

***Quaternary and active tectonics in
peninsular Italy: the contribution of
the long-term geological approach
and tephrochronology***

**DEFENS kick-off meeting
Chieti 01/27/2026**

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The study of the active tectonic typically requires a trans-disciplinary approach, which include the application and integration of a number methodologies that provide us with knowledge and information on a series of spatial, temporal, and physical parameters that depict the architecture and the behavior of active and capable faults.

- Historical Seismology
- Instrumental seismology
- Geophysical exploration
- Structural geology
- Quaternary geology
 - Stratigraphy
 - Geomorphology
 - Geochronology
- Paleoseismology



- Surficial and deep geometry of the fault systems
- Spatio-temporal evolution of fault systems
- Potential seismogenic and magnitude associated to fault systems
- Recurrence of the strong earthquakes

Among others, the Quaternary Geology (= Stratigraphy + Geomorphology + Chronometry) is essential to define:



1. Status of a fault system (i.e., active vs inactive)
2. Fault long-term slip-rate and its variability over the time

The Quaternary: a paradigm from the past to understand the present and future trajectories of the Earth system evolution

Indeed, the Quaternary is a privileged observation context, offering the unique opportunity to investigate and understand the history and dynamics of the processes responsible for the recent evolution of the Earth system (e.g., climate, **tectonics**, volcanism) and thus, in perspective, as they can continue to act currently and in the next future.

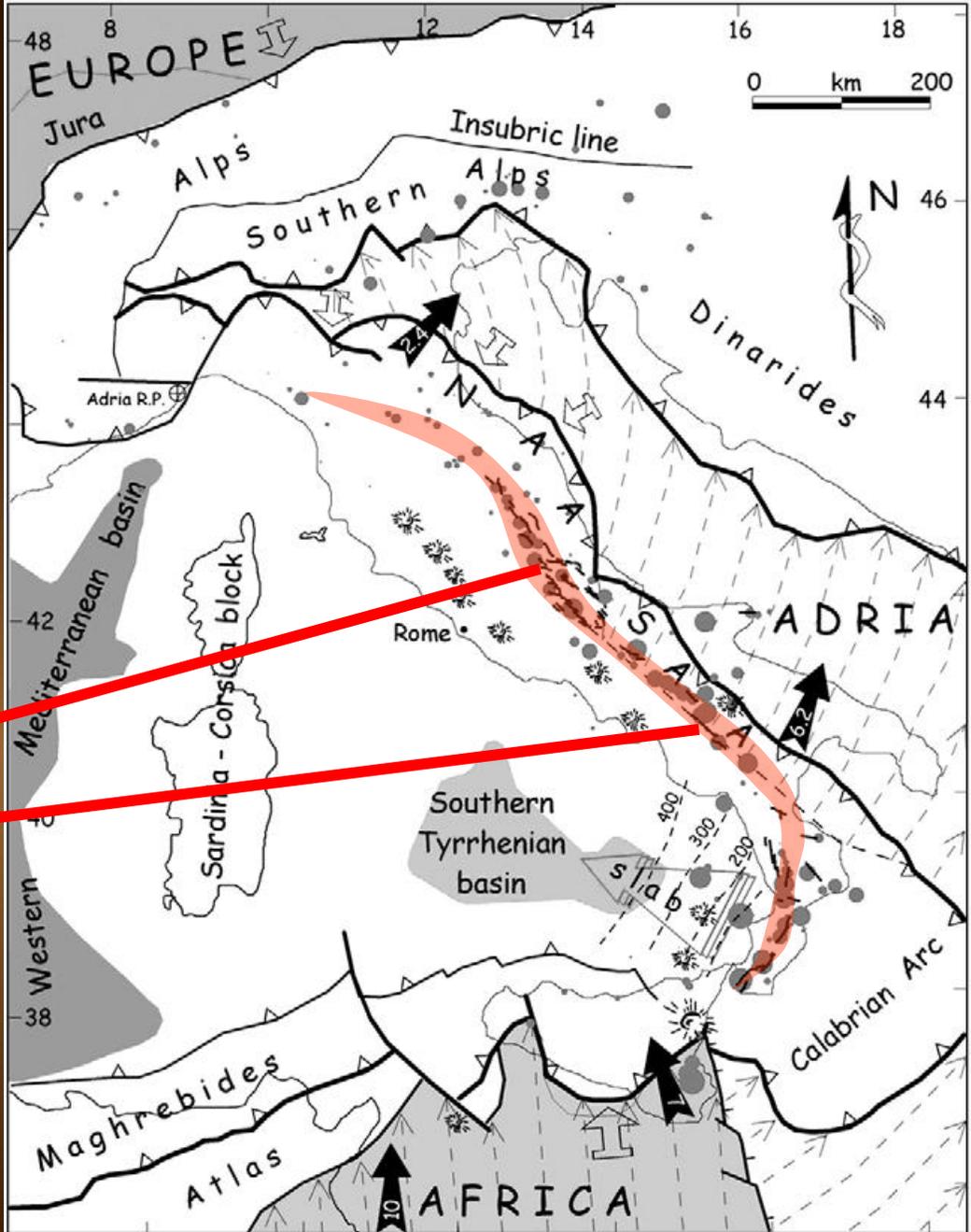
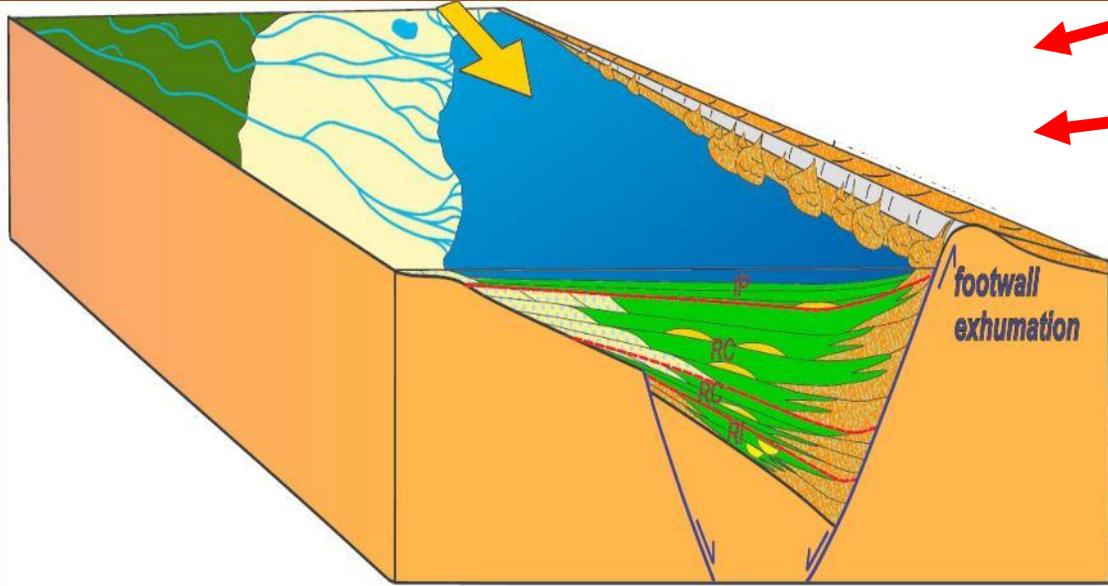
Conceptually, this is reversal formulation of the Actulism Principle by Charles Lyell; if **"the present is the key to the past"**, then **"the past is the key to the present and future"** (Confucio?), provided that the boundary conditions and the driven processes have not significantly varied over time.

