The Leeuwin Current System during the Early-Middle Pleistocene Transition (EMPT): foraminiferal assemblage and sea-level reconstruction

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KEY OBJECTIVES

- Constrain the response of the Leeuwin Current System to the EMPT by combining high-resolution shallow marine productivity data (Auer et al., 2021) with new benthic and planktonic foraminifera data.
- Reconstruct the local sea-level changes through plankton/benthos ratio (PF/BF) and benthic foraminiferal assemblage.

STUDIED TIME INTERVAL AND SITE LOCATION

The Early-Middle Pleistocene Transition (EMPT) represents a fundamental reorganization in Earth's climate system as the obliquity-dominated glacial/interglacial rhythmicity characterizing the Quaternary got progressively replaced by a high-amplitude, quasi-periodic 100 kyr cyclicity. This critical change in the climatic response to orbital cycles occurred without proportional modifications in the orbital-forcing parameters before or during the EMPT, implying a substantial change internal to the climate system.

We investigated an expanded EMPT section from International Ocean Discovery Program (IODP) Expedition 356 **Site U1460** (eastern Indian Ocean, 27°22.4949'S, 112°55.4296'E, 214.5 mbsl; Figure 1). The site is under the influence of the following water masses:

- Leeuwin Current System (LC),
- Leeuwin Undercurrent (LUC),
- West Australian Current (WAC).

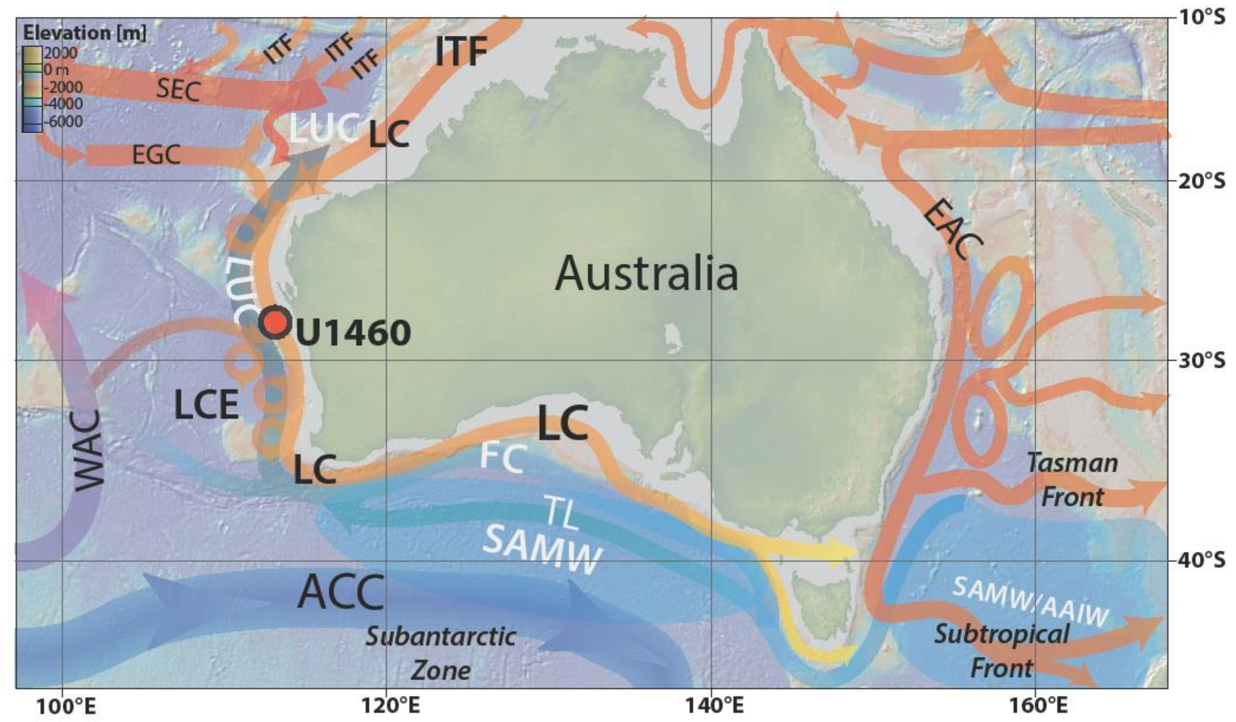

Figure 1: Closeup of the currents around Australia. Site U1460 is indicated in red (Auer et al., 2021).

