SOUTHERN CHRYSE PLANITIA ON MARS AS A POTENTIAL LANDING SITE: INVESTIGATION OF HYPOTHESIZED SEDIMENTARY VOLCANISM. G. Komatsu[1], P. Brož[2]. [1]International Research School of Planetary Sciences, Università d'Annunzio, Viale Pindaro 42, 65127 Pescara, Italy (goro@irsps.unich.it), [2]Institute of Geophysics of the Czech Academy of Sciences, Boční II/1401, 14131, Prague, Czech Republic.

Introduction: Future Mars exploration programs focus on detection of life or traces of life [1, 2, 3]. Asides from the question of if life ever existed on Mars, the detection of extant life or traces of past life presents a great challenge for the scientific and technological communities involved in those exploration programs.

Sedimentary volcanism (also termed as mud volcanism on Earth where hydrocarbon is frequently associated) if ever operated on Mars would be a potentially interesting target for such investigation by future landing missions as it would allow us to understand volatile and sediment migration in the crust and the potential for astrobiology [e.g., 5, 6, 7, 8]. This is because mud intrusion and extrusion on Earth are well-known phenomena causing an ascent of fluid-rich, fine-grained sediments within a lithologic succession [4] and providing a suitable environment for the wide range of microbial life. Topographic features interpreted to be sedimentary volcanoes (SVs) (or mud volcanoes) occur at various locations in the northern plains of Mars, including Isidis Planitia, Utopia Planitia, the Utopia/Isidis overlap, Acidalia Planitia, Arabia Terra, and Chryse Planitia. None of them has been fully confirmed to be SVs but improved spacecraft data provide further support for the purported SVs in some areas. The edifices' formation ages are equal or postdate the surface ages of the northern plains that are post-Noachian, but their more precise ages are not determined due to their small sizes. Here, we discuss rationale for in-situ investigation of purported sedimentary volcanism in southern Chryse Planitia.

The geological context of southern Chryse Planitia: Chryse Planitia is a >1600-km wide circular plains region occupying a basin of probable impact origin. It is part of the northern plains and is located at the dichotomy boundary. The basin has been a depo center for sediment of diverse sources (a thick accumulation of fluvial, marine, aeolian, and glacial sediments). A large quantity of sediment was transported in via circum-Chryse outflow channels [e.g., 9]. Paleo-oceans have been hypothesized to have filled the basin with variable sea levels [e.g., 10] and tsunami may have occurred multiple times due to impact into the oceans [e.g., 11]. The plains' surface records evidence for compressional tectonics in the form of widespread wrinkle ridges.

Morphological features hypothesized to be SVs occur extensively in southern Chryse Planitia, and they are particularly concentrated in the plains beyond the mouths of large outflow channels, Ares, Tiu and Simud [12, 13, 14] (**Fig. 1**). These features exhibit a wide variety of morphological types, from cones, steep-sided domes, pie-like to flow-like features, and their sizes range from hundreds of m to km in basal diameter and up to hundreds of m in height (**Fig. 2**). If they are indeed SVs, it was proposed that their formation might be linked to the high sedimentation rates in the basin.

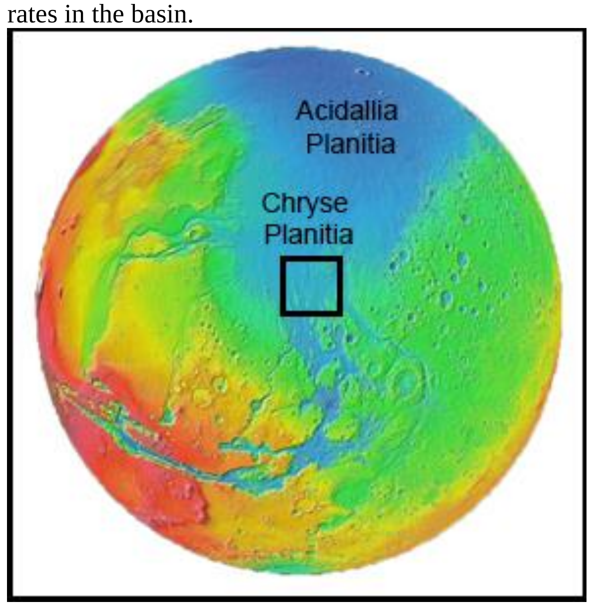

Fig. 1. The area of interest in southern Chryse Planitia for a potential landing mission.

