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In the Philippines, all hot springs are associated with recent volcanism. These are usually marked by acidic pH, a large amount of dissolved Na, Cl, H_2S, SO_4, and CO_2 with significant amounts of dissolved trace elements (i.e. arsenic). Alkaline hot springs are not common and have been usually associated with large ophiolite.

Recently, an alkaline hot spring (pH 8.6 – 9.2) has been documented in Aniniy, Antique, Philippines (Sira-an Hot Spring; 13.502N Lat. 120.953 E Long., 375m absl). There is no recent volcanism documented in the surrounding area, although previous reports have stressed the hot spring's origin to be volcanic. Furthermore, there is no identifiable subsurface heat source to account for the observed water temperature. The hot spring water emanates from fissures in diabasic rocks composed primarily of Mg-rich mafic minerals (e.g. forsterite, enstatite).

Table 1 shows the general characteristics of the hot spring water compared to the local groundwater within the vicinity (about 100 meters away) of the study area. Compared with the local groundwater, the hot spring water is highly reduced, has a high specific electrical conductivity, and Mg-depleted. Although the site is nearby the sea, there is very little dissolved Na in both waters (below detection).

Table 1. Comparison between the local ground water and hot spring water in this study.

Parameter	Groundwater	Hot spring water
Temperature (°C)	24.8	38.6
pH	7.1	8.6 – 9.2
SEC (mS/m)	192	1557
ORP (mv)	(+) 54	(-) 260
Total dissolved Fe (mg/L)	3.750	4.138
Al (mg/L)	0.022	0.004
Ca (mg/L)	190	425
Mg (mg/L)	30	0.067
Total dissolved solids (mg/L)	3800	9200

The hot spring emanations also include most probably $CH_{4(g)}$ and $H_{2(g)}$ due to its characteristics flammability. In other reports, the gaseous emanations were declared as $H_2S_{(g)}$. However, $H_2S_{(g)}$ is not flammable and would not produce a popping blue flame when the gas emanation is ignited. $CH_{4(g)}$ can also give an malodorous tinge similar to $H_2S_{(g)}$. However, there is no quantitative analysis for the gaseous emanations previously performed.

The redox state of the hot spring water is also indicative of an anoxic reaction probably influenced by CH_4 - HCO_3^- couples. The hot spring water may have been the result of mineral dissolution under anoxic condition as described by the following reactions:

$$\text{Enstatite} + 2.5H_2O + 0.5Mg^{2+} + HCO_3^- \rightarrow 0.5\ \text{chrysotile} + CH_{4(g)} + 2O_{2(aq)} \quad (1)$$

$$\text{Forsterite} + 3.5H2O + CH_{4(g)} \rightarrow 0.5Mg^{2+} + 0.5\ \text{chrysotile} + HCO_3^- + 4H_{2(g)} \quad (2)$$

Although zeolites (e.g. natrolite, chabazite) are the main alteration minerals found due to interaction with seawater, the high rate of rainfall increased flushing of Mg leaving only the least mobile components to precipitate (e.g. hydrated aluminosilicates). Rapid flushing of aqueous components also inhibited the formation of Mg-rich minerals such as sepiolite and chrysotile.

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The physicochemical characteristics of this alkaline spring were modeled using the *Geochemist's Workbench*™ Ver. 6.0 to predict the formation of alkaline reducing waters. The formation of alkaline waters can be described by the following equations:

$$\text{Forsterite} + 2H_2O \rightarrow 2Mg^{2+} + SiO_{2(aq)} + 4OH^- \quad (3)$$

$$\text{Enstatite} + H2O \rightarrow Mg2+ + SiO2(aq) + 2OH- \quad (4)$$

The evolution of the pH and redox state redox state of the system in the following figures. Left hand side illustrates the pH and redox evolution of the fluid with the formation of brucite and antigorite. Conversely, pH is more alkaline and redox more reducing if minerals do not form.

With the precipitation of minerals	Without the precipitation of minerals