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Thibaud Lortie, José Ignacio Cuitiño, Bernadette Tessier, Jean-Yves Reynaud, Roberto Adrián Scasso, et al.. Rhythmites preserved into intertidal flat successions of the hypertidal Santa Cruz – Chico River estuary (Southern Patagonia, Argentina). IAS 2024, Jun 2024, Aberdeen (Scotland), United Kingdom. hal-04654564

HAL Id: hal-04654564

<https://hal.science/hal-04654564>

Submitted on 19 Jul 2024

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Rhythmites preserved into intertidal flat successions of the hypertidal Santa Cruz – Chico River estuary (Southern Patagonia, Argentina)

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INTRODUCTION

Within tide-dominated estuaries, upper intertidal sediment successions frequently contain well-preserved tidal rhythmites, basically recording semi-diurnal to neap-spring-neap cycles, eventually annual cycles in the uppermost part of the successions, and that provide valuable information on hydrosedimentary processes and sedimentation rates.

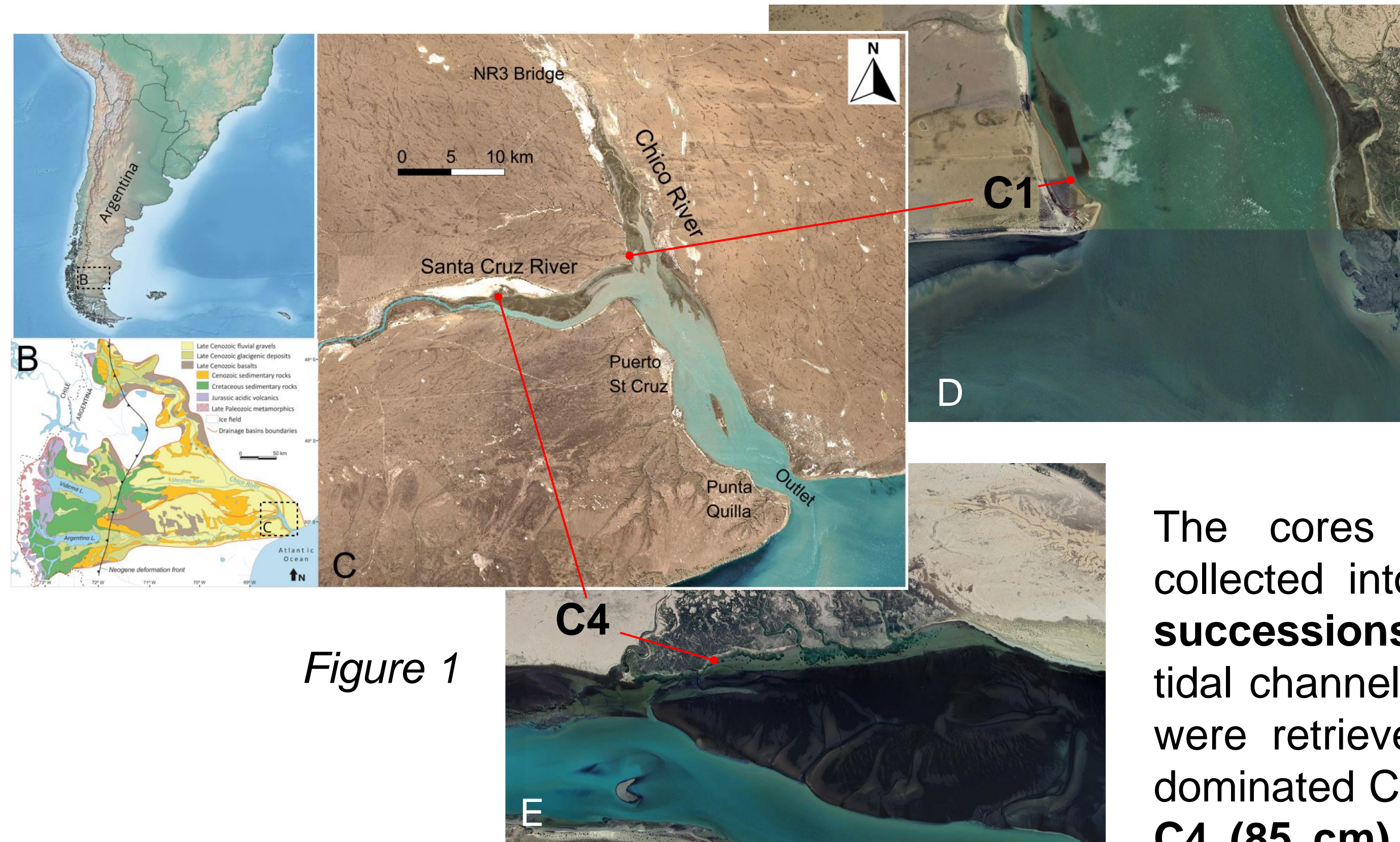


Figure 1

STUDY SITE

Short sediment cores were retrieved from the hypertidal (12 m tidal range) Santa Cruz-Chico River (SC-CR) ria-type estuary (Southern Patagonia, Argentina, Fig. 1). Tidal dynamics are dominant along the Chico river arm, the fluvial discharge of which is low. In contrast, the water discharge of the Santa Cruz River is much higher so that the influence of tidal dynamics drops down at about 20 km upstream. Extensive sandy to muddy tidal flats develop along the edges of the outer portion of the two arms.

CORED SUCCESSIONS

The cores studied (C1 & C4) were collected into **upper intertidal sediment successions** that appear along secondary tidal channel cutbanks. **Core C1 (114 cm)** were retrieved at the mouth of the tide-dominated Chico River arm (Fig. 1D), **core C4 (85 cm)** at about 14 km upstream of the mouth of the tide-influenced Santa Cruz arm (Fig. 1E). They both reveal well-developed rhythmic layering, resembling tidal rhythmites (Fig. 2). Above tidal flat succession, salt marsh sequences display as well rhythmic bedding, the origin of which is probably annual (Fig. 2).

