Nunavut Carving Stone Deposit Evaluation Program (2010–2013): third year results

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Abstract

The Nunavut Carving Stone Deposit Evaluation Program is a collaborative project led by the Government of Nunavut, Department of Economic Development & Transportation and includes the Canada-Nunavut Geoscience Office, the University of Manitoba and Natural Resources Canada. The primary goals of this four-year program are to verify the quality and size of hand-mined carving stone deposits and to identify new deposits throughout Nunavut. To date, many sites of carving stone resources in two of the three regions in Nunavut have been evaluated. Deposits have been characterized by artisan-derived quality, tonnage and composition. A total of 75 sites in proximity to 19 communities were visited and evaluated. A total of 45 carving stone deposits have been defined, of which nine quarries and a further nine undeveloped deposits contain substantial resources of high-quality stone. Sites and deposits in the Kitikmeot Region (western mainland) are to be evaluated in 2013. Two “major” deposits, previously unknown to the nearest communities, have been confirmed: one in the Kivalliq Region (eastern mainland) west of Repulse Bay and one west of Hall Beach in the Qikiqtaaluk Region (Arctic islands). These findings suggest that Nunavut will have sufficient resources of carving stone to access for many years to come. Research on specific characteristics (e.g., geochemical, isotopic signatures) of selected deposits is being conducted through the University of Manitoba. These results will assist in determining which characteristics of the various rock types are most important in determining suitability as carving stone.

Résumé

Le Programme d’évaluation des gisements de pierre à sculpter du Nunavut est un projet conjoint dirigé par le ministère du Développement économique et des Transports du Nunavut et auquel participent le Bureau géoscientifique Canada-Nunavut, l’Université du Manitoba et Ressources naturelles Canada. Les principaux objectifs de ce programme de quatre ans sont de vérifier la qualité et la taille des gisements de pierre à sculpter exploités manuellement et de trouver de nouveaux gisements dans tout le Nunavut. À ce jour, bon nombre des sites de pierre à sculpter dans les deux régions du Nunavut ont été évalués. Les gisements ont été caractérisés en termes de qualité évaluée par les artisans, de tonnage et de composition. En tout, 75 sites à proximité de 19 collectivités ont été visités et évalués. En tout, 45 gisements de pierre à sculpter ont été identifiés, dont neuf carrières et neuf autres gisements non exploités contenant d’importantes quantités de pierre à sculpter de haute qualité. Les sites et les gisements dans la région de Kitikmeot (partie continentale occidentale) doivent être évalués en 2013. L’existence de deux “grands” gisements, jusque-là inconnus des collectivités les plus proches, a été confirmée : un dans la région de Kivalliq (partie continentale orientale) à l’ouest de Repulse Bay, et un à l’ouest de Hall Beach dans la région de Qikiqtaaluk (îles de l’Arctique). Ces résultats semblent indiquer que le Nunavut disposera de ressources suffisantes en pierre à sculpter pour de nombreuses années à venir. L’Université du Manitoba procède à des recherches sur les caractéristiques spécifiques (p. ex., géochimie, signatures isotopiques) de gisements choisis. Les résultats obtenus aideront à identifier chez les différents types de roches les caractéristiques les plus importantes servant à déterminer celles qui conviennent le mieux comme pierre à sculpter.

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Introduction

The Nunavut Carving Stone Deposit Evaluation Program (NCSDEP) is a collaborative project led by the Government of Nunavut, Department of Economic Development & Transportation (GN-EDT) and includes the Canada-Nunavut Geoscience Office (CNGO), the University of Manitoba (through graduate research) and Natural Resources Canada (NRCan) through the Polar Continental Shelf Program (PCSP). This program also relies on assistance from local carvers in each community.

Article 19.9.1 of the Nunavut Land Claims Agreement (NLCA) requires government to inform Inuit of discoveries of any deposits of carving stone on Crown lands. Article 19.9.4 establishes the right of Inuit to gather carving stone, stating “An Inuk shall have the right to remove up to 50 cubic yards per year of carving stone from Crown lands without a permit”. In 2007, the GN-EDT released Ukkusiksaqtarvik: The Place Where We Find Stone: Carving Stone Supply Action Plan (Nunavut Department of Economic Development & Transportation, 2007a). The action plan was prepared in connection with Sanuqgait: A Strategy for Growth in Nunavut’s Arts and Crafts Sector (Nunavut Department of Economic Development & Transportation, 2007b). The action plan was developed to contribute to the arts and crafts sector’s strategic goal of increasing the quality of Nunavut art. It presented ideas to address a number of challenges for the carving stone and arts sectors within Nunavut, with one challenge being the lack of accurate information about carving stone quarry sites. The NCSDEP (2010-2013) is the territorial and federal government’s response to this challenge identified in the action plan and also to Article 19 in the NLCA.

