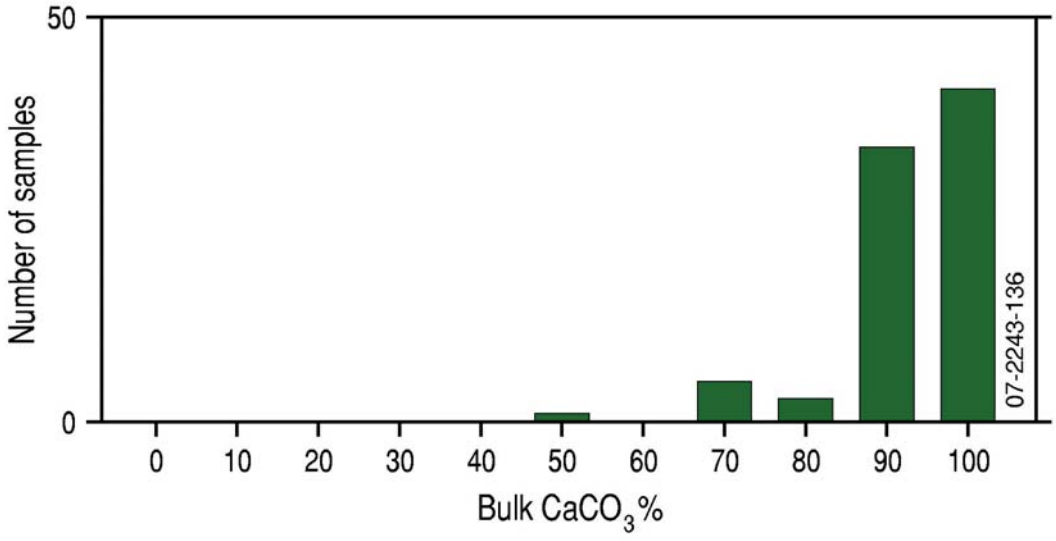


f)

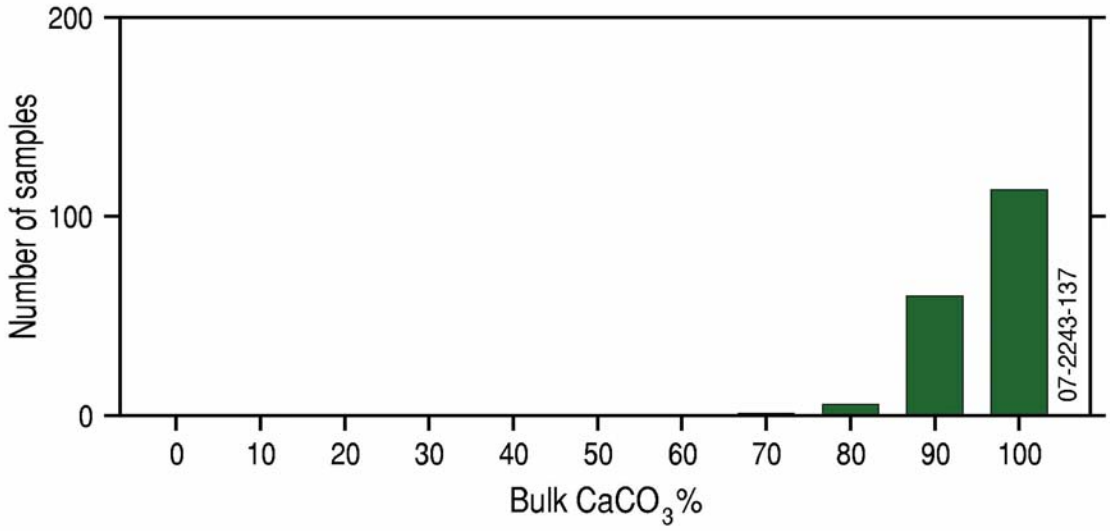


Figure 5.15. Carbonate content of a) bank/shoal; b) deep/hole/valley; c) plateau; d) ridge; e) shallow water terrace; and f) shelf/slope sediments within the NWSP.

5.5. NORTHWEST SHELF TRANSITION (NWST)

5.5.1. Geomorphology and bathymetry

The Northwest Shelf Transition (NWST) covers a total area of 308,450 km² of which 136,660 km² (56%) is situated in the NWMR and the remainder is found in in the North Marine Region (Fig 5.1). This bioregion represents 13% of the total area of the NWMR (Table 5.1).

The NWST extends from Cape Leveque to the eastern end of Melville Island. The NWMR boundary divides the bioregion through the centre of the Joseph Bonaparte Gulf (Fig. 5.1). The entire NWST is located on the shelf except for a single deeps/holes/valleys feature that extends onto the slope (this is an extension of the same feature that occurs in the NWSP) (Fig. 5.16a; Table 5.8). The offshore boundaries of NWST are complex. In the NWMR, it abuts the NWSP, Timor Province, and the unallocated area of the EEZ. The NWST extends > 300 km across the shelf from the inner boundary of the NWMR.

In the area of the NWST included in the NWMR, water depths vary from 0 to approximately 330 m (Fig. 5.17a; Table 5.9). This represents the full range of water depths that exist in the NWST. Within the NWMR, approximately 75% of the area of the NWST occurs at depths between 10 and 100 m. Less than 1% of the area occurs at depths of >150 m. The area of the NWST outside of the NWMR displays a similar bathymetric profile. Within the NWMR, approximately 14,000 km² (8%) occurs in water depths of <10 m and has been excluded from this study. This area lies mainly along the inner boundary of the NWMR, particularly in the Joseph Bonaparte Gulf (Fig. 5.16a).

The NWST comprises 10 geomorphic feature types, all of which are represented in the area located in the NWMR. Shelf (unassigned) forms 15% (19,940 km²) of the area of the NWST within the NWMR but dominates area of the NWST outside of the NWMR. The remaining area within NWMR is composed of terraces (42,510 km², 31% bioregion area in NWMR) followed by banks/shoals (26,430 km², 19%), basins (19,740 km, 14%), plateaus (14,030 km², 10%), deeps/holes/valleys (8,150 km², 6%) and sills (3,720 km², 3%). Tidal sand-wave/sandbanks and reefs total <1,720 km² (<2%) and occur locally. Pinnacles are abundant in the NWST although they cover <1% of the bioregion area (Fig. 5.16b; Table 5.8).

A total of eight significant features occur in the NWST. The large number of significant features selected for this bioregion reflects the relative complexity of the seabed and observations that sedimentology of this region differs from elsewhere in the NWMR. Features are likely to contain seabed environments not found elsewhere in the NWMR.

On the Sahul Shelf, large terraces occur in water depths of <300 m (Table 5.9), and deeps/holes/valleys cover significant areas and distinguish the seabed for this bioregion from that occurring in adjacent bioregions. Banks/shoals in the NWST form more than 90% of the total area of this feature in the NWMR. Basins in the NWST, including the Bonaparte Depression, are the only basins in the NWMR. They contain higher mud and gravel contents than sediments found elsewhere on the shelf in the NWMR (Chapter 4). Deeps/holes/valleys in the NWST, and particularly within the Bonaparte Depression, contain sediments differing from sediments found in these features elsewhere in the NWMR. The Londonderry Rise, a large elongate plateau, is considered significant as it covers a large area of the NWST. Its narrow morphology, bathymetric range (10 to 190 m) and spatial relationship to a range of other features make it unique within the NWMR. Tidal sand wave/sandbanks in the NWST form 100% of the area of these features occurring in the NWMR and >5% of the area of these features in the EEZ, and they are likely to contain sediments differing from sediments found in these features elsewhere in the EEZ. The area of tidal sand wave/sandbanks analysed for this study form approximately 50% of a larger occurrence of these features in the south of the Bonaparte Gulf; the remaining area of these features occurs in water depths <10 m. Pinnacles are abundant, particularly in the north east of the bioregion. These comprise 61% of the area of pinnacles in the NWMR and 8% of the area of this feature in the EEZ.

5.5.2. Sample Coverage

The area of the NWST located in the NWMR is represented by 208 samples. These occur mainly in NW – SE transects extending from the coast inside the Joseph Bonaparte Depression to the EEZ boundary and in clusters on the mid-shelf near the eastern boundary of the bioregion. Few

samples occur on the inner shelf south of Cape Londonderry (Figs. 5.16a).

Average sample density across the assessed area of the bioregion is approximately 1:650 km². Samples achieve sufficient coverage to describe the sediment distribution in all six of the significant geomorphic features identified for this bioregion. A total of 42 samples were collected from the Sahul Shelf; this gives an average density of approximately 1:470 km². However, the uneven distribution of samples means that results are likely to only represent sediments present in the Joseph Bonaparte Depression and likely give no indication of sediments occurring south of Cape Londonderry.

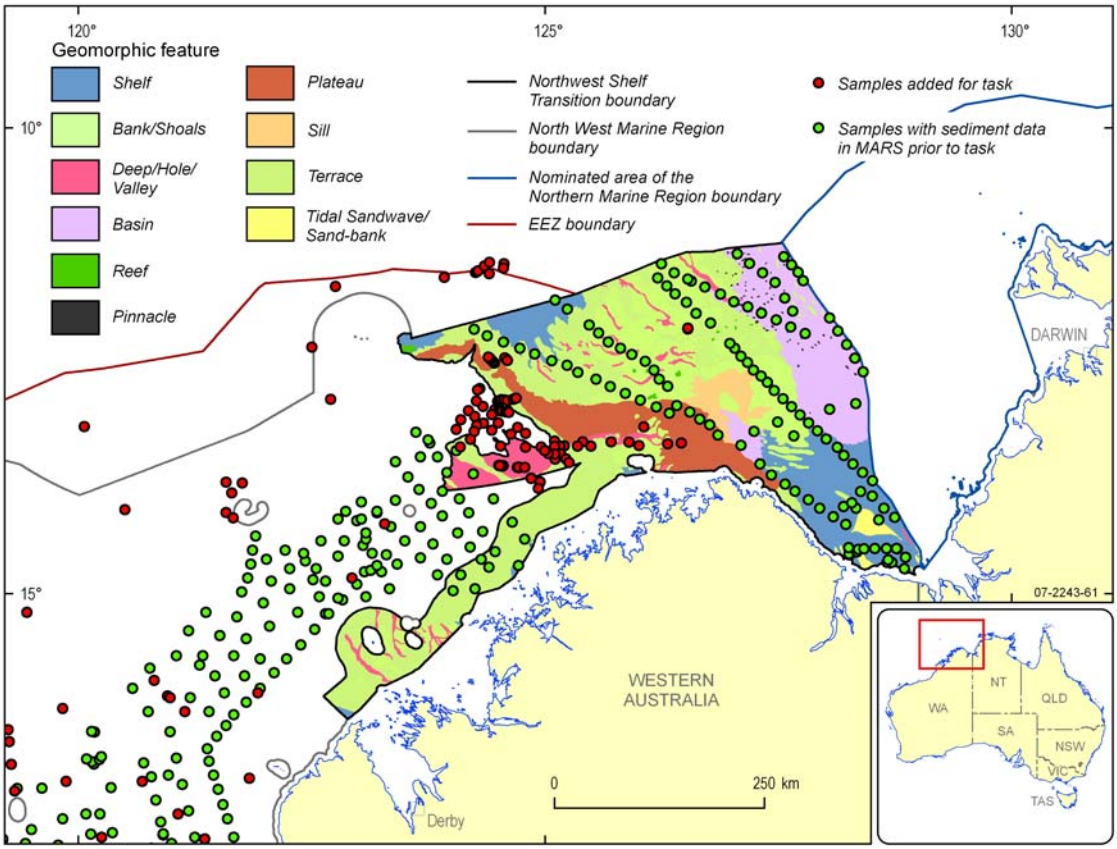
A total of 49 samples were collected from terraces, giving an average density of approximately 1:870 km². More than 50% of samples collected from terraces occur within a 50 km² area on the outer shelf near the boundary of the Timor Province. Remaining samples are distributed across the other terraces. The sample distribution means that not all sedimentary environments covered by the terrace are necessarily characteristic of all other terraces.

Banks/shoals contain 32 samples, giving an average density of 1:830km² for this feature. Deep/hole valleys contain 39 samples, giving an average density of 1:210 km². Sample distribution provides good coverage of all occurrences of these features in the NWST.

The Londonderry Rise contains 14 samples, giving an average density of 1:1,000 km². Samples are not distributed evenly across this feature but achieve sufficient coverage of the plateau to describe the sedimentology.

Basins contain 26 samples, giving an average density of approximately 1:760 km². Samples cover basins in the NWST, but they are more abundant in the deeper water areas of the Bonaparte Depression. These are the only basins containing adequate samples to describe the sedimentology (Fig. 5.16b).

Despite targeted sample addition, sample coverage is inadequate to assess sedimentology in pinnacles and tidal sand wave/sandbank features in the NWST. A total of 62 samples were added to this bioregion for this study, increasing coverage in deeps/holes/valleys (30), terraces (24), banks/shoals (4) and on the Londonderry rise (4).


120°
125°
130°
10°
15°
Geomorphic feature
Shelf
Bank/Shoals
Deep/Hole/ Valley
Basin
Reef
Pinnacle
Plateau
Sill
Terrace
Tidal Sandwave/ Sand-bank
Northwest Shelf Transition boundary
North West Marine Region boundary
Nominated area of the Northern Marine Region boundary
EEZ boundary
Samples added for task
Samples with sediment data in MARS prior to task
DARWIN
WESTERN AUSTRALIA
Derby
0
250 km
07-2243-61
NT
WA
QLD
SA
NSW
VIC
TAS

a)

b)

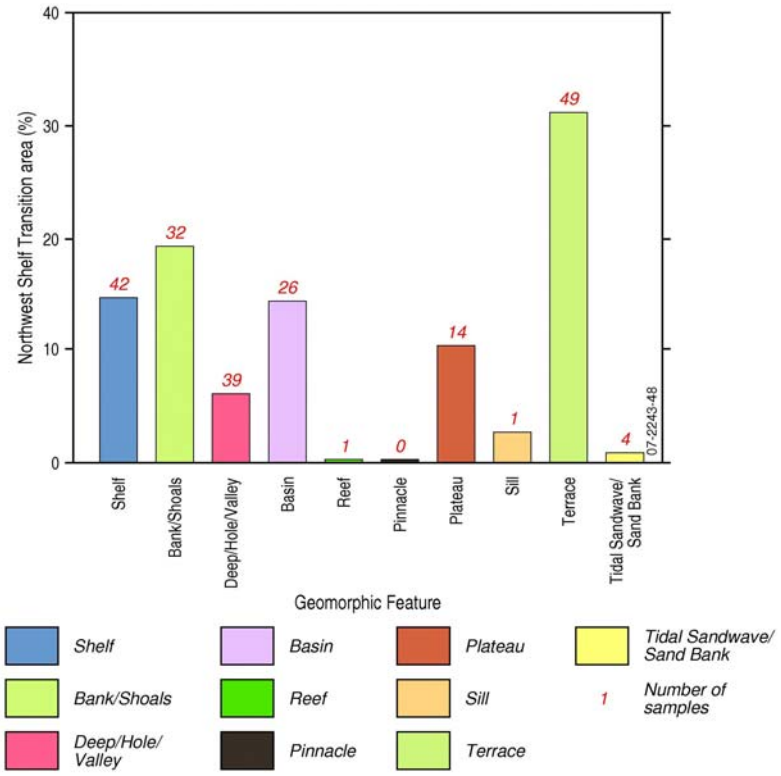
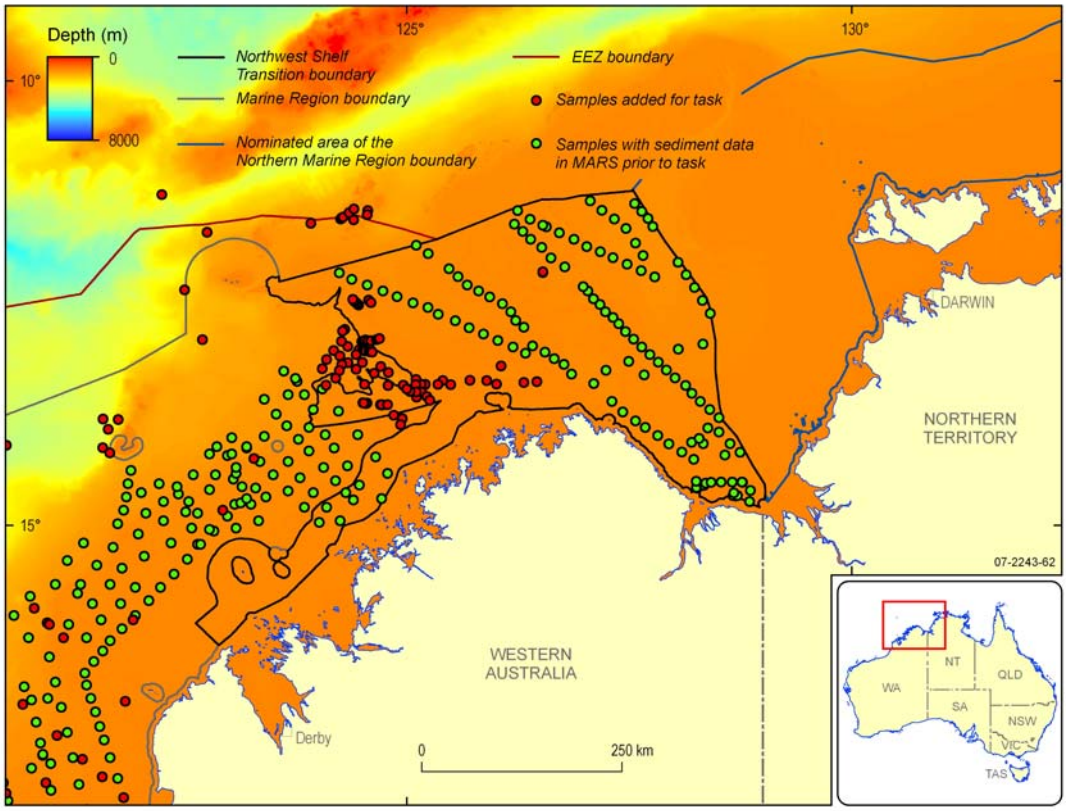


Figure 5.16. a) Geomorphology of the Northwest Shelf Transition (NWST) with location of sediment samples; and b) Percentage area of each geomorphic feature within the NWST with number of corresponding sediment samples.



a)

b)

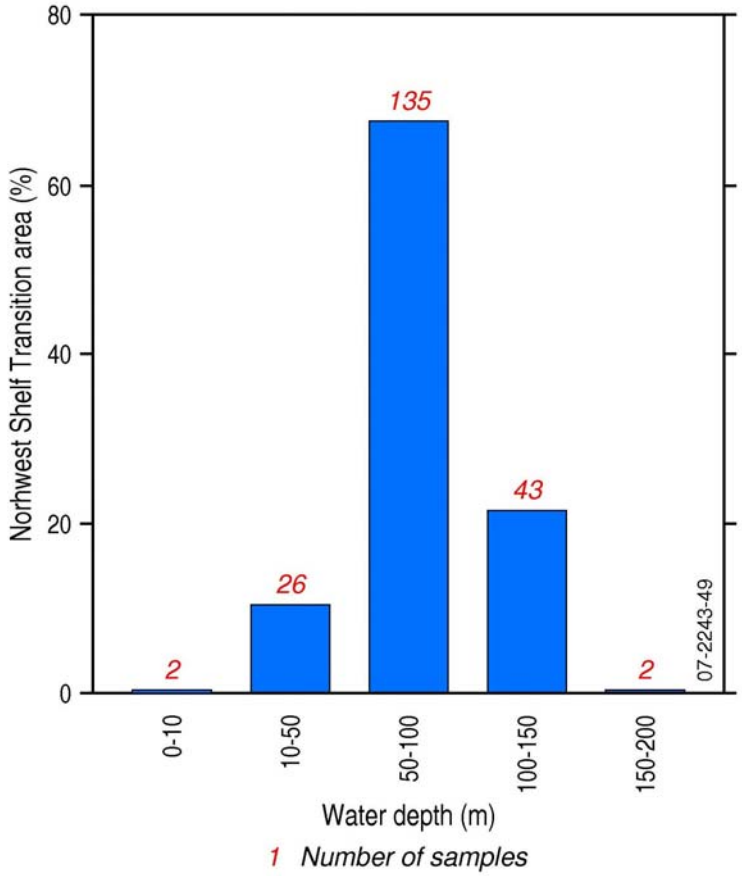


Figure 5.17. a) Bathymetry of the Northwest Shelf Transition (NWST) with location of sediment samples; and b) Percentage area of each bathymetry class within the NWST with number of corresponding sediment samples.

Table 5.8: Details of the geomorphology of the Northwest Shelf Transition.

Feature	% of bioregion area covered	% of NWMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
Geomorphic Feature			
Unassigned shelf and slope	14.59	14.87	1.60
Bank/Shoals	19.34	90.94	52.33
Deep/Hole/Valley	5.97	8.74	4.94
Basin	14.45	100	2.97
Reef	0.26	17.21	0.77
Pinnacle	0.30	61.21	8.10
Plateau	10.27	14.91	0.94
Sill	2.72	100	21.44
Terrace	31.11	18.73	7.33
Tidal Sandwave/Sand Bank	0.99	100	5.64

Table 5.9: Distribution of water depths covered by the geomorphology in the Northwest Shelf Transition.

Feature	Depth Range (m)	Mean Depth (m)
Geomorphic Province		
Unassigned shelf and slope	0 – 330	90
Geomorphic Feature		
Bank/Shoals	4 – 165	160
Deep/Hole/Valley	15 – 235	230
Basin	25 – 160	135
Reef	20 – 330	310
Pinnacle	25 – 165	140
Plateau	15 – 195	180
Sill	70 – 95	25
Terrace	10 – 235	230
Tidal Sandwave/Sand Bank	0 – 85	85

5.5.3. Sedimentology of the North West Shelf Transition

A total of 208 grain size assays and 194 carbonate assays occur in the NWST. Sediments in the east of the NWST differ significantly from those in the west. Within the Bonaparte Depression, sediments are variable but generally dominated by gravels closer to the coast, attaining up to 85% in four samples. Gravel content comprises <10% in five samples due to samples being located on top of tidal sand wave/sand bank features with similar sediment fractions (i.e. gravel <10%). Sand content is generally >50% in the Bonaparte Depression, with four samples attaining >90% sand. Mud content generally attains 20% within Bonaparte Depression but exceeds 50% in four samples located in close proximity to tidal sand wave/ sand bank features.

Sediments within the northern section of Bonaparte Depression are generally more homogenous and dominated by mud. Mud content is generally between 20 and 95%. A total of 15 of the 286 samples contain from 40 to 100% gravel due to proximity to the coast and to pinnacle features with similar sediment fractions (56 to 100% gravel).

In the west of the NWST, sediments contain between 25 and 90% sand. Sand comprises <20% in only one sample. These occur in deeps/holes/valleys features within 100 km of the coast. Mud is the next most abundant fraction with contents ranging from 5 to 52% in 80% of samples. Gravel content is generally between 0 and 33%, although it exceeds 50% in one sample that occurs in close proximity to deeps/holes/valleys and pinnacles.

