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Assessment of a Possible Volcanic Paleolake at Apollinaris Patera, Mars: Constraints on the Composition of the Inner Caldera and Fan Deposits using the MRO Shallow Sounding Radar (SHARAD)

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Mars displays an abundance and great diversity of features that point to a long history of water and volcanic activity, including widespread hydrothermal activity. Many localities, mainly within impact basins, show evidence of lakes [1,2]. Studying such lakes is a key element in the understanding of the geologic evolution of Mars in addition to being primary targets for future exobiological exploration [3]. Lakes on Mars have been mainly attributed to a wetter ancient climate, including precipitation [4], magmatic-driven flooding [5], or impact-generated aqueous activity, including hydrothermal systems [1]. However, a lake occupying a volcanic caldera has never been detected despite the fact that they are commonly associated with magmatic/hydrothermal systems on Earth. In this work, we explore the hypothesis that a volcanic paleolake existed in the caldera of Apollinaris Patera (174.4˚E, 9.3˚S) and has been responsible for the formation of extensive fan deposits that extend approximately 150 km down the southern flank of the volcano from summit to base [6] using data from the shallow sounding radar SHARAD [7] onboard the Mars Reconnaissance Orbiter (MRO).

We have devised a "calibration" technique to compare between the relative surface reflectivity and signal decay losses in the calderas of Apollinaris caldera and Arsia Mons (9.2˚S, 239.6˚E); a site of known volcanic composition with similar surface roughness. We chose Arsia Mons for calibration purposes since its caldera has similar dimensions to those of Apollinaris and a relative age that suggests volcanic activity from Late Noachian/Early Hesperian to as recent as 40 Mya [8,9].

Our preliminary analysis shows that Arsia caldera surface displays a single bright and continuous reflection suggesting the presence of a higher surface dielectric contrast that can be attributed to volcanic material. This is also supported by the rapid signal decay due to the strong dielectric attenuation. In the case of Apollinaris, however, the caldera displays two types of reflecting surfaces that are not as bright as the one in Arsia which suggests that the material in the Apollinaris caldera is not similar to that of Arsia and displays a lower dielectric contrast.

Comparative surface roughness, clutter forward modelling, estimates of the dielectric properties for the materials and radiometric data analysis of these two caldera fills will be presented in detail at the meeting in addition to the results for the fan deposits.

References:

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