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Cone sheet emplacement in sub-volcanic systems: a case study from Ardnamurchan, NW Scotland

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Inclined concentric sheet intrusions (ring dykes and cone sheets) are key elements of the intrusive framework of sub-volcanic systems (central complexes). The nucleus of volcanic centres are often identified by the focus of inward dipping cone sheets based on a fundamental assumption about how the general geometry and disposition of the sheets relates to a (central) source. We aim to test the implications for magmatic plumbing (magma flow and linkage) that is generated by this model and thereby examine this fundamental assumption of sub-volcanic systems. Here we present preliminary evidence for magma flow and emplacement dynamics from the cone sheets of Ardnamurchan, NW Scotland, using anisotropy of magnetic susceptibility (AMS) measurements and structural field observations.

AMS data from over 100 oriented block samples from the Ardnamurchan cone sheets reveals magnetic lineations that are consistent with visible magma flow indicators, such as step and broken bridge axes. Flow directions vary from strike parallel to dip parallel and cannot be traced back in a simple way to a source. Field observations show host rock behaviour during cone sheet emplacement can be linked to lithology; magma fingers (ductile) occur in Palaeogene volcanic and volcaniclastic rocks, broken bridges (brittle-ductile) occur in Mesozoic sediments, and angular xenoliths (brittle) occur in Proterozoic psammites. In well exposed coastal sections, cone sheets intruding Mesozoic sediments are observed parallel to bedding, transgressing up the sedimentary sequence and may be described as transgressive sills. At Mingary Pier (NM 493 626) the transgression appears to be controlled by host rock fractures.

Given that there is little compositional variation between different cone sheets, the host rock lithology and structure needs to be considered before grouping them into separate geometric suites related to volcanic centres. Flow direction data does not support a centralised source model and in fact reveals a general NW-SE trend suggesting an alternative source.