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JURASSIC THROUGH PLIOCENE AGE MEGAFOSSIL SAMPLES COLLECTED IN 2005 BY THE ALASKA DIVISON OF GEOLOGICAL & GEOPHYSICAL SURVEYS FROM THE BRISTOL BAY–PORT MOLLER AREA, ALASKA PENINSULA

by
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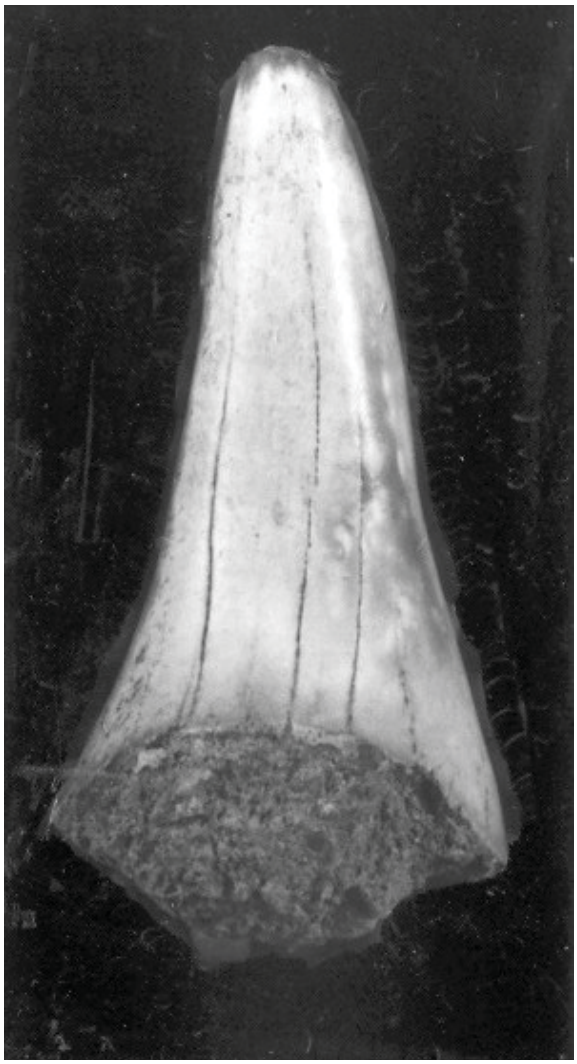

First anterior lower tooth of Isurus oxyrhynchus *(Short Fin Mako shark) from 05RB11, Bear Lake Formation. Identified by Robert Purdy, Smithsonian Institution.*

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Robert B. Blodgett[1], Emily S. Finzel[2,3], Rocky R. Reifenstuhl[2],
Karen H. Clautice[2], Kenneth D. Ridgway[3], and Robert J. Gillis[2]

Abstract

Faunal and floral lists are provided for megafossil collections gathered by the Alaska Division of Geological & Geophysical Surveys in the course of fieldwork conducted in August 2005 on the Alaska Peninsula (Port Moller–Herendeen Bay area). Collections were made in the Upper Jurassic Naknek Formation, Upper Cretaceous Chignik Formation, Paleocene–Eocene Tolstoi Formation, Eocene–Oligocene Stepovak Formation, Miocene Bear Lake Formation, and Pliocene Milky River Formation. Only the collections from the Naknek, Bear Lake, and Milky River Formations yielded age-diagnostic fossils. The Bear Lake Formation in the type area appears to consist of a non-marine (coal- and plant-bearing) lower succession that is overlain by an upper marine succession. Differentiation between uppermost Bear Lake Formation and the overlying Milky River Formation according to marine megafossils is made difficult due to the shared presence of many of the same mollusk species in both units. These new collections provide a significantly more comprehensive overview of the marine megafauna of the Bear Lake and Milky River Formations, and it is proposed that future mapping incorporate both detailed sampling for megafossils and fossil diatoms in order to refine the age and stratigraphic relationships of Miocene–Pliocene-age strata in this region.

