ARCTIC
VOL. 33, NO. 3 (SEPTEMBER 1980), P. 628 - 645

Prehistoric Sources of Chert in Northern Labrador: Field Work and Preliminary Analyses

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ABSTRACT. The Torngat Archaeology Project is involved in a raw materials program that includes the "finger-printing" of certain lithics used by prehistoric cultures in Labrador, and the identification of their geological sources. Field work was carried out in 1978 in the Ramah and Mugford areas to sample chert outcrops and search for evidence of prehistoric quarrying and manufacturing activities. Numerous quarries and workshops were discovered in the Ramah Group, and a suite of Ramah and Cod Island chert samples was collected for analyses.

Thin sections of four visually similar rock types from Labrador — Ramah chert, Cod Island chert, Saglek quartzite, and Ryan's quartz — were examined and samples of each were submitted for trace element analysis by neutron activation. Given the high purity of the cherts and the small number of samples used in the preliminary activation analysis, confident identification of and strong discrimination between the four, based on trace element concentrations, were not possible. However, thin section examination enabled identifications and differentiations to be made based on the petrographic features of each of the lithics.

INTRODUCTION

As one aspect of its interdisciplinary approach to the study of Labrador prehistory, the Torngat Archaeology Project (TAP) is investigating lithic raw material use by each of the different cultural groups that once occupied this arctic and sub-arctic region. The work involves the precise "fingerprinting" of specific lithic materials, the location of their geological sources, and the determination of their use in the cultural assemblages of prehistoric Indian and Eskimo people. The Torngat Project has been actively pursuing a program of field reconnaissance to locate source areas, petrographic examination of thin sections, and neutron activation analysis of samples to determine trace element content. It is expected that this work will enable us to assign lithics to source locales and make it possible to describe the physical movement of resources, and map the routes over which raw materials were traded. The lithics under investigation include Ramah chert, a group of cherts from the Mugford region, soapstone, slate, nephrite and copper (Fig. 1).

This paper is a report on the field work and preliminary analyses completed since the 1978 season on Ramah chert and Cod Island chert, one of the lithics from the Mugford area. Geological sampling and the investigation of prehistoric quarry sites are reviewed, as are petrographic work and neutron activation analysis. Conclusions are also drawn regarding the use of these techniques for the study of Labrador cherts.

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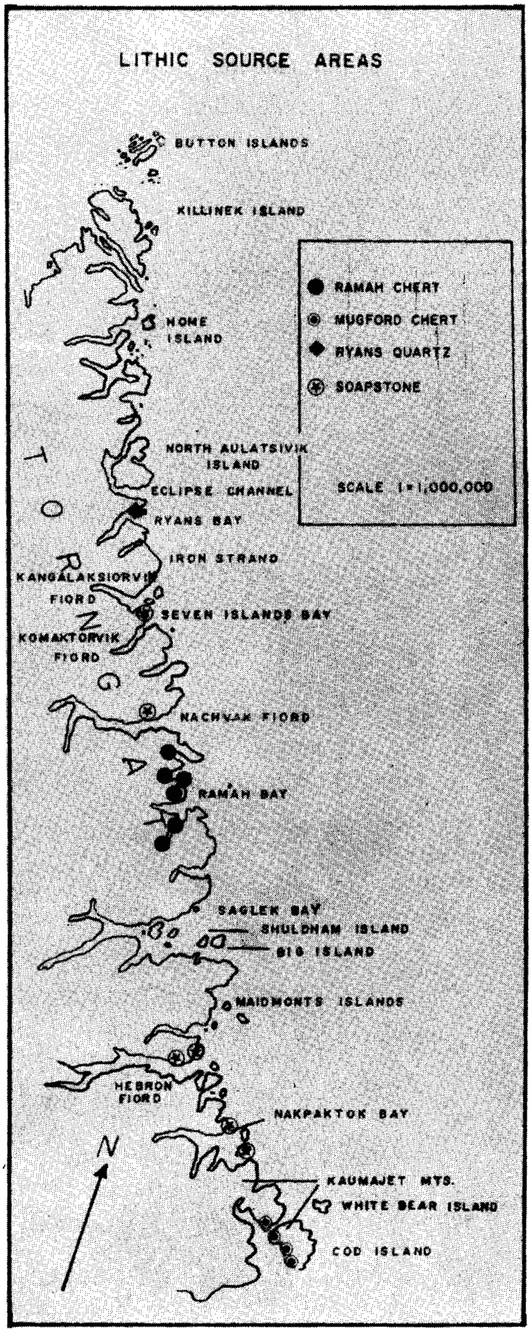

FIG. 1. Lithic source areas of central and northern Labrador

GEOLOGY OF THE MUGFORD AND RAMAH GROUPS

The Mugford Group is located in the Kaumajet Mountains about 145 km north of Nain, the northernmost inhabited settlement in Labrador, and consists of a series of volcanic and sedimentary rocks preserved in a northwest trending syncline (Smyth, 1976). This sequence forms part of the bedrock of a small, off-shore island group. A number of cherts are contained within both a lower sedimentary and a lower volcanic unit, but for reasons which will be discussed below, this report is concerned primarily with the sedimentary variety. The chert-bearing unit occurs at or very near sea level at a number of locations on the islands (Fig. 2).

