

## Fuyuanite $[\text{Mg}_7\text{Nb}_6\text{O}_{18}(\text{OH})_8]$ , a new hydrous magnesian-niobic oxide mineral from the Bayan Obo deposit, China

HAI-DONG SHE<sup>1,2,†</sup>, HONG-RUI FAN<sup>1,2,3,\*</sup>, YUN-XIANG ZHAN<sup>1,2,3</sup>, XIANG-PING GU<sup>4,‡</sup>, XIAO-CHUN LI<sup>1,2,3</sup>, KUI-FENG YANG<sup>1,2,3,§</sup>, AND QI-WEI WANG<sup>5</sup>

<sup>1</sup>State Key Laboratory of Lithospheric and Environmental Coevolution, Institute of Geology and Geophysics, Chinese Academy of Sciences, Beijing 100029, China

<sup>2</sup>Key Laboratory of Mineral Resources, Institute of Geology and Geophysics, Chinese Academy of Science, Beijing 100029, China

<sup>3</sup>College of Earth and Planetary Science, University of Chinese Academy of Science, Beijing 100049, China

<sup>4</sup>School of Gemmology and Mineral Resources, Jiangxi Institute of Applied Science and Technology, Nanchang 330100, China

<sup>5</sup>State Key Laboratory of Baiyunobo Rare Earth Resource Researches and Comprehensive Utilization, Baotou Research Institute of Rare Earths, Baotou 014030, China

### ABSTRACT

A new hydrous magnesian-niobic oxide mineral, fuyuanite (IMA 2024-059), ideally  $\text{Mg}_7\text{Nb}_6\text{O}_{18}(\text{OH})_8$ , has been discovered in the Bayan Obo REE-Nb-Fe deposit, China. The mineral occurs in a Mesoproterozoic dolomite-calcite carbonatite dike, and it is associated with oboniobite, fersmite, pyrochlore, magnetite, dolomite, apatite, and calcite. Individual crystals range in size from 40 to 60  $\mu\text{m}$ , and no twinning is observed. The mineral is reddish-brown to brown and translucent, with a vitreous luster. The calculated density is 4.156  $\text{g}/\text{cm}^3$ . Electron microprobe analyses of 18 spots yielded the main components of fuyuanite (total 99.41 wt%):  $\text{Nb}_2\text{O}_5$  (average of 67.34 wt%),  $\text{MgO}$  (21.66 wt%),  $\text{FeO}$  (2.89 wt%),  $\text{MnO}$  (1.18 wt%),  $\text{TiO}_2$  (0.21 wt%), and  $\text{H}_2\text{O}$  (6.12 wt%, calculated assuming  $H = 8$  apfu). The empirical formula calculated on the basis of  $O = 26$  apfu is  $(\text{Mg}_{6.31}\text{Fe}_{0.53}\text{Mn}_{0.20})_{\Sigma 7.03}(\text{Nb}_{5.96}\text{Ti}_{0.03})_{\Sigma 5.99}\text{O}_{18}(\text{OH})_8$ , and the simplified formula is  $(\text{Mg,Fe,Mn})_7(\text{Nb,Ti})_6\text{O}_{18}(\text{OH})_8$ .

Fuyuanite is trigonal, with space group  $P\bar{3}$  (#147),  $Z = 1$ , and unit-cell parameters  $a = 10.7174(5)$  Å,  $c = 4.7110(2)$  Å, and  $V = 468.62(4)$  Å<sup>3</sup>. The crystal structure of fuyuanite consists of metal-octahedra ( $\text{MO}_6$ ) layers along the  $c$ -axis, where Mg and Nb are octahedrally coordinated with oxygen. In the fuyuanite structure, the layer (L1) of edge-sharing  $\text{MgO}_5(\text{OH})$  octahedra ( $\text{Mg}_2$ ) is stacked with the layer (L2) of discrete rings of six edge-sharing  $\text{NbO}_4(\text{OH})_2$  octahedra enclosing a  $\text{Mg}(\text{OH})_6$  octahedron ( $\text{Mg}_1$ ), and the cation stacking follows the sequence of  $-\text{Mg}_2-(\text{Mg}_1,\text{Nb})-\text{Mg}_2-$ .

Fuyuanite shares a similar chemical composition with oboniobite ( $\text{Mg}_4\text{Nb}_2\text{O}_9$ ), columbite-(Mg) ( $\text{MgNb}_2\text{O}_6$ ) and ternovite ( $\text{MgNb}_4\text{O}_{11}\cdot 8-12\text{H}_2\text{O}$ ), yet it is notably different in its crystallographic, physical, and optical properties compared to the other three minerals. Therefore, fuyuanite is not a variant of oboniobite, columbite-(Mg), or ternovite. Instead, it is a unique new mineral species.

**Keywords:** New mineral, Fuyuanite, hydrous magnesian niobic oxide, Bayan Obo deposit