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Mapping of Postglacial Icelandic Lava Flows as Analogues for Mars

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Mapping of lava flows on extraterrestrial surfaces is commonly complicated by a lack of detailed topography, by lava flow degradation, and in particular on Mars, by widespread dust mantling. Mapping of terrestrial analogues is therefore important for any attempt to interpret remote sensing data of planetary lava flows. We performed a flight campaign with an airborne version of the High Resolution Stereo Camera, HRSC-AX, for the acquisition of stereo and colour images of postglacial lava flows in Iceland as analogues to basaltic lava flows on Mars. The flight campaign in summer 2006 covered several regions, including parts of the Western Volcanic Zone (WVZ). Orthophotographs have a map-projected resolution of 25 cm pixel^{-1}, and Digital Elevation Models (DEM) have a vertical resolution of 10 cm, an absolute accuracy of $\sim$20 cm, and a horizontal grid spacing of 1 m. Images and DEM were mapped to determine the overall extent and morphology of lava flows, and field work in summer 2010 was conducted to verify and refine the mapping results and to collect samples for further laboratory analysis (mineralogy, chemistry, rheology). In general, the region is characterized by ubiquitous vents and fissures. Vents are often craters with rims consisting of scoria and partly welded spatter. Lava flows consist of vesicular basalt, have well expressed flow margins, and display inflation features (e.g., tumuli). Most lava flows are covered by moss, the type and thickness of which can sometimes be used to differentiate between lava flows of different age. Lava flow textures are commonly characterized by ropy pahoehoe, but blocky lavas are also found. Lava flow occurred both in lava tubes and as open channel flows. Many partly drained channels suggest that these lava flows were volume-limited. In this study we present results of the investigation of one selected lava flow, the outline of which was mapped using false-colour ortho-images, shaded DEM, and slope maps. Lava transport is predominantly in lava tubes near the first 1-1.5 km from the vent. After a sharp break in slope (about halfway down the lava flow), the flow continues in open-channel flow conditions over very shallow terrain. The total length of the flow is about 4 km. It proved to be difficult (but possible) to identify the correct location of the vent in image data, which was confirmed by field inspection. It is even more complicated to find the source vents of Martian lava flows, and our results suggest that an unambiguous identification will only be possible in a few fortunate cases. Our results also show that the preexisting topography is a significant factor in determining the final shape of a lava flow. In turn, the observation of changes in flow morphology of planetary lava flows may allow inferring topographic variations even for planetary surfaces where no topographic data are available. Further work will combine the results of our mapping with laboratory results on rheology, allowing to test rheological flow models that are based on lava flow morphometry. The combination of photogeological mapping, field mapping, and laboratory analysis might improve our ability to infer compositional and rheological information from the mapping of planetary data, and to assess emplacement conditions and controls.