CO_2 and heat fluxes in central Apennine, Italy

Giovanni Chiodini[1], Carlo Cardellini[2], Stefano Caliro[1], Francesco Frondini[2], Claudio Chiarabba[3]

[1]Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Vesuviano, Via Diocleziano 328, Napoli, Italy, [2]Dipartimento di Scienze della Terra, Universita' di Perugia, Piazza Universita', Perugia, Italy, [3]Istituto Nazionale di Geofisica e Vulcanologia, CNT, Via di Vigna Murata, 605, Roma, Italy

E-mail: carlo.cardellini@unipg.it

Central and southern Italy are affected by an active and intense process of CO_2 Earth degassing in both volcanic and non volcanic environments, as revealed by the presence of many CO_2 rich gas manifestations in the western sectors of the region, and by regional aquifers rich in deeply derived CO_2 in the eastern sector, i.e. in the Apennine belt. We mapped the process and estimated the total CO_2 involved on the base of the carbon mass balance of the Apennine aquifers. The deeply derived CO_2 involved in this large Earth degassing process resulted in 2-2.5x10^{11} mol/a that represents $\sim$10% of the estimated present-day total CO_2 discharge from the sub aerial volcanoes of the Earth. The groundwaters enriched in deeply derived CO_2 systematically display a slight temperature anomaly, which becomes significant when the differences between the water temperatures at the springs and the temperature of corresponding recharging meteoric waters are compared. These temperature difference, together with the hydrogeologic parameters of the different aquifers, have been used to compute the total amount of heat transported by these groundwaters, which results of $\sim$2.2x10^9 J/s. Most of the heat (57%) is given by geothermal warming while the remaining 43% is due to gravitational potential energy dissipation. This geothermal warming implies very high heat flux, with values higher than 300 mW/m^2, in a large sector of the Apennines. The estimated heat flux in the Apennine is higher than that affecting the famous geothermal provinces of Tuscany and Latium, and the total heat release is about half of the total heat discharged at Yellowstone. This finding is in some way surprising because so far the central Apennines is though to be a cold area. This high heat and CO_2 flux opens a new vision of the Apennines belt and requires the existence of a thermal and fluid source such as a large magmatic intrusion at depth. Recent tomographic images of the area confirm the presence of such intrusion visible as a broad negative velocity of seismic waves. From the deep zone of the magmatic intrusion the heat is transported toward the surface by hot and CO_2 rich fluids, which enter the aquifers and mix with the meteoric waters. This study on the Earth degassing process in Italy reveals how the investigations based on large groundwaters systems are important for a more reliable estimation of both deep CO_2 and heat fluxes. In particular this is true for the tectonically young and active areas of the Earth, where large amount of meteoric waters infiltrate and deeply circulate dissolving the gas and cooling the crust.