Carbonate content exceeds 80% in 81 (42%) samples in the NWST. Throughout the Bonaparte Depression, carbonate contents of <20% are present locally. North of the Bonaparte Depression, carbonate content is generally <80%. Few carbonate assays are available for the textural size fractions, however those present indicate that carbonate content of sand in the NWST exceeds

80% in 144 (74%) samples. Carbonate content of gravel exceeds 90% for 54 (28%) samples. Carbonate content of mud is generally <80% but attains up to 90% in 15 samples.

5.5.4. Sedimentology of Significant Geomorphic Features

5.5.4.1. Sahul Shelf

A total of 42 samples were obtained from the shelf. Sediments in this feature are characterised by variable concentrations in mud, sand and gravel (Fig. 5.18f). Adjacent basin features show similar mud:sand ratios. Samples adjacent to reefs have increased gravel and sand fractions (40 to 75% and 20 to 90%, respectively). Bulk carbonate contents range from 13 to 88% with nine samples containing >50% (Fig. 5.19f). Carbonate sand ranges between 16 and 100% with 23 samples containing >50%.

5.5.4.2. Banks/shoals

A total of 32 samples were obtained from banks/shoals. Sediments in this feature are characterised by mud and sand with gravel present in samples adjacent to deeps/holes/valleys. Mud contents comprise 1 - 99% and >50% for 10 samples (Fig. 5.18a). Sand contents comprise 25 - 75% and >50% for 14 samples. Gravel contents generally attain 37%, with only three samples containing over 50%. At one location adjacent to deep/hole/valley and terrace features, the entire sample is composed of gravel clasts. Bulk carbonate content ranges between 21 and 98% and attains >50% in 24 samples (Fig. 5.19a). Carbonate sand ranges from 38 to 100% with 31 samples containing >50%.

5.5.4.3. Deep/hole/valleys

A total of 39 samples were obtained from deep/hole/valleys. Sand is the dominant fraction comprising between 15 and 80% with a total of 31 samples containing >50% sand (Fig. 5.18c). Mud is the next most dominant fraction with contents ranging between 9 and 83% and exceeding 50% in two samples. Two samples located adjacent to banks/shoal features contain between 80 and 85% mud. The remaining material in the sediments is gravel, ranging in content between 0 and 32% with a maximum of 35% where sand content is low. Bulk carbonate content ranges between 47 and 95%, with 30 samples containing >80% carbonate (Fig. 5.19c). Carbonate gravel ranges between 90 and 95% and attains 100% in three samples. Carbonate sand contents range from 67 to 100% and attains >80% in 34 samples. Carbonate mud contents range between 32 and 73% and attains >50% in 26 samples.

5.5.4.4. Basins

A total of 26 samples were obtained from outer-shelf basins. Mud is the dominant fraction and generally ranges between 9 and 97% with 15 samples containing >50% (Fig. 5.18b). Sand is the next most dominant fraction with contents ranging between 3 and 76% and five samples containing >50% sand content. Generally, samples adjacent to pinnacle features contain between 10 and 25% gravel contents. Bulk carbonate content generally ranges between 29 and 72%, with 13 samples containing >50% (Fig. 5.19b). Carbonate sand ranges between 27 and 100% and exceeds 90% in 20 samples.

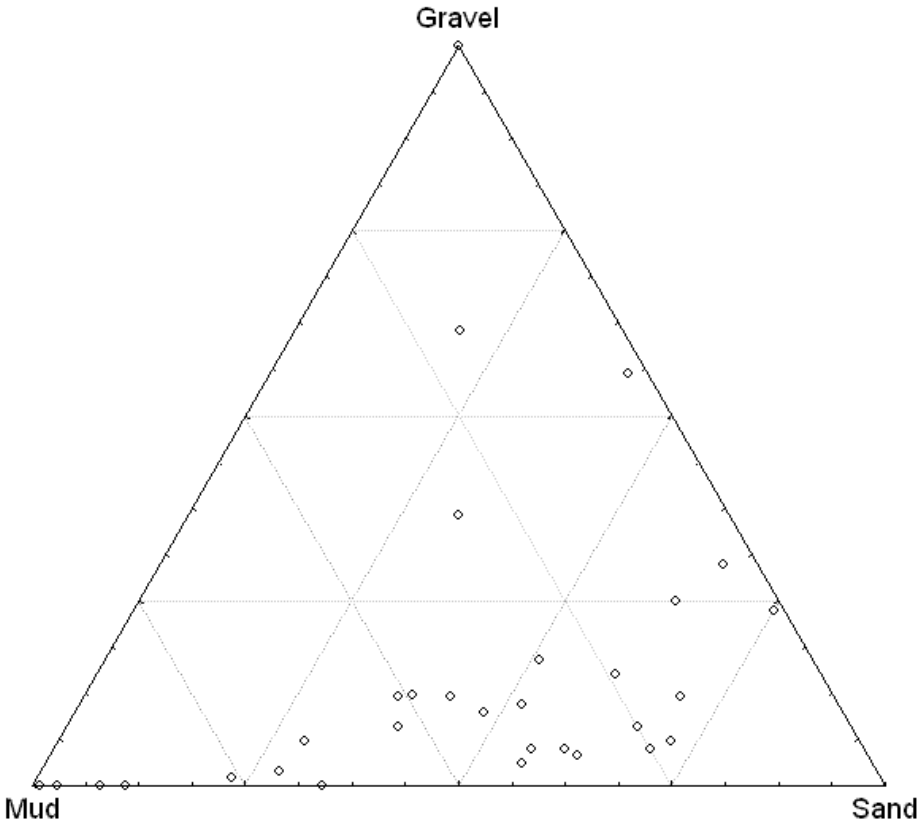
5.5.4.5. Londonderry Rise (plateau),

A total of 14 samples were obtained from plateaus. Sand is the dominant fraction, generally ranging from between 32 and 85% with 11 samples attaining >50% (Fig. 5.18d). Mud is the next most abundant fraction with contents attaining 44% and four samples attaining >30%. Gravel content is consistently <22%, although one sample adjacent to terrace and basin features contained 62% gravel. Bulk carbonate content ranges between 17 and 93% with nine samples containing >50% (Fig. 5.19d). Carbonate sand ranges from 14 to 99% with 10 samples containing >50%.

5.5.4.6. Terraces <300 m Water Depth

A total of 49 samples were obtained from terraces. Sand is the dominant fraction generally ranging between 16 and 89% with 36 samples containing >50% (Fig. 5.18e). The remaining material is mud, which ranges in content between 5 and 84%. Gravel contents of <39% occur across the NWMR, although five samples, collected from areas adjacent to banks/shoals, contain no gravel. Bulk carbonate content generally varies between 48 and 95% with 44 samples containing >50% carbonate (Fig. 5.19e). Carbonate sand content ranges between 92 and 100% with four samples attaining 100%. Carbonate mud content ranges between 44 and 90% with 18 samples exceeding 50%. Carbonate gravel content ranges between 90 and 100% with seven samples attaining 100%.

a)



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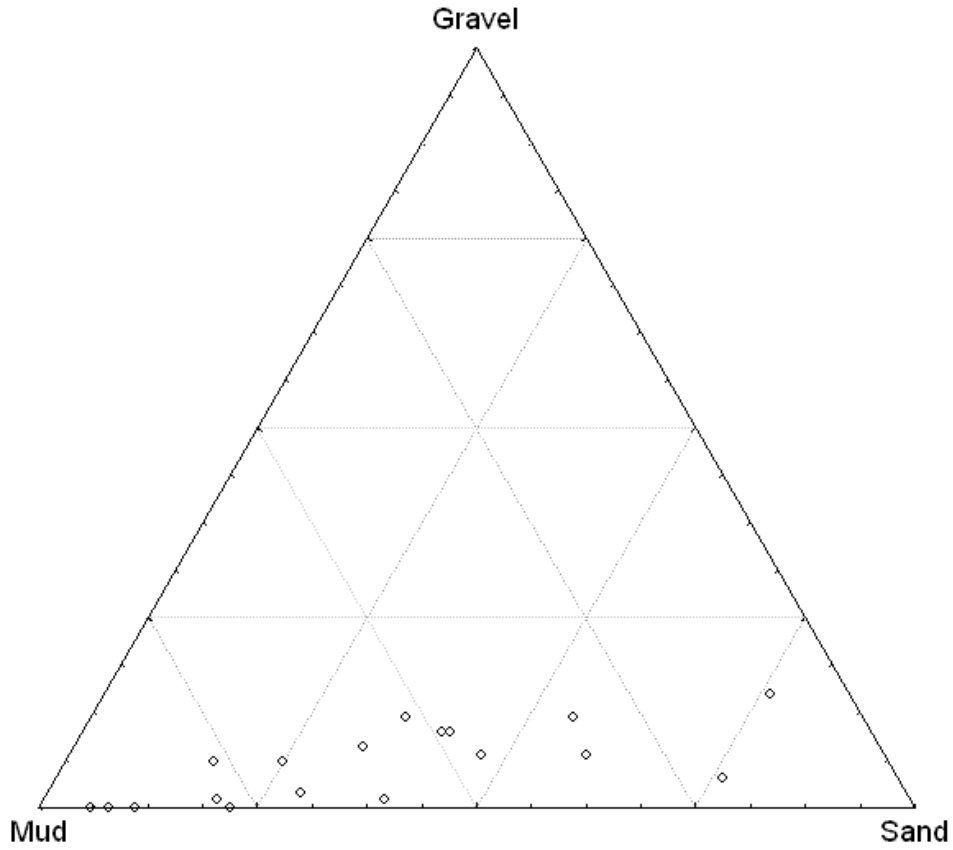
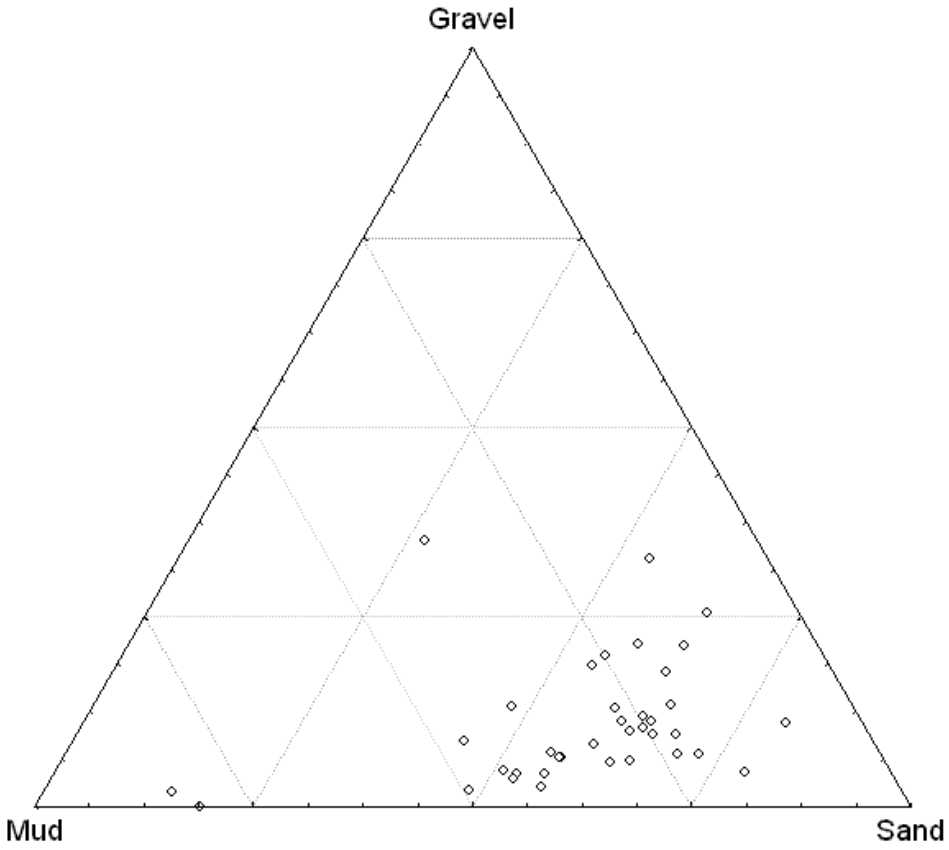
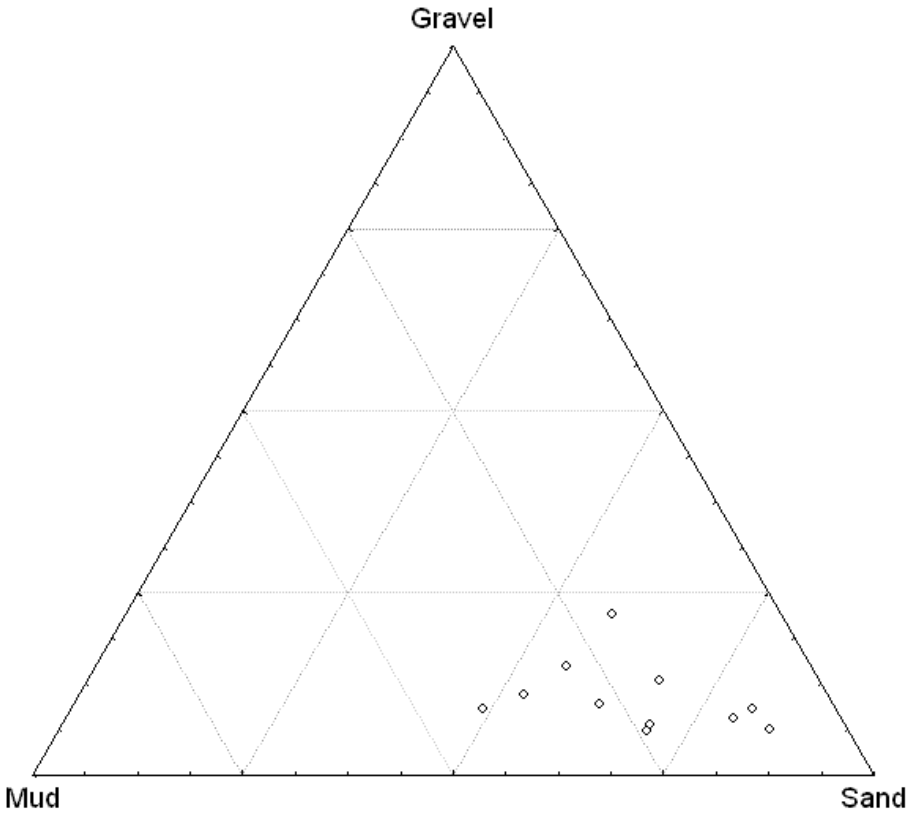


c)



d)



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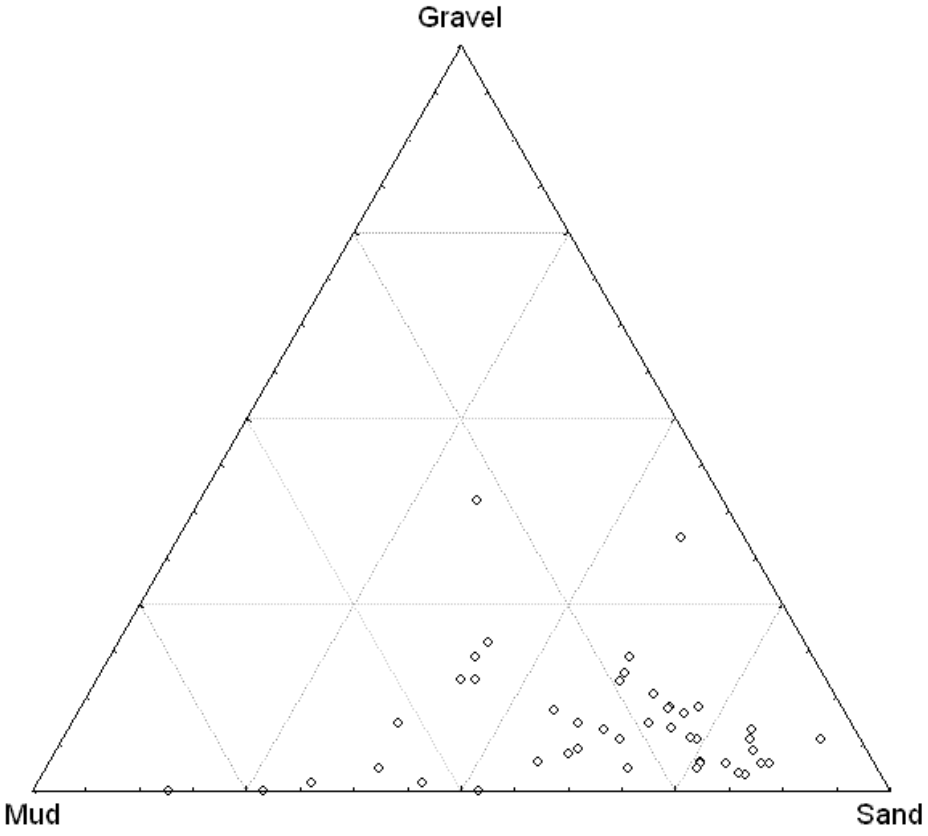

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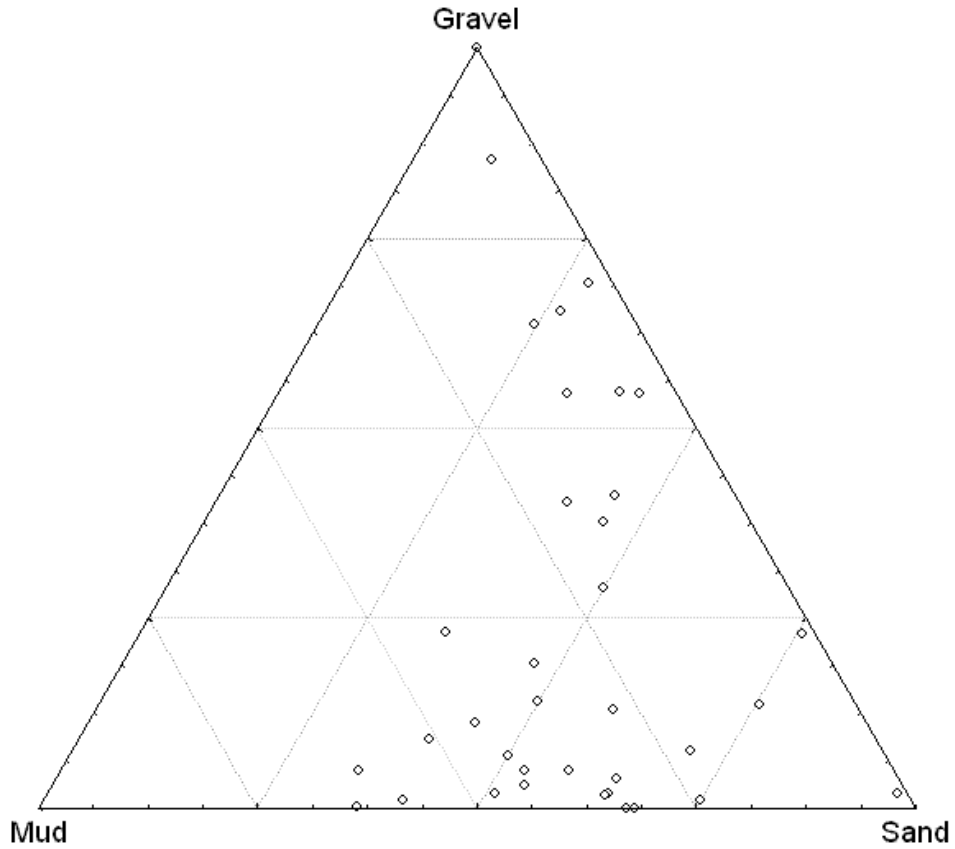
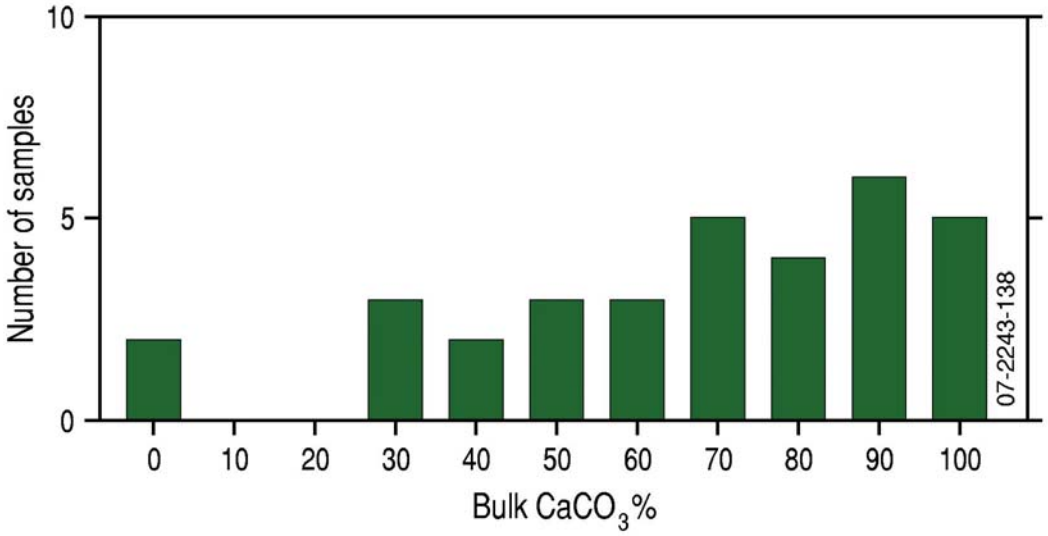


Figure 5.18. Textural composition (mud:sand:gravel ratio) of a) bank/shoal; b) basin; c) deep/hole/valley; d) plateau; e) terrace; f) shelf sediments within the NWST.

a)



