COMMONWEALTH OF AUSTRALIA.

DEPARTMENT OF NATIONAL DEVELOPMENT.

BUREAU OF MINERAL RESOURCES GEOLOGY AND GEOPHYSICS.

RECORDS.

1962/101

REPORT ON THE INTERNATIONAL ASSOCIATION OF VULCANOLOGY (I.A.V.) SYMPOSIUM ON 'IGNIMBRITES AND HYALOCLASTITES', ITALY, 1st September to 1st October, 1961.

by

D.A. White.

REPORT ON THE INTERNATIONAL ASSOCIATION OF VULCANOLOGY (I.A.V.) SYMPOSIUM ON 'IGNIMBRITES AND HYALOCLASTITES', ITALY, 16th September to 1st October, 1961.

by

D.A. White.

RECORDS 1962/101

CONTENTS

FIGURES

......

CONTENTS (ii)

CONTENTS (iii)

REPORT ON THE INTERNATIONAL ASSOCIATION OF VULCANOLOGY (I.A.V.) SYMPOSIUM ON 'IGNIMBRITES AND HYALOCLASTITES', ITALY, 16th September to 1st October, 1961.

SUMMARY

The symposium of the International Association of Vulcanology (I.A.V.) on 'Ignimbrites and Hyaloclastites' was held in Italy from the 16th to the 1st October, 1961. About one hundred delegates attended the symposium, and eighteen countries were represented.

The symposium consisted of thirteen days of excursions to the Quaternary and present-day active volcanic areas, and two and a half days of formal sessions at the Institute of Vulcanology, University of Catania, Sicily.

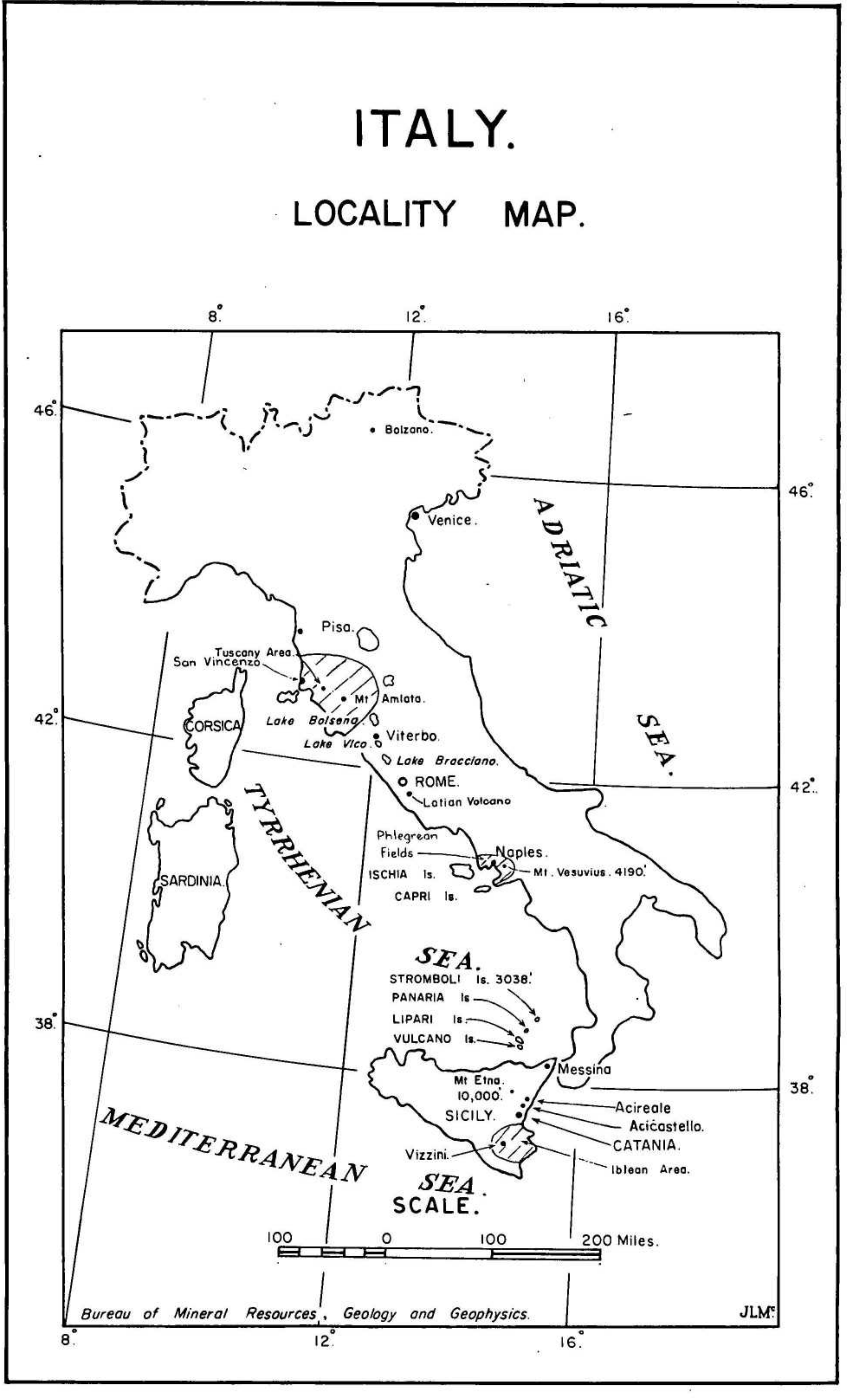
The excursions began in the north-western coast of Italy in the Tuscany region where acid volcanic rocks interpreted as ignimbrites and rheoignimbrites were examined. This interpretation is possibly incorrect, as many of the ignimbrites show features of a lava flow. In this region at Mount Amiata, 'soffioni' (steam vents) were visited; 2.10^9 kwh. of electricity is produced annually from these vents which are operated by the Larderello Company. The steam was formed about 2000 feet below the surface when the ignimbrite magma was emplaced below an impervious cover of clay (flysch). The excursion then continued south through the complex volcanic area of Mount Cimino and Viterbo to the Latian volcano near Rome, where summit calderas and secondary craters were examined.

After the Latian volcano excursion, the formal sessions were held at the University of Catania. A total of 41 papers - 30 on ignimbrites and 11 on hyaloclastites - were read and discussed in these sessions. Many occurrences of ignimbrite were described and discussed at Catania, and it was apparent from these that the term 'ignimbrite' was used for either a welded tuff, an unwelded tuff, or a tuff showing all degrees of welding, and in some places for the nuce ardente by which the ignimbrites are supposedly deposited. A Committee on Nomenclature of Ignimbrites was formed to attempt to define the term 'ignimbrite'. This Committee will report to the next I.A.V. Symposium in Japan in 1962.

After the formal sessions, the excursions resumed with visits to Mt Etna, about 15 miles north of Catania, and the hyaloclastite deposits of the Iblean region, 20 miles south-west of Catania. The Eolian Islands of Vulcano (a compound volcano), Lipari, with its extensive pumice deposits, and Stromboli - the strato volcano - were next examined. The excursion continued north to the Naples area where the complex caldera of the Phlegrean Fields, the atrio volcano of Mt Vesuvius, and the volcano-tectonic horst of Ischia Island were examined.

Ignimbrite is exposed in only one of the areas visited - at Viterbo - during the excursions. The acid volcanics in the Tuscany area are probably not ignimbrites, but lava flows.

FIGURE 1.


ITALY.
LOCALITY MAP.
8°
12°
16°
46°
42°
38°
Bolzano.
Venice.
ADRIATIC
SEA.
Pisa.
Tuscany Area.
San Vincenzo
Mt Amiata.
Lake Bolsena.
Lake Vico.
Viterbo.
Lake Bracciano.
ROME.
Latian Volcano
CORSICA.
SARDINIA.
TYRRHENIAN
SEA.
Phlegrean Fields
Naples.
Mt. Vesuvius. 4190'.
ISCHIA Is.
CAPRI Is.
STROMBOLI Is. 3038'.
PANARIA Is.
LIPARI Is.
VULCANO Is.
Messina
Mt Etna. 10,000'.
SICILY.
Acireale
Acicastello.
CATANIA.
Vizzini.
Iblean Area.
MEDITERRANEAN
SEA.
SCALE.
100
0
100
200 Miles.
Bureau of Mineral Resources, Geology and Geophysics.
JLM

INTRODUCTION

This report gives an account of the International Association of Vulcanology (I.A.V.) Symposium on 'Ignimbrites and Hyaloclastites', which I attended in Italy as an official delegate of the Bureau of Mineral Resources, Department of National Development, Canberra, from the 16th September to the 1st October, 1961. Professor A. Rittmann, Professor of the Institute of Vulcanology, University of Catania, Sicily, organized the symposium, which was sponsored by the I.A.V.

One hundred and two delegates from 18 countries attended the symposium. About half of these were from Italy and most of the others were from Russia, Germany and France. Appendix I lists the participants at the symposium.

The symposium consisted of 13 days of excursions to the Quaternary and present-day active volcanic areas and 2½ days of formal sessions in which 46 papers were read and discussed.

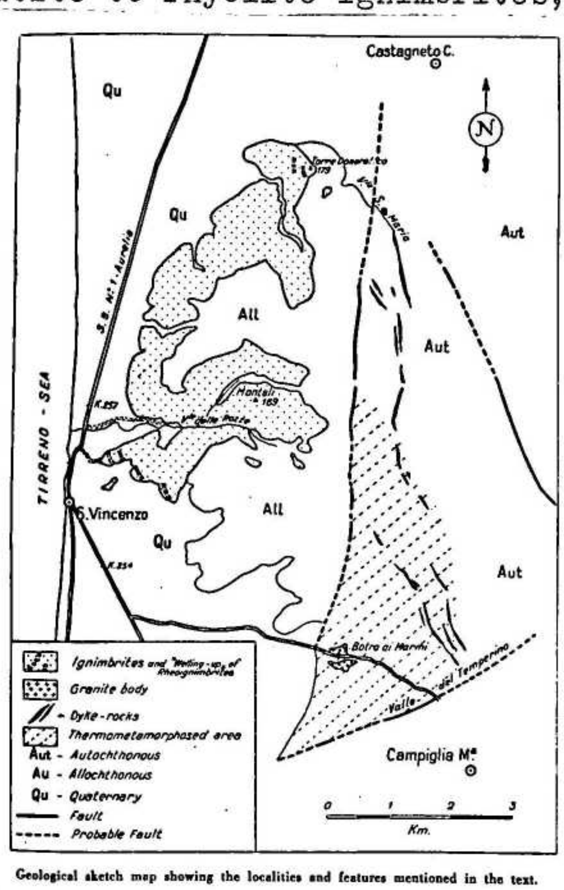
All participants in the symposium were issued with guide booklets prepared and printed by the Institute of Vulcanology at the University of Catania.

EXCURSIONS

Excursions to the Quaternary volcanic areas of Italy formed the main part of the symposium. The excursions began on the 16th September in the Tuscany area in the north-western part of Italy, and they continued south from there to the Latian Volcano region near Rome, farther south to Sicily where Mt Etna and the Iblean region were examined, then north-west to the Eolian Islands, and finally north to the Naples region where Mt Vesuvius, the Phlegrean Fields, and Ischia Island were visited.

