GS-9 Pikwitonei–Snow Lake Manitoba transect (parts of NTS 63J, 63O and 63P), Trans-Hudson Orogen–Superior Margin Metallotect Project: new results and tectonic interpretation

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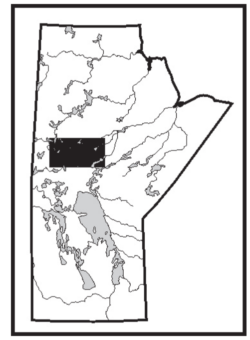

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Summary

The southernmost transect of Trans-Hudson Orogen–Superior Margin Metallotect Project aims to provide new insight into the tectonic history and metallogenic potential of the Thompson region. Evidence for arc-plume interaction or ensialic back-arc magmatism comes from broadly coeval 1890–1885 Ma continental-arc and 1883 Ma mafic-ultramafic magmatism on the western Superior margin. A sliver of Superior crust was detached during the 1883 Ma event and is reflected by the evolved isotopic signatures of plutons in the eastern 40 km of the Kisseynew Domain. A volcanosedimentary sequence at Wuskwatim Lake in the eastern Kisseynew Domain resembles Ospwagan Group sedimentary rocks in the age of its zircon population. Evidence for interaction between the Trans-Hudson Orogen and Superior margin at several times prior to final collision at ca. 1820 Ma suggests development of the juvenile Trans-Hudson Orogen in a marginal basin.

Introduction

This report presents analytical results and describes a working hypothesis for the Pikwitonei–Snow Lake transect of the Trans-Hudson Orogen–Superior Margin Metallotect Project being carried out under the Northern Resources Development Program of Natural Resources Canada. The work aims to shed light on the age, setting and origin of nickel deposits of the Thompson Nickel Belt, through refining the tectonic framework of interaction between the Trans-Hudson internides and Superior margin. Progress has been made in 'seeing through' the effects of ca. 1.8 Ga deformation and metamorphism to determine depositional or emplacement ages, by using the resolving power of the sensitive high-resolution ion microprobe (SHRIMP). In parallel, neodymium isotopic studies are providing information on the age of source materials that contributed to magmatic and sedimentary rocks.

Traditional views on the setting of mafic-ultramafic bodies hosting the Thompson nickel deposits regard a continental-margin rift environment as key. The age and tectonic history of these bodies, however, remain enigmatic. Evidence of early deformation of ultramafic intrusions and hostrocks prior to emplacement of the ca. 1880 Ma Molson dike swarm (Bleeker, 1990; Bleeker and Macek, 1996; cf. Hulbert et al., 2004) indicates complexity not accounted for in a simple rift model. Furthermore, recent results have identified felsic intrusions as old as ca. 1890 Ma in the Superior Boundary Zone, whose setting and significance are poorly understood (cf. Zwanzig et al., 2003; Percival et al., 2004). This report presents evidence that plutons of this age occur in autochthonous Superior Province basement, and that the Superior margin extends up to 40 km west of its surface exposure, beneath rocks of the Trans-Hudson Orogen. These findings call into question interpretations of Superior-margin geometry based on seismic-reflection images (cf. White et al., 2002).

Geological setting

Major Archean to earliest Paleoproterozoic elements of the Thompson area include the Archean Superior Province in the southeast, Sask craton in the west and Assean Lake Block in the north (Böhm et al., 2000, 2003; Ansdell, 2005). The complexly deformed Ospwagan Group and contained nickel-bearing intrusions of the Thompson Nickel Belt (TNB) lie unconformably on Superior Province basement (Bleeker, 1990). The boundary zone between units of Superior Province affinity and migmatite units of the Kisseynew Domain of the Trans-Hudson Orogen (THO) to the west consists dominantly of plutonic rocks of Paleoproterozoic age (Zwanzig et al., 2003), and is referred to as the Thompson Nickel Belt–Kisseynew Domain Boundary Zone (TNB-KD BZ; Figure GS-9-1).

Superior Province basement has a complex Archean history dominated by 3.0–2.65 Ga plutonic and high-grade metamorphic rocks (Hubregtse, 1980; Weber, 1990). These units were cut by 2.07 Ga Cauchon and 1.88 Ga Molson dikes (Halls and Heaman, 1997) prior to ca. 1.80 Ga thermotectonic reworking. Paleoproterozoic structural, metamorphic and plutonic effects increase in intensity from east to west across the western edge of the Superior Province. Structural effects include development of shear zones, foliation and folds at a metamorphic grade that ranges from greenschist to amphibolite facies. Before this study, intrusive rocks of Paleoproterozoic age were known to range from ca. 1845 to 1780 Ma (Machado,

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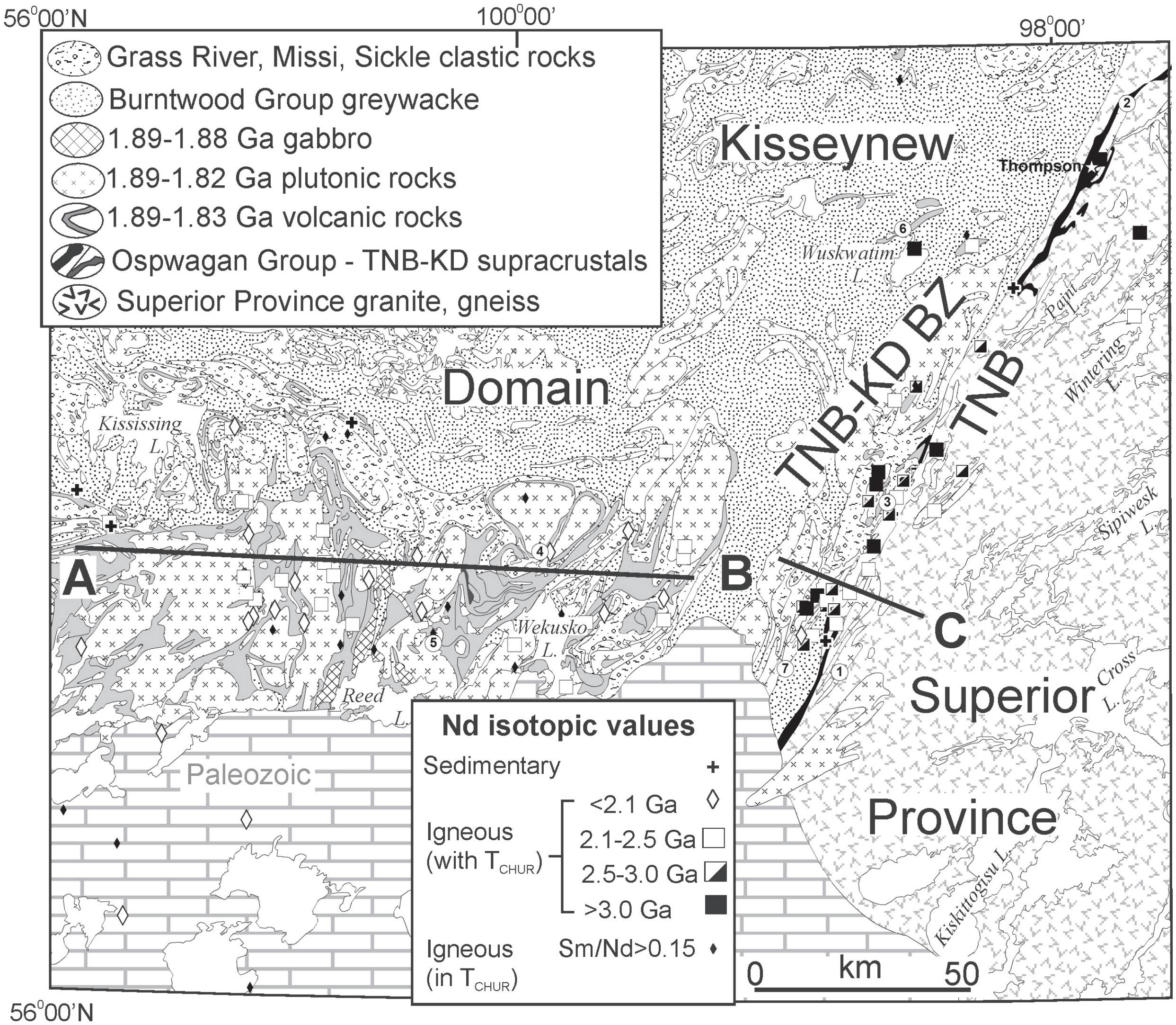

***Figure GS-9-1:** Generalized geology of the Pikwitonei–Snow Lake transect area (*modified after *Manitoba Department of Mines, Natural Resources and Environment, 1979), showing distribution of major tectonic features, locations mentioned in the text and distribution of 115 Nd-Sm depleted-mantle-model ages (T_{CHUR}) calculated using model of Goldstein et al. (1984) and grouped as in symbol legend. Abbreviations: TNB, Thompson Nickel Belt; TNB-KD BZ, Thompson Nickel Belt–Kisseynew Domain Boundary Zone. Localities: 1, Clarke Lake pluton; 2, Mystery Lake pluton; 3, Grass River arkose; 4, Herblet Lake dome; 5, Reed Lake pluton; 6, Wuskwatim Lake sequence; 7, Burntwood metagreywacke. See text for sources and techniques employed for Nd-Sm isotopic analyses.*

1990; Zwanzig et al., 2003).

The Ospwagan Group and underlying Superior Province basement underwent ductile deformation and metamorphism between ca. 1.84 and 1.78 Ga (Machado, 1990). Distinctive stratigraphic units of the Ospwagan Group (Bleeker and Macek, 1996) have been recognized along at least 200 km of strike length through compilation of drill core (Thompson Nickel Belt Working Group, 2001). Although strongly deformed and attenuated, the sedimentary-volcanic sequence is coherent, and youngs stratigraphically to the west (Zwanzig, 1998). Detrital zircon studies indicate provenance from the Superior Province to the east, although a single grain dated at ca. 1974 Ma provides a maximum depositional age for the Setting Formation in the upper Ospwagan Group (Hamilton and Bleeker, 2002). The youngest unit, amphibolite of the Bah Lake assemblage, appears to extend into the Superior Boundary Zone as enclaves within plutonic units.

According to Zwanzig et al. (2003), the TNB-KD BZ (Figure GS-9-1) contains remnants of three supracrustal assemblages and several plutonic suites. Amphibolite of the Bah Lake assemblage is interpreted as belonging to the Ospwagan Group (Zwanzig, 2002). Large units of sandstone and conglomerate make up the Grass River Group (Zwanzig, 1997), and belts of migmatitic greywacke of the Burntwood Group can be traced from the Kisseynew Domain eastward into the Superior Boundary Zone. With the exception of the Burntwood Group (ca. 1850–1840 Ma; Machado et al., 1999), the ages of the supracrustal packages are poorly constrained. Plutonic units are mainly granodiorite and granite, with some diorite, monzodiorite, syenite and leucogranite. They have U-Pb ages in the range 1891–1830 Ma (Zwanzig et al., 2003; Percival et al., 2004) and Nd-Sm model ages between 3.3 and 2.1 Ga (Zwanzig et al., 2003).

The Reindeer Zone forms the juvenile, internide part of the Trans-Hudson Orogen (Lewry, 1981; Lucas et al., 1996). It includes the Flin Flon–Snow Lake (Figure GS-9-1; Syme et al., 1999) and La Ronge–Lynn Lake volcanic belts, the intervening Kisseynew Domain (Zwanzig, 1999) and plutonic rocks of various ages and settings (David and Syme, 1994; Whalen et al., 1999). Ranging in age from ca. 1.92 to 1.83 Ga, both supracrustal and plutonic rocks of the Flin Flon–Snow Lake belt generally have juvenile isotopic signatures and appear to have developed within an intraoceanic-arc setting (Stern et al., 1995, 1999; Syme et al., 1999; Whalen et al., 1999). They appear to be in thrust contact with Archean rocks of the Sask craton (White et al., 1994). Their relationship to the Superior Boundary Zone and Superior craton are more cryptic (cf. Green et al., 1985; Lewry et al., 1994; White et al., 2002), involving early thrusting and late (ca. 1.8–1.72 Ga) motion inferred to be sinistral transcurrent (Bleeker, 1990) or dextral transpressive (Gapais et al., 2005).

Methods

Owing to complex zircon-growth histories, the sensitive high-resolution ion microprobe (SHRIMP) technique was used, in conjunction with scanning electron microscope images, to distinguish inherited, igneous and metamorphic-overgrowth zircon phases. Four plutons and three supracrustal packages were dated from the autochthonous Superior Province, the TNB-KD BZ and Trans-Hudson internides. In addition, Nd isotopic analyses were obtained from these bodies, as well as many additional intrusions.

Uranium-lead SHRIMP geochronology

All crushing and analytical work was performed at the Geological Survey of Canada Geochronology Laboratory in Ottawa. Zircons were extracted from the rock sample using standard crushing, heavy-liquid and magnetic-separation techniques. Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) analytical procedures followed those described by Stern (1997), with standards and U-Pb calibration methods following Stern and Amelin (2003). The internal features of the zircons (such as zoning, structures, alteration, etc.) were characterized with back-scattered electrons (BSE) using a Cambridge Instruments scanning electron microscope. Analyses were conducted using an $^{16}O^-$ primary beam. The sputtered area used for analysis was approximately 25 μm in diameter, and the beam current was approximately 9–15 nA. The count rates of ten isotopes of Zr^+, U^+, Th^+ and Pb^+ in zircon were sequentially measured over five scans for igneous rocks and four scans for sedimentary rocks with a single electron multiplier and a pulse-counting system with deadtime of 32 ns. Offline data processing was accomplished using customized in-house software. The 1σ external errors of $^{206}Pb/^{238}U$ ratios reported in Table GS-9-1 incorporate a ±1.2% error in calibrating the standard zircon (*see* Stern and Amelin, 2003). Isoplot™ v. 2.49 software (Ludwig, 2001) was used to generate concordia plots and calculate weighted means. The errors presented in the text and the ellipses plotted in the figures are reported at the 2σ uncertainty level. The errors in Table GS-9-1 are reported at the 1σ uncertainty level.

Neodymium isotopic analysis and presentation

The 115 Nd-Sm isotopic analyses presented in Figures GS-9-1 and -2 consist of 59 recent analyses, 5 analyses published in Whalen et al. (1999), 36 analyses illustrated in Whalen et al. (1999), 4 unpublished analyses of R. Stern (pers. comm., 2004) and 10 published results from Zwanzig et al. (2003). During 2003–2005, Nd-Sm isotopic ratios were measured using the Nu™ Plasma multicollector inductively coupled plasma–mass spectrometer (ICP-MS) at the Geological Survey of Canada in Ottawa. The $^{143}Nd/^{144}Nd$ isotopic ratios are reported relative to the value of 0.51186 in the La Jolla Nd standard. Nine spiked and unspiked analyses of BCR-1 yielded a weighted average value for $^{143}Nd/^{144}Nd$ of 0.512636 ±0.000009. Neodymium-samarium isotopic ratios for 45 additional samples were obtained during 1994–1996 using techniques described in Stern et al. (1995) and Whalen et al. (1999). The $\varepsilon^{143}Nd$ has been calculated for the igneous age, relative to the accepted Chondritic Uniform Reservoir (CHUR) with $^{143}Nd/^{144}Nd$ of 0.512636 and $^{147}Sm/^{144}Nd$ of 0.1966. Neodymium model ages (T_{CHUR}) were calculated according to the model of Goldstein et al. (1984). The distribution of samples exhibiting juvenile (positive ε_{Nd} and T_{CHUR} <2.5 Ga) versus old (negative ε_{Nd} and T_{CHUR} >2.5 Ga) Nd-Sm isotopic signatures (Figures GS-9-1, -2) indicate that the western portion of the study area (cross-section A-B) is underlain mainly by young crustal sources, whereas, proximal to and within the Superior margin in the east (cross-section B-C), both old and juvenile sources contributed to Paleoproterozoic plutons and sedimentary rocks.

