

Concretions: Chronicles of Diagenesis from Earth to Mars

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There is an amazing array of concretions throughout the sedimentary record of Earth, and now iron oxide examples (“blueberries”) have been found in several regions of Mars. Two questions address the current state of knowledge on these cemented mineral masses as well as coloration patterns. Collectively the authigenic cements and patterns chronicle past diagenetic conditions, particularly in clastic rocks.

What do we know? Concretions occur in many sizes, spanning three orders of magnitude (mm, cm, and m scales). Spheroidal forms are most common, as a minimum free energy shape dominated by diffusive processes. There are multiple cement mineralogies even within single concretions, reflecting different water compositions in open systems. Other concretionary geometries can be affected by primary textures such as bedding, grain size, and porosity/permeability, or later textures such as fractures, joints, and faults. Iron cycling is readily apparent where visual coloration patterns indicate histories of early iron reddening, secondary bleaching (removal of iron), and iron replacement or reprecipitation. Interfingering colors may indicate a possible interface of immiscible fluids.

What don’ t we know? Non-unique pathways or processes may produce similar-looking end products. Thus, it can be difficult to determine exact histories, as well as the fluid compositions and environmental conditions that initiate concretion formation, particularly if an obvious nucleus is lacking. Microbial life may enhance nucleation and precipitation, and geochemical gradients are potential places to search for biosignatures. Timing and events are mostly relative relationships in these open systems, but newer developments in U-Th/He dating may provide age constraints for iron oxide cements. Continued explorations, field studies, modeling approaches, analytical advances, and instrument precision will enlighten our understanding on the diagenetic histories of both Earth and Mars.

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