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

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Aims

- to establish a master record for Mediterranean tephrostratigraphy by detailed geochemical characterisation and direct $^{40}Ar/^{39}Ar$ dating
- to prove undisturbed and continuous sedimentation in the Fucino Basin after the Mid-Brunhes event and to provide detailed chronological information on the timing and duration of climatic and paleomagnetic events
- to improve the knowledge of the eruptive activity, the recurrence, and geodynamic evolution of the volcanic districts of southern and central Italy during the last 430 ka
- to establish an ICDP drilling campaign

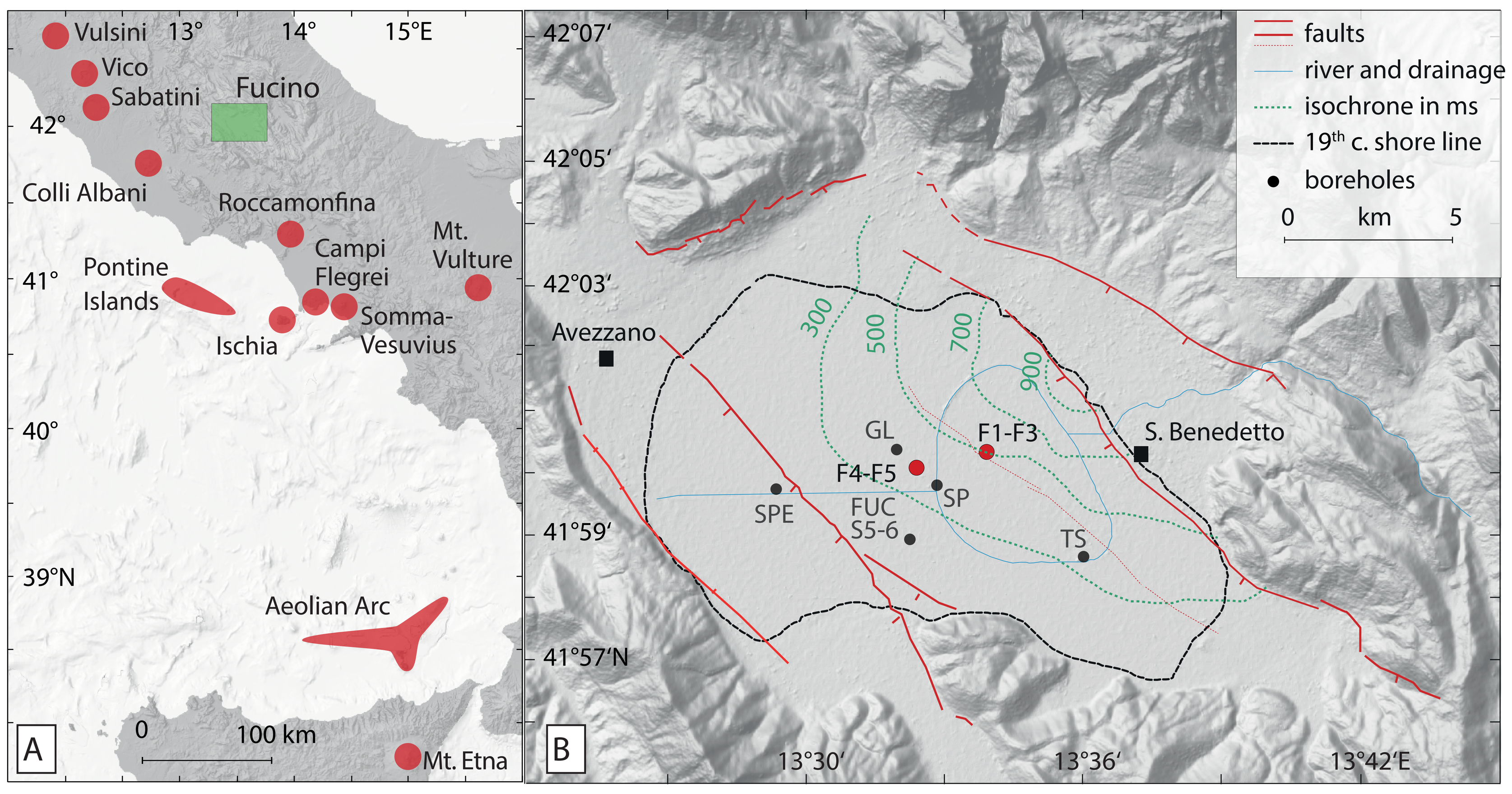


Fig. 1: (A) Location of the Fucino Basin and the main volcanic districts of central and southern Italy. (B) Core locations SP, SPE, GeoLazio (GL), Telespazio (TS), FUC S5-6, F1-F3, and F4-F5 from the Fucino Basin with isopachs of the basin infill (dashed green), and tectonic master faults (red).

