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NOTES ON A PERALKALINE GRANITE FROM CASHES LEDGE, GULF OF MAINE

PRIESTLEY TOULMIN III, *Harvard University, Cambridge 38, Massachusetts.*

The writer has recently had the opportunity to examine a specimen of granite from Cashes Ledge, a submarine prominence in the Gulf of Maine. The specimen was collected by Dr. John M. Zeigler of Woods Hole Oceanographic Institution. Although the precise location of the specimen is not available, reference to topographic maps of the area (Murray, 1947, Fig. 7) indicates that the position must be approximately 42° 54′ N. Lat., 68° 56′ W. Long.

The hand specimen is a roughly rectangular slab approximately 5×4×1 cm. Bryozoans and algae encrust one of its larger sides; the side opposite is freshly broken. Megascopically one can recognize quartz, alkali feldspar, black amphibole, and a little dark green pyroxene, all having an average grain size of about three millimeters. Under the hand lens, tiny crystals of iron-rich olivine may be discerned. The minerals appear quite fresh; the only sign of weathering is an occasional speck of limonite in the amphibole.

Under the microscope, the rock is seen to be holocrystalline, hypautomorphic granular. *Quartz* occurs in anhedral grains averaging 1–3 mm. in diameter, ranging up to 5 mm. The quartz shows very slightly wavy and irregular extinction, and carries many tiny clear inclusions. *Microperthite* subhedra have about the same size range as the quartz, and are composed of elongate and more or less equant irregular areas of albite in an untwinned microcline host. Apparent differences of shape between albite masses probably reflect different orientations of host crystals relative to the plane of the thin section. Plagioclase is concentrated slightly at the margins of perthite grains, but no independent extra-perthitic plagioclase crystals were seen. Tiny specks of clay minerals disseminated through the microcline give it a "dusty" appearance in thin section. A specimen of microperthite was homogenized by heating at 910° C.±10° C. for about fifty hours; an *x*-ray powder pattern was prepared on a Norelco Geiger-counter diffraction spectrometer using $CuK\alpha$ radiation. The bulk composition of the homogenized material was determined from measurements of $d_{(20\bar{1})}$, using quartz as an internal standard, and referring the *d*—spacing to the chart of Bowen and Tuttle (1950, Fig. 2). The average of five measurements of $d_{(20\bar{1})}$ is 4.14 Å, corresponding to $Or_{56}(Ab+An)_{44}$ (wt.%). The accuracy of the determination is of the order of $\pm 5\%$ Or.

There are two amphiboles in the rock. *Hornblende*, apparently iron-rich, occurs in subhedral grains up to 4 mm. across. The hornblende is strongly absorbing and pleochroic, varying from yellow-green to very dark brownish green or black; no useful interference figure was obtained. Strikingly pleochroic *riebeckite*, varying from deep blue or black to light yellow-brown, occurs principally in sheaf-like aggregates of very thin needles 0.1–0.5 mm. long. The aggregates are clustered in several areas in the slide, where they are associated with hornblende, aegirite, iron-rich olivine, astrophyllite, aenigmatite (?), and quartz. Riebeckite also forms larger crystals, one of which is 0.1×0.4 mm. and is in contact with hornblende, aegirite, quartz, and aenigmatite (?).

Aegirite, or aegirite-rich pyroxene, forms 0.1 mm. irregular grains associated with hornblende, riebeckite, and aenigmatite (?). The mineral has a moderate negative 2V, birefringence about 0.05, and X is very nearly parallel to *c*. The pleochroism is rather strong, with Z′ yellow-green and X′ deep grass green.

Iron-rich *olivine* occurs in several small (0.05 mm.) grains and in one large (0.3 mm.) broken euhedron associated with clusters of riebeckite needles in the section studied. $2V_x$ was determined by universal stage to be $60°\pm 5°$, corresponding approximately to Fa_{85} (ferrohortonolite) (Tröger, p. 37).

Astrophyllite occurs in a 0.2×0.5 mm. irregularly shaped grain enclosed in the hornblende of a hornblende-aegirite intergrowth. Many small red-brown to yellow fibrous aggregates associated with aenigmatite (?) and riebeckite may also be astrophyllite.

