

Steady-state magma discharge at Etna 1971–81

ESTIMATIONS by Wadge and Guest¹ of the volumes of lava emitted by each individual eruption of Mount Etna between 1971 and 1981, should be viewed with caution^{2,3}. Despite the impressive number of references (see Table 1 in ref. 1), very few of them contain accurate determinations of the volumes of lava erupted, that is: measurements of the surface covered by each lava flow and a sufficient number of determinations of the thickness. Regarding this latter point, it is symptomatic that all but one (J. B. Murray) of the authors to whom reference is made fail to mention any thickness determination, so that the volumes quoted are in most cases highly speculative: they are not measurements in a scientific sense⁴.

Let us now examine specific points:

- 5 April–12 June 1971: since the error bar of the volume estimate of this flank eruption is unknown, there is no means of inferring that the accuracy is 'probably' better than 50%. For another flank eruption (1950–51), calculations by J. B. Murray (personal communication) from the 1932 and 1969 IGM maps lead to a value of $116 \times 10^6 \text{ m}^3$ ($\pm 10\%$), instead of $55 \times 10^6 \text{ m}^3$ as 'estimated' by Wadge².
- June–September 1971/October 1973: no lava effusion occurred during this period. It is difficult to imagine the meaning of the $17 \times 10^6 \text{ m}^3$ listed. If it represents the filling of the Central Crater Chasm, it must be pointed out that the dimensions of its interior were not known³.
- Eruptions from the NE Crater and the northern flank, 1974–76: except for the small area ($800 \times 500 \text{ m}$) around the NE Cone^{5,6} and for a small part of the lava field (very approximate sketch in ref. 7), there is no map of the erupted products. How, therefore, can their volume be calculated?
- Eruptions from the NE Crater, 1977–78: we have a succession of 17 eruptions, most of which occurred at intervals of a few days in a zone of the volcano which is almost inaccessible during the winter. Not only is there no available map, but the exact location of many flows is not even known. Similar observations can be made for the 1980–81 eruptions of the same NE Crater: the authors to whom reference is made¹ indicate only the approximate length of the lava flows.
- Flank eruptions, 1978–79: none of these flows has been mapped so far. The sketch shown by Mackey and Scott⁸ only represents a small part of the flow corresponding to the less important of the four eruptions.
- March 1981 flank eruption: this is the only case where a detailed map has been

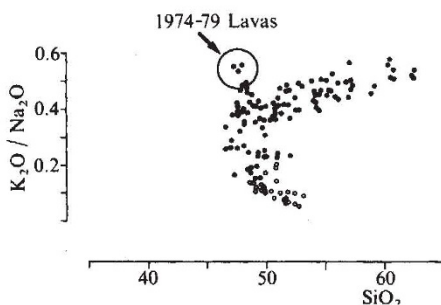


Fig. 1 Composition of the 1974–79 lavas compared with that of all the products of Mt Etna ($\text{K}_2\text{O}/\text{Na}_2\text{O}$ versus SiO_2). ○, Pre-ethnean tholeiitic basalts; ●, alkaline lavas from the strato-volcano of Etna itself, including historic flows (from ref. 4).

made⁹ and a volume actually measured. It represents less than 10% of the total volume taken into account by Wadge and Guest¹ during the period 1971–81.

Therefore, I consider the conclusions drawn by Wadge and Guest to be unfounded, unless they can display a precise topographic map for each of the 35 eruptions listed in their Table 1. Although a steady-state magma discharge appears obvious to many observers for some periods of Mount Etna's 'persistent activity', it cannot be quantified with such speculative estimates. The observations by Italian, British and French researchers only permit the definition of an order of magnitude and we must await extensive topographic work to know with a sufficient degree of accuracy the volume of lava erupted in the decade 1971–81.

Finally, it is incorrect to emphasize the chemical homogeneity of recent lavas of Etna. Since 1974, a significant change in the composition of the products has occurred, with an evolution towards a more potassic character (see Fig. 1)⁴. Added to the exceptional frequency of the eruptions in recent times, this observation seems to indicate a new magma supply from a deep source and does not allow us to guess the future behaviour of Mount Etna.

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WADGE AND GUEST REPLY—Tanguy argues that our interpretation of magma discharge at Etna during 1971–81 is invalid because our estimates of lava volumes are too imprecise. His principal argument is that detailed maps and measured lava thicknesses are not available in most of the references quoted by us. We would point out, however, that our volume estimates are not based on information from these references alone, and that one of us has visited the volcano on average twice a year during the past decade and wherever possible has mapped the areal extent of new lavas and made thickness measurements. These data were used in our calculation of lava volumes and indeed are in part the basis of our study.

Thus, although Tanguy states that the 1981 eruption is the only one where detailed mapping and thickness measurements were made (by one of us and other UK workers), similar measurements were made on flows from other major eruptions. Where we were not able to obtain such data, especially for short-lived NE Crater eruptions, we have relied on eyewitness reports of others, for example R. Romano (personal communication) for the July 1977 eruption and C. R. J. Kilburn (personal communication) for the September 1980 eruption. The eruptions mentioned for June and September 1971 and October 1973 were indeed eruptions on the floor of the Chasm and the Bocca Nuova. Both these eruptions occurred when the internal dimensions of these two pits in the central crater were known from visual observations and range-finder measurements. Our original letter was an inappropriate place to justify each estimated volume.

Tanguy appears to accept our model of a steady state magma discharge but rejects our volumetric data as 'speculative estimates'. However, he does not present any new data that demonstrate our estimates to be less precise than stated in our letter, and indeed the only quantitative data given by him are for an eruption that occurred in 1950–51 which is outside the period of our study.

With regard to Tanguy's comments on lava chemistry, each of the erupted lavas was hawaiitic in common with most historical lavas; but as we pointed out, there were limited variations in composition. Some of these occurred within single eruptions including those of 1971¹ and 1981 (S. Scott, personal communication) when chemically zoned magma-filled fissures may have developed during short repose periods before eruption. Other small variations in chemistry between one set of eruptions and another have been observed during the last decade and may identify individual batches of magma with different chemical signatures (S. Scott,