

 Enercon Services, Inc.	<b>PROJECT REPORT</b>			No.	TXUT-001-PR-010	
				Rev.	0	
				Page	1	of 31
				QA File Number:	TXUT-001	

APPENDIX G-1

## APPENDIX G-1

Petrographic Report # TTZ

(Spectrum Petrographics, Inc., May 24, 2007)

# Glenrose Project

## Petrographic Report #TTZ

May 24, 2007

for

Jeff Locke  
Fugro Consultants, Inc.  
6100 Hillcroft  
Houston, TX 77081

by



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Michael DePangher, Ph.D.  
Spectrum Petrographics, Inc.

### Key to Petrographic and Photomicrographic Descriptions

Clay minerals common in altered rocks must often be identified by X-ray diffraction either because their optic properties are not diagnostic or because they are too fine grained to be reliably identified by optical methods. The term "clay" is used herein to denote fine grained phyllosilicates in general. Under ideal conditions, it is often possible to optically discriminate between 4 major groups: kaolinite, smectite, mica (including illite), and chlorite. This is done whenever conditions permit.

The term "sericite" is applied to fine grained colorless phyllosilicates that show upper 2nd order maximum interference colors. These could include muscovite, illite, paragonite, lepidolite, margarite, clintonite, pyrophyllite, and talc. The term "intermediate clay" is applied to fine grained very pale or colorless phyllosilicates that show upper 1st order maximum interference colors. These are probably dominated by chlorite, smectite, and mixed-layer illite/smectite.

The term "opakes" is used to refer to all materials opaque (and sometimes semi-opaque) to transmitted light. The term "FEOH" is herein used to indicate fine grained, yellowish to reddish brown, earthy materials of varying opacity in transmitted light. FEOH is probably mostly Fe oxy-hydroxides but may sometimes include sphalerite, realgar, orpiment, jarosite, a number of Mn oxy-hydroxides, and organic matter.

A question mark after a rock or mineral name in a petrographic description means that there is uncertainty about the identification of that rock or mineral.

Particle size distributions are given as (A-B  $\mu$ m), where A and B are the median and largest particle sizes, respectively, in microns. A question mark (?) in the position of A or B indicates that the value of A or B was indeterminate, probably because of excessively large or small particle size or statistically insignificant numbers of particles.

Mineral abundances are visual estimates for an entire slide. For multi-lithologic materials (cuttings, etc...), mineralogy, textures, and alteration are described only for the dominant lithology.

Section preparation codes are as follows: (1) Format: 27 x 46 mm, 51 x 76 mm, or 1" round; (2) Finish: standard lapping (STD) or polished (POL); (3) Stains: sodium cobaltinitrite (SCN), alizarin red S (ARS), potassium ferricyanide (PF), and barium chloride + potassium rhodizonate (BCPR); and (4) Cover: none, permanent Loctite acrylic (PLA), or removable Canada Balsam (RCB).

Photomicrograph captions/labels contain the following items of information in consecutive order separated by forward slashes: (1) sample identification; (2) film roll number; (3) frame number; (4) illumination; (5) field of view (FOV); and (6) the job identification number. "PPL" indicates plane-polarized light; "XPL" indicates cross-polarized light; "R" indicates reflected light. "550" means that a 550 nanometer wavelength plate was inserted in the light path. "C" indicates that the substage condenser was in (sometimes used for Fe-oxides). "O" indicates substage condenser in an oblique position. These various illuminations can be combined. "CON" indicates conoscopic illumination. POL means that a polarizing filter was used with the lens, and DAY means the sample was photographed in diffused daylight.

Features on photomicrographs are indicated by the number of the feature in the ALTERATION section of the text or by a mineral name abbreviation: Quartz, Plagioclase, K-feldspar, sericite, biotite, ferroan calcite, actinolite.

For hypertext links to images to function properly, the images must reside in the same folder as the report.

### Comments

Most of the samples are strongly water sensitive, suggesting that the clay is dominantly smectite.



SAMPLE # **1012-49**

May 24, 2007

ROCK NAME SANDSTONE -- formed as a medium quartz arenite (McBride, 1963).

MINERALS Quartz (85%) + calcite (15%).

TEXTURES Clastic sedimentary, non-directed fabric.

Detrital Framework Grains (85%) are subround, 360-2000  $\mu\text{m}$ , monocrystalline quartz (70%) + polycrystalline lithic fragments of chert (15%). Contacts between grains are tangential.

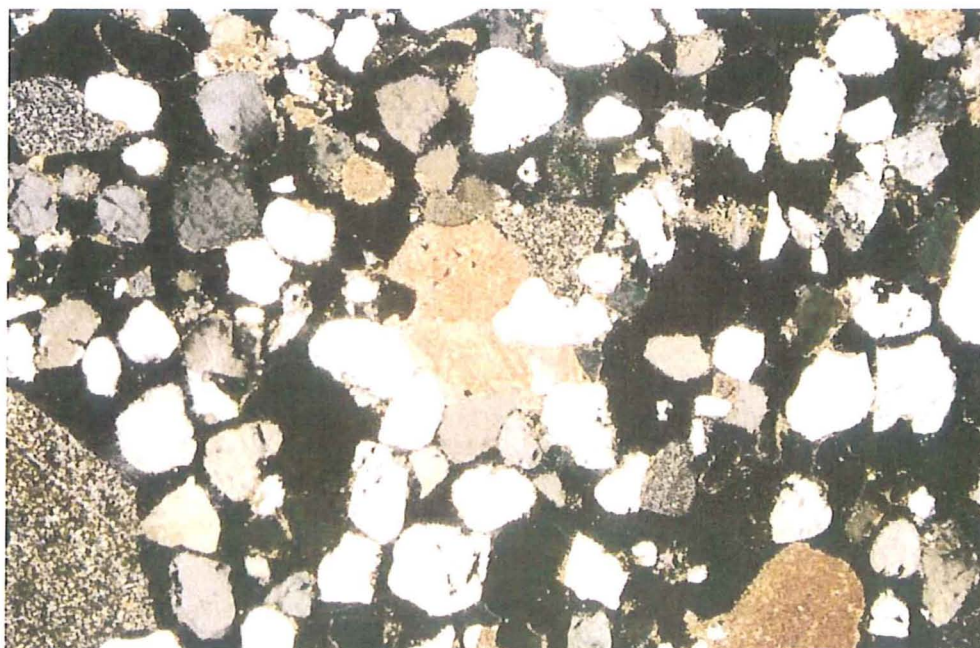
Matrix (0%) was not observed.

Cement (15%) is composed of calcite.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

PHOTOS 1012-49 [07023\\_01.jpg](#)/XPL/28X/TTZ SANDSTONE showing typical appearance of disaggregated material that locally preserves the primary texture of medium sand grains cemented by sparry calcite.



SAMPLE # **2038-09**

May 24, 2007

ROCK NAME ALTERED SILTY LIMESTONE -- formed by alteration (secondary opaques + weakly ferroan dolomite) from a silty limestone protolith.

MINERALS Calcite (51%) + quartz (20%) + clay (15%) + opaques (6%) + weakly ferroan dolomite rhombs (5%) + collophane (3%).

TEXTURES Mixed chemical and clastic sedimentary, non-directed fabric.

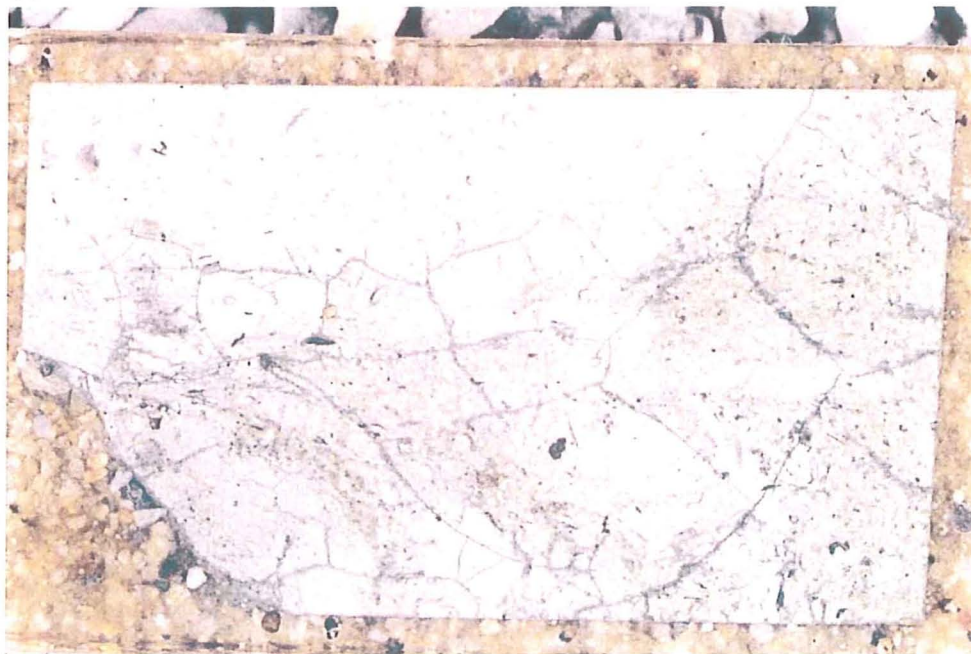
Detrital Framework Grains (30%) are angular, 50-600  $\mu\text{m}$  quartz (20%) + calcite fossils (7%) + collophane fossils. Contacts between grains are floating.

Matrix/Cement (70%) is composed of [calcite weakly altered to euhedral rhombs of weakly ferroan dolomite] + clay + opaques.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

PHOTOS 2038-09 [07018\\_09.jpg](#)/DAY/3X/TTZ ALTERED SILTY LIMESTONE showing typical appearance of hand specimen.





2038-09 [07023\\_02.jpg](#)/XPL/28X/TTZ ALTERED SILTY LIMESTONE showing typical appearance of a clay-rich domain.



**SAMPLE #** 2034-23 May 24, 2007

**ROCK NAME** FOSSILIFEROUS LIMESTONE -- formed as a fossiliferous limestone.

**MINERALS** Calcite (86%) + opaques (6%) + clay (5%) + quartz (3%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (50%) are 400-5200  $\mu\text{m}$  fossiliferous intraclasts (47%) + quartz silt (3%). Contacts between grains are tangential.

Matrix/Cement (50%) is composed of calcite.

**ALTERATION** No other alteration features were observed.

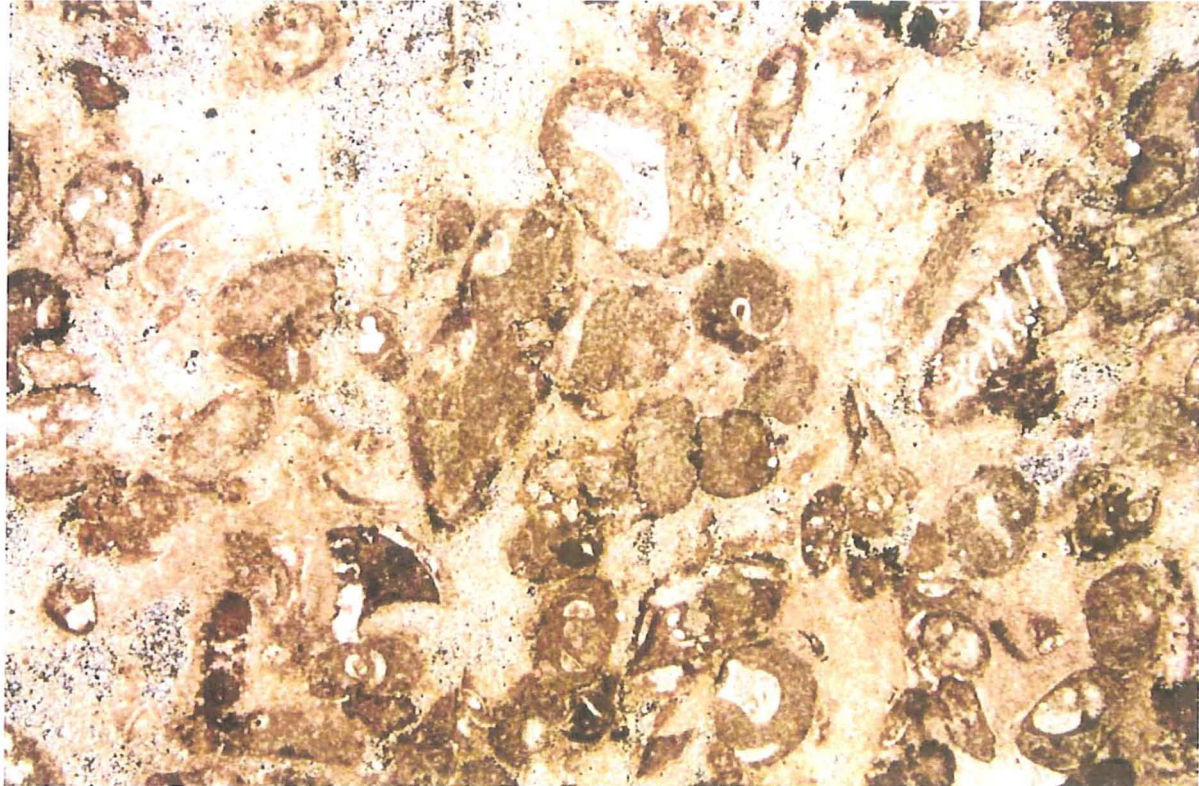
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** 2034-23 [07018 10.jpg](#)/DAY/3X/TTZ FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





2034-23 [07023\\_03.jpg](#)/XPL/28X/TTZ FOSSILIFEROUS LIMESTONE showing typical appearance of abundant fossils.



SAMPLE # **2034-09**

May 24, 2007

ROCK NAME FOSSILIFEROUS LIMESTONE -- formed as a fossiliferous limestone.

MINERALS Calcite (89%) + clay (7%) + quartz (2%) + opaques (2%).

TEXTURES Mixed chemical and clastic sedimentary, non-directed fabric.

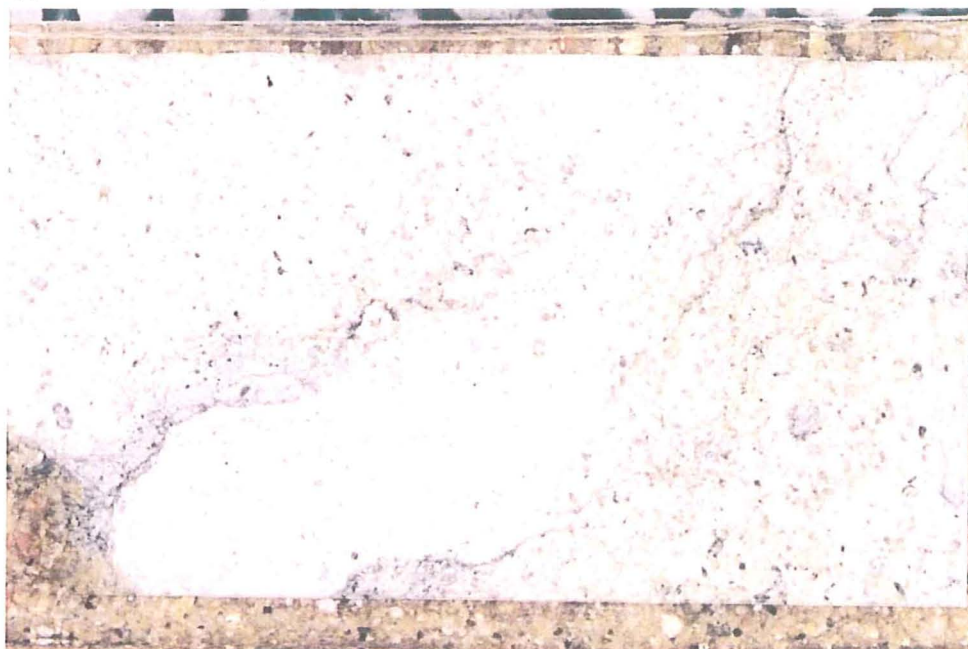
Detrital Framework Grains (50%) are 400-2400  $\mu\text{m}$  fossiliferous intraclasts (48%) + quartz silt (2%). Contacts between grains are tangential.

Matrix/Cement (50%) is composed of calcite + clay.

ALTERATION No other alteration features were observed.

