

*A hydrated barium-strontium pyrochlore in a biotite rock from Panda Hill, Tanganyika.*¹

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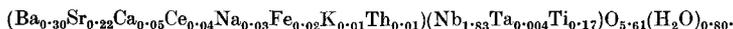
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Summary. A hydrated barium-strontium pyrochlore with only subordinate amounts of Ca and Na has been found in a weathered biotite rock (contact-rock of a carbonatite) from Panda Hill, Tanganyika, as small euhedral yellowish-grey cubic crystals (showing the combination of the octahedron and the cube) in a rock containing euhedral biotite, some orthoclase, and several other minerals. Hydrated Ba-Sr pyrochlore is isotropic, the refractive index varies from 2.07 to 2.10. The reflectivity (vertical illumination) is 13.2%. H. 4½-5. Poor {111} cleavage. The pyrochlore structure (space-group O_h^2-Fd3m) and the unit-cell dimensions (a 10.562 Å.) are derived from X-ray powder and Weissenberg photographs. The calculated specific gravity is 4.01 (observed, 4.00 on dried material). Chemical analysis gives BaO 12.5, SrO 6.4, Na₂O 0.28, K₂O 0.25, CaO 1.35, rare earths (mainly Ce₂O₃) 2, ThO₂ 0.6, FeO 0.45, TiO₂ 3.9, Nb₂O₅ 67.0, Ta₂O₅ 0.22, H₂O + 4.0, other constituents 2.21, total 101.16. After deduction for impurities the following formula resulted:



The ideal formula for pyrochlore is $A_2B_2O_6(\text{F},\text{OH})$. In the mineral described only a third of the A -positions are occupied by Ba, Sr, &c. Infra-red spectrophotometry does not indicate hydroxyl-groups. When the mineral is treated with TiNO₃ solution the intensities of the X-ray diffraction lines 333/511, and 444 are changed; hydrated Ba-Sr pyrochlore shows a certain exchange-capacity.

The name *pandaite*, from Panda Hill, is proposed for the new mineral.

IN the concession area of the Mbeya Exploration Company² (Mbexco) near Mbeya (Tanganyika) (fig. 1a) Dr. J. F. Osten, former geologist of the Mbexco, found early in 1956 a strongly weathered biotite-rich rock, in which he observed many very small yellowish-grey crystals resembling

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² The Mbeya Exploration Company Ltd. (Mbexco) is jointly owned by the N.V. Billiton Maatschappij, Netherlands, and the Colonial Development Corporation, Great Britain. The Mbeya carbonatite (also known as the Panda Hill carbonatite) is a pyrochlore-bearing carbonatite that is being developed by the Mbexco.

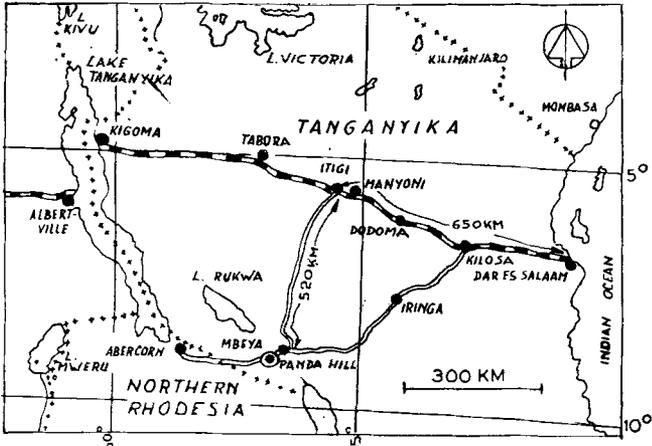


FIG. 1^a = POSITION OF PANDA HILL IN TANGANYIKA

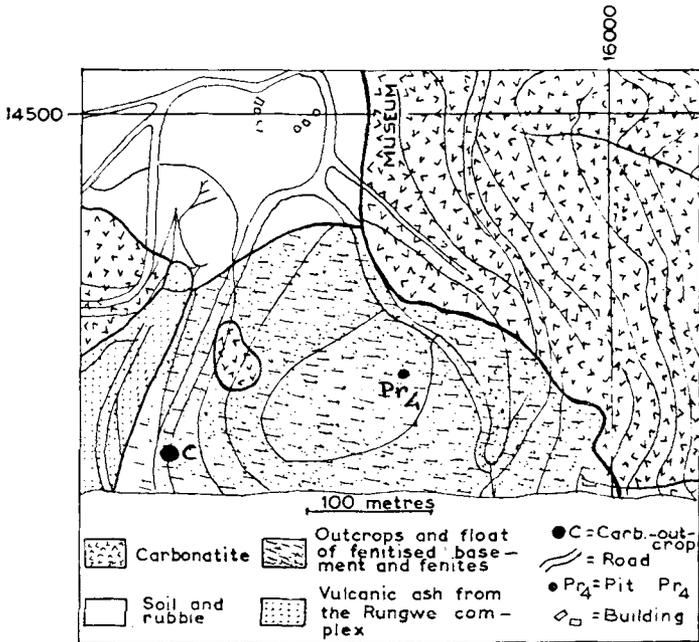


FIG. 1^b = PART OF THE GENERALISED GEOLOGICAL MAP OF THE MBEYA CARBONATITE (FROM THE PAPER OF FICK AND V.D. HEYDE)

