PROCEEDINGS, 45th Workshop on Geothermal Reservoir Engineering
Stanford University, Stanford, California, February 10-12, 2020
SGP-TR-216

Application Petrography on the Process of Water-Rock Interaction in the Neutral Thermal water of Tatun Volcano Group, Taiwan

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Keywords: calcite, lava, pyroclastic rock, neutral thermal water, Tatun Volcano Group, Taiwan

ABSTRACT

It exists a few neutral thermal water in Tatun Volcano Group of Taiwan, and where has the highest geothermal potential area, and a serious corrosion problem during drilling. This study provides the information for solving corrosion solution and expects to provide much better constraints for geothermal power plant location of the Tatun Volcano Group by petrography. The preliminary results display that lava consists of augite, hornblende, andesine, labradorite, zoning plagioclase and calcite, and the calcite replaces the plagioclase. The pyroclastic rock has augite, zoning plagioclase, and quartz. Finally, this study applies the characteristics of petrography of full view to provide the process of water-rock interaction.

1. INTRODUCTION

In Taiwan, there widely surveyed hot springs for geothermal topic since 1970. According to the results of previous studies, it had a lot of data to present the geothermal model in Tatun Volcano Group (Liu et al., 2011; Dobson et al., 2018). Overall, the results displayed that there have three types of thermal water, Type I is SO_4^{2-}acidic water, Type II belongs to HCO_3^- near neutral spring, Type III has Cl^--rich acidic water. Many reposts presented the Type II which is best site for building up geothermal power plant (MRSO, 1969, 1970, 1971, 1973).

According to the results of simulation and experiment of previous studies, the acidic thermal water react with plagioclase could be become to neutralize thermal water, and the process generates anhydrite, montmorillonite, kaolinite, calcite and alunite as hydrothermally precipitated minerals (Kempter and Rowe, 2000; Varekamp et al., 2000; Fang et al., 2003; Marini et al., 2003). Moreover, the hydrothermal minerals are enrich montmorillonite, chlorite, calcite, albite, adularia, illite, anhydrite, pyrite and chalcedony in exploration wells of the Tatun Volcano Group (MRSO, 1969, 1970, 1971, 1973).

To understand the causes of the neutral thermal water in volcanic area that can improve several aspects. In geothermal development, it can provide a better site of geothermal power plant. And in sciences of engineering and materials, it gives a better result that how to choose the materials of drilling and pipeline. However, less academic researchers are focused on the characteristics of lava and pyroclastic in neutral thermal water of volcanic area.

The aim of this study analyzed the petrography of full thin section, and provide more detail information for understanding the process of the water-rock interaction in the future.

2. SAMPLING SITE

Figure 1 displays the sampling location of this study including thermal water and core, which is located in national park area. The thermal water of this study belongs to neutral water of artesian, and characteristics of conductivity, total dissolute solids (TDS) and temperature are 1,700 us, 1150 ppm and 60℃. Based on the concentrations of major elements, the neutral thermal water is $CaHCO_3$ (Figure 2)

In this study, the core can be distinguished between lava flow and pyroclastic rock, lava flow exists from 0-12 m and pyroclastic rock is from 12-20 m, depends on their texture. Based on the color columns, the lava flow can be classified into five segments, which are light gray, medium gray, white stripe, dark gray, and yellowish brown. For the pyroclastic rock, four parts can be distinguished that are yellowish brown, dark gray, light gray, and dark red (Figure 3).

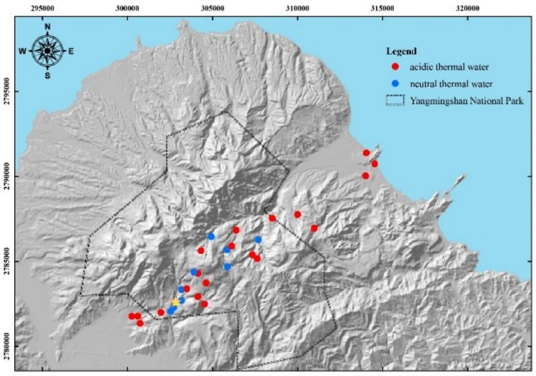

Figure 1: In this study, the sampling locations of neutral thermal water and core in Tatun Volcano Group. The yellow star shows the sampling site.

