ERUPTION OF MOUNT ETNA, 2001

by Karl Donert

ON AVERAGE, once a week around the world, a volcano erupts – and some of them with no warning at all. In July 2001, 37 volcanoes erupted. One of these eruptions was of Mount Etna, which is close to the east coast of Italy's island province of Sicily (Figure 1).

Types of volcano

There are four main kinds of volcano:

- cinder cones
- composite volcanoes
- shield volcanoes and
- lava domes.

Mount Etna is a **composite** volcano. These are usually large, steep-sided cones built of alternating layers of lava flows, volcanic ash, cinders, blocks, and bombs. The volcano is built up as these different materials are added to its slopes. Most composite volcanoes have a crater at the summit that contains a central vent or a clustered group of vents. Lava either flows through breaks in the crater wall or from cracks (fissures) on the flanks of the cone.

Mount Etna

Mount Etna is Europe's highest and most active volcano. (The name 'Etna' comes from the Greek *aitne*, meaning 'I burn'.) It is one of the largest continental volcanoes, with an elevation of 3,290 metres. The base of the volcano is about 60 x 40 km (36 by 24 miles). The upper part of Etna is made of several cones.

Most of the surface of Mount Etna is covered by historic lava flows dating back to eruptions as old as 300,000 years ago. Scientists believe that Mount Etna started as a submarine volcano which gradually grew to stand above sea level on layer upon layer of solidified lava.

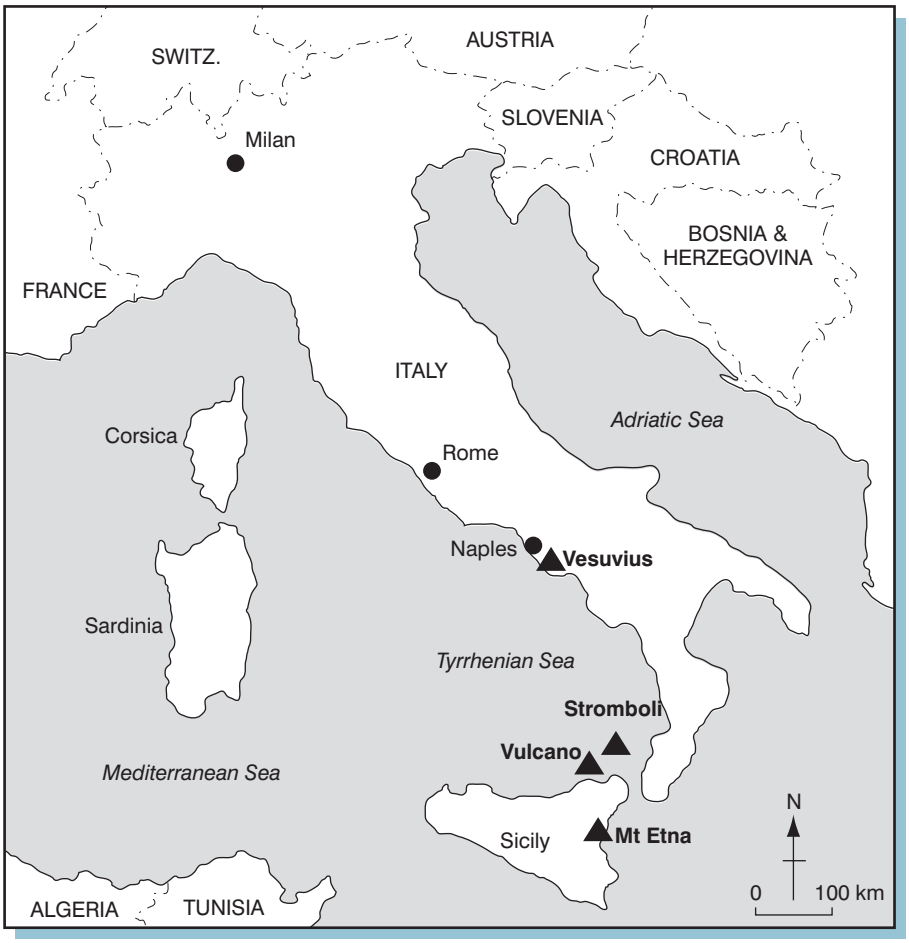

Figure 1: **The location of Mount Etna**

Most of the cones, craters, lava flows and deposits at the summit of Etna have been formed in the last 5,000 years. Many of these eruptions have not been very explosive and the activity is mainly a relatively gentle pouring out of lava, an activity type known as **Strombolian**. Large explosive eruptions from Etna are rare.

The shape and structure of Etna are extremely complex. The reason for this is that Etna did not grow as one single large cone, but was formed as a succession of volcanic features, most of which collapsed at least once during their lifetime.