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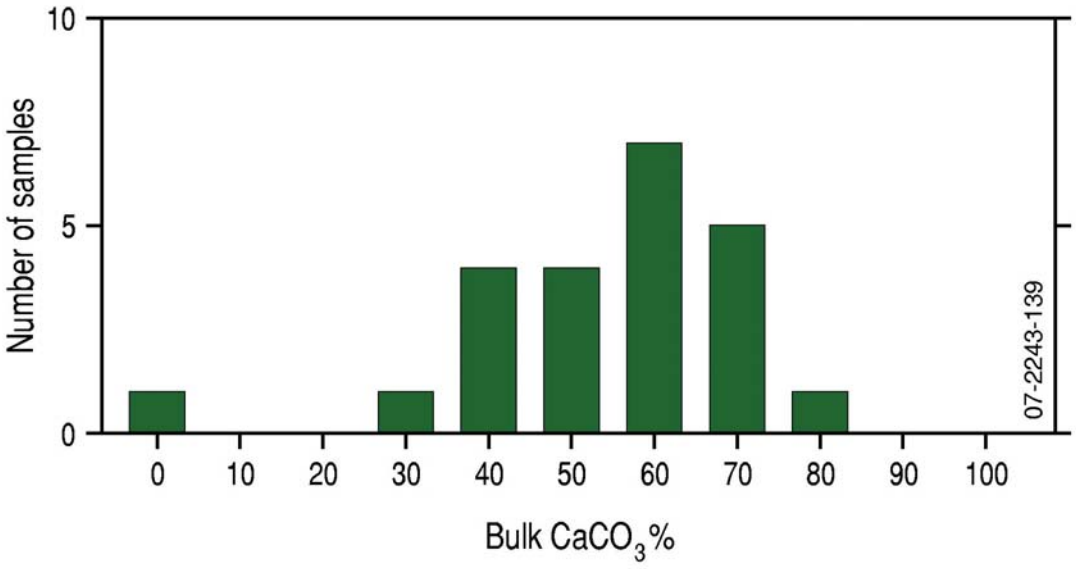
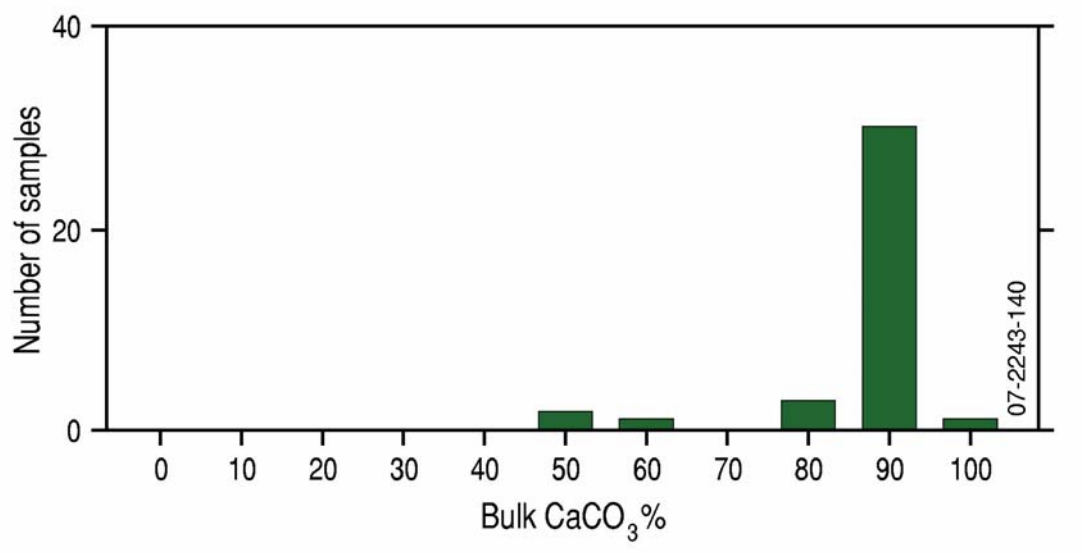
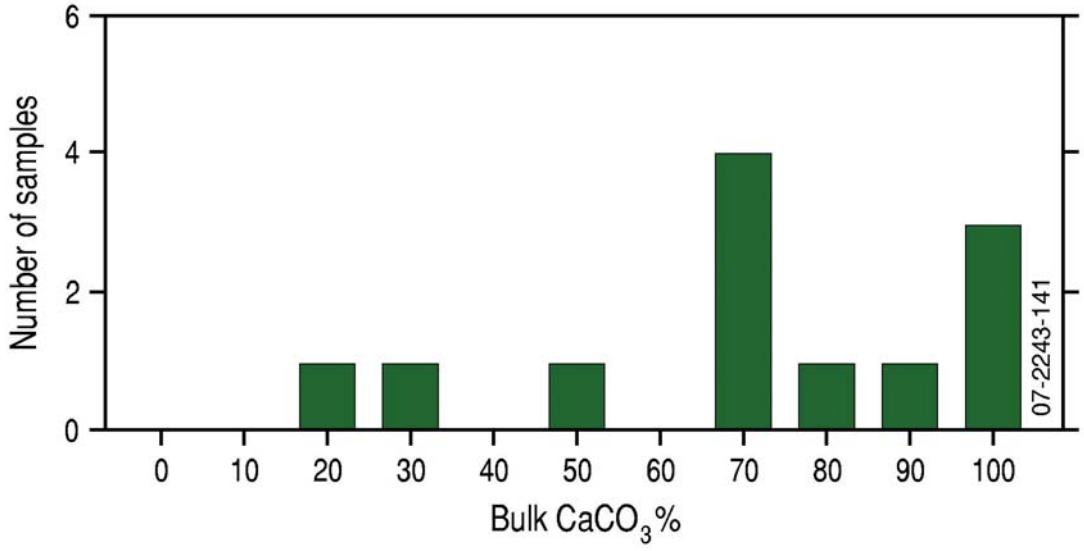

10
5
0
Number of samples
0
10
20
30
40
50
60
70
80
90
100
Bulk $CaCO_3$ %
07-2243-139

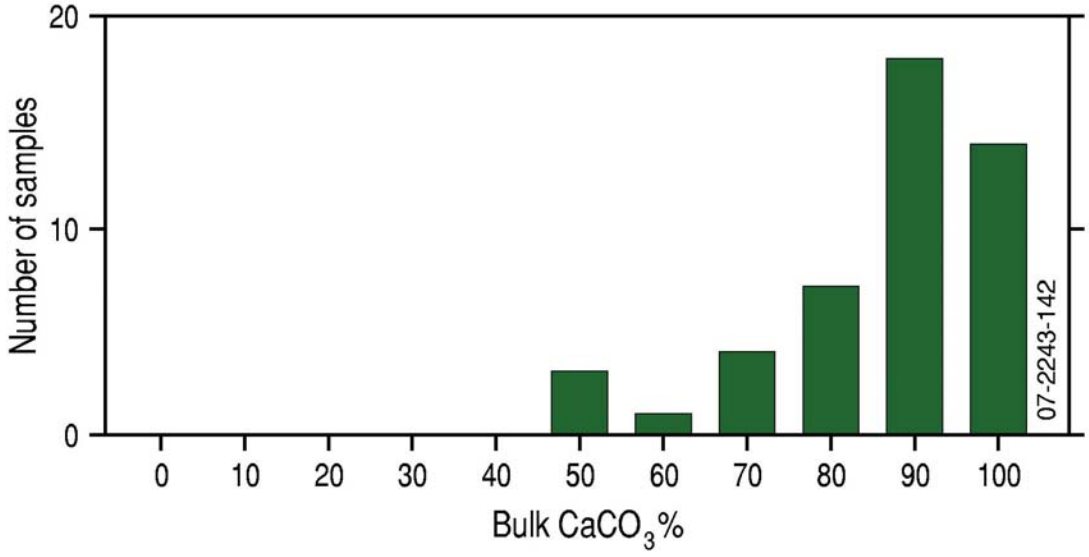
c)


40
20
0
Number of samples
0
10
20
30
40
50
60
70
80
90
100
Bulk $CaCO_3$ %
07-2243-140

d)



e)



f)

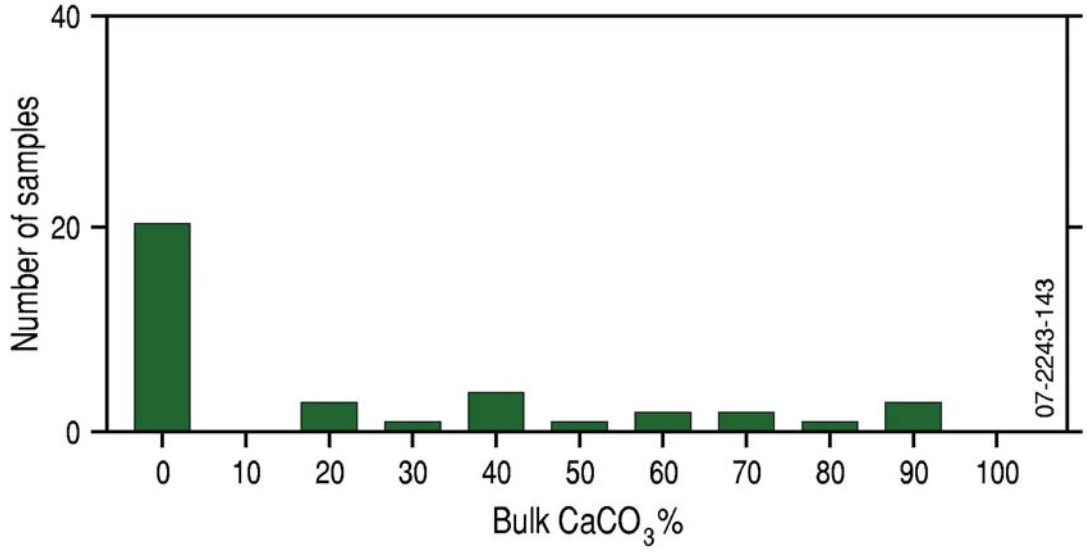


Figure 5.19. Carbonate content of a) bank/shoal; b) basin; c) deep/hole/valley; d) plateau; e) terrace; and f) shelf sediments within the NWST.

5.6. TIMOR PROVINCE (TP)

5.6.1. Geomorphology and bathymetry

The Timor Province (TP) covers a total area of 178,650 km^2, all of which occurs in the NWMR (Fig. 5.1). This bioregion represents 15% of the total area of the NWMR (Table 5.1). The TP is located on the slope, between Broome and Cape Bouganville (Fig 5.20a). It is separated from the coast to the east by the NWSP and NWST, bounded to the south by the NWT, and separated from EEZ boundary to the west by the area of the EEZ not allocated to a bioregion.

Water depths in the bioregion range from 10 m near the shelf break to 5,920 m on the Argo Abyssal Plain (Fig 5.21a). A total of 38% of the area occurs in depths of <500 m and 14% in depths of >5,000 m (Fig. 5.21b; Table 5.11).

The TP is dominated by slope (unassigned) (50,170 km^2, 32%) and terraces (47,510 km^2, 30%). Significant areas are covered by plateaus (18,500 km^2, 12%), abyssal plain/deep ocean floor (unassigned) (17,990 km^2, 12%) and deeps/holes/valleys (12,540 km^2, 8%). Rise, canyons, reefs, aprons/fans, knolls/abyssal hills/peaks and pinnacles are present, but each cover <4,500 km^2 (3%) of the total bioregion area (Table 5.10).

A total of four significant features have been identified that characterise the TP. These have the potential to contain sedimentary environments not found elsewhere in the NWMR or EEZ due to the water depth and oceanographic setting of the region (as described in Section 3). Slope (unassigned) is judged significant as it forms the largest area of any feature in this region and varies in sedimentology from adjacent areas of slope due to a high gravel component (Fig. 5.23c). Small terraces on the upper slope cover approximately 5,670 km^2 (4%) of the bioregion area; however, they represent a larger proportion of all shallow water terraces found in the NWMR (5,670 km^2, 14%). These form the northernmost extent of a string of terraces with similar morphology, bathymetry and tectonic origin that extend across the TP and NWT to the south.

Reefs in the TP are considered significant as they form almost half of the total area of reefs in the NWMR. Reefs north of Ashmore Reef are likely to differ from reefs in elsewhere in the NWMR as they are dominated by algae while reefs occurring to the south are dominated by hard corals (Chapter 3). Aprons/fans are generally associated with the reefs and cover less than 1% of the area of the TP, however this area forms >45% of the total area of aprons/fans in the NWMR.

Terraces located in deeper water cover a far larger area of the bioregion (~55%), including approximately 60% of the Rowley Terrace. The remainder of this feature is located to the south in the NWT where sample coverage is adequate to describe the sedimentology of this feature. Deepwater Terraces in the NWMR contain relatively homogenous sedimentology (Chapter 4), and therefore no additional sediment information can be provided by the analysis of these features at a bioregion scale. Likewise, Scott Plateau and the Argo Abyssal Plain each cover 11% of the bioregion, but relatively homogeneous sedimentology observed across all these features at a NWMR scale means no additional sediment information can be provided by an analysis at a bioregion scale.

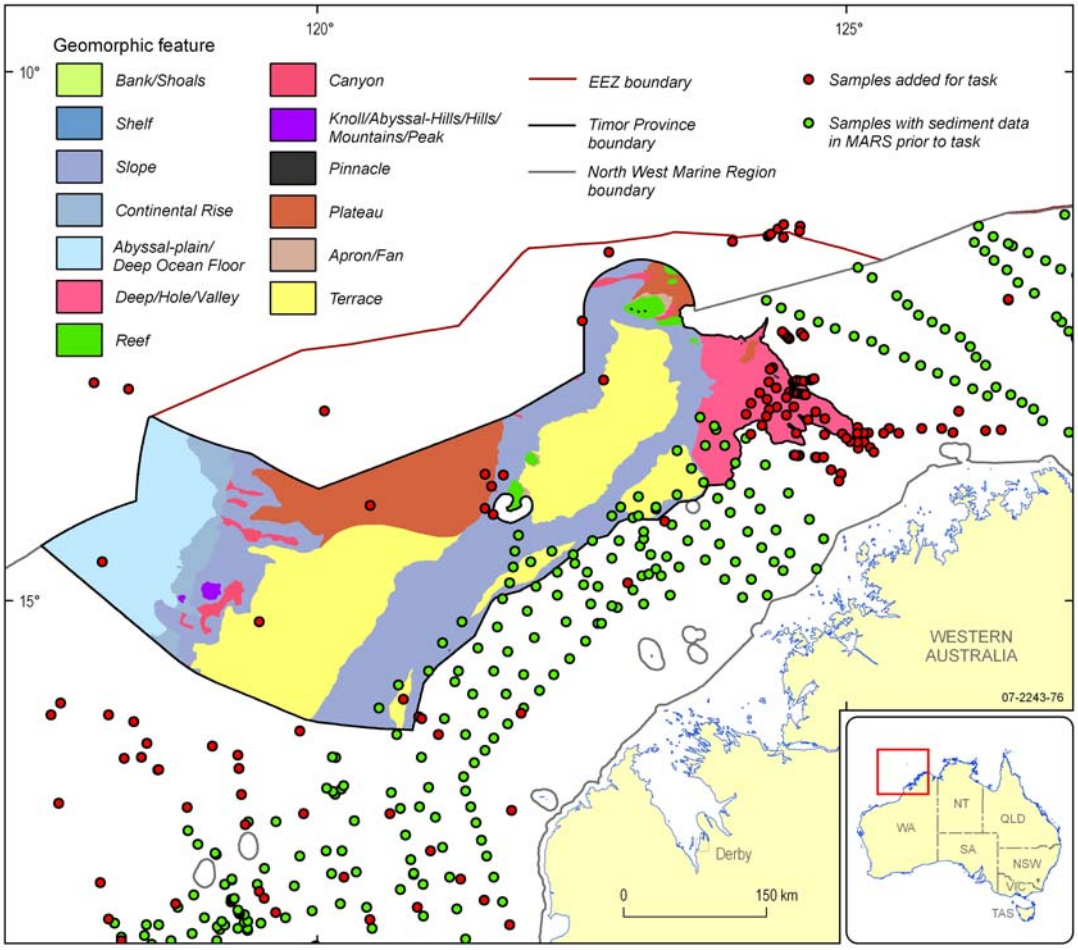
5.6.2. Sample Coverage

The TP is represented by 77 samples (Figs. 5.20a). More than 50% (39) of these are located on the upper slope near the shelf break and some within water depths <500 m and within 250 km of the coast. The remaining samples are distributed across the lower slope with one point on the AP/DOF in water depths >5,000 m.

Average sample density across the assessed area of the bioregion is >1:2,000 km^2, however sample densities are generally higher than this on the upper slope (<200 m water depth) and lower in deep water.

Samples achieve adequate coverage to describe the sedimentology in three of the four significant features identified for this bioregion. A total of 14 samples were collected from the area of the slope (unassigned), giving an average density of approximately 1:3,580 km^2. Clustering of samples means that assays are likely to best represent sediment types present on the upper slope. A total of 15 samples were collected from three terraces on the upper slope, giving an average density of approximately 1:3,170 km^2. A total of 41 samples were collected from deeps/holes/valleys, giving an average density of approximately 1:310 km^2.

Despite targeted sample addition, an insufficient number of samples were collected from reefs and aprons/fans in the TP to describe their sedimentology. One sample was collected from reefs and no samples from aprons/fans were available for procurement for this study. Sedimentology of reefs is discussed in Chapters 3 and 6 from results of previous studies. 42 samples were added to the TP for this study. These increased sample coverage in the slope (unassigned) (3 samples added), terrace (2) and deeps/holes/valleys (31) features.


Geomorphic feature
Bank/Shoals
Shelf
Slope
Continental Rise
Abyssal-plain/ Deep Ocean Floor
Deep/Hole/Valley
Reef
Canyon
Knoll/Abyssal-Hills/Hills/ Mountains/Peak
Pinnacle
Plateau
Apron/Fan
Terrace
EEZ boundary
Timor Province boundary
North West Marine Region boundary
Samples added for task
Samples with sediment data in MARS prior to task
120°
125°
10°
15°
WESTERN AUSTRALIA
07-2243-76
Derby
0
150 km
NT
QLD
WA
SA
NSW
VIC
TAS

a)

b)

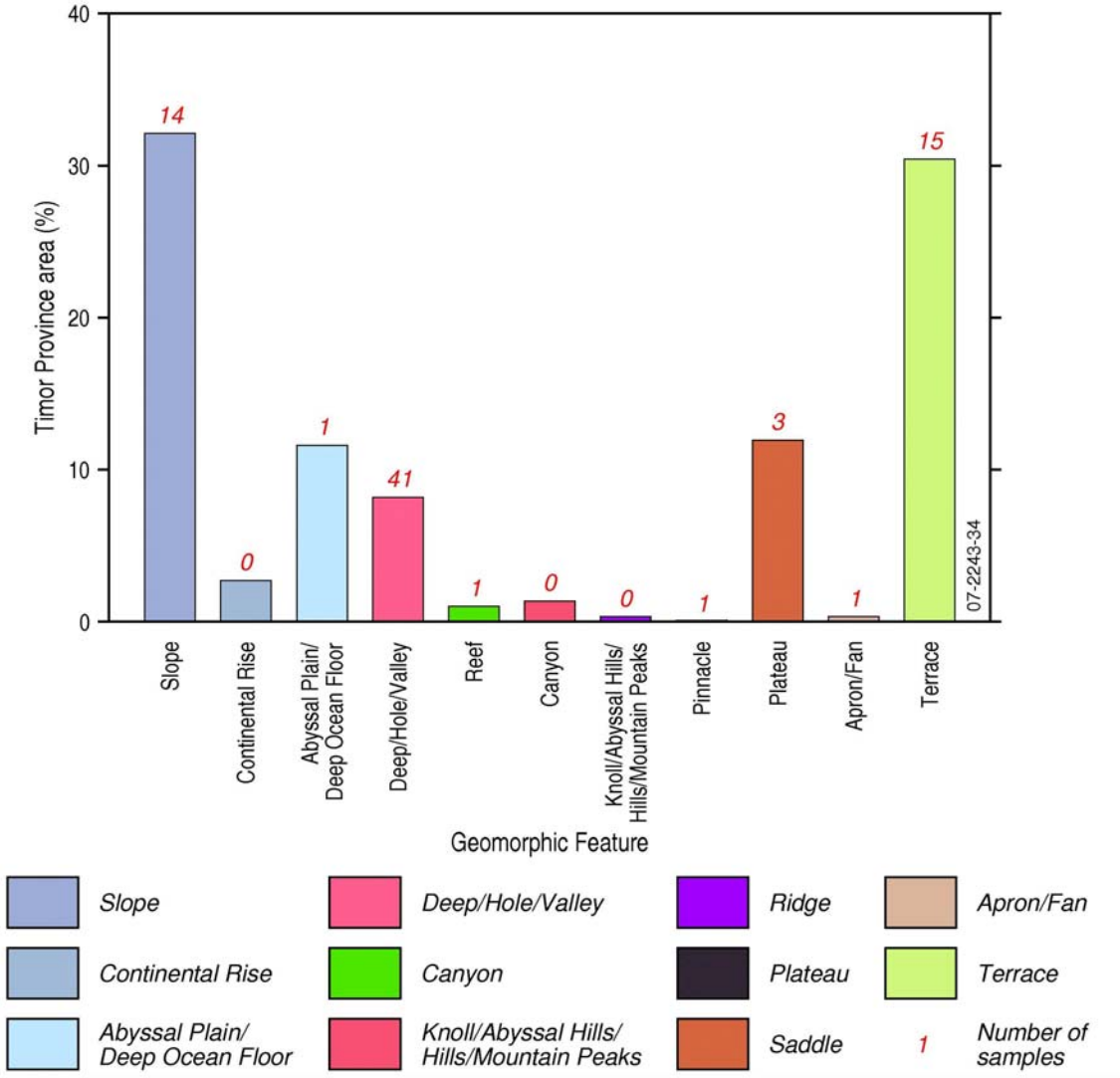
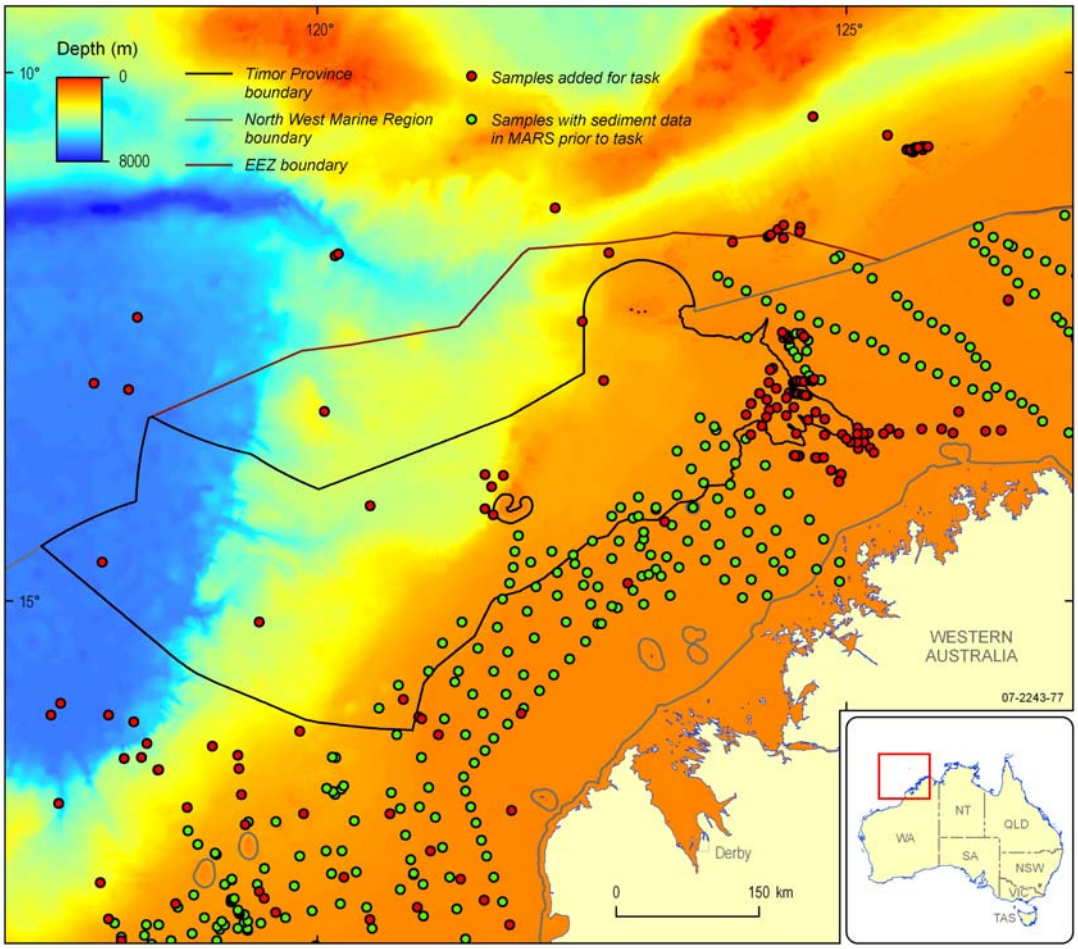


Figure 5.20. a) Geomorphology of the Timor Province (TP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the TP with number of corresponding sediment samples.

a)



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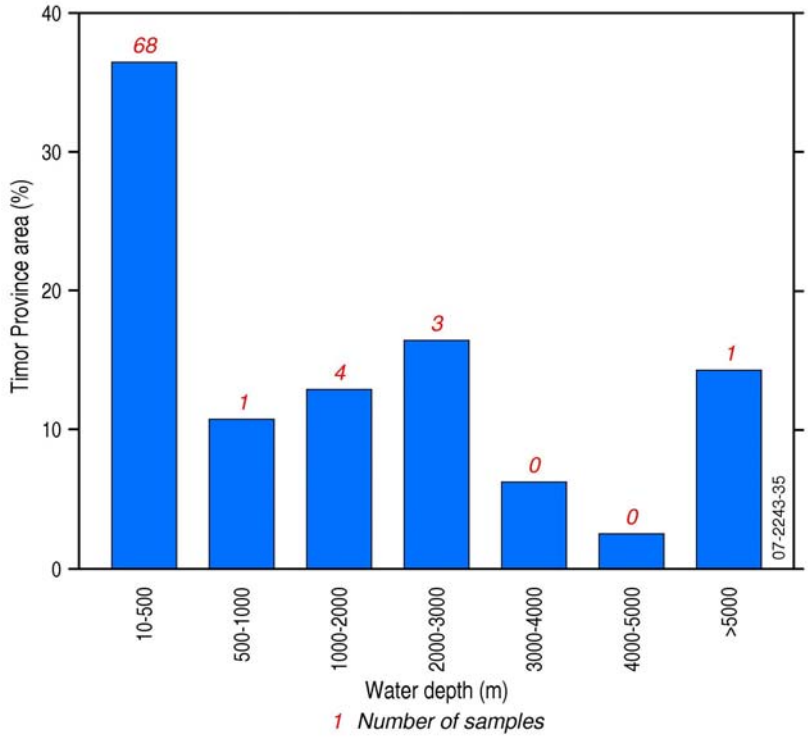


Figure 5.21. a) Timor Province showing bathymetry with location of sediment samples; and b) Percentage area of each bathymetry class within the TP with number of corresponding sediment samples.