SAN VINCENZO (TUSCANY)

The San Vincenzo area consists of Pliocene-Pleistocene quartz-latite to rhyolite ignimbrites, which are exposed in a horst.



Geological sketch map showing the localities and features mentioned in the text.

Figure 2.
Geological map of the San Vincenzo area, Tuscany.

The ignimbrites are divided into 'ignimbrites' and 'rheoignimbrites'.

The ignimbrites are grey to red, and occur as extensive, horizontal sheets. Fumarolic activity has emphasized the layering in the ignimbrites; in most places the sheets are horizontal, but locally they may show an upwards fan structure (Figure 3). Hourglass structures probably caused by differential laminar flow are present. Most of these features were seen in the Rozze Valley quarry about 3 miles north-east of San Vincenzo (Figure 1).

The rheoignimbrites are compacted and hard, and are darker than the ignimbrites. They also show fan like structures which were thought to indicate 'welling-up' within the fumarolically altered sheets. The rheoignimbrites contain breccia blocks of ignimbrite in a fumarolic reddish matrix. These features were seen in the Poggio Castelluccio quarry about 1 mile north-east of San Vincenzo.

Figure 3. Ignimbrite sheets with an upwards fan structure, which is emphasized by fumarolic activity. Rozze Valley Quarry, San Vincenzo region, north-western Italy.

During the excursion, enlarged 5 feet by 3 feet photomicrographs of ignimbrite and rheoignimbrite were exhibited (Figures 4 & 5). These showed that the main difference between the two ignimbrites was the texture of the groundmass. In the rheoignimbrite the groundmass is glassy and has a perlitic structure; in places it contains spherulites and has a pseudo-fluidal microtexture. In the ignimbrites the groundmass is devitrified and felsitic.

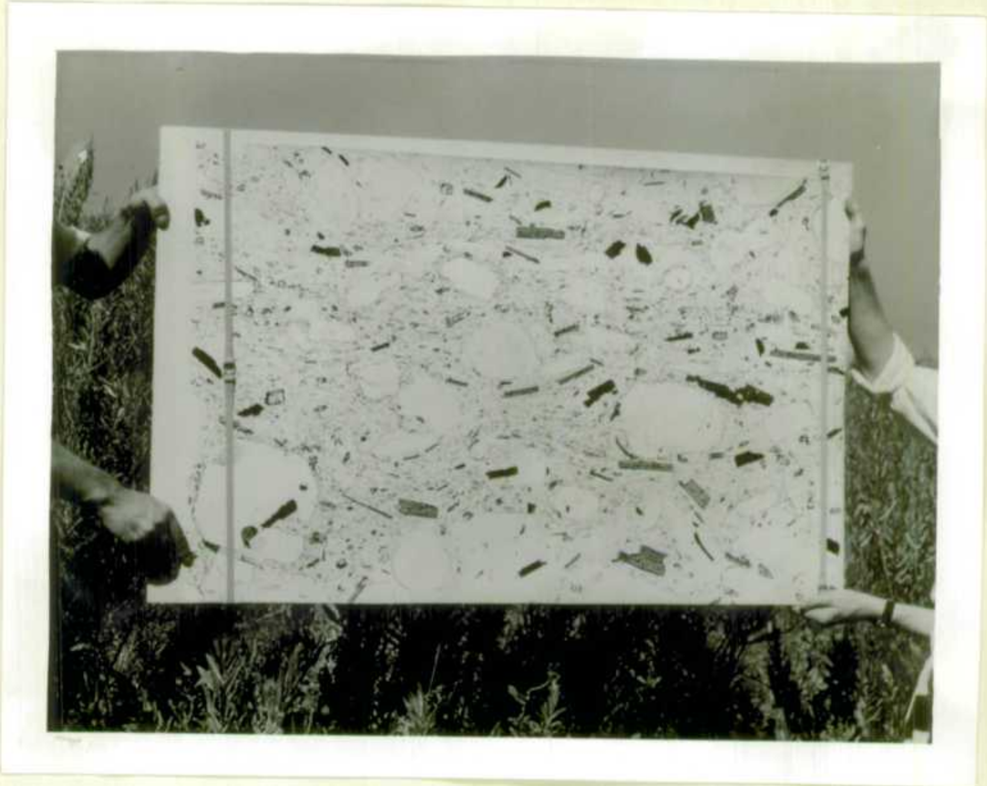


Figure 4. Enlarged 5 feet by 3 feet photomicrograph of a rheoignimbrite in the Poggio Castelluccio Quarry, San Vincenzo area. Note the perlitic structures.

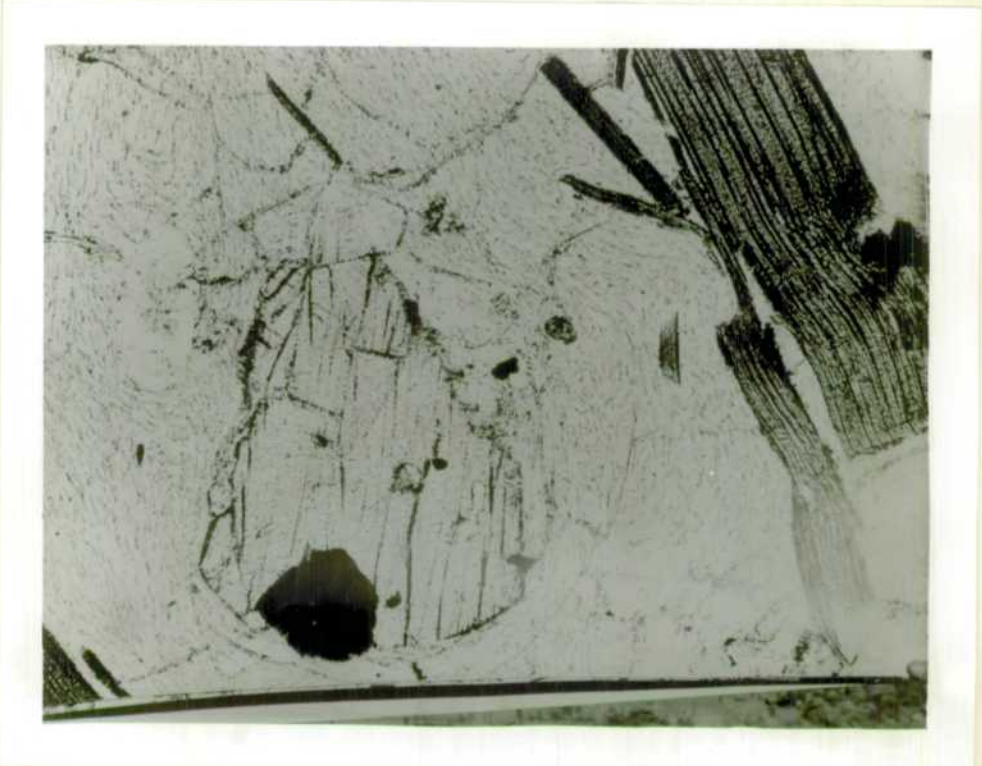


Figure 5. Enlarged 5 feet by 3 feet photomicrograph of a rheoignimbrite in the Poggio Castelluccio Quarry, San Vincenzo area. Note the fluidal microtexture.

ROCCASTRADA (TUSCANY)

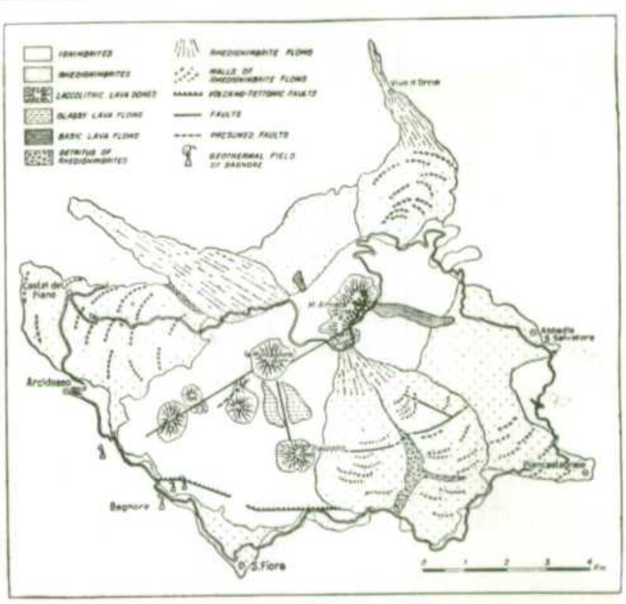
The Roccastrada region contains late Pliocene to early Quaternary ignimbrites which are exposed in many isolated outcrops. The Roccastrada ignimbrites show similar fumarolic, layered, brecciated, and up-welling structures to those seen in the San Vincenzo region. The ignimbrite exposure visited in this area was in a quarry between Rocca Tederighi and Roccastrada.

MT AMIATA (TUSCANY)

The Mount Amiata region is of interest because of its exposures of Quaternary ignimbrite and rheoignimbrite, and the mercury deposits and geothermal activity related to the vulcanism. Unfortunately, the mercury mines were not examined, but some of the 'soffioni' (steam vents) of the Larderello Company were seen.

The ignimbrite mass of Mount Amiata covers more than 50 square miles; its average thickness is about 1,000 feet, and its shape is roughly rectangular. The central part of the area is occupied by about six lava domes which are considered to be laccolithic intrusions (Figure 6).

Several walls of rheoignimbrite were examined, and many of the breccia (Figures 8 & 9) and fumaloric (Figure 10) features seen in the Roccastrada and San Vincenzo regions are repeated here.



Map of Mt. Amiata showing the localities and features mentioned in the text.

Figure 6. Geological map of the Mount Amiata region.

Figure 7. View from Mt Amiata looking east towards the Flysch deposits of the Appenines (without timber cover) in the background. Timber covered area is occupied by ignimbrites and rheoignimbrites. Note mercury mine of Abbadia San Salvatore on edge of ignimbrite area.

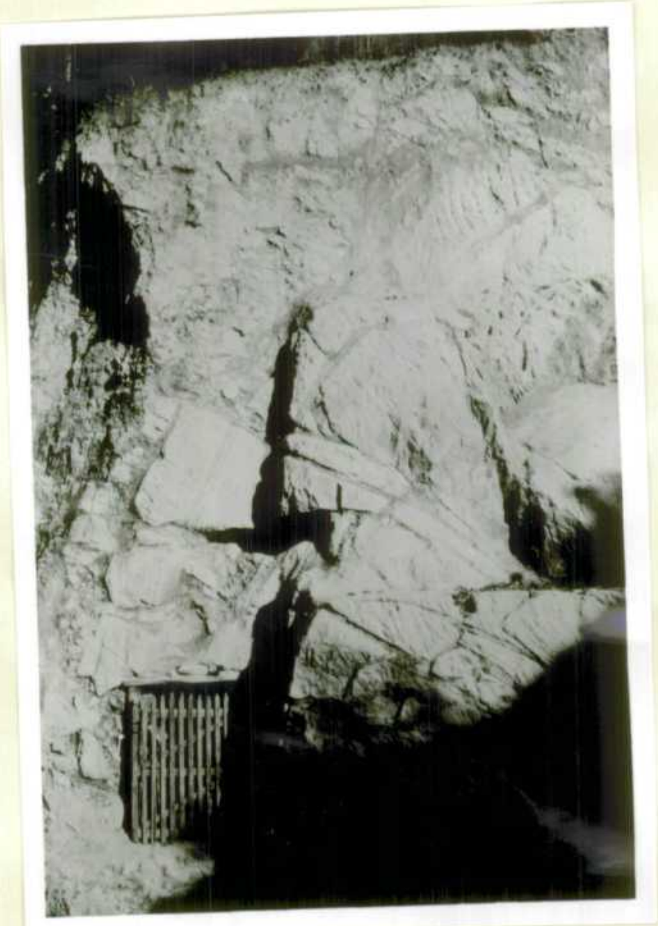


Figure 8. Southern edge of the rheoignimbrite flows of the Mt Amiata region exposed about midway between Piancastagnaio and Santa Fiora. Note fumarolic alteration zones (dark grey) between the rheoignimbrite blocks.

