Volcanoes in Italy

Southern Italy is an area of active volcanism adjacent to large population centers. It is also the home of some of the type localities for the Plinian (i.e., Vesuvius) , Strombolian, and Vulcanian styles of eruptions . The geologic setting for Italian volcanism is complex: a subduction zone exists where the North African plate is diving beneath the Eurasian plate to produce the "Calabrian Arc". There is also a spreading center within the Tyrrhenian Sea which is developing behind the Calabrian arc. Some of the volcanism (e.g., Stromboli and Vulcano) in the Aeolian Islands may be related to this rifting. The Vesuvius region lies at the intersection of the arc and the rift zone.

The volcanoes are compositionally complex - from basaltic at Stromboli and Etna to andesitic at Vulcano to rhyolitic in Lipari. Vesuvius erupts unusual potassium- (and water-) rich lavas called tephrites and leucitites. This is due to contamination/assimilation of primary basaltic magmas with various continental rocks. For example, lavas erupted from Vesuvius may contain xenoliths (i.e. foreign rock inclusions) of limestones; the mineral "vesuvianite" is a calcium-silicate mineral formed by metamorphism of limestone. Basaltic melts are produced at depth in the region from northern Sicily to the Bay of Naples. Active volcanoes include Etna, Stromboli, Volvano, Vesuvius, and Campo Phlegrea, the latter a caldera system about 30 km west.

Vesuvius

79 AD eruption of Vesuvius was the first volcanic event in history for which there is a detailed eyewitness account (Pliny the Younger). This turns out to be scientifically very important, because it has allowed volcanologists to place time constraints on various deposits of air fall, pyroclastic surge, and pumice flow deposits.

Vesuvius is a relatively new stratovolcano which occupies the site of an older volcano called Mt Somma: actually Vesuvius is nested within the caldera of Mt Somma, a configuration which may have resulted from a massive eruption about 17,000 years ago. The older caldera rim is especially high to the north and consequently lava and pyroclastic flows have not inundated the north side of Vesuvius in the past 17,000 years. Since then, Vesuvius has erupted in Plinian cycles with repose intervals of 400-4000 years.

The 79 AD eruption was the 5^{th} in Vesuvius' cylcle. As indicated by the radiocarbon-dated deposits, the eruption cycles have all been similar, beginning with pyroclastic fall deposits, followed by pyroclastic surges and flows, and ending with lava flows. Recently, volcanologists have measured the thicknesses of various tephra and flow layers from the 79 AD eruption in

various regions around Vesuvius. They subdivided the deposits into some 9 airfall tephra units and 6 pyroclastic surge/flow pair deposits.

But it is nearly impossible to establish absolute time relations from the deposits alone. Did these eruption cycle occur over hours, days, weeks, or months ?

A-1, the first air fall deposit does not have pumice, but only lithic fragments and is interpreted as a hydrovolcanic deposit. Assuming that surges were nearly instantaneous events and that pumice fall occurred at a more or less constant rate throughout the eruption, volcanologists can use Pliny the Elders observations to put absolute times on the various eruptive events. The historical account of the 79 AD eruption according to Pliny the Younger places absolute times on key events of the eruption.

August 24th:

7th hour (where in Roman clock, the first hour is sunrise, so this is 1 PM):

Pliny the younger notes the eruption column from his home in Misenum (across Bay of Naples). This is interpreted as A2, the "white pumice". For the next 12 hours, a 27 km-high (and later, with the "gray pumice", a 33 km high) eruption column was sustained. Heaviest fallout, controlled by winds, was to the south and east of Vesuvius (Pompeii region). Fallout in Pompeii region included fist-sized, killer lithic fragments at terminal velocities (50 m/sec) at a density (based on clast counts) of 70 fragments/minute/square meter).

3-4 PM: The fallout of pumice alone had roofs collapsing in Pompeii. The area was in total darkness from the fallout.

8 PM: Composition of pumice changes (to gray; A2) abd the eruption column height increases (as indicated by increasing size of grey relative to white pumice clast sizes in same localities).

August 25th

1 AM: S-1 sweeps into Herculaneum, at velocity great enough to transport building rubble 2 to 4 meters, at temperatures hot enough to carbonize dry, but not green wood. People are asphyxiated because respiration is impossible in the gas cloud.

Surges S2-S3 occurred during the night: S3 buried Herculaneum. S-4, at about 7:30 AM buried Pompeii, killing about 2000 people by asphyxiation:

these are the ones captured in plaster casts of hollows. S-5 followed minutes later.

S-6, at about 8 AM, was the “black cloud” which Pliny the Younger witnessed from Misenum. He and his mother fled the town for higher ground: the surge cloud apparently traveled across the bay to reach Misenum, but was cool by then. Pliny the Elder died from apparent asphyxiation during this event, at Stabiae.

This was the last major event. Minor, phreatic eruptions occurred afterwards for days or weeks.

When the eruption was finished, approximately 4 cubic kilometers of material had been erupted (not that much greater than St Helens, 1980).

Volcanologists believe that the eruption cycle began because a hydrovolcanic eruption (A1), produced a new conduit to the surface for a compositionally zoned magma chamber (3.5 cubic kilometers and at a depth of about 3 km). The magma began to rise due to density contrast with surrounding rocks, and then vesiculated at a depth of about 3 km. The transition from white to gray pumice was the transition from tapping of a magma with lower water content.

The most recent eruptive cycle of Vesuvius was between 1631-1944 (Vulcanian, Strombolian, lava flows). The longer the repose time (a few centuries ?), the more likely that the next eruption cycle will include events with high VEI. In the past several years, public debate has increased concerning evacuation plans for roughly 1 million residents of Naples area.