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Lower to Middle Pleistocene coastal deposits form western Eivissa (Western Mediterranean): chronology and evolution

Photography encouraged

BABEŞ-BOLYAI UNIVERSITY

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ABSTRACT

Colluvial and aeolian successions in coastal environments are useful indicators of geomorphological changes that occurred during the Pleistocene. By their study it possible to unravel the evolution of the coastal landscape. Pleistocene aeolian deposits interbedded with colluvial deposits and palaeosols have been observed in areas of Cap Negret, Punta de sa Pedrera, Cala Bassa and Cala Compte, western coast of Eivissa. These deposits span almost continuously along 14 km of the coast, covering an area of approximately 22 km^2. Here we present a sedimentological and stratigraphical description of these Pleistocene outcrops. Five major sedimentary facies have been described involving the succession of aeolian, colluvial and edaphic environments. Carbonate sandstones, breccias, conglomerates and fine-grained deposits are the main components of these sequences. OSL dating of 15 samples collected from aeolian levels indicates that their deposition took place from Lower to Middle Pleistocene. The sedimentological and chronological analysis of these deposits allows reconstructing the coastal Pleistocene environmental history from MIS 26 to MIS 6. We are showing that while wind direction and coastal relief are major controls on Lower to Middle Pleistocene coastal landscape evolution on western Eivissa, episodes of aeolian activity and dune formation in the Western Mediterranean can be linked to periods of low sea level.

FIELD SITE

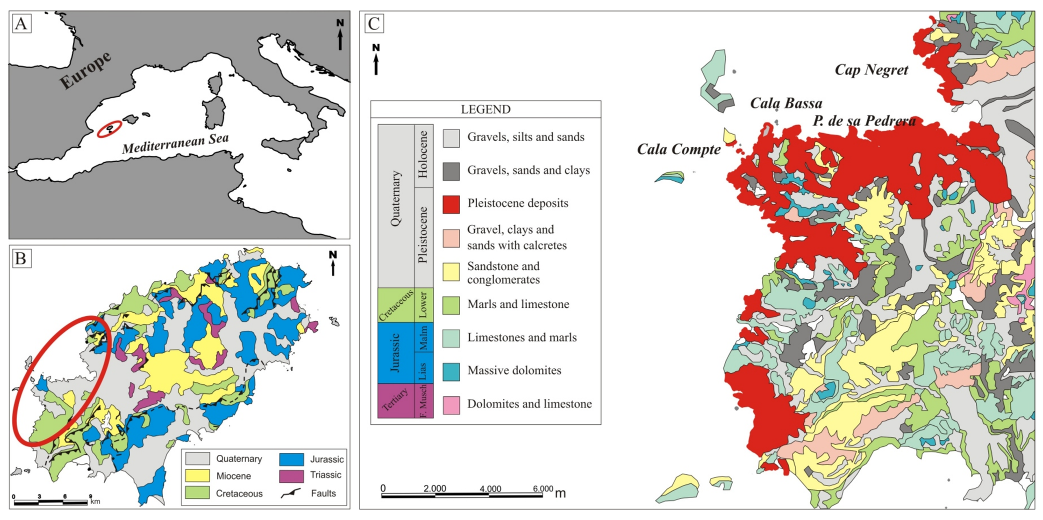


Fig. 1 Study sites in Eivissa

The island of Eivissa is the most western island from the Balearic islands, is located in the south-western part of the Mediterranean Sea.

The main structure of the island is composed of a series of thrust sheets (mainly of Middle Triassic to Middle Miocene carbonate deposits) emplaced during the Alpin compression and trending NE-NW.

MATERIALS AND METHODS

Stratigraphy and Sedimentology

4 coastal sites: *Cap Negret, Cala Compte, Cala Bassa* and *P. de sa Pedrera*.

Cross-bed dip direction, grain size and ***mineralogy analysis***.

68 vertical logs were measured and correlated based on major unconformities and homogeneous units, bounding surfaces or according to the presence of continuous palaeosols.

At each log **major units** were characterized in terms of grain size, composition and mineralogy.

