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# The Revolutionary Role of Re-Os in Reviewing Earth's Sedimentary Record

Holly Stein (1,2), Judith Hannah (1,2), Svetoslav Georgiev (1), Vineet Goswami (1), and Gang Yang (1)

(1) AIRIE Program-Colorado State University, Fort Collins, CO, USA (holly.stein@colostate.edu), (2) University of Oslo, Geosciences, Oslo, Norway

Re-Os geochronology of organic-rich sediments directly dates an integral component of the sedimentatary record – the sedimentary rocks that contain the fossils and chemical proxies that define biostratigraphy, chemostratigraphy, and paleoenviornment. An emerging technology fifteen years ago, Re-Os isotope geochemistry has gone mainstream as a tool for stratigraphic integration and correlation. Age information and use of Os isotopes as a tracer give timelines and paleoenvironmental proxies for major perturbations of climate and/or biogeochemical cycles, commonly brought on by unique paleogeographic configurations and tectonic changes. Re-Os isotope geochemistry in combination with other paleoenvironmental proxies can document precisely when and where specific events occurred in Earth history.

Biostratigraphic changes mark points in the record of geologic time. Absolute ages associated with those points are provided by either direct radiometric ages or astrochronology. Radiometric ages fall principally into two groups: (1) U-Pb ages (mostly zircons) in tuffs within the sedimentary record or datable mineral phases in cross-cutting igneous rocks, and (2) Re-Os ages for organic-rich sedimentary rocks or syn-sedimentary sulfides (e.g., framboidal pyrite), or cross-cutting sulfide-bearing veins or dikes.

Stage and Period boundaries are defined by profound change – a hiatus in progressive evolution, a major extinction event, and/or an intense catastrophic event. In short, by providing a radiometric age for a stage boundary (as defined by, for example, a GSSP) we are dating a critical event in Earth history.

Glacial epochs, including Snowball Earth events, can also be disentangled by Re-Os dating of bracketing organic-rich shales. Episodic freeze-thaw of watersheds and massive meltwater outflows produce chaotic fluctuation in the isotopic composition of Os entering the oceans. This may lead to loss of precision in dating, but at the same time highlights the paleoenvironmental record for earth-altering surficial events.

Re-Os also informs oceanographic and climatologic histories. The Os seawater curve reflects relative inputs from continental weathering and oceanic hydrothermal systems. As such, it reflects hypsometry (the amount of continental freeboard), the volume of the ocean basins (controlled by the length and elevation of mid-ocean ridges), average elevation of continental crust, and the climatic regime controlling the chemical and mechanical weathering of the continents. Short-term perturbations may be caused by major bolide impacts or significant meteor showers. We also consider the possibility of "catastrophic" (i.e. not uniformitarianism) mantle overturn events that might impact crustal or surface reservoirs.

Thus, Re-Os geochronology, when combined with other chronostratigraphic tools from diverse geologic subdisciplines, draws together lithostratigraphy, biostratigraphy, chemostratigraphy, cyclostratigraphy and magnetostratigraphy under one unifying umbrella.