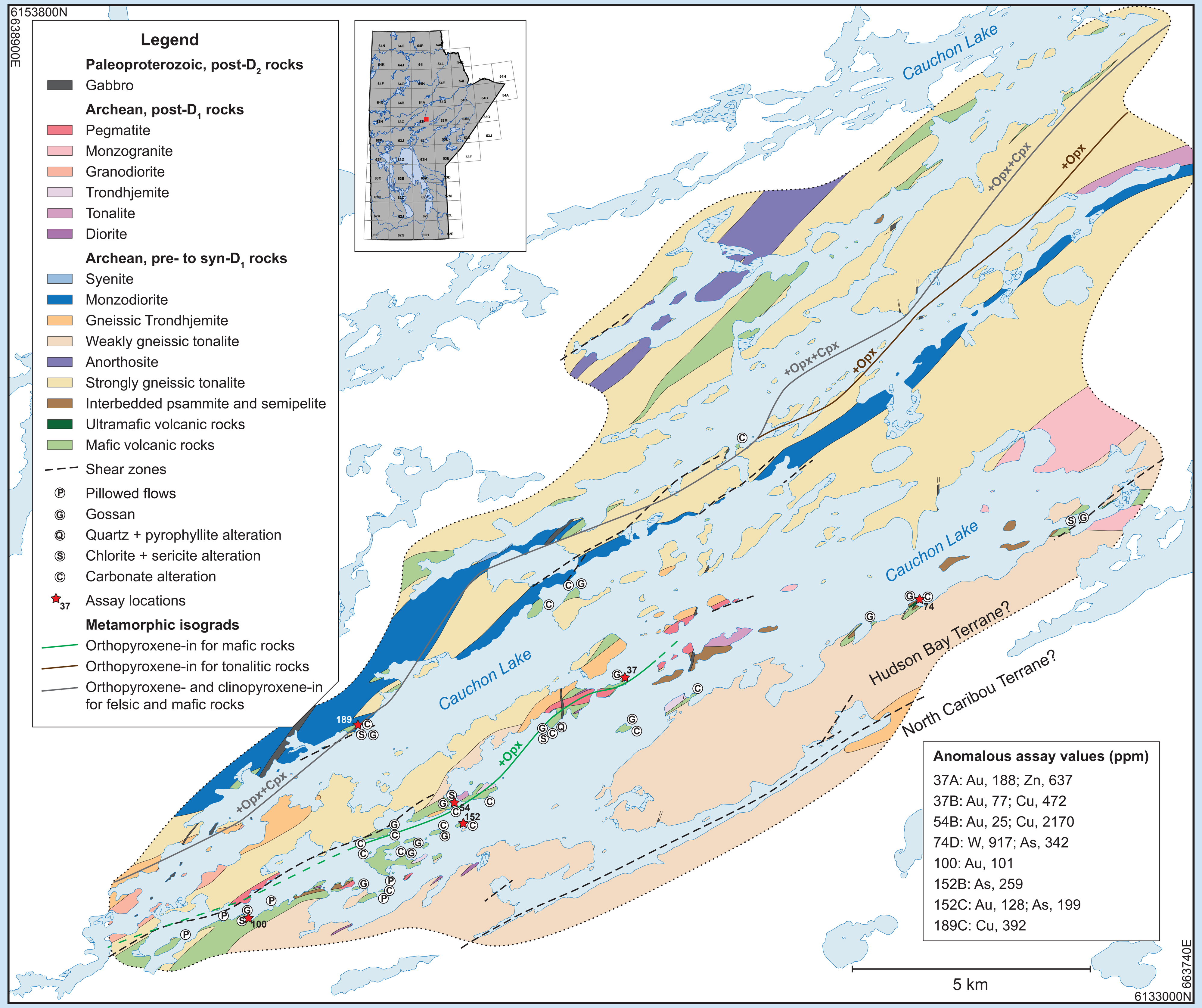
Preliminary results from bedrock mapping in the Cauchon Lake area, eastern margin of the Pikwitonei granulite domain, Manitoba.

