Preliminary Results of Geochemistry Investigation on Lake Taal, Central Philippines
菲律賓中部 Taal 火山湖地球化學體系調查之初步結果

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Abstract

Located in Batangas Province of central Philippines and ~55 km south of Manila, Taal Volcano (14°00.1'N, 120° 59.1'E) is situated on the southwestern part of Luzon Island in the Philippines Archipelago (**Fig. 1**). With 34 recorded eruptions, Taal Volcano is considered one of the most active volcanic centers in the Philippines and is one of the 16 monitored volcanoes by the Global Volcanism Network. The eruptions caused extensive damage of shore towns and villages around Lake Taal, reaching areas as far as Manila. Now, several million people live within a 20-km radius of Taal's caldera rim, making the volcano the largest threat to the Philippine population. Therefore, it is very important to understand the possibility of Taal Volcano eruption. With this mind, we have conducted the following questions: (1) what are the sensitive proxies of volcanic eruptions that can be archived in the sediments? (2) Can we reconstruct of volcanic eruption history of Taal Volcano from the paleo-proxy of sediment cores from Lake Taal during the Holocene time? (3) What are the frequency and cycle of Taal Volcano eruption? And, what are the controlling factors of these eruptions? (4) What are the Holocene paleoclimatic and paleoenvironmental conditions in the central Philippine area? In order to search the answers, we plan to investigate the geochemical system of Lake Taal Volcano and its vicinity area in the central Philippines for detecting the history of eruptions of Taal Volcano and changes in paleoclimate and paleoenvironment during Holocene.

During our first field work on 11/22/2006, we have measured water temperature and depth with an Automatic Temperature and Depth Recorder (Model 70S) at two sites (Fig. 2). Both profiles exhibit small temperature gradients with water depths >50m. This observation reveals quite different thermal gradient feature from normal lakes in non-volcanic related lakes, but similar to that of the Main Crater Lake at Taal. This is because the thermal input and degassing from the lake bottom causing the fast mixing of the water column. Such a thermal gradient will influence the geochemical system of Lake Taal. We have also taken samples from the lake at different locations (Fig. 1) Sample TAL-4 was taken from 40-m depth by using a Niskin bottle. Sample TAL-11 was taken by the staff of Taal Volcano Observation Station at Talisay from the developed mud geysers on 11/17/2006. Sample location of TAL-7 is at the lake shore where a geothermal vent comes from the Volcano Island. We take a series of samples horizontally away from the vent. The concentrations of Na, K, Mg, Ca, Al, Fe, Mn, Sr, Ba, Co, Ni, Cu, Zn, Pb, As, Ti, Cr, Cd in the water samples have been done by Perkin-Elmer Optima 2100 DV ICP－OES, and $\delta^{18}O$ of water samples were measured by GasBench-Delta V IRMS at Southwest University of China, Chongqing.

We have measured the geochemical properties for both acidified, filtered (through 0.45μm filter paper) and non-filtered samples. The $\delta^{87}Sr$ analysis is done by Triton TIMS at NCKU.

From these results, we can conclude that (1) filtered and non-filtered samples have similar concentrations, implying that particle phase in the water samples is insignificant. (2) There is no chemical gradient in the water column shown by the similar concentrations, which corresponds to the weak thermal gradient. The water column is mixed very well. (3) The geothermal fluid (TAL-11) contains high major elements (Na= 4644, K= 916, Mg= 879, Ca= 322ppm), which are 10 times higher than the lake water (Na = 254±9, K = 32±1, Mg = 42±1, Ca = 43±2 ppm). These differences reflect input of volcanic water, dissolution of volcanic rocks, and incursion of seawater. However, because the influence of seawater, we cannot use these major elements as an indicator of volcanic activity. (4) Most samples do not contain Ba，Fe，Mn，Co，Ni，Cu，Zn，Pb，As，Ti，Cr，Cd (<0.01 ppm), and Al (~0.03 ppm). But, geothermal fluid TAL-11 contains significant amount of Al (4.21 ppm), Fe (21.4), Mn (40.0), Co (0.010, Ni (0.035), Cu (0.115) and Zn (0.357). These elements are not abundant in seawater, so that they may be considered as geochemical tracers for volcanic inputs. (5) Concentrations of Ti, Cr and Cd in TAL-11 are also very low, so that they may not be useful for the geochemical tracers of volcanic activity. (6) Concentrations of As in the lake waters are relatively high (0.02-0.07ppm), which is not good for lives that use the lake water. Currently, there are a lot of fish farms in the lake. The accumulation of As in fish bodies would cause health problems when people eat the fishes. (7) Sr content in lake water, TAL-7 and TAL-11 are 0.149±0.003, 0.228 and 0.465 ppm, respectively. (8) The ^{18}O and ^{87}Sr values in lake water, TAL-7 and TAL-11 are -1.75±0.28l (SMOW) and 0.705587 ±0.000046, -1.61 (SMOW) and 0.706235, and 2.22l (SMOW) and 0.704696, respectively. The ^{87}Sr value of the volcanic water (TAL-11) is about 1000ppm lower than that of the lake waters. Therefore, ^{87}Sr may be a good indicator of volcanic activity.

