LAVA–ICE INTERACTIONS IN LOST JIM LAVA FLOW, SEWARD PENINSULA, ALASKA AND TARTARUS COLLES LAVA FLOW, ELYSIUM PLANITIA, MARS. E. C. Marcucci[1], C. W. Hamilton[2], and R. R. Herrick[1], [1]Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK, 99775 USA (emma.marcucci@gi.alaska.edu), [2]Lunar and Planetary Laboratory, University of Arizona, Tucson, AZ, 85721 USA.

Introduction: Sections of the Elysium Volcanic Province on Mars have been volcanically active during the Late Amazonian. During this time near-equatorial ground-ice could have been present, resulting in lava–ice interactions. The association of lava flows over ice-bearing permafrost may generate unique morphological expressions [e.g., 1]; however, there are few places on Earth that are simultaneously volcanically active and cold enough to support ice-bearing permafrost.

Background Information: In Russia, lava flowing down steep slopes interacts explosively with water/ice-bearing materials [2]. Lava flows in Iceland have also been observed to flow over snow and then subside into it as the eruption progresses [3]. Variable melting across a buried sheet of ice would also be expected to generate thermokarst-like collapse pits and cracks as the overlying lava subsides into void spaces. However, in remote sensing data it may be difficult to distinguish between depressions and pits formed by ice melt and the formation of morphologically similar features such as "skylights" formed by partial collapse of lava tubes, "shatter rings" produced by episodic changes in lava flux through a lava tube system [4], or "lava-rise pits" produced by pāhoehoe inflation [5].

Study Sites: Alaska's Seward Peninsula is a location that has both volcanic activity and ice-bearing permafrost, which makes it ideal for a Mars lava–ice interaction analog [6, 7]. In this study, we characterize unique lava flow morphologies and indicators of lava-permafrost interactions from Lost Jim Lava Flow (LJLF), Alaska, and compare those to features of the Tartarus Colles Lava Flow (TCLF) on Mars.

Lost Jim Lava Flow. LJLF is located in the Imuruk Lake Volcanic Field in the Bering Land Bridge National Preserve (Fig. 1). The ~1000 year old pāhoehoe flow extends west 35 km and north 9 km. The northward flow forms a lava delta in Imuruk Lake. Tube-fed flows originate from Lost Jim Cone, which is 30 m high, with a summit crater 12 m deep and 30 m in diameter. The pāhoehoe flow is 3 m to 30 m thick with steep, cracked margins.

Tartarus Colles Lava Flow. The TCLF is located northeastern of Elysium Planitia (Fig. 2). Pitted terrains and volcanic rootless cones are observed throughout the area. Flows hosting the pits are 35–65 m thick. Spatial relationships, cross-cutting and terrain elevations indicate that the pits likely formed after the emplacement of lava. Blocky material observed within pits suggests a thermokarst, collapse origin.

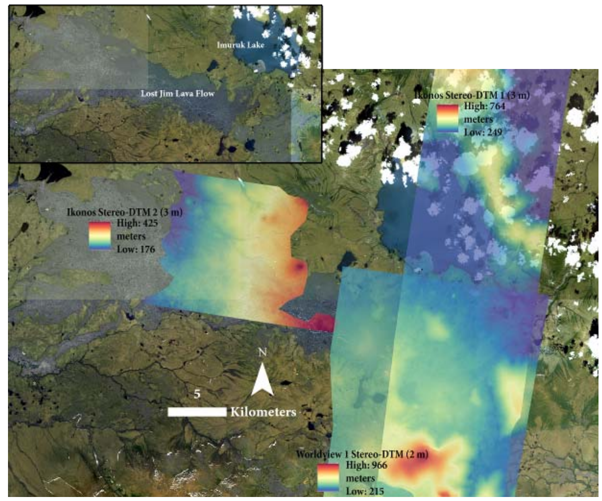

Figure 1. Overview of Lost Jim Lava Flow on Seward Peninsula, Alaska (inset) and the generated DTM coverage. SPOT imagery from alaskamapped.org/ortho.

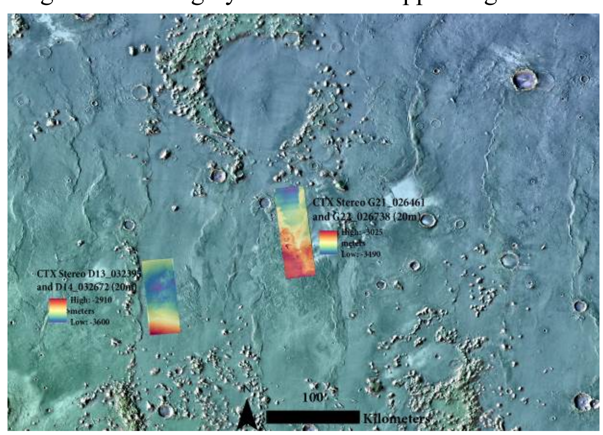

Figure 2. Overview of the Tartarus Colles Lava Flow in northeastern Elysium Planitia. The northern flowing lava fans host both volcanic rootless cones and pitted collapse terrains.

Methodology: We employed the BAE SOCET GXP (terrestrial) and SOCET SET (planetary) software programs to generate digital terrain models (DTMs) using stereophotogrammetry. For LJLF, two IKONOS stereo pairs and one Worldview-1 stereo pair exist for the area of interest and are mostly snow free. Images were aligned using the triangulation tools in SOCET GXP and tied to absolute elevations using ASTER DTMs to seed the higher resolution generated DTMs. Spatial resolution of generated DTMs is 3–4 times the average image resolution and the vertical resolution is on the order of the image resolution. For IKONOS, that results in DTMs with post spacing of 3 m and vertical accuracy of 1 m. For Worldview, the DTMs have a 2 m spatial and a 0.5 m vertical resolution. DigitalGlobe data were provided by NASA's NGA Commercial Archive Data (cad4nasa.gsfc.nasa.gov) under the National Geospatial-Agency's NextView license agreement.

