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R. Poore[1], H. Dowsett[1], J. Barron[2], L. Heusser[3], C. Ravelo[4], A. Mix[5], and A. McMahon[1]

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[1]U. S. Geological Survey, MS 955 National Center, Reston, VA
[2]U. S. Geological Survey, MS 910 345 Middlefield Road, Menlo Park, CA 94025
[3]100 Clinton Road, Tuxedo NY 10987
[4]Ocean Sciences, University of California, Santa Cruz, CA 95064
[5]Ocean and Atmospheric Sciences, Oregon State University, Corvallis, OR 97331

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1. U. S. Geological Survey, MS 955 National Center, Reston, VA
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Introduction

This report contains microfossil and stable isotope data from a multiproxy study of the last interglacial interval in sediments recovered at ODP Sites 1018 and 1020 off central and northern California on the west coast of North America.

ODP Site 1018 is located ~ 75 km west of Santa Cruz, California on a sediment drift just south of the Guide Seamount in water depth of 2477m (fig. 1). Four holes were cored at Site 1018 recovering a Pliocene to Quaternary sequence of siliciclastic to diatom and nannofossil clays and oozes. Weight percent calcium carbonate is low throughout the sequence usually varying between 1 and 5 percent with occasional peaks >10%(Lyle, M., Koizumi, I., Richter, C., and others, 1997). Minimum values occur during interglacials.

ODP Site 1020 is located on the east flank of the Gorda Ridge ~170km west of Eureka, California in water depth of 3038m (fig. 1). Four holes were cored at Site 1020 recovering a Pliocene to Quaternary sequence of siliciclastic clay and nannofossil clay with minor amounts of clayey nannofossil ooze. Weight percent calcium carbonate varies between 1 and 20 percent.

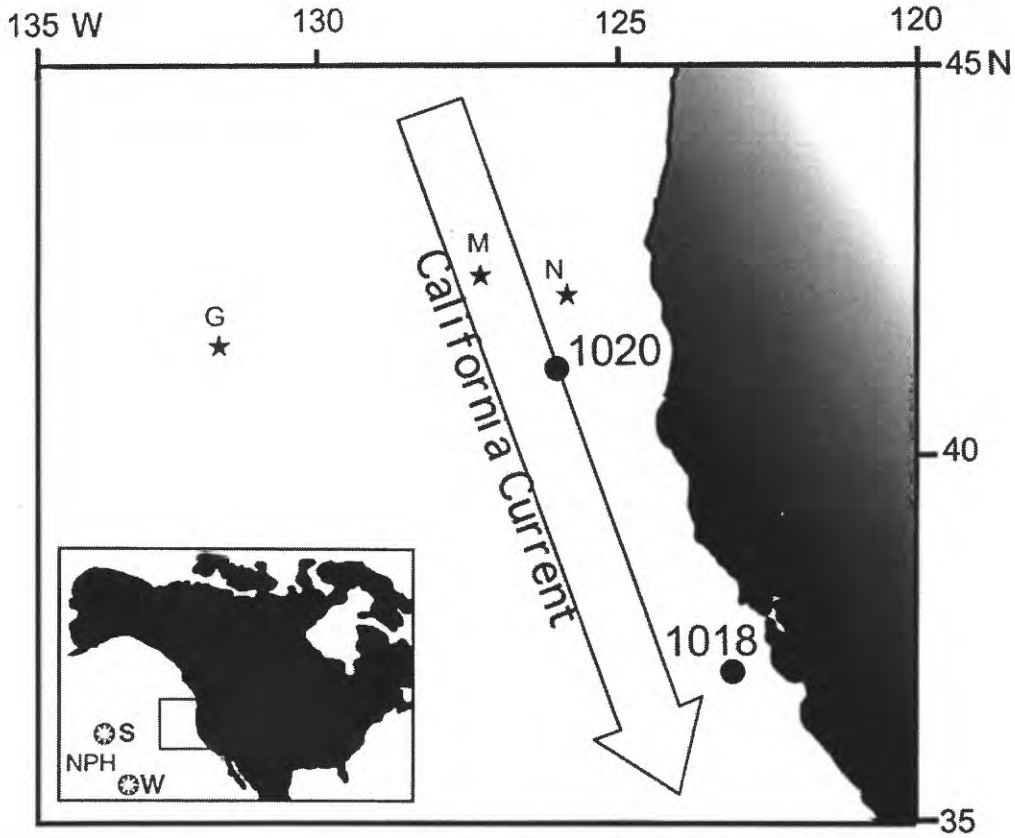

Figure 1. Map showing location of ODP Sites 1018 and 1020 and generalized position of core of southward flowing California Current (broad arrow). Small stars show location of multitracors sediment traps discussed in text. Cores W8709A-13PC and W8709A-9BC discussed in text are located at sediment trap site N. NPH (W) and NPH (S) in inset map show generalized location of North Pacific High

Minimum values occur during interglacials.

Materials and Methods

We obtained a series of samples concentrating on MIS 5e from cores 1018C core 3H and 1018D 3H for foraminifer, isotope and pollen analyses. Samples from Hole 1018C and 1018D are incorporated into a composite depth scale (RMCD) being used by the ODP 167 scientific party (Lyle and others, in press).

Several sets of samples were analyzed from ODP Site 1020. One series of samples from core 1020D 2H concentrating on MIS 5e was obtained for foraminifer, isotope, and pollen analyses. Pollen data in core 1020D 2H are supplemented by 19 samples used for initial reconnaissance studies. A separate set of samples from cores 1020D 2H and 1020C 2H that include all of MIS 5 were obtained from M. Lyle and analyzed for diatoms. Samples from Hole 1020D and Hole 1020C are incorporated into a

composite depth scale, RMCD (Lyle and others, in press).

Samples for foraminifer, pollen, and isotope analyses were dried at <50 °C, disaggregated in deionized water and wet sieved at 63μ. The < 63μ fraction from the initial wet sieving was retained and used for pollen analyses. The >63μ fraction was dry sieved into 63-150μ and > 150μ fractions. Samples with abundant planktic foraminifers in the > 150μ fraction were mechanically split to obtain sub-samples of ~ 300 planktic specimens for faunal census. The entire > 150μ fraction was used for the foraminifer census if less than 300 planktic foraminifers were present. Foraminifer taxa identified are listed below. Estimates of sea-surface temperatures (SST) based on planktic foraminifer assemblages were done with the modern analogue technique (MAT) using a revised modern core-top calibration data set that includes core-top samples from the US Pacific margin (Dowsett and Poore, in prep). Oxygen and carbon isotope analyses were done on *Fontbotia wuellerstorfi* and *Uvigerina* spp. In general 3 specimens of *F. wuellerstorfi* and 5 specimens of *Uvigerina* were used in each analyses. Isotopic analyses of Site 1018 samples were conducted on a Micromass Mass Spectrometer (Prism) at the University of California, Santa Cruz. The instrument is outfitted with a common acid bath automated carbonate device. Foraminiferal specimens were reacted at 90°C in orthophosphoric acid (H_3PO_4, specific gravity 1.93 g/cm^3 at 20°C), and cryogenically separated from water and noncondensable gases before introduction into the mass spectrometer. Analytical precision is ±0.03‰ (1s) for carbon standards and ±0.08‰ (1s) for oxygen standards. Carrara Marble, which has been calibrated to National Institute of Standards and Technology (NIST) isotopic reference material NBS-18 and NBS-19 for conversion to the Vienna Pee Dee Belemnite (VPDB) scale, is used as the in-house standard. All values are reported relative to VPDB.

Analyses of samples from Site 1020 were done at the University of Oregon using a Finnigan MAT-251 stable isotope mass spectrometer, equipped with an Autoprep Systems automated carbonate preparation device. Analytical precision based on replicate analyses of local calcite standards is ± 0.08‰ for oxygen standards and 0.04‰for carbon standards. Isotopic values are reported relative to Pee Dee Belemnite (PDB) in standard in delta notation and expressed in per mil. Calibration to PDB was done through the NBS-19 and NBS-20 standards of NIST.

For all pollen samples standard chemical processing procedures, including the addition of known amounts of an exotic tracer to calculate pollen concentration, were preceded and succeeded by sieving through 7μ nylon screening. Floral (terrestrial pollen grains) counts average ≥130specimens per sample. Specific counting categories for this study are listed below.

Diatom samples (0.5 to 1 cc) were processed in hydrogen peroxide and hydrochloric acid and prepared as strewn slides. Except where preservation was poor, at least 300 diatoms per slide were counted at 1250x during random traverses of the slides using the counting techniques of Schrader and Gersonde (1978). Note that percentages of *Chaetoceros* spores are calculated as percent of the total diatom assemblages whereas percentages of all other taxa are calculated on a *Chaetoceros*-free basis. This is done because *Chaetoceros* spores dominate the diatom assemblages in all samples. Diatom taxa identified in this study are listed below.

Chronology

Dated features of the normalized oxygen isotope age model of Martinson and others (1987) identified in our isotope records (fig 2) were used to create an age model and assign ages to samples. Our isotope data were supplemented by isotopic and carbonate data from Sites 1018 and 1020 (Lyle and others, in press) which were used to help locate the MIS 6/MIS 5 record for Site 1020 of Lyle and others (in press, fig 6).

Site	Event[1]	Depth (rmcd)	Age[1] (kyrs)
1018	4.22	18.49	64.09
	5.1	20.49	79.25
	5.31	22.69	96.21
	5.33	23.89	103.29
	5.4	24.89	110.79
	5.5	26.05	123.82
	6.0	27.20	129.84
1020	5.0	9.85	73.91
	5.3	13.00	99.38
	5.4	14.00	110.79
	5.5	15.20	123.82
	6.0	15.73	129.84
	6.2	16.17	135.10

[1] event terminology and ages taken from Martinson and others, 1987

Table 1. Calibration points used for age models.

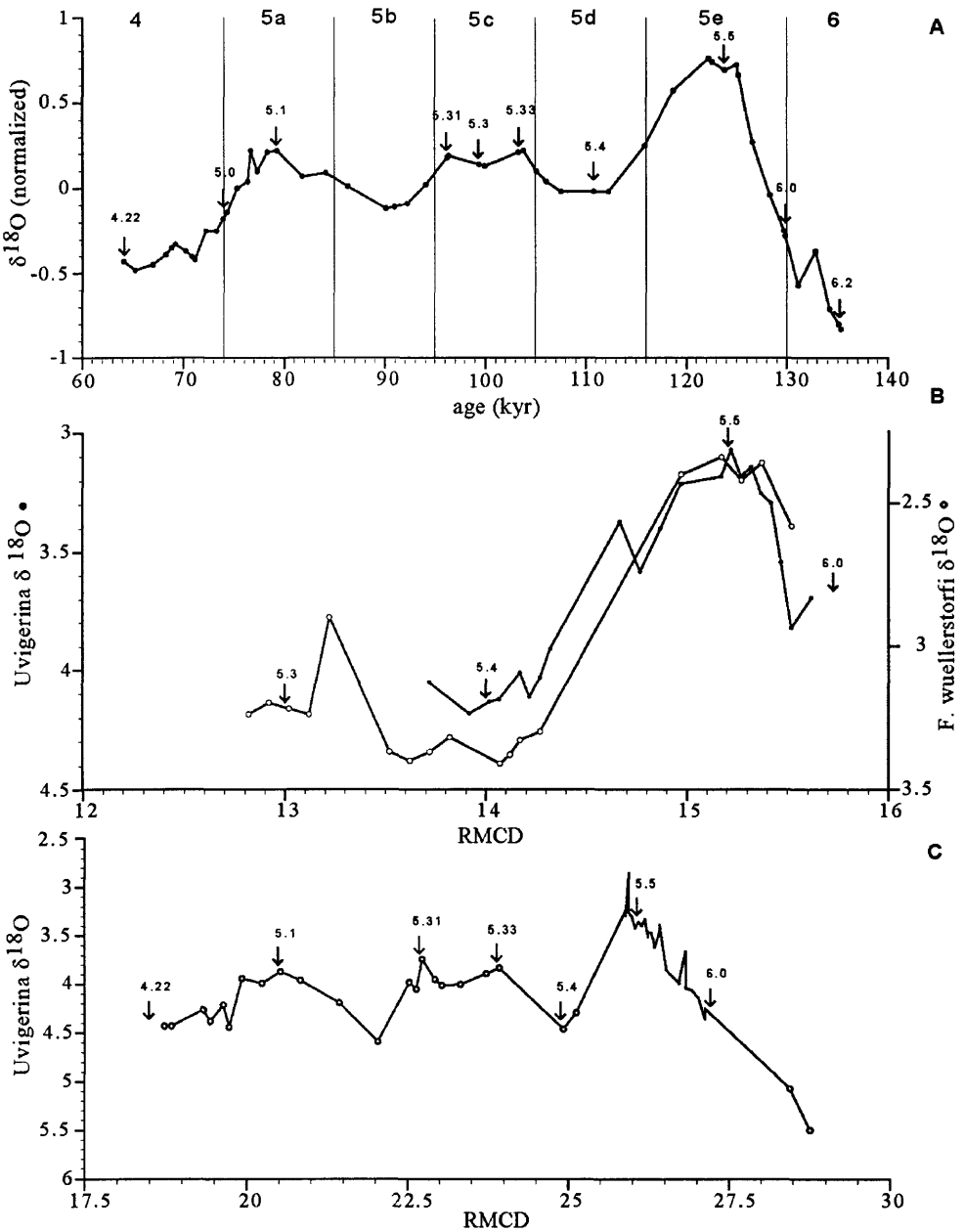

Figure 2. Isotope records and chronology. A. Normalized oxygen isotope record and time scale for MIS 5 (Martinson and others, 1987). Stage 6/ Stage 5 boundary (Termination II) and Stage 5/ Stage 4 boundary are from Martinson and others (1987). Boundaries between substages within MIS 5 are explained in the text. B. Oxygen isotope measurements on *Uvigerina* and *Fontbotia wuellerstorfi* from this study plotted against revised mean composite depth (RCMD) (Lyle and others, in press). Arrows mark points on isotope records that were correlated to the Martinson and others (1987) normalized record and used to construct the age model for this study. Even 5.0 was established from the ODP 1020 oxygen isotope record of Lyle and others (in press, Fig 6). C. Oxygen isotope measurements on Uvigerina from ODP 1018 and points used to construct age model for this study. Data from 24 to 27m RMCD are from this study. Data above 24 RMCD are from Andreasen and others (in press). Ages and depths used for the age models are listed in Table 1.

