SUMMARY OF RECENT SURVEYS IN NORTHERN ALASKA

By PHILIP S. SMITH, J. B. MERTIE, Jr., and W. T. FORAN

INTRODUCTION

Early in 1923, shortly after President Harding ordered a tract of more than 35,000 square miles in northern Alaska set aside as a naval petroleum reserve, the United States Geological Survey, at the invitation and at the expense of the Bureau of Engineering, Department of the Navy, undertook surveys to map the reserve and to determine the geologic facts necessary for guiding the Navy Department in the proper administration of this Government property. Preliminary plans and estimates of time and cost for such surveys prepared by the Geological Survey called for five years' field work and an expenditure of approximately $500,000. A little more than two years has been devoted to this work, and the expenditures to the end of the fiscal year 1925 were about $140,000.

A combined geologic and topographic party which was sent into the field in 1925 continued surveys as late as possible and returned to Washington to work up the field notes and records during the winter. Because of the work which is still in progress and because a report of the work accomplished in 1923 has already been published, it is felt unnecessary to prepare an elaborate separate report of the results of the investigations carried on during the field season of 1924. However, so much interest has been shown in this little-known region that the following summary has been prepared, showing the present state of information (July, 1925) and presenting opinions regarding the possibility of finding oil in the region. Doubtless some of the suggestions will require modification when the results of the explorations made in 1925 are available, but even after the completion of these surveys parts of the reserve still require further examination before all the pertinent and available data are obtained.

GENERAL FEATURES

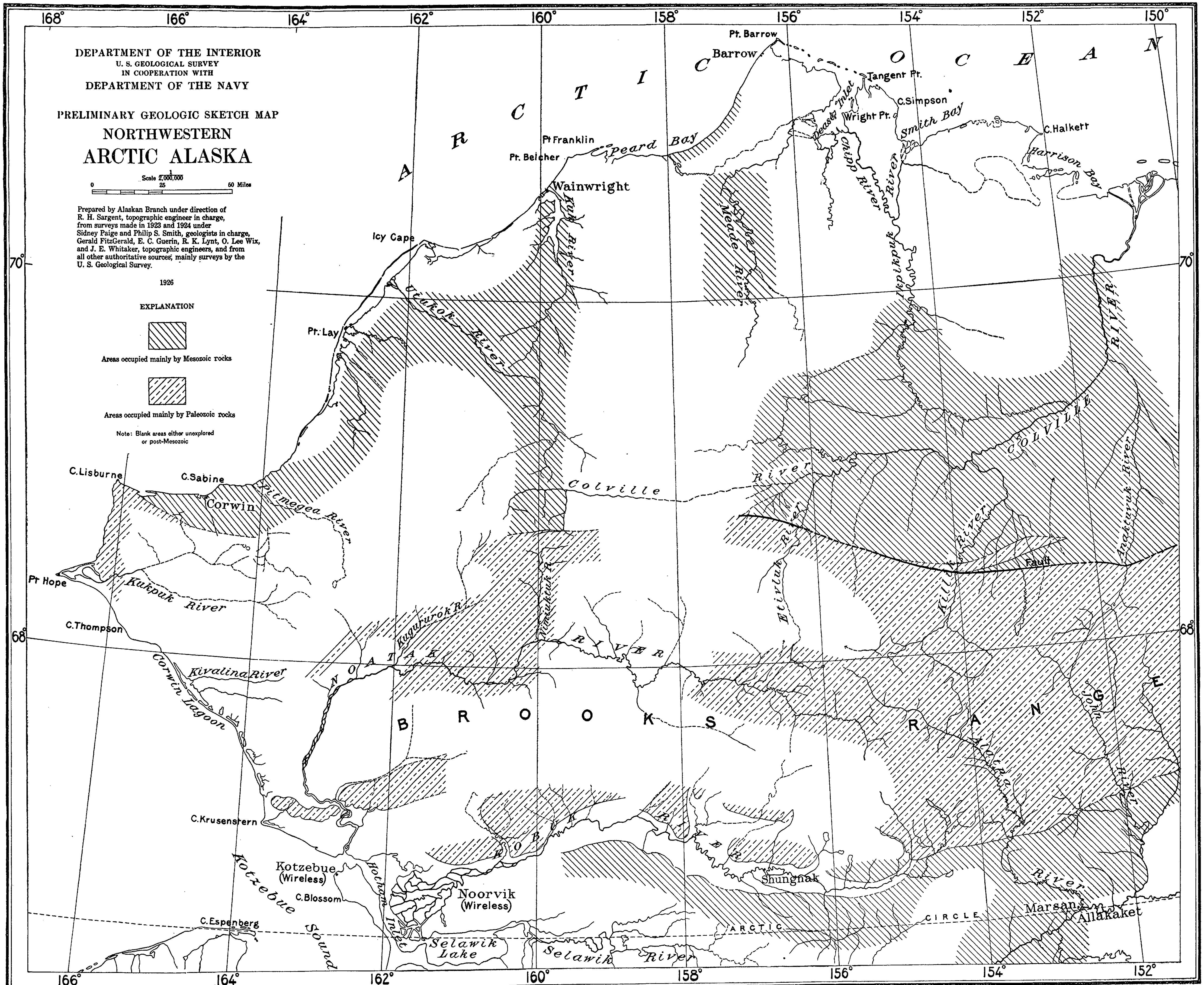
The general location of the reserve, which occupies a large tract in the extreme northern part of Alaska, and the contiguous country are shown on the accompanying sketch map (pl. 7). Topographically the area shown on the map is characterized by a mountainous belt 100 to 200 miles wide that extends in a general east-west direction and forms the western part of the Brooks Range, which crosses northern Alaska, eastward to the international boundary. These mountains are formed mainly of Paleozoic rocks that range from schist and metamorphic limestone to sandstone and slate. Both north and south of the Brooks Range are plateaus developed on later Mesozoic sedimentary rocks that stand 3,000 feet or less above the sea. North of the plateau region is a coastal plain, which is in places 50 to 75 miles wide but gradually tapers toward the west and ends near Cape Beaufort. The mountains closely correspond to the area indicated on the map as formed dominantly of the Paleozoic rocks; the plateaus are indicated by the areas occupied by the later Mesozoic rocks; and the coastal plain is indicated by part of the blank areas near the Arctic coast.

