

On Baddeleyite (native zirconia), a new Mineral, from Rakwana, Ceylon.

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SHORTLY after the Meeting of June 16th, at which Mr. Dick gave the description of the characters of Geikielite,¹ Mr. Joseph Baddeley, who had brought the specimens from Rakwana (or Rackwanné) (80°40' E., 6°25' N., in the District of Kollonnagam, Ceylon), courteously offered to present one of them to the British Museum for preservation in the Mineral Collection: the rest of his small store of eight or nine stones, picked out by him from a heap of other dense pebbles, he required for sending as samples to those friends in Ceylon whom he wished to interest in a search for further material.

In scrutinising the individuals of this small store with the view of selecting the best illustration of the characters of the new mineral, I remarked that one of the fragments differed from any pebble of Geikielite previously noticed in presenting a number of crystal-faces, and on closer examination saw that it really belonged to some other kind of mineral.

The fragment weighs a little over 3 grams, and is 10 mm. long, 12 mm. broad, and 8 mm. thick: it is iron-black in colour and opaque: its lustre is from submetallic to subresinous, and on some parts is splendid: in its hardness (6·5) it lies between adularia and quartz: it is brittle: the fracture is subconchoidal to uneven: the streak is brownish-white. The loss of weight in distilled water at 19 $\frac{3}{4}$ °C. corresponds (neglecting all corrections) to a specific gravity of 6·025. In general aspect the mineral is not unlike columbite.

Morphological Characters.

The form is illustrated in Fig. 1. There is only one well developed zone: it consists of two large parallel pinakoid faces a and \bar{a} , a narrow pinakoid face, b , perpendicular to the former, and three prism-faces m , \bar{m} , m' , having very different dimensions: the specimen shows evidence

¹ Page 145.

of fracture at the part where the faces \bar{b} and m' would be expected to be present. Of the original crystal, only two other visible faces d and δ survive: they form a small re-entrant angle of which the edge is parallel to the face \bar{a} . Most of the above faces are far from truly plane: the images obtained from \bar{m} , b , and δ with the δ -eyepiece of a Fuess-goniometer are fairly definite, but those from a and \bar{a} have each a range of $2\frac{1}{2}^\circ$, and those from m and \bar{m}' a range of $1\frac{1}{4}^\circ$: d gives no image at all.

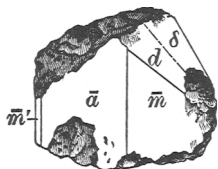


FIG. 1.

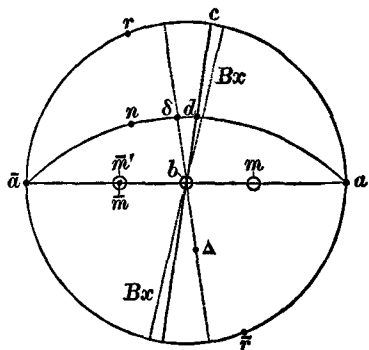


FIG. 2.

During the measurement of the zone $[\bar{a} d \delta]$ with the above eyepiece, an image was obtained from the uneven part between \bar{a} and d which corresponded to a minute face having the position indicated by the pole n (Fig. 2). Similarly, during the measurement of the zone $[b \delta]$, an image was obtained from a broken part of the crystal which corresponded to a minute face having the position indicated by the pole Δ . Further, after a small piece had been broken off for the purpose of optical examination, one part of the fracture gave an image corresponding to a plane having the position indicated by the pole \bar{r} ; and another image almost exactly 180° distant from the former, obtained from the broken part at the other side of the crystal, shows that this position is not an accidental one.

There is also a fair cleavage parallel to the face \bar{b} .

