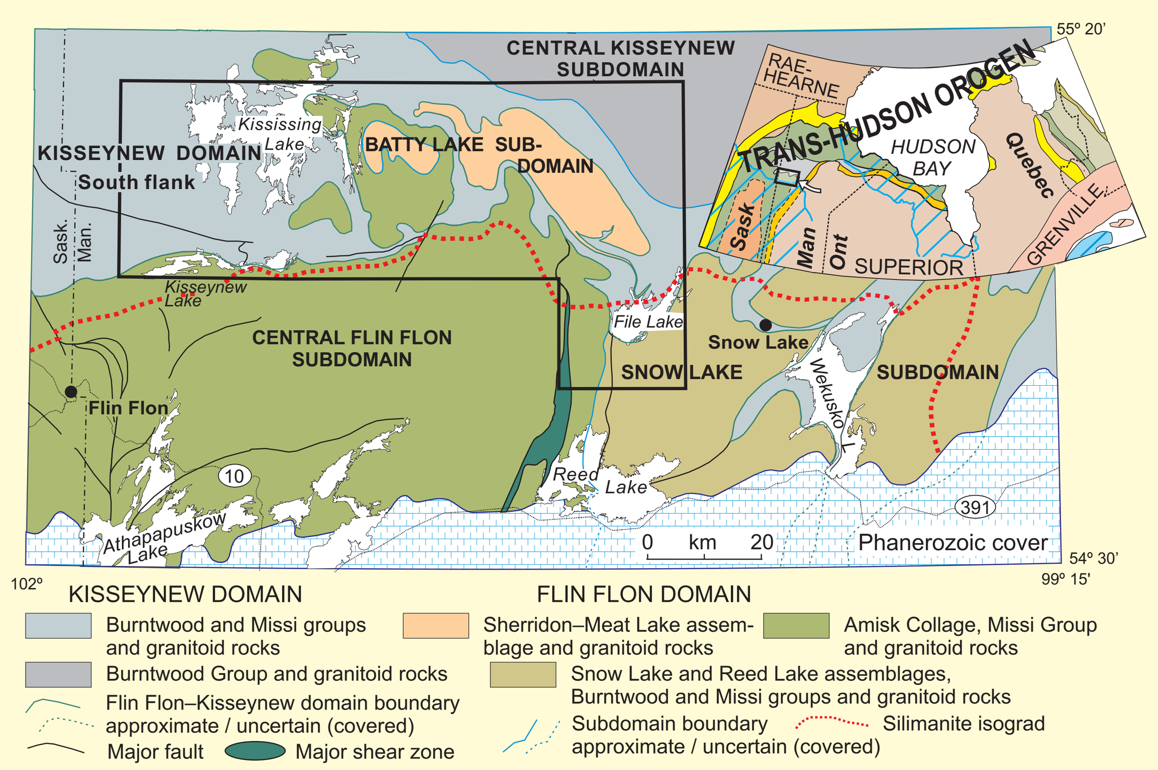
GR2010-1: Kississing–File lakes area, northern FlinFlon and southern Kisseynew domains

by H.V. Zwanzig and A.H. Bailes

Summary

Revised units and subdomains based on structural mapping, geochronology and geochemistry in the Kississing–File lakes area, which straddles parts of two domains (Flin Flon and Kisseynew), provide a new control on the presence and distribution of volcanogenic massive sulphide (VMS) and gold deposits. The supracrustal rocks of the Flin Flon Domain are dominantly metavolcanic, whereas those of the Kisseynew Domain, to the north, are mainly metasedimentary. The change is also from medium-grade metamorphic rocks preserving early structures in the south to highly metamorphosed rocks with deeper level structures in the north.



