Preliminary results of bedrock mapping at the Cat Lake–Euclid Lake in the Neoarchean Bird River greenstone belt, southeastern Manitoba (parts of NTS 52L11, 12)

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Summary

In 2013 the Manitoba Geological Survey conducted bedrock mappingat a scale of 1:10 000 in the Cat Lake–Euclid Lake area in the northern arm of the Bird River greenstone belt, southeastern Manitoba. The main part of this area is underlain by a Neoarchean supracrustal assemblage comprising volcano-sedimentary and intrusive rocks, which is bounded to the south by the Mesoarchean Maskwa Lake batholith and to the north by sedimentary rocks and derived gneissic, weakly foliated to massive granitoid rocks. The supracrustal assemblage consists of 1) mafic volcanic and synvolcanic intrusive rocks, 2) epiclastic and minor volcaniclastic rocks, and 3) mafic–ultramafic intrusions. Both the Mesoarchean granitoid batholith and supracrustal rocks are intruded and disrupted by a Neoarchean tonalite-trondhjemite-granodiorite (TTG) suite and late peraluminous granitoid rocks and associated pegmatites. The mafic–ultramafic intrusions are emplaced within a mid-ocean-ridge basalt (MORB)–type sequence that is extensive in the northwestern part of the map area, and are in fault contact with granitoid and sedimentary rocks in the southeastern part. Some of the mafic–ultramafic intrusions are associated with PGE–Ni–Cu–Cr mineralization, and thus have become targets for mineral exploration. Rare-metal (Li, Cs, Nb, Ta) mineralization is confined to pegmatite intrusions associated with peraluminous granitoid rocks that are relatively younger than the TTG suite, in which pegmatite and aplite intrusions are, in contrast, compositionally simple and devoid of metasomatic textures. There exists, however, a potential for porphyry Cu-(Au) mineralization associated with some granitoid phases in the TTG suite.

The results of bedrock mapping suggest that the MORB-type basalts and related synvolcanic intrusive rocks, as well as the mafic–ultramafic intrusions, may have been emplaced in an extensional setting at a continental margin, possibly represented by older granitoid rocks in the Maskwa Lake batholith (i.e., Maskwa Lake batholith I, ca. 2853–2782 Ma; Gilbert et al., 2008). The Neoarchean mafic–ultramafic intrusions, including the Cat Lake, New Manitoba Mine and Euclid Lake (U-Pb zircon age of 2743 Ma) intrusions, consist of a diversity of rock types, including gabbro, leucogabbro to anorthositic gabbro, melagabbro, amphibolite and/or pyroxenite, and peridotite. Whereas all three of the these intrusions may be coeval and thus the products of the 'Bird River magmatic event' (Houlé et al., 2013), the precise age and affinity of the Cat Lake and New Manitoba Mine intrusions are yet to be determined.

The TTG suite including Neoarchean phases of the Maskwa Lake batholith (Maskwa Lake batholith II, 2725 ±6 Ma; Wang, 1993), as well as the Inconnu pluton I (Černý et al., 1981), may have been formed in a magmatic-arc setting; subsequent emplacement of peraluminous granitoid rocks and associated rare-metal-bearing pegmatites may have occurred during continental collision subsequent to plate subduction. The north-northwest-trending Cat Lake–Euclid Lake shear zone is confined to gneissic, peraluminous granitoid rocks, as well as strongly foliated and mylonitic granitoid rocks that may mark the southern boundary of the English River subprovince.

