MAPPING SHALLOW SUBSURFACE STRUCTURAL ELEMENTS IN MAFIC PYROCLASTICS USING POLARIMETRIC AND MULTIPLE FREQUENCIES GROUND PENETRATING RADAR: IMPLICATIONS FOR MARS SUBSURFACE MAPPING S. S. Hughes[1], E. Heggy [2] and S. M. Clifford[2], [1]Dept. of Geosciences, Idaho State University, 921 South 8th Ave. Stop 8072, Pocatello, ID 83209, USA, hughscot@isu.edu; [2]Lunar and Planetary Institute, 3600 Bay Area Boulevard, Houston, TX, 77058-113, USA.

Volcanic terrains are among the most prevalent on Mars, yet the eruptive mechanisms of small uneroded vents are mostly hidden by their final eruptive products. Plains-style volcanic terrains [1], evident on all terrestrial planets, generally have numerous small cones or shields and fissure sytems that apparently erupted pyroclastic material. Many such eruptions likely changed in style from fire-fountains having large fluid pieces of ejecta (spatter) to more explosive with smaller solidified pyroclastics (lapilli and ash). Planetary analogs on the eastern Snake River Plain (ESRP) [2, 3, 4] provide many examples of the full range of these eruptive styles evident as: coalescent mafic shields, hydromagmatic tuff rings and cones, cinder cones, and both eruptive and non-eruptive fissures. Structural elements of early episodes of volcanism, such as spatter ramparts and cones, eruptive fissures and extension cracks, are often obscured by subsequent pyroclastic fallout or even by wind-blown sand and loess that buries subsurface structures.

Structural and stratigraphical investigation of volcanic features by Ground Penetrating Radar (GPR) provides a powerful tool for understanding the mechanisms and chronological sequence in their formation. For this reason, a broadband (0.5 − 1.5 GHz) GPR was selected as one of the primary instruments for the European Space Agency's ExoMars rover that will be sent to Mars in 2014. Sites on the ESRP and other regions are currently being evaluated to test this GPR system and help define it’s capabilities for future Mars rover missions. As part of the effort to evaluate the potential of this technique, we carried out a parametric study of several features at Craters of the Moon (COM) National Monument in Idaho (USA). This area, which includes extensive lavz fields and numerous volcanic constructs, is a hyper-arid environment with an average annual precipitation of less than ~50 mm. It also displays considerable geochemical and geomorphological similarity to a variety of volcanic regions on Mars.

Among the examples we investigated were a large cinder cone (Inferno Cone, Fig. 1) and surrounding smooth- and rough-surfaced basaltic lava flows. We conducted multiple frequency 270-, 500- and 900-MHz GPR surveys, with both VV and HH polarizations, in both orthogonal and grid form in order to

Fig. 1. The positioning layout of a GPR survey conducted over the tephra-covered Inferno Cone at Craters of the Moon National Monument.

perform a three dimensional mapping of the consolidated core of the cinder cone beneath a thick layer (1-20 m) of tephra that accumulated as a result of different eruptive events. Analysis of the resulting data indicates maximum sounding depths of ~13 m deep at 270 MHz (fig. 1), 8 m at 500 MHz and 5 m at 900 MHz in the unconsolidated tephra. Our gridded profiles show that the tephra distribution over the consolidated core is asymmetric (Fig. 2), the eastern side being covered by thicker deposits than elsewhere. Preliminary results also suggest the potential presence of a small spatter cone beneath the eastern flank of the cone.

A similar approach was used to investigate the Blue Dragon basaltic lava field located to the south of Inferno Cone. The observed penetration depths were an order of magnitude smaller due to the high density of the flow. Our polarimetric survey showed the effect of the different orientations of lava fractures on radar scattering. The size and orientation of these fractures, inferred from the radar data, were then compared to the in-situ measurements. Our data supports the utility of a broadband GPR to investigate and understand the nature of the shallow subsurface on Mars, but also highlighted the potential complexity associated with the future data interpretation.

References: [1] Greeley R. (1982) *JGR 87*, 2705-2712. [2] Hughes S. S. (2001) *LPS XXXII*, #2147. [3] Hughes S.S. et al. (2004) *LPS XXXV*, #2123. [4] Sakimoto et al. (2003) *6th Int. Mars Conf.*, #3197.

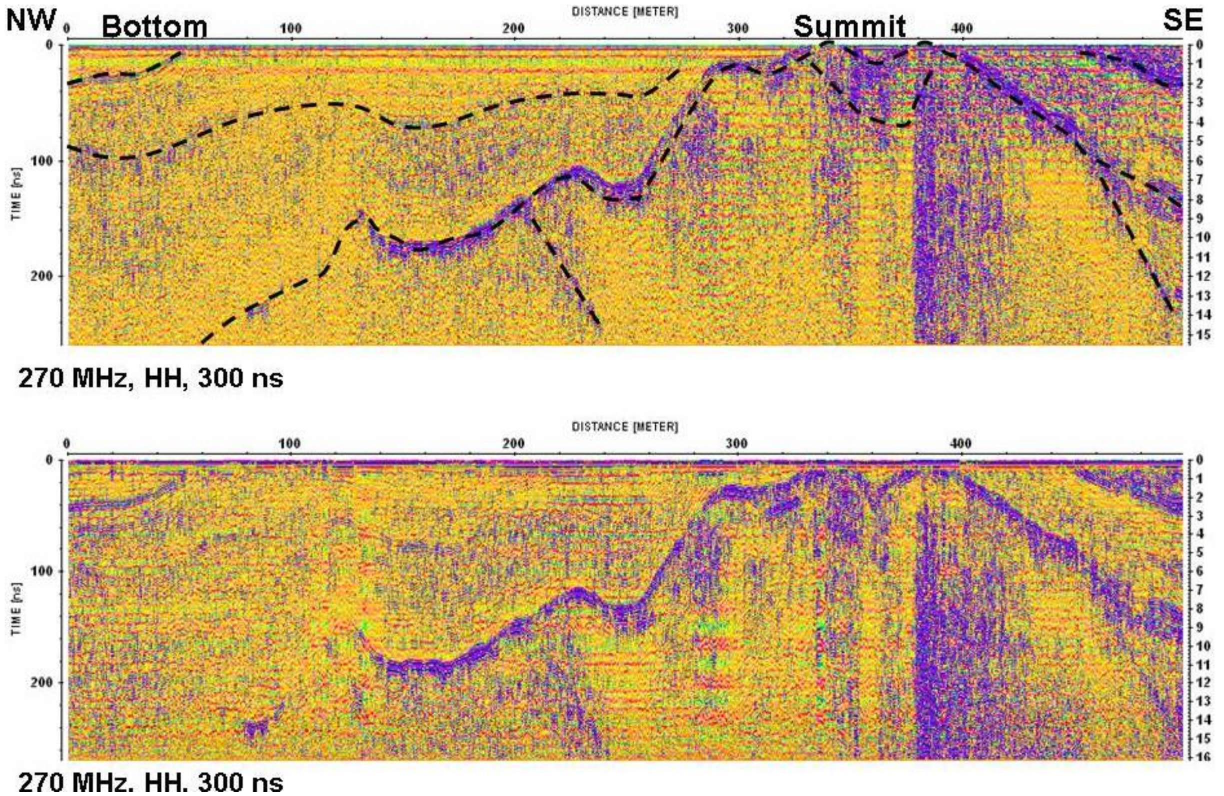

Fig 2. Bottom: 270 MHz GPR profile on the Inferno Cone. Above: The interpreted profile showing the presence of the congealed plastic ejecta underneath the thick tephra mantle.