The human uses of flint and chert

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Proceedings of the fourth international flint symposium held at Brighton Polytechnic 10–15 April 1983

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CAMBRIDGE UNIVERSITY PRESS

CAMBRIDGE

LONDON NEW YORK NEW ROCHELLE

MELBOURNE SYDNEY

CAMBRIDGE UNIVERSITY PRESS
Cambridge, New York, Melbourne, Madrid, Cape Town,
Singapore, São Paulo, Delhi, Tokyo, Mexico City

Cambridge University Press
The Edinburgh Building, Cambridge CB2 8RU, UK

Published in the United States of America by Cambridge University Press, New York

www.cambridge.org
Information on this title: www.cambridge.org/9780521169165

First published 1987
First paperback edition 2010

A catalogue record for this publication is available from the British Library

Library of Congress Cataloguing in Publication Data
International Flint Symposium (4th: 1983: Brighton
Polytechnic)
The human uses of flint and chert.

Includes index.
1. Flint-Europe-Congresses. 2. Chert-Europe
Congresses. 3. Micropaleontology-Europe-Congresses.
4. Stone implements-Europe-Congresses.
I. Sieveking, G. de G. (Gale de G.) II. Newcomer,
M. H. III. Title.
QE391.Q2I56 1983a 930.1 85-17126

ISBN 978-0-521-26253-8 Hardback
ISBN 978-0-521-16916-5 Paperback

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Cambridge University Press
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Cambridge University Press
978-0-521-16916-5 - The Human Uses of Flint and Chert: Proceedings of the Fourth International Flint Symposium Held at Brighton Polytechnic 10–15 April 1983
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Preface

One of the problems with any expanding field of scholarship is the information explosion: everyone seems to want to get in on the act. This band-waggon effect is especially noticeable at scientific meetings devoted to multi-disciplinary and applied studies. The purpose of such meetings seems to be to communicate and reinforce already achieved success, and to provide a rallying point for current practitioners, rather than to break new ground. A recent meeting of a multi-disciplinary archaeological group had almost 170 registered communications, nearly all applications of fairly standard techniques. This raises the problem in another form: everyone tends to say the same thing at such meetings. The proceedings that result from them, though often including excellent papers, have tended to be unfocussed, to fall apart at the edges. This is because the meeting itself has had no deliberate research aim: no educational purpose, or no built-in strategy for effecting it. An effective meeting requires clearly defined objectives and careful preliminary planning to ensure achievement. This is as true for a large meeting covering several different disciplines as it is for a limited size single-topic invitation-only discussion group.

It was with this in mind that the Brighton meeting of the Flint Symposium was limited to a small number of topical problems in the archaeological and scientific study of flint and chert: some to be discussed by a single well-placed contribution, others to be the subject of a seminar with parallel studies by current practitioners. Focus was also sharpened by commissioning review papers in the different fields.

The International Flint Symposium started in 1969 as a collaborative venture between archaeologists and geologists[1] and the balance between the earth and physical sciences and prehistoric archaeology has since been maintained; each undertaking independent studies as well as collaborative applications of science in the archaeological field. Rather than placing undue emphasis on the producer/user aspect of the science/archaeology relationship, we have tried to act on the advice of the physicist Martin Aitken that, 'the archaeologist should also learn about the aid that his discipline can give to other perfectly respectable branches of academic learning' (Aitken, 1982).

Such aims affected the choice of both scientific and archeological subjects at the Brighton Symposium. For example, it was intended to hold a seminar on microwear analysis of flint tools. To complement this a scientific seminar was organised on the SEM analysis of sand grain surface textures, which uses techniques that closely resemble those employed by microwear archaeologists. On the other hand, as a number of geological studies discussed the distribution of flint and chert, studies of the human dispersal of flint tools were commissioned from archaeologists working in the same geographic region. More generally, it was decided to limit the archaeological topics to techniques and results which lent themselves to the application of science and to those whose methods were those of the laboratory, where experiments were carried out, and measurements taken to validate a hypothesis.

The Proceedings that result from the Brighton Symposium are thus limited to eight subject areas: four scientific and four archaeological. The scientific subject areas are: (1) Cretaceous stratigraphy and its relation to the occurrence and natural distribution of flint and chert; (2) the Quaternary environments of the chalklands and residual flint deposits; (3) Geochemistry and the origin of flint; (4) SEM analysis of quartz and flint surface textures. Archaeological subject areas are: (1) spatial analysis and the dispersal and human transport of flint; (2) Flint mine technology and the exploitation of minor raw material sources; (3) Flint tool replication and the reconstruction of tool manufacturing sequences; (4) Flint tool microwear and surface texture analysis.