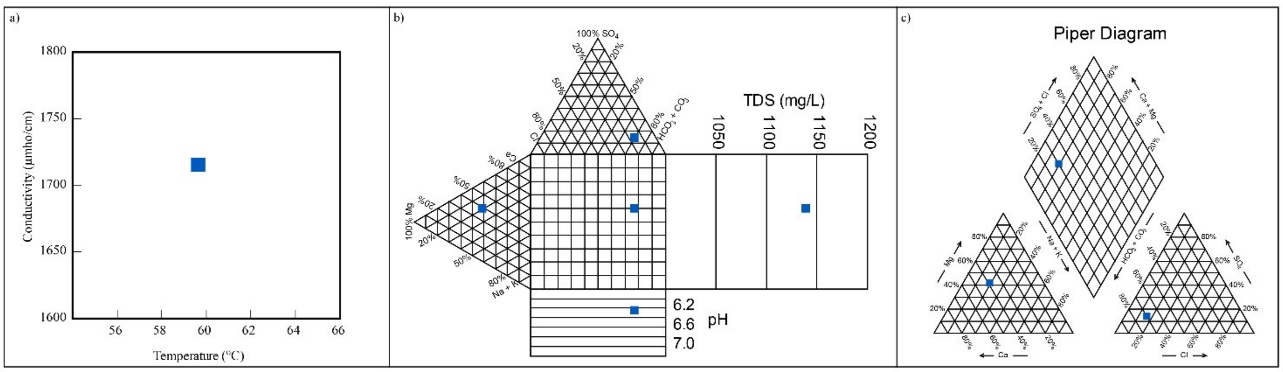

Figure 2: The geochemistry characteristics of artesian water in this study.

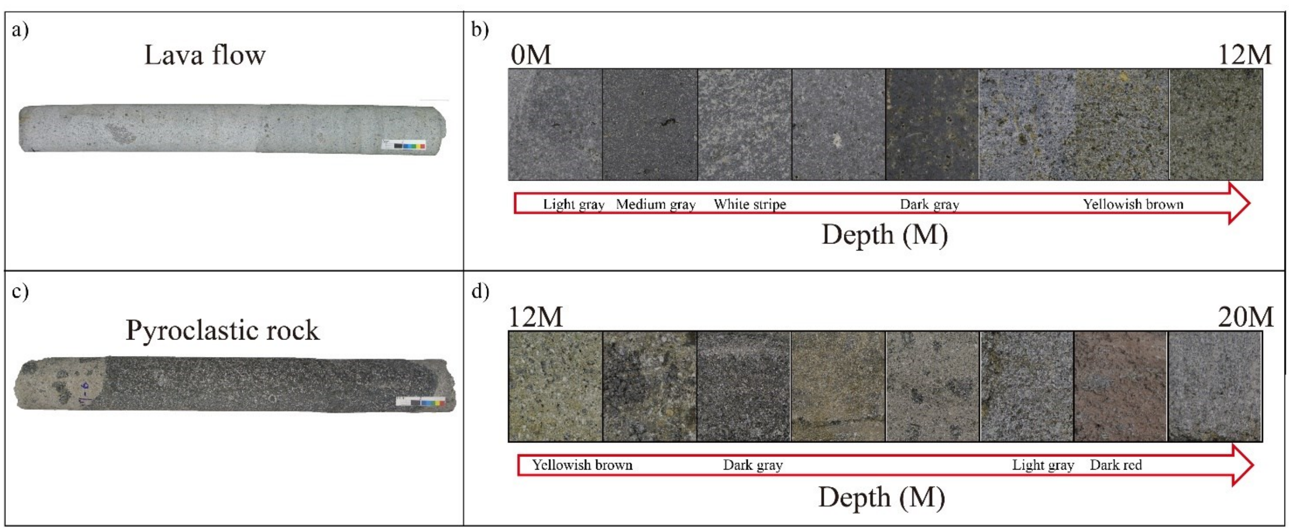

Figure 3: The texture of lava flow and pyroclastic rock in the profile of rock.

