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Aberrant Radiocarbon Dates on an Inuit Arrowhead

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ABSTRACT. Apparently aberrant radiocarbon dates on a Thule culture antler artefact lead to the conclusion that this tool was made of material that was already ancient at the time of manufacture. This finding documents a potential problem in the interpretation of radiocarbon dates on Arctic cultural materials.

Key words: radiocarbon dating, Thule culture, Brooman Point

RÉSUMÉ. Des datations au radiocarbone apparemment aberrantes effectuées sur un objet de la culture Thulé fabriqué en bois d'animal permettent de conclure que cet outil a été fait d'un matériau qui était déjà ancien à l'époque de sa fabrication. Ces résultats documentent un problème potentiel dans l'interprétation de la datation au radiocarbone sur des matériaux culturels de l'Arctique.

Mots clés: datation au radiocarbone, culture Thulé, Brooman Point

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INTRODUCTION

Application of radiocarbon dating to Arctic sites continues to be a matter of concern, as the dates obtained are sometimes inexplicably aberrant and often too old. In a recent informal discussion of the topic at the Canadian Museum of Civilization, one of the authors (McGhee) illustrated the problem with an example from his research. In a study undertaken to improve understanding of the initial movement of ancestral Inuit to Arctic Canada, two samples of caribou antler were submitted to a commercial laboratory for routine radiocarbon dating. Both samples were associated with the occupation of a small habitation feature (House 12) which was thought to be among the first occupied at the Thule culture winter village (QiLd-1) located at Brooman Point, Bathurst Island, in the central High Arctic (McGhee, 1984).

One of the samples, a scrap of cut antler, yielded a conventional radiocarbon age (cf. Stuiver and Polach, 1977) of 590 ± 40 B.P. (Beta-140676; $\delta^{13}C$ = -19.5%). There was nothing unusual about this routine determination, and the stable isotope determination is about as expected. The date itself is consistent both with those obtained during the study from a similar Early Thule culture habitation feature at nearby site QeJu-1 and with the hypothesis of a 13th or 14th century A.D. date for the initial movement of ancestral Inuit from Alaska to Arctic Canada (McGhee, 2000).

The second sample dated was a portion cut from an antler arrowhead; it was selected to preclude potential questions of association between the first sample, which was culturally non-diagnostic, and the Thule culture occupation. The artefact is 184 mm in length, with cylindrical shaft and simple lanceolate blade. The conical tang, which is separated from the shaft by a sloping shoulder, bears an asymmetric, opposed pair of knobs to secure the hafting. The design of the arrowhead is diagnostic of Thule culture affiliation. This form appeared for the first time in the Punuk and Birnirk culture technologies of Alaska during the centuries around A.D. 1000, and it was brought to Arctic Canada shortly thereafter by Thule culture Inuit. The sample removed from the distal portion of the artefact yielded a ^{14}C age of 3220 ± 40 B.P. (Beta 140677; $\delta^{13}C$ = -19.5%).

While there is nothing in this measurement per se to indicate problems, the result pre-dates the earliest known Thule occupation in the area by more than two millennia. A much younger age for the artefact is suggested not only by the stylistic form of the specimen but also by the low elevation of the site above present sea level, which indicates that the arrowhead was deposited at a time much more recent than its radiocarbon age. House 12 at the Brooman Point site lies about 4 m above sea level, at the lower limit of cultural deposits associated with the site. The culturally sterile beaches at lower elevations seem to have emerged during the centuries since site occupation as a result of continuing isostatic rebound. Inland from the site, flights of raised beaches testify to earlier isostatic rebound, at a rate that can be crudely estimated from the associated remains of human occupation. The remnants of Palaeo-Eskimo occupations related to Early Dorset or Independence II cultures, which in other regions are dated to between approximately 2000 and 3000 years ago, lie at elevations of 14 to 15 m above sea level. Early Palaeo-Eskimo occupations, which probably date to between approximately 3500 and 4500 years ago, are found between 20 and 25 m above current sea level.