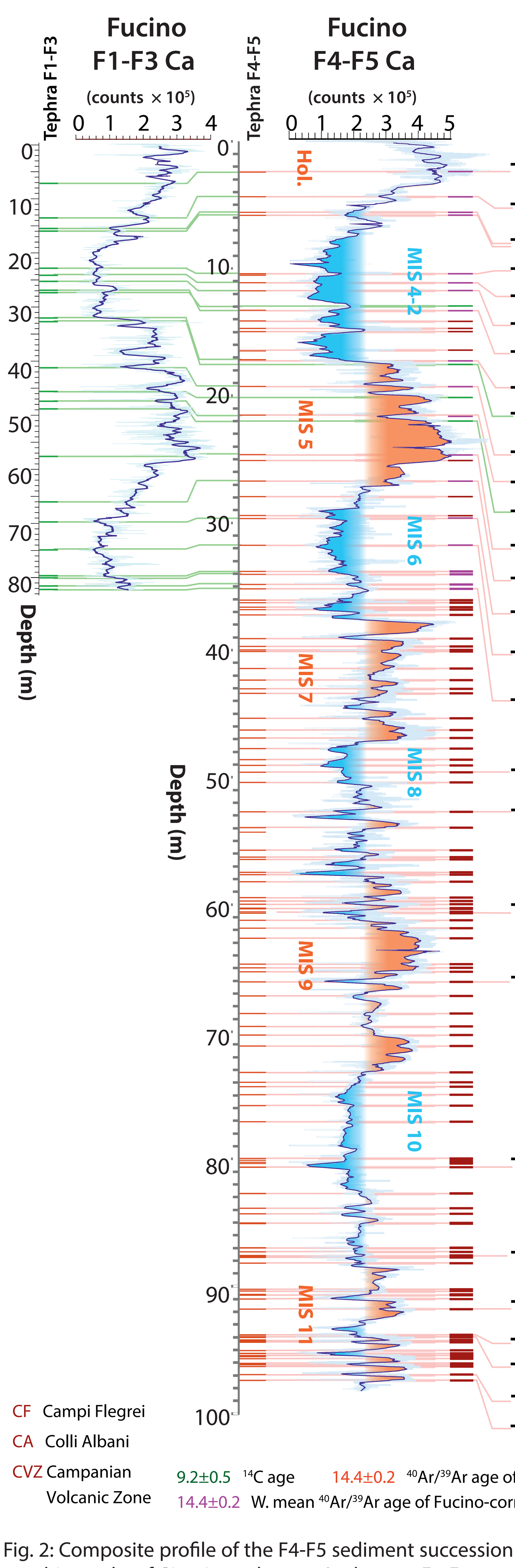
Background and study site

The Fucino Basin is the largest and probably the only Central Apennine basin containing a continuous and thick lacustrine sediment succession, which documents the environmental history from the Early Pleistocene to the 19th century. It is located downwind of the peri-Tyrrhenian volcanic centres (<150 km, Fig. 1a), which makes it the best candidate available in the central Mediterranean to obtain a long and continuous tephrochronological record. Tephra layers can be independently dated with $^{40}Ar/^{39}Ar$ geochronology and directly anchored to a comprehensive time series of paleoenvironmental proxies hosted by the lacustrine sediments. The Fucino lacustrine archive also provides the opportunity to extend the existing network of long terrestrial Mediterranean records (e.g. Dead Sea, Lake Van, Lake Ohrid, and Tenaghi Philippon) to the west, a currently vacant area. Transferring chronological and stratigraphic information on paleomagnetic excursions and long- and short-term climate variability to North Atlantic climate records sets the framework for a better understanding of the spatio-temporal variability, the magnitude, and the different expressions of Quaternary orbital and millennial-scale paleoclimatic variability.

