

Monazite and Xenotime in European Rocks.

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(Communicated by the General Secretary.)

[Read June 17th, 1897.]

AS the phosphates of the cerium and yttrium groups, monazite and xenotime, have proved to be quite widespread microscopic accessories in certain types of Brazilian granites and gneisses, a *batea* test has recently been made on a number of hand specimens obtained from the mineral establishment of Dr. F. Krantz, of Bonn, for the purpose of determining if these interesting minerals were equally characteristic of the corresponding types of European rocks. About half of an ordinary museum specimen was crushed in a porcelain mortar to pass through a moderately fine sieve, concentrated in the *batea* and examined under the microscope after cleaning with the Thoulet or Klein solution, or both, and, when necessary, with the electro-magnet. The identifications of the minerals in the residues thus obtained, especially in cases of doubt, have been kindly revised by Dr. Eugen Hussak.

In making the selection for examination, attention was mainly directed to kaolins of granitic origin, pegmatites, muscovite and muscovite-biotite granites and gneisses, experience in Brazil having shown that negative results might usually be expected from rocks of a more basic character, though one of the minerals in question, monazite, has proved to be a quite common accessory in the purely biotite granites and gneisses as well. In a number of cases the residue obtained was so small (the almost ubiquitous zircon, magnetite and ilmenite being represented by less than a dozen grains) that no definite conclusion could be drawn from a negative result with regard to the presumably rarer accessories. In the notes below, other accessories are only mentioned in cases in which they seemed to offer special interest.

KAOLINS.

Limoëges, France.—Residue very small, containing a few minute milky-white octahedra of xenotime, transparent and glassy at the edges, associated

with rare elongated and short stout prisms of zircon. More abundant are irregular amorphous pinkish granules which, as they often enclose crystals of xenotime and give micro-chemical reactions for phosphoric acid, and apparently also for yttria, are presumed to be alteration products of that mineral. The other elements of the residue are tourmaline in minute slender, white, blue and brown needles, magnetite in minute splendid octahedra and aggregates, ilmenite showing a yellowish alteration product, anatase in irregular bluish white grains, and pseudobrookite represented by a single transparent tabular crystal of deep red colour.

Carlsbad, Bohemia.—Rare grains of unmistakable monazite and anatase, mingled with abundant splendid prisms of zircon and rare octahedral crystals which, from the form and optical characters, so far as they can be determined, might be either zircon or xenotime. A single rather ill-formed specimen appears to be one of the characteristic intergrowths of the two minerals, and in this case the said octahedra, and a number of discoloured grains that could not be satisfactorily determined, may be presumed to be xenotime. A peculiar feature of this kaolin is a great abundance of siderite in rounded aggregates, evidently of secondary origin, ranging from microscopic grains up to the size of a pea, or larger.

These two kaolins appear to result from the decomposition of pegmatites or of muscovite-granites. Washings were also made of kaolin from Seilitz, near Meissen, Saxony (syenite?), Schemnitz, Hungary (trachyte?), and Türkismühle, Nahe, Rhenish Prussia. The residue of the second was comparatively abundant, but relatively small in the other two. Zircon occurs in all in sharp angled splendid prisms, with which rounded forms rich in faces are associated in the Schemnitz rock. The secondary titanium minerals are anatase in the first (possibly after original titanite, as the ilmenite grains show little or no alteration), rutile (sagenite) in the second, and a yellowish aggregate (leucoxene?) in the third. Dirty white opaque grains in the Schemnitz rock are possibly altered titanite.

PEGMATITES.

Hitterö, Norway.—Residue extremely small, with rare grains of zircon and a single grain of titanite.

Ronsperg, Bohemia.—Residue small, mainly composed of garnet with rare tourmalines, zircons and monazite. The specimen, like the preceding, is a typical graphic granite.

Davos, Switzerland.—Residue of garnet with extremely rare zircons.

Offenbanya, Hungary.—Residue consisting mainly of coarse tourmalines and garnets; zircon and iron minerals extremely rare.

Glaser-Haj, Hungary.—Garnet only, no zircon or iron minerals observed.

Chaum, Pyrenees.—Tourmaline only, no zircon observed.

Vallée de Burbe, Pyrenees.—A single grain of zircon only, represents the rare accessories.

Geyer, Saxony.—Residue small, consisting mainly of prismatic zircons with rare octahedral forms that may be either zircon or xenotime, a single fragment of monazite.

Selb, Bohemia.—Residue, apart from tourmaline and epidote, extremely small, consisting mainly of iron minerals and rare grains of zircon and orthite (?).

Pisek, Bohemia.—Residue abundant, but consisting almost exclusively of fragments of the macroscopic monazite and xenotime for which the locality is celebrated, perfect microscopic crystals being extremely rare.

