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NEW BIOSTRATIGRAPHIC RESULTS  
OF DREDGING AND DART CORING IN THE  
WESTERN GULF OF ALASKA  
AND THEIR TECTONIC IMPLICATIONS

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ABSTRACT

Age determinations are reported for microfossils from 21 dredge recoveries and 8 dart cores, and for megainvertebrate fossils from 4 dredge recoveries, collected in 1979 from the outer part of the Kodiak shelf and the nearby upper continental slope. The ages tend to confirm a previous conclusion that the oldest rocks exposed in this vicinity are middle Miocene in age and that they form the deep portion of a landward-younging Miocene through Quaternary sequence in a structural high beneath the shelf edge and on the upper slope. The new microfossil data indicate that the shelf break structure is a faulted anticline in which the middle Miocene through lower Pliocene part of the exposed stratigraphic sequence has been repeated by vertical faulting since the early or middle Pliocene.

## INTRODUCTION

This report summarizes the results of biostratigraphic analyses of dredge and dart-core samples collected on the continental shelf and slope in the western Gulf of Alaska. These results include ages of diatoms (J. A. Barron), foraminifers (R. E. Arnal), radiolarians (S. A. Kling), coccoliths (D. Bukry), and megainvertebrates (L. Marinovich), and are listed in Tables 1A, 2, and 3. The samples were collected from the R/V SEA SOUNDER in 1979 to further document the ages of deformed Neogene strata beneath the continental shelf south of Kodiak Island, which were initially sampled in 1978 (McClellan and others, 1980), and to determine the ages of rocks that crop out along the edge of the continental shelf and on the slope east and south of Kodiak Island.

In 1978, sampling in this region by the U.S. Geological Survey was limited to dart coring across Albatross Bank, a bathymetric high that forms the shelf break roughly 70 km south of Kodiak Island, at longitude 153°W. Multichannel seismic records that transect Albatross Bank show that it is at the axis of a northeast-trending anticlinal structure, which shows at least 3 km of axial uplift (Fisher and von Huene, 1980). Results of biostratigraphic and paleobathymetric analyses of the previously collected dart cores suggest that most (2000 m) of the 3 km of uplift of the shelf-break structure has occurred since the middle Pliocene, at an average rate probably of 1000-3000 m/m.y. (McClellan and others, 1980). Those results provide an important, though limited, record of the pace of Neogene tectonic activity along the southern Alaskan margin. To expand that record, additional sampling was undertaken in 1979, primarily by chain dredge.

Forty-two sites were dredged during the 1979 season of which 21 yielded rocks that were analyzed for microfossils (Table 1A). These sites are distributed on the outer continental shelf and on the middle and upper continental slope in three general areas (fig. 1): (1) a northeastern area centered roughly at latitude 58°N, longitude 149°W (fig. 2A), (2) a central area in the vicinity of Albatross Bank, at 56°15'N, 153°W (fig. 2B), and (3) a southern area at 55°30'N, 154°15'W (fig. 2C). A fourth area was dredged northeast of the central area, roughly at 56°30'N, 152°30'W (fig. 1), but yielded only cobbles and boulders suspected to be glacial dropstones. Those glacial erratics, and similar material from 21 other dredge sites (Table 1B), were not analyzed for microfossils. In addition to the dredge hauls, 8 dart cores (fig. 1 and Table 1A) were collected along a northwest-trending line approximately 15 km northeast of the fourth dredge area where a multichannel seismic record was made in 1975 (U.S.G.S. Line 508). All of the dart cores were analyzed for microfossils.

Water depths at the dredging sites ranged from 3761 m to 70 m, and at the dart-coring sites, from 242 to 40 m. The greatest depth from which microfossils were recovered is 3269 m, at a site on the middle continental slope in the southern sample area. Presented below are (1) the sampling methods, (2) the results of the biostratigraphic analyses, and (3) a discussion of those results and their tectonic implications.

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## METHODS

Dredge samples were collected using a stern-hauled, chain-bag dredge with jaw dimensions of approximately 40 cm x 80 cm. Dart cores were collected using a free-fall sampling device consisting of a detachable steel sample barrel (60 cm long and 5 cm in diameter), bolted to a 907 kg lead weight. A 3.5 kHz bathymetry system was used to locate target outcrops, and NAVSAT and Loran C navigation systems were used to determine positions of dredging and coring stations.

Dredge hauls were sorted on deck immediately after recovery into two groups: (1) angular sedimentary rocks (apparent bedrock), and (2) subangular to rounded igneous and metamorphic cobbles and boulders (apparent glacial erratics). The presumed bedrock samples were retained and presumed erratics discarded. One to seven specific rock samples were selected from each dredge recovery (62 in total), and those and the 8 dart cores were subsampled onboard for microfossil analysis. The subsamples were analyzed for microfossils after the cruise.

## RESULTS

Twenty-one dredge recoveries contained rocks that were subsampled and analyzed for microfossils. Those rocks include moderately to well indurated, fine-grained sandstone, siltstone, claystone and limestone. The ages of the rocks from each dredging station, where determined, and from the 8 dart-coring stations are generalized in Table 1A. The general age assigned to each station in Table 1A is based in the biostratigraphic data listed in Table 2.

In 2 of the 21 sampled dredge recoveries (55C2 and 703A1, Table 1A) microfossils were not found. The remaining 19 dredge and 8 dart-core recoveries together yielded 70 fossiliferous samples. In 42 of those samples only one microfossil group is present (typically either diatoms or foraminifers), in 2 samples only radiolarians are present, and in one, only coccoliths. In the remaining 28 samples, 2 or more of the 4 analyzed microfossil groups are present and yielded ages. Diatoms are the best represented of the microfossil groups, being present in 70% of the 70 samples. Foraminifers were found in 56% of the samples, radiolarians in 20% and coccoliths in 7%. These results and those obtained in 1978 (McClellan and others, 1980), which included a total of 126 analyzed samples, indicate that Neogene rocks on the Kodiak shelf have an approximately equal likelihood of containing diatoms (63%) and foraminifers (62%), and that those two microfossil groups are as likely to be found together (as in 33% of the samples) as they are separately (diatoms in 30%, foraminifers in 29%).