C.G. Couëslan and V.E. Guevara

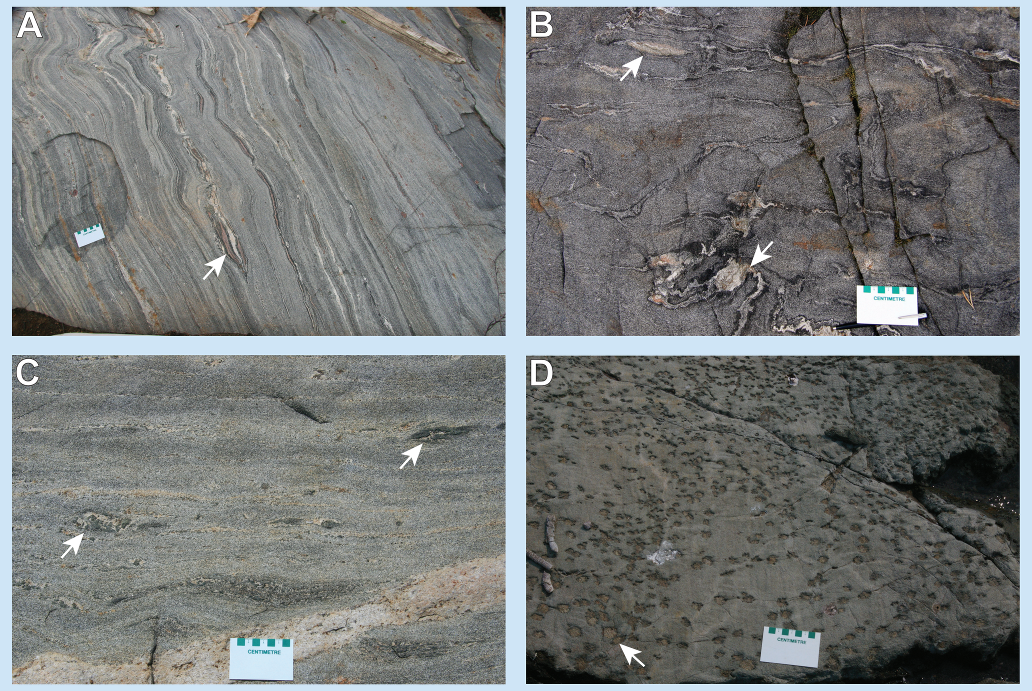


Summary

A project to re-map portions of the Archean Pikwitonei granulite domain in central Manitoba, with emphasis on interpretation of protoliths, continued in 2015 with mapping in the central and southern areas of Cauchon Lake. Exposures in area can be divided into three main groups based on structural observations: Archean pre- to syn-D_1 rocks, Archean post-D_1 rocks, and Paleoproterozoic post-D_2 rocks. Pre- to syn-D_1 rocks include metamorphosed mafic volcanic and associated rocks, psammite and semipelite, iron formation and chert, anorthosite, gneissic tonalite and trondhjemite, and monzodiorite. Post-D_1 rocks consist of metamorphosed intrusive rocks that range in composition from diorite to monzogranite. Post-D_2 rocks consist of unmetamorphosed Paleoproterozoic diabase and gabbro dikes. The oldest group of rocks in the Cauchon Lake area display an S_1 gneissosity. This early gneissosity is cut by M_1 leucosome that formed at upper amphibolite- to granulite-facies metamorphic conditions, which affected all Archean rocks in the area. The rocks were then isoclinally folded and transposed during D_2 deformation, which generated S_2 fabrics in all Archean phases.

