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2015

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2015

doi:10.4095/296445

This publication is available for free download through GEOSCAN (http://geoscan.nrcan.gc.ca/).

Recommended citation
McMechan, M.E., Obermajer, M., Ferri, F., and Stewart, K.R., 2015. Rock-Eval 6/TOC data for selected samples from Devono-Mississippian shale cores in the Liard Basin, northeast British Columbia; Geological Survey of Canada, Open File 7781, 1 .zip file. doi:10.4095/296445

Publications in this series have not been edited; they are released as submitted by the author.

INTRODUCTION

Rock-Eval 6/TOC results were obtained for samples from 34 cores of Devono-Mississippian shale in or adjacent to the Liard Basin area of British Columbia. Every non-confidential core of Devono-Mississippian shale available from the B.C. part of the Liard Basin was sampled in the Fall of 2013. The cores came from 9 different boreholes that intersected several stratigraphic units including the Golata, Banff, Besa River, Mattson, Exshaw, Kotcho, Muskwa, Otter Park and Evie formations as listed below.

Well Name	Location	Licence	Core No.	Interval Sampled (ft)	Interval Sampled (m)	Unit
LTS HZ POPLAR HILLS A-040-G	A-040-G/094-O-03	WA25913	1		1216.5- 1227.8	Exshaw
LTS HZ POPLAR HILLS A-040-G	A-040-G/094-O-03	WA25913	1		1228 - 1233	Kotcho
LTS HZ POPLAR HILLS A-040-G	A-040-G/094-O-03	WA25913	2		2145.1 - 2145.8	Muskwa
BP ENERGY GROUP DEER LAKE A-090-I	A-090-I/094-O-06	WA0531	1		1658.6 - 1663.6	Kotcho
TRANSEURO BEAVER B-019-K	B-019-K/094-N-16	WA02563	1-2	12395 - 12420	3778.00 -3785.62	Besa River/Evie
TRANSEURO ET AL BEAVER B-036-K	B-036-K/094-N-16	WA21755	1-4, 6-9		1835-2114	Mattson/Besa River
JOINT VENTURE NO. 1 C-010-E	C-010-E/094-N-07	WA0038	35	5162 - 5187	1573.38 -1581	Besa River/ Muskwa
EOG MAXHAMISH D-012-L	D-012-L/094-O-15	WA21643	1-10		2956.15 -2975.3	Muskwa
EOG MAXHAMISH D-012-L	D-012-L/094-O-15	WA21643	11		2978.7	Otter Park
TRANSEURO BEAVER D-064-K	D-064-K/094-N-16	WA0325	1	8320 - 8360	2535.94 - 2548.13	Golata
TRANSEURO BEAVER D-064-K	D-064-K/094-N-16	WA0325	20	9500 - 9502	2895.60 - 2896.21	Banff
TRANSEURO BEAVER D-064-K	D-064-K/094-N-16	WA0325	21	11038 - 11063	3364.38 - 3372.00	Besa River/ Muskwa
TRANSEURO HZ BEAVER D-A064-K	D-A064-K/094-N-16	WA02547	6	6282 - 6312	1914.75 - 1923.90	Golata
IOE DUNEDIN D-075-E	D-075-E/094-N-08	WA01331	15	12103 - 12147	3688.99 - 3702.41	Besa River/ Golata?
IOE DUNEDIN D-075-E	D-075-E/094-N-08	WA01331	16	12379.3 - 12385.2	3773.2 - 3775.0	Besa River
IOE DUNEDIN D-075-E	D-075-E/094-N-08	WA01331	17	12761.5 - 12780.5	3889.7 - 3895.5	Besa River

Depths in feet are listed when that is the original unit of measure on the core box. The following cores had poorer recovery and the estimated depth for individual samples from these cores have more uncertainty: WA0325 core 1; WA531 core 1, 21; WA1331 core 16, 17; WA02547 core 6; WA2563 core 1 and WA21643 cores 1-5, 7, 8, 10, 11.

Other previously published Rock-Eval/TOC results are available for cuttings of Devono-Mississippian shale from several wells in the in the Liard Basin area (Fowler et al., 2007, Obermajer et al., 2012; McMechan et al, 2013) and one surface section of the Besa River Formation (Ferri et al., 2011).

