TEXTURAL CHARACTERISTICS OF SPHEROIDAL IRON OXIDE CONCRETIONS: TERRESTRIAL ANALOGUES FOR MARS. Sally L. Potter and Marjorie A. Chan, University of Utah- Department of Geology & Geophysics, 135 S. 1460 E. Room 719, Salt Lake City, UT 84112.

Introduction: The Jurassic Navajo Sandstone contains a large variety of spheroidal concretions due to the porous and permeable nature of this eolian unit [1]. The Navajo Sandstone is well exposed and widespread throughout southern Utah and Northern Arizona. Established geochemical and paleo-fluid flow models for the spectacular coloration and iron oxide concretion formation in the Navajo Sandstone [1, 2, 3, 4] set the framework for the description and classification of the variations of spheroidal iron oxide (primarily hematite and goethite) concretions presented here.

Discussion: Spheroidal concretions in the Navajo Sandstone range in size from ~ 1 mm to 12+ cm in diameter. Size appears to be related to factors such as reactant supply and amount of time for growth. Some concretions show evidence of multiple fluid flow episodes and/or a nucleation phenomenon where large concretions form from the coalescing of smaller concretions. Although many concretions are spheroidal, some are "flying saucer-shaped" or modified from a perfectly spherical form where there are anisotropies related to primary textures such as grain size, lamination/bedding or the amount of iron oxide cement in pore spaces.

Classification is herein based on internal structure, which is likely related to formation (genetic) processes, rather than characteristics like size which may be dependent on reactant supply, or shape which may be dependent on anisotropies in the host rock. Three major classes of spheroidal iron oxide concretions are herein proposed, based on Navajo Sandstone examples: rind, layered and solid.

Rind. Rind concretions typically exhibit a thin (<1 mm) to thick (up to 1 cm) spheroidal rim of iron oxide cement [5] that nearly or completely occludes the pore space (Fig. 1). Some rind concretions display an interior iron oxide cemented ridge that bisects the concretion (Fig 1B). Exteriors can be smooth (even and well cemented) to rough (weakly cemented), or bumpy like an avocado skin (possibly coalesced smaller concretions).

The interiors of rind concretions are commonly depleted in cement and are friable, containing only traces (< ~5%) of iron oxide cement. Some concretion interiors show iron oxide coloration along bedding planes near the rinds oriented along lamina (Fig. 1C). In rare instances, possible remnants of nuclei are present which may represent a preexisting mineral(s) consumed in chemical reactions, and diffusive coloration toward the rinds may exist depending on the amount or stage of completion of chemical reactions (Fig. 1D).

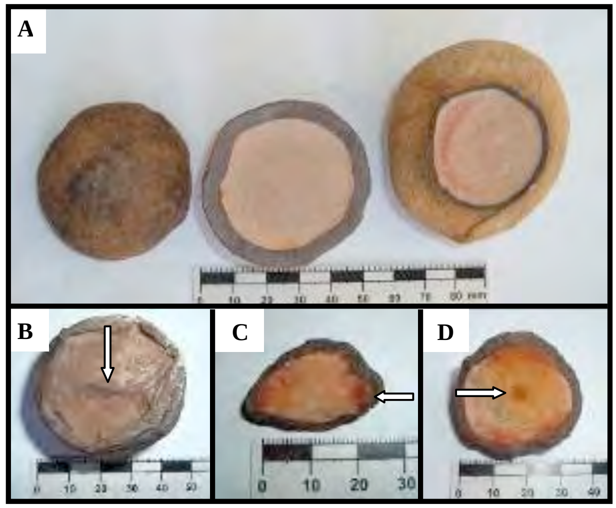

Figure 1. Rind concretions (scale in mm) A. Rind concretions with thin and thick rinds. Exterior (left) and interior (middle and right) of concretions are shown. B. Rind concretion with bisecting ridge (arrow). C. "Flying saucer"- shaped rind concretion with diffusive coloration along lamina (arrow). D. Rind concretion with a possible nucleus (arrow) partly altered or consumed in chemical reaction.

