GEOLOGICAL MAP OF THE OTTER AND DUCKER LAKES AREA

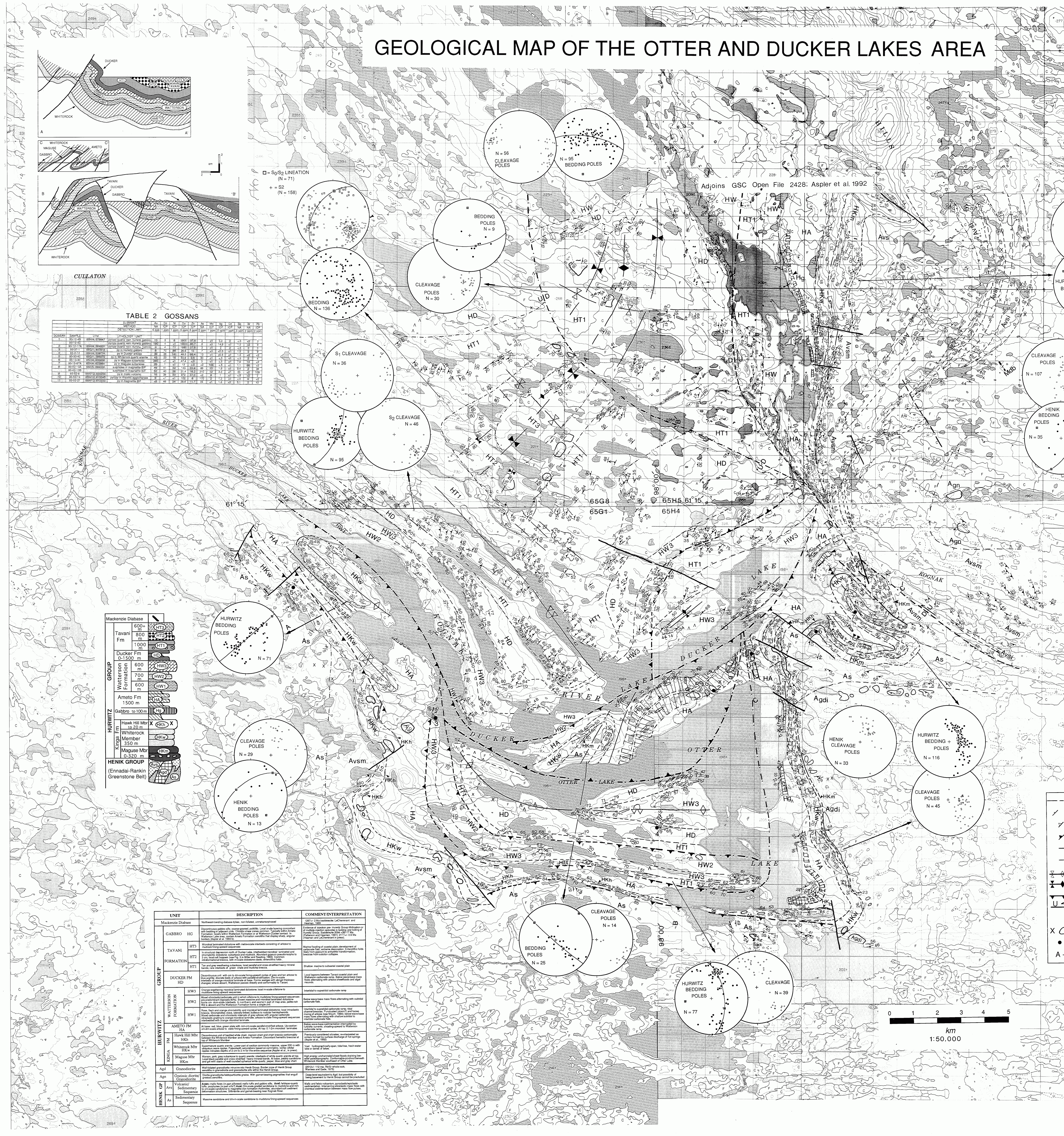

TABLE 2 GOSSANS

GOSSAN	SAMPLE	UTM	LITHOLOGY / UNIT	Au	Co	Ni	Cu	Zn	As	Mo	Ag	Cd	Sb	W	Pb
			METHOD	NA	ICP	ICP	ICP	ICP	NA	ICP	ICP	ICP	NA	NA	ICP
			DETECTION LIMIT	5 ppb	1 ppm	1 ppm	.5 ppm	.5 ppm	2 ppm	1 ppm	.5 ppm	1 ppm	.5 ppm	2 ppm	2 ppm
1	93-12-4B	65H/4; 578847	py/cpy quartz vein Hurwitz gabbro	13	5	8	3900	37.6	2	<1	3.2	2	<.5	<2	3
	93-12-4D		py/cpy quartz vein Hurwitz gabbro	190	4	<1	16600	80.7	6	<1	14.9	<1	1.5	<2	6
2	93-12-17A	65H/4; 564831	py/cpy quartz vein Hurwitz gabbro	9	4	11	1990	27.6	3	<1	2	2	<.5	<2	5
3	93-37-1	65G/1; 447818	py in Hurwitz gabbro	8	70	86	26.6	14	7	<1	<0.5	<1	1.5	2	9
4	93-2-12	65H/4; 539774	py in Ducker arkose	36	26	141	48.5	66.4	13	<1	<0.5	<1	1.3	2	9
5	93-30-40	65G/1; 386875	py in Whiterock quartz arenite	43	23	16	53.6	2.5	30	<1	<.5	<1	1.3	<2	<2
6	93-13-30	65H/4; 605856	py in Maguse subarkose	380	<1	<1	47.4	<.5	3	<1	<.5	<1	<.5	2	4
7	93-15-67A	65H/4; 623864	py in Maguse subarkose	29	1	<1	13	<.5	<2	106	<.5	<1	7.9	13	<2
8	93-42-13A	65H/5; 694034	sulphides in magnetite BIF	49	41	52	143	65.9	89	10	1.9	<1	1.1	66	<2
	93-42-13B		sulphides in magnetite BIF	52	40	26	31.4	16.2	210	12	2.3	<1	9.4	2	39
9	93-52-8	65H/12; 620234	py in mafic volcanic	16	26	33	972	37.3	<2	9	1	<1	23	<2	109
10	93-52-14	65H/12; 615245	py/cpy in rhyolitic agglomerate	9	<1	<1	102	6	170	2	1.3	<1	<.5	<2	2
11	93-52-21	65H/12; 610233	py in magnetite BIF	<5	46	34	28.6	11.7	24	<1	1.6	<1	5.1	2	43

