COMMENT AND REPLY

Comment on

Some considerations on the state of Vesuvius in the Middle Ages and the precursors of the 1631 eruption

Antonio Nazzaro
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Introduction

Among the many eruptions of Vesuvius, the A.D. 1631 event has become one of the most controversial. In fact, for over a century volcanologists unanimously agreed upon the A.D. 1631 eruption as being characterised by an important effusive phase (*e.g.*, Le Hon, 1865; Johnston Lavis, 1884; Burri and Di Girolamo, 1975). However, recently two contradictory assessments of the A.D. 1631 eruption characteristics were compared. One re-states that this eruption was characterised by discharges of lava flows (*e.g.*, Rolandi, 1991; Rolandi and Russo, 1987, 1989), whereas the other denies such a possibility (*e.g.*, Rosi and Santacroce, 1984, 1986; Arnò *et al.*, 1987; Santacroce, 1987), suggesting that lava associated with the A.D. 1631 were much older and were associated with A.D. 968-1037 activity (Santacroce, 1987). This conclusion is shared by Nazzaro (1998) who says: «... the lava flows previously considered to be erupted during this eruption [*i.e.* A.D. 1631] ... were actually ejected during Middle Ages». However, such a general statement is not supported by results of extensive comparative palaeomagnetic investigations on Ischia, Etna and Vesuvius lava flows, carried out since the early nineties.

As is known, lavas acquiring TRM (Thermal Remanent Magnetisation) during cooling below Curie temperatures of their magnetic minerals, record the direction of the EMF (Earth Magnetic Field). It is also known that the EMF changes in time causing lavas emplaced at different times to record different directions of the EMF. Therefore the study of TRM should allow correlation and discrimination among lava flows and if the SVC (Secular Variation Curve) is available relative or absolute magnetic dating becomes possible.

Recently, a procedure involving stringent criteria for definition of magnetisation components has been devised (Gialanella *et al.*, 1993) making palaeomagnetic studies likely to improve the knowledge of the past history of a volcano significantly. The effectiveness of this new procedure has been discussed by Angelino *et al.* (1996) and Incoronato (1996) with reference to previous palaeomagnetic works (references therein) carried out at Etna and Vesuvius.

Results

Palaeomagnetic investigations of 12 lava flows (location in fig. 1; Incoronato, 1996) spread between Torre Annunziata and Portici, showed that except for two sites, the magnetizations of which were mostly unstable, the mean directions of magnetisation exhibited two distinct patterns.

The mean direction of magnetisations of five sites were statistically identical to each other, clustered between the site mean direction; dec = 13.4; inc = 63.8; α_{95} = 0.9; k = 7703 (table 1; Incoronato, 1996), and, therefore, clearly indicating that they had acquired their remanence when the geomagnetic field was in an identical position, *i.e.* they are coeval.

The mean directions of magnetisation of three successive lavas from the Villa Inglese Quarry were clearly different from both the previous one and from one another (dec = 22.1; inc = 58.8; α_{95} = 1.9; k = 1049, - dec = 19.3; inc = 61.3; α_{95} = 2.2; k = 1063, - dec = 22.2; inc = 64.8; α_{95} = 1.8; k = 1359) (table 1, Incoronato, 1996). The site mean directions of magnetisation of the remaining two sites were similar, in one case, and statistically identical, in the other, to those of the Villa Inglese quarry sites (table 1; Incoronato, 1996). All these last five sites depicted a new segment of the Vesuvius SVC, the time variation of which was dictated by the stratigraphic position of the Villa Inglese quarry sites. In addition, this new segment of the Vesuvius SVC, when relocated to Etna, via the Pole method (Noel and Batt, 1990), almost overlapped the new Etna SVC around A.D. 1000 (fig. 3; Angelino *et al.*, 1996) resulting from paleomagnetic re-investigation following the stringent procedure mentioned earlier, Etna lava flows already ascribed to activity occurred around A.D. 1000 (Tanguy *et al.*, 1985).

Conclusions

Results from extensive comparative palaeomagnetic work carried out in recent years on disputed lava flows at Vesuvius show that only in two cases can these lava flows be undisputedly associated with activity that occurred a few hundred years before A.D. 1631, *i.e.* around A.D. 1000. The remaining lava flows exhibit a between site mean direction of magnetisation that conflict with such dating. This is also supported by recent paleomagnetic investigations (Sauna, 1997; Vanacore, 1998) of Etna lava flows, following the stringent procedure mentioned earlier, showing that the between site mean direction of these five sites, when relocated to Etna via the Pole method, fall on the new Etna SVC between A.D. 1537 and A.D. 1646. Work in progress on Etna lava flows is helping to narrow such a time window as far as the oldest threshold is concerned that can be placed at A.D. 1595 (Angelino *et al.*, 1999).

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Reply to comment

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With regard to the comment of Prof. A. Incoronato, I would briefly like to remark that A. Incoronato thinks that the Vesuvius lava sampled in the 1-2-8 southern sites and 10-12 western sites (fig. 1, Incoronato, 1996) were erupted during the 1631 eruption, whereas I believe that this lava flow was emitted from 1694 up to 1724 when many poorly-known Vesuvius eruptions occurred (Nazzaro, 1997).

In fact, a critical review of the historical sources regarding the Vesuvius eruptions, both from the philological, rhetorical and volcanological point of view, enabled me to develop and verify the belief that during the 1631 eruption no lava flow was outpoured (Nazzaro, 1989, 1995, 1996, 1997). Also, from a geological-stratigraphic point of view I would like to recall the authoritative CNR Monograph (Santacroce, 1987) which shares the same opinion.

I think therefore that the Vesuvius lava sampled by A. Incoronato are about 60-80 years older than the 1631 eruption because of statistical errors intrinsic to the paleomagnetic method.

On this topic I would like to recall that a few years ago similar techniques of paleomagnetic correlations led different researches to opposite conclusions to those of A. Incoronato (Carracedo, 1993).

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