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The 1971 Etna Eruption: Petrography of the Lavas [and Discussion]

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The 1971 Etna eruption: petrography of the lavas

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[Plate 1]

Introduction

Most petrologists who have worked on Mt Etna have been surprised by the rather uniform character of its lavas (Lacroix 1908; Washington *et al.* 1926; Di Franco 1930). Except for a slight differentiation from alkali basalts to trachyandesites in the ancient Trifoglietto caldera, almost all the products forming this huge complex edifice have a tephritic basalt composition. They are usually porphyritic, with phenocrysts of calcic plagioclase (zoned from An 85 to An 40), augite, olivine and titaniferous magnetite. All these minerals, except olivine, are present in the groundmass, which also shows notable amounts of cryptocrystalline sanidine (about 10 %) and nepheline (about 5 %), these being determined by X-ray diffraction (Tanguy 1966). This uniformity in the petrochemistry of Mt Etna is interpreted by Rittmann as resulting from the absence of an intermediate magmatic reservoir, in relation with the tectonic history of the volcano (Rittmann 1963, 1973).

It has been previously stated that the recent lavas of Mt Etna (Tanguy 1966*a*, 1968) have a nearly constant chemical composition, the magmatic differentiation between one volcanic cycle and another, or even during a single eruption, being usually negligible; however, they show some petrographic differences in their phenocryst content and in the character, vitreous or crystalline, of the groundmass. These petrographic differences are due to variations in the temperature and fluidity of the magma at the time of eruption. However, this assumption was hypothetical, since temperature and viscosity measurements were lacking for most of the samples studied, especially for those emitted during the strongest phases of flank outbreaks, when it was supposed that these physical parameters and, therefore, the petrographic structures of the lavas, were quite different from those observed during the normal persistent activity. The 1971 eruption, as one of the most important paroxysms of the century, has given the opportunity to complete the study.

The 1971 eruption of Etna volcano

Since January 1966, Mt Etna has been in a normal state of moderate persistent activity, characterized by explosions within the summit craters (NE and/or central crater) and by slow emission of lava limited to the upper slopes of the NE cone. This activity came to an end with the flank outbreak of 1971.

According to Rittmann and Tazieff, the eruption began on 5 April, with the opening, at the foot of the central crater, of two radial fractures about 200 m apart, one directed towards the SSE (usually called the eastern vent, at an elevation of 3100 m above sea level) and the other towards the south (western vent: elevation 3000 m; the altitude of Mt Etna being 3340 m). Continuous explosive activity quickly built new cinder cones 30 to 50 m high on the fissures;

meanwhile lava flows poured out at the lower part with an initial speed reaching sometimes up to 15 km/h. During the entire month of April, the lavas flowed mainly on the south flank of the mountain (Piano del Lago), destroying the observatory and the upper part of the cableway, but also towards the SE in the great volcano-tectonic depression of the Valle del Bove. The more advanced lava fronts in the south and SSW direction reached the altitude of 2200 m.

In the evening of 4 May, a new fissure opened at the east base of the central cone about 2900 m above sea level. The discharge of highly fluid lava increased during the night and the strong degassing brought about the throwing of lava lumps and incandescent scoriae which began to build an elongated, sharp-shaped cone 30 to 35 m high. This cone was open towards the east where a big lava stream was flowing with an initial speed of 10 to 15 km/h. In a few hours the new lava reached a zone south of Monti Centenari in Valle del Bove near the 2000 m level.

This new outbreak did not affect the south vents immediately, which remained active until 6 May. At midnight of this same day, the activity of the new east vent began to decrease considerably and completely ceased on 7 May at 02h00. In the morning of 7 May, all was quiet on the volcano, except for cooling of small lava flows at the south vents and some increased emission of gas from the central crater, accompanied by rumblings and occasionally by brown cinderclouds.

At nightfall, however, a large red glow could be seen towards the east in the Valle del Bove: a new fracture originating from the upper east vent reached down to the 2400 m level where a flank eruption was starting on the slope between Valle del Leone and Valle del Bove (level 2700 to 2400 m). Six or seven lava flows were vigorously active, but explosive activity was almost negligible. For the next few days this eruption continued at a constant rate. Lava flows from several vents on two *en-echelon* fissures were moving at an initial speed of 1 to 2 m/s, while continuous degassing, but without violent explosions, was building small eruptive conelets (hornitos).

On the late evening of 11 May, a group of people standing near Rifugio Citelli (1750 m high on ENE slope of Mt Etna) heard a tremendous noise that was first thought to be located in the upper zone of the mountain. But a short time after they were able to observe a growing glow only 1 km distant from the Rifugio: the eruptive fracture had reached its lowest point (1800 m level) and was now 5 km long. On the morning of 12 May, this new active centre was stabilized by two *en-echelon* fissures about 200 m apart. For three weeks huge quantities of lava were delivered at a more or less constant rate. The erupting magma was highly fluid and foamy with an initial speed of 20/25 km/h, but no real explosions occurred and consequently no pyroclastic cones were formed. The lava flows invaded the pineland of Cubania and then spread on the rich lower eastern slope of Mt Etna, seriously threatening the villages of Fornazzo and Sant' Alfio. The lava stopped in the valley of Cava Grande (altitude about 600 m), the total length of the flow being 8 km.

