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# 1 Neogene to Quaternary evolution of carbonate and mixed 2 carbonate-siliciclastic systems along New Caledonia's eastern 3 margin (SW Pacific)

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14

## 15 ABSTRACT

16 Neogene and Quaternary shallow-water carbonate records surrounding New Caledonia  
17 main island, Grande Terre, provide a good example for understanding the stratigraphic  
18 architecture of tropical mixed carbonate-siliciclastic systems. Due to a southeastern tilt of the  
19 eastern margin, the eastern shelf of Grande Terre has been better preserved from erosion than  
20 the western part, favouring the development and preservation of shallow-water carbonates.  
21 Based on the integration of bathymetric and seismic data, along with paleoenvironmental and  
22 biostratigraphic constraints derived from dredged carbonate rocks, a comprehensive  
23 geomorphological and architectural characterization of the offshore eastern margin of Grande  
24 Terre has been made. During the Mio-Pliocene, a wide, up to 750 m-thick carbonate build-up  
25 developed and extended over at least 350 km from north to south. This Mio-Pliocene build-up,  
26 currently lying at 300 to 600 m water depths, is overlain by a Pleistocene-Holocene barrier reef-  
27 lagoon complex and associated slope deposits. The switch from aggrading Neogene carbonate  
28 banks to backstepping Quaternary platforms likely reflects an increase in accommodation due to  
29 a high subsidence rate or to relative sea-level rise, and/or results from a switch in carbonate

30 producers associated with global environmental changes. The internal architecture of the  
31 Quaternary barrier reef-lagoon complex is highlighted, especially the development of lowstand  
32 siliciclastic prisms alternating with transgressive shallow-water carbonate sequences. This  
33 pattern agrees with the reciprocal sedimentation model typically invoked for mixed sedimentary  
34 systems. This stratigraphic pattern is well developed in front of the Cap Bayes inlet in the north  
35 of our study area, yet it is not observed southward along the eastern margin. This difference  
36 suggests that other factors than relative sea-level variations directed the architecture of the  
37 margin, such as low terrigenous inputs, lagoon paleo-drainage networks or sediment by-pass  
38 towards deep basins.

39

40 **Keywords:** mixed carbonate-siliciclastic system, reciprocal sedimentation, tropical carbonates,  
41 terrigenous inputs, New Caledonia, SW Pacific.

## 42 **1. INTRODUCTION**

43 Mixed carbonate-siliciclastic depositional systems are characterized by a high variability in  
44 facies and architectures resulting from several factors, such as relative sea-level change, tectonic  
45 motions, carbonate production, terrigenous inputs, sediment transfer and hydrodynamic  
46 conditions, complicating the sequence stratigraphy interpretation (Droxler and Jorry, 2013;  
47 Zeller et al., 2015). According to the classical “reciprocal sedimentation” model (Wilson, 1967),  
48 mixed systems in the tropical realm have been commonly subdivided into alternating temporal  
49 phases where siliciclastic deposits would prevail during low sea-level periods whereas  
50 carbonates would dominate during transgressions and highstands. This reciprocal concept is yet  
51 relevant for several ancient and some modern cases studies (Kerans & Tinker, 1999; Toomey et  
52 al., 2016), but has been shown to be inadequate in describing several others examples. This  
53 model appears not applicable for some mixed cool-water carbonate platforms, where  
54 sandstones can be deposited when wave abrasion depth rises above the seafloor during  
55 transgressions, whereas shell-beds formed during lowstands (Brachert et al., 2003). Another  
56 example is the Great Barrier Reef, where siliciclastic deposits are released to the slope and basin  
57 during late transgression, possibly due to the reworking of significant amounts of fine-grained  
58 terrigenous sediment stored on the shelf during lowstand (Wallace et al., 2002; Dunbar and  
59 Dickens, 2003; Mitchell et al., 2007; Harper et al., 2015). In addition, wave and/or current  
60 energy might prevent the infill of the lagoon during highstands, during which carbonate  
61 production is thought to be maximal, inducing, thus, an “empty bucket” pattern (Schlager, 1989;  
62 Purdy and Gischler, 2005; Zinke et al., 2001; Weij et al., 2019). This variability in the  
63 sedimentological response of mixed systems to relative sea-level changes demonstrates that  
64 other controlling parameters should also be considered in order to improve the prediction of  
65 their complex depositional architectures.

66 Around the main island of New Caledonia, “Grande Terre”, Neogene to Quaternary shallow-  
67 water carbonate systems occur coeval with high terrigenous fluxes derived from the erosion of

68 rugged mountain ranges located all across the island and primarily composed of obduction-  
69 related thrust sheets. The oldest known Neogene shallow-water carbonates on Grande Terre are  
70 lower Miocene mixed carbonate-siliciclastic series cropping out in the Népoui area, on the  
71 western part of the island, close to the present day coastline (Fig. 1). These outcrops were  
72 interpreted as reflecting sediment deposition on Aquitanian and Burdigalian ramps where  
73 seagrass-related and scleractinian carbonate production occurred simultaneously to strong  
74 fluvio-deltaic terrigenous inputs (Maurizot et al., 2016; Tournadour et al., 2020). However, the  
75 offshore extent of this Miocene mixed system remains unknown.

76 At the present day, Grande Terre is surrounded by one of the largest modern barrier reef in  
77 the world. This barrier reef has been drilled on the western margin and past studies (Coudray,  
78 1975; Cabioch et al., 2008b ; Montaggioni et al., 2011) showed that it initiated at 400 cal kyr B.P.  
79 or Marine Isotope Stage 11 (MIS 11), over non-reefal shallow water carbonates that were  
80 deposited as of *ca.* 1.2 Ma ago on a carbonate ramp or non-rimmed platform (Montaggioni et al.,  
81 2011). The inner lagoon, in turn, started its infill only since 200 cal kyr, B.P. or Marine Isotope  
82 Stage 7 (MIS7) (Le Roy et al., 2008). This points to the fact that the southwestern shelf of New  
83 Caledonia does not follow a classic reciprocal sedimentation pattern but constitutes a unique  
84 mixed carbonate-siliciclastic tropical system with a strong temporal and spatial partitioning  
85 between the outer coral plateau and the inner lagoon depression where terrigenous clastic  
86 sediments prevail (Le Roy et al., 2019).

87 In contrast, the Neogene to Quaternary shallow-water mixed systems of the eastern margin  
88 of Grande Terre are much less documented than their western counterparts, largely because of a  
89 lack of boreholes, rare outcrops onshore and few acoustic data offshore. However, this margin is  
90 thought to have a very different tectonic history than the western margin, probably a higher  
91 subsidence that would have resulted in a better preservation of shallow-water systems on the  
92 shelf, thus allowing to improve our understanding of the onset of Neogene carbonate systems  
93 and the transition to Quaternary barrier reef lagoon in the regional tectonic context. In addition,  
94 those sedimentary records allow to discuss the potential controlling factors determining the

95 stratigraphic architectures along the margin, such as terrigenous inputs or paleo-drainage  
96 networks. With that aim, we have compiled both existing and newly acquired geophysical data  
97 and dredged carbonate rock samples from Ponérihouen to Antigonía seamount (Fig. 1) to  
98 perform a comprehensive analysis of slope morphologies and to reconstruct the depositional  
99 environments and ages of the main terraces and seismic units observed along the eastern  
100 margin.

## 101 **2. GENERAL SETTINGS**

### 102 **2.1. Geography**

103 New Caledonia is a remote archipelago located in the South West Pacific (Fig.1). Its main  
104 island, Grande Terre, is a 50 to 80 km wide and approximately 400 km long land stripe  
105 oriented in a N140° direction. Highest summits are *ca.* 1600 m high. Because of dominant  
106 southeastward trade winds (N110-120°) its eastern margin is positioned on the windward side,  
107 whereas the western margin is the leeward side. Its eastern part is typified by steep reliefs,  
108 deeply incised valleys and short coastal plains, whereas the western part has more extended  
109 valleys, wider alluvial lowlands and large coastal plains. This landform dissymmetry impacts the  
110 spatial distribution of rainfall, with the eastern windward coast receiving twice as much  
111 precipitation than the western leeward coast. Such differences induce a one-and-a-half-time  
112 higher river discharge along the eastern coast compared to the western coast (Terry & Wolting,  
113 2011).

### 114 **2.2. Tectonics**

115 Grande Terre marks the northeastern tip of Zealandia (Mortimer et al., 2017), a mostly  
116 submerged fragment of continental crust isolated from Gondwana during the Late Cretaceous to  
117 Paleocene due to regional rifting followed by seafloor spreading in the Tasman Sea (Hayes &  
118 Ringis, 1973; Gaina et al., 1998). During the Eocene Grande Terre underwent a convergence

119 phase that led to the NE-SW emplacement of several tectonic nappes and finally, in the late  
120 Eocene-early Oligocene, to the obduction of a prominent kilometres-thick ophiolite mostly  
121 constituted of serpentinized peridotites (Paris, 1981; Maurizot et al., 2020). Once obduction  
122 terminated, extensional tectonics prevailed all over Grande Terre (Lagabrielle et al., 2005;  
123 Chardon & Chevillotte, 2006; Lagabrielle & Chauvet, 2008). During this post-obduction  
124 extensional phase, that may still be active today, widespread normal faulting affected both island  
125 margins. The asymmetric morphology of Grande Terre is likely the result of these obduction and  
126 post-obduction tectonics. Drivers of the extension are either attributed to a plate tectonic  
127 divergent phase (i.e. far-field stresses related to initiation of east-verging subduction of the  
128 Australian plate beneath the Pacific Plate, Chardon & Chevillotte, 2006) and/or to post-orogenic  
129 collapse, dismantling and combined isostatic rebound (Lagabrielle et al. 2005, Lagabrielle &  
130 Chauvet, 2008; Moretti & Turcotte 1985; Collot et al., 2017). In this second hypothesis, unroofing  
131 the ridge of dense allochthonous mantle material and loading the adjacent basins resulted in  
132 subsidence of the basins and uplift of the ridge. The latter uplift is thus interpreted as being at  
133 the origin of the steepening of both the western and eastern margins of Grande Terre. The deep  
134 structure of the eastern margin has not been imaged by seismic data but is interpreted to be  
135 structured by a series of normal faults (see simplified geological cross-section of Fig. 1 and Collot  
136 et al. (1987)). Timing and amplitudes of these extensional events and vertical motions over the  
137 post-obduction period are not constrained as no continuous Oligocene to present day geological  
138 records exist. The Neogene to Quaternary carbonates that are the focus of this paper have  
139 developed on these structures. Offshore, towards the south, major listric normal faults bordering  
140 the obducted mantle sheets are imaged by seismic data along Pines Ridge (Chardon &  
141 Chevillotte, 2006; Flamand, 2006; Chardon et al., 2008; Patriat et al., 2018) (Fig.1). Apart from  
142 post-obduction extension, since the late Miocene, the southern part of Grande Terre and the  
143 Loyalty Islands are the foreland area of the Vanuatu Subduction Zone where the Australian Plate  
144 subducts beneath the Pacific Plate. A lithospheric flexure associated to this process is observed  
145 and results in the uplifts of the Loyalty Islands, the southern tip of Grande Terre and the Isles of

146 Pines. As a result, Quaternary 125 ka fringing reefs around Yaté and Isle of Pines are uplifted and  
147 now are positioned 10 to 20 m above present-day sea level (Cabioch et al., 1996).

### 148 **2.3. Miocene mixed carbonate siliciclastic systems**

149 On land, the post-obduction geology is characterized by an Oligocene sedimentary hiatus  
150 and the oldest known marine sediments that overlie allochthonous units are Miocene mixed  
151 carbonate-siliciclastic sedimentary rocks only cropping out in a restricted nearshore area  
152 located west of Grande Terre, in the region of Népoui (Coudray, 1975; Maurizot et al., 2016;  
153 Tournadour et al., 2020). These successions have been interpreted to reflect deposition of an  
154 Aquitanian carbonate ramp dominated by seagrass-related carbonate production, overlain by  
155 Burdigalian fan delta deposits that laterally evolve towards a carbonate ramp dominated by  
156 seagrass meadows and small-sized coral bioconstructions (Tournadour et al., 2020).

157 Offshore, despite a lack of drill core data, a few dredged carbonate samples were  
158 recovered from the outer slope of the eastern margin of Grande Terre (Chardon et al., 2008;  
159 Yamano et al., 2015) and close to *Munida* and *Crypthelia* seamounts (Daniel et al., 1976; Bitoun  
160 and Recy, 1982) (Fig. 2). These samples, collected between 400 m and 800 m water depths, are  
161 the only evidences of Miocene shallow-water carbonate deposits along the eastern margin of  
162 Grande Terre and Pines Ridge. Based on the interpretation of seismic profiles along Grande  
163 Terre's southeastern margin, Chardon et al. (2008) identified several normal faults that they  
164 interpret as being related to Late Miocene extensional tectonics. These authors also interpreted  
165 two planar surfaces as post-obduction erosional lateritic land surfaces resulting from  
166 weathering processes overlain by shallow-water carbonate deposits.

### 167 **2.4. Quaternary carbonate systems**

168 Our knowledge on the nature, structure and chronology of the New Caledonian  
169 Quaternary carbonate systems primarily comes from coring investigations carried out through  
170 the western parts of the New Caledonian barrier system (Coudray, 1976, Cabioch et al., 2008b;

171 Montaggioni et al., 2011). Four cores, 120 to 226 m-long, reached the upper Cretaceous and  
172 Eocene bedrock and allowed to characterize the Quaternary development history of the western  
173 carbonate shelf margin. The recovered carbonate sequences result from stacking of about ten  
174 sedimentary carbonate units that were deposited during successive transgressive and high sea-  
175 level stands corresponding to interglacial periods (Cabioch et al., 2008b). These units are  
176 separated from each other by unconformities formed during sea-level drops in glacial periods.  
177 The succession of depositional events was reconstructed using lithostratigraphy,  
178 magnetostratigraphy, uranium-series dating and nannofossil stratigraphy (Cabioch et al., 2008b;  
179 Montaggioni et al., 2011). Carbonate sediment production was initiated prior to 1.2 Ma within an  
180 open shallow-water shelf margin, which acted as a carbonate ramp system until 0.48 Ma.  
181 Corresponding deposits forming the lower units recovered in boreholes (red dots on Fig. 1)  
182 include grainstone, packstone and wackstone rich in corals, coralline algae, encrusting  
183 foraminifera with locally thick rodoliths accumulations (Montaggioni et al., 2011). The ramp  
184 system is assumed to have evolved into a rimmed, reef platform as of 0.40 Ma. The initiation of  
185 coral reef tracts and the associated reef-rimmed platform are thus considered to have begun  
186 after MIS 11 (Montaggioni et al., 2011), i.e. the Mid-Brunhes Event. Corresponding sedimentary  
187 units are made up of stacked *poritid*-rich framework beds correlated to reef-flat environments  
188 with moderate to lower-water energy, and corallgal frameworks partly including arborescent  
189 acroporids suggesting deposition in a protected reef-flat setting (Montaggioni et al., 2011).  
190 Complementary studies of the Quaternary evolution of the south-west lagoon obtained seismic,  
191 bathymetric and coring data (Le Roy et al., 2008; Le Roy et al., 2019). Results showed that infill  
192 is composed of two or three 100 ka sedimentary sequences with a first significant flooding of the  
193 lagoon assumed to have started during MIS7, at 220 cal kyr B.P. The disparate ages of the lagoon  
194 and reefs can be reconciled with the fact that the first reefs were probably initially fringing  
195 structures without a significant lagoon that has expanded later in response to subsidence of the  
196 margin and reef growth (Le Roy et al., 2018). Offshore, the outer barrier reef slopes of Grande  
197 Terre are marked by five marine terraces located between ca. 20 and ca. 120 m water depths

198 that Flamand (2006) tentatively correlated to the five reefal lithological sequences cored on the  
199 western barrier reef and interpreted as the morphological expressions of Quaternary  
200 interglacials. However, a younger, last deglacial origin for these terraces located above 120 m  
201 water depth cannot be ruled out. Note that these Quaternary marine terraces are located in the  
202 area indicated by the blue arrow on bathymetrical and seismic data (Figs. 5 to 8).