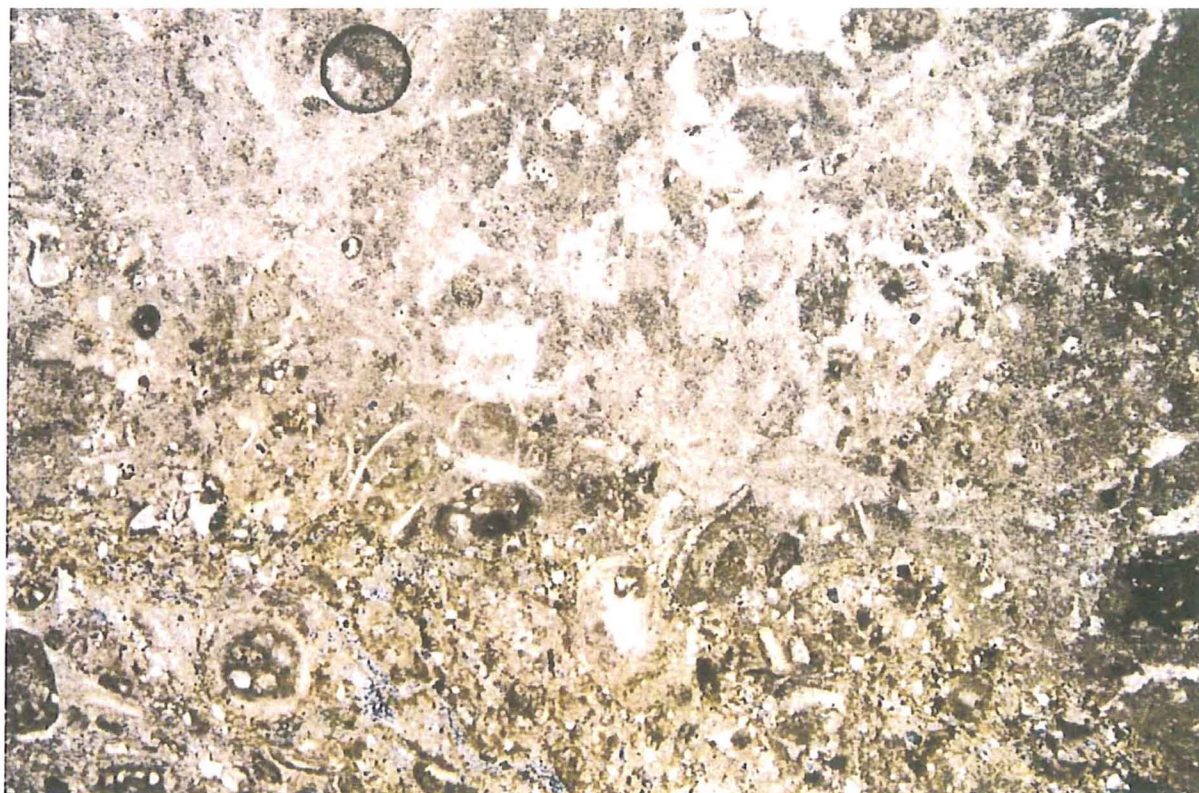
SECTIONING Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

PHOTOS 2034-09 [07018 11.jpg](#)/DAY/3X/TTZ FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





2034-09 [07023\\_04.jpg](#)/XPL/28X/TTZ FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments and clay stringers.



SAMPLE # **2031-15** May 24, 2007

ROCK NAME ALTERED MARLY SILTSTONE -- formed by alteration (secondary weakly ferroan dolomite + opaques) from a marly siltstone protolith.

MINERALS Quartz (50%) + weakly ferroan dolomite rhombs (30%) + clay (13%) + opaques (5%) + carbonaceous matter (2%) + collophane (<1%).

TEXTURES Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (50%) are angular, 30-50  $\mu$ m quartz (50%). Contacts between grains are tangential.

Matrix/Cement (50%) is composed of [calcite (?) completely altered to euhedral rhombs of weakly ferroan dolomite] + clay + opaques.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

PHOTOS 2031-15 [07018\\_12.jpg](#)/DAY/3X/TTZ ALTERED MARLY SILTSTONE showing typical appearance of hand specimen.





2031-15      [07023\\_05.jpg](#)/XPL/57X/TTZ    ALTERED MARLY SILTSTONE showing typical appearance of quartz silt.

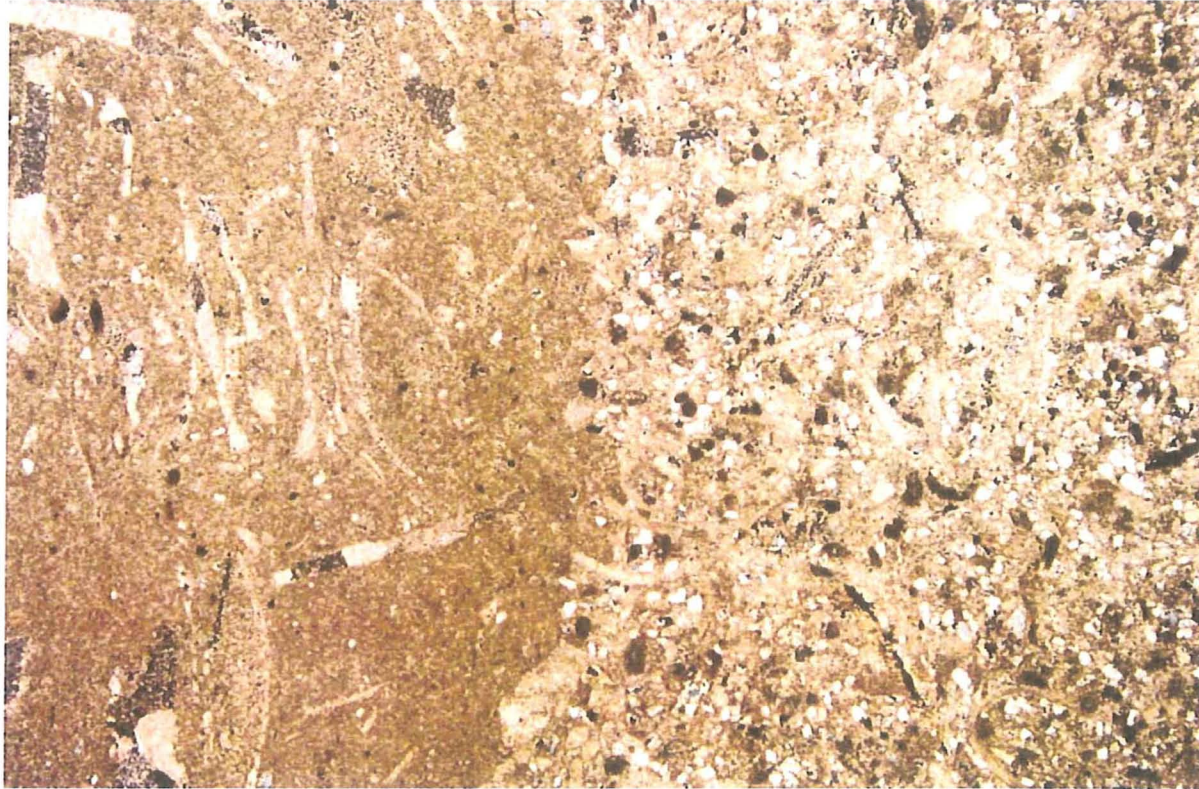


SAMPLE #	2004-12	May 24, 2007
ROCK NAME	SILTY FOSSILIFEROUS LIMESTONE -- formed as a silty fossiliferous limestone.	
MINERALS	Calcite (75%) + quartz (15%) + clay (5%) + opaques (4%) + collophane (1%).	
TEXTURES	Mixed chemical and clastic sedimentary, non-directed fabric.	
	<u>Detrital Framework Grains (50%)</u> are 50-4400 µm calcite fossils (34%) + quartz silt (15%) + collophane fossils (1%). Contacts between grains are floating.	
	<u>Matrix/Cement (50%)</u> is composed of calcite + clay + opaques.	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA	
PHOTOS	2004-12 <a href="#">07018_13.jpg</a> /DAY/3X/TTZ SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.	





2004-12      [07023\\_06.jpg](#)/XPL/28X/TTZ SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of silt-poor domain (left) and silt-rich domain (right).



**SAMPLE #** **2004-07** May 24, 2007

**ROCK NAME** ALTERED SILTY MARL -- formed by alteration (secondary weakly ferroan dolomite + opaques) from a silty marl protolith.

**MINERALS** Clay (35%) + weakly ferroan dolomite rhombs (35%) + quartz (26%) + opaques (4%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (25%) are angular, 40-120  $\mu\text{m}$  quartz (25%). Contacts between grains are floating.

Matrix/Cement (75%) is composed of clay + [calcite (?)] completely altered to euhedral rhombs of weakly ferroan dolomite] + opaques.

**ALTERATION** No other alteration features were observed.

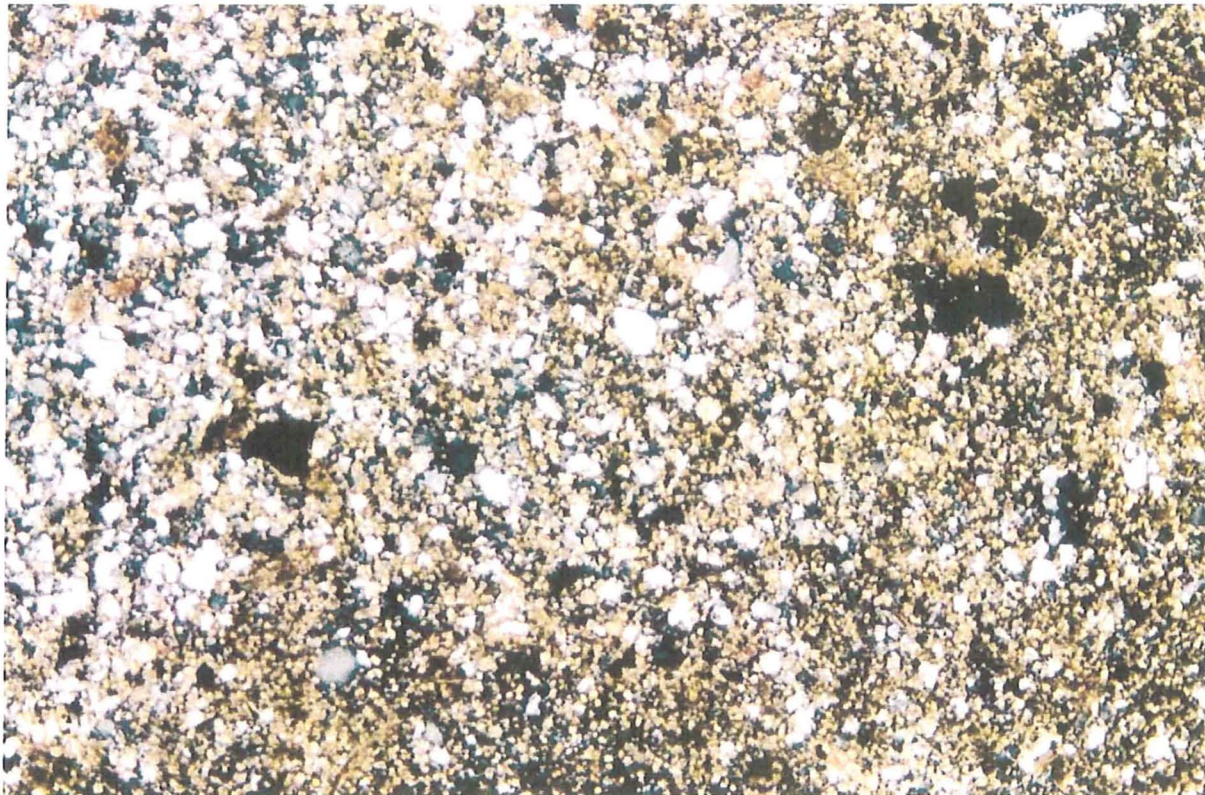
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS** 2004-07 [07018 14.jpg](#)/DAY/3X/TTZ ALTERED SILTY MARL showing typical appearance of hand specimen.





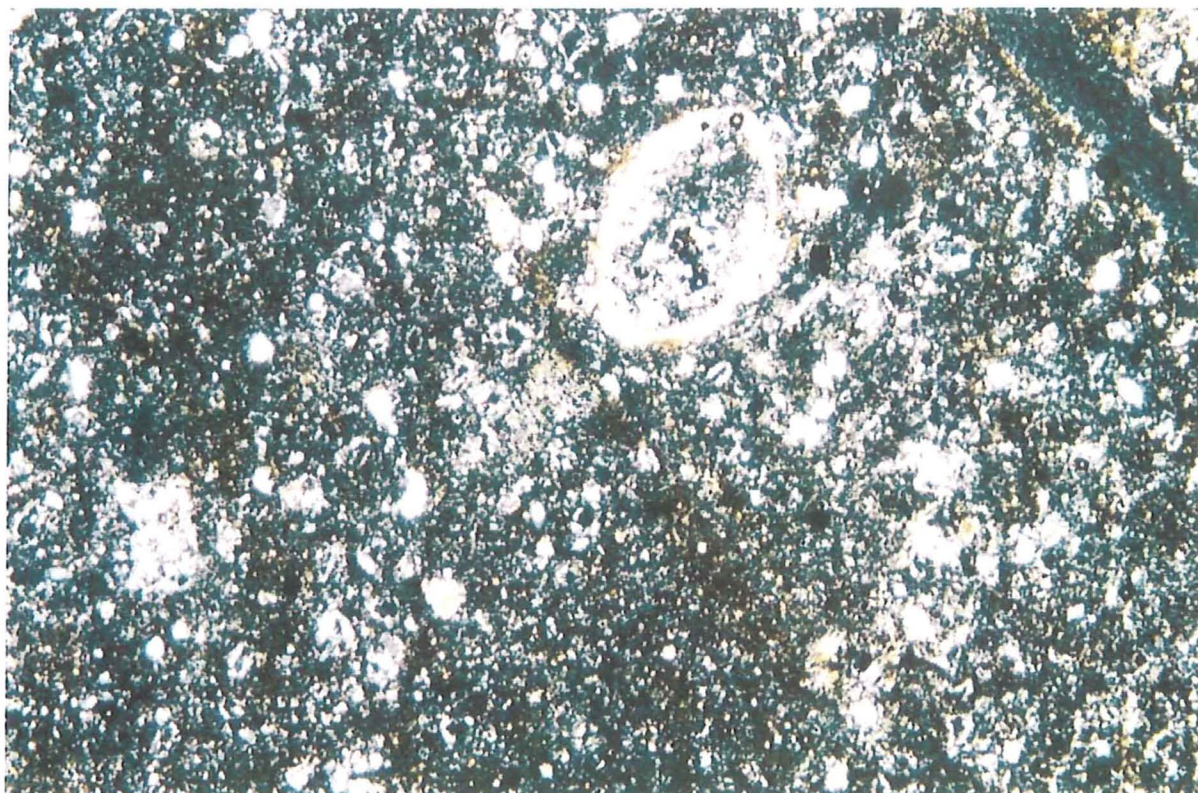
2004-07 [07023\\_07.jpg](#)/XPL/57X/TTZ ALTERED SILTY MARL showing typical appearance of quartz silt.







2002-06R [07023\\_08.jpg](#)/XPL/57X/TTZ SILTY CLAYSTONE showing typical appearance. Dark areas are clay-rich.



SAMPLE # **1041-27**

May 24, 2007

ROCK NAME SILTY CLAYSTONE -- formed as a silty claystone.

MINERALS Clay (81%) + quartz (10%) + opaques (7%) + calcite (2%).

TEXTURES Mixed chemical and clastic sedimentary, non-directed fabric.

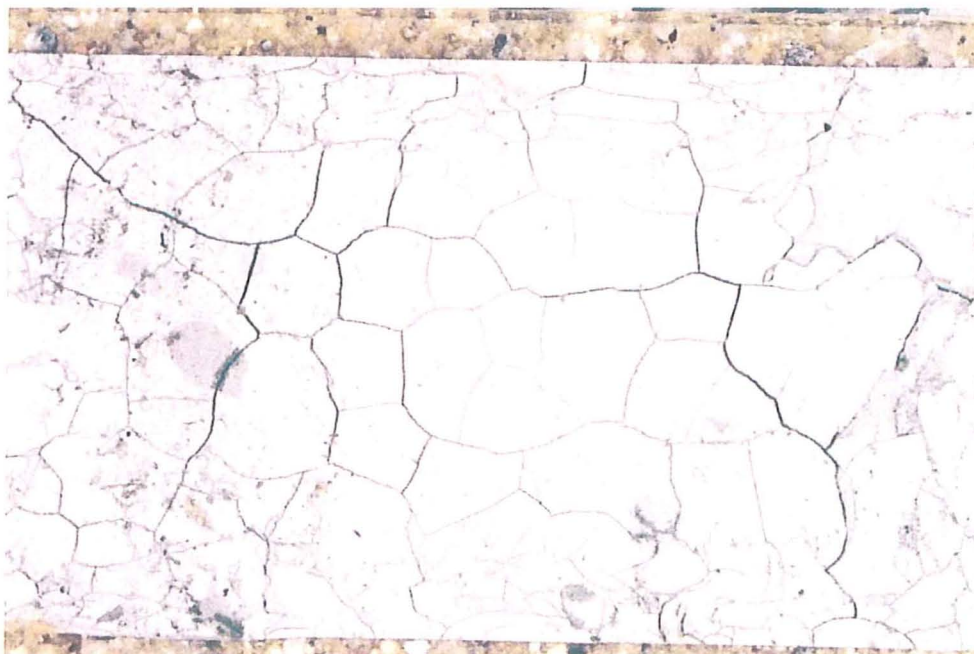
Detrital Framework Grains (10%) are angular, 30-100  $\mu\text{m}$  quartz (10%). Contacts between grains are floating.

Matrix/Cement (90%) is composed of clay + opaques + calcite.

ALTERATION No other alteration features were observed.

