite. X-axis of photo: 2.3mm. Ppl.



B. Oxidized matrix that consists predominantly of fine-grained carbonate, and microcrystalline illite. X-axis of photo: 2.3mm. XN.



C. Fine-grained pyrite disseminate through the matrix. X-axis of photo: 0.45mm. Refl. light.

DGR6-664.31 matrix K-rich clay
ZAF cycles 5 bc drift= .971

	fac	%el	%ox	stfm
SiO2	.74	28.26	60.45	10.466
Al2O3	.74	9.38	17.73	3.619
FeO	.83	.87	1.12	.162
K2O	.85	11.08	13.35	2.950
Total		49.60	92.65	28

DGR6-664.31 matrix clay (illite)
ZAF cycles 6 bc drift= .966

	fac	%el	%ox	stfm
SiO2	.69	25.57	54.71	10.634
Al2O3	.69	11.97	22.62	5.184
TiO2	.83	.29	.49	.071
FeO	.84	3.37	4.34	.706
MgO	.59	1.65	2.74	.793
K2O	.84	4.56	5.49	1.363
Na2O	.44	2.49	3.36	1.266
Total		49.91	93.74	32

DGR6-664.31 euhedral dolomite
ZAF cycles 4 bc drift=.959

	fac	%el	%ox	stfm
CaO	.90	22.27	31.16	16.234
MgO	.52	12.14	20.13	14.592
FeO	.83	2.01	2.58	1.049
MnO	.81	.24	.31	.126
Total		36.65	54.18	32

DGR6-664.31 clay matrix + quartz
ZAF cycles 5 bc drift= .962

	fac	%el	%ox	stfm
SiO2	.76	35.09	75.08	13.504
Al2O3	.72	5.93	11.21	2.376
TiO2	.82	.00	.00	.000
FeO	.83	3.28	4.22	.635
MgO	.61	1.08	1.79	.480
K2O	.83	2.24	2.70	.619
Total		47.63	94.99	32

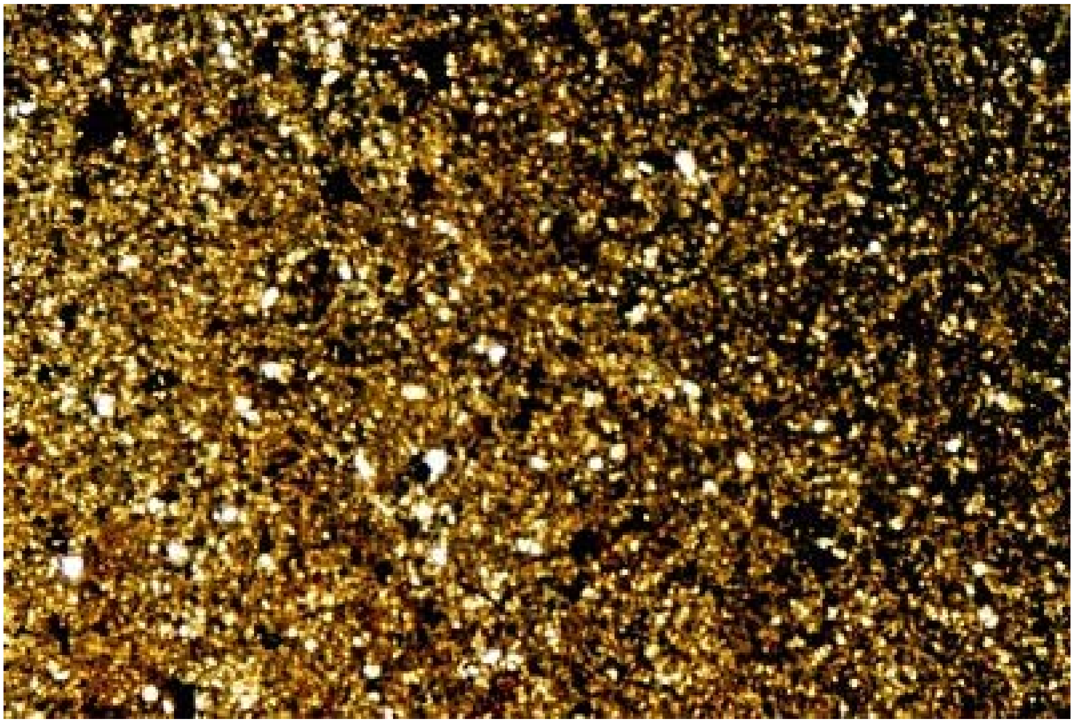
Sample Number: 697.67 **Rock Type: Oxidized calcareous mudstone**

Petrographic Description:

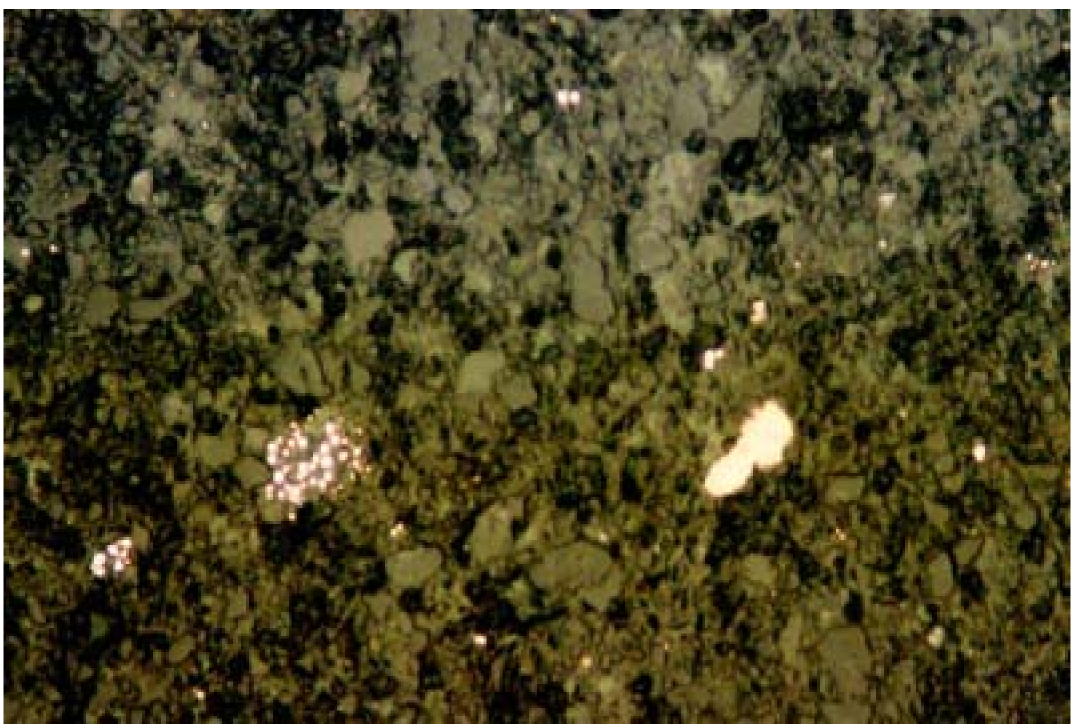
Increasing oxidation is apparent in the rock. Although the mineralogy is comparable to the previous samples, small, subrounded domains, consisting of amorphous Fe-hydroxide are disseminated through the thin section. Fe-staining destroyed the texture of most minerals, and except for some of the carbonates, the individual clasts are difficult to identify. It is a very fine-grained rock that consists of Fe-stained, poorly crystalline illite, interstitial calcite (dolomitic composition) and aggregates of fine-grained, disseminated pyrite. Small, anhedral grains of carbonate and angular clasts of minute grains of quartz are disseminated through the thin section. The quartz grains have resorbed grain boundaries, suggesting that it is in disequilibrium with the enclosing matrix. Some carbonate rhombs are subhedral and are over-printed by Fe hydroxide. A relatively large, colored (reddish) grain of apatite is included in the fine-grained matrix.

Fine-grained pyrite is relatively abundant. It occurs as small framboids that form aggregates, and as disseminated anhedral blocky grains. Several of the framboids show evidence of grain growth.

Mineral	%	Grain size (mm)
Carbonate	43	av. <0.05
Illite	30	
Fe-hydroxide	25	
Quartz	1	av. <0.05
Pyrite	1	
Chalcopyrite	trace	
Apatite	trace	



A. Fine-grained, oxidized rock consisting of Fe-stained illite and fine-grained calcite.
X-axis of photo: 2.3mm. Ppl.



B. Small pyrite framboids and a solid grains of anhedral pyrite in matrix.
X-axis of photo: 0.45mm. Refl. Light.

DGR6-697.67 clay (illite+quartz)
ZAF cycles 5 bc drift= .969

	fac	%el	%ox	stfm
SiO2	.76	31.72	67.87	13.371
Al2O3	.72	6.03	11.40	2.647
TiO2	.83	.35	.58	.086
FeO	.83	2.17	2.79	.460
MgO	.60	.47	.78	.228
K2O	.84	2.80	3.37	.848
Total		43.54	86.79	32

DGR6-697.67 clay matrix
ZAF cycles 6 bc drift= .967

	fac	%el	%ox	stfm
SiO2	.68	23.47	50.21	10.210
Al2O3	.69	12.87	24.31	5.828
TiO2	.83	.00	.00	.000
FeO	.84	4.42	5.69	.967
MgO	.59	2.11	3.49	1.059
K2O	.85	5.19	6.26	1.623
Total		48.06	89.96	32

DGR6-697.67 apatite
ZAF cycles 4 bc drift= .963

	fac	%el	%ox	stfm
CaO	.88	37.13	51.96	11.114
P2O5	.88	21.57	49.43	8.355
Cl	.81	.14	.14	.048
Total		58.85	101.53	32

