Geophysical Research Abstracts
Vol. 14, EGU2012-2479, 2012
EGU General Assembly 2012
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Seasonal evolution of water and dissolved gas chemistry in monomictic lakes: an example from Paterno sinkhole (Central Italy).

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This study examines the distribution of chemical (major, minor and trace compounds) and isotope compositions of water and dissolved gases along the vertical water column of Lake Paterno, a sinkhole located in the NE sector of the S. Vittorino plain (Rieti, Central Italy), an area showing evidences of past and present hydrothermal activity. The main aim of this investigation is to describe the seasonal evolution of the water and dissolved gas chemistry and its dependence on biogeochemical processes occurring in the lake water and within the bottom sediments. Water and dissolved gases were sampled in winter (February) and summer (July) 2011 from the surface to the maximum depth of 54 m at regular intervals of 5 m. Analytical results show that in winter Lake Paterno waters were almost completely mixed, although relatively low amounts of minerogenic and biogenic products were recognized at the interface between lake water and bottom sediments. In summer, well-defined thermal and chemical stratifications established. The occurrence of annual meromixis is a typical feature of non-freezing lakes in temperate climates and is called monomixis. During the stratification period, biological processes, such as sulfate-reduction, denitrification, and NH4 and H2 production are the main controlling factors for the vertical distribution of the chemical species in the water body The carbon isotopic signature of CH4 suggests that this gas is produced by methanogenic processes related to anaerobic activity of archeabacteria. On the contrary, dissolved CO_2 seems to have two different sources: 1) bacteria-driven reactions; 2) contribution from the hydrothermal system that is also feeding the CO_2-rich mineralized springs discharging in the surrounding areas of the lake. The input of deep-seated CO_2 may play a significant role for the development of the seasonal stratification of Lake Paterno. The latter controls the macro-invertebrate population dynamics: in summer, fishes are forced to populate only the epilimnion, whereas in winter they also colonize the deep waters.
To exhaustively define the mechanisms regulating the temporal evolution of the water and dissolved gas chemistry of this lake, a comprehensive investigation of the distribution of bacteria and archaebacteria populations along the vertical water column is strongly recommended.