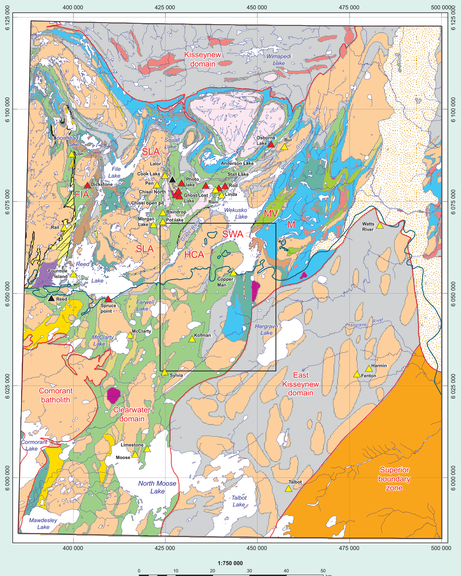
Drillcore observations from the south Wekusko Lake area, eastern Flin Flon belt, north-central Manitoba

K.D. Reid and S. Gagné

Introduction

During a two-week period in the summer of 2016 a total of 18 drillholes were examined and sampled in an effort to further understand the highly prospective sub-Phanerozoic extension of the Flin Flon belt directly south of Wekusko Lake. This work provides critical new data to constrain exploration models for VMS deposits in this geologically complex and challenging area.

The objectives of this season's fieldwork were to 1) document the volcanic facies and alteration associated with the Copper-Man deposit and rocks south of Wekusko Lake; 2) obtain additional whole-rock geochemical data for an area not covered by previous regional compilations; and 3) identify the extent, depositional facies and metamorphic grade of sedimentary rocks, interpreted as Burntwood group turbidites and Missi group sandstone and conglomerate, that extend south from Wekusko Lake, in order to understand the complex tectonostratigraphy of the area.



LATE INTRUSIVE
- Late intrusive rocks

SUCCESSOR-BASIN DEPOSITS
- Missi group
- Missi group volcanic rocks
- Burntwood group
- Schist-Wekusko assemblage
- Rocks of uncertain age
- Intrusive and supracrustal gneiss
- Tectonite, phyllonite, mylonite

SUCCESSOR-ARC PLUTONS
- Intrusive rocks
- Ultramafic rocks

JUVENILE ARC
- Juvenile-arc rocks
- Compositionally layered gabbro sills and intrusions
- Synvolcanic tonalite to granodiorite, granite

EVOLVED ARC
- Evolved-arc rocks

OCEAN FLOOR
- Ocean-floor rocks
- Synvolcanic mafic to ultramafic complexes

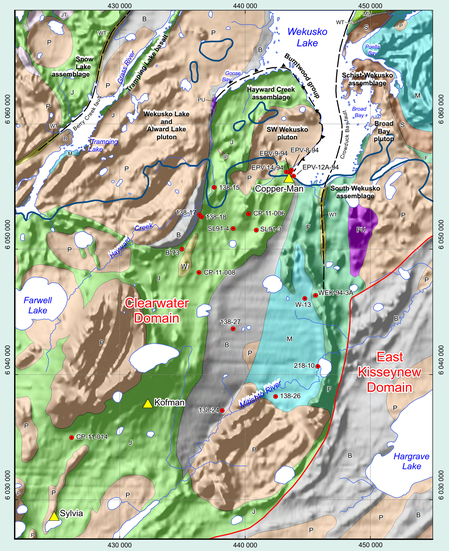
Other
- Paleoproterozoic and Archean
- Areas of no outcrop

- Domain boundary
- Fault
- Phanerozoic boundary edge
- Former producer
- Deposit
- Boundary of drillcore observations

Generalized geology of the exposed and sub-Phanerozoic eastern Flin Flon belt, showing major tectonostratigraphic assemblages/domains and volcanogenic massive-sulphide deposits. Box outlines the study area shown in Drillcore observations. Exposed tectonostratigraphic assemblages: FIA, Fourmile Island assemblage; HCA, Hayward Creek assemblage; M, Missi group; MV, Missi group volcanic rocks; SLA, Snow Lake assemblage; SWA, Schist-Wekusko assemblage. Thick red lines define sub-Phanerozoic domains.