The region as a whole has very little precipitation; the average is less than 6 inches a year at Barrow and less than 13 inches at Allakaket. It has a long, cold winter and a short, warm summer. The mean annual temperature at Barrow is about 10° F. and at Allakaket about 18°. Owing to the low temperature the streams are usually frozen from the middle or later part of September until the later part of May. The ocean is blocked by ice for nearly ten months; in 1924 the first boat reached Barrow in August and the last boat that got out safely left early in September. No regular lines of ocean transportation run to the region, and the vessels that go there belong either to the Coast Guard or to the Bureau of Education, or are owned or under charter by trading companies. Whaling vessels formerly visited these waters regularly, but now only a few come at infrequent intervals. No spruce or other large trees grow north of latitude 68°, and for a hundred miles south of that latitude trees are not plentiful, so that throughout most of the area the only bushes or shrubs are willows, the largest of them less than 15 feet high, and most of them ranging from shrubs 4 or 5 feet high to prostrate forms that rise only a few inches above the ground.

The entire region is uninhabited except for a narrow fringe near the coast and here and there along the larger rivers, where a few small trading posts have been established that are the homes of perhaps a score or two of whites and a thousand natives. Game is fairly abundant in the back country, where it has not been hunted in recent years by the natives or whites.

KNOWN OCCURRENCE OF PETROLEUM

That petroleum occurs in the reserve has been definitely proved. Under what conditions it originated or how much of it there is has not been determined. Many of the problems that must be solved


DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY
IN COOPERATION WITH
DEPARTMENT OF THE NAVY
PRELIMINARY GEOLOGIC SKETCH MAP
NORTHWESTERN
ARCTIC ALASKA
Scale 1/2,000,000
0 25 50 Miles
Prepared by Alaskan Branch under direction of R. H. Sargent, topographic engineer in charge, from surveys made in 1923 and 1924 under Sidney Paige and Philip S. Smith, geologists in charge, Gerald FitzGerald, E. C. Guerin, R. K. Lynt, O. Lee Wix, and J. E. Whitaker, topographic engineers, and from all other authoritative sources, mainly surveys by the U. S. Geological Survey.
1926
EXPLANATION
Areas occupied mainly by Mesozoic rocks
Areas occupied mainly by Paleozoic rocks
Note: Blank areas either unexplored or post-Mesozoic
ARCTIC OCEAN
BROOKS RANGE
Pt. Barrow
Barrow
Tangent Pt.
C. Simpson
Wright Pt.
Dease Inlet
Smith Bay
C. Halkett
Harrison Bay
Pt. Franklin
Pt. Belcher
Peard Bay
Wainwright
Icy Cape
Pt. Lay
C. Lisburne
C. Sabine
Corwin
Pitmegea River
Pt Hope
Kukpuk River
C. Thompson
Corwin Lagoon
Kivalina River
C. Krusenstern
Kotzebue (Wireless)
C. Blossom
C. Espenberg
Kotzebue Sound
Hotham Inlet
Noorvik (Wireless)
Selawik Lake
Selawik River
Shungnak
Marsan
Allakaket
ARCTIC CIRCLE
Kuk River
Utukok River
Colville River
Colville
Meade River
Chipp River
Ikpikpuk River
Kugururok R.
Nimiuktuk R.
Noatak River
Etivluk River
Killik River
Anaktuvuk River
Fault
Alatna
John River
Kobuk River
168° 166° 164° 162° 160° 158° 156° 154° 152° 150°
70° 68°

before commercial development can be undertaken on a sound basis of fact must therefore await the collection of more complete data.

The only direct evidence of the occurrence of petroleum in the reserve is found in the vicinity of Cape Simpson, where two distinct seepages of petroleum occur. These seepages were first reported in publications of the United States Geological Survey by Brooks,[1] who in 1908 noted them on the authority of Leffingwell. Leffingwell [2] apparently did not visit the seepages either at that time or later but based his statements on information given to him by natives and later by Stefansson. He did, however, obtain a sample of the residue collected for C. D. Brower by natives, and this material was analyzed by David T. Day.

In 1921 this region was visited during the open season by geologists and others in the employ of an oil company, and numerous claims were staked.

In 1923 a Geological Survey party visited this region, and the following statements appear in the published report of that expedition: [3]

> A low moss-covered ridge of irregular shape stretches for 2 miles along the Arctic Ocean, its southeast terminal about a mile northwest of Cape Simpson. Its highest point is about 50 feet above the sea. Seepage No. 1 occurs near the inland base of this ridge, a third of a mile from the ocean and 20 feet above tidewater, from which it is visible. Here in an irregular area several hundred feet in diameter the moss is soaked with petroleum, which also slowly seeps from the gentle slope.
>
> Seepage No. 2 is on the southern top, 40 feet high, of a small double knob 3 miles almost due south of seepage No. 1 and 1¼ miles west of Smith Bay. Here the residue from the seepage covers several acres.
>
> The main petroleum flow moves southward down the slope for 600 or 700 feet to a lake. This active channel is 6 to 10 feet wide, though the area covered by residue is several hundred square feet and indicates that a considerable flow is coming from this seepage. The ridge at these two seepages is covered with moss and muck, and there are no surface indications that it is made up of hard rock. In surface form the ridges are not different from others elsewhere that appear to consist of Pleistocene alluvium, but shallow excavations at these localities reveal an aggregate of angular shale débris and clearly prove that hard rock is near the surface and that the ridges are the result of the erosion of bedrock and not of alluvium.