INTRODUCTION

This report provides faunal and floral lists for all megafossil samples collected by the Alaska Division of Geological & Geophysical Surveys (DGGS) field party working on the Alaska Peninsula (Port Moller–Herendeen Bay area) during the month of August 2005 (fig. 1). The megafossil identifications reported were made by R.B. Blodgett, except where noted. The field party consisted of Rocky R. Reifenstuhl, Emily Finzel, and Karen Clautice (all DGGS), as well as Ken Ridgway (Purdue University, West Lafayette, Indiana) and Robert B. Blodgett, an independent contract geologist affiliated with the U.S. Geological Survey in Anchorage. The field project started on August 4 and was completed on August 19, 2005. Most of the samples, especially those from the Jurassic and Neogene (Miocene–Pliocene) contain age-diagnostic fossil taxa, while a minority of the samples (Cretaceous and Paleogene in age) lack well preserved, age-diagnostic species. These collections are sorted below according to assigned formation (fig. 2).

Based on the collections of both 2005 and 2004, we are now getting a better picture of the megafaunal content of both the Bear Lake and Milky River Formations, and given enough taxic diversity with future megafossil collections, it should become easier to distinguish them based on their faunal content. These two formations, especially the uppermost part of the Bear Lake (late Miocene in age) and the lower sedimentary portion of the Milky River Formation, share many of the same mollusk species, although some elements collected this summer suggest some significant differences. This is an important issue in that there has been considerable confusion in the past distinguishing between late Miocene and early Pliocene strata in the study area. It has been suggested in several sources (Larson, 1988; Marincovich and others, 2002; Gladenkov, 2003; John A. Larson, personal commun., 2004) that diatoms provide the most refined method of age resolution in the Miocene–Pliocene interval of the Alaska Peninsula, but we firmly believe that new, taxonomically diverse megafaunal collections (primarily bivalves, gastropods, and, to a lesser degree, echinoids), working together with diatom studies, can provide a clear and detailed means to undertake future fine-scale stratigraphic and paleoenvironmental studies in the region. The material we have gathered this year is already being included in several manuscripts in preparation or in press by other paleontologists (crabs by Rodney Feldmann [Kent State University, Kent, Ohio] and desmostylians by Louis Jacobs [Southern Methodist University, Dallas, Texas]).

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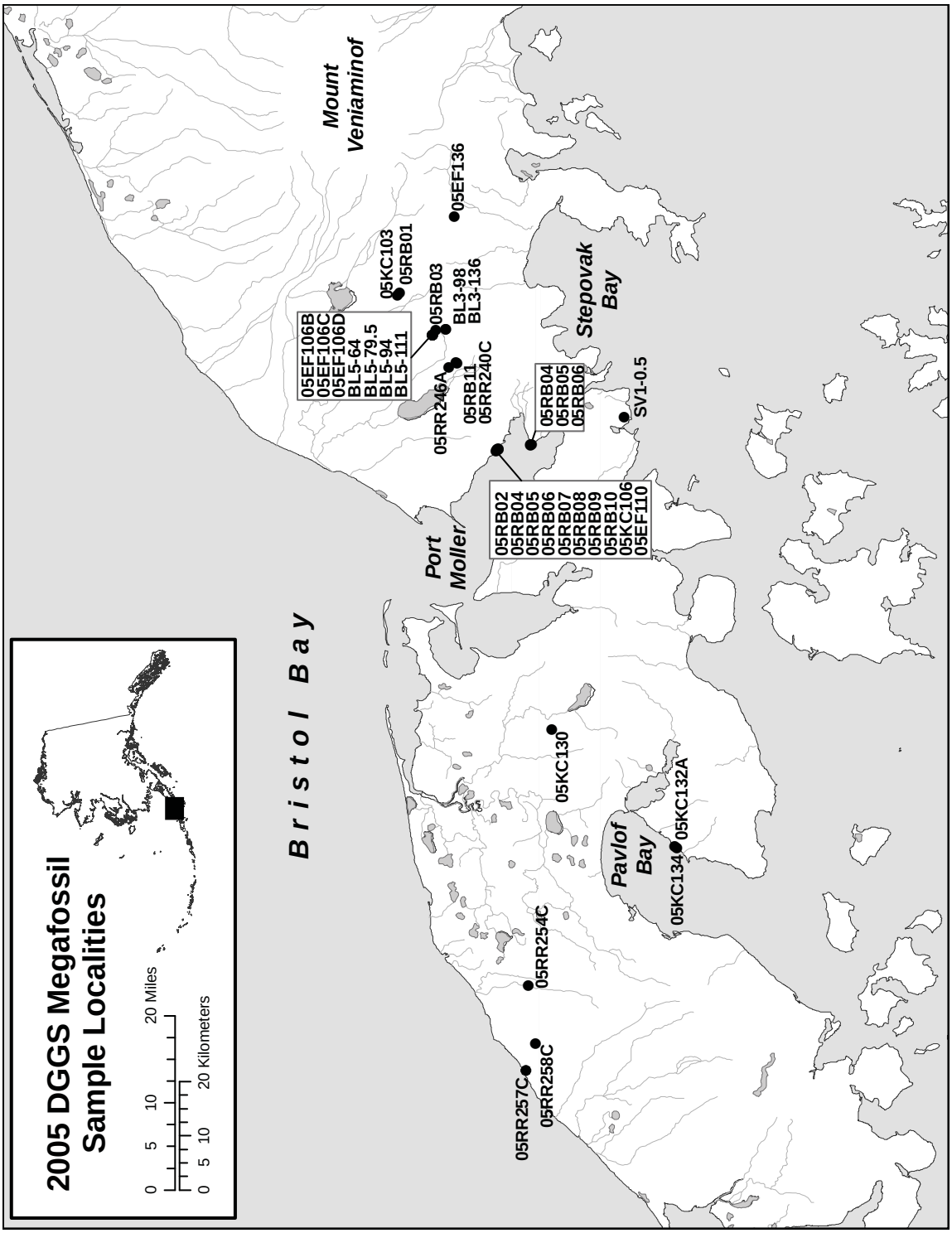

