Geological excursion guide 5: Volcanoes of the Lipari Islands

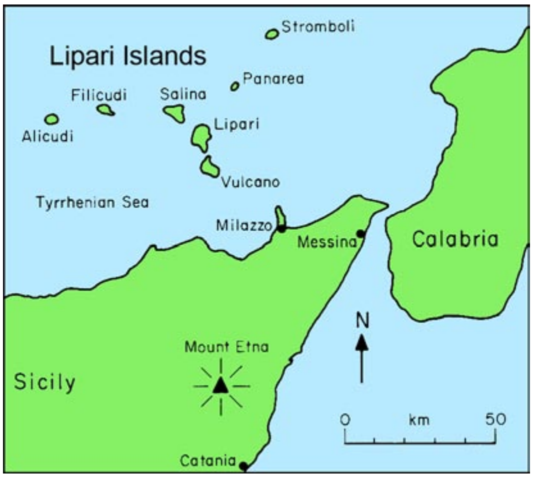
Known also as the Aeolian Islands (or Isole Eolie), the Lipari Islands stand on a 1000-m-deep shelf of the Tyrrhenian Sea off the north coast of Sicily (Fig. 1). There are seven islands in the group, all of volcanic origin, together with at least three submarine volcanic mounts. The main line of islands from Stromboli to Alicudi represents an island arc above the subducting African plate. Lipari and Vulcano, while genetically related to the same subduction, appear to be located on a major fracture zone intersecting the arc and probably relate to fractures further south beneath Etna.

All the magmas of the Lipari Islands volcanoes are of compositions compatible with the fusing of granitic crust in a basaltic host. Much of the surface vulcanicity is the product of fractionated magmas derived from an intermediate host. The most basic common material is andesite and there are evolved sequences through to obsidian.

The subaerial volcanic history of the islands falls into three major phases. The first was between 330 000 and 160 000 years ago, when andesite lavas built the volcanic edifices, now heavily eroded, of Panarea and the eastern tip of Filicudi. The second phase of major activity, between 160 000 and 130 000 years ago, saw andesitic strato-volcanoes create the core of Lipari, the basement of Salina and the main masses of Filicudi and Alicudi.

From 130 000 years ago to the present day, the third phase has had more variety in the vulcanicity. Rhyolites and andesites formed a number of volcanic centres on Lipari, andesites formed the two main cones on Salina, flank eruptions modified Filicudi and smaller acid flows were added on Alicudi. Then activity on Vulcano started about 100 000 years ago, while Stromboli was the last to commence, no more than 40 000 years back. Within historic times, eruptions have been limited to the islands of Lipari, Vulcano and Stromboli.

Fig. 1. The location of the ▶ Lipari Islands.



Fractionated: separated into components.