### 203 **2.5. Quaternary subsidence rates**

204 Based on cores of the Quaternary barrier reef of the western margin of Grande Terre, subsidence  
205 rates are estimated to range between 0.03 to 0.20 mm.yr<sup>-1</sup> since the last 400 ka (Coudray, 1975;  
206 Cabioch et al., 1996; Flamand, 2006; Frank et al., 2006) and display mean rates of  $\leq 0.08$  mm.yr<sup>-1</sup>  
207 over the past 1 Ma (Montaggioni et al., 2011). Such values possibly reflect a long-term  
208 subsidence of the western margin of Grande Terre suggesting that post-obduction extensional  
209 tectonics are still active and allowing sufficient accommodation space to record most Quaternary  
210 sea-level highstands. Unfortunately, the lack of core data on the eastern margin does not allow  
211 reconstructing any Neogene to Quaternary vertical motions.

## 212 **3. DATA AND METHODS**

213 Our morphological and stratigraphic analyses are based on the integration of existing and  
214 newly acquired bathymetrical and 2D seismic reflection data supplemented by dredged rock  
215 samples (Fig. 2). Existing bathymetrical data are derived from four datasets. The former covers  
216 the lagoon of Grande Terre and was essentially acquired during hydrographic surveys of the  
217 French Navy (SHOM), compiled by the New Caledonia Government within a 25 m resolution  
218 grid. The second dataset corresponds to data acquired between 2002 and 2006 onboard RV *Alis*  
219 (EM1002 multibeam echosounder) along all the outer slopes of Grande Terre and Loyalty  
220 islands, as well as on seamounts of the Pines Ridges (down to *ca.* 1000 m of water depth), in the  
221 framework of the ZoNéCo program (*e.g.* Pelletier et al., 2002, 2004, 2012; Perrier et al., 2004a,  
222 2004b, 2004c, 2005) and IRD research projects (*e.g.* Cabioch et al., 2002a, 2002b). The third

223 dataset consists of data acquired in the 90's and 2000's in deeper waters (>1000 m of water  
224 depth), such as in the South Loyalty Basin, onboard RV *L'Atalante* (EM12D multibeam  
225 echosounder), again through ZoNéCo (eg. ZoNéCo-1, Pautot et al., 1993; ZoNéCo-2, Lafoy et al.,  
226 1994; and ZoNéCo-3; Missègue et al., 1996). These two multibeam datasets were compiled in  
227 2009 in 25 m (EM1002) and 100 m (EM12D) resolution grids by New Caledonia Government  
228 (Juffroy, 2009) and included in the 2012 atlas of New Caledonia (Pelletier et al., 2012). The  
229 fourth dataset is the global seafloor topography derived from satellite altimetry and ship depth  
230 soundings (Smith and Sandwell, 1997). Newly acquired bathymetrical data corresponds to those  
231 gathered by the KANACONO cruise onboard R/V *Alis* (Puillandre & Samadi, 2016).

232 The seismic dataset mainly consists of published multichannel seismic reflection profiles  
233 located on the upper slope of the eastern margin of Grande Terre, acquired onboard R/V *Alis*  
234 during the NEOMARGES cruise (Chardon et al., 2007), using a 24 channel streamer and a 20  
235 cubic-inch air gun source. The high-resolution images have a maximum penetration of 0.25 s two  
236 way time (twt) (Table 1) and were reinterpreted in this study through detailed line drawings.  
237 Seismic profiles 206-04 (Lafoy et al. 1998) and AUS-104 (Bitoun & Recy et al. 1982), which are  
238 publicly available in the *Tasman Frontier seismic database* (Sutherland et al., 2012), were also  
239 interpreted. These profiles were acquired using lower frequency seismic devices (see Table 1)  
240 and hence have a lower resolution but a higher penetration, reaching 3 s twt in the offshore  
241 basins. Seismic stratigraphic analysis was performed on these profiles including identification of  
242 seismic facies, unconformities and sequences following Mitchum et al. (1977). To estimate the  
243 thickness of the carbonate units on the Pines Ridge, we assumed that they are composed of  
244 shallow-water carbonates with a low-porosity, affected by early compaction and dissolution, for  
245 which we attributed a mean velocity of 3000 m.s<sup>-1</sup> (Anselmetti & Eberli, 2001).

246 Sedimentary facies determinations were made on 17 carbonate rock samples dredged  
247 during the DR-2005-NC and KANACONO cruises onboard R/V *Alis* (Pelletier et al., 2006;  
248 Puillandre & Samadi, 2016; respectively) in water depths between 250 and 900 m (Table 2).  
249 Samples were described from large thin sections in order to identify textures and main

250 components and ultimately reconstruct depositional environments. Biostratigraphic datings and  
251 paleoenvironmental reconstructions were based on the interpretation of foraminiferal  
252 assemblages (larger benthic and planktonic foraminifera). In our definitions of stratigraphic  
253 ranges, the planktonic foraminiferal zonal scheme of BouDagher-Fadel (2015, 2018a) is used.  
254 This scheme is tied to the time scale of Gradstein et al. (2012) and the revision by Cohen et al.  
255 (2017).

## 256 **4. PHYSIOGRAPHY, STRUCTURE AND STRATIGRAPHY OF THE** 257 **EASTERN MARGIN**

### 258 **4.1. Lagoon**

259 The eastern lagoon, extending from the shoreline to the external barrier reef, is 10-15  
260 km wide between Poindimié and Yaté with an average water depth of 40 m, whereas the  
261 western lagoon does not exceed a width of 5-10 km with an average water depth of 20 m, except  
262 in its southern part where it is deeper and wider (Le Roy et al., 2008, 2019). Another difference  
263 with the western lagoon, which is bounded by continuous barrier reefs, is that the eastern  
264 lagoon is typified by a discontinuous external barrier reef with drowned segments in its  
265 southern part, off Yaté (Cabioch et al., 1996; Andrefouet et al., 2009) (Fig. 2). The eastern lagoon  
266 can be divided into three morphological domains: (1) the shallow-water coastal zone, (2) the  
267 median lagoon and (3) the external barrier reef (Fig. 3B).

268 The shallow-water coastal zone is particularly well-developed between Ponérihouen to  
269 Thio, where coastal bays are shallow and have gentle slopes, due to terrigenous deltas located at  
270 river and estuarine mouths (Fig.3). The deltaic deposits extend for 2.5 to 7 km and can reach the  
271 central part of the lagoon. Between Côte Oubliée and Yaté, deltas are very restricted and do not  
272 exceed 2 km in length (Fig.3A). Previous studies on unconsolidated seafloor sediments revealed  
273 that these deltas are mainly composed of terrigenous sediments (Chevillon, 1997).

274 The deeper median lagoon, is relatively flat in its central part and contains isolated patch reefs  
275 as well as sandy islets aligned parallel to the coastline (Fig.3A). Southeast of the East Ngoé Pass,  
276 the median lagoon deepens (with an average water depth of 60-70 m) and contains a  
277 meandering channel that runs parallel to the coastline (Fig. 3A). This channel extends over 30  
278 km, incises the lagoon up to 40 m deep and is connected to the Kouakoué Pass, where it runs  
279 perpendicular to the coastline thanks to a *ca.* 90° bend (Fig.3A).

280 The barrier reef domain comprises the reef crest, close to sea level, as well as a back-reef  
281 and reef flats within a 5 km-wide shallow-water area (20 to 40 m water depths). The latter is  
282 dominated by carbonate sediments of heterogeneous grain size, ranging from fine-grained sands  
283 to gravels (Chevillon, 1997). The barrier reef domain is interrupted by numerous passes (ie.  
284 inlets) connected to lagoonal channels that cross-cut the back-reef domain and are oriented  
285 roughly perpendicular to the coastline and the reef crest (Fig.3).

## 286 **4.2. Outer slope**

### 287 **4.2.1 Overall slope profile**

288 The outer slope morphologies of Grande Terre were previously described by Bitoun and  
289 Récy (1982), Rigolot (1989), Flamand (2006) and Pelletier et al. (2012). The outer slope of the  
290 western margin is very steep with values up to 20° between 0 to 2000 m water depths. This  
291 margin is very abrupt as the upper part of the slope is also very steep (see W-01 and W-02  
292 profiles Fig.4). In comparison, the outer slope of the eastern margin, from Poindimié to Yaté, is  
293 smoother and extends over 15 to 20 km from the platform edge to the toe of slope at a water  
294 depth of approximately 2200 m (Fig. 4). It is composed of 3 domains: (1) the upper slope,  
295 characterized by a slope gradient lower than 3°, between 100 to approximately 500 m water  
296 depths and extending up to 20 km in areas preserved from the erosion (*e.g.* offshore Côte  
297 Oubliée and Yaté, see E-01 profile Fig.4). On the contrary, some areas are devoid of an upper  
298 slope domain and canyon heads are in direct contact with the external barrier reef (*e.g.* offshore

299 Houailou, see E-02 profile [Fig.4](#)); (2) the middle slope shows a slope gradient of up to 10°  
300 between 400-500 m to approximately 2200 m water depth; (3) the lower slope and toe-of-slope  
301 domain shows a gentle slope gradient ranging from 0.5 to 1°. This slope section starts  
302 approximately at 2200 m water depth, which corresponds with the transition to the Loyalty  
303 Basin floor. The slope section contains numerous erosional by-pass features such as submarine  
304 canyons that incise the slope up to a depth of 200 m. Backscatter imagery reveals depositional  
305 lobes at canyon mouths, offshore Thio and Yaté, as previously reported by Cotillon et al. (1989,  
306 1990). The cut off angles are intended to characterize the morphology of the slope and have no  
307 universal value. Even in the case of a Gaussian slope angle evolution (*sensu* Adams and Kenter,  
308 2013) angle values may vary between different carbonate systems.

#### 309 ***4.2.2 Physiography of the upper slope***

310 The upper slope is delimited by a major scarp located at 300-400 m water depth close to  
311 the Cap Bayes Pass ([Fig. 5A](#)) and the Nakéti Pass ([Fig. 6A](#)), at 400-500 m water depth in front of  
312 Côte Oubliée ([Fig. 7A](#)) and at 500-600 m water depths close to the Yaté Pass. The low-angle  
313 upper slope is only 3 to 4 km wide close to Nakéti Pass and widens southward to reach a width  
314 of 20 km in the vicinity of Yaté ([Fig. 3A](#)). Arcuate scars occur along the scarp, suggesting slope  
315 failure processes along the upper slope ([Fig.5A](#) and [6A](#)). In front of Côte Oubliée, the 5-6 km  
316 wide upper slope is incised by low sinuosity, U-shaped, 40 to 80 m deep gullies ([Fig.7A](#)). Gullies  
317 are of variable extension along the upper slope, some start at 150 m water depth close to the  
318 outer reef slope, whereas others, shorter, gullies start at 300 m water depth, 3-4 km away from  
319 the shelf edge. The majority of gullies are located in front of Kouakoué Pass through which they  
320 are connected to the meandering lagoonal channel ([Fig.3A](#)).

#### 321 ***4.2.3 Stratigraphy of the upper slope***

322 Seismic profiles covering the platform edge to the upper slope region reveal two main  
323 seismic units, U1 and U2 separated by unconformity S1 ([Fig. 5, 6](#) and [7](#)). These profiles also  
324 show that U1 is exposed on the seafloor along a major scarp (see red arrows on maps and

325 profiles of Fig. 5, 6 and 7). U1 comprises wavy reflections and is delimited at its top by erosional  
326 truncations and toplap terminations at bounding surface S1. The latter is overlain by unit 2 (U2)  
327 which shows well-layered reflections downlapping onto S1 (Figs. 5, 6 and 7). The maximal  
328 thickness of U2 varies between 0.1 to 0.25 s twt. In front of Côte Oubliée, on profile NM-13, at  
329 the mouth of the Kouakoué Pass, U2 is twice as thick than on profile NM-12b located 20 km  
330 further north at distance from any pass (Fig. 7).

331 Seismic profile NM1 at the mouth of the Cap Bayes Pass displays a well-developed unit  
332 U2 which forms a 0.2-0.25 s twt thick sedimentary prism (Fig. 5) composed of five stratigraphic  
333 sequences each composed of retrogradational sets (in pink on Fig. 5) overlain by progradational  
334 clinoform foresets (in beige on Fig. 5), noted 1 to 5. The slope break of the youngest (5<sup>th</sup>)  
335 clinoform foreset (annotated “Clinoform slope break” on Fig. 5) is located at 150 m water depth.  
336 Retrogradational sets contain low-amplitude, mound-shaped seismic reflections that are only  
337 observed in topsets. Progradational sets show high-amplitude sigmoidal oblique reflections that  
338 downlap onto the underlying unit and are mainly located in the distal part of the sedimentary  
339 prism.

### 340 **4.3. Pines Ridge**

341 The Pines Ridge corresponds to the structural extension of the eastern margin of Grande  
342 Terre towards the South (Fig. 2). It is a NNW-SSE trending structure extending from the Isle of  
343 Pines to the Cook Fracture Zone.

#### 344 **4.3.1 Basement structure and first-order seismic stratigraphy of the Pines** 345 **Ridge**

346 The Pines Ridge is a horst of peridotite bounded by normal faults (Bitoun & Recy, 1982;  
347 Patriat et al., 2018) and is the southern offshore extension of the Peridotite Nappe cropping out  
348 onland (Patriat et al., 2018). In this paper, we have studied the area comprised between the Isle  
349 of Pines and Antigonina seamount, where Pines Ridge is the shallowest (Fig. 8A). Seismic profile

350 AUS-104 (Fig. 8B) reveals that the Pines Ridge comprises at its top high-amplitude subparallel  
351 reflections between 0.7 and 0.9 s twt, which contrast with the transparent seismic character of  
352 the underlying acoustic basement. Along the eastern flank of the Pines Ridge, the acoustic  
353 basement crops out on the seafloor at 2000 m water depth and was sampled by dredge GEO-I-  
354 3D (Daniel et al., 1976; Bitoun & Recy, 1982) (Fig. 8). The samples comprised altered basalt  
355 pebbles within a carbonate mud matrix containing planktonic foraminifera from the late  
356 Oligocene – earliest Miocene (Daniel et al., 1976). At that location, the acoustic basement forms a  
357 slightly tilted plateau located between 2.5 and 2.7 s twt, interpreted as an erosional weathering  
358 surface on top of peridotites by Bitoun and Recy (1982). This peridotite platform constitutes the  
359 western edge of the South Loyalty Basin (Figs. 8B and 8C). The peridotite basement is covered  
360 by a seismic unit composed of discontinuous low-amplitude subparallel reflections that is about  
361 0.2 s twt thick at the crest of the ridge and up to 0.6 s twt-thick on its eastern flank. This unit is  
362 interpreted as a post-obduction sedimentary sequence (Bitoun & Recy, 1982 ; Patriat et al.,  
363 2018). The unit is incised by several submarine canyons along the eastern slope that extend  
364 from the Pines Ridge to the South Loyalty Basin (Fig. 8).

