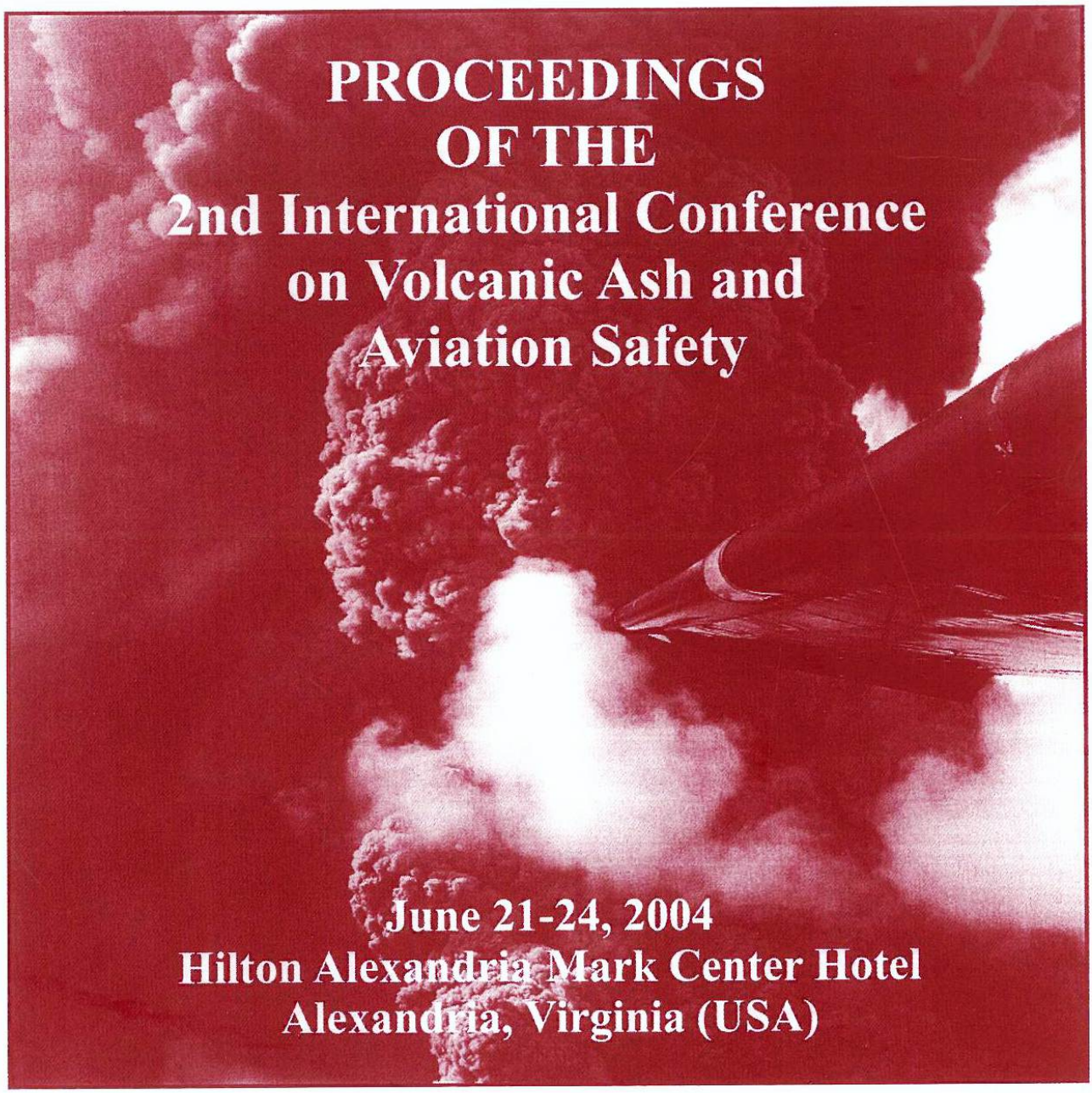
U.S. DEPARTMENT OF COMMERCE/ National Oceanic and Atmospheric Administration

OFCM

OFFICE OF THE FEDERAL COORDINATOR FOR
METEOROLOGICAL SERVICES AND SUPPORTING RESEARCH



PROCEEDINGS OF THE 2nd International Conference on Volcanic Ash and Aviation Safety

June 21-24, 2004
Hilton Alexandria Mark Center Hotel
Alexandria, Virginia (USA)

