EXCEL procedure for log analysis of the Warsaw Formation (Mississippian) in Oasis Deutsch #1

(1) Create a worksheet template similar to that shown for the Oasis Deutsch #1 well.

(2) Set up the **PARAMETERS** box:

ST = Mean annual surface temperature (from map)
TD = Total depth (from log header)
BHT = Bottom-hole temperature (from log header)
FormD = Formation depth from log)
FormT = Formation temperature (calculated from **ST**, **TD**, **BHT**, and **FormD**)
RwCAT = Formation water resistivity from catalog
RwT = Temperature of RwCAT measurement
A = Archie equation a (=1)
M = Cementation exponent (=2)
N = Saturation exponent (=2)
RW = Formation water resistivity at formation temperature (calculated using Arps' formula with **FormT**, **RwCAT**, and **RwT**)

(3) Complete the log data table by inserting readings of porosity (**PHI**) and formation resistivity (**Rt**) for zones A to P.

(5) Compute an estimate of the water saturation for each zone in the column headed **SW** using the Archie equation **PARAMETERS** applied to **PHI** and **Rt**.

(6) Compute values of the bulk-volume water (**BVW**) from:

$$BVW = \Phi.Sw$$ (both in fractional units)

and bulk volume hydrocarbon (**BVH**) from: $BVH = \Phi - BVW$.

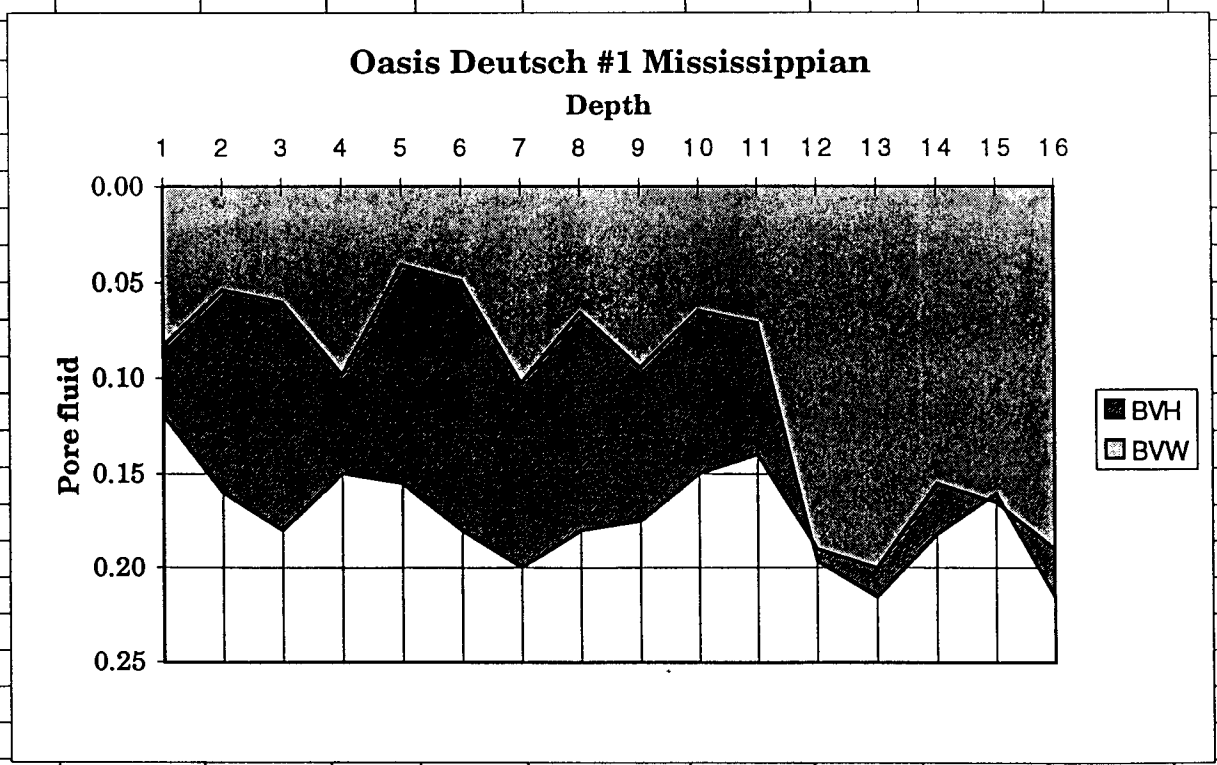
(7) Select the cells in the area of the **BVW**, and **BVH** columns and click on **ChartWizard**.
Choose a gridded cumulative plot form from **Area** for output.
Reverse the **Scale** of Y (this is the logging convention for porosity direction).
You now have a graphic log profile of the volume of porosity subdivided between oil and water content as an ordered (not scaled) function of depth.

