Mass Independent Fractionation of Hg Isotopes in Earth History

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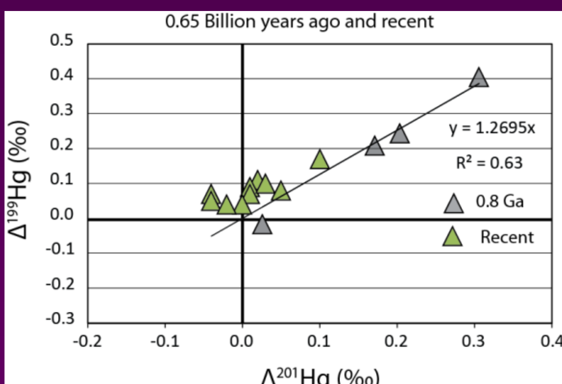
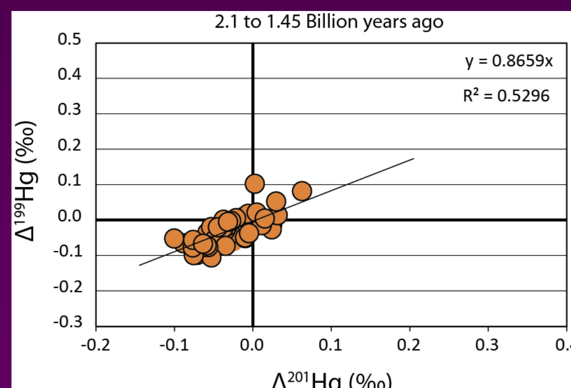
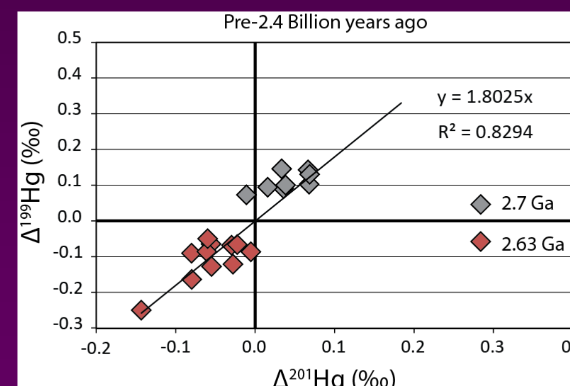
Mercury is one of only three elements (along with O and S) known to produce significant mass independent fractionation (MIF) of its stable isotopes. Specifically, the odd isotopes ^{199}Hg and ^{201}Hg fractionate from the even-numbered isotopes in ways that do not follow usual mass fractionation laws (expressed as D^{199}Hg and D^{199}Hg, where non-zero values indicate MIF). Like for O and S, Hg MIF is driven by photochemical reactions. As such, it is sensitive to the optical depth of ozone, and hence to the concentration of O_2 in the atmosphere. Therefore, we predicted that Hg MIF might be a useful new tool to track the progress oxygenation of Earth's surface environment during the Precambrian. We have survey a suite of ancient black shales to test this hypothesis.







Our preliminary results show a clear evolution in the style and magnitude of Hg MIF fractionation preserved in ancient black shales. Specifically, the slope D^{199}Hg versus D^{199}Hg has changed through time, with a prominent shift spanning the ca. 2.4 Ga Great Oxidation Event. Samples from the late Neoproterozoic show a similar pattern in MIF to recent samples. Although these data appear to reveal a progressive evolution in the style of MIF Hg fractionation, it is not yet clear how these changes related to evolving atmospheric O_2 concentrations.