

5. Geomorphology and Sedimentology of Bioregions

5.1. INTRODUCTION

At the completion of this task there are a total of 883 samples in the EMR with either quantitative grainsize and/or carbonate data. These are distributed across 13 of the 14 bioregions (Fig. 5.1; Table 5.1). New data significantly improve the sample density in six of the 14 bioregions and provide the first sediment data for the Kenn Province and the Kenn Transition in the EMR.

Of the 883 samples, 636 (72%) occur in the three shelf bioregions which comprise <2% of the total EMR area. The remaining 236 (25%) occur in the 11 offshore bioregions which comprise 98% of EMR area (Fig. 5.1.). Eleven samples located outside the EMR have been included in our analysis as they occur in extensions of geomorphic features which have poor sample coverage within the EMR. These samples occur in extensions of features in the Northeast Transition (2), Northeast Province (3), Kenn Transition (3), Kenn Province (2), Cape Province (1). New data adds 13 samples to the shelf bioregions, increasing coverage of this area by 2% and 114 samples to offshore bioregions, increasing coverage by 85%.

Average sample densities in shelf bioregions are >5 samples per 1,000 km² (Table 5.1) and lower in offshore bioregions: <1 sample per 1,000 km². Sample density is lowest (<0.01 samples per 1,000 km²) in the Norfolk Island Province which covers 17% of the EMR and contains only one sample. Sample density in offshore bioregions is highest in the Central Eastern Transition (0.78 samples per 1,000 km²) and the Central Eastern Province (0.36 samples per 1,000 km²).

This section provides a quantitative assessment of the geomorphology, bathymetry and sedimentology of each bioregion and significant geomorphic features. Sample coverage is adequate to describe the sedimentology of significant features in all the shelf bioregions and for select features within offshore bioregions. The sedimentology of slope, abyssal plain/deep ocean floor, trench/trough, basin, plateau, and terraces is assessed in individual bioregions. Where present, pinnacles, reefs and rise are considered significant geomorphic features at a bioregion scale. However, these features do not contain sufficient samples to quantitatively describe their sedimentology in individual bioregions.

Bioregions of the EMR can be distinguished from one another based on sediment texture and composition, and by the spatial distribution of these properties relative to other physical data sets such as bathymetry and geomorphology. Sediments within shelf bioregions can be distinguished from those in offshore bioregions by grainsize and carbonate content. Shelf bioregions are dominated by sand with lesser amounts of mud and negligible gravel (Fig. 5.2.). Offshore bioregions display a more varied sedimentology dominated by mud. Bioregions adjacent to the Great Barrier Reef Marine Park (Cape Province, Northeast Transition and Northeast Province) are distinguished by sediments dominated by carbonate mud (Fig. 5.3.). Limited sample coverage has prevented a detailed quantitative assessment of the sedimentology of the Norfolk Island Province, Southeast Transition and Tasman Basin Province.

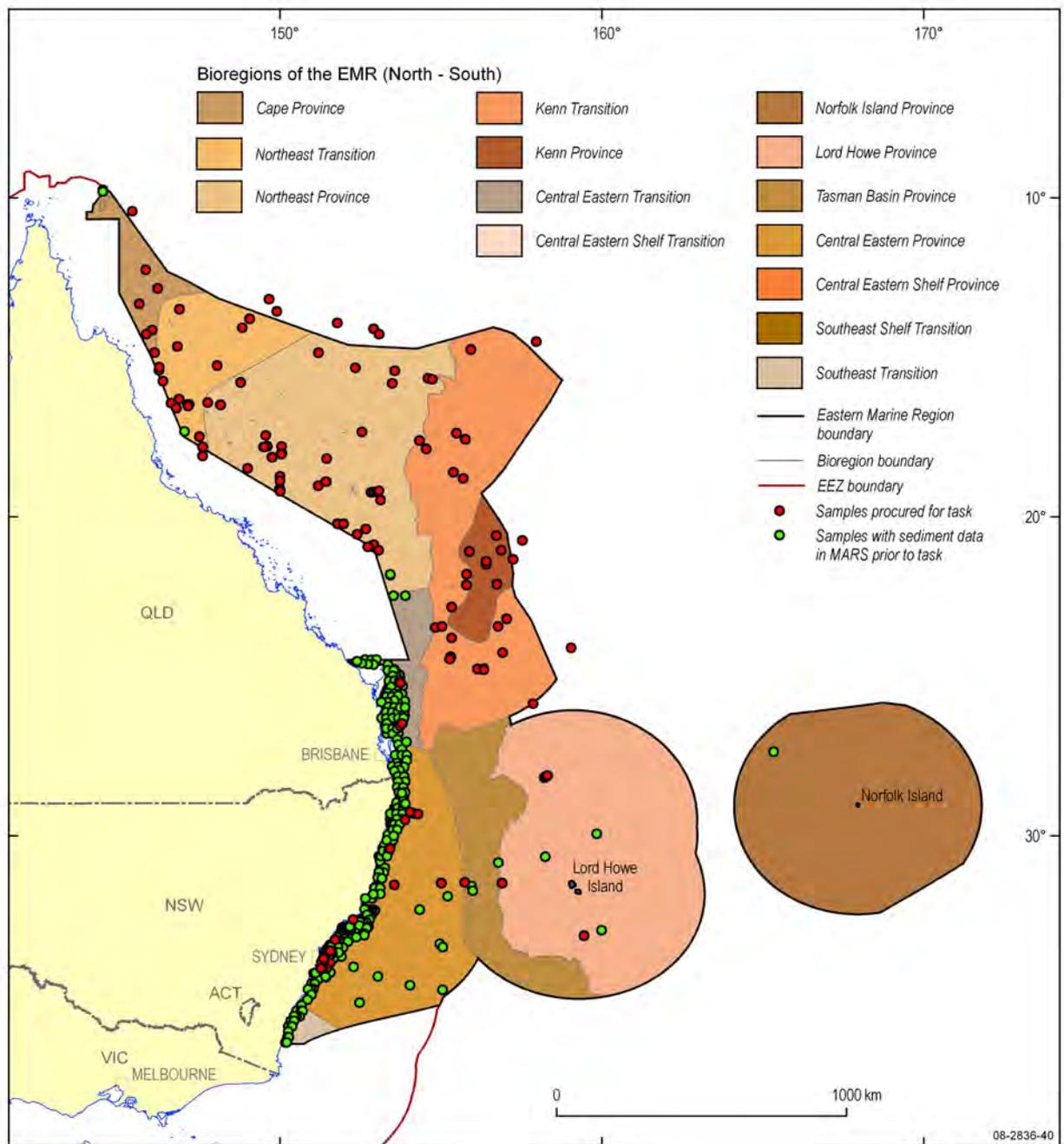


Figure 5.1. Distribution of sediment samples in the EMR bioregions.

Table 5.1. Description of change in sample coverage in bioregions with task.

Bioregion	No. sample points (+ no. added for task)	% EMR Area*	Average sample density (samples per 1,000 km ²)
Southeast Shelf Transition	23 (0)	0.2	5.62
Central Eastern Shelf Province	312 (13)	0.6	22.47
Central Eastern Shelf Transition	230 (0)	1.0	10.90
Central Eastern Province	106 (10)	9.5	0.36
Central Eastern Transition	84 (4)	1.8	0.78
Kenn Province	6 (6)	2.3	0.10
Kenn Transition	20 (20)	15.4	0.05
Lord Howe Province	9 (5)	19.7	0.02
Northeast Province	50 (47)	17.2	0.12
Northeast Transition	18 (15)	5.4	0.14
Tasman Basin Province	3 (1)	6.4	0.02
Cape Province	8 (6)	2.5	0.13
Southeast Transition	1 (0)	0.4	0
Norfolk Island Province	1 (0)	17.5	<0.01

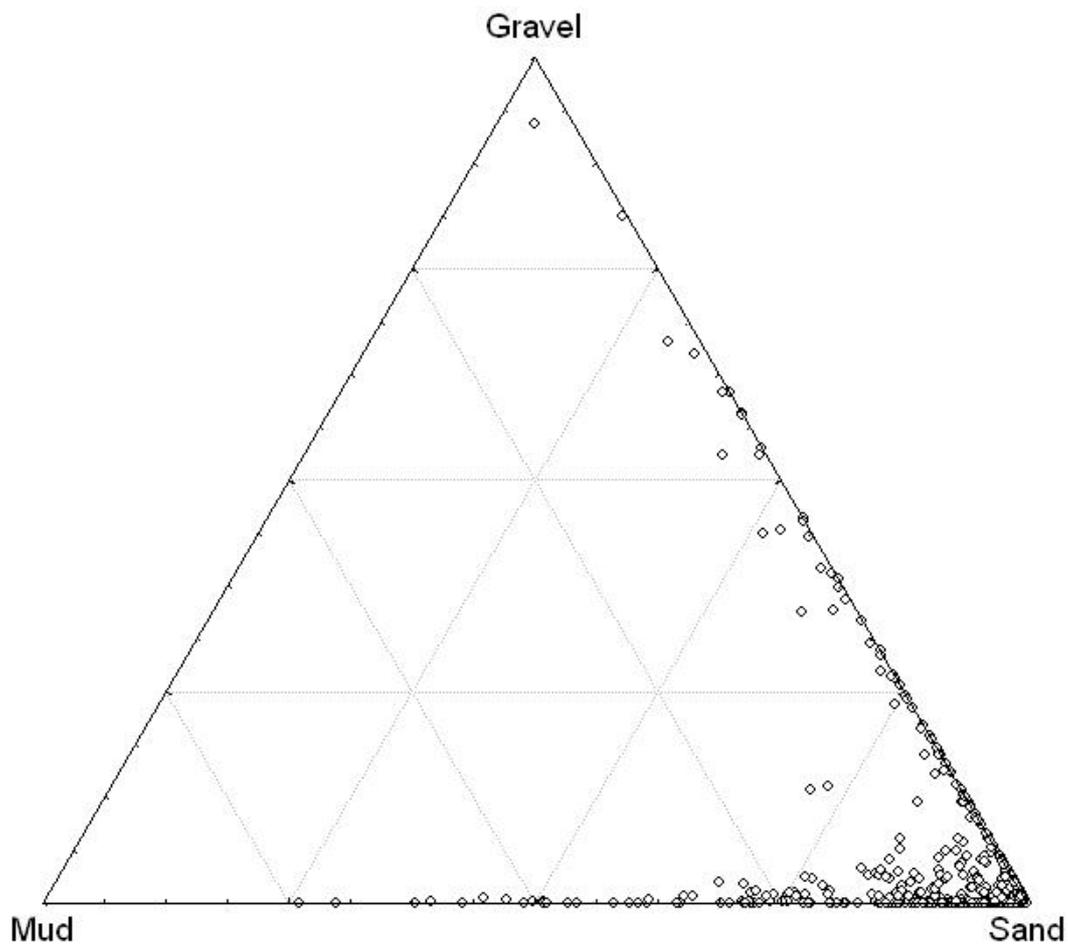
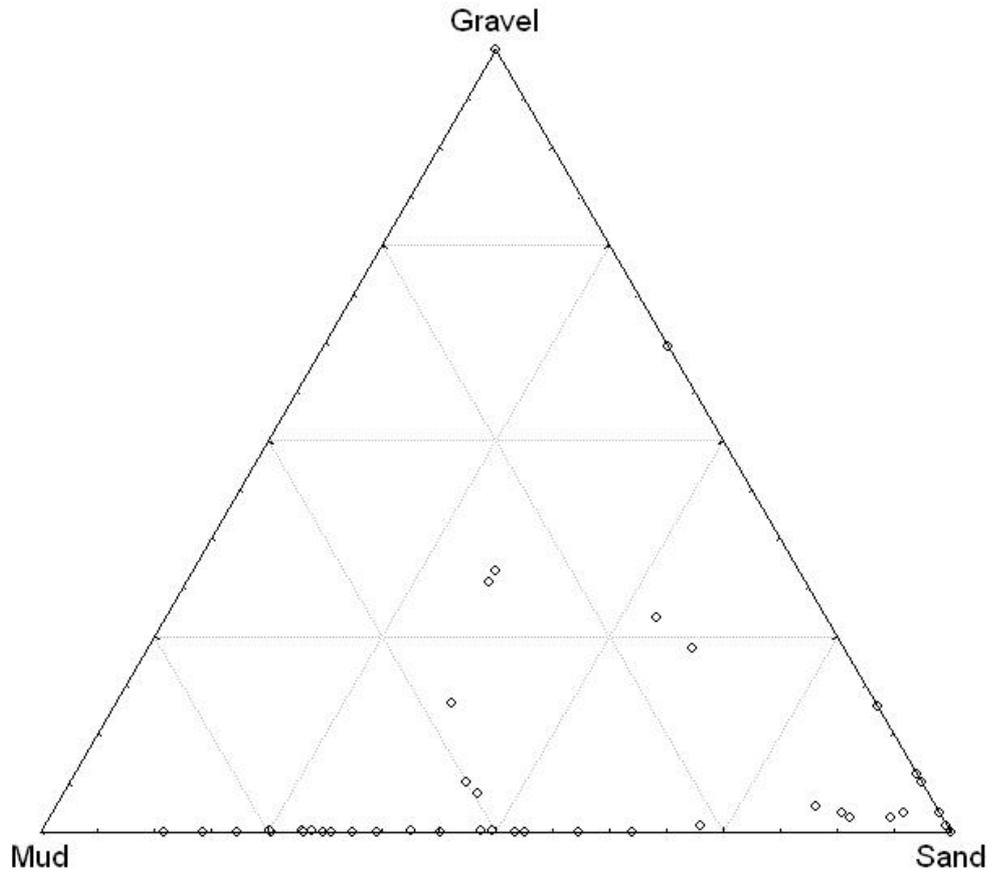
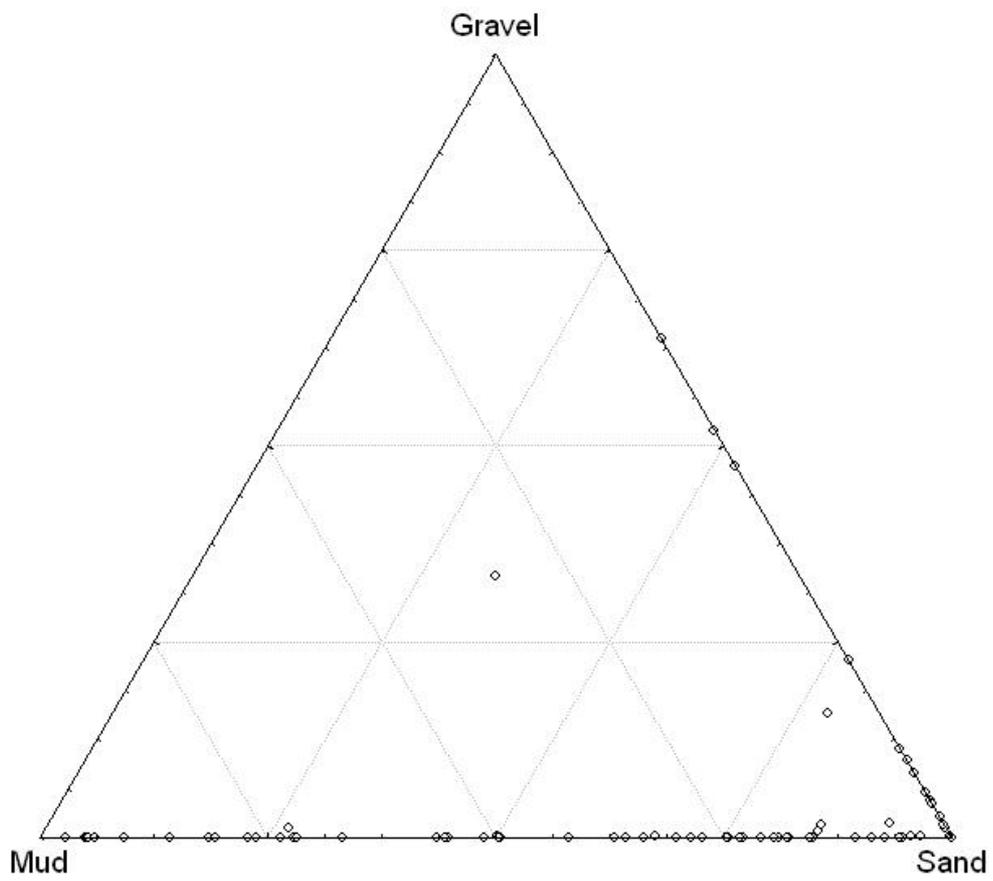


Figure 5.2. Textural composition (mud:sand:gravel ratio) of sediments in shelf bioregions of the EMR.

a)



b)



c)

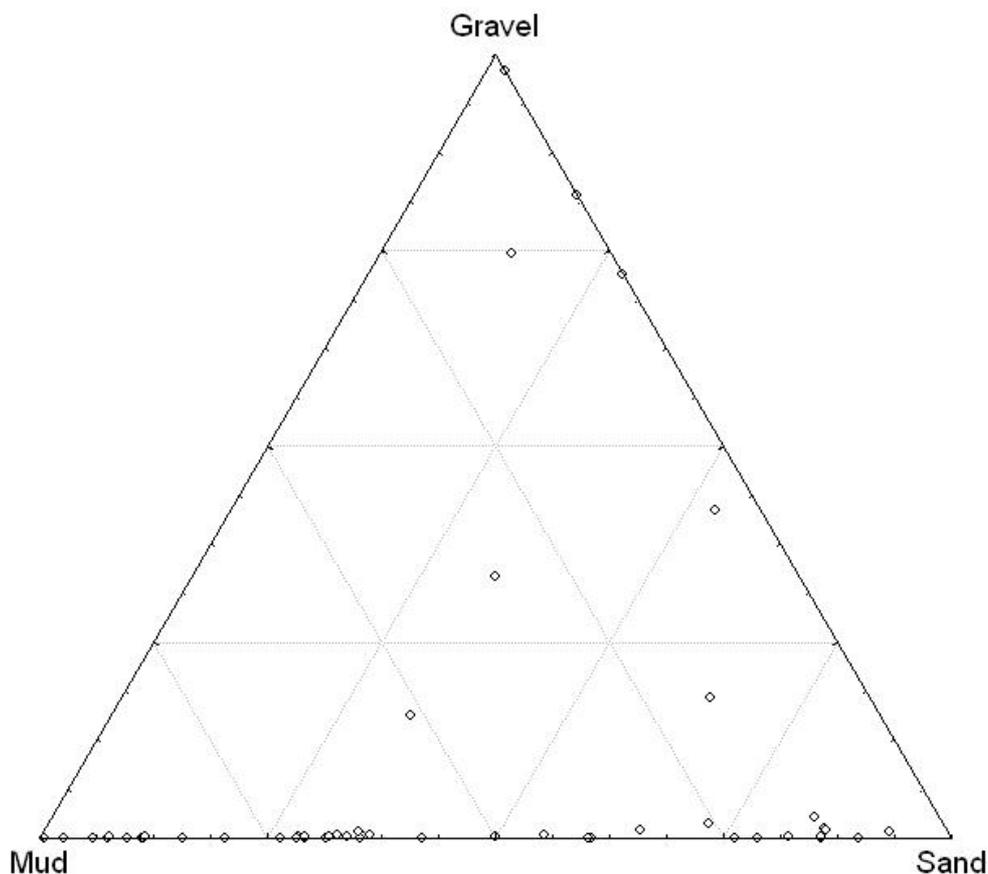


Figure 5.3. Textural composition (mud:sand:gravel ratio) of sediments in offshore bioregions of the EMR, a) the Central Eastern Transition, Kenn Province, and Kenn Transition; b) Cape Province and Central Eastern Province; and c) Northeast Province and Northeast Transition.

5.2. CENTRAL EASTERN SHELF PROVINCE (CESP)

5.2.1. Geomorphology and bathymetry

The CESP covers an area of 13,310 km² or 1% of the EMR (Table 5.4). It is located on the shelf between the towns of Macksville and Minnamurra and is bounded to the north by the CEST, to the south by the SEST, and to the east by the CEP. The CESP runs parallel to the coast and includes an elongate area of seabed ranging in width from 10 – 60 km.

The width of the shelf in the area of the CESP is narrow, ranging from 10 – 50 km. A series of small terraces run parallel to the shoreline at the shelf edge covering an area of 2,310 km² or 17% of the bioregion (Fig. 5.4). Unassigned shelf and slope and shallow water terraces (Chapter 4) are identified as significant geomorphic features of the CESP. Shallow water terraces cover around 1,640 km² or 12.3% of the bioregion and comprise 4% of the total area of shallow water terraces within the EMR (Table 5.2).

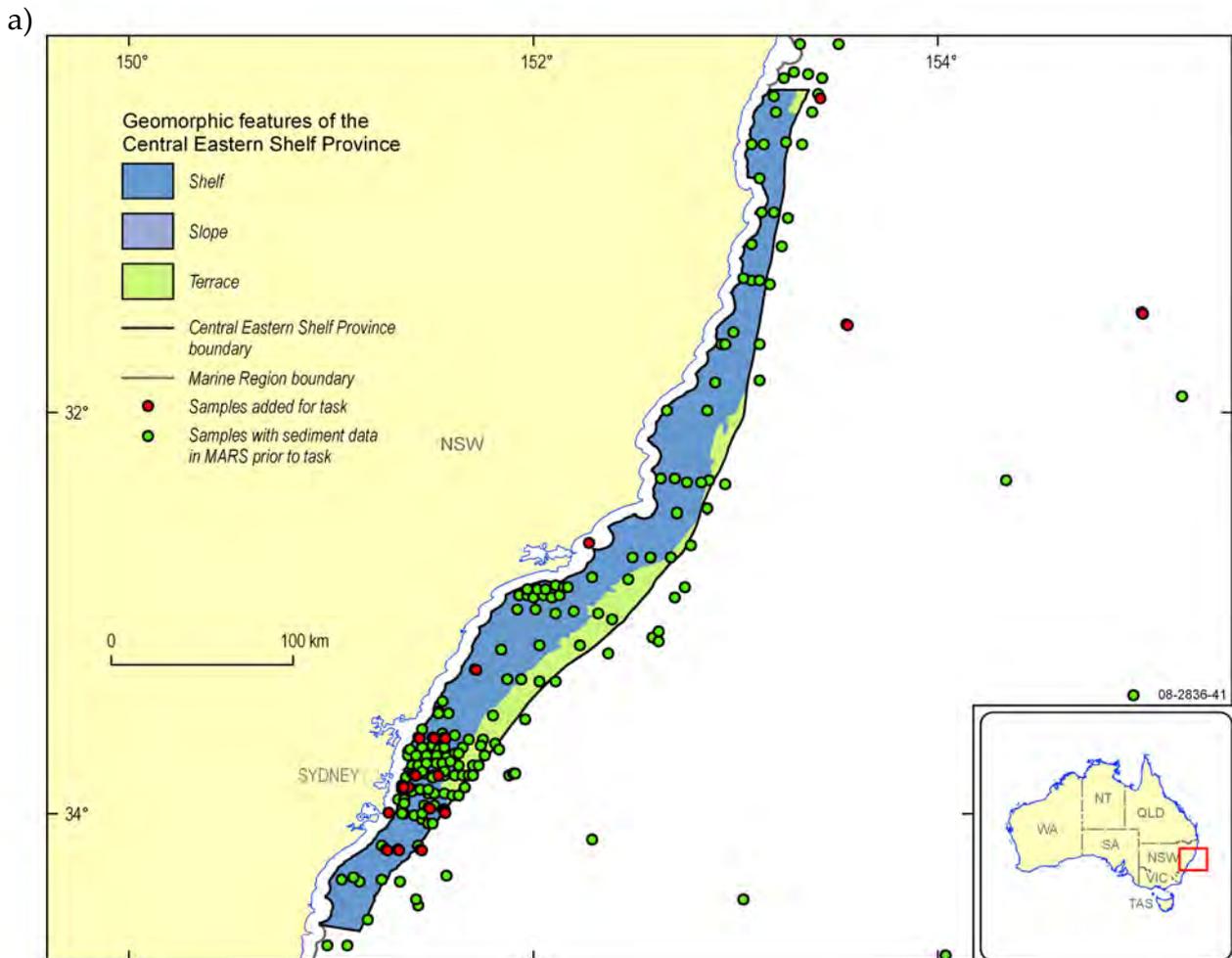
Water depths in the CESP range from 20 – 385 m with an average depth of 115 m. A total of 13,740 km² or 95% of the CESP occurs in water depths of 50 – 200 m (Table 5.3.; Fig. 5.5). Water depths in

areas of unassigned shelf and slope range from 20 – 385 m with an average depth of 105 m. Terraces occur in water depths of 110 – 205 m with an average depth of 145 m.

5.2.2. Sample Coverage

The CESP contains 325 samples. These provide coverage of both unassigned shelf and slope and terraces. The majority of samples (305, 94%) occur on unassigned shelf and slope. More than 98% of these occur in water depths of <200 m. Twenty samples are located in shallow water terraces in water depths of 140 – 160 m.

Average sample density for the CESP is 1:45 km² however, samples are clustered on the shelf adjacent to Sydney Harbour resulting in significantly lower sample density elsewhere in the bioregion. Samples achieve densities of 1:40 km² for unassigned seabed and 1:112 km² for shallow water terraces. As sample density was relatively high in this bioregion prior to the MOU, only 13 samples were selected to be analysed for this area.



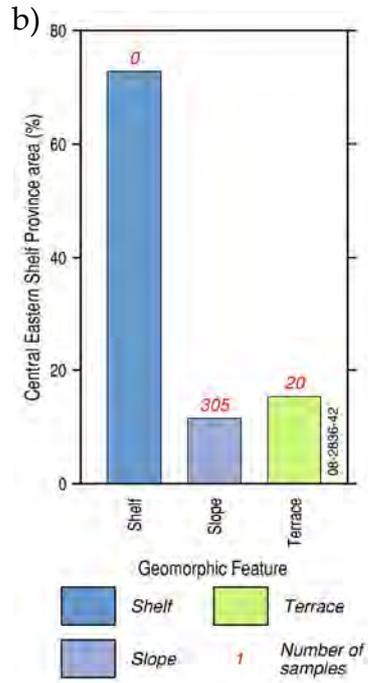


Figure 5.4. a) Geomorphology of the Central Eastern Shelf Province (CESP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the CESP with number of corresponding sediment samples (on top of columns).

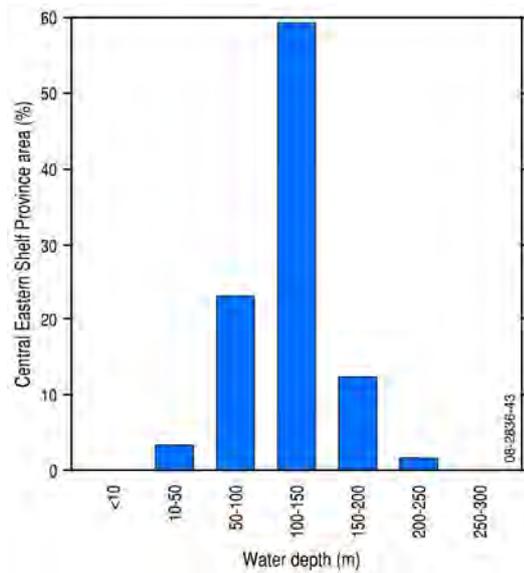


Figure 5.5. Distribution of water depth classes by percentage area within the CESP.

Table 5.2. The percentage area of geomorphic units found in the Central Eastern Shelf Province.

Feature	% area of bioregion	% area of geomorphic unit within the EMR	% area of geomorphic unit within the EEZ
<i>Geomorphic Feature</i>			
Unassigned shelf and slope	84.50	-	-
Terrace	15.50	3.84	0.39

Table 5.3. The water depth of geomorphic units found in the Central Eastern Shelf Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Feature</i>		
Unassigned shelf and slope	20 – 385	110
Terrace	110 – 205	145

5.2.3. Sedimentology of the Central Eastern Shelf Province

A total of 347 grain size assays and 159 carbonate assays are available for the CESP. Sediments in the south of the CESP differ significantly from those in the north. South of Wyong, sediment texture is relatively homogeneous and generally dominated by sand. Mud dominates locally, mainly on areas of the shelf offshore of Sydney and Newcastle. Sediments contain between 60 and 100% sand, with >60% in 274 (79%) samples and >90% in 179 (52%) samples (Fig. 5.2). Mud ranges from 0 to 60% and is <20% in 228 (66%) samples. Gravel generally forms <2% of sediment except offshore of Wollongong and Newcastle, and at the shelf break adjacent to Port Macquarie where gravel contents range from 20-40%.

North of Newcastle, sediment texture is more variable. Sand and gravel dominate, with sand content ranging from 10 - 100% and gravel from 0 - 65%. The distribution of sand and gravel reflect similar sediment patterns to those observed in the adjacent Central Eastern Shelf Transition (Section 5.3). Mud content ranges from 0 – 15% except in a small area off the coast of Newcastle where sediments are significantly finer and attain 60% mud content. Adjacent to Newcastle, mud ranges from 0-70% of sediment and the majority of samples contain no gravel.

A total of 158 bulk carbonate assays are available for the CESP. Carbonate contents of these samples range from 3 – 95% and exceed 70% in 29 (18%) samples. Carbonate contents generally increase towards the shelf break. Few carbonate assays are available for textural size fractions; however, those present give average carbonate mud content around 45%, and carbonate sand content ranging from 7 - 72%. Carbonate content of gravel is 100% in all eight samples analysed.

5.2.4. Sedimentology of Significant Geomorphic Features

5.2.4.1. Shelf (*unassigned*)

A total of 290 samples were obtained from the shelf (*unassigned*). Sand is the dominant sediment fraction with contents ranging from 26 - 100% and 251 (87%) samples attaining >75% (Fig. 5.6). Mud is the next most abundant fraction ranging from 1 - 76%. Gravel content is low ranging from 0 – 34% and attaining <1% in 222 (77%) samples. Bulk carbonate content ranges from 3 - 94% and attains >75% in eight (7%) samples (Fig. 5.7). Carbonate gravel totals 100% in all seven samples containing a carbonate gravel assay. Carbonate sand content is available for eleven samples and ranges from 6 - 72%. Carbonate mud content was assessed for only one sample and totalled 45%.

