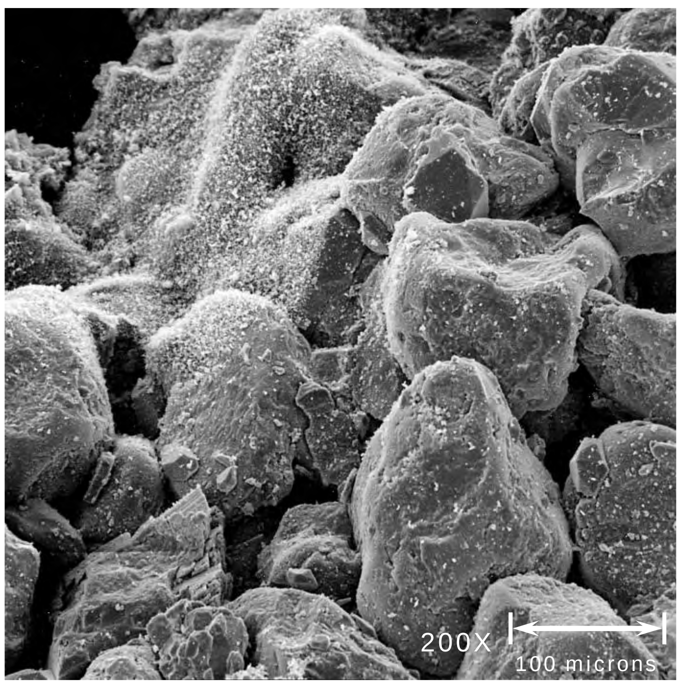
The purpose of this document is to show various aspects of our work.
It is a compilation of unrelated projects.

Stolper Geologic, Inc.
Since 1980
OPTICAL and SCANNING ELECTRON MICROSCOPY

January 2009

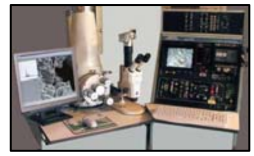
Example Report

XXXX Co., XX



Stolper Geologic, Inc.
OPTICAL and SCANNING ELECTRON MICROSCOPY

www.stolpergeologic.com • 16688 W 73rd Drive, Arvada, CO 80007 USA • Phone 303-674-3100 • Fax 303-674-3131



January 2009

Example Report

XXXX Co., XX

TABLE of CONTENTS

O B J E C T I V E S

The primary objective of this reservoir rock analyses study is to determine if the EXAMPLE formation in the prospect area of EXAMPLE has the attributes necessary for natural gas and/or oil production.

M E T H O D S

Detailed visual estimation of well cuttings using optical binocular microscopy was the primary method used to determine and quantify essential reservoir rock attributes such as:

- Lithology
- Porosity
- Permeability
- Archie “m” value
- Gas Shows *(Kathy Stolper U.S. Patent – See Appendix for more information.)*
- Visible Oil Stain
- Cut Fluorescence

Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Spectrography (EDS) was used to verify clays, and compare pore structures and mineralogic variations.

DATA RECORDING and DISPLAY

All attributes analyzed, for each interval analyzed, are recorded in spreadsheet format (figure 1).

Key rock attributes are represented in a graphical log (figure 2).

SEM and optical photomicrographs start on page 11 of this report. The logs and spreadsheets start at page 18.

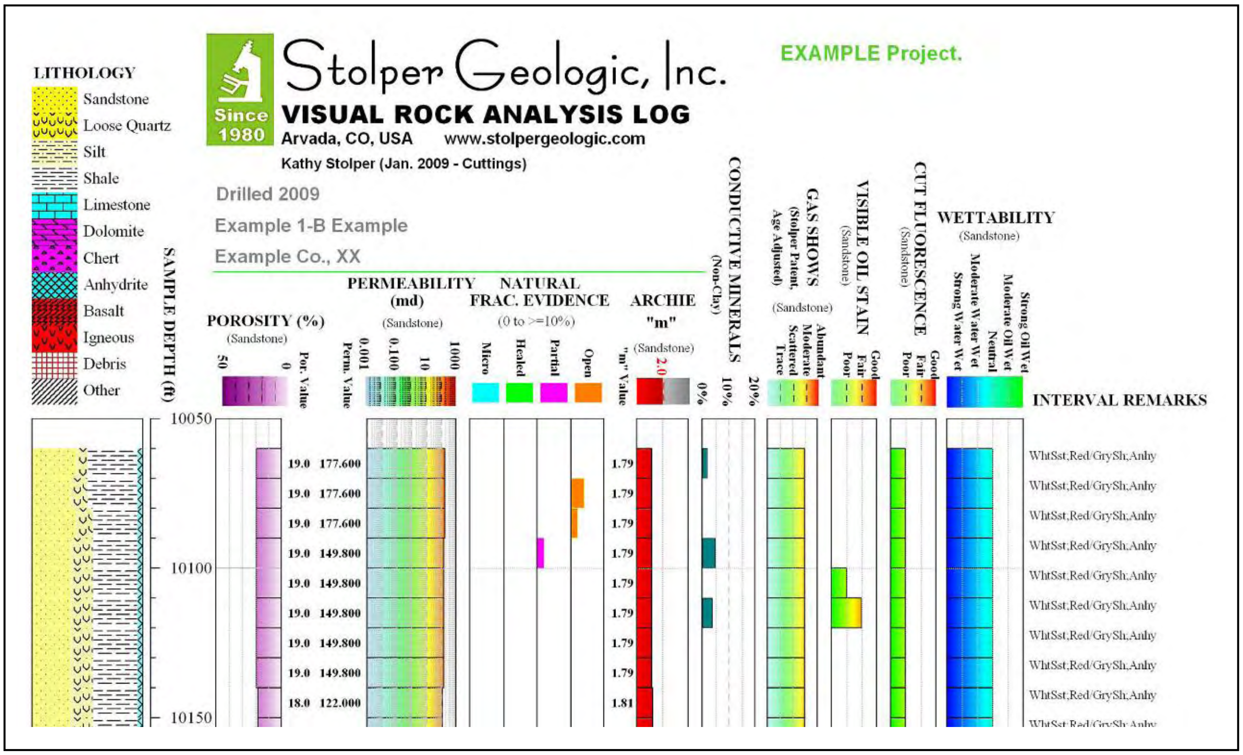


Figure 1

Stolper Geologic, Inc.: Panel 1 of 2 — Stolper Geologic, Inc.: Panel 1 of 2

ROCK ANALYSIS by STOLPER GEOLOGIC, INC. - Arvada, CO, USA

Project: EXAMPLE
Petrologist: Kathy Stolper — **Date of Work:** Jan. 2009
Cuttings: X — SW Core: — Whole Core: — Core Chips:

Well Information

Operator: **EXAMPLE**
Well Name-Number: **1-EXAMPLE**
Location (T-R-S):
County, State: **Example Co., XX**
API#:
Date Drilled: **2009** — PC Filename: stolper_spreadsheet.xls

Ver. 2 — www.stolpergeologic.com

General Remarks: Cuttings too small to test wettability.

(35 API)
A > 300 m (>1000 ft)
B>=150 m but <300 m (>=500 ft but<1000 ft)
C>=30 m but <150 m (>=100 ft but <500 ft)
D>=15 m but <30 m (>=50 ft but <100 ft)
E<15 m (<50 ft)
F = waste zone rocks