For reasons of size, it has been necessary to publish the Proceedings in two separate volumes: the present volume containing studies that are primarily of archaeological interest and a companion volume, *The Scientific Study of Flint and Chert*, which contains papers attributed to the first four subject areas. This splits the Symposium papers quite arbitrarily. Many participants have contributed, at least in part, to both volumes, as commissioned scientific review papers deal with aspects of particular archaeological significance and others describing scientific techniques occur under science, while their research applications are published here under archaeology. Such is the case with heat treatment (Griffiths *et al.*, this volume) flint microstructure (Bradley and Clayton, this volume) River gravels (Harding *et al.*, this volume) and also with the papers already mentioned dealing with flint dispersal and exchange in Eastern Europe. In these and other cases, the archaeological papers stand on their own feet and reference to the science volume is only necessary for those who wish to follow up some point of detail or science on which they are based.

[1] See preface to companion volume.

The subject areas covered in this volume are those in which research is active. Stimulated by the discovery of reliable scientific methods of identifying lithic sources, trade and exchange in their products has been a principal research area in America and the Near East for more than a decade. In Europe, flint mine research revived from the slumber that overtook it in the 1930s and has made considerable progress since the first Flint Symposium in 1969. (cf. Weisgerber *et al.*, 1980) Flint tool replication and refitting, and microwear research are subjects that have more recently achieved or regained popularity among specialists, and the application of mathematical models of spatial analysis to archaeological debris is another relatively recent development. Published monographs and collections of research papers exist in all subject areas. However, archaeological studies have further advanced since these appeared and we are able to include papers representing many different aspects of present research including a number of highly innovatory contributions. While this is primarily due to the Symposium's tactical role as a centre of inter-disciplinary discussion,[2] the proceedings have also been strengthened by additional papers, exploring avenues of research that seemed particularly promising at the Brighton meeting.

In spatial analysis, flint dispersal, and also in reconstruction of flint tool manufacturing sequences, our American colleagues have produced particularly forward looking studies. Larick's paper on the circulation of Solutrean points breaks new ground in a particularly simple and satisfying way, using classic geological stratigraphy to provide the first comprehensible model for a European Palaeolithic flint dispersal system. His use of the knapping qualities of different types of raw material and of the relationship between the distribution of raw material and that of living sites to build up a model of a small-scale economic system, should interest everyone studying the interaction of Pleistocene hunter-gather communities.

In the same spatial analysis field, both Zeitlin and Ammerman and co-workers give descriptions of newly developed techniques that are likely to be widely used in the future. The archaeological adaptation of the *k*-means analysis technique, earlier versions of which have been described elsewhere, should appeal to all field archaeologists, since it offers for the first time an opportunity to use field-data in a common-sense way to correct and amplify a distribution pattern formed by a mathematical spatial analysis model.

In the flint dispersal field also, Griffiths and Woodman publish a first application of a new technique for identifying chert sources and in addition there is an important summary by Barfield of the North Italian evidence, drawing attention to the different value placed by prehistoric communities upon the varying qualities of different lithic sources, to which attention is also drawn by Larick and by Burton. On the broader regional canvas, we are fortunate in being able to publish a further magisterial study by Sherratt of European Neolithic exchange systems, on this occasion confirmed and amplified by geological and archaeological studies by our East European colleagues (Lech; Schild, this volume; Takács-Biró, companion volume). Finally both Miller and Smolla (*inter-alia*) draw attention to limitations on the long-distance transport of lithic raw materials, in part based on calculations from original data of the load to be carried on the back of a single porter.

[2] Cf. Sieveking 1975.

One of the educational functions of the proceedings is to provide English language translations of work that would otherwise appear only as continental publications, unavailable to the reader. This is true both of the papers by Schild and Lech, though both are substantially unpublished, and also of the two valuable papers by Weisgerber, which are preliminary reports of field surveys that are intended to be published more fully in Germany. Weisgerber's paper on the Egyptian Chert Mines at Wadi El Sheikh is particularly important, since the prehistoric industrial remains at this site are so much better preserved than at any other mine complex so far recorded.