A primary goal of, and the carvers’ stated priority for, the Nunavut Carving Stone Deposit Evaluation Program is to identify new deposits of carving stone in Nunavut. Since the initiation of the program in 2010, sites across two regions of the territory have been visited and the number of known substantial deposits of carving stone in Nunavut has doubled. All evaluated deposits have been characterized by artisan-derived quality, tonnage and composition.

Community consultations

Nunavut’s elders and carvers were consulted with regards to local carving stone localities and were generous with sharing their considerable traditional knowledge. As of December 2012, citizens in all 25 communities in Nunavut have been consulted through the NCSDEP. The program’s efforts to date have been conducted in the Kitikmeot and Qikiqtaaluk regions of the territory, with 75 carving stone sites evaluated within reach of 19 communities. The five communities in the Kitikmeot Region and Sanikiluaq (Belcher Islands) of the Qikiqtaaluk Region, were consulted in October 2012 and will be the focus of the summer 2013 field season. Table 1 lists the local carvers and guides who were consulted for the Kitikmeq and Qikiqtaaluk regions.

In the program’s first year (2010), 29 carving stone sites were evaluated in proximity to Arviat, Chesterfield Inlet, Coral Harbour, Repulse Bay and Whale Cove. In 2011, 21 carving stone sites were evaluated near the communities of Cape Dorset, Hall Beach, Igloolik, Iqaluit, Kimmirut, Pangnirtung, Pond Inlet and Repulse Bay. In 2012, 25 sites were evaluated close to Arctic Bay, Baker Lake, Clyde River, Iqaluit, Pond Inlet and Rankin Inlet; sites selected for evaluation in proximity to Qikiqtarjuaq could not be visited due to inclement weather.

Characterization of resources

Carving stone resources are not yet managed by the governments of Canada or Nunavut. The allowed annual extraction of 50 cubic yards of carving stone for an Inuit carver (as set out in the NLCA) is equal to 103 192 kg, or 103 tonnes. More simply, one cubic yard of stone is approximately equivalent to what can be gathered and transported on an average qamutik or sled with a length of 2.3 m.

Through the NCSDEP, Nunavut’s carving stone deposits have been sorted into five categories based on the size of the deposit and the amount of stone that may be hand-mined from the deposit (Table 2). The progression of a quarry can be classified as recently opened to mature to abandoned. The evaluations undertaken through the NCSDEP involved brief site visits of only a few hours. Generally, the bigger the deposit, the more it is shared among carvers.

The NCSDEP staff and the carvers established a system for four distinct qualities and artisanal suitability of a carving stone (Table 3). A carbide hand file is the Nunavut carver’s universal tool for testing the quality of the carving stone. In determining the suitability of stone for carving, many experienced carvers compare the gathered materials against excellent-quality serpentinite, such as the rock found in the Korok Inlet deposits east of Cape Dorset (Figures 1, 2). All grades of carving stone can be carved using carbide tools; all grades can be ultimately polished with wet sandpaper. Contemporary full-time carvers cut, grind and polish carving stone with diamond tools. Project carver J. Ell (who has been part of NCSDEP from 2010 to 2012) has asked carving stone gatherers to never use explosives when gathering carving stone because the resulting fracturing causes damage to the rocks.

An additional goal of the NCSDEP was to identify deposits with, and screen rocks for, the presence of asbestos. Asbestos content in a carving stone resource is of particular concern to artists as it may be a health hazard. Traces of asbestos have been reported in three known quarries that have been used historically by carvers. These deposits are the Murchison River quarry in the Kitikmeot Region; the
Tawsig Fiord deposit on the north shore of the Hall Peninsula, Qikiqtaaluk Region; and a large quarry in the Clyde River area, Qikiqtaaluk Region. One new occurrence of asbestos in carving stone material was recently reported by Agnico-Eagle Mines Ltd. in portions of the rock uncovered in the open pit of the Meadowbank gold mine near Baker Lake (Kivalliq Region).