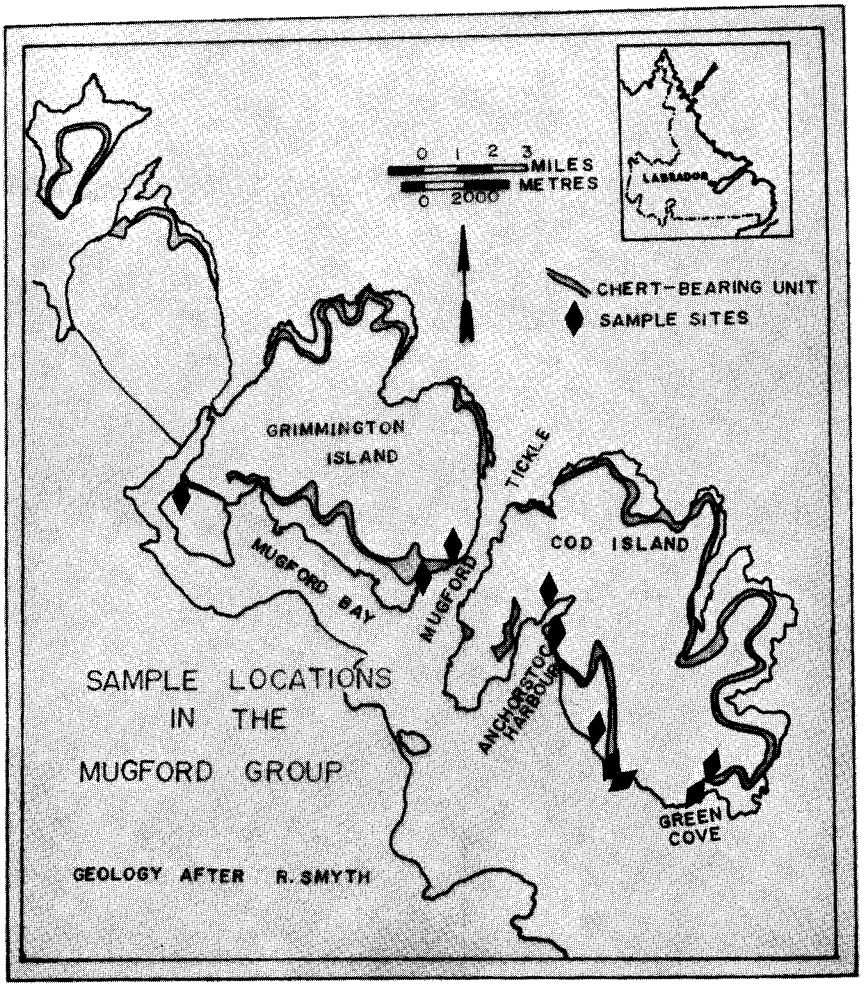

FIG. 2. **Sample locations in the Mugford Group**

The Ramah Group lies about 225 km north of Nain in the Torngat Mountains. It consists of 1700 m of stratified sediments, including chert, and a volcanic flow and several diabase sills (Morgan, 1975; Knight and Morgan, 1976). The rocks of the group lie in a north-south trending regional syncline which extends from Saglek Fjord north to Nachvak Fjord for about 75 km. A narrow, intensely folded and metamorphosed section extends a further 35 km south to Hebron Fjord, but reconnaissance detected no chert in this area. The chert unit is chiefly confined to the north and central sections where it can be traced for about 40 km (Fig. 3).

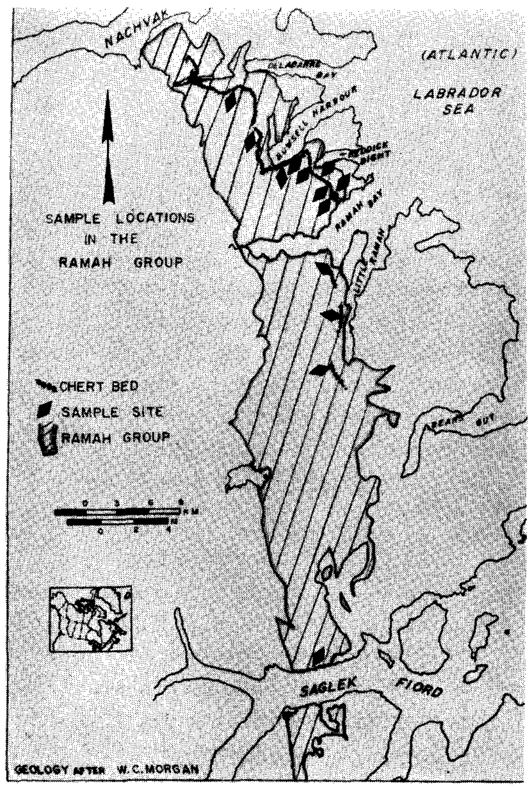

FIG. 3. Sample locations in the Ramah Group

There appears to be a strong geological correlation between the Ramah and Mugford Groups. Both are supracrustal sequences originating contemporaneously in the Aphebian (Lower Proterozoic) and each is composed largely of miogeosynclinal deposits resting on the same extensive Archean-age peneplain (Morgan, 1975; Smyth, 1976). The distance between the northernmost Mugford outcrop and the southern end of the Ramah Group at Hebron Fjord is only 48 km and this, combined with the lithological and depositional similarities as well as the coastal location of both groups, suggests that the Mugford and Ramah sediments may well have been derived from the same North Atlantic craton (Morgan, 1975).

PREVIOUS WORK

Interest in the identification and source of Ramah chert arises from its extensive prehistoric cultural use in Labrador (and Newfoundland) and because of its apparent function as a trade item. Ramah chert has been found as far south as Maine (Fitzhugh, 1972), a distance of 1500 km from its source in the Torngat Mountains, and some specimens are reported from New York, Delaware and even Florida (Fitzhugh, pers. comm.). Cod Island chert also appears in archaeological assemblages from Labrador, and is important to the TAP lithic studies because it can occasionally be confused with Ramah chert on the visual level in artifact collections.

Positive identification of these two lithics, as well as the ability to distinguish them from others, is an essential prerequisite to assigning them to source locales and describing their cultural uses. Previous analytical work on Ramah chert has been done by Fitzhugh (1972), and on lithic source areas in Labrador by Gramly (1978). The present work is an extension of the field program, begun by Gramly, to include the entire Ramah chert deposit, as well as previously-surveyed localities on Cod Island, and an expansion of the analytical program to encompass not only petrographic work, but neutron activation analysis.

Two additional lithics were part of this analysis because they can also be confused with Ramah and/or Cod Island chert on a visual level. One of these is Ryan's quartz, a vein quartz from the Ryan's Bay region (Fig. 1), referred to by Gramly (1978) as similar in appearance to Ramah chert. The other is Saglek quartzite, one of the Ramah Group rocks.

