

Taking a deeper look: revisiting our understanding of deep groundwater systems

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Aims of the study

Improved identification and protection of fresh groundwater resources is important in an increasingly water stressed world. Total dissolved solids (TDS) in groundwater can be used to better understand variations in the quality of deep groundwater systems. Here 'deep groundwater' refers to an interval below the current depth of groundwater exploitation. Could this be used in the future for additional resources?

Using TDS data from the UK & well-depth information, we *i.) identify the presence of currently undeveloped fresh or brackish groundwater at depth that may require protection, & ii.) explore controls on the 3D distribution of the deep fresh and brackish groundwater*, where fresh groundwater is defined as a TDS of <1,625 mg/l, brackish as 1,625 to 10,000 mg/l, & saline water as >10,000 mg/l.

Results

- TDS varies over about five orders of magnitude from about 10 to >100,000 mg/l, with a general increase in mineralisation of groundwater with depth, **1A**. The mean depth of all water wells in the UK is 81 m & the 95%tile water well depth is 202 m, indicated by blue intervals in **1A & 1B**
- Based on a box plot of TDS data binned at 100m depth intervals, groundwater is predominantly fresh down to 500 m, brackish in the 500-700 m interval, & predominantly saline below 700 m, **1B**. This is evidence for currently unexploited fresh and brackish groundwater at depth.
- TDS data can also be visualised as a function of height relative to sea level (sl), **2**. Most fresh groundwater is found above sl, but there are many fresh groundwater observations below the 95%tile depth of all observations relative to sl (i.e. below 157.6 m). These deep TDS observations show spatial coherence, generally associated with relatively deep sedimentary basins, **3**.
- Cross sections of the regional hydrogeological structure of the UK show fresh groundwater present in sedimentary basins (Cheshire & Wessex Basins) & troughs (Gainsborough Trough) either side of topographic highs (Derbyshire Dome) (**4A & 4B**).
- The observed variation in TDS with depth is consistent with the concept of groundwater as a geologic agent. That variations in TDS result from the long-term interaction between chemical & flow processes driven by head differences associated with topographic relief and the evolving relationships between basins and coastlines.

