27. PLEISTOCENE RADIOLARIANS FROM GOBAN SPUR, DEEP SEA DRILLING PROJECT HOLE 548, LEG 80[1]

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ABSTRACT

The paleoenvironmental significance of middle Pleistocene radiolarian assemblages from the Goban Spur area is presented. Upwelling may have been an oceanographic feature of this region during a short Pleistocene period corresponding to oxygen-isotope Stages 13 and 14.

INTRODUCTION

Quaternary sediments from Goban Spur sites are almost barren of radiolarians. A short interval from Hole 548, however, contains diverse radiolarian debris associated with diatoms, silicoflagellates, sponges, and sponge spicules.

Only sparse data are available on the distribution of radiolarians during the Pleistocene in the North Atlantic Ocean. This lack of information results from the scarcity of radiolarians and from their irregular distribution in sediments of this ocean. Surface sediments generally contain radiolarians, but they become barren toward the coastlines and in areas of very low productivity (Goll and Bjørklund, 1971; Labracherie, 1978). Moreover, levels underlying the tops of many cores from the northeastern Atlantic Ocean are barren of biogenic siliceous components (personal observation). Exceptions to this are Quaternary sediments from some regions of high productivity, such as areas of coastal upwelling and oceanic fronts (Labracherie, 1980).

In Hole 548, Quaternary radiolarians and diatoms are restricted to Cores 7 and 8. The abundance and preservation of radiolarians vary greatly throughout these cores (Table 1). Diatoms are sparse to common in the fraction >45 μm. The biosiliceous assemblage from the Hole 548 Pleistocene interval, about 8.5 m thick (Samples 548-7-6, 49–50 cm through 548-8-5, 103–110 cm), reflects an important change in the Quaternary paleoenvironmental history of the northern continental margin of Goban Spur. This assemblage is sometimes dominated by diatoms, which are the most productive organisms in areas of upwelling; this may indicate that superficial waters had higher levels of silica and nutrients than today. This implies that the general vertical water mass structure of this region may have been different from the present configuration.

Quaternary radiolarians from Hole 548 are well diversified. A list is given in Table 1.

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RADIOLARIAN ASSEMBLAGES, HOLE 548

The moderately well preserved to poorly preserved radiolarian assemblage found in the lower part of Core 8 (Samples 548-8-6, 90–91 cm through 548-8-5, 20–27 cm) is dominated by the following species: *Spongopyle osculosa, Stylodictya tenuispina, Stylodictya validispina, Botryostrobus auritus/australis* group, *Theoconus zancleus*, and *Theorocythium trachelium dianae*. If one disregards the high abundance of *C. davisiana*, this assemblage is comparable to that recorded for the southern part of the Rockall Basin (Labracherie, 1978) and for the Reykjanes Ridge (personal observation, not published). *Lithomelissa setosa* is highly concentrated in Sample 548-8-4, 20–27 cm, whereas *T. trachelium dianae* decreases, and numerous species of the Norwegian Sea appear. These changes could be interpreted as indicating a decrease in temperatures of surface waters. The well-preserved stage of this assemblage may be correlated with the most productive period.

The uppermost section of Core 8 (Samples 548-8-2, 40–47 cm and 548-8-1, 90–91 cm) is characterized by low species diversity and rather poor preservation. This interval of low biosiliceous content, high quartz input and increase of typical shallow-water diatom species suggests a decrease of productivity and a downslope transport. The assemblage from sediments of the lower part of Core 7 (Samples 548-7-6, 110-117 cm and 548-7-6, 49–50 cm) is comparable to that of the lower half of Core 8, where preservation and diversity are only moderately poor. This assemblage, judging from the presence of *Ommatartus tetrathalamus* and from the increase of *Lamprocyclas maritalis*, may indicate warmer conditions.

PALEOENVIRONMENTAL ANALYSIS

Most species identified in the Quaternary sediments of Hole 548 are common in Recent sediments of the northeastern Atlantic Ocean at 50–60°N latitude. However, the presence of *"Stylatractus universus,"* of an age greater than 425,000 yr. (Hays and Shackleton, 1976) requires mention. *"Stylatractus universus"* occurs in only one sample (548-7-6, 110–117 cm), located at the top of the short interval yielding radiolarians. Its presence indicates that Core 8 can be dated from a period earlier

Table 1. Occurrence of radiolarians, quartz, and siliceous microfossils in Hole 548.