... and the Quaternary, which spans from a few of million of years to the present, has the temporal requisites ensuring, almost always, that no significant change occurred with respect to the present setting

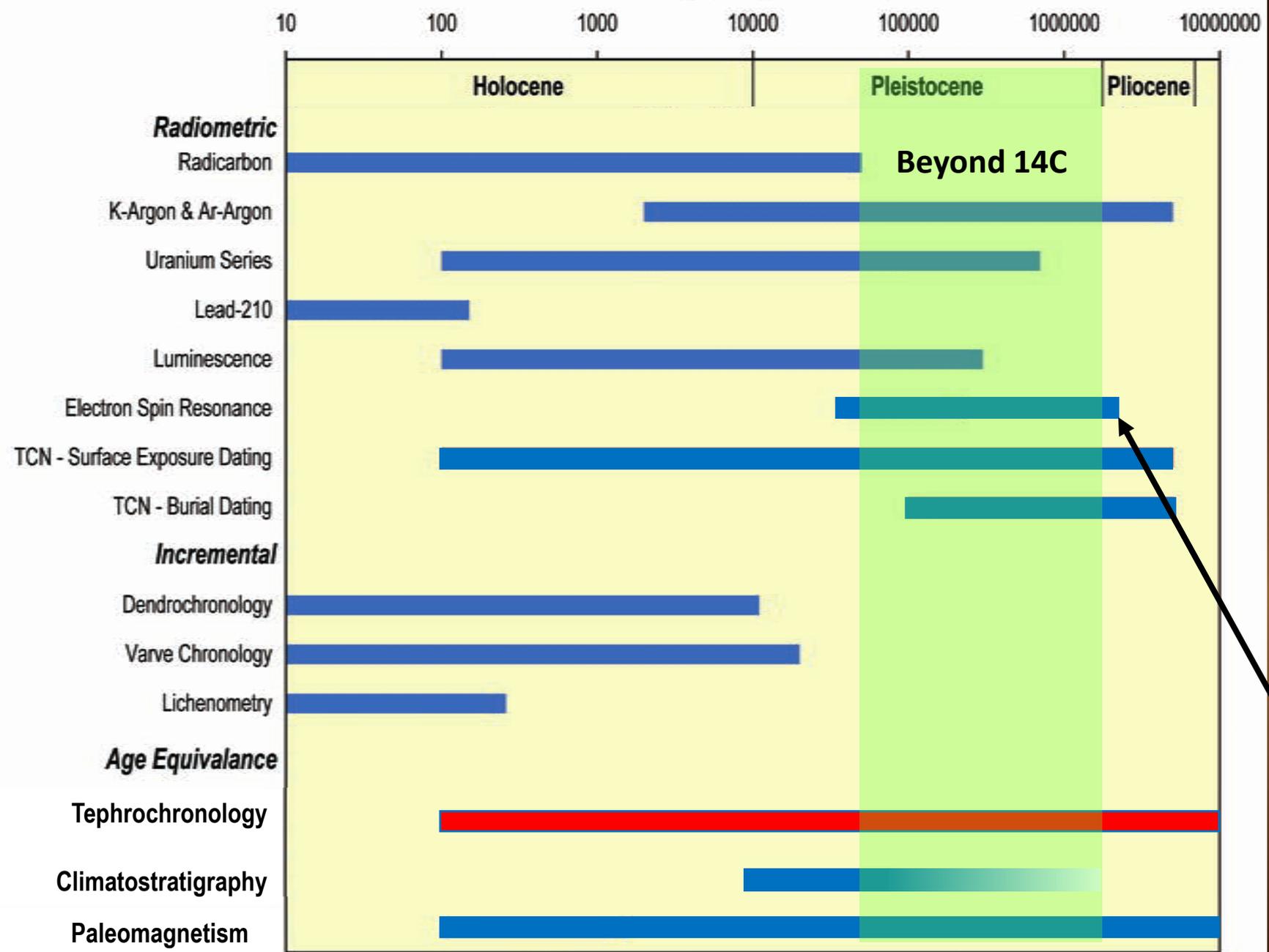


In the framework of the Mediterranean geodynamic, most of the Italian active and seismogenetic faults are located along the axis of the Apennine chain and are often associated to sedimentary basins, which are the morpho-stratigraphic expressions of the long-term tectonic activity.

The investigation these morpho-sedimentary systems is thus vital for studying the recent and active tectonic. However, because of their intrinsic nature, these continental deposits and forms are hardly datable and beyond the limit of the radiocarbon (i.e., c. 45 ka), the chronological framework were essentially relied on assumptions and qualitative regional cross correlations, which provided a very poor and rough chronological framework, far suitable for high-resolution assessments of the fault systems' activity status and slip-rates.



Years ago (in logarithmic scale)