EXPLOSIVE ERUPTIONS OF ETNA VOLCANO SERIOUSLY THREATEN AVIATION SAFETY IN THE CENTRAL MEDITERRANEAN REGION

Mauro Coltelli and Paola Del Carlo

Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Piazza Roma 2, 95123, Catania, Italy

Etna is a basaltic volcano located in eastern Sicily (Italy). Although it is worldwide known for lava flow eruptions that often threat the populated areas on its slopes, in the last decades explosive eruptions represent its more frequent activity either at summit craters or along fissures opened on its flanks, making Etna volcano a serious source of risk for aviation in central Mediterranean region (Fig. 1).
The frequency of Etna's eruptive phenomena in the last four centuries has increased, and particularly the explosive eruptions since 70's years (Branca and Del Carlo, 2004a). From 1979, we surveyed a large number of violent explosive events (Fig. 2) produced by summit craters, including more than 150 lava fountain episodes, characterized by: i) eruptive columns from 2 to 15 km high above the vent, ii) tephra volumes ranging from 10^4 to 10^7 m^3 and iii) magnitude from violent strombolian to subplinian. They often produced tephra fallout over eastern Sicily and the city of Catania.

Fig. 1: 2001 eruption plume of Etna in the Mediterranean Sea (NOAA courtesy).

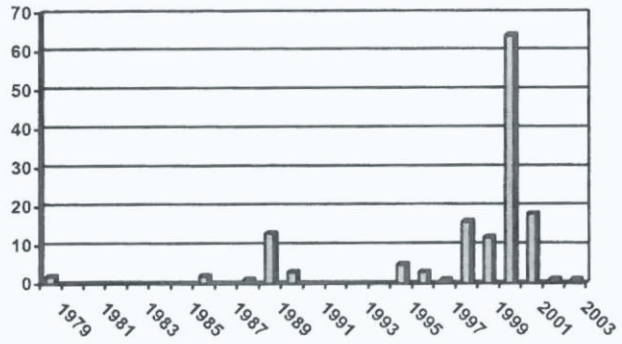


Fig. 2: Frequency of Etna's explosive eruptions occurred in the last 25 years.

At summit craters the prolonged explosive activity is generally weaker and produces limited dispersed tephra fallout, whereas violent strombolian and subplinian types episodes from summit craters are short-lived eruptions (from less than one hour to few hours) that produce widely dispersed deposits up to a few hundred km from the volcano. Due to the small volume of magma erupted they are not able to produce serious damages to the infrastructures also close to the volcano but they produce or induce several collateral damages mainly to the human health (lung ingestion of very small particles), to agriculture (lost of harvests), to the aviation (in-flight encounters with the drifting ash cloud and airport's runway contaminated with ash) and to the surface mobility (slippery roads due to a continuous ash mantle). These events are often repeated in a short time as in September 1989, when 14 episodes occurred during 16 days; in 1990 when other five episodes occurred; between November 1995 and June 1996 when ten strong fire fountain episodes were produced by North East Crater; during 1997 with other 14 episodes mainly from South East Crater; in 1998-9 when 4 episodes occurred, and finally the extraordinary activity

of 2000 when 64 episodes occurred during five months causing the first serious problems to the population of eastern Sicily for the damages to aviation, to agricultures, and to roads and villages around Etna covered by an ash-mantle and almost daily cleared.
During this period, the most relevant air accident occurred on April 2000 when a commercial airplane (Airbus 320) departing from Catania airport encountered Etna's ash cloud damaging cockpit windshields.
During the last flank eruptions, occurred in 2001 and 2002-03, an exceptional and prolonged explosive activity originated from vents opened on the upper slopes of Etna was observed for the first time in the last century (INGV Research Staff, 2001; Andronico et al., 2004). Lava fountaining activity formed an ash plume 1-3 km high above the 2800 m vent (Fig. 3), causing a continuous tephra fallout for almost two months during the 2002-03 eruption.

Fig. 3: 2002-03 eruption ash plume dispersed eastward from the 2800 m vent in the S slope of Etna (Photo UFVG-INGV Sezione di Catania).

Copious lapilli and ash covered the volcano slopes and fine particles reached Rome and central Italy, western cost of Greece at and the northern coast of Libya. Because the effects of this *unusual* flank activity have been very serious on both health and economy, particularly for the respiratory diseases widely reported, and for the frequent disruption of the flight operations at Catania and Reggio Calabria airports, the explosive activity of Etna has started to draw the attention of local administrators and national politicians (Fig. 4).

Fig. 4: 2002-03 eruption plume and ash fall on Catania airport (Photo UFVG-INGV Sezione di Catania).