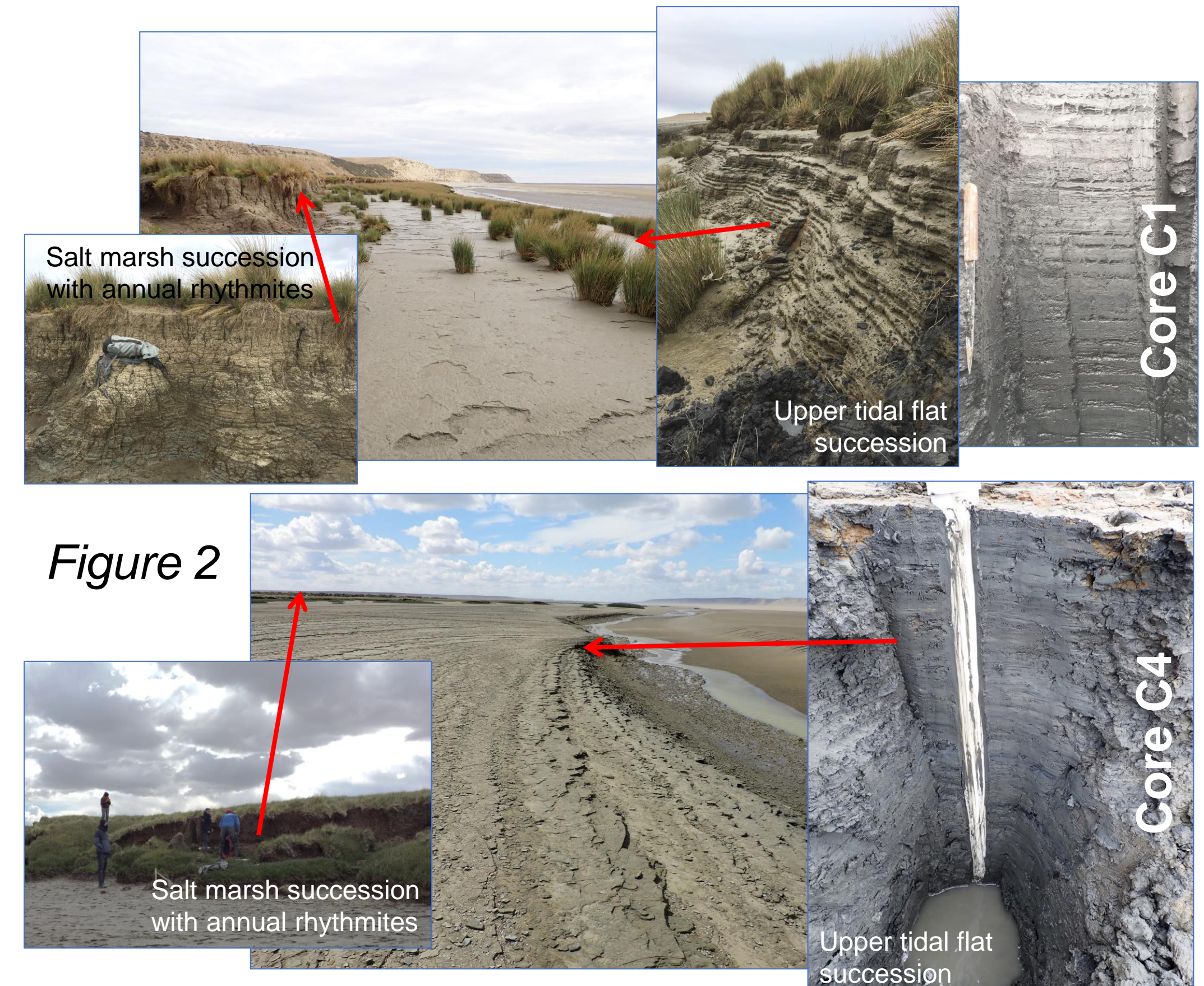


Figure 2

UPPER INTERTIDAL RHYTHMITE DESCRIPTION

Cores C1 and C4 both show sand-dominated beds alternating with mud-dominated beds (mdb, red arrows on Fig. 3 & 4). Thickness of «mdb-to-mdb» packages ranges from a few mm to a few cm. Some of the packages clearly contain sand-mud couplets, of varying thickness and shape (location: light blue rectangles). These **packages** are typical tidal rhythmites recording **neap-spring-neap (semi-lunar) cycles**. Other packages do not clearly show sand-mud couplets, mdb look amalgamated. Such packages are well expressed in C1 (Fig. 3). In C4, mdb are locally poorly discernible (Fig. 4).

RHYTHMITE THICKNESS MEASUREMENTS

Assuming that all mdb-to-mdb packages could represent the record of semi-lunar cycles, their thicknesses have been measured along both cores (blue histograms on Fig. 3 & 4).