3. RESULTS AND DISCUSSION

3.1 The petrography of lava flow

The petrography of lava flow shows in the Figure 4 to Figure 8, which present the petrography of full thin section, mineral assemblages and percentages of plagioclase.

The differentiation of colors of lava flow into five segments, which are light gray, medium gray, white stripe, dark gray, and yellowish brown. Except for lava flow of yellowish brown, lava flow of the other four colors have calcite and hornblende.

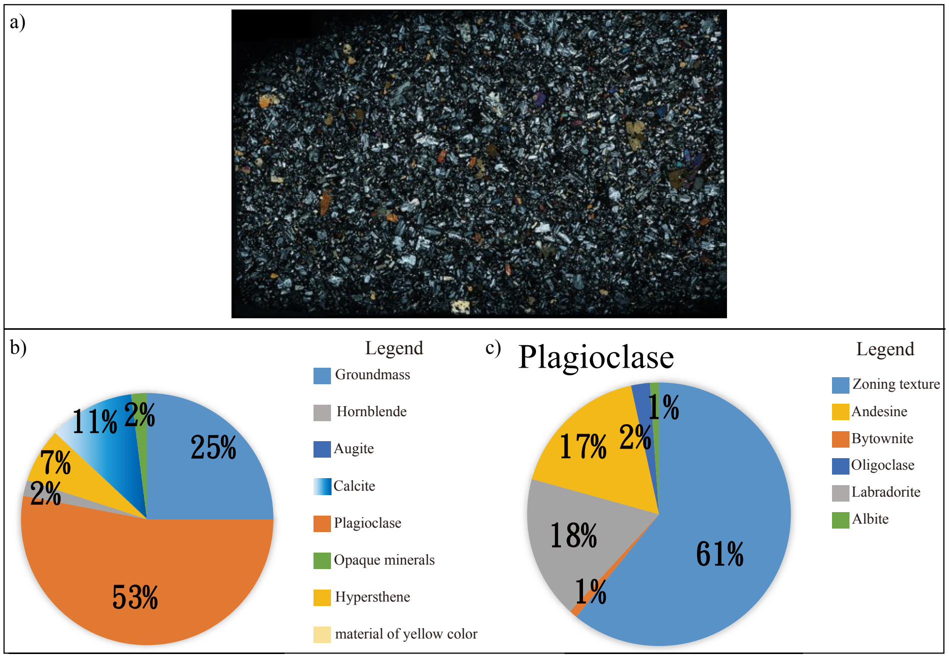

Figure 4: In lava flow of light gray. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