The results of the biostratigraphic analyses of the dredge and dart-core samples (Tables 1A and 2) are outlined below, according to sample area.

(1) Northeastern Area (fig. 2A): Rock samples from 6 dredge sites in this area contain diatoms and foraminifers that are of consistent late Pliocene or Quaternary age. The restricted Quaternary age of foraminifers from site 602C1 suggests possible younging northeastward of the strata beneath the shelf and upper slope in this area, or the restricted age may be due to the shallow outcrop depth of that site. Dredge 602A3 included one sample (602A3C, Table 3) that contained a fragmentary fossil bivalve; its age is indeterminable, however.

(2) Central Area (fig. 2B): Nine datable dredge recoveries were collected from this area. Rocks dredged from site 509H1, about midway between 2 dart-coring lines sampled during the previous year (509 and 509B), contain the oldest microfossils found in the area. Those fossils are diatoms of late early, or early middle Miocene age, and were found in all three of the samples analyzed from this site (Table 2). Ages determined for other microfossil groups from this site are not entirely consistent with that age range, however. Sample 509H1A contains foraminifers of questionable early Pliocene age; these are poorly preserved, however, and may be older than Pliocene. Samples 509H1A and 509H1B contain radiolarians that are typical of a late Miocene or early Pliocene age. The radiolarians are moderately well preserved in both samples but are rare, and the age is based on the zone-defining species Stichochorys peregrina. The concordant diatom ages from samples 509H1A, 509H1B and 509H1C are based on multispecies assemblages in which no species is younger than middle Miocene. Hence, a composite age of middle or late Miocene conservatively accounts for the results from site 509H1. It should be noted that the S. peregrina radiolarian zone is a partial-range zone, and that S. peregrina also occurs, albeit in rare frequencies, in the upper middle Miocene of the tropical and northeastern Pacific (Westberg and Riedel, 1978). Thus, a restricted age of late middle Miocene is possible for site 509H1.

From the adjacent dredge site 509H3, one sample (509H3E) also yields late Miocene or early Pliocene radiolarians; other microfossils in the 5 samples from this site yield only questionable Quaternary and pre-Quaternary ages.



Hence, the rocks sampled at this site may be about the same age as or slightly younger than those at 509H1. Those alternative ages are discussed below (p.12).

Near the crest of Albatross Bank, crossing a line that was drit cored in 1978 (line 509C), 2 dredge hauls were collected, 509I1 and 509I2. Three of the 4 samples analyzed from 509I1 yield Quaternary foraminifers, which occur alone except in sample 509I1D, where middle Miocene to Quaternary diatoms are also present. The fourth sample (509I1B) contains late late Miocene or early Pliocene diatoms, along with radiolarians of probable Miocene age. Hence, bedrock along dredge site 509I1 probably includes outcrops of both late Micoene and Quaternary age. Dredge 509I2, which crossed the southern half of 509I1, yields only Quaternary foraminifers. A third recovery, 509I3, from roughly 1 km west of 509I1 and 509I2, contains foraminifers and diatoms of consistent late Pliocene and Quaternary age. Dredges 509I2 and 509I3 were collected south of 2 prominent high-angle faults (discussed on p. 11) that parallel the shelf edge and cross the northern half of site 509I1 (fig. 3). Probably the late Miocene rocks dredged from 509I1 crop out on the upthrown block north of the more landward fault, whereas the Quaternary rocks in all 3 of the recoveries are from the seafloor south of that fault. This observation is consistent with drit-coring results obtained the previous year (McClellan and others, 1980, fig. 5; this report, fig. 3).

In the southwestern part of the central area, 4 dredge hauls were collected from which 21 specific samples were analyzed. The oldest samples in 3 of those dredges (509J1, 509J2, and 509J3) are late late Miocene or early Pliocene, on the basis of numerous concordant diatom determinations. Other samples from those dredges, and all samples from the fourth dredge (509J4) are

late Pliocene or Quaternary in age, as indicated by foraminifers. Two samples, 509J2F and 509J3A, yielded conflicting ages. Sample 509J2F contains foraminifers of Quaternary age, and diatoms of late late Miocene or early Pliocene age. The diatoms, however, are possibly reworked. Sample 509J3A, on the other hand, contains a diverse assemblage of diatoms that indicates a consistent age of late late Miocene, although near the early Pliocene boundary. Hence, 509J3A, and the other old samples from this vicinity, were probably dredged from upper upper Miocene or lower Pliocene outcrops on the seafloor.

Megainvertebrate fossils were found in 3 dredge hauls from the central area (Table 3). Those 3 assemblages, which include 13 different genera of neritic invertebrates, (5 gastropod, 7 bivalve, and 1 barnacle) are Quaternary in age, and lived at depths 60 to 110 m or more shallower than those presently over the dredge sites. The assemblages probably represent faunas that lived near the outer edge of the Kodiak shelf at times when global sea level was lower than at present, most likely during glacioeustatic regressions of the Pleistocene.

(3) Southern Area (fig. 2C): Twelve dredge hauls were collected in this area, including two (703A1 and 703A2) southwest of the area of Figure 2C (fig. 1). Only 4 dredges yielded datable samples, and the age of samples in one of those dredges (705A1) could be determined only as Cenozoic. Samples in the remaining 3 dredges (703A2, 705A4, and 705A6) are of consistent late Pliocene or Quaternary age. The oldest samples in this area are late Pliocene or early Quaternary, and are from the two northernmost sites, 705A4 and 705A6.

Dart Cores (fig.1): The 8 dart cores are predominantly late Pliocene or Quaternary in age. Two cores (08007 and 08008), however, contain diatoms that range in age from late Miocene to Quaternary. Those cores are from near the axis of an anticlinal structure visible in a multichannel seismic record (USGS line 508), and suggest that rocks at the axis may be as old as late Miocene.