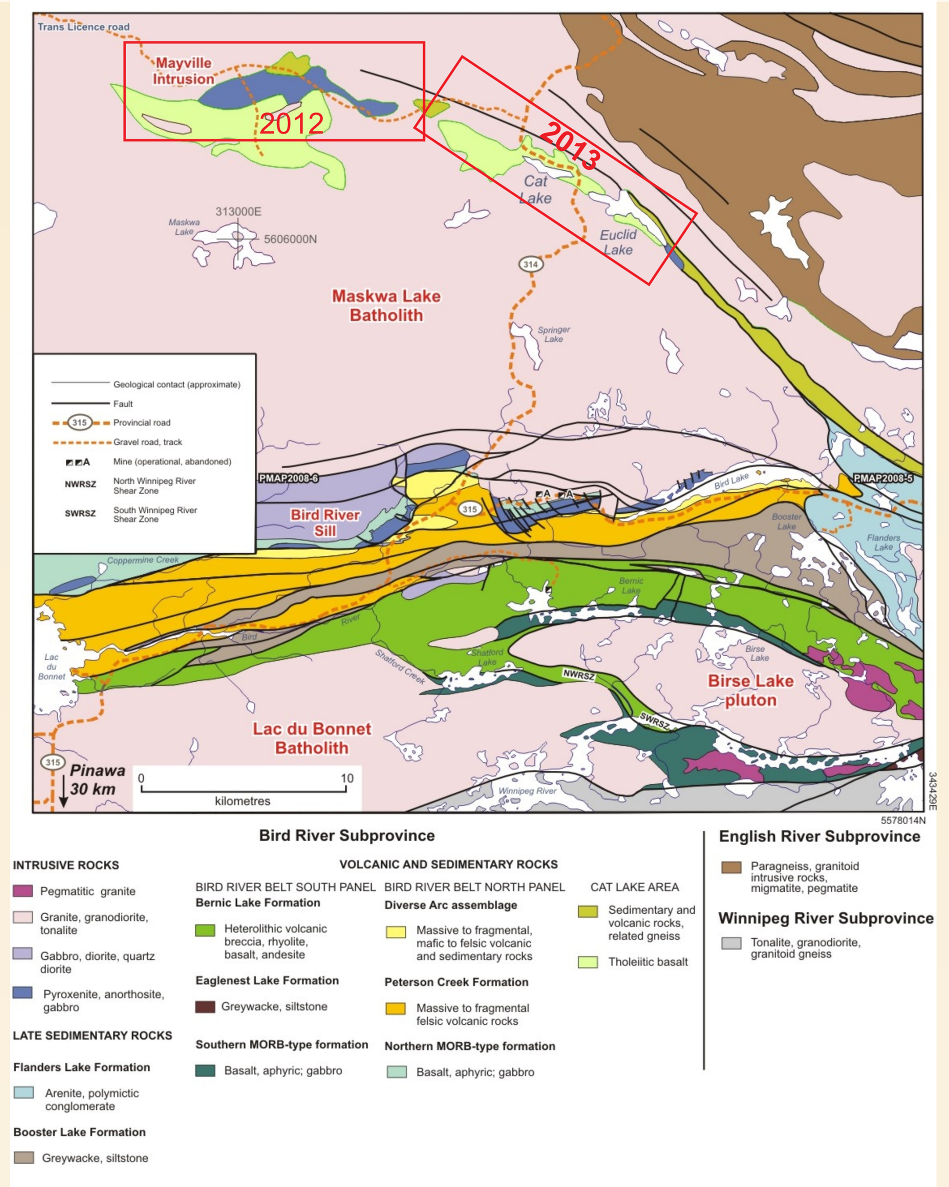


Fig. 1 Simplified geology of the Neoarchean Bird River greenstone belt, showing the location of the Cat Lake-Euclid Lake area and the Bird River Sill (compiled from Bailes et al., 2003 and Gilbert et al., 2008).

