STRATIGRAPHY AND GEOLOGICAL HISTORY OF THE NOACHIAN BASEMENT ON THE WESTERN RIM OF ISIDIS BASIN E. L. Scheller[1] and B. L. Ehlmann[1,2], [1]Division of Geological and Planetary Sciences, California Institute of Technology, Pasadena, CA, USA [2]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA, USA (eschelle@caltech.edu).

Introduction: The Noachian basement is the oldest geological unit (Early to Mid-Noachian) exposed along the western rim of the Isidis basin structure.[1-2] It is comprised of a complex stratigraphy of compositional subunits, including LCP-bearing units, Fe/Mg-smectite-bearing units, megabreccia, ridge networks, and kaolinite-bearing units.[1-4] Analyzing the age relationships and formation processes of these units is essential to understanding aqueous alteration, igneous evolution, and basin-scale impact deformation on ancient Mars. It is also relevant to understanding the source materials of the sediments that will be examined by the Mars-2020 rover in Jezero crater. We have undertaken high resolution analysis of CRISM, HiRISE, and HiRISE DEM data in order to search for and delineate discrete compositional and geomorphological stratigraphic units within the Noachian basement. The aim of our study is to construct a geological model for the formation of the distinct units within the Noachian basement.

Newly-defined igneous compositional units: Our study reports the discovery and definition of three new igneous compositional units in the Noachian basement: Mixed Lithology Smooth Plains (SP), LCP-bearing Plateaus (LP), and LCP-bearing Blue Fractured Unit (BFU) (Fig. 1). We used calculations of the spectral centroid between 1 and 2 μm in order to distinguish between different LCP compositions. SP are flat, low-lying plains. In addition, SP generally have minor Fe/Mg-smectite signatures (Fig. 1). Lastly, the LCP spectral signatures of SP have a slightly higher spectral centroid band position (~1.550) compared to LP (~1.547) and BFU (~1.53-1.54) (Fig. 1).

The LP do not contain any Fe/Mg-smectite signatures or other evidence of hydration/alteration (Fig. 1) and generally have sharp boundaries with Fe/Mg-smectite-bearing materials. Through study of several HiRISE DEMs, we observe that LP are topographically higher compared to all other parts of the Noachian basement (Fig. 2). In some cases, part of the plateau-forming expression of the LP has been heavily eroded to form less well-defined mounds. In some cases, kaolinite-bearing materials are observed to concentrate at the boundary of LP to SP.

The BFU appears blue and highly fractured in HiRISE color images. It contains very strong Fe^{2+}-related absorption bands in a LCP signature (Fig. 1). The BFU only appears in small sparse patches of a few hundred meters in NE Syrtis and in Nili Fossae. Often, BFU appears as eroded angular blocks akin to the megabreccia. In some cases, BFU exhibits minor Fe/Mg-smectite spectral features.

These compositional units were also analyzed through HiRISE color data utilizing IR, RED, and BG bands of HiRISE color images (see Scheller and Ehlmann, *this conference* for details)[5]. We found that these three compositional units were distinct in VNIR HiRISE too. BFU have markedly different HiRISE parameters compared to SP and LP, such as lower IR/BG, lower IR/RED, and higher BG/RED. LP and SP are generally distinct from each other, as SP typically yields HiRISE color parameter values that lie in between the Fe/Mg-smectite and LP color parameter values.

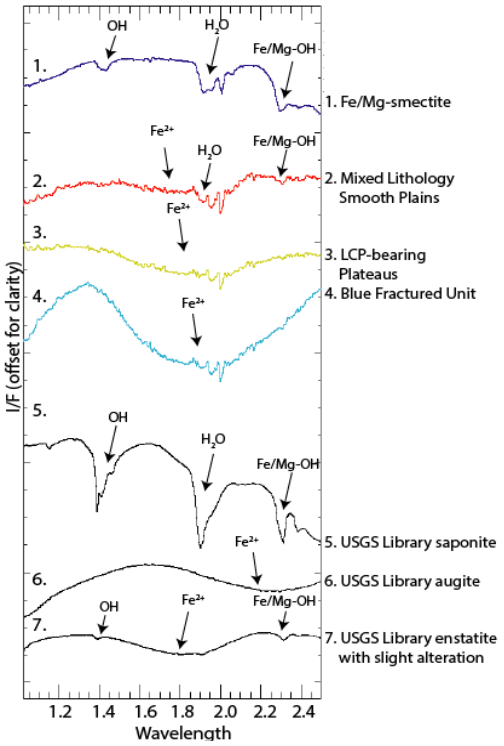

Figure 1: CRISM spectra of Fe/Mg-smectite, mixed lithology smooth plains (SP), LCP-bearing plateaus (LP), and blue fractured unit (BFU).

Fe/Mg-smectite geomorphological units: Distinct geomorphologic expressions of Fe/Mg-smectite-enriched materials occur, including stratified basement, massive structureless basement, and topographically raised mounds. The stratified basement is well-exposed in the grabens surrounding the Isidis basin (Fig. 2). The stratified basement tends to underlie either LP or SP. Massive Fe/Mg-smectite is typically intimiately mixed

with SP with no geomorphological boundaries. The Fe/Mg-smectite-bearing mounds occur primarily in NE Syrtis and are topographically raised compared to SP with which they exhibit sharp lithological boundaries.

