DISTRIBUTION OF MARINE PALYNOMORPHS IN SURFACE SEDIMENTS, PRYDZ BAY, ANTARCTICA

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ABSTRACT

Prydz Bay Antarctica is an embayment situated at the ocean-ward end of the Lambert Glacier/Amery Ice Shelf complex East Antarctica. This study aims to document the palynological assemblages of 58 surface sediment samples from Prydz Bay, and to compare these assemblages with ancient palynomorph assemblages recovered from strata sampled by drilling projects in and around the bay.

Since the early Oligocene, terrestrial and marine sediments from the Lambert Graben and the inner shelf areas in Prydz Bay have been the target of significant glacial erosion. Repeated ice shelf advances towards the edge of the continental shelf redistributed these sediments, reworking them into the outer shelf and Prydz Channel Fan. These areas consist mostly of reworked sediments, and grain size analysis shows that finer sediments are found in the deeper parts of the inner shelf and the deepest areas on the Prydz Channel Fan. Circulation within Prydz Bay is dominated by a clockwise rotating gyre which, together with coastal currents and ice berg ploughing modifies the sediments of the bay, resulting in the winnowing out of the finer component of the sediment.

Glacial erosion and reworking of sediments has created four differing environments (Prydz Channel Fan, North Shelf, Mid Shelf and Coastal areas) in Prydz Bay which is reflected in the palynomorph distribution. Assemblages consist of Holocene palynomorphs recovered mostly from the Mid Shelf and Coastal areas and reworked palynomorphs recovered mostly from the North Shelf and Prydz Channel Fan. The percentage of gravel to marine palynomorph and pollen counts show a relationship which may reflect a similar source from glacially derived debris but the percentage of mud to marine palynomorph and pollen counts has no relationship.

Reworked palynomorphs consist of Permian to Eocene spores and pollen and Eocene dinocysts which are part of the Transantarctic Flora. Holocene components are a varied assemblage of acritarchs, dinoflagellate cysts (dinocysts), prasinophyte algae, red algae and large numbers of *Zooplankton* sp. and foraminifera linings. *In situ* dinocysts are dominated by the heterotroph form *Selenopemphix antarctica* and none

of the Holocene dinocyst species found in Prydz Bay have been recorded in the Arctic. In contrast acritarchs, prasinophytes and red algae are all found in the Arctic and reflect a low salinity and glacial meltwater environment. Comparison with modern surface samples from the Arctic and Southern Ocean show there is a strong correlation to reduction in the autotroph:heterotroph dinocyst ratio with increasing latitude.

Todays assemblage of marine palynomorphs are more complex than those recorded in ancient assemblages and there is a lower level of reworked material. Acritarchs (*Leiosphaeridia* spp. *Sigmopollis* sp.) and prasinophytes (*Cymatiosphaera* spp. *Pterospermella* spp. *Tasmanites* spp.) are recorded in the ancient record in Antarctica as well as surface sediments in Prydz Bay, but there are very low numbers of *Leiosphaeridia* spp. and *Sigmopollis* spp. present today in comparison to the ancient record. Dinocysts *in situ* and recovered in Prydz Bay are endemic to the Antarctic but have not been recorded in the ancient record.

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CHAPTER 1
INTRODUCTION

Antarctic marine and terrestrial palynomorphs are commonly used in studies aimed at increasing our understanding of past climate. Published studies include Deep Sea Drilling Project (DSDP) (Kemp, 1975), MSSTS-1 drill hole McMurdo Sound (Truswell, 1986), CIROS-1 Drillhole (Hannah, 1997), and the Cape Roberts Project (Hannah *et al.* 1998, Wrenn *et al.* 1998, Hannah *et al.* 2000, Hannah *et al*. 2001a). Studies of the ancient record in Prydz Bay include ODP sites 1165 (Hannah, 2005, McPhail & Truswell, 2004a), 1167 and 1166 (McPhail & Truswell, 2004b).

A combined program involving the Australian Geological Survey Organisation (now Geoscience Australia), Australian Antarctic Co-operative Research Centre (CRC) and Australian National Antarctic Research Expeditions (ANARE) resulted in three cruises (1993, 1995 & 1997) investigating several key areas along the Antarctic east coast. The cruises included a marine geophysical survey and sediment sampling programmes. This was done to promote a better understanding of global climate change through the studies of modern sediment transport and the organisms contained in them, and relate this understanding to the ancient sedimentary record (O'Brien *et al.* 1995). The surface sediment samples used in this study are from these cruises.

1.1 Aims of this study

This study documents the palynology of Prydz Bay surface sediments. It aims to:

1. Document the palynomorph assemblages contained in the samples.
2. Understand the distribution of palynomorphs, both *in situ* and reworked in terms of physical characteristics of the bay which include:
    a. Water depth and currents
    b. Sediment supply
3. Compare the modern assemblages with those recovered from the ancient records (e.g. Hannah *et al.* 2000, Hannah, 2005, Wrenn *et al*. 1998) and assess the possibility of any modern analogues with those of the past.

In the ancient record, the number and type of terrestrial palynomorphs found and comparison of changes to marine palynomorph assemblages within sedimentary cycles allow inferences to changes to the environment occurring during that time. ODP investigations on Wild Drift site 1165 Prydz Bay (Hannah, 2005) show that palynomorph numbers have changed in accordance with the types of conditions encountered in the past. Expansion of the Amery Ice Shelf under cooler conditions may have caused marine palynomorphs to be fewer in numbers. As conditions warmed and the ice shelf retreated the palynomorphs increased in numbers (Hannah, 2005). Today the full retreat of the Amery Ice Shelf from the embayment has altered the environment of the bay significantly. The question to be asked is has it also changed the palynomorph assemblages found there today from assemblages found in similar conditions of ice shelf retreat in the past?

1.2 Evolution of Prydz Bay

The origin of Prydz Bay in East Antarctica is associated with the Mesozoic break up of Gondwana. Figure 1.1 shows a reconstruction that juxtaposes Prydz Bay with the east coast of India (Cooper *et al.* 1991, Davey, 1985, Hambrey *et al*. 1991). Stagg, (1983) places the Lambert Graben/Amery area adjacent to Mahanadi Graben, one of two grabens at right angles to the coast beneath the Indian basins. He describes these grabens as a failed rift arm of a triple junction that may have been created in the Late Palaeozoic to Early Mesozoic during the separation of the continents (Davey, 1985, Anderson, 1999). Substantial sediment thicknesses within the Lambert Graben may date back to the Permian, and exposed sediments similar to those in Mahanadi Graben can be found in the Beaver Lake area of the Prince Charles Mountains (Cooper *et al.* 1991, Hambrey, 1991, Hambrey *et al*. 1991).

The Lambert Glacier/Amery ice shelf drainage basin is estimated to cover ~1,090,000 km^2 (Allison, 1979, Hambrey *et al.* 2000). The Lambert Graben is formed largely in Precambrian metamorphic basement and the subglacial floor lies below sea level and extends south for almost 700 km. The Lambert Glacier/Amery Ice Shelf now occupies the area but it was once a fjord with a depth reaching 3000 m and a width of ~50 km (Hambery, 1991). The Lambert Glacier is bordered in the west by the partially exposed Prince Charles Mountain complex with Mt Menzies reaching a height of 3,355 m above sea level (Stagg, 1983, Hambery, 1991). To the East of the Lambert Graben the Mawson Escarpment protrudes and a deep basement depression beneath the Escarpment is part of the main Graben.

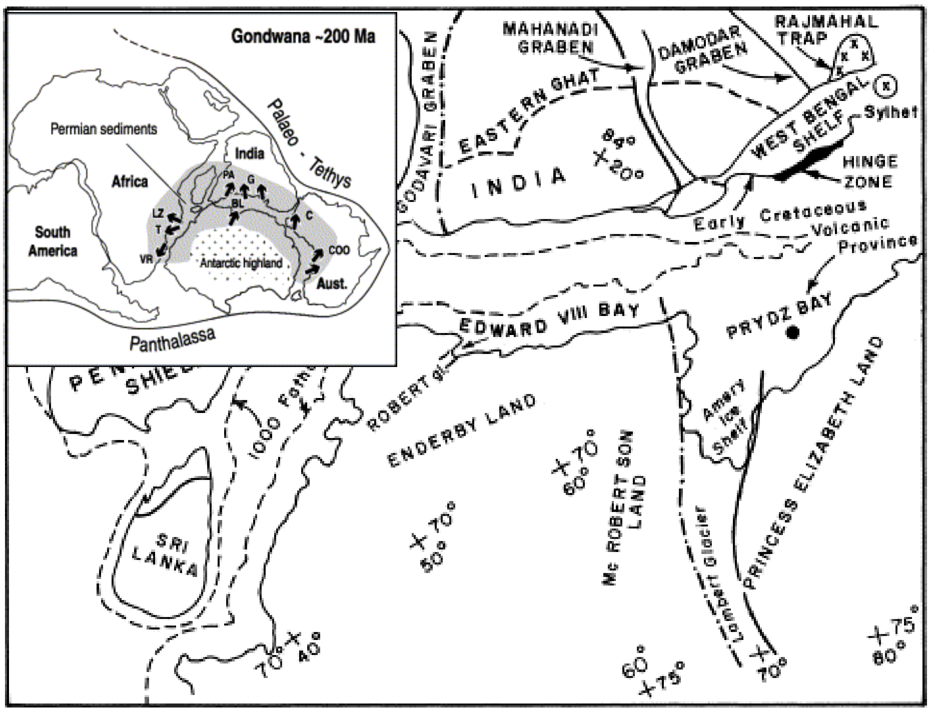


Fig. 1.1: The relative positions of India and Antarctica showing the respective position of Gondwana rift valleys during the early Jurassic. Black dot indicates the probably position of the Kerguelen hotspot. Dot dash lines indicate the master faults of the rift basins of the two continents. Lambert and Mahanadi basins are conjugate structures and show similar crustal structures. Insert shows Gondwana ~200 Ma (Mishra *et al.* 1999).

1.3 Location and setting

Prydz Bay is an embayment situated at 76°E, 68°S and lies at the ocean ward end of the Lambert Graben/Amery Ice Shelf. The inner shelf is underlain by a sediment-filled rift basin containing more than 5 km of Early Cretaceous and older continental rift strata, and Cooper *et al.* (1991) consider it to be separate from the major Lambert Rift Graben. Data from gravity, magnetic and seismic refraction indicate maximum sediment of the inner shelf thicknesses are 5-12 km (Cooper *et al.* 1991). Sediment transport in the present Antarctic ice sheet occurs from the interior in a basal layer that contains 5-8% sediment; however in the past, erosion by grounded ice overdeepened the inner shelf and progradation and aggradation occurred fairly evenly across the bay. During the late Neogene cooler conditions developed the Prydz Channel Ice Stream (fig 1.2) which carried debris to the shelf edge and built out the Prydz Channel Fan (Cooper *et al.* 2004). These past glacial processes have created differing environments within the embayment which is reflected in the palynomorph distribution. The geographical areas of Coastal, Mid Shelf, North Shelf and Prydz Channel Fan are colour highlighted in figure 1.3 which reflect the differing environments of these past glacial processes.

Coastal geographic areas includes depressions in the south western corner of the bay of up to 1000 m, these are the Lambert and Nanok Deeps. On the eastern side of Prydz Bay off the Ingrid Christensen Coast is the elongated trough of the Svenner Channel which is also part of the Coastal area and is up to 1,000 m deep but with several shallower saddles along its length (O'Brien *et al.* 1999, 2003, Passchier *et al.* 2003).

Mid Shelf area contains the broad topographic basin of the Amery Depression, 600-800 m, which deepens shoreward. Along the western edge of the Amery Depression the elongate deep of the Prydz Channel is also Mid Shelf and is 150 km wide and 500-600 m deep and extends to the edge of the continental shelf (O'Brien *et al.* 1999, 2003, Passchier *et al.* 2003).

North Shelf area includes the shallower part of the Prydz Channel near the continental shelf edge. Northeast of the Amery Depression along the shelf edge the shelf shallows to 200-300 m, and the Four Ladies Bank to the east of Prydz Channel and Fram Bank to the West, are also included in the North Shelf area (O'Brien *et al.* 1999, 2003; Passchier *et al.* 2003).

Prydz Channel Fan is included as its own geographic area and is 166 km across and extends 90 km seaward from the shelf break where the surface slopes at 2.0^{o} and is a major sediment depocentre (Harris *et al.* 1998).

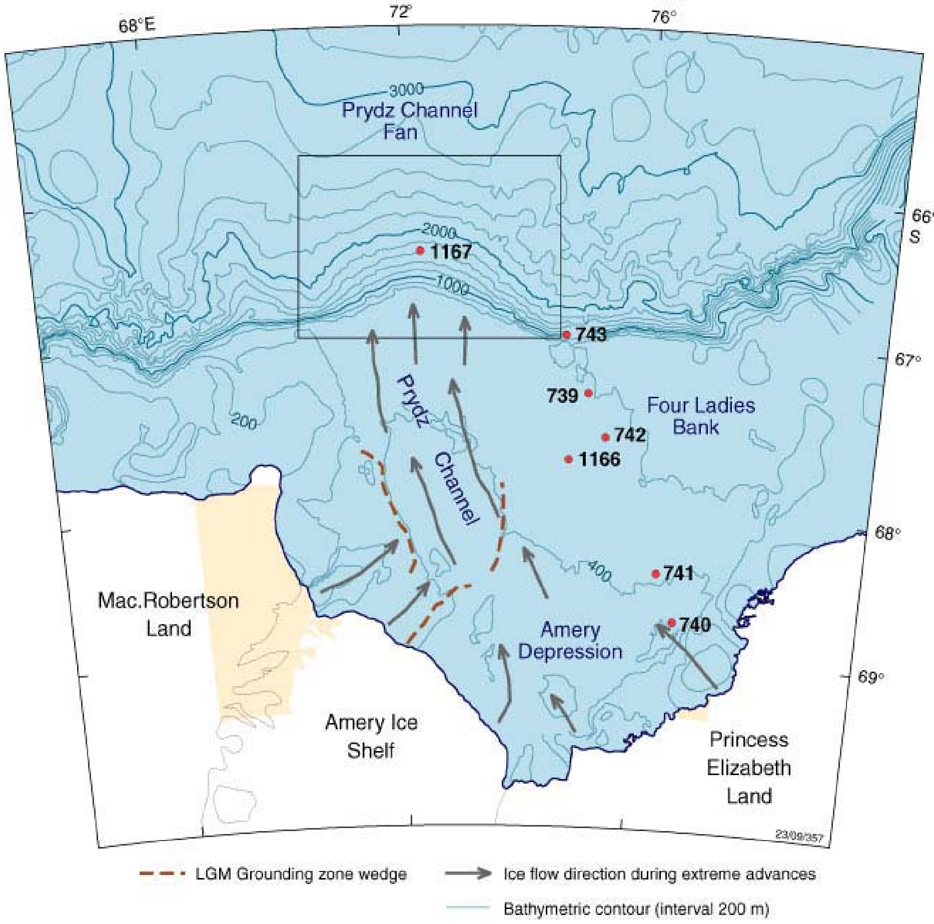


Fig. 1.2: Map of Prydz Bay showing the location of the Prydz Channel Trough Mouth Fan, Prydz Channel, and locations of Leg 119 739-743 and Leg 188 1166-1167. Last Glacial Maximum grounding zone wedges are shown after Domack *et al.* (1998). Arrows indicate ice flow directions during post-late Miocene extreme advances of the Lambert Glacier/Amery Ice Shelf system (modified from O'Brien and Harris, 1996 by O'Brien, 2004).

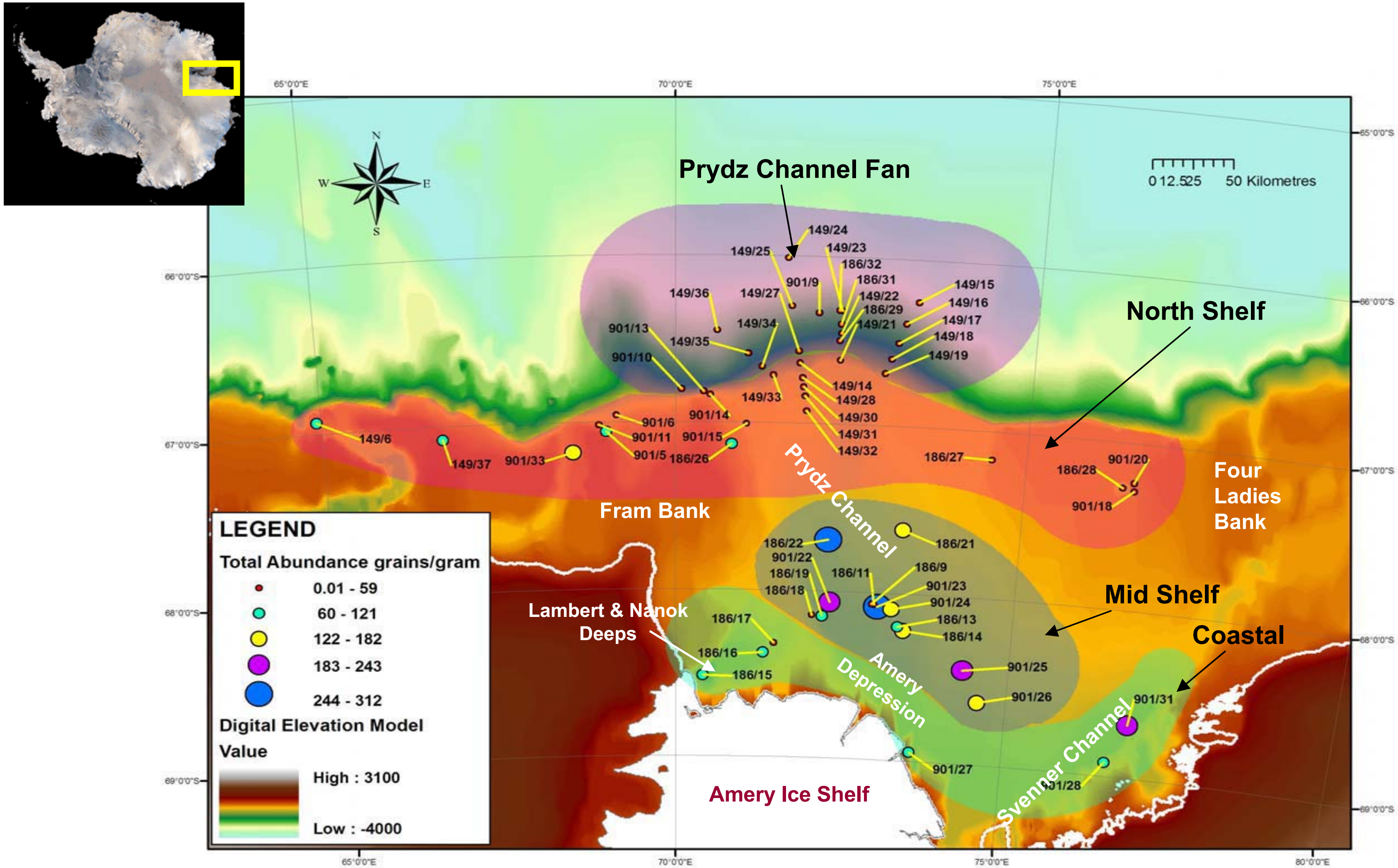


Fig 1.3: Geographical areas have been named as Prydz Channel Fan, North Shelf (includes Fram and Four Ladies Banks and the North Prydz Channel), Mid Shelf (includes Prydz Channel and Amery Depression), and Coastal (includes Lambert and Nanok Deeps and the Svenner Channel). Sample numbers have a yellow leader attached to each coloured circle and are included to show the distribution pattern of palynomorphs in each geographical area.

1.4 Previous Work

1.4.1 Prydz Bay

Diatoms and foraminifera are the only micro-organisms previously studied from the surface sediments of Prydz Bay. Initially, Quilty (1985) investigated foraminifera in surface sediments within Prydz Bay but the first systematic sampling programme was completed by Franklin (1991), who reported on the foraminiferan and diatom content of the surface sediments. Today surface sediments are dominated by large diatom populations in the north west Fram Bank area within Prydz Bay. Further work by Taylor, McMinn and Franklin (1997), Quilty (1985), Franklin (1991), Franklin *et al.* (1995), Taylor & Leventer (2003), Taylor *et al.* (1997), studied the distribution of diatoms in surface sediments of Prydz Bay and recognised four diatom assemblages. They concluded that the environmental variables associated with latitude which includes sea-ice, horizontal water circulation and the Prydz Bay gyre play a major role in the types of diatom assemblages found within the bay.

1.4.2 Southern Ocean studies

Harland *et al.* (1998), in a transect of the Southern Ocean from the Falkland Trough to the Weddell Sea, found that abundances for dinoflagellate cysts (dinocysts) did not exceed 364 grains per gram of sediment between latitudes 50^{o} S to 60^{o} S. From 60^{o} S to higher latitudes the cysts per gram of sediment declined to <23 grains per gram and diversity was lower (maximum of six species) than the Antarctic Circumpolar Current. Marret & de Vernal (1997), transected the Southern Indian Ocean from the Subtropical domain to the Continental Antarctic domain between latitudes 30^{o} S to 68^{o} S. Their results show more than 20 taxa present in assemblages from the Subtropical domain and less than 10 taxa (minimum of 3) recorded in the Sub-Antarctic and Antarctic domains. In addition to dinocysts, other palynomorphs present included Acritarchs, tintinnid cysts and loricae, *Halodinium*, and Prasinophyceae (*Cymatiosphaera*-type spp, *Tasmanites* spp). Esper & Zonneveld (2002) concluded that gonyaulacoid cysts tended to dominate the Subtropical Zone with their highest abundance at ~45^{o} S at 500 grains per gram and were present till approximately 50^{o} S. The protoperidinioid cysts dominated from 40^{o} S in the Sub-Antarctic and Polar Front Zones with a high of 2,000 grains per gram noticeably falling to <250 grains per gram at 60° S. Those results were clearly a higher abundance than Harland *et al.* (1998) had recorded four years earlier.

Harland & Pudsey (1999) studied results from sediment traps deployed in the Bellingshausen, Weddell and Scotia seas and compared them with surface sediments recovered nearby. There was a very low dinocyst assemblage recovered from core-top samples (<10-300 g/g) compared to the sediment traps (500-3,000 g/g) which varied according to their position within the transect. The sediment traps were set above and within the nepheloid layer and within and to the north of the maximum sea ice limit and the core top samples were recovered from within 3 km of the corresponding sediment traps.   Allochthonous elements may be responsible for part of the material captured by sediment traps. These findings may also reflect the uncertainty of core top sample ages and current winnowing of the sediment and factors relating to oxidation and dilution due to the length of time cysts may have lying at the sediment water interface.

Dinocysts may be heterotrophic, that is without photosynthetic pigments, autotrophic with photosynthetic pigments, or mixotrophic which enables them to supplement their photosynthetic capability by taking up organic substances (McMinn & Scott 2005). Gonyaulacoid dinoflagellates inhabit warmer and deeper waters and protoperidinioid dinoflagellates prefer cooler temperatures in high latitudes (Mudie and Harland 1996). Harland & Pudsey (1999) noted that within the sea ice limit the dinocyst assemblages were dominated by the heterotrophic form of protoperidiniod dinoflagellates with the presence of the autotrophic form of gonyaulacoid dinocysts prevalent outside the sea ice limit. There was a low dinocyst assemblage within the sea ice limit in comparison to assemblages in core-tops and traps outside the maximum sea ice limit (Harland & Pudsey, 1999).

1.4.3 Arctic studies

Mudie (1992) studied dinocysts along transects across the Beaufort Sea estuarine environment, the Nansen Basin north of Barents Shelf, and ice shelf and pack ice environments on the Canadian polar margin and in the Canada Basin. Examples of areas studied by Mudie (1992) include Baffin Bay, Beaufort Sea and Barents Sea and they are discussed below.

Mudie (1992) found results for Baffin Bay included 9 dinocyst to 1 Acritarch *Leiosphaeridia scrobiculata*, and a strong positive correlation between Acritarch per cent abundance and sea ice cover which included an increase of *Pterospermella* and Acritarchs towards glacier meltwater. The gonyaulacoid to protoperidinioid (G:P) ratio in Baffin Bay decreased with lower summer temperatures and increasing latitude.

The results from Mudie (1992) for the Beaufort Sea sediments contained an average of 7 dinocyst species and Mudie found low numbers of Acritarchs (*Halodiniuim majus, Leiosphaerida, Beringiella*) and Chlorophytes. *Brigantedinium* and *Leiosphareida scrobiculata* dominate samples within the low salinity sedimentary plume off McKenzie River and *Sigmopollis* are common. Mudie (1992) suggested that gonyaulacoid dominate the pack ice margin in deeper waters with the G:P ratio increasing from 0.5 to 1.5 and overall in the Beaufort Sea there is a low diversity of Acritarchs and Dinoflagellates.

Mudie (1992) found that results for Barents Sea showed the sediments contained one sample with up to 25% of protroperidiniods. Marginal ice zones had G:P ratios ranging from 0.8-1.8 (mean 1.4) and pack ice G:P ratios were 0.3-1.0 (mean 0.6). Mudie (1992) found a correlation for small acritarchs found in abundance and highly stratified water column overlain by a low salinity layer. Other areas of the Canadian Polar Margin and Central Artic Ocean show a G:P ratio 0-1.0 (mean 0.5) with gonyaulacoid cysts rare or absent.

Rochon, Turon, Matthiessen and Head (1999) studied the distribution of recent dinoflagellate cysts in surface sediments throughout the North Atlantic Ocean and adjacent seas. The dinocyst distributions have a low to moderately high species diversity that varies from between 2-18 taxa. Results from continental margins of the North Atlantic Oceans and adjacent seas have high abundances in surface sediments of 100 to 1,000 cysts/cm^2·yr. The results from the Central North Atlantic and Baffin Bay have moderately low surface sediment cyst concentrations in the order of 0.1-1 cysts/cm^{2}·yr. Taxa with morphological similarities were grouped together and the four most abundant (50-100%) of the total were *Operculodinium centrocarpum, Nematosphaeropsis labyrinthus, Pentapharsodinium dalei* and *Brigantedinium spp*. A further 10 taxa were common (10-50%) and 13 taxa were considered rare (0-10%) (Rochon *et al.* 1999).

CHAPTER 2
PRYDZ BAY MARINE ENVIRONMENT

2.1 Circulation in Prydz Bay

Circulation in Prydz Bay appears to be dominated by a clockwise rotating gyre (fig 2.1) which is situated approximately between 66.5^{o} S - 68^{o} S (Wong *et al.* 1998). Within Prydz Bay a cold, less saline coastal current enters the bay from the east flowing westward along the shelf break. In the centre of the bay near the Amery Ice Shelf this water partly joins the gyre. The rest of the coastal current continues to flow westward beneath the eastern side of the Amery Ice Shelf, flowing out the west side as colder Ice Shelf Water. Part of this current joins the northward flowing arm of the gyre to either recirculate back into the bay or join the flow westward with the Antarctic Coastal Current (O'Brien *et al.* 1991; Wong *et al.* 1998).

The Antarctic Divergence acts as a barrier between the eastward flowing Antarctic Circumpolar Current and the westward flowing coastal current and is inferred to be south of 63^{o} S by Smith *et al.* (1994) and Nunes Vasz and Lennon (1996), which would place this area of upwelling within the ocean edge of the Prydz Bay Gyre. Nunes Vas and Lennon (1996) suggest that the gyre results in a deeper inflow of warmer upwelled Circumpolar Deep Water crossing the shelf break at about longitude 74^{o} E resulting in the transport of nutrient rich water into Prydz Bay.

2.2 Water masses in Prydz Bay

Within Prydz Bay, Summer Surface Water occurs only in summer at the top of the water column and has temperatures between -1.8^{o} C to 2.1^{o} C and a lowered salinity of 30.6-34.2. The Summer Surface Water column extends from the surface to 80 m off the continental shelf thinning to 40-50 m within Prydz Bay (Nunes Vas and Lennon, 1996; Wong *et al.* 1998). The freshness of the Summer Surface Water is due to the melting of sea ice during the summer. Higher Summer Surface Water temperatures are found in the south western half of Prydz Bay just north of the Amery Ice Shelf. Wong *et al.* (1998) suggest that this is due to thinner sea ice cover in that area which melts earlier in the season allowing the Summer Surface Water to

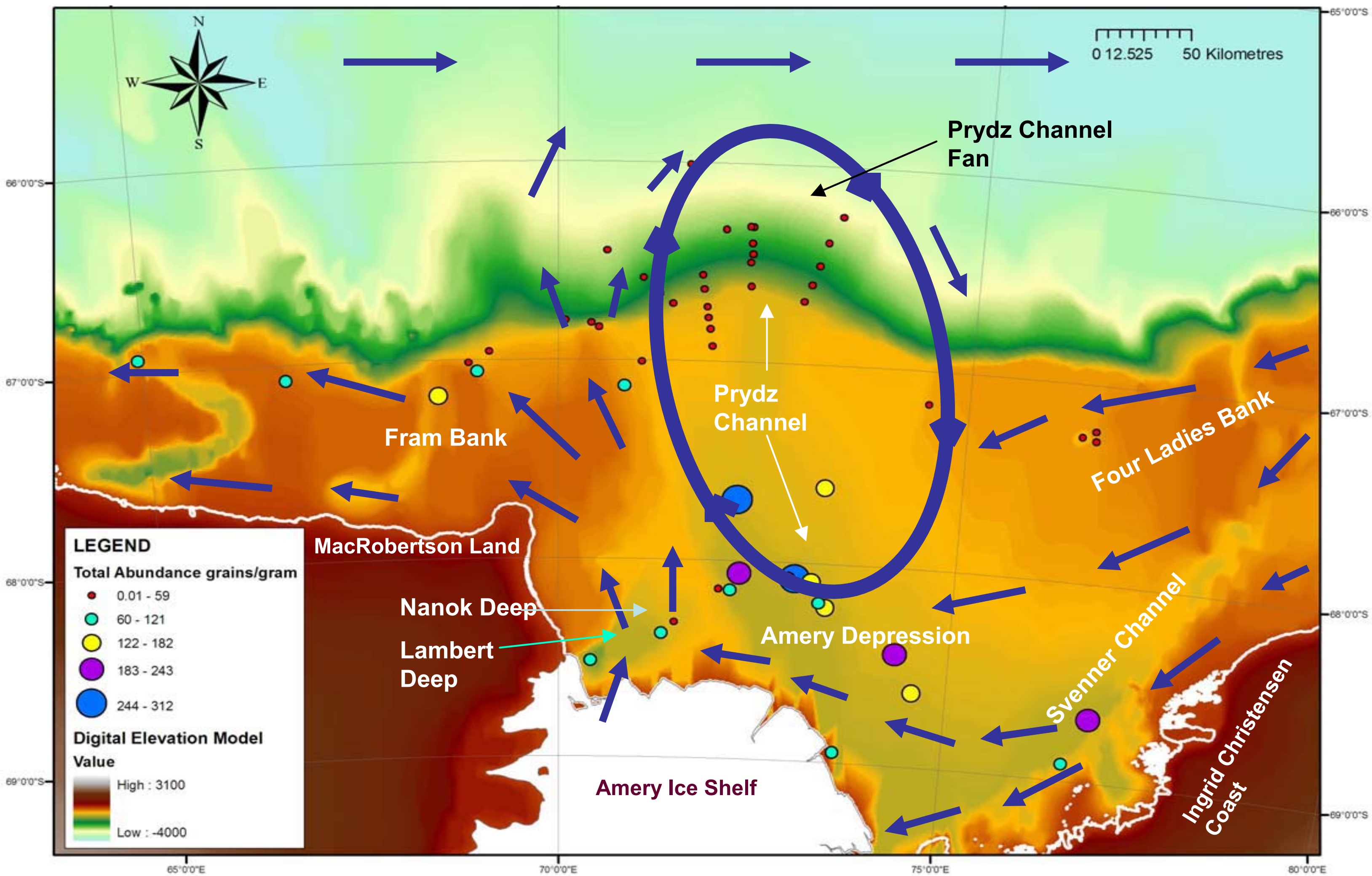


Fig. 2.1: The Prdyz Bay gyre represented by the blue circle, circulates clockwise and dominates the water currents represented by the blue arrows. The coastal current enters the bay from the east flowing westward along the shelf break till it joins the gyre in the centre of the bay. The rest of the current follows the coast line and flows beneath the Amery Ice Shelf in the east and exits from the western side before continuing westward along the coast or heads north west to join the gyre and recirculate back into the bay. Also shown are the sample points for palynomorphs with highest abundances as larger circles as per legend. Adapted from Wong *et al.* 1998.

be heated from solar radiation sooner than elsewhere in the embayment (Smith *et al.* 1984, Smith & Treguer, 1994, Wong *et al.* 1998).

Below the Summer Surface Water is a layer of so called Winter Water, a remnant of surface water formed in winter. Winter Water temperatures are colder between -1.9^{o} C to -1.5^{o} C and Winter Waters have a higher salinity (34.2-34.5) than Summer Surface Water. Below the Summer Surface Water in the ocean domain, the thickness of the layer of Winter Water is 30 m, increasing to 200-300 m on the continental shelf (Nunes Vas and Lennon, 1996, Wong *et al.* 1998). The main depressions within Prydz Bay all contain highly saline water below the Winter Water layer and are called Low Salinity Shelf Water (34.5) which lies above the highly saline Antarctic Bottom Water (34.7). Low Salinity Shelf Water is formed by salt rejected from winter sea ice which sinks to become trapped and accumulate in deeper areas such as the Amery Depression. Low Salinity Shelf Water is also formed by the on shelf mixing of Circumpolar Deep Water that has cooled during the winter (Wong *et al.* 1998).

Surface water masses over the shelf in Prydz Bay have been reported to exhibit anomalously high temperatures (Smith *et al.* 1984, Smith & Treguer, 1994; Wong *et al.* 1998), but also contain a separate water mass of dense Ice Shelf Water found at intermediate depths near the western side of the Amery Ice Shelf caused by the outflow of the current from beneath the Amery Ice shelf (Fricker *et al.* 2001). There is a differing of opinion as to whether Antarctic Bottom Water formation occurs within the bay and Smith and Treguer (1994) suggest that there is no evidence to support Prydz Bay continental shelf water being directly involved with bottom water formation. Wong *et al.* (1998) on the other hand think that there is every possibility that high salinity bottom water could have been formed locally in the Prydz Bay region. O'Brien *et al.* (2001) suggest that in contrast to the Ross and Weddell Sea basins, Prydz Bay produces only a small volume of high salinity deep water due to its geography and bathymetry, in a limited contribution to current activity beyond the shelf.

2.3 Circulation beneath the Amery Ice Shelf

The recognition of marine sediments in cores from beneath the Amery Ice Shelf provides evidence for landward transport due to current activity (Hemer & Harris, 2004). Marine sediments from beneath the ice shelf do have a slower rate of deposition than sediment from open water immediately in front of the ice shelf. This calls into question past researchers defining open water conditions as soon as marine sediments are recognised in the sedimentary record. It is likely that a floating ice sheet may have marine sediments transported beneath the ice sheet but it would clearly not represent open water conditions (Hemer & Harris, 2004).

Circulation beneath the Amery Ice Shelf is predominantly horizontal and driven by the density gradient in the cavity beneath the ice shelf. Circulation is formed by melting and freezing processes combined with the horizontal exchange of heat and salt across the open ocean boundary at the ice front (Williams, 2001). At the Lambert Glacier grounding point ~2,500 m below sea level at 73.2^{o} S (Allison, 2003), high pressure lowers the freezing point of the surrounding sea water to as low as -3.4^{o} C which is considered to be supercooled (Holland *et al.* 2001). Warmer incoming seawater from the westward flowing coastal current with a surface freezing point of about -1.9^{o} C melts the ice, some of which refreezes as marine ice (fig 2.2). This seawater mixes with melt water along the grounding line and in doing so decreases the density and salinity of the melt water. The mixed water mass is referred to as Ice Shelf Water which rises along the base of the ice shelf. As the Ice Shelf Water rises it will eventually reach a point where its temperature becomes lower than the local freezing point and will adhere to the underside of the ice shelf as marine ice. The Ice Shelf Water then flows in a seaward direction on the west side of the Amery Ice Shelf (Fricker *et al.* 2001, Allison, 2003, Williams *et al.* 2001, Church *et al.* 2002, Holland *et al.* 2001).

The landward and seaward flows at the Amery Ice Shelf are laterally separated due to deflection to the left by the Coriolis force combined with the westward flowing Coastal Current (Harris, 2000). This flow pattern should result in sediments on the eastern shelf being higher in marine deposits and those on the western shelf higher in

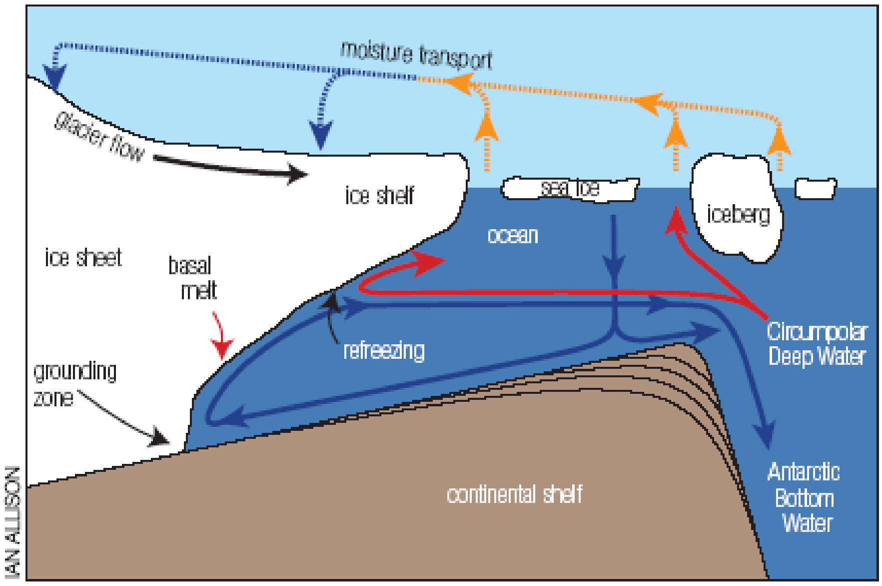


Fig. 2.2: Circulation beneath the Amery Ice Shelf depicting warmer Circumpolar Deep Water under the ice shelf circulating and freezing as marine ice or mixing with melt water and flowing out as Ice Shelf Water. Freezing of marine ice creates more saline waters which sink and flow out as deeper shelf waters (Church *et al.* 2002).

terriginous deposits. Harris (2000) found this to be the case with sediments deposited in front of the Vanderford Glacier, Antarctica.

2.4 Sea Ice inhabitants

Sea ice habitats are characterized by steep gradients in temperature, salinity, light and nutrient concentration (Arrigo, 2003, Arrigo *et al.* 2004). Blooms that occur over the spring and summer leave microbial populations surviving in the surface waters at the beginning of ice formation in the autumn. As the newly formed ice spreads over the surface, micro algae, bacteria and heterotrophic protists which include flagellates, ciliates and amoebae, may be scavenged from the water column. Columnar ice extends down into the water column as more ice is formed, and brine filled channels may form brine pockets in the ice where diatoms and algal communities may flourish, provided they have access to nutrients (Arrigo, 2003, Arrigo *et al.* 2004, Lizotte, 2003). Among the sea ice communities, photosynthetic protists are the dominant autotrophs and these include diatoms, dinoflagellates, prymnesiophytes, prasinophytes, chryosphytes, cryptophytes, chlorophytes, euglenophytes and a photosynthetic ciliate (Lizotte, 2003).

Upper sea ice communities survive at or near the sea ice surface (fig 2.3) and are dominated by small photosynthetic dinoflagellates, chrysophytes and prasinophytes. Due to lower temperatures and hypersaline conditions, growth of diatoms and other plankton may be limited in the upper sea ice in the winter and early spring. Although the upper sea ice community often has adequate light available for growth, it may be restricted in available nutrients (Arrigo, 2003). It is regions with ice floes that are linked with the underlying sea water where the sea ice algae will flourish due to accessible nutrients (Arrigo *et al.* 2004).

Temperatures of surface ice in McMurdo Sound, Antarctica are often lower than -20^{o} C, but at the base, the ice is close to seawater temperature. Internal sea ice communities (fig 2.3) are found at levels where sea water can infiltrate the ice floe and this may be due to snowfall loading which pushes the ice further into the sea (Arrigo, 2003, Arrigo *et al.* 2004). Ice rafting caused by wind and tide movement resulting in the flooding of the ice surface with sea water can also occur. Microbial communities within the ice rely on nutrients seeded by particles scavenged during ice formation. Bottom ice communities form in the skeletal layer, a highly porous layer that forms at the lower margin of growing columnar ice (fig 2.3), and they extend upwards as far as 0.2 m where conditions are environmentally stable (Arrigo, 2003, Arrigo *et al.* 2004). Platelet ice is found beneath landfast ice adjacent to floating ice shelves where it becomes super cooled and is the most porous of sea ice. It has five times more surface area for algal attachment and because of its high surface area and high porosity it contains a high accumulation of sea ice algae (Arrigo *et al.* 2004).

The seasonal ice coverage in the Southern Ocean produces a different timing and distribution of sea ice algae to that of phytoplankton in the water column (Lizotte, 2001). Cyst formation is an overwintering adaptation in the upper sea ice used for survival in the harsh conditions. Some species are able to overwinter as statocysts and begin growth early for dispersal in the water column in summer and fall. The exchange of organisms between the sea ice and water column in this way provides an important environment for natural selection of microalgae for seeding phytoplankton blooms in marginal ice zones (Lizotte, 2001; Stoecker *et al.* 1998). They provide a source of food for higher organisms when nutrients within the water column may be low (Lizotte, 2001).

Summer sea ice melting in the Southern Ocean has an effect on the physical, chemical and biological oceanographic processes (Leventer, 2003). Polar productivity for interglacial periods (fig 2.4) in the form of phytoplankton blooms makes up ~50% of the annual primary production in the Southern Ocean. The release from the sea ice and subsequent blooms seeds ice edge communities and supports the pelagic community by ensuring a source food in the form of sea ice algae both in the winter and during the late spring through to summer.

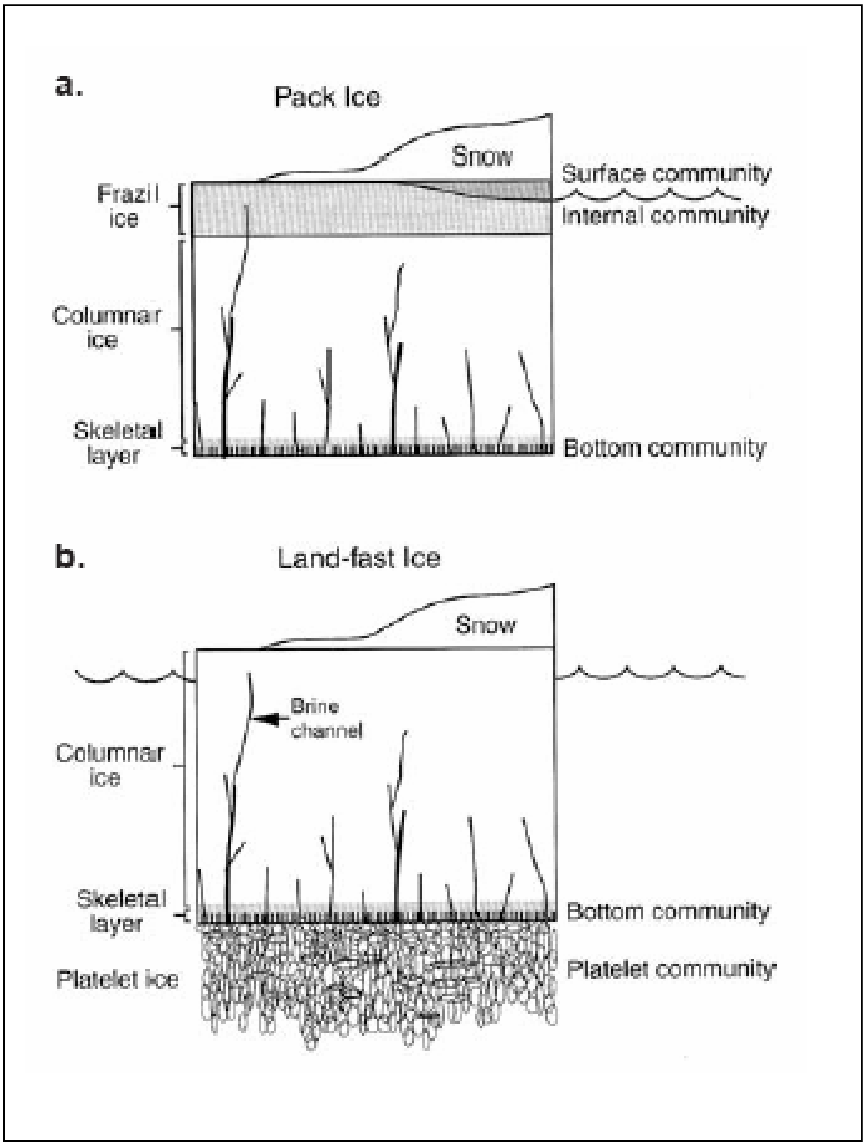


Fig. 2.3: Pack ice and land fast ice showing the major physical features and locations of microbial habitats of surface, internal bottom and platelet communities (Arrigo & Thomas, 2004).

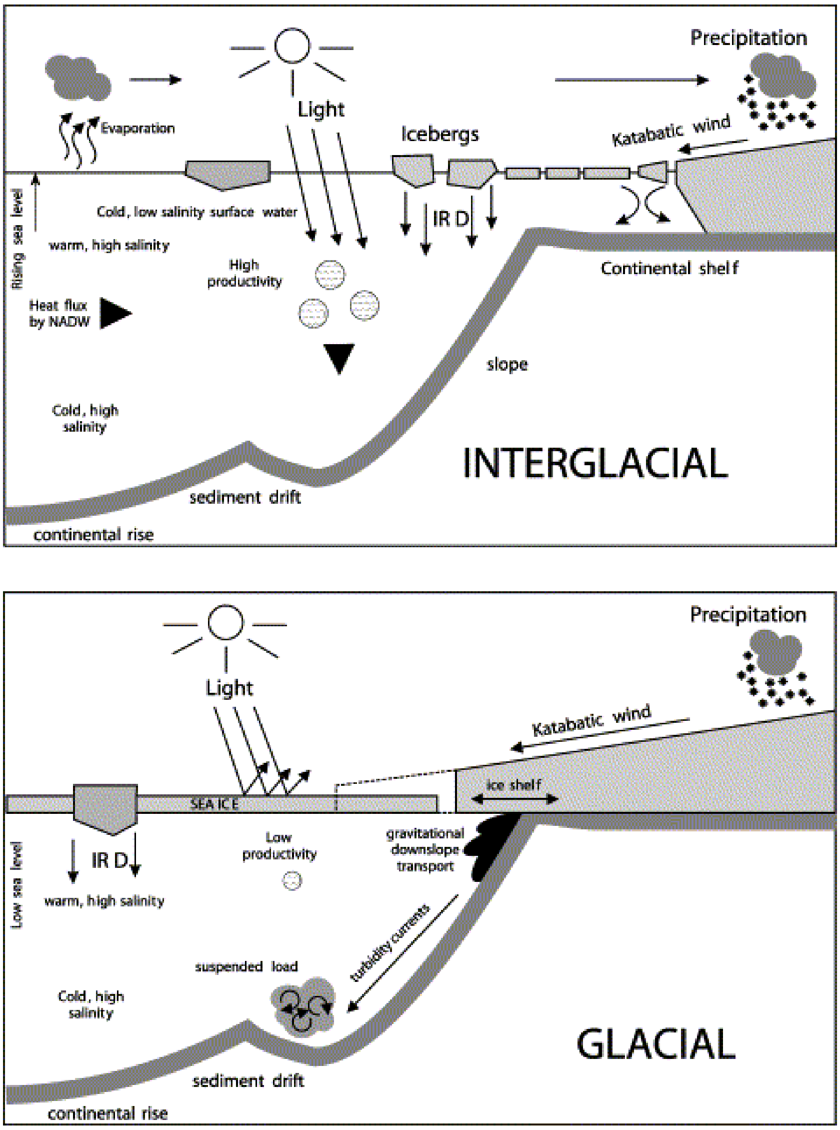


Fig 2.4. Model for the environmental conditions triggering palaeoproductivity during glacial and interglacial intervals, in the continental margin of the Antarctic Peninsula (Villa, *et al*. 2003)

CHAPTER 3
METHODS AND RESULTS – PALYNOLOGY

3.1 Introduction

Fifty eight samples of surface sediments were collected by the Australian Geological Survey Organization from gravity cores (GC) taken in Prydz Bay during three cruises at intervals of 2 years from 1993. The gravity cores are held by Geoscience Australia in Canberra where they are kept in cool storage. Gravity coring requires a weighted corer to be dropped into the ocean where it sinks into the sediments with the assistance of its weight (O'Brien *et al.* 1993). The surface sediments are usually disturbed as the corer hits the sea floor. Therefore the sediments used in this study are actually from just below the sediment/water interface. Each core was cut into lengths of approximately one metre and wrapped in sheets of plastic to keep in the moisture. The sediments were collected from depths of approximately 0-2 cm below sea floor (cbsf) of each core. In some cases where sediment had previously been removed, samples were from as deep as 5 cbsf. All samples were placed in air tight jars and labelled. The samples were transported to Victoria University, Wellington, for palynological processing and grain size analysis.

For each cruise the sample numbers and drill positions were as follows:

1993: GC901 – 19 samples (15 on the shelf, 4 on the fan)
1995: GC149 – 22 samples (6 on the shelf, 16 on the fan)
1997: GC186 – 17 samples (14 on the shelf, 3 on the fan)

Information on the latitude, longitude and the water depth for each sample are included in Appendix A. Each sample was given a preliminary sediment description and approximate grain size determined (Appendix B), and then placed in a beaker and put in an oven overnight to dry out. The dry weight was recorded (Appendix B) and approximately 5 grams per sample was separated out to be used for palynology processing while the remaining sediment was used for grain size analysis. Four samples from the Mid Shelf area did not contain sufficient sediment after the drying process for completion of grain size analysis, (GC901-24, GC901-25, GC901-26, GC186-13) and this was due to their content being of very fine silt, which had a very light dry weight.

3.2 Palynological processing

Processing procedure followed standard palynology techniques but without any oxidation and sieving in order to retrieve as many marine palynomorphs as possible. Hydrochloride acid (HCl) was added to each beaker to dissolve carbonates, stirred, and left to settle and any reaction was noted (Appendix B). The process was repeated until all reaction had ceased which in some cases was 1 or 2 days. The beakers were topped up with filtered water, stirred thoroughly and left for about an hour to settle, then decanted. In order to dissolve silicates Hydrofluoric Acid (HF) was poured into each beaker covering the sediments. The samples were then stirred and left for approximately 36 hours with intermittent stirring during that time. Filtered water was added and each sample was left to settle before decanting into a mixture of bicarbonate of soda and filtered water in order to neutralize the HF. Care was taken during decanting because of the reaction (fizzing) that took place in the neutralising tank. After each beaker was decanted into the soda and water mixture, it was topped up with filtered water, stirred and left to settle for about an hour. This process was repeated until all reaction in the neutralising tank had ceased; in most cases this meant about 3 to 4 washes.

The samples were then transferred into test tubes, agitated and topped up with filtered water, then centrifuged at 2,600 rpm for 5 minutes. This process was repeated, and then a small amount of HCl was added to the samples to help with disaggregation and to remove soluble fluorides. The samples were washed with filtered water a further 3 times. After the final wash, about 30 ml of Sodium Polytungstate with an sg of 1.8 was added, the sample centrifuged at 1,800 rpm for 15 minutes, and left for a few hours. A pipette was used to extract the floating residue (float A) which was put into a test tube with a little HCl added to stop its organic matter clumping, topped with water, agitated then centrifuged at 3,000 rpm for 3 minutes. This washing process was repeated 6 times.

Slides were preheated and a small drop of residue from each sample was placed in the centre and mixed with glycerine jelly, then a cover slip was placed on top of the slide, labelled and left overnight to dry. This process was repeated by agitating and then centrifuging the Sodium Polytungstate leaving it to settle again and obtaining a second float (float B). This second float provided an assurance that maximum numbers of palynomorphs had been recovered. Six slides from each sample were prepared, three from each float.

3.2.1 Microscope and camera technique

A light microscope Leica DML was mounted with a Leica DFC camera for image acquisition. Slides were analysed at x20, x40 or x100 magnification. The colour photographs were later printed out and stored in a catalogue for quick reference. Problems encountered with photography were the position of some of the palynomorphs on the slides, for example if they were half hidden by amorphous material or charcoal, or if they were breaking up or dissolving.

3.2.2 Counting method

All slides were scanned for content before counting and a qualitative record of species was made. The three slides from each sample that were chosen for the count did not always involve both A and B floats due to some samples having very low palynomorph content which was mostly recovered in the first three slides from the initial float A. Slides were scanned from left to right and all palynomorphs were counted, photographed and coordinated using an England finder. Some slides contained a lot of pollen which was often broken and obscured by charcoal pieces. Individual pollen and spores were only counted if more than half of the pollen grain was recognisable.

All data were entered on a separate Excel worksheet for each sample number. Data collected show the type and count of each palynomorph and the latitude and longitude, bathymetry, lithology and total count for the sample. Data from excel worksheets were transferred on to the master spreadsheet (Appendix A) and colour coded with red signifying any count <20, black ≥ 20, green ≥ 100 and blue $\geq 1{,}000$.

Each category in each sample was subtotalled and each sample totalled, then a final palynomorph subtotal and total was given.

3.2.3 Grains per gram

Grains per gram were calculated using the amount of dry weight of sediment used in the palynomorph processing (Appendix B) which was divided by the total number of palynomorphs counted in each sample and multiplied by a factor of 1.5 (grains/ palynomorph x1.5). Based on an initial count, the slides with the highest number of palynomorphs were selected from the 6 slides made up as mentioned above. It was estimated from the initial count that approximately two thirds of the palynomorphs had been captured in those 3 slides, therefore to determine the total number of palynomorphs required multiplying by 1.5.

3.2.4 Contamination

Three or four slides contained modern bisaccate pollen. These were easily identified as a contaminant due to their fresh appearance and excellent preservation. Another source of contamination were plastic filings found in some samples which were believed to have come from the PVC inner linings of the drill cores that were cut into meter long lengths for storage purposes.

3.2.5 Oxidation

Oxidation was carried out on 4 samples that had been processed as above (901/23, 901/25, 901/33 and 186/16) and the results were compared with non processed samples. The process removes unwanted material and concentrates the palynomorphs. The method used 30 ml of Nitric Acid (HNO3) combined with 15 ml of saturated Potassium Chloride (KCl) which was poured over the sample residues and left for 10 minutes. The samples were then topped up with filtered water, centrifuged and rinsed twice and a small amount of Ammonia (NH_3) was added followed by further rinsing. Slides were prepared from the residue and checked for content.

3.3 RESULTS – PALYNOLOGY

3.3.1 Introduction

The 58 samples processed yielded a total of 12,727 palynomorphs. All counts are listed on the master spreadsheet (Appendix A).

8 samples	0 to 20 palynomorphs (includes 1 nil sample)	
14 samples	21 to 99	"
35 samples	100 to 999	"
1 sample	over 1,000	"

The assemblages of palynomorphs recognised in Prydz Bay have been grouped into two broad categories: Holocene and reworked palynomorphs (Appendix A). The Holocene palynomorph groups were further subdivided and their assemblages are described below, followed by reworked palynomorphs assemblages.