## DISCUSSION

The results of dart coring during 1978 (McClellan and others, 1980) indicated that deformed strata beneath Albatross Bank, at the seaward edge of the Kodiak shelf, are part of a northeastward-plunging breached anticline with middle or upper Miocene rocks exposed at its axis. The results of dredging on the outer continental shelf and upper slope seaward of Albatross Bank, in the central area discussed in this report, tend to confirm that structural interpretation in general though necessitate some modifications in detail. Those modifications involve (1) a change in the inferred position of the structural axis, (2) a refinement in the chronostratigraphic subdivision of the deformed strata, (3) an elaboration of the inferred role of faulting seaward of Albatross Bank, and (4) a relocation of the 200 m isobath. Those modifications are discussed below, followed by a comment on alternative ages possible for site 509H3.

(1) Position of the structural axis: The shelf break structure beneath Albatross Bank was initially interpreted to be a simple anticline (McClellan and others, 1980, fig. 5), but it is now believed to be a faulted anticline, as discussed below. The structural axis was earlier inferred to be some distance seaward of the most seaward stations dart cored along lines 509B (station 27) and 509C (especially station 25), because those stations yielded

the oldest microfossils (late middle? or early late Miocene diatoms). Dredge 509H1 of the present study, from about 2 to 5 km seaward of that inferred axis, yielded still older microfossils (late early or early middle Miocene diatoms). Although dredge 509H1 and the earlier collected cores generally may be about the same age (middle or late Miocene), the diatom stratigraphy indicates that the dredge samples probably are older and that the structural axis in the central area, if one exists, is some distance seaward of dredge site 509H1. This interpretation is supported by high-resolution seismic-reflection records of landward-dipping strata beneath the continental slope in the central area at the 509H dredge sites and, to the southwest, at the 509J sites.

(2) Chronostratigraphic refinement: Most of the ages reported here and previously are in the form of age ranges, due in part to limitations in the chronologic precision possible for the usually sparse microfossil assemblages that were found, and to idiosyncracies in the different microfossil zonations as they are correlated to the Lyellian series-epochs. In the central area, recurring age ranges are grouped together to enable a refinement in the chronostratigraphic subdivision of the strata on the Kodiak shelf and upper slope. These recurring age ranges are: (1) middle or late Miocene, (2) late Miocene or early Pliocene, (3) early or middle Pliocene, and (4) late Pliocene or Quaternary. The inferred distribution of strata to which those age ranges are assignable (fig. 4 and accompanying overlay) shows a landward-younging sequence as would be expected from the uniform landward dips visible in seismic records that transect the area (Fisher and von Huene, 1980, fig. 5; McClellan and others, 1980, fig. 3A-3C). However, the chronostratigraphic sequence seems to be repeated: the middle Miocene through early Pliocene

sequence is present in two adjacent and parallel belts. The absence of bilateral symmetry across the strike of these belts suggests that the sequence is not repeated by isoclinal folding. The sequence is more likely repeated by faulting, as outlined below.

(3) Role of faulting: High-resolution seismic records collected in 1978 along sparker lines 509B and 509C (McClellan and others, 1980, figs. 3B and 3C) reveal two high-angle faults, approximately 1 km apart, that cross both of the adjacent sparker lines at the shelf break. Because of the close horizontal spacing and analogous bathymetric position of the two faults along each seismic line, they are inferred to be the same two faults, which strike approximately N 70° E. Seismic and microfossil stratigraphy suggest that those faults juxtapose landward-dipping, middle Miocene through lower Pliocene strata south of the faults and landward-dipping middle Miocene through Quaternary strata on the north. The old rocks north of the faults are, thus, interpreted to be a formerly deep portion of the Neogene sequence beneath the Kodiak shelf that was uplifted relative to the seaward fault block and subsequently exposed by erosion. That old sequence, therefore, is repeated in the middle Miocene through lower Pliocene sequence found south of the faults. The earlier hypothesis (McClellan and others, 1980, fig. 5) that this area is underlain by a simple anticline, therefore, is modified to an interpretation that the structure is a faulted anticline (fig. 4, this report). It is possible that similar fault-repeated sequences may be found still farther seaward, and that a complete anticline, as earlier suggested, does not exist in this area. For that reason, the trace of an anticlinal axis has not been included there in Figure 4 of this report.

(4) Relocation of the 200-m isobath; The detailed bathymetry in Figures 2A-2C and 4 are from a map recently compiled by Dunlavey, Childs and von Huene (1980). In the central sample area (figs. 2B and 4), the location of the 200-m isobath differs from that used previously (McClellan and others, 1980, fig. 5), especially near longitude 153°W, where that contour is at approximately 56°18'N, rather than near 56°10'N.

#### Alternative ages for site 509H3

As noted on page 7, the oldest rocks found on the Kodiak shelf (probably middle or late Miocene) are from site 509H1. At the adjacent site 509H3, one somewhat younger sample was found (late Miocene or early Pliocene), along with several Quaternary and poorly determined pre-Quaternary samples. Because the bathymetric interval dredged at 509H3 (560 to 133 m) largely overlaps with, but begins lower on the slope than that at 509H1 (458 to 114 m), the younger rocks from 509H3 seem to contradict the structural interpretation proposed in Figure 4 of landward-dipping strata in the dredge area. That apparent contradiction is reconciled by the following reasoning. At site 509H1 the bedrock strata (older rocks from higher on the slope) appear in high-resolution seismic records to dip uniformly landward and crop out along the entire dredged interval. At site 509H3 (younger rocks from lower on the slope), seismic records indicate that the dredge first encountered hummocky terrane, perhaps a slump, at the landward edge of a midslope terrace, then sampled upslope across the landward-dipping strata to the position of 509H1. Thus, the young samples from 509H3 may represent rocks on the hummocky terrane, which probably were displaced downslope from younger terrane higher on the slope or on the shelf. If the late Miocene or early Pliocene sample in 509H3 does indeed represent bedrock in place on the slope, then the constraint

of superposition, as seen in the seismic stratigraphy, would suggest that the late Miocene age for this sample is the more likely alternative.

