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GEOLOGY AND OIL POSSIBILITIES OF THE SOUTHWESTERN PART OF THE WIDE BAY ANTICLINE ALASKA

BY

L. B. KELLUM, S. N. DAVIESS, AND C. M. SWINNEY

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INTRODUCTION

The Wide Bay anticline is on the Pacific side of the Alaskan Peninsula about 150 miles west of Kodiak Island (see index of Alaska, fig. 1).

The anticline covers more than 300 square miles. About 60 square miles near the southwest end were mapped during the summer of 1944. Three stratigraphic sections were measured by means of planetable traverse on the northwest side of West Bay and a section of lower rocks was studied farther northeast at Cold Bay.

GEOLOGY

STRATIGRAPHY

General Statement

Systematic study and measurement of stratigraphic sections along the canyons which drain the northwest side of Wide Bay and comparisons of fossils collected from practically every fossiliferous bed observed in these sections has made it possible to recognize four faunal zones and eight subzones in the previously recognized Kialagvik and Shelikof formations. Although individual beds are lenticular and any one lithologic unit cannot be traced very far, the presence of these faunal zones permits the tracing of the variations in lithologic character both vertically and horizontally. There are certain general trends in vertical changes in all the sections and the gross lithologic characters of the larger faunal divisions are fairly persistent throughout the area in which detailed studies were made. These observations bring out certain structural features not otherwise evident and thus clarify the larger structural picture.

The nearest exposed section of rocks older than those which crop out around Wide Bay is along the northeastern shore of Cold Bay (see fig. 1, map A). The locality is about 45 miles northeast of the area covered by this report. The section of Triassic and Lower Jurassic rocks there was studied during the present investigation in order to obtain information on the possible lithologic character, thickness, and probable depth below the surface of strata not exposed on the Wide Bay anticline. Because a deep well drilled on the Wide Bay anticline would probably penetrate these older rocks, the Cold Bay section would aid in the recognition of formations encountered.

The stratigraphic relation of the Cold Bay Lower Jurassic rocks to the Middle Jurassic Kialagvik formation is not known. The Lower Jurassic rocks are said to be directly overlain by the Upper Jurassic Shelikof formation in the section exposed along the northeast shore of Cold Bay 1/. No fossils, however, are reported from the Shelikof in this section so that it cannot be correlated closely with the sections exposed in the mountains along the northeast side of Wide Bay.

The succession of the faunal zones, the diagnostic assemblage of fossils in each zone and subzone, and the lithologic characters of strata in which they occur are shown on figures 2 - 10.

Triassic rocks

A section of Triassic rocks was measured along the northeast shore of Cold Bay (fig. 1, map C). The section has an apparent thickness of about 1400 feet and consists of thin-bedded, dense, organic limestone with interbedded shale and sandstone. The thickness cannot be measured accurately because of faults, igneous bodies and associated contorted strata in the lower portion of the section (figure 2).

1/ Mather, K. F., Smith, W. R., and Martin, G. C., Petroleum on Alaska Peninsula: U. S. Geol. Survey Bull. 773, p. 197, 1925.

The lower part of the section consists of dark, blue-gray, dense, thin-bedded limestone weathering light gray to buff. To the east near Cape Kekurnoi these limestones are reported to be more massive with beds ranging up to 85 feet in thickness 2/. Higher in the section calcareous shale is common but is less abundant than limestone. The shale is very thin-bedded and commonly is accompanied by fine-grained calcareous sandstone. Much of the clastic material is thought to be tuffaceous and where the amount of volcanic material is high the rocks are greenish. Tuffaceous sandstone is interbedded with the limestone and shale in the upper part of the section, and, near the top, is nearly as abundant as limestone.

The base of the Triassic section is not exposed at Cold Bay. The upper contact with the overlying Jurassic sediments is gradational. Where sandstone is most abundant in the section angular grit and agglomerate appear and the base of the lowest agglomerate bed has been selected as the contact. It falls within a zone barren of fossils between strata bearing fossils of Triassic and Jurassic age respectively.

Fossils were collected from the Triassic rocks at three horizons. The lowest (F 74, fig. 1, map C) is apparently 1080 feet below the Jurassic contact. The following Mollusca have been partially identified:

Arniotites? sp. A cfr. vancouverensis (Whiteaves).
Badiotites? sp. A cfr. B carlottensis Whiteaves?
Pecten sp. L (fig. 3, B).

Pseudomonotis subcircularis was also observed at this locality. The next fossiliferous horizon (F 78, fig. 1, map C) is 870 feet below the contact. Pseudomonotis subcircularis (fig. 3, A) was the only species found there. The highest fossil-bearing bed (F 75, fig. 1, map C), 375 feet below the contact, yielded plant and ammonite remains identified as:

Cycad.
Arniotites? sp. B (fig. 3 C).

The Triassic rocks have been intruded by two dikes and a sill in the lower portion of the section along the northeast shore of Cold Bay. These bodies have altered the adjacent sediments for distances up to 10 feet.

Lower Jurassic rocks

Lower Jurassic rocks are exposed on the northeast shore of Cold Bay. They consist chiefly of tuffaceous sandstone and shale.

Two distinct lithologic units are present in the Cold Bay Lower Jurassic section. The lower is coarser grained and consists of about 1000 feet of massive to thin-bedded tuffaceous sandstone, thin-bedded calcareous sandstone, and interbedded calcareous shale and limestone. Agglomerate and conglomerate are present

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2/ Mather, K. F., Smith, W. R., and Martin, G. C., op. cit., p. 194.

in considerable amounts. Approximately 70 percent of this unit is made up of coarser clastic material.

The upper unit consists mainly of dark, gray-black shale, with a few thin beds of light-colored, coarse-grained, well-indurated sandstone. This unit contains more sandy shale and more sandstone beds near the top. Limy concretions and partings are common in the upper more sandy part of this unit. This predominately fine-grained unit is about 1300 feet thick. It is overlain by a conglomerate containing boulders up to 2 feet in diameter with sand lenses forming a crude bedding. This conglomerate was considered the base of the Shelikof formation by Capps and it may be separated from the older beds by a slight unconformity. Although altitudes in the sandy shales were difficult to obtain because of slumping, the shales seemed to be dipping at a steeper angle than the conglomerate.

Fossils were collected at 2 horizons in the Lower Jurassic rocks. The lower (F 77, fig. 1, map C) is in the upper part of the coarse-grained unit about 975 feet above its base. A brachiopod, a gastropod, and three species of pelecypods were found, of which Astarte sp. D. is the most common and characteristic form:

Terebratula sp. A.
Pecten sp. M. (fig. 3, H).
Astarte sp. D. (fig. 3, D).
Lima sp. C.
Calliostoma? sp.

The higher fossiliferous horizon (F 76, fig. 1, map C) is near the base of the fine-grained unit, 80 feet above the lower fossil-bearing bed. Numerous fragments of ammonites in gray platy shale have the original shell material preserved. They are referred to three genera as follows:

Arietites? sp. A.
Arieticeras sp. A (fig. 3, E).
Harpoceras sp. C (fig. 3, F).

The first two genera are known only from lower Jurassic rocks but Harpoceras occurs elsewhere in both Lower and Middle Jurassic strata.

Middle Jurassic rocks

Kialagvik formation

The Kialagvik formation was named by Capps in 1922 3/ although the rocks and some of the fossils which belong to it had been described by earlier writers. It is known to crop out only in the southwestern half of the Wide Bay area but wells drilled in the Kanatak district are believed to have penetrated it and some of the strata cropping out on the northeast shore of Cold Bay have been referred to it by some geologists.

3/ Brooks, A. H., and others, Mineral resources of Alaska: U. S. Geol. Survey, Bull. 739, p. 94, 1923.

The thickest section of the Kialagvik formation exposed in the Wide Bay area is along Short Creek. About 1750 feet of strata were measured there by planetable traverse. The basal 500 feet are stratigraphically lower than strata observed anywhere else on the Wide Bay anticline as determined by paleontological correlations. These beds are chiefly gray shale with sandstone partings. The section crops out discontinuously along the creek and has been compiled from a few outcrops. It appears from these outcrops to become increasingly sandy from the bottom upward.