1=Very Well
2=Well
3=Moderate
4=Poor
5=Very Poor
6=Bimodal
SORTING

Panel 1, Panel 2, Panel 3, Panel 4

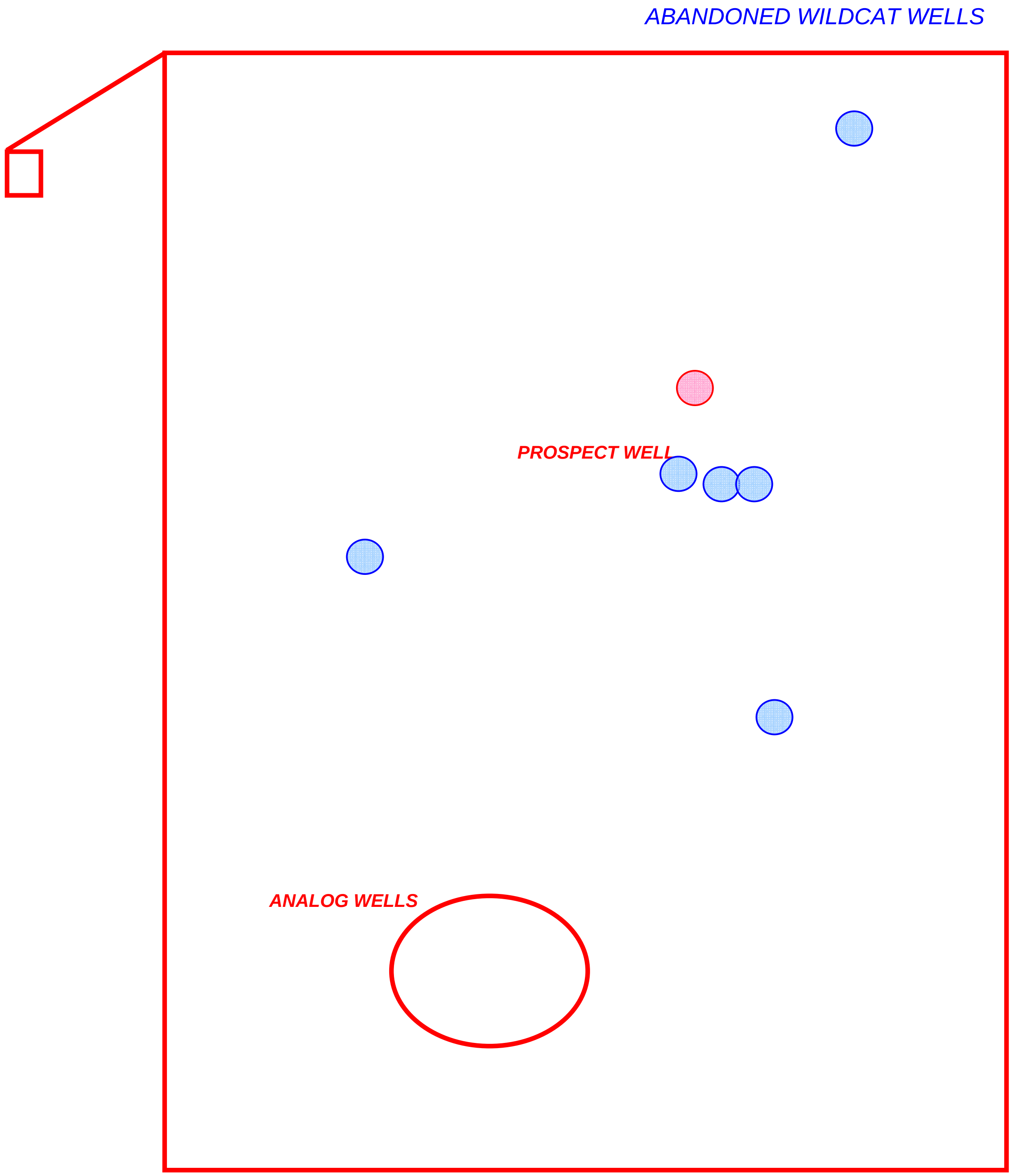
IA=>100 md
IB=10-100 md
IC=1-10 md
ID=0.5-1 md
II=0.07-0.5 md

DEPTH INTERVAL (Feet) Begin	End	% LITHOLOGY Sst	LQ	Sh	LS	Dolo	Cht	Anhy	Deb	Oth	% FRACTURES Micro	Healed	Partial	Open	% SEAL TYPE A	B	C	D	E	F
10,060.0	10,070.0	40	10	45				5												
10,070.0	10,080.0	35	15	45				5												
10,080.0	10,090.0	40	15	40				5												
10,090.0	10,100.0	35	20	40				5												
10,100.0	10,110.0	35	20	40				5												
10,110.0	10,120.0	35	20	40				5												
10,120.0	10,130.0	35	20	40				5												
10,130.0	10,140.0	35	20	40				5												
10,140.0	10,150.0	35	20	40				5												
10,150.0	10,160.0	35	20	40				5												

Begin	% GRAIN SIZE Slt	LVF	UVF	LF	UF	LM	UM	LC	UC	VC	SORTING	% RMS ROCK TYPE IA	IB	IC	ID	II	III	% POROSITY EFFECTIVE	HIDDEN	TOTAL	AMBIENT PERMEABILITY (md)
10,060.0				15	55	25	5				3	55	30	15				19.0		19.0	177.600
10,070.0				15	55	25	5				3	55	30	15				19.0		19.0	177.600
10,080.0				15	55	25	5				3	55	30	15				19.0		19.0	177.600
10,090.0				15	55	25	5				3	45	35	20				19.0		19.0	149.800
10,100.0				15	45	35	5				3	45	35	20				19.0		19.0	149.800
10,110.0				15	45	35	5				3	45	35	20				19.0		19.0	149.800
10,120.0				15	45	35	5				3	45	35	20				19.0		19.0	149.800
10,130.0				15	40	40	5				3	45	35	20				19.0		19.0	149.800
10,140.0				15	40	40	5				3	35	40	25				18.0		18.0	122.000
10,150.0				15	40	40	5				3	35	40	25				18.0		18.0	122.000

Figure 2

MAP & IDENTIFICATION REMOVED



SUMMARY TABLE

WELL (Cuttings unless noted otherwise.)	POROSITY Average % (Range)	PERMEABILITY Average md (Range)	UNCONSOLIDATED (Likely indicator of high permeability.)	CEMENTATION EXPONENT Average "m" (Range)	GAS SHOW RATING (NOT Age adjusted)	VISIBLE OIL STAIN	CUT FLUORESCENCE	PRODUCTION
PROSPECT WELL								
EXAMPLE	16.6 (11.0-19.0)	15.0 (1.2-30.1)	Up to 65%	1.83 (1.80-1.96)	Moderate to Scattered	Poor	Poor	
ANALOG / KNOWN PRODUCING WELLS								
EXAMPLE	14.7 (11.0-17.0)	11.7 (1.46-24.4)	Up to 40% in 60' zone.	1.87 (1.81-1.94)	Moderate to Scattered	Poor	Predominately Poor	4.9 BCF
EXAMPLE	21.0 (20.0-22.0)	65.2 (45.5-92.0)	None	1.80 (1.78-1.81)	Scattered to Moderate	Poor	Predominately Poor	12.8 BCF
EXAMPLE (Core)	12.9 (4.5-18.0)	119.5 (0.2-460.0)	None	1.82 (1.72-1.97)	Predominantly Scattered	Poor	Poor	
EXAMPLE	19.2 (12.0-21.0)	49.3 (7.6-79.0)	None	1.82 (1.78-1.88)	Moderate to Scattered	Poor	Predominately Poor	7.8 BCF
EXAMPLE	17.0 (16.0-18.0)	31.1 (26.9-43.7)	None	1.82 (1.82-1.82)	Moderate	Poor	Poor	10.3 BCF
EXAMPLE	18.6 (16.0-19.0)	54.9 (26.9-58.7)	Up to 70%	1.82 (1.82-1.84)	Scattered to Moderate	Poor	Poor	11.3 BCF
ABANDONED WILDCAT WELLS								
EXAMPLE ***Drilled with oil based mud. Water injection well.***	16.0 (13.0-18.0)	85.9 (4.3-190.6)	Up to 60%	1.85 (1.82-1.92)	Abundant	Fair	Good	IP'd Oil.
EXAMPLE	19.0 (6.0-26.0)	138.5 (0.16-300.0)	Up to 60%	1.83 (1.77-2.00)	Trace to Scattered	None	None	
EXAMPLE (Core)	13.3 (9.0-17.0)	113.4 (1.6-675.0)	None	1.79 (1.72-1.92)	Trace	None	None	
EXAMPLE (Core Chips & Cuttings)	20.2 (8.0-32.0)	143.1 (0.2-300.0)	Up to 60%	1.81 (1.77-2.00)	Scattered (Core Chips) Moderate (Cuttings)	None	None (Core Chips) Poor (Cuttings)	
EXAMPLE	17.3 (15.0-19.0)	78.1 (7.8-121.8)	Up to 70%	1.82 (1.78-1.85)	Trace to Scattered	None	None	
EXAMPLE	28.5 (18.0-32.0)	241.5 (13.4-300.0)	Up to 15%	1.78 (1.77-1.83)	Trace	None	None	Water Wet
EXAMPLE	20.1 (9.0-23.0)	89.5 (0.57-151.6)	Up to 80%	1.83 (1.79-1.98)	Moderate	None	Poor to Fair	
EXAMPLE (Core)	13.0 (11.0-17.0)	11.4 (1.3-59.9)	None	1.87 (1.82-1.93)	Moderate	None	Predominately Poor	

RESERVOIR ROCK

PROSPECT Vs EXAMPLE FIELD Vs OFF STRUCTURE WELLS

The EXAMPLE formation in the prospect area, and the commercially producing EXAMPLE reservoir of analog EXAMPLE, are both predominantly medium to fine grain-size quartz sandstone (figure 3). In addition to the original prospect well, other wells with possible by-passed EXAMPLE pay are identified through the analyses of nearby abandoned wildcat wells. This statement is based solely on comparisons of reservoir rock attributes and hydrocarbon shows of the abandoned wildcat wells to known producing analog wells.

It is important to note that the cuttings of the prospect well contain up to 65% unconsolidated grains throughout the section. Cuttings from three of the five analog wells have zero unconsolidated material recorded, one of the five records an isolated interval of unconsolidated grains, and one of the five records a greater amount of unconsolidated material. ***The unconsolidated grains most likely represent rock of much higher permeability.*** Permeability can only be estimated from consolidated material; therefore, the overall permeability of the prospect well is believed to be greater than the recorded 15md. In addition, the prospect well also contains slightly more grain coating clays and a greater amount of silica cement that would decrease the permeability as compared to the analog wells in this study.

