

## CRYSTAL CHEMISTRY OF TALC: XRD AND SPECTROSCOPIC STUDIES

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In the monolithic (non powdered) samples of talc Wiewióra (1997) determined superstructure, characterised by  $d_{(001)} = 18.7 \text{ \AA}$  with integral series of  $d_{(001)}/l$  until  $l = 18$ , while X-ray tracings of powdered aggregates showed only all the talc common peaks. The strongest reflection for powder is 001, while it is 003 (006 of superstructure) for quasi single crystal sample. From intensities of the basal reflections, divided by Lorentz-polarisation factor for single crystal, a one-dimensional Fourier analysis was performed. It revealed increase in the electron density, right in the middle in the talc interlayer space (Fig. 1). This additional electron density band correlates rightly with a very strong vibration at  $101 \text{ cm}^{-1}$  in the far infrared, for the first time obtained on monolithic sample, while this band is hardly visible in this position in the spectra from powdered sample. This band clearly indicates some Mg in the interlayer space of talc.

There is no direct proof for the occupation of structural positions in talc by Ca, Na, K but positive correlation of Na with tetrahedral Al ( $R^2 = 0.71$ ) may indicate that some Na may enter also the interlayer positions to enable charge balance due to tetrahedral substitution of Si by lower-valency cation, namely Al and/or  $\text{Fe}^{3+}$ .

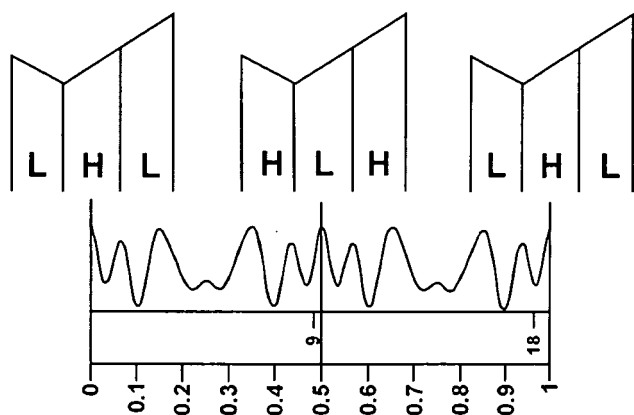


Fig. 1: One-dimensional [001] electron density distribution for two layer structure of talc.

Medium infrared Fourier spectroscopy revealed, in some samples of talc,  $\nu\text{Mg}_3\text{OH}$  (band present in all spectra), but also  $\nu\text{Mg}_2\text{FeOH}$ ,  $\nu\text{MgFe}_2\text{OH}$ ,  $\nu\text{Fe}_3\text{OH}$  and for the first time  $\nu\text{Mg}_2\text{AlOH}$  band. In the same samples  $2\nu\text{Mg}_3\text{OH}$ ,  $2\nu\text{Mg}_2\text{FeOH}$ ,  $2\nu\text{MgFe}_2\text{OH}$ ,  $2\nu\text{Fe}_3\text{OH}$  and  $2\nu\text{Mg}_2\text{AlOH}$  vibrations were for the first time recorded in the near infrared spectral region. The spectra proved presence of Fe and Al substituting Mg in the octahedral positions of talc and enabled their quantification (Petit et al., 2004). Mössbauer technique, as applied to study four samples, demonstrated that 62–68% of iron is as  $\text{Fe}^{2+}$  located in octahedral positions.  $\text{Fe}^{3+}$  is located in the octahedral and tetrahedral positions. The determined distributions of  $\text{Fe}^{2+}$  between M(1), M(2) and M(3) octahedral positions appear to depend on temperature in which experiment was performed. At 80 K the two different octahedral occupancies of Fe were differentiated, but three occupation positions at 4 K.

These XRD and spectroscopic data may mean that our understanding of talc structure as polytype  $1A_A\text{-II}$  ( $(^c_5, ^c_i)$ ), belonging to C-1 space group (more or less disordered) may be not adequate with real structure of some individual samples. In several samples of talc, originated by transformation of e.g. micas or chlorites, superstructure is quite evident. In the light of one-dimensional electron density by Fourier transforms analysis, the structure may be explained as two layer arrangement with the basal spacing  $d_{(001)} = 18.7 \text{ \AA}$ . In each pair of layers, having different electron densities of octahedral sheets (possibly tetrahedral, also), the even (e) orientation of octahedral sheet, intra-layer displacement along  $\langle 5 \rangle$  vector and interlayer displacement of tetrahedral sheets belonging to adjacent layers along  $\langle 1 \rangle$ , produce resultant layer displacement  $\langle 0 \rangle$ . Such a structure (Fig. 1) gives superstructure reflections in XRD pattern.

### References

- PETIT, S., MARTIN, F., WIEWIÓRA, A., DE PARSEVAL, P., DECARREAU, A. (2004): *American Mineralogist*, **80**, 319–326.  
 WIEWIÓRA, A. (1997): *Clays for our future: Proceedings of the 11th International Clay Conference, Ottawa, Canada*, 443–449.