In this report the Kialagvik formation is divided into two zones based principally on paleontologic characters. The lower one is designated the "Hammatoceras" zone. The upper one is designated the Dactylioceras-Inoceramus sp. C zone. Each of these zones appears to become progressively somewhat coarser-grained from the bottom toward the top. The zone boundaries have been placed at the most convenient lithologic breaks consistent with the paleontologic evidence. Each zone is further subdivided principally on faunal grounds and these subdivisions are defined and described below.

"Hammatoceras" zone:- The "Hammatoceras" zone is made up chiefly of interbedded sandstones and shales having a measured thickness of 1150 feet. It crops out almost continuously in the cliffs along the northwest side of Wide Bay from south of Pass Creek to near the southwest end of the bay, a distance of about 9 miles. Two rather well-defined cycles of sedimentation are included in the "Hammatoceras" zone in a section exposed along Short Creek and each of these is characterized by a faunal assemblage. They are designated as subzones - the lower one the "Hammatoceras" howelli subzone and the higher the Hammatoceras? kialagvikense subzone.

"Hammatoceras" howelli subzone:- The "Hammatoceras" howelli subzone has been observed in two areas: (1) along the lower part of the valley of Short Creek and (2) a few thousand feet farther northeast in and near some conspicuous bluffs southwest of the mouth of Pass Creek. Nearly 900 feet assigned to this subzone is intermittently exposed along Short Creek. The lower half of this section appears to be largely dark gray to black shale with some platy sandstone. The upper part seems coarser-grained and platy sandstone is more abundant.

In the low bluffs between Short and Pass Creeks a section about 175 feet thick is partially exposed. The exposed part is largely greenish-gray shaly sandstone with concretionary nodules of sandstone up to several feet in diameter and is believed to correspond to the upper part of the section exposed along Short Creek. One thin limestone stratum was observed about 100 feet below the top of the "Hammatoceras" howelli subzone.

Fossils were collected both from the upper part of the section along Short Creek (F 12) and from the bluffs and neighboring localities along Wide Bay (F 22, 23, 34, 35, 36, and 37). The basis for the definition of the subzone is principally the presence in abundance of "Hammatoceras" howelli. This form is present also, but in much lesser abundance, in the overlying subzone. The diagnostic fossil association of the "Hammatoceras" howelli subzone is:

"Hammatoceras" howelli (White) (fig. 4, A and B).
"Hammatoceras"? kialagvikense (White) (fig. 4, C and D).
"Hammatoceras" sp. B.
Harpoceras whiteavesi (White) (fig. 4, E and F).
Pleuromya dalli (White) (fig. 4, G and H).
Pteria sp. B.

Many other species are present in this subzone, for example, 13 species of ammonites and pelecypods were collected from the Short Creek section and 25 from the bluffs along the bay. Five species of mollusca collected a short distance southwest (F 37) of the main fossil locality in the bluffs were not diagnostic of the subzone but they do indicate the zone. This is stratigraphically the lowest fossil-bearing horizon observed in the Wide Bay area and the rocks here are placed in the subzone on the basis of stratigraphic position as determined by structural interpretation.

Hammatoceras? kialagvikense subzone:- The best exposures of strata included in the Hammatoceras? kialagvikense subzone were observed along Short Creek but they also crop out in the sea cliff at a number of localities between Short Creek and the end of the sea cliffs near the southwest end of Wide Bay. The observed thickness of the subzone is about 200 feet including interbedded sandstone, shale, and conglomerate. The beds increase in coarseness from the base upward and include several beds of conglomerate. This conglomeratic facies is the predominant character of the subzone. Fossils appear to be most abundant about 150 feet below the lithologic break selected as the top of the subzone.

Changes in lithologic character along the beds are an exceptionally common feature of this subzone and intraformational conglomerates were observed.

The principal collections from this subzone were made in and near the lower part of the valley of Short Creek (F 13, 17, 20 and 21) and in and near the sea cliffs south of the above area (F 53, 54 and 55). Other smaller collections were made at several localities along the sea cliffs farther southwest (F 1, 38, 39, 40, 41, 52, 58, 59 and 59a).

One collection on Short Creek (F 13) yielded 29 species of ammonites and pelecypods. Twenty-two species of mollusca were collected from the cliffs along Wide Bay (F 53, 54 and 55). Nine of these species are common in both areas and constitute the diagnostic association of the Hammatoceras? kialagvikense subzone. These species are:

Hammatoceras? kialagvikense (White).
"Hammatoceras" howelli (White).
"Hammatoceras" sp. B.
Harpoceras whiteavesi (White).
Pleuromya dalli (White)
"Hammatoceras" sp. D.
"Hammatoceras" sp. E.
"Hammatoceras" sp. G.
Gervillia sp. A.

The three species listed last are known only from this subzone. The others also are present in the "Hammatoceras" howelli subzone. Although "Hammatoceras" howelli and Hammatoceras? kialagvikense occur together in both subzones, the former is rare in the upper subzone and the latter is rare in the lower subzone. Both are confined to the "Hammatoceras" zone.

From farther southwest along Wide Bay Trigonia sp. G and Mytilus sp. A were collected from the Hammatoceras? kialagvikense subzone.

Dactylioceras-Inoceramus sp. C zone:- The Dactylioceras-Inoceramus sp. C zone is the most persistent zone in the Wide Bay area. On the northwest side of the bay it extends in a narrow belt across the mapped area. On the southeast side of the bay from 3½ miles from the end of the peninsula, it forms the sea cliffs all the way to the end of the bay and continues in the mountain front beyond to the head of the valley. Its total thickness averages about 500 feet. The zone consists of inter-bedded sandstones and shales at the base and the sand content is progressively greater upward. It has been divided into two subzones based in part on lithologic character but principally on faunal assemblages.

The Dactylioceras subzone below has a thickness of about 200 feet along the creek that enters Wide Bay from the north at Camp No. 2. The Inoceramus sp. C subzone above is approximately 200 feet thick.

Dactylioceras subzone:- The Dactylioceras subzone appears to be dominantly a sandy unit. This is true along the creek near Camp No. 2 where virtually the full 200-foot thickness of the subzone is well exposed. At some places, for example in the vicinity of Short Creek and on the southeast side of the bay at the most northerly outcrops of this subzone, the unit is distinctly more shaly. At other places, for example near the most southerly part of the bay, the unit is somewhat conglomeratic.

Dactylioceras sp. A (fig. 5, A-E) was found in place in only three localities and in float at a fourth locality. The three localities are as follows: along the creek upstream from Camp No. 2 (F 43), on the southeast side of Wide Bay northeast of Camp No. 4 (F 67), and on the mountain front south of Kialagvik Creek about 4½ miles southwest of the southwest end of the bay (F 71). It was found in float near the most southerly point of the bay (F 2 and 66).

All collections that contain Dactylioceras sp. A also contain Inoceramus sp. C (fig. 5, F and G). Rocks assigned to this subzone contain at other places such forms as "Harpoceras"? sp. D and H whiteavesi, Lima sp. D, Phylloceras? sp. A, Pteria sp. H, Pleuromya dalli, and representatives of the genera Stephanoceras and Teloceras. Three species, Dactylioceras sp. A, "Harpoceras"? sp. D, and Lima sp. D appear to be limited to this subzone.

Inoceramus sp. C subzone:- A prominent sandstone about 1¼ miles upstream from the mouth of the creek at Camp No. 2 has a thickness of 200 feet, is extremely fossiliferous (F 44), and locally is composed largely of the molds of Inoceramus sp. C. Inoceramus sp. C was found at two horizons 130 feet apart stratigraphically, along an eastern tributary of Short Creek (F 4, 24 and 25). This fossil is very

abundant at the lower horizon in a bed of sandstone about 10 feet thick, especially in calcereous nodules in this bed. At the upper horizon it is present in a thin calcareous sandstone at the top of a sequence of sandy shale. The Inoceramus sp. C subzone is partially exposed from 3/4 mile to 1 mile upstream from the mouth of the creek entering Wide Bay at Camp No. 3. A few casts of Inoceramus were seen in some of these exposures (F 60).

