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Identification of Cerium (Ce) anomalies in the groundwater system of coastal Rhodope (NE Greece)

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The coastal aquifer of Rhodope region (NE Greece) is a complex groundwater system which is impacted by various processes and sources such as seawater intrusion; water rock interaction; geothermal fluid circulation; and agricultural practices. In the context of MEDSAL Project (www.medsal.net) a thorough study of its hydrogeochemical characteristics was performed by collecting and analyzing 47 groundwater samples for a wide set of parameters, including cerium (Ce).

Results revealed anomalous Ce concentrations, reaching up to 142 μg/L. Nearly half of the samples (53%) appeared to have concentrations over 1 μg/L which is an indicative threshold for most natural waters. The anomalous Ce values were not widespread in the area, but oriented along the dominant tectonic structures, indicating their possible connection. Based on geological and hydrogeological evidence, the basement which is consisted of Mesozoic chlorite and sericite schists of the Circum-Rhodope complex and hosts within its deepest sections (>400m) a geothermal reservoir, underlies the aquifer system (hosted in the Neogene formation and the Quaternary deposits) with which is hydraulically connected through preferential flow paths.

This could be further supported by the results of data processing, which resulted in similar hot spots for the relatively elevated groundwater temperature (up to 27°C) and Ce concentrations. The outcome of the R-mode factor analysis of the entire dataset, outlined a co-variation between Ce-U which indicates their common source, probably due to granites (occurring in the eastern neighboring section of the study area), as well as a factor including Ce, Al and Mn (with antithetic loading) denoting the impact redox conditions due to Al-Mn oxides. The elevated salinity content of the aquifer system seems to negatively affect Ce mobility, as reported in similar cases, by resulting in flocculation and immobilization of most particulate Ce. On the contrary, the afore described redox conditions and the increased permeability through preferential flows, seems to be the dominant factors for its fate and transport.

Overall, the hydrogeochemical fingerprint of Ce can be used as a tool in delineating hydrogeochemical processes and solute transport tracing, as well as for revealing groundwater chemical evolution in complex groundwater systems, which are probably affected by deep groundwater circulation and/or impacted by the elevated heat flow regime.