Notwithstanding the wide range of the images from the faces in the well developed zone, the probable perpendicularity of the faces a and b is sufficiently indicated, and there is a manifest symmetry of the prism-faces relative to those perpendicular planes: the most satisfactory images in the zone correspond to an angle of about 44° between the faces \bar{a} and \bar{m} : though it would be difficult to say directly from the measurements themselves that the true angle is not 45° , and measurement with a contact-

goniometer gave a result even as high as 47° . The only other visible faces of the original crystal, d and δ , are likewise far from satisfactory, d itself being too dull, as already mentioned, to give any image at all: still their aspect is such as to suggest that they are both real faces, in which case it would appear that the fragment is composite, and that the re-entrant angle $d\delta$ is probably a result of twinning about the face \bar{a} . The correctness of this interpretation gains support from the following facts:—

(1.) By reason of the weathering of the specimen, the existence of the "junction-plane" can be traced on other parts of the fragment, where the twinning is not otherwise evident.

(2.) The positions of the faces d and δ are consistent, as nearly as the measurements can be relied upon, with symmetry relative to a plane parallel to a .

(3.) The minute fracture-face Δ , unimportant in itself, is equidistant with δ from the face b , and can be accounted for as a face of the second individual.

With this interpretation we have:—

System:—Monosymmetric.

Elements:— $a : b : c = 0.9768 : 1 : 1.0475$

$$ac = 180^\circ - \beta = * 81^\circ 20'.$$

Parametral angles:— $100:110, 44^\circ 0'$; $001:101, 42^\circ 23'$;
 $001:011, 46^\circ 0'$.

Forms present:— $a \{100\}$, $b \{010\}$, which is also a cleavage,
 $m \{110\}$, $d \{011\}$.

Fracture-faces: $n \bar{1}\bar{1}1$ and $r \bar{1}02$.

Twin-plane and face of junction: $a \{100\}$.

Angles.	Observed.	Calculated.
$\bar{a}m'$	$\left(43\frac{3}{4}^\circ - 46\frac{3}{4}^\circ \right)$ (Best about 44°)	$*44^\circ 0'$
$\bar{m}'\bar{b}$	$\left(43\frac{3}{4}^\circ - 46\frac{3}{4}^\circ \right)$ (Best about 46°)	$*46^\circ 0'$
$\bar{a}n$	$57^\circ 49'$	$57^\circ 14'$
$n\delta$	$26^\circ 0'$	$26^\circ 46'$
δd	$11\frac{1}{4}^\circ$ (microscope)	$12^\circ 0'$
$\bar{a}r$	$111^\circ 42'$	$111^\circ 18'$
$\{b\delta$	$136^\circ 10'$	$*136^\circ 0'$
$\{b\Delta$	$135^\circ 17'$	
$\bar{m}\delta$	$54^\circ 9'$	$54^\circ 54'$

The calculated angles are based on those which are distinguished by asterisks.

Optical Characters.

(a.) Although the specimen is itself opaque, microscopic splinters are quite clear and transparent; they are of a light yellow colour and quite homogeneous.

(b.) Most of them when examined in convergent polarised light, show some portion or other of a biaxial figure: it is rare, however, to find a splinter which shows both hyperbolic brushes. The apparent axial angle is somewhat large: direct comparison with a flake of mica of measured axial angle indicated a slightly larger axial angle for the splinter, say 70° - 75° . In none of the many splinters examined was the acute bisectrix found to be in the centre of the field.

(c.) Where both eyes of the axial figure were simultaneously visible, one of them seemed more distinctly coloured than the other, but the difference was scarcely sufficient to fully establish any dispersion of the mean lines for different colours: in other splinters, however, showing only one of the optic axes and the acute bisectrix in the field, the hyperbolic brush is in some cases distinctly blue on the convex side, in others quite as distinctly red: there is never any evidence of want of symmetry relative to the plane of the optic axes itself. These characters point distinctly to inclined dispersion: and if such be really the case, and the above interpretation of the form of the crystal is the true one, the plane of the optic axes must be parallel to the small pinakoid face *b*.

(d.) Owing to the numerous irregular cracks which traverse it, the crystal was found to be too fragile to admit of the cutting of small definitely orientated plates from its fractured portions. By means of a knife small fragments, however, were broken off which sufficed for the preparation of plates having an orientation which was approximately known.

