GROUND TRUTHING ORBITAL LAYER BOUNDARIES IN SITU ALONG CURIOSITY'S TRAVERSE: MARKERS OF CHANGE IN SEDIMENTARY TEXTURES, DIAGENESIS, BOTH, OR NEITHER? M. J. Meyer[1], R. E. Milliken[1], and Kathryn M. Stack[2]. [1]Dept. Earth, Env., and Planetary Sciences, Brown University, Providence, RI 02912, [2]Jet Propulsion Laboratory, Caltech, Pasadena, CA 91109, melissa_meyer@brown.edu.

Introduction: Mars retains a sizable sedimentary rock record that likely preserves evidence of the ancient environmental changes that occurred in the planet's early history [1-4]. Orbital-scale studies of Martian sedimentary rocks often identify layer boundaries which—when assumed to represent primary bedding or erosional surfaces—enables further dip and regional stratigraphic architectural assessments [e.g.,5-10]. These types of first-order analyses from orbital datasets play an essential role in developing broad scientific hypotheses and justifying further *in situ* rover exploration and ground-based stratigraphic mapping of a geologic region. Indeed, such assessments [e.g.,5,6] provide a foundational road map for Curiosity rover's exploration of lower Mount Sharp, a ~5 km thick sequence of layered rocks infilling Gale crater that have thus far been recognized as sedimentary in origin [11-14]. From orbit, this sedimentary rock succession is visibly stratified and seemingly significant layer boundaries can often be traced laterally over several kilometers [5].

A key result from the Curiosity rover team is the recognition that some geologic unit boundaries identified via ground-based stratigraphic mapping may be partially or wholly discordant with layer boundaries mappable in orbital-scale datasets [13]. This finding raises questions about the commonly made assumption that orbital-scale layer boundaries represent primary bedding surfaces and that variations in orbital-scale properties (i.e., albedo, erosion resistance, texture) result from variations in primary depositional processes. Alternatively, variations in these orbital-scale properties may instead be reflections of the differential diagenetic processes that have been extensively documented along Curiosity's traverse [e.g., 15-20]. After almost a decade of exploration by Curiosity, these origin scenarios are now testable by comparing *in situ* and orbital observations. Here we present initial results for ongoing work that is aimed at addressing the following questions: (1) How many and which of the layer boundaries mappable from orbital-scale images can be attributed to changes either in primary sedimentary processes (as evidenced by changes in sedimentary textures and/or bedrock chemistries), early/late diagenetic processes (as evidence by changes in diagenetic textures and/or chemistries), or both? (2) To what degree is mapping layer boundaries from orbit geologically meaningful?

Methods: *Identification of Layer Boundaries.* Layer boundaries are mapped at the highest available orbital image resolution as shapelines within a three-dimensional ArcGIS Pro scene using the Mars MSL Gale orthophoto mosaic basemap (~25 cm per pixel resolution) draped on the associated DEM [21]. Orbital layer boundaries are identified based on changes in topographic slope, relative albedo, and/or surface texture across each boundary. This mapping is completed independent of ground-based mapping efforts.

Classification and Lithologic Description of ChemCam (CCAM) Targets. We analyzed standard elemental measurements and associated RMI, MAHLI, and Mastcam images for each of the most recent CCAM LIBS targets (sol 2600 to present, ~500 targets, ~4,800 individual LIBS observations). Standard elemental abundances (Si, Ti, Al, Fe, Mg, Ca, Na, and K) reported by the CCAM team for each individual LIBS observation

