Diagenesis is not a Dirty Word

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Understanding the diagenetic processes that lead to the preservation (or alteration) of isotopic signals in sedimentary rocks is a major challenge for geochemists. This is a long-standing problem even for well-developed proxies, but it can represent a particularly imposing or potentially insurmountable challenge for proxies in the early stages of development. This challenge is exacerbated by a widespread bias toward regarding diagenesis as a process that alters or ruins paleorecords, rather than the systematic process of signal incorporation into sediments. In many cases, the merely mentioning "diagenesis" seems to taint the discussion, making forward progress difficult or impossible.

Here, we review recent efforts to better understand the behavior of redox-sensitive trace elements in the pore waters of marine sediments, changes during later stage burial diagenesis, and alteration during subsequent uplift and exposure. Compared to other proxies, redox-sensitive metals are particularly sensitive to porewater redox conditions including the presence of oxygen and hydrogen sulfide. Better understanding of these processes through laboratory and field analog studies serves to better inform and strengthen the application of these proxies in the geologic record.

Based on our recent experience developing the $\delta^{238}U$ carbonate paleoredox proxy, we will discuss strategies for proxy validation which are informed rather than hampered by diagenetic concerns. Chief among these strategies is the examination of multiple widely-spaced sections from well-characterized periods in Earth's past. Although "global" isotopic proxies should be nearly identical in contemporaneous sediments from around the world, formal intercomparison and validation studies have been rare. While resource-intensive, we argue that this type of validation is a fruitful and cost-effective strategy for rapidly assessing the validity of emerging proxies.