3.4 Acritarchs

Acritarchs are a polyphyletic group which may include ancestors from both chromophytes and chlorophytes (Strother, 1996). Acritarchs can be found in large numbers and have high taxonomic diversity. They may represent a variety of life stages for eggs, cysts and mature tests, which in turn may represent a higher organism of plant or animal. They are best defined as representing the encystment phase of an unknown algal life cycle (Strother, 1996) and may be regarded as a form of phytoplankton that is either extinct or still living in the water column today (Tappan, 1980). The wall composition of acritarchs is composed of a fatty acid similar to plants, called sporopollenin, which enables the cyst to survive diagenesis (Brasier, 1980, Tappan, 1980, Strother, 1996). This also will enable them to survive adverse environmental conditions over time, for example in the colder Polar Regions. They may contain a wall structured with single or multiple layers surrounding a central cavity which may be closed or open to the exterior by varied means. The shape, structure, and ornamentation may vary; for example a homomorphic cyst will have similar processes and a heteromorphic cyst will have a significant variation of process size and/or shape (Strother, 1996). The types of acritarchs identified during this study are Acanthomorphitae, *Leiosphaerida, Sigmopollis* and *Sphaeoromorphs* and these are described below.

3.4.1 Acanthomorphitae

Acanthomorphs are spherical or ellipsoidal with no inner body or surficial crests. Their topography may be elaborate with processes that have a regular or arbitrary distribution and some may have excystment structures (Strother, 1996). They are represented by Acritarch spp. 1 – 4 (Plate 1) and show variation in morphology with species 2 and 4 being heteromorphic while species 1 and 3 are homomorphic. Species 4 has an excystment opening consisting of a median split (Plate 2 nos. 1-2).

3.4.2 *Leiosphaeridia*

Leiosphaeridia are spherical to ovoid, may have slight ornamentation and are without processes but may exhibit a pylome. They have a thin cell wall and may be light brown to pale yellow or colourless (Plate 2 no. 5). They are difficult to classify due to the lack of taxonomically significant features (Lindgren, 1981).

3.4.3 *Sigmopollis*

Sigmopollis are subspherical to ovoid in shape and the excystment structure is a sigmoidal suture around the periphery. They may have a prominent tab with matching notch on opposite margins of the aperture. The wall is smooth and unornamented, hyaline and colourless (Strother, 1996).

3.4.4 Sphaeoromorphs

Sphaeoromorphs are morphologically simple palynomorphs with a basic spherical shape and cover a wide range of sizes (Plate 2 nos. 6-12).

3.5 Dinoflagellate cysts

Dinoflagellates are a diverse group of unicellular algae and an important part of phytoplankton. Thick walled resting cysts are often produced during a stage in the life cycle of a dinoflagellate and may or may not resemble the living motile cell. In adverse environmental conditions dinoflagellates can also produce temporary cysts (Brasier, 1980, Fensome *et al.* 1996). Identification of dinocysts may rely on thecal plates found on armoured motile cells or in the case of athecate or unarmoured cysts other features may be used for identification. The cell walls are made up of dinosporin, a complex organic compound that is very resistant to dissolution (Brasier, 1980, Tappan, 1980, Fensome, *et al.* 1996, Armand & Leventer, 2003).

In Antarctic waters dinoflagellate assemblages are of low abundance which is in contrast to temperate and warmer tropical seas (McMinn & Scott, 2005). Most Quaternary dinoflagellates belong to the Orders Gymnodiniales and Peridiniales. The largest group of living dinoflagellates from the Peridiniales are the Family Protoperidiniaceae (Mudie & Harland, 1996) from which *Protoperidinium* is the most diverse dinoflagellate genus in Antarctic waters and many species are endemic to the Southern Ocean and Antarctica (McMinn & Scott 2005). Nearly all the *Protoperidinium* spp. are heterotrophic and produce resting cysts which have brown walls, intercalary archeopyles and a simple morphology with little ornamentation. *Protoperidinium* spp. can exist in conditions of reduced light and mixed salinity, and are usually abundant in areas of upwelling (Mudie & Harland, 1996). The major Holocene dinoflagellate species are discussed below followed by other minor Holocene dinoflagellate species.

3.5.1 *Selenopemphix antarctica*

Selenopemphix antarctica is spherical with two antapical horns and is apically to antapically compressed (Plate 5 nos. 1-4). Cysts are slightly pinkish in colour with granulations on the surface but no other ornamentation is present. This species has been exclusively recorded in the Southern Hemisphere and is endemic to the Southern Ocean and Antarctica. *Selenopemphix antarctica* dominates assemblages south of the Antarctic Polar Front close to the Antarctic continent especially in areas seasonally covered with sea ice (Marret & de Vernal, 1997).

3.5.2 *Protoperidinium* sp. 2

Protoperidinium sp. 2 are dark brown in colour with a granular surface with no tabulation or processes present. They are sub-spheroidal to ovoid in shape with a prominent cingulum and sulcus (Plate 4 nos. 10-12). This species was first recorded as a Quaternary Protoperidinioid *in situ* dinocyst from the Cape Roberts Project-1 core unit 3.1 at 32.77 m below the sea floor in the Ross Sea (Wrenn *et al.* 1998).

3.5.3 *Cryodinium* sp.

Cryodinium sp. is a spherical protoperidinioid cyst with a smooth to granular surface and dark brown in colour. The cyst shows paratabulation and an intercalary archeopyle (Plate 3 nos. 4-12). It is a new endemic form recorded between the Antarctic Polar Front and the ACC-Weddell Gyre Boundary by Esper & Zonneveld (2002) and is a new record to the Antarctic Coastal Current and Prydz Bay environment.

3.5.4 Other dinocysts

The dinocyst *Alisocysta* sp. is ovoid with penitabular septa with an apical archeopyle and pale brown in colour (Plate 3 nos. 1-3). *Impagidinium* sp. (Plate 4 nos. 6-9) is a subspherical light brown dinocyst with a smooth wall and paratabulation. *Impagidinium* dinocysts are usually found in deeper oceanic environments (Dale, 1996). *Hystrichosphaeridium* sp. (Plate 4 nos. 4-5) is spherical with chorate processes that vary in length. *Protoperidinium* sp. 1 (Plate 5 nos 5-9) is spherical to ovoid in shape with suessioid tabulation type, pale yellow and no processes. Dinocyst sp (Plate 4 nos. 1-3) is ovoid with an apical archeopyle and chorate processes and cannot be referred to any existing genera.

3.6 Prasinophycean algae

The Prasinophyte group can be defined as noncellulosic green algae with scaly flagella arising from within an apical pit (Tappan, 1980). The diagnostic characters of this group are a two phase life history and the presence of scales on the motile cell body that differ to those on the flagella. In Arctic waters they are reported to be associated with water-column features of low temperature, enhanced productivity and stratified water columns with low salinity surface water overlying low oxygen bottom waters (Mudie, 1992, Mudie & Harland, 1996). The prasinophytes types recovered in this study are two species of *Cymatiosphaera, Tasmanites* sp. and *Pterospermella* sp. The *Tasmanites* sp. were fresh looking and light grey unlike similar species found in ancient sediments which are usually brown.

3.6.1 *Cymatiosphaera* sp. 1 and sp. 2

The Cymatiosphaera characteristically have surface crests making it hard to discern any openings and are most abundant in Arctic waters in upwelling or nutrient rich waters containing normal to low salinity (Mudie & Harland, 1996). They have a spherical central body which may be colourless to pale yellow or light brown and have no processes but surface ornamentation consists of a fine crest which anastomoses over the surface. The difference between these species is their size with species 1 being 15-20 µm in diameter (Plate 5 nos. 10-12) and species 2 much larger, with a diameter of 75-115 µm (Plate 6 nos. 1-10). Specimens similar to C*ymatiosphaera* sp. 2 have been recovered from the lower Miocene with two occurrences in the Quaternary section of the Cape Roberts Project-1 (CRP-1) 20.04 m below sea floor, McMurdo Sound (Hannah *et al*. 1998).

3.6.2 *Tasmanites* and *Pterospermella*

Species assignable to *Tasmanites* (Plate 7 nos. 1-3) change morphology throughout their life cycle. In their early life history the wall is single layered and develops with growth to a double layered wall. They have perforations of radially arranged pores of two distinct sizes. *Pterospermella* (Plate 6 nos. 11-12) are compressed and have no surface crests but are bordered by a wide floatation membrane and though mostly found in oceanic regions are also found in lowered salinity Polar Regions (Mudie & Harland, 1996). *Tasmanites* along with *Pterospermella* are regarded as the two fossil genera that are indisputably prasinophytes (Guy-Ohlson, 1996).

3.7 Red algae

One species of red algae (*Beringiella* sp.) has been identified in this study. This species has not been documented in the Southern Ocean before, but is known to occur in the deltaic and tidewater glacier environment of the Beaufort Sea and Baffin Island in the North Atlantic and at ice margins and arctic estuaries where there is a lowered salinity of <32% in the northern hemisphere (Mudie & Harland, 1996). Individuals are similar to the red alga *Beringiella fritilla* which is found only in upper Pleistocene sediments of the eastern Bering Sea in the Arctic (Mudie, 1992). They have an ovoid central body with smooth walls with the edge ~1 µm, and are brown with an apical archeopyle with serrated edges (Plate 7 nos. 4-11).

3.8 Unknowns

The unknowns consist of marine palynomorphs that cannot be referred to any existing genera. Some are shown on Plate 10 nos. 10-12, Plate 11 nos. 1-3, 6, 9-11 and Plate 12 nos. 11-12. For descriptions see Appendix C.

3.9 Zooplankton

Zooplankton recovered in Prydz Bay consist of Tintinnid loricae and their flask shaped cysts and a species that has not yet been identified.

3.9.1 Tintinnids

The Tintinnid loricae are known to inhabit the Antarctic waters in numbers which are exceeded only by the diatoms that they feed on (Brazier, 1980). Loricae size may be from 20-1,000 µm in length but most are 120-200 µm with a variety of shapes from globular to conical and bell shape. They have an aperture at the oral end and most are closed at the aboral end with either a rounded or pointed form (Plate 8 nos. 5-6). The tintinned ciliate cell, which doesn’t survive processing, is attached to the loricae by a pedical (Brasier, 1980). Tintinnid cysts recovered in this study are ovoid, brown and thin walled which can be easily folded and they have an aperture that extends out from the central body (Plate 8 nos. 3-4). The taxonomic subdivision of Tintinnids is uncertain due to many of their species generations showing infraspecific variability (Petz, 2005).

3.9.2 *Zooplankton* sp.

This species is spherical and two layered with an encysted inner body which is thick walled and brown in colour with no ornamentation but does contain a round aperture. The outer layer is thin and hyaline with a single “tail” attached, this layer folds easily (Plate 8 nos. 7-12 and Plate 9 nos. 1-9). The size can vary but averages between 125-175 µm. This *Zooplankton* sp. is not yet identified.

3.10 Foraminiferan linings

Foraminiferan linings are the acid resistant inner linings of microforaminifera tests, and these organic remains can be up to 40% smaller than the host test. The linings can be found in numbers at shallow depths in most oceans and are usually found in greater numbers near upwelling, coarser sediment and higher salinity conditions but tend to decrease in numbers as water depth increases. Their morphology (Plate 7 no. 12 and Plate 8 nos. 1-2) may be uniserial, biserial or spiral and within the latter, linings may also be planispiral or trochospiral (Stancliffe, 1996).

3.11 Insect parts

Insect parts consist mainly of Scolecodonts, a combination of jaw and tooth fragments (Plate 11 no. 12). They are scattered throughout the samples and include other body casings that have been resistant to palynology processing.

3.12 Egg cases

There are a wide variety of egg cases within Prydz Bay surface sediments. The egg cases range in size from ~75-300+ μm and can be a variety of shapes from ovoid, spherical to acentric and with or without ornamentation that may be elaborate and homomorphic or heteromorphic. Some examples are shown on Plate 11 nos. 4-5, 7-8 and Plate 12 nos. 1-10.

3.13 Reworked palynomorphs

3.13.1 Reworked dinoflagellate cysts

All reworked dinocysts in this study are part of the Transantarctic Flora that has been identified from previous work carried out on the dinoflagellate distribution of the Deep Sea Drilling Project (DSDP) (Kemp, 1975), MSSTS-1 drill hole McMurdo Sound (Truswell, 1986) and the CIROS-1 Drillhole (Hannah, 1997). Also included are Transantarctic Flora from CRP-1, (Hannah *et al.* 1998, Wrenn *et al.* 1998), the marine palynomorphs found in CRP-2/2A (Hannah *et al.* 2000), palynomorphs from CRP-3 (Hannah *et al.* 2001a) and Ocean Drilling Project sites in Prydz Bay 1165 (Hannah, 2005, McPhail & Truswell, 2004a), 1167 and 1166 (McPhail & Truswell, 2004b). The reworked dinocysts are Eocene in age and consist of *Alterbidinium asymmetrica*, *Deflandrea* spp. *Enneadocysta partridgei*, *Spinidinium* spp. *Spinidinium macmurdoense, Turbiosphaera filosa, Vozzhennikovia* spp. and operculae (see Appendix C for descriptions). Identification was hindered by the effects of reworking which often left most cysts in poor condition and not easily identifiable. Examples are provided on Plate 9 nos. 10-12 and Plate 10 nos. 1-9.

3.13.2 Pollen

The terrestrial material recovered in this study contains species of pollen and spores that range in age from the Permian to the Eocene (Raine pers. comm., 2005). They have been previously reported in MSSTS-1 drillhole McMurdo Sound (Truswell, 1986), in the CRP Ross Sea, Antarctica (Askin & Raine, 2000) and from ODP cores in Prdyz Bay (Hannah, 2005, McPhail & Truswell, 2004).

3.14 Results for oxidised samples

Samples that had previously produced large numbers of palynomorphs (901/23, 901/25, 901/33 and 186/16) were oxidised to try and concentrate the palynomorphs, remove unwanted debris and compare to fossil assemblages. The results show that the abundance of some species such as *Zooplankton* sp. *Cymatiosphaera* sp. 2, *Beringiella* sp. and two egg cases (Plate 10 nos. 10-12 and Plate 12 no. 1) were not generally altered in nearly all the samples oxidised. The only other palynomorphs sighted were two species of the dinocyst *Selenopemphix antarctica* but they had been affected by the oxidation and were very faded.

3.15 Palynomorph distribution

Counts of palynomorphs within each of the four geographical areas outlined in chapter one (fig 1.3) are presented in tables of total abundances, relative abundances and grains per gram of samples. Unless specifically mentioned each datum/value is given in grains per gram. Separate counts of Holocene and reworked palynomorphs, and counts of Holocene and reworked dinocysts are on the master spread sheet (Appendix A).

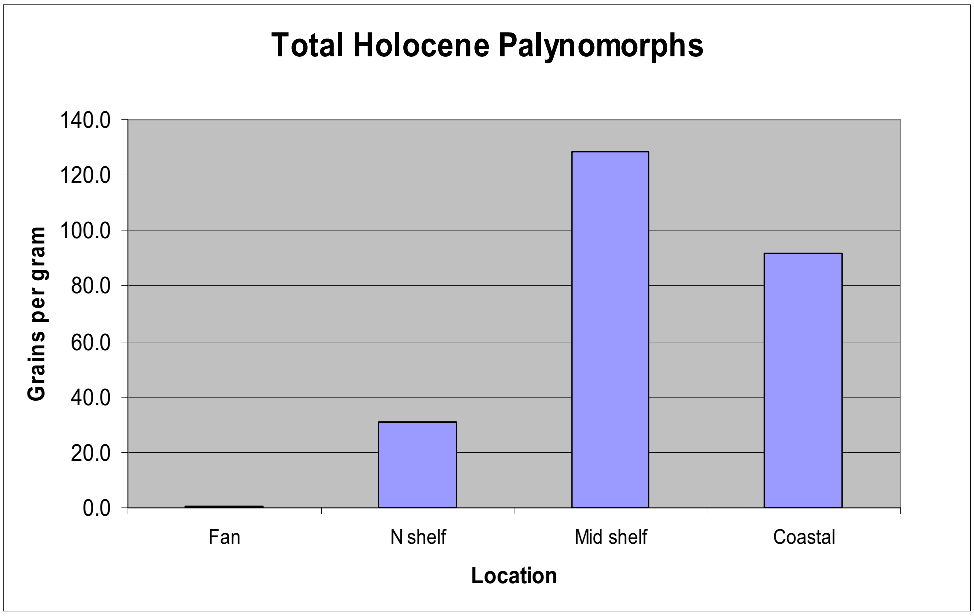
The count data are also represented in graphical form with absolute abundance for total Holocene palynomorphs shown in figure 3.1. Figure 3.2 shows the detailed components of the Holocene palynomorphs assemblage and figure 3.8 shows the Holocene dinocysts. Data for reworked assemblages are separated into reworked dinocysts in figure 3.9 and terrestrial palynomorphs in figure 3.10. The absolute abundance for total Holocene and total reworked palynomorphs is shown in figure 3.11.

Maps of Prydz Bay have been compiled using Arcview and the position of the 58 sample sites plotted. Superimposed on this basic map are data for total Holocene assemblages (fig 3.1), a breakdown of the Holocene palynomorph assemblages (fig 3.2), Holocene dinocysts (fig 3.8), reworked dinocysts (fig 3.9), terrestrial palynomorphs (fig 3.10) and a further map showing absolute abundance for total Holocene and total reworked palynomorphs (fig 3.11). Four separate maps were compiled to show *Zooplankton* sp. (fig 3.3), foraminiferan linings (fig 3.4), red algae (fig 3.5) and *Cymatiosphaera* sp. 2 (fig 3.6). Maps for positions of all other palynomorphs were placed in Appendix D. A contour map showing salinity contours was also compiled (fig 3.7).

3.16 Total Abundance for Holocene Palynomorphs

Total abundances for Holocene palynomorphs (fig 3.1) show significant differences between the geographic areas. Within the embayment, the Holocene palynomorphs have the highest total counts in the Mid Shelf area followed closely by the Coastal areas. Abundance in the North Shelf for total Holocene is lower and palynomorphs become rare on the Fan.

Figure 3.2 indicates that although there seem to be no relative differences between the make up of the assemblages in each geographical area, notably there are higher counts of zooplankton and foraminifera linings and also higher counts of all other species in the Mid Shelf area. In the Coastal area there is a slight drop in numbers for zooplankton whereas the foraminiferan linings do not reduce in numbers significantly. On the North Shelf palynomorph numbers are reduced further, but foraminiferan linings now have a higher abundance than zooplankton which are now the second most common component. There is a very small proportion of Holocene species on the Fan. Comparison of total zooplankton and foraminiferan linings show that they are both represented in nearly all continental shelf samples and only concentrations within the geographic areas differ slightly. Approximately two thirds



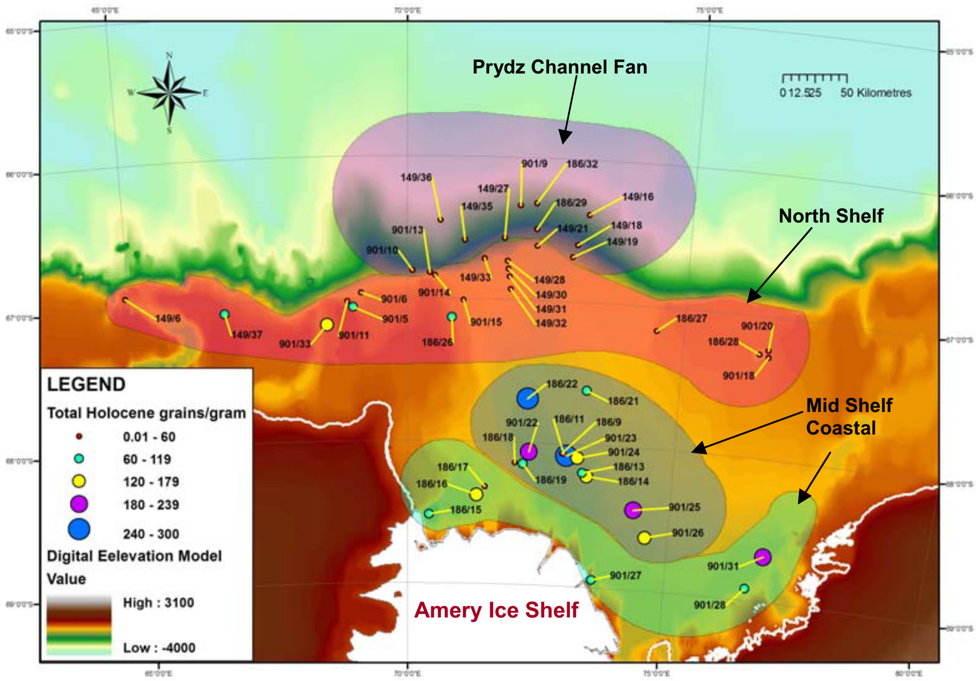


Fig. 3.1: Total Holocene palynomorphs grains per gram. Graph displays the geographical locations for total Holocene palynomorphs. The map is labelled showing the positions of the Fan, North Shelf, Mid Shelf and Coastal areas. The total Holocene palynomorph abundance shows higher abundance displayed with the larger coloured circles, and follows through to lowest abundance displayed with smallest coloured circles as per legend.

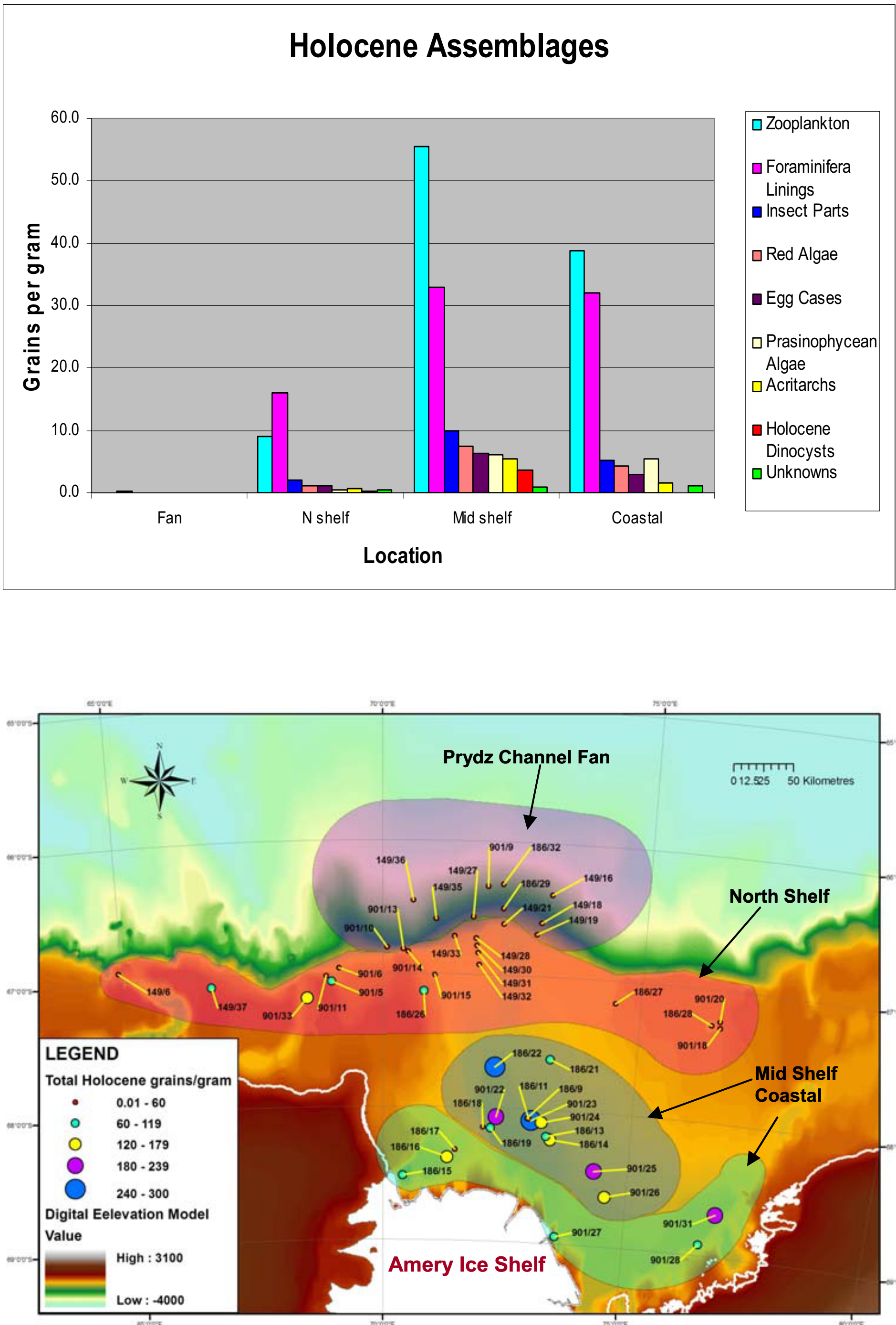


Fig. 3.2: Total Holocene Palynomorphs grains per gram. Graph displays the geographical locations with the individual assemblages. The map is labelled showing the positions of the Fan, North Shelf, Mid Shelf and Coastal areas. The total Holocene palynomorph abundance shows higher abundance displayed with the larger coloured circles and lowest abundance displayed with smallest coloured circles as per legend.

of all Holocene palynomorphs are either zooplankton (39%) or foraminiferan linings (33.93%) (Appendix A).

Zooplankton is dominated by *Zooplankton* sp. (Plate 8 nos. 7-12 and Plate 9 nos. 1-9) which makes up to 93% of this category (Appendix A). *Zooplankton* sp. highest abundances are from the Mid Shelf (51.33 g/g), but they also have a strong presence in the Coastal area (36.65 g/g) (fig 3.3). There is very little representation of this component in the North Shelf area and they are rare on the Fan with only one sample containing specimens of *Zooplankton* sp. that were damaged and looked reworked due to a darker colouring. *Zooplankton* sp. must be living in the water column today as many of their cysts are found well preserved and in good condition. The foraminifera (fig 3.4) showed similar distribution to *Zooplankton* sp. This may mean that they have a similar ecology or it could mean that they are dominating their own ecological niches and not competing for the same types of food and are therefore able to produce large populations.

3.17 Other palynomorph distributions

There are some exceptions to Holocene palynomorph concentration dominating the Mid Shelf area. *Beringiella* sp. (fig 3.5) is the only red alga found in this study and is found in most samples within the embayment and a few samples on the fan. It may be that the *Beringiella* sp. was more affected by currents within the bay than other palynomorphs. *Beringiella* sp. rarely appeared folded or flattened in the sediment and its shape (Plate 7 Nos. 4-11) could be described as oval or egg shaped, good for buoyancy and ease of dispersal. As mentioned earlier this species has been found in the Arctic, which has similar environments to Prydz Bay with regard to its ice margins and the tidewater glacier of the Amery Ice Shelf.

Cymatiosphaera sp. 2 (fig 3.6) was also found in abundance in the areas immediately in front of the Amery Ice Shelf and in the Lambert Deep on the western side of the Amery Ice Shelf. The Lambert Deep area was formed by erosion due to glacial advance of the ice shelf but today this area is where the coastal current enters from the eastern side and circulates underneath the ice shelf before exiting from the west where the Lambert Deep is situated. Mudie and Harland (1996) suggest that

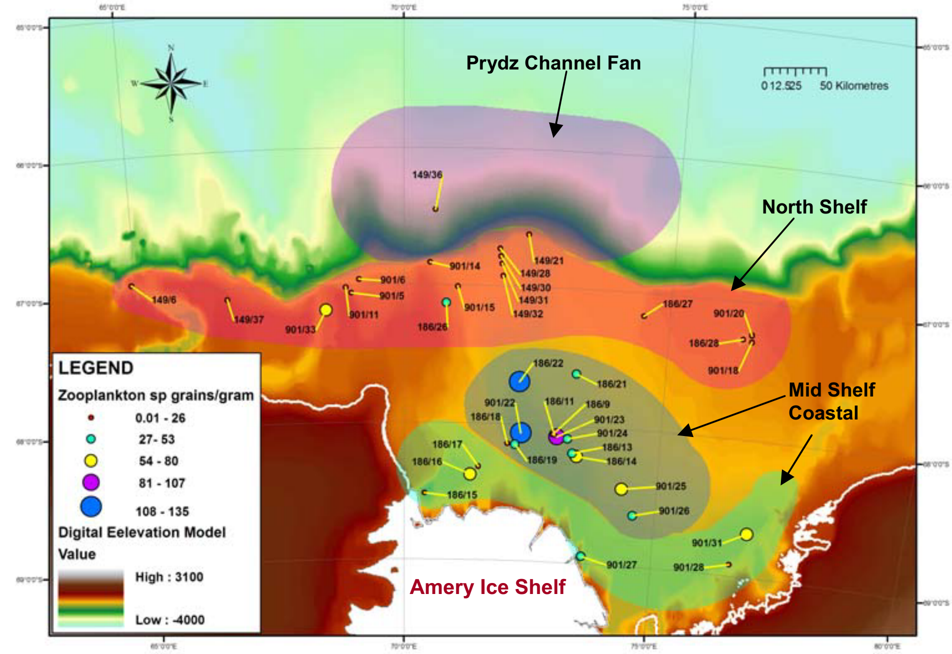


Fig. 3.3: *Zooplankton* sp. has a higher abundance (larger coloured circles) on the Mid Shelf and Coastal geographic areas, and is sparse on most of the North Shelf and spread over most of the samples there. There is only one sample with a low abundance of *Zooplankton* species on the Fan.

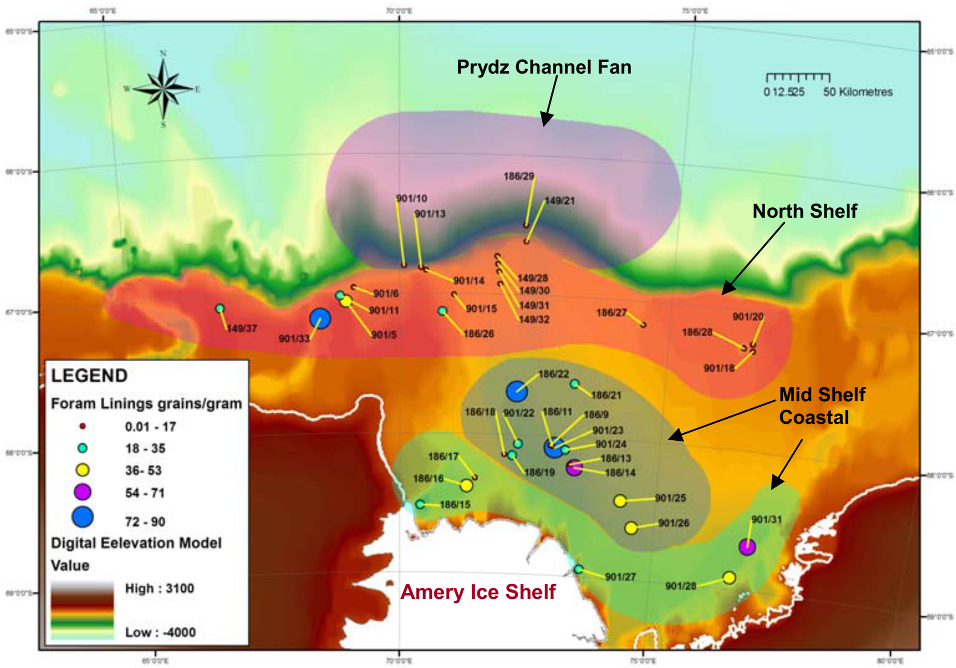


Fig. 3.4: Foraminiferan linings have a higher abundance (larger coloured circles) on the Mid Shelf and Coastal geographic areas but are fewer in number than *Zooplankton* sp. They have a high abundance on the western North Shelf but are less abundant on other parts of the North Shelf and have a small presence on the Fan.

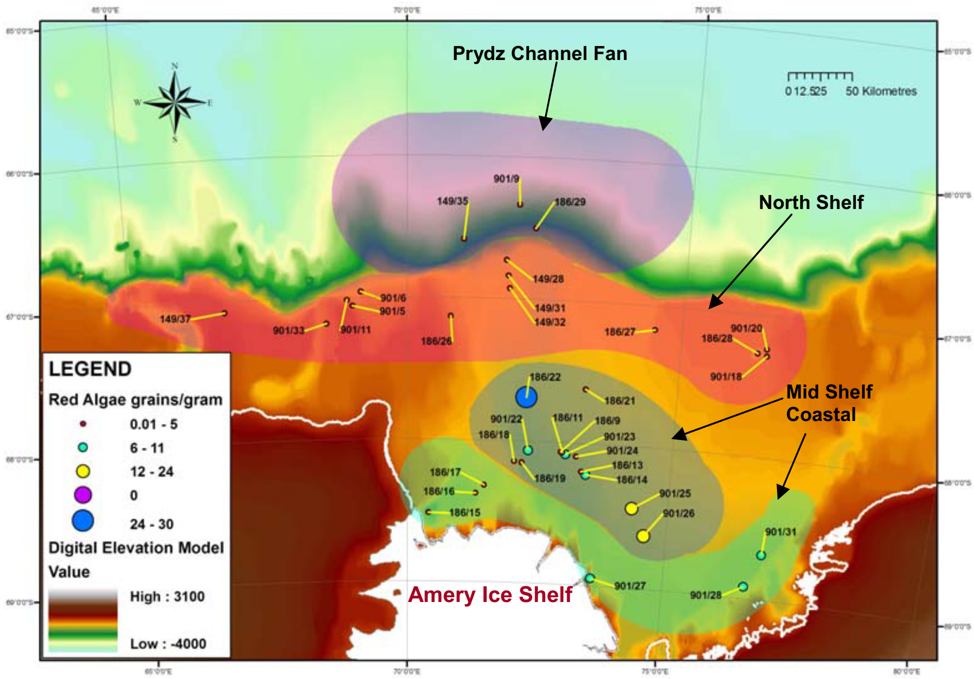


Fig. 3.5: The red algae *Beringiella* sp. show a higher abundance Mid Shelf (larger coloured circles) with less abundance in the Coastal geographic area. They are also present though sparse on the North Shelf and are rare inin three samples on the Fan.

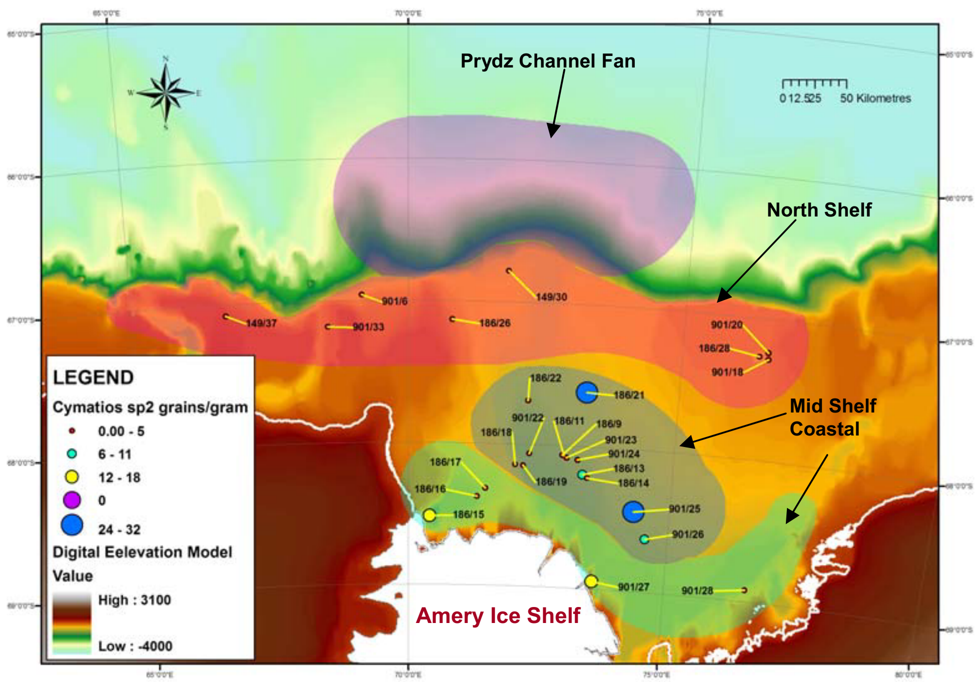


Fig. 3.6: *Cymatiosphaera* sp. 2 unlike the red algae is not present on the Fan and is sparse on the North shelf. They have a high abundance (larger coloured circles) on the Mid Shelf and in the Coastal areas especially in front of the Amery Ice Shelf.

Cymatiosphaera spp. are most common in upwelling areas in the Arctic but in Prydz Bay this species appears in the surface sediments close to the ice shelf. This may indicate a preference for lower salinity (fig 3.7) and/or colder currents circulating under the ice shelf, rather than the more saline oceanic waters imported by the circulation of the Prydz Bay Gyre. This species is not as common in the more shallow areas of the bay where the surface currents are stronger and the salinity is higher.

The unknowns (Appendix D) have a total count of 95 palynomorphs. All the unknowns were located in the continental shelf and the highest concentration was in the coastal area, which makes this category an exception to the dominance of palynomorphs found in the Mid Shelf. The most abundant species of unknowns is species 6 at 41.90% and its location is similar to the prasinophyte and red algae locations which suggest that this species may be algal in origin.

The highest counts (Appendix A) for insect parts and egg cases confined them mostly to the continental shelf area, with their highest concentration in the Mid Shelf at 9.85 grains per gram.

3.18 Reworked v Holocene dinoflagellate cysts

The surface sediment samples obtained for this project are considered to be modern and in some areas of Prydz Bay, for example the Prydz Bay Channel, they have produced extant dinocysts. Figure 3.8 shows the distribution in the bay for Holocene dinocysts. They are abundant in the Mid Shelf but are rare in other locations. According to Dale (1996) a glaciomarine signal is provided by the dominance of a single species. This is consistent with the Holocene dinocyst *Selenopemphix antarctica,* which is present within the bay at more than three times the number of any other dinocyst. *Cryodinium* sp. and *Protoperidinioid* sp. 2 are the next most abundant types. The appearance of two cosmopolitan gonyaulacoid dinocysts, the *Impagidinium* sp. and *Alisocysta* sp. which are normally restricted to open waters, suggest that oceanic waters are entering the embayment (Dale, 1996). 25% of all dinocyst counted are reworked (fig 3.9), and all these are recognised as part of the

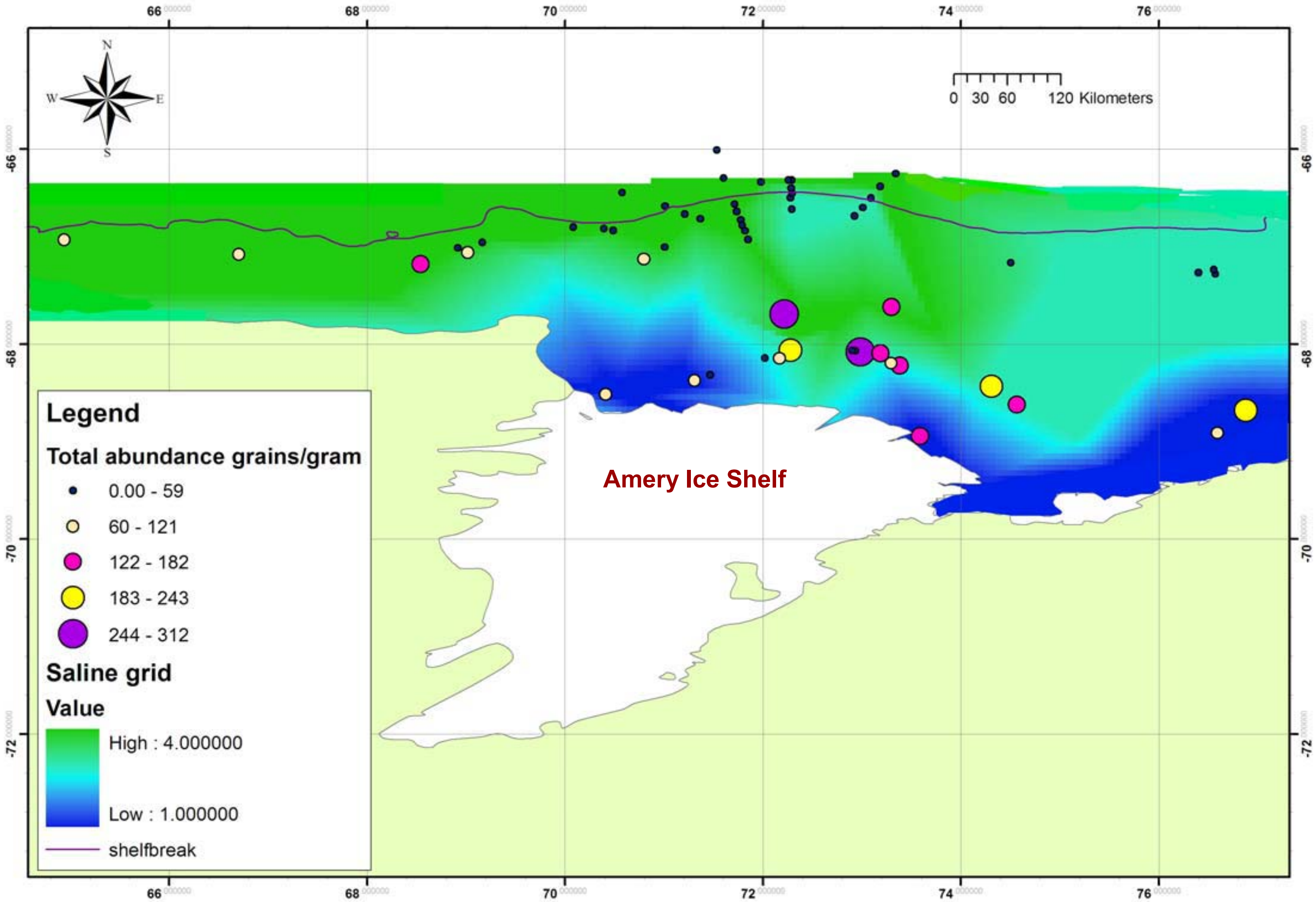
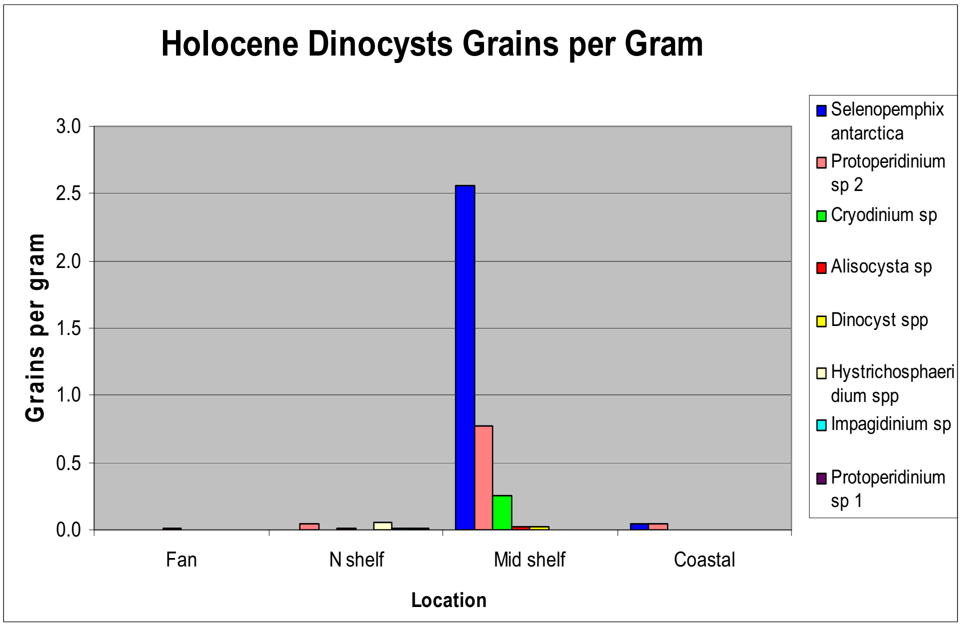


Fig 3.7: Prydz Bay salinity contour map showing higher salinity, dark green through to lower salinity, dark blue. A compilation was selected by Taylor, McMinn & Franklin (1997) table 1, from data collected on separate cruises by ANARE, FIBEX, SIBEX II and



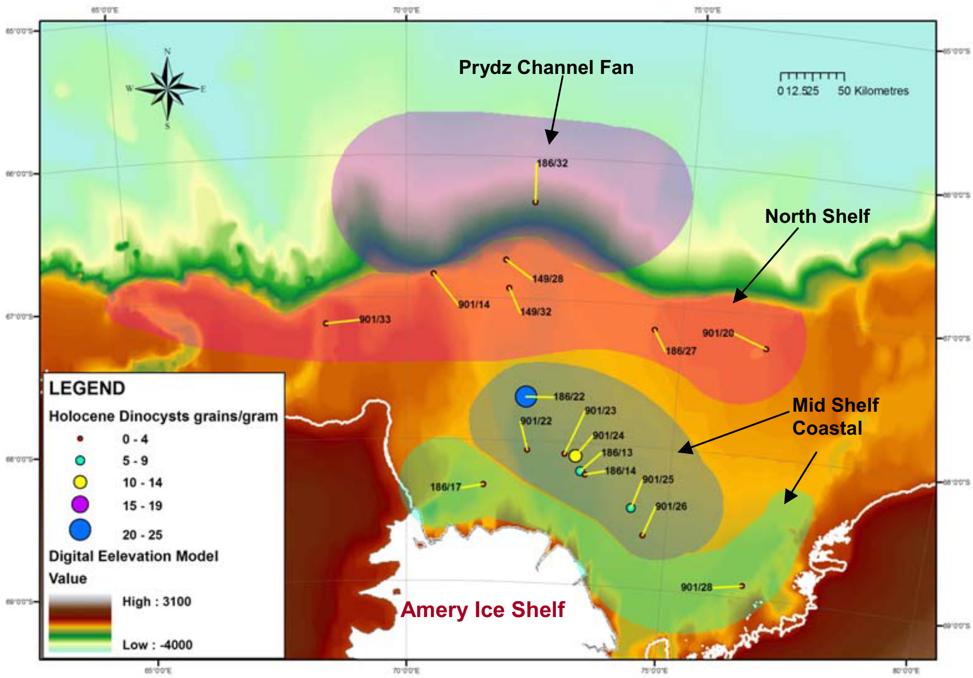
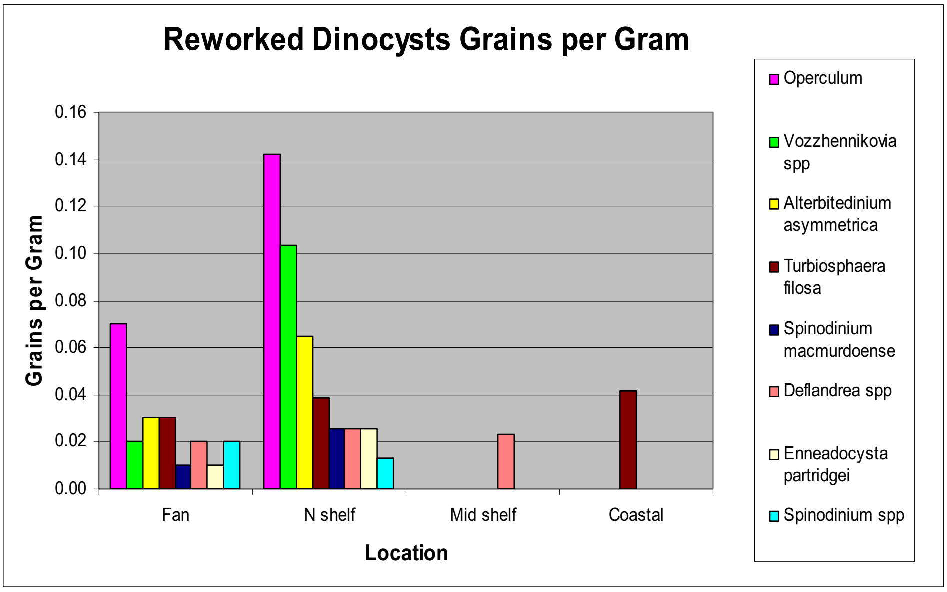


Fig. 3.8: Holocene dinocysts grains per gram. Graph displays the geographical locations with the individual assemblages. The map is labelled showing the positions of the Fan, North Shelf, Mid Shelf and Coastal areas. The Holocene dinocyst abundance shows higher abundance displayed with the larger coloured circles and lowest abundance displayed with smallest coloured circles as per legend.



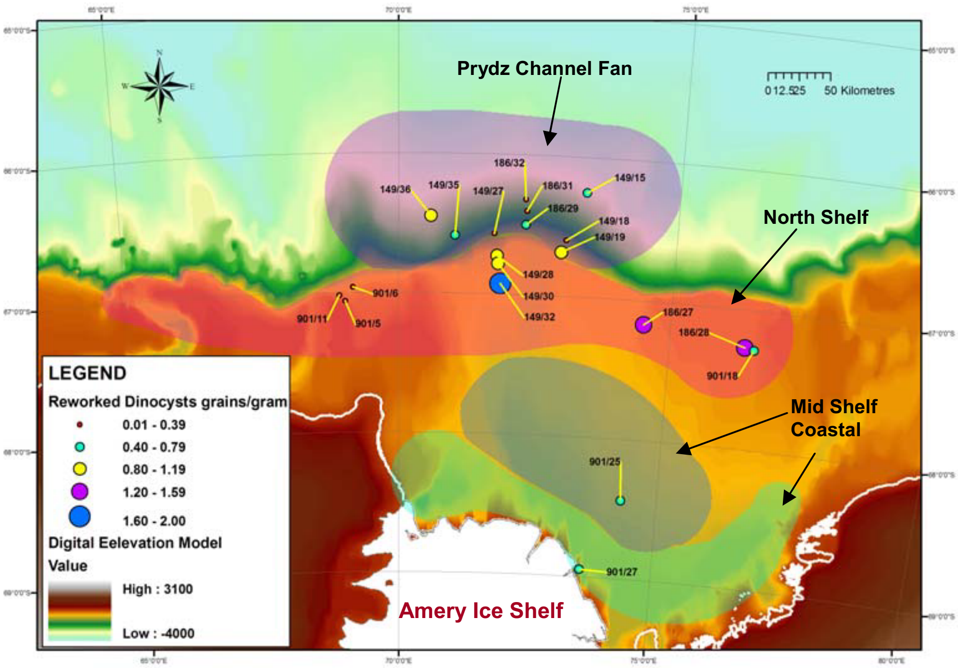


Fig. 3.9: Reworked dinocysts grains per gram. Graph displays the geographical locations with the individual assemblages. The map is labelled showing the positions of the Fan, North Shelf, Mid Shelf and Coastal areas. The reworked dinocyst abundance shows higher abundance displayed with the larger coloured circles and lowest abundance displayed with smallest coloured circles as per legend.

Transantarctic Flora initially reported in the McMurdo Erratics (Levy & Harwood, 2000b) and Eocene in age, with their highest counts recorded in the North Shelf and Fan areas. *Turbiosphaera filosa* is the only reworked dinocyst recorded in the Coastal area and *Deflandrea* sp. the only reworked dinocyst recorded in the Mid Shelf.

3.19 Terrestrial material (reworked)

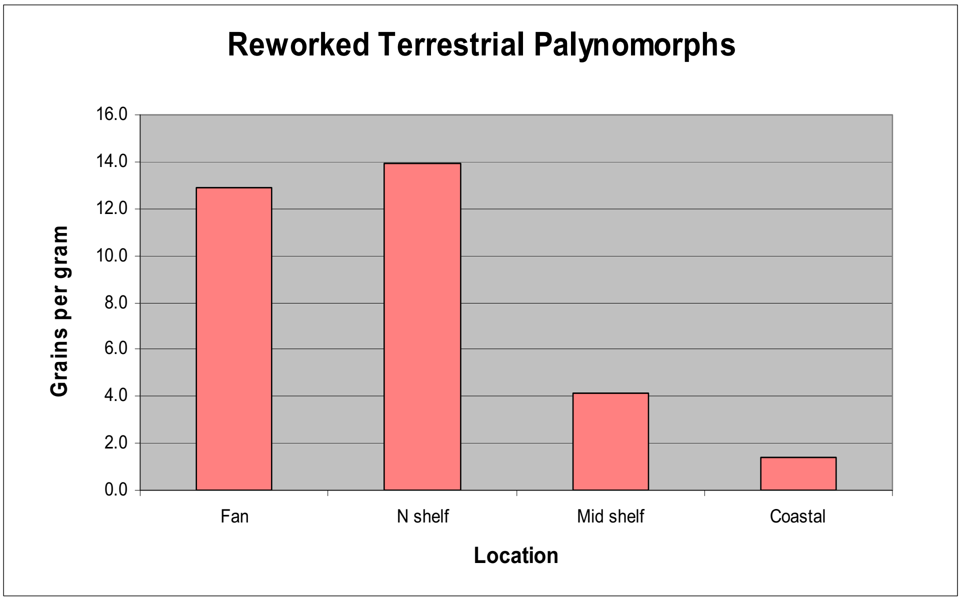
The reworked dinocysts mentioned above make up approximately 2% of the total reworked palynomorph count, the other 98% being terrestrial material (Appendix A) consisting of fragments of charcoal, pollen grains and spores. Figure 3.10 shows that pollen grains and spores have high abundances on the Fan and North Shelf, with decreasing amounts from Mid Shelf and Coastal areas.

There is a mix of terrestrial material found among the modern marine palynomorphs in the Mid Shelf and Coastal areas which may be explained by the Prydz Bay Gyre distributing this material. Other factors may include iceberg ploughing and strong currents in shallow areas that have disturbed sediment where the terrestrial material is most abundant. The material may also be carried into the bay by the coastal currents from the east which have been discussed by Truswell (1983) with regard to the composition, distribution and origin of recycled material on the East Antarctic continental shelf. Truswell (1983) suggested that recycled palynomorph concentrations may be from the erosion of sedimentary sequences on the eastern continental shelf which would be carried to Prydz Bay by the coastal current.

3.20 Total Holocene and reworked palynomorphs

A notable difference between total Holocene and total reworked palynomorphs is in the total counts. Total count for Holocene palynomorphs (10,097) are approximately four times greater than the total count for reworked palynomorphs (2,630) (Appendix A). Graphical results for absolute abundance of total Holocene and reworked grains per gram shows the uneven distribution that is occurring between the Holocene and reworked palynomorphs (fig 3.11). The graph emphasises the dominance of Holocene palynomorphs on the Mid Shelf and Coastal geographic areas which confines them to the deeper parts of the continental shelf. The North

Shelf shows that Holocene palynomorphs are lower in abundance here but still slightly higher than all reworked palynomorphs. In contrast the much lower counts for total reworked palynomorphs show a more even distribution on the Fan and North Shelf geographic areas, but are sparse in the deeper Mid Shelf and Coastal geographic areas. The map displays the overall abundance for palynomorphs and confirms that highest abundances are in the Mid Shelf and Coastal areas and that abundance is lower on the North Shelf and even lower on the Fan.



