THREE NEW HOT SPRING VENTS EXPOSED AT ORAKEI KORAKO GEOTHERMAL FIELD, NEW ZEALAND

Bridget Y. Lynne[1,2] and Gary J. Smith[2]

[1]University of Auckland, 70 Symonds St, Auckland, New Zealand

[2]Geothermal Scientific Investigations Ltd, 11 Kyle Rd, Greenhithe, Auckland, New Zealand

b.lynne@auckland.ac.nz or bridget.lynne@gsilimited.com

Keywords: *Reactivation of buried hot spring vents, changes to surface activity, Orakei Korako, Ground Penetrating Radar.*

ABSTRACT

At Orakei Korako geothermal field, Taupo Volcanic Zone, New Zealand, three new hot spring vents appeared in 2019, underneath and adjacent to the boardwalk. These vents were buried and have now been reactivated following a small hydrothermal eruption. Two of these vents currently have 98°C clear, blue water at their base while the third vent is steaming. Prior to exposure of these three vents, this site had elevated near-surface temperatures for many years which we recorded at 100 °C at 0.5 m depth during our repeated site visits. A survey undertaken in 2012 to assess heat migration pathways at Orakei Korako documented hydrothermal alteration in the shallow subsurface at the site where the three new vents are now visible.

1. 2012 SURVEY

Orakei Korako geothermal field is a tourist site that is located within the Taupo Volcanic Zone, New Zealand (Fig. 1). In 2012, a survey around the boardwalk of Orakei Korako was undertaken to assess heat discharging at the surface (Lynne and Smith, 2013). The survey combined the multiple techniques of Ground Penetrating Radar (GPR), infrared imaging, sinter analyses and downhole temperature measurements.

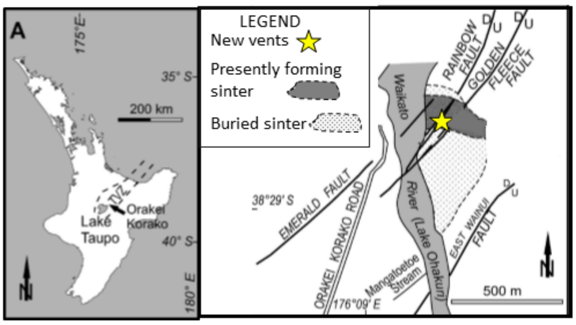
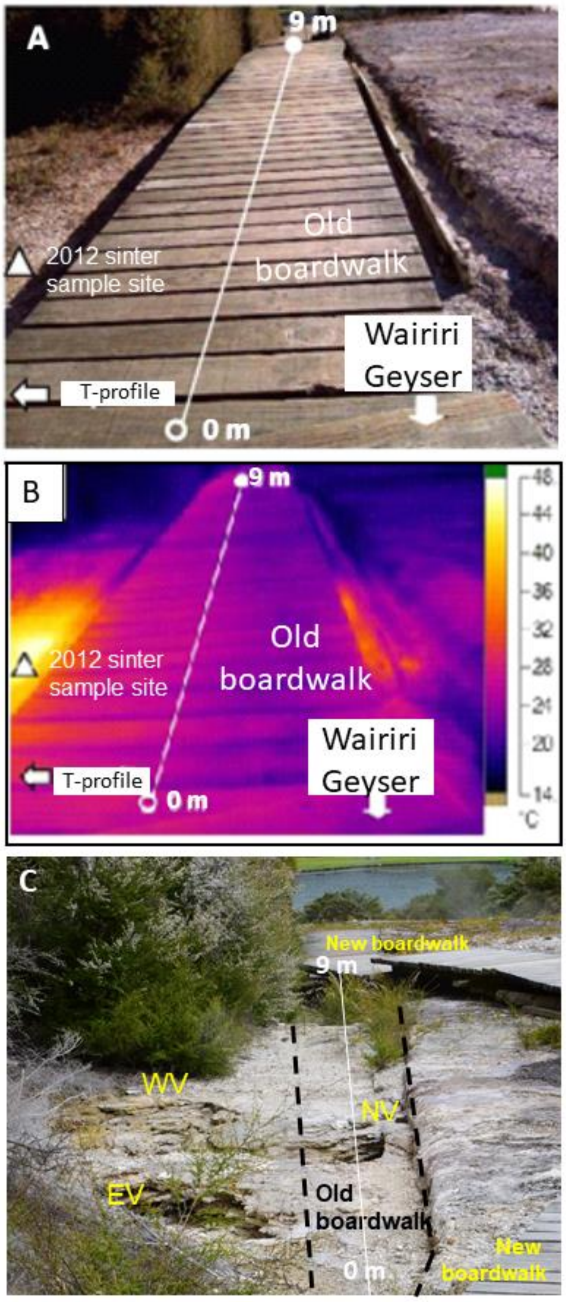


