IDENTIFICATION AND MAPPING OF OLIVINE, ANORTHOSITE AND SNC-LIKE MATERIALS ON MARS: INSIGHTS TO MANTLE RESERVOIRS. F. Poulet¹, A. Ody¹, J. Carter¹². ¹Institut d’Astrophysique Spatiale, Université Paris Sud, 91405 Orsay Cedex, France (francois.poulet@ias.u-psud.fr), ²European Southern Observatory, Santiago de Chile, Chile.

Introduction: It is presumed that, as on Earth, basaltic magma compositions can form through partial melting of the Martian mantle. Remote-sensing studies including spacecraft observations, can provide insight into the composition and distribution of Mars surface materials, and therefore into the compositional evolution of the mantle and the crust. The intent of this work is to use the CRISM and OMEGA datasets to identify and characterize the spatial distribution of olivine and anorthosite as well as to identify and map areas of possible source regions of basaltic shergottites. Their origin and the implication of their occurrence on the composition of the Martian mantle and crust, as well as on the evolution of Mars volcanism are discussed.

Spatial distribution of olivine The spatial and statistical analysis of the global olivine distribution points out several major geological settings where olivine is detected [1]. Olivine is associated to ancient (early) Noachian crustal rock and to early Hesperian volcanism; by contrast, it is not detected in later Noachian terrains, which cover the major part of the southern highlands. This could reflect a difference in the composition of the parent rocks, with mid- to late Noachian material deriving from olivine-poor bedrock relative to early Noachian and Hesperian units. We also observed numerous early Hesperian olivine-enriched smooth crater floors and flat inter-crater plains throughout the southern highlands. These deposits result from infilling of olivine-rich lava restricted to a limited duration, from 3.8 to 3.6 Ga typically. This significant planetary-scale volcanic activity could correspond to a peak global flux. Finally, olivine is found around the two main basins Argyre and Hellas, with a distribution that takes the form of discontinuous olivine-enriched mixtures exclusively localized on hills associated to Noachian units Nplh and Nh1 that are among the oldest geologic units on Mars. We interpret these olivine-bearing hills as olivine-bearing material excavated from the upper mantle/lower crust during the impact. These observations support mantle overturn.

Identification of anorthositic rocks. Anorthosite is an intrusive igneous rock that exhibits high plagioclase content. On Mars, there are several reasons to explain why such rocks would not have been formed [2]. Based on CRISM instrument, we report the detection of a least 8 distinct anorthosite exposures on Mars mostly associated to excavated and/or uplifted early Noachian materials. Significant quantities of anorthositic rocks can be produced either globally during differentiation through magma-ocean or serial magmatism as for the Moon [e.g. 3,4] or locally requiring mechanisms such as fractional crystallization, assimilation, or partial melting of an already evolved (i.e., not ultramafic) source. The very small number of detections is in better agreement with a localized origin implying partial melting and fractional crystallization of a plutonic source. Of special interest are the presence of altered anorthosite and phyllosilicates. This implies that the anorthosite-bearing rocks were formed before the major period of aqueous alteration, which is consistent with the very ancient age of some deposits.

Sources regions of SNCs. Locating one or more regions with composition similar to that of Martian meteorites would provide key information on the Martian crust and mantle, through the extensive laboratory investigations on these meteorites. In addition, it would enable an absolute age calibration of major Mars events. The study presented here focuses on basaltic shergottites. We have confidentially identified areas with near-infrared spectral properties similar to those of basaltic shergottites [5]. These regions are found in the Hesperian volcanic provinces of Hesperia Planum, Syrtis Major and Thaumasia Planum. No young analogue mineralogical sites have been found. This could result from the scarce presence of Amazonian volcanic deposits conspicuous in the NIR. An old age (possibly 4.0 Gy [6]) would better explain that ancient crustal rocks are closer to the composition of basaltic shergottites. This is also consistent with a comparison of the OMEGA-based Mars modal mineralogy of mafic regions with those of basaltic shergottites [7]. The observed trend in pyroxene ratio, which favors a decrease of the low calcium pyroxene abundance through time, is also difficult to reconcile with the young age of shergottites.