We assumed constant accumulation rates between calibration points (see table 1). In order to facilitate discussion of our results we found it convenient to define the boundaries between substages of MIS 5. Following the suggestion of Shackleton (1969) for recognizing the boundary between substage 5e and 5d, we place boundaries between substages of MIS 5 at the mid point of the transition between them (see figure 2). By our definition and using the time-scale of Martinson and others (1987) the total duration of MIS 5e is 14 kyr. The interval of warmest conditions (normalized $\delta 18O > +0.5$ on fig. 2) is ~ 9 kyr.

Results

Microfossil data and stable isotope results from ODP 1018 and 1020 MIS 5 samples examined in this study are in the following tables. The tables are also available in digital format at:

http://chht-ntsrv.er.usgs.gov/warmclimates/products.html

Planktic foraminifers:

Aside from gradational forms between right coiling *Neogloboquadrina pachyderma* and *N. dutertrei* which were recorded as "dupac" standard concepts as outlined by Parker (1962) and Poore (1981) were followed.

Globigerina bulloides d'Orbigny

G. falconensis Blow

Globigerinella aequilateralis (Brady)

Globigerinita glutinata (Egger)

Globigerinoides conglobatus (Brady)

G. ruber (d'Orbigny)

G. sacculifer (Brady)

Globorotalia hirsuta (d'Orbigny)

G. inflata (d'Orbigny)

G. menardii (Parker, Jones, and Brady)

G. pumilio Parker

G. scitula (Brady)

G. truncatulinoides (d'Orbigny)

G. tumida (Brady)

Globorotaloides hexagona (Natland)

Neogloboquadrina dutertrei (d'Orbigny)

N. pachyderma (Ehrenberg)

We separated *N. pachyderma* into left-coiling and right-coiling categories. In addition specimens with >4 chambers in the last whorl that were transitional to large typical forms of *N. dutertrei* were tabulated under the informal category of "dupac" and considered to be transi-

Hole	c	s	cm	ODP mbsf	RMCD	Age (kyr)	*G. bulloides*	*Ga. glutinata*	*Gl. ruber*	*Gn. aequilateralis*	*Gr. inflata*	*Gr. scitula*	*N. "dupac"*	*N. dutertrei*	*N. pachyderma (d)*	*N. pachyderma (s)*	*Orbulina*	*T. quinqueloba*	Total	
1018C	3H	4	47	20.97	22.60	95.52	23	0	0	0	0	0	0	2	0	18	0	0	43	*
1018C	3H	4	67	21.17	22.80	96.86	0	0	0	0	0	0	0	0	0	19	0	0	19	*
1018C	3H	4	77	21.27	22.90	97.45	0	0	0	0	0	0	0	0	0	23	0	0	23	*
1018C	3H	4	87	21.37	23.00	98.04	1	0	0	0	0	0	0	0	2	15	0	0	18	*
1018C	3H	4	97	21.47	23.10	98.63	8	0	2	0	0	0	11	8	10	75	0	1	115	
1018C	3H	4	##	21.57	23.20	99.22	1	0	0	0	0	0	0	0	0	17	0	0	18	*
1018C	3H	4	##	21.67	23.30	99.81	1	0	0	0	0	0	0	0	3	22	0	0	26	*
1018C	3H	4	##	21.97	23.60	101.58	0	0	0	0	0	29	0	0	0	0	0	0	29	*
1018C	3H	5	17	22.17	23.80	102.76	3	0	0	1	0	0	0	0	2	85	0	0	91	
1018C	3H	6	77	24.27	25.90	122.14	41	3	1	2	6	1	7	1	112	4	0	3	181	
1018C	3H	6	82	24.32	25.95	122.70	3	0	0	0	0	0	2	6	6	0	0	1	18	*
1018C	3H	6	87	24.37	26.00	123.26	0	0	0	0	0	0	4	4	11	0	0	4	23	*
1018C	3H	6	92	24.42	26.05	123.82	3	2	0	0	2	0	1	7	2	2	0	1	20	*
1018C	3H	6	97	24.47	26.10	124.08	129	4	0	0	5	1	10	10	64	23	0	8	254	
1018C	3H	6	##	24.52	26.15	124.34	154	7	1	0	7	3	14	8	68	3	2	3	270	
1018C	3H	6	##	24.57	26.20	124.61	69	0	3	2	11	0	28	8	121	10	1	3	256	
1018C	3H	6	##	24.62	26.25	124.87	63	4	2	0	2	5	21	27	128	3	1	1	257	
1018C	3H	6	##	24.67	26.30	125.13	56	8	1	0	29	1	13	47	85	5	0	1	246	
1018D	3H	4	##	24.72	26.33	125.29	119	2	3	2	16	0	15	17	46	0	2	2	224	
1018C	3H	6	##	24.72	26.35	125.39	55	6	1	2	13	0	23	16	165	12	3	4	300	
1018D	3H	5	2	24.82	26.43	125.81	2	0	0	1	1	0	1	4	4	0	0	0	13	*
1018D	3H	5	12	24.92	26.53	126.33	11	6	0	0	6	0	11	8	52	3	0	0	97	
1018D	3H	5	22	25.02	26.63	126.86	4	0	0	0	1	1	1	0	2	1	1	1	12	*
1018D	3H	5	32	25.12	26.73	127.38	3	0	0	0	5	0	1	1	5	2	0	3	20	*
1018D	3H	5	42	25.22	26.83	127.90	4	4	0	0	2	1	1	3	6	11	1	2	35	*
1018D	3H	5	52	25.32	26.93	128.43	11	2	0	2	2	0	0	2	4	42	0	4	69	
1018D	3H	5	62	25.42	27.03	128.95	6	5	0	0	2	0	2	1	5	88	1	1	111	
1018D	3H	5	72	25.52	27.13	129.47	32	3	1	0	1	1	5	0	33	136	0	8	220	

Table 2a - Planktic foraminifer counts in samples from ODP 1018C core 3 and ODP 1018D core 3. RMCD = revised meters composite depth (Lyle and others, in press). Samples marked with an asterisk were eliminated from further analyses because of low numbers or reworking

Hole	Sample c	s	cm	ODP mbsf	RMCD	Age (kyr)	*G. bulloides*	*Ga. glutinata*	*Gl. rubər*	*Gn. aequilateralis*	*Gr. inflata*	*Gr. scitula*	*N. "dupac"*	*N. dutertrei*	*N. pachyderma (d)*	*N. pachyderma (s)*	*Orbulina*	*T. quinqueloba*	SST (°C) Cold	SST (°C) Warm	± 2σ (°C) Cold	± 2σ (°C) Warm
1018C	3H	4	97	21.47	23.10	98.63	6.96	0.00	1.74	0.00	0.00	0.00	9.57	6.96	8.70	65.22	0.00	0.87	6.74	11.70	1.82	2.31
1018C	3H	5	17	22.17	23.80	102.76	3.30	0.00	0.00	1.10	0.00	0.00	0.00	0.00	2.20	93.41	0.00	0.00	0.48	4.75	1.33	1.71
1018C	3H	6	77	24.27	25.90	122.14	22.65	1.66	0.55	1.10	3.31	0.55	3.87	0.55	61.88	2.21	0.00	1.66	-	-	-	-
1018C	3H	6	97	24.47	26.10	124.08	50.79	1.57	0.00	0.00	1.97	0.39	3.94	3.94	25.20	9.06	0.00	3.15	-	-	-	-
1018C	3H	6	102	24.52	26.15	124.34	57.04	2.59	0.37	0.00	2.59	1.11	5.19	2.96	25.19	1.11	0.74	1.11	-	-	-	-
1018C	3H	6	107	24.57	26.20	124.61	26.95	0.00	1.17	0.78	4.30	0.00	10.94	3.13	47.27	3.91	0.39	1.17	13.03	16.51	*	*
1018C	3H	6	112	24.62	26.25	124.87	24.51	1.56	0.78	0.00	0.78	1.95	8.17	10.51	49.81	1.17	0.39	0.39	13.03	16.51	*	*
1018C	3H	6	117	24.67	26.30	125.13	22.76	3.25	0.41	0.00	11.79	0.41	5.28	19.11	34.55	2.03	0.00	0.41	-	-	-	-
1018D	3H	4	142	24.72	26.33	125.29	53.13	0.89	1.34	0.89	7.14	0.00	6.70	7.59	20.54	0.00	0.89	0.89	-	-	-	-
1018C	3H	6	122	24.72	26.35	125.39	18.33	2.00	0.33	0.67	4.33	0.00	7.67	5.33	55.00	4.00	1.00	1.33	13.03	16.51	*	*
1018D	3H	5	12	24.92	26.53	126.33	11.34	6.19	0.00	0.00	6.19	0.00	11.34	8.25	53.61	3.09	0.00	0.00	13.89	17.68	0.45	1.11
1018D	3H	5	52	25.32	26.93	128.43	15.94	2.90	0.00	2.90	2.90	0.00	0.00	2.90	5.80	60.87	0.00	5.80	3.19	7.23	0.43	0.69
1018D	3H	5	62	25.42	27.03	128.95	5.41	4.50	0.00	0.00	1.80	0.00	1.80	0.90	4.50	79.28	0.90	0.90	2.09	6.37	1.64	2.01
1018D	3H	5	72	25.52	27.13	129.47	14.55	1.36	0.45	0.00	0.45	0.45	2.27	0.00	15.00	61.82	0.00	3.64	6.72	12.31	1.83	1.92

Table 2b - Planktic foraminifers as percent sample and sea surface temperature MAT estimates based on foraminifer assemblages. MAT = modern analogue technique, see Dowsett and Poore, (1999). Dash indicates estimate not reliable. * insufficient information to determine standard deviation.

