Geophysical Research Abstracts
Vol. 21, EGU2019-16964, 2019
EGU General Assembly 2019

Characterization of the vadose zone above an abandoned underground quarry of Chalk, using different geophysical tools

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The abandoned underground quarry of Chalk at Saint-Martin le Nœud (80km north of Paris, France) is of particular interest to study infiltration processes in the vadose zone. Permanent underground lakes (at depths between 20 and 30m below the surface, created by the outcroping water table) showed spatial and temporal variations of groundwater geochemistry and hydrodynamics within the quarry. The Chalk is covered by superficial formations of soil and clay-with-flints. Previous studies showed that the transfer processes seem to be controlled by the geometry of the clay layer.
Geophysical measurements were carried out at the surface above and inside the quarry (i) to characterize the geometry and the physical properties of the vadose zone (particularly the clay cover) to study their influence on the groundwater quality variations, and (ii) to identify and quantify infiltration flowpaths and alteration processes.
Electromagnetic induction (EMI) mapping provided a spatial description of the thicknesses of superficial formations covering the Chalk. Electrical resistivity tomography (ERT) emphasized deeper geological structures: different Chalks with their slope. The combined use of pressure-wave traveltime tomography and surface-wave profiling highlighted strong lateral variations of the Poisson's ratio corresponding to significant water content variations at the interface between the clay-with-flints and the Chalk formations (these results could highlight an epikarstic functioning). Infrared thermographic mapping were performed at different seasons. It provided information about heat transfers between the atmosphere, the soil or deeper layers. The first results showed spatial variations of soil water content and areas of preferential infiltration. Spontaneous potential (SP) mapping will characterize the infiltration processes, more particularly in the area of high clay-with-flints thickness. Electrical (direct current, induced polarization and SP) measurements inside the quarry will help imaging its internal structure and characterized the transfers (even quantifying the flows) and the weathering processes.