OLIVINE DETECTIONS IN THE MARTIAN NORTHERN PLAINS WITH OMEGA/MEx.

A.Ody[1], F. Poulet[1], Y.Langevin[1], JP.Bibring[1], B.Gondet[1], J. carter[2]. [1]Université Paris-Sud, 91405 Orsay cedex, France. [2]ESO, Santiago, Chile

Introduction: The northern plains of Mars are underlained by a Noachian basement, and have experienced widespread volcanism during the late Noachian and early Hesperian epochs [1]. This widespread volcanism was followed by sedimentary deposition [2] and modified by secondary geologic processes and effects of recent climate change [3,4]. Assessing the mineralogy of the northern plains is thus crucial to constrain their evolution and the geologic processes that took place. A global analysis of the olivine spatial distribution on the Martian surface using the entire OMEGA dataset, has revealed some olivine detection within the northern plains [5]. The detailed study presented here aims at putting these northern plains olivine-rich sites in their geological context, to constrain the global geological history of these northen plains.

Method: The present study focuses on olivine deposits detected within the northern plains though a global analysis of the olivine distribution on the martian surface using the entire C-channel OMEGA dataset (1.0–2.5 μm) acquired since 2004 [6]. This dataset represents 3.6 martian years of OMEGA observations and more than 8000 orbits and datacubes. Olivine is detected thanks to three spectral parameters developed in [7] and [8] and based on its 1 μm absorption band. These three spectral parameters enable the detection of olivine whetever its Mg/Fe content, and for all grain sizes. Thanks to a filtering process based on parameters that gauge the presence of H2O, CO2 ice and dust opacity, OMEGA observations of obscured surface areas are removed from the dataset [6]. In addition, the olivine spectral parameters being affected by the presence of a large abundance of atmospheric or other surface minerals or dust, we have adjusted the thresholds of the spectral parameters for each olivine detection, to enable the coverage of the entire olivine deposits, to assess their geological context.

Results : Olivine detections are found in a few spots within the entire northern plains, and noticeably in Chryse and Acidalia Planitia, Utopia Planiti and the West of Arcadia Planitia (see olivine global map presented in [5]). Although most of these detections are associated to sand dunes accumulated on the floor of impact craters as previously identified by [9], olivine is also detected in crater ejectas and extended deposits in the region of Chryse, Acidalia and Utopia Planitia. Chryse Planitia (Fig. 1) exhibits olivine mainly within the ejecta of small craters. This would indicate the presence of an underlying olivine-rich layer in this region, some hundreds of meter deep. The olivine detections shown within the square in figure 1 are associated to a high thermal inertia; they are present over a rather large area, and partially covered with ejecta from the nearby craters. They would thus trace an olivine-rich outcrop in this area, possibly connected to the olivine-rich layer identified farther out, as described previously.

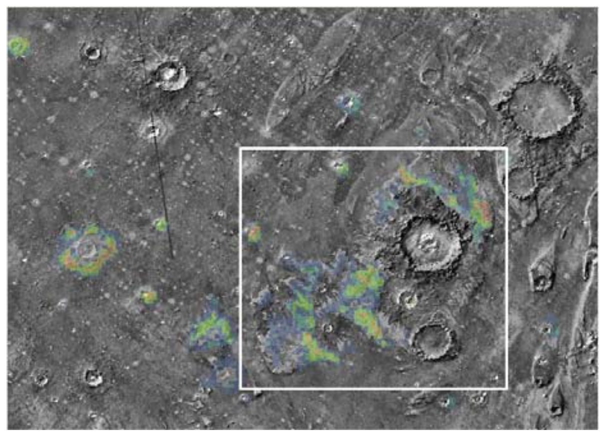

Figure 1. OMEGA olivine detections centered in [-37.1°E, 24.1°N] in the region of Chryse Planitia over THEMIS night mosaic. Olivine detections are mapped from the blue to the red with the increase of the spectral parameter values.