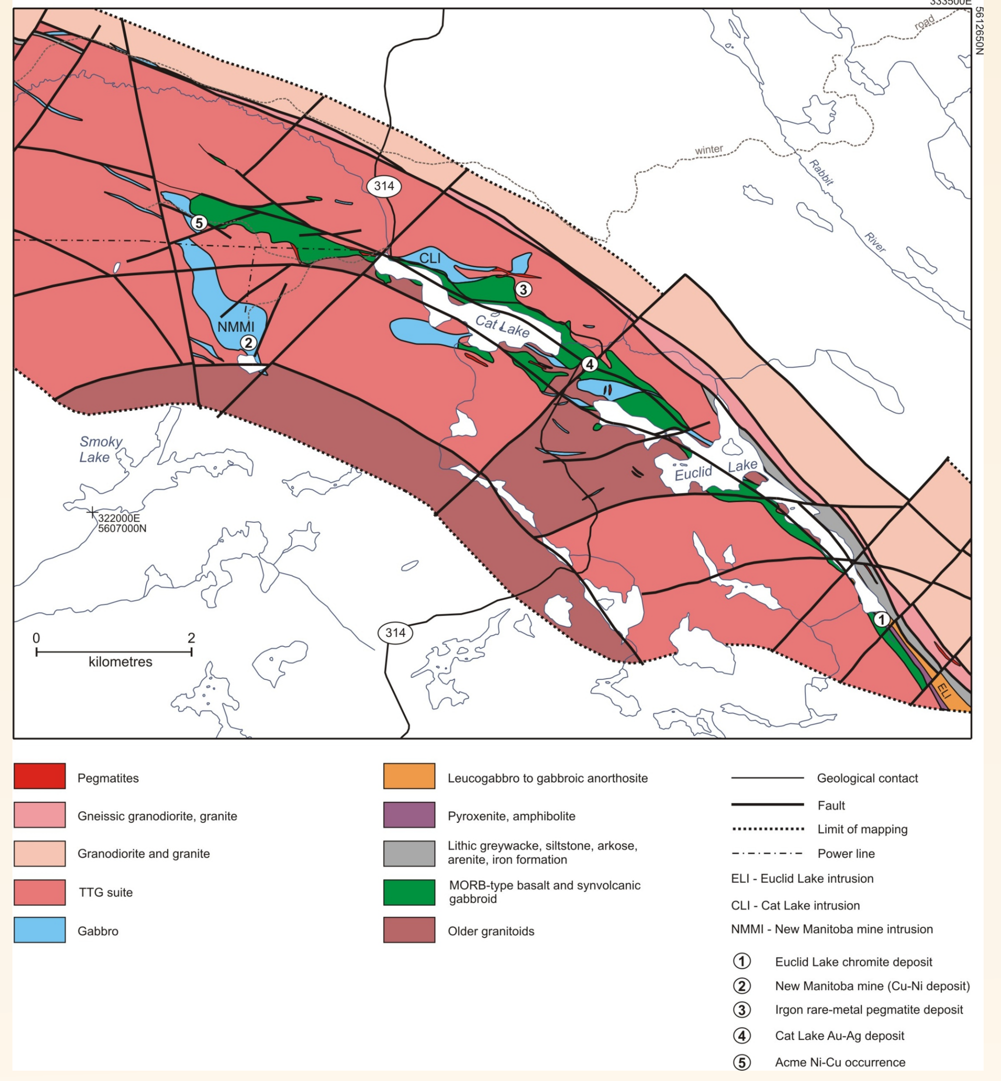


Fig. 2 Simplified geology of the Cat Lake-Euclid Lake in the northern arm of the Neoarchean Bird River greenstone belt, southern eastern Manitoba.

Introduction

In 2013 the Manitoba Geological Survey completed a 1:10 000 scale bedrock mapping project in 2013, providing new insights into geological evolution and geodynamic setting of the Cat Lake-Euclid Lake area in the northern arm of the Bird River greenstone belt (BRGB). The preliminary results of mapping suggest that base-, precious-, and rare-metal mineralization in the region is associated with distinct events during geodynamic evolution, and could be tracked by detailed bedrock geological mapping. This on-going mapping project has been in collaboration with the Geological Survey of Canada via TGI-4 program, supported by mining companies including Mustang Minerals Corp.

Geological setting

The mapping area is situated between the English River and Winnipeg River subprovinces of the western Superior Province (Figs. 1 and 2). The oldest rocks in the Cat Lake–Euclid Lake area, Maskwa Lake batholith I, consist of various granitoid intrusions (2852.8 ±1.1 Ma to 2832.3 ±0.9 Ma [Gilbert et al., 2008], 2844 ±12 Ma [Wang, 1993]) that represent a basement for the BRGB. The supracrustal rocks of the BRGB extend along the north and south margins of the older Maskwa Lake batholith cratonic block (Fig. 1), suggesting that they may have been deposited in a continental-margin setting.

The northern arm of the BRGB consists of mafic volcanic and synvolcanic intrusive rocks, epiclastic and minor volcaniclastic rocks, and mafic–ultramafic layered intrusions. These mafic–ultramafic intrusions within the greenstone assemblage include the Cat Lake, New Manitoba Mine and Euclid Lake intrusions, as well as other relatively smaller intrusions. These intrusions are emplaced within a mid-ocean-ridge basalt (MORB) sequence to the northwest, and are in fault contact with granitoid and sedimentary rocks in the southeastern part of the map area. Relatively younger granitoid rocks (Maskwa Lake batholith II; 2725 ±6 Ma [Wang, 1993]) belong to a tonalite-trondhjemite-granodiorite (TTG) suite that was emplaced in both the granitoid basement and supracrustal rocks of the BRGB; the TTG suite was, in turn, intruded by late, gneissic, peraluminous granitoid rocks; strongly foliated to massive granitoid rocks; and related pegmatites.

During the course of the mapping, ten map units were defined in the Cat Lake-Euclid Lake area These are, from the oldest to youngest (Fig. 2): 1) Maskwa Lake batholith I, 2) MORB-type formation, 3) Euclid Lake formation, 4-5) Euclid Lake intrusion, 6) gabbroic intrusions, 7) TTG suite, 8) Inconnu pluton I, 9) Inconnu pluton II, and 10) late intrusive rocks. These units are described in the following sections (see Figs. 3 to 6).

