APPARENT AGES OF NORWEGIAN MINERALS AND ROCKS

By

HENRICH NEUMANN

A great many age determinations of Norwegian minerals and rocks have been done during a long period of time, by many investigators applying a number of different methods. Some of the results are easily overlooked by geologists as they are published in journals which are not too commonly read, and some have never been published earlier but are given as personal communications. The author would like to express his gratitude to the persons concerned for permission to use data which is not already published elsewhere.

The intention of this paper is first to collect the existing data and make it more easily available to those interested, and discussions of the reported ages have been reduced to a minimum.

Also, for ease of reference, age data have been listed without further comments as they were given by the investigators concerned at the time of publication or personal communication. The figures have not been recalculated, i. e. with respect to possible later corrections of radioactive constants, to make them mutually comparable. Naturally, such recalculations will have to be performed before a more thorough and detailed discussion can be undertaken than that offered in this preliminary paper.

Some of the apparent ages given in table 1 are now of historical interest only, and some of them should for different reasons be disregarded. U/Pb and Th/Pb ages or a combination of them, without isotope determinations may in some cases be remarkably correct, in other cases they are very misleading, and should therefore be discarded because of their unreliability. Lead-alpha ages of zircons will give a first approximation only, and are too crude to merit any further

discussion. The same applies to some extent to K/Ar ages of feldspars, as the causes of a later leakage of already built up Ar in this mineral are not at present sufficiently well understood to permit any safe conclusions concerning the history of formation of the feldspars in question on the basis of their apparent K/Ar ages.

The Re/Os dating of molybdenites (and other minerals with a sufficiently high content of Re), which seems to be a very promising method, suffers from the inherent weekness that it has not been possible as yet to determine the half-life of Re^{187} with a high degree of accuracy. The value used by W. Herr for the calculation of ages quoted in this paper, $T = 6.2 \times 10^{10}$ years, is inferred from the dating of molybdenite deposits by other methods. The Re/Os ages of Norwegian minerals would appear to be somewhat too low, and a half-life 20% higher or so would seem to make them fit better into the time scheme. However, data is too sparse and too vague for anything approaching a dogmatic statement to be made to this effect.

Also, some of the apparent ages given in Table 1 are determined for minerals which are either highly altered or inaccurately located. These data have, of course, a very limited value, if any, from the geochronological point of view.

In Table 1 apparent ages which will be discussed below are marked with an asterisk.

Table 1. List of age determinations.

Informations are given in the following order: apparent age, mineral, method applied, age determination by ..... and literature reference, locality, specimen collected or supplied by .....

136 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Larvik. T. F. W. Barth & H. Neumann.
160 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Barkevik. T. F. W. Barth & H. Neumann.
166 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Låven. T. F. W. Barth & H. Neumann.
*216 m. y.	Zircon. Th^{232}/Pb^{208} H. Faul (1959). Oslo nordmarkite, Trondheimsveien, large new road cut near Oslo city limit. H. Faul.
231 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Barkevik. T. F. W. Barth & H. Neumann.
*235 ± 10% m. y.	Molybdenite. Re/Os. W. Herr & E. Merz (1958). Sørumsåsen Røyken. H. Neumann & B. Nilssen.
*243 m. y.	Thorite. U^{238}/Pb^{206}. A. O. Nier (1939). Brevig.
244 m. y.	Uranothorite. Th^{232}/Pb^{208}. Pb^{208} from molecular weight of Pb. E. Gleditsch & B. Qviller (1932). Pegmatite dyke. Kragerø.

250 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Mörjefiord. T. F. W. Barth & H. Neumann.
*259 m. y.	Zircon. U^{238}/Pb^{206}. H. Faul (1959). Oslo nordmarkite, Trondheimsveien, large new road cut near Oslo city limit. H. Faul.
*259 m. y.	Biotite. K—Ar. H. Faul (1959). Porphyritic granite, road cut near Skoglyst, Drammen. H. Faul.
269 + 10 — 30 m. y.	Zircon. Lead-alpha. S. Moorbath. Barkevik, Langesundsfiord (No. 2). H. Neumann.
+ 10 279 — 30 m. y.	Zircon. Lead-alpha. S. Moorbath. Seiland, plumasite pegmatite. H. Neumann.
*284 m. y.	Biotite. K—Ar. S. S. Goldich. Biotite from essexite porphyrite, Sande, Vestfold. O. Holtedahl & B. Nilssen.
285 + 10 — 30 m. y.	Zircon. Lead-alpha. S. Moorbath. Barkevik, Langesundsfiord (No. 1). H. Neumann.
294 + 15 — 40m. y.	Zircon. Lead-alpha. S. Moorbath. Seiland (No. 1). H. Neumann.
310 m. y.	Uraninite. U, Th/Pb without isotope determinations. I. Th. Rosenqvist (1947). Pegmatite, Tor's mine, Vats, in the county of Ryfylke. I. Th. Rosenqvist.
*315 m. y.	Lepidomelane. K—Ar. A. A. Polkanov & E. K. Gerling. Lepidomelane from nepheline syenite pegmatite dyke. Langesundsfiord. Geological Museum.
329 m. y.	Feldspar. K—Ar. W. Kley & P. Schmidlin. Granite, «Østfold granite», Seut, near Fredrikstad. H. Neumann & M. A. Sellevoll.
331 + 15 — 40 m. y.	Zircon. Lead-alpha. S. Moorbath. Fredriksvern. H. Neumann.
*355 m. y.	Thorite. Th^{232}/Pb^{208}. A. O. Nier (1939). Brevig.
365 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Tellenes (I). T. F. W. Barth & H. Neumann.
366 + 20 — 40 m. y.	Zircon. Lead-alpha. S. Moorbath. Seiland, canadite pegmatite. H. Neumann.
390 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Tellenes (II). T. F. W. Barth & H. Neumann.
*405 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Porphyritic granite. Bindal, Tverrådalen, Namdalen. Chr. Oftedahl. 1958.
413 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Hollaite pegmatite, Fen. H. Neumann.
420 m. y.	Koppite. Th/Pb without isotope determinations. E. Sæther (1957). Søvite, Fen. E. Sæther.
430 m. y.	Uranothorite. U/Pb^{206}. Pb^{206} from molecular weight. E. Gleditsch and B. Quiller. (1932). Pegmatite dyke, Kragerø.
*434 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Biotite from pegmatite. Tveit. Gneiss, Sotra, W. of Bergen. A. Kvale 1958.
437 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Pegmatite, Lakssvelefjell, Egersund formation. P. Michot.
*450 m. y.	Euxenite. U^{238}/Pb^{206}. J. L. Kulp and W. R. Eckelmann. (1957) Pegmatite, Kalstad, Kragerø. H. Neumann.
*450 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Lia, Laksevåg. Gneisses W of Bergen. A. Kvale, 1958.