References: **Bailes, A. H. and Galley, A. G. 2001**: Geochemistry and tectonic setting of volcanic and intrusive rocks in the VMS-hosting Snow Lake area assemblage, Flin Flon Belt, Manitoba: a preliminary release of the geochemical data set; Manitoba Industry, Trade and Mines, Geological Survey, Open File Report 2001-6, 1 CD-ROM.**Gagne, S. 2015**: Examination of exploration drillcore from the Reed Lake area, Flin Flon belt, west-central Manitoba (parts of NTS 63K9, 10): implications for the stratigraphy of the Fourmile Island assemblage and setting of VMS deposits; in Report of Activities 2015, Manitoba Mineral Resources, Manitoba Geological Survey, p. 38–51. **McDonough, W.F. and Sun, S.S. 1995**: The composition of the earth; in Chemical Evolution of the Mantle, W.F. McDonough, N.T.Arndt and S. Shirey (ed.). Chemical Geology, v. 120, p.225-234. **NATMAP Shield Margin Project Working Group 1998**: Geology, NATMAP Shield Margin Project Area (Flin Flon Belt), Manitoba/Saskatchewan; Geological Survey of Canada, Map 1968A, scale 1:100 000. **Pearce, J.A. 1996**: A users guide to basalt discrimination diagrams, in Trace Element Geochemistry of Volcanic Rocks: Applications for Massive Sulphide Exploration, D.A. Wyman (ed.). Geological Association of Canada, Short Course Notes, v.12, p.79-113. **Simard, R.L., McGregor, C.R., Rayner, N. and Creaser, R.A. 2010**: New geological mapping, geochemical, Sm-Nd isotopic and U-Pb data for the eastern sub-Phanerozoic Flin Flon Belt, west-central Manitoba (parts of NTS 63J3-6, 11, 12, 14, 63K1-2, 7–10); in Report of Activities 2010, Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, p. 69–87.**Sun, S.S. and McDonough, W.F. 1989**: Chemical and isotopic systematics of oceanic basalts: implications for mantle composition and processes; The Geological Society of London, Special Publications, v.42, p.313-345.

Drillcore observations



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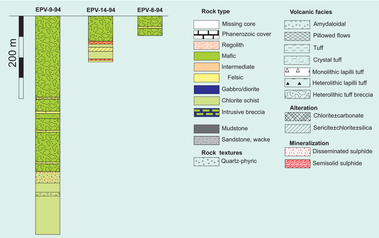
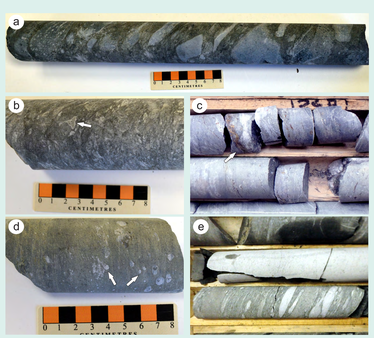
- J Juvenile-arc rocks
- JT Synvolcanic tonalite to granodiorite, granite

OCEAN FLOOR
- F Ocean-floor rocks

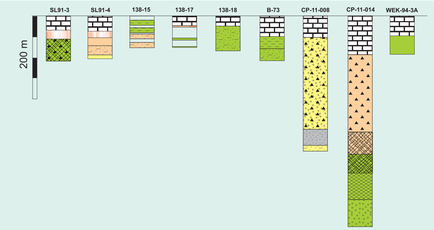
Scale 1:250 000 (0 5 km)
- Phanerozoic boundary edge
- Domain boundary
- Fault
- Thrust fault
- Diamond-drill hole
- Deposit

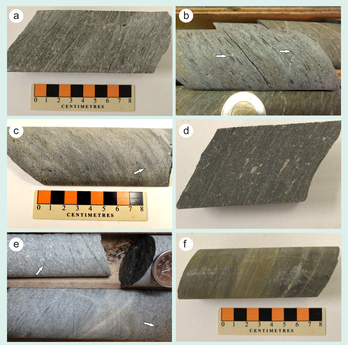
Geology of the south Wekusko Lake area (modified from NATMAP Shield Margin Project Working Group, 1998) underlain by hillshade and slope analyses of the residual total field magnetic survey.