MATERIAL AND METHODS

Hole U1460A, Subunit 1b: unlithified sediment (from sand to gravel) to partially lithified skeletal packstone (from Section 356-U1460A-14F-3 to Section 356-U1460A-24F-1) as well as partially lithified wackestone with mudstone intercalations (from Section 356-U1460A-24F-1 to Section 356-U1460A-35F-4; Figure 2).

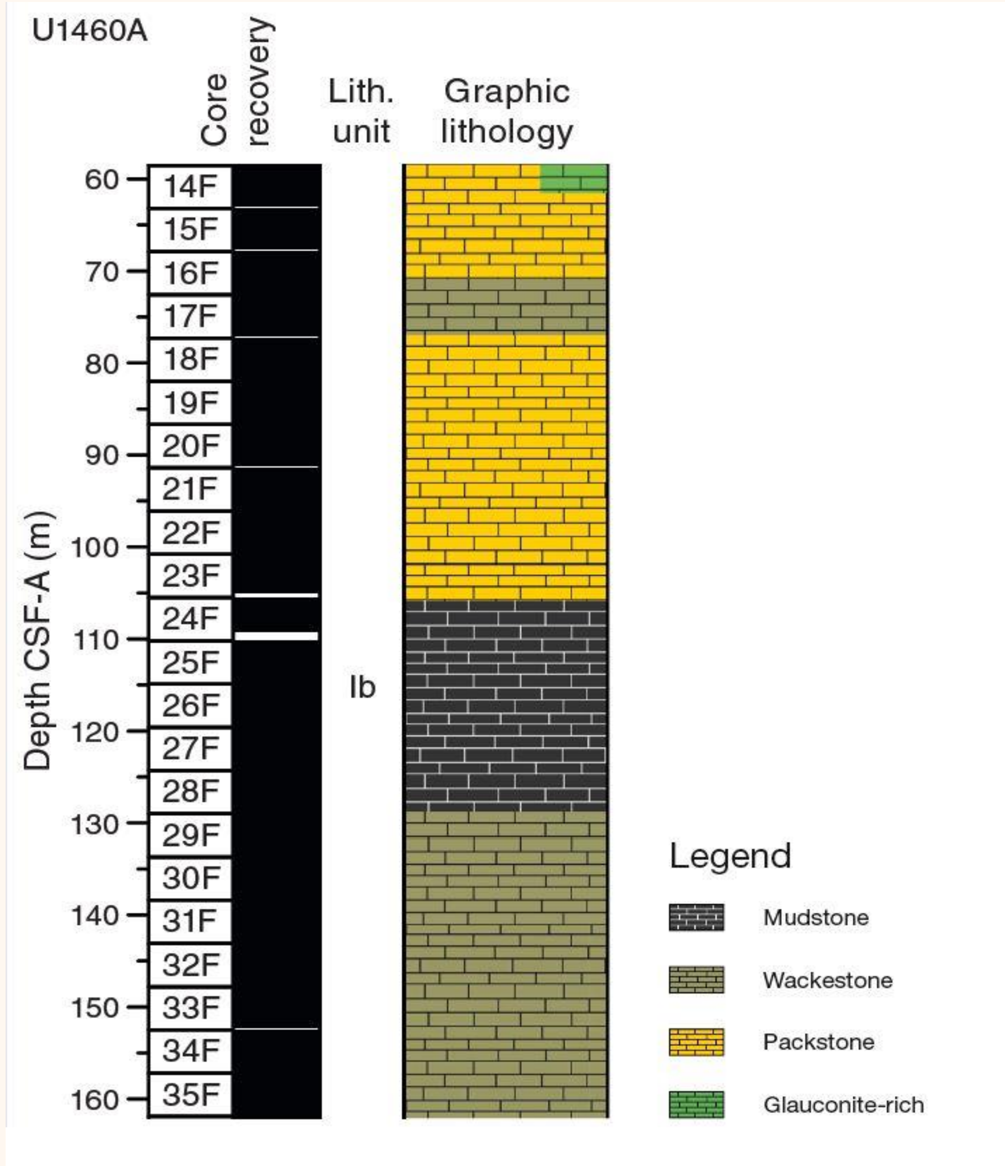

Figure 2: Lithological column of the studied stratigraphic interval at Site U1460 (modified after Gallagher et al., 2017).