Hole	Sample c	s	cm	ODP mbsf	RMCD	Age (kyr)	G. bulloides	G. falconensis	Ga. glutinata	Gl. ruber	Gn. aequilatorales	Gr. hirsuta	Gr. inflata	Gr. menardii	Gr. pumilio	Gr. scitula	Gs. hexagona	N. 'dupac'	N. dutertrei	N. pachyderma (d)	N. pachyderma (s)	Orbulina	T. quinqueloba	Other	Benthic Forams	Total Count	
1020D	2H	1	102	10.42	12.82	97.92	128	0	18	0	0	0	2	0	0	2	0	2	0	33	60	1	9	3	83	258	
1020D	2H	1	112	10.52	12.92	98.73	82	0	26	0	0	0	2	0	0	5	1	3	2	70	151	1	3	1	85	347	
1020D	2H	1	122	10.62	13.02	99.61	228	0	5	0	0	0	0	0	0	1	0	2	0	12	127	1	0	5	107	381	*
1020D	2H	1	132	10.72	13.12	100.75	65	0	8	0	0	0	0	0	0	9	0	14	0	81	112	0	8	3	80	300	
1020D	2H	1	142	10.82	13.22	101.89	28	0	9	0	0	0	0	0	0	4	0	2	0	37	50	0	6	1	48	137	
1020D	2H	2	2	10.92	13.32	103.03	16	0	10	0	0	0	0	0	0	1	0	3	0	9	27	0	1	0	38	67	
1020D	2H	2	12	11.02	13.42	104.17	69	0	13	0	0	0	1	0	0	0	0	0	0	1	156	0	0	1	20	241	
1020D	2H	2	22	11.12	13.52	105.31	105	0	10	0	0	0	0	0	0	0	0	7	0	16	210	0	4	1	31	353	
1020D	2H	2	32	11.22	13.62	106.45	103	0	1	0	0	0	0	0	0	2	1	0	0	8	159	0	6	2	20	282	
1020D	2H	2	42	11.32	13.72	107.60	67	0	2	0	0	0	0	0	0	2	0	25	0	34	153	4	31	2	10	320	
1020D	2H	2	52	11.42	13.82	108.74	49	0	3	0	0	0	0	0	0	1	0	3	0	6	190	0	16	1	25	269	
1020D	2H	2	62	11.52	13.92	109.88	45	0	6	0	0	0	0	0	0	0	0	2	0	2	224	0	11	0	23	290	
1020D	2H	2	67	11.57	13.97	110.45	7	0	1	0	0	0	0	0	0	0	0	0	0	0	41	0	1	0	8	50	
1020D	2H	2	72	11.62	14.02	111.01	81	0	10	0	0	0	0	0	0	6	0	3	0	16	172	0	39	0	60	327	
1020D	2H	2	77	11.67	14.07	111.55	71	0	9	0	0	1	0	0	0	5	0	5	0	23	156	0	59	1	54	330	
1020D	2H	2	82	11.72	14.12	112.09	50	0	4	0	0	0	0	0	0	6	0	11	1	22	171	0	38	0	43	303	
1020D	2H	2	87	11.77	14.17	112.64	46	0	15	0	0	1	0	0	0	0	0	4	0	26	144	0	39	1	0	276	
1020D	2H	2	92	11.82	14.22	113.18	93	0	11	0	0	0	0	0	0	2	0	18	0	30	134	2	43	0	0	333	
1020D	2H	2	97	11.87	14.27	113.72	76	0	7	0	0	0	0	0	0	1	0	20	1	38	146	0	53	5	38	347	
1020D	2H	2	102	11.92	14.32	114.26	116	0	7	0	0	0	0	0	0	3	0	14	0	36	132	0	50	0	56	358	
1020D	2H	2	107	11.97	14.37	114.81	64	0	6	0	0	1	1	0	0	0	1	7	0	37	88	0	18	5	41	228	
1020D	2H	2	117	12.07	14.47	115.89	12	0	6	0	0	0	0	0	0	0	0	15	0	64	71	0	21	0	36	189	
1020D	2H	2	127	12.17	14.57	116.98	39	0	4	0	0	1	3	1	0	1	0	11	2	26	96	2	30	2	38	218	
1020D	2H	2	137	12.27	14.67	118.07	71	0	7	0	0	1	9	0	0	0	0	5	8	32	57	2	7	9	17	208	
1020D	2H	2	147	12.37	14.77	119.15	106	0	23	0	0	5	10	0	0	2	0	8	19	35	60	2	15	2	61	287	
1020D	2H	3	7	12.47	14.87	120.24	42	0	14	0	0	3	25	0	0	4	0	32	67	82	37	2	22	1	58	331	
1020D	2H	3	17	12.57	14.97	121.32	24	1	5	0	0	3	14	0	2	2	2	28	21	56	15	0	6	1	39	180	
1020D	2H	3	27	12.67	15.07	122.41	0	0	1	0	0	0	0	0	0	0	0	0	1	4	1	1	0	0	7	8	*
1020D	2H	3	37	12.77	15.17	123.49	5	1	7	0	0	0	3	0	1	1	0	10	7	26	4	2	0	1	40	68	
1020D	2H	3	42	12.82	15.22	124.05	5	0	3	1	0	0	11	0	0	1	1	8	2	21	3	0	4	2	0	62	
1020D	2H	3	47	12.87	15.27	124.62	17	0	5	0	0	0	15	0	0	2	0	29	5	42	2	0	8	2	0	127	
1020D	2H	3	52	12.92	15.32	125.18	24	0	2	1	0	0	25	0	0	0	0	17	3	17	6	2	8	1	0	106	
1020D	2H	3	57	12.97	15.37	125.75	111	1	9	8	0	2	55	0	0	1	2	39	12	66	11	2	13	3	0	335	
1020D	2H	3	62	13.02	15.42	126.32	48	4	6	14	0	0	22	0	0	1	0	76	35	91	8	6	12	7	0	330	
1020D	2H	3	67	13.07	15.47	126.89	13	0	5	2	0	0	10	0	0	0	2	23	5	28	2	2	12	1	0	105	
1020D	2H	3	72	13.12	15.52	127.45	26	0	10	2	1	0	27	0	0	1	0	20	6	34	19	2	7	3	0	158	
1020D	2H	3	82	13.22	15.62	128.59	37	0	24	0	0	0	31	0	0	32	6	33	7	45	123	20	17	2	0	377	

Table 3a - Planktic foraminifer counts in samples from ODP 1020D cores 2 and 3. RMCD = revised meters composite depth (Lyle and others, in press). Samples marked with an asterisk were eliminated from further analyses because of low numbers or reworking.

Sample Hole	c	s	cm	ODP mbsf	RMCD	Age (kyr)	*G. bulloides*	*G. falconensis*	*Ga. glutinata*	*Gl. ruber*	*Gn. aequilatorales*	*Gr. hirsuta*	*Gr. inflata*	*Gr. menardii*	*Gr. pumilio*	*Gr. scitula*	*Gs. hexagona*	*N. "dupac"*	*N. dutertrei*	*N. pachyderma (d)*	*N. pachyderma (s)*	*Orbulina*	*T. quinqueloba*	SST (°C) cold	SST (°C) warm	± 2σ (°C) cold	± 2σ (°C) warm
1020C 2H	1		102	10.42	12.82	97.92	49.6	0.0	7.0	0.0	0.0	0.0	0.8	0.0	0.0	0.8	0.0	0.8	0.0	12.8	23.3	0.4	3.5	7.03	12.33	2.51	2.63
1020C 2H	1		112	10.52	12.92	98.73	23.6	0.0	7.5	0.0	0.0	0.0	0.6	0.0	0.0	1.4	0.3	0.9	0.6	20.2	43.5	0.3	0.9	-	-	-	-
1020C 2H	1		132	10.72	13.12	100.75	21.7	0.0	2.7	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0.0	4.7	0.0	27.0	37.3	0.0	2.7	7.67	12.16	1.45	1.83
1020C 2H	1		142	10.82	13.22	101.89	20.4	0.0	6.6	0.0	0.0	0.0	0.0	0.0	0.0	2.9	0.0	1.5	0.0	27.0	36.5	0.0	4.4	-	-	-	-
1020C 2H	2		2	10.92	13.32	103.03	23.9	0.0	14.9	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	4.5	0.0	13.4	40.3	0.0	1.5	-	-	-	-
1020C 2H	2		12	11.02	13.42	104.17	28.6	0.0	5.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.4	64.7	0.0	0.0	4.92	10.18	1.10	1.65
1020C 2H	2		22	11.12	13.52	105.31	29.7	0.0	2.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	4.5	59.5	0.0	1.1	4.60	10.02	1.24	1.60
1020C 2H	2		32	11.22	13.62	106.45	36.5	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.4	0.0	0.0	2.8	56.4	0.0	2.1	5.87	12.22	1.14	1.50
1020C 2H	2		42	11.32	13.72	107.60	20.9	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	7.8	0.0	10.6	47.8	1.3	9.7	5.52	10.29	1.06	1.10
1020C 2H	2		52	11.42	13.82	108.74	18.2	0.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	1.1	0.0	2.2	70.6	0.0	5.9	3.77	8.31	0.99	1.40
1020C 2H	2		62	11.52	13.92	109.88	15.5	0.0	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.7	77.2	0.0	3.8	2.96	7.37	1.01	1.31
1020C 2H	2		67	11.57	13.97	110.45	14.0	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	82.0	0.0	2.0	1.74	5.66	1.06	1.35
1020C 2H	2		72	11.62	14.02	111.01	24.8	0.0	3.1	0.0	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.9	0.0	4.9	52.6	0.0	11.9	5.78	10.95	1.45	1.71
1020C 2H	2		77	11.67	14.07	111.55	21.5	0.0	2.7	0.0	0.0	0.3	0.0	0.0	0.0	1.5	0.0	1.5	0.0	7.0	47.3	0.0	17.9	5.28	10.33	1.05	1.10
1020C 2H	2		82	11.72	14.12	112.09	16.5	0.0	1.3	0.0	0.0	0.0	0.0	0.0	0.0	2.0	0.0	3.6	0.3	7.3	56.4	0.0	12.5	5.16	10.10	1.05	1.16
1020C 2H	2		87	11.77	14.17	112.64	16.7	0.0	5.4	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	1.4	0.0	9.4	52.2	0.0	14.1	5.57	10.58	0.98	1.04
1020C 2H	2		92	11.82	14.22	113.18	27.9	0.0	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	5.4	0.0	9.0	40.2	0.6	12.9	5.58	10.72	0.99	1.05
1020C 2H	2		97	11.87	14.27	113.72	21.9	0.0	2.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	5.8	0.3	11.0	42.1	0.0	15.3	5.47	10.40	0.91	0.95
1020C 2H	2		102	11.92	14.32	114.26	32.1	0.0	1.9	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	3.9	0.0	10.0	36.9	0.0	13.9	5.25	10.54	1.05	1.11
1020C 2H	2		107	11.97	14.37	114.81	28.1	0.0	2.6	0.0	0.0	0.4	0.4	0.0	0.0	0.0	0.4	3.1	0.0	16.2	38.6	0.0	7.9	5.32	10.17	1.04	1.09
1020C 2H	2		117	12.07	14.47	115.89	6.3	0.0	3.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.9	0.0	33.9	37.6	0.0	11.1	6.04	11.13	0.99	1.01
1020C 2H	2		127	12.17	14.57	116.98	17.9	0.0	1.8	0.0	0.0	0.5	1.4	0.5	0.0	0.5	0.0	5.0	0.9	11.9	44.0	0.9	13.8	5.80	10.60	0.95	1.03
1020C 2H	2		137	12.27	14.67	118.07	34.1	0.0	3.4	0.0	0.0	0.5	4.3	0.0	0.0	0.0	0.0	2.4	3.8	15.4	27.4	1.0	3.4	8.73	13.52	2.80	2.86
1020C 2H	2		147	12.37	14.77	119.15	36.9	0.0	8.0	0.0	0.0	1.7	3.5	0.0	0.0	0.7	0.0	2.8	6.6	12.2	20.9	0.7	5.2	8.85	14.83	2.41	2.15
1020C 2H	3		7	12.47	14.87	120.24	12.7	0.0	4.2	0.0	0.0	0.9	7.6	0.0	0.0	1.2	0.0	9.7	20.2	24.8	11.2	0.6	6.6	-	-	-	-
1020C 2H	3		17	12.57	14.97	121.32	13.3	0.6	2.8	0.0	0.0	1.7	7.8	0.0	1.1	1.1	1.1	15.6	11.7	31.1	8.3	0.0	3.3	10.17	14.86	0.21	0.19
1020C 2H	3		37	12.77	15.17	123.49	7.4	1.5	10.3	0.0	0.0	0.0	4.4	0.0	1.5	1.5	0.0	14.7	10.3	38.2	5.9	2.9	0.0	-	-	-	-
1020C 2H	3		42	12.82	15.22	124.05	8.1	0.0	4.8	1.6	0.0	0.0	17.7	0.0	0.0	1.6	1.6	12.9	3.2	33.9	4.8	0.0	6.5	10.50	17.01	0.84	1.40
1020C 2H	3		47	12.87	15.27	124.62	13.4	0.0	3.9	0.0	0.0	0.0	11.8	0.0	0.0	1.6	0.0	22.8	3.9	33.1	1.6	0.0	6.3	10.21	14.86	0.54	1.13
1020C 2H	3		52	12.92	15.32	125.18	22.6	0.0	1.9	0.9	0.0	0.0	23.6	0.0	0.0	0.0	0.0	16.0	2.8	16.0	5.7	1.9	7.5	9.26	15.41	0.85	1.25
1020C 2H	3		57	12.97	15.37	125.75	33.1	0.3	2.7	2.4	0.0	0.6	16.4	0.0	0.0	0.3	0.6	11.6	3.6	19.7	3.3	0.6	3.9	10.68	15.39	0.50	0.51
1020C 2H	3		62	13.02	15.42	126.32	14.5	1.2	1.8	4.2	0.0	0.0	6.7	0.0	0.0	0.3	0.0	23.0	10.6	27.6	2.4	1.8	3.6	10.11	19.32	1.03	2.59
1020C 2H	3		67	13.07	15.47	126.89	12.4	0.0	4.8	1.9	0.0	0.0	9.5	0.0	0.0	0.0	1.9	21.9	4.8	26.7	1.9	1.9	11.4	11.36	16.29	1.10	1.45
1020C 2H	3		72	13.12	15.52	127.45	16.5	0.0	6.3	1.3	0.6	0.0	17.1	0.0	0.0	0.6	0.0	12.7	3.8	21.5	12.0	1.3	4.4	-	-	-	-
1020C 2H	3		82	13.22	15.62	128.59	9.8	0.0	6.4	0.0	0.0	0.0	8.2	0.0	0.0	8.5	1.6	8.8	1.9	11.9	32.6	5.3	4.5	8.36	11.87	*	*

Table 3b - Planktic foraminifer as percent sample and sea surface temperature MAT estimates based on foraminifer assemblages. MAT = modern analogue technique, see Dowsett and Poore, (1999). Dash indicates estimate not reliable. * insufficient information to determine standard deviation.

