minerals by this method. The refractive indices of the heavy minerals may then be compared with that of the liquid by standard procedures or the grains cleaned for further study.

If the float fraction is to be studied, a glass slide is carefully lowered into contact with the top of the drop of liquid, then withdrawn, when a considerable portion of the float material and some of the liquid will be removed and may be studied on the slide.

It will be seen that the liquid serves two purposes: (1) as a specific gravity standard; and (2) as a refractive index standard. An ideal set of liquids should embrace several refractive index standards for each specific gravity value so that indices may be rapidly determined on a freshly separated portion of sample rather than going through the messy operation of cleaning up a fraction and adding new liquid. Pure compounds are preferable to mixtures because of the constancy of their properties, but the number of liquids having specific gravities above 2.0 is limited. Ethylene bromide, bromoform, tetrabromomethane, and methylene iodide will be found particularly useful. Mixtures of ethylene bromide with tetrabromoethane or methylene iodide and of alpha chlornaphthalene with methylene iodide will cover the specific gravity range around quartz and the feldspars, which frequently must be removed in order to study minor constituents. The stability of these mixtures has not been investigated.

The foregoing technique will be found especially useful in conjunction with the Donnay grids[1] where even a determination of properties within wide limits may help in tracing an unknown.

DIRECT DETERMINATION OF INTERPLANAR SPACING FROM X-RAY PATTERNS RECORDED ON CHARTS

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The use of the recording x-ray spectrometer which produces powder diffraction patterns on a strip-chart is greatly facilitated by preparing a calibration curve for reading interplanar spacing directly from the recorded pattern. The writer has learned recently that several laboratories in which recording x-ray spectrometers are used do not use these calibration curves so that it seems worthwhile to present a brief description of the procedure which has been applied for the past two years at this laboratory.

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[1] A small set of grids for the determination of non-opaque minerals: *Am. Mineral.*, **23**, 91–100 (1938).

Assume, for example, that the x-ray diffraction pattern of a powdered sample is recorded on a strip-chart at an angular scale of $2\theta = 2°$ per inch, using copper radiation of wave length 1.5374 Å. The calibration curve for patterns made under these experimental conditions is prepared by plotting the value of the interplanar spacing as a function of 2θ crosswise on a strip of blank chart. The values of 2θ are plotted length-wise of the blank chart to a scale of 2° per inch. The values of the interplanar spacings are, of course, most conveniently obtained from tables such as those in "Internationale Tabellen zur Bestimmung von Kristalstructuren" for Cu K_α radiation. A smooth curve is carefully drawn connecting the plotted points.

The calibration curve is then placed directly above the chart containing the diffraction pattern on a table which has a straight lower edge as shown in Fig. 1. A T-square with a straight hair-line scribed along the under side of one of the transparent edges is used as shown to read the interplanar spacing for a particular reflection directly from the calibration curve.

The calibration curve should be plotted in sections so as to obtain a reasonable slope. Most charts are marked with ten major divisions across the chart. Each major division is subdivided into ten or twenty minor divisions. The writer has found it convenient to plot interplanar spacings from 20 Å to 10 Å as a section of curve across the full width of the chart. A section of the curve from 10 Å to 4 Å is plotted to the same scale so that in the range from 4 Å up the scale is one major division per Angstrom unit. In the range from 4 Å down the spacing scale is multiplied by ten so that a section of curve across the chart is required for each Angstrom unit and so that each major division on the chart corresponds to 0.1 Å.

