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U-PB GEOCHRONOLOGY, SR- AND ND-ISOTOPE COMPOSITIONS OF GROUNDMASS PEROVSKITE FROM THE CHIDLIAK AND QILAQ KIMBERLITES, BAFFIN ISLAND, NUNAVUT

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INTRODUCTION

Focussed exploration for primary diamond sources in southern Baffin Island has resulted in the discovery of 59 kimberlites at the Chidliak project and three more kimberlites on the adjacent Qilaq project that form a completely new Canadian kimberlite province extending across a 40 x 70 km area on the Hall Peninsula (Pell et al., this volume), hereafter referred to as the Chidliak-Qilaq kimberlite province. The kimberlites occur as 0.5 to 4.0 hectare pipes, occasional smaller "blows" and northerly trending dykes. Their location and distribution dominantly intruding 2.92-2.80 Ga orthogneisses of the Hall Peninsula Block (Whalen et al., 2010) are shown in Figure 1.

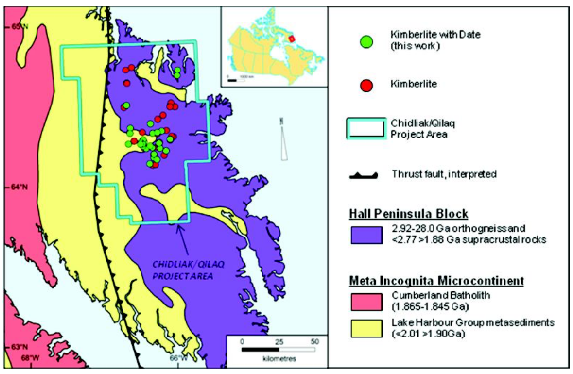

Figure 1. Distribution of kimberlite intrusions, Chidliak-Qilaq kimberlite province, Baffin Island. Age dates are given in Table 1.

The kimberlites have typical Group-1 opaque- and perovskite-bearing, monticellite-carbonate-serpentine groundmass mineralogy with rare minor phlogopite. Roughly eighty percent of near-surface samples have magmatic-hypabyssal textures while occasional volcaniclastic phases are typically distinguished by 3 to 15 modal percent xenoliths of presumed Ordovician carbonate rocks and minor clastic sediments, currently completely eroded for over 130 kilometres in any direction from the project. Dated kimberlites at Victoria Island (286-256 Ma), Churchill (225-170 Ma), Attawapiskat (180-156 Ma), Jericho-Muskox (173 Ma), Kirkland Lake (165-152 Ma), Timiskaming (155-134 Ma) and Somerset Island (105-88 Ma) contain stratigraphically equivalent sedimentary carbonate xenoliths and may consequently be regarded as model-eruptive analogues for the Chidliak-Qilaq kimberlite province.

PEROVSKITE U-PB GEOCHRONOLOGY

U-Pb geochronology and combined Sr-Nd isotopic study was conducted on fresh hand-picked groundmass perovskite to define kimberlite eruption ages, establish the duration of kimberlite magmatism, and constrain the nature of their mantle source regions. The procedures used for U-Pb ID-TIMS perovskite dating and determining

Table 1. U-Pb Age and Sr Isotopic Composition of Perovskite, Chid liak Kimberlite Province, Baffin Island, Nunavut

	Kimberlite	$^{206}Pb/^{238}U$ Age (Ma)	2s	$^{87}Sr/^{86}Sr$	2s
1	CH-1	146.3	6.9		
2	CH-2	147.5	2.2	0.70364	0.00027
3	CH-3	143.5	2.5	0.70381	0.00005
4	CH-4	143.4	2.9	0.70410	0.00015
5	CH-5	149.5	1.9	0.70321	0.00009
6	CH-6	145.4	6.0	0.70319	0.00014
7	CH-7	145.2	6.4	0.70408	0.00010
8	CH-8	143.4	2.4	0.70378	0.00011
9	CH-11	144.5	2.2	0.70411	0.00014
10	CH-13	155.9	3.2	0.70328	0.00012
11	CH-14	143.4	1.9	0.70351	0.00008
12	CH-15	138.4	4.3	0.70410	0.00007
13	CH-16	150.6	1.8	0.70342	0.00007
14	CH-21	141.4	2.2	0.70353	0.00003
15	CH-22	150.5	4.6		
16	CH-29	156.7	5.0		
17	CH-30	152.1	2.5	0.70318	0.00003
18	CH-31	156.0	4.2		
19	CH-32	145.6	1.3	0.70334	0.00002
20	CH-33	149.1	2.4		
21	CH-37	147.7	4.5		
22	CH-39	152.8	1.8		
23	CH-40	147.3	2.5		
24	CH-41	151.8	3.1	0.70343	0.00005
25	CH-42	147.3	1.4	0.70335	0.00002
26	CH-43	139.1	2.0	0.70355	0.00004
27	CH-45	144.8	1.7	0.70377	0.00002
28	CH-46	146.4	1.3	0.70388	0.00003
29	CH-48	150.4	1.3	0.70320	0.00001
30	Q-1	149.8	1.6		
31	Q-2	148.1	1.9		

the Sr-Nd isotopic composition of perovskite on the same fractions have been reported previously (Heaman 1989; Heaman and Kjarsgaard, 2000; Zurevinski et al., 2011).

