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Characteristics of zunyite in the advanced argillic alteration zones of high-sulfidation epithermal deposits: Implications for exploration in lithocaps

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Lithocaps are large, topographically prominent domains of strong silicic, hypogene advanced argillic and argillic-altered rocks that can form above and laterally away from subvolcanic intrusive complexes. Commonly, lithocaps form as part of porphyry-epithermal systems. They may host high sulfidation epithermal mineralization, and overlie or be adjacent to intermediate-sulfidation epithermal deposits; they can also overlie and partially overprint porphyry deposits, if the systems are telescoped sufficiently. All lithocaps have a structure-controlled root zone, which is proximal to most high sulfidation mineralization. Temperature controls on clay mineralogy cause vertical mineral zonation in advanced argillic assemblages, with pyrophyllite, dickite, zunyite, topaz and diaspore more likely to be encountered closer to the heat source. Zunyite as one of the diagnostic minerals of advanced argillic alteration proximal to the heat source has been documented in detail in this study, and the results can be applied in high sulfidation and porphyry deposits exploration.

Zunyite is a hydroxyl-fluoro-chloro silicate of aluminum ($Al_{13}Si_5O_{20}(OH,F)_{18}Cl$), which has a unique crystal structure; it has been reported from porphyry copper deposits, epithermal deposits and from altered aluminous shales located near manganese ore deposits. Zunyite crystals usually are less than 10 μm, rarely can up to 200 μm. To identify them, we need the assistance of SWIR spectroscopy, portable XRF, Raman spectroscopy or XRD. Zunyite has a distinctive SWIR reflectance spectrum related to its crystal structure. For example, the 2135 nm absorption peak position is a diagnostic spectral feature of zunyite and varies with changes in the mineral lattice and chemical characteristics. Zunyite fluoresces blue or red, which is related to the aluminum and silicon distribution in its structure. In the advanced argillic alteration of lithocap, zunyite is the only mineral containing Cl; using portable XRF in the field we can easily map lithocaps to locate the hottest zone. Compositions of Cl and F in zunyite also suggest that the study of zunyite may contribute to our understanding of hydrothermal process and may aid future exploration in porphyry and epithermal environments.