common pyrochlore. He concluded that the relatively high Nb_2O_5 content (1–2 %) of the rock was due to these crystals. Later on, bulk samples of this rock were sent to the laboratories of the N.V. Billiton Maatschappij at Arnhem (Netherlands) for ore-dressing tests. In the Mineralogical and Petrographical Department of these laboratories the yellowish-grey mineral was examined with X-rays, and it was found that it has the pyrochlore structure but that the unit-cell dimension is relatively great. Also the high Ba and Sr content and the lack of Ca were striking. These facts point to a new variety of the pyrochlore family, a barium-strontium pyrochlore. A barium-bearing pyrochlore with nearly the same powder pattern, but with somewhat different intensities of the X-ray reflections, found in Alaska (exact locality unknown), has been reported but not yet described by J. Berman (1955).

The Ba-Sr pyrochlore is found in a strongly weathered biotite-rock. According to L. J. Fick and C. van der Heyde (in press) this rock belongs to a series of fenitized rocks occurring in a roof pendant of the Mbeya carbonatite. The location of the pit where the biotite rock is found can be seen in the small map (fig. 1b) and is indicated with Pr₄. The mineral is also found in several other fenitized rocks, in this area for example those of the Kunja zone. For further data concerning the geology of the Mbeya carbonatite, reference is made to the papers of A. P. Fawley and T. C. James (1955) and of L. J. Fick and C. van der Heyde (in press).

The minerals of the biotite rock.

We investigated rock samples and identified in thin sections and polished specimens the following minerals: major components: biotite, orthoclase (nearly always strongly kaolinized), and limonite; minor components: Ba-Sr pyrochlore, fluorite, quartz, apatite, zircon, chlorite, plagioclase (not further determined), rutile, and hematite. During the tests for ore-dressing, concentrates and tailings were investigated. The following minerals were found: In the concentrates, Ba-Sr pyrochlore, hematite, limonite, martite, fluorite, zircon, tourmaline, sphene, red and yellow garnet, magnetite, columbite, rutile, and several tailing components; in the tailings, biotite, apatite, orthoclase, some quartz, and several concentrate components. Cassiterite is also found in the mineral concentrates (perhaps due to mill contamination). Baryte and celestine were never observed, neither microscopically nor in X-ray powder photographs. Biotite and orthoclase were more fully investigated besides the Ba-Sr pyrochlore.

Biotite occurs in the rock in two forms, a euhedral or nearly euhedral and an anhedral shape. The euhedral biotite shows clearly a zonal structure. The kernels of this mica have very dark tints; the border is very light coloured. The measured optical constants and pleochroism are: Border, α light reddish brown, β very light green, γ very light green, n_m (mean index of refraction in the plane of β and γ) approx. 1.583, $2V$ nearly 0° ; kernel, α rather dark reddish brown, β olive-green to dark brownish olive-green, γ olive-green, n_m approx. 1.603, $2V$ approx. 10° . The anhedral mica has the following optical constants and pleochroism: α light green to reddish brown, β , γ greenish brown to dark olive-green, n_m approx. 1.593, $2V$ approx. 10° .

A concentrate of mica was prepared from the tailings obtained by ore-dressing tests by treatment with heavy liquids, namely a mixture of alcohol and bromoform, density 2.69, and methylene iodide, density 3.30; this concentrate was analysed, and gave:¹ Na₂O 0.85, K₂O 10.1, Al₂O₃ 6.9, SiO₂ 36, FeO 3.6, Fe₂O₃ 8.5, MgO 15, TiO₂ 1.2, Li₂O 0.25 %. An unknown part of the Fe₂O₃ is due to intergrowths of limonite.

According to the tables of W. E. Tröger, pp. 83, 84 (1952), the borders of the euhedral mica-crystals are iron-rich phlogopite. The kernels of these crystals as well as the anhedral mica correspond to varieties of mica between an iron-rich phlogopite and meroxene. The chemical analysis of the concentrate of the biotite is in fair agreement with the measured optical constants.

Orthoclase. In several thin sections $2V$ was measured in relatively fresh orthoclase, and varied from 36° to 68° . Six measurements were above 53° and only two below this value. An orthoclase concentrate was prepared from the tailings obtained by ore-dressing tests by treatment with a mixture of alcohol and bromoform (sp. gr. 2.69). This concentrate, with about 60 % feldspar, was partially analysed. The results are as follows (the alkalis were determined chemically, Ba, Sr, and Al spectrographically): Na₂O 1.3, K₂O 8.8, BaO < 0.1, SrO < 0.1, Al₂O₃ 9.7 %. The orthoclase is mostly anhedral and only rarely subhedral. The rock contains only very few crystals of plagioclase.

Structure and genesis of the biotite rock.