Perovskite U-Pb ID-TIMS dates of thirty one kimberlite bodies from the Chidliak-Qilaq kimberlite province have been determined so far. Groundmass perovskite in these samples consists dominantly of small (40-100 micron), brown to black cubes and to a lesser extent octahedra but some of the samples only contain minuscule crystals (10-30 microns). The analysed perovskite fractions consisted of between 50 and 500 hand selected grains, depending on crystal size. A summary of the perovskite age results for 29 kimberlites at Chidliak and 2 kimberlites at Qilaq are compiled in Table 1 and presented graphically in Figure 2. The emplacement of kimberlites at Chidliak spanned ~18 Ma from 156 to 138 Ma. The two Qilaq kimberlites have identical ages within analytical uncertainty (Table 2, Figure 2 – red squares) and were erupted during the main period of Chidliak kimberlite magmatism. The majority of these kimberlite bodies (22/31) were emplaced in just 7 Ma; between 150 to 143 Ma.

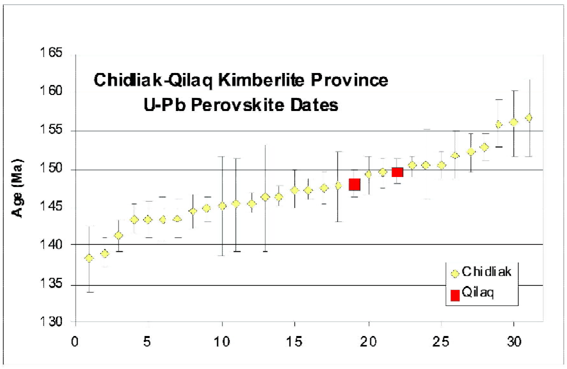

Figure 2. Compilation of U-Pb perovskite dates from 31 kimberlites, Chidliak-Qilaq kimberlite province, Baffin Island. Error bars are shown at two-sigma.

PEROVSKITE SR-ND COMPOSITIONS

The perovskite strontium isotopic compositions for 21 Chidliak kimberlites are presented in Table 1 and summarized on Figure 3. Also shown in Figure 3 are reference evolution lines for two possible mantle source compositions; Chondritic Uniform Reservoir (CHUR) and Depleted Mantle (DM) and the perovskite strontium isotopic compositions for kimberlites from four other Mesozoic kimberlite fields in Canada; Churchill, Attawapiskat, Kirkland Lake and Timiskaming. Chidliak perovskite $^{87}Sr/^{86}Sr$ compositions range from 0.7041 to 0.7032 and can be explained by the involvement of at least two distinct mantle source regions in their generation and evolution: 1) the oldest kimberlites typically have compositions that are slightly more radiogenic (0.70320±1; n=5) than estimates for 150 m.y. depleted-mantle (0.7026) and 2) a subset of the youngest kimberlites have more chondritic-like compositions (0.70410±5; n=4) plotting slightly below estimates of CHUR at 150 m.y. (0.7043). The majority of kimberlites have intermediate values, possibly indicating involvement of both sources in their genesis. The Chidliak perovskite Sr-Nd isotopic compositions display a negative correlation with εNd_t, values vary between +1.5 to +3.7 (not illustrated).

DISCUSSION

At least two origins and tectonic settings have been proposed for Mesozoic kimberlite magmatism in North America and Greenland. Jurassic kimberlite magmatism in eastern Baffin Island coincides with mafic, ultramafic and alkaline magmatism recorded along the conjugate margin of Davis Strait in Greenland, previously ascribed to a young episode of continental extension that preceded Cretaceous rifting of the North Atlantic Craton (Larsen et al., 2009). The timing of Chidliak-Qilaq kimberlite magmatism also overlaps with kimberlite emplacement in other fields in eastern North America (Attawapiskat, Kirkland Lake, Timiskaming) that previously have been interpreted to be linked to the Great Meteor hotspot track (Heaman and Kjarsgaard, 2000).

A minimum of two mantle sources are required to explain the perovskite strontium isotopic results obtained from a number of kimberlite fields in North America. For example, the Attawapiskat and least radiogenic Kirkland Lake kimberlites have CHUR-like compositions similar to the most radiogenic Chidliak perovskites (Figure 3). In contrast, the least radiogenic Chidliak kimberlites and kimberlites from other fields in North America, such as Churchill and Timiskaming, are derived from a relatively unradiogenic, more depleted-mantle-like source. At Chidliak, both of these mantle sources are involved in the generation of kimberlites. Perovskite strontium isotopic compositions >0.7042 in Figure 3 are interpreted to reflect the influence of interaction between kimberlite magma and a more radiogenic subcontinental lithospheric mantle.

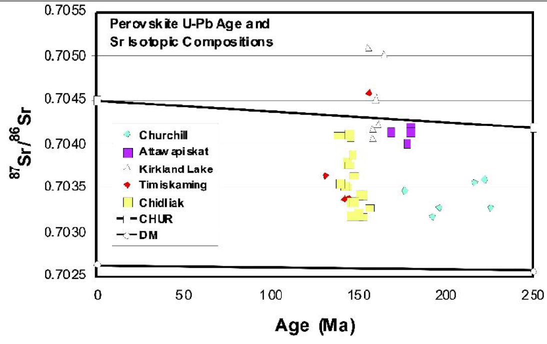

Figure 3. Compilation of U-Pb perovskite dates and Sr isotopic compositions for kimberlites from the Chidliak kimberlite province, Baffin Island (yellow squares; this study) and other similar age fields in North America: Churchill, Attawapiskat, Kirkland Lake and Timiskaming (Heaman 1989; Zurevinski et al., 2011).

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