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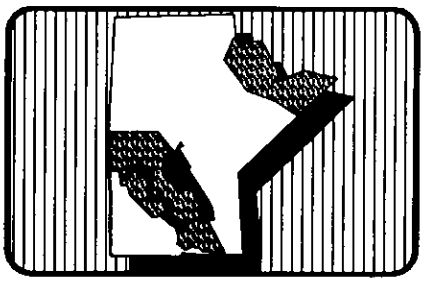

Uranium and Base Metal Potential of the Paleozoic Rocks of Southern Manitoba

G.H. Gale, H.R. McCabe and E. Nielsen
Manitoba Energy and Mines
555 – 330 Graham Avenue
Winnipeg, Manitoba R3C 4E3

Introduction

The only known indications of uranium and base metal mineralization in the Paleozoic rocks of Manitoba are from well waters containing anomalous concentrations of uranium, and a single galena pebble found in Quaternary sediments near Balmoral, 30 km north of Winnipeg. Less than 0.5% of the area underlain by Paleozoic rocks is exposed, however, and these exposures are small widely scattered outcrops and quarries. Although rock chips and cores are available from several hundred drill holes, exploration to date in Paleozoic rocks has been limited to a few reconnaissance programs. This account summarizes the regional geological setting and geological features that could be important in evaluation of the mineral potential of the Paleozoic rocks.

Geology

The Paleozoic outcrop belt of southwestern Manitoba comprises the northeastern flank of the Williston and Elk Point Basins. Variations in the depositional pattern throughout Paleozoic time appear to result from differing tectonic responses of the Precambrian Churchill Province and Superior Province crustal blocks forming the basement (Figure 1). As a result, marked facies variations occur along the Paleozoic outcrop belts. Specifically, Ordovician strata range from thin shelf-type facies in the north to thicker, relatively deep basinal facies to the south, whereas Devonian strata range from shallow shelf-type facies in the southeast to relatively deep basinal facies in the northwest. Consequently, the Paleozoic outcrop belt in Manitoba exhibits a wide range of lithofacies types deposited under a wide range of depositional conditions. These lithofacies variations could be important in their effect on geochemical parameters and potential base metal accumulations. The general lithology and lithofacies variation for Paleozoic strata are summarized in Table 1.

Structurally, the Paleozoic strata dip gently to the southwest between 1 and 5 m per km, except for a prominent synclinal flexure coincident with the Churchill/Superior Province boundary (Figure 1). Dips are relatively uniform except for upper Devonian strata, where all post-Winnipegosis beds have been structurally downdropped (by as much as 90-120 m) and draped over a highly complex sequence of underlying Winnipegosis reefs, as a result of solution of the Devonian Prairie Evaporite beds (Table 1). The complex structures of the upper Devonian strata mirror the configuration of the underlying reefs. Structural anomalies affecting both Paleozoic strata and the Precambrian basement are local, highly disturbed structures believed to be possible meteorite impact features (McCabe and