Hole	Sample c	s	cm	ODP mbsf	RMCD	Age (kyr)	pine	spruce	western hemlock	mt. hemlock	fir	juniper/cypress	redwood	oak	douglas fir	alder	chaparral-type	grass	sedge	chenopods	composites	sage
1018C	3H	4	47	20.97	22.5	95.52	23	0	1	1	0	33	5	9	1	1	3	7	1	2	8	6
1018C	3H	4	57	21.07	22.6	96.27	56	0	0	1	1	15	5	10	0	1	0	2	0	2	5	3
1018C	3H	4	67	21.17	22.7	96.86	31	0	0	0	0	26	4	16	1	1	3	1	0	5	8	5
1018C	3H	4	77	21.27	22.8	97.45	39	1	0	0	1	22	6	12	1	2	4	3	0	1	2	6
1018C	3H	4	87	21.37	22.9	98.04	24	1	0	0	0	28	8	11	1	2	3	5	0	5	8	6
1018C	3H	4	97	21.47	23	98.63	31	0	0	0	0	34	3	16	1	1	1	1	0	2	7	4
1018C	3H	4	107	21.57	23.1	99.22	35	0	0	0	0	29	4	16	0	1	4	1	0	3	6	3
1018C	3H	4	117	21.67	23.2	99.81	30	0	0	0	0	22	4	17	1	1	4	3	1	3	7	6
1018C	3H	4	127	21.77	23.3	100.40	40	0	0	0	1	20	6	18	0	0	1	1	2	1	5	4
1018C	3H	4	147	21.97	23.5	101.58	55	0	0	0	0	19	3	7	0	0	1	1	1	2	3	7
1018C	3H	5	7	22.07	23.6	102.17	51	2	2	0	0	17	0	11	0	2	1	2	1	2	5	5
1018C	3H	5	17	22.17	23.7	102.76	38	0	0	0	0	24	0	17	0	2	2	1	1	1	7	8
1018C	3H	5	27	22.27	23.8	103.37	48	1	0	0	1	17	1	13	1	1	0	2	1	2	5	6
1018C	3H	5	37	22.37	23.9	104.12	40	1	0	0	0	19	2	13	1	2	2	2	2	1	1	12
1018C	3H	5	47	22.47	24	104.87	40	0	0	0	0	14	4	17	0	2	2	0	2	4	5	10
1018C	3H	5	57	22.57	24.1	105.62	34	0	0	0	1	25	5	21	0	1	0	1	0	3	4	5
1018C	3H	5	67	22.67	24.2	106.37	53	0	1	0	0	11	3	18	1	1	2	1	2	1	3	5
1018C	3H	5	77	22.77	24.3	107.12	44	0	2	0	1	18	5	19	1	0	2	0	0	5	2	3
1018C	3H	5	87	22.87	24.4	107.87	53	3	0	0	0	9	5	19	1	0	0	0	1	2	5	3
1018C	3H	5	97	22.97	24.5	108.62	46	3	0	0	1	10	4	12	0	0	2	0	1	4	11	7
1018C	3H	5	102	23.02	24.55	108.99	40	1	0	0	1	20	5	13	0	2	3	3	1	1	7	4
1018C	3H	5	107	23.07	24.6	109.37	55	2	0	0	1	10	5	17	1	0	1	2	1	1	2	4
1018C	3H	5	112	23.12	24.65	109.74	41	0	0	0	1	12	2	17	1	2	3	2	0	2	4	11
1018C	3H	5	117	23.17	24.7	110.12	46	0	0	0	0	24	1	9	1	3	1	0	1	4	5	6
1018C	3H	5	122	23.22	24.75	110.49	46	1	0	0	1	28	0	7	1	3	1	2	0	3	2	6
1018C	3H	5	127	23.27	24.8	110.90	58	0	0	0	1	12	1	8	1	0	1	3	0	3	4	9
1018C	3H	5	132	23.32	24.85	111.46	62	1	0	0	2	12	4	6	2	0	2	0	1	2	4	4
1018C	3H	5	137	23.37	24.9	112.03	57	1	0	0	0	11	2	10	0	0	0	0	2	3	6	6
1018C	3H	5	142	23.42	24.95	112.59	46	0	0	0	0	19	4	14	1	0	3	1	0	2	4	6
1018C	3H	5	147	23.47	25	113.15	55	0	0	0	0	21	3	8	1	2	2	1	1	3	1	4
1018C	3H	6	2	23.52	25.05	113.71	56	0	0	1	1	13	2	7	1	0	3	1	1	3	8	5
1018C	3H	6	7	23.57	25.1	114.27	50	0	1	0	0	21	4	8	0	0	1	1	2	2	9	2
1018C	3H	6	12	23.62	25.15	114.83	55	1	0	1	0	12	2	8	2	1	0	3	0	3	8	5
1018C	3H	6	17	23.67	25.2	115.40	41	0	0	0	0	31	7	12	1	0	0	0	0	2	3	3
1018C	3H	6	22	23.72	25.25	115.96	44	0	0	0	0	18	6	11	1	0	3	0	1	4	9	4
1018C	3H	6	27	23.77	25.3	116.52	52	1	0	0	0	18	11	8	3	0	1	1	0	3	2	3
1018C	3H	6	32	23.82	25.35	117.08	43	1	0	0	0	13	12	9	4	3	1	2	0	1	8	4
1018C	3H	6	37	23.87	25.4	117.64	38	0	0	0	0	14	17	14	3	0	3	0	0	4	5	4
1018C	3H	6	42	2.92	25.45	118.20	36	0	0	0	1	19	17	9	2	1	2	2	0	4	4	1
1018C	3H	8	47	23.97	25.5	118.77	30	1	0	0	0	19	21	13	1	2	0	2	2	3	4	4
1018C	3H	6	52	24.02	25.55	119.33	33	0	0	0	0	13	34	7	1	0	3	1	0	3	4	2
1018C	3H	6	57	24.07	25.6	119.89	36	0	0	0	0	9	35	11	2	0	0	1	1	2	4	0
1018C	3H	6	62	24.12	25.65	120.45	19	1	0	0	0	25	36	8	2	0	1	0	1	2	3	4
1018C	3H	6	67	24.17	25.7	121.01	23	0	1	0	0	19	31	13	0	1	2	0	1	3	4	2
1018C	3H	6	72	24.22	25.75	121.57	26	0	0	0	0	26	25	12	0	2	0	1	1	3	4	0
1018C	3H	6	77	24.27	25.8	122.14	28	0	1	0	0	23	22	12	1	0	0	0	2	3	4	4
1018C	3H	6	82	24.32	25.85	122.70	26	0	0	0	0	16	26	26	1	0	0	0	1	1	1	1
1018C	3H	6	87	24.37	25.9	123.26	31	0	0	0	0	15	23	23	2	0	3	0	1	1	0	3
1018C	3H	6	92	24.42	25.95	123.82	31	1	0	0	0	22	18	12	3	0	0	1	2	4	6	1
1018C	3H	6	97	24.47	26	124.08	32	1	0	0	0	23	16	18	2	1	0	1	0	0	3	3
1018C	3H	6	102	24.52	26.05	124.34	49	1	0	0	0	16	14	11	3	1	0	0	0	2	3	1
1018C	3H	6	107	24.57	26.1	124.61	43	0	0	0	0	18	13	14	1	4	2	0	0	3	3	1
1018C	3H	6	112	24.62	26.15	124.87	36	0	0	0	1	17	10	16	3	4	2	1	2	0	3	3
1018C	3H	6	117	24.67	26.2	125.13	53	1	0	0	0	16	8	9	2	3	1	0	2	2	4	1
1018C	3H	6	122	24.72	26.25	125.39	55	8	0	0	2	16	2	6	2	4	0	0	0	0	2	3
1018D	3H	4	142	24.72	26.23	125.29	49	0	1	0	0	18	17	7	0	2	0	1	0	2	3	2
1018D	3H	5	2	24.82	26.33	125.81	45	4	0	0	1	16	11	10	1	1	0	0	0	3	5	3
1018D	3H	5	12	24.92	26.43	126.33	44	4	4	0	0	18	9	8	3	2	2	0	0	2	4	1
1018D	3H	5	22	25.02	26.53	126.86	43	11	1	0	2	13	8	6	0	5	2	0	1	1	3	3
1018D	3H	5	32	25.12	26.63	127.38	54	12	2	1	1	7	3	5	3	5	1	0	1	1	1	3
1018D	3H	5	42	25.22	26.73	127.90	69	4	0	0	1	7	3	9	1	3	0	0	1	0	2	2
1018D	3H	5	52	25.32	26.83	128.43	66	1	0	0	0	2	2	12	0	6	1	0	1	1	3	6
1018D	3H	5	62	25.42	26.93	128.95	58	2	1	0	1	15	3	4	3	4	2	2	1	2	2	3
1018D	3H	5	72	25.52	27.03	129.47	58	1	2	0	1	15	2	7	2	4	2	0	1	4	2	2

Table 4 - Pollen types as percent assemblage in samples from ODP 1018C core 3 and ODP 1018D core 3. RMCD = revised meters composite depth (Lyle and others, in press)

