Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.13318

The Planetary-Scale Geochemical Cycle. 2022 Urey Medal Talk

PROF. WILLIAM M. WHITE, PHD

Dept. of Earth & Atmospheric Sciences Snee Hall

Presenting Author: wmw4@cornell.edu

Geochemists have known for centuries that many elements cycle through the atmosphere, biota, rivers, oceans, and rocks at the Earth's surface. Over the last five decades, isotope geochemists have demonstrated that these cycles can extend through the entire silicate Earth to the base of the mantle. Armstrong [1] proposed that sediments could be “dragged” into the mantle and then returned to the crust as “juvenile appearing volcanics”. Hofmann and White [2] proposed that subducted oceanic crust and sediment explained the isotopic difference between MORB and OIB produced by mantle plumes. Meanwhile, analysis of rare gases isotopes suggested that OIB carried a primitive component from the deep mantle[3], and it became clear that OIB came in distinctive isotopic flavors. Plumes were controversial then, but seismologists eventually confirmed them and tied their origin to seismic anomalies at the base of the mantle.

The radiogenic isotope evidence alone is equivocal, but significant variations in stable isotope ratios can only be produced at or near the surface of the Earth. Hints of a recycled component in the Earth's mantle from oxygen, hydrogen, and carbon isotope ratios emerged early[4] and continued to trickle out over the subsequent two decades. Over the last two decades, that trickle has become a flood as stable isotope geochemistry has expanded to the entire periodic table. Isotopic variations in elements from Li to U show that the mantle has been extensively polluted by material from the Earth's surface. These variations are not restricted to OIB but can also occur in MORB, indicating the entire mantle has been polluted by material from the Earth's surface.

This raises big questions that remain incompletely answered. Is this planetary-scale cycle in steady-state? Some studies[5], for example, suggest not and instead that the Earth's surface is losing water, N, and C to the mantle.

[1] Armstrong, R.L. (1968). *Rev. Geophys*., 6: 175

[2] Hofmann, A.W. & White, W.M. (1982). *EPSL*, 57: 421.

[3] Kurz *et al.* (1982) *EPSL*, 58:1

[4] Javoy, M. et al. (1982) *Nature,* 300: 171.

[5] Bekaert *et al.* (2021) *Ann. Rev. Earth & Plane. Sci*, 49: 37.