The main complication faced during the processing of the material was the severe encrusting which made all the diagnostic features of the specimens difficult to detect. Since the traditional sieving technique was not sufficient to obtain specimens clean enough for picking and identification, an extensive washing procedure was developed, including the use of the freeze-drying process and repeated soakings in H_2O_2 solution (Figure 3a, b).

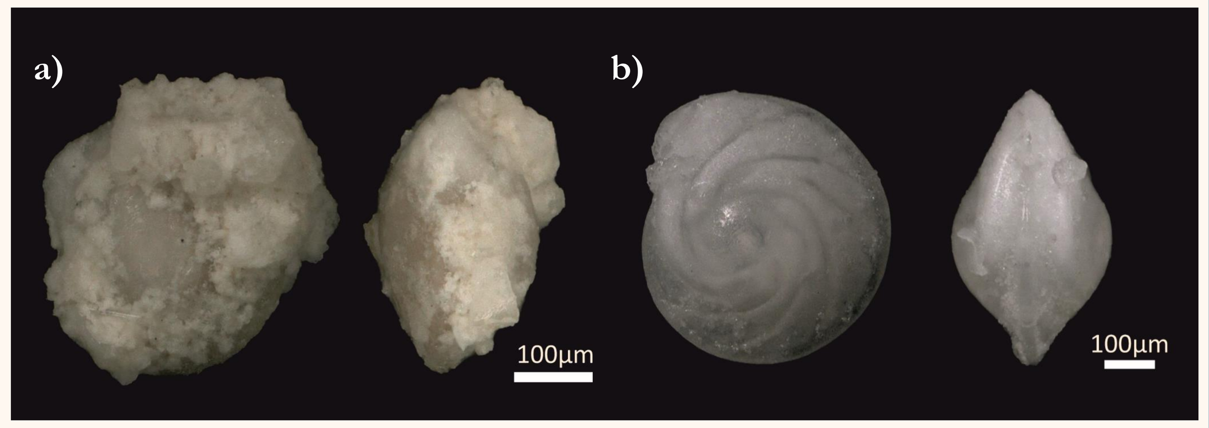

Figure 3: (a) Specimen of *Lenticulina* sp. after one wash with the standard sieving technique; (b) Specimen of *Lenticulina suborbicularis* obtained with the enhanced cleaning protocol.

RESULTS: FORAMINIFERAL ASSEMBLAGE

Preliminary data of the microfossil content revealed a polyspecific benthic foraminifera assemblage with high diversity (Figure 4). The most abundant taxa are trochospiral forms (e.g., *Cibicides*, *Cibicidoides*, *Heterolepa*, *Nuttallides*, *Eponides*). Triserial and biserial taxa are abundant (e.g., *Textularia*, *Spirotextularia*, *Gaudryina*, *Bolivina*, *Uvigerina*). Planispiral tests such as *Melonis* and *Lenticulina* are also commonly present, as well as uniserial ones such as *Siphogenerina*, *Lagena*, and *Cerebrina*. Concerning the preservation, benthic foraminifera are poorly to moderately preserved during glacial stages while exhibiting moderate to good preservation in the interglacials (Figure 5).