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Something was drastically wrong with either the measurement itself, the radiocarbon process as applied to the Arctic, or the basic understanding of Thule archaeology. To test these possibilities, Nelson suggested a careful re-dating of the artefact using the Simon Fraser University (SFU) bone dating procedure. As a simple precaution, the new date was taken blind, and Nelson was not given the original result until his own result was in hand. Fortunately, the remaining portion of the arrowhead was more than large enough to provide the small sample needed for the SFU bone dating process.

RE-MEASUREMENT

An examination at the SFU laboratory of the remaining proximal portion of the artefact (Fig. 1a) indicated that either the antler used in making the arrowhead had included some cancellous tissue, or a portion of the artefact had been degraded in some manner since deposition. The remainder of the artefact had the lustrous appearance that is characteristic of well-preserved bone or antler. This possible degradation was especially evident in the cross-section revealed by the original dating process (Fig. 1b). As the original measurement included the portion of the specimen that might have been degraded, the decision was taken to sample an apparently well preserved inner portion. First, the cut surface was cleaned, and then a hemispherical 3 mm diameter hole was milled into the surface of the cut section. The material removed was discarded as potentially contaminated. At the centre of this hemisphere, a 1.5 mm diameter hole was drilled to a depth of 7 mm using a carbide drill bit operated at slow speed (Fig. 1c). These drillings (23 mg) were collected for measurement. For comparison, this process was also used on a sample of fresh antler obtained from a butcher's shop. This simple sampling method provides another qualitative indication of preservation, in that slow-speed drillings from modern or well-preserved ancient bone or antler are flat spirals, reflecting the presence of intact collagen. Poorly preserved bone or antler yields a powder. In this case, the ancient sample obtained (Fig. 1d) was little different from that of the modern antler (Fig. 1e).

The SFU bone dating process is slightly unusual, in that it is designed to extract for measurement the insoluble, high–molecular weight collagen remnants in the specimen. Details of the application to this case are given in Takahashi and Nelson (2001). In short, both modern and ancient samples were decalcified by sonication in 0.25 N HCl, the soluble material was discarded, and the insoluble collagen remnants were rendered soluble by gentle heating for a day or two in a rocking bath of 0.01 N HCl. The behaviour of the two samples during these processes was very similar, although the ancient material took longer to be made soluble.

These solutions were filtered and the insoluble material discarded. The soluble portion was then ultra-filtered to obtain the more than 30 kiloDalton fraction of the remnant collagen, which was lyophilized to dryness. The product was the white, fluffy sponge-like material that is characteristic of the extract thus obtained from intact collagen. For both the ancient and the modern material, the extract yield was about 25% by weight of the sample processed.

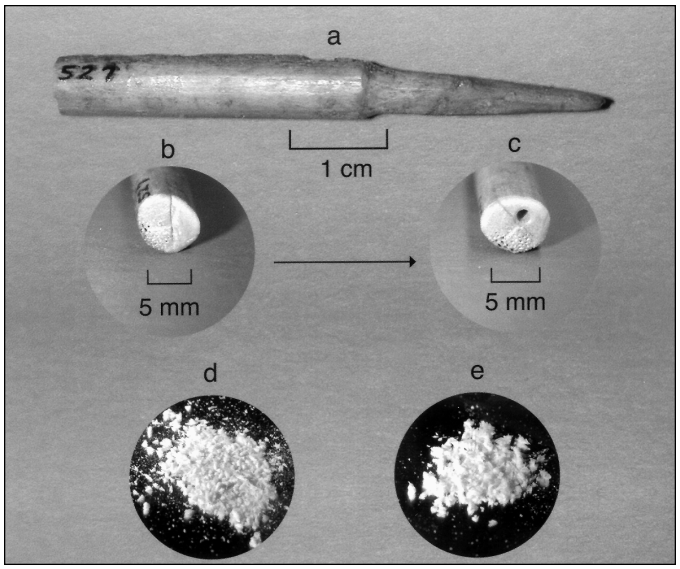

FIG. 1. a) The antler artefact after sampling by the commercial laboratory; b) and c) the exposed section before and after sampling for this re-measurement; d) and e) the materials removed from the artefact and from a modern antler.

