

Thorite in Nigerian Products

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A review of standard
and newly-developed
methods of identification.

Abstract

Economically interesting concentrations of thorite occur in certain Nigerian granites and in the alluvial and eluvial deposits derived therefrom. "Crude" gravity concentrates obtained from these bodies invariably contain an abundance of zircon which, unlike the other associated species, is superficially similar to the thorite grains. Rapid differentiation between these species, both in the field and the mill, is, therefore, the fundamental requisite for identification.

Reported methods for identifying thorite are noted and several new ones, which depend on staining techniques and which may be used to obtain semi-quantitative data, are fully described.

Introduction

In Nigeria thorite (ThSiO_4) tends to occur in economically interesting concentrations in the columbite-bearing granites and in the alluvial and eluvial deposits derived from these. "Crude" gravity concentrates prepared from these bodies usually contain, in addition to thorite and columbite, a number of other "heavy" minerals, including varieties of zircon which are so similar to thorite that rapid differentiation by inspection cannot always be made with certainty. Both thorite and zircon crystallize in the tetragonal system and frequently display similar habits. Both species possess practically the same specific gravity range and their magnetic properties do not always differ sufficiently to permit a clean separation to be made by magnetic methods(1).²

The bulk of Nigerian thorite is reddish-brown and opaque and often many of the associated zircons are not dissimilar in colour, although locally other colours predominate and even in a given deposit the zircons may show a considerable colour range. Furthermore, the dark opaque zircon, unlike the pink transparent variety which is found, for example, in Malaya, does not

fluoresce under ultra-violet light. The white, or near-white opaque Nigerian zircons, however, fluoresce a golden-yellow under short-wave ultra-violet light and the writers have also demonstrated that dark zircons, having been bleached by prolonged immersion in boiling hydrochloric acid, frequently fluoresce under the same conditions. This fact may be of some diagnostic value.

Aids to Identification

Mackay's Method

The ultra-violet light method, developed by Mackay and others (2) primarily for the identification of Nigerian columbite in mill and field samples, also permits the simultaneous recognition of thorite.

In essence the test is conducted as follows:—A quantity of sodium fluoride/fusion mixture/sodium bisulphate flux is so melted in a nickel tray that the bottom is covered with a thin veneer of melt. After cooling, a representative fraction of the sample of grains is scattered over the tray and the whole is heated until the flux melts and then for a further 20 seconds. Finally the cooled product is examined under ultra-violet light. Under these circumstances the columbite grains are surrounded by pale-yellow fluorescent haloes, while grains of thorite, unlike those of any other species normally present in Nigerian products, are associated with intense yellow haloes. Grains of monazite and of zircon are sometimes characterized by the presence of very pale fluorescent haloes.

Considerable practise is necessary before the test can be conducted consistently in such a manner that the fluorescent compound, derived from reaction between a given grain and the adjacent flux, does not contaminate the flux in the vicinity of other grains. Furthermore, only a comparatively small quantity of sample can be conveniently treated at any given time and the products

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² Figures in parentheses refer to the references given at the end of this article.

cannot readily be examined microscopically under ultra-violet light. On the other hand, the employment of a solid comparatively innocuous reagent (although sodium fluoride is poisonous) and fairly simple apparatus, are attractive features of the method.

Jones' Method

Jones (3) who has conducted a series of experiments on the effects of hot concentrated hydrochloric acid on a number of Nigerian minerals, notes that this treatment removes iron and thorium from thorite and leaves a characteristic, fragile, white, non-magnetic silica shell which retains the original shape of the parent grain. He further observes that after 4 hours to 5 hours treatment the thorite loses about 85% of its original weight. Zircon crystals, on the other hand, are rapidly bleached and demagnetized and their radioactivity and specific gravity are decreased.

The present writers have confirmed that when a sample is boiled for only 25 min. with concentrated hydrochloric acid any grains of thorite or zircon present can be fairly readily identified under a binocular microscope. It is clear, however, that if the thorite were coloured distinctively, instead of becoming white, it could be identified much more readily and the approximate quantity present in a given sample could, with experience, be determined easily by unaided visual inspection.

It was also considered by the present writers that the approximate thorite content in a sample of known weight might be obtained by removing any light minerals by treatment with bromoform, subjecting the heavy fraction to a hot hydrochloric acid attack for 25 min., and then removing the thorite shells by means of bromoform and multiplying their dry weight by a factor obtained by the same treatment of a similar sample of known thorite content. However, this was shown to be useless as given thorite grains differed in the degree to which they were attacked (due to differences in size and probably composition also) and not infrequently crystals of heavy minerals—such as, cassiterite—which are not appreciably attacked by the acid treatment were intergrown with the thorite and prevented the silica shells from floating.

