Evidence for welding of a block and ash pyroclastic flow deposit: the case of Cerro Bravo Volcano, Colombia

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Abstract

Cerro Bravo is an active composite volcano located in the San Diego—Cerro Machín Volcano-Tectonic Province (SCVTP), the northernmost volcanic chain in the Colombian Andes. Among the products associated with the volcano, there is a peculiar “indurated” deposit emplaced between 7 and 2.9 ka, which resembles a block and ash pyroclastic flow deposit. Through field observations, physical property analyses, petrography and scanning electron microscopy (SEM), we demonstrate that this induration is the result of welding processes. High density, deformed glassy fragments with a common orientation, low porosity, fiamme and sintering, are the most visible characteristics. The evidence indicates that welding reached up to rank IV in a I to VI classification scheme. We suggest that welding is associated with (1) high emplacement temperature related to the syneruptive destruction of a growing endogenous dome and (2) a low glass transition temperature related to the influence of upward water diffusion after emplacement of the flow over wet ground. Thus, with emplacement temperatures between 670 and 540 °C, and water contents between 0.5 and 1.2 wt%, the welding process was unusually efficient. Calculations made indicate that for the deposit to present the observed characteristics of welding, the emplacement temperature needed to exceed the threshold of the glass transition temperature for a time of 5–6 days and have an effective viscosity of 10^{12} Pa s. As a result of the welding, the deposit decreased its thickness by between 15 and 7 m. This work contributes to the knowledge of welding processes and stresses the unusual occurrence of welding in this type of pyroclastic flow deposit which thus requires special emplacement conditions in terms of temperature and water content.

Keywords: Welding, Block and ash flow, Glass transition temperatura, Flattening of glassy fragments, Sintering, Porosity.