Sea level oscillations within the Last Interglacial: insights from coral reef stratigraphic forward modelling

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WARMCOASTS — Work Package 4 — REEF STRATIGRAPHIC FORWARD MODELLING

1. PROBLEMATIC

Were there any **abrupt sea-level** changes during the **Last Interglacial** *(LIG, MIS 5e, ~122 ka ago)* ?

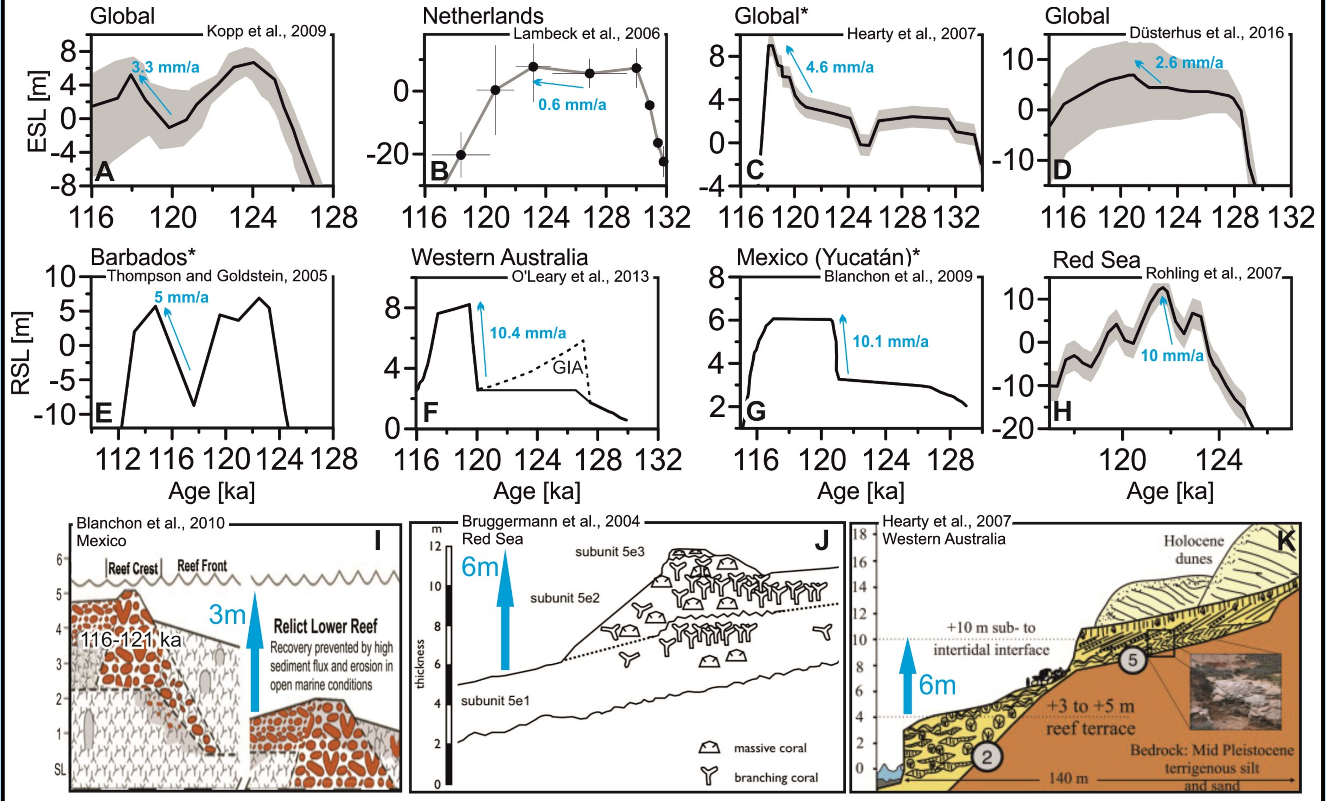
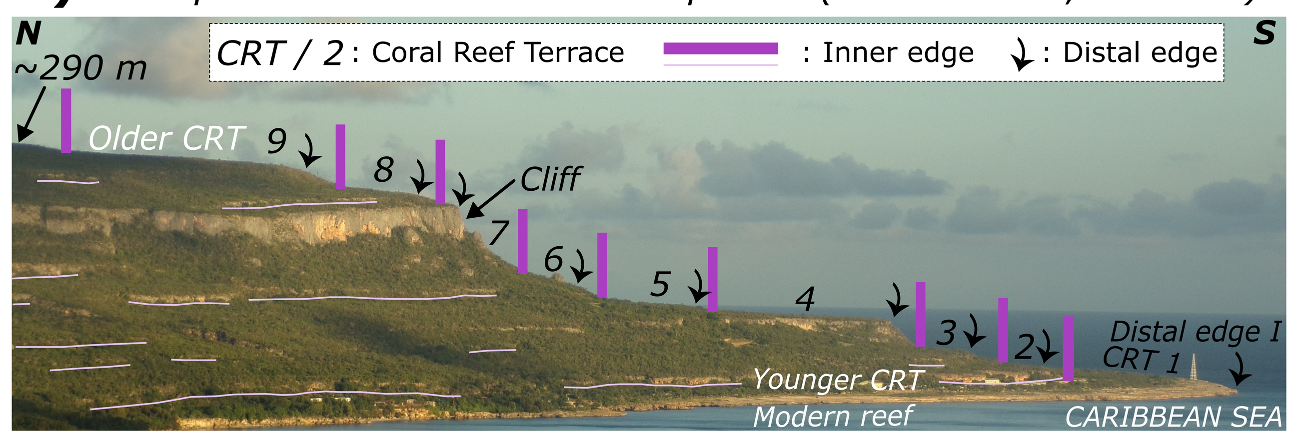