Results (2010–2012)

The NCSDEP results to date have determined that there are at least 45 deposits throughout Nunavut accessible for carving stone resources. Eighteen of these quarries and deposits contain substantial resources. These 18 are shown in Figure 2 and outlined in Tables 4–6. There are two major, undeveloped deposits of good to excellent quality of stone that have been confirmed by the NCSDEP work: Kovic, located in the Kivalliq Region west of Repulse Bay, and Kingora, located west of Hall Beach in the Qikiqtaaluk Region (Figure 1). The results suggest that Nunavut has sufficient resources of carving stone for years to come.

The large to major deposits of carving stone in eastern Nunavut appear to be associated with the Prince Albert Group rocks of Proterozoic age, as determined by earlier geological mapping (e.g., Murphy, 1973; Caine, 1977; Gibbins, 1987, 1988; McDermott, 1990, 1992; Zaleski et al., 1999) and by work done through the NCSDEP. The Prince Albert Group extends from Baker Lake of central Nunavut to the Melville Peninsula and onto central Baffin Island (Figure 2). The deposits evaluated through the NCSDEP that are likely associated with the Prince Albert Group include the large serpentinite formation in the open pit at the Meadowbank gold mine, the major Kovic deposit...
150 km inland from Repulse Bay, the major Kingora deposit 120 km inland from Hall Beach and the large Koonark carving stone deposit at Mary River (Figure 2). Additionally, the Committee Bay volcanic belt in the eastern Kitikmeot Region is underlain by rocks of the Prince Albert Group (Sandeman et al., 2001). It is unknown at this time if the ultramafic rocks associated with the Committee Bay volcanic belt will yield substantial carving stone resources for the eastern Kitikmeot Region.

**Kivalliq Region**

Carving stone resources were confirmed or augmented in the vicinity of Baker Lake, Coral Harbour, Rankin Inlet and Repulse Bay (Tables 4–6, Figure 2). Arviat, Chesterfield Inlet and Whale Cove remain impoverished for carving stone resources with little or no stone remaining or available only in tiny to small deposits. Through the NCSDEP, 41 sites in proximity to the seven hamlets in the Kivalliq Region were evaluated.

The hamlet of Baker Lake has traditionally collected stone from the Jigging Point quarry, located 56 km from the community. Additional resources are available for Baker Lake from an undeveloped modest-sized carving stone deposit in the Schultz Lake area. Furthermore, Agnico-Eagle Mines Ltd. (AEM), the owners of the Meadowbank gold mine located approximately 100 km from the community, have supplied limited amounts of carving stone from the open pit to the Kivalliq communities. However, with the recent discovery of asbestos seams in the hostrock serpentinite, the carving stone sharing from the company mine site to the community carvers may stop, or be suspended, until further research is undertaken.

Visits facilitated by AEM at the Meadowbank gold mine assisted the NCSDEP in the evaluation of serpentinite formations on the mine property previously mapped by the Geological Survey of Canada (Zaleski et al., 1999). A total of more than 2500 kg of suitable serpentinite material exposed in the open pit was selected by carvers to be used in the hamlet of Baker Lake. However, except for the material in the open pit, serpentinite formations examined elsewhere through NCSDEP work did not prove to be favourable carving stone. AREVA Resources Canada Inc. (AREVA) invited the NCSDEP staff to sample the drillcore recovered on the Kiggavik property 80 km west of Baker Lake. A soft rock was discovered in the drillcore, referred to locally as 'pipestone', which comprises kaolinite-altered material. If this material proves suitable for artisan use, AREVA may be able to incorporate the recovery of this stone into their future mine site planning.

For the hamlet of Coral Harbour, carving stone resources are locally available to carvers from five carving stone deposits and one limestone site. Two of these are undeveloped modest-sized deposits near Coral Harbour. The Paniyuk site, located 19 km north of the hamlet, is composed of good-quality, dark green stone. The Qilaliaqvik deposit, located 74 km northeast of Coral Harbour on the coast near the Ascension Islands, is dark green stone of fair quality. Neither of these two deposits is listed in Tables 4-6 because of their modest size.