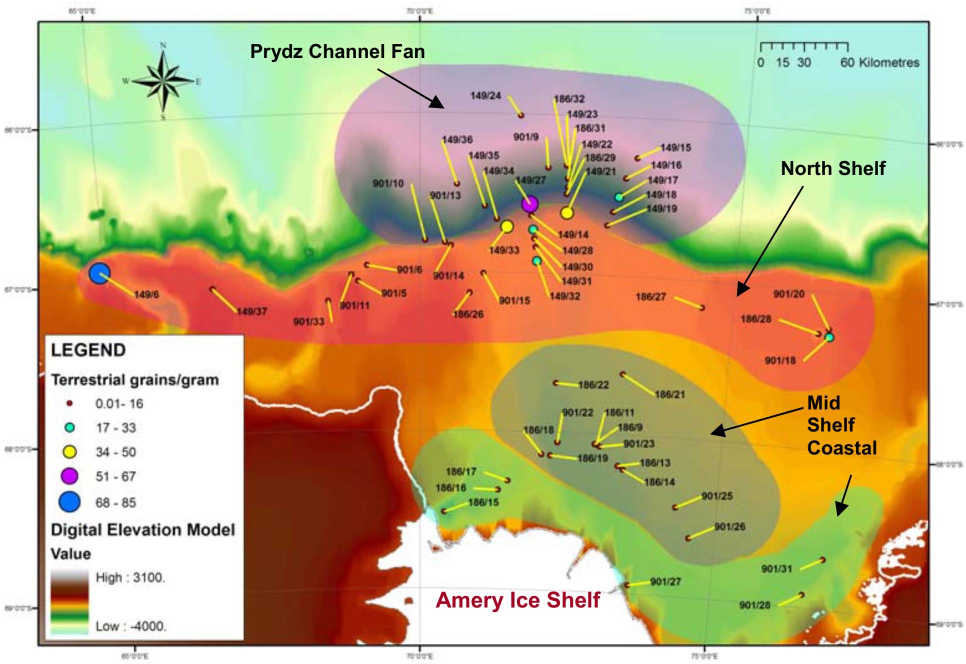
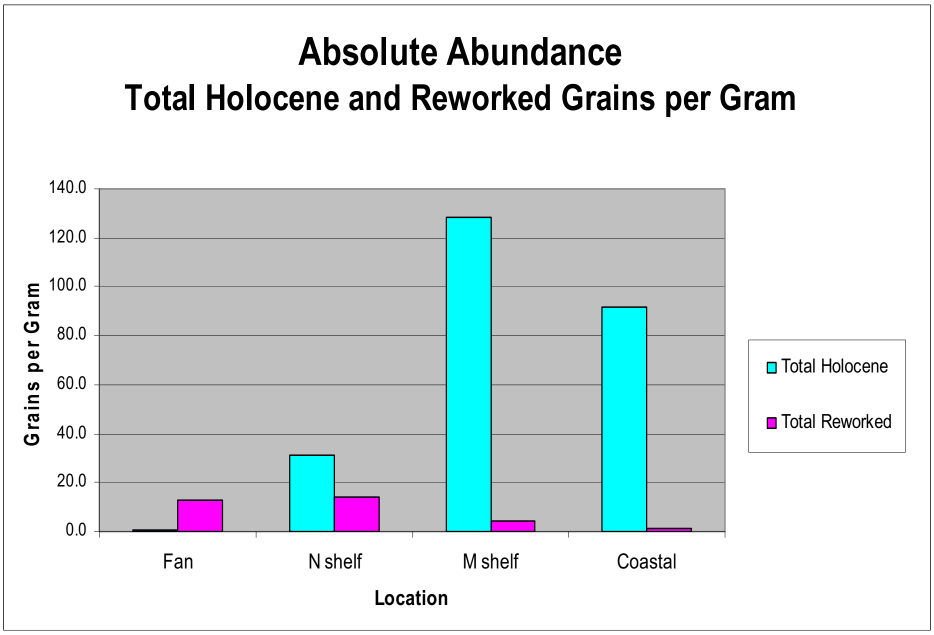


Fig. 3.10: Terrestrial palynomorphs consist of pollen grains and spores. The large coloured circles are the higher abundances and are mostly on the Northern Shelf. There is a scattering of terrestrial material on the inner shelf which must have been transported there by the coastal currents or the gyre. The graph displays the terrestrial material with the highest abundance on the North Shelf followed by the Fan and small counts Mid Shelf and Coastal.



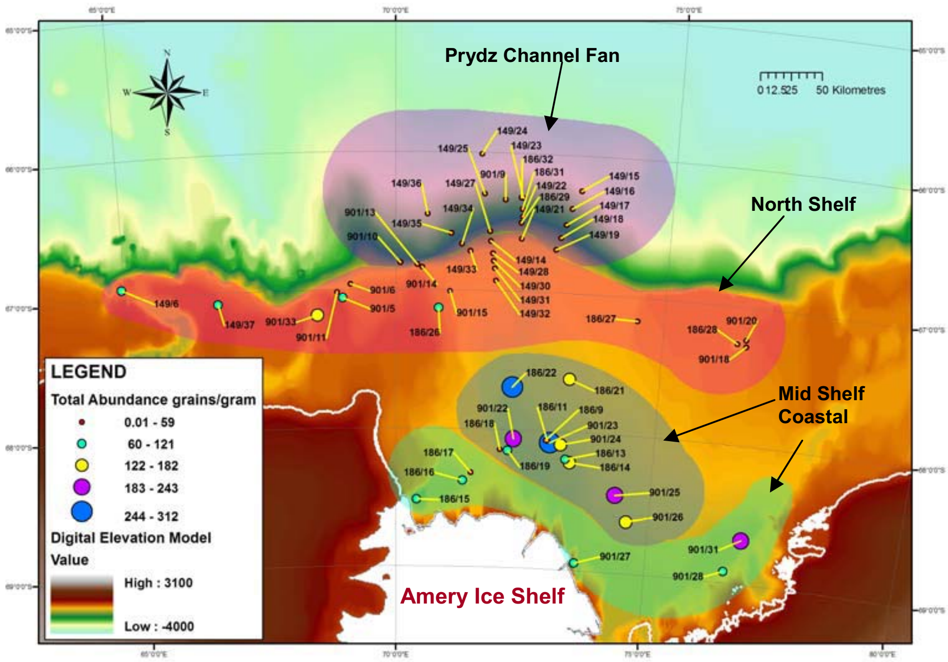
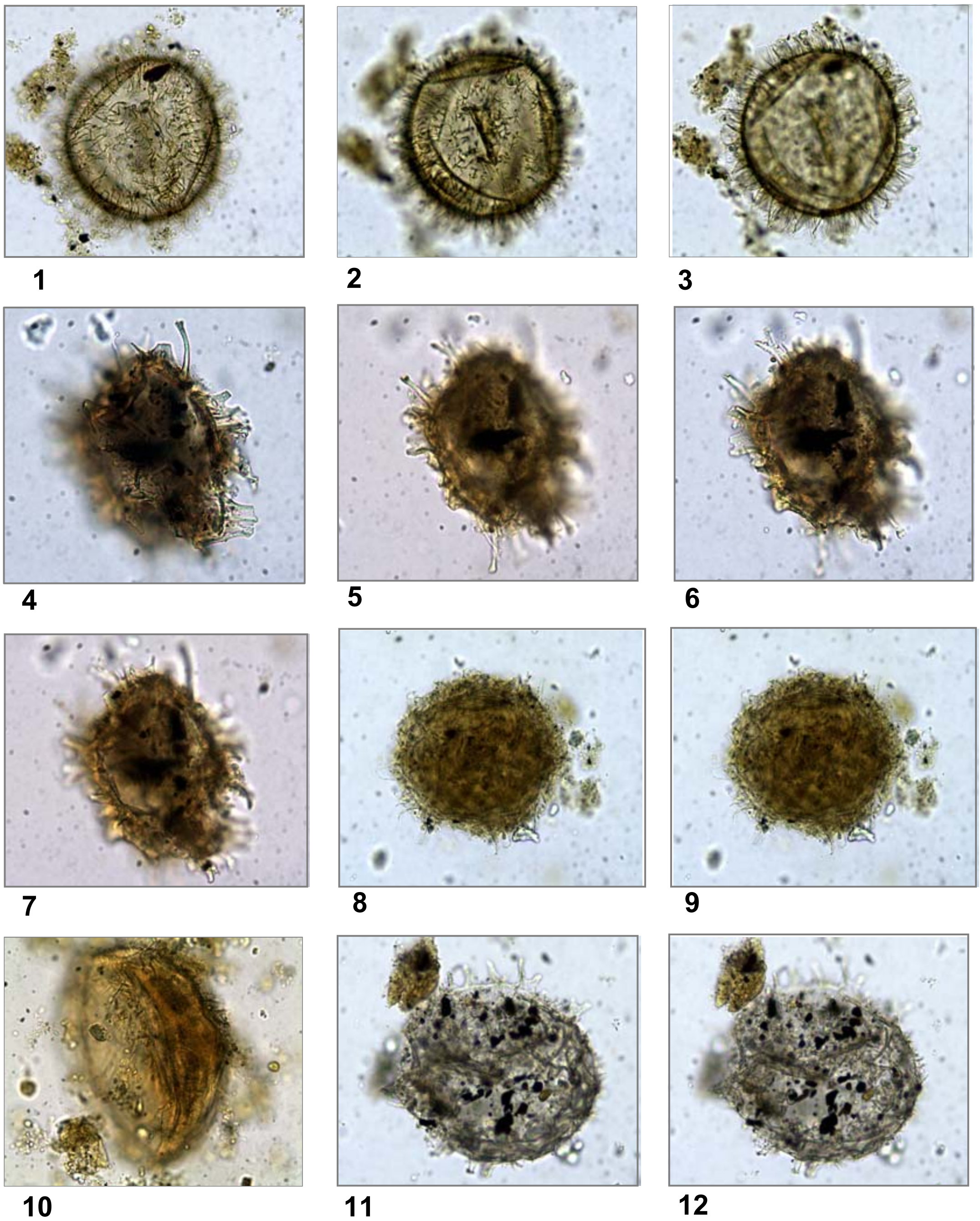


Fig. 3.11: Absolute abundance of grains per gram. Graph displays the geographical locations of total Holocene and total reworked assemblages. The map is labelled showing the geographic locations of the Fan, North Shelf, Mid Shelf and Coastal areas. The absolute abundance shows higher abundance displayed with the larger coloured circles and lowest abundance displayed with smallest coloured circles as per legend.



Illustrative Plates

Plate 1 - Fig. 1-3 Acritarch sp 1**,** longest dimensions in μm = 125 μm, slide number = 901-25-3B, England finder co-ordinates = O28/1; **Fig. 4-7** Acritarch sp 2, 75 μm, 901-26-1B, C32/3; **Fig. 8** Acritarch sp 3, 125 μm 186-22-2A, V38/2; **Fig 9-10** Acritarch sp 3, 125 μm 186-22-3B J53/1; **Fig. 11-12** Acritarch sp 4,125 μm 186/18-3A Q49/3.

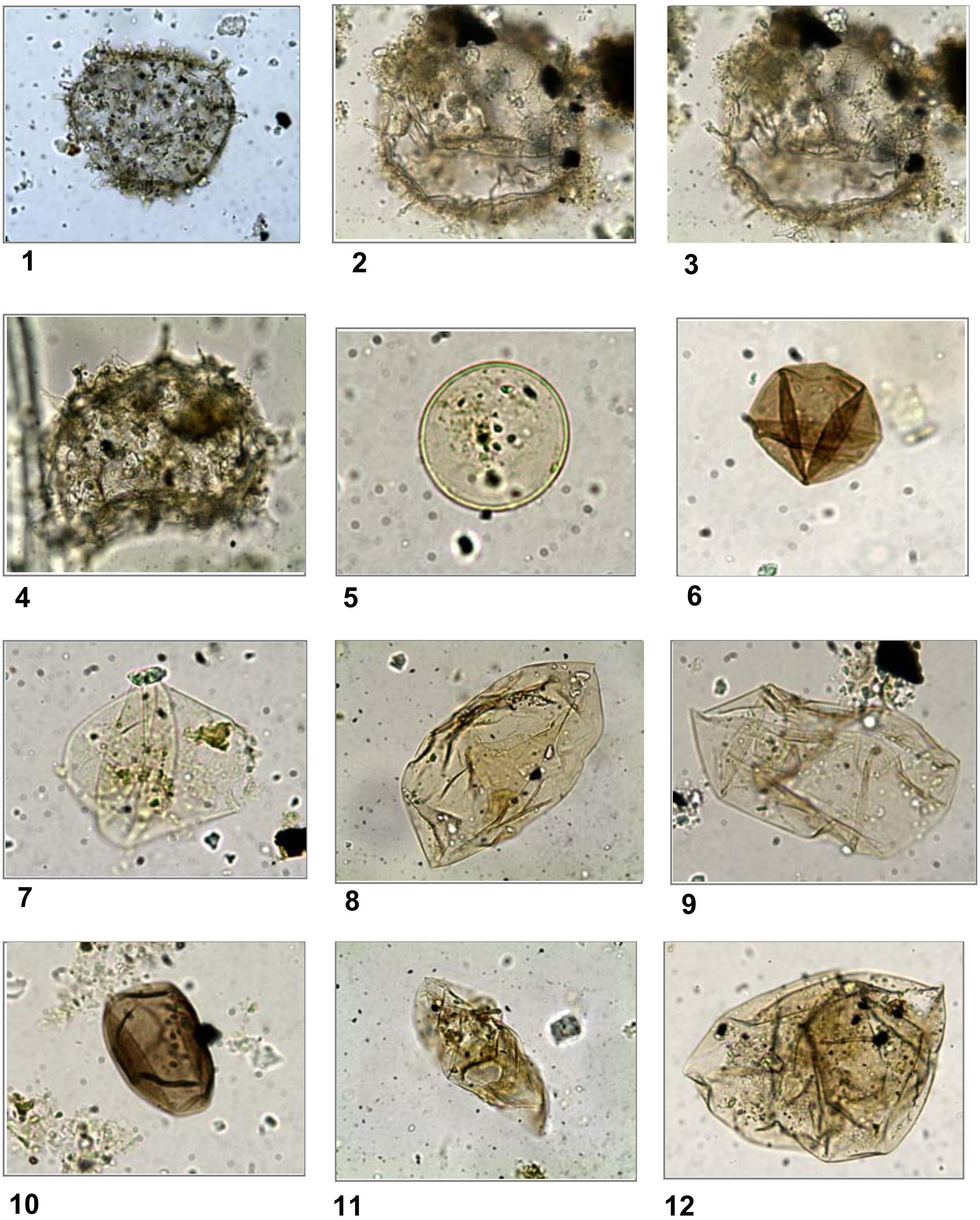


Plate 2 - Fig. 1 Acritarch sp 4 125 µm, 186-9-3A, C28; **Fig. 2-3** Acritarch sp 4, 125 µm, 901-23-2A, B43; **Fig. 4,** Acritarch sp 150 µm, 901-25-3A, X47; **Fig 5** *Leiospherida* sp, 35 µm, 901-33-3A, J49.2; **Fig. 6** *Sphaeromorph,* 30 µm 186-13-2A, Y39; **Fig 7,** *Sphaeromorph,* 60 µm, 901/33-3A, P45; **Fig. 8,** *Sphaeromorph* 145 µm, 186-13-2A, X45; **Fig. 9,** *Sphaeromorph* 85 µm, 901-23-3A, S49/4; **Fig. 10,** S*phaeromorph,* 50 µm, 186-13-1B X32/3; **Fig. 11,** *Sphaeromorph* 100 µm, 186-22-2A, K37/3**; Fig. 12,** *Sphaeromorph* 150 µm, 901-23-3A, R33/1.

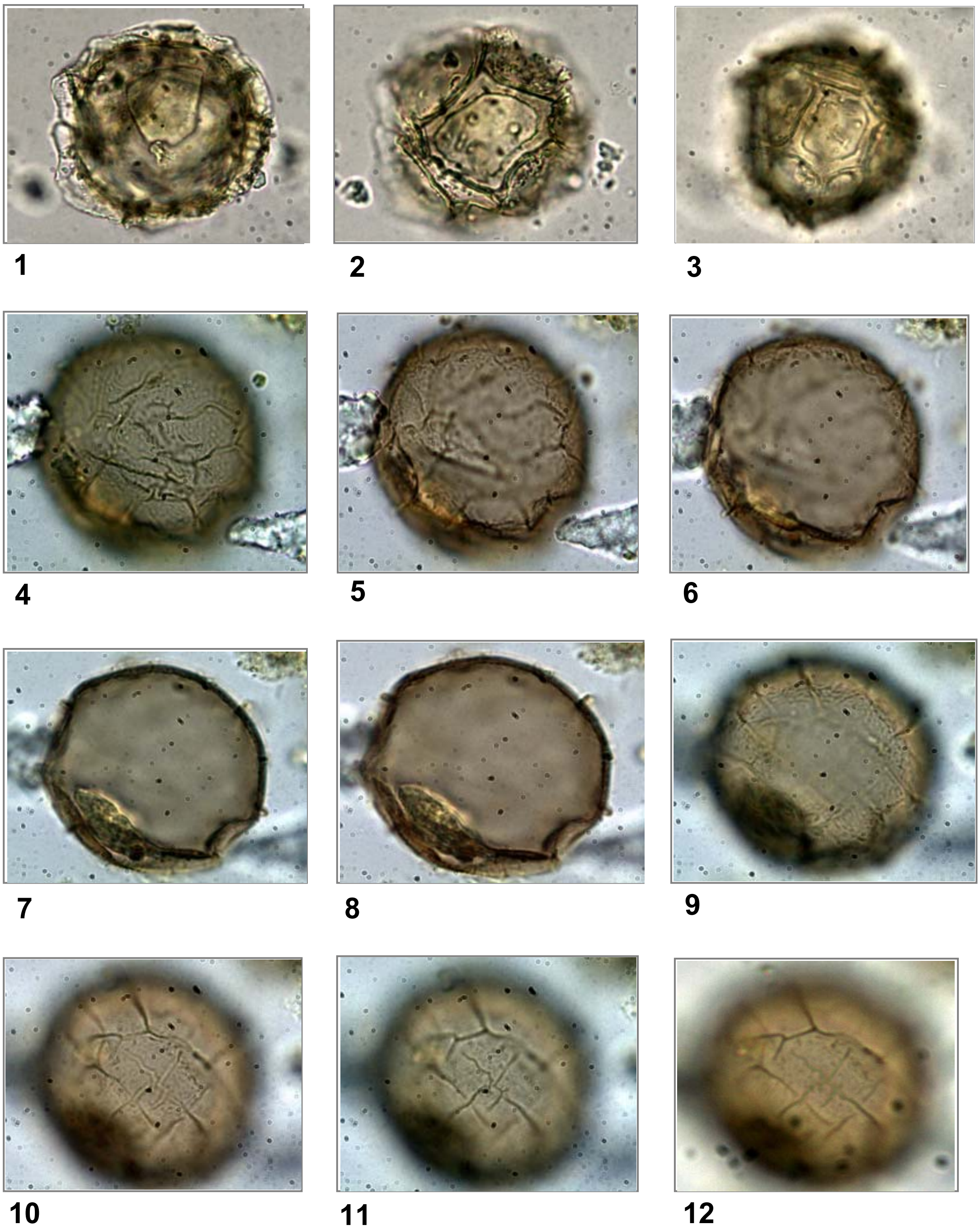


Plate 3 – **Fig. 1-3** *Alisocysta* sp, 75 μm, 186-32-2A, L33; **Fig. 4-12** *Cryodinium* sp, 35 μm, 186-22-2B, O33/1

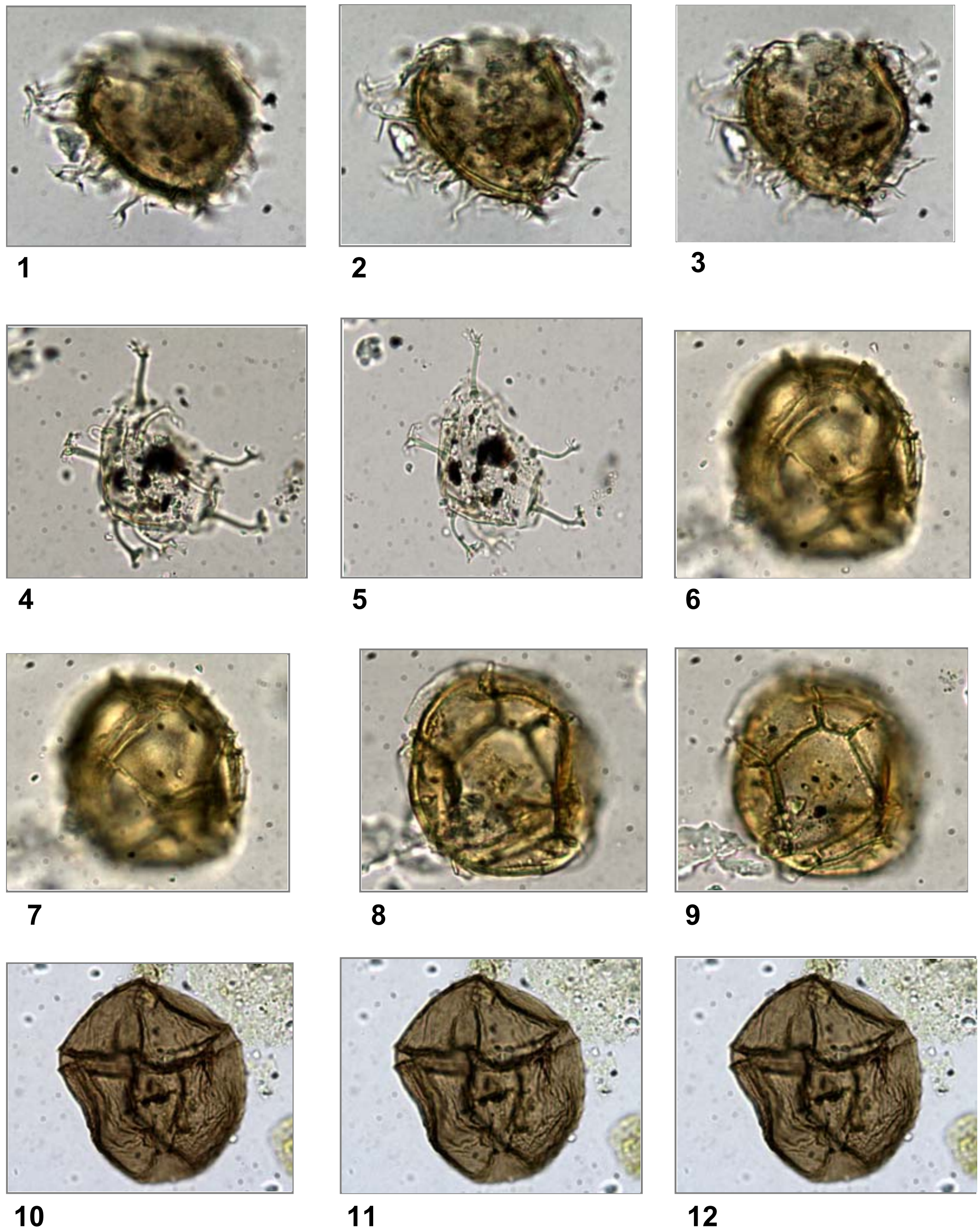


Plate 4 – **Fig. 1-3** Dinocyst sp, 60 μm, 186-29-2A, X34/2; **Fig. 4-5** *Hystrichosphaeridium* sp, 75 μm, 149-28-3A N35; **Fig. 6-9** *Impagidinium* sp, 60 μm, 901-20-3A V38/3; **Fig. 10-12** *Protoperidinium* sp 2, 75 μm, 186-22-3A U53/3

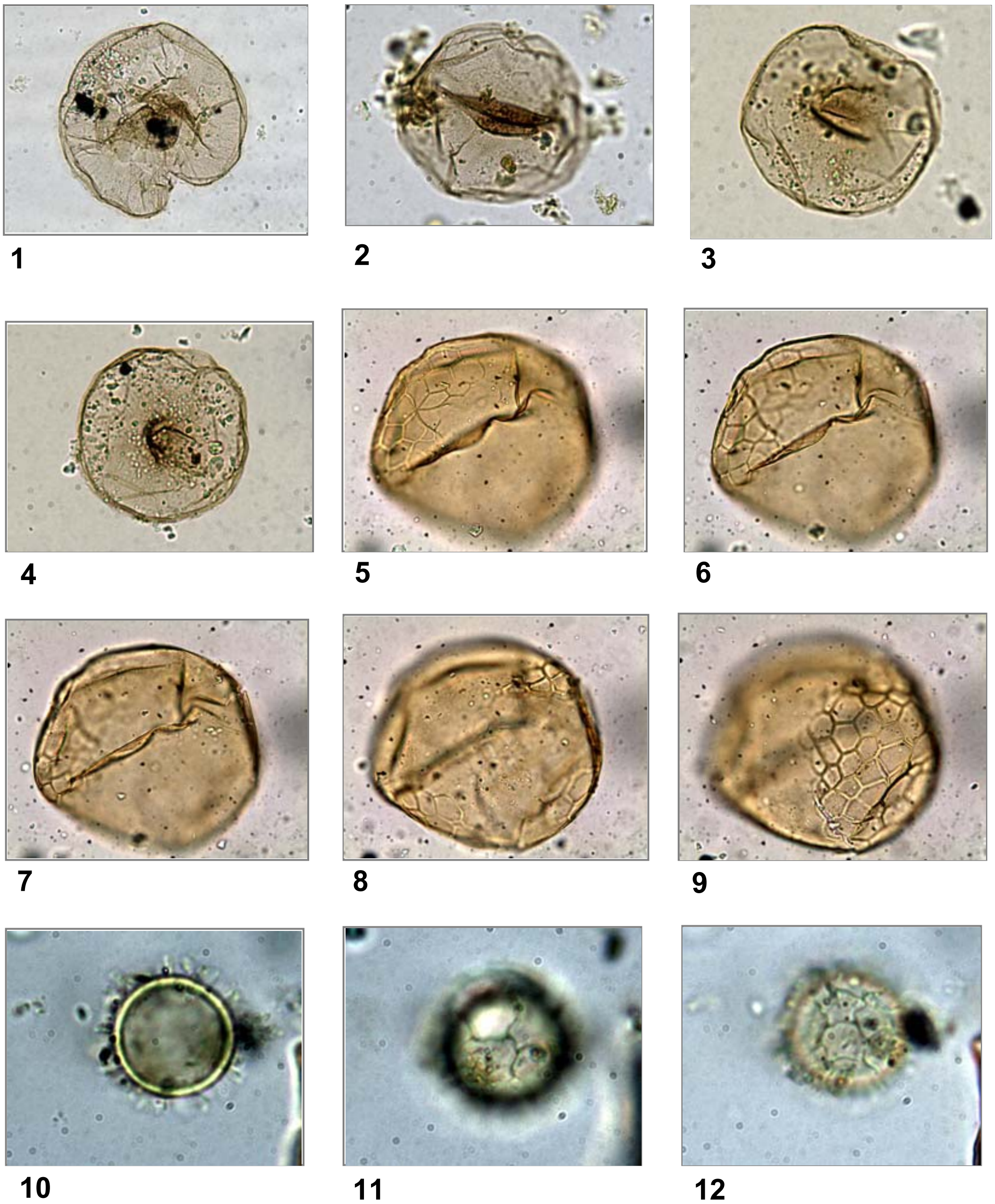


Plate 5 – **Fig. 1** *Selenopemphix antarctica* 75 µm, 186-22-1A B52/3; **Fig. 2** *Selenopemphix antarctica* 75 µm, 186-22-3B H47/1; **Fig. 3** *Selenopemphix antarctica* 75 µm, 901-24-2B G52/1; **Fig. 4** *Selenopemphix antarctica* 75 µm, 901-24-2A T29; **Fig. 5-9** *Protoperidinium* sp 115 µm 901-14-2A B60/1; **Fig. 10-12** *Cymatiosphaera* sp 1 18 µm 149-6-1B T49

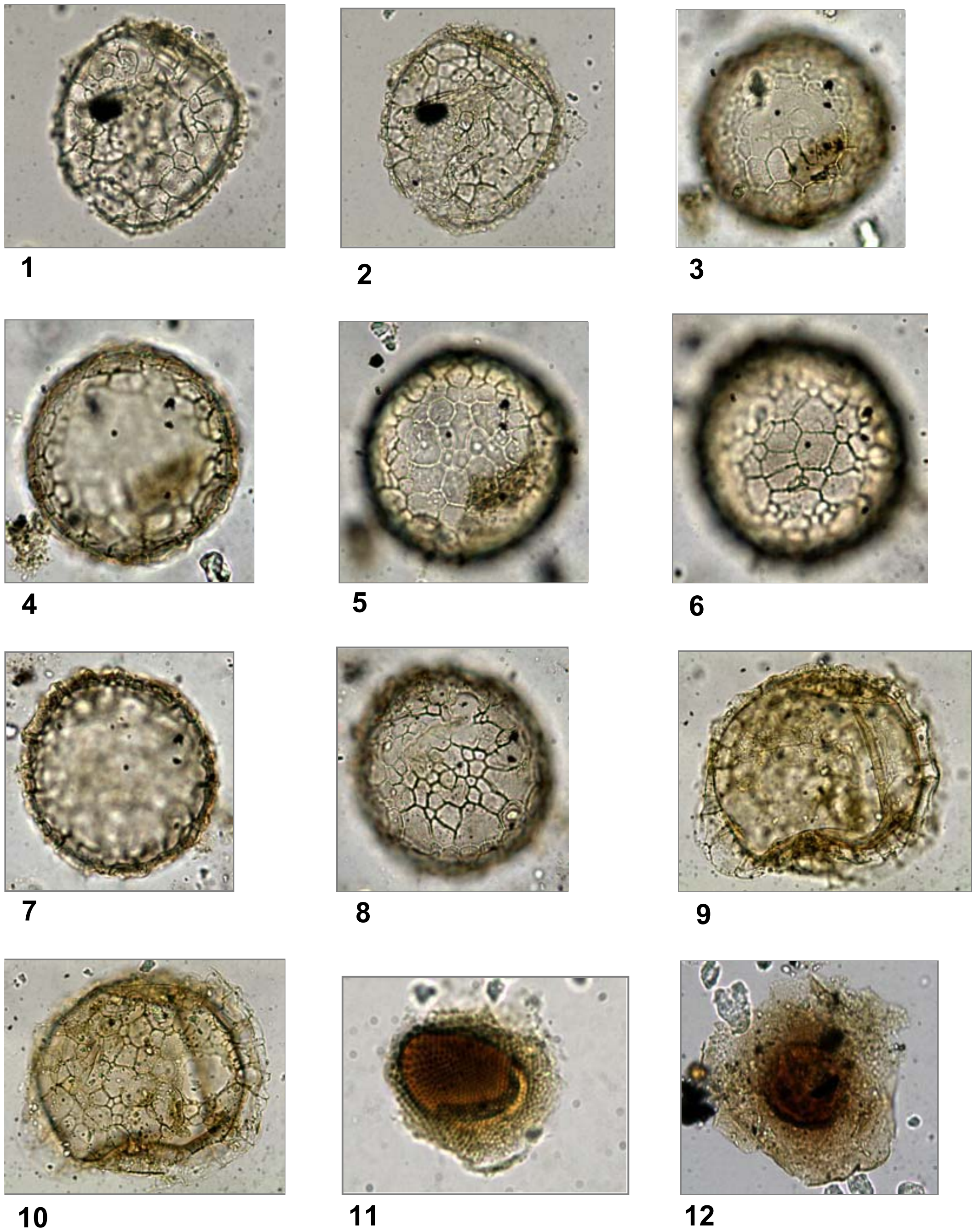


Plate 6 – **Fig. 1-2** *Cymatiosphaera* sp 2 75 μm, 901-23-3A V30; **Fig. 3-5** *Cymatiosphaera* sp 2, 80 μm, 901-26-2B C39; **Fig. 6-8** *Cymatiosphaera* sp 2, 85 μm, 901-20-2B G30/3; **Fig. 9-10** *Cymatiosphaera* sp 2, 115 μm, 149-37-3A, F46; **Fig. 11-12**, *Pterospermella* sp, 40 μm, 901-33-3A, L47/3**; Fig. 12**, 75 μm, 901-23-1A**,** R44/2

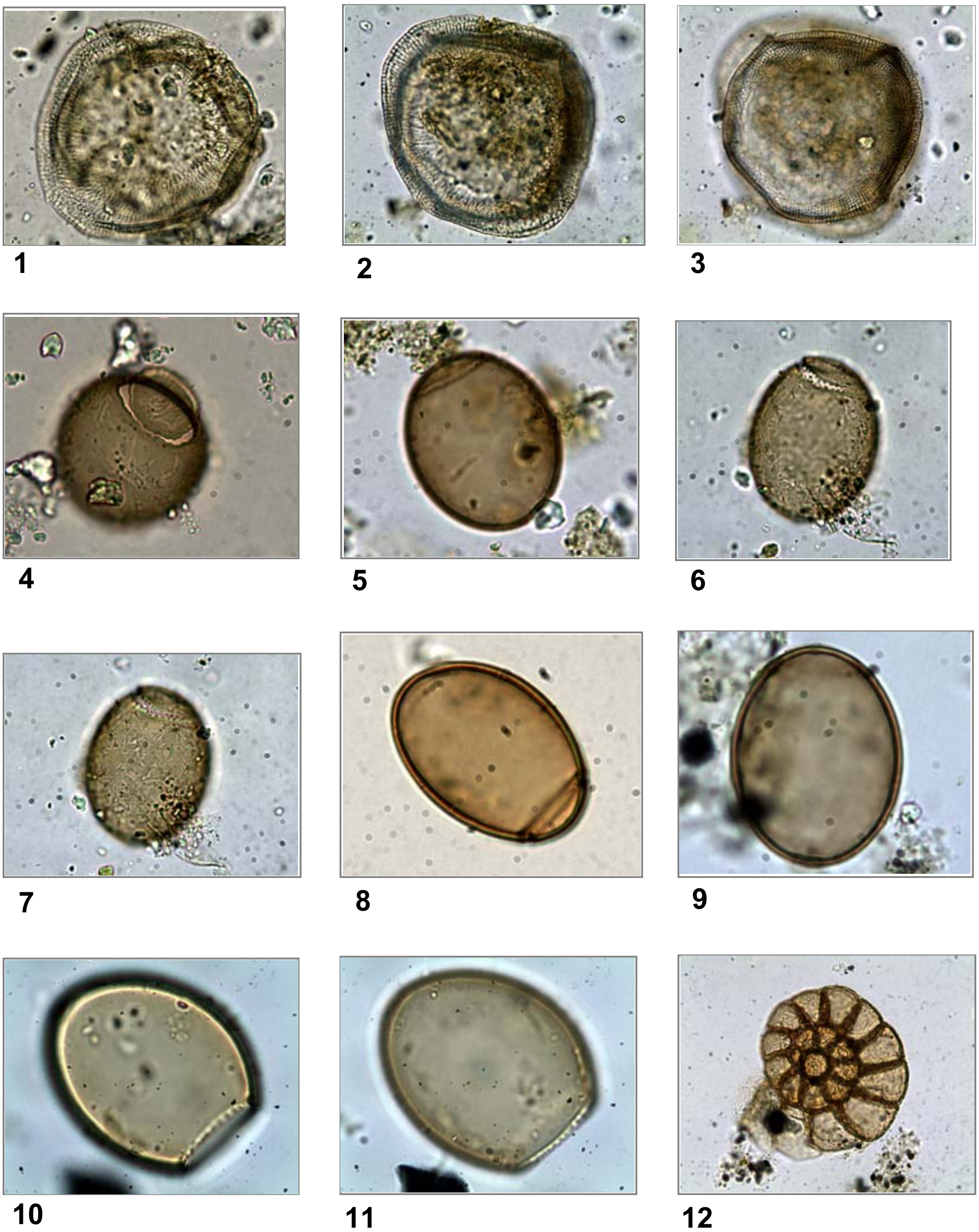


Plate 7 – **Fig. 1,** *Tasmanites* 105 μm, 149-31-2A, K56/4; **Fig. 2-3**, *Tasmanites* 125 μm, 186-13-2A, V34/1; **Fig 4** *Beringiella* sp, 40 μm, 186-14-3A, K52/4; **Fig. 5**, *Beringiella* sp, 50 μm, 901-28-1A, N55; **Fig. 6-7,** *Beringiella* sp, 55 μm, 186-22-3B, U46/2; **Fig. 8,** *Beringiella* sp, 55 μm, 901-27-3B, J49/3; **Fig. 9**, *Beringiella* sp, 55 μm, 901-22-2B, O43/3; **Fig. 10-11**, *Beringiella* sp, 50 μm, 901-5-2B, H45/2; **Fig. 12**, Foraminifera Lining, 100 μm, 186/21-3B X41/1

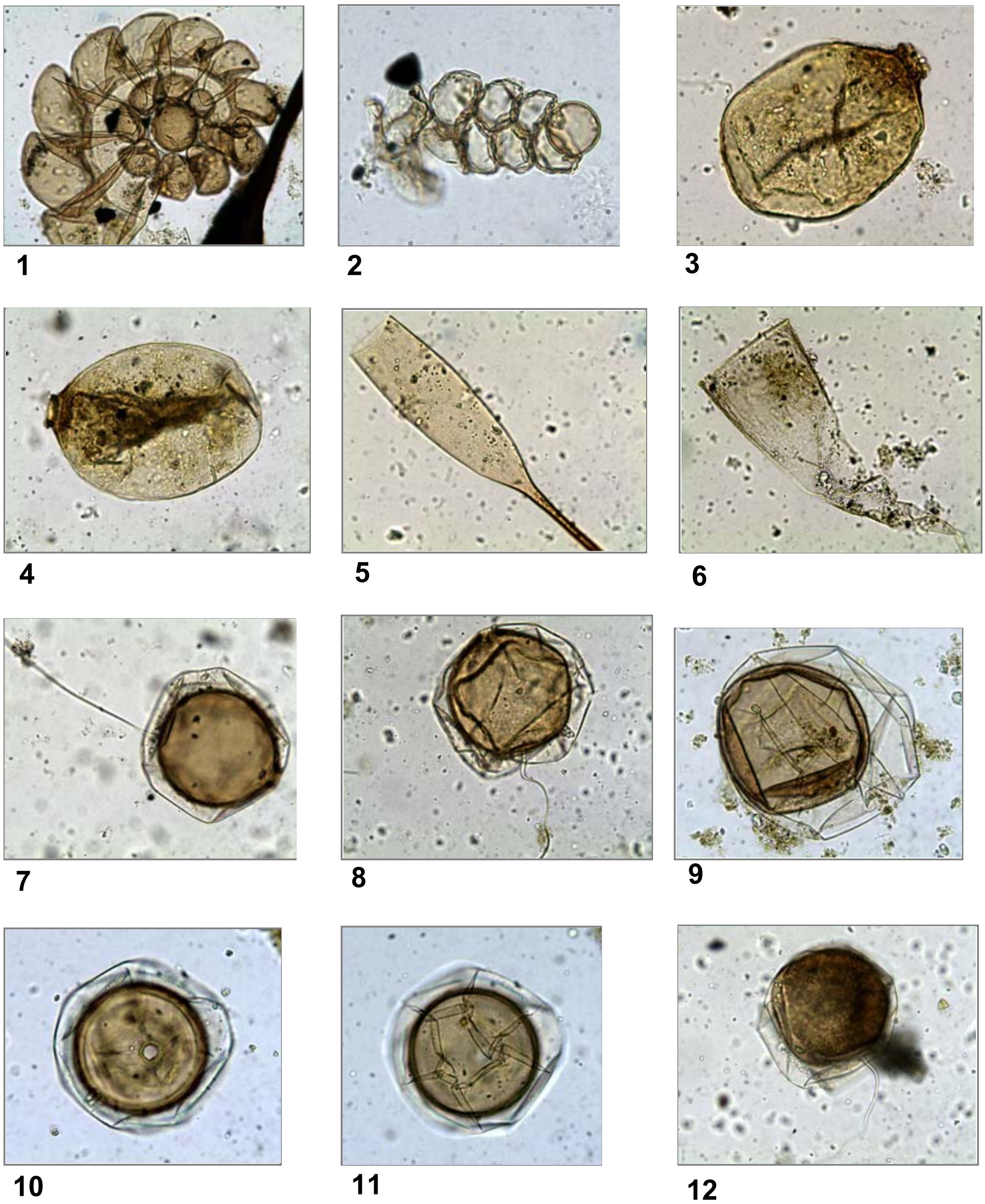


Plate 8 – **Fig. 1**, Foraminifera linings, 300+ μm, 901-52B, Z40/2; **Fig. 2**, Foraminifera linings, 75 μm, 186-21-3B, W40/3; **Fig. 3**, Tintinnid cysts 100 μm, 901-26-3B, Q30/1; **Fig. 4**, Tintinnid cysts 100 μm, 186-16-2A W42; **Fig. 5**, Tintinnid loricae, 250+ μm, 901-34-3A, W33; **Fig. 6,** Tintinnid loricae, 300+ μm, 186-17-3A, C48/1; **Fig. 7**, *Zooplankton* sp, (size not including "tail" for this species) 160 μm, 186-18-3A F43/4; **Fig. 8**, *Zooplankton* sp, 150 μm, 149-31-2A, G56/2; **Fig. 9**, *Zooplankton* sp, 175 μm, 186-22-2B, E47/2; **Fig. 10-11**, *Zooplankton* sp, 155 μm, 186-18-1A, P44/1; **Fig. 12**, *Zooplankton* sp, 150 μm, 901-28-1A, P52

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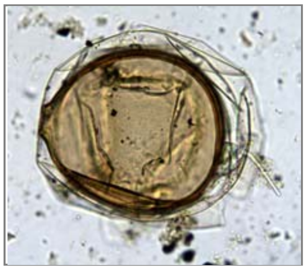

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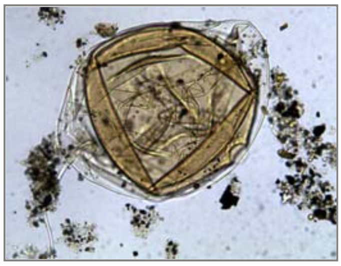

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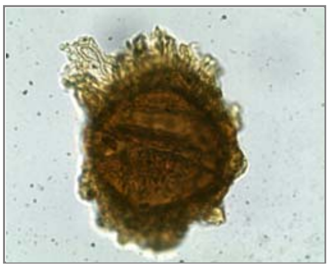

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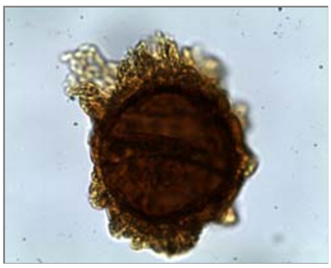

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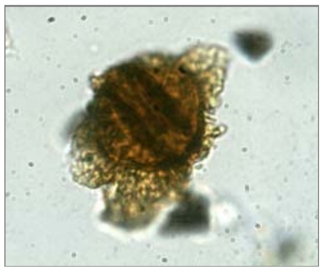

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Plate 9 – **Fig. 1,** *Zooplankton* sp, (size not including "tail" for this species) 175 μm, 186-18-1,3A, Y29/2; **Fig. 2,** *Zooplankton* sp, 125 μm, 186-14-1A, U45/1; **Fig. 3,** *Zooplankton* sp, 150 μm, 901-22-2 T43; **Fig. 4,** *Zooplankton* sp, 175 μm, 186-26-3A Q38; **Fig. 5,** *Zooplankton* sp, 150 μm, 186-17-1A, Y44; **Fig. 6,** *Zooplankton* sp, 175 μm, 901-22-2 X31; **Fig. 7**, *Zooplankton* sp, 160 μm, 901-23-3A R49/4; **Fig. 8,** *Zooplankton* sp, 200 μm, 186-14-1B, V41/2; **Fig. 9,** *Zooplankton* sp, 160 μm, 901-27-4A, W47/1; **Fig. 10-11,** *Turbiosphaera filosa,* 50 μm, 901-27-2B, P42; **Fig. 12,** *Turbiosphaera filosa,* 35 μm, 186-28-2A Q50

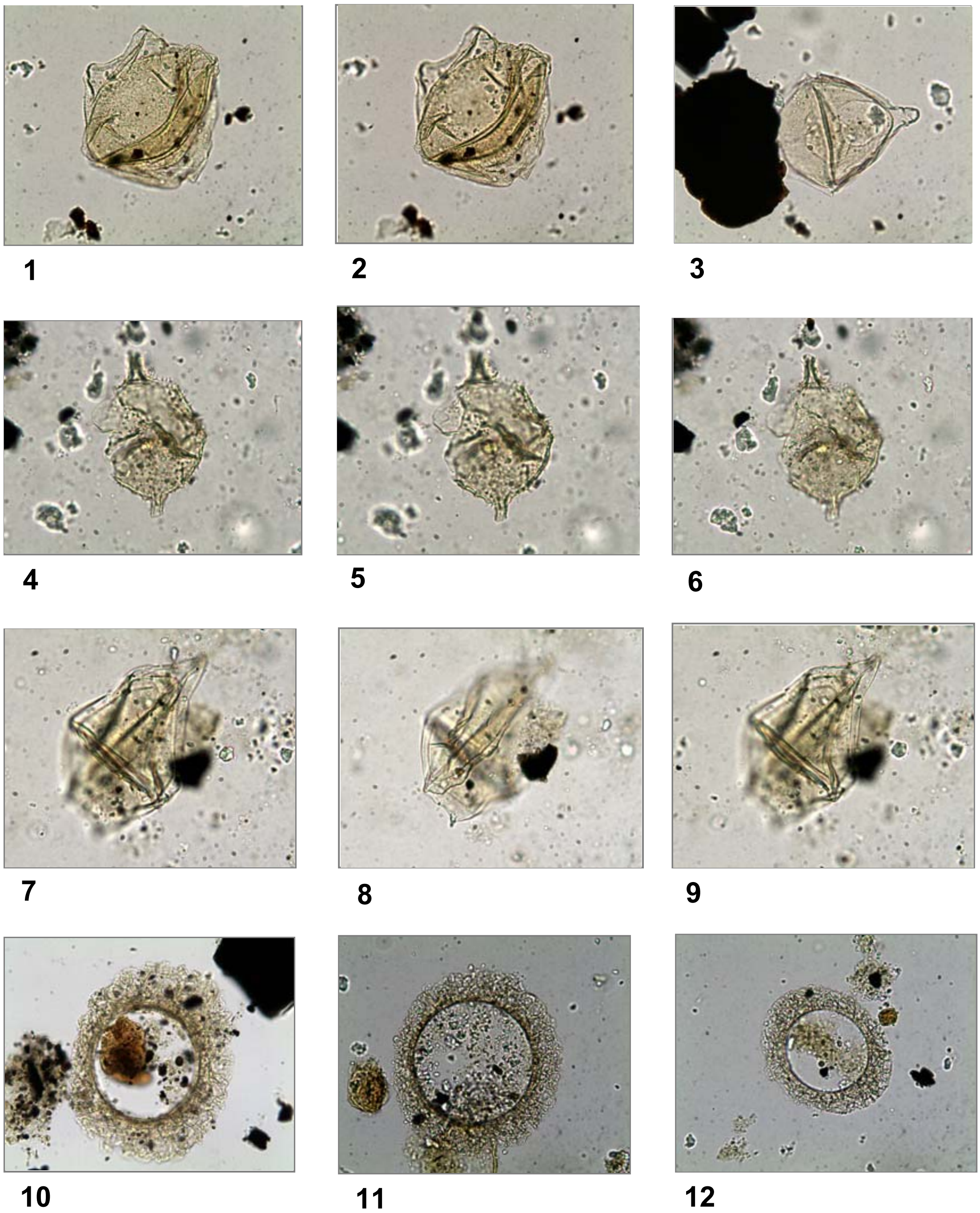

Plate 10 – **Fig. 1-2**, *Deflandrea sp,* 90 μm, 149-35-2A, Y47; **Fig. 3,** *Alterbidinium asymmetricum* 100 μm, 149-35-2A, O32. **Fig. 4-6**, *Spinodinium sp,* 75 μm, 149-36-2B, Q39/4; **Fig. 7-9**, *Alterbidinium asymmetricum* 80 μm, 186-27-1B, N50; **Fig. 10**, Egg case, 115 μm, 901-27-4A, S39/4; **Fig. 11**, Egg case, 125 μm, 901-23-2A, N34; **Fig. 12**, Egg case, 125 μm, 901-23-2A, D33/3

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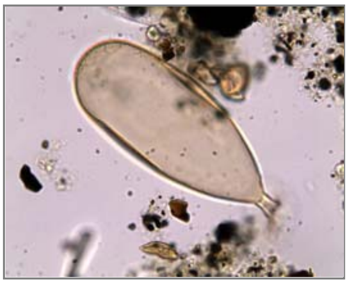

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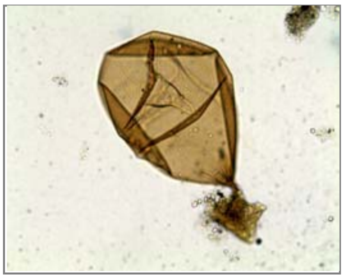

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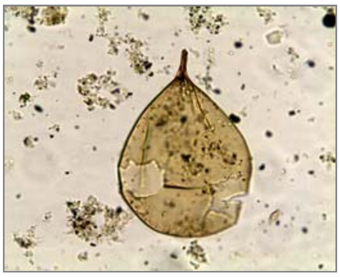

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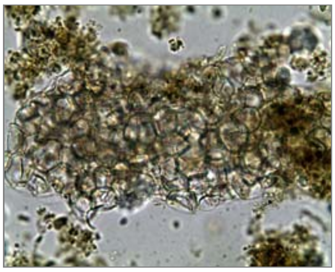

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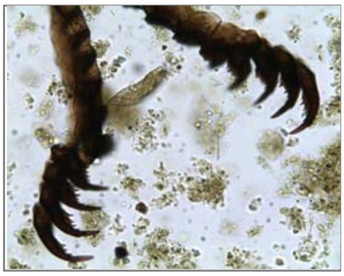

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Plate 11 – **Fig. 1,** Unknown, 35 μm, 901-33-2A, L47; **Fig. 2**, Unknown, 45 μm, 901-33-1A S47/4; **Fig. 3,** Unknown 75 μm, 901-23-1A S50; **Fig. 4,** Egg Case, 250 μm, 186-21-3B, U34/3; **Fig. 5,** Egg Case, 165 μm, 186-9-3B, E44; **Fig. 6,** Unknown, 75 μm, 901-22-4A, Q48/4; **Fig. 7**, Egg Case, 175 μm, 901-22-2B, Q31/4; **Fig. 8,** Egg Case 150 μm, 901-22-2, C31; **Fig. 9**, Unknown, 65 μm, 186-18-1A, D28/2; **Fig. 10**, Algal Group, 186-22-3B, L48/3; **Fig. 11**, Algal Chain, 901-11-1B C39/1; **Fig. 12**, Insect Parts, 300+ μm, 186-22-1B, F28/3

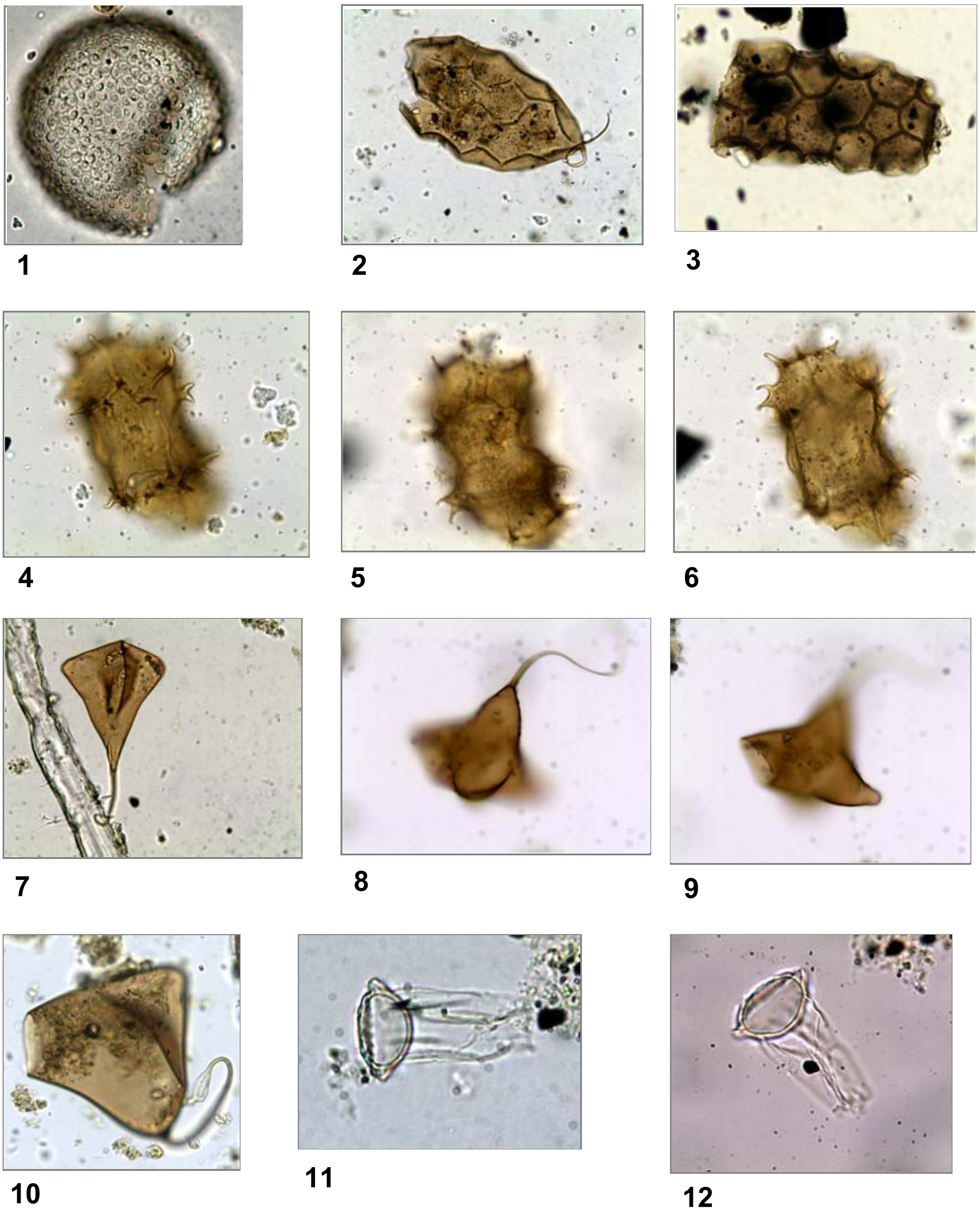


Plate 12 – **Fig. 1,** Egg Case, 100 μm, 901-28-3A, B40/2; **Fig. 2**, Egg Case, 200 μm, 186-16-2A, X49/3; **Fig. 3**, Egg Case 160 μm, 901-11-3A, W41/1; **Fig. 4-6**, Egg Case 125 μm, 901-33-3A, R50/3; **Fig. 7**, Egg Case, 150 μm, 901-24-2B, D36; **Fig. 8-9**, Egg Case, 145 μm, 186-22-3B, Y55/2; **Fig. 10**, Egg Case, 125 μm, 186-22-1B, S32; **Fig. 11**, Unknown, 40 μm, 186-21-2B, W39/2; **Fig. 12**, Unknown, 35 μm, 186-21-3B, Y38/4

CHAPTER 4
METHOD AND RESULTS – GRAIN SIZE

4.0 Introduction

Sediment on the floor of Prydz Bay has been either transported by ice or currents from the Antarctic continent onto the continental shelf and slope or in the case of biogenic sediment produced from the surface waters of the bay and settled to the sea floor. Some sediment has also been reworked by strong currents or redeposited by sediment gravity flows. Grain size analysis was carried out on splits of samples also processed for palynology to help understand how the sediment and the included palynomorphs reached the various sample sites.

4.1 Method

Each sample was dried, weighed and placed in a beaker with 0.1% calgon solution and disaggregated in an ultrasonic tank for half an hour. It was then split into sand and mud fractions by wet sieving through a 62 µm nylon mesh. The fine fraction was washed into a centrifuge bucket, and then centrifuged, decanted, and transferred into a labeled beaker. The coarse fraction was washed off the nylon mesh into another labeled beaker and placed with the fine fraction beaker in an oven for drying at 40^{o}C.

The coarse fraction was dry sieved at ½ ø intervals from -4.0 to 5.0 ø. Contamination of the sieve screens was avoided by cleaning each screen with a brush and compressed air before each sample was sieved. The sieves were nested with the coarsest at the top and the pan at the bottom and the lid fastened tightly. A timer was set for 18 minutes on a shaker to commence the sieving which alternated between intermittent and micro mode. After sieving each size fraction was weighed and recorded.

Two grams of the dried fine fraction were split off, weighed and analysed by a Sedigraph 5100 particle size analyser to determine the grain size distribution of the fine fraction. The results were then merged with the coarse fraction results and entered into the VUWSIZE program to produce statistics and histograms for each sample. The weight of sample sizes was variable with 33 out of 58 samples weighing <10 g and only one sample >20 g. As mentioned in Chapter 3, four samples could not be included in the grain size analysis from the mid shelf area (GC901-24, GC901-25, GC901-26, GC186-13) because they did not contain sufficient sediment for analysis after the drying process.

4.2 Results

Best results are obtained from the method described here for samples of more than 10 g (Barrett & Anderson, 2000). Just over half of the samples were below this amount, but results obtained here compare well to other grain size analysis carried out within Prydz Bay, as can be seen by comparison with the data provided by Harris *et al.* (1998) (fig 4.1a).

