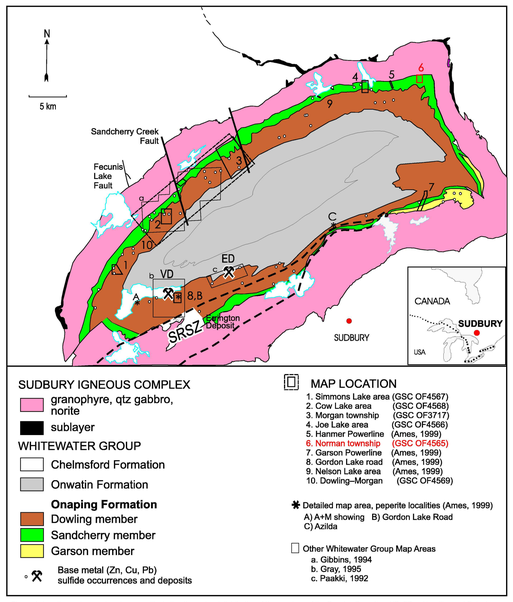

Figure 1. Location and general geology map illustrating the regional distribution of the members of the Onaping Formation. VD, ED = Vermilion and Errington Zn-Pb-Cu-Ag deposits. SRSZ = South Range shear zone.

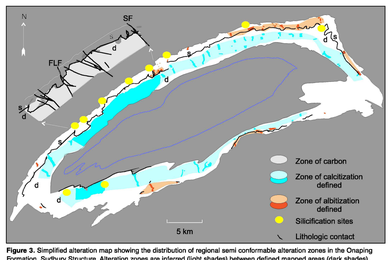

Figure 3. Simplified alteration map showing the distribution of regional semi conformable alteration zones in the Onaping Formation, Sudbury Structure. Alteration zones are inferred (light shades) between defined mapped areas (dark shades). S = Sandcherry member, D = Dowling member. Note the transgressive nature of the carbon contact across the Sandcherry/Dowling member contact on inset map.
Data compiled from this study, unpublished Falconbridge Ltd. Data, Gibbins, 1994, and Gray, 1995.

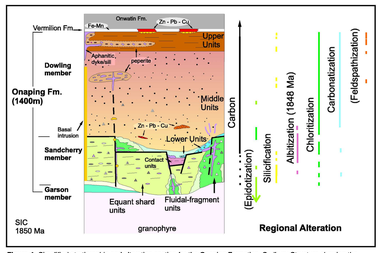

Figure 4. Simplified stratigraphic and alteration section for the Onaping Formation, Sudbury Structure showing the distribution and vertical stacking of regional basinwide hydrothermal alteration zones. Brackets denote alteration types with poorly constrained regional distribution patterns (modified from Ames et al., 1998).

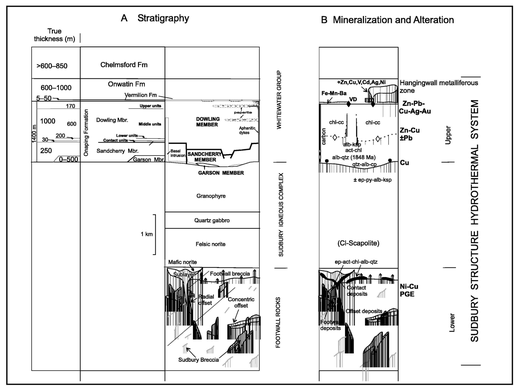

Figure 2. Schematic sections through the Sudbury structure showing: A) Stratigraphic terminology with member and unit thicknesses. The fragmental rocks are intruded by fine grained aphanitic dykes and the xenolithic basal intrusion; B) Distribution of mineralization and alteration, Sudbury structure hydrothermal system. VD, ED = Vermilion and Errington Zn-Pb-Cu-Ag deposits. (Modified after Ames et al., 2002).

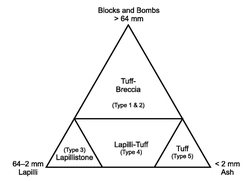

Figure 5. NON-GENETIC granulometric classification of fragmental rocks of the Onaping Formation adapted from Fisher (1966). Type 1–5 after Muir and Peredery (1984).

