Pedogenetic processes on Mars and terrestrial analogues

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Margaritifer region of Mars represent the most interesting areas where study the weathering processes, due to the strong evidence of past hydrological activity and the mineralogical composition including clay minerals suggesting a prominent exobiological potential. Furthermore, previous works of dating the ages of Margaritifer soil is quite poor. We purpose to reconstruct the processes formation of clay minerals and the age in soils exposed in the Margaritifer regions using the comparison with Etna and Cerviero soil analogues and reproducing the weathering processes experimentally in the laboratory respectively. We use a multidisciplinary approach coupled mineralogical qualitative (CRISM analysis) and quantitative (MESMA tool) analysis for Mars and pedological, mineralogical and chemical analysis for the terrestrial analogues. CRISM data show clays widely exposed in Margaritifer region on Mars, where we detected allophane as well as vermiculite, chlorite and smectite(fig.1).
We find good analogies between Etna volcano and Cerviero mount choose, as terrestrial soil profiles analogues and the Martian terrains, in terms of bedrock composition and clay mineralogy. We associate the different clay minerals formation to chemical weathering alteration and hydrotermal alteration. The experimental alteration performed in the laboratory on alkaline Etnean basalts suggests that acidic conditions (pH values ranged between 3.5 and 5.0) and temperature ranged between 150°C and 175°C and acidic promote the clay neoformation. Therefore, we can hypothesize that in Margaritifer regions, the acidic conditions in a warm humid climate similar to the Mediterranean area on the Earth, may have been responsible for the clay formations, accelerating the time of formation. The amount of clays closes to 50-60% estimated from MESMA analysis in the Margaritifer region is comparable to clay contents of red Mediterranean soils comprised between about 0.5 and 1 Ma, developed during warm and humid climatic conditions of Pleistocene interglacials (Scarciglia et al., 2015) and the red soils in the tropical environments ranged in age from about 40 ka to 200 ka (Delarmelinda et al., 2017). The iron oxides also obtained from MESMA data (ca. 11 to 16%) are in accordance with the redness rating RR estimated from the NASA rover on Mars that exhibits similar values of Mediterranean and tropical soils. Margaritifer regions on Mars show clear evidence of past water-shaped landforms as suggested by the clay mineralogy, which could have been deposited at centennial to millennial up to million-years timescales.

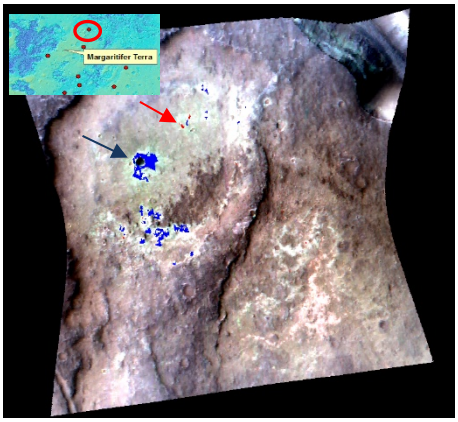

Fig.1 CRISM tile place in Margaritifer Terra with the location of the region of interest (blue and red) representing the clay deposits.

Delarmelinda E.A. et al., 2017. Soil-landscape relationship in a chronosequence of the middle Madeira River in southwestern Amazon, Brazil. Catena 149, 199-208
Scarciglia, F. et al., 2015. A comparison of Quaternary soil chronosequences from the Ionian and Tyrrhenian coasts of Calabria, southern Italy: rates of soil development and geomorphic dynamics. Quat. Int. 376, 146-162.