THE SEARCH OF CARBONATES ON MARS: VOLCANIC VERSUS SEDIMENTARY ORIGIN. F. Liberi[1,2], L. Pompilio[1,2], L. Marinangeli[1,2], E. Piluso[3], G. Rosatelli[1], A. Tranquilli[1] and M. Pepe[3], [1]Dipartimento di Studi Psicologici, Umanistici e del Territorio (DiSPUTer), Università G. d'Annunzio, Chieti-Pescara, f.liberi@unich.it [2]IRSPS, Pescara, Italy [3]Biology, Ecology and Earth Science Department (DIBEST), Università della Calabria, Italy, [4] CNR-IREA, Milano, Italy

Introduction: The presence of layered carbonate-rich rocks near Syrtis Major volcano [1], in the Nili Fossae region [2] and within the Gusev Crater [3] has been interpreted as an evidence for sedimentary carbonate formation on Noachian Mars.

In particular, CRISM spectra indicate the presence of carbonates, a mixture of hydrated Fe-Mg silicates (chlorite, serpentine, pumpellyite and vermiculite) and kaolinite-group minerals in the bedrock exposures located nearby Syrtis Major volcano [1].

The authors have explained the formation of these rocks as the result of metamorphic processes, which acted on interlayered carbonate- and siliciclastic sediments buried under Hesperian age basalts, and were triggered by the heat associated to lava emplacement. Alternatively, the basaltic crust could have been metasomatized by CO_2-rich fluids of unknown origin.

As an alternative hypothesis to both these scenarios, we suggest the emplacement of igneous carbonates: carbonatites.

Scientific rationale: Carbonatites are igneous rocks containing more than 50 wt% of carbonates and minor silicates, such as olivine, pyroxene and phyllosilicates, as well.

Carbonates found in the vicinity of Syrtis Major volcano on Mars occur in association with Fe/Mg-rich hydrated silicates [1]. Here we compare the compositional and mineralogical affinity of some carbonatites belonging to alkaline-carbonatite complexes from Uganda, Spain and Italy with the mineralogical association described in [1] and we show that (i) common mineralogy can be attributed to different genetic processes; (ii) the reflectance spectroscopy alone cannot uniquely address the genetic context; (iii) more detailed in situ analyses are required in order to unravel the controversial presence of carbonates on Mars.

Methods: The mineralogy of rock samples has been assessed through standard petrographic and XRD analyses. Figure 1 shows the diffractograms of a sample subset. The occurrence of mineralogical assemblages typical of car-bonatite-alkaline rocks (calcite ± melilite ± monticellite ±phlogopite ± Mg-olivine ± magnetite ± K-feldspar ± kalsilite), together with chlorite and clay mineral species, such as illite, montmorillonite, smectite, can be observed.

Figure 2 shows the reflectance spectra of the same samples as in Fig. 1 (colored lines), and a subset of minerals from spectral libraries (black lines). Bottom plot shows how, despite from the constituent bulk mineralogy of rock samples (Figure 1), the reflectance spectra show diagnostic features of only a subset of the constituent minerals. In particular, the occurrence of calcite can be certainly observed in some of the samples, although all of them include calcite as a main component. Top plot shows that some minerals diagnostic of carbonatitic as-semblage (melilite, as well as phlogopite in bottom plot) can impart their diagnostic signatures to some spectra of rocks.

