

because  $\delta^{18}\text{O}_{\text{ct}}$  and/or  $\delta^{18}\text{O}_{\text{dol}}$  were not constant over the few feet in the stratigraphic section from which the samples were taken.

Even including the results when the multiple linear regression curve did not account for the variation in the four variables ( $Y, X_1, X_2, X_3$ ) to an acceptable degree (that is, the 1 per cent level of significance) the dolomite was invariably enriched in  $^{18}\text{O}$ . Mean values for the six collecting sites where the coefficient of multiple correlation was highest are:  $\delta^{18}\text{O}_{\text{ct}} = -7.87$  per mil;  $\delta^{18}\text{O}_{\text{dol}} = -3.04$  per mil;  $\delta^{18}\text{O}_{\text{dol}} - \delta^{18}\text{O}_{\text{ct}} = 4.83$ . Both the Flagstaff and the Freeport data support the working hypothesis; the dolomite is relatively enriched in oxygen-18 with respect to modern and Tertiary calcites. If further investigations of freshwater carbonates substantiate these findings, equilibration of the oxygen isotopes of calcite and dolomite prior to lithification may be indicated.

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<sup>1</sup> Epstein, S., Graf, D. L., and Degens, E. T., in *Isotopic and Cosmic Chemistry*, 169 (North Holland Publishing Co., Amsterdam, 1963).

<sup>2</sup> Degens, E. T., and Epstein, S., *Geochim. Cosmochim. Acta*, **28**, 23 (1964).

<sup>3</sup> Weber, J. N., p. 980 of this issue of *Nature*.

<sup>4</sup> Weber, J. N., *Science*, **145**, 1303 (1964).

<sup>5</sup> Keith, M. L., and Weber, J. N., *Geochim. Cosmochim. Acta*, **28**, 1787 (1964).

## CHEMISTRY

### Polythene-backed Paper for High-voltage Electrophoresis

THE improvement of technique achieved in zone electrophoresis through the use of potential gradients up to 150 V/cm has been found to be partially offset by difficulties of manipulation due to the poor wet strength of conventional papers. The marketing of 'Benchkote' ('Benchkote' (Whatman) sold by H. Reeve Angel and Co., Ltd., 9 Bridewell Place, London, E.C.4, in rolls 45 cm x 50 m), a polythene-backed filter paper (primarily intended as a protective covering for benches) of very high wet strength, prompted the tests described here, to determine if such a material would exploit the advantages of high-voltage electrophoresis to the fullest extent.

The trials described were performed using a 'Virus' high-voltage electrophoresis apparatus (supplied by Dr. Virus KG, Rosenburgweg 20, Bonn). This instrument requires that the paper medium (dimensions 100 cm x 45 cm) be soaked in buffer, that excess buffer be squeezed out by passage through rollers and then that it be stretched tightly over a cooled glass plate. The potential is applied through buffer chambers (set 60 cm apart) making contact with the paper through sintered glass moistened with the buffer. Failure to remove excess buffer or to make good contact with the cold glass surface negates the advantages gained by using a high voltage to bring about the resolution desired. The increased wet strength given by the polythene backing of 'Benchkote' makes it a superior material for that series of manipulations, when compared with ordinary chromatographic paper. An added advantage is that the polythene backing prevents water, condensed from the atmosphere on to the cold glass surface, being taken up into the paper.

When 'Benchkote' is soaked with buffer the paper swells but the polythene does not, and it has been found best to blot off most of the excess buffer before squeezing through the rollers. Also the 'Benchkote' should be fed into the rollers paper side down and from above, so that the buffer squeezed out drains off the bottom roller and cannot flood the incoming sheet.

The prepared paper is almost dry to the touch. Electrophoresis has been carried out with potential gradients up to 130 V/cm (the limit of the power pack), but the usual

conditions were 80 V/cm with a maximum current of 40 m.amp and a cooling plate temperature of 1° C.

Most of the work done using 'Benchkote' in this way has been to study the nucleotides produced by the action of acid on yeast RNA. The resolution has been improved relative to other electrophoretic techniques used formerly and only one-quarter of the time is required for an analysis. Substances which absorb ultra-violet light have been detected using 2537 Å illumination (from a low-pressure mercury arc<sup>1</sup>) with the same ease and sensitivity as on ordinary paper.

Tests of the method have also been made running amino-acid separations, and the gain in resolving power reported previously<sup>2</sup> has been seen. The ninhydrin reagent works effectively for the detection.

Other spray reagents involving heating the electrophoretogram may also be used, as temperatures of 100° C do not damage 'Benchkote' unless the exposure is unduly prolonged, when the softening polythene gives a permanent warp.

Polythene-backed paper has considerable advantages for the kind of work described. The results obtained with 'Benchkote' and the versatility of the technique may be improved by bonding to polythene a range of papers of truly chromatographic quality. (Messrs. Reeve Angel have kindly given me a sample of polythene-backed Whatman No. 3MM paper; polythene-backed papers of chromatographic quality may become commercially available later. They warn that 'Benchkote' is marketed as a bench covering, and that due to the tolerances to which it is manufactured its performance in paper electrophoresis may be variable. A suitable standard ought therefore to be included on each electrophoretogram.)

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<sup>1</sup> Markham, R., *Biochem. J.*, **87**, 9 (1963).

<sup>2</sup> Leggett-Bailey, J., *Techniques in Protein Chemistry*, 37 (Elsevier Publishing Co., London, 1962).

### Al-Fe Isomorphous Substitution in 3 CaO·Al<sub>2</sub>O<sub>3</sub> and 2 CaO·Fe<sub>2</sub>O<sub>3</sub>, and Interactions between the So-called C<sub>3</sub>A and C<sub>4</sub>AF Phases

THE isomorphous replacement of iron by aluminium in 2 CaO·Fe<sub>2</sub>O<sub>3</sub> has been widely investigated, but much less attention has been directed to the introduction of iron in the structure of 3 CaO·Al<sub>2</sub>O<sub>3</sub>.

A recent investigation by Schlaudt and Roy<sup>1</sup> led to the conclusion that, at 1,389° C, a maximum of 3.5 moles per cent Fe<sub>2</sub>O<sub>3</sub> can be substituted for Al<sub>2</sub>O<sub>3</sub> in 3 CaO·Al<sub>2</sub>O<sub>3</sub>, leading to the limiting solid solution 3 CaO·(Al<sub>0.965</sub>Fe<sub>0.035</sub>)<sub>2</sub>O<sub>3</sub>. This amount is still lower for different (higher or lower) temperatures.

Work carried out in this laboratory by X-ray diffraction and infra-red absorption spectroscopy is not in accordance with this limiting composition.

The observed 2θ diffraction angles have been plotted as a function of composition for 3 diffraction lines of high indices (lines 8.8.0, 12.4.0 and 12.8.4; C.G.R. diffractometer; iron Kα<sub>1</sub> radiation). For the 3 lines, a regular decrease of the 2θ values is observed for increasing amounts of iron, up to 10 moles per cent Fe<sub>2</sub>O<sub>3</sub>: these results (Fig. 1) suggest a limiting composition 3 CaO·(Al<sub>0.90</sub>Fe<sub>0.10</sub>)<sub>2</sub>O<sub>3</sub> for the solid solutions prepared at 1,310° C.

These results do not necessarily imply that the limiting composition obtained at 1,389° C by Schlaudt and Roy is in error, but, most probably, the 'low' temperature (1,200°-1,350° C) region of their phase equilibrium diagram needs some revision.

By applying the same technique to the isomorphous replacement of iron by aluminium in 2 CaO·Fe<sub>2</sub>O<sub>3</sub>, the