UNIT			DESCRIPTION	COMMENT/INTERPRETATION
Mackenzie Diabase			Northwest-trending diabase dykes, non-foliated, unmetamorphosed	1267+/- 2 Ma baddeleyite: LeCheminant and Heaman, 1989
HURWITZ GROUP	GABBRO HG		Discontinuous gabbro sills; coarse-grained, poikilitic. Local crude layering concordant with bedding in adjacent units. Chloritic shear zones common. Typically within Ameto Formation; locally within Watterson Formation or at Watterson-Ducker contact. In Watterson Lake area, contain Ameto Formation xenoliths that display sharp, angular borders (Aspler et al. 1993 b).	Evidence of injection pre- Hurwitz Group lithification or of multiple injection episodes is lacking; pre folding of Hurwitz Group. Baddeleyite 2094 +26/-17 Ma (Patterson and Heaman, 1991); 2111+/- 0.6 Ma (Heaman and LeCheminant in press).
	TAVANI FORMATION	HT3	Microbial laminated dolostone with metre-scale interbeds consisting of arkose to mudrock fining-upward sequences	Marine flooding of coastal plain; development of carbonate flats; extreme desiccation. Enterolithic folds likely from gypsum to anhydrite transformation; breccias from solution collapse.
		HT2	In structural depression north of Ducker Lake, interbedded microbial laminated and stromatolitic dolostone; subarkose and mudrock. Abundant gypsum pseudomorphs to 3 cm; local salt hoppers (see Fig. 3 in Miller and Reading, 1993). Common intraformational breccia, with m-scale dolostone clasts; enterolithic folds.	
		HT1	Tan and grey weathering subarkose, local parallel and cross-stratified heavy mineral bands; rare interbeds of green shale and mudchip breccia.	Shallow marine to subaerial coastal plain
	DUCKER FM HD		Discontinuous unit with cm to dm-scale fining-upward cycles of grey and tan arkose to blue argillite; discrete beds of arkose with parallel-stratification. Dm-m-scale interbeds of orange microbial laminate at base. Forms wedges with abrupt thickness changes; where absent, Watterson passes directly and conformably to Tavani.	Local lagoons between Tavani coastal plain and Watterson carbonate ramp. Below wave-base mass flows alternating with arkose sheetfloods and algal mounds.
	WATTERSON FORMATION	HW3	Orange weathering microbial laminated dolostone; local m-scale siltstone to mudstone fining upward sequences.	Intertidal to supratidal carbonate ramp
		HW2	Mixed siliciclastic/carbonate unit in which siltstone to mudstone fining-upward sequences are predominant (typically 80%). Brown massive and microbial laminated dolostone forms cm- dcm-scale interbeds. In northern and eastern part of map area, pelite-rich W2 is absent and the Watterson Formation forms a single unit.	Below wave base mass flows alternating with subtidal carbonate flats.
		HW1	Rose, flesh and orange stromatolitic and microbial laminated dolostone; local intraclastic breccia. Stromatolites close, laterally-linked, bulbous to nodular hemispheroids. Mixed carbonate and siliciclastic intervals of grey arkose with angular carbonate intraclasts grading to orange microbial laminate; arkose to slate fining-upward sequences interbedded with orange microbial laminate.	Intertidal to supratidal carbonate ramp; tidal channel breccias. Punctuated (storm?) and facies mixing of arkose (see Mount, 1984); below wave base mass flows alternating with shallow subtidal to intertidal carbonate flats.
	AMETO FM HA		At base: red, blue, green slate with mm-cm-scale parallel-stratified arkose. Up-section: cm-dm-scale arkose to slate fining-upward cycles. At top: 0.1-2m microbial laminates	Below wave-base sedimentation interrupted by turbidity currents; shoaling-upward to Watterson carbonate ramp.
	KINGA FM	Hawk Hill Mbr HKh	Discontinuous unit of bedded white chert, maroon chert and chert breccia conformably between the Whiterock Member and Ameto Formation. Discordant hematitic breccias at top of Whiterock Member	Previously considered silcretes; re-interpreted as sinters formed by surface discharge of hot springs (Aspler et al., 1992)
		Whiterock Mbr HKw	Supermature quartz arenite. Lower part of section commonly massive, upper 200 m with ubiquitous wave ripples. Paleodepth calculations based on symmetric, vortex orbital ripples indicates depths of 2 cm to 2 m for the entire sequence (Aspler et al., in press).	Vast hydrographically-open, tide-free, fresh-water lake or series of lakes.
		Maguse Mbr HKm	Maroon, pink, grey subarkose to quartz arenite; interbeds of white quartz arenite at top. Local black parallel and cross stratified heavy mineral bands. At base, pebbly sandstone and grit with clasts of well rounded spherical white quartz, jasper, blue and grey chert.	High energy unchanneled sheet floods draining low-relief paleotopography. Conformable pinchout beneath Whiterock Member southeast of Otter Lake.
Agd	Granodiorite		Well-foliated granodiorite intrusive into Henik Group. Border zone of Henik Group xenoliths in granodiorite and granodiorite sills within the Henik Group.	(2512+/- 112 ma; Rb/Sr whole rock; Wanless and Eade, 1975)
Agn	Gneissic diorite/ Granodiorite		Diorite-granodiorite-feldspar/biotite gneiss. With garnet-bearing pegmatites that engulf gneissic xenoliths.	Deep-level equivalent to Agd; but possibility of being basement to Henik Group cannot be precluded
HENIK GP	Avs	Volcanic/ Sedimentary Sequence	**Avsm:** mafic flows (in part pillowed) mafic tuffs and gabbro sills. **Avsf:** feldspar-quartz tuffs; porphyries (in part sills?) **Avsi:** Dm-scale graded sandstone to mudstone and mm to cm-scale sandstone to magnetite iron formation rhythmites; abundant soft sediment deformation structures. Sillimanite and garnet-bearing near Kognak River.	Mafic and felsic volcanism, pyroclastic/epiclastic sedimentation. Intervening siliciclastic mass flows with chemical sedimentation between mass flow pulses.
	As	Sedimentary Sequence	Massive sandstone and dm-m-scale sandstone to mudstone fining-upward sequences	