(1.) A small cleavage-fragment was obtained having its faces parallel to *b* and an edge parallel to the vertical edge [*a m*]. The fragment was mounted on a glass slide and the direction of the vertical edge indicated by a scratch on the glass: the fragment was then cautiously rubbed down (by Mr. T. Ryley, the departmental lapidary) until it was sufficiently thin to be transparent. On examination with the microscope, there was visible a series of structural lines having their common direction parallel to the scratch, and therefore to the vertical edge: the direction of extinction was found to be inclined to them at an angle of 13° , but on which crystallographic side there was nothing to determine. In convergent light no axial figure was seen.

(2.) In the same way a fragment was obtained which presented a portion of the face \bar{a} : but in this case there was no cleavage in the desired direction, the splinter was small, showed no edge belonging to the zone $[am]$, and was difficult to work: in fact, the first fragment broke up before it was thin enough for optical examination. In convergent polarised light an optic axis was visible on the extreme edge of the field, while the figure indicated that the acute bisectrix was outside: as far as could be distinguished, the plane of the optic axes passed through the centre of the field.

(3.) When fragments were broken from a corner of the face \bar{a} by means of a knife held perpendicularly to it, one of them was found to be an uneven plate showing a portion of the face \bar{a} and fitting into the crystal in such a way as to prove that its orientation was identical with that of a particular part of the fracture: the position of this part has been already indicated by its pole \bar{r} . After the plate had been mounted and rubbed down, an optic axis was visible almost exactly in the centre, and the acute bisectrix on the edge, of the field: the plane of the optic axes, as nearly as could be distinguished, was perpendicular to the scratch which fixed the direction of intersection of the plate with the face \bar{a} . The hyperbolic brush was in this case faintly blue on the concave side.

(e.) The above characters are all consistent with the crystal being mono-symmetric, and having its optic axes in the plane of symmetry. Since one optic axis is nearly perpendicular to the plane \bar{r} , and the acute bisectrix is inclined at an angle of 13° to the vertical edge, while the apparent axial angle is nearly 70° - 75° , it is inferred that the bisectrix is on the same side of the vertical edge as the zone-circle bd (as shown by Bx in Fig. 2).

(f.) The double refraction is strong: its sign is negative, or in other words the acute bisectrix is the a -axis of the optical indicatrix.

(g.) *Pleochroism*.—The splinters are pleochroic, changing from a greenish yellow to brown with the plane of polarisation of the light: when the principal plane of the single nicol is parallel to the plane of the optic axes and the light is travelling approximately along the acute bisectrix, the splinter is yellow: in the perpendicular position of the nicol, the splinter is brown.

Vibrations parallel to the acute bisectrix are most readily, those parallel to the obtuse bisectrix least readily, absorbed: vibrations parallel to the axis of symmetry of the crystal show intermediate absorption.

(h.) When the light which has traversed a splinter is examined with a spectroscope, no absorption-lines are visible in the spectrum.

Chemical Examination.

The above external characters not being identical with those of any known species, it became necessary to determine the chemical behaviour: but on account of the necessity of preserving the natural faces of what might possibly be a unique fragment, this was a determination requiring the exercise of great caution: fortunately the chemical behaviour was such that it was practicable to determine the precise chemical nature of the mineral without any appreciable injury of the specimen. The result, however, was so unexpected, and the morphological and optical characters are so distinct from those of artificial crystals of the same substance, that it is necessary to give a detailed account of the observations from which the conclusion as to the chemical nature is arrived at: the high specific gravity and the general resemblance to columbite and samarskite had seemed to point to a member of the tantalate group of minerals.

(a.) *Pyrognostic Characters.*—1. A splinter ignited in the blowpipe flame glows with the extreme brightness of the lime-light and becomes quite white: it does not decrepitate, is quite infusible even on its sharpest edges, and on cooling is found to retain its transparency and its action on polarised light.