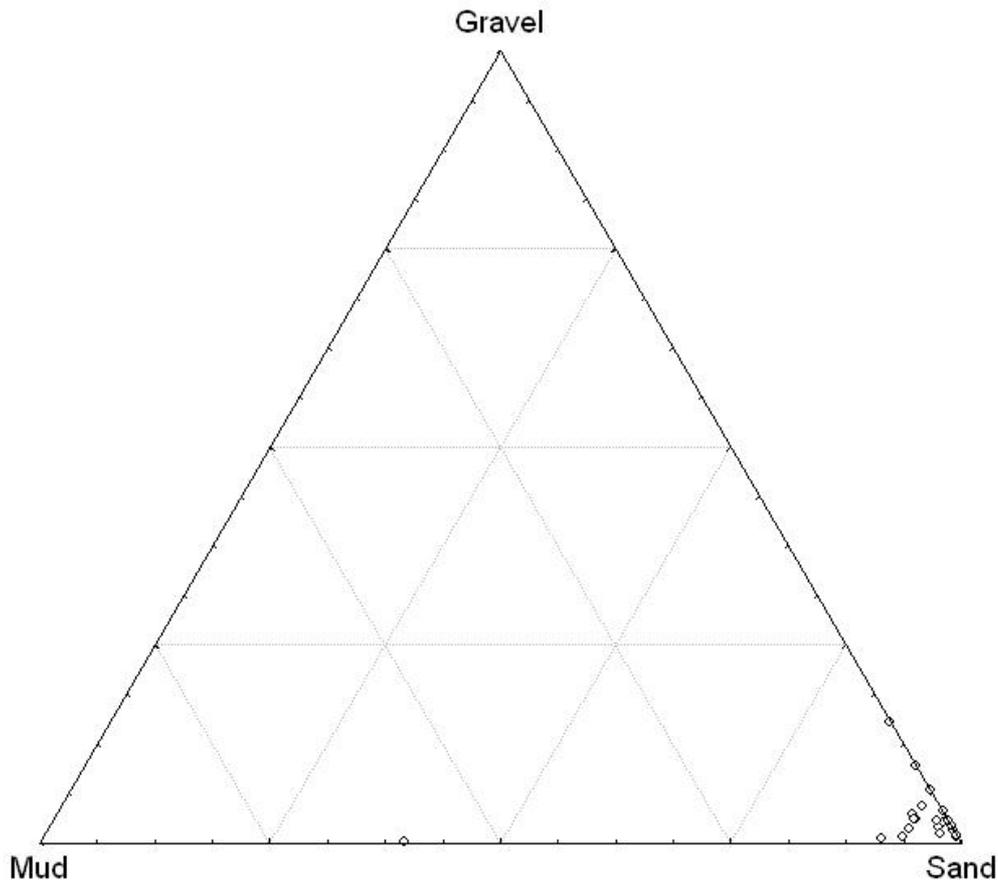
5.2.4.2. Slope (unassigned)

A total of 15 samples were obtained from the slope (unassigned). Sand is the dominant sediment fraction with contents ranging from 42 -100% and attaining >75% in 12 (80%) of samples (Fig. 5.6). Gravel is the next most abundant fraction with contents ranging from 1 - 58% and attaining >50% in three (20%) of samples. Mud content ranges from 4 - 7%. Bulk carbonate content ranges from 21 to 82% and attains >75% in three (21%) samples (Fig. 5.7). Carbonate content of sand and gravel fractions are available for only 1 sample. Gravel is 100% carbonate and sand 67%. Carbonate content of mud was not assessed.

5.2.4.3. Shallow-water Terraces

A total of 20 samples were obtained from terraces. Sand is the dominant sediment fraction with contents ranging from 39 - 99% and 18 (90%) of samples attaining 75% (Fig. 5.6). Mud content ranges from 0 – 60%, however 16 (85%) samples contain <5% mud and 1 sample contains 60% mud. Gravel was detected in all samples but does not exceed 15% and amounts to <5% in 17 (90%) samples. Bulk carbonate content ranges from 52 - 77% with 2 (10%) samples attaining >75% (Fig. 5.7). Individual fractions were not analysed for carbonate content.

a)



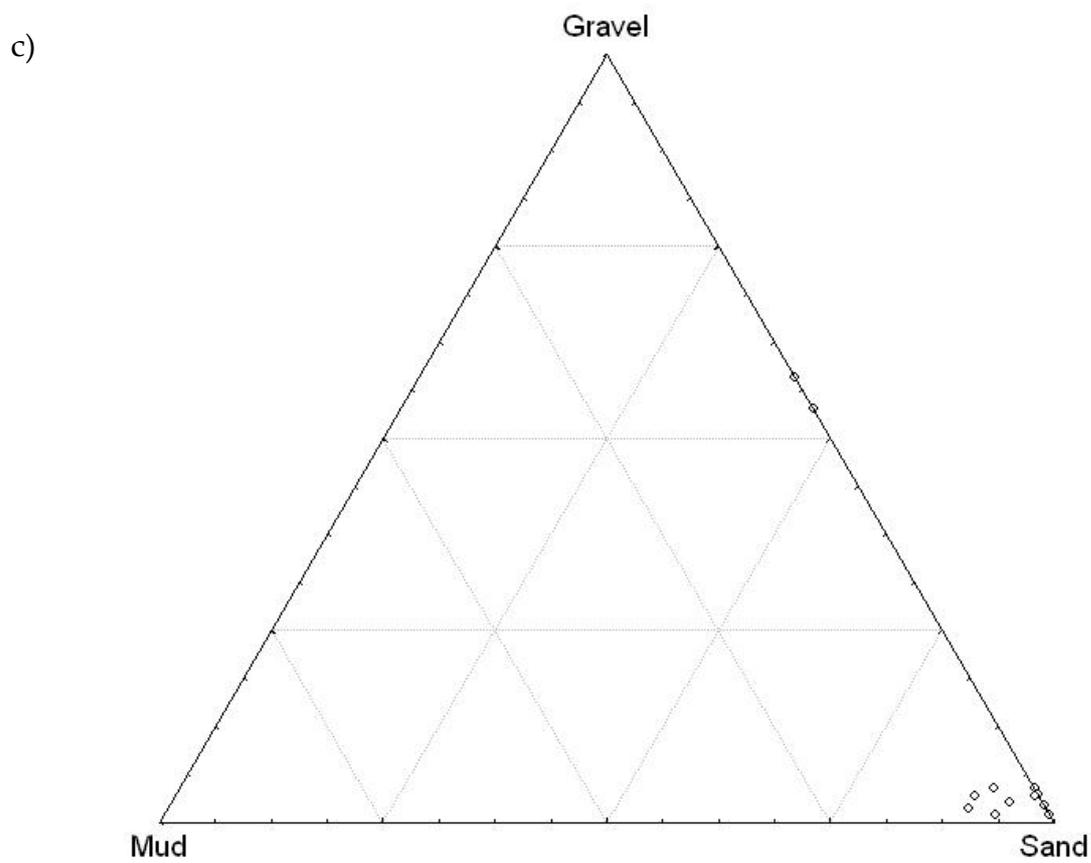
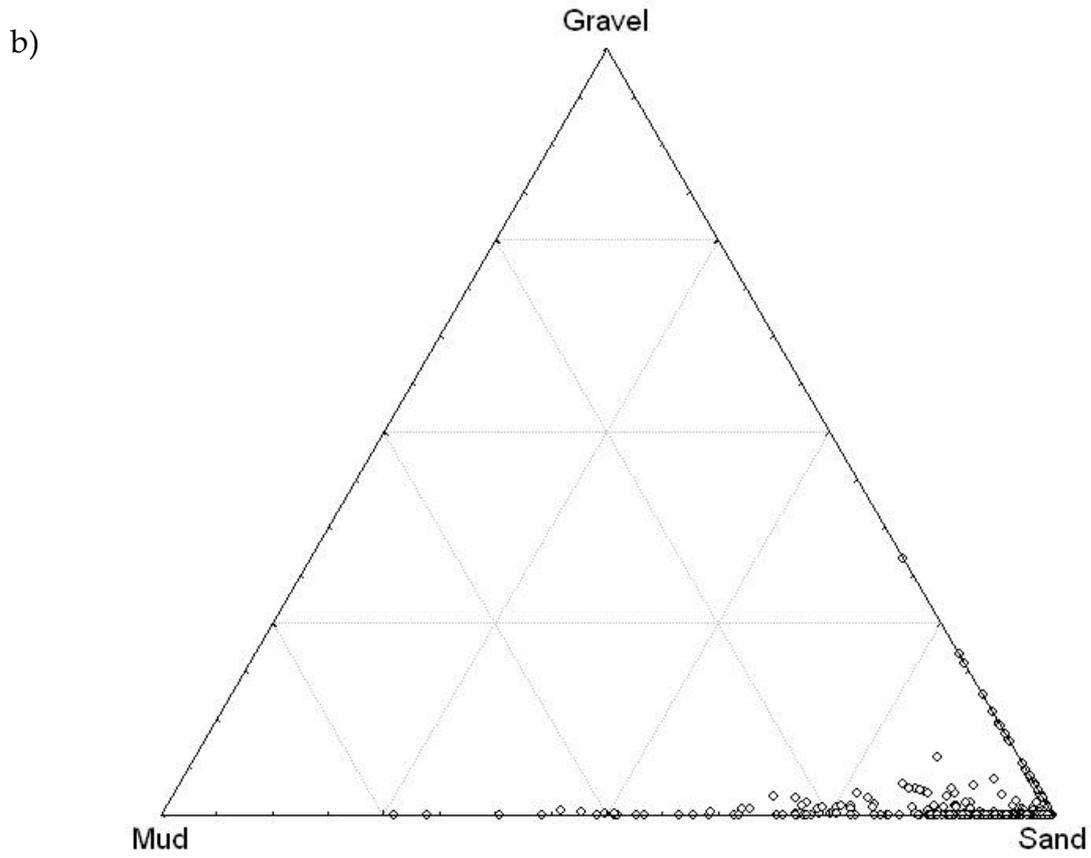


Figure 5.6. Textural composition (mud:sand:gravel ratio) of: a) shallow water terrace sediments; b) shelf sediments; and c) slope sediments, of the CESP.

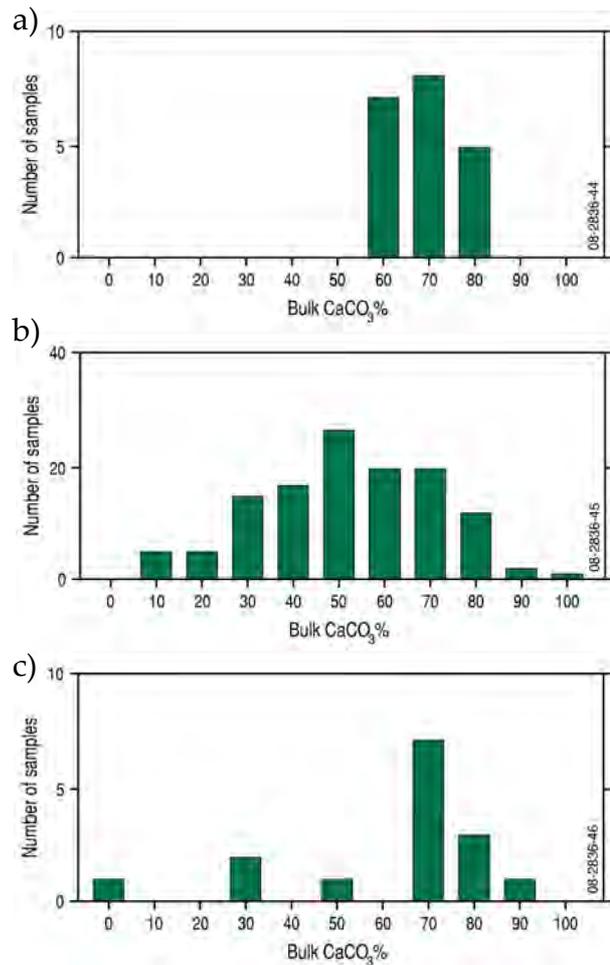


Figure 5.7. Carbonate content of: a) shallow water terrace sediments; b) shelf sediments; and c) slope sediments, of the CESP.

5.3. CENTRAL EASTERN SHELF TRANSITION (CEST)

5.3.1. Geomorphology and bathymetry

The Central Eastern Shelf Transition (CEST) covers 26,335 km² or 1% of the EMR. The CEST is located on the shelf between Fraser Island and Macksville. It lies on the western boundary of the EMR and is bound to the south by the CESP, to the north-east by the CET and to the northwest by the CEP. The Great Barrier Reef Marine Park is situated directly north of the CEST.

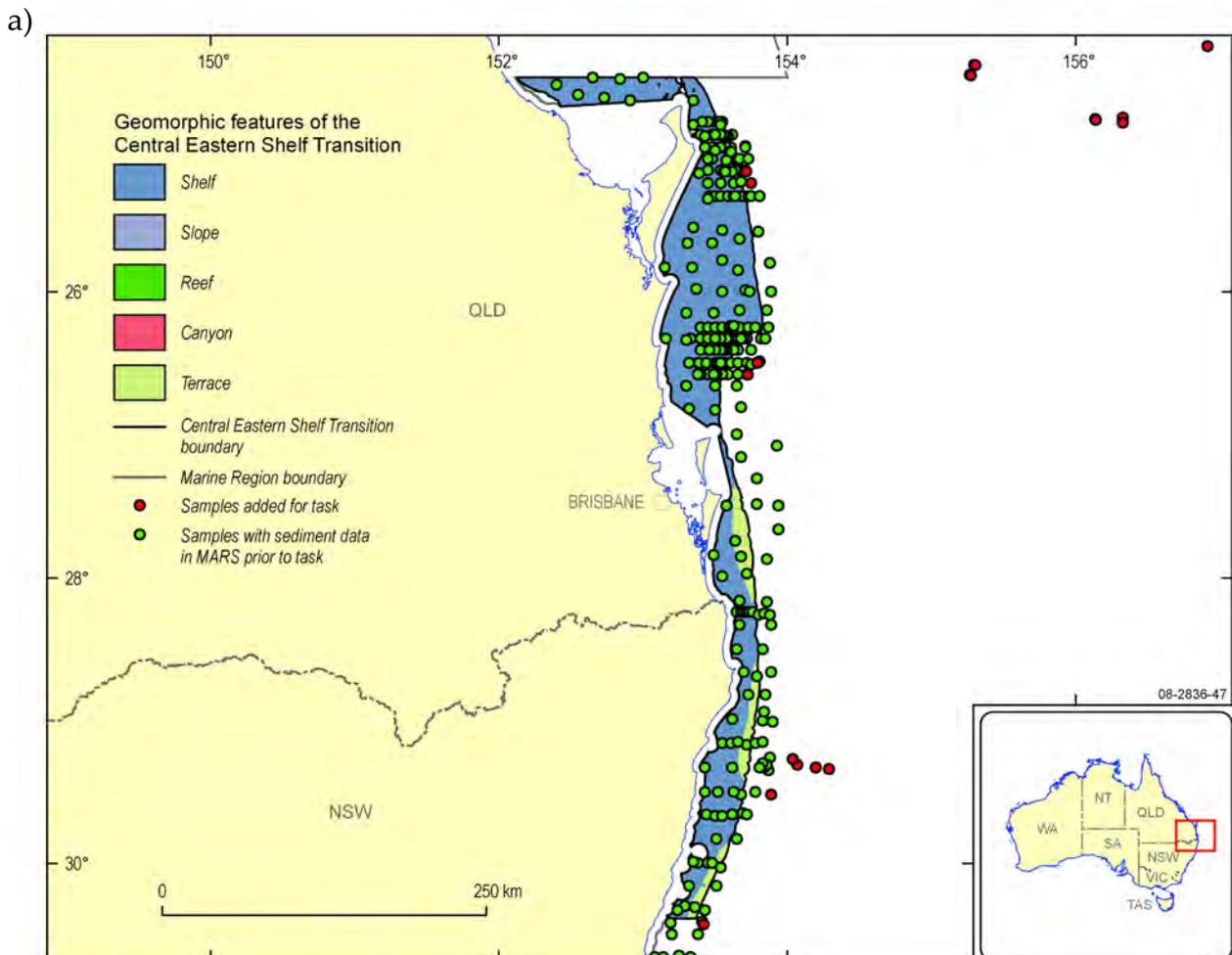
The CEST is located predominantly on the shelf and includes a small section of upper slope (Table 5.4). The shelf varies in width from 130 km to the north of Fraser Island to <25 km adjacent to Macksville. Shelf covers 20,615km² or 78% of the bioregion and Slope 5,719 km² or 21% of the bioregion. The CEST contains unassigned shelf (18,959 km², 71%); unassigned slope (4,093 km², 15%); terrace (3,245 km², 12%); reef (2 km², <1%); canyon (34 km², <1%) and pinnacle (<1 km², <1%) geomorphic features (Fig. 5.8). Significant features include: three shallow water terraces that run parallel to the coast, and separate the shelf from the upper slope; a small area of reef to the north of Fraser Island and two canyons that occur on the slope offshore of Coolangatta and extend offshore of the bioregion boundary into the CEP.

Water depths in the CEST range from 0 – 470 m with an average depth of 80 m (Table 5.5). Approximately 90% of the CEST area occurs in water depths of between 10 and 150 m (Fig. 5.9). Reefs and unassigned shelf are generally the shallowest areas of the bioregion with average water depths of 8 m and 50 m respectively. Water depths increase on the slope (average 140 m). Terraces and canyons occur on the slope and have average water depths of 130 m and 150 m, respectively.

5.3.2. Sample coverage

The CEST contains 287 sample points (Fig. 5.8). Most samples occur along transects that run perpendicular to the shelf break. Samples occur in water depths ranging from 15 – 235 m, however 272 samples (95%) occur on the shelf and slope in water depths of between 15 and 170 m. Samples occur in 4 of the 6 geomorphic features in the CEST. A total of 226 (79%) samples occur in unassigned shelf, 26 (9%) in unassigned slope, 34 (12%) in terraces and 1 (>1%) in canyons.

Average sample density of the CEST is 1:90 km². Samples attain sufficient coverage to describe the sediment distribution on the shelf (unassigned), slope (unassigned) and terraces. Approximately 80% of the samples in the CEST occur on the shelf offshore of Fraser Island and Maroochydoore, achieving densities of around 1:45 km² for these areas.



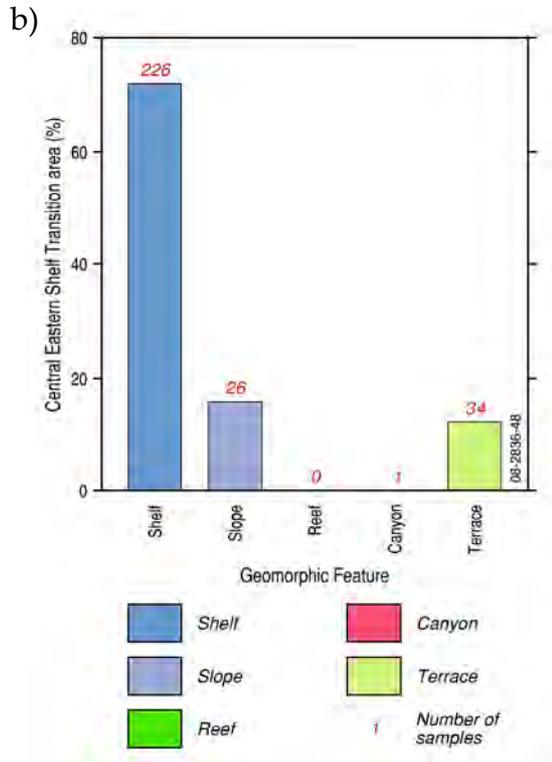


Figure 5.8. a) Geomorphology of the Central Eastern Shelf Transition (CEST) with location of sediment samples; and b) Percentage area of each geomorphic feature within the CEST with number of corresponding sediment samples (on top of columns).

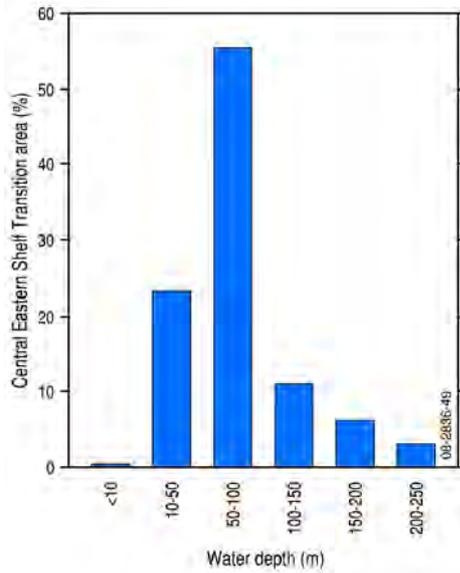


Figure 5.9. Distribution of water depth classes by percentage area within the CEST.

Table 5.4. The percentage area of geomorphic units found in the Central Eastern Shelf Transition.

Feature	% area of bioregion	% area of geomorphic unit within the EMR	% area of geomorphic unit within the EEZ
<i>Geomorphic Feature</i>			
Unassigned shelf and slope	87.54	-	-
Reef	<0.01	<0.01	<0.01
Canyon	0.13	0.35	0.03
Terrace	12.32	5.56	0.56

Table 5.5. The water depth of geomorphic units found in the Central Eastern Shelf Transition.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Feature</i>		
Unassigned shelf and slope	0 – 430	70
Reef	0 – 15	8
Canyon	85 – 210	150
Terrace	55 – 450	130

5.3.3. Sedimentology of Central Eastern Shelf Transition

A total of 200 grain size and 286 carbonate assays are available for the CEST. Sediment texture in the CEST is relatively homogeneous. Sand is the dominant size fraction in all samples with contents generally ranging from 34 - 100%. Sand content exceeds 95% in 106 (61%) samples. Gravel forms <45% of sediment volume in 169 (97%) samples, and exceeds 80% in only two (1%) samples. Mud is <1% in 139 (70%) samples and exceeds 10% in only eight (4%) samples.

Bulk carbonate content ranges from 3 - 98% with 219 (77%) samples exceeding 30% carbonate content. The carbonate content of sediments increases towards the shelf edge where it attains 60 – 100%. The carbonate content of the sand fraction is high and ranges from 1 - 100%, with 59 (61%) samples attaining >50% carbonate sand. No carbonate assays are available for mud and gravel textural size fractions.

5.3.4. Sedimentology of Significant Geomorphic Features

5.3.4.1. Shelf (unassigned)

A total of 227 samples were collected from the shelf (unassigned). Carbonate data is available for all samples and grain size data for 125 samples. Sediments in this area are relatively homogenous and dominated by sand. Sand content ranges from 1 - 99% with 125 (85%) samples containing >75% sand (Fig. 5.10.). Mud content ranges from 0 – 40%, however 135 (90%) samples contain <5% mud. Gravel content ranges from 0 – 81% although 94 (75%) samples contain <5% gravel. Bulk carbonate content ranges from 3 - 98% and is >75% in 86 (38%) samples (Fig. 5.11.). The carbonate content of the sand fraction ranges from 1 - 100% with 48 (67%) containing <75% carbonate sand. No samples were analysed for the carbonate content of the mud and gravel fractions.

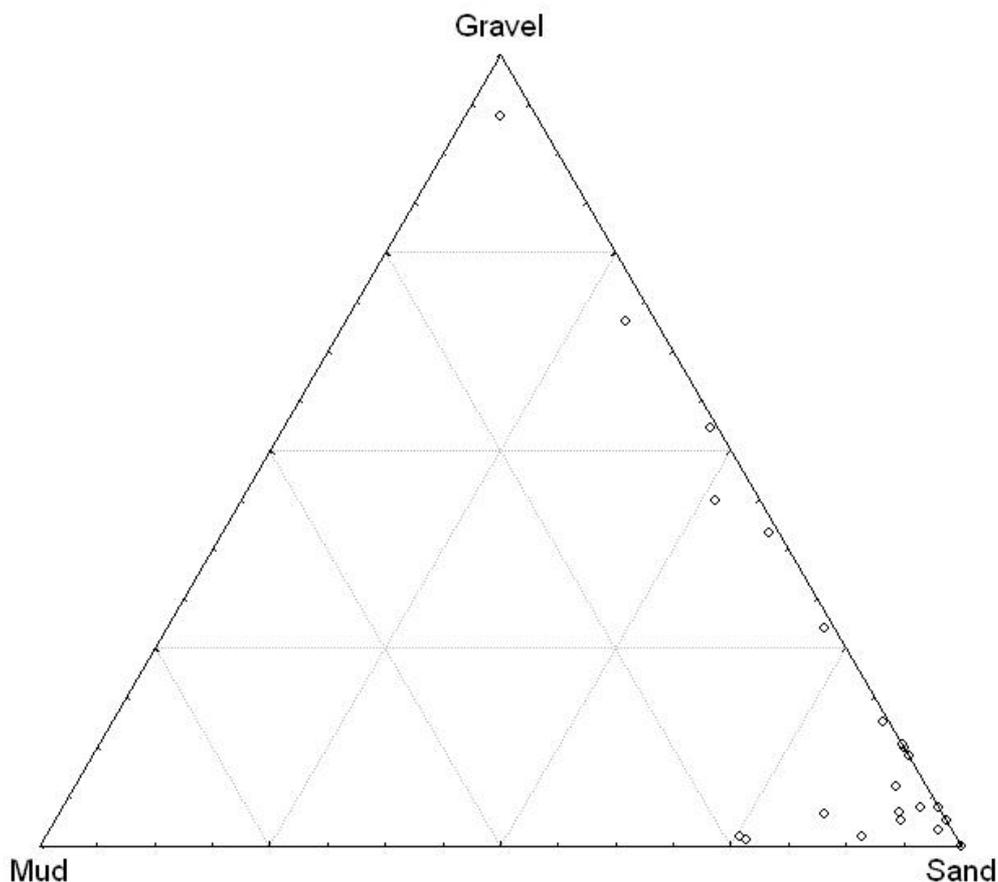
5.3.4.2. Slope (unassigned)

A total of 23 samples were obtained from the slope (unassigned). Sand is the dominant size fraction with contents ranging from 40 - 100% and exceeding 75% in 19 (83%) of samples (Fig. 5.10). Gravel is the next most abundant size fraction with contents ranging from 1 - 60%. Mud did not exceed 13%, and was absent from 11 (48%) of samples. Bulk carbonate content ranges from 41 - 88% and exceeds 75% in 12 (52%) of samples (Fig. 5.11). No samples have been analysed for carbonate mud or gravel content.

5.3.4.3. Shallow-water Terraces

A total of 34 samples were obtained from terraces. Sand is the dominant size fraction with contents ranging from 4 - 100% and exceeding 75% in 20 (80%) samples (Fig. 5.10). Gravel is the next most abundant size fraction with contents ranging from 1 - 92%. Gravel constitutes <15% of the sediment in 19 (75%) samples. Mud content ranges from 0 - 24% but is <5% in 21 (85%) samples. Bulk carbonate content ranges from 39 - 100% and exceeds 75% in 20 (60%) samples (Fig. 5.11.). Carbonate content of the sand fraction ranges from 45 - 82% with 14 (93%) samples containing >50% carbonate sand.

a)



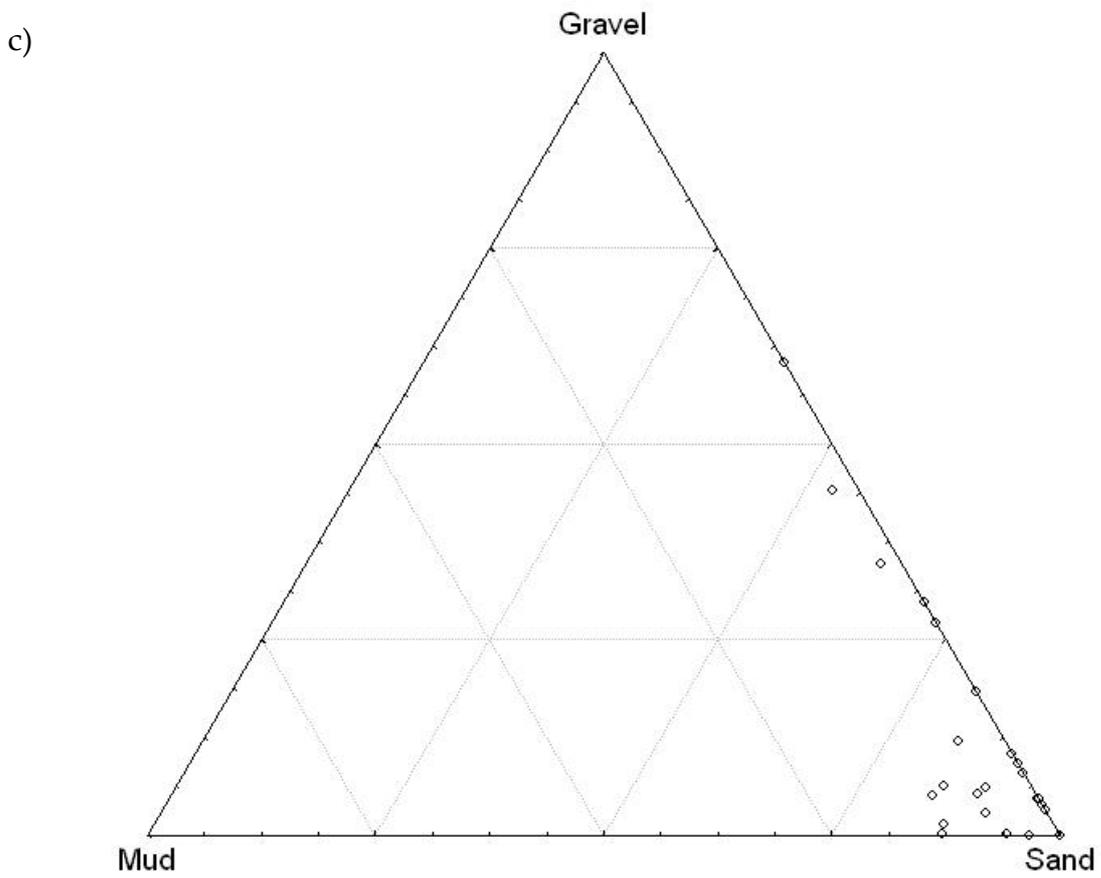
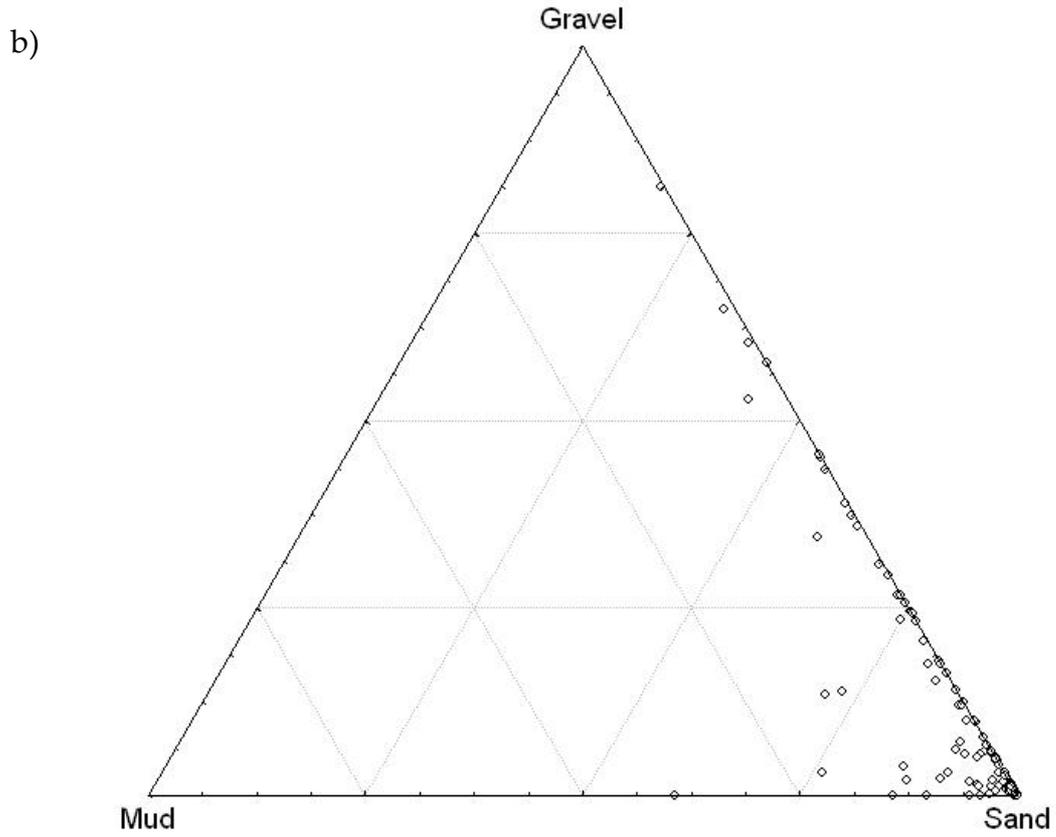


Figure 5.10. Textural composition (mud:sand:gravel ratio) of a) shallow water terrace sediments; b) shelf sediments; and c) slope sediments, from the CEST.

