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Macroscopic palygorskite from Lisbom Volcanic Complex

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Abstract: The palygorskite of the Volcanic Complex near of Lisbom (Portugal) is particular both in the size of the fibres and in chemical composition. It appears as veins of very pure mineral. From hand specimen and optical observations it can be described as a macroscopic palygorskite. The crystals are large with exfoliation traces of several hundred microns to few millimetres in length. In thin section, this palygorskite is colourless, translucent, negative biaxial, with positive elongation and parallel extinction. The optically homogeneous fibres and laths are shown by the selected area electron diffraction to be composed of aggregates of much thinner fibres rotated differently around the c crystal axis which represents their common elongation direction. The chemical formula obtained by the X-ray EDS is $Si_{8.02}\,O_{20}\,(Al_{1.91}\,Fe_{0.04}\,Mg_{\,2.01})\,(OH)_2\,(OH_2)_4\,Ca_{\,0.01}\,Na_{\,0.07}\,4(H_2O)$ very close to the ideal formula of a pure Mg-Al palygorskite, with almost no octahedral Fe, and no Al in tetrahedral sites. The cell parameters are a_0 or $a_0 sin\,\beta = 12.64$ Å, $b_0 = 17.84$ Å and $c_0 = 5.3$ Å.

Key-words: palygorskite, macrocrystalline palygorskite, electron microscopy, powder diffraction, FTIR spectroscopy.

Introduction

Palygorskite is a clay mineral that together with sepiolite forms the group of fibrous clay minerals. Bradley (1940) proposed the structure of palygorskite from a trioctahedral model although he described the existence of a dioctahedral term with octahedral holes when he pointed out that in the section (010) palygorskite is similar to montorillonite with a layer of water. Christ *et al*. (1969) and Chisholm (1990) proposed the existence of two forms, an orthorhombic and a monoclinic, but according to Chisholm (1992) both polymorphs appear in mixture in most of the natural samples. Different authors over the last few decades revisited the structure proposed by Bradley (1940) and no differences with this model have been found. The most recent papers which study the structure of palygorskite by high-resolution synchrotron radiation confirm the Bradley's structural model (Artioli *et al*., 1994 and Chiari *et al*., 2003), and Giustetto & Chiari (2004), by neutron powder diffraction, found a different arrangement in the zeolitic water for monoclinic and orthorhombic forms. Galán & Carretero (1999) affirmed that palygorskite contains mainly Mg, Al and Fe with a R^{2+}/R^{3+} ratio close to 1, and also that the corresponding theoretical structural formula is $Si_8\,O_{20}\,Al_2\,Mg_2\,(OH)_2\,(OH_2)\,4\cdot 4H_2O$. García-Romero *et al*. (2004) reported a very rich magnesium palygorskite which they compared with other palygorskites and with the bibliographic data, and verified that in all samples the Al content is less than Mg content in the octahedral layer, although the rate R^{3+}: Mg is close to 1 due to the presence of Fe^{3+} in most of the samples.

The habit of palygorskite, as a consequence of its structure, is fibrous and the c axis (or a for some authors) is parallel to the fibre. The sizes described in literature are between 100 Å – 4 μm in length with sections of about 100–300 Å × 50–100 Å (Jones & Galan, 1988), but the most frequent length measured by transmission electron microscopy are less than 1 μm. Rautureau *et al*. (1979) studied palygorskites from different localities by TEM and grouped them according to length: "very long fibres" of several micrometres, "medium length" of approximately one micron, and "short fibres", a fraction of a micrometre.

Materials and methods

The palygorskite here studied proceeds from the Lisbom Volcanic Complex (LVC) and it appears as veins of very pure mineral. The presence of palygorskite in LVC as a product of alteration or weathering of basalt and other volcanic rocks has been known for forty years (Galopim de Carvalho *et al*., 1970, Prudencio *et al*., 1993 and 1995). In oldest references to the palygorskite from LVC, this mineral was considered as an amphibole (Choffat, 1950).

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