Mapping, Metamorphism, and Magnesiocarbonatites of the Paint Lake Area, Manitoba.

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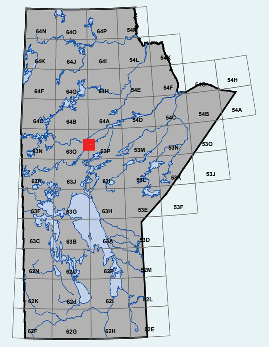

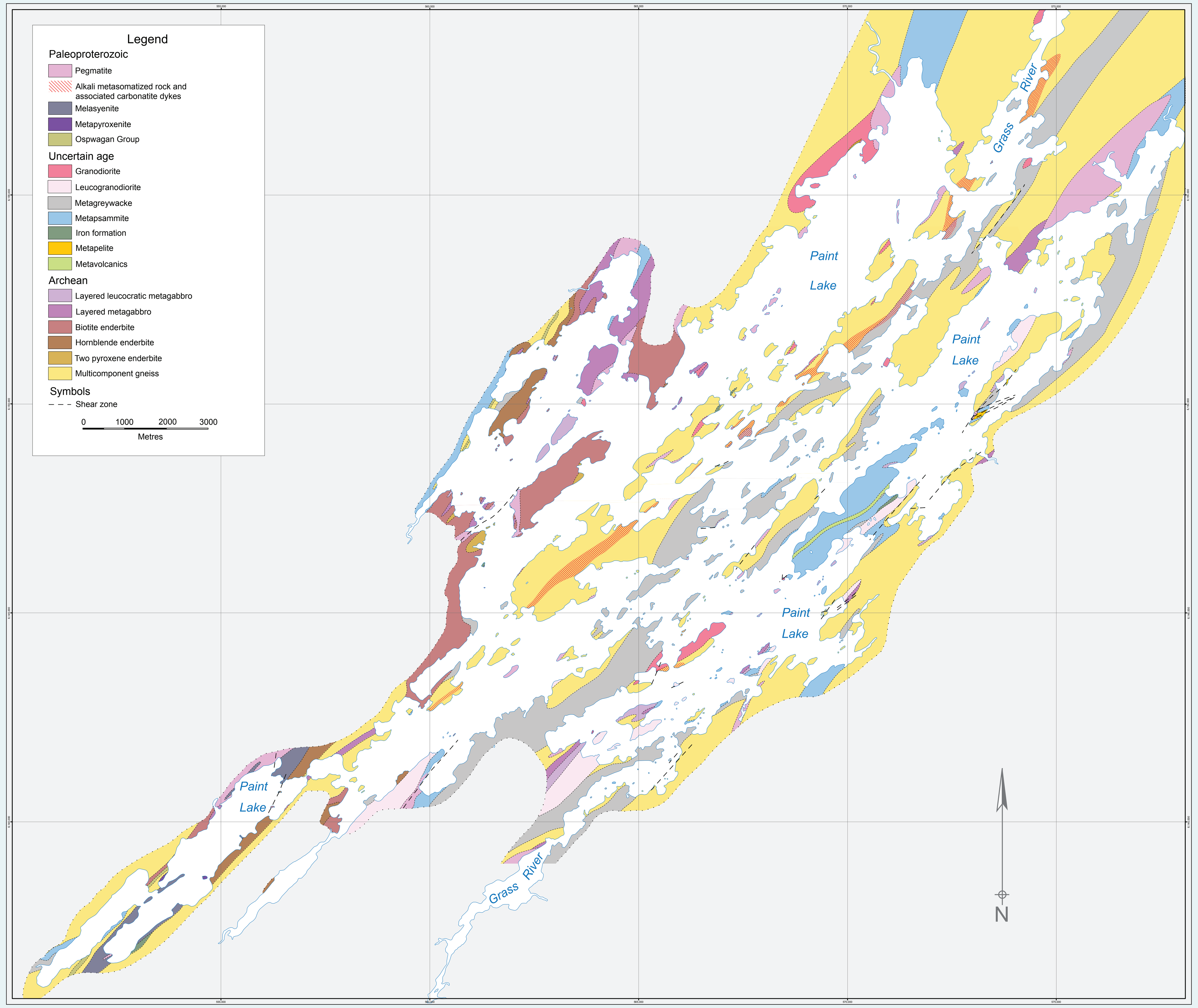

1) Summary

A geological mapping program of the Paint Lake area was completed in June 2010 with mapping at the north end of the lake. The area is underlain by largely multicomponent gneiss. Belts of metapsammite and metagreywacke with minor iron formation are continuous with metasediments mapped the previous year. Trace element and Sm-Nd isotope geochemistry suggests these metasediments are not correlative with the Proterozoic Ospwagan Group (Couëslan & Martins 2010). The Paint Lake metasediments appear to be sourced from an older, more mafic source than the Ospwagan Group. Although the Paint Lake metasediments do not appear to be correlative with the Ospwagan Group, they could act as a potential source of sulphur for intruding ultramafic bodies. Peak metamorphic assemblages from the Paint Lake area suggest conditions of 800–840 °C and 5–6.5 kbar. Relict andalusite in metapelitic gneiss suggest a low pressure prograde metamorphic path.

A zone of previously recognized carbonatite magmatism and metasomatism was traced northward into the Grass River area. The total documented strike length of this system is now 23 kilometres; however, the intensity of magmatism and metasomatism appears to be waning towards the north. Two types of carbonatites are identified in the Paint Lake area: calcite carbonatites, and calcite-dolomite carbonatites (Chakhmouradian *et al.* 2009, Couëslan 2009). Carbon and oxygen isotopic compositions support an igneous origin for the carbonatites, and the trace-element geochemistry is typical of postorogenic carbonatites. Detail mapping of two carbonatite outcrops suggests the carbonatites are intruding late in the tectonomagmatic history of the Paint Lake area. The dykes cross cut all phases but the latest pegmatite intrusions. Given the extraordinary strike length of the carbonatite magmatism and metasomatism, the potential for rare element mineralization is significant.