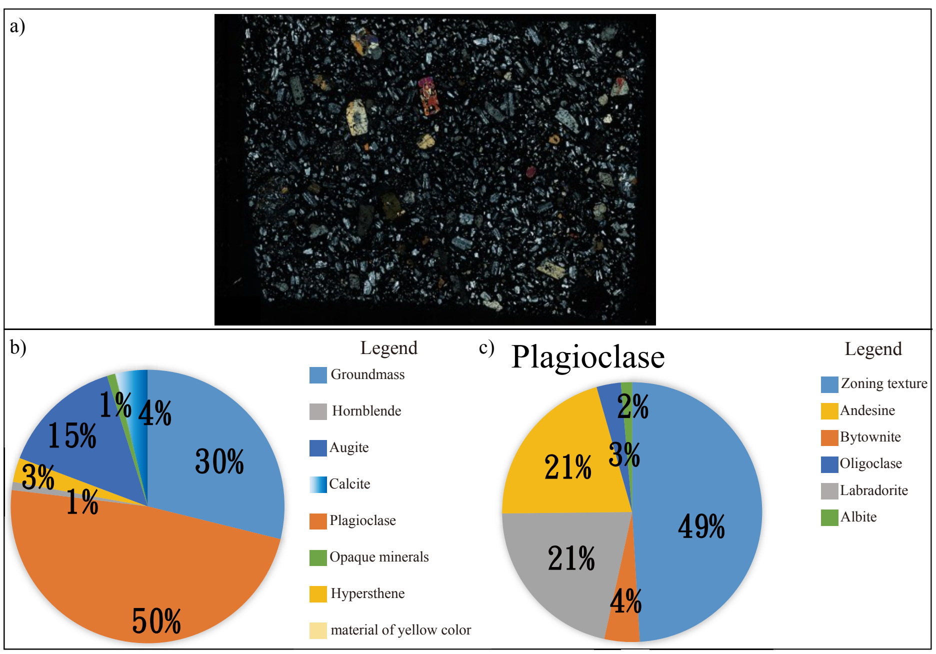

Figure 5: In lava flow of medium gray. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

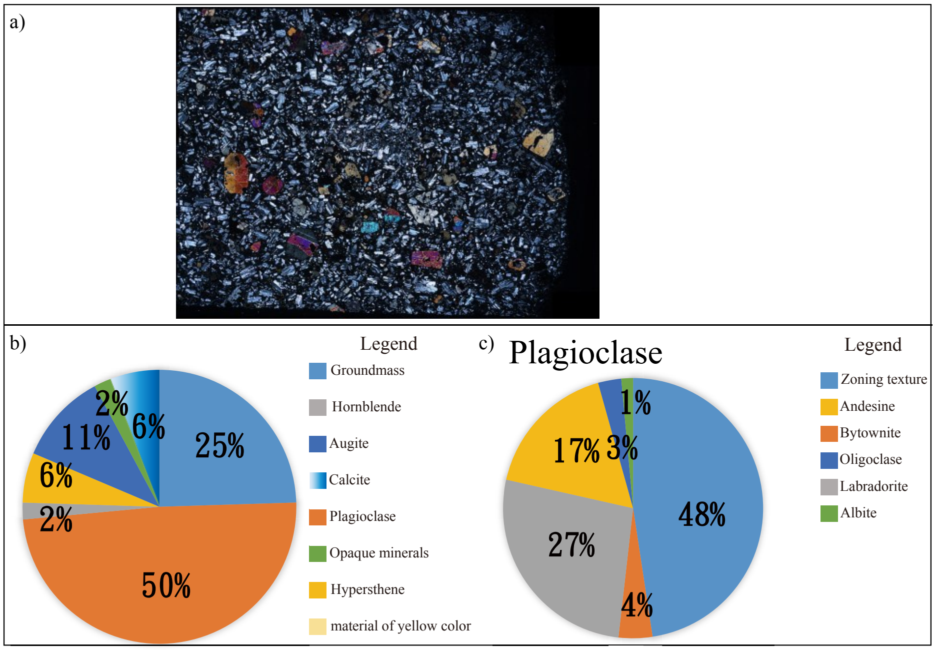

Figure 6: In lava flow of white stripe. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

