

A new nomenclature for the borate minerals in the hilgardite (Ca₂B₅O₉Cl · H₂O)–tyretskite (Ca₂B₅O₉OH · H₂O) group

SUBRATA GHOSE

Department of Geological Sciences
University of Washington, Seattle, Washington 98195

Abstract

The crystal structures of various monoclinic and triclinic mineral phases belonging to the hilgardite, Ca₂B₅O₉Cl · H₂O–tyretskite, Ca₂B₅O₉OH · H₂O group are based on the linkage in chains or layers of pentaborate polyanions, [B₅O₁₂]⁹⁻, which can exist in two stereoisomeric configurations. A new nomenclature for these phases is proposed based on their structural relationships.

Introduction

The minerals in the hilgardite group with the chemical composition Ca₂[B₅O₉]Cl · H₂O occur in a number of triclinic and monoclinic phases (Hurlbut and Taylor, 1937; Hurlbut, 1938; Braitsch, 1959). The crystal structures of two of these phases, hilgardite (monoclinic) and parahilgardite (triclinic) have been described by Ghose and Wan (1977; 1979) and Wan and Ghose (1983) and that of an unnamed triclinic phase by Rumanova et al. (1977). From the unit cell dimensions and space group, it is clear that the OH variety (instead of Cl) of hilgardite which has been named tyretskite by Kondrat'eva (1964) has a very similar crystal structure.

The building block of all these structures is the pentaborate polyanion [B₅O₁₂]⁹⁻ consisting of three borate tetrahedra and two borate triangles sharing corners, which can exist in two stereoisomeric configurations, left- or right-handed (*l* or *d*). By sharing tetrahedral corners, these polyanions form chains parallel to the *c* axis (6.3–6.4 Å), which in turn are connected to four such chains along the *a* and *b* axes, such that the corners of borate tetrahedra share corners of borate triangles. A zeolite-type pseudo-tetragonal open borate framework is formed this way, where the chlorine atoms (or OH groups) and the water molecules are located in straight channels parallel to *c* and the calcium atoms in zigzag channels parallel to the *a* and *b* axes. The polymorphism in the hilgardite–tyretskite group can be explained by various ways in which the borate chains or layers composed of pentaborate polyanions in *l* or *d* configurations are linked within the structure (Ghose, 1982).¹ Following Braitsch (1959), the term “polytropism” is suggested for this particular form of polymorphism, which is a special type of polytypism. Based on the structural relationships among these minerals, a revised nomenclature is proposed (see the original proposal by Braitsch, 1959),

which has been approved by the IMA Commission on New Minerals and Mineral Names (1984). The initial subdivision is according to whether Cl or OH is dominant and a further subdivision based on crystallographic criteria. The new nomenclature has the advantage of accommodating new polymorphs without invoking new names.

Proposed Nomenclature

| Hilgardites | Tyretskites |
|--|---|
| Ca ₂ [B ₅ O ₉]Cl · H ₂ O | Ca ₂ [B ₅ O ₉](OH) · H ₂ O |
| 1. <i>Hilgardite-1Tc</i> (unnamed phase of Rumanova et al. (1977). Triclinic; unit cell volume 205.8 Å ³ ; one formula unit per cell. | <i>Tyretskite-1Tc</i> (Kondrat'eva (1964) Triclinic; unit cell volume 203.3 Å ³ ; one formula unit per cell. |
| 2. <i>Hilgardite-4M</i> (hilgardite) Monoclinic; unit cell volume 817.8 Å; 4 formula units per cell. | not known |
| 3. <i>Hilgardite-3Tc</i> (parahilgardite) Triclinic; unit cell volume 614.8 Å; 3 formula units per cell. | not known |

Furthermore, for consistency strontiohilgardite of Braitsch (1959) should be renamed *strontian hilgardite-1Tc*. The Cl–tyretskite described by Hodenberg and Kühn (1977) is in fact the same mineral as strontian hilgardite-1Tc.

Acknowledgments

The incentive for suggesting the new nomenclature came from Professor Ch. Tennyson, Technische Universität Berlin, to whom the author is grateful.

References

- Braitsch, O. (1959) 1 Tc-Strontiohilgardit (Ca,Sr)₂[B₅O₈(OH)₂Cl] und seine Stellung in der Hilgardit-gruppe X₂^{II}[B₅O₈(OH)₂Cl]. Beiträge zur Mineralogie und Petrographie, 6, 233–247.
Ghose, S. (1982) Stereoisomerism of the pentaborate polyanion [B₅O₁₂]⁹⁻, polymorphism and piezoelectricity in the hilgardite

¹ Some of the atom labels in Fig. 8 (Ghose, 1982): crystal structure of parahilgardite down the *c* axis are incorrect. For the correct figure, see Wan and Ghose (1983), Fig. 5.

- group of minerals: a novel class of polar borate zeolites. *American Mineralogist*, 67, 1265–1272.
- Ghose, S. and C. Wan (1977) Hilgardite and parahilgardite piezoelectric zeolite type phases. *Nature*, 270, 594–595.
- Ghose, S. and C. Wan (1979) Hilgardite, $\text{Ca}_2[\text{B}_5\text{O}_9]\text{Cl}\cdot\text{H}_2\text{O}$: a piezoelectric zeolite-type pentaborate. *American Mineralogist*, 64, 187–195.
- Hodenberg, R. V. and Kühn, R. (1977) Ein neues Mineral der Hilgarditgruppe: der Cl-Tyretskit von Boulby. *Kali und Steinsalz*, 7, 165–170.
- Hurlbut, Jr., C. S. (1938) Parahilgardite, a new triclinic pedial mineral. *American Mineralogist*, 23, 765–771.
- Hurlbut, Jr., C. S. and Taylor, R. E. (1937) Hilgardite, a new mineral species from Choctow Salt Dome, Louisiana. *American Mineralogist*, 22, 1052–1057.
- Kondrat'eva, V. A. (1964) X-ray diffraction studies of some minerals of the hilgardite group (in Russian) *Rentgenografia Mineral'nogo Syr'ia, Moscow ('Nedra')*, 4, 10–18 (Mineralogical Abstracts, (1966), 17, 500–501).
- Rumanova, I. M., Z. I. Yorish, and N. V. Belov (1977) The crystal structure of triclinic hilgardite $\text{Ca}_2[\text{B}_5\text{O}_9]\text{Cl}\cdot\text{H}_2\text{O} = \text{Ca}_2[\text{B}_3^1\text{B}_2^2\text{O}_9]\text{Cl}\cdot\text{H}_2\text{O}$ *Doklady Akademii Nauk SSSR* 236, 91–94 (in Russian).
- Wan, C. and S. Ghose (1983) Parahilgardite, $\text{Ca}_6[\text{B}_5\text{O}_9]_3\text{Cl}_3\cdot 3\text{H}_2\text{O}$: a triclinic piezoelectric zeolite-type pentaborate. *American Mineralogist*, 68, 604–613.

*Manuscript received, October 3, 1984;
accepted for publication, January 14, 1985.*