Table 5.10. Details of the geomorphology of the Timor Province.

Feature	% of bioregion area covered	% of NWMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
Geomorphic Province			
Slope	85.56	20.60	3.33
Rise	2.90	28.56	4.43
AP/DOF*	11.54	17.98	0.62
Geomorphic Feature			
Slope (unassigned)	32.18	16.15	3.65
Rise (unassigned)	2.90	28.56	4.72
AP/DOF* (unassigned)	11.54	18.23	0.73
Deep/hole/valley	8.04	13.44	7.59
Reef	1.028	76.58	3.44
Canyon	1.47	21.20	2.14
Knoll/abyssal hills/mountains/peak	0.23	17.59	0.30
Pinnacle	0.04	9.59	1.27
Plateau	11.87	19.66	1.24
Apron/fan	0.23	49.39	3.11
Terrace	30.48	20.93	8.20

Table 5.11. Distribution of water depths covered by the geomorphology in the Timor Province.

Feature	Depth Range (m)	Mean Depth (m)
Geomorphic Province		
AP/DOF	4,570 – 5,920	5,615
Slope	35 – 5,660	1,315
Continental rise	4,035 – 5,635	5,225
Geomorphic Feature		
Slope (unassigned)	95 – 5,650	5,560
Rise (unassigned)	4,035 – 5,635	5,225
AP/DOF (unassigned)	4,570 – 5,920	5,615
Deep/hole/valley	45 - 275	235
Reef	35 – 1,325	1,360
Canyon	95 – 5,660	5,565
Knoll/abyssal hils/mountains/peak	3,170 – 5,605	2,435
Pinnacle	5 - 295	290
Plateau	35 – 3,440	3,410
Apron/fan	5 – 375	375
Terrace	215 – 3,685	3,470

5.6.3. Sedimentology of the Timor Province

The TP contains 77 grainsize and 70 carbonate assays. Approximately 45 (58%) of these samples occur within 100 km of the shelf break. Sediment texture in this area is highly variable (Fig. 5.22). Sand content comprises 10 to 100% of sediment. Mud content ranges from <1 to 80%, but mud was <1% in 3 samples and >50% in 13 (17%) samples. Gravel exceeds 50% in only two samples and comprises <1% in 32 (42%) samples. Sand contents of <50% occur within 100 km from the shelf break within the area of the Browse Depression.

Samples are distributed more sparsely over the rest of the slope in the bioregion, and a single sample occurs on the AP/DOF. Sand content in these areas is significantly lower than near the shelf break, ranging from 0 to 56%, and exceeding 50% in only one sample. Mud content is generally higher near the abyssal plain/deep ocean floor, ranging from 44 to 99% and attaining >60% in all but one sample. Gravel is generally absent. The single sample from the Argo Abyssal Plain contains 99% mud.

Carbonate in the TP decreases with increasing water depth. Carbonate content within 100 km of the shelf break is regularly >60% and >80% in 61 (87%) samples. In the rest of the bioregion, carbonate content ranges from <1% on the AP/DOF to just under 80% on the slope in the north. Sediments on the mid to lower slope contain between 40 and 80% carbonate.

Carbonate gravel and sand contents attain >80%. Carbonate mud ranges from 50 to 91%, although samples with this information cover only a small area of the bioregion near the shelf break.

5.6.4. Sedimentology of Significant Geomorphic Features

5.6.4.1. Slope

A total of 14 samples were obtained from the slope. Sediments in this feature are characterised by large variations between sand:mud ratios (Fig. 5.22c). Sand content ranges between 12 and 92% with seven samples containing >50% sand. Mud content generally ranges from 24 to 87% with seven samples containing >50% mud. Gravel contents attain 18%, although one sample attains 47% where mud concentration is low. Bulk carbonate content generally ranges from 67 to 92% with five samples comprising >80% (Fig. 5.23c).

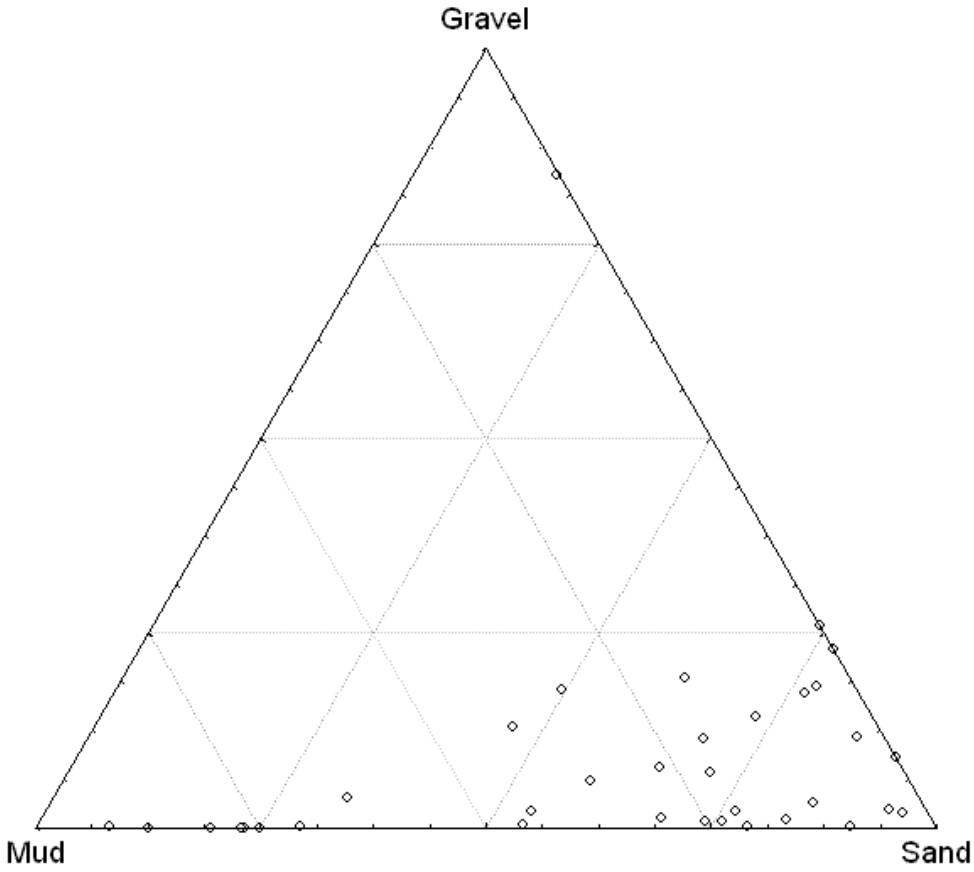
5.6.4.2. Small Upper Slope Terraces

A total of 15 samples were obtained from upper slope terraces. Sand is the dominant fraction comprising between 9 and 100% with 12 samples containing >50% sand (Fig. 5.22b). Mud content ranges from 4 to 77% with four samples attaining contents >50%. Gravel content ranges from 1 to 40%. Adjacent slope and deeps/holes/valleys contain sediments with similar textural properties. Bulk carbonate content generally varies between 63 and 95% with eight samples attaining >80% (Fig. 5.23b).

5.6.4.3. Deep/hole/valley

A total of 41 samples were obtained from deeps/holes/valleys. Sand is the dominant fraction comprising between 8 and 100% with 25 samples attaining contents exceeding 50% (Fig. 5.22a.).

Mud content ranges from <1 to 92% with eight samples attaining contents >50%. Gravel content varies between <1 to 26% but attains 84% in one sample. Bulk carbonate content generally ranges between 65 and 99% with 24 samples exceeding 50% (Fig. 5.23a.). Carbonate sand varies from 81 and 97% and attains >80% in 23 samples. Carbonate mud varies between 58 and 91% and exceeds 80% in five samples. Carbonate gravel ranges from 90 and 100% and attains 100% in 16 samples.



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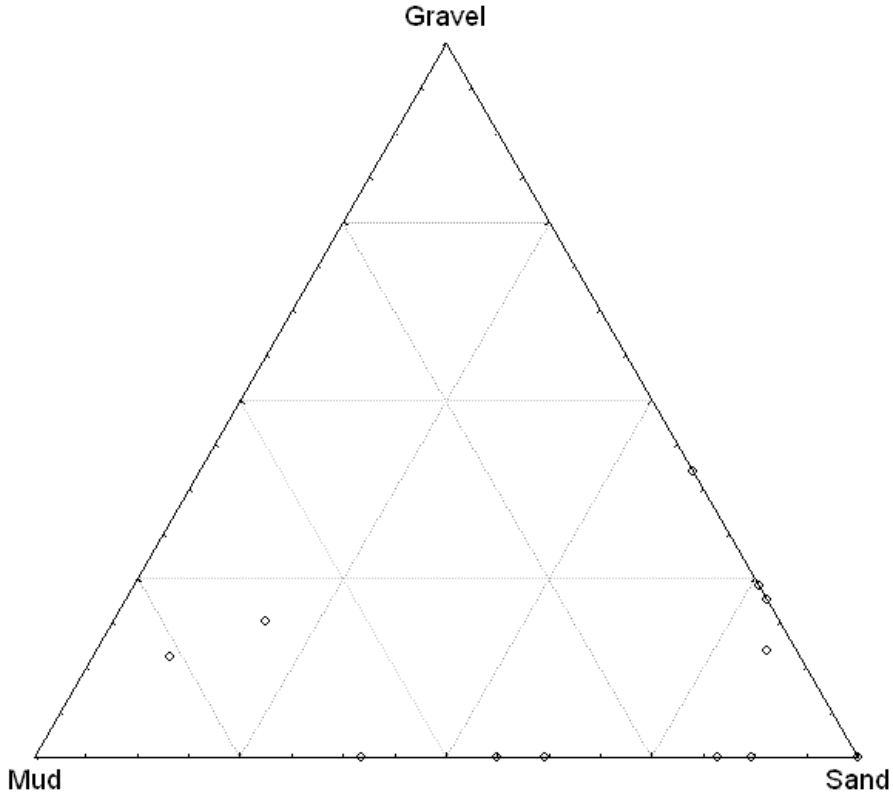

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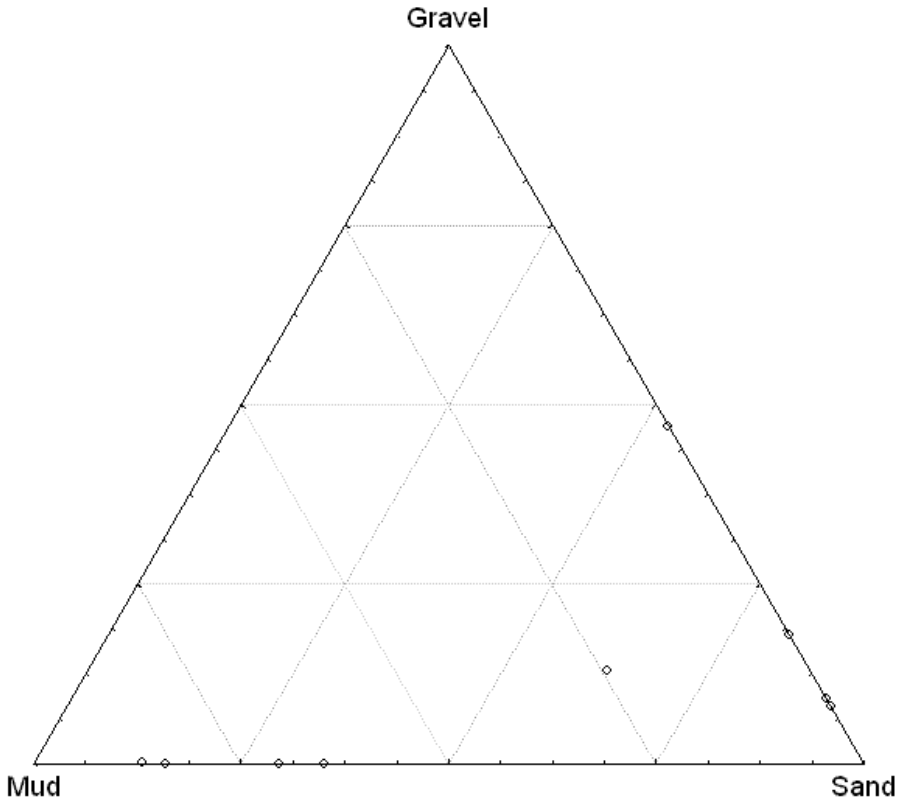
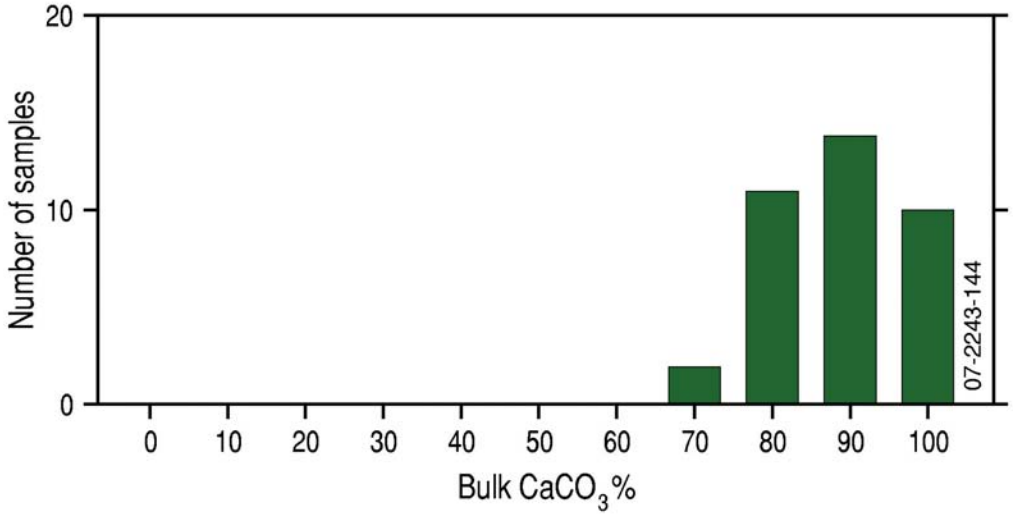


Figure 5.22. Textural composition (mud:sand:gravel ratio) of a) deep/hole/valley; b) terrace; and c) slope sediments within the TP.

a)



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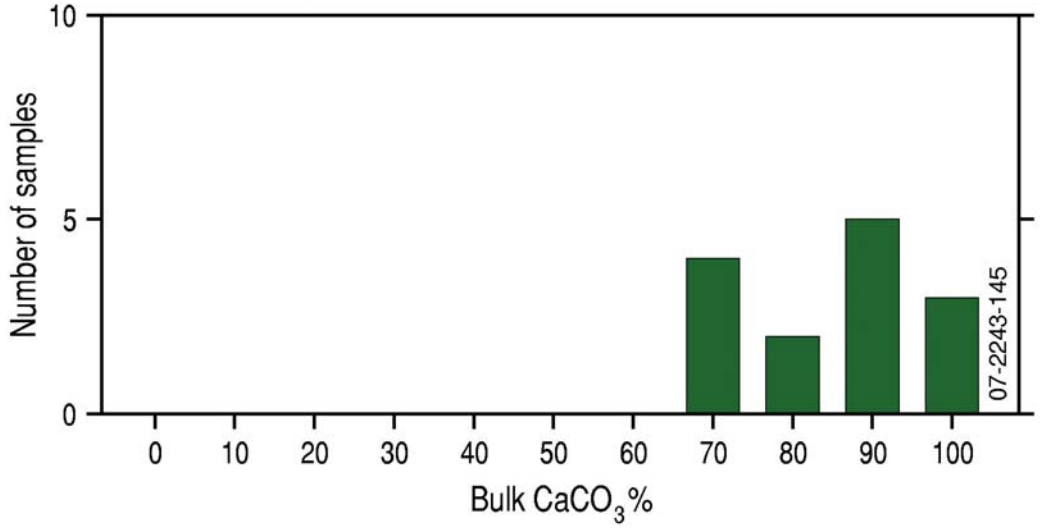

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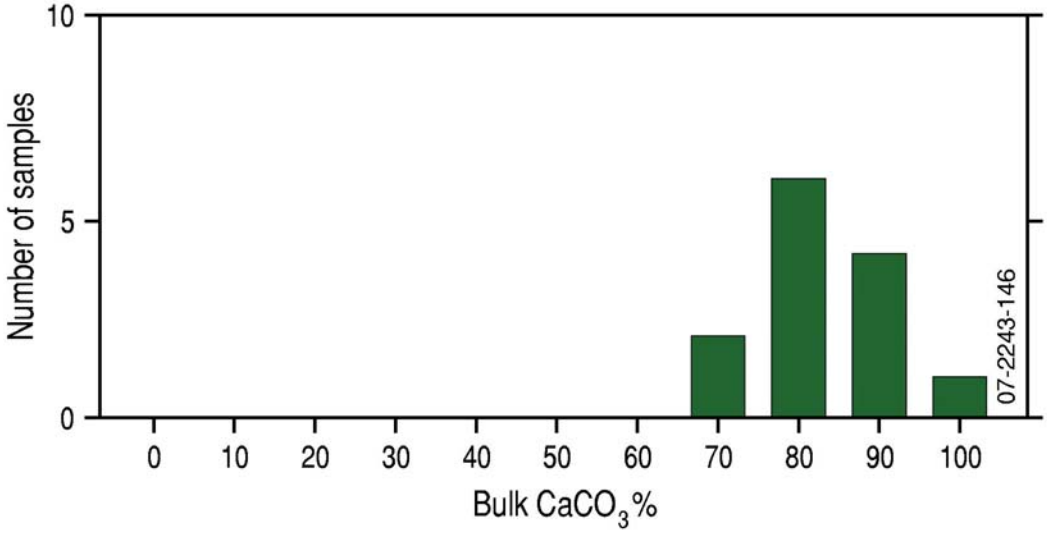


Figure 5.23. Carbonate content of a) deep/hole/valley; b) terrace; and c) slope sediments within the TP.

5.7. NORTHWEST TRANSITION (NWT)

5.7.1. Geomorphology and bathymetry

The Northwest Transition (NWT) covers a total area of 183,550 km², all of which is situated in the NWMR (Fig 5.1). This bioregion represents 17% of the total area of the NWMR (Table 5.1). The NWT is located off the shelf between the Dampier Archipelago and Lacepede Island. It is separated from the coast by the NWSP and extends to the EEZ boundary in the west. It is bounded to the south by the Northwest Province and to the north by the TP.

A total of 96,360 km² (53%) of the NWT occurs on the slope (Fig 5.24b; Table 5.12). Smaller areas in the northwest of the region are located on the Argo Abyssal Plain (40,650 km², 22%) and rise (3,800 km², 2%). The eastern boundary is coincident with the shelf break. Water depths in the bioregion range from 10 m near the shelf break to approximately 5,980 m on the Argo Abyssal Plain (Fig 5.25a). Water depths vary greatly across the bioregion with 34% of the area occurring in depths of <500 m and 21% in depths of >5,000 m. (Fig. 5.25 a& b).

The NWT contains similar geomorphology to the adjacent TP and features such as the Argo Abyssal Plain and Rowley Terrace straddle the boundary between them. The NWT is dominated by slope (unassigned) (96,360 km², 53%), followed by terraces (38,420 km², 21%) and abyssal plain/deep ocean floor (40,650 km², 22%). Other geomorphic features include: rise, ridges, canyons, deeps/holes/valleys, knolls/abyssal hills/peaks, aprons/fans, reefs and saddles each cover <4,000 km² (2%) (Table 5.12).

A total of eight significant features have been identified for the NWT. Slope (unassigned) forms 96,360 km² (52%) of the NWT and is likely to be characterised by different physical attributes from slope in adjacent bioregions because large areas of it lie in deepwater (>4,000 m) adjacent to the Argo Abyssal Plain.

The NWT contains >60% of the area of the Argo Abyssal Plain in the NWMR. This represents 41% of the total area of AP/DOF in the NWMR. This feature has a geological history and morphology that differs from areas of abyssal plain/deep ocean floor elsewhere in the NWMR and has influenced sediment deposition in this area (Chapter 3).

