

DETECTING HYDRAULIC AND BIOLOGICAL SORTING OF HEAVY MINERALS IN SANDSTONES.

Harsh Jay Patel¹, Jian Gong¹ and Michael M. Tice¹, ¹Department of Geology & Geophysics, Texas A&M University, College Station, Texas 77843 USA; mailto: harsh.patel_1993@email.tamu.edu, gojian@gmail.com, mtice@geos.tamu.edu.

Introduction: The Mars 2020 mission rover will include as part of its instrument payload PIXL, an X-ray fluorescence instrument capable of scanning at $\sim 150\ \mu\text{m}$ resolution surfaces over $\sim 1\ \text{cm}^2$. This capability enables investigation of potential biosignatures based on the physical distributions of minerals and elements. Previous observations of naturally occurring microbial mats indicate that they tend to concentrate heavy minerals on their surfaces, although the mechanisms of these grain sorting are unclear [1]. In order to evaluate the usefulness of heavy mineral sorting patterns as a biosignatures supporting other textural or morphological lines of evidence for the past presence of microbial mats, we use benchtop μXRF mapping to compare the distributions of heavy minerals in physical sedimentary structures with those in fossil microbial mats preserved in 3.22 Ga sandstones of the Moodies Group (Barberton greenstone belt, South Africa).

Results and Discussion: The best understood mechanisms sorting heavy minerals in nature are associated with aeolian, hydraulic, and glacial processes. Most effective segregation of heavy and light mineral results from a combination of two or more sorting processes including a) differential entrainment of grains by moving fluids, b) differential settling of grains through fluids, and c) differential transport of grains in granular flows [2]. Thus, heavy mineral grains such as zircon and rutile are commonly concentrated at the bases of laminated cross-sets and along the lower surfaces of cross-laminae in sandstones (Fig. 1A).

Sorting due to biological processes, on the other hand, may be caused by differential mat trapping and binding of sediment [1] or preferential shadowing of small heavy mineral grains on the tops of mats having surface roughnesses close to the diameters of the grains [3]. In addition, recent experiments show that movements of groups of bacteria across the sediment surface can sort sediments (J. Gong, unpublished data). Such processes result in heavy-mineral-lined laminations in sandstones without cross laminations (Fig. 1B).

Determining the roles of such processes in producing texturally distinct heavy mineral deposits will enable detailed interpretation of sedimentary and biological contributions to the formation of layering in sandstones. Geochemical imaging by μXRF , either by benchtop devices on Earth or by PIXL on Mars, enables in situ identification of these patterns, and could

be a valuable tool for interpreting the biological and physical origins of siliciclastic sedimentary deposits.

References: [1] Gerdes, G. et al. (2000) *Sedimentology*, 47, 279-308. [2] Slingerland, R. (1984) *J. Sed. Pet.*, 54, 0137-0150. [3] Tice, M. M. et al. (2011) *Ann. Rev. Earth Plan. Sci.*, 39, 297-319.

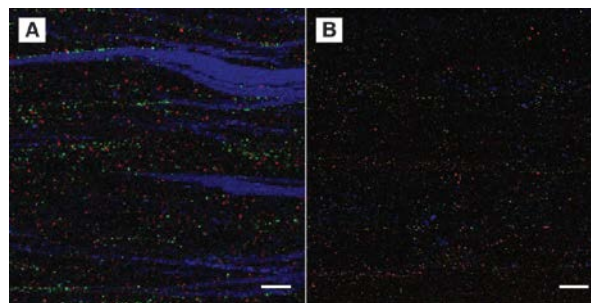


Figure 1: 100 $\mu\text{m}/\text{pixel}$ resolution μXRF fluorescence maps (5.12 cm x 5.12 cm) of hydraulically (A) and biologically sorted (B) heavy minerals, respectively. Color code: Red [Ti], Green [Zr] and Blue [Fe]. All scale bars = 5 mm.