Results and discussion

Paleoproterozoic plutons of the northwestern Superior Province

The Clarke Lake pluton (Figure GS-9-1, location 1)

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area.

Spot name	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	^{204}Pb (ppb)	^{204}Pb/^{206}Pb	± ^{204}Pb/^{206}Pb	f(206)^{204}	^{208*}Pb/^{206*}Pb	± ^{208}Pb/^{206}Pb	^{207*}Pb/^{235}U	± ^{207}Pb/^{235}U
Clarke Lake pluton (GSC lab # z8310):												
8310-2.1	51	26	0.53	19	6	3.94E-04	1.27E-04	0.0068	0.1572	0.0053	5.422	0.132
8310-17.1	237	111	0.49	86	15	2.20E-04	2.70E-05	0.0038	0.1405	0.0014	5.340	0.072
8310-20.1	372	206	0.57	135	15	1.43E-04	2.81E-05	0.0025	0.1668	0.0013	5.265	0.073
8310-35.1	284	146	0.53	103	14	1.73E-04	2.27E-05	0.0030	0.1531	0.0013	5.323	0.078
8310-37.1	324	149	0.48	117	14	1.45E-04	2.07E-05	0.0025	0.1379	0.0014	5.329	0.083
8310-61.1	203	124	0.63	76	22	3.78E-04	3.65E-05	0.0066	0.1882	0.0021	5.329	0.085
8310-62.1	342	140	0.42	121	13	1.31E-04	1.82E-05	0.0023	0.1207	0.0010	5.271	0.076
8310-76.1	489	279	0.59	182	17	1.21E-04	2.90E-05	0.0021	0.1707	0.0017	5.335	0.079
8310-80.1	263	149	0.58	96	24	3.20E-04	4.97E-05	0.0055	0.1676	0.0024	5.269	0.081
8310-79.1	321	262	0.84	122	40	4.50E-04	4.17E-05	0.0078	0.2547	0.0056	5.170	0.163
8310-91.1	632	273	0.45	228	15	8.30E-05	2.13E-05	0.0014	0.1293	0.0010	5.367	0.071
8310-42.1	652	291	0.46	234	18	9.72E-05	1.15E-05	0.0017	0.1326	0.0012	5.273	0.071
8310-46.1	442	242	0.57	161	14	1.10E-04	1.75E-05	0.0019	0.1656	0.0011	5.281	0.075
Mystery Lake pluton (GSC lab # z8309):												
8309-83.1	5558	1262	0.23	1770	430	2.85E-04	6.37E-06	0.0049	0.0676	0.0004	4.660	0.077
8309-49.1	380	74	0.20	129	15	1.35E-04	2.53E-05	0.0024	0.0561	0.0013	5.339	0.075
8309-57.1	45	55	1.28	29	30	1.54E-03	1.26E-04	0.0267	0.3632	0.0056	12.105	0.242
8309-29.1	256	136	0.55	150	18	1.57E-04	3.15E-05	0.0027	0.1519	0.0016	12.645	0.185
8309-2.1	153	77	0.52	85	278	4.03E-03	1.07E-04	0.0699	0.1413	0.0048	12.408	0.376
8309-7.1	66	57	0.89	42	10	3.44E-04	8.69E-05	0.0060	0.2449	0.0055	13.064	0.303
8309-1.1	629	47	0.08	330	8	2.81E-05	8.57E-06	0.0005	0.0214	0.0004	12.906	0.166
8309-11.1	419	176	0.43	243	15	7.91E-05	1.03E-05	0.0014	0.1209	0.0009	13.175	0.170
8309-94.1	415	106	0.26	235	83	4.46E-04	2.98E-05	0.0077	0.0735	0.0013	13.603	0.198
8309-42.1	1189	250	0.22	687	59	1.08E-04	6.47E-06	0.0019	0.0561	0.0003	14.245	0.273
8309-41.1	850	407	0.49	548	11	2.65E-05	4.90E-06	0.0005	0.1343	0.0004	15.732	0.196
8309-20.1	137	142	1.07	121	19	2.47E-04	2.47E-05	0.0043	0.2891	0.0032	23.482	0.323
Grass River arkose (GSC lab # z8307):												
8307-125.1	127	33	0.27	43	54	1.45E-03	1.64E-04	0.0251	0.0628	0.0069	5.006	0.160
8307-28.1	234	110	0.48	83	22	3.27E-04	7.00E-05	0.0057	0.1423	0.0033	5.030	0.087
8307-138.1	181	32	0.18	61	69	1.29E-03	1.01E-04	0.0224	0.0503	0.0040	5.138	0.109
8307-2.1	407	214	0.54	146	13	1.13E-04	2.21E-05	0.0020	0.1575	0.0013	5.028	0.072
8307-34.1	113	28	0.26	38	29	8.75E-04	1.20E-04	0.0152	0.0713	0.0047	5.109	0.136
8307-16.1	192	73	0.39	66	26	4.84E-04	5.82E-05	0.0084	0.1119	0.0038	5.061	0.084
8307-3.1	204	75	0.38	69	15	2.61E-04	5.17E-05	0.0045	0.1100	0.0034	5.011	0.089
8307-82.1	411	230	0.58	151	57	4.77E-04	6.91E-05	0.0083	0.1681	0.0030	5.180	0.106
8307-99.1	246	65	0.27	78	32	4.93E-04	1.47E-04	0.0086	0.0836	0.0059	4.798	0.130
8307-123.1	354	55	0.16	116	45	4.52E-04	1.08E-04	0.0078	0.0423	0.0041	5.108	0.111
8307-75.1	196	89	0.47	70	25	4.37E-04	1.11E-04	0.0076	0.1328	0.0045	5.154	0.142
8307-68.1	272	83	0.31	92	42	5.45E-04	5.69E-05	0.0095	0.0917	0.0024	5.061	0.083
8307-67.1	168	69	0.42	59	44	9.21E-04	1.02E-04	0.0160	0.1208	0.0041	5.112	0.119
8307-104.1	234	71	0.31	80	34	5.14E-04	8.32E-05	0.0089	0.0909	0.0039	5.179	0.104
8307-73.1	287	73	0.26	95	40	5.02E-04	4.58E-05	0.0087	0.0753	0.0019	5.064	0.081
8307-21.1	239	116	0.50	87	7	1.00E-04	3.45E-05	0.0017	0.1447	0.0024	5.253	0.082

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. *(continued)*

Spot name	$^{206*}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	Corr. coeff.	$^{207*}Pb/^{206*}Pb$	$\pm^{207}Pb/^{206}Pb$	Apparent ages (Ma) $^{206}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$\pm^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$\pm^{207}Pb/^{206}Pb$	Disc. (%)
Clarke Lake pluton (GSC lab # z8310):												
8310-2.1	0.3339	0.0046	0.6609	0.1178	0.0022	1857	22	1888	21	1923	33	3.4
8310-17.1	0.3366	0.0041	0.9433	0.1151	0.0005	1870	20	1875	12	1881	8	0.6
8310-20.1	0.3296	0.0041	0.9465	0.1158	0.0005	1837	20	1863	12	1893	8	3
8310-35.1	0.3330	0.0043	0.9298	0.1159	0.0006	1853	21	1873	13	1895	10	2.2
8310-37.1	0.3341	0.0049	0.9617	0.1157	0.0005	1858	23	1874	13	1890	8	1.7
8310-61.1	0.3340	0.0047	0.9301	0.1157	0.0007	1858	23	1873	14	1891	11	1.7
8310-62.1	0.3334	0.0045	0.9652	0.1147	0.0004	1855	22	1864	12	1875	7	1.1
8310-76.1	0.3367	0.0044	0.9354	0.1149	0.0006	1871	21	1875	13	1879	10	0.4
8310-80.1	0.3317	0.0042	0.8807	0.1152	0.0008	1847	20	1864	13	1883	13	1.9
8310-79.1	0.3217	0.0071	0.7765	0.1166	0.0023	1798	34	1848	27	1904	36	5.6
8310-91.1	0.3366	0.0041	0.9616	0.1157	0.0004	1870	20	1880	11	1890	7	1
8310-42.1	0.3341	0.0041	0.9475	0.1145	0.0005	1858	20	1865	12	1871	8	0.7
8310-46.1	0.3306	0.0042	0.9435	0.1159	0.0006	1841	20	1866	12	1893	9	2.7
Mystery Lake pluton (GSC lab # z8309):												
8309-83.1	0.3151	0.0051	0.9961	0.1073	0.0002	1766	25	1760	14	1753	3	-0.7
8309-49.1	0.3370	0.0042	0.9296	0.1149	0.0006	1872	20	1875	12	1879	9	0.4
8309-57.1	0.4946	0.0069	0.7793	0.1775	0.0022	2590	30	2613	19	2630	21	1.5
8309-29.1	0.5104	0.0068	0.9461	0.1797	0.0009	2658	29	2654	14	2650	8	-0.3
8309-2.1	0.4895	0.0068	0.5600	0.1838	0.0047	2569	29	2636	29	2688	42	4.4
8309-7.1	0.5135	0.0100	0.8935	0.1845	0.0019	2672	43	2684	22	2694	17	0.8
8309-1.1	0.5051	0.0062	0.9822	0.1853	0.0005	2636	27	2673	12	2701	4	2.4
8309-11.1	0.5150	0.0064	0.9851	0.1855	0.0004	2678	27	2692	12	2703	4	0.9
8309-94.1	0.5213	0.0066	0.9243	0.1893	0.0011	2704	28	2722	14	2736	9	1.1
8309-42.1	0.5379	0.0066	0.7231	0.1921	0.0026	2775	28	2766	18	2760	22	-0.5
8309-41.1	0.5596	0.0068	0.9927	0.2039	0.0003	2865	28	2861	12	2858	2	-0.3
8309-20.1	0.6602	0.0084	0.9566	0.2580	0.0010	3268	33	3247	13	3234	6	-1
Grass River arkose (GSC lab # z8307):												
8307-125.1	0.3320	0.0052	0.5929	0.1094	0.0028	1848	25	1820	27	1789	48	-3.3
8307-28.1	0.3296	0.0041	0.7947	0.1107	0.0012	1836	20	1824	15	1811	19	-1.4
8307-138.1	0.3353	0.0044	0.7005	0.1111	0.0017	1864	21	1842	18	1818	28	-2.5
8307-2.1	0.3278	0.0042	0.9485	0.1112	0.0005	1828	21	1824	12	1820	8	-0.5
8307-34.1	0.3310	0.0046	0.6252	0.1120	0.0023	1843	22	1838	23	1831	38	-0.6
8307-16.1	0.3275	0.0042	0.8340	0.1121	0.0010	1826	20	1830	14	1833	17	0.4
8307-3.1	0.3234	0.0048	0.8871	0.1124	0.0009	1806	23	1821	15	1838	15	1.8
8307-82.1	0.3339	0.0051	0.8149	0.1125	0.0014	1857	25	1849	18	1841	22	-0.9
8307-99.1	0.3092	0.0041	0.5853	0.1126	0.0025	1737	20	1785	23	1841	41	5.7
8307-123.1	0.3290	0.0044	0.6999	0.1126	0.0018	1833	21	1837	19	1842	29	0.5
8307-75.1	0.3317	0.0061	0.7490	0.1127	0.0021	1846	30	1845	24	1844	34	-0.2
8307-68.1	0.3253	0.0041	0.8465	0.1128	0.0010	1816	20	1830	14	1846	16	1.6
8307-67.1	0.3285	0.0053	0.7696	0.1129	0.0017	1831	26	1838	20	1846	27	0.8
8307-104.1	0.3319	0.0046	0.7737	0.1132	0.0015	1848	22	1849	17	1851	23	0.2
8307-73.1	0.3239	0.0043	0.8945	0.1134	0.0008	1809	21	1830	14	1855	13	2.5
8307-21.1	0.3359	0.0046	0.9226	0.1134	0.0007	1867	22	1861	13	1855	11	-0.7

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. *(continued)*

Spot name	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	^{204}Pb (ppb)	$^{204}Pb/^{206}Pb$	± $^{204}Pb/^{206}Pb$	$f(206)^{204}$	$^{208*}Pb/^{206*}Pb$	± $^{208}Pb/^{206}Pb$	$^{207*}Pb/^{235}U$	± $^{207}Pb/^{235}U$
8307-58.1	128	16	0.13	42	37	10.00E-04	3.06E-04	0.0173	0.0360	0.0119	5.189	0.243
8307-85.1	199	21	0.11	67	54	9.02E-04	1.73E-04	0.0156	0.0313	0.0066	5.381	0.157
8307-60.1	175	50	0.29	60	36	7.20E-04	8.03E-05	0.0125	0.0852	0.0040	5.186	0.107
8307-99'.1	154	104	0.70	59	37	8.25E-04	1.73E-04	0.0143	0.1988	0.0068	5.308	0.157
8307-11.1	118	44	0.38	41	13	3.95E-04	8.73E-05	0.0068	0.1157	0.0048	5.213	0.103
8307-119.1	163	36	0.23	57	35	7.31E-04	8.36E-05	0.0127	0.0658	0.0034	5.371	0.117
8307-86.1	178	33	0.19	60	44	8.57E-04	7.80E-05	0.0149	0.0567	0.0037	5.249	0.120
8307-71.1	59	8	0.14	20	24	1.36E-03	1.79E-04	0.0236	0.0316	0.0069	5.323	0.171
8307-81.1	245	55	0.23	83	43	6.17E-04	5.46E-05	0.0107	0.0667	0.0029	5.219	0.087
8307-74.1	79	20	0.25	27	32	1.38E-03	2.89E-04	0.0239	0.0756	0.0112	5.217	0.252
8307-90.1	216	70	0.33	76	61	9.59E-04	2.23E-04	0.0166	0.0951	0.0086	5.352	0.192
8307-136.1	156	49	0.32	55	56	1.22E-03	1.17E-04	0.0211	0.0941	0.0066	5.324	0.121
8307-54.1	259	103	0.41	93	24	3.20E-04	4.33E-05	0.0056	0.1196	0.0026	5.376	0.098
8307-108.1	163	54	0.34	58	47	9.59E-04	1.07E-04	0.0166	0.1008	0.0046	5.422	0.122
8307-130.1	108	46	0.44	38	42	1.35E-03	3.80E-04	0.0234	0.1314	0.0147	5.155	0.302
8307-128.1	152	65	0.44	53	38	8.89E-04	8.99E-05	0.0154	0.1269	0.0037	5.194	0.114
8307-8.1	121	61	0.52	44	14	3.91E-04	2.00E-04	0.0068	0.1502	0.0082	5.292	0.177
8307-37.1	234	106	0.47	85	17	2.43E-04	3.94E-05	0.0042	0.1373	0.0023	5.370	0.085
8307-122.1	130	39	0.31	44	32	8.58E-04	9.75E-05	0.0149	0.0883	0.0039	5.199	0.120
8307-127.1	237	69	0.30	82	38	5.49E-04	5.35E-05	0.0095	0.0877	0.0022	5.295	0.091
8307-76.1	178	130	0.75	67	34	6.81E-04	1.14E-04	0.0118	0.2205	0.0051	5.202	0.123
8307-30.1	127	57	0.47	46	18	4.84E-04	8.36E-05	0.0084	0.1377	0.0055	5.344	0.120
8307-70.1	126	42	0.34	44	22	5.98E-04	9.51E-05	0.0104	0.1041	0.0045	5.298	0.115
8307-94.1	121	25	0.22	41	26	7.37E-04	1.37E-04	0.0128	0.0673	0.0054	5.327	0.135
8307-31.1	113	29	0.27	38	21	6.45E-04	1.18E-04	0.0112	0.0804	0.0046	5.272	0.127
8307-7.1	128	68	0.55	47	10	2.65E-04	7.40E-05	0.0046	0.1626	0.0033	5.321	0.120
8307-65.1	211	75	0.37	72	29	4.98E-04	6.55E-05	0.0086	0.1128	0.0028	5.205	0.102
8307-72.1	128	42	0.34	45	15	4.18E-04	1.42E-04	0.0072	0.1031	0.0065	5.377	0.149
8307-115.1	125	31	0.25	43	49	1.33E-03	1.86E-04	0.0230	0.0791	0.0072	5.433	0.179
8307-33.1	91	18	0.20	31	14	5.13E-04	1.06E-04	0.0089	0.0669	0.0047	5.502	0.119
8307-27.1	101	33	0.34	35	12	4.04E-04	1.17E-04	0.0070	0.1058	0.0049	5.351	0.131
8307-121.1	119	27	0.23	41	33	9.54E-04	1.10E-04	0.0165	0.0712	0.0049	5.448	0.127
8307-43.1	98	23	0.24	34	25	8.70E-04	1.35E-04	0.0151	0.0723	0.0053	5.538	0.147
8307-102.1	102	38	0.38	36	36	1.18E-03	1.30E-04	0.0205	0.1127	0.0116	5.487	0.171
8307-22.1	87	30	0.36	32	20	7.70E-04	1.45E-04	0.0133	0.1053	0.0059	5.627	0.170
8307-41.1	110	96	0.90	64	32	6.94E-04	7.31E-05	0.0120	0.2531	0.0039	10.951	0.210
8307-133.1	175	6	0.03	87	63	8.48E-04	1.39E-04	0.0147	0.0059	0.0052	11.514	0.289
8307-80.1	273	471	1.78	194	22	1.92E-04	2.49E-05	0.0033	0.5120	0.0022	12.043	0.168
8307-129.1	116	73	0.65	70	52	1.01E-03	2.82E-04	0.0176	0.1811	0.0118	13.090	0.398
8307-49.1	31	49	1.64	22	23	1.64E-03	2.19E-04	0.0284	0.4448	0.0175	13.336	0.407
8307-135.1	60	28	0.48	36	54	1.92E-03	2.25E-04	0.0333	0.1410	0.0090	13.557	0.352
Herblet Lake dome (GSC lab # z8311):												
8311-1.1	378	113	0.31	133	8	7.10E-05	1.38E-05	0.0012	0.0877	0.0008	5.394	0.070
8311-14.1	147	32	0.22	51	7	1.55E-04	6.43E-05	0.0027	0.0635	0.0025	5.448	0.091
8311-16.1	159	40	0.26	55	14	3.08E-04	7.51E-05	0.0053	0.0732	0.0029	5.351	0.098