Oasis Deutsch #1 C-NE-SE 33-21S-24W Hodgeman Co., Kansas

Warsaw Formation (Mississippian)

PARAMETERS	
A	1
M	2
N	2
RW	0.116
ST	57
TD	4723
BHT	117
FormD	4650
FormT	116
RwCAT	0.17
RwT	77

					Graphic:	
ZONE	DEPTH	PHI	RT	SW	BVW	BVH
A	4615	0.12	17	0.688	0.083	0.037
B	4617	0.16	40	0.337	0.054	0.106
C	4621	0.18	32	0.335	0.060	0.120
D	4625	0.15	12	0.656	0.098	0.052
E	4626	0.155	70	0.263	0.041	0.114
F	4627	0.18	48	0.273	0.049	0.131
G	4633	0.2	11	0.514	0.103	0.097
H	4635	0.18	27	0.364	0.066	0.114
I	4642	0.175	13	0.540	0.094	0.081
J	4647	0.15	28	0.429	0.064	0.086
K	4653	0.14	23	0.507	0.071	0.069
L	4664	0.19	3	1.035	0.197	-0.007
M	4669	0.2	2.5	1.077	0.215	-0.015
N	4679	0.155	3.5	1.175	0.182	-0.027
O	4685	0.165	4.5	0.973	0.161	0.004
P	4694	0.19	2.5	1.134	0.215	-0.025



10-4-25MP. No. _____

OPER OASIS PETROLEUM
800 SUTTON PLACE, WICHITA, KS

WELL #1 DEUTSCH

CONTR GABBERT-JONES

FIELD BINDLEY (MISS)

IP STATE IPP 205 BOPD, NO WTR, MISS 4616-36

API # 15-083-20234

S-T-R 33-21S-24W

SPOT APP C NE SE

CO HODGEMAN, KS

ELEV 2423'KB

D
INIT ✓
DO
FIN

SPUD 8-4-72, 8-5/8"@561 w/300, Geol-Bob Euwer

CORE #1(FS-MISS)4609-41, rec 32' descrip not avail

DST #1(FS-MISS)4603-41, op 2 hr, 480' GIP, rec 3300' oil, no wtr, ISIP 1288/30min, IFP 102, FFP 1170, FSIP 1280/60min

CORE #2(MISS)4641-94, rec 53' descrip not avail

DST #2(MISS)4641- 94, rec 1½ hr, 60' GIP, rec 690' very heavily oil gas cut muddy wtr, 60' sli oil cut wtr, 60' wtr, ISIP 1382/30min, IFP 31, FFP 748, FSIP 1374/60min

