

1) Research title:

Constraining climate during the Last Local Glacial Maximum in the Apennines

2) Researchers:

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3) Institution:

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4) Research description:

The Apennines, with their extensive latitudinal range, are a key region for understanding palaeoclimate dynamics in the central Mediterranean during the Last Local Glacial Maximum (LLGM). Despite the significance of the Apennine range, major gaps remain in the extent and chronology of the glaciers during the LLGM. A major challenge is the prevalence of carbonate lithologies, limiting straightforward application of some conventional dating techniques (^{10}Be) and introducing uncertainties related to high erosion rates. As a result, most moraines remain undated or poorly chronologically constrained. This project will investigate LLGM moraines across multiple sectors of the mountain range using independent mapping and multiple potential dating techniques ($^{10}\text{Be}/^{26}\text{Al}$ and ^{36}Cl exposure dating of moraine boulders, identification of (crypto)tephra layers and radiocarbon dating).

Based on these data, palaeoglacier geometries will be reconstructed and palaeo-Equilibrium Line Altitudes (ELAs) will be calculated. The empirical results will be then converted into palaeoprecipitation estimates that combined with regional climate model outputs will help gain better understanding of the palaeoclimate, timing of solid precipitation and atmospheric circulation during LLGM.

5) Research objectives:

1. Geomorphological mapping of glacial landforms (frontal and/or lateral moraines) indicative of the LLGM glacier extents across Northern, Central and Southern Apennines.
2. Establish robust glacial chronologies: using cosmogenic nuclide (boulders/bedrock), organics (lakes, bogs) and tephrochronology (moraines, lakes, bogs) to provide independent, hence more robust, age constraints and establish robust glacial chronology and reconstruct spatial extent of the LLGM glaciation.
3. Based on these new empirical data together with already published data, 3D palaeoglacier geometries will be reconstructed (Pellitero et al., 2016) and topographical palaeo-ELAs will be calculated (Pellitero et al., 2015; Oien et al., 2021).

4. The reconstructed ELAs will be combined with independent temperature proxy records to derive quantitative palaeoprecipitation estimates (Rea et al., 2020; Ohmura et al., 1992, Golledge et al., 2010; Ohmura and Boettcher, 2018) and reveal local to regional palaeoprecipitation patterns.
5. The outputs from the empirical reconstructions will be analysed in conjunction with regional climate models (Del Gobbo et al., 2023), to assess the atmospheric circulation patterns and precipitation seasonality in central Mediterranean during LLGM.

The outcomes of this project will form a core component of my PhD research and will contribute to a publication planned before my PhD submission in 2029.

6) Study area:

Sibillini National Park

- Ussita valley: left half of a frontal moraine, supposed to be somewhere between 1340-1450. There are several possible ridges that could represent the moraine and that need to be examined in the field.
- Val di Panico cirques – several moraine deposits
- Tenna valley – convergence of two lateral ridges
- Vallelunga – several moraine deposits in Vallelunga
- Ambro valley – left bank lateral moraine at ca 1245 m asl

Based on field examination of these localities, the best-preserved moraine/s will be selected for the sampling of suitable boulders for cosmogenic nuclide dating.

7) Fieldwork:

The fieldwork in September 2026 focuses on sampling moraine boulders for cosmogenic nuclide dating at multiple locations across the Apennines including the area of National Park Sibillini.

Field activities will consist of walking to the moraines sites, ground thruthing of moraine deposits, identification and documentation of boulders suitable for sampling, GPS positioning, photographic documentation, and collection of small rock samples from selected moraine boulders using hammer and chisel.

The samples for the cosmogenic nuclide analysis will be sent to an international collaborating laboratory ANSTO in Australia.

8) Number and approximate size of samples:

Sampling: Following a standard procedure, with sample consisting of approximately 0.5-1 kg of rock material (size of a fist), collected from the surface of selected moraine boulders using chisel and hammer.

9) Environmental impact:

No complete boulders or large rock blocks will be removed; only the uppermost few centimetres will be taken from selected boulders. The sampling will be limited to already exposed boulders and will not involve excavation, ground disturbance, removal of vegetation, or modification of the surrounding terrain. Manual methods (hammer and chisel) will be used for the sampling avoiding any risk of noise pollution. Access to the sampling locations will be on foot.

10) Dates of fieldwork:

16.-17. 09. 2026