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. *(continued)*

						Apparent ages (Ma)						
Spot name	$^{206*}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	Corr. coeff.	$^{207*}Pb/^{206*}Pb$	$\pm^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$\pm^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$\pm^{207}Pb/^{206}Pb$	Disc. (%)
8307-58.1	0.3317	0.0047	0.4176	0.1135	0.0049	1846	23	1851	41	1856	80	0.5
8307-85.1	0.3435	0.0045	0.5525	0.1136	0.0028	1903	22	1882	25	1858	45	-2.4
8307-60.1	0.3310	0.0047	0.7633	0.1136	0.0015	1843	23	1850	18	1858	24	0.8
8307-99'.1	0.3383	0.0047	0.5743	0.1138	0.0028	1879	23	1870	26	1861	45	-1
8307-11.1	0.3315	0.0044	0.7544	0.1141	0.0015	1845	21	1855	17	1865	24	1.1
8307-119.1	0.3415	0.0048	0.7274	0.1141	0.0017	1894	23	1880	19	1865	27	-1.5
8307-86.1	0.3336	0.0051	0.7553	0.1141	0.0017	1856	25	1861	20	1866	27	0.6
8307-71.1	0.3380	0.0054	0.5961	0.1142	0.0030	1877	26	1872	28	1867	48	-0.5
8307-81.1	0.3313	0.0044	0.8577	0.1142	0.0010	1845	21	1856	14	1868	16	1.2
8307-74.1	0.3309	0.0063	0.5047	0.1144	0.0048	1843	31	1855	42	1870	78	1.5
8307-90.1	0.3388	0.0047	0.4939	0.1146	0.0036	1881	23	1877	31	1873	58	-0.4
8307-136.1	0.3370	0.0044	0.6691	0.1146	0.0020	1872	21	1873	20	1873	31	0.1
8307-54.1	0.3400	0.0045	0.7991	0.1147	0.0013	1886	22	1881	16	1875	20	-0.6
8307-108.1	0.3428	0.0048	0.7090	0.1147	0.0018	1900	23	1888	19	1876	29	-1.3
8307-130.1	0.3259	0.0063	0.4422	0.1147	0.0061	1818	31	1845	51	1876	99	3.1
8307-128.1	0.3282	0.0052	0.7955	0.1148	0.0015	1830	25	1852	19	1876	24	2.5
8307-8.1	0.3343	0.0050	0.5498	0.1148	0.0032	1859	24	1868	29	1877	52	1
8307-37.1	0.3391	0.0045	0.8876	0.1149	0.0009	1882	22	1880	14	1878	13	-0.2
8307-122.1	0.3282	0.0054	0.7879	0.1149	0.0016	1830	26	1853	20	1878	26	2.6
8307-127.1	0.3337	0.0047	0.8807	0.1151	0.0010	1856	23	1868	15	1881	15	1.3
8307-76.1	0.3277	0.0044	0.6640	0.1151	0.0021	1827	21	1853	20	1882	32	2.9
8307-30.1	0.3363	0.0058	0.8359	0.1152	0.0014	1869	28	1876	19	1884	23	0.8
8307-70.1	0.3330	0.0048	0.7523	0.1154	0.0017	1853	23	1869	19	1886	26	1.7
8307-94.1	0.3347	0.0044	0.6155	0.1154	0.0023	1861	21	1873	22	1886	37	1.3
8307-31.1	0.3305	0.0050	0.7177	0.1157	0.0020	1841	24	1864	21	1891	31	2.7
8307-7.1	0.3333	0.0049	0.7333	0.1158	0.0018	1854	24	1872	19	1892	28	2
8307-65.1	0.3235	0.0050	0.8509	0.1167	0.0012	1807	24	1853	17	1906	19	5.2
8307-72.1	0.3335	0.0049	0.6277	0.1169	0.0026	1855	24	1881	24	1910	40	2.8
8307-115.1	0.3357	0.0053	0.5768	0.1174	0.0032	1866	25	1890	29	1917	50	2.7
8307-33.1	0.3395	0.0046	0.7098	0.1175	0.0018	1884	22	1901	19	1919	28	1.8
8307-27.1	0.3301	0.0052	0.7237	0.1176	0.0020	1839	25	1877	21	1920	31	4.2
8307-121.1	0.3357	0.0051	0.7385	0.1177	0.0019	1866	25	1892	20	1922	29	2.9
8307-43.1	0.3404	0.0047	0.6167	0.1180	0.0025	1889	22	1907	23	1926	38	1.9
8307-102.1	0.3372	0.0062	0.6833	0.1180	0.0027	1873	30	1899	27	1926	42	2.7
8307-22.1	0.3446	0.0063	0.6971	0.1184	0.0026	1909	30	1920	26	1933	40	1.2
8307-41.1	0.4785	0.0074	0.8691	0.1660	0.0016	2521	32	2519	18	2517	16	-0.1
8307-133.1	0.4887	0.0094	0.8315	0.1709	0.0024	2565	41	2566	24	2566	24	0.1
8307-80.1	0.4878	0.0061	0.9419	0.1790	0.0008	2561	27	2608	13	2644	8	3.1
8307-129.1	0.5119	0.0077	0.5985	0.1855	0.0046	2665	33	2686	29	2703	41	1.4
8307-49.1	0.5187	0.0105	0.7489	0.1865	0.0038	2694	45	2704	29	2711	34	0.6
8307-135.1	0.5253	0.0075	0.6422	0.1872	0.0038	2722	32	2719	25	2718	33	-0.1
Herblet Lake dome (GSC lab # z8311):												
8311-1.1	0.3389	0.0041	0.9691	0.1155	0.0004	1881	20	1884	11	1887	6	0.3
8311-14.1	0.3390	0.0042	0.8176	0.1166	0.0011	1882	20	1892	14	1904	18	1.2
8311-16.1	0.3384	0.0043	0.7738	0.1147	0.0013	1879	21	1877	16	1875	21	-0.2

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. *(continued)*

Spot name	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	^{204}Pb (ppb)	^{204}Pb/^{206}Pb	± ^{204}Pb/^{206}Pb	f(206)^{204}	^{208*}Pb/^{206*}Pb	± ^{208}Pb/^{206}Pb	^{207*}Pb/^{235}U	± ^{207}Pb/^{235}U
8311-18.1	186	43	0.24	65	12	2.15E-04	2.95E-05	0.0037	0.0670	0.0015	5.422	0.078
8311-43.1	222	63	0.29	78	10	1.56E-04	2.79E-05	0.0027	0.0827	0.0013	5.361	0.075
8311-76.1	230	66	0.30	81	11	1.56E-04	2.33E-05	0.0027	0.0843	0.0015	5.430	0.078
8311-33.1	246	74	0.31	87	11	1.51E-04	2.17E-05	0.0026	0.0912	0.0011	5.445	0.076
8311-49.1	146	32	0.23	51	8	1.96E-04	3.93E-05	0.0034	0.0669	0.0017	5.469	0.082
8311-56.1	269	74	0.28	94	12	1.52E-04	2.89E-05	0.0026	0.0824	0.0013	5.404	0.077
8311-68.1	333	90	0.28	115	12	1.22E-04	1.84E-05	0.0021	0.0798	0.0009	5.337	0.074
8311-84.1	256	74	0.30	89	13	1.78E-04	4.66E-05	0.0031	0.0853	0.0019	5.401	0.082
8311-81.1	379	140	0.38	136	13	1.21E-04	1.79E-05	0.0021	0.1087	0.0009	5.441	0.073
Reed Lake pluton (GSC lab # z8312):												
8312-22.1	3684	938	0.26	1265	110	1.05E-04	6.35E-06	0.0018	0.1015	0.0009	5.009	0.073
8312-50.1	427	64	0.15	140	56	4.57E-04	8.71E-05	0.0079	0.0466	0.0033	5.169	0.095
8312-49.1	359	128	0.37	122	58	5.74E-04	4.36E-05	0.0099	0.1052	0.0020	5.120	0.092
8312-51.1	302	102	0.35	104	58	6.76E-04	8.92E-05	0.0117	0.1018	0.0035	5.215	0.112
8312-43.1	394	132	0.35	140	46	3.97E-04	3.73E-05	0.0069	0.1004	0.0018	5.410	0.098
8312-71.1	230	0.2	0.00	72	46	7.17E-04	6.17E-05	0.0124	-0.0009	0.0024	5.176	0.086
8312-89.1	954	614	0.67	364	30	1.08E-04	1.21E-05	0.0019	0.1906	0.0009	5.417	0.071
8312-67.1	342	126	0.38	122	41	4.09E-04	3.79E-05	0.0071	0.1099	0.0018	5.380	0.092
8312-18.1	1796	671	0.39	674	26	4.76E-05	8.48E-06	0.0008	0.1125	0.0009	5.673	0.072
8312-27.1	374	146	0.40	135	41	3.71E-04	3.37E-05	0.0064	0.1185	0.0015	5.440	0.078
8312-6.1	1627	646	0.41	628	62	1.25E-04	1.57E-05	0.0022	0.1397	0.0018	5.722	0.127
8312-88.1	401	166	0.43	141	37	3.23E-04	3.15E-05	0.0056	0.1220	0.0017	5.316	0.085
8312-3.1	113	0.1	0.00	35	34	1.06E-03	1.09E-04	0.0184	-0.0050	0.0042	5.264	0.133
8312-20.1	276	87	0.33	97	18	2.20E-04	5.26E-05	0.0038	0.1011	0.0022	5.455	0.089
8312-4.1	106	0.0	0.00	33	46	1.54E-03	1.79E-04	0.0267	-0.0099	0.0068	5.279	0.161
8312-46.1	99	0.2	0.00	31	31	1.09E-03	1.34E-04	0.0190	0.0046	0.0054	5.385	0.134
8312-86.1	86	0.2	0.00	27	30	1.24E-03	1.37E-04	0.0215	-0.0039	0.0053	5.313	0.145
8312-92.1	65	0.1	0.00	21	42	2.18E-03	3.52E-04	0.0378	0.0085	0.0135	5.585	0.284
Wuskwatim Lake sequence (GSC lab # z8334):												
8334-122.1	49	80	1.69	39	2	6.53E-05	6.39E-05	0.0011	0.4483	0.0083	15.889	0.360
8334-122.2	89	153	1.78	72	10	2.45E-04	4.85E-05	0.0043	0.4909	0.0082	16.020	0.325
8334-124.1	110	58	0.55	89	1	2.32E-05	4.12E-05	0.0004	0.1460	0.0026	24.947	0.330
8334-124.2	120	48	0.41	90	2	2.56E-05	2.57E-05	0.0004	0.1063	0.0017	23.309	0.334
8334-114.1	84	50	0.61	67	1	1.63E-05	5.60E-05	0.0003	0.1609	0.0029	24.268	0.458
8334-114.2	104	85	0.84	85	15	2.57E-04	8.96E-05	0.0045	0.2196	0.0049	23.777	0.372
8334-98.1	364	312	0.89	289	11	5.60E-05	9.44E-06	0.0010	0.2388	0.0015	21.069	0.266
8334-98.2	442	108	0.25	297	19	8.27E-05	1.87E-05	0.0014	0.0686	0.0019	19.426	0.859
8334-57.1	65	108	1.73	43	16	6.12E-04	1.49E-04	0.0106	0.4644	0.0120	11.935	0.284
8334-57.2	86	156	1.88	66	20	5.21E-04	6.68E-05	0.0090	0.5402	0.0141	13.759	0.302
Burntwood metagreywacke (GSC lab # z8308):												
8308-17.1	5192	232	0.05	1751	6	3.62E-06	1.14E-06	0.0001	0.0134	0.0001	5.308	0.096
8308-98.1	3823	110	0.03	1311	12	1.02E-05	2.36E-06	0.0002	0.0084	0.0001	5.428	0.095
8308-24.1	176	62	0.36	61	10	2.10E-04	3.91E-05	0.0037	0.1010	0.0019	5.054	0.080
8308-24.1.2	190	68	0.37	65	16	2.94E-04	5.62E-05	0.0051	0.1093	0.0023	5.051	0.104

