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Geochemical evidences for and characterization of CO2 rich gas sources in the epicentral area of the Abruzzo 2009 earthquakes.

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The influx of deeply derived, CO2 rich gases has been recognized in the regional aquifers located in the epicentral area of the Abruzzo 2009 earthquakes, on the basis of the chemical and isotopic compositions of water and dissolved gas. The solution of the carbon isotopic-mass balance allowed to estimate that $\sim$ 600 t/d of CO2 are dissolved and transported by the groundwaters of the area. The gas source has been localised in the subsurface of the area affected by the earthquakes where high pressure sources of fluids were hypothesised to occur based on of seismological data.
The chemical and isotopic composition of the deep gas (Abruzzo gas), derived by comparing the data measured in the springs with the results of a gas-water-rock reaction model, results in CO2 contents between 90 and 95%, N2 contents between 5% and 10%, He contents between 40 ppm and 90 ppm and He isotopic composition from 0.05 R/Ra to 0.15 R/Ra. This estimated composition is in the range of values characterising the deep gases released in the large degassing anomaly of central Italy. There, the gas emissions exhibit a regional compositional trend becoming progressively richer in radiogenic elements (4He and 40Ar) and in N2, moving from the volcanic complexes of the Peri-tyrrhenian sector in the west to the Apennines in the east. In particular, the Abruzzo gas matches the composition of the gases emitted in the east, in the pre-Apennine region. These geochemical trends indicate increasing residence times of the gas in the crust towards east. This is in agreement with the structural setting of the region, in fact, while the western sector is characterized by mantle upwelling and by interconnected networks of extensional fractures and normal faults, which allow a relatively rapid transfer of the deep fluids to the surface, the eastern sector, where the process of crustal thinning has not yet gone to completion, the arrangements of the deeper thrusts and normal faults generate deep structures where the gas is trapped at high pressures for a long time, producing the increase in radiogenic crustal species.
Similarly to what has been proposed for the earthquakes occurring in the northern Apennine, such high pressure gas pockets could have played a major role in the generation of the Abruzzo earthquakes, as suggested by both seismological signals and the geochemical features of the groundwater of the region. In particular, the comparison of the 2009 data with few data collected before the seismic sequence shows that an increased input of the deep fluids could have accompanied, or preceded, the Abruzzo earthquakes. This is an intriguing but still a not well constrained observation because longer time series are necessary to discriminate between the geochemical signal from the source and variations caused by shallow, seasonal processes affecting the aquifers.