Both this site and the South Swedish flint mines discussed by Rudebeck are also interesting for the evidence they provide of the continuation of large-scale mining for chert well into the copper- and bronze-using period. Rudebeck, in particular, suggests that the same site was in use, with similar or identical mining techniques, by groups of different cultural origins over a period of more than a thousand years. While this would have occasioned no remark in the days of the Campignian hypothesis, it is surprising now that short-term radiocarbon dated flint mines, associated with not more than one cultural group, appear to be the rule in Western Europe (Smolla, this volume; Burleigh 1979).

Weisgerber in Egypt and Mercer in Dorset[3] both draw attention to the existence of different types of surface quarrying that are alternative mining strategies to the shaft and gallery mines, and it is good to learn from these authors that we are beginning to move away from the technological fallacy to the realisation that the approach adopted is controlled not only by geological considerations but also by labour supply.

In the field of experimental archaeology, the collected papers concentrate on the manufacture of flint tools and the reconstruction of manufacturing sequences and the other purposes for which stone artefacts, originally from the same blocks of raw material, may be re-assembled. A good summary of previous work on the re-fitting field is provided by Cahen; and two papers by Marks and Volkman and by Bergman and co-workers immediately provide valuable examples of additional uses to which the technique can be put, and which Cahan does not fully take into account.

Due to the bias in favour of techniques and technology in the present volume, the last-mentioned papers are perhaps the only ones we publish where classic Upper Palaeolithic flint typology is mentioned at all seriously, and between them they brilliantly expose its limitations; Marks and

[3] Surface features and trial pits described by Mercer are known at large scale flint mines in England, e.g. Grimes' Graves (Sieveking 1979), and in Eastern Europe.

Volkman, in particular, use the re-fitting technique as a small-scale site experiment to demonstrate the weakness of our present models of the development of Middle and Upper Palaeolithic flint technology, in a way that commands wholehearted attention.

Two further experimental archaeology papers, with which Harding's name is associated, emphasise the importance of the prehistorians measurement of activity-times. In the case of the manufacture of the stone axe, Harding brings to our attention how long is spent on the cosmetic treatment[4] that produces the final ground or polished surface (say 20–30 hours), as opposed to the short period of time (say 20–30 minutes) required to complete the first part of the shaping procedure that provides a fully formed flaked stone axe blade hardly less efficient than the final product. In this connection, attention may be drawn to the difference between the times Harding has recorded for the two operations and those put forward in some recently published Danish experiments, where times of between 1 hour 48 minutes and 2 hours 15 minutes were recorded for the preparation of six thin butted flint axes *up to the point where they were ready for polishing* (Hanson and Madson 1983, pp. 50–1: experiments III and IV).

Harding's times for producing flaked axes with a lenticular cross-section are supported by a long series of carefully controlled experiments (Newcomer and Sieveking 1980: average time 20 min). Though Danish thin-butted axes may be more difficult to make, can they really take four to six times as long to produce? It seems more likely that the contrast between British and Danish manufacturing times is due partly to the adoption of more deliberate production procedures, and the variation between the times recorded in the Danish experiments to the relative skills of different operators.[5]

An equally salutory time and motion study is provided by Harding and co-workers, who demonstrate, in a carefully controlled experiment, that flint hand axes may be transported considerable distances down river and change in appearance from a fresh to a considerably worn condition (in an environment fully comparable to that of British rivers during the Pleistocene), as a result of a handful of small-scale floods, each perhaps lasting not more than a few hours, taking place during a single annual season. The evidence of these experiments, which is borne out by similar flood records (Williams, companion volume, p. 163), would have greatly surprised those who less than a generation ago suggested, in classic accounts of hand axe deposition in river gravels, that a similar degree of abrasion to that recorded on the hand axes in this experiment, were the result of thousands of years of transport in a torrential Pleistocene river environment.

Two general approaches exist in microwear analysis: the study of surface abrasion and edge damage and the study of supposedly additive surface polishes.[6] In our microwear seminar Akoshima is the only contributor to devote a paper wholely to the recognised results of abrasion. *Microflaking Quantification* describes a developed laboratory technique for characterising and recording microflake scars, whose adoption should make possible comparison of data collected by different research workers. Such techniques are badly needed to describe systematically the large amount of potential data in this field (see Bull, companion volume).

The wear trace papers, in the main, are devoted to the discussion of data provided by microwear polishes. The recent development of polish studies is described by Cook and Dumont. We may summarise by saying that, since the appearance of experimental evidence suggesting that different types of microwear polish, such as wood polish, bone polish, hide polish and meat polish, can be recognised and the publication by Keeley of a number of papers and a monograph detailing his results in this field,[7] more than a few researchers have trained themselves in his techniques and papers and doctoral theses dealing with its application to archaeological sites have begun to appear in some numbers.