Figure 1: Location of new vents at Orakei Korako geothermal field situated within the Taupo Volcanic Zone, North Island of New Zealand.

In 2012, at the site immediately west of Wairiri Geyser, Lynne and Smith (2013) undertook a nine metre GPR transect along the boardwalk and measured the subsurface temperature at 0.5 m depth at the 0 m mark along the GPR transect line (Fig. 2A). We also took infrared imagery of the surface (Fig. 2B) and analysed surface sinter samples using Scanning Electron Microscopy. Lynne and Smith (2013) documented: (i) a measured temperature of 100 ˚C at 0.5 m depth; (ii) widespread low-amplitude reflections at depth in the GPR image; (iii) elevated infrared surface temperatures; and (iv) abundant dissolution textures in the surface sinter. We concluded that all of these findings suggested significant sustained heat and hydrothermal alteration in the shallow subsurface.



Proceedings 42nd New Zealand Geothermal Workshop
24-26 November 2020
Waitangi, New Zealand
ISSN 2703-4275

Figure 2: Comparative 2012 and 2019 survey site photographs. (A) Photograph of 2012 survey site with 0 to 9 m GPR transect line shown, downhole temperature measurement site (T-profile) and sinter sample site. (B) Infrared image of (A) taken in 2012. (C) East vent (EV), North vent (NV) and West vent (WV) as they appeared in 2019. Boardwalk moved several meters to the north in 2019 to avoid the new vents. 9 m long GPR transect line shown where it was located in 2012.

2. 2019 OBSERVATIONS AT THE 2012 SURVEY SITE

In 2019, during a site visit to Orakei Korako, we observed the same site studied in 2012, located immediately west of Wairiri Geyser, showed significant surface changes with the appearance of three new vents. The appearance of these new vents has required the boardwalk to be shifted several metres to the north, away from the vents (Fig. 2C).

For the last 10 years the authors have been visiting Orakei Korako and noted that this area had elevated temperatures in the range of 90-100°C several centimetres below the surface. Therefore, thermal activity has been going on for some time at this site. During these visits the ground surface was covered with broken sinter fragments, fine-grained pumice, and soil which formed a loosely-compacted fragmented ground surface. Some grass and low shrubs were also growing in this area.

3. 2019 NEW VENTS

All three vents appeared at the same time. Their appearance was observed by the staff at Orakei Korako, who advised us that there was a small steam eruption. Once the steam discharge stopped, the three vents were visible. We visited Orakei Korako in September and December of 2019 and during both visits all three vents were active. Our measurements reported here were collected in December 2019 when the ambient air temperature was 19.4 °C. All vent walls consisted of multiple layers of siliceous sinter showing a variety of sinter textures. Mild and intermittent wafts of hydrogen sulphide gas could be smelt in the area.

3.1 East vent

The East vent has a maximum length of 1.6 m, width of 1 m and depth of 1 m (Fig. 3). This vent consists of two small vents at its base. One vent is oval (0.3 m x 0.15 m) and one vent is kidney shaped (0.5 m x 0.2 m). No water was visible in either of the small vents at the base. Both of these vents were discharging intermittent puffs of steam. A temperature probe placed inside the steaming vents measured temperatures of 82.2°C (Eastern side vent) and 36.3°C (Western side vent).

3.2 North vent

The North vent is located directly underneath the old boardwalk (Fig. 2B). This vent has a maximum width of 1.4 m and length of 1.3 m and depth of 0.9 m. A 0.3 m x 0.15 m vent can be seen at the base filled with clear, blue water that measured 98.5°C (Fig. 3).