During the late 1950s and early 1960s, carving stone had been brought to the surface from the underground workings of the formerly producing North Rankin nickel mine in the hamlet of Rankin Inlet. A 100 m wide serpentinite sill had been intersected in the workings while extracting the nickel-copper ore. A 1989 diamond drilling exploration report (Hassell, 1989) also indicates that a near-surface soapstone deposit is accessible in the same area.

Substantial carving stone resources were determined and confirmed to be available to Repulse Bay carvers from six soapstone deposits and one marble site. A major carving stone deposit (Kovic) of extraordinary size (likely more than 1 Mt) was confirmed 150 km inland from Repulse Bay (Table 6).

**Qikiqtaaluk Region**

Through the NCSDEP, 34 carving stone sites in proximity to 12 communities in the Qikiqtaaluk Region were evaluated. However, many additional sites known to local carvers could not be evaluated due to poor weather. Nine of the twelve communities—Arctic Bay, Cape Dorset, Clyde River, Hall Beach, Igloolik, Iqaluit, Kimmirut, Pangnirtung and Pond Inlet—have new or augmented carving stone resources in the vicinity of their community (Figure 2).

Three communities in the Qikiqtaaluk Region—Qikiqtarjuaq, Resolute and Grise Fiord—remain impoverished for carving stone resources. The nearest carving stone resource...
Figure 1. Selected large deposits and occurrences confirmed by the Nunavut Carving Stone Deposit Evaluation Program (NCSDEP): a) Repulse Bay’s Kovic deposit; b) Pond Inlet’s Koonark deposit at Mary River; c) Cape Dorset’s Andrew Gordon Bay marble; d) Tatsituya deposit at Aberdeen Bay, 160 km west of Kimmirut; e) Cape Dorset’s Kangiqsuqutaq quarries at Korok Inlet; f) Kangiqsuqutaq Lower Quarry; g) Clyde Inlet’s marble quarry; h) back harbour of Repulse Bay, Naujaat deposit.
Figure 2. Large quarries and undeveloped deposits of Nunavut; numbers correspond to site numbers as listed in Tables 4–6.
Table 4. Characteristics of deposits and occurrences confirmed by the Nunavut Carving Stone Deposit Evaluation Program (NCSDEP) 2010–2012, corresponding to numbers 1–9 on Figure 2.

<table>
<thead>
<tr>
<th>Map</th>
<th>Name</th>
<th>Region</th>
<th>Proximity to community</th>
<th>Latitude/Longitude</th>
<th>Rock</th>
<th>Quality</th>
<th>Notes and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Kangiqsualujaq, Korok Inlet, Lower Quarry</td>
<td>Qikiqtaruk</td>
<td>160 km east of Cape Dorset</td>
<td>64°23′50″N, 73°19′10″W</td>
<td>Serpentinite, streaked yellowish brown to dark green soapstone</td>
<td>Excellent</td>
<td>Lower Quarry is world’s largest inuit hand-mined excavation—now abandoned after 70 years of use; this quarry is debris filled; recommend ground magnetic survey and carver-geologist team mapping of area.</td>
</tr>
<tr>
<td>2</td>
<td>Kangiqsualujaq, Quillim, Korok Inlet, Upper Quarry</td>
<td>Qikiqtaruk</td>
<td>160 km east of Cape Dorset</td>
<td>64°23′50″N, 73°19′10″W</td>
<td>Serpentinite</td>
<td>Excellent</td>
<td>This Upper Quarry is now being used; it is mature and debris impacted.</td>
</tr>
<tr>
<td>3</td>
<td>Tatsiuya, Aberdeen Bay</td>
<td>Qikiqtaruk</td>
<td>160 km west of Kimmirut</td>
<td>63°45′29.7″N, 72°10′55.8″W</td>
<td>Altered marble to apple-green, soft soapstone</td>
<td>Excellent</td>
<td>Recommend geophysical surveys and carver-geologist team mapping the area.</td>
</tr>
<tr>
<td>4</td>
<td>Tatsitui Tininiya, Aberdeen Bay</td>
<td>Qikiqtaruk</td>
<td>160 km west of Kimmirut</td>
<td>63°46′02.9″N, 72°11′55.8″W</td>
<td>Serpentinite, dark green soapstone</td>
<td>Good</td>
<td>Ledge in tidal flat; gathering is accessible by boat from serpentinite ledge at low tide with untouched similar material onshore; recommend geophysical surveys and carver-geologist team mapping of area. Recent community-used quarry, debris impacted, near tidewater; community quarry with potential to be a regional supplier; recommend ground magnetic survey of locale for future development.</td>
</tr>
<tr>
<td>5</td>
<td>Opingivik</td>
<td>Qikiqtaruk</td>
<td>120 km south of Pangnirtung</td>
<td>65°15′01.6″N, 67°04′25.2″W</td>
<td>Serpentinite, dark green to black soapstone</td>
<td>Excellent</td>
<td>Minor usage; community-sized deposit with untouched green marble and black marble.</td>
</tr>
<tr>
<td>6</td>
<td>Clyde River Marble</td>
<td>Qikiqtaruk</td>
<td>80 km southwest of Clyde River, 5 km inland</td>
<td>69°48′52.2″N, 70°37′44.9″W</td>
<td>Pink marble</td>
<td>Good</td>
<td>Minor recent usage; 2 m wide band exploited from 30 cm wide marble formation on tidewater; many linear kilometres of marble formation occur inland and are untested; mostly vertical-dipping marble formations.</td>
</tr>
<tr>
<td>7</td>
<td>Andrew Gordon Bay Marble</td>
<td>Qikiqtaruk</td>
<td>40 km east of Cape Dorset</td>
<td>64°23′29″N, 75°43′40″W</td>
<td>White marble with lesser amounts of rose, yellow and light pastel colours</td>
<td>Good</td>
<td></td>
</tr>
</tbody>
</table>
Table 5. Characteristics of deposits and occurrences confirmed by the Nunavut Carving Stone Deposit Evaluation Program (NCSDEP) 2010–2012, corresponding to numbers 10–16 on Figure 2.

