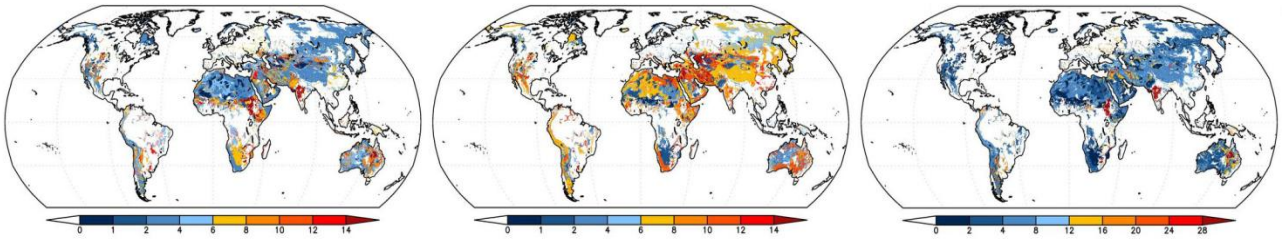
Characterization and modelling of calcined clays for sustainable development

(Proposer: Luca Valentini and Maria Chiara Dalconi)

With the beginning of the new millennium, society has embraced the idea of "sustainable development" as a key goal for the future generations to inherit a clean and more equitable world. In the field of mineralogical sciences applied to building materials, setting the ambitious goal of sustainable design has boosted research oriented at replacing conventional materials based on ordinary Portland cement (OPC) with a new generation of CO_2-free binders. This is motivated by the fact that the production of OPC clinker accounts for more than 6% of the global anthropogenic CO_2 emissions. Among low-CO_2 alternatives to OPC, materials based on the use of clays, which is a relatively cheap and abundant raw material (see figure), have gained consensus over the last few years. This project is focussed on the use of alkali-activated calcined clays for the design of clinker-free binders.



Global distribution of kaolinite (left), illite (middle) and smectite (right) in soils

The main goal of the project is reconciling the observed macroscopic properties of the alkali-activated calcined clay binders (workability, mechanical performance, durability) with the basic physical and chemical processes associated with clay calcination and reaction in alkaline solution. This will be achieved by:

a) Determining the structural variations occurring in the clay minerals as a function of calcination temperature, and in the pseudo-zeolitic reaction products, by MAS solid state NMR analysis;

b) Investigating in detail the kinetics of clay dissolution and reaction product precipitation by implementing specific numerical simulations based on *population balance modelling*.

<u>It is expected that the PhD candidate will</u>:

• Gain familiarity with the concepts of sustainable development (embodied energy and CO_2 etc.) and related instruments (life cycle assessment);

• Become acquainted with the design of alternative cementitious binders based on clays and standardized mechanical testing of cement-based materials;

• Develop skills in advanced experimental and numerical techniques;

• Work in an international environment and improve English language and general communication skills.

<u>Possible collaborations with foreign institutions</u>:

NMR measurements: Aarhus University, DK (local contact: Prof. Jørgen Skibsted)

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