Tephrostratigraphy and tephrochronology of a 430 ka sediment record from the Fucino Basin, central Italy

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The Fucino Basin is the largest and probably the only Central Apennine basin hosting a thick, continuous lacustrine sediment succession documenting the environmental history from the Early Pleistocene to recent historical times. The basin is located downwind of the Italian volcanic districts (< 150 km), which makes it the best candidate available in the central Mediterranean to construct a long and continuous tephrostratigraphic and tephrochronological record. Tephrostratigraphic investigations conducted on a first core (F1-F3) revealed 21 tephra layers of different Italian volcanoes. Among them several widespread and well-dated key Mediterranean marker tephra layers (e.g., Neapolitan Yellow Tuff, Y-1, Campanian Ignimbrite, Y-7, X-5, X-6, and Taurano Ignimbrite) were recognized and allowed to date, together with ⁴⁰Ar/³⁹Ar ages directly obtained from the Fucino tephra layers, the record back to 190 ka.

Based on these promising results, a new drilling site with a lower sedimentation rate was targeted, bringing forth the ~98 m long F4-F5 record. In addition to the already recognised tephra layers occurring in the section that overlaps with core F1-F3, ~110 additional tephra and cryptotephra horizons were identified in the composite sediment succession of the F4-F5 record, providing new insights into the Italian volcanic history for the poorly explored interval beyond 200 ka.

Here we present the first tephrostratigraphic and tephrochronological results for this interval, which is dominated by eruptions from the Sabatini, Vulsini, Vico, and Colli Albani volcanoes. Several important known eruptions were identified and dated for the first time in distal settings: e.g., Canino (256.8 ± 1.1 ka), Tufo Giallo di Sacrofano (288.0 ± 2.0 ka), Magliano Romano Plinian Fall (315.0 ± 2.0 ka), Orvieto-Bagnoregio Ignimbrite (335.8 ± 1.4 ka), Villa Senni (367.5 ± 1.6 ka), Pozzolane Nere and its precursor (408.5 ± 1.3 ka, and 407.1 ± 4.2 ka, respectively). Finally, a tephra
located at the base of the succession was directly dated by $^{40}\text{Ar}/^{39}\text{Ar}$ at 424.3 ± 3.2 ka, thus extending the record back to the MIS 12/11 transition (~430 ka).

Ongoing geochemical analysis, including trace elements, Sr and Nd isotopes, and $^{40}\text{Ar}/^{39}\text{Ar}$ dating of both Fucino tephra layers and potential proximal counterparts will help to reveal their volcanic sources and enable further tephrostratigraphic correlations supported by independent age determinations. These results will contribute towards an improved MIS 11-MIS 7 Mediterranean tephrostratigraphy, which is still poorly characterized and exploited.

The recognition and dating of the numerous tephra layers from the F4-F5 record can be directly combined to construct a comprehensive age-depth series of biogeochemical proxies and geomagnetic excursions derived from the lacustrine sediments, forming the backbone for an independent, radioisotopically anchored chronology for the F4-F5 multi-proxy record. Through paleoclimatic alignments and geomagnetic excursion synchronizations, the independent Fucino chronology can be propagated to the North Atlantic records, and possibly on a global scale, setting the framework for a better understanding of the spatio-temporal variability, magnitude, and different expressions of Quaternary orbital and millennial-scale paleoclimatic changes.