Seepages have also been reported and claims staked by representatives of oil companies in 1921 on Meade River as far south as that stream was surveyed by the Geological Survey in 1923 and possibly even a few miles farther. Although copies of the maps made by the representatives of the oil company, showing these

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[1] Brooks, A. H., The mining industry in 1908: U. S. Geol. Survey Bull. 379, pp. 61–62, 1909.

[2] Leffingwell, E. de K., The Canning River region, northern Alaska: U. S. Geol. Survey Prof. Paper 109, pp. 178–179, 1919.

[3] Paige, Sidney, Foran, W. T., and Gilluly, James, A reconnaissance of the Point Barrow region, Alaska: U S. Geol. Survey Bull. 772, p. 23, 1925.

reported seepages, were in the possession of the Survey geologists and the places where the seepages were indicated were examined with special care, none of these places proved to contain real seepages or showed any definite indications of petroleum. The signs that apparently have been interpreted as indicating seepages proved in all places, when examined critically, to be films of iron oxide on stagnant pools which, when stirred, broke up into irregular patches that did not readily unite again like oil. These films were seen on a number of pools in the basins not only of Meade River but also of the Colville and the Ikpikpuk and unless carefully examined might prove misleading.

Claims have also been staked on reported oil seepages midway between Barrow and the head of Peard Bay. The coastal part of this area was examined by Paige in 1923, but here again the only signs which might be mistaken for indications of the presence of petroleum were films of iron oxide. The rather high ground in this region suggested the possibility of a structural fold there which might be favorable for the accumulation of petroleum, and the Survey geologists report that the beds apparently do form a low flexure. In spite of the apparently favorable structure, however, no indications of petroleum were seen, and the natives, who traverse much of that part of the region in caring for their herds of reindeer and who are especially observant of most natural phenomena, do not know of any seepages or other indications of petroleum in that whole region.

Petroleum seepages about midway along the southern shore of Teshekpuk Lake, have also been reported, but these were not visited by any of the Survey geologists and nothing definite was learned about them. Seepages in the area east of the Colville have also been reported, but secrecy as to their location has been maintained by those who reported them, and most of the rumors appear to have been circulated by other than those who are supposed to have actually seen the occurrences.

CHARACTER OF THE OIL

The only samples of oil from the naval reserve that have been tested by the Government were collected at the seepages near Cape Simpson. These samples were taken from the surface, where the oil had become weathered and many of the lighter, more volatile parts had probably escaped, so that the true character of the fresh oil is not known. Apparently the oil has a naphthalene base and is rather low in sulphur. According to Paige, it appears to be comparable with the oil obtained in the Blue Ridge field of Texas. The following results were obtained from tests made by the Bureau of Mines on the samples collected by Paige in 1923:

Results of tests of oil sample No. 28510, from Naval Petroleum Reserve No. 4, Alaska

[Seepage at surface collected by United States Geological Survey August, 1923; analyzed by United States Bureau of Mines]

Specific gravity, 0.943; A. P. I. gravity, 18.6°.

Sulphur, 0.36 per cent; water, 7.5 per cent.

Saybolt Universal viscosity at 70° F., 5,160 seconds; at 100° F., 1,370 seconds. Pour point, below 5° F.

Distillation, Bureau of Mines, Hempel method

[Vacuum distillation at 40 millimeters]

Temperature (° C.)	Per cent cut	Sum (per cent)	Gravity		Viscosity at 100° F.	Cloud test (° F.)	Temperature (° F.)
			Specific	A. P. I. (°)			
Up to 200	13.6	13.6	0.894	26.8	34	Below 5	Up to 392.
200–225	10.2	23.8	.920	22.3	68	do	392–437.
225–250	9.0	32.8	.923	21.8	116	do	437–482.
250–275	10.5	43.3	.931	20.5	240	do	482–527.
275–300	10.7	54.0	.936	19.7	Over 400	do	527–572.

Carbon residue of residuum, 4.9 per cent.

Approximate summary

	Per cent	Gravity		Viscosity
		Specific	A. P. I. (°)	
Gasoline and naphtha				
Kerosene distillate				
Gas oil	12.5	0.892	27.1	
Nonviscous lubricating distillate	12.7	.906–.922	24.7–22.0	50–100.
Medium lubricating distillate	9.7	.922–.928	22.0–21.0	100–200.
Viscous lubricating distillate	19.1	.928–.939	21.0–19.2	Above 200.

Results of test of petroleum residue from Alaska, sample No. 23508

[Extraction with benzene]

	Oil (per cent)	Sulphur (per cent)	Specific gravity
Sample marked "dried"	44.5	0.55	1.014
Sample marked "undried"	62.0	.47	.971

As a qualitative test by the Holde-Mueller method[4] showed that only a comparatively small part of the oil was precipitated as asphalt with excess of petroleum ether, it would appear that the unusually high viscosity of the sample is not due to an appreciable extent to the presence of asphalt. Although no chemical study of the oil has been made, it seems probable that the high viscosity may be due to the presence of a large proportion of naphthalene hydrocarbons, a view supported by the general appearance of the sample, its low sulphur content, and the small percentage of carbon residue of the residuum.

[4] Holde, D., Hydrocarbon oils and saponifiable fats and waxes, 2d ed., transl. by Edward Mueller, p. 105, 1922.

