ILVAITE AND PREHNITE IN MICROPEGMATITIC DIORITE, SOUTHEAST PAPUA

GEORGE BAKER, *University of Melbourne, Victoria, Australia.*

ABSTRACT

Ilvaite and prehnite occur in hydrothermally altered portions of micropegmatitic diorite outcropping in a geologically little known region of Southeastern New Guinea. The ilvaite replaces some of the pyroxenes in the diorite, while prehnite occurs nearby in narrow veinlets cutting through the diorite. Ilmenite is an abundant accessory component. Marked textural features of the micropegmatitic diorite are well-developed micrographic intergrowths between the components of a quartz-orthoclase mesostasis, and micrographic intergrowths between pyroxene and ilmenite.

INTRODUCTION

Situated northeast of Milne Bay at the southeastern end of Papua (Fig. 1), micropegmatitic quartz diorite outcrops on the shore platform near Hehego Mission at East Cape, and also forms the basal rock of the shore platform on nearby Meimeiara Island, which is separated from the mainland by a channel two hundred yards wide. Dioritic rocks extend for at least ten miles west of East Cape. Parts have been hydrothermally altered, leading to the production of ilvaite and prehnite.

The area occurs at the southeastern end of the Owen Stanley Ranges, and the outcrops of micropegmatitic quartz diorite evidently represent parts of a small, planated batholith, originally intruded into rocks comprising part of the New Guinea basement complex. All that can be deduced at present of the age of this diorite in the Milne Bay region, is that it is older than the Upper Tertiary rocks of the area, which here consist of limestone and volcanic rocks. Specimens of the volcanic rocks from the Gurney Airfield district (see Fig. 1), are dolerites of variable grain size with well-developed ophitic textures, and altered andesites containing chlorite, clinozoisite, zoisite and albite. The specimens were collected by A. Coulson, in 1945, and were accompanied by field notes.

THE MICROPEGMATITIC DIORITE

The rock is green to black in color and medium-grained. Thin sections from specimens collected at East Cape and on Meimeiara Island, reveal that the rock is generally similar at each locality, but has been subjected to variable degrees of hydrothermal alteration.

The essential minerals in the rock at East Cape are augite and partially altered oligoclase, with a little quartz, rare primary and some secondary hornblende, chlorite, rare biotite as remnants in the chlorite, rare epidote and accessory apatite and iron ores with subsidiary zircon.

