Effects of a longer dry period on bentonite composition and performance.

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Rationale

In PA exercises of KBS-3 repositories it is assumed that the bentonite barrier will be saturated a few years after closure of the repository.

This is definitively true for the average behaviour of the clay barriers, but there is a possibility that some portions of the repository with lower flow fields will remain unsaturated for longer periods.

In this event, the unsaturated bentonite buffer will be exposed to a heat transient for longer periods under dry conditions.

Under these conditions it is not known to which extent the heat transient will impose mineralogical changes that will alter the hydraulic conditions of the buffer and to which extent these changes are reversible once the buffer is resaturated.

In this context, it would be very interesting to investigate these processes in the temperature and time regimes expected in the repository. These conditions can only be attained in natural formations of bentonite, which have been exposed to heat transients.

In the late 90's, Amphos 21 (at that time Enviros) was deeply involved in the Natural Analogue programme of Enresa. One of the sites investigated were the bentonite deposits of Cabo de Gata (Almeria) in southeastst Spain where the clay deposits have been originated in a post-volcanic environment. In that site there are a number of locations where bentonite has been exposed to a temperature transient around 120 ºC and therefore there is a possibility to study the mineral alterations that had occurred and more importantly the reversibility of these alterations once the bentonite became saturated.

Bentonite deposits from Cabo de Gata (SE Spain)

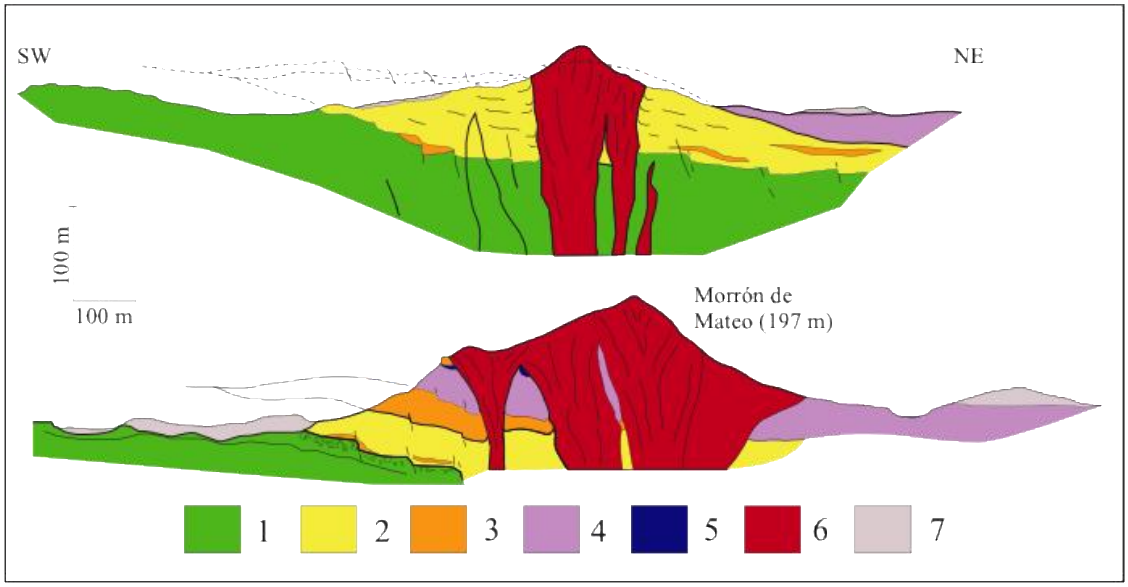
Cabo de Gata is a volcanic region, whose activity was related to the extensional tectonic phases in the Alboran Sea during the Serravallian-Lower Tortonian (14-10 Ma) and the upper Tortonian (9-7.5 Ma) periods. Volcanic rocks outcrop in a narrow band following a NE-SW trend from Cabo de Gata to the south of Murcia.

Volcanic activity started with explosive phases that produced the formation of pyroclastic rocks and the formation of large calderas (sometimes over 5 km in diameter), followed by the extrusion of lava flows and subvolcanic dome intrusions. Bentonites were formed by the alteration of pyroclastic rock, but only in the areas where these rocks are crosscut by fractures. This seems to indicate that fluids flowing through these fractures drove the alteration process.

Carbonate rocks with abundant marine fossils frequently intercalate the different volcanic deposits, which together with the presence of hydromagmatic volcanic facies, indicates that much of the volcanic activity took place in shallow or coastal submarine conditions. However, the presence of Upper Tortonian - Lower Messinian palaeosoils in the northern part of Cabo de Gata confirms that, at least during this period, the volcanic rocks were emerged.

More than 30 bentonite outcrops have been described in the Cabo de Gata area. All of them have similar composition. The relative homogeneity of the bentonites in this area depends not only on the type of rock undergoing alteration, but also on the chemical composition and temperature of the hydrothermal solution.

The bentonite deposit of Morrón de Mateo is located in the Central Sector of the Cabo de Gata volcanic field, in the relatively depressed area of Los Escullos. The rocks of the area (pyroclastic rocks, limestones and bentonite) were intruded by a sub-volcanic dome, which caused a contact metamorphism (mineralogical changes due to the development of a high temperature aureole) on these rocks. This effect is clearly identified in the limestones sandwiched between volcanic tuffs partially transformed into bentonites (Fig. 1). This outcrop has been studied by ENRESA in the frame of their natural analogue programme (Arcos et al., 2001; Pérez del Villar et al., 2005). The main conclusions of these studies indicate that these bentonites were affected by a thermal event associated to the volcanic intrusion and some changes were induced to the bentonite.



We will discuss the potentiality of a more comprehensive investigation of this site in order to qualify the changes induced in bentonite in a long thermal period and the potential reversibility of the alterations once saturated conditions are restored.

References

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