On the occurrence of anatase in sedimentary kaolin.

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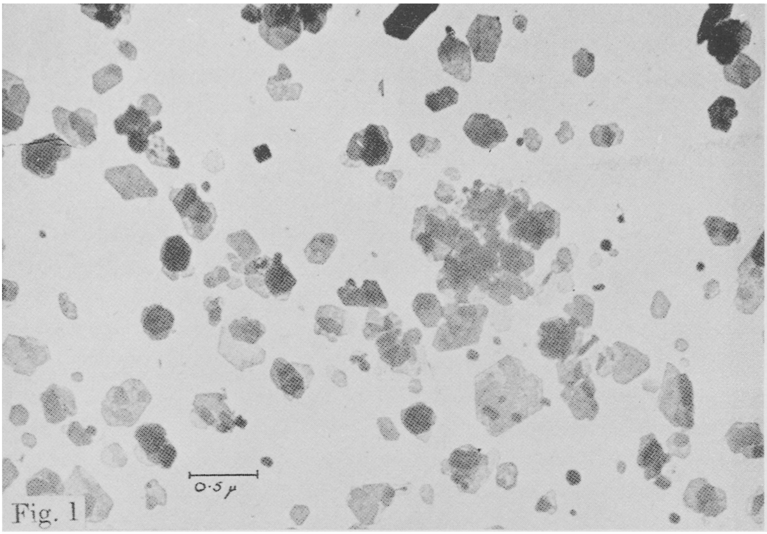
IT has been shown recently by Brindley and Robinson[1] that anatase could be recognized by X-ray diffraction technique in fireclays from Scotland and Yorkshire which contained from one to two per cent. of titanium dioxide. These authors remark that the anatase appeared to be of a fineness comparable to the kaolin mineral which was the main constituent, and although kaolinites from various sources throughout the world were examined, in no case was either anatase or rutile detected.

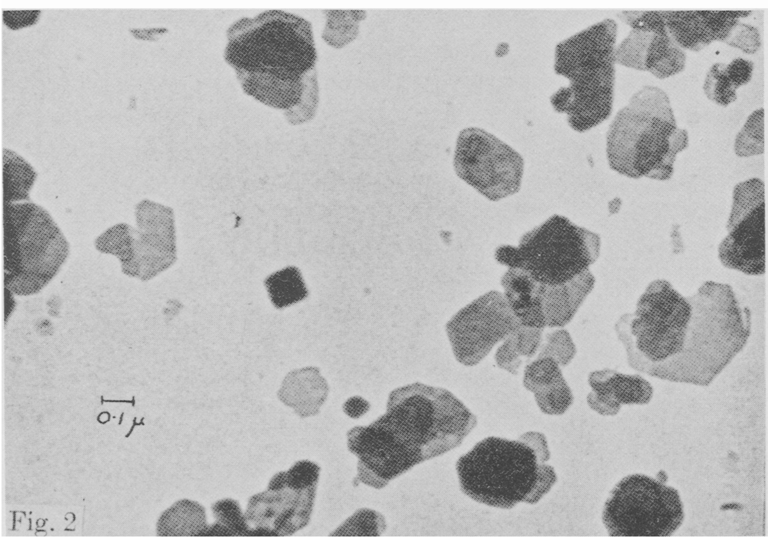
The object of this note is to draw attention to the presence of anatase in the sedimentary kaolins of Georgia and perhaps South Carolina, U.S.A. According to Smith[2] 115 kaolin samples from Georgia had on an average 1·13 % of TiO_2 by chemical analysis. The values ranged from 0·5 to 2·2 % of TiO_2. This is in marked contrast to most primary kaolins; those of Cornwall and Devon, for instance, have as a rule below 0·2 % of TiO_2.

In the course of an X-ray survey of various kaolin samples, it was found in this laboratory that a commercial sample of kaolin from Georgia gave a good kaolinite X-ray pattern. The chief constituent was clearly kaolinite and not one of the types intermediate between kaolinite and halloysite observed in fireclay, for which X-ray data have been given by Brindley and Robinson.[3] But extra lines were present in the diagrams which corresponded to the strongest anatase lines. A fraction below 0·2 micron equivalent diameter prepared by centrifuge separation showed a rather stronger anatase pattern and had, by chemical analysis, 5·7 % of TiO_2.

