Phobos: A Sample of Mars and Its Primordial Environmental Conditions?

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If Phobos originated from primordial Mars similar to the Earth-Moon system [1], then it should contain primordial Martian crustal materials, which include anorthosite and felsic rocks [2]. Hereafter, primordial means Hadean-age-equivalent of Earth, which includes planetary formation including Magma Ocean and its solidification, as proposed for Mars [3]. A scenario hypothesized here includes (through time): (1) formation of blue-colored, Mars-originating, anorthosite-enriched primordial crustal materials (i.e., blue unit), (2) mantling and chemical alteration of the blue unit resulting in the red-colored materials (i.e., red unit), and (3) subsequent activity such as impact cratering (e.g., Limtoc event and associated ejecta that scoured the red unit and exposed the underlying blue unit as possibly observed to the east of Stickney where patches of red occur on the leeward side (with respect to direction of ejecta originating from Limtoc) of relatively small unnamed impact craters (interpreted to be patches shielded downwind of the ejecta by the raised crater rims)). In such a scenario, the red unit, which largely results from the chemical alteration of the blue unit, would be a recorder of the interaction of Phobos with primordial Mars and its associated dynamic history described below, which included magmatic outgassing and Habitable-Trinity conditions (landmass-ocean-atmosphere interaction by hydrological cycling driven by the Sun [4]). An ongoing detailed study of Phobos by [5] has been integral to my formulated scenario. This scenario is testable through "adequate" sample return of Phobos (i.e., core sample of both solid bedrock hypothesized to be the blue unit and the red-colored cover/chemical alteration layer), such as near the geologic contact that separates the red patch of the above modified smaller crater and blue unit, as might be the case in the planned JAXA Phobos sample return (MMX) mission.
Dynamic primordial Mars, updated and abbreviated from that theorized by [3], included the following stages generally through time: **1** - shortly after accretion, dry Mars differentiates from a magma ocean, which includes the formation of a primordial crust with composition that includes anorthosite, KREEP, and komatiite layers [2]; **2 -** Mars is impacted by asteroids and comets which deliver an ocean-atmosphere system to its system, perturbs the solid lid of the solidified magma ocean, and initiates plate tectonic activity around 4.37 Ga to 4.2 Ga in accordance with the ABEL model proposed by [6]; in addition the dynamo initiates sometime during Stages 1-2; **3** –accretion of thickened, continental crust and subduction of hydrated oceanic crust to the lower mantle of Mars occurs, including the development of the felsic Martian supercontinent (i.e., the southern highlands); **4 -** the core dynamo terminates with continued, waning plate tectonic activity; and **5** –large basin-forming impacts result in Hellas, Chryse, Isidis, and Argyre, with the later phase of development of the Martian supercontinent including the termination of plate tectonic activity (estimated to have occurred between the Hellas and Argyre impact events, ~between 4.0 and 3.93 Ga) with significant anorthosite-rich primordial crust preserved due to size [2] contrasting with Earth that destroyed its primordial continental crust [2,6], and Tharsis superplume initiates (also see a summarized Mars evolution by [7]).
Return samples from Phobos will inform on its origin and evolution, as well as possible primordial Martian environmental conditions recorded in both the blue and red units.

References: [1] Craddock, R. A., 1994, Abstracts of the 25th LPSC, p. 2. [2] Dohm JM et al, 2017, Geos. Front., DOI: 10.1016/j.gsf.2016.12.003. [3] Baker VR et al., 2007, In Superplumes: Beyond plate tectonics: Springer, 507–523. [4] Dohm, J.M. Maruyama, S., 2014, Geos. Front. 6, 95-101. [5] Kikuchi, H., Miyamoto, H., 2017, this meeting. [6] Maruyama S., Ebisuzaki T., 2017, Geos. Front., http://dx.doi.org/10.1016/j.gsf.2016.10.005. [7] Dohm, J.M., 2017, abstracts of the 48th LPSC, Abstract #1962.

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