PLATY TERRAIN WITHIN THE 2014–2015 HOLUHRAUN LAVA FLOW-FIELD: AN ANALOG FOR MARTIAN FLOOD LAVAS. J. R. C. Voigt[1], C. W. Hamilton[1], S. P. Scheidt[2], C. N. Achilles[3], C. M. Dundas[4], L. P. Keszthelyi [4], U. Münzer[5] and P. L. Whelley[3,6], [1]Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona, USA, [2]Planetary Science Institute, Tucson, AZ 85719, [3]NASA Goddard Space Flight Center, [4]USGS Astrogeology Science Center, [5]Department für Geo- und Umweltwissenschaften, Sektion Mineralogie, Petrologie & Geochemie, Ludwig-Maximilians-Universität, Munich, Germany, [6]University of Maryland, College Park.

Introduction: Platy-ridged terrains are a prominent component of flood lava flows on Mars, such as the Athabasca Valles flood lava [1,2] and large flows within Marte Vallis [3,4]. Platy-ridged lava superficially resembles pack-ice and has been cited as evidence of low-latitude ice on Mars [5]. However, platy-ridged terrain is a common—though poorly documented—product of terrestrial fissure-fed basaltic eruptions [2,6,7]. This study examines platy-ridged terrains in the 2014–2015 Holuhraun lava flow-field in Iceland [e.g., 8–10] as an analog for platy-ridged terrain on Mars, with the goal of understanding conditions that lead to the development of disrupted lava surfaces.

Geological Context: With an emplaced volume of 1.46 km^3 DRE [8] and an area of 83.82 km^2, the 2014–2015 Holuhraun eruption is the largest lava flow-field in Iceland since the Laki eruption 230 years ago. The olivine tholeiite lava originated from the Bárðarbunga–Veidivötn volcanic system. The most areally extensive lava types within the flow-field are rubbly and spiny lava [11]. These lava types resemble flood lava flows surfaces on Mars [2,3], and this study focuses on an area that exhibits a platy-ridged morphology and is dominated by spiny lava (Fig. 1a).

Data and Methods: During the summers of 2015–2019 field work was performed at the northern margin of the Holuhraun lava flow-field. In addition to in-situ field observations and measurements, this study includes several high-resolution orthomosaics and stereo-derived digital terrain models (DTMs) collected by small Unmanned Aerial System (sUAS). Data products include 1 cm/pixel orthomosaics and 5 cm/pixel DTMs derived from DJI Phantom 3 Pro quadcopter images; 4 cm/pixel orthomosaics and 20 cm/pixel DTMs derived from Trimble UX5-HP fixed-wing sUAS images; and a broader 20 cm/pixel aerial orthomosaic captured by the UltraCam-Xp camera (Fig. 1a). Within our focused study site, we classified platy-ridged terrain and associated units according to their surface texture at a 1:80-scale, resulting in the geomorphological map shown in Fig. 2.

Results: Throughout the whole lava flow-field, platy-ridged terrains most commonly occur in areas that are dominated by spiny lava; however, a minority is also located within rubbly lava. The morphology of the platy terrains is characterized by a flat-topped area exhibiting polygonal pattern. The plates are polygonally-shaped regions characterized by a concave-down surface that typically spans a few meters to tens of meters. The plates are bounded by fractures, which are either negative relief, or include protruding material that forms ridges. The plates typically commonly exhibit an undulating, or “wave-like”, surface,(e.g., Fig. 1c), which includes banded extrusions of spiny lava [7]. On a cm-scale these wave-like features have a spinose texture.

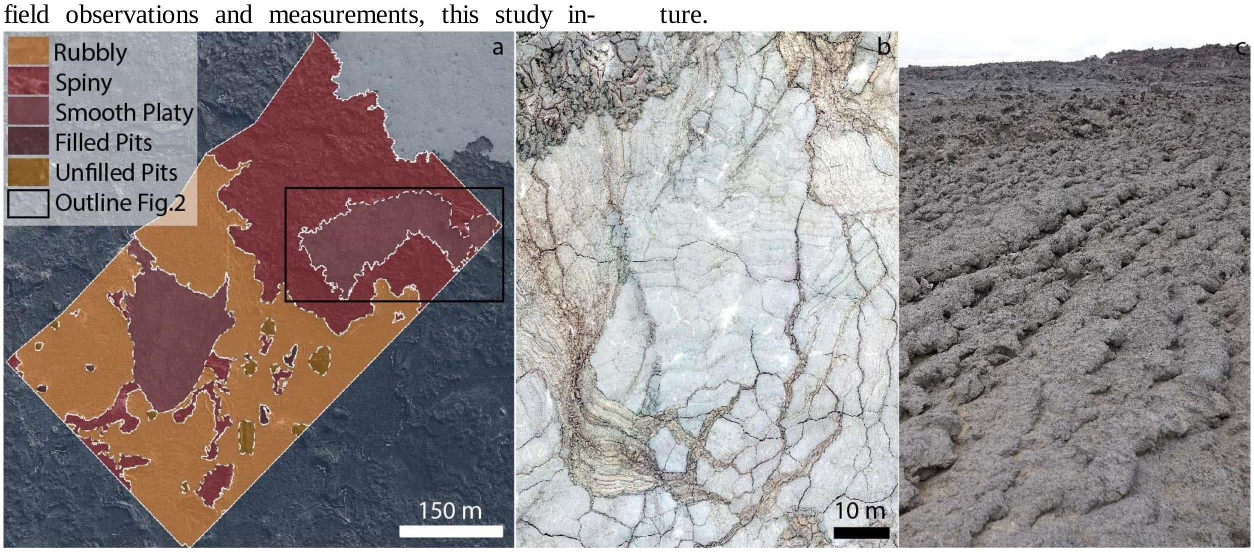

Figure 1 (a) Geomorphological map of platy-ridged terrain near the northern margin at the 2014–2015 Holuhraun lava flow-field. Our focused study location is delimited by the black outline. The map is overlain over a 20 cm/pixel UltraCam basemap. (b) 1 cm/pixel sUAS-derived orthomosiac showing the *Plates* and intervening *Bands I* units within the study area. (c) Ground-based perspective image showing wave-like features on the surface of the *Plates*.