The tests indicate lubricant values in the weathered oil, which in fact appears comparable in Baumé gravity, sulphur content, viscosity, and distillation tests to the oil obtained from shallow wells in the Pliocene rocks of the Blue Ridge field, in Texas.[5]

Beyond doubt light hydrocarbons have escaped from the surface seepage, though evaporation in the Arctic climate may not have been so rapid and may not have taken place at so high a temperature as in the better-known regions in lower latitudes. It is to be remembered, however, that the climate of this region is dry. On the whole, therefore, while it is difficult on the basis of the above tests to predict the composition of the unweathered oil, it is practically certain that the oil contains some of the lighter hydrocarbons. It will be seen that 13.6 per cent of the sample was distilled off under 200° C. at a pressure of 40 millimeters.

The expectation that the oil from wells at depth will be of value for its lighter hydrocarbons, as well as for use as lubricants and fuel, is likely to be fully confirmed. At Blue Ridge, Tex., already mentioned, lighter oils are found in the same field at greater depths.

SUGGESTIONS REGARDING PROBABLE SOURCE OF THE OIL

From the foregoing statements it is evident that there is very little specific information on which to base broad generalizations regarding the possibility of obtaining much oil in the region. The only definite facts are those that relate to the seepages at Cape Simpson. Even there, however, observations are not in entire accord, for Paige states that "the material exposed in shallow beds is sandy and calcareous shale whose structure can not be definitely determined, but it appears to be practically horizontal." H. A. Campbell, a geologist of an oil company, who also notes that the lack of sufficient rock exposures makes it practically impossible to determine the structure, states that the dip of the only beds that may be in place was 80° SE.—that is, nearly vertical. Philip S. Smith reported that he saw no indisputable indications of rock in place, although he spent very little time in the vicinity of Cape Simpson and therefore felt that he was not warranted from direct observation in making even a surmise as to the probable structure and specific character of the underlying hard rocks.

In spite of the absence of indisputable evidence, the following inferences regarding the occurrence of oil near Cape Simpson may be made with considerable probability of correctness. One of the most significant conclusions is that the oil does not originate in the mantle of unconsolidated deposits that forms the surface covering of the coastal plain. Among the reasons for this belief is the fact that this mantle is apparently rather thin, and nowhere in any of the exposures of this formation that have been examined are there any con-

[5] Smith, N. A. C., Banes, A. D., and LeJenne, N. F., Properties of typical crude oils from the producing fields of southern Louisiana and southern Texas: Bur. Mines Repts. Inv. 2416, p. 39, November, 1922.

siderable accumulations of organic material which might have been capable of furnishing an appreciable amount of petroleum. All the geologists who have worked in this region believe that the source of the oil is to be sought in the underlying bedrock. Whether or not the bedrock is exposed near the seepages at Cape Simpson is relatively immaterial, for all the geologists who have seen the region agree that the bedrock is probably the same as that which is exposed at many places along Meade River, as shown by the explorations conducted by the Paige expedition in 1923, or that which is exposed along Ikpikpuk and Colville rivers, according to the observations made by the parties of the Smith expedition in 1924.

The formation on Meade River, according to the paleontologic information now available, is referred to the Jurassic, whereas the beds exposed in the Colville and Ikpikpuk are Upper Cretaceous. The geologists, however, have not been able to diffentiate these formations in the field, so that the distinction has been made solely on paleontologic grounds. Lithologically they appear to be identical, and their mode of formation and subsequent history appear to have been the same. Whether these beds really represent two distinct formations is of considerable economic significance, however, and further work should be done to establish the facts.

The present inability to differentiate the two formations by other than paleontologic criteria has necessitated the description of their general characteristics together. These rocks throughout the greater part of the region consist of sandstone and shale that were deposited in relatively shallow water. Over a large area, however, these rocks have been laid down apparently in swamps and in shallow seas in relatively quiet water. Large accumulations of vegetable matter, now represented by coal beds, were formed contemporaneously with the sand and shale. In the lower and higher members of the later Mesozoic rocks less deposition took place upon and near the land and more in shallow marine waters, as is shown by the marine shells that have been discovered in these beds at many places. On the whole, the conditions that prevailed while the coal-bearing portions of the formations were being deposited do not seem to have been favorable for the production of extensive deposits of oil. The accumulation of the organic remains of animals in the higher and lower sandstones might be regarded as favorable material for the origin of petroleum, but nowhere was evidence found of any considerable mass of this organic material.

However, on Etivluk River, a tributary of the Colville, fragments of true oil shale were found, but as these fragments were not in place, the stratigraphic position of this shale is not accurately known. Furthermore, the structure of the general region where the oil-shale float was found is complex and is subject to various interpretations.

This shale is exceptionally rich, and specimens of it have been critically studied by David White, the foremost authority on microscopic examination of oil shales. He says regarding the specimen of float submitted:

> Examination of thin sections of this specimen under the microscope shows that the rock is made up very largely of the flattened exines of a single type of large megaspore. These exines appear as collapsed or entirely flattened thick golden-yellow bands. The specimen in its fossil constitution is so remarkably similar to tasmanite that no violence would be done in calling it by that name, although the megaspores may have been produced by a different plant and the chemical composition may differ somewhat from that of the material from Tasmania described under the above name. Rough test-tube tests of the material, which is readily combustible, indicate rather copious condensation of hydrocarbon gases in the form of viscous distillate.

Typical tasmanites have yielded on distillation tests an average of as much as 70 gallons of oil to the ton of rock.