On 18 May at 08h00, an explosive outbreak started at the upper end of the fracture near the 3000 m altitude, from a circular, newly opened abyss above the 4 May vent. High-pressure gases throwing cinders and blocks continued to escape for many days from this crater, which was the actual explosive vent of the flank eruption.

During the first days of June the discharge of lava at the Citelli vents began to decrease, and on 12 June the eruption was over.

Tazieff (1971, 1973) has outlined the rather exceptional character of this activity, which was greatly conditioned by the tectonic structure of the volcano. In fact, in the recent history of Mt Etna, the 1971 eruption is one of the most important paroxystic flank outbreaks by its duration and the volume of lava erupted: among such recent paroxysms, only that of 1950–51 lasted for a longer period, although it was only really paroxysmal during the first 5 weeks.

Petrography of the 1971 lavas

Samples were collected from the various flows of the first phase of the eruption, on the south slope of the mountain, according to Rittmann's event chronology (April to early May) (Rittmann 1971). A detailed sampling was made at the various vents during the east flank outburst (May) and at the front of the main lava flow near Fornazzo. Some of these specimens were pieces of molten lava quenched in air.

Chemical analyses were carried out on 10 of the samples (table 1), using the X-ray fluorescence method (Velde & Lenoble 1972) for the determination of major oxides, except FeO and

Table 1. Chemical analyses and c.i.p.w. norms of recent Etna lavas

		1971 lavas									
	1	2	3	4	5	6	7	8	9	10	11
SiO_2	47.38	47.63	47.27	47.37	47.66	47.53	47.01	47.22	47.14	48.17	47.56
Al_2O_3	17.09	17.38	17.34	17.19	17.36	17.44	17.21	17.23	16.94	17.08	17.16
Fe_2O_3	3.15	3.58	6.40	4.51	4.04	3.61	5.58	4.71	4.03	3.28	4.45
FeO	7.59	6.89	4.37	6.09	6.52	7.31	5.83	6.28	6.92	7.25	6.02
MnO	0.18	0.20	0.19	0.19	0.19	0.21	0.19	0.20	0.18	0.19	0.18
MgO	5.50	5.31	5.56	5.65	5.62	5.52	5.54	5.61	5.58	5.37	5.15
CaO	10.32	10.54	10.72	10.56	10.58	10.77	10.77	10.73	10.74	10.57	10.46
Na_2O	4.00	3.88	3.88	3.92	3.97	4.00	4.00	4.12	4.15	4.15	4.00
K_2O	1.75	1.71	1.72	1.69	1.69	1.71	1.72	1.69	1.68	1.68	1.68
P_2O_5	0.38	0.55	0.54	0.55	0.55	0.46	0.51	0.54	0.53	0.53	0.55
TiO_2	1.68	1.65	1.66	1.66	1.69	1.68	1.66	1.69	1.71	1.67	1.68
H_2O^+	—	0.37	0.13	0.20	0.27	0.50	0.11	0.42	0.20	0.31	0.33
H_2O^-	0.06	0.04	0.07	0.12	tr	0.06	0.18	0.15	0.09	tr	0.10
	99.39	99.73	99.85	99.70	100.14	100.80	100.01	100.59	99.89	100.25	99.32
Ne	8.24	6.73	5.89	6.87	7.22	8.65	7.96	8.67	9.28	7.95	6.43
Or	10.57	10.11	10.16	9.99	9.99	10.11	10.16	9.99	9.93	9.93	9.93
Ab	18.87	20.40	21.96	20.49	20.27	17.89	19.16	18.85	17.99	20.43	21.98
An	23.36	24.96	24.82	24.32	24.56	24.58	23.93	23.53	22.64	23.02	23.91
Di	20.40	19.56	19.65	19.93	19.92	21.25	21.13	21.30	22.27	21.41	19.89
Ol	8.88	8.04	3.56	6.90	7.65	8.34	5.33	6.46	7.25	8.11	5.91
Mt	4.63	5.19	9.28	6.54	5.86	5.23	8.09	6.83	5.84	4.76	6.45
Ilm	3.19	3.13	3.15	3.15	3.21	3.19	3.15	3.21	3.25	3.17	3.19
Ap	0.93	1.20	1.18	1.20	1.20	1.01	1.11	1.18	1.16	1.16	1.20

1. Subterminal lava of 3 September 1967. Northern slope of NE crater (total includes $SO_3 = 0.15$; $Cl^- = 0.16$).
2. Lava flow from upper eastern south vent, first days of April 1971.
3. Lava bomb near eastern south vent, beginning (?) of 1971 eruption.
4. Lava lump at the summit of upper eastern south vent, mid-April 1971.
5. Front of lava flow from eastern south vent in Volta del Girolamo, under intermediate station of cable-way, 27/29 April 1971.
6. Quenched lava from the end of western south vent activity, 7 May 1971.
7. Lava from the upper east vent, beginning of the east flank eruption, 4 May 1971.
8. Lava from vent in Valle del Bove, 9 May 1971.
9. Lava from the lower Citelli vent, 12 May, 1971.
10. Lava quenched at the upper Citelli vent (alt. 1850 m), 16 May 1971.
11. Front of lava flow near Fornazzo, early June 1971.

