

Title: Investigation of the geological and mineralogical features of bentonite deposits of northern Sardinia (Italy) and sustainable development

Academic tutor: Prof. Nicola Mondillo

Industrial tutor: Dr. Ph.D. Fabio Granitzio

Co-tutors: Prof. Giuseppina Balassone, Prof. Piergiulio Cappelletti

PhD program DM352

Research program

Bentonites are clay deposits predominantly comprised of smectites that generally form by the alteration of volcanic ash in marine, terrestrial, hydrothermal, or diagenetic settings. The smectite in most bentonites is the mineral montmorillonite, but occasionally other types of smectite are present. The two dominant types of bentonite are calcium bentonite and sodium bentonite which have different properties and uses. Bentonites have special properties such as hydration, swelling, water absorption, viscosity, thixotropy, ability to act as a bonding agent and significant cation exchange capacity. This makes them valuable materials for a wide range of uses and applications including pet litter, foundry sands and iron ore pelletizing, civil engineering applications, use as filler in various industries and others (<https://ec.europa.eu/docsroom/documents/42883/attachments/3/translations/en/renditions/native>), in addition, other unconventional technological and industrial applications foreshadow an important future and potential uses for this type of natural resource. The future of bentonite is expected to vary for different end use sectors. For instance the pet litter application is expected to remain strong. Bentonite used in iron ore pelletising is influenced by trends the iron and steel market. Major iron and steel producers, such as China, have seen a shrinkage in this sector, which is expected to continue and it will influence the iron ore pelletising sector too. The future of bentonite used in foundry sands will follow the trend of key sectors utilising iron ore castings such as the automotive and heavy equipment manufacturing sectors. The EU is a net importer of bentonite: the main suppliers for the EU are Turkey (39%), India (23%), Morocco (13%), UK and United States (6% each). The EU sourced about 80% of bentonite is sourced within the EU, mainly from Greece (36%), Germany (13%) and Czechia (7%) (<https://ec.europa.eu/docsroom/documents/42883/attachments/3/translations/en/renditions/native>). For the above reasons, the long-term availability of secure and adequate supplies of bentonite is monitored by the “European Union Ad-hoc Working Group on defining critical raw materials”, even though this material has never been included till now in the Critical Raw Materials list (<https://ec.europa.eu/docsroom/documents/42883/attachments/1/translations/en/renditions/native>, <https://rmis.jrc.ec.europa.eu/apps/rmp2/#/Bentonite>).

The present Ph.D. project will be developed in the frame of a collaboration with the company Clariant and its Italian subsidiary “Società Sarda di Bentonite” and has two main research objectives (ROs): RO1) to study in more detail the genesis of the bentonite deposits located in northern Sardinia, RO2) to investigate innovative solutions for their sustainable development.

RO1 will be pursued through sampling and analysis of selected ores, and modeling the geological, mineralogical and geochemical processes promoting the formation of smectites from the volcanic precursor. RO2 will be pursued through the investigation of the mining process and industrial process used for the Sardinian deposits.

Proposal for a PhD position

The Department of Earth, Environmental, and Resources Sciences (DiSTAR) at the University of Naples, Federico II will be the main base for the potential PhD position in Earth Sciences. The PhD research project will be carried out in collaboration with the company Clariant and its Italian subsidiary “Società Sarda di Bentonite”, and the Natural History Museum, London (NHM). The involved departments are home to nationally or internationally acknowledged consultancy for the minerals industry, offering a range of services linked to key skills in geology and mineralogy.

Models of the geological, mineralogical and chemical evolution of the bentonite ores will be elaborated through field work, and specific mineralogical (XRPD, SEM-EDS-WDS, HRTEM) and geochemical (ICP-OES-MS) analyses. Specific tests will be conducted to evaluate the technological properties of the specific bentonite deposits, and to optimize their development. The PhD project will be financially supported by the industrial partner Clariant and by specific research programs that are currently funded at the DiSTAR.

The candidate is expected to have a solid background in mineral deposit geology and mineralogy. Knowledge of programming techniques and software for statistical analysis is desirable but not necessary.

months	0-3	3-6	6-9	9-12	12-15	15-18	18-21	21-24	24-27	27-30	30-33	33-36
bibliographic research	X											
sample selection/preparation		X	X			X						
basic geochemical and mineralogical analyses		X	X	X	X	X						
detailed geochemical and mineralogical analyses						X	X	X	X			
ore deposits modeling						X	X	X	X	X		
courses	X			X			X					
participation at conferences				X				X		X		X
papers preparation					X		X		X	X	X	X
Completion of the thesis work										X	X	X