FIELD RECONNAISSANCE AND SAMPLING

The goals of the field program were: 1) to locate and describe outcrops of Ramah and Cod Island chert; 2) to systematically collect outcrop samples for later analyses; 3) to locate and investigate prehistoric quarry-workshops of Ramah and Cod Island chert; and 4) to identify the users of these quarries. Only the first three of these objectives can be discussed within the scope of this paper.

Outcrops:

The descriptions of outcrops are limited to the sections of the chert unit at each of the sampling locations. This also includes a more subjective assessment that gives some indication of "ease of recovery" i.e. the estimated degree of difficulty each outcrop presented for prehistoric quarries. Such factors as the appearance and character of the chert bed (thickness, amount of jointing that may enhance the removal of some pieces while making others unacceptable), the accessibility of the outcrops from the shoreline, the altitude at which certain outcrops lie, and the extent of natural "quarrying" brought about by the action of streams, ice, snow, waves, wind, and talus accumulation, are considered.

The locations of several outcrops of Mugford cherts have been described by Gramly (1978). During the reconnaissance of 1978, we revisited Anchorstock Harbour and discovered an additional locality at Green Cove (Fig. 2). Samples from Anchorstock Harbour, called Kaumajet chert and Kaumajet Black chert (Gramly, 1978), were collected from the lower volcanic unit of the Mugford

Group and are visually distinct from Ramah chert. These cherts are not included in this study. The Green Cove locality is a discontinuous, badly jointed outcrop exposed at 21 m and 100 m a.s.l. (Fig. 2). The chert bed, at places which we call Cod Island chert. These chert outcrops on the landward side of Cod Island are accessible from the shoreline, but the beds on the seaward side are located at high altitude on steep coastlines and appear much more difficult to reach. Further work is planned for the Mugford area to complete the sampling of as much of the chert-bearing formations as possible.

The amazingly extensive and continuous outcropping of chert in the Ramah Group was traversed and sampled for almost the entire length, excluding the northernmost section west of Delabarre Bay. At certain locations, such as the south shore of Ramah Bay and the western shore of Little Ramah Bay, the chert is essentially inaccessible because it lies at dangerously perched altitudes (150 m and 240 m respectively). However, stream (and probably ice and snow) transport to a sea-level plain at the former locale and immense talus slopes littered with chert boulders at the latter enabled us to recover samples with reasonably certain association. Evidence of prehistoric tool manufacture at the sites indicates that ancient people also took advantage of these same factors.

At most of the other sample locations (Fig. 3), the chert is either adjacent to the shoreline, as on the south shore of Rowsell Harbour (Fig. 5), or within easy walking distance or a short climb from the water's edge. Sample locales at Little Ramah Bay, Reddick Bight, on the north shore of Rowsell Harbour and at Delabarre Bay can be reached in this manner. The exception to the above conditions is the Ramah Bay cirque (Fig. 4). The climb to the cirque is a long, steep one that begins at a dangerous beach head (lower left area of the photo-

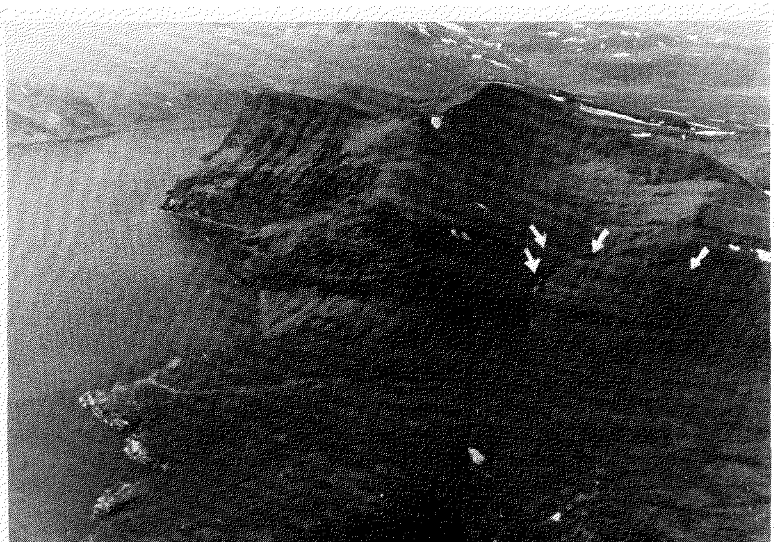

FIG. 4. Ramah Bay and the Ramah Cirque (view west). White arrows indicate the location of the chert beds. Scale: maximum width of the cirque is 1.4 km. Photo: W. Fitzhugh

FIG. 5. Rowsell Harbour (view east). White brackets indicate the chert deposit. Scale: chert bed is up to 4.5 m thick at this location. Photo: C. Lazenby

graph) and rises swiftly to 300 m. Crossing the cirque floor are four separate chert outcrops. A main one follows the general trend of the unit as a whole, while three others have been displaced about 300 m to the northeast (Fig. 3). Gramly (1978) has described the "quarry bowl" and estimates that 20 to 40 million pieces of worked chert lie on the cirque floor, along with evidence of quarrying tools.

The distinctive differences between the Cod Island chert and Ramah chert deposits are those of volume and the nature of the individual pieces of chert that can be "quarried." The thickness of the Ramah chert unit can be as great as 4.5 m and it is exposed at many coastal or near-coastal locations along its 40 km length. The beds are cracked and jointed to some extent, but they are generally massive and it is normal to recover chert boulders as large as footballs with only minor imperfections. By contrast, the Cod Island chert beds that we observed are infrequently exposed, often in difficult locations, and so badly jointed that individual perfect pieces larger than 8 to 10 cm are rare.