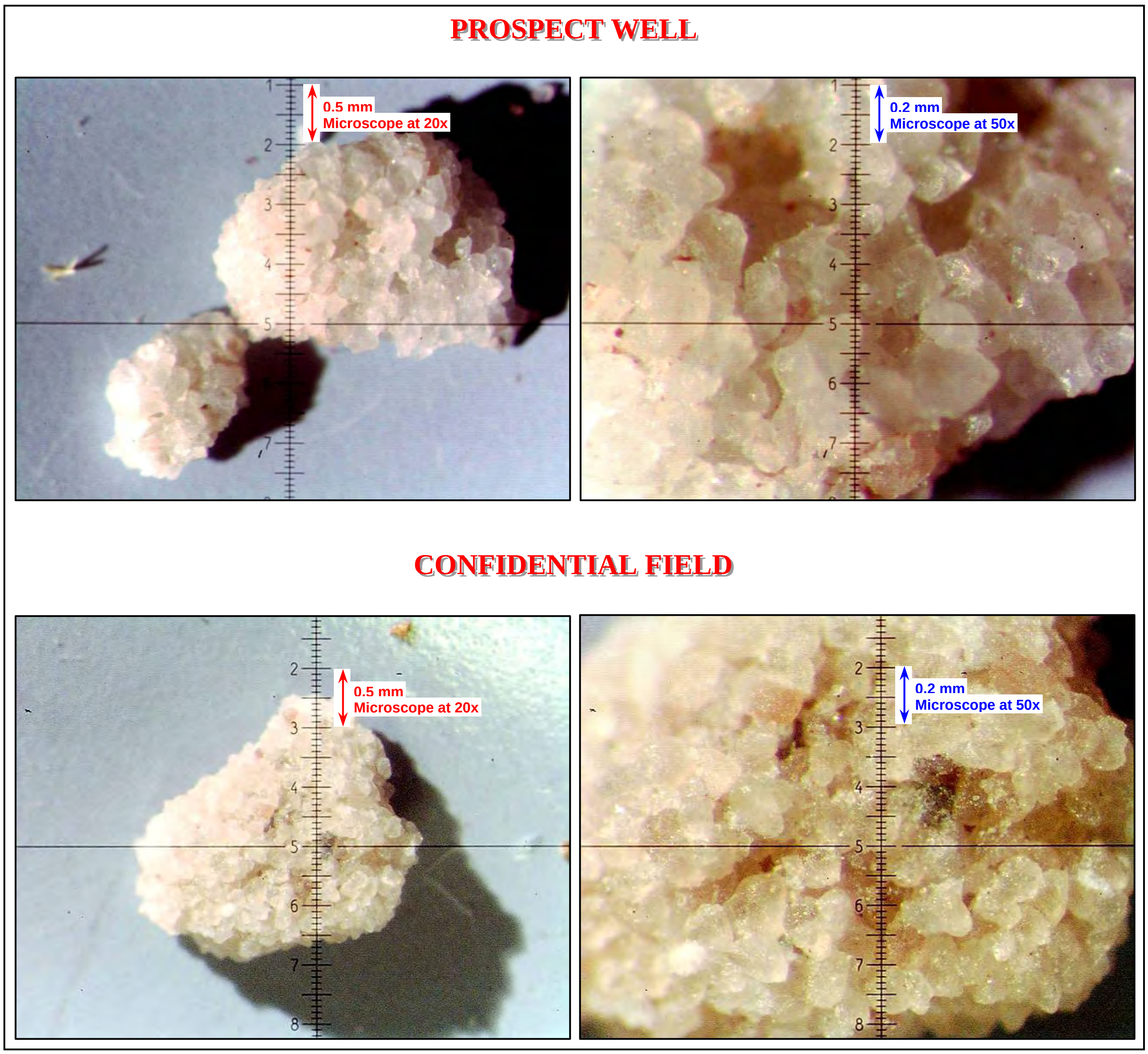


Fig. 3

The prospect well and known EXAMPLE hydrocarbon producing wells have similar grain and pore/pore throat sizes (Figure 4).

The prospect well contains a predominance of grain coating mixed-layer and chloritic clays while the analog/hydrocarbon producing wells contain a somewhat cleaner pore system with quartz overgrowths and a lesser amount of grain coating clays (Figure 5). The additional grain coating clays found in the prospect well may reduce resistivity values as compared to the known hydrocarbon producing wells. Also, these clays along with a greater amount of silica cement in the prospect well would decrease its permeability as compared to the other wells in this study.

Comparing a known water producing, “wet”, well to that of the prospect and hydrocarbon producing wells, a greater similarity is seen between the producing and “wet” well in that there is a significant presence of quartz overgrowths and lesser amounts of grain coating clays than found in the prospect well. This suggests that any lower resistivity intervals in the “wet” vs. hydrocarbon producing wells may likely be due to a fluid type change in the reservoir.

> ***NOTE:*** ***Because of minor occurrences of chlorite clay, there is some potential for damage if acid is introduced to the formation.***

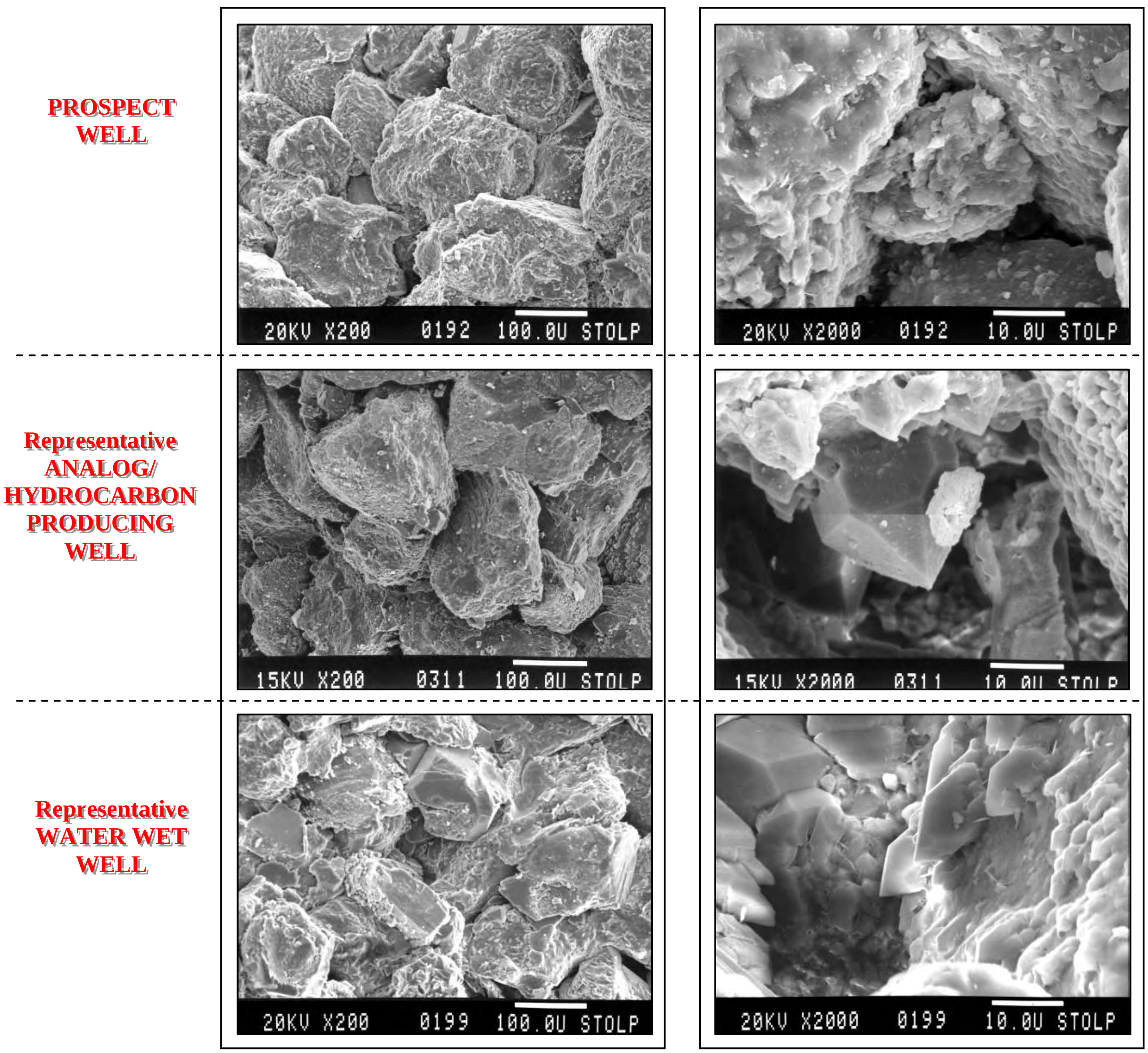


Fig. 4 ***Fig. 5***

Cores from EXAMPLE, EXAMPLE, and EXAMPLE illustrate the presence of an extensive natural fracture network. The fractures are lined and/or filled with pyrite, silica, and/or kaolinite (Figure 6).

