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Use of Rare Earth Element Analysis to Study the Utilization and Procurement of Soapstone Along the Labrador Coast

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Neutron activation analysis provides the necessary sensitivity and accuracy to measure rare earth element (REE) concentrations in soapstone even when geochemical processes have left the soapstone very depleted in trace elements. The types of variation in REE concentrations expected from a single geological source were studied at the Fleur de Lys quarry in Newfoundland. Although the absolute concentrations varied, the chondrite-normalized distribution patterns remained parallel. Analysis of debitage indicates that most materials worked were from nearby outcrops, but there was some working of soapstone from more distant quarries. Artifacts representing various Eskimo and Indian cultures over the past 4000 years have been analyzed and many have been matched to geological outcrops on the basis of their REE patterns.

DESPITE ITS HARSH ARCTIC AND SUBARCTIC CLIMATE, the coast of present-day Labrador has been the home of peoples from several cultural traditions for over 7000 years. Most of the archaeological evidence—the tools and implements left by the prehistoric inhabitants of this area—consists of a variety of lithic (rock) artifacts. The variety of naturally occurring lithic materials utilized indicates that these prehistoric peoples were keen observers of their environment. As in many other parts of the world, the Indian and Eskimo peoples along the Labrador coast found and used the relatively soft, carvable soapstone. Soapstone is a hydrous

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magnesium silicate containing the mineral talc and varying amounts of other minerals including chlorite and carbonate minerals. Soapstone deposits originated during episodes of regional or contact metamorphism and are thus found associated with mountainous areas. Although soapstone exposures or outcrops are not uncommon in certain types of terrain, these outcrops are often relatively small and may be difficult to identify. In late Maritime Archaic times (~ 4000 B.P.), these soapstone outcrops were identified and the soft rock was carved into plummets (*1*). During the Paleo-Eskimo and Neo-Eskimo times (after 4000 B.P.), this material became even more important as a resource when it was fashioned into a variety of lamps and cooking pots. Later, soapstone became (and remains) an important artistic medium for the Eskimo or Inuit.

Soapstone's unique properties are a result of the plate-like crystal structures of the talc and other minerals. These minerals are formed during the metamorphic alteration of several types of ultrabasic or sedimentary rocks. The geochemical process is a complex one, but previous work has indicated that the trace element contents are determined by the metamorphic process (*2*). The possibility of a unique set of trace element concentrations for each region where soapstone was formed makes this useful natural resource an attractive material for archaeologists to study. By identifying and characterizing the soapstone from outcrops that were used by prehistoric peoples, the archaeologist may be able to determine the source of soapstone artifacts found at habitation sites far from the outcrop. The fact that there are soapstone deposits scattered along the entire Labrador coast makes the study of soapstone procurement and utilization particularly interesting. Soapstone is certainly not a common type of rock and requires some effort to find; however, it was certainly more readily available to the prehistoric inhabitants of Labrador than was the Ramah chert that was used for chipped stone tools (*1*). Ramah chert from a single relatively localized source area makes up over 99% of the chipped stone from Dorset Paleo-Eskimo assemblages from the northern tip of Labrador to the areas south of Hopedale (Figure 1). This type of lithic material shows that there must have existed effective mechanisms for the dispersal of chert over long distances. The mechanism for resource procurement and dispersal is unknown, but the patterns in the dispersal of a more readily obtainable material like soapstone may help us understand this mechanism. The appearance of soapstone from nonlocal sources suggests population movements or group interactions. If interactions are the explanation, soapstone links two points in a network.

To show that a soapstone artifact originated from a particular outcrop, the trace element contents of the artifact must match the material from the outcrop. Like most naturally occurring materials, soapstone is some-