Aside from the speed and convenience obtainable in this method there is the additional advantage that it is easy to correct for the slippage that often accumulates between the beginning and the end of a chart. This is accomplished simply by sliding the calibration curve in relation to the diffraction pattern so that calibration marks on the pattern match the proper degree marks on the curve or so that reflections from known substances such as internal standards appear at the correct interplanar spacings. A case of this kind is illustrated in Fig. 1 where slippage of 0.2° has accumulated at the $(10\bar{1}1)$ reflection of quartz. By adjustment of the calibration curve so as to bring this reflection at 3.33 Å on the curve it is possible to read the spacing for the nearby (004) reflection of kaolinite correctly at 3.56 Å. Use of the calibration curve has other advantages inasmuch as it enables one to work directly from the *A.S.T.M.* index cards or other lists of interplanar spacings to the diffrac-
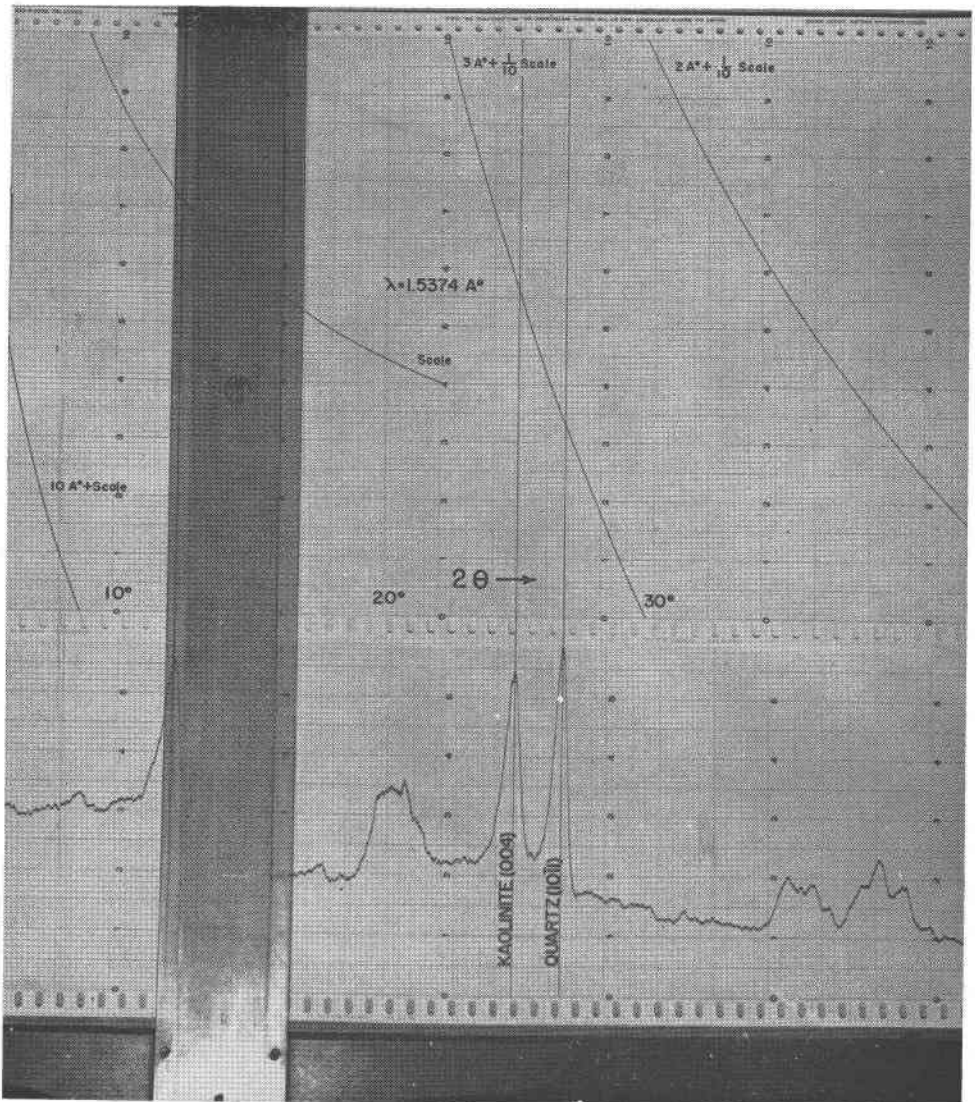
Fig. 1. Arrangement for reading *d* directly from strip-chart by use of plotted calibration chart. Scale for *d* is vertical on calibration chart. Note how quartz reflection may be used to correct 0.2° slip in pattern.

tion pattern or vice versa. Reflections from known substances may be checked off rapidly, weak and doubtful reflections may be identified rapidly, and the necessity for much tabulation of interplanar spacings and relative intensities disappears because the data can be written directly on the diffraction chart which serves as a most satisfactory record of the experiment.

VIVIANITE CONCRETIONS IN AQUIA FORMATION (MIDDLE EOCENE), ANNE ARUNDEL COUNTY, MARYLAND

Authur R. Barwick*

Recently, in conjunction with geological field work done for a project sponsored by the Office of Naval Research, the author found some rather large concretionary masses in the Aquia Formation (Middle Eocene) exposed in a roadcut along Tarnan's Branch of the South River, Anne Arundel County, Maryland. More precisely located, the concretions were found on the south bluff of Tarnan's Branch where the Rutland School Road underpasses the new Expressway, now under construction (long. 76° 38′ 2″ W., lat. 38° 57′ 58″ N.).

The concretions vary in size from about 4 to 8 inches in diameter. They are deep blue in color and are often surrounded by a rusty shell of limonitic material. Under the microscope they are found to consist of deep blue needles of vivianite, $Fe_3(PO_4)_2 \cdot 8H_2O$.[1] The largeness of the concretions and their relative abundance seemed to be a matter of sufficient mineralogical interest to deserve mention.

The strata in which the vivianite concretions occur consist of Middle Eocene greensand of Aquia age. In the South River area of Maryland, the Aquia formation consists of a greenish-gray, glauconitic sand, practically free of clay, that is occasionally indurated by limonitic bands that have resulted from the weathering of the contained glauconite partly through exposure during burial but mostly by the subsequent downward percolation of oxygenated meteoric waters. On the surface the soil derived from this formation consists of a light-brown to greenish sandy loam that is known locally as the Collington fine sandy loam. Although the limonitic bands are fairly common and, at times, may contain casts of Eocene molluscan shells such as *Venericardia planicosta*, *Dosiniopsis lenticularis* and *Turritella mortoni*, the above locality is the only one in which the author has found, or has read accounts of others finding, extensive concretions of vivianite. Specimens of these concretions are

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[1] Identification checked by Division of Mineralogy, U. S. National Museum.