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. ***(continued)***

Spot name	$^{206*}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	Corr. coeff.	$^{207*}Pb/^{206*}Pb$	$\pm^{207}Pb/^{206}Pb$	Apparent ages (Ma) $^{206}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$\pm^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$\pm^{207}Pb/^{206}Pb$	Disc. (%)
8311-18.1	0.3407	0.0043	0.9232	0.1154	0.0006	1890	21	1888	12	1887	10	-0.2
8311-43.1	0.3406	0.0043	0.9356	0.1142	0.0006	1890	21	1879	12	1867	9	-1.2
8311-76.1	0.3408	0.0044	0.9484	0.1156	0.0005	1890	21	1890	12	1889	8	-0.1
8311-33.1	0.3403	0.0042	0.9411	0.1160	0.0006	1888	20	1892	12	1896	9	0.4
8311-49.1	0.3394	0.0043	0.8999	0.1169	0.0008	1884	21	1896	13	1909	12	1.3
8311-56.1	0.3401	0.0043	0.9304	0.1153	0.0006	1887	21	1886	12	1884	9	-0.2
8311-68.1	0.3355	0.0043	0.9584	0.1154	0.0005	1865	21	1875	12	1886	7	1.1
8311-84.1	0.3371	0.0043	0.8877	0.1162	0.0008	1873	21	1885	13	1898	13	1.3
8311-81.1	0.3403	0.0043	0.9646	0.1160	0.0004	1888	20	1891	12	1895	6	0.4
Reed Lake pluton (GSC lab # z8312):												
8312-22.1	0.3294	0.0047	0.9932	0.1103	0.0002	1835	23	1821	12	1804	3	-1.7
8312-50.1	0.3292	0.0040	0.7470	0.1139	0.0014	1835	20	1847	16	1862	23	1.5
8312-49.1	0.3236	0.0045	0.8421	0.1148	0.0011	1807	22	1839	15	1876	18	3.7
8312-51.1	0.3290	0.0048	0.7567	0.1150	0.0016	1833	23	1855	18	1880	26	2.5
8312-43.1	0.3402	0.0048	0.8451	0.1153	0.0011	1888	23	1886	16	1885	18	-0.1
8312-71.1	0.3246	0.0042	0.8366	0.1157	0.0011	1812	20	1849	14	1890	17	4.1
8312-89.1	0.3395	0.0042	0.9771	0.1157	0.0003	1884	20	1888	11	1891	5	0.4
8312-67.1	0.3369	0.0046	0.8559	0.1158	0.0010	1872	22	1882	15	1893	16	1.1
8312-18.1	0.3550	0.0043	0.9874	0.1159	0.0002	1959	21	1927	11	1894	4	-3.4
8312-27.1	0.3403	0.0042	0.9087	0.1159	0.0007	1888	20	1891	12	1895	11	0.3
8312-6.1	0.3570	0.0065	0.8771	0.1162	0.0013	1968	31	1935	19	1899	19	-3.6
8312-88.1	0.3313	0.0042	0.8635	0.1164	0.0009	1844	20	1871	14	1902	15	3
8312-3.1	0.3253	0.0057	0.7691	0.1174	0.0019	1816	28	1863	22	1916	29	5.3
8312-20.1	0.3365	0.0044	0.8683	0.1176	0.0010	1870	21	1894	14	1920	15	2.6
8312-4.1	0.3222	0.0049	0.5966	0.1189	0.0029	1800	24	1866	26	1939	45	7.2
8312-46.1	0.3267	0.0046	0.6582	0.1196	0.0023	1822	22	1883	22	1950	34	6.5
8312-86.1	0.3209	0.0049	0.6533	0.1201	0.0025	1794	24	1871	24	1957	38	8.3
8312-92.1	0.3289	0.0053	0.4279	0.1232	0.0057	1833	26	1914	45	2003	85	8.5
Wuskwatim Lake sequence (GSC lab # z8334):												
8334-122.1	0.5540	0.0095	0.8300	0.2080	0.0027	2842	40	2870	22	2890	21	1.7
8334-122.2	0.5508	0.0088	0.8521	0.2109	0.0023	2829	37	2878	20	2913	17	2.9
8334-124.1	0.6690	0.0079	0.9369	0.2705	0.0013	3302	31	3306	13	3309	7	0.2
8334-124.2	0.6310	0.0079	0.9236	0.2679	0.0015	3153	31	3240	14	3294	9	4.3
8334-114.1	0.6531	0.0095	0.8398	0.2695	0.0028	3240	37	3279	19	3303	16	1.9
8334-114.2	0.6355	0.0083	0.8938	0.2714	0.0019	3171	33	3259	15	3314	11	4.3
8334-98.1	0.6207	0.0070	0.9412	0.2462	0.0011	3113	28	3142	12	3160	7	1.5
8334-98.2	0.5991	0.0153	0.6705	0.2352	0.0078	3026	62	3063	44	3088	54	2
8334-57.1	0.4682	0.0063	0.6584	0.1849	0.0033	2475	28	2599	23	2697	30	8.2
8334-57.2	0.5151	0.0089	0.8518	0.1937	0.0023	2679	38	2733	21	2774	19	3.4
Burntwood metagreywacke (GSC lab # z8308):												
8308-17.1	0.3492	0.0061	0.9911	0.1103	0.0003	1931	29	1870	15	1804	4	-7
8308-98.1	0.3566	0.0061	0.9944	0.1104	0.0002	1966	29	1889	15	1806	3	-8.8
8308-24.1	0.3290	0.0044	0.8930	0.1114	0.0008	1834	21	1828	14	1822	13	-0.6
8308-24.1.2	0.3243	0.0055	0.8888	0.1130	0.0011	1810	27	1828	18	1848	17	2

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. ***(continued)***

Spot name	U (ppm)	Th (ppm)	Th/U	Pb* (ppm)	^{204}Pb (ppb)	^{204}Pb/^{206}Pb	± ^{204}Pb/^{206}Pb	f(206)^{204}	^{208*}Pb/^{206*}Pb	± ^{208}Pb/^{206}Pb	^{207*}Pb/^{235}U	± ^{207}Pb/^{235}U
8308-24.1.3	158	57	0.37	53	17	3.87E-04	4.17E-05	0.0067	0.1103	0.0019	4.999	0.163
8308-110.1	106	29	0.28	35	9	3.21E-04	7.07E-05	0.0056	0.0835	0.0030	4.909	0.112
8308-9.1	105	27	0.27	35	2	7.65E-05	9.83E-05	0.0013	0.0770	0.0039	5.023	0.121
8308-9.2	171	56	0.34	60	22	4.45E-04	4.80E-05	0.0077	0.0970	0.0020	5.232	0.087
8308-9.2.2	164	53	0.33	57	30	6.39E-04	5.01E-05	0.0111	0.0962	0.0024	5.197	0.096
8308-9.3	167	69	0.43	58	16	3.47E-04	4.85E-05	0.0060	0.1242	0.0021	5.175	0.113
8308-9.3.2	159	62	0.40	55	20	4.32E-04	8.35E-05	0.0075	0.1167	0.0033	5.100	0.136
8308-3.1	92	23	0.25	31	2	9.10E-05	1.27E-04	0.0016	0.0753	0.0053	5.070	0.129
8308-16.1	138	37	0.28	46	3	7.04E-05	8.95E-05	0.0012	0.0825	0.0037	5.004	0.102
8308-16.2	155	40	0.27	50	30	6.99E-04	5.77E-05	0.0121	0.0757	0.0024	4.939	0.088
8308-16.2.2	149	39	0.27	48	42	1.02E-03	7.36E-05	0.0177	0.0696	0.0029	4.789	0.105
8308-109.1	101	31	0.32	35	10	3.29E-04	6.53E-05	0.0057	0.0908	0.0028	5.242	0.099
8308-36.1	124	39	0.32	43	4	1.26E-04	5.19E-05	0.0022	0.0969	0.0031	5.173	0.088
8308-18.1	80	24	0.32	27	4	1.88E-04	1.33E-04	0.0033	0.0915	0.0053	5.047	0.141
8308-50.1	220	88	0.42	77	5	8.01E-05	2.87E-05	0.0014	0.1196	0.0015	5.147	0.077
8308-14.1	233	65	0.29	80	6	8.96E-05	2.61E-05	0.0016	0.0830	0.0023	5.223	0.087
8308-40.1	75	22	0.30	26	9	3.89E-04	8.67E-05	0.0067	0.0866	0.0036	5.297	0.110
8308-60.1	84	47	0.57	31	10	4.14E-04	1.27E-04	0.0072	0.1640	0.0078	5.198	0.135
8308-98.2	92	21	0.24	31	9	3.35E-04	1.97E-04	0.0058	0.0618	0.0074	5.266	0.171
8308-10.1	121	26	0.22	41	2	4.96E-05	6.80E-05	0.0009	0.0635	0.0034	5.304	0.130
8308-19.1	80	33	0.42	28	5	2.18E-04	1.46E-04	0.0038	0.1178	0.0057	5.154	0.140
8308-31.1	149	47	0.32	51	5	1.29E-04	3.48E-05	0.0022	0.0945	0.0029	5.227	0.085
8308-22.1	90	44	0.51	32	3	1.32E-04	6.58E-05	0.0023	0.1532	0.0031	5.208	0.111
8308-25.1	87	25	0.30	30	5	2.17E-04	8.56E-05	0.0038	0.0874	0.0036	5.297	0.111
8308-23.1	260	88	0.35	91	3	4.59E-05	1.81E-05	0.0008	0.1011	0.0011	5.276	0.072
8308-52.1	252	72	0.29	86	9	1.21E-04	3.99E-05	0.0021	0.0837	0.0018	5.255	0.081
8308-58.1	71	27	0.39	25	7	3.33E-04	9.92E-05	0.0058	0.1184	0.0042	5.227	0.118
8308-27.1	122	24	0.20	43	2	5.61E-05	3.41E-05	0.0010	0.0603	0.0019	5.453	0.095
8308-55.1	123	35	0.29	43	7	1.99E-04	5.89E-05	0.0035	0.0839	0.0025	5.333	0.097
8308-59.1	129	47	0.38	45	7	2.01E-04	5.07E-05	0.0035	0.1073	0.0025	5.293	0.092
8308-8.1	224	100	0.46	81	4	5.66E-05	2.36E-05	0.0010	0.1349	0.0015	5.390	0.085
8308-32.1	113	32	0.29	40	6	1.89E-04	4.69E-05	0.0033	0.0898	0.0023	5.382	0.096
8308-100.1	90	16	0.19	32	4	1.67E-04	8.44E-05	0.0029	0.0559	0.0034	5.556	0.120
8308-57.1	49	11	0.22	17	6	4.40E-04	9.83E-05	0.0076	0.0726	0.0041	5.483	0.127

Table GS-9-1: Uranium-lead sensitive high-resolution ion microprobe (SHRIMP) data for zircons extracted from samples collected in the Pikwitonei–Snow Lake transect area. *(continued)*

							Apparent ages (Ma)					
Spot name	$^{206*}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	Corr. coeff.	$^{207*}Pb/^{206*}Pb$	$\pm^{207}Pb/^{206}Pb$	$^{206}Pb/^{238}U$	$\pm^{206}Pb/^{238}U$	$^{207}Pb/^{235}U$	$\pm^{207}Pb/^{235}U$	$^{207}Pb/^{206}Pb$	$\pm^{207}Pb/^{206}Pb$	Disc. (%)
8308-24.1.3	0.3171	0.0098	0.9762	0.1143	0.0008	1776	48	1819	28	1869	13	5
8308-110.1	0.3185	0.0058	0.8621	0.1118	0.0013	1782	28	1804	19	1829	21	2.6
8308-9.1	0.3256	0.0042	0.6327	0.1119	0.0021	1817	21	1823	21	1830	35	0.7
8308-9.2	0.3361	0.0046	0.8792	0.1129	0.0009	1868	22	1858	14	1847	14	-1.1
8308-9.2.2	0.3331	0.0053	0.9052	0.1132	0.0009	1853	25	1852	16	1851	14	-0.1
8308-9.3	0.3293	0.0063	0.9155	0.1140	0.0010	1835	30	1849	19	1864	16	1.5
8308-9.3.2	0.3294	0.0073	0.8843	0.1123	0.0014	1836	35	1836	23	1837	23	0.1
										1850	8	mean
8308-3.1	0.3275	0.0046	0.6491	0.1123	0.0022	1826	22	1831	22	1836	36	0.5
8308-16.1	0.3229	0.0042	0.7320	0.1124	0.0016	1804	21	1820	17	1839	25	1.9
8308-16.2	0.3187	0.0044	0.8356	0.1124	0.0011	1784	21	1809	15	1838	18	3
8308-16.2.2	0.3140	0.0047	0.7696	0.1106	0.0016	1760	23	1783	19	1809	26	2.7
										1831	13	mean
8308-109.1	0.3381	0.0047	0.8164	0.1124	0.0012	1878	23	1859	16	1839	20	-2.1
8308-36.1	0.3335	0.0045	0.8505	0.1125	0.0010	1855	22	1848	15	1840	16	-0.8
8308-18.1	0.3252	0.0057	0.7120	0.1126	0.0022	1815	28	1827	24	1841	36	1.4
8308-50.1	0.3306	0.0044	0.9306	0.1129	0.0006	1841	21	1844	13	1847	10	0.3
8308-14.1	0.3352	0.0044	0.8553	0.1130	0.0010	1863	21	1856	14	1849	16	-0.8
8308-40.1	0.3391	0.0045	0.7198	0.1133	0.0017	1882	21	1868	18	1853	26	-1.6
8308-60.1	0.3320	0.0045	0.6238	0.1136	0.0023	1848	22	1852	22	1857	38	0.5
8308-98.2	0.3359	0.0045	0.5236	0.1137	0.0032	1867	22	1863	28	1860	51	-0.4
8308-10.1	0.3381	0.0049	0.6806	0.1138	0.0021	1878	24	1870	21	1861	33	-0.9
8308-19.1	0.3281	0.0048	0.6347	0.1140	0.0024	1829	23	1845	23	1863	39	1.8
8308-31.1	0.3319	0.0044	0.8812	0.1142	0.0009	1848	21	1857	14	1868	14	1.1
8308-22.1	0.3303	0.0057	0.8632	0.1144	0.0013	1840	27	1854	18	1870	20	1.6
8308-25.1	0.3358	0.0048	0.7678	0.1144	0.0016	1866	23	1868	18	1871	25	0.2
8308-23.1	0.3340	0.0041	0.9475	0.1146	0.0005	1858	20	1865	12	1873	8	0.8
8308-52.1	0.3326	0.0042	0.8841	0.1146	0.0008	1851	20	1862	13	1874	13	1.2
8308-58.1	0.3302	0.0048	0.7306	0.1148	0.0018	1839	23	1857	19	1877	28	2
8308-27.1	0.3441	0.0050	0.8840	0.1149	0.0009	1906	24	1893	15	1879	15	-1.5
8308-55.1	0.3361	0.0045	0.8133	0.1151	0.0012	1868	22	1874	16	1881	19	0.7
8308-59.1	0.3332	0.0043	0.8207	0.1152	0.0012	1854	21	1868	15	1883	18	1.6
8308-8.1	0.3374	0.0043	0.8658	0.1159	0.0009	1874	21	1883	14	1893	14	1
8308-32.1	0.3369	0.0043	0.7939	0.1159	0.0013	1872	21	1882	15	1893	20	1.2
8308-100.1	0.3453	0.0054	0.8037	0.1167	0.0015	1912	26	1909	19	1907	23	-0.3
8308-57.1	0.3354	0.0050	0.7257	0.1186	0.0019	1864	24	1898	20	1935	29	3.6

Notes (*see* Stern, 1997):

Uncertainties reported at 1σ (absolute) and are calculated by numerical propagation of all known sources of error

