NOTICE OF ORDINARY MEETING

The next meeting will be held in the Museum Education Building, North Terrace, Adelaide
at
8.00 p.m. on Monday 25 March 1974

AGENDA

1. Apologies.

2. Minutes of Meeting held 29th October, 1973 circulated to members in Journal Vol. 11 No. 9 to be confirmed.

3. Tabling of Papers and Journals.

4. MR. TOM ERNST, Lecturer in Anthropology, Adelaide University will give an address entitled -

"ASPECTS OF RITUAL AND SELF DECORATION OF THE ONABUSULU, A PEOPLE OF THE SOUTHERN HIGHLANDS."

5. The next meeting will be Monday 22nd April, 1974.
MR. H. MORPHY will address the meeting in April on "BARK PAINTINGS".

V. A. TOLCHER,
Honorary Secretary,
213 Greenhill Road,
EASTWOOD, S.A. 5063
WHAT CAN PHYSICS CONTRIBUTE TO ARCHAEOLOGY

by

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Archaeology seeks a reconstruction of past developments in human culture by studying what man has left behind. Whilst it covers all ages, the most interesting discoveries precede the written word - as in Australia.

The common man's impression of Archaeology and archaeologists is probably limited to digging and related activities. He may possibly be aware of the importance of establishing time sequences and chronology. He is less likely to be familiar with the systematic study and classification of human artifacts and the inferences to be drawn from them. He is most unlikely to be aware of the contribution that the more formal sciences such as Physics can make to such a discipline. It is the purpose of the present contribution to give some idea about what Physics can do to help advance the science of Archaeology.

Archaeological Sites

Since the material in which the archaeologist is interested is almost invariably buried beneath the ground and recoverable only by painstaking excavation, advice from the physicist had been sought as to means whereby promising sites can be located and where particular searches should be made within known sites.

The electrical resistance of soil depends upon its composition and water content; the presence of a brick wall (which conducts electricity poorly) or a former ditch, now filled in but damp with respect to its surroundings, (which has a lower resistance than normal) can be found by a systematic survey of electrical resistance between points on a grid located over the area in question. Anomalous results over walls and ditches are also found using instruments designed to measure very small local changes in the earth's magnetic field which is modified slightly by man's activities. It is possible nowadays to feed the results of such surveys into a computer and to have the computer produce a complete map of the areas surveyed in as much detail as required. It is most instructive to compare maps obtained in such surveys with the results of excavations, such as have been performed at Cadbury Castle in Somerset (the legendary Camelot) or e.g. with aerial photographs of iron-age forts in the Rhineland of Germany.

Dr. Aitken of the University of Oxford has used the magnetic survey method for locating buried pottery kilns. In this case the high temperature generated in the kiln by the firing process changes the magnetic properties of the material of which it is made (and also the pots that were baked in it) and this creates a small anomalous region around the kiln where the normal magnetic field due to the earth is slightly changed. Although these changes are small they can be readily detected with suitable instruments.

Dating

Almost all archaeological problems include, in some form or other, the question "how long ago did this happen?" Physics has made some notable
contributions towards resolving problems or chronology. Perhaps the best known of these is the use of radio-carbon, a discovery for which Dr. Libby received the Nobel Prize. Together with other dating methods, the radio-carbon method depends upon a natural radio-active "clock". Some naturally occurring atoms are unstable and change to a different form at an unvarying rate. In the process of re-arrangement the atom emits radio-active radiations which can be monitored and used for determining the rate of decay. In the case of radio-carbon, half of a sample of atoms decays in 5,730 years, one half of the remainder in a further 5,730 years and so on. Living creatures continually incorporate carbon from the atmosphere into their systems through the food chain and while they are alive, the proportion of radio-active carbon in their system remains constant. On death, however, this exchange ceases and the amount of radio-carbon present decreases from the time of death. By measuring the fraction remaining in a sample the physicist can tell how long it was since the sample was alive. By this means it has been demonstrated that man was in Australia, in the region of Lake Mungo in New South Wales, as long as 30,000 years ago. In the old world, radio-active carbon dating has established the age of the various stages in which Stonehenge was built and shown that a hypothetical connection between Mycenae and Stonehenge could not have taken place. In recent years the discovery of bristlecone pines in the Sierra Mountains of the United States with ages of the order of a thousand years and with existing samples of substantially greater age has provided a means of checking radio-carbon dates by comparing the numbers found in the laboratory with dates obtained by counting tree rings.