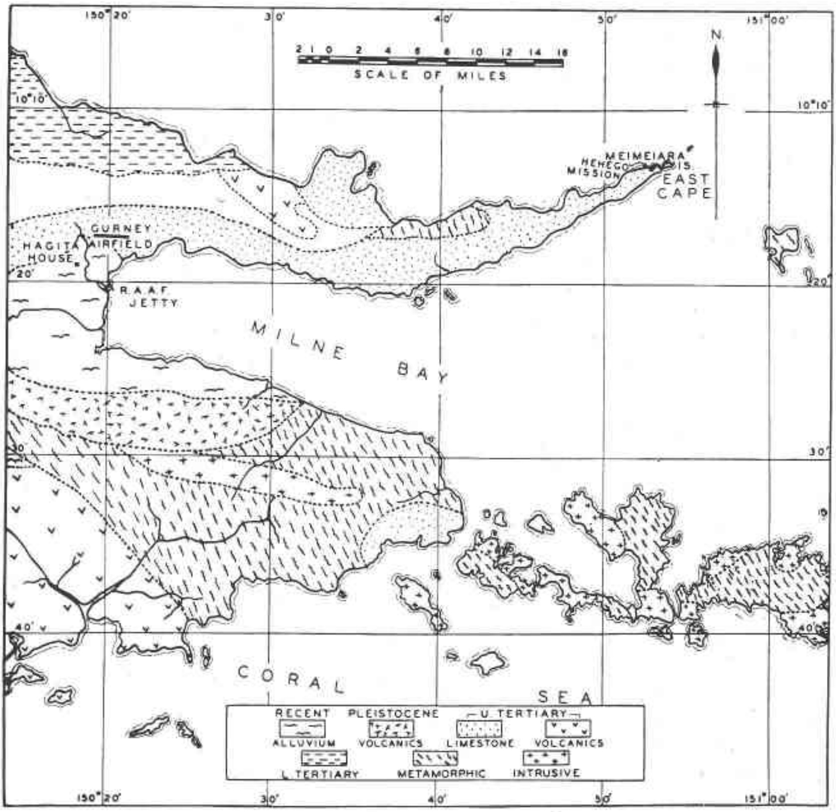

FIG. 1. Geological Sketch Map of the Milne Bay Region, Southeast Papua. Outline based on Australian Army Map (4 miles to 1 inch) of Samarai, First Edition, 1942. Geology from Geological Sketch Map of Eastern New Guinea prepared by Directorate of Research, L.H.Q., Melbourne, December, 1944, from information supplied by J. N. Montgomery, N. Osborne and M. F. Glaessner.

Hatch and Wells (1926, p. 230) state that orthoclase and quartz occur interstitially in diorites and show a tendency towards micrographic intergrowths. Such intergrowths are a characteristic feature of the diorite from East Cape and are particularly well-developed on Meimeiara Island. The augite is mainly pale green in color, but some crystals have pale violet, weakly pleochroic, titaniferous cores. Extinction angles are up to 45°. A few pyroxene crystals are markedly fibrous, with a brownish to neutral tint and straight extinction; they carry occasional inclusions along cleavage directions and represent the bronzite variety of enstatite.

On Meimeiara Island, the diorite is more altered. It contains abundant ilvaite ($H_2O \cdot CaO \cdot 4FeO \cdot Fe_2O_3 \cdot 4SiO_2$) up to 2.2×1.2 mm. in size, which is biaxial, intensely pleochroic from dark brown to black in places, shows straight extinction, two distinct cleavages (001 and 010), and in most places is practically opaque in thin section. Where pleochroism can be observed, the ilvaite shows maximum absorption parallel to the more prominent cleavage direction. A polished surface of the rock shows that the dark colored ilvaite takes a relatively good polish and has a reflectivity a little higher than that of the other silicate minerals, but well below that of opaque oxides present. Under the reflecting microscope, the ilvaite shows particularly strong bireflection from a bluish-green to grayish-brown color. It is also strongly anisotropic, polarization colors being reddish-brown and bronze-like. Internal reflections are reddish-brown (cf. Ramdohr, 1950, p. 759).

Parts of the Meimeiara Island outcrop contain allanite as a nucleus enclosed by the isomorphous species epidote, which is here typically pistachio-green in color. Occasional hypersthene, not observed in the East Cape outcrop, occurs in the Meimeiara Island rock in addition to augite and rare enstatite. Hornblende has been completely altered to chlorite and both the clino- and ortho-pyroxenes are partially chloritized, with flecks of chlorite developed most abundantly along their cleavage directions.

The orthoclase in the micrographic intergrowths has been altered to small opaque masses of kaolinitic material and the associated intergrown quartz is partly strained and biaxial. The oligoclase has not been quite as strongly altered and still retains faint traces of lamellar twinning. It is pale yellowish-green in color from the presence of chlorite along its cleavage planes and from its alteration to fine particles of greenish sericitic matter.

Veinlets of grayish-white prehnite cut through the Meimeiara outcrop of dioritic rock. The prehnite shows typical "bow-tie" and radial structures in places, and is accompanied in the veinlets by a little quartz. Where more extensively hydrothermally altered, parts of the diorite are completely altered to a fine-grained zoisite-epidote-chlorite-quartz rock cut by veinlets of quartz and prehnite. Ghost-like outlines of the oligoclase and more clearly defined remnants of the clino- and ortho-pyroxenes testify to the dioritic parentage of the much altered rock. This type of hydrothermal alteration could be attributed to autometamorphic changes brought about by a concentration of volatile constituents in the late magmatic residuum. In view of the occurrence of hydrothermally altered andesites of younger age in the Milne Bay region, however, the diorite may have been partially altered by hydrothermal solutions liberated during Neogene volcanism.