#### 365 ***4.3.2 Physiography of the Pines Ridge***

366 Along the northern part of the Pines Ridge, on the upper slope, the terrace identified on  
367 the eastern outer slopes of Grande Terre is continuously present between 300 to 600 m water  
368 depths (red arrows on Fig. 8A). East of the Isle of Pines, this terrace is affected by arcuate scarps  
369 most likely corresponding to submarine gravity collapses. Towards the Antigonina seamount, the  
370 top of the Pines Ridge is capped by this terrace (Fig. 2). Indeed, between the Banc de la Torche  
371 and Antigonina seamounts, the ridge's top remains positioned at 400-500 m water depth and its  
372 eastern slope is again characterized by a steep gradient and collapse features (red arrows on Fig.  
373 8A). In turn, the Banc de la Torche and Antigonina display flat tops in 30 m to 60 m water depths  
374 (blue arrows on Fig. 8A). These two submerged isolated banks are surrounded by two terraces  
375 at 80-90 m and 120 m water depth.

376           The isolated Crypthelia and Munida seamounts are delimited by a main scarp at 400-500  
377 m water depths (Figs.2 and 8). Their tops are located at 194 m and 93 m water depths,  
378 respectively. The Crypthelia seamount is 3 km wide and 12 km long elongated in a N160°  
379 direction (Fig. 9A and 9B). Three fault scarps located approximatively in 250, 350 and 500 m  
380 water depth affect the seamount across its entire length. Fault scarp heights are comprised  
381 between 30 m and 100 m (see map and cross section of Fig. 9B). In the northern part, the  
382 eastern fault scarp is associated with a channel probably formed by bottom currents circulating  
383 along the footwall of the fault (Fig. 9A and 9B). The southern edge of the seamount is marked by  
384 two 2-3 km wide failure scars, evidenced by arcuate headscarps located between 350 to 600 m  
385 water depth. The Munida seamount, located further to the northeast, extends over 8 km wide  
386 and 18 km long with a N60° direction (Fig. 9C). Its edges are bordered by N60° and N160°  
387 oriented fractures. On its southern flank, a terrace (M1) bordered by fault scarps is identified  
388 between 400 m and 600 m water depth. Above 200 m water depth, the top of the seamount (M2)  
389 is relatively flat (Fig. 9C) but still shows terraces at 100 m and 120-130 m water depth.

#### 390           ***4.3.3 Stratigraphy of the Pines Ridge***

391           The internal architecture of the post-obduction sedimentary sequence overlying  
392 basement of Pines Ridge and Munida seamount are imaged by seismic profile 206-04 (Fig.10).  
393 Over the Pines Ridge, the capping sedimentary unit reaches up to 0.5 s twt thick, i.e.  
394 approximately 750 m thick considering a velocity of 3000 m.s<sup>-1</sup> for a 30% porosity limestones  
395 according to Geldart (2004). In details, this interval is composed of 3 units, UP1 to UP3 (Fig.10C  
396 and 10D). Unit UP1 mainly developed on the SW edge of the ridge and is composed of low-  
397 amplitude reflections northeastwardly downlapping on basement. Unit UP2 downlaps basement  
398 on the eastern edge of the ridge with very low-amplitude reflections that form mounded  
399 morphologies. To the west, the seismic character of UP2 laterally evolves into low-amplitude,  
400 wavy to horizontal parallel reflections onlapping onto UP1 towards the southwest. Unit UP3 is  
401 typified by low-amplitude, sub-parallel and nearly horizontal reflections with low relief,  
402 mounded morphologies on the eastern edge of the ridge. Because seismic line 206-04 runs along

403 the south-eastern slope of Munida Seamount (Fig. 9C), seismic imaging is poor due to 3D lateral  
404 effects. However, the profile intersects a part of the seamount with less slope that reveals that  
405 the sedimentary sequence has a minimum thickness of 0.4 s twt, i.e. approximately 600 m-thick  
406 (Fig.10A and 10B). It is composed of two distinct seismic units, UM1 and UM2 (Fig.10). Unit UM1  
407 overlies the basement and comprises low-amplitude subparallel mounded reflections with  
408 downlapping and onlapping terminations. Unit UM2 overlies UM1 and comprises high-  
409 amplitude subparallel reflections with downlapping terminations.

#### 410 **4.4. Lithologies and biostratigraphic ages**

##### 411 **4.4.1 Eastern margin of Grande Terre**

412 Seven carbonate rock samples have been collected along the upper slope of the eastern  
413 margin (Table 3, see location on Fig. 2). DR44 and DR45 were recovered on scarps located at  
414 400 m and 600 m water depths, at the seafloor exposure of seismic unit U1 (see location on Figs.  
415 6A and 6B). DR44 is a micritic packstone with recrystallised algae, large benthic foraminifera  
416 (LBF) of Serravallian age (PZ N12, Tf2, 13.82 Ma to 12.00 Ma) (see BouDagher-Fadel, 2018b)  
417 and corals. These elements are reworked within a pelagic mud dominated by planktonic  
418 foraminifera (Table 4) that comprise *Globigerinoides quadrilobatus* (Fig.11A, b.),  
419 *Dentoglobigerina altispira* (Fig.11B, b.), *Globorotalia menardii* (Fig.11B, c.), *Globigerinoides*  
420 *conglobatus* (Fig.11B, d.), *Globigerinoides ruber* (Fig.11B, e.), *Truncorotalia crassaformis*, *Orbulina*  
421 *universa*, *Globorotalia plesiotumida* (Fig.11C, a), *Sphaeroidinella dehiscens* of Early Pliocene age  
422 (N19-N20a, 5.3 Ma to 3.6 Ma). DR45 comprises ultramafic pebbles and gravels encrusted by  
423 algae incorporated in a micritic packstone similar to that of DR44 and also includes  
424 *Lepidocyclina* sp. (Fig. 11D) and *Alveolinella praequoyi*, with the same Serravallian age. DR46,  
425 DR47 and DR48 were collected on the edge of the terrace located between 200 to 400 m water  
426 depths near the Nakéti Pass (Figs. 6A and 6C). These three samples consist of micritic  
427 wackestone/packstones with patches of reworked pelagic micritic facies. DR46 assemblages are  
428 dominated by planktonic foraminifera such as *Truncorotalia crassaformis* (Fig. 11E, a.) *T.*

429 *truncatulinoïdes*, *Globorotalia inflata*, *Globorotalia menardii* and *Orbulina univesa* of Pleistocene  
430 age (N22, 1.8 Ma to 0.12 Ma). DR47 sample shows numerous terrigenous grains (quartz, altered  
431 serpentine and undifferentiated clasts). Planktonic foraminifera are common and include  
432 *Globoquadrina dehiscens* (Fig. 11F, a.), *Globigerinoides quadrilobatus*, *Globigerinoides trilobus*,  
433 *Globigerinoides ruber*, *Globorotalia tumida*, *Globigerinoides spp.*, and *Pulleniatina obliquiloculata*  
434 of Late Pliocene age (N20a, 3.8 Ma to 3.6 Ma). DR48 contains numerous recrystallized algae and  
435 reworked LBF, such as *Alveolinella praequoyi* (Fig. 12A, a.) of Serravallian age (see Adams, 1984;  
436 BouDagher-Fadel and Banner, 1999; BouDagher-Fadel, 2018b), planktonic foraminifera of  
437 Pleistocene in age (N22, 1.8 Ma to 0.12 Ma) such as *Pulleniatina obliquiloculata* (Fig. 12A, b.), *P.*  
438 *primalis* and *Neogloboquadrina dutertrei*. DR49 sample was collected along the scarp at 500 m  
439 water depth, near the East Ngoé pass. The lower part of this scarp corresponds to the top of  
440 seismic unit U1 (Table 3, see location Figs.7A and 7B). Recovered samples comprise a micritic  
441 packstone with algae and LBF of Serravallian age, such as *Alveolinella praequoyi* (Fig. 12B, a.)  
442 and planktonic foraminifera such as, *Globorotalia tumida* (Fig.12C, a.), *Sphaeroidinellopsis*  
443 *subdehiscens*, *Globorotalia menardii* and *Globorotalia inflata* of Early Pliocene age (N19b, 4.2 Ma  
444 to 3.8 Ma) after BouDagher-Fadel (2018a). DR53 is located further south, in front of the Yaté  
445 Pass, in ca. 280 m water depth, and is a micritic packstone containing planktonic foraminifera  
446 such as *Pulleniatina primalis* (Fig.12D, a.), *Prosphaeroidinella parkerae*, *Pulleniatina praecursor*,  
447 *Globigerinoides obliquus* and *Truncorotalia crassaformis* of Late Miocene to Early Pliocene age  
448 (Table 3, see location Fig.2).

#### 449 **4.4.2 Pines Ridge**

450 Seven carbonate rocks were sampled along the Pines Ridge (Table 3, see location Fig. 2  
451 and Fig.8A). These samples are mainly micritic wackestones/packstones with planktonic  
452 foraminifera and algae. Samples DW4737-B, DW4745-B, DW4746-B, DW4747-B1 and DW4747-  
453 X have ages ranging from Pliocene to Late Pleistocene (N19 to N22, 5.33 Ma to 0.12 Ma).  
454 Planktonic foraminifera assemblages of these samples include *Neogloboquadrina pachyderma*,  
455 *Sphaeroidinella dehiscens*, *Truncorotalia truncatulinoïdes*, *Truncorotalia tosaensis*, and

456 *Pulleniatina obliquiloculata* and LBF, such as *Alanlordia* sp. (Fig.12E, a.), are found reworked  
457 together with Pliocene planktonic foraminifera into the younger assemblages. Further south,  
458 samples DW4757-A and DW4782-A were collected along the eastern slope of Pines Ridge (Table  
459 3, see location Fig.8A and Fig.10). DW4757-A includes Oligocene to earliest middle Miocene LBF  
460 such as *Lepidocyclus* sp. and *Planorbulinella solida* (Fig.12F, a.), while DW4782-A comprises late  
461 Miocene to Pleistocene (N17-N20, 8.6 Ma to 3.4 Ma) planktonic foraminifera such as  
462 *Neogloboquadrina humerosa*, *Sphaeroidinellopsis seminulina*, *Sphaeroidinellopsis subdehiscens*.

#### 463 **4.4.3 Munida seamount**

464 Three carbonate rock samples have been collected along the edges of *Munida* (Table 3,  
465 see location on Fig. 8A and Fig. 9C). Samples from DW4770, located on the northeast flank of the  
466 seamount, comprise micritic and sparitic packstones composed of algae and planktonic  
467 foraminifera, such as *Truncorotalia truncatulinoides* (Fig.12F, a) and *Truncorotalia tosaensis*  
468 (Fig.12F, b) of Pleistocene age (N22, 1.8 Ma to 0.12 Ma). DR4772-A and DR4773-A samples,  
469 located on the southern flank, are grainstones cemented by sparite, with planktonic  
470 foraminiferal assemblages including *Sphaeroidinellopsis subdehiscens*, *Sphaeroidinella dehiscens*,  
471 *Truncorotalia tosaensis* and *Pulleniatina obliquiloculata* of Pliocene to Pleistocene age (N21-N22,  
472 3.4 Ma to 0.12 Ma). These samples also reveal many reworked Miocene and Pliocene planktonic  
473 foraminifera.

#### 474 **4.5. Paleoenvironmental interpretations**

475 The assemblages of DR44 and DR45 are dominated by Early Pliocene planktonic  
476 foraminiferal assemblages (e.g. *Sphaeroidinellopsis paenedehiscens*, *Globoquadrina dediscens*,  
477 *Orbulina universa*, *Globorotalia plesiotumida*, *G. tumida* and *Dentoglogigerina altispira*). These  
478 mixed, globular and heavily keeled planktonic foraminifera are indicative of inner to outer  
479 neritic environments (BouDagher-Fadel, 2015). Miocene larger benthic foraminifera (e.g.  
480 *Lepidocyclina* sp., *Katacycloclypeus martini*, *Cycloclypeus* sp.) and fragments of corals and  
481 rodophyte species are also frequently reworked within the deeper Early Pliocene platform.  
482 These larger benthic foraminifera are flat in shape and are associated with symbiont-bearing  
483 diatoms (Leutenegger 1984; Romero et al. 2002). They are common in forereef environment  
484 where they adapted to light attenuation with increasing habitat depth (Hottinger, 1983; Hallock  
485 and Schlager, 1986; Hohenegger, 1995; 2005; Yordanova & Hohenegger, 2002; 2007;  
486 BouDagher-Fadel, 2018b).

487 The Late Pliocene to Pleistocene deposits of DR46, DR47 and DR48 contain mainly  
488 planktonic foraminifera of mixed assemblages of globular forms (e.g. *Globigerinoides*  
489 *quadrilobatus*, *Orbulina universa*) and keeled globorotalids (e.g. *Truncorotalia truncatulinoides*,  
490 *Globorotalia tumida*). These assemblages are indicative of an inner to outer neritic environment  
491 (see BouDagher-Fadel, 2015). Micritic patches of older Miocene deposits with mainly globular  
492 small globigerinids (e.g. *Catapsydrax cf. dissimilis*, *Globigerina praebulloides*) are also present  
493 indicating the reworking of an inner neritic Miocene platform within the deeper deposits of the  
494 Pliocene.

495 DR 49 is interpreted as being deposited in an Early Pliocene inner to outer neritic  
496 platform. It contains planktonic foraminifera assemblages dominated by globular forms (e.g.  
497 *Globorotalia menardii*, *G. inflata*, *Globigerinoides trilobus*, *Gldes quadrilobatus*) with occasional  
498 occurrences of keeled forms (e.g., *Globorotalia tumida*, *G. menardii*) and thickly coated forms in a  
499 thick, smooth cortex of calcite, *Sphaeroidinerlla dehiscens*. The latter is an extant thermocline  
500 dweller found rarely in subsurface, tropical, and subtropical waters (Chaisson and Ravelo, 1997;  
501 BouDagher-Fadel, 2018b). Reworked reefal Miocene larger benthic foraminifera (e.g.,  
502 *Alveolinella praequoyi*, *Lepidocyclina sp.*, *Planorbulina larvata*, *Amphistegina lessonii*,  
503 *Operculinoides spp.*, *Gypsina sp.*) are also present. The presence of the large fusiform miliolid, *A.*  
504 *praequoyi* indicates the reworking of shallow reefal facies into the deeper Early Pliocene neritic  
505 environments.

506 The assemblages of DR53 are dominated by Late Miocene to Early Pliocene globular  
507 planktonic foraminifera species (e.g., *Neogloboquadrina pachyderma*, *N. acostaensis*, *Orbulina*  
508 *universa*, *Prosphaeroidinella parkerae*, *Pulleniatina praecursor*, *P. primalis*, *Globigerinoides*  
509 *obliquus*). Occasional keeled forms (e.g., *Truncorotalia crassaformis*, *Globorotalia menardii*,  
510 *Globorotalia tumida*) are also present. Larger benthic foraminifera such as *Amphistegina spp.* and  
511 *Sphaerogypsina spp.* are also found. The extant *Amphistegina* has adapted to high energy  
512 conditions, however, it is also found in mud free sands in areas of sea grass or coralline algae  
513 and in reefal areas down to depths of 35m (McKee et al, 1959), while *Sphaerogypsina* is  
514 generally common in shallow-water reefal environments (Nebelsick et al. 2001). These  
515 assemblages are interpreted as being deposited in an inner to outer neritic platform.

516 All samples from Pines Ridge point to inner to outer neritic settings, except DW4757-A  
517 which is typified by a forereef environment because of the occurrence of larger benthic  
518 foraminifera, such as *Amphistegina lessonii*, *Lepidocyclina sp.*, and *Planorbulinella solida*. All  
519 samples from Munida seamount contain mixed assemblages of globular and keeled planktonic  
520 foraminifera (e.g., *Sphaeroidinellopsis subdehiscens*, *Sphaeroidinella dehiscens*, *Truncorotalia*  
521 *tosaensis*, *Pulleniatina obliquiloculata*, *Globorotalia inflata*) and are thought to reflect inner to  
522 outer neritic settings.