Figure 9. North-western edge of the rheoignimbrite flows of Mt Amiata region. Smooth dark outcrop in right-centre is part of the sedimentary basement. Cava di Pietre Quarry.

Figure 10. Dark fumarolic alteration zones in the rheoignimbrite of Figure 9.

Figure 11. One of the 'soffioni' (steam vents) of the Larderello Company in the Mt Amiata region.

The geothermal steam in the Mt Amiata area occurs at an average depth of 2,000 feet and at a maximum depth of 4,000 feet in porous Mesozoic dolomite, which is generally capped with anhydrite and overlain by impermeable Flysch sediments; these are in turn overlain by the Quaternary ignimbrites. In the Larderello field 160 wells yield 2,850,000 kilograms/hour of steam at an average temperature of 200° C. and an average pressure of 5 atmospheres (absolute). The annual production of the Larderello field is 2×10^9 k.w.h. The fluid contains 95 percent of steam and 5 percent of other gases. The nearby geothermal field of Bagnore contains 5 wells producing 100 kg/h of a fluid containing 70 percent of steam and 30 percent of other gases, at a pressure of 5.5 atmospheres absolute and a temperature of 150° C.

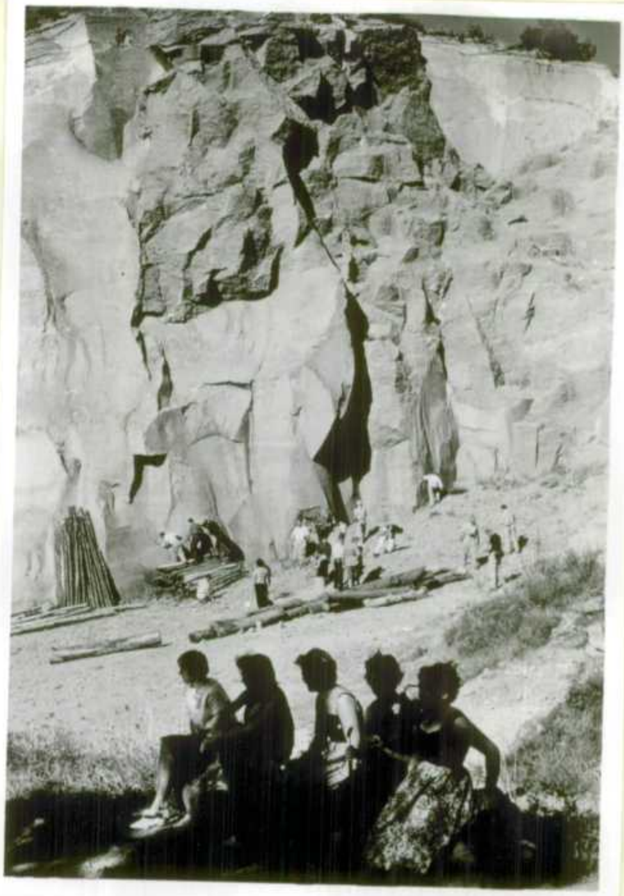


Figure 12. The ignimbrite of Mt Cimino exposed in a quarry near Viterbo. Note the dense, compacted, welded base, and elongated pumice inclusions (white).

Figure 13. Close-up view of the base of ignimbrite shown in Figure 12. Note white elongated pumice inclusions.

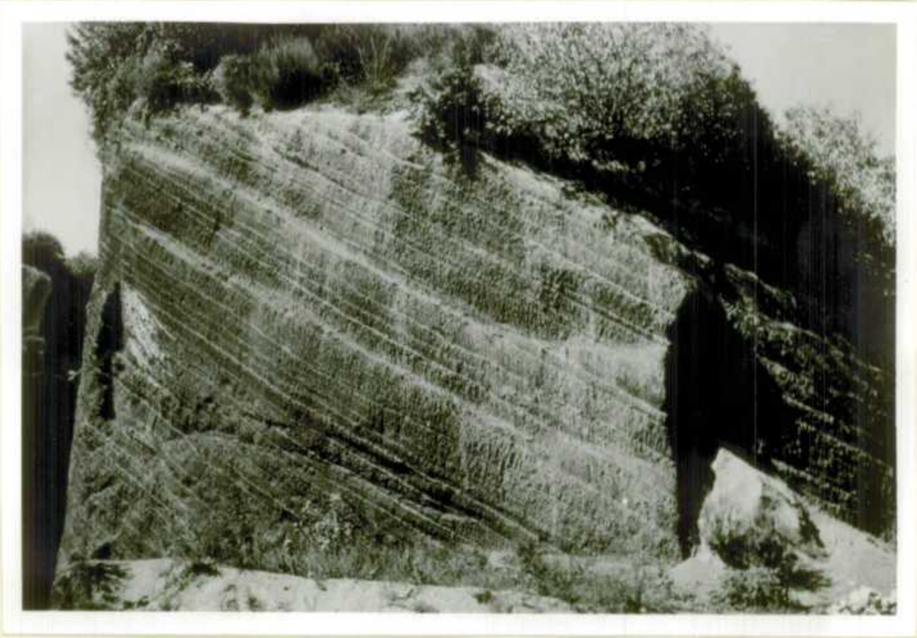


Figure 14. Cross section of the scoria-cone near Valentano mined for pozzolan.

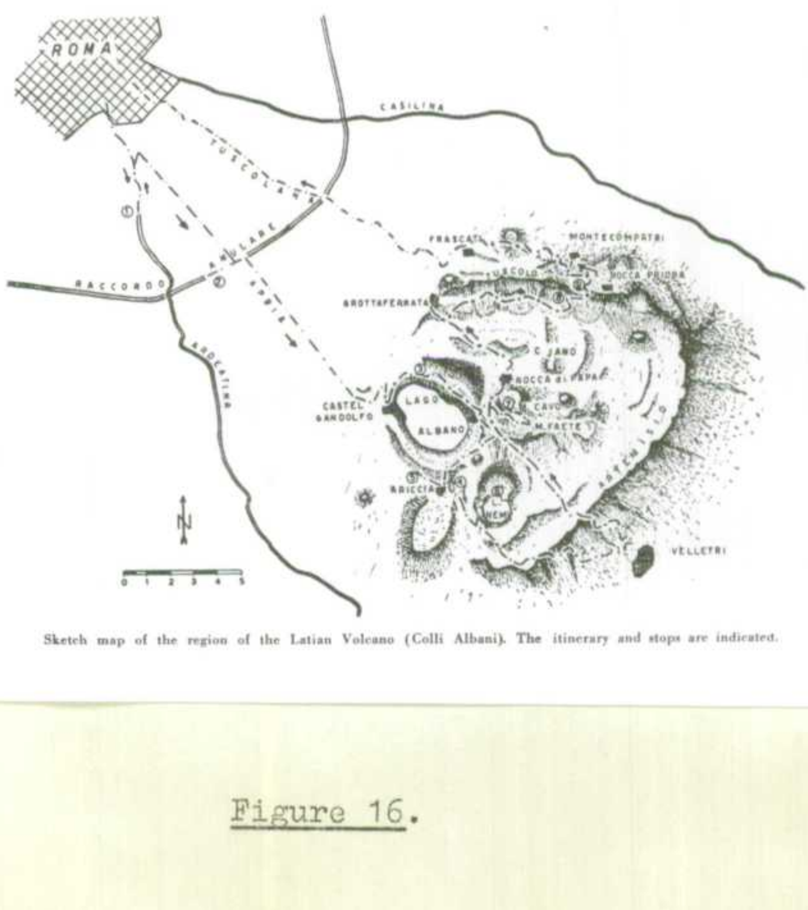
Figure 15. Close-up view of the scoria of Figure 14. Note the inverted graded bedding in each bed.

ARCIDOSSO TO ROME

This volcanic region, with its main township of Viterbo, is situated about 40 miles north-north-east of Rome. Vulcanism began in the Lower Quaternary and continued for several hundred thousand years; thick tuffs are interbedded with leucititic lava flows. There are three crater lakes in the region: Lake Bolsena, Lake Vico, and Lake Bracciano. A scoria core being mined for pozzolan near Valentano was visited (Figures 14 and 15). An example of an ignimbrite sheet was examined in the Mt Cimino area near Viterbo (Figures 12 and 13); this sheet is about 200 feet thick and contains many compacted and welded xenoliths.

LATIAN VOLCANO

The Latian Volcano is situated about 10 miles south-east of Rome (Figure 16). It consists of two coaxial 'crater rims', generally thought to be partly eroded summit calderas. The outer one, referred to as 'Artemisio', has an average diameter of about 6 miles. Secondary craters of 'Nemi' (now a lake), 'Ariccia', and 'Albano' (another lake ; Figure 17) occupy the south-western rim of the Artemisio. The inner summit caldera contains the main peak of Mt Cavo (2,850 feet), from which most of the Latian Volcano can be seen.



Sketch map of the region of the Latian Volcano (Colli Albani). The itinerary and stops are indicated.

Figure 16.

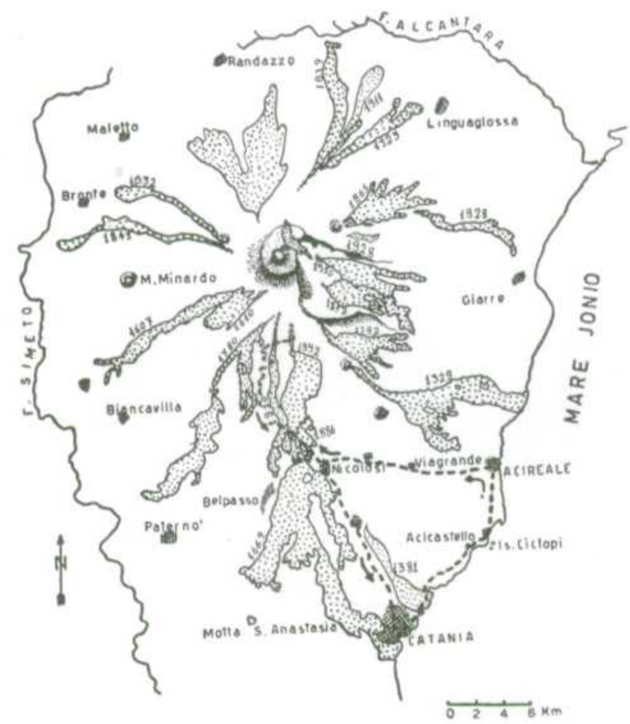
Figure 17. View of Albano Crater Lake, looking west from Mt Cavo in the central part of the Latian Volcano.