The samples of Ryan's quartz and Saglek quartzite that are included in the present study were not collected during 1978, but by other members of the TAP during the 1977 season. Ryan's Bay is located approximately 100 km north of Ramah Bay (Fig. 1). Here the quartz is deposited locally in small veins, and samples were picked up at a workshop adjacent to one of these veins. The Saglek quartzite was collected from talus slopes below the Ramah Group outcrops on the north shore of Saglek Fjord, but it can be found in many areas of the Ramah deposit.

Sampling

The collecting program followed sampling procedures designed to detect mineralogical, textural, and structural differences with stratigraphic position and over horizontal distance, both at individual outcrops and along the chert units as a whole. Outcrops were sampled directly with the exception of those localities previously cited. A number of large samples were chosen to ensure that enough specimens would be available for all proposed analyses. In particular, neutron activation analysis of high purity silicas like chert usually requires substantial amounts of sample for irradiation purposes. These cherts were no exception, and indeed, exceedingly high purity proved to be a distinctive feature of both Ramah and Cod Island chert.

Quarry-Workshops

Evidence was found for prehistoric quarrying of the cherts and the manufacture of tools adjacent to the outcrops (workshops). Gramly (1978) refers to two workshops at Anchorstock Harbour, and a major lithic reduction site exists at Brierly Island, just west of Cod Island (R. Jordan, pers. comm.). At every location that we visited along the length of the Ramah chert deposit, some evidence of prehistoric activity was discovered. The Ramah quarry bowl is an unusually striking example, but an extensive manufacturing site was located on the west shore of Little Ramah Bay, and debitage was scattered across the plain on the south shore of Ramah Bay, and around the outcrops at Reddick Bight, Rowsell Harbour, and Delabarre Bay.

ANALYTICAL WORK

Archaeologists familiar with prehistoric lithic assemblages of Labrador (and Newfoundland) *can* often distinguish the four rock types in this study from one another by visual inspection. There are times, however, when visual similarities can cause uncertainty in the identification of and distinction between Ramah and Cod Island cherts, and on occasion, Ryan's quartz and Saglek quartzite. Hand specimen descriptions will give some idea of the problem, while a summary of petrographic features and the results of neutron activation analysis will show that discrimination between the four is possible.

Hand Specimens

A review of hand specimen characteristics, briefly summarized in Table 1, indicates the areas of overlap and the potential for confusion. Features such as colour, outward crystalline appearance, lustre, opacity/transparency, and fracture are not always sufficiently distinctive to allow the separation of the cherts, quartz, and quartzite in all cases. All four rock types can be whitish although only Ryan's quartz can be truly clear and as colourless as glass. Ramah chert, when nearly colourless, has the appearance of frosted glass or "sleet on a windshield" (Fitzhugh, 1972) because of a relatively coarse crystallinity. Greyish to blue-grey to dark grey is a very common colour range for both the cherts, while yellowish to grey-green to deep sea green is much more frequently found among samples of Cod Island chert, and rarely in Ramah chert. The colour and shape of inclusions are also similar for these rocks. Ramah chert has specks, clouds, bands and swirls of dark grey or black on a pale background (see below under *Petrography*), and it is not uncommon to see single pieces with clear-to-white areas immediately adjacent to an area of solid black. Cod Island chert has

Table 1. Hand specimen descriptions of Labrador samples

	COD ISLAND CHERT	RAMAH CHERT	RYAN'S QUARTZ	SAGLEK QUARTZITE
COLOUR	—white to greyish, blue-grey to blackish, yellowish to green-grey to deep sea green; —iron staining along fractures; —black inclusions.	—white to greyish, blue-grey to charcoal grey to black, yellowish to greenish; —clouds, specks and bands of black colour; —iron staining along fractures and some surfaces.	—colourless to white, often with swirls and streaks of white and/or green in a clear matrix.	—milky white to grey to grey-black; —dark-coloured inclusions; —distinctive white and grey elongated grains are visible
GROSS CRYSTALLINE APPEARANCE	—smooth, homogeneous and fine-grained; —microcrystalline.	—like "sleet on a windshield" or "sugary"; —homogeneous; —microcrystalline, but quite coarse-grained.	—smooth and microcrystalline in some areas, rough faceted surface in others.	—generally a coarse-grained rock; —inidividual crystals visible in a fine-grained cement.
LUSTRE	—dull and somewhat "waxy."	—glassy lustre and slick appearance.	—vitreous; —clear, smooth areas resemble glass.	—generally dull, some individual crystals are glassy.
OPACITY/ TRANSPARENCY	—translucent in flakes.	—translucent in flakes (even the black variety).	—transparent to translucent to opaque.	—translucent to opaque.
FRACTURE	specifically: —conchoidal; generally: —most samples are severely jointed and fractured	—conchoidal; —massive pieces, 20 to 30 cm long are common with some fracturing.	—conchoidal; —only small pieces, 4 to 5 cm long are without fractures.	—subconchoidal; —massive, unfractured pieces are common
OTHER		—pyrite crystals up to 4 mm^2 are visible.		—pyrite crystals and feldspar grains are visible.

similar black-coloured inclusions, however, and Saglek quartzite also contains small black specks, although on closer examination these prove to be feldspar grains. Some specimens of the quartzite are composed on white and grey grains that are noticeably elongated, while other specimens are so close to Ramah chert in colour and inclusions that hand specimen distinctions, based on these features, are not clear. Swirls and streaks of white and green on a pale background are very common for Ryan's quartz, although Ramah chert can occasionally have green streaks in a white or dark field of colour.

Iron staining leaves rusty red, yellow and brown colours along the fracture lines in both cherts and the quartzite. This seems more prevalent in Cod Island chert than in Ramah chert, but that is largely due to the higher proportion of cracks and joints in the former. On the other hand, superficial iron staining of exposed surfaces tends to be more noticeable on Ramah chert pieces because of the larger size. A discontinuous pyrite unit underlies the Ramah chert bed from Rowsell Harbour south (Knight and Morgan. 1976) and chert samples, particularly those from the area adjacent to the pyrite deposit, contain numerous crystals, some up to 4 mm square. A rusty-coloured halo sometimes develops around the crystal sites and is a distinctive feature of Ramah chert.