Striegau, Silesia.—Residue consisting of fine white epidote and beautiful microscopic tourmalines, the heavy accessories being rather rare, small, ill-formed and discoloured by iron oxide, so that their determination is somewhat difficult. Zircon and xenotime occur, but no monazite was observed. Anatase and orthite are rare.

Fuchsberg, Striegau, Silesia.—Abundant residue of coarse tourmaline, apatite, and fine green epidote. Zircon abundant in rather large splendid prisms, with which are associated rare octahedral forms which have more the aspect of zircon than of xenotime.

Oberbessenbach, Spessart.—Residue mainly of magnetite and garnet, with a few large zoned white and yellow zircons and numerous fragments that may be of macroscopic yellow zircons or of monazite. Rather large opaque and rudely formed octahedra occur that are probably partially altered xenotimes, a conclusion that is favoured by one or two ill-formed grains that appear to be intergrowths of xenotime and zircon.

Glattbach, Spessart.—A great quantity of garnet (spessartine) of remarkable beauty and perfection of form, numerous and comparatively large intergrowths of xenotime and zircon, with rarer isolated individuals of the same minerals and of monazite.

APLITES.

Grotto Doccei, Elba.—Numerous but minute intergrowths of xenotime and zircon, whitened, but of singular beauty and perfection of form, with rarer isolated grains of the same minerals, monazite and orthite with strong pleochroism suggestive of andalusite.

Stutzerbach, Thuringia.—Zircon rare and ill-formed, but rather large, magnetite in fine octahedra.

Beresovsk, Ural (Beresite).—A great quantity of cubic pyrites with rare magnetite, zircon, monazite and titanite, the latter possibly of secondary origin, as it is whitish, and in other respects different in aspect from the original titanites of the other rocks examined.

MUSCOVITE GRANITES.

Heidelberg, Baden.—Residue mainly composed of tourmaline and handsome garnets like those of the pegmatite of Glattbach. The heavy residue is very small, and composed of small and mainly rounded grains that, being discoloured by oxide of iron, are not easily determinable. Unmistakable grains of zircon and monazite were observed, and xenotime is probably also present, as indicated by rare octahedra. These might be zircons, but are more probably xenotime, as a couple of ill-formed grains that are almost certainly intergrowths of the two minerals were observed.

Eibenstock, Saxony.—Zircon abundant and fine, rutile also abundant and with the aspect of cassiterite, but giving the titanium reaction with the blowpipe; monazite, xenotime and anatase rare. The grains referred to xenotime are dirty and ill-formed, but the occurrence of the mineral is apparently confirmed by a few cases of intergrowth, though these are not so perfect as might be desired for a perfectly satisfactory identification.

Selb, Bavaria.—Zircon abundant, mostly semi-opaque, whitened and pitted (malaeonised). The comparatively rare grains referred to xenotime have suffered the same alteration, and are therefore scarcely distinguishable. Apparent intergrowths of the two occur rarely. The rather rare monazite, on the contrary, is unaltered, bright yellow, often coated with oxide of iron.

Asch, Bohemia.—An almost completely decomposed rock, which has perhaps furnished the kaolin from the same locality, as the heavy residue is similar, being composed almost exclusively of zircon and anatase.

Königsstein, Silesia.—Fine zircons with a great abundance of beautifully crystallised brown epidote.

Severn, Wosges.—Residue, exclusive of tourmaline, small, consisting of extremely pellucid zircons and greenish anatase.

Berzet, Auvergne, France.—Zircon abundant and fine, mostly rounded, though sharp angled forms also occur; monazite comparatively rare in

rounded grains, rarely with distinct faces; blue anatase abundant, fine in colour, but ill formed.

Porto, Portugal.—Zircon with much yellow and brown anatase, rarely in perfect crystals, rare grains of brookite and of a black mineral with a yellow margin like that of the two-mica granite from the same locality.

MUSCOVITE-BIOTITE GRANITES.

Wunsiedel, Bavaria.—Zircon abundant in extremely handsome elongated prisms, often rounded at the edges and irregularly pitted, as if they had suffered an action of re-absorption; the rare octahedral grains have more the aspect of zircon than of xenotime; blue and green anatase, brookite, apatite and andalusite.

Frauenthal, Bohemia.—Residue, consisting mainly of tourmaline and andalusite, with rare zircons and fine crystals of blue and green anatase.

Reuth, near Gefrees, Fichtelgebirge.—Much apatite with zircon, monazite and xenotime. The two last not being well defined in form and colour from zircon, were verified with the spectroscope. Inter-growths of xenotime and zircon occur, but are ill defined, owing to the almost complete envelopment of the central crystal of zircon by the xenotime.

Johanngeorgenstadt, Saxony.—Zircon abundant in large, handsome prisms and small rounded grains; yellow rutile also abundant; monazite comparatively rare.

