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Comparative study of volcanic landforms on Mars and on the East Pacific Rise using high-resolution AUV and HiRISE data

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Recently developed methods of acquiring high resolution bathymetry allow scientists to observe seafloor morphology at mid-ocean ridges at unprecedented resolution. Using high-resolution data (<2m) collected using the Autonomous Underwater Vehicle (AUV) AsterX, we remapped the lava flows at the summit of the East Pacific Rise (EPR) at 16°N, where this active fast-spreading ridge interacts with the Mathematicians hotspot, and has an elevation of at least 400m above the average depth of the North Pacific ridge, indicating a high magmatic production. We compare the mapped lava flows with HiRISE data with similar resolution from Mars. The 1-2-m-resolution data allow identification of flow internal structure, boundaries, and emplacement sequences. The questions raised by those observations and comparisons concern the mechanism of lava emplacement and the nature of the lava flow.
Mars is indeed fundamentally a volcanic planet. Geological mapping shows that about half the surface seems to be covered with volcanic materials that have been modified to some extent by other processes (such as meteorite impacts, blowing wind, and floods of water). HiRISE provides the ideal tool to study some of the most puzzling aspects of Mars volcanism. It has been already shown, from joined studies of Martian and Hawaiian volcanic flows, that Martian flows "had a viscosity like that of basalt," as do most flood lavas on Earth, but flowed from the ground much faster. In addition to the large shields, Mars has a range of other volcanic features. These include large volcanic domes (tholi), highland paterae (see below), volcanic plains, dikes, spatter ridges, and small domes.

Despite the volumes of eruptions and the emplacement conditions are different in ocean and on mars, we observe similar Pahoehoe-like lava flows at the EPR 16°N and on Mars east of the Aethiopis plain, in the large volcanic provinces of Elysium. At the EPR, these flows areas range from 0.2 to at least 1.5 km2, their thickness ranges few meters to 20 meters. Ground truthing using the manned submersible Nautile (Ifremer) shows that these lava flows are primary composed of lobate flows, with minor occurrence of levees and pillows on flow boundaries and near the eruption point source, when identified. At mars, similar flow areas exceed tens of km2 but their morphology is very similar. These flows have either a relatively smooth or a broken platy texture, consisting of dark, few tens of meter-scale slabs embedded in a light-toned matrix. They have been attributed to rafted slabs of solidified lava floating on a more fluid subsurface. Levees are also observed at some of the flow boundaries, which are characterized by lobate shape of the edges, as well as lava channel meanders through the flows. Flows display a flat or slightly depressed surface, likely due the lava drained off from underneath when continuing to propagate. These observations are used to discuss the contrast of viscosity between terrestrial and Martian lavas and the effect of respective cooling by water and by a very cold atmosphere.