INTERACTIONS OF HIGHLY ALKALINE SOLUTIONS WITH ARGILLACEOUS ROCKS : STUDY OF A NATURAL ANALOGUE (KHUSHAYM MATRUCK, JORDAN)

Isabelle Techer [1], François Rassineux [2], Emmanuel Jacquot [3], Hani N. Khoury [4]

1. **Labo GIS / GdR FORPRO / CEREGE, Parc Scientifique Georges Besse, 150 rue Georges Besse, 30035 Nîmes Cedex 1, France**
2. **ERM, Bâtiment GON, 40 avenue du Recteur Pineau, 86022 Poitiers cedex, France**
3. **Andra, Parc de la Croix Blanche, 1-7 rue jean Monnet, 92298 Châtenay Malabry Cedex, France**
4. **Université de Jordanie, PO Box 17167 Amman-Jordan 11195**

The concepts that may be retained for deep geological storage of high-level long-lived nuclear waste require the introduction of a great proportion of hydraulic binder into the vicinity of the packages. Possible interaction of fluids with these cements will produce highly alkaline solutions (pH around 12.5) that could interact with the surrounding environment notably with argillaceous components of the nearby barrier and/or the geological one. In order to discuss the feasibility of such deep geological nuclear waste storage, the long-term behavior of argillaceous materials in relation to highly alkaline solutions must be evaluated.

In Central Jordan, the sedimentary formation of '*Khushaym Matruck*' is formed by bituminous grey marls from the Muwaqqar formation dating from the Upper Cretaceous (Maestrichtian) until the Upper Palaeocene (72 to 53 Ma). They are overlain over a thickness of around 50 meters, by natural cements and marbles formed by combustion of organic matter during a high temperature process (50 to 600 ky?). After this high temperature process, highly alkaline solutions originating from the cement zone have percolated through the underlying marls. These paleocirculations materialize in the grey marls by the occurrence of sub-vertical veins filled with gypsum, calcite and/or zeolites. Thus, the Khushaym Matruck site constitutes a good natural analogue for studying interactions between highly alkaline solutions and argillaceous rocks.

Marl samples were collected at increasing distances from the cement zone and studied from a mineralogical point of view (MO, MEB, DRX). Non-disturbed marls are composed of layered biomicrite, containing around 10 to 20 % of argillaceous minerals of smectite or of the illite/smectite mixed-layer type. Near to the cements, a significant change in the marl rock's composition may be observed :

- dissolution of primary silicates, and probably of diagenetic clays,
- occurrence of new silicates (calco-sodic zeolites and amorphous silica) as vein filling or in the rock matrix,
- increasing carbonate content,
- decreasing clay cristallinity,
- transformation of clay chemical composition into chromiferous clays,
- decreasing number of smectite layers in illite/smectite mixed-layers.

In order to discuss the nature of these transformations (thermal effect during the combustion process, or highly alkaline solution interaction?) a study based on applying Strontium, Oxygen and Carbon isotopic tracers is being carried out on the same samples. It will be combined with dating linking the radioactive disequilibrium method (U-Th) and the fission track one on apatites of the marl formation and / or of the cements and marbles to date the high thermal process and percolation of the highly alkaline solutions.

At the time of writing this abstract all isotopic data was not available but will be discussed at the international meeting.