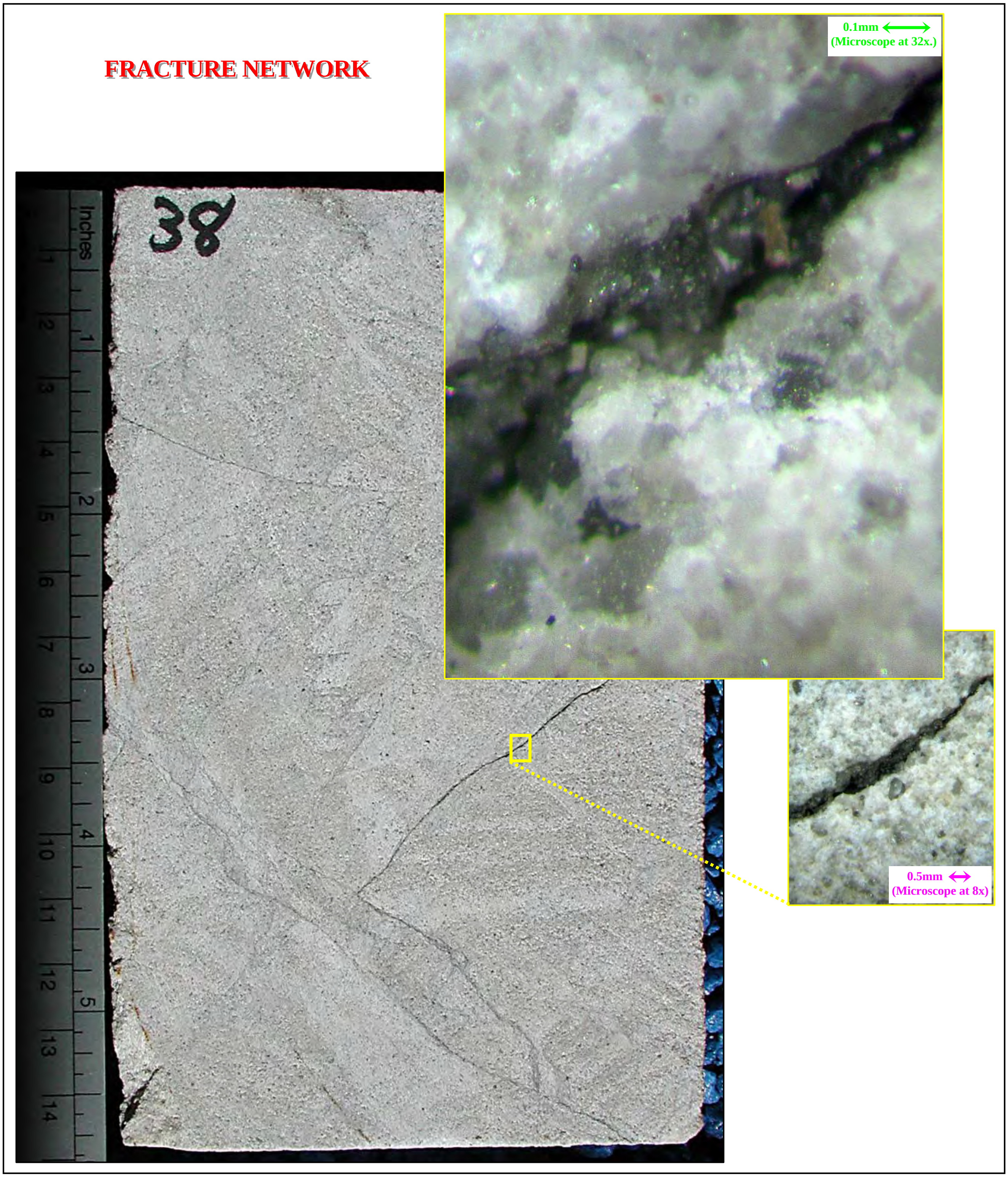


Fig. 6

SIGNIFICANT OBSERVATIONS

1. The EXAMPLE prospect well has an average porosity and permeability of 16.6% and 15.0 md respectively. This is comparable to EXAMPLE in known producing fields such as EXAMPLE.

2. Unconsolidated grains most likely represent much higher permeability rock. The cuttings of the prospect well contain up to 65% unconsolidated grains. Therefore, the overall permeability of the prospect well is believed to be greater than the recorded 15md as estimated from the consolidated rock.

3. A slight increase in clays along with a greater amount of silica cement in the prospect well would decrease its permeability as compared to the other wells in this study; however, the greatest probability for a permeability difference is representation in the cuttings as noted above in point number two.

4. Comparison of the prospect well and known producing well shows a slight increase in grain coating clay present in the prospect well which would increase the micro-porosity, increase the bound water, and decrease the resistivity values when compared to the producing field wells.

5. Although the amount of chlorite present appears to be minimal in the prospect well, acid should still be considered a catalyst to potential formation damage.

6. In addition to the original prospect well, there are at least four other abandoned wildcat wells that contain possible by-passed EXAMPLE pay. The reservoir rock attributes and hydrocarbon shows of the EXAMPLE, EXAMPLE, EXAMPLE, and EXAMPLE compare favorably to that of the analog field wells used in this study.

7. The EXAMPLE well was drilled with oil based mud which contaminates the samples and could lead to misrepresented oil shows. The well was completed as a water injector with an interpreted oil zone at the top of the EXAMPLE. The cut fluorescence remains consistent throughout the entire EXAMPLE interval. A situation of oil on water should give you a change in the cut fluorescence from one phase to the next in spite of the oil based mud system since it stays constant; therefore, the interpretation of water in the lower portion of this EXAMPLE interval is questionable. (This well flowed oil from perforations in the lower EXAMPLE “water” zone).

8. The average pay thicknesses of wells in the EXAMPLE Field are approximately 110 to 260 feet and the pay thickness of the prospect well could exceed that.

9. Gas shows range from moderate to scattered in both the prospect well and the producing EXAMPLE Field wells.

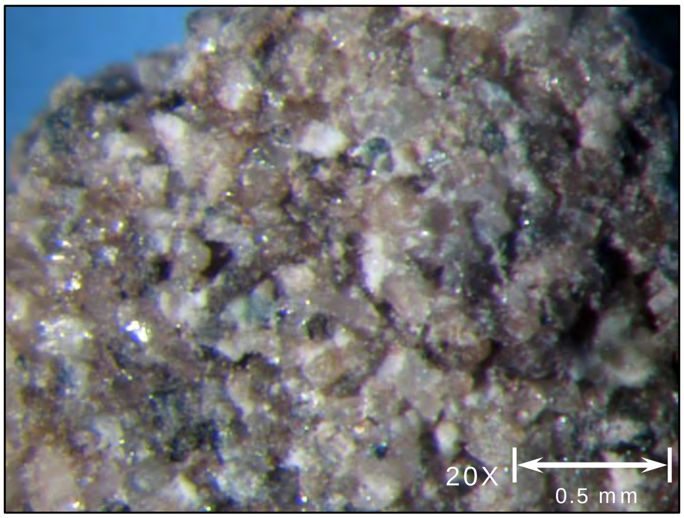
10. The cuttings of both the prospect well and the producing EXAMPLE Field wells contain “poor” visible oil staining as well as predominantly “poor” cut fluorescence. Most of the abandoned wildcat wells analyzed in this study have no visible oil staining and no cut fluorescence.

11. An extensive natural fracturing system is noted in the viewing of the slabbed whole cores from the EXAMPLE, EXAMPLE, and EXAMPLE wells.

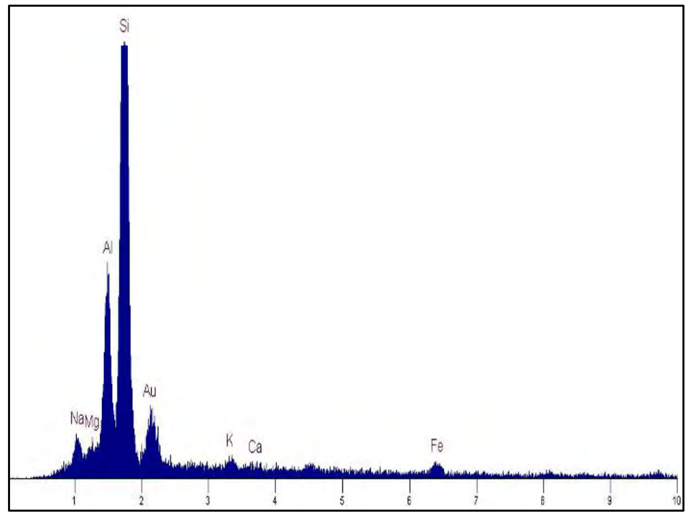
S E M and O P T I C A L P H O T O M I C R O G R A P H S