OSL analysis

15 samples: rock bloks (~80x80 x 60 cm) from the **aeolian deposits**, extracted from the stratigraphic representative layers of the succession.

RESULTS

	FACIES	DESCRIPTION	INTERPRETATION	Photography
Aeolian facies	Sel	Very pale brown bioclastic sandstone. Well sorted medium to coarse-grained sand. Horitzontal to sub-horitzontal bedding up to 0.5 m thick with internal lamination of 5 cm. Root traces.	**Aeolian Sand-sheets dep.**	11 cm
Aeolian facies	Sht	Very pale brown bioclastic sandstone. Well sorted fine grained sand. Trough cross-bedded. Root traces.	**Parabolic and climbing dunes Dep.**	15 cm
Aeolian facies	Shu	Very pale brown bioclastic sandstone. Well sorted fine to medium grained sand. Cross to horitzontal bedded. Root traces.	**Parabolic dunes Dep.**	8 cm
Colluvial facies	Bsc	Yellow silty matrix-supported breccia. Clasts are angular to subangular pebbles to cobbles. Sandy levels.	**Debris-flow dep.**	
Colluvial facies	Bmn	Reddish muddy matrix-supported to clast-supported breccia. Clasts are angular to subangular pebbles. Channel- like structures.	**Slope-wash dep.**	5 cm
Palaeosols	Pmn	Reddish yellow mudstone. Very plastic fine sediments banded by rich in iron layers.		
Palaeosols	Par	Very pale brown to pink, with sandy levels, roots casts, terrestrial fauna and nodular forms.		3 cm

Taula 1. Main characteristics of te identified sedimentary facies. Their interpretation is based on main fabric features and sedimentary structures

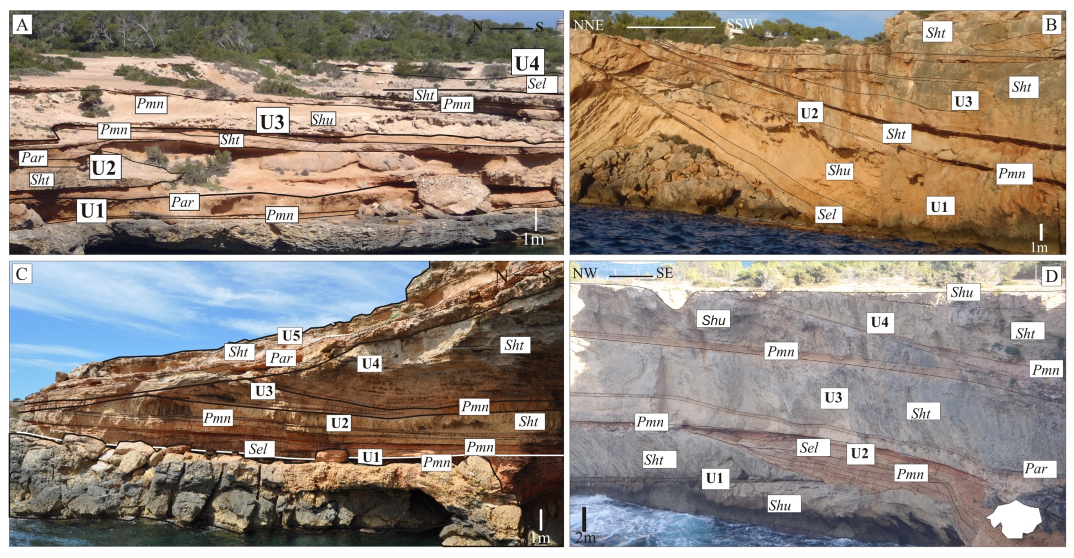
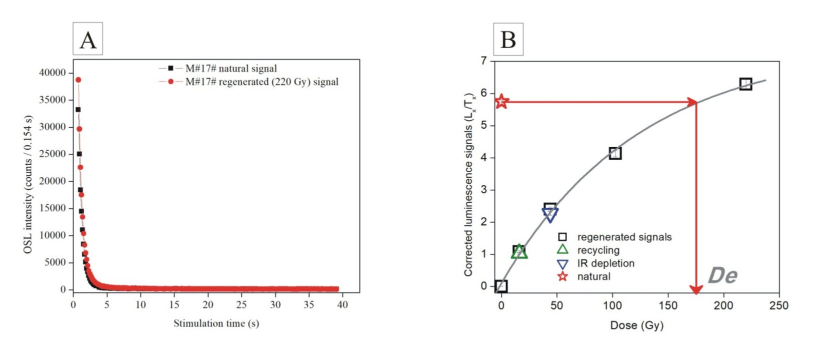


