of the AB-grains in the same condition is the reverse. This self-reversal of thermo-remanent magnetization takes place even in a single AB-grain. It may be concluded, therefore, that the magnetic interaction between the A- and B-constituents within each AB-grain is responsible for the reverse thermo-remanent magnetism of the whole group of ferromagnetic minerals as well as for that of their mother rocks. It may well be that the thermo-remanent magnetization of the B-constituent within an AB-grain is developed under the effect of a demagnetizing field caused by the neighbouring A-constituent within the grain, so that the magnetization of the B-constituent is opposite to the applied magnetic field. The reverse remanent magnetization of the B-constituent becomes larger than the normal magnetization of the A-constituent at atmospheric temperature. The plausibility of the latter argument may be verified by comparing the steep temperature gradient of J_s in the case of the B-constituent with the small gradient of the A-constituent, shown in the graph.

So far as the reverse thermo-remanent magnetism of the Haruna rocks is concerned, the general principle of Néel's theory appears applicable; but it seems to need a slight modification since the magnetic interaction between the two constituents within each grain only is effective, the interaction between the separate grains of different kinds being not primarily significant. It has been proved, in addition, that the A-constituent is nearly stochiometric magnetite, while the B-constituent is rich in titanium oxide (TiO_2). The detailed chemical and crystallographic examination of each mineral constituent is now proceeding.

With reference to the basaltic rock mass at Genbudo, Japan (Tertiary lava), which according to Matuyama[4] has remanent magnetization almost opposite to the present geomagnetic field, this rock shows no positive evidence of reverse thermo-remanent magnetism such as is found in the Haruna rock.

Note added, April 9. A study of the article entitled "Magnetic Properties of Rocks" in *Nature* of March 21 suggests the following comments.

We have examined the magnetic properties of a Whin Sill sample, which was sent us by courtesy of H. Manley. The result shows that the direction of its thermo-remanent magnetism is perfectly parallel to the magnetic field, and its other magnetic properties are completely normal. Among a number of other Japanese samples examined so far, only the dacitic pitchstone of Ashio showed reverse thermo-remanent magnetism similar to that of the Haruna dacite. Hence we do not claim that all igneous rocks having adverse magnetization *in situ* have the character of the adverse thermo-remanent magnetism due to Néel's two-component mechanism.

We are much interested in the report that many experiments in England and in France on the magnetic properties of naturally adversely magnetized rocks gave a negative result for Néel's mechanism. At the same time, we cannot ignore the interesting fact of the adversely magnetized gneisses found by Buddington. The magnetic properties of his samples must also be studied in detail, and we are now going to do this. Thus, although we agree with the argument that a large number of igneous rocks having natural adverse magnetization *in situ* have the normal characteristics of thermo-remanent magnetism in its ordinary meaning, we still hesitate to conclude finally that the earth's magnetic field was reversed during certain geological times, because, from our recent studies, the magnetic properties of igneous rocks seem to be much more complex than their other properties. For example, the ferromagnetic minerals even in a small piece of rock show a wide range of Curie point, and the presence of magnetic interaction between closely neighbouring ferromagnetic constituents is rather usual, though it is in many cases not strong enough to result in reverse thermo-remanent magnetism.

Until, therefore, the physics of the magnetic properties of rock-forming ferromagnetic minerals are well established, the possibility should not be rejected that there exists an unknown mechanism for producing adverse remanent magnetization. The reversal of the magnetic field of the earth during its history must not be assumed without further evidence.

We thank Prof. Néel for discussion.

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Radiocarbon Dating : Large-scale Preparation of Acetylene from Organic Material

THE introduction of the radiocarbon method of dating materials of organic origin by Libby, Anderson and Arnold in 1949 [1] provided the archæologist with an important new tool, and the number of inquiries received by the British Museum laboratory immediately after the announcement indicated the need for carbon-14 dating facilities in Great Britain. As the British Museum laboratory seemed to be the appropriate body to administer such a service, an approach was made in July of that year (1949) to the Atomic Energy Research Establishment, Harwell, for help and advice in setting up such a service.

After investigating the whole problem, the Atomic Energy Research Establishment advised an alternative approach to that of Libby, Anderson and Arnold, namely, conversion of the carbon in the sample to a gas (preferably a diatomic one such as acetylene or ethylene) and subsequent counting of the carbon-14 activity in a proportional counter. While this course of action might result in a long delay before a dating service was available, owing to the amount of research and development necessary, it could possibly lead to two important improvements from the archæological point of view, namely, reduction of sample requirements and increased accuracy of the calculated dates.

Work on the problems of quantity production of acetylene was begun at Harwell in October 1950, and transferred to the British Museum laboratory a few months later, where a plant was built so that the chemical problems could be studied in parallel with those of counter design at Harwell.

Later, in 1951, as a result of an independent approach to the Atomic Energy Research Establishment by the Royal Institution, more resources became available for counter design, and since May 1952 there has been close collaboration between the Royal Institution and British Museum laboratories, it being agreed that the problems of acetylene production and the associated analytical control problem of acetylene and lithium purity should continue to be examined at the British Museum.