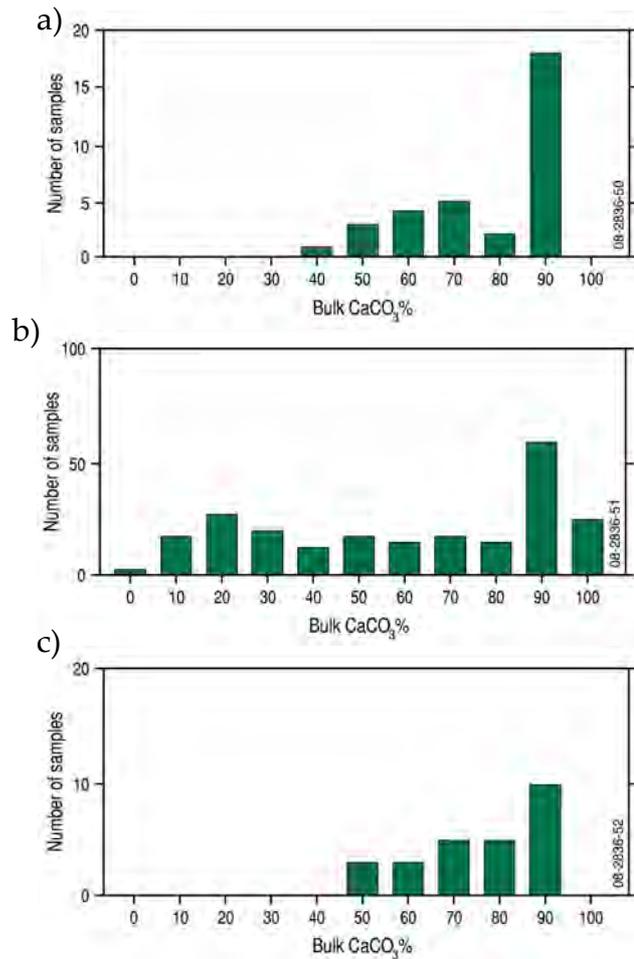


Figure 5.11. Carbonate content of a) shallow water terrace sediments; b) shelf sediments; and c) slope sediments, for the CEST.

5.4. SOUTHEAST SHELF TRANSITION (SEST)

5.4.1. Geomorphology and bathymetry

The SEST covers an area of 59,615 km² of which 4,270 km² lies within the EMR. This area covers <1% of the total EMR area. The SEST is located predominantly on the shelf with a small section of the upper slope between Kiama and Bermagui, and it is the most southerly shelf bioregion in the EMR. The bioregion is relatively narrow (5 – 30 km wide) and runs parallel to the coast. It is bounded to the north by the CESP, to the east by the CEP and SET, and to the south by the EMR boundary. The narrowest sections of the SEST occur adjacent to Sussex Inlet and Mystery Bay.

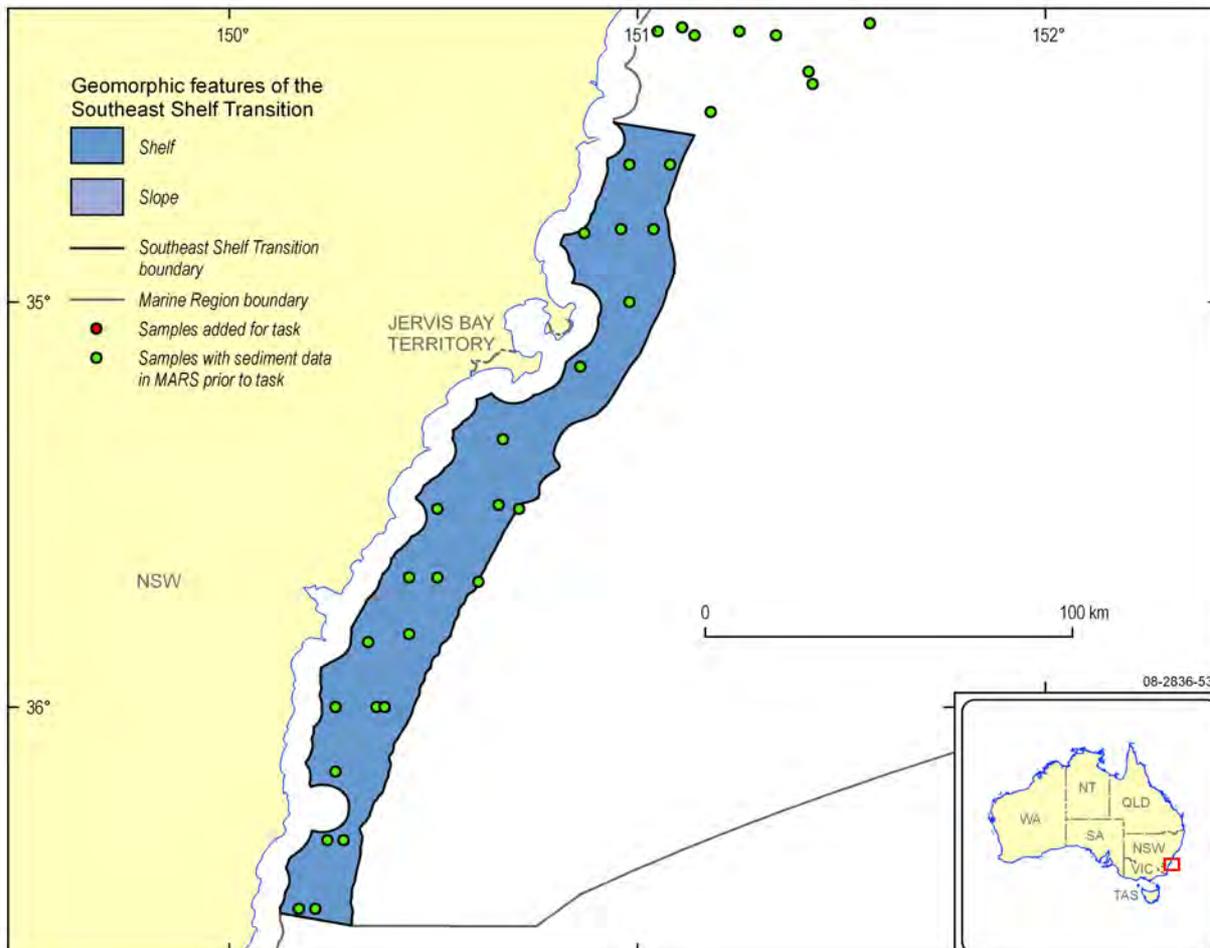
Shelf covers 3,930 km² or 92% of the bioregion and slope covers 340 km² or 8% (Fig. 5.12). No additional geomorphic features are identified within these provinces. Unassigned shelf is considered the only significant geomorphic feature of the SEST.

Water depths in the SEST range from 25 – 325 m, with an average depth of 125 m. A total of 3,140 km² (75%) of the SEST occurs in water depths of 100 – 150 m (Fig. 5.13). Due to the physical homogeneity of the bioregion, no geomorphology or bathymetry summary table is provided.

5.4.2. Sample Coverage

The SEST contains 24 samples, giving an average sample density of 1:180 km². All of these samples occur on the shelf in water depths of between 55 and 160 m. Due to the small area and relatively high sample density existing for the SEST prior to this task, no additional data points were procured and analysed for this bioregion. Sample density is sufficient to assess the sedimentology of unassigned shelf.

a)



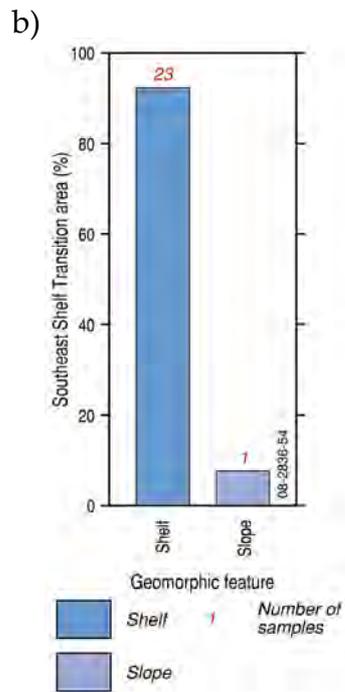


Figure 5.12. a) Geomorphology of the Southeast Shelf Transition (SEST) with location of sediment samples; and b) Percentage area of each geomorphic feature within the SEST with number of corresponding sediment samples (on top of columns).

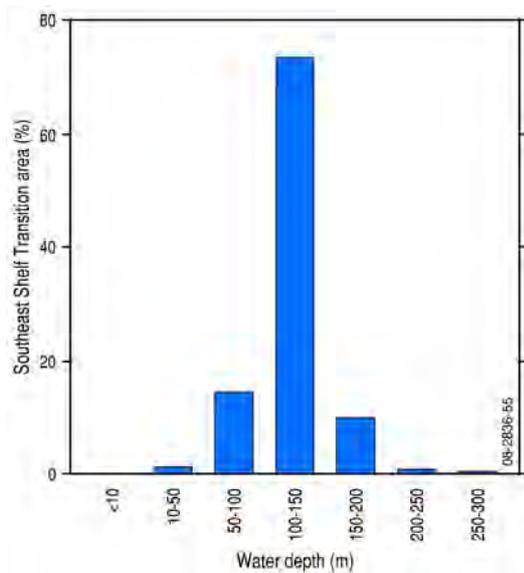


Figure 5.13. Distribution of water depth classes by percentage area within the SEST.

5.4.3. Sedimentology of the Southeast Shelf Transition

The SEST contains 24 grainsize and carbonate assays (Fig. 5.12.). Sediment texture is relatively homogeneous and dominated by sand. Sand forms >60% of sediment in all samples, and exceeds 90% in 15 (65%) samples. Mud and gravel comprises <20% in 22 (96%) samples except for one sample located on the shelf off Minnamurra which contains 26% mud and 38% gravel. The bulk carbonate content of sediments ranges from 23 - 88% and (19) 80% of samples contain between 30 - 60% carbonate content. No carbonate assays are available for textural size fractions.

5.4.4. Sedimentology of Significant Geomorphic Features

5.4.4.1. Shelf (unassigned)

As shelf is the only geomorphic feature represented by samples in the SEST (see above section 5.13.3 for a description of sediment texture and composition). Sand is the most abundant sediment fraction (Fig. 5.14.) and bulk carbonate ranges from 23 – 88% (Fig. 5.15.)

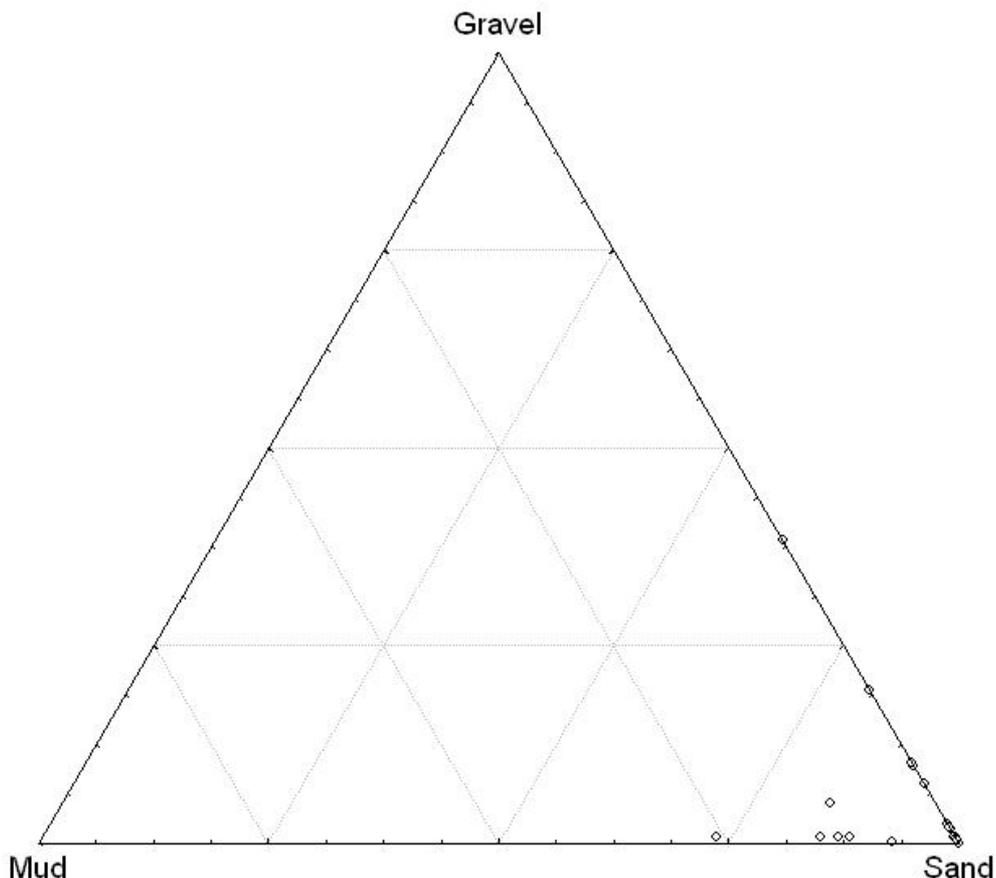


Figure 5.14. Textural composition (mud:sand:gravel ratio) of shelf sediments within the SEST.

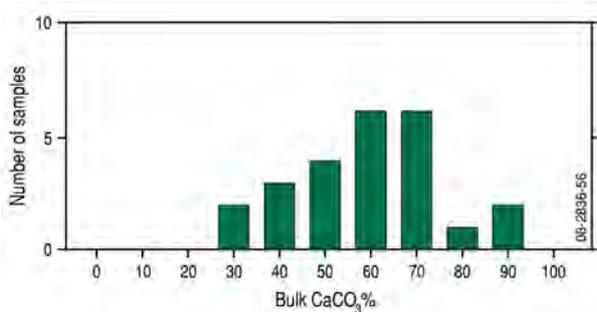


Figure 5.15. Carbonate content of shelf sediments within the SEST.

5.5. CAPE PROVINCE (CP)

5.5.1. Geomorphology and bathymetry

The Cape Province (CP) covers a total area of 109,340 km² of which 62,520 km² occurs in the EMR. This bioregion represents 2.5% of the total area of the EMR (Table 5.1). The CP is situated on the slope between Cape York and Cape Flattery (Fig. 5.2). It is the northern-most bioregion of the EMR and is bound to the south by the Northeast Transition.

The majority of the CP is situated on the slope province. Within this area, 10 geomorphic features have been identified: Trench/trough (7,930 km², 13% CP area); plateau (6,450 km², 10%); deep/hole/valley (4,890 km², 8%); basin (2,090 km², 3%); reef (950 km², 2%); saddle (580 km², 2%); terrace (180 km², <1%); ridge (170 km², <1%); and canyon (10 km², <1%) (Fig. 5.16 & Table 5.6). An area of 130 km² of shelf off Cape York with no other geomorphic features identified within it is also included in the CP.

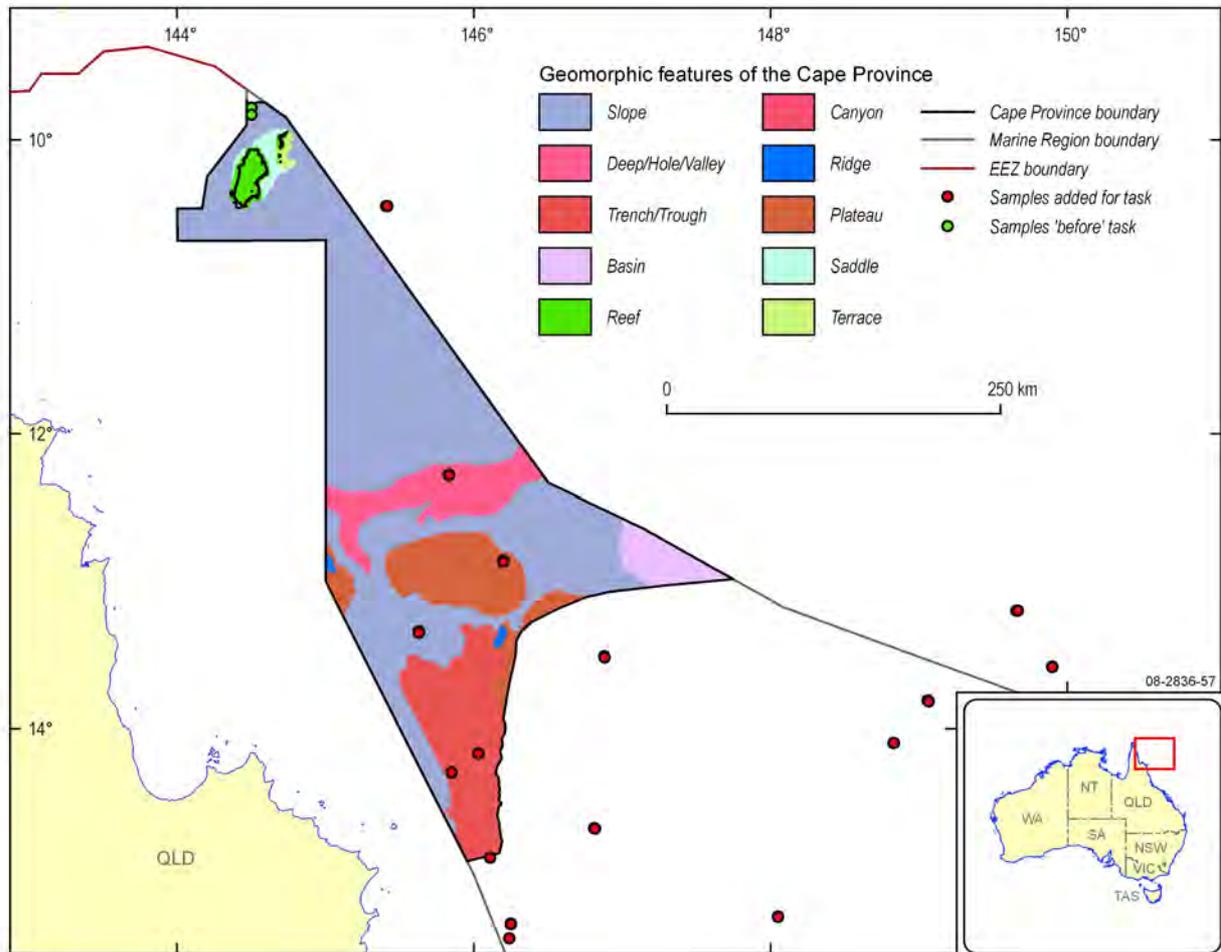
Slope (unassigned), plateau, trench/trough, deep/hole/valley, ridges and reefs are identified as significant features of the CP. Slope (unassigned), plateau and trench/trough features each cover a significant portion (>10,000 km² or >10%) of the bioregion. Deep/hole/valleys cover around 8% of the bioregion and this area represents 26% of the total area of deep/hole/valleys in the EMR. While the area of ridge features within the CP occupies <1% of the bioregion, this represents >15% of total area of ridges within the EMR. A large area of reef (950 km²) is located in the north of the bioregion and includes Ashmore and Boot Reefs. While these reefs have been little explored they are situated to the east of the Great Barrier Reef and may have significant biological importance for the CP.

Water depths in the CP range from 0 – 4,230 m (Table 5.7). More than 90% of the CP occurs in water depths of 1000 – 4000 m (Fig. 5.17). Water depths on the shelf range from 105 – 135 m, with an average depth of 120 m, and on the slope range from 0 – 4,025 m, with an average depth of 2,475 m. Water depths in reefs on the slope average 190 m. Water depths on the abyssal plain/deep ocean floor range from 3,605 – 4,230 m, with an average depth of 4,055 m.

5.5.2. Sample Coverage

The CP contains eight data points with either quantitative textural and/or compositional data (Fig. 5.16). These occur on the slope in water depths of 225 – 3,425 m. Samples provide adequate coverage for unassigned slope, trench/trough, plateau and deep/hole/valley features. No data are available for East Field Reef, or ridge and plateau features. Quantitative assessment of the sedimentology of significant features within the CP is limited by poor sample coverage of all features except unassigned slope.

a)



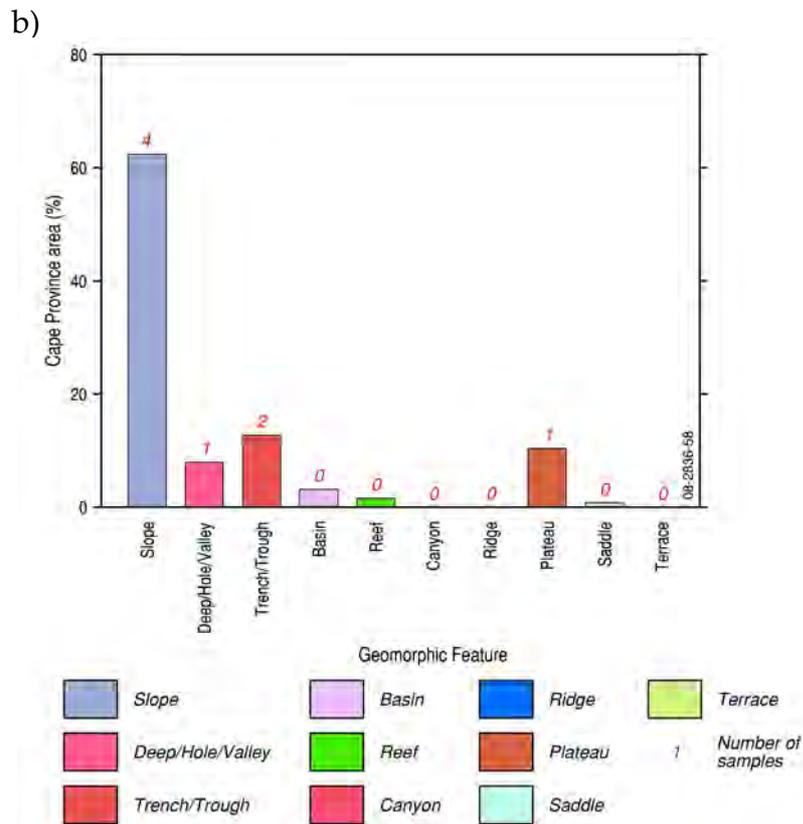


Figure 5.16. a) Geomorphology of the Cape Province (CP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the CP with number of corresponding sediment samples (on top of columns).

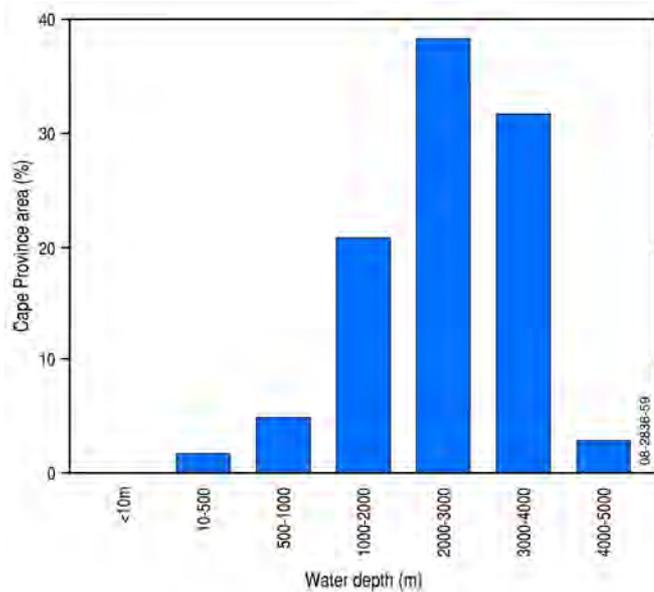


Figure 5.17. Distribution of water depth classes by percentage area within the CP.

Table 5.6. The percentage area of geomorphic units found in the CP.

Feature	% area of bioregion	% area of geomorphic unit within the EMR	% area of geomorphic unit within the EEZ
<i>Geomorphic Province</i>			
Shelf	0.12	0.91	<0.01
Slope	96.54	3.28	1.59
AP/DOF	3.35	0.43	0.09
<i>Geomorphic Feature</i>			
Slope (unassigned)	62.57	17.64	2.85
Basin	3.35	0.57	0.31
Canyon	0.02	0.10	0.01
Deep/hole/valley	7.84	26.31	9.73
Plateau	10.32	0.63	0.43
Reef	1.53	5.14	2.21
Ridge	0.27	15.20	0.15
Saddle	0.92	0.61	0.39
Terrace	0.29	0.31	0.03
Trench/trough	12.71	9.65	4.56

Table 5.7. The water depth of geomorphic units in the Cape Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Shelf	105 – 135	120
Slope	0 – 4,025	2,475
AP/DOF*	3,605 – 4,230	4,055
<i>Geomorphic Feature</i>		
Slope (unassigned)	0 – 4,025	2,310
Deep/hole/valley	105 – 3,695	3,370
Trench/trough	2,115 – 3,065	2,810
Basin	3,605 – 4,230	4,055
Reef	0 – 1,060	190
Canyon	2,120 – 2,315	2,225
Ridge	2,200 – 2,965	2,725
Terrace	40 – 1,360	830
Plateau	2,180 – 3,190	2,880
Saddle	350 – 1,355	945

5.5.3. Quantitative sediment distribution for the Cape Province

Six samples with grainsize data and eight with bulk carbonate data occur in the CP. Sediment texture is relatively fine and carbonate content relatively low compared to other offshore bioregions in the EMR. Mud content ranges from 56 - 95% and sand from 5 - 44%. Gravel comprises <1% in all samples.

Bulk carbonate content ranges from 45 - 85%. Six assays are available for the mud size fraction and two assays are available for the sand size fraction. The carbonate content of the mud fraction ranges from 47 - 84%, and the sand fraction from 79 - 90%. Gravel did not occur in adequate volumes to analyse for carbonate content.

5.5.4. Sedimentology of Significant Geomorphic Features

5.5.4.1. Slope (unassigned)

A total of four samples were obtained from slope (unassigned) within the CP. These are characterised by relatively homogeneous sediment dominated by carbonate mud. All of these samples contain 56 – 95% mud, 5 – 43% sand, and <1% gravel (Fig. 5.18). Bulk carbonate content ranges from 49 – 85% (Fig. 5.19). Carbonate content is highest in the mud fraction where it ranges from 48 – 85%. Four carbonate mud and two carbonate sand assays are available and these range from 48 – 95% and 80 – 90% respectively.

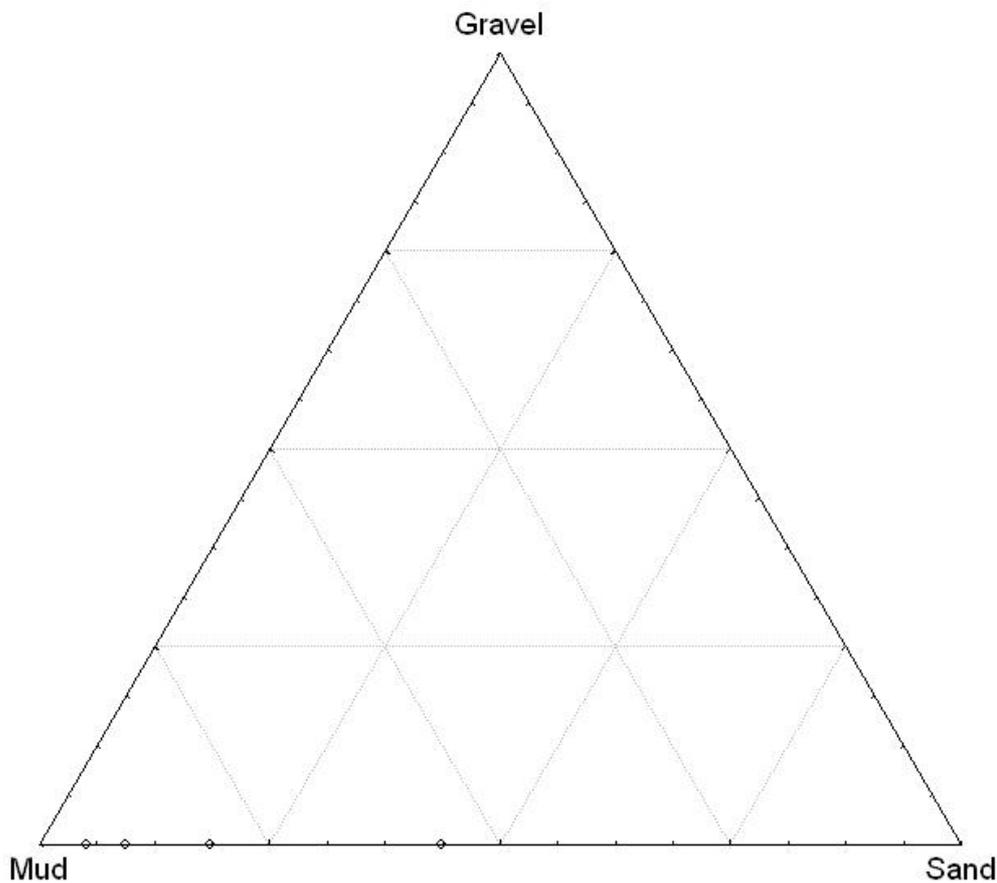


Figure 5.18. Textural composition (mud:sand:gravel ratio) of slope sediments within the CP.

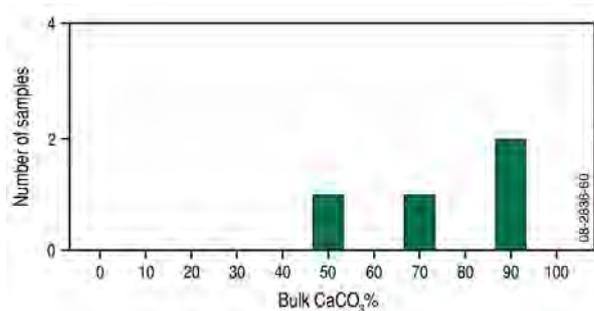


Figure 5.19. Carbonate content of slope sediments within the CP.

5.6. CENTRAL EASTERN PROVINCE (CEP)

5.6.1. Geomorphology and bathymetry

The CEP covers an area of 233,816 km² which represents 10% of the EMR (Table 5.1). The CEP is located offshore between North Stradbroke Island and Ulladulla and shares a boundary with seven other bioregions including the KT and CET to the north, the TBP to the east, the SET and SEST to the south and the CEST and CESP to the west.

The CEP is located predominantly on the slope and abyssal plain/deep ocean floor. Seven geomorphic feature types occur in this area including canyons (3,820 km², 2% of CEP area); terraces (1,140 km², <1%); pinnacles (860 km², <1%); knolls/abyssal hill/hill/mountain/peaks (62 km², <1%); and bank/shoals (3 km², <1%) (Fig. 5.20.; Table 5.8.) No geomorphic features are identified on 60,260 km² of the slope and 169,542 km² of the abyssal plain/deep ocean floor. These represent 26% and 72% of the CEP respectively. Pinnacles occur clustered on the upper slope adjacent to Yamba and also scattered across the abyssal plain/deep ocean floor. A series of canyons extend from the upper slope to the abyssal plain/deep ocean floor and are oriented broadly orthogonal to the coast. Elongate shallow water terraces run parallel to the coast on the upper slope. These are similar to terraces in the CEST and CESP.

