SUPPLEMENTARY DATA

- **Drone Survey**

A drone survey was conducted at 30 m above Castel rock using a DJI Phantom 4 Pro (sensor CMOS 1" 20 Mpx; https://www.dji.com/it?from=site-nav); in 2022. We collected 123 images, processed with Agisoft Metashape, to obtain an orthomosaic and a digital elevation model of 1.8 and 7.4 cm resolution, respectively (www.metashapeitalia.it). Agisoft Metashape Pro® software package (version 2.1.1) based on the Structure-from-Motion and multi-view stereo photogrammetry algorithm (Tibaldi et al., 2025). We also conducted a survey in June 2025 to obtain higher-resolution images of the southern wall of the cliff. We used a DJI Mavic 3 E (sensor: 4/3 CMOS, 20 MP) equipped with a Real Time Kinematic (RTK) module.

- **Paleomagnetic analysis**

Paleomagnetic analyses were conducted at the CIMaN-ALP laboratory in Peveragno (Cuneo – Italy).

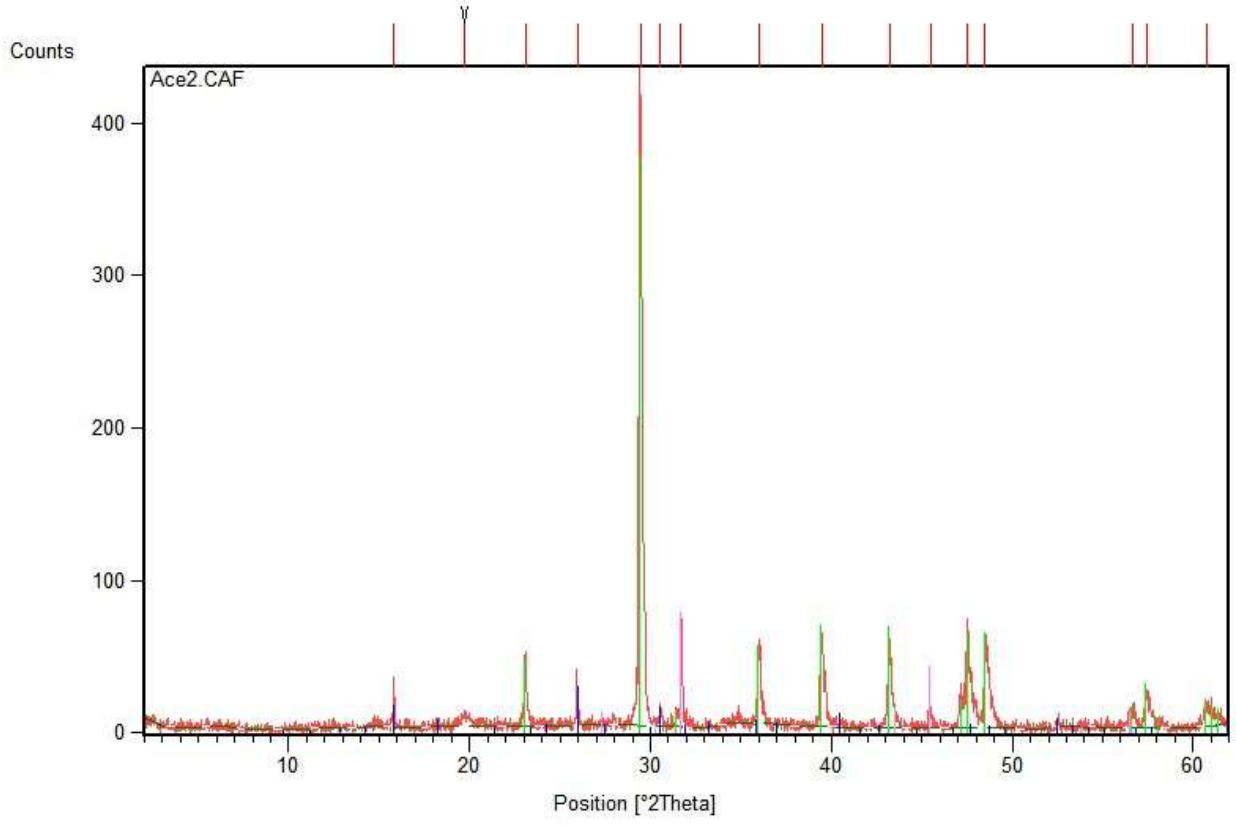
- **Sample location**

All the samples have been collected at the Aci Castello Cliff (coordinate WGS84 37.554034, 15.149555).

- **XRD analysis and detailed results**

XRPD – PANalytical X'Pert PRO PW 3040/60 diffractometer in θ-θ Bragg-Brentano parafocusing geometry with Ni-filtered Cu Kα radiation at 40 kV and 40 mA, in the 2–62° 2θ range.

<u>Marly soft clast sample</u>



Hyaloclastite sample