

Re-Os Chronology Reconstructs Whole Petroleum Systems and Interrogates an External Fluid

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ABSTRACT

Nascent applications of Re-Os isotope geochemistry celebrated the successful dating of a source rock two decades ago. More recently, the technology turned from Re-Os ages for isolated shale occurrences to sampling strategies for absolute time correlation of key intervals of source rock across basins. Re-Os dating of shales is now all but routine [1]. From organic-rich shales the chronometer found application in dating solid hydrocarbon or bitumen. The clock began to give the first measurements on hydrocarbon maturation and/or migration. From there the technology spread to oils. Last year the first Re-Os isochron for a single crude oil, based on its asphaltene and maltene fractions, was unveiled [2]. Here we present a new level of application, the ability to date whole petroleum systems. This effort has moved beyond proof-of-concept and is poised for widespread application. We show that the Re-Os chronometer gives ages for petroleum-forming events, including oil-water and oil-oil encounters. Further, the Os isotope tracer commonly implicates a fluid external to fluids typical of a sedimentary basin. That external fluid has low Os isotopic ratios suggesting that at least a component of petroleum-producing fluids has a deeper sub-crustal (mantle-like) origin. Each petroleum system has its own story. Extricating that story is critically dependent on a sound strategy to deconstruct the system, wise sampling, and the wisdom of industry partners. We work from multiple samples representing residual oils, tar mats, oil legs, and live oils from the well. Knowledge of the timing of events within a greater petroleum system is critical for formulating competitive exploration strategies. Our work is funded by the Norwegian petroleum industry under the CHRONOS project. [1] Stein, H. and Hannah, J. (2015) Rhenium-Osmium geochronology – sulfides, shales, oils, and mantle, in Rink, J. and Thompson, J. (eds), Earth Sciences Series, Encyclopedia of Scientific Dating Methods, Springer. <http://link.springer.com/referencework/10.1007/978-94-007-6326-5>. DOI: 10.1007/978-94-007-6326-5_36-1. [2] Georgiev, S.V., Stein, H.J., Hannah, J.L., Galimberti, R., Nali, M., Yang, G., and Zimmerman, A. (2016) Re-Os dating of maltenes and asphaltenes within single samples of crude oil: *Geochimica et Cosmochimica Acta*, 179: 53-75.