Heat transfer during large-scale lava-ice/snow experiments

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One of the most basic requirements for understanding interactions between lava flows and their emplacement environments is knowledge of heat transfer. This is particularly important when lava flows are emplaced into environments with liquid/solid H2O. Although recent eruptions have provided new insights into heat transfer between lava and snow/ice (e.g. Fimmvorduhals 2010), quantitative measurements of interactions between lava and ice/snow are rare. To address these difficulties, we conducted a series of pilot experiments designed to allow close observation, measurements, and textural documentation of interactions between basaltic melt and ice. Here we discuss the results of the several experiments designed to investigate heat transfer directly between lava and snow/ice, as well as experiments designed to have a boundary layer (silica sand) separating the lava and snow/ice. The experiments involve controlled pours of up to 300 kg of basaltic melt on top of ice. The design of the experiments allows for monitoring of temperatures on the lava surface using FLIR cameras, as well as continuous measurements of temperatures at several critical boundaries (lava-snow/ice, lava-boundary layer-snow/ice) within the experimental vessel. Our experiments provide: 1) estimates for rates of heat transfer through boundary layers and for ice melting; 2) constraints on controls for rates of lava advance over ice/snow; 3) documentation of lava bubbles (Limu o Pele) formed by steam from vaporization of underlying ice/water; and 4) new insights on the role of within-ice discontinuities to facilitate lava migration beneath and within ice. The results of our experiments confirm and provide better constraints for field observations about the rates at which lava can melt snow/ice, the efficiency of heat transfer across a boundary layer, and morphologies/textures indicative of direct lava-ice interaction. We also show that the generation of steam from meltwater can buffer temperatures at the boundary layer interface, and can create bubbles and even large cavities within the overlying lava flow.