Li isotopes in fluid inclusions as tracers for crustal fluids

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Lithium isotopes in hydrothermal vents and ground waters are extensively used to trace fluid migrations and fluid/rock interactions in the shallow Earth's crust. Yet, Li isotopes in deep crustal fluids, commonly preserved as fluid inclusions, remain under-exploited. Here, samples containing a wide range of fluid inclusion compositions representative of a variety of deep crustal fluid environments, from high-grade diagenetic, metamorphic to magmatic-hydrothermal conditions (~ 150 to 600°C and ~ 5 to 78 % salts), have been investigated in order to provide the first overview of the range in Li isotopic composition.

Fluid inclusion leachates, from pure quartz and dolomite separates, of twenty-three samples worldwide were extracted and analysed using an innovative approach including: (i) bulk crush-leach (1-2 g) extraction of fluid inclusions; (ii) Na, K, Ca, Mg, Li and Sr analysis and Li elution using an automated high-performance ion chromatography and (iii) Li isotopes analysis by multi collector - inductively coupled plasma mass spectrometry.

Reconstructed Li concentrations and δ^7Li values of fluid inclusions (respectively 12 to 653 mg.l^{-1} and –1.4 ± 0.2‰ to +41.3 ± 0.8‰) are broadly compatible with previously established models for the origin of the fluids, fluid pathways and fluid-rock interaction. δ^7Li values are independent from conservative tracers (e.g. Br/Cl, I/Cl) and other parameters (e.g. temperature, salinity, Na/Ca, Na/K, Na/Mg, Na/Li and Na/Sr).

The results show that, in conjunction with other parameters, the Li isotopic compositions of fluid inclusions are potentially powerful tracers of deep crustal fluid migrations and fluid-rock interactions within a wide range of possible environments, for example, from sedimentary basins to ore-forming magmatic-hydrothermal systems but also possibly in seafloor hydrothermal systems and subduction zones.