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Diffuse emission of 3He and 4He and thermal energy released in volcanic systems

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Active or recent volcanism indicates the presence of high-enthalpy resources at depth. This is obvious when visible surface emanations as volcanic plumes, fumaroles, solfataras or bubblings appear. However, visible manifestations of deep anomalies do not always appear at the surface, making more difficult the detection of possible geothermal reservoirs. In this work, we propose that in areas where there are no visible emanations, it is possible to make an estimation of the associated thermal energy of the reservoir. For this purpose, 15 volcanic systems located in different geotectonic environments have been studied, where diffuse ^{3}He and ^{4}He emission and thermal energy released have been calculated. This work has focused on the study of diffuse He emissions due to its chemically conservative properties as a noble gas, helium is an excellent indicator of magmatic activity allowing to delimit permeable areas of preferential ascent of deep origin fluids. Two different methodologies for the calculation of diffuse ^{3}He and ^{4}He emissions have been proposed. In addition, the thermal energy released has been calculated following the methodology proposed by Chiodini et al., 2001. A consistent observation across the entire study is that those areas with relatively high diffuse ^{3}He and ^{4}He emissions also show relatively high thermal energy released values, suggesting a clear and positive relationship between the parameters. This implies that, in volcanic areas where no visible geothermal emanations are observed, and therefore, the inability to sample, but anomalies in the diffuse ^{4}He emission are present, there should be a deep thermal anomaly associated, and therefore, a possible geothermal reservoir.

- Chiodini, F. Frondini, C. Cardellini, D. Granieri, L. Marini, G. Ventura. CO_2 degassing and energy release at Solfatara volcano, Campi Flegrei, Italy. J. Geophys. Res. 106 (B8) (2001) 16213e16221, https://doi.org/10.1029/2001JB000246.