SUMMARY OF MAP AREAS, ONAPING FORMATION

AREA	SIGNIFICANCE	MAP SCALE	REFERENCE
Morgan township North Range	Complete stratigraphic section through north range Onaping Fmn. Type area ***Stratigraphic:*** dominance of fluidal breccias in SM, abundant syn-depositional fault control of units block faulting. Unstable SM depositional environment, DM contact units and DM lower units, stable geotectonics during DMMU and DMUU deposition. Syndepositional dyke emplacement into DMCT. Reappearance of water in upper DMMU. ***Alteration:*** basal zone of silicification overprints albitization. Feldspar alteration localized around fluidal breccia-dyke-sill complexes, weak- moderate albitization. Carbon transgresses DM-SM stratigraphic contact. Carbonate (calcite alteration) in upper 2/3rd of OF, with local discordant calcite-dissent zones associated with fracture-controlled silicification and mineralization ***Mineralization:*** Limerick Cu-Zn showing	1:5000	GSC OF3717 (Ames and Gibson, 2004)
Cow Lake (north of Dowling) North Range	***Stratigraphic:*** Section through Dowling member lower units and middle units, scores beds ***Alteration:*** regional carbonate, carbon and disseminated sulphide. ***Mineralization:*** McNunes and Cow Lake Cu-Zn showings cpy-po in amygdules in basal intrusion near top of MU.	1:2000	GSC OF4568 (Ames and Gibson, 2004)
Simmons North Range -West	***Stratigraphic:*** section through DMCT and DMLU thin N/S magnetite-rich mafic dyke abundant intrusions (Basal intrusion) ***Alteration:*** Epidote-pyrite-BaKsp zone at DMCT/LU interface, strong carbonate alteration. ***Mineralization:*** Abundant disseminated po-cpy-sph associated with discordant basal intrusion pods Simmons Pb-Zn-Cu veins.	1:2000	GSC OF4567 (Ames and Gibson, 2004)
Joe Lake North Range	***Stratigraphic:*** section from granophyre SIC to DMLU, complete section through SM, intrusive fluidal-breccia sill/dyke complex proximal facies, possible transported, slumped fluidal vent complex. Discordant intrusive unit Basal intrusion-former Basal Mbr. ***Alteration:*** Type area for Albitization. Regional syn-depositional albitization controlled by fluidal breccia complex, fracture-controlled replacement albitization (1848 Ma). K-feldspar-quartz hydrothermal breccia-local alteration. "Pocket" of carbon-bearing SM 10 m from granophyre contact	1:2000	GSC OF4566 (Ames and Gibson, 2004) (Ames et al., 1997) (Ames et al., 1998) 1848 ± 3.9/-1.8 Ma
Hanmer powerline North Range	***Stratigraphic:*** SM to top of DMCT. Basal intrusion-discontant near base of exposed OFm. SM- numerous bombs, near DMCT abundant sph-cpy-py dykes, excellent contact through DMCT units ***Alteration:*** Regional basal silicification zone in SM and BI. Increased albitization spatially associated with dykes. Fracture-controlled silicification x-cuts SM/DM contact	1:2000	(Ames, 1999)
Nelson Lk. West North Range	***Stratigraphy:*** SM to DM. Two orientations of aphantic dykes of same composition proximal fluidal breccia ***Alteration:*** Intense albitization amphibole alteration of matrix at dyke terminations within SM units	1:5000	Figure A2-4.1a (Ames, 1999)
Nelson East North Range	***Stratigraphy:*** SM near granophyre ***Alteration:*** Basal silicification zone ***Mineralization:*** Unnamed base metal -py gossan	1:5000	(Ames, 1999)
Rockcut Lake - North Range (Capreol- Norman Twp)	***Stratigraphic:*** near base of OFm in SM Multiple textural phases of the basal intrusion, megabrecciia discordant x-cuts fluidal complex excellent 3D view of dyke-sill complex ***Alteration:*** regional albitization, east side of lake carbon-bearing SM near the base of OFm. discordant zone of actinolite fractures and albite-quartz alteration haloes	1:2000	GSC OF4565 (Ames and Gibson, 2004)
Gordon Lk Rd South Range	***Stratigraphic:*** Dowling member below Vermilion Zn-Pb-Cu mine. DMUU and local setting for detailed mapping of peperite peperite is extensive (~ 200 x 1000 m) ***Alteration:*** carbonate-epidote	1:5000 1:2000	Figure 2-12 (Ames, 1999)
Gordon Lk Rd peperite South Range	***Stratigraphic:*** dyke intrusive into DMUU formation of blocky peperite ***Alteration:*** peperite-associated silicification, phengitization, carbonatization crosscut by late quartz veins ***Mineralization:*** cpy-sph	1:250	Figures 2-12, A2-5.1 Figure 4-13 (Ames, 1999)
A&M showing peperite South Range	***Stratigraphic:*** dyke intrusive into DMMU early dykes and associated peperite formation, later intrusive andesite lobes formation of globular peperite ***Alteration:*** peperite associated, silicification, chloritization, carbonatization and Fe-Mn oxides.	1:200	Figures 2-12, A2-5.2 and 3 Figure 4-14, (Ames, 1999)
Azilda peperite South Range	***Stratigraphic:*** upper 60 m of OFm. dykes with blocky peperite ***Alteration:*** peperite associated chloritization, phengitization, carbonatization.	Drill hole BA 91-01	(Falconbridge Ltd.)
Detailed maps	Cow Lake base metal showing McNunes base metal showing Simmons base metal showing Ryan base metal showing	1:200 1:100 1:2000 1:200 to 1:25	GSC OF4568 GSC OF4568 GSC OF4567 Figure 5-2 (Ames, 1999)
Dowling-Morgan	***Stratigraphic:*** 15 km strike length of North Range Onaping Fmn. from Windy Lake/Hwy 144 to the Sandcherry Creek Fault shows lateral distribution of units and members Type area for Sandcherry member ***Alteration:*** Carbon boundary transgresses SM-DM contact large unit of SM conductive Equant shard unit at High Falls. Regional carbonatization in upper ~ 1 km of Onaping Formation. ***Mineralization:*** Numerous replacement type Zn-Cu-Pb showings in DM.	1:10000	GSC OF4569 (Gibbins et al., 2004)

