Forensic Geochronology of an Explosive-Effusive Transition: Ascension Island, S Atlantic

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Geochronological-geochemical-petrological study of the only known explosive-effusive transition on Ascension Island has revealed closed-system 'cold' crystal storage. Major and trace element data, zircon O-isotopic compositions and distinctive large alkali feldspars link the Echo Canyon sequence units, from base to top: Lower Pumice, plutonic clasts, Upper Pumice, Lava Breccia, Baked Pumice, and an associated Dome.

Combined U-Th disequilibrium (indicating crystallisation) and U-series disequilibrium corrected (U-Th)/He zircon dating (registering cooling below ~200ºC) of these deposits has identified two major magmatic events: one at ca. 110 ka and another at ca. 60 ka. The Lower Pumice has concordant U-Th and (U-Th)/He zircon ages of ca. 107 ka and ca. 103 ka, respectively, whereas an Ar/Ar alkali feldspar age is younger at ca. 59 ka. Plutonic 'antelith' clasts sampled at the contact between the Lower and Upper Pumice have U-Pb zircon ages that are uniform within each clast averaging ca. 0.6 Ma and ca. 1.3 Ma. The Upper Pumice yielded a U-Th zircon age of ca. 113 ka, whereas few zircons dated from the overlying Lava Breccia are heterogeneous with U-Th ages of ca. 194 ka, ca. 72 ka, ca. 66.5 ka, and ca. 64 ka. Corresponding (U-Th)/He zircon ages are ca. 89 ka and ca. 55 ka. Baked pumice capping the sequence yielded model U-Th zircon ages between ca. 64 ka and 190 ka with a dominant peak at ca. 110 ka; (U-Th)/He ages are heterogeneous at ca. 116 ka and ca. 53 ka. Finally, the associated Dome, petrographically linked to the pumices and lava in the field, has concordant U-Th and (U-Th)/He zircon ages of ca. 110 ka and ca. 114 ka, respectively.

The explosive-effusive transition sequence ages fit well with other, regional, explosive pumice fall eruptions dated at ca. 110 ka and ca. 60 ka by Ar/Ar. Preservation of old (U-Th)/He zircon ages suggests the younger magmatic event recycled some crystals from older rocks in 'cold storage' at <200ºC. Helium systematics of older, pre-existing, zircon crystals were only partially reset in deposits of the upper part of the sequence, Lava Breccia and Baked Pumice, implying fast magma emplacement and cooling.