460 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Søvite, Fen. T. F. W. Barth and H. Neumann.
484 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*485 ± 5 m. y.	Euxenite. U^{238}/Pb^{206}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*495 ± 30 m. y.	Thorite. Th^{232}/Pb^{208}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
501 m. y.	Feldspar. K—Ar. W. Key and P. Schmidlin. Pegmatite, Halvorsrud, Råde, Østfold. H. Neumann and B. Nilssen.
508 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Pegmatite, Ålgård, Egersund. P. Michot.
520 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Stjernø, W. Finnmark. T. F. W. Barth and H. Neumann.
*530 m. y.	Euxenite. U^{235}/Pb^{207}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Kalstad, Kragerø. H. Neumann.
530 ± 50 m. y.	Zircon. Lead-alpha. Henry Faul. (1959). Carbonatite, Søve, Fen. Sv. Svinndal.
*540 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. Rødsand, Møre. H. Neumann.
560 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Farsundite, Rømteland. H. Neumann and T. Sverdrup.
*560 ± 7 m. y.	Euxenite. U^{235}/Pb^{207}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
560 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Melkedøla, Bygdin. T. F. W. Barth and H. Neumann.
*565 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Oterstrand, Gildeskål. H. Neumann.
*565 m. y.	Biotite. K—Ar. Henry Faul (1959). Carbonatite, Søve mine, Fen. H. Faul.
570 m. y.	Zircon. Th/Pb without isotope determinations. E. Sæther (1957). Søvite, Tufte quarry, Fen. E. Sæther.
570 m. y.	Koppite. Th/Pb without isotope determinations. E. Sæther (1957). Søvite, Cappelen's quarry, Fen. E. Sæther.
*582 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, in gneiss. Loen, Nordfjord. A. Kvale 1958.
587 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Gneiss. Spangereid. E. of Egersund formation. H. Neumann and T. Sverdrup.
*590 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Ortnevik, Sogn. North western gneiss area. A. Kvale. 1958.
*590 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Søvite. Fen. Sv. Svinndal 1958.
590 m. y.	Columbite. Th/Pb without isotope determinations. E. Sæther (1957). Søvite, Tufte quarry, Fen. E. Sæther.
*603 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Søvite, Fen. Sv. Svinndal.
*610 ± 50 m. y.	Thorite. $Pb^{207}/^{206}$. H. Fr. Ehrenberg. Pegmatite dyke, Tvedestrand.
613 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Granite. Iddefjord, Østfold. H. Neumann and B. Nilssen.
*615 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Thoreby, Varteig. H. Neumann.

*621 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. Tarjeisberg, Telemark. H. Neumann and O. Adamson.
640 ± 50 m. y.	Feldspar. K—Ar. W. Herr. «Young red granite», Torset, Langøy, Nordland. K. Heier.
650 m. y.	Feldspar. K—Ar. W. Herr. Svolvær granite, S. Følstad, Lofoten. K. Heier.
*657 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. Bandaksli, Telemark. H. Neumann.
672 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Granite, Hobøl, Østfold. H. Neumann and B. Nilssen.
*676 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Riehammeren, Berge. H. Neumann and B. Nilssen.
*679 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Hosås, Risør. H. Neumann and K. Heier.
*687 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Dalen, Telemark. H. Neumann and B. Nilssen.
*691 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. Dalen, Telemark. H. Neumann and B. Nilssen.
*700 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. Rollag, Nummedal. H. Neumann and K. Heier.
*709 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Rollag, Nummedal. H. Neumann and K. Heier.
720 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Solberg, Tvedestrand. T. F. W. Barth and H. Neumann.
*740 ± 6 m. y.	Thorite. U^{238}/Pb^{206}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*755 ± 65 m. y.	Gadolinite. RaD/Pb. W. Herr, E. Merz, P. Eberhardt and P. Signer (1958). Pegmatite dyke, Frikstad, Iveland. H. Neumann.
*759 m. y.	Biotite. K—Ar. W. Kley and P. Schmidlin. Gneiss. Remesvig, east of Egersund formation. H. Neumann and T. Sverdrup.
*760 ± 8 m. y.	Thorite. U^{235}/Pb^{207}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
760 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Solberg Arendal. T. F. W. Barth and H. Neumann.
*772 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite, Ara-odden, Telemark. O. A. Broch, 1958.
*776 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Onsøy near Fredrikstad. O. A. Broch, 1958.
*777 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Telemark gneiss. S. shore of lake Kviteseid. O. A. Broch 1958.
*802 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Solli, Råde, Østfold. O. A. Broch, 1958.
804 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Stavanger
812 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Gneiss. Heller farm, Askim. H. Neumann and B. Nilssen.
*820 ± 30 m. y.	Gadolinite. Pb^{207}/Pb^{206}. W. Herr and E. Merz, (1958). Pegmatite dyke, Frikstad, Iveland. H. Neumann.
*823 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite, Iddefjord. O. A. Broch 1958.
*824 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite gneiss. Gol, Hallingdal. O. A. Broch 1958.
*830 ± 25 m. y.	Thorite. Pb^{207}/Pb^{206} J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.

