

Enhancing Jordanian National Capabilities in Investigation and Treatment of Natural Radioactivity in Drinking Water: Hydrogeology, Geochemistry, and Radium Removal



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NORM IX: SCIENCE – AWARENESS - SOLUTIONS



AMMAN, JORDAN



MIDDLE EAST

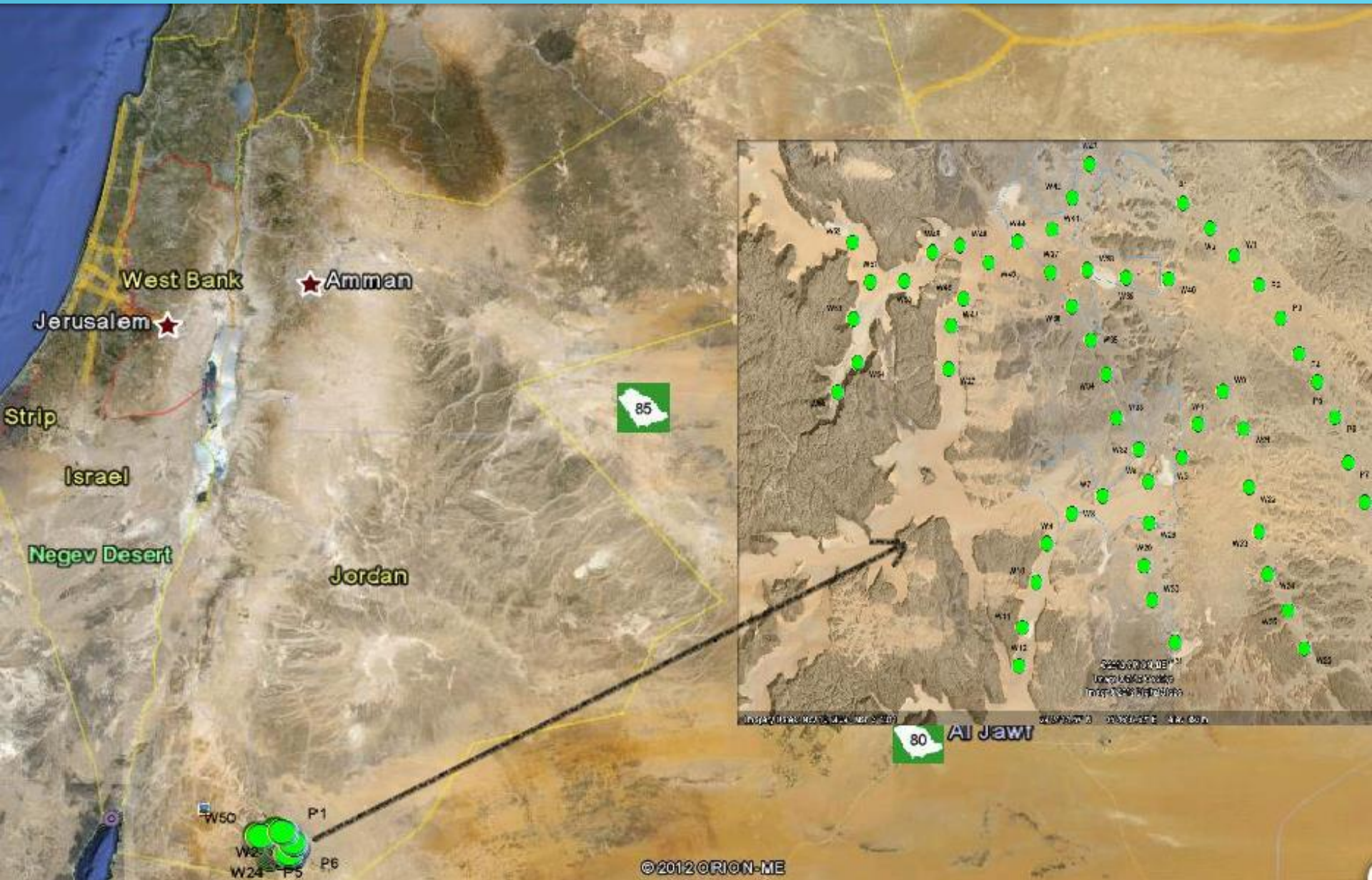


Jordan Ministry of Water & Irrigation

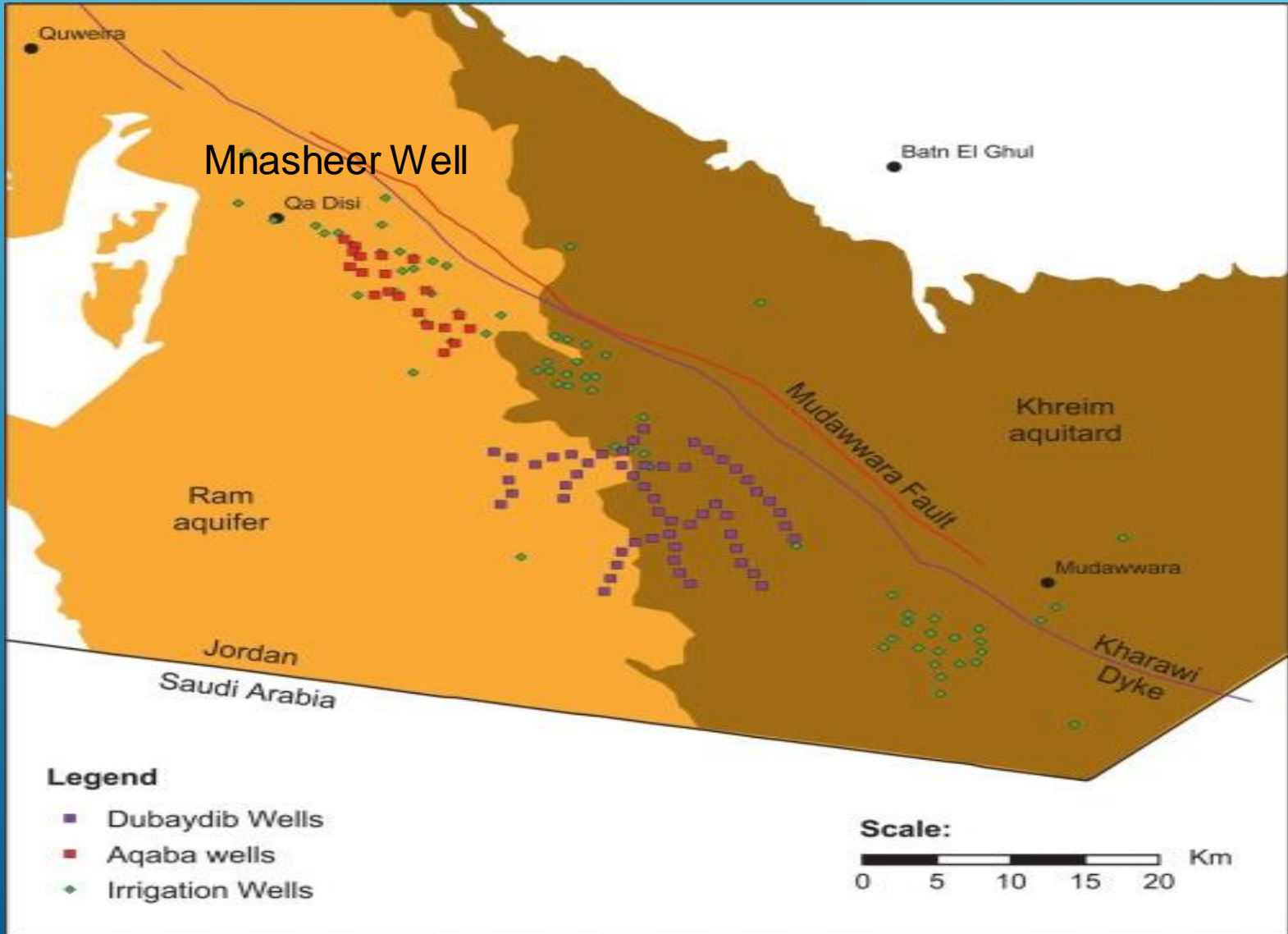
Amman, Jordan