523

## 524 **5. CARBONATE SYSTEM EVOLUTION ON THE EASTERN MARGIN OF** 525 **NEW CALEDONIA**

### 526 ***5.1 Mio-Pliocene carbonate banks***

527 Carbonate rocks sampled on the upper slope scarp along the eastern margin contain  
528 algae, benthic foraminifera and coral fragments evidencing shallow-water carbonate production  
529 as early as the middle Miocene (Serravalian) and up to the Pliocene (Table 3, Fig. 13). This scarp  
530 corresponds to the top of seismic unit U1, which is bounded by the gently downslope dipping  
531 surface S1 (Figs. 5, 6 and 7). Because of its planar character, Chardon et al., (2008) interpreted  
532 this surface, topping a clastic continental wedge, as a lateritic land surface formed by weathering  
533 during emersion. Because none of the dredges that sampled this scarp (and thus U1) contained  
534 any traces of lateritic deposits, we propose an alternative interpretation where seismic unit U1  
535 corresponds to a Mio-Pliocene carbonate bank, presently located at 300-600 m water depth.  
536 This important subsidence cannot be explained only by eustatism and we suggest that the post-  
537 obduction normal faulting that affected the Peridotite Nappe is likely the main driver of the  
538 subsidence. Surface S1 is interpreted as the top of the carbonate bank characterized by low-  
539 inclination features (Fig. 13A and B). The numerous ultrabasic pebbles/gravels and quartz  
540 grains within the carbonate matrix of samples DR45 and DR47 suggest coeval siliciclastic input

541 with the carbonate buildup development. A similar mixed carbonate-siliciclastic system also  
542 occurs along the coastal domain of the western margin of Grande Terre in the well-constrained  
543 Burdigalian Népoui system (Tournadour et al., 2020) (Fig.13B). The onset of these mixed  
544 systems indicates that both margins of Grande Terre experienced shallow marine conditions  
545 during the Miocene. However, their current positions, up to 20 m above present day sea level for  
546 the Lower Miocene Népoui outcrops of the western margin and up to 500 m water depth for the  
547 middle Miocene samples of the eastern margin, suggest a contrasted tectonic evolution of the  
548 margins.

549 Our results suggest that the Mio-Pliocene carbonate platform (Table 3, Fig.13) extended  
550 southward along the Pines Ridge, over peridotite horsts, which were at that time located in  
551 shallow-water (Fig.13A and B). Within this sedimentary succession, unit UP1 is interpreted as an  
552 attached carbonate platform developing on the western edge of the ridge. The eastward  
553 thickening of unit UP2, which unconformably overlies unit UP1 (Fig.10D), suggests deposition  
554 simultaneous or subsequent to the eastward tectonic tilting of Pines Ridge. The aggrading  
555 mounded reflections of the lower part of UP2 on the eastern edge of the ridge, may be  
556 interpreted as shallow-water, reefal bioconstructions (e.g. Miocene from the Browse basin,  
557 Australia: Belde et al., 2017), or as an oligo-mesophotic bank with dominant algal and  
558 foraminiferal production (e.g. Lower Miocene from Myanmar: Teillet et al., 2020a and 2020b).  
559 However, in the upper part of UP2, the upward change from mounded to flat-topped  
560 morphologies on the eastern margin strongly suggests the development of reef-flat  
561 environments aggrading up to sea-level. Finally, subunit UP3 is also characterized by a slight  
562 overgrowth along the eastern edge as evidenced by low-relief mounded reflectors (Fig.10). Such  
563 an asymmetric feature could be explained by the continuation of an eastward tectonic tilt or  
564 could be related to eastward winds driving carbonate growth (Fig.10).

565 Based on seismic interpretation, two stages of carbonate growth are identified on the  
566 Munida seamount (seismic units UM1 and UM2). A carbonate sample, collected 15 km away  
567 from the seamount (GEO-I-13D; location on Fig.2), contains benthic foraminifera indicative of

568 shallow-water environment, that can be dated Early Miocene (Daniel et al., 1976; Bitoun and  
569 Recy, 1982). This sample suggests a first stage of carbonate growth (UM1) of Miocene age coeval  
570 with carbonate platforms from Pines Ridge (UP1 and/or UP2) (Fig.13A and B). A Miocene  
571 carbonate platform also likely developed on the Crypthelia seamount as suggested by a Middle  
572 to Late Miocene carbonate sample exhibiting forereef facies (GEO-I-9D, see location Fig.2 and  
573 Fig.9A) (Daniel et al., 1976; Bitoun and Recy, 1982).

574         Based on aforementioned observations, we propose the following palaeogeographical  
575 reconstruction of the distribution of Mio-Pliocene shallow-water carbonate systems along the  
576 margin of New Caledonia (Fig. 13B). The Mio-Pliocene carbonate systems extend for about 350  
577 km, along the southeastern margin to Antigonina Seamount. On the western margin, the  
578 Quaternary carbonate reef-lagoon system directly overlies Eocene allochthonous units (see  
579 Fig.1). At that location, the absence of Miocene shallow-water deposits could be explained by a  
580 non-deposition or by erosion in relation to the uplift of the western margin. The thickness of the  
581 Miocene ramp is at least 200 m on the Nepoui area (Maurizot et al., 2016; Tournadour et al.,  
582 2020), but remains unknown along the eastern margin. However, it can be estimated to be  
583 around 750 m on the Pines Ridge (Fig.10B). Similar Miocene carbonate growth rates have been  
584 reported for the southwestern Pacific suggesting that, in addition to local tectonic control  
585 (subsidence) allowing significant volumes of sediments to accumulate, larger-scale  
586 oceanographic or global factors favoured a sufficiently high carbonate production to fill the  
587 created accommodation. For example, the 600 m-thick Marion Plateau platforms, northeast of  
588 Australia, result from robust carbonate growth through early and middle Miocene up to its  
589 terminal demise in the late Miocene (Ehrenberg et al., 2008). Along the northwestern shelf of  
590 Australia, seismic profiles reveal a giant middle Miocene prograding barrier reef that  
591 backstepped in the late Miocene (McCaffrey et al., 2020). Finally, the Gulf of Papua is also  
592 structured by large-scale isolated long-lived carbonate platforms during the late Oligocene-early  
593 Miocene and which demised during late Miocene-early Pliocene (Tcherepanov et al., 2008b). In  
594 our study, the prolific Mio-Pliocene carbonate accumulation is favoured by the subsidence of the

595 shelves of New Caledonia and Pines Ridge, most likely in relation to post-obduction extensional  
596 tectonics (Lagabrielle and Chauvet, 2008; Patriat et al., 2018).

## 597 ***5.2 Transition from Mio-Pliocene to Quaternary platforms***

598         Along the eastern margin of Grande Terre, the Quaternary rimmed platform is thought to  
599 have backstepped onto a Mio-Pliocene carbonate bank (Fig. 13A and 13C). Southward, along the  
600 Pines Ridge and associated seamounts, the Mio-Pliocene carbonate banks are drowned but  
601 several Quaternary flat-topped isolated platforms survived and aggraded.

602         In the vicinity of the study area, the carbonate platform of Maré, on the Loyalty Ridge,  
603 records a significant change in the nature of carbonate production which is rhodalgal-dominated  
604 during the late Miocene, and coralgal-dominated during the Pliocene (McNeill and Pisera, 2010;  
605 Maurizot et al., 2020). These authors explain the switch of carbonate production by the trend of  
606 decreased coralline red algae species richness (Aguirre et al., 2000) combined with the global-  
607 scale Zanclean Flood Event (McKenzie et al., 1999). The exposure of these carbonate records  
608 would result from the local tectonic uplift of the Loyalty Ridge related to Pliocene-Pleistocene  
609 lithospheric flexure associated with the New Hebrides subduction (Dubois et al., 1974 and  
610 1975).

611         Along the western margin of Grande Terre, the coral reef flourished from 400 ky (MIS-  
612 11) considered as a period of luxuriant reef expansion in the southwest Pacific (Cabioch et al.,  
613 2008b). Nevertheless, during the Quaternary, non-reefal carbonates were identified prior to  
614 MIS-11 as early as 1.4 Ma, overlapping the Eocene allochthonous units and could form the  
615 foundation of the Quaternary rimmed platform (Cabioch et al., 2008b; Montaggioni et al., 2011).

616         Along the eastern margin, the occurrence of a Mio-Pliocene platform below the eastern  
617 barrier reef-lagoon suggests that an older carbonate platform developed similarly to what is  
618 observed in Maré Island. The common occurrence of normal faults suggests that the eastern  
619 margin and Pines Ridge were dominated by tectonic subsidence that would have promoted

620 accommodation for Neogene carbonate deposition and preservation, by opposition to the  
621 western margin where the Quaternary carbonates are found on top of Eocene peridotites.  
622 However, high subsidence rates could also explain the demise of the Mio-Pliocene carbonate  
623 systems along the Pines Ridge and the backstepping of Quaternary platforms. After 125 ky, the  
624 southeastern margin is slightly uplifted in the Yaté area and the Isle of Pines (Launay, 1985;  
625 Cabioch et al., 1996). This uplift could be due to the isostatic rebound of the central part of  
626 Grande Terre (Cabioch et al., 1996; Lagabrielle and Chauvet, 2008) or alternatively, could be  
627 associated with the lithospheric bulge of the New Hebrides subduction which is known to have a  
628 regional impact from the Loyalty Islands to the Isle of Pines (Dubois et al., 1974 and 1975;  
629 Cabioch et al., 1996). Hence, both margins of New Caledonia seem to have been affected by long-  
630 term subsidence during the Quaternary which, together with high-amplitude eustatic sea-level  
631 variations, allowed the aggradation and preservation of the reef-lagoon successions.

### 632 ***5.3 Quaternary carbonate platform***

#### 633 ***5.3.1 Late Quaternary mixed carbonate siliciclastic systems along the eastern*** 634 ***margin***

635 At the mouth of the Cap Bayes Pass, seismic unit U2 forms a 200 m-thick prism  
636 comprising five stratigraphic sequences (Fig. 5). In detail, the internal geometries of these  
637 parasequences are characterized by successive sets of aggrading to retrograding mounded  
638 reflections and progradational inclined reflections. We interpret these parasequences as mixed  
639 carbonate-siliciclastic prisms that developed at the mouth of the pass, with aggrading and  
640 retrograding shallow-water carbonate sequences that developed during a transgression (pink  
641 colour on Fig. 5C), deposited during the last glacial-interglacial Quaternary cycles. This  
642 interpretation is consistent with core data collected on the western barrier reef (see location of  
643 Fig. 1), which revealed that the barrier reef itself consist of four to five lithological sequences  
644 deposited during successive transgressions and highstands in sea level since the Mid-Brunhes,  
645 each transgressive reefal units being separated by subaerial unconformities (subaerial

646 exposures) (Cabiocch et al., 2008b; Montaggioni et al., 2011). The prograding seismic patterns  
647 (yellow colour on Fig.5C) thus can be interpreted as lowstand siliciclastic wedges that formed  
648 during Late Quaternary glacial lowstands.

649 Siliciclastics might have developed contemporaneously with the Quaternary barrier reef  
650 bordering the eastern lagoon (Figs. 5, 6B and 7). This observation is consistent with the  
651 reciprocal sedimentation concept traditionally developed for carbonate-siliciclastic mixed  
652 systems (see review by Chiarella et al., 2017). According to this concept, siliciclastic deposits  
653 prevailed on the upper slope during sea-level lowstands and at the beginning of the shelf  
654 reflooding, whereas carbonate facies dominate during transgressions and highstand periods.  
655 This configuration is currently observed on the platform edge of Quaternary mixed carbonate-  
656 siliciclastic systems such as the Australia and Papua New Guinea Reef (Tcherepanov et al.,  
657 2008a; 2008b; 2010; Harper et al., 2015; Mallarino et al., 2021) or the Belize Barrier Reef (Esker  
658 et al., 1998; Ferro et al., 1999; Gischler et al., 2010; Droxler and Jorry, 2013). However, the  
659 reciprocal pattern is not expressed everywhere along the upper slope of the eastern margin.  
660 Near the Côte Oubliée, seismic unit U2 is not characterized by sedimentary prograding  
661 clinofolds but rather by a downlapping aggrading wedge with a maximum thickness of 200 m in  
662 front of the Kouakoué Pass (Fig.7). The lack of prograding features associated with the lowstand  
663 clastic wedge could be explained by low terrigenous sedimentation rates as suggested by small  
664 deltas restricted to the coastal domain (Fig. 3A). Moreover, the southeastern part of the lagoon is  
665 characterized by a meandering channel network parallel to the coast and to the barrier reef,  
666 suggesting an alongshore transport which can partly intercept outgoing sedimentary flux from  
667 lagoon (Fig. 3A). In addition, the numerous gullies cutting the upper slope suggest high off-bank  
668 sediment transport toward the deep basin and thus the accumulation of sediments along the  
669 upper slope (Fig. 7A). This off-bank sediment transport could result from density cascading  
670 processes driven by seasonal meteorological conditions (Wilson and Roberts, 1992, 1995). The  
671 alongslope heterogeneity of the eastern margin upper slope deposits clearly shows that the  
672 behaviour of a mixed carbonate-siliciclastic margin is difficult to predict and is not only

673 dependent of relative sea-level changes, as mentioned previously (Chiarella et al., 2017;  
674 O'Connell et al., 2020).

### 675 ***5.3.2 Quaternary isolated flat-topped banks of Pines Ridge and seamounts***

676 Along the Pines Ridge, dredged carbonate rock samples show that shallow-water  
677 carbonate deposition occurred on the Banc de la Torche and Antigonina seamounts during the  
678 Quaternary (Fig.13A and C). The two marine terraces at 80-90 m and 120 m water depth might  
679 evidence reef backstepping during the last deglacial sea-level rise, as reported around the Great  
680 Barrier Reef (Webster et al., 2018), the Gulf of Mexico (Khanna et al. 2017), the Maldives  
681 (Fürstenau et al., 2010; Rovere et al., 2018), the SW Indian Ocean (Jorry et al., 2016), the  
682 Marquesas Island (Cabioch et al., 2008a) and in Tahiti (Camoin et al., 2012). Carbonate rock  
683 samples dated at the youngest from the Pleistocene and collected on the flat-top of the Munida  
684 seamount that is currently submerged in 93 m water depth, are thought to be representative of  
685 seismic unit UM-2 which would correspond to the last stage of the carbonate platform's growth.  
686 Similarly to the Banc de la Torche and Antigonina, the flat-top of the eastern part of the Munida  
687 seamount is currently located in the photic zone which suggests continuous carbonate  
688 aggradation from the Miocene to the Quaternary. Such a continuous deposition was possibly  
689 favoured by a slower subsidence at that location compared to other seamounts (Fig.13). The  
690 Crypthelia seamount that is submerged at 194 m water depth is affected by three N160°E  
691 normal faults scarps, leading to an overall eastward deepening of the seamount topography  
692 along several stepped terraces at ca 200 m, 300 m and 350 m water depths (Fig.9A). The lack of  
693 samples on these stepped terraces does not allow us to determine if the carbonate factory was  
694 active during the Quaternary and when the isolated carbonate platform was drowned (Fig.13A).

695

696 **6. CONCLUSIONS**

697 The eastern margin of Grande Terre records the evolution of a shallow-water mixed  
698 carbonate-siliciclastic system, with the successive development an aggrading Mio-Pliocene  
699 carbonate bank and a backstepping Quaternary barrier reef.

700 - A Mio-Pliocene shallow-water carbonate platform, presently drowned at 300 to 600 m water  
701 depth, extends about 350 km from Ponerihouen to Antigonie seamount and can be up to 750 m  
702 thick along the Pines Ridge.

703 - In front of Grande Terre, the Mio-Pliocene carbonate sediments are mixed with quartz grains  
704 and ultrabasic pebbles, which document terrigenous inputs resulting from high relief of the  
705 island topography dismantling coeval with carbonate production as early as the Serravalian.