CANADA-NWT MINERAL INITIATIVES 1991-1996

Canada CANADA-GNWT ECONOMIC DEVELOPMENT AGREEMENT

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MARGINAL NOTES

This open file summarizes the initial results of 1:50,000-scale mapping in the Otter and Ducker lakes area. It extends work south from Bray and Montgomery lakes (Aspler et al., 1992) and represents the continuation of a project designed to better understand Archean and Proterozoic supracrustal rocks in the south-central District of Keewatin (Aspler et al., 1989; 1993 a; b; 1994; Aspler and Bursey, 1990).

STRATIGRAPHY AND SEDIMENTATION

The local stratigraphy of the Archean **Henik Group** (Eade, 1974) part of the Ennadai-Rankin greenstone belt, consists of a siliciclastic turbidite sequence (unit **As**) and a mixed mafic and felsic volcanic sequence with magnetite iron formation-bearing turbidites (unit **Avs**). Both sequences are intruded by Archean granitic plutons (unit **Agd**). Near the base of unit Avs, mafic volcanic rocks, in part pillowed, are predominant. Up section are lenses of magnetite iron formation-bearing sandstone to mudstone turbidites and, toward the top, magnetite-jasper iron formation. The number and thickness of iron formation-bearing lenses diminishes southward such that at the Kognak River, iron formation-bearing turbidites form a single 50-metre-thick bed within felsic and mafic tuffs.

The Early Proterozoic **Hurwitz Group** is preserved in a northeast-trending belt of outliers that represent the remnants of a large intracratonic basin thought to have formed due to compressive intraplate stress arising from the pre- ca 2.1 Ga convergence of the Buffalo Head terrane (Ross et al., 1991) with the western margin of the Churchill Province (Fig. 1; Aspler et al.,1992). Lower Hurwitz Group strata are arranged in a conformable onlap sequence of radial basin expansion. The Maguse Member is the lowest unit exposed in the present map area (Table 1). North of the map area, in The Grey Hills, the Maguse Member is about 320 metres thick. It thins southward and pinches out conformably beneath quartz arenites of the Whiterock Member southeast of Otter Lake; further to the west the Maguse Member is represented by rare lenses less than 5 metres thick. Quantitative analysis of wave-ripples within the Whiterock Member indicate average water depths of 2 cm to 2 m over an area of about 100,000 km^2. The Whiterock Member was deposited in a large, hydrographically open, tide-free lake or series of lakes that onlapped fluvial and eolian deposits of the Maguse Member within a low relief continental depression (Aspler et al., in press). Several new exposures of Hawk Hill Member chert and chert breccia, likely sinter deposits (Aspler et al., 1992) were mapped as thin (<10 m) discontinuous lenses above the Whiterock Member east and south of Otter Lake.