DGR6-697.67 dolomitic calcite
ZAF cycles 4 bc drift= .954

	fac	%el	%ox	stfm
CaO	.92	30.94	43.29	24.809
MgO	.49	4.01	6.65	5.302
FeO	.83	2.54	3.27	1.464
MnO	.81	.73	.94	.426
Total		38.22	54.15	32

Sample Number: 717.97 **Rock Type: Oxidized calcareous mudstone**

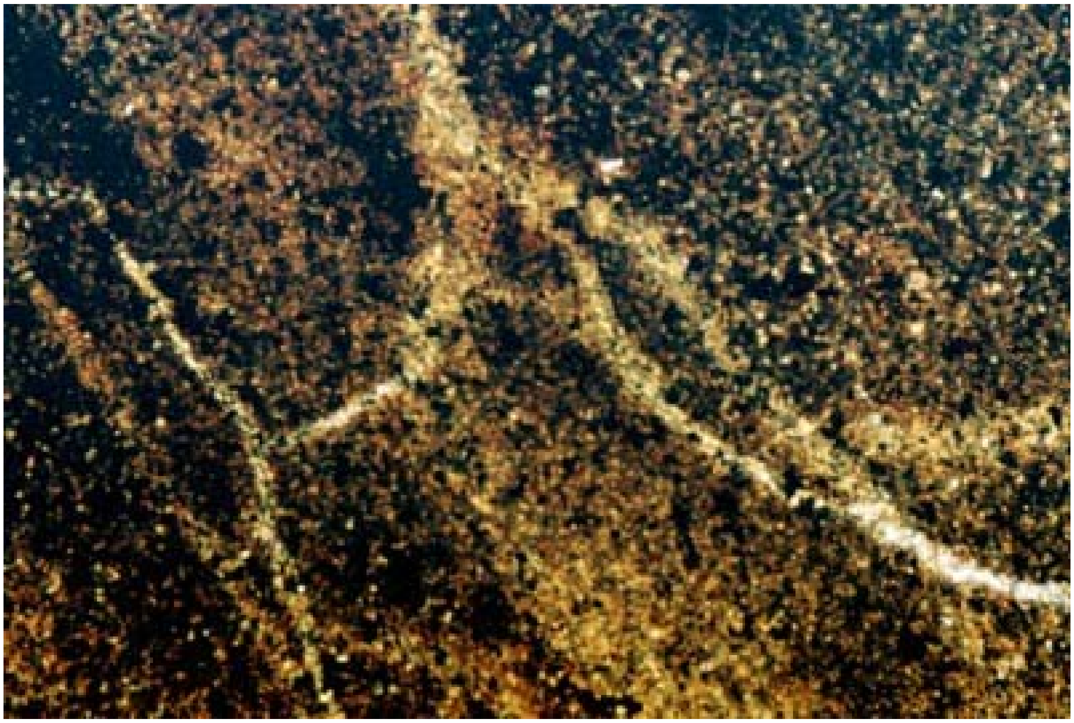
Petrographic Description:

An oxidized, calcareous mudstone that contains a few subrounded domains are filled by fine-grained carbonate, and one large, irregularly shaped discontinuous ‘pinch and swell’ vein is filled by fine-grained pyrite. The very fine-grained matrix consists of Fe-stained clays (illite), fine-grained anhedral calcite, and fine-grained pyrite. Minute clasts of anhedral calcite and lesser quartz are disseminated through the rock.

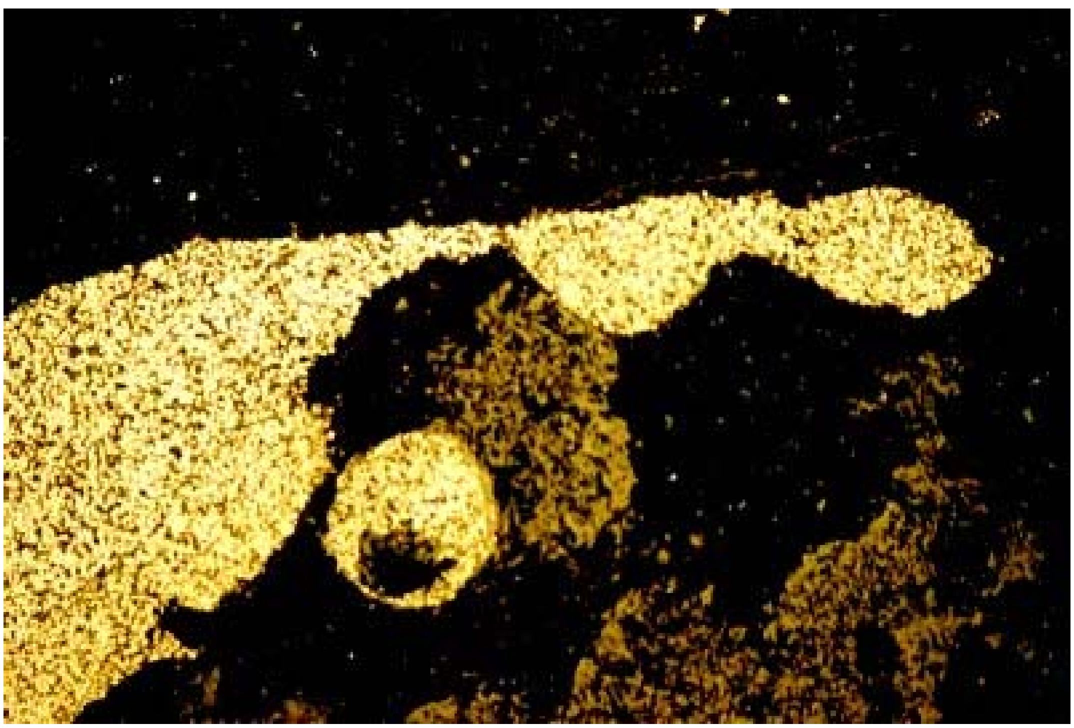
The rock is cross-cut by several veins having different orientation. The two largest veins are more or less parallel, they are 0.1-0.2 mm wide, and both, 2 cm long. The veins are filled by mineral aggregates (clays and carbonate) similar to the matrix. The original minerals (s) in the veins appear to have been lost, and were probably filled by matrix material during thin section preparation. Six other small veinlets (0.05-0.1 mm wide) form an intricate network, ranging in length between 1 and 2 cm.

Fine-grained pyrite is relatively abundant. The equigranular, subhedral / euhedral grains occur in aggregates, whereas small, anhedral grains are disseminated through the matrix and are interstitial to the carbonates.

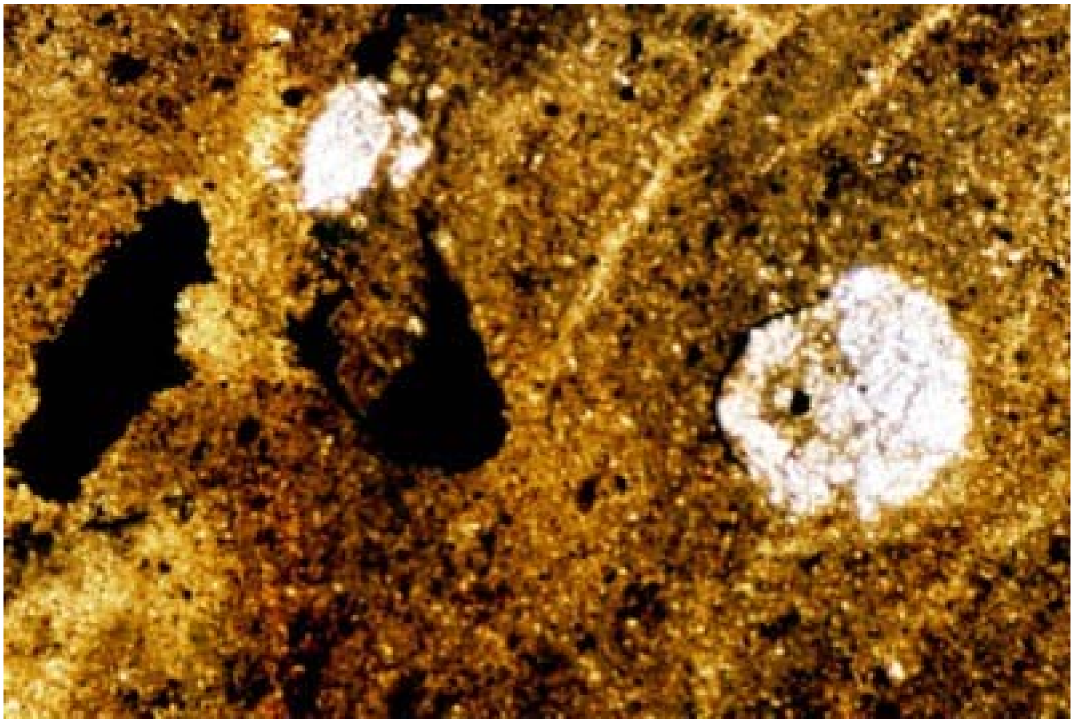
Mineral	%	Grain size (mm)
Carbonate	45	av. <0.05, replacement av. 0.1-0.3
Illite	42	
Fe-hydroxide	10	
Quartz	trace	
Pyrite	3	
Chalcopyrite	trace	