(2.) Heated in a glass tube closed at one end, a minute quantity of the brownish-white powder gives off no perceptible fumes or vapour: its colour changes to a pinkish tint.

(3.) Fusion with borax or microcosmic salt in the reducing flame gives a bead which is colourless, hot and cold, and in the oxidising flame a bead which is yellow when hot and becomes first greenish and then colourless on cooling. In the microcosmic bead, the powder only disappears with extreme slowness: a small splinter first turned brownish-grey, then yellowish-white, and on prolonged ignition gradually broke up and gave a dull opalescent bead, colourless both hot and cold: (this excludes, amongst other minerals, samarskite, of which uranium is a normal constituent).

(4.) Fused with sodium carbonate and potassium nitrate, it gives a light brown bead, showing the absence of manganese: (this excludes, among other minerals, columbite and tantalite, of which manganese is a normal constituent).

(5.) Fused with sodium carbonate and potassium cyanide on charcoal, it gives no metallic residue.

(b.) *Action of acids.*—The mineral, whether in small splinters or fine powder, is almost absolutely unaffected by hot strong hydrochloric, nitric or nitro-hydrochloric acids, or by cold weak hydrofluoric acid: the powder, when examined with the microscope, is found to retain its original characters even after two months' immersion in cold hydrochloric acid; merely a trace of iron passing into solution. A small flake which had been boiled in strong sulphuric acid and then allowed to stand in the cold acid for two months was found to be quite unaltered: on very prolonged digestion in strong sulphuric acid, however, in a platinum crucible over a Bunsen burner, the powder is gradually affected, and the material can thus be brought, though with difficulty, into solution.

(c.) The fine powder is scarcely affected by fusion with caustic soda or a mixture of potassium and sodium carbonates: in the latter case, however, treatment of the fused mass with water and hydrochloric acid extracts an appreciable proportion of iron, and the insoluble residue is then perfectly white in colour. The mineral is gradually brought into a soluble form by fusion with potassium bisulphate.

(d.) Owing to the small amount of available material, the qualitative examinations were made to a certain extent quantitative.

36.8 milligrams of the powdered mineral, dried at 112°C ., still weighed 36.65 milligrams after exposure to a low red heat, and 36.4 milligrams after subjection to the full heat of a gas-blowpipe: it thus appears probable, having regard to the smallness of the change, that there is no appreciable proportion of volatile matter: the ignited powder was dark brown when hot and brownish-red when cold.

After fusion for nearly three hours with potassium bisulphate, the product was found to be completely soluble in cold water, thus excluding the possibility of the mineral being a tantalate or niobate.

The solution still retained its limpidity even after long boiling: thus excluding most compounds of titanitic acid.

Hydrochloric acid gave no precipitate, and sulphuretted hydrogen only a small precipitate of platinum sulphide, which was found to be fully accounted for by the loss of weight of the crucible in which the fusion had taken place.

After removal of the excess of sulphuretted hydrogen, oxidation, and addition of a large proportion of ammonium chloride, ammonia threw down a white (faintly tinged with yellow or light brown) bulky gelatinous precipitate; this was dissolved in hydrochloric acid and the precipitation repeated: after expulsion of the ammoniacal salts from the filtrates, ammonium oxalate and ammonia and sodium phosphate gave no indication of the presence of calcium or magnesium.

The ammonia precipitate was again dissolved in hydrochloric acid and the solution evaporated to dryness on the water-bath: the residue was small in volume, of a yellow colour, and consisted of gelatine-like flakes which had no action on polarised light: on treatment with water the flakes, which were not easily wetted, disappeared, but the solution was incomplete, for there was a slight opalescence as if due to a powder in a state of extremely fine division: it was found that this disappearance was less ready the longer the heating on the water-bath was continued: the whole of the material, however, passed through the pores of filter-paper. After the addition of hydrochloric acid and warming, the liquid became perfectly clear, and remained so on cooling: a strong cold solution of caustic potash gave a white gelatinous precipitate which seemed quite as bulky as that obtained with ammonia: no base could be detected in the filtrate. The precipitate was again dissolved in hydrochloric acid, the solution concentrated, and barium carbonate added in the cold: after removal of the barium the material was again found with the precipitate, while no trace of it could be detected in the filtrate. The ammonia precipitate was now dried (whereupon it contracted enormously, and became brown and wax-like), ignited and weighed: as the weight was still 29.1 milligrams out of the original 36.8, or nearly 80 per cent., notwithstanding a long series of operations intended to be only qualitative in general character, it was probable that it represented the whole in its characters.