Sample (interval in cm)	Quartz abundance	Microfossil abundance and preservation					Radiolarians																																									
		Diatoms	Sponges	Sponge spicules	Radiolarian abundance	Radiolarian preservation	*Actinomma medianum*	*Echinomma leptodermum*	*Hymeniastrum* sp.	*Perichlamydium* sp.	*Spongopyle osculosa*	*Stylodictya tenuispina*	*Stylodictya validispina*	*Streblacantha circumtexta*	*Spongocore puella*	*Botryostrobus auritus/australis* gr.	*Cycladophora davisiana*	*Cycladophora davisiana* var. *cornutoides*	*Eucyrtidium acuminatum*	*Lamprocyclas maritalis*	*Theoconus zancleus*	*Theocorythium trachelium dianae*	*Cromyechinus borealis*	*Lithelius spiralis*	*Ommatartus tetrathalamus*	*Phorticium clevei*	*Stylatractus universus*	*Androcyclas gamphonycha*	*Lithomelissa setosa*	*Stichocorys seriata*	*Hexacontium pachyderma*	*Polysolenia arktios*	*Peridium longispinum*	*Pseudodictyophimus gracilipes*	*Drymyomma elegans*	*Cornutella profunda*	*Corocalyptra craspedota*	*?Larcopyle butschlii*	*Lithomitra lineata*	*Artostrobus joergenseni*	*Lamprocyrtis(?) hannai*	*Lithocampe* sp. Nigrini	*Phormacantha hystrix*
548-7-5, 110-111	A	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
548-7-6, 49-50	A	F	F	—	F	M	R	F	R	F	F	F	R	R	R	R	A	F	R	F	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
548-7-6, 110-117	A	F	F	r	F	P	—	C	R	F	R	R	F	R	R	C	F	R	R	R	R	R	R	C	R	R	R	R	R	R	—	—	—	—	—	—	—	—	—	—	—	—	—
548-8-1, 90-91	AA	r	—	—	r	P	R	R	—	—	—	—	—	R	—	R	F	—	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
548-8-2, 40-47	A	C	R	r	F	M	R	F	R	R	—	—	R	R	—	C	A	C	—	R	R	—	R	R	—	—	—	R	F	R	R	R	R	F	—	R	R	—	—	—	—	—	—
548-8-2, 140-147	C	C	R	F	C	M	R	F	R	—	F	R	—	R	R	C	C	F	F	R	R	—	R	F	—	—	—	—	F	F	R	—	R	R	F	—	—	—	—	—	—	—	—
548-8-4, 20-27	r	A	r	F	A	G	—	F	R	—	R	F	—	R	R	C	C	F	C	R	C	R	R	F	—	R	—	R	A	R	R	—	R	R	R	—	—	R	R	R	R	R	R
548-8-5, 20-27	—	AA	—	F	A	G	—	R	R	—	F	F	—	F	—	C	C	R	F	—	F	F	F	F	—	—	—	—	C	R	—	—	—	F	C	—	—	R	—	—	—	—	—
548-8-5, 90-91	A	R	R	C	C	P	F	F	F	—	C	F	F	R	R	C	C	—	R	—	R	C	R	F	—	—	—	—	R	—	R	—	—	—	F	—	R	—	—	—	—	—	—
548-8-5, 103-110	A	R	r	C	F	P	F	R	—	—	F	R	F	R	R	C	C	R	R	—	—	F	—	F	—	—	—	R	C	—	—	—	—	—	—	—	—	—	—	—	—	—	—
548-8-6, 90-91	A	r	r	r	r	—	—	—	—	—	R	—	—	—	—	—	—	—	—	—	—	R	—	—	—	—	—	—	R	—	—	—	—	—	R	—	—	—	—	—	—	—	—

Note: Core samples include a fraction >45 μm. For illustrations and descriptions of radiolarian species, see Bjørklund, 1976; Jörgensen, 1900; Nigrini, 1967, 1979; Petrushevskaya, 1971, 1974; and Petrushevskaya and Bjørklund, 1974. Six abundances were used for quartz and siliceous microfossils (estimated values): AA = very abundant, A = abundant, C = common, F = few, R = rare, r = very rare. Five abundances were used for radiolarians: — = not found; R < 3%; F = 3-12%; C = 12-25%; A > 25%. Preservation: P = poor, M = moderately good, G = good.

than the *S. universus* extinction. The datum of the last occurrence of *Pseudoemiliania lacunosa* was observed in Sample 548-7-5, 140–141 cm (Pujos, this volume); it was placed at the top of isotopic Stage 13 (Thierstein et al., 1977).

