PRELIMINARY REPORT ON THE SATREPS PROJECT

JUNE 2012 AND JANUARY 2013 FIELD EXPEDITION TO LAKES NYOS AND MONOUN, CAMEROON

Japanese-Cameroonian SATREPS Project on Safety, Rehabilitation, and Development of the Lakes Nyos and Monoun areas in Northwest Cameroon. American participation by the U.S. Geological Survey and the University of Michigan

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SUMMARY

In 1984 Lake Monoun released carbon dioxide gas that killed 37 people, and in 1986 Lake Nyos released a burst of gas which killed over 1800 people. Scientists and engineers have been working since the Nyos disaster in 1986 to safely remove the gas from these lakes and make them safe.

As part of the 5-year SATREPS project funded by the Japanese government (JICA, JST) and supported by the Cameroonian government (MINRESI, IRGM), American scientists Bill Evans (U.S. Geological Survey) and George Kling (University of Michigan) traveled with Japanese and Cameroonian scientists to Lake Monoun and Lake Nyos from 1-10 June 2012 and again from 16 – 26 January 2013. Here we provide a brief report on our activities and preliminary findings.

(1) In June 2012 we installed a climate station at Lake Nyos on a floating platform built by our Japanese colleagues. Sensors were installed to monitor the air temperature and humidity, the wind speed and direction, the incoming solar radiation, the barometric pressure, and rainfall. In addition, sensors were installed in the lake to monitor water temperature, salt content, and the pressure of total dissolved gases (including carbon dioxide, CO_2 and methane, CH_4) at two depths in the lake (Figure 1).

(2) On our second trip in January 2013 we installed a floating platform on Lake Monoun to measure the same basic climate variables as measured at Lake Nyos. Similar to the station at Nyos, sensors were installed to monitor the water temperature, salt content, and the pressure of dissolved gases (carbon dioxide, CO_2 and methane, CH_4) at two depths in the lake (Figure 1).

(3) At Lake Nyos in January 2013 we checked the operation of the climate station that was installed on our first trip of this project in June 2012. The station is operating normally (with the exception of

one sensor which has failed), and the lake temperature and conductivity (salt content) are behaving as expected (Figure 2). This information is useful to make sure that the degassing is proceeding smoothly and not creating dangerous conditions in the lake.

(4) The three degassing pipes continue to operate in Lake Nyos (Figure 3). Measurements of the total gas pressure in Lake Nyos showed that the degassing operation is steadily reducing gas amounts in the bottom of the lake. The gas pressure at the deepest part of the lake has been reduced by ~2.5 times from a maximum content in 2001 when the first pipe was installed (Figure 4). The total CO_2 in the lake has been reduced by 40% since 2001, from ~710,000 to 425,000 metric tons (Figure 5).

(5) Measurements in January 2013 of the total gas pressure in Lake Monoun show that the prior degassing has reduced gas amounts in the bottom of the lake (Figure 6). The lake is now considered to be "safe" for the surrounding population. The installed climate station on the lake will help to monitor any future build up of gas.

(6) Although we are not directly involved, we can report that operations have begun at Lake Nyos to strengthen the weak natural dam impounding the upper 40 m of the lake (supported by the EU and Cameroonian government) (Figure 7). Liquid cement will be injected into the dam and when it sets it will prevent further leakage of lake water through the dam which causes erosion. This strengthening will reduce the danger of the dam failing and creating a flood that could reach into Nigeria and affect from 5,000 to 10,000 people below the lake.

Figure 1. Climate monitoring station anchored in Lake Nyos (top) and Lake Monoun (bottom).

Figure 2. Degassing pipes at Lake Nyos. The first pipe was installed in 2001 as part of the USAID – OFDA project with Japanese, Cameroonian, and French scientists and engineers. In 2010 two additional pipes were installed by a French company using money provided by the Cameroonian government.

The red color of the lake is due to dissolved iron in the lake bottom waters that is brought to the surface by the degassing pipes. At the surface the iron contacts oxygen and forms and iron-hydroxide ("rust") which colors the water.

