PALEOPROTEROZOIC STARK FORMATION, ATHAPUSCOW BASIN, NORTHWEST CANADA: RECORD OF CRATONIC-SCALE SALINITY CRISIS

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ABSTRACT: The Paleoproterozoic Stark Formation, a thick breccia unit, formed during the transition from marine to non-marine foreland basin fill in the Athapuscow Basin, Northwest Territories, Canada. Four types of breccia occur in the Stark Formation: (1) bedded breccias at the base of the unit, overlying the basinal facies of the underlying Pethei Group, are interpreted as debris flows, (2) massive chaotic breccias occur in the lower part of the Stark Formation throughout the basin and these are interpreted to be evaporite-collapse breccias; (3) siltstone and mudstone breccia occurs in the upper part of the Stark Formation and is also interpreted as evaporite collapse breccia, though much less evaporite was involved in its formation than the underlying chaotic breccia; and (4) laminar accretionary breccia consisting of laminar carbonate clasts, commonly with flat bottoms and convex-up upper surface geometries; these clasts occur in lenticular pods and are interpreted to form in caves following dissolution of evaporites or carbonates.

The widespread presence and abundance of evaporite pseudomorphs (especially halite) in all breccia types, the stratigraphic restriction of the Stark Formation, and irregular filling above this unit indicates that all but the bedded breccia formed by the dissolution and collapse of evaporites. Chaotic breccia directly above underlying Pethei Group shallow-water and deep-water carbonates indicates the evaporates formed across the platform and adjacent deep basin. Foundered megaclasts (up to 1.5 km long and 40 m thick) in basinal settings suggest cumulative evaporite thicknesses on the order of a few tens to a few hundreds of meters. Carbonate clasts in all the breccias contain abundant wave ripples, planar laminations, stromatolites, and ooids. These structures along with a paucity of subaerial exposure features indicates nearly all carbonate deposition in the Stark was subaqueous. Thus, by inference the evaporites in the Stark Formation were also partially subaqueous.

Displacive halite pseudomorphs are common throughout all facies in the Stark Formation. Silicified and dolomite-filled halite pseudomorphs are common along the contact between the evaporite-collapse breccia and underlying carbonate platform (Pethei Group) and surrounding large clasts in basinal settings. Silicified hopper crystal casts within deep-water rhythmites of the uppermost Pethei Group indicate precipitation of halite over deep waters. Gypsum pseudomorphs are exceedingly rare, and anhydrite pseudomorphs were not observed. The dominance of halite features in this basin and two penecontemporaneous basins (Kilihigok Basin and Wopmay Orogen) surrounding the Slave Craton suggests that, relative to the present day, seawater at ~ 1.9 to 1.8 Ga was oversaturated with respect to calcium carbonate, had higher HCO_3^{--} concentration, and possibly was depleted in SO_4^{2--}. The dearth of extensive, thick-bedded marine gypsum in the Archean and early Paleoproterozoic can be explained by low atmospheric oxygen content prior to ~ 2 Ga in conjunction with increased carbonate saturation before ~ 1.6 Ga.