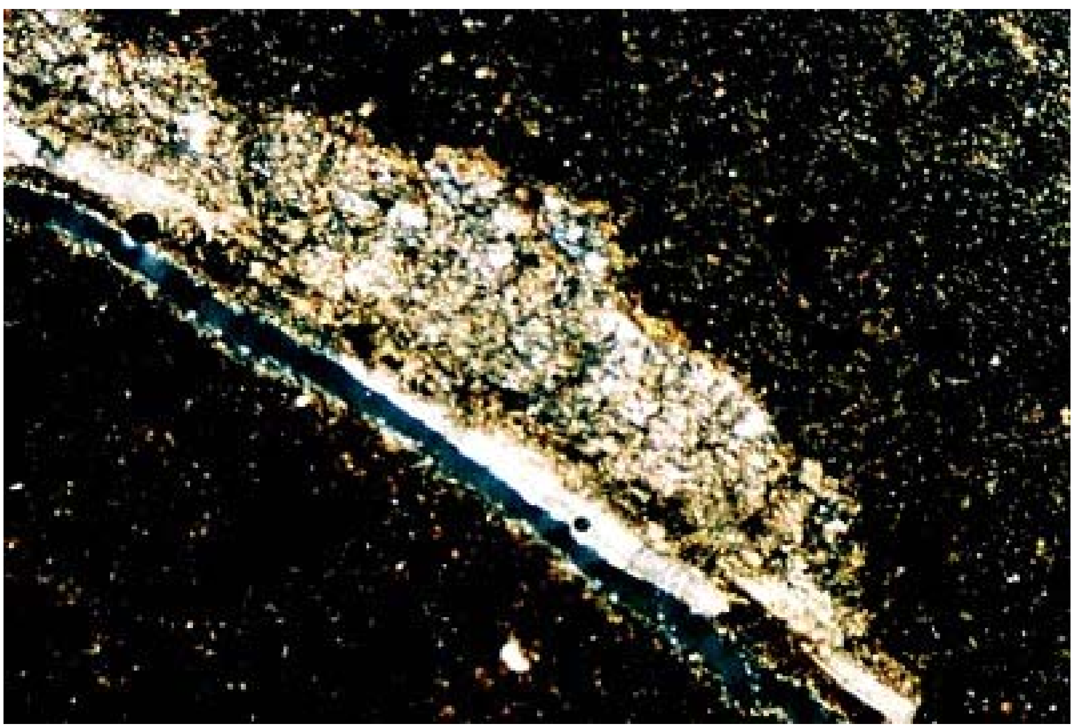
A. Network of small veinlets. X-axis of photo: 2.3mm. XN.



B. Fine-grained pyrite (yellow) fills a ‘pinch and swell’ vein (?)
X-axis of photo: 2.3mm. Refl. Light.



C. Carbonate replacement (light color) in semi-circular cavities.
X-axis of photo: 2.3mm. Ppl.



D. Calcite vein (narrow) partly fills fracture. Calcite aggregates adjacent to vein appear to fill a large dissolution cavity. X- axis of photo: 2.3mm. XN.

DGR6-717.97 calcite
ZAF cycles 4 bc drift= .961

	fac	%el	%ox	stfm
CaO	.92	36.45	51.00	31.780
MgO	.49	.00	.00	.000
FeO	.82	.35	.45	.220
Total		36.80	51.45	32

DGR6-717.97 matrix illite
ZAF cycles 5 bc drift= .965

	fac	%el	%ox	stfm
SiO2	.70	24.44	52.28	10.804
Al2O3	.71	12.18	23.01	5.607
MgO	.60	1.01	1.67	.515
FeO	.84	3.19	4.11	.710
K2O	.85	4.75	5.72	1.510
Total		45.57	86.79	32

DGR6-717.97 matrix calcite
ZAF cycles 4 bc drift= .962

	fac	%el	%ox	stfm
CaO	.92	36.18	50.63	31.661
MgO	.49	.00	.00	.000
FeO	.82	.54	.70	.339
Total		36.72	51.32	32

DGR6-717.97 matrix calcite
ZAF cycles 4 bc drift= .951

	fac	%el	%ox	stfm
CaO	.92	36.66	51.30	31.727
MgO	.49	.00	.00	.000
FeO	.82	.44	.57	.273
Total		37.10	51.86	32

Sample Number: 735.40 **Rock Type: Oxidized calcareous siltstone**

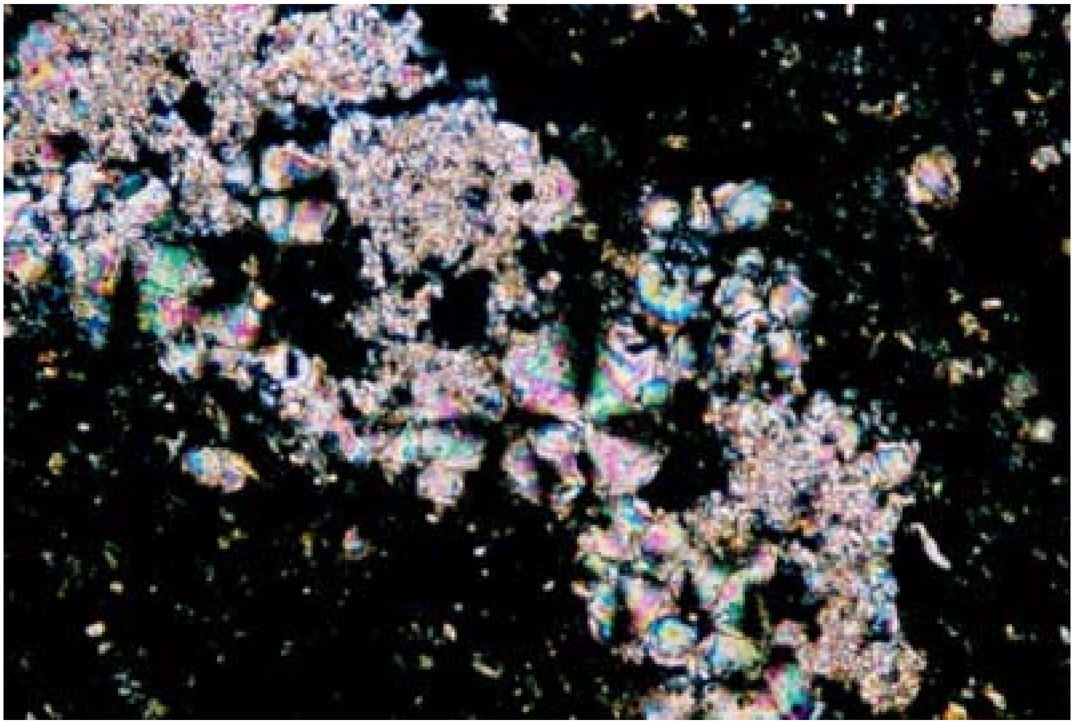
Petrographic Description:

An oxidized, fine-grained calcareous rock that consists predominantly of fine-grained, often Fe-stained calcite, interstitial illite, minor biotite, and fine-grained pyrite. The carbonate matrix is partly recrystallized, and is rimmed by the Fe-stained illite. Aggregates and single grains of larger, subhedral calcite make up some of the domains in the thin section. The larger grains are often intergrown with or occur in aggregates that also contain anhedral quartz clasts. Oxidation is manifest in the Fe-staining of the carbonates and illite, but also in the presence of disseminated fragments of poorly crystalline goethite. A few larger grains of dolomite are disseminated through the matrix. An oval-shaped, relatively large yellow apatite in the matrix has comparable texture and chemistry to the hydroxy apatite in the fossiliferous wackestone (DGR6-750.80).

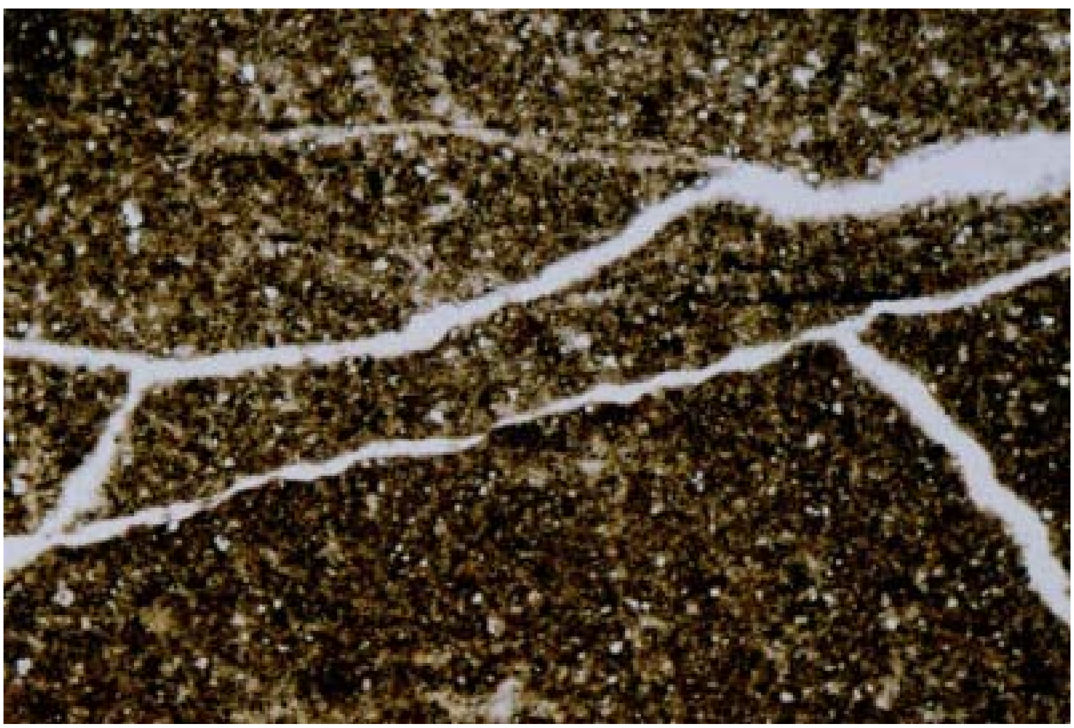
The rock originally contained a few small veins (≤0.05-0.1 mm wide, 1-2 cm long), which are presently empty. They are randomly oriented and form a small network. It appears that originally they contained fine-grained carbonate.

Fine-grained, anhedral / subhedral pyrite occurs in aggregates and as single grains. Small pyrite framboids form aggregates within the Fe-stained illite, and single grains of blocky pyrite are rimmed by an over-growth of minute framboids.