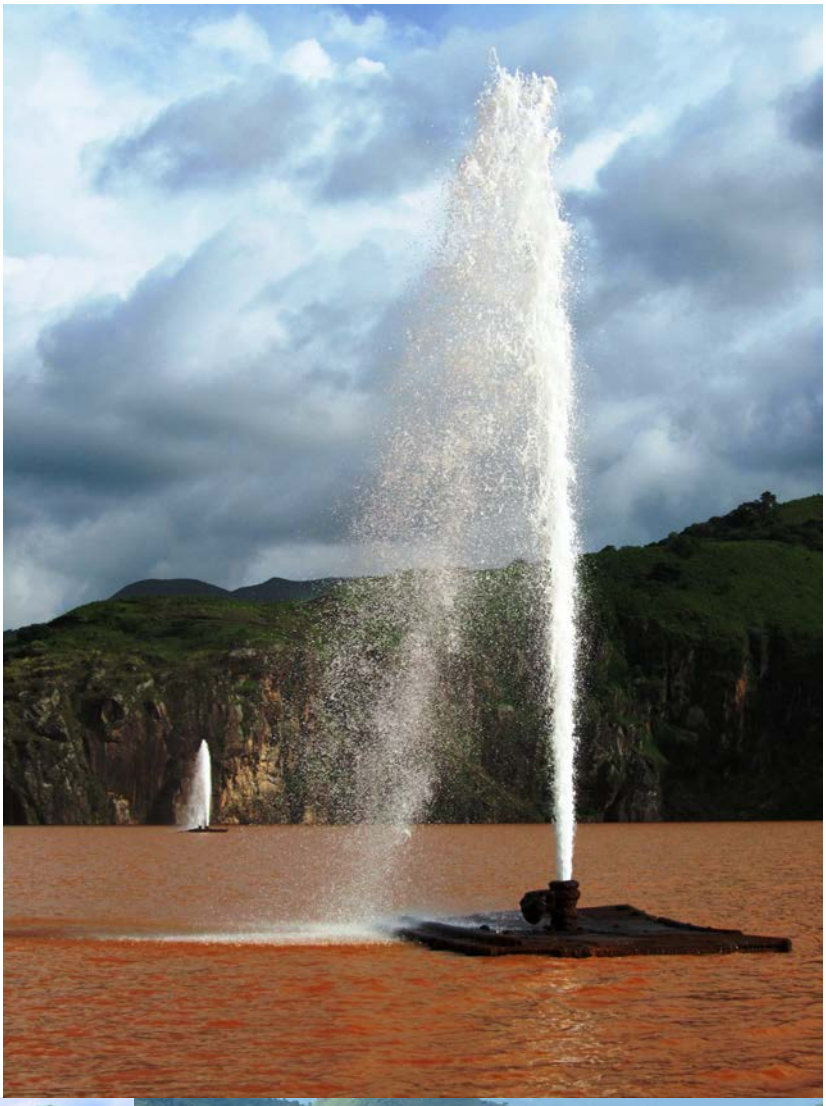

Figure 3. Changes in water temperature and conductivity (salt content) in the surface water of Lake Nyos taken from the climate station installed in June 2012. Water temperature (red line) cools during the summer monsoon rains, warms in the fall, and then cools dramatically starting in the dry season in December.

