Hutchinson (1950) has examined the literature on guano and is a useful reference in the absence of the original sources.

Specimens are preserved in the collections of the W.A. Government Chemical Laboratories.

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Hornblendites from the southern portion of the New Caledonian ultramafic belt

HORNBLENDE-BEARING rocks are rare members of the alpine-type, peridotite–gabbro–granodiorite complex of New Caledonia. They occur as bojite-gabbros (Rodgers, 1972), as hornblende diorites and granodiorites (Rodgers, 1973) and as hornblendites. The last-named rocks have been found in two regions of the southern portion of the largest ultramafic massif, the Massif du Sud, where both occurrences are probably dyke-like in nature but extensive laterization of the encasing harzburgite has obscured field relationships.

The first occurrence consists of small, isolated, remnant boulders seated in a ferralite road-cut about 1 km south of the Rau Pernod ford on Route du Carénage. The second locality is more substantial and forms a continuous series of waterfalls

and bluffs for over 50 m along the channel of a small stream on the western slopes of Mt. Kouré, due east of the upper reaches of Baie Ngo. Upper and lower contacts are concealed beneath alluvium and laterally the body passes into the ferralite of the hillside.

TABLE I. *Analyses and structural formulae of pyroxene and magnesian hornblendes from southern New Caledonia*

	1	2	3	4		1*	2*	3*	4†
SiO_2	46·08	46·23	45·69	53·42	Si	6·596	6·648	6·623	1·947
TiO_2	0·70	0·93	1·10	0·07	Al^{iv}	1·404	1·352	1·377	0·049
Al_2O_3	11·44	9·85	10·25	1·15	Al^{vi}	0·526	0·318	0·374	—
Cr_2O_3	n.d.	0·18	0·21	0·17	Ti	0·076	0·101	0·120	0·002
Fe_2O_3	2·84	3·57	3·20	0·51	Cr	—	0·021	0·024	0·005
FeO	5·14	7·56	7·36	16·47	Fe^{3+}	0·306	0·387	0·349	0·014
MnO	0·10	0·14	0·13	0·35	Fe^{2+}	0·615	0·909	0·892	0·502
MgO	17·10	16·18	15·82	26·65	Mn	0·012	0·017	0·016	0·011
CaO	11·46	10·84	11·01	0·61	Mg	3·648	3·468	3·418	1·448
Na_2O	2·18	2·04	2·08	n.f.	Ca	1·757	1·670	1·710	0·039
K_2O	0·15	0·17	0·15	n.f.	Na	0·604	0·568	0·584	—
H_2O^+	2·00	2·13	2·04	n.d.	K	0·026	0·030	0·028	—
					OH	1·908	2·043	1·972	—
Total	99·19	99·82	99·04	99·40					
					Y	5·18	5·22	5·19	—
					X	2·39	2·27	2·32	2·02
					mg	0·80	0·73	0·73	0·74

1. Hornblende, hornblendite 20034, Route de Carénage.
2. Hornblende, pyroxene-hornblendite 20035, Mt. Kouré. Core of large (5 cm) crystal.
3. Hornblende, pyroxene-hornblendite 20035, Mt. Kouré. Margin of large crystal given in 2.
4. Bronzite, pyroxene-hornblendite 20035, Mt. Kouré.

* Structural formulae on a basis of 24 (O, OH).

† Structural formulae on basis of 6 oxygen.

FeO/Fe_2O_3 and H_2O^+ determined by wet chemistry; other constituents, including total iron, by electron probe.

Petrography and mineralogy. The Carénage boulders consist of over 99 % close-packed crystals of hornblende ranging from 0·1 to 1 cm in diameter and set in an allotriomorphic granular texture. The only accessory mineral is small ragged flakes of hydrous mica replacing the amphibole. Although this hornblende is dark, almost black-green in hand specimen, in thin section it is pale green to colourless and only very weakly pleochroic. $2V_\alpha$ gave consistent values of 87° and α averaged 1·649, β 1·66, and γ 1·671. Microprobe analysis showed the mineral to be a magnesian hornblende (Table I, col. 1).

At Mt. Kouré the rock is a pyroxene-hornblendite and shows a range of textures from granitic, through porphyritic to pegmatitic. Towards the margins of the mass the rocks are roughly equigranular with anhedral orthopyroxenes and hornblendes set in a close-packed texture and ranging from 0·1 to 1 mm long. Away from the margins a greater range in grain size is apparent, textures become more loosely packed and anhedral crystals frequently possess ragged terminations. In the interior of the dyke,

very large crystals of amphibole up to 25 cm long [001] and 15 cm across are found either in groups of a dozen or as individuals seated in a finer grained loosely packed inequigranular mosaic of anhedral orthopyroxene up to 1 mm long. Terminations of the larger crystals are ill defined. Towards their margins, large crystals poikolitically enclose numerous anhedral and subhedral bronzite crystals similar to those of the mesostasis. The number of included crystals increases sharply over the last centimetre of the host crystal.