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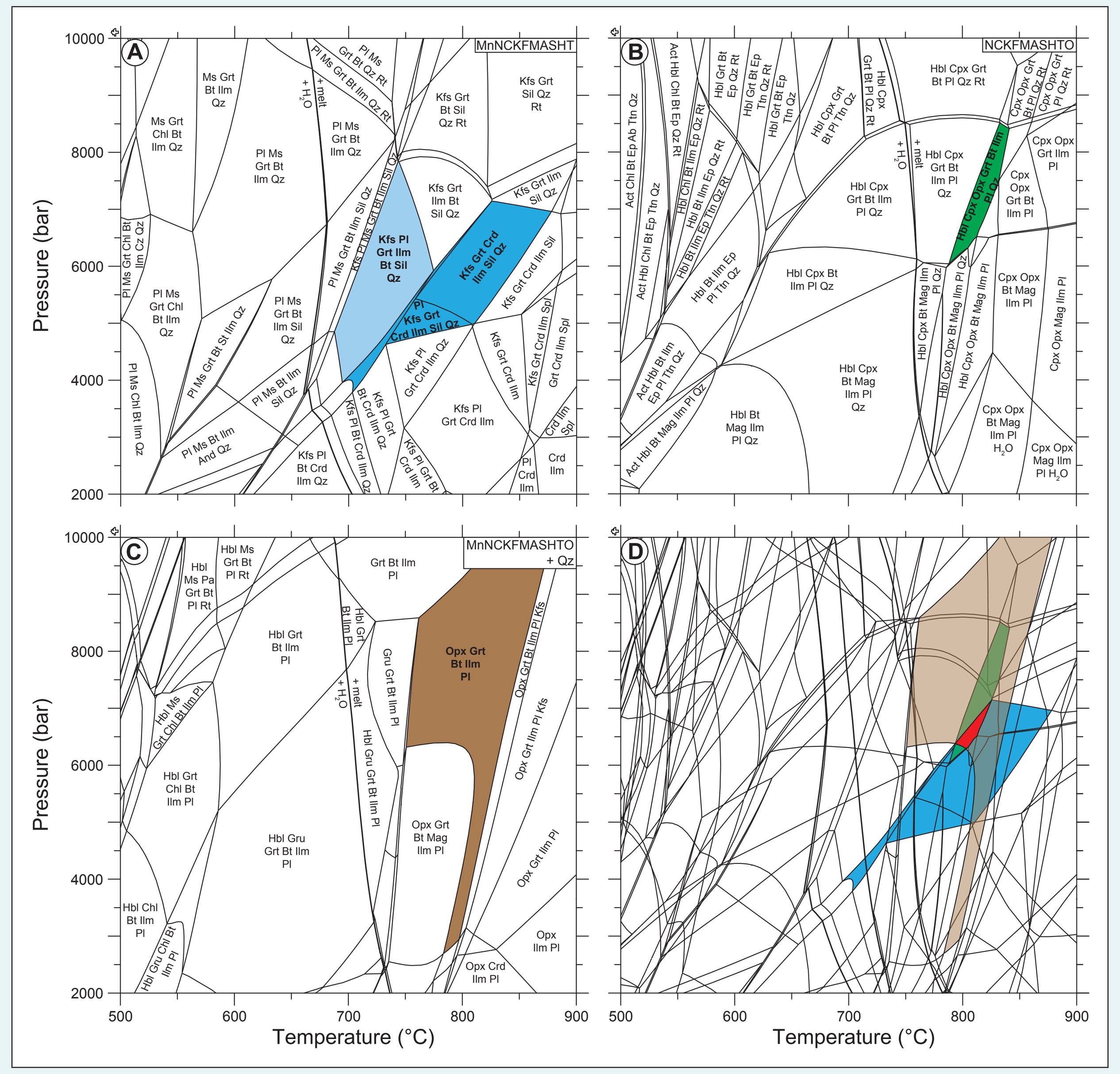