On the southeast side of Wide Bay only one locality is referred to the Inoceramus sp. C subzone, although every locality where fossils were collected on that side belongs in the Dactylioceras-Inoceramus sp. C zone. A collection from about 2¼ miles northeast of the most southerly point of the bay (F 68) contains Inoceramus sp. C in abundance and one poorly preserved specimen referred to Phylloceras? sp. A? The fossils were found in loose blocks of greenish-gray medium-grained sandstone at the base of the sea cliff.

Upper Jurassic rocks
Shelikof formation

The Shelikof formation was so named by Capps 4/ because it is the prevailing formation on the northwest shore of Shelikof Strait from Katmai Bay at least as far southwest as Wide Bay. He divides the formation into three lithologic units as follows:

	Feet
Massive black shale with some limestone lenses and nodules..	700-1000
Massive brown to gray sandstones with minor amounts of shale and conglomerate.....	4000-4700
Shale with some limy lenses and concretions.....	1500

Capps states that on Kialagvik (Wide) Bay the lowest 1500 feet of the formation is mostly shale with some limy lenses and concretions. The uppermost unit lies immediately beneath the basal conglomerate of the Naknek formation. The contact between the Naknek and Shelikof formations as shown on his map (pl. II, Bull. 739) indicates that the sandstones which cap the mountains on the northwest side of Wide Bay were included in the Shelikof. However, a thick, coarse conglomerate which caps some of the ridges in the western part of the area mapped in 1944 is here interpreted as the basal conglomerate of the Naknek formation. Between this conglomerate and the top of the Kialagvik formation near the southwest end of Wide Bay were measured 3600 feet of strata referred to the Shelikof formation. On the creek entering Wide Bay at Camp No. 2, 4150 feet of strata measured above the top of the Kialagvik formation are all included in the Shelikof and the Naknek was not reached. On Short Creek the Shelikof is represented by about 2400 feet of strata above the Kialagvik and the measured section stops far below the Naknek. The lower part of the Shelikof in these sections is fossiliferous but in the upper part few fossils were found.

4/ Brooks, A. H. and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 739, p. 97, 1923.

In these sections the lower fossiliferous part of the Shelikof formation (1200 to 1600 feet thick) consists chiefly of shales with limestone partings and concretions, and the upper part is chiefly sandstone or siltstone. The sandstone increases in thickness and coarseness to the northeast and is believed to represent the middle sandstone division of the Shelikof formation of Capps' report.

Two faunal zones are recognized in the lower unit of the Shelikof formation. (fig. 2). Within each of the zones two subzones are recognized. This sequence of zones and subzones is:

Cadoceras zone
- Cadoceras sp. G subzone
- Cadoceras doroschini subzone

Seymourites-Inoceramus sp. E zone
- Inoceramus sp. E subzone
- Seymourites subzone

Above the Cadoceras zone, 825 feet stratigraphically above the beds that yielded Cadoceras doroschini, an assemblage of pelycypods and a fragment of a coarsely-ribbed ammonite (F 62) were found. The assemblage contains five species of which Astarte sp. E cfr. A packardi is the only common form.

The Shelikof formation was traced from Pass Creek southwest nearly to the top of Mt. Kialagvik. In the southwest part of the area mapped it was traced around the axis of the anticline and it doubtless extends along the southeast side of the bay, forming the mountain front back of the sea cliffs. It was not examined on the southeast side of the bay.

The basal contact of the Shelikof formation with the underlying Kialagvik formation was examined in each of the measured sections and no clear evidence of unconformity was recognized. The locality near the mouth of Lee Creek, where Capps 5/ and others 6/ have described an angular unconformity believed to mark the contact between conglomerate of the Shelikof formation and the Kialagvik, was visited during the present investigation. No fossils could be found either in the conglomerate or in the underlying sequence of well stratified sandstone and shale. Although conglomerates are common within the Kialagvik formation farther southwest, no conglomerate is present at the contact in any of the sections which were studied in detail. Until the strata above and below the conglomerate at the mouth of Lee Creek have yielded fossils to prove that it is at the formational boundary, this locality provides doubtful evidence that an unconformity separates the two formations.

5/ Brooks, A. E., and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 739, p. 95, 1923.

6/ Brooks, A. H., and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 755, p. 176, 1924.

Seymourites - Inoceramus sp. E zone:- Seymourites subzone:- The Seymourites subzone has been recognized only in the section measured along the creek entering Wide Bay at Camp No. 2 where it is present in outcrops along the east side of a tributary that drains southwestward nearly parallel to the strike of the underlying ridge-forming sandstone. An outcrop about 40 feet thick consists of interbedded sandy shale and fine to medium-grained silty sandstone, weathering grayish brown and containing gray limestone concretions. Wood fragments are common and a few marine fossils were found in the upper 15 feet of the exposure. The collection (F 49) contains seven species of pelecypods and ammonites, none of which was found elsewhere in the Wide Bay area. Two of these, Seymourites sp. A and Inoceramus sp. D (fig. 6), are very distinctive and may be of use in correlation with other areas.

Inoceramus sp. E subzone:- Inoceramus sp. E has a diameter of 10 to 12 inches and is characterized by coarse concentric undulations (fig. 7). It occurs (F 50, F 81) in limestone concretions of a well-stratified shale sequence exposed along Short Creek and along the first valley southwest of there.

On the creek entering Wide Bay from the west at its southwest end, Inoceramus sp. E was not found, but rocks occupying the same stratigraphic position below the Cadoceras zone are exposed. They consist of gray shale and siltstone with few sandstone partings and numerous limestone concretions. A few fossils collected (F 61) from the upper part of the strata referred tentatively to this zone are new forms not found elsewhere in the Wide Bay area.

Cadoceras zone:- Cadoceras doroschini subzone:- The Cadoceras doroschini subzone was found at four localities in the Wide Bay area. One of these is near the head of Kialagvik Creek and the other three are in the sections measured along the valleys on the northwest side of the bay (Fig. 1, map C).

In the Short Creek section, Cadoceras doroschini (fig. 8, A and B) was found in the float of limestone concretions in a steep tributary gully (F 5). Several other ammonites of the genus Cadoceras and one referred doubtfully to the genus Cosomoceras were collected in the float from several horizons (F 7) of this part of the section. Strata referred to this subzone consist of interbedded sandstone and shale.

In a tributary of the creek entering Wide Bay at Camp No. 2 (F 51) Cadoceras doroschini was found with several other species of the genus in a very conspicuous zone of gray shale carrying limestone concretions which weather ashy gray in contrast to the usual buff-colored concretions. The weathered concretions from this zone can be seen from a distance and are easily traced wherever the beds crop out.

At the southwest end of Wide Bay in a canyon tributary from the northwest the Cadoceras doroschini subzone is well represented. Fossils collected at two localities (F 63 and 63 B) within a few hundred feet along the same group of beds and in float yielded several species of Cadoceras and a number of large ammonites referred to the genus Yakounites (fig. 9).

The fossils were found in limestone concretions in a sequence of gray sandy shale and siltstone. Along this creek there is no lithologic break between the Cadoceras doroschini subzone and the underlying Inoceramus sp. E subzone.

Near the head of Kialagvik Creek, Cadoceras doroschini was found associated with another species of Cadoceras and a Phylloceras in a loose block of fine-grained calcareous gray sandstone (F 69). At that place an outcrop of dark gray silty shale contains limestone concretions and a few limestone partings. This shale is similar to that at the locality mentioned in the preceeding paragraph.