#### CONCLUSIONS

The biostratigraphic results of dredging and dart coring of deformed strata on the outer continental shelf and upper slope south of Kodiak Island indicate that those strata are part of a northeast-plunging anticlinal structure and that they range in age from middle Miocene (or possibly late early Miocene) near the shelf edge to Quaternary landward. New and previous microfossil and high-resolution seismic-reflection data, suggest the structure is cut by 2 east-northeast-striking, high-angle faults that repeat the middle Miocene to lower Pliocene portion of the stratigraphic sequence near the shelf edge.

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Tables 1, 2, and 3. Biostratigraphic results.

Abbreviations: "B" = sample barren of fossils

Epoch subdivisions:

L = late

M = middle

E = early

Sample numeration (examples):

509H3		A
dredge		specific
site		sample
		designation

08003 = dart core

Table 1A. Location and age of analyzed 1979 dredge and dart-core recoveries from the Kodiak shelf and slope, western Gulf of Alaska. Biostratigraphic and lithologic data are listed in Table 2.

Dredge Station	Starting Position				Ending Position				General Age of Rocks at Station
	Latitude (N)	Longitude (w)	Depth (m)	Latitude (N)	Longitude (w)	Depth (m)			
55C2	57°15.1'	149°32.1'	2960	57°17.3'	149°34.8'	2481	(microfossils not found)		
509H1	56°18.0'	153°02.8'	458	56°19.1'	153°02.9'	114	Prob. M. or L. Miocene		
509H3	56°17.8'	153°02.5'	560	56°18.7'	153°02.9'	133	E. Pliocene		
509I1	56°18.1'	153°12.6'	270	56°18.8'	153°13.1'	83	Prob. L. Miocene		
509I2	56°18.0'	153°12.8'	297	56°18.7'	153°12.6'	113	Quaternary		
509I3	56°18.2'	153°13.3'	177	56°18.4'	153°14.1'	70	Quaternary		
509J1	56°17.0'	153°14.9'	227	56°17.2'	153°15.7'	121	L. L. Miocene or E. Pliocene		
509J2	56°16.6'	153°14.5'	391	56°17.1'	153°15.3'	146	L. L. Miocene or E. Pliocene		
509J3	56°16.6'	153°14.8'	367	56°16.9'	153°15.5'	159	L. L. Miocene or E. Pliocene		
509J4	56°16.2'	153°14.5'	389	56°17.0'	153°15.6'	104	L. L. Miocene or E. Pliocene		
602A1	57°58.9'	148°51.6'	700	58°00.00'	148°53.9'	261	Prob. Quaternary		
602A3	57°58.9'	148°51.7'	704	57°59.4'	148°54.5'	261	L. Pliocene or Quaternary		
602A4	58°00.8'	148°56.2'	330	58°00.3'	148°54.7'	224	L. Pliocene or Quaternary		
602B1	57°56.2'	148°56.5'	862	57°57.4'	148°58.4'	364	Quaternary(?)		
602B2	57°55.9'	148°56.4'	883	57°57.4'	149°01.1'	449	L. Pliocene or Quaternary		
602C1	58°01.6'	148°51.2'	500	58°02.9'	148°53.9'	191	Quaternary		
703A1	55°15.0'	154°31.9'	3150	55°17.0'	154°34.4'	2483	(microfossils not found)		
703A2	55°23.8'	154°41.5'	1612	55°24.9'	154°43.1'	1088	L. Pliocene or Quaternary		
705A1	55°28.1'	154°01.9'	3269	55°30.8'	154°06.9'	2266	Cenozoic		
705A4	55°41.4'	154°11.0'	737	55°42.3'	154°11.6'	365	L. Pliocene or E. Quaternary		
705A6	55°41.1'	154°10.8'	902	55°41.7'	154°12.5'	281	L. Pliocene or E. Quaternary		
Dart Core	Latitude (N)	Longitude (w)	Depth (m)	Age					
08002	56°32.4'	152°00.1'	242	Quaternary					
08005	56°33.3'	152°01.4'	169	L. Pliocene or Quaternary					
08006	56°34.1'	152°02.3'	117	L. Cenozoic					
08007	56°35.0'	152°03.3'	102	L. Pliocene or Quaternary					
08008	56°35.8'	152°04.2'	94	L. Miocene to Quaternary					
08013	56°40.9'	152°09.9'	45	Quaternary					
08014	56°42.1'	152°11.4'	40	L. Pliocene or Quaternary					
08023	56°43.7'	152°13.3'	99	Probably Quaternary					

Table 1B. Location of 1979 dredge recoveries containing only ice-rafted cobbles and boulders. Recoveries not sampled for microfossils.