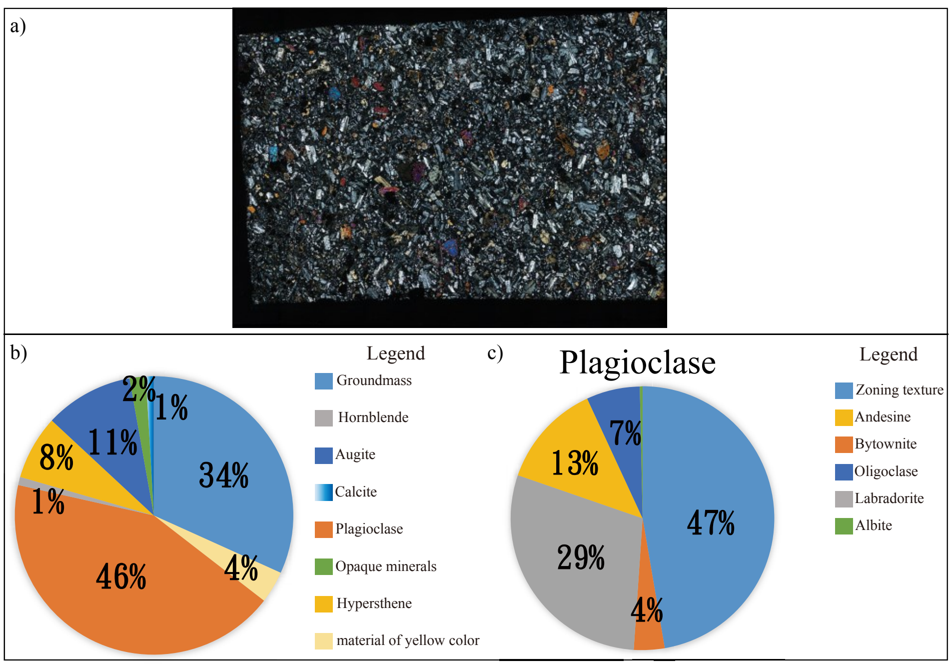

Figure 7: In lava flow of dark gray. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

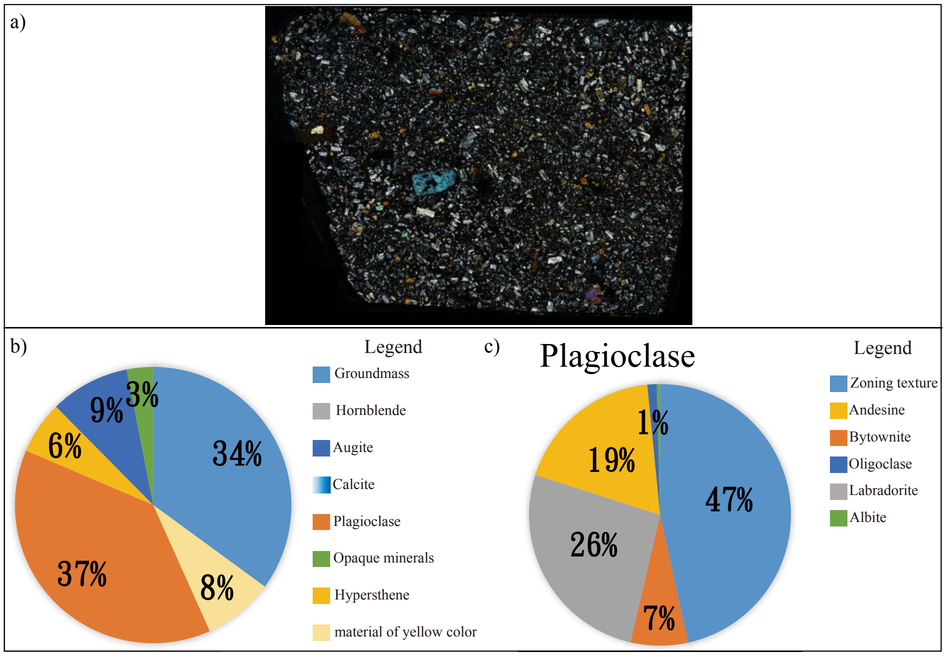

Figure 8: In lava flow of yellowish brown. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

3.2 The petrography of pyroclastic rock

The petrography of pyroclastic rock displays in the Figure 9 to Figure 12, which present the petrography of full thin section, mineral assemblages and percentages of plagioclase.

The colors of pyroclastic rock can be divided into four parts that are yellowish brown, dark gray, light gray, and dark red. All samples are composed of augite, plagioclase, hypersthene, and groundmass. In addition, most plagioclase of single grain exists with textures of zoning and twin.

