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Multi-frequency electrical and electromagnetic measurements for imaging water flows: application to catchment and landslide hydrology.

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Imaging water flows in mountainous watersheds is a difficult task, not only because of the topography and the dimensions of the existing structures, but also because the soils and rocks consist of unsaturated porous and heterogeneous fractured media, leading to multi-scale water-flow properties. In addition, these properties can change in time, in relation to temperature, rainfall and biological forcings.
Electrical properties are relevant proxies of the subsurface hydrological properties. In order to image water flows, we consider measurements of the complex electrical conductivity (conduction and polarization/chargeability effects) which translate into a frequency dependance of the conductivity at the sample scale. We further discuss the combined use of electromagnetic (CS-AMT) and electric (DC and IP) measurements at the slope scale. The solving of processing, calibration and modelling issues allows the estimation of hydrological properties (i.e. permeability, soil humidity) giving master constraints for slope-scale hydrological modelling.
We illustrate the application of these methods for the identification of the hydrological role of weathered structures of granitic catchments (e.g. Strengbach, Vosges mountains, ca. 80 km from Strasbourg, North East France) where new AMT processing has been developed in the AMT dead band to improve DC electrical imaging. We also illustrate the use of these methods to document the seasonal regime of the groundwater of the Lodève landslide (unstable slope located at Pégairolles, foot of the Cévennes mountain, ca. 80 km from Montpellier, South of France) where a new detailed time-lapse DC and IP setup (surface and borehole) is being tested.
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