Five significant geomorphic features are located within the CEP. These include, slope (unassigned), abyssal plain/deep ocean floor (unassigned), canyons, pinnacles and shallow water terraces. Although pinnacles and canyons constitute only <1% and <2% the total area of the CEP, respectively, they represent 17% and 4% of the total area of these features in the EMR. Sample coverage is adequate to assess the sedimentology of the slope (unassigned), abyssal plain/deep ocean floor (unassigned), and shallow water terraces.

Water depths in the CEP range from 130 – 5,170 m (Table 5.9.). Around 80% of the area of the CEP occurs in water depths between 4,000 – 5,000 m (Figure 5.21.). Water depths on the slope range from 40 - 5,025 m, with an average depth of 2,655m. Water depths on the abyssal plain/deep ocean floor range from 3,740 – 5,175 m, with an average depth of 4,775 m. Terraces are located in water depths of 165–780 m and banks/shoals in depths of 200 – 190 m. Pinnacles on the upper slope occur in water depths of 200-400 m and pinnacles on the abyssal plain/deep ocean floor in water depths >4,000 m.

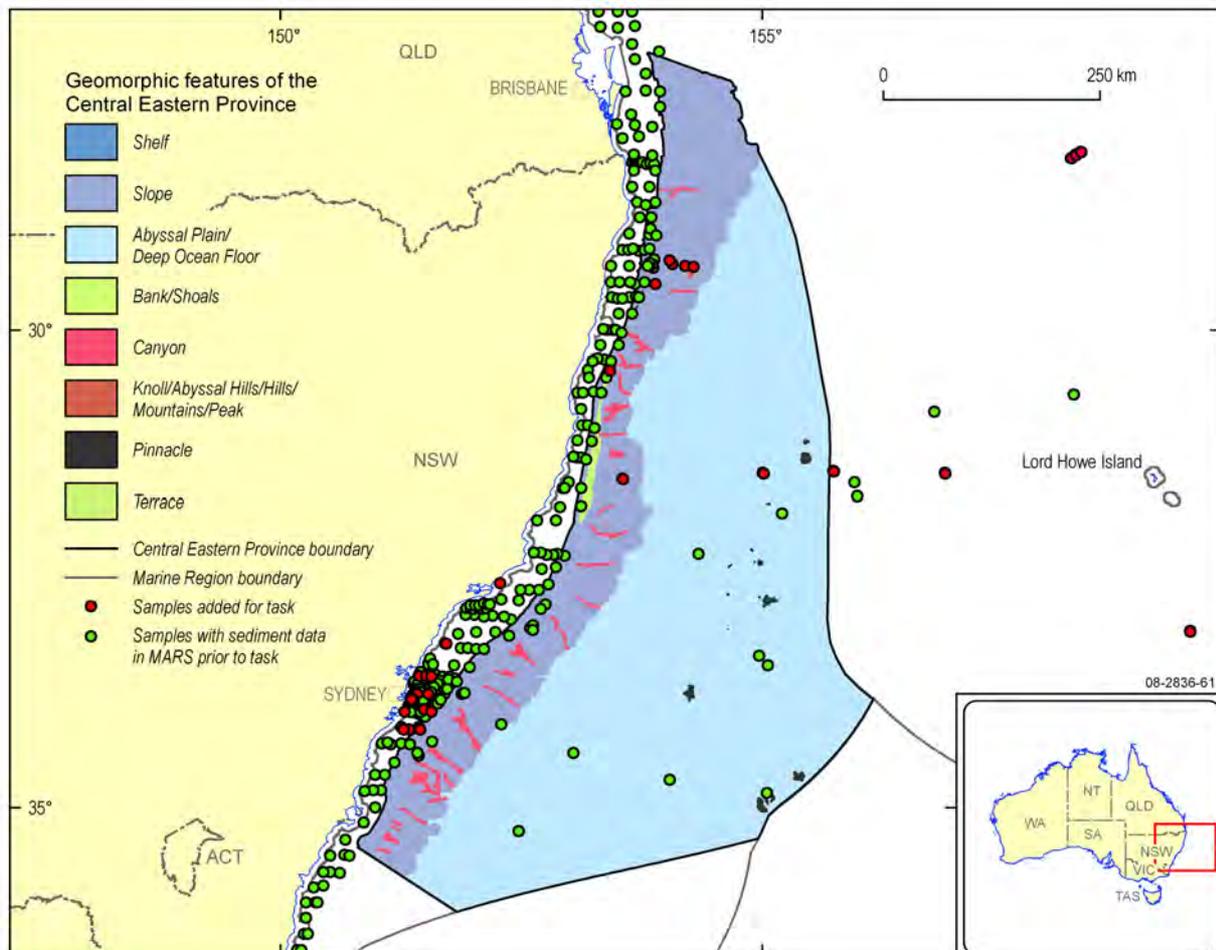
5.6.2. Sample Coverage

The CEP contains 86 samples with either quantitative textural and/or compositional data. Seventy-one of these (83%) are located on the upper slope adjacent to the CESP and CEST. Ten (12%) samples occur on the abyssal plain/deep ocean floor and 3 (3%) on terraces.

Average sample density in the CEP is 1:2,750 km². Samples achieve sufficient coverage to quantitatively describe the sedimentology of: terraces, slope (unassigned), and abyssal plain/deep ocean floor (unassigned). The majority of samples are clustered on the upper slope, meaning that statistics for the whole bioregion are likely to mainly represent sediments present on the slope and not necessarily represent sediments present on the abyssal plain/deep ocean floor.

A total of 10 samples were added to this bioregion for this study, increasing coverage for slope (8), terrace (1), and abyssal plain/deep ocean floor (1). Despite targeted sample addition, sample coverage remains inadequate to quantitatively assess the sedimentology in bank/shoal, canyon, knoll/abyssal hill/hill/mountain/peak and pinnacle features in the CEP.

a)



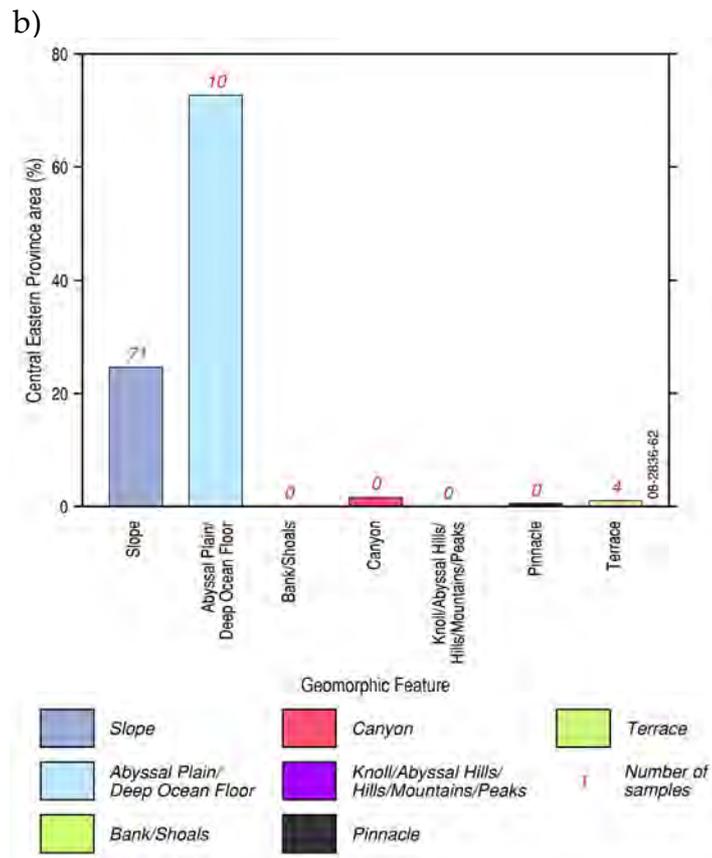


Figure 5.20. a) Geomorphology of the Central Eastern Province (CEP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the CEP with number of corresponding sediment samples (on top of columns).

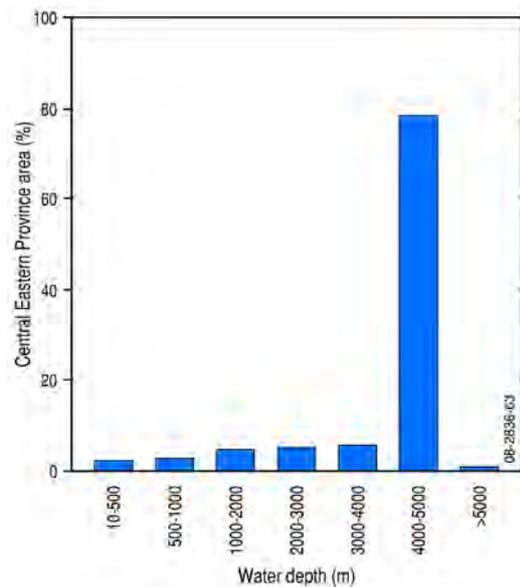


Figure 5.21. Distribution of water depth classes by percentage area within the CEP.

Table 5.8. The percentage area of geomorphic units found in the Central Eastern Province.

Feature	% area of bioregion	% area of geomorphic unit within the EMR	% area of geomorphic unit within the EEZ
<i>Geomorphic Province</i>			
Slope	27.11	3.45	1.67
AP/DOF	72.87	35.08	7.07
<i>Geomorphic Feature</i>			
Slope (unassigned)	24.54	25.87	4.18
AP/DOF (unassigned)	72.51	45.81	6.88
Bank/shoals	<0.01	0.43	<0.01
Canyon	1.66	39.41	3.63
Knoll/abyssal hills/mountains/peak	0.03	0.64	0.05
Pinnacle	0.37	34.96	16.82
Terrace	0.88	3.52	0.35

Table 5.9. The water depth of geomorphic units found in the Central Eastern Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Shelf	155 – 170	160
Slope	40 – 5,025	2,600
AP/DOP	3710 – 5,175	4,775
<i>Geomorphic Feature</i>		
Shelf (unassigned)	155 – 170	160
Slope (unassigned)	40 – 5,025	2,655
AP/DOF	3740 – 5,175	4,775
Bank/shoals	200 – 290	240
Canyon	195 – 4,885	2,965
Knoll/abyssal hills/mountains/peak	3135 – 4,235	3,675
Pinnacle	150 – 4,940	4,360
Terrace	165 – 780	330

5.6.3. Sedimentology of the Central Eastern Province

A total of 64 grain size and carbonate assays occur in the CEP. Sediment texture is variable with higher gravel content present in sediments located to the north of Hawks Nest. Mud content ranges from 0 – 97% but is <75% in 56 (88%) samples. Areas with the highest mud content are located on the lower slope and abyssal plain/deep ocean floor. Sand content ranges from 3 – 100% and is most dominant on the upper slope. Sand exceeds 60% in 40 (63%) samples and exceeds 90% in 17 (27%) samples. Gravel content ranges from 0 – 64%, although 58 (90%) samples contain <5% gravel.

Bulk carbonate content of samples ranges from 0 - 88% and exceeds 40% in 49 (77%) samples. The carbonate content of the mud and sand fractions were assessed for eight samples and these contain 21 - 88% and 0 - 85% carbonate respectively. The carbonate content of gravel was assessed for three samples, giving a range of 20 - 100%. Carbonate contents are lower (generally <50%) in samples with high mud content, suggesting carbonate content of the mud tends to be lower than that of sand in this area.

5.6.4. Sedimentology of Significant Geomorphic Features

5.6.4.1. Slope (unassigned)

A total of 71 samples were obtained from the slope (unassigned). Sixty of these samples have grain size data and fifty have carbonate data. Sand is the dominant fraction with contents ranging from 3 - 100% and exceeding 50% in 41 (69%) samples (Fig. 5.22). Mud is the next most abundant fraction with contents generally ranging from 5 - 97%, although 43 (72%) samples contain <50% and no mud is present in 15 (25%) samples. Gravel content is generally low and ranges from 0 - 63%, with 54 (90%) samples containing >5% gravel content. Bulk carbonate content ranges from 21 - 89% and is between 30 - 60% in 35 (70%) samples (Fig. 5.23). Carbonate content of mud was assessed for six samples and ranges from 33 - 88%. Carbonate content of sand was assessed for four samples and ranges from 59 - 85%. Two carbonate gravel assays are present and these equal 20% and 95% carbonate content.

5.6.4.2. Abyssal plain/deep ocean floor

A total of ten samples occur on the abyssal plain/deep ocean floor in the CEP. Grainsize data are available for only 1 sample (95% mud, 5% sand). Bulk carbonate content was assessed for all 10 samples, and ranges from 5 - 42% (Fig. 5.23.). Data is available for the carbonate content of mud fraction for one sample and this equals 22%. Low sample density in this area means that data may not adequately represent the range and relative proportions of sedimentary environments present on the abyssal plains/deep ocean floor in the CEP.

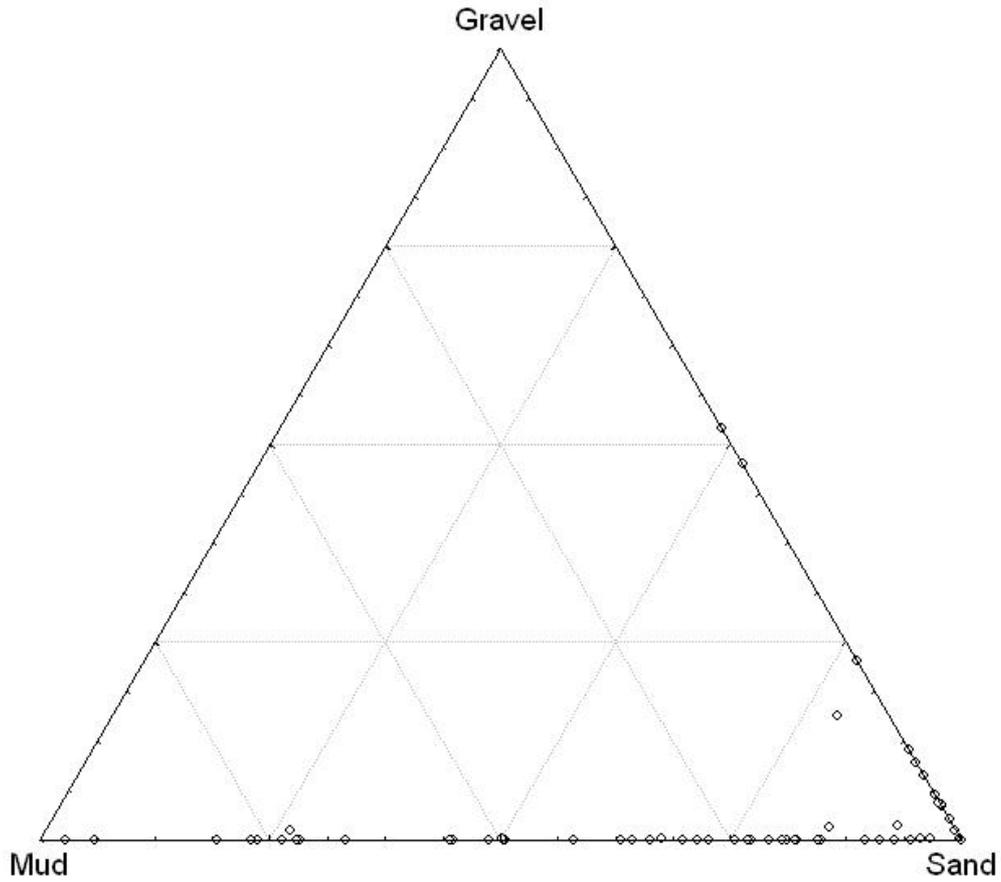


Figure 5.22. Textural composition (mud:sand:gravel ratio) of slope sediments within the CEP.

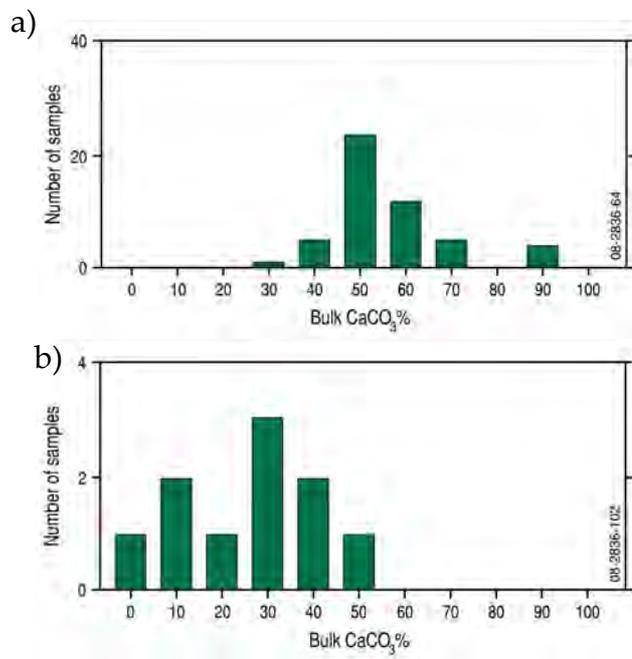


Figure 5.23. Carbonate content of a) slope; and b) abyssal plain/deep ocean floor sediments within the CEP.

5.7. CENTRAL EASTERN TRANSITION (CET)

5.7.1. Geomorphology and bathymetry

The Central Eastern Transition (CET) covers an area of 67,150 km² of which 44,840 km² (67%) occurs in the EMR (Fig. 5.1). This bioregion represents 2% of the total area of the EMR (Table 5.1). The CET is situated on the slope and rise to the east of Fraser Island, and to the southeast of the Great Barrier Reef Marine Park (Fig 5.24; Table 5.10). It shares a boundary with four bioregions including the NEP to the north, KT to the east, CEP to the south and CEST to the west.

The CET is dominated by slope (35,205 km² or 79%) and contains a small area of rise (9,633 km² or 21%). Two geomorphic features types are identified within the slope: canyons 597 km² (1%); and terraces 8,775 km² (20%). A total of 25,834 km² (58%) of the bioregion is unassigned slope. No features are identified within the area of the rise. Slope (unassigned); rise; canyons; and terraces are identified as significant geomorphic features. The rise within the CET occurs to the east of the bioregion and separates the slope from the abyssal plain/deep ocean floor and represents the second largest area of rise in the EMR. A large terrace borders the western boundary of the CET and a series of canyons cut the slope.

Water depths in the CET range from 110 – 4,735 m with an average depth of 2,110 m. Water depths on the slope range from 80 – 1,740 m (average 1,910 m) and on the rise range from 2,775 – 4,650 m (average 4,030 m). Terraces occur in the shallower areas of the CET, with water depths ranging from 80 – 880 m (average 420 m). Water depths are relatively evenly distributed over the CET (Fig. 5.25).

5.7.2. Sample Coverage

The CET contains 35 samples with either quantitative textural and/or compositional data (Figs. 5.24). The average sample density in the bioregion is 1:1,281 km². A total of 16 samples are located on the slope (unassigned) and 19 on terraces. All but one sample occur in water depths of 165 – 450 m. One sample is located on the slope to the north of the bioregion in 1,845 m water depth. Four samples were added to the CET during this task. These improve coverage of terraces on the upper slope.

Sample density is sufficient to describe the sedimentology on the slope (unassigned) and terraces. Despite targeted sample selection, no samples are available for rise and canyons features.

a)

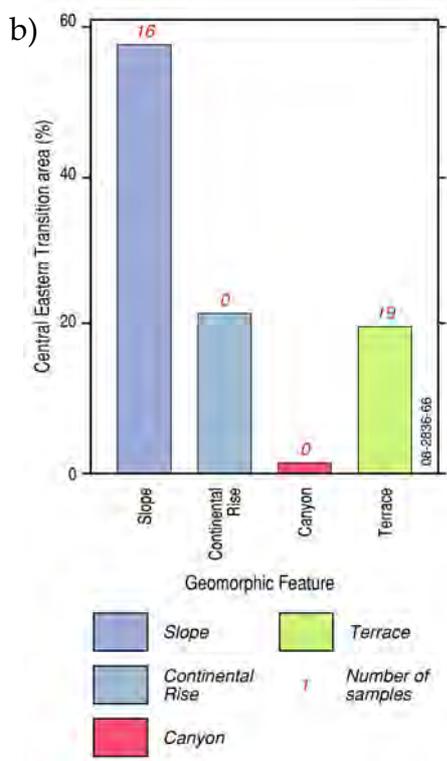
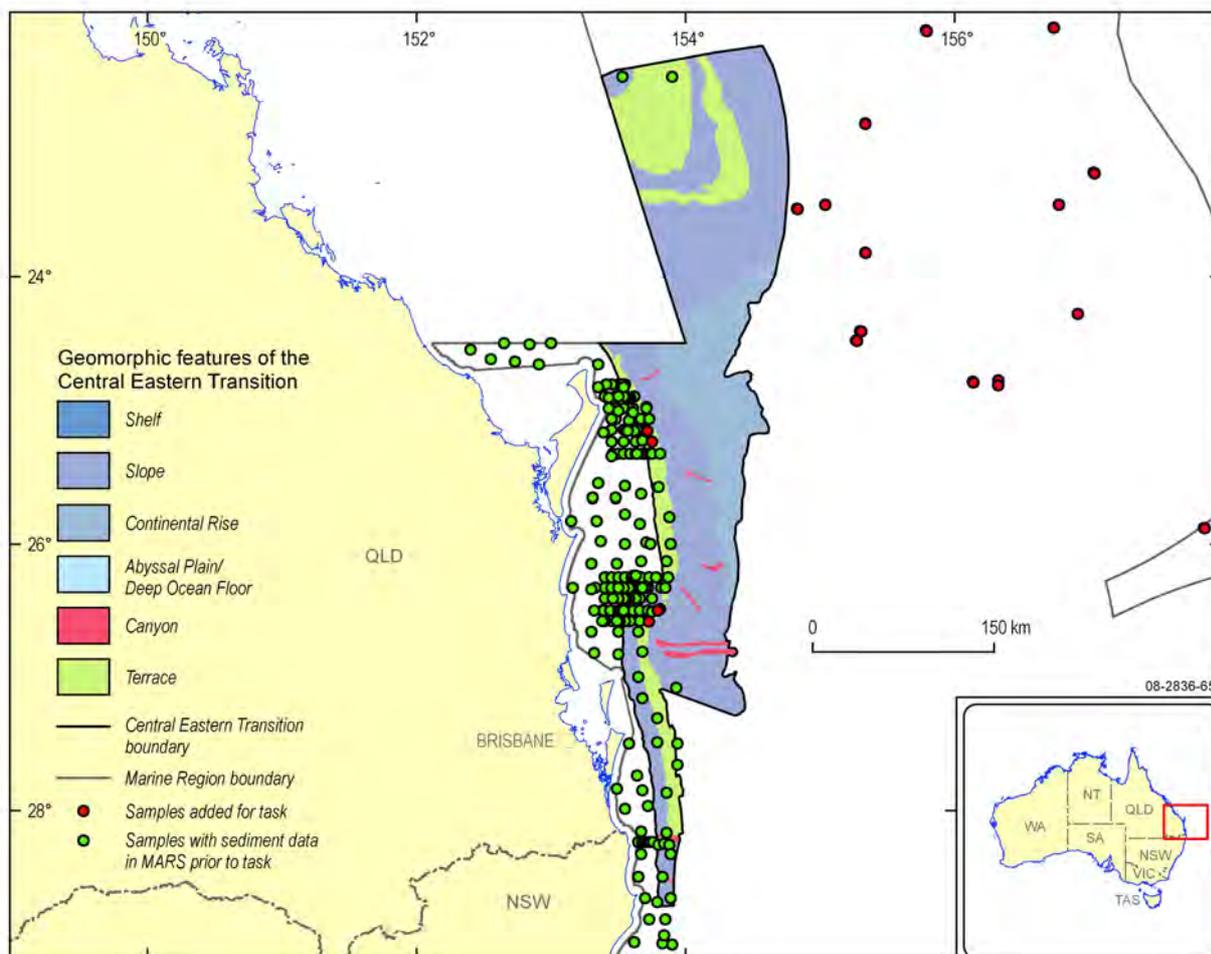


Figure 5.24. a) Geomorphology of the Central Eastern Transition (CET) with location of sediment samples; and b) Percentage area of each geomorphic feature within the CET with number of corresponding sediment samples (on top of columns).

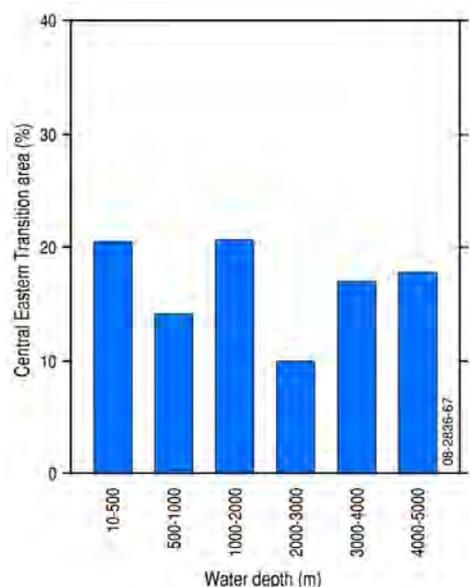


Figure 5.25. Distribution of water depth classes by percentage area within the CET.

Table 5.10. The percentage area of geomorphic units found in the Central Eastern Transition.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	80.94	1.92	0.93
Rise	19.06	31.66	9.55
<i>Geomorphic Feature</i>			
Slope (unassigned)	57.29	11.65	1.88
Rise (unassigned)	19.06	33.01	10.06
Canyon	1.34	6.08	0.56
Terrace	22.31	15.04	1.51

Table 5.11. The water depth of geomorphic units found in the Central Eastern Transition.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	80 – 4,735	1,565
Rise	2,775 – 4,650	4,025
<i>Geomorphic Feature</i>		
Slope (unassigned)	120 – 4,735	1,910
Rise (unassigned)	2,775 – 4,650	4,025
Canyon	1,205 – 4,715	3,415
Terrace	80 – 885	420

5.7.3. Sedimentology of the Central Eastern Transition

The CET contains 12 grainsize and 35 carbonate assays. Sediment in the CET is relatively homogenous and dominated by sand. Sand content ranges from 65 -100% and exceeds 60% in 11 (92%) of samples and exceeds 90% in six (50%) samples. Mud content ranges from 0 – 35%, although eight (67%) samples contain <10% mud. Gravel content ranges from 0 – 100% however ten (83%) samples contain <10% gravel.

Carbonate content of sediment does not show any clear spatial relationship to geomorphology or bathymetry within this bioregion. Bulk carbonate content ranges from 46 - 96% and exceeds 60% in 32 (91%) samples and exceeds 90% in 11 (31%) samples. Few carbonate assays are available for textural size fractions however, those present indicate carbonate content of mud is approximately 55% (two samples), carbonate content of sand ranges from 52 - 81% (five samples) and carbonate content of gravel is 100% (two samples).

5.7.4. Sedimentology of Significant Geomorphic Features

5.7.4.1. Slope (*unassigned*)

A total of 16 samples were obtained from the slope (*unassigned*). Textural data is available for two samples. Sand is the dominant size fraction with contents ranging from 93 - 98% (Fig. 5.26), with the remainder of sediment composed of gravel. Bulk carbonate content was assessed for all samples and ranges from 46 - 96% and exceeds 75% in 13 (81%) of samples (Fig. 5.27). Carbonate content was not assessed for the mud, sand and gravel fractions.

5.7.4.2. Terraces

A total of 19 samples were obtained from terraces. Carbonate assays are available for all of these samples and grain size assays are available for ten samples. Sand is the dominant size fraction and ranges from 0 - 100% with eight (80%) samples exceeding 80% sand (Fig. 5.26). Gravel is the next most abundant fraction and ranges from 1 - 16%, excluding one outlier sample composed of 100% gravel. Mud ranges from 0 – 35% with five (50%) samples containing no mud. The remaining five (50%) samples contain 6 – 35% mud. Bulk carbonate content ranges from 49 - 95% and exceeds 75% in 11 (58%) of samples (Fig. 5.27). Carbonate content of sand was assessed for five samples and ranges from 52 - 81%. Carbonate content of mud was assessed for two samples and ranges from 50 - 55%. Where assessed, gravel was composed entirely of carbonate.

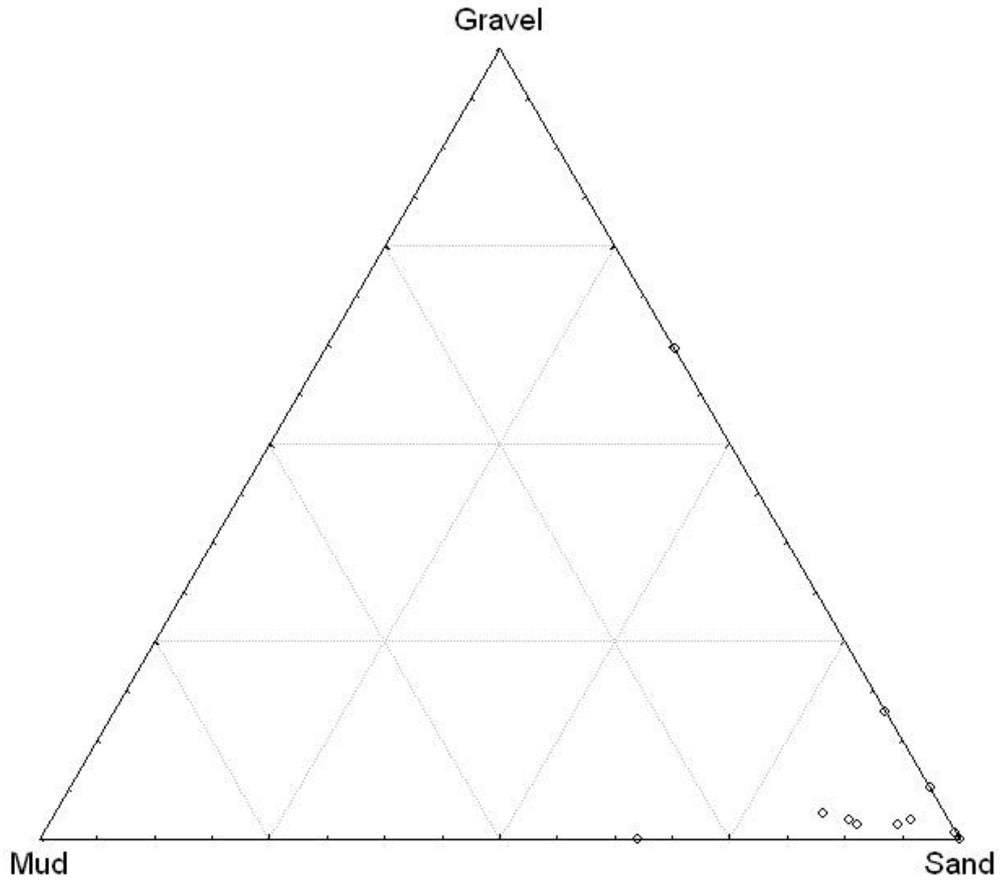


Figure 5.26. Textural composition (mud:sand:gravel ratio) of terrace sediments within the CET.