Several recent conferences have detailed these results. Keeley's procedure involves the use of high-power stereoscopic microscopy to recognise features thought to be characteristic of each type of polish (the 'high-power school', as opposed to the 'low-power school' of abrasion studies mentioned by Akoshima). The type of polish is identified by the experienced observer under the microscope, by comparison with typical specimens of polish of known origin. Polishes are poorly defined by conventional incident light photomicrography, so that no satisfactory objective record is obtained except in extreme (i.e. 'typical') cases. This has meant that each observer has had to rely on his own skill and experience to determine the boundary between polishes held to be characteristic of certain contact materials. The unsatisfactory nature of the recording procedure has attracted increasing attention, leading to the development of alternative methods of polish characterisation by interferometry (Cook and Dumont, 54; Dumont, Fig. 12.1, this volume) and image processing (Grace *et al.*, this volume).

The papers in this volume appear at a climacteric period in microwear polish studies, when the re-definition of this form of research is under way, though conventional polish identification is still undertaken. All our contributors show signs of this change in emphasis. The two microwear site reports include conventional polish identification with other types of evidence, but concentrate on an all-round

[4] Olaussen's suggestion (1982,62) that polishing strengthens the body and the blade of the axe against the risk of fracture is not substantiated. The well-known experiments suggesting that a polished flint axe is more efficient than a flaked axe as a tool for felling young trees, relate to the efficiency of the axe blade, and do not explain the presence of overall polish. In any case the experimental results are unconvincing (for bibliography, see Harding, this volume; Olaussen 1982; also Steensberg 1979); supposed differences in efficiency between the two tool types, as measured by comparative speed of tree felling, are likely to be due to experimental error.

[5] The production technique is relatively simple and production times for skilled operatives making thin-butted axes on a routine basis should not vary by more than 10 minutes.

[6] Though theoretically possible, additive polishes have not been demonstrated satisfactorily and certain well developed forms of polish, e.g. sickle gloss, appear to be due to abrasion (cf. Meeks *et al*, 1982. 336ff).

[7] Newcomer & Keeley 1977; Keeley 1980; see Cook and Dumont, this volume for additional bibliography.

examination of tool classes. Dumont discusses the number of use-episodes that can be identified on tools of different types and the interpretation of polish and abrasion traces in terms of different types of hafting and tool-use. Vaughan's Palaeolithic cave site report discusses the utilised zones shown by microwear traces on Palaeolithic scrapers, but also pays attention to the identification of (microwear) activity areas in the cave and to the percentage of the total assemblage in a single occupation level to show traces of use, an approach seldom applied since it was introduced by McBurney (1968).

The three remaining contributors in the microwear field discuss matters relating to the characterisation of contact polishes. Two independent contributions study variation of flint surface textures and its effect on polish formation. In the first paper, Bradley and Clayton demonstrate considerable variation in the microstructure of different Cretaceous chalk flint sources and show how this can affect the appearance of contact polishes. In the second paper, Holmes compares the surface microtopography of Brandon (Norfolk) flint with that of fine quality Egyptian chert and shows how polish formation varies with changes in surface texture. She also discusses post-depositional surface effects that resemble contact polishes. The authors conclude that variation in microstructure affects the rate of polish formation and the final appearance of some contact polishes: such poorly developed polishes may not exhibit features considered typical of contact materials.

Two final discussion papers (by members of the same research team) consider the development and application of an objective method of polish characterisation by image processing and compare results obtained by these means with those obtained by experienced specialists using Keeley's identification techniques. The first paper, by Grace, and Co-workers and delivered at the 1983 Flint Symposium, is a detailed description of the application of image processing to the characterisation of microwear polish textures, giving an explanation of the data provided by the new technique and some preliminary results illustrating its application. The second paper (Newcomer *et al*) is a report on a subsequent stage of the research, incorporating a modification of the technique itself and a summary of a series of detailed experiments on contact materials. A group of experienced microwear analysts each identify a series of 'unknown' contact polishes, exhibiting considerable operator variance in their results. Texture analysis of the same experimentally produced contact polishes shows, in this instance, that polishes produced by a single type of contact material such as wood or bone exhibit considerable variations, and in certain cases are indistinguishable from each other by this technique.

