21. SYNTHESIS OF RADIOLARIAN RESULTS FROM DSDP LEGS 56 AND 57 AND THEIR RELATION TO OTHER NORTH PACIFIC SECTIONS

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INTRODUCTION

Leg 56 and 57 sites are located in the area of the confluence of the Oyashio and Kuroshio currents. They are positioned between latitudes of 39°N and 41°N and longitudes of 143°E and 146°E. All of the sites are located on the west side of the Japan Trench except Site 436, which is on the Pacific Plate. The majority of the sediment recovered is Neogene, with a minor amount of Paleogene and Cretaceous from Sites 436 and 439.

There is a collection of both "warm"- and "cold"-water radiolarian species at the confluence. This permits direct comparison of radiolarian biozonations for the equatorial (Riedel and Sanfilippo, 1970, 1971, 1977, 1978) and transitional and subarctic (Hays, 1970; Kling, 1973; Forman, 1975; and Reynolds, this volume) Pacific.

There is a brief discussion of the relationship of Leg 56 and 57 sites to Japanese and California land-based sections and other North Pacific DSDP sites. This discussion is limited to the Neogene. None of the other sections provide as complete a Neogene section as do those recovered from Legs 56 and 57.

SUMMARY

Excellent sequences of Neogene radiolarian assemblages were recovered from both Legs 56 and 57 offering correlations between the sites drilled (see Figure 1). These correlations are based on the radiolarian zones shown in Figure 2. For the uppermost Miocene to Recent, our zonation follows that of Forman (1975). Below this interval it is based on the zonations developed by Riedel and Sanfilippo (1970, 1971, 1977, 1978) and Reynolds (this volume).

Because of the influx of warm subtropical waters from the Kuroshio Current into the study area, we were able to recognize several "warm"-water radiolarian datums. Today the study area is predominately influenced by the Oyashio Current, which because of its origin contains a subarctic radiolarian fauna.

Except for Site 436, all the sites drilled on both legs are similar in that they possess radiolarian assemblages dominated by transitional and polar species with only a minor equatorial component. Site 436 contains radiolarian assemblages in its lower portion which are more typical of equatorial regions, as exemplified by the continuous presence of the following warm-water genera: *Cannartus, Dorcadospyris, Calocycletta,* and *Ommatartus.* These genera are either absent or only sporadically present at the other sites. This anomaly is probably due to the more equatorial position of Site 436 during the deposition of its lowermost part and to the increasing influence of high-latitude radiolarian faunas upsection as the Pacific Plate moved northwest.

Differences in sediment accumulation rate may be determined from Figure 1 by the divergence in correlation lines among the sites. We can generalize from this figure as follows:

1) Hole 438A had high accumulation rates (about 120 m/m.y.) during the deposition of sediments representing the *Lamprocyrtis heteroporos* Zone and *Sphaeropyle langii* Zone.

