ABSTRACT

Throughout February and March of 1997 Okmok volcano, in the eastern Aleutian Islands of Alaska, erupted a 6 km long lava flow of basaltic a'a within its caldera. A numerical model for lava flow cooling was developed and applied to the flow to better understand the nature of its cooling. Radiation and convection from the surface, as well as conduction to the ground, were used to transport the flow's heat to its surroundings in the model. Internally, a conduction-only approach moved heat from the interior out. Vesiculation, latent heat generation, and thermal conductivity changes with temperature are among the other factors that were dynamically accounted for.

The model predictions were then compared to corroborative data on two time scales. In the short term comparison, computed surface temperatures from the model were compared to estimates of the flow surface temperature from thermal infrared AVHRR (Advanced Very High Resolution Radiometer) imagery (Band 4: $\lambda=10.3 – 11.3 \mu m$) throughout a 200 day cooling period following the eruption. Various methods were used to extract the sub-pixel lava component from the AVHRR pixel radiance, including pixel-integration and the dual-band approach. Results indicated that ambient temperature fluctuations, on the scale of days to weeks, must be taken into account to create an accurate record of lava surface temperature. Daily data of rainfall and ambient temperature, as opposed to yearly averages used in comparable models, greatly increased the accuracy of the model. Furthermore, convective cooling of the lava surface was observed to be the dominant heat loss process during extended cooling indicating the convective heat transfer coefficient is a prime determinant of the accuracy of the model.

For the long term comparison, the model was run for four years. Model results predicted a significant level of remnant internal heat, and these were compared to AVHRR and FLIR (Forward Looking Infrared Radiometer) observations of surface conditions indicative of a molten interior. Over the long term, density, porosity and thermal conductivity proved to be among the dominating factors for accuracy. The model's flexibility allows application to flows beside that of the 1997 Okmok eruption. Input parameters can easily be modified, allowing the user to measure flow crust thickness and surface heat flux, among other things, for a wide range of lava flow types.