Optical Reflections from Coal

The classification of the petrological constituents of coals developed in Great Britain by Dr. Marie C. Stopes and published in a revised version in 1935[1] has been widely adopted as a basis for further research in many directions. Much more attention appears, however, to have been given to petrological and chemical than to physical properties. Many workers give density determinations and C. Mahadevan has made an X-ray diffraction study of coals[2]. In general, measurements for the coal properties selected have cut across the Stopes classification when they have been determined for vitrain, clarain, durain and fusain. Typical results taken from Hoffmann's paper[3] are given in Table 1 showing the maximum variations in samples taken from different seams in the same coalfield, and the overlap between the constituents.

TABLE 1. SAMPLES FROM TWELVE MINES IN SAAR COALFIELD SHOWING MAXIMUM VARIATIONS.

Constituent		Ash	Volatile matter	Specific gravity
Vitrain	....	0·4– 2·2	27–36	1·2–1·9
Fusain	....	1·0– 8·0	9–18	1·4–1·7
Clarain	....	0·7–11·0	32–47	1·2–1·4
Durain	....	0·3–45·0	29–62	1·2–1·7

From the wide range of variations, it would appear that if an attempt were made to select a specimen of one of the constituents on the basis of the quantitative data alone, a mistake might easily be made. Since so much work has been done by so many workers on the subject, some property or properties of coal must have been used first to select, without doubt, from a lump of coal a specimen of, say, vitrain. Dr. Stopes's reference to "such ingredients, in hand specimens, as are visibly different from each other", suggests the relevance of optical properties. (Elastic properties are also involved in the detailed description, given in the large table "A Classification of Coal Ingredients", accompanying Dr. Stopes's paper.)

An attempt has therefore been made to study quantitatively the optical properties of coals. Specimens were prepared by cutting, grinding and polishing plane surfaces on the samples of the petrological constituents (with the exception of fusain). The specimens were mounted, in turn, on the table of a spectrometer in which the telescope had been re-
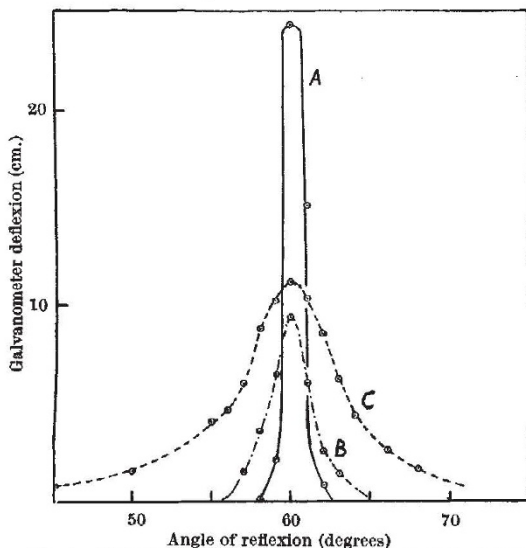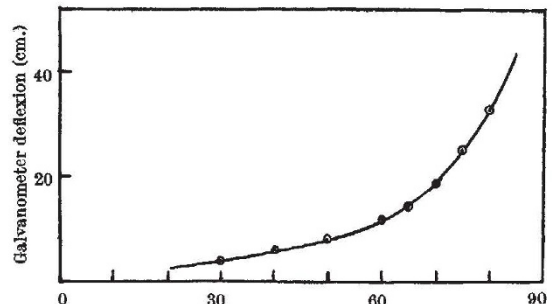

Fig. 2. VARIATION OF MAXIMUM INTENSITY OF REFLEXION WITH ANGLE OF INCIDENCE.

placed by a photo-electric cell unit for measuring light intensities. With the collimator fixed, the coal surface was mounted in a vertical plane reflecting the incident parallel beam of light. At various fixed angles of incidence, the intensity of the light reflected in the region of the specular angle was measured. Typical results are shown in Fig. 1 for the region around a specular angle of 60°. The spreading of the reflected beam is greatest for fusain, least for vitrain, with durain lying between the two. Data are not given for clarain, which in the new Stopes classification is regarded as vitrain mixed with some of the microscopic constituents of durain and fusain. Fig. 2 is a typical curve for the variation of maximum intensity of reflection with angle of incidence, showing, as grazing incidence is approached, the rapid increase in intensity of reflection characteristic of dielectrics.

The method was then applied to typical specimens of some of the petrological constituents from different types of coals and the results are shown in Table 2.

TABLE 2. SPECULAR REFLECTION FOR POLISHED COAL SURFACES AT 60° ANGLE OF INCIDENCE AND REFLECTION.

Sample and description		Galvanometer deflection (proportional to intensity)	Percentage reflection (approx.)
	(Incident intensity approximately 150 cm.)		
DURAIN	Warwickshire	3·5 cm.	2·0
	Northumberland	5·2 cm.	3·5
CANNEL	Derby	7·6 cm.	5·0
VITRAIN	Freeburning coal, Yorks.	8·6 cm.	5·7
	Coking coal, Durham	9·7 cm.	6·5
	Freeburning coal, North'd	10·7 cm.	7·1
	Bright coal, Derby	10·9 cm.	7·3
	Bright coal, Warwick	10·9 cm.	7·3
	Anthracite, S. Wales 1....	11·1 cm.	7·4
	Anthracite, S. Wales 2....	14·7 cm.	9·8
	Anthracite, Durham	23·6 cm.	15·7

It would appear that the petrological constituents fall into groups; for example, durain 2–4 or vitrain 5·7–15·7, giving a quantitative classification corresponding with that of Stopes, allowing individual variation, without the overlapping of the groups common to quantitative determinations of other properties. Although the numerical values are altered by the method of treatment of the surfaces, the distinctions remain if the different surfaces are given comparable treatment.

C. G. Cannon.
W. H. George.

Physics Department,
Chelsea Polytechnic,
London, S.W.3.

Fig. 1. VARIATION OF REFLECTED INTENSITY AROUND THE SPECULAR ANGLE WHEN THE ANGLE OF INCIDENCE IS 6°. A, VITRAIN; B, DURAIN; C, FUSAIN.

[1] Fuel, 14, 4–13 (1935).
[2] Fuel, 14, 231–241 (1935).
[3] Fuel, 8, 525 (1929).