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Boron content and sources in Tertiary aquifers in the Sultanate of Oman

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The boron (B) content of relatively shallow groundwaters in arid areas is high due to extreme evaporation which precipitates several salts with subsequent boron accumulation originating from rocks dissolution and/or rainwater. In deeper aquifers, where there is no groundwater-surface connection, other sources of boron may affect the water quality. The present study investigates the boron origin observed in 197 wells completed within the units of Umm Er Radhuma (UeR), Rus, Dammam and Fars (from older to younger geological units) which all belong to the Tertiary units of the interior of Oman. The acquired chemical data include major ions (cations and anions), Rare Earth Elements (REE) along with B isotopes (10 and 11) and Sr isotopes (86 and 87). In addition, leaching tests were performed in selected samples to validate the release of B in distilled water. The water samples were grouped based on B concentration of less than 5 mg/l, 5 to 15 mg/l and extreme values of higher than 15 mg/l.
The Fars and UeR groundwater samples showed the most extreme boron content (higher than 15 mg/l) yet the former is the shallower and younger unit and the latter is the deeper and older unit. The Fars water of high boron content (higher than 15 mg/l) shows very high content of magnesium and calcium as well as low concentration of Sr. Furthermore, the magnesium and calcium are also high in UeR, while Sr concentration is much higher in UeR compared to Fars. The UeR water with extreme boron content appears in the field of diagenetic water in a diagram of δ11BNIST951 [‰versus 1/B, along with Sr isotopes ratio and europium (Eu) positive anomaly, while Fars waters appear in a mixing zone of marine water with infiltrated rainwater.
The regression analysis of sodium and chloride showed that concentrations of boron up to 10 mg/l can be correlated to halite dissolution in infiltrated rainwater in all units. The laboratory leaching tests verified the rocks capability to release boron up to 7 mg/l with a low water/solid ratio (low porosity rocks). Thus, the lowest boron content (up to 5 mg/l) is correlated to the dissolution of minerals within the Tertiary units. Whilst the samples containing 5 to 15 mg/l of B could correspond to lower water to solid ratio aquifer and/or mixing of low and high boron waters (rainwater and diagenetic or marine water). Finally, B isotopes along the REE analysis are considered as better indices of groundwater origin compared to Sr isotopes ratio especially in the case of diagenetic water identification.