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Book of Abstracts

Gonçalo Vieira, Pedro Pina, Carla Mora and António Correia (eds.)

Groundwater silicification as a proxy of paleo-permafrost depth and a constraint for a fluid flow and geothermal modelling

Anne Jost, UPMC, France
Médard Thiry, Mines ParisTech, France
Agnès Rivière, University of Calgary, Canada
Sophie Violette, UPMC, France
Julio Gonçalvès, Aix-Marseille University, France

In the Paris basin, the Fontainebleau Sand (Early Oligocene) contains superposed flat-lying lenses of very tightly cemented sandstones. Drill-hole data indicate that these sedimentary quartzite layers are restricted to outcrops on the valley slopes and do not extend more than a few hundred meters beneath the overlying limestone cover of the plateaux. The discontinuous distribution of the silicified bodies, as well as the correlation between their localisation and the recent or present morphology, suggest a relatively recent surficial silicification. The general arrangement of the sandstone in subhorizontal layers and their elongated morphologies towards valleys may also indicate a control on their genesis by paleo-groundwater.

Moreover, the Fontainebleau Sand often contains calcite crystallarias, the dating of which shows formation during the past two cold periods of the Quaternary, around 300 kyr and 50-30 kyr. They would be equivalent to the cryocalcites related to frozen karst cavities, but would have developed in the sand aquifer. They are sometimes included in the quartzite, suggesting that sand silicification also has to be related to Quaternary cold periods. Silica precipitation would be facilitated by a decrease in solubility with decreasing temperature of groundwater outflow in contact with permafrost (Thiry et al., 2013). Quartzite lenses would therefore act as a proxy for the presence and thickness of permafrost. The modelling of these silicifications in permafrost context would allow to validate the cementation model but also to refine the dynamics of paleo-permafrost.

In this context, we run a set of transient simulations on a typical 2-D hydrogeologic section of the Beauce Plateau using a fully coupled groundwater flow and heat transfer model with integrated freezing and thawing processes. The code takes into account latent heat effects and modifications of hydraulic and thermal properties due to ice formation. Our model calculations allow us to investigate the temperature and pressure conditions associated with permafrost propogation that could have prevailed in the valleys at the groundwater outlet. We discussed them in terms of constrains on fluid flow and geothermal profile to provide favourable conditions to achieve silica deposition.

Thiry M, Schmitt J-M, Innocent C, Cojan I, 2013. Sables et Grès de Fontainebleau : que reste-t-il des faciès sédimentaires initiaux ? 14e Congrès Français de Sédimentologie, Paris 2013, Trois excursions géologiques en région parisienne, Livre d'excursions, Publ. ASF, n°74, p. 37-90.