706 - The transition between the aggrading Mio-Pliocene carbonate bank and the backstepping  
707 Quaternary carbonate platforms along the eastern margin could be explained by the regional  
708 subsidence context driven by an extensional tectonic regime or by global climate change  
709 associated with Late Quaternary high-amplitude sea-level variations and/or changes of  
710 carbonate producers through time.

711 - The stratigraphic architectures of mixed carbonate-siliciclastic systems, represented by the  
712 Quaternary reef-lagoon complex along the upper slope, vary widely from north to south. In front  
713 of the Cap Bayes Pass, this contribution evidences for the first time in New Caledonia the  
714 presence of a lowstand terrigenous prism alternating with transgressive shallow-water  
715 carbonate sequence, typical to reciprocal sedimentation models. Nevertheless, this configuration  
716 is not observed southward, probably because other control parameters prevailed such as low  
717 terrigenous inputs, the particular morphology of the paleo-drainage network, which appears  
718 parallel to the coastline, or the high by-pass sediment transport toward the deep basin.

719

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1067 **FIGURE AND TABLE CAPTIONS**

1068

1069 **Figure 1:** **A.** Regional location map of the study area. **B.** Simplified geological map of Grande  
1070 Terre, New Caledonia (modified after Maurizot and Vendé-Leclerc, 2009) and shaded  
1071 bathymetric map of surrounding offshore areas with the southern extensions of the Peridotite  
1072 Nappe and metamorphic belt (Pines and Félicité ridges, respectively; after Patriat et al., 2018).  
1073 Drill sites of the Quaternary barrier reef (Coudray, 1975; Cabioch et al., 2008; Montaggioni et al.,  
1074 2011) and outcrops of the Lower Miocene mixed carbonate siliciclastic systems of Népoui are  
1075 also indicated (Maurizot et al., 2016 ; Tournadour et al., 2020). **C.** Simplified SW to NE oriented  
1076 geological cross-section of Grande Terre (modified after Lagabrielle et al., 2005 and Collot et al.,  
1077 1987). N: Nouméa ; Pn: Ponérihouen ; Th: Thio ; Yt: Yaté ; IP: Isle of Pines ; T : Banc de la Torche ;  
1078 S: Stylaster seamount ; B : Brachiopod seamount ; A : Antigonia seamount ; C : Crypthelia  
1079 seamount ; M : Munida seamount.

1080 **Figure 2:** Bathymetric map of the eastern margin of Grande Terre, from Poindimié to the Pines  
1081 Ridge with location of the dataset used in this study including seismic profiles AUS-104 (Bitoun  
1082 & Recy, 1982), 206-04 (dashed black lines), NEOMARGES (Chardon, 2006; Chardon et al. 2008,  
1083 black lines), and dredged carbonate samples (yellow circles). T : Banc de la Torche ; S : Stylaster  
1084 seamount ; B : Brachiopod seamount ; A : Antigonia seamount ; C : Crypthelia seamount ; M :  
1085 Munida seamount.

1086 **Figure 3:** **A.** Bathymetric map of the eastern lagoon of Grande Terre from Ponérihouen to Yaté.  
1087 On the outer slope, note the terrace mapped in orange between 300 to 600 m water depths. **B.**  
1088 Bathymetrical profile across the lagoon from the coast of Houailou to the outer barrier reef (see  
1089 location on Figure A) showing three main morphobathymetric zones: 1) a shallow-water coastal  
1090 zone dominated by fine-grained terrigenous sediments; 2) a deeper median lagoon with aligned  
1091 islands and a coast-parallel channel network in front of Cote Oubliée; 3) a barrier reef domain  
1092 cross-cut by passes, dominated by coarse-grained carbonate sedimentation. D: Deltas; D\*:

1093 Restricted deltas; SI: Sandy Islets; PR: Patch Reefs. Red lines are positions of seismic profiles.  
1094 Yellow circles are positions of dredged carbonate samples.

1095 **Figure 4:** Typical bathymetric profiles of the outer slopes of Grande Terre (location on [Fig.2](#))  
1096 highlighting the very steep character of the western margin (dashed green lines; W-01 and W-  
1097 02) contrasting with the more gently inclined eastern margin (solid blue lines; E-01 and E-02).  
1098 The latter illustrate the main morpho-bathymetric domains of the eastern margin slope, which  
1099 can be divided into a low gradient (2-3°) upper slope mostly preserved from erosion, a middle  
1100 slope affected by numerous submarine canyons and a lower slope to to-of-slope region. The  
1101 hatched area shows the elevation difference between the southern and central parts of the  
1102 eastern margin (E-01 and E-02, respectively), highlighting that the slope is better preserved  
1103 from retrogressive erosion by slope canyons processes towards the south.

1104 **Figure 5: A.** 3D bathymetrical map of the outer slope in front of Cap Bayes Pass with location of  
1105 dip-oriented seismic profile NM-1. **B.** Seismic profile NM-1 profile with location of quaternary  
1106 terraces (blue arrow, see details in Flamand, 2006), clinoform slope break of U2 prism (green  
1107 arrow) and the bathymetrical scarp associated with the top of U1 seismic unit (red arrow). **C.**  
1108 Interpretation of seismic profile NM-1 highlighting five sub-units inside U2, interpreted as  
1109 parasequences (numbered from 1 to 5). Each parasequence is typified by an alternation of  
1110 lowstand forced regressive wedges (in beige) and aggrading to retrograding shallow-water  
1111 carbonate transgressive sequences (in pink), consistent with the pattern of reciprocal  
1112 sedimentation model.

1113 **Figure 6: A.** 3D bathymetrical map of the outer slope in front of Canala with location of seismic  
1114 profiles NM-4 and NM-9 and dredged carbonate rocks (see [Table 3](#)). **B.** Uninterpreted seismic  
1115 profile NM-4. **C.** Interpreted seismic profile NM-4. **D.** Uninterpreted seismic profile NM-9. **E.**  
1116 Interpretation of seismic profile NM-9. Both profiles show U1 seismic unit overlain by  
1117 downlapping U2 seismic unit interpreted as external slope deposits derived from the quaternary  
1118 barrier reef.

1119 **Figure 7: A.** 3D bathymetrical map of the outer slope in front of Côte Oubliée with location of  
1120 seismic profiles NM-12B and NM-13 and dredged carbonate rock DR-49 (see [Table 3](#)). **B.**  
1121 Uninterpreted seismic profile NM-12B. **C.** Interpretation of seismic profile NM-12B. **D.**  
1122 Uninterpreted seismic profile NM-13. **E.** Interpretation of seismic profile NM-13. The upper  
1123 slope is characterized by a thick downlapping U1 sedimentary unit incised by numerous gullies  
1124 suggesting significant off-bank transport from the lagoon towards the basin.

1125 **Figure 8: A.** 3D bathymetrical map of the southeastern slope of Grande Terre and Pines Ridge  
1126 with location of AUS-104 and 206-04 seismic profiles. T : Banc de la Torche ; S : Stylaster  
1127 seamount ; B : Brachiopod seamount ; A : Antigonina seamount ; C : Crypthelia seamount ; M :  
1128 Munida seamount. **B.** Seismic profile AUS-14 across the Loyalty Basin bordered by the Loyalty  
1129 and Pines ridges. **C.** Line drawing interpretation of profile AUS-14 showing spectacular normal  
1130 faults affecting the peridotite nappe overlain by post-obduction sedimentary units. This study  
1131 focuses on shallow-water carbonates that cover peridotite horsts of the Pines Ridge and which  
1132 are currently at 300-400 m water depths.

1133 **Figure 9:** Bathymetric map (**A**) and profile (**B**) of Crypthelia seamount located from 200 to 800  
1134 m water depth and marked by N160° oriented faults (f) associated with a channel (Ch) and large  
1135 collapses on its southern edge. Bathymetric map of Munida seamount (**C**) marked by a southern  
1136 terrace noted M1, located between 400 to 600 m water depth, and by a relatively flat top above  
1137 200 m water depth, noted M2.

1138 **Figure 10: A.** Seismic profile 206-04 through the Pines Ridge and Munida seamount (see  
1139 location on [Fig.8A](#) and [10C](#)). **B.** Interpretation of profile 206-04 showing the normally faulted  
1140 geometry the Peridotite Nappe and HP-LT Metamorphic complex resulting from post-obduction  
1141 extensional tectonics (Patriat et al., 2018). Associated flat-topped horsts are capped by a shallow  
1142 water carbonate ramp interpreted as being of Mio-Pliocene age based on biostratigraphic  
1143 analysis of DW-4757 and DW-4782-A dredged samples (see [Table 3](#)). **C.** Close-up view on  
1144 seismic profile 206-04 on the Pines Ridge. **D.** Detailed line drawing interpretation of C. showing

1145 3 subunits UP1 to UP3 and an overall asymmetric configuration suggesting a tilt of Pines Ridge  
1146 before and during deposition of the Mio-Pliocene carbonate ramp. The eastern part of UP2  
1147 subunit is characterized by build-up geometries that could be interpreted as aggrading platform.

1148 **Figure 11:** A. DR44 sample, (a.) *Katacycloclypeus martini*, (b.) *Globigerinoides quadrilobatus*. B.  
1149 DR44 sample, (a.) *small rovaliid* in reworked micrite, (b.) *Dentoglobigerina altispira*, (c.)  
1150 *Globorotalia menardii*, (d.) *Globigerinoides conglobatus*, (e.) *Globigerinoides ruber*. C. DR44  
1151 sample, (a.) *Globorotalia plesiotumida*. D. DR45 sample, (a.) *Lepidocyclina sp.* E. DR46 sample,  
1152 (a.) *Truncorotalia crassaformis*. F. DR47 sample, (a.) *Globoquadrina dehiscens*. G. DR47 sample,  
1153 (a.) *Globorotalia tumida*.

1154 **Figure 12:** A. DR48 sample, (a.) *Alveolinella praequoyi* (b.) *Pulleniatina obliquiloculata*. B. DR49  
1155 sample, (a.) *Alveolinella praequoyi*. C. DR49 sample, (a.) *Globorotalia tumida* D. DR53 sample,  
1156 (a.) *Pulleniatina primalis* E. DW4737-B sample, (a.) *Alanlordia sp.* F. DW4757-A sample, (a.)  
1157 *Planorbulinella solida*. G. DW4770 sample, (a.) *Truncorotalia truncatulinoides* (d'Orbigny) (b.)  
1158 *Truncorotalia tosaensis* (Takayanagi and Saito).

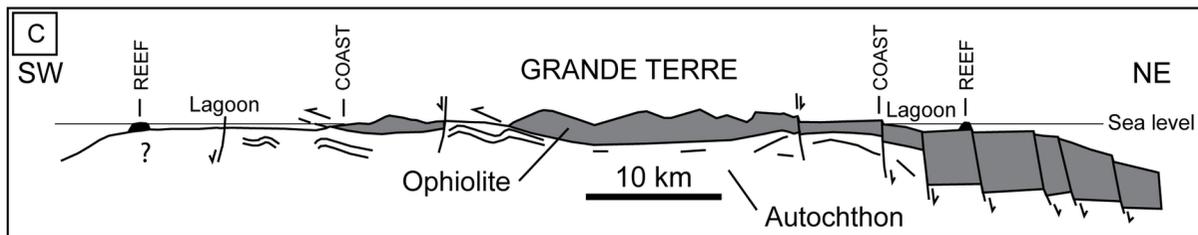
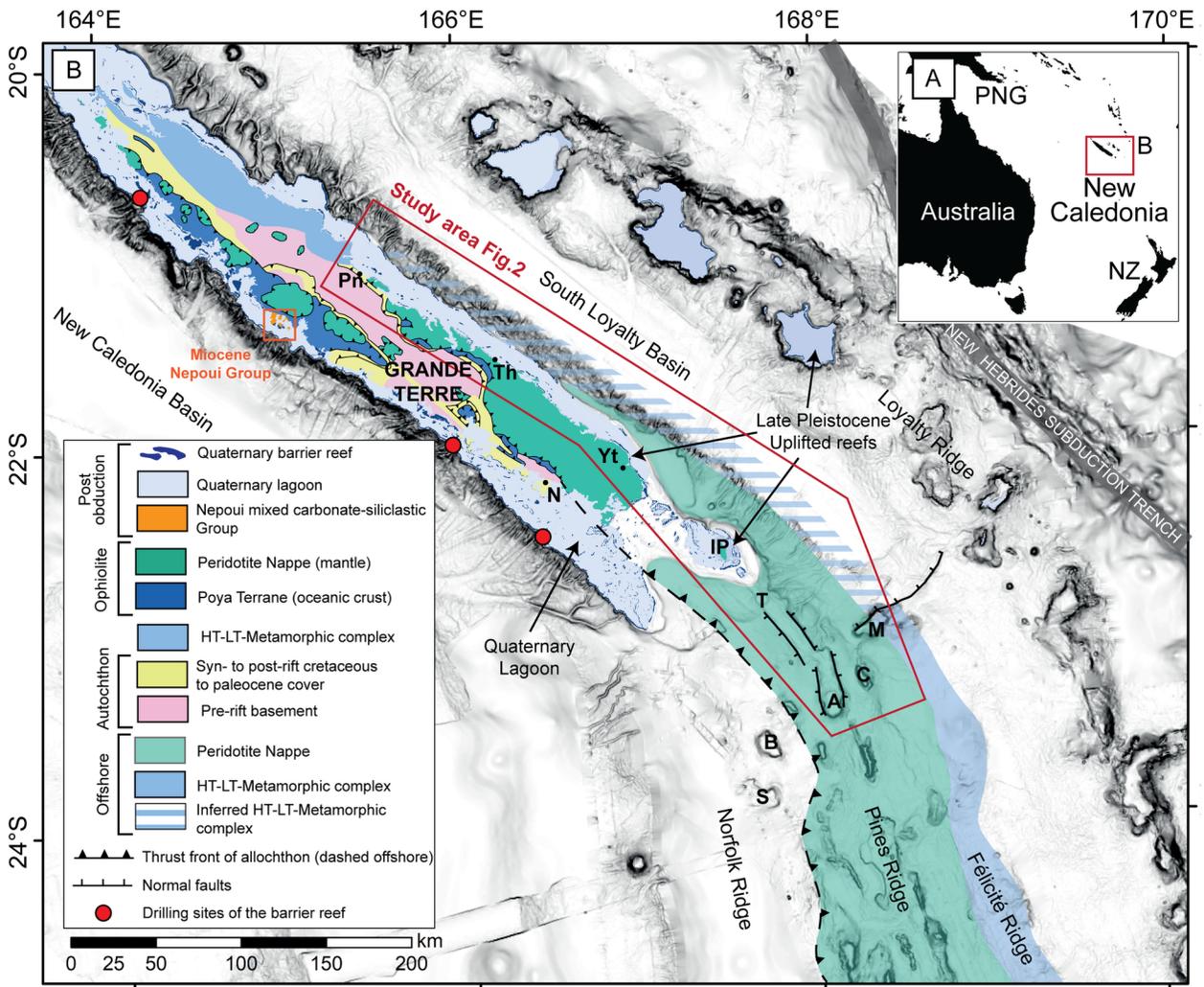
1159 **Figure 13:** A. Schematic cross-sections showing the geometry and evolution of shallow water  
1160 post-obduction systems on the eastern margin of Grande Terre in the vicinity of Poindimié (1),  
1161 north of Pines Ridges along Banc de la Torche (2), south of Pines Ridge (3), and over Crypthelia  
1162 (4) and (5) Munida seamounts. (location in Fig. 13C). B. Paleogeographical reconstruction and  
1163 spatial distribution of Mio-Pliocene carbonate banks. C. Paleogeographical reconstruction and  
1164 spatial distribution of Quaternary barrier reef of Grande Terre and submerged isolated  
1165 platforms along Pines Ridges and seamounts.

