

A physico-chemical study of the Gulf of Kabuno which highlights the risk of a cataclysmic gas explosion

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The gulf of Kabuno, located in the northwest corner of Lake Kivu (DRC), shows a particular configuration that sets its waters apart from those of the main basin. The gulf, 140 m deep, is almost landlocked; it is linked to the main lake by only a narrow passage, the threshold of which is only twenty meters deep. Therefore, the gulf is a lake in its own right, and the physicochemical characteristics of its waters are completely different from those of the waters of Lake Kivu.

Two experimental surveys were carried out in August 2007 and September 2008 to study the physico-chemical stratification of the gulf's waters. The critical part of the experiments consisted in obtaining the concentrations of dissolved gases (carbon dioxide, methane and hydrogen sulphide) as a function of depth, down to 140 m. This study relied on the technique known as "Pan pipes" that we used on the Cameroonian lakes and improved on Lake Kivu. From the concentration profiles of dissolved gases we can deduce the partial pressures of each gas, and finally the total gas pressure. This quantity determines the risk of gas eruption.

The classic CTD profiles (Conductivity, Temperature, Depth) were also performed by adding a partial pressure sensor for methane, which allowed us to deduce the dissolved methane concentration at any depth. When analyzing our results, it clearly appeared that the total gas pressure (the sum of partial pressures) was very close to the hydrostatic pressure at a depth of only 12 m. We are currently faced with a dangerous risk of a limnic eruption; the situation is similar to the one prevailing at lakes Nyos and Monoun in Cameroon before the catastrophic gas releases.

Using a bathymetric map and data giving the concentrations of dissolved CO₂ at each depth, we were able to deduce that the total carbon dioxide content in the gulf is 2.92 km³, i.e., almost 10 times the amount of gas in Lake Nyos (0.3 km³).

The Gulf of Kabuno is located in a densely populated area and the city of Goma (one million inhabitants) is only 15 km away. Moreover, the gulf is located on a highly seismic area and threatened by the lava flows from the neighbouring volcano Nyamulagira, of which three flows reached the gulf during the past century. It seems obvious that we must take seriously in consideration the risk of a limnic eruption at Kabuno, which could prove much more deadly than that of Lake Nyos. We therefore proposed to the authorities of the Democratic Republic of Congo a plan aimed at degassing safely the gulf in a controlled way. A project is under discussion with the Ministry of Environment of the DRC.

It turns out that an experimental degassing column, 200 mm diameter and 120 m long, was anchored in the gulf of Kabuno in 2008. The self-siphoning process was easily started by using the "gas-lift" procedure. A water and gas fountain showing a white and sparkling appearance gushed to a height of 80 cm. This demonstration column is still functional today (January 2013).