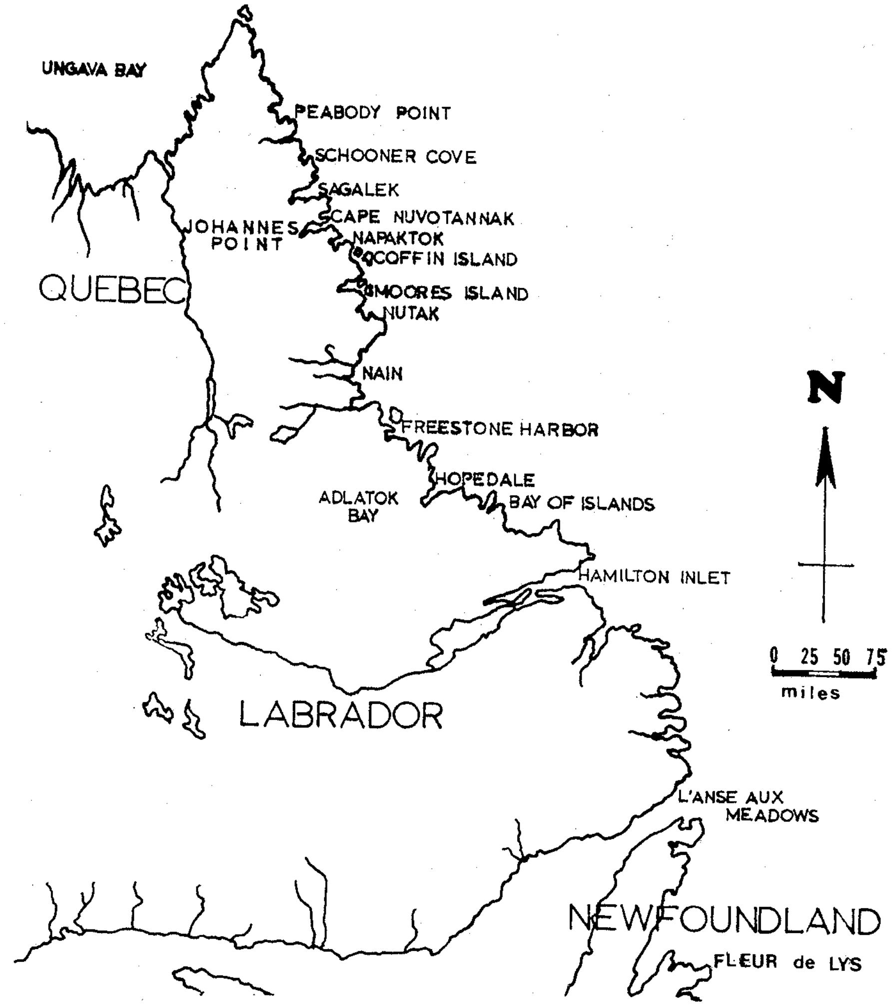

Figure 1. Map of Labrador coast and northern Newfoundland showing some of the soapstone outcrops and archaeological sites studied.

what inhomogeneous; therefore, a particular soapstone outcrop requires extensive sampling to determine the variability of the trace element contents for the material from a single geological formation. This type of extensive sampling was carried out for several soapstone outcrops in Labrador, including the best known aboriginal quarry in the region, located near Fleur de Lys in northern Newfoundland. The analysis of these samples helps to establish the variability expected for an outcrop and eliminates the uncertainty in matching artifacts with a particular quarry.

Background and Sampling

In Labrador, true prehistoric soapstone quarries—as opposed to geological outcrops—where clear evidence of mining or other extractive activities is preserved, have proved to be rather difficult to locate. An exception is the well-documented Fleur de Lys quarry, where Dorset Paleo-Eskimos apparently worked the deposits for many years (3). Quarried zones are found in two discrete localities, referenced as Localities 1 and 2, which are located about 0.5 km apart. The most intensively worked location (Locality 1) consists of a discontinuous series of areas where soapstone was removed, spaced over a distance of 200 m. Preliminary calculations based on the number of preform removal scars and unfinished preforms suggest that material for a minimum of 1000–2000 vessels was mined from this locality alone during the period of time that it was being quarried.

A total of 26 samples from locality 1 and 4 samples from locality 2 were selected for analysis to investigate intrasource variability in trace element content. Several other quarries along the Labrador coast, whose locations are shown in Figure 1, were sampled extensively. These samples include 16 from the Peabody Point (Seven Islands Bay area), 12 from a Coffin Island outcrop, 25 from Cape Nuvotannak, and 28 from the Bay of Islands. In addition, a total of over 20 other outcrops were sampled, including several outcrops in the Ungava Bay area. In some cases, only a few samples were obtained from a particular region. All outcrop samples were selected to be physically soft enough to have been material that could have been used during prehistoric times.

In addition to outcrop and quarry samples, we have analyzed debitage, preforms, and finished vessels to test the hypothesis that manufacturing took place in the proximity of the outcrops where the soapstone was obtained. Intuitively, this seemed logical, and evidence that Dorset (Paleo-Eskimo) sites near known outcrops contained substantial quantities of debitage and preform fragments bolstered this assumption. Trace element analysis of these materials and the nearby outcrops allowed this assumption to be tested. The most extensive test was for samples from Komaktorvik and other archaeological sites in the Peabody Point region. A total of 67 debitage samples and 16 preform fragments were analyzed from various sites in the Peabody Point area. In addition, 49 artifacts (cooking pots and lamps) were analyzed.

Over 650 soapstone samples from the Labrador region have now been analyzed. Of these, 400 samples are artifacts from a large number of different sites. The archaeological sites represent an extensive spatial distribution, but they also come from sites representing the different cultural traditions that span over 4000 years of human activity along the Labrador coast. The detailed discussion of these artifacts is not the subject of this chapter, but our analysis has included artifacts from Maritime Archaic; Early, Middle, and Late Dorset; Thule, or Labrador Eskimo sites.