The focused study region (facies map in Fig. 2) has an area of 0.0198 km^2. However, the original emplaced total area seems to be larger since, at least the southern and northern edges are buried by younger lava lobes. The platy terrain is composed of four groups of facies: *Plates*, *Bands I* (characterized by vertical orientated wedges), *Bands II* (composed of highly brecciated lava crust), and *Depression* (significant elevation change relative to the surrounding) shown in Fig. 2.

Interpretation and Discussion: *Plates* are the oldest units exposed within the study area. They exhibit a wave-like surface texture formed by the successive extrusion of spiny lava, with bands formed perpendicular to the local flow direction. These plates of "toothpaste" lava were previously described in the context of the 1960 Kapoho eruption in Hawaii [7]. However, within our study region, the plates underwent successive fracturing events, which exposed new material where the plates diverged, and form angular breccia where plates converged. Within the divergent plate boundaries, the new crust manifested itself as *Bands I*. These spreading zones commonly include squeeze-ups viscous material that forms high-standing ridges between the plates. In contrast to this extensional process, *Bands II* are composed of crustal slabs that formed within shearing and compressional zones where adjacent plates collided. *Depressions* are lava-rise pits formed once translation of the platy-ridged terrain stabilized and the lobe began to inflate.

The cross-cutting relationships between these facies provide information about the emplacement history of the lava lobe, and Fig. 2 presents a chronological map, illustrating that the formation and break-up of crust occurs in multiple stages. Interestingly, while the platy-ridged surface of this lobe provides evidence of lateral translation, detailed examination of the plates suggests that there was minimal down-flow rafting of material and instead most of the disruption takes place in-situ. Also, while platy-ridged terrain visually suggests formation within a high energy environment, incremental fracturing and extrusion of material between the plates implies a gradual formation mechanism. Slow formation in multiple stages is further supported by depressions, which are interpreted to be lava-rise pits formed once the surface re-solidified into a coherent crust that thermally insulated molten lava that continued to be supplied through the underlying molten core. This suggests that platy-ridged terrains on Mars may result from gradual breakup of large channels and lava ponds, and do not necessarily imply disruption due to rapid (i.e., turbulent) flow, although flux of lava can also continue after the disruption event.

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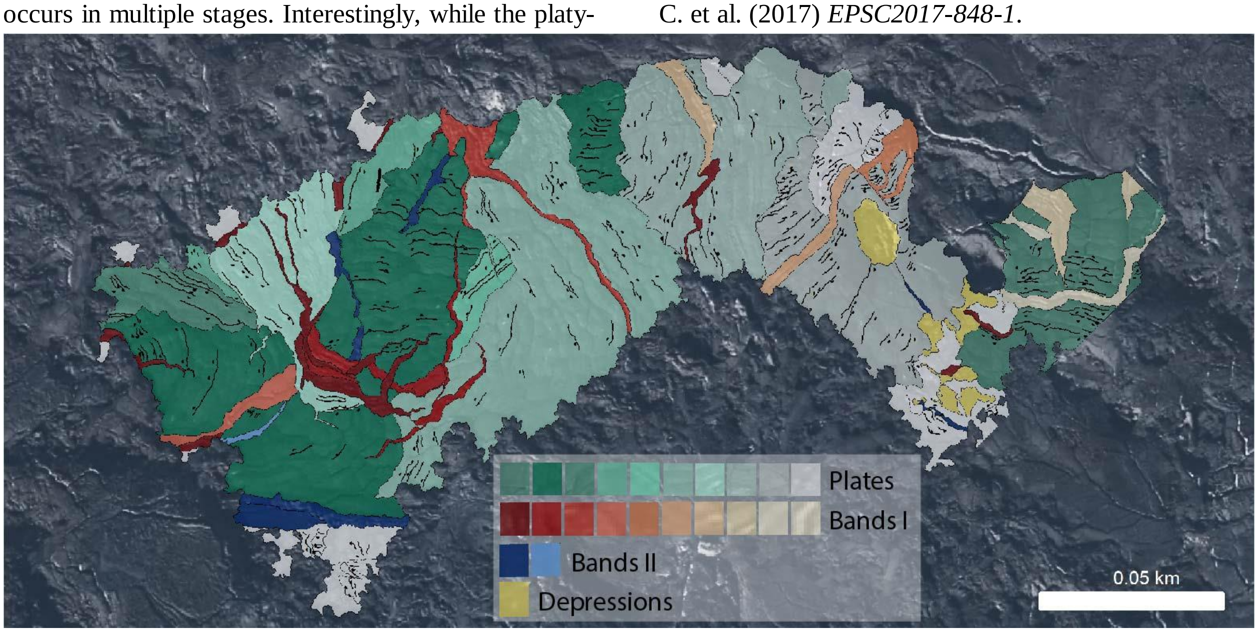

Figure 2. Chronological map of the study site showing the relative emplacement timing of materials within the four facies groups. The map (generated using a 1 cm/pixel basemap) is displayed over UltraCam-Xp data (20 cm/pixel).