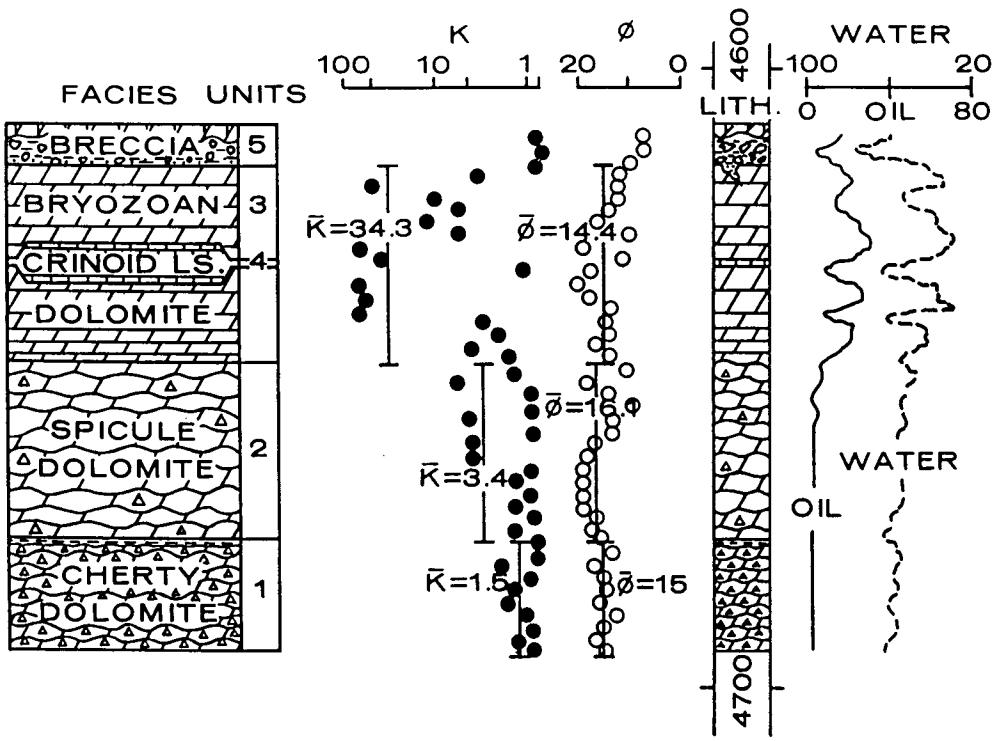
Drlg Completed 8-17-72

RTD 4724, Welex Log, 5½"@4723 w/250, DV tool @1722 w/325 MICT, CO 4700, Perf(MISS)4/4616 -18, 12/4620-26, 6/4633-36, Fill up 3500' oil, no wtr, 12 hrs, swab 7½ BOPH, 6 hrs, 2000' off btm, POP

STATE IP 205 BOPD, NO WTR, MISS 4616-36 COMPLETED 10-18-72

KB LOG TOPS

ANHYDRITE	1670 +753
HEEBNER	3920 -1497
LANSING	3970 -1547
FORT SCOTT	4500 -2077
MISS DOLOMITE	4612 -2189
LTD	4723 -2300
RTD	4724 -2301
TD IN MISS	



From Ebanks and others (1977)

DIGITAL LOG DATA

Log analysis calculations used to be done mostly with slide-rules and charts (pre-1972), then with calculators, and now increasingly with computers. The digital data for computations are recorded by the logging truck and are made available either directly or from the logging company computer processing center. The data are stored either in binary format (LIS) on tapes, or in ASCII format (LAS) usually on floppy discs. LAS (Log Ascii Standard) is the more recent standard and was introduced by the Canadian Well Logging Society in the late 1980's. LIS (Log Information Standard) tapes are often difficult to read, not only because of their binary code, but the variability in formatting styles. LAS files on floppy discs can be read by standard word-processing programs and LAS is ideal for PCs. Both forms conventionally list data at a rate of two readings per foot of hole for common log combinations which have vertical resolutions of 2 to 3 feet or greater. This frequency is fine enough to pick up the systematic features of the log curves without wasteful oversampling, but not so coarse as to cause "aliassing" problems.

Blue-line logs can also be digitized using relatively inexpensive hardware and software, or through the service of a digitizing company. Digitized logs for some areas are available for purchase over the Internet. In all cases, the most popular data format is LAS.