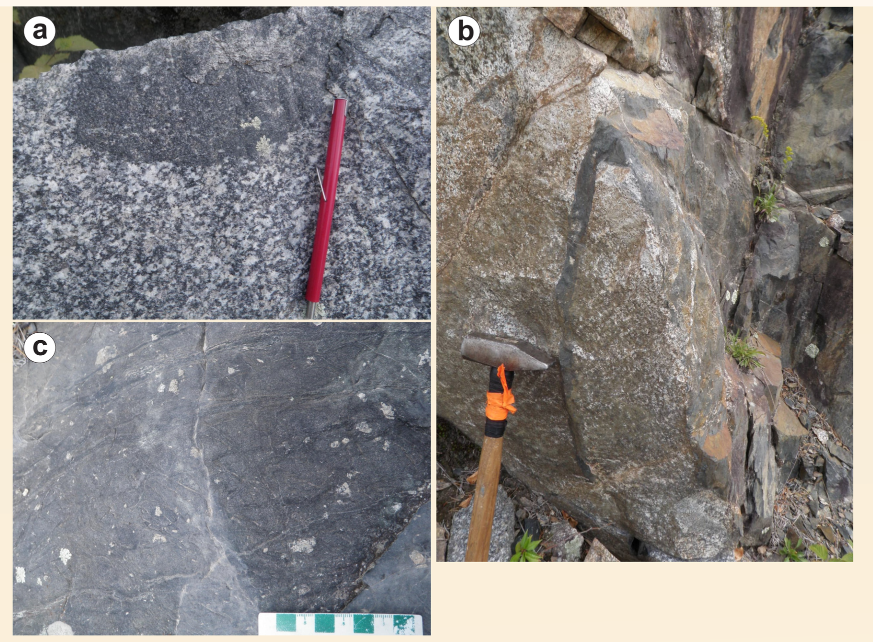


Fig. 3 Typical granitoid rocks of the Maskwa Lake batholith I (map unit 1), and their relationship with mafic volcanic rocks and synvolcanic gabbro (unit 2): a) medium- to coarse-grained tonalite with subrounded to elongated mafic xenoliths; b) tonalite intruded by a diabase dike at the contact zone; c) very fine grained to aphanitic basalt containing plagioclase glomerocrysts.

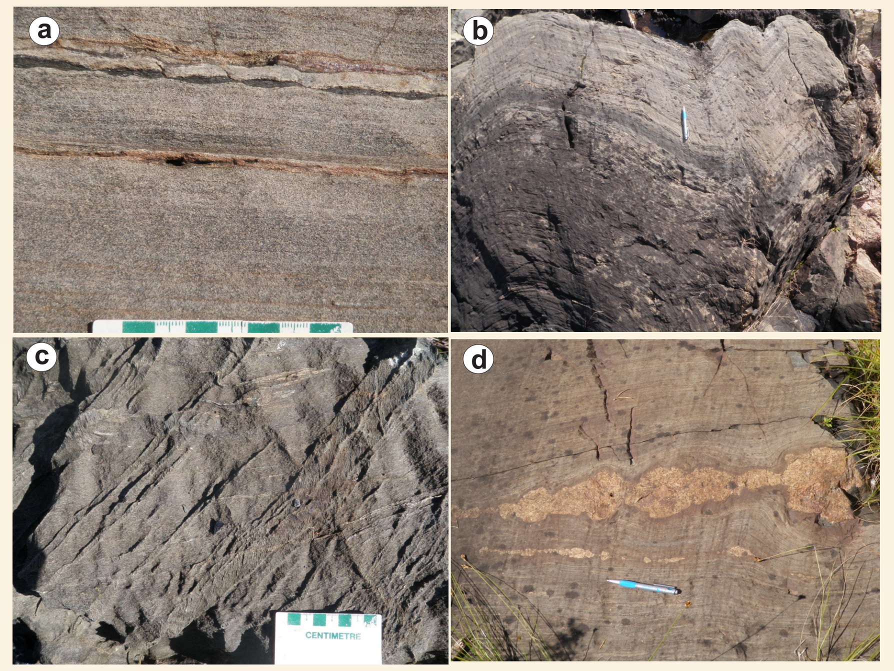
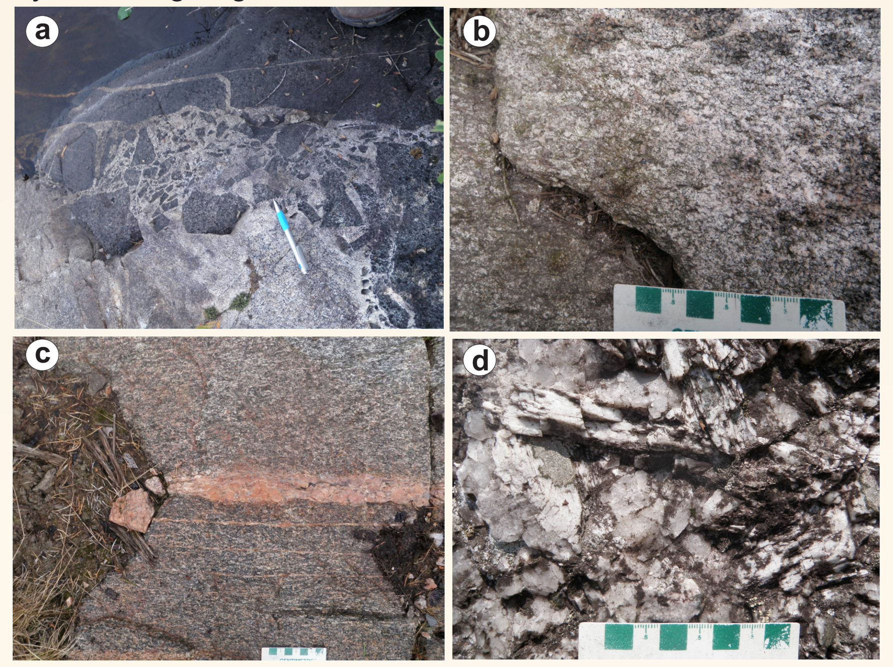