Materials and Methods

All samples were analyzed by instrumental neutron activation analysis (INAA) following procedures described previously (2,4). Because the rare earth elements (REEs) have proved to be most useful in characterizing the soapstone from the different quarries (5), the analysis was optimized for the measurement of these elements. Following a 2-h irradiation, with a flux of $\sim 2 \times 10^{12}$ neutrons cm^{-2} s^{-1}, the soapstone samples (0.3–0.7 g) were transferred to new counting vials for radioassay. The radioactivity was measured once with solid state Ge (Li) detectors 4–10 days after irradiation. The length of the count was determined by the activity of the ^{140}La, ^{153}Sm, ^{169}Yb, and ^{170}Lu that were being measured. In a second measurement, 40–50 days after the irradiation, ^{141}Ce, ^{152}Eu, ^{153}Gd, ^{160}Tb, ^{169}Yb, and ^{170}Yb were measured. Other long-lived radionuclides, such as ^{59}Fe, ^{46}Sc, ^{60}Co, and ^{51}Cr were measured at both times. In most cases, concentrations were determined by comparison to a soapstone standard prepared and analyzed in our laboratory. In some cases, other U.S. Geological Survey standard rocks (e.g., BCR–1) were also run as a cross check on the soapstone standard.

Results, including a measurement of the uncertainty due to counting statistics, were calculated, stored, and displayed with laboratory microcomputers.

The data display of particular interest is the normalized REE distribution pattern. The concentration of the particular REE is normalized by dividing it by the average concentration of that element found in chrondritic meteorites. The geochemist assumes that the REE concentrations in chondritic meteorites represent undifferentiated primordial material. During the history of the earth, the REE and other elements have been partially separated from each other by geochemical processes on the basis of the charge and size of the ion (Goldschmidt's rule). In these natural processes, the REEs are normally all 3+ ions, so separations are the result of the decrease in ionic size (lanthanide contraction) with atomic number. The one exception is europium, which can be partially reduced to the 2+ ionic state during geochemical processes; this rare earth element behaves anomalously. In most studies of geochemistry of REE, the normalized concentrations have been plotted with the more convenient atomic number as the abscissa because the reciprocals of the rare earth element ionic radii are a linear function of atomic number (6). Although all 3+ ions (including scandium) could be plotted if ionic radii were used (e.g., Ref. 7), this chapter is concerned primarily with the REE. In the case of soapstone, the distribution of the concentrations of REE depends upon the metamorphic conditions as well as the original concentrations of REEs in the particular rocks being altered. Thus the distribution patterns of REE in soapstone show a great deal of variation among the different geological regions where the material is formed (5).

The key features in a normalized REE distribution plot are (1) the absolute magnitude of the concentrations; (2) the differentiation of the lighter REEs from each other in going from the radius of La^{3+} (1.14 Å) to Sm^{3+} (1.00 Å); (3) the differentiation of the heavier REEs as the size decreases from Gd^{3+} (0.97 Å) to Lu^{3+} (0.85 Å); and (4) the difference between the europium concentration measured and that predicted by a smooth variation in normalized concentrations between samarium and gadolinium. Because the REE distribution curves are smooth functions of atomic number (or size), the essential features of the curve can be determined by accurate measurements of lanthanum, samarium, europium, gadolinium, and lutetium. We are fortunate that these elements are the ones where INAA data are the most precise, although at extremely low concentrations, the gadolinium measurements are subject to some analytical error owing to spectral interferences. These elements, where the results are most precise, were used to calculate five parameters that were used to describe the general features of the REE distribution plot. These parameters were (1) normalized lanthanum concentration; (2) normalized lutetium concentration; (3) slope, on a semilog plot, from lanthanum to samarium; (4) slope, on a semilog plot, from gadolinium to lutetium; and (5) the difference between the log of the measured europium concentration and that obtained by extrapolating between samarium and gadolinium on a semilog plot. These parameters as well as the concentrations of iron, scandium, cobalt, and chromium were evaluated using ARTHUR, a series of programs designed for pattern recognition and statistical algorithm development (*8*).

Results

The accuracy of the matching of artifacts to quarries depends upon the accuracy of the raw data, the variations in REE concentration within a geological formation or outcrop, and the uniqueness of the REE distribution pattern associated with each quarry. For soapstone from the Labrador area, the REE concentrations were often at or below the levels found in chondritic meteorites; these low concentrations are near the sensitivity limit for the INAA procedures utilized. The uncertainty in the analysis is based upon the counting statistics (Table I). In Figure 2 the results of the analysis of two typical soapstone samples from Labrador are shown normalized to chondritic meteorites. The standard deviation ($\pm 1\sigma$) due to counting statistics is indicated by the error bars for each element. It is clear from these results that at low concentrations the uncertainty in the analytical data must be considered in matching patterns. By focusing on the importance of the REE distribution pattern, the analytical uncertainty of a single element is not as critical. For the iron, cobalt, and scandium concentrations, the analytical uncertainties are generally less than $\pm 3\%$.