Dredge Station	Starting Position				Ending Position			
	Latitude (N)	Longitude (W)	Depth (m)		Latitude (N)	Longitude (W)	Depth (m)	
508B1	56°28.4'	152°12.5'	275		56°29.1'	152°12.4'	145	
508B2	56°28.4'	152°12.4'	263		56°29.0'	152°12.0'	163	
508C1	56°30.3'	152°14.9'	213		56°30.5'	152°14.1'	118	
508C2	56°30.2'	152°15.1'	254		56°30.4'	152°14.2'	120	
508D1	56°31.8'	152°17.0'	273		56°32.1'	152°16.4'	122	
508E1	56°32.6'	152°19.5'	256		56°33.0'	152°19.0'	129	
508F1	56°32.9'	152°22.9'	240		56°33.6'	152°22.6'	154	
509D1	56°29.5'	152°34.2'	248		56°29.4'	152°35.0'	210	
509E1	56°27.5'	152°33.7'	253		56°27.5'	152°35.5'	151	
509F1	56°21.1'	152°25.4'	380		56°21.5'	152°25.4'	143	
509G1	56°17.1'	152°58.6'	542		56°17.8'	152°58.2'	155	
509G2	56°17.1'	152°58.8'	538		56°18.0'	152°59.0'	150	
509H2	56°17.9'	153°03.0'	532		56°18.7'	152°01.7'	131	
511A1	56°25.0'	154°13.2'	3761		55°27.4'	154°17.4'	1775	
511A3	56°31.7'	154°18.7'	1380		55°33.4'	154°19.6'	811	
511A4	56°31.4'	154°19.3'	1099		55°32.5'	154°23.5'	690	
511B2	56°36.9'	154°16.1'	543		55°38.1'	154°16.7'	297	
602A2	57°58.8'	148°51.7'	697		57°59.9'	148°53.1'	289	
705A2	55°36.1'	154°07.7'	1800		55°37.3'	154°08.8'	1225	
705A3	55°38.0'	154°10.1'	1174		55°40.0'	154°11.7'	888	
705A5	55°41.2'	154°10.8'	889		55°42.6'	154°10.4'	472	

Table 2 Biostratigraphic and lithologic data for dredge and dart-core samples from the Kodiak shelf and slope, western Gulf of Alaska.

DREDGE SPECIFIC SAMPLE	LITHOLOGY	MICROFOSSIL AGES			
		Diatoms (Barron)	Foraminifers (Arnai)	Radiolarians (Kling)	Coccoliths (Bukry)
509H1A	claystone	L. E. Miocene or E. M. Mio.	E. Pliocene(?)	L. Miocene or E. Plio.	B
509H1B	claystone	L. E. Miocene or E. M. Mio.	B	L. Miocene or E. Plio.	B
509H1C	silty claystone	L. E. Miocene or E. M. Mio.	B	B	B
509H3A	claystone	B	B	L. Miocene or E. Plio.(?)	B
509H3B	laminated siltstone	B	B	L. Miocene or E. Plio.(?)	B
509H3C	concretion	Cenozoic	pre-Quaternary(?)	B	B
509H3D	laminated siltstone	B	B	B	Quaternary(?)
509H3E	claystone	Miocene to Quat.	B	L. Miocene or E. Plio.	B
509I1A	very fine-grained sandstone	B	Quaternary	B	B
509I1B	claystone	L. L. Miocene or E. Plio.	B	Prob. Miocene	B
509I1C	sandy siltstone	B	Quaternary	B	B
509I1D	sandy siltstone	M. Miocene to Quat.	Quaternary	B	B
509I2A	silty claystone	B	Quaternary	B	B
509I2B	silty claystone	B	Quaternary	B	B
509I2C	silty claystone	B	Quaternary	B	B
509I2D	sandy claystone	B	Quaternary	B	B
509I3A	silty claystone	B	L. Pliocene or Quat.	B	B
509I3B	claystone	L. L. Pliocene or Quat.	B	B	B
509I3C	claystone	B	Quaternary	B	Cenozoic
509I3D	silty very fine-grained sandstone	B	Quaternary	B	B
509J1A	siltstone	Pliocene, prob. E. Plio.	B	B	B
509J1B	siltstone	Pliocene or Quat.	B	B	B
509J1C	siltstone	Prob. L. L. Miocene	B	B	B
509J1D	siltstone	B	Holocene	B	B
509J2A	siltstone	L.L. Miocene or E. Plio.	B	B	B
509J2B	sandy siltstone	L.L. Miocene or E. Plio.	B	B	B
509J2D	siltstone	Pliocene or Quat.	B	B	B
509J2E	sandy siltstone	L. E. Miocene to Quat.	B	B	B
509J2F	siltstone	L. L. Miocene to Plio.	Quaternary	B	B
509J2G	sandy siltstone	L. L. Miocene to Quat.	B	B	B
509J2H	siltstone	Pliocene or Quat.	B	B	B
509J3A	siltstone	L. L. Miocene	L. Pliocene or Quat.	B	B
509J3B	siltstone	L. L. Miocene or E. Plio.	B	B	B
509J3D	pebbly mollusk-bearing sandy siltstone	Miocene to Quat.	Quaternary	B	B
509J3E	siltstone	L. L. Miocene to Quat.	B	B	B
509J3F	sandy siltstone	Prob. E. Pliocene	B	B	B
509J3G	siltstone	L. L. Miocene to Plio.	B	B	B
509J4A	laminated siltstone	Cenozoic	B	B	B
509J4B	siltstone	B	Prob. L. Pliocene or Quat.	B	B
509J4C	siltstone				
509J4D	siltstone	L. E. Miocene to Quat.	Quaternary	B	B
602A1A	pebbly limestone conc.	Cenozoic	L. Pliocene or Quat.	B	B
602A3A	pebbly sandstone	B	Prob. Quaternary	B	B
602A4A	siltstone	B	L. Pliocene or Quat.	B	B
602A4B	silty claystone	B	L. Pliocene or Quat.	B	B
602A4C	siltstone	M. Miocene to Quat.	B	B	B
602A4D	silty claystone	L. Cenozoic	B	B	B
602B1A	pebbly fine-grained sandstone	Miocene to Quat.	B	B	B
602B2A	clayey siltstone	B	Quaternary(?)	B	B
602C1A	pebbly siltstone	L. Pliocene or Quat.	L. Pliocene or Quat.	B	B
703A2A	sandy siltstone	B	Quaternary	B	B
705A1A	sandy siltstone	L. Pliocene or Quat.	B	B	B
705A4B	concretion	Cenozoic	B	B	B
705A4C	concretion	Quaternary	L. Pliocene or Quat.	Pliocene or Quat.(?)	B
705A4D	concretion	Quaternary, pre-0.25 m.y.	L. Pliocene or Quat.	Pliocene or Quat.	B
705A4E	concretion	B	Quaternary	B	B
705A4F	concretion	L. Pliocene or Quat.	L. Pliocene or Quat.	Pliocene or Quat.	B
705A6A	concretion	L. Pliocene or E. Quat.	B	Pliocene or Quat.	B
705A6B	claystone	B	Quaternary	Pliocene or Quat.(?)	B
705A6C	concretion	E. Quaternary	B	Pliocene or Quat.	B
705A6D	clay	Cenozoic	Quaternary	B	B
705A6E	concretion	Quaternary, pre-0.25 m.y. L. Miocene to Quat.	L. Pliocene or Quat. Holocene(?)	Pliocene or Quat.(?) B	L. Quaternary B
DART CORE					
08002	silty sand	L. Pliocene or Quat.	Quaternary	B	Quaternary
08005	silty sand	L. Pliocene or Quat.	B	B	B
08006	silty claystone	L. Cenozoic	B	B	B
08007	silty claystone	L. Miocene to Quat.	L. Pliocene or Quat.	B	B
08008	claystone	L. Miocene to Quat.	Holocene(?)	B	B
08013	silty claystone	Quaternary	L. Pliocene or Quat.	B	B
08014	silty claystone	L. Quaternary	L. Pliocene or Quat.	Pliocene or Quat.(?)	B
08023	sand	L. Quaternary	Pliocene or Pleist., prob. L. Pliocene or E. Pleist.	B	Quaternary