Fig. 4 Sedimentary and volcaniclastic rocks, syndepositional mafic rocks (unit 3) and younger pegmatite dikes: a) lithic greywacke and arkose, with thin, mafic volcaniclastic sandstone and quartzite beds; b) greywacke, arkose and mafic volcaniclastic sandstone, with leucosome veinlets both parallel and oblique to foliation planes; c) medium-grained amphibolite interpreted as intrusive, penecontemporaneous with deposition of sedimentary host; d) greywacke intruded by boudinaged granite dike and veinlets.



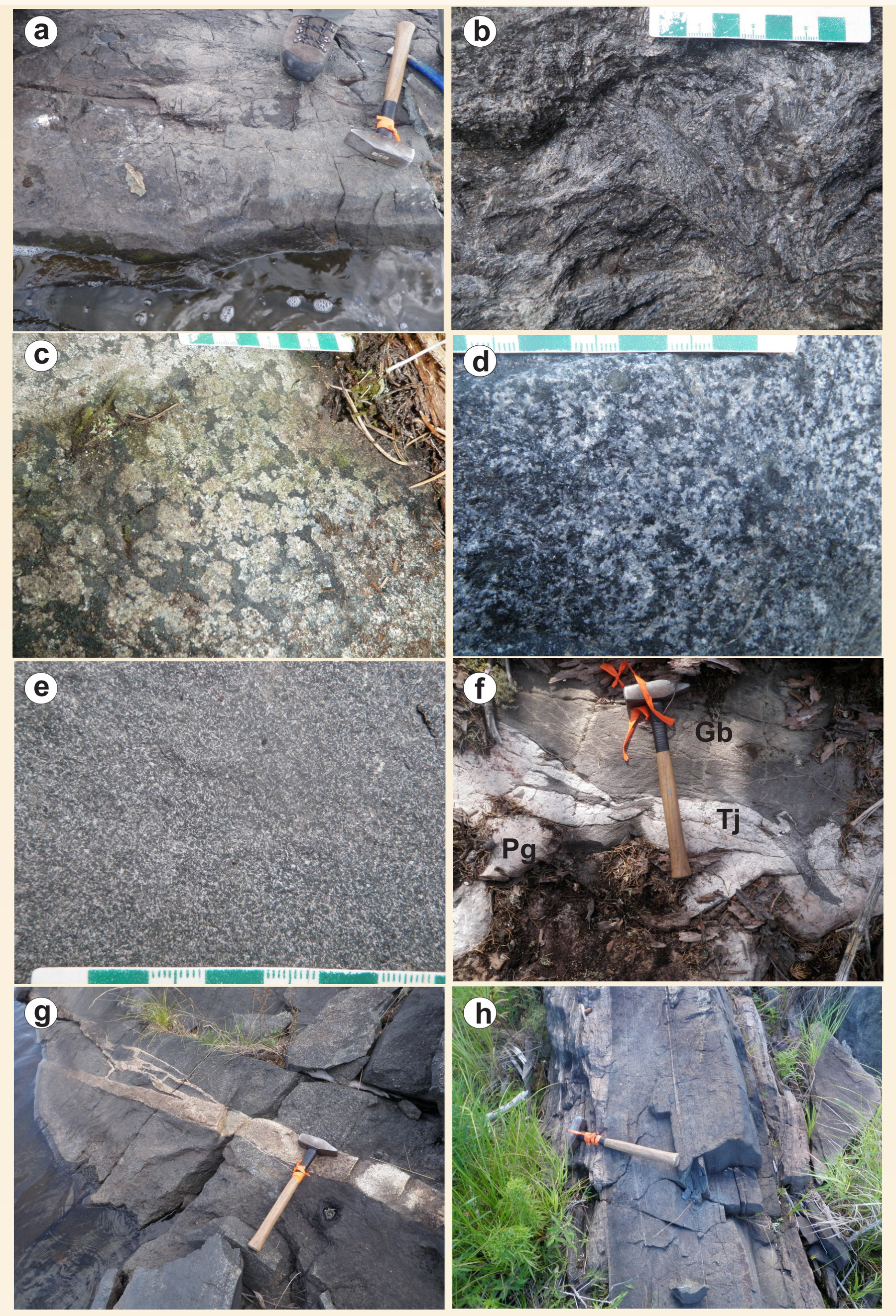


Fig. 5 Representative mafic–ultramafic intrusive rocks (units 4 to 6): a) medium- to coarse-grained pyroxenite, strongly magnetic, with scattered disseminated pyrrhotite (unit 4); b) very coarse grained amphibolite, consisting of radiating amphibole crystals up to 5 cm in length (unit 4); c) very coarse grained to megacrystic leucogabbro to anorthositic gabbro, with euhedral to subhedral plagioclase crystals and interstitial amphibole (unit 5); d) medium- to coarse-grained gabbro with disseminated chalcopyrite and pyrrhotite (unit 6); e) fine-grained gabbro, marginal phase of New Manitoba Mine intrusion); f) fine- to medium-grained gabbro (Cat Lake intrusion, unit 6), intruded first by trondhjemite and then by pegmatite (locally contains gabbro xenoliths); g) medium-grained gabbro (unit 6) intruded by a granodiorite dike derived from the Maskwa Lake batholith II (unit 8); h) medium-grained gabbro dike (unit 6) emplaced in tonalite of the Maskwa Lake batholith I; both rock types are strongly foliated (unit 1).

Fig. 6 Field photographs of various phases of granitoid rocks and pegmatites, showing some of the key field relationships (units 7 to 10): a) medium- to coarse-grained granodiorite, Maskwa Lake batholith II (unit 7), which intrudes and brecciates medium-grained gabbro (unit 6); b) coarse-grained granite with heterogeneous texture (unit 8); c) gneissic granodiorite (unit 9) and associated simple pegmatite vein; d) spodumene-muscovite pegmatite.

Lithogeochemistry

MORB-type basalt and related gabbroic rocks (unit 2), as well as mafic–ultramafic intrusive rocks (units 4–6), are collectively tholeiitic, with evidence of minor crustal contamination (Fig. 7a, b). Their geochemical signatures are consistent with those of modern back-arc basin basaltic rocks.

