# *The age of fergusonite from the Jos area, Northern Nigeria.*[1]

By A. G. DARNLEY, M.A., Ph.D., A.M.I.M.M., F.G.S.

Atomic Energy Division, Geological Survey of Great Britain,

G. H. SMITH and T. R. D. CHANDLER,

National Chemical Laboratory, Teddington, Middlesex,

and

D. F. DANCE

Atomic Energy Research Establishment, Harwell, Berkshire.

[Taken as read 2 November 1961.]

*Summary.* Two fergusonite concentrates from different localities in the Jos area of Northern Nigeria have been analysed by the complete lead method and are accepted as having a mean age of 159±25 m.y.

IN Northern Nigeria fergusonite is known to occur only in the amphibole granites of the Younger Granite complexes. The fergusonite-bearing group includes granites, granite porphyries, and quartz–pyroxene–fayalite porphyries, which form the majority of the ring-dykes in the province as well as some large plutons and stocks (Jacobson, Macleod, and Black, 1958). In the Jos area fergusonite derived from the intrusive porphyries occurs in alluvial sands, which are being worked for their cassiterite content. Mr. K. E. Beer of the Atomic Energy Division collected material in 1956 from two such localities about 40 miles apart: close to Kuru about 9° 36′ N., 9° 20′ E., and from the north-west corner of the Sara Hills, near Tokkos, about 9° 39′ N., 8° 48′ E. Fergusonite was obtained in the first instance from electrostatically-separated table-concentrates prepared from the alluvial sands. Further concentration of the material was carried out in A.E.D. laboratories by panning, electromagnetic separation, and finally hand picking.

[1] A preliminary account of these results was issued in September 1959 on a limited circulation by the Atomic Energy Division, Geological Survey of Great Britain, as Age Determination Report No. 10.

The fergusonite from both localities is honey-coloured, with grains a few millimetres in length. The Tokkos material has a rather distinctive appearance, resembling grass seed, due to its slender bipyramidal habit. In plane-polarized reflected light polished surfaces are uniformly greyish-white, and the few fractures within the crystals show very little associated alteration. The Kuru material has a similar habit but it is less distinctive, the crystals being broken by cross fractures. In reflected light some of these broken fragments show minor alteration along fine irregular cracks. Between crossed polars the larger fragments of fergusonite are opaque and isotropic, whilst thinner flakes are translucent with golden-brown internal reflections. Strong yellowish-white internal reflections are produced by the thin films of alteration products along some fracture surfaces. No galena is present in either concentrate.

The X-ray spectrograms of material from both localities show predominant niobium and rare earths, together with minor Th, U, Fe, Zr, Pb, and Ta. The rare earths are predominantly Y with some Er, Dy, Yb, and Gd, and minor Nd, Sm, Ho, Ce, Tb, Tm, and Lu. To ascertain whether the alteration visible in polished sections is accompanied by any significant change in overall chemical composition, X-ray spectrograms of more and less altered hand-picked grains from Kuru were compared and found to be similar, showing no loss or enrichment of constituents. Examination of autoradiographs showed all the grains from each locality to be uniform in radioactivity, whilst at the same time indicating that the Kuru material is more radioactive than that from Tokkos, as confirmed by the chemical analyses. The effectiveness of these tests for investigating the homogeneity of the analysed material has been established by similar comparisons between altered and unaltered fragments of other metamict minerals such as samarskite and yttrotantalite. In these examples distinct variations in composition, particularly in lead and rare earth content, have been noted in specimens showing visible alteration and yielding discordant age results.

The chemical and isotopic analyses, and the apparent ages derived from them are given in table I.

*Discussion*. These two concentrates are notable for their high common-lead content, which in each case is approximately 60 % of the total lead present. The galena analysed to provide the common-lead correction was concentrated from the Liruei albite–riebeckite granite, which forms part of the Younger Granite complex of the region. It should be noted that the Holmes–Houterman model age of this galena is considerably greater than the apparent ages obtained for the fergusonites. Using the

TABLE I.