830 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Næs skjerp, Arendal. T. F. W. Barth and H. Neumann.
*840 m. y.	Cleveite. Th^{232}/Pb^{208}. A. O. Nier (1939). Auselmyren, Holt, Aust-Agder.
*852 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Bjertnes feldspar quarry, Krødsherad. O. A. Broch.
*857 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Telemark. Granite gneiss. O. A. Broch. (Same sample as 869 m. y.).
*862 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Kobbernuten, Bykle. H. Neumann.
*869 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite gneiss. Gol, Hallingdal. O. A. Broch 1958.
*874 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite. By road from Vik (near Grimstad) to Froland. O. A. Broch. 1958.
879 m. y.	Feldspar. K—Ar. W. Kley and P. Schmidlin. Gneiss. Magnor. H. Neumann and B. Nilssen.
*880 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Håverstad, Iveland. O. A. Broch 1958.
*880 ± 30 m. y.	Lepidolite. Rb—Sr. J. L. Kulp. Pegmatite, Tørdal. H. Neumann and B. Nilssen.
*882 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Pegmatite, Tveit, Iveland. H. Neumann.
*882 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Birkeland granite, Sennomstad bridge S. of Herefoss. O. A. Broch 1958.
*884 ± 75 m. y.	Blomstrandine. RaD/Pb. W. Herr and E. Merz. Pegmatite dyke, Kåbuland, Iveland. H. Neumann.
*890 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss. Ål railway station. Hallingdal. O. A. Broch 1958.
*890 ± 5 m. y.	Uraninite. U^{238}/Pb^{206}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*892 ± 8 m. y.	Uraninite. U^{235}/Pb^{207}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
895 ± 5% m. y.	Feldspar. K—Ar. W. Gentner and W. Kley (1957). Pegmatite dyke, Hyttåsen, Hobøl. H. Neumann and B. Nilssen.
*900 ± 30 m. y.	Uraninite. Th^{232}/Pb^{208}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*900 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss. Omre, between Grimstad and Lillesand. O. A. Broch. 1958.
*900 m. y.	Lepidolite. Rb/Sr. S. R. Taylor. Tørdal, Telemark. H. Neumann.
*904 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatitic rock. Tor's mine, Vats, Ryfylke. A. Kvale.
*904 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Mica from pegmatite. Løvrak, Aust-Agder. O. A. Broch 1958.
*905 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Åmli. O. A. Broch 1958.
910 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Skarvvann, Seiland. T. F. W. Barth and H. Neumann.
*910 ± 20 m. y.	Euxenite. Pb^{207}/Pb^{206}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.

*920 ± 20 m. y.	Uraninite. Pb^{207}/Pb^{206}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*920 ± 35 m. y.	Euxenite. Th^{232}/Pb^{208}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*920 m. y.	Uraninite. Pb^{207}/Pb^{206}. S. Moorbath. Pegmatite, Rømteland. H. Neumann and T. Sverdrup.
*920 ± 60 m. y.	Blomstrandine. Pb^{207}/Pb^{206}. W. Herr and E. Merz (1958). Pegmatite dyke, Kåbuland, Iveland. H. Neumann.
*920 m. y.	Uraninite. Pb^{207}/Pb^{206}. S Moorbath. Pegmatite, Karlshus, Østfold. H. Neumann.
*927 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Grøsle. O. A. Broch.
*927 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Flå granite. Above Gulsvik station. O. A. Broch 1958.
*929 m. y.	Biotite. K—Ar. W. Kley and P. Schmidlin. Gneiss. Heller farm, Askim. H. Neumann and B. Nilssen.
*930 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Killandsvann, Herefoss. O. A. Broch 1958.
*930 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite. O. A. Broch. (Same sample as 927 m. y.).
930 m. y.	Zircon. Lead-alpha. U. S. Geological Survey. Skarvberg, Seiland. T. F. W. Barth and H. Neumann.
*940 m. y.	Euxenite. Pb^{207}/Pb^{206}. J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Kalstad, Kragerø. H. Neumann.
*943 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Flå granite. Ospeholt in Hedal, Opland. O. A. Broch, 1958.
*946 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Nordby, Rakkestad. O. A. Broch 1958.
*950 ± 50 m. y.	Microcline. Rb—Sr. J. L. Kulp. Pegmatite, Tørdal. H. Neumann.
*952 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Flå-granite. Gryte 6 km S. of Viken church, Sperillen., O. A. Broch 1958.
*956 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Granite. Birkeland granite. Skiftenes, Herefoss. O. A. Broch 1958.
*962 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. (1958). Pegmatite, Tuftan, Iveland. H. Neumann.
*965 m. y.	Muscovite. K—Ar. W. Gentner and W. Kley. (1957). Pegmatite dyke, Hyttåsen, Hobøl. H. Neumann and B. Nilssen.
*966 m. y.	Biotite. Rb—Sr. A. A. Polkanov and E. K. Gerling. Pegmatite. Grøsle. Feldspar quarry. O. A. Broch.
968 m. y.	Broeggerite. U/Pb without isotope determination. Ellen Gleditsch. Pegmatite, Karlshus, Råde.
*970 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Løvrak, Aust-Agder. O. A. Broch 1958.
970 ± 80 m. y.	Feldspar. K—Ar. W. Herr. Tarjeisberg (F), Telemark. H. Neumann and O. Adamson.
*977 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Pegmatite, Bjertnes, Krødsherad. O. A. Broch 1958.
*980 m. y.	Euxenite. Th^{232}/Pb^{208} J. L. Kulp and W. R. Eckelmann (1957). Pegmatite, Kalstad, Kragerø. H. Neumann.
*990 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Veined gneiss. By the road from Hamremoen to Noresund. O. A. Broch 1958.