In the fresh fracture plane and in polished surfaces of the biotite rock, greyish-black to dark grey patches with more or less sharply defined contours can be observed. These patches lie in fields of medium grey to

¹ The SiO₂ was spectrographically estimated, the other data chemically determined.

medium dark grey colour (fig. 2). The rock is small to fine grained.

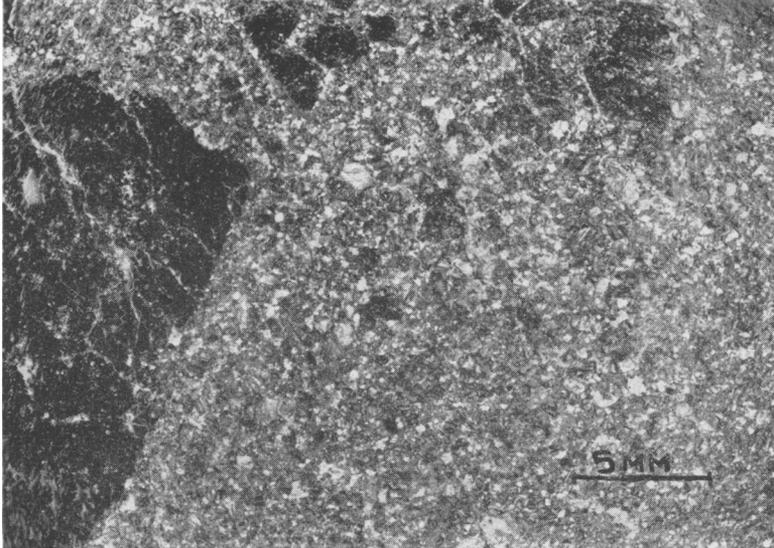


FIG. 2. Photomicrograph of a polished biotite rock (oblique reflected light, 1 mm. on the photo. is c. 280 μ). Black patches = biotite aggregates, white spots = Ba-Sr pyrochlore (for more than the half), grey = euhedral biotite (the shape not observable on the photo.).

The dark coloured patches are aggregates of anhedral biotite crystals with reddish-brown to dark olive-green colours in thin sections. Ba-Sr pyrochlore is lacking in the dark parts. Recrystallization zones and veins with euhedral biotite and Ba-Sr pyrochlore are observed in the dark patches, the borders of which are rather irregular, probably due to corrosion by the surrounding greyish areas. In thin section the crystal-size of the biotite in the dark coloured patches was estimated at a mean of 60 to 100 μ , with a range from 10 to 330 μ ; in the greyish areas the mean size was about 100 to 300 μ , with a range from 25 to 1900 μ .

The medium grey to medium dark grey parts are mainly composed of euhedral to nearly euhedral biotite with (in thin section) very light coloured borders (fig. 3). The kernels of these mica crystals are dark reddish brown to dark olive-green. Locally they are nearly opaque, owing to abundant very fine inclusions. Other minerals observed in thin

section are rather strongly kaolinized orthoclase (locally concentrated), Ba-Sr pyrochlore, locally much limonite, and rarely some quartz. The composition by volume is roughly estimated at 1 to 25 % orthoclase,

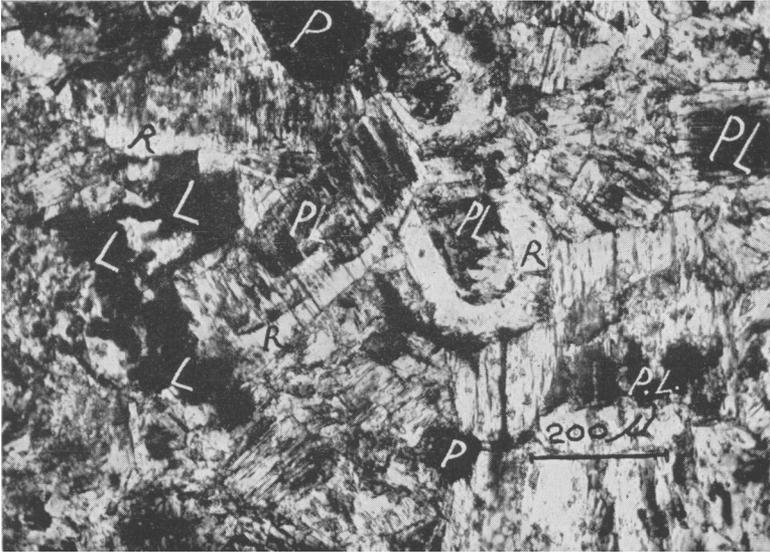


FIG. 3. Photomicrograph of the part of the biotite rock with the euhedral biotite (transmitted ordinary light, 1 mm. on the photo. is $c. 11.5 \mu$). P = pyrochlore (here nearly opaque), PL = euhedral biotite, R = light coloured borders of the biotite, L = limonite (photo. made by Prof. Dr. Ir. C. Schouten).