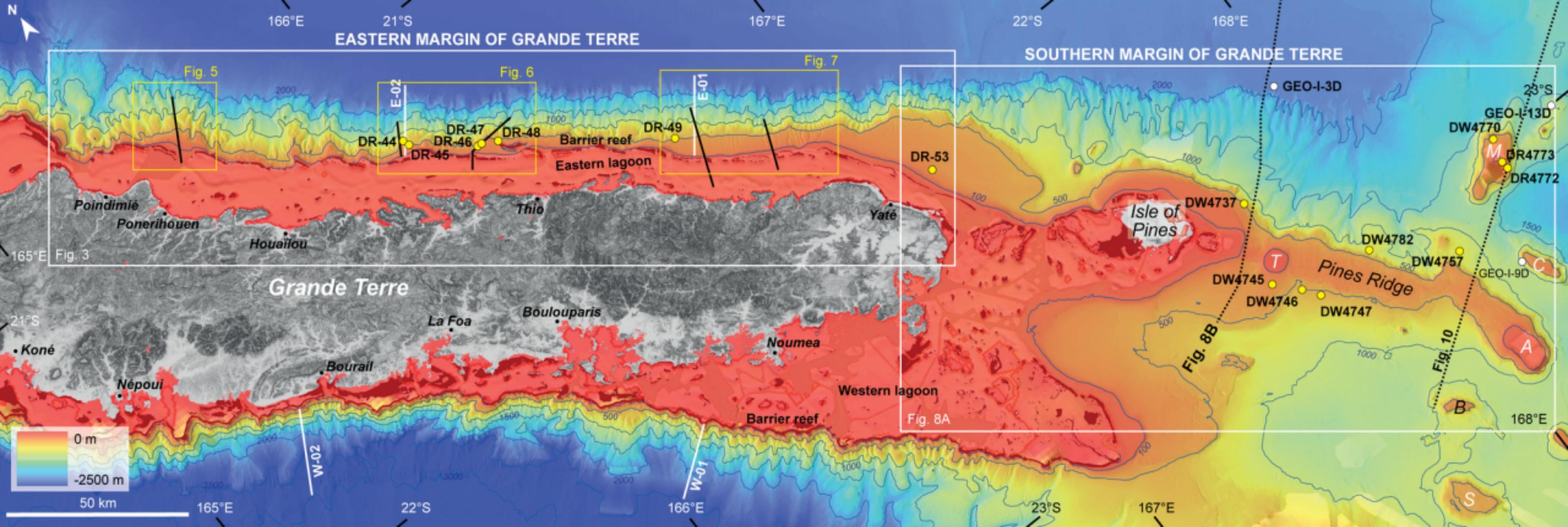
1166 **Table 1:** Characteristics of the seismic acquisition devices.

1167 **Table 2:** List of carbonate rock samples analysed in this study

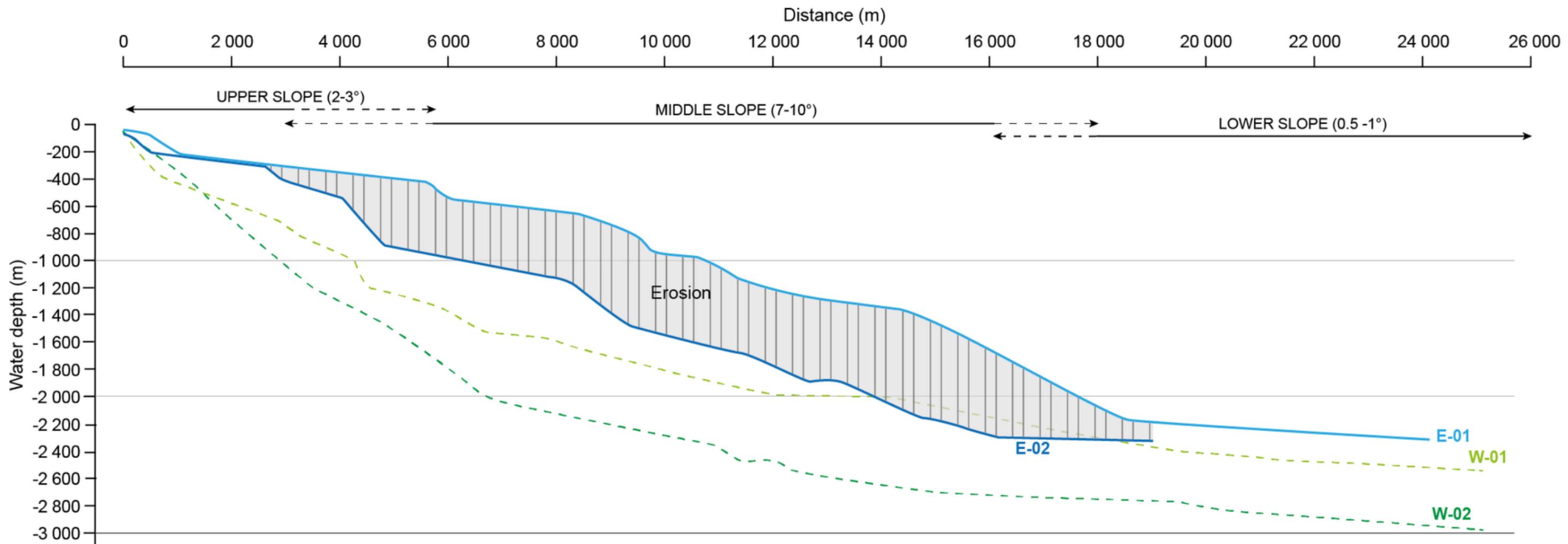
1168 **Table 3:** Table summarizing microfacies description and interpretation of depositional  
1169 environment, age of *in-situ* components and age of reworked components (identified in red in  
1170 Table 4)

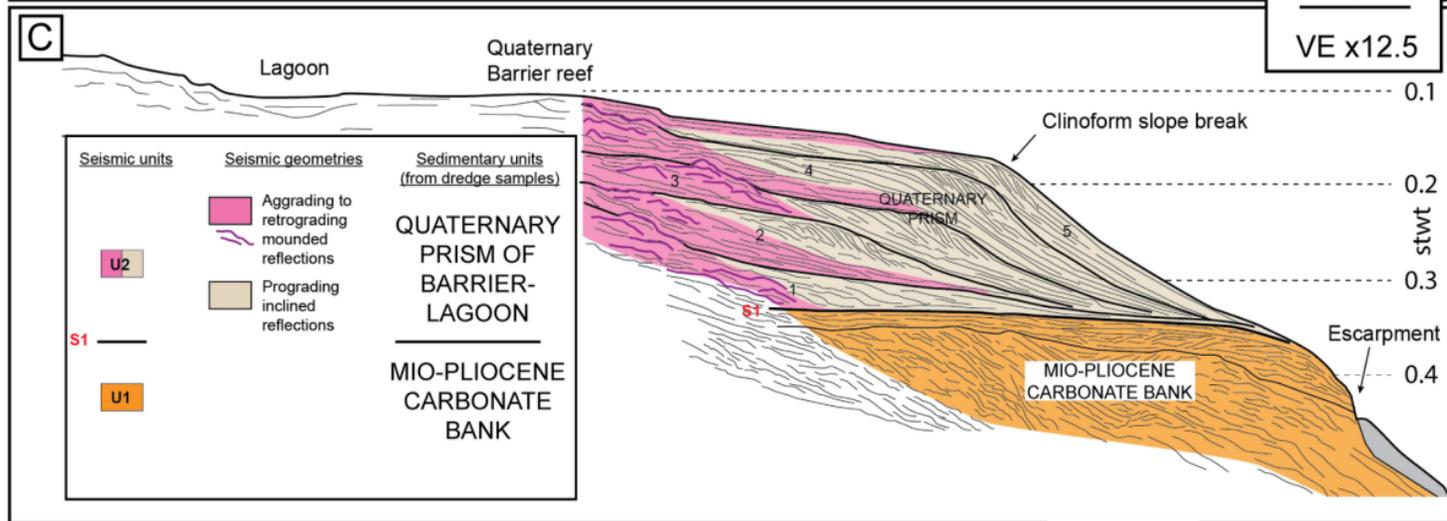
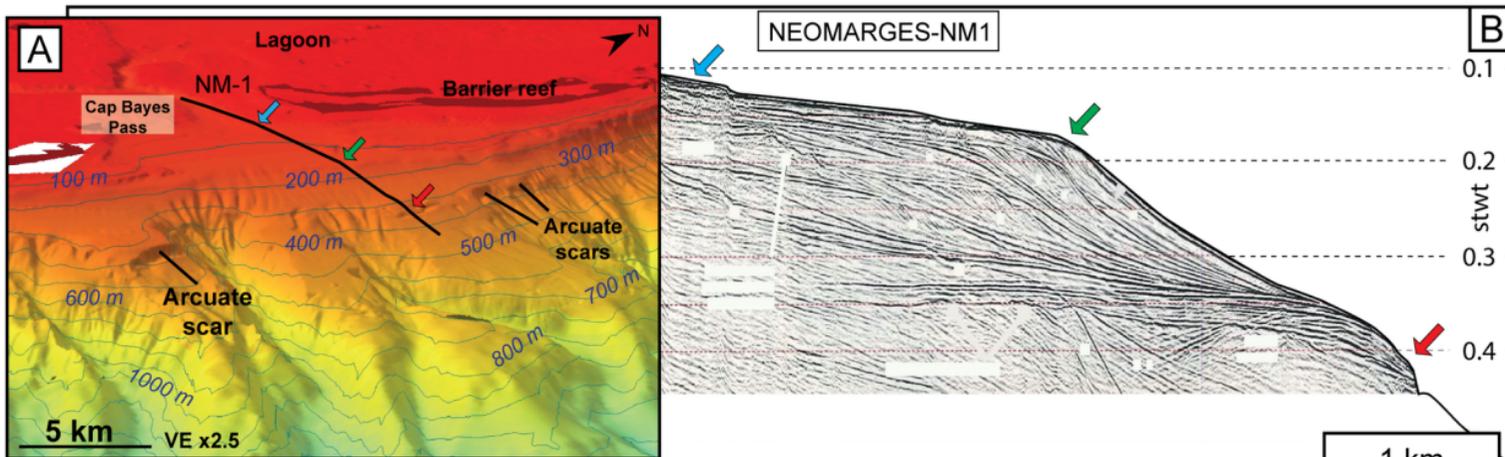
1171 **Table 4:** List of the component occurrence with identification of reworked elements (red cross).

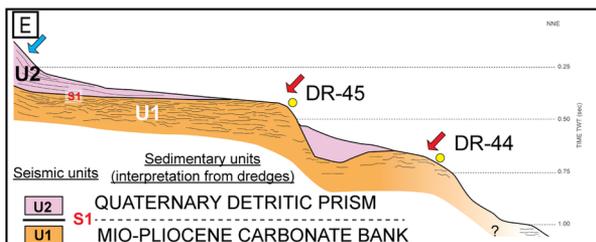
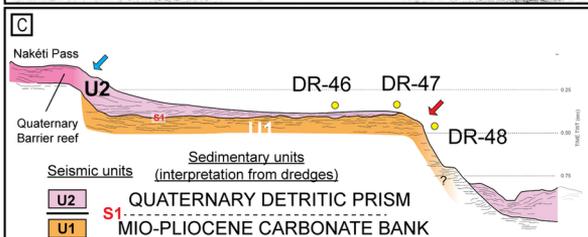
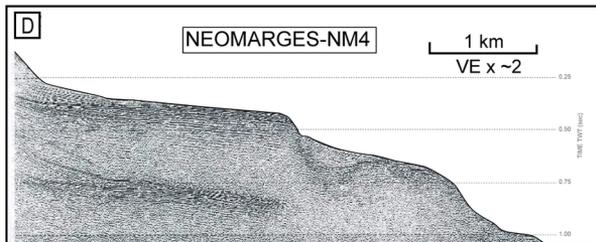
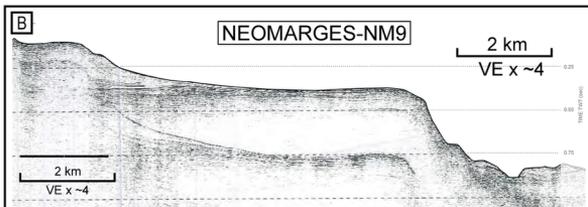
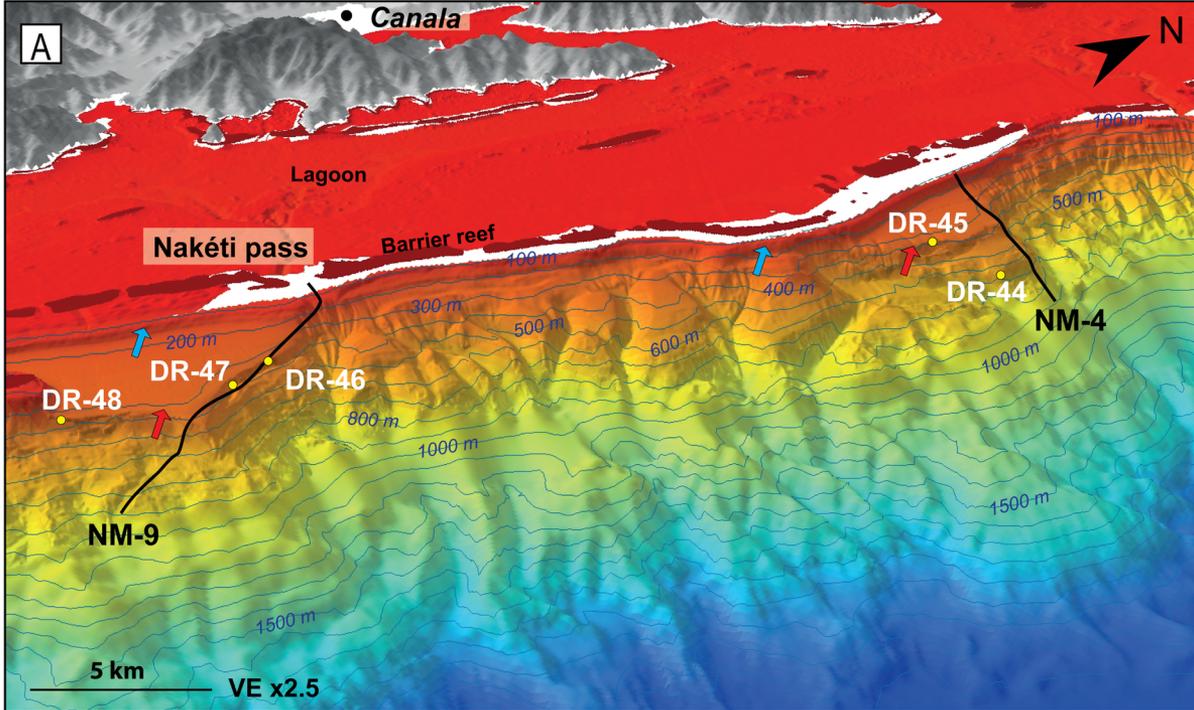