Corwan, Cornwall.—Zircon abundant in small and handsome prisms, with extremely elongated pyramids; iron-stained and ill formed grains may represent monazite or xenotime, or both, but are perhaps zircons.

Haytor, Devonshire.—Zircon and monazite tolerably abundant in pellucid grains, mostly rounded at the edges and angles.

Louchon, Pyrenees.—Zircon abundant in elongated prisms and rounded forms, rich in faces, rare grains of rutile.

Altweiler, Vosges.—Much zircon and blue anatase; a black mineral of which a single grain shows faces apparently of the tetragonal system, could not be determined.

Bressoir, Vosges.—Apatite abundant with fine blue anatase; zircon and andalusite rare.

Porto, Portugal.—Zircon, anatase and very handsome brookite are comparatively rare; more abundant is an opaque yellowish mineral, which evidently results from the alteration of a black one, as grains with a black centre and a yellow semi-transparent border are frequent. The appearance is that of ilmenite with a superficial alteration to leucoxene, or of

pyrites altered to limonite, but negative results were obtained in tests for titanium, and with acids. The form is apparently tetragonal, as several tolerably well formed prisms and a single perfect octahedron were observed. A test for silica with hydrofluoric acid gave a negative result. The same mineral occurs rarely, and not so well defined in form, in the muscovite granite of the same locality.

BIOTITE GRANITES.

As most of the representatives of this group at hand were known to carry titanite, and were therefore presumed to be unfavourable for the special purpose of this investigation, only a few were examined on account of some peculiarity of the type or of interest in the locality.

Jekaterinenburg, Ural (Plietengranite).—Great abundance of large and extremely handsome titanite, few and small zircons, green epidote, much magnetite, apatite abundant.

Wiborg, Finland (Rapakiwi).—Comparatively large and handsome zircons, with apatite. The larger zircons often contain crystalline inclusions which in part seem to be small needles of the same mineral, in part apatite.

Breitenstock, Switzerland (Protogine Granite).—Great abundance of small but very fine zircons, with fragments of tourmaline.

Heidelberg, Baden (Porphyritic Granite).—Zircon and apatite abundant, the former frequently enclosing crystals of magnetite.

Serra de Conillas, Portugal.—Zircon and apatite, the latter much the most abundant, large and fine, often with pleochroic bands of dust-like inclusions arranged parallel to the prismatic faces.

Shap, Westmoreland.—Zircon, apatite and titanite abundant and fine, pyrites very rich in faces.

GRANITE-GNEISS.

Altweiler, Vosges.—Residue small, consisting principally of apatite with rare zircons.

Repistye, Hungary.—Fine zircons with tourmaline and rare grains of anatase.

Straitkopf, Thuringia.—Residue abundant, with apatite and zircon in about equal proportions.

Ruhla, Thuringia.—Handsome sharp angled zircons abundant, with fine crystals of apatite and with titanite.

Trusethal, Thuringia.—Zircon extremely abundant and exceptionally fine, full of cavities, and the larger ones with included crystals which appear to be small zircons.

Albersweiler, Bohemia.—Residue small, with more apatite than zircon.

Fussberg, near Aschaffenburg, Spessart.—Zircon extremely abundant in small and for the most part rounded grains. No other rare accessories observed.

Grauberg, Spessart.—Zircon abundant with beautiful zonal structure, apatite abundant, monazite rather rare but in large grains, rutile (?) rare, no xenotime seen.

Ruhwald, near Gailbach, Spessart.—Much magnetite; non-magnetic residue very dirty and discoloured by oxide of iron, with zircon, monazite, and xenotime in about equal proportions; apatite, which is given by Kitter, extremely rare, only two grains being found in two preparations.

Lochmühle, near Rochlitz, Saxony.—Of the two specimens from this place, one is decidedly gneissic, the other decidedly granitic in aspect. Both are rich in biotite, and from their general appearance were, before washing, judged to be unfavourable for the main purpose of this investigation. Both gave extremely abundant heavy residues, in which small milky-white octahedra of xenotime predominate. The grains are often transparent and glassy at the margins, the troubled milky appearance of the central portions being apparently due to fracturing, rather than to alteration. Monazite in tabular rounded crystals, rich in inclusions, is abundant in the granitic type, but lacking in the other. The same type has rare prisms of apatite with a dark centre, full of dust-like inclusions and larger rounded masses that resemble glass inclusions. Both rocks have an abundance of colourless zircons, rich in inclusions of prismatic and pyramidal types, the latter often compressed giving very singular and beautiful rhombic, rarely trigonal, tabular forms. Rare grains of anatase in both rocks. If xenotime should, like monazite, become commercially valuable, these rocks or the detritus from them might repay examination.