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Wenlanzhangite–(Y) from the Yushui deposit, South China: A potential proxy for tracing the redox state of ore formation

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Abstract

Mineral phases in which vanadium (V) and heavy-rare-earth elements (HREEs) coexist are rarely documented. Here, we report a new V-HREE-bearing silicate mineral species, wenlanzhangite-(Y), which is a vanadiferous derivate of jingwenite-(Y) [$Y_2Al_2V^{4+}_2(SiO_4)_2O_4(OH)_4$] coexisting with jingwenite-(Y) in bedded/massive ores at Yushui, South China. Wenlanzhangite-(Y) forms as a dark brown, 70–100 μm thick rim on a core domain of jingwenite-(Y), which occurs as 100–200 μm columnar crystals. The color, streak, luster, and hardness (Mohs) are dark brown, yellow-gray, vitreous, and ~4, respectively. Compared to jingwenite-(Y), wenlanzhangite-(Y) has higher vanadium and lower aluminum contents. Calculated on the basis of 8 cations, the empirical formula is $(Y_{1.26}Dy_{0.17}Er_{0.11}Gd_{0.09}Yb_{0.09}Nd_{0.09}Sm_{0.06}Sc_{0.04}Ho_{0.03}Ce_{0.02}Tb_{0.02}Tm_{0.02}Pr_{0.01})_{\Sigma 2.00}(V^{3+}_{1.46}Al_{0.54})_{\Sigma 2.00}V^{4+}_2(SiO_4)_2O_4(OH)_4$, which can be simplified to the ideal formula $Y_2V^{3+}_2V^{4+}_2(SiO_4)_2O_4(OH)_4$.

Wenlanzhangite-(Y) is triclinic, with space group $P\bar{1}$(#2), Z = 2, and unit-cell parameters a = 5.9632(7) Å, b = 9.599(1) Å, c = 9.9170(9) Å, α = 90.033(8)°, β = 98.595(2)°, γ = 90.003(9)°, and V = 561.28(10) Å^3. Wenlanzhangite-(Y) is approved by the International Mineralogical Association Commission on New Minerals, Nomenclature and Classification (IMA2022-142). The structure of wenlanzhangite-(Y) is composed of *a*-axis-oriented chains of [VO_6] octahedra consisting of edge-sharing octahedra linked by insular [SiO_4] tetrahedra, leaving open channels occupied by rare earth elements. Observed compositional variation and crystal structure demonstrate that V^{3+} can substitute for Al^{3+} in jingwenite-(Y), forming wenlanzhangite-(Y). The occurrence of wenlanzhangite-(Y) indicates a relatively more reducing hydrothermal environment, causing a reduction of V^{5+} in oxidized fluids to V^{3+} and thus represents a useful proxy for tracing the redox state of ore formation.

Keywords: New mineral, wenlanzhangite-(Y), heavy rare earth elements, Yushui Cu deposit

Introduction

Recent studies have reported the first account of significant HREE (and associated U) mineralization within a sediment-hosted Cu deposit, the Yushui deposit, South China (Liu et al. 2023). It is well known that sandstone-hosted uranium deposits can host economic concentrations of V (e.g., Colorado Plateau, U.S.A.) (Dahlkamp 2010), and form at an oxidation-reduction interface (Northrop et al. 1990; Shawe 2011). Vanadium, as V^{3+}, V^{4+}, V^{5+}, or a combination thereof, can occur as oxide phases or is combined with redox-sensitive elements (Weeks et al. 1959). In practice, V-HREE-bearing mineral phases are rarely documented.

A new V-HREE-bearing silicate mineral, jingwenite-(Y) [$Y_2Al_2V^{4+}_2(SiO_4)_2O_4(OH)_4$], has been discovered and is an abundant phase in the Yushui deposit (Liu et al. 2023). Here we describe a vanadiferous derivate of jingwenite-(Y) from Yushui, wenlanzhangite-(Y), ideally $Y_2V^{3+}_2V^{4+}_2(SiO_4)_2O_4(OH)_4$. Wenlanzhangite-(Y) has been approved by the International Mineralogical Association Commission on New Minerals, Nomenclature and Classification (IMA2022-142). It is named in honor of Wenlan Zhang (born in 1957), professor and famous expert in electron probe microbeam analysis at the School of Earth Sciences and Engineering, Nanjing University, China. She has published more than 80 papers that contribute to improvements and capabilities of electron probe analysis technology in China. Type material is deposited in the mineralogical collections of the Geological Museum of China, catalog number GMCTM 2202.

Geological background

The Yushui deposit, located in the southwestern domain of the southeastern coastal belt, South China (Fig. 1a), is a small yet high-grade Cu deposit with significant HREE enrichment and minor enrichment in U, Co, and V (Liu et al. 2023). Mineralization is concealed beneath Late-Jurassic volcanic cover and is hosted at the unconformity between Upper Carboniferous dark gray dolostone/limestone with organic- and apatite-rich

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