CTX and HiRISE stereo pairs for Mars were identified with the Planetary Image Locator Tool (PILOT) USGS website and processed with SOCET SET modified to include tools from the USGS Astrogeology Group. Two CTX stereo pairs cover the area of interest. Using similar triangulation and seeding procedures as the terrestrial data, the stereo pairs along with gridded MOLA DTM and individual tracks produced 20 m horizontal, 6 m vertical resolution DTM products. HiPrecision products were obtained from the HiRISE team, but have not yet been used for stereophotogrammetry. The work is in progress and will generate a 1 m resolution DTM.

Results: The DTM of the lava delta in the LJLF highlights the presence of two types of pits (Fig. 3). Small pits (~20 m) are generally shallow with gradually-sloped walls. Larger pits (~50 m) are deep with steep walls. This difference may be due to formation mechanism. The small pits may represent lava-rise pits formed during flow inflation, while the large pits may represent collapse pits. Fieldwork by [7] examined pits on the lava flow and found that the walls of some pits exposed lava tube structures, suggesting the collapse occurred after the flow was emplaced. However, the collapse could be due to melting permafrost or a drop in lava level within the tube. Average depth of the large pits is on the order of the delta thickness, which may suggest the pits collapsed due to melting and evacuation of ice.

In the TCFL, lava is inferred to have been emplaced as a sheet-like flow, rather than the tube-fed lava in Alaska. The flow appears to experience sheet-wide collapse as ground–ice is melted and the flow subsided into the voided pore spaces below. Pits are about an order of magnitude larger in diameter than Alaska pits; however, they have similar depths. The CTX DTMs only have a 20 m horizontal and 6 m vertical resolution, thus a HiRISE DTM is needed to examine whether small pits exist in TCFL and to better constrain pit depths. Another striking difference between the Alaskan and Martian pits is that Alaskan pits are more localized. This may be a factor of the difference in transportation system (tube vs. sheet) or a difference in the abundance of ground–ice.

Conclusions: The Lost Jim Lava Flow is one of the only places on Earth where lava has flowed over ice-bearing permafrost and it serves as an analog for pitted lava flow terrains in the Elysium Volcanic Province. Stereophotogrammetry provides a technique for quantitatively comparing pitted terrains in Alaska and on Mars and future work will explore the processes that give rise to their similarities and differences.

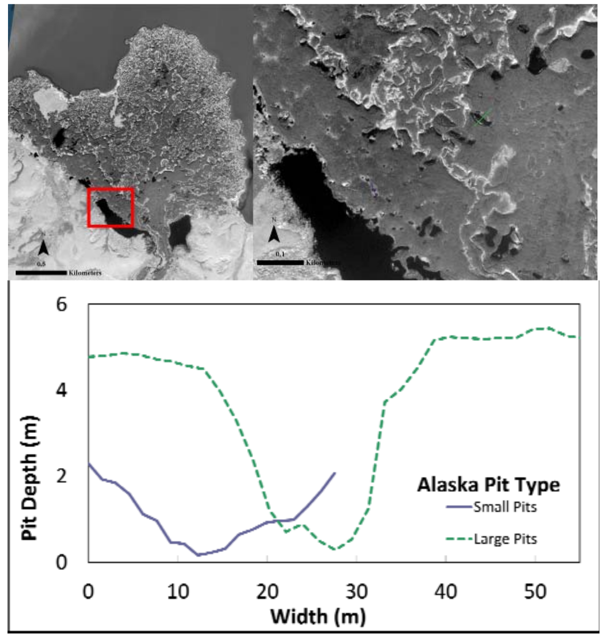

Figure 3. Two types of Alaska pits (small/shallow and large/deep) may represent a difference in formation.

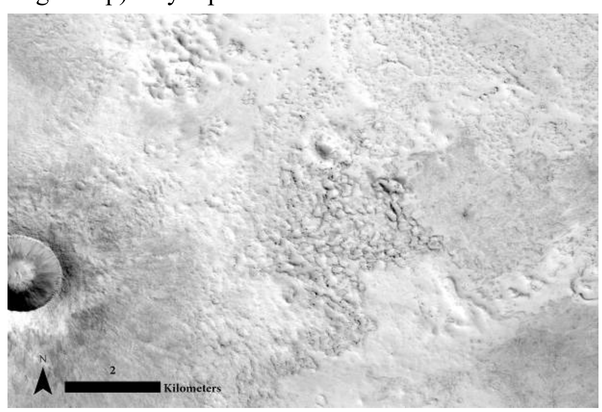

Figure 4. Pits in TCLF are large and more widespread than in Alaska, which may be due to transportation method or ice abundance.

References: [1] Hamilton C. W. et al. (2011) *JGR-Planets, 116*. [2] Belousov A. et al. (2011) *J. Volcan. Geoth. Res., 202*. [3] Edwards B. et al. (2012) *JGR, 117*. [4] Orr T. R. (2011) *Bull. Volcan., 73*. [5] Walker G. P. (1991) *Bull. Volcanol., 53*. [6] Wood C. A. and Kienle J. ed. (1990) Vol. of North Am: US and Can., *Cambridge Press*. [7] Beget J. E. and Kargel J. S. (2008) *NPS v. 7*.