Goldschmidt 2022 Abstract
https://doi.org/10.46427/gold2022.13251

Evidence for Phanerozoic Crustal Oxidation from the Evolution of Manganese Minerals

DANIEL R HUMMER[1], JOSHUA J GOLDEN[2], GRETHE HYSTAD[3], ROBERT T DOWNS[2], AHMED ELEISH[4], CHAO LIU[5], JOLYON RALPH[6], SHAUNNA M MORRISON[5], MICHAEL B MEYER[7] AND ROBERT M HAZEN[5]

[1]Southern Illinois University
[2]University of Arizona
[3]Purdue University Northwest
[4]Rensselaer Polytechnic Institute
[5]Carnegie Institution for Science
[6]Mindat.org
[7]Harrisburg University

Presenting Author: daniel.hummer@siu.edu

Changes in crustal redox state are critical to understanding Earth's evolution. An especially important gap in our understanding is the timing and mechanisms of redox changes between the crust, mantle, and atmosphere. However, very few methods exist for evaluating spatially averaged crustal redox state through time. Manganese (Mn) is a redox-sensitive metal whose variable oxidation states and abundance in crustal minerals make it a useful tracer of crustal oxidation. We used a database of 560 IMA-approved manganese-bearing mineral species and 2666 data pairs of their localities and geologic ages to trace the redox behavior of Mn mineralization through geologic time. We find that the average oxidation state of crustal Mn occurrences has systematically risen in the last 1 billion years in response to atmospheric oxygenation following a 66 ± 1 million-year time lag. We interpret this lag as the average time necessary to equilibrate the shallow crust to atmospheric oxygen fugacity. This study employs large mineralogical databases to evaluate geochemical conditions through Earth's history, and we propose that this and other mineral data sets form an important class of proxies that constrain the evolving redox state of various Earth reservoirs.