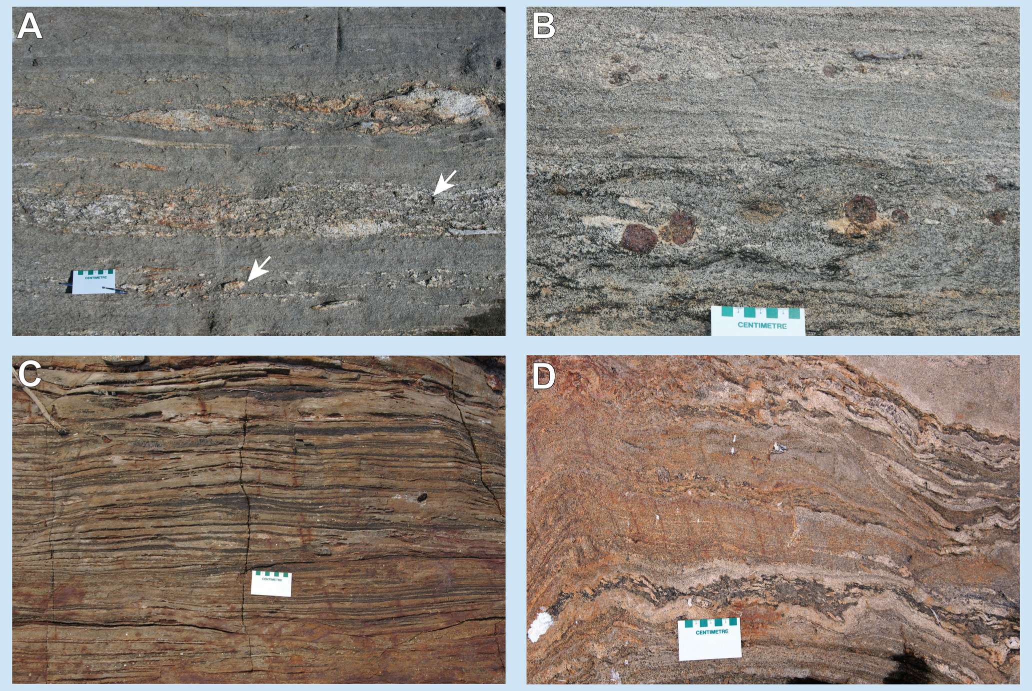
The mafic volcanic rocks were subjected to widespread hydrothermal alteration prior to high-grade regional metamorphism. Carbonate alteration is the dominant style of alteration; however, evidence for chlorite + sericite and quartz + pyrophyllite alteration is also present. These styles of alteration suggest potential for both gold and volcanogenic massive sulphide mineralization.