3.3 West vent

The West vent is aligned with the East vent in an East-West direction (Fig. 2B). Both the East and West vents are located behind the North vent.

The West vent is surrounded by a broad, flat, vent area that has a maximum width of 2.4 m x 1.8 m. An active 0.3 m diameter vent is visible at a depth of 1.5 m. This vent was filled with clear, blue water that measured 98.4°C in temperature (Fig. 3). Steam was vigorously discharging from the vent and the height of ebullition was approximately 5 mm.

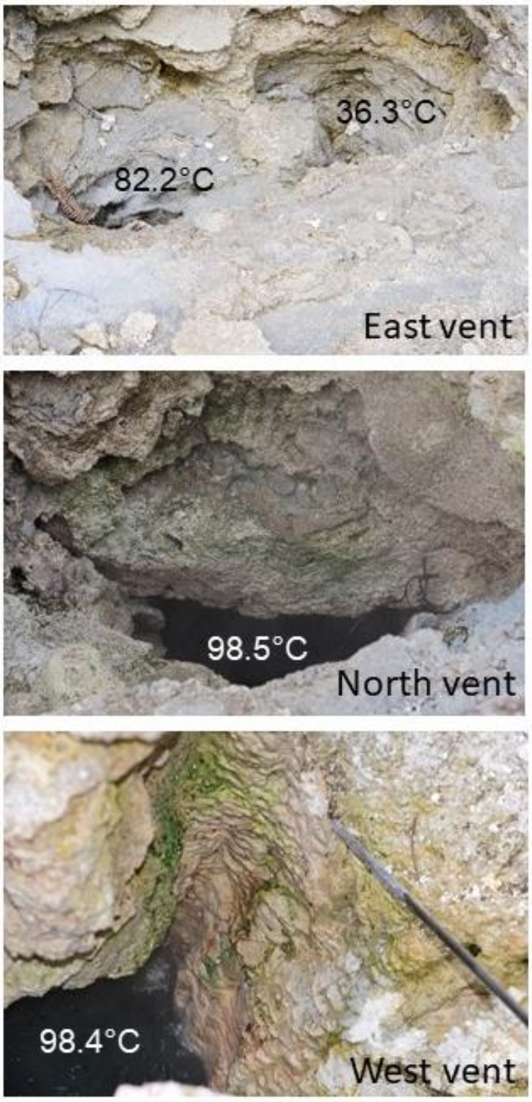


Figure 3: New vents at Orakei Korako.

3.4 2012 Ground Penetrating Radar and 2019 new vents

The location of the three new vents have been placed onto the 2012 GPR image as shown in Figure 4 (original GPR image from Lynne and Smith, 2013).

The 2012 GPR image shows very low amplitude reflections (black areas) immediately below the surface at all three new vent sites. Furthermore, these very low amplitude areas are connected to deeper, contorted fracture networks that can also been seen further West of the West vent (Fig. 4B). Typically, these very low amplitude reflections in siliceous sinter settings implies voids (Lynne et al., 2017, 2018). The dotted line in figure 3B indicates the top of the siliceous sinter terrace, below the boardwalk. An air gap exists between the bottom of the wooden boardwalk and the top of the sinter terrace and this is also appearing black in the 2012 GPR image.

Proceedings 42nd New Zealand Geothermal Workshop
24-26 November 2020
Waitangi, New Zealand
ISSN 2703-4275

The red, yellow and green areas represent moderate amplitude GPR reflections and indicate zones of moderate hydrothermal alteration (Lynne et al., 2017, 2018). The 100°C temperature measured at 0.5 m depth occurs within moderate amplitude reflections supporting active alteration in these areas.

Stronger amplitude reflections (white and grey areas) are shown as irregular patches in the GPR image. These are typical GPR reflections of unaltered siliceous sinter (Lynne et al., 2017, 2018). Underneath the East vent, strong amplitude reflections occur in a narrow band from 0.1 to 1 m depth.