The crystalline nature of Ramah chert is unusually coarse, although it still falls under the terms and general size range for microcrystalline (Williams *et al.*, 1954; Table 2). Individual grains are not easily discernible with the naked eye and are best observed through microscopic examination. In hand specimen, the chert has a distinctive "sugary" appearance, a glassy lustre, and a slick feeling. Some Ramah chert samples from the northern areas of the deposit seem to be more fine-grained than others, and further sampling north of Ramah Bay and more petrographic work will test the theory that the fine-grained, and possibly blacker varieties, occur in this region. White to pale grey Ramah chert is translucent in large pieces, and even the black variety is translucent in flakes. As is characteristic of microcrystalline siliceous rocks, Ramah chert exhibits conchoidal fracture.

Cod Island chert has an homogeneous, microcrystalline nature, with a fine-grained quality approaching that of a classic chert. Its lustre is dull and waxy, lacking the brilliance and glassiness of Ramah chert, and the fracture is conchoidal. Cod Island chert is translucent, again even flakes of the darkest variety. Saglek quartzite can be both translucent and opaque, and the lustre is dull. It has a granular texture and individual feldspar grains, coarse quartz grains, and pyrite crystals are visible. This coarse nature of the grains contributes to subconchoidal fracture. Hand samples of Saglek quartzite can be found that resemble Ramah chert, but on closer examination, the dull appearance, presence of impurities such as feldspar, and the granularity separate the two. Although the quartzite is also similar in colour to Cod Island chert, it is never as fine-grained, and it is unlikely that these two rocks would be confused.

Ryan's quartz has a dual crystalline appearance. Surface areas are macrocrystalline and faceted on one hand, and smooth and microcrystalline on the other. The quartz is vitreous, exhibits conchoidal fracture, and is often transparent, although swirls and streaks of colour create areas that are translucent to opaque. Generally it can be easily distinguished in hand specimen from the cherts and the

Table 2. Thin section descriptions of Labrador samples

	COD ISLAND CHERT	RAMAH CHERT	RYAN'S QUARTZ	SAGLEK QUARTZITE
CRYSTALLINITY	—microcrystalline approaching true cryptocrystallinity; —occasional coarse pockets; —equant grains, boundaries generally sharp with some fuzziness; —two size ranges: .004-.008mm and .012-.020mm, but largely homogenous.	—microcrystalline, but grain size up to 5 times larger than C.I. chert; —sub-rounded to —sub-angular; —size range from .022-.036mm wide and .042-.080mm long; —deformed grains with fuzzy boundaries.	—inequigranular: transition from equant, interlocking grains to angular grains with serrated edges; —larger grains are .044-.156mm long and .022-.056mm wide, smaller equant grains are .004-.008mm in size.	—inequigranular: large, angular grains with serrated edges are —.076-.214mm long and .010-.034mm wide; small size range from .004-.008mm
ACCESSORY MINERALS	—clusters of yellow-green to sea-green chlorite blades: 2-7% —carbonates: 2-6%; —opaques: <1-4%.	—opaques, related to pyrite occurrences: <1-6%; —carbonates: 2-4%. —interstitial graphite content ranges from "present" in greyish to "abundant" in black samples.	—none observed	—pyrite and other opaques: 1%; feldspar crystals: 1% —carbonates: 1%
STRUCTURAL FEATURES	—uniform crystallinity; —secondary infilling of fractures; mineralization associated with fractures: limonite	—all samples show strain, and elongation of the quartz grains; appear to be minor differences in crystal size and degree of deformation in samples from different locales; —secondary infilling of fractures; associations: reddish opaques after pyrite (hematite?), carbonates, coarser quartz		—deformation in all samples indicated by pronounced elongation of grains.
NAME	CHERT: —a compact, microcrystalline variety of quartz composed of interlocking grains; —chlorite, carbonate cause colour variation	CHERT: —the term *metachert* can be used to describe the metamorphosed texture of the grains; —colour due to interstitial graphite.	VEIN QUARTZ	ORTHOQUARTZITE: —quartzite of sedimentary origin composed of silica cemented quartz sand; silica cement has grown in optical continuity with the original grains.