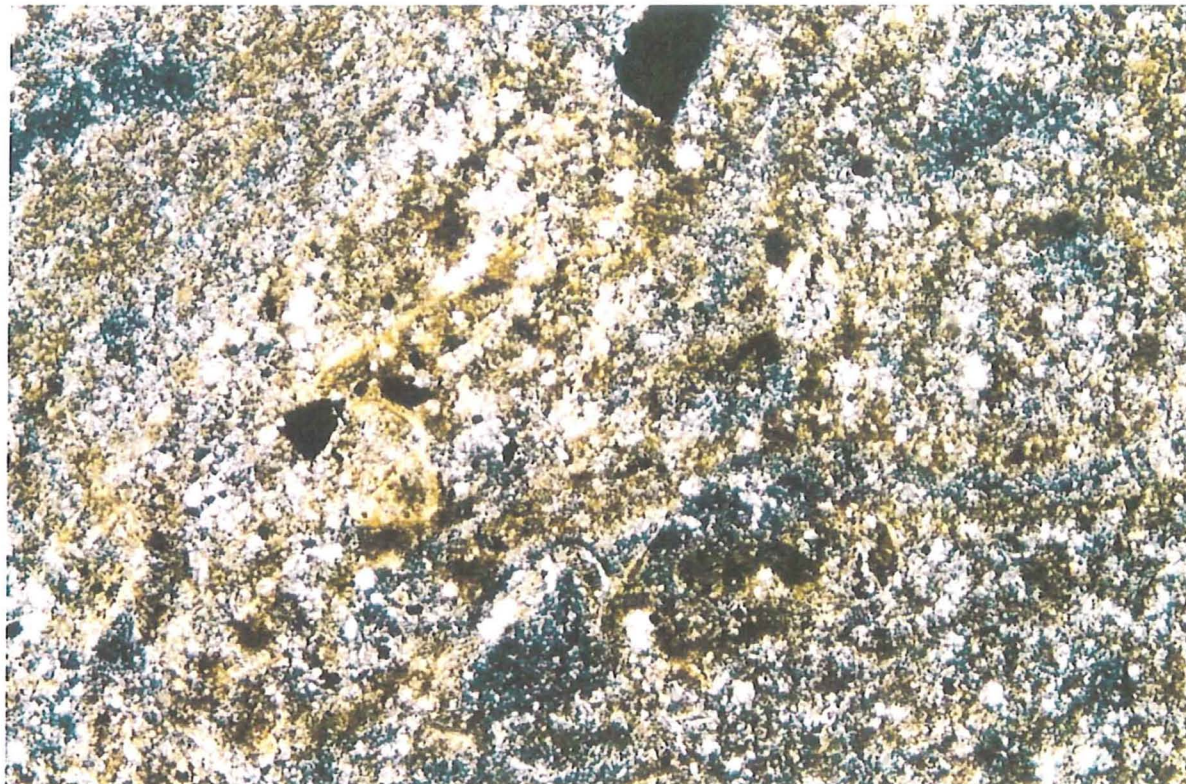
SECTIONING Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right  $\frac{1}{2}$ ) Cover: PLA

PHOTOS 1041-27 [07018\\_16.jpg](#)/DAY/3X/TTZ SILTY CLAYSTONE showing typical appearance of hand specimen.





1041-27      [07023\\_09.jpg](#)/XPL/57X/TTZ SILTY CLAYSTONE showing typical appearance.

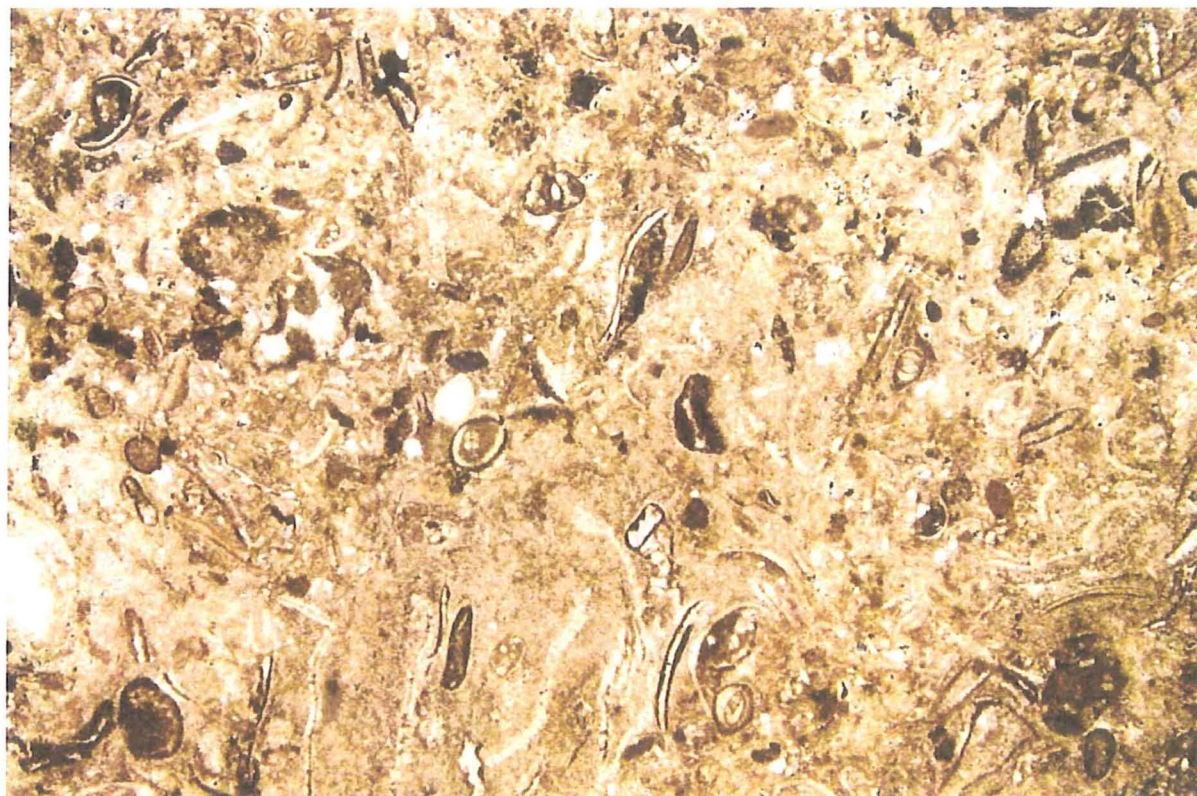


SAMPLE #	1037-18	May 24, 2007
ROCK NAME	SILTY FOSSILIFEROUS LIMESTONE -- formed as a silty fossiliferous limestone.	
MINERALS	Calcite (78%) + clay (15%) + quartz (3%) + opaques (3%) + collophane (1%).	
TEXTURES	Mixed chemical and clastic sedimentary. Weak fine bedding defines a weakly directed fabric.	
	<p><u>Detrital Framework Grains (33%)</u> are 280-1400 µm calcite fossils (30%) + quartz silt (3%) + collophane fossils (1%). Contacts between grains are floating to tangential.</p> <p><u>Matrix/Cement (67%)</u> is composed of calcite + clay + opaques.</p>	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA	
PHOTOS	1037-18 <a href="#">07018_17.jpg</a> /DAY/3X/TTZ SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.	





1037-18 [07023\\_10.jpg](#)/XPL/28X/TTZ SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments.

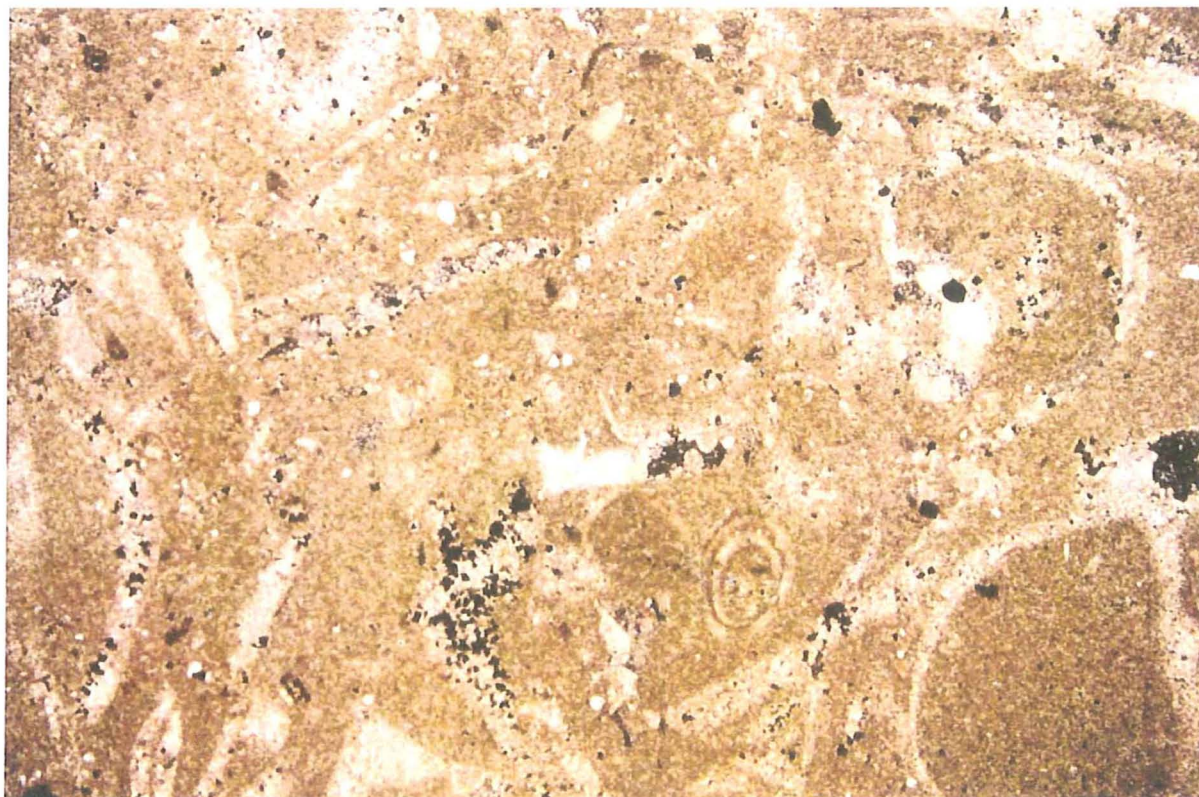


SAMPLE #	1035-12	May 24, 2007
ROCK NAME	SILTY FOSSILIFEROUS LIMESTONE -- formed as a silty fossiliferous limestone.	
MINERALS	Calcite (87%) + clay (5%) + opaques (5%) + quartz (3%) + collophane (<1%).	
TEXTURES	Mixed chemical and clastic sedimentary, non-directed fabric.	
	<p><u>Detrital Framework Grains (33%)</u> are 30 µm to 10 mm calcite fossils (30%) + quartz silt (3%) + collophane fossils (&lt;1%). Contacts between grains are floating to tangential.</p> <p><u>Matrix/Cement (67%)</u> is composed of calcite + clay + opaques.</p>	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA	
PHOTOS	1035-12 <a href="#">07018_18.jpg</a> /DAY/3X/TTZ SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.	





1035-12 [07023 11.jpg](#)/XPL/28X/TTZ SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments.



**SAMPLE #** **1032-19** May 24, 2007

**ROCK NAME** ALTERED SILTY MARL -- formed by alteration (secondary weakly ferroan dolomite + opaques) from a silty marl protolith.

**MINERALS** Clay (43%) + quartz (30%) + weakly ferroan dolomite rhombs (20%) + opaques (7%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (30%) are angular, 40-190  $\mu\text{m}$  quartz (30%). Contacts between grains are floating to tangential.

Matrix/Cement (70%) is composed of clay + [calcite (?)] completely altered to euhedral rhombs of weakly ferroan dolomite] + opaques.

**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS** 1032-19 [07018\\_19.jpg](#)/DAY/3X/TTZ ALTERED SILTY MARL showing typical appearance of hand specimen.





1032-19 [07023\\_12.jpg](#)/XPL/57X/TTZ ALTERED SILTY MARL showing typical appearance of quartz silt.



SAMPLE #	1031-16	May 24, 2007
ROCK NAME	ALTERED SILTY MARL -- formed by alteration (secondary weakly ferroan dolomite + opaques) from a silty marl protolith.	
MINERALS	Clay (55%) + quartz (20%) + weakly ferroan dolomite rhombs (15%) + opaques (10%).	
TEXTURES	Mixed chemical and clastic sedimentary, non-directed fabric.	
	<u>Detrital Framework Grains (20%)</u> are angular, 20-50 µm quartz (20%). Contacts between grains are floating.	
	<u>Matrix/Cement (80%)</u> is composed of clay + [calcite (?) completely altered to euhedral rhombs of weakly ferroan dolomite] + opaques.	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA	
PHOTOS	1031-16 <a href="#">07018_20.jpg</a> /DAY/3X/TTZ ALTERED SILTY MARL showing typical appearance of hand specimen.	





1031-16 [07023 13.jpg](#)/XPL/57X/TTZ ALTERED SILTY MARL showing typical appearance of quartz silt.



**SAMPLE #** **1031-10** May 24, 2007

**ROCK NAME** ALTERED SILTY FOSSILIFEROUS LIMESTONE -- formed by alteration from a silty fossiliferous limestone.

**MINERALS** Calcite (63%) + euhedral dolomite rhombs (20%) + quartz (10%) + opaques (6%) + collophane (1%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (61%) are 50-200 µm calcite fossils + intraclasts (50%) + quartz silt (10%) + collophane fossils (1%). Contacts between grains are mostly tangential.

Matrix/Cement (39%) is composed of [calcite moderately altered to dolomite] + opaques.

**ALTERATION** No other alteration features were observed.

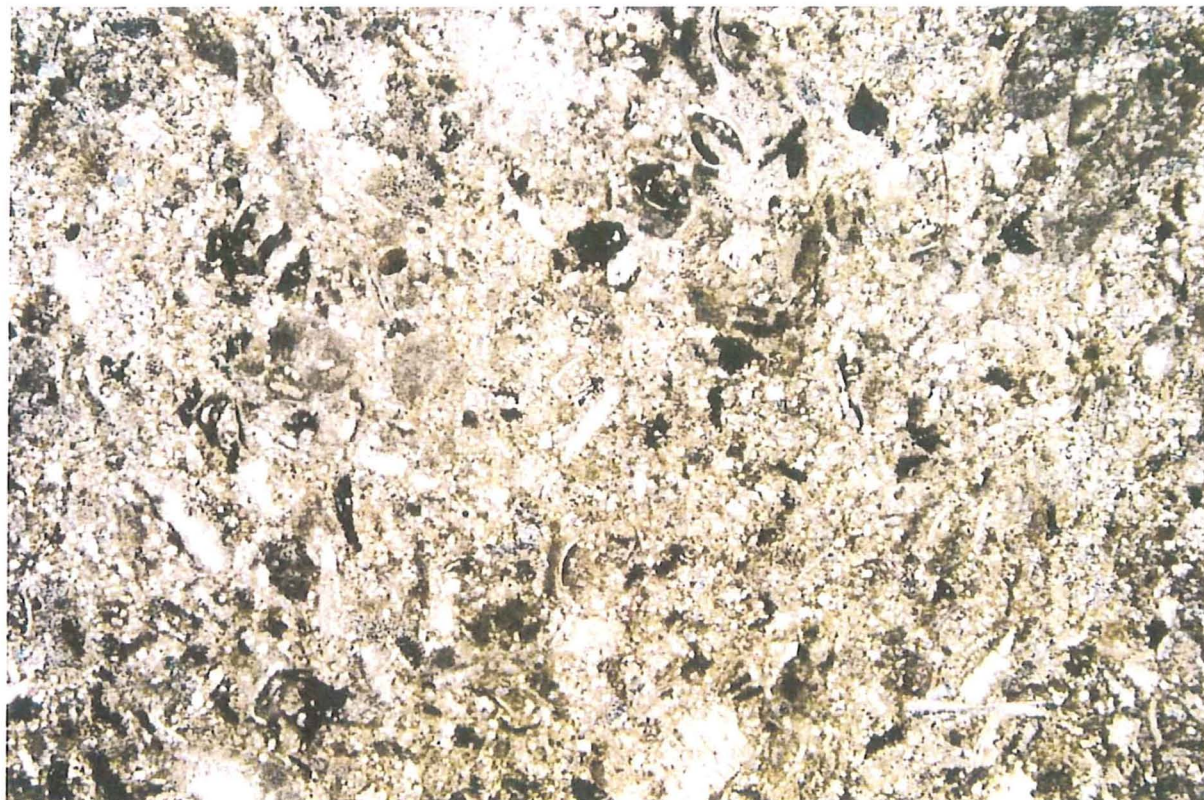
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS** 1031-10 [07018\\_21.jpg](#)/DAY/3X/TTZ ALTERED SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





1031-10 [07023\\_14.jpg](#)/XPL/28X/TTZ ALTERED SILTY FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments and abundant tiny rhombs of dolomite in matrix/cement.



 Enercon Services, Inc.	<b>PROJECT REPORT</b>			No.	TXUT-001-PR-010	
				Rev.	0	
				Page	1	of 54
				QA File Number:	TXUT-001	

APPENDIX G-2

## APPENDIX G-2

**Petrographic Report # TZJ**

**(Spectrum Petrographics, Inc., August 21, 2007)**



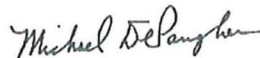
## **Petrographic Report (#TZJ) for the Comanche Peak COL Project**

August 21, 2007

Prepared for

William Lettis & Associates, Inc.  
1454 Greene Street, Suite A  
Augusta, GA 30901  
WLA Project 1863

Prepared by

A handwritten signature in black ink that reads "Michael DePangher". The signature is written in a cursive, flowing style.

Michael DePangher, Ph.D.  
Spectrum Petrographics, Inc.

### Key to Petrographic and Photomicrographic Descriptions

Clay minerals common in altered rocks must often be identified by X-ray diffraction either because their optic properties are not diagnostic or because they are too fine grained to be reliably identified by optical methods. The term "clay" is used herein to denote fine grained phyllosilicates in general. Under ideal conditions, it is often possible to optically discriminate between 4 major groups: kaolinite, smectite, mica (including illite), and chlorite. This is done whenever conditions permit.