Thermoluminescent dating can be used on samples that do not contain carbon. This has only recently been tried in Australia and a small exploratory programme has begun in the Physics Department at the University of Adelaide. The details of this method are rather technical but the general principles can be understood readily enough; a piece of pottery, say, may contain small amounts of sand in the form of minute quartz crystals. Over a long period of time such crystals are able to store a proportion of the energy that they may receive from natural background radiation in their environment. On heating to a sufficiently high temperature this stored energy is released, primarily in the form of visible light. The amount of this light can be measured, to give an indication of the length of time that the sample had been exposed to the background radiation since it was last heated. In the case of a pot or fireplace we can therefore tell how long ago that heating was. While the method is still not as accurate as some others, it has been very useful when precision is not necessary. For example, it has confirmed the radio-carbon results that the earliest fired clay artifacts yet found anywhere were made about 30,000 years ago. The technique is also very useful for authenticity testing. Thus, a recent fake would have had no time to acquire any stored energy such as shown by the genuine article. In this way a recent survey of 66 allegedly neolithic items from Hacilar showed that 47 were fakes.

Techniques for Physical Examination

Physics is able to provide a variety of methods for analysis of archaeological materials. These have been very useful in determining where materials came from, how and where they were traded, and they have often given useful information about the skills of ancient artisans.

A sample of obsidian from a certain location will be distinguishable from a sample obtained from somewhere else by reason of the relative proportions of certain elements in it as revealed by spectral analysis, that is, by the colour of the light emitted when it is placed in a flame or arc. In this way it has been possible to classify paleolithic obsidian objects made in the Near East some 9,000 years ago and in many cases to determine the actual site from which the material originally came. Once the original site of origin
is known it is possible to study the pattern of sites where the objects were found. It was found in one case that the material is found more-or-less uniformly distributed for about 200 kilometres around the primary site but then with increasing rarity for distances up to 1,000 kilometres. This implies that the material was actively traded in the 200 kilometres circle nearest the source but reached the larger distances only by casual exchange.

Each chemical element has a characteristic X-ray spectrum and this can be used for identifying materials, particularly in those cases where optical spectroscopy is unsuitable. X-ray analysis shows that Minoan artisans, three and a half thousand years ago, had discovered how to bond silver to copper. This implies a very close control over temperature in the forges where this was done and is all the more surprising when one recognises that the process is properly supposed to have been discovered by Bolsover in 1743 when he introduced "Sheffield plate".

Neutron activation analysis, in which a sample is exposed in a nuclear reactor to a high intensity of neutrons, gives an alternative method of analysis, particularly suitable for the determination of extremely small quantities of particular elements. This method of analysis has been used for example, to study the silver content of Greek coins in the 5th Century B.C. The percentage of silver in the coins is found to reflect the political changes that took place at that time, presumably as succeeding governments had a greater or lesser requirement for money. The analysis also shows that the metallurgists of the time were capable of controlling the relative proportions of copper and silver in the coinage to within a percent or so. As a different and perhaps slightly macabre example, one might quote the analysis of the silver concentration in English silver pennies minted during the 11th and 12th Centuries. In the reign of Henry I there is documentary evidence to suggest suspected debasement and forgery of the coinage. In 1124 A.D. Henry I summoned moneys from all over England to Winchester where they were deprived of their right hands and their testicles; this brutal mutilation was justified on the grounds that they had fraudulently debased the coinage and caused a collapse of confidence. X-ray analysis of coins from this period show that there is no significant difference between coins minted before 1124 and those minted after (when the moneys might have been expected to be considerably more careful about maintaining the percentage of silver).

Perhaps one might finally mention the recent studies of Stonehenge and similar stone structures throughout northern Europe. It has long been known that these structures are oriental on astronomical fixed points such as the summer and winter solstices, the rising and setting of the moon, and so on. By the use of computerised analysis and by calculating back to the appearance of the sky at the time of the building of these structures, it has been possible to infer, at least to some extent, how much geometry was known to their builders and there is sufficient evidence to convince some people that the builders of Stonehenge were not only able to predict eclipses but used their structures as a computer for doing so.