Previous work had indicated that the variations of REE contents within an outcrop were less than those between outcrops (*4*); this conclusion required further testing for the Labrador quarries. The large Fleur de Lys quarry offered an excellent opportunity for this study. Figure 3 shows the REE patterns typical of Fleur de Lys quarry. Over half of the samples are parallel to and fall between curves 1 and 2. Although this pattern is characteristic of the soapstone in this formation, the pattern shown by curve 3 is typical of the samples found at locality 2 and one worked area (B) at locality 1. The difference between these similar types of REE patterns is in the size of the europium anomaly. In early studies, this kind of difference between soapstone samples from

Table I. Some Representative INAA Data for Soapstone Outcrops Along Labrador Coast

Outcrop Sample	*La (Norm.)*[a]	*Sm (Norm.)*[a]	*Eu (Norm.)*[a]	*Gd (Norm.)*[a]	*Lu (Norm.)*[a]	*Sc (ppm)*	*Co (ppm)*	*Fe_2O_3 (%)*
Saglek[b]	0.11	0.032	0.04	0.03	0.08	0.46	76.6	4.40
$\pm \sigma$[c]	(0.03)	(0.004)	(0.01)	(0.02)	(0.01)	(0.01)	(0.7)	(0.02)
Komaktorvik[b,d]	82.3	6.86	0.53	5.0	0.18	0.57	99.0	8.81
$\pm \sigma$[c]	(1.3)	(0.03)	(0.04)	(0.9)	(0.02)	(0.01)	(0.9)	(0.06)
Peabody Point	0.33	0.087	0.10	0.09	0.06	4.8	75.4	3.07
Bay of Islands	2.1	7.15	2.2	7.1	3.2	29.3	138	13.25
Johannes Point	39.7	11.2	2.7	3.0	3.9	42.6	35.1	10.25
Fleur de Lys	0.21	0.059	0.17	0.07	0.14	9.5	83	5.66
Fleur de Lys	0.45	0.044	0.22	0.05	0.21	6.3	167	7.72
Fleur de Lys	0.55	0.14	0.12	0.10	0.11	5.9	64	4.79
Fleur de Lys	0.39	0.11	0.15	0.09	0.10	10.6	101	6.42
Fleur de Lys	0.25	0.045	0.11	0.05	0.10	11.2	129	6.83

[a] Rare earth elements normalized to chondritic meteorites. La = 0.33 ppm, Sm = 0.181 ppm, Eu = 0.069 ppm, Gd = 0.249 ppm, Lu = 0.034 ppm.
[b] Samples plotted in Figure 2.
[c] Uncertainty ($\pm 1\sigma$) due to counting statistics. These values are representative of the analytical uncertainty in the other samples.
[d] Debitage from site 10 km from Peabody Point.

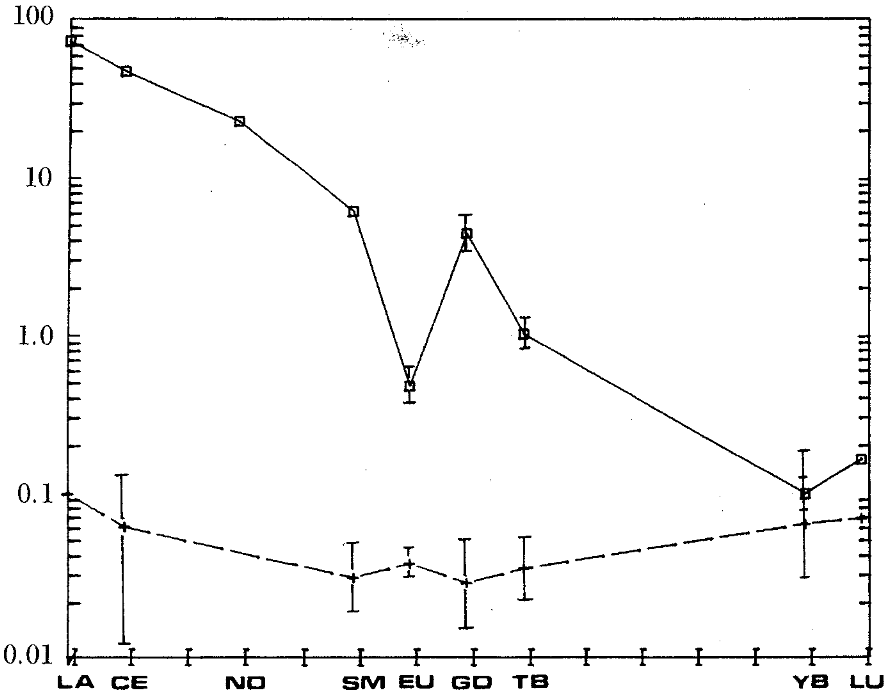

Figure 2. Chondrite-normalized REE distribution patterns for soapstone from Labrador showing analytical uncertainty based upon counting statistics.