Drilling of F1-F3 & F4-F5

- first drilling in June 2015 provided a 82 m long sediment succession (F1-F3), which contained -> 23 tephra layers (Giaccio et al., 2017)
- tephra correlation and direct $^{40}Ar/^{39}Ar$ dating (CEA-CNRS-UVSQ, France & BGC, USA) revealed that F1-F3 reaches back to 190 ka
- promising results of the F1-F3 succession supported a new drilling (F4-F5) and borehole logging in June 2017
- borehole logging data, sediment color changes, XRF downcore data, and first tephrochronological results infer that the new F4-F5 succession comprises continuously several glacial-interglacial cycles (MIS1-12) and contains more than 130 tephra and cryptotephra horizons (Fig. 2)

Tephrostratigraphy and -chronolgy of F4-F5 & F1-F3



Fucino composite tephrochronology

	Volcano	Eruption or tephra	Best age (ka ± 2s)
TF-1	CF	P. S. Nic.-Sart. 1-2-S. Mart.	9.2±1.0
TF-2	CF	Nepolitan Yellow Tuff	14.4±0.4
TF-3	Etna	Unit D/Biancavilla - Y-1	18.0±0.4
TF-4	CA	Albano 7	35.8±1.2
TF-5	CA	Albano 5	38.8±1.4
TF-5a	CF	Campanian Ignimbrite	40.0±0.1
TF-7	Ischia	MEGT - Y-7	55.9±1.0
TF-8	CA	Albano 3	70.0±2.0
TF-9	CA	Albano 1	69.9±1.0
TF-10	CVZ	C-22	100.3±10.4
TF-12	CVZ	X-5	105.6±0.5
TF-13	CVZ	X-6	109.1±0.8
TF-14	Sabatini	Baccano	126.0±1.0
TF-15	Vico	Ignimbrite C	153.5±4.6
TF-16	Vico	Ignimbrite B	160.6±4.0
TF-17	CVZ	Taurano Ignimbrite	159.4±1.6
TF-21	Ischia	C-52	187.0±8.0
TF-44	Vulsini	Canino	256.8±1.1
TF-48	Sabatini	Tufo Giallo di Sacrofano	288.0±2.0
TF-62	Sabatini	Magliano Plinian Fall	315.0±2.0
TF-69	Vulsini	Orvieto-Bagnoregio	335.8±1.4
TF-85	CA	Villa Senni	367.5±1.6 365.8±1.2
TF-98	Vico	Sant'Angelo	390.3±4.0
TF-116	Vico	Vico b	406.5±0.8
TF-117	CA	Pozzolane Nere	405.0±2.0
TF-118	CA	pre-Pozzolane Nere	407.0±4.2
TF-125	Vico	Vico a	414.5±1.2
TF-126	Vico	pre Vico a	424.3±3.2

CF Campi Flegrei
CA Colli Albani
CVZ Campanian Volcanic Zone

9.2±0.5 ^{14}C age; 14.4±0.2 $^{40}Ar/^{39}Ar$ age of Fucino tephra; 14.4±0.2 Best $^{40}Ar/^{39}Ar$ age of correlated tephra; 14.4±0.2 W. mean $^{40}Ar/^{39}Ar$ age of Fucino-correlated tephra; 187.0±4.0 Astrochronological age of correlated tephra

Fig. 2: Composite profile of the F4-F5 sediment succession correlated with the previously drilled F1-F3 succession using the tephropstratigraphic results of Giaccio et al., 2017. In the new F4-F5 record ca. 130 tephra and cryptotephra layers have been identified during visual core description and initial XRF-downcore data analysis and are subject of ongoing analyses. Ages presented are according to Mannella et al. (2019 and references therein), Giaccio et al. (2019) and new unpublished results.

Tephrostratigraphic work

Assignment of tephra layers to their volcanic origin, in order to improve the knowledge on the poorly known periods of volcanic activity of the explosive peri-Thyrrhenian volcanism

- identification of tephra and cryptotephra layers by visible inspection of core halves and XRF downcore scanning and MSCL data
- major and minor oxide compositions of juvenile glass shards, micropumice, or scoria of all tephra layers are measured by WDS - EPMA
- trace element concentrations of single glass shards will be obtained by LA-ICP-MS analyses
- Sr-Nd isotopic compositions will be measured using MC-ICP-MS analyses

Chronostratigraphic work

- $^{40}Ar/^{39}Ar$ dating of tephra layers
- establishment of an age-depth model for F4-F5 composite section
- the chronological information of the age model will be linked with pollen and geochemical data sets (XRF, TIC, TOC, C/N/S, stable isotopes) and paleomagnetic excursions of the F4-F5 record

Evaluation of the timing and duration of short-term and long-term climate variability and paleomagnetic excursions.

