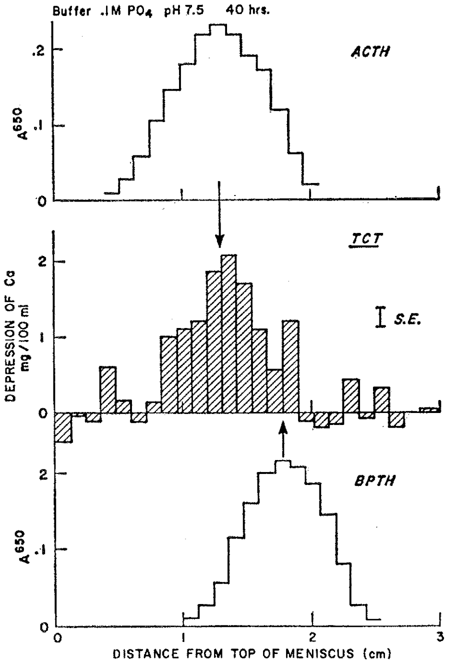

Fig. 1. Distribution of porcine corticotropin (*ACTH*), bovine parathyroid hormone (*BPTH*), and the biological activity of thyrocalcitonin (*TCT*) in a sucrose gradient after ultracentrifugation for 40 hours at 65,000 rev/min. Highly purified (chromatographed on carboxymethylcellulose) thyrocalcitonin (180 μg) in 0.1 ml of buffer was applied to the top of the gradient. Biologic activity for thyrocalcitonin was determined by injecting each fraction into a group of three rats and measuring the depression (serum Ca of uninjected control group minus serum Ca in test group) in serum calcium. The vertical bar (*S.E.*) represents the standard error found for serum calcium in the test and control animals; changes of calcium within 1 S.E. were considered insignificant. The distance from the meniscus to the peak concentration, of protein or of biologic activity, is a direct function of the sedimentation constant. The vertical arrows mark the centers of the *ACTH* and *BPTH* peaks, respectively.

ilar results), or to differences in extraction procedures [the method of extraction with urea, used by us, was almost identical with that of Tennenhouse *et al.* (*3*)]. If one assumes that the hydrodynamic properties of thyrocalcitonin resemble those of most polypeptides of comparable size, the molecular weight is in the range 5000 to 6000—considerably less than the estimate of 8700 (*3*), which was based not on direct biologic testing but on amino acid and equilibrium-sedimentation analyses of polypeptide material.

Another type of thyrocalcitonin has been isolated (*7*) from hot, dilute acid extracts of thyroid glands; it seems to be even lower in molecular weight—approximately 3000—and may represent a smaller active component hydrolyzed from the native substance during the extraction process.

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Pacific Pleistocene Cores: Faunal Analyses and Geochronology

Abstract. *Two cores from the eastern Pacific were analyzed faunally and dated by the ionium : thorium method. Comparison of the results of these and of similar studies of Atlantic cores indicate that faunal changes, representing changes between the glacial and interglacial stages of the Pleistocene, occurred in both oceans simultaneously.*

Quaternary events have been defined in Atlantic Ocean sediments by foraminiferal changes that have been interpreted as reflecting glacial and interglacial conditions (*1, 2*). Similar definitions have not been made in Pacific Ocean sediments, but in equatorial-Pacific sediments such events have been defined (*3*) on the basis of total productivity of calcareous and siliceous plankton, and of changes in the reproductive cycle in diatoms. It was our purpose to determine whether or not foraminiferal changes similar to those in the Atlantic can be detected in the Pacific and, if so, whether such changes correspond in time to those in the Atlantic.

Planktonic species larger than 250 μ were counted in 56 surface samples (top 1 cm) of gravity cores (Fig. 1); 300 to 500 individuals were counted in each sample, and 19 species were recognized on the basis of Parker's classification (*4*).

All samples were placed in faunal groups based on vector analysis (*5*). Briefly this method consists in determining the compositionally extreme samples, called end members, of which all other samples are considered to be mixtures. The proportional contribution of each end member to the other samples is then determined. Each end member defines a faunal group composed of samples to which the end member has made a proportional contribution of 70 percent or more. Four faunal groups were thus defined: equatorial, tropical, mid-latitude, and high-latitude groups. Table 1 lists the more abundant species in each group in order of abundance, and Fig. 1 shows the distribution of the groups in the surface-sediment samples.