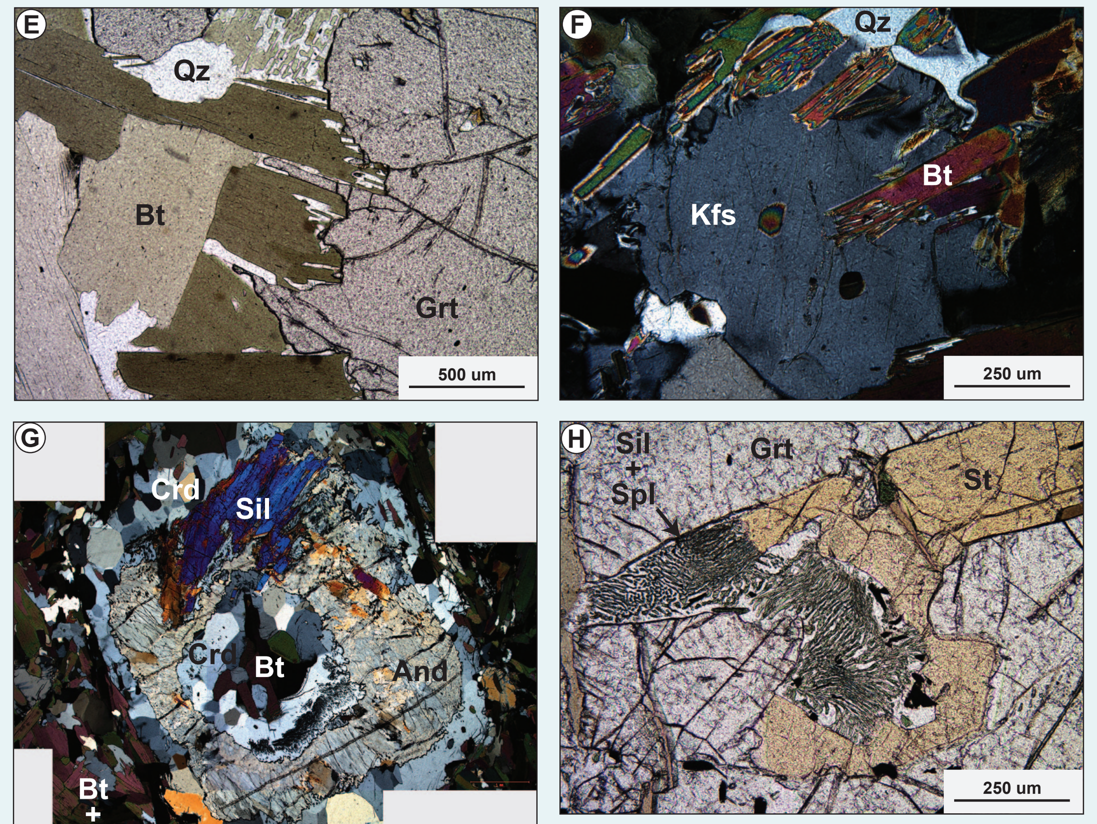
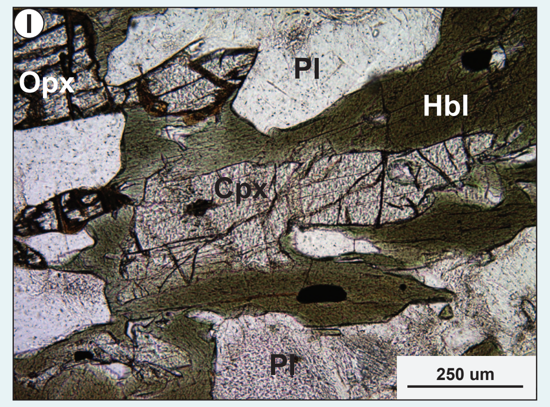
2) Metamorphism