SM - Sandcherry member EQ - Equant shard units FL - Fluidal fragment unit DM - Dowling member CT - Contact units LU - Lower units MU - Middle units UU - Upper units

REFERENCES

Ames, D.E. and Gibson, H.L.:
2004: Geology, alteration and mineralization of the Onaping Formation, Morgan Township, Sudbury Structure, Ontario. 2 map sheets with descriptive notes, 8 figures, scale 1:2000, Geological Survey of Canada, Open File 3717 (January).
2004: Geology, alteration and mineralization of the Onaping Formation, Rockcut Lake area, Norman Township, Sudbury, Ontario. 1 sheet with 4 figures and 1 table, scale 1:2000, Geological Survey of Canada, Open File 4565.
2004: Geology, alteration and mineralization of the Onaping Formation, Joe Lake area, Wisner Township, Sudbury, Ontario. 1 sheet, 5 figures and 1 table, scale 1:2000, Geological Survey of Canada, Open File 4566.
2004: Geology, alteration and mineralization of the Onaping Formation, Simmons Lake area, Dowling Township, Sudbury, Ontario. 1 sheet with 4 figures and 1 table, scale 1:2000, Geological Survey of Canada, Open File 4567.
2004: Geology, alteration and mineralization of the Onaping Formation, Cow Lake area, Dowling Township, Sudbury, Ontario. 2 sheets with 7 figures and 1 table, scale 1:2000, Geological Survey of Canada, Open File 4568.

Ames, D.E., Golightly, J.P., Lightfoot, P.C., and Gibson, H.L.:
2002: Vitric compositions in the Onaping Formation and their relationship to the Sudbury igneous Complex, Sudbury Structure. *In* Geology and Ore deposits of the Sudbury District, Economic Geology, v. 97, no. 7, p. 1541–1562.

Ames, D.E.
1999: Geology and regional hydrothermal alteration of the crater-fill, Onaping Formation: Association with Zn-Pb-Cu mineralization, Sudbury Structure, Canada. Unpublished Ph.D. thesis, Carleton University, 460p.

