

DRUSE PYROXENES IN D'ORBIGNY: A MÖSSBAUER SPECTROSCOPY STUDY.

R.B. Scorzelli,¹ I. Souza Azevedo¹, S. Stewart^{1*}, M.E. Varela² and G. Kurat³, ¹Centro Brasileiro de Pesquisas Físicas, R. Xavier Sigaud 150, 22290-180 Rio de Janeiro, Brazil, ²CONICET-UNS, Dpto. Geología, San Juan 670, B. Blanca, Argentina, ³Institute of Geological Sciences, University of Vienna, A-1090 Vienna, Austria, *On leave of Universidad Nacional de La Plata, Argentina.

Introduction: D'Orbigny is the sixth and by far the largest angrite known. It is peculiar with respect to three features: the abundance of hollow shells, the abundant presence of glasses and the open druses with perfectly crystallized augites of prismatic habit [1-2]. Here we report on the distribution of Fe²⁺ among the non-equivalent sites in the druse pyroxenes of the D'Orbigny meteorite as determined by Mössbauer spectroscopy.

Sample: Our specimen consists of 200 mg of euhedral augites, ranging in size from 70 to 400 μm. Electron microprobe analyses showed that augites are chemically homogeneous with a slight compositional change at the outermost ~ 5 μm (rim) – in wt%: SiO₂ - 46.4 (45), TiO₂ - 1.53 (1.91), Al₂O₃ - 8.1 (9.4), FeO - 12.7 (13), MgO - 9.1 (8.3), CaO - 22.7 (22.9).

Results and Discussion: The study of cation distributions over non-equivalent lattice sites in minerals can provide valuable information on its pT history. In pyroxene crystals that have been cooled slowly to temperatures lower than 500 °C, the Fe²⁺ ions populate primarily the M₂ position whereas the Mg²⁺ ions occupy predominantly the M₁ position. In crystals that have been rapidly cooled, a more disordered Mg, Fe distribution over the M₁ sites is observed.

The Mössbauer spectra of D'Orbigny druse augites obtained at room temperature consist of an intense inner doublet due to Fe²⁺ at the M₂ sites and a less intense outer doublet due to Fe²⁺ at the M₁ sites, whose relative areas are A₂=70% and A₁=27% respectively. Most Fe is present as Fe²⁺ but traces of Fe³⁺ (~ 3%) have also been observed and can be due to the presence of superparamagnetic particles of Fe oxide. By means of the relative areas A₁ and A₂ we determine the population of the Fe²⁺ in M₁ and M₂ crystallographic sites of the augite. The Fe²⁺ occupancies at M₁ and M₂ in these two nonequivalent sites are given by $X_{Fe}(M_1) = 2yA_1/(A_1+A_2)$ and $X_{Fe}(M_2) = 2yA_2/(A_1+A_2)$, being A₁ and A₂ the Mössbauer relative areas and $y = Fe/(Fe+Mg+Ca+Al)$. Considering the disordering reaction due to intracrystalline Mg²⁺ and Fe²⁺ exchange among the non equivalent M₁ and M₂ sites, the site populations of Fe²⁺ and Mg²⁺ can be related to the disordering coefficient α , defined by $\alpha = X_1(1-X_2)/X_2(1-X_1)$ where $X_1 = X_{Fe}(M_1)$ and $X_2 = X_{Fe}(M_2)$. Taking into account the chemical composition data, our results yield a disordering parameter $\alpha = 0.31$. Comparing this result with α values obtained from heating experiments with orthopyroxenes under controlled conditions [3], we can suggest that D'Orbigny augite exhibits a cation distribution corresponding to equilibrium temperatures of at least 1000 °C to 1200 °C. This is in good agreement with late phases equilibrium which indicates formation of kirschsteinite and ferroaugite at similar temperatures [1]. Further variable temperature Mössbauer experiments are in progress in order to acquire more details on the thermal history of these pyroxene crystals.

References: [1] Kurat et al., (2004) *Geochim. Cosmochim. Acta* (in press), [2] Varela et al., (2003) *Geochim. Cosmochim. Acta* 67, 5027-5046. [3] R.W. Dundon and S.S. Hafner. (1971) *Science* 174, 581-582.