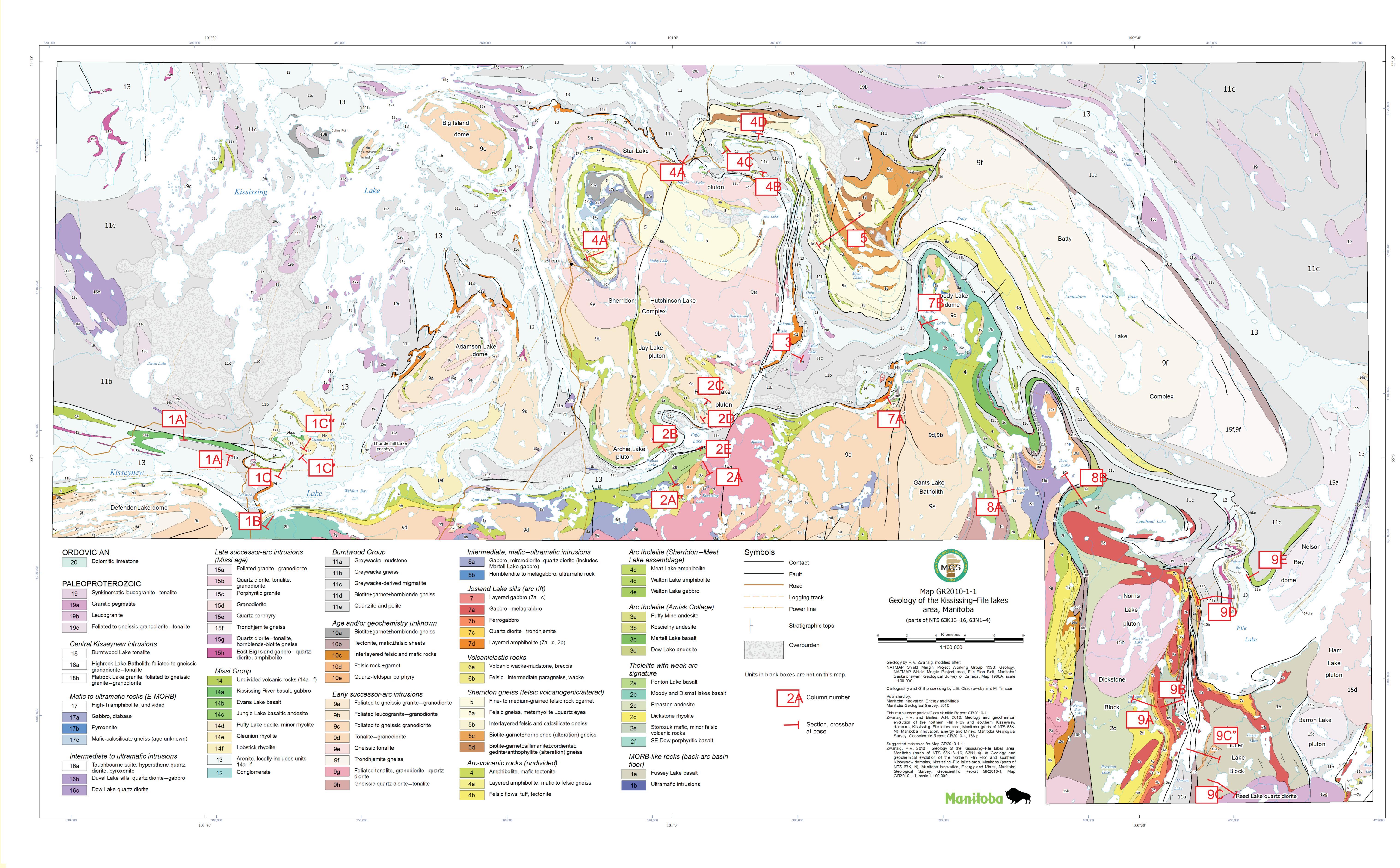
Subdomains of the Flin Flon Domain and southern Kisseynew Domain in Manitoba, also showing the outline of the Kississing–File lakes area and the sillimanite-biotite-garnet isograd. The Trans-Hudson Orogen (key map with internides in green) is shown between the Archean cratons and under Phanerozoic cover; main figure is at the arrow.

