XXth International Conference of Young Geologists

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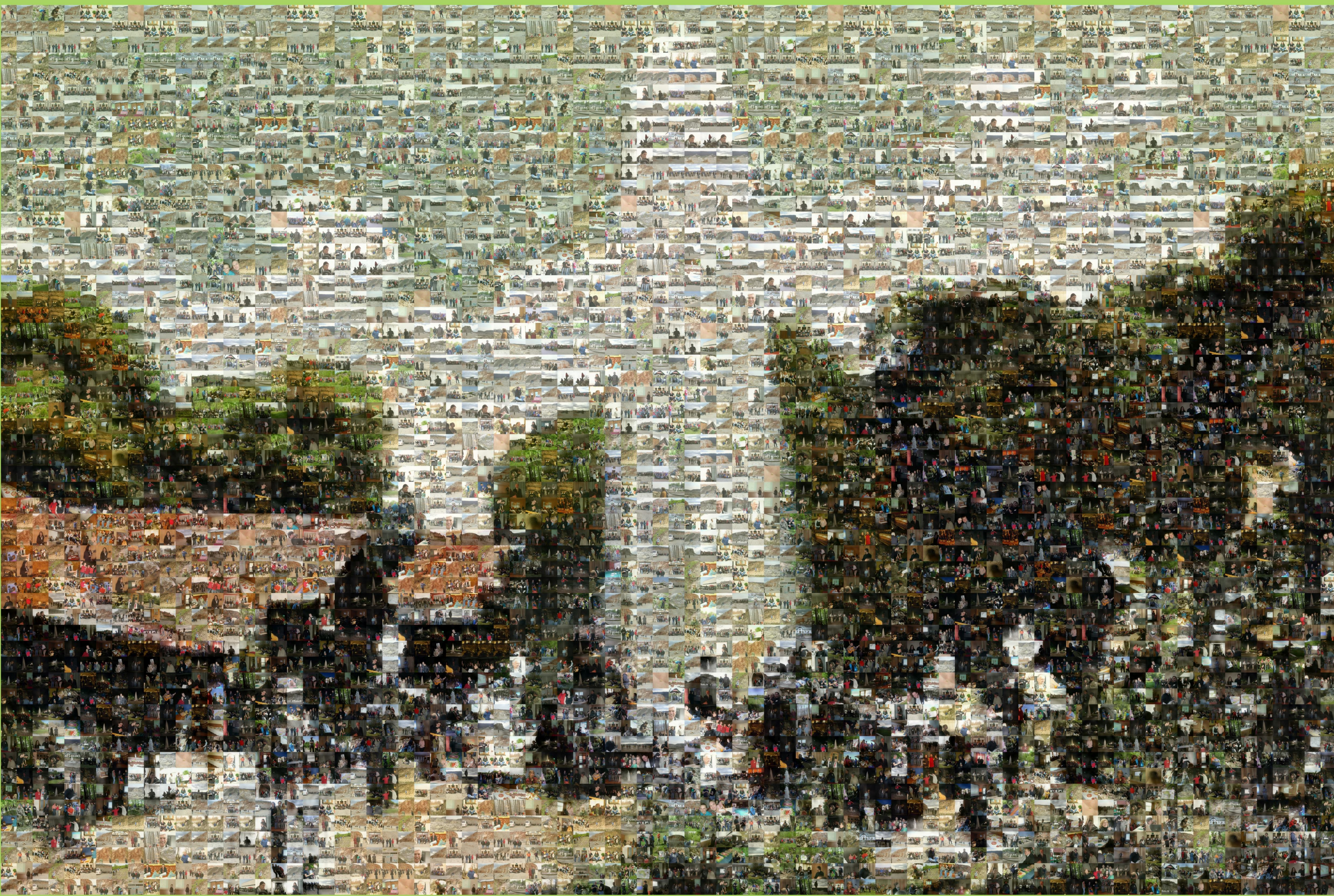

