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Preferential direction, anisotropy and differential anisotropy of flows and their textures

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Textural morphology of subsurface lava flows is an expression of the intense stress applied at the surface during an eruption over a large range of scales. Pahoehoe and A'a Hawaiian textures are typical terrestrial examples illustrating different conditions of volcanic eruption styles. Flows and textures are direction dependent; their statistical properties are anisotropic. While the anisotropy and orientations may be the same at all scales, more generally they will be differentially anisotropic with aspect ratios and orientations scale dependent. To be manageable, additional assumptions are necessary, we argue for anisotropic scaling (generalized scale invariance; GSI). Indeed, a particular and prominent aspect of the observed textures is the ubiquity of scaling properties, implying a scaling symmetry over a wide range of scales.

A qualitative difference between the two Hawaiian texture types is the differentially oriented structures present in the Pahoehoe lavas as for example in the ropey type Pahoehoe. In such cases, GSI could provide new powerful insights for describing highly variable anisotropic phenomena. We will discuss this question through Pahoehoe and A'a textures acquired in Hawaii studying images spanning the range of millimeters to meters. We describe a new analysis technique which allows us to systematically determine orientation and anisotropy as a function of scale we apply this to A'a and pahoehoe flows. Such studies have direct implications in the identification of lava flows and their related underlying processes in hostile or non accessible regions including on other planets.