



Assessment of rock properties and slope stability at Pacaya Volcano, Guatemala

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Pacaya is an active stratovolcano located 30 km south of Guatemala City, Guatemala. A large (0.65 km³) sector collapse of the volcano occurred 0.6 - 1.6 ka B.P., producing a debris avalanche that traveled 25 km SW of the edifice. The structural setting of the current cone, along with two recent smaller-volume collapses in 1962 and 2010, suggest gravitational instability of this volcano. Recent measurements of the geomechanical properties of lava and breccia from Pacaya are used to improve our understanding of the destabilizing potential of different volcanic processes. Room-temperature uniaxial and triaxial compressive tests, and total porosity tests, were conducted on 17 breccia and 21 lava samples. The average uniaxial compressive strength (σ_{ci}) of lava rocks was moderately strong ($\sigma_{ci} = 72.4$ MPa), with breccia rocks being 62.2% weaker ($\sigma_{ci} = 27.4$ MPa). These values can partially be contributed to lava rock's very low porosity (0.054) and breccia rock's higher porosity (0.19). We also find an apparent rate-dependent strengthening of the samples as strain rate is increased from 10^{-5} to 10^{-1} . Values of Poisson's Ratio (ν) and Young's Modulus (E) calculated from triaxial tests, are $\nu = 0.28$ and $E = 13.9$ GPa for breccia and $\nu = 0.31$ and $E = 17.6$ GPa for lava. These experiments highlight the contrasting character of breccia versus lava, and suggest that sector collapse may have initiated in the weaker breccia. Additionally, cohesion (c) and friction angle (ϕ) calculated from triaxial tests yielded values of $c = 1.8$ MPa and $\phi = 19.4^\circ$ for breccia and $c = 4.0$ MPa and $\phi = 41.4^\circ$ for lava. Following sector collapse, the frictional properties of the rocks partially dictate the flow and deposition of the debris avalanche, and these were studied using high velocity rotary shear experiments on ash and lava rock. Experimental results are combined to understand the historical flank stability and assess the likelihood of future sector collapse at Pacaya.