We present an analysis of the distribution of these groups in two cores, DWBG 98C and DWBG 114. Sediments in the cores are light-tan to buff,

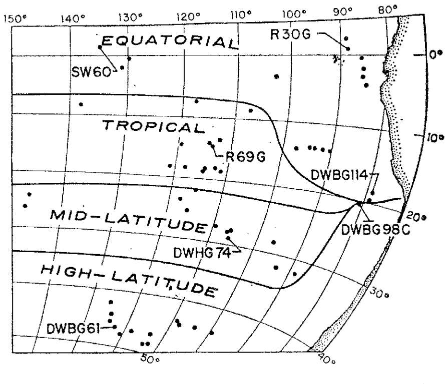


Fig. 1. Sources of 56 cores from the southeast Pacific, and the distribution of the four surface-sediment faunal groups defined by vector analysis. Only the group end members, the two cores discussed in the text, and the equatorial core dated by Arrhenius are identified.

well-mottled, foraminiferal oozes and show no evidence of disturbance in sedimentation. The cores are near the boundaries of the faunal groups and are ideally located to record any past shifts in these boundaries (see Fig. 1).

Proportional contributions by three of the end members to the samples are plotted in Fig. 2: by equatorial end-member R30G, tropical end-member R69G, and high-latitude end-member DWBG 61. The shaded intervals are defined by a high-proportional contribution (approximately 90 percent or more) by high-latitude end-member DWBG 61. The unshaded intervals are defined by a high-proportional contribution by equatorial end-member R30G in core 114 (approximately 70 percent), and by proportional contributions by end-members R30G and R69G of approximately 20 percent or more in core 98C. Thus the unshaded intervals are not defined on the same basis as are the surface-sediment faunal groups. Use of these criteria, however, permits recognition of faunally distinct intervals which would not otherwise be recognized.

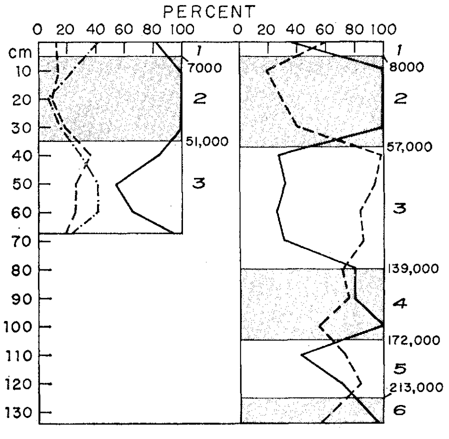


Fig. 2. Proportional contributions of the end members DWBG 61 (solid line), R69G (dash-dotted line), and R30G (dashed line). The odd-numbered intervals represent present-day oceanographic conditions; shaded even-numbered intervals represent oceanographic conditions in which there was displacement of high-latitude fauna toward the equator. The smaller numbers to the right of the cores are the ages of the boundaries between the intervals.

Table 1. Faunal groups defined by vector analysis of surface samples; species are listed in descending order of abundance.

Equatorial group
Globoquadrina dutertrei
Globorotalia tumida
Globorotalia cultrata
Pulleniatina obliquiloculata
Globigerinalla siphonifera
Globigerinoides quadrilobatus sacculifer
Tropical group
Globigerinoides quadrilobatus sacculifer
Globigerinoides ruber
Globoquadrina conglomerata
Globigerinella siphonifera
Globorotalia tumida
Globorotalia cultrata
Globigerinoides conglobatus
Globoquadrina dutertrei
Mid-latitude group
Globigerinoides conglobatus
Globigerinoides ruber
Globorotalia truncatulinoides
Globigerinoides quadrilobatus sacculifer
Globigerinella siphonifera
Globoquadrina conglomerata
Globorotalia inflata
High-latitude group
Globigerina bulloides
Globorotalia inflata
Globorotalia truncatulinoides
"Orbulina universa"

Core 114 consists of alternations in abundances of the proportional contributions of the equatorial end-member R30G and the high-latitude end-member DWBG 61; these two account for 86 percent of the total contributions by all four end members to all samples of core 114. In core 98C, the proportional contribution by the equatorial end member is less and the proportional contribution by the high-latitude end-member DWBG 61 is greater than in the other core. The low frequency of the equatorial end-member R30G is compensated by a higher proportional contribution by the tropical end-member R69G. Core 98C is in the high-latitude faunal group and is also closer to the tropical faunal group than is the other core; thus it consists of alternation in abundances of the proportional contributions of equatorial and tropical end-members R30G and R69G and the high-latitude end-member DWBG 61.