Cadoceras sp. G subzone:- The subzone characterized by Cadoceras sp. G (fig. 8, C) has been recognized only in the Short Creek section. A few fragments of ammonites apparently belonging to a single species of Cadoceras were found in place and in the float associated with a thin lens of graywacke and fine-grained sandstone in a shale sequence assigned to this subzone. Fossilized wood fragments are present in the shale just below the graywacke. The graywacke and sandstone lens has a thickness of about 11 feet and is approximately 400 feet below the base of cliff-forming sandstones which have been designated "middle" Shelikof by previous authors.

STRUCTURAL GEOLOGY

Wide Bay anticline

The anticline along Wide Bay was described by Capps 7/ who designated it the Kialagvik Bay anticline. Later Smith and Baker 8/ called it the Wide Bay anticline and described it in greater detail. The investigation in 1944 was a more detailed study than any previous one of the southwestern part of the Wide Bay area. According to earlier reports, the Wide Bay anticline is a southwest continuation of the Bear Creek-Salmon Creek anticline which extends northeastward from Portage Bay. On the cape between Portage and Wide Bays the line of folding is interrupted by a large igneous intrusion. Southwest of the Wide Bay the anticline is terminated at the head of Kialagvik Creek by large masses of igneous rocks. Some of the igneous rocks, especially the basalt, may be surface flows, but a large intrusion of quartz diorite is present farther southwest beyond the mapped area.

The axial part of the anticline is concealed beneath Wide Bay and beneath the alluvium extending southwest from the head of the bay. The position of the axis and the attitude of its axial plane therefore must be determined from the stratigraphic position and dip of the beds exposed along the flanks. Dips of 12 to 20 degrees were observed on the southeast flank of the Wide Bay anticline and 4 to 17 degrees on the northwest flank. The axis trends approximately N 50° E along the central part of the bay, and because of the slightly steeper dips on the southeast flank, the axial plane probably dips steeply to the northwest.

7/ Brooks, A. H., and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 739, pp. 109 and 110 and 112 and 113, 1923.

8/ Brooks, A. H. and others, Mineral resources of Alaska: U. S. Geol. Survey Bull. 755, pp. 201 and 202, 1924.

The cliffs along the northwest side of the bay expose the Hammatoceras? Kialagvikense subzone of the "Hammatoceras" zone, the top of which is about 500 feet below the top of the Kialagvik formation. On the southeast side of the bay, however, the cliffs are cut in the Dactylioceras-Inoceramus sp. C zone. There is thus a stratigraphic difference at sea level between the beds exposed on opposite flanks of the anticline.

At one locality near the head of Kialagvik Creek, unfossilferous sandstone referred tentatively to the Dactylioceras-Inoceramus sp. C zone of the Kialagvik formation is nearly flat and is interpreted to be on the axis of the anticline. The possibility of faulting along the axial part of the anticline is one factor that makes uncertain the exact position of the axis as shown on the map.

Lone Hill in the southwest part of the area mapped, by its height and size, by its isolated position relative to the neighboring mountains, and by the apparent low dip of the strata which comprise it, suggests a fault block. The section exposed on Lone Hill was not studied in detail but the lower part of it was examined and the unfossiliferous sandstones exposed there were not diagnostic. The overlying fine-grained beds suggest the lower part of the Shelikof formation. If the section exposed on the lower slopes of Lone Hill does not correlate with the Dactylioceras-Inoceramus sp. C zone exposed on the southwest side of Kialagvik Creek, then the proximity of these two sections would indicate some displacement close to the axis of the anticline.

Southwest of Lone Hill at the head of the valley of Kialagvik Creek, siltstones and shales of the lower unit of the Shelikof formation cross the axis of the fold. Fossils collected at one locality (F 69) indicate that the strata belong to the Cadoceras zone. Dips of 6, 7, and 12 degrees to the south and southwest around the nose indicate the plunging end of the fold.

The oldest strata observed along the Wide Bay anticline are near the mouth of Short Creek. They are included in the lower part of the "Hammatoceras" zone, and are 1750 feet stratigraphically below the top of the Kialagvik formation. This indicates that structurally the highest part of the anticline is off the mouth of Short Creek in the central part of Wide Bay.

Faults

From the large number of small faults and the few larger ones observed along the flanks of the Wide Bay anticline, it is evident that the anticline is complicated by a series of transverse displacements. Most of the observed faults are described briefly in the following paragraphs.

Most of the faults in the area mapped trend northwesterly and dip steeply. Displacements are estimated to be as much as 900 feet but the displacements along most faults are much less.

Along the most easterly mapped fault, between Pass and Short Creeks, the base of the cliff-forming middle sandstone unit of the Shelikof formation is displaced with the down-throw on the north. The throw is estimated to be 150 feet. The

fault appears to extend as far east as the bay, where it displaces the "Hammatoceras" zone a small amount. The fault trends N. 85° W to W. Near the bay it dips about 60° N, but farther west it is nearly vertical.

Between the fault just described and Short Creek is another fault that is well exposed where it is in the Shelikof formation but is less well exposed farther east toward the bay. Where well exposed the fault is marked by a zone of shearing with calcite veinlets. The faults strike about N. 70° W and are nearly vertical. The northeast side is downthrown and the displacement is estimated to be about 900 feet.

Between Short Creek and the creek that enters Wide Bay at Camp No. 2 is a graben. The fault bounding the graben on the northeast strikes about N 70° W and dips steeply southwest. The fault bounding the graben on the southwest strikes N. 70° W and dips northeast at an undetermined but steep angle. The displacement is estimated to be 600 feet.

A short distance southwest of the creek that enters the bay at Camp No. 2, the Dactylioceras-Inoceramus sp. C zone has been displaced by a fault trending N 70° W. The fault is nearly vertical and the northeast side has been dropped perhaps as much as several hundreds of feet.

In the sea cliffs north of Camp No. 3 many faults displace the exposed strata. The displacement on these faults is 100 feet or less with the relative movement down on the northeast side of each fault. The faults strike about N 40° W and the blocks are tilted to the west, causing a repetition of the strata.

From a point on the beach about 2/3 mile north of Camp No. 3, a fault extends southwesterly to a point north of Mt. Alai. The fault is well exposed where it displaces the basal conglomerate of the Naknek (?) formation between 250 and 300 feet. The north side is downthrown. The displacement of this fault is very much less near the bay than farther west.

The erratic attitude of the beds exposed on the isolated knob south of Alai Creek suggests a continuation of the zone of block faulting in the sea cliffs north of Camp No. 3.

Although the locality was not visited, a fault is inferred on Lone Hill from the abrupt termination of a prominent sandstone bed which dips gently northwestward on the north flank of the hill. On the south side of this fault less indurated sediments, having the same appearance as those which underlie the prominent sandstone unit, persist to the top of the hill. The fault appears to trend approximately west across Lone Hill with the downthrown side on the north.

Numerous faults displace the Dactylioceras-Inoceramus sp. C zone in the mountain front southeast of Wide Bay and southeast of Kialagvik Creek. These faults strike about N 50° W and are downthrown on the southwest. As the strata strike northeast and dip to the southeast, faults cause repetition of the section and account for the persistence of the zone near sea level along the mountain front for several miles along the southeast side of the bay. These faults have not been mapped in detail and are shown diagrammatically on the map.

Many small faults were noted at scattered localities but were not mapped in detail and they have not been indicated on the map.

IGNEOUS ROCKS

In the southwest part of the mapped area, fine-grained igneous rocks are exposed for a considerable distance northeast from Mt. Kialagvik and at Icy Peak. Where examined, they are phyritic and are probably andesite or basalt. Locally, columnar jointing is prominent.

Igneous rocks in minor amounts are found elsewhere in the mapped area. Three diabase sills and one andesite sill are present in the Short Creek section. On the southeast side of Wide Bay two small dikes were seen. The rock appears to be andesite. These sills and dikes have had very little effect on the enclosing sediments.

OIL POSSIBILITIES

Because no wells have been drilled on the Wide Bay anticline, the possibility of commercial oil accumulation in this structure must be inferred.