Mafic volcanic rocks



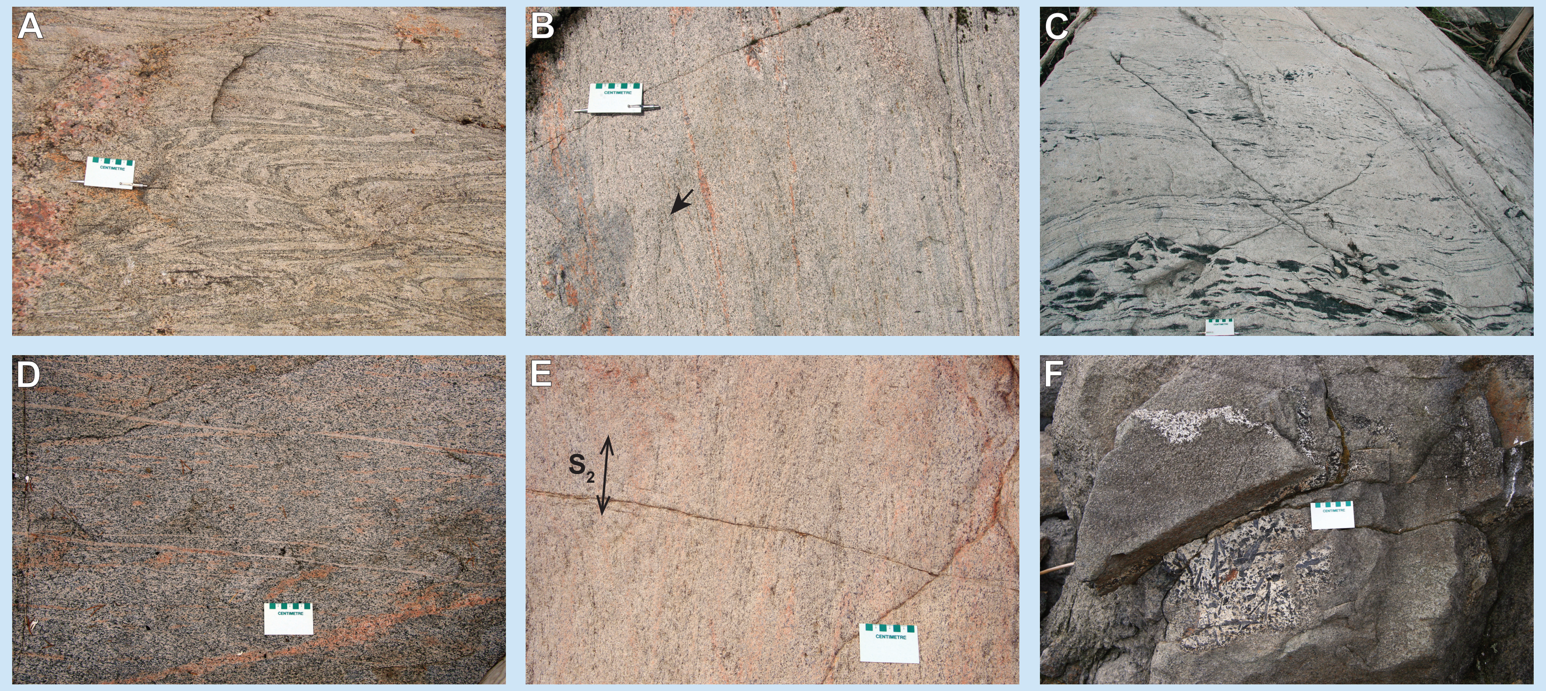
A) Diffusely banded mafic volcanic rocks with local pods of garnet-rich calcsilicate (arrow). B) Deformed pillow selvedges and calcsilicate pods (arrows) in mafic volcanic rocks. C) Mafic volcanic rocks with granulite-facies metamorphic assemblages and local relict pods of calcsilicate (arrows). D) Ultramafic volcanic rocks with aggregates of olivine (arrow, station 74).

Sedimentary rocks



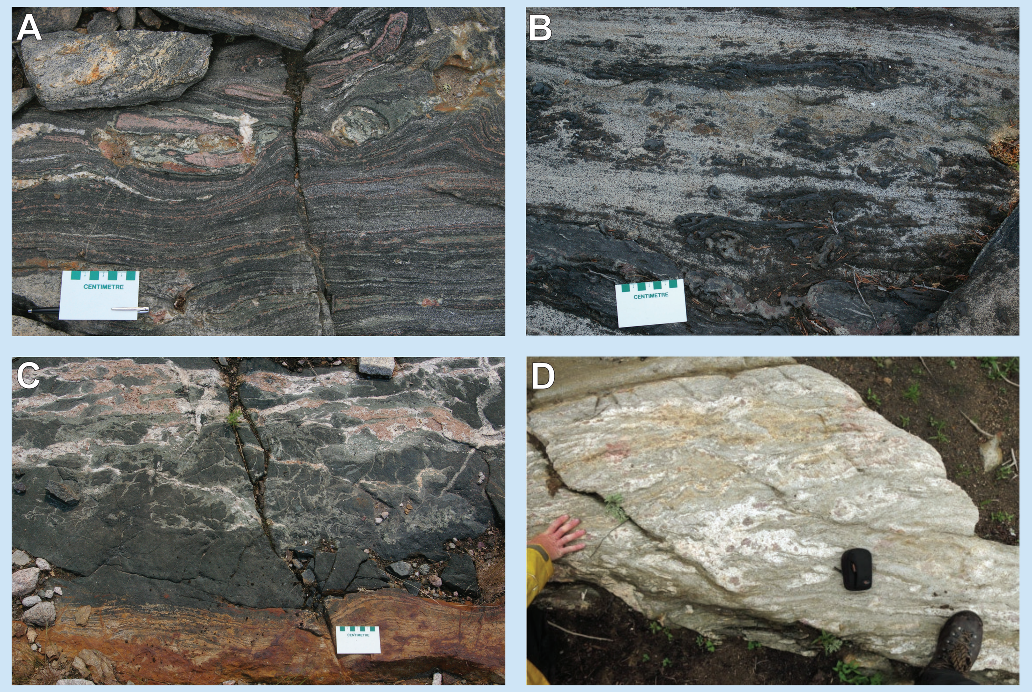
A) Psammite interbedded with semipelitic diatexite (arrows). B) Semipelitic diatexite with garnet porphyroblasts. C) Iron formation overlying ultramafic volcanics at station 74. D) Locally sulphidic chert interlaminated with pelite at station 37.