The term "sericite" is applied to fine grained colorless phyllosilicates that show upper 2nd order maximum interference colors. These could include muscovite, illite, paragonite, lepidolite, margarite, clintonite, pyrophyllite, and talc. The term "intermediate clay" is applied to fine grained very pale or colorless phyllosilicates that show upper 1st order maximum interference colors. These are probably dominated by chlorite, smectite, and mixed-layer illite/smectite.

The term "opaques" is used to refer to all materials opaque (and sometimes semi-opaque) to transmitted light. The term "FEOH" is herein used to indicate fine grained, yellowish to reddish brown, earthy materials of varying opacity in transmitted light. FEOH is probably mostly Fe oxy-hydroxides but may sometimes include sphalerite, realgar, orpiment, jarosite, a number of Mn oxy-hydroxides, and organic matter.

Particle size distributions are given as (A-B  $\mu\text{m}$ ), where A and B are the median and largest particle sizes, respectively, in microns. A question mark (?) in the position of A or B indicates that the value of A or B was indeterminate, probably because of excessively large or small particle size or statistically insignificant numbers of particles.

Mineral abundances are visual estimates. For multi-lithologic materials (cuttings, etc...), mineralogy, textures, and alteration are described only for the dominant lithology.

Section preparation codes are as follows: (1) Format: 27 x 46 mm, 51 x 76 mm, or 1" round; (2) Finish: standard lapping (STD) or polished (POL); (3) Stains: sodium cobaltinitrite (SCN), alizarin red S (ARS), potassium ferricyanide (PF), and barium chloride + potassium rhodizonate (BCPR); and (4) Cover: none, permanent Loctite acrylic (PLA), or removable Canada Balsam (RCB).

Photomicrograph captions/labels contain the following items of information in consecutive order separated by forward slashes: (1) sample identification; (2) **image file name composed of "film roll number\_frame number.jpg"**; (4) illumination; (5) field of view (FOV); and (6) the job identification number. "PPL" indicates plane-polarized light; "XPL" indicates cross-polarized light; "R" indicates reflected light. "550" means that a 550 nanometer wavelength plate was inserted in the light path. "C" indicates that the substage condenser was in (sometimes used for Fe-oxides). "O" indicates substage condenser in an oblique position. These various illuminations can be combined. "CON" indicates conoscopic illumination. POL means that a polarizing filter was used with the lens, and DAY means the sample was photographed in diffused daylight.

Features on photomicrographs are indicated by the number of the feature in the ALTERATION section of the text or by a mineral name abbreviation: Quartz, Plagioclase, K-feldspar, sericite, biotite, ferroan calcite, actinolite.

A question mark after a rock or mineral name in a petrographic description means that there is uncertainty about the identification of that rock or mineral.



## Introduction

This report presents the results of a petrographic study conducted on selected samples collected from the proposed Comanche Peak Nuclear Station COL project site. The evaluated samples were provided by Rick Ortiz, William Lettis & Associates, Inc., Valencia, CA. The following samples were evaluated:

### Sample No.

B1012 HS-1  
B1012 HS-2  
B1012 HS-3  
B1012 HS-4  
B1012 HS-5  
B1012 HS-6  
B1012 HS-7  
B1012 HS-8  
B1012 HS-9  
B1012 HS-10  
B1012 HS-11  
B1012 HS-12  
B1012 HS-13  
B1012 HS-14  
B1012 HS-15  
B1012 HS-16  
B1012 HS-17  
B1012 HS-18  
B1012 HS-19  
B1012 HS-20  
B1012 HS-21  
STA 34 HS-22  
STA 38 HS-23  
STA 42-A HS-24  
STA 42-A HS-25

## General Comments

Protolithologies are dominated by fossiliferous limestones with lesser silty claystones and sandstones. Many samples show water sensitivity, suggesting that the clay is dominantly smectite.

**SAMPLE #** **B1012 HS-1** August 21, 2007

**ROCK NAME** FOSSILIFEROUS LIMESTONE-- probably formed as a fossiliferous marine limestone.

**MINERALS** Calcite (99%) + opaques (1%) + collophane (<1%).

**TEXTURES** Mixed chemical and clastic sedimentary. Preferential orientation of the long axes of fossil fragments defines a weakly directed fabric.

Detrital Framework Grains (50%) are round, 4000-6000 µm calcite fossil fragments (50%) + collophane fossil fragments (<1%). Contacts between grains are tangential.

Matrix/Cement (50%) is composed of sparry calcite (49%) + opaques (1%).

**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-1 [07031\\_01.jpg](#)/DAY/3X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





B1012 HS-1 [07035\\_11.jpg](#)/XPL/28X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of preferentially oriented fossil fragments.



**SAMPLE #** **B1012 HS-2** August 21, 2007

**ROCK NAME** SILTY DOLOMITE -- probably formed by alteration (secondary weakly ferroan dolomite + opaques) of a silty carbonate protolith.

**MINERALS** Weakly ferroan dolomite (88%) + quartz (5%) + opaques (5%) + collophane (2%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

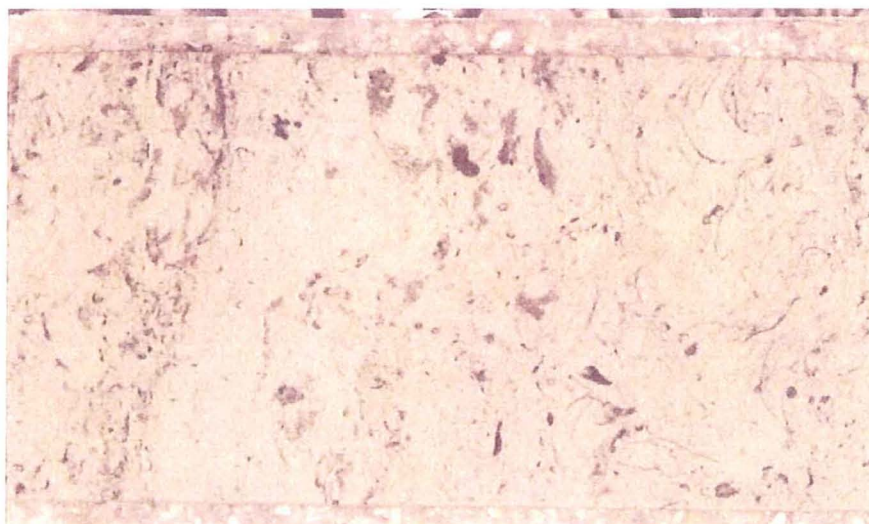
Detrital Framework Grains (7%) are angular, 40-1680  $\mu\text{m}$  quartz (6%) + collophane fossil fragments (2%). Contacts between grains are floating.

Matrix/Cement (93%) is composed of microsparry weakly ferroan dolomite.

**ALTERATION** No other alteration features were observed.

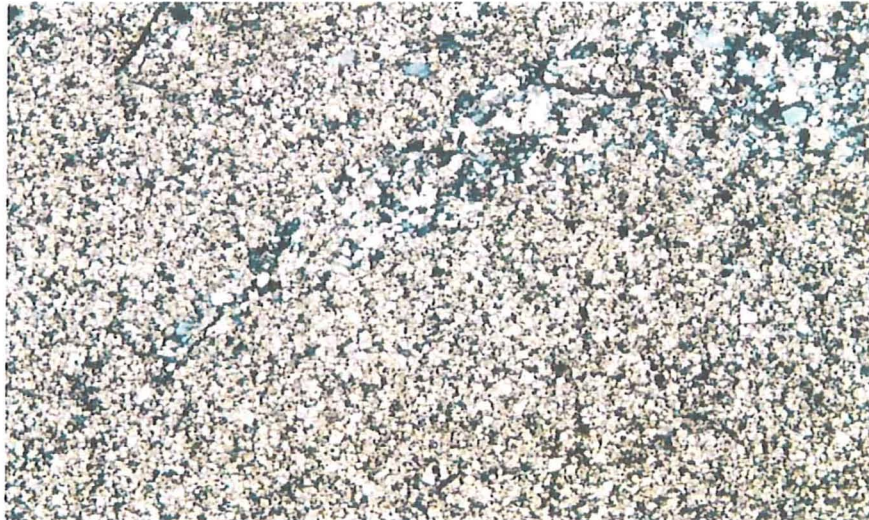
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-2 [07031\\_02.jpg](#)/DAY/3X/TZJ SILTY DOLOMITE showing typical appearance of hand specimen.





B1012 HS-2 [07035\\_12.jpg](#)/XPL/57X/TZJ SILTY DOLOMITE showing typical appearance of sparry weakly ferroan dolomite and scattered quartz grains.



**SAMPLE #** **B1012 HS-3** August 21, 2007

**ROCK NAME** FOSSILIFEROUS LIMESTONE-- probably formed as a fossiliferous marine limestone.

**MINERALS** Calcite (93%) + opaques (5%) + quartz (2%).

**TEXTURES** Mixed chemical and clastic sedimentary. Weak preferential orientation of the long axes of fossil fragments defines a weakly directed fabric.

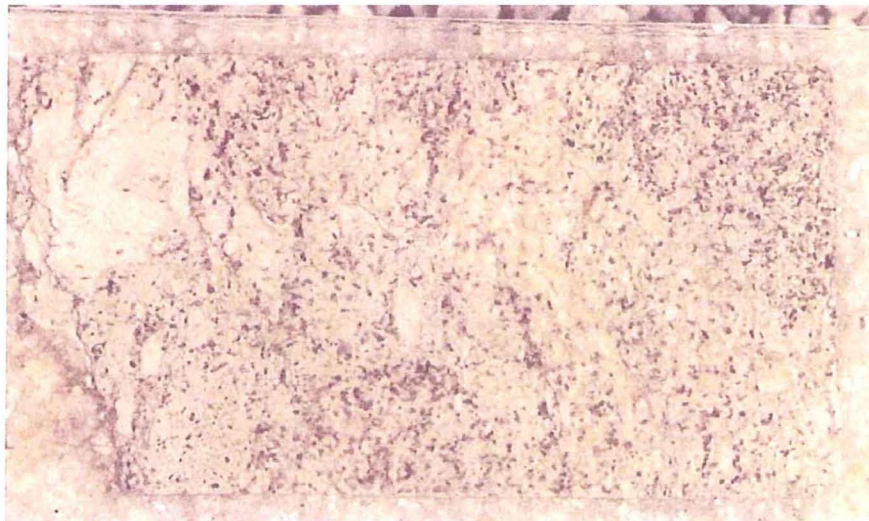
Detrital Framework Grains (50%) are subround, 280-380  $\mu$ m calcite fossil fragments (48%) + quartz silt (2%). Contacts between grains are tangential.

Matrix/Cement (50%) is composed of micritic calcite + opaques.

**ALTERATION** No other alteration features were observed.

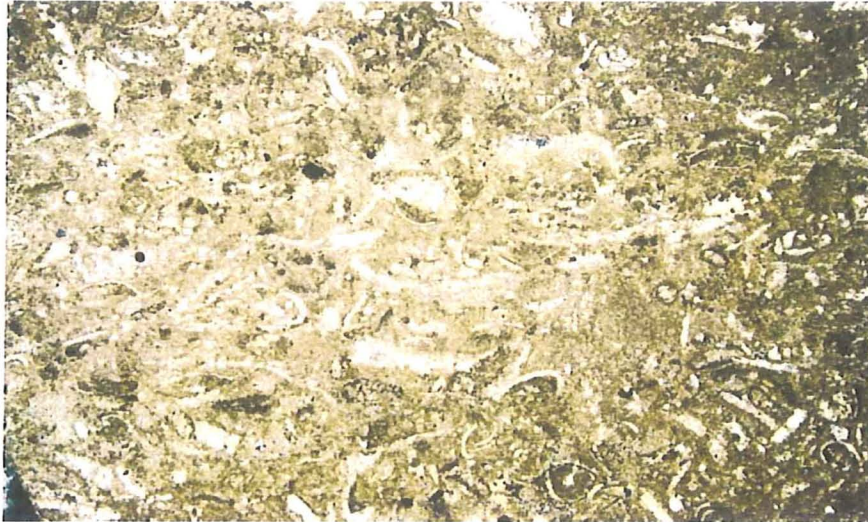
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-3 [07031\\_03.jpg](#)/DAY/3X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





B1012 HS-3 [07035\\_13.jpg](#)/XPL/28X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments in micrite matrix.



**SAMPLE #** **B1012 HS-4** August 21, 2007

**ROCK NAME** FOSSILIFEROUS LIMESTONE-- probably formed by alteration (secondary weakly ferroan dolomite) of a fossiliferous marine limestone.

**MINERALS** Calcite (45%) + weakly ferroan dolomite (40%) + clay (6%) + opaques (6%) + quartz (3%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (33%) are subround, 3-10 mm calcite fossil fragments (30%) + quartz silt (3%). Contacts between grains are floating.

Matrix/Cement (67%) is composed of [calcite moderately altered to weakly ferroan dolomite] + clay + opaques.

**ALTERATION** No other alteration features were observed.

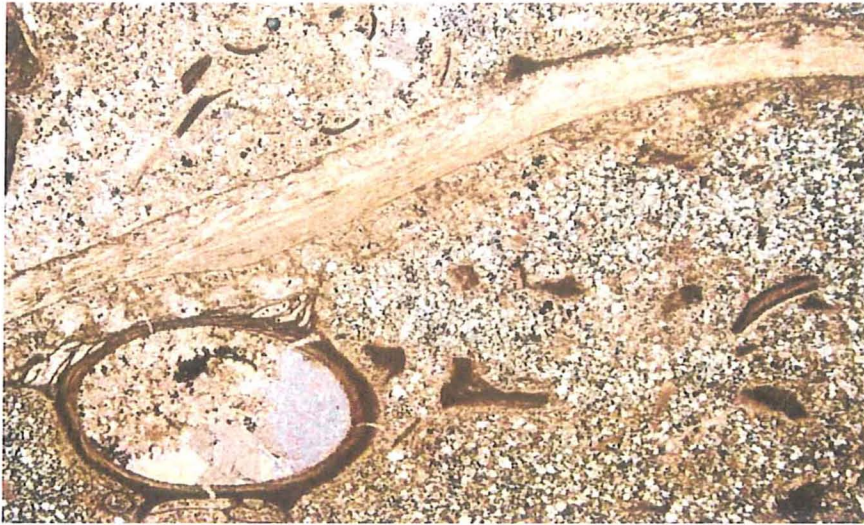
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-4 [07031\\_04.jpg](#)/DAY/3X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





B1012 HS-4 [07035\\_14.jpg](#)/XPL/28X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments in matrix/cement dominated by [calcite moderately altered to weakly ferroan dolomite].



**SAMPLE #** **B1012 HS-5** August 21, 2007

**ROCK NAME** SILTY CLAYSTONE -- probably formed as a silty mudstone.

**MINERALS** Clay (58%) + quartz (20%) + weakly ferroan dolomite (12%) + opaques (10%).

**TEXTURES** Clastic sedimentary. Alternating clay- and silt-rich laminae define a moderately directed fabric.

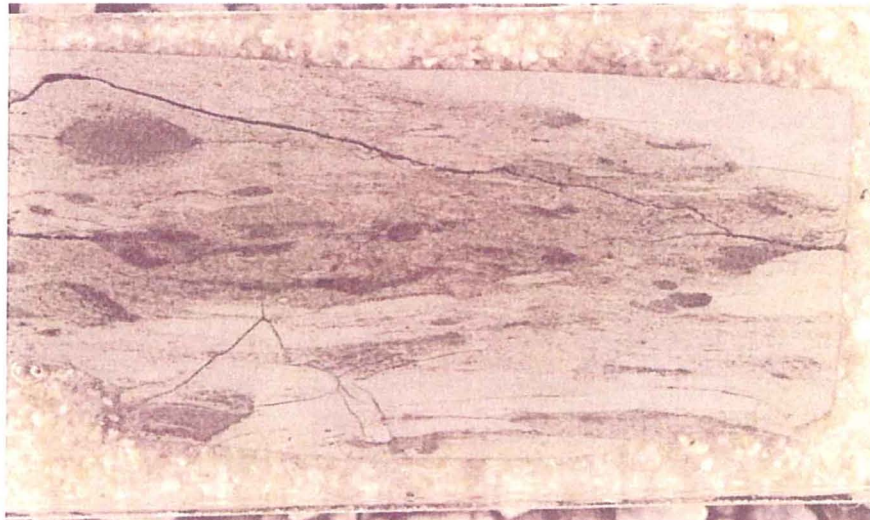
Detrital Framework Grains (20%) are angular 30-100  $\mu$ m quartz (20%). Contacts between grains are floating.

Matrix/Cement (80%) is composed of clay + weakly ferroan dolomite rhombs + opaques.

**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS** B1012 HS-5 [07031\\_05.jpg](#)/DAY/3X/TZJ SILTY CLAYSTONE showing typical appearance of hand specimen.





B1012 HS-5 [07035\\_15.jpg](#)/XPL/28X/TZJ SILTY CLAYSTONE showing typical appearance dominated by clay with scattered quartz silt grains.



**SAMPLE #** **B1012 HS-6** August 21, 2007

**ROCK NAME** ALTERED FOSSILIFEROUS LIMESTONE-- probably formed by alteration (secondary calcite) of a fossiliferous marine limestone.

**MINERALS** Calcite (92%) + quartz (4%) + clay (2%) + opaques (2%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (54%) are 200-1200 µm calcite fossil fragments (50%) + quartz silt (4%). Contacts between grains are floating to tangential.

Matrix/Cement (46%) is composed of micritic calcite (42%) + clay (2%) + opaques (2%).