The volcanic deposits and places visited in the Latian Volcano were : the old 'cecilite' lava flows at Roccordo Anulare; Albano Crater Lake (Figure 17) and its pyroclasts; the 'piperino di Ariccia' containing augite, leucite, melanite, and hauyze; Nemi Crater Lake; Mt Cavo; augite leucitite lava of the outer wall of the Latian Volcano near Rocca Priora; and the 'sperone' - an ash deposit in a quarry at San Silvestro.

MT ETNA

Mt Etna is situated about 15 miles north of Catania on the east coast of Sicily (Figure 18). The lavas of Mt Etna cover an area of about 1,000 square miles. The volcano dates from the earliest part of the Quaternary period. Activity was first submarine; pillow lavas and hyaloclastites were formed in the submarine activity, then subaerial (Figure 19). The height of Mt Etna has varied from 9,900 feet in 1864 to about 9,800 in 1956; today it is about 10,000 feet high.

The internal structure of the volcano has been modified by displacements of the vent. Violent eruptions of the volcano were followed by caldera collapse, and hundreds of adventive cinder cones have formed on its flanks (Figure 21).



Sketch map of Mt. Etna showing the most important lava flows and eruptive centres. The itinerary is also indicated.

Figure 18.

Since 1955 the activity of Mt Etna has been persistent; subterminal effusions of lava of low gas content have frequently occurred.

During the excursion to Mt Etna the present activity was examined by day and night. At intervals of about ten minutes ash and lapilli were ejected onto the slopes of a cinder cone (Figure 22), and andesitic lava was being extruded continuously from a 3-foot diameter conduit about 100 yards from the active cone. The floor of the cone consisted of a semi-solidified lava lake with two small openings through which the ash and lapilli were ejected; the eruptions were accompanied by steam and a considerable amount of sulphurous vapour. The lava has been flowing since January, 1961. Other major lava flows took place at intervals from 1892 to 1955 (Figure 18).

Figure 19. Terrestrial basaltic lava overlying early submarine lava of Mt Etna. Note vertical jointing in terrestrial flow and pillows in submarine flow. Acicastello.

Figure 20. View of Mt Etna, looking north from near Nicolosi.
The blocky lava in the foreground is the 1910 basaltic flow. Dark area in centre of photograph is the 1892 flow; lighter grey hills are adventive cores (grey).

Figure 21. Southern slope of Mt Etna as viewed from about 2,000 feet below the summit. Note numerous adventive scoria cores.

Figure 22. Present active cinder cone on the northern part of summit of Mt Etna. Height of cone is about 300 feet. Dark foreground is edge of a previously active crater, which is now in fumarolic stage.

Figure 23. Broken pillows in a basaltic hyaloclastite deposit, near Vizzini, Iblean region, south-eastern Sicily.

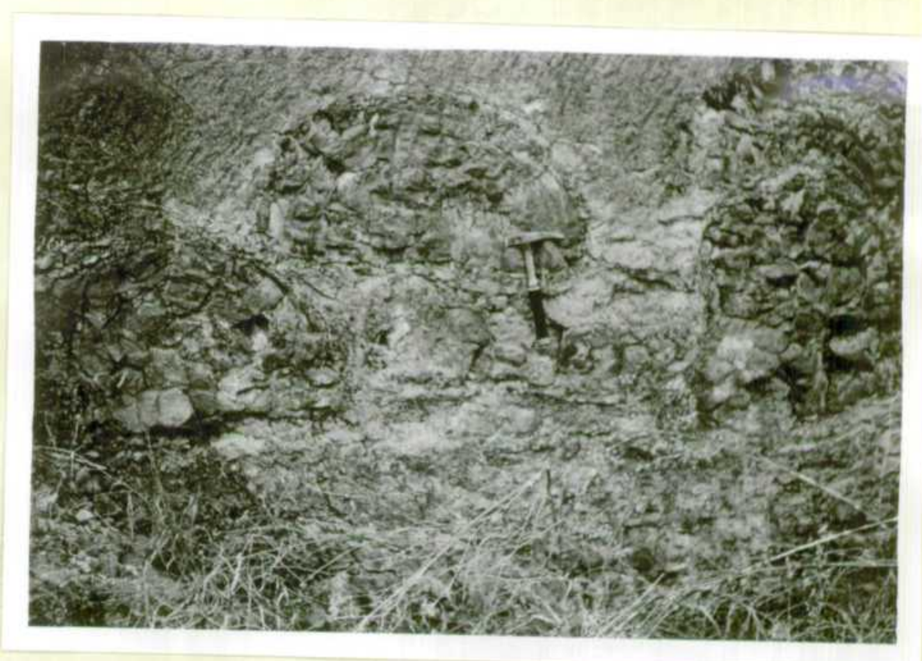


Figure 24. Pillows in a tephritic basalt hyaloclastite deposit, near Vizzini, Iblean region.

IBLEAN REGION

The Middle Triassic to Pleistocene volcanics of the Iblean region cover an area of 150 square miles in south-eastern Sicily, about 20 miles south-west of Catania.

The Iblean eruptive rocks are mainly submarine flows of basalt and tephritic basalt accompanied by widespread deposits of hyaloclastites with or without preserved pillows (Figures 23 and 24). According to Rittman the hyaloclastites are formed in submarine effusion when the lava is immediately chilled by the water and covered by a glassy crust, which, due to the progressing flow of lava, is broken and crumbled to small pieces (once called 'palagonite'). In the meantime, a new glassy crust is formed below the first one, and it too will be broken, and so on. The small flows of lava form rounded protrusions which are covered by a glassy crust. The process continues as long as lava is supplied; the protrusion grows as the glassy crust is broken to pieces. When the flow of lava to the protrusion stops by the narrowing of the channel of supply, a pillow is formed. The hyaloclastites consist of broken material from the lava flows and from the pillows. This material generally collects at the margin of the lava flow, and it may contain more or less well-preserved pillows. Where they have been transported by marine currents, the hyaloclastites are stratified.

VULCANO ISLAND

Vulcano Island is the southernmost of the Eolian Islands (Figure 27) situated about 15 miles north of Sicily. It is a compound volcano (Figure 25). A few hours were spent on the island, and its main crater of Vulcano della Fossa was seen only from the distance; some fumaloric activity was seen near the harbour, and an ancient trachybasalt flow was examined.

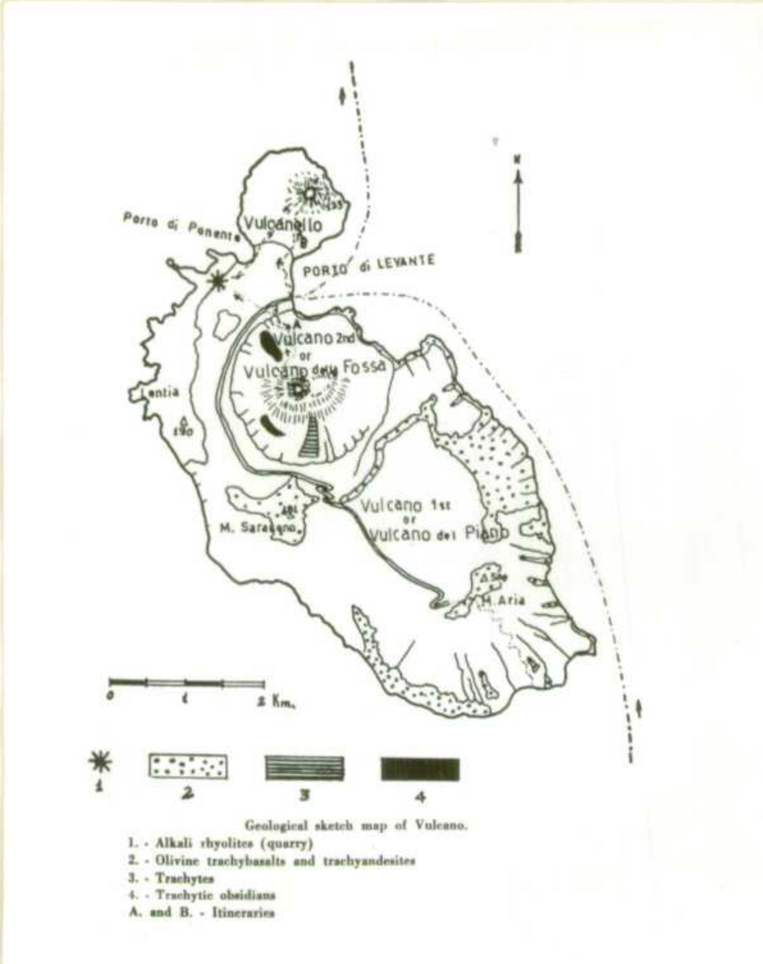
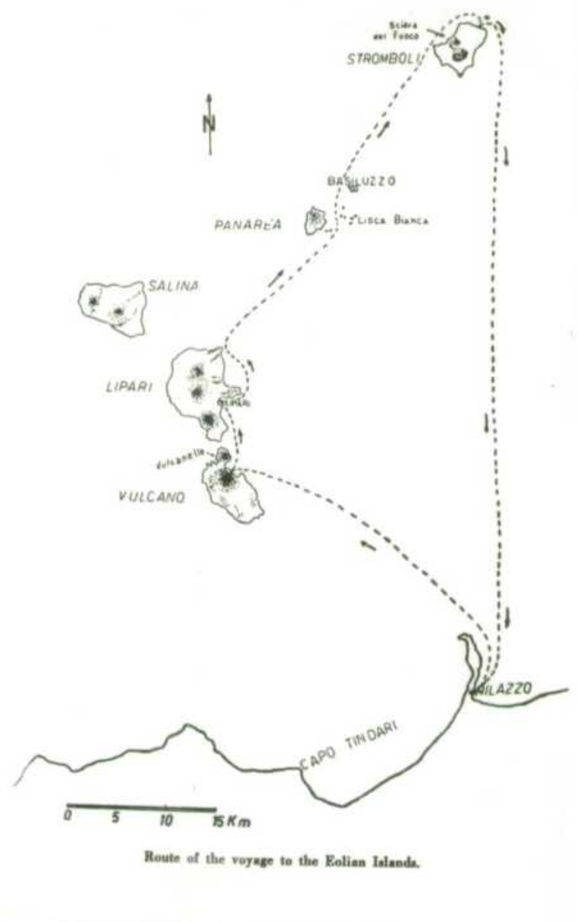


Figure 25.

Figure 26. The northern part of the Vulcano della Fossa cone as viewed from Porto di Ponenta. The white areas are due to fumarolic activity. Note the adventive crater on left and the blocky trachytic obsidian flow in centre of the slope. Ash deposits (dark) are exposed on the right slope of the cone.