The upper Hurwitz Group stratigraphy defines a marine to terrestrial offlap sequence. The abrupt switch from shallow water lacustrine sedimentation of Whiterock Member quartz arenites to deep water mudrock and arkose of the Ameto Formation is attributed to sudden basin deepening and marine waters flooding through gaps in basement arches. With the source of quartz sand effectively cut off by drowning, the compositional maturity of arenites overlying the Whiterock Member decreased and carbonate rocks of the Watterson Formation accumulated on ramps that prograded away from low-relief arches. Accordingly, mudrocks of the Ameto Formation are considered a distal ramp facies, carbonate rocks of the Watterson Formation an inner ramp facies, isolated lenses of semi-pelite (+/- carbonate) of the Ducker Formation local lagoons, and arkose and subarkose of the Tavani Formation a coastal sand complex.

In the northern and eastern part of the map area, the Watterson Formation forms a single unit of stromatolitic and microbial laminated dolostone, with mixed carbonate-siliciclastic interbeds and local intraformational breccia. In the southern part, a ca. 700 m thick semipelite (+/- carbonate) unit (HW_2) separates the Formation into lower (HW_1) and upper (HW_3) carbonate-rich members. One of the regional characteristics of the Ducker Formation is its lateral impersistence (Eade, 1974). Hence carbonate rocks of the Watterson Formation can pass directly upsection to subarkoses of the Tavani Formation (such as in the eastern part of the map area) or wedges of Ducker Formation semi-pelite may intervene (such as in the southern and western parts of the map area). A structural depression preserves rocks at the highest stratigraphic levels of the Tavani Formation. These include microbial laminated and stromatolitic dolostones and mudrocks similar to those of the Watterson Formation, within which are evaporite pseudomorphs, enterolithic-like folds and intraformational breccias (solution collapse?) and conglomerates (map unit HT2) and an overlying subunit of microbial laminted dolostone and mudrock (map unit HT3).

Gabbros within the Hurwitz Group constitute a set of discontinuous sills that extend for a strike length of about 350 km, from the Tavani area southwest to the Watterson Lake area. The gabbros are typically within weak pelitic rocks of the Ameto Formation, but form local splays within the Watterson Formation. The stratigraphically highest sills are at the contact between the Watterson and Ducker formations in the Griffin Lake area (Aspler and Bursey, 1990) and at the contact between the Whiterock Member and the Tavani Formation in the Tavani area (Park and Ralser, 1991). In the present map area, the gabbros form multiple sheets, up to 100 metres thick, within the Ameto Formation; on the west shore of Ducker Lake one small body is within the Watterson Formation. The gabbros are folded with sedimentary rocks of the Hurwitz Group and thus were intruded before Hurwitz Group deformation. Bell (1968) suggested that the gabbros were coeval with the Happotiyik Member, a mafic volcanic unit exposed in the Kaminak Lake area, on the basis of possible sill-flow feeder relations. Yet the paucity of soft sediment deformation structures in rocks adjacent to the gabbros and the presence of angular Ameto Formation xenoliths that display sharp, well-defined boundaries, argue that the Hurwitz group was well lithified before gabbro emplacement. It is uncertain if there was more than one episode of gabbro injection; baddeleyite ages of 2094 +26/-17 Ma from the Kaminak Lake area and of 2111 +/- 0.6 Ma from the Montgomery Lake area 180 km to the southwest (Heaman and LeCheminant in press) are consistent with a single episode.

