



Gas study from natural CO₂-degassing sources near Sainte Marguerite, Allier, France

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We collected 7 gas samples from natural bubbling sources and geyser near Sainte Marguerite, Allier, France. This area is known to present an important heat flow anomaly, and the probable existence of a mantle plume just below. The site exhibits a lot of water sources, with also giant "bubbles" forming always at the same place in the Allier river, indicating an important degassing process.

We also made some ground measurements on the field, during the collection of the gas samples. The use of a portable micro-chromatography allowed to make some volume balances of the major gases and showed important variability of CO₂ contents (from 0.4 to almost 100%).

Back in the laboratory, we analysed the gas which is composed of almost 100% CO₂, with a $\delta^{13}\text{C}$ CO₂ of around -5‰, compatible with a mantle-derived origin. We analysed noble gas concentrations (He, Ne, Ar, Kr and Xe) and isotopic ratios ($^3\text{He}/^4\text{He}$, $^{20}\text{Ne}/^{22}\text{Ne}$, $^{21}\text{Ne}/^{22}\text{Ne}$, $^{38}\text{Ar}/^{36}\text{Ar}$ and $^{40}\text{Ar}/^{36}\text{Ar}$) at IPGP. The preliminary results are very surprising. Indeed, The Helium concentrations range between 0.28 and 8.22 ppmv, with 5 samples having concentrations lower than the atmospheric helium concentration of 5.24 ppmv.

However, within these samples, all $^4\text{He}/^{20}\text{Ne}$ ratios even low (from 2.12 to 198) are greater than the air value of 0.288. Thus, air contamination can be discarded. The most intriguing result is that all our samples exhibit very high and relatively homogeneous values of R/Ra, around 3.5-4Ra, implying a large contribution of mantle-derived helium (R/Ra = 8 for the upper mantle, R/Ra = 6 for the SCLM) to the total budget of this gas.

The neon and argon isotopic ratios are not far from the atmospheric values, suggesting a small, if any, crustal contribution and an important Air Saturated Water (ASW) contribution, in agreement with this hydrothermalism. This is in agreement with our very low total budget of helium .

To our knowledge, this is the first time that so low Helium concentrations combined with so high $^3\text{He}/^4\text{He}$ are measured in crustal fluids.

Our tentative interpretation is that gas comes from a degassing magma at depth, and then is transported to the surface as dissolved in water without accumulation. This is confirmed by the slight isotopic fractionation seen in the neon isotopes together with some elemental ratios, enriched in the lightest noble gas.