Na_2O, the latter being estimated by flame photometry. MnO and P_2O_5 were determined colorimetrically and H_2O+ was obtained using the Penfield method.

The most striking feature is the uniformity of the composition, despite the duration and complexity of the eruption. The chemistry of the magmatic flows shows no significant variation, and from this point of view the 1971 lavas are practically identical to the products erupted during the persistent activity of the past ten years, and with those of the last centuries. Most of the recent Etnean lavas, including those emitted in 1971 are tephritic basalts (or trachybasalts), usually with a cryptocrystalline groundmass that includes sanidine and nepheline. In some cases, however, and especially for the quenched samples, these minerals have not crystallized as the groundmass remains partly glassy.

All the lavas studied are porphyritic, having a nearly constant phenocryst content of 30 to 35 % (table 2). Plagioclase feldspar (phenocrysts and microlites) is by far the most abundant mineral, making up about half the volume of the rock. Small phenocrysts range from 0.2 to 2 mm in length, but some rare crystals occasionally reach 5 mm. These phenocrysts often contain numerous inclusions of submicroscopic ore minerals which appear as patches of dark dust. The phenocrysts are strongly zoned from An 80 (core) to An 50 on the margins. The microlites are sometimes too small for determination, but they seem to have a more sodic composition than the phenocrysts, varying from An 60/55 to An 45/40.

Augite, which forms about 20 % of the rock, also occurs as phenocrysts and microlites. The euhedral phenocrysts generally do not exceed 3 or 3.5 mm. They are slightly pleochroïc, from pale green to yellowish grey, with $2V_z$ around 60°. Zoning is often evident, although somewhat restricted. The microlites are very small prisms of apparently the same composition.

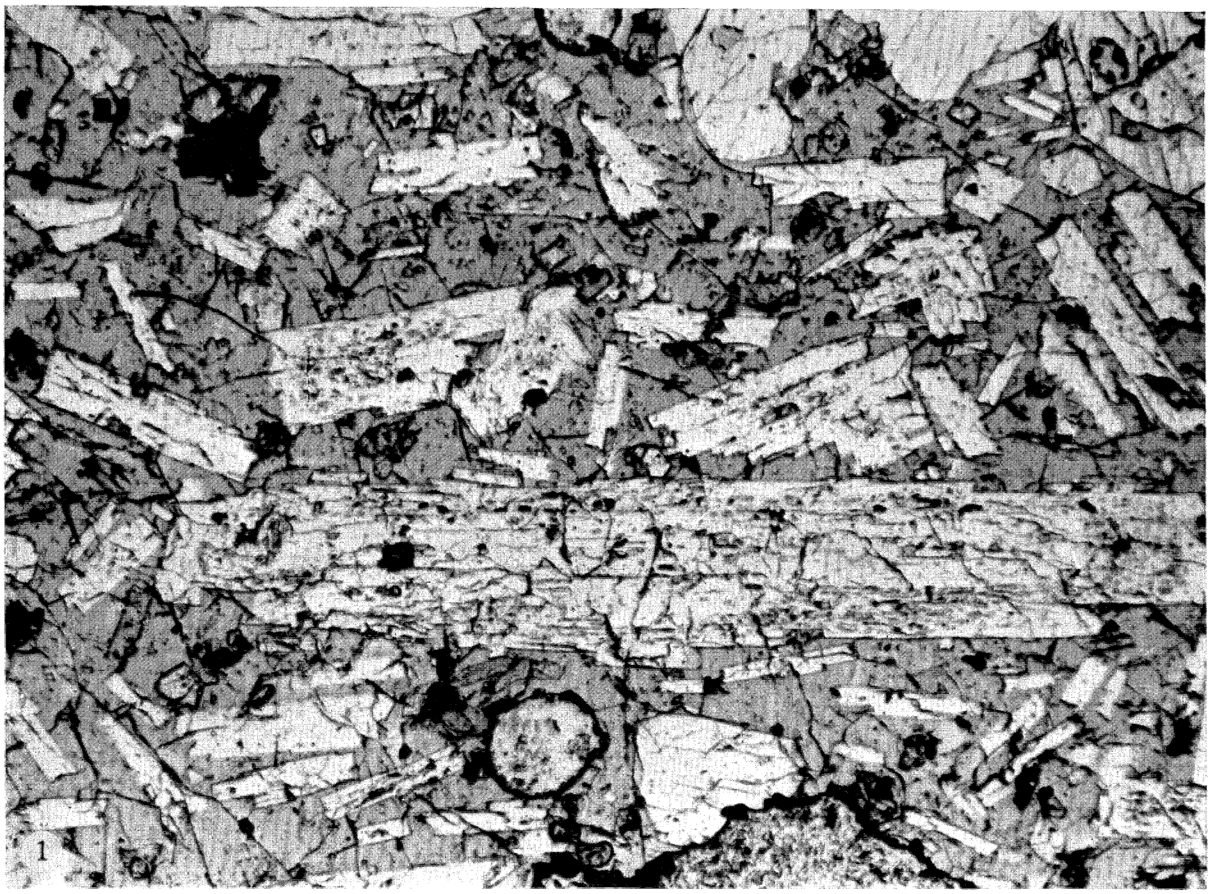
Olivine occurs as phenocrysts only, the percentage being no more than 3 or 4. They are sometimes surrounded by a dark rim denoting incipient oxidation.