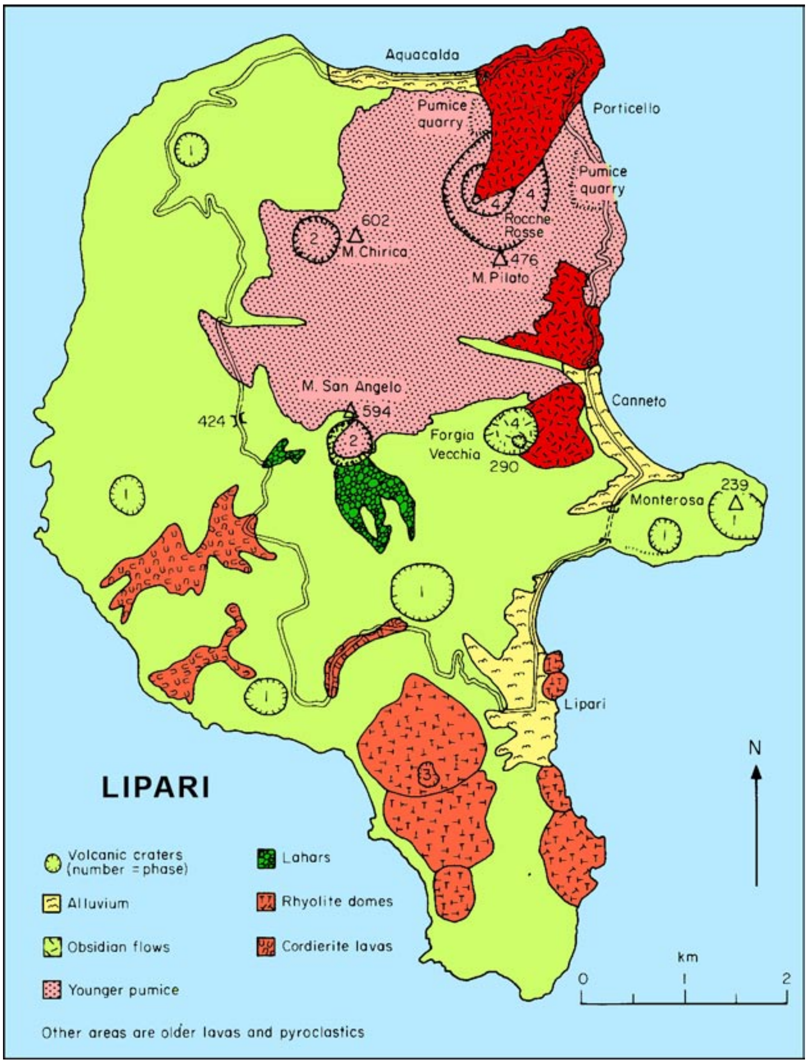
Intermediate: said of an igneous rock which is neither silica-rich nor silica-poor but which lies between.

Andesite: a dark-coloured, fine-grained, extrusive igneous rock.

Obsidian: a black or dark-coloured volcanic glass.

Rhyolite: a type of extrusive igneous rock.

Fig. 2. Geological map of Lipari. ▼



Lipari (Fig. 2)

Being the largest and among the older of the islands, the geology of Lipari is not, surprisingly, complex. It first emerged from the sea about 150 000 years ago when subaerial volcanics developed on top of a pile of pillow lavas. These andesitic volcanics form Monte Chirica and other centres in the west, and were soon followed by the double andesitic volcano of Monterosa in the east. This activity lasted until 130 000 years ago, and continued uplift exposed the pillow lavas beneath the 30-m-high terrace now remaining on the northwest coast.

The second volcanic phase lasted from 100 000 to 80 000 years ago. Its main feature was the growth of the massive andesitic stratovolcano of Monte San Angelo with subsidiary centres to the northwest. That the activity was not continuous is shown by the six paleosoils within this sequence of lava and pyroclastics. One special feature is the lava which contains phenocrysts of cordierite, garnet, sillimanite, andalusite and spinel, formed by the fusion of a buried metamorphic schist sequence.

Vulcanicity changed to an acidic type about 40 000 years ago, when a series of rhyolite domes developed to form the south end of the island, including the dome on which the Lipari castello stands above the modern town. A palaeosoil dated to 10 000 years marks the end of this phase, but more extrusions occurred north of Canneto between 11 000 and 8000 years ago, producing the older obsidian and pumice deposits. From about 4000 years ago, this obsidian was the raw material which made Lipari a widely known centre of trade, and Neolithic obsidian tools are known from much of Europe.

Life on the island was interrupted around 700 AD when the Monte Pilato centres produced the enormous volumes of pumice (Fig. 3). These are over 200 m thick down to the east coast, and they also plaster the older volcano of Monte Chirica. This explosive production of frothy pumice came to an end when the two huge obsidian flows were produced from the Rocche Rosse and Forgia Vecchia vents (Fig. 4). Both these obsidians are characterized by spectactular flow banding enhanced by the pumice material which has been incorporated in and drawn out within the viscous lava. In the last 1200 years there have been no further eruptions.

Localities on Lipari

A circular tour of the island is best on a bicycle rented in Lipari town. Approaching the Monterosa tunnel, road cuts expose tuffs, agglomerates and lapilli-pumice dipping at 20°. North of the tunnel the brown-weathered Forgia Vecchia obsidian is conspicuous, but its form is best appreciated seen from a passing ferry. Beyond Canneto the older obsidian is poorly exposed and the gullied pumice is spectacular but scarred by quarrying. At the Porticello road junction there is a good exposure of obsidian, stratified and flow-banded with the included pumice, and further road cuts reveal more clean obsidian.

