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Water chemistry of lakes Nyos and Monoun, Cameroon in 2011

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1. Introduction

The explosive discharges of CO2 gas (= limnic eruption) at Lake Nyos and Monoun killed about 1800 people around the lakes in mid-1980s. The cause of the limnic eruption was the excessive accumulation of CO2 gas in lake water. The CO2 gas originated from a degassing magma. A mineralized water containing CO2 gas is expected to be discharged on the lake floor. The accumulation of the dissolved CO2 gas facilitated strong stratification of lake water. Investigation on the water chemistry and the formation of stratification is important for the prediction of the next limnic eruption.

2. Observation

The lake water was sampled on January 2011 at various depths on lake Nyos and Monoun. The anionic components were analyzed by a Dionex ion chromatograph. The stable isotope ratio of H2O was measured by a Picarro laser absorption isotope analyzer. The carbonic (=CO2aq + HCO3-) concentration was determined by the combination of the method by Kusakabe (2001) and micro diffusion volumetric analysis.

3. Lake Nyos

The carbonic concentration was high between the bottom (= about -210m) and -200m extending to 372 mmol/L. The concentration decreases gradually along ascent to -80m, being 6 mmol/L at -60m. The concentration of Cl- and SO42- was less than 1 and 0.5 mg/L, respectively. The dD of H2O was -8 permil between surface and -80m. The dD decreased to -10 permil deeper than -80m and stable to -200m. The dD again decreased gradually unitl -11.2 permil at -210m. The summation of the NO2- and NO3- concentration was high as 0.3 mg/L between surface and -50m. The concentration decreased to 0.02 mg/L between -80 to -170m. The NO2- and NO3- were not detected at the depth deeper than -175m.

4. Lake Monoun

The carbonic concentration was high as 73 to 93 mmol/L between -98 to -86m. The concentration decreased quickly along ascent until 6 mmol/L at -70m. The dD of H2O was -18 to -17 permil between the surface and -70m. The dD was low as -21 to -20 permil at the depth deeper than -80m. The total concentration of NO2- and NO3- was high at -98 and -40m as 2.6 mg/L. The concentration other than the above depth was less than 0.1 mg/L. The NO2- was detected at the depth near the bottom.

5. Stratification of lake water

The isotope ratio of lake water between the surface and -80 or -70m for both Nyos and Monoun suggests the effect of evaporation. The low isotopic ratio of water near the bottom suggests the discharging of mineralized water with isotope ratio similar to local meteoric water. Mixing of water is taking place in the intermediate depths. Cattle grazing is seen around Lake Nyos. This activity results in inflow to lake of nitrogenous constituent to the lake giving rise the source of NO2- and NO3- in the lake. Nitrogenous component were found down to -170, suggesting the influence of surface water at Lake Nyos. In Lake Monoun, the influence of surface water reaches near the lake bottom.

6. Magmatic component

For both lakes, concentration of Cl- and SO42- concentration is proportional to the carbonic concentration. The Cl/CO2 molar ratio is 5.08E-5 and 5.31E-4 for Lake Nyos and Monoun, respectively. The SO4/CO2 molar ratio is 5.31E-6 and 6.41E-5 for Lake Nyos and Monoun, respectively. The gas phase equilibrated with basaltic magma should have Cl/CO2 and S/CO2 ratios of (1.5˜10)E-6 and (5˜13)E-4, respectively (Giggenbach, 1996). The SO4/CO2 ratio for both lakes is much lower than the magmatic S/CO2 ratio. It is speculated that sulfur species in the magmatic fluid was reduced during migration through a hydrothermal system which might develop beneath the lakes.

Keywords: Nyos, Cameroon, CO2, Limnic eruption