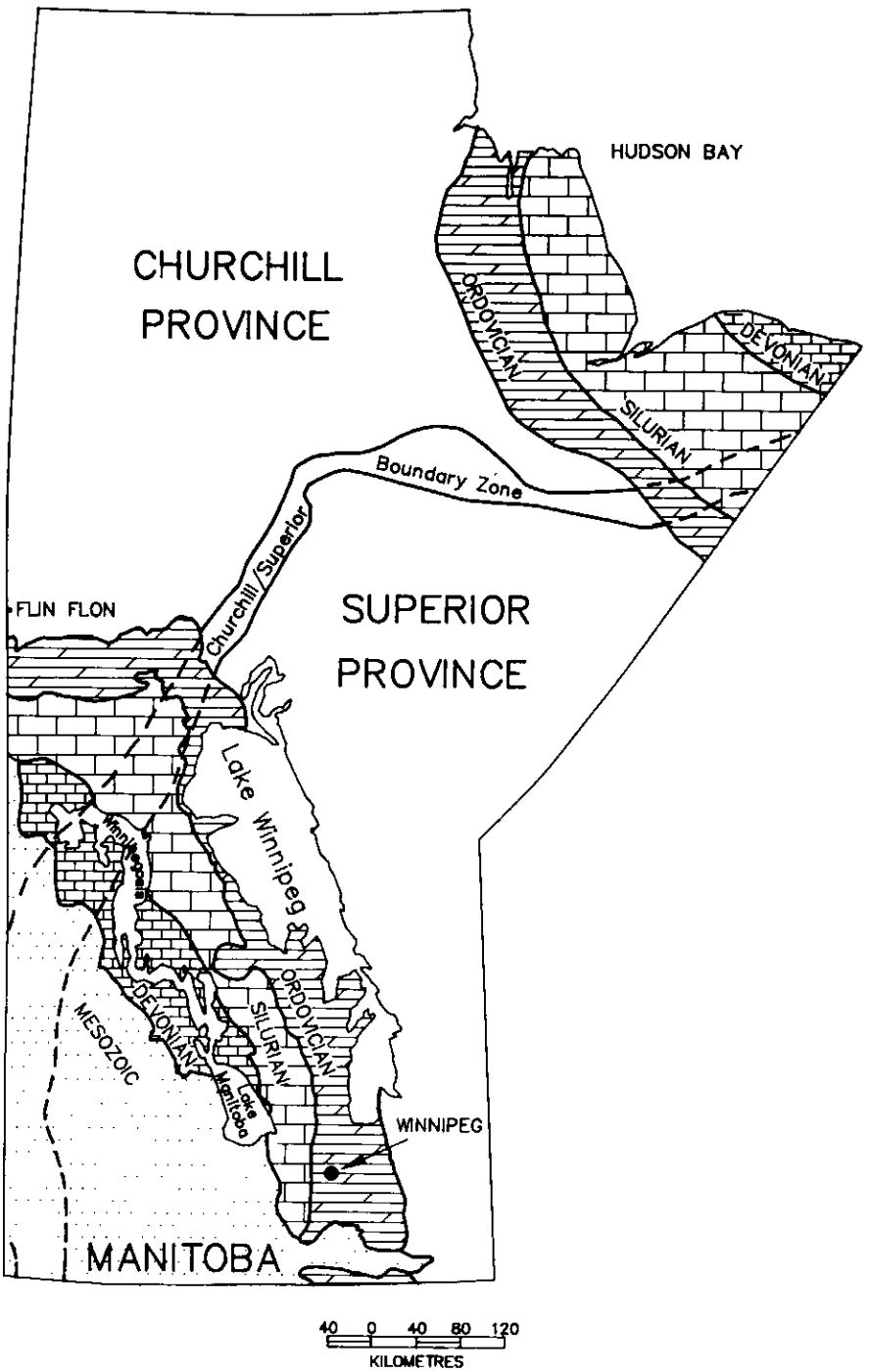

Figure 1 *Distribution of Paleozoic rocks in Manitoba.*

Bannatyne, 1970). Several other Precambrian structural highs of uncertain origin have been encountered in single drill holes.

Dolomitization of carbonate rocks in southern Manitoba is extensive and has affected rocks of Ordovician to Devonian age (Bannatyne, 1988). In Ordovician strata, variations in dolomitization are for the most part regional, associated with shelf-to-basin facies changes. Silurian strata are uniformly and completely dolomitized. Devonian strata, however, show highly complex and local variations from pure high-calcium limestone to dolomite: this dolomitization may have been associated with evaporite solution. Dolomitized Devonian reef deposits are common in the northern part of the Winnipegosis outcrop belt (Figure 1).

Solution caverns (open and infilled) and collapse breccias are common in the Paleozoic rocks of southwestern Manitoba. Incipient karst development occurs in upper Silurian dolomites, beneath the pre-middle Devonian unconformity. Karst and channel-type deposits with up to 150 m of Jurassic and Cretaceous sediment infill are common. Throughout the entire Devonian outcrop belt, post-Winnipegosis strata have been collapsed by as much as 120-150 m. In places, collapse is uniform with little or no structural disruption, but locally, intense deformation/brecciation is evident. Collapse occurred intermittently from late Devonian to Recent time, with the major episode probably contemporaneous with the pre-Middle Jurassic unconformity.

Table 1 Stratigraphy and lithofacies variations, Paleozoic, southwestern Manitoba.

