Etna Blows its Top!!

The 2002 Eruptions Observed from Space

Figure 1: (a) An overview of Sicily and the south-western tip of Italy, the dense plume of smoke and ash being emitted from Mount Etna being clearly visible. This space image (having a ground pixel of 1km) was acquired on 28th October 2002 by the ATSR-2 scanner mounted on-board the ERS-2 satellite. (Source: ESA)
(b) A rather higher-resolution space image of the plume (with a 250m ground pixel) taken on 28th October by the MODIS scanner mounted on the Aqua satellite. (Source: NASA)

Volcanic activity takes place continuously all over the Earth, but especially along the edges of its various tectonic plates, such as those located along the coastlines of the Pacific Ocean - the so-called 'Pacific Rim of Fire'. Since many of these active volcanos are located in remote areas such as Alaska, Kamchatka (Eastern Siberia), Papua New Guinea and the high mountain regions of the Andes (most recently in Colombia, Ecuador and Chile), increasingly space imagery is being used to monitor their activity and behaviour on a global scale. Closer to home in Europe, current volcanic activity is confined to a very few areas, most notably those that occur in Italy and Iceland. Although these European activities are monitored closely through ground observatories, still space imagery can be a very useful supplement to these observations.

By Prof. Gordon Petrie

Mount Etna's Eruptions

The 3,350m (11,000 ft.) high Mount Etna in Sicily is the largest and one of the most active volcanos in Europe. It lies on the interface between the African and Eurasian plates. Over the last few years, there has been strong volcanic activity on Mount Etna on an annual basis with earthquakes; explosions; fissures; crater and cone formation; lava flows; fire fountains; and abundant emissions of smoke, ash and gases. During July and August 2001, its eruptions caused dense ash clouds to be formed that could readily be seen on space images. After some low level activity earlier this year (2002), Mount Etna came fully back to life on October 26th/27th, starting with an earthquake having a measured magnitude of 4.4 on the Richter scale. This was followed immediately afterwards by a series of major eruptions that took place along a fissure that had formed on the north flank of the mountain. Another 3.8 magnitude earthquake took place next day (on 28th October) when another large fissure appeared on the south side of the mountain. The resulting lava flows traveled distances of up to 2km and came close to the towns of Linguaglossa and Piano Provenzana causing the precautionary evacuation of 1,000 people. Also numerous forest fires were started on the north side of

