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Re-Os Dating of Polymetallic Ni-Mo-PGE-Au Mineralization in Lower Cambrian Black Shales of South China and Its Geologic Significance

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Abstract

Black shales of the basal Lower Cambrian Niutitang Formation, southeast China, host a regionally distributed concordant, several centimeter-thick, sulfide layer which displays extreme metal enrichment, i.e., Mo-Ni-Se-Re-Os-As-Hg-Sb >1,000 times enriched and Ag-Au-Pt-Pd >100 times enriched over bulk continental crust. Mineable portions have about 5.5 wt percent Mo, 3.5 wt percent Ni, and 1 g/t PGE + Au. A six-point $^{187}Os/^{188}Os$ versus $^{187}Re/^{188}Os$ isochron on molybdenum-nickel ore samples defines an age of 541 ± 16 Ma (2σ) with an initial $^{187}Os/^{188}Os$ ratio of 0.78 ± 0.19. This age is in agreement with the depositional age of the black shale host; the initial ratio is close to present-day seawater. The sulfide layer/average seawater metal ratio is on the order of 10^6 to 10^8, about 10 to 100 times higher than that for the black shale host and for average metalliferous black shale. Synsedimentary metal enrichment from seawater under anoxic (sulfate-reducing) conditions appears likely but requires an unusually low sedimentation rate and/or high replenishment rate of fresh seawater to the marine basin. The paleogeographic setting of the Lower Cambrian continental margin of the Yangtze craton indicates local basins controlled by synsedimentary rifting. Stagnant water episodically replenished by upwelling oxidized seawater is thought to be responsible for the formation of the polymetallic sulfide layer and of phosphorite, barite, and sapropelic "stone coal" (combustible black shale) beds.