Results are published in printed and DVD formats in the Geoscientific Report GR2010-1: **Geology and geochemical evolution of the northern Flin Flon and southern Kisseynew domains, Kississing–File lakes area, Manitoba (parts of NTS 63K, N)** by H.V. Zwanzig and A.H. Bailes and maps GR2010-1-1 and -2 (1:100 000 scale).

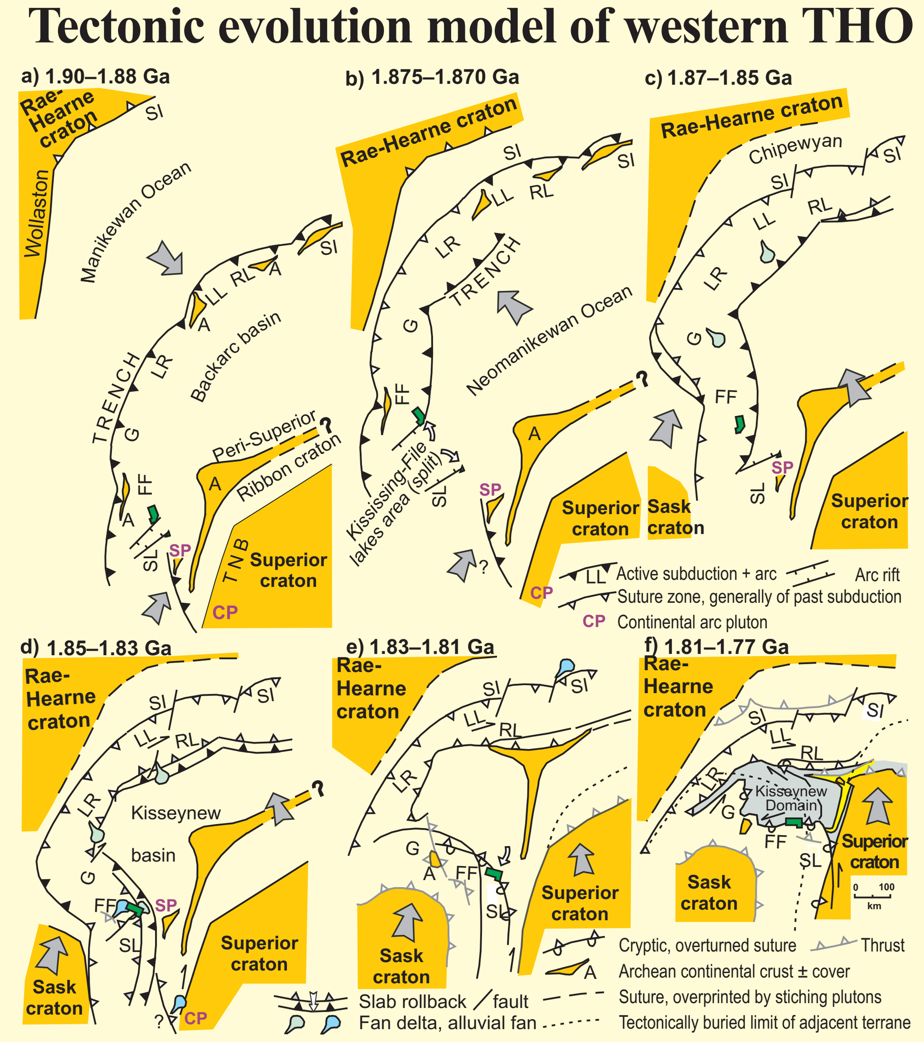
Assemblages of volcanic units and groups of sedimentary rocks occurring in fault-bounded structural blocks in the southeast are traced for up to 80 km into highly deformed and metamorphosed packages adjacent to the Kisseynew Domain. Trace-element patterns in most units are remarkably persistent and still indicative of tectonic origin. The oldest, predominantly volcanic rocks (Amisk Collage, Northeast Reed assemblage and Snow Lake assemblage) are recognized because they are intruded by the widespread layered sills of the 1886 Ma Josland Lake gabbro. An important arc assemblage is the Fourmile Island assemblage, which is interpreted to include arc-rift volcanic rocks in the north that host the Dickstone VMS deposit. An important new interpretation, based on a preliminary U-Pb zircon age of about 1850–1855 Ma, is that the highly metamorphosed felsic rocks in the Sherridon–Batty Lake area represent VMS-hosting, early successor-arc volcanic rocks (Sherridon–Meat Lake assemblage). Approximately coeval intrusions like those in the Batty Lake complex may have acted as hydrothermal heat engines.