Fig. 2 General overview of sedimentary facies with details concerning to the contact of different units and facies deposition

Sedimentological and stratigraphical analysis performed have allow identifying **5** major **sedimentary facies** and **2 palaeosols** (Fig. 2 and Table 1). Facies have gruped in two main associations representing and colluvial-alluvial sedimentary environments. Based on the main erosive surfaces and palaeosols, **9 unconformity-bounded units** are observed. Aeolian deposits represents the thickest and the most continuous layers in the studied area. They show a lateral shift of sedimentary facies due to the orientation of the coast at each study site, as well as due to the basement paleotopography.

OSL dates



Luminescence measurements were undertaken using automated Riso TL/OSL-DA instrument from the Luminescence Dating Laboratory of Babes-Bolyai University (Cluj-Napoca).

A typical SAR-OSL protocol was employed. For samples proceeding, luminescence investigations were performed on coarse (63 -250 µm) grained quartz.

OSL dating of 19 aeolian levels indicate that their deposition took place between the Lower to Middle Pleistocene (130 ka to 947 ka).

Fig. 3. A) Representative sensitivity-corrected growth curve constructed for sample M#17# using one aliquot of coarse (63-250 µm) quartz grains. The regenerated doses are shown as black open squares. The sensitivity corrected natural signal is depicted as a star and the equivalent dose is indicated by arrows. Recycling and IR depletion points are represented as an blue open down triangle and an green open up triangle, respectively. B) The inset shows a typical decay curve of natural CW-OSL signal (black squares) in comparison to a regenerated signal (red circles).