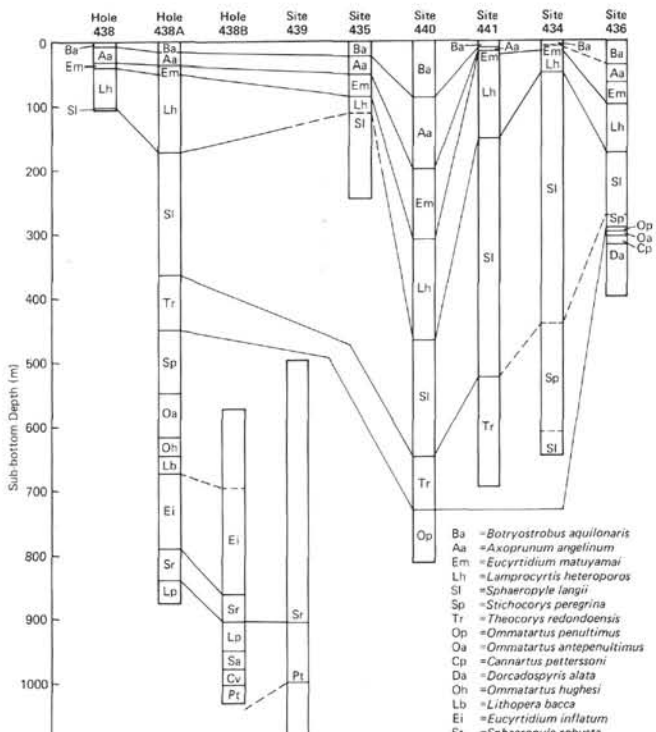

Figure 1. *Correlation of holes drilled on DSDP Legs 56 and 57.*

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Age		Riedel and Sanfilippo (1977, 1978)	Sakai Leg 56 (this volume)	Reynolds Leg 57 (this volume)	Datums
Quaternary			*Botryostrobus aquilonaris*	*Botryostrobus aquilonaris*	T *Axoprunum angelinum*
Quaternary			*Axoprunum angelinum*	*Axoprunum angelinum*	T *Eucyrtidium matuyamai*
Quaternary			*Eucyrtidium matuyamai*	*Eucyrtidium matuyamai*	T *Pterocanium prismatium* *Eucyrtidium calvertense* → *E. matuyamai*
Pliocene		*Pterocanium prismatium*	*Lamprocyrtis heteroporos*	*Lamprocyrtis heteroporos*	T *Stichocorys peregrina*
Pliocene		*Spongaster pentas*	*Sphaeropyle langii*	*Sphaeropyle langii*	B *Sphaeropyle langii*
Miocene	upper	*Stichocorys peregrina*	*Stichocorys peregrina*	*Theocorys redondoensis*	*Stichocorys delmontensis* → *S. peregrina*
Miocene	upper	*Ommatartus penultimus*	*Ommatartus penultimus*	*Ommatartus penultimus*	*Ommatartus antepenultimus* → *O. penultimus*
Miocene	upper	*O. antepenultimus*	*O. antepenultimus*	*O. antepenultimus*	*Cannartus laticonus* → *O. antepenultimus*
Miocene	upper	*Cannartus petterssoni*	*Cannartus petterssoni*	*O. hughesi*	*C. petterssoni* → *O. hughesi*
Miocene	upper / middle			*Lithopera bacca*	B *C. petterssoni* T *E. inflatum*
Miocene	middle	*Dorcadospyris alata*	*Dorcadospyris alata*	*E. inflatum*	B *E. inflatum*
Miocene	middle	*Calocycletta costata*		*Sphaeropyle robusta*	B *Sphaeropyle robusta*
Miocene	lower	*Calocycletta virginis*: *Stichocorys wolffii		*Lithocarpium polyacantha*	B *Lithocarpium polyacantha*
Miocene	lower	*Calocycletta virginis*: *S. delmontensis		*Stichocorys armata*	B *Stichocorys delmontensis*
Miocene	lower	*Calocycletta virginis*: *Cyrtocapsella tetrapera		*Cannartus violina*	B *C. violina*
Miocene	lower	*Calocycletta virginis*: *Lychnocanome elongata		*Prunopyle titan*	B *Prunopyle titan*; B *Cyrtocapsella tetrapera*

Figure 2. *Correlation of radiolarian biozonations and their associated radiolarian datums. (B = morphologic bottom, T = morphologic top, and → = transition from first species to other species; asterisks refer to zones defined by Riedel and Sanfilippo, 1978.)*

2) The holes at Site 435 had moderate sediment accumulation rates (approximately 40 m/m.y.).

3) The holes at Site 440 had very high accumulation rates (about 230 m/m.y.) from the beginning of the *Lamprocyrtis heteroporos* Zone to the present.

4) The holes at Site 441 in its uppermost part had very low rates of sediment accumulation (about 30 m/m.y.) and very high rates (approximately 170 m/m.y.) during the time of the *Lamprocyrtis heteroporos* Zone to the *Theocorys redondoensis* Zone.

5) The holes at Site 434 had high accumulation rates (about 180 m/m.y.) during the *Sphaeropyle langii* and *Theocorys redondoensis* zones and very low rates (about 10 m/m.y.) in its uppermost part.

6) Hole 436 had very low rates of accumulation (about 10 m/m.y.) in its lowermost part (probably because of its pelagic origin) and moderate rates (about 50 m/m.y.) in the rest of the section (because of the influence of hemipelagic sedimentation).

High sediment accumulation rates (and the consequent thickening of radiolarian zones) may be due to a high influx of terrigenous sediment (probably caused by slumping), trapping of sediment in ponds (bypassing of highs), higher biogenic sedimentation, relatively small amounts of compaction, or a combination of these. Low sediment accumulation rates (thinning of radiolarian zones) may be due to the presence of one or more hiatuses, low influx of terrigenous sediment, bypassing of sediment, lower biogenic sedimentation, or a relatively large amount of compaction. In general, high sediment accumulation rates migrate from Site 434 (most distal site on west wall of trench) in the upper Miocene and lower Pliocene, through Site 441 in the lower Pliocene, to Site 440 in the Pleistocene.

