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How spatial variations of chalk groundwater geochemistry are related to superficial formations and infiltration processes of unsaturated zone (quarry of Saint Martin le Noeud, France)

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Chalk is complex because of its dual porosity and because of superficial layers more or less thick and more or less permeable. Furthermore there is few knowledge in understanding of groundwater infiltration and dissolution processes in the chalk unsaturated zone (UZ). The role of superficial formations has to be studied especially.

The experimental site is an ancient underground quarry of chalk which extends over 1200 m long and 150 m wide (30 m depth) in Saint Martin le Noeud, south of Beauvais, France. This quarry is particularly interesting to study infiltration and dissolution processes indeed this site allows to access to the interface between the unsaturated zone and the saturated zone. Water percolates from the top of the quarry more or less depending on the season. Water table outcrops in the cave and makes about 20 underground lakes. Above the quarry chalk is covered clay-with-flints (CWF) and loess, in surface there are cultivated crops fields.

On the first year of the study, physicochemical parameters: temperature, depth, pH, conductivity were recorded in seven lakes with high frequency (every hour). During the same period we sampled the 20 lakes water every month to measure major ions. During this sampling period, percolation was not sufficient to collect percolated water.

Results of underground GPS, electric resistivity tomography and observations of three borehole showed that thickness unsaturated zone and that the thicknesses of the superficial formations vary a lot spatially. Three interesting points (separated by less than 1 km) are presented: the above the Pedro lake (25 m of UZ, a few cm of CWF), above the Stalactites lake (30 m of UZ, more than 2.40 m of CWF); above the Blue lake (35 m depth, 60 cm of CWF).

First results of chemistry showed that the temporal variation is very low during the first year but there spatial variation is very important at quarry scale. The geochemistry of the lakes are very different: HCO_3- varies from 100 to 250mg/l, NO_3- from 25 to 100mg/l and Mg from 1.5 to 4 mg/l. . The results of the three previous lakes are: Pedro lake (100 mg/l of HCO_3-, 100 mg/l of NO_3-, 1.5 mg of Mg2+); Stalactites lake (200 mg/l of HCO_3-, 25 mg/l of NO_3-, 4 mg/l of Mg2); Blue lake (250 mg/l of HCO_3-; 25 mg/l of NO_3-, 1.5 mg/l of Mg2+).

We may distinguish three different origins for the chalk groundwater quality: an autochtonous origin with ions as HCO_3-, an allochtonous origin with agricultural ions as NO_3- and another allochthonous origin with CWF markers as Mg2+.

Spatial heterogeneity of chalk groundwater geochemistry will be related to physical characteristics of the unsaturated zone to understand the chalk infiltration processes.