Terraces on the upper slope are a continuation of similar features in the TP. These features cover an area of approximately 22,900 km² or 11% of the NWT. Individual features in the NWT are generally larger than those in the TP. Five terraces, each exceeding 10,000 km² in area, occur in deepwater and cover approximately 27,900 km² or 13% of the NWMR. This area includes the southern half of the Rowley Terrace. These features have been shown to have homogeneous sedimentology at a NWMR scale (Chapter 4), and therefore no information can be added by analysis at a planning region scale.

Reefs of the Rowley Shoals comprise 12% of the total area of this feature in the NWMR, and are known to differ from hard-coral reefs occurring elsewhere in the NWMR by their bathymetry, with significant areas occurring in water depths >150 m. Aprons/fans, ridges, knolls and rise in the NWT form significant portions of the total NWMR area for these features.

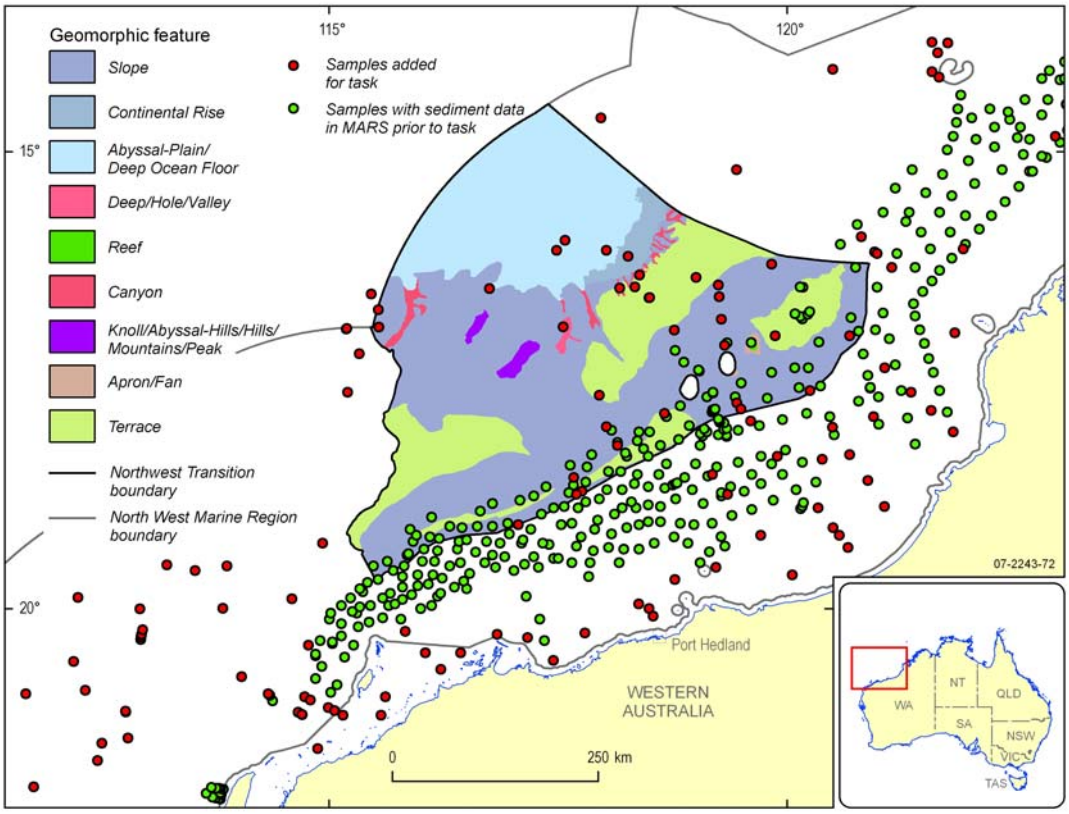
5.7.2. Sample Coverage

The NWT is represented by 125 samples (Figs. 5.24a). More than 75% of samples occur on the upper slope within 100 km of the shelf break and in <500 m water depth (Fig. 5.25a). Remaining samples occur on the slope, rise and AP/DOF in the northern half of the bioregion. These provide coverage of water depths ranging from 500 to >5,000 m.

Average sample density across the bioregion is approximately 1:1,450 km². A total of 88 (70%) samples occur on areas of the slope (unassigned) resulting in an average density of approximately 1:1,100 km² in this feature. Terraces contain 31 (25%) samples resulting in an average density of approximately 1:1,240 km². AP/DOF contains three samples (<1%) giving an average density of 1:13,550 km².

Samples achieve adequate coverage to describe the sedimentology in three of the eight significant features identified for this bioregion. Details of coverage of the slope and Argo Abyssal Plain are given above.

Despite targeted sample addition, not enough samples were collected from reefs, aprons/fans, knolls and continental rise in the TP to describe the sedimentology in these features. A total of 34 samples were added to the NWT for this study. These increased sample coverage on the slope (unassigned) (22 samples added), the Argo Abyssal Plain (3), rise (1) and terrace (5). No samples collected from reefs, aprons/fans or knolls were available for procurement. Sedimentology of these features is discussed in Chapters 3 and 6.


Geomorphic feature
Slope
Continental Rise
Abyssal-Plain/
Deep Ocean Floor
Deep/Hole/Valley
Reef
Canyon
Knoll/Abyssal-Hills/Hills/
Mountains/Peak
Apron/Fan
Terrace
Northwest Transition
boundary
North West Marine Region
boundary
Samples added
for task
Samples with sediment data
in MARS prior to task
115°
120°
15°
20°
Port Hedland
WESTERN
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a)

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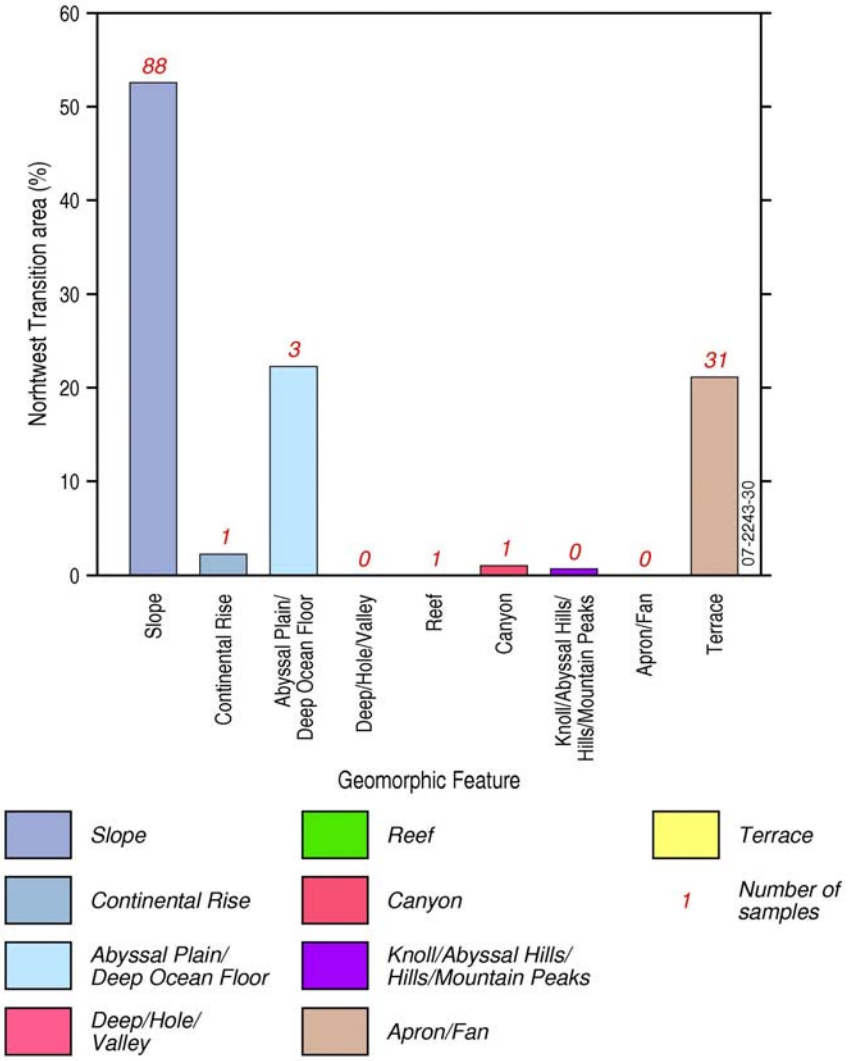
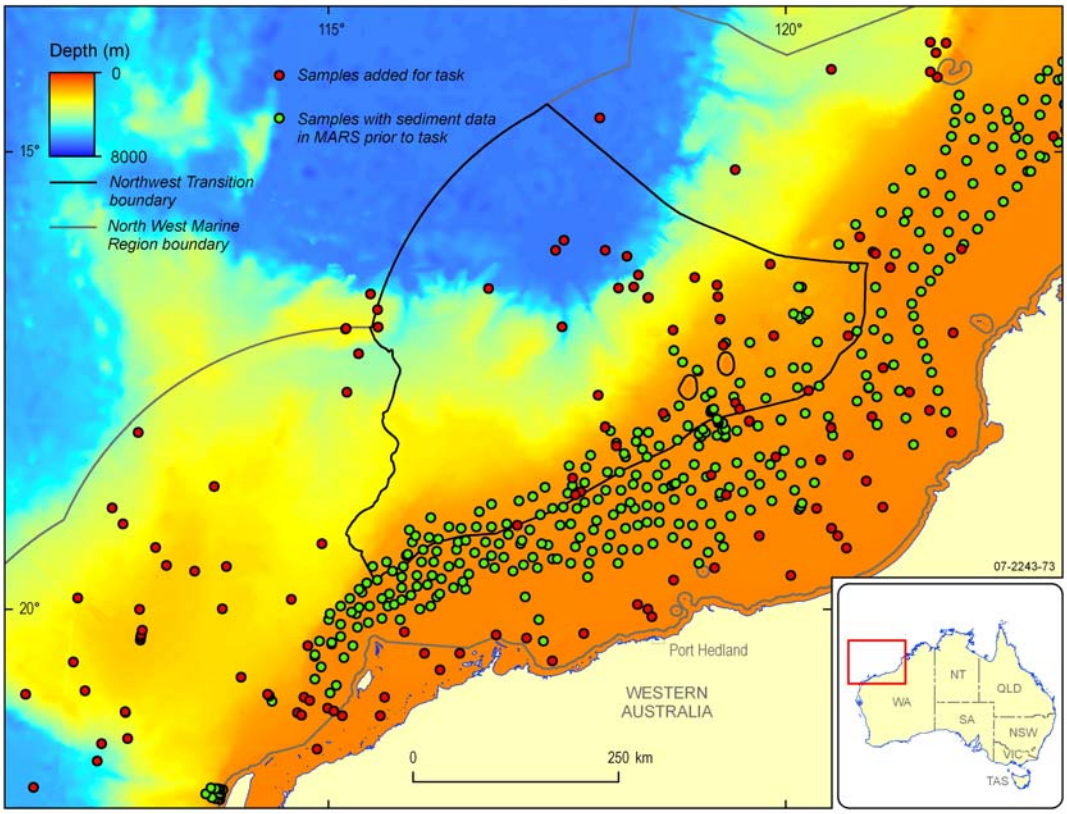


Figure 5.24. a) Geomorphology of the Northwest Transition (NWT) with location of sediment samples; and b) Percentage area of each geomorphic feature within the NWT with number of corresponding sediment samples.

a)



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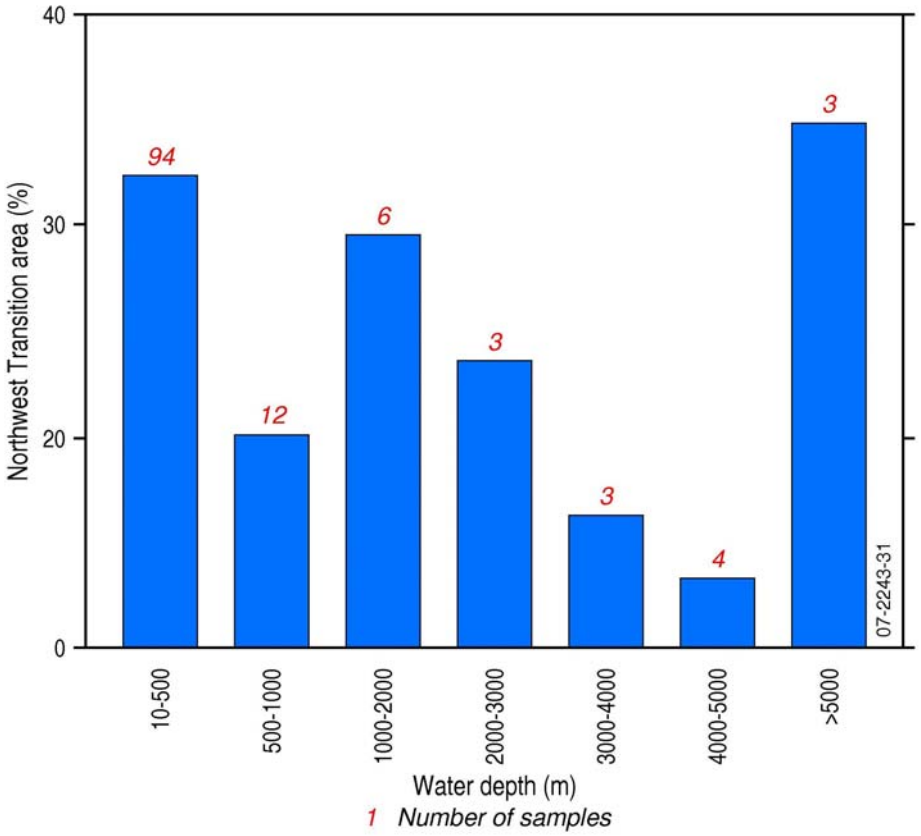


Figure 5.25. a) Bathymetry of the Northwest Transition (NWT) with location of sediment samples; and b) Percentage area of each bathymetry class within the NWT with number of corresponding sediment samples.

Table 5.12. Details of the geomorphology of the Northwest Transition.

Feature	% of bioregion area covered	% of NWMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
Geomorphic Province			
Slope	75.78	21.48	3.47
Rise	2.07	23.97	3.72
AP/DOF	22.15	40.63	1.41
Geomorphic Feature			
Slope (unassigned)	52.50	31.03	7.01
Rise (unassigned)	2.07	23.97	3.97
AP/DOF* (unassigned)	22.15	41.18	1.65
Deep/hole/valley	0.25	0.49	0.27
Reef	0.07	6.21	0.28
Canyon	1.08	18.42	1.86
Knoll/abyssal hills/mountains/peak	0.75	68.62	1.16
Apron/fan	0.20	50.61	3.18
Terrace	20.93	16.92	6.63

Table 5.13. Distribution of water depths covered by the geomorphology in the Northwest Transition.

Feature	Depth Range (m)	Mean Depth (m)
Geomorphic Province		
Slope	1 – 5,705	1,540
Rise	4,220 – 5,695	5,160
AP/DOF	4,575 – 5,975	5,680
Geomorphic Feature		
Slope (unassigned)	180 – 5,700	1,540
Rise (unassigned)	4,220 – 5,695	5,160
AP/DOF (unassigned)	4,575 – 5,975	5,680
Apron/fan	135 – 460	335
Canyon	2,830 – 5,705	2,875
Deep/hole/valley	3,160 – 4,930	4,050
Knoll/abyssal hills/mountains/peak	1,700 – 2,550	1,910
Reef	1 – 420	145
Terrace	205 – 4,025	1,370

5.7.3. Sedimentology of the Northwest Transition

The NWT contains 125 grain size and 121 carbonate assays. A total of 100 (80%) samples occur within 100 km of the shelf break (Fig. 5.24a). Sediments in this area show variable textural properties. Sand is the dominant fraction in all samples, ranging from 8 to 100% with 63 samples exceeding 50%. Mud ranges from <1 to 87% with 28 samples exceeding 50%. Gravel

varies from <1 to 83% and comprises <1% of sediment in 54 (43%) sample. Gravel is the dominant fraction in three samples with contents ranging from 64 to 92%.

Samples are distributed more sparsely over the rest of the slope, rise and AP/DOF. Textural properties of samples from this area show patterns with water depth. Samples from the area adjacent to the Rowley Shoals contain 25 to 95% sand, 0 to 75% mud and <5% gravel. Samples on the middle to lower slope contain <40% sand, and frequently <20%. Samples on the AP/DOF contain >80% mud with the remainder of sediment composed of sand.

Carbonate content of sediments in the NWT is also associated with water depth. Bulk carbonate ranges from 3 to 99%, and attains >50% in 118 samples. Low <1 to 76% carbonate contents occur only on the AP/DOF and continental rise. Within 100 km of the shelf break, carbonate content exceeds 80% in 95% of samples. For middle lower slope areas carbonate ranges from 40 to 80%, except adjacent to the Rowley Shoals where it exceeds 80%.

Carbonate content of gravel and mud textural size fractions display similar patterns to bulk carbonate. Carbonate sand exceeds 80% in all samples where sand was present, including samples from all geomorphic provinces of the NWT.

5.7.4. Sedimentology of significant geomorphic features

5.7.4.1. Slope

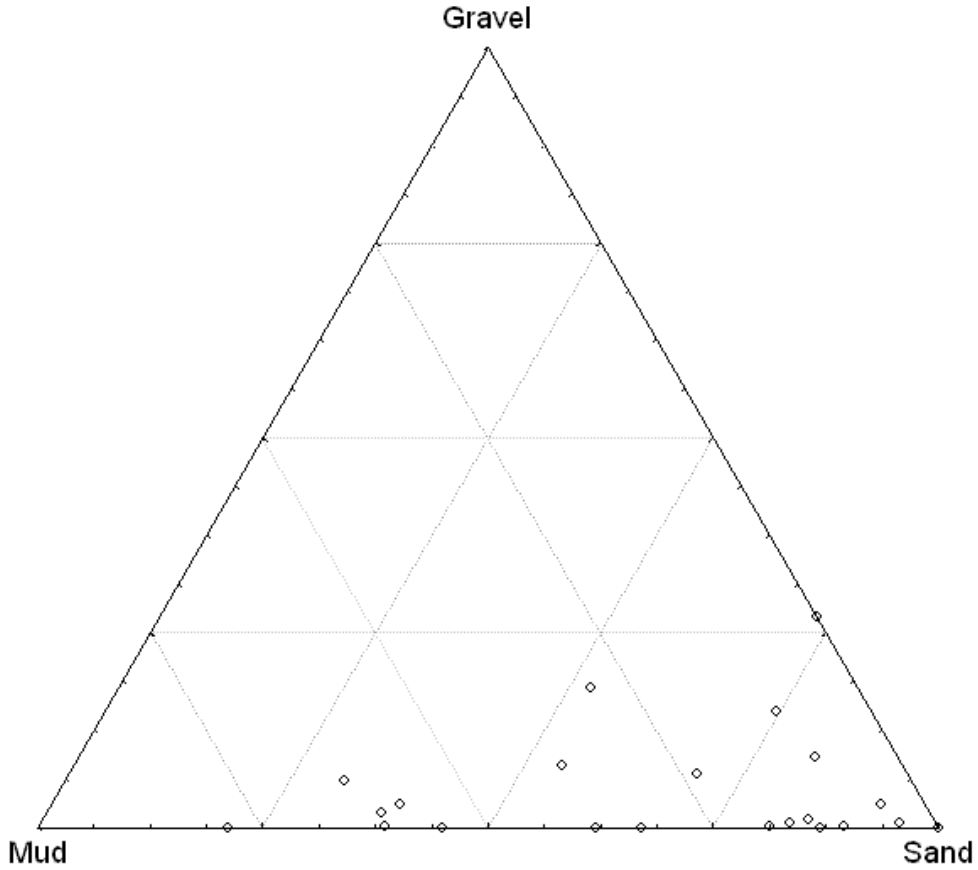
A total of 88 samples were obtained from the slope (Fig. 5.23b). Sand is the dominant fraction with contents generally ranging between 8 and 100% with 49 samples exceeding 50% (Fig. 5.26b). Mud is the next most abundant fraction and contents generally ranging between 1 and 88% and 34 samples containing >50% mud. Gravel concentrations generally range from 1 to 49%. However, gravel contents of up to 92% occur in three samples. Bulk carbonate content varies from 42 to 98%, with 84 samples exceeding 50% carbonate (Fig. 5.27b). Carbonate sand content ranges from 78 to 98% with 31 samples exceeding 90%. Carbonate mud content varies between 66 to 92% with three samples exceeding 90%. Carbonate gravel content ranges from 65 to 100% and attains 100% in 23 samples.

5.7.4.2. Argo Abyssal Plain

A total of three samples were obtained from abyssal plain/deep ocean floor environments. Despite the relatively large area of this province and widely spaced sample locations, variability in texture and composition of sediments is low. Mud is the dominant fraction, comprising >80% in all samples (Fig. 5.26 c). While sand comprises <20%, gravel was not present. Bulk carbonate content varies between 7 and 76%, although values <1% were observed at two locations. One sample contained >60% carbonate mud content. The small number of assays (3) for this feature means that these carbonate content percentages do not necessarily describe the entire distribution of textural and compositional characteristics of abyssal plains/deep ocean floor in the NWT.

5.7.4.3. Upper Slope Terraces

A total of 22 samples were obtained from upper slope terraces. Sand is the dominant fraction with contents generally ranging from 21 to 100% and exceeding 50% in 16 samples (Fig. 5.26a). Mud is the next most abundant fraction with contents ranging from 4 to 79% with six samples containing >50% mud. Gravel content attains 27%. Sediments in adjacent slope areas show similar textural properties. Bulk carbonate content generally varies between 82 to 99% with 11 samples containing >90% (Fig. 5.27a). Carbonate sand content ranges from 91 to 97% with five samples exceeding 95%. Carbonate mud content varies between 76 and 84% and exceeds 80% in one sample. Carbonate gravel attains 100% in nine samples.