Intrusive suites are presented in the report as: 1) coeval with the early volcanic rocks; 2) early successor arc, predating the sedimentary rocks typical of the Kisseynew Domain (Burntwood and Missi groups); 3) late successor arc, coeval with and postdating these sedimentary rocks; and 4) syntectonic, weakly peraluminous granitoid intrusions interpreted to postdate early continental collision in the Trans-Hudson Orogen (THO).

The report explains how the northerly trending structures in the central part of the Flin Flon Domain previously existed also on its northern margin where they were converted in mid-crust into recumbent structures in a northeast-dipping crustal stack. This conclusion has a profound influence on recognizing how the tectonostratigraphic units were juxtaposed and then further deformed during postcollisional convergence of the surrounding Archean cratons (Sask, Rae-Hearne and Superior). A comparison of the area with surrounding parts of the Trans-Hudson internal zone leads to a new tectonic and metallogenic model for the evolution of the THO in Manitoba, and suggests an undiscovered high mineral potential for the wider region, similar to that of the Flin Flon Domain.

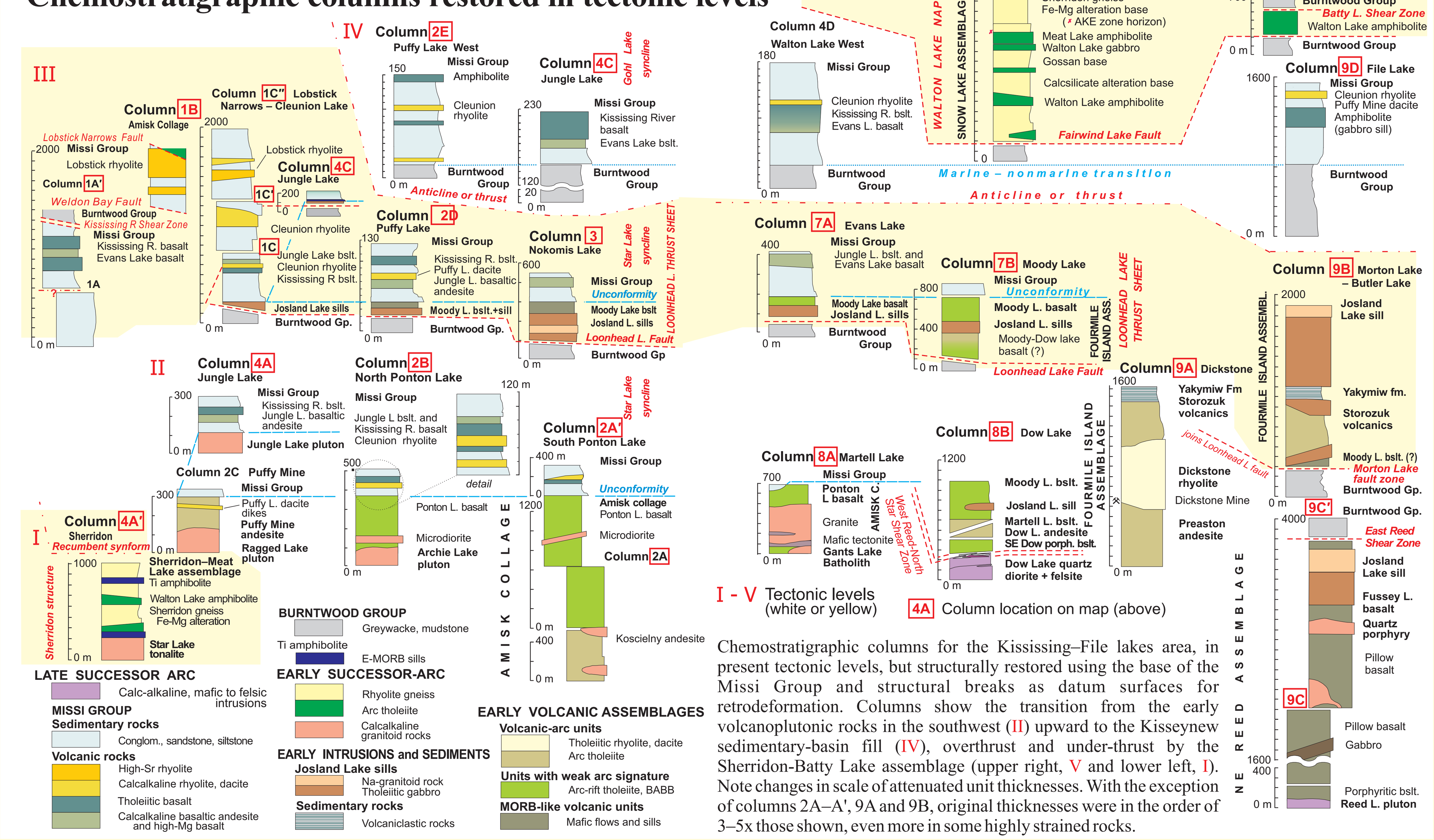


Tectonic evolution model of western THO