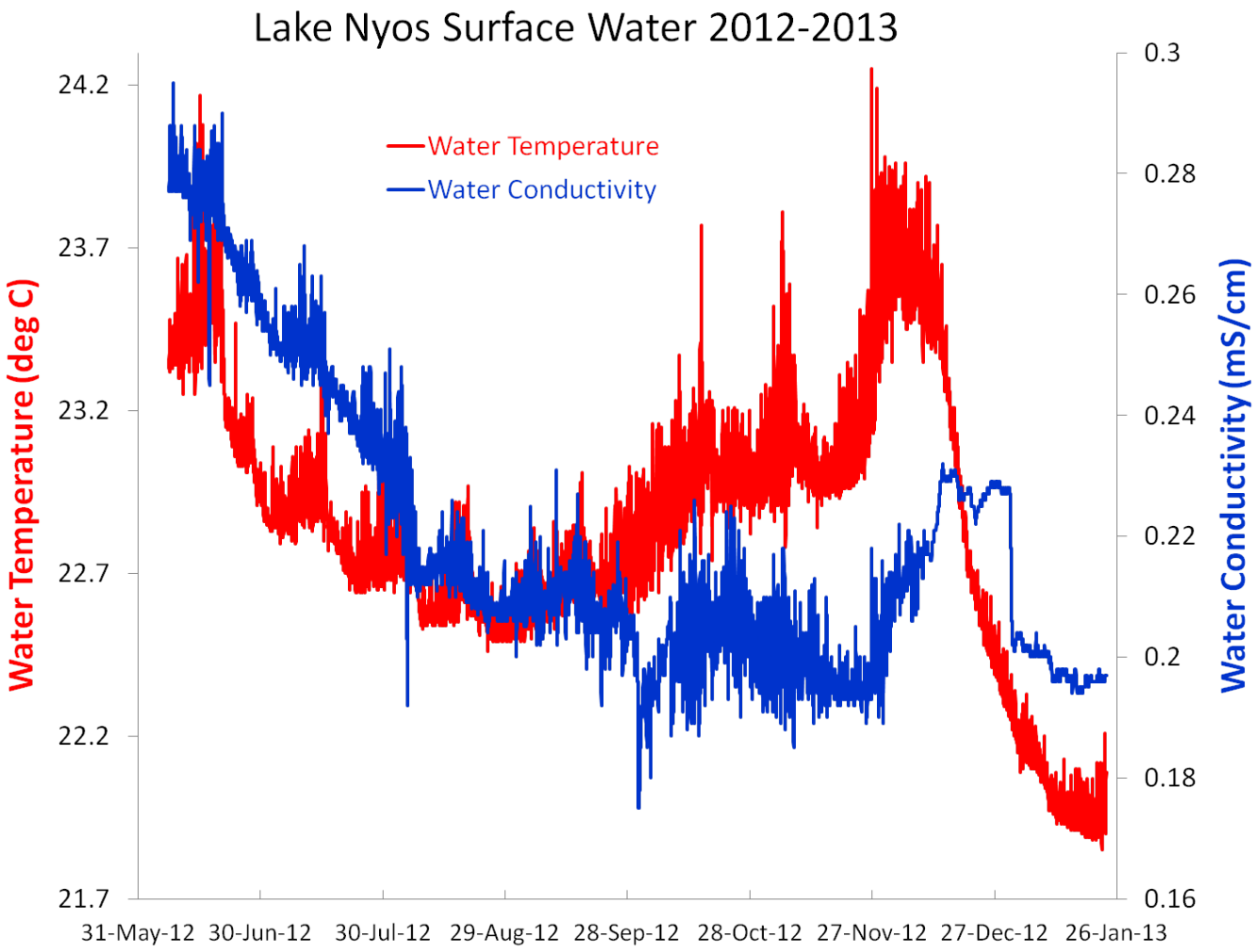

Figure 4. Profile of total gas pressure (CO_2 plus CH_4) in the bottom waters of Lake Nyos. The gas pressures increased from 1992 to 1998 to a maximum in 2001 (red line) when the first degassing pipe was installed. In June 2012 the profile (green diamonds) shows the gas pressures at the bottom of the lake have been reduced by ~2.5 times from the maximum in 2001.