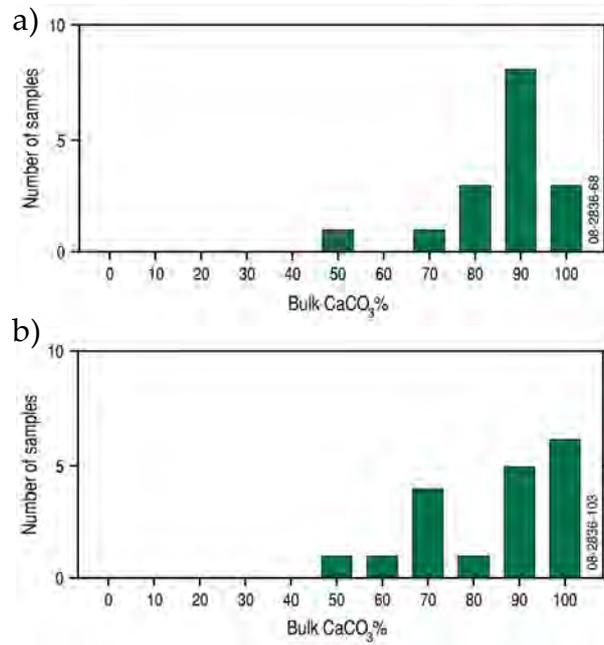


Figure 5.27. Carbonate content of: a) slope; and b) terrace sediments within the CET.

5.8. KENN PROVINCE (KP)

5.8.1. Geomorphology and bathymetry

The Kenn Province (KP) covers 57,419 km² or 2% of the total area of the EMR (Table 5.1). The KP is situated on the Kenn Plateau which is located at the junction of the Coral and Tasman Seas and occupies the eastern portion of the EMR. The KP is bounded by the KT to the north, west and south, and extends to the EEZ boundary in the east.

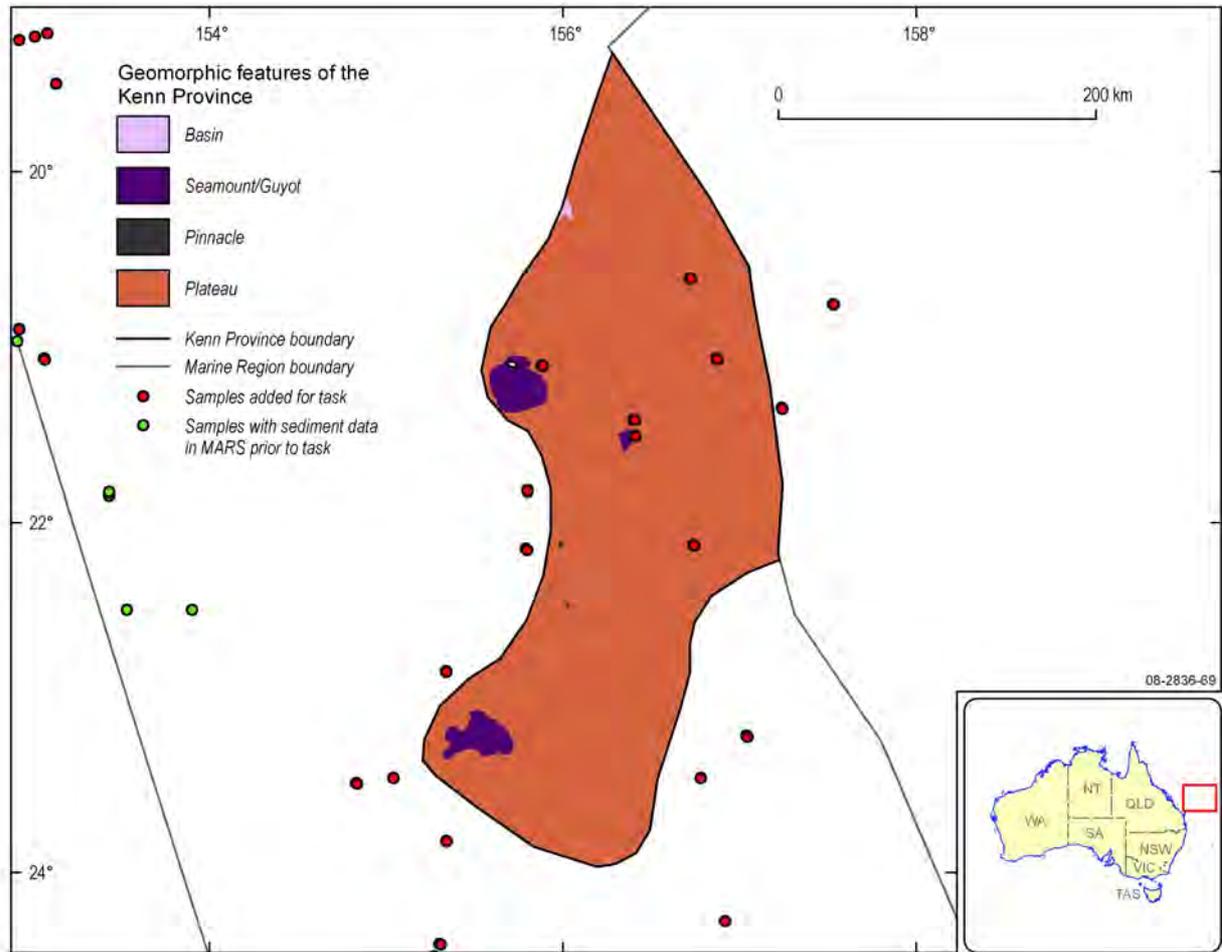
The Kenn Plateau covers a total area of 55,580 km² or 97% of the KP. Three additional geomorphic features also occur within the KP. These include, seamount/guyots (1,730 km², 3% of total KP area), basins (60 km², <1%) and pinnacles (16 km², <1%) (Fig. 5.28 & Table 5.12). Three seamounts/guyots and two pinnacles are located on the Kenn Plateau. The KP includes a small area of a larger basin that occurs to the west of the bioregion boundary. Seamount/guyots and plateaus are identified as significant features of the KP.

Water depths in the KP range from 0 – 3,190 m with an average depth of 1,890 m (Table 5.13). Around 95% of the total area of the KP occurs in water depths of between 1,000 - 3,000 m (Fig. 5.29). Seamounts/guyots occur in relatively shallow areas of the bioregion, with water depths from the base to summit of these features ranging from 0 – 1,880 m (average 645 m). Pinnacles occur in average water depths of 1,640 m. Water depths in the area of the Kenn Plateau within the KP range from 100 – 3,190 m. Water depths in the area of the basin within the KP average 3,170 m.

5.8.2. Sample Coverage

The KP contains six sediment samples that have quantitative textural and compositional data; all of these samples were collected and procured for the task (Fig. 5.28.). Samples are unevenly distributed, with the majority located in the northern section of the province. All samples occur at water depths of 726 – 2,210 m and give an average density of 1:9,570 km² for the bioregion. While sample density of the region is low, the predominant geomorphic feature within the bioregion (the Kenn Plateau) contains adequate data points to assess sedimentology of this feature (average sample density 1:9,570 km²). Pinnacles and seamounts/guyots are considered significant features of the KP but contain inadequate data points to quantitatively assess sedimentology in these areas.

a)



b)

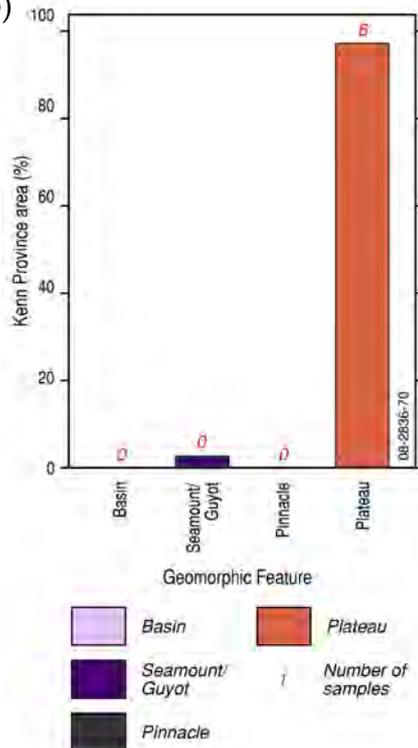


Figure 5.28. a) Geomorphology of the Kenn Province (KP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the KP with number of corresponding sediment samples (on top of columns).

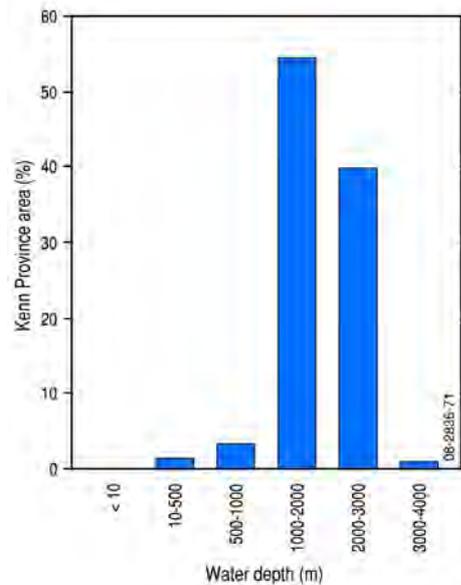


Figure 5.29. Distribution of water depth classes by percentage area within the KP.

Table 5.12. The percentage area of geomorphic units found in the Kenn Province.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	100	3.12	1.51
<i>Geomorphic Feature</i>			
Basin	0.11	0.02	0.01
Pinnacle	0.03	0.67	0.32
Plateau	96.85	5.41	3.72
Seamount/guyot	3.02	4.14	1.73

Table 5.13. The water depth of geomorphic units found in the Kenn Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	0 – 3,190	1,890
<i>Geomorphic Feature</i>		
Basin	3,025 – 3,190	3,170
Seamount/guyot	30 – 1,880	645
Pinnacle	1,570 – 1,710	1,640
Plateau	100 – 3,190	1,930

5.8.3. Quantitative sediment distribution for the Kenn Province

The KP contains six grain size and carbonate assays. Sediments in this area show variable textural properties. Mud is the dominant size fraction and ranges from 17 – 71%. Sand content is less variable

and ranges from 29 – 60% in all samples. Gravel content ranges from 0 – 27%, although four (67%) samples contain <20% gravel.

Bulk carbonate content ranges from 74 - 91%, and exceeds 85% in five (83%) samples. Samples with highest bulk carbonate content correspond to those with lowest mud contents (Fig. 5.30). Samples with lower bulk carbonate contents (<85%) generally occur on the plateau and adjacent to seamounts/guyots where samples have significant mud fractions (generally >60%). Carbonate content of sand ranges from 84 - 95% and exceeds 90% in five (83%) samples (Fig. 5.31). Carbonate content of mud ranges from 86 - 89% and is highest in the centre of the Kenn Plateau. Carbonate content of gravel ranges from 10 - 80% but is <50% in all but one sample.

5.8.4. Sedimentology of significant geomorphic features

5.8.4.1. Plateau

As all of the samples were collected from plateau within the KP, the description of the sediment distribution is in Section 5.7.3. The grain size distribution and bulk carbonate content of these samples are shown below (Figs. 5.30 & 5.31).

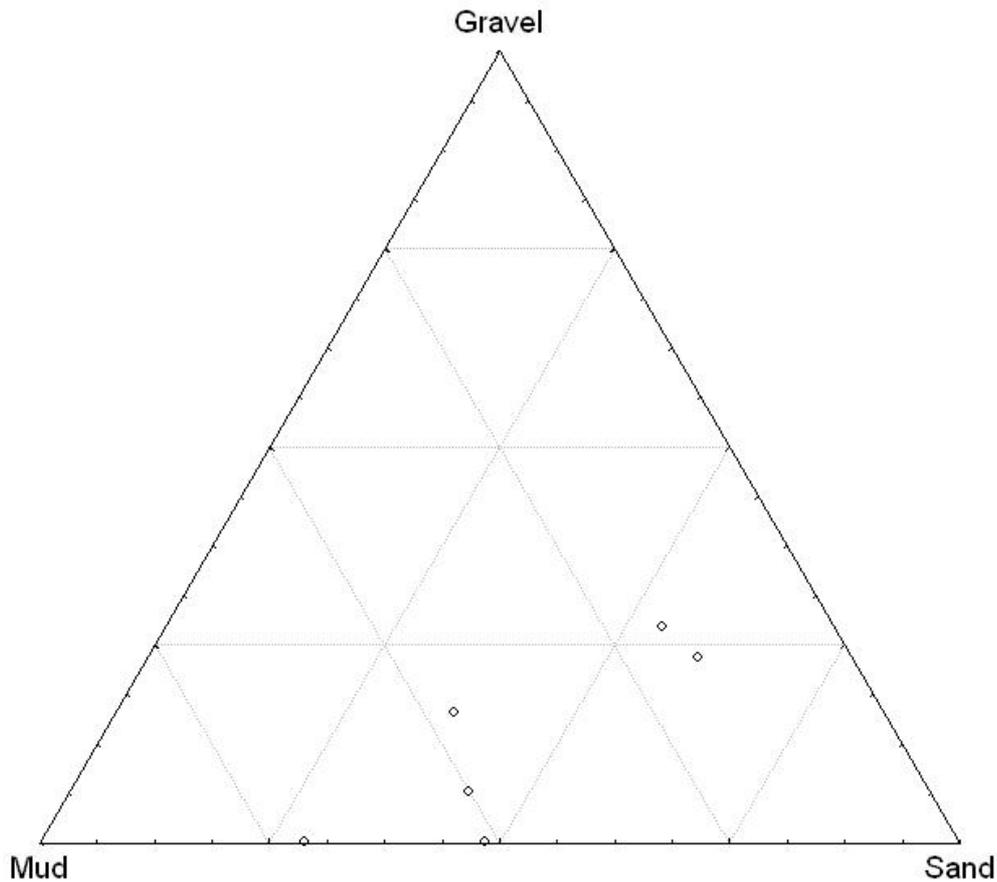


Figure 5.30. Textural composition (mud:sand:gravel ratio) of plateau sediments within the KP.

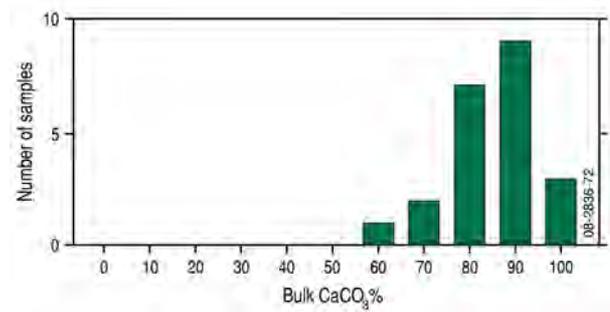


Figure 5.31. Carbonate content of plateau sediments within the KP.

5.9. KENN TRANSITION (KT)

5.9.1. Geomorphology and bathymetry

The Kenn Transition (KT) covers an area of 377,130 km² or 15% of the EMR (Table 5.1). The KT occurs mainly on the lower slope and abyssal plain/deep ocean floor offshore between Cooktown and North Stradbroke Island. The KT is bounded to the west by the NEP and the CET, to the south by the TBP and extends to the EEZ boundary in the east.

The KT includes areas of slope (242,026 km² or 64% of total KT area); rise (5,378 km² or 1%); and abyssal plain/deep ocean floor (64,988 km² or 17%)(Table 5.14). Paucity of data has prevented geomorphology from being interpreted for an area of approximately 64,740 km² (17%) in the east of the KT. Fourteen geomorphic features are identified in the KT: deep/hole/valley (13,010 km², 3%); basin (43,580 km², 12%); canyon (105 km², >1%); knoll/abyssal hills/hills/mountains/peak (593 km², >1%); seamount/guyot (10,569 km², 3%); pinnacle (167 km², >1%); saddle (32,113 km², 9%); apron/fan (365 km², >1%); and terrace (2,734 km², >1%). No features were identified for 3,315 km² (<1%) of the slope and 60,380 km² (93%) of the abyssal plain/deep ocean floor. No features were identified on the rise (Fig. 5.32. & Table 5.14).

Eight significant geomorphic features are identified within the KT. These include abyssal plain/deep ocean floor (unassigned), rise (unassigned), plateaus, basins, saddles, deep/hole/valleys, seamount/guyots, and apron/fans. Rise (unassigned) in the KT represents 18% of total rise in the EMR. The Kenn Plateau is a large plateau situated in the centre of the bioregion and is a prominent physical feature of the KT representing 14% of the total area of plateaus within the EMR. A large basin, the Cato Trough, covers 43,640 km² (12%) of the KT and separates the northern from the southern area of the bioregion. This basin forms approximately 12% of the area of basins in the EMR, and approximately 7% of the area of this feature type in the EEZ. A series of large seamounts/guyots ranging in area from approximately 80 – 1,600 km² occur within the area of the plateau, basin and abyssal plain/deep ocean floor. These represent 25% of the total area of seamounts/guyots in the EMR, and 10% of the total area of this feature in the EEZ. Areas of abyssal plain/deep ocean floor and apron/fan within the KT are significant as they represent 16% and 14% respectively, of the total area of this feature found in the EMR. Saddles within the KT constitute 22% of all saddles found in the EEZ.

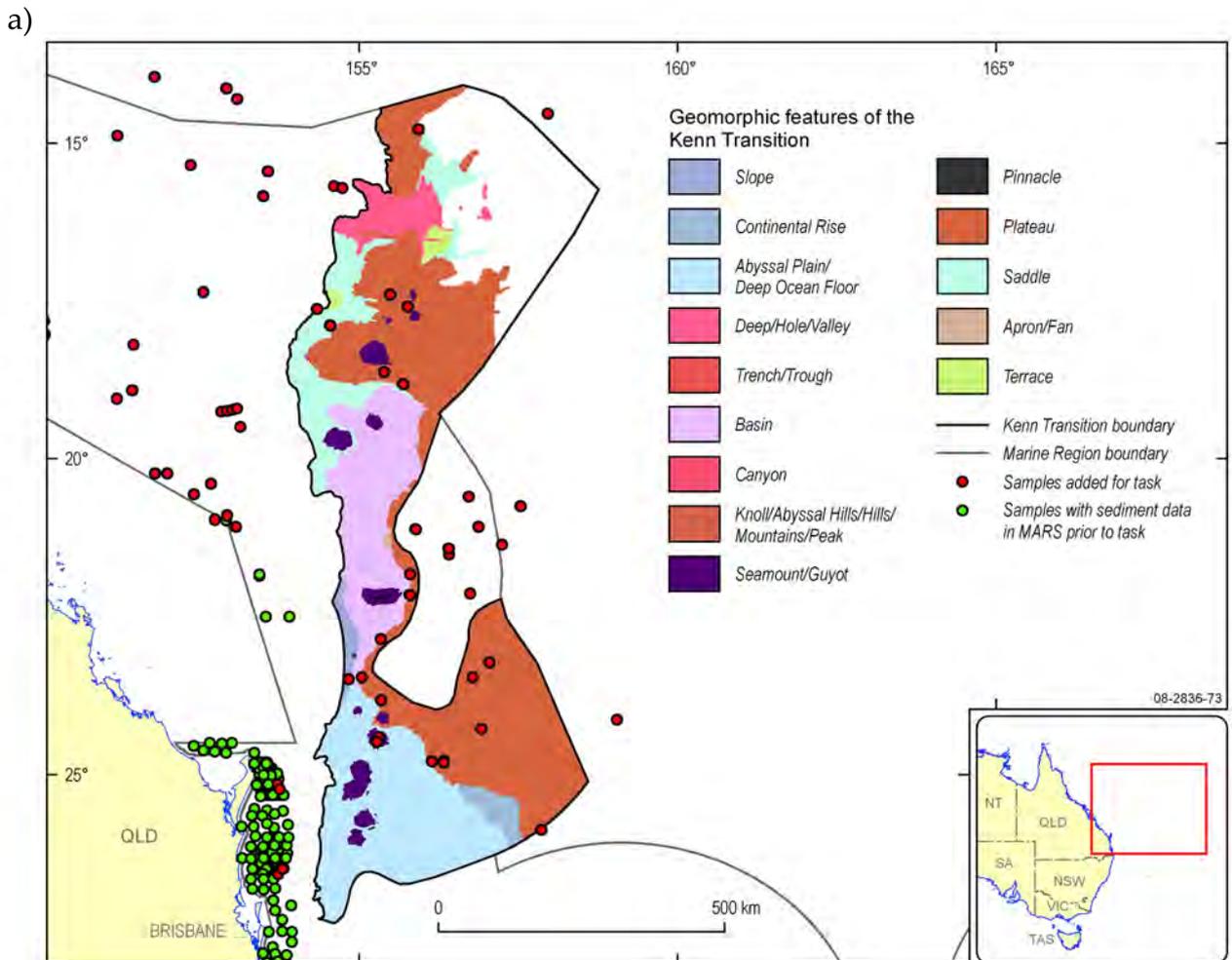
Water depths in the KT ranges from 0 – 4,890 m, with an average depth of 3,130 m (Table 5.15). Approximately 95% of the KT occurs in water depths of 2,000 – 5,000 m (Fig. 5.33). Water depth is greatest on the abyssal plain/deep ocean floor in the south of the bioregion, averaging 4,520 m. Water

depths are shallowest on seamounts occurring on the Kenn Plateau in the north of the bioregion, with depths as shallow as 30 m.

5.9.2. Sample Coverage

The KT contains 20 sample points with quantitative textural and compositional data (Fig. 5.32). These samples occur on the slope (unassigned) (1 sample, 5%), on seamount/guyots on the abyssal plain/deep ocean floor (2, 10%), on plateaus (16, 80%), and saddles (1, 5%). Samples occur in water depths from 730 – 4,020 m, with 15 samples (75%) in depths >2,000 m.

Average sample density in the KT is 1:18,860 km². All samples in the KT were procured and analysed for this task, allowing the first quantitative assessment of sedimentology for this region. Samples achieve adequate coverage to assess the sedimentology of the Kenn Plateau only. Targeted sample collection resulted in addition of two samples from seamounts/guyots but data coverage remains inadequate to assess sedimentology in these features.



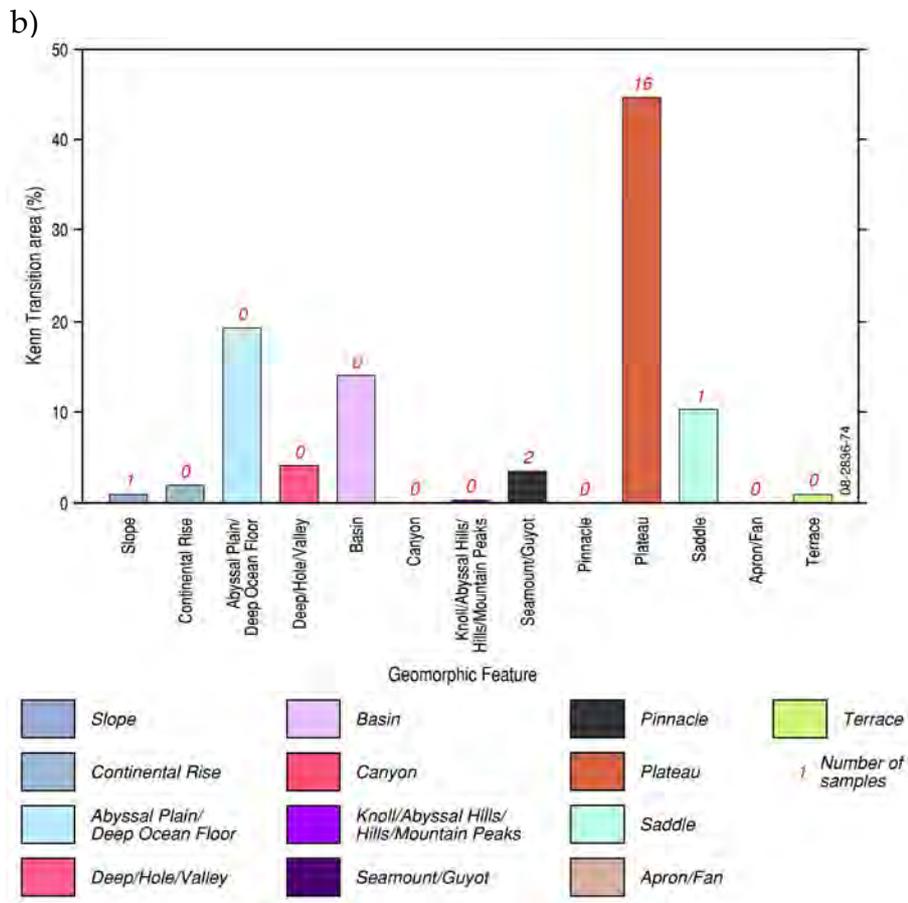


Figure 5.32. a) Geomorphology of the Kenn Transition (KT) with location of sediment samples; and b) Percentage area of each geomorphic feature within the KT with number of corresponding sediment samples (on top of columns).

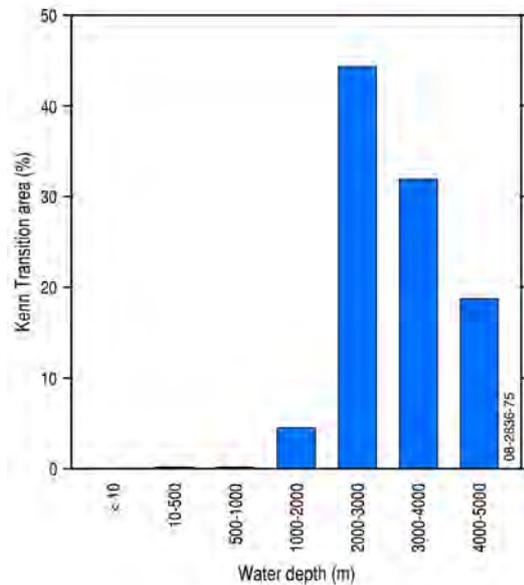


Figure 5.33. Distribution of water depth classes by percentage area within the KT.

Table 5.14. The percentage area of geomorphic units found in the Kenn Transition.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	64.18	13.17	6.37
Rise	1.42	17.67	5.33
AP/DOF	17.23	13.38	2.70
<i>Geomorphic Feature</i>			
Slope (unassigned)	0.88	1.49	0.24
Rise (unassigned)	1.42	18.43	5.61
AP/DOF (unassigned)	16.01	16.31	2.45
Deep/hole/valley	3.45	68.93	7.88
Basin	11.56	11.90	6.56
Canyon	0.03	1.08	0.10
Knoll/abyssal hills/hills/mountains/peak	0.16	6.12	0.50
Seamount/guyot	2.80	25.08	10.50
Pinnacle	0.04	6.75	3.25
Plateau	44.84	13.62	9.36
Saddle	8.52	33.94	21.93
Apron/fan	0.10	13.76	3.11
Terrace	0.72	4.69	0.47

Table 5.15. The water depth of geomorphic units found in the Kenn Transition.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	15 – 4,740	2,740
Rise	3,130 – 4,650	4,145
AP/DOF	320 – 4,885	4,435
<i>Geomorphic Feature</i>		
Slope (unassigned)	1,700 – 4,715	2,860
Rise (unassigned)	3,130 – 4,650	4,145
AP/DOF	2,115 – 4,885	4,520
Deep/hole/valley	2,215 – 4,175	3,545
Trench/trough	2,645 – 2,825	2,770
Apron/fan	2,660 – 3,195	3,040
Basin	1,155 – 4,175	3,160
Canyon	2,760 – 4,720	3,245
Knoll/abyssal hills/mountains/peak	2,370 – 4,290	3,645
Seamount/guyot	30 – 4,700	2,460
Pinnacle	1,105 – 4,795	3,665

Plateau	100 – 4,740	2,515
Saddle	1,995 – 3,810	2,515
Terrace	2,255 – 3,650	2,955

5.9.3. Sedimentology of the Kenn Transition

The KT contains 20 quantitative grain size and carbonate assays. Sediment texture across most of the bioregion is relatively homogeneous. Mud is the dominant size fraction with contents ranging from 27 - 86% and exceeding 50% in 14 (70%) samples. The sand content of samples ranges from 14 – 72% and is below 60% in 19 (95%) samples. Four (20%) samples are sand dominated samples and these are located offshore Townsville and adjacent to the southern border of the KP. Gravel forms <1% of the sediment volume in 18 (90%) samples. Gravel attains 5% and 32% in two (10%) samples located offshore Cairns.

Bulk carbonate content in the KT ranges from 57 – 90%, and exceeds 70% in 16 (80%) samples, and exceeds 80% in nine (45%) samples. Carbonate content is highest in the north of the bioregion with carbonate contents ranging from 76 - 90%. This contrasts to the south of the bioregion where carbonate content ranges from 60 - 81%. Carbonate content of mud ranges from 52 - 88% and exceeds 70% in 14 (70%) samples. Carbonate content of sand ranges from 81 - 96% and exceeds 90% in 18 (90%) samples. Carbonate content of gravel ranges from 0 - 100% with 11 (55%) samples containing >5% carbonate gravel and eight (40%) samples exceeding 80% carbonate gravel.

5.9.4. Sedimentology of significant geomorphic features

5.9.4.1. Plateau

A total of 16 samples were obtained from the Kenn Plateau in the KT. Mud is the dominant size fraction, with contents ranging from 34 - 83%. Eleven (70%) of the 16 samples contain >50% mud. Sand is the next most abundant fraction with contents ranging from 18 - 59%. Gravel content ranges from 0 - 32% and 14 (88%) samples contain <1% gravel (Fig. 5.34). Bulk carbonate content ranges from 57 - 90% and exceeds 75% in 10 (63%) samples (Fig. 5.35). Carbonate content of sand ranges from 81 - 96% and exceeds 90% in 15 (94%) samples. Carbonate content of mud ranges from 52 - 88% and exceeds 75% in nine (56%) samples. Carbonate content of gravel ranges from 5 - 100% and is absent in eight (50%) samples and 100% in five (31%) samples.

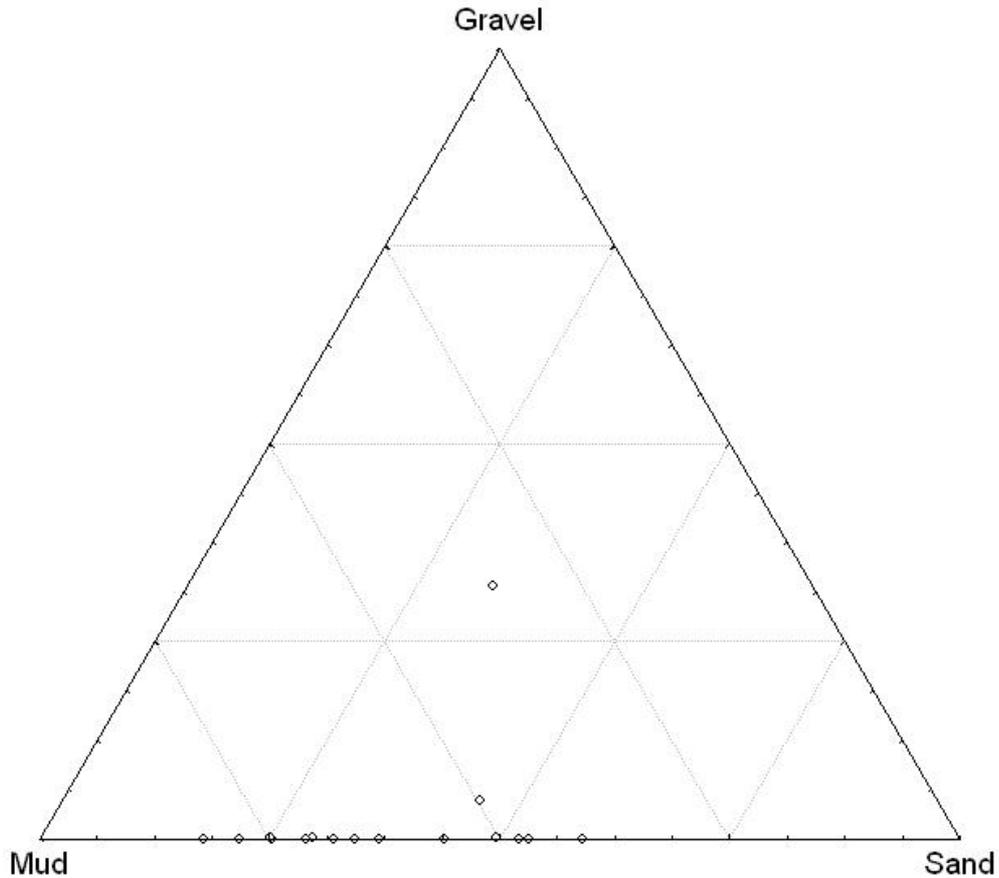


Figure 5.34. Textural composition (mud:sand:gravel ratio) of plateau sediments within the KT.