Bases for appraisal are furnished by:

1. The section exposed at Cold Bay.
2. The section penetrated by the Grammer Well No. 1.
3. The section exposed at Wide Bay.
4. The structure at Wide Bay.
5. Oil seepages.
6. Igneous activity.

SECTION EXPOSED AT COLD BAY

The Triassic rocks at Cold Bay are dominantly impure organic limestones and are probably favorable source rocks for petroleum. The limestones are only slightly metamorphosed and the few igneous dikes and sills which penetrate them have produced only narrow zones of alteration. These intrusions are thought to be of pre-Jurassic age because they are confined to the Triassic rocks. The gradational and apparently conformable contact between the Triassic and Jurassic systems in this section indicates that there was no interval of folding, uplift and erosion after the Triassic rocks had been deposited. Tuffaceous sandstones in the upper part of the Triassic section furnish possible reservoirs for the accumulation of oil formed in the source rocks.

The Jurassic section at Cold Bay consists of about 2300 feet of dark colored shales and tuffaceous sandstones. They constitute a favorable association of possible source and reservoir rocks. Shales predominate near the top of the formation and would serve as a cap rock for the more porous sandstones. The absence of limestones as potential source rocks in the Jurassic section may be in part offset by their presence in the underlying Triassic rocks.

All the sediments in the Cold Bay section between the Triassic and the overlying discomformable basal conglomerate of the Upper Jurassic Shelikof formation are believed to be Lower Jurassic. The Kialagvik formation of Middle Jurassic age was not recognized at Cold Bay although the upper 1300 feet of rocks thought to be Lower Jurassic did not yield any fossils. The stratigraphic interval between the Kialagvik formation which crops out on the Wide Bay anticline and the Lower Jurassic rocks at Cold Bay is not known.

SECTION PENETRATED BY GRAMMER WELL NO. 1

The Grammar Well No. 1 of the Standard Oil Company of California was drilled in 1938-40 on the Bear Creek anticline about 28 miles northeast of Wide Bay. Because of its depth, 7596 feet, and proximity to the Wide Bay anticline, and its location on the same line of folding, the section penetrated is of considerable importance in anticipating the character and thickness of strata which would be encountered by a deep test on the Wide Bay anticline. The log indicates mostly shale from top to bottom; the upper 3500 feet is dominantly non-calcareous shale with a few sandy zones. The lower 4096 feet is dominantly calcareous shale with partings of impure limestone. Oil residue, light oil, oil in fractures, tarry oil, oil stain, and faint heavy oil odor are reported at intervals from 1935 to 7328 feet. The surface rocks at the well are reported to be in the lower part of the middle unit of the Shelikof formation. The well was thought to have gone directly from the middle unit of the Shelikof into the Kialagvik formation at 1109 feet. It continued in the Kialagvik formation to the bottom; with the possibility that the last few feet were in Triassic rocks.

Hammatoceras howelli was recognized in the core at 1385 feet and shows that the well was in the "Hammatoceras" zone of the Kialagvik formation at that depth. Sandstones and conglomerates, well developed in the "Hammatoceras" zone in the Wide Bay area, were not encountered in the well. Possibly some of the fossils reported at various depths in the well, and which were not identified, could be identified and would be a more reliable basis for correlation with the outcrop sections.

The numerous traces of oil and gas recorded in the log are of interest especially in view of the almost complete absence of porous beds. If suitable reservoirs had been present there might have been greater concentration of the hydrocarbons. As sandstones and conglomerates are notably lenticular in the Kialagvik formation, it is possible that suitable reservoirs may be present in the Wide Bay anticline.

SECTION EXPOSED AT WIDE BAY

A comparison of the lithologic variations vertically within many of the faunal zones and subzones at Wide Bay seems to indicate a cyclic nature of the sedimentation from finer to coarser grained. If this persists in the subsurface section it would provide an alternation of potential source and reservoir rocks. No measurements of porosity were made of any of the rocks studied in 1944.

The coarsest exposed sediments in the Kialagvik formation are the conglomerates interbedded with sandstones in the upper part of the "Hammatoceras" zone. The zone has an exposed thickness of 1150 feet and grades upward from shales in the lowest outcrops to conglomerates at the top. This sequence of lithologic units implies a regressing sea. As the shoreline moved closer to the Wide Bay area, coarser sediments were deposited. Hence, limestones might be expected to comprise a larger percentage of the subsurface section than is present in the exposed part of the Kialagvik formation. This is supported by the repeated record of thin beds of impure limestone in calcereous shale throughout the lower half of the log of the Grammer Well No. 1 in strata included in the Kialagvik formation by the Company's geologists.

STRUCTURE AT WIDE BAY

The Wide Bay anticline is the most favorable structure now known on the Alaska Peninsula for a test of the Triassic rocks and the lower part of the Jurassic rocks. It is the only well-defined fold where the Kialagvik formation is exposed. The fact that there are about 1750 feet of this formation on the surface along Short Creek means that a well on the shore of Wide Bay at the mouth of this creek would begin about 2000 feet below the top of the Kialagvik. Such a well presumably would start approximately 3000 feet stratigraphically below the horizon where the Grammer Well No. 1 was started.

The large number of cross faults observed on the Wide Bay anticline are comparable to faults in many producing structures, and probably do not detract appreciably from the importance of the anticline as a structural trap although they do present minor hazards to the location of individual wells. Possibly the highest part of the anticline may be an elevated fault block on the dominently folded structure.

OIL SEEPAGES

Two oil seepages have been reported from the Kialagvik formation on Wide Bay but they were not observed in 1944. A few thin, lenticular streaks of a black, dense, brittle, amorphous substance resembling coal were noted in the sandstone along Wide Bay northwest of Short Creek. The absence of seepages along the faults does not signify that there has been no accumulation of oil in reservoirs beneath the surface.

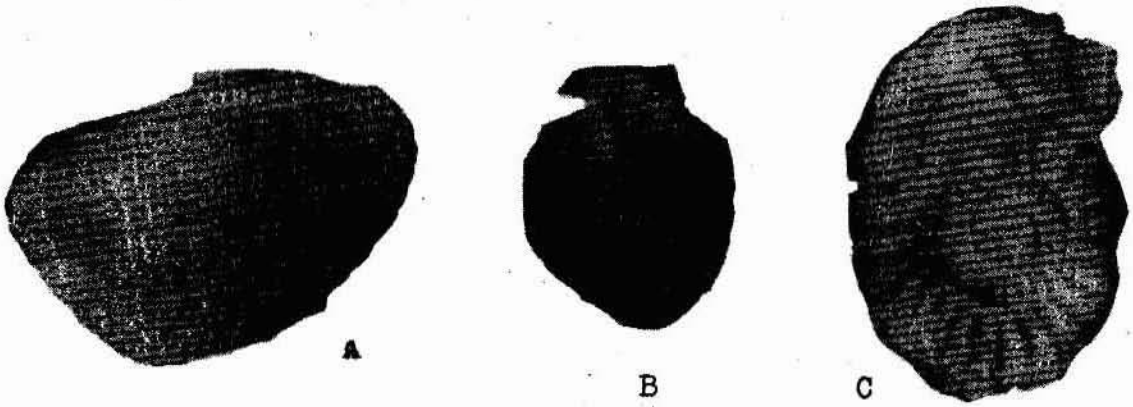
IGNEOUS ACTIVITY

Except for the large igneous intrusions reported at the northeast and southwest ends of the anticline, the igneous rocks along it at the surface include only a few fine-grained, thin dikes and sills which have had very local metamorphic effect on the sediments they intrude. They probably would not have appreciably influenced the accumulation or preservation of oil in the central part of the structural trap.

CONCLUSIONS

A review of all known factors bearing on the possibility of the presence or absence of oil and gas in commercial quantities in the Wide Bay anticline leads to the conclusion that a reservoir may be present. Much more geologic field work will be necessary before the information available on the surface is complete, but from present knowledge of the surface geology of the southwestern part of the Wide Bay anticline, the structure seems to be worth a deep test. It is one of the most promising untested folds known on the Alaska Peninsula. The location for such a test should be on the northwest shore of Wide Bay near the mouth of Short Creek. The objective of any well drilled on the Wide Bay anticline should be to penetrate the Triassic rocks.

