Rubbly Pahoehoe, Flood Basalts, and Mass Extinctions

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The potential role of flood basalt eruptions in mass extinctions has been debated for many years. The coincidence in timing between mass and major extinctions and flood basalt volcanism is well established. It has also been shown that a single flood basalt eruption released >10 Gt of volcanic acids (i.e. SO2, HCl, HF) into the atmosphere. But our earlier studies suggested that only a fraction of this gas would enter the stratosphere, making it unclear if such eruptions would affect the atmosphere and climate globally. We present new studies on the physical volcanology of flood basalt lava flows that indicates that the eruption associated with a specific type of lava flow was probably capable of injecting the majority of its released volcanic gas into the stratosphere. These flows, which we have called "rubbly pahoehoe" flows, may be link between extinctions and flood basalt eruptions.

Rubbly pahoehoe flows are characterized by a flow top breccia composed of broken pahoehoe lobes. Below this breccia, the flow has the characteristics of an inflated pahoehoe flow. The base of the flow is usually a smooth pahoehoe surface and the interior often includes unusual, 2-4 cm long, elliptical vesicles. To date, such flows have been found in the Columbia River Basalt Group, the Kerguelen Plateau, Iceland, and on Mars. The Laki flow is the only known example of a large rubbly pahoehoe flow that was witnessed by humans. From our studies of Laki and other rubbly pahoehoe flows, we infer that these flows required very high lava discharge rates. In fact, for flood basalt scale flows (order 1000 km3), we predict rubbly pahoehoe flows were emplaced at eruption rates an order of magnitude higher than for normal pahoehoe flows. This order of magnitude increase in eruption rate increases the estimated height of the gas plume over the eruptive fissure to 9-16 km, allowing penetration of the stratosphere in most cases. Further studies to better constrain these estimates are underway.