Fig.1. Sea-level variations at LIG (Kopp et al., 2017). Most of the multi-peak sea-level curves are derived from studies of coasts exposing double/multiple LIG fossil coral reefs

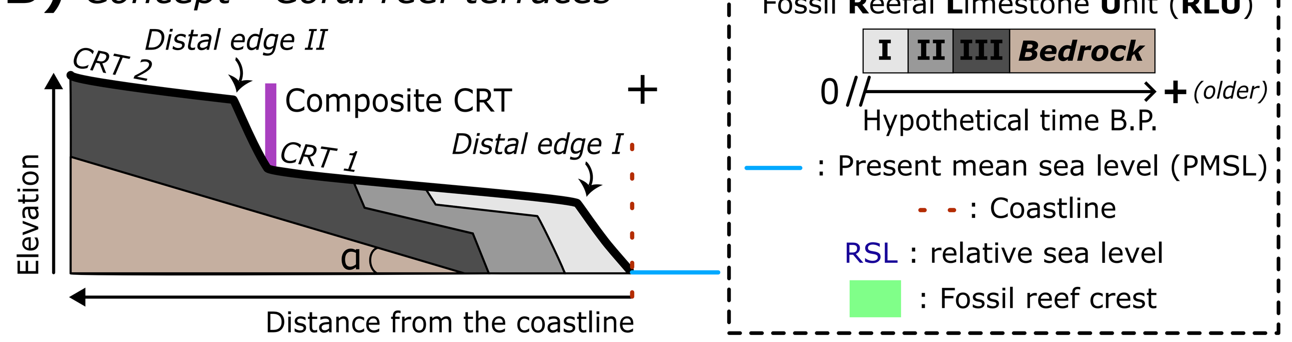
Coastal sequence characterized by **abrupt shifts** in their geological **facies** or **steps** within the **reef** topography

