

Patterns of selenium isotope variability within and among Phanerozoic black shales

MICHAEL A. KIPP^{1,2}, THOMAS J. ALGEO³, ROGER BUICK^{1,2}

¹Department of Earth & Space Sciences, University of Washington, Seattle, WA, USA (kipp@uw.edu)

²Virtual Planetary Laboratory, NASA Nexus for Exoplanet System Science, Seattle, WA, USA

³Department of Geology, University of Cincinnati, Cincinnati, OH, USA

The selenium (Se) isotope system is emerging as a proxy for detecting oxygen fluctuations at high redox potential in ancient marine environments. Since the early exploration of this system as a paleo-environmental proxy (Mitchell et al. 2012) many studies have refined analytical methods for Se isotope analysis (Stüeken et al. 2013; von Strandmann et al. 2014; Kurzawa et al. 2017) and applied this proxy to major events in Earth's history (Stüeken et al. 2015a,b; von Strandmann et al. 2015; Kipp et al. 2017). Despite these advances, there remain large gaps in our understanding of Se isotope systematics in both modern and ancient marine sediments. These uncertainties currently limit ancient Se isotope studies to searches for broad, first-order trends and preclude nuanced paleo-redox interpretations.

In order to expand the utility of the Se paleo-redox proxy, we conducted a systematic survey of Se enrichment and isotopic fractionation in various anoxic black shales deposited during the Phanerozoic. We assembled a database of ~200 Se measurements and supplemented these with 68 new analyses of Paleozoic black shales from North America. We then examined other published trace metal datasets from these same sample archives to compare with the behavior of the Se paleo-redox proxy in ancient marine settings.

We find that interpretations of Se data can benefit from the additional context provided complementary trace metal datasets. In particular, recognition of water-mass restriction, intensity of anoxia/euxinia, and redox thresholds revealed by trace-metal co-variation can all shed light on the controls on Se enrichment and isotopic fractionation in anoxic marine environments. We present a synthesis of these findings and discuss a way forward for this young proxy.

References: Kipp et al. (2017) *PNAS*, Kurzawa et al. (2017) *Chem Geol*, Mitchell et al. (2012) *GCA*, Stüeken et al. (2013) *JAAS*, Stüeken et al. (2015a) *Geology*, Stüeken et al. (2015b) *Chem Geol*, von Strandmann et al. (2014) *JAAS*, von Strandmann et al. (2015) *Nat Comm*