Oxygen Isotopic Study of Quartz in Andesite from Chinlung Volcano Group, Northern Taiwan

Yu-Hsuan Liu[a], Yu-Ming Lai[a], Pallab Roy[b], Min-Jo Hsu[a]
[a] Department of Earth Sciences, National Taiwan Normal University, Taiwan
[b] Institute of Earth Sciences, Academia Sinica, Taiwan

Abstract

The Chilung Volcano Group(CVG) and Tatun Volcano Group(TVG) are the two main volcano groups in Northern Taiwan, with a key difference being the presence of quartz. Quartz in the CVG can result from crystallization during magma cooling or capture from surrounding rocks. This research aims to analyze samples and conduct oxygen isotope tests to determine the source of quartz in the Chilung Volcanic Group.

Geological Background

Northern Taiwan Volcanic Zone

- May be an extension of the Ryukyu Arc or a result of extension and fragmentation.

Chilung Volcano Group

- Includes Benshan, Wutanshan, Chilungshan, Caoshan, and Jimumuling.
- Chilungyu may be related to this volcano group.

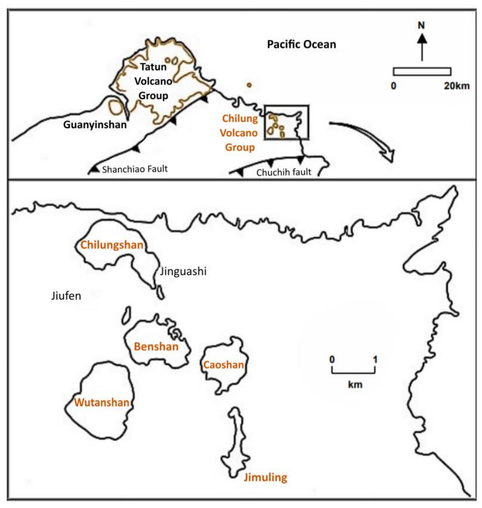

Fig.1 Location of the NTVZ [1]

Methods

1. Sampling

- There're eight samples in total. Three from Chilungshan, two from Chilungyu, one from Wuchishan Formation and one from Szuling Sandstone Formation.

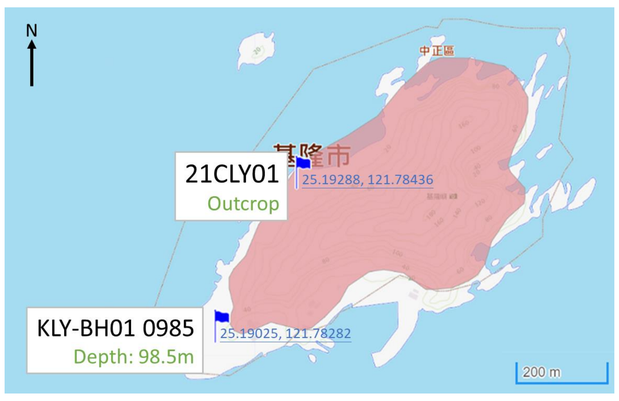

Fig.2 Sampling Location in Chilungyu

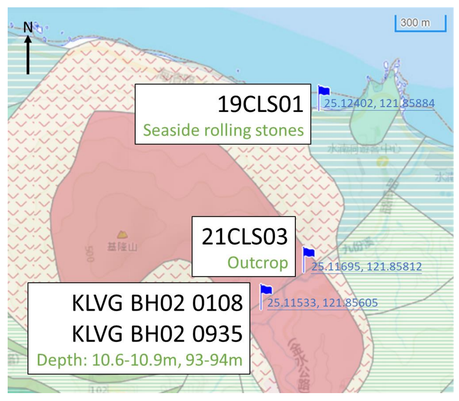

Fig.3 Sampling location in Chilungshan

2. Sawing, Crushing and Sieving

- Cut off the weathered part and cut the rocks in to 2×2×2 cm^3.
- Use jaw crusher to crush the samples.
- Sieve samples within the range of 180~425 μm.

