Hudsonian regional metamorphic isograds and bathozones in the Thompson Nickel Belt, Manitoba

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The Thompson Nickel Belt (TNB) is a 10–30 km wide and almost 200 km long belt situated along the northwest margin of the Superior craton. The belt is underlain by Archean granulite facies gneisses and subordinate Paleoproterozoic supracrustal rocks of the Ospwagan Group. The Archean gneiss and overlying cover sequence was reworked and metamorphosed to amphibolite to granulite facies during the 1880–1760 Ma Trans-Hudson orogeny. Metapelite and silicate-facies iron formation from the Ospwagan Group, as well as metagreywacke from the adjacent Kisseynew Domain, were analyzed to constrain the effects of Hudsonian regional metamorphism.

Four major metamorphic assemblages are identified in the metapelite (which also include quartz + biotite + plagioclase + sillimanite): a) muscovite + staurolite + garnet ± andalusite, b) muscovite + garnet, c) K-feldspar ± garnet, and d) K-feldspar + cordierite + garnet. These assemblages define 3 regional metamorphic isograds, 1) the disappearance of staurolite ± andalusite, 2) the reaction quartz + muscovite = K-feldspar + sillimanite + H_2O/melt, and 3) the reaction biotite + sillimanite + quartz ± plagioclase = garnet + cordierite + melt ± K-feldspar.

The silicate-facies iron formations are found to have a wide variation in mineral assemblages not only regionally but also at single localities. One consistent difference between lower- and higher-metamorphic grade iron formation assemblages is the presence of Fe-Mg amphibole (grunerite) versus orthopyroxene (ferrosilite). Comparative studies show the ferrosilite-in isograd roughly corresponds with the K-feldspar-in isograd for metapelites (isograd 2).

Kisseynew Domain metagreywackes differ from the metapelite assemblages in that they lack muscovite. There are three main metagreywacke assemblages of increasing grade, all containing quartz + biotite + garnet + plagioclase: a) staurolite + cordierite ± sillimanite, b) cordierite + sillimanite, and c) K-feldspar + cordierite + sillimanite. The metagreywacke assemblages define two metamorphic isograds 1) the disappearance of staurolite, and 2) the reaction biotite + sillimanite + quartz ± plagioclase = garnet + cordierite + melt ± K-feldspar (identical to metapelite isograd 3).

The metamorphic isograds lie roughly parallel to the axial trace of regional F_3 fold structures and are rotated slightly clockwise (~ 5°) from the main trend of the belt. The metamorphic isograds in the northern half of the TNB define an elongate, 1.5–4.0 km wide, central zone of middle amphibolite-grade rocks (~ 550–630 °C) with a lobate, southern termination. The middle amphibolite-grade rocks are flanked by a zone of upper amphibolite-grade rocks, 1.5–10 km wide (~ 630–700 °C); and finally granulite facies rocks (~ 700–800 °C) towards the periphery of the belt. In the southern half of the TNB, the central metamorphic low is truncated by the Superior Boundary Fault Zone, and the rocks consist largely of upper amphibolite-grade rocks.

The lowest pressure metamorphic domain in the belt is characterized by andalusite and indicates peak metamorphic pressures of 3–4 kbar. This domain coincides with the lobate termination of the central metamorphic low. Pressures south of this zone are poorly constrained, although the presence of sillimanite and lack of either andalusite or cordierite suggest higher pressures. North of this zone, near Thompson, sillimanite + staurolite assemblages in metapelite and sillimanite + staurolite + cordierite assemblages in metagreywacke suggest pressures of 4–5 kbar. Further to the northwest, metagreywacke assemblages with sillimanite + cordierite + melt suggest pressures of 5–6 kbar. Thus, metamorphic depth contours (bathograds) occur roughly perpendicular to the trend of the belt, the axial trace of the F_3 folds, and the isograds.