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Magma changes during ascent and its impact on eruptive style: a study from Mt. Taranaki andesites, New Zealand

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Subduction-related andesite volcanoes show a variety of eruptive styles from effusive emission of lava flows and emplacement and destruction of lava domes to explosive sub-plinian eruptions. All these styles may occur within one eruptive episode, with transitions between contrasting styles of events often being sudden. To understand these different eruptive behaviours, petrographic and geochemical studies on Mt. Taranaki andesite rocks have been undertaken.

The Taranaki andesite rocks can broadly be subdivided into three categories: virtually hornblende (hbl) -free rocks, hbl-containing rocks with different degrees of hbl alteration, and unaltered hbl-containing rocks. The presence or absence of hbl in volcanic rocks is a crucial indicator of water contents of the magma, which strongly influences the eruptive style.

Petrographic data, e.g. degree of alteration of hbl and groundmass glass textures, as well as geochemical data such as that from melt inclusions in clinopyroxene and hornblende, suggest that there are two end member magma compositions, a ‘dry’ and a ‘wet’ andesitic magma. The terms ‘dry’ and ‘wet’ are used to illustrate whether the magma contains hbl (wet) or not (dry). We conclude that both magmas are derived from the same initial parental melt at the base of the continental crust, which then evolves differently during ascent within the crust. The two magma compositions erupt either as lava flow (dry) or pumice fall (wet). There is also evidence that some rocks represent hybrid magmas caused by mixing/mingling of dry and wet magma.

The shift from initial lava dome emplacement to an explosive sub-plinian phase is also documented in studies from the Burrell Lapilli eruption (AD 1655). We identify internal (dyke propagation, magma ascent and supply rate) and external factors (vent and crater morphology) as controlling the eruptive style and demonstrate where further research is needed.