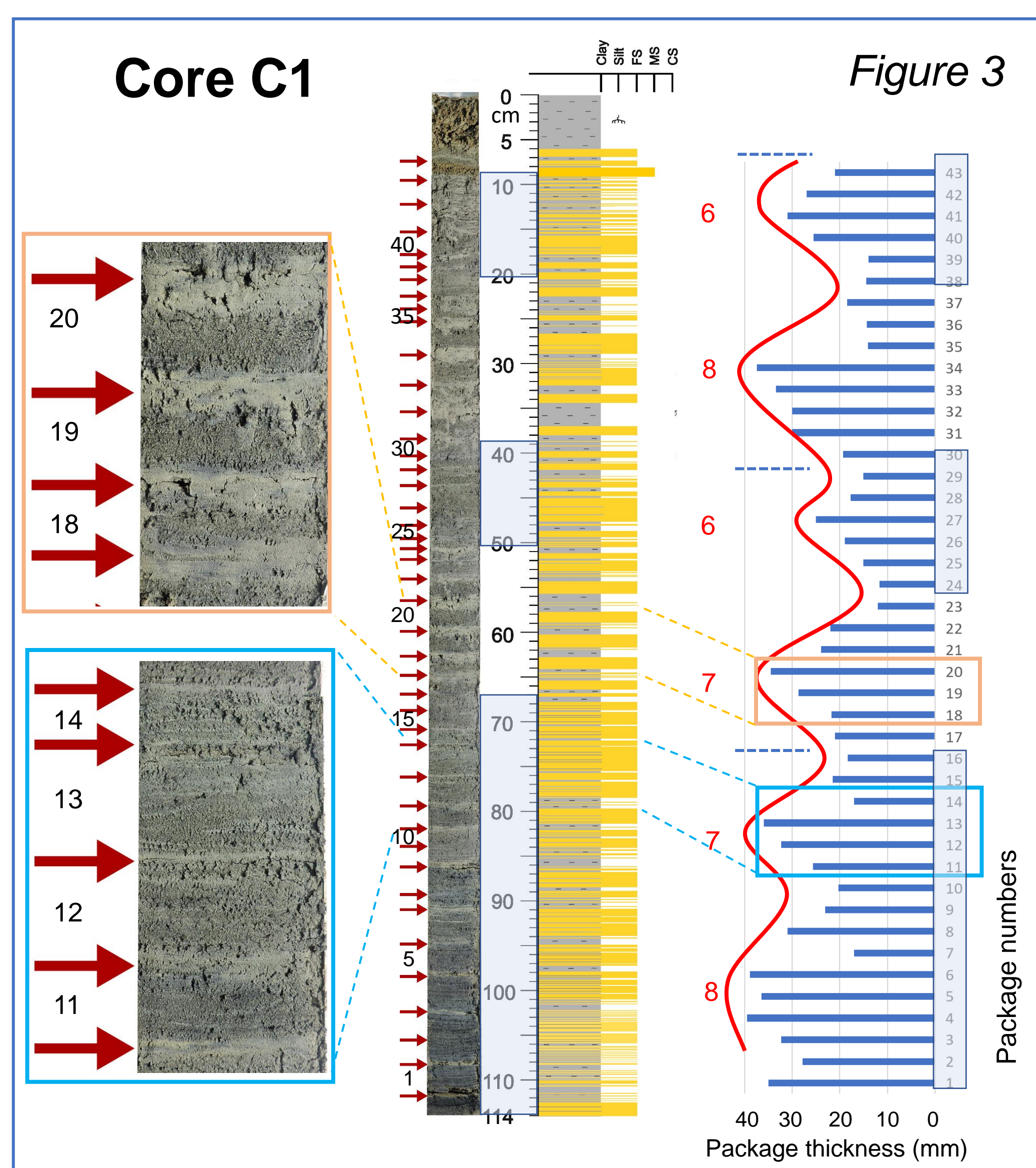


Figure 3

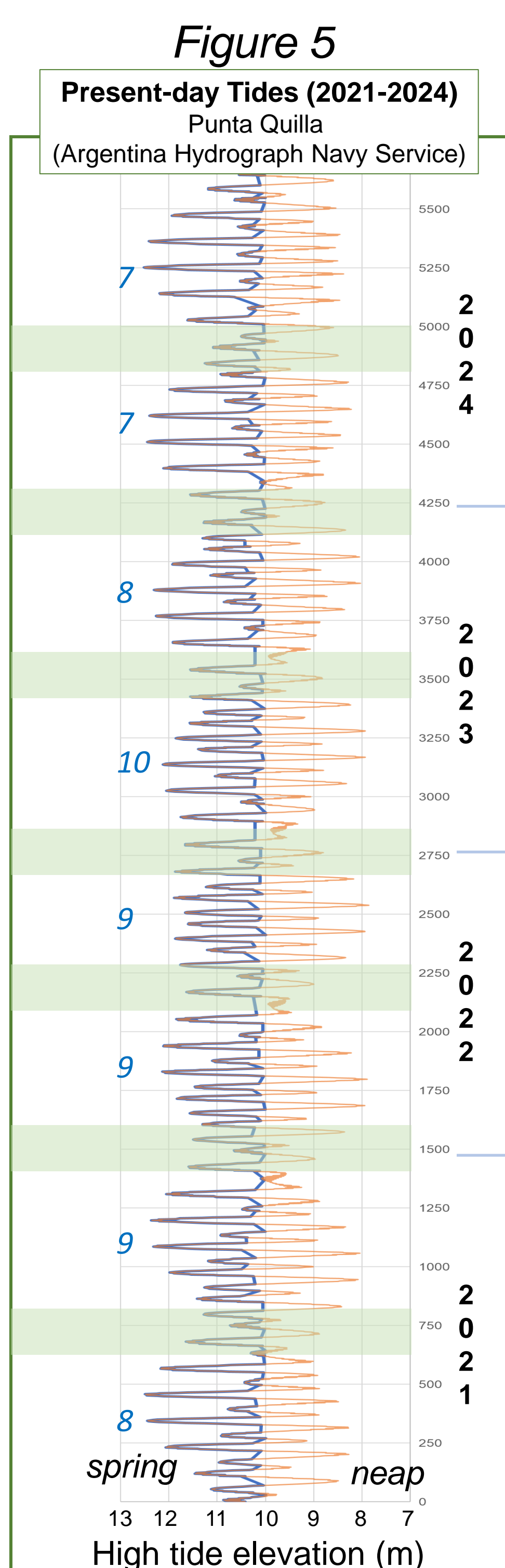


Figure 5

RESULTS

Thickness evolution of mdb-to-mdb packages show a cyclic pattern (smoothed red curve on Fig. 3 & 4) with successive thickening and thinning. The cyclic pattern is especially well expressed on **core C1** (Fig. 3), with an average number of 7 mdb-to-mdb packages per cycle. Along **core C4** a cyclic evolution is barely detected (Fig. 4). Cycles contain between 4 and 9 packages.

