Tracking the role of fluorine on genesis of A-type granites from Jiuhuashan Region (South China)

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A-type granite has been considered to be anhydrous but F- and/or Cl- rich. However, halogen data of natural samples are limited. Hereby we present an integrated study involving halogen elements (F-Cl-Br-I) and routine geochemical studies on the I- and A- type granites from Jiuhuashan region of South China. The investigated I-type granites are granodiorite and monzogranite, while associated A-type series include alkaline granite, alkaline granite porphyry and quartz syenite. Some dolerite dykes intruding into the granodiorites were also studied. The A-type series are fluorite-bearing, free of mafic microgranular enclaves and display miarolitic structures. Geochemically, the rocks exhibit typical A-type granite affinities of high alkaline ratios, HFSE and HREE contents, and low MgO+FeO, CaO, Ba, Sr and Eu contents. Geochronologically, A-tpye granites and dolerite dyke rocks formed simultaneously at 125-130 Ma, slightly younger than the I-type (140-143 Ma). Initial $^{87}Sr/^{86}Sr$ ratios and εNd(t) values of both granitic series are similarly lower than the dolerite dykes. Whole-rock halogen results reveal that the A-type granites contain much higher F, slightly lower Cl and Br, and undistinguishable I contents than the I-type series. The F and Cl contents in biotite and apatite show consistent variations, indicating an magmatic origin for the halogens rather than anion exchange with late-stage circulating fluids. The increase of most HFSE and HREE with an increase F suggests that F plays a key role on genesis of A-type granite. We propose that direct partial melting rather than fractional crystallization is likely the preferred generic model for A-type granites. The source rock is supposed to be the felsic granulite remaining in the lower crust after previous melting events which produced earlier I-type granitic magmas. Upwelling of mantle-derived mafic magmas provides abundant heat to trigger high-temperature, vapour-absent melting of the residue granulite to generate a low viscosity, relatively anhydrous and F-rich A-type granitic melt.