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Hydrothermal monazite trumps rutile: Applying U-Pb geochronology to evaluate complex mineralization ages of the Katbasu Au-Cu deposit, Western Tianshan, Northwest China

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Abstract

The Tianshan orogenic belt hosts several world-class gold deposits and is one of the largest gold provinces on Earth. The Katbasu Au-Cu deposit in the Chinese Western Tianshan is hosted in a granite intrusion. Previous researchers have shown that the main gold ores formed much later than the ore-hosting granite. However, the formation age of Cu mineralization and its possible link to Au mineralization remain poorly understood. This paper reports detailed mineralogical studies, combined with zircon U-Pb, in situ hydrothermal monazite as well as rutile U-Pb ages to constrain the timing of Cu mineralization and its possible link to Au mineralization. The two main ore types in the Katbasu deposit include Cu-Au ores with pyrite-chalcopyrite veins that crosscut the granite and Au ores with massive pyrite and quartz as the main minerals. The Cu-Au ores are spatially associated with diorite that intruded the granite, and they are overprinted by massive gold ores. Detailed mineralogical studies show that chalcopyrite is the main Cu-bearing mineral in the Cu-Au ores, and it is closely associated with some native gold, monazite, and rutile.

Secondary ion mass spectrometer (SIMS) U-Pb dating of zircon grains from the ore-hosting granite and mafic enclave yielded concordant ages of 354.1 ± 1.6 and 355.8 ± 1.7 Ma, respectively. The diorite that intruded the granite has a zircon U-Pb age of 352.0 ± 3.2 Ma. The trace element compositions of the monazite suggest they were formed by hydrothermal fluids rather than inherited from the ore-hosting granite. Hydrothermal monazite coexisting with chalcopyrite and native gold yielded a concordant age of 348.7 ± 2.3 Ma, and the W-rich hydrothermal rutile grains associated with the chalcopyrite yielded a U-Pb age of 345 ± 27 Ma, indicating an early Cu-Au mineralization event prior to the major Au mineralization (ca. 323–311 Ma). The formation time of early Cu-Au mineralization is consistent with the emplacement age of the diorite and may be of magmatic-hydrothermal origin, whereas the main Au has no genetic associations with magmatic rocks in the ore district and may belong to the orogenic type. Monazite geochronology provided a more reliable age constraint than rutile in the Katbasu Au-Cu deposit, and we suggest hydrothermal monazite has advantages over rutile in dating the complex mineralization ages of gold deposits.

Keywords: Hydrothermal monazite, rutile, geochronology, Katbasu Au-Cu deposit, Western Tianshan