Shift in Sedimentary Dynamics in the Belluno Basin (Southern Alps, Italy) after the Peak of the Early Toarcian Oceanic Anoxic Event

Jan G. C. Meissner[1] (jan.meissner@eaps.ethz.ch), Miriam Cobianchi[2], Axel Munnecke[3], and Vincenzo Picotti[1]

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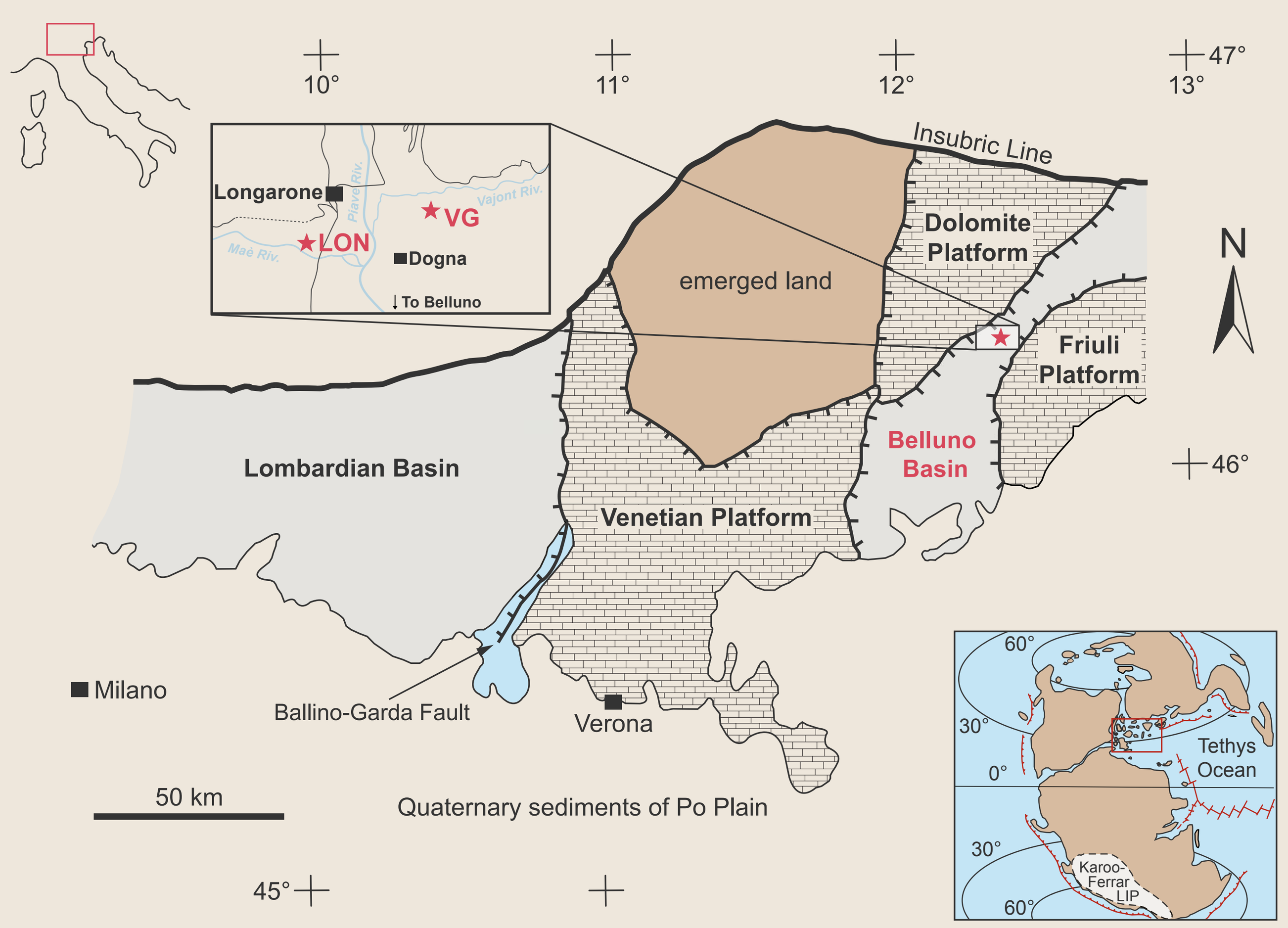
The Toarcian Oceanic Anoxic Event (T-OAE, ~183 Ma) was marked by widespread ocean deoxygenation and increased organic matter accumulation, which resulted from a major global carbon cycle perturbation[1, 2].

