

Trace Metals in Crude Oil: An Alternative Geochemical Interpretation

I. SUGIYAMA^{1*} AND A.E. WILLIAMS-JONES¹

¹Department of Earth and Planetary Sciences, McGill University

ichiko.sugiyama@mail.mcgill.ca (*primary author)

Crude oils are known to contain elevated concentrations of metals such as nickel (Ni), vanadium (V), zinc (Zn), iron (Fe), molybdenum (Mo), and chromium (Cr) [1,2,3,4]. Elevated metal concentrations in crude oils are thought to be controlled by the composition of the crude oil (eg. Porphyrin abundance, asphaltene content, etc.), protolith shale geochemistry or basin architecture (open vs. closed) [1,2,3,4,5]. The relative importance of the aforementioned parameters remains poorly understood and the possible contributions of other processes have been under explored.

In order to test some potential processes that might affect metal profiles in crude oils, we analyzed 17 crude oils from various locations (Canada and Norway) for Ni, V, Mo, Zn, nitrogen (N), and sulfur (S). We also isolated the asphaltene fraction from one of the heavy crude oils and performed trace metal analyses to test the proportion of metals in the asphaltene fraction.

Based on our results, Ni and V showed strong linear correlations with S and moderate correlation with N, while Mo and Zn did not show a significant correlation. Furthermore, Ni and S ratios significantly differed from a 1:1 nickel sulfide (NiS) stoichiometric ratio, which is thought to be one of the favorable species likely to occur in crude oils [1,2,4]. Finally, the majority of the Ni and V resides within the asphaltene fraction (>90%), indicating that sulfur macromolecules and/or other organosulfur compounds might be playing a key role in controlling the Ni and V concentrations in crude oils.

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