Petrology and geochemistry of intra-caldera ignimbrites from the Central Ring Complex, Isle of Arran, western Scotland

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The current exposure of the British & Irish Palaeogene Igneous Province (BPIP) is dominated by significant thicknesses of fissure-fed basaltic lava fields, and large, granitic and gabbroic plutonic complexes that represent the root zones of later Palaeogene volcanic superstructures. The majority of the volcanic products erupted from these central volcanic complexes have been removed by erosion, and our understanding of their spatial, temporal and compositional evolution remains relatively poor. However, at a number of localities across the BPIP, rocks previously interpreted as intrusions or lavas ("felsites") and subterranean explosion breccias ("agglomerates"), have now been re-classified as ignimbrites and breccias associated with caldera collapse [1, 2, 3]. Through these advances, and other ongoing studies, we have now started to develop our understanding of these enigmatic rocks.

The Central Ring Complex (CRC) on the Isle of Arran, western Scotland, has long been considered the remnants of a caldera and is thought to represent the "shallowest" and most complete example in the BPIP [4]. However, the CRC has not benefitted from a detailed modern investigation and interpretation. Here, we present preliminary field and petrographic evidence from the CRC, which has allowed us to identify a range of ignimbrite lithofacies, including: i) non-welded to incipiently welded massive lapill tuff; ii) massive breccia; iii) massive rheomorphic lapilli tuff; iv) massive crystal tuff; and v) planar- to cross-stratifed tuff and lapilli tuff. The ignimbrites are compositionally distinct and range from basaltic to rhyolitic, and include andesitic units which are rare in the BPIP.

The ignimbrites are locally interbedded with fluivatile and debris flow conglomerates and breccias, indicating hiatuses in caldera collapse and ignimbrite deposition. The planar- and cross-stratified tuffs and lapilli tuffs (v) are of basaltic composition and overlie coarse debris flow breccias and conglomerates. We interpret the tuffs as phreatomagmatic deposits formed by the explosive interaction of basaltic magma with groundwater in the breccias and conglomerates. This magma-water interaction produced high eruption columns, which collapsed and formed mobile low-particle concentration density currents that deposited the tuffs. The massive lapilli tuffs and breccias (i, ii) were deposited from high-particle concentration density currents, with variable mass flux. The rheomorphic lapilli tuffs (v) were most likely formed from low eruption column boil-over events.

The ignimbrite units are generally more evolved up sequence, although rhyolites are also exposed towards the base. The more evolved units all contain basaltic inclusions suggesting magma mixing by chamber replenishment and physical mingling, which may have acted as an eruption trigger.

Mapping, logging and analysis of the CRC is ongoing. Watch this space!

References
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