Ames, D.E., Watkinson, D.H., and Parrish, R.R.:
1998: Dating of a hydrothermal system induced by the 1850 Ma Sudbury impact event: Geology, v. 26, p. 447–450.

Ames, D.E., Bleeker, W., Heather, K.B., and Wodicka, N. (eds)
1997: Timmins to Sudbury transect: New insights into the regional geology and the setting of ore deposits: Geological Association of Canada, Fieldtrip Guidebook, v. 86, 130p.

Fisher, R.V.
1966: Rocks composed of volcanic fragments and their classification: Earth Science Reviews, v. 1, p. 287–298.

Gibbins, S., Ames, D.E., and Gibson, H.L.:
2004: Geology, alteration and mineralization of the Onaping Formation, Dowling, Morgan, Bowell, and Lewack townships, Sudbury Structure, Ontario. 1 map sheet with 4 figures and 1 table, scale 1:10 000, Geological Survey of Canada, Open File 4569.

Gibbins, S.F.M.
1994: Geology, geochemistry, stratigraphy and mechanisms of emplacement of the Onaping Formation, Dowling Area, Sudbury Structure, Ontario, Canada: unpublished MSc thesis, Laurentian University, Sudbury, Ontario. 314p.

Gray, M.J.
1995: The Geological Setting of the Vermillion Zn-Cu-Pb-Ag-Au Massive Sulphide Deposit, Sudbury Basin, Canada: Msc. thesis, Laurentian University, Sudbury, Ontario, 244p.

Krogh, T.E., Corfu, F., Davis, D.W., Dunning, G.R., Heaman, L.M., Kamo, S.L., Machado, N., Greenough, J.D., and Nakamura, E.
1987: Precise U-Pb isotopic ages of diabase dykes and mafic to ultramafic rocks using trace amounts of baddeleyite and zircon. In Diabase dyke swarms. Edited by H.C. Halls and W.F. Fahrig. Geological Association of Canada, Special Paper 34, pp. 147–152.

Krogh, T.E., Davis, D.W., and Corfu, F.
1984: Precise U-Pb zircon and baddeleyite ages for the Sudbury area: in The Geology and Ore Deposits of the Sudbury Structure, (eds) E.G. Pye, A.J. Naldrett, and P.E. Giblin, Ontario Geological Survey, Special Vol. 1, p. 431–446.

Muir, T.L., and Peredery, W.
1984: The Onaping Formation. (eds) E.G. Pye, A.J. Naldrett, and P.E. Giblin, Ontario Geological Survey, Special Volume 1: 139–210.

Paakki, J.
1992: The Errington Zn-Cu-Pb massive sulphide deposit, Sudbury, Ontario: its structural and stratigraphic setting and footwall alteration. Unpubl. MSc. thesis, Laurentian University, Sudbury, Ontario.