EXAMPLE
X-EXAMPLE
Example Co., XX

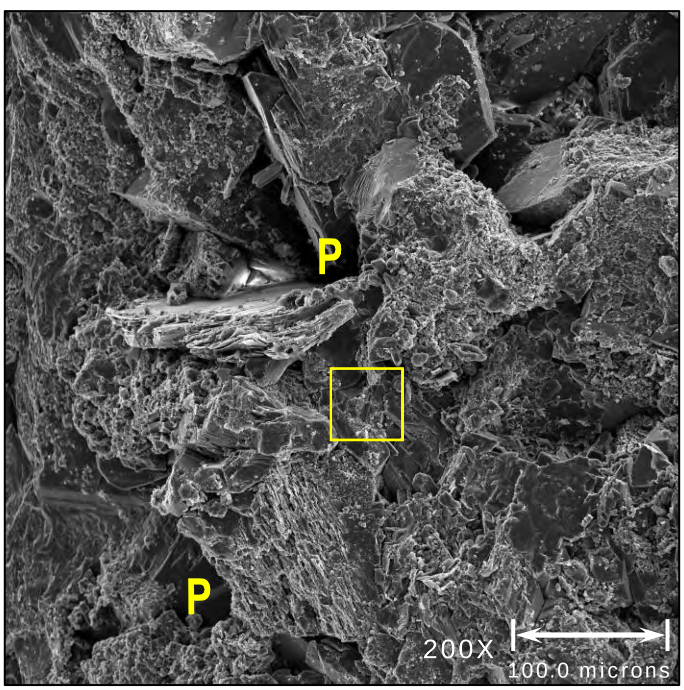
X,XXX' – X,XXX'
Example Formation



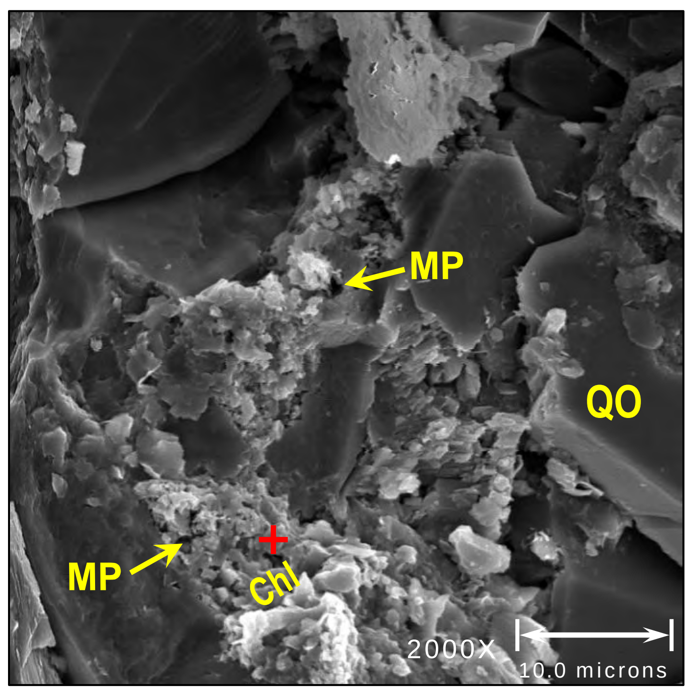
Quartz Sandstone



Energy Dispersive X-ray Spectrography (+) *confirming chlorite clay.*



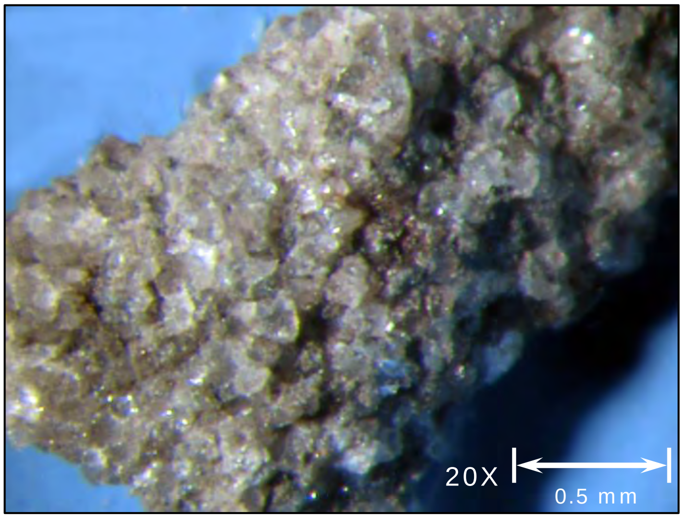
Intergranular porosity ***(P).***



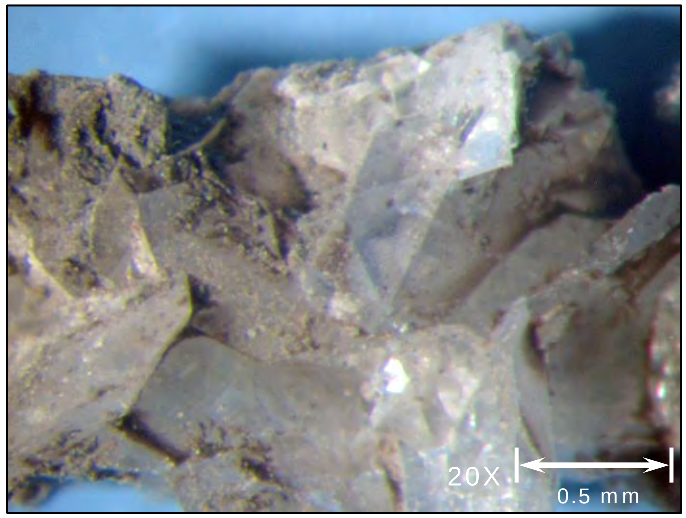
High magnification ***of boxed area at left showing microporosity (MP), quartz overgrowth (QO), chloritic clay (Chl), and location of EDS analysis (+).***

EXAMPLE
X-EXAMPLE
Example Co., XX

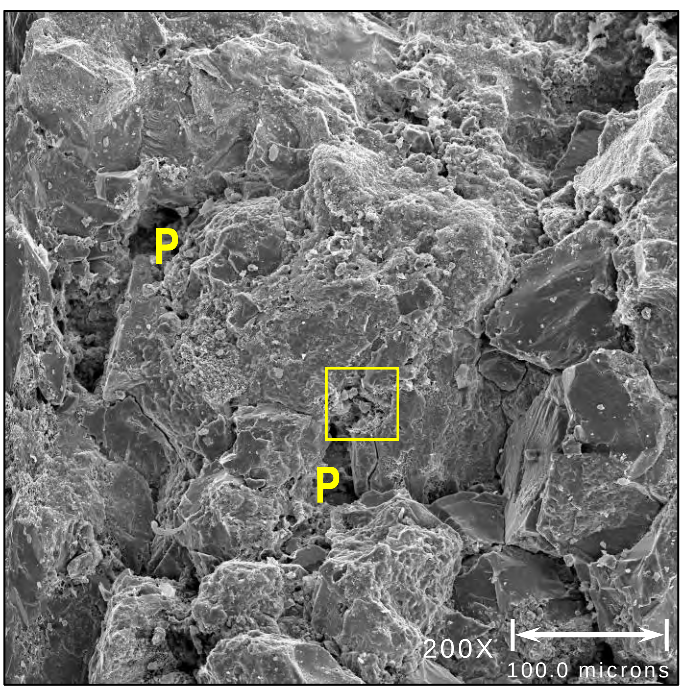
X,XXX' – X,XXX'
Example Formation



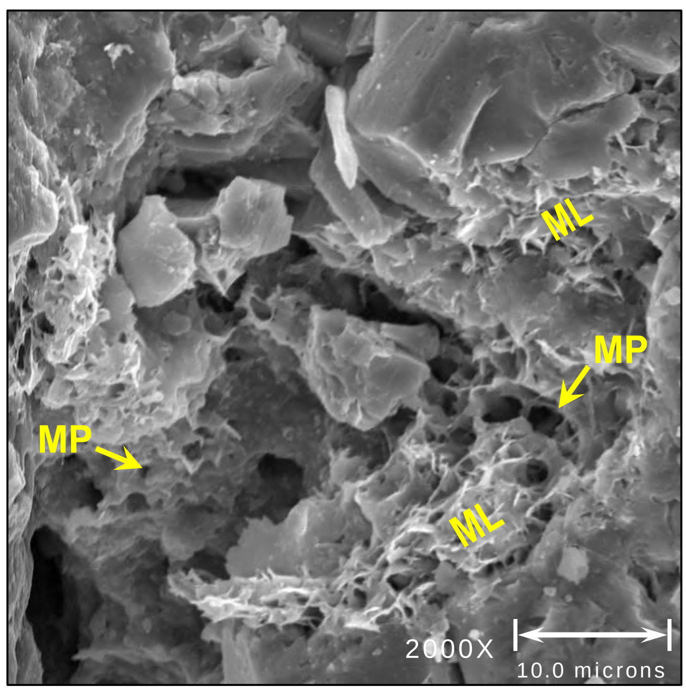
Quartz Sandstone



Fracture Evidence



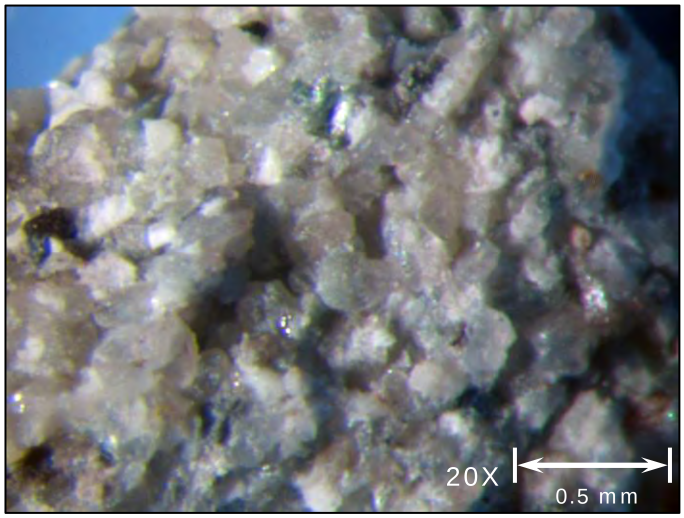
Intergranular porosity ***(P).***



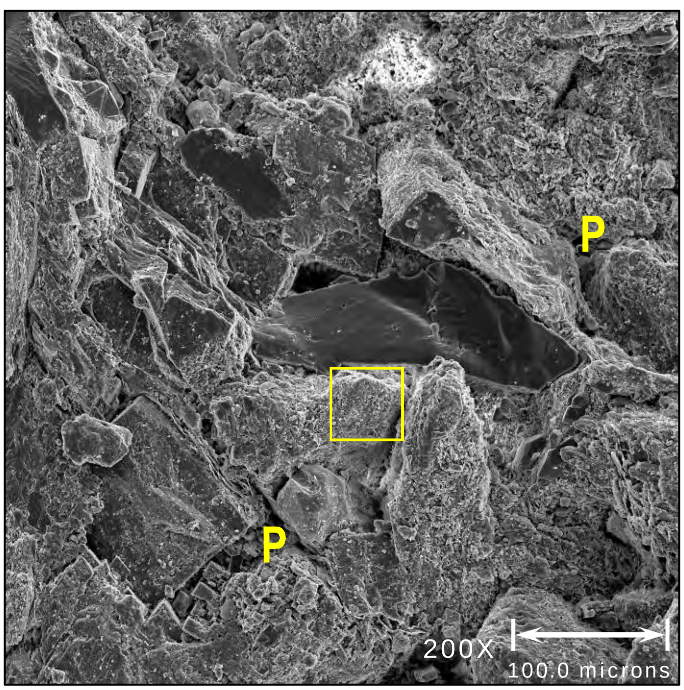
High magnification ***of boxed area at left showing microporosity (MP) and mixed-layer illite-smectite clay (ML).***