In many basins, ocean deoxygenation was linked to the establishment of a relatively sluggish circulation and poor communication with the open ocean[3].

Due to its relevance to understanding and forecasting future deoxygenation scenarios, the T-OAE has been extensively studied in marine and continental records. Yet, the environmental dynamics during this event's recovery phase are still poorly understood.

We wanted to explore how the sediment dynamics of an intraplatform basin recovered from the peak T-OAE, focusing on both short- and long-term trends.

Therefore, we sampled the Vajont Gorge Section of the Belluno Basin in the Southern Alps, a critical region for studying the evolution of the T-OAE.

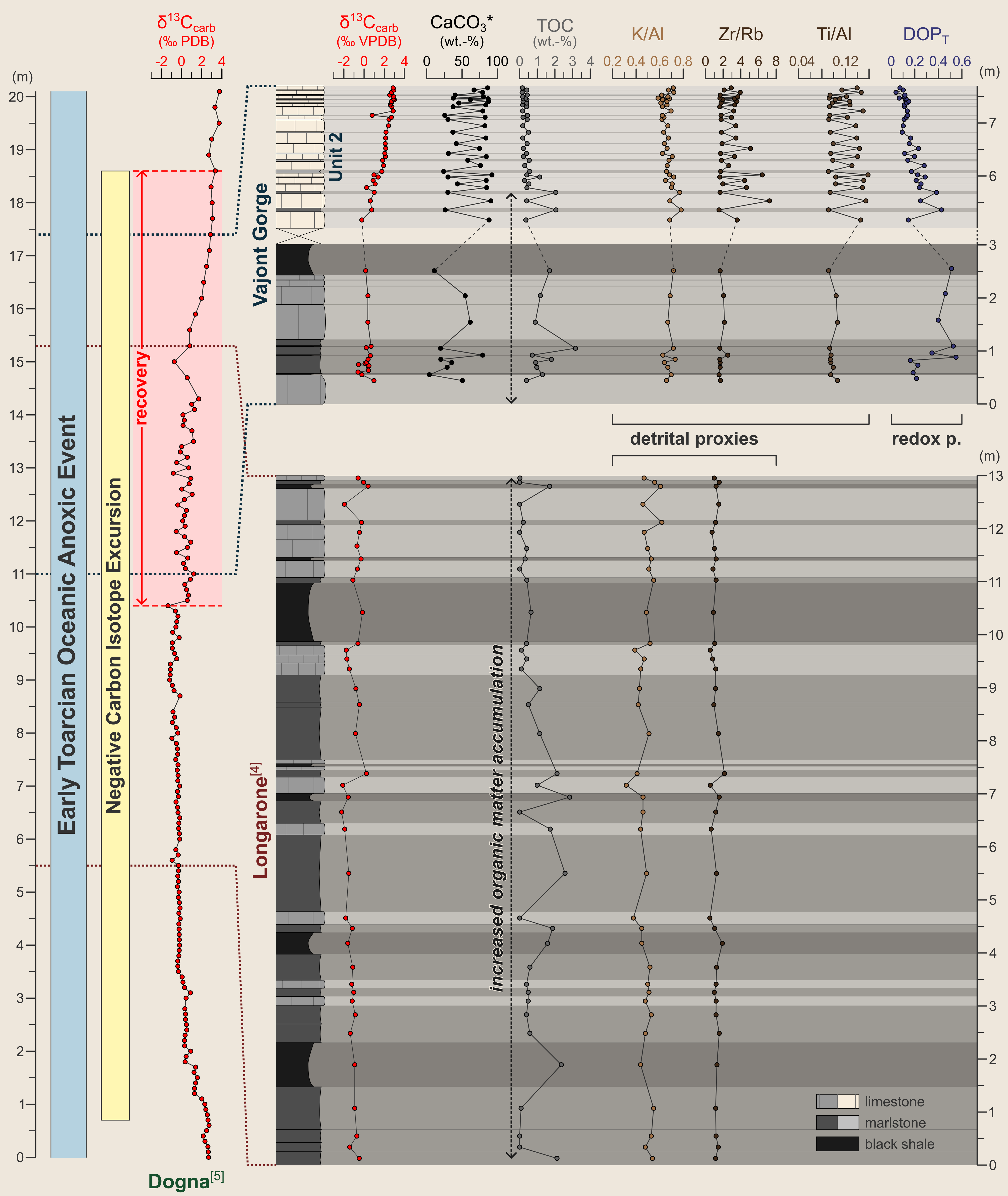


Our approach consists of a bed-by-bed analysis of petrographic, geochemical, mineralogical, and calcareous nannofossil data.

