Metal ions exchanged after interaction of methylene blue with clay: assesment of the environmental effects

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Methylene blue (MB) solution has been used in determination of cation exchange capacity (CEC) in clay minerals [1, 2] but it can also be found as a pollutant in the wastewaters [3]. Clay minerals have been used as effective adsorbents of MB from polluted waters. MB exchanges metal ions on the surface and interlayer of the clay and release them into environment. The main goal of present study is to deternine the amount of metal ions that can be exchanged after saturation with MB solution. We have selected four mostly kaolinite clays [4] and saturated them with MB solution ($2*10^{-6}$ mol/l). Experiment were followed by ICP-OS measurements on raw samples and on the supernatant after addition of MB solution, three in total. Elements such as Na, Mg, Mn and Ca are easily replaced by MB cation on the surface of the particles. MB cation replaces Na^{+} more easily compering to Fe^{2+} ion. Carbonate mineral decomposition into CO_2 and and free Ca ions leads to higher attraction by MB. Exchange also occurs with the second and third addition of MB solution but in smaller percent. On the other side, release of relatively small amount of cations such as Fe, Ni and K, even after higher concentration of MB solution is observed. Due to the ion double layer they are dispersed around clay particles are less strongly held. Large MB cations held by van der Waals attractions, are likely to exchange ions on the surface depending on their valent number and relative concentration. Alkaline Earth metals are being easily exchanged by MB in comparison with transition and alkali metals with the exception of Na ion. These ions when found in a natural environment can form salts. Sodium hydroxide leaches rapidly into the soil, possibly contaminating water sources. Continuous release of these ions in the same locality may potentially lead to additional ecological problems if they are overlooked.

[1] Czimerova et al., 2006, Applied Clay Science 34, 2-13. [2] Milošević et al., 2015, Geophysical Research Abstracts Vol. 17. [3] Bellir et al., 2010, International Renewable Energy Congress, Sousse, Tunisia. [4] Milošević & Logar, 2017, Clay Minerals 52, 329–340.