The material described above may be the same as that noted by Ensign (now Rear Admiral retired) Howard in his remarkable exploratory trip through part of the region in 1886. He described a material found on the Etivluk as "a substance called wood by the natives. It was hard, brittle, light brown in color, very light in weight, and burned readily, giving out quantities of gas. This material was scattered about in all shapes and sizes and quantities." Later this material was considered by Martin[6] to be probably a petroleum residue. The party of 1924 probably did not visit the exact locality noted by Howard in 1886, but in view of the similarity in physical character between Howard's material and that obtained in 1924 and in view of the optical determination by David White the interpretation that this material is a rich oil shale and not a petroleum residue seems to be warranted.

If an oil shale similar to the specimen collected occurs in the later Mesozoic strata it could furnish an adequate source for a considerable volume of oil. A flat-lying bed 1 foot thick contains about 1,000,000 tons of rock to each square mile, and the equivalent amount of oil it would contain may be computed by multiplying this tonnage by the oil content of a ton of oil shale. In view of the extremely doubtful quality of many of the factors of the problem when applied to the specific field here considered, it does not seem advisable to carry out the foregoing arithmetical process to a conclusion, for such a result would appear to have a definiteness far more specific than the facts on which it is based would warrant. The foregoing analysis is given only to show that apparently an adequate source of a considerable volume of oil is suggested by the field observations.

[6] Martin, G. C., Preliminary report on petroleum in Alaska: U. S. Geol. Survey Bull. 719, pp. 69–70, 1921.

Some further conclusions may be drawn from acceptance of the assumption that this oil-shale float is really part of the stratigraphic sequence and belongs in that sequence rather near the place where the float was found. From these assumptions and from the observations regarding the general structure and stratigraphy of the region it follows that the oil shale must lie fairly well down in the later Mesozoic succession and that consequently it might underlie a considerable part of the reserve north of the latitude of the place where the float was found on the Etivluk. If this conclusion is correct it implies that north of this line, where physical conditions are favorable, there is a reasonable source from which oil may be derived. True, this source may be too deeply buried to produce deposits of oil within reach of the drill, and the bed may not have been subjected to those earth processes whereby oil was expressed from the shale. Furthermore, nothing is yet known that indicates that this oil shale is not a distinctly local deposit, without widespread distribution, either laterally along the strike or along the dip. In spite of these uncertainties, however, it is believed that the original conclusion holds true, for, although interrupted and in places even reversed, the general dip of the beds of the region as a whole to the north of this latitude seems to be northward, so that oil or any other liquid would tend to migrate in that direction.

Another conclusion that may be drawn from the assumptions already made regarding the fragments of oil shale is that any oil that might be derived from it will practically be limited to the later Mesozoic sediments lying north of the mountain mass. Certainly the oil shale that has been found is younger than any of the Paleozoic or Upper Triassic rocks that have been seen in the mountain area. Therefore, even if the float has moved some distance from its parent ledge, it must almost certainly have come from the area north of the east-west line (see pl. 7) that marks the southern boundary of the later Mesozoic rocks. This statement does not deny the possibility that there may be infolded or infaulted patches of later Mesozoic rocks within the area that is reported to be dominantly Paleozoic. In fact, the authors strongly suspect that there are such areas. It does, however, imply that any such areas are relatively small, are more or less isolated, and have a synclinal rather than an anticlinal structure. For all these reasons, therefore, these areas probably do not have much significance with respect to the occurrence of oil. Furthermore, later Mesozoic beds lying within the Paleozoic-Upper Triassic area are in all probability duplicated to the north of the boundary between the later Mesozoic and older beds, where the folding, faulting, and deformation which the region has undergone first bring in the more continuous sequence of later Mesozoic rocks.

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This conclusion is worthy of being carefully tested, for if correct it indicates that prospecting for oil within the Paleozoic area is unwarranted, and furthermore that if test drilling is done in the Mesozoic area to the north of this boundary it should be discontinued when the rocks older than the later Mesozoic are encountered.

In the foregoing paragraphs the assumption is made that the source of the oil is in the later Mesozoic beds in a rock similar to the oil-shale float found on the Etivluk. Before accepting the conclusion based on this assumption as ruling out of consideration search for oil in any of the areas occupied by the Paleozoic and Upper Triassic rocks, it is necessary to consider the possibility that such rocks might in themselves have been a source for oil. So far as is shown by the evidence that has been obtained from any part of Alaska, none of the Paleozoic rocks anywhere in the Territory have shown indications that they have been the source of petroleum. Careful examination of the exposures of Devonian and Carboniferous shales and sandstones and the Upper Triassic chert, wherever seen within the reserve, disclosed nothing even suggestive of the presence of petroleum. The Lisburne limestone, of Mississippian age, which is exposed north of the Brooks Range, from Schrader's section on the Anaktuvuk[7] westward to the area studied by Smith and Mertie and still farther west to the tract traversed by Foran, has in places a petroliferous odor that justifies inquiry as to whether the limestone may not be a source of oil.

The direct answer to this inquiry is that, to the best of the writers' judgment, this limestone is not the source of the oil. The correctness of this belief can not be demonstrated, for it is based solely on negative evidence and as such may be overthrown by the discovery of positive evidence. The composition of the limestone is such that it undoubtedly was at one time rich in organic matter, which might have yielded petroleum. That this organic matter did not yield petroleum, however, is strongly indicated by the fact that nowhere are any oil seepages found near the limestone, though it has been examined at many places along the hundreds of miles of its extent through Alaska. Practically every limestone that has not been intensely metamorphosed or recrystallized has a petroliferous odor on freshly fractured surfaces, so that this feature of the Lisburne limestone in this region is not unique. However, even if the Lisburne limestone is the source of the oil, its texture is such that it does not form a good rock to store much oil, so that any oil emanating from it would be likely to migrate into the overlying, more porous rocks for storage.