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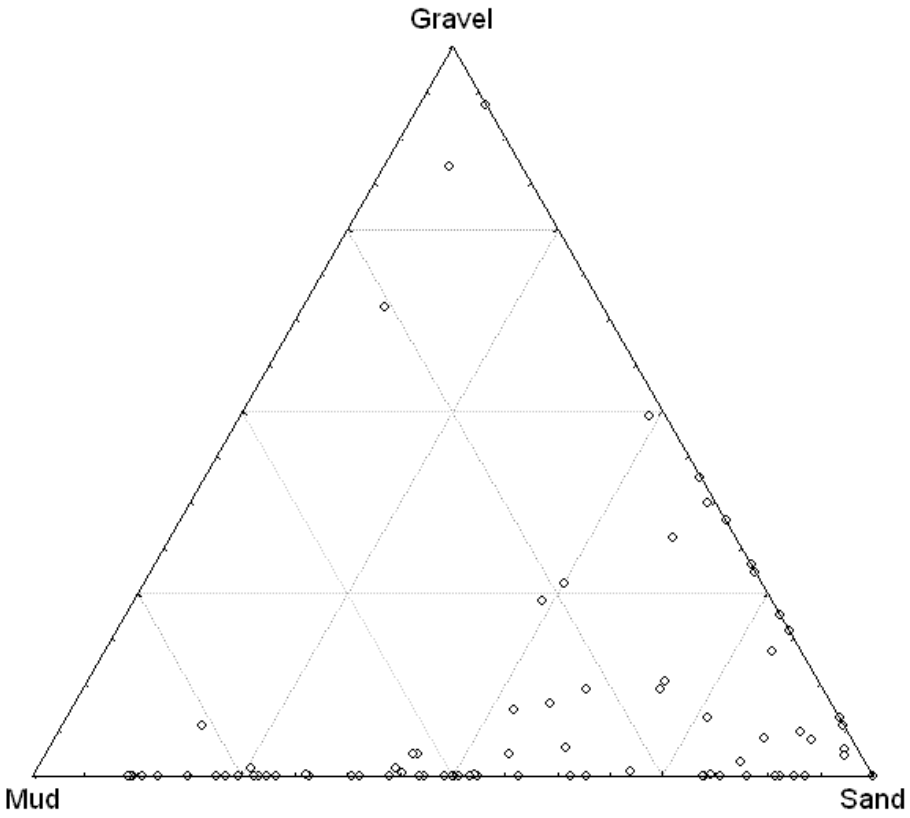

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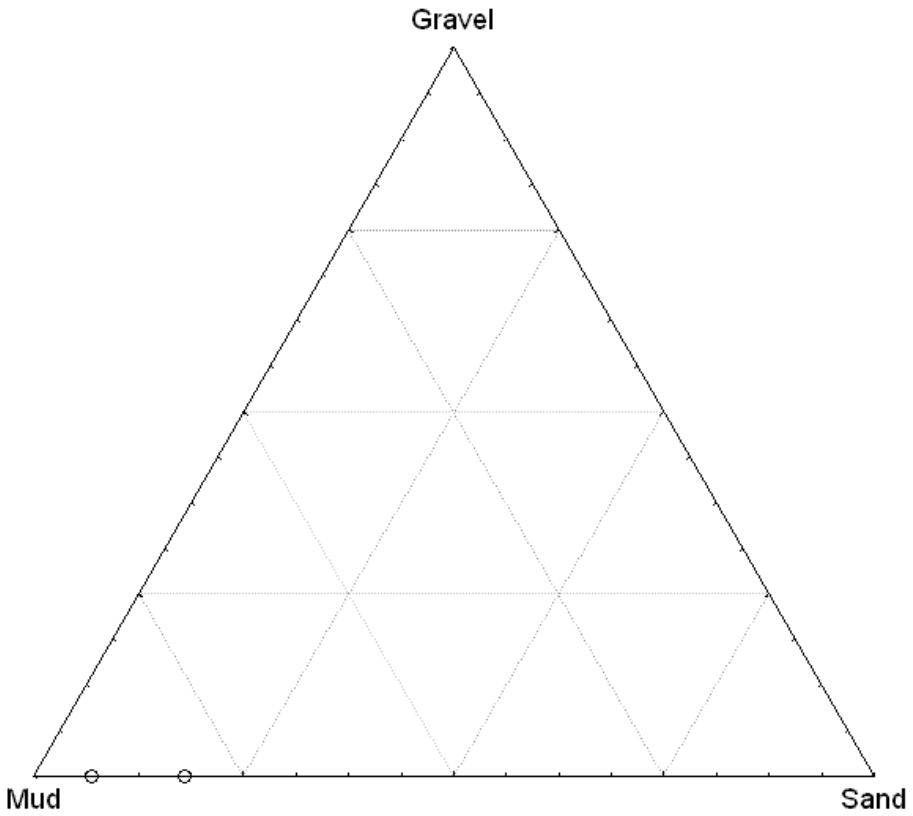
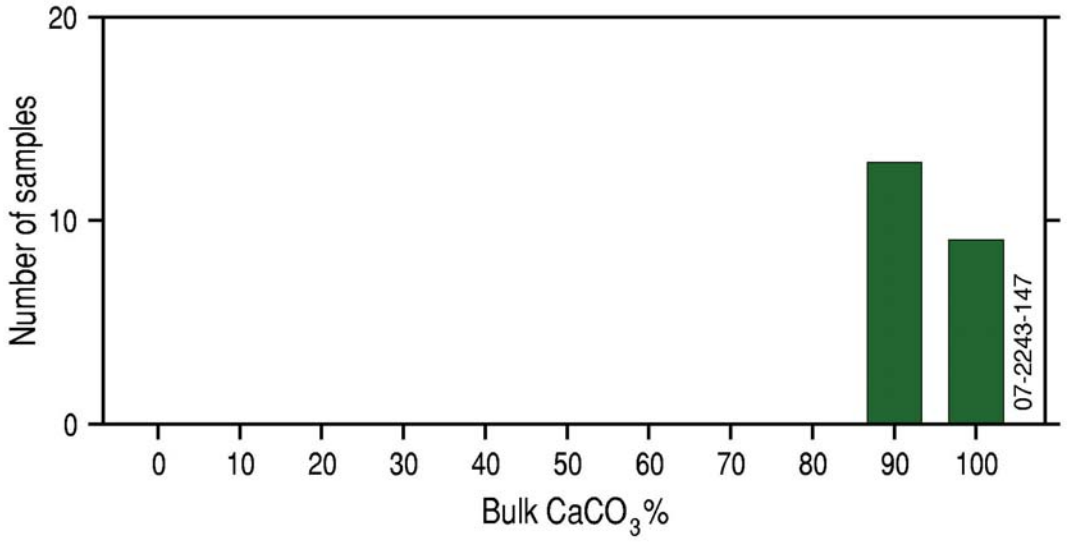


Figure 5.26. Textural composition (mud:sand:gravel ratio) of a) upper slope terrace and b) slope sediments c) Argo Abyssal Plain within the NWT.

a)



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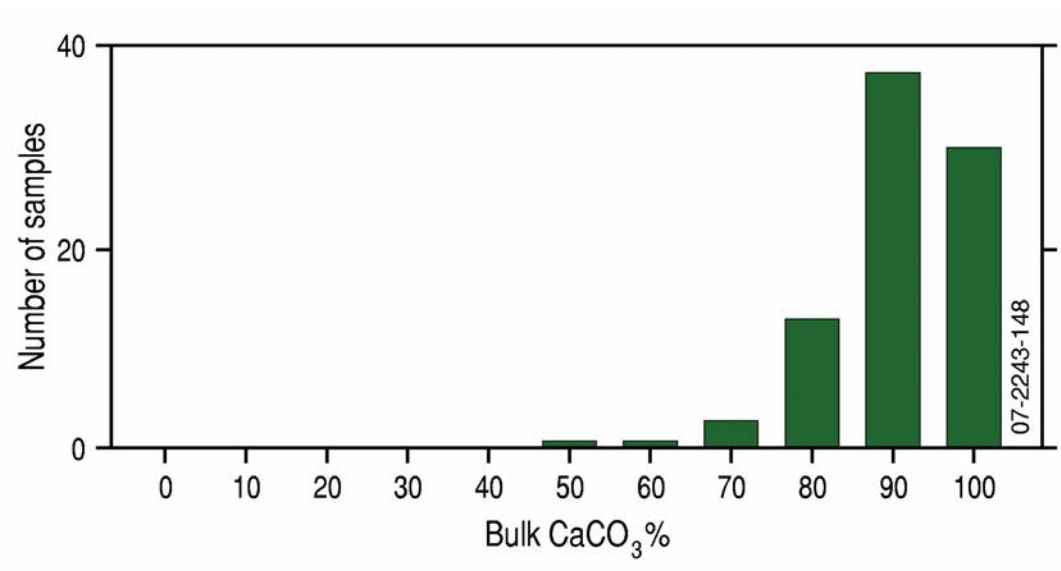


Figure 5.27. Carbonate content of a) terrace and b) slope sediments within the NWT.

5.8. NORTHWEST PROVINCE (NWP)

5.8.1. Geomorphology and bathymetry

The Northwest Province (NWP) covers a total area of 188,170 km², all of which is situated in the NWMR (Fig. 5.1). This bioregion represents 15% of the total area of the NWMR (Table 5.1) and approximately 2% of the total area of the EEZ. The NWP is located offshore of the western Australian margin between Exmouth and Port Hedland and is separated from the coast by the Northwest Shelf Province. It is bounded to the north by the NWT and to south by the Central Western Transition. This bioregion is composed entirely of slope environments, approximately 400 km from the shelf break to the outer EEZ boundary (Fig. 5.28a; Table 5.14). Water depths vary from 10 m locally near the shelf break to over 5,170 m on the lower slope, although almost 80% of the bioregion lies in depths between 1,000 and 3,000 m (Fig. 5.29b).

The slope contains seven types of geomorphic features. Features covering significant areas of the Northwest Province include: plateaus (49,310 km², 28% bioregion area), deeps/holes/valleys (33,150 km², 19%), terraces (14,530 km², 8%), trenches/troughs (10,120 km², 6%) and canyons (4,090 km², 2%). Ridges and knoll/abyssal hills/mountains/peaks each cover less than 1,500 km² (<1%) (Table 5.14). Geomorphic features could not be identified over 71,500 km² (38%) of the total area.

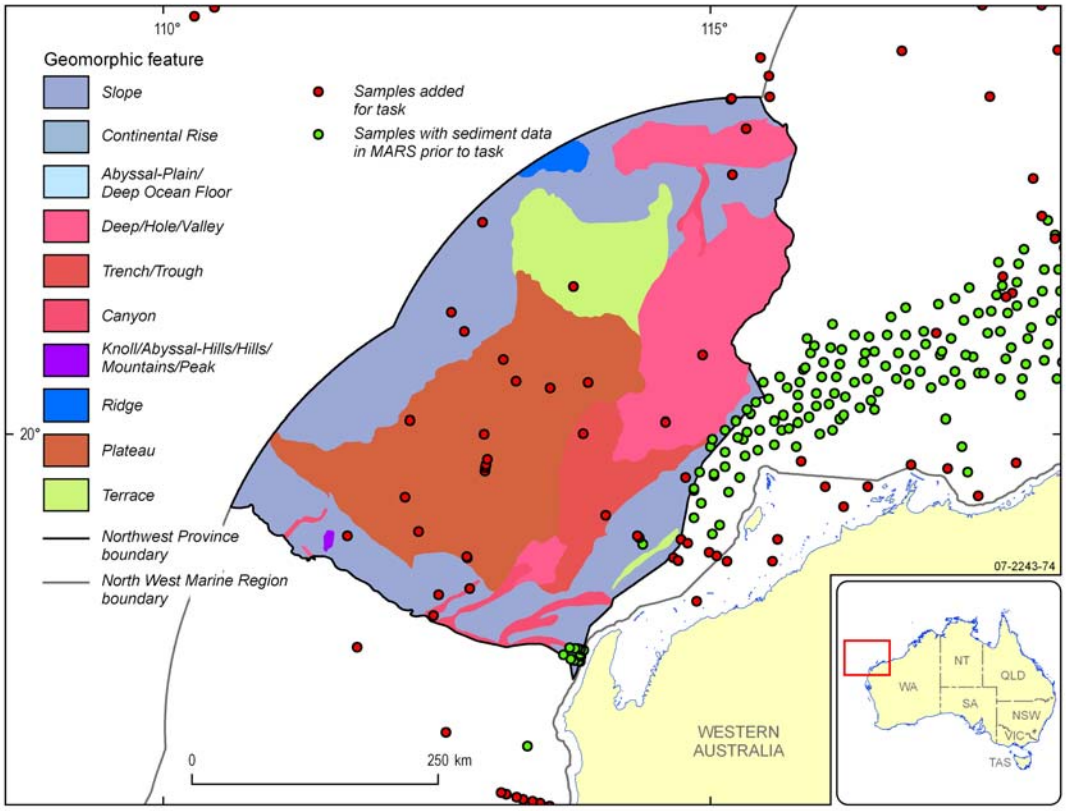
Four significant geomorphic features are identified for the NWP. Slope (unassigned) and deeps/holes/valleys cover significant areas of the bioregion (37 and 19% respectively). Trench/troughs in the NWP represent 100% of the area of this feature occurring in the NWMR. The Exmouth Plateau covers approximately 28% of the bioregion, and forms approximately 50% of the total area of plateaus in the NWMR. However, plateaus located in deep water have been shown to have relatively homogeneous sedimentology across the NWMR and therefore no information can be added by analysis at a bioregion scale.

5.8.2. Sample Coverage

The NWP is represented by 58 sample points (Figs. 5.28a). Approximately 32 (55%) samples occur on the upper slope within 80 km of the shelf break and in <1000 m water depth (Fig. 5.29a). A total of 12 samples occur clustered in a 15 km² area in the southeast corner of the bioregion around the heads of the Caperange Canyon. Other samples are distributed sparsely across the rest of the bioregion area, reaching an average sample density of 1:3,100 km².

Samples achieve adequate coverage to describe the sedimentology for all of the significant features. Slope (unassigned) contains 32 samples, resulting in an average density of 1:2,060 km². Plateaus contain 16 samples, resulting in an average density of 1:3,080 km². Deeps/holes/valleys and trenches/troughs contain three samples, resulting in an average density of 1:11,050 km² and 1:3,370 km², respectively. This study added 33 samples to the NWP, improving coverage of slope (unassigned) (8 samples added), plateaus (14), deeps/holes/valleys (3) and trenches/troughs (2).

a)



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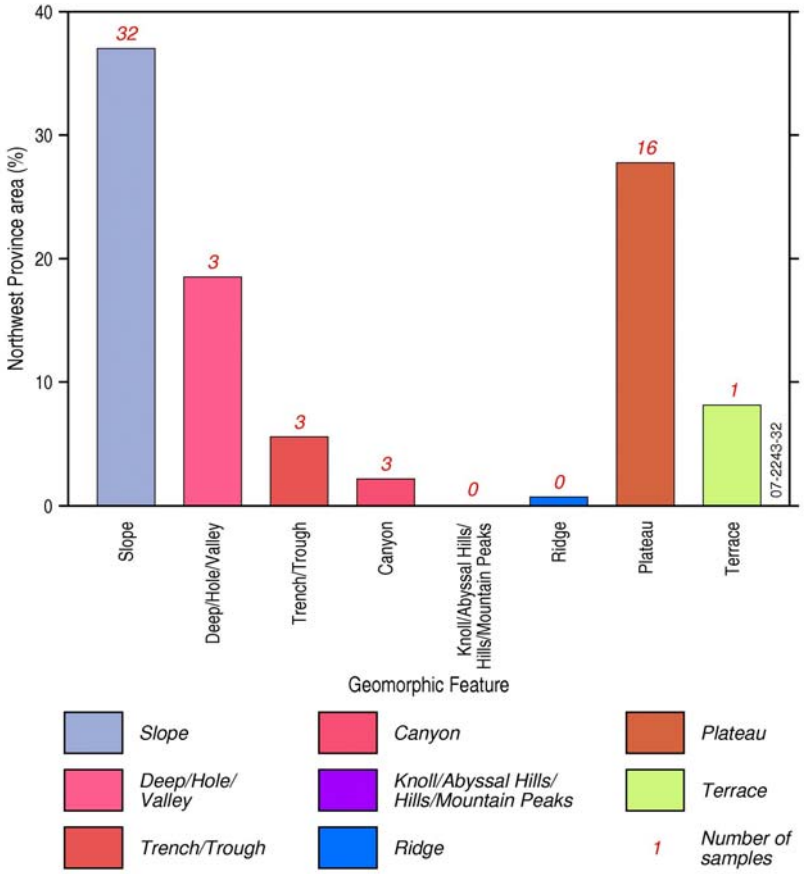
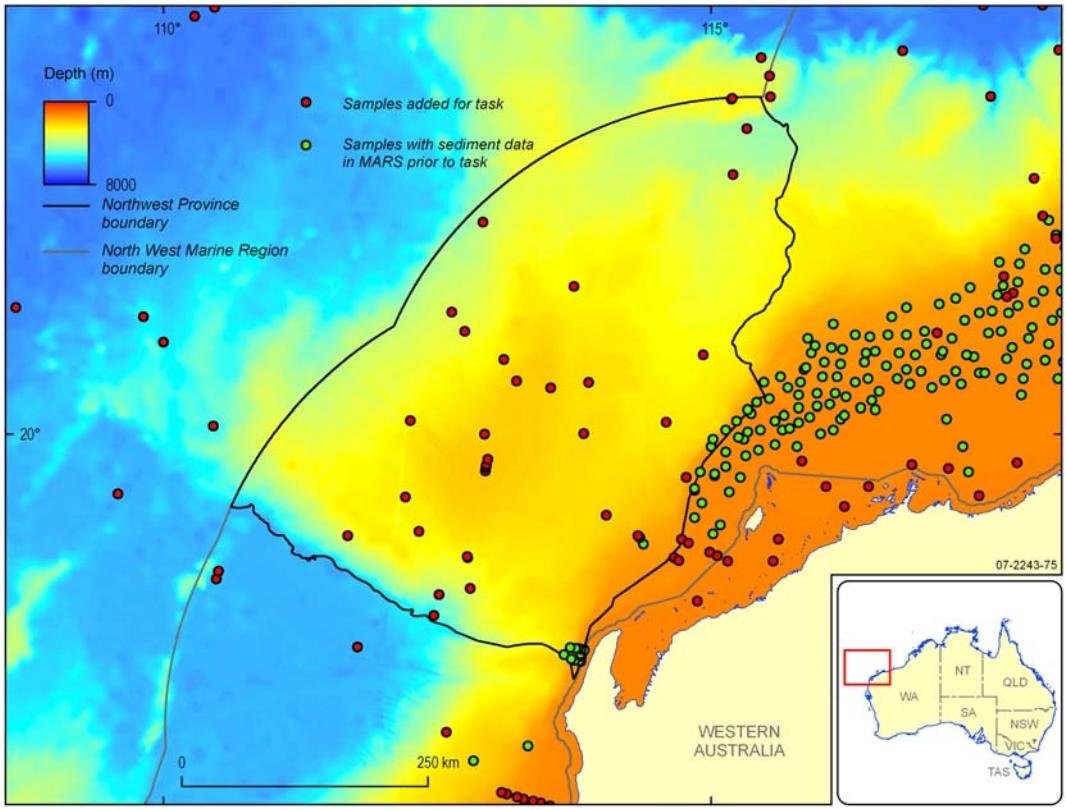


Figure 5.28. a) Geomorphology of the Northwest Province (NWP) with location of sediment samples; and b) Percentage area of each geomorphic feature within the NWP with number of corresponding sediment samples.

a)



b)

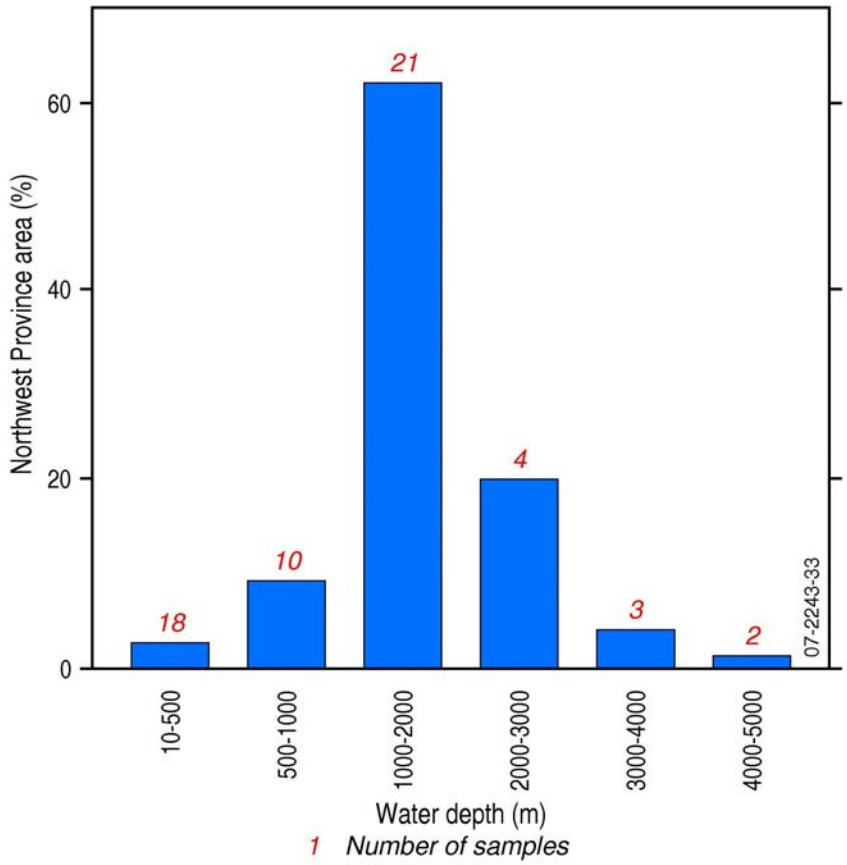


Figure 5.29. a) Bathymetry of the Northwest Province (NWP) with location of sediment samples; and b) Percentage area of each bathymetry class within the NWP with number of corresponding sediment samples.

Table 5.14. Details of the geomorphology of the Northwest Province.

Feature	% of bioregion area covered	% of NWMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
Geomorphic Province			
Slope	100	27.58	4.46
Geomorphic Feature			
Slope (unassigned)	36.90	21.22	4.80
Deep/hole/valley	18.56	35.53	20.07
Trench/trough	5.67	100	5.82
Canyon	2.29	37.91	3.83
Knoll/abyssal hills/mountains/peak	0.09	8.45	0.14
Ridge	0.75	23.07	1.20
Plateau	27.61	52.40	3.30
Terrace	8.14	6.40	2.51

Table 5.15. Distribution of water depths covered by the geomorphology in the Northwest Province.

Feature	Depth Range (m)	Mean Depth (m)
Geomorphic Province		
Slope	125 – 5,165	1,675
Geomorphic Feature		
Slope (unassigned)	125 – 5,165	5,045
Deep/hole/valley	535 – 5,045	4,510
Trench/trough	570 – 1,285	715
Canyon	200 – 4,815	4,615
Knoll/abyssal hills/mountains/peak	2,440 – 3,955	1,515
Ridge	1,665 – 2,085	420
Plateau	830 – 2,110	1,280
Terrace	290 – 2,060	1,770

5.8.3. Sedimentology of the Northwest Province

The NWP contains 58 grain size and 59 carbonate assays. Mud occurs in all but two sites with contents ranging from <1 to 97%. Mud contents for the area within 100 km of the shelf break have the highest variability (0 to 97%). Elsewhere in the bioregion, mud content consistently attains 50% with the remaining sample volume composed of sand (0 to 50%). Gravel comprises <1% in 53 (91%) samples. Gravel contents of >1% are only present in samples within 100 km of the shelf break, with contents exceeding 5% in two samples.

Carbonate content in the NWP exceeds 55% in all samples and exceeds 80% in 14 (24%) samples. Carbonate contents show some spatial zoning, but this does not correspond directly to changes in water depth. Within 100 km of the shelf break carbonate contents generally exceed

80% and range from 60 to 80% elsewhere in the bioregion. The exception to this trend occurs in the southern corner of the bioregion, near the shelf break in samples collected from submarine canyons. These comprise less carbonate than those for the rest of the bioregion with contents of <80% and mostly between 55 and 70%. Carbonate sand and gravel contents in this area generally exceed 75%. Carbonate mud contents are consistently <70%.