similar areas had been observed. In one case, samples from southeastern Pennsylvania had parallel REE patterns but differed in the size of the europium anomaly because the samples came from two distinct geological settings (2). In the case of the Fleur de Lys samples, the sources of the soapstone represented by the two types of REE patterns were only a few meters apart, so the same explanation seems unlikely. The two types of patterns may more likely represent metamorphic reaction zones within the same geological formation. In geochemical studies of the alteration of serpentine to talc at Tamarack Lake (Calif.), a zone was observed where the europium anomaly changed dramatically over a distance of a meter. Although the other REE concentrations and the mineralogical compositions were very similar across this zone, the different behavior of the europium was attributed to changes in oxidation conditions as the hydrothermal solutions passed through the rocks causing the metamorphic alterations (2).

The observation of two similar but slightly different REE patterns for soapstone from the same outcrop was repeated for several other outcrops in Labrador. The geochemical reasons for different types of REE patterns in the same outcrops are not known. However, because

the trace elements are redistributed by the movement of hydrothermal solutions through the geological body and the mobility and "solubility" (partitioning between the mineral phase and solution) of each REE is a function of its ionic size (and oxidation state), the patterns observed probably reflect degrees of partial separation of the REEs from each other. An outcrop requires sufficient sampling to discover this type of inhomogeneity; this is especially true when there is overlap with REE patterns from other geological sources. There are significant differences between most of the soapstone outcrops studied (e.g., Table I); however, there are some differences that are difficult to distinguish. For instance, one of the two types of samples found at Peabody Point is indicated in Figure 3. Curves 4 and 5 represent the range of this type of Peabody Point soapstone.

Another type of variation, observed for outcrop samples in Labrador as well as in the eastern United States (*9,10*), is shown in Figure 4. In this case, each separate outcrop located within several miles of the other

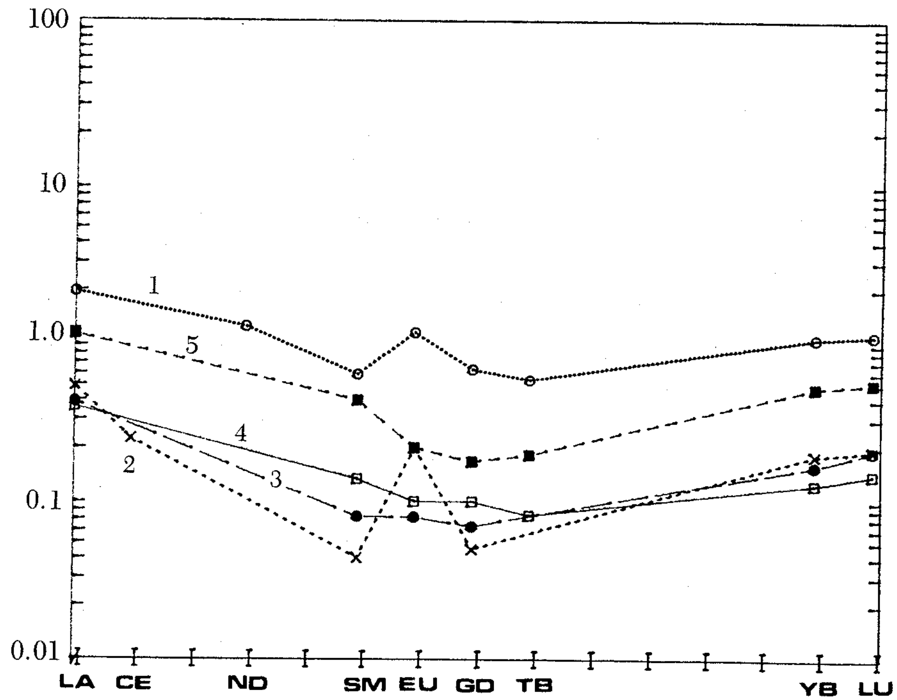

Figure 3. Chondrite-normalized REE patterns showing the range of patterns found for soapstone from the Fleur de Lys quarry in Newfoundland. Curves 1 (○) and 2 (×) represent range of concentrations for most of the samples; curve 3 (●) is the somewhat different pattern that was more typical of the Locality 2 soapstone. Range of REE patterns typical of the soapstone outcrops at Peabody Point is shown by curves 4 (□) and 5 (■).

