The third assumption is that the carbon of the sample was 'Recent' carbon at the time when the specimen became an object of archæological interest. This assumption may be erroneous in two very different respects. First, the material may have been old at the time when it was used. For example, wood, when made into an article by man, is not necessarily quite recent. Thus it is well known from the ring-counts carried out by Dr. Douglass and his collaborators in the south-western United States that beams, sometimes hundreds of years old, were used again and again in the construction of Indian pueblos. The use of old wood must have been very common in countries where this raw material was relatively scarce.

On the other hand, although the raw material may have been quite 'recent' at the time of its becoming an archæological specimen, the carbon of which it is composed need not always be 'recent' carbon of that time. It will almost certainly be nothing but 'recent' carbon in the case of vegetable matter, since plants derive their carbon from the atmospheric carbon dioxide. Molluscan shells, however, are a different matter. As they are often available in quantities in archæological sites, their calcium carbonate affords a good source of carbon for investigation. But it is not certain whether the isotopic constitution of such carbon corresponds to that of the atmosphere when the mollusc was alive. It may have taken up carbonates, for example, from Palæozoic limestone, and incorporated it in its shell. This adds a complication to the use of carbonates. In addition to the possibility of selective intake of carbon-14, as suggested by Nier's discovery of the favoured intake of carbon-13 in the formation of carbonates, very little is known about the processes of building up of molluscan shells. A special investigation may become necessary if the use of carbonates for carbon-14 age estimates is to be developed.

The ordinary method is restricted to the last 20,000 years, which can be extended to the maximum of 30,000 years by enriching in a thermal diffusion column[1]. It is virtually limited to the Late Palæolithic, Mesolithic, Neolithic and Bronze Age periods. Physicists are actively improving their apparatus and refining the analytical technique. According to Dr. Oakley's report, one of the troubles encountered by Drs. Libby and Arnold is the difficulty of removing completely the magnesium oxide from the carbon after its reduction from carbon dioxide. It has been solved for the time being by making a correction for unremoved magnesium oxide. It is, however, urgently necessary to study also the geological and prehistoric aspects of the method in order to eliminate the sources of error involved in the sampling. New developments may well emerge from such work. Thus, the use of flotation methods for the recovery of finely divided carbon from prehistoric hearths and occupation layers had been suggested, and Dr. Oakley stated that American workers have had some success using zinc chloride.

In spite of its limitations and difficulties, the carbon-14 method of dating promises to settle many outstanding chronological problems, such as the beginning of food production, and the first colonization of America. Some of these were discussed at the Viking Fund Seminar in Physical Anthropology held in June in New York, at which Dr. Oakley was present. The last (Mankato) advance of the Wisconsin glaciation passed over tree trunks the age of which by the carbon-14 method is of the order of eleven thousand years, that is, less than half the age expected by geologists. This is the time when man is believed to have first appeared in North America. Dates from occupation sites in the western United States are of the order of 7–10,000 years. In the eastern United States, the earliest cultures are proving to be later than in the west. Carbon-14 dates suggest that man spread there about five thousand years ago.

Check samples from sites in Egypt and Syria dated by historical evidence have produced satisfactory results[6]. Dr. Braidwood, of the Oriental Institute of the University of Chicago, has great hopes that the carbon-14 method will help in the dating of the appearance of agriculture in the Near and Middle East[7]. At the recent Zurich session of the International Congress of Prehistoric and Protohistoric Sciences, Braidwood reported on some preliminary results based on carbon-14 determinations, which seem to confirm the beginning of the First Dynasty of Egypt at about 3000 B.C., and that primitive agriculture was already being practised in the Kurdish hills at about 5000 B.C. F. E. ZEUNER

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LANDSCAPE EVOLUTION IN GREAT BRITAIN

AMONG the discussions at the Birmingham meeting of the British Association was one carried on by geographers and geologists (Sections E and C) on "The Pre-Glacial Evolution of the British Land Surface". This topic is one of real importance to both groups of workers. To the geographer seeking an explanation of the complex relationships which obtain between the different elements of the physical and cultural landscapes of his own country, some understanding of the stages by which the former developed is vital. The key to the role and relationships of soils, surface forms and ground-water conditions in the present landscape lies often in the phases of its past evolution. To the geologist concerned with elucidating the geological history of Britain, the record of the evolution of the land surface is a chapter which should not be ignored. Yet ignored or overlooked it certainly has been. Only in the volcanic districts of Antrim and the Hebrides in the north-west, and in East Anglia and the London and Hampshire Basins in the south-east, is there direct stratigraphical witness as to what was going on in Britain in Tertiary time, and geologists have therefore devoted themselves to the task of piecing together the record of earlier phases of our palæo-geography from the rich records of the Palæozoic and Mesozoic successions, or have devoted themselves to the complexities of the glacial, interglacial and post-glacial successions. As Prof. S. W. Wooldridge remarked in the course of his presidential address to Section E, "by a combination of physical chance and human perversity the Tertiary era has almost become a

neglected 'Dark Age' in the geological history of Britain". A joint discussion of geologists and geographers intended to throw light on the problems of this 'Dark Age'—which the radioactive clock tells us was sixty-five or seventy million years long—is therefore greatly to be welcomed, and if the lamps held up at Birmingham cannot be said to have cast their light very far into its depths, it is certain that their beams are turned in the right direction.