Hole	Sample c	s	cm	ODP mbsf	RMCD	Age (kyr)	pine	spruce	western hemlock	mt. hemlock	fir	juniper/cypress	redwood	oak	douglas fir	alder	R R a	grass	sedge	chenopods	composite - (sage)	sage
1020D	2H	1	85	10.25	12.65	96.55	58	5	24	2	1	0	0	1	1	0	0	1	0	2	0	6
1020D	2H	1	102	10.42	12.82	97.92	49	5	21	0	2	9	3	2	1	1	0	1	0	1	2	3
1020D	2H	1	105	10.45	12.85	98.17	52	6	17	0	2	6	3	3	2	2	0	1	0	2	2	4
1020D	2H	1	112	10.52	12.92	98.73	52	6	13	3	2	9	0	5	0	3	1	0	1	2	1	3
1020D	2H	1	122	10.62	13.02	99.61	53	6	9	0	2	7	2	6	1	2	2	1	1	1	3	2
1020D	2H	1	125	10.65	13.05	99.95	69	3	4	1	2	5	5	4	0	1	0	0	0	0	1	5
1020D	2H	1	132	10.72	13.12	100.75	63	4	8	1	1	9	4	5	2	0	0	1	1	0	0	2
1020D	2H	1	142	10.82	13.22	101.89	52	4	12	0	4	8	2	6	1	2	3	0	1	0	1	4
1020D	2H	1	145	10.84	13.24	102.12	62	7	8	0	4	6	4	3	0	0	0	1	0	0	1	5
1020D	2H	2	2	10.92	13.32	103.03	62	2	10	0	1	5	1	3	1	4	1	1	2	1	1	2
1020D	2H	2	12	11.02	13.42	104.17	64	2	8	0	2	7	3	1	1	2	1	1	0	2	2	5
1020D	2H	2	15	11.05	13.45	104.51	55	7	14	0	5	7	0	1	1	0	2	1	1	1	2	4
1020D	2H	2	22	11.12	13.52	105.31	52	8	11	2	3	6	1	6	0	2	0	0	0	1	5	3
1020D	2H	2	32	11.22	13.62	106.45	59	5	12	1	3	4	1	4	2	2	0	0	0	0	3	3
1020D	2H	2	35	11.25	13.65	106.80	60	5	9	1	3	6	0	0	2	2	2	1	0	2	3	6
1020D	2H	2	42	11.32	13.72	107.60	59	5	7	1	2	8	2	4	0	2	2	2	2	1	1	4
1020D	2H	2	52	11.42	13.82	108.74	57	3	15	1	0	8	2	2	2	2	1	1	0	2	2	4
1020D	2H	2	55	11.45	13.85	109.08	66	3	4	0	1	5	2	4	0	2	1	0	0	0	3	10
1020D	2H	2	62	11.52	13.92	109.88	70	4	4	2	4	3	0	3	0	5	1	2	0	0	3	2
1020D	2H	2	67	11.57	13.97	110.45	75	3	5	1	0	5	0	2	0	0	0	2	1	0	3	4
1020D	2H	2	72	11.62	14.02	111.01	75	3	5	1	2	6	1	1	0	1	0	2	0	0	0	2
1020D	2H	2	75	11.65	14.05	111.33	60	8	13	1	3	3	2	1	1	1	1	0	0	2	3	3
1020D	2H	2	77	11.67	14.07	111.55	57	7	16	0	3	4	1	3	2	1	1	1	2	0	1	2
1020D	2H	2	82	11.72	14.12	112.09	59	6	9	0	4	6	3	2	1	2	0	2	0	0	1	6
1020D	2H	2	87	11.77	14.17	112.64	61	7	14	0	1	4	2	2	1	1	0	0	0	0	1	4
1020D	2H	2	92	11.82	14.22	113.18	66	6	9	1	1	3	2	2	0	0	2	3	1	1	1	2
1020D	2H	2	95	11.85	14.25	113.50	73	8	10	1	0	1	1	1	1	0	1	0	0	1	2	0
1020D	2H	2	97	11.87	14.27	113.72	62	9	9	0	1	4	3	3	2	0	1	0	1	1	3	2
1020D	2H	2	102	11.92	14.32	114.26	58	11	8	0	3	7	2	4	3	0	0	0	0	1	2	3
1020D	2H	2	107	11.97	14.37	114.81	61	12	13	0	0	5	0	4	0	0	0	1	0	0	3	3
1020D	2H	2	115	12.05	14.45	115.68	63	8	10	0	4	3	3	4	0	2	1	1	0	0	1	1
1020D	2H	2	117	12.07	14.47	115.89	53	12	11	0	1	8	1	2	1	4	0	3	1	1	2	3
1020D	2H	2	127	12.17	14.57	116.98	53	14	13	0	4	3	5	2	3	1	1	0	1	0	0	3
1020D	2H	2	135	12.25	14.65	117.85	65	2	14	0	0	2	4	2	0	1	2	0	0	2	5	2
1020D	2H	2	137	12.27	14.67	118.07	55	7	16	0	0	7	7	1	3	3	0	1	0	0	1	0
1020D	2H	2	147	12.37	14.77	119.15	45	8	11	1	1	7	7	2	0	10	1	0	1	2	1	4
1020D	2H	3	5	12.45	14.85	120.02	43	0	10	0	1	4	18	7	1	5	0	2	1	2	4	3
1020D	2H	3	7	12.47	14.87	120.24	43	4	10	0	1	9	11	6	2	3	1	1	0	4	1	3
1020D	2H	3	17	12.57	14.97	121.32	37	3	9	1	0	7	17	13	1	2	3	0	1	2	2	2
1020D	2H	3	25	12.65	15.05	122.19	44	6	5	2	0	5	19	14	0	4	1	0	0	0	1	1
1020D	2H	3	27	12.67	15.07	122.41	40	5	3	1	0	3	10	17	5	2	2	2	0	1	2	7
1020D	2H	3	37	12.77	15.17	123.49	43	4	7	0	0	6	12	16	3	3	1	0	0	1	3	1
1020D	2H	3	42	12.82	15.22	124.05	35	5	8	0	1	6	9	15	4	12	2	1	0	2	0	2
1020D	2H	3	45	12.85	15.25	124.39	39	2	3	2	0	2	14	14	0	8	1	1	2	4	4	4
1020D	2H	3	47	12.87	15.27	124.62	45	7	8	1	1	4	10	9	2	6	0	0	0	1	1	5
1020D	2H	3	52	12.92	15.32	125.18	43	4	9	0	1	5	9	12	2	6	0	1	1	0	2	4
1020D	2H	3	57	12.97	15.37	125.75	58	5	8	0	1	3	3	6	4	6	0	2	0	1	2	1
1020D	2H	3	62	13.02	15.42	126.32	55	4	8	0	2	7	1	8	3	6	3	0	1	3	0	0
1020D	2H	3	65	13.05	15.45	126.66	45	1	8	0	1	12	6	12	1	4	0	1	0	1	3	4
1020D	2H	3	67	13.07	15.47	126.89	51	8	13	0	1	2	4	1	3	11	1	1	1	0	0	3
1020D	2H	3	72	13.12	15.52	127.45	48	9	19	1	2	8	1	1	1	10	0	0	0	0	0	1
1020D	2H	3	82	13.22	15.62	128.59	56	5	18	1	2	4	1	2	1	9	1	0	0	0	0	1
1020D	2H	3	85	13.25	15.65	128.93	54	6	17	0	6	4	0	4	0	2	0	1	1	1	2	3
1020D	2H	3	105	13.45	15.85	131.27	70	4	11	1	1	2	1	2	0	2	0	0	2	0	2	3
1020D	2H	3	125	13.65	16.05	133.67	60	4	12	0	0	2	3	2	1	2	0	1	0	0	3	10
1020D	2H	3	145	13.85	16.25	136.06	60	10	17	1	1	4	2	1	0	0	0	0	0	1	2	2

Table 5 - Pollen types as percent assemblage in samples from ODP 1020D core 2. RMCD = revised meters composite depth (Lyle and others, in press)

tional forms between *N. dutertrei* and *N. pachyderma*.

Orbulina universa d'Orbigny

Pulleniatina obliquiloculata (Parker and Jones)

Turborotalita quinqueloba (Natland)

Palynomorphs:

Taxonomic identification of pollen was based on the use of modern pollen reference collections from western North America. Taxonomic nomenclature follows Munz and Keck (1968). Pollen grains were identified to species level when possible, otherwise pollen and spores are assigned to genera or higher rank. For example *Tsuga* (*T. heterophylla* and *T. mertensiana*) are identified to species whereas grasses (Gramineae) chenopods (Chenopodiaceae) and composites (Compositae) are identified to family level. Excluding the papillate thick/exined grains of *Sequoia* (redwood), inaperturate pollen of other genera in the Taxodiaceae, Cupressaceae, Taxaceae (*Juniperus*, *Torreya*, *Cupressus*, *Libocedrus*, *Chamaecyparis*, and *Thuja*) which cannot be confidently separated using light microscopy are referred to as juniper-cypress. Common and formal names for categories include:

Pine – *Pinus* spp.

Spruce - probably *Picea sitchensis* although *P. breweriana*, and *P. engelmannii* may be represented.

Western hemlock - *Tsuga heterophylla*

Mountain hemlock - *Tsuga mertensiana*

Fir – *Abies*

Juniper/cypress – Includes inaperturate pollen grains from the Cupressaceae (cypress family. This includes juniper (*Juniperus*) and cypress (*Cupressus*), as well as arbor vitae (*Thuja*) and Libocedrus.

Coastal redwood - *Sequoia sempervirens*

Oak - *Quercus* spp.

Douglas fir - *Pseudotusuga menziesii*

Alder – *Alnus* spp.

Chaparrel type - Includes various members of three families: Rosaceae, Rhamnaceae, and Anacardiaceae.

Grass - Gramineae

Sedge - Cyperaceae

Chenopods - Chenopodiaceae

Composites – Sage - Compositiae

Sage - *Artemisia* spp.

Diatoms:

The taxonomy used mostly follow that of Hemphill-Haley and Fourtanier (1995) and Schrader (1973).

Actinocyclus curvatulus Janisch

Azpeitia nodulifera (Schmidt) Fryxell & Sims

A. tabularis (Grunow) Fryxell & Sims - includes A. *neocrenulata* (Schmidt) Fryxell & Watkins

Chaetoceros spp. -mostly undifferentiated resting spores

Coscinodiscus radiatus Ehrenberg

Delphineis spp. -mostly D. *karstenii* (Boden) Fryxell

Hemidiscus cuneiformis Wallich

Neodenticula seminae (Simonsen & Kanaya) Akiba &Yanagisawa

Nitzschia fine-long -mostly *N. interruptestriata* Simonsen

Pseudoeunotia doliolus Wallich

Rhizosolenia spp. -undifferentiated taxa

Roperia tesselata (Roper) Grunow

Stephanopyxis spp. -mostly *S. turris* (Greville and Arnott) Ralfs, but including *S. dimorpha* Schrader

Thalassionema nitzschioides (Grunow) Van Heurck

Thalassiosira eccentrica (Ehrenberg) Cleve - includes *T. simonsenii* Hasle & Fryxell

T. oestrupii (Ostenfeld) Proshkina-Lavrenko

Actinoptychus spp. -mostly *A. senarius* (Ehrenberg) Ehrenberg

Paralia sulcata (Ehrenberg) Cleve

small centric forms - possibly *Minidiscus* spp.

Freshwater planktic- mostly *Stephanodiscus* spp.