	Sample Code	Depth (cm)	Grain size (µm)	Water content (%)	De (Gy)	U-Ra (Bq/Kg)	Th (Bq/kg)	K (Bq/kg)	Total dose rate (Gy/Ka)	Total Random error (%)	Total systematic error (%)	Age (ka)	MIS
Cala Compte	M#15#	1020	63-250	3	242 ± 11 n=16	15.3 ± 0.2	2.6 ± 0.3	31.1±2.7	0.52 ± 0.01	4.9	5.8	**464 ± 35**	**12**
	M#16#	1040	63-250	3	240 ± 12 n=14	16.0 ± 0.4	3.3 ± 0.2	34.6±3.7	0.57 ± 0.01	5.6	6.6	**422 ± 36**	**12**
	M#17#	440	63-250	3	215 ± 7 n=12	17.1 ± 0.5	3.0 ± 0.3	38.1±3.6	0.64 ± 0.01	4	6.7	**337 ± 26**	**10**
	M#20#	55	63-250	3	78 ± 3 n=9	15.3 ± 0.2	2.3 ± 0.1	12.7±3.4	0.59 ± 0.01	4.3	7.1	**131 ± 11**	**6**
Cap Negret	M#26#	1950	63-250	0.7	224 ± 16 n=7	8.0 ± 0.5	1.5 ± 0.5	8.0 ± 2.1	0.24 ± 0.01	9.1	5.3	**947 ± 100**	**21/26**
	M#36#	820	63-250	3	189 ± 11 n=11	4.8 ± 0.1	1.5 ± 0.2	10.5 ± 3.3	0.25 ± 0.01	7.1	6.6	**747 ± 33**	**18**
	M#33#	410	63-250	3	213 ± 14 n=11	3.8 ± 0.6	2.0 ± 0.5	17.6 ± 3.2	0.31 ± 0.02	8.3	7.4	**695 ± 77**	**16**
	M#2#	260	63-250	3	183 ± 11 n=11	9.6 ± 0.7	2.9 ± 0.8	22.0 ± 3.3	0.47 ± 0.02	7.3	7	**390 ± 39**	**10**
	M#3#	30	63-250	3	185 ± 12 n=12	11.6 ± 1.1	4.3 ± 0.1	30.4 ± 4.2	0.61 ± 0.02	4.8	6.8	**292 ± 29**	**8**
Punta de sa Pedrera	M#5#	850	63-250	3	230 ± 17 n=8	13.5 ± 0.5	1.7 ± 0.2	14.6±3.6	0.43 ± 0.01	8	5.8	**530 ± 52**	**15b /16**
	M#4#	420	63-250	3	136 ± 6 n=11	10.6 ± 0.2	2.4 ± 0.2	24.8±2.7	0.47 ± 0.01	4.8	6.3	**293 ± 23**	**9b**
	M#49#	150	63-250	3	175 ± 9 n=12	21.4 ± 0.9	3.2 ± 0.3	29.8±2.9	0.75 ± 0.02	5.7	6.3	**235 ± 20**	**8**
Cala Bassa profile	M#9#	390	04-Nov	2	179 ± 2 n=8	16.5 ± 0.2	2.7 ± 0.5	24.2±3.1	0.73±0.02	2.4	10	**251 ± 16**	**7**
			63-90		139 ± 6 n=12				0.60±0.01	4.8	5.5		
			90-125		146 ± 5 n=10				0.59±0.01	4.1	5.5		
			125-180		148±5 n=10				0.58±0.01	4	5.6		
			180-250		161±7 n=10				0.58±0.01	4.9	5.6		
	M#6#	355	04-Nov	4	175 ± 2 n=8	16.0 ± 0.6	2.0 ± 0.5	54.9±3.0	0.80±0.02	2.6	8.9	**236 ± 15**	**7d**
			63-90		165 ± 4 n=10				0.67±0.01	3.3	5.6		
			90-125		155 ± 9 n=9				0.66±0.01	6.2	5.6		
			125-180		175 ± 7 n=10				0.65±0.01	4.6	5.6		
			180-250		137 ± 6 n=8				0.65±0.01	4.9	5.6		
	M#11#	110	04-Nov	4	133 ± 2 n=8	16.2 ± 0.7	2.0 ± 0.6	19.3±3.5	0.73±0.02	3.4	9.8	**172 ± 12**	**6**
			63-90		107 ± 4 n=8				0.61±0.02	4.8	6.1		
			90-125		103 ± 5 n=11				0.60±0.02	5.7	6.2		
			125-180		107 ± 6 n=10				0.60±0.02	6.4	6.2		
			180-250		91 ± 5 n=11				0.59±0.02	6.3	6.2		

Table 2. Osl age results from Cala Compte, Cap Negret, Punta de sa Pedrera and Cala Bassa.

What are the sediments of the Pityuses Islands telling us about *past climate* and *geomorphological processes*?