EXAMPLE
X-EXAMPLE
Example Co., XX

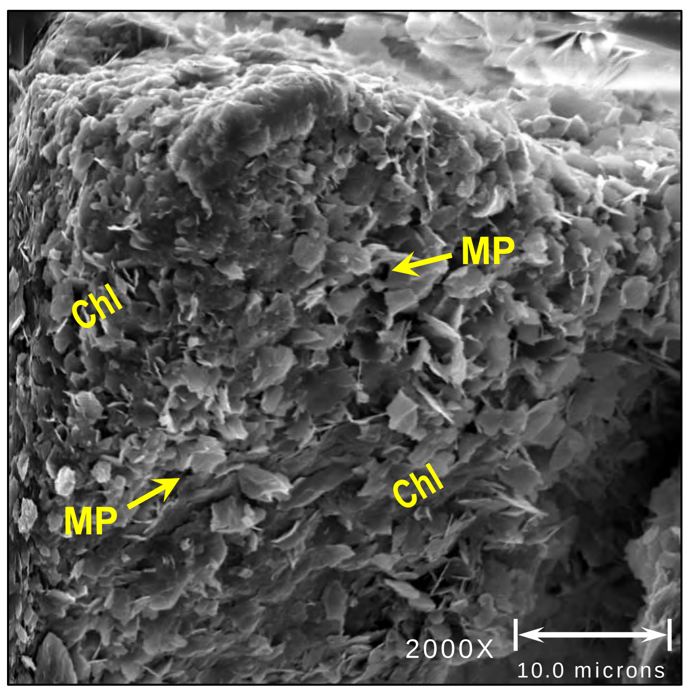
X,XXX' – X,XXX'
Example Formation



Quartz Sandstone



Intergranular porosity ***(P).***



High magnification ***of boxed area at left showing microporosity (MP, and chloritic clay (Chl).***

CORE PHOTOS

EXAMPLE
X-EXAMPLE

This is the 2/3 slab core (page 2 of 4, boxes 10-17).
Depth labels are as shown on the core box.
Indicates a close up photo is on a following page.

5790’ 5793’ 5796’ 5921.25’ 5924’ 5927’ 5941’ 5947’

5793’ 5796’ 5797.5’ 5924’ 5927’ 5930.3’ 5943’ 5950’

EXAMPLE
X-EXAMPLE

5793'
Fractured microcrystalline limy argillaceous dolomite.

5793'
Partially open fracture and healed micro fractures.

5793'
Open and healed fractures with mineralization.

VISUAL ROCK ANALYSIS LOG and SPREADSHEET

Stolper Geologic, Inc.

Since 1980

VISUAL ROCK ANALYSIS LOG

Arvada, CO, USA www.stolpergeologic.com

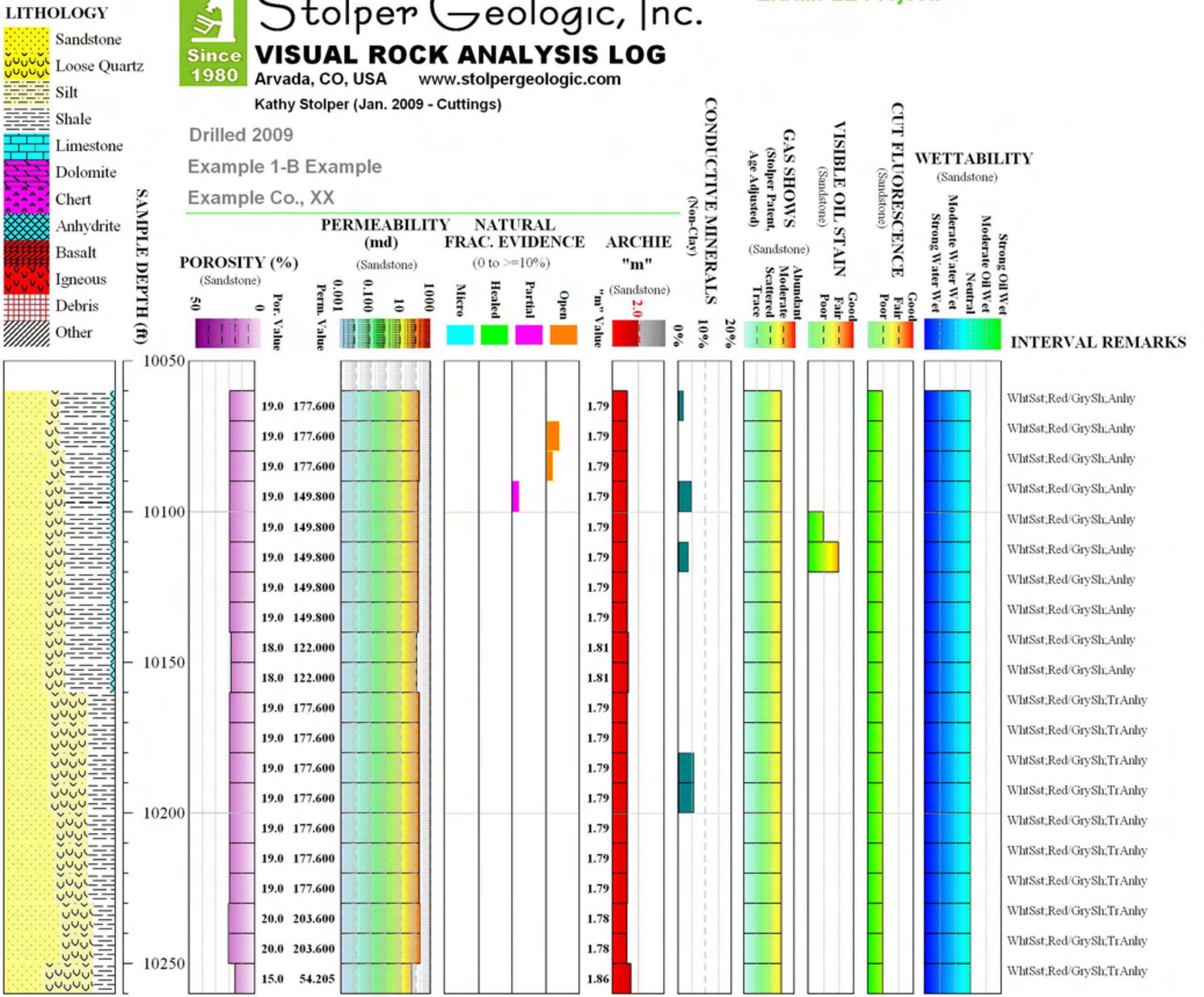
Kathy Stolper (Jan. 2009 - Cuttings)

EXAMPLE Project.

Drilled 2009

Example 1-B Example

Example Co., XX



Por. Value	Perm. Value	"m" Value	Interval Remarks
19.0	177.600	1.79	WhtSst;Red/GrySh;Anhy
19.0	177.600	1.79	WhtSst;Red/GrySh;Anhy
19.0	177.600	1.79	WhtSst;Red/GrySh;Anhy
19.0	149.800	1.79	WhtSst;Red/GrySh;Anhy
19.0	149.800	1.79	WhtSst;Red/GrySh;Anhy
19.0	149.800	1.79	WhtSst;Red/GrySh;Anhy
19.0	149.800	1.79	WhtSst;Red/GrySh;Anhy
19.0	149.800	1.79	WhtSst;Red/GrySh;Anhy
18.0	122.000	1.81	WhtSst;Red/GrySh;Anhy
18.0	122.000	1.81	WhtSst;Red/GrySh;Anhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
19.0	177.600	1.79	WhtSst;Red/GrySh;TrAnhy
20.0	203.600	1.78	WhtSst;Red/GrySh;TrAnhy
20.0	203.600	1.78	WhtSst;Red/GrySh;TrAnhy
15.0	54.205	1.86	WhtSst;Red/GrySh;TrAnhy

Stolper Geologic, Inc.: Panel 1 of 3

ROCK ANALYSIS by STOLPER GEOLOGIC, INC. - Arvada, CO, USA

Project: EXAMPLE

Petrologist: Kathy Stolper ***Date of Work:*** Jan. 2009

Cuttings: X *SW Core:* *Whole Core:* *Core Chips:*

Well Information

Operator: **EXAMPLE**
Well Name-Number: **1-EXAMPLE**
Location (T-R-S):
County, State: **Example Co., XX**
API#:
Date Drilled: **2009** *PC Filename:* stolper_spreadsheet.xls

General Remarks: Cuttings too small to test wettability.