In core 114, the surface sample contains mixtures of equatorial and high-latitude end members; the odd-numbered intervals 3 and 5 contain similar mixtures. In core 98C, the surface sample contains mixtures of equatorial, tropical, and high-latitude end members, and interval 3 has a similar composition. Intervals 3 and 5 in these cores are thought to represent oceanographic conditions similar to modern conditions, because of their faunal similarity with the surface samples. The even-numbered intervals in both cores consist primarily of the high-latitude end member; they represent oceanographic conditions under which there was displacement of the high-latitude fauna toward the equator.

Figure 3 is a plot of the percentages of right-coiling *Globoquadrina dutertrei, Globorotalia crassaformis*, and *G. truncatulinoides* from the same cores; the first is almost 100-percent right-coiled throughout the cores except for interval 2, in which it becomes left-coiled. *Globorotalia crassaformis* and *G. truncatulinoides* are right-coiled in the odd-numbered intervals and left-coiled in the even-numbered intervals.

Changes in direction of coiling support the idea of geographic displacement of fauna. In the surface sediments, *Globoquadrina dutertrei* changes direction of coiling from almost 100-percent right-coiled in low latitudes to 80-per-

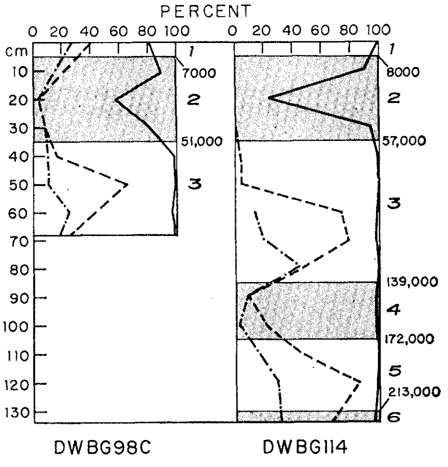


Fig. 3. Percentages of right-coiling of three species in the two cores discussed in the text. *Globoquadrina dutertrei* is represented by a solid line; *Globorotalia crassaformis*, by a dashed line; and G. *truncatulinoides*, by a dash-dotted line. Intervals as in Fig. 2; the smaller numbers to the right of the cores are the ages of the boundaries between the intervals.

Table 2. Thorium-isotopic analyses and calcium carbonate contents of the two cores.

Core section (cm)	$CaCO_3$ (%)	Th^{-232} $CaCO_3$-free basis (ppm)	Io : Th, activity ratio
Core DWBG 98C			
0–4	90	5.4	53
10–14	91	7.5	47
20–24	90.4	6.7	42.6
30–34	93.5	10.4	34.6
40–44	89.4	5.5	29.7
47–50	90.0	7.0	29.2
52–57	92.4	7.2	28.5
Core DWBG 114			
4–8	82.0	9.2	30.0
12–16	72.4	6.2	25.4
24–28	76.2	8.1	19.3
34–38	71.1	8.0	17.0
45–50	74.3	7.3	18.8
90–94	79.3	7.5	7.4
120–125	81.8	8.1	5.9

cent right-coiled in high latitudes; the change in direction in interval 2 suggests displacement of this species from a higher latitude. The percentage of right-coiling of *Globorotalia crassaformis* is distributed irregularly in the surface samples, but there does appear to be a left-coiling province to the south of the core area. Thus the even-numbered intervals having a higher percentage of left-coiling suggest displacement of this species from higher latitudes. *Globorotalia truncatulinoides* is clearly left-coiling in high latitudes (higher than 36°S) and right-coiling in mid-latitudes; thus left-coiling in even-numbered intervals again suggests displacement of this species from higher latitudes.

