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Characteristics and Genesis of Lithocaps in Middle-Lower Yangtze River Metallogenic Belt, China

Taofa Zhou, [Jing Chen](#), Xuanxuan Li, Noel White, Yu Fan
Hefei University of Technology, Hefei, China

The Middle-Lower Yangtze River Metallogenic Belt (MLYB) is an important polymetallic area in eastern China, with a series of iron oxide-apatite, porphyry, skarn, and epithermal deposits developed. The Luzong Mesozoic continental volcanic basin of the MLYB hosted significant nonmetallic deposits, including the second biggest alunite deposit of China—Fanshan. By detailed analyses of short-wave infrared spectroscopy, scanning electron microscopy, and X-ray diffraction, the lateral zonation of silicic, advanced argillic, and argillic alteration has been defined at Fanshan, confirming it is a typical lithocap developed in MLYB. The main host rocks of Fanshan are the Cretaceous Zhuanqiao Formation (134.1 ± 1.6 Ma; zircon LA-ICP-MS dating), dominantly trachyandesite and tuff. The hypogene alunite Ar-Ar dating shows that the Fanshan lithocap is formed coeval with the host volcanic rocks, at 131.2 ± 6.6 Ma, with lithospheric thinning and an extensional setting.

Hypogene alunite can be divided into two stages (IA and IB) at Fanshan. Stage IA alunite is characterized as replacements of feldspars in trachyandesite and tuff, whereas stage IB alunite occurs as open-space infills. The content of Na, Ca, Sr, and Ba in alunite decreases from early to late stage by electronic microprobe and LA-ICP-MS analyses, which is governed by the decrease of temperature of fluid. A discrimination diagram of $\text{Ca} + \text{Sr} + \text{Ba-Na}/(\text{Na} + \text{K})$ content of alunite has been developed to indicate the temperature (depth) of lithocap based on these data.

Results of fluid inclusion study and the O-D isotopes of alunite indicate that the fluid forming Fanshan lithocap is a mixture of magmatic hydrothermal fluid and meteoric water. Fluid reacted with the permeable volcanic rocks, and the lateral outflow helps to develop such an extensive silicic and advanced argillic alteration at Fanshan. Fluid evolved from acidic and oxidized at the early stage to a neutral environment with low temperature. Fluid is not conducive to the dissolution of metal elements during the late stage, resulting in precipitation of metals, which indicate a potential prospect at the bottom of the Fanshan lithocap. A series of intermediate-sulfidation copper-silver vein deposits have been discovered within the Fanshan district, indicating that the Fanshan and Luzong basin is a fertilized system for forming epithermal deposits.

The detailed case study of Fanshan lithocap shows a slightly different pattern from other lithocaps with calc-alkaline volcanic rocks developed in the arc setting. Fanshan is predominantly hosted by alkaline volcanic rocks, and the low potassium fugacity prohibited the formation of pyrophyllite. High-sulfidation epithermal and porphyry deposits are not discovered yet to be related to Fanshan, but intermediate-sulfidation epithermal Cu-Ag vein deposits are closely related to Fanshan. Other small lithocaps developed in the Luzong basin have also been studied in this research, and they all illustrate the similar patterns. The intracontinental lithocaps seem to have different characteristics from the classic model, and more research should be focused on this topic for further exploration strategy in alkaline rock-hosted lithocaps.