Pore Pressure Patterns in Tertiary Aquifers and Hydrodynamic Implications, Beaufort Sea and Mackenzie Delta Basin, Canada

Zhuoheng Chen*
Geological Survey of Canada, Calgary, Alberta, Canada
zchen@nrcan.gc.ca

and

Kirk Osadetz, Dale Issler and Stephen Grasby
Geological Survey of Canada, Calgary, Alberta, Canada

Abstract

Three patterns of pore pressure variation with depth are recognized in the Beaufort Sea and Mackenzie Delta Basin (BMB), each of which is associated with a specific tectonic domain. The overpressure distribution pattern reflects the interplay of tectonic forcing and mechanical compaction. Mobile shale diapirism creates fracture systems on top of shale-cored anticlines, causing a migration of overpressured fluid to a shallower depth in the north. In the center of the Mackenzie Delta, where listric faulting prevails, overpressure due to mechanical compaction depends on lithology and rate of deposition. In this tectonic domain, overpressure usually does not occur above 3000 meters, except for the area close to front of the thrust fault zones. In contrast, the pressure system is hydrostatic in the area where normal faults associated with the Jurassic-Early Cretaceous rift system dominate. The basin hydrodynamic flow shows a predominant outward flow pattern controlled by overpressure. Gravity-driven flow is indicated by formation water geochemistry and temperature anomalies, but it is restricted to the southern basin margins. The spatial variations of hydraulic head at given depths, as well as along specific aquifers, indicate that regional fault zones can be both a barrier and a preferred flow path network for deep fluid fluxes. Evidence shows that, in general, fault zones are more likely to be regional barriers to lateral flow in an aquifer, but are the preferred flow networks for vertical fluid migration, at least episodically.