	Formation	Thickness (m)	Lithofacies Variation
DEVONIAN	Souris River	60-95	– dense pure high-Ca limestone to north; variable porous limestone and dolomite to south
	Dawson Bay	40-65	– upper stromatoporoidal high-Ca limestone, variably dolomitized; medial red calcareous shale, lower bioclastic limestone and, to the south, bituminous dolomite; basal red shale
	Prairie Evaporite	0-130	– salt, anhydrite, potash; removed by subsequent evaporite solution over large areas
	Winnipegosis/Elm Point	6-105	– lower platform beds high-Ca biomicrite, variable and extensive dolomitization; upper reef-interreef complex, black bituminous mudstone as interreef facies. Reefs to 100 m thick in northwest (basin). Shelf edge to the southeast (40 m)
SILURIAN	Ashern	3-18	– red dolomitic mudstone with local basal breccia
	Interlake	50-120	– dolomite, relatively uniform laterally with widespread sandy argillaceous markers, ranges from aphanitic to biohermal. Karsting at top
	Stonewall	9-25	– dolomite, variably fossiliferous, uniform, medial sandy argillaceous marker at top
ORDOVICIAN	Upper Stony Mountain	16-23	– dolomite, relatively uniform sandy argillaceous marker at top
	Lower Stony Mountain	8-30	– fossiliferous limestone and calcareous shale in the south (basinal), passing abruptly to slightly argillaceous dolomite in the north (shelf)
	Upper Red River	8-40	– relatively uniform dolomite and argillaceous dolomite, evaporite solution breccias
	Lower Red River	30-125	– dolomitic limestone to south (basin), dolomite with some chert to the north (shelf): thins rapidly to the north
	Winnipeg	0-70	– complex interfingering of sand and shale; dominantly shale to south (basin), thinning rapidly and changing to sandstone to the north

Indications of Uranium and Lead-Zinc Mineralization

Uranium concentrations up to 73 ppb were obtained in drinking water from wells in the Beauséjour area, approximately 40 miles east of Winnipeg near the Paleozoic-Precambrian contact (Southard, 1978). The well waters were presumably derived from the Winnipeg Formation sandstones and although some of the uranium could have been derived from underlying radioactive granitic rocks in the Precambrian, the values obtained in the initial survey were considered too high to have been simply leached from the granitic rocks (Southard, 1978). To date, there have not been any follow-up studies to determine if "roll-front" type deposits exist in the area.

Some of the features of geological environments containing Mississippi Valley-type (MVT) lead-zinc deposits, namely, extensive dolomitization, reef deposits, solution collapse features, basement highs and karst features, are present in Manitoba. The discovery of a galena pebble, 3 cm in diameter, in glaciolacustrine deposits near Balmoral, 30 km north of Winnipeg, stimulated several regional exploration programs, however, no additional base metal pebbles or geochemical anomalies were discovered. Lead isotope determinations indicate that the Balmoral pebble has isotopic values similar to those of the MVT lead-zinc deposits of Pine Point and Missouri, and quite different from those of galenas in the Precambrian rocks of Manitoba. Because the glaciolacustrine environment where the Balmoral galena pebble was found contains material believed to be deposited from icebergs, the Paleozoic rocks of both southern Manitoba and the Hudson Bay Basin are considered to be potential sources, and hence should contain as yet undiscovered lead-zinc mineralization.

Preliminary geochemical studies of drill cores and Quaternary sediments have been undertaken by the authors (Gale *et al.*, 1981). Trace amounts of lead and zinc were found in drill cores from the Middle Devonian Winnipegosis Formation. Some of the Devonian reef deposits of the Winnipegosis outcrop belt (Figure 1) have associated salt springs with anomalously high concentrations of base metals and helium. To date, no anomalous base metal or uranium values have been found in the overburden.

Conclusions

Because so little of the area underlain by Paleozoic rocks has actual outcrops, the search for uranium or lead-zinc mineralization in these platformal rocks resembles the search for a single needle in many haystacks. Indicators are favourable at least locally as noted, but it will require much additional systematic effort to truly evaluate these rocks for economic quantities of uranium or base metals.

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