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Regional distribution of late Quaternary and Holocene sedimentary facies in the southeast Pacific subantarctic and antarctic

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The distribution of modern sedimentary facies in the far southeastern Pacific-Antarctic region is controlled by the regional circulation pattern, biogenic productivity, the extent of seasonal sea-ice development, regional bathymetry, the influx of terrigenous detritus from antarctic continental margin by ice-rafting, bottom and turbidity currents, and the level of the calcite compensation depth.

The complex interaction of these factors results in the occurrence of three primary sedimentary facies within the region: calcareous ooze, siliceous ooze, and glacially derived clayey silts and silty clays. Regional facies boundaries are characterized by transitional lithologies comprised of mixed calcareous-siliceous ooze near the Polar Front Zone and muddy siliceous ooze and diatomaceous muds with the ephemeral sea-ice zone.

A cross section of the regional spatial and temporal distribution of sedimentary facies deposited throughout the study area during the last 194,000 years is illustrated in figure 1. This diagram clearly documents paleo-oscillations in the characteristic sedimentary facies encountered in modern antarctic sediments. The core profile can be divided into three groups based on the latitudinal distribution and sedimentary facies. (See table 1.)

The sequential evolution of regional sedimentary facies for the last 194,000 years can be delineated from the 11 cores used in this study. The data shown in table 2 are presented in the context of chronostratigraphic oxygen isotope stages (OIS). (See figure 2.)

Eltanin core 17-17 contains three clayey silt intervals that occur in OIS-2, 5, and 6 (figure 1.) The terrigenous intervals

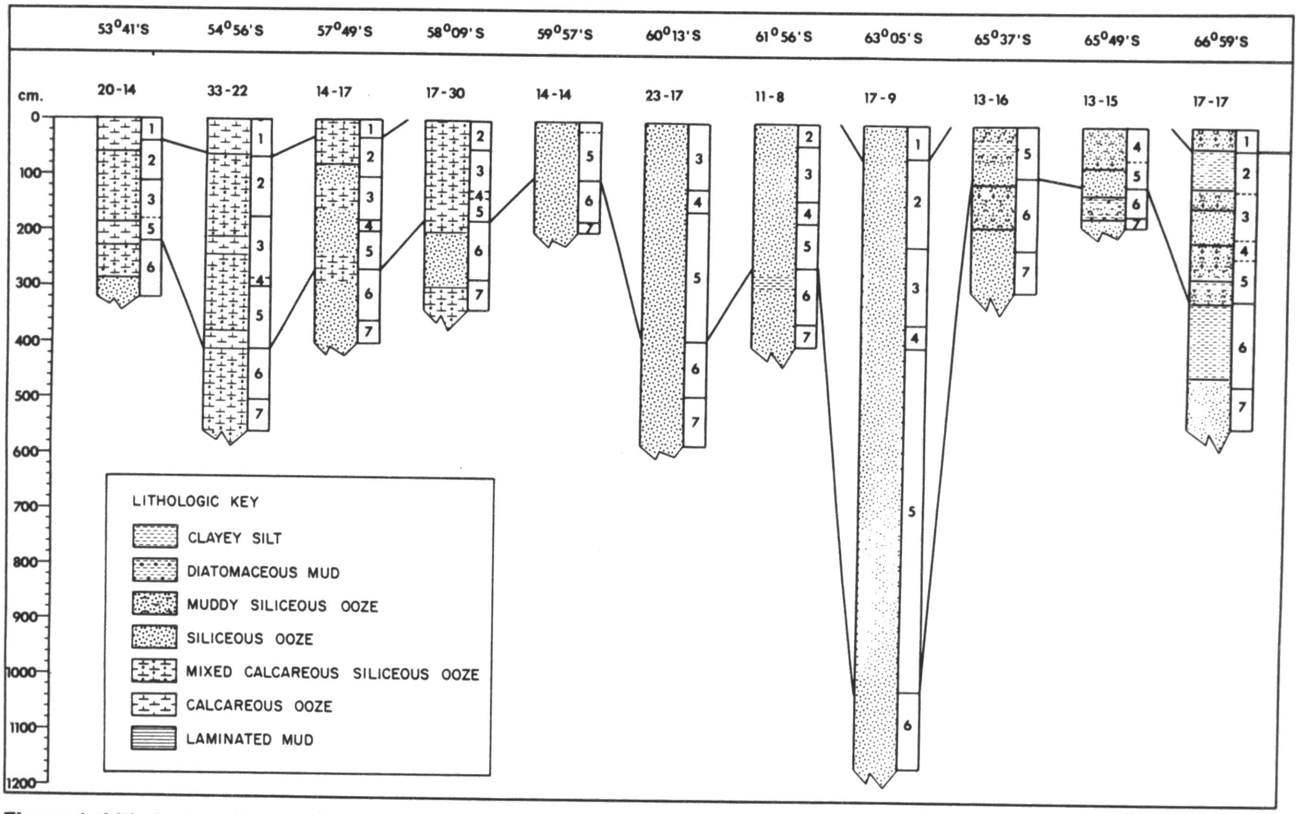

Figure 1. Lithologic units, x-radiography, and sedimentology of fine-grained laminated sediments in core E17–17. For lithology key, see figure 2.