TRIASSIC



A. Pseudomonotis subcircularis Gabb. B. Pecten sp. L.
C. Arniotites sp. B.

LOWER JURASSIC

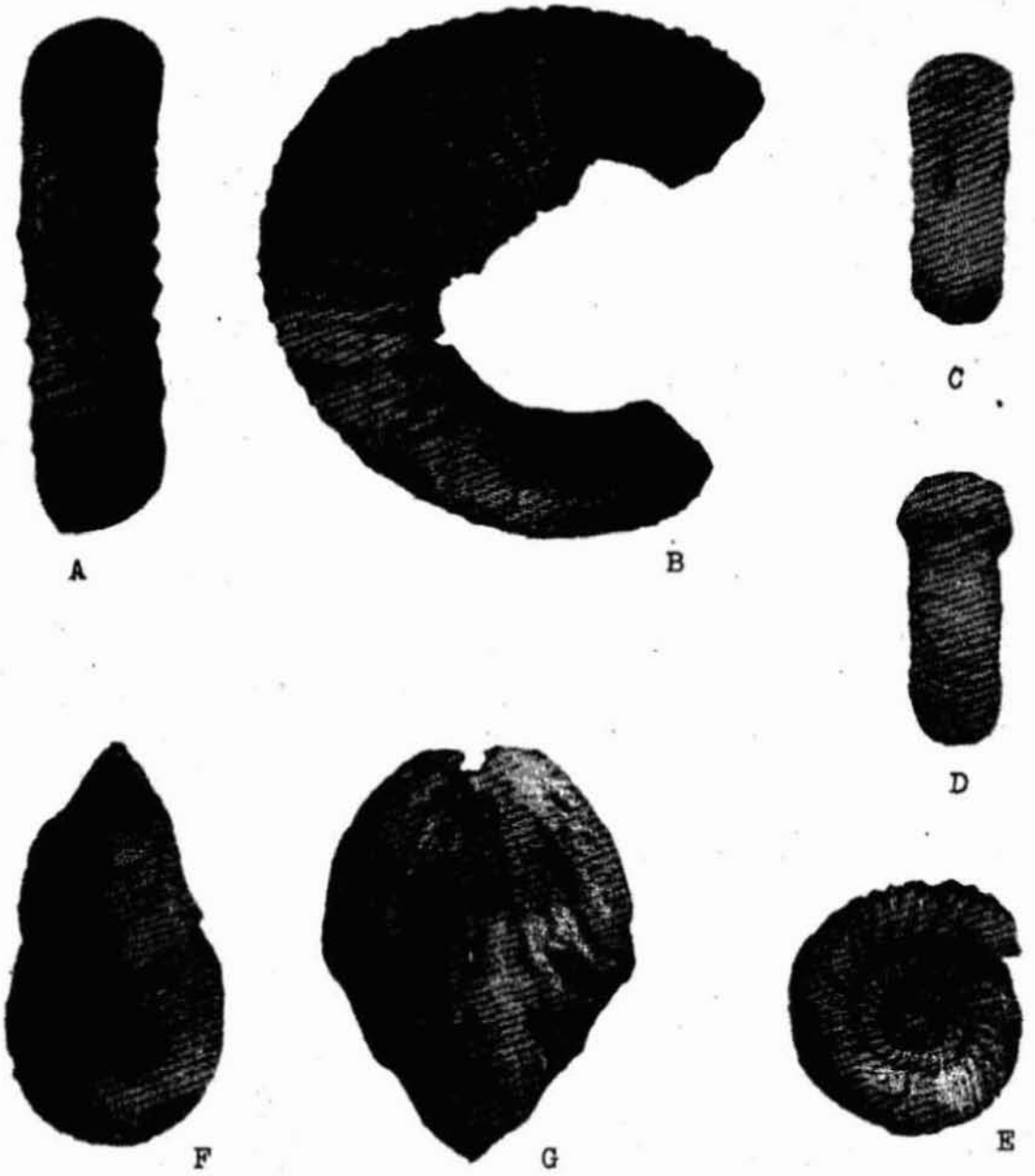
D. Astarte sp. D. E. Arieticeras sp. A. F. Harpoceras sp. C.
G, H. Pecten sp. M.

TRIASSIC AND JURASSIC GUIDE FOSSILS FROM COLD BAY, ALASKA

HAMMATOCERAS ZONE

A, B. "Hammatoceras" howelli White. C, D. Hammatoceras? kialagvikense White. E, F. Harpoceras whiteavesi White. G, H. Pleuromya dalli White.

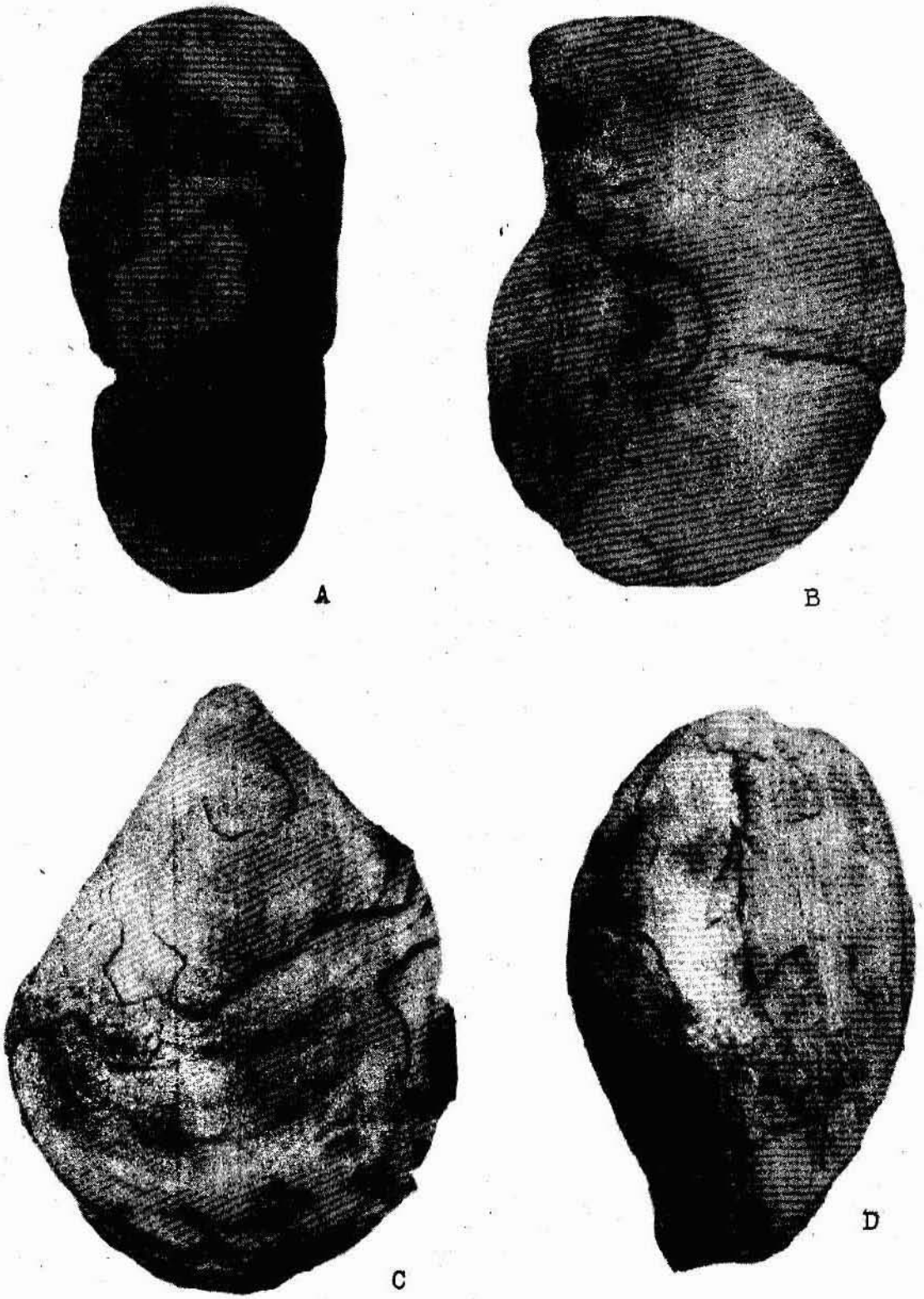
DACTYLIOCERAS-INOCERAMUS SP. C ZONE



A, B. Dactylioceras sp. A. C, D, E. Dactylioceras sp. A.
F, G. Inoceramus sp. C.

