Goldschmidt 2025 Abstract
https://doi.org/10.7185/gold2025.28109

Application of multiple isotope systematics to unravel water-rock interaction processes and hydrological pathways in seismically active areas towards the deployment of a water monitoring network aimed at seismic surveillance

MR. LORENZO CHEMERI[1], MARCO TAUSSI[1], JACOPO CABASSI[2], STEFANIA VENTURI[3], ANTONIO DELGADO HUERTAS[4], ARSENIO GRANADOS[4], SAMUELE AGOSTINI[2], DAVIDE FRONZI[5], ALBERTO RENZULLI[1] AND ORLANDO VASELLI[6]

[1]Università degli Studi di Urbino Carlo Bo
[2]CNR- IGG Institute of Geosciences and Earth Resources
[3]University of Florence
[4]Andalusian Institute of Earth Sciences
[5]Università Politecninca delle Marche
[6]Università degli Studi di Firenze, Dipartimento di Scienze della Terra, Firenze, Italia

Waters circulating in the seismically active Pesaro-Urbino province (central Italy) were investigated to understand water-rock interaction processes and groundwater pathways through a multi-isotopic approach. The aim was to select specific sites to be included in a water monitoring network for seismic surveillance intended at recognizing seismic tracers.

The geochemical composition of groundwaters reflects their complex story underneath: the hydrologic and hydrogeologic features such as recharge-discharge mechanisms, flow velocity and water movement within the aquifers, together with the assessment of the lithological features, are fundamental aspects to be considered for establishing a monitoring network aimed at seismic surveillance. In this context, the application of multiple isotope systematics (C, S, O, H, B, Sr) plays a crucial role. In fact, the isotopic data make it possible to trace the primary sources of some solutes, or the secondary processes affecting the waters during their underground circulation, also allowing to identify the geological formations interacting with the circulating waters along their paths.

The investigated waters show various compositions (Ca-HCO_3, Ca-SO_4, Ca-HCO_3-SO_4, Na-HCO_3). Water geochemistry and isotopic contents suggest that Ca-HCO_3 waters interact with limestones and silicates at shallow depths. Contrarily, Ca-SO_4, Ca-HCO_3-SO_4 and Na-HCO_3 waters relate to longer water-rock interaction and/or deeper circulation patterns within the aquifers. All the waters show δ^{13}C-TIDC values mainly biogenically-derived, with δ^{2}H- and δ^{18}O-H_2O fingerprints suggesting a meteoric origin. By combining δ^{34}S-SO_4 and $^{87}Sr/^{86}Sr$ ratios we recognized that Ca-HCO_3-SO_4 and Ca-SO_4 waters interact with the evaporitic Triassic Burano formation constituting the regional basal aquiclude, suggesting long and deep flow paths. This makes these waters interesting to be monitored for seismic tracers, being likely able to carry possible deep seismic signals (e.g., deep-sourced gases inflow, enhanced metals mobility). Contrarily, Na-HCO_3 waters are characterized by $^{87}Sr/^{86}Sr$ ratios and δ^{11}B values approaching those of the siliciclastic Marnoso Arenacea Fm, consistent with long-lasting interactions with Na-bearing silicates. Our results suggest that the hydrogeochemical and multi-isotopic approach provided paramount information to detect sites more prone to record possible geochemical variations during the build-up phase of seismic events, making it suitable for being applied to other seismically active areas.