Apatite sulfur isotopes trace mantle-input S for giant Qulong porphyry deposit formation in continental collision zone

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The genesis of giant continental collision-related porphyry deposits (PCDs) remains controversial. Although partial melting of subduction-modified lower crust has been proposed to generate such magmas, the main debate arises from the discussion that whether the lower crust can provide enough S for giant porphyry deposit formation. In addition, the porphyry system is common with several pulses of magmatism coeval with mineralization. It is unclear that why one pulse of magma is ore causative but the rest. Qulong deposit is the largest porphyry Cu-Mo deposit in China and located in the Tibetan-Himalayan collisional zone. The mineralization is related to a protracted magmatism with several pulses of intrusions through an interval of ~1.5 Ma. We here report the S, F, Cl contents and *in situ* SIMS S-O isotopic compositions of magmatic apatites from all pulses of Qulong intrusions and adjacent mantle-derived trachyandesite. The apatite from ore-forming intrusion, P-porphyry, is unique with the highest F, Cl and MnO contents, lowest $\delta^{18}O$ ratios, largest S isotopic variations among Qulong intrusions. The high-S band with high $\delta^{34}S$ ratios is found in apatite grains from P-porphyry, and such high $\delta^{34}S$ ratios are similar to apatites from mantle-derived trachyandesite. These results support the idea of adding a shot of mantle-derived sulfur to the system to make it fertile, and this most likely comes from a pulse of more mafic magma. This might explain the origin of giant porphyry deposits in collisional zone.