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Supplemental Material

Figure S1. Thermomagnetic curves for selected specimens from the studied lava flows.

Figure S2. (A, B, C, D) Hysteresis loops for four representative samples and (E) hysteresis ratios for one sample per site plotted on a Day et al. (1977) diagram modified by Dunlop (2002a, 2002b).

Figure S3. Representative photographs of thin sections (cross-polarized light) from the ETN24 and ETN25 sites of the Barriera del Bosco lava flow. (A,B,C) ETN24 rock sections, representing a porphyritic texture with predominant plagioclase (Pl) phenocrysts. (D,E,F) ETN25 thin sections, showing a porphyritic texture and plagioclase (Pl), clinopyroxenes (Cpx) and olivine (Ol) phenocrysts.

Table S1. Bulk rock major and selected trace elements composition for samples of Larmisi and San Giovanni Galermo lava flows (analyses by Corsaro and Cristofolini, 1993)

S4. Watson Test

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BARRIERA DEL BOSCO FLOW

BARRIERA DEL BOSCO FLOW

SAN GIOVANNI GALERMO FLOW

SAN GIOVANNI GALERMO FLOW

LARMISI FLOW

LARMISI FLOW

BARRIERA DEL BOSCO FLOW

ETN24 site

ETN25 site

**TABLE S1. BULK ROCK MAJOR AND SELECTED TRACE ELEMENTS COMPOSITION
FOR SAMPLES OF LARMISI AND SAN GIOVANNI GALERMO LAVA FLOWS (ANALYSES
BY CORSARO AND CRISTOFOLINI, 1993)**

Sample Lava flow	RH1 San Giovanni Galermo	RH3 San Giovanni Galermo	RI10 Larmisi	RI11 Larmisi
Major elements (wt%)				
SO ₂	49.92	50.18	50.07	49.96
TiO ₂	1.45	1.28	1.4	1.36
Al ₂ O ₃	18.5	18.9	18.6	18.72
Fe ₂ O ₃	3.73	3.65	2.09	2.25
FeO	4.8	4.23	6.02	5.8
MnO	0.16	0.16	0.17	0.16
MgO	5.34	5.45	5.45	5.56
CaO	8.9	8.63	8.65	8.69
Na ₂ O	4.46	4.58	4.71	4.56
K ₂ O	1.64	1.7	1.69	1.68
P ₂ O ₅	0.61	0.68	0.67	0.66
H ₂ O-*	0.15	0.1	0.15	0.14
L.O.I.†	0.34	0.47	0.33	0.47
Total	100	100.01	100	100.01
Trace elements (ppm)				
Rb				28
Cs				0.8
Sr				1175
Ba				768
Ta				1.9
Th				9.2
U				2.6
Zr				237
Hf				3.9
La				63
Ce				110
Nd				44
Sm				7.5
Eu				2.4
Tb				0.8
Yb				1.6
Lu				0.24
Y				26
Ni				30
Cr				50
Sc				19
V				290
Co				30
Cu				140
<i>Note: (*) Imbibition water; (†) Loss On Ignition.</i>				

Supplemental Material S4

Watson Test

Theory:

As described in Tauxe et al. (2018), the Watson test (Watson, 1983) is considered statistically more reliable than the most common and used F test (Watson, 1956). The Watson test consists of the analysis of the statistic value V_w , calculated for the data sets, and its comparison with a V critical value (V_{crit}), determined with the Monte-Carlo simulation. The greater difference between the mean directions of the two data sets, the greater the V_w value. Therefore, if two data sets share a common mean direction, the V_w value will be smaller than the V_{crit} .

The calculations for the V_w are the following:

- ❖ considering two datasets with N_1, N_2 samples, calculate R_i and k_i , where $i = 1, 2$:

R is given by:

$$R^2 = \left(\sum_i x_{1i} \right)^2 + \left(\sum_i x_{2i} \right)^2 + \left(\sum_i x_{3i} \right)^2$$

k is given by:

$$\kappa \simeq k = \frac{N-1}{N-R}$$

- ❖ Calculate $\underline{x}_{ij}$ (where $j = 1, 2, 3$ for the three axes) according to:

$$\underline{x}_1 = \frac{1}{R} \left(\sum_i x_{1i} \right); \quad \underline{x}_2 = \frac{1}{R} \left(\sum_i x_{2i} \right); \quad \underline{x}_3 = \frac{1}{R} \left(\sum_i x_{3i} \right);$$

- ❖ Calculate:

$$X_{ij} = R_i x_{ij}$$

- ❖ Calculate the weighted means for the two data sets, according to:

$$\hat{x}_j = \sum_i^2 k_i \underline{x}_{ij}$$

- ❖ Calculate the weighted overall resultant vector R_w by:

$$R_w = (\hat{x}_1^2 + \hat{x}_2^2 + \hat{x}_3^2)^{\frac{1}{2}}$$

- ❖ Calculate the weighted sum S_w by:

$$S_w = \sum_i^2 k_i R_i$$

- ❖ Watson's V_w is defined as:

$$V_w = 2(S_w + R_w)$$

To calculate the V_{crit} , simulations are carried out: two Fisher distributed data sets, with dispersions of k_1 and k_2 and N_1 , N_2 , but having a common true direction, are considered; then, the V_w is calculated for the simulated data sets. The simulation must be repeated for a large number of times (1000 at least). Then, the V_{ws} must be sorted in order of increasing size, and the critical value at the 95% level of confidence is the 950th simulated V_w . Finally, the V_w and V_{crit} have to be compared: if V_w exceeds the V_{crit} , the null hypothesis can be rejected and, consequently, the two data sets do not share a common mean direction.

Calculations:

For this work, the PmagPy function “watson_v”, developed by Tauxe et al. (2016), has been used. PmagPy is a software package for analysing paleomagnetic and rock magnetic data using Python (more information about the program can be found here https://earthref.org/PmagPy/cookbook/#next_steps). In this function, the k , n , D and I values for each data set can be inserted; the function is set with 5000 simulations. Results of the Watson test can be read as text and visualized in a graph.

Results:

In figure, the result of the Watson test for Larmisi and Galermo lava flows is presented. The red line represents the distribution of V_w for simulated Fisher distributions. The blue dashed line represents the V_{crit} , while the green vertical line is the V_w calculated for the two data sets. In this case, the V_w value (5.5) is younger than the V_{crit} (6.2) value; therefore, the data sets passed the test, and the two distributions could have been drawn from a common mean.