Kuru fergusonite.

| Chem. anal. (wt. %) | Lead-isotope proportions: Fergusonite | Galena* | Fergusonite corrected | Isotopic ages (m.y.) |
|---|---|---|---|---|
| Pb 0·190 | $^{204}$Pb 0·813±0·002 | 1 | — | 207:206 negative |
| U 2·12$_0$ | $^{206}$Pb 38·9±0·1 | 18·14 | 14·75 | 206:238 161±10 |
| Th 4·39$_4$ | $^{207}$Pb 13·9±0·1 | 15·78 | 12·83 | 207:235 146±65 |
| | $^{208}$Pb 46·4±0·1 | 38·07 | 30·95 | 208:232 153±20 |

Tokkos fergusonite.

| Chem. anal. (wt. %) | Lead-isotope proportions: Fergusonite | Galena* | Fergusonite corrected | Isotopic ages (m.y.) |
|---|---|---|---|---|
| Pb 0·146 | $^{204}$Pb 0·86±0·03 | 1 | — | 207:206 negative |
| U 1·21$_3$ | $^{206}$Pb 35·6±0·4 | 18·14 | 20·00 | 206:238 180±20 |
| Th 3·34$_0$ | $^{207}$Pb 14·4±0·2 | 15·78 | 0·83 | 207:235 152±175 |
| | $^{208}$Pb 49·1±0·4 | 38·07 | 16·36 | 208:232 164±40 |

The method of calculation and accuracy of the analyses have been referred to in Darnley *et al.* (1960), p. 657.

* The common-lead correction is based on galena from Kaffo Valley granite, Liruei, N. Nigeria with the following composition (atomic per cent): $^{204}$Pb 1·37±0·02, $^{206}$Pb 24·85±0·31, $^{207}$Pb 21·62±0·26, $^{208}$Pb 52·16±0·31. (Anal. A.E.R.E., Harwell, 1954.) This analysis is incorrectly reported by Holmes and Cahen (1957, p. 155), who give the proportions 204:208 as 1:38·18.

table published by Russell and Farquhar (1960, p. 47) the model age is of the order of 600 m.y. If the apparent ages of the fergusonites are calculated using a common-lead correction corresponding to a lower model age, the results are not seriously affected:

| | Model age of common lead. | 207:206 | 206:238 | 207:235 | 208:232 |
|---|---|---|---|---|---|
| Kuru | 180* | negative | 158 | 144 | 145 |
| | 600 | negative | 161 | 146 | 153 |
| Tokkos | 180* | negative | 175 | 149 | 155 |
| | 600 | negative | 180 | 152 | 164 |

* The following hypothetical composition was used: 1:18·70:15·80:39·10.

In view of the large correction, the possible errors in the isotopic analyses of the galena have been taken into consideration in calculating the accuracy of the results. In so far as the common-lead correction reduces confidence in accepting any individual result as giving the most probable age, the age accepted for the fergusonite is taken as the arithmetic mean of the apparent ages contained in table I, neglecting the 207:206 results which are usually unsatisfactory for relatively young material.

The age of 159±25 m.y. thus obtained is compatible with potassium-argon ages obtained on biotites from the Younger Granites, analysed at Lamont Geological Observatory, U.S.A., and the University of Oxford, England (N. J. Snelling, personal communication), which have a mean value of 162 m.y. On the basis of the available evidence Holmes and Cahen (1957) tentatively assigned the Younger Granite Complex to the 485 m.y. orogenic cycle. However, as this suggestion was based on discordant results provided by a monazite, and on a single galena model age, it seems justifiable to discount it in the light of subsequent data. Pyrochlore from the Kaffo Valley has also produced discordant ages, and only the $^{206}$Pb:U result (204±40 m.y.) was considered to have any possible significance because of the high common-lead content (*c.* 90 %, Horne, 1955).

*References.*

DARNLEY (A. G.), SMITH (G. H.), CHANDLER (T. R. D.), DANCE (D. F.), and PREECE (E. R.), 1960. Min. Mag., vol. 32, p. 654.

HOLMES (A.) and CAHEN (L.), 1957. Géochronologie africaine 1956. Mem. Acad. R. Sci. colon. A. Sci. nat., new series, vol. 5, no. 1, 169 pp.

HORNE (J. E. T.), 1955. An interim report on the age and composition of pyrochlore from Kaffo Valley, Liruei-n-Kano, N. Nigeria. Atomic Energy Division, Geological Survey of Great Britain.

JACOBSON (R. R. E.), MACLEOD (W. N.), and BLACK (L.), 1958. Memoir No. 1, Geological Society of London.

RUSSELL (R. D.) and FARQUHAR (R. M.), 1960. Lead isotopes in geology. London. (Interscience Publishers Ltd.)