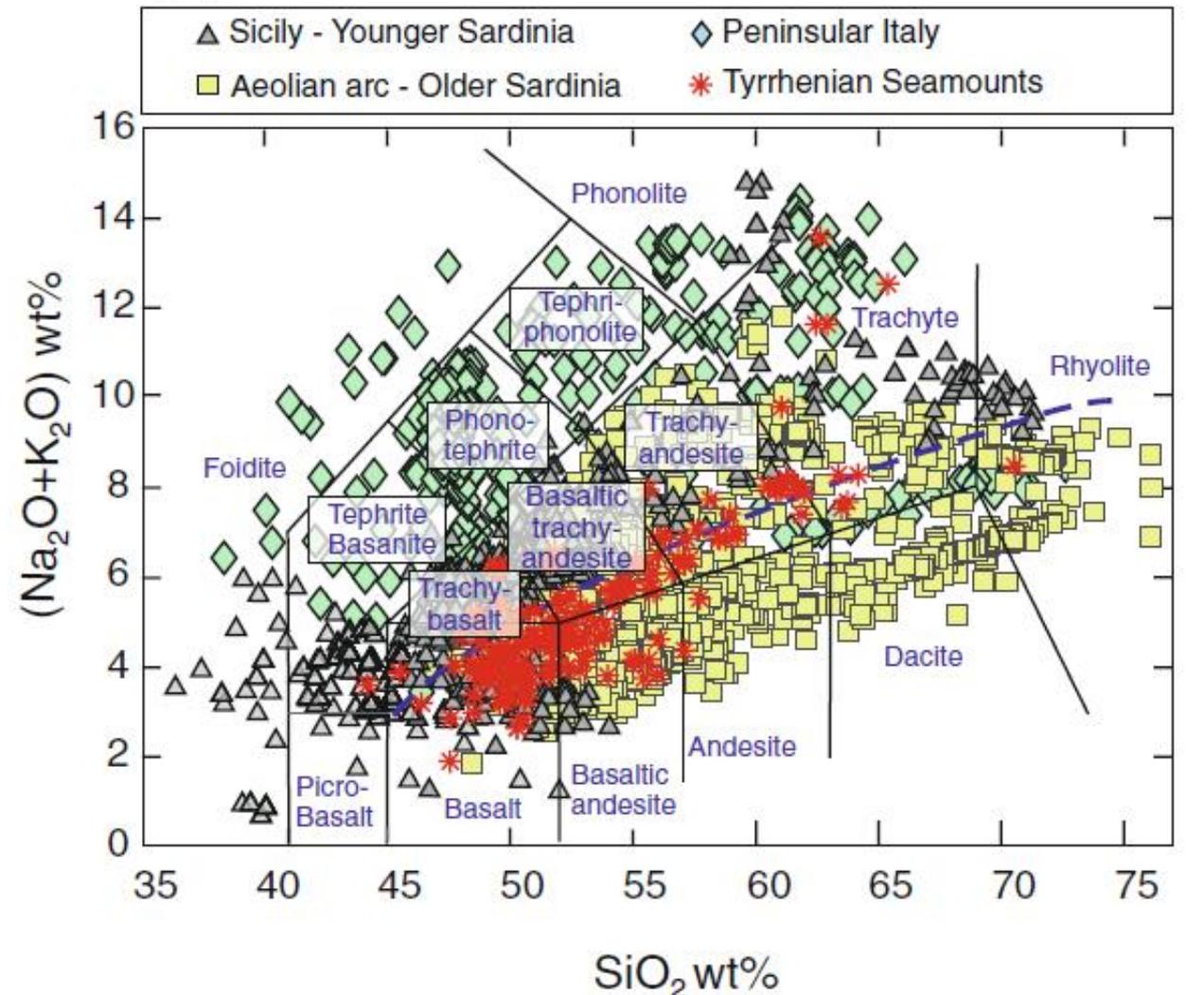
Beyond 14C dating limit, there are several methods that can be applied for dating Quaternary deposits, as, e.g., the ESR, for which within DEFENS a collaboration with French colleagues has been established

However, in the framework of the Central-Southern Apennines, tephrochronology has proven be one of the most powerful tool

Jean-Jacques Bahain and Pierre Voinchet
Muséum National d'Histoire Naturelle, Paris

Because of ...

1. Great variability of the magma composition of the different volcanic sources linked to the complex geodynamic setting of the Mediterranean basin, facilitating tephra source identification