<table>
<thead>
<tr>
<th>Map</th>
<th>Name</th>
<th>Region</th>
<th>Proximity to community</th>
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<th>Quality</th>
<th>Notes and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Quilliajaniavik, Belcher Islands</td>
<td>Qikiqtaruk</td>
<td>48 km southeast of Sanikiliuag</td>
<td>56d 11m N, 79d 53.5m W</td>
<td>Argillite</td>
<td>Good</td>
<td>Mature argillite quarry near tidewater.</td>
</tr>
<tr>
<td>9</td>
<td>Murchison River</td>
<td>Kitikmeot</td>
<td>135 km west of Kugaaruk</td>
<td>68d 07m N, 92d 58m W</td>
<td>Serpentinite</td>
<td>Good</td>
<td>Mature, inland soapstone quarry; also accessible to 120–160 km south-southeast of Gjoa Haven, 125 km south of Taloyoak.</td>
</tr>
</tbody>
</table>

**Undeveloped large deposits**

<table>
<thead>
<tr>
<th>Map</th>
<th>Name</th>
<th>Region</th>
<th>Proximity to community</th>
<th>Latitude/Longitude</th>
<th>Rock</th>
<th>Quality</th>
<th>Notes and recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Hamlen Bay, Ikatuyak, Hall Peninsula</td>
<td>Qikiqtaruk</td>
<td>110 km southeast of Iqaluit, 12 km inland from tidewater</td>
<td>63d 13m 51.7s N, 66d 21m 29.5s W</td>
<td>Soapstone, mottled dark pattern</td>
<td>Excellent</td>
<td>Newly discovered by Canada-Nunavut Geoscience Office; accessible by snowmobile; approximately 450 m in elevation.</td>
</tr>
<tr>
<td>11</td>
<td>Schultz Lake</td>
<td>Kivalliq</td>
<td>95 km west of Baker Lake, 3 km inland from Schultz Lake</td>
<td>64d 39m 39s N, 97d 52m 12s W</td>
<td>Green soapstone; untouched soft grey stone</td>
<td>Good (green); excellent (grey)</td>
<td>Modest deposit, minor usage of good-quality green soapstone; undeveloped resource of excellent grey soapstone 250 m further west; best stone is on the east and west margins of a set of small, east-west-trending hills.</td>
</tr>
<tr>
<td>12</td>
<td>Koonark, Mary River</td>
<td>Qikiqtaruk</td>
<td>160 km inland and south of Pond Inlet</td>
<td>71d 17m 01s N, 79d 09m 25s W</td>
<td>Dark green to black soapstone</td>
<td>Excellent</td>
<td>New deposit 2012; site is 5 km southeast of Baffinland’s Mary River iron ore Deposit No. 1; this resource has the potential to be an additional community quarry; additional small occurrences with a variety of colours also are found in the area; recommend prospecting-mapping of extensive serpentine belt by team of carver-geologist.</td>
</tr>
<tr>
<td>13</td>
<td>Naujaat</td>
<td>Kivalliq</td>
<td>Back harbour of Repulse Bay</td>
<td>66d 32m 03.0s N, 86d 11m 24.8s W</td>
<td>Fine-grained, dark grey serpentine</td>
<td>Good</td>
<td>Deposit on tidewater; stone is slightly harder than marble.</td>
</tr>
<tr>
<td>14</td>
<td>Ajuqutalik River</td>
<td>Qikiqtaruk</td>
<td>75 km inland southwest of Hall Beach</td>
<td>68d 11m 08.7s N, 83d 10m 46.8s W</td>
<td>Serpentinite, dark green soapstone</td>
<td>Fair</td>
<td>This rock is a harder stone (H = 3.0) with minor amounts of good-grade softer rock; stone is slightly harder than marble with good-quality, soft, grey-coloured sections.</td>
</tr>
<tr>
<td>15</td>
<td>Qukutitalik Lake area</td>
<td>Kivalliq</td>
<td>75 km inland and northeast of Repulse Bay</td>
<td>67d 16m 40.2s N, 84d 27m 14.4s W</td>
<td>White marble outcrop</td>
<td>Good</td>