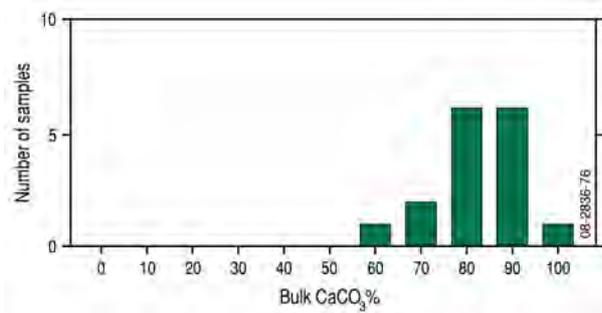


Figure 5.35. Carbonate content of plateau sediments within the KT.

5.10. NORFOLK ISLAND PROVINCE (NIP)

5.10.1. Geomorphology and bathymetry

The NIP covers an area of 430,790 km² which represents 18% of the EMR. The NIP surrounds Norfolk Island and is isolated from the rest of the EEZ. The province is separated from the LHP to the east by a strip of seabed approximately 100 km wide.

The NIP is located predominantly on the slope (430,156 km², or 99% of total NIP area). The remainder comprises a small area of shelf that surrounds Norfolk Island (675 km², >1%). The NIP

contains a complex geomorphology with thirteen geomorphic features identified on the slope: bank/shoal (705 km², >1%); deep/hole/valley (9 km², >1%); trench/trough (9,825 km², 2%); basin (167,445 km², 39%); canyon (625 km², >1%); knoll/abyssal hills/hills/mountains/peak (6,785 km², 2%); ridge (275 km², >1%); seamount/guyot (4,575 km², 1%); pinnacle (790 km², >1%); plateau (178,025 km², 41%); and saddle (29,795 km², 7%) (Fig. 5.36. & Table 5.16). No geomorphic features are identified on 31,300 km² or 7% of slope. No geomorphic features are identified on the shelf. Together basins and plateaus cover 345,470 km² or 80% of the NIP. This area includes the Kingston Plateau, New Caledonia Basin, North Norfolk Basin, and South Norfolk Basin.

Due to the complex geomorphology of the NIP, nine significant features are identified. These include slope (unassigned), bank/shoals, trench/troughs, basins, knoll/abyssal hills/hills/mountains/peaks, seamount/guyots, pinnacles, plateaus and saddles. Pinnacles and seamount/guyots occur in slope, trench/trough, basin, plateau, and saddle geomorphic features in the east of the bioregion. These features each represent a significant portion of the total area of the feature type in the EMR. 14% of slope, 99% of banks/shoals, 12% of trench/troughs, 45% of basins, 40% of knoll/abyssal hills/hills/mountains/peaks, 11% of seamount/guyots, 32% of pinnacles, 17% plateaus, and 31% of saddles within the EMR are located within the NIP.

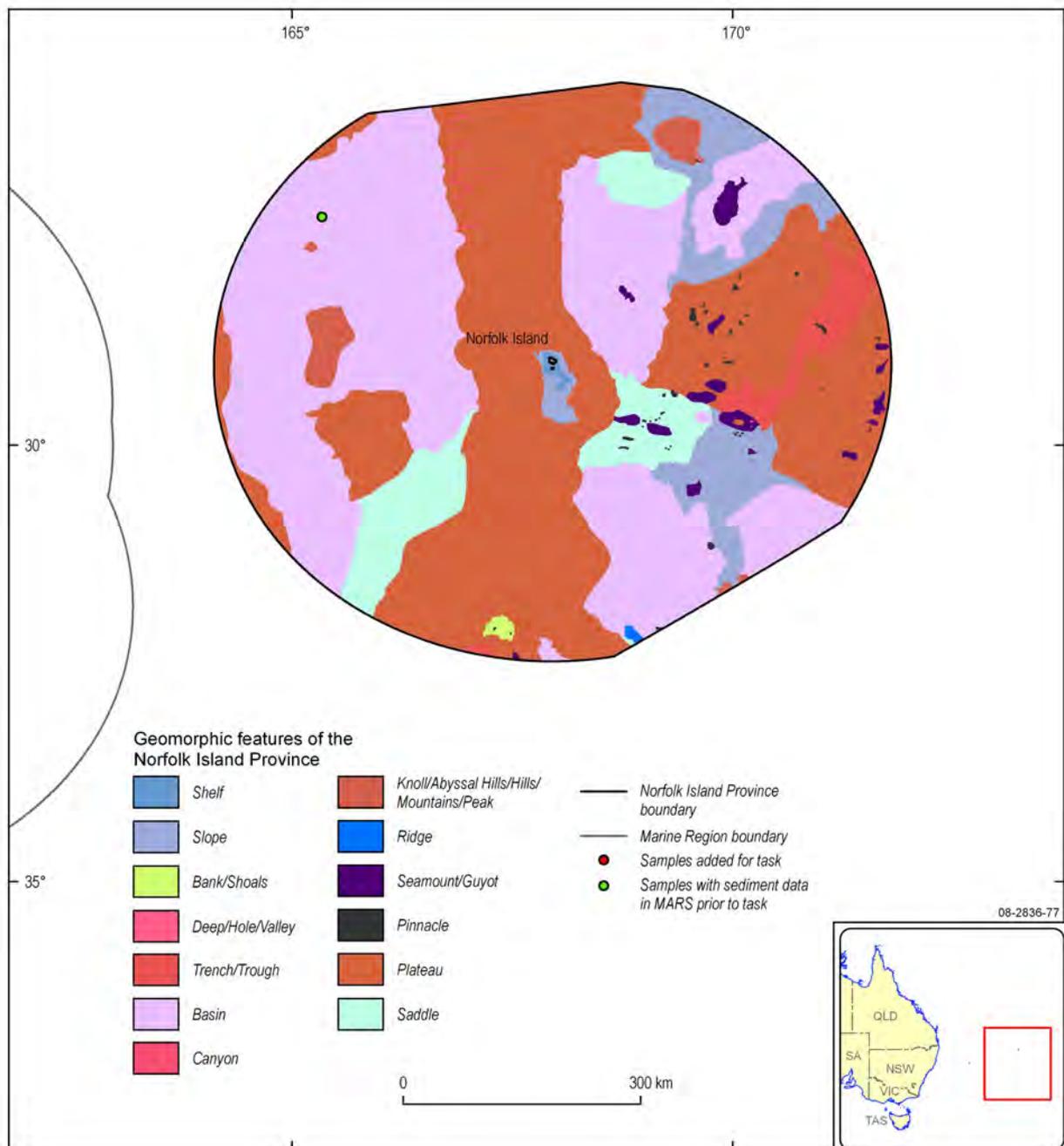
Water depths in the NIP range from 0 – 4,920 m with an average depth of 2,775 m (Table 5.17). Approximately 80% of the NIP occurs in water depths of 2,000 – 5,000 m (Fig. 5.37). Water depths on the shelf range from 0 – 205 m. Water depths on the slope range from 15 – 4,475 m with an average depth of 3,015 m. Bank/shoals generally occur in relatively shallow areas of the slope (average depth 915 m) while other features occur at significantly greater depths: plateaus average 2,120 m, seamount/guyots 2,170 m, pinnacles 2,550 m, saddles 2,760 m, knoll/abyssal hills/hills/mountains/peaks 2,810 m, trench/troughs 3,225 m and basins 3,430 m. Unassigned areas are dominantly located in deeper areas of the slope with average water depths of 3,015 m.

5.10.2. Sample Coverage

The NIP contains one sample with quantitative compositional data. This sample is located on the New Caledonia Basin in 3,525 m water depth. Bulk carbonate content of this sample is 86%, but beyond this no quantitative assessment of sedimentology is possible for the NIP.

Average sample density for the bioregion is the lowest of all bioregions in the EMR at 1:430,790 km². Despite being identified as a significant data gap in the EMR, no samples from the NIP were available from either Australian or international data repositories. Additional samples for this region were collected by GA during September/October 2007. These will be analysed and added to the MARS database during 2008. The NIP contains one carbonate assay.

a)



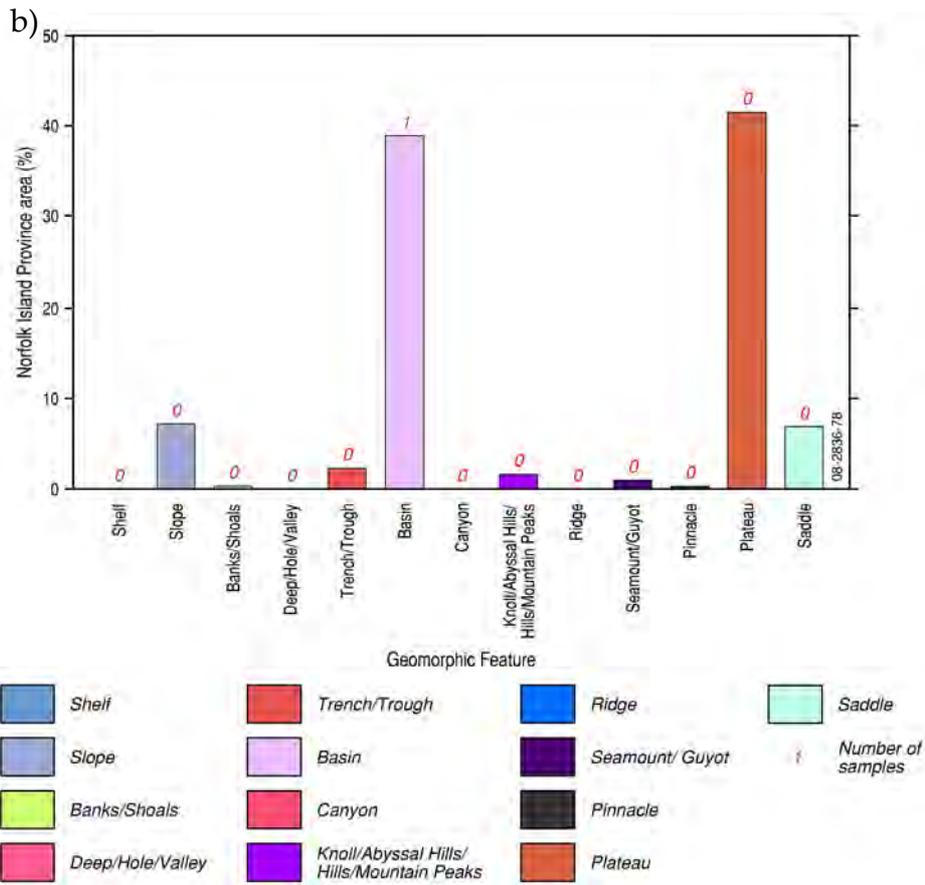


Figure 5.36. a) Geomorphology of the Norfolk Island Province (NIP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the NIP with number of corresponding sediment samples (on top of columns).

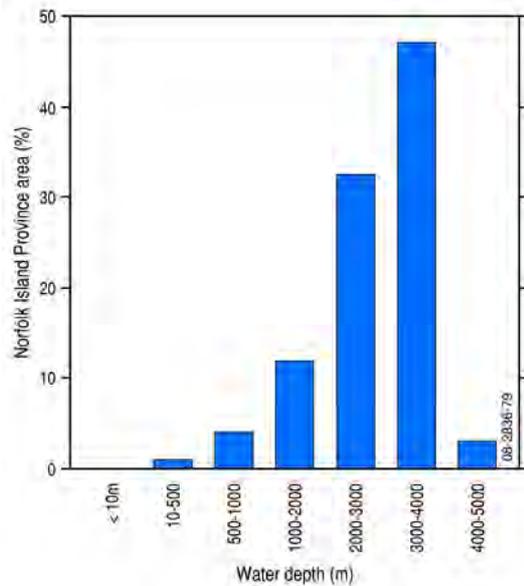


Figure 5.37. Distribution of water depth classes by percentage area within the NIP.

Table 5.16. The percentage area of geomorphic units found in the Norfolk Island Province.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Shelf	0.15	1.67	0.02
Slope	99.85	23.41	11.33
<i>Geomorphic Feature</i>			
Shelf (unassigned)	0.15	1.87	0.05
Slope (unassigned)	7.27	14.11	2.28
Banks/shoals	0.16	99.57	1.39
Deep/hole/valley	<0.01	0.05	<0.01
Trench/trough	2.28	11.96	5.65
Basin	38.87	45.73	25.21
Canyon	0.14	6.34	0.58
Knoll/abyssal hills/hills/mountains/peak	1.58	70.04	5.72
Ridge	0.06	24.88	0.25
Seamount/guyot	1.06	10.86	4.54
Pinnacle	0.18	32.05	15.43
Plateau	41.32	17.32	11.90
Saddle	6.92	31.49	20.34

Table 5.17. The water depth of geomorphic units found in the Norfolk Island Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Shelf	0 – 205	55
Slope	15 – 4,955	2,775
<i>Geomorphic Feature</i>		
Shelf (unassigned)	0 – 205	55
Slope (unassigned)	15 – 4,475	3,015
Banks/shoals	240 – 1,420	915
Deep/hole/valley	1,625 – 2,305	1,870
Trench/trough	880 – 3,900	3,225
Basin	1,375 – 4,955	3,430
Canyon	945 – 3,540	2,755
Knoll/abyssal hills/hills/mountains/peak	1,315 – 4,045	2,810
Ridge	960 – 3,810	2,390
Seamount/guyot	205 – 3,965	2,170
Pinnacle	225 – 3,950	2,550
Plateau	50 – 3,900	2,120
Saddle	1,510 – 3,620	2,760

5.11. NORTHEAST PROVINCE (NEP)

5.11.1. Geomorphology and bathymetry

The Northeast Province (NEP) covers an area of 422,290 km² and represents 17% of the EMR. The NEP occurs on the slope and abyssal plain/deep ocean floor to the east of the Great Barrier Reef. It is bordered by the Great Barrier Reef Marine Park to the west, the NET to the north, the KT and EEZ boundary to the east, and the CET to the south.

The NEP is dominated by slope (351,505 km² or 85% of the total NEP area) but includes a significant area of abyssal plain/deep ocean floor (68,510 km² or 16%) and a small area of rise (2,440 km² or >1%) (Table 5.18). Thirteen geomorphic features are identified within these: deep/hole/valley (475 km², >1%); trench/trough (48,835 km², 12%); basin (68,230 km², 16%); reef (18,405 km², 4%); canyon (2,575 km², >1%); knoll/abyssal hills/hills/mountains/peak (305 km², >1%); seamount/guyot (1,310 km², >1%); pinnacle (365 km², >1%); plateau (176,095 km², 42%); apron/fan (1,499 km², >1%); and terrace (39,105 km², 9%) (Fig. 5.38 & Table 5.18). No geomorphic features are identified for 63,060 km² or 18% of the area of the slope and 2,195 km² or 90% of the rise. All of the area of abyssal plain/deep ocean floor occurs in Coral Sea Basin of which part occurs in the north of the NEP.

Ten significant features are identified within the NEP, reflecting the complex geomorphology of the region. These include, slope (unassigned); trench/trough basin; reef; canyon; knoll/abyssal hills/hills/mountains/peak; pinnacle; plateau; apron/fan and terrace features. The NEP contains the largest area of reefs in any bioregion in the EMR and include the Willis, Lihou, Coringa, and Tregrosse Reefs. Although this feature covers only 4% of the bioregion, this represents 92% of the total area of reefs in the EMR and 40% of reefs in the EEZ. Trench/trough, terrace, and apron/fan features in the NEP also represent large proportions of the total area of these features in the EMR (60%, 67% and 57% respectively). Pinnacles within the NEP are clustered on the Queensland and Marion Plateau and occupy an area of <1% of the total area of the NEP, however they represent 15% of pinnacles within the EMR. The Townsville Trough separates the Queensland and Marion Plateaus and is the largest single area of this feature type in the EMR. The Coral Sea Basin is situated adjacent to the EEZ boundary in the north of the NEP and represents 18% of the total area of basins in the EMR.

Water depths in the NEP range from 0 – 4,915 m with an average depth of 1,755 m (Table 5.19). Approximately 65% of the area in the NEP lies in water depths of 10 – 2,000 m (Fig. 5.39) Significant geomorphic features occur over a large range of water depths.: A total 13% of the area lies in water depths between 4,000 – 5,000 m in the Coral Sea Basin. Rise (unassigned), deep/hole/valley, basin and knoll/abyssal hills/hills/mountains/peak occur at mean water depths of 3,485 m, 8,865 m, 4,305 m, and 3,725 m respectively. Apron/fan, reef, saddle and plateau occur in shallower areas of the NEP, with mean water depths of 435 m, 130 m, 435 m, and 985 m respectively.

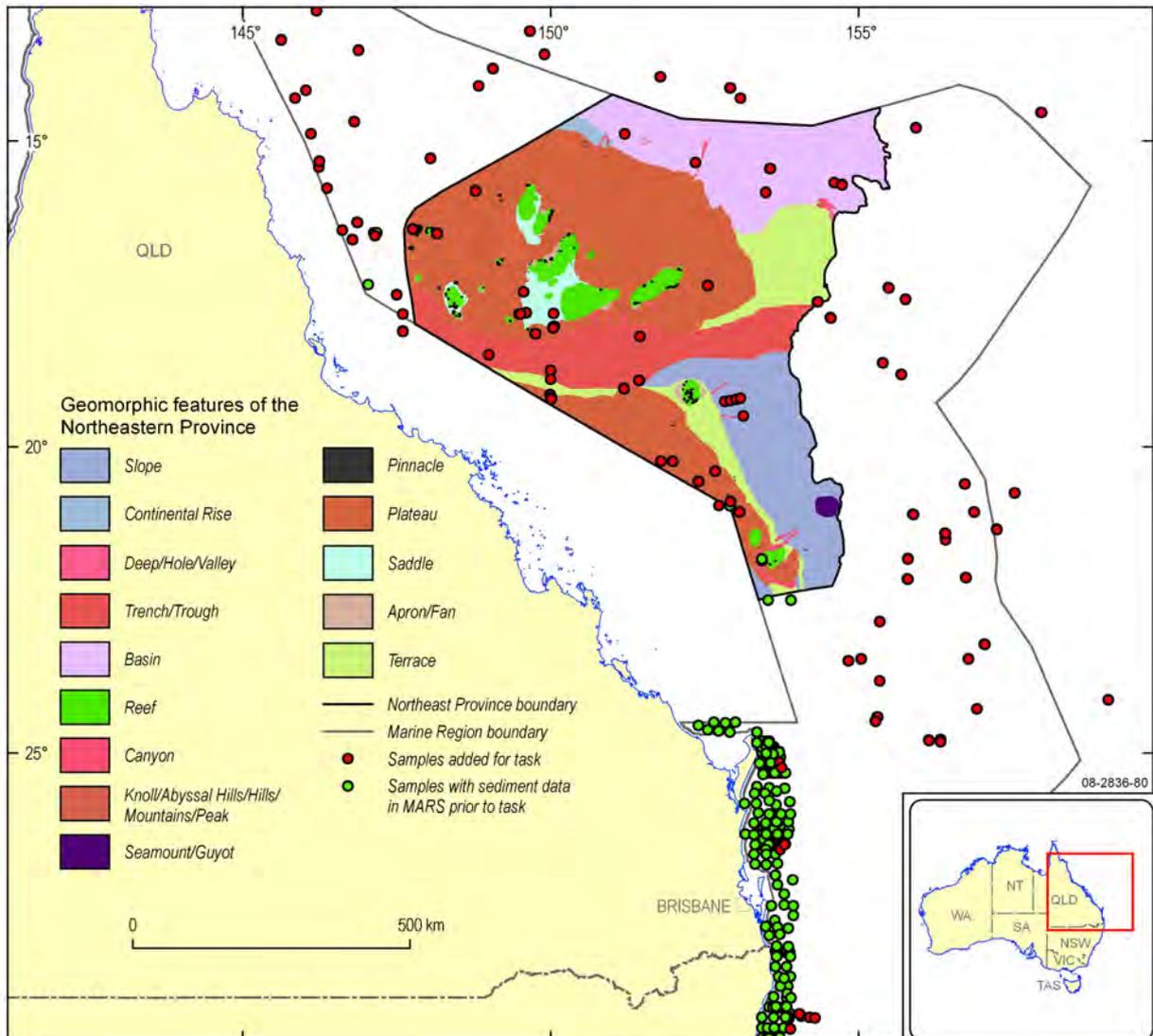
5.11.2. Sample Coverage

The NEP contains 50 sample points with either quantitative grainsize and/or carbonate data. Samples occur in water depths of 285 – 4,650 m within slope (unassigned) (6 samples, 12%); trench/trough (7 samples, 14%); basin (6 samples, 12%); canyon (1 sample, 2%); plateau (24 samples, 48%); saddle (3 samples, 6%); and terrace (3 samples, 6%) geomorphic features. A total of 44 of the 50 samples were

procured for the task, significantly improving the data coverage of the NEP. New samples have particularly improved coverage of trench/trough, terrace, canyon and basin features for which there were no quantitative sediment data prior to this task.

Average sample density in the NEP is 1:8,450 km. Sample coverage is sufficient to assess the sedimentology of the slope (unassigned), basins, plateaus and trench/troughs. Sample density remains too low to assess the sedimentology of saddles, terraces and canyons. Despite targeted sample addition, no data is available for reef, knoll/abyssal hills/hills/mountains/peak, pinnacle, and apron/fan features.

a)



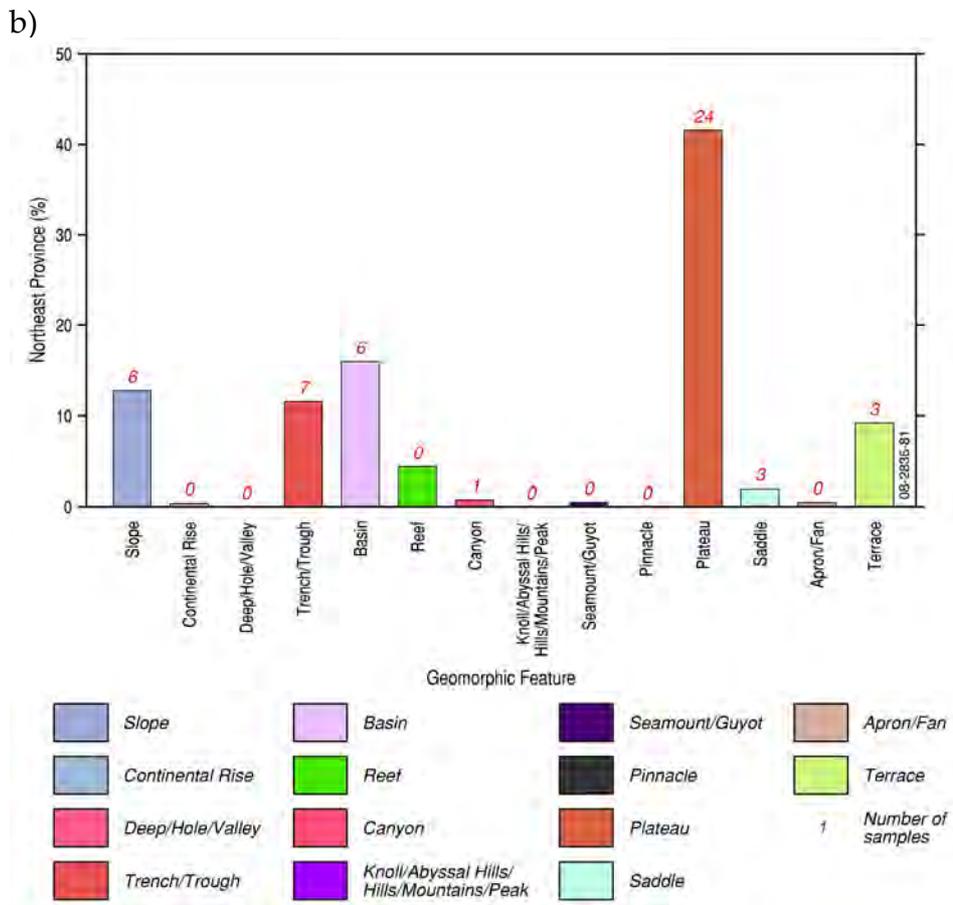


Figure 5.38. a) Geomorphology of the Northeast Province (NEP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the NEP with number of corresponding sediment samples (on top of columns).

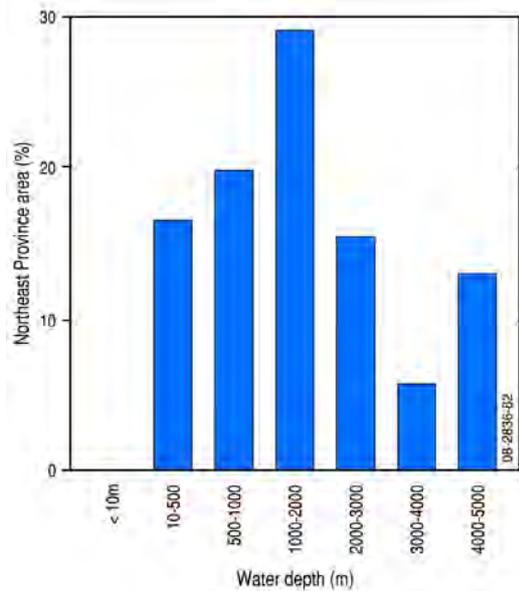


Figure 5.39. Distribution of water depth classes by percentage area within the NEP.

Table 5.18. The percentage area of geomorphic units found in the Northeast Province.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	83.20	19.07	9.25
Rise	0.58	9.65	2.42
AP/DOF	16.22	14.11	2.84
<i>Geomorphic Feature</i>			
Slope (unassigned)	14.92	33.68	4.59
Rise (unassigned)	0.52	7.52	2.29
Deep/hole/valley	0.11	2.53	0.28
Trench/trough	11.56	59.44	28.10
Basin	16.16	18.63	10.27
Reef	4.36	91.98	39.50
Canyon	0.61	26.22	2.41
Knoll/abyssal hills/mountains/peak	0.07	3.14	0.27
Seamount/guyot	0.31	3.11	1.30
Pinnacle	0.09	14.76	7.12
Plateau	41.70	17.13	11.77
Saddle	2.05	9.15	5.92
Apron/fan	0.35	56.53	12.79
Terrace	9.26	67.04	6.75

Table 5.19. The water depth of geomorphic units found in the Northeast Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	0 – 4,540	1,255
Rise	1,975 – 4,290	3,455
AP/DOF	2,540 – 4,915	4,305
<i>Geomorphic Feature</i>		
Slope (unassigned)	150 – 3,295	1,890
Rise (unassigned)	2,485 – 4,290	3,485
Deep/hole/valley	3,245 – 4,445	3,865
Trench/trough	500 – 2,905	1,590
Basin	2,540 – 4,915	4,305
Reef	30 – 1,105	130
Canyon	305 – 4,610	1,240
Knoll/abyssal hills/mountains/peak	3,020 – 4,325	3,725
Seamount/guyot	15 – 3,210	1,775
Pinnacle	40 – 2,720	755

Plateau	35 – 4,120	985
Saddle	45 – 3,500	3,455
Apron/fan	5 – 1,090	435
Terrace	50 – 4,540	1,855

5.11.3. Sedimentology of the Northeast Province

The NEP contains 49 grain size and 50 carbonate assays (Fig. 5.40). Sand content of samples ranges from 1 – 93% and decreases with increasing water depth. Mud content ranges from 0 – 99% and increases with increasing water depth. Gravel content is low throughout the entire NEP with 41 (83%) samples containing <10% gravel. Bulk carbonate content of sediments in the NEP is high, exceeding 90% in 46 (92%) samples. Carbonate content is highest adjacent to the Great Barrier Reef and reduces with distance from the reef and increasing water depth.

5.11.4. Sedimentology of Significant Geomorphic Features

5.11.4.1. Slope (unassigned)

A total of six samples with quantitative grain size and carbonate data were obtained from the slope (unassigned). Mud is the dominant sediment fraction with contents ranging from 26 - 80% and five (83%) samples containing >55% mud (Fig. 5.40). Sand is also relatively abundant and contents range from 20 - 72% and are <45% in five (83%) samples. Gravel content does not exceed 42%. Bulk carbonate content is high for all samples, ranging from 83 - 87% (Fig. 5.41). Where analysed, the carbonate content of all textural fractions is also high, ranging from 82 - 86% for mud, 95 - 96% for sand, and 100% for gravel.

5.11.4.2. Trenches/troughs

A total of seven samples with bulk carbonate assays and five samples with grain size assays were obtained from trench/troughs within the NEP. Mud is the dominant sediment fraction and ranges from 33 - 71% with three (60%) samples containing <50% mud (Fig. 5.40). Sand ranges from 28 – 65% and three (60%) samples lie between 50 – 65% sand content. Gravel formed less than 2% of sediment in all samples. Bulk carbonate content ranges from 85 - 91% in all samples (Fig. 5.41). Carbonate content is high for all textural fractions: 88 – 90% for mud, 93 – 97% for sand and 100% for gravel.

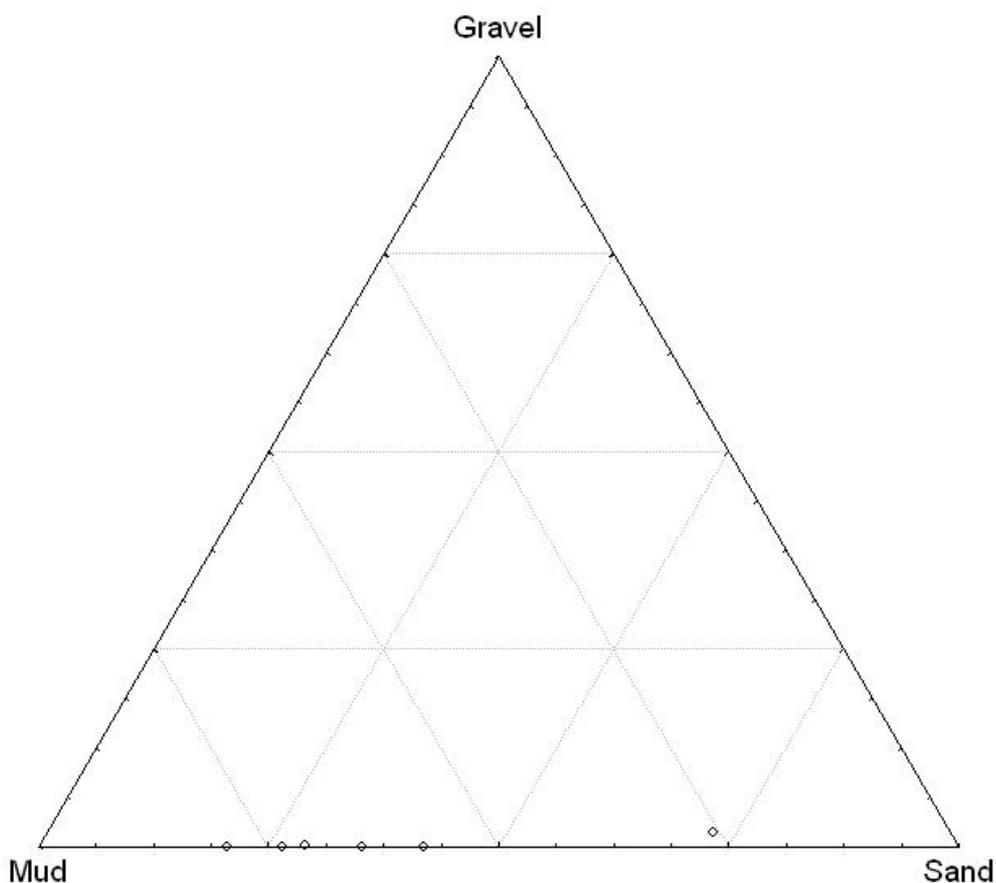
5.11.4.3. Basins

Two samples with quantitative grainsize and six samples with quantitative carbonate values are available for basins in the NEP. These two samples are dominated by a mud content of 89% and >99% and a sand content of 11% and <1% respectively. No gravel is present in either of the samples. Bulk carbonate assays are available for six samples and carbonate contents ranges from 16 - 86% and six (67%) samples contain <60% bulk carbonate (Fig. 5.41). Carbonate content of the mud fraction ranges from 58 - 89%. No carbonate analyses were performed on sand and gravel fractions.

