Pilot plant for the removal of extreme gas charges from deep waters installed

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Phe pit Lake Guadiana in the former mining area Herrerias in Andalusia, Spain. Credit: Bertram Boehrer/UFZ

Being part of the mining area Herrerias in Andalusia, deep waters of Pit Lake Guadiana show extremely high concentration of dissolved carbon dioxide (CO_2). In the case of a spontaneous ebullition, human beings close-by would be jeopardized. To demonstrate the danger and the

possible solution, scientists of the Spanish Institute of Geology and Mining, the University of the Basque Country (UPV/EHU, Bilbao) and the Helmholtz Centre for Environmental Research (UFZ) constructed a pilot plant for degassing. A fountain pulls deep water through a pipe to the surface, where the gas can escape from the water. The buoyancy produced by the bubbles provides the energy required for driving the flow.

"The deep water in the residual lake Guadiana contains an extremely high volume of carbon dioxide (CO_2). Oxidation of ores has created a very acidic milieu, which is also known from other mining areas. In the mining area Herrerias however, this acidity dissolves carbonate from the rocks and produces carbonic acid (dissolved CO_2), which can be accumulated under the high pressures of deep waters in the lake. There is not much circulation beyond 25 meter depth to remove the gas load" says Dr. Bertram Boehrer of UFZ, who is physicist and has been investigating stratification in lakes at many places on Earth. Due to the high hydrostatic pressure, each liter of deep water contains about 2.5 liters of CO_2 gas. As long as the stratification remains stable, the gas is retained in the deep water. A land slide or other processes producing large water movements could facilitate a sudden release of gas previously confined under high pressure. Inhaled air of 8 percent CO_2 are considered deadly for humans.

Now the scientists installed a degasing pipe which is the heart of the new pilot plant: Deep water enters a pipe at 61m depth. On the way up, hydrostatic pressure drops and gas bubbles form. The reduced density of the water-gas-mixture allows that deep water is pushed out of the pipe at the upper end to form a fountain above the water table, where gas is released to the atmosphere. This is an elegant solution, as the system does not require any additional driver, and the controlled release of CO_2 does not pose any problem. "With this pilot plant, we could demonstrate that this approach also works in Guadiana pit lake. This can now be

proposed to authorities as a possible approach to deal with the gas load." Though the lake in the mining area is fenced and access is not permitted to the public, this prohibition is difficult to survey.

Earlier installations in Lake Nyos in Cameroon served as a good example for this approach. In this lake, degassing pipes had been installed, which released the gas load with three fountains. On August 21st 1986, a large volume of gas escaped from the lake suddenly. The gas entered valleys of the surrounding area. 1700 human beings and thousands of animals were killed. The trigger could have been a land slide though this was never really proven. To avoid a repetition of this disaster, the gas load is slowly removed from the lake. One more crater lake called Monoun in Cameroon suffocated 37 human beings close to its shores in a similar eruption. Also in Monoun degasing fountains have been installed.

In Guadiana pit lake we do not see the same danger as in Lake Nyos, due to smaller size and depth. In addition, a density gradient between surface waters and deep waters is keeping the system stable. However, gas concentrations are so high that precaution must be taken. More detailed investigations must be implemented and remediation must be considered, says Dr. Boehrer. For the formation of such extreme gas loads, lakes must be sufficiently deep with incomplete winter recirculation (meromixis) and a strong carbon dioxide source. At the moment, we do not have such a lake in Germany.

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