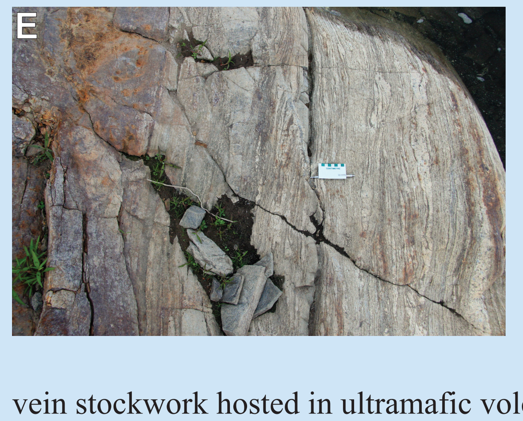
Intrusive rocks



A) Strongly gneissic tonalite with S_1 gneissosity folded by F_2 and intruded by a discordant pegmatite injection (left edge of photo). B) Gneissic trondhjemite with diffuse, folded gneissosity (arrow). C) Anorthosite from the northwest portion of the map area. D) Monzodiorite with attenuated pods and veins of syenitic leucosome or injection. E) Granodiorite with strong S_2 quartz fabric. F) Gabbro dike, assumed to be related to the ca. 1880 Ma Molson swarm, with pegmatitic segregation (left of, and above, the scale card).

Economic considerations





A) Strongly altered mafic volcanic rocks (station 54) consisting of alternating garnet-, hornblende-, and diopside-rich bands with local garnet-, diopside-, and carbonate-rich calcsilicate boudins (arrow). B) Marble with calcsilicate lenses interpreted as intensely carbonate-altered mafic volcanic rocks (station 152). C) Quartz- carbonate vein stockwork hosted in ultramafic volcanic rocks at station 74. The ultramafic volcanics are overlain by iron formation (bottom of photo). D) Schist containing abundant biotite, sillimanite, and garnet ± staurolite, interpreted as intensely chloritized and sericitized mafic volcanic rocks (station 54). E) Garnet-, cordierite-, and sillimanite-bearing rock, interpreted as altered volcanic rock, in contact with 1.5 m wide gossanous zone (left side of photo, station 189).

Evidence for metamorphosed hydrothermal alteration zones is relatively common in the mafic volcanic rocks of the south basin of Cauchon Lake. Zones of pervasive carbonate alteration are manifested by discontinuous bands of marble and heterogeneous diopside-rich, hornblende-rich, and garnet-rich bands within the mafic volcanic rocks. Pods, stringers, and local vein networks of calcsilicate ± quartz ± carbonate likely represent metamorphosed quartz-carbonate veins. Local bands of 'pelitic' schist likely represent metamorphosed zones of chlorite + sericite alteration, whereas bands of quartz + sillimanite likely represent metamorphosed quartz + pyrophyllite alteration. Local quartz-rich bands could represent zones of metamorphosed silicification. In all cases, the presence of high-grade, peak metamorphic mineral assemblages and deformation fabrics suggests that hydrothermal systems were active in the volcanic rocks prior to high-grade metamorphism.