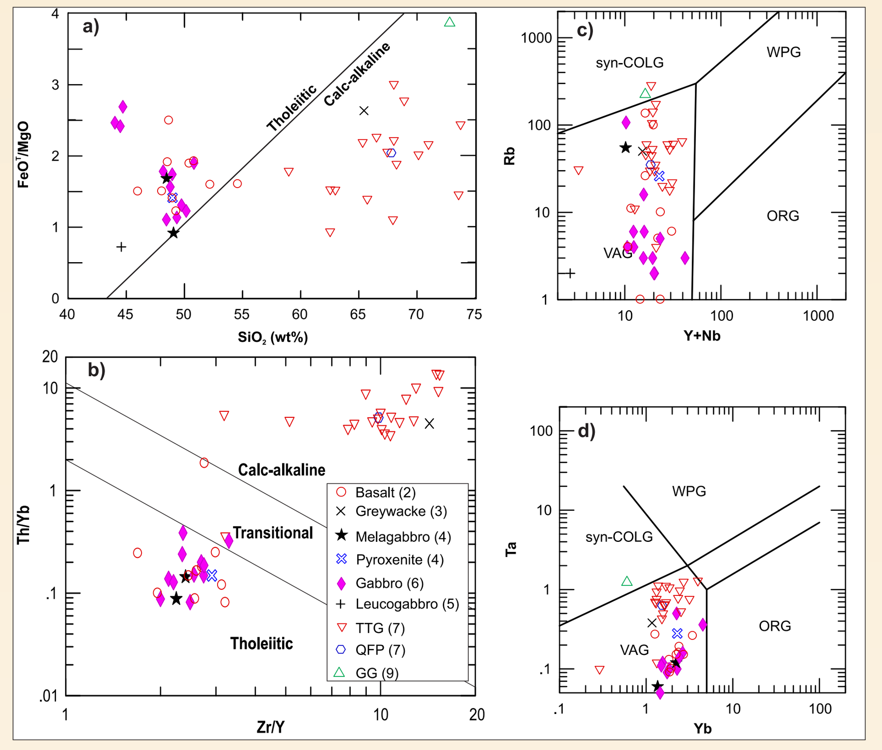


Fig. 7: Discrimination diagrams for rocks of various map units (shown in brackets) in the Cat Lake–Euclid Lake area, southeastern Manitoba: a) FeOT/MgO vs. SiO2 (Miyashiro, 1974); b) Th/Yb versus Zr/Y (Ross and Bédard, 2009); c) Rb vs. (Y+Nb); and d) Ta vs. Yb (fields of tectonomagmatic discrimination from Pearce et al., 1984). Abbreviations: GG, gneissic granodiorite; QFP, quartz-feldspar porphyry; TTG, tonalite-trondhjemite-granodiorite; ORG, ocean-ridge granitoid rocks; Syn-COLG, syncollisional granitoid rocks; VAG, volcanic-arc granitoid rocks; WPG, within-plate granitoid rocks.