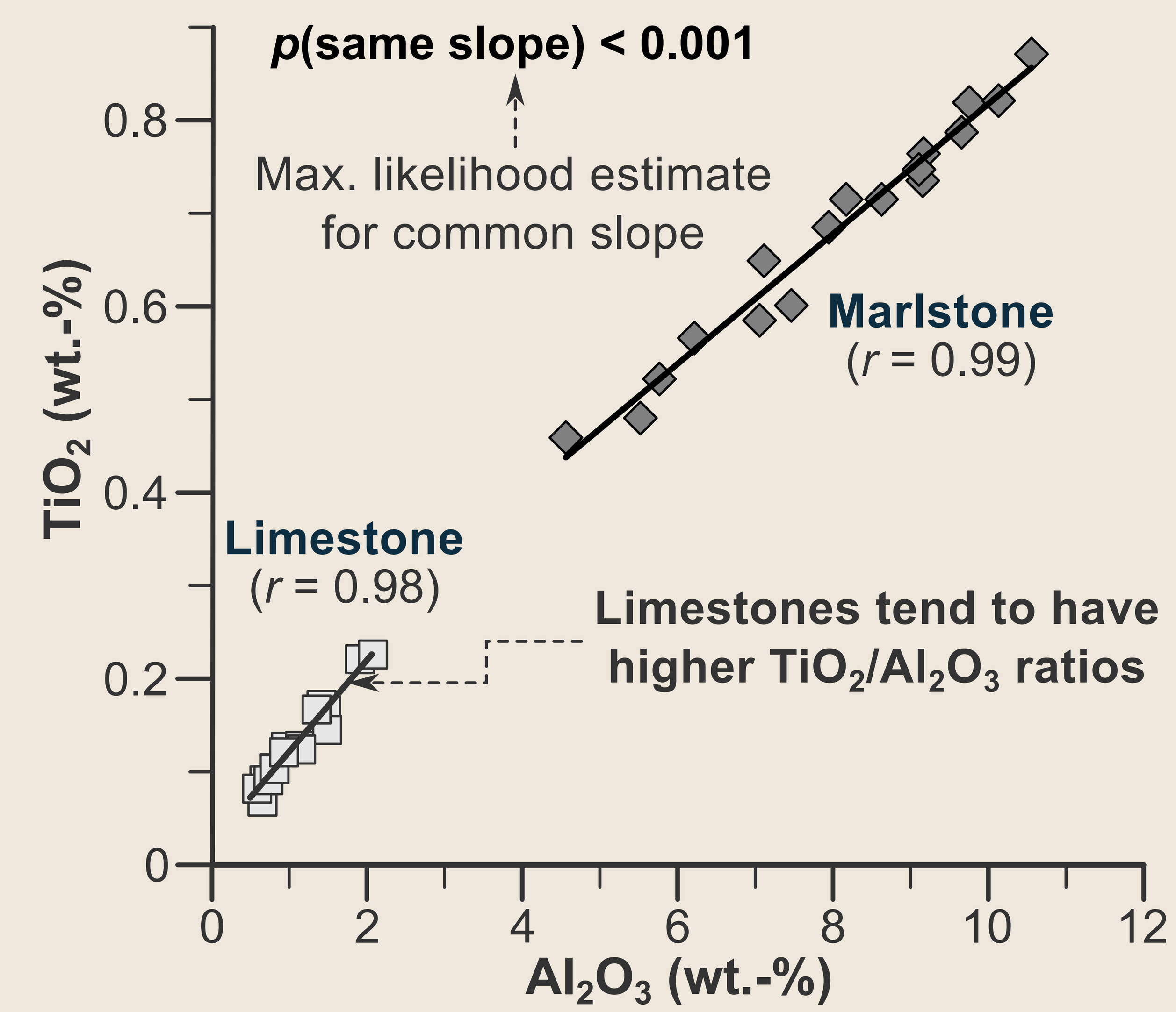
To identify changes in sediment dynamics, we compared our results with published data from the nearby Longarone Section[4] and Dogna core[5].