Wells in Southern Jordan, Pipeline to Amman

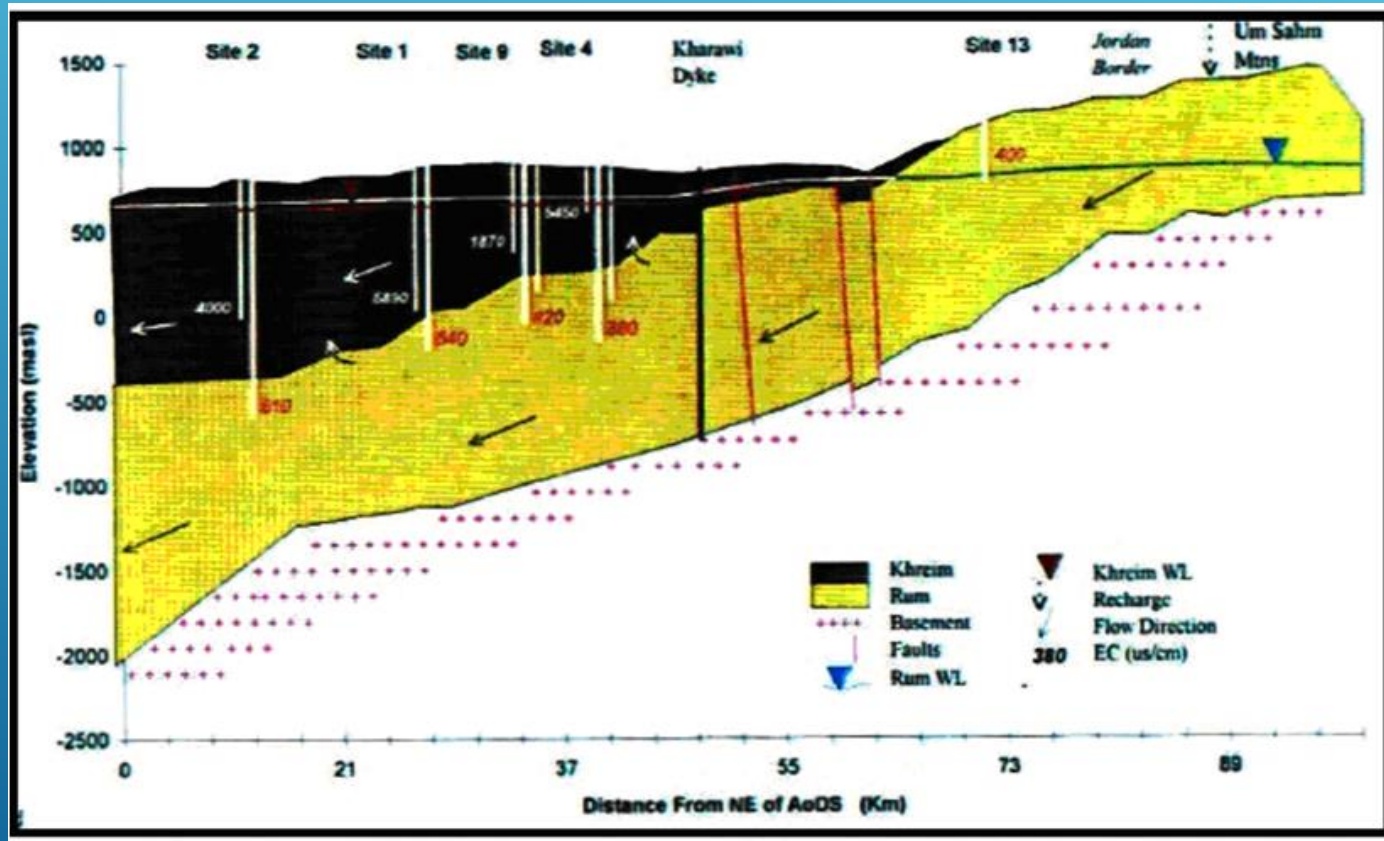


Map of Outcrop Rum Aquifer and Khreim Aquitard with Well Types



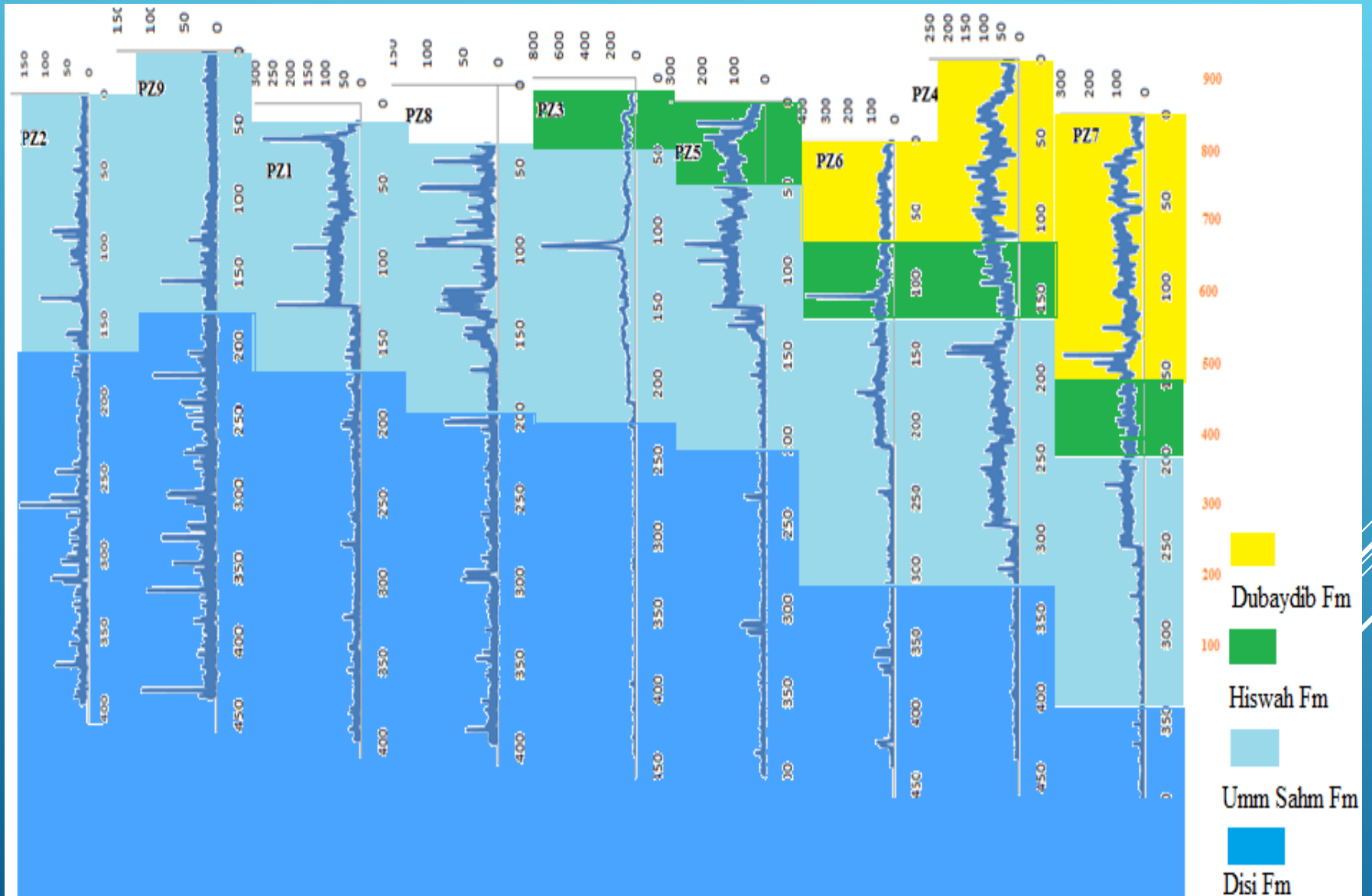


Hydrogeology relationship between Rum Aquifer and Khreim Aquitard



Mehaysen Ahmed Mahasneh et al. Groundwater Quality of Disi-Aquifer in Southern Jordan. American Journal of Water Resources, 2017, Vol. 5, No. 5, 152-161. doi:10.12691/ajwr-5-5-3