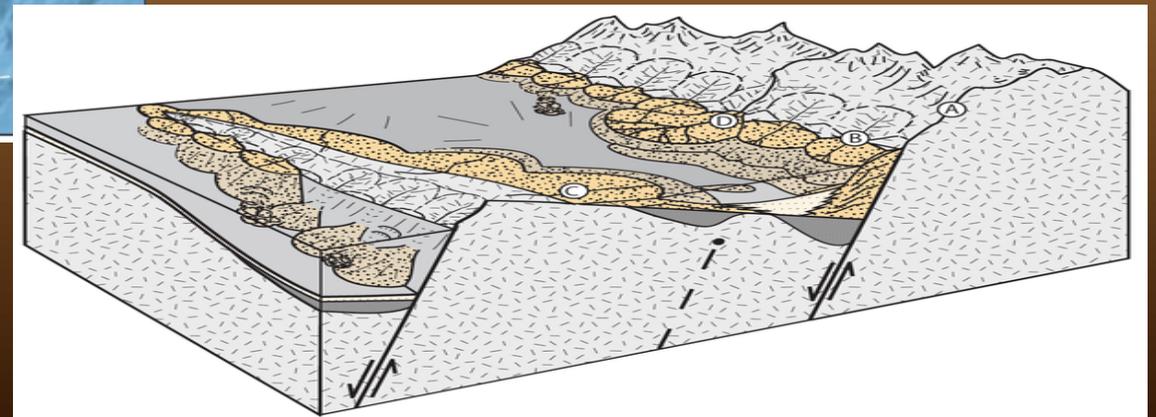
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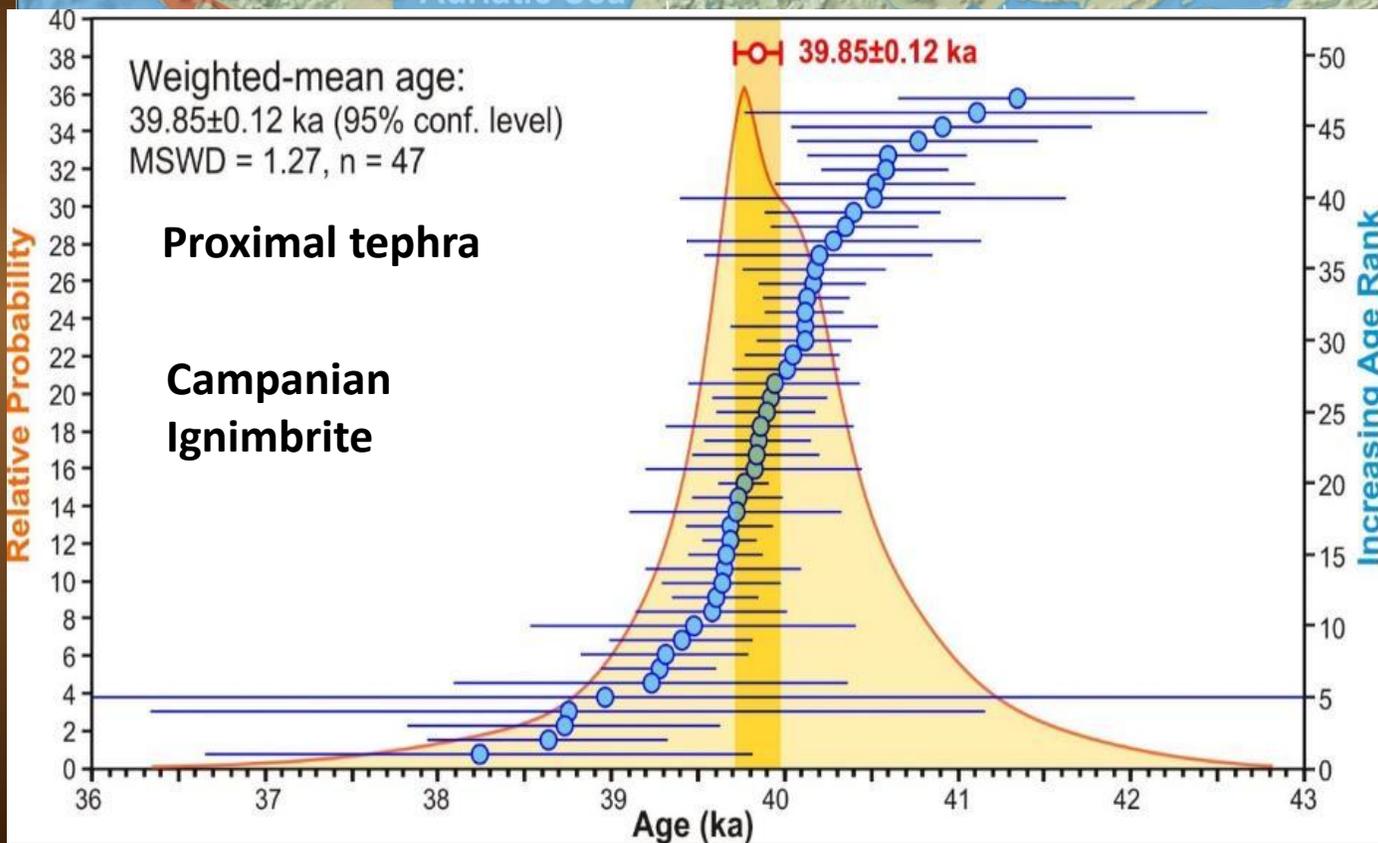
1. Great variability of the magma composition of the different volcanic sources linked to the complex geodynamic setting of the Mediterranean basin, facilitating tephra source identification
2. Intense and continue volcanic activity during the last 1 Ma, at least, and more discontinuously since 4.2 Ma



