

Diagenetic features in Yellowknife Bay, Gale Crater, Mars: implications for substrate rheology and potential gas release

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Multiple diagenetic features have been observed in clay-bearing mudstone exposed within Yellowknife Bay, Gale Crater, Mars. These features occurred during at least two separate episodes: an early generation of spheroidal concretions that co-occur with a dense networks of mineralized fractures, and a later generation of mineralized veins.

Concretions consist of mm-sized spheroids (0.4 to 8.0 mm, mean diameter of 1.2 mm) that are distinctly more resistant than the encompassing mudstone. Dissected spheroids suggest an origin via compaction and incipient lithification of the substrate at the perimeter of syndepositional void space. Concretions are generally patchy in their distribution within clay-bearing mudstone, but in places can be the dominant fabric element. Locally dense networks of mineralized fractures occur in regions of low concretion abundance. These consist of short (< 50 cm), curvilinear to planar mineralized voids that occur across a range of orientations from vertical to subhorizontal. Fractures are filled by multi-phase cement consisting of two isopachous, erosionally resistant outer bands, and a central less resistant fill. Physical relationships suggests that original fractures may have formed as both interconnected voids and as discrete cross-cutting features.

Co-occurrence of early diagenetic concretions and fracture networks suggests a common origin via gas release within a subaqueous, shallow substrate. We suggest that gas release within weakly cohesive subsurface sediments resulted in substrate dewatering and an increase in the cohesive strength of the substrate. Local differences in substrate strength and rate of gas production would have result in formation of either discrete voids or fracture networks.

A second generation of mineralized veins is characterized by a regionally low spatial density, predominantly vertical or horizontal orientations, and a single phase of Ca-sulfate mineral fill. These veins cross-cut the early diagenetic elements and intersect a greater thickness of stratigraphy within Yellowknife Bay, suggesting a later-diagenetic origin via hydraulic fracturing.