Figure 1. *Map of the Alaska Peninsula centered on the Port Moller area, showing sample locations as black dots.*

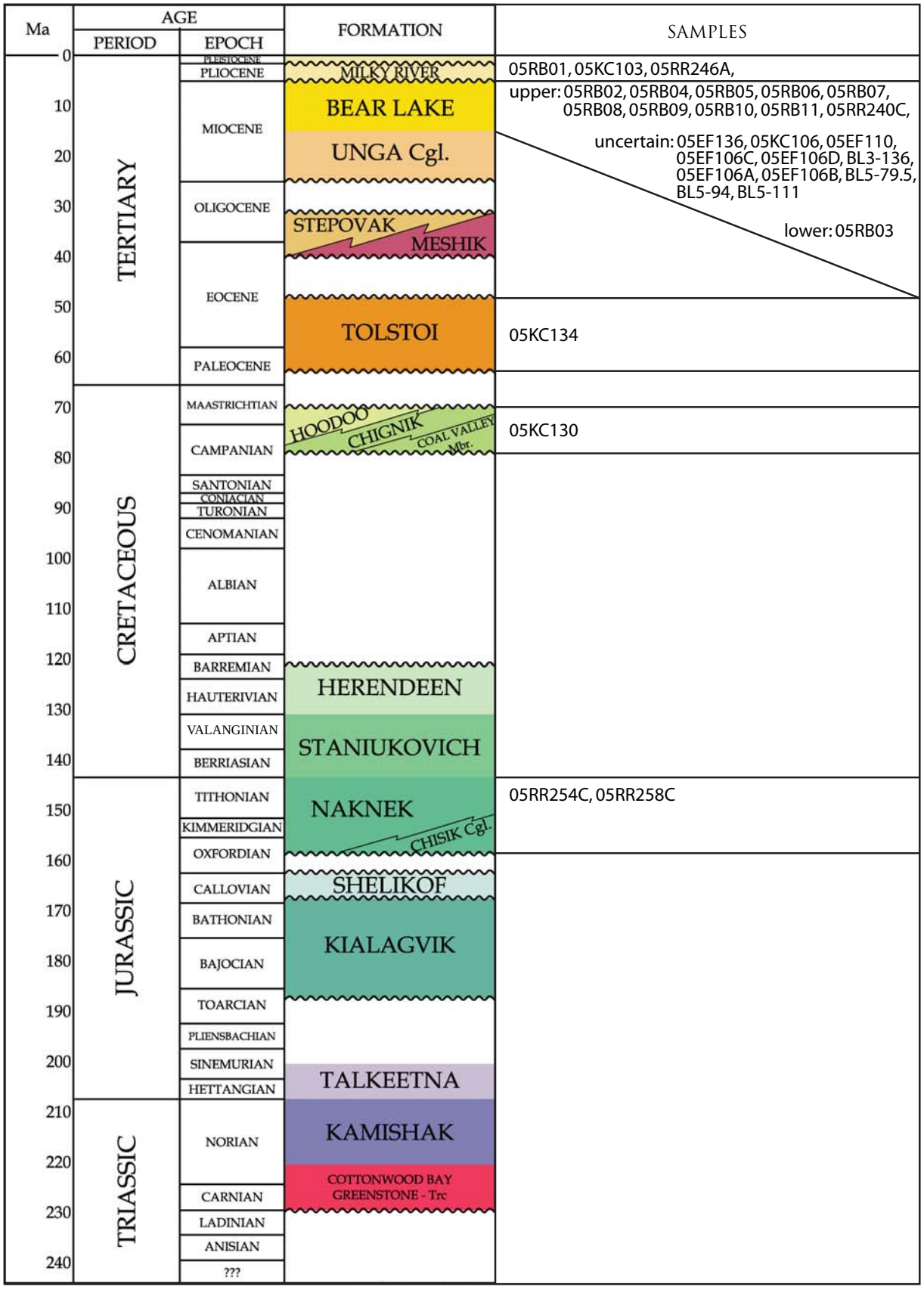

Figure 2. *Generalized stratigraphic column of the Port Moller area, showing the formations from which individual samples were collected.*

Location data (latitude/longitude) were determined by use of a handheld GPS using the NAD27 datum. Many of the localities reported in this paper were solitary spot localities, but the following samples were from measured sections: SV1 section (SV1-05); BL3 section (BL3-98 and BL3-136); BL5 section (BL5-79.5, BL5-94, and BL5-111); Sundean section (samples 05RB02, 04, 05, 06 were collected from bottom to top, but not measured as to the distance separating them); and Left Head section (samples 05RB07, 08, 09, and 10, were collected from bottom to top, but not measured as to the distance separating them). Sample 05RB11 was collected as an isolated sample from the upper part of the type section of the Bear Lake Formation.

ACKNOWLEDGMENTS

We are grateful to Arthur J. Boucot (Oregon State University, Corvallis, OR) and David M. Rohr (Sul Ross State University, Alpine, TX) for their reviews of this paper. Several taxonomic points also benefited from consultation with Louie Marincovich (California Academy of Sciences, San Francisco, CA) and Anton E. Oleinik (Florida Atlantic University, Boca Raton, FL).

FOSSIL FAUNAL AND FLORAL LISTS

NAKNEK FORMATION