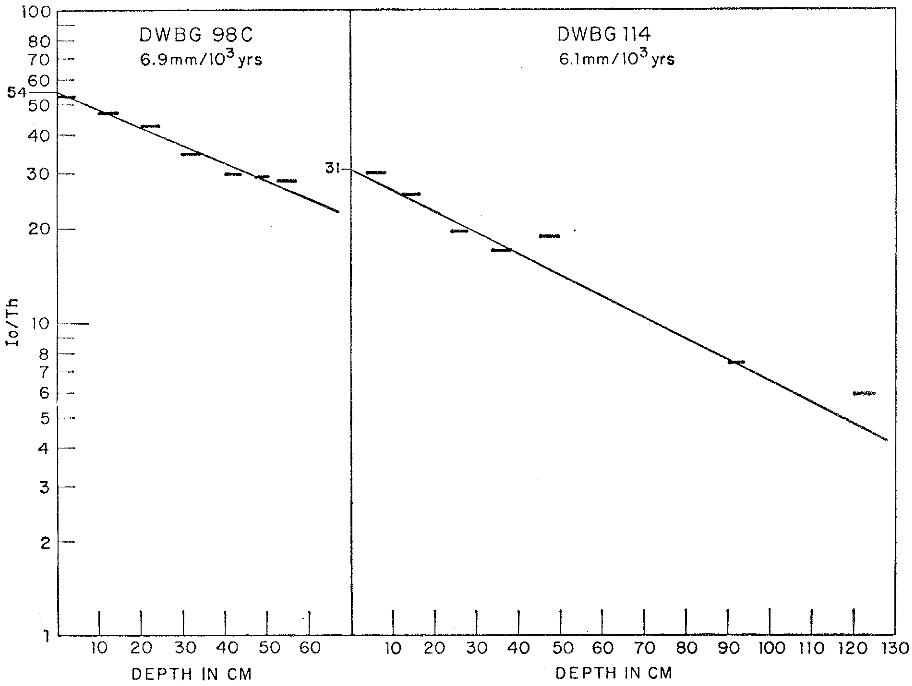
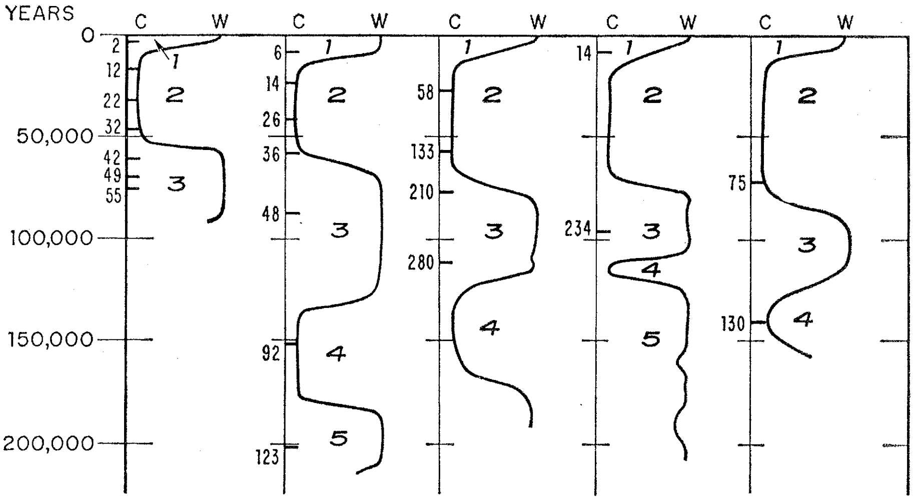


Fig. 4. Io:Th ratios as functions of depth in the cores; total sedimentation rates are given.



CORE	DWBG98C	DWBG114	V12-122	A179-4	A180-32
DATING METHOD	Io/Th	Io/Th	Pa	Pa/Io	Pa
Publication	This work	This work	Ericson (*12*)	Ericson (*12*)	Ericson (*12*)
Latitude	20°49'S	18°20'S	17°00'N	16°36'N	29°07'N
Longitude	81°08'W	79°21'W	74°24'W	74°48'W	26°15'W
Depth	2300 M	3090 M	2730 M	2965 M	5030 M
Length	68 Cm.	134 Cm.	1090 Cm.	690 Cm.	420 Cm.

