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The Cooling Rate of an Active Aa Lava Flow Determined Using an Orbital Imaging Spectrometer

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The surface temperature of an active lava flow is an important physical property to measure. Through its influence on lava crystallinity, cooling exerts a fundamental control on lava rheology. Remotely sensed thermal radiance data acquired by multispectral sensors such as Landsat Thematic Mapper and the Terra Advanced Spaceborne Thermal Emission and Reflection Radiometer, are of insufficient spectral and radiometric fidelity to allow for realistic determination of lava surface temperatures from Earth orbit. This paper presents results obtained from the analysis of active lava flows using hyperspectral data acquired by NASA's Earth Observing–1 Hyperion imaging spectrometer. The contiguous nature of the measured radiance spectrum in the 0.4–2.5 micron region means that, although sensor saturation most certainly occurs, unsaturated radiance data are always available from even the hottest, and most radiant, active lava flow surfaces. The increased number of wavebands available allows for the assumption of more complex flow surface temperature distributions in the radiance–to–temperature inversion processes. The technique is illustrated by using a hyperspectral image of the active lava lake at Erta Ale volcano, Ethiopia, a well characterized calibration target. We then go on to demonstrate how this approach can be used to constrain the surface cooling rate of an active lava flow at Mount Etna, Sicily, using three images acquired during a four day period in September 2004. The cooling rate of the active channel as determined from space falls within the limits commonly assumed in numerical lava flow models. The results provide insights into the temperature–radiance mixture modeling problem that will aid in the analysis of data acquired by future hyperspectral remote sensing missions, such as NASA's proposed HyspIRI mission.