(e.) In a second examination, 25.5 milligrams of the powdered mineral were first fused with a mixture of sodium and potassium carbonates: after treatment with water and hydrochloric acid there was evidently a considerable residue, from which, as already stated, the brownish tinge had disappeared: the weight of the residue was 23.6 milligrams: the solution was yellow, and yielded with ammonia a precipitate which consisted of sesquioxide of iron and weighed 1.2 milligrams: hence it is inferred that the iron is only present in the colouring matter. The 23.6 milligrams of insoluble residue were fused with potassium bisulphate, and after removal of a trace of platinum the solution was oxidised and precipitated with ammonia. The whole of this precipitate was found to be dissolved by oxalic acid giving a limpid solution, thus again excluding the rarer earths: the solution gave a bulky precipitate with ammonia, which after ignition was found to weigh 23 milligrams, practically the original weight of the insoluble residue.

It is thus clear, as suggested by the results of the first examination, that the whole is brought down by ammonia, and that the substance is either an "earth" or some compound which is reprecipitated whenever its acid

solution is neutralised : on the other hand, if the substance is an earth its characters are incompatible with those of the known members of that group (iron-indium) to which the complete solubility of the ammonia precipitate in oxalic acid and the complete precipitation of the hydrochloric acid solution by barium carbonate in the cold seemed to have relegated it.

(*f.*) The above mentioned ammonia precipitate, when powdered and ignited, was yellow while hot, and white when cold : ignited in a current of hydrogen, passed through the perforated lid of the crucible, the powder became dark grey in colour, but even after prolonged action the weight was only reduced by a fraction of a milligram, and nothing appreciable was extracted by means of dilute hydrochloric acid : when ignited in air, the powder resumed its original character.

The ignited precipitate is quite unacted upon by hot strong hydrochloric acid, even when the digestion is long continued.

It behaves in the borax and microcosmic beads in the same way as the original powder.

(*g.*) The above precipitate was again brought into solution in the same way as before, reprecipitated by ammonia, and the whole redissolved in hydrochloric acid. With this solution sodium carbonate gave a precipitate which redissolved when the reagent was in considerable excess : the solution was partially precipitated on boiling, and the precipitate did not effervesce on solution in acid : it was found that the incompleteness of the precipitation on boiling was not due to the presence of two kinds of material.

Experimenting on a much smaller scale, the same reaction was observed in the case of ammonium carbonate.

This behaviour is so characteristic of zirconia that comparative experiments were made on about the same weight of that material, and it was found that with this quantity of zirconia the solution of the ammonia precipitate in oxalic acid and the precipitation by barium carbonate in the cold are both of them complete. All the above reactions are thus consistent with the mineral being zirconia coloured by a small proportion of an iron compound.

(*h.*) A drop of the hydrochloric acid solution of the ammonia precipitate allowed to evaporate spontaneously on a glass slide gives a crystallised residue consisting of long needles, each branching into several others near its extremity.

The whole of the precipitate was dissolved in hydrochloric acid and allowed to evaporate more slowly in a watch-glass : it crystallised com-

pletely as long flat colourless transparent crystals of uniform character ; in parts of the watch-glass, however, a faint yellow tinge indicated that a trace of iron was present : the crystals had an oblique termination (about 70°), and showed strong double refraction, the direction of extinction being parallel to their longer edges. They disappeared immediately when moistened with water. On exposure to the air, they suffered alteration and lost their action on polarised light.