**ALTERATION** Alteration features in relative chronological order from oldest to youngest are: (1) veins of calcite.

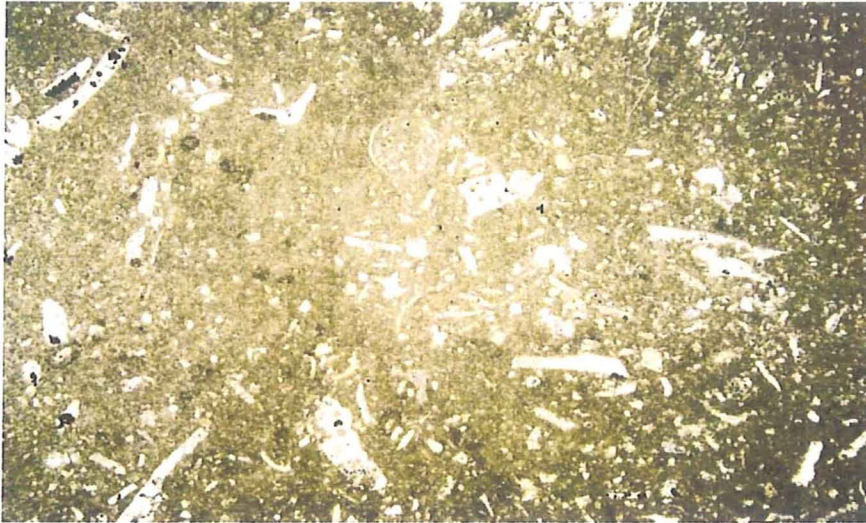
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-6 [07031\\_06.jpg](#)/DAY/3X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.





B1012 HS-6 [07035\\_16.jpg](#)/XPL/28X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments in micrite matrix.



**SAMPLE #** **B1012 HS-7** August 21, 2007

**ROCK NAME** ALTERED FOSSILIFEROUS LIMESTONE-- probably formed by cataclasis of a fossiliferous marine limestone.

**MINERALS** Calcite (90%) + opaques (6%) + quartz (2%) + clay (2%).

**TEXTURES** Mixed chemical and clastic sedimentary. Cataclasis and preferred orientation of elongate fossil fragments define a weakly directed fabric.

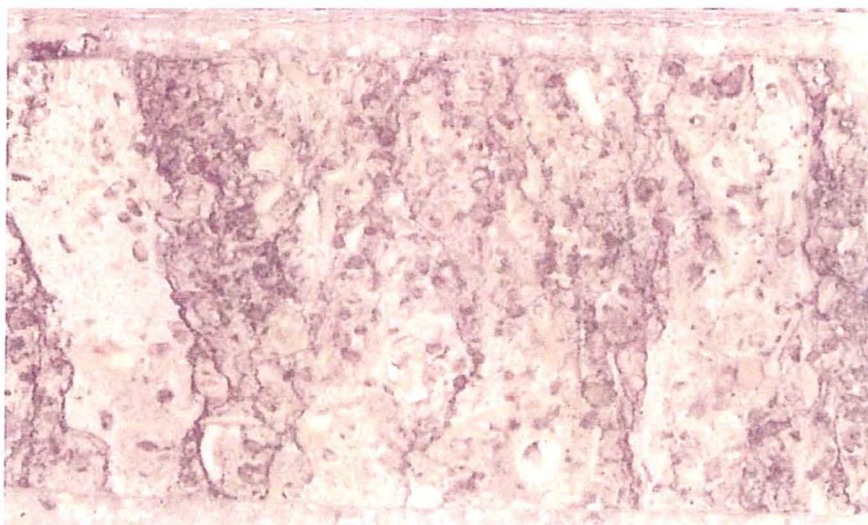
Detrital Framework Grains (52%) are 1120-4800  $\mu\text{m}$  calcite fossil fragments (50%) + quartz silt (2%). Contacts between grains are floating to tangential.

Matrix/Cement (48%) is composed of micritic calcite (40%) + opaques (6%) + clay (2%).

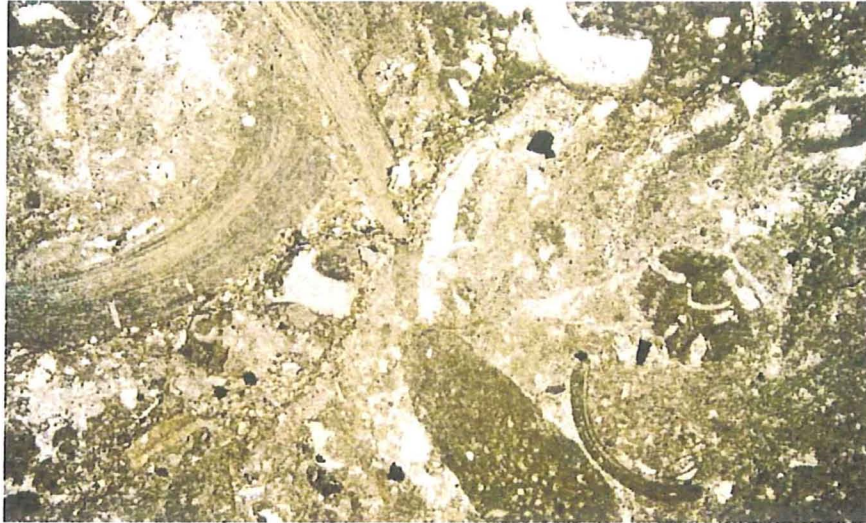
**ALTERATION** Alteration features in relative chronological order from oldest to youngest are: (1) cataclasis.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-7 [07031\\_07.jpg](#)/DAY/3X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.



B1012 HS-7 [07035\\_17.jpg](#)/XPL/28X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments in micrite matrix.





**SAMPLE #** **B1012 HS-8** August 21, 2007

**ROCK NAME** ALTERED FOSSILIFEROUS LIMESTONE-- probably formed by alteration (secondary dolomite) of a fossiliferous marine limestone.

**MINERALS** Calcite (45%) + dolomite (45%) + quartz (5%) + opaques (4%) + clay (1%) + collophane (<1%).

**TEXTURES** Mixed chemical and clastic sedimentary, non-directed fabric.

Detrital Framework Grains (30%) are 100-600  $\mu$ m calcite pellets (20%) + calcite fossil fragments (10%) + quartz silt (5%) + collophane (<1%). Contacts between grains are floating.

Matrix/Cement (70%) is composed of micritic calcite + microsparry dolomite.

**ALTERATION** Alteration features in relative chronological order from oldest to youngest are: (1) calcite matrix moderately altered to dolomite.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-8 [07031\\_08.jpg](#)/DAY/3X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.



B1012 HS-8 [07035 18.jpg](#)/XPL/28X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments in matrix/cement of micritic calcite + microsparry dolomite.



SAMPLE #	<b>B1012 HS-9</b>	August 21, 2007
ROCK NAME	ALTERED FOSSILIFEROUS LIMESTONE-- probably formed by alteration (secondary dolomite) of a fossiliferous marine limestone.	
MINERALS	Dolomite (62%) + calcite (20%) + quartz (8%) + opaques (8%) + collophane (2%).	
TEXTURES	Mixed chemical and clastic sedimentary. Poorly developed fine bedding defines a weakly directed fabric.  <u>Detrital Framework Grains (30%)</u> are 40-1000 µm calcite pellets (10%) + calcite fossil fragments (10%) + quartz silt (8%) + collophane (2%). Contacts between grains are floating.  <u>Matrix/Cement (70%)</u> is composed of micritic calcite + microsparry dolomite.	
ALTERATION	Alteration features in relative chronological order from oldest to youngest are: (1) calcite matrix strongly altered to dolomite.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA	
PHOTOS	B1012 HS-9 <a href="#">07031_09.jpg</a> /DAY/3X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.	





B1012HS-9 [07035\\_19.jpg](#)/XPL/28X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments and quartz silt in a matrix/cement composed of micritic calcite + microsparry dolomite.



**SAMPLE #** **B1012 HS-10** August 21, 2007

**ROCK NAME** SANDSTONE -- probably formed as a fine quartz arenite (McBride, 1963) protolith.

**MINERALS** Quartz (60%) + clay (probably smectite) (35%) + opaques (5%) + K-feldspar (1%) + tourmaline (<1%).

**TEXTURES** Clastic sedimentary, non-directed fabric.

Detrital Framework Grains (60%) are subangular, 160-560 µm, monocrystalline [quartz (55%) + K-feldspar (1%)] + polycrystalline lithic fragments of chert (4%). Contacts between grains are floating to tangential.

Matrix/Cement (40%) is composed of clay.

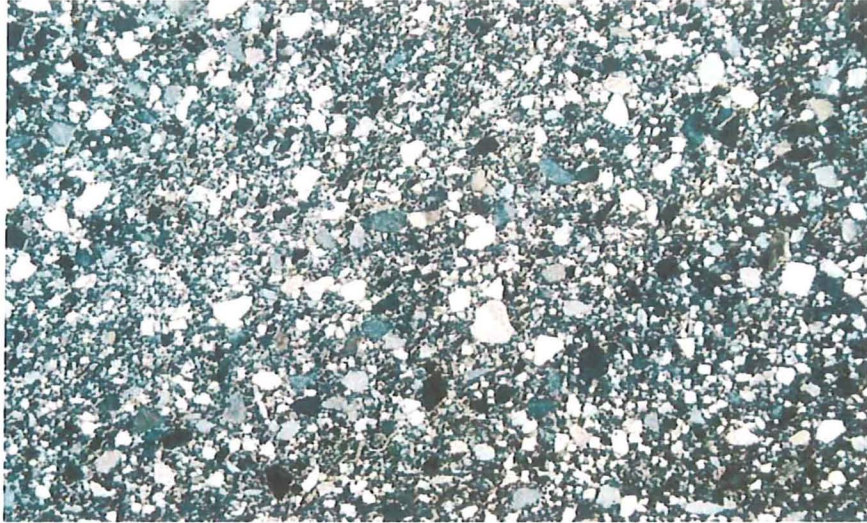
**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS** B1012 HS-10 [07031\\_10.jpg](#)/DAY/3X/TZJ SANDSTONE showing typical appearance of hand specimen.



B1012 HS-10     [07035\\_20.jpg](#)/XPL/28X/TZJ SANDSTONE showing typical appearance.

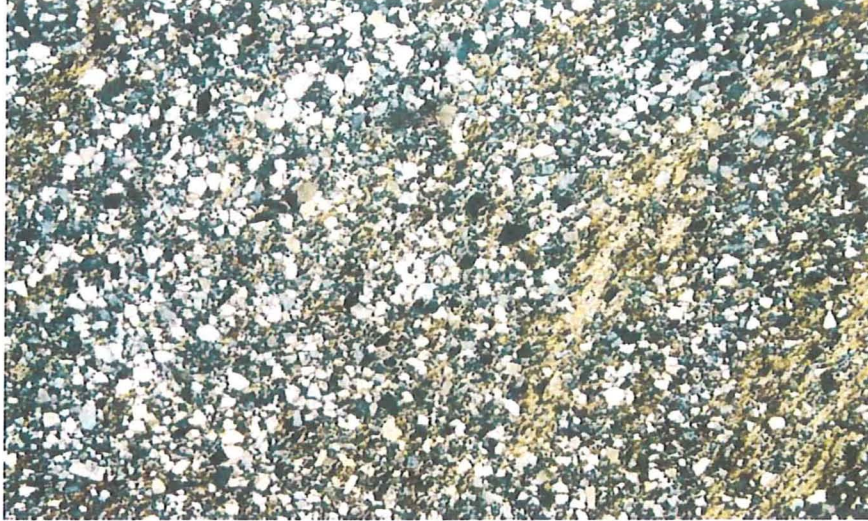




SAMPLE #	B1012 HS-11	August 21, 2007
ROCK NAME	SANDSTONE -- probably formed as a fine quartz arenite (McBride, 1963) protolith.	
MINERALS	Quartz (50%) + clay (probably smectite) (45%) + opaques (5%) + ferroan calcite (<1%).	
TEXTURES	<p>Clastic sedimentary. Poorly developed fine bedding defines a weakly directed fabric.</p> <p><u>Detrital Framework Grains (50%)</u> are subangular, 100-200 µm, monocrystalline quartz (50%). Contacts between grains are tangential.</p> <p><u>Matrix/Cement (50%)</u> is composed of clay (45%) + opaques (5%).</p>	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA	
PHOTOS	B1012 HS-11 <a href="#">07031_11.jpg</a> /DAY/3X/TZJ SANDSTONE showing typical appearance of hand specimen.	



B1012 HS-11     [07035\\_21.jpg](#)/XPL/28X/TZJ SANDSTONE showing typical appearance.



**SAMPLE #** **B1012 HS-12** August 21, 2007

**ROCK NAME** SILTY MARL -- probably formed as a clayey silty carbonate protolith.

**MINERALS** Quartz (35%) + weakly ferroan dolomite (35%) + clay (probably smectite) (24%) + opaques (3%) + FEOH (3%).

**TEXTURES** Clastic sedimentary. Poorly developed fine bedding defines a weakly directed fabric.

Detrital Framework Grains (35%) are angular, 40-110  $\mu\text{m}$ , monocrystalline quartz (35%). Contacts between grains are floating.

Matrix/Cement (65%) is composed of euhedral weakly ferroan dolomite rhombs (35%) + clay (24%) + opaques (3%) + FEOH (3%).

**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS** B1012 HS-12 [07031\\_12.jpg](#)/DAY/3X/TZJ SILTY MARL showing typical appearance of hand specimen.



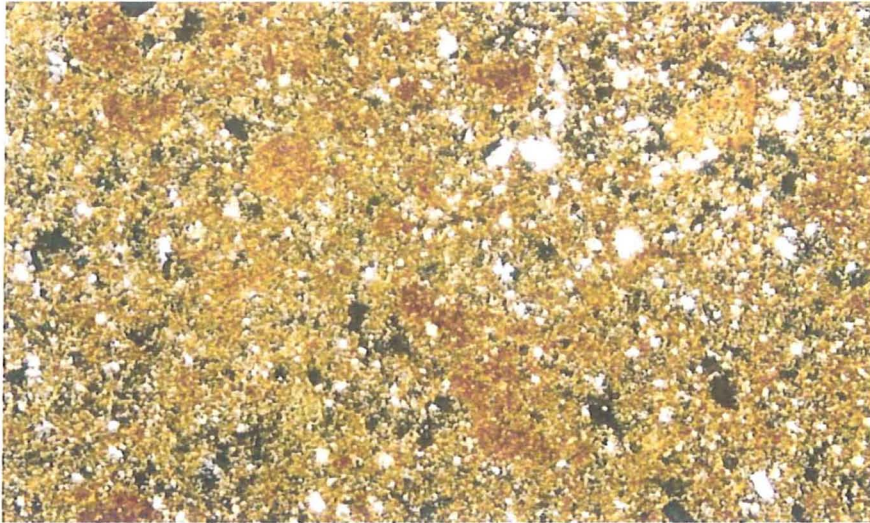


B1012 HS-12 [07035 22.jpg](#)/XPL/28X/TZJ SILTY MARL showing typical appearance of quartz grains in a matrix/cement dominated by euhedral weakly ferroan dolomite rhombs + clay. Red area at right is cemented by FEOH.



SAMPLE #	B1012 HS-13	August 21, 2007
ROCK NAME	SILTY CLAYSTONE -- probably formed as a silty claystone protolith.	
MINERALS	Clay (probably smectite) (81%) + quartz (15%) + weakly ferroan dolomite (2%) + opaques (2%).	
TEXTURES	Clastic sedimentary, non-directed fabric.	
	<p><u>Detrital Framework Grains (15%)</u> are angular, 25-250 μm, monocrystalline quartz (15%). Contacts between grains are floating.</p> <p><u>Matrix/Cement (85%)</u> is composed of clay (81%) + euhedral weakly ferroan dolomite rhombs (2%) + opaques (2%).</p>	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA	
PHOTOS	B1012 HS-13 <a href="#">07031_13.jpg</a> /DAY/3X/TZJ SILTY CLAYSTONE showing typical appearance of hand specimen.	

B1012 HS-13 [07035\\_23.jpg](#)/XPL/57X/TZJ SILTY CLAYSTONE showing typical appearance of scattered silt grains in a clay matrix.





**SAMPLE #**      **B1012 HS-14**      August 21, 2007

**ROCK NAME**      SILTSTONE -- probably formed as a siltstone protolith.

**MINERALS**      Quartz (41%) + K-feldspar (20%) + weakly ferroan dolomite (20%) + clay (probably smectite) (15%) + opaques (3%) + detrital mica (1%).

**TEXTURES**      Clastic sedimentary. Fine bedding defines a weakly directed fabric.

Detrital Framework Grains (62%) are subangular, 60-320 µm, monocrystalline [quartz (41%) + K-feldspar (20%)]. Contacts between grains are tangential to straight.

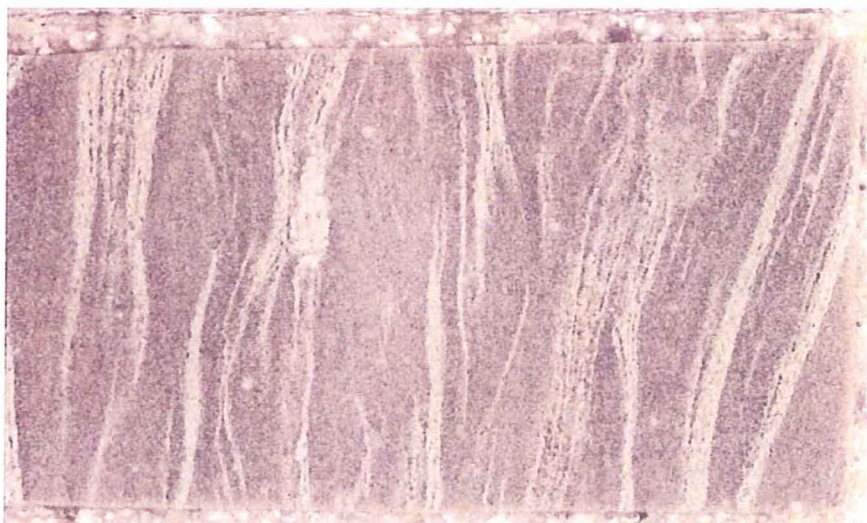
Matrix (18%) is composed of clay + opaques.