STRUCTURAL GEOLOGY

Similar to other Hurwitz Group outliers, the distribution rocks in the Otter-Ducker lakes area is controlled largely by Early Proterozoic dome and basin basement-cover infolds. In the western and southern part of the area, NW and E-trending D_1 structures are predominant. Basement and cover are deformed together in a series of open, in part box-like, concentric folds and high angle thrusts. The folds (in part overturned) and thrusts display an opposing vergence and define a geometry similar to the "pop-up" and "triangle" zones of Butler (1982; section B-B'). In the northern part of the map area, NE and N-trending D_2 structures are predominant; NW-trending D_1 folds are refolded by open, concentric D_2 folds with moderately to steeply-dipping axial surfaces; the variation in S_0/S_2 lineations reflects the pre-existing D_1 fold geometry. The structural depression cored by uppermost Tavani Formation rocks in the western part of the map area defines a Type I (Ramsay and Huber, 1987) interference pattern. Both sets of structures are cut by variably oriented minor oblique-slip faults, particularly around the periphery of the outlier where such faults likely reflect outer arc extension due to flexural slip folding. The Hurwitz Group was deformed before ca. 1.75 Ga, the age of the Nueltin granite (U/Pb, Loveridge et al., 1988; cf. Rb/Sr, Wanless and Eade, 1975). How long before is uncertain; a preliminary metamorphic zircon determination of ca. 1.83 Ga (L. Heaman p. comm. 1992) suggests that deformation of the Hurwitz Group may be related to collisional events in Trans-Hudson Orogen, signifying a large time gap between sedimentation (pre- 2111 Ma; Heaman and LeCheminant in press) and deformation.

On the east side of the map area, a major N and NW-trending, Proterozoic, east-side up, sinistral-oblique fault was traced for abot 40 km, south from Bray Lake and across the Kognak River . Archean rocks east of the fault are part of a moderately to steeply-dipping package that extends south from Montgomery Lake (Aspler et al., 1992). The strike of this package follows the outline of the west-plunging, west-facing syclinorium defined by Hurwitz Group rocks centered at The Grey Hills, yet the Archean rocks are east-plunging and east-facing, indicating Pre-Hurwitz Group tilting. Close to the Kognak River, the northeast trends of the Archean rocks deflect into coincidence with the fault. West of the fault, Archean rocks are tightly infolded with the Hurwitz Group (section C-C'). Elsewhere around the margins of the outlier, cleavage trends in the Henik Group are broadly coincident with those of the Hurwitz Group, presumably due to both deflection of Archean cleavage during basement-cover infolding and to the generation of Proterozoic cleavage in the Archean rocks.

ECONOMIC GEOLOGY

Mineral occurrences are plotted on Figure 1; UTM co-ordinates and available analyses are given in Table 2. The highest gold value in this study is from subarkoses of the Maguse Member that contain pyrite-quartz veinlets (380 ppb Au, Gossan 6). Quartz veins in Hurwitz gabbros display elevated gold (to 190 ppb Au; Gossan 1) and silver (14.9 ppm Ag; Gossan 1).

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REFERENCES CITED

Aspler, L.B., and Bursey, T.L., 1990: Stratigraphy, sedimentation, dome and basin basement-cover infolding and implications for gold in the Hurwitz Group, Hawk Hill-Griffin-Mountain Lakes area, District of Keewatin; *in* Current Research Part C, Geological Survey of Canada Paper 90-1C, p. 219-230.

Aspler, L.B., Bursey, T.L., and LeCheminant, A.N., 1992: Geology of the Henik, Montgomery Lake, and Hurwitz groups in the Bray-Mongomery-Ameto lakes area, southern District of Keewatin, Northwest Territories; *in* Current Research Part C, Geological Survey of Canada Paper 92-1C, p. 157-170.

Aspler, L.B., Bursey, T.L., and Miller, A.R., 1989: Sedimentology, structure and economic geology of the Poorfish-Windy thrust-fold belt, Ennadai Lake area, District of Keewatin, and the shelf to foreland transition in the foreland of Trans Hudson Orogen; *in* Current Research Part C, Geological Survey of Canada Paper 89-1C, p.143-155.