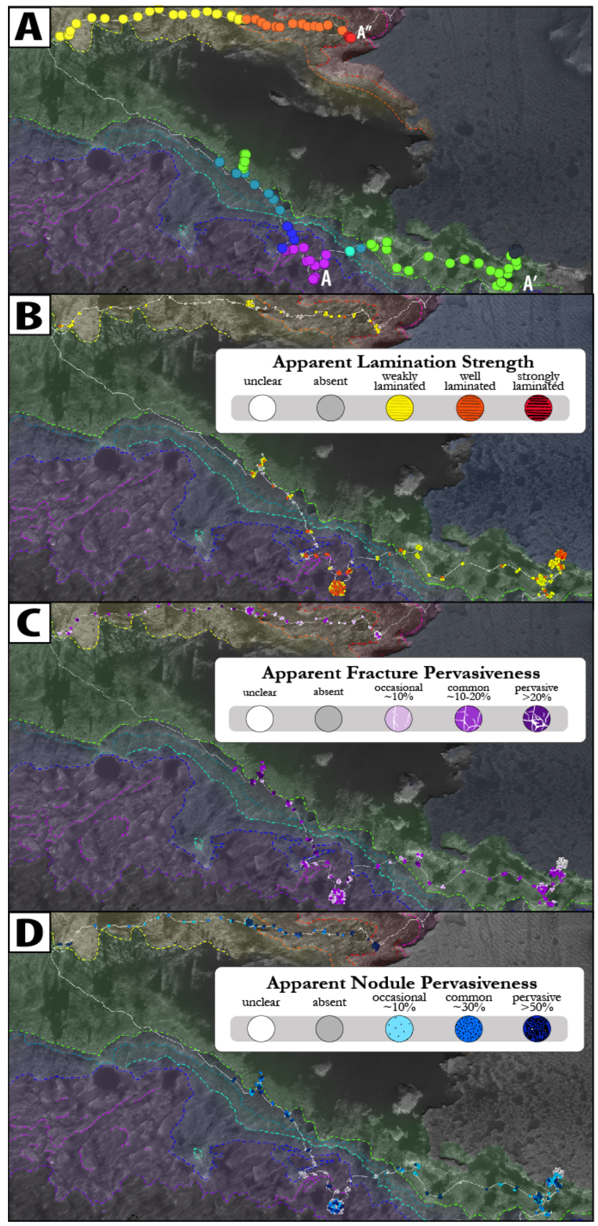

Fig. 1: (A). CCAM LIBS targets colored by location between mapped orbital layer boundaries (dashed colored lines). **(B). - (D).** Selected CCAM LIBS target descriptions, dispersed for clarity.