Table 3. Labrador sample numbers, locations and analyses

Sample # &/or Name	Geological Group & or Location	Analyses[1]	Collected from; by
Ramah Bay chert-1	Ramah; Ramah Bay	TS	Gramly, 1976
Ramah Bay chert-2	Ramah; Ramah Bay	TS	Gramly, 1976
77-1	Ramah; Ramah Bay quarry	TS	Gramly, 1976
77-2	Ramah; Ramah Bay quarry	TS	Gramly, 1976
77-3	Ramah; Ramah Bay quarry	TS	Gramly, 1976
77-4	Ramah; Ramah Bay quarry	TS	Gramly, 1976
77-5	Ramah; Ramah Bay quarry	TS	Gramly, 1976
Ramah chert-a-	Ramah; Ramah Bay	TS	quarry workshop area; Gramly, 1976
Ramah chert-b-	Ramah; Ramah Bay	TS	quarry workshop area; Gramly, 1976
Ramah chert-c-	Ramah; Ramah Bay	TS	quarry workshop area; Gramly, 1976
I C.M.	Ramah; Reddick Bight, south shore	TS	cultural material; Lazenby, 1978
II A[2]; B[1]	Ramah; Reddick Bight, south shore, locality B	TS — B[1]; NAA — A[2]	outcrop; Lazenby, 1978
IV A	Ramah; Ramah Bay, south shore	NAA	surface collection, outwash; Lazenby, 1978
IV B	Ramah; Ramah Bay, south shore	TS; NAA	surface collection, outwash; Lazenby, 1978
V B	Ramah; Ramah Bay cirque, north locale	NAA	outcrop, stratigraphic sample; Lazenby, 1978
V D	Ramah; Ramah Bay cirque, north locale	TS; NAA	outcrop, stratigraphic sample; Lazenby, 1978
V E	Ramah; Ramah Bay cirque, north locale	NAA	outcrop, stratigraphic sample; Lazenby, 1978
VI A	Ramah; Ramah Bay cirque, northeastern locale	NAA	outcrop; Lazenby, 1978
VII A	Ramah; Ramah Bay cirque, northeastern locale	NAA	outcrop; Lazenby, 1978
VIII A	Ramah; Little Ramah Bay, south end, locality A	TS; NAA	outcrop; Hay, 1978
VIII-1 C.M.	Ramah; Little Ramah Bay, south end, locality A	NAA	cultural material; Lazenby, 1978
IX B	Ramah; Little Ramah Bay, west shore, locality B	TS; NAA	talus below outcrop; Lazenby, 1978
X B	Ramah; Rowsell Harbour, south shore, locality B	NAA	outcrop, stratigraphic sample; Lazenby, 1978
X C[3]	Ramah; Rowsell Harbour south shore, locality B,	TS; NAA	talus below outcrop; Lazenby, 1978
XII	Ramah; Rowsell Harbour, north shore	NAA	surface collection, outwash; Kaplan, 1978
XIII B	Ramah; Delabarre Bay, southwest end, locality B	TS; NAA(2)	talus at outcrop; Lazenby, 1978
AVA-1	Ramah; Avayalik Island	TS	cultural material; Jordan, 1978
77-7	Mugford; Cod Island	TS	Gramly, 1976
77-8	Mugford; Cod Island	TS	Gramly, 1976
77-9	Mugford; Cod Island	TS	Gramly, 1976
Cod Island chert-1	Mugford; Cod Island	TS	Gramly, 1976
Cod Island chert-8	Mugford; Cod Island	TS	Gramly, 1976
G78-2A[1]	Mugford; Green Cove, south locale, elevation 1	TS; NAA	outcrop; stratigraphic sample; Johnson 1978
G78-2A[2]	Mugford; Green Cove, south locale, elevation 1	TS	outcrop, stratigraphic sample; Johnson, 1978
G78-2B	Mugford; Green Cove, south locale, elevation 1	TS; NAA	outcrop, stratigraphic sample; Johnson, 1978
79-2	Mugford; north of Green Cove, L-2	TS	surface collection; Jordan/Cox, 1977
RB-1	Ryan's Bay, locality 1	TS; NAA	surface collection at outcrop; Cox, 1977

[1]TS = thin section; NAA = neutron activation analysis

Sample # &/or Name	Geological Group & or Location	Analyses[1]	Collected from; by
RB-1 (a)	Ryan's Bay, locality 1	TS	surface collection at outcrop; Cox 1977
RB-1 (b)	Ryan's Bay, locality 1	TS	surface collection at outcrop; Cox, 1977
77-6	Ramah; Ugjoktok Fiord	TS	Gramly, 1976
"Ramah Bay" quartzite-2	Ramah; Ramah Bay, west end	TS	Gramly, 1976
"Ramah Bay" quartzite-5	Ramah; Ramah Bay, west end	TS	Gramly, 1976
SG-1	Ramah; Saglek Fiord, north shore	TS; NAA	talus; Jordan Cox, 1977
SG-2	Ramah; Saglek Fiord north shore	NAA	talus; Jordan[1]/Cox, 1977

same in every direction (Fig. 7). Grain boundaries are usually sharp, although occasionally indistinct, and edges are subrounded. Grain deformation similar to that found in Ramah chert has not been observed in any samples of Cod Island chert, nor is deformation of grains an expected feature of cherts in general. For quartzite, but artifacts of Ryan's quartz can sometimes be confused with Ramah chert. Petrographic descriptions of the four rock types were undertaken to discover features, other than those visible in hand specimen, that would make differentiation possible.

Petrography

Through the microscopic examination of thin sections, differences between rock types can be quantified in terms of essential and accessory mineralogy, grain size, texture, and structure. Thirty-five thin sections (19 Ramah chert, 9

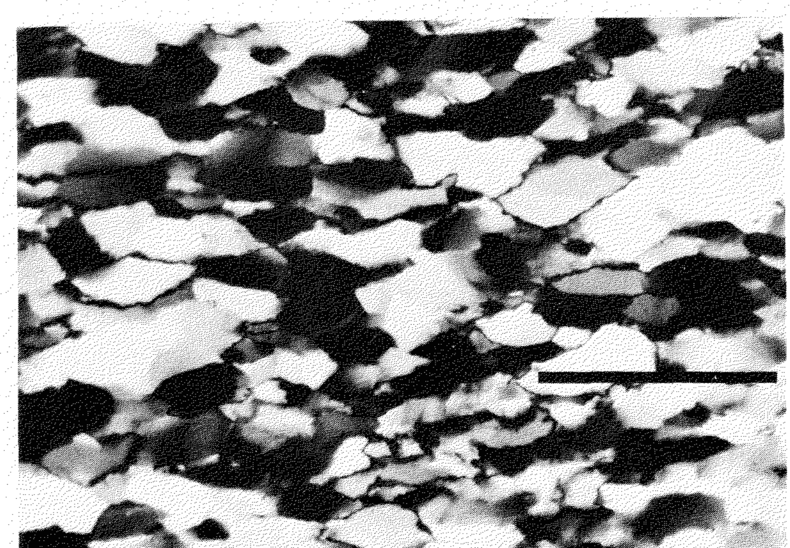

FIG. 6. Photomicrograph, Ramah Chert — sample #77-4. Note the deformation of the quartz grains. Bar scale 0.1 mm. Photo: C. Lazenby

Cod Island chert, 3 Ryan's quartz and 4 Saglek quartzite; see Table 3) were examined using these characteristics as a basis for study. Figures 6 to 9 are photomicrographs of four of these thin sections and Table 2 briefly summarizes the petrographic features of each of the lithics.