Polished surfaces of the dioritic rocks reveal that ilmenite, the principal opaque mineral observed, is relatively common and constitutes a few per cent of the rock. The ilmenite occurs mainly in the granular form, but occasionally also as laths. The granules range in size from 0.025 mm. across to 0.40×0.60 mm., and the laths range up to 0.15×0.50 mm.

The ilmenite forms rare micrographic intergrowths with the pyroxene in which it is most commonly set. Evidently its crystallization period occurred principally prior to, but in places overlapped that of the pyroxenes. The constituent parts of the ilmenite in any one of these micrographic intergrowths are all in optical continuity.

The bulk of the ilmenite is structureless in itself, but there are a few small areas where the ilmenite carries closely spaced lamellae of magnetite, thrown down on exsolution along rhombohedral directions in such a manner as to form a marked meshwork structure. In many parts, hematite lamellae are present almost to the exclusion of the magnetite, and in such positions, the magnetite has been largely martitized, possibly from the effects of the hydrothermal solutions that partially altered the dioritic rocks.

The polished surfaces also reveal that the ilmenite and the ilvaite are frequently closely associated. Much of the ilvaite occurs in the areas of pyroxene, but in parts it contains inclusions of ilmenite and evidently formed after the ilmenite. In other parts, however, the ilvaite and the ilmenite occur in micrographic intergrowth, the several parts of the two components in the intergrowths being respectively in optical continuity. Since such intergrowths occur in a rock that has been subjected to hydrothermal alteration, it seems likely that the ilvaite in the intergrowths is a replacement product of the pyroxene, which elsewhere in the rock forms micrographic intergrowths with the ilmenite.

A little limonite, resulting from alteration by weathering of the ilvaite, forms very narrow veinlets cutting through the ilvaite. The ilmenite is principally fresh, but shows occasional alteration to thin rims of leucoxene around crystal edges and narrow veinlets of the same material along cracks.

Chemical Composition of the Diorite

A chemical analysis of the dioritic rock reveals the constituents listed in Table 1. The rock was analyzed by Mr. G. C. Carlos in the chemical laboratory of the Mineragraphic Investigations Section, Commonwealth Scientific and Industrial Research Organization.

The rock differs chemically from the usual run of diorites in having less alumina, magnesia and alkalies, and more ferrous iron oxide, lime and titania than average diorite (cf. Tyrrell, 1924), most likely as a consequence of the hydrothermal alteration processes. The rock is rich in

TABLE 1

SiO_2	55.76	
Al_2O_3	10.24	
Fe_2O_3	4.48	
FeO	10.18	*Norm.*
MgO	1.57	Q—18.72
CaO	9.41	or— 6.12
Na_2O	2.27	ab—18.86
K_2O	1.01	an—14.73
H_2O (+)	1.80	di—26.46
H_2O (−)	0.37	hy— 0.73
CO_2	0.02	mt— 6.50
TiO_2	2.75	il— 5.32
P_2O_5	0.12	ap— 0.34
MnO	0.03	
Cl_2	tr.	
SO_3	tr.	
Total	100.01	

titania for diorites generally, and this finds expression mineralogically in the abundant development of ilmenite. The high normative quartz content is partly a result of the vein quartz accompanying prehnite in veinlets, but is largely due to quartz in the micrographic intergrowths with orthoclase. Some of the FeO and some of the Fe_2O_3 has to be assigned to ilvaite, which also probably contains the small percentage of MnO. The P_2O_5 content is accredited entirely to the numerous, small apatite needles that occur included in both the feldspars and in the pyroxenes.

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REFERENCES

HATCH, F. H., AND WELLS, A. K. (1926), Textbook of Petrology, Vol. I. The Petrology of the Igneous Rocks. Allen and Unwin, Ltd., London.

RAMDOHR, P. (1950), Die Erzmineralien und Ihre Verwachsungen. Akademie-Verlag, Berlin.

TYRRELL, G. W. (1924), *Geol. Mag.*, lxi, 19–25.

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