Fig. 5. Plot of cores showing division into warm (*w*, interglacial stages) and cold (*c*, glacial stages) on the basis of foraminiferal analysis. Vertical scale is time in years. The small dashes at the left of the plots represent sections of the cores dated, and the numbers over these dashes are the depths of these sections. The numbers in the centers of the plots identify the intervals.

The vertical faunal differences observed in these cores also occur in many other cores from the southeast Pacific. The faunal displacement represented by even-numbered intervals is reflected in equatorial cores by the occurrence of *Globorotalia inflata* at depth. Changes in direction of coiling by *Globoquadrina dutertrei* are traceable into the mid-latitude and tropical cores; there is only one change in coiling direction by this species, so that it serves to mark the most recent displaced-faunal interval as it does in the core discussed here. Changes in coiling direction by *Globorotalia crassaformis* and *G. truncatulinoides* are traceable into the mid-latitude cores; this fact indicates that the faunal displacements were widespread geographically. Such widespread changes may be interpreted as reflecting global climatic changes that are believed to have resulted from glacial and interglacial stages of the Pleistocene: odd-numbered intervals represent interglacial stages; even-numbered, glacial stages. The displaced fauna of the even-numbered intervals can thus result from the unique climatic conditions prevailing during the glacial stages. The changes observed in these cores thus represent similar events, as do the changes in Atlantic cores.

Cores 98C and 114 have been dated by the thorium-230 : thorium-232 method (referred to as the ionium : thorium method) (Table 2, Fig. 4; *6*). Core 98C contains an average of 91 percent calcium carbonate and has a surface Io : Th ratio of 54 (extrapolated to zero depth; see Fig. 4); the sedimentation rate is 6.9 mm/1000 years. Core 114 averages 77 percent calcium carbonate and has a surface Io : Th ratio of 31 (Fig. 4); the sedimentation rate is 6.1 mm/1000 years. These rates match within 13 percent.

It appears that high content of calcium carbonate is associated with high surface Io : Th ratio, as was observed by Goldberg and Griffin (*7*), who explained it on the basis of the removal of thorium isotopes by Foraminifera from surface waters. In both cores there is an ash layer: in core 98C, at

60 to 68 cm; in core 114, at 55 to 80 cm. These portions are being saved for possible dating by the K-Ar method (*8*). Errors due to counting statistics in the Io : Th ratio are 8 percent. The half-life of ionium used to calculate the rate of sedimentation is 75,200 years (*9*).

In Fig. 5 cores 98C and 114 are divided into glacial and interglacial stages on the basis of faunal analyses; the three other cores are the Atlantic cores, similarly divided on the basis of faunal analyses and dated beyond the range of C^{14}. These cores have been dated by the protoactinium method and the protoactinium-ionium method, as indicated in Fig. 5. Other Atlantic cores, dated past the range of C^{14} and divided into glacial and interglacial stages on the basis of $O^{18} : O^{16}$ analysis, are not included here because the correlation between $O^{18} : O^{16}$ changes and faunal changes is questionable (*2, 10*).

The ages of the boundaries between faunal intervals 1 and 2 in cores 98C and 114 are 7000 and 8000 years, respectively; these ages have been well-established in Atlantic cores by C^{14} dating (*2*) as 11,000 years. The age of the boundary between intervals 2 and 3 ranges from 51,000 to 85,000 years; between intervals 3 and 4, from 110,000 to 140,000 years; and between intervals 4 and 5, from 120,000 to 180,000 years. These ranges in age are not unreasonable if allowances are made for the accuracy and precision of the dating method, the use of different dating methods, and a 5-cm uncertainty in the positions of the boundaries. Arrhenius (*11*) reports a Pa : Io age of 80,000 years for the boundary between intervals 2 and 3 for Pacific equatorial core SW60 (Fig. 1), which falls in the range reported here. Ages of the boundaries between faunal intervals are taken at the midpoints of the changes.

Thus there is good agreement between the ages of the postglacial stage 1 and stages 2, 3, and 4 in all cores. Comparison with Emiliani's (*10*, p. 140, fig. 7) generalized climatic zonation of Atlantic deep-sea cores shows that his interval 3 is not detectable by the faunal analysis used by us. It is not desirable to speculate upon a generalized Pleistocene chronology before more cores that have been analyzed faunally are dated.