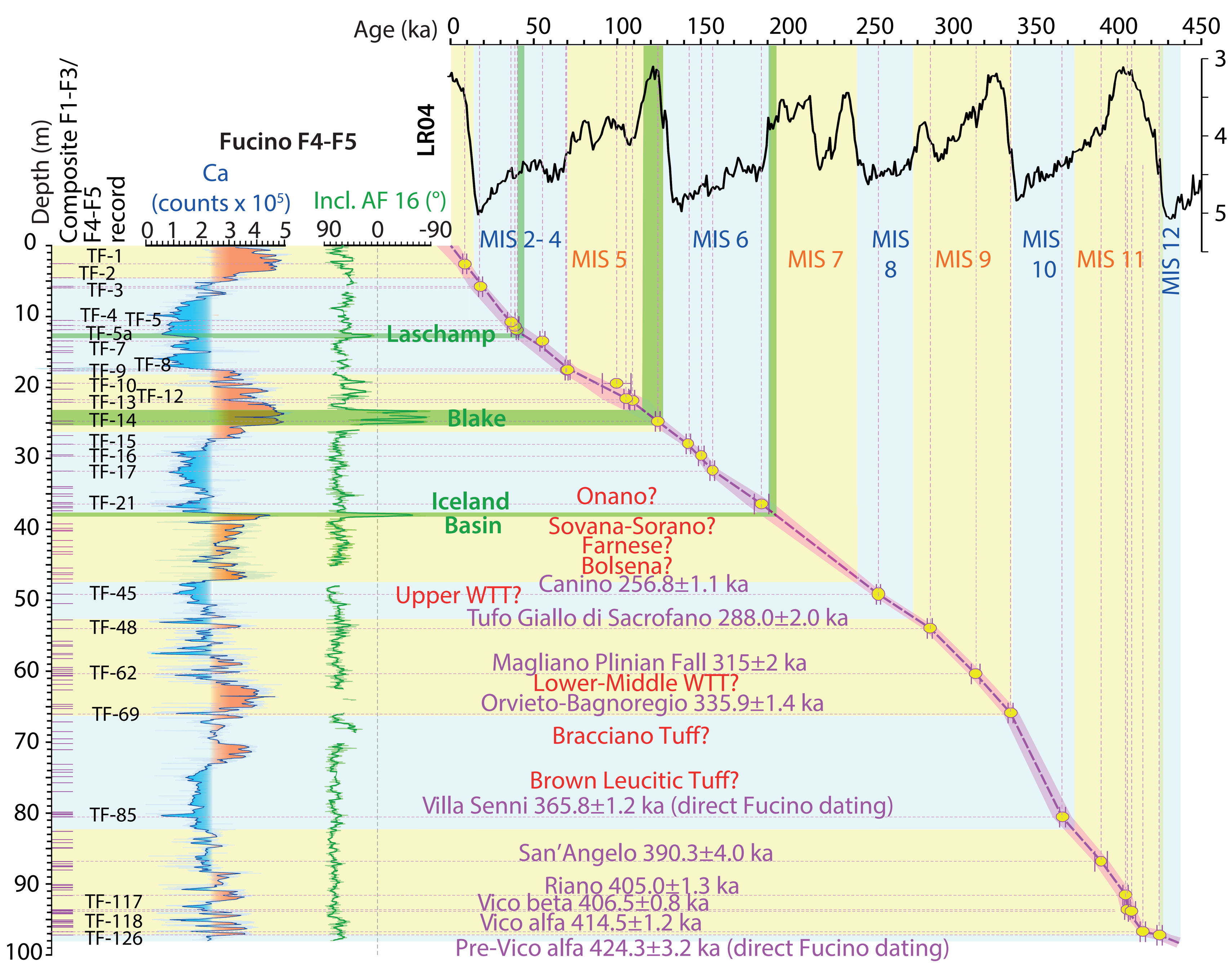


Fig. 3: Preliminary age model for the composite F1-F3/F4-F5 tephra and F4-F5 Ca and palaeomagnetic records. In addition the LR04 benthic stack (Lisiecki and Raymo, 2005) is shown to illustrate boundaries of the marine isotope stages (MIS).

References

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