Layered. Layered concretions have ≥2 concentric shells formed from iron oxide cementation, where the inner shells are typically thin, but the outer rind may be slightly thicker. Typically, pore space is completely occluded with iron oxide cement within the concentric shell layers. These shells, resembling layers of an onion, can persist throughout the concretion or the concretion can have an interior similar to rind concretions (Fig. 2A). Some larger concretions exhibit small bulbous inward digitate cementations that slightly resemble geode growth (Fig. 2B).

Solid. Solid concretions are typically <1.5 cm diameter spherules (Fig. 3A) though variants exist. The entire concretion is solid with iron oxide cement and although generally solid concretions are preferentially resistant to weathering, cementation does not completely occlude pore space. In some solid concretions, a faint, thick rind (distinguishable by color) is visible; however, the center is not depleted of iron oxide (Fig. 3B).

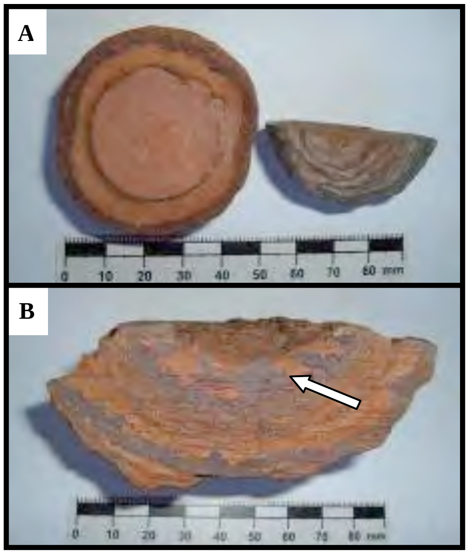

Figure 2. Layered concretions. A. Double (left) and multiple (right) layers. B. Bulbous inward digitations (arrow).

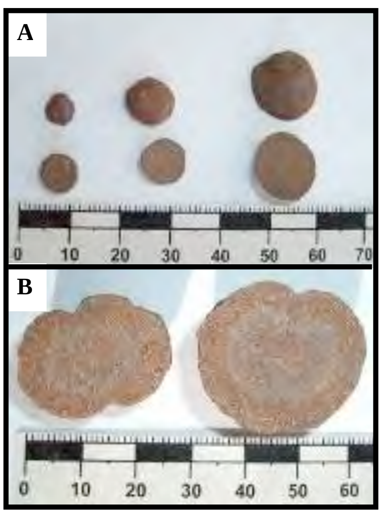

Figure 3. Solid concretions and variants. (scale in mm) A. Solid concretions in varying sizes. Exterior (top row) and interior (bottom row) of each concretion is shown. B. Larger solid concretions (doublets) with faintly visible rinds.

Conclusion: Spheroidal iron oxide concretions in the Navajo Sandstone can be classified according to internal structure, which is related to formation processes and reactant supply. The three classifications of concretion described herein may represent end members. Variants and combinations of these end members may represent different stages in the concretion formation process.

Iron oxide concretions in the Navajo Sandstone are similar to Mars "blueberries" in characteristics including mineralogy, formation by diagenetic fluid flow in a porous, permeable media, self-organizing spacing in the host rock, resistance to weathering creating "pools" of concretions collected in topographic lows, geometric and possible textural similarities.

Continuing terrestrial research in the Navajo Sandstone will help to better understand the formation processes of iron oxide concretions, which will illuminate similar processes and possible variations on Mars. The quest to understand the concretions on Mars, which may have a simpler diagenetic history, might in turn provide insights to help unravel the mysteries of the Navajo concretions.

References: [1] Chan et al. (2005) GSA Today 15, no. 8, 4-10 [2] Chan et al. (2006) Proposal for NASA Grant, unpublished [3] Beitler et al.(2003) Geology December, 1041-1044 [4] Parry et al. (2004) AAPG Bulletin 88, no. 2, 175-191 [5] Beitler et al. (2004) Instruments, Methods, and Missions for Astrobiology VIII, 162-169

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