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# Changes in crustal fluid flow over geologic time

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**Abstract**

Important changes in the physical drives for crustal fluid flow may have occurred when substantial organic matter began to be buried in post-Proterozoic time, when continental glaciers grew and melted, and when continents assembled or broke up.


## 1. Discussion

The 3.74 Ga Amitsoq gneiss in Quilangarssuit Greenland, that is composed of metamorphosed volcanics and sediments that include banded ironstones and conglomerates, indicates that the basic physical causes of crustal fluid flow (the hydrologic cycle, gravity-driven flow, sedimentation and compaction, and convection near igneous intrusions) have been in place since the very earliest times. The implication that crustal fluid flow has changed mainly because the intensity of the physical drives has varied (e.g., pulses in seafloor spreading and volcanism, rapid rifting events, the rise of well-watered orogens, etc.) is, however, probably misleading. Although true and important, these changes are not the entire story. Two, and perhaps three changes are more than a variation in the intensity of the driving forces for flow. First, the dramatically increased rate of burial of organic material in post-Proterozoic time subjected flow in basins to entirely new constraints that derive from the interfacial tension between petroleum (oil and gas) and aqueous liquids. Basins filled entirely with gas, probably for the first time, and capillarity blocked escape of the gas, allowing gas accumulations to be preserved for hundreds of millions of years. Capillary interactions between aqueous and petroleum fluids produced seals that may have directed flow in water-dominated basins in new ways. Interactions between fluids, such as the washing of oil by water and gas, became important and provided new ways to investigate fluid flow. Second, intervals of continental glaciation caused unusually rapid sedimentation in adjacent areas, unusually rapid changes in surface load under the glaciers, and unusually rapid changes in loading across all of the world's oceans and continental shelves due to changes in sea level. Rapid loading of gas-filled basins may be one of the few mechanisms that could produce the rate and volume of brine expulsion required to explain the thermal anomalies that are associated with Mississippi Valley-type Pb–Zn deposits (Cathles and Adams, 2005). Finally, it may be useful to consider the flow systems that develop when continents assemble in super-continents as more than just larger versions of what could occur on smaller land masses. It is remarkable, for example, that expulsion of brines from the entire eastern (500 × 500 km) Zechstein basin is required to produce the Kupferschiefer-type Cu–Pb–Zn deposits on its southern margin in Poland and Germany. The large size and thickness of the evaporite cap that

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covered the brine-saturated redbed sediments of this basin almost guaranteed economic mineral deposits would result when it was further loaded by sediment deposition. The presentation will emphasize what we have yet to understand and attempt to stimulate discussion.

## References

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