Across the NWP carbonate content generally ranges from 60 to 100% for the sand fraction and 60 to 80% for mud.

5.8.4. Sedimentology of significant geomorphic features

5.8.4.1. Slope

A total of 32 samples were obtained from slope features (Fig 5.30b). Mud is the dominant fraction, with contents ranging from 15 to 96% and 25 samples comprising >50% mud. Sand is the next most abundant fraction, with contents ranging from 4 to 85% and seven samples containing >50%. Sand concentrations are generally higher closer to the shelf break where samples show similar sedimentology to that observed in adjacent shelf features. Gravel concentrations generally range from <1 to 5% (Fig. 5.30b). Samples that contain gravel occur near the shelf break. Bulk carbonate content varies between 57 and 93% with 22 samples exceeding 70% (Fig. 5.31a). Carbonate sand varies from 75 to 95% with 10 samples containing >90%. Carbonate mud varies from 59 to 81% with eight samples exceeding 70%. Carbonate gravel ranges between 90 and 100% and attains 100% in seven samples.

5.8.4.2. Deep/hole/valleys

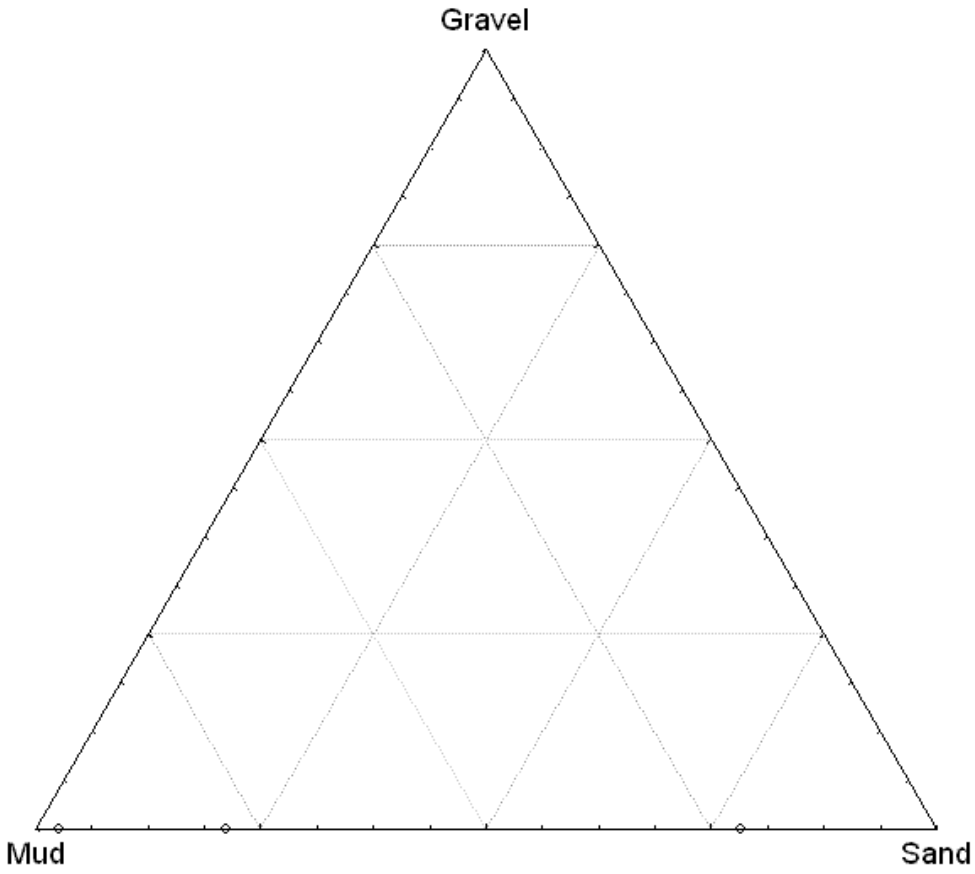
A total of three samples were obtained from deeps/holes/valleys (Fig. 5.30a). Sediments are principally composed of sand and mud, with contents ranging from 3 to 78% and 22 to 97%, respectively (Fig. 5.30a). Bulk carbonate content of sediments comprises between 68 and 85%, with high bulk carbonate contents often corresponding to increases in sand content. Samples occurring on the slope adjacent to deeps/holes/valleys generally show similar sedimentology to samples collected within these features. The small number of assays for this feature means that samples may not accurately characterise the range and distribution of sediments present in deeps/holes/valleys in the NWP.

5.8.4.3. Trench/troughs

A total of three samples were obtained from trenches/troughs (Fig. 5.30c). Mud is the dominant fraction, with contents generally ranging between 84 and 89% (Fig. 5.30c). Sand is the next most abundant sediment fraction, with contents ranging between 11 and 16%. Gravel is not present. Bulk carbonate content of sediments comprises between 60 and 70% (Fig. 5.31b). Samples collected from plateaus and deeps/holes/valleys occurring adjacent to ridges in the NWP show similar sedimentology to those collected within ridges. The small number of assays for this feature means that samples may not accurately characterise the range and distribution of sediments present in trench/troughs in the NWP.

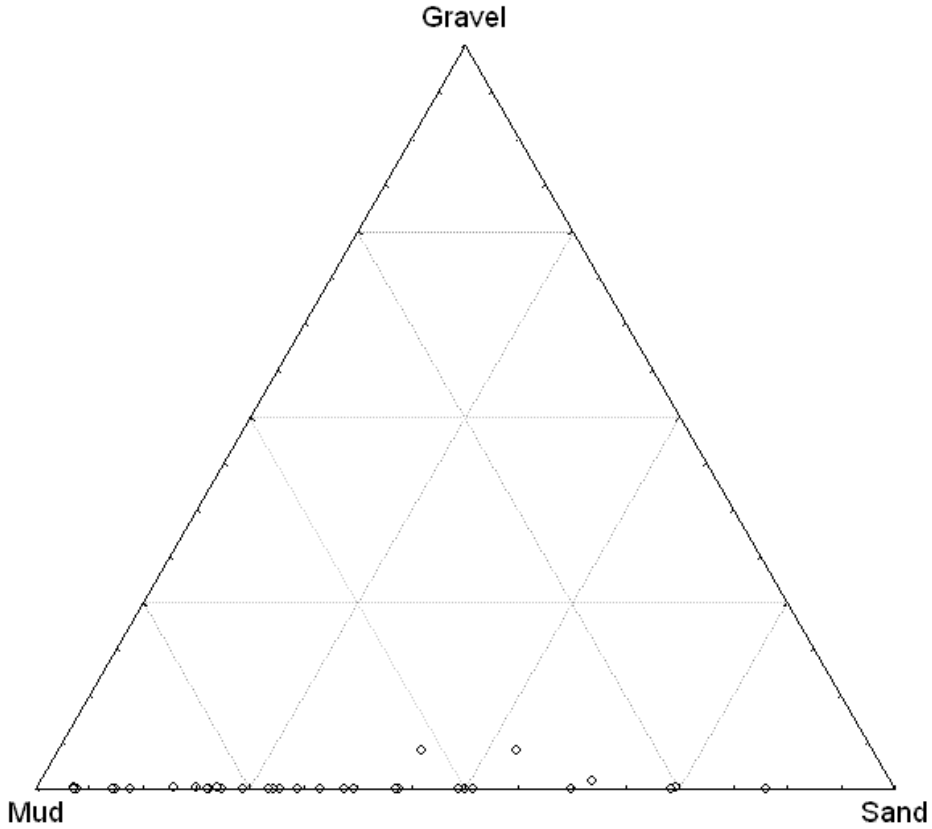
5.8.4.4. Deep water plateaus

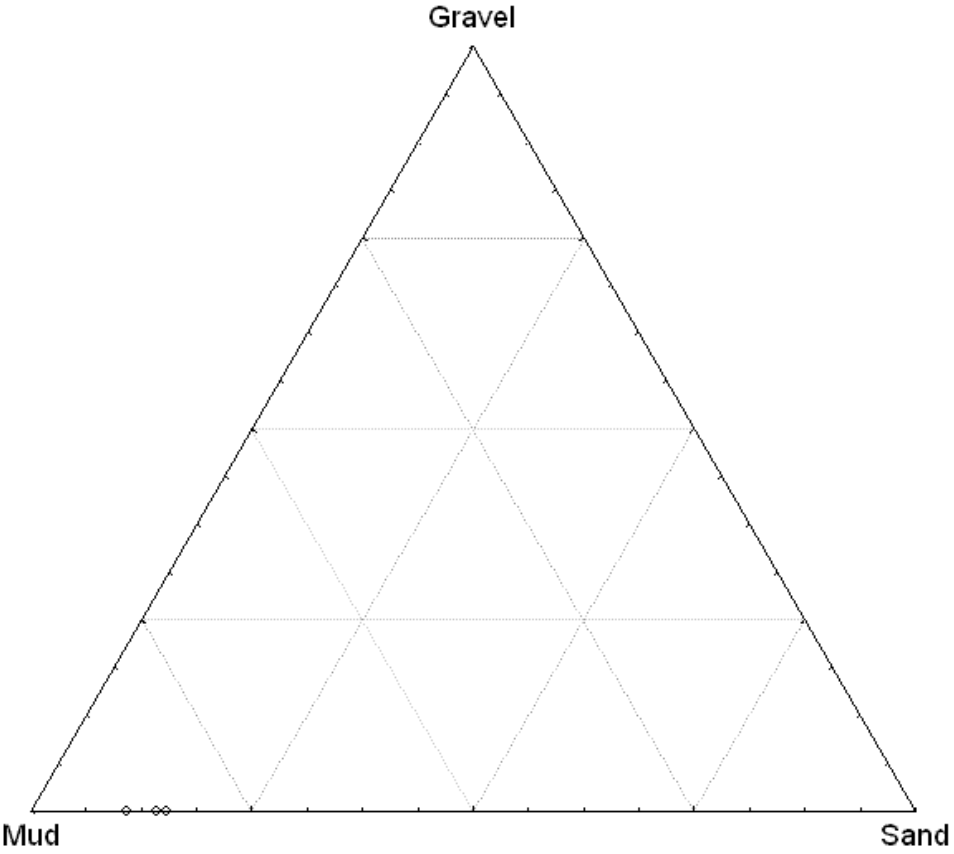
A total of 16 samples were obtained from deep water plateaus (>500m) (Fig. 5.30d). Mud is the dominant fraction, with contents varying from 51 to 83% (Fig. 5.30c). Sand is the next most abundant sediment fraction, with contents ranging between 17 and 48%. Gravel is not present. Bulk carbonate content of sediments comprises between 68 and 82% (Fig. 5.31c). Carbonate mud ranges between 68 and 87%, with 10 samples attaining >70%. Carbonate sand content varies from 92 to 99%.



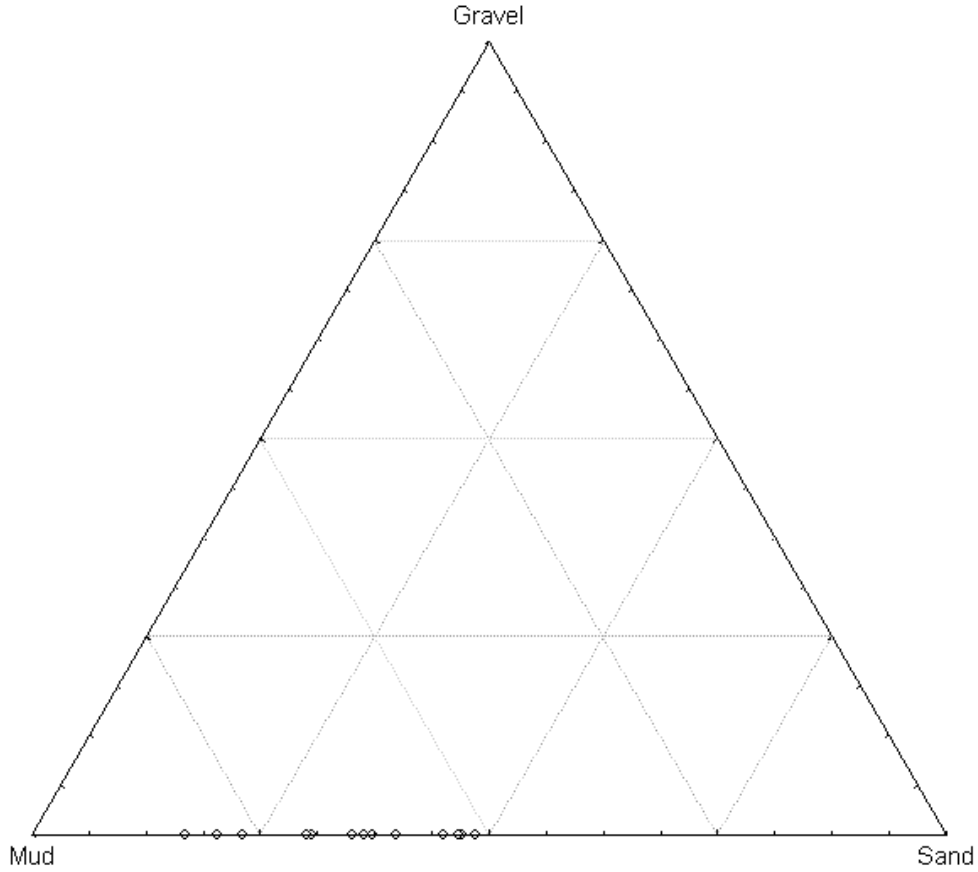
a)

b)





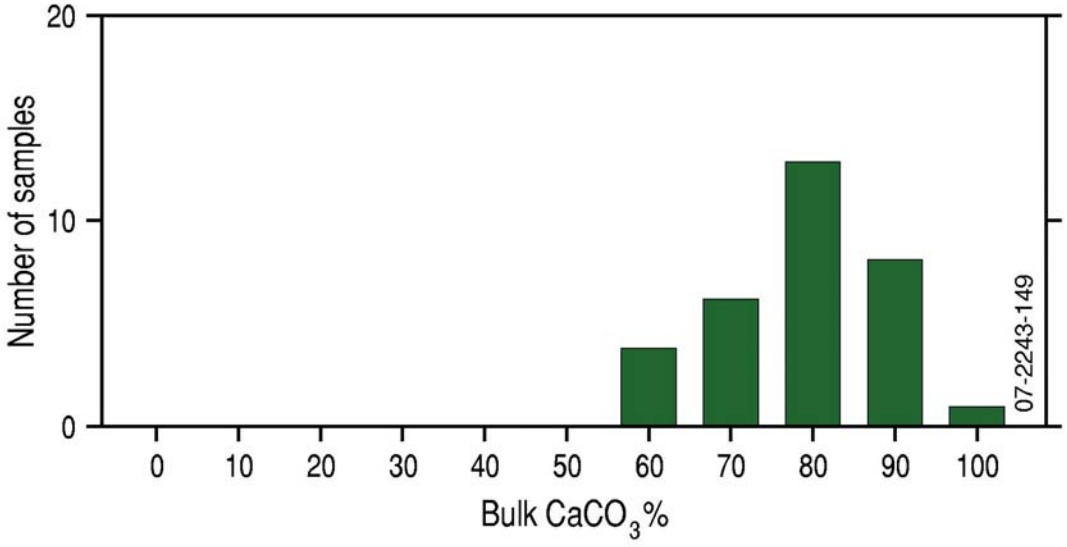
c)



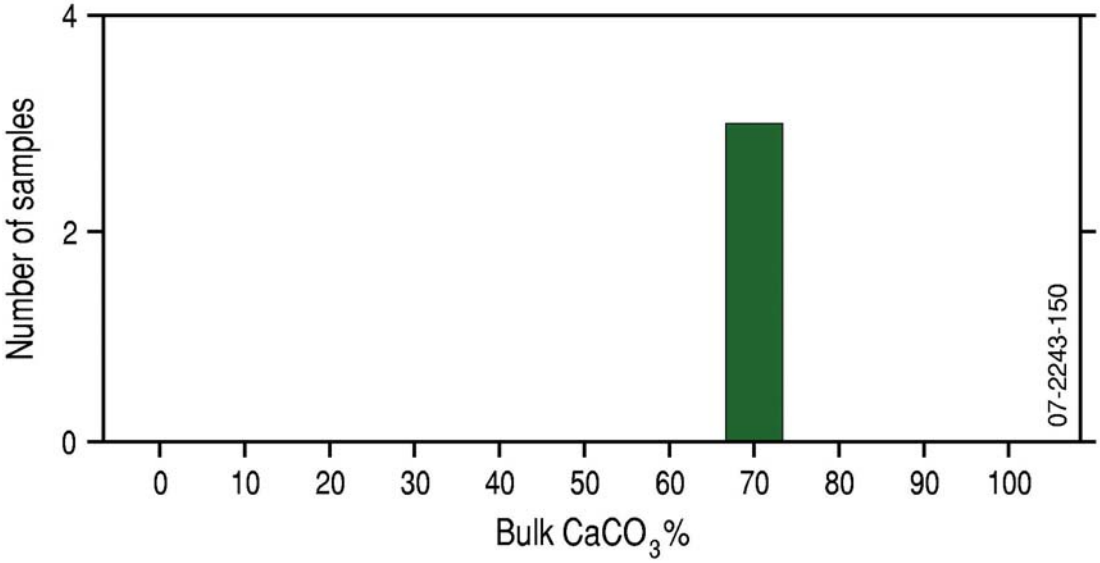
d)

Figure 5.30. Textural composition (mud:sand:gravel ratio) of a) deep/hole/valley; and b) slope c)Trench/troughs d)Deep water plateaus sediments within the NWP.

a)


20
10
0
Number of samples
0
10
20
30
40
50
60
70
80
90
100
Bulk $CaCO_3$%
07-2243-149

b)


4
2
0
Number of samples
0
10
20
30
40
50
60
70
80
90
100
Bulk $CaCO_3$%
07-2243-150

c)

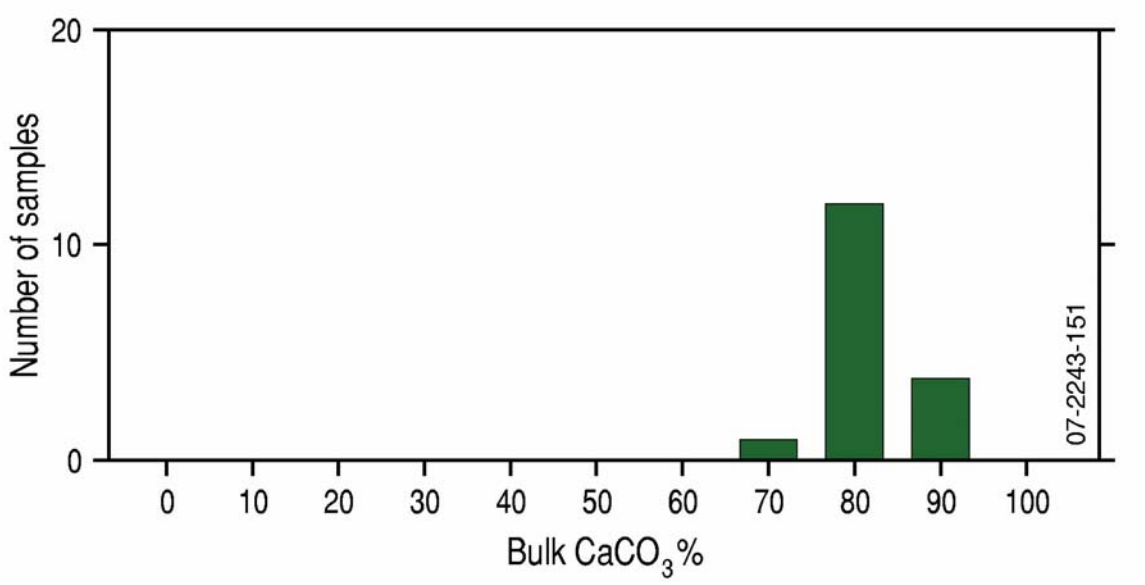


Figure 5.31. Carbonate content of a) slope b)Trench/troughs and c)Deep water plateaus sediments within the NWP.

5.9. CENTRAL WESTERN TRANSITION (CWT)

5.9.1. Geomorphology and bathymetry

The Central Western Transition (CWT) covers a total area of 162,890 km², all of which is situated in the NWMR (Fig. 5.1). This bioregion represents 15% of the total area of the NWMR. The CWT is located off the shelf between Dirk Hartog Island and Northwest Cape and is separated from the coast by the Central Western Shelf Province in the south and the Central Western Shelf Transition in the north. It lies on the southern boundary of the NWMR and is bounded to the north by the NWP and to south by the CWP (partially included in the NWMR).

More than 51,930 km² 30%) of the CWT is located on the slope (Fig. 5.32b; Table 5.16). Smaller areas in the northwest of the region are located on the Cuvier Abyssal Plain (40,080 km², 25%) and adjacent rise (7,520 km², 5%). The bioregion's eastern boundary coincides with the shelf break and comes within a few kilometres of the coast in the north near Northwest Cape. Water depths in the bioregion range from 10 m near the shelf break to approximately 5,330 m on the Cuvier Abyssal Plain (Fig. 5.33a). The bioregion contains a relatively large percentage of deep water areas relative to other bioregions in the NWMR. Approximately 69,700 km² (40%) of the CWT occurs in water depths >4000 m, and <35,000 km² (20%) of the bioregion occurs in water shallower than 1,000 m (Fig. 5.33b).

The CWT contains large areas of slope (unassigned) (51,930 km², 32% CWT area) and abyssal plain/deep ocean floor (40,080 km², 25%), terraces (36,610 km², 22%), deeps/holes/valleys (12,180 km², 7%), saddles (7,880 km², 5%) and rise (7,520 km², 5%). Plateaus, canyons, ridges and knoll/abyssal hills each cover less than 2,500 km² or 1.5% of the bioregion (Table 5.16).