We highlight the following long-term trends (post-peak):

- **Decreasing degree of pyritization (DOP_T) suggests a return to oxic bottom waters during the recovery phase from the negative CIE**
- **Detrital proxies suggest increased clastic grain size, particularly in the precursor sediments of the limestone layers**



We found evidence that the rhythmite of Unit 2 reflects an original short-term cyclic environmental signal



A likelihood ratio test[6] revealed a significant difference in TiO_2/Al_2O_3 ratios between the lithologies

XRD analyses showed that heavy minerals are enriched relative to clays in limestones, which may indicate winnowing by bottom currents

The limestone layers show sedimentary features indicative of bottom current reworking

Our data show that sedimentary dynamics in the Belluno Basin shifted markedly after the peak T-OAE

This shift likely resulted from intensified bottom currents that promoted re-oxygenation following a period of relatively sluggish circulation

[1]Geological Institute, ETH Zürich, Zurich, Switzerland [2]University of Pavia, Pavia, Italy
[3]GeoZentrum Nordbayern, FAU Erlangen-Nürnberg, Erlangen, Germany

ETH zürich

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Supplementary Material for

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Jan G. C. Meissner[1], Miriam Cobianchi[2], Axel Munnecke[3], Vincenzo Picotti[1]

[1] Geological Institute, ETH Zurich, Zurich, Switzerland (jmeissner@student.ethz.ch)

[2] Dipartimento di Scienze della Terra e dell'Ambiente, University of Pavia, Pavia, Italy

