

Analysis of inflated submarine and sub-lacustrine Pahoehoe lava flows using high-resolution bathymetric and lidar data

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The summit of the East Pacific Rise (EPR), 16°N, is investigated based -among others- on high-resolution bathymetry acquired using the AUV Aster-X, and photos and videos collected using the submersible Nautil (Ifremer). HR bathymetry reveals submarine tumuli and inflated smooth lava flows at the summit of the ridge, emplaced on sub-horizontal terrains. They are primarily composed of jumbled and lobate flows with occurrences of sheet flows, and pillows close to the flow margins. They are 5 to 15 meters -high, and their surface ranges 0.2 to 1.5 km². Their surface is either planar or depressed, likely due to lava drainback during eruption. At their margins, planar slabs of lava, few meters wide, slope down from the top of the flow, at angles ranging 40 to 80°. A series of cracks, 0.5 to 1.5 m deep, separate the horizontal surface of the flow from their inclined flanks. These cracks parallel the sinuous edges of the flows, suggesting the flow flanks tilted outward. Tumuli are also observed. Some of these smooth flows form 80 to 750 m -long sinuous ridges, suggesting the existence of lava tubes. Their morphology indicates that these flows experienced inflationary emplacement styles, but at a much larger scale than Pahoehoe lavas in Hawaii and La Réunion Island. In these two islands, indeed, inflation structures are typically less than 2 meters high and only several tens of meters in length at maximum, suggesting that their mechanism of emplacement and inflation is significantly different. Conversely, we observe comparable inflation flows in Iceland and in Idaho and Oregon, also emplaced onto sub-horizontal terrains. We use high-resolution aerial photographs and lidar data to investigate their morphology. In the Eastern Snake River Plain (ESRP), quaternary basaltic plains volcanism produced monogenetic coalescent shields, and phreatomagmatic basaltic eruptions that are directly related to proximity of magmatism to the Snake River or Pleistocene lakes. For example, the Hells Half Acres Holocene lava flows, Idaho, display similar morphology as EPR flows, with sheet lavas, flow lobes 5-8 m high and approximately 100 m wide, and pressure ridges. Similar flows are observed in the ESRP: Craters of the Moon, Wapi, and Cerro Grande lava flows for example. In Oregon, Potholes, Devils Garden, Diamond Craters, Deschute River, Owyhee River, Jordan Crater flows are also strictly comparable. In Iceland, Lake Mytvan lava flows, for example, were emplaced in sublacustrine environments, and Budahraun flows in Snaefellness were emplaced at the coast below the sea level. The common point of these presently "aerial" lava flow is their emplacement in lakes, paleo-lakes and river beds, thus in "wet" environment, often controlled by rivers and their tributaries. A more efficient cooling of the lava lobes in wet environment probably triggers the development of strong and plastic margins due to cooling, which resists continued movement of the flow, whereas a thinner margin developing in aerial environment may favor lobe break out when internal pressure rises above the tensile strength of the crust. We propose a theoretical model for these lava flow emplacement on sub-horizontal basement.

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