*990 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss. (Migmatite). Between N. Herefoss and Hanefoss. O. A. Broch 1958.
*1007 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss. O. A. Broch 1958.
1011 m. y.	Broeggerite. U + Th/Pb without isotope determinations and without molecular weight of Pb. E. Føyn (1938). Pegmatite, Karlshus, Råde.
*1016 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss. Valebø, near Fen area. Sv. Svinndal.
1018 m. y.	Cleveite. U/Pb without isotope determinations. Ellen Gleditsch (1925). Pegmatite, near Arendal.
1020 ± 70 m. y.	Microcline. K—Ar. A. Holmes, H. A. Shillibeer (1955). Pegmatite, Arendal.
*1030 m. y.	Mica. K—Ar. A. A. Polkanov and E. K. Gerling. Coarse grained granite. By the road from Vik, near Grimstad, to Froland. O. A. Broch 1958.
*1040 m. y.	Biotite. K—Ar. S. S. Goldich. Arendalite, Langsev. S. Norway. H. Neumann and B. Nilssen.
*1041 m. y.	Phlogopite. K—Ar. W. Kley and P. Schmidlin. Pegmatite, Snarum. H. Neumann and O. B. Jøsang.
1043 m. y.	Cleveite. U/Pb without isotope determinations. Ellen Gleditsch (1925). Pegmatite, Iveland.
*1048 m. y.	Biotite. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss rich in mica. By the road from Hønefoss to Hamre, Heradsbygd. O. A. Broch 1958.
*1052 m. y.	Muscovite. K—Ar. A. A. Polkanov and E. K. Gerling. Gneiss rich in mica. O. A. Broch 1958. (Same sample as 1048 m. y.)
*1060 m. y.	Cleveite. U^{238}/Pb^{206}. S. Moorbath. 1960. Pegmatite, Auselmyra, Aust-Agder. H. Neumann.
*1070 m. y.	Cleveite. U^{235}/Pb^{207}. S. Moorbath 1960. Pegmatite, Auselmyra, Aust-Agder. H. Neumann.
*1085 m. y.	Cleveite. U^{238}/Pb^{206}. A. O. Nier, (1939). Pegmatite, Auselmyra, Holt, Aust-Agder.
*1090 m. y.	Cleveite. Pb^{207}/Pb^{206}. A. O. Nier. Pegmatite from Auselmyra, Holt, Aust-Agder.
*1090 m. y.	Cleveite. Pb^{207}/Pb^{206}. S. Moorbath. Pegmatite, Auselmyra, Aust-Agder. H. Neumann.
*1110 m. y.	Cleveite. Th^{232}/Pb^{208}. S. Moorbath. Pegmatite, Auselmyra, Aust-Agder. H. Neumann.
1193 m. y.	Cleveite. U + Th/Pb without isotope analysis and without molecular weight of Pb. E. Føyn (1938). Pegmatite, Aust-Agder.
1251 m. y.	Cleveite. U/Pb without isotope determinations. R. Bakken, E. Gleditsch and A. C. Pappas (1948). Pegmatite, Auselmyren.
1254 m. y.	Cleveite. U + Th/Pb without isotope determinations and without molecular weight of Pb. E. Føyn (1938). Pegmatite, Arendal.
1269 m. y.	Cleveite. U + Th/Pb Without isotope determinations and without molecular weight of Pb. E. Føyn (1938). Pegmatite, Auselmyren, Aust-Agder.
1283 m. y.	Cleveite. U + Th/Pb without determ. of isotopes nor mol. weight. R. Bakken and E. Gleditsch (1938). Pegmatite, Auselmyren, Holt.

1294 m. y.	Cleveite. U + Th/Pb without determ. of isotopes nor mol. weight of Pb. R. Bakken and E. Gleditsch (1938). Pegmatite, Auselmyren, Holt.
1300 m. y.	Allanite. Th/Pb without isotope determinations. N. Jordanov (1957). Pegmatite, Hitterø.
1308 m. y.	Cleveite. U + Th/Pb without determ. of isotopes nor molecular weight of Pb. R. Bakken and E. Gleditsch. (1938). Pegmatite, Auselmyren, Holt.
*1560 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz. Tarjeisberg, Telemark. H. Neumann and O. Adamson.
1620 ± 120 m. y.	Feldspar. K—Ar. W. Herr. Tarjeisberg, Telemark. H. Neumann and O. Adamson.
2080 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Lofoten.
*2290 ± 10% m. y.	Molybdenite. Re/Os. W. Herr and E. Merz (1958). Vatterfjord, Lofoten, county of Nordland. H. Neumann.

Oslo area rocks.

The following age determinations have been made by different methods (see Table 1): 355, 315, 284, 259, 259, 243, 235, and 216 m. y. At present the author is not prepared to offer any comments to these apparent ages.

Caledonian rocks.