Table 1. Core profiles

Core numbers	Location	Composition
E20–14, 33–22, 14–17, 17–30	Near or slightly north of the Antarctic Polar Front Zone	Intercalated units of calcareous, mixed siliceous-calcareous, and siliceous oozes.
E14–14, 23–17, 11–8, 17–9	South of 59°S and north of the mean September pack-ice limit	Entirely siliceous oozes except for one narrow band of unfossiliferous clayey silt at 265–285 centimeters in E11–8, probably representing distal turbidite deposition within the basin
E13–16, 13–15, 17–17	South of 65°S	Interbedded siliceous oozes, clayey silts, and silty clays; transitional muddy siliceous ooze; and diatomaceous muds.

in OIS–2 and OIS–6 are composed of interbedded laminated muds and structureless clayey silts. The laminated muds are composed of very thin laminae measuring less than 1 millimeter in thickness. Close examination of laminated intervals reveals some low-angle micro-crossbedding at some intervals. Microscopic examination of the laminated mud intervals shows that they are composed of pure quartz silt with a lesser clayey fraction and are completely devoid of microfossils. Sedimentological analysis of samples from the laminated muddy intervals has shown that they are fine grained (mean ϕ size = 4.25 to 9.00) and poor to moderately sorted standard deviation (s.d. = 0.76 to 1.30). They are generally characterized by a bimodal grain-size distribution (figure 1).

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Table 2. Sequential evolution of facies

Oxygen isotope stage (OIS)	Nature of change	Implication
OIS–7	Siliceous ooze/mixed ooze/calcareous ooze boundaries were found slightly north of their modern positions; siliceous ooze/muddy ooze boundary was found 2° south of its modern position.	The OIS–7 siliceous ooze zone was approximately 4° wider than it is today.
Early OIS–6	Calcareous ooze/mixed ooze/siliceous ooze boundaries at 125°W remained very close to their OIS–7 position but concurrently shifted nearly 5 degrees to the north between 110° and 90°W within the study area.	Between OIS–7 and early OIS–6, a general pattern of northward shifting of facies is evident.
Late OIS–6	Siliceous ooze/mixed ooze boundary moved southward across the entire study area to at least 58°S. Southernmost silty clay/clayey silt facies remained fixed south of 67°S throughout OIS–6.	Between early OIS–6 and late OIS–6, facies shifted southward.
OIS–5e	Calcareous ooze/mixed ooze boundary was located near its modern distribution; mixed ooze moved no further north than 57° to 58°S.	Between late OIS–6 and OIS–5e, calcareous ooze/mixed ooze boundar shifted southward.
	Siliceous/muddy siliceous ooze boundary in the southern sector of the study area was again in a similar position (66°S) to that encountered in OIS–7: 2 to 3 degrees of latitude south of its modern position. Muddy siliceous ooze/siliceous mud boundary similar to modern position: near 67°S.	This facies distribution resulted in a muddy siliceous ooze belt at leas 3 degrees of latitude narrower than that found in modern antarcti sediments.
OIS–5	Siliceous ooze belt shifted northward to 57°S, displacing the mixed ooze/calcareous ooze boundary just north of 55°S in the western sector of the study area. Siliceous ooze/muddy siliceous ooze boundary to the south shifted north of 65°S, at least 2 degrees north of its present position. For a short period during the latter portion of OIS–5, the clayey silt/silty clay facies shifted north of 65.5°S but then suddenly returned to south of 67°S near its modern position within the study area.	There was a general northward trend during OIS–5.

OIS–4 and OIS–3	*Western sector of the study area:* Calcareous ooze/mixed ooze boundary shifted first to the north to 55°S with oscillations back to south of 55°S and stabilizing in a position at least 2 degrees north of its modern position. Mixed ooze/siliceous ooze boundary shifted north between 55° and 58°S, receded south of 58°S, and finally migrated back to north of 58°S at the end of OIS–3. *Eastern sector of the study area*: Calcareous ooze/mixed ooze boundary was positioned north of 53°S. Mixed ooze/siliceous ooze boundary developed south of 59°S. *Southern sector of the study area*: Muddy siliceous ooze/diatomaceous mud boundary remained south of 67°S during OIS–4 and OIS–3. Siliceous ooze/muddy siliceous ooze moved south of 67°S and then back north of it by the end of OIS–3.	Oscillations typified OIS–4 and OIS–3.
OIS–2	Distribution of regional sedimentary facies was similar to distribution at the end of OIS–3 except for (1) a shift in the siliceous ooze/mixed ooze boundary north of 58°S in the western sector of the Amundsen Basin and (2) a migration of clayey silts just north of 67°S in the southernmost sector of the basin.	The clayey silts' position in OIS–2 was 1 degree north of their present position.
OIS–1	Calcareous ooze/mixed ooze boundary shifted southward to a position between 55° and 57°S in the western sector of the study area and south of 54°S in the eastern portion of the area. Mixed ooze/siliceous ooze zone migrated south of 58°S, and concurrently the clayey silt/diatomaceous mud boundary to the south shifted south of 65°S.	The general trend in OIS–1 was a southward shift.

