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Problems in Devonian Stratigraphy, Northeastern Alberta

Chris L. Schneider
Energy Resources Conservation Board/Alberta Geological Survey, Edmonton, Alberta
chris.schneider@ercb.ca

Summary

Several correlation and nomenclatural issues, most of which fall within the Elk Point and Beaverhill Lake groups, afflict the Devonian stratigraphy of northeastern Alberta. Some problems are easily fixed, such as the undertaking of a new biostratigraphic correlation to trace units into the subsurface. Other problems, such as that of an extensive carbonate unit simultaneously bearing the names Keg River Formation, Methy Formation, and Winnipegosis Formation, will require deeper consideration of scientific and industry-related issues before a recommendation is made.

Introduction

Devonian rocks of northeastern Alberta attracted the interest of even the earliest explorers. Travelers along the Athabasca and Clearwater rivers noticed the undulose to pillar-like limestones lining the riverbanks, and many natural historians speculated on the correlation of Devonian outcrops with others in North America and Europe. The century of surface and subsurface geological exploration that followed resulted in a sound understanding of stratigraphic relationships; however, differences arising from subsurface or outcrop-based approaches, problems with correlation to units elsewhere and separate naming of subsurface and surface units resulted in a myriad of nomenclatural and correlative problems in northeastern Alberta. Many stratigraphic difficulties arise from two major phenomena: the correlation between outcrop and subsurface strata and the presence of Wood Buffalo National Park, Canada's largest national park.

The subsurface record in northeastern Alberta is sparse but punctuated by areas of heavy exploration and hence, high well concentration. Subsurface data exist in abundance for key areas of northeastern Alberta, such as the Fort McMurray region. Unfortunately, much of northeastern Alberta is inaccessible except by air transportation, making geological exploration difficult in these areas. Furthermore, Wood Buffalo National Park, covering over 35,000km^2 in Alberta, completely lacks subsurface data within its boundaries, thereby impeding correlation between bordering areas. Although the presence of outcrops is of great benefit in stratigraphic work, large areas of northeastern Alberta lack any data on Devonian stratigraphy.

As a result, several issues arose in the correlation or nomenclature of Devonian stratigraphic units. Some nomenclatural problems originate from the use of different names by stratigraphers or by the proposal of new names for known stratigraphic units. Difficulties in correlation largely result from the lack of subsurface data to tie to nearby outcrops. Before a unified stratigraphic column for the Devonian of northeastern Alberta can be established, specific problems must be identified.

Discussion

To discover these nomenclatural and correlative problems, I undertook an exhaustive literature search, supported by well log interpretation and outcrop and core description, to identify potential problems in northeastern Alberta stratigraphy.

Nearly a century of geological exploration gave rise to differences of stratigraphic interpretation, some minor, and others with potentially wider impacts (Figure 1). As a result, multiple issues occur in the nomenclature or correlation of most of the formations in the Elk Point Group. A few correlation problems also exist for the Beaverhill Lake Group. Each of these is discussed below in stratigraphic order, from oldest to youngest:

1. Granite wash, basal redbeds, and the La Loche Formation. Several names exist for the heterogeneous conglomerate and arkosic sandstone of Lower Devonian age or older that underlies Devonian marine strata. In northern Alberta, this unit separates the Precambrian crystalline rock (from which it was derived) from the marginal marine sediments of the initial Devonian sea. Over the Peace River Arch, and in much of northern Alberta, this unit is known as the "Granite Wash." In central Alberta, Belyea (1952) and Sherwin (1962) instead used the term "Basal Redbeds," but applied this name to both the sediments derived from the Precambrian basement and to those overlying the Cambrian strata. In his 1963 publication, Norris proposed the name "La Loche Formation" for the granite wash between the Precambrian basement and the marginal marine siltstone and shale of the Contact Rapids Formation.

The informal name "Granite Wash" is a common descriptor for similar basement-derived rocks worldwide, so is not appropriate as a formation name. Likewise, the phrase "Basal Redbeds" has similar problems as a widely-used phrase. Norris's (1963) name "La Loche Formation" remains valid, but is not in common use.

2. Fitzgerald Formation: correlation with the Ernestina Lake or Keg River formations. Cameron (1918) described the biostromal Fitzgerald Formation from outcrops in the Northwest Territories and from along the Slave River in northeastern Alberta. The Fitzgerald Formation has not been found in the subsurface of Alberta, but Richmond (1965) and others suggested a correlation between the biostromal carbonate and the subsurface Ernestina Lake Formation. Craig and others (1967) placed the Alberta Fitzgerald Formation outcrops in the younger Keg River Formation. Unfortunately, the lack of subsurface data through Wood Buffalo National Park inhibits correlation between Slave River outcrops and subsurface units to the west and south of the Park. A potential solution lies in the comparison of biostromal fossils between the Fitzgerald outcrops along the Slave River and potential subsurface correlatives.