The header information and initial curve data are shown overleaf for a an extension well in the Hugoton North field of Scott County, Kansas. The data were read from an LAS file on the floppy disc pictured below, by a standard word processing program on a PC.

The file OCRK.LAS records logs from Lario Oil & Gas Whitebead #2-2 drilled in Garvin County, Oklahoma. The digitized interval on the file ranges from 5950 - 6150 feet. The well produces oil from the Oil Creek Sandstone (6010 - 6115), a Middle Ordovician formation. The Oil Creek Sandstone is a prolific oil producer in parts of Oklahoma, while at other localities it is mined in quarries as a source of sand for glass manufacture. The grains in this highly pure sandstone are both well-sorted and very well-rounded.

The logs on OCRK.LAS can be read using a word-processor (such as WORD) or a spreadsheet program (such as EXCEL).

A spreadsheet program can be used to plot the logs. See the gamma ray, neutron and density porosity, and resistivity logs plotted for the interval from 5950 - 6150 feet depth by EXCEL.

Log analysis of the Oil Creek Sandstone section between depths of 6010 and 6115 feet depth. can be made on a spreadsheet using the deep induction for the resistivity (Rt) and the porosity estimated by an average of the neutron and density limestone-equivalent porosity readings for each depth increment.

Water saturations were computed for the zones, using an Oil Creek Sandstone water resistivity at formation temperature of 0.03 ohm-m, in conjunction with the Archie equation, using equation constants of: a=1, m=1.8, n=2.

The bulk volume water (BVW) of each zone is found by multiplying the (fractional) porosity by the (fractional) water saturation: BVW = Φ*Sw
The BVW is the proportion of the rock that is estimated to be formation water. Bulk volume hydrocarbon (BVH) is computed from BVH = Φ*(1-Sw). Notice that BVW + BVH = Φ, so that the bulk volumes subdivide the pore volume into water and hydrocarbon. A log profile of Φ- BVW - BVH is a graphic illustration of the reservoir structure created by the log analysis.