A) Equilibrium assemblage diagram for Paint Lake metapelite in the system MnO-Na_2O-CaO-K_2O-FeO-MgO-Al_2O_3-SiO_2-H_2O-TiO_2. The light blue field identifies the observed assemblage in a sample of medium- to coarse-grained metapelite which may represent a relict, upper amphibolite-facies assemblage. The darker blue field represents the observed assemblage in a very coarse-grained sample and indicates granulite-grade conditions. Both metapelite samples contain relict andalusite suggesting a low pressure prograde path.
B) Equilibrium assemblage diagram for a metadiabase dyke in the system Na_2O-CaO-K_2O-FeO-Fe_2O_3-MgO-Al_2O_3-SiO_2-H_2O-TiO_2, with the observed assemblage marked in green. **C)** Equilibrium assemblage diagram for Paint Lake metagreywacke in the system MnO-Na_2O-CaO-K_2O-FeO-Fe_2O_3-MgO-Al_2O_3-SiO_2-H_2O-TiO_2 with the observed assemblage indicated in brown. **D)** An overlay of the three observed assemblages with the overlapping fields marked in red and indicating peak metamorphic conditions of *ca.* 790-825°C and 6-7 kbar.

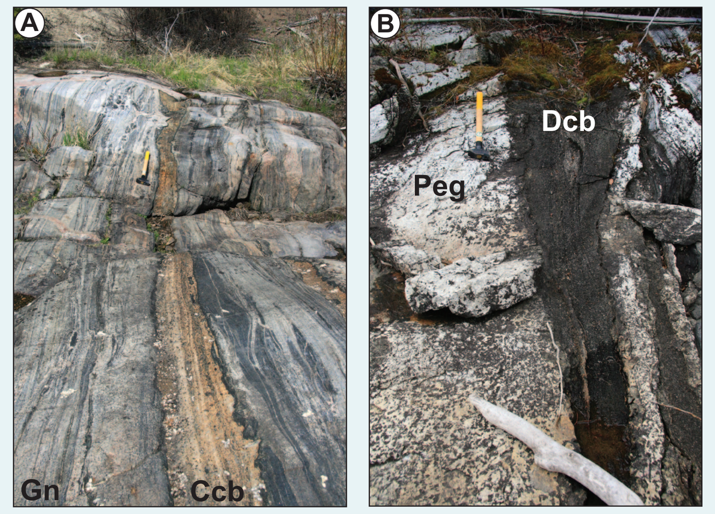


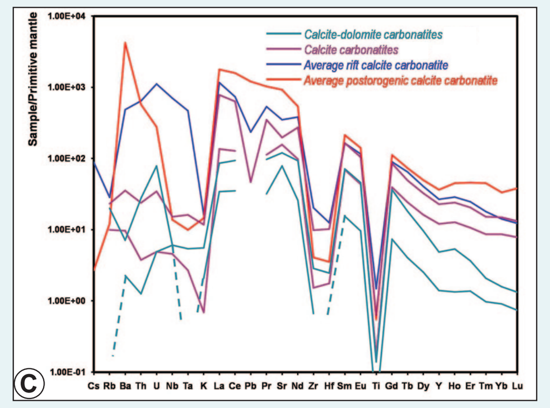


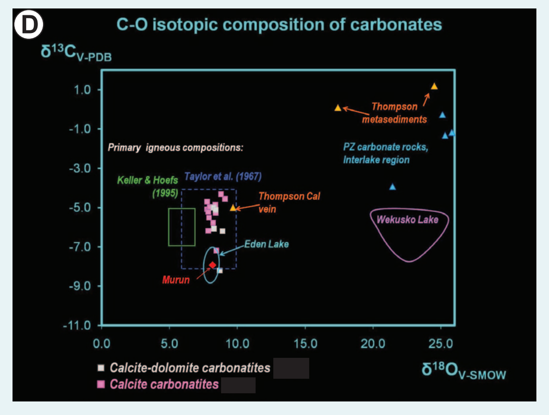
E) Retrograde replacement of garnet by biotite + quartz +/- plagioclase symplectite, and **F)** of potassium feldspar by biotite + quartz symplectite, in metapelite. Both textures suggest the reversal of the granulite-grade biotite consuming reaction: Bt + Sil + Qz +/- Pl = Grt + Crd + melt +/- Kfs. **G)** Relict andalusite partially replaced by sillimanite and cordierite indicating a low pressure, prograde metamorphic path for the metapelite. **H)** A staurolite inclusion in garnet replaced by sillimanite + spinel symplectite in metapelite. The texture is characteristic of staurolite breakdown, in an isolated system, above the second sillimanite isograd (Cesare 1994). **I)** Clinopyroxene and orthopyroxene partially replaced by retrograde hornblende + quartz. It is unclear if all hornblende is a retrograde product.

Abbreviations: Ab = albite, Act = actinolite, And = andalusite, Bt = biotite, Chl = chlorite, Cpx = clinopyroxene, Crd = cordierite, Cz = clinozoisite, Ep = epidote, Grt = garnet, Gru = grunerite, Hbl = hornblende, Ilm = ilmenite, Kfs = potassium feldspar, Mag = magnetite, Ms = muscovite, Opx = orthopyroxene, Pl = plagioclase, Qz = quartz, Rt = rutile, Sil = sillimanite, Spl = spinel, St = staurolite, Ttn = titanite.