Staining Techniques

The procedures described here are the outcome of work undertaken to develop

methods for the certain identification and approximate determination of Nigerian thorite in field and mill gravity concentrates and fractions derived from these by other means. Such tests had to be simple and rapid and necessitate the use of neither ultra-violet light nor the microscope.

The material used during the investigations was derived from the Nigerian mining areas of Federe and Odegi.

(1) Ammonium Molybdate Method

Transfer about 2 g. of the sample to a 100-ml. beaker and cover with the minimum of concentrated hydrochloric acid. Cover with a watch-glass and boil rapidly for 4 min. Decant and wash the residue 5 or 6 times with water, but leave the solids just covered with water after the last wash. Add about 0.5 g. of *finely-ground* ammonium molybdate and swirl to effect solution. Add 10 ml. of concentrated nitric acid and boil rapidly for 3 min. Decant, wash 8 times with water, dry, and examine with or without the aid of a binocular microscope.

This treatment causes thorite grains, unlike grains of other species normally occurring in Nigerian gravity concentrates, to assume a matt, intense lemon-yellow appearance, while zircon grains become bleached and glassy. Any dark minerals are coated, to varying degrees, with a whitish veneer.

Notes

(i) If syrupy phosphoric acid is used instead of hydrochloric acid the thorite grains become a deeper yellow.

(ii) Semi-quantitative data can be obtained by comparing the unknown with standard samples which have been similarly treated. These will not deteriorate appreciably provided they remain in a dry atmosphere.

(2) Methylene Blue Method

After an initial attack with hydrochloric or phosphoric acid, exactly as indicated in the ammonium molybdate method, decant, wash 5 or 6 times with water, add 10 ml. of a 1.25% aqueous solution of Methylene Blue, and swirl for one minute. Decant and wash 10 times with water; drain well and dry.

Thorite grains, unlike those of other species likely to occur in the sample, assume a strong-blue matt appearance, but the depth of colour may vary somewhat from grain to grain.

(3) *Malachite Green Method*

If a strong aqueous solution of Malachite Green is substituted for Methylene Blue in the above method only the thorite grains are stained various shades of green.

Notes

(i) Although Methods 2 and 3 are more rapid than Method 1 they are somewhat inferior to it in that, on drying the grains in the beaker after staining them, the colour tends to migrate into cracks on the surfaces of zircon and other species, causing them to display a slightly stained appearance. Although this is unlikely to result in misidentification it is undesirable and it can be offset to some extent by scattering the treated grains over a disc of filter paper and drying them on a hot plate.

(ii) Both the Methylene Blue and the Malachite Green methods are excellent for identifying thorite in very small groups of similar grains and under such circumstances an initial boiling acid attack of 2 min. duration is sufficient.

(iii) Staining Methods 2 and 3 may be used, in the same manner as the Ammonium Molybdate method, for obtaining semi-quantitative data and the prepared standards

will not deteriorate *provided* they remain absolutely dry.

(iv) Doubtless equally satisfactory results could be obtained by substituting any one of a number of other organic dyes for those in the above methods.

Conclusion

In view of the increasing interest which is being taken in thorium the simple and quick methods for detecting thorite and determining the approximate amount of the mineral in samples, without resorting to the use of expensive apparatus, should prove of considerable use to the Nigerian mining industry. Conceivably also these methods may prove of value to those working in other countries.

References

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High-Tension Separation of Minerals

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Introduction

The use of magnetism and electricity in the separation of minerals has been a well-established practice for many years and the ordinary magnetic separator depends for its functioning in the variation in response of minerals when placed in magnetic fields of appropriate intensity. Electrostatic separation, which has also been in use for over half a century, is limited in its applications, because it can be applied only to relatively dry materials, while very finely divided minerals are difficult to separate by this means. As its name implies an electro-

static process does not involve any flow of current, but early modifications of the high-voltage equipment used employed charged fields with a small current flow.

From this modification of the electrostatic method modern techniques have been developed which are classed as high-tension separation methods. One of these techniques makes use of a toboggan-type separator, wherein the mineral is passed over an earthed chute in close proximity to a charged electrode, while another employs a shaking table placed underneath the charged electrode. These types of high-tension

Modern

commercial

practice

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reviewed