The VUWSIZE program collates the output data, providing one table of frequency percent data and another of basic statistics (key percentiles, moment measures, graphic measures) and percent gravel, sand, silt and clay (Appendix B). The program also depicts histograms (phi v frequency) for each sample and examples are shown in fig 4.2. Silt and clay proportions were combined to obtain mud percent and contour maps were compiled on GIS Arcview as described in Chapter 3. The mud percent data were combined with data from Harris *et al.* (1998) to give a more complete picture of the distribution of mud in the bay. A contour map was also compiled for percent gravel using data from this study (fig 4.1b). Other Arcview maps show possible lithology (fig 4.3) and depth for each sample (fig 4.4) and individual maps for mud, sand and gravel proportions were compiled (fig 4.5a, b, c). A table was compiled showing sample numbers, depth and raw count for total palynomorphs and separated into the four main geographic areas (Table 4.1). Graphs were compiled (fig 4.6a, b, c, d) showing pollen count vs mud %, dinocyst vs mud %, pollen vs gravel % and dinocyst vs gravel %.

Table 4.1

Prydz Channel Fan

Sample Number	Depth (m)	Gravel (%)	Sand (%)	Mud (%)	Acri-tarchs	Holocene dinocysts	Egg cases	Prasino-phytes	Foram-inifera	Red algae	Zoo-plankton	Insect parts	Un-knowns	Reworked dinocysts	Pollen	Total
149-14	849	3.5	58.0	38.5	0	0	0	0	0	0	0	0	0	0	54	54
149-15	2,250	6.7	39.8	53.5	0	0	0	0	0	0	0	0	0	2	31	33
149-16	1,960	0.5	7.3	92.3	0	0	0	0	0	0	0	1	0	0	4	5
149-17	1,540	0.7	10.7	88.6	0	0	0	0	0	0	0	0	0	0	86	86
149-18	1,170	12.6	37.3	50.1	1	0	0	0	0	0	0	0	0	1	29	31
149-19	765	10.3	71.6	18.1	1	0	0	0	0	0	0	0	0	5	31	37
149-21	1,060	2.9	57.9	39.2	0	0	0	0	1	0	2	0	0	0	208	211
149-22	1,450	0.5	46.3	53.1	0	0	0	0	0	0	0	0	0	0	33	33
149-23	1,884	2.3	30.4	67.2	0	0	0	0	0	0	0	0	0	0	24	24
149-24	2,535	0.0	4.6	95.4	0	0	0	0	0	0	0	0	0	0	3	3
149-25	2,010	0.0	10.2	89.8	0	0	0	0	0	0	0	0	0	0	0	0
149-27	1,200	1.8	60.2	38.0	1	0	0	0	0	0	0	0	0	1	397	399
149-33	834	9.6	25.1	65.2	1	0	0	0	0	0	0	0	0	0	183	184
149-34	1,215	8.5	81.8	9.7	0	0	0	0	0	0	0	0	0	0	45	45
149-35	1,566	0.5	49.8	49.6	0	0	0	0	0	3	0	0	0	3	49	55
149-36	2,105	1.4	12.6	86.0	0	0	0	0	0	0	1	0	0	4	15	20
186-29	1,230	6.9	40.4	52.8	3	0	1	0	8	2	0	0	0	3	41	58
186-31	1,625	0.0	3.1	96.9	0	0	0	0	0	0	0	0	0	1	17	18
186-32	1,830	0.9	9.2	89.9	0	1	0	0	0	0	0	0	0	1	13	15
901-09	1,879	12.8	82.5	4.7	2	0	0	2	0	1	0	0	0	0	16	21
901-10	1,257	31.5	63.6	4.9	0	0	0	0	1	0	0	0	0	0	5	6
901-13	880	0.8	11.3	87.9	1	0	2	0	3	0	0	1	1	0	2	10

North Shelf

Sample Number	Depth (m)	Gravel (%)	Sand (%)	Mud (%)	Acri-tarchs	Holocene dinocysts	Egg cases	Prasino-phytes	Foram-inifera	Red algae	Zoo-plankton	Insect parts	Un-knowns	Reworked dinocysts	Pollen	Total
Fram Bank																
149-06	805	1.4	89.9	8.7	0	0	0	4	0	0	3	0	0	0	382	389
149-37	168	2.8	55.9	41.4	0	0	10	6	124	20	43	7	1	0	2	213
901-05	320	5.7	54.1	40.2	2	0	2	1	244	4	30	21	6	1	4	315
901-06	489	20.5	62.2	17.3	2	0	10	1	79	8	36	8	4	2	5	155
901-11	402	0.0	62.2	37.9	0	0	2	3	120	5	37	30	4	1	57	259
901-14	430	31.7	38.4	29.9	0	1	4	0	60	0	5	16	0	0	14	100
901-33	376	6.5	75.3	18.2	38	3	29	3	344	4	235	18	8	0	2	684
Northern Prydz Channel																
149-28	527	16.0	54.4	29.6	2	3	1	0	8	1	9	3	1	5	107	140
149-30	515	5.6	62.5	32.0	2	0	2	1	19	0	12	15	3	4	40	98
149-31	512	0.8	61.2	38.0	0	0	1	2	19	7	21	3	1	0	10	64
149-32	502	3.0	57.9	39.1	4	1	3	1	29	4	37	13	0	7	96	195
186-26	390	12.5	64.7	22.8	1	0	10	1	115	6	150	3	0	0	4	290
186-27	436	0.0	36.4	63.6	1	1	1	0	11	3	9	4	0	5	63	98
901-15	480	8.4	61.2	30.4	0	0	2	0	35	0	16	5	2	0	78	138
Four Ladies Bank																
186-28	338	15.7	36.5	47.8	0	0	1	1	4	6	25	9	0	7	55	108
901-18	320	2.9	47.0	50.1	1	0	5	5	17	12	11	6	1	2	88	148
901-20	318	30.5	42.2	27.4	1	1	2	1	9	4	24	1	0	0	70	113

Mid Shelf

Sample Number	Depth (m)	Gravel (%)	Sand (%)	Mud (%)	Acri-tarchs	Holocene dinocysts	Egg cases	Prasino-phytes	Foram-inifera	Red algae	Zoo-plankton	Insect parts	Un-knowns	Reworked dinocysts	Pollen	Total
186-09	698	11.5	47.9	40.6	7	0	9	14	56	15	93	21	2	0	18	235
186-11	655	n/a	n/a	n/a	6	0	9	1	50	15	62	6	2	0	69	220
186-13	678	8.6	19.2	72.2	40	20	17	39	47	11	193	26	4	0	2	399
186-14	690	0.4	52.3	47.3	5	1	14	9	196	26	265	28	3	0	1	548
186-18	608	10.5	23.8	65.7	1	0	3	11	60	3	65	4	0	0	3	150
186-19	775	0.0	4.3	95.7	0	0	7	8	78	11	133	25	1	0	10	273
186-21	570	0.0	11.8	88.2	12	0	11	45	39	9	62	13	2	0	14	207
186-22	660	1.4	42.8	55.8	17	77	48	8	296	91	378	66	6	0	27	1014
901-22	766	0.0	7.4	92.6	6	1	16	14	72	26	338	51	2	0	16	542
901-23	661	0.0	8.0	92.0	65	15	54	20	251	28	334	83	4	0	2	856
901-24	705	n/a	n/a	n/a	25	22	11	1	44	6	99	15	5	0	0	228
901-25	676	n/a	n/a	n/a	9	17	51	63	84	26	173	40	3	1	6	473
901-26	676	n/a	n/a	n/a	37	2	23	28	135	52	176	42	1	0	8	504

Coastal

Sample Number	Depth (m)	Gravel (%)	Sand (%)	Mud (%)	Acri-tarchs	Holocene dinocysts	Egg cases	Prasino-phytes	Foram-inifera	Red algae	Zoo-plankton	Insect parts	Un-knowns	Reworked dinocysts	Pollen	Total
186-15	1,050	16.0	56.7	27.4	4	0	13	74	82	9	112	4	0	0	1	299
186-16	726	17.3	46.3	36.5	7	0	18	2	254	18	313	29	2	0	1	644
186-17	716	3.4	61.9	34.8	7	1	16	3	24	9	128	7	2	0	2	199
901-27	776	1.8	10.5	87.7	15	0	8	40	75	15	98	28	5	1	12	297
901-28	710	0.0	64.4	35.6	1	1	11	8	178	28	94	23	6	0	1	351
901-31	806	0.0	17.9	82.1	4	0	6	0	155	22	182	34	13	0	17	433

Table 4.1: Raw counts of total Prydz Bay palynomorphs and sample numbers, depths in meters and four main geographic areas of Prydz Channel Fan, North Shelf (split into Fram Bank, Northern Prydz Channel and Four Ladies Bank), Mid Shelf and Coastal.

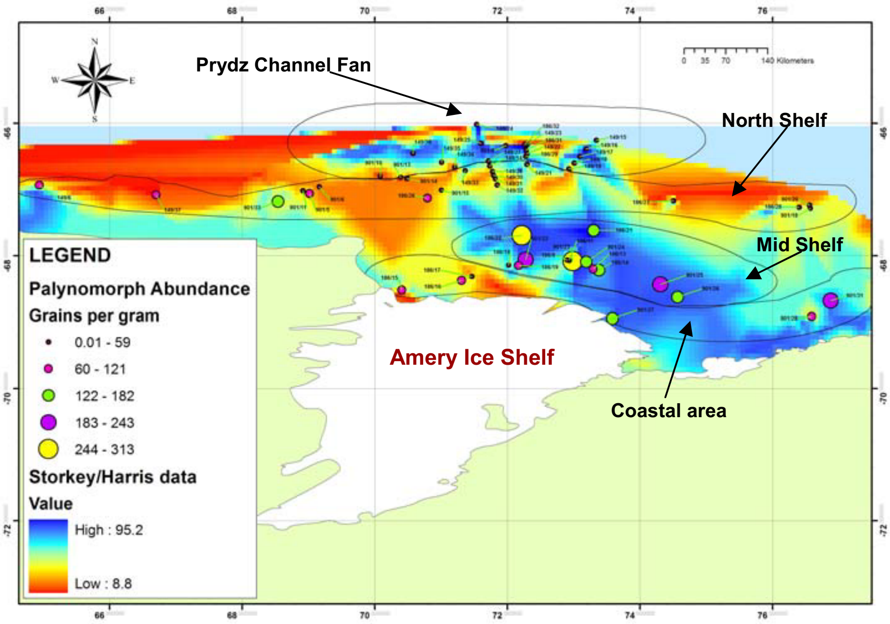


Fig. 4.1a: Combined mud % compiled from grain size of mud proportions from Storkey (this study) and from mud proportions compiled by Harris *et al* (1998). Highest proportion of mud is blue, lowest is red. Sample numbers are shown with highest abundance as per legend.

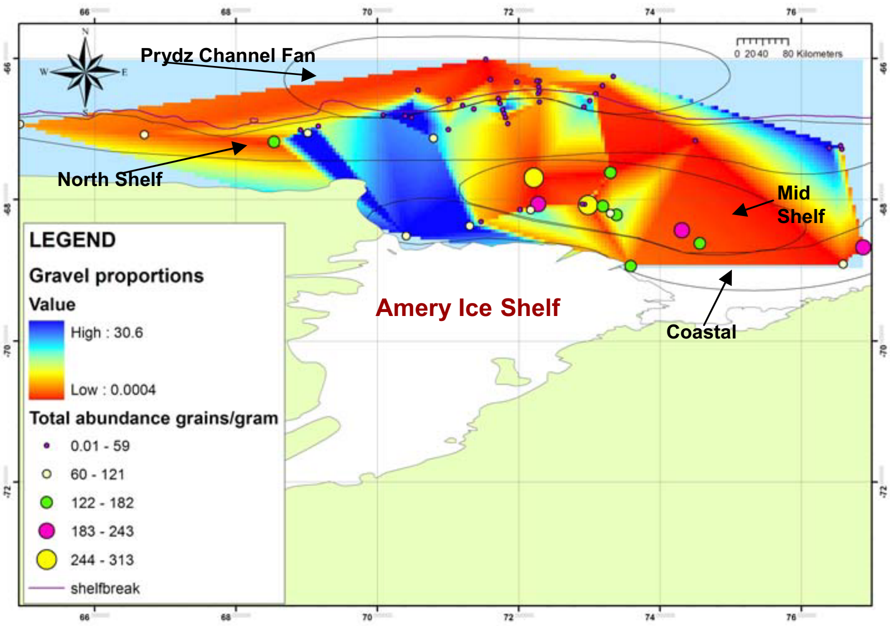
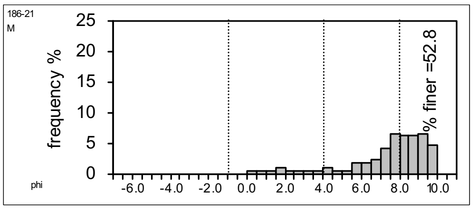
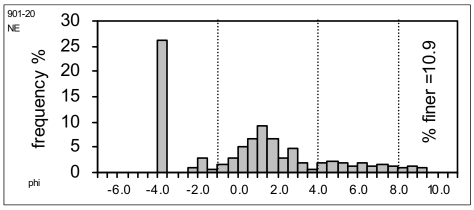


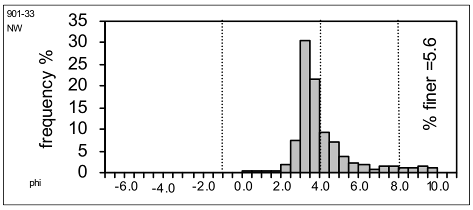
Fig. 4.1b: Contour map showing proportions for gravel, taken from Storkey grain size analysis (this study). Highest gravel proportions are blue as per legend. Geographic areas are shown with black lines encircling the different areas in both figures a & b. Sample numbers are shown with highest abundance as per legend.



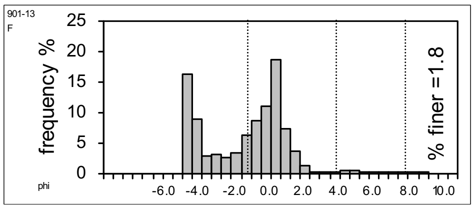
186/21 mud and Ice Rafted Debris just to the east of the Prydz Channel



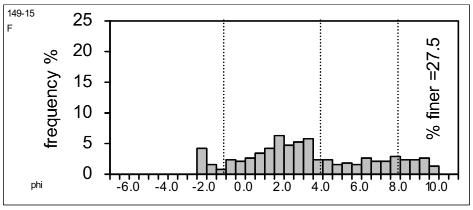
901/20 very sandy with pebbles and some mud on the Four Ladies Bank diamicton



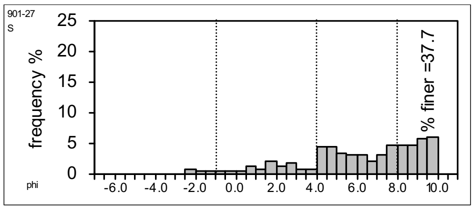
901/33 current swept sand on the Fram Bank



901/13 Current swept pebbles and Ice Rafted Debris on the Fan



149/15 Sediment Gravity Flow on the Fan



901/27 Ice Rafted Debris and mud in front of the Amery Ice Shelf

Fig. 4.2: Examples of histograms taken from the grain size analysis for this study and showing typical types of sediment from the surface cores in Prydz Bay. They illustrate the range of textures from diamicton and current swept sediment to Ice Rafted Debris and Sediment Gravity Flows.

4.3 Interpretation

The overall grain size distribution shown in figures 4.5a, b and c, shows a clear link with the area and depth (fig 4.4) sampled within the embayment. In addition to the modern sediment flux the Prydz Bay area is greatly influenced by past glacial advances. Sediments within Prydz Bay have been eroded from the continent and deposited from glaciers as either directly from more extensive grounded ice, by meltout from the basal debris layer of a floating ice tongue, or carried offshore by bergs and sea ice (ice-rafted debris or IRD) (fig 4.3). The former two processes result in very poorly sorted sediment, ranging in size from clay to boulders, and termed diamicton (Hambrey *et al.* 1992). IRD is mainly medium to coarse sand with a little gravel, and is transported over the entire bay area and beyond into the Southern Ocean. The amount of such sediment is small though, being evident as the coarse fraction in mud deposited in quiet environments. Terrigenous mud is also derived from the continent through subglacial meltwater discharge or reworking of diamicton and settles in parts of the bay where current velocities are low e.g. less than 10 cm/sec. Diatomaceous mud is common in the bay also, the diatoms themselves being also largely of mud size. However, unlike mud, which circulates in suspension for days and weeks, they settle out within a day from surface waters as medium sand-sized pellets from grazing planktic crustacean organisms (Dunbar *et al.* 1989).

The sediments of Prydz Bay are in places locally winnowed and redeposited by currents where bottom velocities exceed around 20 cm/sec (Hujhlstrom, 1935), leaving sorted sand, or mixed and redeposited by sediment gravity flows in areas with slopes of more than a degree or so (Pickering *et al.* 1989). Seismic geometries suggest that the latter process dominates the formation of the Prydz Channel Fan (O'Brien, 1994).

4.4 Prydz Channel Fan

Surface samples (901-13, 149-14, 149-19) on the Fan but close to the shelf edge, at depths of between 750–1,000 m (fig 4.4) contain some gravel 10-31%, (fig 4.5c) and

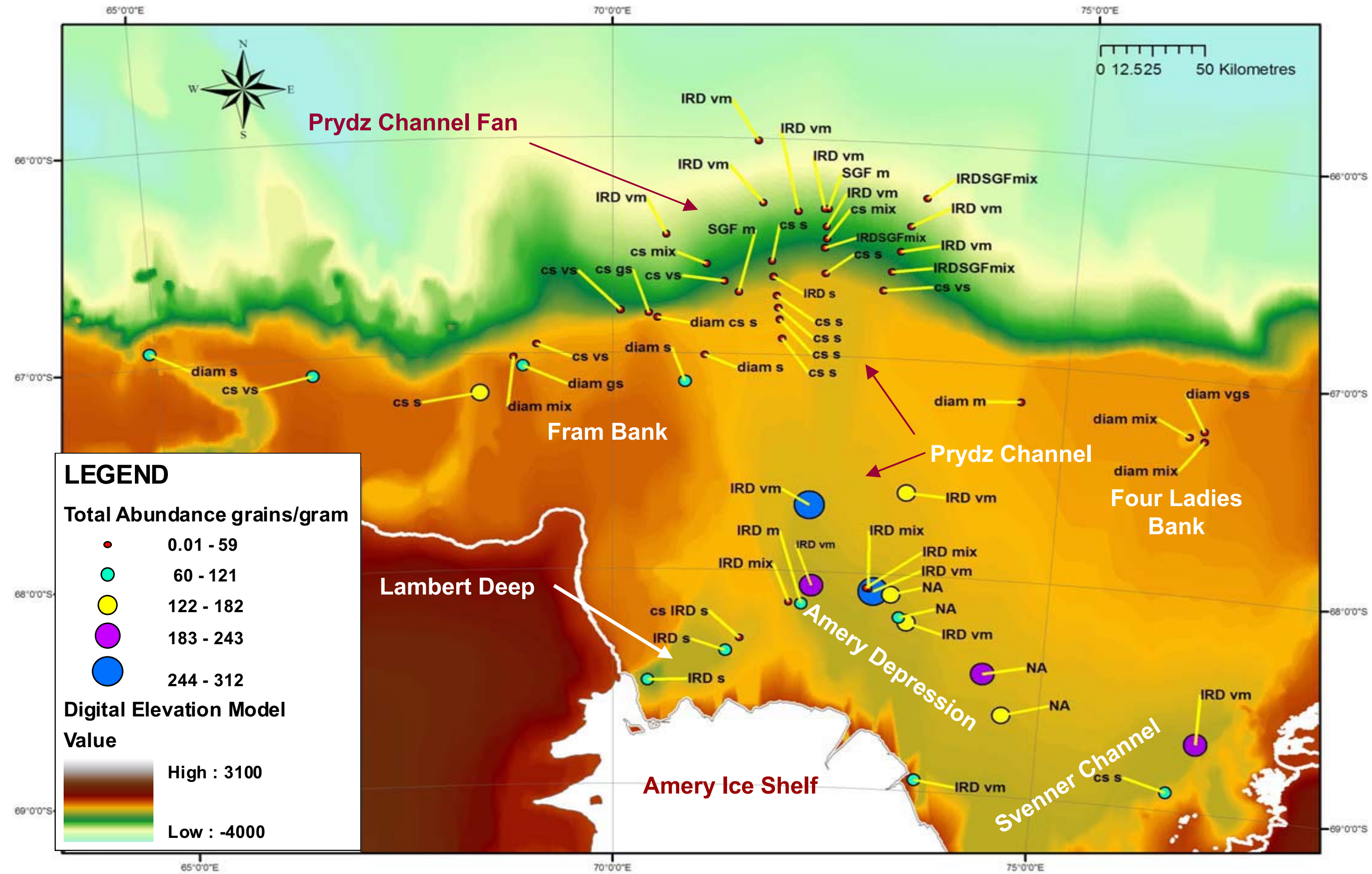


Fig 4.3: Lithology of possible sediment types taken from grain size analysis carried out on each sample. Diamicton (diam), ice rafted debris (IRD), current swept (cs), sediment gravity flow (SGF, gravel and sand (gs), sand (s), very sandy (vs), mud (m), very muddy (vm), an approximately equal amount of coarse gravel and sand, and fine mud = mixture (mix). Also displayed are the grains per gram for total abundance with highest abundance the larger coloured circles as per legend.

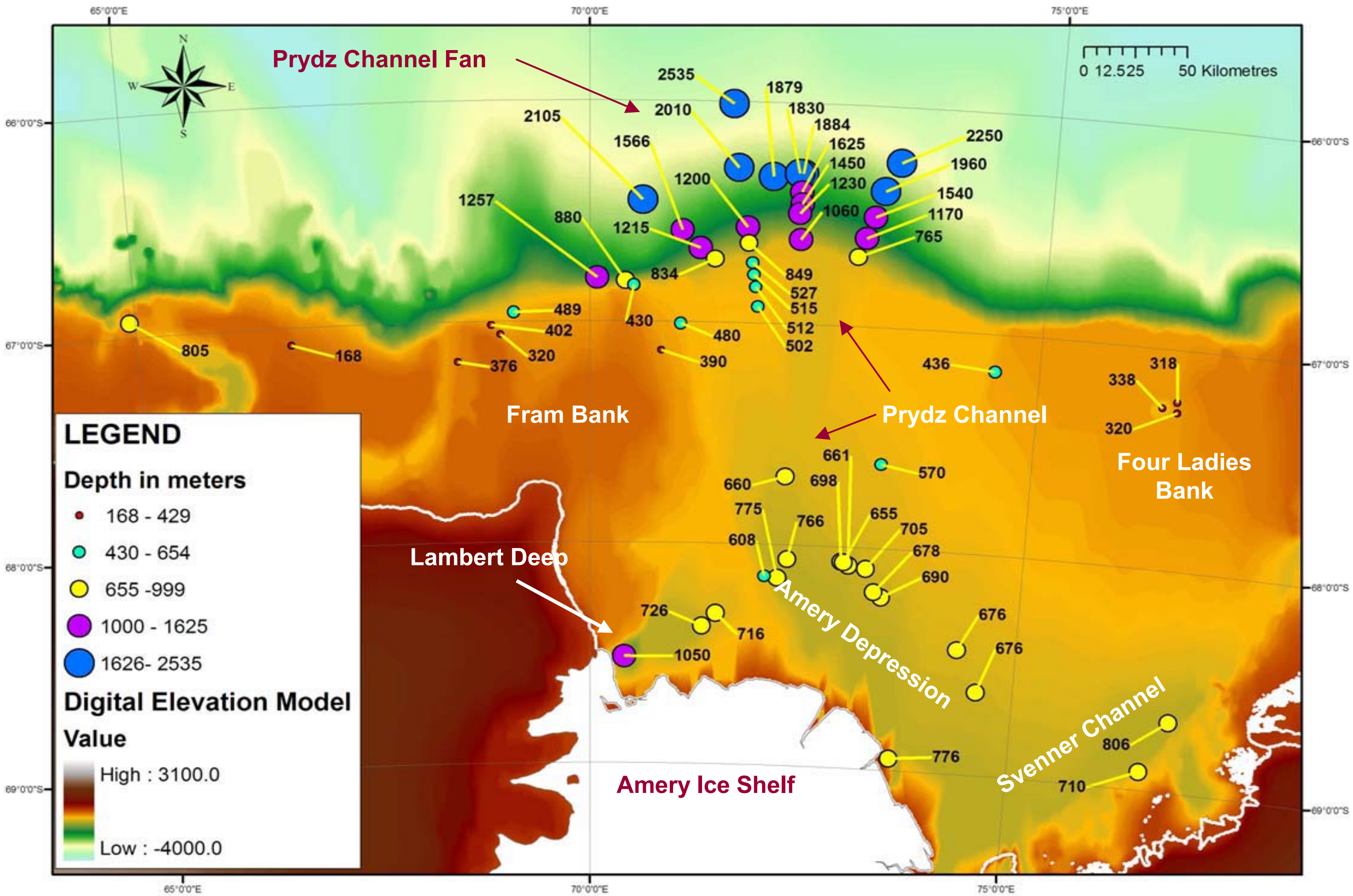


Fig 4.4: Bathymetry depth in meters for each sample shows larger circles with the greater depths. Areas on the continental shelf show that the inner shelf is deeper nearer the Coastal areas of the Lambert Deep and Svenner Channel. The Prydz Channel is deeper in the Mid Shelf area near the Amery Depression but is shallower in the North shelf closer to the Fan. The Four ladies and Fram Banks are shallow in comparison and the Prydz Channel Fan deepens seaward off the continental shelf.

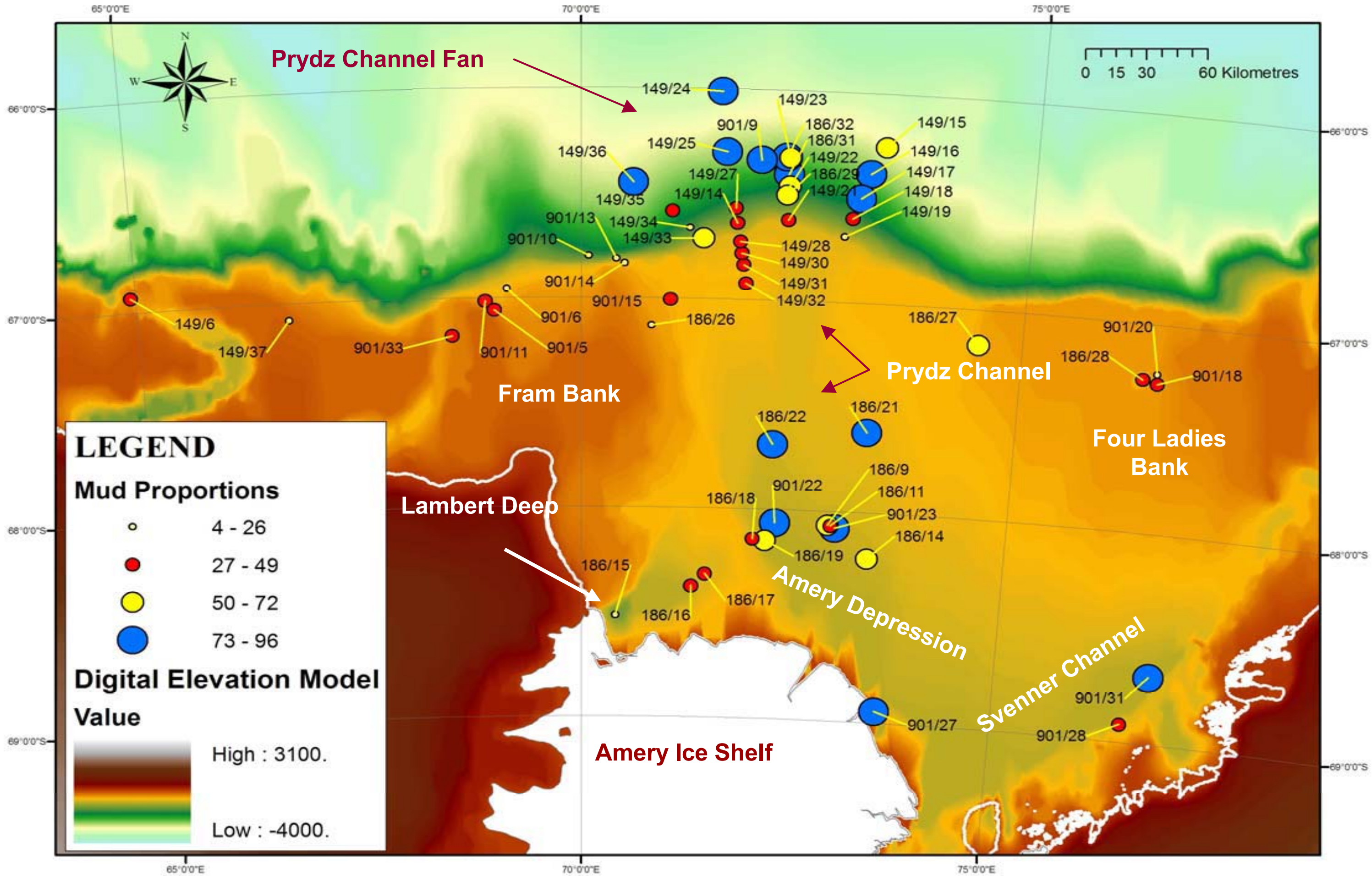


Fig 4.5a: Highest mud proportions shown here as the larger coloured circles (blue) through to smallest mud proportions with smallest circles as per legend. Sample numbers are attached to each circle with a yellow leader.

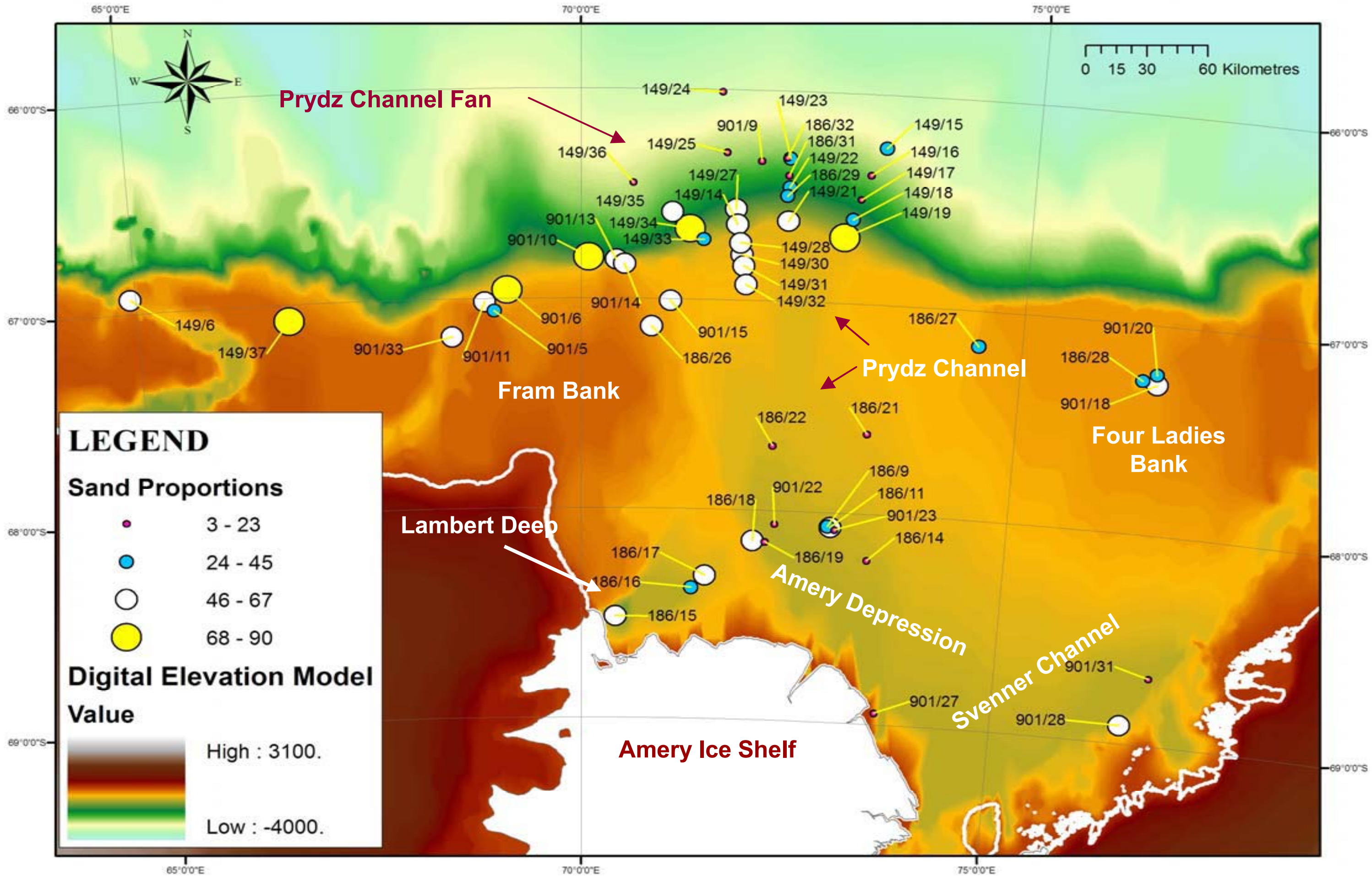


Fig 4.5b: Highest sand proportions shown here as the larger coloured circles (yellow) through to smallest mud proportions with smallest circles as per legend. Sample numbers are attached to each circle with a yellow leader.

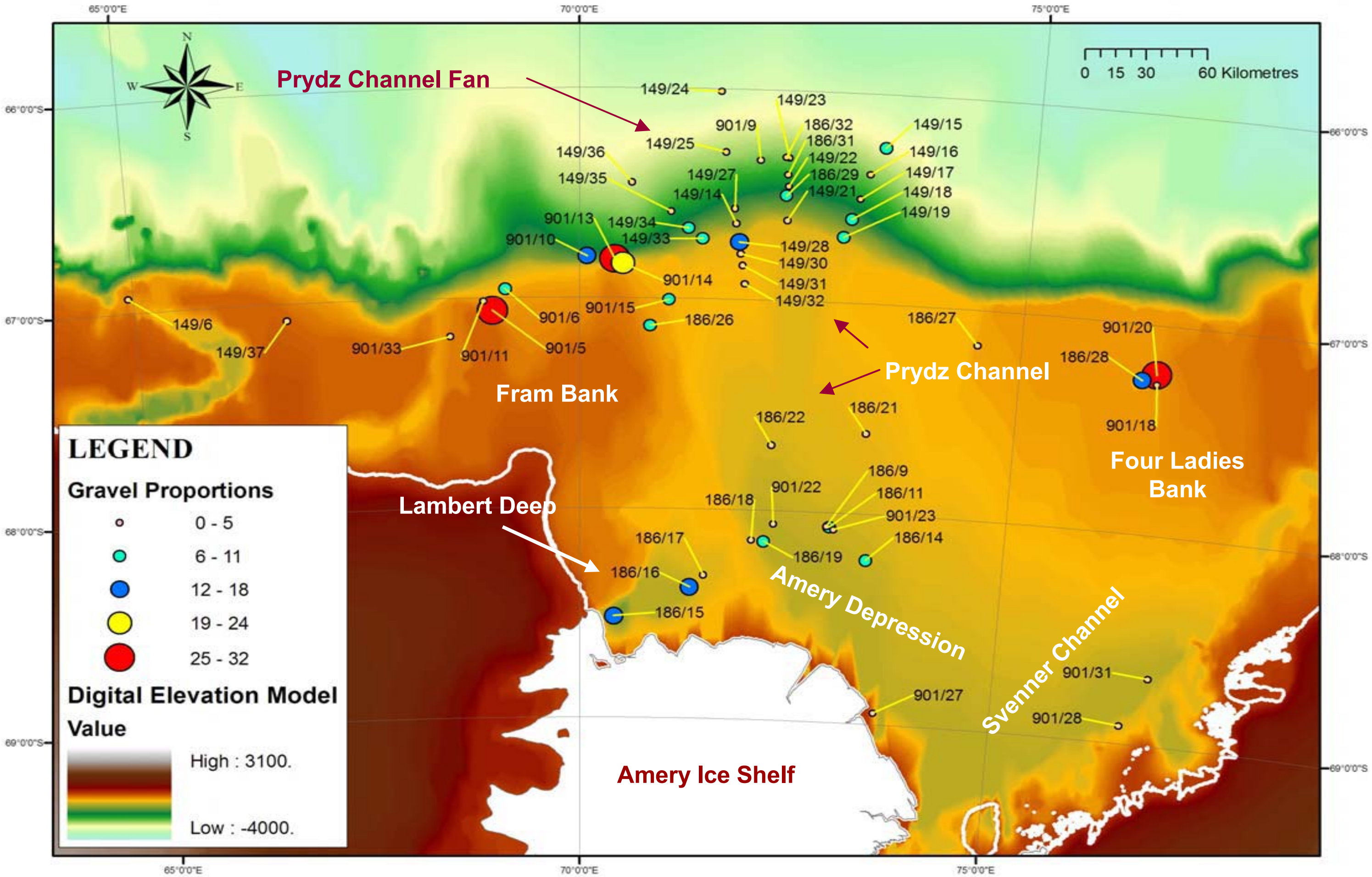


Fig 4.5c: Highest gravel proportions shown here as the larger coloured circles (Red) through to smallest gravel proportions with smallest circles as per legend. Sample numbers are attached to each circle with a yellow leader.

large proportions of sand 62-72% (fig 4.5b), consistent with glacial transport and redeposition. Only one sample contains more than 65% mud (149-33, Appendix B; fig 4.5a).

Further seaward of the shelf edge, at depths of 1,060–1,650 m, sediments are mixed, with gravel proportions 2-12% up to depths of 1,257 m. High sand proportions (58-82%) occurred in some samples (149-21, 149-27, 149-34, 901-10), but six samples (149-18, 186-29, 149-22, 149-17, 149-35, 186-31) contained a higher mud content (50-97%). Samples from these depths indicate sedimentation in some areas from glacial transport and redeposition but others with sediment largely from suspension.

At greater depths of 1,830-2,535 m the grain size consisted of very high mud proportions in most samples at 67-95% mud, with one sample (149-15) at 2,250 m, containing a more even distribution 7% gravel, 40% sand and 53% mud (Appendix B). The high mud content of these surface samples in deep water indicates a lack of current sorting, though the mud itself may well have come from currents winnowing mud from glacially deposited shelf edge sediments. At these depths grounding of the ice shelf could not occur, but gravel might still have been transported as ice rafted debris or sediment gravity flows. O’Brien (1994) suggested that sediment gravity flows were present at various depths, from results obtained from echo sounder records.

4.5 North Shelf

4.5.1 Four Ladies and Fram Banks

The Four Ladies and Fram Banks (Table 4.1) are the shallowest parts of the embayment. Between 168-805 m on the Fram Bank the sea floor is sandy (54-90%), and current sorted, apart from 901-5 which is a diamicton (gravel 32%, sand 38%, mud 30%). The Four Ladies Bank samples between 318-338 m also show the grain size was mixed and variable for all three samples typical of diamicton (fig 4.2, fig 4.5a, b, c). O’Brien & Leitchenkov (1997) have described these areas as shallow and disturbed by scouring from iceberg keels and the strong coastal currents. These conditions cause the removal of finer sediments which once disturbed remain in suspension and are unable to settle on the Banks, but are carried by currents to settle in quieter waters.

4.5.2 Northern Prydz Channel

Surface sediment samples here are between the Four Ladies and Fram banks, but in relatively shallow depths between 390-527 m (fig 4.4, Table 4.1). Almost all samples are moderately sandy (54-65%), with a little gravel (1-16%), and are interpreted as current influenced with some ice-rafting. Only 186-27 has a higher mud proportion of 63% and no gravel, and plainly results from suspension sedimentation. The area deepens slightly more in the centre due to a fast-flowing ice stream that once eroded the Prydz Channel and transported debris from the Lambert Graben and the inner shelf areas, out to the shelf edge and depositing it on the upper slope of the fan during glacial advance of the Amery Ice Shelf (O'Brien *et al.* 2004).

4.6 Mid Shelf

4.6.1 Prydz Channel

In Prydz Channel textures are variable, with all nine samples in deep water (570-775 m, fig 4.4) ranging from somewhat to extremely muddy (41-95%, fig 4.5a). Four had no gravel, limited sand and more than 88% mud, and hence were largely from suspension. The other five ranged from 19 to 52% sand and from 0.4 to 11% gravel, indicating significant ice rafting, with possibly some patches of basal glacial debris.

4.6.2 The Amery Depression

Only one of the five samples from this area could be used for grain size analysis as explained in section 4.1. This sample was 186-14 and at a depth of 690 m (fig 4.4), its grain size consisted of gravel 9%, sand 19% and mud 72%. (fig 4.5a, b, c). The grain size histogram suggests this sample was deposited as ice-rafted debris (high mud content with coarse tail, as in sample 901/27, fig. 4.2). The samples not analysed contained high counts of palynomorphs and may have had a finer grain size, which would be consistent with other samples with high palynomorph counts. Previous work in the Amery Depression (Domack *et al.* 1991, Pushina *et al.* 1997) recorded ~1.2 m of thick diatomaceous ooze in this area, which overlay thin sandy to silty intervals, which in turn overlay dark grey diamicton and sandy pebbly clay.

O'Brien (1999) suggests that the mid shelf area contains grounding line wedges and moraines probably laid down by the Lambert Glacier. There is speculation that the eastern part was grounded while the western side was still floating (O'Brien & Leitchenkov, 1997). Several reasons for this could be a difference in mass balance conditions between the eastern and western sides of the ice sheet, or the different response to sea level rise from the east and west sides of the glacier. O'Brien (1994) suggests that the last deglaciation and sea level rise would have floated the western side which is 100 m deeper than the Four Ladies Banks area on the eastern side. Once floated the western side would have thinned rapidly with the grounding line retreating. The slower retreat on the eastern side left thick glaciomarine muds between the two sides which accounts for the findings in the area from this study.

4.7 Coastal

4.7.1 Lambert and Nanok Deeps

Three surface samples taken from the Lambert (186-15) and Nanok Deeps (186-16, 186-17), from the western edge of the Amery Ice Shelf at depths between 710-1,050 m., were predominantly sandy (46-62%) with some gravel (3-17%) (fig 4.5b, c). These samples are just seaward of the western edge of the Amery Ice Shelf, and likely influenced by westerly currents which probably resulted in the winnowing out the finer sediment and deposition of ice-rafted sediment in these unusually deep shelf basins.

Sample 901-27 has a similar depth 780 m as the three samples above but has much higher mud content (88%), and some gravel (2%). Its position is directly in front but towards the south eastern part of the Amery Ice Shelf which places it in a different environment from the Lambert and Nanok deeps, but similar to the deeper part of the Svenner Channel (fig 4.5a).

4.7.2 Svenner Channel

The Svenner Channel area is in the south east of Prydz Bay where two samples were analysed. Sample 901/31 was situated on the Svenner Channel floor and deeper at

806 m with a very muddy content (82%) (fig 4.5a). Sample 901-28 was shallower at 710 m (fig 4.4) and predominantly sandy (64%), and was positioned to the side of the Channel, an area close to a basement outcrop composed of steep sided hills and U shaped valleys, which O'Brien (1994) suggests may have been formed by the erosion of softer, finer sediments. Neither sample contained gravel, unlike the other coastal samples which all contained proportions of gravel mentioned above (fig 4.5b).

4.8 Mud distribution and palynomorph abundance

The mud contour map (fig 4.1a) is a combination of samples from past surveys (Harris *et al.* 1998) combined with mud proportions from this study and shows the possible mud distribution across the Prydz Bay continental shelf. The samples, represented by different sized coloured circles on the map, are the palynomorph total abundance grains per gram analysis from this study and show that areas with higher proportions of mud generally contain a higher abundance of palynomorphs, with one exception and this is in the Lambert and Nanok deeps. The gravel proportions (fig 4.1b) were analysed from the grain size taken from this study only. Comparison of both data reinforces analysis of grain size shown as proportions of mud and gravel in figures 4.5a and c.

Figure 4.6a, b, c, and d shows percent mud versus counts for pollen and marine palynomorphs have no relationship, but percent gravel does have a relationship to counts for marine palynomorphs and pollen. A possible interpretation could be that at least in significant part, both pollen and marine palynomorph assemblages are from a glacially derived debris source.

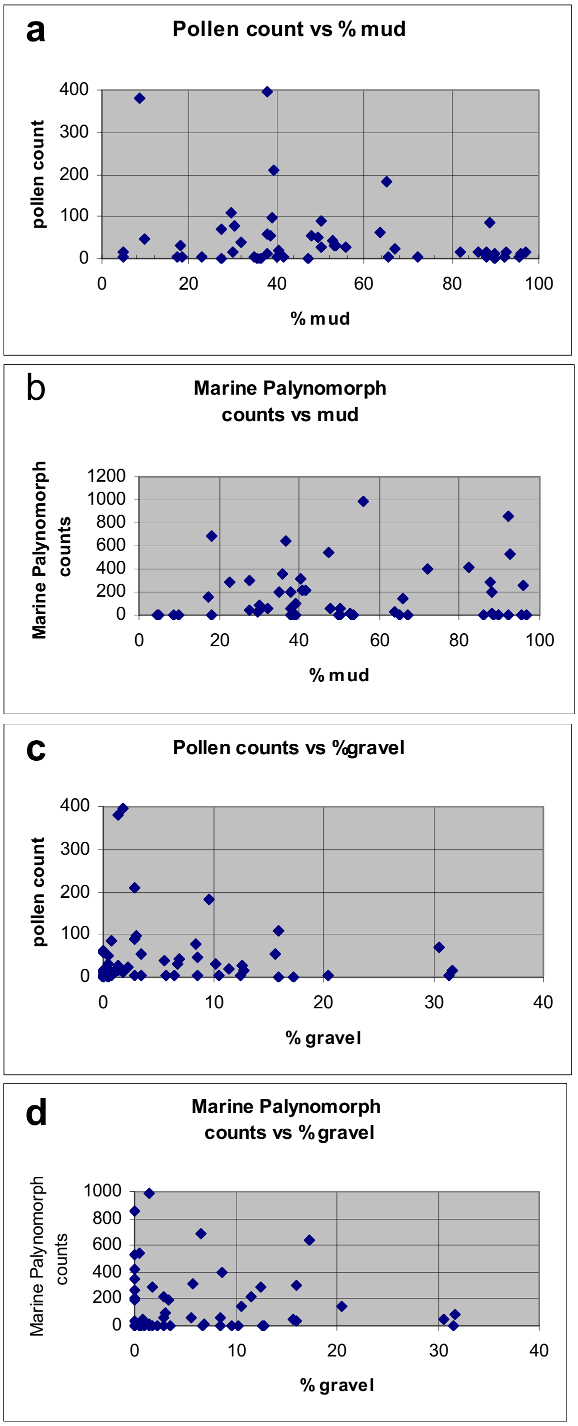


Fig. 4.6: Graphs displaying (a) pollen counts vs % mud, (b) marine palynomorph counts vs % mud, (c) pollen counts vs % gravel and (d) marine palynomorph counts vs % gravel. Results show no relationship between the % mud and pollen and marine palynomorph, but a relationship between % gravel and pollen and marine palynomorphs.

CHAPTER 5
DISCUSSION

5.0 Introduction

Most of the samples collected for this project have been affected by modern environmental factors such as current winnowing which removed a lot of the finer material in the shallow areas of the embayment, or iceberg ploughing. Icebergs on the eastern side of the bay are swept along by the coastal currents traveling west and are either carried across the shelf edge or along the coast towards the Amery Ice Shelf (O'Brien, 1994). Areas on the Four Ladies Bank that are compacted till with a smooth sea floor (O'Brien & Leitchenkov, 1997) are protected because of the shoaling that is created by kick points made by icebergs when they ground into the banks. Many icebergs with keels that are >300 m deep kick into and gouge out the shallow banks, and may wallow there disturbing and suspending sediment which may later be reworked back into the sediment. The icebergs may then break up and pass over the area without disturbing sediment protected by shoaling (O'Brien & Leitchenkov, 1997). Three samples had a high mud content on the Four Ladies Bank (901/18, 186/27, 186/28), which may mean that they remained undisturbed by iceberg ploughing. Reworked pollen distribution in Prydz Bay could be current affected and sea floor samples from the 1911-14 Australasian Antarctic Expedition contained large amounts of recycled pollen on the east coast between 91^{o} E – 146^{o} E (Truswell, 1982). Some of this pollen if disturbed may remain in suspension long enough to be transported by the coastal currents into the embayment and become entrapped within the Prydz Bay Gyre to eventually settle in the Mid Shelf or Coastal areas.

Figure 3.7 shows water is more saline in the north and north west of Prydz Bay and the gyre may account for the high salinity waters entering the embayment. The inflow from the east by the coastal current is less saline and an area of low salinity can be seen stretching across the Coastal areas of the Svenner Channel and in front of the Amery Ice Shelf. Salinity affect the prasinophycean algae *Cymatiosphaera* sp. 2 (fig 3.6) which are found in abundance in two samples (186/15, 901/27) from the lowest salinity areas in front of the ice shelf. This is consistent with studies in the Arctic where *Cymatiosphaera* species are found in areas of low salinity and meltwater (Mudie, 1992).

The grain size distribution in Prydz Bay combined with the total abundance for palynomorphs in figure 3.11 shows that the higher abundances were found in higher mud content of sediments within the Mid Shelf and Coastal areas, however, in some samples individual species with high counts were dominant regardless of high mud content e.g. *Zooplankton* sp. (901/33, 186/16) and *Cymatiosphaera* sp. 2 (186/15). Figure 4.6 shows that there is a relationship to percent gravel and counts for marine palynomorphs and pollen which may be due in part to sources from glacially derived debris, but there is no relationship for percent mud and counts for marine palynomorphs and pollen. Currents also controlled the distribution of palynomorphs occurring in the North West Fram Bank and in the distribution of most Holocene palynomorphs e.g. *Beringiella* was more widely distributed on the shelf areas. These factors indicate that processes such as the water currents dominated by the gyre and Coastal Current, combined with the influence of water depth and salinity, the sediment deposition created by glacial erosion in the past and the open marine conditions today, are all influences controlling the distribution of palynomorphs within the embayment.

5.1 Palynomorph assemblages in Prydz Bay

Samples from the Prydz Bay Fan and the North Shelf contain mostly reworked palynomorphs (figs 3.9, 3.10). The disturbance of the sediments on the Fan by sediment gravity flows and contour currents and on the North Shelf by water currents and iceberg ploughing has brought to the surface the reworked terrestrial and marine palynomorphs contained in these sediments. Figure 3.1 shows Holocene palynomorphs are rare on the Fan due to contour currents and sediment gravity flows disturbing the sediment and winnowing out the finer grain size in shallower depths on the Fan. Holocene palynomorphs cannot settle in this environment. The reworked palynomorphs present within the sediment consist of terrestrial pollen grains and spores which date from the Permian and Jurassic. Reworked dinocysts are poorly preserved and have been dated as Eocene/early Oligocene and are part of the Transantarctic Flora. The Miocene marks the beginning of ice sheet advances in Prydz Bay and must be the reason why the reworked dinocysts come from that epoch.

Figure 3.1 shows the Holocene palynomorph assemblage on the Fram Bank contained few reworked palynomorphs. This differs from the Four Ladies Bank and North Prydz Channel. The gyre and Coastal Current as shown in figure 2.1 must be recirculating the Holocene palynomorphs which are found mostly in Mid Shelf and Coastal areas. The high proportions of sand found on the Fram Bank samples combined with the shallow water depths (168-527 m) also indicate currents have winnowed out the fines. For example, 901/33 has a high sand grain size (62%) and a high Holocene marine palynomorph count (174 g/g) with very little reworked palynomorphs (0.51 g/g). Such a high Holocene marine palynomorph count in coarse sediments in a shallow area would only occur if carried there recently by the coastal current or the northward flowing arm of the gyre. Other samples on Fram Bank have high counts for foraminiferan test linings (fig 3.4) and to a lesser degree *Zooplankton* sp. (fig 3.3), *Sphaeromorphs* (Appendix D) and lower abundances of *Beringiella* sp. (fig 3.5) and *Cymatiosphaera* sp. 2 (fig 3.6). 149/6 is the exception and contains high counts of pollen and a few *Zooplankton* sp. and notably a number of *Cymatiosphaera* sp. 1. 149/6 is far enough west to be considered almost part of the MacRobertson Shelf and is deeper (805 m) and out of range of the gyre, and these facts combined give 149/6 a different environment from other samples on the Fram Bank.

Figure 3.1 shows that the North Prydz Channel and the Four Ladies Bank have very low counts of Holocene palynomorphs. Figure 3.9 shows high counts for reworked dinocysts and figure 3.10 shows very high counts for terrestial palynomorphs in the same areas. There may be more reworking occurring in these areas than the Fram Bank, or incoming material from the coastal current may contain more reworked palynomorphs. This suggests little transport of marine palynomorphs in the southward flowing arm of the gyre (fig 2.1). The Four Ladies Bank has higher mud proportions in three samples (fig 4.5a) but figure 4.5c shows one sample 901/20 very high in gravel, whereas the North Prydz Channel shows a higher sand proportion. The grain size in these areas differs from sample to sample and contrasts with the palynomorph assemblages present which show a similarity in all of these samples. Overall the North Shelf and Fan areas are still lower in abundance than Mid Shelf and Coastal areas.

Prydz Bay deepens (fig 4.4) from the North shelf to the Mid shelf region, an area where a fast flowing ice stream once carried debris out to the shelf edge which now creates a different environment for cyst settlement. The sediment in the Mid Shelf is deposited at greater water depths (570-775 m) and not disturbed by surface currents or iceberg ploughing, resulting in high mud content (fig 4.5c). The Mid Shelf is where the highest abundances of Holocene marine palynomorphs are located and there is a notable increase in acritarchs and Holocene dinocysts. Pollen counts are high in one or two samples and may have been transported into this area by the coastal currents and the south flowing arm of the gyre. Figure 3.1 shows that all samples from the Mid Shelf have a high total Holocene abundance of marine palynomorphs. Figure 4.1a is the mud contour map and clearly shows this area and parts of the Coastal region have a high mud percent.

The Coastal region is the deepest part of the embayment caused by the expanding Amery ice sheet which eroded sediment and moved it towards the North Shelf. Grain size is variable and mud, sand, or gravel predominates in different samples. Gravel and sand predominate in the Lambert Deep which may be due to disturbance by currents exiting beneath the Amery Ice Shelf. The Prasinophyte *Cymatiosphaera* sp. 2 (fig 3.6) has a high abundance in the sample closest to the exit area in the Lambert Deep (186/15) along with a reasonable Acritarch count. The Nanok Deep samples (186/17, 186/18) have a high abundance of foram linings, and overall this western part of the Coastal area has very high counts for *Zooplankton* sp, with low numbers of most other marine palynomorphs. Notably the sample taken on the eastern part of the Amery Ice shelf (901/27) shows a very high count for the *Cymatiosphaera* sp. 2. In the Svenner Channel area to the east, there are two samples (901/28, 901/31) that vary in their counts according to the type of grainsize and depth within the Channel (fig 4.4; Table 4.1). The deeper sample contains a finer grain size and a higher palynomorph count. There is notably a very small pollen content in all the Coastal samples and overall this geographic area has the second highest palynomorph abundance within Prydz Bay.

5.2 Comparison with other modern assemblages

In the Southern Ocean, Harland *et al.* (1998) found the number of cysts declined from the Antarctic Polar Front (~50^{o} S) towards the higher latitudes. This clearly distinguishable distribution pattern is in agreement with the Arctic studies of Mudie (1992) and Rochon *et al.* (1999). Harland *et al.* (1998) found that this decreasing diversity with increasing latitude corresponded with an increase in heterotrophic dinocysts and decrease in autotrophic dinocysts. Harland *et al.* (1998) related the increasing number of heterotrophs as due to upwellings north of the maximum sea ice limit of ~60^{o} S. In contrast Mudie (1992) relates the A:H ratio to autotrophic dinocysts dominating summer open waters with higher salinity values (>27%) and heterotrophic dinocysts increasing with ice thickness and reduced salinity (17-27%). The A:H ratios of <0.2 marked permanent pack ice, tidewater glacier and glaciofluvial environments in the Arctic. This study has recorded more heterotroph than autotroph dinocysts within Prydz Bay.