Probable stages (a–f) of paleogeographic evolution of the Trans-Hudson internides and surrounding Archean cratons. The assumption that all greenstone belts were part of a single oceanic arc or a number of contiguous arcs is based on their identical products of the same age and similar tectonic events for a period of 70 m.y., as well as the final near continuity. Southeasterly subduction in the La Ronge–Rusty Lake arc–back-arc segment probably involved Flin Flon–Glennie domains as well (a). Early polarity near the TNB was northeast. A subduction flip (b) is inferred to be in response to collision with Rae-Hearne craton, causing the onset of early (1865–1850 Ma) successor-arc magmatism from La Ronge to Southern Indian and batholiths to the northwest. Sask plate must have drifted northerly (c). Late successor-arc magmatism (d) was by continued northwest-directed subduction, producing Missi-age volcanic rocks and abundant intrusions at Snow Lake, and similarly aged plutons from La Ronge to Southern Indian. Overturning, inversion and rotation of major structures on a crustal scale (e) occurred in front of the colliding Sask craton. Final crustal architecture was the result of continued convergence of the cratons (f, nearly to scale). Small green polygons indicate the Kississing–File lakes area. Abbreviations: A, Archean; CP, Clark pluton; FF, Central Flin Flon subdomain; G, Glennie Domain; LL, Lynn Lake Domain; LR, La Ronge Domain; RL, Rusty Lake Domain; SI, Southern Indian Domain; SL, Snow Lake subdomain; SP, Saw Lake pluton.