Direct comparison with the crystallised product (hydrated oxychloride of zirconium) derived from zirconia by a similar series of operations simultaneously performed showed that distinction between them was impossible : these products are shown at the Meeting.

(i.) The nitric acid solution of the ammonia precipitate gives no trace of precipitate with molybdic solution, showing the absence of phosphoric acid.

(j.) Mixed with powdered potassium bisulphate and fluor spar, a small portion of the ammonia precipitate gave no green colouration to the flame, showing the absence of boric acid.

(k.) There is not the faintest colouration when a strip of zinc is dissolved in, or when hydrogen peroxide is added to, the hydrochloric acid solution of the ammonia precipitate : showing the absence of tungstic, molybdic, titanous and niobic acids.

(l.) Various other experiments were made with the ammonia precipitate and its hydrochloric acid solution :—

(1.) The precipitate is insoluble in acetic acid.

(2.) The hydrochloric acid solution gives no absorption-bands when examined with the spectroscope.

(3.) On addition of ammonium sulphide, the ammonia precipitate becomes tinged with green (trace of iron).

(4.) The precipitation by ammonia is completely prevented by the addition of tartaric acid.

(5.) Addition of ammonium sulphide to the last solution gives, after a time, a small precipitate of greenish colour (trace of iron).

(6.) The hydrochloric acid solution gives immediately a white gelatinous precipitate with sodium phosphate.

(7.) It gives an apple-green precipitate with potassium ferrocyanide (trace of iron).

(8.) It gives no visible reaction with potassium ferricyanide, sulphate, or bichromate.

(9.) If nearly neutralised with ammonia, it gives an opalescence with ammonium oxalate, and afterwards a not very bulky precipitate :

but on filtration nothing remains on the filter, and the opalescent filtrate becomes clear on standing.

(10.) On conversion into sulphate, and expulsion of the excess of sulphuric acid, the residue dissolves in water : on warming, the solution gives a considerable white precipitate soluble in oxalic acid.

(11.) Notwithstanding the complete solubility of the ammonia precipitate in oxalic acid, addition of a few drops of that reagent to a small quantity of the hydrochloric acid solution seemed to give a slight precipitate.

(12.) The hydrochloric acid solution turns turmeric paper brown.

(18.) A borax bead, if saturated with the ammonia precipitate and then heated for some time in a Bunsen flame to volatilise the excess of solvent, is found to contain long prismatic crystals.

All these reactions are consistent with the substance being zirconia.

Artificial Crystals of Zirconia.

Baron Nordenskiöld¹ obtained excellent microscopic crystals of zirconia by heating ordinary zirconia and borax together in a porcelain-oven : they belong to the tetragonal system and are isomorphous with cassiterite, zircon and rutile.

M^M. Lévy and Bourgeois² obtained crystallisations of two kinds by heating zirconia and sodium carbonate together, and the two forms, though both optically uniaxial, are apparently incompatible with each other : one kind consists of rectangular crystalline aggregations, perhaps really identical with that obtained by Baron Nordenskiöld, the other consists of hexagonal composite lamellæ : the specific gravity of the latter kind is as low as 4.9.

For this new mineral I beg to propose the name *Baddeleyite*, in honour of Mr. Joseph Baddeley, by whom the interesting dense minerals of Rakwana have been brought to the notice of the mineralogical world.

APPENDIX.

Since the results of the above investigation were sent to *Nature* (1892, Vol. 46, p. 420) for publication, a description of a new mineral, *Brazilite*, has appeared in the *Neues Jahrbuch für Mineralogie* (1892, Band 2, p. 141), as part of a letter sent by Dr. Hussak from Brazil in the month of June : the mineral is found as an accessory constituent of an augitic rock

¹ *Pogg. Annalen der Physik* ; 1861, Vol. 114, p. 625.