Micro-phenocrysts and small grains of homogeneous titanomagnetite constitute a relatively high amount (6–7 %) of ore minerals in these lavas.

From microscopic examination, and since the chemical composition of the lavas is the same, it seems evident that these minerals are nearly identical to those of the 1950 flows (Tanguy 1966).

In well-crystallized specimens, plagioclase, augite and Ti-magnetite microlites are not contiguous, but are enclosed in a very fine, pale pink residuum with low refringence and birefringence, the nature of which can be only demonstrated by X-ray powder patterns. As in most of the recent Etnean lavas, this residuum is composed mainly of sanidine Or 50 Ab 50 (about 10 to 12 % from analytical data) and nepheline (5 to 7 %), and perhaps a trace of sodalite. These latter minerals denote the tephritic tendency of this basalt, added to its leucocratic character (colour index is between 30 and 35). This rock, which has been called ‘etnaïte’ by Rittmann, is somewhat similar to hawaiites, although having a higher Ca and Al content and, therefore, a more calcic plagioclase.

Attention must be drawn to the differences between the products of the 1971 flank paroxysm and those of the persistent activity of the previous years. As outlined above, these differences are reflected in the phenocryst content and the structure of the groundmass. Samples of lava emitted under normal conditions of slow persistent activity, e.g. from 1966 to 1970, show numerous phenocrysts and microphenocrysts (about 50 % of the whole rock, see table 3) in a brownish yellow glass almost without microlites. In the 1971 lavas, phenocrysts are less abundant (30 to 35 % of the whole rock, see table 2), and the groundmass is often entirely crystallized, although the plagioclase microlites generally are small. This fact is even more



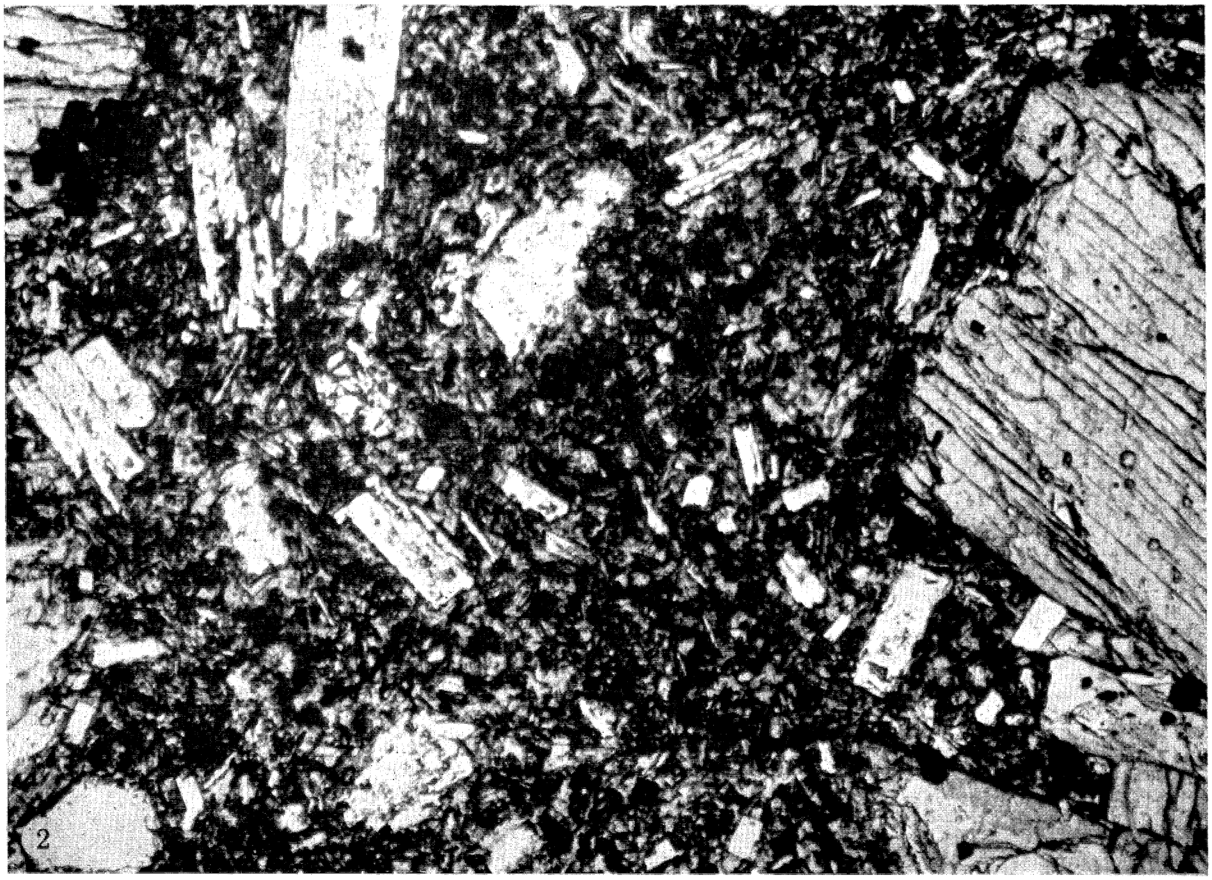


FIGURE 1. Quenched subterminal lava from the NE crater, September 1967, showing numerous phenocrysts and microphenocrysts in a vitreous groundmass. (Magn. × 50.)