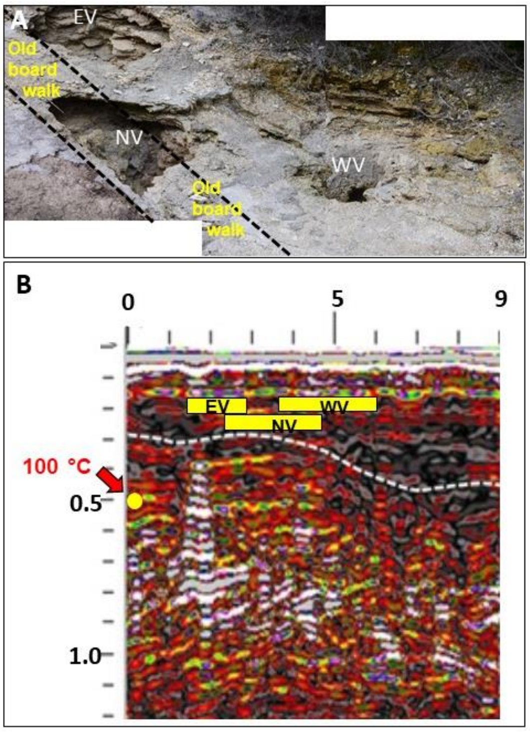


Figure 4: 2019 site photograph and 2012 GPR image of same area (EV = East vent, NV = North vent, WV = West vent). (A) Location of the three 2019 new vents with respect to the old boardwalk. (B) 2012 GPR image (dotted line = ground surface below boardwalk) with the three new vent locations shown. (C) Infrared photograph taken in 2012.

4. FUTURE WORK

Siliceous sinter samples have been collected from the three vents and are under investigation via Scanning Electron Microscopy (SEM). Based on the preserved sinter textures, SEM will determine the flow conditions and temperature of the hot spring water that historically discharged from these vents.

5. DISCUSSION

The appearance of the vents was described by Orakei Korako staff as a sudden event where steam was seen discharging from the area and bubbling water and steam was later observed in the North vent. This event may well have been a hydrothermal eruption where pressure was released through three areas of weakened ground. No eruption breccia has been identified in the area.

The sinter layers in the uppermost section of all three vents does appear to have been suddenly snapped and broken, which would be consistent with a hydrothermal eruption. However, the sinter near the vents in the base of all three vents consists of smooth sinter with no visible signs of suddenly snapping (Fig. 3). We suggest that these three vents are actually old vents that were infilled and buried. During a hydrothermal eruption the infill was thrown out and the vents became reactivated.

Our study provides an example of the dynamic changes that happen within geothermal fields. While we were aware of elevated near-surface temperatures from our multiple site visits over the last 10 years, there were no indications of buried vents at this site.

The 2012 survey as reported by Lynne and Smith (2013) did reveal subsurface hydrothermal alteration (GPR data), increased shallow subsurface temperatures (100°C at 0.5 m depth), elevated surface heat discharge captured by the infrared image and dissolution via acidic steam condensate overprinting, in the sinter beside the vents.

This study emphasizes the importance of baseline and repeated on-going monitoring in order to track surface feature changes taking place within our geothermal systems.

Including GPR into monitoring surveys can provide important information that may elude to sites with the potential to undergo significant changes in the future.

ACKNOWLEDGEMENTS

We would like to thank Craig and Philippa Gibson for allowing on-going access to Orakei Korako and the University of Auckland for supporting this research.

REFERENCES

Lynne, B.Y., Smith, G.J.: A new investigative approach to understanding heat migration pathways within the shallow subsurface at Orakei Korako, New Zealand. *Geothermal Resource Council Transactions*, USA, volume 37. (2013).

Lynne, B.Y., Heasler, H., Jaworowski, C., Foley, D., Smith, I.J., Smith, G.J.: Using Ground Penetrating Radar, scanning electron microcopy and thermal infrared imagery to document near-surface hydrological changes in the Old Faithful Geyser area, Yellowstone national Park, USA. *Geothermics*, volume 68, pp. 33-53. (2017).

Lynne, B.Y., Heasler, H., Jaworowski, C., Smith, G.J., Smith, I.J., Foley, D.: Ground Penetrating Radar documents short-term near-surface hydrological changes around Old Faithful Geyser Yellowstone National Park, USA. *Journal of Volcanology and Geothermal Research*, volume 354, pp.1-12. (2018).