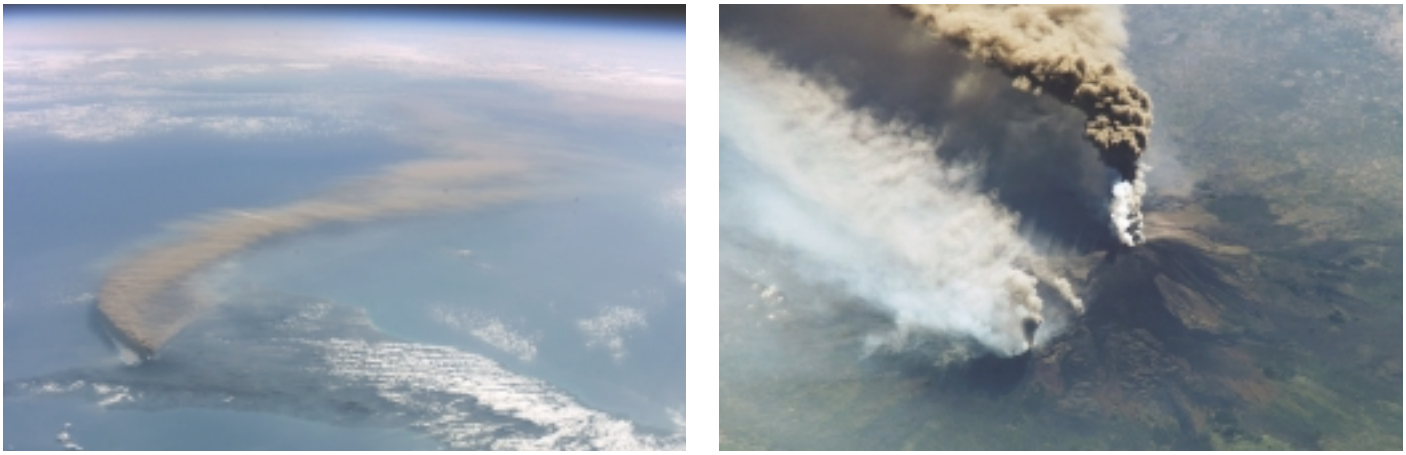

Figure 2: Photos of the eruption plume from Mount Etna taken by the crew of the International Space Station (ISS) and supplied by the Earth Sciences & Image Analysis Lab at NASA's Johnson Space Center. (a) This photo, taken on 30th October, shows the ash plume curving first to the south-east under the influence of the low-level winds and then turning southwards towards North Africa at higher altitudes. (b) This shot, taken closer to the mountain, shows not only the main (dark-coloured) plume, but also the lighter-coloured smoke being generated by the forest fires started by the molten lava flowing through the pine forests to the north of the main summit.

the mountain by the hot lava flowing into the surrounding pine forests. Since then, numerous small earthquakes have taken place. However, by mid-November, volcanic activity had decreased considerably - only for a thick river of molten lava to begin to threaten a tourist resort on the southern slopes of the mountain after a series of five earthquakes had shaken the region on November 25th.

Smoke, Ash & Gas Plume

The huge plume of smoke, ash and gas emitted by Mount Etna that resulted from its volcanic eruptions was transported southwards by the prevailing winds across Sicily towards the North African coast, causing ash to be deposited in Libya, 550km (350 miles) from Mount Etna. After November 1st, a wind shift caused the plume to be carried over Greece and into the Eastern Mediterranean. The tracking of the smoke and ash plume could readily be carried out using space images.