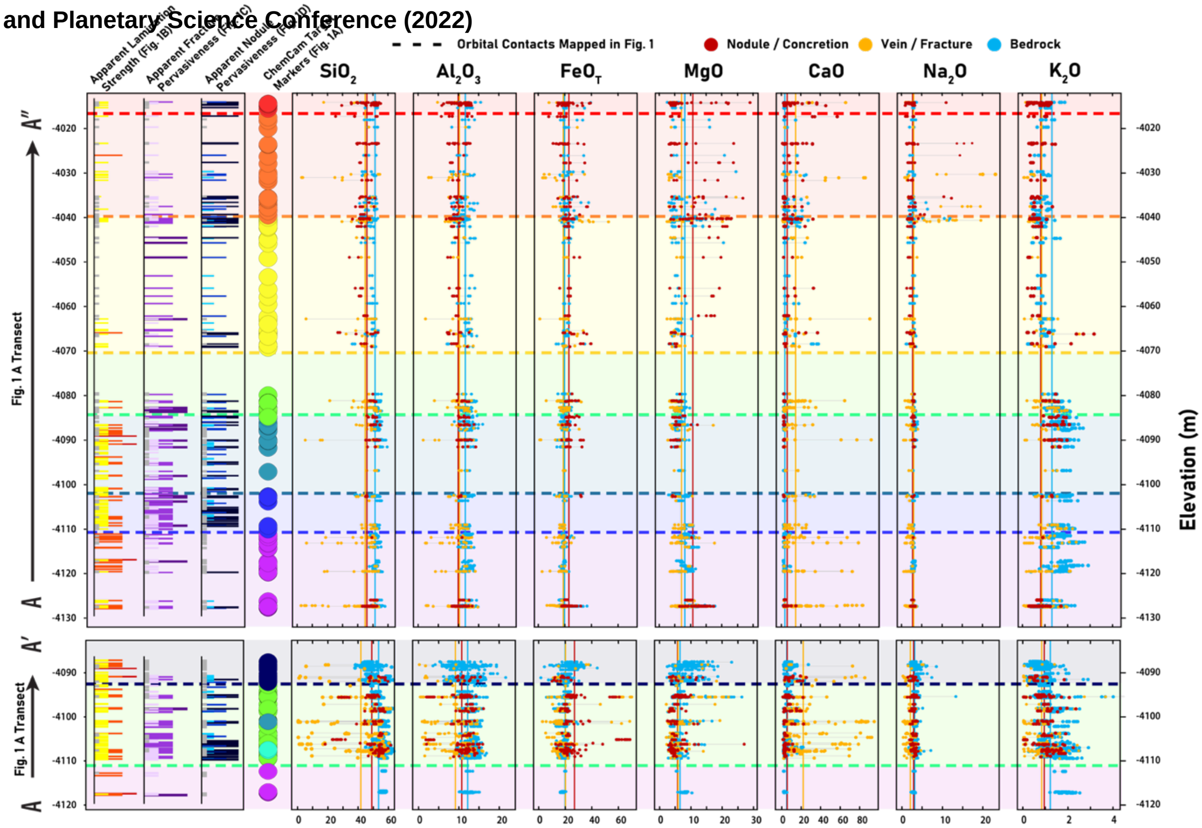

Fig. 2: Left most tracks show selected target descriptions (i.e., Fig. 1B-D) plotted against elevation. Right most tracks show CCAM LIBS measurements, colored by feature classification and plotted against elevation. Individual LIBS points for a given target are connected by grey horizontal lines. Float rock and sand measurements have been omitted. Traced orbital contacts are shown as horizontal dashed lines and colored consistently with Fig. 1 mapped contacts. A – A' and A – A" transect locations are shown in Fig. 1A.

of each target [22] are renormalized on a volatile free basis to sum to 100%. Each measurement point within a CCAM LIBS target is classified a vein/fracture, nodule/concretion, bedrock, or sand measurement. Associated Mastcam images are inspected to classify each target as in place, likely in place, or float rock. CCAM RMI, Mastcam, and MAHLI images are collectively inspected to complete descriptions of *apparent* sedimentary and diagenetic textures including: lamination strength, lamination thickness, grain size, lamination style, fracture pervasiveness, nodule pervasiveness, nodule size, nodule resistance, and nodule fill.

Results: We identify nine layer boundaries from orbit (Fig. 1) across which Curiosity traversed since sol 2600. Fig. 2 documents observations of sedimentary texture, diagenetic texture, bedrock chemistry, and/or diagenetic chemistry trends across these boundaries. Table 1 addresses this study's motivating question for each of the mapped boundaries. We find that many contacts, traceable from orbit via subtle breaks in topography, can plausibly be correlated with increases in the pervasiveness of diagenetic features. Clear changes in sedimentary texture and bedrock chemistry are more subtle and less frequent. In other cases, no systematic variations in texture or chemistry are observed across orbital boundaries. These boundaries may reflect subtle differences in cementation or grain size that cannot be determined unambiguously with the employed datasets. Additionally, we observe an inverse relationship between apparent lamination strength and nodule pervasiveness and significant target textural and chemical heterogeneity within a given rover traverse waypoint workspace (Fig. 1B-D). These and other results will be compared with the independently produced team-based stratigraphic column.

Table 1. Summary of results.

	Are changes observed across each identified orbital layer boundary (Fig. 1A)?				
	Overall	In Sedimentary Texture	In Bedrock Chemistry	In Diagenetic Texture	In Diagenetic Chemistry
Navy	✓	✓	✓	✓	✓
Red	TBD	TBD	TBD	TBD	TBD
Orange	✓	✕	✕	✓	✓
Yellow	✓	✕	✕	✓	✓
Green	✓	✓	✓	✕	✕
Teal	✕	✕	✕	✕	✕
Cyan	✕	✕	✕	✕	✕
Blue	✓	✕	✕	✓	✕
Purple	TBD	TBD	TBD	TBD	TBD

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