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Helium, Carbon and Geodynamics in a Regional Context: Central and Southern Italy.

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Fluids associated with the central and southern quaternary volcanism and regional faults have usually $^3He/^4He$ ratio (as R_a) higher than crust with generally consistent associated $\delta^{13}C$. Fluids from volcanic [1] and natural environments are homogeneously distributed along the 600 kilometres of collection from south to north, from Sicily to southern Tuscany and west to east, from the Tyrrhenian coast line through the inner Apennine respectively. The $^3He/^4He$ ratio (R_a) shows a striking geographical distribution with a decreasing trend, from 6.0 to 0.01, from south to north while no particular differences have been detected in the west-east transect. Correlation between isotopic ($\delta^{13}C$ and R_a) and gas chemistry ($CO_2/^3He$ and $CH_4/^3He$) suggests that fluid(s) enter volcanic and fault systems directly from the mantle. Few exceptions are due to local surficial geological features, but no anomalous values, out of this characteristic trend, have been found. The main important feature, is that no large differences have been found in R_a ($\delta^{13}C$) between volcanic and natural gas samples located in nearby-latitudes. This result suggests a similar genesis and a general close-relationship, although the different geodynamic context, between He (and C) with local mantle signatures more than contamination by superficial crust or rich-atmospheric fluids. This finding shows the importance of the link between, regional and local/regional tectonics, expressed as rock deep permeability and helium and carbon distribution over such a wide area. The decreasing trend from S to N is the evidence of a continuous evolution of the local upper mantle likely due to the nature of the subducting slab: oceanic crust in the S (Mt. Etna and Aeolian islands) versus a more pronounced continental U-rich crust going towards central Italy. To confirm our free-gas data, from some selected sites, helium data have also been obtained from fluid inclusions.

References

[1] Systematic variations in the $^3He/^4He$ ratio and carbon of fumarolic fluids from active volcanic areas in Italy: Evidence for radiogenic ^4He and crustal carbon addition by the subducting African plate? Tedesco D. Earth Planet. Sci. Lett. 255-269, 1997.

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