West of Aquacalda, exposures are mainly of surge agglomerates with matrix-supported pumice and obsidian blocks, and also stratified, partly welded, tuffs. The west side of the island is scenically splendid but with less visible geological detail. Just south of the road summit, a lahar is exposed on a sharp right bend, and there are scrappy road cuts in the cordierite andesite on the long descent back to Lipari.

Vulcano (Figs 5 and 6)

Igneous activity at Vulcano commenced about 100 000 years ago when basaltic and andesitic lavas and tuffs created a large volcano, now forming the southern half of the island. This phase ended with a caldera collapse followed by the growth of the acidic lava dome of Lentia to the northwest. A second caldera collapse, north of the first, cut Monte Lentia on its west face and then became the site of the next phase of activity which created the Fossa cone (Fig. 7).

The Fossa volcano started around 10 000 years ago; it postdates a recognizable Lipari pumice dated between 11 000 and 8500 years BC. It started on a centre northeast of the modern crater and produced a massive cone of grey, dry surge and airfall stratified tuffs together with the trachyte lava which descended its north flank to meet the sea at Punte Nere, where it is still exposed.

The succeeding Palizzi and Commenda phases produced mainly wet surge pyroclastics from a vent further to the southwest, which also had lava overflow down the southern slopes. At the same time a parasitic explosive vent opened the Forgia Vecchia on the north side. This was followed by the Pietre Cotte phase with its vent just a little further to the north. This was notable for the production of the massive, red, wet surge tuffs which are still a conspicuous feature of the cone. There were also stratified dry surge tuffs, some airfall pumice layers, and lahars created by reworking of the loose tuffs on the lower slopes. The Forgia Vecchia II crater was formed in 1727, and the obsidian lava flowed down the north flank of the Fossa cone in 1739.

The vent of the modern phase opened a little further back to the south and produced the upper, grey, stratified tuffs, of airfall and dry surge origin, which are still well exposed. The explosive activity has been concentrated in periods each of a few years duration, starting in 1771, 1812, 1873 and 1886. The

▲
Fig. 3. The pumice quarry on the east side of Monte Pilato, on Lipari.

Pyroclastic: fragmented material produced in an explosive volcanic eruption.

Phenocryst: a large, conspicuous crystal in an igneous rock.

Tuff: a rock consisting of small fragments of volcanic material that have been consolidated.

Agglomerate: a coarse assemblage of angular volcanic rock fragments.

Lapilli: volcanic fragments with dimensions in the range 2–64 mm.

Lahar: a mudflow consisting mainly of volcanic material.

Fig. 4. The bulbous mass of the Forgia Vecchia obsidian flow on Lipari, with Canneto on the coast and Monte San Angelo behind.
▼

Caldera: a large, basin-shaped volcanic depression.

Lithic: comprising previously formed rocks.

Juvenile: derived directly from magma.

Tephra: a general term for pyroclastics.

Fumarole: a volcanic vent from which gases are emitted.

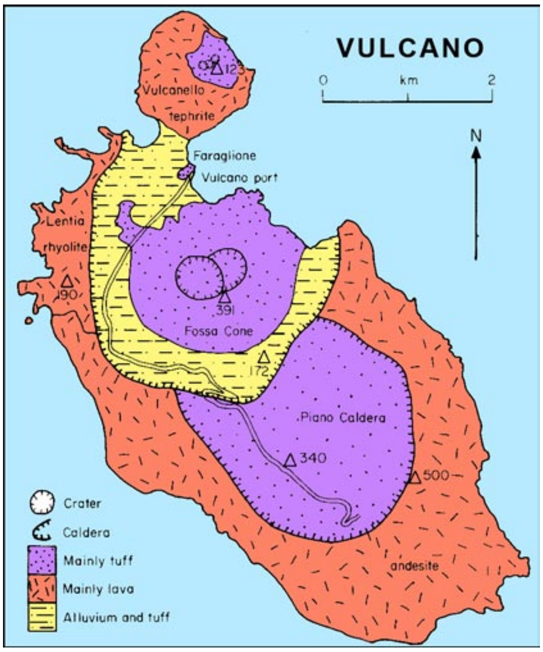


Fig. 5. Geological map of ▶ Vulcano.