Three K/Ar determinations of Caledonian rocks by A. A. Polkanov and E. K. Gerling[1] give the apparent ages 450, 434, and 405 m. y. The two molybdenites with Re/Os ages 540 and 565 m. y. done by W. Herr[2] are also probably of Caledonian origin.

The two micas from pegmatites in Nordfjord and Sogn with apparent K/Ar ages 582 and 590 m. y. (A. A. Polkanov and E. K. Gerling) may be of Caledonian origin but are probably older. Argon built up in the mineral previously may have been expelled during a later period of Caledonian orogeny and metamorphism; thus producing an apparent age lower than the true age of formation.

Søvite, Fen area.

K/Ar determinations of large unaltered mica crystals in the carbonatite (Søvite) in the Fen area have been made by H. Faul (1959) who found an apparent age of 565 m. y., and by A. A. Polkanov and E. K. Gerling who found 590 m. y. and 603 m. y. by two determinations of the same specimen.

Following the revised time-scale of A. Holmes (1959) an early Cambrian age is indicated.

[1] Laboratory for pre-Cambrian Geology, Leningrad.
[2] Max Planck Institut für Chemie, Mainz.

Molybdenite deposits
supposed to be related to the «Telemark granite» (see later).

W. Herr and E. Merz (1958, and personal communications) have dated eight molybdenites by the Re/Os method. These were obtained from molybdenite deposits which are presumed to have been deposited by late hydrothermal solutions emanating from the youngest member of the rock series, which is generally referred to as the «Telemark granite». The following apparent ages were found: 862, 709, 700, 691, 687, 679, 676, and 657 m. y. The average of these values is 708 million years, or, if the highest value (in fact the Kobbermuten deposit, 862 m. y., may have a different origin) and the lowest value are excluded, 690 million years, a value which may appear somewhat low.

The Østfold granite.

Three K/Ar age determinations have been performed by A. A. Polkanov and E. K. Gerling on micas from the Østfold granite (776, 802, 823 m. y.) of which two are from the same sample (802 and 823 m. y.). The average of the three determinations is 800 m. y.

An age of approximately 800 million years for the Østfold granite is not inconsistent with age determinations carried out by other investigators on the same granite which outcrops on the Swedish side of the border, where it is called the Bohus granite.

The Thoreby molybdenite deposit has been supposed to be related to the Østfold granite. The apparent Re/Os age of 615 $\pm$ 10% m. y. (W. Herr and E. Merz, 1958) is contradictory to this supposition.

Pegmatite from Vik, near Grimstad.

Biotite from a pegmatite at Vik, near Grimstad was K/Ar dated by A. A. Polkanov and E. K. Gerling and has an apparent age of 874 m. y. The pegmatite is located in the Kongsberg—Bamble area close to a coarse grained granite with an apparent age of 1030 m. y.

The same geological events which led to the formation of this pegmatite may have modified the Ar content of mica in the banded gneiss from Omre (between Grimstad and Lillesand) to give this rock an apparent age of 900 m. y. (K/Ar, A. A. Polkanov and E. K. Gerling). On the other hand this banded gneiss of the Kongsberg—Bamble area may have formed at that time, a problem which cannot be solved without further investigations.

The «Telemark granite».

The «Telemark granite» is a somewhat unfortunate name for types of granitic rocks covering a great part of the South Norwegian pre-Cambrian area. The rocks are mostly gneissic and «Telemark gneisses» would be a better name, while there are also younger members of the suite which are genuine homogeneous granites, as well as pegmatites.

Four K/Ar determinations performed by A. A. Polkanov and E. K. Gerling on mica from the gneisses give the apparent ages 890, 869, 857, and 824 m. y. The highest apparent age, 890 million years, is probably a fair approximation to the age of formation of the older rocks of this suite; while the younger apparent ages may be too low, because of a loss of Ar from the minerals and rocks concerned caused by later geological events (as for example the formation of the youngest homogeneous granites of the same series of rocks).

A nearly homogeneous granite from Ara-odden in Telemark, called by O. A. Broch, who collected the analyzed specimen, «a younger, probably palingeneous granite» has an apparent age of 772 m. y., and a pegmatite on the southern shore of lake Kviteseid, an apparent age of 777 m. y. (both on mica, K/Ar, A. A. Polkanov and E. K. Gerling).

Pegmatitic rock from Tor's mine, Vats.

One K/Ar dating of a muscovite from Tor's mine has been done by A. A. Polkanov and E. K. Gerling who found an apparent age of 904 million years. A possible Caledonian origin has been discussed for the Vats pegmatite and the surrounding rocks, a geological interpretation which is strongly contradicted by this figure.

Pegmatites of the Iveland district.

W. Herr and E. Merz (1958 and personal communications) have made the following age determinations of minerals from the pegmatite dykes in Iveland:

RaD/Pb method, gadolinite, Frikstad ..... 755 ± 65 m. y.
Pb^{207}/Pb^{206} method, gadolinite, Frikstad ..... 820 ± 30 m. y.
RaD/Pb method, blomstrandine, Kåbuland..... 844 ± 36 m. y.
Pb^{207}/Pb^{206} method, blomstrandine, Kåbuland..... 920 ± 60 m. y.
Re/Os method, molybdenite, Tveit ..... 882 ± 70 m. y.
Re/Os method, molybdenite, Tuftan ..... 962 ± 80 m. y.

A. A. Polkanov and E. K. Gerling report a K/Ar age of biotite from Håverstad of 880 m. y.

More data are desirable but tentatively an approximate age of 880—920 million years may be assigned to the Iveland pegmatites.

The Tørdal pegmatite.