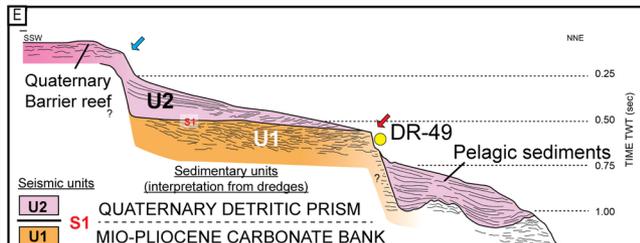
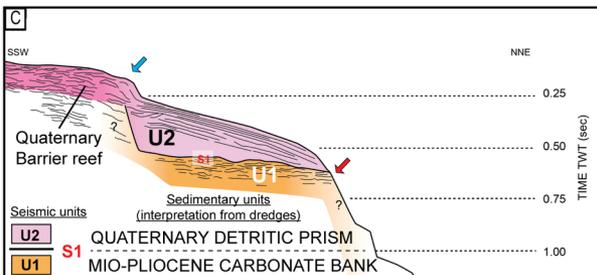
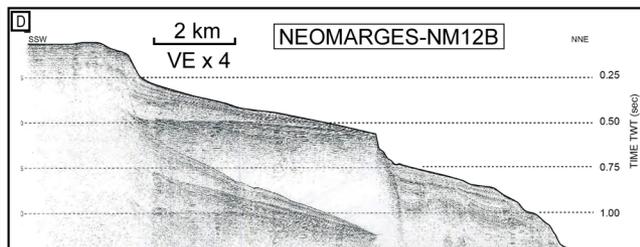
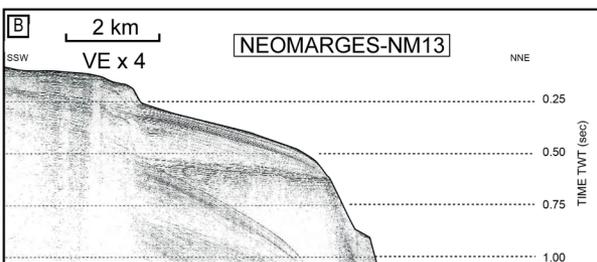
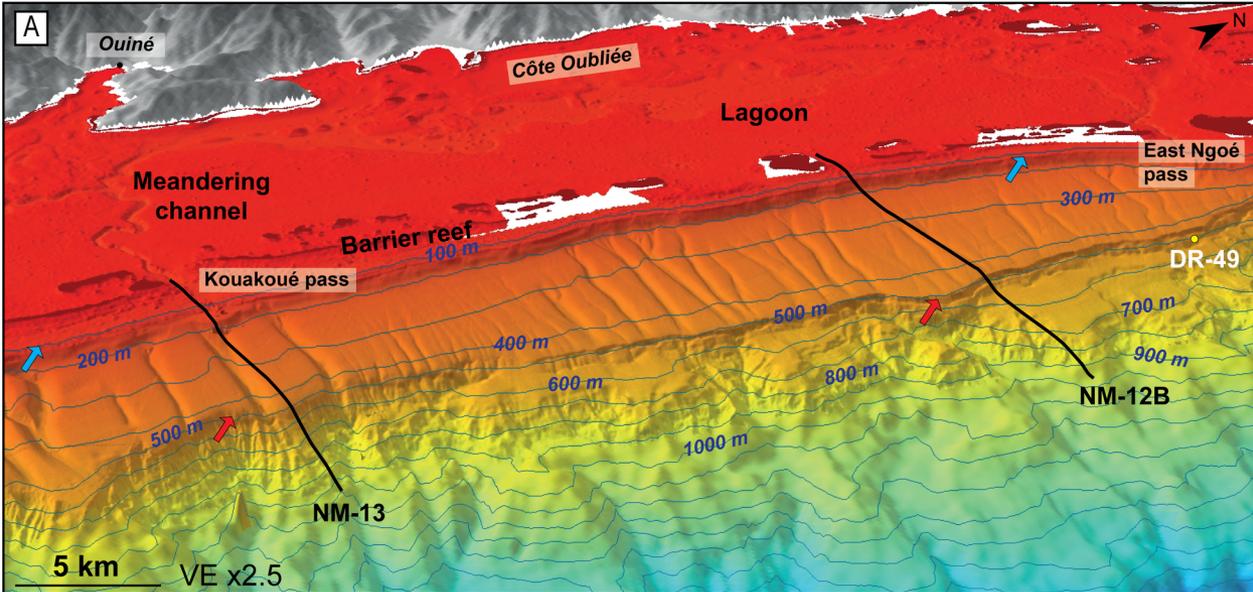


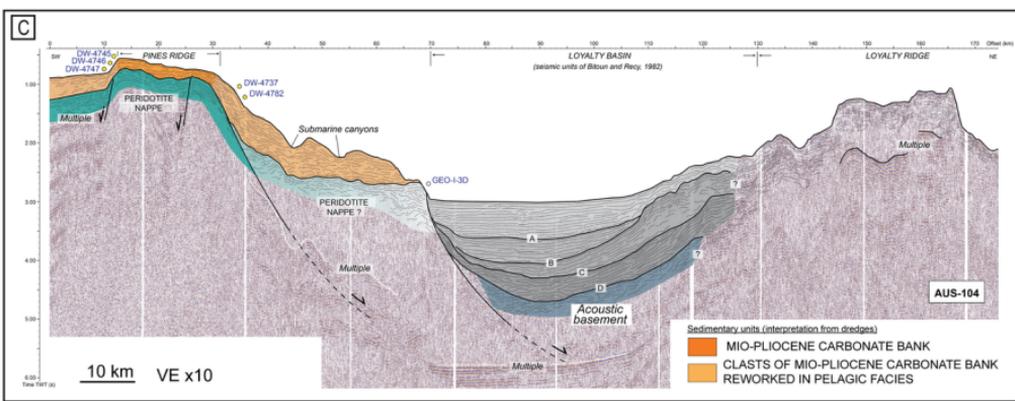
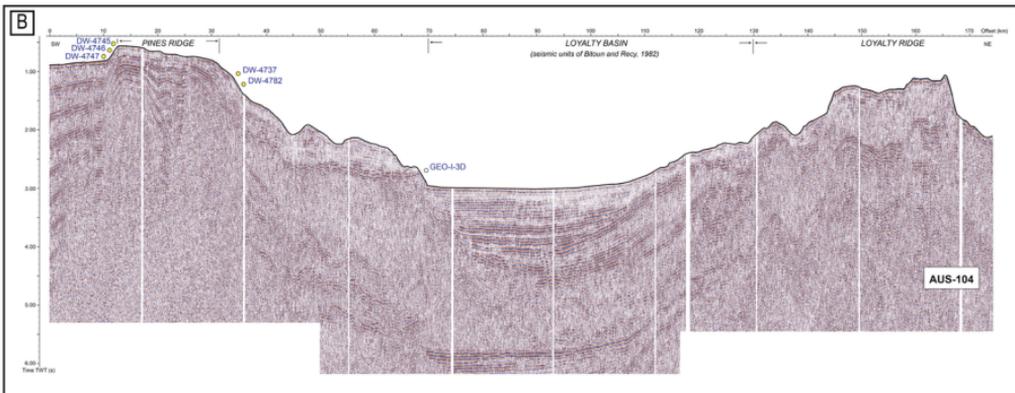
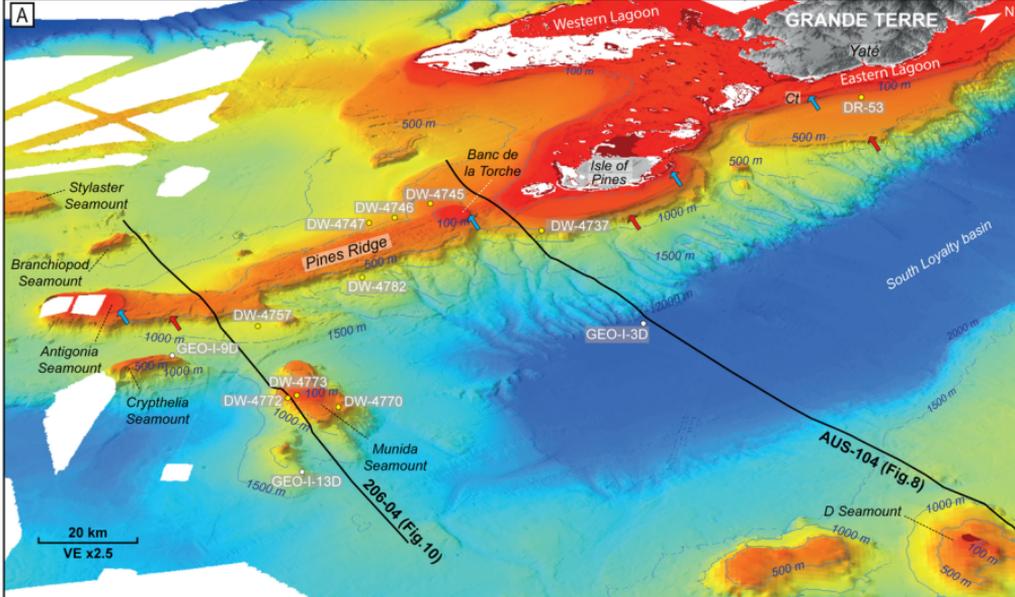




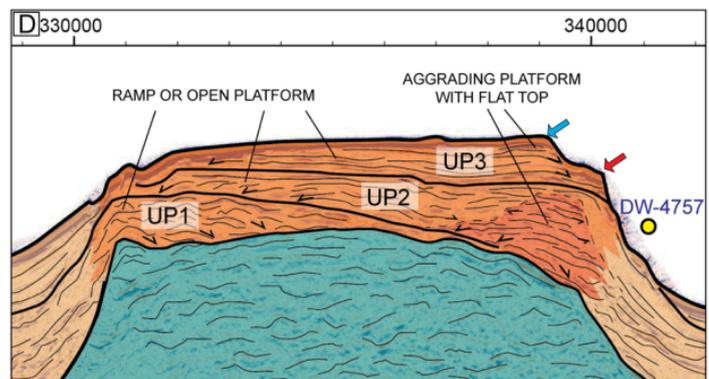
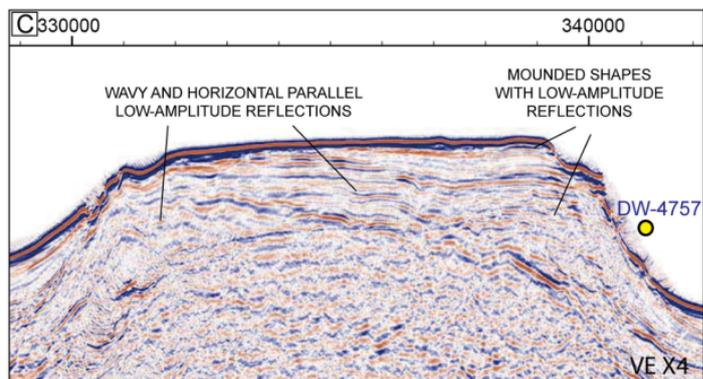
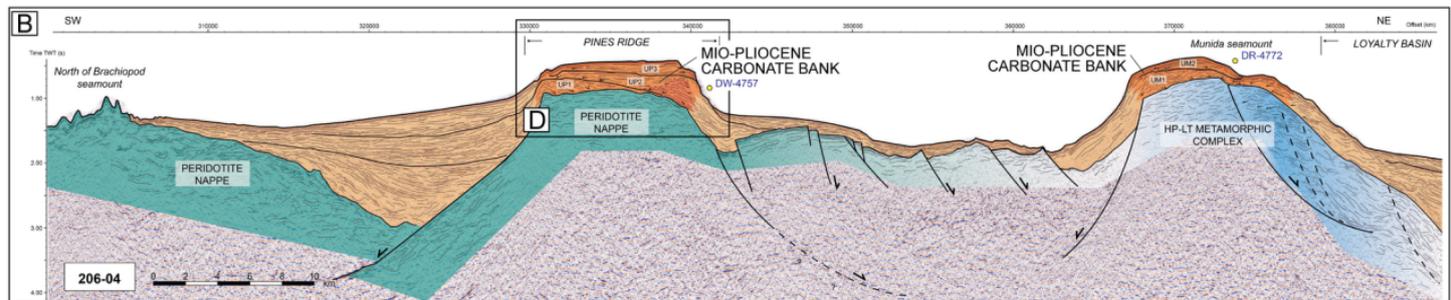
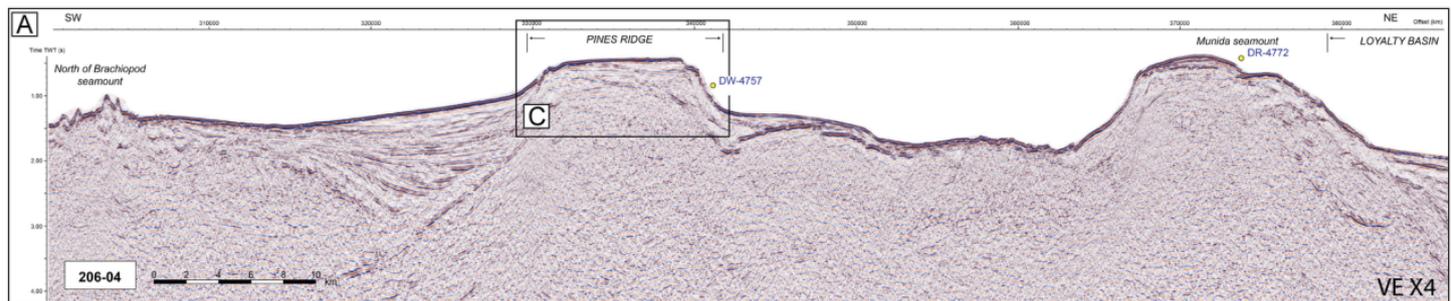


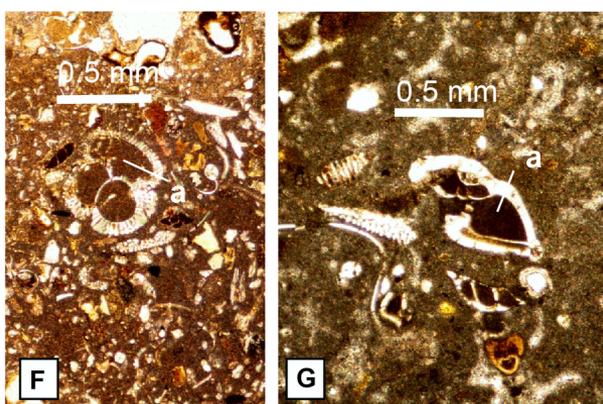
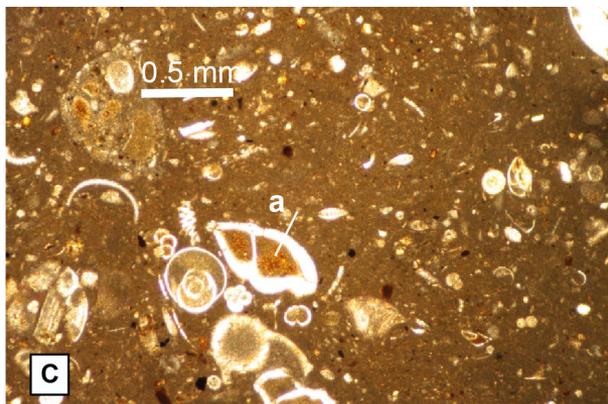
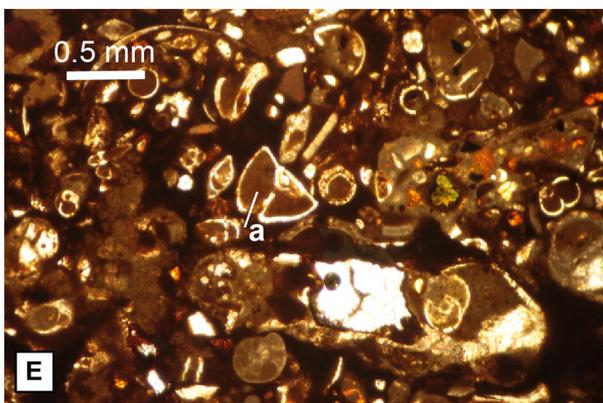
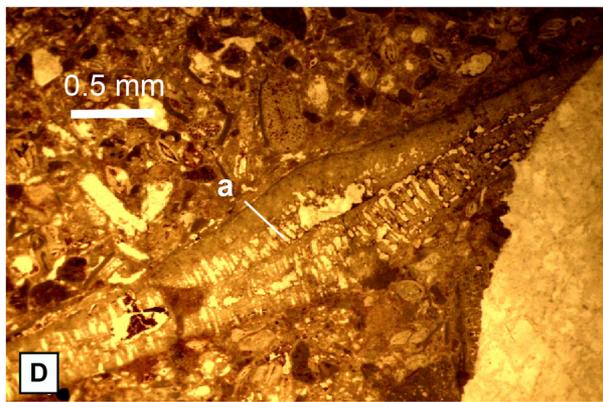
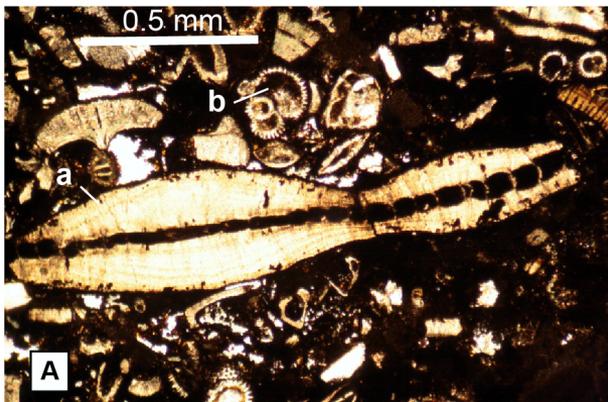


