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Hydro-chemical anomalies in clay-rich landslides: evidences from case studies in the northern Apennines (Italy)

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The presence of deep faults can affect the groundwater circulation. They can control the rising of deep fluids to the ground surface. Normally, deep fluids have a chemical composition completely different from the shallow groundwater; depending on the travel depth, temperature and pressure conditions, mineral composition of the rocks crossed and time of interaction.
This can affect the hydro-chemical characteristics of near-surface groundwater. Eventually, it can change the fingerprint of groundwater circulating in landslides and it can influence long-term pore-pressure fluctuations, playing a role on slope stability.
In the northern Apennines of Italy, several large-scale earth slides – earth flows affecting faulted clayey formations are believed to be somehow influenced by deep fluids. The study was aimed at detecting hydro-chemical anomalies in groundwater circulating in 3 landslides that have resumed activity several times in the last decades, and that are occurring in areas of potential deep-fluid influence (Silla, Ca' Lita, Vedriano). More than 30 water-samples were collected at different depth in the landslide body and in the underlying bedrock, owing to the presence of several piezometers. Physical and chemical analyses comprised determination of temperature, conductibility, pH, main cations and anions (K+, Na+, Cl−, Ca2+, Mg2+, SO42 − and HCO−). Isotopic analyses (oxygen and deuterium) are still ongoing. Results allowed discriminating between a Ca-Carbonate hydrotype (400-600 μS/cm), that is interpreted as being directly connected with rainfall infiltration, and a Na-sulfate-rich hydrotype, that is interpreted as the evidence of deep fluids upflow. This would actually be the result of the mixing between two extreme hydrotypes: Na-bicarbonate water and Ca-sulfate waters, both characterized by high salinity, over 4000 μS/cm. The first is typical of geothermal water in the Apennines and is linked to the infiltration at great depth of rain water and the subsequent long term interaction between water and rock masses that allows to degradation of the Na-silicate. The second hydrotype, Ca-sulfate water, might be related to the presence of gypsum deposits in the stratigraphic sequence of the Apennines chain.