STRUCTURAL, THERMAL AND SURFACE FORCE CHARACTERISATION OF MODIFIED LAYER SILICATES: RESULTS ON TALC, KAOLINITE AND MONTMORILLONITE

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In the last decades nanostructured materials are receiving a great attention since their properties are different and often superior than conventional materials. In particular, many studies have involved the characterisation of silicate layered structures (e.g. clay minerals) which can be considered natural nanostructured materials since display size-dependent properties that make them useful as industrial raw materials and for many applications, such as environmental remediation. Lately, a great attention has been paid to study structural modifications of clay minerals after mechanical deformation via planetary ball milling, because it can induce nanostructuring and physical and chemical changes in the treated materials for new application techniques. Several studies concerning structural and textural changes by mechanical deformation of kaolinite (e.g. Horváth et al., 2003; Frost et al., 2001; Sanchez-Soto et al., 2000), talc (e.g. Pérez-Maqueda et al., 2004; Godet-Morand et al., 2002), and montmorillonite (e.g. Dellisanti and Valdrè, 2004; Christidis and Makri, 2003; Čičel and Kranz, 1981) were presented, however the available data are often incoherent. The aim of this paper is to show preliminary results from well characterised mechanical treatment of simultaneously compacted and shear stressed commercial Ca-montmorillonite, kaolinite and talc.

After mechanical grinding in controlled environment for 20 hours all analysed minerals have shown a severe broadening and decrease of intensity both in 001 basal diffraction peaks and in 060 peaks (XRD data). This indicates a reduction of crystallinity (increasing of FWHM values) and an increase of microstrain in treated sample respect to the untreated ones. Finally, only for the montmorillonite sample mechanical deformations have induced a progressive reduction of the d001 lattice spacing of the montmorillonite from 1.5 to 1.3 nm due to the expulsion of interlayer water molecules.

FTIR results have shown that the structural damage regards both the bonds in octahedral sites and between tetrahedral and octahedral sheets. A change is also observed in the ratio between OH-stretching band and hydrogen bond absorption band. Moreover, a slight broadening of the Si-O bond could also indicate an initial destabilisation of tetrahedral layers.

Thermal analysis (DTA, TG, DTG) has shown a reduction of weight loss relative to the expulsion of structural water during mechanical treatment. A decrease of the maximum temperature of dehydroxylation was observed for talc (ΔT = 100°C) and kaolinite (ΔT = 150°C) and in minor extent for montmorillonite (ΔT = 20°C).

Surface force analysis was performed by Atomic Force Microscope (AFM). Calibration curves were obtained using various layered silicates and preliminary results on talc and smectite showed different surface potentials.

The following results indicate that mechanical treatment via compression and shear involves structural destabilisation which could induce significant changes in chemical and physical properties of minerals. These modifications are very important for several industrial applications. Determination of particle size distribution, cation exchange capacity (CEC), specific surface and colour measurements (CIELAB system) are in progress.

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