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Integrate Monitoring Data and Geochemical Modeling Construct Carbonate Precipitation of Tuchang Geothermal Area, Taiwan

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ABSTRACT

In Taiwan, there are a lot of hot springs distribution on the low-grade metamorphic rock, and has a geothermal power plant setting in the Chingshui Geothermal Field, which consists on slate and meta-sandstone. The carbonate scaling is always a big issue, which causes geothermal power plant of Chingshui Geothermal Field stop at 1993 and restart the geothermal power plant at 2021. The pilot geothermal power plant, which was 260kWe ever set up at Tuchang area. That area is Tuchang River catchment and has raining record station which is located on the upper stream. The whole river catchment has three types of thermal water which one type is artesian from 2,200 m depth; another is geyser that belongs artificial borehole, which depth is less than 1,000 m; and the one is artesian from outcrop. This study collected samples including rain, surface water and thermal water between 201808 and 202007.

The preliminary results shown that borehole artesian and artificial geyser are Na-HCO_3, and outcrop artesian is Ca-HCO_3 based on the monitoring data. The concentrations of sodium, potassium of borehole artesian and artificial geyser are achievement 1,000 ppm and 20 ppm, respectively, however, the outcrop artesian only is about 200 ppm and 9 ppm. In addition, the concentration of calcium of outcrop artesian is about 100 ppm, the borehole artesian and artificial geyser are less than 1 ppm. This study infers to The outcrop artesian is in the geothermal reservoir of shallow depth and enriches calcium. The artesian of well and geyser locates in the geothermal reservoir of deeper depth and has enriched sodium and potassium. Finally, this study points out that the pressure would be controlled which could reduce carbonate precipitation in Tuchang Geothermal area of Taiwan.

1. INTRODUCTION

In Taiwan, the timeline infographic of geothermal development has three stages including 1962-1993, 2009-2020, and 2020 till now. Stage I, hot springs were found in low-grade metamorphic rock, and there have four higher geothermal potential areas including Tatun Volcano Group, Ilan, Lushan and HuaTung. In addition, first geothermal power plant was sat up in Chingshui Geothermal Field in 1982 (Figure1). The stage II, we achieved two targets, one is that we were re-building up the geothermal power plant in Chingshui Geothermal Field, and the other one it is detected the resistance time of thermal water, and providing the conceptual model in the acidic and neutral thermal water of Tatun Volcano Group (TVG). The stage III, we achieved two targets, one is that in the low-grade metamorphic rock, we select three places to set up geothermal power plan, and the other one is that we will prepare to build up a geothermal power plant in TVG (Chang et al., 2013, and Chen et al., 2013).

In 1985-1994, there has the pilot geothermal power plant, which was 260kWe set up at Tuchang geothermal area. The carbonate scaling was well controlled at that time. Therefore, this study collects waters from artesians of borehole and outcrop and artificial geyser to construct carbonate precipitation condition in the Tuchang geothermal area.

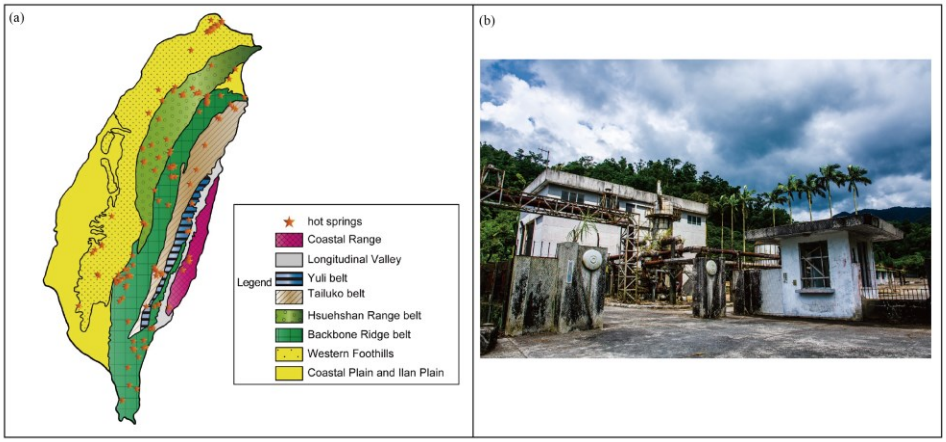

Figure 1: (a) The hot springs distribution in different terrains of Taiwan. (b) first geothermal power plant in the Chingshui Geothermal Field.

2. SAMPLING SITES

We collected waters from Tuchang River Catchment, which include Towang and Tienkou Rivers. There are six sites from stream and four sites from hot spring (Figure 2).