2. CONCEPT

A) *Example of coral reef terrace sequence (Punta Caleta, SE Cuba)*



B) *Concept - Coral reef terraces*



C) *Concept - Backstepped fossil coral reef*

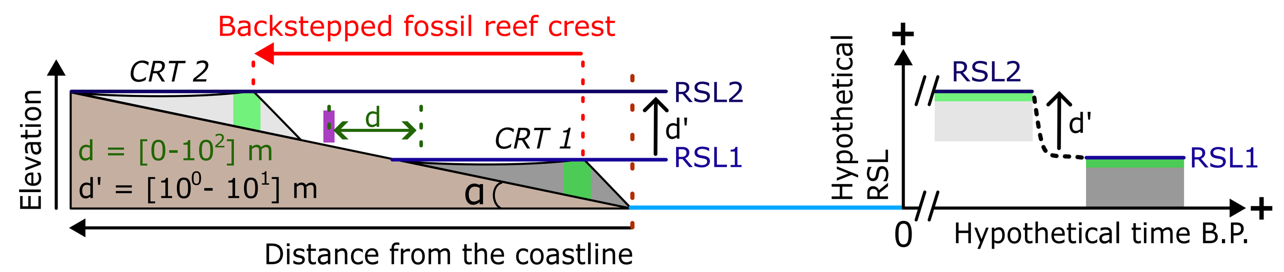


Fig 2. A) View from the west of Punta Caleta (SE Cuba). The CRT sequence visible in the image is around 1.5 km long. The inner edges drawn on the image are only those visible and therefore do not represent all of those mapped by Peñalver et al. (2021). The highest CRT is estimated to be several million years old (Authemayou et al., 2023). Schematic concept of **B)** a CRT including several reefal limestone units and **C)** a backstepped fossil CRT. The process of backstepping consists of the abrupt demise of a reef (CRT 1) and the construction of a new reef surface (CRT 2), topographically higher than the previous one. The cause of reef backstepping is a rapid rise in RSL (elevation d', i.e., the difference between RSL1 and RSL2), which drowns the older reef and prevents coral growth due to the RSL rising faster than the reef growth rate. CRTs 1 and 2 may be separated by relatively long distance (d; e.g., Blanchon, 2010).

3. METHODOLOGY

Wide range of values for each parameters + 17 **sea-level** scenarios = **~50 000** simulations

Modelling fossil coral reefs with **REEF code**

(Husson et al., 2018; Pastier et al., 2019)

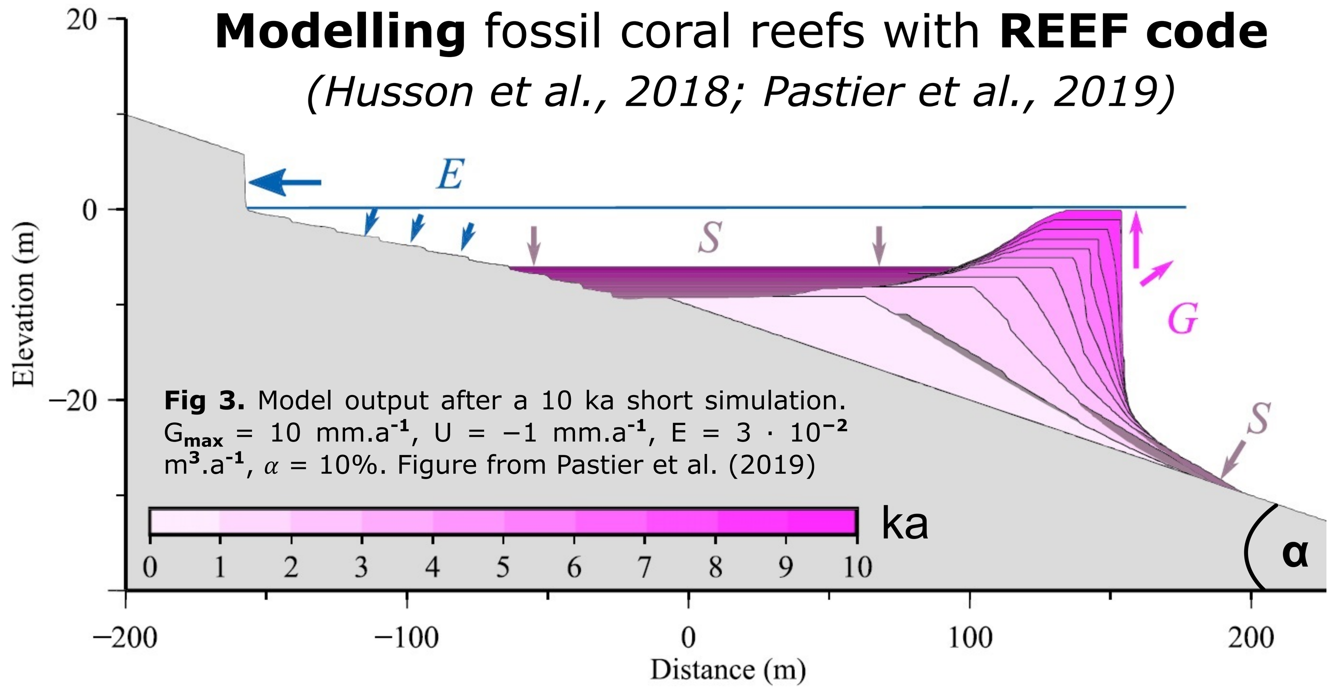


Fig 3. Model output after a 10 ka short simulation. G_{max} = 10 mm.a^{-1}, U = −1 mm.a^{-1}, E = 3 · 10^{-2} m^{3}.a^{-1}, α = 10%. Figure from Pastier et al. (2019)