Table 3. Biostratigraphic, paleobathymetric, and lithologic data for megafossils dredged from the Kodiak shelf and slope.

Dredge Specific Sample	Lithology	Megafossil Groups (no. of genera)	Dredge Depth (m)	Probable Paleodepth of fauna (m)	Probable Age
509I2C	silty claystone	gastropods (1) bivalves (1)	113-297	0-37	Quaternary
509J3C	pebbly mollusk- bearing sandy siltstone	gastropods (1) bivalves (4)	159-367	0-100	Quaternary
509J3D	pebbly mollusk- bearing sandy siltstone	gastropods (5) bivalves (5) barnacles (1)	159-367	20-50	Quaternary
602A3C	pebbly mollusk- bearing medium- grained sandstone	bivalves (1)	261-704	?	?

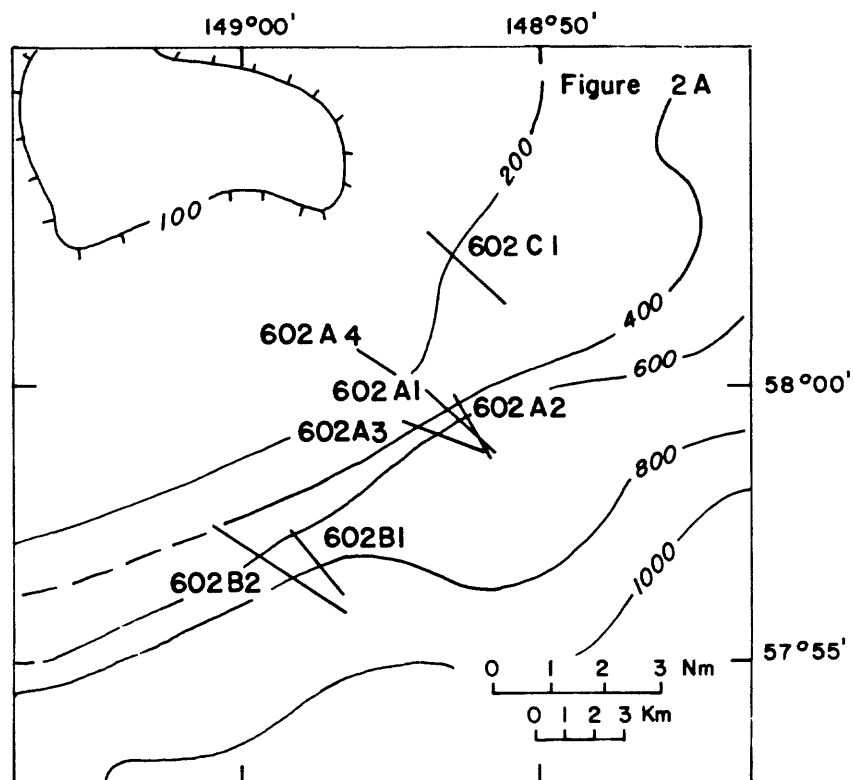


Figure 2A. Detailed locations of dredge sites in northeastern sample area on the Kodiak shelf.