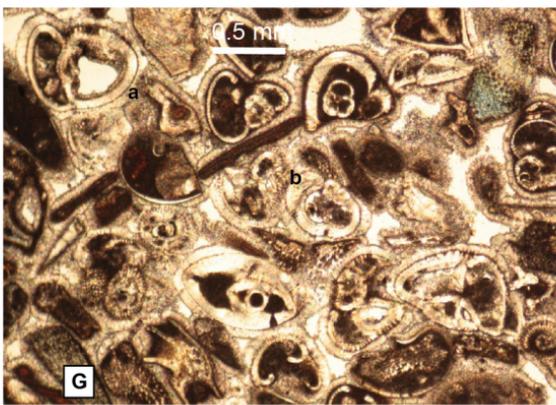
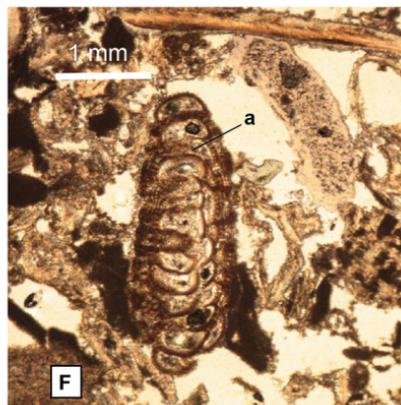
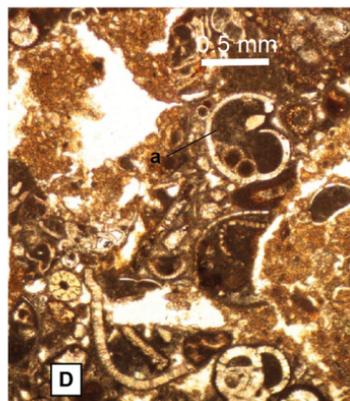
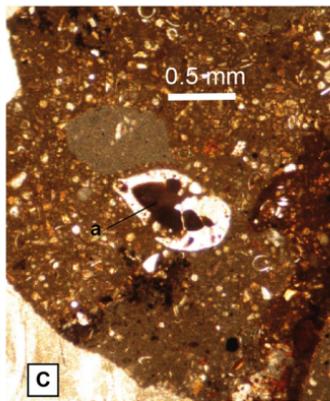
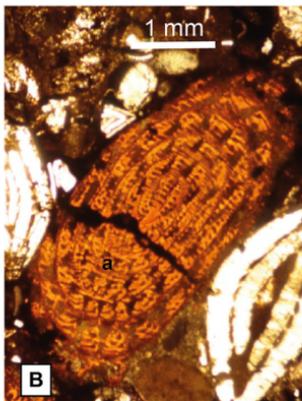
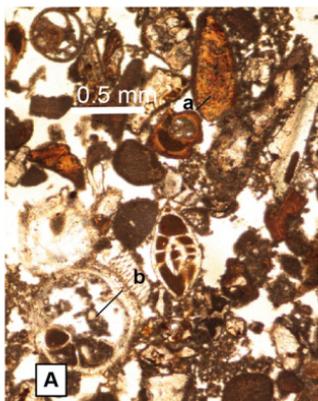


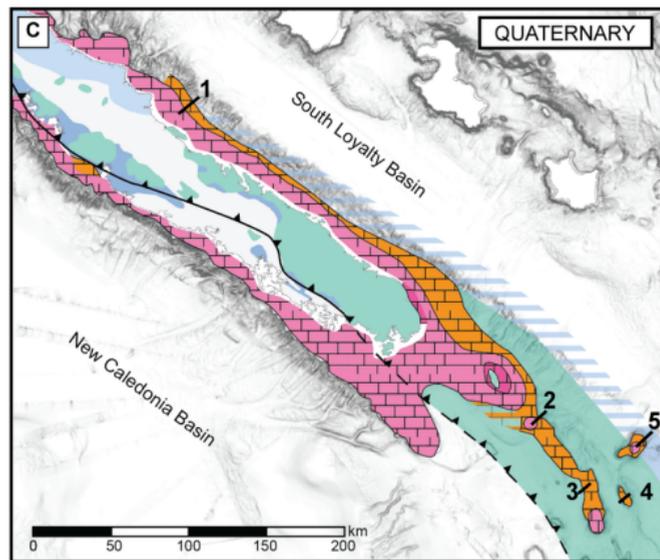
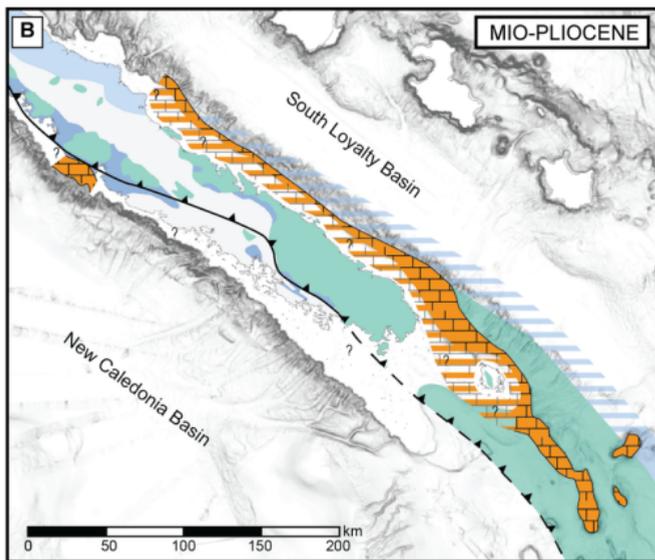
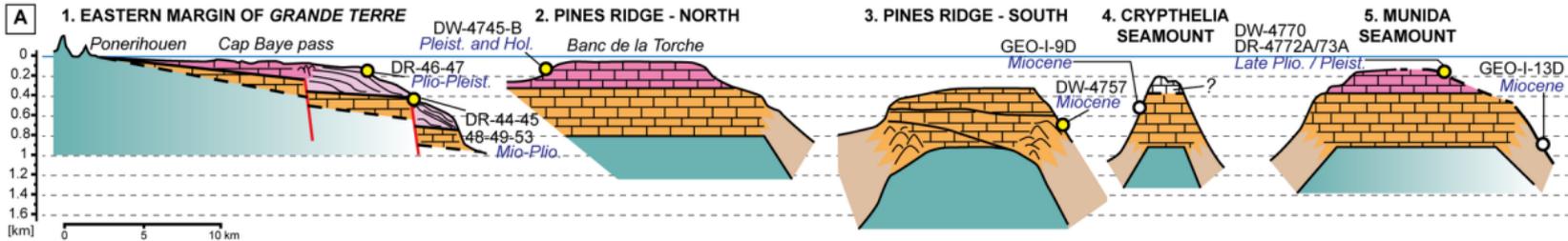












POST-OBUCTION CARBONATE UNITS



SEISMIC PROFILE	Figure in this study	CRUISE	STREAMER LENGTH (KM)	NUMBER OF CHANNELS	SOURCE TYPE	SOURCE VOLUME (CU)	SOURCE BAND WIDTH (Hz)	SHOT INTERVAL (m)
NM-1	Fig. 5	NEOMARGES, 2006	0.072	24	Airgun Bolt 600BT	20	50 to 500	5,5 to 8
NM-4	Fig. 6B							
NM-9	Fig. 6C							
NM-12B	Fig. 7B							
NM-13	Fig. 7C							
AUS-104	Fig. 8B	AUSTRADDEC-1, 1972	–	12 or 24	Flexichoc source	–	–	–
206-04	Fig. 10	FAUST-1, 1998	3.3	264	Systems HG Sleeve guns	3000	50-60	50

SAMPLE NAME	CRUISE	SITE	WATER DEPTH (m)	LATITUDE	LONGITUDE
DR44	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	550 to 680	-21.276	166.020
DR45	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	300 to 410	-21.295	166.023
DR46	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	295 to 380	-21.404	166.170
DR47	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	295 to 380	-21.405	166.183
DR48	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	290 to 400	-21.426	166.220
DR49	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	400 to 500	-21.701	166.598
DR53	2005-NC-DR	Eastern margin of <i>Grande Terre</i>	280	-22.168	167.092
DW4737-B	KANACONO	Southern margin of Isle of Pines	387 to 456	-22.716	167.709
DW4746-B	KANACONO	Southern margin of Isle of Pines	494 to 508	-22.975	167.693
DW4745-B	KANACONO	Southern margin of Isle of Pines	310 to 403	-22.918	167.636
DW4747-B1	KANACONO	Southern margin of Isle of Pines	550 to 590	-23.015	167.722
DW4747-X	KANACONO	Southern margin of Isle of Pines	550 to 590	-23.015	167.722
DW4757-A	KANACONO	Southern margin of Isle of Pines	800 to 850	-23.142	168.096
DW4782-A	KANACONO	Southern margin of Isle of Pines	845 to 856	-23.000	167.903
DW4770	KANACONO	Munida seamount	455 to 470	-22.975	168.350
DR4772-A	KANACONO	Munida seamount	230 to 795	-23.051	168.336
DR4773-A	KANACONO	Munida seamount	230 to 400	-23.035	168.334

SAMPLES	SITE	DEPTH	CRUISE	MICROFACIES	DEPOSITIONAL ENVIRONNEMENT	ZONE and AGE	ZONE and AGE of reworked components (in red Table.4)
DR44	Eastern Margin, in front of Canala (Fig.6)	550 to 680 m	2005-NC-DR	Micritic pelagic packstone with reworked micritic patches of planktonic foraminifera, recrystallised algae and larger benthic foraminifera	Forereef environment LBF reworked into inner to outer neritic environment	N19-N20a (5.3 Ma to 3.6 Ma) Early Pliocene	N12 (13.82 Ma to 12.00 Ma) Serravallian
DR45		300 to 410 m	2005-NC-DR	Micritic pelagic packstone with reworked micritic patches of planktonic foraminifera, recrystallised algae and larger benthic foraminifera	Forereef environment LBF reworked into inner to outer neritic environment	N19-N20a (5.33 Ma to 3.6 Ma) Early Pliocene	N12-N13 (13.82 Ma to 11.63 Ma) Serravallian
DR46	Eastern Margin, in front of Nakéti Pass (Fig.6)	295 to 380 m	2005-NC-DR	Micritic packstone of planktonic foraminifera with reworked patches of reworked pelagic micrite	Inner to outer neritic	N22a (1.8 Ma to 1.00 Ma) Pleistocene	N4-N17a (23.03-7.2Ma) Miocene
DR47		295 to 380 m	2005-NC-DR	Micritic wackestone of recrystallised algae with reworked patches of reworked pelagic micrite	Inner to outer neritic	N20a (3.8 Ma-3.6 Ma) Late Pliocene	N4-N17a (23.03-7.2Ma) Miocene
DR48		290 to 400 m	2005-NC-DR	Micritic packstone of algae with reworked patches of reworked pelagic micrite	Forereef environment LBF reworked into inner to outer neritic environment	N22 (1.8 Ma to 0.12 Ma) Pleistocene	N12-N13 (13.82 Ma to 11.63 Ma) Serravallian
DR49	Eastern Margin, in front of Ngoé Pass (Fig.7)	400 to 500 m	2005-NC-DR	Micritic packstone of algae and larger benthic foraminifera reworked into pelagic micrite	Forereef environment LBF reworked into inner to outer neritic environment	N19 (5.3 Ma to 3.8 Ma) Early Pliocene	N12-N13 (13.82 Ma to 11.63 Ma) Serravallian
DR53	Eastern Margin, in front of Yaté (Fig.8)	280 m	2005-NC-DR	Micritic packstone of planktonic foraminifera	Inner to outer neritic	N18-N21a (5.8 Ma to 2.5 Ma) Late Miocene (Messinian) to Early Pliocene (Zandclean))	Serravallian to Pliocene, N12-N21
DW4737-B	SE Isle of Pines (Fig.8)	387 to 456 m	KANACONO	Micritic wackestone of foraminifera and fragments of algae	Inner to outer neritic	N20b-N21 (3.6 Ma to 2.5 Ma) Pliocene	
DW4745-B	West of Pines Ridge (Fig.8)	310 to 403 m	KANACONO	Micritic packstone of foraminifera and algae	Inner to outer neritic	N22-Recent (1.8 Ma to Recent) Pleistocene - Holocene	
DW4746-B		494 to 508 m	KANACONO	Grainstone cemented by sparite of planktonic foraminifera with reworked micritic patches	Inner to outer neritic	N22 (1.8 Ma to 0.12 Ma) Pleistocene	N19-N21 (5.33 Ma to 1.8 Ma) Pliocene
DW4747-B1		550 to 590 m	KANACONO	Micritic packstone of foraminifera and algae	Inner to outer neritic	N19-N22 (5.33 Ma to 0.12 Ma) Pliocene - Pleistocene	
DW4747-X		550 to 590 m	KANACONO	Micritic wackestone of foraminifera	Inner to outer neritic	N21-N22 (2.5 Ma to 0.12 Ma) Late Pliocene - Pleistocene	
DW4757-A	East of Pines Ridges (Fig.8)	800 to 850 m	KANACONO	Micritic wackestone of foraminifera	Forereef environment	N4-N12 (23.03 Ma to 12 Ma) Early Miocene	
DW4782-A		845 to 856 m	KANACONO	Micritic wackestone of foraminifera	Inner to outer neritic	N17-N20 (8.6 Ma to 3.4 Ma) Late Miocene - Early Pliocene	
DW4770	Munida seamount (Fig.8 and Fig.9)	455 to 470 m	KANACONO	Micritic/sparitic packstone of foraminifera and algae	Inner to outer neritic	N22 (1.8 Ma to 0.12 Ma) Pleistocene	
DR4772-A		320 to 795 m	KANACONO	Grainstone cemented by sparite of planktonic foraminifera with reworked micritic patches	Inner to outer neritic	N21-N22 (3.4 Ma to 0.12 Ma) Late Pliocene - Pleistocene	N4-N17a Miocene
DR4773-A		230 to 400 m	KANACONO	Grainstone cemented by sparite of planktonic foraminifera with reworked micritic patches	Inner to outer neritic	N21-N22 (3.4 Ma to 0.2 Ma) Late Pliocene - Pleistocene	N4-N17a (23.03-7.2Ma) Miocene