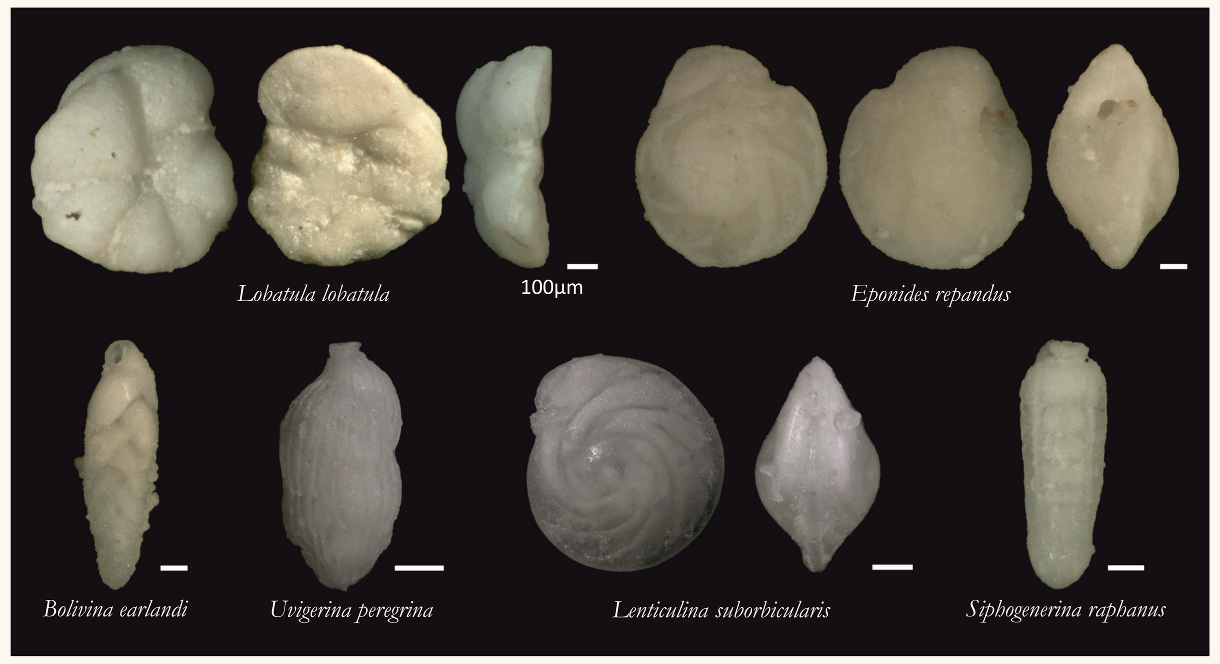

Figure 4: Selection of taxa representing the benthic foraminifera assemblage. All the specimens were imaged using a VXH-6000 Keyence digital microscope. All scale bars are 100µm.

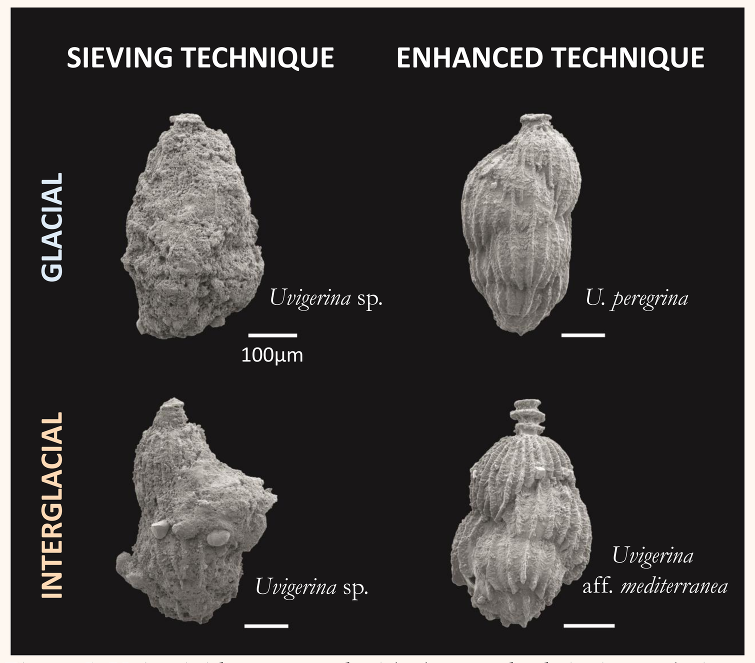

Figure 5: Uvigerinids processed with the standard sieving technique and with the enhanced cleaning protocol. All specimens were imaged at 5kv external secondary electron (SE) detector.

RESULTS: SEA-LEVEL RECONSTRUCTION

Low to mid-latitude shelf regions are strongly sensitive to glacial/interglacial sea-level oscillations. The variations in the PF/BF ratio allowed to constrain the sea-level changes along the Australian shelf (Figure 6). Specifically, higher and lower values of this ratio indicate highstand and lowstand phases, respectively.