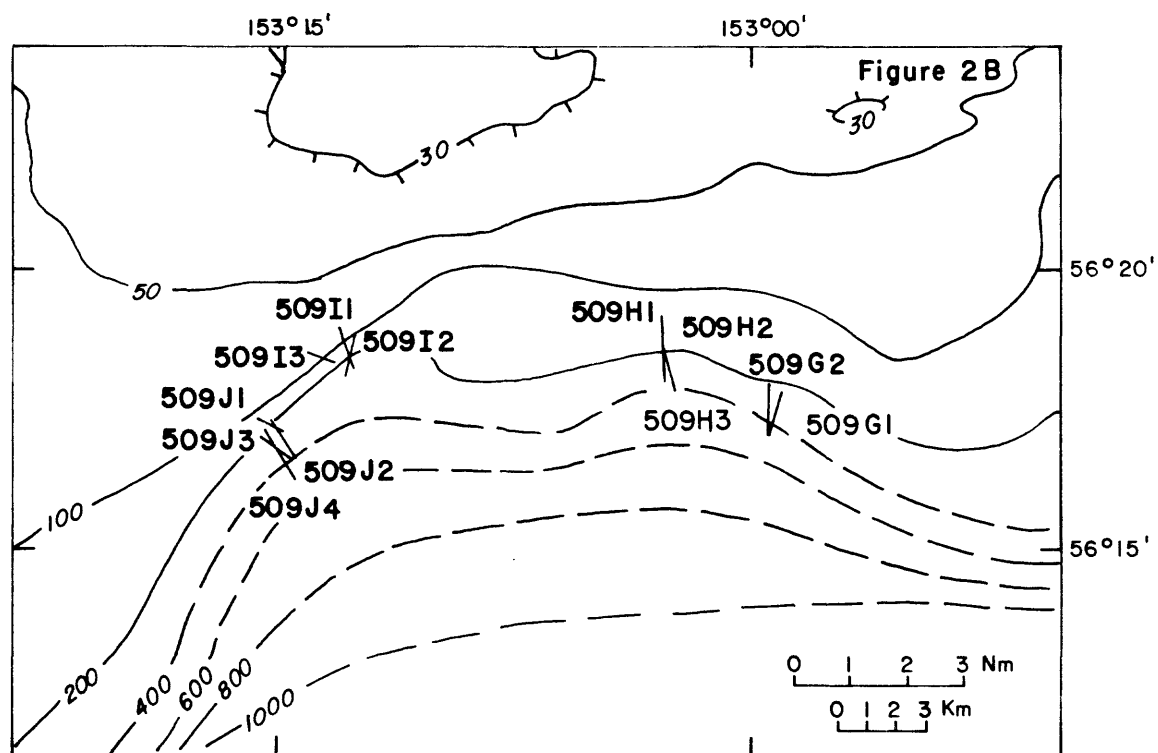


Figure 2B. Detailed locations of dredge sites in central sample area on the Kodiak shelf.

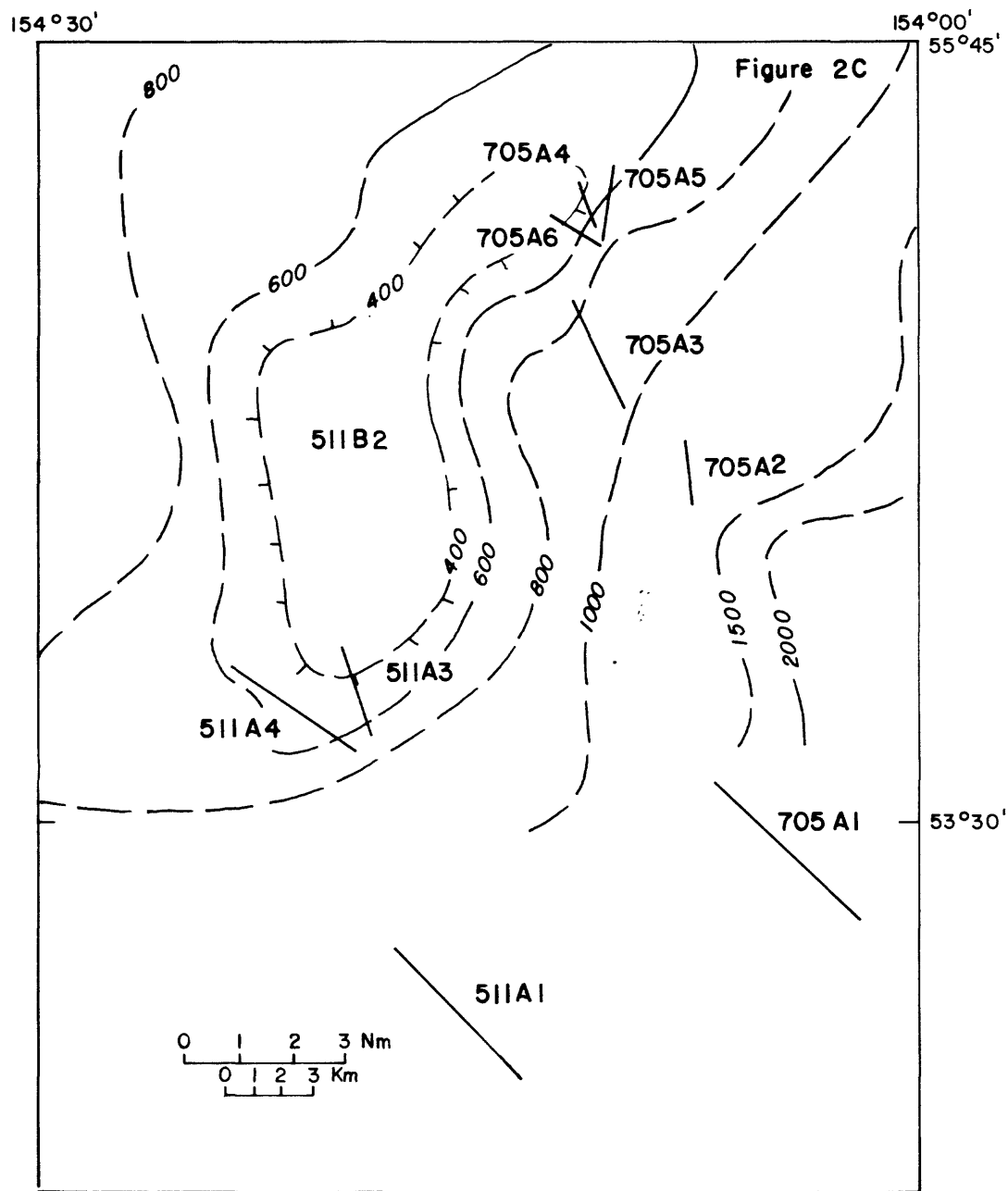


Figure 2C. Detailed locations of dredge sites in southern sample area on the Kodiak shelf.