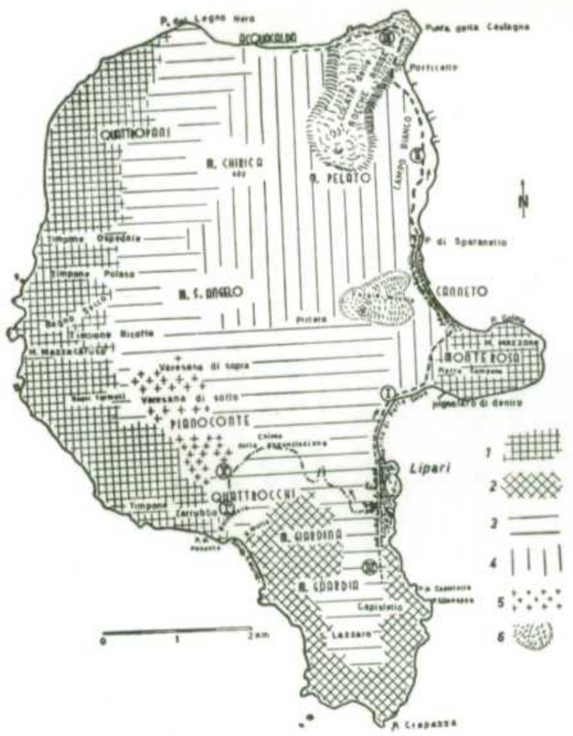
LIPARI ISLAND

The island of Lipari (Figure 28) is the largest of the Eolian Islands. It is 20 square miles in area, and is situated about 1 mile north of Vulcano. The island consists of many extinct volcanoes, in which three broad groups have been recognised: the first group consists of young cones situated in the central and eastern part of the island; the second group comprises dome-shaped volcanoes consisting of old obsidian and rhyolite with remnants of a cover of pumice; to the third group belong two well preserved volcanoes - Forgia Vecchia and Mount Pelato - which initially extruded obsidian and ejected pumice blocks at the end of the eruption. Mount Pelato is of economic interest because of its extensive deposits of pumice, which are mined near Campo Bianco (White Field) on the north-eastern coast of the island (Figure 29).



Route of the voyage to the Eolian Islands.

Figure 27.



Geological sketch map of Lipari.
1. - Lava flows and tuffs of basaltic or andesitic aspect (Group I)
2. - Rhyolites, partially ignimbrites (Group II)
3. - Acid tuffs
4. - Rhyolitic pumice
5. - Quartz-latite with cordierite
6. - Rhyolitic obsidian (Group III)
Roman numbers: itinerary and stops.

Figure 28.

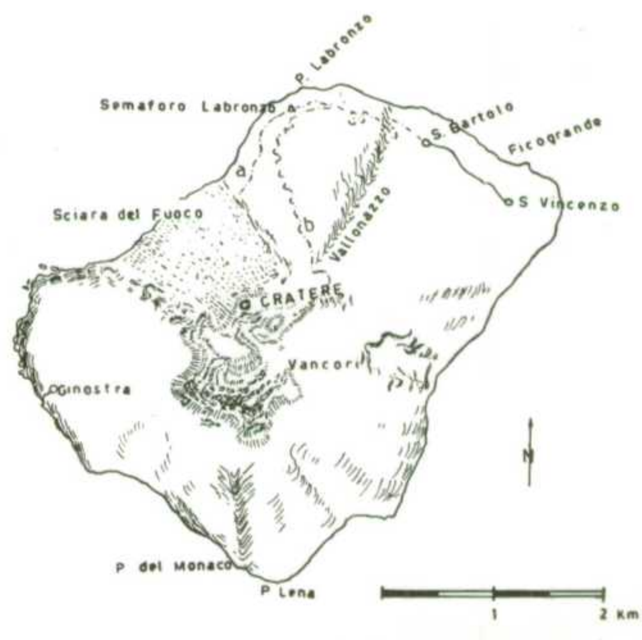
Figure 29. View of the pumice deposits (white) of Campo Bianco on the north-eastern end of Lipari Island.
Note blocky obsidian flow in centre which has flowed into the sea from Mount Pelato (highest peak in background).

STROMBOLI

Stromboli (Figure 30) is the northernmost of the Eolian Islands. It is famous for its persistent central activity. Stromboli is a conical strato-volcano (Figure 31) consisting of alternating basic lava flows and ash. Its area at the base is about 8 square miles, and it rises to a height of 2,775 feet; the sea around Stromboli is about 3,000 feet deep. The crater contains five flat eruptive cones with funnel-shaped openings. The largest one of these is in persistent activity, ejecting incandescent material at intervals of between one and fifteen minutes. Hollow rumbles accompany these explosions. At other times, instead of lava fountains, high blast flames can be observed, accompanied by sharp detonations, which are probably caused by explosions of gas mixtures consisting of hydrogen and air.

A marked feature of Stromboli is its steep north-western slope called the 'Sciara del Fuoco' (Figure 32); this represents the cone of the crater and consists of lavas and cinders, which formed in a collapsed sector of the old volcano. The 'Sciara' continues down to the shore and into the sea.

During the visit to Stromboli the small island of Strombolicchio, north-east of Stromboli, was visited. This island is the remnant of a volcanic neck.



Sketch topographical map of Stromboli. The routes of excursion (a) to Labronzo and (b) to the crater are indicated.

Figure 30.

Figure 31. Mt Stromboli - a strato volcano - as viewed from the south. Height of volcano is 2,775 feet.

Figure 32. The 'Sciara del Fuoco' on the north-western slope of Mt Stromboli - a new cone of ash and lava formed in a collapsed part of the old volcano. Sea is in foreground.

PHLEGREAN FIELDS

The volcanic region of the Phlegrean Fields extends from Naples westwards to the Tyrrhenian Sea, at the Gulf of Pozzuoli. It contains mainly trachytes and some trachyandesites. The Fields cover an area of about 100 square miles, and contain more than 50 eruptive centres. The area consists mainly of a complex caldera, with a diameter of about 8 miles, and many nested monogenic volcanoes (Figure 34). The Phlegrean volcanism is still active: in 1538 an explosive eruption formed the 450 feet high cinder cone called 'Monte Nuovo', and the crater of Solfatora has shown uninterrupted fumarolic activity since Roman times.

The yellow Napolitanean tuff (Figure 35) is the most widespread volcanic deposit in the Phlegrean Fields. The tuff, overlain by a welded ash-flow tuff ('piperno'), and a breccia were examined near the eruptive centre of Soccavo (Figures 36 and 37). The cross-bedding in the Napolitanean tuff and some of the graded bedding in the breccia suggested deposition of the volcanics in water.

ISCHIA ISLAND

Ischia Island is situated 20 miles west of Naples. It has an area of 30 square miles. The highest mountain, Mt Epomeo, is 2,370 feet high and is situated near the centre of the island. The island is a volcano-tectonic horst (Figure 33) containing many adventive cones which are formed on the faults of the horst. Ischia consists mainly of trachytes and related rocks - latites and sodalite phonolites - which have been emplaced as domes and lava tongues in green trachytic tuff, which except for its colour, resembles the Napolitanean tuff.

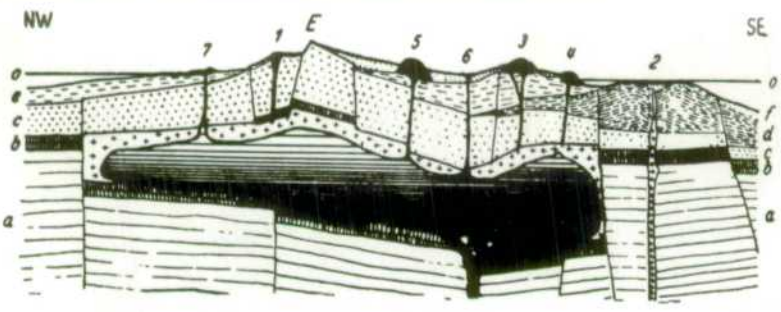


Fig. 5. - Cross section through the volcano-tectonical horst of Ischia (according to RITTMANN).

a. - Sedimentary basement
b. - Basalt and trachybasalts
c. - Green trachytic tuff called Epomeo tuff (E)
d. - Submarine tuffs and lavas
e. - Younger tuffs
1. - Montagna Nuova

The differentiation of the magma within the laccolithic chamber is indicated by various shading. The crosses indicate the consolidated part of the magma chamber.

Figure 33.
2. Secca d'Ischia
3. Dome of Mt Vezzi (alkali-trachyte)
4. Dome of S. Pancrazio (soladite phonolite)
5. Dome-ridge of Mt Trippodi (trachyte)
6. Crater of McLara (latite)
7. Dome of Zara (alkali-trachyte)

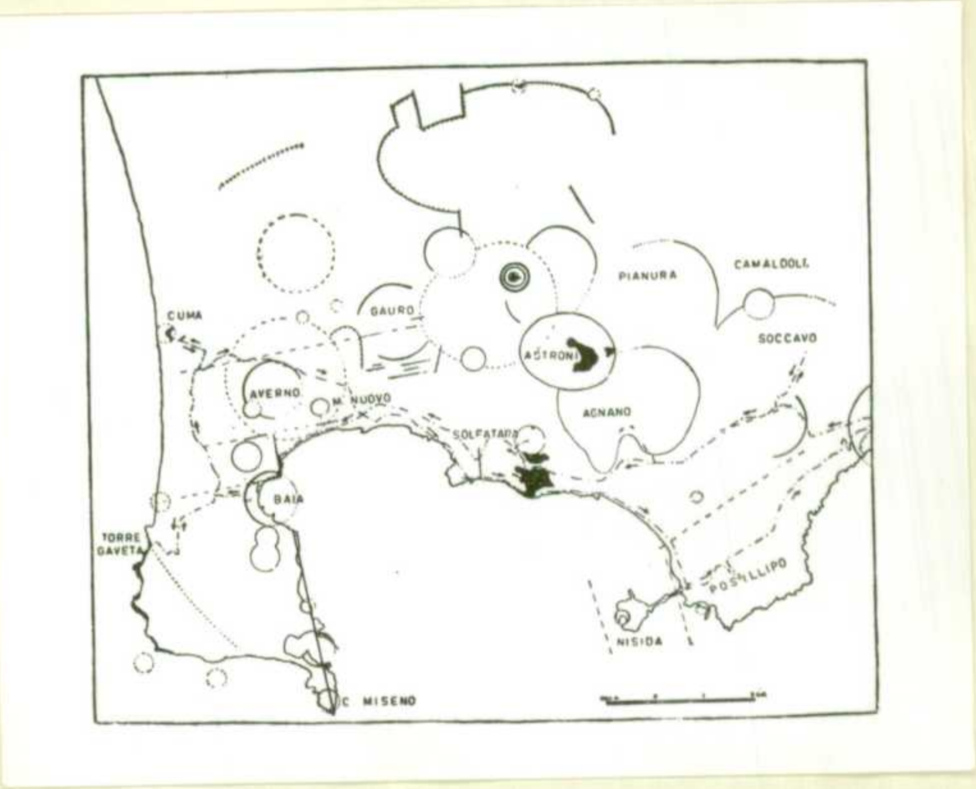


Figure 34. Sketch map of the Phlegrean Fields occupying the western part of Naples. Craters are indicated by full lines where their rims are preserved; otherwise dotted lines are used. Faults are indicated by saw-toothed full lines. Lava domes and flows are black. The route of the excursion is shown by a broken line with arrows.