Other studies in the Southern Ocean by Marret & de Vernal (1997) showed a reduction in taxa from the Subtropical (20 taxa) to Sub-Antarctic and Antarctic domains (less than 10 taxa, minimum of 3). Esper & Zonneveld (2002) also found a clearly distinguishable pattern in distribution of dinocysts as the A:H ratio decreased towards the higher latitudes. High rates of heterotrophic dinocysts dominated from south of 45^{o} – 55^{o} S and the endemic S*elenopemphix antarctica* increased in numbers, dominating the sea ice zone from 60^{o} S to coastal areas. This study has recorded S*elenopemphix antarctica* as the dominant dinocyst in Prydz Bay. All Southern Ocean studies were in agreement with Arctic studies of changes in biota and distribution with increasing latitude.

Mudie (1992) showed that dinocyst assemblages from surface sediments in the Arctic Ocean usually contain at least 32 dinocyst species and 4 acritarch species. In general, Mudie (1992) found a strong correlation between modern palynomorph cyst distribution and surface water masses with species changing between cool temperate, Sub-Arctic and colder Arctic surface water masses. There was a strong correlation to increase in latitude and reduction of A:H dinocyst ratio, and the presence of acritarchs and prasinophytes indicated deposition in stratified glaciofluvial and seasonal meltwater environments. In the Barents Sea north of 84^o N, sediments contained fewer dinocysts (63-165 g/g) and sediments from lower salinity surface meltwater areas frequently contained pransinophytes or *Sphaeromorph* acritarchs and *Leiosphaeridia* spp.

A further study in the Arctic (Rochon *et al.*1999) examined the distribution of recent dinoflagellate cysts in surface sediments throughout the North Atlantic Ocean and adjacent seas and found a higher concentration of taxa on continental shelves and slopes where the primary productivity is highest. Dinocyst species diversity was between 2-18 taxa and North Atlantic samples contained 100-1,000 cysts/cm^{2}yr and Artic seas had moderately low cyst concentrations in the order of 0.1-1 cysts/cm^{2}yr.

Table 5.1 highlights the 7 species that are represented in both the Arctic and Antarctic Holocene surface sediment studies. Arctic and North Atlantic species that are most abundant include *Operculodinium centrocarpum, Nematosphaeropsis labyrinthus, Spiniferites frigidus, Multispinula minuta, Brigantedinium* spp, *Pheopolykrikos hartmanii, Pentapharsodinium dalei,* and *Impagidinium pallidum* (Mudie, 1992; Rochon *et al*. 1999). Of 53 dinocyst taxa identified from the analysis of studies on surface sediments of the Southern Indian Ocean, 49 are also reported to occur in modern surface sediments in the Northern Hemisphere (Marret & de Vernal, 1997). Dinocyst assemblages from the Southern Ocean and Antarctica (Table 5.1) are largely dominated by *Selenopemphix antarctica, Brigantedinium* spp, *Impagidinium pallidum, Nematosphaeropsis labyrinthus, Operculodinium centrocarpum, Impagidinium sphaericum, Protoperidinium* spp. *and Cryodinium meridianum.*

This study has found that the low dinocyst numbers and continuous reduction in diversity southward and the decreasing A:H ratio with increasing high latitude, has meant results for numbers of dinocysts in Prydz Bay have been low. This is indicated by the low dinocyst counts (3.85 grains per gram) and dominance of heterotrophic dinocysts recovered in Prydz Bay. *Selenopemphix antarctica, Protoperidinium* sp. and *Cryodinium* sp. were the most abundant dinocyst species in Prydz Bay but none of the Holocene dinocysts from Prydz Bay have been recorded

Holocene Surface Sediments		
Arctic Mudie, 1992 Rochon et al, 1999	**Antarctica** Marret & de Vernal, 1997 Harland *et al*, 1998 Harland & Pudsey, 1999 Esper & Zonneveld, 2002	**Antarctica** Prydz Bay This study
Algidasphaeridium minutum ***Brigantedinium* spp.** ***Impagidinium pallidum*** ***Impagidinium sphaericum*** *Lejeunecysta* *Multispinula minuta* ***Nematosphaeropsis labyrinthus*** ***Operculodinium centrocarpum*** *Pentapharsodinium dalei,* *Polykrikos schwartzii* ***Spiniferites elongates*** *S.ramosus* *S.mirabilis,* *S. belerius* *Selenopemphix quanta*	***Algidasphaeridium minutum*** ***Brigantedinium* spp.** ***Cryodinium meridianum*** *Dalella chathamense* ***Impagidinium pallidum*** *Impagidinium variaseptum* ***Impagidinium sphaericum*** ***Nematosphaeropsis labyrinthus*** ***Operculodinium centrocarpum*** *Operculodinium israelianum,* ***Protoperidinium* spp.** *Protoceratium reticulatum* ***Selenopemphix antarctica*** ***Spiniferites elongates***	***Selenopemphix antarctica*** ***Protoperidinium* spp.** ***Cryodinium* sp.** *Alisocysta* sp. Dinocyst sp. *Hystrichosphaerikium* sp. *Impagidinium* sp. *Protoperidinium* sp. 1
Acritarchs *Hallodinium* spp. *Leiosphaeridia* sp. *Sigmopollis* *Sphaeromorphs* **Prasinophytes** *Cymatiosphaera* *Pterospermella* sp. **Red Algae** *Beringiella* sp. **Others** *Lingulodinium* sp.	Pollen grains, spores, Foraminiferan linings, Tintinnid cysts and loricae **Acritarchs** *Hallodinium* spp. **Prasinophytes** *Cymatiosphaera* *Tasmanites*	Pollen grains, spores, Foraminiferan linings, Tintinnid cysts, loricae, **Acritarchs** *Leiosphaeridia* sp. *Sigmopollis* *Sphaeromorphs* **Prasinophytes** *Cymatiosphaera,* *Tasmanites* *Pterospermella* **Red algae** *Beringiella*

Table 5.1**:** Palynomorphs that were in abundance in surface sediments from Arctic and North Atlantic from studies by Mudie (1992) and Rochon *et al.* (1999). Antarctic and Southern Ocean palynomorphs from studies by Marret & de Vernal (1997), Harland *et al.* (1998), Harland & Pudsey (1999) and Esper & Zonneverld (2002). Palynomorphs found in both the Arctic and Antarctic are in blue and palynomorphs found in both the Southern Ocean and Prydz Bay are in Green.

in Northern Hemisphere studies. *Selenopemphix antarctica,* together with *Cryodinium meridianum, Dalella chathamense* and *Impagidinium variaseptum* (Harland *et al.* 1998; Harland & Pudsey, 1999; Esper & Zonneveld, 2002) appear to be endemic to Antarctica. Table 5.1 highlights 3 of the species that are represented in Prydz Bay and also found in studies carried out in the Southern Ocean. Most marine palynology studies discuss dinocyst concentrations, however this study has results which include counts for other palynomorphs present in equal and sometimes greater numbers than the Holocene dinocysts. They are the acritarchs, prasinophytes, red algae, tintinnids and foraminifera linings recorded either in the Southern Ocean studies or in the Arctic studies (Table 5.1) and the *Zooplankton* sp. recorded in very high numbers in this study but not been recorded elsewhere.

5.3 Ancient and modern assemblages

The number of living dinoflagellates today is approximately 1,772 marine and 230 freshwater species, many of which are yet to be adequately described. The number of dinoflagellates that produce preservable resting cysts may only be about 10% of this total (Dale, 1996, Head, 1996**).** In Antarctica, extant dinoflagellates have been reported in greater numbers than fossil dinocysts. Out of nearly 80 motile species of Holocene dinoflagellates discovered in the Antarctic only five were known to produce cysts (Wrenn *et al.* 1998). A comparison of the fossil record for Antarctic dinocyst diversity with the record for world wide fossil dinocyst diversity is shown in figure 5.1 from Wrenn *et al.* (1998). This shows that the limited number of drill holes and the few productive outcrops of marine sediments that do exist, have compared well with the distribution curves for world wide fossil dinocyst diversity, although their abundance is lower (Wrenn *et al.* 1998).

Most reworked palynomorphs in this project have also been identified from previous work carried out on the palynology of Seymour Island, Antarctica (Wrenn & Hart, 1988), Deep Sea Drilling Project (DSDP) drill hole (Kemp, 1975), MSSTS-1 drill hole McMurdo Sound (Truswell, 1986) the CIROS-1 Drillhole (Wilson, 1989; Hannah, 1997) and McMurdo Sound Erratics, (Levy & Harwood, 2000b). Our understanding of Oligocene-Miocene marine palynology of high latitude sites, increased significantly through the Cape Roberts Project (Hannah *et al.* 1998, Wrenn

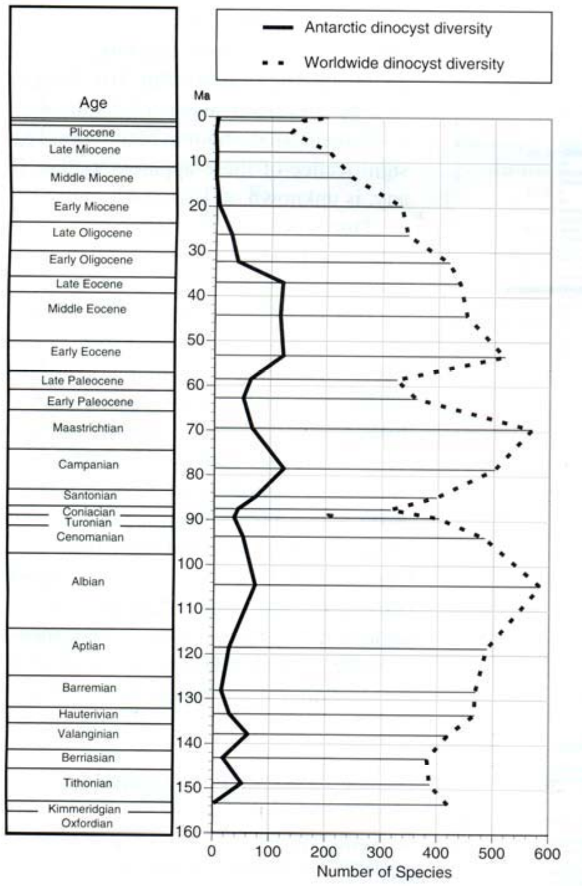


Fig. 5.1: Dinocyst curve in the Antarctic fossil record (solid black line) compared to that of the world-wide dinocyst record. The Antarctic pilot is based on a PALYNODATA search that retrieved data from 91 Antarctic dinocyst papers in its database. The world-wide dinocysts curve is adapted from MacRae et al.1996 (J.H. Wrenn *et al.* 1998)

et al. 1998, Hannah *et al.* 2000, Hannah *et al.* 2001a) and Ocean Drilling Project sites in Prydz Bay (Hannah, 2005, McPhail & Truswell, 2004a, b).

The Transantarctic Flora were first recovered from the McMurdo Erratics by Cranwell *et al.* (1960). The Erratics are fossiliferous and found in coastal moraines around McMurdo Sound, East Antarctica. They provide a record of both ice-free coastal and glacial-marine depositional environments (Levy & Harwood, 2000). Wrenn & Hart (1988) further documented the flora from Seymour Island near the Antarctic Peninsular, and since then the flora have been found *in situ* and dated as mid Eocene to early Oligocene, or as reworked dinocysts in most other projects within the Antarctic. Other palynomorphs that were present in the ancient assemblages in previous work mentioned above and are also present in the surface sediments from this project are acritarchs (*Leiosphaeridia* spp, *Sigmopollis,*) and prasinophytes (*Cymatiosphaera* spp, *Pterospermella, Tasmanites).*

5.3.1 Prydz Bay Ocean Drilling Program

The Ocean Drilling Program (ODP) Leg 119 sites 739 to 743 along with Leg 188 sites 1165, 1166 and 1167 (fig 5.2) were drilled in Prydz Bay with the purpose of investigating glacial/preglacial conditions during the Miocene. ODP site 1165 sampled the Wild Drift on the continental rise; site 1166 was drilled on the eastern part of the continental shelf; site 1167 was drilled on the Prydz Channel Fan.

Hannah (2005) extensively studied ODP site 1165 on the Wild Drift and found both *in situ* and reworked palynomorphs recognized as a Miocene record of glacial advance and retreat. As the ice sheet expanded a long colder period occurred and high numbers of reworked palynomorphs were evident. Full retreat of the ice shelf reduced the numbers of reworked palynomorphs but brought a generally large increase in numbers of *Leiospheres* and during warmer periods an increase in other flora was evident (Hannah, 2005). Reworked palynomorphs consisted of terrestrial spores and pollen from the Devonian to Early Eocene, and Transantarctic flora which were reworked into Miocene sediments. *In situ* palynomorphs consisted of acritarchs, prasinophyte algae and *in situ* dinocysts that were dominated by

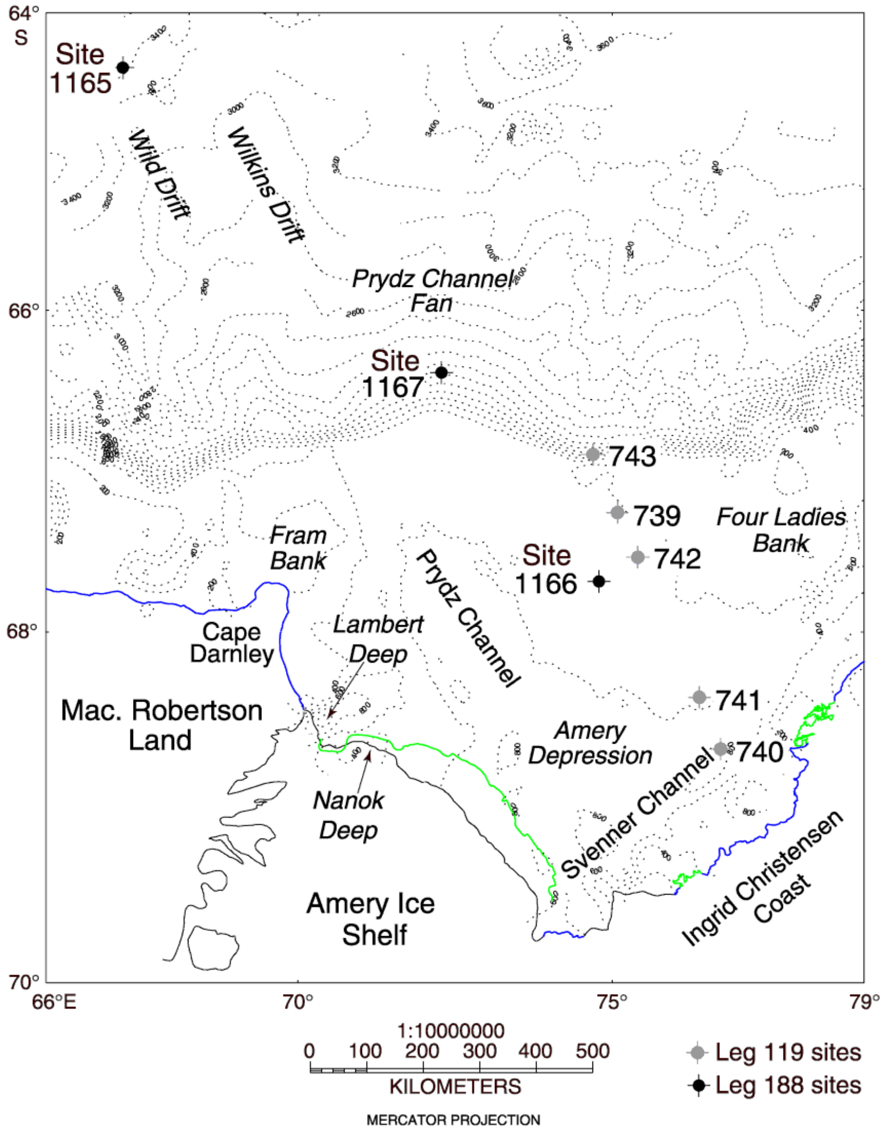


Fig. 5.2: Previous work has been completed by ODP leg 119 where drilling on the shelf (site 166), fan (site 1167) and rise (site 1165) were completed. ODP leg 188 sites were drilled on the continental shelf from site 739 to 743 (O'Brien *et al* 2001).

Lejeunecysta. The acritarch *Leiosphaeridia* was the dominant palynomorph in most samples from the base of the drill hole up to depths of 325 m below sea floor.

The palynology of ODP sites 1165 and 1167 was initially investigated by MacPhail and Truswell (2004a). Site 1165 contained Neogene dinocysts taxa including *Batiacasphaera* sp. and also included the Prasinophyte *Cymatiosphaera* as well as fossil pollen and spores. Site 1167 contained recycled plant microfossils that are Permian and early Jurassic to late Eocene and Oligocene. Neither site contained dinocysts from the Transantarctic Flora. McPhail and Truswell (2004b) studied site 1166 more extensively to recover late Cretaceous and Eocene pollen and spores and *in situ* dinocysts from the Transantarctic Flora.

A further study by Truswell *et al.* (1999) reported pollen grains and spores from Mesozoic in the Nielsen basin on the MacRobertson shelf (west of Prydz Bay) and dinocysts have been identified further west on the MacRobertson Shelf which are also present in Prydz Bay surface sediments as Reworked dinocysts from the Trans Antarctic Flora.

There is a higher diversity within the embayment today and a significantly lower level of reworked material than in ancient assemblages recorded throughout Antarctica which reflects warmer conditions today compared to the Ice Shelf advance and retreats of the past. This study contains elements from previous work on the ODP drill holes for Transantarctic Flora, pollen and spores, acritarchs (*Leiosphaeridia* spp*, Sigmopollis)* and Prasinophytes (*Cymatiosphaera* spp, *Pterospermella* spp). Table 5.2 shows a comparison of ODP drill holes in Prydz Bay and this study. Notably the red algae *Beringiella* sp. and *Tasmanites* spp. have not been recorded in the ODP sites and Holocene dinocysts in this study also differ from ODP *in situ* dinocysts. Other differences are the very low counts found in this study for *Leiosphaeridia* spp. in reworked or Holocene sediments compared to the high counts from Hannah (2005) that occurred in ODP 1165 during ice shelf retreats in the past. Wild Drift site 1165 is situated on the continental rise to the north west of Prydz Bay, which may mean the lack of similarity of species between Wild Drift and the Prydz Bay embayment may reflect the different environments. It could also reflect a different climate today which has not produced *Leiosphaeridia* spp. in

This Study vs Ancient Assemblages		
This study Reworked Dinocysts	Hannah, (2005) Reworked Dinocysts	McPhail & Truswell (2004a,b) Transantarctic Flora Dinocysts
Alterbidinium asymmetrica *Deflandrea* spp. *Enneadocysta partridge***,** *Spinidinium* sp. *Spinidinium macmurdoense* *Turbiosphaera filosa* *Vozzhennikovia* spp.	*Alisocysta* sp. *Alterbidinium* *asymmetricum* *Arachnodinium antarcticum* *Deflandrea antarctica* *Enneadocysta partridgei* *Vozzhennikovia aperture*	*Deflandrea* sp. cf. *Deflandrea antarctica* *Enneadocysta partridgei* *Spinidinium* sp. *Spinidinium macmurdoense* *Turbiosphaera* sp. cf. *Turbiosphaera filosa* *Vozzhennikovia aperture*
Other Palynomorphs	Other Palynomorphs	Other Palynomorphs
Pollen grains, spores, *Foraminiferan linings,* *Tintinnid cysts, loricae,* **Acritarchs** *Leiosphaeridia* sp. *Sigmopollis* *Sphaeromorphs* **Prasinophytes** *Cymatiosphaera* spp. *Tasmanites* sp. *Pterospermella* spp. **Red Algae** *Beringiella* sp.	*Pollen grains, spores* **Acritarchs** *Leiosphaeridia* spp. *Micrhyistridium* spp. *Sigmopollis* **Prasinophytes** *Cymatiosphaera* sp. 1 *Cymatiosphaera* spp. *Pterospermella* spp.	*Pollen grains, spores,* *Foraminiferan linings,* **Prasinophytes** *Pterosperma* spp. *Cymatiosphaera invaginata*

Table 5.2: Transantarctic Flora recovered from this project in comparison with Hannah (2005) and McPhail and Truswell (2004a, b). Other palynomorphs shown are pollen grains, spores, acritarchs, and prasinophytes which are also compared.

numbers but has produced a variety of palynomorphs that were not present in the ancient records. This study records terrestrial palynomorphs from the Permian to the Eocene in contrast to Hannah (2005) who recorded terrestrial palynomorphs from the Devonian to Early Eocene.

5.3.2 Reworked surficial sediments in the Ross Sea

Truswell and Drewrey (1984) noted that reworked palynomorphs were evident in surficial sediments in the Ross Sea. The highest densities were immediately north of the Ross Ice Shelf and were dominated by Late Cretaceous to Eocene microfossils. In contrast, this study of Prydz Bay has found that the area immediately north of the Amery Ice Shelf is dominated by modern marine palynomorphs and the highest densities for Prydz Bay reworked palynomorphs were on the North Shelf and Prydz Channel Fan. Also noted by Truswell and Drewrey (1984) were rare Paleozoic spores and Eocene dinoflagellates some of which are also present in Prydz Bay surface sediments namely: *Alterbidinium asymmetrica*, *Deflandrea* spp. *Turbiosphaera filosa, Vozzhennikovia spp.* that are all part of the Transantarctic Flora.

The Ross Sea Ice drainage basin only reflects the Amery Ice Shelf drainage basin in that it has been responsible for the transport of palynomorphs from an expanded ice shelf or from discharge from ice streams. Marine bottom currents do not seem to have significantly affected distribution of the recycled microfossils in the Ross Sea sediments in areas where transport of sediment occurs from a floating ice shelf or discharge from ice streams. Deposition below the ice mass of near grounded or grounded ice leaves only a very short water column with little opportunity to be affected by current transport (Truswell & Drewrey, 1984). In contrast the Prydz Bay Gyre and the Coastal Current from the east combined with iceberg grounding in the shallower areas of the bay have influenced what is found in the sediments there today.

CHAPTER 6

CONCLUSIONS

This study has demonstrated that:

1. Prydz Bay surface sediment samples contain Holocene palynomorphs, reworked Eocene dinocysts and reworked Permian to Eocene terrestrial palynomorph assemblages. Past glacial processes have created four differing environments (Prydz Channel Fan, North Shelf, Mid Shelf and Coastal areas) in the embayment which is reflected in the palynomorph distribution. In addition, conditions for cyst settlement today are partly controlled by a clockwise rotating gyre which enters the embayment from the north. The southward flowing arm of the gyre combines with the westward flowing coastal current and circulates beneath the Amery Ice Shelf before exiting on the western side and joins the outgoing arm of the gyre north or follows the coastal current west. Processes such as the water currents dominated by the gyre and coastal current, combined with the influence of water depth and salinity, the sediment deposition created by glacial erosion in the past and the open marine conditions today, are all influences controlling the distribution of palynomorphs within the embayment.

2. Most Holocene palynomorphs were contained in the Mid Shelf and Coastal areas with very few located on the North Shelf and very sparse counts on the Prydz Channel Fan. The highest counts were obtained for *Zooplankton* sp. and foraminifera linings. *In situ* dinocysts were dominated by the heterotroph form *Selenopemphix antarctica,* with other palynomorphs identified including acritarchs, prasinophytes and a red algae *Beringiella* sp. The percentage of gravel to marine palynomorph and pollen counts show a relationship which may reflect a similar source from glacially derived debris but the percentage of mud to marine palynomorph and pollen counts has no relationship.

3. During the early Oligocene, glacial erosion moved terrestrial sediments from the Lambert Graben, deepened the embayment from the Coastal and Mid

Shelf areas and redeposited and mixed them with marine sediments. Repeated ice shelf advances towards the shelf edge reworked the sediments into the North Shelf and Fan where elements of the Transantarctic Flora and reworked terrestrial palynomorphs are recorded in low numbers today.

4. In comparison with modern assemblages none of the Holocene dinocysts from Prydz Bay have been recorded in Northern Hemisphere studies. In contrast, all of the Prydz Bay acritarchs, prasinophytes, red algae, pollen grain and spores, foraminiferan linings and tintinnids have been recorded either in the Southern Ocean studies or in the Arctic studies as shown in Table 1.5. In the Arctic, sediments from lower salinity and glacial meltwaters frequently contained pransinophytes or *Sphaeromorph* and *Leiosphaeridia* acritarchs.

5. Autotroph:heterotroph ratios decrease with increasing latitude. In the Northern Atlantic high abundances of 100 to 1,000 cysts/cm$^{2}\cdot$yr were recorded, however in the Arctic north of 84^{o} N sediments contained fewer dinocysts (63-165 g/g). In the Sub-Antarctic and Polar Front Zones a high of 2,000 grains per gram noticeably fell to <250 grains per gram at 60^{o} S and from 60^{o} S to higher latitudes the cysts per gram of sediment declined to <23 grains per gram and diversity was lower (maximum of six species). In Prydz Bay the Holocene dinocyst count is 3.85 grains per gram with eight species recovered, but two are considered oceanic and carried into the embayment via the Prydz Bay gyre.

6. Most reworked palynomorphs in this project have also been identified from previous work carried out in Prydz Bay ODP drill holes and the McMurdo Sound, Ross Sea area which includes projects such as CIROS-1 and the Cape Roberts Project. They contain elements of the Transantarctic Flora, pollen and spores, acritarchs (*Leiosphaeridia* spp. *Sigmopollis* sp.), and prasinophytes (*Cymatiosphaera* spp. *Pterospermella* spp. *Tasmanites* spp.).

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APPENDIX A The distribution of marine palynomorphs in surface sediments of Prydz Bay, Antarctica

MASTER SPREADSHEET

			nw	nw	f	f	nw	f	nw	n	ne	ne	m	m	m	m	m	c	c	c	nw	nw	f	f	f
	Palynomorphs	Count	901-5	901-6	901-9	901-10	901-11	901-13	901-14	901-15	901-18	901-20	901-22	901-23	901-24	901-25	901-26	901-27	901-28	901-31	901-33	149-6	149-14	149-15	149-16
Acritarchs	Acritarch spp 1	5			1																				
	Acritarch spp 2	2															2								
	Acritarch spp 3	3																							
	Acritarch spp 4	9												1	2	3									
	Leiospherida sp	25										1	2	5	6		1				1				
	Leiospherida sigmopolis	3						1																	
	Sphaeromorphs	285	2	2	1						1		4	59	17	6	34	15	1	4	37				
	Total Acritarchs	**332**	**2**	**2**	**2**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**6**	**65**	**25**	**9**	**37**	**15**	**1**	**4**	**38**	**0**	**0**	**0**	**0**
Holocene Dinocysts	*Alisocysta* sp	3													1										
	Cryodinium sp	11												2											
	Dinocyst spp	1											1												
	Hystrichosphaeridium spp	4																							
	Impagidinium sp	1										1													
	Protoperidinium sp 1	1							1																
	Protoperidinium sp 2	37												6		1			1		3				
	Selenopemphix antarctica	110												7	21	16	2								
	Total Holocene Dinocysts	**168**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**0**	**1**	**1**	**15**	**22**	**17**	**2**	**0**	**1**	**0**	**3**	**0**	**0**	**0**	**0**
Egg Cases	Egg cases	433	2	10			2	2	4	2	5	2	16	54	11	51	23	8	11	6	29				
	Total Egg Cases	**433**	**2**	**10**	**0**	**0**	**2**	**2**	**4**	**2**	**5**	**2**	**16**	**54**	**11**	**51**	**23**	**8**	**11**	**6**	**29**	**0**	**0**	**0**	**0**
Prasinophycean Algae	*Cymatiosphaera* spp 1	6	1		1																	3			
	Cymatiosphaera spp 2	396		1							2	1	14	17	1	63	28	40	8		2				
	Pterospermella	16			1		3				3			3							1	1			
	Tasmanites	2																							
	Total Prasinophycean Algae	**420**	**1**	**1**	**2**	**0**	**3**	**0**	**0**	**0**	**5**	**1**	**14**	**20**	**1**	**63**	**28**	**40**	**8**	**0**	**3**	**4**	**0**	**0**	**0**
Foraminifera Linings	Foraminifera linings	3426	244	79		1	120	3	60	35	17	9	72	251	44	84	135	75	178	155	344				
	Total Foraminifera Linings	**3426**	**244**	**79**	**0**	**1**	**120**	**3**	**60**	**35**	**17**	**9**	**72**	**251**	**44**	**84**	**135**	**75**	**178**	**155**	**344**	**0**	**0**	**0**	**0**
Red Algae	*Beringiella* sp	510	4	8	1		5				12	4	26	28	6	26	52	15	28	22	4				
	Total Red Algae	**510**	**4**	**8**	**1**	**0**	**5**	**0**	**0**	**0**	**12**	**4**	**26**	**28**	**6**	**26**	**52**	**15**	**28**	**22**	**4**	**0**	**0**	**0**	**0**
Zooplankton	Tintinnid cyst	46											3	3	3	3	12	6		3					
	Tintinnid loricae	233	5	4			4			1	3	4	9	31	11	14	24	3	2	6	3	1			
	Zooplankton spp	3725	25	32			33		5	15	8	20	326	300	85	156	140	89	92	173	232	2			
	Total Zooplankton	**4004**	**30**	**36**	**0**	**0**	**37**	**0**	**5**	**16**	**11**	**24**	**338**	**334**	**99**	**173**	**176**	**98**	**94**	**182**	**235**	**3**	**0**	**0**	**0**

APPENDIX A The distribution of marine palynomorphs in surface sediments of Prydz Bay, Antarctica

MASTER SPREADSHEET

		f	f	f	f	f	f	f	f	f	n	n	n	n	f	f	f	f	nw	m	m	m	m
	Palynomorphs	149-17	149-18	149-19	149-21	149-22	149-23	149-24	149-25	149-27	149-28	149-30	149-31	149-32	149-33	149-34	149-35	149-36	149-37	186-9	186-11	186-13	186-14
Acritarchs	Acritarch spp 1		1																				
	Acritarch spp 2																						
	Acritarch spp 3																						
	Acritarch spp 4																			1		1	
	Leiospherida sp									1												8	
	Leiospherida sigmopolis			1											1								
	Sphaeoromorphs										2	2		4						6	6	31	5
	Total Acritarchs	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**0**	**4**	**1**	**0**	**0**	**0**	**0**	**7**	**6**	**40**	**5**
Holocene Dinocysts	*Alisocysta* sp																						
	Cryodinium sp																					4	
	Dinocyst spp																						
	Hystrichosphaeridium spp										3			1									
	Impagidinium sp																						
	Protoperidinium sp 1																						
	Protoperidinium sp 2																					1	1
	Selenopemphix antarctica																					15	
	Total Holocene Dinocysts	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**20**	**1**
Egg Cases	Egg cases										1	2	1	3					10	9	9	17	14
	Total Egg Cases	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**3**	**0**	**0**	**0**	**0**	**10**	**9**	**9**	**17**	**14**
Prasinophycean Algae	*Cymatiosphaera* spp 1													1									
	Cymatiosphaera spp 2											1							6	14		38	7
	Pterospermella												1								1		2
	Tasmanites												1									1	
	Total Prasinophycean Algae	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**1**	**0**	**0**	**0**	**0**	**6**	**14**	**1**	**39**	**9**
Foraminifera Linings	Foraminifera linings				1						8	19	19	29					124	56	50	47	196
	Total Foraminifera Linings	**0**	**0**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**8**	**19**	**19**	**29**	**0**	**0**	**0**	**0**	**124**	**56**	**50**	**47**	**196**
Red Algae	*Beringiella* sp										1		7	4			3		20	15	15	11	26
	Total Red Algae	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**0**	**7**	**4**	**0**	**0**	**3**	**0**	**20**	**15**	**15**	**11**	**26**
Zooplankton	Tintinnid cyst																				1	6	1
	Tintinnid loricae										1	3	1	3					4	11	3	11	16
	Zooplankton spp				2						8	9	20	34				1	39	82	58	176	248
	Total Zooplankton	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**0**	**9**	**12**	**21**	**37**	**0**	**0**	**0**	**1**	**43**	**93**	**62**	**193**	**265**

APPENDIX A The distribution of marine palynomorphs in surface sediments of Prydz Bay, Antarctica

MASTER SPREADSHEET

		c	c	c	m	m	m	m	n	n	ne	f	f	f
	Palynomorphs	186-15	186-16	186-17	186-18	186-19	186-21	186-22	186-26	186-27	186-28	186-29	186-31	186-32
Acritarchs	Acritarch spp 1											3		
	Acritarch spp 2													
	Acritarch spp 3							3						
	Acritarch spp 4				1									
	Leiospherida sp													
	Leiospherida sigmopolis													
	Sphaeoromorphs	4	7	7			12	14	1	1				
	Total Acritarchs	4	7	7	1	0	12	17	1	1	0	3	0	0
Holocene Dinocysts	*Alisocysta* sp									1				1
	Cryodinium sp							5						
	Dinocyst spp													
	Hystrichosphaeridium spp													
	Impagidinium sp													
	Protoperidinium sp 1													
	Protoperidinium sp 2							24						
	Selenopemphix antarctica			1				48						
	Total Holocene Dinocysts	0	0	1	0	0	0	77	0	1	0	0	0	1
Egg Cases	Egg cases	13	18	16	3	7	11	48	10	1	1	1		
	Total Egg Cases	13	18	16	3	7	11	48	10	1	1	1	0	0
Prasinophycean Algae	*Cymatiosphaera* spp 1													
	Cymatiosphaera spp 2	74	2	3	11	8	45	8	1		1			
	Pterospermella													
	Tasmanites													
	Total Prasinophycean Algae	74	2	3	11	8	45	8	1	0	1	0	0	0
Foraminifera Linings	Foraminifera linings	82	254	24	60	78	39	296	115	11	4	8		
	Total Foraminifera Linings	82	254	24	60	78	39	296	115	11	4	8	0	0
Red Algae	*Beringiella* sp	9	18	9	3	11	9	91	6	3	6	2		
	Total Red Algae	9	18	9	3	11	9	91	6	3	6	2	0	0
Zooplankton	Tintinnid cyst	1	1	2			1							
	Tintinnid loricae	5	10	12		3	8	8	9					
	Zooplankton spp	106	302	114	65	130	53	370	141	9	25			
	Total Zooplankton	112	313	128	65	133	62	378	150	9	25	0	0	0

APPENDIX A The distribution of marine palynomorphs in surface sediments of Prydz Bay, Antarctica

MASTER SPREADSHEET

			nw	nw	f	f	nw	f	nw	n	ne	ne	m	m	m	m	m	c	c	c	nw	nw	f	f	f
	Palynomorphs	Count	901-5	901-6	901-9	901-10	901-11	901-13	901-14	901-15	901-18	901-20	901-22	901-23	901-24	901-25	901-26	901-27	901-28	901-31	901-33	149-6	149-14	149-15	149-16
Insect Parts	Insect parts	709	21	8			30	1	16	5	6	1	51	83	15	40	42	28	23	34	18				1
	Total Insect Parts	**709**	**21**	**8**	**0**	**0**	**30**	**1**	**16**	**5**	**6**	**1**	**51**	**83**	**15**	**40**	**42**	**28**	**23**	**34**	**18**	**0**	**0**	**0**	**1**
Unknowns	Unknown sp 1	6																1			2				
	Unknown sp 2	7													1		1								
	Unknown sp 3	13	1											2	1	3					2				
	Unknown sp 4	6													3					2	1				
	Unknown sp 5	2																							
	Unknown sp 6	44	2	3			1	1		1			2	2				4	2	10	2				
	Unknown sp 7	9					3			1									2	1	1				
	Unknown sp 8	3	2																1						
	Unknown sp 9	5	1	1							1								1						
	Total Unknowns	**95**	**6**	**4**	**0**	**0**	**4**	**1**	**0**	**2**	**1**	**0**	**2**	**4**	**5**	**3**	**1**	**5**	**6**	**13**	**8**	**0**	**0**	**0**	**0**
Reworked Dinocysts	*Alterbitedinium asymmetrica*	8																							
	Deflandrea spp	5		1												1									
	Enneadocysta partridgei	3																							
	Operculum	18	1	1			1				1														
	Spinidinium macmurdoense	3									1														
	Spinidinium spp	3																							
	Turbiosphaera filosa	7																1						2	
	Vozzhennikovia spp	10																							
	Total Reworked Dinocysts	**57**	**1**	**2**	**0**	**0**	**1**	**0**	**0**	**0**	**2**	**0**	**0**	**0**	**0**	**1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**	**2**	**0**
Pollen	Pollen	2573	4	5	16	5	57	2	14	78	88	70	16	2		6	8	12	1	17	2	382	54	31	4
	Total Pollen	**2573**	**4**	**5**	**16**	**5**	**57**	**2**	**14**	**78**	**88**	**70**	**16**	**2**	**0**	**6**	**8**	**12**	**1**	**17**	**2**	**382**	**54**	**31**	**4**
	Total Holocene	**10097**	**310**	**148**	**5**	**1**	**201**	**8**	**86**	**60**	**58**	**43**	**526**	**854**	**228**	**466**	**496**	**284**	**350**	**416**	**682**	**7**	**0**	**0**	**1**
	Total Reworked	**2630**	**5**	**7**	**16**	**5**	**58**	**2**	**14**	**78**	**90**	**70**	**16**	**2**	**0**	**7**	**8**	**13**	**1**	**17**	**2**	**382**	**54**	**33**	**4**
	Total Count	**12727**	**315**	**155**	**21**	**6**	**259**	**10**	**100**	**138**	**148**	**113**	**542**	**856**	**228**	**473**	**504**	**297**	**351**	**433**	**684**	**389**	**54**	**33**	**5**
	Dry weight (grams)	**365.33**	**7.67**	**7.78**	**5.41**	**7.91**	**8.47**	**6.55**	**6.86**	**8.47**	**7.07**	**6.36**	**3.65**	**4.85**	**2.53**	**2.96**	**5.15**	**3.66**	**6.5**	**3.28**	**5.89**	**6.99**	**5.85**	**7.01**	**5.86**
	Total abundance grains per gram	**1.5**	**61.6**	**29.9**	**5.8**	**1.1**	**45.9**	**2.3**	**21.9**	**24.4**	**31.4**	**26.7**	**222.7**	**264.7**	**135.2**	**239.7**	**146.8**	**121.7**	**81.0**	**198.0**	**174.2**	**83.5**	**13.8**	**7.1**	**1.3**

Latitude		-67.0592	-66.9588	-66.3360	-66.8025	-67.0165	-66.8158	-66.8355	-67.0083	-67.2833	-67.2358	-68.0650	-68.0818	-68.0938	-68.4365	-68.6238	-68.9465	-68.9153	-68.6818	-67.1813	-66.9317	-66.6400	-66.2533	-66.3850
Longitude		69.0163	69.1635	71.9765	70.0827	68.9148	70.3920	70.4840	71.0040	76.5703	76.5552	72.2760	72.9840	73.1893	74.3078	74.5642	73.5857	76.5893	76.8765	68.5383	64.9383	71.7333	73.3400	73.1850
Depth		320	489	1879	1257	402	880	430	480	320	318	766	661	705	676	676	776	710	806	376	805	849	2250	1960

Lithology		901-5	901-6	901-9	901-10	901-11	901-13	901-14	901-15	901-18	901-20	901-22	901-23	901-24	901-25	901-26	901-27	901-28	901-31	901-33	149-6	149-14	149-15	149-16
gravel		31.73	6.53	0.79	12.75	5.71	31.46	20.5	8.4	2.9	30.46	0	0	n/a	n/a	n/a	1.75	0	0	0	2.77	3.5	6.71	0.5
sand		38.39	75.26	11.29	82.51	54.09	63.63	62.23	61.23	46.97	42.18	7.39	7.96	n/a	n/a	n/a	10.53	64.44	17.88	62.15	55.86	57.97	39.76	7.25
silt		16.26	9.47	20.21	2	18.31	2.45	6.95	15.04	26.91	13.4	23.15	25.66	n/a	n/a	n/a	28.51	18.13	38.41	27.57	19.97	14.58	17.15	45.25
clay		13.61	8.74	67.72	2.73	21.89	2.45	10.31	15.33	23.22	13.96	69.46	66.37	n/a	n/a	n/a	59.21	17.43	43.71	10.28	21.4	23.96	36.38	47

APPENDIX A The distribution of marine palynomorphs in surface sediments of Prydz Bay, Antarctica

MASTER SPREADSHEET

		f	f	f	f	f	f	f	f	f	n	n	n	n	f	f	f	f	nw	m	m	m	m
	Palynomorphs	149-17	149-18	149-19	149-21	149-22	149-23	149-24	149-25	149-27	149-28	149-30	149-31	149-32	149-33	149-34	149-35	149-36	149-37	186-9	186-11	186-13	186-14
Insect Parts	Insect parts										3	15	3	13					7	21	6	26	28
	Total Insect Parts	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**3**	**15**	**3**	**13**	**0**	**0**	**0**	**0**	**7**	**21**	**6**	**26**	**28**
Unknowns	Unknown sp 1																		1		1		
	Unknown sp 2																					3	
	Unknown sp 3																					1	1
	Unknown sp 4																						
	Unknown sp 5																			2			
	Unknown sp 6										1	2	1										2
	Unknown sp 7											1											
	Unknown sp 8																						
	Unknown sp 9																				1		
	Total Unknowns	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**1**	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**1**	**2**	**2**	**4**	**3**
Reworked Dinocysts	*Alterbitedinium asymmetrica*			1						1		1					1						
	Deflandrea spp																1						
	Enneadocysta partridgei													1									
	Operculum		1	3							1	2		1				3					
	Spinidinium macmurdoense																	1					
	Spinidinium spp										1												
	Turbiosphaera filosa													1									
	Vozzhennikovia spp			1							3	1		4			1						
	Total Reworked Dinocysts	**0**	**1**	**5**	**0**	**0**	**0**	**0**	**0**	**1**	**5**	**4**	**0**	**7**	**0**	**0**	**3**	**4**	**0**	**0**	**0**	**0**	**0**
Pollen	Pollen	86	29	31	208	33	24	3		397	107	40	10	96	183	45	49	15	2	18	69	2	1
	Total Pollen	**86**	**29**	**31**	**208**	**33**	**24**	**3**	**0**	**397**	**107**	**40**	**10**	**96**	**183**	**45**	**49**	**15**	**2**	**18**	**69**	**2**	**1**
	Total Holocene	**0**	**1**	**1**	**3**	**0**	**0**	**0**	**0**	**1**	**28**	**54**	**54**	**92**	**1**	**0**	**3**	**1**	**211**	**217**	**151**	**397**	**547**
	Total Reworked	**86**	**30**	**36**	**208**	**33**	**24**	**3**	**0**	**398**	**112**	**44**	**10**	**103**	**183**	**45**	**52**	**19**	**2**	**18**	**69**	**2**	**1**
	Total Count	**86**	**31**	**37**	**211**	**33**	**24**	**3**	**0**	**399**	**140**	**98**	**64**	**195**	**184**	**45**	**55**	**20**	**213**	**235**	**220**	**399**	**548**
	Dry weight (grams)	**5**	**6.88**	**7.24**	**6.74**	**6.99**	**6.95**	**5.23**	**6.65**	**10.92**	**7.02**	**7.13**	**6.01**	**5.4**	**6.33**	**9.62**	**6.99**	**6.54**	**5.18**	**7.62**	**6.53**	**5.56**	**5.06**
	Total abundance grains per gram	**25.8**	**6.8**	**7.7**	**47.0**	**7.1**	**5.2**	**0.9**	**0.0**	**54.8**	**29.9**	**20.6**	**16.0**	**54.2**	**43.6**	**7.0**	**11.8**	**4.6**	**61.7**	**46.3**	**50.5**	**107.6**	**162.5**

	149-17	149-18	149-19	149-21	149-22	149-23	149-24	149-25	149-27	149-28	149-30	149-31	149-32	149-33	149-34	149-35	149-36	149-37	186-9	186-11	186-13	186-14
Latitude	-66.5033	-66.6000	-66.6867	-66.6183	-66.4567	-66.3200	-66.0117	-66.3000	-66.5683	-66.7283	-66.7833	-66.8383	-66.9267	-66.7150	-66.6650	-66.5867	-66.4500	-67.0800	-68.0667	-68.0700	-68.1983	-68.2200
Longitude	73.0917	73.0083	72.9250	72.2933	72.2967	72.2933	71.5350	71.6017	71.7133	71.7750	71.7917	71.8167	71.8467	71.3650	71.2067	71.0100	70.5750	66.7017	72.9000	72.9300	73.2950	73.3833
Depth	1540	1170	765	1060	1450	1884	2535	2010	1200	527	515	512	502	834	1215	1566	2105	168	698	655	678	690

Lithology	149-17	149-18	149-19	149-21	149-22	149-23	149-24	149-25	149-27	149-28	149-30	149-31	149-32	149-33	149-34	149-35	149-36	149-37	186-9	186-11	186-13	186-14
gravel	0.67	12.61	10.3	2.86	0.53	2.34	0	0	1.79	15.98	5.57	0.8	3	9.64	8.47	0.54	1.44	1.4	1.43	11.51	n/a	8.61
sand	10.72	37.31	71.57	57.92	46.34	30.43	4.58	10.22	60.18	54.43	62.46	61.23	57.92	25.12	81.8	49.82	12.61	89.94	42.75	47.9	n/a	19.21
silt	26.01	17.69	9.42	17.05	23.32	20.48	17.81	29.28	14.77	13.2	17.01	15.51	19.69	31.2	5.99	29.86	7.39	5.87	13.34	8.71	n/a	17.88
clay	62.6	32.39	8.71	22.16	29.82	46.74	77.61	60.5	23.27	16.39	14.96	22.46	19.4	34.04	3.74	19.78	78.56	2.79	42.47	31.88	n/a	54.3

APPENDIX A **The distribution of marine palynomorphs in surface sediments of Prydz Bay, Antarctica**

MASTER SPREADSHEET

		c	c	c	m	m	m	m	n	n	ne	f	f	f
	Palynomorphs	186-15	186-16	186-17	186-18	186-19	186-21	186-22	186-26	186-27	186-28	186-29	186-31	186-32
Insect Parts	Insect parts	4	29	7	4	25	13	66	3	4	9			
	Total Insect Parts	**4**	**29**	**7**	**4**	**25**	**13**	**66**	**3**	**4**	**9**	**0**	**0**	**0**
Unknowns	Unknown sp 1							1						
	Unknown sp 2						2							
	Unknown sp 3		1					1						
	Unknown sp 4													
	Unknown sp 5													
	Unknown sp 6		1	2		1		4						
	Unknown sp 7													
	Unknown sp 8													
	Unknown sp 9													
	Total Unknowns	**0**	**2**	**2**	**0**	**1**	**2**	**6**	**0**	**0**	**0**	**0**	**0**	**0**
Reworked Dinocysts	*Alterbitedinium asymmetrica*									3	1			
	Deflandrea spp									1		1		
	Enneadocysta partridgei										1		1	
	Operculum										3			
	Spinidinium macmurdoense									1				
	Spinidinium spp											2		
	Turbiosphaera filosa										2			1
	Vozzhennikovia spp													
	Total Reworked Dinocysts	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**7**	**3**	**1**	**1**
Pollen	Pollen	1	1	2	3	10	14	27	4	63	55	41	17	13
	Total Pollen	**1**	**1**	**2**	**3**	**10**	**14**	**27**	**4**	**63**	**55**	**41**	**17**	**13**
	Total Holocene	**298**	**643**	**197**	**147**	**263**	**193**	**987**	**286**	**30**	**46**	**14**	**0**	**1**
	Total Reworked	**1**	**1**	**2**	**3**	**10**	**14**	**27**	**4**	**68**	**62**	**44**	**18**	**14**
	Total Count	**299**	**644**	**199**	**150**	**273**	**207**	1014	**290**	**98**	**108**	**58**	**18**	**15**
	Dry weight (grams)	**6.78**	**8.03**	**7.6**	**7.36**	**5.28**	**2.42**	**5**	**6.88**	**6.16**	**6.83**	**6.43**	**6.2**	**6.04**
	Total abundance grains per gram	**66.2**	**120.3**	**39.3**	**30.6**	**77.6**	**128.3**	**304.2**	**63.2**	**23.9**	**23.7**	**13.5**	**4.4**	**3.7**

Latitude	-68.5167	-68.3750	-68.3167	-68.1450	-68.1500	-67.6183	-67.6917	-67.1317	-67.1687	-67.2683	-66.5000	-66.4017	-66.3183
Longitude	70.4083	71.3067	71.4650	72.0200	72.1667	73.3000	72.2167	70.7950	74.5033	76.3983	72.2750	72.2850	72.2583
Depth	1050	726	716	608	775	570	660	390	436	338	1230	1625	1830

Lithology	186-15	186-16	186-17	186-18	186-19	186-21	186-22	186-26	186-27	186-28	186-29	186-31	186-32
gravel	15.96	17.27	3.35	0.44	10.48	0	0	12.54	0	15.65	6.85	0	0.9
sand	56.67	46.28	61.87	52.27	23.79	4.29	11.8	64.68	36.36	36.52	40.36	3.08	9.19
silt	7.31	19.33	18.46	15.82	30.45	19.05	29.81	13.45	30.98	20.63	21.08	25.59	28.92
clay	20.06	17.12	16.33	31.47	35.27	76.67	58.39	9.32	32.65	27.21	31.71	71.33	60.99

Sample 901-5

Lithology	gravel	31.73	Bathymetry	320 m
	sand	38.39	Latitude	-67.05916
	silt	16.26	Longitude	69.01633
	clay	13.61		

Palynomorphs	Count	
Unknowns	Unknown sp. 3	1
	Unknown sp. 6	2
	Unknown sp. 8	2
	Unknown sp. 9	1
Acritarchs	Sphaeoromorphs	2
Dinoflagellates	Operculum	1
Egg Cases	Egg cases	2
Pollen	Pollen	4
Prasinophyte algae	Cymatiosphaera sp. 1	1
Red Algae	Beringiella sp.	4
Zooplankton	Tintinnid loricae	5
	Zooplankton spp.	25
Foraminiferan linings		244
Insect parts		21
looked at 901/5 - 901/5-2 - 901/5-2b	Total Count	315

Sample 901-6

Lithology	gravel	6.53	Bathymetry	489 m
	sand	75.26	Latitude	-66.95883
	silt	9.47	Longitude	69.1635
	clay	8.74		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	3
	Unknown sp. 9	1
Acritarchs	Sphaeoromorphs	2
Dinoflagellates	Deflandrea spp.	1
	Operculum	1
Prasinophyte algae	Cymatiosphaera sp. 2	1
Egg Cases	Egg cases	10
Pollen	pollen	5
Red Algae	Beringiella sp.	8
Zooplankton	Tintinnid loricae	4
	Zooplankton spp.	32
Others	Foraminiferan linings	79
	Insect parts	8
	Total Count	155

Sample 901-9

Lithology	gravel	0.79	Bathymetry	1879 m
	sand	11.29	Latitude	-66.336
	silt	20.21	Longitude	71.9765
	clay	67.72		

	Palynomorphs	Count
Acritarchs	Acritarch spp. 1	1
	Sphaeoromorphs	1
Red Algae	Beringiella sp.	1
Pollen	Pollen	16
Prasinophycean Algae	Cymatiosphaera sp. 1	1
	Pterospermella	1
	Total Count	21

Sample 901-10

Lithology	gravel	12.75	Bathymetry	1257 m
	sand	82.51	Latitude	-66.8025
	silt	2	Longitude	70.08266
	clay	2.73		

	Palynomorphs	Count
Pollen	Pollen	5
Foraminiferan linings		1
	Total Count	6

Sample 901-11

Lithology	gravel	5.71	Bathymetry	402 m
	sand	54.09	Latitude	-67.0165
	silt	18.31	Longitude	68.91483
	clay	21.89		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	1
	Unknown sp. 7	3
Dinoflagellates	Operculum	1
Egg Cases	Egg cases	2
Prasinophycean Algae	Pterospermella	3
Pollen	Pollen	57
Red Algae	Beringiella sp	5
Zooplankton	Tintinnid loricae	4
	Zooplankton spp.	33
Foraminiferan linings		120
Insect parts		30
	Total Count	259

Sample 901-13

Lithology	gravel	31.46	Bathymetry	880 m
	sand	63.63	Latitude	-66.81583
	silt	2.45	Longitude	70.392
	clay	2.45		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	1
Egg Cases	Egg cases	2
Pollen	Pollen	2
Acritarch	Sigmopollis	1
Foraminiferan linings		3
Insect parts		1
	Total Count	10

Sample 901-14

Lithology	gravel	20.5	Bathymetry	430 m
	sand	62.23	Latitude	-66.8355
	silt	6.95	Longitude	70.484
	clay	10.31		

Palynomorphs	Count	
Dinoflagellates	Protoperidinium sp. 1	1
Egg Cases	Egg cases	4
Pollen	Pollen	14
Zooplankton	Zooplankton sp.	5
Foraminiferan linings		60
Insect parts		16
	Total Count	100

Sample 901-15

Lithology	gravel	8.4	Bathymetry	480 m
	sand	61.23	Latitude	-67.0083
	silt	15.04	Longitude	71.004
	clay	15.33		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	1
	Unknown sp. 7	1
Pollen	Pollen	78
Egg Cases	Egg Cases	2
Zooplankton	Tintinnid loricae	1
	Zooplankton sp.	15
Foraminiferan linings		35
Insect parts		5
	Total Count	138

Samples 901-18

Lithology	gravel	2.9		Bathymetry	320 m
	sand	46.97		Latitude	-67.28333
	silt	26.91		Longitude	76.57033
	clay	23.22			

Palynomorphs	Count	
Unknowns	Unknown sp. 9	1
Acritarchs	Sphaeoromorphs	1
Dinoflagellates	Spinodinium macmurdoense	1
	Operculum	1
Egg Cases	Egg cases	5
Pollen	Pollen	88
Prasinophycean Algae	Pterospermella	3
	Cymatiosphaera sp. 2	2
Red Algae	Beringiella sp.	12
Zooplankton	Tintinnid loricae	3
	Zooplankton sp.	8
Foraminiferan linings		17
Insect parts		6
	Total Count	148

Sample 901-20

Lithology	gravel	30.46		Bathymetry	318 m
	sand	42.18		Latitude	-67.23583
	silt	13.4		Longitude	76.55516
	clay	13.96			
	Total Count		113		

Palynomorphs	Count	
Acritarchs	Leiospherida sp.	1
Dinoflagellates	Impagidinium sp.	1
Egg Cases	Egg cases	2
Pollen	Pollen	70
Prasinophyte Algae	Cymatiosphaera sp. 2	1
Red Algae	Beringiella sp.	4
Zooplankton	Tintinnid loricae	4
	Zooplankton sp.	20
Foraminiferan linings		9
Insect parts		1
	Total Count	113

Sample 901-22

Lithology	gravel	0	Bathymetry	766 m
	sand	7.39	Latitude	-68.065
	silt	23.15	Longitude	72.276
	clay	69.46		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	2
Acritarchs	Leiospherida spp.	2
	Sphaeoromorphs	4
Dinoflagellates	Dinocyst sp.	1
Egg Cases	Egg cases	16
Pollen	Pollen	16
Prasinophycean Algae	Cymatiosphaera sp. 2	14
Red Algae	Beringiella sp.	26
Zooplankton	Tintinnid loricae	9
	Zooplankton spp.	326
	Tintinnid cyst	3
Foraminiferan linings		72
Insect parts		51
	Total Count	542

Sample 901-23

Lithology	gravel	0		Bathymetry	661 m
	sand	7.96		Latitude	-68.08183
	silt	25.66		Longitude	72.984
	clay	66.37			
	Total Count		856		

