
Impact of Geological Structures on the Functioning of the Oum Er Rbia Spring System, Middle Atlas, Morocco

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Résumé

In Mediterranean basins, observations and climate change scenarios point out an increase in aridity especially in the southern regions like Morocco. In such context, the availability in fresh groundwater resources are critical for water supply and the socio-economic activities, which requires a deeper insight into the functioning of hydrogeological systems. In the semi-arid Middle Atlas, the Oum Er Rbia (OER) springs system is one of the most significant karst springs of Morocco (≈ 6 m³/s in April, 2025) although the analysis of historic surveys has revealed a decline by 1,5 m³/s per decade during the mid-twentieth century. OER system exhibits a striking contrast in water quality, ranging from freshwater springs ($800\mu\text{S}/\text{cm}$) to saltwater springs (up to $35\,000\mu\text{S}/\text{cm}$). Despite its importance for water supply, the geological structures that control OER system groundwater circulation and salinity remains poorly understood.

In 2024-2025, hydrochemical and geological field investigations were conducted in the OER springs system area. The research integrates chemical and water stable isotope approaches at multiple sampling points across different hydrological periods. The geological approach includes field and aerial mapping, faults analysis and structural setting interpretation.

Water quality is mainly controlled by lithology. Freshwater springs show a Ca-HCO₃ facies and are associated with the Lias dolomitic rocks. In contrast, salty springs show a Na-Cl facies and are linked to Triassic evaporitic clays. This hydrochemical heterogeneity

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is also reflected in different groundwater recharge areas: freshwater springs show depleted $\delta^{18}\text{O}$ values (-8, 58 ‰ vsmow) with a 2000 m asl recharge basin, while saltwater springs exhibit more enriched $\delta^{18}\text{O}$ values (-7,61 ‰ vsmow), 1400-1600 m asl recharge basin.

Geological surveys have revealed numerous markers of salt tectonic, which may explain the disconnection between both groundwater reservoirs. A salt wall (elongated diapir) seems delimiting the reservoir of saltwater by juxtaposing Lias dolomitic rocks and evaporitic clays (hydraulic barrier). Furthermore, NNE-SSW-oriented and EW oriented drains in fault damaged zones and diaclases, with local evidences of ghost-rock karstification processes, control the circulation up to the spring localisations. As a result, these surveys will be resumed into a conceptual model explaining the functioning of the OER Spring System.

Mots-Clés: Groundwater, Morocco, Middle, Atlas, Salt tectonic, Hydrochemistry, Hydrogeology