The Crystalline Nature of the Chief Constituent of Ordinary Coal.

The examination of thin sections of coal with the petrological microscope (see Nature, Dec. 25, 1926, p. 913) has been extended to Tertiary coals from Baluchistan, the Punjab Salt Range, and Assam. The observations previously made on Palæozoic coals have been confirmed by the later investigations, except for the pleochroism, which is deceptive and probably not actual.

In every section which has been studied in ordinary transmitted light, practically all the bright coal and much of the dull coal layers seem to have the structure of polished wood and to consist of a madder-red coloured, translucent substance. If the section is thick or the illumination feeble, this substance is darker coloured or almost black. In very thin sections or with strong sunlight, this substance has a distinct golden yellow colour. Examined in plane polarised light, all sections show an exceedingly faint waxing and waning in the illumination of the coal substance throughout the movement of rotating the section. There is no definite darkening or lightening as a whole at certain positions, and thus pleochroism is evidently absent.

Sections of bright coal cut parallel to the plane of lamination and examined between crossed Nicols show the coal substance to be isotropic. The section, although dark, is not absolutely dark between crossed Nicols. Close attention, while rotating the section in this position, shows that every part of the substance goes absolutely dark at some point, but it lets a little light through in other positions. The total light coming through is, however, small, and the darkened section seems to be uniformly darkened even during the rotation of the slide. There is of course the same very faint continuous waxing and waning during the rotational movement, as was noticed for the illuminated section in plane polarised light.

All sections cut perpendicular to the planes of lamination and examined between crossed Nicols show the coal substance to have the crystalline character of a uniaxial mineral. The whole of the coal substance seen in the field of the microscope is in optical continuity as if parts of a single crystal. It has, on rotation of the section, a definite extinction, very distinct with really strong illumination, parallel to the lines of the laminæ. The extinction is not absolute at its darkest point, nor is the section very bright when the Nicols are at 45° to the laminæ. However, there is no doubt whatsoever about the extinction phenomena being quite clear in all the sections cut perpendicular to the coal laminæ.

The coal substance is seen to be somewhat granular under higher powers of the microscope. In some portions of the slides there is evidence of a cellular or woody structure. The presence of recognisable structure in the coal substance does not affect the optical phenomena at all. If a honey-comb was filled with opaline silica and a section made, the general appearance of the slice under the microscope would probably be similar. Stopes and Wheeler ("The Constitution of Coal," Department of Scientific and Industrial Research, 1918, pp. 20-21) have recorded an observation of this nature in the case of a piece of fossil-wood examined by them. The siliceous matter had permeated and filled the wood cells without destroying or replacing the tissues separating the cells of the original wood.

In addition to the main or chief constituent of coal, the section reveals the presence of three types of minor constituents: (1) Resinous bodies, (2) amorphous 'mineral charcoal,' and (3) inorganic matter. Any one or more of these three minor constituents may be present in abundance and impart a distinctive character to the coal, *e.g.* dull waxy or spore coal (bog head), dull silky coal, and coal shale being types respectively. Each of these minor constituents offers an attractive field for research. Their study is far more complex than the simple names suggest.

The discovery that the chief substance or constituent in ordinary coal was probably liquid or a fluid jelly which has afterwards hardened affects the existing nomenclature of coal constituents. No terms based on lithological characters (*e.g.* vitrain, clarain, and durain) or on a botanical origin (*e.g.* anthraxylon and attritus) can have more than a descriptive significance. Such names may be convenient if restricted to the appearance or structure, respectively, of the coal, and not extended to the nature of the coal substance. The older, well-known terms, bright coal, dull coal, and mineral charcoal, with perhaps the introduction of such adjectives as silky, glossy, matte, waxy or resinous, and shaley, can be made just as explicit as any of the above terms for descriptive purposes. (See descriptions by Fermor, *Memoirs, Geological Survey of India*, vol. 41, pt. 2, 1914, pp. 180-181.)

A note of warning must, however, be sounded in regard to the naming of the chief constituent of coal. It is as certain as can be that this constituent permeates the coal and has crystalline properties suggestive of a definite substance. We are under no delusion that analyses of the purest forms of brown coal, bituminous coal, and anthracite clearly indicate a loss of carbon dioxide and methane from a composition, say, of *dopplerite*. There is little doubt that with loss of volatile matter the coal substance has not merely hardened, become denser and changed in appearance (lustre), but that there is an evident change in composition. Therefore in giving a name to this chief constituent we must remember this change of chemical composition. It would be simplest for the present, perhaps, to use the word *coal substance*, in a strict scientific sense, for the chief constituent of coal, using the general word 'coal' as it has always been used.

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Origin of the Rio Tinto Ore Bodies.

After a year's intensive study of the surface and underground conditions at the Rio Tinto Mines in the Province of Huelva, Spain, I have been led to a theory as to the origin of the great ore bodies in this region. As this theory or working hypothesis has already borne fruit, inasmuch as it has led directly to the finding of several new ore masses, it is deemed worthy of brief mention here in advance of the full discussion which will appear later.

In the vicinity of the mines there are two masses of quartz porphyry. The southern mass is a sill which has been injected along the cleavage of the slate. To the north of this sill, and separated by slate, there is another porphyry intrusion which maps as a dyke. On its southern flank it either undercuts or reverses the dip of the slates. On its northern flank it has a conformable intrusive contact with slates, that is, the strike and dip of the porphyry-slate contact are the same as the strike and dip of the slaty cleavage. Within the porphyry area there are numerous isolated bands of slate. The North Lode group is entirely surrounded by porphyry. On the other hand, San Dionisio, Eduardo, and South Lode are on the south contact between porphyry and slate.