Figure 35. The Napolitanean Tuff exposed on Cape Miseno, Gulf of Naples. Note giant cross-beds.

Figure 36. A volcanic conglomerate unconformably overlying a 'piperno' deposit (welded tuff) in the Verdolino Valley, near Soccavo.

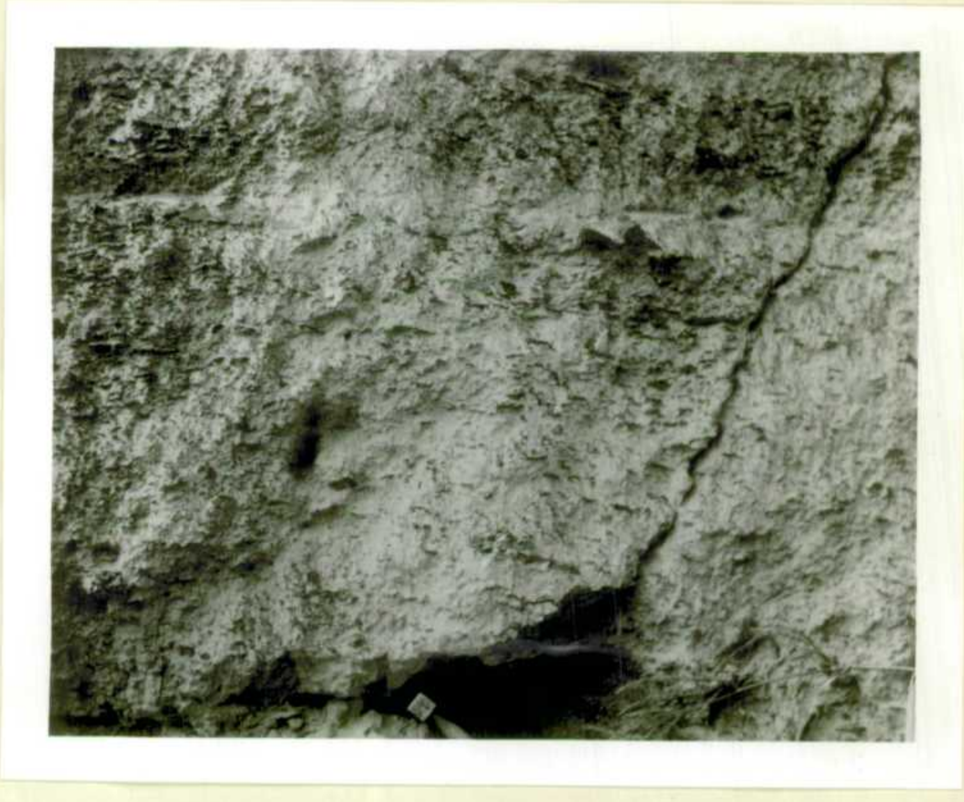


Figure 37. Close-up view of the 'piperno' deposit of Figure 36. Note dark elongated compacted, and welded fragments. (Hammer end of geological pick in foreground).

MT VESUVIUS

Mt Vesuvius (Figure 40) is situated a few miles from the city of Naples, and it extends almost to the central part of the Gulf of Naples. It has the shape of a regular truncated cone with a base of about 300 square miles (Figure 38). The volcano has two tops: 'Mt Somma' on the northern side with a height of 3,400 feet, and 'Vesuvius' on the southern side with a height of 3,800 feet. Vesuvius is an example of an 'atrio volcano', also called a volcano of 'Somma type'. Unlike Mt Etna, Vesuvius has few adventive cones on its flanks.

Eruptive activity began about 12,000 years ago, when the 'Primitive Somma' volcano was formed and yielded trachytic products, like the Phlegrean vulcanism, which was going on contemporaneously. Up to 6,000 B.C. the Somma volcano was inactive; then it erupted trachytes and phonolitic leucite-tephrites. In 1,200 B.C. a new cone called the 'Young Somma' volcano (Figure 41) was formed in the summit caldera and more leucite-tephrite was erupted. The most violent eruption of Vesuvius was the Plinean eruption of 79 A.D., when the summit of Young Somma was blown up and collapsed to form a large caldera, and the volcanic products completely buried Pompei. Vesuvius proper was formed within this caldera (Figure 39).

During the visit to Mt Vesuvius, pahoehoe lava of the 1858 flow (Figure 43) and the 1944 flow (Figure 41) were examined, as well as the main crater of Vesuvius (Figure 42) which, at the time of the visit, was showing only fumarolic activity.

The excursion to Mt Vesuvius was concluded with a brief examination of the ash which buried Pompei, situated 6 miles south-east of the central crater of Vesuvius.

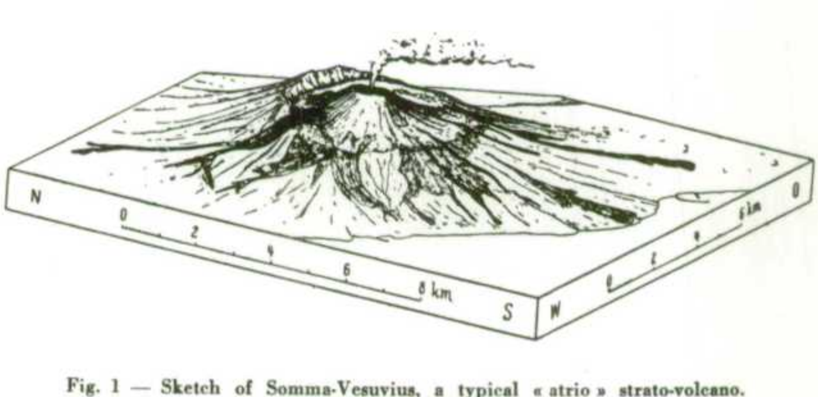


Fig. 1 — Sketch of Somma-Vesuvius, a typical « atrio » strato-volcano. In the northern part the caldera rim of *Mt. Somma* is observed, in the centre the smoking cone of *Vesuvius* proper, formed after the eruption of A.D. 79. The lavas of Vesuvius have covered a great part of the old Somma edifice (Sketch by A. Rittmann, 1933).

Figure 38.

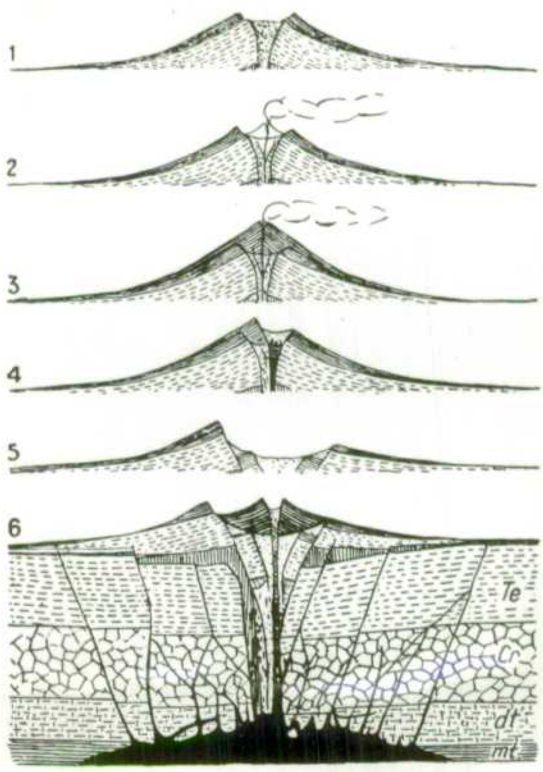


Figure 39. Cross sections showing evolution of Mt Vesuvius according to A. Rittmann.

1. The Old Somma Volcano, at the top of which a large caldera is formed.

2. A new volcano (Young Somma) begins to grow in the caldera.

3. The Young Somma volcano has reached its maximum height, covering the Old Somma volcano.

4. On the top of Young Somma is a partly filled caldera (about 800 B.C.)

5. The large caldera formed at the great Plinian eruption of 79 A.D.

6. Vesuvius has grown in the caldera largely filling the latter. Te, Cr, dt, and mt refer to Cainozoic and Triassic basement sediments.
Vertical lines - trachytic volcanics of the Primitive Somma volcano. Volcanics overlying the trachytes (from base to top) are phonolitic leucite tephrites of Old Somma (orvietites), leucite tephrites of Young Somma (ottajanites), and tephritic leucitites of Vesuvius (vesuvites).

Figure 40. View of Mt Vesuvius from the south on highway between Naples and Pompei. Caldera rim of Mt Somma on left separated from Mt Vesuvius proper on right by an exogenous dome (Colle Umberto).

Figure 41. The inside of the caldera rim of Mt Somma. Dark lava flow at the bottom of the caldera is the 1944 tephritic leucitite flow.

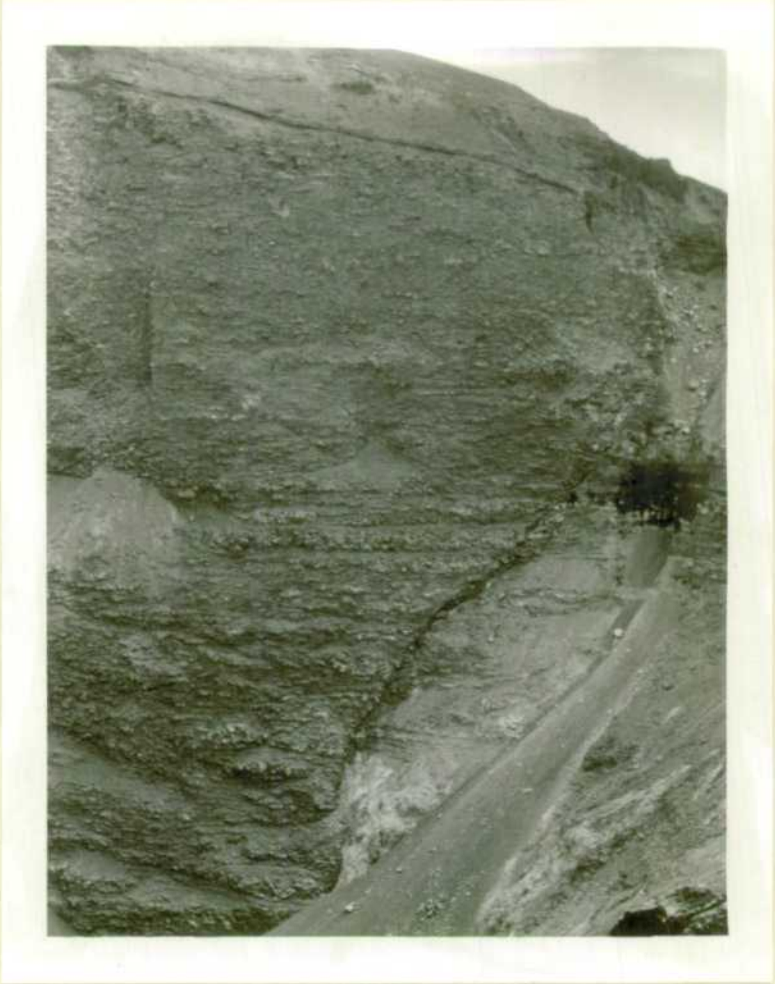


Figure 42. View inside of northern wall of the crater of Mt Vesuvius. The abrupt, steep, wavy line to right of photograph marks the intersection between two crater walls.