Benthic - mostly *Cocconeis, Navicula* and related species

Sample Hole	c	s	cm	ODP mbsf	RMCD	Age (kyrs)	A. curvatulus	A. noduifer	A. tabularis	C. radiatus	Delphineis spp.	H. cuneiformis	N. seminae	Nitzschia fine-long	P. dolioius	Rhizosolenia spp.	R. tesselata	Stephanopyxis spp.	T. nitzschioides	T. eccentrica	T. oestrupii	T. pacifica	T. spp.	T. longissima	Other planktic	Actinopychus spp.	P. sucata	small centric forms	Benthic	Freshwater planktic	non spores counted	Chaetoceros spores	# diatoms / traverse
1020C 2H	3	2	7.32	8.9	66 23	0.0	0 0	0 0	0.0	0 0	0.0	3 8	0 0	0 0	0 0	0 0	67.9	11.3	1 9	0 0	0.0	1.9	0.0	0.0	0.0	0.0	0.0	1 9	9.4	53	36.14	8.30
1020C 2H	3	6	7.36	8.94	66 55	0 0	0 0	0.0	0.0	0 0	0.0	0 0	0 0	0 0	0.0	0 0	0 0	0 0	0.0	0 0	0.0	0.0	0.0	0.0	0 0	0 0	0 0	100	0 0	1	50.00	0.20
1020C 2H	3	10	7.4	8.98	88.66	0.0	0 0	0.0	0 0	0 0	0 0	5 3	0 0	0.0	0 0	0 0	42.1	21 1	0 0	0 0	10.5	0 0	0 0	0 0	0 0	0 0	0 0	21 1	0 0	9 5	68 65	3 05
1020C 2H	3	21	7 51	9.09	87 78	4.3	0 0	0.0	0 0	2 9	0 0	2 9	0 0	0.0	0 0	0.0	80 9	8.7	7 2	0 0	0 0	2 9	0.0	1.4	0 0	0 0	0 0	7 2	0 0	69	37.27	11.00
1020C 2H	3	27	7 57	9 15	88.25	0 0	0.0	0 0	0 0	6 7	0.0	0 0	13 3	0 0	0.0	0.0	26.7	26.7	13.3	0 0	0 0	13.3	0.0	0.0	0 0	0 0	0 0	0.0	0 0	7.5	40.00	1.25
1020C 2H	3	30	7.6	9 18	88 49	0 0	0 0	0 0	1 8	1 8	0 0	2 7	0 0	0 0	1.8	0 0	60 7	8.0	0.0	0 0	1 8	3 6	1.8	0.0	0 0	0 0	0 0	8.9	7.1	58	51.72	11.60
1020C 2H	3	42	7.72	9.3	69 46	0 0	0 0	0 0	11 1	22 2	0 0	0 0	0 0	0 0	0 0	0 0	11 1	16 7	0 0	0 0	0 0	0 0	5 8	0 0	0 0	0 0	0 0	33.3	0 0	9	52 63	1.90
1020C 2H	3	46	7.76	9 34	69 79	5 6	0.0	0.0	0 0	2 8	0 0	5 6	0 0	0 0	0.0	0 0	22 2	38 1	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	27 8	0 0	18	82.50	4.80
1020C 2H	3	51	7 81	9 39	70 19	0.0	0.0	0 0	0 0	13 3	0 0	0 0	6 7	0 0	0.0	0.0	0 0	28 7	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	53 3	0 0	7 5	54 55	1 65
1020C 2H	3	82	7 92	9 5	71 06	0 0	0 0	0.0	0 0	0 0	0.0	6 7	13.3	0 0	0.0	0 0	26.7	40.0	0.0	0 0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	13 3	0 0	7 5	54 55	1 65
1020C 2H	3	67	7 97	9 55	71 48	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0.0	0 0	12 9	35 5	6 5	0 0	6 5	6 5	8.5	0 0	0 0	0 0	0 0	25 8	0 0	15.5	60.76	3.95
1020C 2H	3	71	8 01	9.59	71 81	0.0	0 0	0 0	9 1	0 0	0 0	9 1	0 0	0 0	4 5	0 0	22 7	31.8	0.0	0 0	0 0	4 5	0 0	0.0	0 0	0 0	0 0	18 2	0.0	22	60.71	5.60
1020C 2H	3	81	8.11	9 69	72 82	0.0	0 0	0 0	3 2	9 5	0 0	0 0	3 2	0 0	0 0	0 0	0 0	36 5	0 0	0 0	0 0	0 0	8 3	0 0	0 0	3 2	3 2	0 0	9 5	25 4	31 5	51.91	6 55
1020C 2H	3	87	8 17	9 75	73 10	7 4	0 0	0 0	3.7	3 1	0 0	3 1	0 0	0 0	1 8	3 1	13 5	33 2	4 3	2 5	3 1	5 5	2 2	1 2	0 8	1 2	1 2	3 7	5 5	182 5	46 63	25 38
1020C 2H	3	92	8 22	9 6	73 51	0 0	0.0	0 0	4.8	8 3	0 0	2 4	0 0	0.0	0.0	0.0	21 4	39 3	2 4	2 4	4 8	4 8	0 0	0.0	0 0	0 0	2 4	2 4	4 8	42	48 78	8 20
1020C 2H	3	102	8 32	9 9	74 31	0 0	0.0	0.0	0.0	0 0	0 0	0 0	0.0	0 0	0 0	0 0	0.0	12.8	0 0	0 0	15 4	5 1	0 0	0 0	0 0	0 0	20 5	15 4	30 8	19 5	66 09	5 75
1020C 2H	3	107	8 37	9 95	74 72	0 9	0 0	0 0	0 0	12 3	0 0	6 6	0 9	0 0	1 8	1.8	14.0	26 3	4 4	2 6	10 5	7 9	0.4	1 8	0 9	0 9	0 0	2 6	3 5	114	63.34	18.29
1020C 2H	3	111	8 41	9 99	75 04	0 0	0 0	0 0	2 8	0 0	0 0	2 6	0 0	0 0	0 0	2.6	55 3	10 5	0 0	0 0	13 2	7 9	0 0	0 0	0 0	0 0	0 0	2 6	2 6	38	83 11	10.30
1020C 2H	3	121	8 51	10 09	75 85	0 8	0 0	0 0	1 6	0 4	0 0	0 8	0 0	0 0	4 0	3 2	53 4	2 4	1 6	0 0	14.6	9 7	0 0	2 4	0 0	0 0	0 0	2 4	2 4	123 5	61.22	22 75
1020C 2H	3	127	8 57	10 15	76 34	3.8	0 0	0 0	3 8	3 8	0 0	0 0	1 3	0 0	0 0	1 3	44 0	12 6	0 0	2 5	6 3	1 3	0 6	1 3	1 3	0 0	0 0	6 3	10 1	79 5	32.91	11 85
1020C 2H	3	130	8 6	10 18	76 58	2 6	0 0	0 6	0 6	7 1	0 0	3 9	0 6	0 0	1 3	5 2	25 8	29 0	3 2	2 6	3 9	3 9	0 8	0 6	1 3	0 0	0 6	5 2	1 3	155	51 26	22 71
1020C 2H	3	141	8 71	10 29	77 47	5.4	0 0	0 0	4 0	2 2	0 0	2 7	0 9	0 0	0 0	5 4	11 7	45 3	1 6	3 1	4 5	2 7	0 9	0 0	0 0	0 4	0 4	3 8	4 9	223	25 91	18 72
1020C 2H	3	146	8 76	10 34	77.87	2 1	0 0	0 0	3 6	1 3	0 0	1 8	2 3	0 0	0.5	4 7	4 7	46 6	5 7	1 6	7 3	4 1	1 3	0 0	0 0	4 1	1 0	4 1	3 1	193	38 54	17 44
1020C 2H	4	2	8 82	10 4	78 36	3 4	0 0	0 6	1 7	0 6	0 0	5 0	1 4	0 0	1.7	2 8	6 7	49.7	2 8	2 8	8.4	3 4	1 4	0 6	1 1	0 6	0 0	2 2	3 4	179	41 31	78 25
1020C 2H	4	11	8 91	10 49	79 08	4 5	0 0	0 9	0.0	2 2	0 0	3 1	0 0	0 0	1 8	2.7	20 5	12.5	2 7	1 8	17 9	9 8	0 9	1 8	0 0	0 0	0 9	9 8	6 3	112	64 44	105 00
1020C 2H	4	16	8 96	10 54	79 49	2 8	0 0	0 0	0 9	1 9	0 0	4 7	0 0	0 0	0 0	2 8	27 9	11 2	0 0	1 9	23 3	10 2	0 5	1 9	1 9	0 9	0 0	5 6	1 9	107 5	64 58	25 29
1020C 2H	4	20	9	10 58	79 81	2 0	0 0	1 0	0 0	5 4	0 0	4 5	0 0	0 0	2.0	1 0	35.6	10 4	2 0	1 0	10 9	6 9	1 5	1.0	0 0	0 0	0 0	8 9	5 9	101	66 99	102.00
1020C 2H	4	31	9 11	10 89	80 70	0 9	0 0	1 7	0 9	7 7	0 0	6 0	0 9	0 0	1 7	3 4	24 7	13.6	5.1	0 9	18 7	3 4	1 3	0.9	1.7	0 0	0 9	4 3	1 7	117 5	61 41	33 10
1020C 2H	4	37	9 17	10 75	81 19	0 7	0 0	1 4	1 4	0 7	0 0	5 7	0 0	0 0	0 7	5 0	35 5	20.6	0 7	0 0	9 2	4 3	2.8	1 4	0 0	0 0	0 0	8 4	3 5	141	55 94	53.33
1020C 2H	4	40	9 2	10.78	81 43	2 2	0 0	2 9	1 5	0 7	0 0	7 3	0 4	0 0	0 7	4 4	35.2	21 2	3 7	1 5	5 1	2 2	2.2	0 7	0 7	0 7	0 0	5 9	0 7	136 5	55 32	21.82
1020C 2H	4	51	9.31	10.89	82 32	1 5	0 0	0 5	1 5	2 0	0 0	3 0	0 5	0 0	1 0	2 0	58 3	18 3	1 0	0 5	4 9	2 5	1 2	1 0	2 0	0 0	0 0	2 0	0 5	202 5	33 93	30 65
1020C 2H	4	56	9 36	10.94	82.72	0 6	0 0	3.2	2.6	1 8	0 0	6 4	0 3	0 0	0 6	1 3	40 3	31 3	1 9	0 6	4 5	3 2	1 0	0 0	0 0	0 0	0 0	0 6	0 0	158 5	50 08	14 93
1020C 2H	4	61	9.41	10 99	83 13	0 7	0.0	1 3	3 3	0 3	0 0	5 0	0.0	0 0	0 0	0 7	24 1	58 9	1 3	0 0	1 3	0 7	1 0	0 0	0 0	0 0	0 0	2 7	0 7	149 5	51.22	81 30
1020C 2H	4	71	9 51	11 09	83 94	2.5	0 0	0.0	2 5	1.6	0 0	5 3	0 6	0 0	0.0	1.2	19 3	54 0	3.1	3 7	2.5	0.6	0.6	0.6	0 0	0 0	0 0	1 9	0.0	161	46.40	70 91
1020C 2H	4	77	9 57	11 15	84 42	2 2	0 0	0.5	2 7	0 8	0.0	2 7	0 5	0 0	1.6	2.7	8.1	62.0	3.8	3 8	2.7	3 2	1.1	1.1	0 0	0 0	0.0	0 0	0 5	185.5	44.87	112 17
1020C 2H	4	81	9 81	11 19	64 74	1 9	0 0	0.0	2 9	0 5	0 5	2 2	0 2	0 0	0 5	1.5	9.7	83.7	2.9	3 4	2.9	2.4	1 7	0.5	0 5	0 0	0 0	1 5	0 5	205.5	32.51	101.50
1020C 2H	4	91	9 71	11 29	65.55	3 6	0 0	1.2	2 4	0 2	0 0	2 4	0 0	0 8	0.4	2.4	4.8	87.2	4.8	3.6	1.2	2 0	0 8	0.4	0.0	0 8	0.0	0.8	0 0	246 5	25.26	66 50
1020C 2H	4	96	9 76	11 34	65 96	0.6	0 0	0.8	6 9	0 0	0 0	1 3	0 0	0 3	1 9	0 0	12 5	61 3	3 8	3 8	0.8	1 3	1 8	0 0	0.6	0 0	0 0	1 9	1 3	160	47.71	38 25
1020C 2H	4	102	9.82	11.4	66.44	0 0	0 0	1 3	0 6	1 9	0 0	3 8	3 8	0 0	0 0	1 3	37 3	37 3	3 8	1 3	3 2	2 5	1.9	0 0	0 0	0 0	0 0	0 0	0 0	158	48.03	21 71
1020C 2H	4	111	9.91	11 49	87.17	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	57 1	14 3	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	28 8	0 0	3 5	72.00	1 25
1020C 2H	4	118	9 96	11.54	87.57	0 0	0 0	0.0	0.0	0 0	0 0	0 0	0 0	0 0	0 0	0.0	90 4	4 1	2 7	0 0	0 0	0 0	0 0	0 0	0 0	0 0	0 0	2 7	0 0	36 5	58 76	8 85
1020C 2H	4	121	10 01	11 59	87 98	0 0	0 0	0 0	0.0	3.1	0.0	1 5	0.0	0.0	3.1	0 0	87.7	6.2	3 1	0 0	9 2	3 1	0 0	0 0	0 0	0 0	0 0	3 1	0 0	32.5	69.48	10.65
1020C 2H	4	131	10.11	11 89	66 79	1 9	0 0	0.0	1 9	0 9	0 0	1 9	0.9	0 0	1.9	0.0	85.4	4.7	1.9	0 0	11.2	1 9	0 0	1.9	0 0	0 0	0 0	1 9	1 9	53.5	82 14	33.28
1020C 2H	4	137	10 17	11 75	89 27	1.5	0 0	0 0	0 0	2 2	0 0	4 4	1.5	0 0	0 0	0 0	58.4	13.1	2.9	0 0	10.2	2 9	0 0	0.0	0 0	0 0	0 0	1.5	1.5	66.5	79.02	36.28
1020C 2H	4	140	10.2	11.78	89.52	2.3	0 0	0 0	0 0	0 0	0 0	1 7	0 0	0 0	0 0	0 0	75 1	5.2	3 5	0 0	8.9	2.3	0 8	0 0	1.2	0 0	0 0	1 2	0 0	66.5	72.50	69.89
1020C 2H	5	2	10.32	11 9	90 49	2.3	0 0	2 3	2 3	4 0	0 0	3 4	0 0	0 0	0 0	0 0	35 6	20 7	1 1	2 3	8 0	5 7	1 7	3 4	1 1	0 0	0 0	4 8	1 1	87	72 12	22 29
1020C 2H	5	8	10.38	11.96	90 97	0.0	0 0	1.7	0 8	5 9	0 0	3 4	0 4	0 4	2 5	0 8	50 0	19.5	0 0	0 8	6.8	1.7	1 7	0 0	0 8	0 0	0 0	1 7	0.8	118	62.89	108.00
1020C 2H	5	11	10.41	11.99	91.21	3.1	0 0	0.0	1 8	2.8	0.0	4 0	1 2	0 0	3 7	0.6	46 0	14 1	2 5	0 8	4 9	8 1	1.2	0 0	1 2	0 0	0 0	4 9	1 2	183	47.59	93.39
1020C 2H	5	21	10.51	12.09	92 02	2.9	0.0	1.2	1.2	2.0	0.0	5 8	0.8	0.0	1.6	1 2	26 1	21.6	3 5	2 3	11.7	5.6	2.6	1.2	1 2	0 0	0 0	3 5	1 8	171	46.39	29.00
1020C 2H	5	27	10.57	12 15	92.51	4.5	0 0	1.3	7.1	2.6	0 0	10.3	1.6	0.6	0.6	1 3	16.8	27.1	5.2	5.8	3.2	2 6	1.6	0.6	0 0	0.6	0 0	3.9	2 6	155	49.01	30.40
1020C 2H	5	31	10 61	12 19	92.83	2.1	0.0	4.2	5 8	2 1	0 0	4.5	0.5	0.0	0.5	0 0	17.4	26.3	5.3	5.3	11.6	4.2	0.3	0.5	0.0	1.6	0.5	5.8	1.6	190	40 63	20.00
1020C 2H	5	41	10.71	12.29	93.64	1.2	0.0	10 5	0 6	2 9	0 0	5 8	2 8	0 0	2.3	0 6	29.2	17 5	2.3	3.5	4 7	5.3	0.9	0 6	1.2	1.2	0 6	5.3	1.2	171	43.56	55.09
1020C 2H	5	46	10 76	12.34	94.04	3.2	0 0	8.4	1.3	2 5	0.0	3.8	1 9	0.0	1 3	0 6	22.9	28.0	4 5	1 3	9.6	5 7	0.0	0.0	0.0	0 6	0 6	3.2	2.5	157	50.94	45.71
1020C 2H	5	51	10 81	12 39	94.45	0.0	0.0	5.4	5.4	2.7	0 0	2 7	0.0	0.0	0.0	0 0	45.9	27.0	0 0	0.0	0.0	0 0	0.0	2 7	2 7	0.0	0 0	5.4	0 0	37	55.42	8.30
1020C 2H	5	82	10.92	12.5	95.34	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	47.6	33.3	0.0	0.0	0 0	9.5	0.0	0.0	9.5	0.0	0.0	0.0	0 0	10.5	22.22	1 35
1020C 2H	5	87	10.97	12.55	95.74	0.0	0.0	0.0	0.0	0.0	0.0	12 5	12.5	0.0	0.0	0.0	25.0	37.5	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6	38.46	1.30
1020C 2H	5	71	11.01	12 59	96.06	0.0	0 0	0.0	0.0	0 0	0 0	5 9	0 0	0 0	5.9	0 0	23.5	32.4	11.8	5.9	5.9	5.9	2.9	0.0	0 0	0 0	0 0	0.0	0 0	17	37.04	2.70
1020C 2H	5	61	11.11	12.7	96.95	1.0	0 0	14 4	2 1	2 6	0 0	1 3	0 8	0.0	0.5	0 0	20.6	33.0	4.6	3.1	0.5	3.1	1.5	1.0	2.1	0.0	0.0	8.2	1.5	194	36.81	16.16
1020C 2H	5	87	11 17	12.75	97.38	2.9	0 0	2 9	5.6	4.3	0 0	2 9	2 9	0 0	2 9	0 0	8.7	49.3	2 9	0 0	0 0	2 9	5.8	0.0	0 0	0 0	0 0	5.8	0 0	34.5	34.29	5.25
1020C 2H	5	91	11.21	12.79	97.68	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0 0	33.3	50.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0	0.0	0 0	11 1	0 0	9	25.00	1.20
1020C 2H	5	102	11 32	12.9	98.57	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	0.0	0.0	0.0	0.0	25.0	0.0	0.0	0.0	0.0	0.0	0.0	2	71.43	0.70
1020C 2H	5	106	11.36	12.94	98 89	0.0	0 0	13.3	0.0	0 0	0.0	0.0	13.3	0.0	0.0	0.0	26.7	26.7	0.0	0.0	0.0	0.0	6.7	0.0	0.0	0.0	0.0	13.3	0.0	7.5	51.61	1.55
1020C 2H	5	111	11.41	12.99	99.30	5.9	0.0	4.0	0.0	0.0	0.0	19.8	0.0	0.0	2.0	0.0	17.8	39.6	0.0	0.0	0.0	4.0	1.0	0.0	0.0	0.0	0.0	2.0	4.0	50.5	29.37	7.15
1020C 2H	5	121	11.51	13.09	100.41	3.3	0.0	3.3	6.7	0.0	0.0	10.0	0.0	0.0	0.0	0.0	20.0	43.3	0.0	0.0	3.3	3.3	3.3	0.0	0.0	0.0	0.0	0.0	0.0	30	21.05	3.80
1020C 2H	5	126	11 58	13.14	100.96	0.0	0 0	0.0	0.0	0 0	0 0	0 0	0 0	0 0	0.0	0.0	57.1	35.7	0.0	0.0	0.0	0.0	7.1	0.0	0 0	0.0	0.0	0.0	0 0	7	41.67	1.20
1020C 2H	5	131	11 81	13.19	101.55	0.0	0.0	7.7	0.0	0.0	0.0	23 1	0.0	0.0	0.0	0.0	38.5	19.2	7.7	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	0.0	0.0	13	53.57	2.80
1020C 2H	5	141	11.71	13.29	102 69	0 0	0 0	0.0	0.0	0 0	0.0	5 9	0 0	0.0	0.0	0.0	58.8	17.6	0.0	0.0	0.0	5.9	0.0	0.0	0.0	0.0	0.0	5.9	5.9	17	19.05	2.10