Thin sections of Ramah chert and Cod Island chert clearly demonstrate the microscopic differences between the two that are not always visible in hand specimen. Ramah chert is composed of quartz grains with indistinct or fuzzy grain boundaries and edges that are subrounded to subangular. The texture tends to be homogeneous, while individual grains are always strained and appear elongated, giving each a length and width measurement (Fig. 6; Table 2). Cod Island chert is composed of equant grains whose dimensions are essentially the this reason it appears that the strained nature of Ramah chert is an identifying characteristic that will, in combination with its other features, certainly separate it from Cod Island chert, and probably from other microcrystalline siliceous

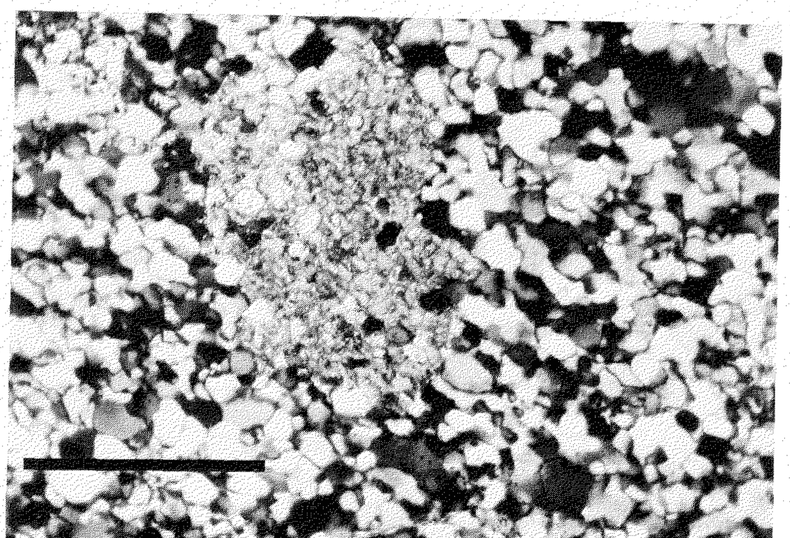

FIG. 7. Photomicrograph, Cod Island chert-sample #77-8. Note the small size of the grains and the absence of deformation. Large grain in the centre is a carbonate. Bar scale = 0.1 mm. Phote: C. Lazenby.

rocks in a larger regional comparison. Grain size also differs for these two cherts: Ramah chert grains can be up to five times larger than those of Cod Island chert (compare Fig. 6 and 7) although, as noted, this may not always be constant. Coarse-grained pockets and the infilling of fractures by coarser quartz are common to both lithics, but are not consistent in thin section or distinctive for either.

Both Ryan's quartz and Saglek quartzite have inequigranular texture in thin section. The quartz (Fig. 8) has small, equant grains that are interlocking, unevenly distributed among large, angular grains with serrated edges. This is reflected in the hand specimens, previously described as having both smooth and faceted surfaces in the same sample. Saglek quartzite is a combination of large angular grains showing pronounced elongation (Fig. 9), welded together with a fine-grained silica cement. This cement has filled in the pore spaces between the original quartz sand grains and grown in optical continuity with them.

Quartz is the major constituent for all four rock types, but accessory minerals account for small percentages of the total minerals present in three of the four. No accessory minerals were observed in Ryan's quartz. Saglek quartzite contains pyrite and other minerals that are opaque in thin sections as well as feldspar grains, attesting to the impure nature of the original quartz sand. Neither chert contains feldspar, but Ramah chert contains reddish opaques after pyrite along

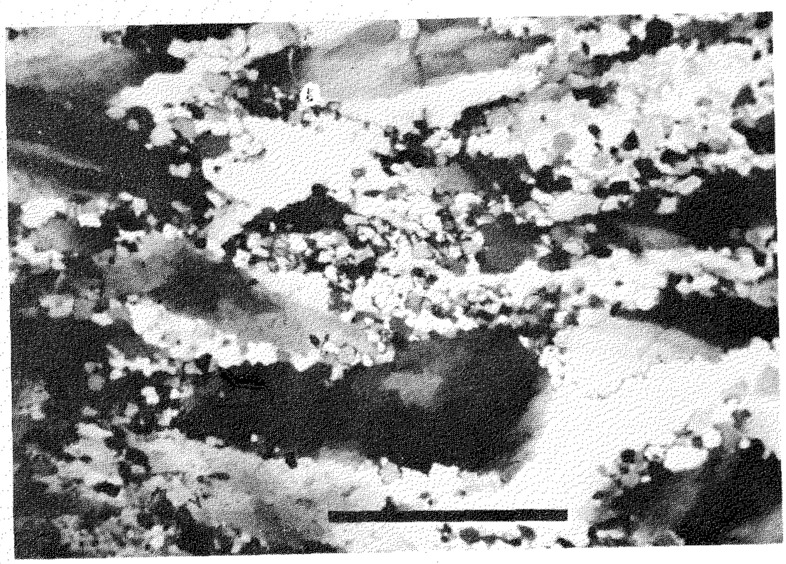

FIG. 8. Photomicrograph, Ryan's Quartz — sample #RB-1. Note fine grains dispersed among larger ones. Bar scale = 0.29 mm. Photo: C. Lazenby

with other opaque minerals associated with the pyrite occurrences. Carbon in compound (carbonates) as well as native carbon (graphite) are also present. The graphite, held in submicroscopic pores between the quartz grains, causes the grey to black colors noted in hand specimens of Ramah chert. An increased amount of interstitial graphite is associated with increasingly darker samples.