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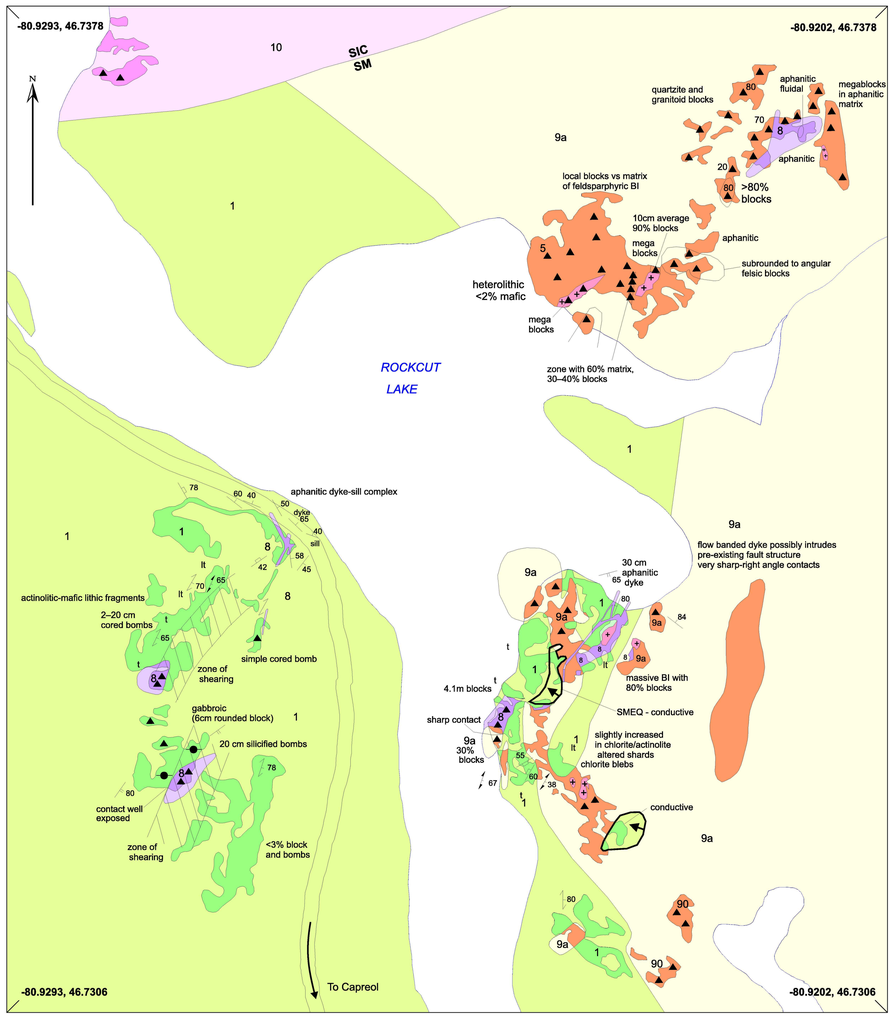


LEGEND

(See Figures 2 and 4 for context within entire Onaping Formation stratigraphy)

PALEOPROTEROZOIC
SUDBURY STRUCTURE
SIC SUDBURY IGNEOUS COMPLEX (~ 1849.6 +3.4/-3.0 Ma)

10 *Granophyre*

WHITEWATER GROUP
ONAPING FORMATION
Syn-Onaping intrusive rocks

9a *Basal intrusion* (BI) *"semi-concordant" xenolith-rich with fragments predominantly of Archean rocks in a fine-grained sugary-textured igneous matrix, aphanitic, quartz diorite massive, locally fluidal, block-rich (parts > 80%), megablocks*

8 *Aphanitic dykes and sills - andesite; fine grained, aphyric, commonly flow banded, spherulitic, amygdaloidal, typically < 50 cm wide, up to 15 m wide, sharp or peperitic margins, typically 340 and/or 020o trend*

Individual granitoid xenoliths in basal intrusion and aphanitic dykes

SM SANDCHERRY MEMBER (~ 60% blocky, altered vitric fragments, < 35% matrix, commonly non-carbonaceous)

Equant shard units (EQ)

1 *EQ > 50% pink to pinkish white equant altered vitric fragments commonly fine lapilli-sized in a light green weathering matrix, commonly altered pink (albitization), bleached (silicification) or dark gray (carbon-bearing commonly conductive), < 15% simple, complex and cored bombs, < 10% fluidal fragments, 1-5% accretionary lapilli and 5-15 % lithic blocks*

Note: non-genetic size classification used (Figure 5)

Geological boundary
Area of outcrop
Carbon boundary (arrow indicates carbon-bearing)
Shear zone
Tuff
Lapilli-tuff
Blocks, modal estimate
Bomb
Bedding tops unknown
Strike/dip of dykes
Foliation (inclined, vertical, dip unknown)
Shear foliation (inclined, dip unknown)
Joint

Geology of the Onaping Formation, Rockcut Lake Area, Norman Township, Sudbury Structure, Ontario 1:2000

