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Basin compartmentalisation: interpretation and importance in the long-term migration of hydraulic fracturing fluids

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An environmental concern shared by governments, regulators, and the public is that deeply injected hydraulic fracturing (fracking) fluids could migrate upwards along natural geological pathways and contaminate shallow groundwater resources. In academic studies and industry environmental risk assessments, high permeability faults are usually considered as the key risk factor for the upward migration of fracking fluids. However, recent numerical modelling of the Bowland Basin, northwest England, has suggested that rather than high permeability faults being the cause of vulnerability, it was hydraulic compartmentalisation of the basin by low permeability faults that was the source of vulnerability of shallow aquifers to injected fracking fluids. Compartmentalisation discourages lateral dispersion of fracking fluids and can encourage vertical migration if upward driving forces are sufficient. To further investigate compartmentalisation in the Bowland Basin, surface and groundwater data for the years 2000-2016 from the Environment Agency (England) were analysed. These data included major and minor cations and anions, metal ions, pH, conductivity, and methane. The distributions of these data were compared to interpreted geological structure and stratigraphy from two-dimensional seismic reflection interpretation, thereby providing a more informed view of basin hydraulics. This approach links seismic interpretation with water chemistry observations to better understand groundwater flow and the risk of shallow groundwater contamination by the upward migration of fracking fluids.