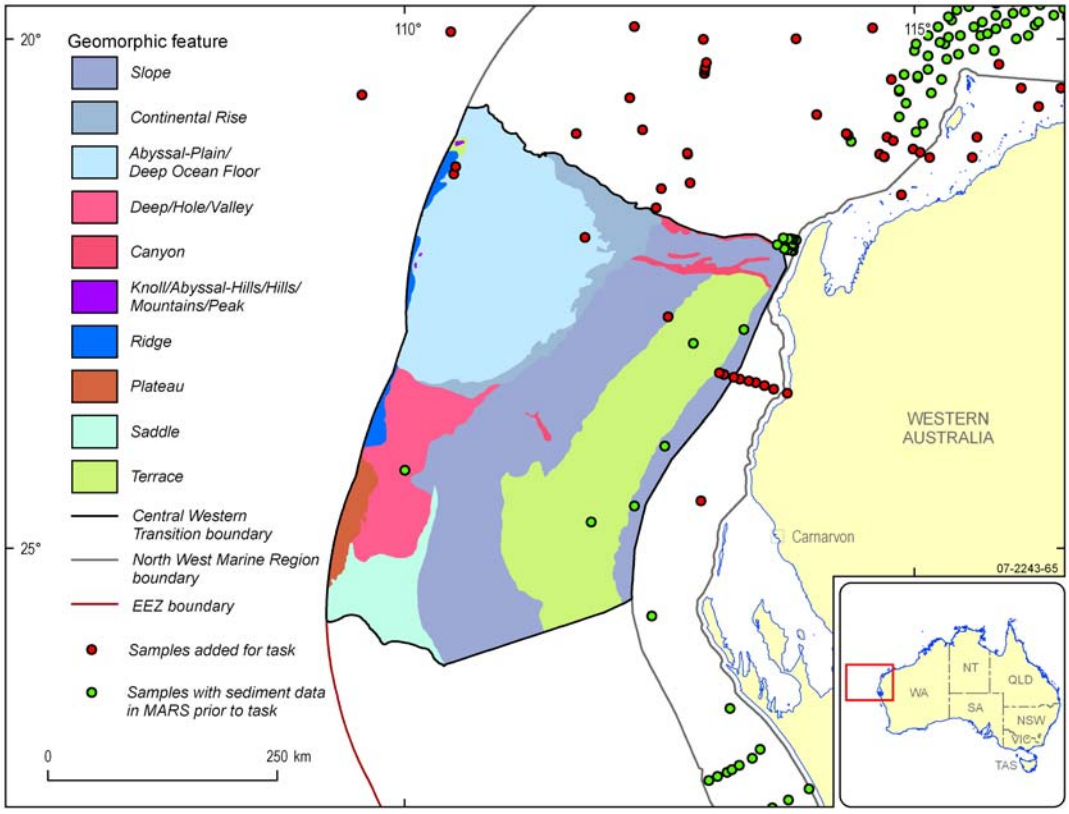
Four significant geomorphic features are identified for the CWT. Slope (unassigned) forms a significant area of the CWT. The CWT contains the entire area of the Cuvier Abyssal Plain included in the NWMR. This forms >40% of the total area of AP/DOF in the NWMR. This feature has a geological history and morphology that differs from areas of abyssal plain elsewhere in the NWMR (Chapter 3). More than 65% of the Canarvon Terrace occurs within the CWT (the remained of this terrace occurs outside the NWMR) and has a morphology and tectonic history that differentiates it from other terraces in the NWMR. The CWT also contains almost the entire area of saddles in the NWMR.

5.9.2. Sample Coverage

The CWT is represented by 15 samples (Figs. 5.32a). Approximately 50% of these occur on the upper slope near the shelf break in <500 m water depth (Fig. 5.33a). More than 35% of samples occur in water depths of >4,000 m (Fig 5.33b). These samples provide the majority of sediment information for areas at these water depths within the NWMR. Average sample density across the bioregion is 1:10,850 km².

Samples achieve adequate coverage to describe the sedimentology in two of the four significant features identified for the CWT. Slope (unassigned) contains six samples, resulting in an average sample density of 1:8,660 km². A total of four samples were collected from the Cuvier Abyssal Plain, resulting in an average density of 1:10,020 km².

Despite targeted sample addition, not enough samples were collected from the Carnarvon Terraces or saddles to describe sedimentology for these features. Six samples were added to the CWT for this study. These increased sample coverage on the slope (unassigned) (3 samples added), abyssal plain/deep ocean floor (2) and knoll/abyssal-hill/hills/mountains/peak (1). No additional samples collected from the Carnarvon Terrace or saddles were available for procurement.



a)

b)

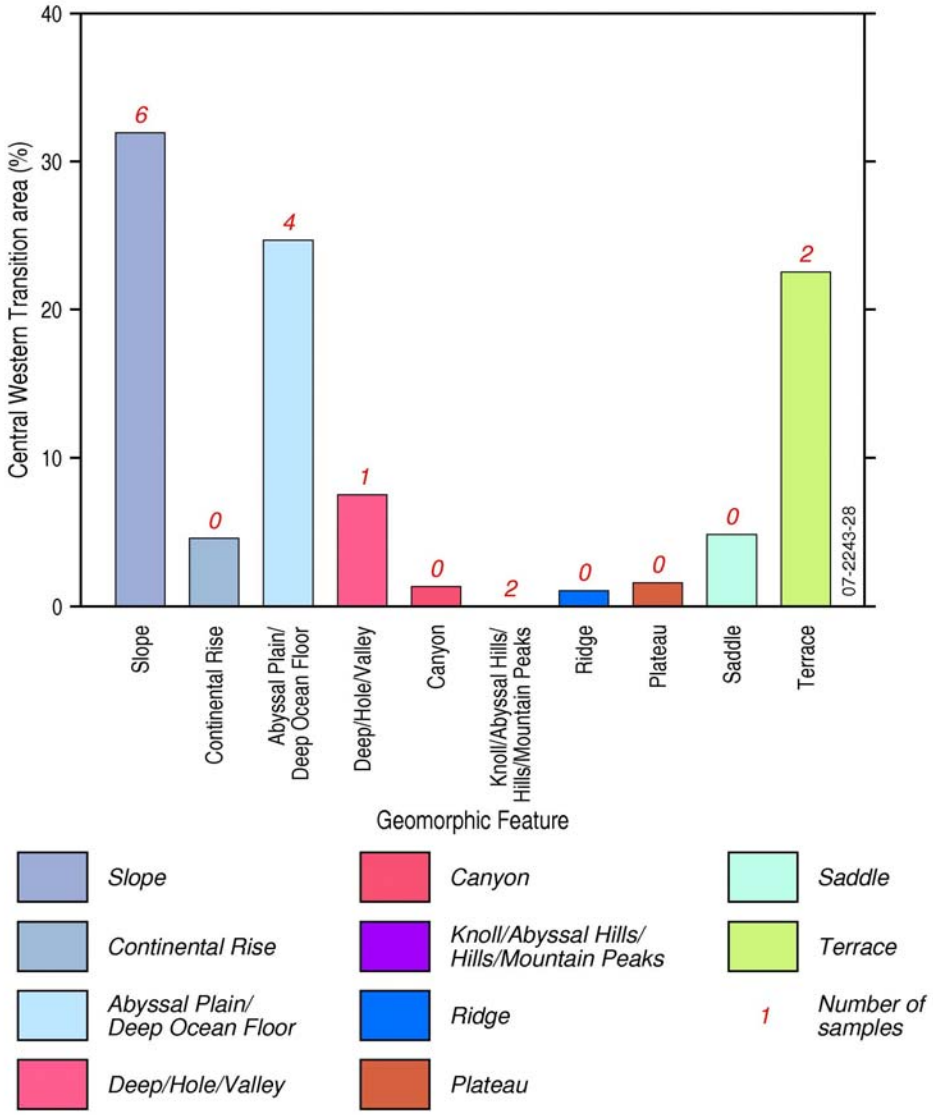
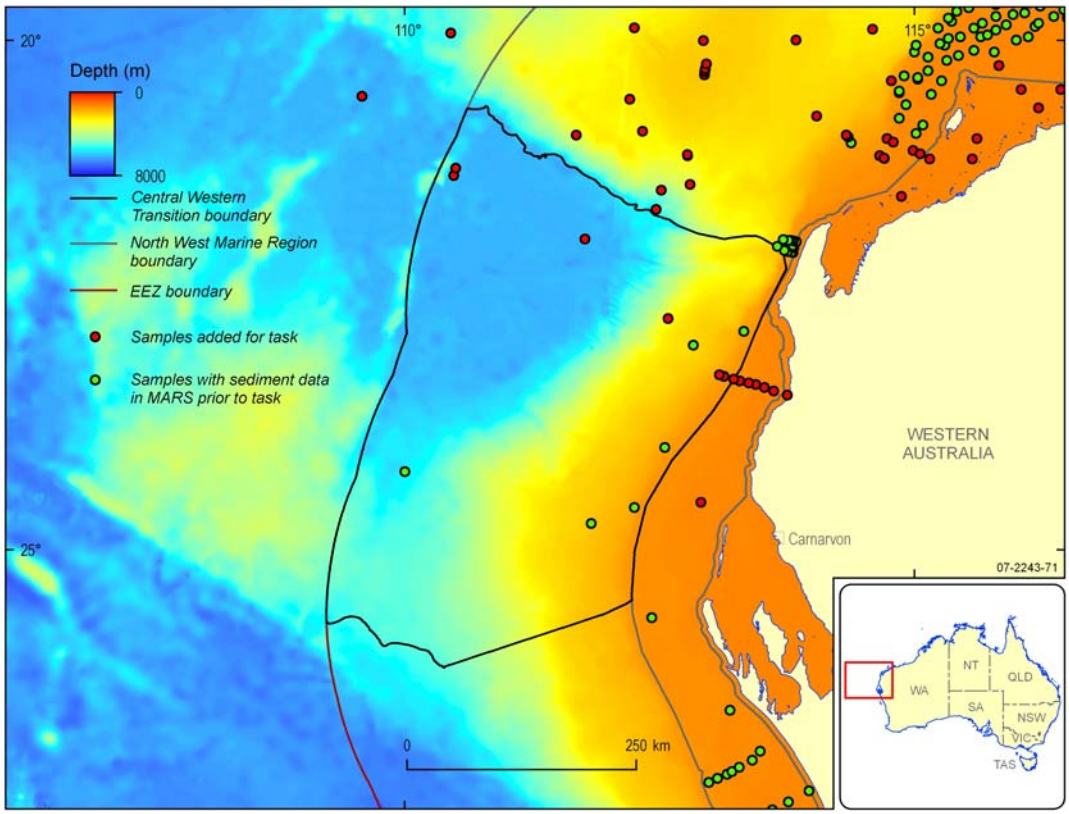


Figure 5.32. a) Geomorphology of the Central Western Transition (CWT) with location of sediment samples; and b) Percentage area of each geomorphic feature within the CWT with number of corresponding sediment samples.

a)



b)

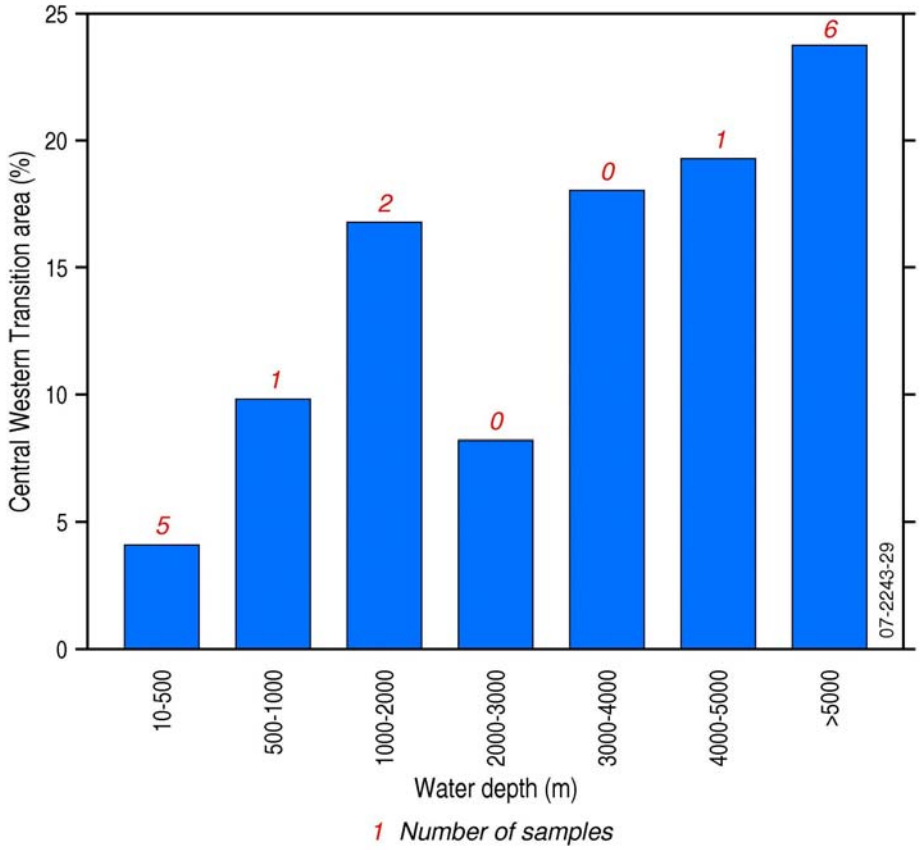


Figure 5.33. a) Bathymetry of the Central Western Transition (CWT) with location of sediment samples; and b) Percentage area of each bathymetry class within the CWT with number of corresponding sediment samples.

Table 5.16. Details of the geomorphology of the Central Western Transition.

Feature	% of bioregion area covered	% of NWMR area this unit lies within this bioregion	% of EEZ area this unit lies within this bioregion
Geomorphic Province			
Slope	69.95	17.59	2.84
Rise	4.62	47.47	7.36
AP/DOF*	25.43	41.40	1.44
Geomorphic Feature			
Slope (unassigned)	31.88	16.72	3.78
Rise (unassigned)	4.62	47.47	7.85
AP/DOF* (unassigned)	24.60	40.60	1.63
Deep/hole/valley	7.48	13.06	7.38
Canyon	1.33	20.09	2.03
Knoll/abyssal hills/mountains/peak	0.07	5.35	0.09
Ridge	1.15	32.43	1.69
Plateau	1.56	2.69	0.17
Saddle	4.84	98.67	5.38
Terrace	22.47	16.13	6.32

Table 5.17. Distribution of water depths covered by the geomorphology in the Central Western Transition.

Feature	Depth Range (m)	Mean Depth (m)
Geomorphic Province		
Slope	110 – 5,335	5,220
Rise	4,155 – 5,300	1,150
AP/DOF	3,290 – 5,455	2,165
Geomorphic Feature		
Slope (unassigned)	110 – 5,335	5,220
Rise (unassigned)	4,155 – 5,300	1,150
AP/DOF (unassigned)	3,375 – 5,455	2,080
Deep/hole/valley	3,805 – 5,270	1,470
Canyon	215 – 4,980	4,765
Knoll/abyssal hills/mountains/peak	4,490 – 5,085	595
Ridge	3,290 – 5,180	1,895
Plateau	3,370 – 4,625	1,255
Saddle	3,655 – 4,300	650
Terrace	260 – 4,995	4,735

5.9.3. Sedimentology of the Central Western Transition

A total of 15 grain size and carbonate assays occur in the CWT. Sand content ranges from <1 to 97%, gravel content from 0 to 7%, and mud content from <1 to 100%. Mud and sand comprise

the majority of the sediment. Gravel comprises <1% in 13 (87%) samples and is absent in 9 (60%). Mud comprises <5% in four (27%) samples and exceeded 95% in five (33%) samples.

Sediment grain size decreases with increasing water depth. Samples within 100 km of the shelf break contain >50% sand with <1% mud and <20% gravel. Samples elsewhere on the slope generally contain sand and mud in ratios varying between 40:60 and 60:40, with gravel not exceeding 1%. Sediments in this area of the CWT are coarse-grained compared with those at similar water depths elsewhere in the NWMR. Samples that occur on the AP/DOF contain >95% mud.

Carbonate content exceeds 75% at all locations except for four, where carbonate ranges from 37 to 73%. Samples with carbonate contents of <80% occur on the slope in the north of the bioregion and on the AP/DOF. Carbonate sand and gravel are consistently >80%. Where analysed, the carbonate content of mud ranges from 40 to 85%.

5.9.4. Sedimentology of significant geomorphic features

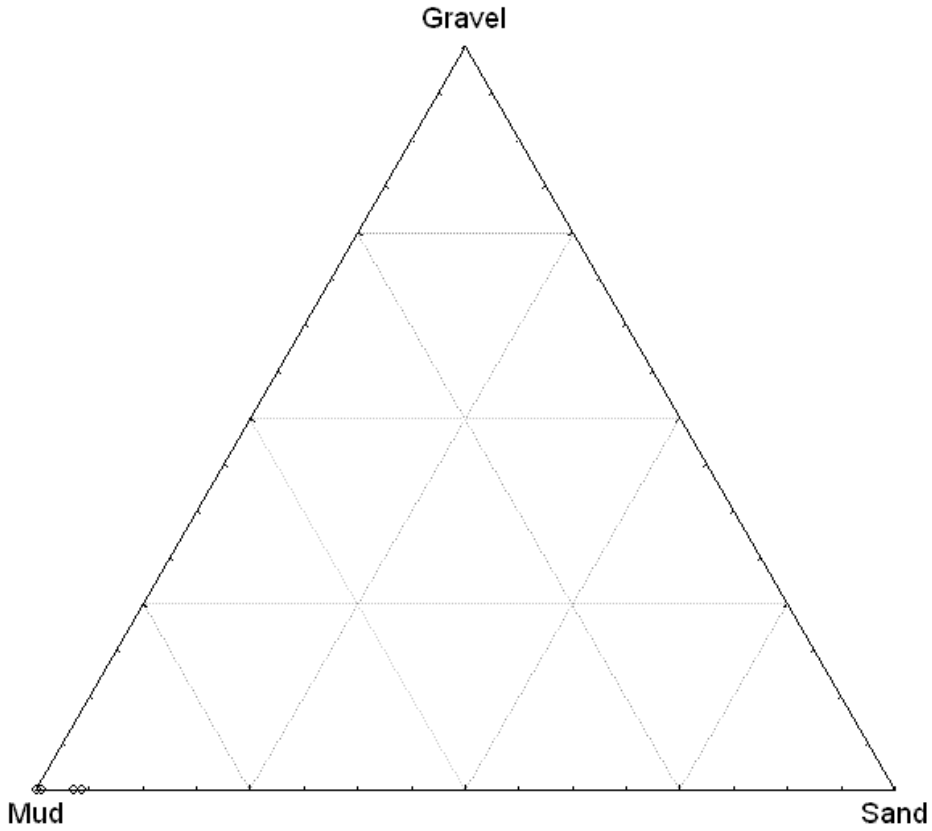
5.9.4.1. Slope

A total of six samples were obtained from the slope. Sand is the dominant fraction ranging between 47 and 97% (Fig. 5.34b) and exceeding 80% in four samples. Mud is the next most abundant fraction, with contents generally <30% although mud exceeding 52% in one sample (Fig. 5.35). Gravel content is <7% for all samples. Bulk carbonate content ranges between 76 and 91% and exceeds 90% in two samples (Fig. 5.35). Carbonate sand varies from 90 to 94% in five samples. Carbonate gravel ranges from 95 to 100% and attains 100% in three samples.

5.9.4.2. Cuvier Abyssal Plain

A total of four samples were obtained from the Cuvier Abyssal Plain. Mud is the dominant fraction, with contents ranging from 95 to 100% (Fig. 5.34a). Sand forms the remainder of sediment volume. Bulk carbonate content is bimodal, with a total of approximately 50% of sediments containing either between 30 and 50% or 70 and 80%.

a)



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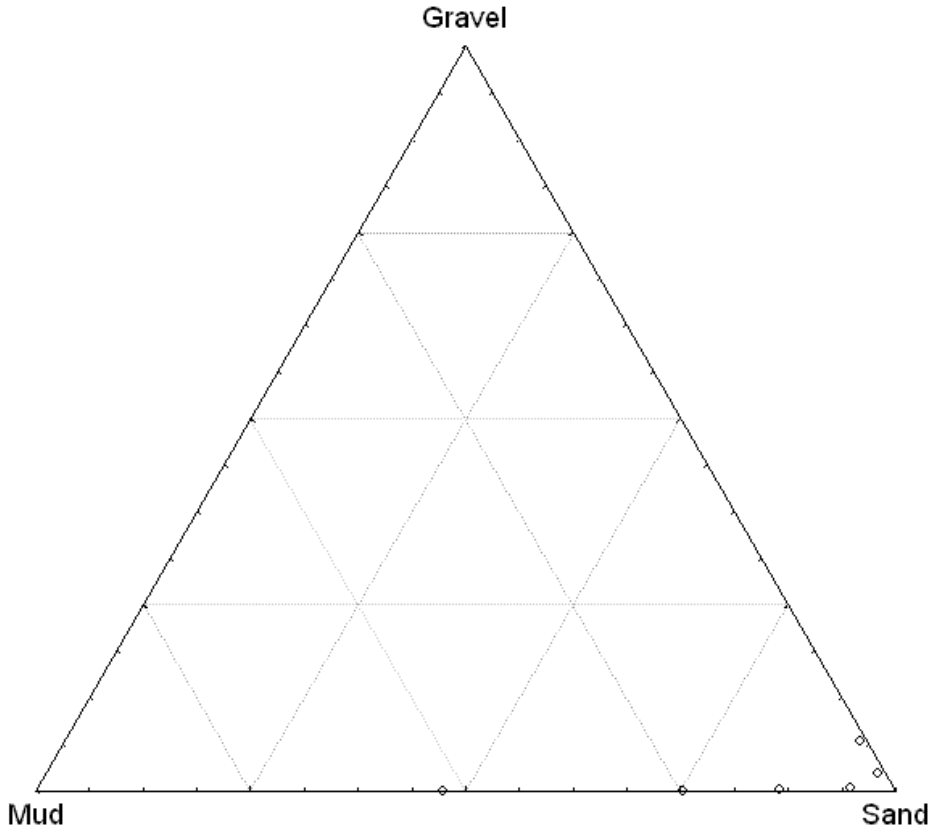

Figure 5.34. Textural composition (mud:sand:gravel ratio) of a) abyssal plain/deep ocean floor; and b) slope sediments within the CWT.

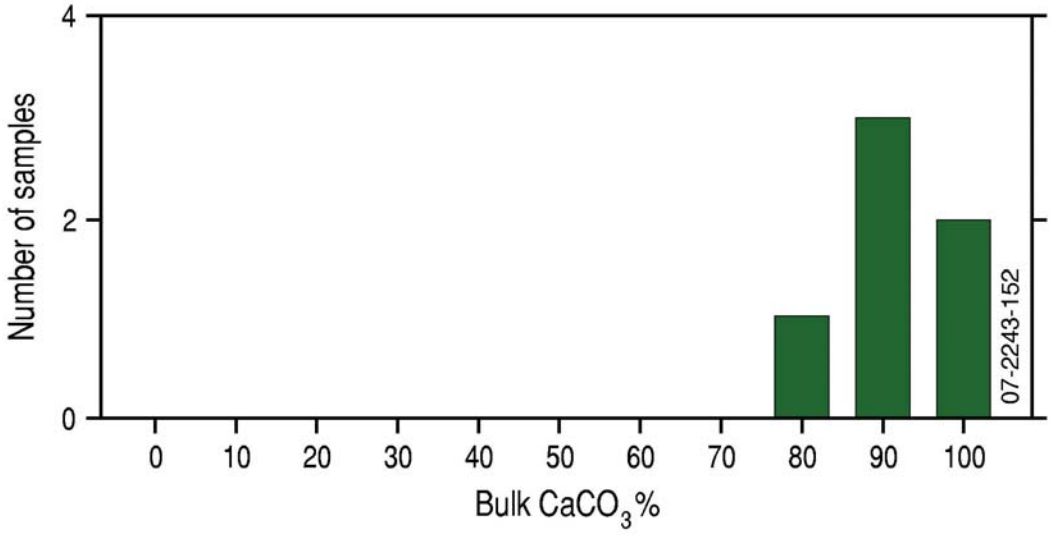

Figure 5.35. Carbonate content of slope sediments within the CWT.