Table 6a - Diatom taxa in ODP 1020C core 2. Chaetoceros spores are tabulated as percent of total diatom assemblage. All other taxa are tabulated as percent of chaetoceros free assemblage. RMCD = revised meters composite depth (Lyle and others, in press)

Hole	c	Sample s	cm	ODP mbsf	RMCD	Age (kyrs)	A. curvatulus	A. nodulifer	A. tabularis	C. radiatus	Delphineis spp.	H. cuneiformis	N. seminae	Nitzschia fine-long	P. dolioius	Rhizosolenia spp.	R. tesselata	Stephanopyxis spp.	T. nitzschioides	T. eccentrica	T. oestrupii	T. pacifica	T. spp.	T. longissima	Other planktic	Actinoptychus spp.	P. sucata	small centric forms	Benthic	Freshwater planktic	non spores counted	Chaetoceros spores	# diatoms / traverse
1020D	2H	2	2 020D 2H-2, 2-	10.92	13.32	103.03	0.0	0.0	0.0	8.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	75.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12	36.84	1.90
1020D	2H	2	11 20D 2H-2, 11-	11.01	13.41	104.06	3.8	0.0	0.0	3.8	0.0	0.0	11.5	0.0	0.0	0.0	0.0	30.8	30.8	11.5	0.0	3.8	3.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	26	49.02	5.10
1020D	2H	2	16 20D 2H-2, 16-	11.06	13.46	104.63	1.5	0.0	1.5	0.0	1.1	0.0	4.4	0.7	0.0	0.0	0.0	66.2	10.9	0.7	1.5	5.1	2.9	0.7	0.7	0.0	0.0	0.0	0.7	1.5	137.5	57.23	27.96
1020D	2H	2	20 20D 2H-2, 20-	11.1	13.5	105.09	1.6	0.0	4.3	2.1	1.1	0.0	1.1	1.3	0.5	2.1	0.0	23.6	41.8	3.8	2.1	5.4	2.7	2.7	2.1	0.5	0.0	0.0	1.1	0.0	186.5	38.55	23.35
1020D	2H	2	31 20D 2H-2, 31-	11.21	13.81	106.34	3.3	0.0	1.6	1.1	1.1	0.0	0.3	0.8	0.0	0.5	0.0	23.5	49.7	3.8	1.6	3.3	5.5	1.6	0.0	0.0	0.5	0.0	1.1	0.5	183	40.78	30.59
1020D	2H	2	36 20D 2H-2, 36-	11.26	13.86	106.91	3.9	0.0	1.1	3.9	0.0	0.0	1.7	0.3	0.0	0.0	0.0	14.6	45.5	5.1	2.6	13.5	4.5	2.0	0.6	0.0	0.0	0.0	0.6	0.0	178	42.39	38.63
1020D	2H	2	41 20D 2H-2, 41-	11.31	13.71	107.48	3.1	0.0	1.3	1.3	0.4	0.0	0.0	1.8	0.2	0.0	0.0	8.4	65.1	4.8	1.6	1.8	2.2	2.6	0.4	0.0	0.9	0.0	3.1	0.9	227.5	27.89	105.17
1020D	2H	2	51 20D 2H-2, 51-	11.41	13.81	106.62	0.6	0.0	0.8	1.5	1.5	0.0	0.4	0.8	0.0	0.0	0.0	17.4	55.8	2.3	0.8	5.3	1.5	2.3	0.6	0.8	0.0	0.0	3.8	3.8	132.5	58.14	24.35
1020D	2H	2	56 20D 2H-2, 56-	11.46	13.86	109.19	4.3	0.0	0.0	0.0	0.0	0.0	0.0	2.2	0.0	0.0	0.0	30.4	23.9	4.3	8.7	4.3	4.3	4.3	0.0	0.0	0.0	0.0	8.7	4.3	23	57.41	5.40
1020D	2H	2	61 20D 2H-2, 61-	11.51	13.91	109.76	0.0	0.0	0.0	0.0	11.1	0.0	0.0	22.2	0.0	0.0	0.0	0.0	22.2	0.0	22.2	0.0	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.5	52.63	0.95
1020D	2H	2	71 20D 2H-2, 71-	11.61	14.01	110.90	4.7	0.0	4.7	0.0	4.7	0.0	0.0	0.0	0.0	4.7	0.0	27.9	30.2	0.0	0.0	4.7	0.0	0.0	0.0	4.7	0.0	0.0	14.0	0.0	21.5	75.43	8.75
1020D	2H	2	75 20D 2H-2, 75-	11.65	14.05	111.33	0.0	0.0	13.8	0.0	5.2	0.0	0.0	1.7	0.0	0.0	0.0	6.9	51.7	0.0	0.0	0.0	3.4	0.0	0.0	0.0	3.4	0.0	10.3	3.4	29	23.68	3.80
1020D	2H	2	81 20D 2H-2, 81-	11.71	14.11	111.98	6.2	0.0	6.2	3.1	6.2	0.0	7.7	1.5	0.0	0.0	0.0	12.3	40.0	6.2	3.1	0.0	0.0	1.5	3.1	0.0	0.0	0.0	3.1	0.0	32.5	23.53	4.25
1020D	2H	2	91 0D 2H-2, 91-	11.61	14.21	113.07	0.0	0.0	0.9	0.0	6.5	0.0	6.1	0.0	0.0	0.9	0.0	24.3	29.0	6.5	0.9	5.6	7.5	3.3	1.9	0.0	0.9	0.0	4.7	0.9	107	64.69	30.30
1020D	2H	2	96 20D 2H-2, 96-	11.86	14.26	113.61	1.7	0.0	0.9	0.9	11.9	0.0	6.8	2.6	0.0	0.9	0.0	15.3	38.3	4.3	0.9	6.0	1.7	2.1	2.6	0.0	0.0	0.0	2.6	0.9	117.5	61.29	40.47
1020D	2H	2	100 0D 2H-2, 100-	11.9	14.3	114.05	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	0.0	16.7	0.0	16.7	0.0	0.0	0.0	0.0	50.0	6	71.43	2.10
1020D	2H	2	111 0D 2H-2, 111-	12.01	14.41	115.24	2.3	0.0	0.8	0.0	9.2	0.0	3.8	1.1	0.0	0.8	0.0	20.6	32.1	5.3	3.1	7.6	3.8	1.9	0.0	0.8	0.0	0.0	5.3	1.5	131	57.47	61.60
1020D	2H	2	116 0D 2H-2, 116-	12.06	14.46	115.78	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7	0.0	0.0	16.7	0.0	0.0	0.0	0.0	0.0	0.0	16.7	33.3	6	62.50	1.60
1020D	2H	2	121 0D 2H-2, 121-	12.11	14.51	116.33	1.3	0.0	1.9	2.8	3.2	0.0	3.5	1.3	0.3	0.8	0.0	10.9	41.0	4.5	4.5	5.1	5.1	3.2	1.3	0.6	0.0	0.6	7.1	1.3	156	53.01	110.67
1020D	2H	2	131 0D 2H-2, 131-	12.21	14.61	117.41	3.2	0.0	1.6	0.0	3.9	0.0	4.2	1.3	0.0	0.5	0.0	15.8	44.2	6.3	1.8	3.2	5.3	2.1	0.5	1.1	0.5	0.0	3.2	1.6	190	37.50	95.00
1020D	2H	2	136 0D 2H-2, 136-	12.26	14.66	117.96	6.4	1.0	0.0	1.0	5.4	0.0	3.9	1.0	0.0	1.5	0.0	19.1	32.4	3.9	6.9	0.0	4.4	1.5	2.9	1.5	1.0	1.0	2.5	2.9	204	33.77	41.07
1020D	2H	2	140 0D 2H-2, 140-	12.3	14.7	116.39	1.3	0.0	1.3	0.0	7.9	0.0	4.0	2.0	0.0	0.0	0.0	17.9	38.4	4.0	2.8	1.3	6.0	1.3	0.7	1.3	0.0	0.0	6.6	3.3	151	50.65	48.57
1020D	2H	3	2 020D 2H-3, 2-	12.42	14.82	119.69	5.2	0.0	2.3	0.0	9.8	0.0	3.4	0.6	0.0	0.6	0.0	9.8	36.8	6.3	5.7	1.1	8.0	2.3	1.1	1.1	0.0	0.0	5.2	0.6	174	43.87	28.18
1020D	2H	3	6 020D 2H-3, 6-	12.46	14.66	120.13	0.0	0.0	0.0	0.0	9.4	0.0	1.9	7.5	0.0	3.8	0.0	15.1	30.2	0.0	7.5	0.0	0.0	1.9	3.8	7.5	3.6	0.0	7.5	0.0	26.5	47.52	5.05
1020D	2H	3	11 20D 2H-3, 11-	12.51	14.91	120.67	1.3	0.0	2.7	2.7	8.7	0.0	0.7	1.3	0.0	0.0	0.0	12.0	44.0	6.7	5.3	1.3	2.7	0.0	1.3	0.0	5.3	0.0	2.7	1.3	75	40.00	10.42
1020D	2H	3	21 20D 2H-3, 21-	12.61	15.01	121.76	1.2	0.6	1.8	4.2	8.4	0.0	1.8	0.0	0.0	2.4	0.0	10.8	37.3	4.8	3.6	0.0	5.4	3.0	3.0	0.8	4.2	2.4	2.4	1.8	166	44.65	48.16
1020D	2H	3	26 20D 2H-3, 26-	12.66	15.06	122.30	1.9	1.3	1.9	3.6	2.5	0.6	1.9	0.0	1.9	3.6	0.0	0.6	49.4	2.5	5.7	0.0	5.7	5.7	1.9	1.3	0.6	1.3	5.1	0.6	158	50.00	15.05
1020D	2H	3	30 20D 2H-3, 30-	12.7	15.1	122.73	2.9	1.0	2.9	2.4	2.4	1.0	0.5	1.0	2.9	4.9	0.5	8.8	41.5	2.4	3.4	0.5	5.4	3.9	3.4	3.4	1.5	0.5	2.9	0.0	205	34.29	39.00
1020D	2H	3	42 0D 2H-3, 42-4	12.82	15.22	124.05	1.1	0.0	0.5	1.1	2.7	1.1	1.6	1.1	8.1	3.2	0.0	1.6	49.2	8.1	7.0	0.0	3.2	5.4	2.2	1.6	1.6	1.1	5.4	1.1	185	38.33	33.33
1020D	2H	3	46 20D 2H-3, 46-	12.66	15.26	124.50	3.5	0.8	3.5	0.0	4.0	1.2	0.6	1.7	12.7	0.6	0.0	4.0	50.3	3.5	4.6	1.2	6.9	5.2	4.0	0.0	0.6	1.2	2.9	0.0	173	42.33	14.29
1020D	2H	3	51 20D 2H-3, 51-	12.91	15.31	125.07	0.0	0.0	0.0	11.3	1.9	0.0	0.0	1.9	7.5	3.8	0.0	0.0	45.3	7.5	7.5	0.0	3.8	5.7	11.3	0.0	0.0	0.0	0.0	0.0	26.5	43.01	4.65
1020D	2H	3	61 20D 2H-3, 61-	13.01	15.41	126.21	0.0	0.0	0.0	21.3	0.0	4.3	2.1	0.0	4.3	0.0	0.0	12.8	51.1	0.0	0.0	8.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	23.5	41.98	4.05
1020D	2H	3	66 20D 2H-3, 66-	13.06	15.46	126.77	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	20.0	0.0	20.0	10.0	0.0	0.0	0.0	0.0	10.0	0.0	5	44.44	0.90
1020D	2H	3	70 20D 2H-3, 70-	13.1	15.5	127.23	0.0	0.0	0.0	0.0	14.3	0.0	0.0	0.0	7.1	0.0	0.0	0.0	71.4	0.0	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7	22.22	0.90
1020D	2H	3	81 20D 2H-3, 81-	13.21	15.61	128.48	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	76.9	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	15.4	0.0	0.0	6.5	55.17	1.45
1020D	2H	3	86 20D 2H-3, 86-	13.26	15.66	129.04	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.5	12.5	0.0	0.0	31.3	0.0	12.5	0.0	12.5	6.3	0.0	12.5	0.0	12.5	0.0	0.0	8	11.11	0.90
1020D	2H	3	90 20D 2H-3, 90-	13.3	15.7	129.50	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	0.0	0.0	0.0	37.5	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	0.0	0.0	0.0	4	55.56	0.90
1020D	2H	3	102 0D 2H-3, 102-	13.42	15.62	130.92	0.0	0.0	0.0	0.0	0.0	0.0	36.4	9.1	0.0	0.0	0.0	0.0	36.4	0.0	0.0	0.0	18.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.00	0.55
1020D	2H	3	107 0D 2H-3, 107-	13.47	15.87	131.51	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	88.89	0.45
1020D	2H	3	110 0D 2H-3, 110-	13.5	15.9	131.87	0.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	0.0	40.0	0.0	0.0	0.0	0.0	20.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	28.57	0.35
1020D	2H	3	121 0D 2H-3, 121-	13.61	16.01	133.19	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0	100.00	0.10
1020D	2H	3	125 0D 2H-3, 125-	13.65	16.05	133.67	0.0	0.0	14.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	42.9	0.0	14.3	0.0	0.0	7.1	14.3	0.0	0.0	0.0	7.1	0.0	7	46.15	1.30
1020D	2H	3	130 0D 2H-3, 130-	13.7	16.1	134.26	0.0	0.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	0.0	0.0	0.0	22.2	0.0	0.0	0.0	22.2	11.1	0.0	0.0	0.0	0.0	22.2	0.0	4.5	52.63	0.95
1020D	2H	4	2 020D 2H-4, 2-	13.92	16.32	136.89	0.0	0.0	9.1	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	9.1	63.6	0.0	0.0	0.0	9.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11	52.17	2.30
1020D	2H	4	12 20D 2H-4, 12-	14.02	16.42	136.09	0.0	0.0	7.4	0.0	2.5	0.0	4.9	0.0	0.0	0.0	0.0	19.8	39.5	9.9	0.0	2.5	0.0	1.2	2.5	0.0	2.5	0.0	4.9	2.5	40.5	24.30	5.35
1020D	2H	4	17 20D 2H-4, 17-	14.07	16.47	138.69	4.1	0.0	4.1	0.0	4.1	0.0	0.0	0.0	0.0	0.0	0.0	8.2	34.7	16.3	8.2	4.1	0.0	0.0	4.1	0.0	0.0	0.0	0.0	12.2	24.5	51.49	5.05
1020D	2H	4	22 20D 2H-4, 22-	14.12	16.52	139.28	0.0	0.0	6.3	0.0	6.3	0.0	6.3	3.1	0.0	0.0	0.0	12.5	21.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.8	25.0	16	60.98	4.10