Mineral	%	Grain size (mm)
Carbonate	60	0.05-0.3
Illite	27	
Fe-hydroxide	12	
Quartz	0.5	av. 0.06
Pyrite	1	
Apatite	trace	



A. Fine-grained aggregates of calcite (multi color) over-grows the stained matrix illite. X-axis of photo: 0.45mm. XN.



B. Randomly oriented veins (presently empty) cross-cut the Fe-stained matrix. X-axis of photo: 2.3mm. Ppl.

DGR6-735.40 yellow apatite
ZAF cycles 4 bc drift= .959

	fac	%el	%ox	stfm
CaO	.88	35.74	50.00	11.631
P2O5	.88	19.35	44.33	8.149
Cl	.82	.57	.57	.209
Total		55.65	94.90	32

DGR6-735.40 dolomite rhomb
ZAF cycles 4 bc drift= .958

	fac	%el	%ox	stfm
CaO	.91	23.15	32.39	17.512
MgO	.51	10.29	17.07	12.836
FeO	.83	2.82	3.62	1.529
MnO	.81	.23	.29	.125
Total		36.49	53.37	32

DGR6-735.40 clay/ carbonate matrix
ZAF cycles 5 bc drift= .952

	fac	%el	%ox	stfm
SiO2	.71	27.20	58.19	11.413
Al2O3	.69	9.27	17.52	4.051
TiO2	.83	.40	.67	.099
FeO	.84	4.97	6.39	1.048
K2O	.85	3.90	4.70	1.177
CaO	.83	1.75	2.45	.515
MgO	.59	1.54	2.55	.747
Total		49.03	92.47	32

DGR6-735.40 illite+quartz matrix
ZAF cycles 5 bc drift= .946

	fac	%el	%ox	stfm
SiO2	.75	32.42	69.36	12.950
Al2O3	.72	7.02	13.27	2.921
TiO2	.82	.28	.46	.065
FeO	.83	3.04	3.91	.611
K2O	.84	3.12	3.75	.894
CaO	.83	.21	.29	.058
MgO	.61	1.02	1.70	.473
Total		47.11	92.75	32

DGR6-735.40 calcite
ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.92	36.83	51.53	31.064
MgO	.49	.42	.70	.590
FeO	.82	.57	.74	.346
Total		37.82	52.97	32

DGR6-735.40 calcite
ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.92	36.07	50.47	31.584
MgO	.49	.00	.00	.000
FeO	.82	.66	.85	.416
Total		36.74	51.33	32

Sample Number: DGR6-750.80 **Rock Type: Wackestone**

Petrographic Description:

A medium-grained wackestone. It consists of various fragments of broken fossils, that include crinoids, bryozoan, sponges, and echinoderm. The fossil fragments are included in lime mud that locally contains aggregates of euhedral / subhedral carbonate. Several of the fossils are partly recrystallized to carbonate aggregates, and some contain minute inclusions of pyrite. Aggregates of minute pyrite framboids partly replace some of the fossils. A number of fossil fragments are partly dissolved in the matrix and recrystallized to fine-grained carbonate aggregates. Some of the carbonates (and the fossil fragments) are rimmed by Fe-hydroxide, or by dark brown apatite.

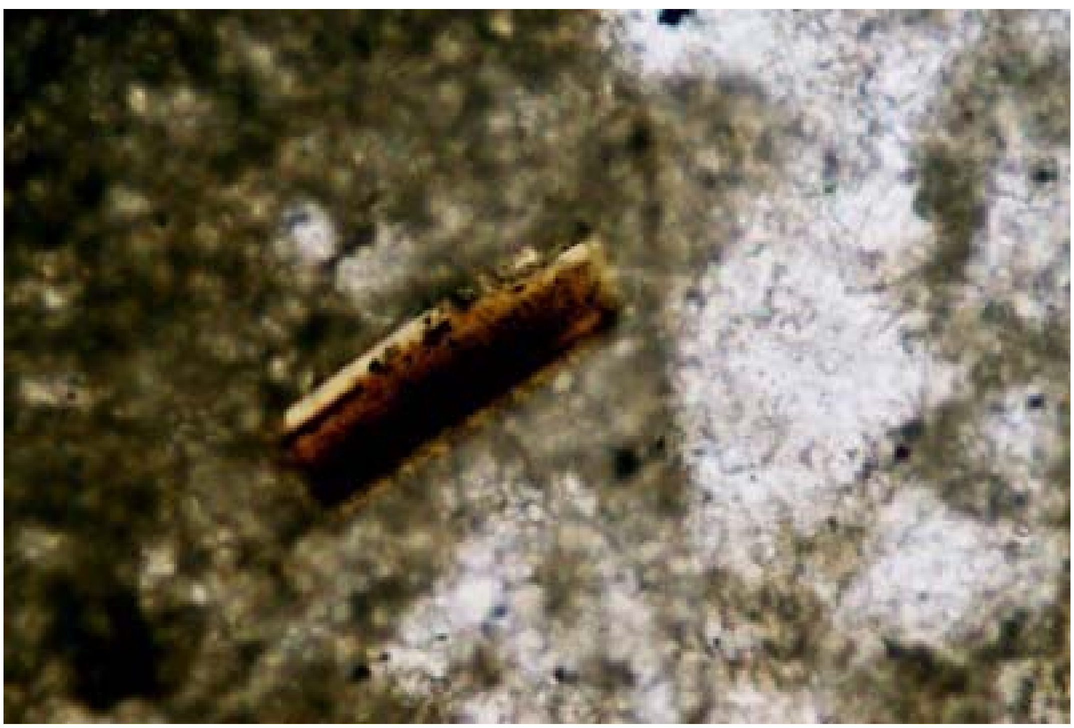
Microprobe analysis of carbonates suggests that most are Fe-rich dolomite, and the fossils are mostly Mg-rich calcite. In one domain (ca. 3 mm diameter), euhedral dolomite aggregates occur with anhydrite. Textural evidence suggests that the dolomite + anhydrite crystallized in a vug (dissolution cavity?).

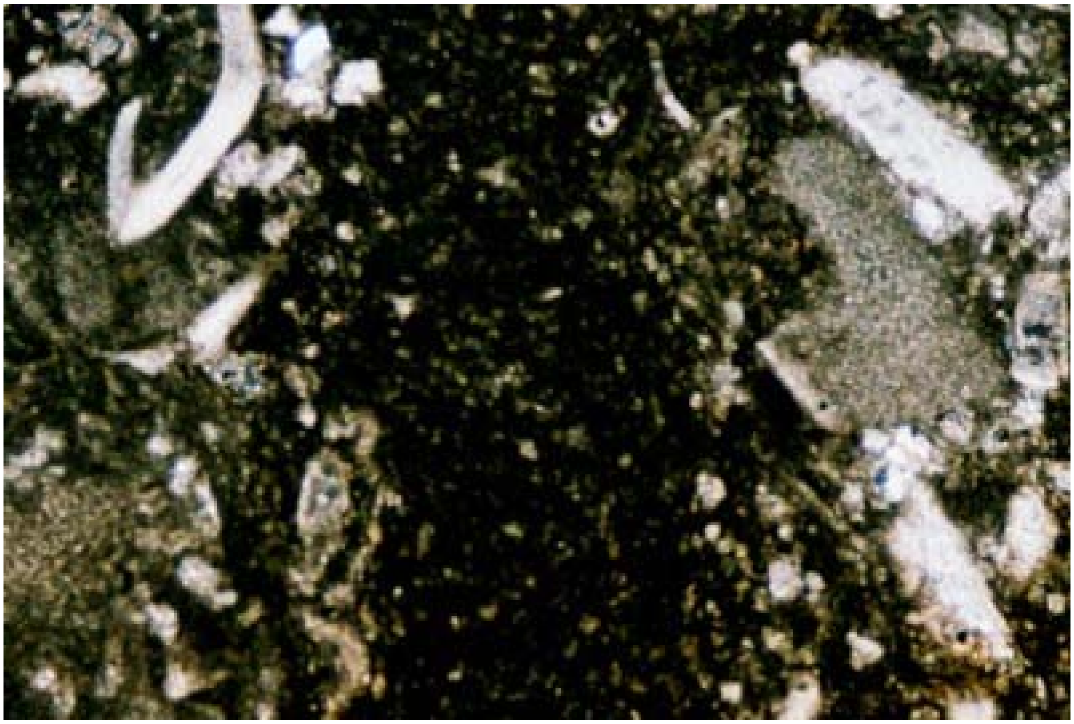
A few small, anhedral grains of rusty brown apatite occur in the matrix, and also within partly recrystallized fossil fragments. Their morphology is similar to the brown apatite identified in some of the DGR5 samples (DGR5-704.99).

Pyrite is not abundant in comparison with the oxidized mudstones. It occurs as minute framboids that form aggregates replacing some of the fossil fragments. Other, minute anhedral grains of pyrite are disseminated through the matrix.

