Lam, J. and Pedersen, K. Raunsgaard (in press) Precambrian organic compounds from the Ketilidian of South-West Greenland II. Medd. Grønland, Bd. 185, Nr. 6.

Pedersen, K. Raunsgaard (1966) Precambrian fossils from the Ketilidian of South-West Greenland. Rapp. Grønlands geol. Unders., Nr. 11, 40-41.

Pedersen, K. Raunsgaard (1967) Nogle prækambriske fossilér fra Vestgrønland. Medd. dansk geol. Foren., Bd. 16, 195-196.

Pedersen, K. Raunsgaard and Lam, J. (in press) Precambrian organic compounds from the Ketilidian of South-West Greenland I. Medd. Grønland, Bd. 185, Nr. 5.

PROSPECTING INSTRUMENTS USED IN THE SURVEY OF URANIUM-THORIUM AND BERYLLIUM IN THE ILÍMAUSSAQ INTRUSION, SOUTH GREENLAND

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A series of detailed investigations initiated in the Ilímaussaq alkaline intrusion in 1964 comprises petrological, geochemical and mineralogical examinations carried out by the Petrological Institute of the University of Copenhagen and the Danish Atomic Energy Commission's Research Establishment at Risø, under the auspices of the Geological Survey of Greenland.

As uranium-thorium and niobium mineralizations are most common in the lujavrites of the Kvanefjeld area and beryllium and niobium mineralizations are common on the Taseq slope in the north-western part of the intrusion, the work so far has been concentrated in these areas. The first part of the detailed mapping of the Kvanefjeld area was completed in 1967. A summary of the results will be given by Sørensen, Hansen and Bondesen (in prep.). In the survey of the beryllium mineralization portable beryllium detectors (beryllometers) have been used, while in the survey of the uranium-thorium mineralization newly constructed geiger-counters and transportable γ-spectrometers have been used. These prospecting instruments are described briefly here.

The beryllium minerals are found especially in late hydrothermal veins of the Taseq slope. The veins, which are from less than a mm to ca. 2 m wide, show considerable variation in their content of beryllium minerals. The most common beryllium mineral is chkalovite, but 10 other beryllium minerals have been found. The chkalovite crystals are from ca. 1 mm to 20 cm in size (Sørensen, 1962; Hansen, 1966 and in press; Hansen and Løvborg, 1966).

The lujavrites, which make up several km^2 of the surface area of the intrusion, are all weakly radioactive. The strongest radioactivity is found in the Kvanefjeld area, especially where the lujavrites are in contact with the roof of the intrusion. In the roof zone the lujavrites contain up to 0.3% uranium and 1.3% thorium (Bondam and Sørensen, 1959; Hansen, 1966; Sørensen, Hansen and Bondesen, in prep.).

The prospecting instruments were designed in 1965-67 by the Radioisotope Measurement Group of the Electronics Department at the AEC Research Establishment at Risø, under the direction of the first author in cooperation with the second author. The development and use of the instruments have lead to a special research project in the application of nuclear methods to mineral prospecting.

Instruments for beryllium prospecting

Two different beryllium detectors (beryllometers), both utilizing the (γ, n) - reaction which occurs when Be atoms are irradiated with γ-rays from a Sb^{124} source, have been constructed and used in the investigation of the beryllium mineralization. One instrument (beryllometer I) has a circular sensitive area of about

25 cm^2, and a limit of detection of about 0.01% Be. The other instrument (beryllometer II) has an approximately rectangular sensitive area of about 10 x 25 cm, and the limit of detection is about 0.1% Be. The difference in the shape and size of the sensitive areas is due to the difference in the arrangement of the irradiation sources in the two instruments: beryllometer I contains a single point-source whereas there are 31 point-sources in beryllometer II. The latter sources are arranged linearly so as to produce an approximately constant γ-flux over a length of about 30 cm. The limits of detection are different because the ratio between the number of beryllium neutrons and the number of background neutrons is higher in beryllometer I than in beryllometer II. In beryllometer I the activity of the point source in 100 mCi (milli Curie), and two BF_3-counters are used for detecting the neutrons. The total activity of the sources in beryllometer II is 20 mCi, and the neutrons are detected by means of two He^3-counters. The effect of the reduced source strength in beryllometer II is partly compensated by the detection efficiency of a He^3-counter which is higher than that of a BF_3-counter, but the neutron background is also higher.

The biological shields which are necessary in order to protect the users of the two beryllometers from the intense γ-radiations are designed so as to limit the dose rates on the surfaces of the instruments, apart from the sensitive areas, to about 100 mR/h. At a working distance of 2 m the dose rates are about 5 mR/h. These shields constitute the heaviest components of the instruments. The total weight of beryllometer I is 41 kg, while beryllometer II weighs 20 kg.

The two beryllometers are designed for different purposes: beryllometer I has the highest sensitivity, but requires a dense sample pattern, while beryllometer II is useful in the exploration of ore-grade beryllium mineralizations and makes possible a fast scanning of veins.

The measurements in the field have been combined with laboratory measurements on powder from a "cobra" drill. It is planned also to measure drill cores using automatically controlled sampling devices.