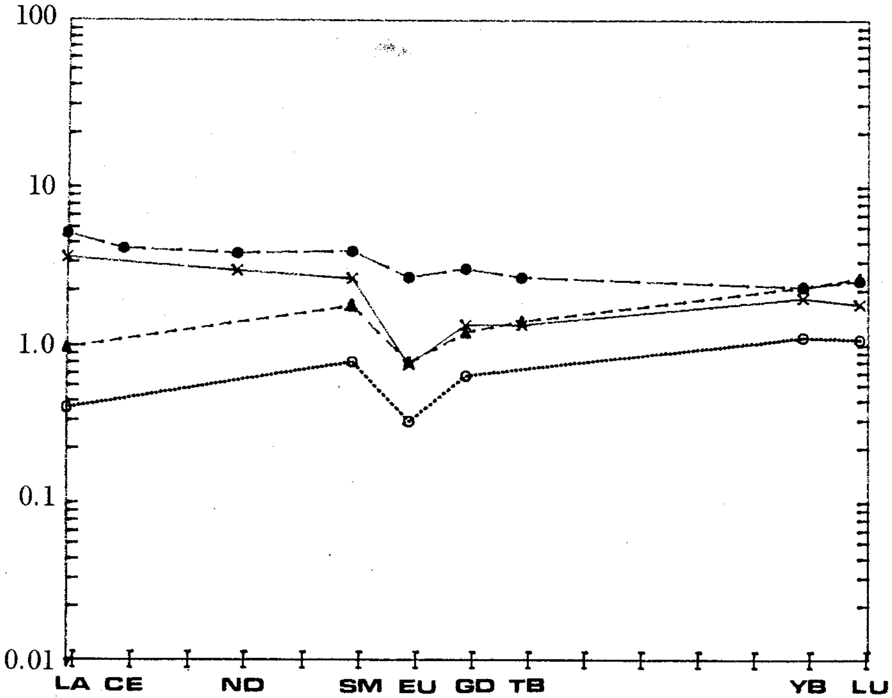

Figure 4. Chondrite-normalized REE patterns for representative soapstone samples from outcrops in the Okak area. Curves 1 (○) and 2 (●) are the types of patterns found at the Coffin Island outcrop; curve 3 (×) is an outcrop at Moores Island; curve 4 (▲) is typical of the Nutak outcrop.

outcrops in the region near Coffin Island has a similar pattern. The differences are due primarily to the size of the europium anomaly and the partitioning of the lighter REEs (the slope between lanthanum and samarium). Such "regional" changes could result from differences in the rocks that were metamorphically altered or differences in the extent of metamorphic activity throughout the region. Recognition of this type of regional variation may be valuable when it is impossible to find and analyze all of the soapstone outcrops in a region. For example, it may be reasonable to suggest that an artifact originated from soapstone in a given region if it is similar to, but not an exact match for, any of the outcrops sampled.

The matching of outcrop samples with debitage and other artifactual material is an ideal problem for computer-assisted pattern recognition techniques (8). The use of ARTHUR for the analysis of the soapstone from Labrador will be discussed in a future publication, but the important parameters for comparing soapstone are given in Table II. For this table, the samples from a given quarry were taken as one or two groups. The

Table II. Mean and Standard Deviation for Parameters Used to Distinguish REE Patterns in Soapstone

Quarry	*Concentration*[a] *La*	*Concentration*[a] *Lu*	*Slope*[b] *La to Sm*	*Slope*[c] *Gd to Lu*	*Europium Anomaly*[d]
Fleur de Lys A	0.73 ± 0.10	0.46 ± 0.11	−0.11 ± 0.02	0.028 ± 0.009	0 ± 0.03
Fleur de Lys B	0.55 ± 0.10	0.39 ± 0.14	−0.14 ± 0.02	0.064 ± 0.006	0.48 ± 0.04
Bay of Islands A	4.4 ± 0.7	2.3 ± 0.2	0.025 ± 0.009	−0.048 ± 0.005	−0.41 ± 0.03
Bay of Islands B	4.0 ± 0.8	3.7 ± 0.3	0.090 ± 0.009	−0.054 ± 0.003	−0.25 ± 0.04
Cape Nuvotannak A	2.8 ± 0.5	0.60 ± 0.10	−0.12 ± 0.01	−0.011 ± 0.010	−0.57 ± 0.03
Cape Nuvotannak B	1.7 ± 0.3	0.31 ± 0.05	−0.11 ± 0.01	−0.025 ± 0.010	−0.27 ± 0.01
Johannes Point	27.3 ± 5.0	6.9 ± 2.0	−0.06 ± 0.01	0.007 ± 0.006	−0.14 ± 0.04
Coffin Island	14.9 ± 2.9	5.2 ± 0.5	0 ± 0.008	−0.030 ± 0.003	−0.33 ± 0.03
L'Anse aux Meadows	0.68 ± 0.10	4.9 ± 0.8	0.17 ± 0.01	0.002 ± 0.008	0.11 ± 0.03
Napaktok Point	9.6 ± 2.0	2.3 ± 0.6	−0.08 ± 0.02	0.017 ± 0.006	−0.94 ± 0.01
Peabody Point	1.5 ± 0.2	0.48 ± 0.05	−0.11 ± 0.02	0.06 ± 0.01	−0.10 ± 0.06

