Paper Number: 2205

SIMS S isotope composition of pyrite from HPM rocks and associated veins, Tianshan, China: implication for sulfur evolution

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Understanding the exchange of volatiles in geochemical reservoirs and recycling in Earth's interior are central issues of terrestrial geodynamics [1,2,3]. The major volatiles in Earth's crust and upper mantle are H_2O, CO_2, Cl, and S [4,5,6,7,8,9,10], but their partitioning between various phases and their mechanisms of transport in the crust and upper mantle still remain somewhat enigmatic despite decades of research. In particular, sulphur occurs as sulfide minerals in the Earth's mantle, as sulfide or sulfate minerals in crustal rocks, as native sulfur near active or dormant volcanoes, as dissolved sulfate or dimethyl sulfide in ocean water, and as a trace gas in the atmosphere. However, the behaviour of sulfur during subduction processes is little understood. Studies of exhumed tracts of high-P/low-T metamorphic rocks of the Tianshan, China, may provide detailed information regarding the extent of loss of volatile components during subduction.

Pyrite, as a stable phase of sulfur, is a major phase in the subduction zone, and therefore it provides information on the petrogenesis and thermo-mechanical evolution of sulfur through its crystal-chemical and geochemical behaviour [11,12,13]. In this contribution, four sulfide-bearing samples (074h, L86-1, 10sw4, 10sw7) located in the HP region of the western Tianshan LT–(U)HP belt were selected for high spatial resolution textural (SEM), chemical (EMP), and sulfur isotope (SIMS) analysis of pyrite. 074h and L086-1 consist of blueschist host and eclogitic selvage, and eclogite host and amphibolite vein, respectively. Both 10sw4 and 10sw7 consist of blueschist host and vein. The sulfide minerals consist of dominant pyrite and minor chalcopyrite in all samples. Micro-textural information distinguishes four types of pyrite. (1) Pyrite occuring as fine-grained inclusions in garnet. (2) Pyrite occuring as disseminated subhedral to anhedral 0.5-2.5mm-sized grains, commonly in concentrated aggregates or clusters, and showing numerous inclusion-rich central regions overgrown by nearly clear rims. The numerous inclusions include omphacite, glaucophane, epidote, rutile + titanite, dolomite, quartz, apatite, zircon, chalcopyrite and lawsonite. (3) Pyrite forming larger (1.5-3.5mm in size) subhedral to anhedral crystals with irregular boundaries, which display heterogeneous composition and brittle deformation, and chalcopyrite-filled fractures. Occasionally, magnetite occurs alongside the outer-rim of pyrite. (4) Clear pyrite occuring as discrete, isolated euhedral to subhedral grains. The results reveal an enormous variation (−24.73 to +13.22‰) in sulfur isotopic composition of pyrite during various paragenetic stages. Based on dissipative structure, geochemistry, and S isotope composition, we discuss the pyrite types and gain insights into the source and evolution of sulfur in the subduction processes.

References:

[1] Keppler H (1993) Contrib Mineral Petrol 114: 479-488
[2] Rapp JF et al. (2010) Geology 38: 323-326
[3] Su W et al. (2015) Amer Miner 100: 138-147
[4] Symonds RB et al. (1994) Rev Mineralogy 30: 1-66
[5] Philippot P et al. (1998) Earth Planet Sci Lett 161: 33-44
[6] Wallace PJ (2001) J Volc Geothermal Res 108: 85-106
[7] Berlo K et al. (2004) Science 306: 1167-1169

[8] Self S and Blake S (2008) Elements 4: 41-46
[9] Aiuppa A et al. (2009) Chem Geology 263: 1-18
[10] Rowe MC et al. (2009) Geochim Cosmochim Acta 73: A1126
[11] Kesler SE et al. (2005) Mineralium Deposita 40: 127-136
[12] Large RR et al. (2011) Econ Geol 106:331-358
[13] Li JL et al. (2013) Geochim. Cosmochim. Acta 120: 326-362