HYDRATED MINERAL DETECTIONS IN ARABIA TERRA: ANOTHER EVIDENCE FOR TWO EPISODES OF DEPOSITION AT MERIDIANI. J. Flahaut[1], M. Offringa[1], A.P. Rossi[2], F. Poulet[3], J. Carter[3], G.R. Davies[1] and W. van Westrenen[1]. [1]Faculty of Earth and Life Sciences, VU University Amsterdam, The Netherlands (jessica.flahaut@ens-lyon.org), [2]Jacobs University Bremen, Germany, [3]Institut d'Astrophysique Spatiale, CNRS/Université Paris Sud, 91405 Orsay Cedex, France.

Introduction: Remote sensing and *in situ* data from recent orbiter and rover missions have provided extensive evidence for the presence of water lain sedimentary rocks on Mars [1]. Imaging spectrometers onboard Mars Express and Mars Reconnaissance Orbiter have also detected hydrated minerals such as ancient phyllosilicates and sulfates on the Martian surface. These minerals appear to have formed in two distinct climatic episodes [2]: 1-The Noachian period (4.2-3.7 Gy), at least transiently warm and wet, resulted in the formation of clays, whereas 2-The intermediate Hesperian (3.7-3.0 Gy) could mark a transition to a dryer and more acidic climate, resulting in the formation of sulfates. In contrast, the younger Amazonian terrains lack hydration features, implying that the surface has been mostly dry for at least 3 Gy [2].

The occurrence of a thick sedimentary sequence dominated by phyllosilicates and sulfates at higher elevation in the central mound of Gale Crater [3] has been interpreted to be a possible record of this climatic transition; Gale crater was therefore chosen as the final landing site for the latest rover mission, Mars Science Laboratory (MSL, NASA). MSL rover Curiosity landed in Gale crater in August 2012 and has just reached the central mound to start the analysis of this sedimentary sequence. Flahaut et al. [4] have shown that a similar stratigraphic sequence is present in the etched terrains of eastern Meridiani, but with a thicker and larger extent. The etched terrains underlie the hematite plains where Opportunity landed in 2004. More sediments are present to the north, in the greater Arabia Terra region, but so far their relationship to Meridiani has not been directly determined. This present study describes the mineralogy, morphology and extent of the Arabia Terra deposits and compares them to the sediments of Meridiani Planum.

Previous work on Meridiani Planum*:* Meridiani Planum became of interest after the detection of crystalline grey hematite by TES (MGS) [5] which led to the choice of southwest Meridiani as one of the two MER landing sites. Previous geological mapping outlined four main units (Fig. 1, [6]), including the hematite-rich plains where Opportunity landed (unit Ph). The first hydrated minerals to be observed lay in the central portion of the 'etched terrains' (unit ET), a few hundred kilometers to the northeast [7,8]. In addition to this detection of kieserite made by OMEGA (MEx), polyhydrated sulfates (PHS, possibly ferric) and phyllosilicates were observed associated with the etched terrains [9,10], while the remaining units (MCT: mantled cratered terrains; DCT: dissected cratered terrains) seemed dominated by dust and mafic mineral signatures.

Recent work from Flahaut et al. [4] suggests that the etched terrains are made of a thick sulfate-rich unit, topped by a clay-rich layer at its surface. This clay-rich layer is overlain to the south-west by a layer of sulfates and hematite – those analyzed by Opportunity in Meridiani Planum and forming the hematite plains. Therefore the stratigraphy appears to be a succession of two sulfate-rich units, separated by a ~100 meter thick clay-rich unit. Diverse landforms including karsts and pan features are observed at the surface of the hydrated etched terrains and indicate past surface water and potential groundwater aquifers. Both surficial water and groundwater processes are required to explain the diversity of morphologies and mineralogies observed in the area. These results indicate that the very acidic conditions that prevailed during the formation of the topmost sulfate-rich unit, as observed in Meridiani Planum and in the hematite plains by the rover Opportunity, are not representative of the entire history of the etched terrains. In contrast, most hydrated minerals in Meridiani Planum likely formed at more neutral pH, at the beginning of the Hesperian [4].

Layered deposits in Arabia Terra*:* Light-toned, layered, sedimentary rocks in northwest Sinus Meridiani are also present in Arabia Terra, where they are mantled by dust [11]. We used a combination of global maps (TES and THEMIS thermal inertia, MOLA topography, THEMIS IR day and night mosaics) and CTX mosaics, computed at Jacobs University for Planetserver [12], to map the distribution of these deposits. They are often characterized by high thermal inertia values and occur in most craters of diameters 30-60 km between 0 and 15° of latitude, even though four individual plain deposits were also identified.