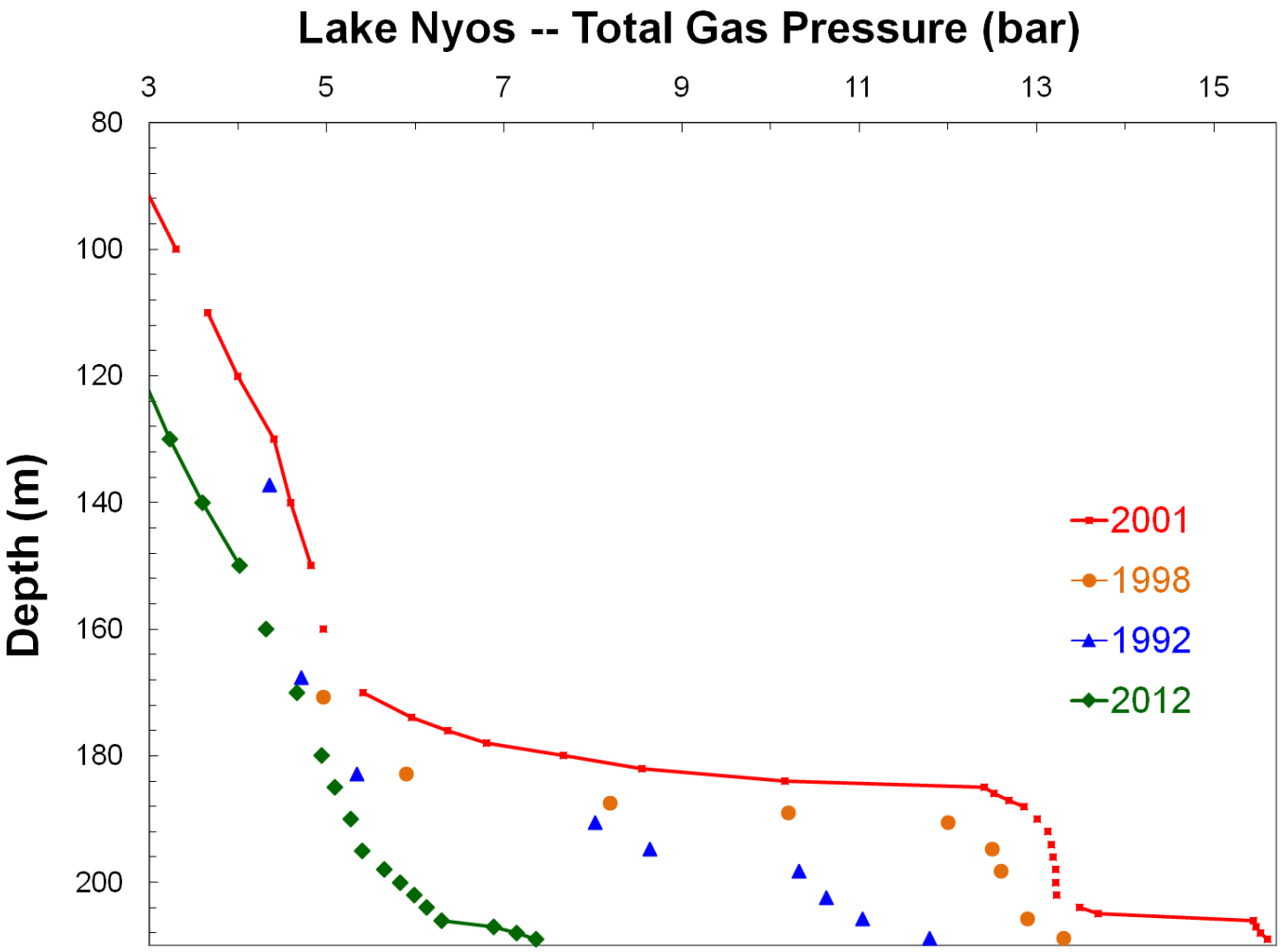

Figure 5. Total amount of CO_2 in Lake Nyos in 2001 (maximum content after the 1986 gas disaster) was reduced by ~ 7% by 2003 with the pipe installed in 2001. Two more pipes installed in March 2011 have further reduced the gas content to 40% of the maximum held in the lake in 2001.