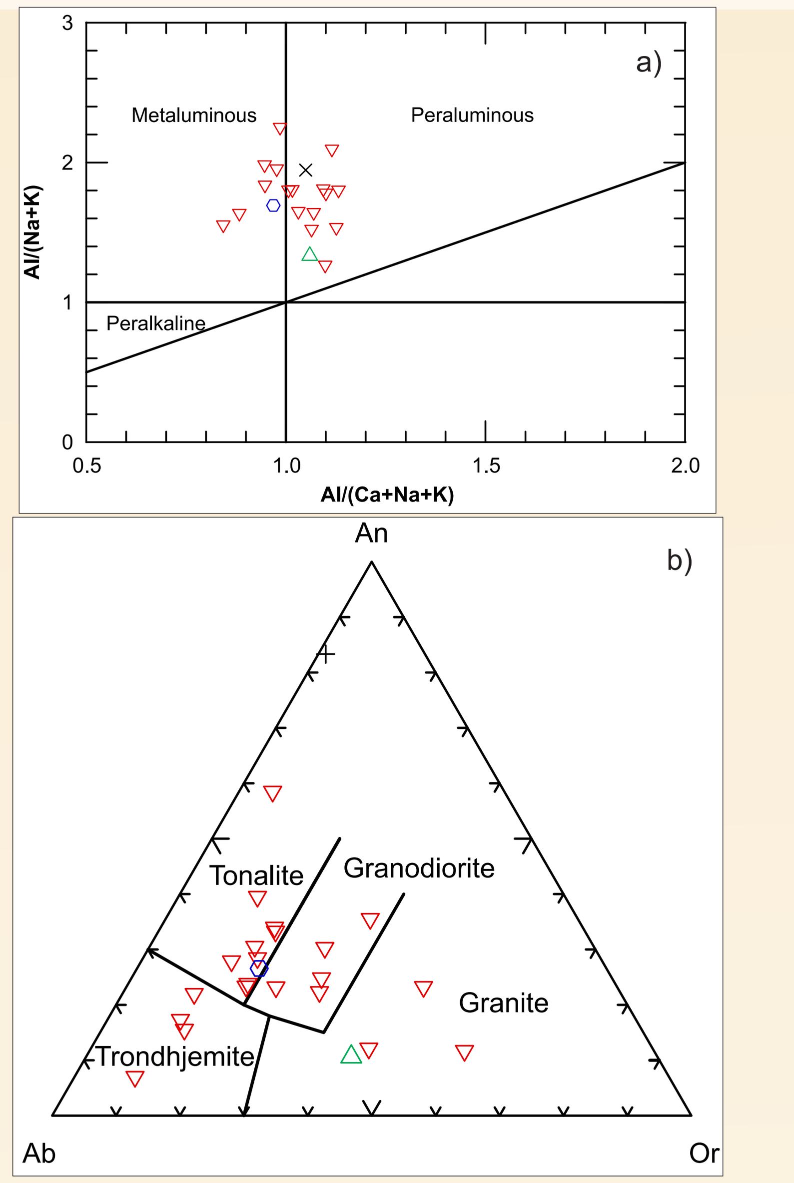


Fig. 8 Classification of granitoids: a) Shand index (after Maniar and Piccoli, 1989); b) plot of An-Ab-Or (after Barker, 1979). Symbols same as Fig. 7.

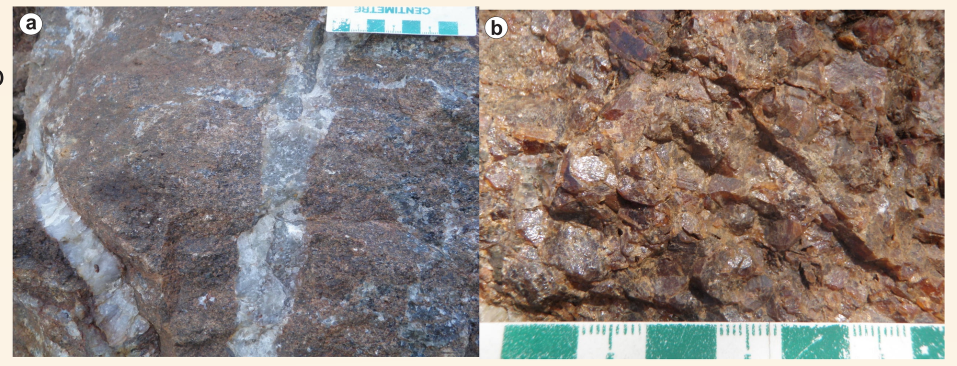


Fig. 9 Skarn Cu-Au-Ag mineralization in a boulder extracted from the Cat Lake Au-Ag mine: a) massive scapolite-garnet skarn cut by chalcopyrite-pyrite–bearing quartz veins; b) enlarged view of euhedral to subhedral garnet crystals in (a).

Geodynamic evolution and mineralization

Magmatic Ni-Cu-PGE-Cr mineralization (e.g., Euclid Lake chromite deposit, New Manitoba mine), probably formed in an extensional, continental-margin setting;

Porphyry Cu (Au) and skarn Cu-Au-Ag mineralization (e.g., Cat Lake Au-Ag mine; Fig. 9), related to arc magmatism and the TTG suite in an environment akin to a modern suprasubduction setting (Figs. 7& 8);

Rare metal–bearing pegmatites (e.g., Irgon mine at Cat Lake), related to younger peraluminous granitoid rocks (units 8, 9) emplaced in a continental-collision setting.

References