FIGURE 2. Quenched lava from the flank eruption, May 1971: phenocrysts are less abundant, but the groundmass is characterized by crystallites and microlites. (Magn. × 50.)

evident on the quenched samples: those of the first type (figure 1, plate 1) show phenocrysts and microphenocrysts in a perfectly clear glass without crystallites, whereas in the 1971 quenched lavas (figure 2, plate 1), numerous crystallites are present in the glass.

Table 2. Modal analyses of 1971 lavas

(Legend is the same as table 1)

	2	3	4	5	6	7	8	9	10	11
plagioclase	21.4	14.9	18.3	17.5	17.1	18.5	17.5	19.4	19.3	22.6
augite	11.0	7.0	11.8	9.7	13.0	9.2	10.8	8.4	9.6	10.3
olivine	3.2	1.9	1.7	3.1	2.7	4.7	2.5	2.6	4.2	2.4
Ti-magnetite	1.6	0.8	1.7	1.9	1.7	1.0	1.3	1.2	1.6	1.7
groundmass	62.8	75.3	66.5	67.7	65.5	66.6	67.9	68.3	65.3	63.1

Table 3. Modal analyses of 1966–1970 lavas

	A	B	C	D	E	F	G	H
plagioclase	35.4	36.0	29.8	34.1	33.7	30.5	30.7	28.1
augite	10.2	8.0	11.2	11.6	11.7	10.2	10.2	9.7
olivine	3.2	2.6	3.3	2.8	2.9	4.0	2.6	2.6
Ti-magnetite	2.0	2.0	2.8	2.0	2.1	2.0	1.6	2.1
groundmass	49.2	51.4	52.9	49.5	49.6	53.3	54.9	57.5

A. Subterminal lava of 16 September 1966. NNE slope of NE crater, alt. about 3100 m.
B. Subterminal lava of 10 October, 1966. Northern slope, alt. about 2850 m.
C. Subterminal lava of 3 September, 1967. North foot of NE crater, alt. 3130 m.
D. Subterminal lava of 18 August, 1968. East slope of NE crater, alt. about 3000 m.
E. Subterminal lava of 18 August, 1968. East slope of NE crater, alt. about 2800 m.
F. Subterminal lava of 28 July, 1970. NW slope of NE crater, alt. about 3100 m.
G. Subterminal lava of 2 August, 1970. West slope, alt. 3050 m.
H. Lava lump erupted through NE crater, probably July or August 1970.

The relatively low phenocryst content and the tendency of the melt to crystallize fast in the 1971 lavas are considered to be a consequence of a higher temperature and lower viscosity of the magma. This assumption is supported by the pyrometric and viscosity measurements that were carried out at the time of the eruption and during the persistent activity of the previous years: in 1966, 1967 and 1968, the best values of lava temperature at the vents were mostly around 1020 to 1030 °C and never exceeded 1050 °C. The viscosity was found to be between 3000 and 70000 Pa s, the most accurate measurements probably being about 10000 Pa s. For the 1970 lava, the temperature reached 1075 to 1080 °C, but no significant variation occurred in the phenocryst content of the lava, a point that has not been explained up to the present time. Finally, during the 1971 outbreak, values as high as 1100 to 1130 °C were recorded near the various vents, although it was difficult to get values from the most active lava flows, where the temperature might have been higher. Viscosity was very low, from 100 to 1000 Pa s only, the first value being most probable. These measurements are summarized in table 4. Temperatures were obtained using chromel-alumel and platinum-rhodium thermocouples which were usually put at least 30 cm beneath the surface of the lava flow. Optical pyrometers were used in some favourable cases, and only the highest value was recorded. Viscosity was estimated by mean of Jeffreys's formula:

$$\eta = g \sin \alpha e^2 d/3v,$$

v being the velocity of the lava flow, e its thickness, d its density, α the angle of the slope where

