On the Occurrence of Rutile-needles in Clays.

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THE discovery by my friend, Mr. Dick, of zircon, rutile, tourmaline, cyanite, &c., in the Hampstead and other sands,[1] and also the necessities of a work in which I am engaged, have induced me within the last few weeks to turn my attention in a somewhat systematic manner to the sedimentary rocks, and especially to the clays. At present I have examined only eight or nine samples of clays, but I have already come across a fact which I trust will be thought of sufficient interest to justify this communication. In examining the clays the method I adopt differs from that followed by Thurach in his classic investigations, "Ueber das vorkommen mikroskopischer Zirkone und Titan-Mineralien in den Gesteinen,"[2] only in one respect. I examine the washings which are removed by his process. The method is as follows:—The dry clay is roughly pounded up in a mortar, and the powder thus formed is placed in a sieve having 70 or 80 meshes to the inch. The sifting is effected under water in a porcelain basin. After most of the material has passed through, the sieve is removed, the water in the basin is agitated, and the turbid water is decanted. The process is repeated until only the clean grit remains. This grit contains quartz, felspar, and the heavy minerals zircon, tourmaline, rutile in orange and yellow crystals or grains, cyanite, pyrite, &c., when these are present. An average sample of the grit is examined both in water and when mounted in balsam, and also a sample from which the lighter materials have been roughly separated by vanning. The turbid water poured off during the first operation is allowed to settle in a beaker for about a minute, and then samples are taken by means of a glass tube from the top and bottom of the turbid portion.

Now I find amongst the finer material of certain clays a large number of extremely minute acicular crystals. These appear like short black bristles when examined with a low power, but under a high power and when mounted in balsam they are generally seen to be transparent and

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[1] *Nature*, Vol. XXXVI., p. 91.

[2] *Verh. d. phys.-medic. Gesellschaft zur Wurzburg. Neue Folge.* Band xviii.

nearly colourless; the blackness is evidently due to a marked difference between the refractive indices of the needles and the balsam. Some needles are so thin as to be dark under a very high magnifying power: these, however, are rare. The finest needles are less than ·001 mm. in thickness; but on the average their thickness is about ·002 mm. As a rule they are from 8 to 15 times longer than broad, but sometimes they are as much as 30 times longer than broad.

Under crossed nicols the thicker needles give colour, and even the thinnest on which any observation can be made produce a marked depolarising effect. They extinguish straight in all cases, and the minor axis of depolarisation (in this case an axis of elasticity) lies parallel with the length of the crystal. Assuming the mineral to be uniaxial, this shows that its double-refraction must be positive.

The above facts are sufficient to render it highly probable that we are here dealing with rutile, and this is rendered certain by the occurrence of the characteristic twins. Rutile frequently occurs twinned, so that the principal axes of the two individuals make angles of either 65° 35′ or 54° 44′ (Rosenbusch). Now both these types of twinning have been observed several times in the needles from the clays. The angles measured do not deviate more than one or at the most two degrees from the above values, and this deviation is well within the limits of experimental error. Sometimes, though rarely, the twinning is seen to be of a complex character, suggesting the sagenite aggregates of De Saussure.

The needles in question are similar to those which have been recognised by so many observers as occurring in the clay-slates, and which are generally termed clay-slate-needles (thon-schiefer-nädelchen). They were first described by Zirkel,[1] and subsequently identified as rutile by Werneke,[2] Cathrein,[3] and Sauer.[4]

Their occurrence in the clays is therefore by no means surprising; and I should not have described them so minutely were it not for the fact that their apparent absence from the clays has been commented upon. Thurach states that he has not found them in the ordinary sedimentary rocks; but this is easily accounted for, as they are carried away with the finer material during the process of washing, and he does not appear to have examined this material. I am not prepared to say that they are

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[1] *Pogg. Ann.* 1871, cxliv. 319.
[2] *Neues Jahrb.* 1880, ii. 281.
[3] *Ibid.* 1881, i. 169.
[4] *Ibid.* 1881, i. 227.

present in all clays, and they certainly vary in abundance in those specimens which contain them. In some they are extraordinarily abundant, in others they are comparatively rare. The needles must not be confused with the larger crystals and grains of rutile which are often so abundant in the finer sands and clays. The latter are probably as distinct in origin as they are in character from the former. I will now give a brief account of the mineralogical character of those clays in which I have observed the needles. The ill-defined substance (or substances) generally termed kaolin forms of course in each case the bulk of the clay. This will not be referred to.

The measurements appended will give a general notion of the sizes of the constituents.

Pipe-clay from the Bagshot Beds, Alum Bay, Isle of Wight.—Quartz grains; diameter of average grains about ·013 mm. Prisms of tourmaline sometimes terminated at one end by the faces of a rhombohedron and at the other by the basal plane, thus showing the characteristic hemimorphism; ·012 × ·02 and ·012 × ·046. Grains (·03) and crystals (·01 and ·06) of zircon. Anatase in octahedra; ·003 + ·01. Rutile-needles abundant, sometimes showing characteristic twins.

Sandy Kimmeridge Clay, Drayton.—A large number of microscropic nodules of pyrites, exactly similar in form and appearance to the well-known larger nodules; average size ·07 mm.; largest observed ·2 mm. zircon grains and crystals; ·13 × ·06 and smaller. Tourmaline. Rutile in grains and crystals; same size as zircon. Anatase in pyramidal (.02 × ·01), and also in tabular (·034 × 044) form. Cyanite in cleavage flakes (·16) giving extinction referred to trace of second cleavage of 28° and showing a negative bissectrix in convergent light. Rutile-needles scarce.

Sandy Clay containing Plant Remains from the Shaw Kiln, Newbury.—Quartz grains. Zircon in crystals, sometimes capped, and grains. Rutile in grains (·05), individual crystals and twins. Tourmaline. Black grains. Rutile-needles comparatively scarce.

Plastic Clay, Newbury.—Nodules of ferric oxide evidently pseudomorphous after pyrites-nodules similar to those described above. Quartz. The heavy minerals, zircon, tourmaline, &c., comparatively rare. Rutile-needles and twins.

Thames Mud at Kew.—Quartz grains. Zircon crystals and grains. Tourmaline. Several undetermined minerals. Many individuals and species of diatoms. Rutile-needles scarce. The abundance of diatoms suggests that these organisms may contribute an important amount of silica to certain argillaceous deposits.

Silurian Clay, Rubery Asylum, Lickey Hill, Worcestershire.—Quartz grains. Tourmaline. Zircon crystals and grains (rare). Black grains. Pyramidal anatase in very minute crystals. Rutile-needles both single and twinned.

In conclusion, I have to state that I am indebted to my friend, Mr. Jukes Browne, and also to Mr. Bennet, for several of the specimens above referred to.