0 to 6 % Ba-Sr pyrochlore, 50 to 100 % biotite, and up to 20 % other minerals in the grey areas, while the dark patches contain 90 to 100 % biotite. The genesis of the rock is not clear. It belongs to the contact zone of the Mbeya carbonatite. The euhedral shape of the biotite in the greyish rock parts points to partial anatexis with supply of material (Ba, Sr, Nb).

Mineral separation.

To obtain a sample of pure Ba-Sr pyrochlore the rock was crushed and the mineral concentrated with a shaking table. This table concentrate had a Nb_2O_5 content of 39 %. 485 g. of this concentrate were centrifuged with methylene iodide (sp. gr. 3.30). About 83 % of the sample had a density more than 3.30, and contained the Ba-Sr pyrochlore.

Since the larger Ba-Sr pyrochlore crystals and fragments contain many inclusions and the smaller ones much less, the dense fraction was sieved on a 200-mesh screen. A Frantz Isodynamic separator was used on the

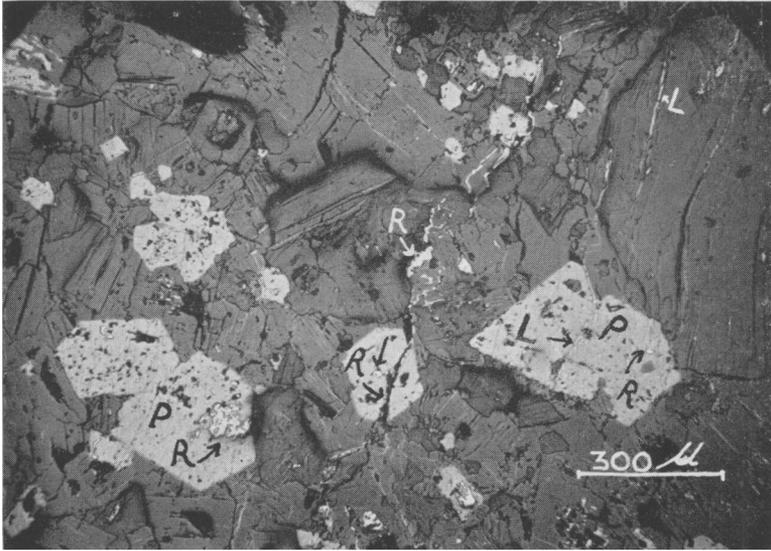


FIG. 4. Photomicrograph of the biotite rock with the Ba-Sr pyrochlore (vertically reflected ordinary light, 1 mm. on the photo. is *c.* 16.2 μ). P = Ba-Sr pyrochlore (light grey), R = rutile (white and light grey), dark grey = gangue material (biotite, &c.), black = pits, cleavages, trenches, &c. (photo. made by Prof. Dr. Ir. C. Schouten).

part of the sample passing 200 mesh, in order to obtain a very high concentrate of Ba-Sr pyrochlore, and this rich product was centrifuged once more with methylene iodide. The dense fraction was treated with Clerici solution (sp. gr. 4.25), and the light fraction of this last separation was treated twice more with methylene iodide, to try to remove the last traces of apatite and zircon. The end-product (19.14 g.) contained only very small amounts of other minerals such as apatite, zircon, rutile, quartz, &c. About 1 g. of the 'pure' Ba-Sr pyrochlore was used to make two polished sections, to study the contamination in the sample; the product was also examined with a binocular microscope and a petrographical microscope. Fifteen grammes of the final product were used for the chemical and spectrographical analysis. In the same manner another Ba-Sr pyrochlore sample was made with a Nb_2O_5 content of

about 70 % (spectrographical estimation); part of this sample was used for the infra-red spectrographic analysis.

Description of the hydrated Ba-Sr pyrochlore.

Physical properties. Ba-Sr pyrochlore occurs as euhedral crystals showing a combination of the octahedron and very small cube faces.

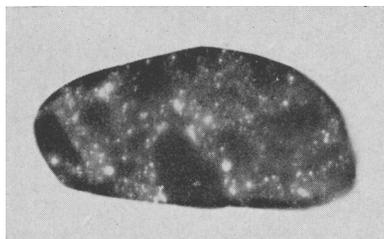


FIG. 5. Positive print of an autoradiograph of biotite rock (real size). Exp. time 28 days, made with Ilford Ilflex X-ray film. Dark grey = biotite aggregates, medium grey = euhedral biotite (weakly radioactive), light grey to white = Ba-Sr pyrochlore.