² *Bull. Soc. Min. de France* : 1882, Vol. 5. p. 136.

of S. Paulo, to which Mr. Orville Derby has given the name of Jacupirangite, and had been regarded three years ago by Dr. Hussak (who had then only a small amount of material for examination) as probably orthite, a mineral with which it agrees in its more obvious external characters: it is mentioned as orthite in Mr. Derby's description of the constituents of the rock. More recently Dr. Hussak, on isolating a score of "flawless crystals" from the decomposed rock, recognised the distinctness of the mineral from orthite, determined the geometrical and physical characters, and decided from a chemical examination that the material was a tantaloniobate of probably some member of the yttrium-cerium group. On January 3, 1893, I received from Dr. Hussak a separate copy of his paper with a statement written on the margin that the mineral, which had been sent to Sweden for a quantitative analysis, has been determined by Professor Blomstrand to be "almost pure zirconia."

As regards crystalline form, the parametral elements obtained by myself for Baddeleyite agree, though only expected to be of an approximate character, in a very satisfactory way with those determined by Dr. Hussak for the Brazilian mineral: Dr. Hussak's values being

$$a : b : c = 0.98594 : 1 : 0.51091; \beta = 98^{\circ}45\frac{1}{2}' :$$

the parametral element c having been thus taken as half that of the corresponding element of Baddeleyite. For the reasons already mentioned (p. 149), the fundamental angle am (44°) was only given to what seemed the nearest degree: it is interesting to remark that in my measurement-book, under date July 1892, it is noted that the best pair of images corresponded to an angle of $44^{\circ}18'$: Dr. Hussak's final result is $44^{\circ}17\frac{1}{2}'$. Dr. Hussak's crystals are flawless and rich in forms.

The descriptions of the optical characters of the two minerals are practically identical. The only important deviation of external character is in the case of the specific gravity; that of Baddeleyite is 6.025, that of selected crystals of the Brazilian mineral is 5.006.

Now it seems almost impossible that the specific gravity of crystals of an almost pure simple oxide, presenting otherwise identical characters, can vary to this extent, and the explanation of all the difficulty will probably be found to be that Dr. Hussak's specimens really belong to two distinct minerals; that while the crystalline form and optical characters were determined from the one (zirconia), the specific gravity and the composition were originally determined from the other (tantaloniobate of yttrium). In fact, it was stated in my letter to *Nature* that the Baddeleyite is associated at Ceylon with such a chemical compound, and I may

add that this associated mineral was there designated without the use of the expected species-name, for the very reason that it was found to have a specific gravity (4.9) far below the inferior limit (5.5) hitherto observed in the case of undoubted Yttrotantalite: it was intended later to ascertain whether or not the lowness of the specific gravity was associated with a difference in the chemical composition: this has since been done by my colleague, Mr. G. T. Prior, with the result that the mineral is found to be chemically identical with Fergusonite. Further, the zirconia and tantalio-niobate from Ceylon are very similar to each other in general aspect, and might easily be mistaken the one for the other. It need scarcely be pointed out that this explanation would be consistent with the complete accuracy of the observations of Dr. Hussak, whose reputation stands so high in the annals of Mineralogical Science.

There remains the fact that two names have thus come to be suggested for the same mineral: according to the Rules of Nomenclature formulated by Dana (Rule 13*d*) the name Baddeleyite should stand: I may remark that the name Brazilite was in use in England, commercially at least, eight years ago for the specification of an oil-bearing rock found in the neighbourhood of Bahia.

Postscript.—In a letter just received by me from Brazil, Dr. Hussak, with characteristic courtesy, offers to simplify mineralogical nomenclature by withdrawing the name Brazilite. He further informs me that by an unlucky series of accidents the 5½ grams of carefully selected material, already recognised by Dr. Hussak from its geometrical and physical characters to be a new mineral, had been sent off by post to Professor Blomstrand, in Sweden, 18 months ago, but failed to reach its destination; the letter of Professor Blomstrand to Brazil notifying the non-arrival of the material likewise miscarried; though the next 1½ grams reached Sweden safely, the letter giving the analytical results did not get to Brazil; meantime Dr. Hussak began a six months' journey into the interior of the country.
