Geophysical Research Abstracts
Vol. 18, EGU2016-12759, 2016
EGU General Assembly 2016

Geochemical and isotopic features of geothermal fluids around the Sea of Marmara, NW Turkey

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Earthquake processes provoke modifications of the crust affecting the fluid regime with changes in water level in wells, in temperature and/or chemical composition of groundwaters, in the flow-rate of gas discharges and in their chemical and isotopic composition. In the frame of MARsite (MARsite has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No 308417) the relationship between fluids and seismogenesis has been approached collecting geochemical data of local significance and evaluating them in geochemical interpretative models of fluids circulation and interactions as well as defining their behaviour over a seismic-prone area.

During three fluid sampling campaigns in 2013, 2014, and 2015 a suite of 120 gas samples were collected from 72 thermal and mineral water springs/wells in the wider Marmara region along the Northern and Southern branches of the North Anatolian Fault Zone (NAFZ). Bubbling gases were collected if available, in all other cases the gas phase was extracted from water samples collected on that purpose. Gas samples were analyzed for the main chemical composition as well as their isotopic composition (He and C).

The results highlight that the vented gases are a binary mixture of two end-members having nitrogen and carbon dioxide as main components. The geochemical features of the gas phase are the result of several processes that have modified their pristine composition. Atmospheric and deep-originated volatiles mix at variable extents and interact with cold and hot groundwaters. CO_2 is normally the main gas species. But it's concentration may decrease due to gas-water interactions (GWI) increasing the relative concentration of N2 and other less soluble gases. A high CO_2 content indicates minor interactions. Thus, the easier and faster the pathways are from the deep layers toward the Earth's surface, the lower are the interactions. The volatiles keep their pristine composition. Faults represent a preferential way for rising volatiles due to local high permeability. 3He/4He ratios ranging from 0.1 to 4.8Ra (Ra = 3He/4He atmospheric ratio) indicate the presence of mantle contribution. The highest ratio was found at the eastern end of the Ganos fault. Mantle degassing is not obvious in non-volcanic areas, however the measured helium isotopic ratios indicate mantle degassing likely through lithospheric faults. All the information we got indicate that the fluids circulating over this area are the result of fluid mixing at variable extents of three end-members: mantle, crust and atmosphere.