In the region traversed by the parties of the expedition of 1924 no rocks were recognized that were laid down in the interval between

[7] Schrader, F. C., A reconnaissance in northern Alaska in 1901: U. S. Geol. Survey Prof. Paper 20, 1904.

the deposition of the Lisburne limestone and the overlying Upper Triassic chert and that of the Jurassic or Cretaceous beds. Whether no rocks were laid down north of the Brooks Range during this interval—that is, whether the region was then a land surface—or whether rocks were laid down during this period and subsequently removed by erosion can only be conjectured and in a measure is immaterial for the purpose of the present analysis. Only oil that was expressed from the lower rocks after they were covered by the later Mesozoic rocks which now remain would be preserved. Therefore, for all practical purposes, the distribution of such oil would be nearly the same as that already outlined for oil derived from the assumed source in the oil shale—namely, in the area north of the boundary between the Paleozoic-Upper Triassic sequence and the later Mesozoic beds. True, if the oil were derived from the Lisburne limestone it might be found at somewhat greater depths than if it were derived from a shale member in the later Mesozoic beds, but as no specific position has been assigned to this shale member, this difference in depth is practically negligible in the present discussion. This consideration leads to a repetition of the statement made earlier in this report that search for oil south of the rocks older than the later Mesozoic or drilling below the contact of the later Mesozoic and the older beds north of the Brooks Range is not warranted by the evidence in hand.

OCCURRENCE OF STRUCTURE FAVORABLE FOR THE ACCUMULATION OF OIL

In addition to the necessity of finding a probable source for the oil, it is essential in attempting to determine the probability of the existence of commercial deposits that there should be suitable structural features and that the rocks should have texture competent to induce the accumulation of oil and should be capable of retaining the oil thus trapped. So far as is shown by the studies which have been made, the later Mesozoic rocks of the region are folded into a number of anticlines or domes, which are features everywhere regarded as favorable for causing the accumulation of oil. The pressure that has produced these features resulted in relatively close folding in the area near the mountains, and this area is succeeded northward by one in which the folding is more open, and this in turn is succeeded nearer the Arctic coast by an area in which the beds are still more gently arched.

Close to the south margin of the later Mesozoic area there is evidence that some of the beds have been overturned, and in the section made by the central party of the expedition of 1924 on the Etivluk the dips of the lowest later Mesozoic rocks are almost vertical. Under these conditions the structure is not favorable for the accumu-

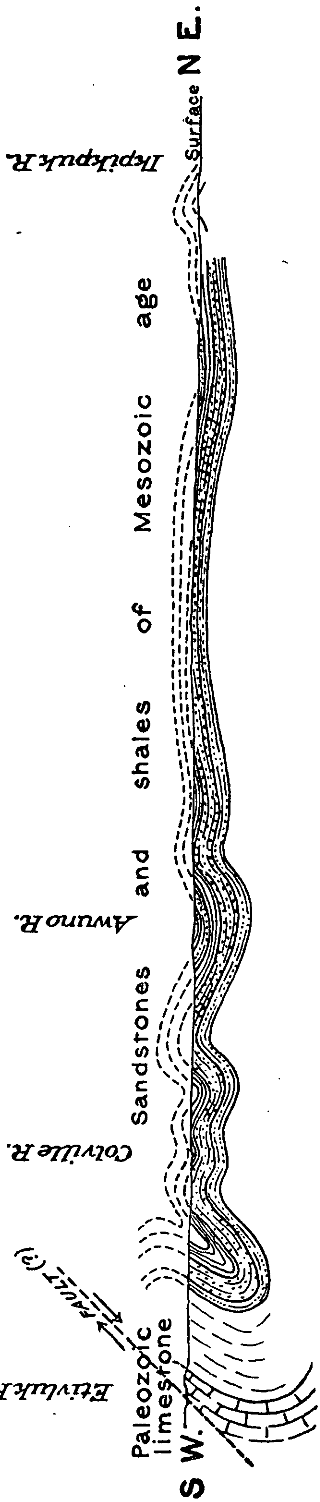

FIGURE 8.—Generalized cross section of northern Alaska from Etivluk River to Ikpikpuk River

lation of oil, but elsewhere, at many places to the north, folding of the rocks seems to be favorable. The general favorable character of the folding does not at all imply that favorable structure is everywhere present. As is well known, in a region of folded rocks folds that are convex upward (anticlines) are separated from one another by folds that bend in the opposite direction (synclines) or by unfolded rocks, and it is on the flanks of the anticlines that valuable oil pools are most likely to be found. A generalized structure section (fig. 8) from the area near the central part of the Etivluk to the most northern exposures on the Ikpikpuk shows the larger structural features observed in the area studied and confirms the statement already made that favorable structures have been noted in widely separated parts of the reserve.

It is perhaps pertinent to suggest that the folding which has been observed may have had an important effect in expressing oil from any oil shale involved. The folding and deformation of a great series of beds, such as the later Mesozoic in this region, inevitably produced considerable heat or pressure, which are the means employed in the commercial extraction of oil from oil shale in the laboratory or in a manufacturing plant. Where the pressure or heat was intense, the oil may have been driven far from its original source before it reached rocks which were cool enough or which afforded sufficient relief of pressure for it to condense, but in regions where the pressure was less or the temperature was lower it may not have escaped far from its original source. It is therefore in the moderately folded rocks in this area that the best accumulations of oil are to be expected.

The porosity of the later Mesozoic rocks is on the whole favorable for the retention of oil that may have originated in or near them. As already pointed out these rocks are dominantly sandstone and shale. The sandstones have fairly open texture and considerable pore spaces. They are interbedded with shales that could seal in any gas or oil that might be present and prevent the rapid vertical escape of these substances. Therefore, although the sandstones allow the lateral migration of liquids in response to hydrostatic or other pressure incident to the folded structure of the rocks as a whole, the escape of these valuable liquids to the surface is impeded or reduced to a minimum by the intercalated nearly impervious shales.