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~Version Information Section
VERS.          2.0            : CWLS LOG ASCII Standard
WRAP.          YES            : Multiple lines per depth step
~Well Information Section
STRT.FT        5950.000       : Start Depth
STOP.FT        6150.000       : Stop Depth
STEP.FT        0.500          : Step
NULL.          -999.000       : NULL Value
COMP.   LARIO OIL AND GAS     : Company
WELL.   WEST WHITEBEAD 2-2    : Well
FLD.                          : Field
LOC.                          : Location
SRVC.                         : Service Company
DATE.                         : Date
CTRY.          USA            : Country
STAT.      OKLAHOMA           : State
CNTY.        GARVIN           : County
API.                          : API Number
~Curve Information Section
DEPTH.FT                      :   Depth
CALI.IN                       :   Caliper
GR.GAPI                       :   Gamma ray
SP.MV                         :   Spontaneous Potential
ILD.OHMM                      :   Deep induction resistivity
ILM.OHMM                      :   Medium induction resistivity
SFL.OHMM                      :   Spher-focussed resisistivity
RHOB.G/C3                     :   Bulk density
DRHO.G/C3                     :   Density correction
PDL.DECIMAL                   :   Density porosity (ls equiv.)
PEF.B/E                       :   Photo-electric factor
NPHI.DECIMAL                  :  Neutron porosity (ls equiv.)
~A Log Data Section
DEPTH  CALI  GR  SP  ILD  ILM  SFL  RHOB  DRHO  PDL  PEF  NPHI
5950 7.958 81.229 -29.436 6.719 6.569 9.786 2.587 0.032 0.072 3.292 0.106