$f(206)^{204}$ refers to mole fraction of total ^{206}Pb that is due to common Pb, calculated using the ^{204}Pb-method; common Pb composition used is the surface blank

* refers to radiogenic Pb (corrected for common Pb)

Discordance relative to origin = 100 * (1-($^{206}Pb/^{238}U$ age)/($^{207}Pb/^{206}Pb$ age))

Results in shaded fields are replicate analyses within an individual zircon grain; the mean age of the replicate is noted when the age is reproducible

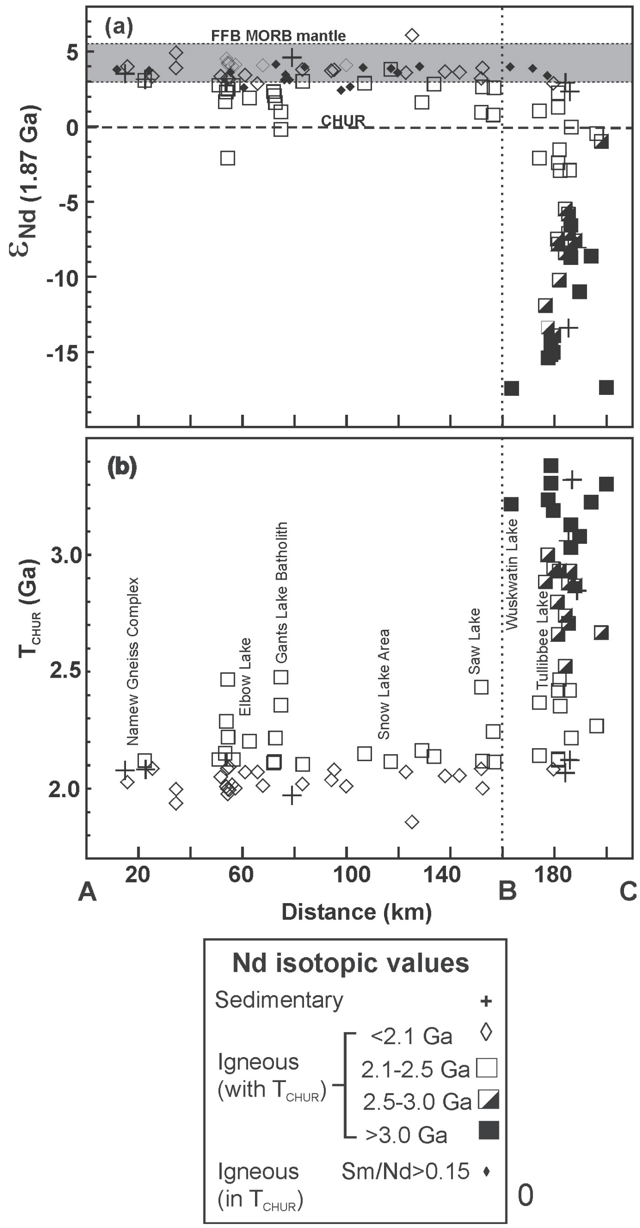

Figure GS-9-2: *Plots of a) ε_{Nd} (1.87 Ga), and b) T_{CHUR} model ages, projected on a west (A) to east (B) and a northwest (B) to southeast (C) cross-section, for samples from the Pikwitonei–Snow Lake transect area. See Figure GS-9-1 for cross-section location and spatial distribution of Nd-Sm samples. Also shown in (a) as a shaded field is the range of Flin Flon Belt (FFB) mid-ocean ridge basalt (MORB) mantle from Stern et al. (1995). Abbreviations: CHUR, chondritic uniform reservoir; FFB, Flin Flon Belt; MORB, mid-ocean ridge basalt.*

is in contact with units of the Bucko pluton in the west and with Superior Province rocks in the east. The body is at least 3.5 km wide and 15 km long, but its southern extent is unknown. Previously mapped as Archean granite, this medium- to coarse-grained, homogeneous, foliated hornblende-biotite granodiorite carries a single foliation, unlike adjacent polydeformed Archean gneiss, and lacks deformed mafic dikes. Its field characteristics resemble those of Paleoproterozoic intrusions in the TNB-KD BZ. Units of similar description have been observed in drillcore beneath Paleozoic cover to the south (Thompson Nickel Belt Working Group, 2001). A sample collected in 2004 yielded a population of good-quality, zoned, prismatic zircons with few inclusions and some iron-oxide staining. Uranium-lead SHRIMP analysis gave a weighted-mean $^{207}Pb/^{206}Pb$ age of 1885 ±5 Ma (Figure GS-9-3; mean square of weighted deviates (MSWD) = 0.98, probability of fit = 46%), interpreted as the crystallization age. No inherited zircons were documented, nor were any cores observed in the back-scattered electron (BSE) images. The dated sample gave an ε_{Nd} value of –3.3 and T_{CHUR} age of 2.5 Ga.

Results from the Clarke Lake pluton suggest the presence of a continental arc on the Superior margin at

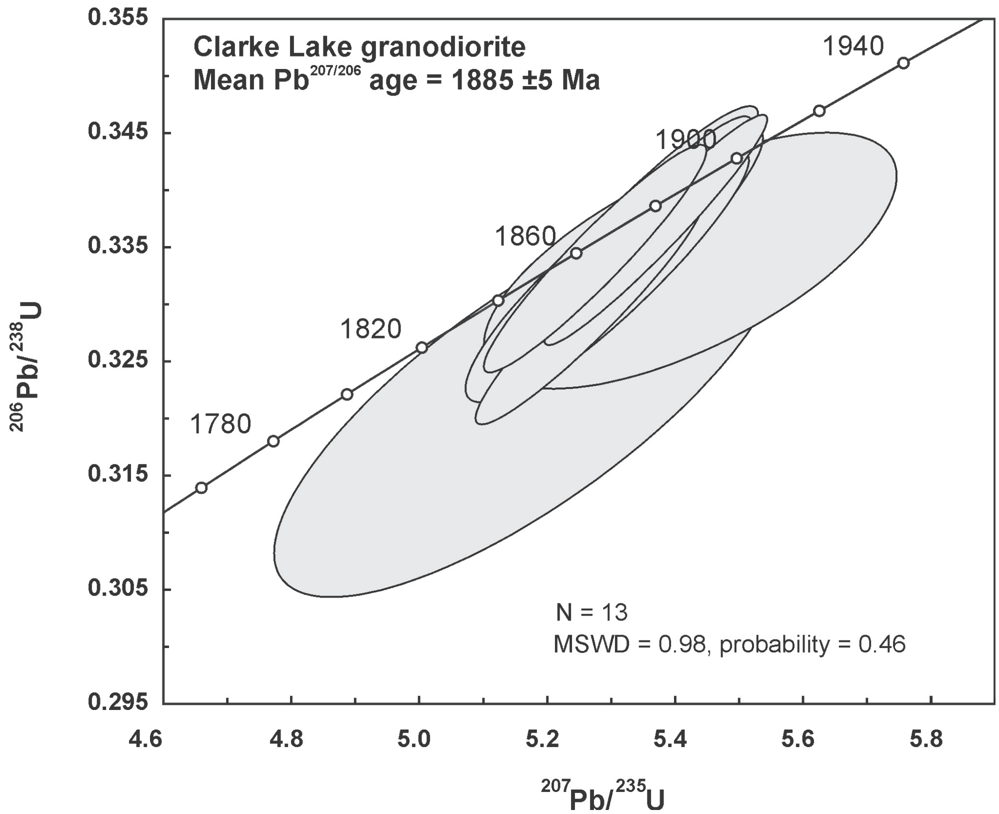

Figure GS-9-3: *Uranium-lead concordia plot of sensitive high-resolution ion microprobe (SHRIMP) age data on zircon from Clarke Lake granodiorite, Pikwitonei–Snow Lake transect area.*

1885 Ma. This sample's ε_{Nd} value, which is intermediate between those of Superior basement (approx. –17) and Flin Flon mid-ocean ridge basalt (MORB) mantle (ε_{Nd} = +3 to +5.5; *see* Figure 2a of Stern et al., 1995) signatures, likely reflects contamination of mantle-derived magma by ca. 3.1 Ga crust. Its high zirconium content (235 ppm) and elevated (804ºC) zircon saturation temperature (Watson and Harrison, 1983) explain the absence of inherited zircon as being due to dissolution in a high-temperature magma (Miller et al., 2003).

The new age data indicate that a period of arc magmatism preceded and may have accompanied emplacement of the Molson mafic dike swarm (1883–1880 Ma), which is generally related to rifting of the Superior margin (e.g., Halls and Heaman, 1987; Hulbert et al. 2004). If 1880 Ma mafic magmatism is truly a reflection of a regional plume-driven rifting event, then the Thompson area may represent the intersection of plume and arc processes. This geodynamically unusual setting has been proposed for the Archean Abitibi belt of the Superior Province (Dostal and Mueller, 1997; Wyman, 1999; Ayer et al., 2002; Wyman et al., 2002; Sproule et al., 2002) and may have been an important factor in the generation of large massive sulphide deposits such as Kidd Creek (Wyman et al., 1999). Alternatively, the close spatial and temporal association of coeval plutons and dikes could indicate a continental-arc–back-arc setting. The metallogenic implications of both models warrant further consideration.

The Mystery Lake pluton (Figure GS-9-1, location 2) cuts both Superior Province gneiss and supracrustal rocks of the Ospwagan Group. It consists of at least two phases: 1) a foliated, pink, medium-grained biotite granodiorite with K-feldspar augen up to 2 cm and local boudinaged mafic dikes; and 2) a weakly foliated, white, medium-grained muscovite-biotite granodiorite. Contact relationships were not observed between the two phases, although (2) appears younger based on its less-strained state. The second phase contains inherited zircons ranging in age from 3.2 to 2.7 Ga and yielding an ε_{Nd} (1844 Ma) value of -8.8 and a T_{CHUR} of 3.2 Ga.

The foliated pink granodiorite is characterized by localized high-strain zones, some of which are cut by mafic dikes up to 1 m wide, themselves foliated and boudinaged. Zircons from the granodiorite (WX04-T024B) consist of highly fractured, prismatic cores overgrown by zoned rims. Most of the rims are highly altered, however, and unsuitable for analysis. Most of the zircons analyzed are xenocrysts, with ages ranging from 3.23 to 2.63 Ga (n = 12). One possibly magmatic zircon was analyzed and gave an age of 1879 ±9 Ma (1σ), but the authors were unable to identify other zircons of that age. A single, extremely high uranium (5558 ppm U) overgrowth was analyzed and gave an age of 1750 Ma (Figure GS-9-4).

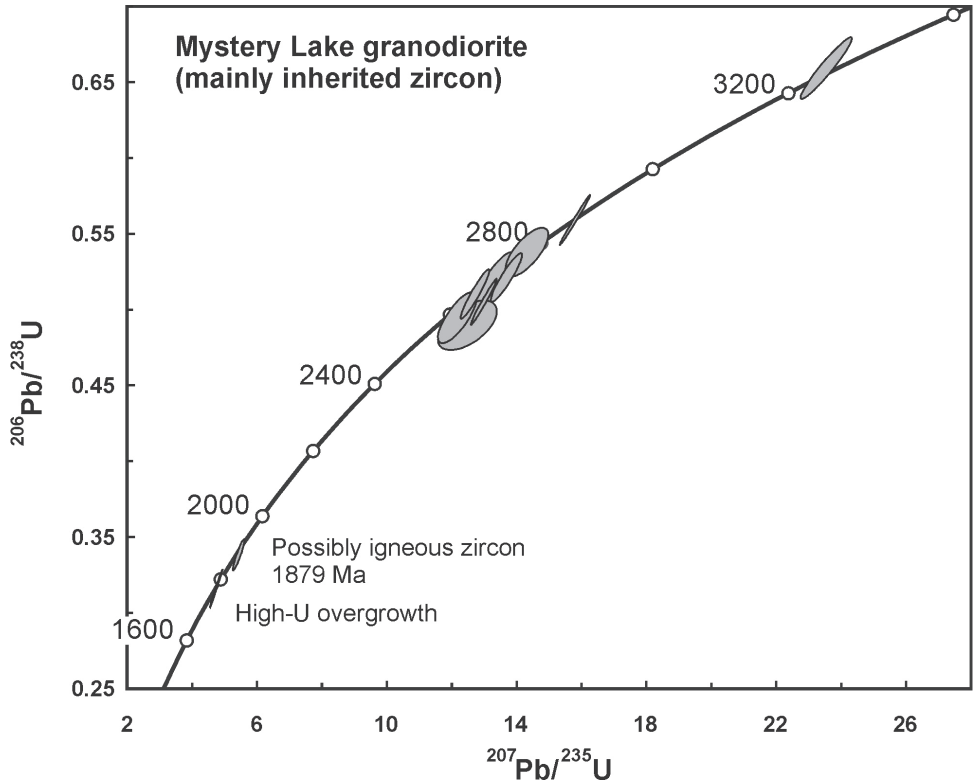

Figure GS-9-4: *Uranium-lead concordia plot of sensitive high-resolution ion microprobe (SHRIMP) age data on zircon from Mystery Lake granodiorite, Pikwitonei–Snow Lake transect area.*

Thompson Nickel Belt–Kisseynew Domain Boundary Zone

The Grass River Group is restricted to the TNB-KD BZ. It consists of arkose and minor conglomerate, and exhibits ambiguous field relationships. Early work indicated that the sedimentary rocks are cut by plutonic rocks (Zwanzig, 1997), whereas more recent interpretations regard them as unconformable on some plutons (Zwanzig et al., 2003). A sample of Grass River arkose (Figure GS-9-1, location 3) yielded abundant detrital zircons. They are generally of good quality, with stubby to prismatic morphology. The grains are not markedly rounded. Uranium-lead SHRIMP analysis of 57 different zircon grains indicates a spectrum of ages. The majority of analyses falls in the range 1.9–1.84 Ga and forms a statistical population centred at 1865 Ma. A smaller population (6 grains) is in the range 2.5–2.7 Ga (Figure GS-9-5). This sample yielded a ε_{Nd} (1840 Ma) of +2.6 and T_{CHUR} of 2.1 Ga.

Because the youngest ages are statistically indistinguishable from the main population, the maximum depositional age is taken to be 1.864 Ga, supporting a correlation of the Grass River Group with the Missi and Sickle sedimentary sequences in the Trans-Hudson internides to the west. Correlation of the Grass River Group with the Missi is supported by ε_{Nd} (1840 Ma) values of +2.8 and +4.3 and T_{CHUR} ages of 2.0 and 2.1 Ga obtained from the Missi Group in the western portion of the current transect (*see* Figures GS-9-1, -2). The presence of material of Archean age in the TNB-ND Grass River Group sample, however, is uncharacteristic (cf. Ansdell et al., 1992) and suggests deposition of the Grass River Group in relative proximity to a source region of Archean age, likely the Superior Province. This interpretation is supported by the ε_{Nd} (1840 Ma) of –8.1 and T_{CHUR} age of 3.3 Ga obtained from a granite cobble, contained within the Grass River Group, that was collected on Setting Lake approximately 7 km northeast of the dated sample.