Table 4. Temperature and viscosity measurements of recent Etnean lavas

time and location	temperature (°C) thermocouple	temperature (°C) optical	viscosity (Pa s) (Jeffreys formula)	observations
(*a*) 18 September, 1966, small subterminal flows 150 m from the foot of NE crater	1045	—	1.2×10^4 to 7.4×10^4	Tanguy & Biquand (1967)
(*b*) 25 September, 1966, lava bocca at the foot of NE cone	1020	1010–1050	7.3×10^3 to 2.9×10^3	Tanguy & Biquand (1967)
(*c*) 10 October 1966, lava bocca 600 to 700 m distant from NE crater	1010	—	5.1×10^3 to 3.8×10^4	Tanguy & Biquand (1967)
(*d*) 3 September 1967, upper lava boccas on NE cone	1010	1020	7.8×10^3	Tanguy & Biquand (unpublished data)
(*e*) 17 August 1968, small hornitos about 500 m east of NE crater	1000	1005	—	lava surface in vent possibly temperature of gas. Tanguy & Le Goff (unpublished data)
(*f*) 18 August, 1968, subterminal flow on slope of Valle del Bove	low, undetermined		1.4 to 5.5×10^4	
(*g*) 28 July 1970, front of small subterminal flow 150 m from the bocca, at the NW foot of NE cone	1065	—	—	Tanguy & Pozzi (unpublished data) – conditions were unfavourable for viscosity determinations
(*h*) 2 August 1970, pseudo-bocca 50 m west from the foot of NE cone	1070	—	—	
(*i*) lava flow, as (*h*)	1050	—	—	
(*j*) lava bocca, as (*h*)	1080	—		
(*k*) 7 May 1971, lava bocca under western south vent, alt. about 2900 m	1125	1100		Archambault, Gauthier & Tanguy (unpublished data) – thermocouple stabilized for 10 min.
(*l*) 6 May 1971, main lava flow from the upper east vent (alt. 2900 m)	—	—	1.5×10^2	
(*m*) 9 May 1971, lava flow from upper vent in Valle del Bove (alt. 2680 m)	1050	1110	1.5 to 4.3×10^2 9×10^2	thermocouple not stabilized; optical measurements at the vent; viscosity estimated at the vent and 50 m farther away
(*n*) 20 May 1971, lava flows at the upper Citelli vents (alt. 1850 m)	—	1100	1 to 7×10^2	

the lava was flowing. However imprecise this method is, it is sufficiently accurate to show the large variations in the viscosity of the magma. For the 1971 eruption, a device for the direct measurement of viscosity constructed by Gauthier (1971) gave results consistent with those obtained using Jeffreys's formula.

These two closely related parameters – temperature and viscosity – should both depend on the rate of lava discharge. During the 1971 paroxysm, the lava discharge, although somewhat irregular, was evidently much higher than during the slow persistent effusive activity of the previous years (velocities between 5 and 25 km/h were observed at the vents, as compared to a maximum of 1 or 2 km/h for the small lava flows from the NE crater). Thus, the high rate of discharge that occurs in such a paroxysmal outburst should prevent the magma from cooling in the upper part of the conduit, producing a lava poorer in intratelluric phenocrysts. On the other hand, the relatively low viscosity, owing to the high temperature of emission and perhaps a higher gas content, permits the microlites to form and grow, even in very quickly cooled samples (Tanguy 1968).

Conclusions

The present results confirm the view that, as previously stated, the magmatic differentiation during Etnean eruptions is usually negligible. All the samples studied are tephritic basalts, having modal or potential sanidine and nepheline in the groundmass. However, in contrast to the lavas of the preceding years which always contained about 50 % phenocrysts in a vitreous groundmass, those erupted during the 1971 flank eruption have only 30 to 35 % phenocrysts and microlites or crystallites in the groundmass. These differences being considered as resulting from a higher temperature and lower viscosity of the 1971 magma. If confirmed by further studies, it is suggested that a relatively high temperature and fluidity of the magma could also make its migration easier along the faults and fractures of the volcanic edifice and, therefore, constitute one of the causes of the flank outbreaks. In any case, the interest of concomitant volcanological and petrological investigations seems evident on such active volcanoes as Mt Etna.

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Discussion

H. Tazieff: I do not think that the 1971 eruption was either the most important or the longest one Mt Etna has delivered this century: those of 1928 and 1950–51 were much bigger (especially the latter, which lasted about 10 months and delivered far larger amounts of lava and had a much higher output). The most exceptional eruption has been the nearly 20 years long one which the NE Bocca has delivered and which is rather unique in Etna's volcanic history.

J. C. Tanguy: Among the recent flank eruptions of Mt Etna, we have to record those of 1908 (which lasted only two days: 29/30 April), 1910 (from 23 March to 18 April), 1911 (3 to 22 September), 1923 (16 May to 16 June), 1928 (2 to 20 November), 1942 (30 June), 1947 (24 February to 10 March), 1949 (1 to 3 December) and 1950–1 (25 November 1950 to early December 1951). Thus, the 1971 eruption is the second longest of the century. Although it is difficult to estimate the volume of the products erupted*, it seems likely that the 1971 eruption (south and east lava flows) came also second after the 1950–1 one, and is at least of the same order of magnitude as the large outbursts of 1910, 1923 or 1928.

On the other hand, the persistent activity of the NE crater can be distinguished from these flank (or lateral) paroxysms by the sluggishness of the lavas flows, expressed by the fact that they usually do not exceed 1 or 2 km in length. During the past 20 years, the NE crater has been active from June to December 1955, from early 1957 to June 1960, from January 1961 to late 1963 and from January 1966 to 1971. This activity, therefore, should not be considered as a single eruptive event (even including intermittent eruptions in various vents of the central crater, namely in 1956, 1960, 1961 and 1964). It is rather representative of a normal state of dynamic equilibrium within Mt Etna, where true repose periods with the closing of the eruptive conduit are few and short-lived.

H. Tazieff: There is a contradiction between the demonstration Dr Romano just offered that an evolution had been observed in the lavas poured out during the 1971 outbreak and your assumption that chemical compositions did not show any significant variation. How do you explain this difference, both in analytical results and, consequently, in conclusions?