The small size (down to $10\ \mu$) of the purest crystals and the many inclusions in the larger crystals (the largest measure $800\ \mu$) made measurements of physical properties difficult. The colour of the pure mineral, seen macroscopically, is yellowish-grey (5 Y 7/2) to somewhat light olive-grey (5 Y 5/2) (symbols according to Rock-colour Chart, 1951). With a binocular microscope it is observed that the colour of the crystals is yellowish-grey (5 Y 7/2) to very pale orange (10 YR 8/2). In polished sections a very poor $\{111\}$ cleavage was observed; the fracture is conchoidal. Mr. K. Taylor of the Geological Survey of Great Britain, Atomic Energy Division, measured the micro-hardness of the mineral. He obtained a value of 550 V.H.N. (Vickers Hardness Number); a G.K.N. hardness tester was used with 100 g. load. According to E. W. Taylor (1949) this corresponds with a hardness between $4\frac{1}{2}$ and 5 on Mohs' scale. The mineral is radioactive, due to its U and Th content (see chemical analysis).¹ An autoradiograph (fig. 5) made of a polished rock section shows many radioactive patches. Pure Ba-Sr pyrochlore is non-magnetic. When it has rutile or limonite intergrowths it is weakly magnetic and most of these grains can be removed from the concentrate with a Frantz Isodynamic magnetic separator. In thin section the

¹ After completion of the manuscript, it was found that another Ba-Sr pyrochlore sample with 67 % Nb_2O_5 contained 0.31 % U and 0.72 % Th.

mineral is translucent; when it is weathered or when it contains many fine colourless inclusions it is opaque white. The composition of the products of alteration is unknown.

Ba-Sr pyrochlore is isotropic. The refractive index lies mainly between 2.08 and 2.09, but some crystals have indices between 2.09 and 2.10 and some between 2.07 and 2.08. In vertical reflected light the colour of the mineral is grey. The reflectivity is 13.2 % (determined by Mr. K. Taylor), measured photoelectrically with the apparatus described by S. H. U. Bowie (1957). This was done in air, using white light of colour-temperature 3050° K. With crossed nicols the internal reflection of pure Ba-Sr pyrochlore is colourless to white. Several times a brownish to reddish internal reflection was observed, due to very fine limonite inclusions. These properties agree well with those of the other members of the pyrochlore family.

Density measurements using the pycnometer and immersion methods (in Clerici solution) always gave high values compared with the calculated density from chemical formula, lattice constant, and type of structure (pyrochlore). This is attributed to water adsorbed in the holes of the crystal structure during the weighing of the sample in water and lost when the sample is dried at 110° C. Therefore we changed the pycnometer method as follows: The powder was covered with distilled water, evacuated, and weighed. After this we found a great difference in weight between the sample dried in vacuum at room temperature and the material heated to 110° C. The vacuum-dried sample showed lower density values, but still too high because of the water that remained in the holes of the crystals. The vacuum-dried powder was heated to 130° C. in the thermobalance; the loss in weight gave the correction to dried material. Density values derived from pycnometer method: Normal method, 4.11–4.15; vacuum-dried 4.04; thermobalance correction –1%, so the corrected value for dry material is 4.00. The calculated density value (from X-ray data and chemical composition) is 4.01.

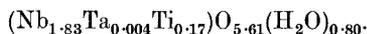
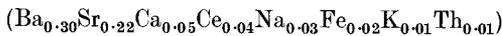
In Clerici solution of density 4.04 the crystals floated in the beginning, but after several days they sank to the bottom while their colour had changed from greyish to orange-yellow.

Chemical composition. Before analysis the sample was dried during several hours at a temperature of 100–110° C. The H_2O^+ content was then established by the Penfield method. During this analysis the sample was heated to a temperature not higher than 500° C. After 5 to 10 minutes no more water was lost. SO_3 , F, and rare earths together with ThO_2 were determined by the usual chemical methods. Subtracting

the spectrographically determined value of ThO_2 ($\pm 0.6\%$) the total amount of the rare earths could be found. Spectrographically Ce, Yt, and La were found in the proportion of roughly 40:2:1. CO_2 was determined by a gas-evolution method and Na_2O and K_2O by flame-photometry. The other values, including ThO_2 , were spectrographically determined. The Nb_2O_5 content was checked spectrophotometrically, using hydrogen peroxide in sulphuric acid; this gave the same value as the spectrographic determination. CaO and FeO were determined both by chemical methods and spectrographically, giving (spectrographic data in parentheses): CaO 1.4% (1.3%), FeO 0.45% (0.45%).

Mr. J. H. L. Zwiers of the Analytical Institute T.N.O., Rijswijk, did not find any indication of hydroxyl groups by infra-red spectrophotometry. Unfortunately, it was impossible to prepare a completely pure pyrochlore sample. In a polished section a minor quantity of rutile was observed (estimated 0.1–0.2 per cent. by weight). Other impurities are zircon, phlogopite, orthoclase, apatite, cassiterite, and quartz.

Table I gives the spectrographical-chemical analysis of the mineral, from which we derive the formula:



We cannot decide if Fe is, according to this formula, really in *A*-positions; $\text{Fe} \rightleftharpoons \text{Nb}$ substitution is also possible. The formula, compared with the normal pyrochlore formula $\text{CaNa}(\text{Nb}_2\text{O}_6)\text{F} = A_2B_2O_6F$, indicates a lack in Ba, Sr, Ca, Na . . . atoms; only a third of the *A*-positions are occupied. There is also a small deficit in oxygen (5.6 instead of 6) and instead of 1 fluorine we found only 0.8 water molecules. In the *A*-group of elements Ba and Sr dominate over Ca and Na. The pyrochlore-mineral in the biotite rock of Panda Hill is thus a partially hydrated *barium-strontium pyrochlore*, with only one-third of the *A*-positions occupied by cations.