Geomorphology offers two contrasted and complementary lines of approach to the problem, namely, by the elucidation of denudation chronology and by the reconstruction of the original pattern of our drainage system. The latter is possible at all only by virtue of the fact that when a new cycle of erosion begins as the result of general uplift, the landscape inherits the rivers of the previous cycle unless these have been extinguished by a marine transgression. Not all the rivers so inherited will survive long, and not all of them belonged to the initial drainage pattern. But some of our present-day rivers may be older than any feature of our present land-surface, and in applying this method to the Midland region of Great Britain (in a very wide sense of that term) Prof. D. L. Linton made this claim for the North Welsh Dee where it crosses the Berwyn Hills, and for the south-flowing streams of the southern Pennines and notably the Derbyshire Derwent. From these and other surviving remnants he reconstructed a Proto-Trent, with headwaters as far west as Snowdonia, which flowed eastwards across the North Midlands receiving the Derwent and its analogues as left-hand tributaries, and the ancestors of the present north-flowing Penk, Tame and Soar from the right, and flowed into the North Sea beyond the site of the Wash. An east–west watershed, he argued, bounded this system from that of a comparable proto-Thames to the south, also carrying Welsh water to the North Sea, while to the north other workers have stressed the importance of the east-flowing element in the original drainage of Yorkshire, Durham and Northumberland, and even beyond the Border.

Later work in many parts of Britain will be necessary to establish such a reconstruction and to give it precision; but if it be allowed that the general pattern of our earliest rivers is being revealed, it becomes clear that the movements that brought it into existence comprised a widespread, though not uncomplicated, tilting from west to east. Prof. Linton would identify this movement with those known to have upraised the Chalk before the deposition of the basal Eocene strata of the London Basin, and if he is correct some new light is thrown on the earliest episodes in our Dark Age.

The later phases are better illumined by tracing the remnants of former valley floors or of base-levelled surfaces of wider extent. Such work must needs be detailed and precise, and therefore local, and the interim results of work being carried on in three widely separated areas—Exmoor, County Clare and the Derby–Staffordshire border—were presented by Mr. W. G. V. Balchin, Dr. Marjorie M. Sweeting and Mr. G. T. Warwick. Each has recognized a series of landscape features corresponding to periods of stillstand and has designated those periods by a non-committal local terminology. The question of correlating the stillstands of one region with those elsewhere had already been taken as far as it can profitably be taken at present by Prof. Wooldridge in his presidential address, and it was therefore not pursued. But a point that was taken up in general discussion concerned the question whether the surfaces at higher levels are marine or sub-aerial. Mr. Warwick's succession of inland stages is wholly sub-aerial, and Dr. Sweeting's partly so; Mr. Balchin's stages at comparable altitudes are all marine and regarded as successive strand-flats cut during the discontinuous emergence of south-western England from the sea. If this emergence is regarded, as it is by Mr. Balchin, as being due to a succession of eustatic drops in sea-level, a somewhat wholesale late-Tertiary submergence of the English lowland would seem to be implied—a conclusion not in accord with the drainage reconstructions so far made. The eustatic hypothesis is attractive, and by its aid some correlations at the lower levels—say, up to 650 ft. or 200 metres—seem to be in sight; but at higher levels the possibility of tilting of the older surfaces must be borne in mind. Prof. Dudley Stamp, in one of his now rare utterances as a geologist, underlined this point and urged the growing band of younger British geomorphologists to supplement the record of their own observed stages of erosion by the depositional record provided by the late-Tertiary succession of Holland. That record is one which implies warping or tilting of the areas to the west and south from which the deposited material came. It was fitting that the last and youngest contributor to the discussion—Miss Alice Coleman—should announce that work she is completing in East Kent displays evidence in the uniclinal shifting of the Stour and, by the discrepancies in altitude between the Kentish succession of stillstands and those worked out for the South Downs by Mr. B. W. Sparks, of eastward tilting during even the latest phases of landscape evolution.

It is evident that in this field of common interest to geologists and geographers a good deal of work is being done, chiefly at the moment by the geographers; and that as the body of evidence derived from the field-work grows, it will demand for its proper interpretation the experience and imagination of some of the best minds in both subjects. This joint discussion made a not inauspicious beginning.

D. L. Linton

NEW DISCOVERIES OF THE AUSTRALOPITHECINÆ

In 1946 there appeared a memoir of the Transvaal Museum by Dr. R. Broom and Dr. G. W. H. Schepers, in which were described the fossil remains of the Australopithecinæ discovered up to that date at Taungs, Sterkfontein and Kromdraai. In 1947 Dr. Broom, continuing his indefatigable search in the stalagmitic deposits at Sterkfontein, came upon a site which proved to be astonishingly rich in the remains of the Australopithecine group to which he had given the generic name *Plesianthropus*. A further memoir* provides a description of these new discoveries. The description, abundantly illustrated, is not intended to be more than a general account. Indeed, there is now so much material available for study that some years are bound to elapse before it can all be subjected to a complete analysis. Nevertheless, this preliminary

* Transvaal Museum Memoir No. 4. Part 1: Further Evidence of the Structure of the Sterkfontein Ape-Man *Plesianthropus*. Part 2: The Brain Casts of the recently discovered *Plesianthropus* Skulls. By Robert Broom, J. T. Robinson and G. W. H. Schepers. Pp. 117+8 pl. (Pretoria: Transvaal Museum, 1950.)