Palynomorphs	Count	
Unknowns	Unknown sp. 3	2
	Unknown sp. 6	2
Acritarchs	Leiospherida sp.	5
	Acritarch sp. 4	1
	Sphaeoromorphs	59
Dinoflagellates	Selenopemphix antarctica	7
	Cryodinium sp.	2
	Protoperidinium sp. 2	6
Egg Cases	Egg cases	54
Pollen	Pollen	2
Prasinophycean Algae	Cymatiosphaera sp. 2	17
	Pterospermella	3
Red Algae	Beringiella sp.	28
Zooplankton	Tintinnid loricae	31
	Tintinnid cyst	3
	Zooplankton spp.	300
Foraminiferan linings		251
Insect parts		83
	Total Count	856

Sample 901-24

Lithology	gravel	n/a	Bathymetry	705 m
	sand	n/a	Longitude	73.18933
	silt	n/a		
	clay	n/a		

Palynomorphs	**Count**	
Unknowns	Unknown sp. 2	1
	Unknown sp. 3	1
	Unknown sp. 4	3
Acritarchs	Acritarch sp. 4	2
	Leiospherida sp.	6
	Sphaeoromorphs	17
Dinoflagellates	Selenopemphix antarctica	21
	Alisocysta sp.	1
Prasinophyte algae	Cymatiosphaera sp. 2	1
Egg Cases	Egg cases	11
Red Algae	Beringiella sp.	6
Zooplankton	Tintinnid loricae	11
	Tintinnid cyst	3
	Zooplankton spp.	85
Foraminiferan linings		44
Insect parts		15
	Total Count	228

Sample 901-25

Lithology	gravel n/a	Bathymetry	676 m
	sand n/a	Latitude	-68.4365
	silt n/a	Longitude	74.3078
	clay n/a		

	Palynomorphs	**Count**
Unknowns	Unknown sp. 3	3
Acritarchs	Acritarch sp. 4	3
	Sphaeoromorphs	6
Dinoflagellates	Protoperidinium sp. 2	1
	Selenopemphix antarctica	16
	Deflandrea spp.	1
Prasinophyte algae	Cymatiosphaera sp. 2	63
Egg Cases	Egg cases	51
Pollen	Pollen	6
Red Algae	Beringiella sp.	26
Zooplankton	Tintinnid loricae	14
	Tintinnid cyst	3
	Zooplankton spp.	156
Foraminiferan linings		84
Insect parts		40
	Total Count	473

Sample 901-26

Lithology	gravel n/a	Bathymetry	676 m
	sand n/a	Latitude	-68.6238
	silt n/a	Longitude	74.56416
	clay n/a		

	Palynomorphs	**Count**
Unknowns	Unknown sp. 2	1
Acritarchs	Acritarch sp. 2	2
	Sphaeoromorphs	34
	Leiospherida sp.	1
Dinoflagellates	Selenopemphix antarctica	2
Egg Cases	Egg cases	23
Pollen	Pollen	8
Prasinophyte algae	Cymatiosphaera sp. 2	28
Red Algae	Beringiella sp.	52
Zooplankton	Tintinnid loricae	24
	Tintinnid cyst	12
	Zooplankton sp.	140
Foraminiferan linings		135
Insect parts		42
	Total Count	504

Sample 901-27

Lithology	gravel	1.75	Bathymetry	776 m
	sand	10.53	Latitude	-68.9465
	silt	28.51	Longitude	73.58566
	clay	59.21		

Palynomorphs	Count	
Unknowns	Unknown sp. 1	1
	Unknown sp. 6	4
Acritarchs	Sphaeoromorphs	15
Dinoflagellates	Turbiosphaera filosa	1
Prasinophyte algae	Cymatiosphaera sp. 2	40
Egg Cases	Egg cases	8
Pollen	Pollen	12
Red Algae	Beringiella sp.	15
Zooplankton	Tintinnid loricae	3
	Tintinnid cyst	6
	Zooplankton sp.	89
Foraminiferan linings		75
Insect parts		28
	Total Count	297

Sample 901-28

Lithology	gravel	0	Bathymetry	710 m
	sand	64.44	Latitude	-68.91533
	silt	18.13	Longitude	76.58933
	clay	17.43		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	2
	Unknown sp. 7	2
	Unknown sp. 8	1
	Unknown sp. 9	1
Acritarchs	Sphaeoromorphs	1
Dinoflagellates	Protoperidinium sp. 2	1
Prasinophyte algae	Cymatiosphaera sp. 2	8
Egg Cases	Egg cases	11
Pollen	Pollen	1
Red Algae	Beringiella sp.	28
Zooplankton	Tintinnid loricae	2
	Zooplankton sp.	92
Foraminiferan linings		178
Insect parts		23
	Total Count	351

Sample 901-31

Lithology			Bathymetry	806 m
	gravel	0	Bathymetry	806 m
	sand	17.88	Latitude	-68.68183
	silt	38.41	Longitude	76.8765
	clay	43.71		

Palynomorphs	Count	
Unknowns	Unknown sp. 4	2
	Unknown sp. 6	10
	Unknown sp. 7	1
Acritarchs	Sphaeoromorphs	4
Egg Cases	Egg cases	6
Pollen	Pollen	17
Red Algae	Beringiella sp.	22
Zooplankton	Tintinnid loricae	6
	Tintinnid cyst	3
	Zooplankton sp.	173
Foraminiferan linings		155
Insect parts		34
	Total Count	433

Sample 901-33

Lithology				
	gravel	0	Bathymetry	376
	sand	62.15	Latitude	-67.18133
	silt	27.57	Longitude	68.53833
	clay	10.28		

Palynomorphs	Count	
Unknowns	Unknown sp. 1	2
	Unknown sp. 3	2
	Unknown sp. 6	2
	Unknown sp. 4	1
	Unknown sp. 7	1
Acritarchs	Leiospherida sp.	1
	Sphaeoromorphs	37
Dinoflagellates	Protoperidinium sp. 2	3
Egg Cases	Egg cases	29
Pollen	Pollen	2
Prasinophycean Algae	Pterospermella	1
	Cymatiosphaera sp. 2	2
Red Algae	Beringiella sp.	4
Zooplankton	Tintinnid loricae	3
	Zooplankton sp.	232
Foraminiferan linings		344
Insect parts		18
	Total Count	684

Sample 901-34 Kergulen Plateau not Prydz Bay error

Lithology	gravel	0	Bathymetry	1676
	sand	15.95		
	silt	72.39		

Palynomorphs	Count		
Unknowns	Unknown sp. 5		2
Pollen	Pollen	2	
Red Algae	Beringiella sp.	6	
Zooplankton	Tintinnid loricae	1	
Insect parts		9	
	Total Count	20	

Sample 149-6

Lithology	gravel	2.77	Bathymetry	805 m
	sand	55.86	Latitude	-66.931667
	silt	19.97	Longitude	64.938333
	clay	21.4		

Palynomorphs	Count	
Pollen	Pollen	382
Prasinophycean Algae	Cymatiosphaera sp. 1	3
	Pterospermella	1
Zooplankton	Tintinnid loricae	1
	Zooplankton sp.	2
	Total Count	389

Sample 149-14

Lithology	gravel	3.5	Bathymetry	849 m
	sand	57.97	Latitude	-66.64
	silt	14.58	Longitude	71.7333333
	clay	23.96		

Palynomorphs	Count	
Pollen	Pollen	54
	Total Count	54

Sample 149-15

Lithology	gravel	6.71	Bathymetry	2250 m
	sand	39.76	Latitude	-66.253333
	silt	17.15	Longitude	73.34
	clay	36.38		

Palynomorphs	Count	
Dinoflagellates	Turbiosphaera filosa	2
Pollen	Pollen	31
	Total Count	33

Sample 149-16

Lithology	gravel	0.5	Bathymetry	1960 m
	sand	7.25	Latitude	-66.385
	silt	45.25	Longitude	73.185
	clay	47		

Palynomorphs	Count	
Pollen	Pollen	4
Insect parts		1
	Total Count	5

Sample 149-17

Lithology	gravel	0.67	Bathymetry	1540 m
	sand	10.72	Latitude	-66.503333
	silt	26.01	Longitude	73.091667
	clay	62.6		

Palynomorphs	Count	
Pollen	Pollen	86
	Total Count	86

Sample 149-18

Lithology	gravel	12.61	Bathymetry	1174
	sand	37.31	Latitude	-66.6
	silt	17.69	Longitude	73.008333
	clay	32.39		

Palynomorphs	Count	
Acritarchs	Acritarch sp. 1	1
Dinoflagellates	Operculum	1
Pollen	Pollen	29
	Total Count	31

Sample 149-19

Lithology	gravel	10.3	Bathymetry	765
	sand	71.57	Latitude	-66.686667
	silt	9.42	Longitude	72.925
	clay	8.71		

Palynomorphs	Count	
Pollen	Pollen	31
Dinoflagellates	Alterbidinium asymmetrica	1
	Operculum	3
	Vozzhennikovia sp.	1
Acritarch	Sigmopollis	1
	Total Count	37

Sample 149-21

Lithology	gravel	2.86	Bathymetry	1060
	sand	57.92	Latitude	-66.618333
	silt	17.05	Longitude	72.293333
	clay	22.16		

Total Count 211

Palynomorphs	Count	
Pollen	Pollen	208
Zooplankton	Zooplankton sp.	2
Foraminiferan linings		1
	Total Count	211

Sample 149-22

Lithology	gravel	0.53	Bathymetry	1450 m
	sand	46.34	Latitude	-66.456667
	silt	23.32	Longitude	72.29667
	clay	29.82		

Palynomorphs	Count	
Pollen	Pollen	33
	Total Count	33

Sample 149-23

Lithology	gravel	2.34	Bathymetry	1884 m
	sand	30.43	Latitude	-66.32
	silt	20.48	Longitude	72.293333
	clay	46.74		

Palynomorphs	Count	
Pollen	Pollen	24
	Total Count	24

Sample 149-24

Lithology	gravel	0	Bathymetry	2535 m
	sand	4.58	Latitude	-66.011667
	silt	17.81	Longitude	71.535
	clay	77.61		

Palynomorphs	Count	
Pollen	Pollen	3
	Total Count	3

Sample 149-25

Lithology	gravel	0	Bathymetry	2010 m
	sand	10.22	Latitude	-66.3
	silt	29.28	Longitude	71.601666
	clay	60.5		

Palynomorphs	Count	
	Total Count	0

Sample 149-27

Lithology	gravel	1.79	Bathymetry	1200 m
	sand	60.18	Latitude	-66.568333
	silt	14.77	Longitude	71.713333
	clay	23.27		

Total Count 399

Palynomorphs	Count	
Dinoflagellates	Alterbidinium asymmetrica	1
Pollen	Pollen	397
Acritarach	Leiospherida sp.	1
	Total Count	399

Sample 149-28

Lithology	gravel	15.98	Bathymetry	527 m
	Sand	54.43	Latitude	-66.728333
	silt	13.2	Longitude	71.775
	clay	16.39		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	1
Acritarchs	Sphaeoromorphs	2
Dinoflagellates	Operculum	1
	Hystrichosphaeridium spp.	3
	Spinodinium spp.	1
	Vozzhennikovia spp.	3
Egg Cases	Egg cases	1
Pollen	Pollen	107
Red Algae	Beringiella sp.	1
Zooplankton	Tintinnid loricae	1
	Zooplankton sp.	8
Foraminiferan linings		8
Insect parts		3
	Total Count	140

Sample 149-30

Lithology	gravel	5.57	Bathymetry	515 m
	sand	62.46	Latitude	-66.783333
	silt	17.01	Longitude	71.791667
	clay	14.96		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	2
	Unknown sp. 7	1
Dinoflagellates	Alterbidinium asymmetrica	1
	Operculum	2
	Vozzhennikovia spp	1
Egg Cases	Egg cases	2
Prasinophyte algae	Cymatiosphaera sp. 2	1
Acritarchs	Sphaeoromorphs	2
Pollen	Pollen	40
Zooplankton	Tintinnid loricae	3
	Zooplankton sp.	9
Foraminiferan linings		19
Insect parts		15
	Total Count	98

Sample 149-31

Lithology	gravel	0.8	Bathymetry	512 m
	sand	61.23	Latitude	-66.838333
	silt	15.51	Longitude	71.816667
	clay	22.46		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	1
Egg Cases	Egg cases	1
Pollen	Pollen	10
Prasinophycean Algae	Pterospermella	1
	Tasmanites	1
Red Algae	Beringiella sp.	7
Zooplankton	Tintinnid loricae	1
	Zooplankton sp.	20
Foraminiferan linings		19
Insect parts		3
	Total Count	64

Sample 149-32

Lithology	gravel	3	Bathymetry	502 m
	sand	57.92	Latitude	-66.926667
	silt	19.69	Longitude	71.846667
	clay	19.4		

Palynomorphs	Count	
Acritarchs	Sphaeoromorphs	4
Dinoflagellates	Turbiosphaera filosa	1
	Enneadocysta partridgei	1
	Operculum	1
	Hystrichosphaeridium sp.	1
	Vozzhennikovia sp.	4
Egg Cases	Egg cases	3
Pollen	Pollen	96
Prasinophycean Algae	Cymatiosphaera sp. 1	1
Red Algae	Beringiella sp.	4
Zooplankton	Tintinnid loricae	3
	Zooplankton sp.	34
Foraminiferan linings		29
Insect parts		13
	Total Count	195

Sample 149-33

Lithology	gravel	9.64	Bathymetry	834 m
	sand	25.12	Latitude	-66.715
	silt	31.2	Longitude	71.365
	clay	34.04		

Palynomorphs	Count	
Pollen	Pollen	183
Acritarch	Sigmopollis	1
	Total Count	184

Sample 149-34

Lithology	gravel	8.47	Bathymetry	1215 m
	sand	81.8	Latitude	-66.665
	silt	5.99	Longitude	71.206667
	clay	3.74		

Palynomorphs	Count	
Pollen	Pollen	45
	Total Count	45

Sample 149-35

Lithology	gravel	0.54	Bathymetry	1566 m
	sand	49.82	Latitude	-66.586666
	silt	29.86	Longitude	71.01
	clay	19.78		

Palynomorphs	Count	
Dinoflagellates	Deflandrea sp.	1
	Alterbidinium asymmetrica	1
	Vozzhennikovia sp.	1
Pollen	Pollen	49
Red Algae	Beringiella sp.	3
	Total Count	55

Sample 149-36

Lithology	gravel	1.44	Bathymetry	2105 m
	sand	12.61	Latitude	-66.45
	silt	7.39	Longitude	70.575
	clay	78.56		

Palynomorphs	Count	
Dinoflagellates	Operculum	3
	Spinodinium macmurdoense	1
Pollen	Pollen	15
Zooplankton	Zooplankton sp.	1
	Total Count	20

Sample 149-37

Lithology	gravel 1.4		Bathymetry	168 m
	sand 89.94		Latitude	-67.08
	silt 5.87		Longitude	66.701667
	clay 2.79			
	Total Count	213		

Palynomorphs	Count	
Unknowns	Unknown sp. 1	1
Prasinophyte algae	Cymatiosphaera sp. 2	6
Egg Cases	Egg cases	10
Pollen	Pollen	2
Red Algae	Beringiella sp.	20
Zooplankton	Tintinnid loricae	4
	Zooplankton sp.	39
Foraminiferan linings		124
Insect parts		7
	Total Count	213

Sample 186-9

Lithology	gravel 1.43	Bathymetry	698 m
	sand 42.75	Latitude	-68.066667
	silt 13.34	Longitude	72.9
	clay 42.47		

Palynomorphs	Count	
Unknowns	Unknown sp. 5	2
Acritarchs	Acritarch sp. 4	1
	Sphaeoromorphs	6
Prasinophyte algae	Cymatiosphaera sp. 2	14
Egg Cases	Egg cases	9
Pollen	Pollen	18
Red Algae	Beringiella sp.	15
Zooplankton	Tintinnid loricae	11
	Zooplankton sp.	82
Foraminiferan linings		56
Insect parts		21
	Total Count	235

Sample 186-11

Lithology	gravel	11.51	Bathymetry	655 m
	sand	47.9	Latitude	-68.07
	silt	8.71	Longitude	72.93
	clay	31.88		

Palynomorphs	Count	
Unknowns	Unknown sp. 1	1
	Unknown sp. 9	1
Acritarchs	Sphaeoromorphs	6
Egg Cases	Egg cases	9
Pollen	Pollen	69
Prasinophycean Algae	Pterospermella	1
Red Algae	Beringiella sp.	15
Zooplankton	Tintinnid loricae	3
	Tintinnid cyst	1
	Zooplankton sp.	58
Foraminiferan linings		50
Insect parts		6
	Total Count	220

Sample 186-13

Lithology	gravel	n/a	Bathymetry	678 m
	sand	n/a	Latitude	-68.198333
	silt	n/a	Longitude	73.295
	clay	n/a		

Palynomorphs	Count	
Unknowns	Unknown sp. 2	3
	Unknown sp. 3	1
Acritarchs	Acritarch spp. 4	1
	Leiospherida sp.	8
	Sphaeoromorphs	31
Dinoflagellates	Protoperidinium sp. 2	1
	Cryodinium sp.	4
	Selenopemphix antarctica	15
Egg Cases	Egg cases	17
Pollen	Pollen	2
Prasinophycean Algae	Cymatiosphaera sp. 2	38
	Tasmanites	1
Red Algae	Beringiella sp.	11
Zooplankton	Tintinnid loricae	11
	Tintinnid cyst	6
	Zooplankton sp.	176
Foraminiferan linings		47
Insect parts		6
	Total Count	399

Sample 186-14

Lithology	gravel	8.61	Bathymetry	690 m
	sand	19.21	Latitude	-68.22
	silt	17.88	Longitude	73.383333
	clay	54.3		

	Palynomorphs	**Count**
Unknowns	Unknown sp. 3	1
	Unknown sp. 6	2
Acritarchs	Sphaeoromorphs	5
Dinoflagellates	Protoperidinium sp. 2	1
Egg Cases	Egg cases	14
Pollen	Pollen	1
Prasinophycean Algae	Cymatiosphaera sp. 2	7
Pterospermella		2
Red Algae	Beringiella sp.	26
Zooplankton	Tintinnid loricae	16
	Tintinnid cyst	1
	Zooplankton sp.	248
Foraminiferan linings		196
Insect parts		28
	Total Count	548

Sample 186-15

Lithology	gravel	15.96	Bathymetry	1050 m
	sand	56.67	Latitude	-68.516667
	silt	7.31	Longitude	70.408333
	clay	20.06		

	Palynomorphs	**Count**
Acritarchs	Sphaeoromorphs	4
Prasinophyte Algae	Cymatiosphaera sp. 2	74
Egg Cases	Egg cases	13
Pollen	Pollen	1
Red Algae	Beringiella sp.	9
Zooplankton	Tintinnid loricae	5
	Tintinnid cyst	1
	Zooplankton spp.	106
Foraminiferan linings		82
Insect parts		4
	Total Count	299

Sample 186-16

Lithology	gravel	17.27	Bathymetry	726 m
	sand	46.28	Latitude	-68.375
	silt	19.33	Longitude	71.306667
	clay	17.12		

Palynomorphs	Count	
Unknowns	Unknown sp. 3	1
	Unknown sp. 6	1
Acritarchs	Sphaeoromorphs	7
Prasinophyte algae	Cymatiosphaera sp. 2	2
Egg Cases	Egg cases	18
Pollen	Pollen	1
Red Algae	Beringiella sp.	18
Zooplankton	Tintinnid loricae	10
	Tintinnid cyst	1
	Zooplankton spp.	302
Foraminiferan linings		254
Insect parts		29
	Total Count	644

Sample 186-17

Lithology	gravel	3.35	Bathymetry	716 m
	sand	61.87	Latitude	-68.316667
	silt	18.46	Longitude	71.465
	clay	16.33		
	Total Count	199		

Palynomorphs	Count	
Unknowns	Unknown sp. 6	2
Acritarchs	Sphaeoromorphs	7
Prasinophyte algae	Cymatiosphaera sp. 2	3
Egg Cases	Egg cases	16
Pollen	Pollen	2
Dinoflagellates	Selenopemphix antarctica	1
Red Algae	Beringiella sp.	9
Zooplankton	Tintinnid loricae	12
	Tintinnid cyst	2
	Zooplankton spp.	114
Foraminiferan linings		24
Insect parts		7
	Total Count	199

Sample 186-18

Lithology	gravel	0.44	Bathymetry	608 m
	sand	52.27	Latitude	-68.145
	silt	15.82	Longitude	72.02
	clay	31.47		

	Palynomorphs	**Count**
Acritarchs	Acritarch spp. 4	1
Prasinophyte algae	Cymatiosphaera sp. 2	11
Egg Cases	Egg cases	3
Pollen	Pollen	3
Red Algae	Beringiella sp.	3
Zooplankton	Zooplankton sp.	65
Foraminiferan linings		60
Insect parts		4
	Total Count	150

Sample 186-19

Lithology	gravel	10.48	Bathymetry	775m
	sand	23.79	Latitude	-68.15
	silt	30.45	Longitude	72.166667
	clay	35.27		

Palynomorphs	**Count**	
Unknowns	Unknown sp. 6	1
Prasinophyte algae	Cymatiosphaera spp. 2	8
Egg Cases	Egg cases	7
Pollen	Pollen	10
Red Algae	Beringiella sp.	11
Zooplankton	Tintinnid loricae	3
	Zooplankton spp.	130
Foraminiferan linings		78
Insect parts		25
	Total Count	273

Sample 186-21

Lithology			Bathymetry	570m
	gravel	0	Latitude	-67.618333
	sand	4.29	Longitude	73.3
	silt	19.05		
	clay	76.67		

	Palynomorphs	Count
Unknowns	Unknown sp. 2	2
Acritarchs	Sphaeoromorphs	12
Prasinophyte algae	Cymatiosphaera sp. 2	45
Egg Cases	Egg cases	11
Pollen	Pollen	14
Red Algae	Beringiella sp.	9
Zooplankton	Tintinnid loricae	8
	Tintinnid cyst	1
	Zooplankton sp.	53
Foraminiferan linings		39
Insect parts		13
	Total Count	207

Sample 186-22

Lithology			Bathymetry	660m
	gravel	0	Latitude	-67.691667
	sand	11.8	Longitude	72.216667
	silt	29.81		
	clay	58.39		

	Palynomorphs	Count
Unknowns	Unknown sp. 1	1
	Unknown sp. 3	1
	Unknown sp. 6	4
Acritarchs	Acritarch sp. 3	3
	Sphaeoromorphs	14
Prasinophyte algae	Cymatiosphaera sp. 2	8
Dinoflagellates	Selenopemphix antarctica	48
	Cryodinium sp.	5
	Protoperidinium sp. 2	24
Egg Cases	Egg cases	48
Pollen	Pollen	27
Red Algae	Beringiella sp.	91
Zooplankton	Tintinnid loricae	8
	Zooplankton spp.	370
Foraminiferan linings		296
Insect parts		66
	Total Count	1014

Sample 186-26

Lithology	gravel	12.54	Bathymetry	390 m
	sand	64.68	Latitude	-67.131666
	silt	13.45	Longitude	70.795
	clay	9.32		

Palynomorphs	Count	
Acritarchs	Sphaeoromorphs	1
Prasinophyte algae	Cymatiosphaera sp. 2	1
Egg Cases	Egg cases	10
Pollen	Pollen	4
Red Algae	Beringiella sp.	6
Zooplankton	Tintinnid loricae	9
	Zooplankton sp.	141
Foraminiferan linings		115
Insect parts		3
	Total Count	290

Sample 186-27

Lithology	gravel	0	Bathymetry	436 m
	sand	36.36	Latitude	-67.168667
	silt	30.98	Longitude	74.503333
	clay	32.65		

Palynomorphs	Count	
Acritarchs	Sphaeoromorphs	1
Dinoflagellates	Alterbidinium asymmetrica	3
	Alisocysta sp.	1
	Deflandrea sp.	1
	Spinodinium macmurdoense	1
Egg Cases	Egg cases	1
Pollen	Pollen	63
Red Algae	Beringiella sp.	3
Zooplankton	Zooplankton sp.	9
Foraminiferan linings		11
Insect parts		4
	Total Count	98

Sample 186-28

Lithology	gravel	15.65	Bathymetry	338 m
	sand	36.52	Latitude	-67.268333
	silt	20.63	Longitude	76.398333
	clay	27.21		

Palynomorphs		**Count**
Prasinophyte algae	Cymatiosphaera sp. 2	1
Dinoflagellates	Operculum	3
	Turbiosphaera filosa	2
	Alterbidinium asymmetrica	1
	Enneadocysta partridgei	1
Egg Cases	Egg cases	1
Pollen	Pollen	55
Red Algae	Beringiella sp.	6
Zooplankton	Zooplankton sp.	25
Foraminiferan linings		4
Insect parts		9
	Total Count	108

Sample 186-29

Lithology	gravel	6.85	Bathymetry	1230 m
	sand	40.36	Latitude	-66.5
	silt	21.08	Longitude	72.275
	clay	31.71		

Palynomorphs		**Count**
Acritarchs	Acritarch spp. 1	3
Dinoflagellates	Spinodinium spp.	2
	Deflandrea spp.	1
Egg Cases	Egg cases	1
Pollen	Pollen	41
Red Algae	Beringiella sp.	2
Foraminiferan linings		8
	Total Count	58

Sample 186-31

Lithology	gravel	0	Bathymetry	1625 m
	sand	3.08	Latitude	-66.401667
	silt	25.59	Longitude	72.285
	clay	71.33		

Palynomorphs		Count
Dinoflagellates	Enneadocysta partridgei	1
Pollen	Pollen	17
	Total Count	18

Sample 186-32

Lithology	gravel	0.9	Bathymetry	565 m
	sand	9.19	Latitude	-66.318333
	silt	28.92	Longitude	72.258333
	clay	60.99		

Palynomorphs		Count
Pollen	Pollen	13
Dinoflagellates	Alisocysta sp	1
	Turbiosphaera filosa	1
	Total Count	15

PALYNOMORPH DISTRIBUTION TABLES 3.2a

Raw Count

Total Holocene	Fan	N shelf	M shelf	Coastal	Total
Acritarchs	10	54	230	38	332
Holocene Dinocysts	1	10	155	2	168
Prasinophycean Algae	2	30	261	127	420
Red Algae	6	84	319	101	510
Egg Cases	3	85	273	72	433
Zooplankton	3	703	2,371	927	4,004
Foraminifera Linings	13	1,237	1,408	768	3,426
Insect Parts	2	162	420	125	709
Unknowns	1	31	35	28	95
Total Holocene	41	2,396	5,472	2,188	10,097
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.41	30.94	128.31	91.55	41.46

Raw Count

Total Reworked	Fan	N shelf	M shelf	Coastal	Total
Reworked Dinocysts	21	34	1	1	57
Pollen	1,286	1,077	176	34	2,573
Total Reworked	1,307	1,111	177	35	2,630
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	13.13	14.35	4.15	1.46	10.80

Raw Count

Marine Palynomorphs	Fan	N shelf	Mid shelf	Coastal	Total
Acritarchs	10	54	230	38	332
Holocene Dinocysts	1	10	155	2	168
Prasinophycean Algae	2	30	261	127	420
Red Algae	6	84	319	101	510
Total	19	178	965	268	1,430
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.19	2.30	22.63	11.21	5.87

Raw Count

Holocene Dinocysts	Fan	N shelf	Mid shelf	Coastal	Totals
Alisocysta sp	1	1	1	0	3
Cryodinium sp	0	0	11	0	11
Dinocyst spp	0	0	1	0	1
Hystrichosphaeridium spp	0	4	0	0	4
Impagidinium sp	0	1	0	0	1
Protoperidinium sp 1	0	1	0	0	1
Protoperidinium sp 2	0	3	33	1	37
Selenopemphix antarctica	0	0	109	1	110
Total	1	10	155	2	168
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.01	0.13	3.63	0.08	0.69

Raw Count

Reworked Dinocysts	Fan	N shelf	Mid shelf	Coastal	Totals
Alterbitedinium asymmetrica	3	5	0	0	8
Deflandrea spp	2	2	1	0	5
Enneadocysta partridgei	1	2	0	0	3
Operculum	7	11	0	0	18
Spinidinium macmurdoense	1	2	0	0	3
Spinidinium spp	2	1	0	0	3
Turbiosphaera filosa	3	3	0	1	7
Vozzhennikovia spp	2	8	0	0	10
Total	21	34	1	1	57
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.21	0.44	0.02	0.04	0.23

Raw Count Continued

Acritarchs	Fan	N shelf	Mid shelf	Coastal	Totals
Acritarch spp 1	5	0	0	0	5
Acritarch spp 2	0	0	2	0	2
Acritarch spp 3	0	0	3	0	3
Acritarch spp 4	0	0	9	0	9
Leiospherida sp	1	2	22	0	25
Leiospherida sigmopolis	3	0	0	0	3
Sphaeoromorphs	1	52	194	38	285
Total	10	54	230	38	332
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.10	0.70	5.39	1.59	1.36

Raw Count

Prasinophycean Algae	Fan	N shelf	Mid shelf	Coastal	Totals
Cymatiosphaera spp 1	1	5	0	0	6
Cymatiosphaera spp 2	0	15	254	127	396
Pterospermella	1	9	6	0	16
Tasmanites	0	1	1	0	2
Total	2	30	261	127	420
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.02	0.39	6.12	5.31	1.72

Raw Count

Red Algae	Fan	N shelf	Mid shelf	Coastal	Totals
Beringiella sp	6	84	319	101	510
Total	6	84	319	101	510
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.06	1.08	7.48	4.23	2.09

Raw Count

Zooplankton	Fan	N shelf	Mid shelf	Coastal	Totals
Tintinnid cyst	0	0	33	13	46
Tintinnid loricae	0	46	149	38	233
Zooplankton spp	3	657	2,189	876	3,725
Total	3	703	2,371	927	4,004
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.03	9.08	55.60	38.79	16.44

Raw Count

Insect parts	Fan	N shelf	Mid shelf	Coastal	Totals
Insect parts	2	162	420	125	709
Total	2	162	420	125	709
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.02	2.09	9.85	5.23	2.91

Raw Count

Foraminifera linings	Fan	N shelf	Mid shelf	Coastal	Totals
Foraminifera linings	13	1,237	1,408	768	3,426
Total	13	1,237	1,408	768	3,426
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.13	15.97	33.02	32.13	14.07

Raw Count

Egg cases	Fan	N shelf	Mid shelf	Coastal	Totals
Egg cases	3	85	273	72	433
Total	3	85	273	72	433
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.03	1.10	6.40	3.01	1.78

Raw Count Continued

Unknowns	Fan	N shelf	Mid shelf	Coastal	Totals
Unknown sp 1	0	3	2	1	6
Unknown sp 2	0	0	7	0	7
Unknown sp 3	0	3	9	1	13
Unknown sp 4	0	1	3	2	6
Unknown sp 5	0	0	2	0	2
Unknown sp 6	1	13	11	19	44
Unknown sp 7	0	6	0	3	9
Unknown sp 8	0	2	0	1	3
Unknown sp 9	0	3	1	1	5
Total	1	31	35	28	95
Dry Weight	149.34	116.17	63.97	35.85	365.33
Grains per Gram	0.01	0.40	0.82	1.17	0.39

Raw Count

Total Holocene N Shelf	NE shelf	N shelf	NW shelf	Total
Acritarchs	2	10	42	54
Holocene Dinocysts	1	5	4	10
Prasinophycean Algae	7	5	18	30
Red Algae	22	21	41	84
Egg Cases	8	20	57	85
Zooplankton	60	254	389	703
Foraminifera Linings	30	236	971	1,237
Insect Parts	16	46	100	162
Unknowns	1	7	23	31
Total	147	604	1,645	2,396
Dry Weight	20.26	47.07	48.84	116.17
Grains per Gram	10.88	19.25	50.52	30.94

Raw Count

Dinocysts N Shelf	NE shelf	N shelf	NW shelf	Total
Alisocysta sp	0	1	0	1
Cryodinium sp	0	0	0	0
Dinocyst spp	0	0	0	0
Hystrichosphaeridium spp	0	4	0	4
Impagidinium sp	1	0	0	1
Protoperidinium sp 1	0	0	1	1
Protoperidinium sp 2	0	0	3	3
Selenopemphix antarctica	0	0	0	0
Alterbitedinium asymmetrica	1	4	0	5
Deflandrea spp	0	1	1	2
Enneadocysta partridgei	1	1	0	2
Operculum	4	4	3	11
Spinidinium macmurdoense	1	1	0	2
Spinidinium spp	0	1	0	1
Turbiosphaera filosa	2	1	0	3
Vozzhennikovia spp	0	8	0	8
Total	10	26	8	44
Dry Weight	20.26	47.07	48.84	116.17
Grains per Gram	0.74	0.83	0.25	0.57

Raw Count

Dinocysts	Fan	N shelf	Mid shelf	Coastal	Total
Holocene	1	10	155	2	168
Reworked	21	34	1	1	57
Total	22	44	156	3	225
Dry Weight	149.34	116.17	63.97	35.85	365.33
	0.22	0.57	3.66	0.13	0.92

PALYNOMORPH DISTRIBUTION TABLES 3.2b

Percentages

Total Holocene	Fan	N shelf	Mid shelf	Coastal	Total
Acritarchs	24.39%	2.25%	4.20%	1.74%	3.29%
Holocene Dinocysts	2.44%	0.42%	2.83%	0.09%	1.66%
Prasinophycean Algae	4.88%	1.25%	4.77%	5.80%	4.16%
Red Algae	14.63%	3.51%	5.83%	4.62%	5.05%
Egg Cases	7.32%	3.55%	4.99%	3.29%	4.29%
Zooplankton	7.32%	29.34%	43.33%	42.37%	39.66%
Foraminifera Linings	31.71%	51.63%	25.73%	35.10%	33.93%
Insect Parts	4.88%	6.76%	7.68%	5.71%	7.02%
Unknowns	2.44%	1.29%	0.64%	1.28%	0.94%

Percentages

Total Reworked	Fan	N shelf	M shelf	Coastal	Total
Reworked Dinocysts	1.61%	3.06%	0.56%	2.86%	2.17%
Pollen	98.39%	96.94%	99.44%	97.14%	97.83%

Percentages

Marine Palynomorphs	Fan	N shelf	Mid shelf	Coastal	Total
Acritarchs	52.63%	30.34%	23.83%	14.18%	23.22%
Holocene Dinocysts	5.26%	5.62%	16.06%	0.75%	11.75%
Prasinophycean Algae	10.53%	16.85%	27.05%	47.39%	29.37%
Red Algae	31.58%	47.19%	33.06%	37.69%	35.66%

Percentages

Holocene Dinocysts	Fan	N shelf	Mid shelf	Coastal	Total
Alisocysta sp	0.00%	10.00%	0.65%	0.00%	1.79%
Cryodinium sp	0.00%	0.00%	7.10%	0.00%	6.55%
Dinocyst spp	0.00%	0.00%	0.65%	0.00%	0.60%
Hystrichosphaeridium spp	0.00%	40.00%	0.00%	0.00%	2.38%
Impagidinium sp	0.00%	10.00%	0.00%	0.00%	0.60%
Protoperidinium sp 1	0.00%	10.00%	0.00%	0.00%	0.60%
Protoperidinium sp 2	0.00%	30.00%	21.29%	50.00%	22.02%
Selenopemphix antarctica	0.00%	0.00%	70.32%	50.00%	65.48%

Percentages

Reworked Dinocysts	Fan	N shelf	Mid shelf	Coastal	Totals
Alterbitedinium asymmetrica	14.29%	14.71%	0.00%	0.00%	14.04%
Deflandrea spp	9.52%	5.88%	100.00%	0.00%	8.77%
Enneadocysta partridgei	4.76%	5.88%	0.00%	0.00%	5.26%
Operculum	33.33%	32.35%	0.00%	0.00%	31.58%
Spinidinium macmurdoense	4.76%	5.88%	0.00%	0.00%	5.26%
Spinidinium spp	9.52%	2.94%	0.00%	0.00%	5.26%
Turbiosphaera filosa	14.29%	8.82%	0.00%	100.00%	12.28%
Vozzhennikovia spp	9.52%	23.53%	0.00%	0.00%	17.54%

Percentages Continued

Acritarchs	Fan	N shelf	Mid shelf	Coastal	Totals
Acritarch spp 1	50.00%	0.00%	0.00%	0.00%	1.51%
Acritarch spp 2	0.00%	0.00%	0.87%	0.00%	0.60%
Acritarch spp 3	0.00%	0.00%	1.30%	0.00%	0.90%
Acritarch spp 4	0.00%	0.00%	3.91%	0.00%	2.71%
Leiospherida sp	10.00%	3.70%	9.57%	0.00%	7.53%
Leiospherida sigmopolis	30.00%	0.00%	0.00%	0.00%	0.90%
Sphaeoromorphs	10.00%	96.30%	84.35%	100.00%	85.84%

Percentages

Prasinophycean Algae	Fan	N shelf	Mid shelf	Coastal	Totals
Cymatiosphaera spp 1	50.00%	16.67%	0.00%	0.00%	1.43%
Cymatiosphaera spp 2	0.00%	50.00%	97.32%	100.00%	94.29%
Pterospermella	50.00%	30.00%	2.30%	0.00%	3.81%
Tasmanites	0.00%	3.33%	0.38%	0.00%	0.48%

Percentages

Red Algae	Fan	N shelf	Mid shelf	Coastal	Totals
Beringiella sp	100.00%	100.00%	100.00%	100.00%	100.00%

Percentages

Zooplankton	Fan	N shelf	Mid shelf	Coastal	Totals
Tintinnid cyst	0.00%	0.00%	1.39%	1.40%	1.15%
Tintinnid loricae	0.00%	6.54%	6.28%	4.10%	5.82%
Zooplankton spp	100.00%	93.46%	92.32%	94.50%	93.03%

Percentages

Insect parts	Fan	N shelf	Mid shelf	Coastal	Totals
Insect parts	100.00%	100.00%	100.00%	100.00%	100.00%

Percentages

Foraminifera linings	Fan	N shelf	Mid shelf	Coastal	Totals
Foraminifera linings	100.00%	100.00%	100.00%	100.00%	100.00%

Percentages

Egg cases	Fan	N shelf	Mid shelf	Coastal	Totals
Egg cases	100.00%	100.00%	100.00%	100.00%	100.00%

Percentages Continued

Unknowns	Fan	N shelf	Mid shelf	Coastal	Totals
Unknown sp 1	0.00%	9.68%	5.71%	3.57%	6.32%
Unknown sp 2	0.00%	0.00%	20.00%	0.00%	7.37%
Unknown sp 3	0.00%	9.68%	25.71%	3.57%	13.68%
Unknown sp 4	0.00%	3.23%	8.57%	7.14%	6.32%
Unknown sp 5	0.00%	0.00%	5.71%	0.00%	2.11%
Unknown sp 6	100.00%	41.94%	31.43%	67.86%	46.32%
Unknown sp 7	0.00%	19.35%	0.00%	10.71%	9.47%
Unknown sp 8	0.00%	6.45%	0.00%	3.57%	3.16%
Unknown sp 9	0.00%	9.68%	2.86%	3.57%	5.26%

Percentages

Total Holocene N Shelf	NE shelf	N shelf	NW shelf	Total
Acritarchs	1.36%	1.66%	2.55%	2.25%
Holocene Dinocysts	0.68%	0.83%	0.24%	0.42%
Prasinophycean Algae	4.76%	0.83%	1.09%	1.25%
Red Algae	14.97%	3.48%	2.49%	3.51%
Egg Cases	5.44%	3.31%	3.47%	3.55%
Zooplankton	40.82%	42.05%	23.65%	29.34%
Foraminifera Linings	20.41%	39.07%	59.03%	51.63%
Insect Parts	10.88%	7.62%	6.08%	6.76%
Unknowns	0.68%	1.16%	1.40%	1.29%

Percentages

Dinocysts N Shelf	NE shelf	N shelf	NW shelf	Total
Alisocysta sp	0.00%	3.85%	0.00%	2.27%
Cryodinium sp	0.00%	0.00%	0.00%	0.00%
Dinocyst spp	0.00%	0.00%	0.00%	0.00%
Hystrichosphaeridium spp	0.00%	15.38%	0.00%	9.09%
Impagidinium sp	10.00%	0.00%	0.00%	2.27%
Protoperidinium sp 1	0.00%	0.00%	12.50%	2.27%
Protoperidinium sp 2	0.00%	0.00%	37.50%	6.82%
Selenopemphix antarctica	0.00%	0.00%	0.00%	0.00%
Alterbitedinium asymmetrica	10.00%	15.38%	0.00%	11.36%
Deflandrea spp	0.00%	3.85%	12.50%	4.55%
Enneadocysta partridgei	10.00%	3.85%	0.00%	4.55%
Operculum	40.00%	15.38%	37.50%	25.00%
Spinidinium macmurdoense	10.00%	3.85%	0.00%	4.55%
Spinidinium spp	0.00%	3.85%	0.00%	2.27%
Turbiosphaera filosa	20.00%	3.85%	0.00%	6.82%
Vozzhennikovia spp	0.00%	30.77%	0.00%	18.18%

Percentages

Dinocysts	Fan	N shelf	Mid shelf	Coastal	Totals
Holocene	4.55%	22.73%	99.36%	66.67%	74.67%
Reworked	95.45%	77.27%	0.64%	33.33%	25.33%

PALYNOMORPH DISTRIBUTION TABLES 3.2c

Grains per Gram

Total Holocene	Fan	N shelf	Mid shelf	Coastal
Acritarchs	0.10	0.70	5.39	1.59
Holocene Dinocysts	0.01	0.13	3.63	0.08
Prasinophycean Algae	0.02	0.39	6.12	5.31
Red Algae	0.06	1.08	7.48	4.23
Egg Cases	0.03	1.10	6.40	3.01
Zooplankton	0.03	9.08	55.60	38.79
Foraminifera Linings	0.13	15.97	33.02	32.13
Insect Parts	0.02	2.09	9.85	5.23
Unknowns	0.01	0.40	0.82	1.17
Total Holocene	0.41	30.94	128.31	91.55

Grains per Gram

Total Reworked	Fan	N shelf	M shelf	Coastal
Reworked Dinocysts	0.21	0.44	0.02	0.04
Pollen	12.92	13.91	4.13	1.42
Total Reworked	13.13	14.35	4.15	1.46

Grains per Gram

Marine Palynomorphs	Fan	N shelf	Mid shelf	Coastal
Acritarchs	0.10	0.70	5.39	1.59
Holocene Dinocysts	0.01	0.13	3.63	0.08
Prasinophycean Algae	0.02	0.39	6.12	5.31
Red Algae	0.06	1.08	7.48	4.23
Total	0.19	2.30	22.63	11.21

Grains per Gram

Holocene Dinocysts	Fan	N shelf	Mid shelf	Coastal
Alisocysta sp	0.01	0.01	0.02	0.00
Cryodinium sp	0.00	0.00	0.26	0.00
Dinocyst spp	0.00	0.00	0.02	0.00
Hystrichosphaeridium spp	0.00	0.05	0.00	0.00
Impagidinium sp	0.00	0.01	0.00	0.00
Protoperidinium sp 1	0.00	0.01	0.00	0.00
Protoperidinium sp 2	0.00	0.04	0.77	0.04
Selenopemphix antarctica	0.00	0.00	2.56	0.04
Total	0.01	0.13	3.63	0.08

Grains per Gram

Reworked Dinocysts	Fan	N shelf	Mid shelf	Coastal
Alterbitedinium asymmetrica	0.03	0.06	0.00	0.00
Deflandrea spp	0.02	0.03	0.02	0.00
Enneadocysta partridgei	0.01	0.03	0.00	0.00
Operculum	0.07	0.14	0.00	0.00
Spinidinium macmurdoense	0.01	0.03	0.00	0.00
Spinidinium spp	0.02	0.01	0.00	0.00
Turbiosphaera filosa	0.03	0.04	0.00	0.04
Vozzhennikovia spp	0.02	0.10	0.00	0.00
Total	0.21	0.44	0.02	0.04

Grains per Gram Continued

Acritarchs	Fan	N shelf	Mid shelf	Coastal
Acritarch spp 1	0.05	0.00	0.00	0.00
Acritarch spp 2	0.00	0.00	0.05	0.00
Acritarch spp 3	0.00	0.00	0.07	0.00
Acritarch spp 4	0.00	0.00	0.21	0.00
Leiospherida sp	0.01	0.03	0.52	0.00
Leiospherida sigmopolis	0.03	0.00	0.00	0.00
Sphaeromorphs	0.01	0.67	4.55	1.59
Total	0.10	0.70	5.39	1.59

Grains per Gram

Prasinophycean Algae	Fan	N shelf	Mid shelf	Coastal
Cymatiosphaera spp 1	0.01	0.06	0.00	0.00
Cymatiosphaera spp 2	0.00	0.19	5.96	5.31
Pterospermella	0.01	0.12	0.14	0.00
Tasmanites	0.00	0.01	0.02	0.00
Total	0.02	0.39	6.12	5.31

Grains per Gram

Red Algae	Fan	N shelf	Mid shelf	Coastal
Beringiella sp	0.06	1.08	7.48	4.23

Grains per Gram

Zooplankton	Fan	N shelf	Mid shelf	Coastal
Tintinnid cyst	0.00	0.00	0.77	0.54
Tintinnid loricae	0.00	0.59	3.49	1.59
Zooplankton spp	0.03	8.48	51.33	36.65
Total	0.03	9.08	55.60	38.79

Grains per Gram

Insect parts	Fan	N shelf	Mid shelf	Coastal
Insect parts	0.02	2.09	9.85	5.23

Grains per Gram

Foraminifera linings	Fan	N shelf	Mid shelf	Coastal
Foraminifera linings	0.13	15.97	33.02	32.13

Grains per Gram

Egg cases	Fan	N shelf	Mid shelf	Coastal
Egg cases	0.03	1.10	6.40	3.01

Grains per Gram Continued

Unknowns	Fan	N shelf	Mid shelf	Coastal
Unknown sp 1	0.00	0.04	0.05	0.04
Unknown sp 2	0.00	0.00	0.16	0.00
Unknown sp 3	0.00	0.04	0.21	0.04
Unknown sp 4	0.00	0.01	0.07	0.08
Unknown sp 5	0.00	0.00	0.05	0.00
Unknown sp 6	0.01	0.17	0.26	0.79
Unknown sp 7	0.00	0.08	0.00	0.13
Unknown sp 8	0.00	0.03	0.00	0.04
Unknown sp 9	0.00	0.04	0.02	0.04
Total	0.01	0.40	0.82	1.17

Grains per Gram

Total Holocene N Shelf	NE shelf	N shelf	NW shelf
Acritarchs	0.15	0.32	1.29
Holocene Dinocysts	0.07	0.16	0.12
Prasinophycean Algae	0.52	0.16	0.55
Red Algae	1.63	0.67	1.26
Egg Cases	0.59	0.64	1.75
Zooplankton	4.44	8.09	11.95
Foraminifera Linings	2.22	7.52	29.82
Insect Parts	1.18	1.47	3.07
Unknowns	0.07	0.22	0.71
Total	10.88	19.25	50.52

Grains per Gram

Dinocysts N Shelf	NE shelf	N shelf	NW shelf
Alisocysta sp	0.00	0.03	0.00
Cryodinium sp	0.00	0.00	0.00
Dinocyst spp	0.00	0.00	0.00
Hystrichosphaeridium spp	0.00	0.13	0.00
Impagidinium sp	0.07	0.00	0.00
Protoperidinium sp 1	0.00	0.00	0.03
Protoperidinium sp 2	0.00	0.00	0.09
Selenopemphix antarctica	0.00	0.00	0.00
Alterbitedinium asymmetrica	0.07	0.13	0.00
Deflandrea spp	0.00	0.03	0.03
Enneadocysta partridgei	0.07	0.03	0.00
Operculum	0.30	0.13	0.09
Spinidinium macmurdoense	0.07	0.03	0.00
Spinidinium spp	0.00	0.03	0.00
Turbiosphaera filosa	0.15	0.03	0.00
Vozzhennikovia spp	0.00	0.25	0.00
Total	0.74	0.83	0.25

Grains per Gram

Dinocysts	Fan	N shelf	Mid shelf	Coastal
Holocene	0.01	0.13	3.63	0.08
Reworked	0.21	0.44	0.02	0.04
Total	0.22	0.57	3.66	0.13

APPENDIX B
Sediment description taken from raw samples before processing

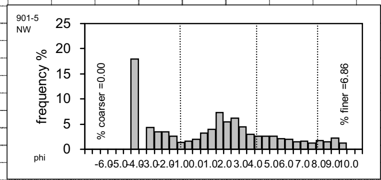
Samples Ga/gc	Dry wgt g Process.	Bathy metry	Colour	Sedi-ment	Sediment Discription	Carbon-ate fizz
901/5 NW	17.88 7.67	320	yellow brown	silty sand	some grains visible gritty in fingers, pebbles and shell frag.	fizz
901/6 NW	17.81 7.78	489	greyish olive	sandy	grains visible sandy looking	none
901/9 F	9.22 5.41	1879	greyish olive	silt	no grains visible, slightly gritty to taste medium	none
901/10 F	20.86 7.91	1257	greyish olive	sandy	grains visible, coarse looking, shell frag, small pebbles	fizz
901/11 NW	20.84 8.47	402	greyish	sandy	grains visible, vegetation fibres? may be shell frags	fizz
901/13 F	18.17 6.55	880	greyish olive	sandy	shell frag, sandy, grains visible, coarse	fizz
901/14 F s edge	15.49 6.86	430	greyish olive	sandy	grains visible, shell frag. large pebbles, bryozoa	fizz
901/15 N	19.23 8.47	480	olive black	sandy silt	some grains visible, gritty between fingers,	none
901/18 NE	11.76 7.07	320	olive black	silt	no grains visible, gritty between fingers,	none
901/20 NE	23.43 6.36	318	greyish olive	sandy	grains visible whitish fragments but may not be shell frag	none
901/22 M	5.68 3.65	766	greyish olive	clay	no grains visible no grit to taste melted in mouth. shell frag.	fizz
901/23 M	6.44 4.85	661	greyish olive	silt	no grains visible, gritty between teeth	minimal
901/24 M	2.53 Nil g/s	705	greyish olive	silty clay	no grains visible, very very fine between teeth	minimal
901/25 S	2.96 Nil g/s	676	light grey	clay	no grit between teeth, very very fine	big fizz
901/26 S	5.15 Nil g/s	676	greyish olive	clay	no grains visible and no grit between teeth, shell frag.	fizz
901/27 S	5.91 3.66	776	greyish olive	silt	no grains visible gritty to taste. 1 or 2 small pebbles	minimal
901/28 SE	14.34 6.50	710	dark olive	silt	no grains visible, gritty between fingers, med. white frag ???	none
901/31 SE	6.30 3.28	806	greyish olive	silt	some grains visible, gritty on teeth small pebbles shell frag	minimal
901/33 NW	14.34 5.89	376	dark olive	silt	no grains visible fine grit between fingers	none
149/6 NW	26.65 6.99	805	brownish black	sandy silt	some grains visible grit between fingers, pebbles	none
149/14 F	19.28 5.85	849	greyish brown	silt	no grains visible gritty between fingers medium	none
149/15 F	26.1 7.01	2250	brownish grey	silt	no grains visible gritty between fingers few pebbles	none
149/16 F	10.69 5.86	1960	dark olive	sandy silt	grains visible, gritty between teeth	none
149/17 F	14.79 5.00	1540	greyish olive	silt	no grains visible, gritty between fingers	none
149/18 F	21.31 6.88	1170	grey	sandy silt	some grains visible gritty between fingers. medium	none
149/19 F	26.09 7.24	765	greyish olive	sandy silt	grains visible, gritty between fingers	none
149/21 F	30.83 6.74	1060	olive black	silt	no grains visible, gritty between fingers	none
149/22 F	26.06 6.99	1450	greyish olive	silt	no grains visible, gritty between fingers	none
149/23 F	20.24 6.95	1884	greyish olive	silt	no grains visible, gritty between fingers	none
149/24 F	9.16 5.23	2535	olive brown	silt	no grains visible, gritty to taste fine to medium	none
149/25 F	11.34 6.65	2010	greyish olive	silt	no grains visible, gritty between teeth	none

149/27 F	19.86 10.92	1200	brownish grey	sandy silt	grains visible gritty between fingers medium to coarse	none
149/28 N	25.26 7.02	527	olive black	sandy silt	grains visible, gritty between fingers, shell fragments	minimal
149/30 N	10.93 7.13	515	greyish olive	sandy silt	gritty between fingers, a few grains visible	none
149/31 N	15.3 6.01	512	greyish olive	silt	no grains visible, gritty between fingers. medium	none
149/32 N	12.96 5.40	502	greyish olive	sandy silt	some grains visible, gritty between fingers	none
149/33 F	19.10 6.33	834	dark brown	sandy silt	pebbles visible, gritty between fingers, still fine	minimal
149/34 F	28.02 9.62	1215	darkish grey	sandy	grains and pebbles visible, shell frag. sandy looking	none
149/35 F	13.29 6.99	1566	dark olive	sandy silt	gritty between fingers, a few grains visible	none
149/36 F	12.35 6.54	2105	greyish olive	silt	no grains visible, gritty on teeth, fine	none
149/37 NW	8.82 5.18	168	greyish olive	sandy	sandy with grains visible	none
186/9 M	16.36 7.62	698	greyish olive	sandy silt	some grains visible, gritty between fingers	fizz
186/11 M	13.41 6.53	655	darkish grey+olive	sandy silt	some grains visible, gritty between fingers	none
186/13 M	5.56 Nil g/s	678	grayish olive	silt	no grains visible, gritty on teeth, shell frag fine	fizz
186/14 M	7.00 5.06	690	greyish olive	sandy silt	shell frag some grains visible very fine mixed in with it	fizz
186/15 SW	22.95 6.78	1050	redbrown grey/olive	sandy silt	some pebbles visible gritty between fingers medium	none
186/16 SW	21.29 8.03	726	darkbrown greyolive	sandy silt	some grains visible, gritty between fingers	none
186/17 SW	17.93 7.60	716	greyish olive	sandy	pebbles and grains visible, gritty between fingers	fizz
186/18 M	20.13 7.36	608	brown	sandy silt	some grains visible gritty between fingers	none
186/19 M	11.67 5.28	775	greyish olive	sandy silt	gritty between fingers, some larger grains visible	minimal
186/21 M	4.45 2.42	570	greyish olive	silt	no grains visible, very fine gritty to taste	minimal
186/22 M	7.24 5.0	660	olive	silt	no grains visible gritty between teeth shell frag.	fizz
186/26 N	22.14 6.88	390	greyish olive	silt	no grains visible gritty between fingers medium some pebbles	none
186/27 N	11.94 6.16	436	greyish olive	silt	no grains visible gritty between fingers medium	none
186/28 NE	20.34 6.83	338	greyish olive	sandy silt	gritty between fingers, some large pebbles	none
186/29 F	12.47 6.43	1230	greyish olive	silt	no grains visible, gritty between fingers medium	none
186/31 F	11.45 6.20	1625	dark olive	silty clay	no grains visible fine grit between fingers	none
186/32 F	10.28 6.04	1830	dark olive	sandy silt	gritty between teeth, no grains visible	none

APPENDIX B Output data for grain size

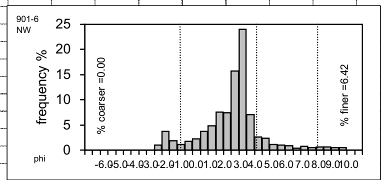
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
4	**901-5**																																	
5	Data	0.00	0.00	0.00	0.00	0.00	1.83	0.00	0.44	0.35	0.36	0.26	0.14	0.16	0.20	0.33	0.41	0.74	0.56	0.63	0.45	0.30	0.26	0.26	0.27	0.22	0.20	0.15	0.17	0.13	0.18	0.15	0.23	0.13
6	Frequency %	0.00	0.00	0.00	0.00	0.00	17.92	0.00	4.31	3.43	3.53	2.55	1.37	1.57	1.96	3.23	4.02	7.25	5.48	6.17	4.41	2.94	2.55	2.55	2.64	2.15	1.96	1.47	1.67	1.27	1.76	1.47	2.25	1.27
7	Cumulative %	0.00	0.00	0.00	0.00	0.00	17.92	17.92	22.23	25.66	29.19	31.73	33.10	34.67	36.63	39.86	43.88	51.13	56.61	62.78	67.19	70.13	72.67	75.22	77.86	80.02	81.98	83.45	85.11	86.39	88.15	89.62	91.87	93.14
8	Bathymetry 320 m																																	

