Geophysical Research Abstracts
Vol. 14, EGU2012-10851, 2012
EGU General Assembly 2012

Hydrothermal water exhalations at the submarine volcano Panarea, Italy – insights from stable isotope investigations

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Differences in stable isotopic signatures are a powerful indicator to get information on the composition and the origin of water, different geothermal reservoirs and also separation processes. The investigation area which is about 2 kilometers east of Panarea, part of the Aeolian Islands (Italy), belongs to a back–arc volcanic system where characteristic marine hydrothermal gas and water emission occur. The locations underwater were investigated via scuba diving. Water samples were collected in water depths between 8 and 30 meters.

Isotopic analyses were focused on stable isotopes for δ^2H_{water}, $\delta^{18}O_{water}$, $\delta^{13}C_{DIC}$, $\delta^{34}S_{Sulphate}$, $\delta^{34}S_{Sulphide}$. The isotopic composition $\delta D/\delta^{18}O$ signals a water mixture between a magmatic and/or andesitic magmatic component plus local meteoric water and Mediterranean Sea water. The sampling sites show a significantly different influence in these components, a magmatic input of up to 30 % could be determined.

The signature of $\delta^{13}C_{DIC}$ is quite variable ranging from -12.1 ‰ to 22.5 ‰ versus PDB. One potential cause for the observed variation range may be methanogenesis, a microbial process leading to the formation of methane that produces an increase of the $\delta^{13}C_{DIC}$ values in the residual fraction (Rayleigh enrichment during CO_2 reduction). However, low methane concentrations (up to 3700 ppm) and high temperatures (up to 135 ˚C in 49 cm sediment depth) dissent this theory. A further potential cause for the carbon isotope variation might be related to the influence of evaporates from the Messinian salinity crisis in the Miocene which matured in a series of sub-basins. Methanogenesis could occur, generated methane could fumigate whereby heaver carbon isotopes could enriched in the basement residual fraction.

Measured $\delta^{34}S$ values are slightly shifted to heavier ^{34}S (1 to 3 ‰) in the residual fraction compared to the mean isotopic composition of dissolved marine sulphate. This offset can be caused by biogenic reduction of the original marine sulphate. The isotopic signature of $\delta^{34}S$ in sulphide varies between -0.48 ‰ to 3.67 ‰ (VCDT) confirming isotopic signatures assumed to be characteristic for back-arc basins.