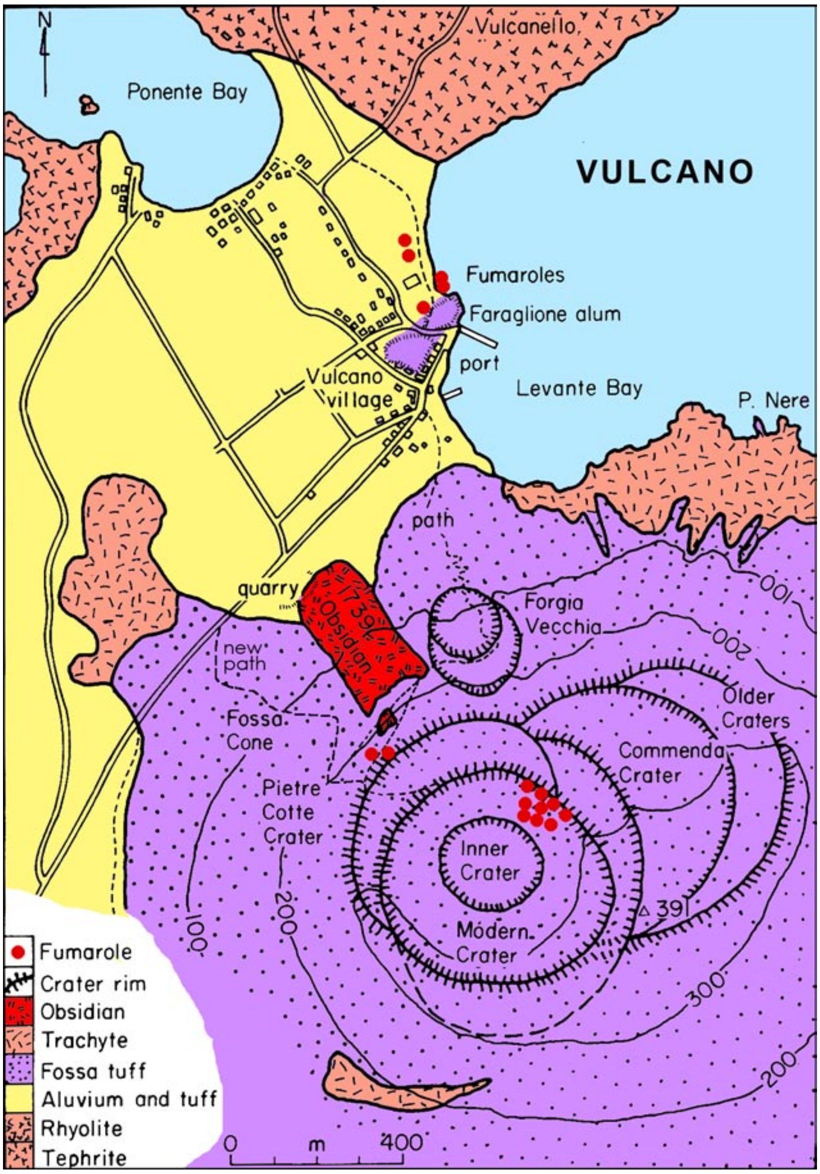


Fig. 6. Geological map of part of Vulcano. ▼

culmination of the last period was between 2 August 1888 and 22 March 1890 with what is now taken as the type example of Vulcanian activity. Intermittent explosions ejected first all old lithic debris and then juvenile material; between explosions there were periods of quiet lasting from a few minutes to a few days; there was no lava; breadcrust bombs up to a metre across landed as far as a kilometre away. In total over 5 m of tephra were deposited on the cone, of which nearly 2 m remain on the rim today. This eruption prompted the temporary evacuation of the island's inhabitants to Lipari.

