

Zinconigerite-2*N1S* ZnSn₂Al₁₂O₂₂(OH)₂ and zinconigerite-6*N6S* Zn₃Sn₂Al₁₆O₃₀(OH)₂, two new minerals of the nolanite-spinel polysomatic series from the Xianghualing skarn, Hunan Province, China

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ABSTRACT

Zinconigerite-2*N1S* ZnSn₂Al₁₂O₂₂(OH)₂ and zinconigerite-6*N6S* Zn₃Sn₂Al₁₆O₃₀(OH)₂ are two new minerals with different numbers and ratios of nolanite (*N*) and spinel (*S*) modules. Both phases have been discovered in the Xianghualing skarn, Hunan Province, China. Zinconigerite-2*N1S* (zn-2*N1S*) and zinconigerite-6*N6S* (zn-6*N6S*) are named for their chemical composition, number, and ratios of *N*-*S* modules, according to the nomenclature of the nolanite-spinel polysomatic series of Armbruster (2002). Both phases occur as aggregates, sub-to-euhedral crystals, with maximal dimensions up to 100 μm, within fluorite aggregates, and they are closely associated with phlogopite, chrysoberyl, magnetite, cassiterite, margarite, and nigerite-taaffeite group minerals. They do not show fluorescence in long- or short-wave ultraviolet light. The calculated densities are 4.456 g/cm³ for zn-2*N1S* and 4.438 g/cm³ for zn-6*N6S*. Optically, zn-2*N1S* is uniaxial (+) with ω = 1.83(1), ε = 1.84(2); zn-6*N6S* is uniaxial (+) with ω = 1.85(1), ε = 1.87(2) (λ = 589 nm). Their chemical compositions by electron-microprobe analyses give the empirical formulas (Zn_{0.734}Mn_{0.204}Na_{0.122}Ca_{0.063}Mg_{0.044})_{Σ1.166}(Sn_{1.941}Zn_{0.053}Ti_{0.007})_{Σ2}(Al_{11.018}Fe_{0.690}Zn_{0.200}Si_{0.092})₁₂O₂₂(OH)₂ for zn-2*N1S* and (Zn_{1.689}Mn_{0.576}Mg_{0.328}Fe_{0.407})_{Σ3}(Sn_{1.882}Zn_{0.047}Ti_{0.071})_{Σ2}(Al_{14.675}Fe_{1.088}Na_{0.13}Ca_{0.086}Si_{0.017})_{Σ15.996}O₃₀(OH)₂ for zn-6*N6S*. Both phases have trigonal symmetry; the unit-cell parameters of zn-2*N1S* (*P* $\bar{3}$ *m*1) and zn-6*N6S* (*R* $\bar{3}$ *m*), refined from single-crystal X-ray diffraction data, are, *a* = 5.7191(2) and 5.7241(2) Å, *c* = 13.8380(6) and 55.5393(16) Å, *V* = 391.98(3) and 1575.96(12) Å³, and *Z* = 1 and 3, respectively. The structure of zn-2*N1S* is characterized by the alternating O-T₁-O-T₂-O-T₁ layers stacked along the *c*-axis, showing the connectivity of *N*-*S*-*N*. The polyhedral stacking sequence of zn-6*N6S* is 3 × (O-T₁-O-T₂-O-T₂-O-T₁), reflecting a *N*-*S*-*S*-*N*-*N*-*S*-*S*-*N*-*S*-*N* connectivity of the polysomatic structure. By contrast, the structure of zn-2*N1S* shows the elemental replacements of Al → Sn and Al → Zn, suggesting the substitution mechanism of 2Al → Zn + Sn. The complex substitution of Zn by multiple elements (Al, Fe³⁺, Mn, Mg) in the structure of zn-6*N6S*, is coupled with the low occupancy of Al5-octahedra. Fe³⁺ → Al substitution occurs in Al1-tetrahedra of both zn-2*N1S* and zn-6*N6S*. The new polysomes, zn-2*N1S* and zn-6*N6S*, likely crystallized under F-rich conditions during the late stages of the Xianghualing skarn formation. The discovery of zn-2*N1S* and zn-6*N6S* provides new insights into the crystal chemistry of the *N*-*S* polysomatic series and its origin.

Keywords: Zinconigerite-2*N1S*, zinconigerite-6*N6S*, nolanite module, spinel module, polysomatic series, Xianghualing skarn