05RR254C – Lat. 55.70309, Long. -162.067; sandstone

Buchia rugosa (Fischer) (more abundant than *B. mosquensis*)	bivalve
Buchia mosquensis (von Buch) (common)	bivalve
Pleuromya? sp. (one specimen)	bivalve
indeterminate smooth bivalve (one specimen)	bivalve

Age: late Kimmeridgian–early Tithonian
Paleoecology: relatively shallow-water, inner shelf

05RR257C – Lat. 55.72329, Long. -162.1794; sandstone

Buchia concentrica (J. de C. Sowerby) (one specimen)	bivalve
undetermined bivalve, possibly *Pleuromya*?	bivalve
Perisphinctes (Dichotomosphinctes) cf. *P. (D.) muhlbachi* Hyatt of Imlay (1981) – ammonite (one specimen)	

Age: late Oxfordian–early Kimmeridgian
Paleoecology: relatively shallow-water, inner shelf

05RR258C – Lat. 55.72697, Long. -161.903; sandstone

Buchia mosquensis (von Buch) (abundant)	bivalve
Buchia rugosa (Fischer) (uncommon, only one specimen)	bivalve

Age: late Kimmeridgian–early Tithonian
Paleoecology: relatively shallow-water, inner shelf

CHIGNIK FORMATION

05KC130 – Lat. 55.73649, Long. –161.14508

undetermined smooth bivalve
indeterminate, poorly preserved ribbed bivalve
indeterminate gastropod steinkern (internal mold)

Remark: This sample consisted of a single large slab that was broken apart in the lab.
Age: Indeterminate

TOLSTOI FORMATION

05KC132A – Lat. 55.50834, Long. -161.45135

indeterminate smooth bivalve shells (several morphotypes present, one suggestive possibly of the genus *Solen*). Nothing age-diagnostic present.

