graphy, but also that I have made an effort to direct the attention of chemists to Day's important contribution at a time when the work of this pioneer seems to have been forgotten.

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¹ Weil, H., and Williams, T. I., *Nature*, **166**, 1000 (1950).

² Zechmeister, L., "Progress in Chromatography 1938-1947" (London: Chapman and Hall; New York: Wiley, 1950).

³ Zechmeister, L., *Ann. New York Acad. Sci.*, **49**, 145 (1948).

Paper Chromatography of Browning Reaction Fluorogens

As part of a research programme on non-enzymatic browning of foods, browned solutions were prepared by refluxing all the combinations of glycine and D-glucose at 0.1 M and 1.0 M concentrations, for periods up to 100 hr. At various time intervals samples of these solutions were removed, applied as thin lines across sheets of Whatman No. 1 filter paper and chromatographed by the ascending method in 77 per cent ethanol. The brown pigments (melanoidins) did not move. After air drying, examination of the chromatograms under ultra-violet light in the 3650 Å. region revealed as many as ten fluorescent bands, ranging in R_F from 0.07 to 0.91. None of these coincided with glycine or glucose, which did not fluoresce but were detected on the paper by chemical means.

In the beginning, these colourless fluorescent bands appeared only at the lower R_F 's; but additional bands appeared at progressively higher R_F 's with continued heating. The maximum number appeared at 48 hr., after which the number of fluorogens on the chromatograph decreased. Maximal absorption of the refluxed solutions occurred at 285 mμ when excess glucose was present, and at 295 mμ when excess glycine was present. With 1.0 M glycine and 1.0 M glucose, the maximum appeared first at 295 mμ and shifted during heating to a final value at 285 mμ. This shift was apparently due to variation in the proportions of distinct fluorogens present in the mixture, since at intermediate stages chromatographed samples showed simultaneous presence of fluorogens at separate R_F 's having absorption peaks at 285 mμ and 295 mμ, respectively.

Observable changes in the overall character of the chromatograms suggested that as heating continued the glucose was exhausted faster than the glycine. The march of the fluorogens up the paper with continued heating suggested the possibility that they represent successive degrees of polymerization of the colourless precursors of the brown pigments, the end-products of such polymerization. During unsuccessful attempts to maintain pH by use of buffers, it was observed that the presence of inorganic ions altered the number, order of appearance, and character on the chromatographs of colourless fluorogens produced by the browning reaction. Preliminary results with other amino-acids, heated with glucose, have been quite different from those obtained with glycine. This technique offers a useful means for further study of the Maillard browning reaction.

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Stages in the Dissolution of Coal

MANY interesting observations on the solution of coal in a wide variety of solvents have been recorded by investigators in a number of countries, and in particular by those attached to the U.S. Bureau of Mines and the Carnegie Institute of Technology¹. The time seems appropriate for the presentation of a synthesis of these observations in the light of a hypothesis which I have developed during twenty years work in this field. I consider that it is possible by means of this hypothesis to explain both the fusion and carbonization of caking coals when heated alone, and the geological transformation of vitrain (the bright petrological constituent) and clarain, or translucent attritus, into Thiessen's² opaque granular matter which is the principal constituent of durain.

It has long been clear that the selective extraction of coal by good solvents such as pyridine differs from the almost complete solution which is obtained at higher temperatures, for example above 350° C. with hydrocarbons such as phenanthrene and about 290° C. with naphthols. In selective extraction at the lower temperatures, I consider that the insoluble residue (fraction α of Wheeler) represents the humin portion of coal and the soluble extract (γ- and part of the β-fractions of Wheeler) the bitumen; yields of soluble extract under these conditions commonly amount to between 10 and 30 per cent of the coal substance. On the other hand, anthracene oil and phenanthrene appear to dissolve coal as a unitary substance—like gelatin in water—and to the extent of as much as 95 per cent in favourable circumstances using pure vitrain.

Although at the higher temperatures almost complete solution may be obtained, it is important to note that this high solubility is transient^{3,4}. If the temperature of such a solution after filtration is maintained constant at the temperature of its generation, within a comparatively short time a considerable part of the dissolved material is precipitated. In my view, the explanation of this is to be found in the hypothesis that a 'fat' or caking coal (say, 30 per cent volatile matter) consists of a compound of two distinct classes of substances. I regard these two groups of constituents as equivalent to Wheeler's⁵ α-fraction and β- + γ-fractions respectively, and also to the humin ('ulmins' of British workers) and bitumen fractions of Fischer⁶. In anthracene oil or phenanthrene, I consider that the complex or compound of the two constituents dissolves as an entity, whereas in pyridine it would seem that the complex is first decomposed chemically by the solvent and that the selective solution involves subsequent extraction of the bitumen fraction of this complex. When the solution of the unchanged complex in anthracene oil is maintained at its (relatively high) temperature of formation, the complex is unstable and gradually decomposes to form the same constituents as are initially separated by the selective solvent; the humin flocculates and the bitumen remains dissolved. In short, solvents attack the coal complex both physically and chemically, and the initial results appear very different according to whether chemical dissociation precedes or follows the physical solution, which in turn depends on the relative rates of these processes and so on the temperature.

The same concept can readily be applied to the phenomena of transient fusion which I have also studied⁴. The humin/bitumen complex melts physi-