The method of acetylene production is based on that of Arrol and Glascock[2] for the conversion of carbon dioxide to acetylene on a microscale, but using lithium instead of barium. The sample is burned in a stream of oxygen at atmospheric pressure in a silica furnace of special design—there being difficulties with the traditional copper oxide packing when burning material which yields large quantities of volatile products. The resulting carbon dioxide is freed from water vapour and other condensible impurities by passing through traps cooled to – 78° C. and is condensed in further traps at liquid-oxygen temperature. When the combustion is finished, non-condensable gases are pumped away and the carbon dioxide is expanded into storage bulbs until required. The carbon dioxide is then allowed to react with an excess of metallic lithium at high temperature (700° C.) in a stainless-steel furnace of the type described by Arrol and Glascock[2], to give lithium carbide. Acetylene is then obtained from the carbide by the addition of carbon dioxide-free, distilled water.

Good yields of carbide are favoured by using a large excess of lithium and allowing the reaction (which is exothermic) to proceed at as high a temperature as possible. Good yields of acetylene are only obtained in practice if the final concentration of lithium hydroxide in the furnace after the addition of water is not much in excess of 5 per cent, since the rate of evolution of acetylene from lithium carbide falls off markedly as the concentration of lithium hydroxide rises. In practice, it has been possible to obtain approximately 65 per cent efficiency for the conversion $CO_2 \rightarrow C_2H_2$ by employing a 50 per cent excess of lithium and a furnace of such dimensions that the final concentration of lithium hydroxide was not greater than 10 per cent. This should be improved upon when a large furnace becomes available.

After liberation from the carbide, the acetylene is freed from condensable impurities by passage through a trap at – 78° C. and is condensed at liquid oxygen temperature, while hydrogen liberated at the same time by reaction of the excess lithium with the water is pumped away. The acetylene is finally purified by repeated passage over solid adsorbents.

It is hoped in the New Year to complete the installation of carbon-14 dating apparatus incorporating these processes and the counting techniques developed by the Atomic Energy Research Establishment, Harwell, and the Royal Institution, thus providing at the British Museum laboratory a complete dating system which will be used in the service of archæology.

I wish to thank the Director of the Atomic Energy Research Establishment, Harwell, for the generous provision of facilities, and Dr. W. J. Arrol, Isotope Division of the Establishment, for his help and encouragement in the early stages of the work.

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Use of an Acetylene-filled Counter for Natural Radiocarbon

THE use of natural carbon-14 activity for purposes of archæological dating was suggested by Libby, who used a screen-wall counter[1]. The majority of workers in this field have employed the same type of counter in which the carbon is introduced as a solid. However, the counting of carbon-14 in its elementary form appears to be inherently a method of low efficiency, and the alternative use of a counter in which the filling gas is also the sample seems to offer greater scope for improvement. This has been the subject of several recent publications. De Vries and Barendsen[2] have used carbon dioxide as the sample gas, and Faltings[3] has considered the use of methane as an alternative to carbon dioxide. A further improvement may be sought by the use of a gas containing more than one carbon atom per molecule, and to this end an apparatus has been constructed in this laboratory for the counting of natural radiocarbon in the form of acetylene.

The operating conditions for a counter which will produce the best statistical accuracy for a sample rate of counting S, where the background rate B is random, is given by the largest obtainable value for S^2/B. In general, this ratio will increase with increasing size of counter and will increase more rapidly with size for a gas-sample counter at constant pressure than for a solid-sample counter. This follows from the fact that the ratio S/B also increases for the former counter but remains approximately constant for the latter. This is shown in an analysis by Anderson and Levi[4]. On these grounds the gas counter should be as large as possible ; but in practice limits are set by the difficulties of shielding and by the desirability of not too high an operating voltage.

In the work outlined here a mild steel counter of about three litres volume is employed and thus 3 gm. of carbon may be introduced by filling to one atmosphere pressure with acetylene. The counter is surrounded by eleven Geiger counters used in anti-coincidence and the whole array is enclosed in a 4-in. thick lead shield. The sample counter is operated in the proportional region and a further reduction in background is thus obtained by discriminating against small pulses ; in this way some of the smallest β-particle pulses from the decay of carbon-14 are also lost and the optimum discriminator setting is determined by plotting bias curves for background and sample-plus-background counts. The background counting-rate is obtained by filling the counter with acetylene produced from anthracite, which contains no carbon-14. Under standard operating conditions, this value for the background is 30 c.p.m. A figure for the efficiency of the counter for detection of carbon-14 may be obtained by filling it with acetylene made from modern biological material such as contemporary wood. For such material Libby has found the specific activity to be 15·3 disintegrations per min. per gm. Maintaining the same operating conditions as for the background determinations and filling the counter with acetylene made from contemporary wood, the count-rate is 64·5 c.p.m. This corresponds to an efficiency for carbon-14 of 75 per cent at the optimum discriminator setting : minimum discriminator setting gave a counting efficiency of 90 per cent but poorer sample statistics. The figure quoted by other workers using screen-wall counters is about 5 per cent.