Response of marginal marine ostracods to Holocene environmental changes: river influences vs marine influxes in the Danube delta

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Introduction

The study provides the first multi-proxy record, combining ostracod data, sediment texture and geochemistry from the upper Danube delta, reconstructing a series of well-defined environmental changes during the mid and late Holocene.
The research was undertaken in Lake Babele (45°12' N, 28°39' E), which is located within the Somova - Parcheș lacustrine system, in the uppermost Danube delta (Fig. 1). It is part of the upstream fluvial delta close to the apex which started to develop ca 8000 cal yr ago (Vespremeanu-Stroe et al., 2017). The present, Somova-Parcheș wetland system covers about 8,000 ha and is bordered to the N and NE by the Danube River, in the SW by the Niculițel Plateau, and in the south by the Tulcea Hills. Lake Babele is linked via a 500 m long channel to an old secondary distributary channel (Somova) which was disconnected in the late 20th century from the Danube main course.

Fig.1 Location of Babele core (yellow star)

Methods

A 16 m long sediment core was taken from the SW part of Lake Babele, with a Cobra TT percussion corer.
The analyses start from 400 cm depth as the borehole passed through a floating reed bed and water before reaching the lake floor sediments. The uppermost one meter of floating reed-peat was not analysed to avoid possible mixed material from channel dredging in the area. The following analysis were undertaken:

- Ostracod analysis
- AMS radiocarbon dating
- XRD analysis
- Geochemical analyses (PIXE)
- Grain-size analysis
- Loss on ignition (LOI)
- Magnetic susceptibility

Results & Discussion

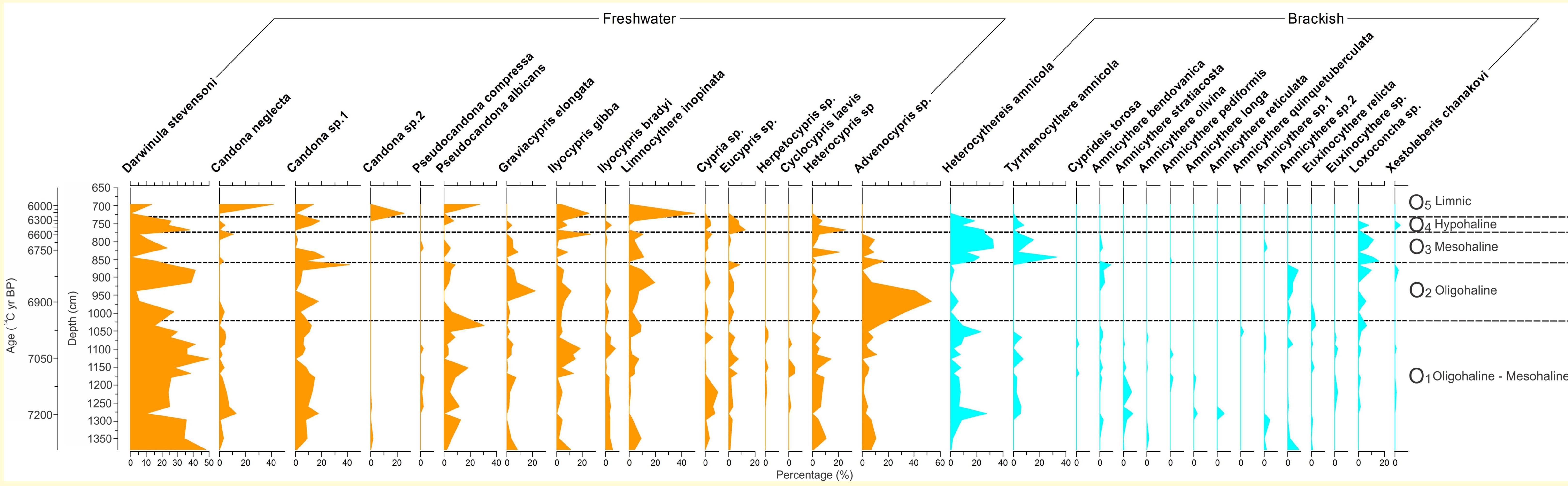

Fig. 2 Ostracod species and assemblages from Babele core

1) Ostracod assemblages

O1 (1380-1025 cm; 7300-6950 cal yr BP) Oligohaline– Mesohaline

- Freshwater specimens - 83% (*Darwinula stevensoni* 31%) (Fig. 2)
- Brackish ostracods represent constant occurences (*H. amnicola* 8%, *T. amnicola* 2.2%, *Amnicythere stratiacosta* 1.3%

