## ISOTOPE STUDIO: A FAIR-Compliant VRE for Harmonized Isotope Data and Modelling within the ITINERIS Framework

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Isotope Geochemistry plays a pivotal role in exploring the natural variability of isotope ratios in Earth materials. The application of stable, noble gases, non-conventional stable, and radiogenic isotopes is fundamental across a wide range of Earth System disciplines, including geology, biology, archaeology, agronomy, ecology, up to medicine, food provenance studies, and climate change

In this light, as part of the ITINERIS Project, Task 8.9 focuses on developing a Virtual Research Environment (VRE) dedicated to environmental isotopes. The ISOTOPE VRE has been developed within the D4Science e-Infrastructure, adhering to the principles of Open Science by promoting transparency, collaboration, and inclusivity throughout the entire research workflow. To further these objectives, we introduce ISOTOPE STUDIO, a web-based application hosted within the ISOTOPE VRE and designed for acquiring, managing, standardizing, and processing a wide range of geochemical data, including major and trace elements, intensive parameters, and isotopic compositions. A standout feature of ISOTOPE STUDIO is its data homogenization engine, which integrates and categorizes heterogeneous inputs, allowing seamless integration of diverse datasets into a unified, queryable structure. This ensures the reliability of modelling performed by this web application.

ISOTOPE STUDIO supports various modelling functionalities for interpreting natural processes. Practical applications include binary diagrams, ternary plots, normalized spider diagrams and mixing processes. The outcomes produced align closely with established literature, validating the platform’s analytical robustness and scientific utility; selected examples will be presented to demonstrate the quality and reliability of the underlying database.

**Keywords: ISOTOPE VRE; ISOTOPE STUDIO; MODELLING**