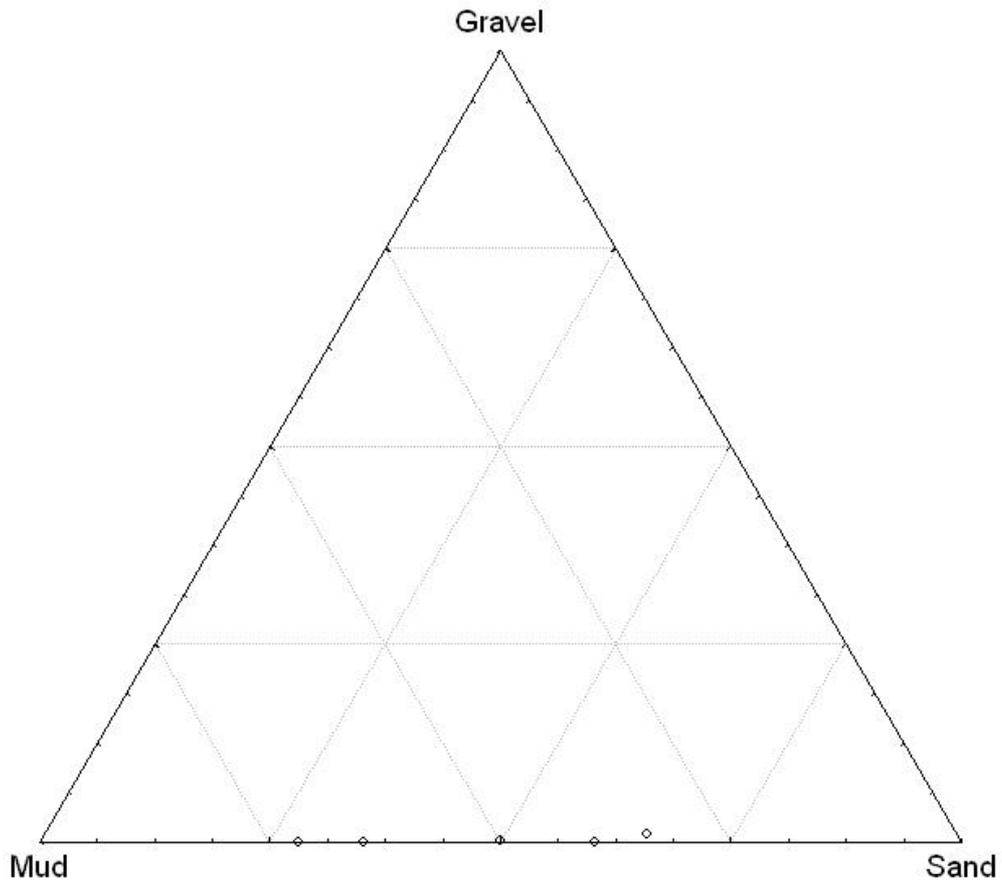
5.11.4.4. Plateau

A total of 24 samples occur on plateaus in the NEP. A total of 20 of these samples have grain size assays and 24 have bulk carbonate assays. Sand is the dominant textural fraction with contents ranging from 7 - 93% and is less than 55% in 14 (67%) samples (Fig. 5.40). Mud is the next abundant fraction with contents ranging from 6 - 93% and <75% in 18 (85%) samples. Gravel content is bimodal, being <3% in 16 (67%) samples and from 72 - 82% in three (12%) samples. Bulk carbonate content is consistently high, ranging from 84 - 97% (Fig. 5.41). Carbonate contents of all textural size fractions are high ranging from 86 – 96% for mud and 93 – 98% for sand. Where analysed, gravel was entirely composed of carbonate.

a)



b)



c)

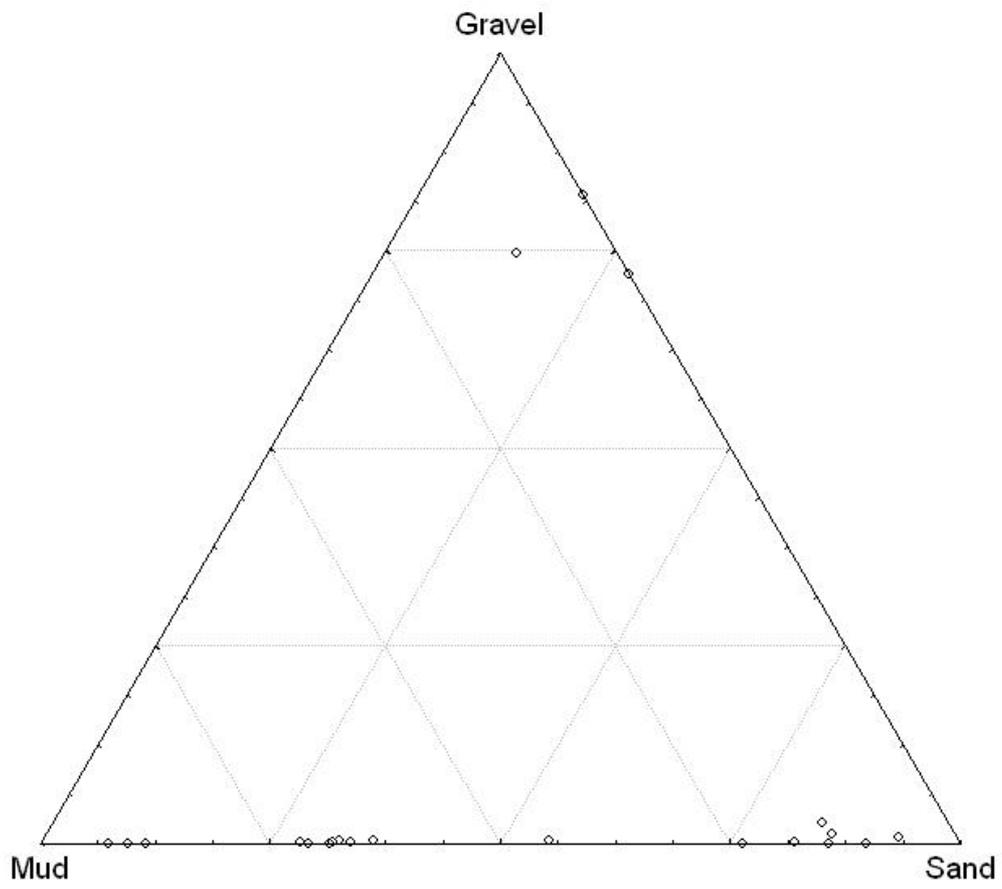


Figure 5.40. Textural composition (mud:sand:gravel ratio) of a) slope; b) trench/trough; and c) plateau sediments within the NEP.

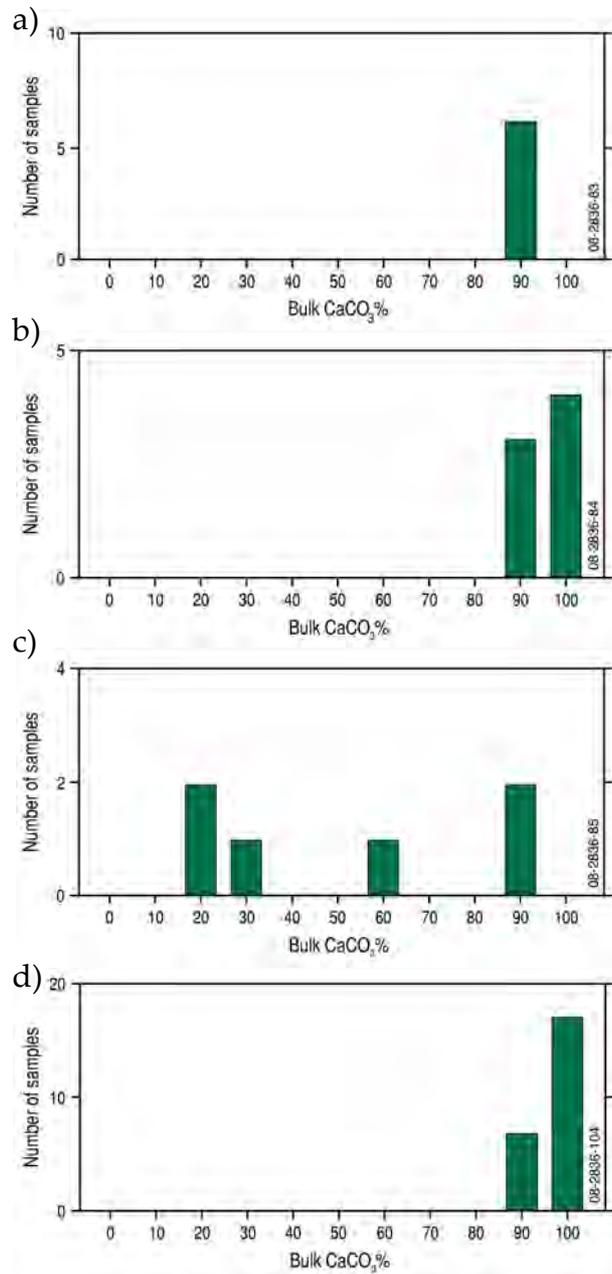


Figure 5.41. Carbonate content of a) slope; b) trench/trough; c) basin; and d) plateau sediments within the NEP.

5.12. LORD HOWE PROVINCE (LHP)

5.12.1. Geomorphology and bathymetry

The Lord Howe Province (LHP) covers an area of 484,880 km², which represents 20% of the EMR. The LHP is situated on the slope surrounding Lord Howe Island. This bioregion is separated from the NSW coast to the east by the TBP, CEP and CESP, and extends to the KT in the north and the EEZ boundary in the west.

The entire LHP occurs on the slope and contains eight geomorphic features types. These include deep/hole/valleys (410 km² or <1% of total LHP area); basin (65,100 km², 13%); knoll/abyssal hills/hills/mountains/peak (795 km², <1%); ridge (224 km², <1%); seamount/guyot (5,454 km², 1%); plateau (389,387 km², 80%); and saddle (23,467 km², 5%) (Fig. 5.42 & Table 5.20). Basin within the LHP is separated into the Lord Howe and Middleton Basins. Areas of seamount include, Gifford Guyot located to the north of the bioregion; and Middleton and Elizabeth Reefs located within the saddle in the centre of the bioregion.

Five significant features are identified for the LHP: Basins, ridges, seamount/guyots, plateaus and saddles. Plateaus cover the greatest area of any feature in the LHP. Basins cover >13% of the LHP, and this represents 18% of the area of basins in the EMR and 10% of the area of basins in the EEZ. While ridge, seamount/guyot and saddle features cover relatively small areas of the LHP (<5%), the area of these features in the LHP represents a significant proportion of the total area for each feature in the EMR. For example, ridges in LHP represent 20% of the total area of ridges in the EMR, and saddles represent 25% of the area of saddles in the EMR and 16% of the area of saddles in the EEZ.

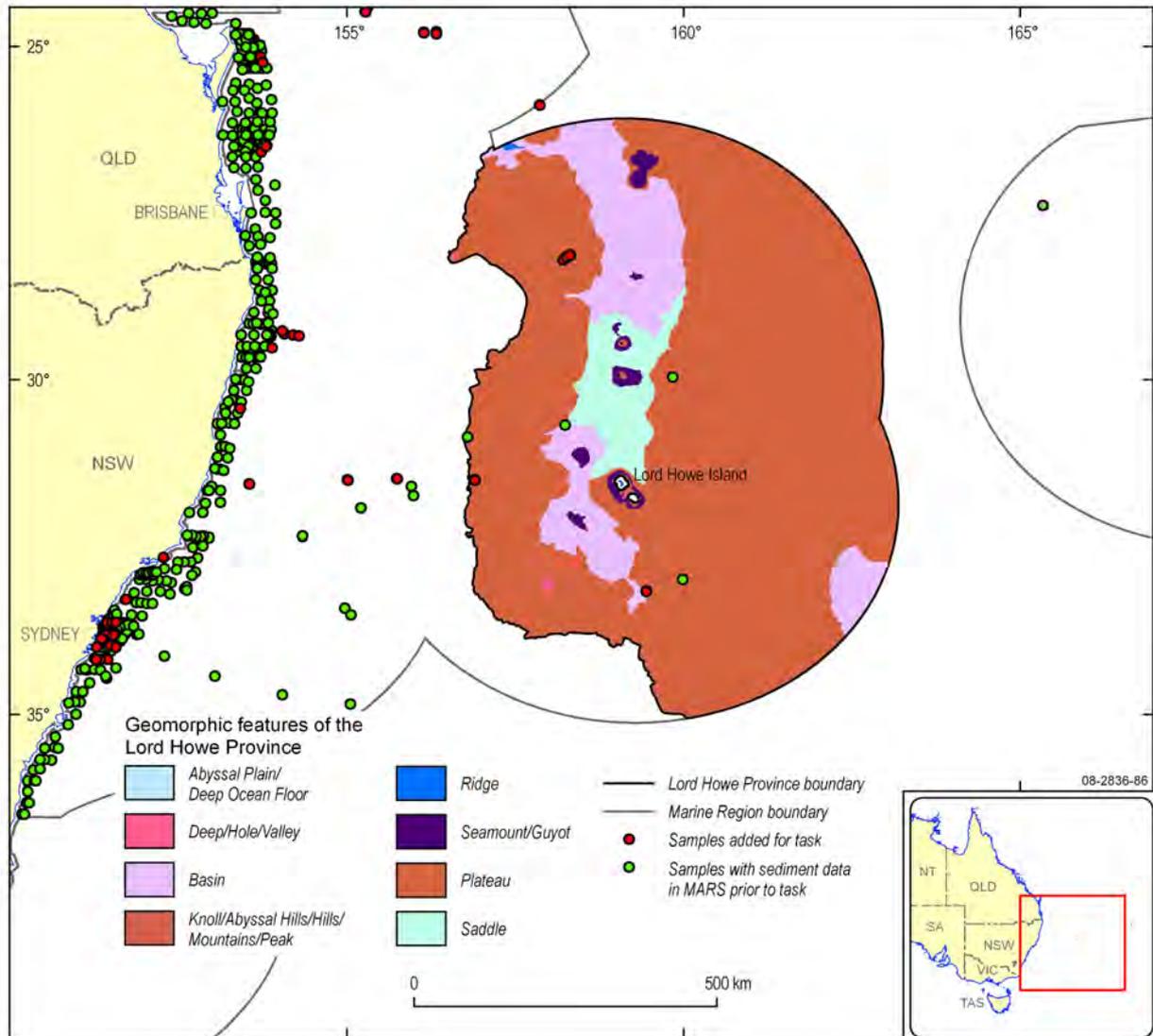
Water depths in the LHP range from 0 – 5,135 m with an average depth of 2,335 m (Fig. 5.43). Approximately 90% of the total area in the LHP occurs in water depths between 1,000 – 4,000 m (Table 5.21).

5.12.2. Sample Coverage

The LHP contains nine samples with quantitative textural and/or compositional data, resulting in an average sample density of 1:53,875 km². Five of these samples were procured and analysed for this task, significantly improving data coverage in the region.

All samples in the LHP are located on the Lord Howe Rise in water depths of 1,660 – 4,500 m. Samples achieve sufficient coverage to assess the sedimentology of plateau features within the LHP. Despite targeted sample addition, no samples were procured for other significant geomorphic features.

a)



b)

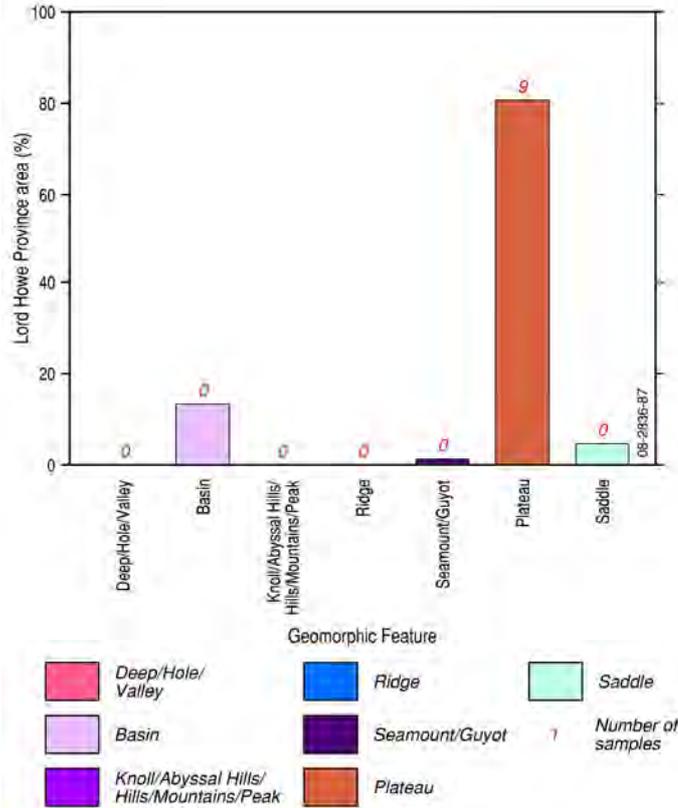


Figure 5.42. a) Geomorphology of the Lord Howe Province (LHP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the LHP with number of corresponding sediment samples (on top of columns).

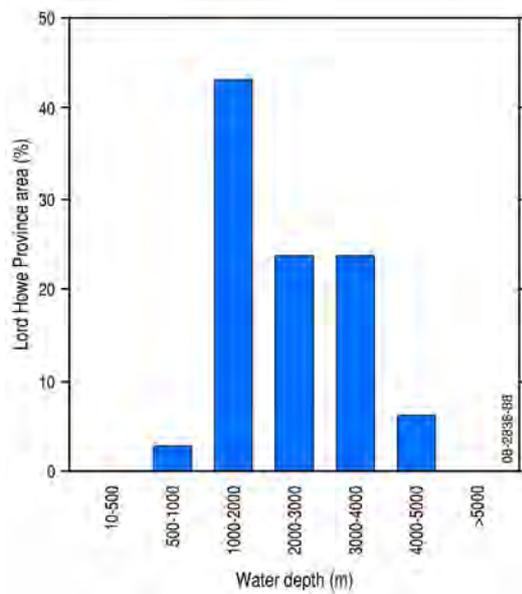


Figure 5.43. Distribution of water depth classes by percentage area within the LHP.

Table 5.20. The percentage area of geomorphic units found in the Lord Howe Province.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	100	26.30	12.77
<i>Geomorphic Feature</i>			
Deep/hole/valley	0.08	2.18	0.24
Basin	13.41	17.77	9.80
Knoll/abyssal hills/mountains/peak	0.16	8.21	1.09
Ridge	0.05	20.25	0.20
Seamount/guyot	1.13	12.95	5.42
Plateau	80.31	37.88	26.02
Saddle	4.84	24.80	16.02

Table 5.21. The water depth of geomorphic units found in the Lord Howe Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	0 – 5,140	2,335
<i>Geomorphic Feature</i>		
Deep/hole/valley	450 – 4,015	2,570
Basin	260 – 4,750	3,245
Knoll/abyssal hills/mountains/peak	0 – 4,480	570
Ridge	2,750 – 3,980	3,215
Seamount/guyot	75 – 4,070	1,890
Plateau	805 – 5,140	2,170
Saddle	335 – 3,875	2,760

5.12.3. Sedimentology of the Lord Howe Province

A total of five grain size and nine carbonate assays are available for the LHP. LHP sediments are dominated by mud, and become finer with increasing water depth. Mud content ranges from 66 - 98% and exceeds 70% in three (60%) samples. Sand content ranges from 2 - 34%, and exceeds 20% in five (83%) samples. No gravel was detected in any samples from the LHP.

Bulk carbonate content ranges from 31 – 86% and exceeds 50% in 8 (89%) samples. Carbonate content of mud ranges from 34 - 83%. One carbonate sand assay is available and this equals 92%.

5.12.4. Sedimentology of significant geomorphic features

5.12.4.1. Plateau

A total of nine samples were obtained from plateaus. Five have grain size data and nine have bulk carbonate data. Mud is the dominant fraction with contents ranging from 65 – 98% (Fig. 5.44). Sand is the next most abundant fraction with contents ranging from 1 - 34%. Gravel was not present in any of the samples. Bulk carbonate content ranges from 31 - 86% and seven (78%) samples contain >60% carbonate content (Fig. 5.45). Carbonate content of mud was analysed for 5 samples and ranges from 34 - 83%. Carbonate content of sand was 92% in the one sample analysed.

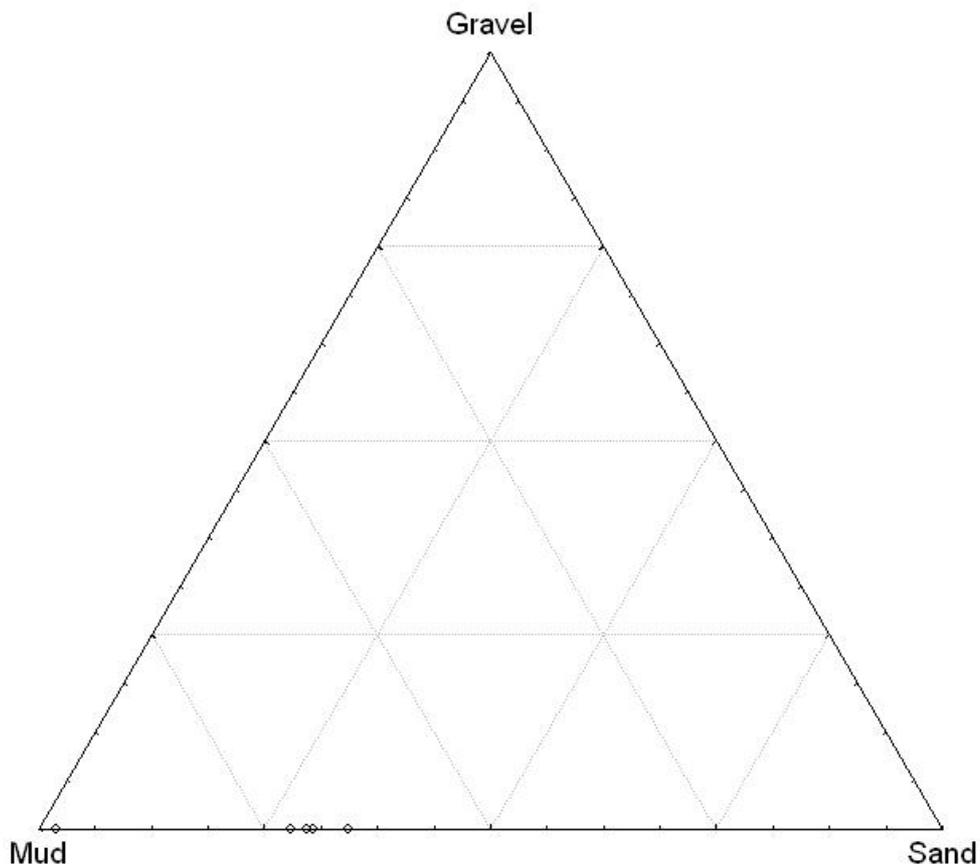


Figure 5.44. Textural composition (mud:sand:gravel ratio) of plateau sediments within the LHP.

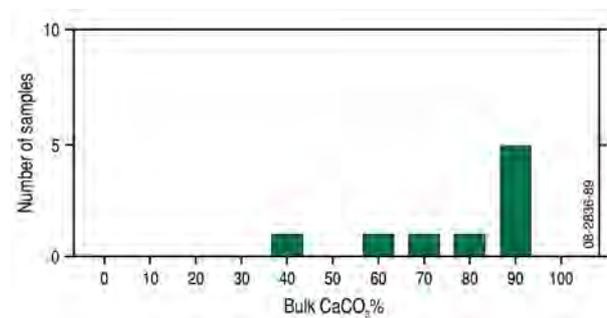


Figure 5.45. Carbonate content of plateau sediments within the LHP.

5.13. NORTHEAST TRANSITION (NET)

5.13.1. Geomorphology and bathymetry

The Northeast Transition (NET) covers an area of 132,490 km² which represents 5% of the EMR. The NET is located off the shelf between Cape Sydmouth and Cardwell and is bound north by the CP, to the south by the CEP, and to the east by the EEZ boundary.

More than 99,830 km² or 75% of the NET is located on the slope with a small area of rise (12,990 km², 10 %) and contains a complex geomorphology. Geomorphic features covering significant areas of the slope include, trench/trough (15,580 km², 12%); basin (19,680 km², 15%); and plateau (82,260 km², 62%) (Fig. 5.46. & Table 5.22). Geomorphic features covering minor areas (<1%) of the bioregion include, apron/fans (790 km²); canyons (750 km²); reefs (570 km²) and ridges (440 km²) (Fig. 5.46. & Table 5.22). No features are identified on 11,970 km² (12%) of the slope and 10,600 km² (82%) of the rise.

The rise in the NET separates the plateau from the adjacent Coral Sea Basin and is cut by a series of ridges and canyons. A large trench/trough, the Queensland Trough occurs in the west of the bioregion and extends south east offshore to Cairns. Reefs in the NET include the Osprey Reef, located on the plateau and surrounded by apron/fans.

Six significant geomorphic features are identified for the NET: rise (unassigned), trench/trough, deepwater basins, pinnacles, plateaus, apron/fans, and ridges. The NET contains the largest area of rise of any bioregion in the EMR and represents 41% of the total area of rise in the EMR and 13% of rise in the EMR. Apron/fan, ridge and trench/trough features in the NET represent 30%, 40% and 19% respectively and are significant due to the total area these features represent in the EMR. Rise, deepwater basins, pinnacles, canyons, reefs and plateaus represent <10% of area in each feature in the EMR

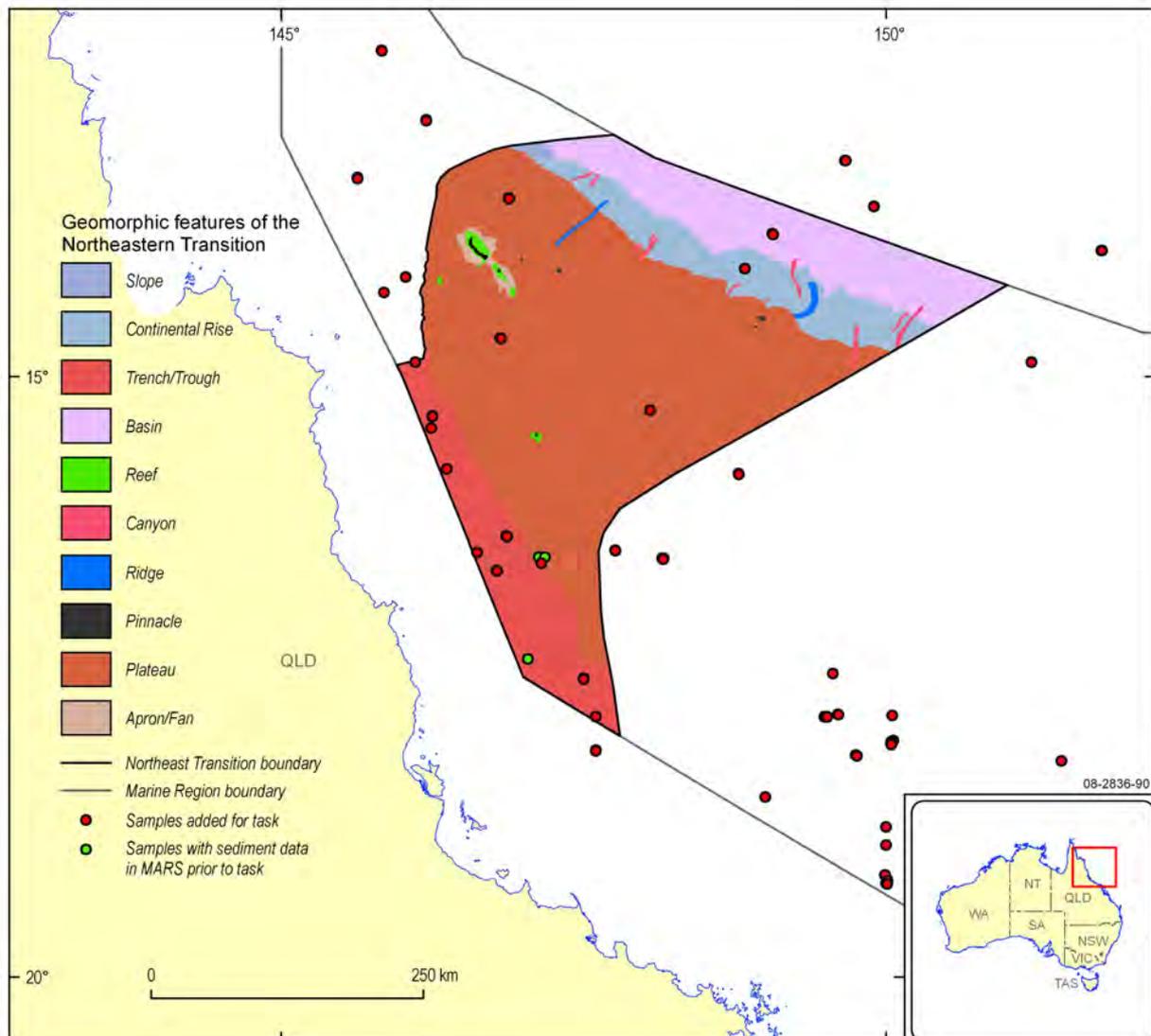
Water depths in the NET range from 0 – 4,230 m water depth, with an average depth of 2,275 m (Table 5.23). More than 99% of the total area of the NET occurs in water depths >1,000 m, and 55% occurs in depths of 1,000 – 2,000 m (Fig. 5.47). Reefs occur in shallower areas of the bioregion (average depth 595 m) and basins form the deepest areas of the region (average 4,415 m).