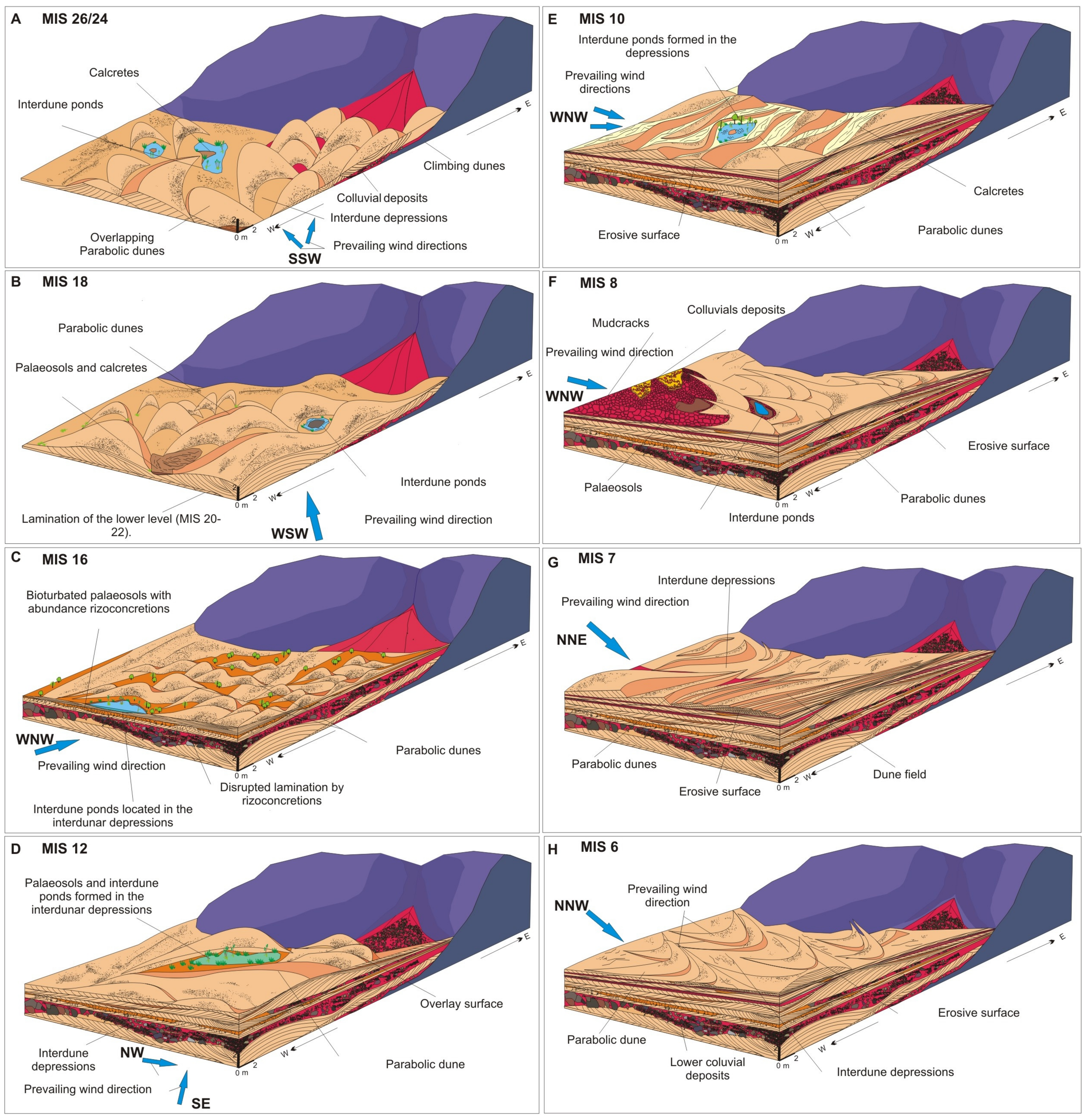


Figure 4. Depositional environment evolution model showing the succession of the main sedimentary environments and paleocurrent directions of the western coast of Eivissa from MIS 26 to MIS 6

a **Sedimentological + stratigraphic** analysis = **5** sedimentary facies and **2** palaeosols identified.

=

Complex interaction of depositional process generated by **Pleistocene** Climatic variability

b Wind direction analysis = **Lower** Pleistocene = ***S-SW*** ; **Middle** Pleistocene = ***NW-W*** } Similarities with *Mallorca* and *Sardinia*

c **OSL dates = MIS 26** to **MIS 6** → Reinforce the theory {
- **Aeolian activity** = low sea level and cool-arid climatic conditions
- **Soils- colluvials** = wetter conditions (sea transgressions)
- **Calcretes-travertines** = arid bet still warm conditions (alternation H/A).

d Finally, inland space, coast orientation and a rugged coastal terrain were the main constraints on dune morphology and formation. The *glacioeustatic fluctuations*, *wind direction* and their interaction with *coastal relief* were the major controls on **Lower to Middle Pleistocene coastal landscape evolution on western Eivissa.**

Acknowledgements: This work was supported by the research fund projects, CGL2013-48441P (AEI - FEDER, UE) and CGL2016-79246-P (AEI -FEDER, UE). A. Timar-Gabor acknowledges the financial support from PN-III-P3-3.6-H2020-2016-0015.

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