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Abstract Book

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Mg/Al LDH formation via transformation of minerals through the $AlCl_3$ hydrolysis

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In recent years, many studies have been devoted to the Layered Double Hydroxides (LDH) because of their numerous applications in many fields (e.g. catalysis, pharmacy, environmental protection) (Mishra et al., 2018). LDH are non-silicate oxides and hydroxides, also called 'anionic clays' due to their similarities to clay minerals. With their general formula $[M^{II}_{1-x} M^{III}_{x} OH_2]^{x+}[A^{n-}]_{x/n}\cdot y$ H2O, the structure of LDH can accommodate different divalent (M^{II}) and trivalent (M^{III}) metals which form brucite-like layers intercalated with several types of anions (A^{n-}). Due to their layered structure having a positive charge balanced with the hydrated anions in the interlayer space, LDH were found as effective anion exchangers that may be applied in wastewater treatment (Goh et al., 2008).

With an increasing demand for low-cost and effective adsorbents, the cheap synthesis of materials with high affinity towards anionic forms is gaining more attention. LDH can be rarely found in nature and are classified as minerals belonging to the hydrotalcites supergroup, however their synthesis in the laboratory conditions is very easy. Among many different methods, the coprecipitation technique was found to be the most straightforward (He et al., 2006), but the need to use chemical reagents still makes the whole process expensive. Therefore, the aim of this work was to synthesize Mg/Al LDH via transformation of minerals as metal-bearing substrates through the hydrolysis of aluminum chloride.

For the synthesis, magnesite [M] and dolomite [D], which are Mg and Ca/Mg carbonates, were used as sources of M^{II}, while $AlCl_3\cdot 6H_2O$ [Al] was used as a source of M^{III} and the dissolving agent. Additionally for the synthesis of a reference samples, $MgCl_2\cdot 6H_2O$ [Mg] was used as a source of M^{II}. The materials were obtained in 3 versions (Mg/Al, M/Al, D/Al) with combinations including three different M^{II}/M^{III} molar ratios and 2 h or 24 h ageing time of the precipitate. The dissolution of M and D was achieved through aqueous hydrolysis of $AlCl_3$ (Lewis acid) which substantially lowers the pH. Despite the lower dissolution efficiency of carbonates, the need to use additional chemical reagents (e.g. corrosive HCl) was avoided. Aliquots of the obtained solution containing $Mg^{2+}/Mg^{2+}+Ca^{2+}$ and Al^{3+} were added to the 2M NaCl solution where pH = 10 was set by an aqueous NaOH, and maintained at a constant level throughout the whole process. The final slurry was aged at room temperature, washed and dried at 60˚C overnight. The obtained materials were characterized by XRD, FTIR and SEM.

The XRD confirmed presence of LDH in all samples as compared to the magnesium aluminum carbonate hydroxide (hydrotalcite) standard pattern (JCPDS #14-191). Simultaneously, gibbsite (JCPDS #01-263) was formed in the M/Al and D/Al samples, while calcite (JCPDS #01-1032) was formed in the D/Al samples. An increasing M^{II}/M^{III} molar ratio led to structural changes revealed by shift of reflections in the XRD patterns. The shifts were both due to changes of unit cell parameters as well as change of interlayer distance. The XRD results also revealed, that with increasing ageing time the crystallinity of the obtained phases increased as attested by more narrow and sharp diffraction peaks. The FTIR spectra confirmed the formation of LDH phases as metal-oxygen and metal-oxygen-metal were found in the 800 – 400 cm^{-1} region. Moreover, CO_3^{2-} bands were observed in 1540 – 1310 cm^{-1} region. The gibbsite band was visible at 980 cm^{-1} (M/Al and D/Al samples) while calcite bands were found at 876 and 715 cm^{-1} (D/Al sample). The SEM images enabled to observe characteristic stacked layers of LDH comprising of hexagonal plates.

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