Panel 1 | Panel 2 | Panel 3
Panel 4 | Panel 5 | Panel 6

Ver. 2

www.stolpergeologic.com

Since 1980

(35 API)
A > 300 m (>1000 ft)
B>=150 m but <300 m (>=500 ft but<1000 ft)
C>=30 m but <150 m (>=100 ft but <500 ft)
D>=15 m but <30 m (>=50 ft but <100 ft)
E<15 m (<50 ft)
F = waste zone rocks

1=Very Well
2=Well
3=Moderate
4=Poor
5=Very Poor
6=Bimodal

SORTING

IA=>100 md
IB=10-100 md
IC=1-10 md
ID=0.5-1 md
II=0.07-0.5 md

DEPTH INTERVAL (Feet)		% LITHOLOGY									% FRACTURES				% SEAL TYPE						% GRAIN SIZE (Sst)										SORTING	% RMS ROCK TYPE (Sst)						MODIFIED ARCHIE CLASSIFICATION (Carb) % TYPE I					% II	% TYPE III				
Begin	End	Sst	LQ	Sh	LS	Dolo	Cht	Anhy	Deb	Oth	Micro	Healed	Partial	Open	A	B	C	D	E	F	Slt	LVF	UVF	LF	UF	LM	UM	LC	UC	VC		IA	IB	IC	ID	II	III	MX	VF	F	Med	Crs	VF	XF	VF	F	M	Crs
10,060.0	10,070.0	40	10	45				5																15	55	25	5				3	55	30	15														
10,070.0	10,080.0	35	15	45				5																15	55	25	5				3	55	30	15														
10,080.0	10,090.0	40	15	40				5																15	55	25	5				3	55	30	15														
10,090.0	10,100.0	35	20	40				5																15	55	25	5				3	45	35	20														
10,100.0	10,110.0	35	20	40				5																15	45	35	5				3	45	35	20														
10,110.0	10,120.0	35	20	40				5																15	45	35	5				3	45	35	20														
10,120.0	10,130.0	35	20	40				5																15	45	35	5				3	45	35	20														
10,130.0	10,140.0	35	20	40				5																15	40	40	5				3	45	35	20														
10,140.0	10,150.0	35	20	40				5																15	40	40	5				3	35	40	25														
10,150.0	10,160.0	35	20	40				5																15	40	40	5				3	35	40	25														
10,160.0	10,170.0	40	35	25																				15	40	40	5				3	55	30	15														
10,170.0	10,180.0	40	35	25																				15	40	40	5				3	55	30	15														
10,180.0	10,190.0	40	35	25																				15	40	40	5				3	55	30	15														
10,190.0	10,200.0	40	35	25																				15	40	40	5				3	55	30	15														
10,200.0	10,210.0	45	30	25																				15	40	40	5				3	55	30	15														
10,210.0	10,220.0	45	30	25																				15	40	40	5				3	55	30	15														
10,220.0	10,230.0	45	30	25																				15	40	40	5				3	55	30	15														
10,230.0	10,240.0	50	30	20																				15	40	40	5				3	65	20	15														
10,240.0	10,250.0	50	30	20																				15	40	40	5				3	65	20	15														
10,250.0	10,260.0	35	45	20																				30	40	30					3	15	20	25	25	15												

Stolper Geologic, Inc.: Panel 2 of 3

Op: **EXAMPLE**

Well: **1-EXAMPLE**

Panel 1	Panel 2	Panel 3
Panel 4	Panel 5	Panel 6

B < 0.125mm
C = 0.125-2.0mm
D > 2.0mm

IEP = Interparticle
IAP = Intraparticle
IEXL = Intercrystal
IAXL = Intracrystal
M = Moldic
Fen = Fenestral
Frac = Fracture
Vug = Vuggy
S=Separate
T=Touching
Oth = Other

MDST = Mudstone
WKST = Wackstone
PKST = Packstone
GRST = Grainstone
BDST = Boundstone
XLN = Crystalline
SUC = Sucrosic

Micro = Micro Crystalline
XF = Extremely Fine
VF = Very Fine
F = Fine
Med = Medium
Crs = Coarse
VCRS = Very Coarse
XCRS = Extremely Coarse

DEPTH INTERVAL (Feet)		% VISIBLE PORES (Carb)			% POROSITY EFFECTIVE		HIDDEN		TOTAL		% CHOQUETTE-PRAY POROSITY TYPES (Carb)										% DUNHAM CLASSIFICATION (Carb)							% PARTICLE/CRYSTAL SIZE (Carb)								AMBIENT PERMEABILITY (md)	
																		Vug																			
Begin	End	B	C	D	Sst	Carb	Sst	Carb	Sst	Carb	IEP	IAP	IE-XL	IA-XL	M	Fen	Frac	S	T	Oth	MDST	WKST	PKST	GRST	BDST	XLN	SUC	Micro	XF	VF	F	Med	Crs	VCRS	XCRS	Sst	Carb
10,060.0	10,070.0				19.0				19.0																											177.600	
10,070.0	10,080.0				19.0				19.0																											177.600	
10,080.0	10,090.0				19.0				19.0																											177.600	
10,090.0	10,100.0				19.0				19.0																											149.800	
10,100.0	10,110.0				19.0				19.0																											149.800	
10,110.0	10,120.0				19.0				19.0																											149.800	
10,120.0	10,130.0				19.0				19.0																											149.800	
10,130.0	10,140.0				19.0				19.0																											149.800	
10,140.0	10,150.0				18.0				18.0																											122.000	
10,150.0	10,160.0				18.0				18.0																											122.000	
10,160.0	10,170.0				19.0				19.0																											177.600	
10,170.0	10,180.0				19.0				19.0																											177.600	
10,180.0	10,190.0				19.0				19.0																											177.600	
10,190.0	10,200.0				19.0				19.0																											177.600	
10,200.0	10,210.0				19.0				19.0																											177.600	
10,210.0	10,220.0				19.0				19.0																											177.600	
10,220.0	10,230.0				19.0				19.0																											177.600	
10,230.0	10,240.0				20.0				20.0																											203.600	
10,240.0	10,250.0				20.0				20.0																											203.600	
10,250.0	10,260.0				15.0				15.0																											54.205	

Stolper Geologic, Inc.: Panel 3 of 3

Op: **EXAMPLE**
Well: **1-EXAMPLE**

Panel 1	Panel 2	Panel 3
Panel 4	Panel 5	Panel 6

% ADDITIONAL CUMULATIVE CONDUCTIVE MINERALS

CONSOLIDATION
1=Unconsolidated
2=Slightly
3=Moderate
4=Moderately Well
5=Well
6=Very Well

CEMENTATION EXPONENT

MINERALOGY
1=Present

GAS SHOWS (Stolper Patent)
A=Abundant
B=Moderate
C=Scattered
D=Trace

SHOWS
Visible Oil Stain
Dead Oil Stain
Gas
Lignite
Natural Fluorescence
Cut Fluorescence
Residual Cut Fluores
1=Poor (1-40%)
2=Fair (41-85%)
3=Good (86-100%)
S=Sandstone C=Carbonate

WETTABILITY (Druyff Scale)
5=Strong Oil Wet
4=Moderate Oil Wet
3=Neutral
2=Moderate Water Wet
1=Strong Water Wet

SAMPLE QUALITY
1=Good
2=Fair
3=Poor

DEPTH INTERVAL (Feet) Begin	End	% CLAY Non-Swelling Kao	Non-Swelling Oth	Swelling	% Add. Cum. Conductive Minerals	% CEMENTS Qtz	Cal	Dol	Pyr	Mic	Spr	Oth	Consolidation	MINERALOGY Qtz	Fspr	% Arg	% Rk Frag	% Oth	CEMENTATION EXPONENT Sst	Carb	GAS SHOWS Sandstone Present	Sandstone Age Adjusted	Carbonate Present	Carbonate Age Adjusted	VOS S	VOS C	DOS S	DOS C	Lig S	Lig C	NF S	NF C	CF S	CF C	RCF S	RCF C	Wettability Sst	Wettability Carb	SAMPLE QUALITY	REMARKS
10,060.0	10,070.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,070.0	10,080.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,080.0	10,090.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,090.0	10,100.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,100.0	10,110.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,110.0	10,120.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,120.0	10,130.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,130.0	10,140.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,140.0	10,150.0		7			4							3						1.81		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,150.0	10,160.0		7			4							3						1.81		B	B											1						1	WhtSst;Red/GrySh;Anhy
10,160.0	10,170.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,170.0	10,180.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,180.0	10,190.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,190.0	10,200.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,200.0	10,210.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,210.0	10,220.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,220.0	10,230.0		6			4							3						1.79		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,230.0	10,240.0		6			3							3						1.78		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,240.0	10,250.0		6			3							3						1.78		B	B											1						1	WhtSst;Red/GrySh;TrAnhy
10,250.0	10,260.0		7			6							4						1.86		B	B											1						1	WhtSst;Red/GrySh;TrAnhy

A P P E N D I X

- STOLPER VISUAL GAS SHOW IDENTIFICATION TECHNIQUE
- EFFECTS of MINERALS to WIRELINE LOG RESPONSES
- EFFECTS of ROCK PROPERTIES on ARCHIE'S CEMENTATION EXPONENT "m"
- STOLPER FRACTURE EVIDENCE GUIDE
- R. M. SNEIDER CLASSIFICATION SYSTEM for CLASTICS
- ARCHIE CLASSIFICATION SYSTEM for CARBONATES
- DISCLAIMER

STOLPER VISUAL GAS SHOW IDENTIFICATION TECHNIQUE

Stolper Geologic, Inc. applies an observation of gas shows to our description of potential reservoir quality rocks. This technique is patented by Kathy Stolper and began in 1994 with a study of tight gas sands in East Texas where the quantity of gas shows were found to be directly related to the quality of gas production. ***Some example areas are listed at the bottom of this page.***

Gas bubbles are liberated in a solution that causes the bubbles to cling to the dish rather than escape to the surface. This has been proven by gas chromatography as well as blind testing of samples from producing and non-producing wells. The observations are categorized as abundant, moderate, scattered, and trace.