[3] GeoZentrum Nordbayern, FAU Erlangen-Nürnberg, Erlangen, Germany

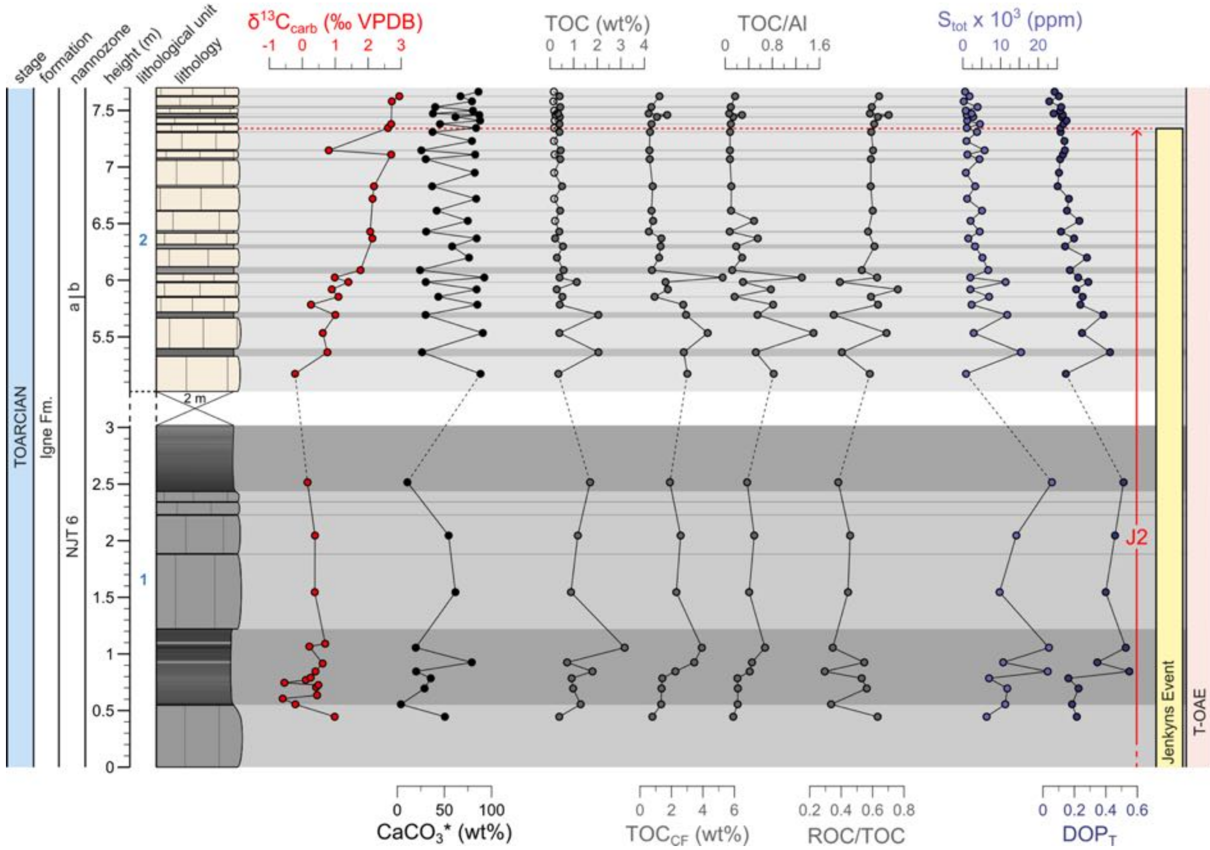

Figure S1: Chemostratigraphic profiles showing variations in $\delta^{13}C_{carb}$ values, $CaCO_3$* content, TOC content, TOC_{CF}, TOC/Al, ROC/TOC, total S content, and DOP_T relative to the calcareous nannofossil biostratigraphy and lithological variations of the investigated interval of the Vajont Gorge section. Open circles in the TOC profile indicate values < 0.2 wt%. Dark gray horizontal bars highlight the shale and marlstone interbeds, while lighter gray bars indicate the limestone and indurated marlstone beds.

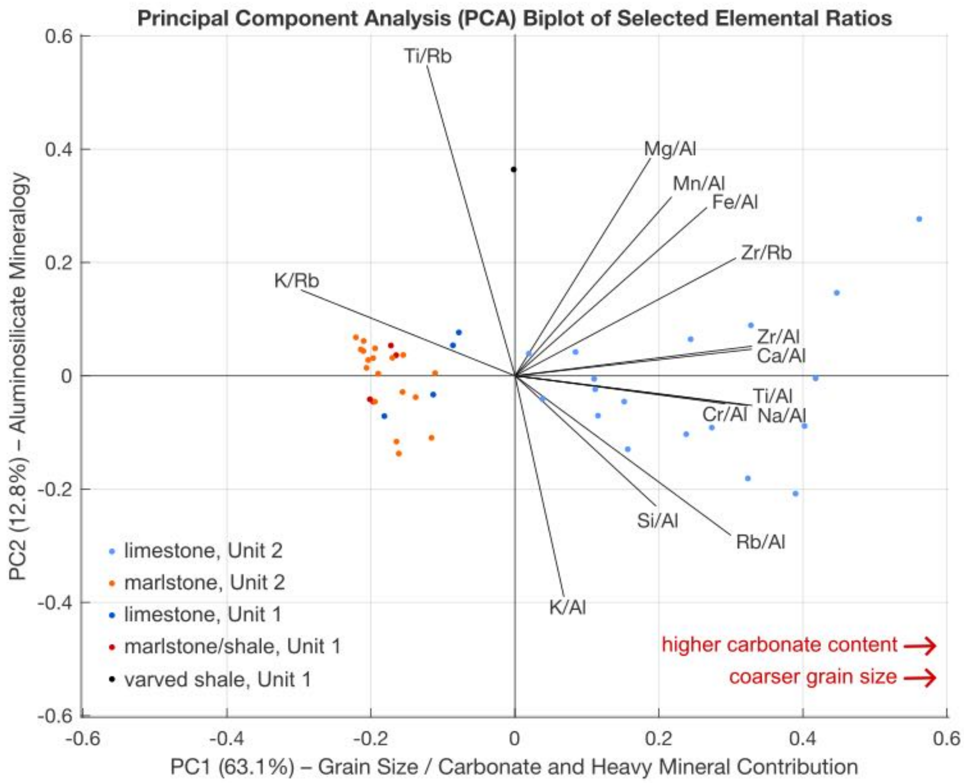

Figure S2: Compositional biplot derived from principal component analysis (PCA). The coloured dots represent the analyzed rock samples. The length of the dark grey rays is proportional to the variation that the corresponding proxy explains. PC1 represents changes in grain size and/or carbonate and heavy mineral contribution to the precursor sediment. PC2 reflects changes in the composition of aluminosilicate minerals, such as clay and feldspars.