<td>This rock is a harder stone (H = 3.0).</td>
</tr>
<tr>
<td>16</td>
<td>North Rankin mine</td>
<td>Kivalliq</td>
<td>Inside municipal boundaries</td>
<td>62d 48m 51s N, 92d 05m 24s W</td>
<td>Serpentinite sill</td>
<td>Good to unknown near-surface</td>
<td>Good-quality samples at surface from underground workings of the former nickel mine; serpentine sill was intersected during mining operations; near-surface resources (at a depth of 1–3 m?) under two undeveloped lots next to Health Centre; resource and depth yet to be determined.</td>
</tr>
</tbody>
</table>
to Qikiqtarjuaq is Pangnirtung’s Opingivik quarry—a distance of approximately 300 km by snowmobile. Because of the paucity of suitable carving stone resources in proximity to Grise Fiord and Resolute, local carvers are encouraged to prospect other geological targets for potential resources of carving stone.

There are small deposits of marble accessible to Arctic Bay. The NCSDEP staff is recommending mapping of the many small sites of marble adjacent to the Franklin gabbro dikes outcropping around Arctic Bay (Harrison et al., 2011) to determine if there are any potential carving stone resources associated with these rocks.

There are four carving stone deposits in the southern Baffin Island area occurring along the shores between Cape Dorset and Kimmirut that have been traditional carving stone quarries. A serpentinite deposit, Kangiqsuqutaq, at Korok Inlet 160 km east of Cape Dorset, hosts two quarries (Figure 1). The Kangiqsuqutaq Lower Quarry deposit is now abandoned but was the largest and oldest hand-mined excavation for carving stone in Nunavut. This 100 m long site is currently filled with wasterock debris from 70 years of ad hoc gathering by carvers from many communities. The active Kangiqsuqutaq Qullimi Upper Quarry site is a mature quarry and partially filled with debris. Ground magnetometer surveying and future resource mapping by a team of a local carver and geologist is recommended for Korok Inlet.

There are two separate deposits on tidewater at Aberdeen Bay, 160 km west of Kimmirut (Figure 1). The Tatsituya deposit is an excellent-quality, modest-sized, apple green, altered marble quarry that has been worked for more than 50 years and is currently filled with debris. A second serpentinite deposit, Tatsitui Tiniiniya, is found on a rock ledge in a tidal flat. Similar undeveloped material occurs onshore at this locality in the same ultramafic rock unit. An airborne magnetometer and resource mapping survey is recommended at Aberdeen Bay over the marble and ultramafic formations within a north-trending fault structure. Additionally, good-quality white marble occurs at Andrew Gordon Bay on tidewater 40 km east of Cape Dorset.

There are resources of coloured marble available to Clyde River from the community quarry located 80 km from the hamlet. At this quarry, historical gathering of pink marble has occurred during the winter months. Through the NCSDEP, it has been determined that there are also undeveloped green and black marble outcrops adjacent to the quarry. A large, known carving stone deposit in the Clyde River area is suspected to contain asbestos but has not been used by carvers for more than a decade. Testing for asbestos will be performed as part of the NCSDEP.

