Trace elements characteristics of the Utica Shale in southeastern Quebec, Canada

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This study presents the preliminary results of whole rock trace elements analysis of the Utica Shale in southeastern Quebec. Samples obtained from Talisamn Saint-Edouard No1 exploration well are from a 32m interval of the deep part of the Utica Shale (1998-2030m). The sample lithology varies from shale to fine to medium grained calcareous siltstone (MINC up to 12%). Samples have generally fair to good TOC content ranging from 0.08 to 2.25%, with average 1.31%. The major organic matter constituents of samples are migrated solid bitumen and chitinozoan skeleton, which show a high thermal maturity (1.95 to 2.33% $Ro_{equiv.}$) and are in the dry gas zone.

The samples show a wide range of Mo and narrow range of U enrichment factor (0.6 to 317 and 2.3 to 12.7, respectively) in comparison to the average continental crust elemental composition. The Mo concentration varies from 0.2 to 81.2 ppm with a mode of 0.9 ppm which indicates precipitation under suboxic condition with short periods of euxinic condition with higher concentrations (>30 ppm) of Mo.

Unlike many black shales and oxygen-deficient modern marine basins, the Utica Shale samples show a negative correlation between TOC and Mo ($r = –0.377$, $P < 0.0001$, $n = 210$). However there is a significant positive correlation between U and TOC ($r = 0.455$, $P < 0.0001$, $n = 210$). In addition, there is a good positive correlation between Na ($r = 0.566$, $P < 0.0001$, n 210), Al ($r = 0.2$, $P = 0.004$, $n = 210$) and K ($r = 0.185$, $P = 0.007$, $n = 210$) with TOC.

These results suggest that there is not a genetic correlation between Mo and organic matter. As most of the organic matter in the rock is migrated bitumen, which is mainly adsorbed by clay fraction in the rock, there is a good correlation between aluminosilicates and TOC. However, this results in a negative correlation between Mo and TOC. The findings of this study show that trace element data could be an effective measure for discriminating reservoir intervals from source rock zones in unconventional resources studies.