

Detailed bathymetric map of Lake Monoun, Cameroon: A new interpretation for the limnic eruption in 1984

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Introduction

In August 1984, the Lake Monoun discharged a large amount of CO₂ gas killing 37 of residences around the lake. The explosive discharge of CO₂ gas is called as limnic eruption. Accepting the request by the Cameroonian government, Sigurdsson et al (1987) carried out a field research at the lake and found a remnant of water wave on the east shore of lake with a scarp on the shore. They also detected a dissolved CO₂ with high concentration in the bottom layer of lake. Sigurdsson et al (1987) conclude that the rock dropped from the scarp disturbed the bottom layer of lake, then a CO₂ enriched water was lifted, triggering the trigger of limnic eruption. On the other hand, Kusakabe et al (2008) suggested a spontaneous start of limnic eruption is possible in Lake Monoun based on the temporal variation of lake water after the eruption in 1984. On the floor of Lake Monoun seems to preserve the remnant of eruption which is an important key to reveal the fact of limnic eruption. In this study, a detailed topographic map was obtained by a multibeam sonar survey. In the map, a feature was recognized which is inconsistent to the conclusion by Sigurdsson et al (1987).

Bathymetric survey

The multibeam sonar emits a flat ultrasonic wave with strong directionality of 200 to 400 kHz targeting the bottom of lake. The reflected ultrasonic wave is received by the array of sonic sensors. The system of sonar is composed by the emitter and receiver of ultrasonic wave, GPS sensors, a gyro-sensor for detecting the perturbation of system, the controller of system and an engine power generator. The above system was assembled and installed on a rubber boat. The operation of the survey was carried out by 2 or 3 persons. Moving on the lake surface, the topography of lake floor was scanned. In this study, we used a multibeam sonar, Sonic2022 of R2SONIC co Ltd. The survey was carried out on 31th Oct to 4th November.

Results and discussions

The topography of lake bottom was measured with the precision ± 30 cm. The lake is extending in the direction of east and west. In the lake three basins, west, central and east were recognized. The depth of west and central basin was 46 and 56 m, respectively. Those basin looks to be the remnant of circular explosive crater the diameter of which is 145 and 134 m, respectively. The north wall of the central basin was well preserved. On the other hand, most of the crater wall of west basin was eroded, suggesting the central basin is younger than the west crater. The depth of the east basin reaches to 100 m. The shape of the east basin was ellipsoidal. The length of longer and shorter axis was 360 and 290 m, respectively. The south wall of the east basin was almost vertical. The floor of the east basin was flat with two small depression, the diameter of which was about 40 m and the depth of which was 1 to 2 m lower than the surrounding floor. The depressions were located near the east and south wall of east basin. Between the depression and the wall of basin, a bank was detected for each depression. The bank looks like the remnant of landslide.

The coupling of the depression and the bank brings us a new idea for the triggering of limnic eruption. At first, we assume the depression near the east shore of east basin is the outlet of CO₂ enriched fluid, and assume that the CO₂ concentration of lake water was close to the saturated concentration just before the eruption in 1984. Because the fluid from the depression is diluted with the lake water, the limnic eruption would happen above the depression. A big wave of water generated by the limnic eruption attacked the east shore of east basin, developing the scarp. If the landslide is the cause of limnic eruption, the coupling of the depression and the bank is difficult to be explained. There is another depression near the south wall of the east basin, suggesting another limnic eruption before 1984.

Keywords: Limnic eruption, Cameroon, Lake Monoun, CO₂, Bathymetry