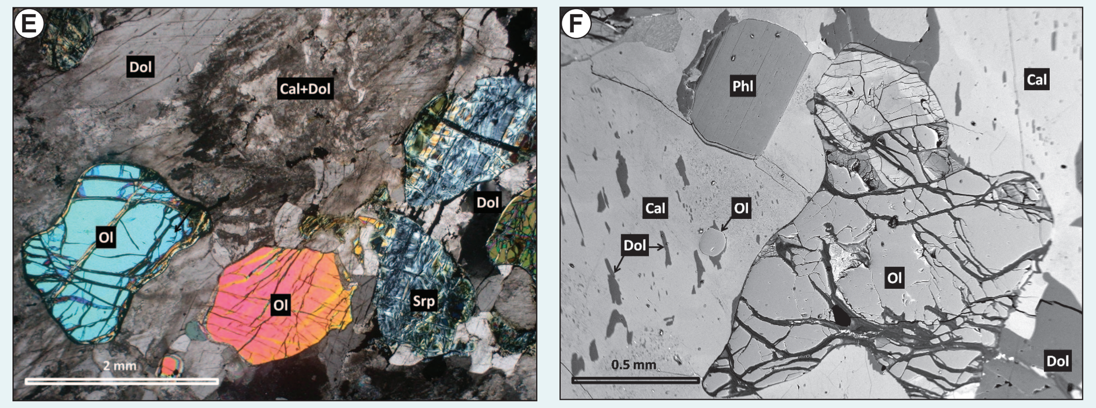
3) Carbonatites

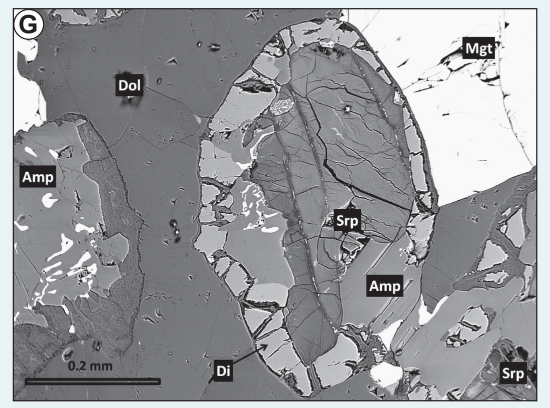






A) The largest calcite carbonatite dyke from detail map 4A), cuts the regional gneissocity at a low angle. **B)** Calcite-dolomite carbonatite dyke in central Paint Lake enclosed in metasomatized pegmatite. **C)** Normalized trace-element compositions of the Paint Lake carbonatites (primitive mantle of McDonough & Sun 1995) compared to the average composition of calcite carbonatite from different tectonic settings (Chakhmouradian, unpubl. data). The Paint Lake samples show depletion in Ti, Zr, Hf, Nb, and Ta, typical of postorogenic carbonatites. **D)** C-O isotopic compositions of the Paint Lake carbonatites compared to other examples from the literature. They plot similar to primary igneous compositions in contrast to Ospwagan Group metasediments from the Thompson Nickel Belt.

