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Electrical signature of CO2-rich mineral groundwater systems - Application in the Ardennes, South-East of Belgium

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CO_2-rich mineral groundwaters have been exploited for centuries for both bottling and thermal activities. The detection and understanding of productive areas is therefore of great interest to manage future supply in a sustainable way. CO_2-rich mineral water systems are complex since they usually involve an intricated network of water bearing fractures enabling the uplift of CO_2-rich groundwater to the surface, a process that is still poorly understood. Geophysical prospection is crucial to detect potential uplift zones and to address corresponding uncertainties before drilling operations.

In this context, non - to minimally - invasive near-surface geophysical methods can prove to be efficient. The objective of this contribution is to assess the ability of the induced polarization method, combined with the electrical resistivity technique, to make the distinction between CO_2-rich groundwater from non-gaseous groundwater.

Several combined electrical resistivity and induced polarization tomography profiles were performed in the Ardennes (Belgium) where thousands of CO_2-rich groundwater springs are observed. The profiles were all set immediately above known uplift zones. Inversion results were consistent between all profiles and important contrasts in both electrical resistivity and chargeability distributions in the vicinity of the uplift zone were observed, which were also reflected in the normalized chargeability sections computed on the basis of the measured data.

Low resistivity vertical contrasts extending in depth were observed and interpreted as saturated fractures enabling the uplift of deep groundwater to the surface. In addition, high chargeability anomalies appeared directly close to the CO_2-rich groundwater resurgence. Those anomalies are thought to be associated to the presence of metallic oxides and hydroxides, as a result of dissolved metallic species precipitation in the upper part of the fractured aquifer due to the pressure decrease and change in redox conditions in up-flowing groundwater towards the land surface.

We conclude that the combined interpretation of electrical resistivity and induced polarization datasets is a very promising method for a more robust prospection of naturally sparkling

groundwater.