O2 (1025-860 cm; 6950-6800 cal yr BP) Oligohaline

- Freshwater specimen abundance increases to 90% (*Darwinula stevensoni* and *Advenocypris* both with 23%)
- Dramatic decline of brackish species (*H. amnicola* 1.5%, complet disappereance of Amnicythere group

O3 (860-770 cm; 6800-6450 cal yr BP) Mesohaline

- Threefold decrease of *Darwinula stevensoni* abundance to 11%.
- Subtantial increase in mean relative abundance of brackish species with *H. amnicola* as the dominant species (24%), and *Loxoconcha* sp. (8.5%) and the emergent *T. amnicola* (13%) as important secondary occurrences

O4 (770-725 cm; 6450- 6250 cal yr BP) Hypohaline

- Re-increase percentages of freshwater species, on average 75% of the association. *D. stevensoni* becomes again the dominant species with a mean abundance of 29% followed by significant rises of mainly hypohaline specimens such as *Candona* sp. 1 (10%), *Heterocypris* sp. (12%), *Eucypris* sp. (9.3%)
- Brackish water ostracods record a decline in their diversity (2.3 species/sample in this section) with *H. amnicola* and *T. amnicola* down to 17% and 4%, respectively

O5 (725-650 cm; 6250- 5627 cal yr BP) Limnic

- Monotonous abundance of freshwater species. The ostracod diversity is down to 4 species per sample (from 9 species/sample in the unit underneath)
- Absence of brackish taxa

2) Paleoenvironmental evolution and depositional history

Fluvial-dominated phase (7500 - 7000 BP)

- High sedimentation rates, coarse sediments, sometimes well sorted sands indicate a high energy deposition environment (Fig. 3)
- The ostracod record shows a high species diversity and concentration reflecting the influence of interplay between the floodplain waters and nearby coastal brackish lagoons. Occasional peaks of the freshwater species Darwinula stevensoni which prefers clear-water bodies, implies episodic fluvial discharges
- We interpret the bottom part of the core corresponding to Unit 1, formed during ca. 7500-7000 cal yr BP, as a well-drained floodplain developed under the influence of a nearby active channel

Lacustrine phase/Open lake phase (7000/6200-5700 BP)

- Between 7000 and 5700 cal yr BP the sedimentary record indicates a progressive transition from a floodplain, with lakes still connected to the brackish coastal lagoons, to fully freshwater conditions with saline incursions
- Around 7000 cal yr BP, the rapid shift from the sand-dominated to the silt-dominated sediment type indicate the change to less energetic conditions specific to a poorly drained floodplain, possibly a lake fringe crevasse splay, fully exposed to river floods as indicated by the numerous terrigenous inputs with coarser fractions
- Between 6800 and 6450 BP, the marked increase in brackish species indicates a mesohaline environment induced by saline influxes in the system which could be related to the sea-level rise and/or the water exchange increase with the brackish lagoon.
- During 6450-6200 cal yr BP a rapid decrease of floodplain wetland salinity occurs as indicated by the ostracod association in zone O4. The latter horizon corresponds with the top of Unit 2A which indicates a fluvial reactivation or the advance of a river channel in the proximity which favored nearly freshwater (but still oligohaline) conditions. The presence of brackish ostracods reflects the influence of the coastal brackish lagoons nearby, though a few fresh species display relative growth such as the hypohaline Ilocypris gibba and Advenocypris sp, pointing to the onset of stagnant water conditions
- Around 6200 cal yr, BP within Unit 2B (725-660 cm) the transition to the quiescent open-lake conditions less dominated by direct fluvial influx is completed. The quiescent shallow open-lake sequence is characterized by an increase in sorting of the finer sediments while S and Fe/Mn increase. The strong match between lacustrine Unit 2B and the Zone O5 of the ostracod diagram (Fig. 4) points to floodplain water-freshening. It becomes a shallow river-connected delta plain lake, active during 6250-5700 BP, which remained distant (at ca 50 km) from the continuously prograding shoreline (Vespremeanu-Stroe et al., 2017) and at ca. 25 km west of the brackish lagoon (Preoteasa et al., 2021) to be further affected by the sea-level rise pulses.