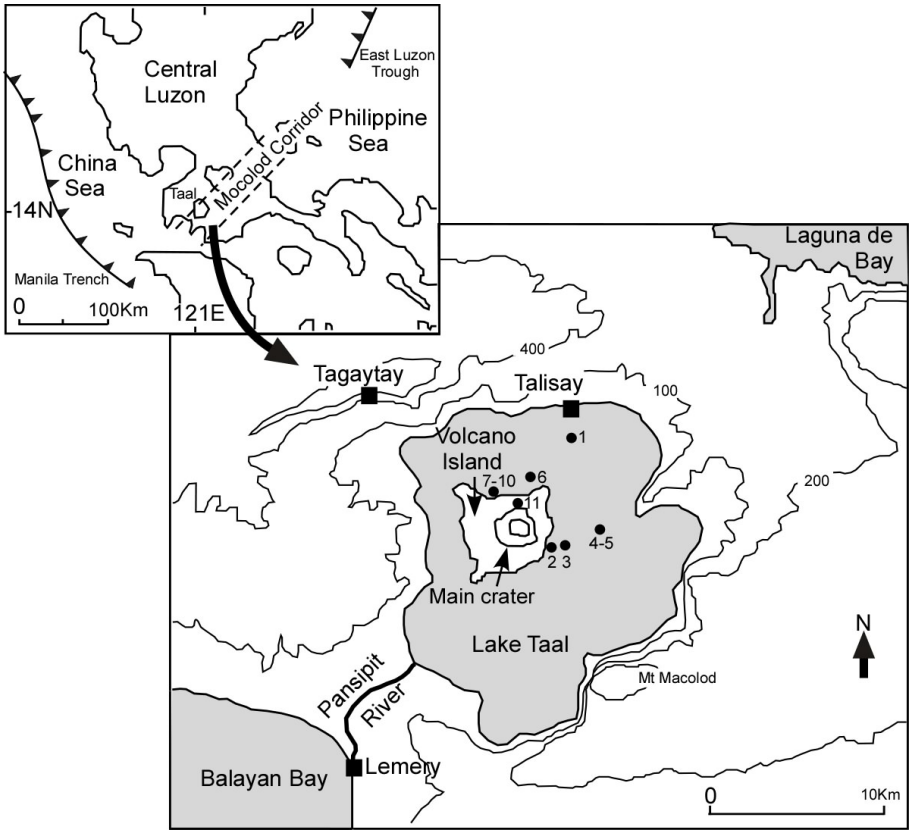

Fig. 1 Map of study area. The numerical numbers denote sampling locations during the 2006-11-22 trip.

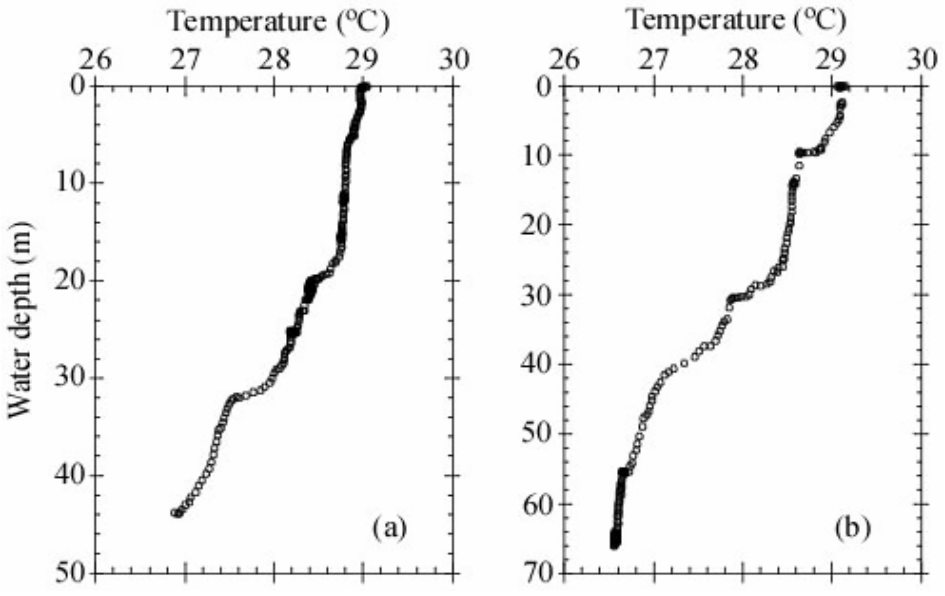

Fig. 2 Temperature profiles at two sites of Lake Taal measured on 11/22/2006.