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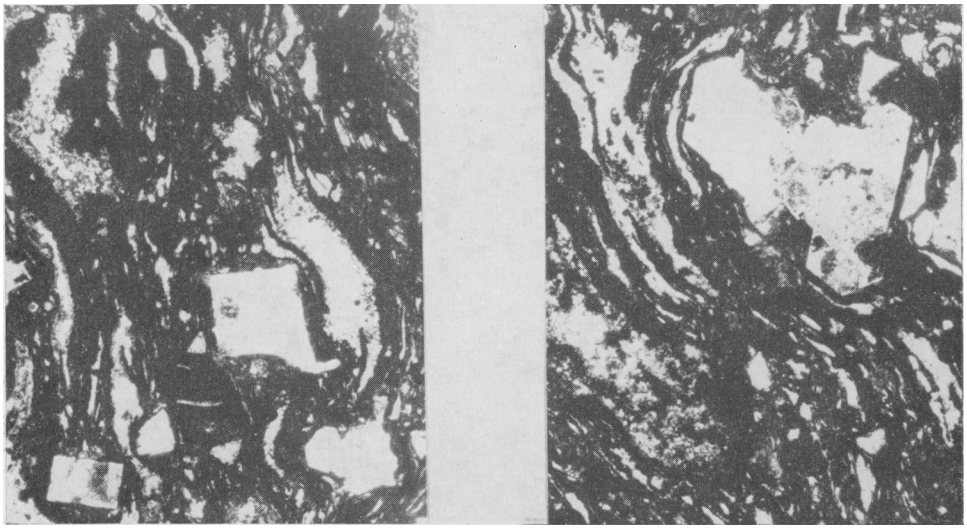
Phonolitic ash-flow tuffs from northern Kenya

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



FIGS. 1 and 2: Photomicrographs of phonolitic ash-flows (×2·5, plane polarized light). The broken phenocrysts are nepheline and sanidine.

TABLE I

	I	II	III
SiO_2	55·00	53·37	52·88
TiO_2	0·53	0·40	0·40
Al_2O_3	19·94	19·66	19·31
Fe_2O_3	2·41	2·80	3·00
FeO	2·27	2·02	1·70
MnO	0·27	0·27	0·26
MgO	0·51	0·18	0·18
CaO	1·42	1·59	1·66
Na_2O	8·34	8·60	8·50
K_2O	5·94	5·39	5·18
P_2O_5	0·07	0·04	0·04
H_2O+	3·19	3·60	4·91
H_2O-	0·66	0·59	0·59
CO_2	—	0·69	1·43
	100·55	99·20	100·04
ne	25·5	24·9	21·9

I average plateau phonolite from Lippard (1973*a*).
II phonolitic ash-flow tuff from the Tiati area.
III „ „ „ „ „ „ „

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are flinty, eutaxitic rocks, dark green to brown in colour and contain darker coloured fiamme. The tuffs have a particulate matrix (figs. 1 and 2) composed of flattened and rarely cuspate shards, which are largely devitrified and may have a delicate axiolitic structure. Each lenticular fiamma is composed of small, radially orientated crystals of alkali feldspar projecting into an analcime-rich core (compare Webb, 1973). The tuffs contain about 20 % by volume broken phenocrysts, mostly sanidine and

fresh nepheline. Microphenocrysts of green pyroxene, magnetite, and rare red-brown biotite also occur.

Chemical analyses of specimens from the ash-flows are given in Table I and confirm their phonolitic composition. The tuffs have lower SiO_2 and Al_2O_3 and correspondingly higher volatile contents than the average plateau phonolite. The high H_2O+ content of the phonolites may be correlated with the presence of abundant groundmass analcime. The occurrence of analcime and primary calcite in a phonolite from Tiati has been reported by Webb (1973).

Ash-flows that are strongly undersaturated have not been previously reported. Even within the 50 000 km^3 estimated volume of plateau phonolite lavas in Kenya, ash-flows appear to be exceedingly rare. The apparent low viscosity of the phonolite flows and their morphological similarities to basaltic lavas have been commented upon by Lippard (1973*b*). In general, the plateau phonolite magma seems to have maintained sufficient fluidity during vesiculation and extrusion to remain coherent and unfragmented.

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Microchemical determination of FeO and of available oxygen in minerals

THE main weakness of most methods currently available for the determination of the state of oxidation ('ferrous iron' or 'available oxygen') of milligram quantities of minerals is that they involve the addition of reagents that are difficult to remove and interfere with other determinations on the same solution. The present method avoids