	A	D	E	F	G	H	I	J	K
9		1%	5%	16%	25%	50%	75%	84%	95%
10	Percentiles	-3.75	-3.63	-3.51	-2.09	1.92	4.96	7.16	10.88
12		Mean	StDev	Skew	Kurt				
13	Moment measures	2.04	4.42	0.34	2.12				
14	Graphic (Folk)	1.86	4.87	0.11	0.84				
15	Inman		5.34	-0.02					
17		Gravel	Sand	Silt	Clay				
18	Proportions	31.73	38.39	16.26	13.61				



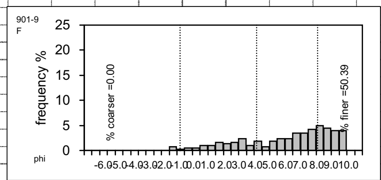
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
20	**901-6**																																	
21	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.35	0.18	0.11	0.16	0.21	0.35	0.46	0.72	0.70	1.49	2.28	0.67	0.25	0.22	0.11	0.09	0.08	0.03	0.07	0.05	0.06	0.06	0.05	0.05
22	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	3.68	1.89	1.16	1.68	2.21	3.68	4.84	7.58	7.37	15.68	24.00	7.05	2.63	2.32	1.16	0.95	0.84	0.32	0.74	0.53	0.63	0.63	0.53	0.53
23	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.95	4.63	6.53	7.68	9.37	11.58	15.26	20.11	27.68	35.05	50.74	74.74	81.79	84.42	86.74	87.89	88.84	89.68	90.00	90.74	91.26	91.89	92.53	93.05	93.58
24	Bathymetry 489 m																																	

	A	D	E	F	G	H	I	J	K
25		1%	5%	16%	25%	50%	75%	84%	95%
26	Percentiles	-1.98	-1.39	1.08	1.83	2.98	3.52	4.42	11.53
28		Mean	StDev	Skew	Kurt				
29	Moment measures	3.13	2.75	1.06	4.71				
30	Graphic (Folk)	2.83	2.79	0.09	3.14				
31	Inman		1.67	-0.14					
33		Gravel	Sand	Silt	Clay				
34	Proportions	6.53	75.26	9.47	8.74				



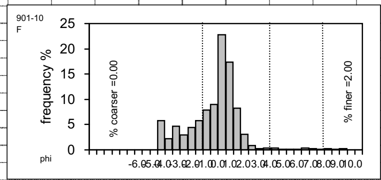
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
36	**901-9**																																	
37	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.02	0.02	0.04	0.04	0.06	0.05	0.06	0.09	0.04	0.07	0.03	0.07	0.09	0.09	0.13	0.13	0.16	0.19	0.17	0.15	0.15
38	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.26	0.52	0.52	1.05	1.05	1.57	1.31	1.57	2.36	1.05	1.84	0.79	1.84	2.36	2.36	3.41	3.41	4.20	4.99	4.46	3.94	3.94
39	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	1.05	1.57	2.10	3.15	4.20	5.77	7.09	8.66	11.02	12.07	13.91	14.70	16.54	18.90	21.26	24.67	28.08	32.28	37.27	41.73	45.67	49.61
40	Bathymetry 1879m																																	

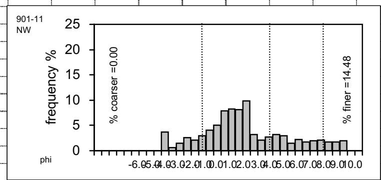
	A	D	E	F	G	H	I	J	K
41		1%	5%	16%	25%	50%	75%	84%	95%
42	Percentiles	-0.59	1.77	5.36	7.05	10.05	13.46	15.08	18.37
44		Mean	StDev	Skew	Kurt				
45	Moment measures	8.37	2.96	-1.39	3.98				
46	Graphic (Folk)	10.16	4.94	0.02	1.06				
47	Inman		4.86	0.03					
49		Gravel	Sand	Silt	Clay				
50	Proportions	0.79	11.29	20.21	67.72				

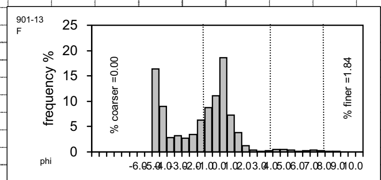


APPENDIX B Output data for grain size

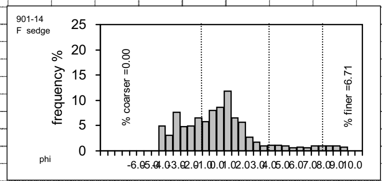
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B Output data for grain size**																																			
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
52	**901-10**																																			
53	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.63	0.25	0.52	0.33	0.49	0.64	0.86	0.99	2.50	1.91	0.91	0.34	0.09	0.03	0.04	0.04	0.01	0.02	0.01	0.04	0.03	0.01	0.03	0.01	0.03
54	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.74	2.28	4.74	3.01	4.46	5.83	7.83	9.02	22.77	17.40	8.29	3.10	0.82	0.27	0.36	0.36	0.09	0.18	0.09	0.36	0.27	0.09	0.27	0.09	0.27
55	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.74	8.01	12.75	15.76	20.22	26.05	33.88	42.90	65.66	83.06	91.35	94.44	95.26	95.54	95.90	96.27	96.36	96.54	96.63	96.99	97.27	97.36	97.63	97.72	98.00
56	Bathymetry 1257m																																			
57				1%	5%	16%	25%	50%	75%	84%	95%																									
58	Percentiles			-2.17	-2.02	-0.47	0.42	1.65	2.25	2.55	3.83																									
59																																				
60				Mean	StDev	Skew	Kurt																													
61	Moment measures			1.47	2.16	1.52	8.62																													
62	Graphic (Folk)			1.24	1.64	-0.33	1.31																													
63	Inman				1.51	-0.41																														
64																																				
65				Gravel	Sand	Silt	Clay																													
66	Proportions			12.75	82.51	2.00	2.73																													
67																																				
68	**901-11**																																			
69	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	0.07	0.17	0.30	0.25	0.34	0.47	0.60	0.93	0.97	0.95	1.16	0.38	0.25	0.32	0.37	0.35	0.17	0.26	0.20	0.23	0.24	0.20	0.20	0.23
70	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.66	0.60	1.45	2.56	2.13	2.90	4.00	5.11	7.92	8.26	8.09	9.88	3.24	2.13	2.73	3.15	2.98	1.45	2.21	1.70	1.96	2.04	1.70	1.70	1.96
71	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.66	4.26	5.71	8.26	10.39	13.29	17.29	22.40	30.32	38.59	46.68	56.56	59.80	61.93	64.65	67.80	70.78	72.23	74.45	76.15	78.11	80.15	81.86	83.56	85.52
72	Bathymetry 402 m																																			
73				1%	5%	16%	25%	50%	75%	84%	95%																									
74	Percentiles			-2.14	-1.23	0.85	1.67	3.17	7.16	9.61	13.55																									
75																																				
76				Mean	StDev	Skew	Kurt																													
77	Moment measures			4.21	3.72	0.41	2.11																													
78	Graphic (Folk)			4.54	4.43	0.44	1.10																													
79	Inman				4.38	0.47																														
80																																				
81				Gravel	Sand	Silt	Clay																													
82	Proportions			5.71	54.09	18.31	21.89																													
83																																				
84	**901-13**																																			
85	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.87	1.02	0.33	0.37	0.31	0.40	0.72	1.00	1.27	2.12	0.83	0.43	0.14	0.04	0.02	0.03	0.05	0.05	0.04	0.02	0.03	0.04	0.03	0.02	0.02	0.00
86	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.39	8.94	2.89	3.24	2.72	3.51	6.31	8.76	11.13	18.58	7.27	3.77	1.23	0.35	0.18	0.26	0.44	0.44	0.35	0.18	0.26	0.35	0.26	0.18	0.18	0.00
87	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	16.39	25.33	28.22	31.46	34.18	37.69	44.00	52.76	63.89	82.47	89.75	93.51	94.74	95.09	95.27	95.53	95.97	96.41	96.76	96.93	97.20	97.55	97.81	97.98	98.16	98.16
88	Bathymetry 880 m																																			
89				1%	5%	16%	25%	50%	75%	84%	95%																									
90	Percentiles			-2.75	-2.62	-2.50	-2.02	0.84	1.78	2.09	3.87																									
91																																				
92				Mean	StDev	Skew	Kurt																													
93	Moment measures			0.49	2.58	1.18	6.08																													
94	Graphic (Folk)			0.14	2.13	-0.26	0.70																													
95	Inman				2.30	-0.46																														
96																																				
97				Gravel	Sand	Silt	Clay																													
98	Proportions			31.46	63.63	2.45	2.45																													
99																																				

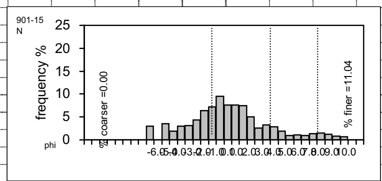


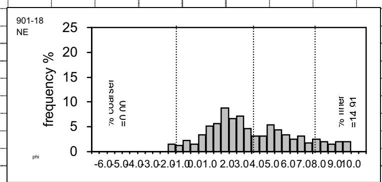




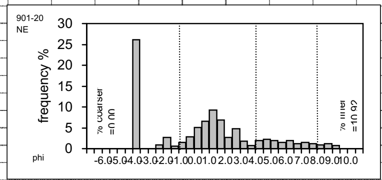
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**		**Output data for grain size**																															
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
100	**901-14**																																	
101	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.41	0.26	0.64	0.40	0.41	0.54	0.48	0.67	0.72	0.99	0.54	0.47	0.23	0.14	0.08	0.09	0.09	0.08	0.05	0.06	0.05	0.08	0.08	0.08	0.08	0.06
102	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.92	3.12	7.67	4.80	4.92	6.47	5.76	8.03	8.63	11.87	6.47	5.64	2.76	1.68	0.96	1.08	1.08	0.96	0.60	0.72	0.60	0.96	0.96	0.96	0.96	0.72
103	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.92	8.03	15.71	20.50	25.42	31.89	37.65	45.68	54.32	66.19	72.66	78.30	81.06	82.73	83.69	84.77	85.85	86.81	87.41	88.13	88.73	89.69	90.65	91.61	92.57	93.29
104	Bathymetry 430 m																																	
105		1%	5%	16%	25%	50%	75%	84%	95%																									
106	Percentiles	-2.66	-2.48	-1.47	-0.54	1.25	2.70	4.64	11.39																									
107																																		
108		Mean	StDev	Skew	Kurt																													
109	Moment measures	1.83	3.49	1.17	3.77																													
110	Graphic (Folk)	1.47	3.63	0.29	1.75																													
111	Inman		3.05	0.11																														
112																																		
113		Gravel	Sand	Silt	Clay																													
114	Proportions	20.50	62.23	6.95	10.31																													
115																																		
116	**901-15**																																	
117	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.36	0.19	0.30	0.32	0.44	0.66	0.74	0.98	0.78	0.78	0.76	0.51	0.26	0.34	0.29	0.20	0.10	0.11	0.10	0.14	0.16	0.13	0.08	0.07
118	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.03	0.00	3.52	1.86	2.93	3.12	4.30	6.45	7.23	9.57	7.62	7.62	7.42	4.98	2.54	3.32	2.83	1.95	0.98	1.07	0.98	1.37	1.56	1.27	0.78	0.68
119	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.03	3.03	6.54	8.40	11.33	14.45	18.75	25.20	32.42	41.99	49.61	57.23	64.65	69.63	72.17	75.49	78.32	80.27	81.25	82.32	83.30	84.67	86.23	87.50	88.28	88.96
120	Bathymetry 480 m																																	
121		1%	5%	16%	25%	50%	75%	84%	95%																									
122	Percentiles	-2.62	-1.68	0.19	0.99	2.53	4.92	7.75	15.92																									
123																																		
124		Mean	StDev	Skew	Kurt																													
125	Moment measures	3.30	3.57	0.70	2.73																													
126	Graphic (Folk)	3.49	4.56	0.45	1.83																													
127	Inman		3.78	0.38																														
128																																		
129		Gravel	Sand	Silt	Clay																													
130	Proportions	8.40	61.23	15.04	15.33																													
131																																		
132	**901-18**																																	
133	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.05	0.09	0.06	0.13	0.20	0.22	0.34	0.26	0.28	0.18	0.12	0.12	0.21	0.17	0.13	0.10	0.12	0.07	0.10	0.08	0.06	0.08	0.08
134	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.54	1.29	2.31	1.54	3.34	5.14	5.66	8.74	6.68	7.20	4.63	3.08	3.08	5.40	4.37	3.34	2.57	3.08	1.80	2.57	2.06	1.54	2.06	2.06
135	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.54	2.83	5.14	6.68	10.03	15.17	20.82	29.56	36.25	43.44	48.07	51.16	54.24	59.64	64.01	67.35	69.92	73.01	74.81	77.38	79.43	80.98	83.03	85.09
136	Bathymetry 320 m																																	
137		1%	5%	16%	25%	50%	75%	84%	95%																									
138	Percentiles	-1.55	-0.52	1.08	1.75	3.81	7.54	9.73	13.56																									
139																																		
140		Mean	StDev	Skew	Kurt																													
141	Moment measures	4.59	3.60	0.36	1.94																													
142	Graphic (Folk)	4.87	4.30	0.38	1.00																													
143	Inman		4.32	0.37																														
144																																		
145		Gravel	Sand	Silt	Clay																													
146	Proportions	2.83	48.33	26.22	22.62																													
147																																		

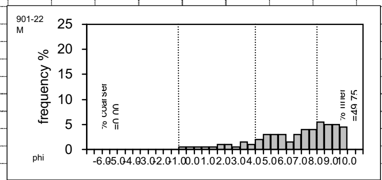


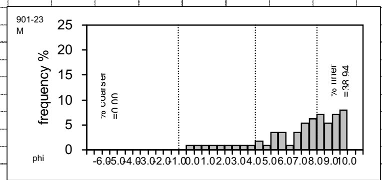




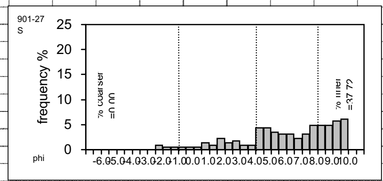
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**				**Output data for grain size**																															
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
148	**901-20**																																			
149	Data			0.00	0.00	0.00	0.00	0.00	4.20	0.01	0.01	0.15	0.44	0.10	0.25	0.45	0.81	1.07	1.50	1.10	0.44	0.77	0.29	0.12	0.32	0.35	0.32	0.23	0.31	0.19	0.25	0.19	0.15	0.20	0.13	0.01
150	Frequency %			0.00	0.00	0.00	0.00	0.00	26.05	0.06	0.06	0.93	2.73	0.62	1.55	2.79	5.02	6.64	9.31	6.82	2.73	4.78	1.80	0.74	1.99	2.17	1.99	1.43	1.92	1.18	1.55	1.18	0.93	1.24	0.81	0.06
151	Cumulative %			0.00	0.00	0.00	0.00	0.00	26.05	26.12	26.18	27.11	29.84	30.46	32.01	34.80	39.83	46.46	55.77	62.59	65.32	70.10	71.90	72.64	74.63	76.80	78.78	80.21	82.13	83.31	84.86	86.04	86.97	88.21	89.02	89.08
152	Bathymetry 318 m																																			
153				1%	5%	16%	25%	50%	75%	84%	95%																									
154	Percentiles			-3.77	-3.66	-3.56	-3.51	1.19	4.58	7.22	72.53																									
155																																				
156				Mean	StDev	Skew	Kurt																													
157	Moment measures			1.69	4.60	0.54	2.29																													
158	Graphic (Folk)			1.62	14.24	0.50	3.86																													
159	Inman				5.39	0.12																														
160																																				
161				Gravel	Sand	Silt	Clay																													
162	Proportions			30.46	42.18	13.40	13.96																													
163																																				
164	**901-22**																																			
165	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.01	0.03	0.02	0.04	0.06	0.06	0.06	0.03	0.06	0.08	0.08	0.11	0.10	0.10	0.09
166	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.49	0.49	0.49	0.49	0.99	0.99	0.49	1.48	0.99	1.97	2.96	2.96	2.96	1.48	2.96	3.94	3.94	5.42	4.93	4.93	4.43
167	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.49	0.99	1.48	1.97	2.46	3.45	4.43	4.93	6.40	7.39	9.36	12.32	15.27	18.23	19.70	22.66	26.60	30.54	35.96	40.89	45.81	50.25
168	Bathymetry 766 m																																			
169				1%	5%	16%	25%	50%	75%	84%	95%																									
170	Percentiles			0.02	3.03	5.63	7.30	9.97	13.00	14.44	17.36																									
171																																				
172				Mean	StDev	Skew	Kurt																													
173	Moment measures			8.57	2.64	-1.42	4.32																													
174	Graphic (Folk)			10.01	4.37	0.02	1.03																													
175	Inman				4.40	0.01																														
176																																				
177				Gravel	Sand	Silt	Clay																													
178	Proportions				7.39	23.15	69.46																													
179																																				
180	**901-23**																																			
181	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.01	0.04	0.04	0.01	0.04	0.06	0.07	0.08	0.06	0.08	0.09
182	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	1.77	0.88	3.54	3.54	0.88	3.54	5.31	6.19	7.08	5.31	7.08	7.96
183	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.77	2.65	3.54	4.42	5.31	6.19	7.08	7.96	9.73	10.62	14.16	17.70	18.58	22.12	27.43	33.63	40.71	46.02	53.10	61.06
184	Bathymetry 661 m																																			
185				1%	5%	16%	25%	50%	75%	84%	95%																									
186	Percentiles			0.08	2.33	5.77	7.28	9.28	10.97	11.76	13.36																									
187																																				
188				Mean	StDev	Skew	Kurt																													
189	Moment measures			8.37	2.61	-1.43	4.48																													
190	Graphic (Folk)			8.94	3.17	-0.22	1.22																													
191	Inman				2.99	-0.17																														
192																																				
193				Gravel	Sand	Silt	Clay																													
194	Proportions				7.96	25.66	66.37																													
195																																				

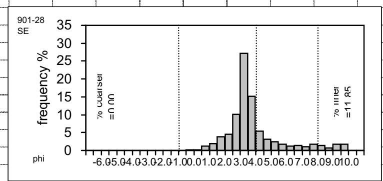


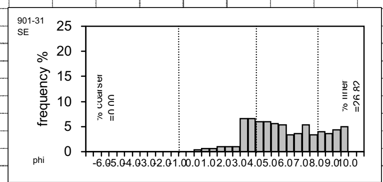




	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**		**Output data for grain size**																															
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
196	**901-27**																																	
197	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.05	0.03	0.04	0.02	0.02	0.10	0.10	0.08	0.07	0.07	0.05	0.07	0.11	0.11	0.11	0.13	0.14
198	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	0.44	0.44	0.44	0.44	0.44	1.32	0.88	2.19	1.32	1.75	0.88	0.88	4.39	4.39	3.51	3.07	3.07	2.19	3.07	4.82	4.82	4.82	5.70	6.14
199	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.88	1.32	1.75	2.19	2.63	3.07	4.39	5.26	7.46	8.77	10.53	11.40	12.28	16.67	21.05	24.56	27.63	30.70	32.89	35.96	40.79	45.61	50.44	56.14	62.28
200	Bathymetry 776 m																																	
201		1%	5%	16%	25%	50%	75%	84%	95%																									
202	Percentiles	-1.84	1.36	4.43	5.57	8.95	11.14	12.15	14.21																									
203																																		
204		Mean	StDev	Skew	Kurt																													
205	Moment measures	7.76	3.18	-1.11	3.42																													
206	Graphic (Folk)	8.51	3.88	-0.18	0.95																													
207	Inman		3.86	-0.17																														
208																																		
209		Gravel	Sand	Silt	Clay																													
210	Proportions	1.75	10.53	28.51	59.21																													
211																																		
212	**901-28**																																	
213	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.09	0.14	0.28	0.33	0.73	1.95	1.08	0.39	0.23	0.17	0.12	0.09	0.10	0.08	0.12	0.10	0.05	0.12	0.13
214	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.14	1.26	1.95	3.91	4.60	10.18	27.20	15.06	5.44	3.21	2.37	1.67	1.26	1.39	1.12	1.67	1.39	0.70	1.67	1.81
215	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.28	1.53	3.49	7.39	11.99	22.18	49.37	64.44	69.87	73.08	75.45	77.13	78.38	79.78	80.89	82.57	83.96	84.66	86.33	88.15
216	Bathymetry 710 m																																	
217		1%	5%	16%	25%	50%	75%	84%	95%																									
218	Percentiles	0.86	1.73	2.72	3.06	3.52	5.40	8.53	12.66																									
219																																		
220		Mean	StDev	Skew	Kurt																													
221	Moment measures	4.67	2.76	1.15	3.02																													
222	Graphic (Folk)	4.92	3.11	0.70	1.91																													
223	Inman		2.90	0.72																														
224																																		
225		Gravel	Sand	Silt	Clay																													
226	Proportions		64.44	18.13	17.43																													
227																																		
228	**901-31**																																	
229	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.02	0.03	0.03	0.03	0.20	0.20	0.18	0.18	0.17	0.16	0.10	0.11	0.16	0.10	0.12	0.11	0.13	0.15
230	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.66	0.66	0.99	0.99	0.99	6.62	6.62	5.96	5.96	5.63	5.30	3.31	3.64	5.30	3.31	3.97	3.64	4.30	4.97
231	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.99	1.66	2.65	3.64	4.64	11.26	17.88	23.84	29.80	35.43	40.73	44.04	47.68	52.98	56.29	60.26	63.91	68.21	73.18
232	Bathymetry 806 m																																	
233		1%	5%	16%	25%	50%	75%	84%	95%																									
234	Percentiles	1.01	3.04	3.87	4.60	7.22	10.19	11.30	13.55																									
235																																		
236		Mean	StDev	Skew	Kurt																													
237	Moment measures	7.12	2.83	-0.21	1.75																													
238	Graphic (Folk)	7.46	3.45	0.15	0.77																													
239	Inman		3.71	0.10																														
240																																		
241		Gravel	Sand	Silt	Clay																													
242	Proportions		17.88	38.41	43.71																													
243																																		

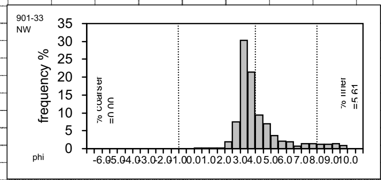




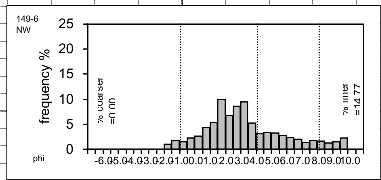


APPENDIX B Output data for grain size

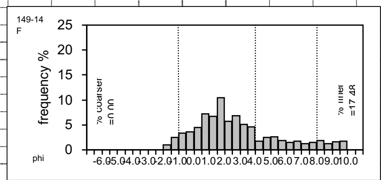
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
244	**901-33**																																	
245	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.08	0.32	1.30	0.92	0.40	0.30	0.16	0.09	0.08	0.03	0.06	0.06	0.05	0.05	0.06	0.04
246	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.23	0.23	0.23	1.87	7.48	30.37	21.50	9.35	7.01	3.74	2.10	1.87	0.70	1.40	1.40	1.17	1.17	1.40	0.93
247	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.47	0.70	0.93	2.80	10.28	40.65	62.15	71.50	78.50	82.24	84.35	86.21	86.92	88.32	89.72	90.89	92.06	93.46	94.39
248	Bathymetry 376 m																																	
249		1%	5%	16%	25%	50%	75%	84%	95%																									
250	Percentiles	2.03	2.71	3.13	3.29	3.72	4.74	5.91	10.36																									
251																																		
252		Mean	StDev	Skew	Kurt																													
253	Moment measures	4.48	2.10	1.73	5.17																													
254	Graphic (Folk)	4.25	1.86	0.66	2.16																													
255	Inman		1.39	0.58																														
256																																		
257		Gravel	Sand	Silt	Clay																													
258	Proportions		62.15	27.57	10.28																													
259																																		



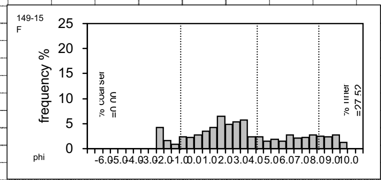
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
260	**149-6**																																	
261	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.31	0.27	0.40	0.47	0.78	0.96	1.79	1.21	1.56	1.72	0.94	0.57	0.61	0.58	0.50	0.42	0.36	0.25	0.32	0.29	0.23	0.27	0.41
262	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	1.71	1.49	2.21	2.60	4.31	5.31	9.90	6.69	8.63	9.51	5.20	3.15	3.37	3.21	2.77	2.32	1.99	1.38	1.77	1.60	1.27	1.49	2.27
263	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.05	2.77	4.26	6.47	9.07	13.38	18.69	28.60	35.29	43.92	53.43	58.63	61.78	65.15	68.36	71.13	73.45	75.44	76.83	78.60	80.20	81.47	82.96	85.23
264	Bathymetry 805 m																																	
265		1%	5%	16%	25%	50%	75%	84%	95%																									
266	Percentiles	-1.51	-0.31	1.26	1.83	3.32	6.89	9.72	13.19																									
267																																		
268		Mean	StDev	Skew	Kurt																													
269	Moment measures	4.41	3.51	0.54	2.14																													
270	Graphic (Folk)	4.77	4.16	0.49	1.09																													
271	Inman		4.23	0.51																														
272																																		
273		Gravel	Sand	Silt	Clay																													
274	Proportions	2.77	55.86	19.97	21.40																													
275																																		

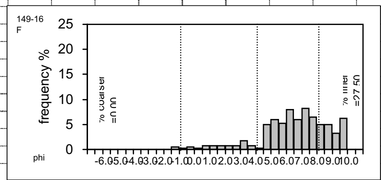


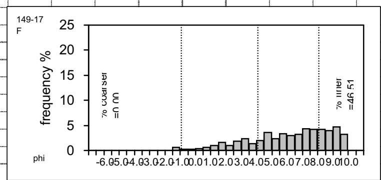
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
276	**149-14**																																	
277	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.12	0.29	0.40	0.42	0.52	0.84	0.79	1.22	0.67	0.80	0.60	0.54	0.20	0.29	0.30	0.22	0.17	0.21	0.14	0.18	0.22	0.14	0.19	0.21
278	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	2.47	3.41	3.58	4.43	7.16	6.73	10.40	5.71	6.82	5.12	4.60	1.71	2.47	2.56	1.88	1.45	1.79	1.19	1.53	1.88	1.19	1.62	1.79
279	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.02	3.50	6.91	10.49	14.92	22.08	28.82	39.22	44.93	51.75	56.86	61.47	63.17	65.64	68.20	70.08	71.53	73.32	74.51	76.04	77.92	79.11	80.73	82.52
280	Bathymetry 849 m																																	
281		1%	5%	16%	25%	50%	75%	84%	95%																									
282	Percentiles	-1.50	-0.75	0.58	1.23	2.87	7.66	10.44	15.26																									
283																																		
284		Mean	StDev	Skew	Kurt																													
285	Moment measures	4.17	3.85	0.54	1.92																													
286	Graphic (Folk)	4.63	4.89	0.54	1.02																													
287	Inman		4.93	0.54																														
288																																		
289		Gravel	Sand	Silt	Clay																													
290	Proportions	3.50	57.97	14.58	23.96																													
291																																		



	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**		**Output data for grain size**																															
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
292	**149-15**																																	
293	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.76	0.28	0.15	0.42	0.39	0.48	0.62	0.75	1.14	0.85	0.95	1.02	0.43	0.43	0.27	0.34	0.27	0.48	0.37	0.39	0.49	0.44	0.43	0.48	0.22
294	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29	1.58	0.85	2.37	2.20	2.71	3.50	4.23	6.43	4.79	5.36	5.75	2.43	2.43	1.52	1.92	1.52	2.71	2.09	2.20	2.76	2.48	2.43	2.71	1.24
295	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.29	5.87	6.71	9.08	11.28	13.99	17.48	21.71	28.14	32.94	38.30	44.05	46.47	48.90	50.42	52.34	53.86	56.57	58.66	60.86	63.62	66.10	68.53	71.24	72.48
296	Bathymetry 2250m																																	
297		1%	5%	16%	25%	50%	75%	84%	95%																									
298	Percentiles	-2.15	-1.76	0.80	1.76	4.86	11.05	15.40	24.25																									
299																																		
300		Mean	StDev	Skew	Kurt																													
301	Moment measures	5.30	4.26	-0.09	1.61																													
302	Graphic (Folk)	7.02	7.59	0.47	1.15																													
303	Inman		7.30	0.44																														
304																																		
305		Gravel	Sand	Silt	Clay																													
306	Proportions	6.71	39.76	17.15	36.38																													
307																																		
308	**149-16**																																	
309	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.01	0.03	0.03	0.03	0.03	0.03	0.07	0.03	0.01	0.20	0.24	0.21	0.32	0.24	0.33	0.26	0.20	0.20	0.13	0.25
310	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.25	0.50	0.25	0.75	0.75	0.75	0.75	0.75	1.75	0.75	0.25	5.00	6.00	5.25	8.00	6.00	8.25	6.50	5.00	5.00	3.25	6.25
311	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.50	0.75	1.25	1.50	2.25	3.00	3.75	4.50	5.25	7.00	7.75	8.00	13.00	19.00	24.25	32.25	38.25	46.50	53.00	58.00	63.00	66.25	72.50
312	Bathymetry 1960m																																	
313		1%	5%	16%	25%	50%	75%	84%	95%																									
314	Percentiles	-0.22	2.84	5.27	6.05	7.77	10.21	11.11	12.93																									
315																																		
316		Mean	StDev	Skew	Kurt																													
317	Moment measures	7.66	2.58	-0.83	3.50																													
318	Graphic (Folk)	8.05	2.99	0.08	0.99																													
319	Inman		2.92	0.14																														
320																																		
321		Gravel	Sand	Silt	Clay																													
322	Proportions	0.50	7.25	45.25	47.00																													
323																																		
324	**149-17**																																	
325	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.02	0.02	0.03	0.05	0.07	0.12	0.07	0.14	0.18	0.10	0.15	0.27	0.18	0.25	0.22	0.24	0.32	0.31	0.31	0.30	0.35	0.24
326	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.27	0.27	0.40	0.67	0.94	1.61	0.94	1.88	2.41	1.34	2.01	3.62	2.41	3.35	2.95	3.22	4.29	4.16	4.16	4.02	4.69	3.22
327	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.67	0.94	1.21	1.61	2.28	3.22	4.83	5.76	7.64	10.05	11.39	13.40	17.02	19.44	22.79	25.74	28.95	33.24	37.40	41.55	45.58	50.27	53.49
328	Bathymetry 1540m																																	
329		1%	5%	16%	25%	50%	75%	84%	95%																									
330	Percentiles	-0.37	2.10	4.87	6.38	9.47	13.63	15.62	19.64																									
331																																		
332		Mean	StDev	Skew	Kurt																													
333	Moment measures	8.17	2.91	-1.14	3.37																													
334	Graphic (Folk)	9.98	5.35	0.15	0.99																													
335	Inman		5.37	0.14																														
336																																		
337		Gravel	Sand	Silt	Clay																													
338	Proportions	0.67	10.72	26.01	62.60																													
339																																		





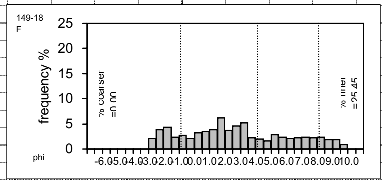


APPENDIX B Output data for grain size

	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
340	**149-18**																																	
341	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.52	0.58	0.31	0.36	0.28	0.43	0.46	0.52	0.83	0.50	0.62	0.70	0.30	0.26	0.22	0.38	0.32	0.28	0.30	0.31	0.30	0.31	0.25	0.25	0.12
342	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	3.88	4.33	2.31	2.69	2.09	3.21	3.43	3.88	6.19	3.73	4.63	5.22	2.24	1.94	1.64	2.84	2.39	2.09	2.24	2.31	2.24	2.31	1.87	1.87	0.90
343	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.09	5.97	10.30	12.61	15.30	17.39	20.60	24.03	27.91	34.10	37.84	42.46	47.69	49.93	51.87	53.51	56.34	58.73	60.82	63.06	65.37	67.61	69.93	71.79	73.66	74.55
344	Bathymetry 1174m																																	
356	**149-19**																																	
357	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.13	0.34	0.15	0.25	0.37	0.45	0.62	0.93	1.31	2.50	2.21	2.18	1.90	0.52	0.32	0.37	0.32	0.26	0.12	0.10	0.10	0.12	0.15	0.10	0.10	0.13
358	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.23	1.87	0.83	1.38	2.04	2.48	3.42	5.12	7.22	13.77	12.18	12.01	10.47	2.87	1.76	2.04	1.76	1.43	0.66	0.55	0.55	0.66	0.83	0.55	0.55	0.72
359	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.23	8.10	8.93	10.30	12.34	14.82	18.24	23.36	30.58	44.35	56.53	68.54	79.01	81.87	83.64	85.67	87.44	88.87	89.53	90.08	90.63	91.29	92.12	92.67	93.22	93.94
360	Bathymetry 765 m																																	
372	**149-21**																																	
373	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.40	0.53	0.78	1.17	1.54	1.58	2.46	1.34	1.32	1.73	0.49	0.38	0.65	0.56	0.56	0.40	0.46	0.29	0.51	0.35	0.28	0.36	0.21
374	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07	1.79	2.37	3.49	5.24	6.89	7.07	11.01	6.00	5.91	7.74	2.19	1.70	2.91	2.51	2.51	1.79	2.06	1.30	2.28	1.57	1.25	1.61	0.94
375	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.07	2.86	5.24	8.73	13.97	20.86	27.93	38.94	44.94	50.85	58.59	60.79	62.49	65.40	67.91	70.41	72.20	74.26	75.56	77.84	79.41	80.66	82.27	83.21
376	Bathymetry 1060m																																	

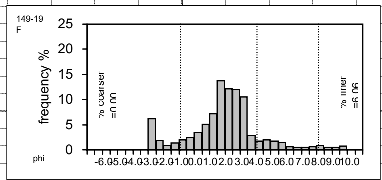
149-18

	A	D	E	F	G	H	I	J	K
345		1%	5%	16%	25%	50%	75%	84%	95%
346	Percentiles	-2.59	-2.09	-0.33	1.13	4.02	10.25	16.04	27.79
348		Mean	StDev	Skew	Kurt				
349	Moment measures	4.74	4.47	0.00	1.61				
350	Graphic (Folk)	6.58	8.62	0.53	1.34				
351	Inman		8.18	0.47					
353		Gravel	Sand	Silt	Clay				
354	Proportions	12.61	37.31	17.69	32.39				



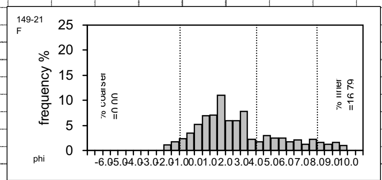
149-19

	A	D	E	F	G	H	I	J	K
361		1%	5%	16%	25%	50%	75%	84%	95%
362	Percentiles	-2.68	-2.52	0.18	1.12	2.23	3.30	4.59	10.83
364		Mean	StDev	Skew	Kurt				
365	Moment measures	2.55	3.08	0.89	4.17				
366	Graphic (Folk)	2.33	3.13	0.18	2.52				
367	Inman		2.20	0.07					
369		Gravel	Sand	Silt	Clay				
370	Proportions	10.30	71.57	9.42	8.71				

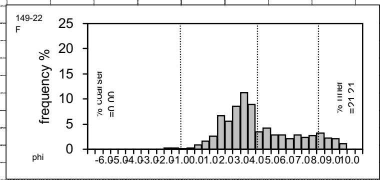


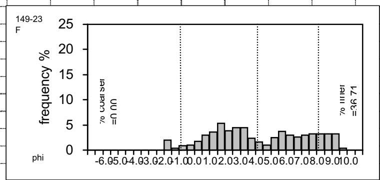
149-21

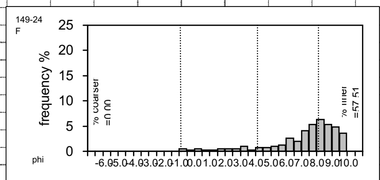
	A	D	E	F	G	H	I	J	K
377		1%	5%	16%	25%	50%	75%	84%	95%
378	Percentiles	-1.51	-0.54	0.66	1.30	2.93	7.28	10.43	19.27
380		Mean	StDev	Skew	Kurt				
381	Moment measures	4.16	3.76	0.57	1.98				
382	Graphic (Folk)	4.67	5.44	0.59	1.36				
383	Inman		4.89	0.54					
385		Gravel	Sand	Silt	Clay				
386	Proportions	2.86	57.92	17.05	22.16				



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**				**Output data for grain size**																															
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
388	**149-22**																																			
389	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.04	0.02	0.05	0.14	0.27	0.45	1.14	0.95	1.45	1.92	1.52	0.60	0.71	0.48	0.49	0.36	0.48	0.40	0.46	0.54	0.38	0.35	0.20
390	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.23	0.12	0.29	0.82	1.58	2.64	6.68	5.57	8.49	11.25	8.90	3.51	4.16	2.81	2.87	2.11	2.81	2.34	2.69	3.16	2.23	2.05	1.17
391	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.53	0.64	0.94	1.76	3.34	5.98	12.65	18.22	26.71	37.96	46.87	50.38	54.54	57.35	60.22	62.33	65.14	67.49	70.18	73.35	75.57	77.62	78.79
392	Bathymetry 1450m																																			
393				1%	5%	16%	25%	50%	75%	84%	95%																									
394	Percentiles			0.05	1.34	2.31	2.91	4.45	8.87	12.45	20.63																									
395																																				
396				Mean	StDev	Skew	Kurt																													
397	Moment measures			5.56	3.33	0.32	1.72																													
398	Graphic (Folk)			6.40	5.46	0.63	1.33																													
399	Inman				5.07	0.58																														
400																																				
401				Gravel	Sand	Silt	Clay																													
402	Proportions			0.53	46.34	23.32	29.82																													
403																																				
404	**149-23**																																			
405	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.04	0.10	0.12	0.20	0.35	0.43	0.64	0.46	0.53	0.53	0.28	0.19	0.12	0.29	0.44	0.35	0.31	0.36	0.39	0.38	0.39	0.39	0.04
406	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	0.33	0.84	1.00	1.67	2.93	3.60	5.35	3.85	4.43	4.43	2.34	1.59	1.00	2.42	3.68	2.93	2.59	3.01	3.26	3.18	3.26	3.26	0.33
407	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.01	2.34	3.18	4.18	5.85	8.78	12.37	17.73	21.57	26.00	30.43	32.78	34.36	35.37	37.79	41.47	44.40	46.99	50.00	53.26	56.44	59.70	62.96	63.29
408	Bathymetry 1884m																																			
409				1%	5%	16%	25%	50%	75%	84%	95%																									
410	Percentiles			-1.58	0.26	1.85	2.89	7.50	28.88	46.92	83.59																									
411																																				
412				Mean	StDev	Skew	Kurt																													
413	Moment measures			6.58	3.86	-0.45	1.77																													
414	Graphic (Folk)			18.76	23.89	0.79	1.31																													
415	Inman				22.53	0.75																														
416																																				
417				Gravel	Sand	Silt	Clay																													
418	Proportions			2.34	30.43	20.48	46.74																													
419																																				
420	**149-24**																																			
421	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.02	0.01	0.01	0.02	0.02	0.02	0.04	0.01	0.03	0.03	0.04	0.05	0.10	0.08	0.16	0.21	0.25	0.21	0.19	0.14
422	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.25	0.51	0.25	0.25	0.51	0.51	0.51	1.02	0.25	0.76	0.76	1.02	1.27	2.54	2.04	4.07	5.34	6.36	5.34	4.83	3.56
423	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.51	0.76	1.27	1.53	1.78	2.29	2.80	3.31	4.33	4.58	5.34	6.11	7.12	8.40	10.94	12.98	17.05	22.39	28.75	34.10	38.93	42.49
424	Bathymetry 2535m																																			
425				1%	5%	16%	25%	50%	75%	84%	95%																									
426	Percentiles			0.26	4.28	7.38	8.21	11.03	14.70	16.45	19.99																									
427																																				
428				Mean	StDev	Skew	Kurt																													
429	Moment measures			9.10	2.23	-2.07	7.54																													
430	Graphic (Folk)			11.62	4.65	0.17	0.99																													
431	Inman				4.53	0.19																														
432																																				
433				Gravel	Sand	Silt	Clay																													
434	Proportions				4.58	17.81	77.61																													
435																																				





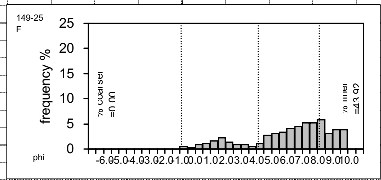


APPENDIX B Output data for grain size

	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
436	**149-25**																																	
437	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.03	0.04	0.06	0.08	0.05	0.03	0.03	0.02	0.04	0.10	0.11	0.12	0.15	0.16	0.19	0.19	0.21	0.11	0.14	0.14
438	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.28	0.83	1.10	1.66	2.21	1.38	0.83	0.83	0.55	1.10	2.76	3.04	3.31	4.14	4.42	5.25	5.25	5.80	3.04	3.87	3.87
439	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.83	1.66	2.76	4.42	6.63	8.01	8.84	9.67	10.22	11.33	14.09	17.13	20.44	24.59	29.01	34.25	39.50	45.30	48.34	52.21	56.08
440	Bathymetry 2010m																																	
452	**149-27**																																	
453	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.18	0.36	0.51	0.68	0.69	0.98	0.60	0.60	0.47	0.31	0.22	0.21	0.15	0.15	0.15	0.10	0.19	0.15	0.13	0.12	0.15	0.05
454	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	2.01	4.03	5.70	7.61	7.72	10.96	6.71	6.71	5.26	3.47	2.46	2.35	1.68	1.68	1.68	1.12	2.13	1.68	1.45	1.34	1.68	0.56
455	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.79	3.80	7.83	13.53	21.14	28.86	39.82	46.53	53.24	58.50	61.97	64.43	66.78	68.46	70.13	71.81	72.93	75.06	76.73	78.19	79.53	81.21	81.77
456	Bathymetry 1200m																																	
468	**149-28**																																	
469	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.85	1.22	0.12	0.33	0.24	0.37	0.65	0.85	1.12	1.13	1.53	0.98	1.00	1.11	0.66	0.39	0.45	0.38	0.26	0.27	0.13	0.18	0.22	0.21	0.22	0.18	0.22
470	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	4.92	7.06	0.69	1.91	1.39	2.14	3.76	4.92	6.49	6.54	8.86	5.67	5.79	6.43	3.82	2.26	2.61	2.20	1.51	1.56	0.75	1.04	1.27	1.22	1.27	1.04	1.27
471	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	4.92	11.99	12.68	14.59	15.98	18.12	21.89	26.81	33.29	39.84	48.70	54.37	60.16	66.59	70.41	72.67	75.28	77.48	78.98	80.54	81.30	82.34	83.61	84.83	86.10	87.15	88.42
472	Bathymetry 527 m																																	

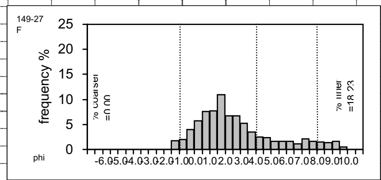
149-25

	A	D	E	F	G	H	I	J	K
441		1%	5%	16%	25%	50%	75%	84%	95%
442	Percentiles	0.13	1.65	5.32	6.55	9.21	12.67	14.32	17.65
443									
444		Mean	StDev	Skew	Kurt				
445	Moment measures	8.13	2.88	-1.17	3.51				
446	Graphic (Folk)	9.62	4.67	0.09	1.07				
447	Inman		4.50	0.13					
448									
449		Gravel	Sand	Silt	Clay				
450	Proportions		10.22	29.28	60.50				
451									



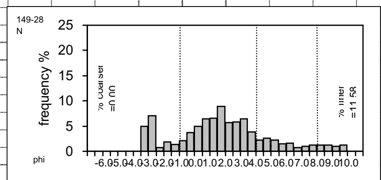
149-27

	A	D	E	F	G	H	I	J	K
457		1%	5%	16%	25%	50%	75%	84%	95%
458	Percentiles	-1.07	-0.32	0.68	1.26	2.76	7.49	12.10	27.63
459									
460		Mean	StDev	Skew	Kurt				
461	Moment measures	4.18	3.79	0.62	1.94				
462	Graphic (Folk)	5.18	7.09	0.71	1.84				
463	Inman		5.71	0.64					
464									
465		Gravel	Sand	Silt	Clay				
466	Proportions	1.79	60.18	14.77	23.27				
467									



149-28

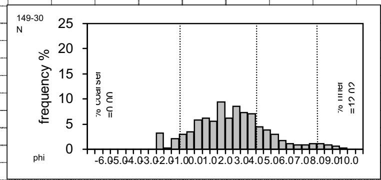
	A	D	E	F	G	H	I	J	K
473		1%	5%	16%	25%	50%	75%	84%	95%
474	Percentiles	-3.16	-2.99	-1.00	0.32	2.11	4.95	8.16	13.57
475									
476		Mean	StDev	Skew	Kurt				
477	Moment measures	2.88	4.03	0.53	2.45				
478	Graphic (Folk)	3.09	4.80	0.35	1.47				
479	Inman		4.58	0.32					
480									
481		Gravel	Sand	Silt	Clay				
482	Proportions	15.98	54.43	13.20	16.39				
483									



APPENDIX B Output data for grain size

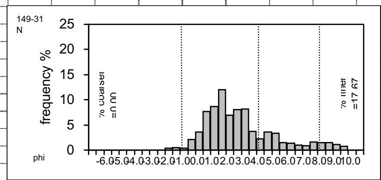
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
484	**149-30**																																	
485	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.01	0.07	0.10	0.12	0.20	0.21	0.19	0.32	0.21	0.29	0.25	0.24	0.15	0.13	0.10	0.06	0.04	0.03	0.03	0.04	0.04	0.03	0.02	0.01
486	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	0.29	2.05	2.93	3.52	5.87	6.16	5.57	9.38	6.16	8.50	7.33	7.04	4.40	3.81	2.93	1.76	1.17	0.88	0.88	1.17	1.17	0.88	0.59	0.29
487	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.23	3.52	5.57	8.50	12.02	17.89	24.05	29.62	39.00	45.16	53.67	61.00	68.04	72.43	76.25	79.18	80.94	82.11	82.99	83.87	85.04	86.22	87.10	87.68	87.98
488	Bathymetry 515 m																																	

	A	D	E	F	G	H	I	J	K
489		1%	5%	16%	25%	50%	75%	84%	95%
490	Percentiles	-2.13	-1.12	0.35	1.09	2.78	4.83	7.55	26.23
491									
492		Mean	StDev	Skew	Kurt				
493	Moment measures	3.46	3.45	0.77	2.82				
494	Graphic (Folk)	3.56	5.94	0.52	2.99				
495	Inman		3.60	0.32					
496									
497		Gravel	Sand	Silt	Clay				
498	Proportions	5.57	62.46	17.01	14.96				
499									



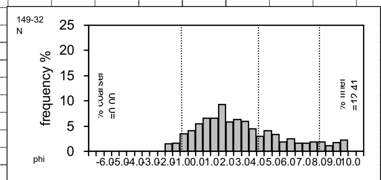
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
500	**149-31**																																	
501	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.03	0.18	0.31	0.67	0.76	1.05	0.61	0.71	0.72	0.33	0.20	0.31	0.29	0.13	0.12	0.09	0.08	0.14	0.13	0.13	0.10	0.06
502	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.46	0.34	2.05	3.53	7.64	8.67	11.97	6.96	8.10	8.21	3.76	2.28	3.53	3.31	1.48	1.37	1.03	0.91	1.60	1.48	1.48	1.14	0.68
503	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.34	0.80	1.14	3.19	6.73	14.37	23.03	35.01	41.96	50.06	58.27	62.03	64.31	67.84	71.15	72.63	74.00	75.03	75.94	77.54	79.02	80.50	81.64	82.33
504	Bathymetry 512 m																																	

	A	D	E	F	G	H	I	J	K
505		1%	5%	16%	25%	50%	75%	84%	95%
506	Percentiles	-0.69	0.29	1.11	1.59	3.00	6.99	11.28	23.76
507									
508		Mean	StDev	Skew	Kurt				
509	Moment measures	4.30	3.57	0.72	2.11				
510	Graphic (Folk)	5.13	6.10	0.70	1.78				
511	Inman		5.09	0.63					
512									
513		Gravel	Sand	Silt	Clay				
514	Proportions	0.80	61.23	15.51	22.46				
515									

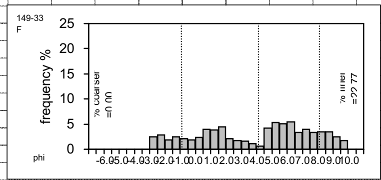


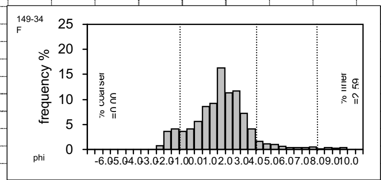
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
516	**149-32**																																	
517	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10	0.11	0.24	0.29	0.38	0.46	0.46	0.65	0.41	0.44	0.42	0.31	0.21	0.29	0.23	0.13	0.17	0.11	0.11	0.13	0.13	0.08	0.12	0.16
518	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	1.57	3.42	4.14	5.42	6.56	6.56	9.27	5.85	6.28	5.99	4.42	3.00	4.14	3.28	1.85	2.43	1.57	1.57	1.85	1.85	1.14	1.71	2.28
519	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.43	3.00	6.42	10.56	15.98	22.54	29.10	38.37	44.22	50.50	56.49	60.91	63.91	68.05	71.33	73.18	75.61	77.18	78.74	80.60	82.45	83.59	85.31	87.59
520	Bathymetry 502 m																																	

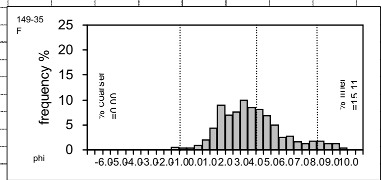
	A	D	E	F	G	H	I	J	K
521		1%	5%	16%	25%	50%	75%	84%	95%
522	Percentiles	-1.54	-0.67	0.50	1.20	2.96	6.37	9.12	12.33
523									
524		Mean	StDev	Skew	Kurt				
525	Moment measures	3.95	3.61	0.60	2.17				
526	Graphic (Folk)	4.19	4.12	0.44	1.03				
527	Inman		4.31	0.43					
528									
529		Gravel	Sand	Silt	Clay				
530	Proportions	3.00	57.92	19.69	19.40				
531									



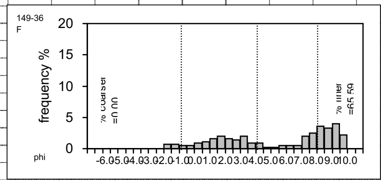
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**				**Output data for grain size**																															
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
532	**149-33**																																			
533	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.35	0.23	0.31	0.26	0.23	0.29	0.49	0.48	0.55	0.26	0.21	0.20	0.13	0.07	0.52	0.66	0.62	0.67	0.41	0.49	0.41	0.43	0.43	0.31	0.22
534	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.43	2.84	1.86	2.51	2.11	1.86	2.35	3.97	3.89	4.46	2.11	1.70	1.62	1.05	0.57	4.21	5.35	5.02	5.43	3.32	3.97	3.32	3.48	3.48	2.51	1.78
535	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.43	5.27	7.13	9.64	11.75	13.61	15.96	19.94	23.82	28.28	30.39	32.09	33.71	34.76	35.33	39.55	44.89	49.92	55.35	58.67	62.64	65.96	69.45	72.93	75.45	77.23
536	Bathymetry 834 m																																			
537				1%	5%	16%	25%	50%	75%	84%	95%																									
538	Percentiles			-2.60	-2.04	0.50	1.64	6.01	9.41	12.15	17.77																									
539																																				
540				Mean	StDev	Skew	Kurt																													
541	Moment measures			5.43	4.20	-0.36	1.88																													
542	Graphic (Folk)			6.22	5.91	0.12	1.04																													
543	Inman				5.82	0.05																														
544																																				
545				Gravel	Sand	Silt	Clay																													
546	Proportions			9.64	25.12	31.20	34.04																													
547																																				
548	**149-34**																																			
549	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.62	0.71	0.62	0.72	0.98	1.48	1.59	2.83	1.96	2.04	1.26	0.72	0.28	0.20	0.17	0.11	0.07	0.06	0.07	0.08	0.03	0.06	0.05	0.06
550	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	3.57	4.09	3.57	4.15	5.65	8.53	9.16	16.30	11.29	11.75	7.26	4.15	1.61	1.15	0.98	0.63	0.40	0.35	0.40	0.46	0.17	0.35	0.29	0.35
551	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.81	4.38	8.47	12.04	16.19	21.83	30.36	39.52	55.82	67.11	78.86	86.12	90.26	91.88	93.03	94.01	94.64	95.05	95.39	95.79	96.26	96.43	96.77	97.06	97.41
552	Bathymetry 1215m																																			
553				1%	5%	16%	25%	50%	75%	84%	95%																									
554	Percentiles			-1.94	-1.40	-0.02	0.70	1.82	2.82	3.34	6.44																									
555																																				
556				Mean	StDev	Skew	Kurt																													
557	Moment measures			1.98	2.34	1.44	6.69																													
558	Graphic (Folk)			1.71	2.03	0.04	1.51																													
559	Inman				1.68	-0.10																														
560																																				
561				Gravel	Sand	Silt	Clay																													
562	Proportions			8.47	81.80	5.99	3.74																													
563																																				
564	**149-35**																																			
565	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.02	0.05	0.11	0.24	0.50	0.39	0.42	0.55	0.47	0.45	0.38	0.28	0.14	0.15	0.09	0.07	0.10	0.10	0.07	0.07	0.02
566	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.36	0.36	0.90	1.98	4.32	8.99	7.01	7.55	9.89	8.45	8.09	6.83	5.04	2.52	2.70	1.62	1.26	1.80	1.80	1.26	1.26	0.36
567	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.54	0.90	1.26	2.16	4.14	8.45	17.45	24.46	32.01	41.91	50.36	58.45	65.29	70.32	72.84	75.54	77.16	78.42	80.22	82.01	83.27	84.53	84.89
568	Bathymetry 1566m																																			
569				1%	5%	16%	25%	50%	75%	84%	95%																									
570	Percentiles			-0.34	1.13	1.93	2.54	3.98	6.40	9.29	30.12																									
571																																				
572				Mean	StDev	Skew	Kurt																													
573	Moment measures			4.80	3.08	0.71	2.41																													
574	Graphic (Folk)			5.07	6.23	0.62	3.08																													
575	Inman				3.68	0.44																														
576																																				
577				Gravel	Sand	Silt	Clay																													
578	Proportions			0.54	49.82	29.86	19.78																													
579																																				