D.T.A. and thermobalance investigations. 0.4 g. of Ba-Sr pyrochlore and of common Ca-Na pyrochlore from Panda Hill were analysed with D.T.A. apparatus (E. Jäger and S. Schilling, 1956), giving the results shown in fig. 6. Ba-Sr pyrochlore shows an endothermic peak at 330° C. and exothermic reactions at 540°, 800°, and 820° C. The endothermic peak is the dehydration-peak; at the first exothermic reaction the pyrochlore structure of the Ba-Sr pyrochlore is totally destroyed, as we found by X-ray analysis. Common Ca-Na pyrochlore shows no dehydration peak;

the broad exothermic peaks at 400° and 600° C. might be due to oxidation or recrystallization. X-ray diagrams of Ca-Na pyrochlore heated to 600° C. indicate recrystallization from a weakly metamict state. The dehydration by means of the thermobalance apparatus (Chevenard type) was carried out with 2.0 g. of Ba-Sr pyrochlore previously dried at 130° C., and gave the curve shown in fig. 7. D.T.A. and thermobalance analyses show that the dehydration process is finished at 350° C. Therefore it is probable that in this structure the water is present as H₂O molecules and not as (OH) groups.

TABLE I. Chemical composition of hydrated barium-strontium pyrochlore from Panda Hill.

			<i>Analysis of the purest material available.</i>	<i>Analysis corrected for impurities.*</i>	<i>Molecular ratios</i>	<i>Atomic ratios on a basis of 2(Nb,Ti,Ta).</i>
Na ₂ O	...	...	0.28	0.28	4.5	Na 0.031
K ₂ O	...	...	0.25	0.15	1.6	K 0.011
CaO	...	...	1.35	0.86	15.3	Ca 0.054
BaO	...	...	12.5	12.88	84.0	Ba 0.295
SrO	...	...	6.4	6.60	63.7	Sr 0.224
Rare earths†	...	...	2	2.06	6.3	Ce 0.044
ThO ₂	...	...	0.6	0.62	2.3	Th 0.008
FeO‡	...	...	0.45	0.44	6.1	Fe" 0.021
TiO ₂	...	...	3.9	3.87	48.4	Ti 0.170
Nb ₂ O ₅	...	...	67	69.06	259.8	Nb 1.826
Ta ₂ O ₅	...	...	0.22	0.23	0.5	Ta 0.004
H ₂ O +	...	...	4.0	4.11	228.1	H ₂ O 0.802
MnO	...	...	0.01			O 5.61
MgO	...	...	0.07			
ZrO ₂	...	...	0.28			
SnO ₂	...	...	0.32			
SiO ₂	...	...	0.89			
PbO	...	...	0.01			
CuO	...	...	0.01			
Al ₂ O ₃	...	...	0.12			
SO ₃	...	...	trace			
CO ₂	...	...	0.1			
F	...	...	trace			
P ₂ O ₅	...	...	0.4			
Total	...	...	101.16	101.16		

* The analysis is corrected for impurities by deduction of 0.42 % zircon, 0.27 % phlogopite (with some Fe"), 0.42 % orthoclase (with some Na), 0.92 % apatite, 0.32 % cassiterite, 0.33 % quartz, 0.15 % rutile (estimated in polished section), and by deduction of 0.01 % CuO, 0.01 % PbO, and 0.1 % CO₂.

† Calculated as Ce₂O₃.

‡ All iron is calculated to FeO.

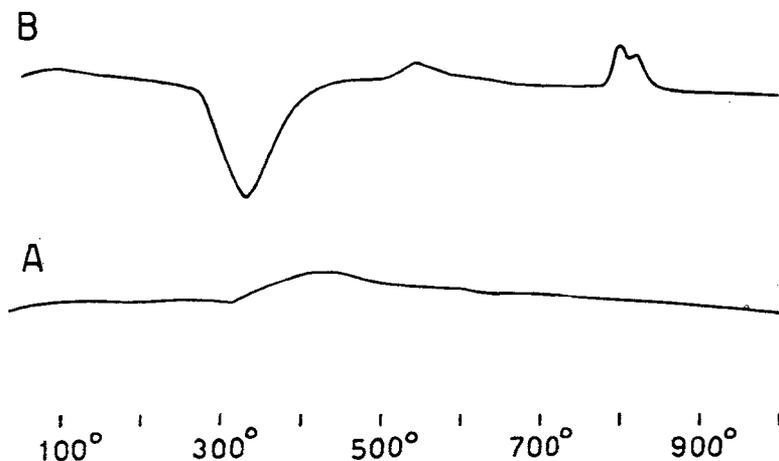


FIG. 6. A: D.T.A. curve of Na-Ca pyrochlore; B: D.T.A. curve of Ba-Sr pyrochlore. Heating-rate 10° C. per minute, inert material corundum.

