Resins and Waxes in Colorado Coals

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The nature and behavior of resinous substances in the Upper Cretaceous coals of the Anthracite-Crested Butte quadrangles, Colorado, are being investigated by the writer. At present such studies are still in the preliminary stage but certain information has been gathered which may be of interest to students of coal.

In the Anthracite-Crested Butte district all coals below the rank of an anthracite contain small blebs and veinlets of resinous substances. Some of these substances are known to be resins, whereas others have certain properties which distinguish them from resins and are tentatively designated as "waxes."

Resins appear to be of two varieties, (1) oval-shaped, yellow or orange colored, anisotropic bodies which occur in resinous cells within cellular woody material, and (2) oval-shaped, round or angular masses of canary-yellow color occurring predominantly in the attritus. The former are found chiefly within the anthraxylon in ovaloids 1/100 mm. or less in diameter, but occasionally appear in the attritus. Thus they are distinct from the yellow resins which are strongly anisotropic and appear to be restricted to the attritus. Ordinarily the canary-yellow resins are irregularly distributed throughout the attritus much as are spores and cuticles, but occasionally they are found in zones within the attritus, suggestive of deposition as detrital grains.

Strongly contrasted with the resin cells in the anthraxylon and the canary-yellow bodies of the attritus are other gum-like substances, the "waxes." The former are microscopic in size but waxes range from small bodies less than 1/100 mm. in length to veinlets whose length exceeds 2 cm. The wax varies in color from a light honey-yellow color to a deep brown, and is readily distinguished under the petrographic microscope by its isotropism, in contrast to the anisotropism of the resins.

Waxes appear to have several habits of occurrence. They may occur bedded within the attritus and in such instances appear to be original constituents, since the micro-banded attritus is commonly contorted about the wax bleb. In other cases wax occurs as fillings in cleat fractures, desiccation cracks within the anthraxylon, or not infrequently, filling lumens of plant cells in fusain. The latter cases demonstrate that wax may also be a secondary deposit. Late secondary deposition of waxes was clearly shown in one case where a deposit of calcite and "kaolin" in a cleat fracture formed a crusted vein with the wax. The calcite-"kaolin" deposit lay adjacent to the coal, and the wax had been deposited on the inorganic matter.

Waxes of the yellow, translucent type are extremely soft, having a hardness of 2, and break with conchoidal fracture into a white powder. In ordinary light they have an index of refraction of 1.537 $\pm$ 2, and when fresh melt over a temperature range of 193-210°C. A dark brown variety melts at various temperatures ranging from 35°C., for those fragments taken from highly weathered coal, to 180°C. for those waxes taken from seemingly unaltered coal. Except for the great disparity in melting points the brown wax behaves very much like the yellow variety, and a complete gradation seems to exist between the two types. Either kind may occur singly but if the two occur together the yellow variety is always surrounded with brown wax. Likewise brown wax is rarely found without a yellow core.

Weathering alters the brown variety to a dark colored, granular substance, which completely loses its brittleness and becomes a soft powder melting at temperatures as low as 35°C. Such alteration is believed to be largely the result of oxidation, for yellow wax was altered to the brown variety by heating for 15 hours in an oven at a temperature of 130°C., well below the melting temperature of the yellow wax. Heating raised the index of refraction from 1.537 ± 2 to 1.551 ± 2, an increase which is proportional to the darkening of color. Similar results were produced by boiling the waxes five minutes in concentrated nitric acid. Oxidation of waxes within the coal was accomplished by heating polished blocks of coal containing veinlets and lenses of waxes within the attritus. The blocks were heated in an oven for 300 hours at a temperature of 165°C. When placed in the oven all waxes were of honey-yellow color but after eight hours of heating some had already become dark brown. Some waxes within the fissures had shrunk in size, allowing cracks to develop through their center. On the other hand, some of the bedded waxes showed signs of swelling and had burst their way through the block to the polished surface. All such masses of wax were now a brown color. Twenty-four hours after first being placed in the oven the blocks were again removed. Some of the waxes had become so dark as to be nearly indistinguishable from the anthraxylon with which they were closely associated. In other instances honey-colored wax had altered to a powdery dark brown substance apparently identical with that noted in the highly weathered coal. After 300 hours of heating there was practically no further change beyond that of the first 24 hours. The dark material occupying fissures was partly dissipated or highly fractured but a few veinlets of lighter colored wax remained and by swelling had completely separated themselves from the polished block. Swelling seems to be followed in a later stage by marked shrinkage and fissuring of the wax.

The study has not advanced sufficiently to warrant any definite conclusions except that changes in the resins brought about through heating in the laboratory seem to parallel those observed by White[1] to have taken place as the coals approached higher ranks.

[1] White, David, Resins in Paleozoic plants and in coals of high rank: U. S. Geol. Survey, Prof. Pap. 85, p. 69, 1913.