CORRELATIONS AND IMPLICATIONS

The correlation of DSDP Holes 436 and 438A to land-based sections in Japan and California and to holes at DSDP Sites 33, 34, 173, and 310 is shown in Figure 3 (back pocket, Pt. 1). The purpose of these correlations is to reveal the stratigraphic position of land-based formations which do not contain the continuous and complete radiolarian assemblages present at the Leg 56 and 57 sites. Because not all authors records the same radiolarian events, the datums on which the correlations are based are few in number. Thus the correlations are limited in reliability and not as detailed as they would have been had many datums been used.

The transition from *Stichocorys delmontensis* to *S. peregrina* is a datum reported by most authors and appears to be the most reliable tie between the sections. Most of the other datums are reported only for a few sections, and some do not occupy equivalent stratigraphic positions.

Sections examined from holes at DSDP Site 310, from Holes 436, 438A, and from Japan possess radiolarian datums at equivalent stratigraphic positions. Hole 438A contains the most complete radiolarian assemblages and record of any of the sections correlated in this study. Therefore it will be the basis of comparison for all the sections, using the datums in Figure 3.

The radiolarian datums from the Malaga Cove section are comparable to Hole 438A with the exception of the stratigraphic position of the last occurrences of *Theocorys redondoensis* and *Lychnocanium grande*. The other southern California land-based section, upper Newport Bay, is also comparable except for the stratigraphically lower position of the last occurrence of *Theocorys redondoensis* and higher (questionable) position of the first occurrence of *Ommatartus hughesi*. Holes 33 and 34 yield similar results: *T. redondoensis* and *L. grande* make a lower last appearance than in Hole 438A. The upper limit of *T. redondoensis* better approximates its stratigraphic position north of the previous sections in Hole 173. Therefore the last appearances of *T. redondoensis* and *L. grande* are time-transgressive and occur at stratigraphically higher positions in progressively higher latitudes. This suggests that transitional or polar faunas were excluded first from southern and then from northern California, as would be expected with the withdrawal of a polar influence on this region.

Moore (1978) has shown that an exclusion of transitional and polar faunas (of which *T. redondoensis* and *L. grande* are a part) from the California region is indicative of a glacial or Ice Age event. This implies glacial expansion or Ice Age conditions during the time these faunas are displaced northward within the California sections. The time period at which this occurred is just below and includes the Miocene/Pliocene boundary (the boundary is approximated by the first occurrence of *Lamprocyrtis heteroporos*). These conclusions are consistent with results of Casey and Reynolds (in press), from the European-type sections; Cita and Ryan (1978), from Morocco; Ciesielski et al. (1978), from the southern Atlantic and Antarctic Oceans; Wise (1978), from the Antarctic Ocean; Kennett (1978), from the south Pacific; Keigwin (1978), from the equatorial and central Pacific; and Armentrout et al. (1978), from the Gulf of Alaska; all indicate a worldwide cooling during this time period.

CONCLUSIONS

DSDP Legs 56 and 57 provide excellent, continuous, transitional to subarctic Neogene radiolarian sequences. They allow for the definition of a new Neogene radiolarian biozonation (Reynolds, this volume) and direct comparison to other DSDP sites and to land-based sections in both Japan and California. Such correlations reveal the time-transgressive nature of radiolarian datums (particularly the last occurrences of *Theocorys redondoensis* and *Lychnocanium grande*). An upper Miocene cooling event is recognized for the north Pacific. The influence of this event is recognized first in southern California, then in northern California. Its progressive northward influence and the time lag in paleotemperature curves for the north Pacific (Reynolds, this volume) may be related.

ACKNOWLEDGMENTS

Acknowledgment is made to the Donors of the Petroleum Research Fund, administered by the American Chemical Society, for partial support of this research (PRF Grant 8657-AC2) and to the Oceanography Section of the National Science Foundation for partial support (NSF Grant OCE74-21805). The authors appreciate the constructive reviewing efforts of J. B. Anderson (Rice University) and F. M. Weaver (Exxon Production Research). Thanks go to C. J. Reynolds for her assistance in the final preparation of this manuscript.

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