J. C. Tanguy: I want to state that I have not had any opportunity, as of yet, to study closely Dr Romano's data, and the contradiction with his work is perhaps more apparent than real. The variations shown by Dr Romano's analyses are very small and consequently the magmatic differentiation, if any, cannot be compared, for example, with that known to occur in Hawaiian volcanoes. Let us observe, however, that X-ray fluorescence is more adapted than classical wet chemical analysis for such a study: each element being determined independently from the others, there are no compensating errors, which could give a false variation (for example low SiO_2 compensated by high Al_2O_3), and the quality of the analysis is checked by good totals. Mr Downes, who also carried out analyses of the 1971 lavas using a similar X-ray method, did not find any evidence of a chemical evolution.

R. Cristofolini: In saying that the 1971 magma has not been differentiated do you imply

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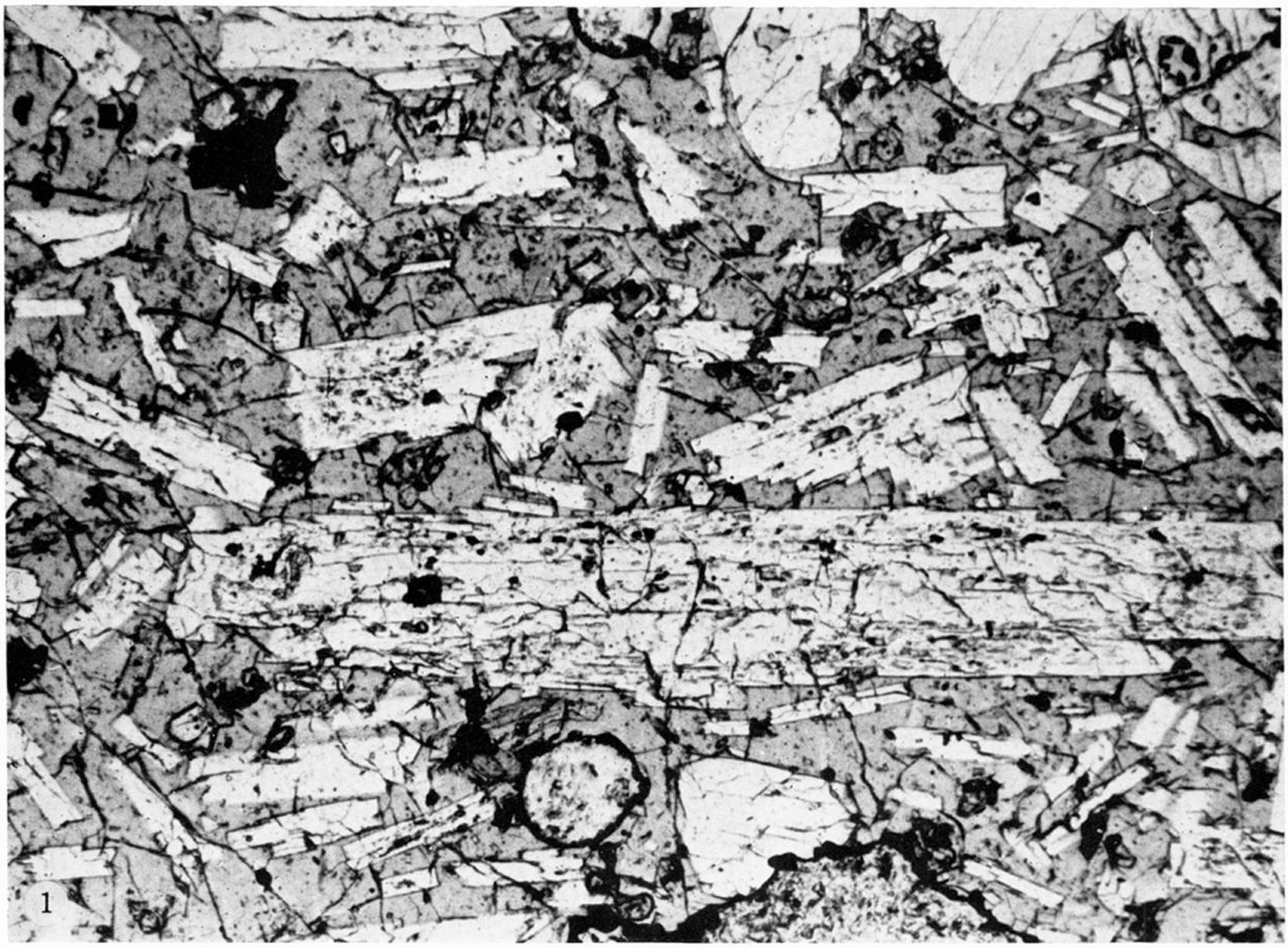
* *Editors' note*: During the 1971 eruption, lava erupted exceeded 35×10^6 m^3 and may have been as much as 78×10^6 m^3 according to Rittmann, Romano & Sturiale (see Appendix).

that the analyses represent the original magma composition for the Etnean region? If not, does the homogeneous composition of most of the 1971 lava mean that magma was stored in a chamber (whatever its shape) large enough to allow the same differentiation stage to be reached, before the eruption began, by all the erupted magma?

