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Origin and transport of CH4 in two maar lakes fed by mantle-derived volatiles (Mt. Vulture volcano, Italy)

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It has been assessed that lakes contribute 6 to 16% to global CH4 emission in atmosphere. Accumulation of CH4 in the water is strongly dependent on the input of gas and the dynamic of the lake's water.
Lakes located on tectonically and volcanically active areas (e.g., Kivu, Nyos) generally contain relevant amount of mantle-derived volatiles. This generated an open debate on the origin of CO_2 and CH4 in volcanic lakes because the complex bio-geological cycling of these two gases.
This study is a part of larger investigation carried out on two maar lakes (LPM and LGM) formed about 140.000 years ago during the last eruption of Mt. Vulture (Italy). In spite of it generally is considered to be extinct, both lakes are characterized by an active inflow of mantle-derived fluids (Caracausi et al., 2013). Although the two lakes are only 150 m apart, their respective dynamics are different being LPM a meromictic lake, while LGM a monomictic one (Caracausi et al., 2013).
The stagnant waters of LPM are enriched in CO_2 and CH4 but the total gas pressure is below the hydrostatic pressure, so that the transfer of gas towards the surface doesn't occur via bubbles. Vertical profiles at LPM reveal a marked decrease of the dissolved CH4 content in the shallower layers due to aerated water. The amount of CH4 dissolved in LGM water column shows seasonal variations: in autumn it is comparable to that of LPM at the same depth; in winter CH4 is fully released into atmosphere through overturn of waters.
C and H isotopes of CH4 clearly indicate in both lakes an active production both by acetoclastic methanogenesis and by CO_2 reduction although with different proportions.
Historical reports describe intense episodic releases of gases from both lakes occurred up to about 200 years ago. Caracausi et al. (2013) highlight that these events could be caused by a release of mantle-derived CO_2 accumulated in the crust or directly linked to magma degassing.
In the present study the knowledge gained from previous limnological-geochemical investigations has been joined with isotope signature of gas (CH4 and CO_2) collected from sediments at the bottom of LPM, by means of a specially designed robot called "Muddy". Muddy is also able to perform vertical profiles both of pH and of temperature in the water column and in the sediments as well.
The obtained results lead us: 1) to assess the production ratio of CH4 through acetoclastic methanogenesis and CO_2 reduction in the sediments; 2) to determinate CH4 oxidation; 3) to detect the origin of CO_2 involved in methanogenic processes, evaluating the contribution organic-CO_2 and the sink of mantle-derived CO_2.;4) to discuss the differences in CH4 sources in the water and sediments; 5) to properly define gas hazards assessment.

A. Caracausi, M. Nicolosi, P.M. Nuccio, R. Favara, M. Paternoster, A. Rosciglione (2013) Geochemical insight into differences in the physical structures and dynamics of two adjacent maar lakes at Mt. Vulture volcano (southern Italy), G. Cubed, doi: 10.1002/ggge.2011