Lower-Resolution, Wider-Swath Space Images

Observations from space have offered a fascinating view of many of the differ-

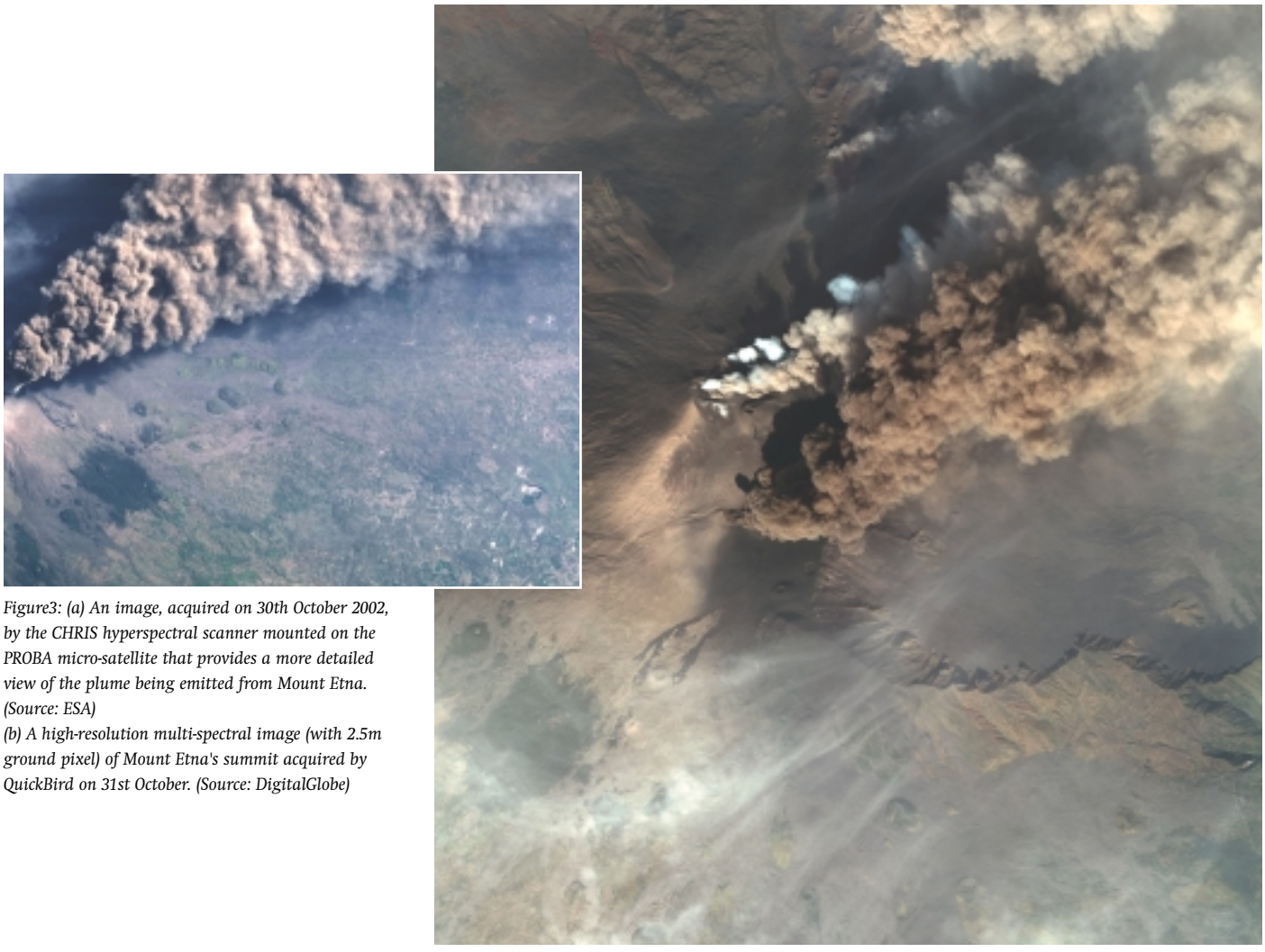

Figure3: (a) An image, acquired on 30th October 2002, by the CHRIS hyperspectral scanner mounted on the PROBA micro-satellite that provides a more detailed view of the plume being emitted from Mount Etna. (Source: ESA)
(b) A high-resolution multi-spectral image (with 2.5m ground pixel) of Mount Etna's summit acquired by QuickBird on 31st October. (Source: DigitalGlobe)

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ent aspects of Mount Etna's recent volcanic activity. Synoptic vertical overviews of the plume were provided by the low-resolution, wide-swath imagery produced by various imaging sensors such as MODIS (with its 250m ground pixel size) mounted on NASA's Terra and Aqua satellites and the ATSR/AATSR (with 1km ground pixel) and MERIS (with 300m ground pixel) scanners mounted on ESA's ERS-2 and Envisat satellites. These were supplemented by non-image data from the GOME instrument on ERS-2, the AIRS instrument on Aqua, and the Schiamachy instrument on Envisat, all of which showed that the levels of sulphur dioxide in the atmosphere were 20 times higher than normal in the area covered by the plume. In this particular regard, the sulphur dioxide that is present in the troposphere is known to be responsible, to a considerable extent, for the so-called "acid rain" phenomenon. Besides these vertical images produced from unmanned satellites, some spectacular oblique overviews were acquired by the crew (Expedition Five) on-board the International Space Station (ISS) using photographic cameras.

Higher-Resolution, Narrower-Swath Space Images

Turning next to higher resolution images, ESA's PROBA micro-satellite, equipped with its CHRIS hyperspectral scanner - which produces images with a 17m ground pixel size - gave a still more detailed picture of the dense smoke and ash plume being generated by the volcano and its relationship with the adjacent ground features. Finally a close-up of Mount Etna showing the main summit crater and the several smaller craters and side vents emitting steam as well as smoke and ash, together with the lava flows, was acquired by the QuickBird commercial satellite via an image having a ground pixel size of 2.5m that was generated by its multi-spectral scanner.

Additional Information on Volcanos

Readers wishing to gain additional information on volcanos can find this on the following Web sites:- (i) NASA's Earth Observatory - Natural Hazards - Volcanoes - http://earthobservatory.nasa.gov/NaturalHazards/natural_hazards_v2.php3?topic=volcano
(ii) Smithsonian Institution- Global Volcanism Program - http://rathburn.si.edu/gvp/
(iii) University of North Dakota - Volcano World - http://volcano.und.nodak.edu/
(iv) Michigan Technological University - Volcanoes Page - http://www.geo.mtu.edu/volcanoes/

Professor G. Petrie (g.petrie@geog.gla.ac.uk)
Department of Geography & Topographic Science, University of Glasgow, Glasgow, G12 8QQ, Scotland, U.K.
Web Pages - http://www.geog.gla.ac.uk/~gpetrie