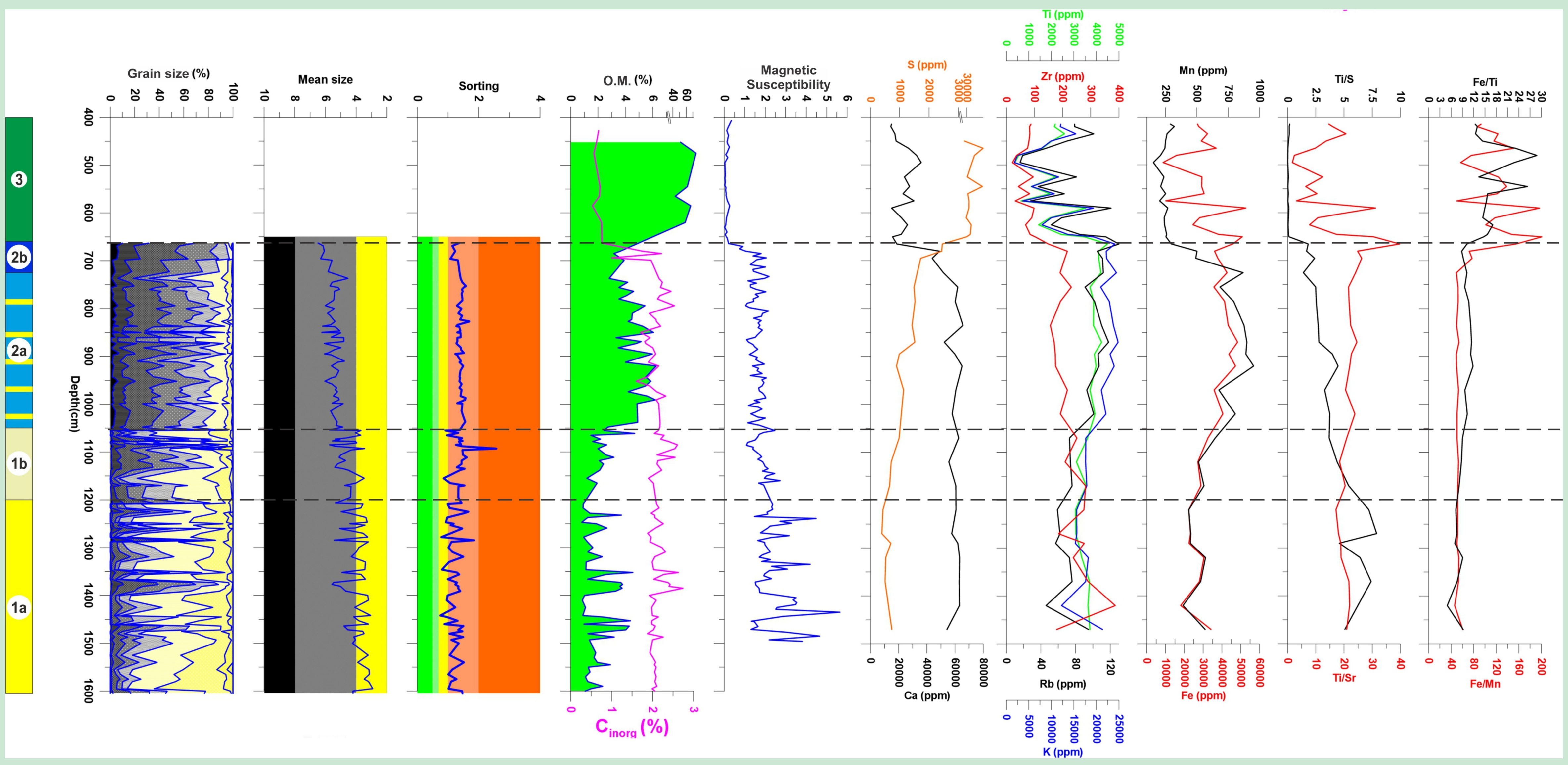

Fig. 3 Sediment properties and selected geochemical components alongside stratigraphical zonation

