Re-Os Geochronometer Constraint on Timing of Petroleum Generation and Migration and Associated Tectonism of the Northern Longmen Shan Thrust, China

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Abstract

The Longmen Shan Thrust belt (SW China) is a complex tectonic zone, with its northern section being host to hydrocarbons that equate to several million barrels of oil, which are considered to have formed over a protracted evolution of the thrust belt. Here, we investigate the temporal relationship between petroleum generation and the tectonic events of the Longmen Shan Thrust belt. Rhenium-Osmium (Re-Os) geochronology is a novel technique that has the potential to constrain the timing of hydrocarbon generation, to identify source units and to determine the time of orogeny activity associated with contemporaneous bitumen and oil generation. Hydrocarbon in the northern Longmen Shan Thrust belt exist as solid bitumen dykes and as coatings along fault planes, and as present day oil seeps. The Re and Os abundances of bitumen are significantly more enriched (Re = 283.3-563.3 ppb; Os = 4058.2-15347.3 ppt) than present day oil seeps (Re = 7.7-9.6 ppb; Os = 90.3-127.2 ppt). The bitumen Re-Os isotope data define two positive correlations that yield two Re-Os dates of 158 +- 77 Ma and 199.7 +- 2.6 Ma. The two Re-Os dates, are in agreement with field evidence, fluid inclusion and burial history models, and Sm-Nd, Ar-Ar, and U-Th-Pb isotope dating in Northern Longmen Shan Thrust belt and adjacent Sichuan Basin. As such, the Re-Os data provide direct absolute age evidence for the timing of petroleum generation/migration and associated complex tectonism. The Re-Os data for the present day oil seep samples are too similar to yield a meaningful age. The organic geochemistry of the oil from the present day oil seeps indicate they are derived from a far younger source (Permian) than the bitumen (Sinian-Cambrian shales). This is also supported by the initial Os isotope (187Os/188Os, IOs) compositions for the oil seeps. Moreover, the IOs of the bitumen coupled with organic geochemistry indicate both Sinian and Cambrian shale sources.