EXPERIMENTAL

Rock-Eval/TOC analysis provides fast and reliable characterization of the quantity and quality of sedimentary organic matter, as well as its thermal maturity. All samples were analyzed on a Rock-Eval 6 Turbo (RE 6) instrument equipped with a Total Organic Carbon analysis module. A typical RE 6 experiment is initiated with heating of a pulverized rock sample at 300ºC for 3 min in nitrogen atmosphere, when naturally occurring hydrocarbons (free and adsorbed) are volatilized. The oven temperature is then steadily increased to 650ºC at a rate of 25ºC/min and decomposition of kerogen occurs. The amount of hydrocarbons volatilized at 300ºC and evolved from kerogen during the ramped heating are quantitatively determined by a flame ionization detector, and recorded as the S1 and S2 peaks, respectively. The final stage involves oxidation and combustion of the residual organic matter at 850ºC. The temperature measured at the maximum of the S2 peak is referred to as Tpeak while Tmax is calculated by subtracting about 40ºC from Tpeak (the exact correction is determined using a manufacturer standard). The amounts of CO and CO_2 are quantitatively determined by infrared detectors. Additional details on the RE6 instrument are available in Behar et al. (2001).

The percentage of carbon in CO_2 formed during oxidation and in the hydrocarbon peaks S1 and S2 is used to define the total organic carbon content (TOC), expressed as a weight percentage. The determination of the quality of organic matter is based upon the calculation of Hydrogen (HI) and Oxygen (OI) indices (HI=100xS2/TOC, OI=100xS3/TOC) which are related to the atomic H/C and O/C ratios (Espitalié et al., 1977). The OI versus HI cross plots ("pseudo van Krevelen diagrams") can be used as an organic matter type indicator at low and moderate maturities. The Tmax is an indicator of relative thermal maturity. According to Espitalié et al. (1985) the oil window is defined by the following Tmax ranges: 440º-448ºC (Type I), 430º-455ºC (Type II) and 430º-470ºC (Type III). A cross plot of Tmax versus HI is used to constrain estimations of organic matter type and its thermal maturity, while the Production Index (PI=S1/[S1+S2]) is used to indicate staining of a sample or as an additional maturity parameter.

Rock-Eval results correlate to other techniques (Espitalié et al., 1985; Tissot and Welte, 1978). Source rock potential is sensitive to lithology, TOC and S2 values. It is common practice to rate carbonate rocks with lower TOC comparable with richer clastic rocks. Extractable HC yields from leaner carbonate rocks are comparable to richer clastic rocks (Tissot and Welte, 1978, p. 430; Gehman, 1962). The organic matter associated with carbonate rocks is often more hydrogen-rich and thermally labile than that in fine-grained clastic rocks. As a result, more TOC in carbonate rocks may be transformed into bitumen compared with average clastic source rocks of comparable maturity.

Rock-Eval/TOC parameters have reliable significance only above threshold TOC, S1 and S2 values. If TOC is less than or equal to 0.3% then all parameters have questionable significance and the experiment suggests no petroleum source potential. Oxygen Index (OI) has questionable significance if TOC is less than or equal to 0.5%. Both Tmax and Production Index (PI = S1/(S1+S2)), have questionable significance if S1 and S2 values are less than or equal to about 0.2 mg HC/g rock. Results can be affected by rock mineral composition. The mineral matrix may either retain hydrocarbon compounds, generally lowering the S1 or S2 peaks, while increasing Tmax, or liberate inorganic CO_2 increasing S3 and OI. These effects are important if TOC, S1 and S2 are low, an effect not significant where sources have TOC values greater than 5%. OI values greater than 150 mg/g TOC suggest either low TOC or a mineral matrix CO_2 contribution during pyrolysis. Generally, a TOC content of at least 2% is needed for a source rock. Note that TOC and Hydrogen Index decrease with increasing thermal maturity due to hydrocarbon generation. Additional guidelines on the interpretation of Rock-Eval data may be found in Peters (1986), Snowdon (1995) and Sykes and Snowdon (2002).

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