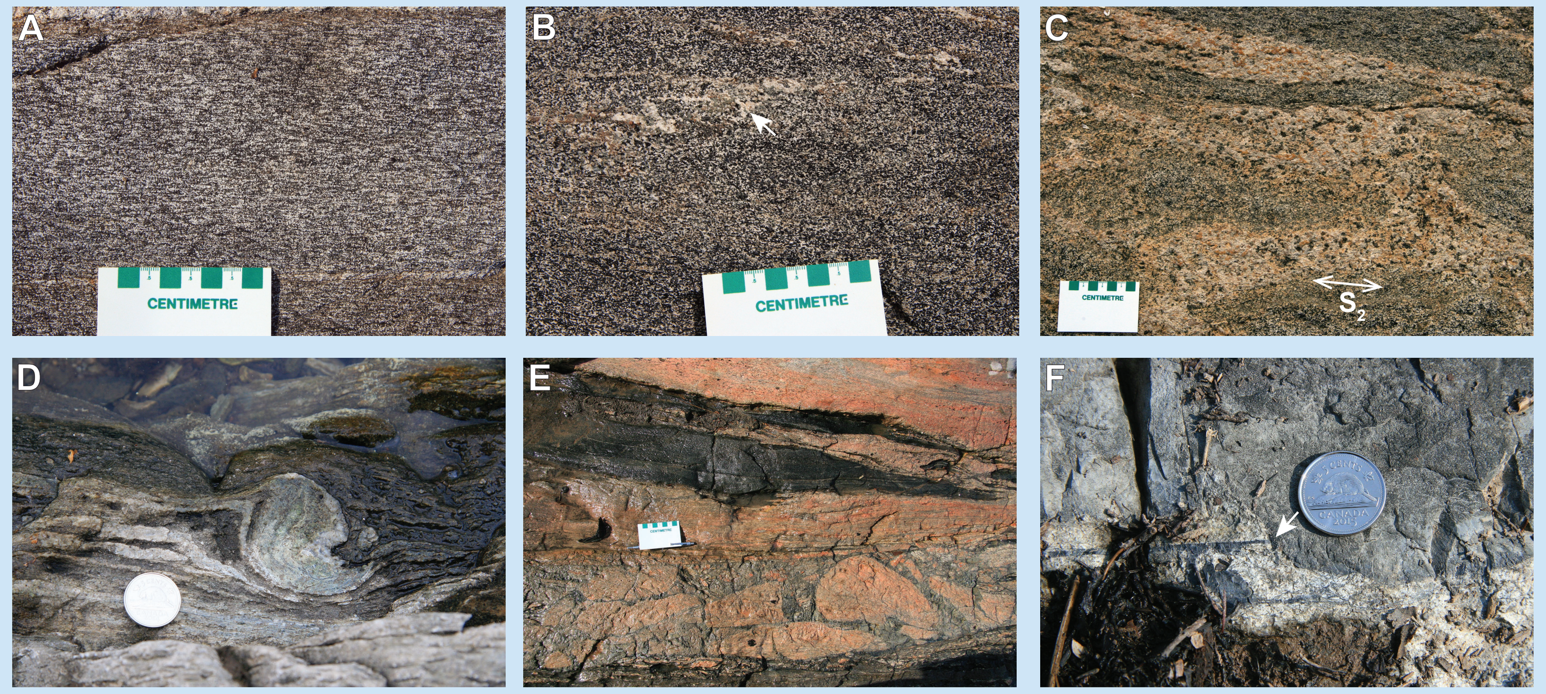
Pervasive carbonate alteration occurs in several outcrops of the mafic volcanic rocks, and there is local evidence for attenuated quartz-carbonate vein stockworks. This style of alteration is commonly associated with orogenic gold mineralization (Robert, 1995; Dubé and Gosselin, 2007). The close proximity of the mafic volcanic rocks with the southern margin of the Hudson Bay terrane and a potential terrane-bounding fault could therefore make this area favourable for orogenic gold mineralization. Crustal-scale fault zones act as major pathways for hydrothermal fluids, and gold deposits are often associated with second- and third-order, oblique shear and high-strain zones located within 5 km of the main fault (Dubé and Gosselin, 2007).