The critical revision of the historical reports from the last four centuries (Branca and Del Carlo, 2004b) shows that eruptions characterised by long-lasting explosive activity, such as the 2001 and 2002-03, are not so unusual. The report by abbot Recupero (1985) describes a copious tephra fallout of 4 kg per square meter in Catania in about ten days during the La Montagnola eruption in 1763, whereas during the 2002-03 eruption, we measured 2.5 kg per square meter in two days. In the 19th century, the occurrence of this type of eruption is more frequent. Eruptions occurred in 1811, 1852, 1886 and 1892 caused abundant ash fallout in the distal areas of the volcano. Therefore, the eruptive behaviour of Etna during the 2001 and 2002-03 eruptions is not a frequent phenomenon, yet at the same time it does not represent any anomaly in the eruptive history over the past centuries.
The thick volcaniclastic successions, that blanket the eastern slope of the Etna edifice, record a history of important explosive activity in Late Pleistocene and Holocene times characterised by plinian, phreatoplinian and subplinian central eruptions and violent strombolian lateral eruptions (Coltelli et al., 1998; 2000; Del Carlo et al., 2004).
The discovery of these explosive eruptions raises important issues for hazard assessment of basaltic volcanoes in almost persistent activity such as Etna, indicating that even a volcano, commonly considered non-hazardous for humans, can become very dangerous for aviation safety.
In summary, Etna's explosive eruptions observed and quantitatively described, historically reported and stratigraphically

studied, represent a severe threat for aviation and economy of Sicily.

INGV staff in Catania, is in charged of the monitoring of the eruptive activity of Sicilian volcanoes, in response to this source of hazard, up to a few years ago completely ignored. It worked with Catania International Airport Direction, Italian Agency for Civil Aviation (ENAC), Meteorological Office of Italian Air Force and Italian National Civil Protection for warnings continuously the aviation authorities about the incidence of ash clouds on Sicilian airspace and the ash fallout on Catania airport depending on the intensity of the eruptive plume and the wind direction. With this aim, INGV is organizing an articulate strategy for studying in depth these eruptions, for setting an instrumental network to observe ash-cloud formation and developing, and finally for forecasting by mean of simulating computer models the ash dispersion in atmosphere and its fallout on the ground.

The lesson learned during the 2001 and 2002-03 crises was used to improve our volcanic ash cloud monitoring system, and transferred to ENAC for editing an official procedure for air-traffic and airport operations management in case of future crises at Etna, and in any case, to have a broad applicability worldwide.

References

Andronico D, Branca S, Calvari S, Burton MR, Caltabiano T, Corsaro RA, Del Carlo P, Garfi G, Lodato L, Miraglia L, Muré F, Neri M, Pecora E, Pompilio M, Salerno G, Spampinato L (2004) A multi-disciplinary study of the 2002-03 Etna eruption: insights for a complex plumbing system. Bull Volcanol, DOI: 10.1007/s00445-004-0372-8

Branca S, Del Carlo P (2004a) Eruptions of Mt Etna during the past 3,200 Years: a revised compilation integrating the historical and stratigraphic records. In: Bonaccorso A, Calvari S, Coltelli M, Del Negro C, Falsaperla S (eds) Mt Etna Volcano Laboratory. AGU Geophysical monograph series 143, 1-27

Branca S, Del Carlo P (2004b) Types of eruptions of Etna Volcano AD 1670-2003: Implications for short-term eruptive behavior. Bull. Volcanol., in press

Coltelli M, Del Carlo P, Vezzoli L (1998) The discovery of a Plinian basaltic eruption of Roman age at Etna volcano (Italy). Geology, 26:1095-1098

Coltelli M, Del Carlo P, Vezzoli L (2000) Stratigraphic constrains for explosive activity for the past 100 ka at Etna volcano, Italy. Int. J. Earth Sciences, 89:665-677

Del Carlo P, Vezzoli L, Coltelli M (2004) Last 100 ka tephrostratigraphic record of Mount Etna. In: Bonaccorso A, Calvari S, Coltelli M, Del Negro C, Falsaperla S (eds) Mt Etna: Volcano Laboratory. AGU Geophysical monograph series 143, 77-89

INGV Research Staff Sezione di Catania (2001) Multidisciplinary Approach Yields Insight into Mt Etna 2001 Eruption. EOS Transactions, American Geophysical Union 82:653-656

Recupero G (1815) Storia naturale e generale dell'Etna. Ed. Dafni, Tringali Editore, Catania, 1970