3. Methy, Winnipegosis, or Keg River? In this case, three separate names are commonly used for the same extensive, contiguous carbonate platform. In southern and central Alberta, Saskatchewan, Manitoba, and the

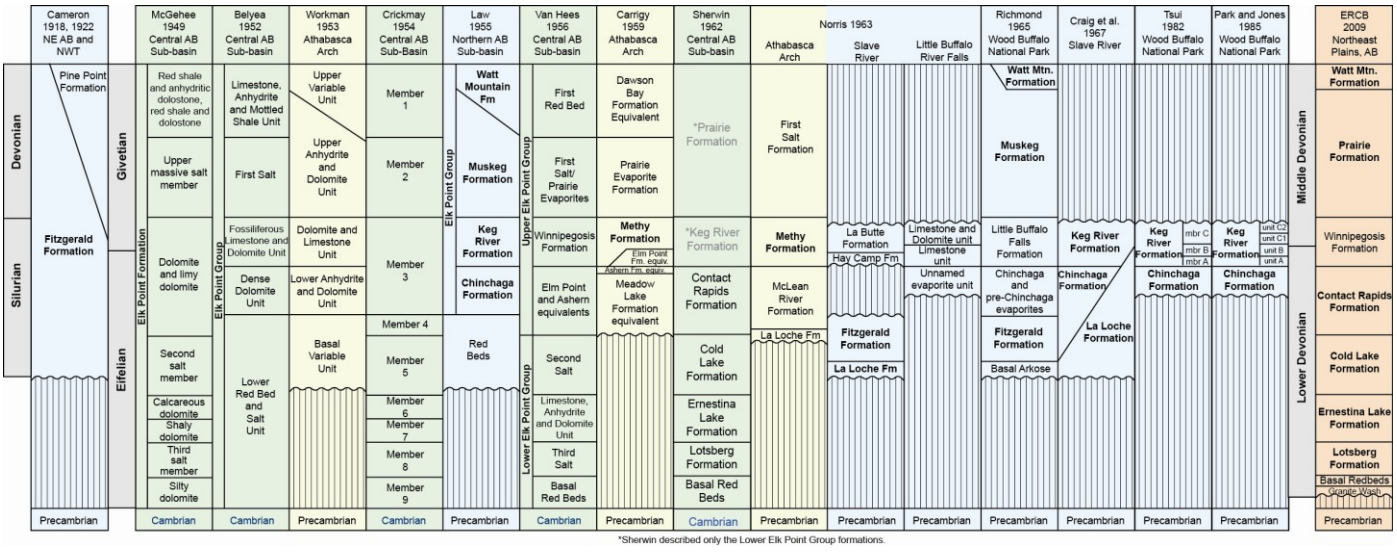

Figure 1: Devonian stratigraphy of northeastern Alberta and adjacent areas. Colours are codes as such: **blue**: northernmost northeastern Alberta and northern Alberta; **green**: central Alberta; **yellow**: Fort McMurray area of northeastern Alberta; and **orange**: northeastern Alberta in general.

adjacent U.S., the unit is known as the Winnipegosis Formation, named by Baillie in 1953 for outcrops along Lakes Winnipegosis and Manitoba. In northern Alberta, the southern Northwest Territories, and northeastern-most British Columbia, the name "Keg River Formation" is widely used, originally described from the northern Alberta subsurface by Law (1955). The name "Methy" was first used informally for outcrops along the Clearwater River (Cote, in Norris, 1965), later published by Nauss (1950) and given a subsurface type section by Greiner (1956).

The name "Methy" has precedence by prior publication, but the names "Winnipegosis" and "Keg River" also are valid, as both are commonly used in industry and in scientific publication. The name "Methy" remains in use, albeit sporadically, in northeastern Alberta. Unfortunately, the choice of one name for a province-wide, unified formation name over the other two would cause additional problems, given the half century of frequent use of two of the names in industry and in scientific literature.

4. The Watt Mountain Formation in litho- and sequence stratigraphy. The formation, described by Law (1955), is the topmost unit in the Elk Point Group. However, the Watt Mountain Formation also represents the basal transgression of the Beaverhill Lake Sequence of Moore (1988, 1993) and Major Sequence 4 of Wendte (1992), and therefore is genetically related to the strata of the Beaverhill Lake Group.

As long as lithostratigraphy of Devonian rocks in northeastern Alberta remains distinct from sequence stratigraphy, the Watt Mountain Formation is both the uppermost unit in the Elk Point Group and the basal transgressive unit in the Beaverhill Lake sequence.

5. The Muskeg, Fort Vermilion, and Nyarling anhydrites. In northern Alberta, the Muskeg Formation of the Elk Point Group and the Fort Vermilion Formation of the Beaverhill Lake Group are separated by the Watt Mountain Formation. Where the Watt Mountain Formation is missing, the anhydrite of the Muskeg and Fort Vermilion formations appear to be continuous. Norris (1965) erected the "Nyarling Formation" for the continuous Muskeg-Fort Vermilion anhydrite in areas lacking the Watt Mountain Formation.

Geochemical analysis may aide in distinguishing the Muskeg anhydrite from that of the Fort Vermilion; however, this solution would be costly, time-consuming and dependent on the availability of cores. With the lack of the Watt Mountain Formation in some well logs, only the Nyarling Formation can be picked.