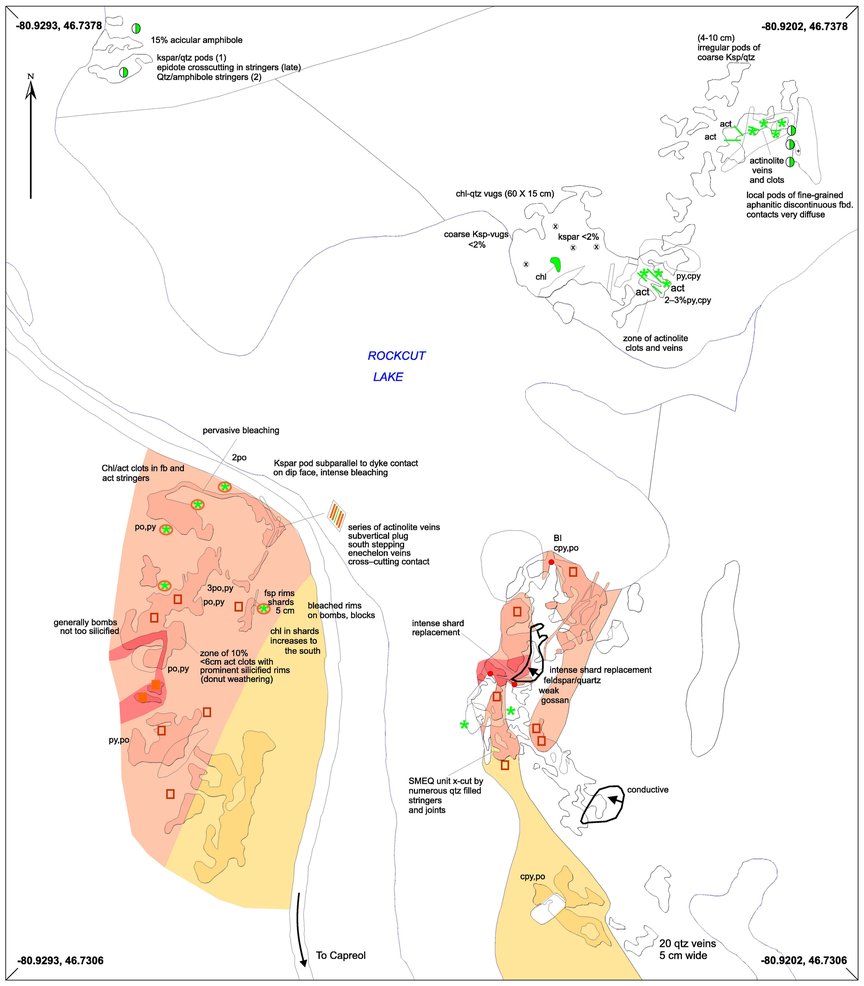
0 50 100 Metres

Base map from the Ontario Provincial topographic sheets, scale of 1:20 000, updated by the Geological Survey of Canada from aerial photograph enlargements

Geology by D.E. Ames, August, 1994

Digital cartography by E. Hillary

Field Assistant: J. Fowler



LEGEND

(See Figures 3 and 4 for context within entire Onaping Formation stratigraphy)

ALTERATION ZONES (outcrop shown in darker colour)

Albite-quartz-K-feldspar alteration, weak

Albite-quartz-K-feldspar alteration, moderate

Albite-quartz-K-feldspar alteration, strong

Carbon boundary (arrow indicates carbon-bearing)
Bleached shard rims
Pervasive replacement of shard
Fracture-controlled albitization
Epidote alteration
Vug
Vein
Modal estimate 1-2
Actinolite
Actinolite with bleached rims

SULPHIDES

Gossan

MINERALS

Pyrrhotite.....po	*Actinolite*.....act
Pyrite.....py	*Albite*.....alb
Chalcopyrite.....cpy	*K-feldspar*.....ksp
Chlorite.....chl	*Quartz*.....qtz

Alteration and Mineralization of the Onaping Formation, Rockcut Lake Area, Norman Township, Sudbury Structure, Ontario 1:2000

0 50 100 Metres

Base map from the Ontario Provincial topographic sheets, scale of 1:20 000, updated by the Geological Survey of Canada from aerial photograph enlargements

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OPEN FILE 4565

GEOLOGY

GEOLOGY, ALTERATION AND MINERALIZATION OF THE ONAPING FORMATION, ROCKCUT LAKE AREA, NORMAN TOWNSHIP, SUDBURY STRUCTURE

ONTARIO

Universal Transverse Mercator Projection
North American Datum 1983 - Zone 17

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