Through the NCSDEP, it has been determined that there are substantial carving stone resources available to Hall Beach and Igloolik from three undeveloped deposits on the Melville Peninsula. The largest of these is a 1 Mt major deposit (Kingora) of extraordinary size with portions of excellent-quality carving stone. Kingora was confirmed on Crown land 120 km inland in the headwaters of the Kingora River. The other two deposits (Ajaqutalik River, Qukiuitalik Lake) are considered to be large deposits and accessible to both Hall Beach and Repulse Bay. Ground magnetometer surveying and future resource mapping is recommended for these three substantial deposits.

Iqaluit, centred on the Cumberland Batholith (Whalen et al., 2010; Harrison et al., 2011), has been considered historically to have limited amounts of available resources suitable for carving stone. However, following the 2012 field season of the Canada-Nunavut Geoscience Office’s Hall Peninsula Integrated Geoscience Project, a modest-sized deposit was identified (Ikatuyak) of excellent-quality serpentinite, as well as several other carving stone occurrences (Budkewitsch et al., 2013; Machado et al., 2013; Senkow, 2013). The smaller occurrences were not visited due to inclement weather; future work will define and evaluate these deposits. However, until such work is completed, Iqaluit carvers will continue to rely on resources supplied by commercial operators hauling excellent-quality stone—with small boats on round trips of up to 1200 km—from the historical quarries on Baffin Island’s south coast.

There are substantial carving stone resources available from the Mary River iron ore property (owned by Baffin-
land and ArcelorMittal) for communities of western Baffin Island and the Melville Peninsula. Koonark is a large undeveloped deposit of good- to excellent-quality dark green to black carving stone and is located 5 km to the southeast of Baffin Island’s Deposit No. 1. Through the NCSDEP, it has been determined that there are additionally six small carving stone deposits and one modest-sized deposit, all located on the Mary River property, accessible to the hamlet of Pond Inlet. Resource mapping and prospecting is recommended for the serpentinite belt at Mary River.

Abundant resources are available to the hamlet of Pangnirtung from several deposits. The Opingivik quarry is part of a large and mostly undeveloped deposit of excellent-quality stone. Ground magnetometer surveying and resource mapping is recommended.

Fieldwork at possible resource sites identified during Qikiqtarjuaq community consultations could not be performed due to poor weather conditions and the unavailability of local carvers and guides who were otherwise employed. There is a promising carving stone occurrence located across Sunneshine Fiord from the Cape Dyer distant early warning (DEW)–line site. Large boulders of carving stone from gravel pits at Cape Dyer were sampled.

Future work

During the summer 2012 field season, carving stone deposit evaluations were examined in collaboration with the University of Manitoba. Samples were collected and will be systematically evaluated. Although measures of the quality and the criteria for selection of carving stone may be standard among Inuit artists throughout Nunavut and other places, understanding of the geochemical compositions, isotopic signatures and microstructural features of common carving stone varieties may strengthen these criteria and benefit the artisan industry. The carving stone deposits of the Qikiqtaruk and Kivalliq regions evaluated in 2012 will be thoroughly examined with extensive laboratory analyses. Laboratory analyses should aid in understanding any characteristics of a rock that could dictate its suitability and appropriateness for artisanal carving purposes.

Furthermore, examination of how the carving stones’ geochemical signatures and microstructural features are influenced by fluid flow patterns in the middle and upper crust may provide insight into the tectonic settings that occurred at the time of formation of carving stone deposits as well as the common alteration processes. This information could help with prospecting for carving stone because, for example, the characteristics determined by the analysis of excellent-quality carving stone may be recognizable in the field.

Another objective of the research work is to integrate laboratory results (petrography, mineral chemistry and isotope geochemistry), microstructural analyses and estimates of the metamorphic conditions of the selected carving stone deposits with the standard measures (hardness, toughness and colour) of traditional artisanal quality. These factors will all determine the suitability of a deposit for carving material.

The specific carving stone deposits evaluated in 2012 were selected for analyses based on artisanal suitability, size, locality and surface exposure of the deposit. Samples of each deposit, as well as samples of the surrounding country rock, were systematically collected. These samples will be evaluated petrographically using transmitted and reflected light microscopy, to determine mineralogy and also to determine textural relationships of the minerals in the rocks and any microstructural features. These identifiable textural and microstructural features may indicate the overall toughness or brittleness of the carving stone because planar and linear fabrics and fractures or microfractures cause weakness in a rock.