High-resolution observations from MRO were used to further characterize the areas marked as sedimentary deposits. CTX and HiRISE image show evidence for recent, incomplete exhumation at multiple sites. Differ-

ent types of sediments are observed: high albedo, finely layered sediments (such as those in Danielson Crater, figure 1d) in contrast with more massive sediments, marked by dissolution features (dolines). Most sediments are affected by wind erosion as evidenced by the presence of yardangs and intracrater dunes. Thicknesses appear to vary between a few hundred meters to 1.5 km. Detailed stratigraphic analyses based on high-resolution topography are ongoing,

CRISM tiles and targeted observations were used to survey the mineralogy of these sediments. All the sediments are characterized by a strong 1.9 µm feature, which is diagnostic of the presence of water. This absorption is coupled to a 2.4 µm drop, indicating the presence of polyhydrated sulfates as previously reported [9]. About half of the deposits show additional features at 2.2 and 2.3 µm, suggesting a mixture with Al- and Fe-rich smectites [4, 13]. Similar assemblages were reported in the etched unit of Meridiani Planum [4]. These signatures are specifically observed in association with the massive-type sediments, which are generally located closer to Meridiani Planum, in the DCT unit. A carbonate-rich outcrop was identified in the rim of one of the crater thanks to a combination of absorptions at 1.9, 2.3, 2.5, 3.4, and 3.9 µm [14]. Because of their mineralogical and morphological similarities, we believe the massive-type sediments are related to the etched terrains of Meridiani and formed during the same episode, under the action of groundwater. The finely layered sediments, in which clays and dissolution features are rarely observed, most likely correspond to a different episode of deposition, possibly related to the rest of the Meridiani Planum sequence or its erosion. Possible mechanisms and timing of these deposits will be discussed.

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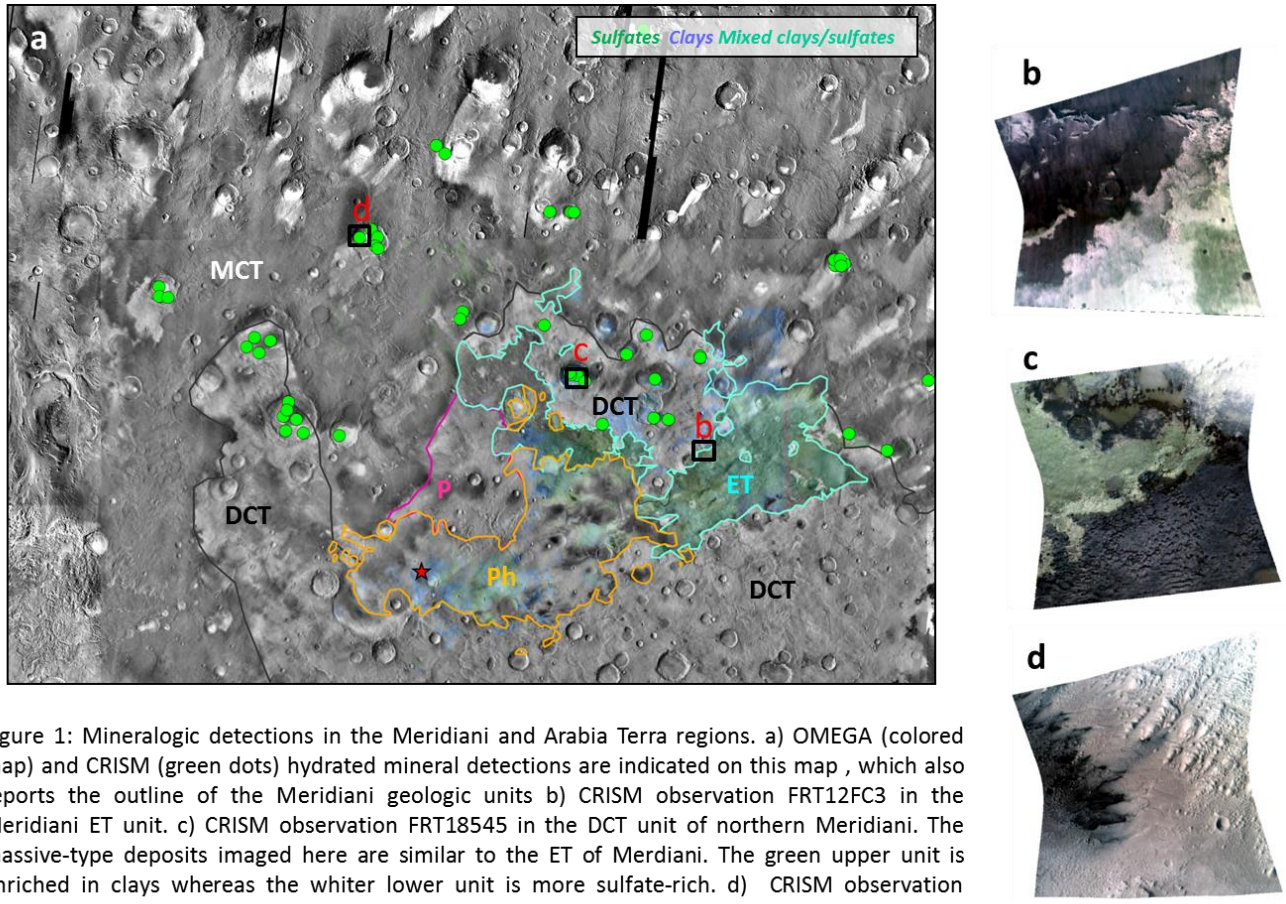

Figure 1: Mineralogic detections in the Meridiani and Arabia Terra regions. a) OMEGA (colored map) and CRISM (green dots) hydrated mineral detections are indicated on this map , which also reports the outline of the Meridiani geologic units b) CRISM observation FRT12FC3 in the Meridiani ET unit. c) CRISM observation FRT18545 in the DCT unit of northern Meridiani. The massive-type deposits imaged here are similar to the ET of Merdiani. The green upper unit is enriched in clays whereas the whiter lower unit is more sulfate-rich. d) CRISM observation FRT49CA of a layered-type of deposit in Danielson Crater, Arabia Terra.