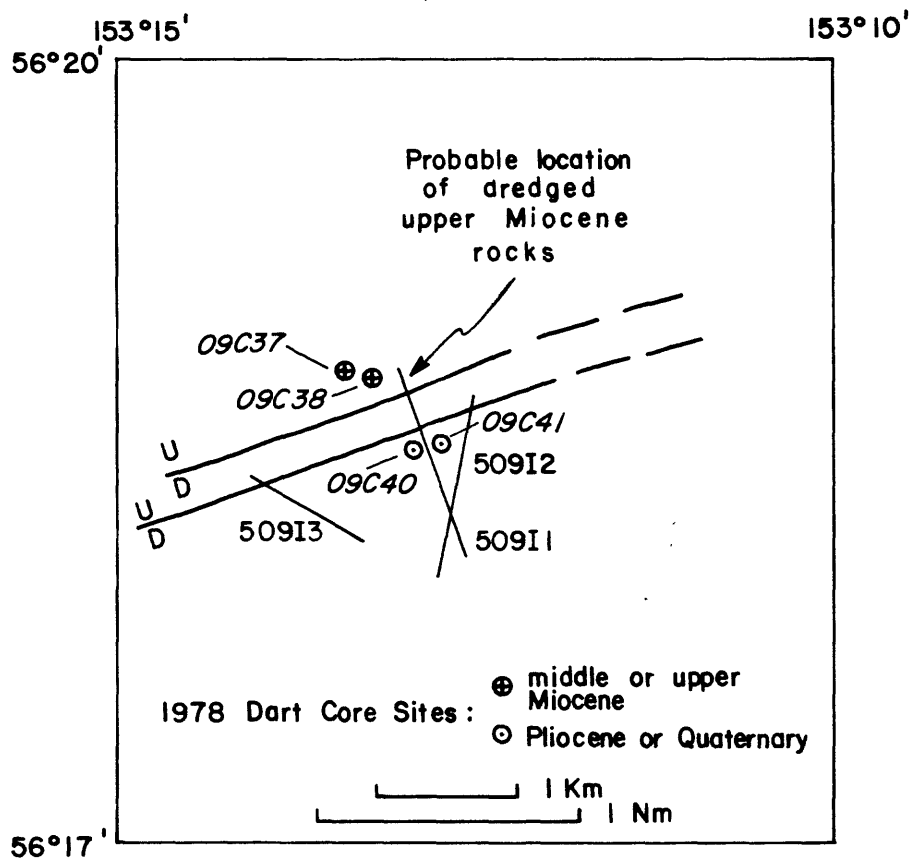


Figure 3. Relative locations of high-angle faults and dredged and dart-cored upper Miocene rocks in part of central sample area, discussed in text.



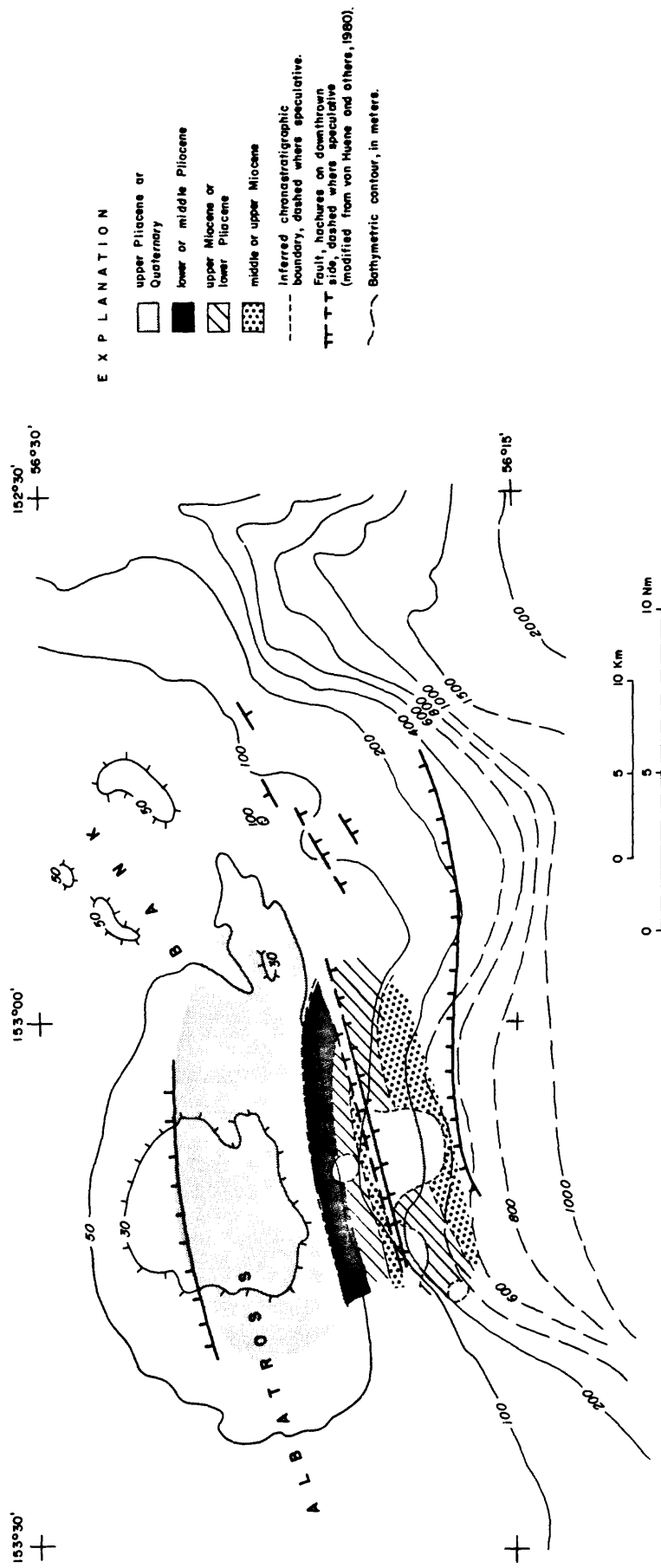


Figure 4. Geology of the Kodiak shelf at Albatross Bank, as inferred from microfossil ages (McClellan and others, 1980; and this report) and seismic data (Fisher and von Huene, 1980; von Huene and others, 1980). See text for explanation of the overlapping chronostratigraphic intervals.