Trans-Hudson internides

The Herblet Lake dome is an approximately 20 km wide, triangular body in the northern Snow Lake belt. It consists of homogeneous, biotite-hornblende granodiorite and tonalite with a concentric foliation and is surrounded by steeply dipping supracrustal units (1.89–1.83 Ga). Previous geochronological studies have indicated ages of 1890 +8/–6 Ma (Gordon et al., 1990), 1901 ±4 Ma and 1884 ±6 Ma (David et al., 1996). Inheritance was a possibility in these ages, because the body is unlike other synvolcanic plutons of the belt, which are mainly tonalite to quartz diorite and cut by numerous younger intrusive phases, particularly multiple generations of mafic dikes (cf. Gants Lake batholith; Whalen et al., 1999). A sample from the Herblet Lake dome (Figure GS-9-1, location 4)

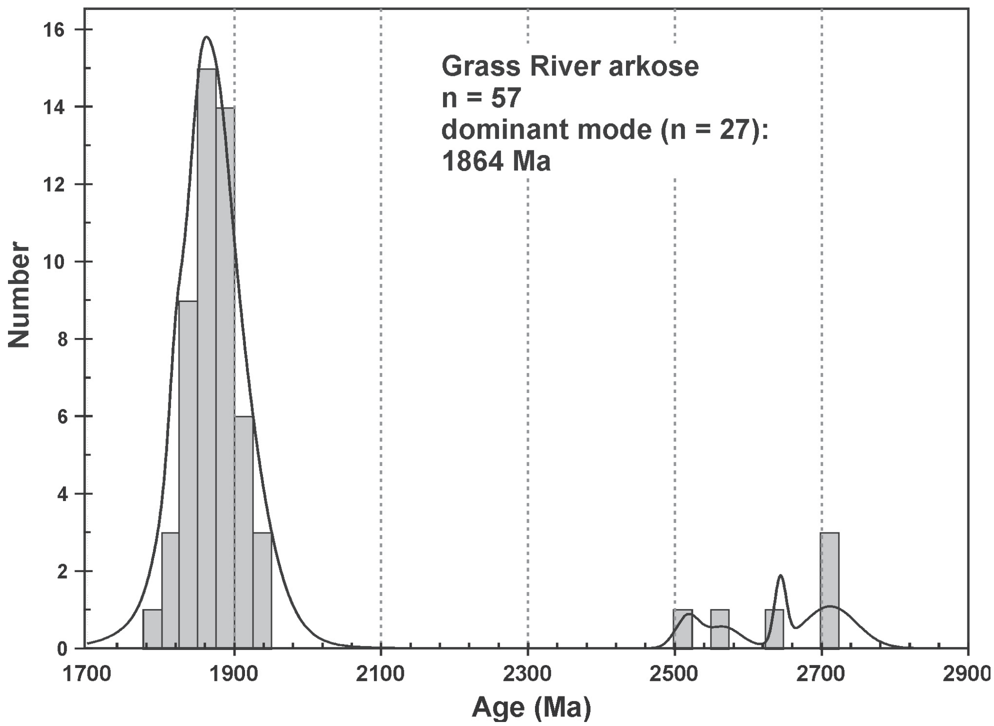

***Figure GS-9-5:** Uranium-lead concordia plot of sensitive high-resolution ion microprobe (SHRIMP) age data on zircon from Grass River arkose, Pikwitonei–Snow Lake transect area.*

contains a homogeneous population of good-quality, well-faceted zircons with no cores or rims observed in either transmitted light images or BSE images. Uranium-lead SHRIMP analysis on 12 zircon grains gave a weighted-mean $^{207}Pb/^{206}Pb$ age of 1889 ±5 Ma (Figure GS-9-6; MSWD = 1.17, probability of fit = 30%), interpreted as the age of crystallization. No other age components were identified. The dated sample gave an ε_{Nd} of +3.8 and T_{CHUR} age of 2.1 Ga, and an additional sample from the northern end of this dome yielded comparable values of +3.7 and 2.2 Ga. A lithologically similar sample collected from the proximal Pulver Lake gneiss dome gave an ε_{Nd} (1891 Ma) of +6.3 and T_{CHUR} of 1.9 Ga.

The Herblet Lake dome includes both felsic (SiO_2 = 72.4–75.5 wt%) low-K tonalite and high-K granodiorite, both of which have chondrite-normalized La/Yb <5.5, suggesting formation through relatively shallow, intra-crustal melting of felsic to intermediate sources without residual garnet. In light of the isotopic data, the body appears to have been generated from sources without a long-term history of light rare earth element (LREE) enrichment. Subvolcanic tonalitic rocks, like the Richard and Sneath Lake plutons, associated with the 1.906–1.883 Ga mature-arc sequence of the Snow Lake assemblage (Bailes and Galley, 1999), could be potential candidates. Juvenile ε_{Nd} (1890 Ma) values, obtained from these plutons, of +3.4 and +4.2, respectively (Whalen et al., 1999), are compatible with such an interpretation. Nevertheless, the Herblet Lake dome remains enigmatic because, based on its age, it should exhibit more evidence of diking by abundant younger magmatic units and more structural complexity, like that exhibited by the Reed Lake tonalite gneiss phase (*see* below) and the Namew gneiss.

The Reed Lake complex (Figure GS-9-1, location 5) is made up of at least two discrete phases. An east-central zone consists of fine- to medium-grained, thinly layered, biotite-tonalite gneiss, characterized by open to close folds of layering, cut by metre-scale mafic dikes, themselves foliated and boudinaged. The western marginal phase of the Reed Lake complex is a homogeneous, medium- to coarse-grained, biotite-hornblende-orthopyroxene-clinopyroxene diorite to quartz diorite that has an unpublished U-Pb zircon age of 1839 Ma (R.A. Stern, unpublished data, 1995).

Zircons from the biotite-tonalite gneiss form a bimodal population. One group consists of excellent-quality, inclusion- and fracture-free grains, whereas the other is highly altered and contains numerous inclusions and some thick overgrowths, one of which was dated (*see* below). A weighted-mean $^{207}Pb/^{206}Pb$ age of 1895 ±5 Ma (Figure GS-9-7; n = 16, MSWD = 0.96, probability of fit = 49%) is interpreted as the time of crystallization. One high-uranium rim was dated at 1804 ±3 Ma and is interpreted to be metamorphic in origin. This dated sample gave an ε_{Nd} of +2.6 and T_{CHUR} of 2.3 Ga. A massive diorite sample from the western phase of the complex gave an ε_{Nd} (1839 Ma) of +3.9 and T_{CHUR} of 2.2 Ga.

The Reed Lake complex resembles the Namew complex in that five Namew gneiss samples yielded ε_{Nd}

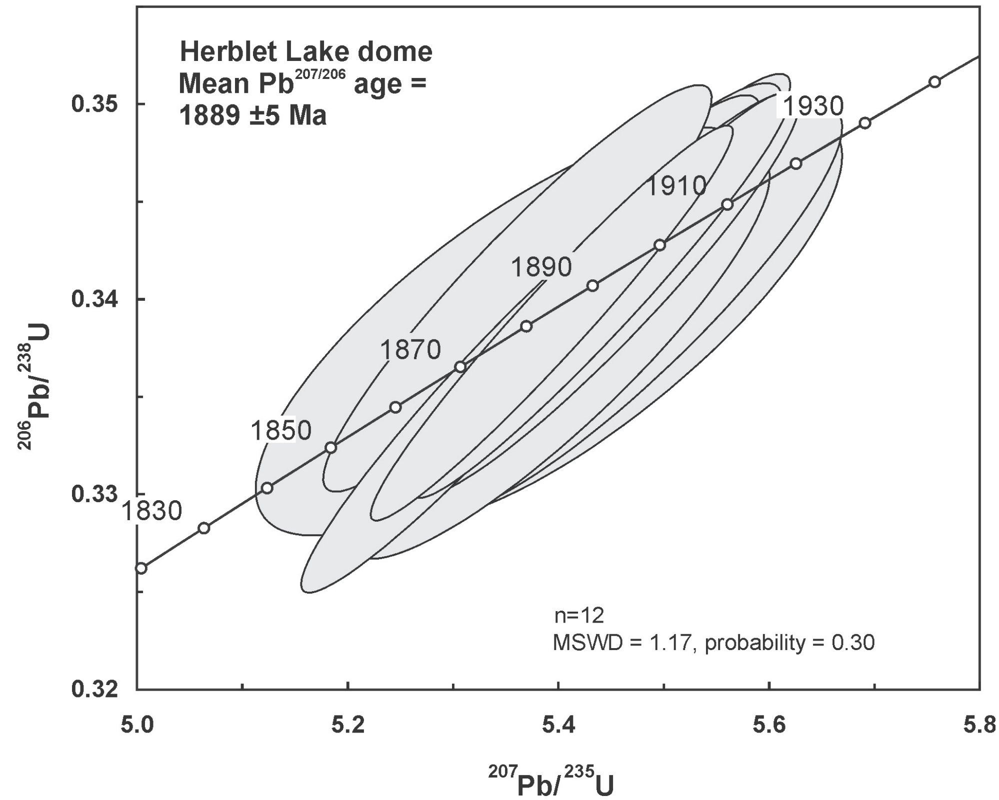

Figure GS-9-6: *Uranium-lead concordia plot of sensitive high-resolution ion microprobe (SHRIMP) age data on zircon from the Herblet Lake dome, Pikwitonei–Snow Lake transect area.*

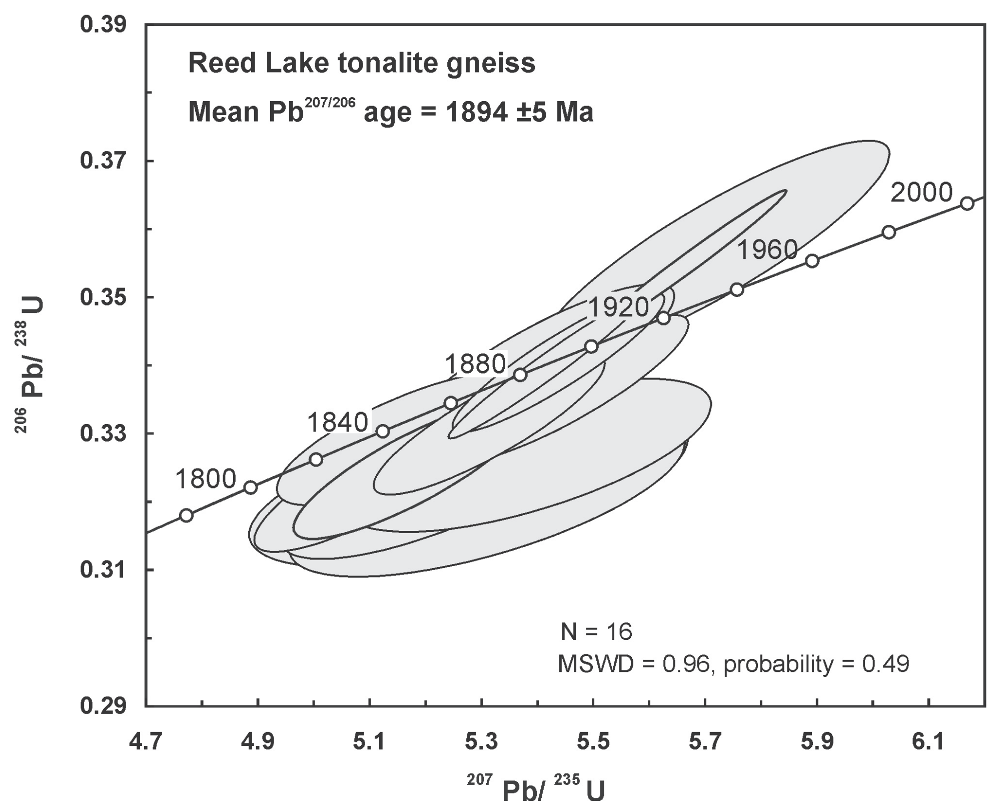

Figure GS-9-7: *Uranium-lead concordia plot of sensitive high-resolution ion microprobe (SHRIMP) age data on zircon from Reed Lake tonalite gneiss, Pikwitonei–Snow Lake transect area.*

values between +3.5 and +4.1 and T_{CHUR} ages of 2.0 to 2.2 Ga (R.A. Stern, unpublished data, 1995), and in its U-Pb zircon age of 1885 Ma (Leclair et al., 1993). As well, gneissic phases in both complexes exhibit chondrite-normalized La/Yb <5, indicative of garnet-absent melting. It is likely that these bodies have similar origins, possibly representing exposures of the roots of a juvenile arc. The structural chronology of the Reed Lake complex can be used to provide constraints on the age of ductile deformation. The S_1 gneissosity formed prior to 1839 Ma, the age of the weakly foliated marginal phase, and likely before 1888 Ma, the age of structurally overlying volcanic units and possibly the mafic dikes in the gneiss. The significance of ca. 1.89 Ga deformation is further considered below.

Mafic rocks in the vicinity of Wuskwatim Lake form part of a coherent belt of supracrustal rocks that extends northwestward for at least 10 km along the Burntwood River (Figure GS-9-1). Metamorphic grade is high in this part of the Kisseynew Domain, based on widespread occurrences of ortho- and clinopyroxene, zones of diatexite within migmatite units and the presence of charnockitic granite. The metabasalt and associated gabbroic units, up to 5 m thick, are interlayered with thinly layered, fine-grained felsic rocks of uncertain origin and metagreywacke. A felsic unit of presumed volcanic origin (Figure GS-9-1, location 6; Figure GS-9-8) was sampled for geochronology. The rock consists of fine quartz, plagioclase and K-feldspar, with up to 5% biotite aligned in a moderate foliation. This rock yielded a population of optically acceptable zircons with few fractures or visible inclusions. The zircons are prismatic to subequant, varying from well faceted to rounded, typical of a volcano-sedimentary rock. In BSE images, the zircons are unzoned or exhibit faint oscillatory zoning. No cores were observed. Initial examination of the images indicated nothing abnormal about these zircons. Uranium-lead SHRIMP results for this sample are limited, as the analytical results were unusually variable. The analyses typically yielded very large statistical uncertainties, and multiple analyses of the same grain gave inconsistent age results. Further detailed examination of the zircons revealed the presence of small (submicrometre to 3 μm) monazite inclusions. The authors tentatively conclude that these small inclusions, which were not apparent at the lower magnification levels of the BSE images, are responsible for the erratic analytical behaviour of most of these zircons. Despite this challenge, reproducible results were obtained from five zircon grains. Ages are in the range 2.7–3.3 Ga and are interpreted as a detrital or inherited component in this volcanosedimentary rock. Charnockite from a nearby location yielded an ε_{Nd} (1840 Ma) value of –17.9 and T_{CHUR} age of 3.2 Ga (Figure GS-9-2), suggesting derivation from isotopically evolved crust resembling that of the northwestern Superior Province.

The Wuskwatim Lake area is situated approximately 40 km west of Thompson in an area interpreted as being underlain by Burntwood Group. The present results, however, suggest a different affinity. The mafic and associated supracrustal rocks are atypical of the monotonous Burntwood metagreywacke package. Furthermore, the detrital zircon population of Burntwood greywacke is exclusively of Paleoproterozoic age (1.95–1.83 Ga; Ansdell et al., 1992, 1995; *see* below). In its exclusively Archean zircon population, the Wuskwatim rock resembles metasedimentary units of the Ospwagan Group (Hamilton and Bleeker, 2002; Rayner and Percival, unpublished data, 2004). Similar rocks are exposed in structural culminations within the Kisseynew Domain in the Mel zone, 10 km west of the exposed Superior margin (Zwanzig and Böhm, 2002), and the present results suggest that Superior crust and Ospwagan cover units extend considerably farther to the west than previously

Figure GS-9-8: *Field photograph of interlayered metabasalt (left) and layered felsic rock of volcanic or clastic sedimentary origin, Wuskwatim Lake.*

thought (Figure GS-9-1). The origin of the mafic units and their nickel potential remain speculative.