Cement (20%) is composed of euhedral rhombs of weakly ferroan dolomite.

**ALTERATION**      No other alteration features were observed.

**SECTIONING**      Format: 27 x 46 mm   Finish: STD   Stains: SCN (top 1/2) [ARS + PF] (right ½) Cover: PLA

**PHOTOS**      B1012HS-14 [07031\\_14.jpg](#)/DAY/3X/TZJ SILTSTONE showing typical appearance of hand specimen.



B1012 HS-14     [07035\\_24.jpg](#)/XPL/28X/TZJ SILTSTONE showing typical appearance.



**SAMPLE #** **B1012 HS-15** August 21, 2007

**ROCK NAME** ALTERED SANDSTONE -- probably formed as a fine quartz arenite (McBride, 1963) protolith.

**MINERALS** Quartz (70%) + clay (probably smectite) (15%) + K-feldspar (10%) + kaolinite (3%) + dolomite (2%) + plagioclase (<1%) + tourmaline (<1%) + detrital mica (<1%).

**TEXTURES** Clastic sedimentary. Fine bedding defines a weakly directed fabric.

Detrital Framework Grains (80%) are subangular to subround, 200-520 µm, monocrystalline quartz (60%) + K-feldspar (10%) + plagioclase (<1%) + tourmaline (<1%) + detrital mica (<1%). Contacts between grains are tangential.

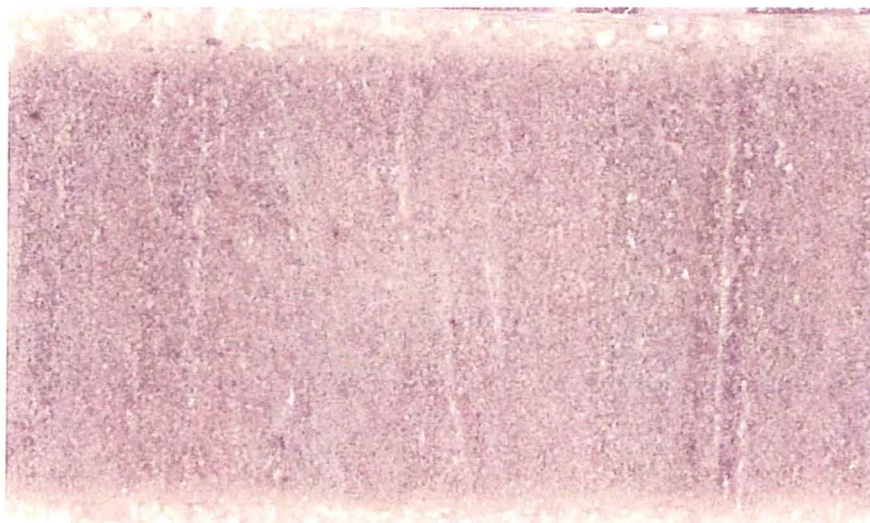
Matrix (18%) is composed of clay (15%) + kaolinite (3%).

Cement (2%) is composed of dolomite.

**ALTERATION** The following alteration features are also present but of indeterminate relative ages: (1) plagioclase weakly altered to clay; and (2) detrital mica strongly altered to kaolinite.

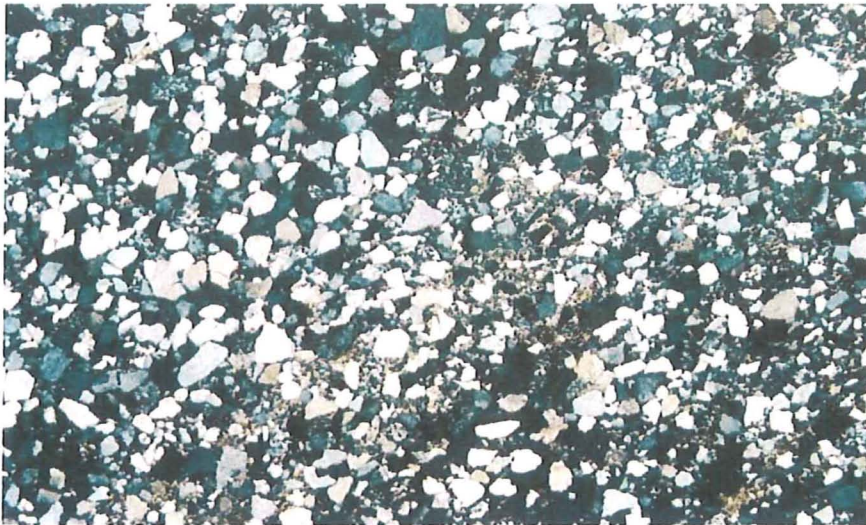
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) [ARS + PF] (right ½) Cover: PLA

**PHOTOS** B1012 HS-15 [07031\\_15.jpg](#)/DAY/3X/TZJ ALTERED SANDSTONE showing typical appearance of hand specimen.





B1012 HS-15     [07035\\_25.jpg](#)/XPL/28X/TZJ ALTERED SANDSTONE showing typical appearance.



**SAMPLE #** **B1012 HS-16** August 21, 2007

**ROCK NAME** ALTERED SANDSTONE -- probably formed as a coarse litharenite (McBride, 1963) protolith.

**MINERALS** Quartz (60%) + dolomite (37%) + K-feldspar (3%) + tourmaline (<1%) + opaques (<1%).

**TEXTURES** Clastic sedimentary. Preferred orientation of elongate grains defines a weakly directed fabric.

Detrital Framework Grains (90%) are round, 680-5600 µm, monocrystalline [quartz (32%) + K-feldspar (3%) + tourmaline (<1%)] + polycrystalline lithic fragments of [chert (28%) + dolomite and silty dolomite (27%)]. Contacts between grains are tangential.

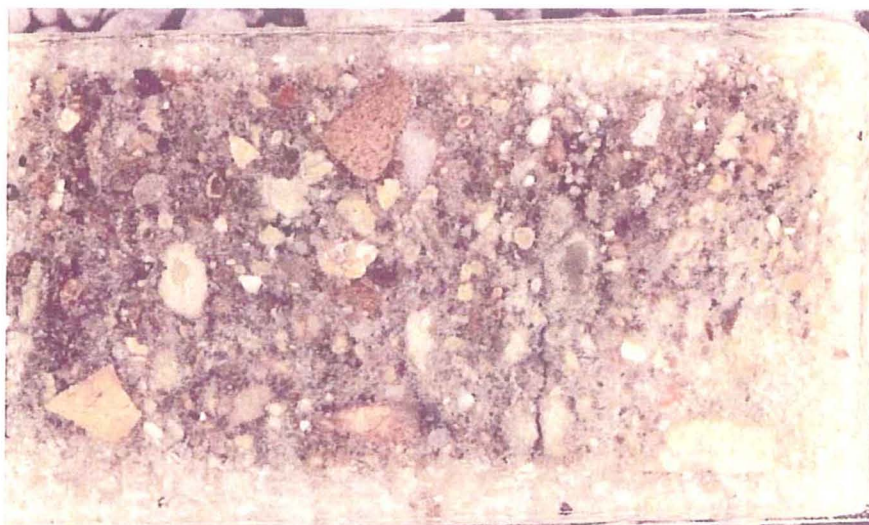
Matrix (0%) was not observed.

Cement (10%) is composed of ferroan dolomite.

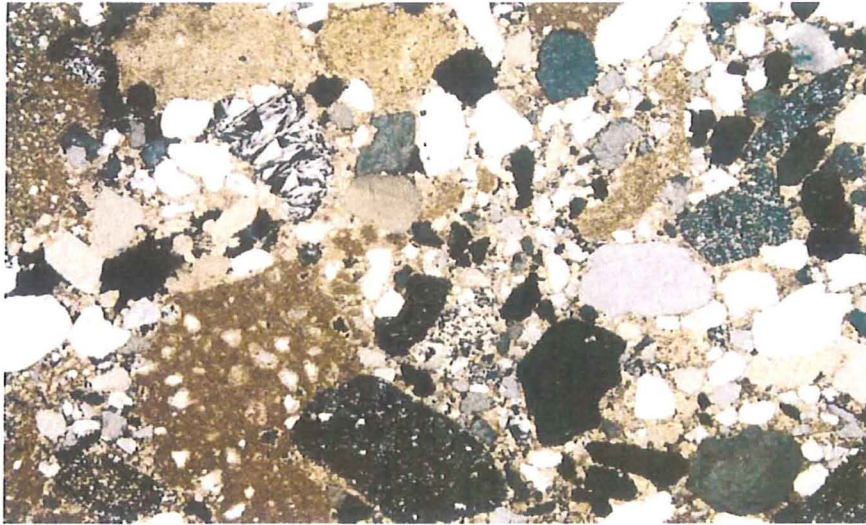
**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) [ARS + PF] (right ½) Cover: PLA

**PHOTOS** B1012 HS-16 [07031\\_16.jpg](#)/DAY/3X/TZJ ALTERED SANDSTONE showing typical appearance of hand specimen.



B1012 HS-16     [07034\\_01.jpg](#)/XPL/28X/TZJ ALTERED SANDSTONE showing typical appearance.





**SAMPLE #** **B1012 HS-17** August 21, 2007

**ROCK NAME** ALTERED SANDSTONE -- probably formed as a medium litharenite (McBride, 1963) protolith.

**MINERALS** Quartz (65%) + dolomite (35%) + K-feldspar (<1%) + plagioclase (<1%) + opaques (<1%).

**TEXTURES** Clastic sedimentary. Preferred orientation of elongate grains defines a weakly directed fabric.

Detrital Framework Grains (75%) are subround, 360-1200 µm, monocrystalline [quartz (40%) + K-feldspar (<1%) + plagioclase (<1%)] + polycrystalline lithic fragments of [chert (25%) + dolomite and silty dolomite (10%)]. Contacts between grains are tangential.

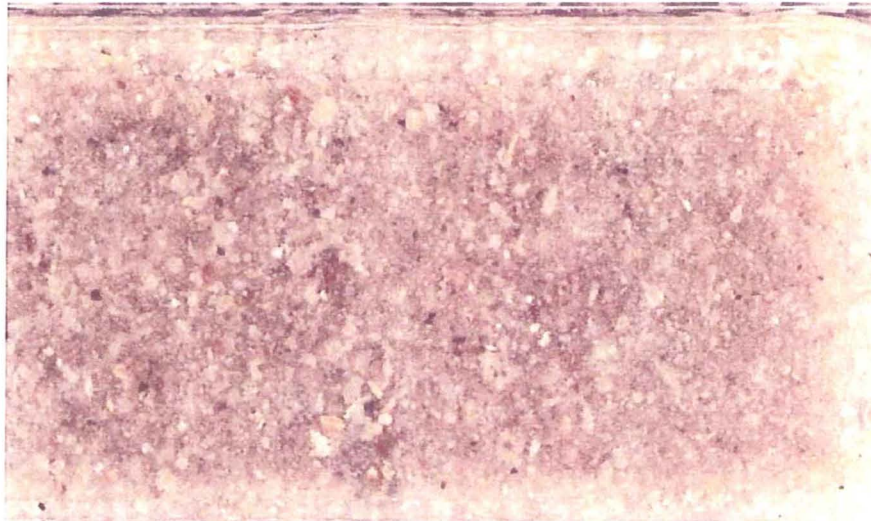
Matrix (0%) was not observed.

Cement (25%) is composed of ferroan dolomite.

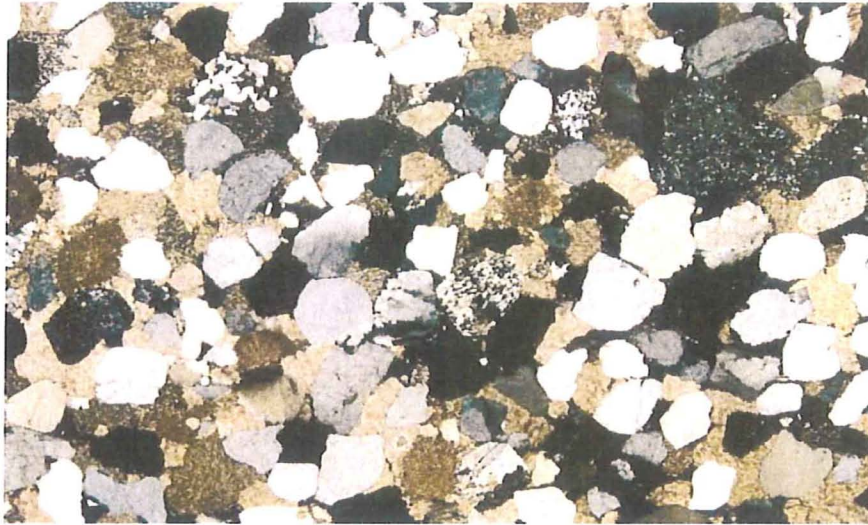
**ALTERATION** No other alteration features were observed.

**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) [ARS + PF] (right ½) Cover: PLA

**PHOTOS** B1012 HS-17 [07031\\_17.jpg](#)/DAY/3X/TZJ ALTERED SANDSTONE showing typical appearance of hand specimen.



B1012 HS-17 [07034\\_02.jpg](#)/XPL/28X/TZJ ALTERED SANDSTONE showing typical appearance of grains cemented by ferroan dolomite.



**SAMPLE #** **B1012 HS-18** August 21, 2007

**ROCK NAME** ALTERED SILTY CLAYSTONE -- probably formed by alteration (secondary calcite + FEOH) of a silty claystone protolith.

**MINERALS** Quartz (30%) + clay (probably smectite) (30%) + calcite (30%) + FEOH (9%) + dolomite (1%).

**TEXTURES** Clastic sedimentary. Fine bedding defines a weakly directed fabric.

Detrital Framework Grains (30%) are angular, 50-180  $\mu$ m, monocrystalline quartz (30%). Contacts between grains are floating.

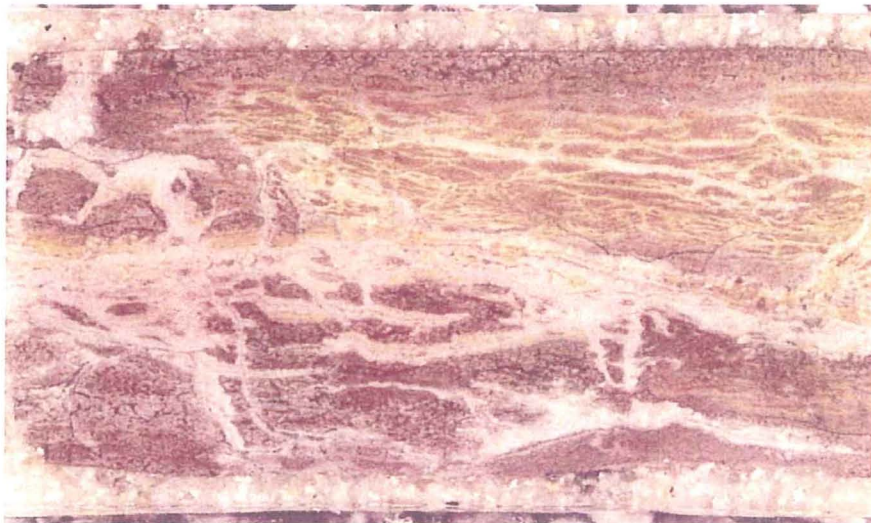
Matrix (40%) is composed of clay (30%) + FEOH (9%) + euhedral dolomite rhombs (1%).

Veins (30%) are composed of calcite.

**ALTERATION** No other alteration features were observed.

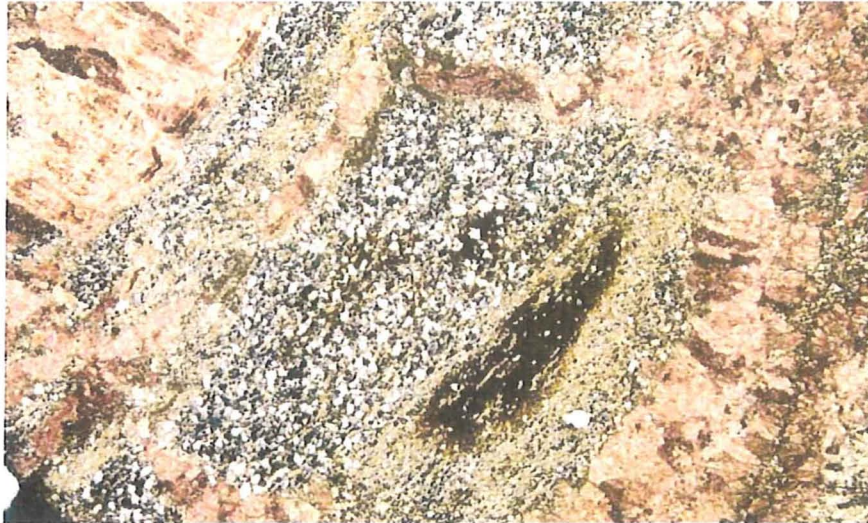
**SECTIONING** Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) [ARS + PF] (right 1/2) Cover: PLA

**PHOTOS** B1012 HS-18 [07031 18.jpg](#)/DAY/3X/TZJ ALTERED SILTY CLAYSTONE showing typical appearance of hand specimen.





B1012 HS-18 [07034\\_03.jpg](#)/XPL/28X/TZJ ALTERED SILTY CLAYSTONE showing typical appearance of silty claystone with calcite veins.



