The Microstructure of Coal.

A VALUABLE and original paper on the economic selection of coal was contributed at the autumn meeting of the Iron and Steel Institute by Mr. A. L. Booth. The method usually adopted is to carry out a proximate chemical analysis, which at the best is very unsatisfactory and of little real use, to collate the results with practical experience, and to make a trial on some particular plant. Only too often it proves to be unsatisfactory, and trouble arises from the fact that two coals can have practically the same appearance and give the same analysis, and yet be totally different in behaviour. This occurs quite frequently, and does not seem to be realised by fuel-users generally. Sir W. G. Armstrong, Whitworth, and Co.'s works, with which Mr. Booth is connected, use some 250,000 tons of coal per annum for different purposes, and it was the unsatisfactory nature of chemical methods of classification which led to experiments being made with the microscope to ascertain whether a more trustworthy method could not be devised. The method adopted was as follows:

Sections were cut of a large number of typical pieces of coal from different sources. Some had been proved over a period of years to be suited to a particular class of work, while others had proved unsatisfactory for the same class of work. All were carefully examined under the microscope. It was soon seen that there were three main types, and that each type was suitable for certain classes of work. Further investigation rendered it possible to decide how far a departure from the typical member could be made without getting into difficulties.

The method of cutting sections is similar to that used in making rock sections, but is considerably more difficult and requires more patience. A piece of coal is selected and, if soft and cracked, treated with a transparent, colourless binder. One side of the coal is then ground down, using carborundum powders of finer and finer grades, finishing off with a water of Ayr stone. The result should be a smooth, flat face. The coal is then mounted in Canada balsam on a piece of glass, the face being well pressed against it. When the balsam is set, a slice of coal is cut off and ground down until it transmits light.

In his paper Mr. Booth considers only coals in commercial use in this country, and these fall into three main types: (1) "Humic," composed of leaves, stems, and broken-down woody tissue, together with some spores. (2) "Spore" coals, in which both "micro-" and "mega-" spores predominate. (3) Cannel coals.

The spores are the reproductive organs of the plants, and correspond with the pollen and ovules in present-day flowering plants. The micro-spores are very small, while some of the mega-spores are about $\frac{1}{8}$ in. in diameter. The cannel coals contain small, round, yellow bodies. It will be realised, of course, that these three classes merge into one another. Humic coals occur containing more and more spores, while spore coals become more cannellised as the yellow bodies merge with the spores. This is where microscopic work is necessary to enable a decision to be made as to what a particular sample of coal can be used for. The author shows sixteen coloured photomicrographs of thin sections of specimens of the three main types at magnifications varying from 50 to 560 diameters.

So far as the main economic uses of coal are concerned, the study of their microscopic structure has resulted in the following conclusions:

For steam-raising, humic coals which contain a fair proportion of spores are the most suitable. These coals coke fairly well, and give a good, hot fire without too long a flame. For town-gas manufacture humic coals are also suitable, and for this purpose those which swell on heating and burn with a long flame are the best. They give a good yield of gas and by-products. Some humic coals containing much yellow substance constitute the best coking coals, and should be reserved for that purpose.

For producer-gas work the spore coals are necessary. The best coals for non-recovery producers are those which have been partially cannellised. They do not soften, the coke is very fragile, and the fixed carbon is very high. This is a necessary feature in producer practice. If the ash is not very fusible it is possible to work these coals with a low blast saturation, and thus get a dry gas with a high carbon monoxide content, the flame of which has a higher radiating power than the hydrogen flame. In recovery work, coal containing more humic matter may be used, because here a primary low-temperature distillation takes place, and through the high saturation of the blast the tendency to swell is checked.

For direct-fired furnaces (*e.g.* reheating and reverberatory) the hard coals are used. These are almost true cannels, and are usually dull-looking. They are free-burning, having no tendency to coke, and unless iron be present through infiltration it is difficult to fuse the ash.

The microscope has not only been found helpful in the selection of coals, but in some cases it is also of use in deciding whether or no it would pay to wash them, and will explain why an apparently good and clean coal has, for instance, a high ash-content. In such a case a washing may be quite useless. In the event of a shortage of a particular class of fuel the more detailed knowledge of coal which the microscopic study gives will enable the best substitutes to be used; and to obtain satisfactory working with the substitute, any necessary alterations in the running of a plant can be made without waiting for adverse effects to develop.

The author states in conclusion that coal from the same seam is generally very uniform, and mentions that sections cut from a given seam, but delivered on dates twelve years apart, showed that the coal is of the same type. As he says, perhaps one day it will be possible to buy coal to specification as we now buy steel.

Mr. Booth's paper is very timely, and indicates what a considerable saving could be made if the present output of coal were scientifically utilised in the manner indicated.

The Cretaceous-Tertiary Boundary in North America.[1]

By PROF. A. C. SEWARD, F.R.S.

ONE of the most difficult problems with which American geologists and palæontologists are confronted is the correlation of the Later Cretaceous and Lower Tertiary strata in the different regions of the United States. The Professional Paper by Messrs. Lee and Knowlton is concerned with some of the Cretaceous and Tertiary rocks in the Rocky Mountains region of Colorado and New Mexico. A considerable area in the interior of North America was occupied by a Cretaceous sea, and it was part of this area which was afterwards uplifted as the Rocky Moun-

[1] Department of the Interior, United States Geological Survey. Professional Paper No. 101: "Geology and Palæontology of the Raton Mesa and other Regions in Colorado and New Mexico." By Willis T. Lee and F. H. Knowlton.