Episodic degassing of He in continental region affected by seismicity

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The degassing of the continental crust provides the major source of ^{4}He to the Earth's atmosphere and a steady-state atmosphere-reservoir requires a continental ^{4}He flux approximately equivalent to the whole crustal production of ^{4}He from U and Th-decay.

In our study, we investigated if the outgassing of He through the continental crust can be episodic in active tectonic regions over long time scale. In the north of Italy some mud volcanoes systems are located in regions characterized by catastrophic earthquakes. Fluids emitted from these systems are thermogenic-CH_4 rich, which vertically migrate towards the surface. Helium is in traces and its isotopic signature (≈0.01-0.02Ra, Ra is the ^{3}He/^{4}He in air) indicates that ^{4}He is mainly produced in the crust. We reconstructed the 3D model of the reservoirs feeding the gaseous emissions at the surface and we assessed that the amount of ^{4}He stored in the natural traps cannot be supported by a steady-state degassing.

An increase of the rock dilatancy because of a change the field of stress due to an active tectonic improves the release of He produced in the rocks over time. Based on recent and historical earthquakes catalogues, we computed the volume of rock where dilatation and micro-fracturation due to the local field of stress can increase the ^{4}He release. This allowed us to estimate He released from the rocks at the time of the earthquakes. Our study indicates that the regional seismicity contributes to the He-excess that accumulated in the gas reservoirs since their age of formation. Therefore, the effective vertical rate of fluid transport through the continental crust can be depending by episodic tectonic events.

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