Water Table Level Controls in Western Arabia Terra Recognized from the Characteristics of the ELDs within Becquerel Crater, Mars. G.W. Schmidt[1*], E. Luzzi[2], A. Apuzzo[1], A.P. Rossi[2], M. Pondrelli[3], F. Salvini[1] [1]Science Dept. Università degli Studi Roma Tre, Largo S. L. Murialdo 1, Rome, Italy; [2]Physics and Earth Sciences Dept. Jacobs University, Campus Ring 1, 28759 Bremen, Germany; [3]International Research School of Planetary Sciences, Università Gabriele D'Annunzio, Viale Pindaro 42, Pescara, Italy *e-mail: genewalter.schmidt@uniroma3.it

Introduction: The large region of Arabia Terra, with a 4850 km diameter, is located in the transitional zone between the northern lowlands and the southern highlands. Arabia Terra offers many clues of past groundwater activity [1] and an intense past of sedimentary (both aqueous and aeolian) and structural processes. Strewn across the region are equatorial layered deposits (ELDs), which occur in many craters and have been previously interpreted as lacustrine, fluvial, aeolian, volcanoclastic, mud volcanoes, spring and/or evaporitic deposits. Becquerel, a 3 km deep, 160 km diameter crater (Fig. 1A) and contains two massive deposits of water-altered strata.

This study examined the stratigraphy (ie. thicknesses and attitudes) and mineralogy of two separate ELDs within Becquerel to gain a better understanding of the influence of water during their deposition and alteration, as well as to regional constrain the possibility of sustained water levels.

Becquerel Crater ELDs: The main ELD mound is a 900 m high, 44 by 28 km oblique shape with a maxium height of -2,725 m.. A separate, smaller, ELD is contained in a secondary crater 17 km to the north and resides 1 km lower than the main mound Henceforth referred to as the Upper and Lower ELDs.

Methodology: A CTX mosaic was registered to a HRSC composite DEM forms the basis for this study. Layer measurements were done using HiRISE stereopairs. 271 layer thickness measurements were taken along 25 transects within the Upper ELD. Layer attitudes were obtained using the Orion Software (Pangaea Scientific). Spectral analysis was done using CRISM hyperspectral data (Fig. 1A,B) following the method described by Flahaut et al. (2015).

Results: Layer thicknesses of the ELD mound ranged 0.37 - 8.44 m with an average of 3.76 m, whereas those in the Lower ELD ranged 0.12 – 8.34 m with an average of 1.5 m. The ELD mound layer attitudes ranged 0° - 35° with an average of 8.27°. The Lower ELD attitudes ranged from 0° - 27° with an average of

Spectral analysis indicates that the ELDs have a diverse composition of hydrated minerals including both mono and polyhydrated sulfates, as well as clays (Fig. 1B). There are several major compositional differences between the main ELD mound and the Lower ELD within the secondary crater. The main mound was found to be predominately monohydrated sulfates with sparse detections of possible mixed clays. Conversely, spectra from the ELD within the secondary crater show a predominately polyhydrated sulfate composition. The separate material which truncates layering possess a distinct spectral signature similar to vermiculite (Figs. 15 and 16), but it is unclear if this is superimposed on a single ELD or a matrix in between layered blocks.

Discussion:

Analysis shows that these are two separate ELD units. with different alteration histories and possibly represent a separate deposition. Differences in elevation might reflect the differing mineralogies in a scenario where either: 1. The ELDs received different intensities and/or temperatures of upwelling groundwater or 2. The elevation difference between the two deposits was likely at least a strong influence on the formation of vermiculite in the lower secondary crater. In an lacustrine deposition, the height of the mound represents a minimum water level, or the water level that was sustained during the deposition of the last layer of the ELD mound.

Differences in layer thickness and elevation between the two ELDs, as well as their compositions, might reflect the previously propsed -4,000 m long term water level [3]. While some relatively high layer attitudes were discovered, nothing suggests that the Lower ELD is composed of vertical blocks. Differences in layer thickness do not support the Lower ELD having once been a part of the ELD mound.

A scenario involving fluid expulsion within craters undergoing a fluctuating water-table forming diverse depositional and post-depositional environments is proposed. The Mawrth Valles river system is located 315 km away from the ELD mound and begins at an elevation range from -2800 to -2600 m. This is strikingly similar to the -2,725 height of the ELD mound. In a lacustrine depositional scenario, this height range could represent the elevation of a sustained water level that marked the beginning of the formation of Mawrth Valles as the water level receded over time.

References: [1] Andrews-Hanna, J. C. et al., (2008) JGR: Planets, 115(E6); [2] Flahaut, J. et al., (2015) Icarus, 248, 269-288; [3] Salese et al., (2019) 124(2), 374-395.