It is clear to anyone reading this paper that the identification of contact polishes is a great deal more difficult than has been assumed in the past, and that microwear analysts simply do not have sufficiently good control material at present to identify polishes on a routine basis. As a preliminary hypothesis we may accept, as do the authors of the paper, that there is likely to be a close resemblance between polishes produced by contact with material of similar consistency: 'soft' materials such as hide and meat; 'hard' materials such as wood and bone. There may still be architypical well-developed polishes, where more exact identifications are possible, as Keeley's research suggests, but this is something that will have to be demonstrated.

This conclusion will come as a disappointment to many who had pinned their hopes on the original technique. But it should not be concluded that the study of microwear polishes is necessarily a blind alley; merely that further research is needed to establish the value of the data it produces.

In fact, the difficulties that have been encountered in this field are not unique, but typical of such fields of study, where human skill is used for exact measurement and reference criteria are imperfect or lacking. The adoption of the SEM in the biological and earth sciences more than 15 years ago, opened up many new fields of investigation, where similar problems are still unsolved. (Bull, companion volume: introduction). As has been said by another investigator 'the discrimination that the human brain can achieve is not constant (on different occasions) . . . nor indeed is it constant for different people' (Whalley and Orford, companion volume: introduction). The solution plainly lies in some form of objective control of the data, in microwear studies as well as in other forms of microscopy.

Chalk flint and other forms of chert have been used by modern man and other hominids for millions of years; they are one of the most long-lived and widespread of all human raw materials for tool makers and the words 'flint tools' are often used more generally as a synonym for stone implements for many different rocks, as well as for those of other varieties of chert. In this book we discuss four unique aspects of these rocks related to their use by man: their characteristics as tool making materials; their location and extraction from natural deposits; their dispersal to their eventual owners; and their use and abandonment. Research in all these fields is continuing and the cover provided by this book is necessarily incomplete: the part has to stand for the whole.

A few years ago a materials scientist from Nasa came to my office with a request for a few kilos of Brandon Flint, to build into the nose-cone of a spacecraft for protective purposes. So far I have received no report on the results of this venture. But it reminds us that the scientific investigation of the properties of chert and the archaeological study of its use may still have some way to go.

Bibliography

Aitken, M. J. (1982). 'Archaeometry does not only serve archaeology'. In: *Future Directions in Archaeometry* (ed. J. S. Olin). Smithsonian Institution, Washington, DC.

Burleigh, R. (1979). 'Radiocarbon dates for flint mining': In *Proceedings of the Third International Symposium on Flint 24–27 May 1979*. *Staringia*, **5**, 45–6 Oldenzaal.

Hanson, P. V. & Madson, B. (1983). 'Flint axe manufacture in the Neolithic'. *J. Danish Archaeology*, **2**, 43–59.

Keeley, L. H. (1980). *Experimental Determination of Stone Tool Uses: a Microwear Analysis*. University of Chicago Press, Chicago.

Keeley, L. H. & Newcomer M. H., (1977). 'Microwear analysis of experimental flint tools: a test case'. *J. Arch. Sc.*, **4**, 29–62.

McBurney, C. B. M. (1968). 'The cave of Ali-Tappeh and the Epipalaeolithic in North Eastern Iran'. *Proc. Prehist. Soc.*, **34**, 385–413.

Meeks, N. D., Sieveking, G. de G., Tite, M. S. & Cook, J. (1982). 'Gloss and use wear traces on flint sickles and similar phenomena'. *J. Arch. Sc.*, **9**, 317–40.

Newcomer, M. H. & Sieveking, G. de G. (1980). 'Experimental flake scatter-patterns: a new interpretive technique'. *J. Field, Archaeology*, **7**, 345–52.

Olaussen, D. S., (1982). 'Lithic technological analysis of the thin-butted flint axe'. *Acta Archaeologica*, **53**, 1–87.

Sieveking, G. de G., (1975). 'The second Maastricht International Flint Symposium: results and conclusions'. In: *Proceedings of the Second Internaitonal Symposium on Flint 8–11 May 1975.* Maastricht (Ed. E. F. G. Engelen). *Staringia*, **3**, 86–7. Oldenzaal.

Sieveking, G. de G. (1979). 'Grimes Graves and European flint mining'. In: *Subterranean Britain* (ed. H. Crawford), pp. 1–43.

Steensberg, A., (1979). *Draved. An Experiment in Stone Age Agriculture*. National Museum, Copenhagen.

Weisgerber, G., Slotta, R. & Weiner, J. (eds.) (1980). *5000 Jahre Feuersteinbergbau*. Veroffenlichungen aus dem Bergbau-Museum, **22**, Bochum.