

Gismondine-Sr, $\text{Sr}_4(\text{Al}_8\text{Si}_8\text{O}_{32})\cdot 9\text{H}_2\text{O}$, a new strontium dominant, orthorhombic zeolite of the gismondine series from the Hatrurim Complex, Israel

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ABSTRACT

A new mineral, gismondine-Sr with ordered gismondine framework type [$B22_12$ no. 20, $Z = 1$; $a = 14.0256(2)$ Å, $b = 10.45900(10)$ Å, $c = 13.79360(10)$ Å, $V = 2023.44(4)$ Å³] and the ideal chemical formula $\text{Sr}_4(\text{Si}_8\text{Al}_8\text{O}_{32})\cdot 9\text{H}_2\text{O}$ was discovered in amygdaloidal voids of partly melted gehlenite hornfels at Haramish locality, Hatrurim Basin of the Hatrurim Complex, Negev Desert, Israel. Gehlenite hornfels is mainly composed of gehlenite, wollastonite, and garnet of the grossular-andradite-schorlomite series. In a low-temperature association occur minerals such as thomsonite-Ca, flörkeite, analcime and minerals of the tobermorite supergroup. Gismondine-Sr forms spherulitic aggregates up to 180 µm and, rarely, pseudotetragonal bipyramidal crystals up to 50 µm. Empirical crystal-chemical formula of gismondine-Sr is $(\text{Sr}_{2.02}\text{Ca}_{1.09}\text{Ba}_{0.02}\text{K}_{0.72}\text{Na}_{0.62})_{\Sigma 4.47}\text{Al}_{7.91}\text{Si}_{8.09}\text{O}_{31.85}\cdot 9\text{H}_2\text{O}$. It is the strontium analog of gismondine-Ca and the second orthorhombic zeolite with the **GIS** structure topology. Crystals are transparent to translucent and feature vitreous luster. The mineral exhibits a white color, imperfect cleavage in [101] direction, a brittle tenacity, and uneven fracture. The Mohs hardness was estimated at approximately 4. Gismondine-Sr is biaxial negative, $\alpha = 1.488(3)$, $\beta = 1.492(3)$, $\gamma = 1.495(3)$, $2V_{\text{obs}} = 70\text{--}80^\circ$. The Raman spectrum is characterized by a band at 465 cm⁻¹, which is also the main band in gismondine-Ca. The structure refinement using SC-XRD ($R_1 = 0.0353$) reveals the ordered distribution of framework cations and the disordered arrangement of extraframework cations. The aluminosilicate framework is built by crankshaft chains with 8-membered apertures channels parallel to [101] and [10 $\bar{1}$]. In gismondine-Sr, the 8-membered rings are elliptically deformed and the T-O-T angle of the upward and downward tetrahedra in the double crankshaft chains is smaller compared to that for gismondine-Ca. Consequently, a slight rotation of the double crankshaft chains has been noticed. Similar observations have been made in partially dehydrated and the pressure-modified gismondine-Ca. The present study suggests that, in addition to high-pressure and dehydration, the elliptical deformation of the channels in **GIS** also arises as a consequence of the extraframework cations and H₂O content. Thus, the extraframework content influences the aluminosilicate framework leading to the orthorhombic symmetry.

Keywords: Zeolite, **GIS** topology, gismondine, Raman, crystal structure, Hatrurim; Microporous Materials: Crystal-chemistry, Properties, and Utilizations