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Editorial: Volcanic and tectonic degassing: fluid origin, transport and implications

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Editorial on the Research Topic
Volcanic and tectonic degassing: fluid origin, transport and implications

Deeply-sourced fluids are released in volcanically and tectonically active regions through conduits such as fumaroles, natural springs, and permeable soils. The origin and transport of the fluids in volcanic and tectonic systems are a key research theme in Earth Sciences, which is of particular importance for geo-hazard mitigation and resource exploration. This Research Topic aims to present recent advances in fluid geochemistry and its application in volcanically and tectonically active regions. Under this context, 10 papers covering a series of research themes in fluid geochemistry were published in this Research Topic, as briefly summarized below.

People living close to active fault zones are threatened by earthquake hazard and therefore monitoring the status of active faults is important to mitigate the damage caused by future earthquakes. Caracausi et al. reported data from a novel infrastructure designed for multidisciplinary and continuous monitoring of the Alto Tiberina fault, Italy. Monitoring results (including seismic, geodetic, and geochemical data) from The Alto Tiberina Near Fault Observatory (TABOO-NFO) would shed new light on earthquake prediction studies in other countries. Fidani et al. conducted a comprehensive statistical analysis of CO_2 time series registered at the Gallicano test site, Italy, and identified the correlations between low-magnitude earthquakes and CO_2 anomalies in spring waters. Li et al. studied the spatial variations in soil Rn and CO_2 emissions in the Wuzhong-Lingwu region, NW China, as well as the possible controlling factors of earthquakes, stress state, and deep-to-shallow crustal structures. Their findings offer new insight into combining geochemical characteristics of soil gas and seismological methods to estimate regional seismic hazards.

Under the context of continuous collision between Indian and Asian continents, the Tibetan Plateau and its surrounding regions have drawn increasing concern from the Earth science community because of intensive and frequent earthquake events. Liu et al. reported the first estimates of diffuse soil CO_2 flux (~1.2 Mt yr^{-1}) for the Anninghe-Zemuhe fault in the Southeast Tibetan Plateau and found close relationships between spatial variations in soil CO_2 fluxes and that of regional seismic activity. Based on the geochemistry of hot spring waters, Liu et al. explored the controls of the Jinshajiang fault zone (SW China) on hydrothermal fluid circulation, water-rock interaction, and earthquakes, which

highlighted the role of hot spring water discharging from fracture zones in receiving the hydrological information on seismic activity. Also published in this Research Topic, Liu et al. presented an example of post-earthquake hydrological changes based on carbon isotope data of spring waters collected after the 2021 M_w 7.4 Maduo earthquake in eastern Tibetan Plateau. They quantitatively identified enhanced mobilization of the shallow soil organic carbon following the 2021 Maduo earthquake and suggested that earthquakes could disturb the circulation of subsurface fluids and their interaction with the country rocks and sediments on short timescales. Wang et al. investigated origin and circulation of geothermal waters in the Karakoram strike-slip fault zone in western Tibet. Their results show that geothermal water is correlated with the epicenter and focal depth of earthquakes, especially for high-temperature spring water with deeper circulation and extremely high Li, B, Fe, and As concentrations.

Three papers in this Research Topic focus on the degassing of historically active volcanoes. Gherardi et al. investigated helium isotopes on gas extracted by crushing from melt and fluid inclusions in minerals from Plinian and inter-Plinian tephra and lavas of Vesuvius, Italy. Their results show that i) $^3He/^4He$ values are buffered within an extended, deep-seated reservoir at about 10 km filled with magma rising from the mantle, and ii) magma ponding at crustal depth could be considered a key mechanism that might have the potential to homogenize the helium isotope signal. Located in the hinterland of Northeast Asia, the active Arxan volcanic field remains less studied for the characteristics of its present-day volcanic degassing. Pan et al. focused on diffuse soil CO_2 fluxes and found that annual CO_2 emission flux from the volcanic field to the atmosphere is ~0.63×10^5 t and is comparable to that of the Iwojima volcano in Japan. This is the first flux estimate for soil CO_2 emissions of the Arxan volcanic field. Cui et al. presented a geochemical study on the hot spring water and gases from the Arxan volcanic field. They identified ~3%–23% mantle helium inputs and thus heat supply in the hydrothermal fluids, suggesting that the residual mantle-derived melts beneath the Arxan volcanic field are still releasing fluids/volatiles and heating the overlying hydrothermal systems.

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Conflict of interest

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