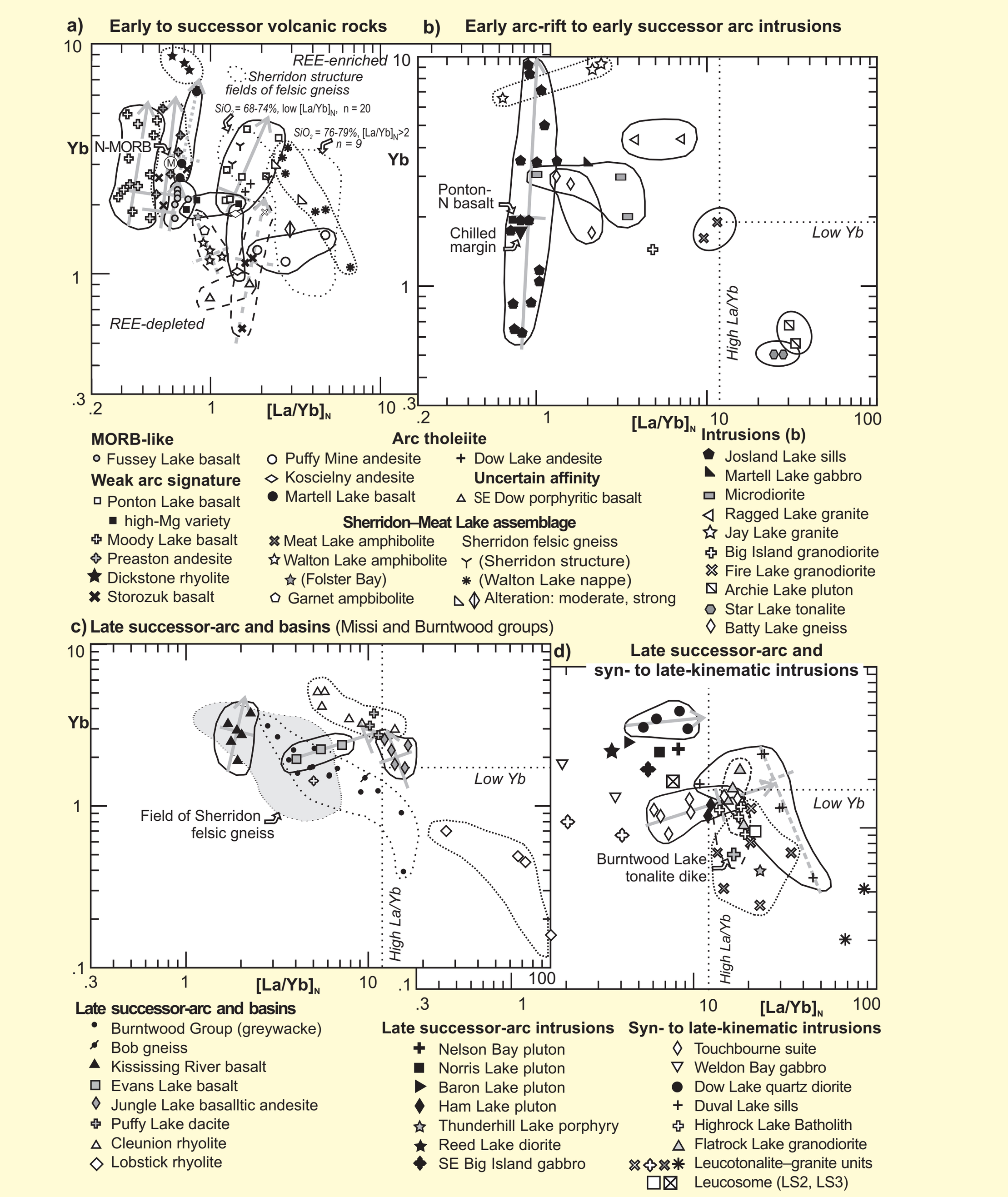
Chemostratigraphic columns restored in tectonic levels



Chemostratigraphic columns for the Kississing–File lakes area, in present tectonic levels, but structurally restored using the base of the Missi Group and structural breaks as datum surfaces for retrodeformation. Columns show the transition from the early volcanoplutonic rocks in the southwest (II) upward to the Kisseynew sedimentary-basin fill (IV), overthrust and under-thrust by the Sherridon-Batty Lake assemblage (upper right, V and lower left, I). Note changes in scale of attenuated unit thicknesses. With the exception of columns 2A–A', 9A and 9B, original thicknesses were in the order of 3–5x those shown, even more in some highly strained rocks.