Since 1890 there has been only fumarole activity on the Fossa. The emitted gases vary in composition and temperature over time, but they average around 95% steam and 0.2% sulphur dioxide, most of the remainder being carbon dioxide. At lower temperatures they precipitate sulphur crystals around the vents. The rim of the Fossa now rises to a maximum elevation of 391 m, with the current crater floor standing at 216 m, and it is a classically beautiful volcanic cone and crater.

Paralleling the growth of the Fossa has been the development of Vulcanello at the northern end of the island. This started in 183 BC when a platform of tephrite lavas was soon created. The main vent was the easterly of the three which now exist, and it also produced a small ash cone within the lava sequence – now so well cross-sectioned by the eastern sea cliff and clearly seen from the Lipari ferry. Later, less effusive, eruptions were from the western vent, with the last dating to around 1550. Only since then has the sand isthmus been created to join Vulcanello to the main part of Vulcano. Fumarole activity on Vulcanello died out in the last century but continues today close to the parasitic vent of Faraglione.

Localities on Vulcano

All the best features of Vulcano are conveniently located around the port and town. The twin yellow rocks of Faraglione cannot be missed and are heavily scarred by old alum mining. Immediately to their north, a group of fumaroles and mud pools lies on the Levante beach. The main mud pool has a floor of hydrothermally altered clays breached by small hot springs. It is normally occupied by mud-coated health fetishists, while the keenest of this breed occupy nearby rock niches where they sit on personal-size fumaroles (though there is conjecture as to what this habit cures). The adjacent sea is discoloured, sulphurous and very warm owing to shallow submarine fumaroles which mimic jacuzzis and provide an alternative tourist attraction.

The Fossa volcano should be visited; a good path climbs its northern slope and also offers excellent views. In the Forgia Vecchia crater, stratified ashes are exposed with some bedding planes dented by volcanic bombs and ejected blocks. Banded obsidian of the 1739 flow is well exposed and the path then winds between active fumaroles. From the rim of the modern crater, a good exposure is seen to the right. The lower, massive, red tuffs are wet surge deposits from the 1500-year-old Pietre Cotte phase; they are overlain by grey, stratified material of alternating dry surge and airfall material. The top 2 m are ashes from 1889. Round to the left, the northern rim has numerous fumaroles and solfataras, which have spectacular

Fig. 7. Vulcano seen from the north; Vulcanello is on the right, and the Fossa cone, with its summit steam vents, is beyond.

Pillow lava: a lava which, having been formed under water, comprises a series of pillow-shaped segments.

Alum: aluminium sulphate minerals once mined for various chemical uses.

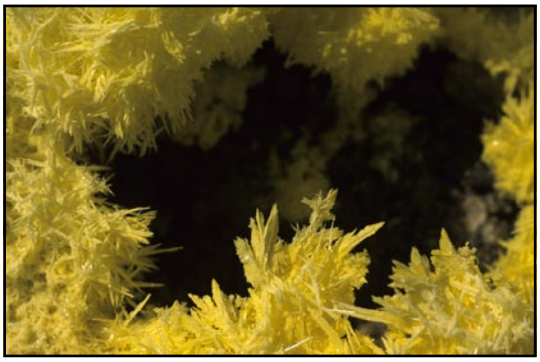


Fig. 8. Sulphur crystals in a fumarole vent on the Fossa cone, Vulcano.

but unstable sulphur crystals around their vents (Fig. 8).

Stromboli (Fig. 9)

The island of Stromboli stands away on its own, almost circular, rising in a nearly perfect cone to a summit at 924 m overlooking the complexities of the central vents both old and active. The main village is on the north coast only 2 km from the vent but safe from almost all activity, while a steep cinder slope on the northwest side, the Sciara del Fuoco, is kept active and barren as it catches most of the material thrown out of the modern vents.