Gamma logs in Rum Group boreholes

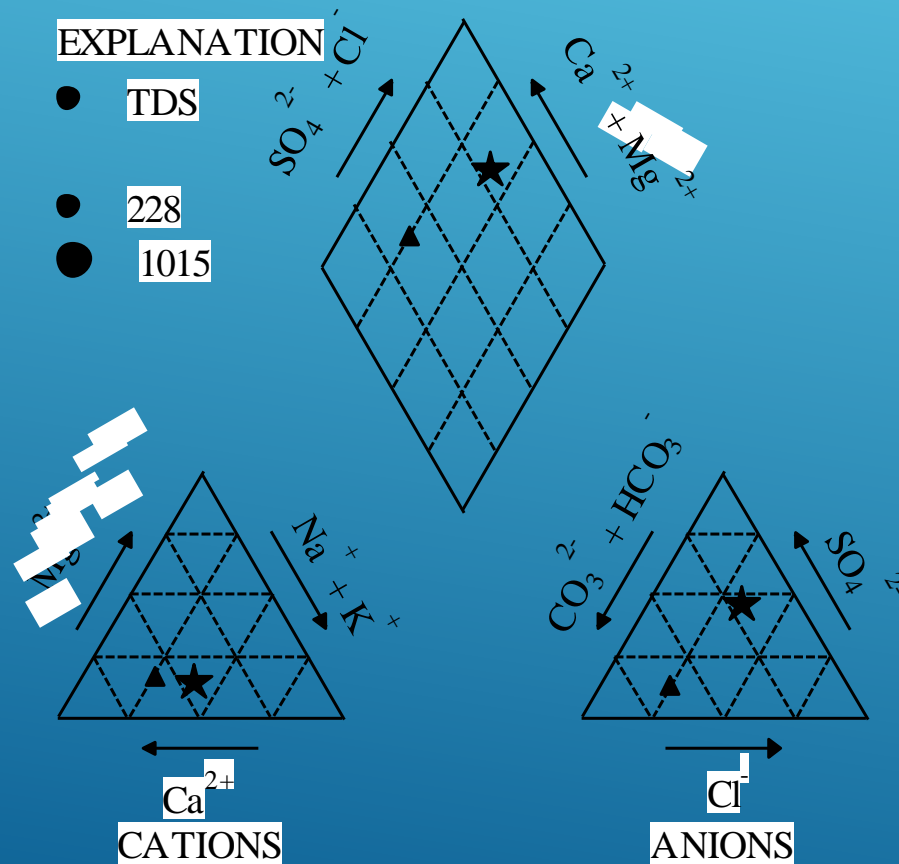


Mnasheer well in Qa Disi for proposed pilot treatment plant



WATER QUALITY

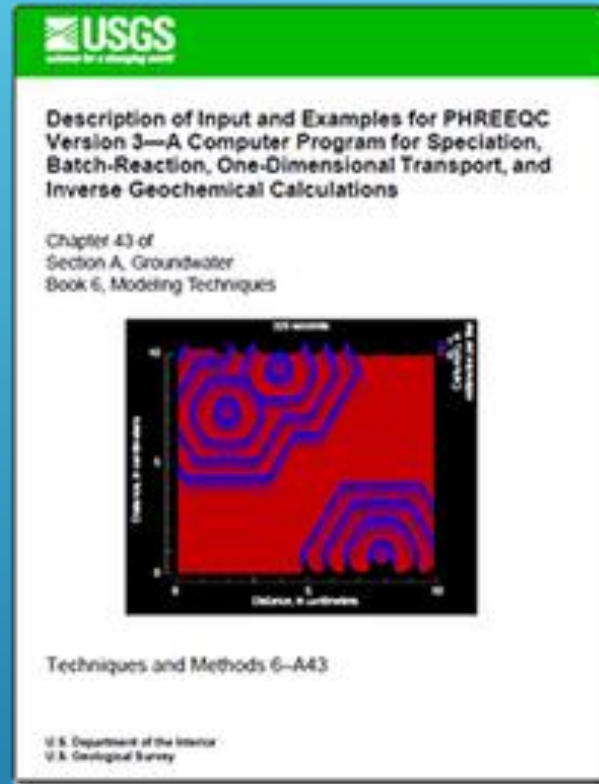
Groundwater Quality Variations



WATER QUALITY

- ▶ Average Ra-226 = 0.37 Bq/L and Ra-228 = 1.34 Bq/L for 55 Dubaydid wells
- ▶ Mnasheer well: Ra-226 = 1.0 Bq/L and Ra-228 = 1.86 Bq/L
- ▶ Jordan DW Standard: 0.1 Bq/L for alpha emitters and 1.0 Bq/L for beta emitters
- ▶ Ra 228 (beta) > Ra 226 (alpha) suggest Thorium not Uranium source
- ▶ Double the highest radium in comparison to northcentral US of 0.52 Bq/L
- ▶ Elevated radium found in Cambrian-Ordovician rocks in Jordan and U.S.
- ▶ Low Fe and Mn (no sorption) and long residence time
- ▶ Need field water quality data parameters

GEOCHEMICAL MODELING



- ▶ Water chemistry input indicates dissolved minerals
- ▶ Likely saturated minerals include RaBaSO_4
- ▶ Scaling likely from concentrated minerals

TREATMENT OPTIONS

- Mixing (blending) SW and GW
- Ion Exchange
- Reverse Osmosis
- Hydrous Manganese Oxides (HMO)
- Zeolite clay minerals or other techniques
- Optimize water supply requirements based on lower radium concentrations
- Water treatment poses radioactive waste issue and potential occupational doses from radon

SUMMARY

Radium activity in groundwater wells exceeds Jordan's drinking water limits so various water treatment and supply management options are being considered.

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