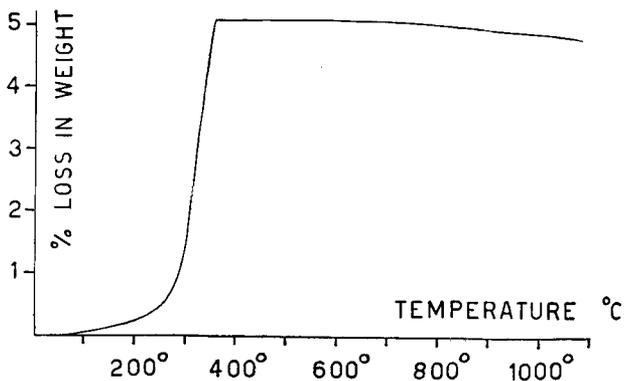


FIG. 7. Dehydration curve of Ba-Sr pyrochlore, heating-rate 2.5° C. per minute.

X-ray data. A small crystal of Ba-Sr pyrochlore 0.08 mm. in diameter was examined by rotating crystal and Weissenberg methods. We looked for forbidden reflections according to R. S. Roth (1956), but only spots with the indices allowed in the pyrochlore structure were found. We conclude that the mineral is a true member of the pyrochlore group. From powder photographs (table II) we calculated the lattice constant a 10.562 ± 0.006 Å. This value was found by linear extrapolation to the zero value of the function $\cos^2 \theta / \sin \theta + \cos \theta / \theta$.

TABLE II. Powder data (Fe- $K\alpha$ radiation) of two Ba-Sr pyrochlore samples. Intensities estimated.

1488 CB.				1614 DA.			
d , Å.	d , Å.	I .	hkl .	d , Å.	d , Å.	I .	hkl .
6.11	6.09	80	111	1.373	1.373	15	731/553
3.18	3.18	50	311	1.320	1.319	15	800
3.045	3.044	100	222	1.243	1.244	5	822/660
2.638	2.636	40	400	—	1.218	2	751/555
2.421	2.424	< 1	331	1.211	1.210	50	662
2.156	2.152	5	422	1.180	1.180	50	840
2.033	2.029	20	511/333	1.159	1.158	10	911/753
1.866	1.864	70	440	1.107	1.106	10	931
1.783	1.781	15	531	1.077	1.077	40	844
1.611	1.609	5	533	1.061	1.061	10	933/771/755
1.592	1.590	70	622	1.0164 α_1	1.0164 α_1	60	10.2.2/666
1.524	1.521	20	444	1.0160 α_2	1.0160 α_2	10	
1.479	1.477	15	711/551				

In some powder patterns of Ba-Sr pyrochlore we also found reflections with d -values of 2.238 and 1.755 Å., which might correspond to the forbidden indices 332 and 600/422. In Weissenberg photographs these spots are always absent; in powder patterns they are caused by small quantities of quartz ($d = 2.24$ Å.) and perhaps tapiolite ($d = 1.75$ Å.). The strongest quartz line ($d = 3.343$ Å.) is always present. In addition, the Weissenberg diagrams gave us the allowed reflection 620 ($d = 1.670$ Å.).

From the gravity measurements we might expect an exchange capacity. Therefore Ba-Sr pyrochlore was treated with a concentrated solution of TINO_3 for 10 days and then an X-ray diffractometer diagram was made. Comparing this with the diagram of untreated Ba-Sr pyrochlore we found a marked change in the intensities of the 333/511, and 444 reflections. Moreover the 222, 400, and 440 reflections of the TINO_3 -treated Ba-Sr pyrochlore are accompanied by very weak lines (the intensity of these reflections is less than 5 % of the main reflection) with higher d -values (see refl. 440 of curve I in fig. 8). The differences between main reflection and satellite agree with $\Delta a = +0.1$ Å. It is not clear why only three reflections show this effect. We tried to remove the Tl-ions from the treated Ba-Sr pyrochlore by digestion with $\frac{1}{4}$ N nitric acid for 5 days. A new X-ray diffractometer diagram showed the disappearance of the satellites and the intensities of the 333/511, and 444 reflections approached the mean value between TINO_3 -treated and normal Ba-Sr pyrochlore (see fig. 8). Diffractometer curves from Ba-Sr pyrochlore treated with Clerici solution also showed strong changes in the intensities and a

