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Hydrocarbon Maturation and Os Mixing on Bolide Impact at the Frasnian-Famennian Boundary

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An intractable problem in the application of Re-Os geochemistry has been knowledge of the distribution of Re and Os between source rock and generated hydrocarbon. Solutions lie in combined experimental work with controlled and induced maturation, and field studies optimized by known source rock and time of hydrocarbon generation. The Siljan impact site with its variably tilted but largely intact Ordovician-Silurian sections provides an unsurpassed opportunity to examine the Re-Os systematics of source rock and generated crude oil, and the Re-Os imprint of the bolide. This three-component system contains (1) a time pin for maturation (377 $\pm$ 2 Ma; laser argon dating of impact melt, Reimold et al. 2005) arguably at the Frasnian-Famennian boundary, (2) known source rocks with kerogens still intact, and (3) crude oils generated on impact. Modeling takes into consideration the possibility of pre-impact maturation as well.

At Siljan, numerous quarries expose the Upper Ordovician Boda and Kullsberg limestone mounds, and locally, the underlying and laterally equivalent Tretaspis (Fjäcka) shale. We obtained a sample of crude oil seeping from a drill hole in the quarry floor at Solberga. Preliminary Re-Os analyses on four aliquots of this oil form an excellent linear array in $^{187}Re/^{188}Os$ versus $^{187}Os/^{188}Os$ space. The associated age, however, is impossibly old (Neoproterozoic), and the initial $^{187}Os/^{188}Os$ unreasonably low (0.2). Rather, this linear array fits a mixing line between a meteoritic component and a hydrocarbon generated from the Tretaspis shale. We are presently performing further tests to isolate the two end-members. Filtering suggests that the extraterrestrial component consists of small physical particles which can be largely removed from the petroleum fraction. The extreme contrast in Re-Os composition between meteorite (known) and black shale (in progress) end-members maximizes the sensitivity of the isotopic study.

Reimold, W.U., Kelley, S.P., Sherlock, S.C., Henkel, H., and Koeberl, C. (2005) Laser argon dating of melt breccias from the Siljan impact structure, Sweden: implications for a possible relationship to Late Devonian extinction events: Meteoritics & Planetary Science, v. 40, no. 4, p. 591-607.