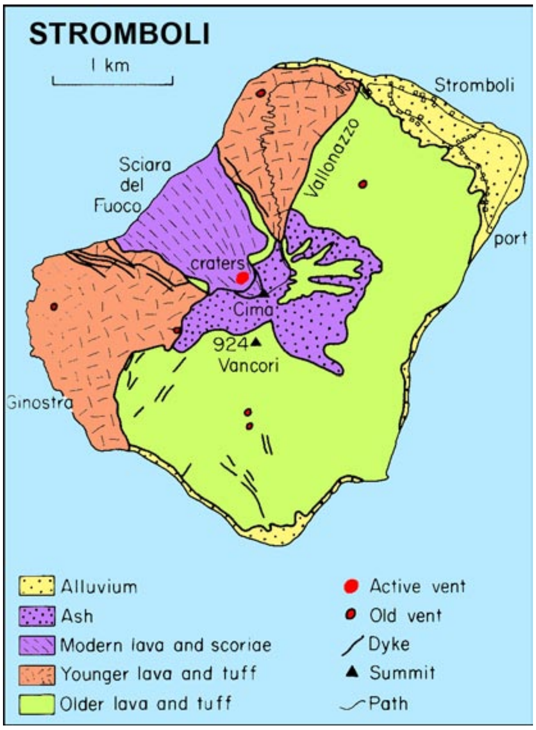


Fig. 9. Geological map of Stromboli.

Fig. 10. Small eruption cloud from the summit vent of Stromboli.

Stromboli's first phase of activity opened about 40 000 years ago when the large stratovolcano of Vancori was created by lavas and pyroclastics of mainly andesitic composition. The vent then shifted 500 m to the north to initiate the younger cone of Cima, and around 10 000 years ago a landslip occurred on the northwest side of Cima. This exposed the currently active vents, five in number, which hurl debris and lava down the Sciara del Fuoco – the massive, black cinder slope within the old landslip scar. The vents have been in a state of permanent activity since at least 300 BC, and they offer the type example of Strombolian eruptions (characterized by generally modest explosions). The situation is due to the presence of a deep-rooted feeder of intermediate, mildly explosive, magma. Critically important is the fact that the magma chamber and vent are relatively dry, as there is no major input of groundwater which would lead to much more violent explosions.

Though activity is permanent, it is interrupted by occasional larger eruptions, of which there have been 16 so far this century. That of 11 September 1930 was the most dramatic and destructive. Starting with two major explosions, an eruption cloud 2500 m high was created and blocks weighing up to 30 tons were thrown as far as the village. A rain of incandescent cinders lasted for 40 minutes and a metre of ash accumulated in places. A glowing avalanche, 10 m thick, swept down the Vallonazzo gullies, killing four people. Lavas poured down the Sciara to the sea for 12 hours, the island was gently lifted, and a small tsunami was created.

Localities on Stromboli

The active crater close to Stromboli's summit should not be missed (Fig. 10). From the west end of the

Fig. 11. Night-time eruption on Stromboli, with lava thrown to heights of around 100 m.

village a path winds up the northern flank; it is well marked but steep and rough, and its higher part follows the rim of the Sciara del Fuoco. At 700 m above sea level the path breaks out onto the upper ridge, covered in cinders and devoid of vegetation. The craters are then a few hundred metres to the right.

Normally, one or other of the five active vents erupts about every twenty minutes, throwing debris and molten lava about 100 m high. This reliable pattern of activity has lasted for many years, although it was interrupted in 1985 when eruptions were more irregular until a lava flow reached the sea in December. By summer 1986 it was almost back to its normal pattern. By day, Stromboli is impressive, but in darkness it is superb, especially when there is plenty of molten lava in the eruptive bursts. The volcanic firework show makes a night spent in a sleeping bag on the crater rim unforgettable (Fig. 11).

Suggestions for further reading

Frazzeta, G., La Volpe, L. & Sheridan, M.F. 1983. Evolution of the Fossa cone, Vulcano. *Journal of Volcanology and Geothermal Research*, v. 17, pp. 329–360.

Villari, L. 1980. *The Aeolian Islands*. Istituto Internazionale di Vulcanologia, Catania.

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Fig.12. Looking across the Fossa crater on Vulcano, down to the wooded lowland on Vulcanello, with Lipari island just across the narrow strait, and the twin peaks of Salina island rising in the distance.