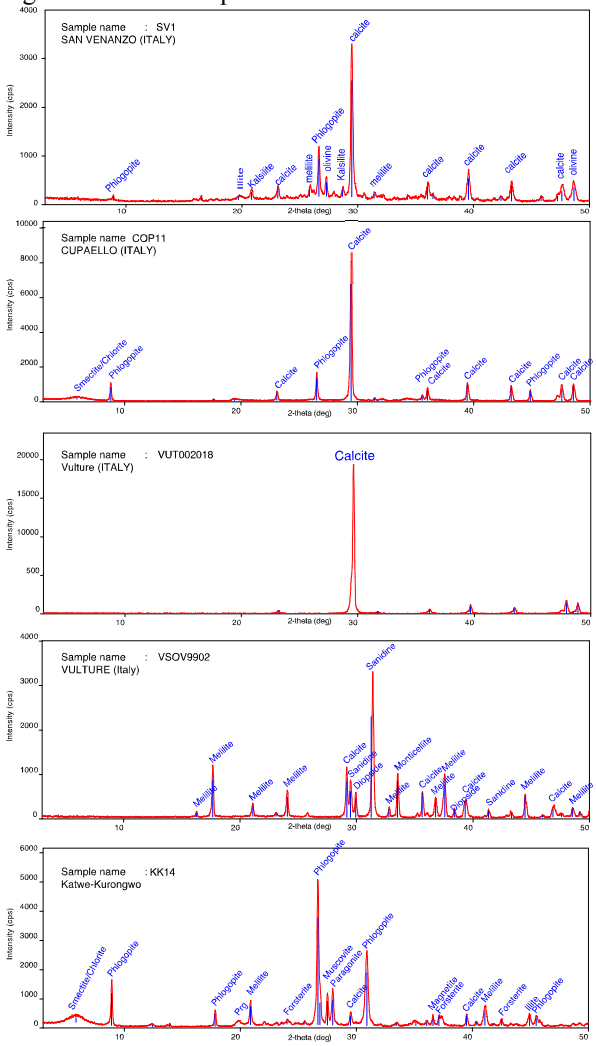

Figure 1. X-Ray diffraction diagrams of a carbonatite sample subset.

Discussion: The presence of clay minerals (montmorillonite in reflectance spectra) and chlorite, as revealed by XRD analyses, is related to hydration

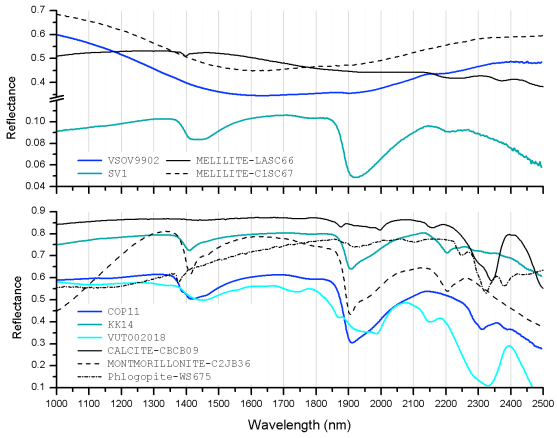

Figure 2. Reflectance spectra for the carbonatite sample subset showed in figure 1 (colored lines) and for minerals from spectral libraries (black lines).

processes subsequent to rock emplacement. Accordingly, it can be argued that alteration processes, acting on carbonate-rich rocks of igneous origin, within an hydrated environment, can lead to the same mineralogical assemblage reported for the Martian carbonate-bearing rocks described in the literature.

Although very carbonate-rich, diagnostic features of carbonates may be masked by more prominent absorptions in the reflectance spectra of carbonatites. Minerals, such as melilite and phlogopite, can be used as markers of the occurrence of carbonatite other than sedimentary calcite. This observation has remarkable implications in the searching for carbonates at the Martian surface.

It is important to remark that XRD analyses, as shown here, are required in order to assess the clay mineralogy and discriminate between rocks having different origin. Moreover, XRD can be applied for the study of the Martian surface.

On Earth, carbonatites occur in rift-related continental settings and are generally associated to alkali-silicate rocks, usually with nephelinitic or melilititic affinity [4]. The relationships between carbonatites and the associated silicatic rocks are complex and still controversial however, carbonatites and primitive silicate volcanic rocks are mantle derived. Thus, if this hypothesis will be corroborated by further data, the geological implication to the petrogenesis of this type of rocks on Mars must be investigated

References:

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