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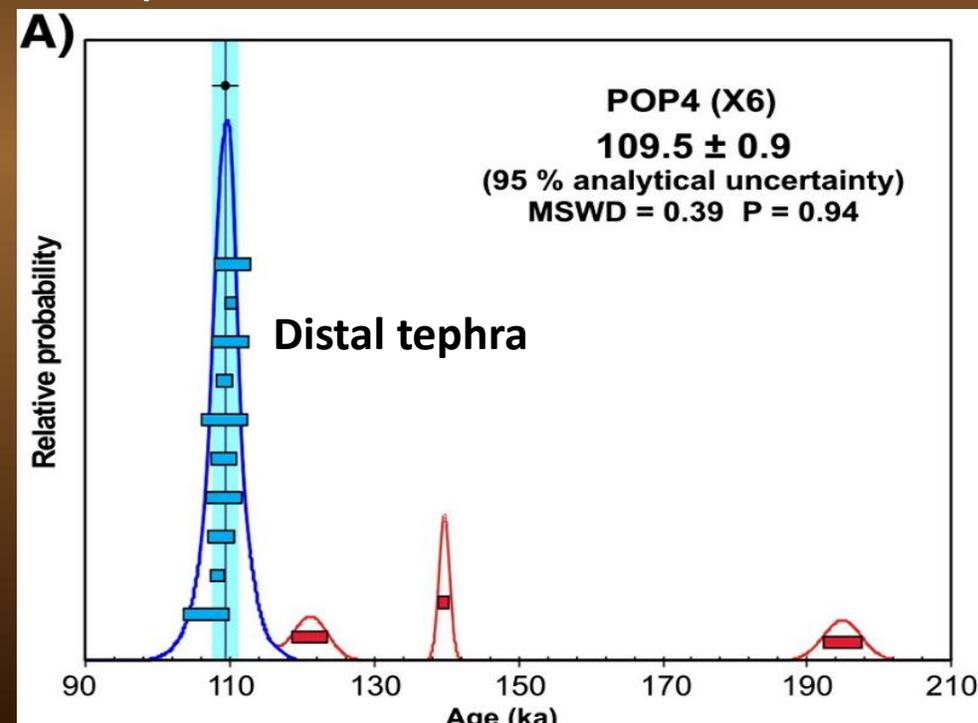