Instruments for uranium-thorium prospecting

These comprise a digital geiger-counter (Løvborg, 1967) and a completely portable γ-spectrometer (Løvborg, in press).

The geiger-counter contains a γ-sensitive GM-tube and a scaler-timer which is powered from a built-in rechargeable Ni-Cd battery. The scaler consists of an electro-mechanical register preceded by a scaling-circuit which can be adjusted to give a scale factor of 1, 2, 4, 20 and 40. The timer is entirely electronic and can be pre-set to count periods of 1, 2, 4, and 8 minutes. Both scaler and timer are constructed on the basis of integrated circuit elements, which has resulted in a very compact instrument. This geiger-counter has proved to be very useful in the survey of the radioactive rocks. Its digital feature eliminates the error source which occurs in the still widely used rate-meter instruments because of the difficulty involved in reading these in the correct manner.

The portable γ-spectrometer incorporates a general-purpose single-channel pulse-height analyser and two different scintillation detectors. One detector contains a 2 x 2 inch NaI(Tl) crystal. It was designed for use with the single-channel analyser in the determination of the intensities of the characteristic components in the γ-ray spectra obtained from rocks which contain uranium and thorium. The other detector contains a small NaI(Tl) crystal. This detector was designed for use in static γ-ray logging of narrow and shallow bore-holes with the pulse-height analyser in the integral counting mode of operation. The outstanding feature of the logging sonde is its small diameter of only 23 mm. The pulse-height analyser contains, in one carrying case, all the circuits necessary for the analysis and recording of pulses from a scintillation counter: high voltage supply, linear amplifier, differential discriminator, rate-meter, scaler-timer and rechargeable battery. The circuits are for the most part fully integrated, and the total weight of the instrument is ca. 20 kg.

γ-spectrometry has been used in the exploration of the uranium and thorium mineralizations of Kvanefjeld. The investigations carried out until now include the recording of some 100 γ-spectra in the range 1.6 - 3.0 MeV. This energy range comprises the 1.76 MeV peak from Bi^{214} in the U^{238} decay series, and the 2.62 MeV peak from Tl^{208} in the Th^{232} decay series. In these measurements the crystal of the scintillation detector was placed 10 cm above the rock surface which corresponds to an effective sample volume of several hundred kg. It is intended to use these 100 γ-spectra, which represent a dynamic range of uranium-thorium concentration of more than two orders of magnitude, for the purpose of an absolute calibration of the γ-spectrometer in terms of cpm/ppm over two energy bands giving optimum sensitivity for uranium and thorium respectively. The calibration is carried out as a comparison between the counting rates in the two energy bands and the actual contents of uranium and thorium in a sample of rock collected from each measurement site.

References

Bondam, J. and Sørensen, H. (1959) Uraniferous nepheline syenites and related rocks in the Ilímaussaq area, Julianehaab district, Southwest Greenland. Proc. 2nd Intern. Conf. Geneva, Sept. 1958, U.N. Peaceful uses of Atomic Energy, Vol. 2, 555-559.

Hansen, J. (1966) Report on the survey of beryllium, niobium, uranium and thorium mineralization in the Ilímaussaq complex, South Greenland. Rapp. Grønlands geol. Unders., Nr. 11, 47-49.

Hansen, J. (in press) Niobium mineralization in the Ilímaussaq alkaline complex, South-West Greenland. Rep. 23rd Intern. geol. Congr. Prague, 1968, Part 7.

Hansen, J. and Løvborg, L. (1966) På spor af sjældne metaller i Sydgrønland. IV. Beryllium-efterforskning. Grønland, 1966, 243-256.

Løvborg, L. (1967) A scaler-timer for portable instruments. Nuclear Instruments and Methods, Vol. 54, 137-138.

Løvborg, L. (in press) A portable γ-spectrometer for field use. Danish Atomic Energy Comm. Res. Establ. Risø, Rep. No. 168.

Sørensen, H. (1962) On the occurrence of steenstrupine in the Ilímaussaq massif, Southwest Greenland. Medd. Grønland, Bd. 167, Nr. 1.

Sørensen, H., Hansen, J. and Bondesen, E. (in prep.) Preliminary account of the geology of the Kvanefjeld area of the Ilímaussaq intrusion, South Greenland. Rapp. Grønlands geol. Unders.

THE FLAT-LYING METAMORPHIC COMPLEX AND RELATED IGNEOUS ROCKS OF THE KAP FARVEL AREA

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7000 km^2 have been mapped on a scale 1:100 000, in an area east of Frederiksdal (44°40' W) extending 90 km northwards from Kap Farvel to the northern side of Lindenows Fjord (60°35' N). The chronology previously established in the southern part of the area (Bridgwater, Sutton and Watterson, 1966) has been confirmed and found applicable to the whole area.

Much of the area is underlain by high-grade crystalline rocks derived from a supracrustal succession of predominantly clastic sediments. No crystalline basement has been recognised to this, presumeably Ketilidian, sequence which is several km thick. Metasediments range from impure quartzites to pelites and frequently contain sufficient calcium to develop minerals such as diopside; in spite of this characteristic high calcium content, marbles and calc-silicates are relatively uncommon except in the topmost part of the known succession. Graphitic and iron-rich horizons occur