In this regard, foraminifera data will be integrated with a multiproxy dataset available for Site U1460 to obtain new insights on sea-level-driven environmental changes in the area during the EMPT. This, in turn, will allow to resolve the impact of local versus global climatic change across the studied interval.

$$P(\%) = \left(\frac{P}{(P+B-S)}\right)$$

$$Depth(m) = e^{3.58718} + 0.03534 * P(\%)$$

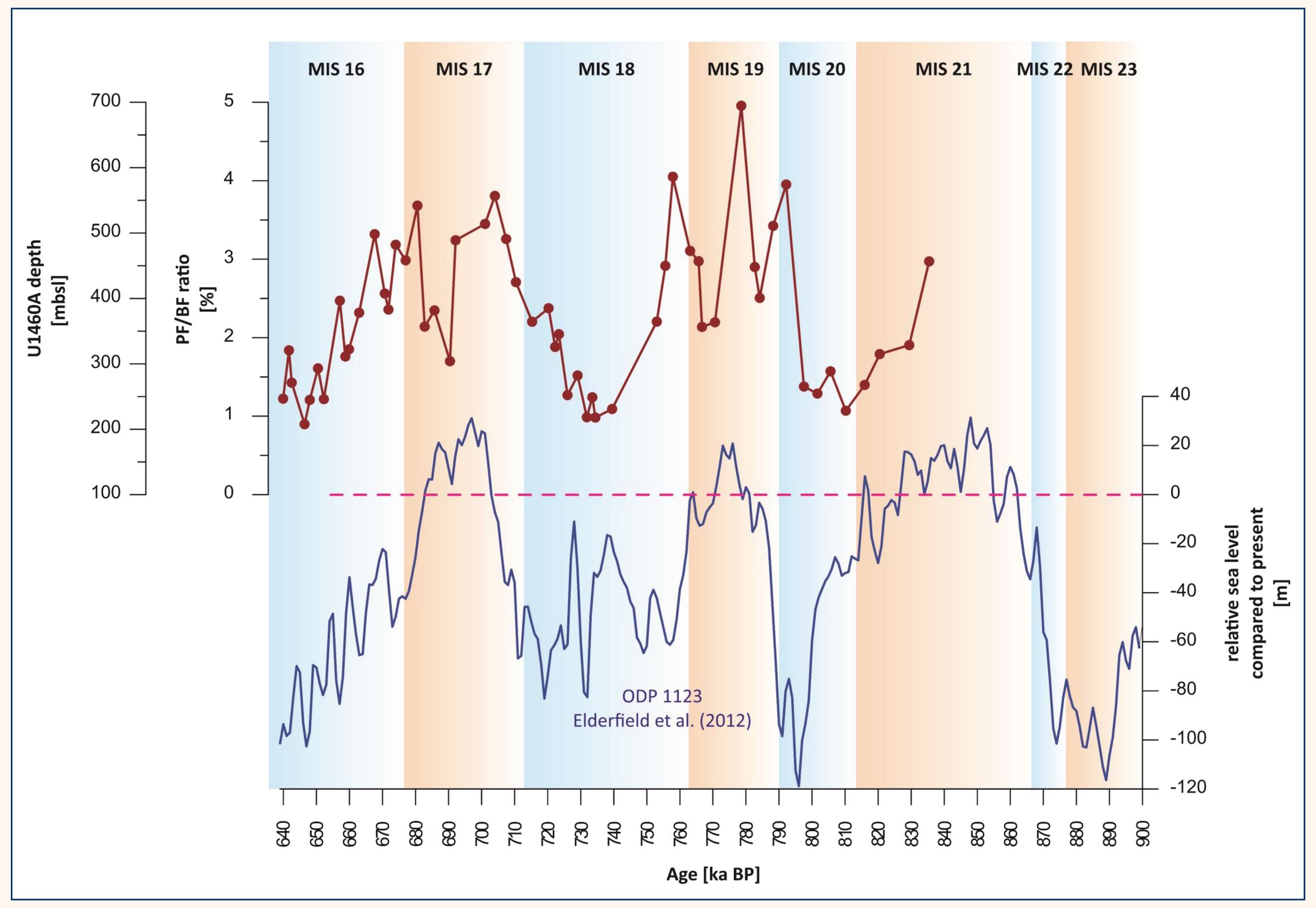

Figure 6: Site U1460 Hole A PF/BF ratio (red curve) compared to the global sea level curve (blue curve) of Elderfield et al. (2012). Site U1460 Hole A paleodepth is also expressed in mbsl, obtained with the formula of Van der Zwaan (1990) (red curve). The modern sea level is marked with the pink dashed line.

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