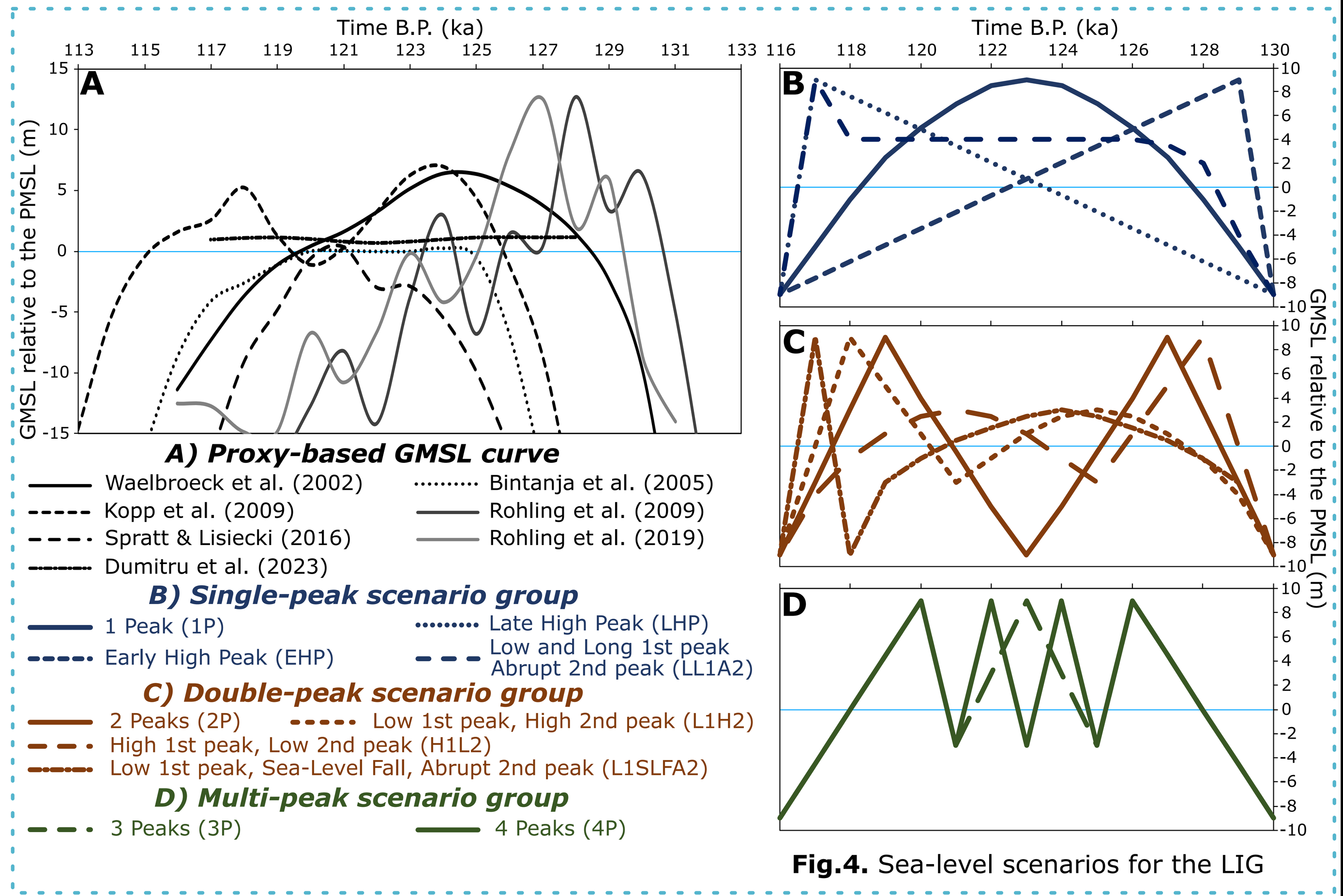


Fig.4. Sea-level scenarios for the LIG

SCORING APPROACH

1) One emerged fossil reef / **2) Multiple** emerged fossil reefs / **3)** The **youngest** fossil reef lies **above** the **oldest**