J. C. TANGUY: I do not think that the 1971 etnean lavas represent the composition of a primary magma. The petrochemistry of etnaîtes may be explained by a restricted gravitative differentiation, in a normal olivine basalt composition, occurring in large abyssal fissures during the ascent of magma; alkali enrichment in the upper part of magma column under the effect of gaseous transfer in relation with the persistent activity of Mt Etna would also play a part. As the phenomenon is a dynamic one, lavas slowly extruded have nearly the same composition. However, it is quite surprising that this uniformity persists during strong outbreaks, as those of 1971 and mainly 1950–51, when huge quantities of lavas are delivered in a relatively short time (a slight, but apparently real differentation has been nevertheless observed by Stella Starrabba for the 1669 and 1928 eruptions). And it is even more surprising that no general trend of differentiation towards decidedly more femic compositions seems to occur along geological times.



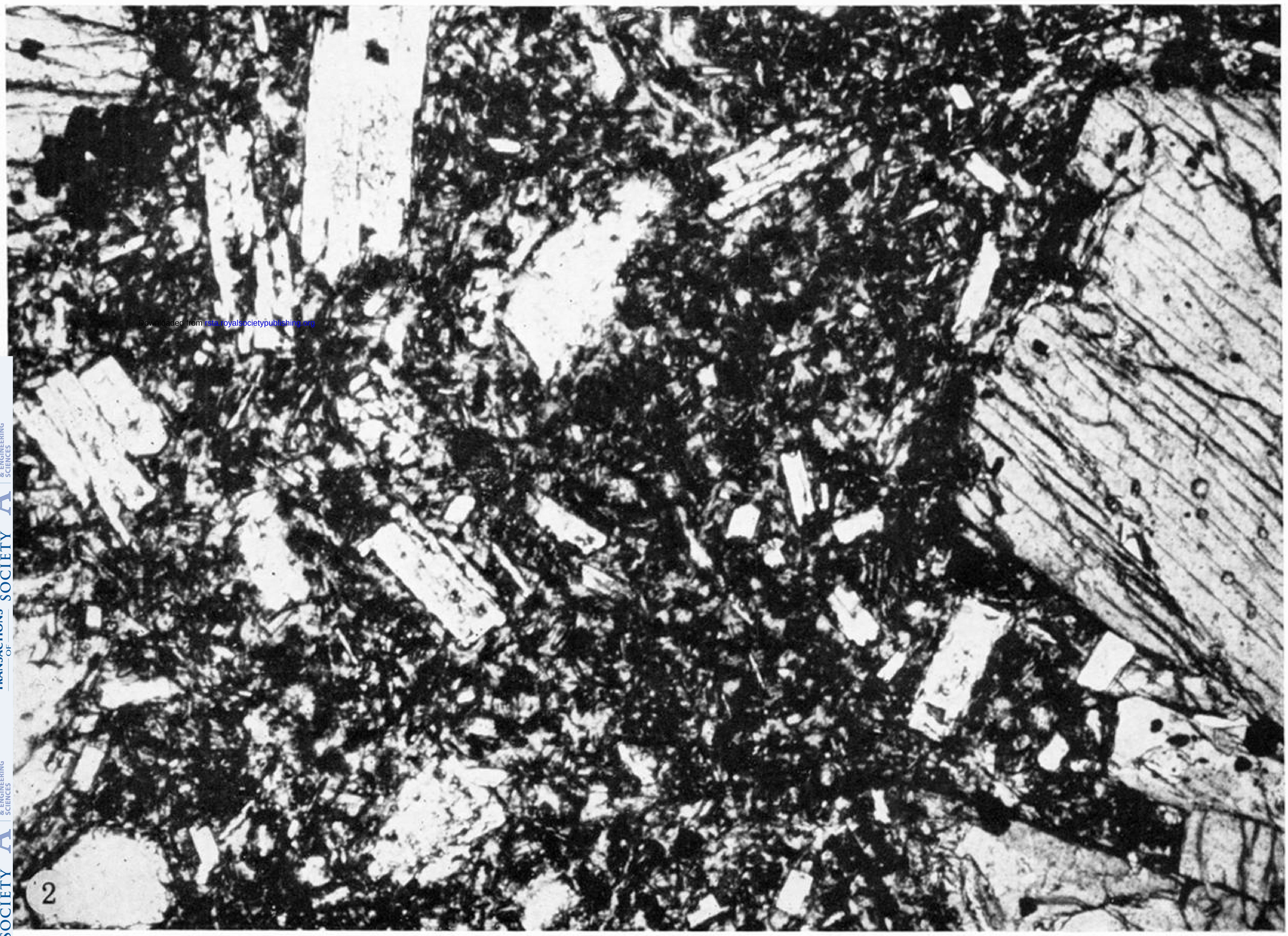


FIGURE 1. Quenched subterminal lava from the NE crater, September 1967, showing numerous phenocrysts and microphenocrysts in a vitreous groundmass. (Magn. × 50.)

FIGURE 2. Quenched lava from the flank eruption, May 1971: phenocrysts are less abundant, but the groundmass is characterized by crystallites and microlites. (Magn. × 50.)