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### Multi-phase Tectonic Evolution and Fluid Interaction in the Amora Fault System (central Southern Alps, N Italy)

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#### Abstract Text:

Understanding the evolution of brittle faults, related fractures, and associated fluid flows in the upper crust is fundamental for gaining insights into fault mechanics, seismic hazards, hydrocarbon and geothermal reservoir exploitation. Unraveling the history of fault zones that have undergone multiple tectonic stages is challenging due to the limited time constraints often provided solely by crosscutting relationship. The advent of in situ U-Pb dating of syn-kinematic carbonates offers significant improvements for deciphering complex fault evolution, provided that a careful structural, petrographic, and geochemical characterization is carried out beforehand.

The Amora Fault System (AFS) in the central Southern Alps of Italy is an N-S-trending normal fault system developed within the Upper Triassic to Jurassic succession. Its multi-phase evolution began with the Jurassic rifting event, forming part of the Lombardian Basin connected to the Alpine Tethys opening. The activity as a rift-related fault system stopped before the Middle Eocene when the emplacement of E-W-trending andesitic dikes occurred. Later, it was reactivated as a primarily left-lateral strike-slip fault system due to N-S-oriented Alpine compression. Throughout these stages, intense fluid circulation accompanied faulting, leading to the precipitation of syn-kinematic carbonates such as veins and slickenfibres. Meso- and micro-scale structural analyses, geochemical characterization (O-C stable isotopes, and elemental analyses including REE), and in-situ U-Pb dating of syn-kinematic carbonates that provide a detailed understanding of the tectonic evolution of the AFS. Fluid inclusion microthermometry allowed the inference

of paleo-fluid temperatures and salinities. Results integration revealed five tectonic stages: (1) Early to Middle Jurassic rifting associated with high fluid temperatures. (2) Early Cretaceous final-stage of rifting activity. (3) Late Cretaceous early Alpine orogeny. (4) Emplacement of andesitic dikes. (5) Oligo-Miocene strike-slip reactivation of AFS associated with low-temperature fluid circulation.

**Session Selection:**

T021. Shallow fault zone deformation over the earthquake cycle: observations, experiments, and models

**Submitter's E-mail Address:**

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**Abstract Title:**

Multi-phase Tectonic Evolution and Fluid Interaction in the Amora Fault System (central Southern Alps, N Italy)

**Requested Presentation Type:**

Poster Only

**Virtual Participation:**

In-person

**Recording Permission Given?**

Yes

**Previously Published?:**

Yes

**Previously Published Material:**

Research article: Rocca, M., Zanchetta, S., Gasparri, M., Mangenot, X., Berra, F., Deschamps, P., Guihou, A., & Zanchi, A. (2024). U-Pb carbonate dating reveals long-lived activity of proximal margin extensional faults during the Alpine Tethys rifting. *Terra Nova*, 00, 1–11. <https://doi.org/10.1111/ter.12717>

**Abstract Payment:**

Paid (agu-agu24-1726828-1281-0710-4214-8428)

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