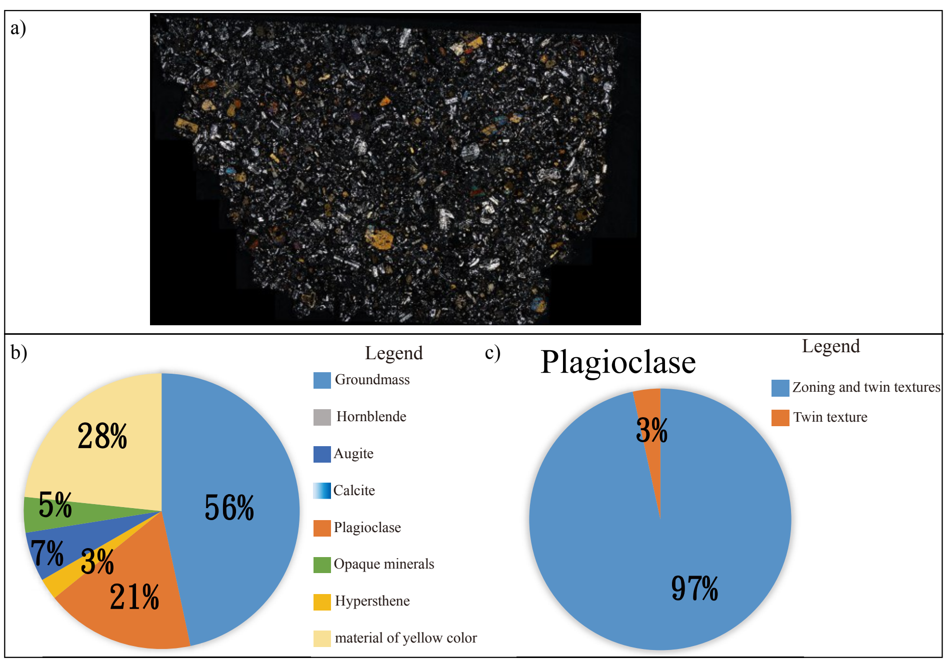

Figure 9: In pyroclastic rock of yellowish. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

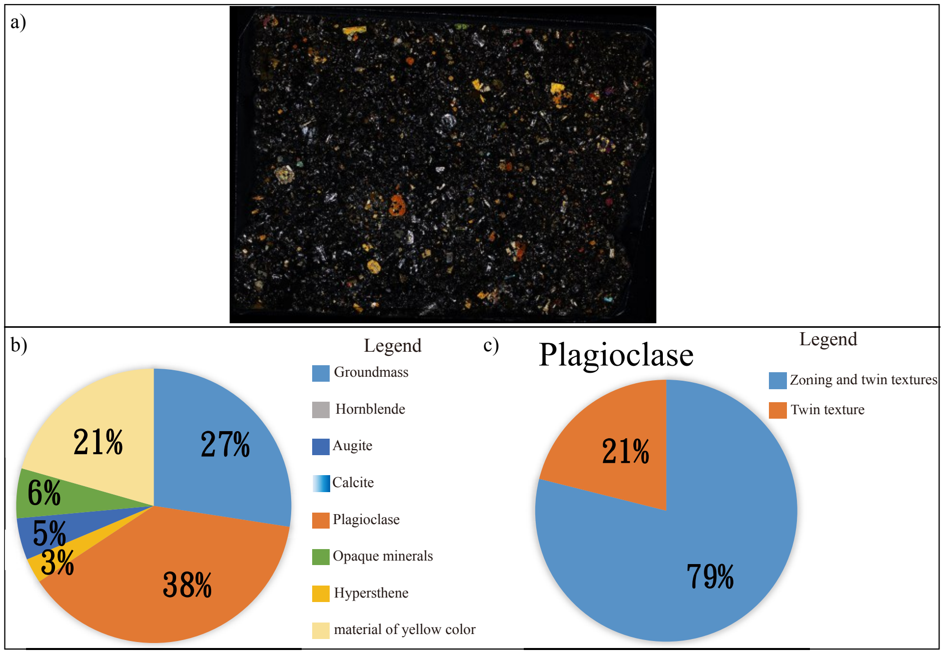

Figure 10: In pyroclastic rock of dark gray. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

