



Chimney Blowout Punctures of the Athabasca Bitumen Platform in Northeast Alberta: Morphogenesis by Over-Pressured Devonian Aquifer with Laurentide Proglacial Meltwater Flow

Dr. Paul Broughton, Broughton and Associates

Abstract

Open chimney-like vents cross-cut the 50 m thick bitumen-cemented sand platform in the McMurray Formation (Aptian) strata accumulated across the northern Athabasca Oil Sands Deposit. The morphogenesis provides insight to the hydrogeological forces that resulted from Laurentide proglacial melt water flows into the Devonian karst aquifer underlying the bitumen platform and the localized overpressuring that resulted. The chimneys were preferentially located over vertical permeability conduits developed at sites where Prairie Evaporite salt beds overlapped margins of Keg River mounds in the Middle Devonian substrate 200 m below the bitumen platform. These open chimney vents are unlike any known sinkhole collapses, but their sites were preconditioned by vertical brittle fracture meshwork induced by incipient breccia pipe-sinkholes. These Quaternary structures resulted when glacial melt waters along the margin of the Laurentide ice sheet flowed westward into the subsurface along Devonian strata. The eastward flow up structure into the Devonian karst aquifer below the northern Athabasca Deposit was partially reversed by proglacial water flow westward towards the sub-glacial Athabasca River Valley. The flows comingled as they permeated the Middle Devonian hypogene karst and ascended along faults of the fragmented Upper Devonian strata below the bitumen platform. Aquifer fingers created patchy areas of extreme overpressuring as they connected to discontinuous areas of 5-10 m thick beds of water-saturated McMurray sand at the base of the 45-50 m thick bitumen column. Withdrawal of the 3 km thick Laurentide ice sheet approximately 8-12,000 years BP, and possibly during the earlier interglacial, released confining pressure on the bitumen platform and triggered open chimney-like blowouts as pressure-release valves. They punctured the 50 m thick bitumen column, resulting in open chimneys 45-50 m high and 5-15 m wide at two known locations. Similar occurrences of proglacial melt water aquifer induced blowouts are known in central Saskatchewan and western North Dakota, but were not previously known in bitumen-cemented strata.