J. L. Kulp[1] has dated lepidolite and microcline from the Tørdal dykes by the Rb—Sr method and found the ages 880 ± 30 m. y. and 950 ± 50 m. y. respectively. S. R. Taylor[2] found an age of 900 million years, for the lepidolite using the same method. The average of these three determinations 910 million years, is probably fairly close to the correct age of the dykes. The Tørdal pegmatite is located in the Telemark area south of the lake Flåvann.

The Rømteland pegmatite.

The Rømteland pegmatite is located within a large mass of farsundite, (a biotite and hornblende-bearing quartz-monzonite). The pegmatite dyke is mineralogically closely related to the farsundite, and is probably a coarser grained facies of this rock. The farsundite may or may not be genetically related to the anorthosites, norites and charnockites of the Egersund—Sogndal formation. It has also been tentatively grouped with the «young» granitic bodies of the southern pre-Cambrian area such as the Birkeland granite.

Uraninite, euxenite, and thorite from this pegmatite have been studied by J. L. Kulp and W. R. Eckelmann (1957) applying U—Th—Pb methods. They conclude that the age of these minerals is 920 ± 20 million years, and this figure would appear to be amongst the best founded and most reliable of the age data on Norwegian minerals and rocks. The reader is referred to the above mentioned paper for details.

The Karlshus pegmatite.

A Pb^{207}/Pb^{206} determination of uraninite (brøggerite) from this dyke by S. Moorbath[3] indicates an age of 920 m. y. for this deposit. (An older U/Pb age without isotope determination by E. Gleditsch

[1] Lamont Geological Observatory, New York.
[2] Then at the Department of Geology, Oxford.
[3] Department of Geology, Oxford.

gave 968 m. y.) The Karlshus dyke is located a short distance north of the Østfold granite, with which it was earlier supposed to be genetically related; an interpretation which is made impossible by the younger age (800 m. y.) of that granite.

The pegmatite dyke at Hyttåsen, Hobøl, 965 m. y. (muscovite, K—Ar, W. Gentner and W. Kley (1957)), the pegmatite dyke at Nordby, Rakkestad, 946 m. y. (muscovite, K—Ar, A. A. Polkanov and E. K. Gerling) and the gneiss from Heller farm, Askim, 929 m. y., (biotite, K—Ar, W. Kley and P. Schmidlin[1]), all in the county of Østfold, may belong to the same geological epoch as the Karlshus pegmatite.

The Birkeland granite, the Flå granite, and related rocks.

The Birkeland granite has been dated by three K—Ar determinations (882, 930, 956 m. y.) of the granite itself, and five K—Ar determinations (904, 905, 927, 930, 970 m. y.) and one Rb—Sr determination (966 m. y.) of pegmatites supposed to be genetically related to it. In all cases micas from the rocks mentioned were analyzed by A. A. Polkanov and E. K. Gerling.

The average of these nine determinations is 930 m. y. with a variation from 882 to 970 m. y.

The Flå granite has been dated by three K—Ar determinations on mica from the granite (927, 943, 952 m. y.) and two from a related pegmatite (852, 977 m. y.) done by A. A. Polkanov and E. K. Gerling. The average of the five determinations is 930 m. y. with a variation from 852 to 977 m. y.

The Birkeland and Flå granites have a similar geological situation on or near the junction between the Kongsberg—Bamble area and the Telemark area, but are otherwise rather different chemically and mineralogically as well as in appearance. They have consequently not been considered by Norwegian geologists as being related in any way. Nevertheless they seem to be contemporaneous with an age of approximately 930 million years.

The Telemark area veined gneiss with a K—Ar age of 990 m. y. from the road from Hamremoen to Noresund is situated not too far from the Flå granite and is described by O. A. Broch, who collected the analyzed specimen, as a migmatite «with vein material possibly

[1] Physikalisches Institut. Universität Freiburg i. Br.

from the Flå granite, ...» Probably this is an older gneiss which was transformed in one way or another at the time of formation of the Flå granite and then partly lost its content of earlier formed Ar. Its slightly higher apparent age (approximately 990 m. y. as compared to 930 m. y.) may not be entirely fortuitous.

The apparent age of 1000 m. y. (990 and 1007 m. y.) of the gneiss between northern Herefoss and the barracks for Hanefoss power station should probably be interpreted in the same way. The distance to the Birkeland granite is about 3 km and the gneiss is situated within the aureole of porphyroblastesis surrounding that granite.

The Kalstad pegmatite near Kragerø.

J. L. Kulp and W. R. Eckelmann (1957) give the following apparent ages for euxenite from the Kalstad dyke: U^{238}/Pb^{206} 450 m. y., U^{235}/Pb^{207} 530 m. y., Pb^{207}/Pb^{206}, 940 m. y. and Th^{232}/Pb^{208} 980 m. y. The ages are discordant and the discordance pattern of euxenite is not too well known. It would, therefore, be highly desirable to have some more data before an age is assigned to this dyke.

The Tarjeisberg molybdenite deposit in Telemark.

W. Herr and E. Merz have dated the Tarjeisberg deposit west of Nisservann in the Telemark area by the Re/Os method. Two different samples of molybdenite were analyzed and gave the apparent ages of 1560 $\pm$ 10% m. y. and 621 $\pm$ 10% m. y. Two microclines from different sites in the deposit were also dated by W. Herr by the K/Ar method and gave the apparent ages of 1620 $\pm$ 120 m. y., and 970 $\pm$ 80 m. y.

At present no attempt will be made to interpret these controversial data. Further investigations would certainly seem to be of considerable interest.

The Auselmyra pegmatite, and other rocks of approximately the same age.

