Chabazite-Mg: A new natural zeolite of the chabazite series

G. Montagna, S. Bigi, S. Kónya, S. Szakáll, and G. Vezzalini

1 Dipartimento di Scienze della Terra, University of Modena and Reggio Emilia, via S. Eufemia 19, I-41100 Modena, Italy
2 Geological Institute of Hungary, Stefánia út 14, H-1143 Budapest, Hungary
3 Department of Mineralogy and Petrology, University of Miskolc, Egyetemváros, H-3515 Miskolc, Hungary

ABSTRACT

Chabazite-Mg, (Mg$_{0.067}$K$_{0.5}$Ca$_{0.44}$Na$_{0.08}$Sr$_{0.03}$)$_{24}$[(Al$_{1.16}$Si$_{3.88}$)$_{2}$O$_{12}$]$_{2}$·9.68H$_{2}$O, is a new zeolite species of the chabazite series, occurring in basalts of the Karikás-tető area of Prága Hill, Veszprém County, Balaton Highland, Transdanubia, West Hungary. It crystallizes as single, colorless rhombohedra up to 0.4 mm in size. The streak is white and the luster is strong vitreous. Mohs’ hardness is about 4. The observed density is 1.98(1) g/cm$^3$ and the calculated density is 1.964(7) g/cm$^3$. Chabazite-Mg is anisotropic, uniaxial (+), $\omega = 1.465(5)$, $\epsilon = 1.469(5)$ (546 nm). In its chemical composition, a predominance of Mg is observed among the extraframework cations. However, K and Ca are also very abundant, while Na and Sr levels are very low. The ratio Si/(Si+Al) is among the highest found in chabazite of hydrothermal genesis. Chabazite-Mg is rhombohedral, $R\bar{3}m$ space group, $a = 9.3433(5)$ Å, $c = 94.894(4)^\circ$. The six strongest X-ray lines measured in the powder pattern [d in Å (I) (hkl)] are: 9.306 (60) (100), 5.537 (37) (111), 4.958 (25) (110), 4.315 (100) (201), 2.924 (78) (311), 2.869 (41) (310). Single-crystal structure refinement of chabazite-Mg indicated that the extraframework occupation is distinct from other chabazite-series minerals. In particular, the Mg site (C3a) and one water site (W6a) are displaced from the threefold axis parallel to [111].

Keywords: Zeolite, chabazite, chemical composition, physical properties, structure refinement

INTRODUCTION

Chabazite, general formula $(Ca_{0.8}$,Na,K,Sr,Mg)$_4$[(Al$_{1.2}$Si$_{3.8}$O$_{12}$)$_2$]·12H$_2$O, is one of the most widespread natural zeolites and was one of the first zeolites to be studied, due to its excellent ion-exchange properties and its wide range of industrial and technological applications. Its genesis can be hydrothermal, for samples found in vugs and geodes of plutonic, volcanic, and metamorphic rocks, or sedimentary, when it is generated by alteration of glass in palagonitic basalts and pyroclastic rocks. Chabazite is rhombohedral, space group $R\bar{3}m$, with $a_0$ and $c_0$ unit-cell parameters ranging from 13.69 to 13.86 Å and 14.80 to 15.42 Å, respectively (Passaglia and Sheppard 2001). The chabazite framework (framework type CHA, Baerlocher et al. 2001) consists of parallel stacks of six-membered double rings (d6R) of tetrahedra in the sequence ABC. The resulting channel system is three-dimensional, and the channels are perpendicular to [001] (in the hexagonal setting) and are delimited by 8-membered rings (Dent and Smith 1958; Smith et al. 1963). In the rhombohedral symmetry, where only one tetrahedral site is present, the (Si, Al) distribution in this tetrahedron is disordered. However, Mazzi and Galli (1983) determined the space group $P\bar{1}$ for four chabazite samples and attributed the symmetry lowering to the presence of domains with ordered (Si, Al) distribution. Accurate determination of the positions of extraframework cations and water molecules in natural and cation-exchanged hydrated chabazites was conducted by Alberti et al. (1982) and Calligaris et al. (1982) and more recently by Nakatsuka et al. (2007) and Zema et al. (2008).

Passaglia (1970) reported a thorough description of the chemical variability of natural chabazite showing that it is one of the most chemically variable zeolites, both as regards the exchangeable cations as well as the Si/Al ratio. This author also identified relationships between chemical composition and physical properties.

The “Recommended nomenclature for zeolite minerals: report of the subcommittee on zeolites of the IMA, Commission on New Minerals and Mineral Names” (Coombs et al. 1998) defined the chabazite series as consisting of three separate species: chabazite-Ca, chabazite-Na (Passaglia 1970), and chabazite-K (De Gennaro and Franco 1976). More recently, Pekov et al. (2000) reported a fourth new species, chabazite-Sr. Passaglia and Ferro (2002) described the new occurrence of three chabazite samples—strictly associated with the magnesian zeolite offretite—with unusually high levels of Mg and classified these zeolites as magnesian chabazite-Ca. In the same paper, the structure refinement of the sample from Mont Semiol, France, is discussed.

Here we describe a new species of the chabazite series, chabazite-Mg, with magnesium as the most abundant extraframework cation, recently found in the Karikás-tető area of Prága Hill, Hungary. The new mineral and name have been approved by the Commission on New Minerals and Mineral Names of the IMA. The name of the species chabazite-Mg follows the “Recommended nomenclature for zeolite minerals: report of