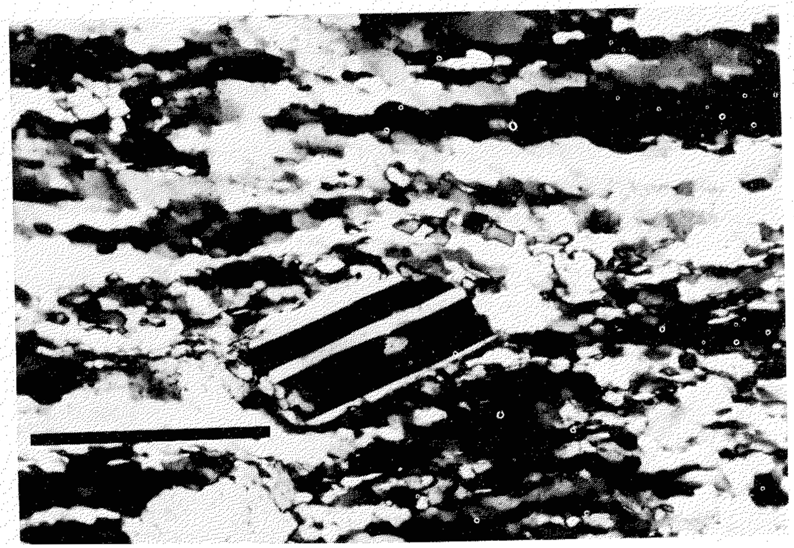

FIG. 9. Photomicrograph, Saglek Quartzite — sample #77-6. Note the high degree of deformation and the presence of feldspar (striped grain). Bar scale = 0.1 mm. Photo: C. Lazenby

Cod Island chert contains clusters of chlorite blades which cause the yellow to green colouration in the hand speciments. Carbonates and opaques are present in thin sections of Cod Island chert as well. Secondary infilling of fractures includes the coarse-grained quartz mentioned above, limonite in Cod Island chert, and more opaques and carbonates in Ramah chert.

For a number of reasons, we were unable to adhere to a strict program of stratigraphic sampling and the collection of many different outcrop samples of Cod Island chert, but were able to concentrate on these aspects of the Ramah chert collection program. There appears to be some indication of mineralogical, textural and/or structural differences in Ramah chert that have a stratigraphic position or are related to certain points along the length of the deposit. The location of the pyrite unit, below some sections of the chert deposit and not others, has already been mentioned as contributing to the abundance of pyrite crystals in some samples. (The relationship of trace element content to the geographic position of the sample will be discussed below under the *Neutron Activation* section of this paper.) The distinctive elongation of quartz grains seen in both Ramah chert and Saglek quartzite reflects post-depositional metamorphic events; Morgan (1975) has shown that the southernmost areas of the Ramah Group, between the southern shore of Ramah Bay and Hebron Fjord, are more deformed than those areas farther north to Nachvak Fjord. Thin sections of samples from these different areas show small gradations in the degree of deformation of the quartz grains, and work is continuing on quantifying this change. The possibility that graphite content increases from south to north is also being studied, as is the idea, arising from field observations, that more fine-grained Ramah chert is deposited in the northern sections of the deposit.

Neutron Activation

Generally, the use of trace element analysis by the neutron activation technique can significantly raise the confidence level of raw material source attribution. A mixed set of twenty-one samples of Ramah and Cod Island cherts, Ryan's quartz, and Saglek quartzite (Table 3) was submitted to Dr. J. Blackman, Conservation Analytical Laboratory, Smithsonian Institution, for a trial run. The rocks were analyzed in a preliminary test to determine whether they could be distinguished from each other on the basis of trace element concentrations, and to determine the range of variability in the element content of each lithic. The relative purity of the cherts, established through the examination of thin sections and X-ray diffraction analysis, necessitated the use of unusually large sample size (500 mg) and long irradiation times (2 minutes for short-lived and 10 hours for long-lived nucleides). Twenty-five minor elements were detected. fifteen of those in significant concentrations (Na, Sc, Cr, Mn, Fe, Co, Sb, La, Ce, Sm, Eu, Yb, Lu, Hf, U). The "significant" elemental concentrations were, however, extremely low and this fact, combined with the small number of samples, allows only tentative conclusions based on preliminary statistical manipulations.

The use of neutron activation analysis appears to discriminate Saglek quartzite from the cherts, and provides inconclusive evidence for the Ryan's quartz sample. Ramah and Cod Island cherts could not be clearly differentiated from each other on the basis of their trace element concentrations alone, and although a much larger sample size could possibly enable discrimination, the exceedingly pure nature of these cherts makes them unsuitable candidates for even such a highly sensitive technique as neutron activation. (J. Blackman, pers. comm.). Further observations on Ramah chert alone suggest that it is inhomogeneous with a range of trace element concentrations that varies by two orders of magnitude for some elements and by at least one order for all others (Blackman, 1979). The variability does not seem to coincide with sampling position along the length of the outcrop, except in the case of iron, which exhibits elevated concentrations at the Ramah Bay cirque locality. Neutron activation analysis of more samples from this area may give us some idea of the significance of this anomaly.

SUMMARY

The systematic sampling undertaken in the Ramah deposit is considered to have tested the full range of variability of the cherts and gives confidence in the analytical results. More field work, however, is warranted in the Mugford region to expand the lithic program into this potentially fruitful area. The discovery of large and numerous quarries and workshops in northern Labrador has confirmed the prehistoric mining of chert, particularly along the Ramah deposit.

The use of petrographic determinations and the neutron activation technique for trace element analysis was designed to explore various methods of identifying raw lithics and for source characterization. Preliminary analysis of these rocks by neutron activation indicates that trace element concentrations cannot be used to identify and discriminate all four types with a high level of confidence. It appears that petrographic analysis will be more useful for the future identification of and distinctions between Ramah and Cod Island cherts, Saglek quartzite, and Ryan's quartz.

ACKNOWLEDGEMENTS

The author is grateful for financial assistance from the Department of Anthropology, Carleton University, the Department of Indian and Northern Affairs, Government of Canada, and for financial and logistic support from the Torngat Archaeology Project, and the Department of Anthropology and the Conservation Analytical Laboratory, Smithsonian Institution. The author also appreciates the support and guidance of: Drs. W. Fitzhugh, P. Johnson, W. C. Morgan, R. H. Jordan, V. Blundell, J. Blackman, M. L. Crawford. G. Rowley, P. Goetz, and Messrs. S. Hay and J. H. Grimes.

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