The role of meta-clay surface area for binder materials

J. Dietel[1], L. N. Warr[1], K. Emmerich[2], M. Bertmer[3]

[1]*University of Greifswald, Institute for Geology, Greifswald, Germany*

[2]*Competence Center for Material Moisture (CMM) and Institute for Functional Interfaces (IFG), Karlsruhe, Institute of Technology, Karlsruhe, Germany*

[3]*Leipzig University, Institute of Experimental Physics II, Leipzig, Germany*

All cementation processes are significantly influenced by the binder to grain ratio, however the importance of the specific surface area (SSA), as measured by BET, is often not considered. In this study, we investigated the role of SSA in meta-clay produced from I/S-rich Friedland clay from N Germany, which is currently being investigated for usage as geopolymer cement. Geopolymers are inorganic binders made of alkali activated aluminosilicate materials such as furnace slag or dehydroxylated clays ("meta-clays"). The alkaline treatment leads to dissolution of Al and Si which condenses and polymerises while hardening even under wet conditions, to form a polymer network. Dehydroxylated kaolin (meta-kaolin) is the most commonly used precursor material for geopolymers, but 2:1 sheet silicates such as smectite, mica or mixed layered I/S can also be used. The common assumption made is that the reactivity of the meta-clay is dependent largely on the amount of 5-fold coordinated aluminium and the Al:Si ratio of the reacted material. However, our results show neither the concentration of the 5-fold coordination of Al nor the Al:Si ratio explain the improved hardening properties of the meta-clay powder observed with an increase in the sintering temperature. Instead a clear relationship is revealed between geopolymer cement hardening and a reduction of the SSA. We postulate that enhanced thermal treatment leads to a lower SSA and therefore less cement phase is needed to connect residual grains. The challenge is to find the optimum ratio between SSA and the amount of cement phase produced for different geopolymer precursor materials. This reaction model could explain why some kaolin clays are less suitable for geopolymer cements than others, which show varying particle size distributions and degrees of disordering that result in varying SSA to grain size ratios.