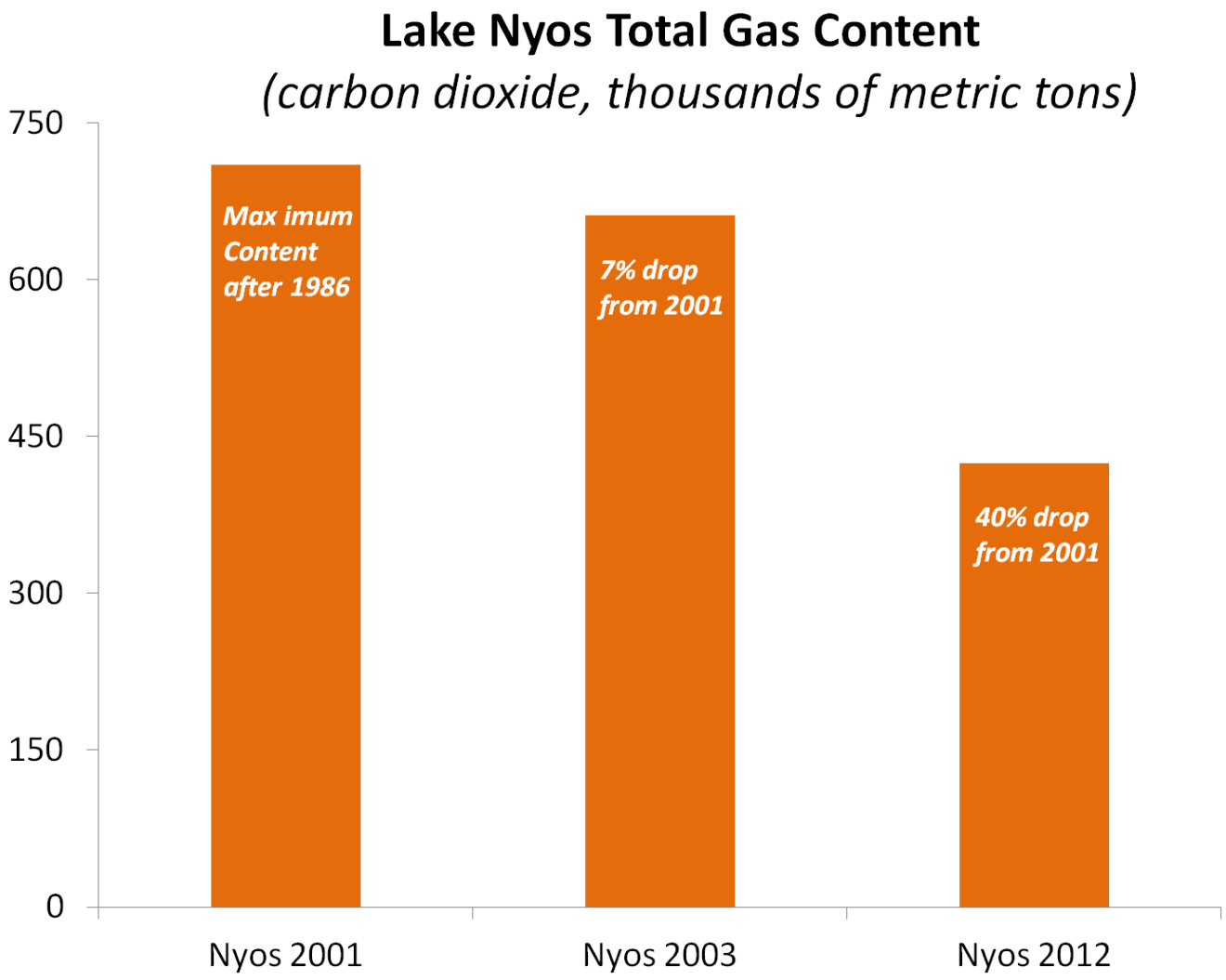

Figure 6. Profile of total gas pressure (CO_2 plus CH_4) in the bottom waters of Lake Monoun. The gas pressures were highest in 2003 just before the first degassing pipe was installed. Gas pressures dropped by 2006 and by January 2013 the lake has essentially been degassed. Although gas pressures at the very bottom (below where the degassing pipe inlet reached) are still ~4 bar, the amount of water in this deepest part of the lake is very small and the total amount of gas contained constitutes no danger at this time for the surrounding populations.