Cleveite from this dyke has been dated by A. O. Nier (1939), and by S. Moorbath by U/Pb and Th/Pb methods with the following results:

	U^{238}/Pb^{206}	U^{235}/Pb^{207}	Pb^{207}/Pb^{206}	Th^{232}/Pb^{208}
A. O. Nier	1085 m. y.		1090 m. y.	840 m. y.
S. Moorbath	1060 m. y.	1070 m. y.	1090 m. y.	1110 m. y.

Because of the concordance of the U ages an age of ~ 1090 m. y. can be assigned to this dyke with a high degree of probability. It is situated in the Kongsberg—Bamble area, and the surrounding rocks must be just as old or older than the dyke. Thus 1090 m. y. must be the minimum age of at least some of the rock suites in the Kongsberg—Bamble area.

Based on K—Ar determinations of micas done by A. A. Polkanov and E. K. Gerling, a somewhat lower age 1050 m. y., is indicated for a banded gneiss from the Kongsberg—Bamble area between Hønefoss and Hamre, while a coarse grained granite from the same formation has an apparent age of 1030 m. y. The gneiss at Valebø near the Fen area in the Telemark area gives an age of 1016 m. y.

S. S. Goldich[1] dated biotite from arendalite at Langsev near Arendal by the K—Ar method and found an apparent age of 1040 m. y. in good agreement with the above mentioned results. Arendalite is a metasomatic rock of quartz-hypersthene diorite composition supposed to belong to a younger rock series of the Kongsberg—Bamble area.

Phlogopite from a pegmatite dyke of the Kongsberg—Bamble area in Snarum was dated (K—Ar) by W. Kley and P. Schmidlin, and has an apparent age of 1041 m. y.

Lofoten and Vesterålen islands.

A Re/Os dating by W. Herr and E. Merz (1958) of molybdenite from the Vatterfjord molybdenite deposit give an apparent age of 2290 ± 10% m. y. indicating that there may be a very ancient rock complex in the Lofoten—Vesterålen area. B. J. Gilletti's (1959) recent tentative dating of the Lewisian of Scotland to ~ 2700 m. y. is interesting in this connection.

Feldspars from the «Svolvær Granite», and from a «young red granite» from Torset on Langøy give the apparent K/Ar ages 650 m. y. and 640 m. y. (W. Herr).

These apparent ages must be regarded as minimum ages for the rocks concerned, which may be very much older, and even if they do not confirm the high Re/Os age, they do at least indicate that the two granites are probably of pre-Cambrian age and not of Caledonian origin.

[1] University of Minnesota.

General remarks.

It will be clear from what is written above that the dating of the geological complexes in Norway is only in its primary stages, and that a lot of work lies ahead before it is possible to make any conclusive statements on the basis of age determinations, especially about the geological history of the pre-Cambrian suites. It is indicated, however, that two epochs have been more important than others, as the geological events of greatest consequence in pre-Cambrian times in this country seem to have taken place during two periods, one from ~ 900 to ~ 950 million years, and another at ~ 1100 million years. It is surprising, that during the reconaissance work done so far there have been no indications of rockforming processes at times ~ 1400 m. y., and ~ 1800 m. y. so common in other parts of the world, and also in areas not too far away.

Another point worthy of note is the following: The pre-Cambrian rocks of south Norway has been divided into three "formations" on the basis of geological investigations, namely the southeastern area or the Østfold formation east of the Oslo graben, and the Kongsberg—Bamble formation and the Telemark formation west of it. (The Egersund—Sogndal formation of anorthositic-charnockitic affinities is a fourth formation on which very little dating work has been done). The relations of these three "formations" to each other have been very vague and problematic, and the time of formation of their rock suites and their «relative ages» have been matters of controversy. It is of great interest that young apparent ages as well as old apparent ages are found in all three formations, with the one exception, that rocks of an apparent age of ~ 1100 m. y. have not as yet been traced in the Østfold formation. It is indicated that the whole of the pre-Cambrian in the south of the country is formed by a number of geological events which were pene-contemporaneous and in principle identical and that the variations in the resulting products were dependent on variations in the pressure and temperature conditions and in chemical environment from one place to another. The division into three (or four) "formations" may be mainly a geographical convenience and be of much lesser genetical importance than formerly anticipated.

LITERATURE

BAKKEN, R. and GLEDITSCH, E. (1938) Am. Journ. Sci., 5th ser. vol. 36, pp. 95—106.
BAKKEN, R., GLEDITSCH, E. and PAPPAS, A. C. (1948). Bull. Soc. Chim. France, ser. 5, vol. 15, pp. 515—517.
EHRENBERG, H. FR. (1953). Zeitschr. f. Physik, *134*, pp. 315—333.
FAUL, H. (1959). Geochim. et Cosmochim. Acta, *17*, pp. 153—156.
FØYN, E. (1938). Vid.-Akad. Skr. I, Mat.-Naturv. Kl. 1938, No. 4.
GENTNER, W. and KLEY, W. (1957). Geochim. et Cosmochim. Acta, *12*, pp 323—329.
GILETTI, B. J. (1959). Nature, *184*, p. 1793.
GLEDITSCH, E. (1925). Vid.-Akad. Skr. I, Mat.-Naturv. Kl. 1925, No. 3.
GLEDITSCH, E. and QVILLER, B. (1932). Phil. Mag. 14 II, pp. 233—243.
HERR, W. and MERZ, E. (1958). Zeitschr. f. Naturforschung, *13 a*, pp. 231—233.
HERR, W., MERZ, E., EBERHARDT, P. and SIGNER, P. (1958). Zeitschr. f. Naturforschung, *13 a*, pp. 268—273.
HOLMES, A. (1959). Trans. Edin. Geol. Soc., *17*, part 3, pp. 183—216.
HOLMES, A., SCHILLIBEER, H. A. and WILSON, J. T. (1955). Nature, *176*, p. 390.
JORDANOV, N. (1957). Anal. Chemie, University, Sofia.
KULP, J. L. and ECKELMANN, W. R. (1957). Am. Mineral, *42*, pp. 154—164.
NIER, A. O. (1939). The Physical Review, 2nd ser., *55*, pp. 153—163.
ROSENQVIST, I. TH. (1947). Norsk Geol. Tidsskr. *26*, pp. 219—220.
SÆTHER, E. (1957). Det Kgl. Norske Videnskabers Selskabs Skrifter, 1957, no. 1.