5950.5 7.881 82.519 -30.689 6.401 5.782 7.672 2.566 0.061 0.084 2.997 0.119
5951 7.815 86.114 -32.691 5.924 5.346 6.151 2.536 0.089 0.102 2.844 0.144
5951.5 7.862 87.242 -34.944 5.561 5.074 5.525 2.506 0.101 0.119 2.835 0.158
5952 7.81 85.754 -36.446 5.194 5.081 5.397 2.49 0.103 0.128 2.946 0.179
5952.5 7.898 89.822 -37.449 4.962 5.144 5.912 2.502 0.124 0.122 2.91 0.176
5953 8.017 84.862 -36.951 4.947 5.009 5.639 2.5 0.123 0.123 3.096 0.192
5953.5 7.804 87.764 -36.204 5.098 5.141 5.684 2.507 0.114 0.119 3.087 0.183
5954 7.739 76.56 -35.956 5.313 5.471 6.384 2.511 0.091 0.116 3.01 0.168
5954.5 7.751 76.118 -35.959 5.488 6.016 7.451 2.512 0.065 0.116 2.919 0.116
5955 7.781 67.354 -35.961 5.599 6.355 8.995 2.561 0.065 0.087 3.015 0.081
5955.5 7.888 63.105 -34.964 5.704 6.235 10.451 2.61 0.071 0.059 3.016 0.072
5956 7.823 63.672 -33.716 6.036 6.145 11.099 2.623 0.057 0.051 3.164 0.082
5956.5 7.741 70.295 -32.469 6.502 6.119 9.565 2.627 0.053 0.048 3.262 0.1
5957 7.806 89.456 -31.221 6.896 6.39 8.283 2.615 0.05 0.056 3.365 0.12
5957.5 7.862 93.581 -30.224 7.27 7.078 7.395 2.618 0.05 0.054 3.719 0.137
5958 7.886 85.196 -28.976 7.675 7.875 7.315 2.613 0.041 0.057 3.921 0.129
5958.5 7.823 60.369 -28.979 7.841 8.741 8.822 2.63 0.05 0.047 3.669 0.081
5959 7.811 44.075 -29.481 7.931 9.427 15.912 2.64 0.065 0.041 3.476 0.056
5959.5 7.624 35.666 -30.484 8.145 8.7 19.204 2.635 0.069 0.044 3.435 0.059
5960 7.645 42.684 -31.736 8.423 8.697 16.336 2.605 0.053 0.061 3.255 0.088
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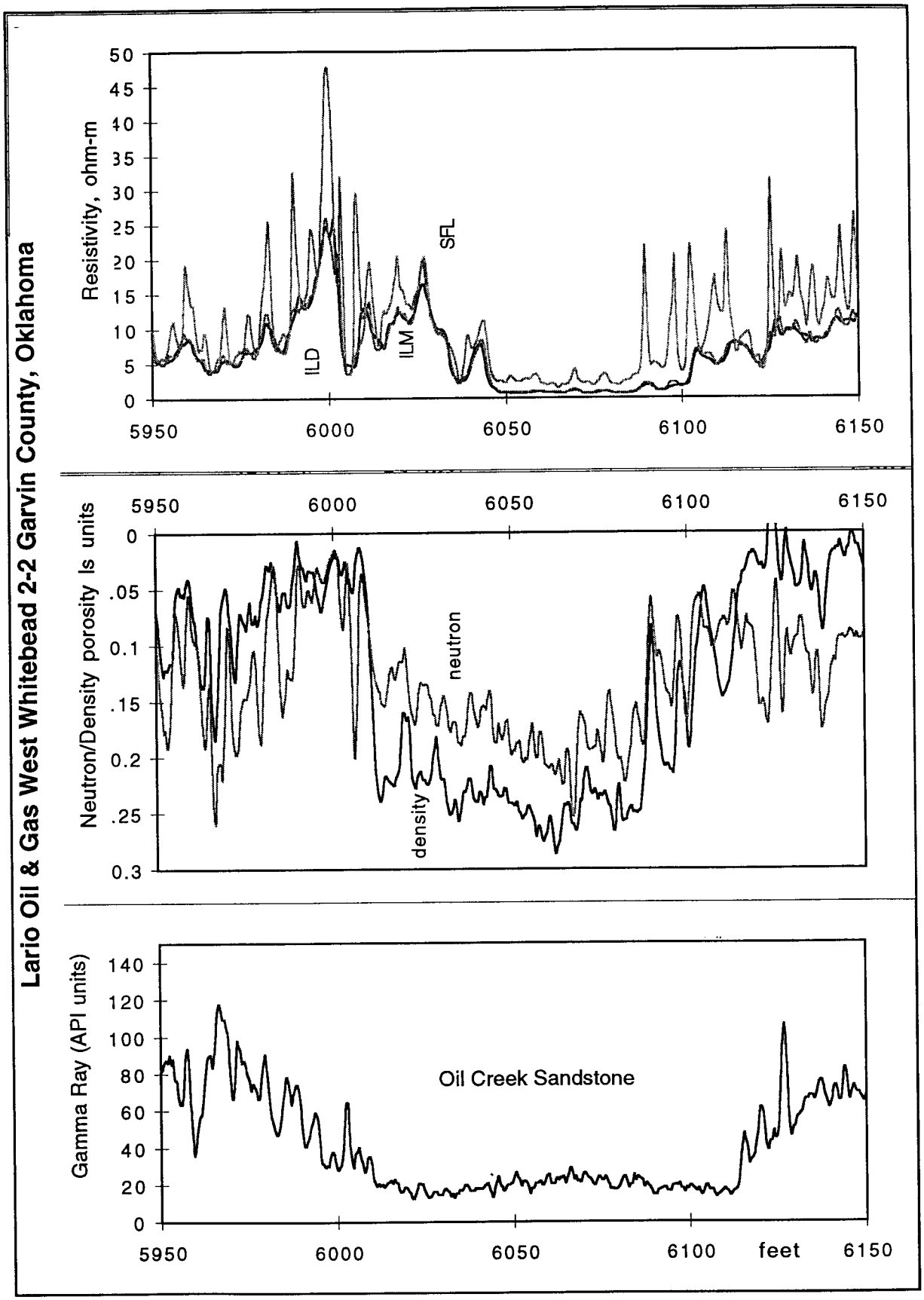
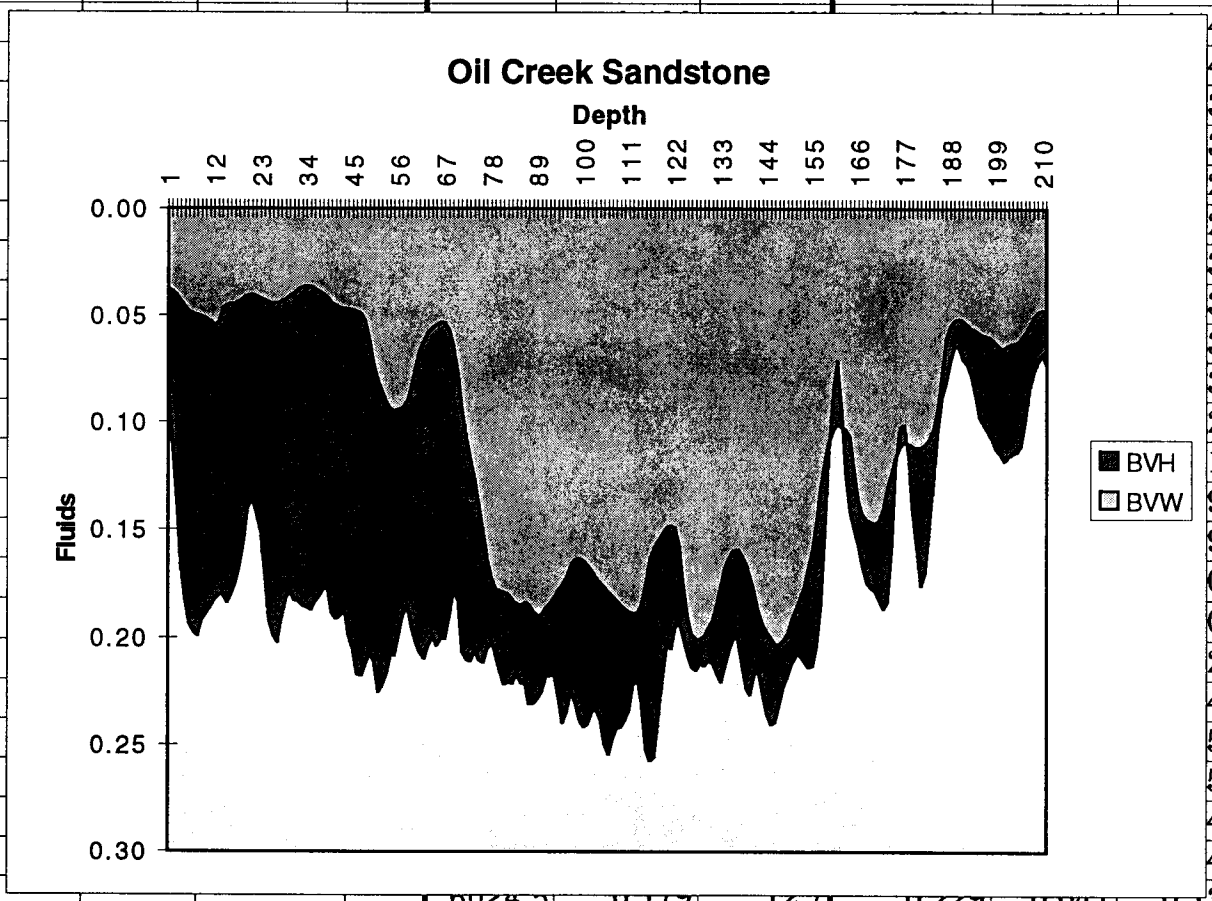

