Geological investigation of Mars using muon radiography - Target selection and priorities

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Muon radiography has the potential to reveal the interior structure of a number of geological features on the surface of Mars, addressing key questions in geologic history, climate, biologic potential and the nature of current activity. Among the targets are caves and caverns, glacial and periglacial features such as putative pingoes - ice-cored mounds formed by the freezing of pressurized groundwater, and mid-latitude ice-masses ("lobate debris aprons") that have been penetrated by sounding radar and likely represent remnants of glaciers from a different climate epoch. Another possible target class is mesas in so-called "chaos" regions that were the source of massive outflow water floods and may currently contain confined aquifers. Volcanic structures have been imaged with the technique on Earth, and numerous features on Mars are potential targets, including small volcanic edifices associated with recent platy lava flows of Elysium Planitia that may suggest ongoing activity.

We will discuss the merits of each of these classes of geological targets and their alignment with NASA's long-term priorities and missions for the exploration of Mars outlined in NASA's Planetary Science Decadal Survey and Mars Exploration Program Analysis Group report. We will also discuss the challenges and advantages that each class of targets pose to a muon radiography mission, and their suitability for a rover versus a lander mission. Particular attention will be paid to using muon radiography as a potential precursory mission to identify and characterize subsurface environments for future *in situ* life-seeking missions. Based on the proposed 2016 ExoMars Trace Gas Orbiter findings, a follow-up ~2022 timeframe mission that would include a muon detector could set the stage for a future mission to directly explore subsurface habitable environments on Mars.