Age: Indeterminate.

05KC134 – Lat. 55.51186, Long. -161.44623

undetermined simple lanceolate leaf

Age: Indeterminate.

STEPOVAK FORMATION

SV1-0.5 – Lat. 55.66864, Long. -160.20856; sandstone

indeterminate smooth bivalve (one specimen)

Age: Indeterminate.

BEAR LAKE FORMATION (LOWER NON-MARINE PORTION)

05RB03 – Lat. 55.99264, Long. -160.00591; mudstone (lower non-marine portion of the Bear Lake Formation)

Metasequoia glyptostroboides Hu and Cheng	plant
Carpinus cf. *C. cappsensis* Wolfe	plant

Age: Seldovian floral stage of Jack Wolfe (early to middle Miocene)

BEAR LAKE FORMATION (UPPER MARINE PORTION)

(Localities 05RB02, 04, 05, and 06 are from continuous stratigraphic section, referred here as the Sundean section)

05RB02 (float block on beach of coquinoid pebble conglomerate with sandstone matrix) – Lat. 55.8752, Long. -160.34348; conglomeratic sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (eight to nine disarticulated valves)	bivalve
One large, smooth, indeterminate bivalve	

Age: middle to late Miocene
Paleoecology: The abundance of *Mytilus (Plicatomytilus) gratacapi* is indicative of either a lower intertidal or very shallow subtidal setting.

05RB04 (float block of coquinoid conglomeratic sandstone) – Lat. 55.81892, Long. -160.31725; conglomeratic sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (43 disarticulated valves)	bivalve
Clinocardium cf. *C. pristinum* Keen of Marincovich, 1983 (two specimens)	bivalve
Spisula (Mactromeris) sp. (ten specimens, some placed here with doubt)	bivalve
Chlamys sp.	bivalve
Crepidula sp. (one specimen)	gastropod
undetermined high-spired gastropod (one specimen)	
indeterminate naticid gastropod (internal mold) (three specimens)	
vertical burrow	

Age: middle to late Miocene.
Paleoecology: very shallow subtidal environment

05RB05 (*in-situ* collection along beach face) – Lat. 55.81847, Long. -160.31735; coquinoid sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (numerous disarticulated valves	bivalve

Age: middle to late Miocene
Paleoecology: lower intertidal to very shallow subtidal

05RB06 (lowest coquinoid shell horizon along transect) – Lat. 55.81735, Long. -160.31567; coquinoid sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (abundant, mostly disarticulated valves, but also including one or two articulated specimens)	bivalve
undetermined smooth bivalve (probably *Spisula*) (four specimens)	

Age: middle to late Miocene
Paleoecology: lower intertidal to very shallow subtidal

(Localities 05RB07, 08, 09, and 10 are from continuous stratigraphic section, referred here as the Left Head section)

05RB07 – Lat. 55.8727, Long. -160.3404; sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (numerous articulate and disarticulated specimens)	bivalve

Age: middle to late Miocene
Paleoecology: This large collection consists wholly of a monospecific accumulation of the species noted above. The abundance of this species, to the exclusion of other species, indicates a lower intertidal (most likely) to very shallow, subtidal setting.

05RB08 – Lat. 55.87165, Long. -160.33958; sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (several disarticulated valves)

Age: middle to late Miocene
Paleoecology: as for 05RB07.

05RB09 – Lat. 55.87152, Long. -160.33932; sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (approx. 18 disarticulated valves)	bivalve
Spisula (Mactromeris) cf. *brevirostrata* Packard) (one specimen)	bivalve
Mizuhopecten mollerensis (MacNeil, 1967) (one specimen)	bivalve
indeterminate naticid gastropod internal mold (one specimen)	gastropod

Age: middle to late Miocene
Paleoecology: This locality was probably situated an in extremely shallow-water, subtidal setting. The increase in taxonomic diversity above that at localities 05RB07 and 08 suggests an overall slight increase in depth as one moves upsection from 05RB07 through 05RB10 (probably from lower intertidal into shallow subtidal).