NEED FOR FURTHER INVESTIGATIONS

In endeavoring to present a fairly consecutive and definite statement of the beliefs now held regarding the possibility of the presence of petroleum in the reserve, the writers have possibly minimized the importance of things not now known and perhaps have seemed to place undue emphasis on some of the observed facts. The foregoing pages, however, should not mislead anyone into too ready acceptance of the tentative conclusions suggested. In fact, the writers feel that the suggestions above presented are really challenges to accumulate more facts and to scrutinize these new facts as well as the old observations most critically. There still remain large areas that have not been visited at all, and there is no assurance that even in the regions that have been reconnoitered all the significant facts have been observed. The first thing to be done, therefore, in continuance of the studies already made, is to explore the country still more thoroughly and collect all the additional data that are available.

This need has been met in part by a survey that was carried on in 1925 by Gerald FitzGerald, topographer, and Walter R. Smith, geologist. As a result of this work most of the now unsurveyed areas in the western part of the reserve and adjacent territory should be mapped topographically and geologically.

There still remains the need of traverses in the coastal-plain region between the Ikpikpuk and Colville, including especially the country adjacent to Teshekpuk Lake and some of the country adjacent to Meade River that was not covered by the explorations of the FitzGerald party of 1925. The writers, however, do not feel very optimistic that such traverses will yield many significant geologic data relating to the probable occurrence of oil, because much of the region is doubtless covered with unconsolidated deposits of late geologic age, which effectually mask the underlying bedrock. Observations of structure will therefore probably be few and far between and not adequate to serve as a basis for a reliable interpretation of the structure of the region. For this reason the writers believe that the next step in determining the possibility that the reserve may contain extensive deposits of oil should be to drill test holes at selected localities. Such test holes need not be very deep and could probably be made with a light drill rig that could be moved around the country rather easily, especially while snow and ice are on the ground.

Apparently the place that should be tested first by drilling is in the vicinity of the oil seepages at Cape Simpson. This place is especially suitable, for it is accessible from the sea and is the place where petroleum is actually known to occur. It is, of course, entirely probable that the petroleum at the seepages has migrated some distance from its original source, but by keeping a careful log of the drilling many significant facts would be learned that would direct further drilling and exploration. A competent geologist should keep in close touch with the drilling so that a complete record of the rocks penetrated, based on samples taken carefully and at short intervals, can be made. After a detailed and comprehensive section is constructed from the drill records, further traverse of the region would undoubtedly yield more practical results than if it were made in advance of such drilling. At that time probably not only scouting through certain of the areas suggested above but also through others that might be indicated by these records would be desirable. For instance, further search for the horizon of the oil shale on the Etivluk should be made, and when this horizon is found it should be traced throughout its extent.

SPECIAL PROBLEMS OF DEVELOPMENT

Although a discussion of some of the broader economic principles regarding the actual development of oil fields does not fall within the main province of the geologist and it may seem premature to discuss the development of a field not yet proved, it does seem desirable to summarize some of the features of Naval Petroleum Reserve No. 4 which make the problem of developing oil in this region unique and which therefore might be overlooked by a mining engineer or promoter, who necessarily approaches the problem first in his office, remote from the field and with only the experience gained in more accessible oil regions.

Many of the unusual conditions have been touched upon in the early pages of this report dealing especially with the general features of the region. Attention was there briefly called to the accessibility, climate, timber, and other features, which take on added significance when considered in their relation to the economic problem of developing a productive oil field in the region. Take, for instance, the matter of accessibility. It has been shown that vessels can not reach Barrow until after the first of August and should be out of that region early in September and that even during this short period they run the hazard of being caught in the ice and lost. Furthermore, there are no harbors for ocean-going vessels for several hundred miles. Vessels must lie in the open roadsteads and can not approach close to the shore, and their cargoes can be taken off or discharged only by lighters or by special arrangements which can be easily removed so as not to be destroyed by ice. Under these conditions it seems extremely unlikely that any considerable quantity of petroleum can be moved by vessels. This conclusion has added weight when the problem is viewed in relation to national defense, for it seems essential that to be effective in time of war the supply of oil must be quickly available at all times and not subject to seasonal obstructions.

Apparently, therefore, a pipe line or railroad would be required to move any material tonnage of oil. A pipe line from the reserve to an ice-free harbor would probably have to be 1,000 miles long. Through half of this distance even trails, on which all supplies and materials would have to be hauled, are lacking, and for a third of the distance there is not even timber enough to build shelters for the workmen. Then, again, the extreme cold will give rise to many new problems in the transportation of oil that will require thorough technical analysis before plans can be prepared for a suitable pipe line with its required heating and pumping stations.

The extension of a railroad through this region would encounter some of the same difficulties as those attendant on the construction of a pipe line and would also face others inherent only to railroads. The writers can not give any close estimate as to the cost of building a railroad into the reserve. Statements of the cost of the construction of the Alaska Railroad are of course available and may serve as a guide for conjecturing the cost of an additional 500 to 600 miles of railroad to reach the reserve.

One other aspect of the problem of development and also one on which geologists can not venture an expert opinion is the adequate safeguarding of the oil in transit if it is to be used for national defense. It is apparent that if this region is developed as a source of oil for the Government adequate protection will necessarily have to be provided, not only for the ocean terminal and for the producing field but also for the long stretch of unsettled country between, through which the oil will have to be transported by pipe line or railroad. This will be a difficult as well as an expensive task, and therefore the cost must be considered as one more proper charge against the prospective operation of an oil field in this region.