JURASSIC GUIDE FOSSILS FROM WIDE BAY, ALASKA

SEYMOURITES-INOCERAMUS SP. E ZONE



A, B. Seymourites sp. A. C, D. Inoceramus sp. D.

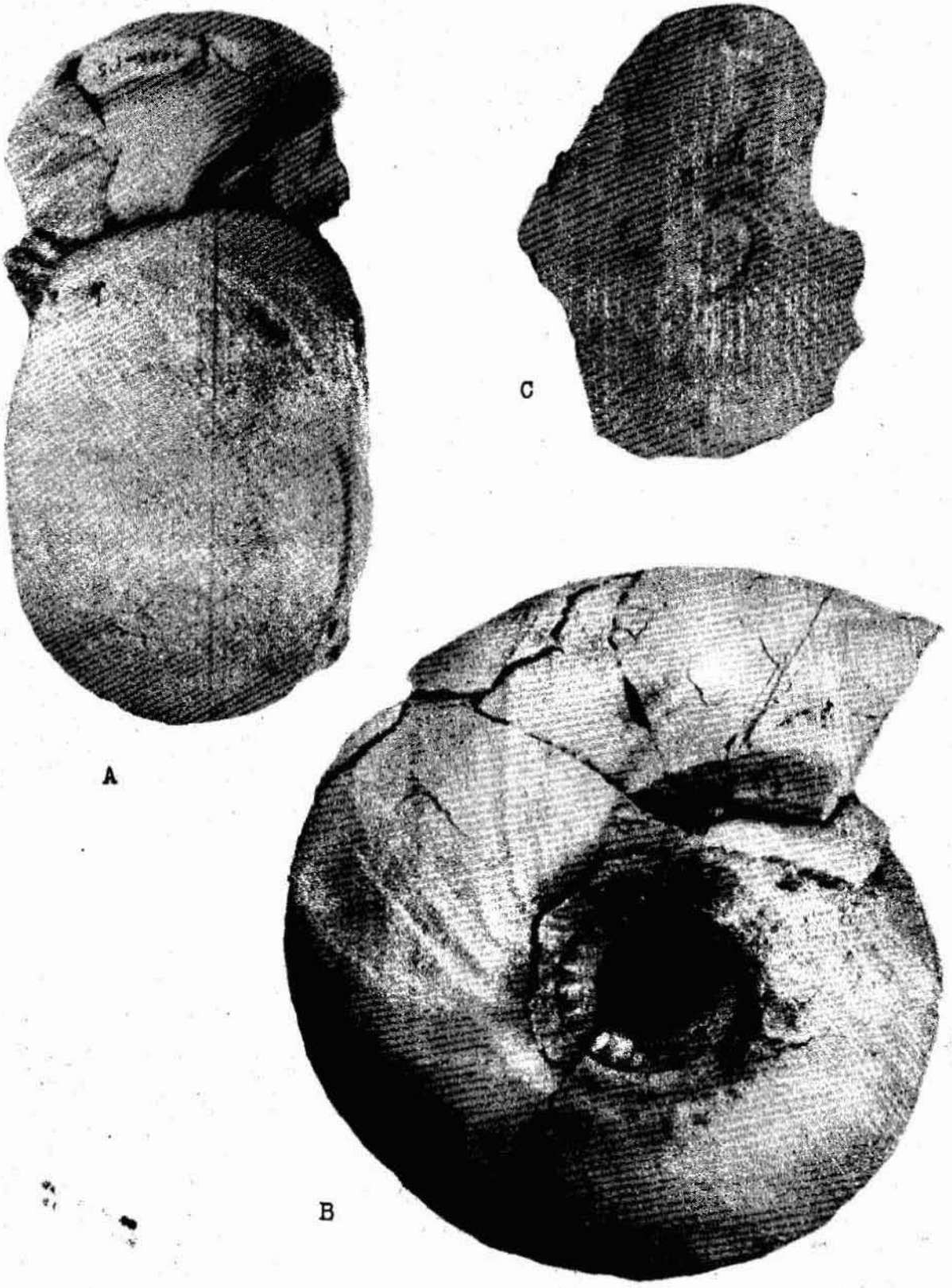
JURASSIC GUIDE FOSSILS FROM WIDE BAY, ALASKA

SEYMOURITES-INOCERAMUS SP. E ZONE

A. Inoceramus sp. E.

JURASSIC GUIDE FOSSILS FROM WIDE BAY, ALASKA

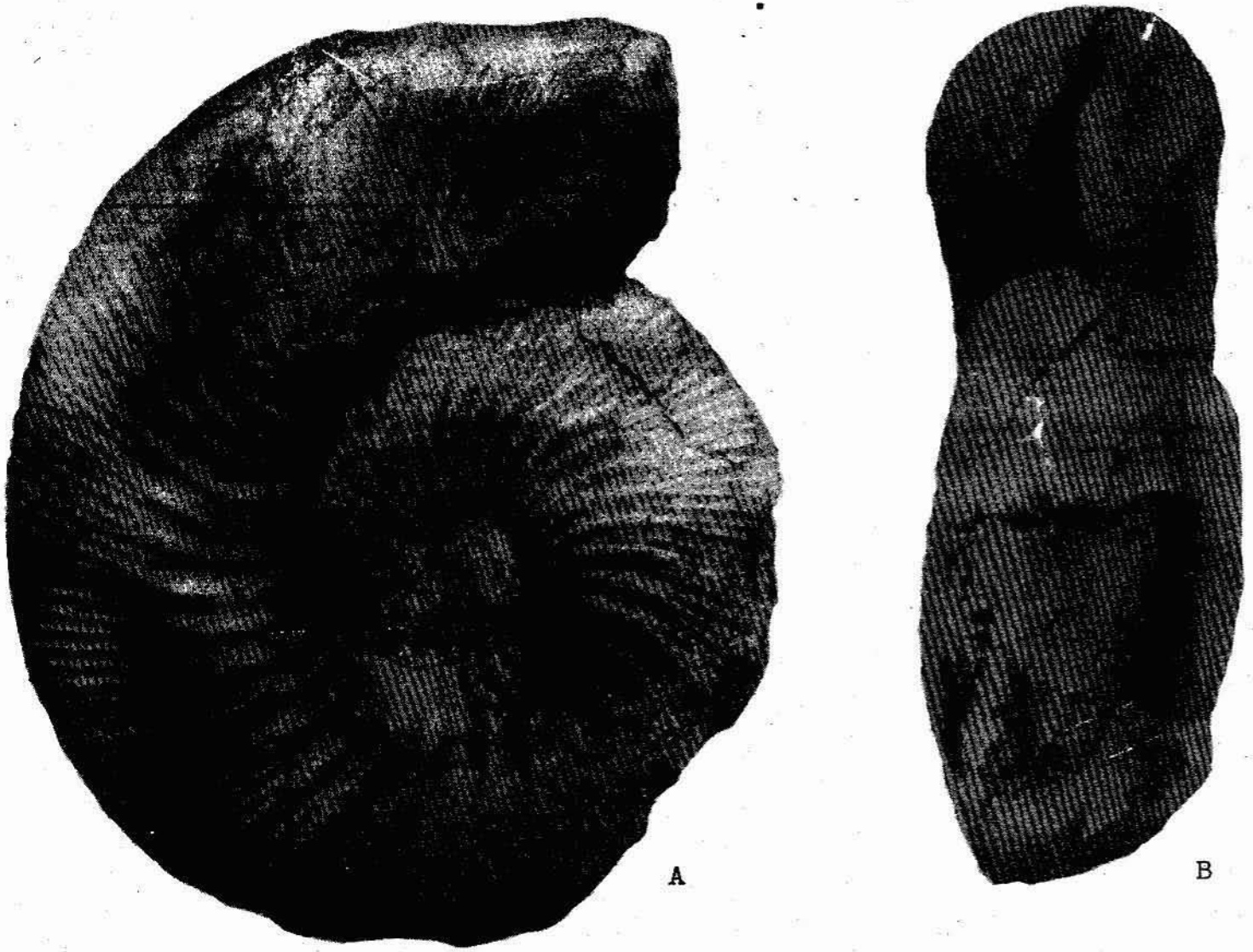
CADOCERAS ZONE



A, B. Cadoceras doroschini (Eichwald). C. Cadoceras sp. G.

