Geochemistry of claystone/cement paste interface at 70 °C: an in situ experiment

P. LALAN[1]*, A. DAUZERES[1], L. DE WINDT[2], D. BARTIER[3], I. TECHER[4] AND V. DETILLEUX[5]

[1]IRSN, BP 17, 92262 Fontenay-aux-Roses cedex, France (*correspondence: philippines.lalan@irsn.fr)

[2]MINES ParisTech, PSL Research University, Centre de Géosciences, 77305 Fontainebleau Cedex, France

[3]CNRS UMR 7566, Université de Lorraine, BP 70239, 54506 Vandœuvre-lès-Nancy, France

[4]Univ. Nimes, EA 7352 CHROME, rue du Dr Georges Salan, 30021 Nîmes, France

[5]Bel V, 148 Rue Walcourt, 1070 Anderlecht, Belgium

Radioactive wastes in future deep geological disposals will generate heat and locally increase temperature in the engineered barriers and host-rock. In the French design of disposal cells, temperature may reach 70 °C in cementitious materials and at their contact with the clayey host-rock. The impact of temperature under such disposal conditions is still poorly known, especially the geochemical and physical evolution at interface between these two materials.

An in situ specific experiment was installed in the Underground Research Laboratory in Tournemire (France) to understand the mineralogical and geochemical processes occurring at an Ordinary Portland Cement (OPC) paste / clayey host-rock interface in this temperature range. An engineered cemented borehole including a heating system and crosscutting the argillite under water-saturated conditions was designed [1]. Many complementary analyses of the solid phases (XRD, TGA, SEM-EDS, TEM, Sr isotopy, microstructural analysis) were performed after dismantling.

A temperature of 70 °C was maintained during a one-year experiment and gave access to very rare data. Neoformation of phillipsite (zeolite), tobermorite (well-crystallised C-S-H) and calcite formed a layer at the interface. Significant decalcification and carbonation were noticed in the cement paste. On the contrary, clayey phases seem to be only weakly altered in the argillite. Globally, porosity decreased at both sides of the interface without a full clogging. Geochemical modelling supports these experimental results, especially the existence of tobermorite and phillipsite at 70 °C, minerals never observed before in concrete/clay interface experiments.

[1] Lalan et al., Cem. Concr. Res. (2016).