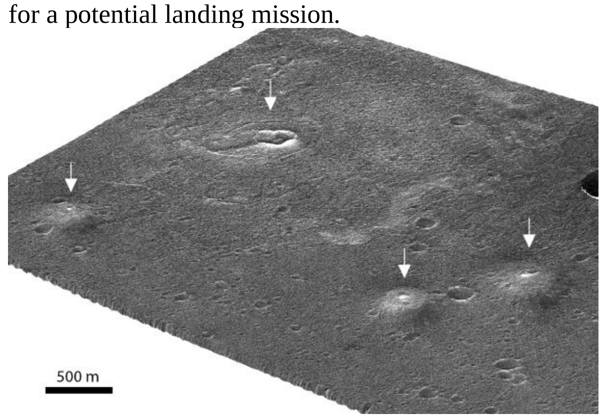

Fig. 2. An example of a field of possible SVs in Chryse Planitia. Different types of edifices (arrows) occur in this relatively small area. HiRISE 3-d perspective image. No vertical exaggeration.

Feasibility for a landing mission in southern Chryse Planitia: The area of interest is situated at low latitudes (15-25°N) and it is generally flat and characterized by low elevations (-3500 - -4000 m), which are advantageous for landing operation [e.g., 15, 16]. The area (**Fig. 1**) contains many clusters of possible SVs. The landing site can be chosen near one of them, and a deployed rover-type probe can visit multiple edifices without traversing long distances (i.e., over tens of km) (**Figs. 2** and **3**). A drone-type probe can also be used. Because its mobility, a relatively large area can be covered and visited within a short operation period.

Fig. 3. Mud volcano landscape in Azerbaijan. Three major mud volcanoes are visible at distance. The sizes (basal diameters: hundreds of m to km wide, heights: up to hundreds of m) and distances (hundreds of m to tens of km) between the representative mud volcanoes are similar to those in southern Chryse Planitia.

Possible in-situ investigations at the southern Chryse Planitia landing site: The conceivable in-situ investigations include those for 1) geology, 2) geo-biochemistry, and c) biology. First of all, the origin of the edifices must be understood. Sedimentary volcanism is a strong candidate, but in-situ lithological and mineralogical examination of edifices' surface or sub-surface would be essential for determining the processes that formed them. If their origin by sedimentary volcanism would be confirmed, this would bring more insight about the water occurrence both on the surface and in the subsurface of Mars. In the second step, an analysis of the erupted mud breccia is necessary. On Earth, mud volcanoes are an important "window" into the underlying strata, because both a low-competence parent bed (clay-rich layer) and some rock fragments are transported to the surface [4]. Sources of fine-grained materials for mud volcanism on Earth could reach great depths. For example, in Azerbaijan, the depths of the sources are estimated to be several km [17]. Considering that sizes of the purported Martian SVs and their terrestrial analogs are in similar ranges, the depths to the sources could reach ~km also on Mars. Thus, sedimentary volcanism on Mars would provide a window into subsurface crustal materials that were deposited earlier in geologic records. Besides liquid water and hydrocarbon, an important fluid component in terrestrial mud volcanism is gas, such as methane and carbon dioxide [18]. Terrestrial mud volcanoes derive gas, mainly methane, from organic–rich source deposits [e.g., 19], but some exceptional cases for dominance of carbon dioxide in mud volcanism are also known [20]. The purported SVs in southern Chryse Planitia do not appear to be active today. Nevertheless, measurement of gas levels in the environment is worth consideration as it might provide additional insight into the Martian subsurface.

Astrobiological investigation of Martian SVs should focus on localities where more recent mud eruptions occurred, such as summit craters and small mud mounds (called gryphons) where emissions of mud and gas continued even after the major eruptions. However, young fresh-looking mudflows emanating away from the summit craters are also promising candidate targets. It is recommended to conduct shallow drilling into the mud in order to sample materials less exposed to the harsh surface environment. Individual terrestrial mudflows could reach nearly 10 m in thickness [21], and the base part of such mudflows could have been well shielded from the radiation and oxidation for geologically significant time scales.

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