The mafic volcanic rocks locally host and are locally overlain by iron formation and sulphidic chert. Iron formations are known to form chemical traps for sulphide- and gold-bearing fluids channeled along fold hinges, shear zones or faults in many Archean and Paleoproterozoic greenstone belts (Kerswill, 1995). This association is also found in greenstone belts in the northwestern Superior craton (including at Bear, Utik and Oxford lakes), where gold and base metals are associated with altered volcanic rocks and exhalative deposits (Hartlaub and Böhm, 2006; Böhm et al., 2007; Anderson et al., 2012).

There is also some potential for volcanogenic massive sulphide (VMS) mineralization in the Cauchon Lake area. Pillows indicate a subaqueous environment for at least some of the mafic volcanic rocks, and a limited dataset of bulk rock geochemical analyses suggest a volcanic arc setting (Couëslan, 2014). Iron formations and sulphidic chert suggest the magmatism was accompanied by exhalative sedimentation. Bands of intense chlorite + sericite alteration indicate flow of hydrothermal fluids which could have transported base metals and sulphides. Quartz + pyrophyllite ±sulphide alteration indicate focused flow of hot, acidic fluid. These types of alteration are typically found in the footwall of VMS deposits, with the most intense quartz + aluminosilicate alteration occurring proximal to the deposit (e.g., Galley et al., 2007; Hudak, 2015).

Assay	Au	Ag	Cu	Pb	Ni	Zn	S	Ba	Ca	Co	Cr	Fe	Mn	Sr	V	W	As
	ppb	ppm	ppm	ppm	ppm	ppm	%	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
108-15-037A	188	< 0.3	18	6	8	637	0.04	< 50	1.53	14	10	32	1030	12	9	< 1	2.6
108-15-037B	77	< 0.3	472	5	6	38	0.19	< 50	1.48	8	51	4.91	429	36	26	28	2.6
108-15-054B	25	0.7	2170	< 3	38	76	0.88	< 50	4.81	33	160	15.4	4400	8	242	< 1	5.3
108-15-074D	< 2	< 0.3	2	< 3	809	96	< 0.01	< 50	11.9	73	1650	6.74	2370	284	133	917	342
108-15-074G	2	0.4	231	19	155	192	1.78	< 50	4.13	38	335	9.63	326	571	90	< 1	23.4
108-15-100	101	0.8	123	14	13	67	0.95	180	1.69	< 1	7	3.3	247	199	4	< 1	21.9
108-15-152B	< 2																259
108-15-152C	128	< 0.3	119	< 3	34	52	0.05	< 50	17	19	57	8.46	3730	65	40	< 1	199
108-15-189C	< 2	< 0.3	392	8	112	324	2.47	< 50	6.23	57	32	9.3	1360	13	22	< 1	3.2

Structure and metamorphism



Metamorphic isograds striking northeast (see map figure) indicate a metamorphic field gradient with increasing metamorphic grade towards the northwest. Mafic volcanic rocks in the southern-most portion of the map area are characterized by upper amphibolite-facies metamorphic assemblages with no orthopyroxene or leucosome (A). (B) Increasing metamorphic grade results in the first appearance of orthopyroxene and incipient leucosome development (arrow). In the northern portions of the map area, the mafic volcanic rocks are characterized by two pyroxene, granulite-facies assemblages with abundant leucosome (C). The leucosome commonly transects the S_1 gneissosity and has an S_2 foliation, indicating that metamorphism post-dates D_1 but was outlasted by D_2. D) Protomylonitic to mylonitic shear zones are common in the southern basin of the map area, and both sinistral and dextral (pictured) shear-sense indicators are observed. E) Subparallel veins of pseudotachylite locally overprint the mylonite zones (below scale card). F) A pseudotachylite vein cross-cut by a mafic dike interpreted to be part of the ca. 1880 Ma Molson dike swarm (arrow), this indicates that the brittle faulting pre-dates the Trans-Hudson orogeny.