4. RESULTS - BACKSTEPPED FOSSIL CORAL REEF

The simulation set from the **sea-level** curve of ***Rohling et al. (2009)***

is the **only one** showing the formation of a **LIG backstepped reef**

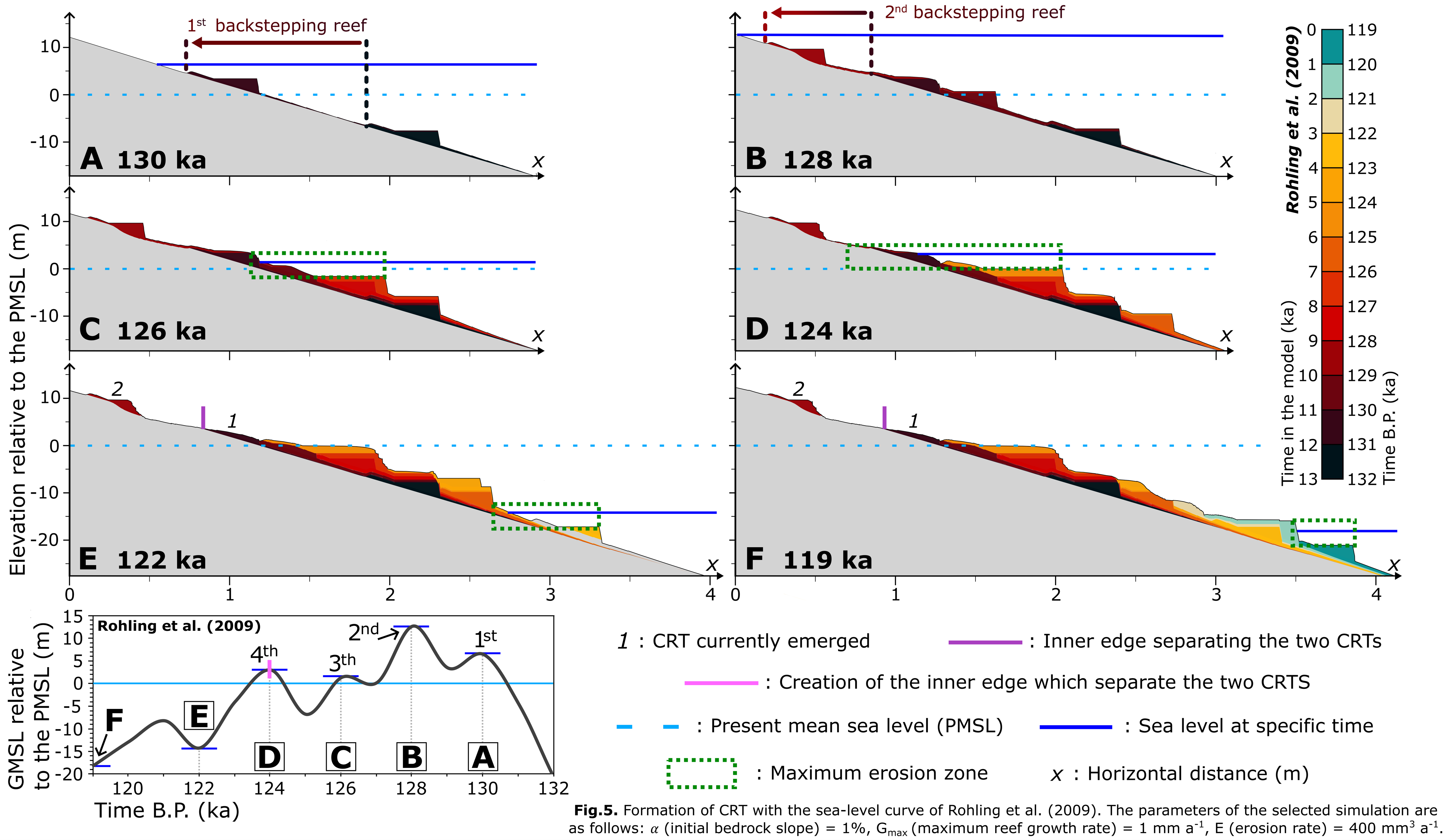


Fig.5. Formation of CRT with the sea-level curve of Rohling et al. (2009). The parameters of the selected simulation are as follows: α (initial bedrock slope) = 1%, G_{max} (maximum reef growth rate) = 1 mm a^{-1}, E (erosion rate) = 400 mm^{3} a^{-1}.