JURASSIC GUIDE FOSSILS FROM WIDE BAY, ALASKA

CADOCERAS ZONE



A, B. Yakounites sp. A.

JURASSIC GUIDE FOSSILS FROM WIDE BAY, ALASKA

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY
WAR MINERALS INVESTIGATIONS

FIGURE 10

Fossils collected in 1944	Hammatoceras Zone		Dactylioceras-Inoceramus sp. C Zone		Seymourites-Inoceramus sp. E Zone		Cadoceras Zone		Locality 825 feet above Cadoceras doroschini Subzone	Float	Cold Bay Section	
	Hammatoceras howelli Subzone	Hammatoceras kialagvikense Subzone	Dactylioceras Subzone	Inoceramus sp. C Subzone	Seymourites Subzone	Inoceramus sp. E Subzone	Cadoceras doroschini Subzone	Cadoceras sp. G Subzone			Triassic	Lower Jurassic
	F12, F22, F23, F34, F35, F36, F37	F17, F40?, F13, F15 to F19, F20, F21, F38?, F39?, F41?, F52, F53, F54, F55, F58, F59, F59a	F42, F43, F65?, F67, F71, F72?, F2, F3, F66, F56	F4, F24, F25, F44, F46, F45, F47, F48, F57, F60, F64, F68?	F49	F6, F27, F50, F61, F81	F5, F51, F63, F62b, F69	F30, F31	F62	F7, F33	F74, F75, F78	F76, F77
Rhynchonella sp. A	X											
R. sp. B		X										
R. sp. C			X									
Terebratula sp. A												X
T. sp. B										X		
Cucullaea increbescens White	X											
C. sp. A			X									
C. sp. B				X								
Parallelodon sp. A					X							
Cardinia sp. A										X		
Trigonia sp. A		X										
T. sp. B Costatae group		X										
T. sp. C Undulatae group		X										
T. sp. D Undulatae group		X										
T. sp. E		X										
T. sp. F			X									
T. sp. G, Glabrae group, Excentrica subgroup		XX X										
T. sp. H. aff. T. montanaensis Meek		X										
T. sp. J. Costatae group		X										
T. sp. K.			X									
T. sp. L		X										
T. sp. M			X									
T. sp. N	X											
T. sp. O aff. T. quadrangularis H and W		X										
Astarte ? sp. A		X										
A. ? sp. B		X										
A. ? sp. C		X										
A. sp. D												X
A. sp. E cfr. A. packardi White									X			
Lucina sp. A	X											
L. sp. B			X									
Protocardium sp. A	X											
Artica ? sp. A					X							
Cyprimeria ? sp. A		X										
Pleuromya dalli (White)	XX	X X? XXX	XX ? XX									
P. sp. A		X										
P. sp. B	X	X										
P. ? sp. C		X										
P. sp. D												
P. sp. E							X					
P. sp. F									X			
Goniomya sp. A		X X										
G. sp. B		X										
Anatina ? sp. A		X										
A. sp. B			X									
Pholadomya sp. A		X										
P. ? sp. B		XX										
P. sp. C		X										
P. sp. D			X									
P. sp. E									X			
Thracia sp. A		X										
T. ? species indeterminate	X	X										
Pteria sp. A	X											
P. sp. B	XX											
P. sp. C	X											
P. sp. D	X											
P. sp. E					X							
P. sp. F					X							
P. sp. G				X								
P. sp. H			XX									
P. sp. J									X			
P. ? sp. K									X			
Pseudomonotis subcircularis Gabb											X X	
Pinna sp. A				X								
Gervillia sp. A		X X										
G. ? sp. B		X										
Inoceramus lucifer Eichwald	X	?										
I. sp. A						X						
I. sp. B		X										
I. sp. C			XX XX? XX	XXXXXXX ? X								
I. sp. D					X							
I. sp. E						X X						
I. sp. F			X X									
Lima (Plagiostoma) sp. cfr. L. gigantea Sowerby	X	X										
L. sp. A		X										
L. sp. B		X										
L. sp. C												X
L. sp. D			X									
Pecten sp. A	X											
P. sp. B	X											
P. sp. C	X	X X	XX X	X								
P. sp. D		X										
P. sp. E		XX										
P. sp. F		X										
P. sp. G		X										
P. sp. H	X											
P. sp. J		X										
P. sp. K		X										
P. sp. L											X	
P. sp. N					X							
P. sp. O				X								
P. ? sp. P			X									
P. sp. Q			X									
P. sp. R			X									
Ostrea sp. A		X										
O. sp. B		X										
O. sp. C		X										
Alectryonia sp. A		X										
A. sp. B		X										
A. sp. C		X										
Mytilus sp. A		X X										
Pleurotomaria dalli (White)			X									
Calliostoma ? sp. A												X
Natica sp. A		X	X									
Nautilus sp.	X											
Ammonite (indeterminate)			X						X			
Badiotites ? sp. A cfr. B. carlotensis Whiteaves											X	
Arniotites ? sp. A cfr. A. vancouverensis (Whiteaves)											X	
A. ? sp. B											X	
Arietites ? sp. A												X
Phyloceras ? sp. A			XX	X								
P. sp. B						X						
P. sp. C						X	X					
Dumortieria ? sp. A						X						
"Hammatoceras" howelli (White)	XXXX	X ? X? XX	X									
do ? kialagvikense (White)	XX	XXXX X X										
do sp. A	X											
do ? sp. B	XX X	XX ?? ? X										
do sp. C	X											
do sp. D	X	? XX										
do sp. E		X X										
do sp. F		X										
do sp. G		X X										
do sp. H		X										
do sp. J		X										
do sp. K		XX										
do sp. L	X	X										
Paltopleuroceras ? sp. A	X											
P. ? sp. B		X										
Sonninia sp. A	X X	X										
S. sp. B	X	X										
Harpoceras whiteavesi (White)	XX	XXX X XX X X	X X?									
H. ? sp. A	X											
H. sp. B		X										
H. sp. C												X
"Harpoceras" sp. D			X									
Arieticeras sp. A												X
Oppelia ? sp. A		X										
Dactylioceras sp. A			X XX X									
Reineckia sp. A			X									
Stephanoceras sp. A		X	X									
Teloceras sp. A			X									
Cadoceras doroschini (Eichwald)							X ? X X					
C. ishmae (Eichwald)							X			X		
C. sp. A cfr. C. sublaeve (J. Sowerby)							X X					
C. sp. B							X					
C. sp. C							X					
C. sp. D							X					
C. sp. E										X		
C. sp. F										X		
C. sp. G								XX				
C. sp. H cfr. C. wosnessenski (Grewingski) ?							?					
Seymourites sp. A					X							
Cosmoceras? sp. A										X		
Yakounites sp. A							XX					
Belemnites sp.	XX	X X X	X XX	X		X	X	X				
Crustacean sp.	X											