Bailes, A.H., Percival, J.A., Corkery, M.T., McNicoll, V.J., Tomlinson, K.Y., Sasseville, C., Rogers, N., Whalen, J.B. and Stone, D. 2003: Geology and tectonostratigraphic assemblages, West Uchi map area, Manitoba and Ontario; Manitoba Geological Survey, Open File OF2003-1, Geological Survey of Canada, Open File 1522, Ontario Geological Survey, Preliminary Map P.3461, 1:250 000 scale.

Barker, F. 1979: Trondhjemite; definition, environment and hypotheses of origin; In Barker, F. (ed.), Trondhjemites, dacites, and related rocks, p. 1-12.

Gilbert, H.P., Davis, D.W., Duguet, M., Kremer, P., Mealin, C.A. and MacDonald, J. 2008: Geology of the Bird River Belt, southeastern Manitoba (parts of NTS 52L5, 6); Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, Geoscientific Map MAP2008-1, scale 1:20000.

Miyashiro, A. 1974: Volcanic-rock series in island arcs and active continental margins; American Journal of Science, v. 274, p. 321–355.

Pearce, J.A., Harris, N.B.W. and Tindle, A.G., 1984. Trace element discrimination diagrams for the tectonic interpretation of granitic rocks; Journal of Petrology, v. 25, p. 956–983.

Ross, P.-S. and Bédard, J.H. 2009: Magmatic affinity of modern and ancient subalkaline volcanic rocks determined from trace-element discriminant diagrams; Canadian Journal of Earth Sciences, v. 46, p. 823–839.

Acknowledgments

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