Aspler, L.B., Chiarenzelli, J. R., and Bursey, T.L., 1993 a: Archean and Proterozoic geology of the Padlei belt, District of Keewatin, NWT, *in* Current Research Part C: Geological Survey of Canada Paper 93-1C, p. 147-158.

Aspler, L.B., Chiarenzelli, J. R., and Bursey, T.L., in press: Ripple marks in quartz arenites of the Hurwitz Group, Northwest Territories, Canada: Evidence for sedimentation in a vast, Early Proterozoic, shallow, fresh-water lake: Journal of Sedimentary Petrology.

Aspler, L.B., Chiarenzelli, J. R., Ozarko, D.L., and Powis, K.B., 1993 b: Geological map of the Watterson Lake area, District of Keewatin, Northwest Territories: Geological Survey of Canada Open File 2767; scale: 1:50,000.

Aspler, L.B., Chiarenzelli, J. R., Ozarko, D.L., and Powis, K.B., 1994. Geology of Archean and Proterozoic supracrustal rocks in the Otter and Ducker lakes area, southern District of Keewatin, Northwest Territories; *in* Current Research Part C: Geological Survey of Canada Paper 94-1C.

Bell, R.T., 1968: Preliminary notes on the Proterozoic Hurwitz Group, Tavani (55K) and Kaminak Lake (55L) areas, District of Keewatin; Geological Survey of Canada Paper 68-36, 17 p.

Butler, R.W.H., 1982: The terminology of structures in thrust belts; Journal of Structural Geology, v. 4, p. 239-245.

Eade, K.E., 1974: Geology of Kognak River area, District of Keewatin, Northwest Territories; Geological Survey of Canada Memoir 377, 66p.

Eade, K.E., and Chandler, F.W. 1975: Geology of Watterson Lake (west half) map-area, District of Keewatin; Geological Survey of Canada Paper 74-64, 10p.

Heaman, L.M., and LeCheminant, A.N., in press: Paragenesis and U-Pb systematics of baddeleyite (ZrO2): Chemical Geology.

LeCheminant, A.N. and Heaman, L.M. , 1989: Mackenzie igneous events, Canada: Middle Proterozoic hotspot magmatism associated with ocean opening; Earth and Planetary Science Letters, v.96, p.38-48.

Loveridge, W.D., Eade, K.E., and Sullivan, R.W., 1988: Geochronological studies from Precambrian rocks from the southern District of Keewatin; Geological Survey of Canada Paper 88-18, 36p.

Miller, A.R., and Reading, K.L., 1993: Iron-formation, evaporite, and possible metallogenetic implications for the Lower Proterozoic Hurwitz Group, District of Keewatin, Northwest Territories; *in* Current Research Part C: Geological Survey of Canada Paper 93-1C, p. 179-185.

Mount, J.F., 1984: Mixing of siliciclastic and carbonate sediments in shallow shelf environments; Geology, v. 12, p. 432-435.

Patterson, J.G., and Heaman, L.M., 1991: New geochronologic limits on the depositional age of the Hurwitz Group, Trans-Hudson hinterland, Canada; Geology, v. 19, p. 1137-1140.

Park, A.F., and Ralser, S., 1991: Structure of the early Proterozoic Hurwitz Group in the Tavani area, Keewatin, N.W.T.; Canadian Journal of Earth Sciences, v. 28, p. 1078-1095.

Ramsay, J.G., and Huber, M.I., 1987: The techniques of modern structural geology, V.2. Folds and Fractures, Academic Press, London, 462 p.

Ross, G.M., Parrish, R.R., Villeneuve, M.E., and Bowring, S.A., 1991: Geophysics and geochronology of the crystalline basement of the Alberta Basin, western Canada; Canadian Journal of Earth Sciences, v. 28, p. 512-522.

Wanless, R.K., and Eade, K.E., 1975: Geochronology of Archean and Proterozoic rocks in the southern District of Keewatin; Canadian Journal of Earth Sciences, v. 12, p. 95-114.

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