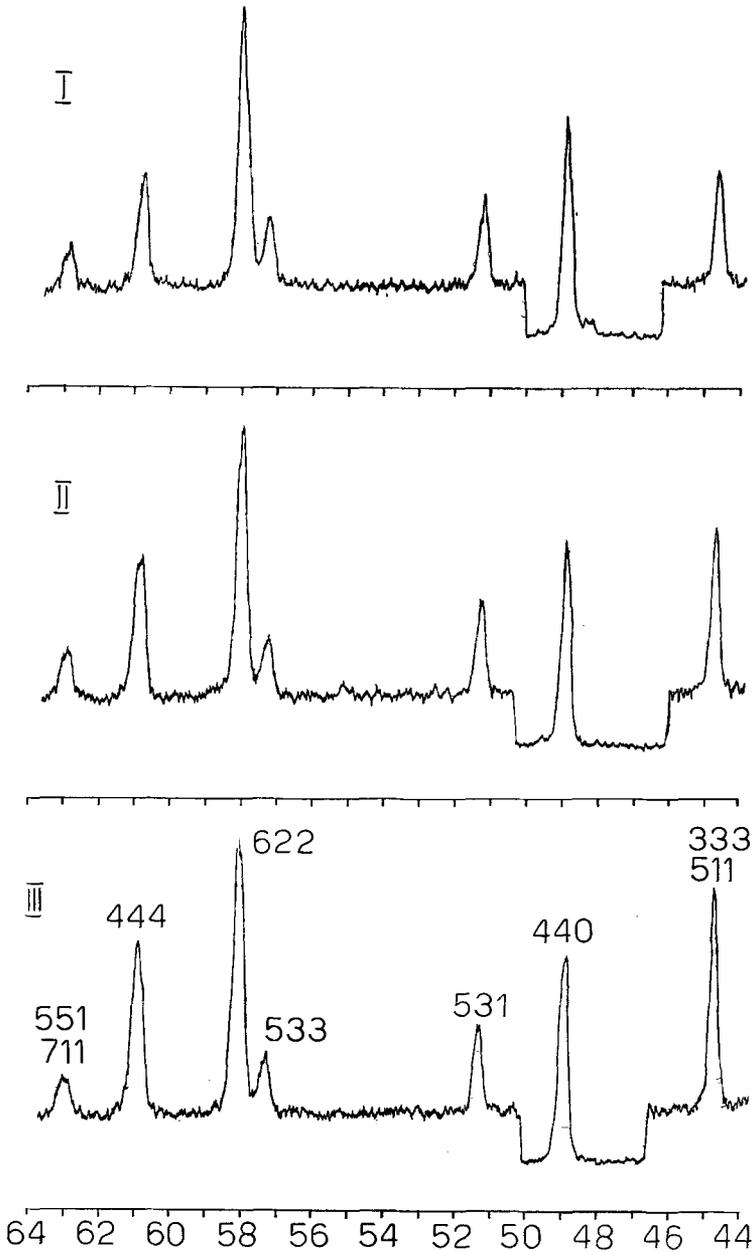


FIG. 8. X-ray diffractometer diagrams of Ba-Sr pyrochlore: I, TlNO_3 treated; II, sample I HNO_3 -treated; III, untreated. The numbers under the diagram III indicate the diffraction angles, 2θ ; reflection 440 is measured with half the sensitivity of the others.

broadening of many reflections to higher d -values. A diffractometer diagram of Ba-Sr pyrochlore heated to 350° C. gives only minor differences in intensities and a small shrinkage of the lattice constant, $\Delta a = 0.015$. The following points can be stated from X-ray experiments: the mineral shows pyrochlore structure; the lattice constant is higher than usual in natural pyrochlores (except the Ba-bearing pyrochlore reported by J. Berman, 1955); the holes in the structure can be filled up reversibly by Tl-ions; and heating to 700° C. destroys the pyrochlore structure whereas heating to dehydration (350° C.) does not give essential changes.

Discussion of the experimental results. Infra-red, D.T.A., and thermo-balance analyses indicate the presence of water molecules. From chemical analysis a domination of $(\text{Ba,Sr})_{0.52}$ over $(\text{Ca,Na,Fe,Ce,Th,K})_{0.16}$ was found. Besides this some F and (Ca,Na) positions must be vacant or occupied by water molecules. This leads to the following considerations:

In the normal pyrochlore structure the fluorine ions are surrounded by 4 (Ca,Na) positions and each Ca or Na ion has two F ions as nearest neighbours. The result is a network of Ca-F links, branched at every fluorine position. In the Ba-Sr pyrochlore described only half of this network of positions is occupied: $(\text{Ba,Sr,Na...})_{0.68} + (\text{H}_2\text{O})_{0.80} = 1.48$ instead of $(\text{Ca,Na})_2 + \text{F} = 3$. Thus results a system of irregular channels in the Ba-Sr pyrochlore structure. From this point of view a certain possibility of exchange capacity can be expected, which was confirmed by treatment with concentrated TlNO_3 solution. We do not yet understand the results with Clerici solution. These exchange experiments have just been started and are being continued.

The mineral occurs in a weathered rock and it is possible that, connected with a hydration process, the pyrochlore of the biotite-rock of Panda Hill lost a part of the A-position ions.

Nomenclature. It is well known that there is no unanimously accepted rule in the nomenclature of the pyrochlore group. Some authors prefer to include under pyrochlore all the members of the group. Others give distinct names to the various members of this group.

We prefer the latter and therefore propose to give the mineral described above the name of *pandaite* (after Panda Hill). This name shall be used for those minerals of the pyrochlore group in which Ba predominates over other elements in the A positions.

The pandaite of Panda Hill having an important Sr-content can be characterized more exactly as a strontian pandaite.

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