Goldschmidt 2023 Abstract
https://doi.org/10.7185/gold2023.20066

# Temporal evolution of the upper continental crust from glacial diamictites: evidence for co-evolving crustal and atmospheric compositions - *V.M. Goldschmidt Medal Lecture*

**ROBERTA RUDNICK**

University of California, Santa Barbara

Presenting Author: rudnick@geol.ucsb.edu

For the past decade, we (the author and many, many collaborators) have been using the chemical composition of the fine-grained matrix of glacial diamcitites, deposited between 2.96 Ga and 300 Ma to investigate the compositional evolution of the upper continental crust over time. Although the idea of using glacial deposits to obtain an average crustal composition originated with Goldschmidt, little work had previously been done on such deposits. We generated composites of 24 formations where multiple samples were collected. These included over 120 individual samples from outcrops and/or drill cores. The samples have been analyzed for their mineralogy via X-ray diffraction, major- and trace-element concentrations (including complete halogens, and platinum-group elements -- PGE), U-Pb dates and Hf isotopes in detrital zircon, and a wide array of isotope systems, both radiogenic (Nd, $^{182}$W, Os, Pb) and stable (H, Li, N, O, Si, S, K, Ca, Ti, V, Cr, Fe, Ni, Zr, Mo, Ba, U). Two signals dominate: a) chemical weathering, which largely originates from the provenance (weathered regolith scraped off by the glaciers), and b) a change in the bulk composition of the upper continental crust over time. Mesoarchean samples show evidence of strong chemical weathering in an anoxic environment where redox-sensitive elements such as V, Mo and U were present in their reduced and insolbule forms, and therefore were retained in the weathered regolith. These elements become systematically depleted from the Paleoproterozoic onwards due to the rise of atmospheric oxygen. The second clear signal, seen in Ni/Co ratios, PGE and Cu concentrations and V isotopes is a change from a provenance dominated by mafic rocks in the Archean, to felsic rocks post-Archean. This signal is not due simply to the greater proportion of komatiite in the Archean, but requires a large proportion of basalt to be present.

Collectively, the diamictites record a changing Earth from a largely mafic and highly weathered UCC in the Archean, to more evolved crust since the Paleoproterozoic. These chemical changes may have impacted nutrient fluxes to the oceans and atmospheric $O_2$ content.