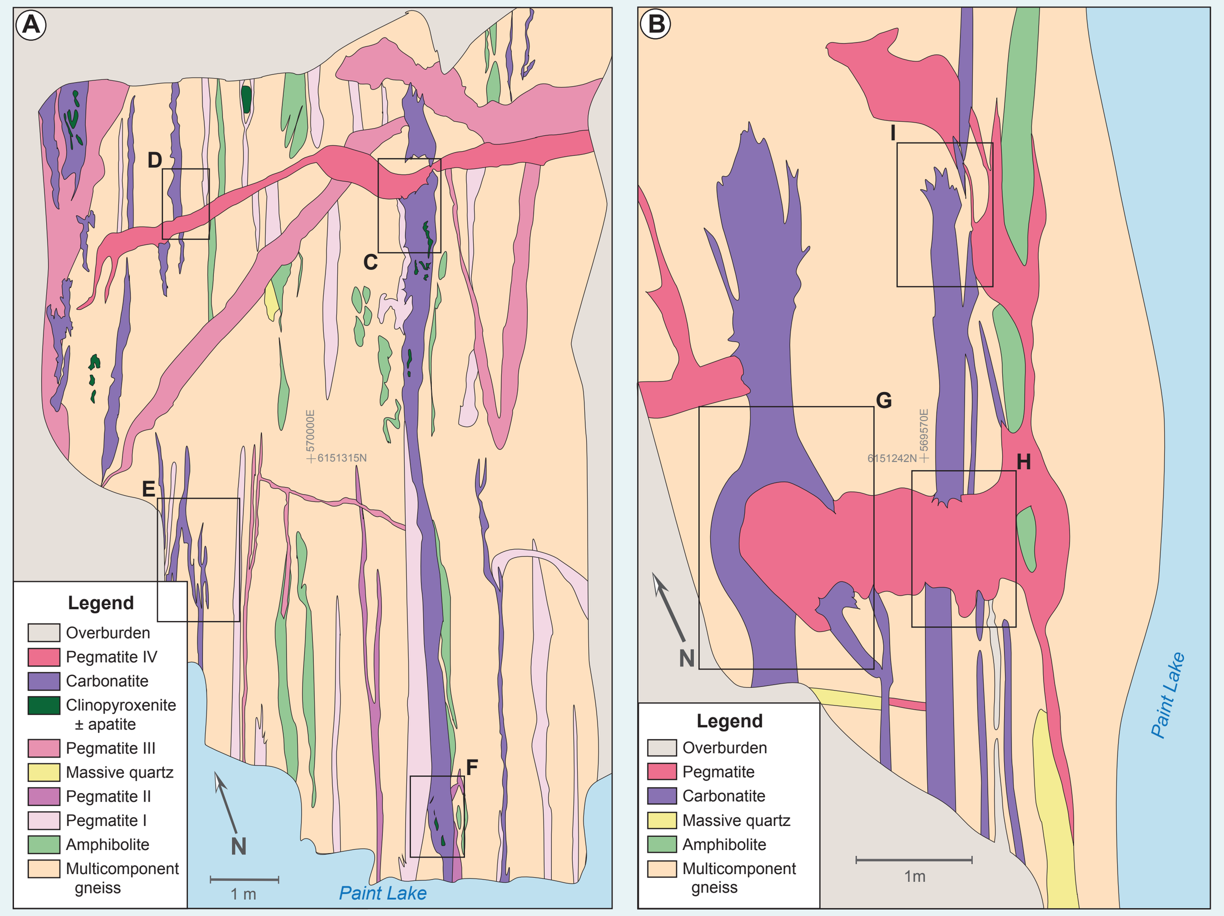


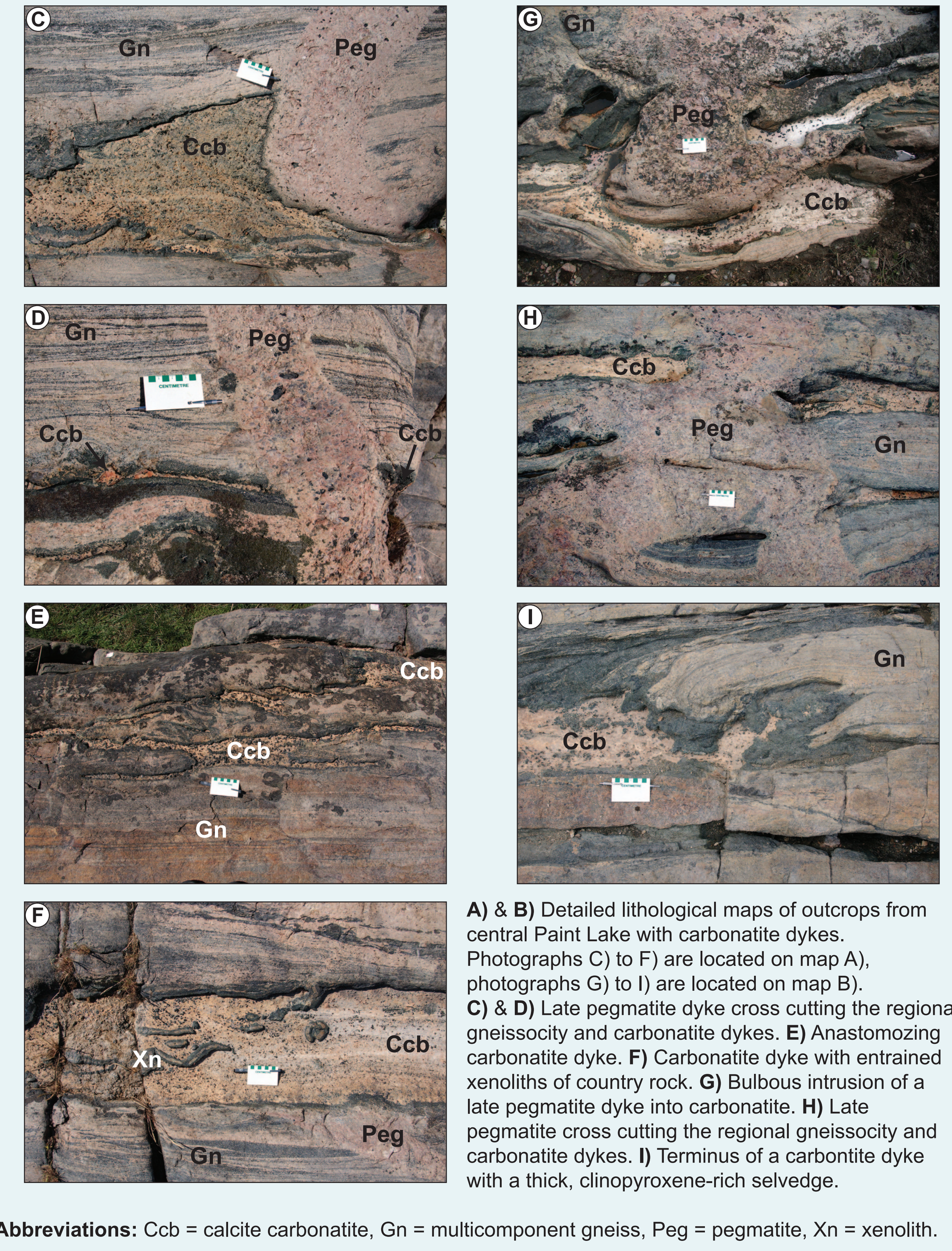


E) Calcite-dolomite carbonatite with resorbed olivine crystals in a calcite-dolomite matrix; some olivine is pseudomorphed by serpentine. **F)** Back scatter electron image of calcite-dolomite carbonatite with phlogopite and olivine in a carbonate matrix of Mg-calcite, with exsolved and interstitial dolomite. **G)** Back scatter electron image of calcite-dolomite carbonatite. Olivine is replaced by amphibole +/- magnetite exsolution lamellae, and diopside; their relative order of crystallization remains to be determined.

Abbreviations: Amp = amphibole, Cal = calcite, Ccb = calcite carbonatite, Dcb = calcite-dolomite carbonatite, Di = diopside, Dol = dolomite, Gn = multicomponent gneiss, Mgt = magnetite, Ol = olivine, Peg = pegmatite, Phl = phlogopite, Srp = serpentine

4) Detail Mapping





A) & B) Detailed lithological maps of outcrops from central Paint Lake with carbonatite dykes. Photographs C) to F) are located on map A), photographs G) to I) are located on map B).
