Water Chemistry of the Ngawha Springs Tourist Baths

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The Ngawha geothermal field consists of ~20 hot springs, many of which attract visitors for their reputed therapeutic properties (Northland Regional Council, 2002). The hot springs are of particular interests for their unique water chemistry and geology. Recently, the tourist baths of Ngawha Springs have become the focus of a joint research project between the University of Melbourne (Australia) and the Institute of Geological and Nuclear Sciences (GNS-Wairakei). This report summarizes the background geology and water chemistry of the hot springs in this area.

Background Information

Previous studies suggested that the hot springs in the region formed from groundwater-filled hollows with a minor influx of geothermal water (Davey & van Moort 1986). The springs most likely share a common deep source of geothermal water, with temperatures as high as 230-240°C. Surface water temperatures in the region range from 20°C to 45°C, and change seasonally and with rainfall.

The highest recorded surface temperature in the region was 90°C; this was recorded in 1973 from a shallow hole adjacent to Tiger Bath (Davey & van Moort 1986).

All the Ngawha thermal sites emit gases (Davey & van Moort 1986). The gas comes from a deep source, as do the geothermal waters, and percolates through the springs. These gases at the surface mainly consist of carbon dioxide and methane; deeper gases have higher concentrations of dihydrogen sulfide and ammonia, and less hydrocarbons than at the surface.

The mineralogy of the Ngawha Springs region is dominated by cinnabar (mercury sulfide), pure sulfur, elemental mercury, iron-sulfide (marcasite), and iron-oxide (hematite) . The bulk of the cinnabar deposits are located in the Tiger Bath area; this region has undergone several attempts at mercury mining, all of which have been unprofitable. According to Davey & van Moort (2009), cinnabar mineralization is favored in baths of pH 5-2.5, whereas pyrite at pH ≥ 6.

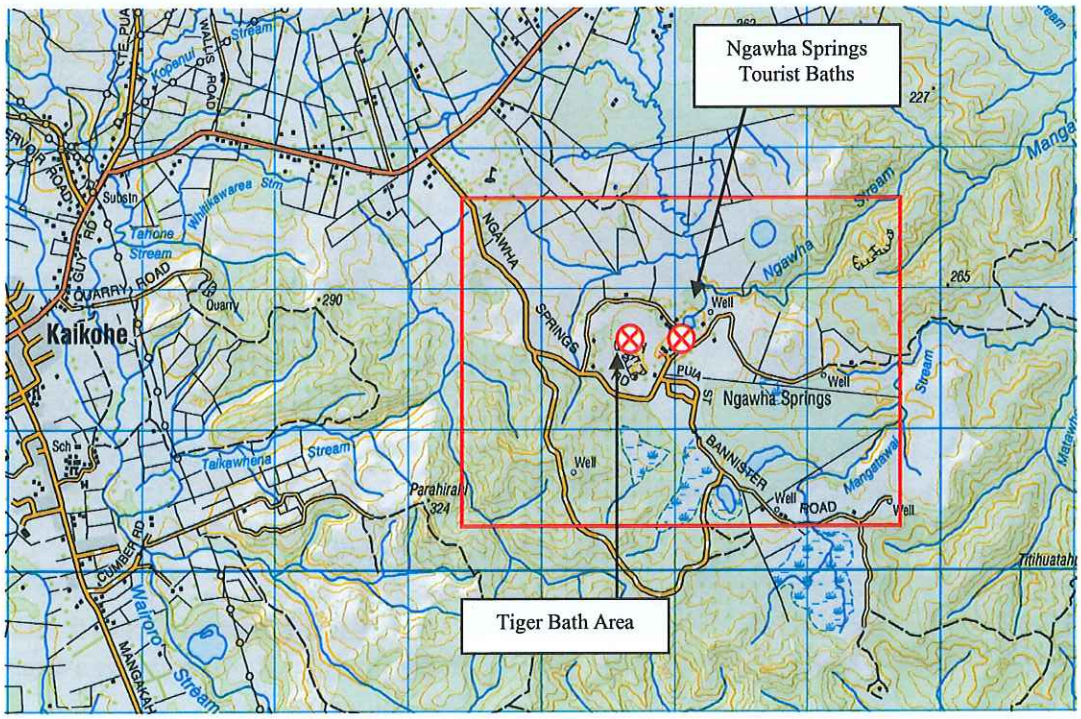

Figure 1.

Topo map of the Ngawha Geothermal Field, scale 1:50,000 (LINZ 2009)

Chemistry of the Ngawha thermal baths

Water and sediment samples were collected in Feb. 2011 from five of the Ngawha Springs tourist baths: Kotanitanga, Favourite, Doctor, Bulldog, and an unnamed sulfur bath. Temperature and pH readings were performed on site. The surface water temperatures of the baths ranged from 30°C to 45°C. The recorded pH for each bath was: Kotanitanga (6.37), Favourite (6.42), Doctor (6.58), Bulldog (6.77), and the sulfur bath (5.54). The pH of the sulfur bath is most likely controlled by the formation of bi-sulfates from oxidized sulfate, as evidenced by the bath's milky complexion and sulfuric odor (Davey & van Moort 1986). The high sulfur content results in the slightly acidic conditions.

Figure 2. Thermal baths at Ngawha Springs.

Dissolved mercury was measured in several areas near baths at Ngawha Springs. Detectable levels of mercury were measured in Kotanitanga bath. Dissolved mercury was also found in a drain next to the sulfur baths and in the bath behind Favourite that is not currently being used. Although the levels of mercury were detectable using analytical instruments, the amounts are less than the regulated amount of mercury allowed in drinking water. Therefore, the levels of mercury in the baths are not of concern for human health. It is not surprising that mercury is present in the spring waters, considering the prevalence of cinnabar (mercury sulfide) in the region. Both Bulldog and Favourite contained hydrocarbon byproducts. The pools emit a sweet methane-like odor, and both show a thin, shiny metallic film of hydrocarbons on their surfaces.

In general, the water chemistry of the hot pools mainly consists of ammonia, bicarbonates, and boron (Northland Regional Council 2002). However, it is apparent that there is a great diversity in water chemistry among the baths.

References:

Davey H. A. & van Moort J. C. 1986. Current Mercury Deposition at Ngawha Springs, New Zealand. *Applied Geochemistry* 1, 75-93.

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