5.13.2. Sample Coverage

The NET contains 18 samples with either quantitative grain size and/or carbonate data. Sixteen of these were procured and analysed for the task, resulting in significant improvement in data coverage. The average sample density in the NET is 1:7,360 km². Due to the small sample volumes provided by external institutions, only 6 of the new samples were sieved for weight % mud/sand/gravel. Six of these samples are located on the plateau and 10 are located on trench/trough. One sample is situated on the rise and basin. Of the samples that have grain size data, one (13%) sample is located on the plateau and seven (88%) samples are located on trench/troughs. These samples achieve sufficient coverage to assess the sedimentology in two of the six significant features: trench/troughs and

plateaus. Sample coverage is inadequate to assess sedimentology of the rise (unassigned), deepwater basins, pinnacles, apron/fans, and ridges.

a)



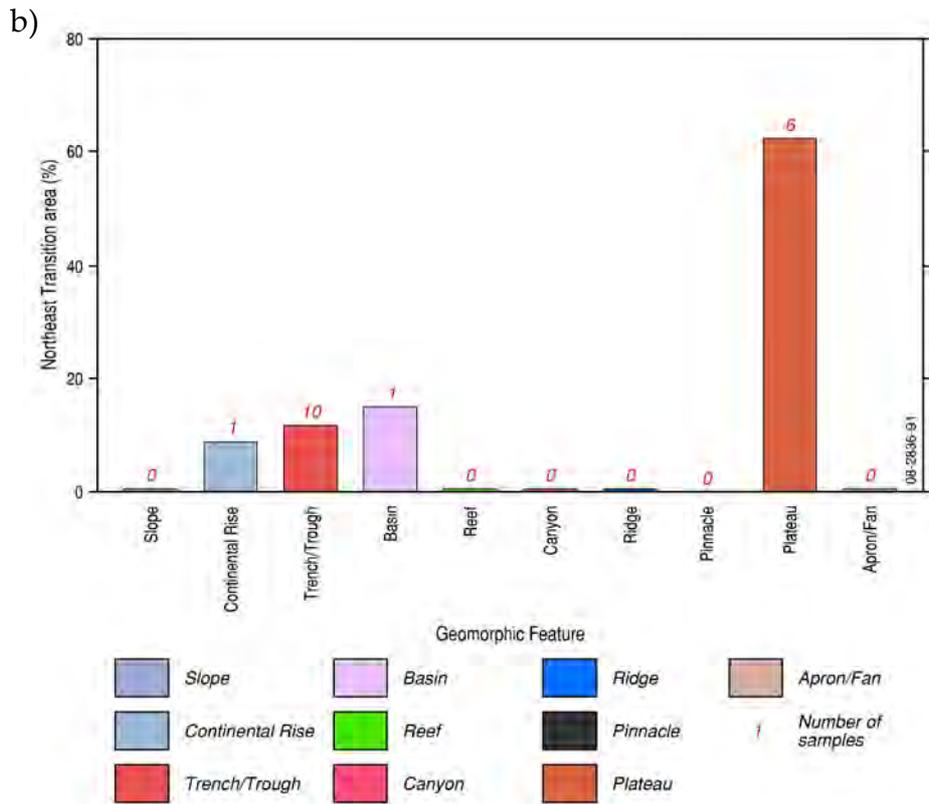


Figure 5.46. a) Geomorphology of the Northeast Transition (NET) with location of sediment samples; and b) Percentage area of each geomorphic feature within the NET with number of corresponding sediment samples (on top of columns).

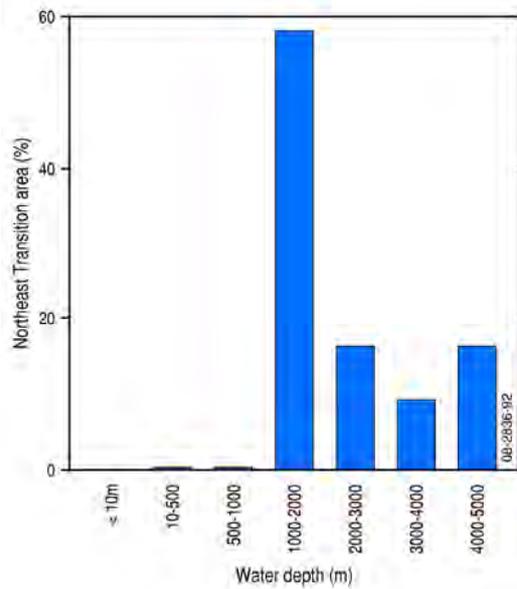


Figure 5.47. Distribution of water depth classes by percentage area within the NET.

Table 5.22. The percentage area of geomorphic units found in the Northeast Transition.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	75.35	5.42	2.63
Rise	9.80	51.28	12.86
AP/DOF*	14.86	4.05	0.82
<i>Geomorphic Feature</i>			
Slope (unassigned)	0.29	0.17	0.03
Rise (unassigned)	9.04	41.03	12.50
Trench/trough	11.76	18.96	8.96
Basin	14.86	5.37	2.96
Reef	0.43	2.87	1.23
Canyon	0.57	7.65	0.70
Ridge	0.33	39.67	0.39
Pinnacle	0.04	2.38	1.15
Plateau	62.10	8.00	5.50
Apron/fan	0.59	29.71	6.72

Table 5.23. The water depth of geomorphic units found in the Northeast Transition.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	0 – 4,030	1,670
Rise	1,925 – 4,665	3,655
AP/DOF	3,740 – 4,830	4,420
<i>Geomorphic Feature</i>		
Slope (unassigned)	2,875 – 4,030	3,400
Rise (unassigned)	2,785 – 4,410	3,660
Trench/trough	1,135 – 2,560	1,680
Basin	3,740 – 4,835	4,420
Reef	0 – 2,295	595
Canyon	1,925 – 4,665	3,630
Ridge	1,670 – 4,065	3,090
Pinnacle	1,490 – 2,905	2,110
Plateau	190 – 3,510	1,670
Apron/fan	420 – 2,585	1,505

5.13.3. Sedimentology the Northeast Transition

A total of 16 mean grain size, 8 weight % of textural fraction and 18 carbonate assays occur in the NET. Mud is the dominant textural fraction with contents ranging from 15 – 97% with five out of eight samples attaining >84%. Sand contents range from 2 – 85% with a majority (62%) samples attaining

<16%. Gravel forms <1% of all samples. Samples with the highest mud contents occur in trench/trough features.

Carbonate content exceeds 50% in 15 (83%) samples, and exceed 80% in 5 (28%) samples. Three samples contain carbonate ranging from 21 - 37%. Samples with carbonate contents of <80% occur on the abyssal plain/deep ocean floor and rise. Where analysed, the carbonate content of mud consistently exceeds 50% with three (38%) samples attaining >75%. The carbonate content of sand is more variable, ranging from 28 to 95%. Where present, gravel is entirely composed of carbonate.

5.13.4. Sedimentology of significant geomorphic features

5.13.4.1. Trench/Trough

Ten samples were collected from trench/troughs in the NEP. Mud is the dominant textural fraction with contents ranging from 21 - 97% with five out of seven samples (71%) attaining >84%. (Fig. 5.48). Sand is the next most abundant fraction, ranging from 3 - 78% with six out of seven samples (86%) attaining <35%. Gravel content is <1% in all samples. Bulk carbonate content data is available for all ten samples and ranges from 37 - 94% and exceeds 50% in 90% of samples (Fig. 5.49).

5.13.4.2. Plateau

Six samples were obtained from plateaus. Due to small sample volumes, weight % data for textural fractions was only generated for one sample. This sample is composed of 14% mud, 86% sand and <1% gravel. Mud in this sample is composed of 91% carbonate, sand 95%, and gravel 100%. Bulk carbonate data is available for all six samples and ranges from 29 - 91% and exceeds 75% in four (67%) samples (Fig. 5.49).

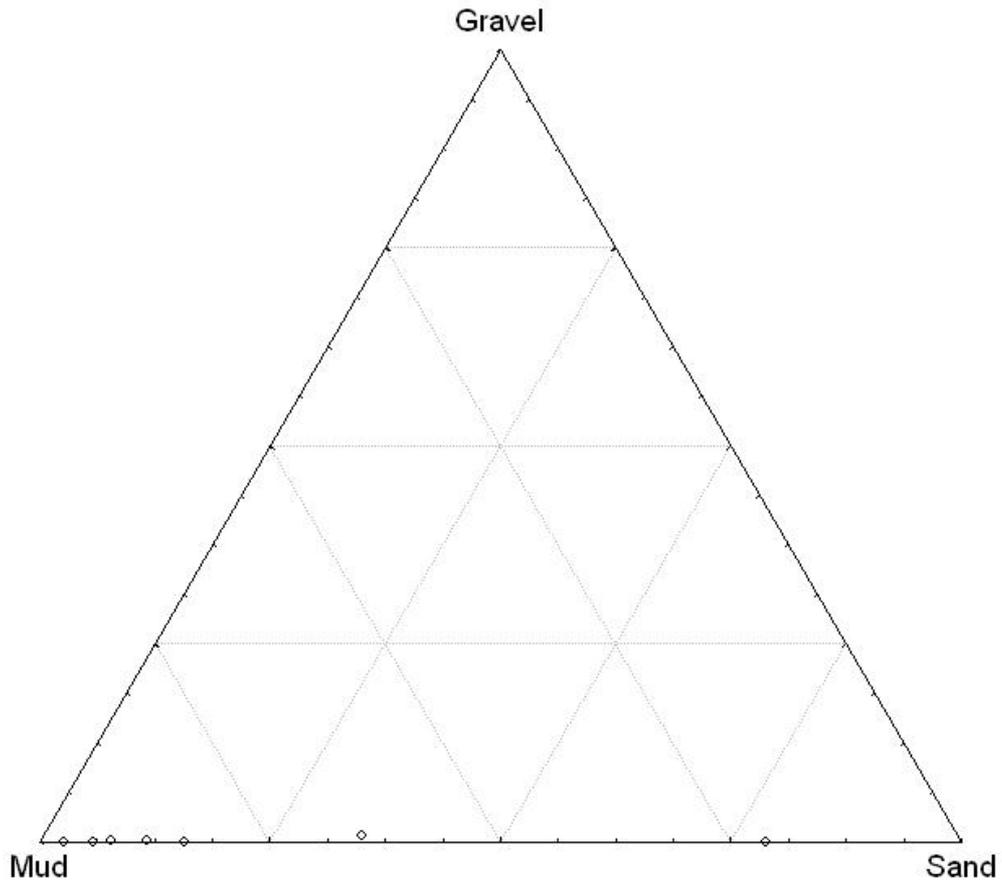


Figure 5.48. Textural composition (mud:sand:gravel ratio) of trench/trough sediments within the NET.

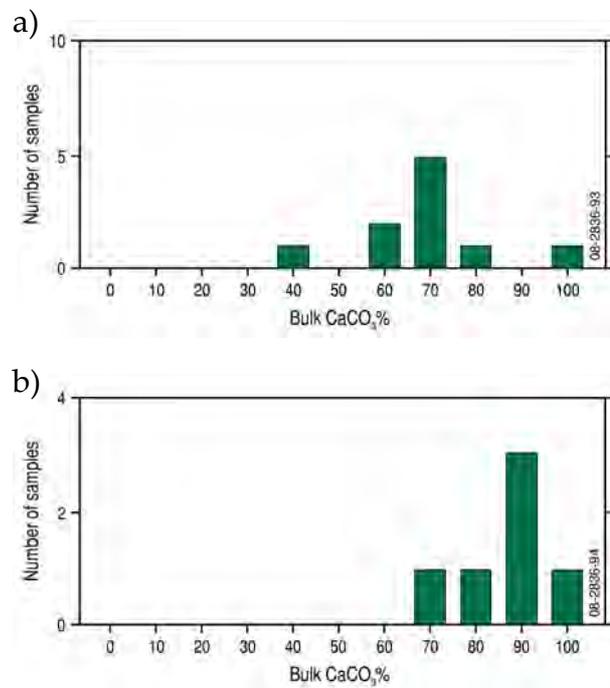


Figure 5.49. Carbonate content of a) trench/trough and b) plateau sediments within the NET.

5.14. SOUTHEAST TRANSITION (SET)

5.14.1. Geomorphology and bathymetry

The SET covers a total area of 241,910 km² of which 8,800 km² (4%) is located within the EMR. The SET represents <1% of the total area of the EMR. The SET is located on the offshore between Ulladulla and Bermagui. In the EMR, the SET is bounded to the northeast by the CEP to the west by the CEST, and to the south and southeast by the EMR boundary.

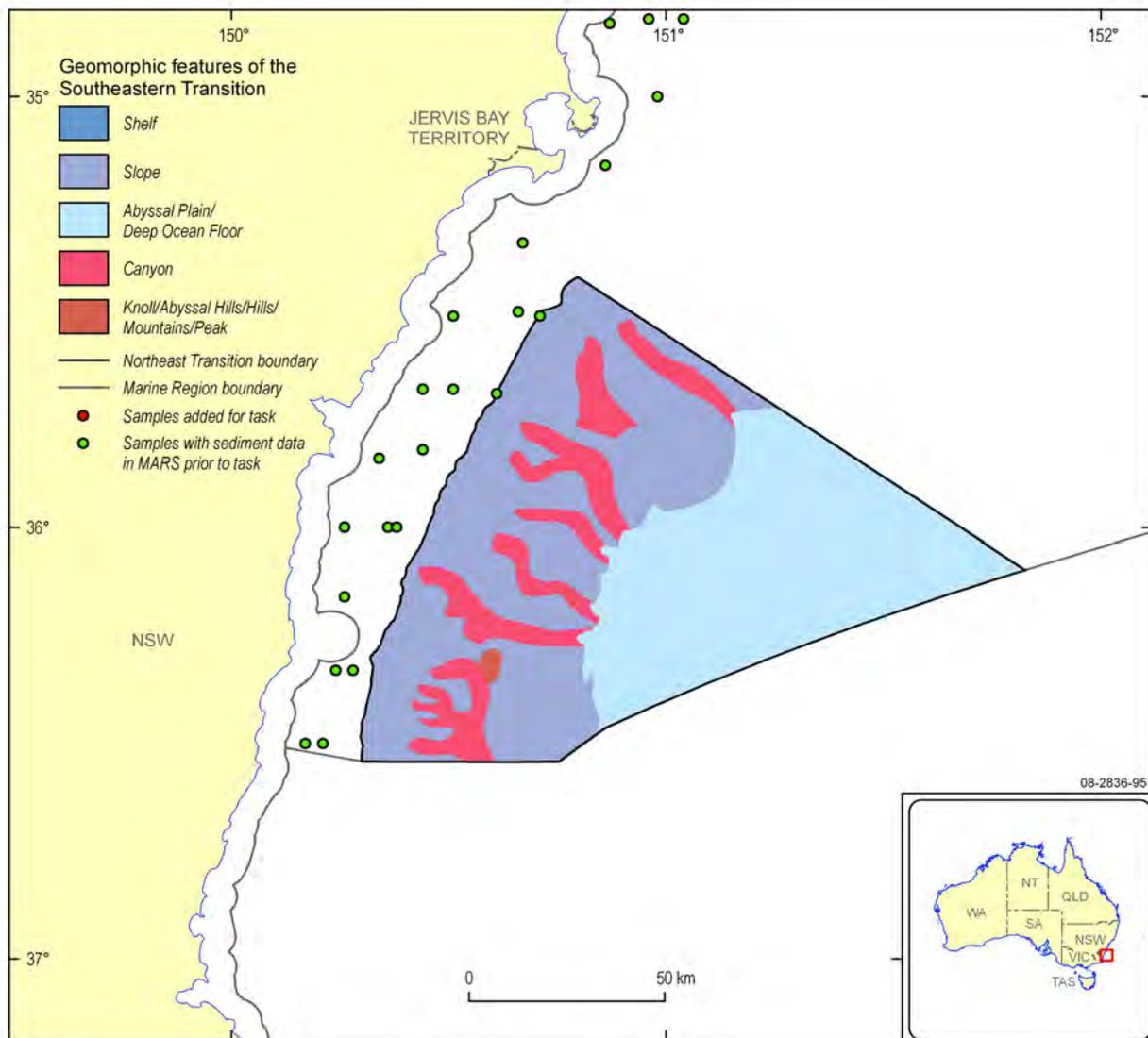
The area of the SET in the EMR occurs on the slope (5,190 km², 59%) and abyssal plain/deep ocean floor (3,595 km², 41%). Two geomorphic features are identified within the area of the slope: canyons (1,255 km², 14%); and knoll/abyssal hills/hills/mountains/peak in the south of the region (30 km², >1%) (Fig. 5.50. & Table 5.24). No geomorphic features were identified on 3,910 km² (75%) of the slope. No features occur on the abyssal plain/deep ocean floor.

Water depths in the area of the SET included in the EMR range from 125 m near the shelf break to 5,265 m on the abyssal plain/deep ocean floor with an average depth of 3,485 m (Table 5.25). More than 82% of the region lies in water depths >2,000 m (Fig. 5.51). Canyons occur in water depths from 405 – 4,845 with an average depth of 2,980 m. Knoll/abyssal hills/hills/mountains/peaks occur in water depths of 1,595 – 2,490 with an average depth of 4,810 m.

5.14.2. Sample Coverage

The area of the SET within the EMR contains no textural and/or compositional data. Although this bioregion was identified as a significant data gap, no samples were available for this area either at GA or from external repositories.

a)



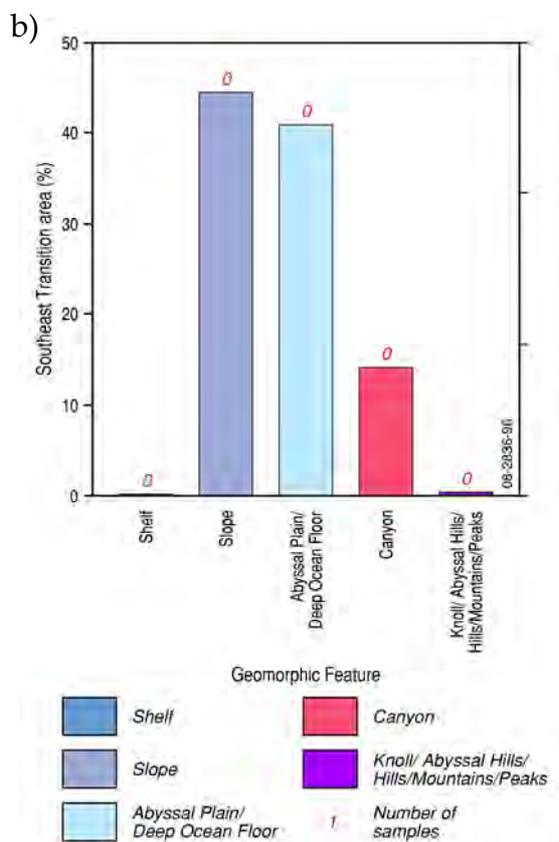


Figure 5.50. a) Geomorphology of the Southeast Transition (SET) with location of sediment samples; and b) Percentage area of each geomorphic feature within the SET with number of corresponding sediment samples (on top of columns).

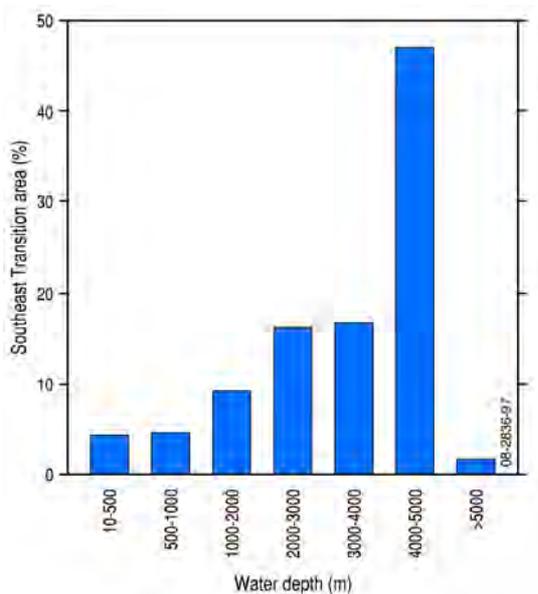


Figure 5.51. Distribution of water depth classes by percentage area within the SET.

Table 5.24. The percentage area of geomorphic units found in the Southeast Transition.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
Slope	59.03	0.28	0.14
AP/DOF	40.85	0.74	0.15
<i>Geomorphic Feature</i>			
Slope (unassigned)	44.44	1.76	0.28
AP/DOF (unassigned)	40.85	0.97	0.15
Canyon	14.25	12.76	1.17
Knoll/abyssal hills/hills/mountains/peak	0.34	0.31	0.03

Table 5.25. The water depth of geomorphic units found in the Southeast Transition.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	140 – 5,270	2,505
AP/DOF	4,170 – 5,270	4,810
<i>Geomorphic Feature</i>		
Slope (unassigned)	140 – 5,270	2,360
AP/DOF (unassigned)	4,170 – 5,270	4,810
Canyon	405 – 4,845	2,980
Knoll/abyssal hills/hills/mountains/peak	1,595 – 2,490	1,880

5.15. TASMAN BASIN PROVINCE (TBP)

5.15.1. Geomorphology and bathymetry

The TBP covers 156,420 km² which represents 6% of the total area of the EMR. The TBP is located on abyssal plain/deep ocean floor offshore between North Stradbroke Island and Sussex Inlet, and comprises seabed from the abyssal plain of the Tasman Basin to Dampier Ridge (located in the LHP). It includes the Tasman Basin and the Tasmantid Seamount Chain, a chain of volcanic seamounts. The seamounts are flat topped and include the Brisbane Guyot, Queensland Guyot, the Britannia Guyots, Stradbroke Seamount, Derwent-Hunter Guyot, Barcoo Bank and Taupo Bank. The TBP is bounded to the east by the LHP, to the east by the CEP and CEST, and to the north by the KT.

More than 136,090 km² or 87% of the TBP occurs on the abyssal plain/deep ocean floor. Within this area, three geomorphic features are identified: knolls/abyssal hills/hills/mountains/peaks (1,120 km², 1%); seamounts/guyots (18,480 km², 12%); and pinnacles (210 km², <1%) (Fig. 5.52). No geomorphic features are identified on 136,610 km² (87%) of the abyssal plain/ deep ocean floor. All geomorphic features that occur in the TBP are considered significant due to the unique features positioned adjacent to the western edge of the province and the relatively large percentage (>10% with the

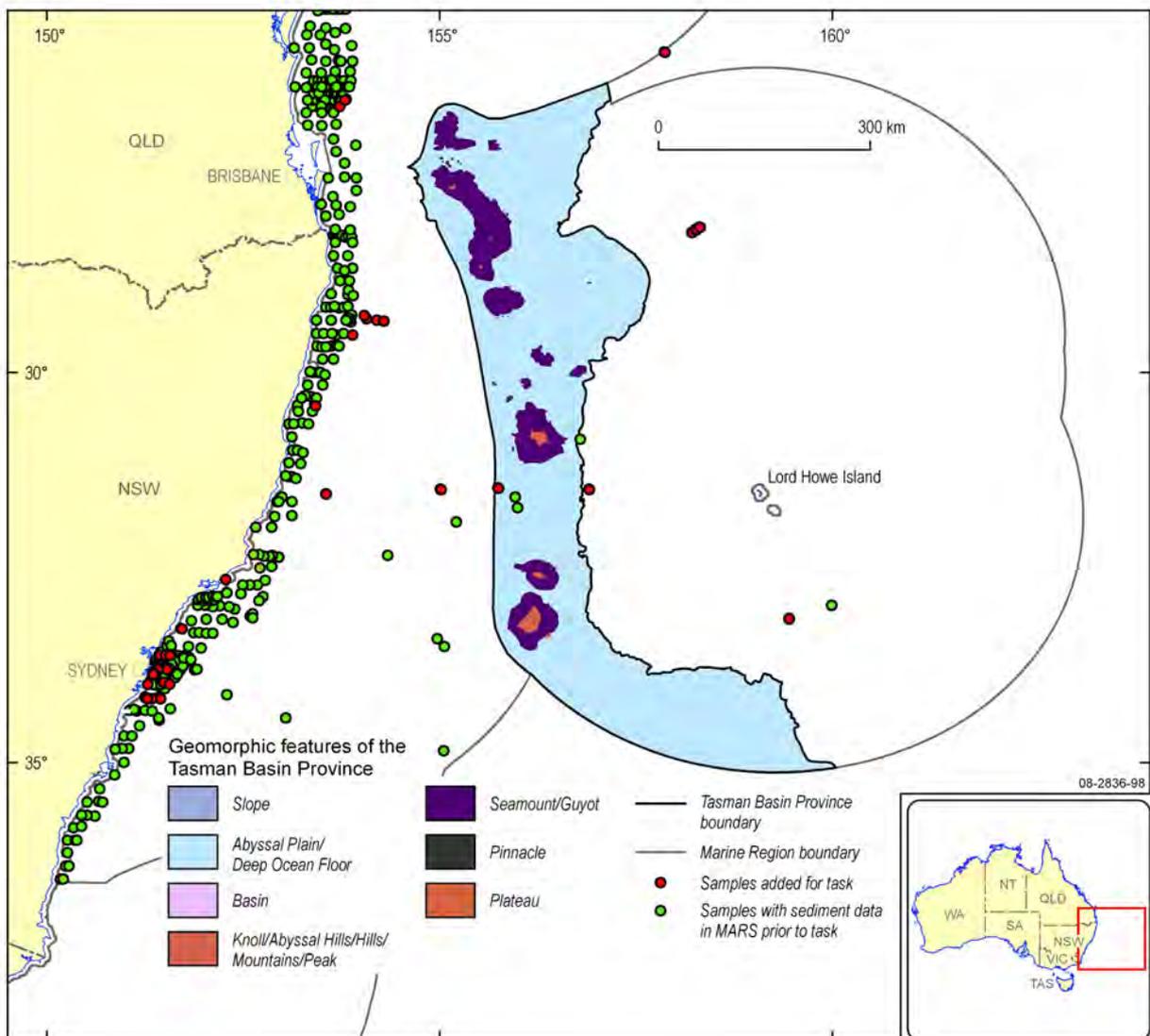
exception of pinnacles which occupy 8% of the total area of pinnacles in the EMR) of area of each feature within the EMR (Table 5.26).

Water depths in the area of the TBP included in the EMR range from 125 m to 5,180 m on the abyssal plain/deep ocean floor with an average depth of 4,670 m (Table 5.27). More than 83% of the region lies in water depths >4,000 m (Fig. 5.53).

5.15.2. Sample Coverage

The TBP contains three samples with quantitative grain size and/or carbonate data. All three of the samples occur on the abyssal plain/deep ocean floor (unassigned) in water depths >4,700 m. The average sample density in the TBP is 1:7,800 km², and samples do not achieve sufficient coverage to describe sedimentology of individual feature types. Despite targeted sample selection, only one sample from the TBP was procured and analysed for this task, and no other samples were found to be available at GA or in external repositories.

a)



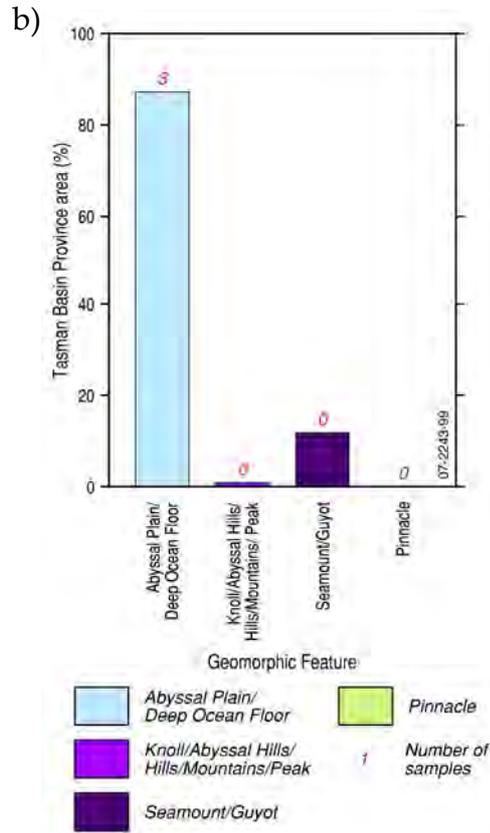


Figure 5.52. a) Geomorphology of the Tasman Basin Province (TBP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the TBP with number of corresponding sediment samples (on top of columns).

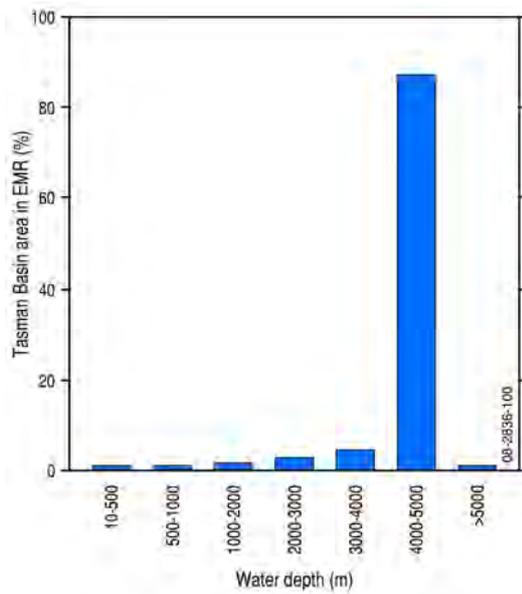


Figure 5.53. Distribution of water depth classes by percentage area within the TBP.

Table 5.26. The percentage area of geomorphic units found in the Tasman Basin Province.

Feature	% of bioregion area covered	% of EMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
<i>Geomorphic Province</i>			
AP/DOF*	100	32.21	6.49
<i>Geomorphic Feature</i>			
AP/DOF (unassigned)	87.34	36.91	5.54
Knoll/abyssal hills/hills/mountains/peak	0.71	11.53	0.94
Seamount/guyot	11.81	43.86	18.36
Pinnacle	0.13	8.41	4.05

Table 5.27. The water depth of geomorphic units found in the Tasman Basin Province.

Feature	Depth Range (m)	Mean Depth (m)
<i>Geomorphic Province</i>		
Slope	4,005 – 5,105	4,600
AP/DOF	125 – 5,180	4,425
<i>Geomorphic Feature</i>		
Slope (unassigned)	4,590 – 4,765	4,690
AP/DOF (unassigned)	1,585 – 5,180	4,670
Basin	4,560 – 4,750	4,660
Knoll/abyssal hills/hills/mountains/peak	125 – 3,975	395
Seamount/guyot	200 – 5,150	2,835
Pinnacle	3,300 – 5,055	4,640
Plateau	4,005 – 5,105	4,595

5.15.3. Sedimentology of the Tasman Basin Province

One grain size and three bulk carbonate assays are available for the TBP. The sample with grainsize data occurs on the abyssal plain/deep ocean floor (unassigned) and comprises >99% mud with the remainder of sediment composed of sand. Carbonate content of the mud in this sample is 51%. Sediments in this sample are similar to those found at >4000 m depths in the adjacent LHP. Bulk carbonate contents for all samples range from 24 – 55% (Fig. 5.54).

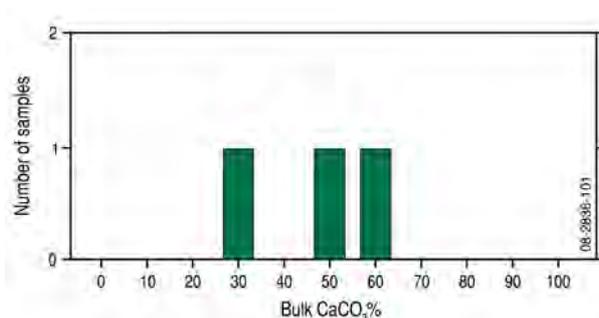


Figure 5.54. Carbonate content of abyssal plain/deep ocean floor sediments within the TBP.