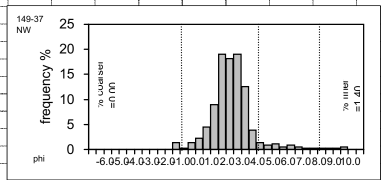




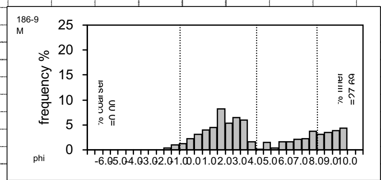
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**				**Output data for grain size**																															
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
580	**149-36**																																			
581	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.04	0.03	0.03	0.05	0.06	0.09	0.11	0.09	0.08	0.11	0.05	0.05	0.01	0.01	0.03	0.03	0.03	0.11	0.14	0.20	0.18	0.22	0.12
582	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	0.72	0.54	0.54	0.90	1.08	1.62	1.98	1.62	1.44	1.98	0.90	0.90	0.18	0.18	0.54	0.54	0.54	1.98	2.52	3.60	3.24	3.96	2.16
583	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	1.44	1.98	2.52	3.42	4.50	6.13	8.11	9.73	11.17	13.15	14.05	14.95	15.14	15.32	15.86	16.40	16.94	18.92	21.44	25.05	28.29	32.25	34.41
584	Bathymetry 2105m																																			
585				1%	5%	16%	25%	50%	75%	84%	95%																									
586	Percentiles			-1.27	1.17	6.13	8.49	13.37	19.04	21.73	27.20																									
587																																				
588				Mean	StDev	Skew	Kurt																													
589	Moment measures			8.75	3.19	-1.82	4.98																													
590	Graphic (Folk)			13.75	7.84	0.07	1.01																													
591	Inman				7.80	0.07																														
592																																				
593				Gravel	Sand	Silt	Clay																													
594	Proportions			1.44	12.61	7.39	78.56																													
595																																				



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
596	**149-37**																																			
597	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.01	0.05	0.08	0.16	0.32	0.68	0.65	0.68	0.45	0.14	0.05	0.03	0.04	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.02
598	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40	0.28	1.40	2.23	4.47	8.94	18.99	18.16	18.99	12.57	3.91	1.40	0.84	1.12	0.56	0.84	0.56	0.28	0.28	0.28	0.28	0.28	0.56
599	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.40	1.68	3.07	5.31	9.78	18.72	37.71	55.87	74.86	87.43	91.34	92.74	93.58	94.69	95.25	96.09	96.65	96.93	97.21	97.49	97.77	98.04	98.60
600	Bathymetry 168 m																																			
601				1%	5%	16%	25%	50%	75%	84%	95%																									
602	Percentiles			-1.04	0.44	1.37	1.69	2.34	3.00	3.34	5.77																									
603																																				
604				Mean	StDev	Skew	Kurt																													
605	Moment measures			2.54	1.76	2.10	10.27																													
606	Graphic (Folk)			2.35	1.30	0.15	1.66																													
607	Inman				0.99	0.02																														
608																																				
609				Gravel	Sand	Silt	Clay																													
610	Proportions			1.40	89.94	5.87	2.79																													
611																																				



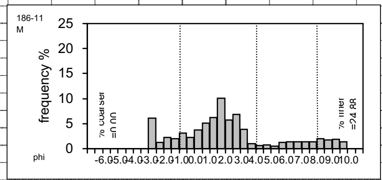
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
612	**186-9**																																			
613	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.07	0.09	0.16	0.22	0.28	0.31	0.57	0.37	0.45	0.42	0.11	0.01	0.10	0.03	0.11	0.11	0.15	0.16	0.26	0.22	0.24	0.27	0.30
614	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	1.00	1.29	2.30	3.16	4.02	4.45	8.18	5.31	6.46	6.03	1.58	0.14	1.43	0.43	1.58	1.58	2.15	2.30	3.73	3.16	3.44	3.87	4.30
615	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.43	1.43	2.73	5.02	8.18	12.20	16.64	24.82	30.13	36.59	42.61	44.19	44.33	45.77	46.20	47.78	49.35	51.51	53.80	57.53	60.69	64.13	68.01	72.31
616	Bathymetry 698 m																																			
617				1%	5%	16%	25%	50%	75%	84%	95%																									
618	Percentiles			-1.16	0.00	1.43	2.02	6.65	10.33	11.62	14.24																									
619																																				
620				Mean	StDev	Skew	Kurt																													
621	Moment measures			5.89	4.01	-0.14	1.41																													
622	Graphic (Folk)			6.57	4.70	0.02	0.70																													
623	Inman				5.09	-0.02																														
624																																				
625				Gravel	Sand	Silt	Clay																													
626	Proportions			1.43	42.75	13.34	42.47																													
627																																				



APPENDIX B Output data for grain size

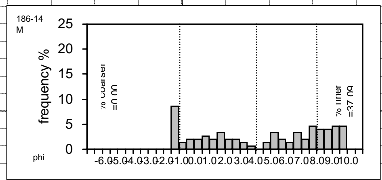
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
628	**186-11**																																	
629	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.39	0.08	0.14	0.13	0.20	0.14	0.24	0.33	0.40	0.65	0.37	0.44	0.25	0.06	0.04	0.05	0.03	0.08	0.09	0.09	0.09	0.09	0.13	0.11	0.12	0.09
630	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.07	1.24	2.18	2.02	3.11	2.18	3.73	5.13	6.22	10.11	5.75	6.84	3.89	0.93	0.62	0.78	0.47	1.24	1.40	1.40	1.40	1.40	2.02	1.71	1.87	1.40
631	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	6.07	7.31	9.49	11.51	14.62	16.80	20.53	25.66	31.88	41.99	47.74	54.59	58.48	59.41	60.03	60.81	61.28	62.52	63.92	65.32	66.72	68.12	70.14	71.85	73.72	75.12
632	Bathymetry 655 m																																	

	A	D	E	F	G	H	I	J	K
633		1%	5%	16%	25%	50%	75%	84%	95%
634	Percentiles	-2.68	-2.52	-0.18	0.94	2.66	9.96	13.63	21.11
635									
636		Mean	StDev	Skew	Kurt				
637	Moment measures	4.28	4.55	0.22	1.60				
638	Graphic (Folk)	5.37	7.03	0.57	1.07				
639	Inman		6.91	0.59					
640									
641		Gravel	Sand	Silt	Clay				
642	Proportions	11.51	47.90	8.71	31.88				
643									



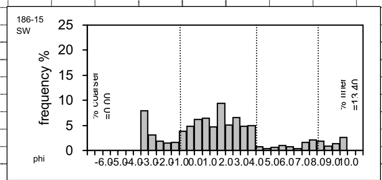
	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
644	**186-14**																																	
645	Data	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.13	0.02	0.03	0.03	0.04	0.03	0.05	0.03	0.03	0.02	0.01	0.00	0.02	0.05	0.03	0.02	0.05	0.03	0.07	0.06	0.06	0.07	0.07
646	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.61	1.32	1.99	1.99	2.65	1.99	3.31	1.99	1.99	1.32	0.66	0.00	1.32	3.31	1.99	1.32	3.31	1.99	4.64	3.97	3.97	4.64	4.64
647	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	8.61	9.93	11.92	13.91	16.56	18.54	21.85	23.84	25.83	27.15	27.81	27.81	29.14	32.45	34.44	35.76	39.07	41.06	45.70	49.67	53.64	58.28	62.91
648	Bathymetry 690 m																																	

	A	D	E	F	G	H	I	J	K
649		1%	5%	16%	25%	50%	75%	84%	95%
650	Percentiles	-1.20	-1.06	0.90	2.79	8.54	11.43	12.76	15.45
651									
652		Mean	StDev	Skew	Kurt				
653	Moment measures	6.76	4.21	-0.77	2.06				
654	Graphic (Folk)	7.40	5.47	-0.23	0.78				
655	Inman		5.93	-0.29					
656									
657		Gravel	Sand	Silt	Clay				
658	Proportions	8.61	19.21	17.88	54.30				
659									



	A	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
660	**186-15**																																	
661	Data	0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.48	0.29	0.24	0.25	0.59	0.76	0.97	1.00	0.73	1.46	0.79	1.02	0.75	0.77	0.11	0.05	0.09	0.15	0.11	0.06	0.25	0.32	0.29	0.13	0.22	0.40
662	Frequency %	0.00	0.00	0.00	0.00	0.00	0.00	7.88	3.08	1.86	1.54	1.60	3.78	4.87	6.22	6.41	4.68	9.36	5.06	6.54	4.81	4.94	0.71	0.32	0.58	0.96	0.71	0.38	1.60	2.05	1.86	0.83	1.41	2.56
663	Cumulative %	0.00	0.00	0.00	0.00	0.00	0.00	7.88	10.96	12.82	14.36	15.96	19.74	24.62	30.83	37.24	41.92	51.28	56.35	62.88	67.69	72.63	73.33	73.65	74.23	75.19	75.90	76.28	77.88	79.94	81.79	82.63	84.04	86.60
664	Bathymetry 1050m																																	

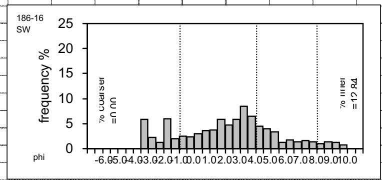
	A	D	E	F	G	H	I	J	K
665		1%	5%	16%	25%	50%	75%	84%	95%
666	Percentiles	-3.20	-3.05	-0.99	0.03	1.93	5.90	9.49	12.40
667									
668		Mean	StDev	Skew	Kurt				
669	Moment measures	2.94	4.30	0.54	2.19				
670	Graphic (Folk)	3.47	4.96	0.40	1.08				
671	Inman		5.24	0.44					
672									
673		Gravel	Sand	Silt	Clay				
674	Proportions	15.96	56.67	7.31	20.06				
675									



APPENDIX B Output data for grain size

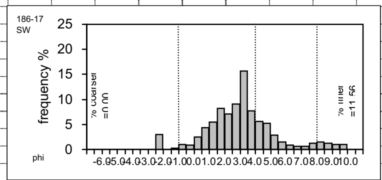
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
676	**186-16**																																			
677	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.74	0.28	0.15	0.76	0.25	0.31	0.30	0.37	0.45	0.47	0.73	0.59	0.74	1.07	0.81	0.57	0.51	0.43	0.16	0.22	0.17	0.20	0.18	0.12	0.17	0.16	0.09
678	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	5.86	2.22	1.19	6.02	1.98	2.46	2.38	2.93	3.57	3.72	5.78	4.68	5.86	8.48	6.42	4.52	4.04	3.41	1.27	1.74	1.35	1.58	1.43	0.95	1.35	1.27	0.71
679	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	5.86	8.08	9.27	15.29	17.27	19.73	22.11	25.04	28.61	32.33	38.11	42.79	48.65	57.13	63.55	68.07	72.11	75.52	76.78	78.53	79.87	81.46	82.88	83.84	85.18	86.45	87.16
680	Bathymetry 726																																			

	A	D	E	F	G	H	I	J	K
681		1%	5%	16%	25%	50%	75%	84%	95%
682	Percentiles	-3.18	-3.02	-1.32	0.49	3.08	5.42	8.56	17.65
683									
684		Mean	StDev	Skew	Kurt				
685	Moment measures	3.32	4.05	0.31	2.28				
686	Graphic (Folk)	3.44	5.60	0.26	1.72				
687	Inman		4.94	0.11					
688									
689		Gravel	Sand	Silt	Clay				
690	Proportions	17.27	46.28	19.33	17.12				
691									



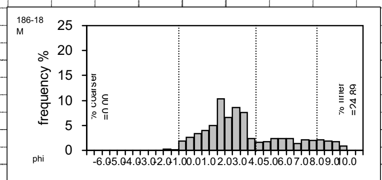
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
692	**186-17**																																			
693	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.00	0.03	0.10	0.08	0.24	0.43	0.54	0.81	0.70	0.90	1.54	0.76	0.55	0.51	0.28	0.15	0.09	0.06	0.06	0.12	0.15	0.12	0.10	0.10
694	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.04	0.00	0.30	1.01	0.81	2.43	4.36	5.48	8.22	7.10	9.13	15.62	7.71	5.58	5.17	2.84	1.52	0.91	0.61	0.61	1.22	1.52	1.22	1.01	1.01
695	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.04	3.04	3.35	4.36	5.17	7.61	11.97	17.44	25.66	32.76	41.89	57.51	65.21	70.79	75.96	78.80	80.32	81.24	81.85	82.45	83.67	85.19	86.41	87.42	88.44
696	Bathymetry 716 m																																			

	A	D	E	F	G	H	I	J	K
697		1%	5%	16%	25%	50%	75%	84%	95%
698	Percentiles	-2.12	-0.10	1.38	1.96	3.26	4.90	8.11	14.43
699									
700		Mean	StDev	Skew	Kurt				
701	Moment measures	3.97	3.20	0.75	3.01				
702	Graphic (Folk)	4.25	3.88	0.49	2.03				
703	Inman		3.36	0.44					
704									
705		Gravel	Sand	Silt	Clay				
706	Proportions	3.35	61.87	18.46	16.33				
707									



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
708	**186-18**																																			
709	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.02	0.21	0.30	0.38	0.45	0.56	1.16	0.74	0.96	0.86	0.26	0.18	0.20	0.27	0.26	0.26	0.15	0.24	0.22	0.24	0.21	0.19	0.10
710	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.18	1.87	2.67	3.38	4.00	4.98	10.31	6.58	8.53	7.64	2.31	1.60	1.78	2.40	2.31	2.31	1.33	2.13	1.96	2.13	1.87	1.69	0.89
711	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.27	0.44	2.31	4.98	8.36	12.36	17.33	27.64	34.22	42.76	50.40	52.71	54.31	56.09	58.49	60.80	63.11	64.44	66.58	68.53	70.67	72.53	74.22	75.11
712	Bathymetry 608 m																																			

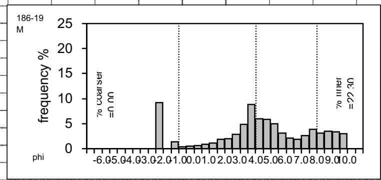
	A	D	E	F	G	H	I	J	K
713		1%	5%	16%	25%	50%	75%	84%	95%
714	Percentiles	-0.77	0.00	1.38	1.88	3.47	9.94	15.70	27.40
715									
716		Mean	StDev	Skew	Kurt				
717	Moment measures	5.12	3.86	0.29	1.55				
718	Graphic (Folk)	6.85	7.73	0.73	1.39				
719	Inman		7.16	0.71					
720									
721		Gravel	Sand	Silt	Clay				
722	Proportions	0.44	52.27	15.82	31.47				
723									

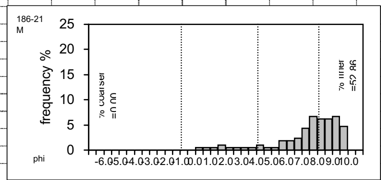


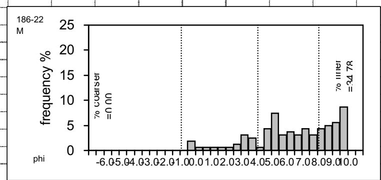
APPENDIX B Output data for grain size

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	**APPENDIX B**				**Output data for grain size**														
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**
724	**186-19**																		
725	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.55	0.00	0.08	0.02	0.03	0.04	0.05	0.07
726	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.15	0.00	1.33	0.33	0.50	0.67	0.83	1.16
727	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.15	9.15	10.48	10.82	11.31	11.98	12.81	13.98
728	Bathymetry 775 m																		
729				1%	5%	16%	25%	50%	75%	84%	95%								
730	Percentiles			-2.21	-2.07	2.05	3.45	5.39	9.55	11.20	14.56								
731																			
732				Mean	StDev	Skew	Kurt												
733	Moment measures			5.67	3.97	-0.45	2.29												
734	Graphic (Folk)			6.21	4.81	0.19	1.12												
735	Inman				4.57	0.27													
736																			
737				Gravel	Sand	Silt	Clay												
738	Proportions			10.48	23.79	30.45	35.27												
739																			
740	**186-21**																		
741	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
742	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.48	0.48
743	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.48	0.95	1.43
744	Bathymetry 570 m																		
745				1%	5%	16%	25%	50%	75%	84%	95%								
746	Percentiles			1.06	4.38	7.43	8.14	10.30	13.10	14.42	17.12								
747																			
748				Mean	StDev	Skew	Kurt												
749	Moment measures			9.07	2.12	-1.94	6.90												
750	Graphic (Folk)			10.72	3.68	0.13	1.05												
751	Inman				3.50	0.18													
752																			
753				Gravel	Sand	Silt	Clay												
754	Proportions				4.29	19.05	76.67												
755																			
756	**186-22**																		
757	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.01	0.01	0.01
758	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.86	0.62	0.62	0.62
759	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.86	2.48	3.11	3.73
760	Bathymetry660 m																		
761				1%	5%	16%	25%	50%	75%	84%	95%								
762	Percentiles			-0.07	2.51	4.92	5.63	8.91	10.62	11.33	12.76								
763																			
764				Mean	StDev	Skew	Kurt												
765	Moment measures			7.87	2.86	-0.95	3.02												
766	Graphic (Folk)			8.38	3.16	-0.25	0.84												
767	Inman				3.21	-0.24													
768																			
769				Gravel	Sand	Silt	Clay												
770	Proportions				11.80	29.81	58.39												
771																			

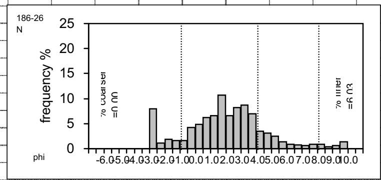
	A	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
2	**Class midpts**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
725	Data	0.11	0.12	0.17	0.29	0.53	0.36	0.35	0.30	0.19	0.13	0.11	0.16	0.23	0.19	0.21	0.20	0.18
726	Frequency %	1.83	2.00	2.83	4.83	8.82	5.99	5.82	4.99	3.16	2.16	1.83	2.66	3.83	3.16	3.49	3.33	3.00
727	Cumulative %	15.81	17.80	20.63	25.46	34.28	40.27	46.09	51.08	54.24	56.41	58.24	60.90	64.73	67.89	71.38	74.71	77.70
741	Data	0.02	0.01	0.01	0.01	0.01	0.02	0.01	0.01	0.04	0.04	0.05	0.09	0.14	0.13	0.13	0.14	0.10
742	Frequency %	0.95	0.48	0.48	0.48	0.48	0.95	0.48	0.48	1.90	1.90	2.38	4.29	6.67	6.19	6.19	6.67	4.76
743	Cumulative %	2.38	2.86	3.33	3.81	4.29	5.24	5.71	6.19	8.10	10.00	12.38	16.67	23.33	29.52	35.71	42.38	47.14
757	Data	0.01	0.01	0.02	0.05	0.04	0.01	0.07	0.12	0.05	0.06	0.05	0.07	0.05	0.07	0.08	0.09	0.14
758	Frequency %	0.62	0.62	1.24	3.11	2.48	0.62	4.35	7.45	3.11	3.73	3.11	4.35	3.11	4.35	4.97	5.59	8.70
759	Cumulative %	4.35	4.97	6.21	9.32	11.80	12.42	16.77	24.22	27.33	31.06	34.16	38.51	41.61	45.96	50.93	56.52	65.22

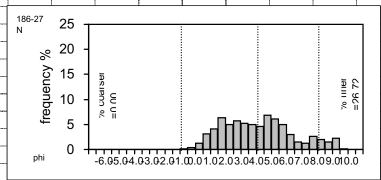


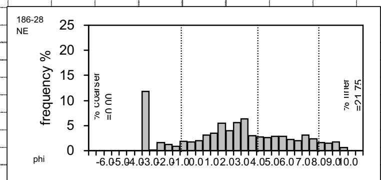




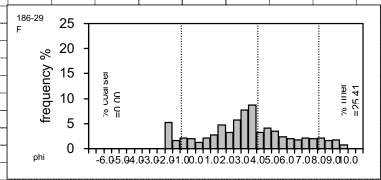
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**					**Output data for grain size**																														
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
772	**186-26**																																			
773	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.16	0.26	0.23	0.23	0.60	0.70	0.88	0.94	1.52	0.94	1.17	1.25	1.00	0.49	0.45	0.36	0.20	0.12	0.10	0.08	0.12	0.12	0.06	0.09	0.20
774	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.99	1.12	1.82	1.61	1.61	4.20	4.91	6.17	6.59	10.65	6.59	8.20	8.76	7.01	3.43	3.15	2.52	1.40	0.84	0.70	0.56	0.84	0.84	0.42	0.63	1.40
775	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	7.99	9.11	10.93	12.54	14.16	18.36	23.27	29.43	36.02	46.67	53.26	61.46	70.22	77.22	80.66	83.81	86.33	87.74	88.58	89.28	89.84	90.68	91.52	91.94	92.57	93.97
776	Bathymetry 390 m																																			
777				1%	5%	16%	25%	50%	75%	84%	95%																									
778	Percentiles			-2.70	-2.55	-0.27	0.65	2.25	3.83	5.04	10.43																									
779																																				
780				Mean	StDev	Skew	Kurt																													
781	Moment measures			2.58	3.28	0.71	3.48																													
782	Graphic (Folk)			2.34	3.29	0.15	1.67																													
783	Inman				2.65	0.05																														
784																																				
785				Gravel	Sand	Silt	Clay																													
786	Proportions			12.54	64.68	13.45	9.32																													
787																																				
788	**186-27**																																			
789	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.07	0.17	0.22	0.34	0.27	0.31	0.28	0.27	0.25	0.37	0.33	0.27	0.16	0.08	0.07	0.14	0.11	0.08	0.12	0.01
790	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.37	1.30	3.15	4.08	6.31	5.01	5.75	5.19	5.01	4.64	6.86	6.12	5.01	2.97	1.48	1.30	2.60	2.04	1.48	2.23	0.19
791	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.19	0.56	1.86	5.01	9.09	15.40	20.41	26.16	31.35	36.36	41.00	47.87	53.99	59.00	61.97	63.45	64.75	67.35	69.39	70.87	73.10	73.28
792	Bathymetry 436 m																																			
793				1%	5%	16%	25%	50%	75%	84%	95%																									
794	Percentiles			0.23	1.00	2.07	2.90	5.17	14.71	43.12	100.87																									
795																																				
796				Mean	StDev	Skew	Kurt																													
797	Moment measures			5.85	3.44	0.16	1.63																													
798	Graphic (Folk)			16.79	25.40	0.88	3.47																													
799	Inman				20.53	0.85																														
800																																				
801				Gravel	Sand	Silt	Clay																													
802	Proportions				36.36	30.98	32.65																													
803																																				
804	**186-28**																																			
805	Data			0.00	0.00	0.00	0.00	0.00	0.00	1.47	0.01	0.20	0.16	0.11	0.24	0.21	0.25	0.39	0.44	0.68	0.49	0.69	0.79	0.37	0.34	0.33	0.35	0.35	0.28	0.25	0.38	0.29	0.20	0.18	0.22	0.08
806	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	11.80	0.08	1.61	1.28	0.88	1.93	1.69	2.01	3.13	3.53	5.46	3.93	5.54	6.34	2.97	2.73	2.65	2.81	2.81	2.25	2.01	3.05	2.33	1.61	1.44	1.77	0.64
807	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	11.80	11.88	13.48	14.77	15.65	17.58	19.26	21.27	24.40	27.93	33.39	37.32	42.86	49.20	52.17	54.90	57.54	60.35	63.16	65.41	67.42	70.47	72.79	74.40	75.84	77.61	78.25
808	Bathymetry 338 m																																			
809				1%	5%	16%	25%	50%	75%	84%	95%																									
810	Percentiles			-3.23	-3.09	-0.91	1.09	3.64	8.71	14.94	29.96																									
811																																				
812				Mean	StDev	Skew	Kurt																													
813	Moment measures			4.25	4.60	-0.07	1.85																													
814	Graphic (Folk)			5.89	8.97	0.51	1.78																													
815	Inman				7.92	0.43																														
816																																				
817				Gravel	Sand	Silt	Clay																													
818	Proportions			15.65	36.52	20.63	27.21																													
819																																				



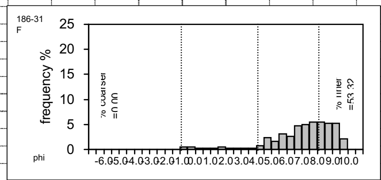




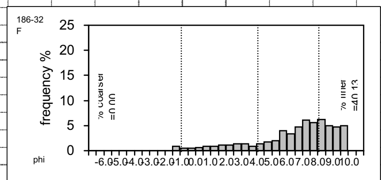
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
1	**APPENDIX B**				**Output data for grain size**																															
2	**Class midpts**			**-6.50**	**-5.75**	**-5.25**	**-4.75**	**-4.25**	**-3.75**	**-3.25**	**-2.75**	**-2.25**	**-1.75**	**-1.25**	**-0.75**	**-0.25**	**0.25**	**0.75**	**1.25**	**1.75**	**2.25**	**2.75**	**3.25**	**3.75**	**4.25**	**4.75**	**5.25**	**5.75**	**6.25**	**6.75**	**7.25**	**7.75**	**8.25**	**8.75**	**9.25**	**9.75**
3	**Class limits**			**-6.00**	**-5.50**	**-5.00**	**-4.50**	**-4.00**	**-3.50**	**-3.00**	**-2.50**	**-2.00**	**-1.50**	**-1.00**	**-0.50**	**0.00**	**0.50**	**1.00**	**1.50**	**2.00**	**2.50**	**3.00**	**3.50**	**4.00**	**4.50**	**5.00**	**5.50**	**6.00**	**6.50**	**7.00**	**7.50**	**8.00**	**8.50**	**9.00**	**9.50**	**10.00**
820	**186-29**																																			
821	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.09	0.12	0.11	0.07	0.12	0.15	0.26	0.18	0.32	0.43	0.48	0.18	0.23	0.19	0.13	0.11	0.10	0.12	0.11	0.12	0.09	0.10	0.04
822	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.23	1.62	2.16	1.98	1.26	2.16	2.70	4.68	3.24	5.77	7.75	8.65	3.24	4.14	3.42	2.34	1.98	1.80	2.16	1.98	2.16	1.62	1.80	0.72
823	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.23	6.85	9.01	10.99	12.25	14.41	17.12	21.80	25.05	30.81	38.56	47.21	50.45	54.59	58.02	60.36	62.34	64.14	66.31	68.29	70.45	72.07	73.87	74.59
824	Bathymetry 1230m																																			
825				1%	5%	16%	25%	50%	75%	84%	95%																									
826	Percentiles			-1.67	-1.51	1.30	2.49	4.43	10.28	17.45	32.02																									
827																																				
828				Mean	StDev	Skew	Kurt																													
829	Moment measures			5.24	3.96	0.01	1.80																													
830	Graphic (Folk)			7.73	9.12	0.63	1.76																													
831	Inman				8.08	0.61																														
832																																				
833				Gravel	Sand	Silt	Clay																													
834	Proportions			6.85	40.36	21.08	31.71																													
835																																				



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
836	**186-31**																																			
837	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.02	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.03	0.10	0.07	0.13	0.11	0.20	0.21	0.23	0.23	0.22	0.22	0.09
838	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.47	0.24	0.24	0.24	0.47	0.24	0.24	0.24	0.24	0.71	2.37	1.66	3.08	2.61	4.74	4.98	5.45	5.45	5.21	5.21	2.13
839	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.47	0.95	1.18	1.42	1.66	2.13	2.37	2.61	2.84	3.08	3.79	6.16	7.82	10.90	13.51	18.25	23.22	28.67	34.12	39.34	44.55	46.68
840	Bathymetry 1625m																																			
841				1%	5%	16%	25%	50%	75%	84%	95%																									
842	Percentiles			0.12	4.78	6.78	7.67	10.77	17.04	20.02	26.06																									
843																																				
844				Mean	StDev	Skew	Kurt																													
845	Moment measures			8.90	2.24	-1.69	6.15																													
846	Graphic (Folk)			12.52	6.54	0.42	0.93																													
847	Inman				6.62	0.40																														
848																																				
849				Gravel	Sand	Silt	Clay																													
850	Proportions				3.08	25.59	71.33																													
851																																				



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ
852	**186-32**																																			
853	Data			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.04	0.02	0.02	0.03	0.04	0.04	0.05	0.05	0.06	0.06	0.04	0.06	0.08	0.09	0.18	0.15	0.21	0.27	0.25	0.28	0.22	0.21	0.22
854	Frequency %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.45	0.45	0.67	0.90	0.90	1.12	1.12	1.35	1.35	0.90	1.35	1.79	2.02	4.04	3.36	4.71	6.05	5.61	6.28	4.93	4.71	4.93
855	Cumulative %			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	1.35	1.79	2.47	3.36	4.26	5.38	6.50	7.85	9.19	10.09	11.43	13.23	15.25	19.28	22.65	27.35	33.41	39.01	45.29	50.22	54.93	59.87
856	Bathymetry 565 m																																			
857				1%	5%	16%	25%	50%	75%	84%	95%																									
858	Percentiles			-0.87	1.84	5.60	6.76	8.98	11.69	12.96	15.54																									
859																																				
860				Mean	StDev	Skew	Kurt																													
861	Moment measures			8.12	2.84	-1.30	4.13																													
862	Graphic (Folk)			9.18	3.92	0.02	1.14																													
863	Inman				3.68	0.08																														
864																																				
865				Gravel	Sand	Silt	Clay																													
866	Proportions			0.90	9.19	28.92	60.99																													
867																																				



APPENDIX C

List of Species

Informal Group ACRITARCHA Evitt (1963), Downie et al (1963)

Subgroup ACANTHOMORPHITAE Downie, Evitt and Sargent (1963)

Acritarch sp. 1

Plate 1 Figure 1-3

Acanthomorphitae: Spherical with no inner body, processes are simple have regular symmetry, and are homomorphic. No obvious opening. Size 125 µm. Size of processes 25 µm.

Acritarch sp. 2

Plate 1 Figure 4-7

Acanthomorphitae: Ovoid with no inner body, processes are simple, acuminate, pelatoid and cylindrical, have regular symmetry and are heteromorphic. No obvious opening. Size 75 µm. Second type size 95.

Acritarch sp. 3

Plate 1 Figure 8-10

Acanthomorphitae: Spherical and dorso-ventrally compressed; processes are simple, have regular symmetry and are homomorphic. No obvious opening. Size 120-125 µm.

Acritarch sp. 4

Plate 1 Figure 11-12, Plate 2 Figure1-4

Acanthomorphitae: Spherical with no inner body; processes are simple, acuminate, and cylindrical, have regular symmetry and are heteromorphic. Opening visible. Size 100-150 µm.

Order PYRAMIMONADALES Chadefaud 1950

Family Leiosphaeridiaceae Timofeev 1956

Form genus *Leiosphaeridia* Eisenack 1958

***Leiospherida* sp.**

Plate 2 Figure 5

2000 *Leiosphaeridia* sp.2 Hannah *et al* Figure 4d

Spherical and pale yellow in colour, wall is smooth unornamented ~1 µm thick. No visible opening; size ~ 35 µm.

Subgroup uncertain

Genus Sigmopollis Hedlund 1965, Tappan 1980

***Sigmopollis* sp. Hannah *et al* 1998**

1998 *Sigmopollis* sp. Hannah *et al* Figure 4g

2000 *Sigmopollis* sp. Hannah *et al* Figure 4c

Subspherical to ovoid and sigmoidal, wall is smooth unornomented, hyaline and colourless; size 55 µm.

Subgroup SPHAEROMORPHITAE Downie, Evitt & Sarjeant 1963

***Sphaeromorph* sp.**

Plate 2 Figure 6-12

Spherical to ovoid no inner body; wall is usually smooth and easily folded, unornamented with no visible opening. Size 60-200+ µm.

Division PYRRHOPHYTA Pascher, 1914

Class DINOPHYCEAE Fritsch, 1929

Order GONYAULACALES Taylor, 1980

Family Goniodomaceae Lindemann, 1928

***Alisocysta* sp. Stover & Evitt 1978**

Plate 3 Figure 1-3

1980 *Alisocysta* sp. Tappan Figure 4.124

2000 *Alisocysta* sp. Levy & Harwood Plate 1, Figures a-d

Ovoid with penitabular septa with an apical archeopyles, pale brown colour size 75 µm.

Genus *Impagidinium* Stover and Evitt 1978

***Impagidinium* sp.**

Plate 4 Figures 6-9

Subspherical light brown in colour, wall smooth, paratabulation, singulum visible; Size 60 µm.

Genus *Hystrichosphaeridium* Deflandre 1937b, Davis and Williams 1966

Plate 4 Figures 4-5

1980 *Hystrichosphaeridium* Wilson and Close page 56

2000 *Hystrichosphaeridium* Levy & Harwood, Plate 6, h-j

Spherical, processes vary in length but chorate. Size 50 - 75 µm.

Order PERIDINIALES Haekel, 1894

Family Protoperidiniaceae Bujak and Davies, 1998

Genus *Cryodinium* Esper and Zonneveld 2002

***Cryodinium* sp.**

Plate 3 Figure 4-12

2002 *Cryodinium meridianum* sp. Esper and Zonneveld Figure 4-9

Spherical and dark brown in colour, paratabulation with intercalary archeopyles size 35-50 µm.

Genus *Protoperidium* Bergh, 1881 emend. Balech, 1974

***Protoperidiniod* sp. 1**

Plate 5 Figure 5-9

Spherical to ovoid with Suessioid tabulation type, pale yellow in colour and no processes; possible cingulum in the form of smaller latitudinal plate arrangements size 115 µm.

Genus *Protoperidium* Bergh, 1881 emend. Balech, 1974

***Protoperidiniod* sp. 2**

Plate 4 Figure 10-12

1998 Dinocyst sp. Wrenn *et al* Figure 5a,b

Sub-spheroidal to ovoid in shape with a prominent cingulum and sulcus. Wall is dark brown and granular with no tabulation or processes present; size 75 µm.

Genus *Selenopemphix* Benedek, 1972 emend. Head, 1993

***Selenopemphix antarctica* Marret and de Vernal, 1997**

Plate 5 Figures 1-4

1997 *Selenopemphix antarctica* Marret, and de Vernal Plate V Figures 1-5

1998 *Selenopemphix antarctica* Harland *et al* Plate 2 Figures 10-12
Spherical with two antapical horns, apically and antapically compressed, slightly pinkish in colour with granulations on the surface. Size 60 - 75 µm

Dinocyst sp.

Plate 4 Figure 1-3

Dinocyst sp: Ovoid with apical archeopyle and processes chorate, size 60 µm.

Reworked Dinocysts

Genus Alterbidinium Lentin & Williams 1985; emend. Khowaja-Ateequzzaman and Jain 1991

***Alterbidinium asymmetricum* Wilson, 1967 comb. Nov.**

Plate 10 Figure 3, Figure 7-9

Ovoid, hyaline bi-layered, dorso-ventrally flattened, angular, bi-laterally asymmetric, smooth walls. Long apical horn, smaller antapical horns, cingulum, intercalary archeopyle. Size 80 µm.

Genus Deflandrea Eisenack 1938; emend. Williams and Downie 1966;

Deflandrea sp.

Plate 10 Figure 1-2

Spherical inner body, thick walled smooth, dorso-ventrally flattened, outer layer forms pointed apical horn and two antapical horns. Intercalary archeopyle. Size 70 µm.

Family Gonyaulacaceae Lindemann, 1928

Genus *Enneadocysta partridgei* Stover & Williams 1995

Spherical, chorate processes splayed out at the end. Size 75 µm.

Genus Spinidinium Cookson & Eisenack, 1962; Lentin & Williams 1976

***Spinodinium* sp.**

Sub spherical showing short spines with long apical horn. Species broken. Size ~75 µm.

***Spinidinium macmurdoense* (Wilson 1967) Lentin & Williams, 1976**

2000 *Spinidinium macmurdoense* Levy & Harwood Plate 9, Figure c,d

Sub spherical with smooth hyaline inner body, dorso-ventrally flattened, angular bilaterally asymmetric. Outer covering has small spines. Long apical horn shorter antapical horn. Size 75 µm.

Genus *Turbiosphaera* Archangelsky, 1969a

***Turbiosphaera filosa* (Wilson, 1967) Archangelsky 1969a**

Plate 9 Figures 10-12

1999 *Turbiosphaera filosa* CRP Science Team Figure 5.8i p129

2000 *Turbiosphaera filosa* Levy & Harwood Plate 10 d-i

Spherical dark brown inner body, cingulum visible, outer membrane appearance granular and extends out over inner body unevenly. Size 50 µm.

Genus *Vozzhennikovia* sp.

Sub-spherical to spherical with long apical horn most are broken up but have slightly longer spines covering. Size ~50 µm.

Operculae

Most unknown some may be from Enneadocysta partridgei. All are operculae with processes.

Division PRASINOPHYTA Round 1971

Order PTEROSPERMATALES Schiller 1925

Family Cymatiosphaeraceae Mädler 1963

Genus *Cymatiosphaera* O.Wetzel, 1933 *ex* Deflandre, 1954

***Cymatiosphaera* sp. 1**

Plate 5 Figure 10-12

1998 *Cymatiosphaera* sp. Hannah *et al* Figure 3d

2000 *Cymatiosphaera* sp. 1 Hannah *et al* Figure 3c,d

Spherical central body, wall smooth colourless to pale yellow ~1 µm. hyaline, fine membrane anastomoses over surface, processes visible. No opening visible. Size 15 - 20 µm.

***Cymatiosphaera* sp. 2**

Plate 6 Figure 1-10

Spherical central body, wall smooth, membrane like netting anastomoses over surface, no visible opening, membrane gathered at edges. Size 75 – 115 µm.

Family Pterospermellaceae Eisenack 1972

Genus *Pterospermella* Eisenack

***Pterospermella* sp.**

Plate 6 Figure 11-12

1998 Pterospermella sp. Hannah et al Figure 3i

2000 Pterospermella sp. Hannah et al Figure 3g

Large flotation membrane colourless, borders a spherical compressed central body yellow-brown in colour. No aperture visible. Size 75-90 µm.

Family Tasmanitaceae Sommer 1956

Genus *Tasmanites* Newton 1875

***Tasmanites* sp.**

Plate 7 Figure 1-3

1980 *Tasmanites* sp. Tappan Figure 10.10

1999 *Tasmanites* sp. CRP Science Team Figure 5.9g

Spherical central body, double layered wall with perforations of radially arranged pores of two distinct sizes. Size 105 – 125 µm.

Class RHODOPHYCEAE

SubClass FLORIDEOPHYCIDAE

Order CERAMIALES

Family Rhodomelaceae

Genus *Beringiella* Bujak 1984

***Beringiella* sp.**

Plate 7 Figure 4-11

1984 *Beringiella* Mudie 1992 Plate 2 Figure 17

1996 *Beringiella* Mudie and Harland Plate 2 Figure 15

Ovoid central body, smooth walls with edge ~1 µm, brown with apical archeopyle with serrated edges. Size 50-60 µm.

Order TINTINNIDA

Family Favellidae Kofoid and Campbell, 1929

Genus unknown

Plate 8 Figure 5-6

Large various shapes bell, to conical, aperture at oral end closed aboral end rounded or pointed form. Hyaline to brown in colour. Size 100 – 300+ µm.

***Tintinnid* cyst**

Plate 8 Figure 3-4

Ovoid shape jug like type, tin walled light brown, aperture round. Size100-125 µm.

UNKNOWN SPECIES

Zooplankton sp.

Plate 8 Figure 7-12, Plate 9 Figure 1-9

Spherical two layered, inner body thick walled brown no ornamentation, round aperture. Outer layer thin hyaline with "tail" attached, easily folds. Size 125 – 175 µm.

Egg Cases

Plate 10 Figure 10-12, Plate 11 Figure 4-5, 7-8 Plate 12 Figure 1-10

Various shapes and sizes, with or without processes and crests and usually an aperture present.

Phylum Foraminiferan linings

Plate 7 Figure 12, Plate 8 Figure 1-2

Various, uniserial, biserial or spiral - planispiral or trochospiral. Sizes 75 – 200+ µm.

Arthropod

Plate 11 Figure 12

Conodonts single or in jaw sockets, skeletal remains, claws. Various sizes

Unknowns

Algal Chains

Plate 11 Figure 10-11

Spherical, hyaline, grouped together to form chains or clumped together.

Unknown sp. 1

Plate 12 Figure 11-12

Ovoid with two loops attached opposite, aboral free flowing thin membrane attached. Size ~25 µm.

Unknown sp. 2

Plate 11 Figures 1-2

Ovoid, cocoon like single stands coiling in layers. Size 45 µm.

Unknown sp. 3

Ovoid shape, no ornamentation, no obvious aperture. Size 25 µm.

Unknown sp. 4

Ovoid, dark brown, no ornamentation, wall thick ~1 µm narrowing at apical end. Size 50 µm.

Unknown sp. 5

Ovoid enlongated central body, pale brown with apical archeopyle, antapical wall narrows and thickens. Size 65 µm.

Unknown sp. 6

Plate 11 Figure 6

Ovoid, brown with apical archeopyle, smooth wall extends antapically into long thin strand. Size 75 µm.

Unknown sp. 7

Sub-spherical to ovoid with granulated wall, apical wall narrows. No openings no processes, 2 eyespot markings. Size 125 µm.

Unknown sp. 8

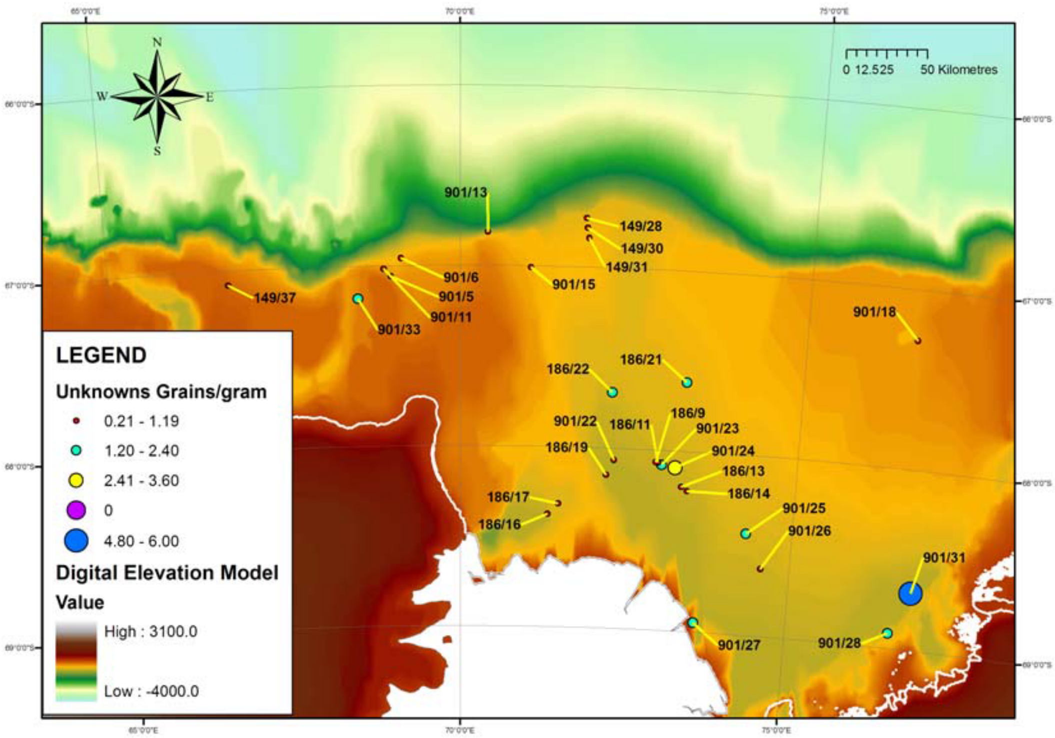
Sub-spherical, granulated membrane covers central body and overlaps the edge. Opening appears to be in centre. Size 165 µm.

Unknown sp. 9

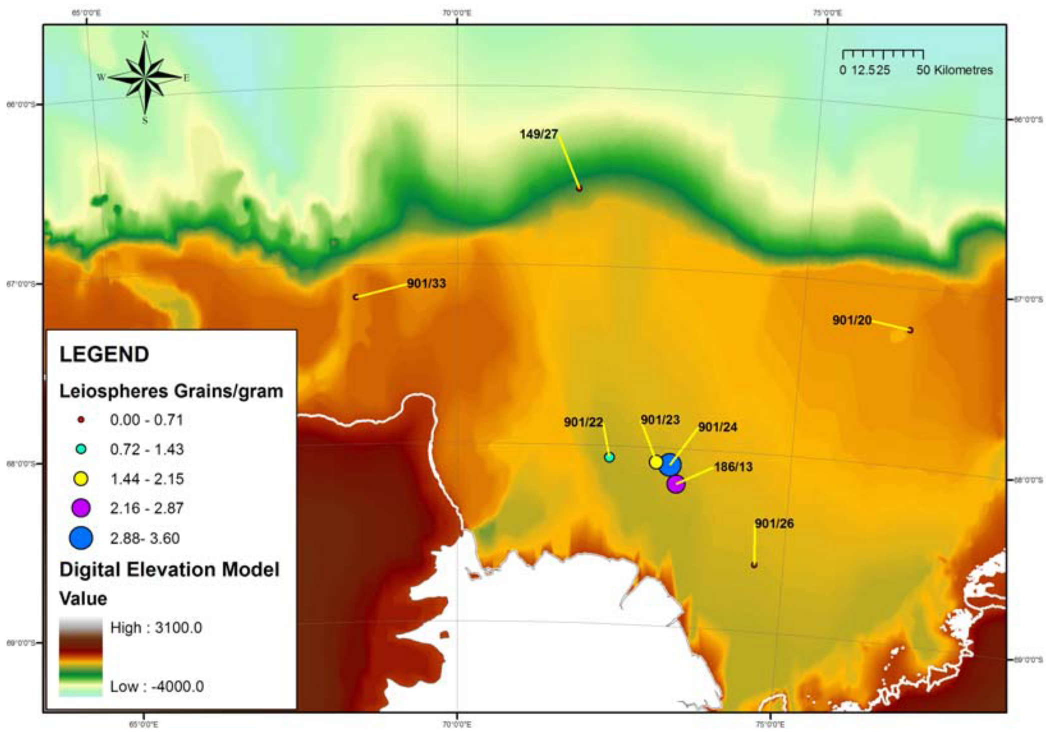
Breaking up but covered in small proximate processes, shape ovoid to elongate, size 75-85 µm.

Reworked Pollen

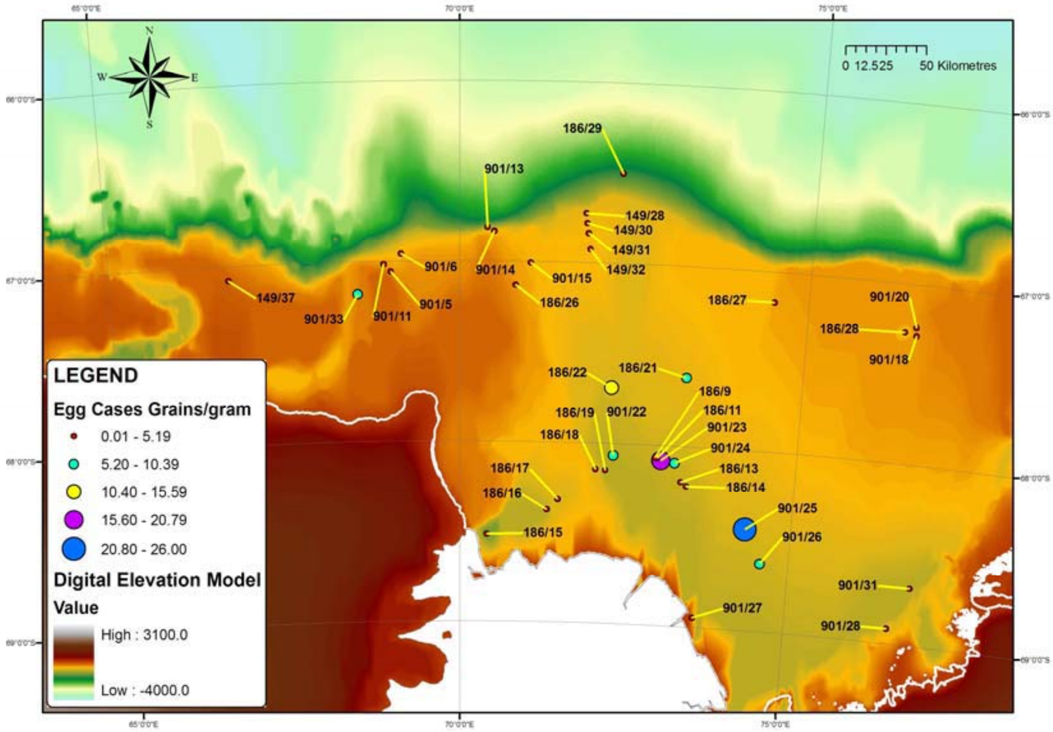
The terrestrial material recovered in this project contains pollen species which date back as far as the Permian and the Jurassic and there are some samples on the Fan that are void of marine palynomorphs and contain only terrestrial material. This could imply that they have not travelled far enough to be mixed in with the marine material and are outcropping in that area.



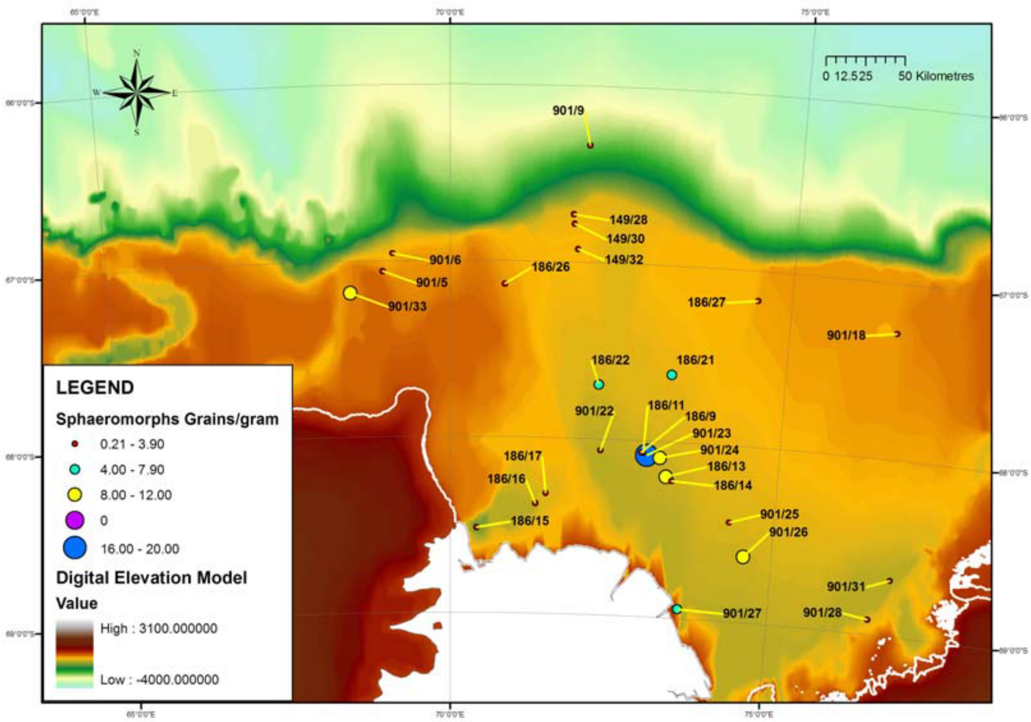
Appendix D: Position of all unknowns grains per gram with highest abundances the larger blue circles as per legend.



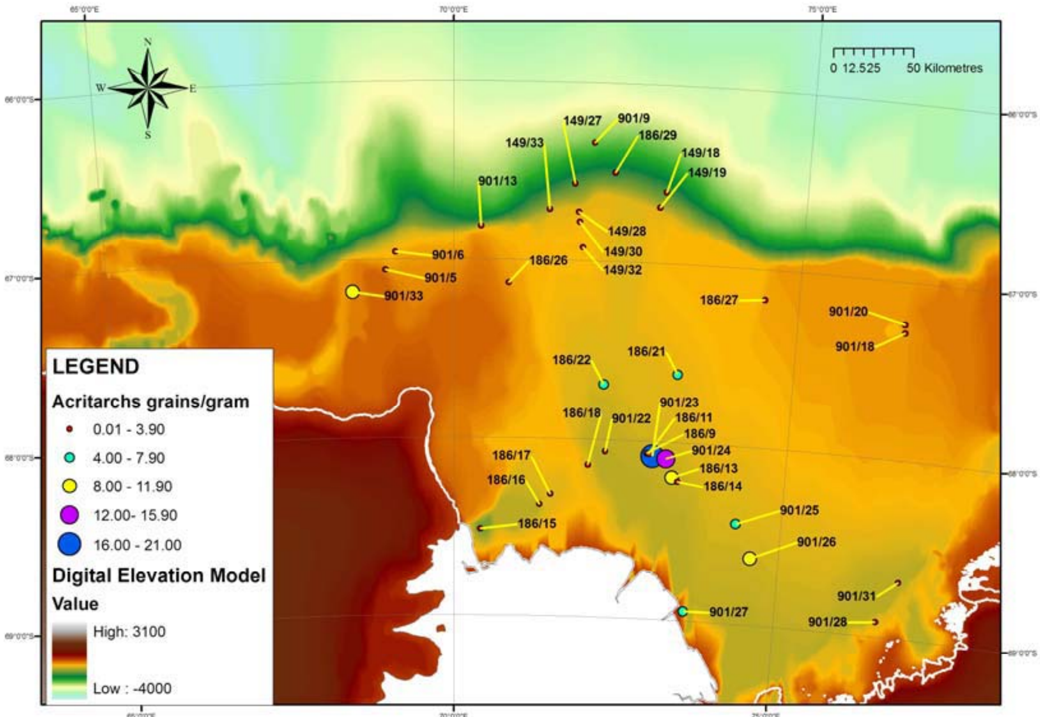
Appendix D: Position of all *Leiospheres* grains per gram with the highest abundance the larger blue circles and per legend.



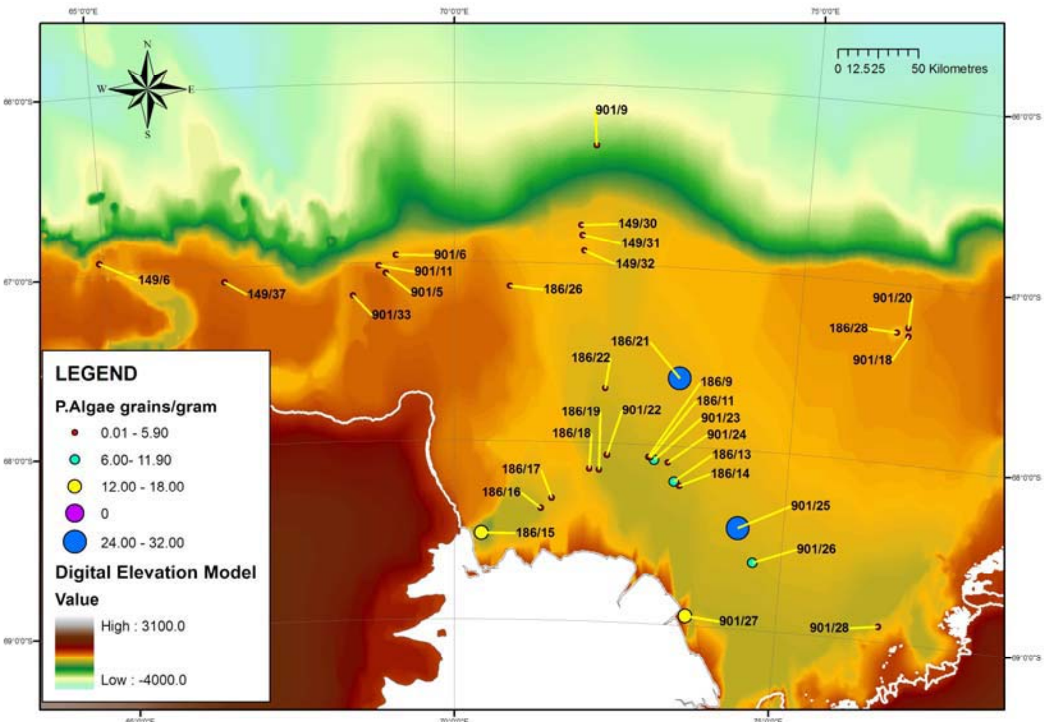
Appendix D: Position of egg cases grains per gram the highest abundance are the larger blue circles.



Appendix D: Position of *Sphaeromorphs* grains per gram the highest abundance are the larger blue circles as per legend.



Appendix D: Position of acritarchs grains per gram the highest abundances are the larger blue circles as per legend.



Appendix D: Position of prasinophycean algae grains per gram the highest abundances are the larger blue circles as per legend.