[a] Ratio of concentrations normalized to chondritic meteorites.
[b] Slope = (log [Sm] − log [La])/5.
[c] Slope = (log [Lu] − log [Gd])/7.
[d] Log [Eu] − [(log [Sm] + log [Gd])/2].

grouping was based upon the similarity of the samples using hierarchal dendrograms of feature correlations generated by the HIER routine in ARTHUR (8). Each of the five parameters used to characterize the REE pattern was averaged for all of the samples in the particular group. The number of samples included in determining the mean value as well as the standard deviation from the mean for each parameter is given. Only outcrops represented by five or more samples are included.

The outcrop samples from Peabody Point were compared to debitage, preforms, and finished vessels from the archaeological sites within 20 km. Much of the material analyzed had REE patterns similar to the Peabody Point outcrop (*see* Table II); however, there was a significant number of samples that were similar but had a lower degree of correlation (using hierarchal dendrograms) than did the outcrop samples. Many of the debitage samples were analyzed before the Peabody Point quarry had been completely characterized. The similarity with the analyzed outcrop samples was enough to suggest that there was another outcrop in the Peabody Point region that had not been sampled. Further sampling at Peabody Point did find this second REE pattern to be characteristic of some soapstone from this outcrop. About 64% of the debitage analyzed from Komaktorvik and all 12 debitage samples from the nearest archaeological sites match those from the Peabody Point outcrop. The other debitage from Komaktorvik includes samples with REE patterns that are very similar to samples from outcrops further south along the coast (e.g., Okak and Napaktok). There are several debitage samples that have a positive slope between lanthanum and samarium, and this particular REE pattern has not been found at the outcrops sampled to date. This characteristic REE pattern (positive La–Sm slope) was found for several artifacts from the Seven Islands Bay area (which included Peabody Point) as well as for the debitage.

Discussion

The Fleur de Lys soapstone quarry is unique in preserving considerable evidence of the methods used to extract soapstone. The worked areas at Fleur de Lys are almost certainly Dorset (*11*). There is no archaeological or historical evidence that the Neo-Eskimo population, which supplanted the Dorset peoples in Labrador, ever occupied the northern Newfoundland area (*12*). In more recent times, the 17th and 18th centuries, the Neo-Eskimos frequented the Strait of Belle Isle to trade with Europeans. The only other people who might have used the soapstone at Fleur de Lys were the Maritime Archaic Indians, who also lived in Newfoundland. However, these people used soapstone for plummets, so it is doubtful that they would have needed to employ any elaborate quarrying methods to extract the small amounts they needed.

Evidence of plummet manufacture was not observed from survey and test excavations at the quarry (3). There is no evidence for soapstone utilization by other Indian cultures in the area. Although no lithic tools, which are diagnostic of the Dorset culture, were found at Fleur de Lys, the preform morphology observed in the quarry corresponds to finished Dorset vessels in size and shape. Thus the consistent and uniform technology of soapstone extraction observed at Fleur de Lys is assumed to be only that of the Dorset people. Association of artifacts from dated archaeological sites may provide some indication of the length of time that the quarry was in use.

The amount of soapstone extracted from the Fleur de Lys quarry was large. In locality 1, there is a strong tendency for preforms, removal scars, and mounds of tailings from the quarrying operations to be clustered together in discrete groups over a 200-m length of the cliff face (Figure 5). The quality of the soapstone may have determined the locations of the worked areas, but other evidence at the site suggests an efficient technological reason for the intensive working of a particular area. Most partially carved but unremoved preforms found in place at

Figure 5. Photograph of prehistoric soapstone quarry at Fleur de Lys showing site of removal of preforms from the cliff face.

Fleur de Lys possess an "access zone" along one or more sides. Once a single preform has been removed the deep (15–20 cm) depression of the removal scar acts as one of the sides for the next preform if it is carved from the adjacent soapstone. The preform shapes are variable, but most are oval or subrectangular in the range of 20–25 cm in width and 25–30 cm in length. The outlines of the preform appear to have been carved using a semicircular scraping motion. The scrapers found in the test excavations were fashioned from thin tabular slabs of the hard neighboring bedrock. These "tools" were apparently shaped expeditiously to create an acute edge suitable for scraping the soapstone. After the preform was excavated all around the sides with the scrapers, it was removed by a clean break. There is no evidence of undercutting preforms to facilitate breaking them away from the outcrop. Although the removal method is not known, it may have been facilitated by the accessibility on one side.