Several collapsed craters, known as **calderas**, can be identified. The most impressive is the huge Valle del Bove (Valley of the Oxen) on the eastern side of the present volcano. Etna's morphology is further complicated by the presence of areas with more frequent volcanic activity than others. Hundreds of minor cones are scattered all over the mountainside, some of which appear to be small volcanoes on their own. At the summit of Mount Etna is a complex of large cones, which include the four summit craters. This group of craters is a relatively recent feature.

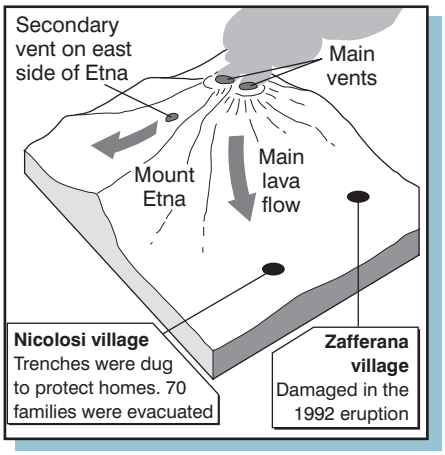

Figure 2: **July 2001 eruption of Mount Etna**

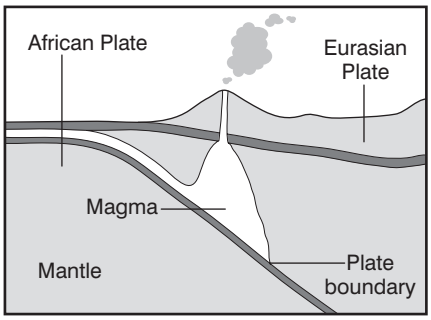

Figure 3: **Moving plates cause Mount Etna's eruptions**

Etna has a long historical record of eruptions. Its first recorded eruption was in 1500 BC. Since then Etna has erupted at least 190 times. The 1669 eruption, in which 20,000 people died, is probably the most destructive of those recorded. In July 2001 Etna erupted when five fissures cracked open on the mountain (Figure 2).

What is a volcanic eruption?

Volcanoes are built of materials from inside the Earth. An eruption occurs when these arrive at the surface. Most eruptions involve either explosions of rocks and ash, or the flowing of liquid lava, or both. Volcanoes that show signs of erupting are normally known as **active** volcanoes while those that do not are either **dormant** (sleeping), or **extinct** (dead). At least 20 volcanoes will probably be erupting around the world at any one time.

What causes volcanoes?

Inside the Earth's core there is a red-hot liquid rock, called **magma**. Volcanoes happen when magma rises to the surface of the Earth, which causes bubbles of gas to appear in it. This gas can cause pressure to build up and it is released by coming to the surface. When the magma bursts out of the Earth, it is called **lava**.

Volcanic eruptions occur in specific active zones of the Earth. These are the result of plate tectonic activity, where crustal plates collide or spread apart. Volcanoes can also occur in the middle of a plate.

The generally accepted explanation for the formation of Mount Etna is that part of the northward-moving African Plate is sliding beneath the Eurasian Plate (Figure 3). This is called **subduction**.

Volcanic hazards

Active volcanoes pose many hazards to life and property. Lava flows are destructive due to the high temperature of the molten rock. An explosive blast of an erupting volcano happens when fragments of rock and lava are forced to rise rapidly due to expanding gases. These blasts may throw great blocks of rock many miles. The high-velocity winds within the cloud are also very destructive due to the high gas temperatures that burn or suffocate anything in their path. These are known as **pyroclastic flows**. While the threat to the local population is constant, Etna's volcanic eruptions have not killed many people in recent times (Figure 4).

Etna's eruptions

Mount Etna demonstrates four main types of eruption, based on their location (Figure 5) and style of eruption. Etna erupts both from the summit craters and from vents away from the summit craters.

The 2001 eruption was an example of **lateral** and **eccentric** activity at the same time, from different fissure systems. There were eruptions from the south-east and north-east craters, but magma also erupted from the lowest fissures on the southern flank as an eccentric eruption.

Two styles of eruptive activity typically occur at Etna:

1 Persistent explosive eruptions, sometimes with minor lava flows, usually from one or more of the three main summit craters.

2 Flank vents with higher lava flow rates – these are less frequently active and originate from fissures that open down from the summit.