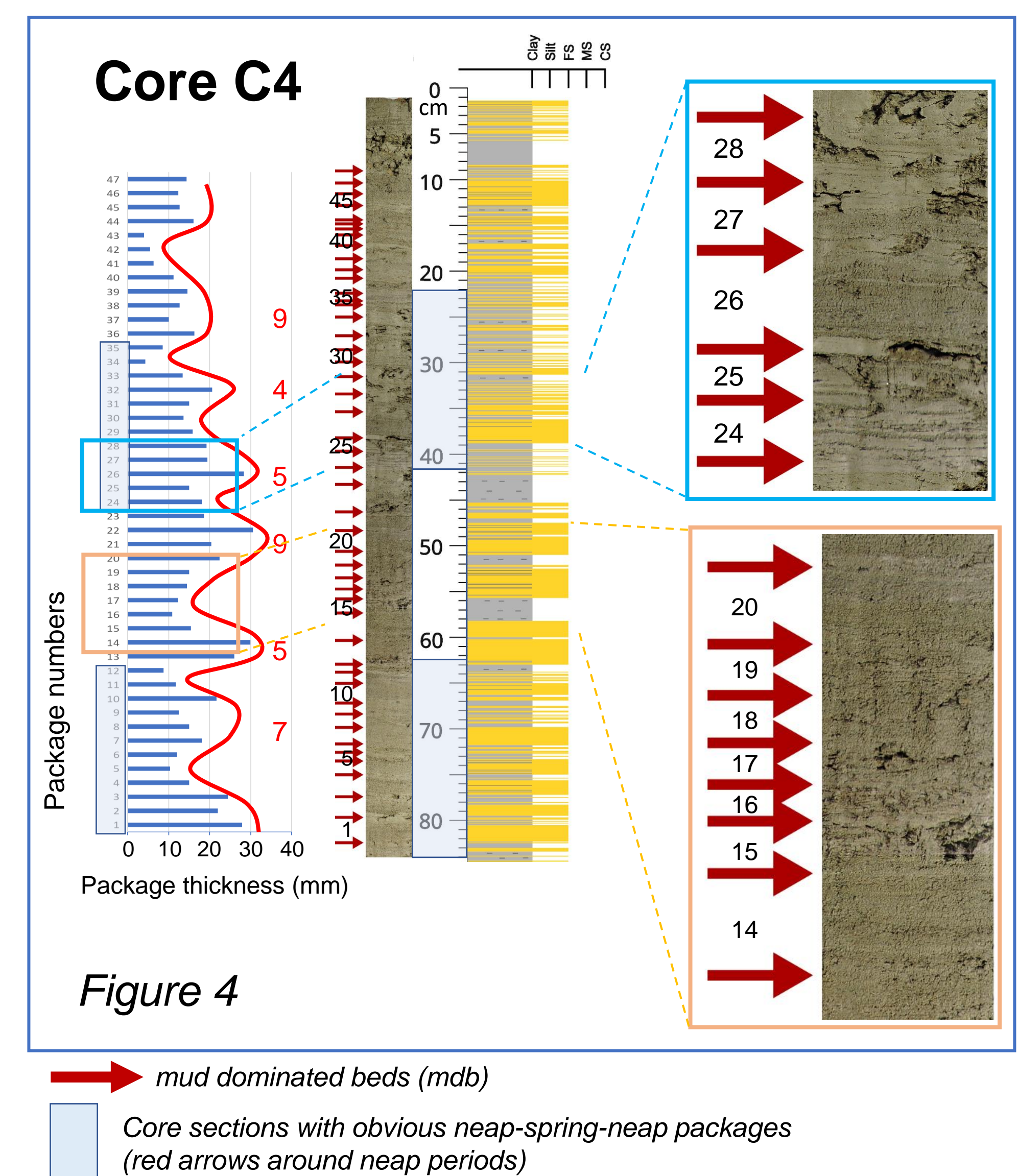


Figure 4

INTERPRETATION - DISCUSSION

The elevation of the 2 sites is about 10-10,5 m above lowest tide level, meaning that only spring tides can reach them.

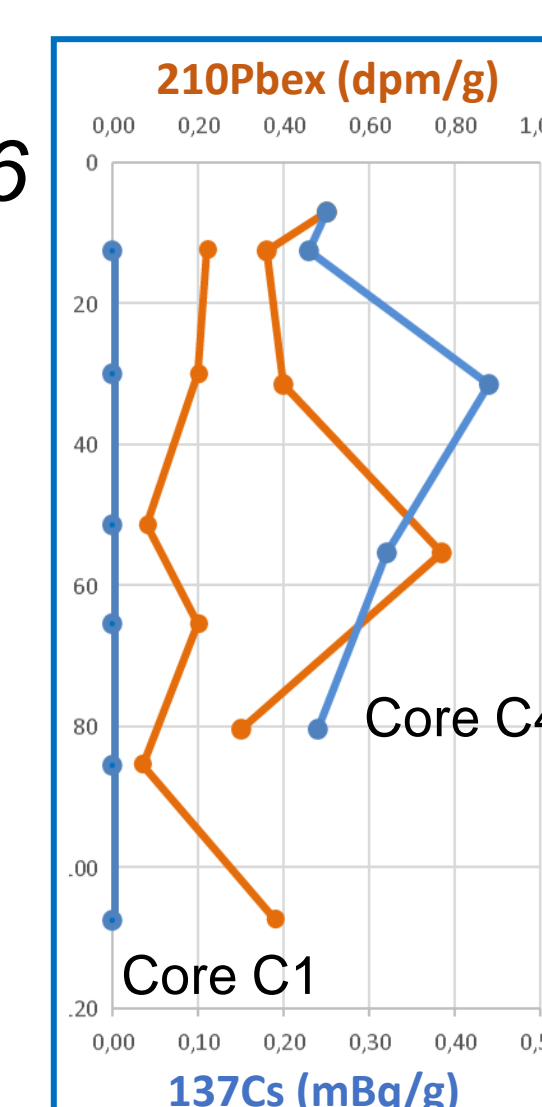
Present-day high tide level variations (Fig. 5) show typical semi-annual cycles (equinox-solstice-equinox), comprising ca. 12 semi-lunar cycles. Above an elevation of 10 m (purple curve Fig. 5), less than 10 spring tide periods in average, in some case only 7, over 12, are effective.

Based on the comparison with present-day tidal data, **all mdb-to-mdb packages** in core **C1** are inferred to be **semi-lunar cycles**, and the **lower cyclicity semi-annual**. Within the **3-year record**

contained into **C1**, semi-lunar cycles with **amalgamated mdb** typify only a part (half) of years 2 and 3. Their occurrence could thus be of **seasonal origin** (fluvial fine-grained sed. discharge > tidal dynamics?).

The signal in core **C4** is more difficult to decipher. The site is exposed to waves and eolian sand supply induced by permanent westerlies, and is influenced by the highly fluctuating fluvial discharge and levels of the Santa Cruz river. C4 probably features a **very disturbed tidal signal**.

Figure 6



Very high sedimentation rates are confirmed by **210Pbex** measurements. **137Cs** data highlight that the successions have deposited **at least a few decades ago**, i.e. > 50 years at least, C4 being probably younger (Fig. 6).

CONCLUSION

Upper tidal flat successions preserved into the internal domain of the hypertidal SC-CR estuary record tidal cyclicities, modulated (C1) to highly disturbed (C4) by seasonally changing hydro-sedimentary conditions according to tidal flat exposure. **137Cs** data suggest that the studied tidal flats are in course of abandonment, maybe due to the regional uplift context.