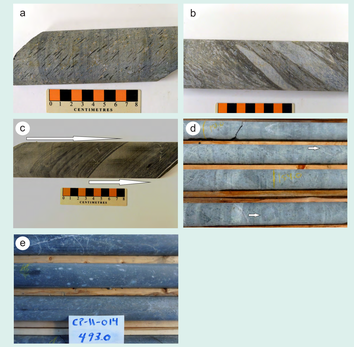


Volcanic rocks of the Copper-Man deposit: **a**) heterolithic tuff breccia showing quartz-phyric dacitic fragments and mafic fragments of various compositions in a fine-grained, green pyroxene–phyric tuff matrix, EVP-9-94, 349 m; **b**) silicified, shard-like, felsic lapilli fragments (arrow) in a green-grey tuff matrix, EVP-9-94, 247 m; **c**) stringer sphalerite and chalcopyrite (arrow) in chloritized footwall basalt, EVP-9-94, 412 m; **d**) chloritized basalt with quartz amygdules (arrows), EVP-9-94, 379 m; **e**) coherent dacite and heterolithic tuff breccia, EVP-8-94, 24 m.

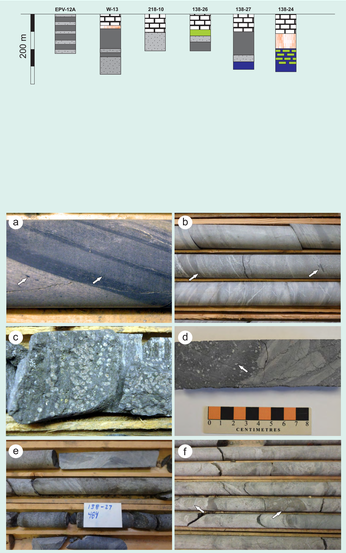




Volcanic rocks from the south Wekusko Lake area: **a**) mafic feldspar-crystal tuff, SL91-3, 60.4 m; **b**) mafic lapilli tuff that is pervasively chlorite altered and contains 'pinhead' garnets in the matrix (arrows show flattened lapilli), SL91-3, 98.8 m; **c**) clast-supported breccia with jigsaw fit (arrow shows clast outline), SL91-4, 113.7 m; **d**) mafic feldspar-crystal tuff, 138-17, 46.6 m; **e**) feldspar-crystal tuff with a few flattened mafic lapilli (arrows), 138-18, 63.4 m; **f**) weakly laminated mafic tuff, B-73, 70.1 m.



Volcanic rock types from the south Wekusko Lake area: **a**) quartz-phyric dacite with mafic lapilli, CP-11-008, 192 m; **b**) heterolithic tuff breccia with chloritized matrix, CP-11-008, 262.5 m; **c**) bedded feldspathic wacke (arrows show two fining sequences), CP-11-008, 290.7 m; **d**) intermediate feldspar-pyroxene–crystal tuff with block-size clasts (arrows show clasts), CP-11-014, 155.5 m; **e**) silicified basalt with 1 cm quartz amygdules, CP-11-014, 493 m.



