Integration of proxy data for understanding CO_2-rich mineral groundwater in the Ardennes region (southeast of Belgium)

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For centuries, people have travelled across the continent heading to a little town located in the southeast of Belgium, Spa – city that gave its name to the wellness bathing traditions. In Spa, and in the surrounding Ardennes region in general, can be found natural springs of sparkling mineral groundwaters that are recognized for their healing thermal properties and their extreme pureness. Even though those waters have been known forever and exploited as drinking and thermal waters since the beginning of the 19th century, lots of questions remains regarding their age, the origin of the CO_2, and their circulation paths.

A better understanding is needed to both ease their sustainable exploitation in the future and protect them from surrounding pollution sources, guaranteeing their quality and particular composition. Former research works on the subject have concluded to a flowing system in which rainwater infiltrates in a 'still-to-be-defined' area, reaches a 'still-to-be-discovered' carbonated layer at potentially great depth where groundwater gets saturated in CO_2. Finally, the water upwells to the surface through an intricated faults network and as pressure decreases, CO_2 is released.

We present the first results of an integrated research that aimed at further understanding these CO_2-rich groundwater systems, their particular composition and the potential additional reserves in the Ardennes region. Different kind of data (either existing or to be collected on the field) are being gathered to be used as proxy-data: 1) geophysical Electrical Resistivity Tomography (ERT) and Induced Potential (IP) results to identify the particular signature of CO_2-rich waters upwelling zones, 2) hydro-geochemical analysis including indicator elements of deep groundwater pathways, 3) carbon isotopes analysis to identify the origin of the CO_2, 4) water isotopes and rare gases analysis to assess groundwater age, 5) radon in the Fe and Mn-rich oxides precipitated at the surface of some upwelling zones, 6) use of an actualized geological mapping of the region including a new interpretation of the local structural framework.

Our final objective is to gathered and processed theses data using a self-organizing machine learning algorithm, which will help to recognize and categorize points of the dataset presenting similar characteristics for the different proxy-data. From this integrated analysis, we aim to deduce a better understanding with detailed mapping and a better reserve assessment, allowing a smart and sustainable management of these CO_2-rich groundwater resources in the future.

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