05RB10 – Lat. 55.87122, Long. -160.3376; sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (mostly disarticulated valves, but one articulated specimen observed as well)	bivalve
Macoma (Macoma) cf. *M. (M.) astori* Dall of Marincovich, 1983 (second most abundant species in collection)	bivalve
Crepidula sp. (most abundant species in collection)	gastropod
indeterminate naticid gastropod internal mold (two specimens)	gastropod

Age: middle to late Miocene
Paleoecology: Same remarks as for 05RB09 above.

05RB11 – Upper Bear Lake Formation, type section (orange-weathering, medium gray (fresh) sandstone lenses within softer, friable silty sandstone-bearing bivalves, gastropods and local pockets of sand dollars (echinoids) – Lat. 55.95497, Long. -160.09583 (a remarkable site for marine vertebrate remains)

Yoldia (Cnestrium) scissurata Dall (two specimens)	bivalve
Clinocardium sp. or spp. (second most abundant taxon here, material too incomplete and poorly preserved for confident species level identification)	bivalve
Protothaca (Protothaca) staleyi (Gabb) (several specimens)	bivalve
Spisula (Mactromeris) brevirostrata Packard (most abundant species present)	bivalve
Mya n. sp. Marincovich, 1983 (one specimen)	bivalve
Crepidula sp. (common)	gastropod

indeterminate naticid gastropod steinkerns (internal molds)
undetermined high-spired gastropod internal mold (most of this single specimen is preserved only as a mold, but uppermost spiral whorl preserves remain of collabral ornamentation
Isurus oxyrhynchus (Short Fin Mako shark) first lower anterior tooth – identified by Robert Purdy, Smithsonian Institution (Louis Jacobs, written commun., 2006) (cover page)
Metacarcinus goederti Schweitzer and Feldmann, 2000 (fig. 3) crab
[Note: This specimen along with other crabs collected in the area by Louie Marincovich are described in Conkle and others, 2006.]
undetermined vertebrate bone (being studied by Dr. Louis Jacobs, Southern Methodist Univ., Dallas, TX)
desmostylian molar (being studied by Dr. Louis Jacobs, Southern Methodist Univ., Dallas, TX)
woody plant debris

Remarks: Analysis of remaining sample may yield diatom age.
Age: probably late Miocene (according to accepted age of upper part of Bear Lake Formation)
Paleoecology: relatively shallow-water, inner shelf

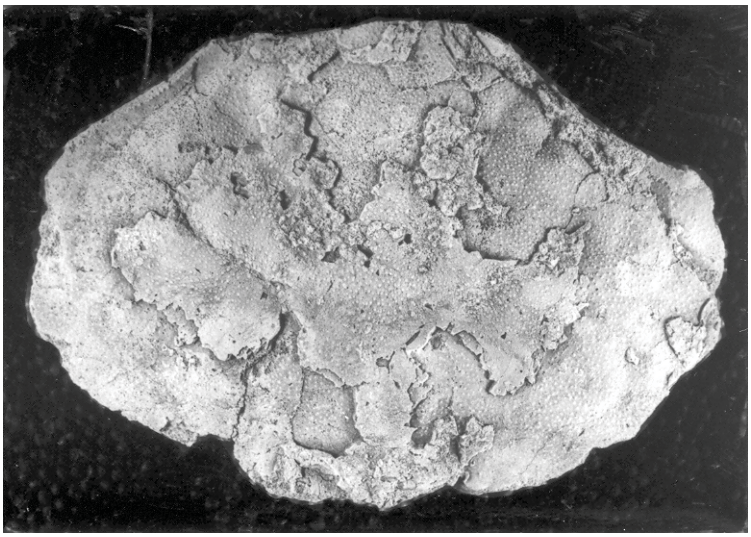

Figure 3. *The crab* Metacarcinus goederti *Schweitzer and Feldmann from locality 05RB11, Bear Lake Formation (see Conkle and others, 2006, for further information).*

05RR240C – Lat. 55.95309, Long. -160.09687; sandstone

poorly preserved mytilid bivalves (probably *Mytilus (Plicatomytilus) gratacapi* Allison and Addicott)

Remarks: The specimens in this collection, gathered from a conglomeratic sandstone, all appear to be highly fragmented and abraded; the few free specimens (free of matrix) have a shape consistent with that of *Mytilus (Plicatomytilus) gratacapi*.
Age: middle to late Miocene
Mytilus (Plicatomytilus) gratacapi Allison and Addicott)
Paleoecology: lower intertidal to very shallow subtidal setting.