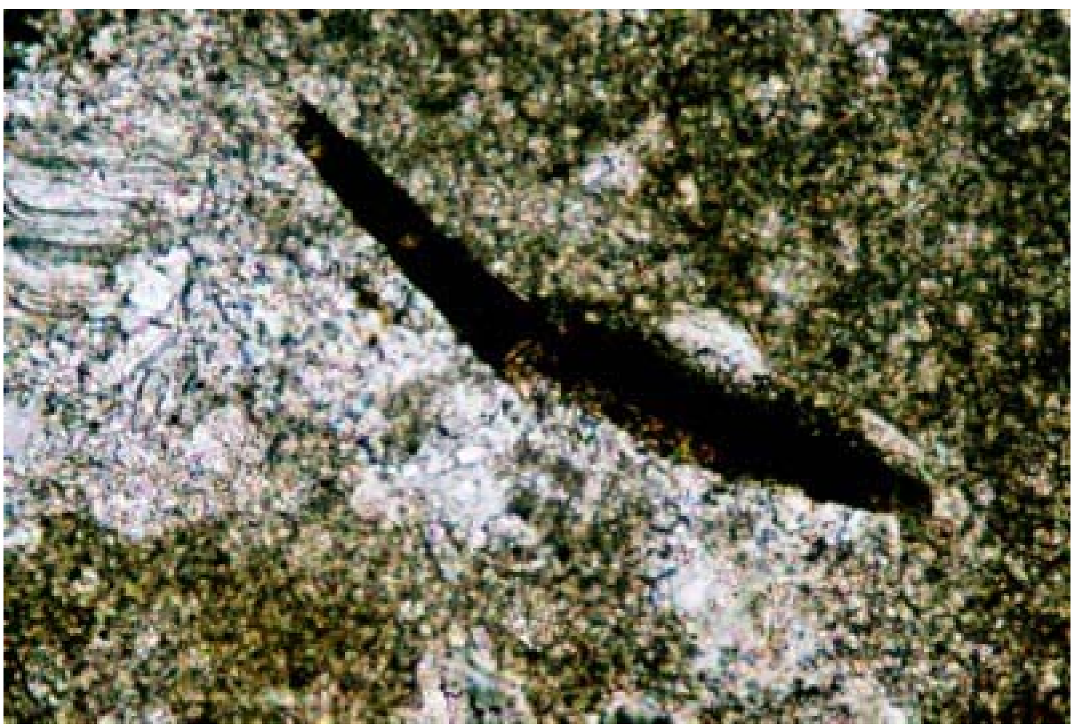
Mineral	%	Grain size (mm)
Calcite (in matrix)	30	0.05-0.2
Dolomite	20	0.08-0.4
Fossils	35	up to 3.0
Illite	15	
Quartz	trace	
Apatite	trace	0.1-1.0
Anhydrite	trace	
Pyrite	trace	

A. Vug-filling dolomite and anhydrite. X-axis of photo: 2.3mm. XN.


B. Dark brown lath of hydroxy apatite in carbonate aggregates.
X-axis of photo: 0.45mm. Ppl.



C. Fossil fragments and interstitial dark lime mud. X-axis of photo: 2.3mm. XN.



D. Broken apatite (long, dark grain) in dolomite aggregates.
X-axis of photo: 0.45mm. XN

DGR6-750.80 brown apatite
ZAF cycles 4 bc drift= .935

	fac	%el	%ox	stfm
CaO	.89	39.15	54.77	9.558
P2O5	.87	18.28	41.90	5.778
Cl	.83	.30	.30	.082
Total		57.73	96.97	24

DGR6-750.80 rim brown apatite
ZAF cycles 4 bc drift= .951

	fac	%el	%ox	stfm
CaO	.89	38.78	54.26	9.389
P2O5	.87	18.66	42.75	5.845
Cl	.83	.24	.24	.065
Total		57.67	97.25	24

DGR6-750.80 'fan' shaped apatite
ZAF cycles 4 bc drift= .949

	fac	%el	%ox	stfm
CaO	.88	38.90	54.43	9.257
P2O5	.88	19.15	43.88	5.898
Cl	.83	.34	.34	.092
Total		58.39	98.66	24

DGR6-750.80 anhydrite
ZAF cycles 4 bc drift= .940

	fac	%el	%ox	stfm
CaO	.85	27.22	39.88	5.930
SO3	.90	23.05	57.88	5.981
Total		50.27	97.76	24

DGR6-750.80 anhydrite
ZAF cycles 4 bc drift= .941

	fac	%el	%ox	stfm
CaO	.86	29.22	40.88	6.030
SO3	.92	23.22	57.98	5.991
Total		52.44	98.86	24

DGR6-750.80 coarse dolomite
ZAF cycles 4 bc drift= .929

	fac	%el	%ox	stfm
CaO	.90	21.86	30.58	12.887
MgO	.52	10.53	17.46	10.235
FeO	.83	2.08	2.67	.879
Total		34.46	50.71	24

DGR6-750.80 fine dolomite
ZAF cycles 4 bc drift= .926

	fac	%el	%ox	stfm
CaO	.91	22.82	31.93	13.580
MgO	.50	8.84	14.66	8.677
FeO	.83	4.08	5.25	1.744
Total		35.74	51.84	24

DGR6-750.80 fossil
ZAF cycles 4 bc drift= .926

	fac	%el	%ox	stfm
CaO	.92	31.54	44.13	19.330
MgO	.50	4.05	6.72	4.094
FeO	.83	1.31	1.69	.577
Total		36.90	52.54	24

DGR6-750.80 brown apatite
ZAF cycles 4 bc drift= .924

	fac	%el	%ox	stfm
CaO	.88	37.85	52.96	9.235
P2O5	.87	18.70	42.86	5.907
Cl	.83	.26	.26	.072
Total		56.81	96.08	24

DGR6-750.80 clay+carbonate matrix
ZAF cycles 4 bc drift= .932

	fac	%el	%ox	stfm
SiO2	.76	11.05	23.65	5.838
Al2O3	.67	3.26	6.16	1.794
K2O	.95	4.66	5.61	1.767
CaO	.87	23.64	33.07	8.749
Total		42.61	68.50	24

DGR6-750.80 calcite+quartz in matrix
ZAF cycles 4 bc drift= .932

	fac	%el	%ox	stfm
SiO2	.76	4.04	8.64	2.937
Al2O3	.64	.49	.93	.372
K2O	1.02	.24	.28	.123
FeO	.82	.31	.40	.114
CaO	.91	34.13	47.75	17.392
Total		39.20	58.00	24

Sample Number: 761.76 **Rock Type: Wackestone + calcareous mudstone/siltstone**

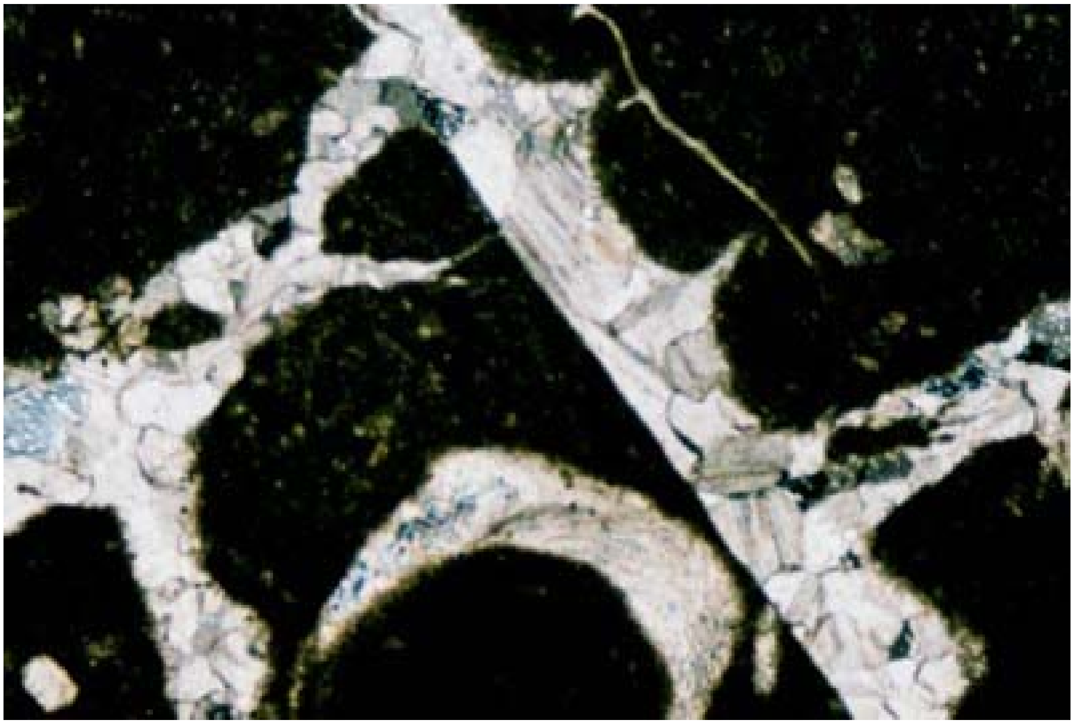
Petrographic Description:

The thin section consists of two rock fragments, 1) wackestone and 2) weakly laminated calcareous mudstone/siltstone. The wackestone consists of large, relatively sparse fossil fragments within a microcrystalline matrix, and the oxidized, laminated calcareous mudstone consists of laminated lime mud with small pockets of fossil fragments. The mudstone is weakly deformed, and contains parallel seams of amorphous Fe-hydroxide.

