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Tensile strength of dome rocks and lavas at Santiaguito dome complex, Guatemala

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Lava domes are inherently unstable structures, subject to intense gas flux and rapid variations in the state of stress. At shallow depths confining stresses are minimal and deformation is dilatant, occurring predominantly through tensile fractures. This fracture mode facilitates outgassing and contributes to the development of gas-and-ash activity as well as vulcanian eruptions. However, there is a paucity of tensile strength data for volcanic materials in the published literature, and we know of no paper which addresses this at high temperatures.
We study the tensile strength of dome rocks collected at the Santiaguito dome complex, Guatemala, over a porosity range of 3-25%. Indirect tensile (Brazilian) tests were conducted on 40-mm diameter cores, by imposing a compressive displacement rate (radial to the core) of 4 micron/s at room temperature as well as an eruptive temperature of ca. 850 °C. An acoustic monitoring system is employed to track the nucleation, propagation and coalescence of fractures leading to complete sample failure.
We find that the rocks' tensile strength exhibits a nonlinear decrease with porosity. Preliminary tests at high temperature indicate that some rocks exhibit a higher tensile strength (than at room temperature); in these experiments, samples containing a higher fraction of interstitial melt revealed an additional component of viscous flow. Further experiments conducted at higher strain rates will define the brittle response of the liquid during tensile failure.
The data is compared against similar datasets for volcanic rocks. We will discuss implications for shallow volcanic processes ranging from dilation bands and tuffisite formation to gas-and-ash explosions and dome structural stability.