Electron micrographs of this fraction (figs. 1 and 2) show numerous dense particles of 0·05 to 0·2 micron diameter. These particles tend to

[1] G. W. Brindley and K. Robinson, Min. Mag., 1947, vol. 28, pp. 244–247.
[2] R. W. Smith, Bull. Geol. Surv. Georgia, 1929, no. 44.
[3] G. W. Brindley and K. Robinson, Trans. Brit. Ceram. Soc., 1947, vol. 46, pp. 49–62. [M.A. **10**–367.]





Electron micrographs of Georgia kaolin no. 5, fraction below 0·2 μ.
Fig. 1, ×18,000. Fig. 2, ×42,000.

be isometric with rounded, hexagonal, or square outline. Well-defined square particles like the one in the centre of fig. 2 are rare. These particles are denser than the hexagonal shapes of the kaolinite plates of similar or larger size shown in the same figure. Electron micrographs of fractions of comparable size from kaolinite samples from Cornwall do not show particles of this type. The higher density can be caused by greater thickness of the particles or by the higher scattering power of the titanium atoms in them. Both causes are probably active. It appears likely that these dense particles are anatase.

In order to follow this observation in more detail, six more commercial samples of kaolin from Georgia or South Carolina were examined. Fractions below 0·2 micron were prepared by centrifuge separation and the samples and fine fractions were analysed for titanium dioxide. The chemical analyses were done by colorimetric determination of the pertitanic acid in sulphuric acid, after a sodium carbonate fusion of the clay. The results are given in table I.

TABLE I. Titanium content of seven samples of sedimentary kaolin.

Sample.	TiO_2 % in whole sample.	TiO_2 % in fraction under 0·2 micron.
Georgia 1	1·3	0·8
,, 2	1·6	0·8
,, 3	1·6	1·6
,, 4	1·4	3·6
,, 5	2·3	5·6
,, 6*	2·0	2·4
South Carolina 1	1·2	1·7

* The sample marked no. 6 from Georgia was prepared in this laboratory from a coarser kaolin from Dry Branch, Georgia, kindly given us by Dr. R. E. Grim. The original sample had 1·6 % TiO_2.

All the samples showed anatase lines on X-ray diagrams and there was a reasonable agreement between the relative intensities of certain anatase lines and the analytical data.

The figures given in table I are not easy to interpret. If anatase is the stable form of titanium dioxide formed as a weathering product of titanium from primary minerals, then one might expect it to be concentrated in a fraction of particles of small size such as the one below 0·2 micron. Such a concentration seems to occur to a small extent in some but not in all of the samples.

As the fraction below 0·2 micron only represents from two to ten per cent. of the clays it is quite obvious that only a small portion of the total titanium occurs in this fraction.

A further sample of Georgia kaolin was split into six fractions by repeated decantations and the six fractions were analysed for titanium with the results given in table II.

TABLE II. Titanium contents of fractionated Georgia kaolin, no. 7.

Size of fraction in microns.	% TiO_2.
+ 10	0·8
5–10	1·0
2·5–5	1·2
1–2·5	1·7
0·5–1	1·9
below 0·5	2·6

This shows a regular small increase with decreasing particle size. Further data, which need not be given in detail here, also lead to the conclusion that the bulk of the anatase is distributed throughout the kaolin and not concentrated in any particular size fraction.

V. M. Goldschmidt[1] gives the value of 0·73 % TiO_2 (0·44 % Ti) as average for the composition of clay-sand sediments as well as of igneous rocks. Compared with this value, the titanium content of Georgia kaolin is high and that of kaolin from Cornwall and Devon is low.

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Abstract.—The occurrence of anatase in sedimentary kaolins from Georgia, U.S.A., is described on the basis of chemical, X-ray, and electron microscope studies. The anatase is of a size comparable to kaolinite which forms the chief constituent of the clays, but there is a slight tendency for it to be concentrated in the smallest size classes.

[1] V. M. Goldschmidt, Geochemische Verteilungsgesetze der Elemente. IX. Skrift. Norsk. Vid. Akad. I. 1938, for 1937, no. 4. [M.A. 7–166.]