Year	Number killed	Description
1928	5	Killed by the lava flow that destroyed the town of Mascali
1929	2	Sudden explosion at north-east crater
1979	9	Tourists killed by a sudden explosion at Bocca Nuova.
1987	2	Sudden explosion at south-east crater

Figure 4: **Deaths caused by Mount Etna in the 20th century**

Name	Type	Examples
Terminal	Eruption from one or more of the summit craters	1787, 1960, 1964, 1995–99
Subterminal	Eruption vents close to the summit craters	1971, 1975–77
Lateral	Eruption occurs at some distance from the summit craters	1892, 1950–51, 1978–79, 1983, 1989, 1991–93, and many more
Eccentric	Eruptions not linked to the summit; fed by magma from deep in the Earth	1669, 1763, 1974

Figure 5: **Eruption types**

Etna 2001

The summer 2001 eruption was a complex flank eruption where all four summit craters produced spectacular and powerful activity, ranging from mild, persistent, slow (Strombolian) activity, to high-energy explosive episodes. Lava overflowed from all four summit craters as well as from fissures near the south-east crater.

The main eruption on Etna started on 12 July 2001 and lasted for 24 days (Figure 6). The lava flows reached temperatures of 1,000°C. The eruption involved some flank and summit activity. It occurred from six different fissure systems on the south and north-east flanks in a very irregular manner. Some of the flank activity was unusually violent. A dense plume of ash drifted for hundreds of kilometres, mostly to the south-east, causing heavy ash falls that disrupted air traffic in the area and were a serious nuisance to local people.

The July–August 2001 eruption caused significant damage, mostly to the cable-car and ski-lifts located between 1,900 and 2,600 metres on the southern flank of the volcano. Yet it was not a devastating event. In the end the eruption stopped much earlier than was expected.

About 5.5 km^2 of Etna's upper and middle slopes were covered with new lava. The total volume of lava, rocks and ash emitted during the eruption was approximately 40 million m^3. The activity was enough to significantly modify the shape of the southern flank (Figure 7).

The July–August 2001 eruption emitted at least eight different lava flows, mostly on the southern flanks of Etna. Fissures produced the largest lava flows at 2,100 and 2,700 metres. The most damaging flows and ash came from vents at an elevation of 2,570 metres.

Monitoring the eruption

Volcano monitoring aims to determine what a volcano is going to do. In order to do this, its past activity must be studied and a close watch kept on any current eruptions. Permanent volcano observatories are maintained around the world, especially in areas of high volcanic activity. Ground-based monitoring devices are assisted by the most modern satellite techniques.

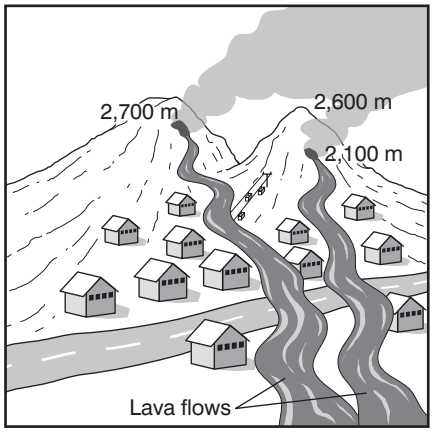

Figure 6: **An artist's impression of the Etna eruption 2001**

Satellites using sensors can allow the study of even the smallest changes in the ground surface over time. Thus volcanologists hope to be able to improve their eruption detection capabilities.

There are plans to establish the first-ever global volcano monitoring system. The launch of the Terra satellite by NASA (http://volcano2.pgd.hawaii.edu/eos) will allow scientists to be able to spot a volcano that is about to erupt. The satellite will scan the Earth every one or two days collecting information about the Earth's surface, with the objective of providing warnings when high temperatures, known as **thermal anomalies**, are produced by lava near the surface.

In other research, scientists are analysing weather satellite pictures in order to monitor about a hundred dangerous, remote volcanoes in Alaska and Russia, to indicate when they are likely to erupt. These volcanoes are a serious threat to local residents and to aircraft throughout the region. About 25,000 passengers and more than £700 million in cargo and equipment are moved in these areas each day.