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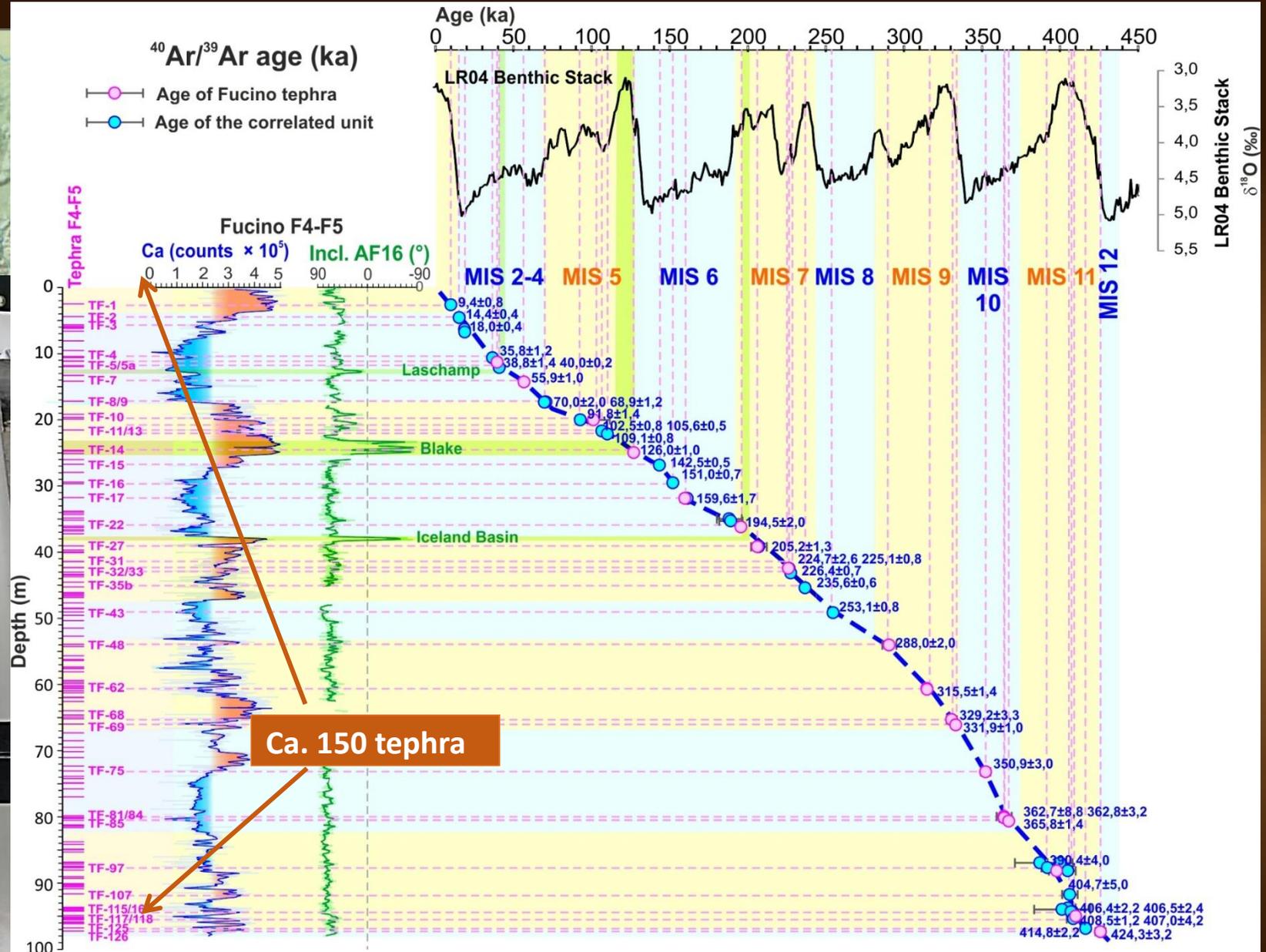
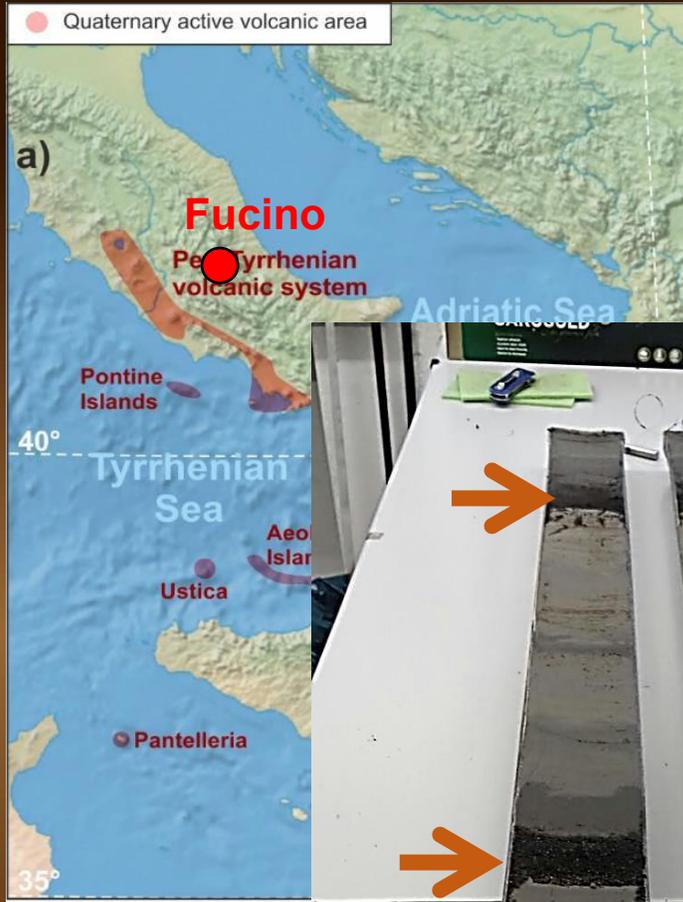