The high concentration of *Cycladophora davisiana*, regularly the most abundant species, is particularly interesting. The percentages of this species in radiolarian-bearing surface sediments from the North Atlantic are always low (2–5%). The greatest values were reported in Recent sediments from the Sea of Okhotsk (Robertson, 1975); these values in high latitudes were related to "extensive winter sea-ice formation and melting" (Morley and Hays, 1979). *C. davisiana* is also one of the dominant species in the Peru Current assemblage described by Molina-Cruz (1977). Its presence at low latitude was correlated with cool, nutrient-rich and oxygen-poor waters of eastern boundary currents and associated regions of coastal upwelling. The reason for changes in the abundance of *C. davisiana* over time is not yet well understood (Morely and Hays, 1979). The factors responsible for its distribution pattern in high and middle latitudes during glacial periods cannot possibly account for the high concentrations in Hole 548, because conditions of an ice-free circulation ought to prevail during oxygen-isotope Stages 13 and 14 (Vergnaud Grazzini, this volume) over the northeastern Atlantic Ocean. On the other hand, during this Pleistocene time a nutrient-rich subsurface oxygen-minimum layer may have developed on the northern margin of the Bay of Biscay; this might also explain the distribution of siliceous planktonic organisms in Hole 548.

The absence of radiolarians and diatoms at Site 549, near Site 548, could result from a low sediment accumulation rate. An average sediment accumulation rate of 3 cm/1000 yr. (Pujol and Duprat, this volume) must be inadequate to prevent the dissolution of siliceous organisms in sediments.

The bathymetric positions of Sites 548 and 549 (Fig. 1) may help us to explain more accurately the presence of radiolarians and diatoms at Site 548 and their absence at Site 549. High productivity for an interglacial period, the maximum of which corresponds to the extinction level of *Pseudoemiliania lacunosa* and is dated at 468,000 yr. ago (Thierstein et al., 1977), suggests that the patterns of oceanic and atmospheric circulation would have been significantly different from present ones. A more permanent high-pressure system may have appeared at that time over western Europe, involving changes in the wind regime and driving increased upwelling processes over the continental slope; these upwelling processes would have been, as they are nowadays (Castaing, pers. comm., 1983), restricted to surface waters overlying the upper part of the continental slope (Site 548), and would have been weakened or absent seaward, over the lower continental slope (Site 549). Such a meteorological situation could be compared to that in France and England during the 1975–1976 drought (Rognon, 1981). Simultaneously, in the northwestern Atlantic, increased production of submerged cold water having a rather low salinity and in which *C. davisiana* may live in great abundance, could be related to a strong thermal asymmetry over the North Atlantic Ocean (Rognon, 1981; Thepenier, 1978).

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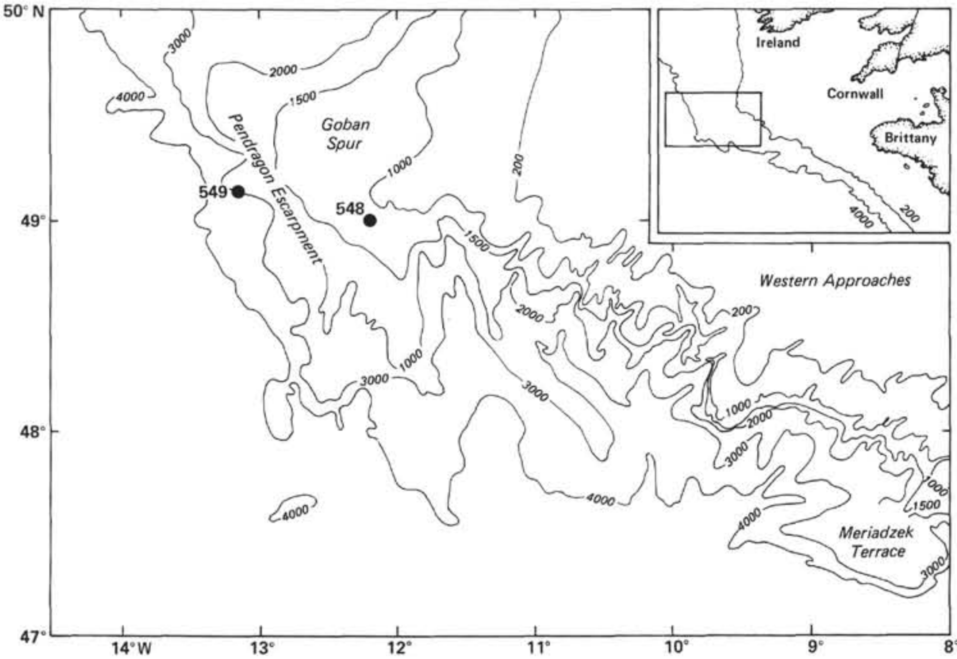

Figure 1. Map showing locations of DSDP Sites 548 and 549. Water depth in m.