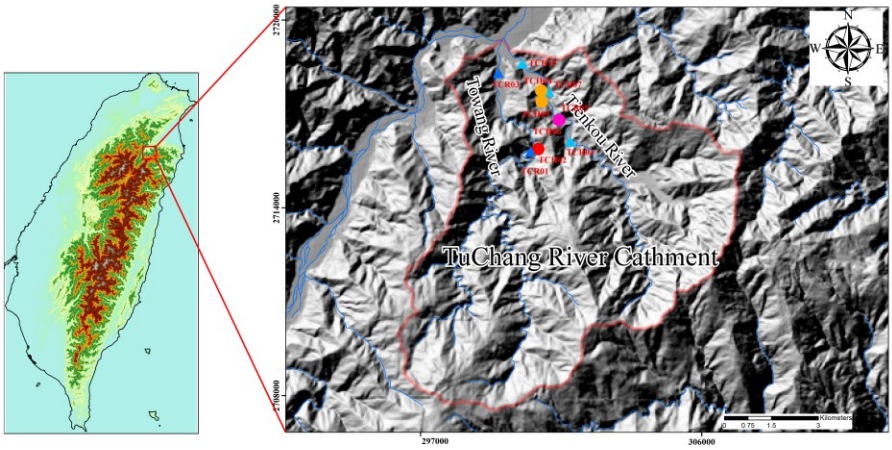

Figure 2: The sampling sites in this study.

3. RESULTS AND DISCUSSION

Figure 3 displays that TDS, pH value, and classify type by Piper diagram. The TDS and pH value are from 200 ppm to 500 ppm, and between 7 and 9, respectively. It shows the concentration of major elements of samples from Towang and Tienkuo rivers. The calcium is between 20 ppm and 50 ppm and the carbonate is from 100 ppm to 200 ppm.

Figure 4 displays that TDS, pH value, and classify type by Piper diagram. The TDS and pH value are from 1,000 ppm to 4,000 ppm, and between 7 and 9, respectively. It shows the concentration of major elements of samples from hot spring. The calcium is between 1 ppm and 5 ppm and the carbonate is from 500 ppm to 2,500 ppm.

According to the geochemistry data, this study provides the conceptual model in the Tuchang Geothermal area in Figure 5.

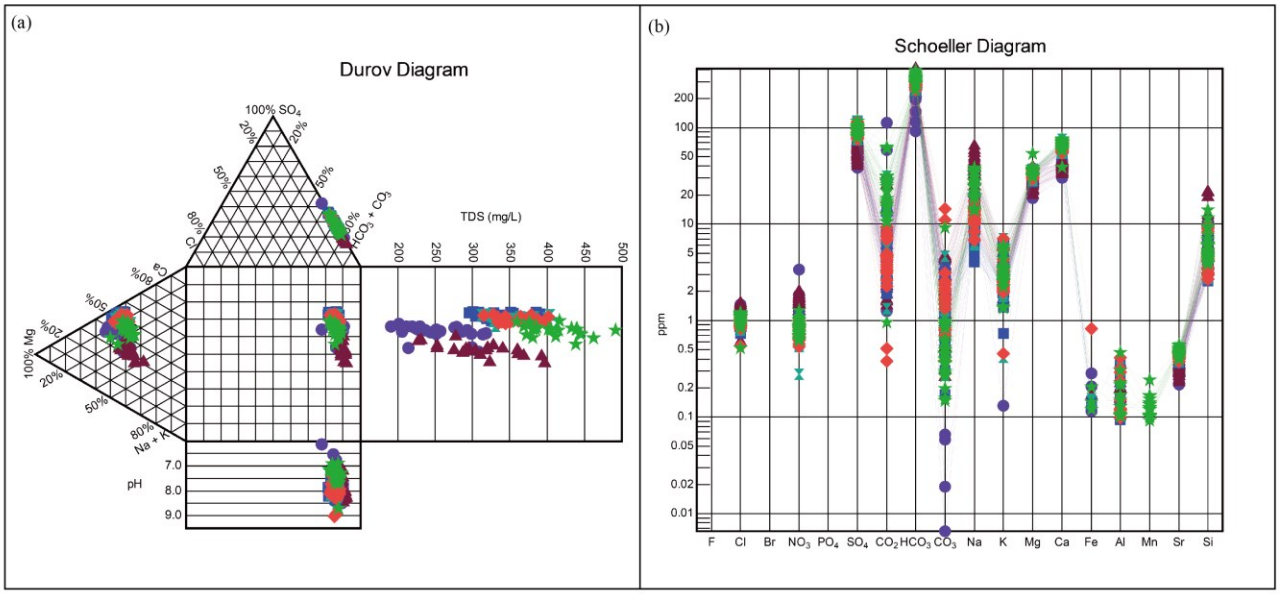

Figure 3: The samples of river. (a) the Durov diagram, (b) Schoeller diagram.