C) & D) Late pegmatite dyke cross cutting the regional gneissocity and carbonatite dykes. **E)** Anastomozing carbonatite dyke. **F)** Carbonatite dyke with entrained xenoliths of country rock. **G)** Bulbous intrusion of a late pegmatite dyke into carbonatite. **H)** Late pegmatite cross cutting the regional gneissocity and carbonatite dykes. **I)** Terminus of a carbontite dyke with a thick, clinopyroxene-rich selvedge.

Abbreviations: Ccb = calcite carbonatite, Gn = multicomponent gneiss, Peg = pegmatite, Xn = xenolith.

Cesare B. 1994: Contrib. Mineral. Petrol. **116**, 239-246.
Chakhmouradian A.R. *et al.* 2009: Man. Geol. Surv., Rep. Act., 118-126.
Couëslan C.G. 2009: Man. Geol. Surv., Rep. Act., 108-117.
Couëslan C.G. & Martins T. 2010: Man. Geol. Surv., Rep. Act., in press.
Keller J. & Hoefs J. 1995: *In* Carbonatite volcanism, 113-123.
McDonough W.F. & Sun S.-s. 1995: Chem. Geol. **120**, 223-253.
Taylor H.P. et al. 1967: Geochim. Cosmochim. Acta **31**, 407-430.