The Separation and Concentration of Vitrain, Clarain, and Fusain in Illinois Coal*

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The ingredients composing the bands in Illinois coals are termed vitrain, clarain, fusain, and durain, each of which possesses distinctive physical and combustion characteristics. Variations in the relative proportions of these ingredients must therefore affect the usefulness of a coal for any given purpose. The Illinois State Geological Survey has undertaken a study of such variations. Summarized data relating to the screenings from one mine in Williamson county, operating in No. 6 coal, are presented herewith.

Before proceeding with an examination of the data, the nature and relative importance of the four ingredients might well be reviewed. The homogeneous, vitreous-appearing vitrain is characterized by low ash content and high as-received calorific value. When coked, it has great swelling power and yields a fragile, well-fused coke, evolving important amounts of by-products. Vitrain comprises about 46.0 per cent of the screenings investigated.

The non-homogeneous clarain is seen to be finely banded, with a bright silky lustre and blocky fracture. Due to its content of coalified remains from the more resistant parts of the coal-forming plants, its as-received ash content is higher than that of vitrain, and its calorific value is somewhat lower. Clarain is structurally stronger than vitrain, and hence tends to concentrate in the larger sizes. The data indicate 41.9 per cent present in the screening studied.

Coal commonly breaks along layers of the soft and friable fusain. Although this ingredient shows great variability in chemical composition, it has, in general, considerable ash and a high fuel ratio ($\frac{FC}{VM}$). The latter factor together with its naturally fine size recommends it for pulverized fuel firing. Thiessen[1] has found 200-mesh dust from an Illinois dedusting plant to be very rich in fusain, indicating a possible source of supply. The screenings examined in this work contain about 2.4 per cent fusain.

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Durain has been definitely noted in only four Illinois mines, appearing as a narrow band. Although it closely resembles bone coal, it may have a low ash content (3.7 per cent in one instance), a high percentage of volatile matter, and a low specific gravity. It forms a weak sandy coke and its ash fusion temperature is relatively high[2]. However, its extreme hardness causes it to remain in the lump coal, so that it appears in insignificant proportions in the screenings.

Details of the method employed in making the microscopic counts have been described elsewhere by McCabe[3].

Table I summarizes the results of the petrographic analyses in terms of standard coal sizes. A comparison of these data with a previous analysis[4] of a column cut from the coal face at this mine demonstrates that ordinary preparation processes appreciably affect the actual character of the coal. The relative toughness of the clarain causes it to be somewhat concentrated in the sizes larger than 1¼ inches, as is shown by the drop in percentage from the coal at the face to minus 1¼-inch screenings; while the more brittle vitrain has been more than doubled in the finer coal. Fusain and refuse matter likewise increase in the screenings. A study of the three common screening sizes indicates the trends of the ingredients with reduction in size. It is seen that vitrain, fusain, and refuse tend to increase, while the clarain content drops markedly.

Since most of the refuse material appears in the heavier gravity fractions, cleaning of the various sizes of coal at, for example, 1.50 specific gravity may be expected to reduce the refuse considerably. Table II presents data on dedusted screenings from which all sink at 1.50 has been removed. The refuse contents are all greatly lowered; and the minimum figure is reached not in the largest size, as was true for uncleaned coal, but at ⅜ inch x 48-mesh. Here, then, is a coal having an identical refuse content as the original face sample, 2.0 per cent, but with over two and one-half times the percentage of vitrain, double that of the fusain, and only about one-half that of the clarain. It would seem that we have produced a coal of greatly changed composition, which might be expected to form less ash on the grates and more by-products in the coke ovens.

It is thus apparent that coal preparation processess not only produce different sizes, together with a reduction in ash content, but they give us truly different coals which are composed of different proportions of the ingredients and which undoubtedly possess different combustion, coking, and hydrogenation properties. It is the aim of the State Geological Survey to study these changes by accurately determining the variations in the concentration of the ingredients in a number of typical Illinois coals. Combustion tests to correlate with the data on composition will then be undertaken. It is highly probable that we may some day produce concentrates of the ingredients, blending them as need be to produce coal of optimum composition for any specific use.

TABLE I—SIZED SCREENINGS FROM COAL NO. 6

	Vitrain	Clarain	Fusain	Refuse
	Per cent	*Per cent*	*Per cent*	*Per cent*
Face sample [4]	20.1	76.5	1.4	2.0
1¼ inch x 0—Screenings	46.0	41.9	2.4	9.7
1¼ inch x ¾ inch—Chestnut	42.4	49.5	1.7	6.4
¾ inch x ⅜ inch—Pea	47.5	43.2	1.5	7.8
⅜ inch x 0—Carbon	47.4	36.5	3.3	12.8

TABLE II.—COAL NO. 6 SCREENINGS DEDUSTED AND CLEANED AT 1.50 SPECIFIC GRAVITY

	Vitrain	Clarain	Fusain	Refuse
	Per cent	*Per cent*	*Per cent*	*Per cent*
1¼ inch x 48 mesh—Screenings	48.7	46.5	2.3	2.5
1¼ inch x ¾ inch—Chestnut	44.0	51.0	1.7	3.3
¾ inch x ⅜ inch—Pea	50.7	45.6	1.5	2.2
⅜ inch x 48 mesh—Carbon	51.2	43.6	3.2	2.0

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