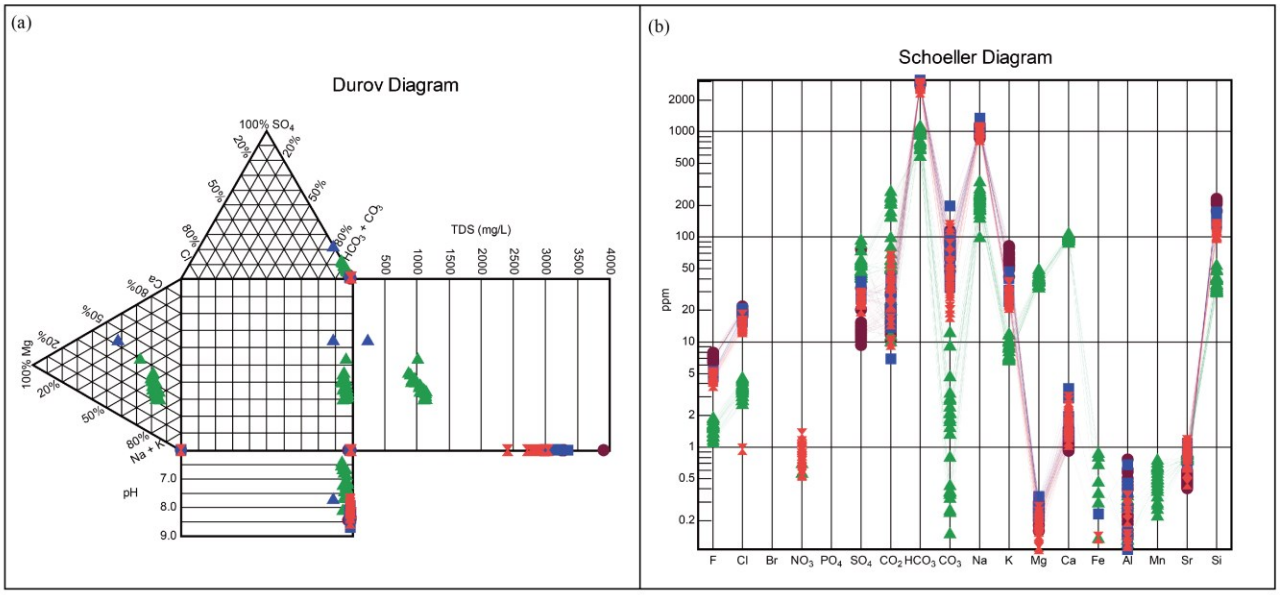

Figure 4: The samples of hot spring. (a) the Durov diagram, (b) Schoeller diagram.

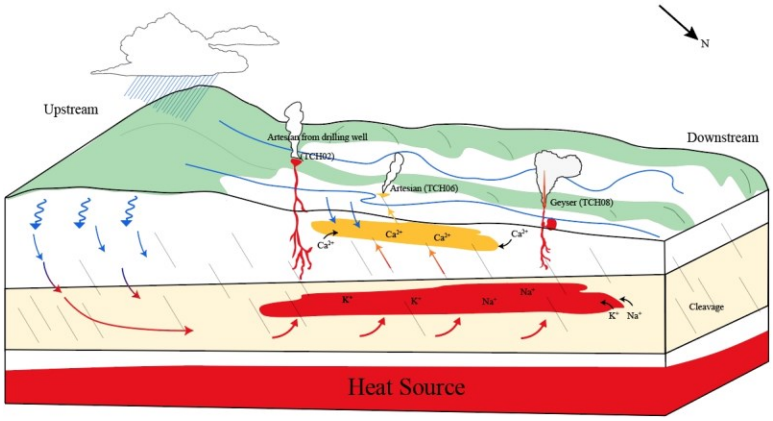

Figure 5: The conceptual model of this study in Tuchang Geothermal area.

4. CONCULSION

We summaries above:

(1) The river samples belong to Ca-Mg-HCO_3, and hot springs have Na-HCO_3, and outcrop artesian is Ca-HCO_3.

(2) This study shown that there have two geothermal reservoirs in Tuchang River. The origin of thermal water sites in the geothermal reservoir of shallow depth and enriches calcium. The origin of artesian of well and geyser locates in the geothermal reservoir of deeper depth and has enriched sodium and potassium.

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