6. The Peace Point Member and the base of the Waterways Formation. Based on Kindle's (1928) description of the "Peace Point beds" for the Waterways shale infill of Slave Point Formation karst, Norris (1963) proposed the "Peace Point Member" for the basal Waterways Formation at Gypsum Cliffs along Peace River. Although the Peace Point Member lacks the *Lingula* fauna of the basal Firebag Member, the Peace Point fauna otherwise is indistinguishable from that of the Firebag Member. Even though the name "Peace Point" has priority over the name "Firebag" through prior publication, the name "Firebag" may take precedence because of common usage.

7. The Waterways-Hay River correlation. In northeastern Alberta, the Waterways Formation is a series of argillaceous limestones traceable into southern Alberta and westward through clinoforms into a basinal succession of starved shales and argillaceous carbonates. In northern-most Alberta and the southern Northwest Territories, the stratigraphically equivalent unit is the Hay River Formation, a massive shale with sparse, thin limestone beds. Williams (1977) traced the Calumet Member of the Waterways Formation to a thin limestone in the Hay River Formation, but could not correlate any other beds. A detailed Waterways-Hay River correlation remains elusive, and may be solved through biostratigraphic comparisons.

Conclusions

Several correlative and nomenclatural problems plague the stratigraphic resolution of northeastern Alberta. Although some issues may be considered minor because of their low impact on overall stratigraphic understanding or industry needs, others, like the Winnipegosis/Keg River/Methy problem, can create difficulties in communication. Some problems are easily fixed, such as a common acceptance of a name for the granite wash sediments in northeastern Alberta. Other problems, like the Winnipegosis/Keg

River/Methy nomenclatural issue, require careful consideration of all the factors involved before a resolution can be proposed. Some others, like the Waterways-Hay River correlation, require more work, and still others, like the Watt Mountain lithostratigraphic versus sequence stratigraphic problem, may not need resolution.

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References

Belyea, H.R.. 1952, Notes on the Devonian system of the north-central plains of Alberta: Geological Survey of Canada, Paper **52-27**, 66 p.

Cameron, A.E., 1918, Explorations in the vicinity of Great Slave Lake: Geological Survey of Canada, Summary Report 1917, part C, 21-28.

Craig, J., Devine, J., McGill, P. and Meneley, R., 1967, Chinchaga and Keg River Formations of Slave River area, northern Alberta: Bulletin of Canadian Petroleum Geology, **15**, 125-137.

Greiner, H.R., 1956, Methy dolomite of northeastern Alberta: Middle Devonian reef formation; Bulletin of the American Association of Petroleum Geologists, **40**, 2057-2080.

Kindle, E.M., 1928, The occurrence and correlation of a Devonian fauna from Peace River, Alberta: Contributions to Canadian Paleontology, Geological Survey, Canada, Bulletin **49**, 14-18.

Law, J., 1955, Geology of northwestern Alberta and adjacent areas: Bulletin of the American Association of Petroleum Geologists, 39, 1927-1975.

Moore, P.F., 1988, Devonian geohistory of the Western Interior of Canada: *in* Devonian System of the World, N.J. McMillan, A.F. Embry and D.J. Glass (ed.), Canadian Society of Petroleum Geologists, Second International Symposium on the Devonian System, memoir 14, 67-84.

Moore, P.F., 1993, Devonian, Subchapter 4D: *in* Sedimentary Cover of the Craton of Canada, D.F. Scott and J.D. Aitken (ed.) Geological Survey of Canada, Geology of Canada, **5**, 150-201.

Nauss, A.W., 1950, Regional cross-section through the reef fields of Alberta: Special Report, Aeromagnetic Survey Ltd., Toronto, Oil in Canada, **11**, 46-48.

Norris, A.W., 1963, Devonian stratigraphy of northeastern Alberta and northwestern Saskatchewan: Geological Survey of Canada, Memoir **313**, 168 p.

Norris, A.W., 1965, Stratigraphy of Middle Devonian and older Paleozoic rocks of the Great Slave Lake region, Northwest Territories: Geological Survey of Canada, Memoir **322**, 180 p.

Richmond, W.O., 1965, Paleozoic stratigraphy and sedimentation of the Slave Point Formation, southern Northwest Territories and northern Alberta: Ph.D. dissertation, Stanford University, 565 p.

Sherwin, D.F., 1962, Lower Elk Point section in east-central Alberta: Journal of the Alberta Society of Petroleum Geologists, **10**, 185-191.

Wendte, J.C., 1992, Cyclicity of Devonian strata in the Western Canada Sedimentary Basin: *in* Devonian-Early Mississippian Carbonates of the Western Canada Sedimentary Basin: A Sequence Stratigraphic Framework, J. Wendte, F.A. Stoakes and C.V. Cambell (ed.), Society for Sedimentary Geology (SEPM) Short Course, **28**, 25-40.

Williams, G.K., 1977, The Hay River Formation and its relationship to adjacent formations, Slave River map-area, N.W.T.: Geological Survey of Canada, Paper **75-12**, 17 p.