Sedimentary and plutonic rocks from south Wekusko Lake area: **a**) sharp contact between pebbly sandstone with quartz and lithic grains (left arrow) and garnet/staurolite–bearing mudstone beds (right arrow), EPV-12A, 112.5 m; **b**) pebbly sandstone bed with well-developed basal scour into underlying mudstone (left arrow) and mudstone rip-up clasts (right arrow), W-13, 167.6 m; **c**) andalusite porphyroblasts in dark grey mudstone, W-13, 86.9 m; **d**) chiastolite (andalusite) crosses in dark grey mudstone, 138-27, 59.1 m; **e**) quartz diorite intercalated with wacke, 138-27, 147.2 m; **f**) xenoliths of andesite (left arrow) and sulphide (right arrow) in quartz diorite/gabbro, 138-24, 158.5 m.

Geochemistry

Key characteristics

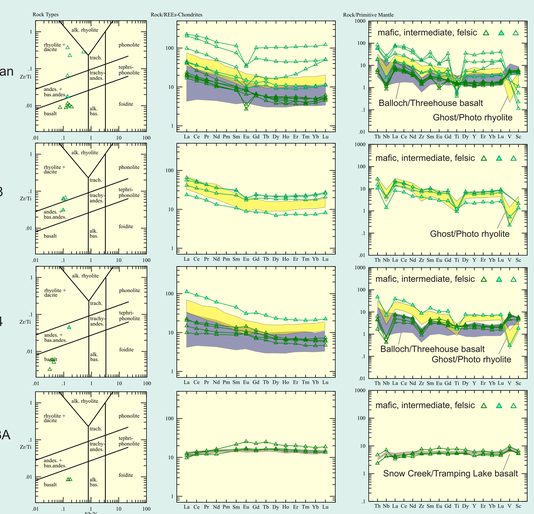
- Variety of felsic, intermediate and mafic volcanic rocks.

- LREE enriched - similar to rocks of the mature 'evolved' arc of the Snow Lake assemblage (see Balloch/ Threehouse basalt and Ghost/Photo rhyolite).

- Distinct Nb, Zr, and Ti depletion characteristic of VMS hosting volcanic arc rocks.

- Basalt from WEK-94-3A and 138-26 are very similar to the Snow Creek and Tramping Lake arc-rift/ocean-floor basalts, showing flat chondrite normalized REE and imcompatible element normalized profiles.

- Although the Copper-Man and Kofman VMS deposits are proximal to each other, the Copper-Man has LREE and incompatible element enriched profiles whereas Kofman has flat REE and incompatible element profiles (see Simard et al. 2010), possibly representing mature and primitive arc settings, respectively.



Economic potential

Volcanogenic Cu-Zn-Ag-Au
- Bimodal (felsic and mafic) volcanic rocks of arc affinity.
- Similar 'evolved' geochemical signature as the prolific VMS hosting Chisel sequence of the Snow Lake assemblage.
- Widespread hydrothermal alteration (i.e., epidote, chlorite).
- Known VMS mineralization and potential to contain prolific VMS deposits like the Snow Lake assemblage.

All data indicate that the area south of Wekusko Lake is highly prospective for VMS exploration. The volcanic rocks intersected in drillhole 138-15 are reported to contain 1.02% Zn between 58.8 and 60.1 m (Assessment File 92428). A more recent drillhole (CP-11-006) intersected a disseminated sulphide lens between 222 and 234 m that contains sphalerite mineralization, including a short interval (0.35 m) containing 3.93% Zn (Assessment File 63J1159).

Magmatic Ni-Cu±Co±PGE
The Reed Lake–Wekusko Lake area includes Ni-Cu±Co±PGE sulphide deposits (e.g., Rice Island) and occurrences of Ni-PGE±Co mineralization, indicating significant regional potential for these types of deposit, which have historically received little exploration attention in the region south of Wekusko Lake. As such, sulphide-graphite–rich intermediate tuff and dacite intruded by gabbro in drillcore 138-24 represent a sub-Phanerozoic example of a magmatic system that could produce Ni-Cu±Co sulphide deposits. Historically, the core was partially split and sampled for Cu-Zn but not assayed for Ni, Co or platinum-group elements (Assessment File 92428). Identifying fertile magmatic systems, similar to Rice Island, will be a part of the focus for future work in the sub-Phanerozoic Flin Flon belt.

Acknowledgements

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