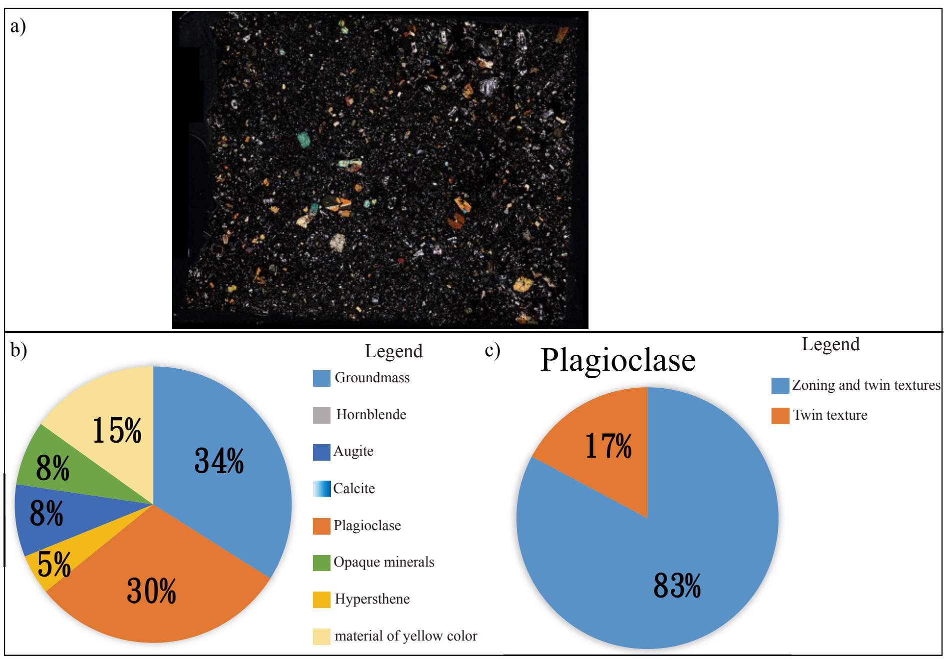

Figure 11: In pyroclastic rock of light gray. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

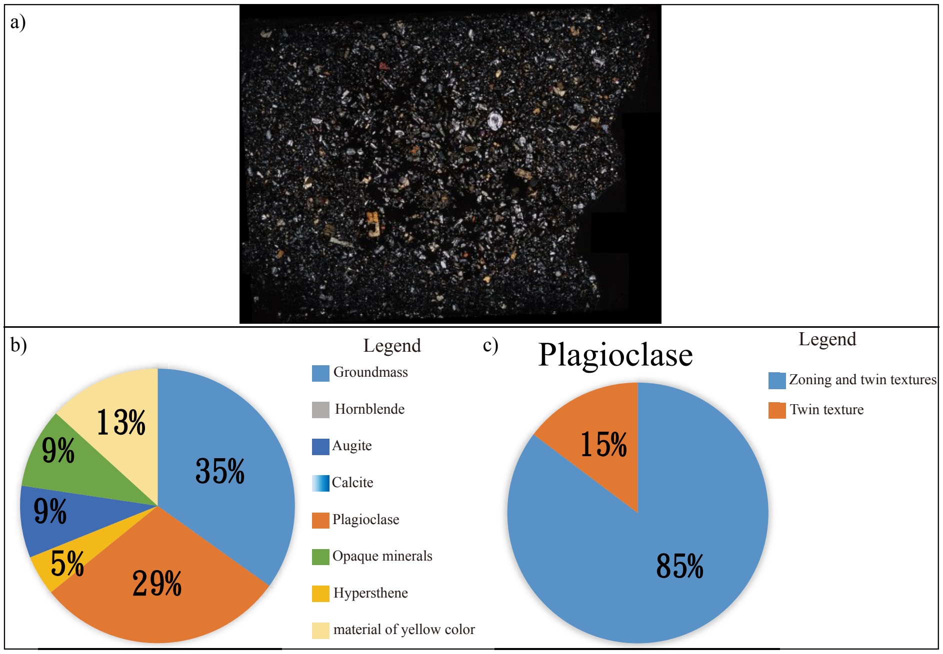

Figure 12: In pyroclastic rock of dark red. (a) full thin section, (b) mineral assemblages and (c) percentages of plagioclase.