Manuscript received June 7, 1960.
Printed July 1960.

Addendum

While this paper was in print the following age determinations were completed by professor J. L. Kulp of Lamont Geological Observatory, Columbia University, in cooperation with the author.

385 m. y.	Biotite. K—Ar. J. L. Kulp. Gneiss, Dalsnibba, Romsdal. J. L. Kulp.
395 m. y.	Muscovite. K—Ar. J. L. Kulp. Pyrite ore, Bleikvassli, county of Nordland. F. M. Vokes.
405 m. y.	Biotite. K—Ar. J. L. Kulp. Gneiss, Geiranger, Romsdal. J. L. Kulp.
423 m. y.	Biotite. K—Ar. J. L. Kulp. Pegmatite, Røshagen, Selvågfjord, Langøy, Vesterålen. K. S. Heier.
425 m. y.	Muscovite, K—Ar. J. L. Kulp. Pegmatite, Kvamsvåg, Alversund, Hordaland. M. A. Sellevoll.

430 m. y.	Biotite. K—Ar. J. L. Kulp. Grey gneiss, Jægtbøgen, Langøy, Vesterålen. K. S. Heier.
450 m. y.	Biotite. K—Ar. J. L. Kulp. Mica schist, Storelva between Viksfjord and Geirsfjord, Langøy, Vesterålen. K. S. Heier.
575 m. y.	Biotite. K—Ar. J. L. Kulp. Augen gneiss, crossroads between Sandnes and Sandnesodden, Langøy, Vesterålen. K. S. Heier.
585 m. y.	Biotite. K—Ar. J. L. Kulp. Kimberleyite, Steinsrud, Holla, 1 km SW of the Fen area. S. Bergstøl.
815 m. y.	Biotite. K—Ar. J. L. Kulp. "Telemark granite", Sandå, S. Sundsli, Aust-Agder. H. Neumann and B. Nilssen.
825 m. y.	Biotite. K—Ar. J. L. Kulp. Farsundite, Rømteland, Vest-Agder. T. Sverdrup.
839 m. y.	Biotite. K—Ar. J. L. Kulp. "Østfold granite", Iddefjord, Østfold. H. Neumann and B. Nilssen.
850 m. y.	Biotite. K—Ar. J. L. Kulp. Granite, Fevik, Aust-Agder. H. Neumann and B. Nilssen.
850 m. y.	Biotite, K—Ar. J. L. Kulp. Granite, Amtmannsvingen near Tvedestrand, Aust-Agder. H. Neumann and B. Nilssen.
860 m. y.	Muscovite. K—Ar. J. L. Kulp. Pegmatite, Iveland, Vest-Agder. H. Neumann and B. Nilssen.
860 m. y.	Biotite. K—Ar. J. L. Kulp. Granite, Herefoss, Aust-Agder. B. Nilssen.
870 m. y.	Biotite. K—Ar. J. L. Kulp. Gneiss, Flaten, Aust-Agder. H. Neumann and B. Nilssen.
895 m. y.	Sericite. K—Ar. J. L. Kulp. Pegmatite, Bjertnes feldspar quarry, Krødsherad, Buskerud. H. Neumann and B. Nilssen.
915 m. y.	Biotite. K—Ar. J. L. Kulp. Pegmatite, Tarjeisberg, Telemark. H. Neumann and O. Adamson.
925 m. y.	Biotite. K—Ar. J. L. Kulp. Mica schist, NNE Flaten, Aust-Agder. H. Neumann and B. Nilssen.
935 m. y.	Biotite. K—Ar. J. L. Kulp. Pegmatite, feldspar quarry Hella no. 3, Tromøysund, Aust-Agder. H. Neumann and B. Nilssen.
940 m. y.	Biotite. K—Ar. J. L. Kulp. Gneiss, Assevvann, Aust-Agder. H. Neumann and B. Nilssen.
950 m. y.	Biotite. K—Ar. J. L. Kulp. "Flå granite", WNW Hedal church, Buskerud. H. Neumann.
965 m. y.	Biotite. K—Ar. J. L. Kulp. Granite ("Tinn granite"), north of Tinnsjø, Telemark. J. A. Dons.
1010 m. y.	Biotite. K—Ar. J. L. Kulp. Arendalite, Hisøy, Aust-Agder. H. Neumann and B. Nilssen.
1055 m. y.	Muscovite. K—Ar. J. L. Kulp. Pegmatite 650 m WNW of W. Sone church, Modum, Buskerud. O. Jøsang.

1080 m. y.	Biotite. K—Ar. J. L. Kulp. Productive vein, apatite mine, Ødegården Verk, Bamble, Telemark. R. D. Morton.
1105 m. y.	Biotite. K—Ar. J. L. Kulp. Banded gneiss, Hisøy, Aust-Agder. H. Neumann and B. Nilssen.
1105 m. y.	Biotite. K—Ar. J. L. Kulp. Gneiss, Skarerveien, Lørenskog near Oslo, Akershus. H. Neumann and B. Nilssen.
1345 m. y.	Biotite. K—Ar. J. L. Kulp. Arendalite, Langsev, Aust-Agder. H. Neumann and B. Nilssen.