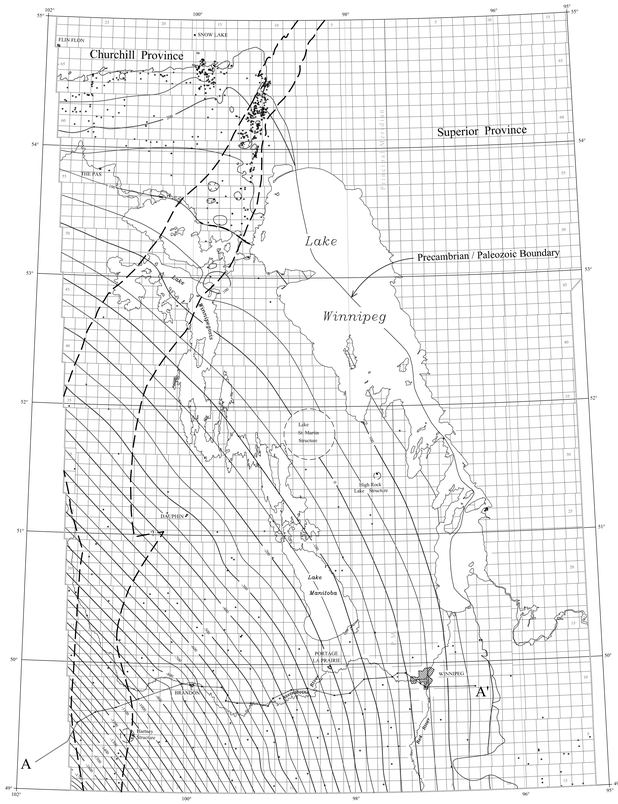
Manitoba
Energy and Mines
GEOLOGICAL SERVICES BRANCH

THE PRECAMBRIAN IN MANITOBA
Stratigraphic Map Series PC - 1



Structure Contour Map
1 : 2 000 000

0 25 50 75 100 km

PRECAMBRIAN

Geological Framework

The Precambrian Shield in Manitoba is divided into two geological or structural provinces. The rocks of the Superior Province have an easterly structural grain and were involved in the Kenoran Orogeny that ended approximately 2.5 billion years ago (i.e. 2.5 Ga). The Churchill Province contains Proterozoic and Archean rocks that were involved in the Hudsonian Orogeny, and exhibit both an easterly and north-easterly structural grain. Rb/Sr isotopic ages from these rocks range from approximately 2.8-1.7 Ga.

The contact between the Churchill and Superior provinces comprises, in part, a highly tectonized boundary zone in which Archean gneisses and minor Proterozoic supracrustal rocks are complexly interfolded and faulted. The "Thompson Nickel Belt" which contains some of the world's major nickel deposits is part of the boundary zone. The "Churchill Superior Boundary Zone" (CSBZ) is characterized by a gravity high and a distinct aeromagnetic signature and trend. These geo-physical features are used to extrapolate the boundary zone underneath the overlying Phanerozoic rocks, east into Ontario, and south into North Dakota.

A northeast-trending suite of mafic/ultramafic dykes, the Molson Swarm, was intruded in the northwest corner of the Superior Province during the interval between the Kenoran and Hudsonian orogenies. Sporadic northeast-trending mafic dykes of the Mackenzie swarm were intruded between 1.3-1.1 billion years ago (Rb/Sr), and cut both the Churchill and Superior provinces.

Throughout most of Manitoba, the Precambrian Shield was eroded to an almost featureless peneplain by the time the initial sediments of the Cambrian period were deposited.

The Superior Province is dominated by granite-greenstone domains and metasedimentary gneiss belts. Metamorphism, intrusion and deformation of the Precambrian rocks of the Superior Province terminated approximately 2.5 billion years ago.

The Churchill Province contains three major geologic domains. Characterized by metavolcanic and metasedimentary rocks with abundant granitic intrusions, and three domains composed of metasedimentary gneisses. Within the Churchill Province, the last metamorphic, deformational and intrusive activity terminated about 1.6 billion years ago.

The greenstone belts of both the Superior and Churchill provinces have been important producers of copper, zinc and gold. The CSBZ marks the location of some of the world's largest nickel deposits; the best known is at Thompson.