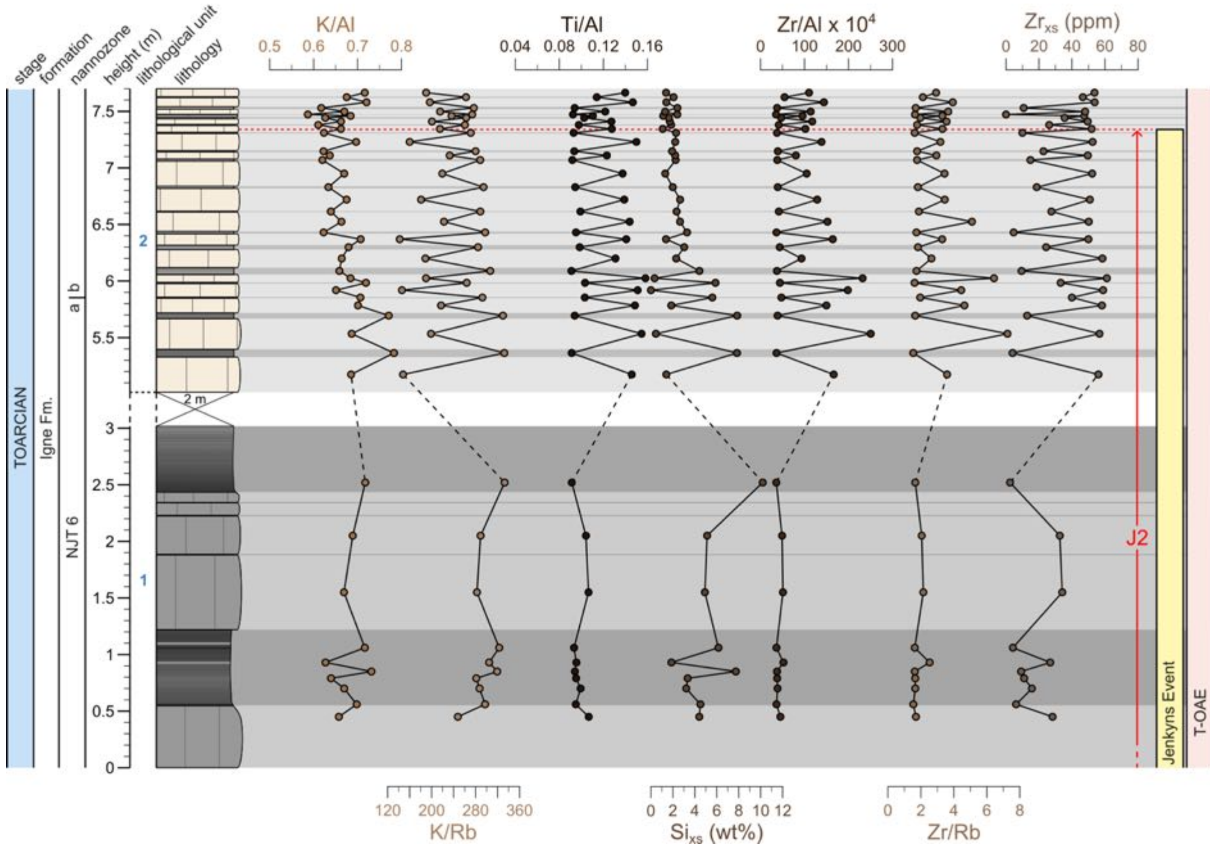

Figure S3: Chemostratigraphic profiles showing variations in ratios of K/Al, K/Rb, Ti/Al, Zr/Al, and Zr/Rb, as well as in the excess amounts of SiO_2 (Si_{xs}) and Zr (Zr_{xs}) relative to the calcareous nannofossil biostratigraphy and lithological variations of the investigated interval of the Vajont Gorge section. Titanium is the most diagenetically stable element (e.g., Westphal et al., 2010), typically bound to clay and heavy minerals. Potassium and Rubidium are typically bound to aluminosilicate minerals, while zirconium occurs almost exclusively as the heavy mineral zircon (e.g., Calvert & Pedersen, 2007). Dark gray horizontal bars highlight the shale and marlstone interbeds, while lighter gray bars indicate the limestone and indurated marlstone beds.