Chemostratigraphy

Stratigraphic analysis in the high-grade metamorphic rocks of the Kississing–File lakes area relies on structural and geochemical data to make up for the loss of primary volcanic and sedimentary structures. The metavolcanic and metaplutonic rocks have been newly subdivided in detail, based partly on their U-Pb zircon ages and on their surprisingly well-preserved geochemistry. The least mobile elements (high field strength elements [HFSE] and rare earth elements [REE]) provide geochemical data that is little altered compared to the major elements; they reliably characterize individual units and define tectonic affinity. Of the 43 igneous units that have had more than one sample analyzed for trace elements, most form compact fields on several commonly used variation diagrams, e.g. Yb versus [La/Yb]N. These fields show little overlap and therefore help to define the units **(figure below)** and allow them to be mapped out. Other diagrams show petrogenetic and tectonic origins.



Scatterplots of Yb (ppm) vs. $[La/Yb]_N$ (chondrite-normalized), with distinguishing fields of units based on the contents and ratios of REE. Grey lines are regressed trends due to fractional crystallization (up arrows), fractional melting (away from up arrows) or mixing with a high–La/Yb melt component (right arrows); crossbars indicate Yb7 contents (at 7% MgO, fitted from Yb vs. MgO scatterplots, not shown).

Various plots of relatively immobile major and trace elements indicate a division of early units into 1) MORB (or BABB [backarc-basin basalt] formed dominantly by decompression mantle melting) and those with 2) weak and 3) strong arc-like signatures. This subdivision identifies assemblages with low and high mineral potential according to tectonic origin (i.e., non-arc and arc). Several units that fall between the fields of MORB and arc may have formed during arc extension or at the margin of a back-arc basin, also with significant mineral potential. The conclusions based on standard diagrams are supported by the shape of chondrite-normalized REE plots, as well as by the presence or absence of the typical negative HFSE (Nb, Hf, Zr and Ti) anomalies in MORB-normalized or primitive-mantle extended-element plots.

A summary of the geochemical stratigraphy and structural continuity of units is given in restored columns arranged in the currently overlapping structural sheets and early fold limbs **(I–V figure to left)**.

Tectonic evolution

The tectonic evolution is divided into five stages: 1) early arc, arc-rift and back-arc volcanism with early assembly of these disparate terrane fragments; 2) arc rifting and mafic intrusion with non-arc geochemistry; 3) early successor-arc magmatism; 4) late successor-arc magmatism and basin evolution during collision tectonics; and 5) orogeny involving synkinematic magmatism, terminal collision and deformation with final convergence and block faulting.

Structural and stratigraphic considerations indicate that the late successor-arc magmatism was syncollisional, occurring during the collision of the Flin Flon–Glennie Complex, the Sask craton and probably the Superior craton **(figure on far left)**. Final plate convergence in THO in Manitoba must have involved the subduction of a sizable remnant ocean basin, precursor of the Kisseynew basin. Collision probably involved microplate rotation that, along with postcollisional convergence, led to the present shape of the volcanoplutonic domains and the crustal architecture of the western THO.

Economic considerations

Newly proposed ideas pertinent to mineral exploration as suggested by the evolution of the western THO include the following:

- An early (>1886 Ma) assembly of the entire Flin Flon Domain was probably from a single oceanic arc that may have spanned the entire western THO with abundant primitive bimodal volcanism and exceptionally high VMS potential .
- This was followed by arc rifting and possible terrane dispersal, which may have left only parts of the arc (e.g. Batty Lake subdomain) in a younger fertile marine environment.
- The importance of geochemistry, even more than age, is a guide for mineral exploration, as suggested by the Sherridon deposits.