Churchill Superior Boundary Zone

Control on Lower Paleozoic structural patterns are probably related to irregularities in the basement of the CSBZ. The Churchill and Superior blocks exhibit distinctly different tectonic and lithostratigraphic patterns, and more importantly, distinctly different crustal thickness and composition (Green *et al.*, 1980). The trend of this major Precambrian structure, as it is traced by its associated geophysical anomalies (gravity and magnetic) beneath the Paleozoic cover of western Manitoba, cuts deeply into the eastern flank of the Williston Basin, and roughly defines the extent of anomalous Ordovician thickening (Dietrich *et al.*,1997).

Since the major Paleozoic tectonic element represented by the Williston Basin straddles the major basement (crustal) discontinuity of the CSBZ, it seems inevitable that the discontinuity should have had some modifying or distortional effect on the "normal" pattern of basin subsidence. However, structure contour maps of the individual Paleozoic formations and on top of the Precambrian basement show little or no apparent deviation along the boundary zone, except for the small synclinal flexure (Moose Lake Syncline) near the northern limit of Paleozoic cover (McCabe, 1967). This would seem to indicate that little or no permanent dislocation or distortion of the crust has occurred. Paleozoic isopachs, however, show a considerable number of anomalies that are approximately coincident with the CSBZ, suggesting that distortion has occurred at certain times. (The structure contours reflect only the cumulative effects of subsequent tectonism, whereas the isopachs reflect, in part, tectonism during a specific time interval). The isopach anomalies apparently cancel out over time so that the end result is little or no overall distortion of the structural framework. For example, the thickening of Ordovician strata in southern Manitoba apparently has been compensated for by the late Paleozoic uplift and erosional event that exposed the Precambrian Shield area of eastern Manitoba (see Stratigraphic Maps OW - 1, ORR - 1, and OSM - 1).

Basement control on the Paleozoic depositional framework seems to result from crustal blocks reacting with slight differences to imposed tectonic forces. Relative to the Churchill block, the Superior block apparently has undergone greater subsidence during depositional episodes, compensated for by relatively greater uplift during erosional episodes.

The suggestion that basement tectonic elements in southern Manitoba may have exerted some control over the Paleozoic depositional/tectonic framework is not new. McCabe (1967) originally proposed this idea. The proposal is stressed because of the major effect this mechanism may have had in controlling not only the depositional framework in the which the subcropping sediments were deposited; but also the distribution of the outcrop belts themselves, and the unusual dip-section configuration the outcrops have relative to the depositional framework.

Meteorite Impact Structures
(and other structural anomalies)

Manitoba has local, structural features such as West Hawk Lake crater, Popular Bay crater, Lake St. Martin crater, High Rock Lake crater, Hartney crater, Denby structure, Shoulder-blade Island, Ochre Lake and Limestone Point Lake. The Lake St. Martin structure is a cryptoexplosion crater, a descriptive term used to designate a roughly circular structure formed by the sudden release of energy, resulting in rock deformation with no relation to tectonic activity. The Lake St. Martin structure is probably a meteorite impact in origin and is approximately Permian in age. The West Hawk Lake, Popular Bay and High Rock Lake structures may also be the result of meteorite impacts. The Hartney crater is located 55 km southwest of Brandon and is covered by Mesozoic sedimentary rocks.

References and Selected Bibliography

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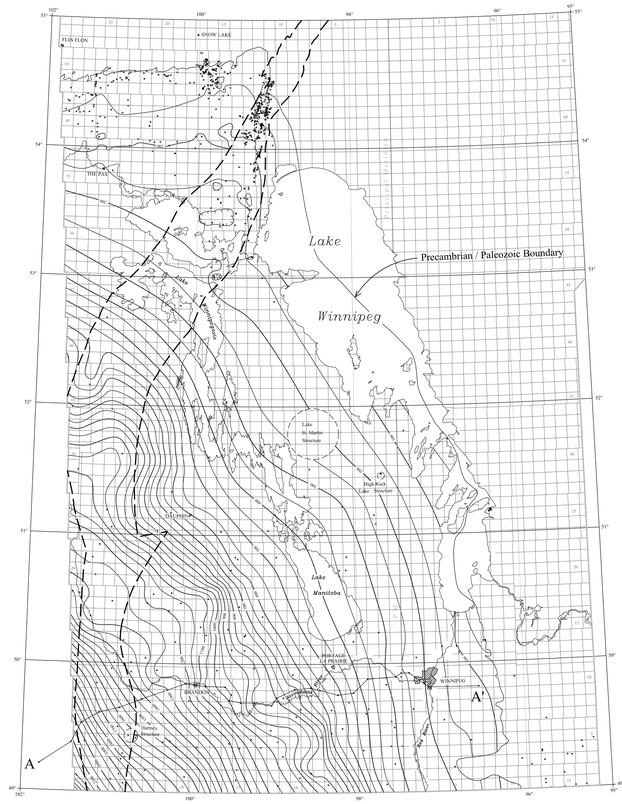