A strongly absorbing, pleochroic mineral, referred to in this note as *aenigmatite (?)*, occurs as a few remnants of euhedral crystals one to five mm. long; the mineral is highly fractured, and much of it was lost in preparation of the thin section. The color varies from dark chestnut brown (X′) through dark red-brown to black (Z′). The extinction is at 45° to the elongation. The mineral is very similar to that which Washington (1898, pp. 792–793) described as allanite in a granite from Gloucester, Massachusetts, but the pleochroism and extinction angle of the material in the Cashes Ledge specimen are more nearly those of aenigmatite. Unfortunately, sufficient pure material for *x*-ray determination has not been obtained. Small red-brown granules, probably of the same mineral, are associated with the clusters of riebeckite needles.

Zircon is quite rare in the section examined; the few tiny crystals seen are enclosed in amphibole grains. A small amount of an opaque mineral, probably *magnetite*, seems to have formed by alteration of hornblende.

Although no banded structure is apparent in the hand specimen, quartz and feldspar are concentrated in different parts of the thin section. For this reason, and because of the small size of the thin section (1×3 cm.), no quantitative modal analysis has been attempted. In general, the amounts of quartz and of feldspar are about equal, and the color index is about 10.

The mineralogy of the rock clearly reflects its peralkaline character; petrographically it resembles many of the alkaline granites of New England that generally have been assigned to, or correlated with, the White Mountain magma series (Billings, 1945; Greenwood, 1951, pp. 1171–1178; Chapman and Williams, 1935). Like these rocks, it shows little or no cataclastic or gneissic structure. It is quite similar to certain granites of Cape Ann, Massachusetts, in which fayalite and allanite (the latter "very rare") are reported as accessory minerals (Warren and McKinstry, 1924, p. 332). The absence or rarity of extraperthitic plagioclase, association of hastingsitic and riebeckitic amphiboles and aegiritic pyroxenes, and the occurrence of accessory iron-rich olivine and astrophyllite are all characteristics of the more alkaline granites of the Cape Ann area; the bulk composition of the microperthite is within the rather narrow range found by the writer for the microperthites of granites and quartz syenites in the southwestern part of the Cape Ann granitic body. These microperthites range from Or_{48} to Or_{60} (wt. %), corresponding to a range of 4.13 A. to 4.15 A. in $d_{(20\bar{1})}$.

Recent zircon-age studies (Webber *et al.*, 1956; Tilton *et al.*, 1957; Lyons *et al.*, 1957; Quinn *et al.*, 1957) suggest that at least two unrelated groups of alkaline intrusive rocks of late Paleozoic to early Mesozoic (?) age may exist in the new England area. The rocks of Cape Ann and Peabody, Massachusetts, appear to be about 85 million years older than the rocks of the White Mountain magma series in New Hampshire. If this apparent age difference is real, it seems unlikely that the two groups are genetically related. Petrographic criteria by which rocks of the two series can be distinguished with certainty are not available at present.

Cashes Ledge is approximately 75 miles east-northeast of Rockport, Massachusetts, and about the same distance east-southeast of the Mt. Agamenticus area, Maine, the two nearest shore points where similar rocks are exposed. Dr. Zeigler, who obtained the specimen, states definitely that it was broken from bedrock. This occurrence thus implies a considerably greater souteastward extent for rocks of this type than has been indicated by earlier data. It should be noted that certain granites of eastern Maine are petrographically similar to the rocks under consideration (Chapman, 1956; Wing, 1953); to the writer's knowledge, however, the relationship of these rocks to the White Mountain magma series has not yet been the subject of a detailed study.

Professor M. P. Billings suggested the examination of this specimen to the writer. Dr. Zeigler kindly provided the specimen and consented to publication of this description. Professor J. B. Thompson, Jr., read the manuscript and made a number of helpful suggestions.

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The next Conference of the X-ray Analysis Group of the British Institute of Physics will be held in Manchester, England, on April 18–19, 1958. Full details will be available in January, 1958, from Dr. R. L. Gordon, Safety in Mines Research Establishment, Portobello St., Sheffield 1, England.

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