**SAMPLE #**      **B1012 HS-19**      August 21, 2007

**ROCK NAME**      SANDSTONE -- probably formed as a medium litharenite (McBride, 1963) protolith.

**MINERALS**      Quartz (67%) + K-feldspar (18%) + clay (15%) + tourmaline (<1%).

**TEXTURES**      Clastic sedimentary, non-directed fabric.

Detrital Framework Grains (90%) are subround, 120-480 µm, monocrystalline [quartz (52%) + K-feldspar (18%) + tourmaline (<1%)] + polycrystalline lithic fragments of [claystone (15%) + chert (5%)]. Contacts between grains are curved.

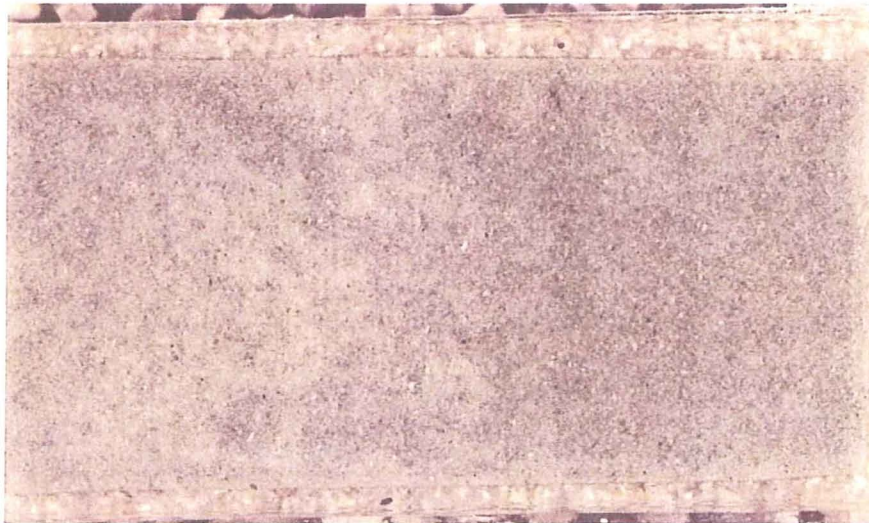
Matrix (0%) was not observed.

Cement (10%) is composed of quartz overgrowths.

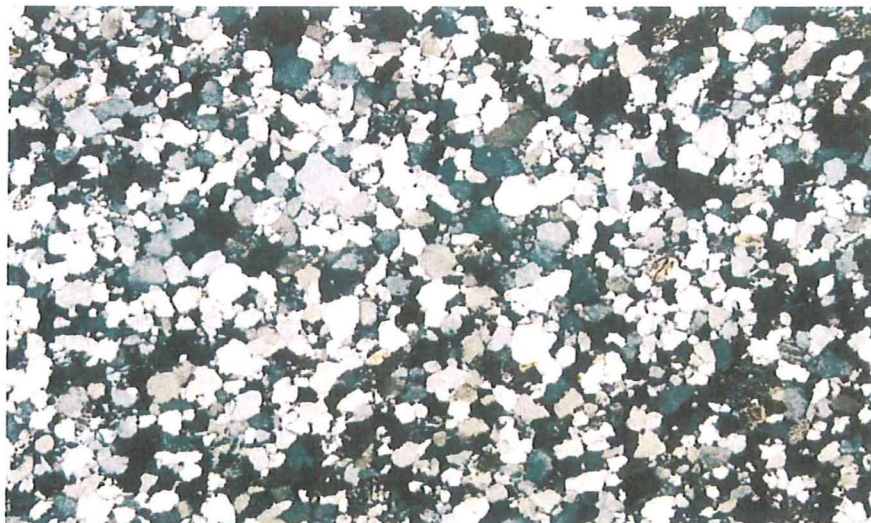
**ALTERATION**      No other alteration features were observed.

**SECTIONING**      Format: 27 x 46 mm   Finish: STD   Stains: SCN (top 1/2) [ARS + PF] (right ½)   Cover: PLA

**PHOTOS**      B1012 HS-19 [07031\\_19.jpg](#)/DAY/3X/TZJ SANDSTONE showing typical appearance of hand specimen.



B1012 HS-19     [07034\\_04.jpg](#)/XPL/28X/TZJ SANDSTONE showing typical appearance.





SAMPLE # **B1012 HS-20**

August 21, 2007

ROCK NAME SILTY CLAYSTONE -- probably formed as a silty claystone protolith.

MINERALS Clay (probably smectite) (54%) + quartz (40%) + detrital mica (2%) + carbonaceous matter (2%) + opaques (2%) + weakly ferroan dolomite (<1%).

TEXTURES Clastic sedimentary. Fine bedding defines a moderately directed fabric.

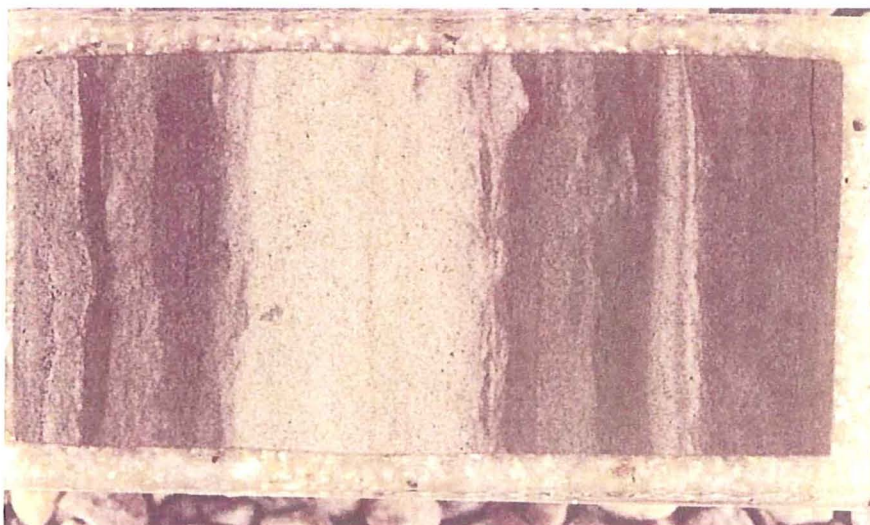
Detrital Framework Grains (42%) are subangular, 50-120  $\mu\text{m}$ , monocrystalline quartz (40%) + detrital mica (2%). Contacts between grains are floating to tangential.

Matrix/Cement (58%) is composed of clay (54%) + carbonaceous matter (2%) + opaques (2%) + euhedral weakly ferroan dolomite rhombs (<1%).

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA

PHOTOS B1012 HS-20 [07031\\_20.jpg](#)/DAY/3X/TZJ SILTY CLAYSTONE showing typical appearance of hand specimen.



B1012 HS-20 [07034 05.jpg](#)/XPL/28X/TZJ SILTY CLAYSTONE showing typical appearance.



**SAMPLE #**      **B1012 HS-21**      August 21, 2007

**ROCK NAME**      SILTY CLAYSTONE -- probably formed as a silty claystone protolith.

**MINERALS**      Clay (probably smectite) (64%) + quartz (30%) + detrital mica (2%) + carbonaceous matter (2%) + opaques (2%) + weakly ferroan dolomite (<1%).

**TEXTURES**      Clastic sedimentary. Fine bedding defines a weakly directed fabric.

Detrital Framework Grains (32%) are angular to subangular, 50-400 µm, monocrystalline quartz (30%) + detrital mica (2%). Contacts between grains are floating.

Matrix/Cement (68%) is composed of clay (64%) + carbonaceous matter (2%) + opaques (2%) + euhedral weakly ferroan dolomite rhombs (<1%).

**ALTERATION**      No other alteration features were observed.

**SECTIONING**      Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right ½) Cover: PLA

**PHOTOS**      B1012 HS-21 [07031 21.jpg](#)/DAY/3X/TZJ      SILTY CLAYSTONE showing typical appearance of hand specimen.





B1012 HS-21     [07034\\_06.jpg](#)/XPL/28X/TZJ SILTY CLAYSTONE showing typical appearance.



SAMPLE #	STA 34 HS-22	August 21, 2007
ROCK NAME	FOSSILIFEROUS LIMESTONE-- probably formed as a fossiliferous marine limestone.	
MINERALS	Calcite (98%) + FEOH (2%) + opaques (<1%)	
TEXTURES	<p>Mixed chemical and clastic sedimentary, non-directed fabric.</p> <p><u>Detrital Framework Grains (75%)</u> are round, 400-4000 µm calcite fossil fragments (75%). Contacts between grains are tangential.</p> <p><u>Matrix (10%)</u> is composed of micritic calcite + opaques.</p> <p><u>Cement (15%)</u> is composed of sparry calcite.</p>	
ALTERATION	No other alteration features were observed.	
SECTIONING	Format: 27 x 46 mm Finish: STD Stains: [ARS + PF] (right 1/2) Cover: PLA	
PHOTOS	STA 34 HS-22 <a href="#">07031 22.jpg</a> /DAY/3X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.	



STA 34 HS-22 [07034 07.jpg](#)/XPL/28X/TZJ FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments.





**SAMPLE #**      **STA 38 HS-23**      August 21, 2007

**ROCK NAME**      ALTERED FOSSILIFEROUS LIMESTONE-- probably formed by alteration (secondary dolomite) of a fossiliferous marine limestone.

**MINERALS**      Calcite (79%) + dolomite (15%) + quartz (3%) + opaques (3%)

**TEXTURES**      Mixed chemical and clastic sedimentary. Preferentially oriented elongate fragments define a weakly directed fabric.

Detrital Framework Grains (43%) are 0.8-10 mm calcite fossil fragments (40%) + angular quartz silt (3%). Contacts between grains are tangential.

Matrix/Cement (57%) is composed of [micritic calcite weakly altered to euhedral dolomite] + opaques.

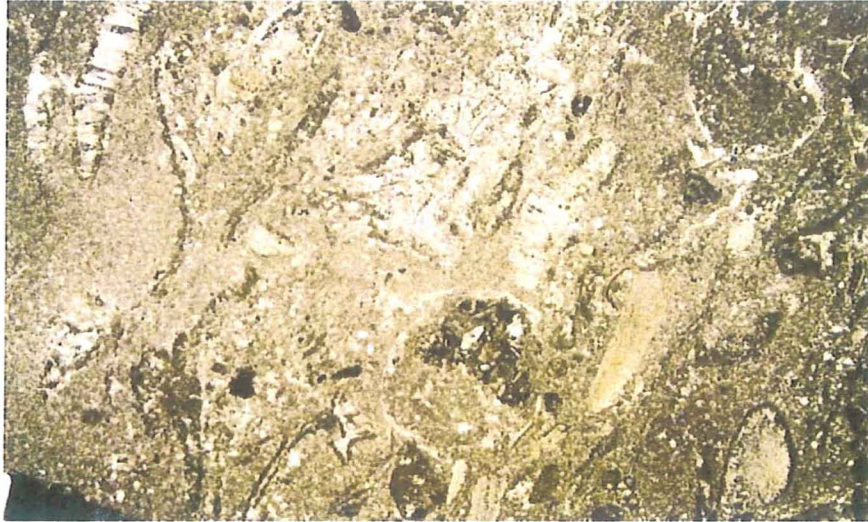
**ALTERATION**      No other alteration features were observed.

**SECTIONING**      Format: 27 x 46 mm   Finish: STD   Stains: [ARS + PF] (right 1/2)   Cover: PLA

**PHOTOS**      STA 38 HS-23   [07031\\_23.jpg](#)/DAY/3X/TZJ   ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of hand specimen.



STA 38 HS-23 [07034\\_08.jpg](#)/XPL/28X/TZJ ALTERED FOSSILIFEROUS LIMESTONE showing typical appearance of fossil fragments in matrix dominated by micritic calcite.



SAMPLE # **STA 42-A HS-24** August 21, 2007

ROCK NAME SANDSTONE -- probably formed as a very fine subarkose (McBride, 1963) protolith.

MINERALS Quartz (80%) + K-feldspar (10%) + clay (10%) + tourmaline (<1%).

TEXTURES Clastic sedimentary, non-directed fabric.

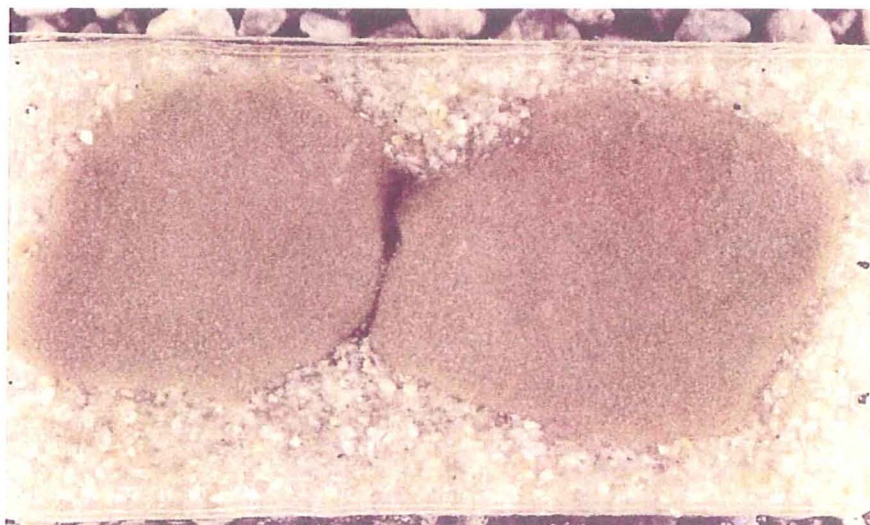
Detrital Framework Grains (90%) are subangular, 80-320  $\mu\text{m}$ , monocrystalline [quartz (80%) + K-feldspar (10%) + tourmaline (<1%)]. Contacts between grains are tangential.

Matrix/Cement (10%) is composed of clay.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) [ARS + PF] (right 1/2) Cover: PLA

PHOTOS STA 42-A HS-24 [07031\\_24.jpg](#)/DAY/3X/TZJ SANDSTONE showing typical appearance of hand specimen.





STA 42-A HS-24 [07034\\_09.jpg](#)/XPL/28X/TZJ SANDSTONE showing typical appearance.



SAMPLE # **STA 42-A HS-25**

August 21, 2007

ROCK NAME SANDSTONE -- probably formed as a very fine subarkose (McBride, 1963) protolith.

MINERALS Quartz (75%) + FEOH (15%) + K-feldspar (10%).

TEXTURES Clastic sedimentary, non-directed fabric.

Detrital Framework Grains (80%) are subangular, 100-520  $\mu\text{m}$ , monocrystalline [quartz (70%) + K-feldspar (10%) + tourmaline (<1%)]. Contacts between grains are tangential.

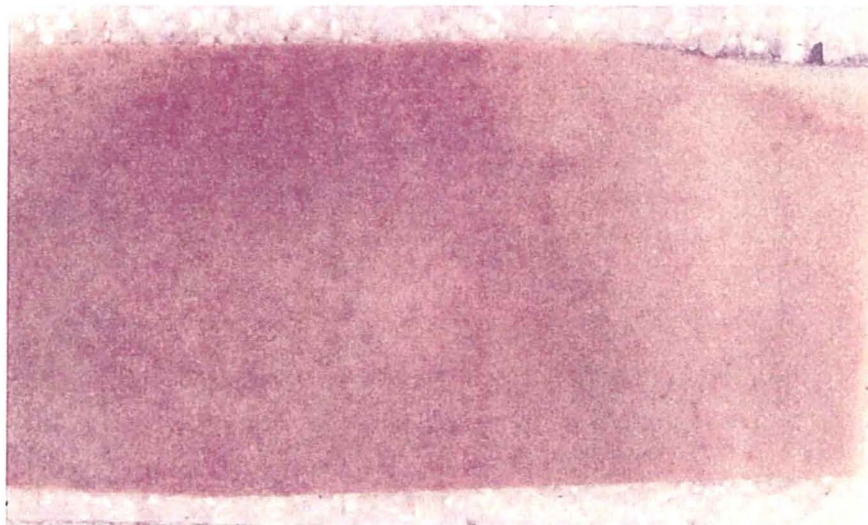
Matrix (0%) was not observed.

Cement (20%) is composed of FEOH + quartz overgrowths.

ALTERATION No other alteration features were observed.

SECTIONING Format: 27 x 46 mm Finish: STD Stains: SCN (top 1/2) [ARS + PF] (right 1/2) Cover: PLA

PHOTOS STA 42-A HS-25 [07031\\_25.jpg](#)/DAY/3X/TZJ SANDSTONE showing typical appearance of hand specimen.



STA 42-A HS-25 [07034\\_10.jpg](#)/XPL/28X/TZJ SANDSTONE showing typical appearance.