Electron microprobe analyses and scanning electron microscopy will be used for mineral identification because these methods of analysis determine mineral compositions and chemistry. From the compositions, estimates of the metamorphic conditions, such as temperature and pressure, may be calculated. Knowledge of the metamorphic conditions prevailing at the time of rock formation may provide insight into the tectonic environments in which the carving stones were formed, and may also provide insight into the alteration processes affecting the rocks.

Powder X-ray diffraction (XRD) will be used to qualitatively determine the bulk rock chemistry. X-ray diffraction will also be used to identify any asbestos present in the rocks because the presence of asbestos is a potential health concern. Radiometric isotopes will be analyzed to determine the age of carving stone deposits and the timing of metamorphism and alteration processes. In particular, the \textsuperscript{40}Ar-\textsuperscript{39}Ar method will be used to date specific events. Stable isotope contents, specifically oxygen isotopes, will also be analyzed. These analyses will be performed using secondary ion mass spectrometry and the results will help to identify the source of alteration fluids.

Economic implications

The results of the field evaluations have doubled the amount of known carving stone resources by confirming 45 sites of a sufficiently suitable quality of stone close to communities. Eighteen of the sites confirmed have substantial resources that could service carvers for many years. Generally, quality is more important than quantity. It is rare to find consistently excellent quality coupled with large tonnage (size) in the same deposit.

Confirmed resources of new material adjacent to a community may provide immediate and valuable income to carv-
ers; this potential value-added income may range between $10 and $100/kg. Over time, the value (per kilogram) of the finished product of new material may also increase significantly, subject to acceptance by the arts industry.

Conclusions

The Nunavut Carving Stone Deposit Evaluation Program has confirmed the quality and size of known carving stone resources in two of the three regions of Nunavut. Many sites of carving stone resources have been evaluated, with 75 sites in proximity to 19 communities documented. Deposits have been characterized by artisan quality, tonnage and composition, with 45 resources of carving stone defined. Of these 45 localities, a further 18 deposits have been characterized as containing substantial resources. Nine quarries and a further nine undeveloped deposits contain substantial resources of high-quality stone. Of significant interest, two previously unknown major deposits have been confirmed: one in the Kivalliq Region west of Repulse Bay, and the second west of Hall Beach in the Qikiqtaaluk Region.

The graduate research being conducted through the University of Manitoba will assist in determining which characteristics of the various rock types are most important for suitable carving stone. More work is recommended to validate sites of substantial undeveloped resources, particularly where excellent quality was noted. By using the results of these studies, carvers may have ready access to sufficient resources of stone, and, while gathering, be able to determine and hand-pick the materials most suitable for carving.

The findings to date suggest that Nunavut will have sufficient resources of accessible carving stone for years to come.

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Several mining companies provided access to their mine and/or exploration sites. In 2012, the field crew received assistance from two mining companies working in the Baker Lake area. Agnico-Eagle Mines Ltd. allowed us access to the Meadowbank mine site and provided shipments of stone from the mine’s open pit to Kivalliq Region communities. Shipments of stone required considerable handling by AEM employees; these contributions of time and effort are all greatly acknowledged. AREVA also extended an invitation for the field evaluation team to visit and evaluate drillcore and rocks on the Kiggavik exploration property. Baffinland Iron Mines Corporation also graciously invited the field crew to visit the Mary River iron ore development project in both 2011 and 2012 and provided assistance in the field.

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References


Caine, T.W. 1977: Carving stone communities of the Northwest Territories; in Requirements, Sources of Supply and Problems, Mining Section, Department of Indian Affairs and Northern Development, Yellowknife, NWT, 35 p.


Indian and Northern Affairs Canada 1993: Agreement between the Inuit of the Nunavut settlement area and Her Majesty the Queen in Right of Canada; Government of Nunavut, p. 150, URL <http://www.gov.nu.ca/hr/site/doc/nlca.pdf> [December 2012].


Murphy, J.D. 1973: Soapstone occurrences in the NWT; Open File Report, Indian and Northern Affairs Territorial Compilation, 1 sheet at 1:500 000 scale.