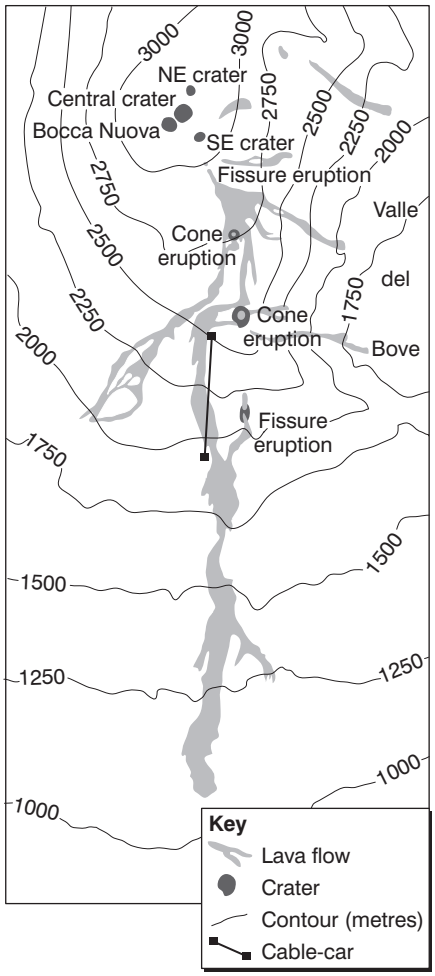

Figure 7: **Lava flows during the 2001 eruption**

Conclusions

Studies of Mount Etna's recent eruptions suggest that the volcano is becoming more explosive when compared with past events. Recent eruptions have produced lava that is more characteristic of explosive volcanoes. However, the origins and behaviour of Etna are hotly debated and there is no agreement on the source of the magma or reasons for the recent changes in eruption patterns.

It is not possible to predict when or even whether a big eruption might occur there. However, contrary to what might be expected, life for people living close to the volcano is essentially peaceful and pleasant. The area has a warm climate, extremely fertile soils and spectacular scenery.

Activities

1 What do the following terms mean?
i) fissure
ii) eruption
iii) Strombolian
iv) vent
v) crater
vi) lava

2 Research the types of location where volcanoes are found. Write an explanation for each of them.

3 Use the information provided in this unit to explain what is so unusual about the eccentric eruptions described in Figure 5.

4 (a) Use Figure 7 to measure the different lengths of each lava flow in the 2001 eruption of Mount Etna.
(b) Label those lava flows on the map that might be classed as **eccentric**.

5 (a) Use the reporter's notes provided in Figure 8, and the rest of this unit, to write a newspaper article about the Etna eruption.

Effect	Details
Negative effects	
Death	Lava can kill people, plants and animals, and falling ash can make it impossible for them to breathe. Some deaths from famine, fires, tidal waves and earthquakes can be related to volcanic eruption.
Damage	People lose their possessions as volcanoes can destroy houses, roads and fields. Lava ruins all objects in its path, including gardens, fields and houses. Ash covers a wide area.
Disruption	Traffic affected, including aircraft, road and rail. Affects economy and activities.
Weather	Can cause rain, thunder and lightning. Volcanoes can also have long-term effects on the climate, making the world cooler.
Economic	Loss of infrastructure and communications causes economic losses, and the costs of clearance and rebuilding are high.
Social	Loss of family, belongings and homes causes social distress. Many sick and elderly people may die due to the living conditions in the evacuation area. People separated from their families.
Positive effects	
Soil	Volcanic ash is very good for the soil, so plants grow quickly and strongly after a volcanic eruption.
Plants	The slopes left after an eruption are very steep, so rare and delicate plants and animals can establish themselves there and be protected.
Development	Volcanic disasters can be an opportunity for development organisations to challenge unjust political, social and economic systems.

Figure 9: **Some effects of volcanoes**

(b) Compare your article with those of others in your class.
(c) How could you have made your article seem more dramatic?
(d) Use the internet to search for articles about natural hazards (eruptions, floods, earthquakes). What messages are the journalists trying to convey?
(e) How have any photographs been used?
(f) Read your article again and make any changes to it that you think would improve it.

6 Use the information provided in Figure 9 and in the unit to explain why people are prepared to live in the shadow of Mount Etna despite the threats that it poses.

7 Research and write a case study of a volcano in another part of the world.
(a) How does it differ from Etna?
(b) What similarities are there?
(c) Try to find reasons for these similarities and differences.

January–April 2001 – slow lava flow from a vent on the SE crater cone.

May 2001 – more rapid lava emission from the vent and mild Strombolian activity at the SE crater vent.

June–July 2001 – a series of 15 eruptive episodes.

After days of tremors, Sicily's Mount Etna, the most active volcano in Europe, erupted. Lava spewed out of a new fissure in the volcano at a height of 2,100 m, forcing emergency services to build up defences against lava moving at 150 m an hour.

Mud walls erected to guide the direction of the lava flow, while fire-fighters sprayed the magma with water.

Lava has not yet threatened any homes, but one man needed hospital treatment after he was hit by a rock thrown out of the volcano.

Lava flows swallowed up a huge cabin that housed the snow ploughs. A tourist car park and several ski-lift pylons have disappeared.

The army made dams of earth and volcanic rock. Using heavy earth-moving equipment they try to block and divert lava flows in order to protect the tourist base. They seem to have diverted the flow and appear to be keeping it under control.

None of the towns on Etna's slopes has been damaged, but there have been huge losses in agriculture and tourism. The Italian Government pledged tax breaks for villagers to help get through the crisis and more than $8m (£5.6m) in immediate financial assistance.

Figure 8: **A reporter's notes on the Etna eruption**

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