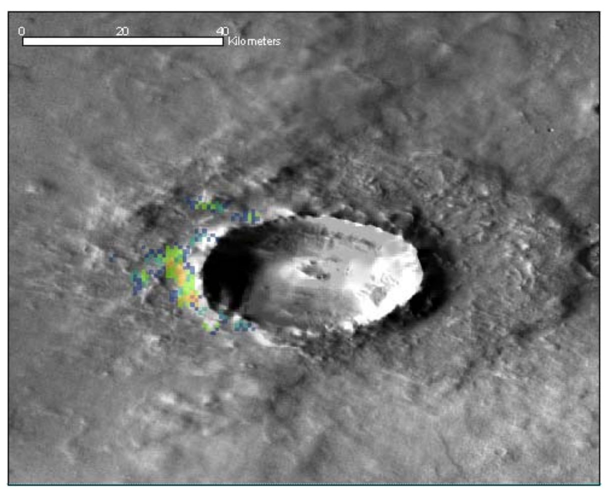

Figure 2. (A) Exemple of olivine-rich crater ejecta on the west of Utopia Planitia [14.9°E,8.8°N]. OMEGA olivine detections are mapped on THEMIS day mosaic.

These observations are in agreement with [10] which reveals olivine signature in the shallow subsurface exposed by impact craters in the regions of Chryse and Acidalia Planitia.

Olivine shallow signatures are detected in crater ejectas in the west of Utopia Planitia, as illustated in figure 2. It could indicate that the underlying olivine-rich layer observed in Chryse and Acidalia Planitia could extend much further in the Northern plains.

As previously mentioned, olivine is also detected in an extended deposit in the region of Utopia Planitia [111.2E°,49.6N°]. This deposit illustrated in figure 3 extends over about 500 kilometers and exhibits strong olivine signatures. This deposit, found in the Amazonian Elysium formation units [11], could be an excavated part of the underlying Utopia Planitia Hesperian plain or associated to Elysium volcanism.

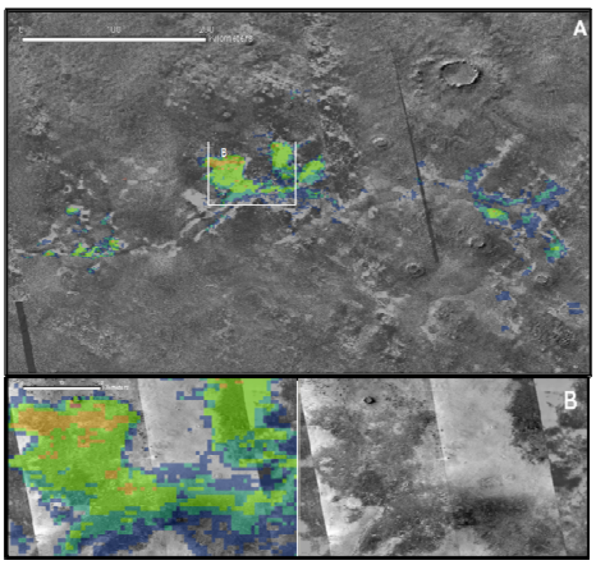

Figure 3. (A) Olivine-rich extended deposit in the northern plains [111.2E°,49.6N°]. OMEGA olivine detections are mapped from the blue to the red with the increase of the spectral parameter values, and overlain THEMIS night mosaic. (B) OMEGA olivine detections (left) and CTX observation (right) for the region indicated with white square in (A).

This study supports the idea that a primary olivine-rich basaltic units lies below the sedimentary surface within the northern plains. A variety of processes have exhumed olivine-rich outcrops, preserved unaltered over geological exposures. It strongly argues against an ocean having covered these regions since their formation.

References: [1] Head et al. (2002) JGR 107,E1. [2] Kreslavsky and Head (2002) JGR 107,E12. [3] Mustard et al. (2001) Nature, 412, 411-414. [4] Costard et al. (2002) Science, 295, 110-113. [5] Ody et al. (2011) LPSCXXXXII. [6] Ody et al. (2010) LPSCXXXXI. [7] Poulet F. et al. (2007) JGR, 112,E08S02. [8] B. Gondet et al. (2007) LPSC XXXVIII. [9] Rogers and Christensen (2003) JGR 108, E4. [10] Salvator et al. (2010) JGR 115 E07005. [11] Tanaka et al. (2005) USGS.