STRATIGRAPHY OF THE NILI FOSSAE AND THE JEZERO CRATER WATERSHED: A REFERENCE SECTION FOR THE MARTIAN CLAY CYCLE. B. L. Ehlmann and J. F. Mustard, Department of Geological Sciences, Brown University (bethany_ehlmann@brown.edu).

Introduction: The last of the major Martian impact basins is the Isidis basin, which formed at ~3.96 Ga [1]. In and around its western margin are well-exposed sections of ancient Noachian crust that are covered in the south by Hesperian lavas of the Syrtis Major formation, emplaced at ~3.7 Ga [2]. Data from orbiting visible/near-infrared imaging spectrometers have revealed geographically extensive and diverse alteration minerals in these Noachian terrains including smectites, kaolinite, chlorite, zeolites, Mg carbonates and serpentine [3-7]. The area is also morphologically diverse: fractures hundreds of km in length concentric to the Isidis basin (the Nili Fossae) expose a deep stratigraphy and extensive fluvial dissection has both incised the crust to reveal stratigraphy and has produced sedimentary rock units. Particularly notable is the 15,000 km^2 system of valleys which comprises the watershed of Jezero crater, an open basin paleolake with a well-preserved delta comprised of clay and carbonate sediments [8-9].

In the clay cycle of Mars, tectonic processes (e.g., metamorphism, uplift) and burial diagenesis of sediments play a minimal role while impact processes, weathering, and fluvial transport are of utmost importance. The area in and around the Nili Fossae, including the Jezero crater watershed, preserves a record of all major elements of the Martian clay cycle. The diversity of clay forming and transporting environments observed in this region is unique on Mars. Data from this well-preserved stratigraphic sequence allows a coherent, time-ordering of alteration processes on Mars from middle Noachian to early Hesperian. Here we focus on sediment sources and sinks and evidence for the importance of weathering and fluvial processes.

Sediment sources: *(1) The megabreccia basement*: On Mars, the lowermost stratigraphic units are megabreccias, generated by impact processes early in the planet's history. Impacts were critical in the Martian clay cycle by (1) redistributing already formed clays and (2) generating hydrothermal systems in which new clay minerals formed. The Nili Fossae expose a >600-m thick unit of brecciated, Fe/Mg smectite clay-bearing materials resulting from disruption during Isidis basin formation [5]. The bulk materials are mafic but contain both unaltered (low calcium pyroxene-bearing) and altered (Fe/Mg smectite-bearing) breccia blocks, some of which exhibit fine-scale layering, i.e. they represent fragments of pre-existing stratigraphies. (2) *Ultramafic impact melt/lava:* Overlying the basement megabreccia unit along the easternmost fossae is a banded, draping unit enriched in olivine (~30 wt. %). It is thought to represent materials excavated from Mars' lower crust/upper mantle during the Isidis impact event and emplaced as impact melt [5] or komatiitic lavas emplaced shortly after the basin formed [10].

Pedogeneisis/near-surface alteration: Near-surface, in-situ alteration of the different precursor lithologies has resulted in distinctive stratigraphic sections. Along the eastern fossae, the olivine-bearing unit sometimes shows signs of alteration to magnesium carbonate and serpentine, as in alteration of ultramafic bodies on Earth [6-7]. The result is carbonate capping smectite clays. To the west, in some locations, rocks and sediments derived from the basement megabreccia are capped by a thin (<10s of meters), unit of kaolinite-bearing materials. A plausible scenario for this stratigraphy is the leaching of Fe, Mg, and Ca from the underlying materials and the transformation or neoformation of Al-rich clays as in pedogenesis [6].

Fluvial transport/deposition: Walls of topographic lows such as craters and the fossae are dissected by channels and infilled by sediments [4]. Weathering and fluvial transport processes were clearly active at the same time. For example, a one 40 km crater has been infilled by >1km of Fe/Mg smectite-bearing sediments. The upper 10-30 m of fill have been altered to form kaolinite, and this stratigraphy has subsequently been eroded (and hence exposed) by fluvial erosion.

Valleys sourced in and around the Nili Fossae drain into 45-km Jezero crater from the north and west and cut through the stratigraphy of megabreccia and the olivine rich unit. The ~800m (1,000 km^3) of fill in Jezero is far more than the 58 km^3 eroded to form the main valleys, consistent with landscape denudation by surface runoff within the watershed rather than erosion by sapping activity. Jezero crater hosted an open lake system and the western delta within has lobes indicating channel-switching events and epsilon cross-beds formed during lateral accretion. The minerals comprising the deltaic sediments are Fe/Mg smectite clays and Mg carbonates. Although neoformation in crater lake waters is possible, given this mineralogy, the simplest explanation is detrital transport. The assemblage suggests neutral to alkaline waters since acidic waters over long periods of time would destroy carbonates.

References: [1] S Werner, PhD thesis, 2005 [2] H Hiesinger & J Head, *JGR*, 2004 [3] F Poulet, *Nature*, 2005 [4] N Mangold, *JGR*, 2007 [5] Mustard, *JGR*, 2009 [6] Ehlmann, *JGR*, 2009, [7] B Ehlmann, *Science*, 2008, [8] C Fassett and J Head, *GRL*, 2005, [9] B Ehlmann, *Nat. Geosci*., 2008. [10] V Hamilton and P Christensen, *Geology*, 2005.