Depth to Precambrian Map
1 : 2 000 000

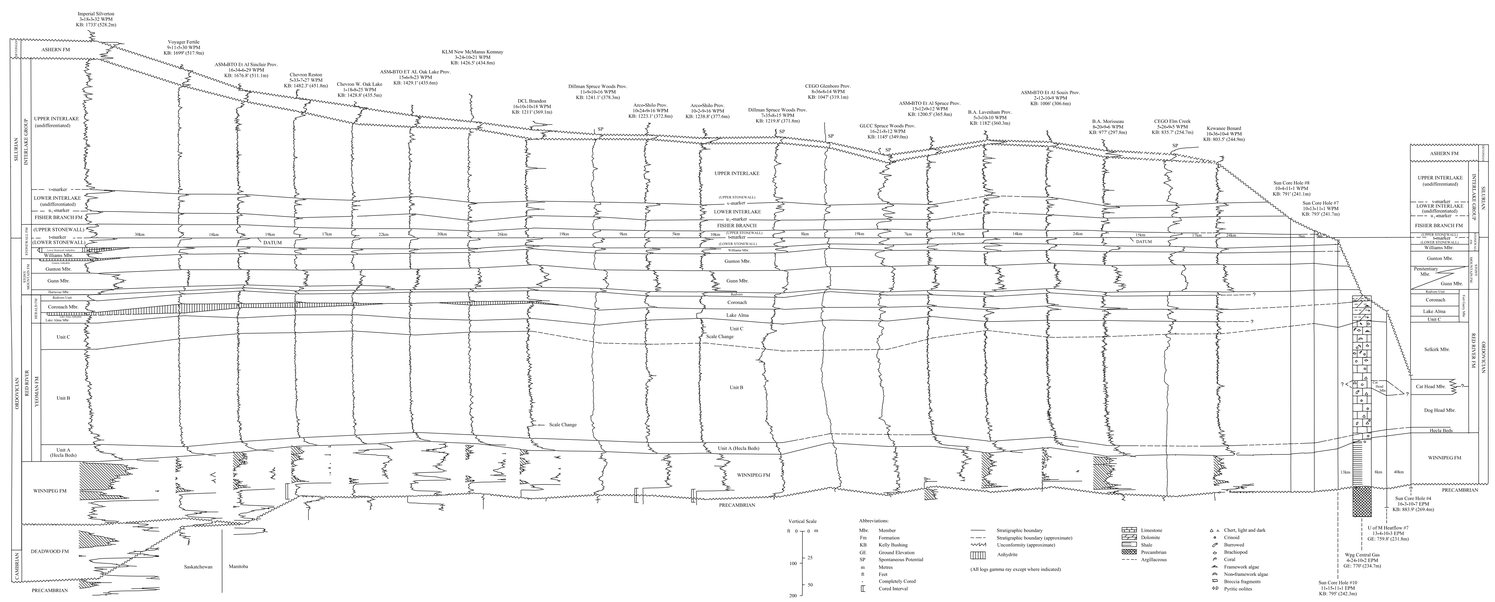
0 25 50 75 100 km

LEGEND (1 : 2 000 000 maps)

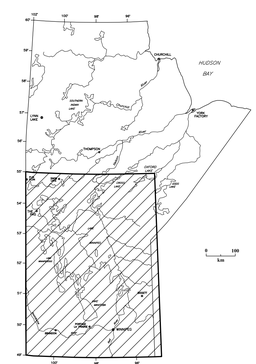
- Control well *
- Depth to Precambrian contour interval (50 m)
- Structure Map contour interval (50 m) (sea-level datum)
- A A' Stratigraphic cross section
- Churchill Superior Boundary Zone

* Both confidential and non-confidential wells were used in the construction of these maps; only non-confidential wells are depicted.

A — Stratigraphic Cross Section — A'



Location Map



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