A sample of metagreywacke was collected from one of the easternmost exposures of the Burntwood Group, southwest of Kiski Lake (Figure GS-9-1, location 7). The garnet-biotite paragneiss has nonmigmatitic patches that contain abundant detrital zircon, forming a population of excellent-quality, clear, colourless zircons with a range in the degree of roundedness. Some of the grains exhibit thin, high-uranium rims. Thirty-eight SHRIMP analyses of 28 grains yielded a range of ages between 1.93 and 1.81 Ga (Figure GS-9-9). After replicate analyses were carried out on grains that gave the youngest ages, the maximum depositional age is constrained to be 1831 ±25 Ma, the youngest reproducible age. Two high-uranium overgrowths were dated and gave ages of 1.8 Ga, interpreted as being metamorphic in origin. Although this dated sample has not yet been analyzed for Nd-Sm, two Burntwood Group samples from the northwestern portion of the study area (Figure GS-9-1) yielded ε_{Nd} (1840 Ma) values of +3.0 and +3.4 and identical T_{CHUR} ages of 2.1 Ga.

Working model for tectonic interaction between the Trans-Hudson internides and Superior margin

The new information reported here helps to constrain the nature and timing of tectonic interaction between the Trans-Hudson Orogen and Superior margin (Figures GS-9-10, -11). Early evidence of rifting of the Superior margin is indicated by emplacement of the Cauchon dike swarm at 2090 Ma (Halls and Heaman, 1997). The maximum age of deposition of the Ospwagan Group (Figure GS-9-11a) is constrained by the 1974 Ma age of a single detrital zircon grain (Hamilton and Bleeker, 2002). A continental arc on the Superior margin produced plutons at 1891–1885 Ma (Favell Island suite, Clarke Lake pluton). Early (D_1) deformation affected the Ospwagan Group prior to ca. 1883 (Bleeker, 1990). Although it could be considerably older, this event (Figure GS-9-11b) could be related to the cryptic 'early accretion' event inferred in the Trans-Hudson internides (Stern et al., 1995; Whalen et al., 1999) and possibly represented by D_1 gneissosity of the Reed Lake tonalite gneiss. Zwanzig et al. (2001) noted evidence for early recumbent folding during emplacement of the 1886 ±3 Ma Josland Lake sills (Figure GS 9-10). A sliver of the Superior margin (presently the TNB-KD BZ) was subsequently rifted during the ca. 1883 Ma Molson event (Figure GS-9-11c). The Fox River belt is likely a preserved remnant of the rift margin or back-arc sequence. If nickel mineralization in the Thompson belt can be related to the 1883 Ma event, as suggested by Hulbert et al. (2004), then the influence of mantle dynamics on magma genesis requires evaluation from an economic perspective.

Juvenile-arc magmatism in the Trans-Hudson Orogen

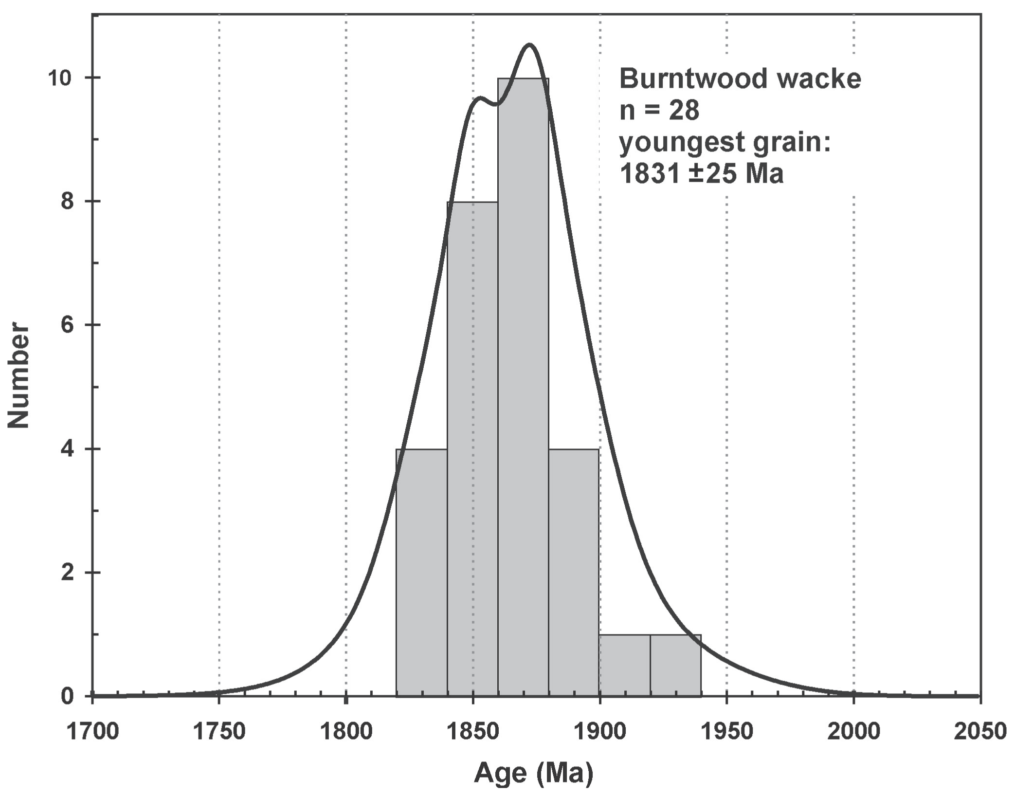

Figure GS-9-9: *Uranium-lead concordia plot of sensitive high-resolution ion microprobe (SHRIMP) age data on detrital zircon from Burntwood Group metagreywacke, Pikwitonei–Snow Lake transect area.*

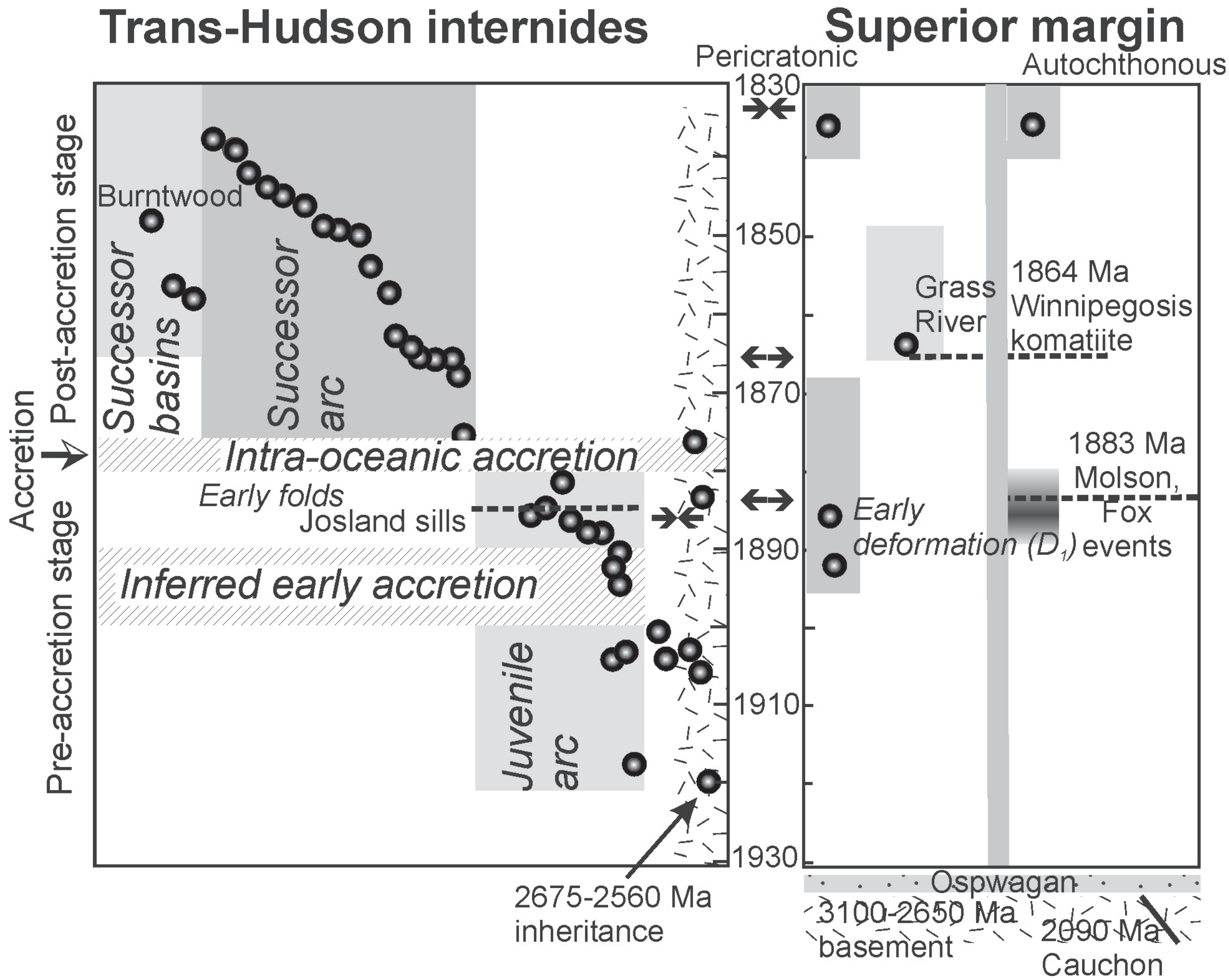

Figure GS-9-10: *Event correlation diagram comparing evolution of the Trans-Hudson Orogen and the Superior margin.*

(1888–1881 Ma) was followed by an intraoceanic accretion event (ca. 1878 Ma; Lucas et al., 1996; Figure GS-9-11d). The 1878 Ma Kiski Creek granite of the TNB-KD BZ (Percival et al., 2004) may represent an early example of successor-arc magmatism. The Superior margin underwent renewed rifting at 1864 Ma, when Winnipegosis komatiite was erupted (Hulbert et al., 1994). By 1835 Ma, emplacement of the mantle-derived Bucko pluton suggests that east-dipping subduction had been re-established beneath the Superior margin (Figure GS-9-11f). The Kisseynew Domain was likely still isolated from Superior crust at this time, as Burntwood greywacke, deposited after ca. 1830 Ma, does not contain Archean detritus. Grass River sedimentary rocks, which were deposited at approximately the same time or slightly earlier, may have received the Archean component of their detritus from the pericratonic TNB-KD BZ or directly from the Superior margin. Collision between the Trans-Hudson internides and Superior margin (Figs. GS-9-11g, h) occurred between the time of deposition of Burntwood greywacke (ca. 1.83 Ga) and the earliest evidence of metamorphism (ca. 1820 Ma; Machado et al., 1999; Zwanzig et al., 2003). Deformation and high-grade metamorphism produced prograde effects in the Kisseynew Domain at the same time as amphibolite-facies retrogression and structural reworking of the Superior margin. The structural geometry resulting from the collision are reflected in seismic-reflection images of the boundary (Figure GS-9-11h; White et al., 2002).

Economic considerations

Two main conclusions of this work warrant further testing and follow-up. The regional Nd isotopic study indicates that crust of Superior affinity extends at least 40 km west of exposed Superior Province beneath the juvenile eastern Kisseynew Domain. Field observations and geochronology in the Wuskwatim Lake area suggest that a cover sequence, possibly equivalent to the Ospwagan Group, is exposed in structural culminations that are perhaps similar to those described for the Mel zone (Zwanzig and Böhm, 2002). Based on the structural geometry indicated on seismic-reflection images, the Archean crust and cover sequence may belong to the pericratonic sliver that was detached from the Superior margin ca. 1883 Ma. Regardless of their detailed history,

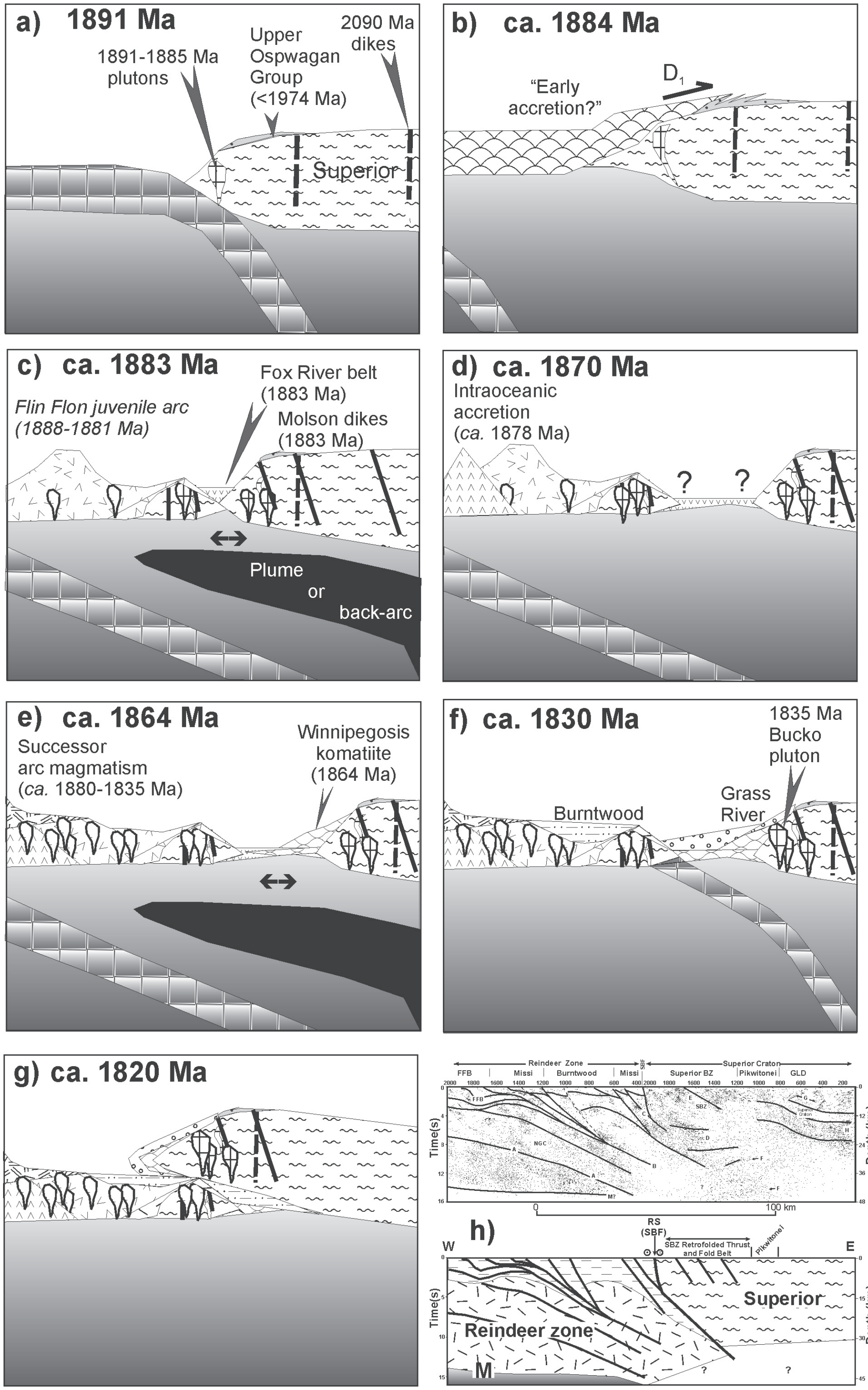

__Figure GS-9-11:__ Schematic cross-sections illustrating the evolution of the Superior margin and times of interaction with the Trans-Hudson Orogen: __a)__ arc magmatism on Superior margin; __b)__ early collision between Trans-Hudson Orogen and Superior margin; __c)__ rifting of Superior margin, including separation of a pericratonic sliver; __d)__ intraoceanic accretion event in Trans-Hudson Orogen; __e)__ renewed rifting of Superior margin; __f)__ deposition of Burntwood (Trans-Hudson Orogen) and Grass River groups prior to collision; __g)__ Superior margin overrides Trans-Hudson Orogen; __h)__ present crustal geometry based on seismic-reflection data (White et al., 2002).

the mafic rocks associated with the Wuskwatim cover sequence warrant attention as possible equivalents of mafic-ultramafic intrusions of the Thompson Nickel Belt.