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4. Occurrence of a volcanism feed by ultra-potassic magma (Provincia comagmatica Romana), which allows getting high-precision and accurate $^{40}\text{Ar}/^{39}\text{Ar}$ dating, from both proximal and distal tephra



Outstanding examples of the richness and the potential of the tephrochronology in central-southern Italy are provided by the Fucino succession, with ca. 150 tephra in the last 430 ka, 40 out of which precisely dated by $^{40}\text{Ar}/^{39}\text{Ar}$



Ca. 150 tephra

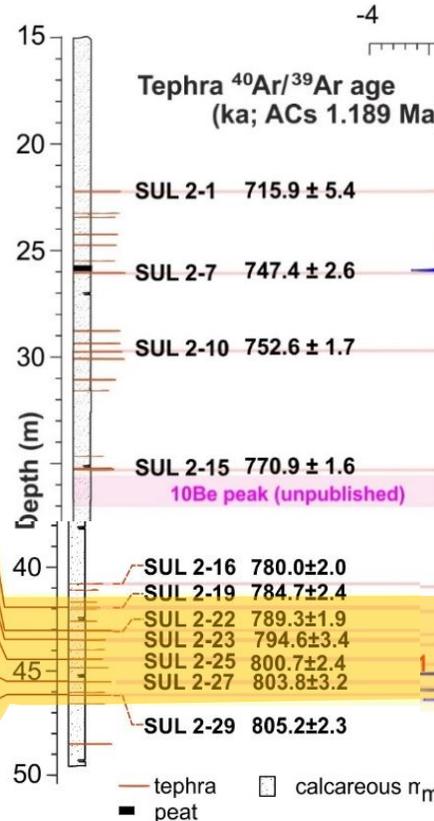
And Sulmona Basin ... but they are just a couple of examples among a continuously increasing number of tephra archives and widening of the tephra record lattice