In general:

ABUNDANT is associated with commercial gas production (provided the interval is of adequate thickness).

MODERATE is associated with gas production plus a minor amount of water.

SCATTERED is associated with predominant water production and minor gas production.

TRACE is associated with water production.

The technique is easiest to interpret in rocks with relatively low permeability. Higher permeability (roughly greater than 3.0 md) may result in somewhat ambiguous results. In higher permeability rocks, the technique becomes more useful when known producing zones are available for calibration. The age of the sample appears to have a significant effect on the quality of gas show. With time, the gas show diminishes. Logically, the show will diminish more quickly for higher permeable material and more slowly for low permeability material. For instance, an abundant gas show in a "tight" rock may degenerate to a moderate gas show after fifteen to twenty years or so in storage; therefore, an "age adjusted" show is also recorded.

Some examples of where the technique has been tested:

- **East Texas, Cotton Valley** tight gas sands. Abundant gas shows in cuttings are observed in commercially productive reservoirs. Lesser production rates are associated with poorer quality gas shows, and non-economical (or dry) wells are associated with trace to zero gas shows.
- **Whitney Canyon, Wyoming Overthrust Belt**. A Paleozoic tight dolomite reservoir with zones of abundant to moderate gas shows contributing to gas production while zones opened with scattered to trace gas shows are not contributing to the overall production as confirmed by production logs.
- **Colorado Niobrara** shaly chalk. Low permeability gas reservoir with abundant to moderate gas shows in cuttings corresponds to higher resistivities in logs and productivity while trace gas shows are observed in reservoirs with very low resistivities that produce water. It is apparent that the lower resistivities reflect a change from gas to water in the reservoir.
- **Southern Oklahoma, Britt** formation, low permeability sands. Abundant gas shows in cuttings versus scattered to trace gas shows were used to successfully pinpoint gas bearing reservoirs.
- **Jonah Field, Western Wyoming Lance** formation, tight gas sands. Abundant gas shows identified hundreds of feet of continuous gas column versus the ten to twenty foot intervals traditionally completed.
- **Texas Panhandle, Morrow** formation. Visual gas show observations in cuttings successfully differentiated gas bearing zones from water bearing zones where the wireline logs were very similar.
- **Australia, Carnavon Basin**, low permeability sands. Abundant gas shows in cuttings differentiated 100+ feet of continuous gas-bearing section from water. Tested and producing.

EFFECTS of MINERALS to WIRELINE LOG RESPONSES

MINERAL	EFFECT ON LOG RESPONSES			REASON
	GR	Res.	Other Effects	
Mica	↑	↓	Causes under estimation of density porosity.	Radioactive; micro-porous; heavy mineral
Glauconite	↑	↓		Radioactive; micro-porous
Illite	↑	↓	Generally decreases neutron porosity.	Radioactive; micro-porous
Smectite	↑	↓	Generally decreases neutron porosity.	Radioactive; micro-porous
Kaolinite		↓		Micro-porous
Chlorite		↓		Micro-porous
Pyrite		↓	Can suppress resistivity if distributed in laminated beds; causes under estimation of density porosity.	Heavy mineral; conductive if distributed in laminated beds
Pyrite with Dolomite		↓		Conductive
Dolomite		↓	Causes under estimation of density porosity if on sandstone matrix.	Micro-porous; heavy mineral
Calcite	↓	↑	Causes under estimation of density porosity.	Heavy mineral
Siderite		↓	Can suppress resistivity if distributed in laminated beds; causes under estimation of density porosity.	Heavy mineral; conductive if distributed in laminated beds
Shale Micro-laminae or Argillite	↑	↓		Radioactive; micro-porous

Kathy Stolper

EFFECTS of ROCK PROPERTIES on ARCHIE'S CEMENTATION EXPONENT "m"

$$Sw = \sqrt{\frac{aRw}{Rt\ Ø^{m}}}$$

ROCK PROPERTY		"m"	REASON
Cementation	↑	↑	Pore geometry becomes more disorderly.
Patchy Cement	↑	↑	Due to the breaks in net electrical continuity.
Compaction	↑	↑	Pore throats are cut off, thus isolating pores.
Bimodality	↑	↑	Pore geometry becomes more disorderly.
Inter-connected Vugs	↑	↑	Pore geometry becomes more disorderly.
Clay	↑	↑	The surface area to grain volume increases. Certain clay types will have more effect on "m" than others will.
Grain Sorting	↑	↓	Pore geometry becomes more orderly.
Grain Size	↑	↓	The surface area to grain volume increases.
Uniformly Distributed Porosity	↑	↓	Pore geometry becomes more orderly.

Kathy Stolper

STOLPER VISUAL FRACTURE EVIDENCE GUIDE

Estimates are based on the average percent of rock, out of the entire volume of rock sampled in that interval, which exhibits the following characteristics:

OPEN

Well-formed quartz druse crystals and/or loose calcite crystals.

PARTIALLY OPEN

A fracture face showing signs of both healed and open characters.

HEALED

Fractures seen in the cuttings are completely filled with cement (usually quartz or calcite).

MICRO

Hairline fractures are seen on surface of cuttings. (Fractures may or may not be open.)

R. M. SNEIDER CLASSIFICATION SYSTEM for CLASTICS

The R. M. Sneider Classification system for clastics allows a geoscientist to assign a permeability range to any rock sample, whether in the form of whole core, sidewall core, or cuttings. This can be done quickly, efficiently, and without the expense of mechanical measurements. The quality of a reservoir rock, in assigning a rock type, is assessed by the visual characteristics of dry, freshly broken rock surfaces at 20X to 50X magnification using a binocular microscope.

The RMS classification system categorizes rocks into type I, II, or III with type I being subdivided into types IA, IB, IC, and ID. The characteristics and permeability ranges assigned are as follows:

TYPE I

- Very abundant to common visible porosity.
- Very abundant to common pinpoint porosity.
- Some pore throats visible.
- Grains are easily dislodged from rock surface with needle probe to reveal pores.
- Reservoir quality rock capable of producing gas without natural or artificial stimulation (if of adequate thickness).

IA	**> 100 md**
IB	**10 - 100 md**
IC	**1 - 10 md**
ID	**0.5 - 1 md**

TYPE II

- Scattered visible porosity.
- Abundant to common pinpoint porosity.
- Grains are occasionally dislodged from rock surface with needle probe.
- Reservoir quality rock capable of producing gas if it is of adequate thickness, interlayered with type I, has natural occurring fractures, and/or is artificially fractured.
- Permeability range is > **0.07 to 0.5 - 1.0 md** dependent on grain size, sorting, and clay content.

TYPE III

- Very isolated to no visible porosity.
- Little to no pinpoint porosity, few scattered pores possible.
- Usually very well consolidated and/or having abundant pore-filling material such, as clay.
- Not usually reservoir quality being too tight to produce at commercial rates neither with natural or artificial fractures nor with interlayered type I rock.

ARCHIE CLASSIFICATION SYSTEM for CARBONATES

ARCHIE TYPE I

- Matrix is composed of tightly interlocking crystals and/or particles with no visible pores. The resultant texture is a resinous to vitreous appearance.
- A broken fresh surface usually has "feathered edges" as a result of breaking across grains (crystals/particles).
- The rock appears compact/dense at 5X magnification.

ARCHIE TYPE II

- Crystals/particles are not effectively interlocked.
- The rock appears chalky or earthy and dull at 5X magnification.
- The particle or crystal sizes are usually 20 microns or less.

ARCHIE TYPE III

- Crystals/particles interlock at varying angles allowing for intercrystalline porosity. Oolites and other grainstones fall in this category.
- Rock appears sucrosic, granular, or sandy at 5X magnification.

MODIFIED ARCHIE GRAIN SIZES

EXTREMELY COARSE	2.00 - 4.00 mm
VERY COARSE	1.00 - 2.00 mm
COARSE	0.50 - 1.00 mm
MEDIUM	0.25 - .050 mm
FINE	0.125 - 0.25 mm
VERY FINE	0.063 - 0.125 mm
EXTREMELY FINE	0.020 - 0.063 mm
MICRO CRYSTALLINE	<0.004 - 0.020 mm

D I S C L A I M E R

All data and conclusions are presented in good faith; however, no express or implied warranty is intended or given. Stolper Geologic, Inc. assumes no liability for any use made of these data or conclusions.