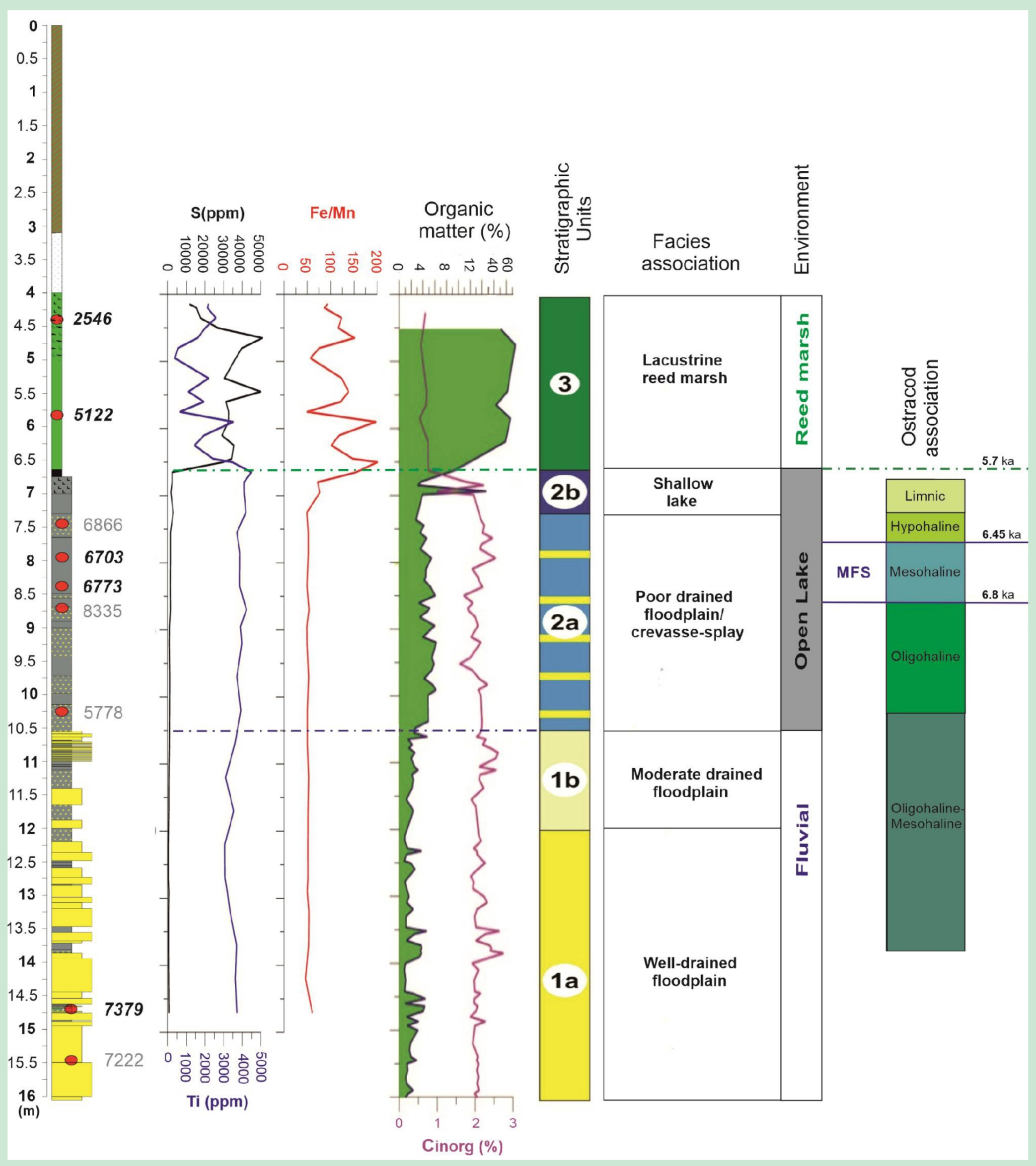

Fig.4 The evolution model reconstructed from Lake Babele, upper Danube delta

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