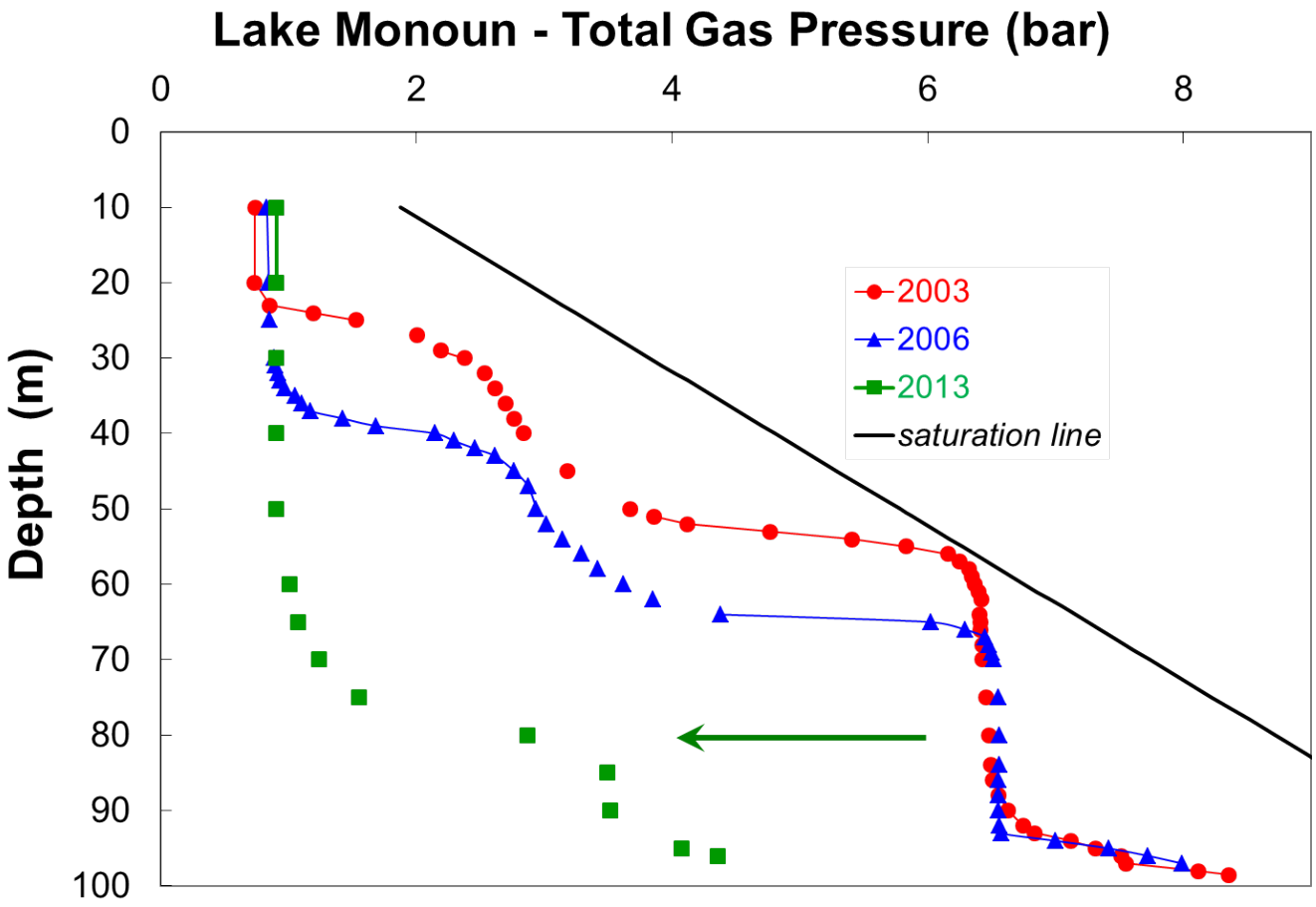

Figure 7. Operations to strengthen the weak natural dam at Lake Nyos include drilling into the dam and injecting liquid cement in order to stabilize the dam and prevent leakage of lake water through the dam. This picture was taken on 22 January 2013 and shows the drilling process across the dam.