

Studies on the Sujiadian porphyry Cu-Au deposit in the Tongling orefield, Anhui Province

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Yangtze valley is one of the most important metallogenic region in Jurassic-Cretaceous period in East China with more than 200 polymetallic Cu-Fe-Au, Mo, Zn, Pb, Ag deposits [1-14]. Among them, the Tongling region is an important metal ore district with world famous skarn deposits [1-6]. Recently, a porphyry Cu-Au deposit associated with the Sujiadian pyroxene diorite intrusive was discovered in the region. Here we report mineralogy, petrology and element geochemistry studies on Sujiadian porphyry Cu-Au deposit related to local pyroxene diorite pluton in the Tongling region.

The tectonic setting of Sujiadian intrusive rocks and other magmatic rocks in the Tongling orefield should be closely related to the paleo-Pacific plate subduction of the continental margin, during which the lithospheric mantle source might have been transformed. The adakitic geochemical characteristics may be related to a mid-ocean ridge subduction, with crustal contamination. Slab melting during ridge subduction led to the formation of Cu, Au enriched parent magma, providing Cu-Au sources of ore-forming materials with the previous studies [13, 14].

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Hybrid Einstein-Debye model to calculate isotope fractionation at high temperature and pressure

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McCrea (1950) dealt with lattice motion in terms of Einstein and Debye model. Many other researchers (O'Neil, Bottiga, Kawabe, Deines and Chacko etc.) followed this idea to calculate the reduced partition function ratio (RPF) of minerals. Due to including several approximations, this Einstein and Debye model will produce noticeable errors at low temperature for many systems. Here, we propose a method that using this hybrid Einstein-Debye model to precisely calculate isotope fractionation at high temperature and pressure.

For a crystal, which is represented by a chosen unit cell, the three translational frequencies (i.e., acoustic modes) of its vibrational degrees of freedom follow a Debye distribution and the remains are described by discrete Einstein oscillators (i.e. optical modes). The optical modes and their frequencies shifts after isotopic substitution can be calculated by first principle methods at the Γ point. The Debye characteristic temperature Θ can be derived from the experimental heat capacity at low temperature, where both the C_p - C_v and Einstein terms can be negligible. The Debye temperature shift (Θ^*/Θ) can be obtained from high temperature product rule or square root of the unit cell molar mass (i.e., $\Theta^*/\Theta = \sqrt{M/M^*}$). This is to say, RPF is separated into two parts: the Einstein and the Debye terms. Practically, we can use supercell method to decrease the contribution from Debye term, which is a way to improve the accuracy. Although this model ignores the variations of $\omega(k)$ with k (i.e., the wave vector), the coupling between oscillators and the anisotropy and dispersion in the acoustic branches, these ignored terms actually are not important for isotopic substitutions at high temperature and pressure. Many examples have been used to illustrate this point.

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