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Role of Fault Damage Zones in the Thermal State of Basins

The faulting process creates damage zones, often with a core zone of fault-rock. The petrophysical properties of these materials are typically very different from the initial rock properties, (=considerable spatial variation of intrinsic permeabilities – often with along-fault enhancements, and across-fault degradations). This work considers how faults may influence the hydrogeological systems operative in basins – in particular, how buoyancy-driven flows can transport significant amounts of heat. Two case studies are used. One is from the modern North Sea basin. Here, subsurface temperature patterns indicate local thermal anomalies as large as 50 C over distances as short as 5 km. These anomalies can be explained by flow systems using fault damage zones for the updraft portion of their circulation, and in some cases, by flow systems that are completely contained WITHIN the damage zones. The other case study concerns the Carboniferous (Mississippian) evolution of central Ireland. Here, syn-depositional block faulting allowed circulation cells to develop, delivering very hot (250 C) fluids to the seabed, causing major zinc-lead mineralization. These fault-modified convective flows interacted with local fault-modified flow systems, and with regional-scale topographically-driven systems. Typical basin models do not address such fault-related flow, primarily due to the associated need for a fine mesh in to adequately represent the physics of the system. The magnitude of the thermal disturbances associated with such flows means that it is important to find a way to account for this aspect of fault zones in a further generation of basin modelling tools.