 Enercon Services, Inc.	<b>PROJECT REPORT</b>	No.		TXUT-001-PR-010	
		Rev.		0	
		Page	1	of	17
		QA File Number:		TXUT-001	

APPENDIX H

## APPENDIX H

X-Ray Diffraction Analysis Report  
(Portland State University, 2007)



December 7, 2007

Georg H. Grathoff, Ph.D.  
Applied Mineralogy Laboratory  
Department of Geology  
Portland State University  
Portland OR 97207-0751

## **RE: X-Ray Diffraction Analysis of Clay Size and whole rock**

### **1. Sample Preparation:**

The sample were received for X-ray diffraction analysis of whole rock rock analyses and the clay size fraction. For the clay size analyses the sample was lightly crushed, soaked in distilled water, and sonified. The  $<2\mu\text{m}$  size fraction was then collected and mounted onto a glass slide using the Millapore transfer method. The oriented slides were X-rayed in the air-dried, glycol solvated, and heated state ( $550^{\circ}\text{C}$ ). The X-ray diffraction scan of 3 to 35 degrees 2-THETA (Co-K-alpha).

For the random powders the whole rock was ground up to smaller than  $63\mu\text{m}$  and then X-rayed from 7 to 80 degrees 2-THETA (Co-K-alpha) using a side packed powder holder.

### **2. X-Ray Diffraction Analyses and Results:**

The mineralogy of the clay size fraction ( $<2\mu\text{m}$ ) is mainly illite and mixed layered illite smectite. The mixed layered illite/smectite is an expandable clay mineral. The illite can expand slightly because it commonly contain a small amount of expandable interlayers. Only one sample (1041-27) contains discrete smectite. In addition there is varying amounts of kaolinite in the samples and minor amounts of chlorite. We quantified the expandable clay mineral, smectite, illite, chlorite and kaolinite using the intensity in the ethylene glycol solvated state. The results of the quantification is more semi-quantification. Quantification is difficult due to the preferred orientation of the clay minerals.

The random powder results of the bulk samples were analyzed using a Rietveld whole pattern calculation and fit program. We did not use an internal standard and long count time, which would improve the quantification. The quantification is better than the clay minerals, because it is a whole pattern fit program, but still more semi quantitative than quantitative. Our results compare well with the petrographic analyses.

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Georg Grathoff

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Scott F. Burns • Sherry Cady • Kenneth M. Cruikshank • Michael L. Cummings • Ansel G. Johnson (Chair) • Curt D. Peterson  
Nancy Eriksson (Office Coordinator) • David Percy (GIS Lab) • Marvin H. Beeson (Emeritus) • Richard E. Thoms (Emeritus)

## SUMMARY DATA TABLES:

Weight percent of clay size fraction (<2µm) using oriented preparations for XRD analyses:

Sample ID	% Exp I/S	% Exp Smectite	% Illite	% chlorite	% kaolinite
1012-49	5		40	10	45
2038-09	5		80		15
2034-23	10		80		10
2034-09	10		90		
2031-15	5		70	5	20
2004-12	10		85		5
2004-07	10		85		5
2002-06R	10		80		10
1041-27		30	55		15
1037-18	15		75		10
1035-12	10		85		5
1032-19	10		75		15
1031-16	5		60	5	30
1031-10	10		80		10

Weight percent of bulk sample determined using powder XRD

	Quartz	Calcite	Ankerite	Dolomite	Phyllosilicates	pyrite	Sanidine	Albite
1012-49	65	30			5			
2038-09	21	67	3		8	1		
2034-23	4	83	4		9			
2034-09	2	92			5			
2031-15	65	1		26	8			
2004-12	5	89			6			
2004-07	38	1	16		40			
2002-06R	18				82			
1041-27	19				76		2	2
1037-18	9	85			6			
1035-12	3	92			5			
1032-19	36		10		47		4	4
1031-16	42	3	6		44	2	1	2
1031-10	5	74	13		8			

Note: Phyllosilicates includes kaolinite and illite

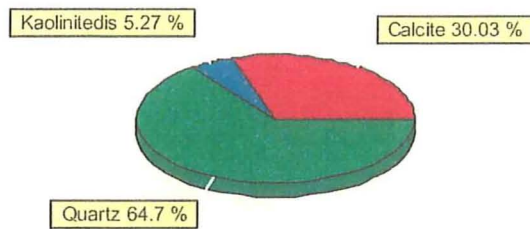
Details of all of the analyses can be found below.



Sample # 1012-49

## XRD analyses

### 1) Mineralogy Random powder of bulk rock:



Calcite	30.03	±1.17
Kaolinite	5.27	±1.47
Quartz	64.70	±1.56

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

- Kaolinite (45%)
- Chlorite (10%)
- illite (40%)

Expandable clay minerals:

- Mixed layered illite/smectite (5%)

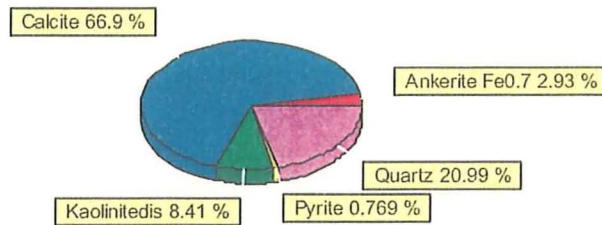
Additional non clay minerals in the size fraction

- quartz
- calcite

Sample # 2038-09

## XRD analyses

### 1) Random powder of bulk rock:



### 2) Mineralogy of the clay size fraction (<2 $\mu$ m):

Non expanding clay minerals:

Kaolinite (15 %)

Illite (80%)

Expandable clay minerals:

Mixed layered illite/smectite (5%)

Additional non clay minerals in the size fraction

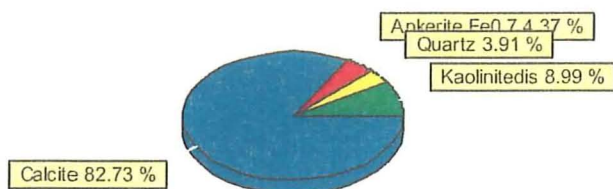
quartz

calcite

Sample # 2034-23

## XRD analyses

### 1) Random powder of bulk rock:



Ankerite Fe0.7	4.37	±0.45
Calcite	82.73	±2.13
phyllosilicates	8.99	±2.31
Quartz	3.91	±0.36

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (10%)

Illite (80%)

Expandable clay minerals:

Mixed layered illite/smectite (10%)

Additional non clay minerals in the size fraction

quartz

calcite

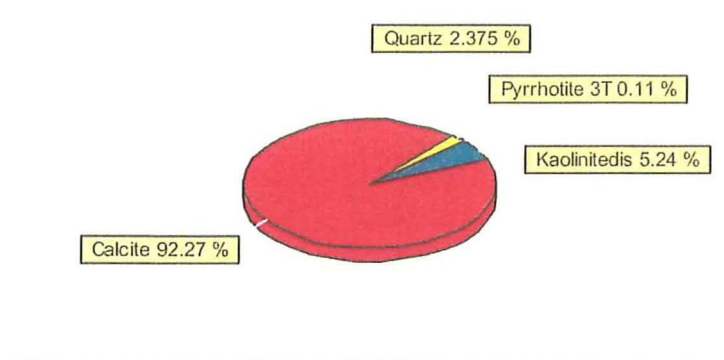


Sample # 2034-09

### XRD analyses

#### 1) Random powder of bulk rock:

Calcite	92.27	$\pm 1.35$
Phyllosilicates	5.24	$\pm 1.38$
Pyrrhotite 3T	0.11	$\pm 0.36$
Quartz	2.38	$\pm 0.28$



#### 2) Mineralogy of the clay size fraction (<2 $\mu$ m):

Non expanding clay minerals:

illite (90%)

Expandable clay minerals:

Mixed layered illite/smectite (10%)

Additional non clay minerals in the size fraction

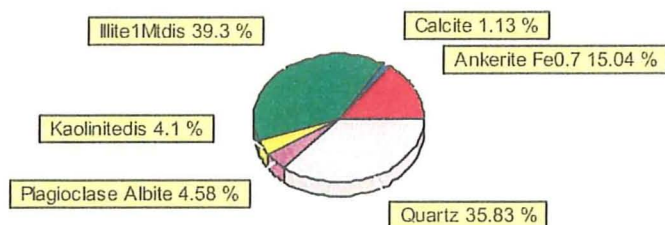
quartz

calcite

Sample # 2031-15

## XRD analyses

### 1) Random powder of bulk rock:



Ankerite Fe0.7	15.04	±1.20
Calcite	1.13	±0.36
Illite1Mt	39.30	±3.30
Kaolinite	4.10	±1.50
Plagioclase Albite	4.58	±0.93
Quartz	35.83	±2.34

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (20%)

Chlorite (5%)

illite (70%)

Expandable clay minerals:

Mixed layered illite/smectite (5%)

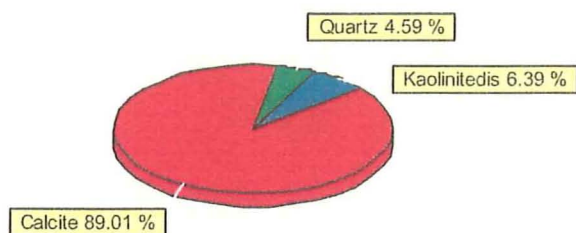
Additional non clay minerals in the size fraction

quartz

Sample # **1004-12**

## XRD analyses

### 1) Random powder of bulk rock:



Calcite	89.01	±1.80
Phyllosilicates	6.39	±1.83
Quartz	4.59	±0.48

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (5%)

illite (85%)

Expandable clay minerals:

Mixed layered illite/smectite (10%)

Additional non clay minerals in the size fraction:

Calcite

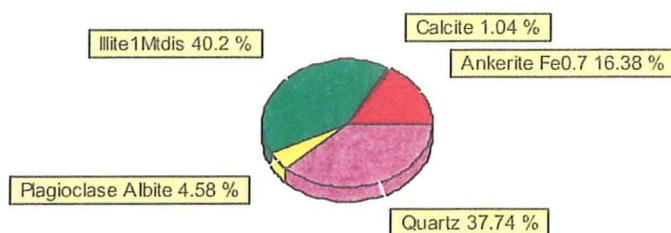
quartz



Sample # 2004-07

## XRD analyses

### 1) Random powder of bulk rock:



Ankerite Fe0.7	16.38	±1.23
Calcite	1.04	±0.33
Illite1Mt	40.20	±3.60
Plagioclase Albite	4.58	±0.84
Quartz	37.74	±2.52

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (5%)

illite (85%)

Expandable clay minerals:

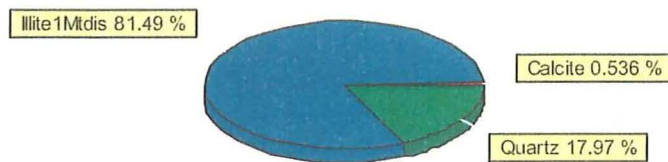
Mixed layered illite/smectite (10%)

Additional non clay minerals in the size fraction  
quartz

Sample # **2002-06R**

## XRD analyses

### 1) Random powder of bulk rock:



Calcite	0.54	±0.29
Illite1Mt	81.49	±1.41
Quartz	17.97	±.38

### 2) Mineralogy of the clay size fraction (<2μm):

Non expanding clay minerals:

Kaolinite (10%)  
illite (80%)

Expandable clay minerals:

Mixed layered illite/smectite (10%)

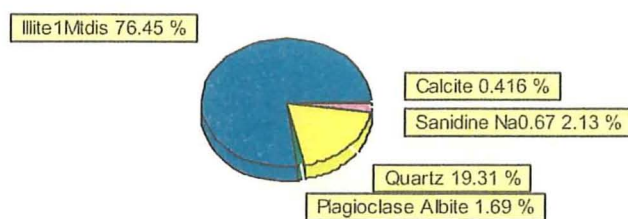
Additional non clay minerals in the size fraction  
quartz

Sample # **1041-27**

## XRD analyses

### 1) Random powder of bulk rock:

Calcite	0.42	±0.29
Illite1Mtdis	76.45	±2.01
Plagioclase Albite	1.69	±0.45
Quartz	19.31	±1.68
Sanidine Na0.67	2.13	±0.48



### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (15%)  
Illite (55%)

Expandable clay minerals:

Smectite (30%)

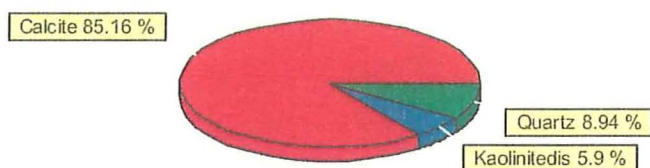
Additional non clay minerals in the size fraction  
quartz



Sample # **1037-18**

## XRD analyses

### 1) Random powder of bulk rock:



Calcite	85.16	±2.22
Phyllosilicates	5.90	±2.07
Quartz	8.94	±1.26

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (10%)  
illite (75%)

Expandable clay minerals:

Mixed layered illite/smectite (15%)

Additional non clay minerals in the size fraction

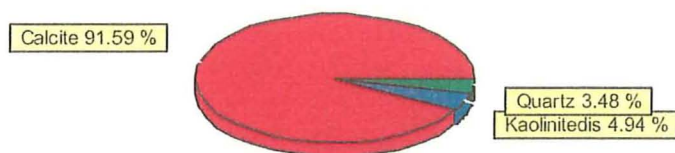
quartz  
calcite

Sample # **1035-12**

### XRD analyses

#### 1) Random powder of bulk rock:

Calcite	91.59	$\pm 2.58$
phyllosilicates	4.94	$\pm 2.70$
Quartz	3.48	$\pm 0.39$



#### 2) Mineralogy of the clay size fraction (<2 $\mu$ m):

Non expanding clay minerals:

Kaolinite (5%)

Illite (85%)

Expandable clay minerals:

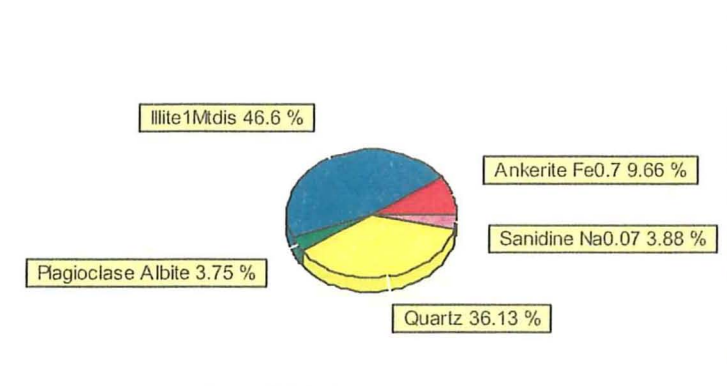
Mixed layered illite/smectite (10%)

Additional non clay minerals in the size fraction

Sample # 1032-19

## XRD analyses

### 1) Random powder of bulk rock:



Ankerite Fe0.7	9.66	±1.02
Illite1Mtdis	46.60	±3.60
Plagioclase Albite	3.75	±0.75
Quartz	36.13	±2.64
Sanidine Na0.07	3.88	±1.05

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (15%)

illite (75%)

Expandable clay minerals:

Mixed layered illite/smectite (10%)

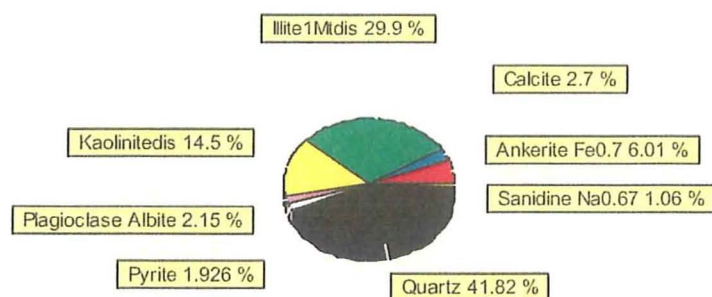
Additional non clay minerals in the size fraction  
quartz



Sample # **1031-16**

## XRD analyses

### 1) Random powder of bulk rock:



Ankerite Fe0.7	6.01	±0.72
Calcite	2.70	±0.33
Illite1Mt	29.90	±3.60
Kaolinite	14.50	±4.50
Plagioclase Albite	2.15	±0.66
Pyrite	1.93	±0.29
Quartz	41.82	±2.97
Sanidine Na0.67	1.06	±0.78

### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

- Kaolinite (30%)
- Chlorite (5%)
- illite (60%)

Expandable clay minerals:

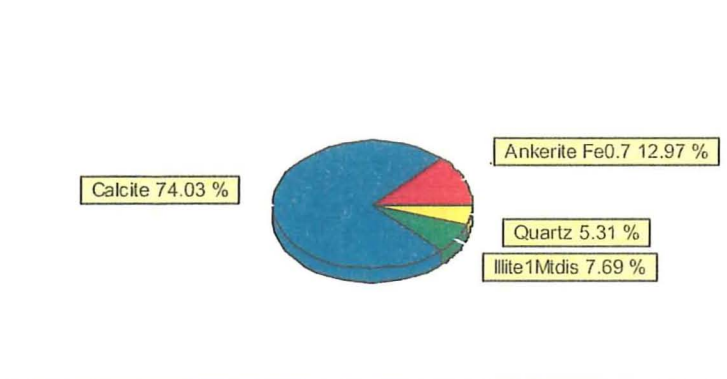
- Mixed layered illite/smectite (5%)

Additional non clay minerals in the size fraction

Sample # **1031-10**

### XRD analyses

#### 1) Random powder of bulk rock:



Ankerite Fe0.7	12.97	±0.84
Calcite	74.03	±1.89
Illite1Mtdis	7.69	±2.10
Quartz	5.31	±0.45

#### 2) Mineralogy of the clay size fraction (<2µm):

Non expanding clay minerals:

Kaolinite (10%)  
illite (80%)

Expandable clay minerals:

Mixed layered illite/smectite (10%)

Additional non clay minerals in the size fraction

quartz  
calcite