Lario Oil & Gas West Whitebead 2-2 Garvin County, Oklahoma
Resistivity, ohm-m
50
45
40
35
30
25
20
15
10
5
0
ILD
ILM
SFL
5950
6000
6050
6100
6150
Neutron/Density porosity ls units
0
.05
0.1
.15
0.2
.25
0.3
neutron
density
Gamma Ray (API units)
140
120
100
80
60
40
20
0
Oil Creek Sandstone
feet

Lario Oil & Gas West Whitebead #2-2, Garvin County, Oklahoma

Oil Creek Sandstone (Middle Ordovician)

PARAMETERS	
A	1
M	1.8
N	2
RW	0.030



						Graphic:	
DEPTH	PHI	RT	SW	BVW	BVH		
6010	0.087	12.9	0.434	0.038	0.049		
6010.5	0.109	12.9	0.354	0.039	0.071		
6011	0.138	12.2	0.294	0.041	0.098		
6011.5	0.167	11.1	0.260	0.043	0.123		
6012	0.183	9.9	0.254	0.046	0.136		
6012.5	0.193	9.2	0.251	0.049	0.145		
6013	0.198	8.9	0.249	0.049	0.148		
							49
							41
							38
							33
							28
							27
							33
							39
							36
							30
							24
							13
							99
							95
							01
							09
							27
							48
							54
							58
							48
							40
6024.5	0.179	12.7	0.229	0.041	0.138		
6025	0.183	13.8	0.215	0.039	0.144		
6025.5	0.183	15.0	0.206	0.038	0.146		
6026	0.186	15.8	0.198	0.037	0.149		
6026.5	0.186	16.3	0.195	0.036	0.150		
6027	0.187	16.1	0.195	0.036	0.151		
6027.5	0.184	15.1	0.205	0.038	0.146		
6028	0.181	14.2	0.214	0.039	0.142		
6028.5	0.178	13.3	0.225	0.040	0.138		