Apart from orthopyroxene and hornblende, the rest of the Kouré rock consists of small irregular flakes of brown biotite, pale green chlorite, and hydromuscovite, together with rare anhedral grains of magnetite. The biotite, which represents no more than 2 % of the rock, occurs in patches and appears to be replacing the amphibole. The chlorite and hydromuscovite are more sparsely developed and are normally associated with biotite which they appear to replace.

The majority of the Kouré amphibole consists of pale brown pleochroic common hornblende. Optic axial angle ranges from 65 to 95° and γ from 1·661 to 1·673. Electron microprobe analyses of a number of sections failed to reveal any marked compositional differences either between crystals or within crystals. Small differences were noted in alumina, whose concentration appeared to rise slightly towards the margins of the larger crystals. Two representative analyses of a core and margin are given in Table I. The associated orthopyroxene is a bronzite (Table I, col. 4). $2V_{\alpha}$ ranges from 80 to 85°, α averages 1·675, and γ 1·688.

Discussion. Few analyses exist of amphiboles from alpine-type ultramafic environments. In the New Caledonian belt all primary amphiboles so far analysed have proved to be magnesian hornblendes, although those from the hornblendites differ somewhat in composition from those of either bojites (Rodgers, 1972) or diorites (Rodgers, 1973). For example, hornblendite hornblendes have higher *mg* and lower *si* values.

The orthopyroxene of the pyroxene-hornblendite has a much lower *mg* value than that of any other ultramafic rock type so far examined from the belt. Only a few rare examples of iron-rich bronzites, found as accessories in cumulate eucrites (the last major rock type to crystallize in the belt), have a comparable composition.

A wide variety of very coarse grained, late-stage dykes, invariably containing primary hydroxyl-bearing minerals, have been recorded as intruding both the cumulate and non-cumulate rocks in New Caledonia (e.g. tourmaline-pegmatite, diorites, glimmerites, pyroxenites). Presumably the hornblendites are related to this period of activity, which probably immediately preceded the overthrusting of the peridotites into their present position.

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Phonolitic ash-flow tuffs from northern Kenya

MOST ash-flow tuffs (or ignimbrites) described in the literature are highly silicic in composition. The calc-alkaline ash-flows of the Taupo volcanic zone, New Zealand, and the western United States, for example, are dominantly rhyolites, rhyodacites, and dacites, but andesitic ash-flows are also well represented (Ross and Smith, 1961). In addition, ash-flows of peralkaline rhyolitic composition have been described from Nevada (Noble, 1965; 1968), Ethiopia (Gibson, 1970), and elsewhere. The Kenya rift is one of the major areas in the world where alkaline, silicic volcanics are abundant and ash-flows of peralkaline trachytic and rhyolitic compositions are numerous.

All the ash-flow compositions mentioned above are oversaturated with respect to silica. Ash-flows of undersaturated composition have not been described with the exception of some slightly undersaturated trachytic tuffs from Gran Canaria (Schmincke, 1969). These deposits occur within a sequence of trachyte and trachyphonolite lavas and have SiO_2 in excess of 62 wt. %. The occurrence, therefore, in the Kenya rift of ash-flow tuffs of a strongly undersaturated composition is of some interest.

The presence within the Kenya rift of large volumes of phonolite is well known. Chapman (1971) recognizes two chemically and petrographically distinct phonolite types, *phonolites* (*sensu stricto*) and *trachyphonolites*. The latter type is only mildly undersaturated and every gradation exists between trachyphonolite and trachyte. Phonolite *sensu stricto* or 'plateau' phonolite is strongly undersaturated with 15 to 30 % *ne* and is present in enormous volumes both within the rift and on its shoulders (Lippard, 1973*b*). The petrology of these different phonolite types has been described by Lippard (1973*a*) who suggests that the plateau phonolite successions are in fact the flanks of huge, low-angle, shield volcanoes. The phonolitic ash-flows reported here are found on the north-western flanks of one such centre (at 35° 31′ E., 1° 27′ N.) and form part of the Tiati massif.

Two ash-flows occur near the base of a 1000 metre succession of phonolite lavas and pumice tuffs; each is about 15 m thick and welded throughout. The ash-flow tuffs