Figure 43. Pahoehoe lava of the 1858 tephritic leucitite lava flow of Mt Vesuvius.

FORMAL SESSIONS

Two and a half days of formal sessions were held at the Institute of Volcanology, University of Catania. During these sessions a total of forty-one (41) papers - 30 on ignimbrites and 11 on hyaloclastites - were read and discussed.

The papers presented were:

1. 'Alkaline ignimbrites in the Precambrian of Israel', by Professor S.K. Bentor, Institute of Geology, Jerusalem.

2. 'The palaeogeographic significance of Ordovician ignimbrites in Britain', by N. Rast, Geology Dept, University of Liverpool, England.

3. 'Permo-Triassic ignimbrites in North Queensland, Australia', by C.D. Branch, Bureau of Mineral Resources, Geology and Geophysics, Canberra, A.C.T. Read by D.A. White, Bureau of Mineral Resources.

4. 'Cainozoic volcanic rocks of west-central Nevada, U.S.A.', by C.J. Vitaliano, Dept of Geology, Indiana University, Bloomington, Indiana, U.S.A.

5. 'Rholites and ignimbrites of Marungu, Lake Tanganyika (Katanga, Congo)', by I. de Magnee, Bruxelles, Belgium.

6. 'The Middle American ignimbrites', by R. Weyl, Giessen, Germany.

7. 'Preliminary observations on various types of ignimbrite from the Eolian Island of Pantelleria', by G. Marinelli, S. Borsi, F. Mazzoncini, M. Mittenpergher, and C. Tedesco, Institute of Mineralogy, Pisa, Italy.

8. 'Observations on ignimbrites in Indonesia, Northern Italy, and the United States of America', by R.W. van Bemmelen, Institute of Mineralogy and Geology, State University of Utrecht, Holland.

9. 'Ignimbrites of the Great Basin, U.S.A.', by E.F. Cook, College of Mines, University of Idaho, Moscow, U.S.A.

10. 'Acid lava flow structure, as compared to ignimbrites', by M. Rutten, Institute of Mineralogy and Geology, Utrecht, Holland.

11. 'The ignimbritic material erupted during the eruption of the 10th July, 1960 by the volcano of Lopevi, New Hebrides', by J.M. Remy, Geology Dept, Montpellier, France.

12. 'The risk of an ignimbrite eruption', by A. Steiner, New Zealand Geological Survey, Lower Hutt, New Zealand.

13. 'Contributions to the ignimbrite problem', by G. Choubert, Geological Service of Morocco, Morocco.

14. 'The formation of tuff and the ignimbrite problem',
by H. Hentschel, Germany.

15. 'Mechanism of pumice flow eruption',
by H. Kuno, K. Yogi, T. Ishikawa, Y. Katsui,
M. Yomasaki, and S. Takeda, Geological Institute,
University of Tokyo, Japan.

16. 'On the question of the ignimbrite genesis in relation
to recent eruptions', by G.S. Gorshkov, Laboratory of
Vulcanology of the Academy of Science of the U.S.S.R.

17. 'Ignimbrites of Hungary and their genesis and classification',
by G. Panto, Hungary.

18. 'Zonality of lava flows originating after their effusion
and the formation of 'tuff-lavas' ',
by V.P. Petrov, Laboratory of Vulcanology of the
Academy of Science of the U.S.S.R.

19. 'Texture and structure of the ignimbrites of Mt Amiata',
by R. Mappiroli and M. Pratesi, Institute of Mineralogy,
Pisa, Italy.

20. 'Exhibition of piperno rocks from the Phlegrean region',
by V. Gottini, Institute of Vulcanology, University of
Catania.

21. 'Preliminary observations on the Tuscany ignimbrites',
by M. Micheluccini, Institute of Mineralogy, Pisa, Italy.

22. 'Geochemical contribution to the Tuscany ignimbrite',
by F. Tonani, Institute of Mineralogy, Florence, Italy.

23. 'Tridymite and cristobalite in the glassy groundmass
of the Tuscany ignimbrite',
by L. Schiaffino, Institute of Mineralogy, Pisa, Italy.

24. 'Observations on the temperature of crystallization of
the Tuscany ignimbrite',
by S. Borsi, Institute of Mineralogy, Pisa, Italy.

25. 'Ignimbrites and tuff-lavas. Classification principles
and condition for their formation as exemplified by
Armenia',
by K.G. Shirinian, U.S.S.R.

26. 'On the genesis of the Tuffolavas at Kamchatka',
by V.I. Vlodavetz, Soviet Geophysical Committee, U.S.S.R.

27. 'Ash Flow problems - a synthesis based on field and
laboratory studies',
by R.L. Smith, U.S. Geological Survey, Washington, U.S.A.

28. 'The tectonic causes of ignimbrite deposition and of
subsequent basalto-andesitic volcanism',
by J. Westerveld, Holland.

29. 'Origin of the ignimbrite magma and its crystallization',
by A. Steiner, New Zealand Geological Survey, New
Zealand.

30. '(i) The volcanics of Cape Passero (Sicily)
(ii) Proposed classification for the Iblean hyaloclastic material ',
by S. Cucuzza Silvestri, Institute of Vulcanology, Catania, Italy.

31. 'Pillows and hyaloclastites of Ustica',
by C. Sturiale, Institute of Vulcanology, Catania, Italy.

32. 'Hyaloclastite and submarine lava of Ragusa (Sicily)',
by A. Campione, Institute of Vulcanology, Catania, Sicily.

33. 'On the submarine volcanics of Acicastello (Catania)',
by M. Di Re, Institute of Vulcanology, Catania, Italy.

34. 'Submarine vulcanism at Mt Tauro during August (Sicily)',
by P. Aloisio, Institute of Vulcanology, Catania, Italy.

35. 'Comparison of some physical and chemical properties of the volcanics of Pachino, of the Noto Valley; and of Etna',
by M. Carapezza, Italy.

36. 'The hyaloclastites of the northern river of Kivu Lake (Congo)',
by M. Denaeyer, Institute of Mineralogy and Petrography, Bruxelles, Belgium.

37. 'Contribution to the mineralogy of Mt Iblei',
by T.G. Sahama, Institute of Geology, Helsinki, Finland.

38. 'On the origin of hyaloclastites',
by J. Honnorez, Institute of Vulcanology, Catania, Italy.

39. 'Submarine eruptions of hyaloclastites'
by A.F. Richards, U.S. Navy Electronics Laboratory, California, U.S.A.

40. 'In situ breccias of the Lower Carboniferous Pillow-Diobose of the Dill area',
by H. Hentschel, Germany.

41. 'Rhomb porphyries and ignimbrites of the Oslo region',
by C. Oftedahl, Geological Institute, Trondheim, Norway.

Since these papers will shortly be published in a volume of the Bulletin Volcanologique they will not be discussed here. Some general comments on the papers are listed in the Conclusion section.

COMMITTEE ON NOMENCLATURE OF IGNIMBRITES

During the formal session of the I.A.V. Synposium, Professor Rittmann moved that a committee be formed to define the term 'ignimbrite'. The term 'ignimbrite' was used at the Symposium for a volcanic rock and an eruption; it was not clear that when 'ignimbrite' was used as a name for a volcanic rock, what degree of welding, if any, it did imply.

The ignimbrite committee selected consisted of 8 members:

R. Smith (U.S.A.), Secretary.
R. Weyl (Germany)
R. van Bemmelen (Holland)
H. Kuno (Japan)
G. Marinelli (Italy)
P. Bordet (France)
N. Rast (England)
C. Fuster (Spain)

The committee was asked to prepare a report on ignimbrite nomenclature for presentation in May, 1962 at the next I.A.V. Symposium in Japan. It met once for a brief period during the symposium, and the Secretary was asked to prepare a circular on ignimbrites, and distribute it for comment before the symposium in Japan.

CONCLUSIONS

1. On the excursions the ignimbrites and rheoignimbrites of the Tuscany region were discussed, particularly those exposed at San Vincenzo and Mt Amiata. Most geologists would not accept these volcanics as ignimbrites, and they objected to the term 'rheoignimbrite'. The brecciated, fumarolic, 'welling up', and stratified features seen in the Tuscany volcanics could be explained as features developed in the top and edges of a lava flow. Furthermore, the photomicrographs of the San Vincenzo - Mt Amiata rheoignimbrites and ignimbrites do not show the typical welded glass shard groundmass which is a characteristic of rocks called 'ignimbrites' elsewhere.

2. There was general agreement amongst the geologists that the ignimbrite exposed at Viterbo (Figures 12 and 13) is a true ignimbrite. The Permian Bolzano Porphyries, which I examined in Northern Italy after the symposium, contained some welded rhyolitic ash-flow tuffs. Van Bemmelen (1961) interpreted these porphyries as ignimbrites.

3. The 'piperno' seen in the Phlegrean Fields is a good example of a welded ash deposit (Figures 36 and 37). Good evidence for welding was seen where the ends of the pumice lapilli lens out, and the air tubes in the lapilli are compacted. Where welding was extreme the pumice lapilli were dark and dense.

4. From the papers presented at the symposium it appears that ignimbrite is a common volcanic rock in most countries except Italy.

5. Most geologists today use the term 'ignimbrite' as synonymous with welded tuff. American geologists mapping in one of the world's largest ignimbrite provinces of 60,000 square miles, in the Tertiary Great Basin in Nevada and Utah, use the term 'ignimbrite' for a 'non-sorted, sheet-like pyroclastic deposit of probable Pelean or nuee ardente origin'; it is used as a rock-unit term, not as a rock type according to the American Stratigraphic Code. The term 'ignimbrite', as used in describing volcanics in the Great Basin, may be applied to tuff or tuff breccia; such rocks may be welded, partly welded, or entirely non-welded.

Ignimbrite was originally defined by Marshall (1935, p.1) as 'deposited from immense clouds or showers of intensely heated, but generally minute fragments of volcanic magma. The temperature of the fragments is thought to have been so high that they were viscous and adhered together after they reached the ground'. Elsewhere Marshall states (1935, p.38), 'ignimbrite is used as a name for a tuffaceous rock of acid composition that has been formed from a 'nuee ardent Katmaiene' in the nomenclature of A. Lacroix '.

Most ignimbrites are of rhyolitic or toscanitic composition, and contain quartz and feldspar phenocrysts, generally of ash size (diameter less than 4 mm.), set in a glassy shard groundmass. The shards show all degrees of welding and compaction and they can generally be recognised in ignimbrites even where the groundmass is devitrified. Ignimbrite sheets generally are uniform over long distances; they occupy areas ranging from 1,000 square miles to 60,000 square miles and averaging about 10,000 square miles. The ignimbrites generally occupy areas of rifting and cauldron subsidence.

