ELEMENTAL DISTRIBUTIONS PRODUCED BY SORTING IN SILICICLASTIC SEDIMENTS: POTENTIAL FOR PROCESS INTERPRETATION. M. M. Tice[1], [1]Department of Geology & Geophysics, Texas A&M University, 3115 TAMU, College Station, Texas, 77843, tice@geo.tamu.edu.

Introduction: Some enrichments and depletions of elements associated with heavy minerals in Martian rocks and soils observed by lander alpha particle x-ray spectrometers (APXS) probably resulted from transport sorting [1]. Since many heavy minerals are composed of elements that are only trace components in most major rock-forming minerals (e.g. Ti in rutile, anatase, ilmenite, titanomagnetite, etc.; Zr in zircon; Fe in ilmenite, magnetite, titanomagnetite, hematite, etc.), transport-induced fractionations can be reflected in sediment elemental composition [2]. Moreover, sorting can produce heavy mineral enrichments or depletions lining laminations in a variety of sedimentary deposits [e.g. 3-6].

However, most compositional data for siliciclastic rocks are collected from relatively homogeneous material in order to infer source terrains or alteration processes. It is possible that patterns of spatial variability in rock composition arising from sorting processes could be used to infer information about transport and deposition supplementary to descriptions of sedimentary structures or physical grading. Compositional data could be particularly significant in rocks for which these traditional descriptions are difficult to obtain, especially fine-grained sedimentary rocks.

In order to investigate spatial patterns associated with elemental sorting produced by specific depositional processes, the distributions of compositionally distinctive heavy mineral grains were mapped in sandstone, siltstone, and mudstone slabs by x-ray fluorescence microscopy over areas up to 10 cm × 10 cm at 10 μm and 100 μm resolution. Samples included turbiditic sandstones and siltstones of the Brushy Canyon Formation (Middle Permian), deltaic interbedded sandstones and mudstones of the Fall River Formation (Cretaceous), and fluvial cross-laminated sandstones of the Bluejacket Sandstone (Middle Pennsylvanian).

Results and Interpretations: Massive/normally graded turbiditic sandstones (Bouma A divisions), although typically exhibiting size grading only toward to their tops, show characteristic upward decreasing Zr and Ti abundances throughout. This suggests that gradients in the abundances of both elements within individual beds may be useful for identifying the deposits of waning flows, even where physical grading is difficult to detect or absent. Ti abundances are maximum in finely laminated siltstones at turbidite tops (Bouma D divisions), suggesting an additional, hydraulically fine phase for Ti in these rocks.

Mudstone beds are enriched in Fe, Ti, and Al. Cross-laminations in all samples are marked by enrichments of Zr, Zr + Ti, Ti + Fe, or Fe + Al, probably reflecting shielding of small or flat grains by larger light mineral grains in separation bubbles on the lee sides of migrating ripples (Fig. 1) [5]. These elemental associations are consistent with overall grading patterns observed in turbidites and suggest that, in sediments with similar heavy mineral assemblages, elements are sorted from heaviest to lightest in the order Zr, Ti, Fe/Ti, and Al. Boundaries between cross sets are enriched in Zr, Ti, or both, reflecting trapping of the densest grains in the troughs of migrating ripples.

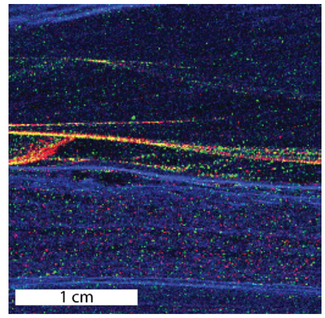

Figure 1. False-color map of Zr (red), Ti (green), and Fe (blue) in cross-laminated sandstone (Brushy Canyon Formation). Note sorting into characteristic assemblages of Zr, Zr + Ti, Fe + Ti, and Fe.

Conclusions: Spatial distributions of Zr, Ti, and Fe in sandstones, siltstones, and mudstones deposited in a variety of environments show consistent patterns of sorting reflecting shear velocities of the depositing flows. Current research is exploring the utility of this data for distinguishing between wind- and water-transported deposits and for quantitatively estimating such flow properties as shear velocity, volumetric sediment concentration, etc. These results may have application to interpreting physical sedimentary features on Mars by careful selection of APXS measurement spots, particularly if extended to different tectonic settings or basins with more mafic source terrains.

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