A second metallogenic aspect concerns the genesis of the mafic-ultramafic intrusions of the Thompson Nickel Belt. Hulbert et al. (2004) presented geochronological evidence that mineralized intrusions are ca. 1880 Ma in age. The present study shows that continental-arc magmatism preceded and may have overlapped with the 1880 Ma mafic event, suggesting the possibility of an arc–back-arc setting or arc-plume interaction at this time. The setting of mafic magma production has not been considered as an important factor in the generation of nickel deposits in the Thompson Nickel Belt. It is possible that a suprasubduction zone setting gave rise to production of particularly metal-rich magmas.

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References

Ansdell, K.M. 2005: Tectonic evolution of the Manitoba-Saskatchewan segment of the Paleoproterozoic Trans-Hudson Orogen, Canada; Canadian Journal of Earth Sciences, v. 42, p.741–759.

Ansdell, K.M., Kyser, T.K., Stauffer, M.R. and Edwards, G. 1992: Age and source of detrital zircons from the Missi Formation: Proterozoic molasse deposit, Trans-Hudson orogen, Canada; Canadian Journal of Earth Sciences, v. 29, p. 2583–2594.

Ansdell, K.M., Lucas, S.B., Connors, K. and Stern, R.A. 1995: Kisseynew metasedimentary gneiss belt, Trans-Hudson orogen (Canada): back-arc origin and collisional inversion; Geology, v. 23, p. 1039–1043.

Ayer, J., Amelin, Y., Corfu, F., Kamo, S., Ketchum, J., Kwok, K. and Trowell, N. 2002: Evolution of the southern Abitibi greenstone belt based on U-Pb geochronology: autochthonous volcanic construction followed by plutonism, regional deformation and sedimentation; Precambrian Research, v. 115, p. 63–95.

Bailes, A.H. and Galley, A.G. 1999: Evolution of the Paleoproterozoic Snow Lake arc assemblage and geodynamic setting for associated volcanic-hosted massive sulphide deposits, Flin Flon, Manitoba, Canada; Canadian Journal of Earth Sciences, v. 36, p.1789–1805.

Bleeker, W. 1990: New structural-metamorphic constraints on Early Proterozoic oblique collision along the Thompson nickel belt, northern Manitoba; *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, p. 57–74.

Bleeker, W. and Macek, J. 1996: Evolution of the Thompson nickel belt, Manitoba: setting of Ni-Cu deposits in the western part of the circum-Superior boundary zone; Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Field Trip Guidebook A-1, 44 p.

Böhm, C.O., Heaman, L.M., Creaser, R.A. and Corkery, M.T. 2000: Discovery of pre-3.5 Ga exotic crust at the northwestern Superior Province margin, Manitoba; Geology, v. 28, p. 75–78.

Böhm, C.O., Heaman, L.M., Stern, R.A., Corkery, M.T. and Creaser, R.A. 2003: Nature of Assean Lake ancient crust, Manitoba: a combined SHRIMP–ID-TIMS U-Pb geochronology and Sm-Nd isotope study; Precambrian Research, v. 126, p. 55–94.

David, J., Bailes, A.H. and Machado, N. 1996: Evolution of the Snow Lake portion of the Palaeoproterozoic Flin Flon and Kisseynew belts, Trans-Hudson Orogen, Manitoba, Canada; Precambrian Research, v. 80, p. 107–124.

David, J. and Syme, E.C. 1994: U-Pb geochronology of late Neoarchean tonalites in the Flin Flon belt, Trans-Hudson orogen: surprise at surface; Canadian Journal of Earth Sciences, v. 31, p. 1785–1790.

Dostal, J. and Mueller, W. 1997: Komatiite flooding of a rifted Archean rhyolitic arc complex: geochemical signature and tectonic significance of the Stoughton-Roquemaure Group, Abitibi greenstone belt, Canada; Journal of Geology, v. 105, p. 545–563.

Gapais, D., Potrel, A., Machado, N. and Hallot, E. 2005: Kinematics of long-lasting Paleoproterozoic transpression within the Thompson Nickel Belt, Manitoba, Canada; Tectonics, v. 24, TC3002, DOI 10.1029/2004TC001700.

Goldstein, S.L., O'Nions, K. and Hamilton, P.J. 1984: Sm-Nd study of atmospheric dusts and particulates from major river systems; Earth and Planetary Science Letters, v. 70, p. 221–236.

Gordon, T.M., Hunt, P.A. and Bailes, A.H. 1990: U-Pb ages from the Flin Flon and Kisseynew belts, Manitoba: chronology of crust formation at an Early Proterozoic accretionary margin; *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, p. 177–199.

Green, A.G., Hajnal, Z. and Weber, W. 1985: An evolutionary model of the western Churchill Province and western margin of the Superior Province in Canada and the north-central United States; Tectonophysics, v. 116, p. 281–322.

Halls, H.C. and Heaman, L.M. 1997: New constraints on the Paleoproterozoic segment of the Superior Province apparent polar wander path from U-Pb dating of Molson dykes, Manitoba (abstract); Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Program with Abstracts, v. 22, p. A61.

Hamilton, M.A. and Bleeker, W. 2002: SHRIMP U-Pb geochronology of the Ospwagan Group: provenance and depositional age constraints of a Paleoproterozoic rift sequence, SE externides of the Trans-Hudson orogen (abstract); Geological Association of Canada–Mineralogical Association of Canada, Joint Annual Meeting, Abstracts, v. 27, p. 44–45.

Hubregtse, J.J.M.W. 1980: The Archean Pikwitonei granulite domain and its position at the margin of the northwestern Superior Province, central Manitoba; Manitoba Energy and Mines; Mineral Resources Division, Geological Paper 80-3, 16 p.

Hulbert, L.J., Hamilton, M.A., Horan, M.F. and Scoates, R.F.J. 2004: U-Pb zircon and Re-Os isotope geochronology of mineralized ultramafic intrusions and associated nickel ores from the Thompson Nickel Belt, Manitoba, Canada; Economic Geology, v. 100, p. 29–41.

Hulbert, L.J., Stern, R., Kyser, K., Pearson, J., Lesher, M. and Grinenko, L. 1994: The Winnipegosis komatiite belt, central Manitoba (abstract); Manitoba Energy and Mines, Manitoba Mining, Minerals and Petroleum Convention 1994, Abstracts, p. 21.

Leclair, A.D., Scott, R.G. and Lucas, S.B. 1993: Sub-Paleozoic geology of the Flin Flon belt from integrated drillcore and potential field data, Cormorant Lake, Manitoba and Saskatchewan; *in* Current Research, Part C, Geological Survey of Canada, Paper 93-1C, p. 249–258.

Lewry, J.F. 1981: Lower Proterozoic arc-microcontinent collisional tectonics in the western Churchill Province; Nature, v. 294, p. 69–72.

Lewry, J.F., Hajnal, Z., Green, A., Lucas, S.B., White, D., Stauffer, M., Ashton, K., Weber, W. and Clowes, R. 1994: Structure of a Paleoproterozoic continent-continent collision zone: a LITHOPROBE seismic reflection profile across the Trans-Hudson orogen, Canada; Tectonophysics, v. 232, p. 143–160.

Lucas, S.B., Stern, R.A., Syme, E.C., Reilly, B.A. and Thomas, D.J. 1996: Intraoceanic tectonics and the development of continental crust: 1.92–1.84 Ga evolution of the Flin Flon belt, Canada; Geological Society America Bulletin, v. 108, p. 602–629.

Ludwig, K.R. 2001: User's manual for Isoplot/Ex rev. 2.49: a geochronological toolkit for Microsoft Excel; Berkeley Geochronology Center, Berkeley, California, Special Publication 1a, 55 p.

Machado, N. 1990: Timing of collisional events in the Trans-Hudson orogen, the Thompson belt and the Reindeer zone (Manitoba and Saskatchewan); *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, p. 433–441.

Machado, N., Zwanzig, H.V. and Parent, M. 1999: U-Pb ages of plutonism, sedimentation and metamorphism of the Paleoproterozoic Kisseynew metasedimentary belt, Trans-Hudson orogen (Manitoba, Canada); Canadian Journal of Earth Sciences, v. 36, p. 1829–1842.

Manitoba Department of Mines, Natural Resources and Environment 1979: Geological map of Manitoba; Manitoba Department of Mines, Natural Resources and Environment, Mineral Resources Division, Map 79-2, scale 1:1 000 000.

Miller, C.F., McDowell, S.M. and Mapes, R.W. 2003: Hot and cold granites? implications of zircon saturation temperatures and preservation of inheritance; Geology, v. 31, p. 529–532.

Percival, J.A., Whalen, J.B. and Rayner, N. 2004: Pikwitonei–Snow Lake, Manitoba transect (parts of NTS 63J, 63O and 63P), Trans-Hudson Orogen–Superior Margin Metallotect Project: initial geological, isotopic and SHRIMP U-Pb results; *in* Report of Activities 2004, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 120–134.

Sproule, R.A., Lesher, C.M., Ayer, J.A., Thurston, P.C. and Herzberg, C.T. 2002: Spatial and temporal variations in the geochemistry of komatiites and komatiitic basalts in the Abitibi greenstone belt; Precambrian Research, v. 115, p. 153–186.

Stern, R.A. 1997: The GSC sensitive high resolution ion microprobe (SHRIMP): analytical techniques of zircon U-Th-Pb age determinations and performance evaluation; *in* Radiogenic Age and Isotopic Studies: Report 10, Geological Survey of Canada, Current Research 1997-F, p. 1–31.

Stern, R.A. and Amelin, Y. 2003: Assessment of errors in SIMS zircon U-Pb geochronology using a natural zircon standard and NIST SRM 610 glass; Chemical Geology, v. 197, p. 111–142.

Stern, R.A., Syme, E.C., Bailes, A.H. and Lucas, S.B. 1995: Paleoproterozoic (1.9–1.86 Ga) arc volcanism in the Flin Flon belt, Trans-Hudson orogen, Canada; Contributions to Mineralogy and Petrology, v. 119, p. 117–141.

Stern, R.A., Machado, N., Syme, E.C., Lucas, S.B. and David, J. 1999: Chronology of crustal growth and recycling in the Paleoproterozoic Amisk collage (Flin Flon Belt), Trans-Hudson Orogen, Canada; Canadian Journal of Earth Sciences, v. 36, p. 1807–1827.

Syme, E.C., Lucas, S.B., Bailes, A.H. and Stern, R.A. 1999: Contrasting arc and MORB-like assemblages in the Paleoproterozoic Flin Flon belt, Manitoba, and the role of intra-arc extension in localizing volcanic-hosted massive sulphide deposits; Canadian Journal of Earth Sciences, v. 36, p. 1767–1788.

Thompson Nickel Belt Working Group 2001: Thompson nickel belt geology; Manitoba Geological Survey, Preliminary Maps 2001FN-1 to -4, scale 1:50 000.

Watson, E.B. and Harrison, T.M. 1983: Zircon saturation revisited: temperature and composition effects in a variety of crustal magma types; Earth and Planetary Science Letters, v. 64, p. 295–304.

Weber, W. 1990: The Churchill-Superior boundary zone, southeast margin of the Trans-Hudson orogen: a review; *in* The Early Proterozoic Trans-Hudson Orogen of North America, J.F. Lewry and M.R. Stauffer (ed.), Geological Association of Canada, Special Paper 37, pp. 41–55.

Whalen, J.B., Syme, E.C. and Stern, R.A. 1999: Geochemical and Nd isotopic evolution of Paleoproterozoic arc-type granitoid magmatism in the Flin Flon belt, Trans-Hudson orogen, Canada; Canadian Journal of Earth Sciences, v. 36, p. 227–250.

White, D.J., Lucas, S.B., Bleeker, W., Hajnal, Z., Lewry, J.F. and Zwanzig, H.V. 2002: Suture-zone geometry along an irregular Paleoproterozoic margin: the Superior boundary zone, Manitoba, Canada; Geology, v. 30, p. 735–738.

White, D.J., Lucas, S.B., Hajnal, Z., Green, A.G., Lewry, J.F., Weber, W., Bailes, A.H., Syme, E.C. and Ashton, K.E. 1994: Paleo-Proterozoic thick-skinned tectonics: LITHOPROBE seismic reflection results from the eastern Trans-Hudson orogen; Canadian Journal of Earth Sciences, v. 31, p. 458–469.

Wyman, D. 1999: A 2.7 Ga depleted tholeiite suite: evidence for plume-arc interaction in the Abitibi greenstone belt, Canada; Precambrian Research, v. 97, p. 27–42.

Wyman, D., Bleeker, W. and Kerrich, R. 1999: A 2.7 Ga plume, proto-arc to arc transition and the geodynamic setting of the Kidd Creek deposit: evidence from precise ICP-MS trace element data; Economic Geology, Monograph 10, p. 511–528.

Wyman, D.A., Kerrich, R. and Polat, A. 2002: Assembly of Archean cratonic mantle lithosphere and crust: plume-arc interaction in the Abitibi-Wawa subduction-accretion complex; Precambrian Research, v. 115, p. 37–62.

Zwanzig, H.V. 1997: Revised stratigraphy of the Setting Lake area (parts of NTS 63O/1 and 2, and 63J/15); *in* Report of Activities 1997, Manitoba Energy and Mines, Minerals Division, p. 103–108.

Zwanzig, H.V. 1998: Structural mapping of the Setting Lake area (parts of NTS 63J/15 and 63O/1, 2); *in* Report of Activities 1998. Manitoba Energy and Mines, Geological Services, p. 40–45.

Zwanzig, H.V. 1999: Structure and stratigraphy of the south flank of the Kisseynew domain in the Trans-Hudson orogen, Manitoba: implications for 1.845–1.77 Ga collision tectonics; Canadian Journal of Earth Sciences, v. 36, p. 1859–1880.

Zwanzig, H.V. and Böhm, C.O. 2002: Tectonostratigraphy, Sm-Nd isotope and U-Pb age data of the Thompson nickel belt and Kisseynew north and east margins (NTS 63J, 63O, 63P, 64A, 64B), Manitoba; *in* Report of Activities 2002, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 102–114.

Zwanzig, H.V., Bailes, A. and Böhm, C.O. 2001: Josland Lake sills: U-Pb age and tectonostratigraphic implications (parts of NTS 63K and 63N); *in* Report of Activities 2001, Manitoba Industry, Trade and Mines, Manitoba Geological Survey, p. 28–32.

Zwanzig, H.V., Böhm, C.O., Potrel, A. and Machado, N. 2003: Field relations, U-Pb zircon ages and Nd model ages of granitoid intrusions along the Thompson Nickel Belt–Kisseynew Domain boundary, Setting Lake area, Manitoba (NTS 63J15 and 63O2); *in* Report of Activities 2003, Manitoba Industry, Economic Development and Mines, Manitoba Geological Survey, p. 118–129.