05EF136 – Lat. 55.97874, Long. -159.66509; sandstone

Ostrea sp. (several shell fragments)

Remarks: This is the first *bona fide* true oyster to show up in either the 2004 or 2005 Alaska Peninsula fossil collections made by the Alaska Division of Geological & Geophysical Surveys.
Age: not age-diagnostic.
Paleoecology: shallow subtidal environment (inner shelf).

05KC106 – Lat. 55.87275, Long. -160.34207

Mytilus (Plicatomytilus) gratacapi Allison and Addicott (one articulated specimen, two disarticulated valves) bivalve

Age: middle to late Miocene
Paleoecology: lower intertidal to very shallow, subtidal environment

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05EF110 – Lat. 55.87309, Long. -160.34087; sandstone

Mytilus (Plicatomytilus) gratacapi Allison and Addicott bivalve

Age: middle to late Miocene
Paleoecology: This monospecific accumulation, so common at many localities (esp. in the Sundean and Left Head sections) indicates a lower intertidal to very shallow, subtidal environment (Allison and Addicott, 1976, p. 13).

BL3-98 – Lat. 55.97592, Long. -160.00093; sandstone

infilled burrow

Age: no age significance

BL3-136 – Lat. 55.97592, Long. -160.00093; sandstone

indeterminate object

Age: no age significance

05EF106A – no Lat./Long. data, same as or close to 05EF106B

Beringius hertleini MacNeil, 1970 (most of shell decorticated, but shell and ornament moderately well preserved on penultimate whorl) gastropod

Age: This species has previously only been reported from the Tachilni Formation, dated as either late Miocene by Marincovich (1983) or Pliocene by others (MacNeil, 1970; Allison, 1978). Its stratigraphic position here suggests a late Miocene age.

05EF106B – Lat. 55.99698, Long. -160.02208; sandstone

petrified wood with *Teredo*-like (bivalve) borings

Age: None in particular; members of the family Teredininae Rafiniesque, 1815 (which includes *Teredo*) extend at least back into the Eocene.

05EF106C – Lat. 55.99698, Long. -160.02208; sandstone

calcareous algae?
smooth, undetermined bivalve

Remarks: These curious globose to club-like objects (in the latter case tapering to a sharp point) are similar to calcareous algal bodies observed in Paleozoic-age rocks. One specimen has broken apart so that it is possible to observe a very thick calcareous layer surrounding a large hollow central cavity. This same specimen appears to have encrusted upon a small smooth bivalve shell.

05EF106D – Lat. 55.99698, Long. -160.02208; sandstone

Clinocardium sp. indet. (two decorticated shells)	bivalve
indeterminate internal molds of bivalves	
indeterminate pectenid bivalve shell fragment (lacking auricles)	

Age: This collection is not age specific.

BL5-79.5 – Lat. 55.99725, Long. -160.01964; sandstone

Crenomytilus coalingensis (Arnold) (one specimen)	bivalve
Clinocardium meekianum (Gabb) n. subsp.? of Marinconvich, 1983 (one right valve)	bivalve
Clinocardium cf. C. *pristinum* Keen of Marincovich, 1983 (two fragmentary valves)	bivalve
undetermined gastropod internal mold (with small remnants of adhering shell, but not enough to facilitate identification.	

Age: late Miocene or early Pliocene. All the named species occur in the Tachilni Formation.
Paleoecology: relatively shallow-water, inner shelf depths.

BL5-94 – Lat. 55.99725, Long. -160.01964; sandstone

Spisula (Mactromeris) brevirostrata Packard? (one articulated specimen, two free valves)	bivalve
Beringius hertleini MacNeil, 1970 (five specimens)	gastropod

Age: late Miocene or early Pliocene. *B. hertleini* is known only from the Tachilni Formation of the Alaska Peninsula.

BL5-111 – Lat. 55.99725, Long. -160.01964; sandstone

Acila (Truncacila) empirensis Howe (one specimen)	bivalve
Mya sp. indet.	

