Linking lava domes to their structural setting

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The eruption of lava domes can be strongly controlled by local and regional structure, yet it is not always easy to observe this volcano-tectonic relationship. We infer that the conduits for these eruptions will often be close to, or along, major faults and so the internal structure of the dome, defined by the shape and position of the conduit, can also be linked to the structural setting. To investigate the volcano-tectonic relationship, we have focussed our studies on the internal structures of lava domes that sit within two different calderas in the Taupo Volcanic Zone (TVZ) of New Zealand. At Ngongotaha Dome, Rotorua Caldera, quarrying has exposed a cross section through part of the dome, and at Tarawera Volcano, Okataina Caldera Complex, a rift produced during the historical 1886AD eruption exposed part of the interior of the domes. In such a hyperactive caldera-forming region like the TVZ, it can be difficult to observe the geometry or structure of calderas because of their rapid burial, and thus, domes may remain as their only structural clue.

At Ngongotaha Dome, a fan-like arrangement of flow bands from the outer edge to the centre suggests a central dyke-fed conduit running parallel to the outer edge of the dome. The location and morphology of the conduit can be related to caldera structures, as flow band orientations from within the dome matches elongation of gravity lows associated with caldera collapse. Post dome growth fractures share similar orientations to the dominant northeast trending structural grain of the region. We compare the structural orientations within Rotorua Caldera (gained from mapping of Ngongotaha Dome) to those at nearby Okataina Caldera Complex, in order to investigate the volcano-tectonic evolution of the regional structure.

Tarawera Volcano is more complex. Previous research has concluded that the domes of Tarawera were inflated with minor flow development, as suggested by the presence of an onion skin-like circular flow band pattern. However, flow bands are often near vertical above the proposed conduit, and show a wide variety of orientations at the flanks of the dome. Instead, a series of vertically emplaced sheets that were then carried outwards from the vent is suggested as a possible method of emplacement of this dome.

Analysis of the internal structures of lava domes can provide a wealth of knowledge as to the emplacement of the dome and structural setting it resides within. In particular, where other structural clues like faults are missing, internal structures and morphologies of lava domes can help to reproduce structural maps at a caldera scale. These structural maps can also provide insights into the wider regional scale tectonics and evolution of the structure of the TVZ.