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Gas composition and helium isotope ratios in geothermal sources from Cerna Valley (Romania)

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Abstract. The gas composition and helium isotope ratios were investigated in the region of Herculane geothermal anomaly. The natural radioactivity, originating in the granitic rocks of the basement, is very high. The measured helium isotope ratios are characteristic for young structures with tectono-magmatic activity.

1 Introduction

In south-western Romania, an important geothermal anomaly occurs in the region of Herculane Spa. The anomaly is associated to a major transcrustal intra-Carpathian fracture. The main longitudinal fault is intersected by numerous transversal fissures (Fig. 1). The geothermal water sources (springs and drills), always accompanied by large amounts of gases, are located at the intersection of these fractures. The presence of granite rocks at the surface is another remarkable characteristic of this area. Nitrogen and methane are the main components of emanated gases, and high helium and radon concentrations were also found.

The gases composition was determined by using a Dempster mass spectrometer. The radon content from these gases and the rate of radon exhalation from the ground were determined by gamma spectrometry method. The argon isotopes were analysed by means of a quadrupole mass spectrometer (AMP-4). The isotopic analyses of helium were performed by a static vacuum mass spectrometer (VG 5400, VG Isotopes modified by the addition of a "split flight tube") on helium purified from 0.3 ml of gas sample in an Ultra High Vacuum preparation system.

In the vicinity of transversal fissures, the radon exhalation rates present the highest values measured in this area. The ratio $^{4}He/^{20}Ne > 400$ is a very good indicator of the fact that these gases are not contaminated with atmospheric air and therefore they come from the depth. Also as can be seen in Table 1, the $^{4}He/^{40}Ar$ and $^{40}Ar/^{36}Ar$ ratios suggest that the helium in these sources may have a no negligible part of primordial helium arising from the Earth mantle (Aliev and Kabulova, 1981).

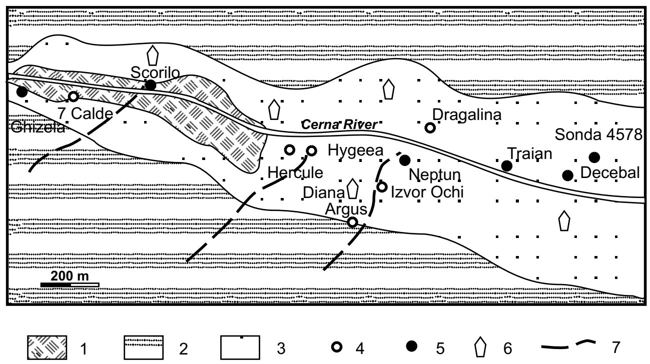

Fig. 1. Geothermal sources and radon flux measurements sites in Herculane area. 1 – outcropping granite; 2 – alluvium; 3 – limestone; 4 – spring; 5 - drilled well; 6 – high radon flux; 7 – fault.

Table 1. Isotopic ratios for gases from Cerna and Mehadica Valleys

Ratio	Neptun	Abator	S.C.D.*	Mehadica
$^{4}He/^{20}Ne$	>400	>400	>400	>400
$(^{4}He/N_2) \cdot 10^2$	1.25	1.09	0.45	1.15
$^{4}He/^{40}Ar$	0.95	1.1	0.33	1.1
$(^{40}Ar/N_2) \cdot 10^2$	1.05	1	1.38	1.04
$^{40}Ar/^{36}Ar$	333	344	301	280
$^{38}Ar/^{36}Ar$	0.2	–	0.18	0.18

The concentration of primary helium in gases can be found by the equation (Poreda and Craig, 1989; Cosma and Ristoiu, 1999):

$$C_p(He) = \left[\left(^{3}He/^{4}He\right)_{meas} - \left(^{3}He/^{4}He\right)_{rad} \right] / \left(^{3}He/^{4}He\right)_p \quad (1)$$

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where $\left({}^{3}\mathrm{He}/{}^{4}\mathrm{He}\right)_{\mathrm{rad}} = 3 \cdot 10^{-8}$, and $\left({}^{3}\mathrm{He}/{}^{4}\mathrm{He}\right)_{p} = 3 \cdot 10^{-5}$.

The measurements of the ten samples from this region give for $\mathrm{R}/\mathrm{R_a}$ (measured/atmospheric helium isotope ratio) values ranging in the 0.075 – 0.117 interval and these ratios are characteristic to young geological structures as an evidence for past tectono-magmatic activity.

References

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