A 2.2 mg aliquot of the ancient extract was burned to CO_2 and submitted for AMS radiocarbon determination to the Center for Accelerator Mass Spectrometry (CAMS) at Lawrence Livermore National Laboratory. A second aliquot was submitted for carbon/nitrogen stable isotope and concentration determinations to the Earth and Ocean Sciences Department, University of British Columbia. The results are shown in Table 1.

INTERPRETATION AND CONCLUSION

There is nothing in this re-dating to indicate that this artefact and the material extracted from it for dating are anything other than that expected. The appearance of the artefact itself, the appearance of the drillings, their behaviour under chemical extraction, and the yield of high molecular weight extract do not differ from those of the modern antler. Concentrations of C and N are exactly as expected for well-preserved collagen, as is the C/N ratio. The stable isotope values are very similar to those measured in other studies at the SFU laboratory for ancient caribou bone samples. In short, everything connected to this measurement indicates that the date obtained is reliable, and that it satisfies, in every aspect, the requirements for a conventional radiocarbon age.

The original determination (3220 ± 40 B.P.) is slightly younger, which likely reflects different sample-extraction procedures and differing levels of contaminant elimination.

TABLE 1. Results of the re-measurement of the antler artefact.

Laboratory Nos.	SFU ID:QiLd-1:527; CAMS ID: 74628
Carbon concentration of extract	42%
Nitrogen concentration	15.8%
C/N ratio	2.7
Extract $\delta^{13}C$	-18.9%
Extract $\delta^{15}N$	+1.3%
Radiocarbon age (B.P.)	3340 ± 40 B.P.

While this would be of concern in high-accuracy studies, it is of no significance in this context, in which the discrepancy is measured in millennia, not decades. There remains little doubt that this artefact has a true radiocarbon age of more than 3000 years B.P.

The only plausible explanation for the great discrepancy between the age and the artefact style of this specimen is that the radiocarbon dates obtained reflect the date of growth of the antler on a living animal, and not the making of the arrowhead. This artefact was apparently made from the antler of an animal that had lived some 2500 years earlier than the maker of the arrowhead.

While the use of such old material may seem unlikely, other evidence supports this conclusion. The artefact today, about 700 years after its construction from a 2500 year-old antler, is still in excellent condition and could easily be re-shaped to form a useful arrowhead. Sutcliffe and Blake (2000) document the survival of an antler in natural circumstances for 2000 years in a High Arctic surface environment similar to that at Brooman Point. Although supporting a complex microenvironment of plants and invertebrates, this antler appears to have survived to such a degree that it would still be suitable raw material for the carving of an arrowhead similar to the one made by the Thule culture occupant of the Brooman Point site. Recent measurements of walrus ivory artefactual debris from the Canadian Arctic (P. Sutherland, pers. comm. 2001) indicate that this material is also extremely well preserved in Arctic sites and can be expected to retain its qualities as suitable raw material for artefact production over centuries or millennia.

The arrowhead found at Brooman Point may have been made on an antler scavenged from a long-dead caribou found in nature, or it could have been fashioned from ancient artefactual material taken from a much earlier Palaeo-Eskimo occupation, perhaps that at the local 15 m beach level. Park (1993) has assembled evidence indicating that Thule culture people collected and used artefacts recovered from archaeological deposits, and it seems likely that such deposits could have been used as sources of raw materials as well. However, since local conditions result in rather poor preservation of materials associated with the Palaeo-Eskimo occupation, it seems more likely that the specimen came from a better-preserved deposit at a more distant location.

This example of congruent radiocarbon determinations that are at wide variance with the style of manufacture and depositional environment of a specimen clearly indicates that Inuit artisans used ancient organic materials. Is this an isolated incident, or a reflection of a more common practice? The extent of such use in different times and places must have been determined by the relative availability of contemporary and ancient materials. In most cases, the most visible and best-preserved ancient materials would be a few decades or centuries old when recycled, and radiocarbon dates on these materials would not be as apparently anomalous as those noted in this investigation. This factor would appear to have potential significance for confusing our understanding of Inuit history. It may have contributed to the "sporadic effect or consistent bias towards dates which are earlier than they ought to be" that McGhee (2000:189) notes as a problem in the application of the radiocarbon dating technique to Thule culture materials.

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