Acknowledgements

Thanks to K. Crawford for assistance in the field and remaining cheerful through the worst of hailstorms. Thanks to N. Brandson and E. Anderson for logistical support, and Wings Over Kississing for providing air services. Thanks to Vale Exploration - Thompson for accomodating us while transiting through Thompson. Thanks to M. Caddick and B. Dragovic (Virginia Tech) for many enlightening field and metamorphic geology discussions.

References

Anderson, S.D., Kremer, P.D. and Martins, T. 2012: Preliminary results of bedrock mapping at Oxford Lake, northwestern Superior province, Manitoba (parts of NTS 53L12, 13, 63I9, 16); in Report of Activities 2012, Manitoba Innovation, Energy and Mines, Manitoba Geological Survey, p. 6–22.

Böhm, C.O., Kremer, P.D. and Syme, E.C. 2007: Nature, evolution and gold potential of the Utik Lake greenstone belt, Manitoba (parts of NTS 53M4, 5, 63P1, 8); in Report of Activities 2007, Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, p. 98–113.

Couëslan, C.G. 2014: Mapping progress in the Pikwitonei granulite domain: tectonic and economic implications; Manitoba Mineral Resources, Manitoba Geological Survey, Manitoba Mining and Minerals Convention 2014, Winnipeg, Manitoba, November 19–21, 2014, oral presentation, URL < https://www.youtube.com/embed/1M-9_jHzjKs>.

Dubé, B. and Gosselin, P., 2007: Greenstone-hosted quartz-carbonate vein deposits; in Mineral Deposits of Canada: a Synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods, W.D. Goodfellow (ed.), Geological Association of Canada, Mineral Deposits Division, Special Publication, no. 5, p. 49–73.

Galley, A.G., Hannington, M.D. and Jonasson, I.R. 2007: Volcanogenic massive sulphide deposits; in Mineral Deposits of Canada: a Synthesis of Major Deposit-Types, District Metallogeny, the Evolution of Geological Provinces, and Exploration Methods, W.D. Goodfellow (ed.), Geological Association of Canada, Mineral Deposits Division, Special Publication, no. 5, p. 141–161.

Hartlaub, R.P. and Böhm, C.O. 2006: Preliminary results from geological mapping of the Bear Lake greenstone belt, Manitoba (parts of NTS 53M4 and 63P1); in Report of Activities 2006, Manitoba Science, Technology, Energy and Mines, Manitoba Geological Survey, p. 65–73.

Hudak, G.J. 2015: Field trip 10: Mattabi/Sturgeon Lake historic VMS camp; in Proceedings of the 61st Institute on Lake Superior Geology annual meeting: part 2, A. MacTavish, P. Hollings (ed.), Institute on Lake Superior Geology, p. 116–151.

Kerswill, J. A. 1995: Iron formation-hosted stratabound gold; in Chapter 15 of Geology of Canadian Ore Deposit Types, O.R. Eckstrand, W.D. Sinclair and R.I. Thorpe (ed.), Geological Survey of Canada, Geology of Canada, no. 8, p. 367–382 (also Geological Society of America, The Geology of North America, v. P-1).

Robert, F. 1995: Quartz-carbonate vein gold; in Chapter 15 of Geology of Canadian Ore Deposit Types, O.R. Eckstrand, W.D. Sinclair and R.I. Thorpe (ed.), Geological Survey of Canada, Geology of Canada, no. 8, p. 350–366 (also Geological Society of America, The Geology of North America, v. P-1).