THE INTEGRATION OF SCIENCES REQUIRED FOR A LOGICAL STUDY OF COAL

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Because coal is a heterogeneous mixture of chemical compounds formed from botanical structures by biological means, the whole metamorphosed by physical forces exerted by geological processes, a study of coal requires the application of all of the natural sciences.

The fact that in spite of the vast literature on the subject, we know relatively little about the fundamental properties of coal is caused by the fact that the data contained in this literature represent mainly the viewpoint of only the particular science used by the investigator, or, indeed frequently the viewpoint of only a very specialized part of that science. Among others, the sciences of geology, petrology, paleontology, botany, chemistry, bacteriology, and physics are concerned in the study of coal. Findings of each science must be critically reviewed in the light of other sciences. Failure to do this has often led to erroneous conclusions. For example, certain chemical work has been put forth in Germany, purporting to show that cellulose rather than lignin is the substance from which coal originates. The argument is that coals artificially produced from lignin show cell structure, while those from cellulose do not; natural coals showing no cell structure in the woody tissue are therefore derived from cellulose. This argument entirely rejects the findings of biologists who have shown that the cellulose in wood is readily destroyed by decay while lignin is stable; of peat investigators, who have shown that cellulose is exceedingly rare in the lower parts of peat swamps, and that cellulose content decreases with age of the peat; and of microscopists, who have shown conclusively that coal derived from woody tissues always shows structure, though in some cases very refined technique is required to demonstrate it.

The geologist has, at times, tried to estimate the temperatures to which coal deposits were subjected during metamorphosis. Their estimates are frequently in the neighborhood of 200° to 300°C. as a maximum. If the conclusions of Lipman that bacteria have continued to live in coal since the peat stage are true, then this temperature must be revised downwards. The geologists in this phase of the work must cooperate thoroughly with the bacteriologist, but at the same time must be very critical of his work. The geologist, the bacteriologist, and the pedologist have related interests. Some chemists in studying coal have frequently been too prone to treat coal as a homogeneous material—as a pure compound whose identity is to be unraveled. A casual consideration of the compounds making up the plants whose decay products form coal, let alone a microscopic examination of coal, can leave no doubt as to the heterogeneous nature of coal. A study of the compounds in plants and the changes which these compounds undergo during decay and in the early stages of coalification, promises much greater progress in unravelling the chemical nature of coal than does the study of coal itself. To do this, however, the chemist must familiarize himself with the chemistry of living plants, with plant anatomy, with decay and the biology of decay organisms, and with the geology of coal formation. All of his conclusions must stand scrutiny in the light of the findings of other sciences as to the conditions under which the chemical changes took place.

If we study the minerals in coal, we bring mineralogy into the picture. It would seem that this should have been done long ago, yet a review of the literature shows that no mineralogical study of coal with any degree of completeness or accuracy has been made until the last two years. Other studies are found to be speculations based upon ash analyses and minerals found in nature. True, the minerals are found in nature, but only a certain few are found to make up over 95 per cent of the mineral matter in coal. A small amount of scientific study can settle volumes of philosophical speculation. Because of these accurately made mineralogical studies, we can take a new hold on the problem of ash-to-mineral matter calculations. By studying the fracture planes in coal, the physicist can tell to what forces the coal was subjected and perhaps their relative magnitude. Since the geologist believes that earth and tectonic pressures have much to do with coalification, the relationship is obvious. The behavior of coal components under high pressures is of great importance from the standpoint of possible flow of components from one part of the coal structure to another. For example, whether the resinous material to be found in fusain was always there, or whether it flowed in after fusainization is an important question in deciding the origin of fusain.