Evidence for the next stage of soapstone manufacturing has not been found at Fleur de Lys. No Dorset habitation sites or soapstone processing sites with debitage were found or have been reported. There were very few fragments of partially worked vessel rejects in the tailings below the cliff face, which suggests that secondary reduction took place away from the quarry zones. Thus for information on this stage of manufacture, we must shift north to Komaktorvik, which appears to be a secondary reduction station for the material from the nearby outcrops at Peabody Point. Most of the debitage (78%) and preforms (62%) from Komaktorvik and the other sites in the area have REE patterns that fall within the range found at the Peabody Point outcrop. The debitage, and to a greater extent the preforms, at these sites were not derived exclusively from the Peabody Point outcrops, and some have REE patterns that match closely the patterns found in outcrops at Okak and Napaktok Point (*5*). This observation raises questions regarding the assumption that all manufacturing took place near the outcrops. The presence of nonlocal material may result from one of the following explanations: (1) After extraction and initial preforming, the soapstone can be transported and finished at another site where debitage and/or preform fragments can be deposited far from the quarry; (2) Dorset and later people often repaired and (or) reworked broken soapstone vessels to make them once again serviceable, and in the process they could produce debitage; (3) it is possible that blocks of soapstone or preforms were traded and (or) transported from considerable distances before being finished. In terms of the final explanation, it should be noted that some Dorset lamps are quite small and would not have required a very large piece of soapstone to be carried to a distant habitation site.

Although it is clear that the presence of "exotic" (nonlocal) soapstone will provide the best information about population movements and/or

contacts, the high percentages of local debitage at Peabody Point and Komaktorvik does show predominant use of local resources. Thus it should be possible to postulate that REE patterns for debitage (from sites where high quantities of debitage and preforms are found) represent a nearby "quarry" when none is known. Because we have analyzed only the relationship between Peabody Point and the surrounding sites, we feel that this assumption must be used with due caution.

Now that we have sufficient sampling of many soapstone outcrops, the variability of the trace elements within an outcrop region and among distant outcrops can help us to establish a statistical probability for the nearness of match for soapstone artifacts. While details of this matching will be the subject of a future publication, a few preliminary observations can be made. The most obvious finding is that the majority of the artifacts at a particular site originated from local or nearby outcrops. At Peabody Point, all the artifacts analyzed matched the nearby outcrops. However, in the entire Seven Islands Bay, only 36% of the 49 vessel fragments analyzed matched the Peabody Point outcrop. It should be recognized that these vessel fragments represent not only different geographical locations within the Seven Islands Bay area, but different cultural periods as well. The artifacts and debitage from Peabody Point were all from a late Dorset occupation, but in general the artifacts at other sites are from Pre- or Mid-Dorset times. When looking at the REE patterns for artifacts from this area, there appear to be at least four different sources of soapstone that were utilized but for which we have not sampled the outcrop. Those artifacts that match each other, but for which we have no matching quarry or where the quarry appears to be further south along the coast, tend to group by time period. For example, the six artifacts with one particular pattern are all from Late Dorset sites at Komaktorvik and Big Head.

By knowing the cultural context of an artifact, we will be able to determine the time frame for the utilization of a particular outcrop. Preliminary analysis indicates that the Fleur de Lys quarry was used during earlier Dorset periods, and some matching artifacts are found north along the Labrador coast. Although this is evidence for Dorset utilization of soapstone from Newfoundland (Fleur de Lys), these people apparently only populated the more northern regions of Labrador during the late Dorset (after A.D. 800) period. The one Dorset lamp from this period, which has been found south of the Nain area, was recovered from the suspected Norse (Viking) settlement at L'Anse aux Meadows on the northern tip of Newfoundland. Along with this late Dorset lamp, the most important soapstone artifact from this site was a spindle whorl (*13*). Earlier analysis indicated that this object could have been made from soapstone found at an outcrop within 2 km of the site (*14*). The analysis of a sample of the Dorset lamp, provided through the courtesy of Parks Canada, indicates that it was not made from soapstone found at L'Anse aux Meadows. The best match for this Dorset artifact appears to be from a northern Labrador outcrop at Cape Nuvotannak. This unusual location for a late Dorset artifact from such a distant quarry raises the question of how the lamp came to Newfoundland. Could it have been brought from the northern coast by the Vikings? Single artifact-to-source matches are difficult to interpret, but large-scale studies such as this one can show how raw materials were distributed from sources. These patterns of resource procurement can suggest the mechanisms of distribution.

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