VIRTUAL REALITY ENABLED EXPLORATION OF PLANETARY SURFACE ANALOGS – KINGS BOWL VOLCANIC TERRAINS

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Analogs of Self-secondary Impact Features: Self- secondary features, analogous to self-secondary craters on the Moon, have been identified on Earth in the volcanic terrains of Craters of the Moon National Monument and Preserve (COTM) in Idaho (*Fig. 1*), USA. These features were formed from a phreatic volcanic explosion which released rock into the air on ballistic trajectories which then re-impacted the volcanic melt sheet surrounding the Kings Bowl (KB) fissure system *(Fig. 2)*. White arrows in Fig. 3 point to self-secondary impact features – called "splash craters" for their unusual morphology – found in Tycho Crater lunar melt ponds (*Fig. 3*, red stars). Although the ejecta that formed these two types of self-secondary impact features originated differently on the Moon and Earth (e.g., via cratering and volcanic processes, respectively), features on both planetary bodies fundamentally formed from similar physical processes in that they were the product of ejecta fallout onto a not yet solidified target immediately after the emplacement of that target material– i.e. both are self-secondary impact features.

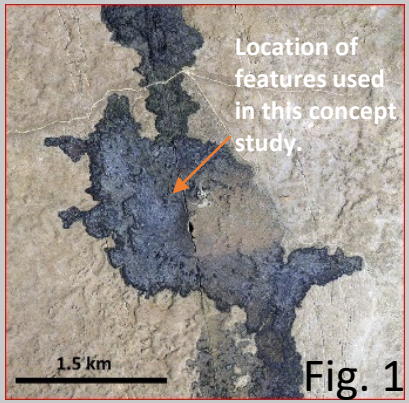

Fig. 1

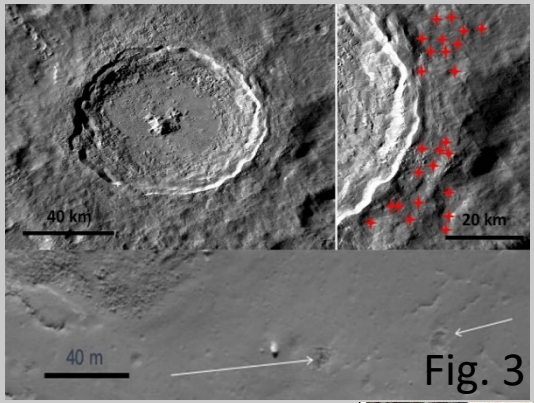

Fig. 3

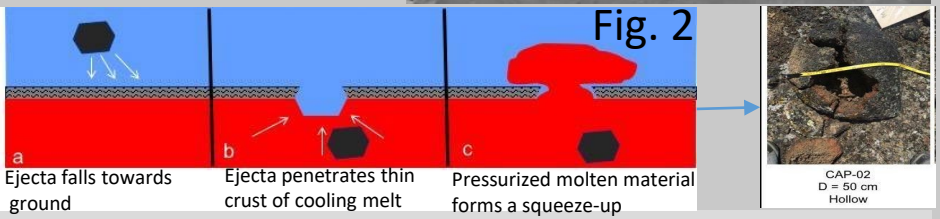

Fig. 2

For this work, we initialized a proof-of-concept project to finish measuring the self-secondary features with a Virtual Reality (VR) environment rendered from collected LiDAR data at the KB volcanic field. This approach will allow us to collect the necessary data to complete this science investigation at lower cost (no field travel) and without the associated time constraints of travel to the field.

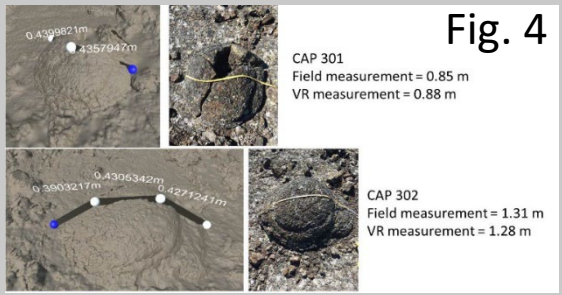

Fig. 4

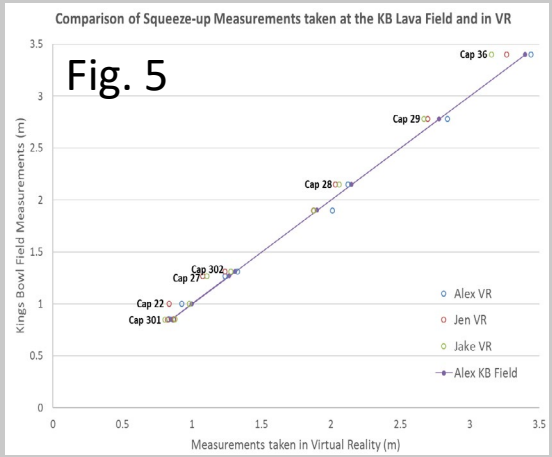

Fig. 5

Analog Field Work in Virtual Reality: Fieldwork at the Idaho KB site in 2015 and 2016 by this team yielded interesting results which confirmed the non-uniform nature of the feature size, distribution, morphology, and morphometry of the self-secondary features. We have compared VR measurements with in situ field measurements of feature size, distribution, morphology, and morphometry by measuring the same features in the VR environment (Fig. 4), and having different VR operators take measurements of the same feature, to test the robustness and reproducibility of the VR approach (*Fig. 5*).

Results: The proof-of-concept work allowed us to test two aspects of this project: 1.) the reliability of VR measurements vs field measurements, and therefore a simulation of a field study, as well as 2), the comparison of multiple investigators taking measurements of the same features. **The primary value of this effort comes from the ability for researchers to make measurements in a virtual environment as if they were physically present on a remote planetary surface**. The tools we have built will enable these measurements, as well as expanding on what is typically possible in a real environment. The plot in Fig.5 provides a comparison of measurements taken in the VR environment by the three authors to those taken in the field by the lead author. The purple line is used to show how the measurements for each feature diverged from the field measurements. In all feature measurements tested so far in the VR environment, there is agreement with measurements take in the field. Furthermore, there was not much difference among the individual VR operators. Based on these initial results, we feel confident going forward and taking measurements in VR to add to our analog study.