6. Recently Smith (1960[a,b]) and Ross and Smith (1961) have increased our knowledge of ignimbrites by their study of ash-flow tuffs.

7. All rhyolite and rhyodacite 'porphyries' covering areas of thousands of square miles should be examined carefully for an ash-flow origin. Field criteria of uniform porphyritic texture, phenocrysts of ash size, lenticular inclusions, lack of liquid flow textures, and dark, dense (welded) areas which merge into the more massive (unwelded) parts, particularly near their base, all suggest an ash-flow rather than a lava-flow origin.

Field examination and study of the literature suggest that the Devonian acid volcanics of the Marysville, Dandenong, Violet Town, and the Snowy River areas in Victoria may contain more welded ash-flow tuffs than has been previously recognised.

8. During the symposium I visited the Institute of Vulcanology at the University of Catania. Here Professor A. Rittmann conducts a course in vulcanology as part of a four-year Geological Science degree. The vulcanological lectures are delivered either to 3rd or 4th year students. The four year degree consists of :

1st Year - Engineering Physics (Practical and Theory).
Mathematics
Chemistry

2nd Year - Mineralogy (Practical and Theory)
Petrology (Theory)
Engineering Physics (Practical and Theory)
Geography (Physical)

3rd Year - Petrology (Practical and Theory)
Vulcanology
General Geology
Geochemistry
Geography
Field Geology

4th Year - Applied Geology
Mining
Petroleum Geology
Vulcanology (repeat of third year lectures)

The Institute has a well equipped museum containing numerous specimens of volcanic rocks from all countries.

RECOMMENDATIONS

1. Future delegates to I.A.V. symposia should have a supply of reprints of Bureau publications on vulcanology for distribution among other delegates. Publications were freely exchanged among delegates at the I.A.V. Symposium in Italy. An enormous amount of goodwill can be achieved by the exchange and distribution of publications.

2. Delegates should have copies of their papers distributed to other delegates in advance of their presentation.

3. Delegates should carry introduction cards so that contacts with other delegates can be made more readily. Name tags were not worn by delegates at the I.A.V. Symposium.

4. Geologists interested in the study of ignimbrites should read Cook (1959), Smith (1960a,b), Ross and Smith (1961), and van Bemmelen (1961).

REFERENCES

COOK, E., 1959 - Ignimbrite bibliography. Idaho Bur.Min. Geol.Inf. Circ., 4.

MARSHALL, P., 1935 - Acid rocks of Tampo-Rotorua volcanic district. Roy.Soc.N.Z.Trans., 64(3), 1-44, 323-366.

RITTMANN, A., 1933 - Die geologisch bedingte Evolution and Differentiation des Somma-Vesuvmagmas. Zeitscht.f.Vulk., V, 1-2, Berlin.

ROSS, C.S. and SMITH, R.L., 1961 - Ash-flow tuffs, their origin, geologic relations, and identification. U.S.Geol.Surv.Prof.Pap., 366.

SMITH, R.L., 1960a - Ash flows. Bull.Geol.Soc.Amer.,71,795-842.

SMITH, R.L., 1960b - Zones and zonal variations in welded ash flows. U.S.Geol.Surv.Prof.Pap. 354-F

van BEMMELEN, R.W., 1961 - Volcanology and geology of ignimbrites in Indonesia, North Italy, and the U.S.A. Geol.en Mijn., 40, 399-411.

APPENDIX I

List of participants (102) at the I.A.V. Symposium, Italy, 1961.

(Arranged in order of greatest representation)

ITALY (50)

Dr P. Aloisio, Institute of Vulcanology, Catania.
Prof. A. Azzaroli, Institute of Geology, Bari.
Dr P. Baggio, C.N.E.N., Toreno.
Prof. M. Balconi, Institute of Mineralogy and Petrography, Pavia.
Prof. B. Baldanza, Institute of Vulcanology, Catania.
Dr S. Borsi, Institute of Mineralogy, Pisa.
Dr A. Brondi, C.N.E.N., Rome.
Dr E.C. Burckhardt, Lavagna.
Dr A. Campione, Institute of Vulcanology, Catania.
Prof. M. Carapezza, Bologna.
Dr M. Castiglione Gerlando, Institute of Vulcanology, Catania.
Prof. S. Cucuzza Silvestri, " " " "
Dr F. Cugusi, Institute of Applied Geology, Rome.
Prof. P.G. Damani, Acereale.
Dr C. D'Amico, Institute of Mineralogy, Bologna.
Dr L. de Marco, C.N.E.N., Toreno.
Prof. A. Desio, Milano.
Prof. G. Dessau, Institute of Geology, Pisa.
Dr I. Dieni, Institute of Geology, Padova.
Dr M. Di Re, Institute of Vulcanology, Catania.
Dr M. Franzini, Livorno.
Prof. P. Gallitelli, Institute of Mineralogy and Petrography, Bologna.
Dr C. Giovagnotti, Institute of Mineralogy and Geology, Perugia.
Dr V. Gottini, Institute of Vulcanology, Catania.
Dr M. Govi, C.N.E.N., Rome.
Dr C. Gratzin, Institute of Mineralogy, Pisa.
Dr J. Honnorez, Institute of Vulcanology, Catania.
Dr J. Klerlox, " " "
Prof. C. Lippi Boncampi, Institute of Mineralogy and Geology, Perugia.
Dr E. Locardi, Rome.
Dr T. Lundquist, Institute of Vulcanology, Catania.
Prof. G. Marinelli, Institute of Mineralogy, Pisa.
Dr F. Mazzoncini, " " "
Dr R. Mazzuoli, " " "
Dr M. Micheluccini " " "
Dr W. Munch, Rome.
Prof. F. Penta, Institute of Applied Geology, Rome.
Dr P. Perusini, Institute of Mineralogy, Pisa.
Dr G. Piccoli, Institute of Geology, Padova.
Dr H. Pichler, International Institute of Volcanological Research, Catania.
Dr A. Pistolesi, Florence.
Dr M. Pratesi, Institute of Mineralogy, Pisa.
Prof. A. Rittmann, Institute of Vulcanology, Catania.
Dr M. Sacerdoti, Venice.
Dr L. Schiaffino, Institute of Mineralogy, Pisa.
Prof. G. Schiovenato, Institute of Mineralogy, Milano.
Prof. A. Segal, Rome.
Dr C. Sturiale, Institute of Vulcanology, Catania.
Dr C. Tedesco, C.N.E.N., Rome.
Prof. F. Tonani, Institute of Mineralogy, Florence.

U.S.S.R. (8)

Dr G.S. Gorshkov, Laboratory of Vulcanology of the Academy of Science.
Prof. N.V. Koronovsky, Moscow.

Prof. E.F. Maleev, Moscow.
Prof. E.E. Milanovsky, Moscow.
Prof. V.P. Petrov, Moscow.
Prof. B.I. Piip, Moscow.
Prof. K.G. Shirinian, Moscow.
Prof. V.I. Vlodavetz, Soviet Geophysical Committee, Moscow.

U.S.A. (7)

Dr F. Chayes, Geophysical Laboratory, Washington, D.C.
Prof. E.F. Cook, College of Mines, University of Idaho.
Prof. E.F. Osborn, University Park Pennsylvania.
Dr A. Richards, U.S. Navy Electronics Laboratory, San Diego.
Dr R.L. Smith, U.S. Geological Survey, Washington, D.C.
Prof. C. Vitaliano, Indiana University, Indiana.
Dr D.E. White, U.S. Geological Survey, Mento Park.

GERMANY (7)

Dr H. Falke, Mainzgonsenheim.
Dr R. Geaedcke.
Prof. H. Hentschel, Wiesbaden.
Dr D. Jung, Dept of Mineralogy, Saarbrücken.
Prof. J. Michael, Jena.
Dr B. Schroder, Institute of Geology, Erlangen.
Prof. R. Weyl, Giessen.

FRANCE (5)

Dr P.J. Carron, Paris.
Dr C. Pareyn, Caen.
Dr J.M. Remy, Montpellier.
Dr A. Sandrea, Paris.
Prof. H. Tazieff, Paris

UNITED KINGDOM (5)

Dr P. Baker, University Museum, Oxford.
Dr M.L. Curtis, The City Museum, Bristol.
Dr. N. Rast, University of Liverpool, Liverpool.
Dr J. Tomblin, University Museum, Oxford.
Dr E.A. Vincent, University Museum, Oxford.

HUNGARY (4)

Dr G. Panto, Budapest.
Prof. K. Sztrokay, Budapest.
Dr G. Varyu, Budapest.
Dr A. Vidaes, Budapest.

HOLLAND (3)

Prof. R. van Bemmelen, Institute of Mineralogy and Geology,
Prof. M. Rutten, " " " " " Utrecht.
Prof. J. Westerveld, Amsterdam.

BELGUIM (3)

Prof. I. de Magnee, Bruxelles.
Prof. M. Denaeyer, Institute of Mineralogy and Petrography, Bruxelles.
Prof. J. Parent, University of Bruxelles.

SPAIN (2)

Dr J. Fuster Casas, Madrid.
Prof. A. San Miguel Arribas, Laboratory of Petrology, Barcelona.

AUSTRALIA (1)

D.A. White, Bureau of Mineral Resources, Canberra.

FINLAND (1)

Prof. T.G. Sahama, Institute of Geology, Helsinki.

IRAN (1)

Prof. S. Abdaban, Institute of Geophysics, Teheran.

ISRAEL (1)

Prof. S.K. Bentor, Institute of Geology, Jerusalem.

JAPAN (1)

Prof. H. Kuno, Geological Institute, Tokyo.

MOROCCO (1)

Dr G. Choubert, Geological Service of Morocco, Robat.

NEW ZEALAND (1)

Dr A. Steiner, N.Z. Geological Survey.

NORWAY (1)

Prof. C. Oftedahl, Trondheim.

APPENDIX II

List of specimens collected on the excursions and lodged at the Geological Branch, B.M.R., Museum.

1. Banded ignimbrite, San Vincenzo area, Tuscany.
2. Fresh and fumarolically altered rheoignimbrite, San Vincenzo area, Tuscany.
3. Ignimbrite, between Rocca Tederighi and Roccastrada, Tuscany.
4. Rheoignimbrite (fresh and fumarolically altered) Mt Amiata region.
5. Rheoignimbrite of Mt Amiata region.
6. Ignimbrite of Mt Amiata region.
7. Quartz latite of central dome of Mt Amiata.
8. 'Piperino tepico' - a sanidine bearing ignimbrite, Viterbo.
9. Leucitites, Lake Vico.
10. 'Piperino de Ariccia' - an augite-leucite-melanite-hauyne pyroclast, Latian Volcano.
11. Cecilite, Latian Volcano.
12. Augite leucitite, Latian Volcano.
13. 'Sperone', Latian Volcano.
14. 'Piperino', Ischia Island.
15. Obsidian, Mt Pelato, Lipari Island.
16. Napolitanean tuff, Phlegrean Fields.
17. 'Piperino', Phlegrean Fields.
18. Hyaloclastite, Iblean region.
19. Part of volcanic neck, Strombolicchio Island.