Geochemical evolution for subvolcanic analogue of rare metal bearing Li-F-rich granites

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Spatial zonation is well studied for the rare metal bearing granites and pegmatites. Little is known for their subvolcanic analogues. Dike no. 431 is found in Xianghualing district, South China. It is 1770 m long, 1.8-18.0 m wide, and steeply dipping. This dike contains a complete suite of vertically and horizontally zoned rock types. From the deeper level upwards and from the dike center outwards, the following spatial zonation is clearly detected: (1) porphyritic microcline-albite microgranite; (2) ongonite, characterized by high Na_2O content and moderately higher content of F; (3) Xianghualingite, characterized by predominance of K_2O over Na_2O, and abnormally high content of F (4.60%-10.76%). In several places of the 3rd zone, typical topazite is observed. In this evolutionary series, there is a systematic decrease in SiO_2 content and increase in F, Li, Rb, Cs, Ta, Nb, W, Sn contents.

These subvolcanic rocks are undoubtedly magmatic in origin: crosscutting relationship with the country rocks, flow and foliation structures, chilled margin, magmatic crystallization textures, glass and devitrified materials, distinctly idiomorphic appearrance of topaz crystals, melt inclusions in topaz and quartz phenocrysts etc.

This spatial zonation is consistent with the vertical zonation of the nearby Xianghualing Li-F-rich rare metal bearing granite stock. From the deeper level upwards, its vertical zonation is as follows: protolithionite granite → bimicaceous granite → leucocratic K feldspar-albite granite → albite granite → topaz-zinnwaldite greisen → topaz-zinnwaldite pegmatoid and massive quartz stockscheider. The three zones of dike no. 431 are chemically and mineralogically close to the leucocratic granite, albite granite and greisen zones respectively. Similarity in spatial zomation of the Xianghualing Li-F-rich granite and its subvolcanic analogue suggests that these rock types are products of fractional crystallization at different stages of geochemical evolution of the residual granitic melts.

Metallogenesis by adsorption

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Three cases are presented in this paper to describe the process of adsorbed metallogenesis:

1. Carlin-type gold deposits: Pyrite, arsenopyrite and other sulfides adsorbed nano-sized native gold or gold complex ions in ore-forming solutions.
2. Laterite-type gold deposits: When Au-bearing volcanic rocks were leached by surface water, gold would be mobilized, transported and adsorbed on clay and hydroxides of iron and manganese in weathering crust.
3. Hydrothermal fluorite deposits: CaF_2, NaF and other ionic compounds adsorbed on the surface of plagioclase in biotite-plagioclase gneiss were leached by cycling surface water and then released to form fluorite deposits.

The mechanisms of metallogenesis described above indicate that adsorption occurs mainly under low temperature and supergene conditions, not too high contents of ore-forming materials in solutions are needed, and adsorption is a process in which ore-forming materials are enriched progressively. Surface reactions in an inhomogeneous multi-phase system with solid, liquid and gaseous phases coexisting are a problem worthy of note in geochemical study.