Clinocardium meekianum (Gabb) new subsp.? of Marincovich, 1983 (most abundant species in collection)	bivalve
Clinocardium cf. *pristinum* Keen of Marincovich, 1983	bivalve
Mizuhopecten mollerensis (MacNeil, 1967) (one large specimen)	bivalve
Spisula (Mactromeris) brevirostrata Packard (second most abundant species in collection)	bivalve
Spisula (Mactromeris) polynyma (Stimpson)	bivalve
Beringius hertleini MacNeil, 1970	gastropod
indeterminate smooth shelled gastropod (one specimen)	

Age: late Miocene or early Pliocene. This collection shares many species in common with two collections from the Milky River Formation (05RB01 and 05SK03).
Paleoecology: relatively shallow-water, inner shelf depths

MILKY RIVER FORMATION

05RB01 (basal Milky River Formation collection, material gathered from 30–50 ft. above the prominent basal conglomerate that sits above the unconformity with underlying contorted, coal-bearing strata of the Bear Lake Formation) – Lat. 56.05814, Long. -159.90344; sandstone (note this locality is same as 05KC103)

Acila (Truncacila) empirensis Howe (most abundant species here)	bivalve
Clinocardium meekianum (Gabb) n. subsp.? of Marincovich, 1983	bivalve
Clinocardium cf. *C. pristinum* Keen of Marincovich, 1983	bivalve
Spisula (Mactromeris) brevirostrata Packard? (one specimen)	bivalve
Peronidia? sp. (one specimen)	bivalve
Neptunea (Neptunea) sp. (one specimen)	gastropod
Cancellaria sp. (one specimen)	gastropod
indeterminate gastropod internal molds (numerous specimens)	

Age: The sedimentary portion of the Milky River Formation is now dated as early Pliocene according to diatom work by Gladenkov (2003). Nearly all the molluscan species listed above occur in the Tachilni Formation fauna that outcrops farther west on the Alaska Peninsula. Marincovich (1983) ascribed a late Miocene age to the Tachilni, though other workers (MacNeil, 1970; Allison, 1978) assigned it a Pliocene age.

Paleoecology: relatively shallow-water, inner shelf

05KC103 (higher up stratigraphically in the Milky River Formation) – Lat. 56.06129, Long. -159.91263

Clinocardium meekianum (Gabb) n. subsp? of Marincovich, 1983 (one articulated specimen, two right valves, two left valves)	bivalve
Clinocardium cf. *C. pristinum* Keen of Marincovich, 1983 (three articulated specimens)	bivalve
Mya (Arenomya) elegans (Eichwald) (one articulated specimen)	bivalve
Mya new species of Marincovich, 1983 (four articulated specimens)	bivalve
Mizuhopecten mollerensis (MacNeil)? (two poorly preserved, decorticated valves)	bivalve
Chlamys (Swiftopecten) cosibensis cosibensis (Yokoyama) (several loose fragmentary specimens)	bivalve
Chlamys (Chlamys) sp. (one external mold of a right valve)	bivalve

Age: early Pliocene according to recent diatom work of Gladenkov (2003)
Paleoecology: relatively shallow-water, inner shelf

05RR246A – Lat. 55.96572, Long. -160.11196

Glycimerus grewingki Dall (one articulated specimen and one partial isolated valve fragment)	bivalve
Clinocardium sp.	bivalve
Mya (Arenomya) elegans (Eichwald)	bivalve

undetermined coarse-ribbed pectenid bivalve (single, poorly preserved specimen)
indeterminate naticid gastropod (three internal molds)
echinoid (sand dollar) – same species present as in locality 05RB11 (type section of Bear Lake Formation)

Age: This fauna includes elements found in middle Miocene, late Miocene, Pliocene, and in the case of M. (A.) *elegans* even up to the Recent. A late Miocene or early Pliocene age seems most likely for this locality. This sample is considered by R. Reifenstuhl to represent the Milky River Formation according to regional geologic and stratigraphic relationships.

Note: Locality 04RR158C reported in Blodgett, 2004 (unpublished report) should be reassigned as Milky River Formation, not Bear Lake Formation, according to the new faunal data gathered this year. The collection is faunally similar to that reported from 05KC103 (this report).

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