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Estimation of the energy release and thermal properties of ejected clasts from explosive eruptions using a thermal imaging camera

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Thermal images were obtained at Popocatépetl, central Mexico, during the period of high lava-dome destruction activity between 1998 and 2002. Similarly, thermal cameras have operated at Colima volcano, western Mexico during episodes of similar explosive activity in 2005 and 2007. We have developed a method to estimate the relative thermal energy release among explosions, and the degree of conversion into mechanical energy spent in the fragmentation of the ejecta, based on the cooling rate inferred from successive thermal images obtained immediately after each explosion. The thermal imaging cameras were located at about 11 km from the crater at Popocatépetl, and at about 6 km from the crater at Colima. The selected explosions threw significant amounts of hot debris on the volcano flanks. The cooling rate was then measured on selected pixels of the thermal images, and compared with different possible distributions of fragment sizes considering weighted averages of fragments in the pixels. The optimal fitting of fragment distributions reveals the degree of fragmentation of individual explosions, and along with a model for the cooling process, permitted to estimate the relative thermal energy release on the area covered by the image. Additionally, the results indicate that the radiative thermal conductivity plays a significant role on the outer shell of the fragments, suggesting a free mean path of thermal infrared photons that may reach several millimeters or even a few centimeters.