5. RESULTS - MARINE EROSION VS BEDROCK SLOPE

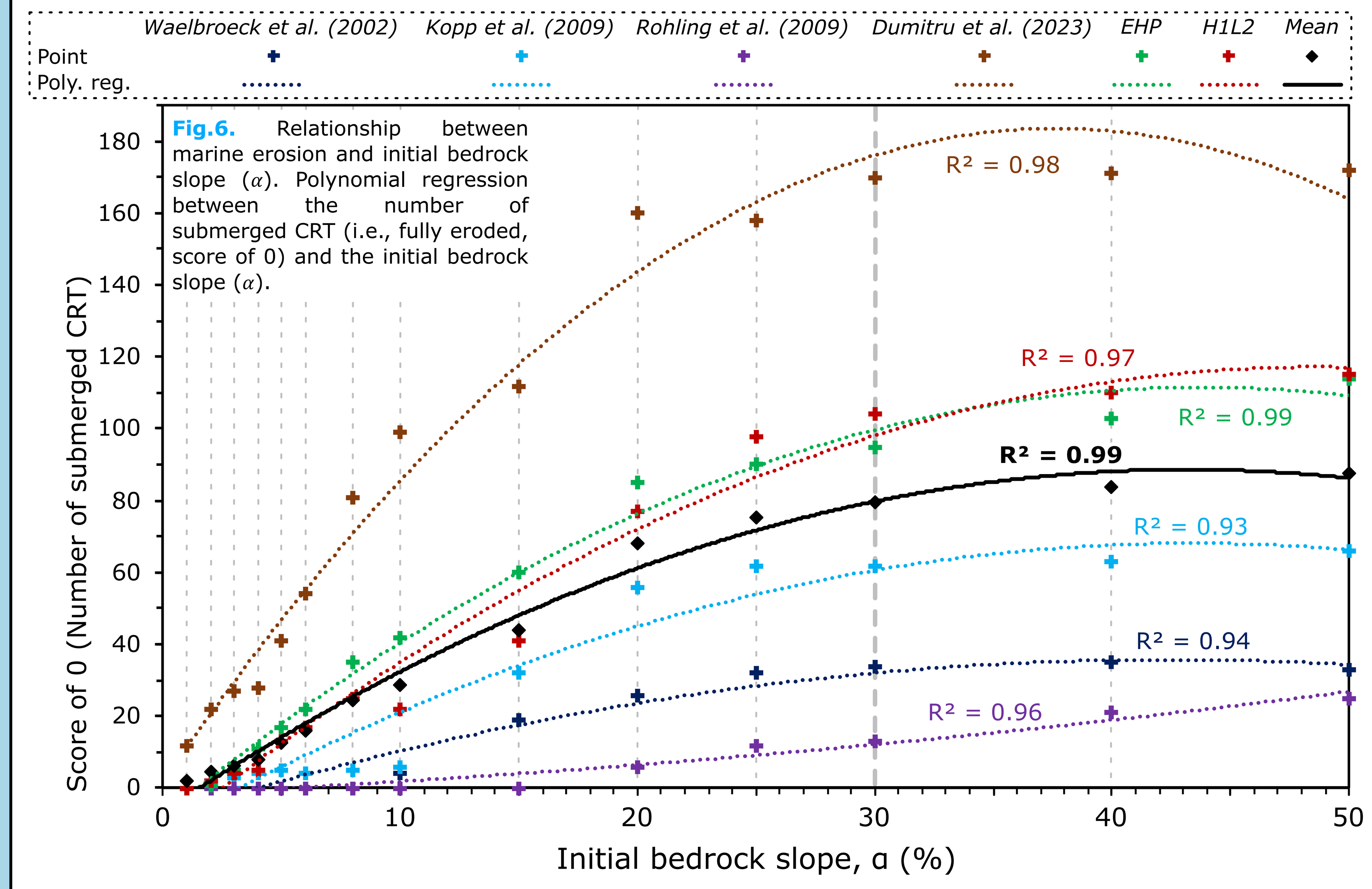


Fig.6. Relationship between marine erosion and initial bedrock slope (α). Polynomial regression between the number of submerged CRT (i.e., fully eroded, score of 0) and the initial bedrock slope (α).

The **greater** the **bedrock slope**, the **more easily** the emerged fossil reef will be **eroded**

6. CONCLUSION

- The only **sea-level** history that could explain the generation of an emerged **LIG backstepped reef** is a **first sea-level** peak followed by an **abrupt rise** in **sea level** and a **second short-term peak**
- Any other **multiple-stepped stratigraphy** *(Fig. 1)* can be explained by the **interplay** between **reef growth**, **marine erosion** & **bedrock slope**
- **Marine erosion** is **major shaping agent**, as it can strip recent reefal limestone units to expose older ones, leading to chrono-morpho-stratigraphies that can be misinterpreted

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