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Absence of Neutral Alkali Atoms in Rhodizite

Abstract. *The formula $CsB_{12}Be_4Al_4O_{28}$ has been proposed by others for the mineral rhodizite. Electron-spin-resonance and magnetic susceptibility measurements prove the absence of neutral cesium atoms. An ionic formula $CsB_{11}Be_4Al_4O_{26}(OH)_2$ is proposed.*

Buerger and Taxer (*1*) have proposed the formula $CsB_{12}Be_4Al_4O_{28}$ for the mineral rhodizite; cesium or the substituting alkali atoms would have to be present in the neutral state. Their proposal is based on a structure determination, whose unweighted residual *R* (discrepancy index) was 0.125 at the time that they published their results. A neutral alkali atom is placed at the origin of the cell, at a distance of 3.24 Å from 12 oxygen atoms that form a cage around it, as has been predicted by Frondel and Ito (*2*). The recorded Cs—O distances for 12-coordinated cesium ions range from 3.28 to 3.42 Å (*3*), so that the distance reported by Buerger and Taxer is small for an atomic contact even if the substitution of smaller alkalis for cesium is taken into account. But, more important, the nature of the structure, which is a close packing of oxygen ions with boron, beryllium, and aluminum ions in tetrahedral and octahedral interstices, rules out a covalent or metallic bond treatment. In a clathrate structure such as Na_8Si_{46} (*4*) to which Buerger and Taxer refer, neutral sodium atoms are acceptable because silicon forms a covalently bonded framework. In rhodizite, on the other hand, we can see no reason why the formal valences should not be expected to add up to zero. All formulas of oxide minerals would have to be reexamined if neutral alkali atoms were found in rhodizite.

Two independent physical measurements can be made to test the hypothesis that neutral cesium atoms exist in rhodizite. In that neutral cesium has an unpaired electron, its presence should lead to absorption peaks on an electron-spin-resonance (ESR) spectrum. For the same reason rhodizite should be paramagnetic. When the ionic susceptibilities of Angus are used (*5*), the calculated magnetic susceptibility for the formula used by Buerger and Taxer, $(Cs_{0.47}K_{0.33}Rb_{0.17}Na_{0.03})B_{12}Be_4Al_4O_{28}$, is $+1.10 \times 10^{-6}$ emu/g.

Professor C. Frondel has given us some of the material from Manjaka, Madagascar, on which Buerger and Taxer determined the structure. Sioda obtained an ESR spectrum both at room temperature and at the tempera-

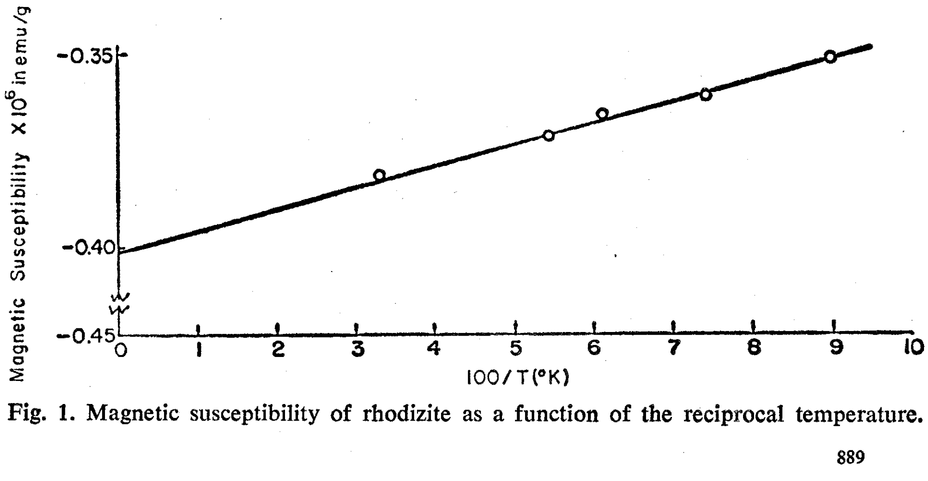

Fig. 1. Magnetic susceptibility of rhodizite as a function of the reciprocal temperature.