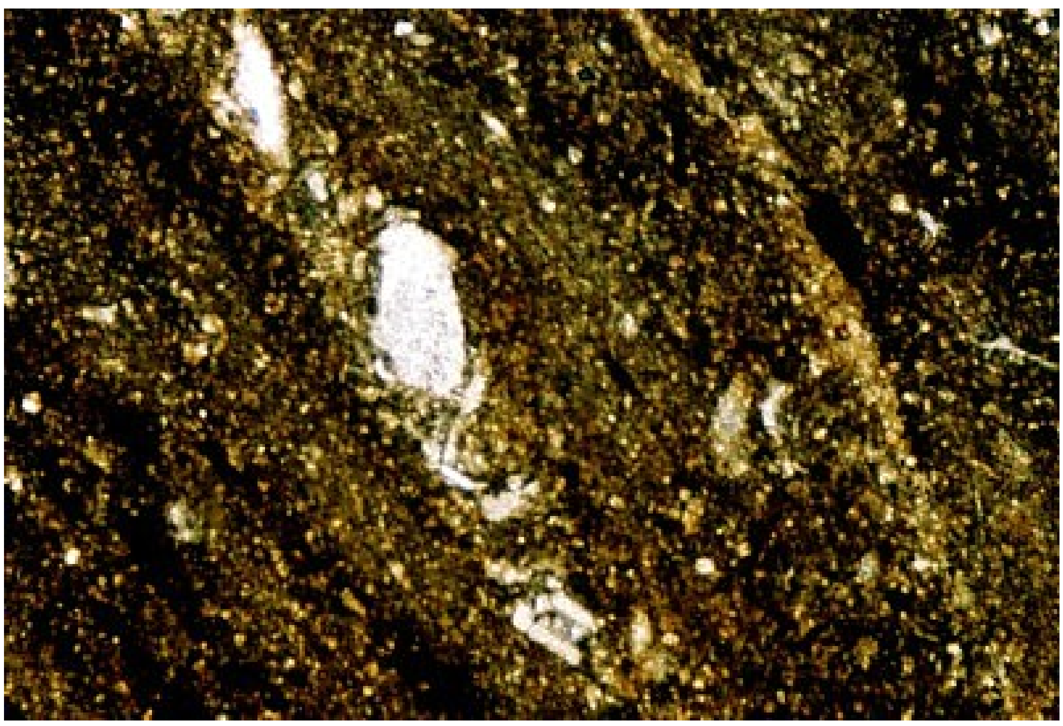
Some of the fossil fragments are partly replaced by aggregates of well crystallized pure calcite, and partly by microcrystalline mud-like mixture that consists of dolomite + quartz, and locally, very K-rich clays. The composition of the clays, having 15 wt% K_2O and 64 wt% SiO_2, is close to the composition of K-feldspars and not to illite or muscovite. Euhedral / subhedral aggregates of dark, blocky dolomite is locally abundant, and generally occurs in a tight cluster, or as single, euhedral grains.

The oxidized, calcareous mudstone / siltstone is weakly laminated, and contains discontinuous bands of anhedral dolomite and calcite. The matrix is somewhat more granular than in the wackestone, and it contains a few small grains of corroded quartz with resorbed grain boundaries.

Mineral	**%**	**Grain size (mm)**
Calcite	10	0.05-0.4
Dolomite	22	av. 0.08
Fossils	23	up to 5.0
Calcareous mud	30	
K-rich clays	12	
Quartz	trace	
Fe-hydroxide	3	
Pyrite	trace	



A. Partly recrystallized (to calcite) fossil fragments in dark lime mud.
X-axis of photo: 2.3mm. XN.



B. Weakly laminated, oxidized calcareous matrix with a narrow band of blocky calcite and fossil bits. X-axis of matrix: 2.3mm. XN.

DGR6-761.76 calcite
ZAF cycles 4 bc drift= .928

	fac	%el	%ox	stfm
CaO	.92	38.15	53.38	24.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		38.15	53.38	24

DGR6-761.76 calcite core
ZAF cycles 4 bc drift= .928

	fac	%el	%ox	stfm
CaO	.92	38.15	53.38	24.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		38.15	53.38	24

DGR6-761.76 dolomite
ZAF cycles 4 bc drift= .949

	fac	%el	%ox	stfm
CaO	.90	22.89	32.03	13.218
MgO	.52	10.66	17.68	10.148
FeO	.83	1.31	1.68	.543
SrO	.74	.35	.41	.093
Total		35.22	51.81	24

DGR6-761.76 matrix
ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.90	23.17	32.42	10.884
MgO	.52	4.17	6.91	3.226
FeO	.83	1.21	1.56	.408
SiO2	.74	7.07	15.13	4.741
Total		35.62	56.02	24

DGR6-761.76 K-rich matrix
ZAF cycles 5 bc drift= .943

	fac	%el	%ox	stfm
SiO2	.75	30.01	64.21	12.098
Al2O3	.75	9.45	17.86	3.966
K2O	.84	12.81	15.43	3.709
Total		52.27	97.49	32

Sample Number: 768.58 **Rock Type: Wackestone**

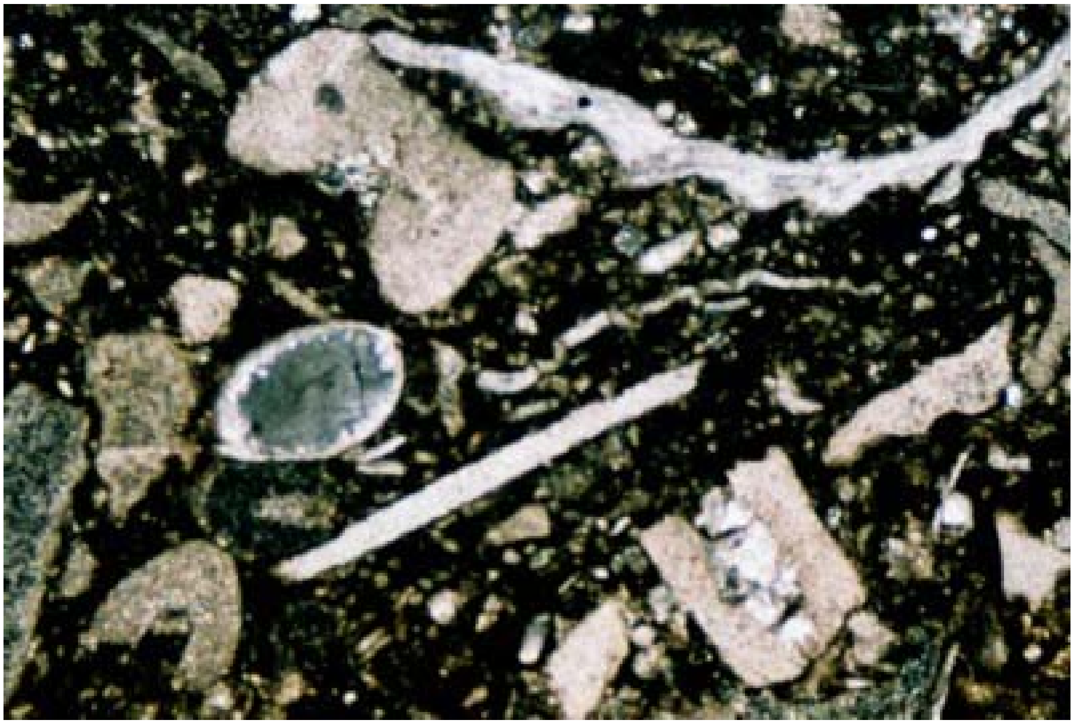
Petrographic Description:

A relatively coarse-grained wackestone that consists of broken fossil fragments, some of which recrystallized to blocky aggregates of dolomite. The fine-grained matrix consists predominantly of small fossil bits and it is the cement to the large fragments. The large fragments include sponges, echinoderms, and bryozoan, and the small fragments in the matrix contain partly dissolved and recrystallized fossil bits. Several small grains of yellow apatite occur at the rim of some of the larger fossils and in the matrix. They are also recrystallized at the grain boundaries to fine-grained aggregates. There is a significant range in grain size of the matrix and the large fossil fragments, suggesting that the thin section is made up of several rock fragments derived from different sources.

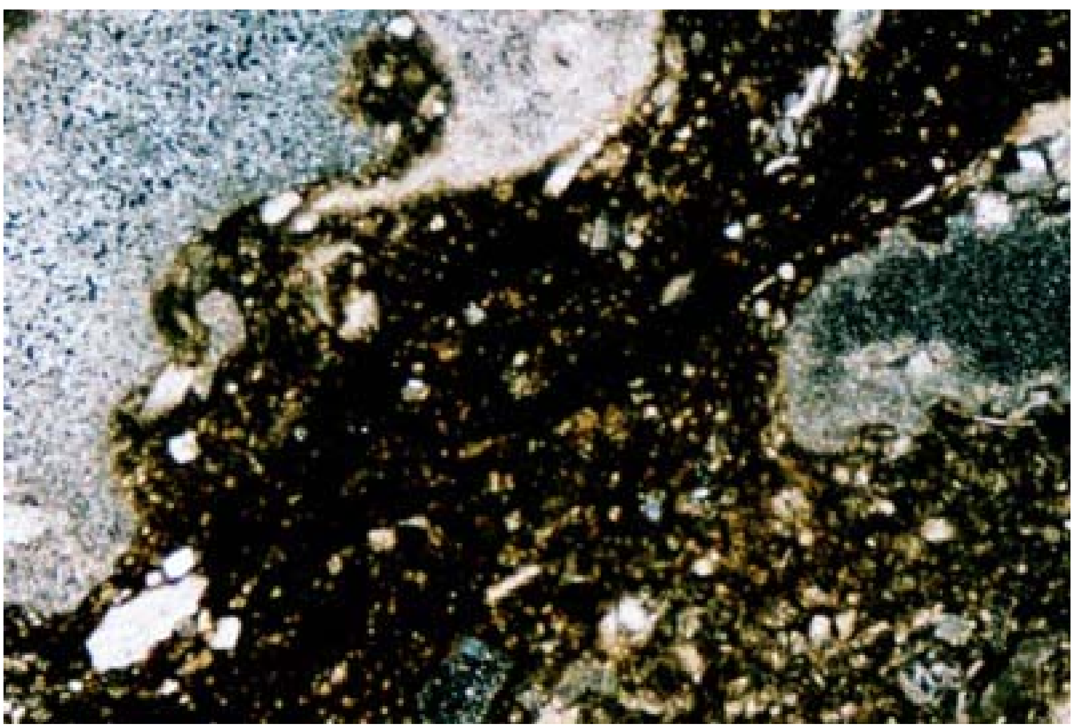
Although a few of the larger fossils are partly recrystallized to aggregates of dolomite, on the whole, carbonate aggregates (apart from replacement of fossils), so common in samples DGR6-761.76 and in DGR6-750.80, are rare. The fine-grained calcareous matrix to the fossils is made up of a mixture of very fine-grained calcite and K-rich clays. It is estimated that the lime mud mixture consists of approximately 30% calcite and 70% clays.

Pyrite occurs as minute framboids or euhedral grains – mostly in aggregates. They also occur as small discontinuous veinlets, and one relatively large vein (or fossil replacement (?) consists of fine-grained aggregates of pyrite.