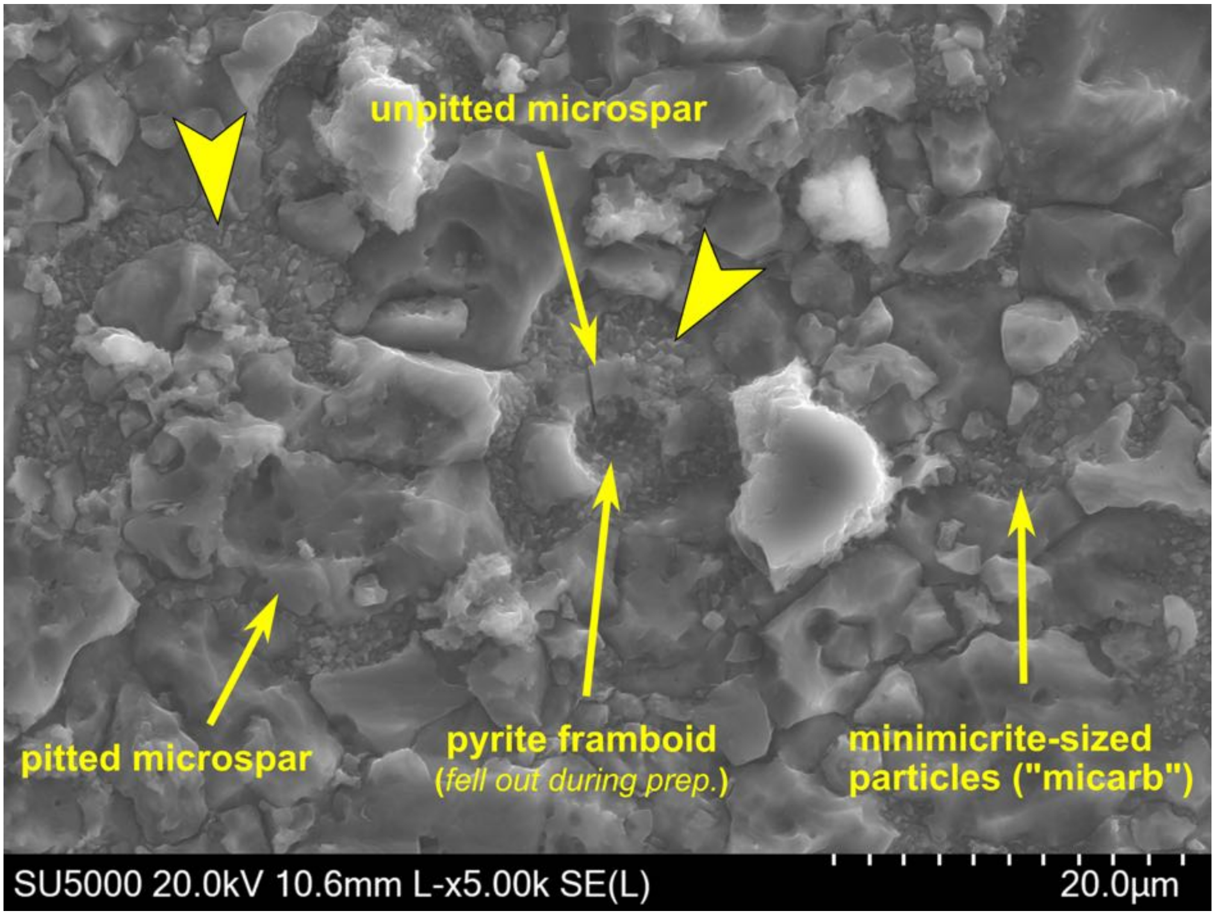

Figure S4. Scanning electron microscope photomicrograph from a limestone sample (Unit 2) showing *Schizosphaerella* spp. nannoliths (yellow arrows) that are sharply embedded in a matrix of pitted microspar and abundant mini-micrite-sized carbonate crystals, which are interpreted as nannofossil debris (the "micarb" of Cook & Egbert, 1979). Note that a pyrite framboid formed within one of the nannoliths, which was then filled with non-pitted microsparite, indicating that the framboid must have formed before the cementation of the cavity.

References

Calvert, S. E., & Pedersen, T. F. (1993). Geochemistry of Recent oxic and anoxic marine sediments: Implications for the geological record. *Marine Geology*, 113(1), 67–88.

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