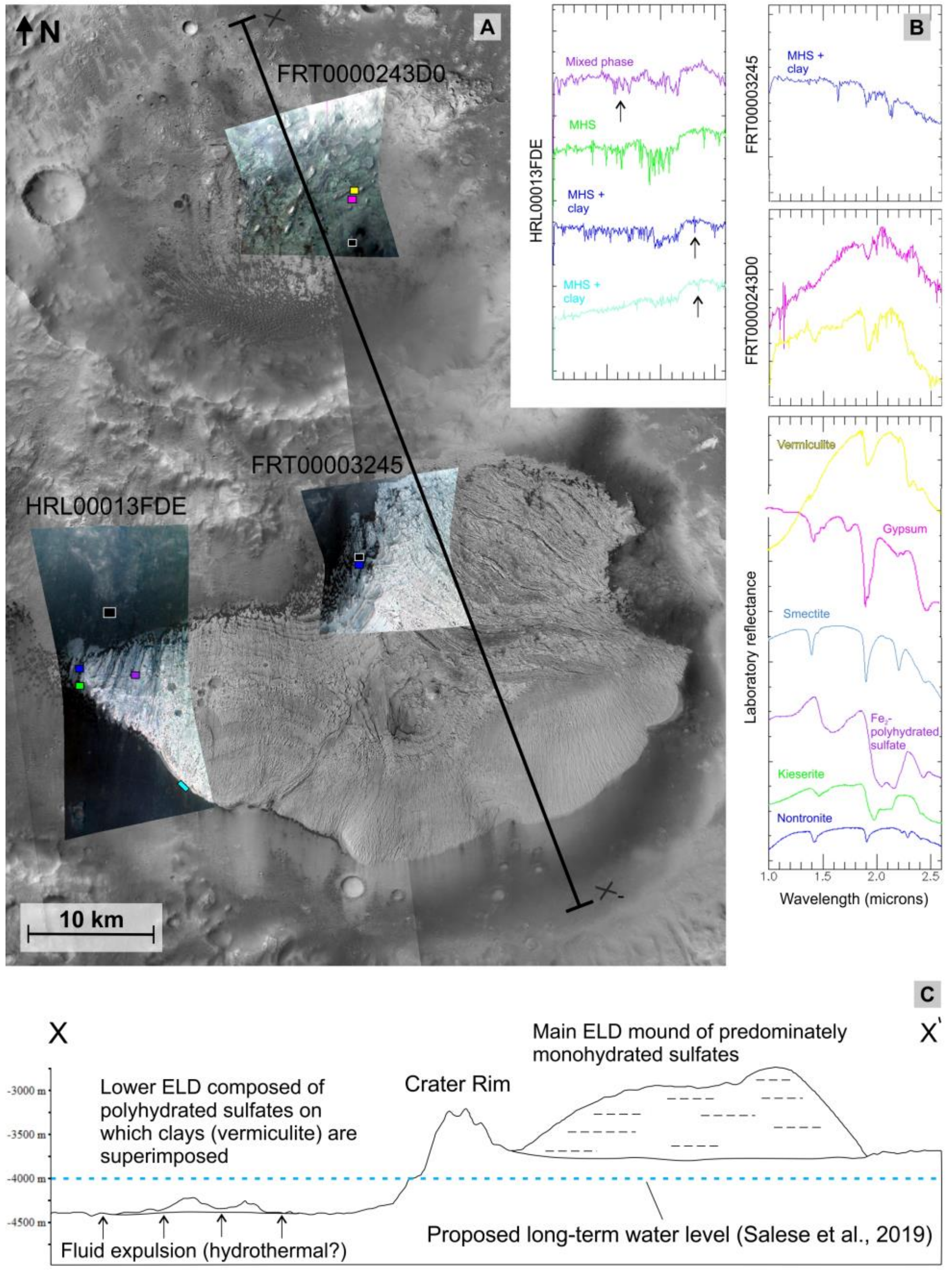

Figure 15. CRISM analysis and cross-section of the ELD mound of Becquerel crater and the ELDs within the secondary crater Becquerel B. (a) CTX mosaic of the ELDs overlain by composite CRISM observations. Colored squares represent the ROIs in which the spectra in part b were obtained. (b) Spectral signatures color coded to match the colored squares in part a. The Lower ELDs are a mix of monohydrated sulfate and clays which have been matched with vermiculite and kieserite laboratory spectra. The ELD mound itself has much dust interfering with the CRISM spectra, however both mono and polyhydrated sulfate signatures were derived and matched to kieserite, gypsum, and possibly an iron bearing hydrated sulfate. A mixed clay signature is also present, though faint, and matched to nontronite. (c) Cross-section showing the elevation difference between these deposits. The proposed water boundary [Salese et al., 2019] is shown by the dashed blue line.