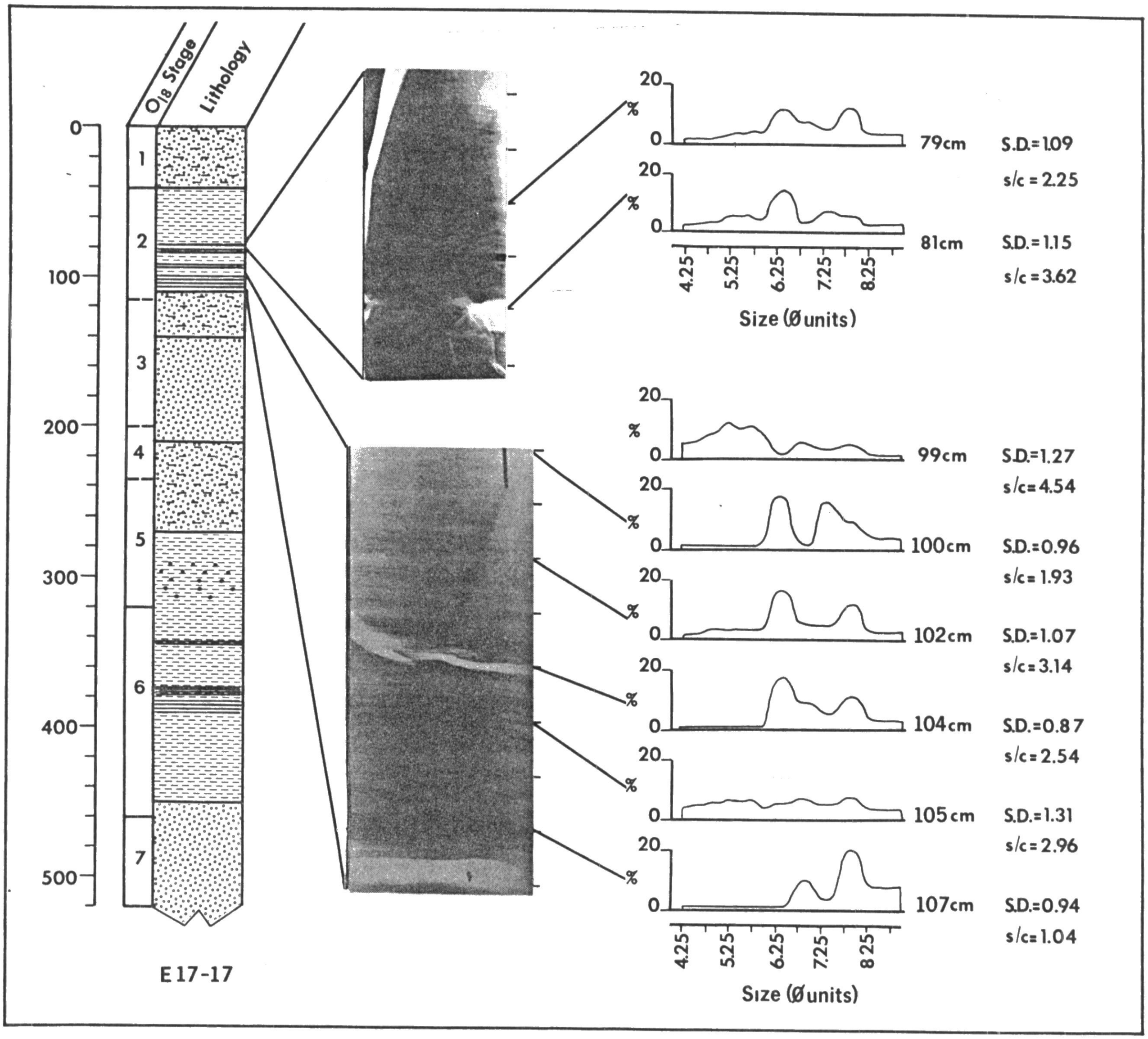

Figure 2. Regional distribution of late Quaternary and Holocene sedimentary facies in the southeast Pacific subantarctic and antarctic regions. Correlations based on: 18,000 = *Cycladophora davisiana* peak, 124,000 = oxygen isotope stage 5e, and 194,000 = *Hemidiscus karstenii* datum. Columns to the right of lithologic columns identify the oxygen isotope stages.

Regional biostratigraphic correlations of *Eltanin* piston cores in the southeast Pacific, subantarctic and antarctic

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Significant advances in the development of high-resolution biostratigraphy for the southern ocean have made possible an integrated approach to the documentation of late Quaternary paleo-oceanography in the high latitudes of the southeast Pacific subantarctic and antarctic. Using high-solution biostratigraphy in conjunction with a multiparametric approach, we examined 11 *Eltanin* piston cores from the southern ocean for regional paleo-oceanographic, marine geological, and biological variability through a glacial cycle.

The *Cycladophora davisiana* stratigraphy used in this investigation for regional correlation of cores is based on the