Quaternary active volcanic area

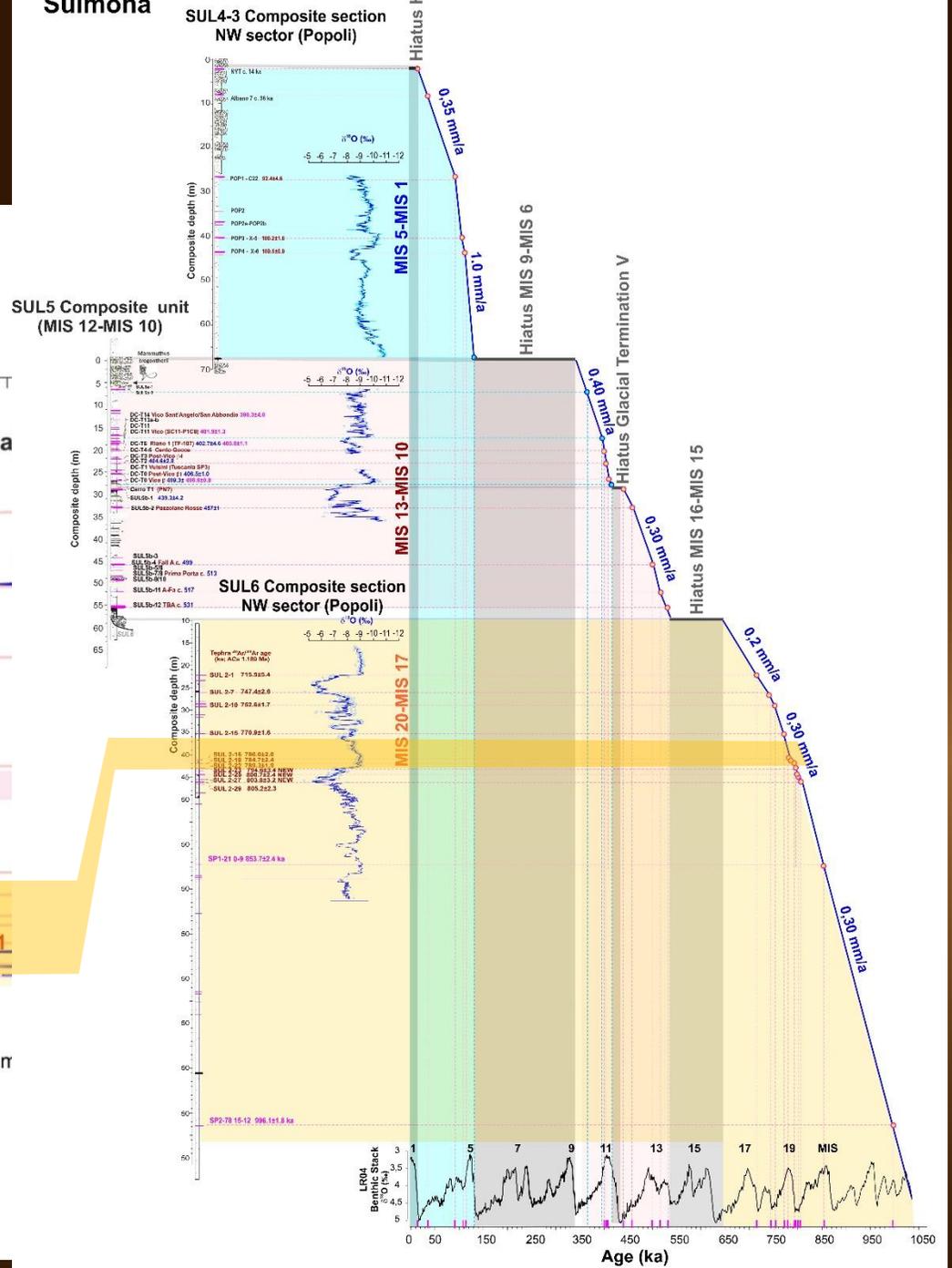


Sulmona

SUL6 Composite section



Sulmona



Tephrochronology has been already applied with success for defining the long-term slip rates of fault systems and their variability over the time in a number of study cases in Central-Southern Apennines, and we are confident that it will provide valuable contributions within DEFENS as well.

Thank you for your attention and my apologies to have missed the meeting

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Quaternary Science Reviews

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(sou Unveiling the hidden source of major historical earthquakes: A multi-scale, trans-disciplinary approach to the 1456 and 1688 Sannio earthquakes (Mw 7.0, southern Italian Apennines)

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Vincenzo Amato ^{a,*} , Sabatino Ciarcia ^b , Paolo Galli ^{c,d} , Domenico Cicchella ^b , Antonio Galderisi ^{e,d}, Lorenzo Monaco ^f , Giada Fernandez ^d , Roberto Isaia ^g, Sebastien Nomade ^h , Alison Pereira ⁱ, Biagio Giaccio ^d 