Stratigraphic relationships: The stratigraphically lowermost units of the Noachian basement include stratified Fe/Mg-smectite, massive Fe/Mg-smectite, and SP (Fig. 3). These units appear to pre-date the formation of megabreccia, since megabreccia are observed within these units, and larger megabreccia deposits overlie these units (Fig. 2). Additionally, Fe/Mg-smectite appears to be a substantial component of pre-Isidis lithologies in megabreccia.[5]

The extent of BFU deposits are generally very limited. Hence, the stratigraphic position of BFU is still ambigious and yet to be determined. Our study found that some BFU deposits are interlayered with stratified Fe/Mg-smectite. In general, BFU deposits also appear to occur at topographic levels similar to SP and massive Fe/Mg-smectite. However, lithological and geomorphological boundaries between BFU and SP are sharp. In addition, megabreccia have been observed to contain materials that match with the BFU-spectral signature[5], suggesting that BFU must either be a pre-Isidis aged lithology or have formed as an impact deposit that was later brecciated through mass-wasting processes.

Megabreccia are not observed to overlie or to occur in contact with LP. LP are always topographically raised compared to SP, massive Fe/Mg-smectite, stratified basement, and megabreccia deposits (Fig. 2). These observations suggest that LP may have either formed or evolved through different pathways compared to SP.

The youngest units within the Noachian basement include kaolinite[3] and ridges[4,6-7] (Fig. 3). No direct contact has been observed between kaolinite and ridges. We observe that ridges cross-cut SP, massive Fe/Mg-smectite, stratified Fe/Mg-smectite, megabreccia, and BFU consistent with what we have defined to be the oldest Noachian basement units. No contact has been observed between ridges and LP. Kaolinite is observed to overlie LP, SP, massive Fe/Mg-smectite, stratified Fe/Mg-smectite, and Fe/Mg-smectite mounds. This suggest that Fe/Mg-smectite-bearing ridges and kaolinite have formed through later alteration events.

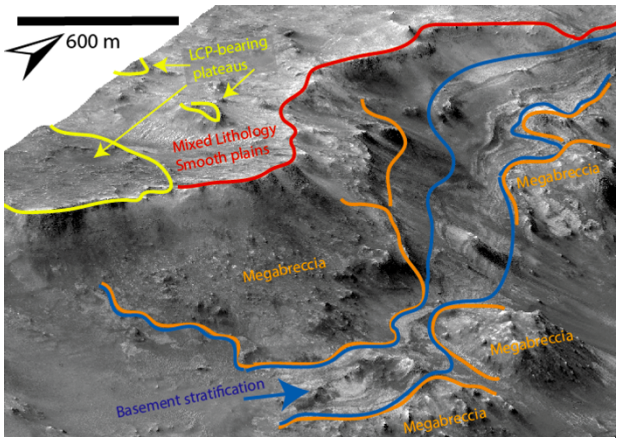

Figure 2: ESP_019621_2005 HiRISE DEM showing the contact relationships between SP, LP, megabreccia deposits, and stratified basement.

Conclusions and future work: Our study defines three new primarily igneous units with variying geomorphological expression, LCP-composition, and Fe/Mg-smectite content within the Noachian basement surrounding the Western rim of Isidis basin. In addition, we observe three different geomorphological expressions of Fe/Mg-smectite: stratified, massive, and mounds. These six units as well as megabreccia, ridges, and kaolinite appear to form a complex stratigraphy containing units with very different ages and origins. Future work will focus on determining the nature of lithological contacts through HiRISE DEM models in order to understand their ages and geological relationships.

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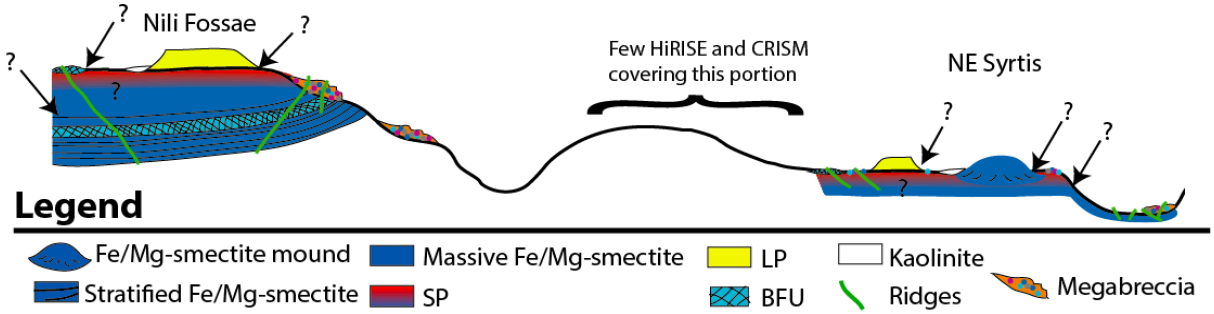

Figure 2: Schematic illustrating relative timing of compositional subunits in the Noachian basement. Question marks indicate where the nature of stratigraphic contacts are not exposed or not yet understood fully.