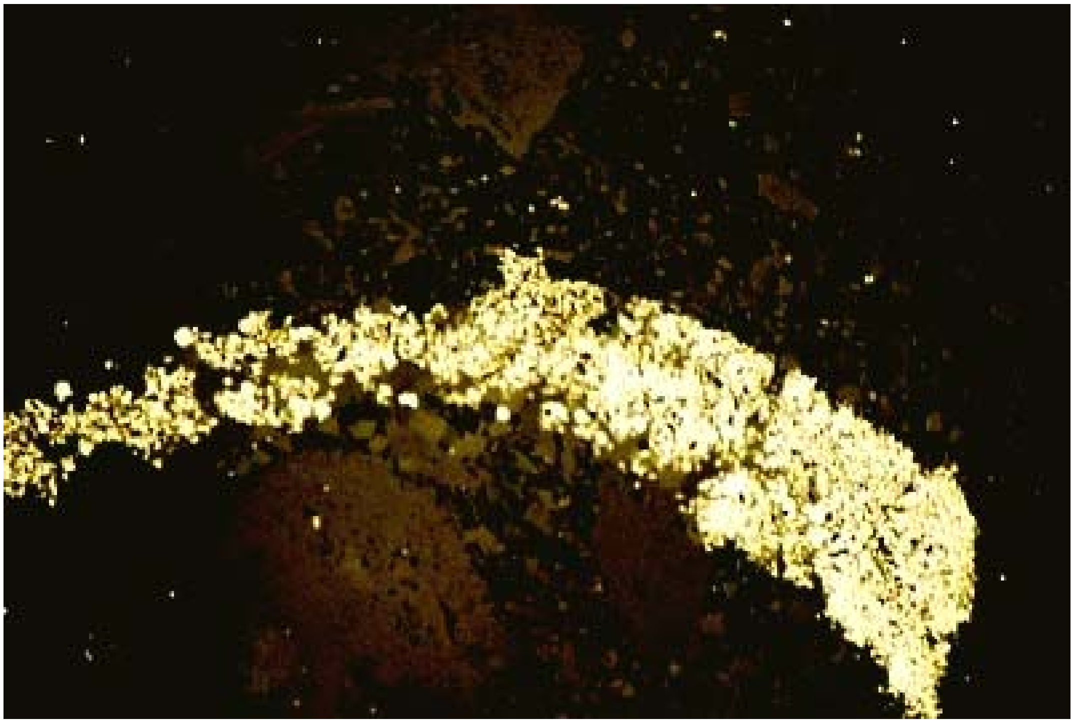
Minerals	%	Grain size (mm)
Calcite	20	<0.05-0.1
Dolomite	12	av. 0.05
Fossils	40	up to 3.0
Illite	10	
K-rich clays	15	
Pyrite	3	
Quartz	trace	
Apatite	trace	



A. Large, partly recrystallized fossil fragments in dark, lime mud.
X-axis of photo: 2.3mm. XN.



B. Similar to above. X-axis of photo: 2.3mm. XN.


C. Very fine-grained aggregates of pyrite (a vein or fossil replacement?).
X-axis of photo: 2.3mm. XN.

DGR6-768.58 dolomite
ZAF cycles 4 bc drift= .938

	fac	%el	%ox	stfm
CaO	.91	23.97	33.54	13.595
MgO	.51	9.75	16.17	9.121
FeO	.83	2.81	3.61	1.143
MnO	.81	.34	.44	.142
Total		36.88	53.77	24

DGR6-768.58 dolomite matrix
ZAF cycles 4 bc drift= .942

	fac	%el	%ox	stfm
CaO	.90	23.34	32.65	13.332
MgO	.53	11.09	18.39	10.445
FeO	.83	.00	.00	.000
MnO	.81	.54	.69	.224
Total		34.97	51.74	24

DGR6-768.58 clays
ZAF cycles 6 bc drift= .935

	fac	%el	%ox	stfm
SiO2	.75	30.78	63.85	8.512
Al2O3	.77	10.78	20.38	3.178
K2O	.84	17.80	20.44	3.418
Total		59.36	104.66	24

DGR6-768.58 calcite in matrix
ZAF cycles 4 bc drift= .921

	fac	%el	%ox	stfm
CaO	.92	36.00	50.37	23.833
MgO	.49	.00	.00	.000
FeO	.82	.35	.45	.168
MnO	.80	.00	.00	.000
Total		36.35	50.82	24

DGR6-768.58 illite+calcite matrix
ZAF cycles 5 bc drift= .920

	fac	%el	%ox	stfm
SiO2	.76	24.61	52.64	8.384
Al2O3	.72	6.02	11.37	2.134
K2O	.88	8.29	9.99	2.029
CaO	.83	12.62	17.66	3.014
Total		51.54	91.66	24

APPENDIX
DGR-6 Microprobe Analysis of Selected Minerals

DGR6-654.58 carbonate
ZAF cycles 4 bc drift= .969

	fac	%el	%ox	stfm
CaO	.92	26.73	37.40	22.739
MgO	.49	4.53	7.50	6.347
FeO	.83	4.06	5.22	2.476
MnO	.81	.71	.91	.439
Total		36.02	51.04	32

DGR6-654.58 calcite
ZAF cycles 4 bc drift= .968

	fac	%el	%ox	stfm
CaO	.92	35.78	50.06	30.108
MgO	.49	.91	1.51	1.264
FeO	.82	.73	.94	.439
MnO	.80	.31	.40	.189
Total		37.73	52.91	32

DGR6-654.58 matrix clay
ZAF cycles 5 bc drift= .953

	fac	%el	%ox	stfm
SiO2	.71	23.33	49.92	11.392
Al2O3	.67	8.03	15.18	4.084
TiO2	.84	.18	.29	.051
FeO	.84	5.96	7.66	1.462
MgO	.56	1.60	2.66	.904
K2O	.85	3.54	4.26	1.242
Cl	.77	.14	.14	.053
Total		42.78	80.11	32

DGR6-654.58 chlorite
ZAF cycles 5 bc drift= .962

	fac	%el	%ox	stfm
SiO2	.62	12.64	27.04	6.290
Al2O3	.57	9.52	18.00	4.935
FeO	.86	19.88	25.58	4.977
MgO	.48	5.29	8.76	3.039
Total		47.33	79.38	28

DGR6-654.58 chlorite
ZAF cycles 5 bc drift= .959

	fac	%el	%ox	stfm
SiO2	.62	12.64	27.04	6.231
Al2O3	.56	9.69	18.31	4.972
FeO	.86	20.27	26.08	5.027
MgO	.48	5.36	8.88	3.051
Total		47.96	80.32	28

DGR6-654.58 carbonate
ZAF cycles 4 bc drift= .956

	fac	%el	%ox	stfm
CaO	.91	23.82	33.33	16.147
MgO	.49	7.88	13.07	8.809
FeO	.83	5.66	7.28	2.752
MnO	.82	.59	.77	.294
Total		37.95	54.44	28

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DGR6-664.31 matrix clay
ZAF cycles 5 bc drift= .971

	fac	%el	%ox	stfm
SiO2	.74	28.26	60.45	10.466
Al2O3	.74	9.38	17.73	3.619
FeO	.83	.87	1.12	.162
K2O	.85	11.08	13.35	2.950
Total		49.60	92.65	28

DGR6-664.31 matrix clay
ZAF cycles 6 bc drift= .966

	fac	%el	%ox	stfm
SiO2	.69	25.57	54.71	10.634
Al2O3	.69	11.97	22.62	5.184
TiO2	.83	.29	.49	.071
FeO	.84	3.37	4.34	.706
MgO	.59	1.65	2.74	.793
K2O	.84	4.56	5.49	1.363
Na2O	.44	2.49	3.36	1.266
Total		49.91	93.74	32

DGR6-664.31 clay matrix
ZAF cycles 5 bc drift= .962

	fac	%el	%ox	stfm
SiO2	.76	35.09	75.08	13.504
Al2O3	.72	5.93	11.21	2.376
TiO2	.82	.00	.00	.000
FeO	.83	3.28	4.22	.635
MgO	.61	1.08	1.79	.480
K2O	.83	2.24	2.70	.619
Total		47.63	94.99	32

DGR6-664.31 dolomite
ZAF cycles 4 bc drift= .959

	fac	%el	%ox	stfm
CaO	.90	22.27	31.16	16.234
MgO	.52	12.14	20.13	14.592
FeO	.83	2.01	2.58	1.049
MnO	.81	.24	.31	.126
Total		36.65	54.18	32

DGR6-697.67 clay
ZAF cycles 5 bc drift= .969

	fac	%el	%ox	stfm
SiO2	.76	31.72	67.87	13.371
Al2O3	.72	6.03	11.40	2.647
TiO2	.83	.35	.58	.086
FeO	.83	2.17	2.79	.460
MgO	.60	.47	.78	.228
K2O	.84	2.80	3.37	.848
Total		43.54	86.79	32

DGR6-697.67 clay matrix
ZAF cycles 6 bc drift= .967

	fac	%el	%ox	stfm
SiO2	.68	23.47	50.21	10.210
Al2O3	.69	12.87	24.31	5.828
TiO2	.83	.00	.00	.000
FeO	.84	4.42	5.69	.967
MgO	.59	2.11	3.49	1.059
K2O	.85	5.19	6.26	1.623
Total		48.06	89.96	32

DGR6-697.67 apatite
ZAF cycles 4 bc drift= .963

	fac	%el	%ox	stfm
CaO	.88	37.13	51.96	11.114
P2O5	.88	21.57	49.43	8.355
Cl	.81	.14	.14	.048
Total		58.85	101.53	32

DGR6-697.67 calcite
ZAF cycles 4 bc drift= .954

	fac	%el	%ox	stfm
CaO	.92	30.94	43.29	24.809
MgO	.49	4.01	6.65	5.302
FeO	.83	2.54	3.27	1.464
MnO	.81	.73	.94	.426
Total		38.22	54.15	32