3.3 The characteristics of different types of calcite in the lava flow

According to the textures of calcite and plagioclase in andesite of this study, the calcite can be divided into three types, which are Type I, Type II and Type III.

The Type I shows that calcite replaces plagioclase along its zoning boundary, and the plagioclase has zoning texture. The Type II displays that most calcite replace the groundmass of andesite of Tatun Volcano Group. The Type III presents that calcite replace the plagioclase, which exists zoning texture (Figure 13).

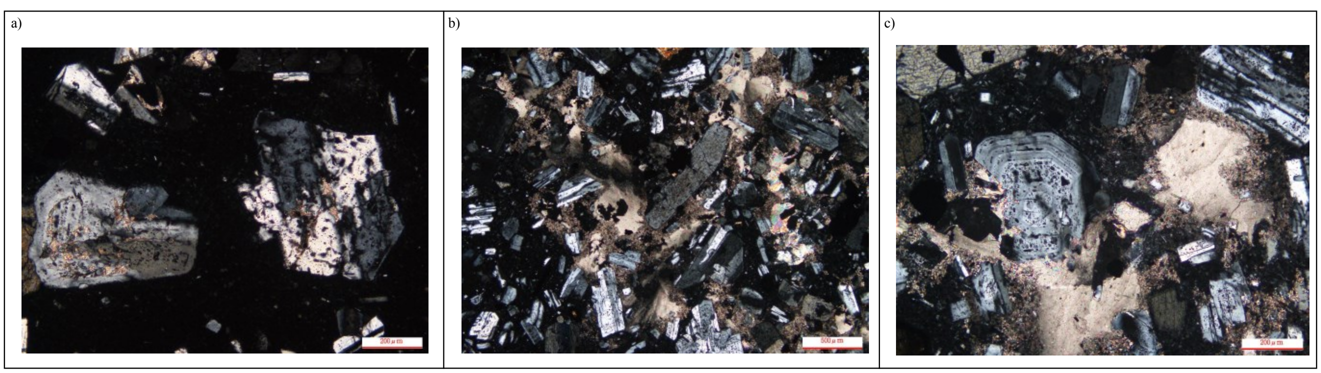

Figure 13: Three types of calcite presents on the lava flow in Tatun Volcano Group. (a) Type I replaces the plagioclase along zoning boundary of plagioclase. (b) Type II replaces the groundmass of andesite. (c) Type III replaces the plagioclase, which has zoning texture.

4. CONCLUSIONS

(1) The thermal water of this study belongs to neutral water of artesian, and be identified $CaHCO_3$ Type. The core can be distinguished between lava flow and pyroclastic rock, lava flow exists from 0-12 m and pyroclastic rock is from 12-20 m.

(2) The differentiation of colors of lava flow into five segments, which are light gray, medium gray, white stripe, dark gray, and yellowish brown. Except for lava flow of yellowish brown, lava flow of the other four colors have calcite and hornblende.

(3) The colors of pyroclastic rock can be divided into four parts that are yellowish brown, dark gray, light gray, and dark red. All samples are composed of augite, plagioclase, hypersthene, and groundmass. In addition, most plagioclase of single grain exists with textures of zoning and twin.

(4) From petrography of full thin section. the calcite can be divided into three types. The Type I shows that calcite replaces plagioclase along its zoning boundary, and the plagioclase has zoning texture. The Type II displays that most calcite replace the groundmass of andesite of Tatun Volcano Group. The Type III presents that calcite replace the plagioclase, which exists zoning texture.

(5) Finally, it is of paramount importance that we observed the texture of full thin section which can present the percentages of mineral assemblages and mineral relationship.

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