3. Hand Picking Quartz Grains

4. Laser Fluorination

- $SiO_2 + 2BrF_5 \rightarrow SiF_4 + 2BrF_3 + O_2\uparrow$

5. Oxygen Isotope Analysis

- The magnetic field would influent the accelerated ions.
- Ions would be bend into curved paths.
- The smaller M/e ratio would lead to larger curvature.

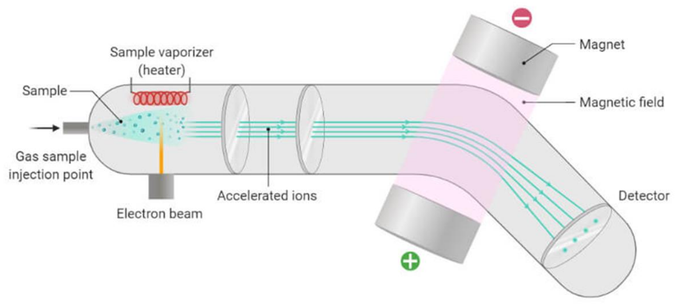

Fig.4 Mass spectrometry schematic diagram [2]

Results and Discussion

1. Calculation of the $\delta^{18}O$ Values

The $\delta^{18}O$ can be calculated through the equation [2] below:

$$\delta^{18}O = \frac{(^{18}O/^{16}O)_{Sample} - (^{18}O/^{16}O)_{Standard}}{(^{18}O/^{16}O)_{Standard}} \times 1000‰$$

According to Fig.5, the $\delta^{18}O$ values of quartz in sedimentary rocks >12 ‰, whereas it ranges 8.9~10.2 ‰ in igneous rocks. In this study, the calculated $\delta^{18}O$ data in Tab.1 indicate that quartz from Chilungshan and Chilungyu originated from crystallization during magma cooling, and the sandstone samples fit within the range established in previous research.

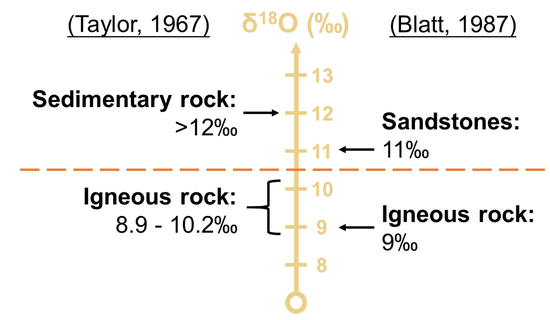

Fig.5 $\delta^{18}O$ values range of quartz in different rock types in previous researches

2. Calculation of the Magmatic Temperature

Referencing the Magnetite data from previous research [1] and calculate the magmatic temperature through the equation [3]:

$$T = \sqrt{\frac{6.29 \times 10^6}{\delta^{18}O_{Qz} - \delta^{18}O_{Mgt}}}$$

Except the rolling stone samples, all the other samples indicate that the magmatic temperature increases with depth.

Source	Sample	Depth (m)	Qz $\delta^{18}O$ (‰)	Mgt $\delta^{18}O$ (‰) (Kuo, 2002)	T (℃)
Chilungshan (Andesite)	19CLS01	Rolling Stone	07.96	3.75	949
	21CLS03	Outcrop	08.87	3.75	835
	KLVG-BH02 0108	10.6-10.9	08.59	3.75	866
	KLVG-BH02 0935	93-94	08.50	3.75	877
Chilungyu (Andesite)	21CLY01	Outcrop	08.53	3.00	793
	KLY-BH01 0985	98.5	08.00	3.00	848
Wuchihshan Formation (Sandstone)	WCS	-	12.26	-	-
Szuling Sandstone Formation (Sandstone)	SLSS	-	13.29	-	-

Tab.1 Calculated $\delta^{18}O$ values and magmatic temperatures of samples

Conclusions

- Magmatic temperature of Chilungshan: 835~949 ℃; Chilungyu: 793~848 ℃.
- $\delta^{18}O$ of Chilungshan: 7.96~8.87 ‰; Chilungyu: 8.00~8.53 ‰; Wuchihshan Formation: 12.26 ‰; Szuling Sandstone Formation: 13.29 ‰.
- The calculated data indicate that quartz in Chilungshan and Chilungyu were result in crystallization during magma cooling.

References