Precise 2004 ± 9 Ma Re-Os age for Pechenga black shale: Comparison of sulfides and organic material

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Recent analytical advances have led to highly precise and accurate Re-Os ages for sedimentary sections based on synsedimentary-early diagenetic sulfides ***or*** organic material from black shales [1,2]. Here we show that both synsedimentary sulfides ***and*** organic material in black shales of the "Productive" Formation in the Pechenga Greenstone Belt, Kola Peninsula, Russia, yield identical depositional ages, whereas diagenetic sulfide concretions yield scattered results. The "Productive" Formation is roughly coeval with Ni-Cu-bearing ultramafic flows and intrusions dated at 1988 ± 39 Ma [3]. Textural analysis documents synsedimentary-early diagenetic sulfidic layers and later zoned sulfide concretions. In both cases, sulfides are dominated by pyrite ± pyrrhotite. Sulfur isotope data suggest precipitation of sulfides by bacterial sulfate reduction in an open system followed by closed-system diagenesis [4].

Chemically extracted organic material from eight shale samples yields an age of 2006 ± 26 Ma with a chondritic initial $^{187}Os/^{188}Os$ of 0.130 ± 0.042 (MSWD = 4.3). Analysis of five sulfidic layers yields an identical age of 2004 ± 20 Ma and an identical initial $^{187}Os/^{188}Os$ of 0.133 ± 0.058 (MSWD = 17). A combined 13-point isochron precisely defines the depositional age and clear chondritic Os initial ratio (2004 ± 9 Ma, $^{187}Os/^{188}Os$ = 0.133 ± 0.020, MSWD = 7). Re-Os data from later sulfide concretions, mostly zoned, scatter widely, with model ages from 1926 to 2231 Ma. The scatter likely reflects mixing of Os of variable isotopic composition and/or diachronous growth of the concretions.

The chondritic initial $^{187}Os/^{188}Os$ ratio reflects the predominance of mantle-derived Os in seawater in the active Pechenga paleorift. Prevalence of sulfate species documents an oxygenated atmosphere at 2.0 Ga, but cycling of radiogenic Os released by oxidative weathering of continental crust [1] may have remained modest in the Paleoproterozoic.

References

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