****

DGR6-717.97 calcite
ZAF cycles 4 bc drift= .961

	fac	%el	%ox	stfm
CaO	.92	36.45	51.00	31.780
MgO	.49	.00	.00	.000
FeO	.82	.35	.45	.220
Total		36.80	51.45	32

DGR6-717.97 clay matrix
ZAF cycles 5 bc drift= .965

	fac	%el	%ox	stfm
SiO2	.70	24.44	52.28	10.804
Al2O3	.71	12.18	23.01	5.607
MgO	.60	1.01	1.67	.515
FeO	.84	3.19	4.11	.710
K2O	.85	4.75	5.72	1.510
Total		45.57	86.79	32

DGR6-717.97 matrix calcite
ZAF cycles 4 bc drift= .962

	fac	%el	%ox	stfm
CaO	.92	36.18	50.63	31.661
MgO	.49	.00	.00	.000
FeO	.82	.54	.70	.339
Total		36.72	51.32	32

DGR6-717.97 matrix calcite
ZAF cycles 4 bc drift= .951

	fac	%el	%ox	stfm
CaO	.92	36.66	51.30	31.727
MgO	.49	.00	.00	.000
FeO	.82	.44	.57	.273
Total		37.10	51.86	32

****

DGR6-735.40 yellow apatite
ZAF cycles 4 bc drift= .959

	fac	%el	%ox	stfm
CaO	.88	35.74	50.00	11.631
P2O5	.88	19.35	44.33	8.149
Cl	.82	.57	.57	.209
Total		55.65	94.90	32

DGR6-735.40 dolomite rhomb
ZAF cycles 4 bc drift= .958

	fac	%el	%ox	stfm
CaO	.91	23.15	32.39	17.512
MgO	.51	10.29	17.07	12.836
FeO	.83	2.82	3.62	1.529
MnO	.81	.23	.29	.125
Total		36.49	53.37	32

DGR6-735.40 clay/ carbonate matrix
ZAF cycles 5 bc drift= .952

	fac	%el	%ox	stfm
SiO2	.71	27.20	58.19	11.413
Al2O3	.69	9.27	17.52	4.051
TiO2	.83	.40	.67	.099
FeO	.84	4.97	6.39	1.048
K2O	.85	3.90	4.70	1.177
CaO	.83	1.75	2.45	.515
MgO	.59	1.54	2.55	.747
Total		49.03	92.47	32

DGR6-735.40 clay/quartz matrix
ZAF cycles 5 bc drift= .946

	fac	%el	%ox	stfm
SiO2	.75	32.42	69.36	12.950
Al2O3	.72	7.02	13.27	2.921
TiO2	.82	.28	.46	.065
FeO	.83	3.04	3.91	.611
K2O	.84	3.12	3.75	.894
CaO	.83	.21	.29	.058
MgO	.61	1.02	1.70	.473
Total		47.11	92.75	32

DGR6-735.40 calcite
ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.92	36.83	51.53	31.064
MgO	.49	.42	.70	.590
FeO	.82	.57	.74	.346
Total		37.82	52.97	32

DGR6-735.40 calcite
ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.92	36.07	50.47	31.584
MgO	.49	.00	.00	.000
FeO	.82	.66	.85	.416
Total		36.74	51.33	32

DGR6-735.40 calcite
ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.92	36.07	50.47	31.584
MgO	.49	.00	.00	.000
FeO	.82	.66	.85	.416
Total		36.74	51.33	32

****

DGR6-750.80 brown apatite
ZAF cycles 4 bc drift= .935

	fac	%el	%ox	stfm
CaO	.89	39.15	54.77	9.558
P2O5	.87	18.28	41.90	5.778
Cl	.83	.30	.30	.082
Total		57.73	96.97	24

DGR6-750.80 rim brown apatite
ZAF cycles 4 bc drift= .951

	fac	%el	%ox	stfm
CaO	.89	38.78	54.26	9.389
P2O5	.87	18.66	42.75	5.845
Cl	.83	.24	.24	.065
Total		57.67	97.25	24

DGR6-750.80 'fan' shaped apatite
ZAF cycles 4 bc drift= .949

	fac	%el	%ox	stfm
CaO	.88	38.90	54.43	9.257
P2O5	.88	19.15	43.88	5.898
Cl	.83	.34	.34	.092
Total		58.39	98.66	24

DGR6-750.80 anhydrite
ZAF cycles 4 bc drift= .941

	fac	%el	%ox	stfm
CaO	.86	29.22	40.88	6.030
SO3	.92	23.22	57.98	5.991
Total		52.44	98.86	24

DGR6-750.80 second anhydrite
ZAF cycles 4 bc drift= .941

	fac	%el	%ox	stfm
CaO	.86	29.22	40.88	6.030
SO3	.92	23.22	57.98	5.991
Total		52.44	98.86	24

DGR6-750.80 coarse dolomite
ZAF cycles 4 bc drift= .929

	fac	%el	%ox	stfm
CaO	.90	21.86	30.58	12.887
MgO	.52	10.53	17.46	10.235
FeO	.83	2.08	2.67	.879
Total		34.46	50.71	24

DGR6-750.80 fine dolomite
ZAF cycles 4 bc drift= .926

	fac	%el	%ox	stfm
CaO	.91	22.82	31.93	13.580
MgO	.50	8.84	14.66	8.677
FeO	.83	4.08	5.25	1.744
Total		35.74	51.84	24

DGR6-750.80 fossil
ZAF cycles 4 bc drift= .926

	fac	%el	%ox	stfm
CaO	.92	31.54	44.13	19.330
MgO	.50	4.05	6.72	4.094
FeO	.83	1.31	1.69	.577
Total		36.90	52.54	24

DGR6-750.80 brown apatite
ZAF cycles 4 bc drift= .924

	fac	%el	%ox	stfm
CaO	.88	37.85	52.96	9.235
P2O5	.87	18.70	42.86	5.907
Cl	.83	.26	.26	.072
Total		56.81	96.08	24

DGR6-750.80 clay+carbonate matrix

ZAF cycles 4 bc drift= .932

	fac	%el	%ox	stfm
SiO2	.76	11.05	23.65	5.838
Al2O3	.67	3.26	6.16	1.794
K2O	.95	4.66	5.61	1.767
CaO	.87	23.64	33.07	8.749
Total		42.61	68.50	24

DGR6-750.80 clay+calcite matrix

ZAF cycles 4 bc drift= .932

	fac	%el	%ox	stfm
SiO2	.76	4.04	8.64	2.937
Al2O3	.64	.49	.93	.372
K2O	1.02	.24	.28	.123
FeO	.82	.31	.40	.114
CaO	.91	34.13	47.75	17.392
Total		39.20	58.00	24

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DGR6-761.76 calcite

ZAF cycles 4 bc drift= .928

	fac	%el	%ox	stfm
CaO	.92	38.15	53.38	24.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		38.15	53.38	24

DGR6-761.76 calcite core

ZAF cycles 4 bc drift= .928

	fac	%el	%ox	stfm
CaO	.92	38.15	53.38	24.000
MgO	.50	.00	.00	.000
FeO	.82	.00	.00	.000
Total		38.15	53.38	24

DGR6-761.76 dolomite

ZAF cycles 4 bc drift= .949

	fac	%el	%ox	stfm
CaO	.90	22.89	32.03	13.218
MgO	.52	10.66	17.68	10.148
FeO	.83	1.31	1.68	.543
SrO	.74	.35	.41	.093
Total		35.22	51.81	24

DGR6-61.76 matrix

ZAF cycles 4 bc drift= .943

	fac	%el	%ox	stfm
CaO	.90	23.17	32.42	10.884
MgO	.52	4.17	6.91	3.226
FeO	.83	1.21	1.56	.408
SiO2	.74	7.07	15.13	4.741
Total		35.62	56.02	24

DGR6-761.76 matrix
ZAF cycles 5 bc drift= .943

	fac	%el	%ox	stfm
SiO2	.75	30.01	64.21	12.098
Al2O3	.75	9.45	17.86	3.966
K2O	.84	12.81	15.43	3.709
Total		52.27	97.49	32

DGR6-768.58 dolomite
ZAF cycles 4 bc drift= .938

	fac	%el	%ox	stfm
CaO	.91	23.97	33.54	13.595
MgO	.51	9.75	16.17	9.121
FeO	.83	2.81	3.61	1.143
MnO	.81	.34	.44	.142
Total		36.88	53.77	24

DGR6-768.58 dolomite matrix
ZAF cycles 4 bc drift= .942

	fac	%el	%ox	stfm
CaO	.90	23.34	32.65	13.332
MgO	.53	11.09	18.39	10.445
FeO	.83	.00	.00	.000
MnO	.81	.54	.69	.224
Total		34.97	51.74	24

DGR6-768.58 K-rich clay
ZAF cycles 6 bc drift= .935

	fac	%el	%ox	stfm
SiO2	.75	30.78	63.85	8.712
Al2O3	.77	10.78	20.38	3.178
K2O	.84	17.80	20.44	3.618
Total		59.36	104.66	24

DGR6-768.58 calcite in matrix
ZAF cycles 4 bc drift= .921

	fac	%el	%ox	stfm
CaO	.92	36.00	50.37	23.833
MgO	.49	.00	.00	.000
FeO	.82	.35	.45	.168
MnO	.80	.00	.00	.000
Total		36.35	50.82	24

DGR6-768.58 clay+qtz+calcite matrix
ZAF cycles 5 bc drift= .920

	fac	%el	%ox	stfm
SiO2	.76	24.61	52.64	8.384
Al2O3	.72	6.02	11.37	2.134
K2O	.88	8.29	9.99	2.029
CaO	.83	12.62	17.66	3.014
Total		51.54	91.66	24