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Subsoil alteration and degassing processes in an active hydrothermal field at Rotokawa geothermal field, New Zealand

Lena Ray (1), Bettina Scheu (1), Cristian Montanaro (2), Shane Cronin (2), and Candice Bardsley (3)

(1) Geo- und Umweltwissenschaften, Ludwig-Maximilians-Universität München, Germany (lena.e.ray@gmail.com), (2) School of Environment, University of Auckland, New Zealand, (3) Mercury Energy NZ, New Zealand

Surface expressions of hydrothermal systems such as mud-pools, fumaroles, and collapse or explosion craters are manifold, highly complex and highly variable in space and time. Such features often lend themselves to becoming tourist attractions (e.g. in Yellowstone, USA, or Wai-o-Tapu, NZ), or are present in geothermally exploited areas, as is the case of the Rotokawa geothermal field (New Zealand). The Rotokawa geothermal field is a valuable power resource (174 MWe capacity), representing a critical facility supporting NZ communities and industry. The geothermal area is characterized by abundant hydrothermal surface features that may represent a significant threat to both safety and operability.

In particular, the Rotokawa steamfield has been an area of intense hydrothermal activity and site of extensive sulfur mining in the 20th century. The steamfield is generally characterized by a complex pattern of alteration, and its surficial manifestations are controlled mostly by a regional NE-SW trending fracture system, and the presence of the heterogeneous, ash- to pumice-rich Taupo Ignimbrite deposit. At the subsoil level (<1m), the distribution of degassing features has been further affected by mining activity.

A field campaign was carried out to assess the surficial distribution of hydrothermal features and temperatures, as well as the physical and mechanical properties of subsoil units within the Rotokawa steamfield. Lab-porosity measurements were also determined on select samples. Four distinct soil domains could be recognized based on their properties, structures and textures: undisturbed Taupo soil units, excavated areas with sulfur-cemented crusts and hummocks on the ground surface, areas dominated by mud and heated pools, and areas of active sinter deposition. The spatial distribution of these domains suggests that fluid circulation, alteration intensity, and degassing are strongly controlled by field/scale faults and permeable contacts/layers within the subsoil.

Surface temperatures range from approximately 10 to 100 [U+25E6]C, with the hottest temperatures measured in water pools or in close proximity to sulfur-encrusted areas, and the coolest temperatures measured in mud and undisturbed Taupo units. Regions of mid-high temperature (>50 [U+25E6]C) are commonly, but not exclusively, distributed along inferred fracture systems and/or geological unconformities. Pumice-rich, as well as more permeable (e.g. sand-rich) soil levels act as lateral [U+FB02]uid pathways. The presence of lower-permeability (e.g. ash- or clay-rich) levels within the Taupo Ignimbrite/reworked subsoil, or the formation of sinters, inhibit surficial fluid degassing.

The investigation of near-surface environment at Rotokawa allows us to better understand the factors controlling hydrothermal alteration in active and dynamic hydrothermal areas. Furthermore, it demonstrate how complex relations between natural and anthropogenic effects may result in sinkhole-collapse craters or, potentially, explosive events.