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INTERACTION: INTERaction between life, Rifting And Caldera Tectonics In Okataina

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Calderas are major volcanic features with large volcanic and seismic hazards. They also host diverse microbiota, provide heat, energy, mineral and economic benefits. Despite their scientific and socio-economic importance, we still do not completely understand calderas and the interactions between volcanism, tectonism, fluid circulation and the deep biosphere because in-situ and subsurface observations are sparse.

The Okataina Volcanic Centre (OVC) in Aotearoa New Zealand, is one of two active giant calderas of the Taupō Volcanic Zone within the rapidly extending continental intra-arc Taupō Rift. This superb natural laboratory has: 1) numerous past eruptions of varied size and style, 2) documented co-eruptive earthquakes, 3) vigorous hydrothermal manifestations, 4) diverse microbial communities in hot springs but unknown in the subsurface.

We propose to establish a scientific drilling programme at the OVC to address:

- What are the conditions leading to volcanic eruptions; and volcano-tectonic feedbacks in intra-rift calderas?

- What controls fluid circulations in active calderas/rift regions?
- Does subsurface microbial community composition vary with tectonic and/or volcanic activity?

High temperatures complicate drillhole design, restrict data collection and prevent exploration of the biosphere. By targeting the cooler parts of the caldera, this project will use conventional engineering to maximise sampling (drill cores and fluids), downhole logging and establish long-term observatories.

Two preliminary drill targets are suggested: (1) in the centre of the caldera; (2) through the caldera margin. Drill data will provide a comprehensive record of past activity, establishing eruption frequency-magnitude relationships and precursors. Combined with well-known fault rupture history, the relative timing of tectonic and magmatic activity will be untangled. Drill data will unravel the relationships between the groundwater and hydrothermal systems, magma, faults and stress, informing thermo-hydro-mechanical regional caldera models with findings applicable worldwide. Drill cores and a dedicated fluid sampler triggered by nearby earthquakes will reveal the composition, function and potential change of microbial activity in response to rock and fluid variations.

The programme is informed by indigenous Māori, regulatory authorities and emergency managers to ensure scientific, cultural, regulatory and resilience outcomes. The programme will underpin 1) community resilience to volcanic and seismic hazards; 2) sustainable management of groundwater and geothermal resources, and 3) understanding of subsurface microbial diversity, function and geobiological interactions. At these early stages of planning, we invite the scientific community to contribute to the concept of this project in the exceptional OVC settings and strengthen linkages with other ongoing research and scientific drilling programmes.