Table 6b - Diatom taxa in ODP 1020C core 2. Chaetoceros spores are tabulated as percent of total diatom assemblage. All other taxa are tabulated as percent of chaetoceros free assemblage. RMCD = revised meters composite depth (Lyle and others, in press)

Sample				ODP	RMCD	age	*Uvigerina auberiana*		*Uvigerina perigrina*		*Uvigerina hispida*	
Hole	c	s	cm	mbsf		(kyr)		δ18O	δ13C	δ18O	δ13C	δ18O	δ13C
1018C	3	H	4	20.97	22.60	95.52	*	4.04	-0.91				
1018C	3	H	4	21.27	22.90	97.45	*	4.05	-1.05				
1018C	3	H	4	21.37	23.00	98.04	*	4.01	-1.26				
1018C	3	H	4	21.47	23.10	98.63	*	4.03	-1.2				
1018C	3	H	4	21.57	23.20	99.22	*	4.04	-1.11				
1018C	3	H	4	21.67	23.30	99.81	*	4.04	-1.11				
1018C	3	H	5	22.07	23.70	102.17	*	4.13	-1.15				
1018C	3	H	5	22.17	23.80	102.76	*	4.1	-1.1				
1018C	3	H	6	24.27	25.90	122.14		3.24	-1.47	3.29	-1.46		
1018C	3	H	6	24.32	25.95	122.70		2.85	-2.1	3.26	-1.58		
1018C	3	H	6	24.37	26.00	123.26				3.3	-1.73		
1018C	3	H	6	24.42	26.05	123.82				3.42	-1.6		
1018C	3	H	6	24.47	26.10	124.08				3.36	-1.48		
1018C	3	H	6	24.52	26.15	124.34				3.4	-1.91		
1018C	3	H	6	24.57	26.20	124.61				3.33	-1.63		
1018C	3	H	6	24.62	30.62	124.87		3.51	-2.1	3.46	-2.23		
1018C	3	H	6	24.67	30.67	125.13		3.47	-1.54	3.49	-1.77		
1018C	3	H	6	24.72	30.72	125.39				3.62	-2.28		
1018D	3	H	4	24.72	26.33	125.29				3.53	-1.73		
1018D	3	H	5	24.82	26.43	125.81				3.45	-1.74	3.39	-1.01
1018D	3	H	5	24.92	26.53	126.33				3.85	-1.66		
1018D	3	H	5	25.12	26.73	127.38		3.99	-1.66	3.96	-0.9		
1018D	3	H	5	25.22	26.83	127.90		3.66	-1.93	4.03	-1.76	4.04	-1.22
1018D	3	H	5	25.32	26.93	128.43		4.06	-1.37				
1018D	3	H	5	25.42	27.03	128.95		4.14	-1.26				
1018D	3	H	5	25.52	27.13	129.47				4.36	-1.19	4.25	-1.1

Table 7 - Benthic foraminifer isotope data from ODP 1018C core 3 and ODP 1018D core 3. RMCD = revised meters composite depth (Lyle and others in press). Samples marked with an asterisk were not used to plot Figure 2.

Sample				ODP	RMCD	Age	*Uvigerina* spp		*F. wuellerstorfi*	
Hole	c	s	cm	mbsf		(kyr)	δ18O	δ13C	δ18O	δ13C
1020D	2H	1	102	10.42	12.82	97.92			3.24	-0.19
1020D	2H	1	112	10.52	12.92	98.73			3.2	-0.32
1020D	2H	1	122	10.62	13.02	99.61			3.22	-0.35
1020D	2H	1	132	10.72	13.12	100.75			3.24	-0.45
1020D	2H	1	142	10.82	13.22	101.89			2.9	-0.24
1020D	2H	2	22	11.12	13.52	105.31			3.37	-0.59
1020D	2H	2	32	11.22	13.62	106.45			3.4	-0.53
1020D	2H	2	42	11.32	13.72	107.60	4.05	-0.91	3.37	-0.43
1020D	2H	2	52	11.42	13.82	108.74			3.32	-0.49
1020D	2H	2	62	11.52	13.92	109.88	4.18	-0.78		
1020D	2H	2	72	11.62	14.02	111.01	4.13	-1.13		
1020D	2H	2	77	11.67	14.07	111.55	4.12	-1.35	3.41	-0.39
1020D	2H	2	82	11.72	14.12	112.09			3.38	-0.54
1020D	2H	2	87	11.77	14.17	112.64	4.01	-1.39	3.33	-0.4
1020D	2H	2	92	11.82	14.22	113.18	4.11	-1.31		
1020D	2H	2	97	11.87	14.27	113.72	4.03	-1.39	3.3	-0.41
1020D	2H	2	102	11.92	14.32	114.26	3.91	-1.31		
1020D	2H	2	137	12.27	14.67	118.07	3.37	-0.57		
1020D	2H	2	147	12.37	14.77	119.15	3.58	-0.75		
1020D	2H	3	7	12.47	14.87	120.24	3.4	-0.78		
1020D	2H	3	17	12.57	14.97	121.32	3.21	-0.69	2.4	-0.15
1020D	2H	3	37	12.77	15.17	123.49	3.18	-1.01	2.34	-0.21
1020D	2H	3	42	12.82	15.22	124.05	3.07	-0.93		
1020D	2H	3	47	12.87	15.27	124.62	3.18	-0.92	2.42	-0.32
1020D	2H	3	52	12.92	15.32	125.18	3.14	-0.94		
1020D	2H	3	57	12.97	15.37	125.75	3.25	-1.15	2.36	-0.37
1020D	2H	3	62	13.02	15.42	126.32	3.29	-0.96		
1020D	2H	3	67	13.07	15.47	126.89	3.54	-0.92		
1020D	2H	3	72	13.12	15.52	127.45	3.82	-1.02	2.58	-43
1020D	2H	3	82	13.22	15.62	128.59	3.69	-1.15		

Table 8 - Benthic foraminifer isotope data from ODP 1020D core 2. RMCD = revised meters composite depth (Lyle and others, in press)

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