The difficulties set forth above have not been enumerated with the idea of deterring development of oil in this region but rather to indicate the magnitude of the oil fields that must be found if these large items of equipment and development are to be amortized by the production of oil. In this region a field capable of yielding a few million barrels of oil may, for all practical purposes, be regarded as of no present importance. The stakes are therefore high, and the risks are grave and the expenses enormous. As a matter of public policy, if this field is not developed by the Government itself, it seems little short of criminal to impose on private enterprises that may attempt development laws and restrictions that are entirely appropriate for oil fields in Oklahoma or California. In order that the uncertainties, the risks, and the costs in the two regions should be at all comparable it is probably no exaggeration to say that the prize played for in northern Alaska should be at least 10 times that required under the same conditions in the States. In fact, it would probably be sound public policy, before granting prospecting permits or leases for oil on the unappropriated public lands in northern Alaska, to require an acceptable showing of adequate financial backing and of sound methods of marketing the product. The region is most assuredly not one where anybody can get rich quick in oil without enormous expenditures of capital for development, and no one should risk funds whose loss will seriously embarrass him, because development of oil in this region is distinctly a wildcat undertaking of the most speculative character, and at the same time the development can be successful only if undertaken on a large scale.

INDEX

SELECTED LIST OF SURVEY PUBLICATIONS ON ALASKA

[Arranged geographically. A complete list can be had on application]

All these publications can be obtained or consulted in the following ways:

1. A certain number of copies are delivered to the Director of the Survey, from whom they can be obtained for a limited period free of charge (except certain maps) on application.

2. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they can be had at the price indicated. No copies are available of those marked with an asterisk (*); they may be consulted at many public libraries.

3. Copies of all Government publications are furnished to the principal public libraries throughout the United States, where they can be consulted by those interested.

The maps whose price is stated are sold by the Geological Survey and not by the Superintendent of Documents. On an order for maps amounting to $5 or more at the retail price a discount of 40 per cent is allowed.

GENERAL

REPORTS

*The geography and geology of Alaska, a summary of existing knowledge, by A. H. Brooks, with a section on climate, by Cleveland Abbe, jr., and a topographic map and description thereof, by R. U. Goode. Professional Paper 45, 1906, 327 pp.

Placer mining in Alaska in 1904, by A. H. Brooks. In Bulletin 259, 1905, pp. 18–31. 15 cents.

The mining industry in 1905, by A. H. Brooks. In Bulletin 284, 1906, pp. 4–9. 25 cents.

The mining industry in 1906, by A. H. Brooks. In Bulletin 314, 1907, pp. 19–39. 30 cents.

The mining industry in 1907, by A. H. Brooks. In Bulletin 345, 1908, pp. 30–53. 45 cents.

The mining industry in 1908, by A. H. Brooks. In Bulletin 379, 1909, pp. 21–62. 50 cents.

The mining industry in 1909, by A. H. Brooks. In Bulletin 442, 1910, pp. 20–46. 40 cents.

Alaska coal and its utilization. Bulletin 442–J, reprinted 1914. 10 cents.

The mining industry in 1910, by A. H. Brooks. In Bulletin 480, 1911, pp. 21–42. 40 cents.

The mining industry in 1911, by A. H. Brooks. In Bulletin 520, 1912, pp. 19–44. 50 cents.

The mining industry in 1912, by A. H. Brooks. In Bulletin 542, 1913, pp. 18–51. 25 cents.

The Alaskan mining industry in 1913, by A. H. Brooks. In Bulletin 592, 1914, pp. 45–74. 60 cents.

The Alaskan mining industry in 1914, by A. H. Brooks. In Bulletin 622, 1915, pp. 15–68. 30 cents.

The Alaskan mining industry in 1915, by A. H. Brooks. In Bulletin 642, 1916, pp. 17–72. 35 cents.
The Alaskan mining industry in 1916, by A. H. Brooks. In Bulletin 662, 1917, pp. 11–62. 75 cents.
The Alaskan mining industry in 1917, by G. C. Martin. In Bulletin 692–A, 1918, pp. 11–42. 5 cents.
*The Alaskan mining industry in 1918, by G. C. Martin. In Bulletin 712, 1919, pp. 11–52.
The Alaskan mining industry in 1919, by A. H. Brooks and G. C. Martin. Bulletin 714–A, reprinted 1921. 25 cents.
The Alaskan mining industry in 1920, by A. H. Brooks. In Bulletin 722, 1921, pp. 7–67. 25 cents.
The Alaskan mining industry in 1921, by A. H. Brooks. Bulletin 739–A, 1922, pp. 1–44. 10 cents.
The Alaskan mining industry in 1922, by A. H. Brooks and S. R. Capps. In Bulletin 755, 1924, pp. 3–49. 40 cents.
Alaska's mineral resources and production, 1923, by Alfred H. Brooks. In Bulletin 773, 1925, pp. 3–52. Free on application.
Mineral industry of Alaska in 1924, by Philip S. Smith. In Bulletin 783, 1926, pp. 1–39. Free on application.
Railway routes, by A. H. Brooks. In Bulletin 284, 1966, pp. 10–17. 25 cents.
Railway routes from the Pacific seaboard to Fairbanks, Alaska, by A. H. Brooks. In Bulletin 520, 1912, pp. 45–88. 50 cents.
Geologic features of Alaskan metalliferous lodes, by A. H. Brooks. In Bulletin 480, 1911, pp. 43–93. 40 cents.
The mineral deposits of Alaska, by A. H. Brooks. In Bulletin 592, 1914, pp. 18–44. 60 cents.
The future gold-placer mining in Alaska, by A. H. Brooks. In Bulletin 622, 1915, pp. 69–79. 30 cents.
Tin resources of Alaska, by F. L. Hess. In Bulletin 520, 1912, pp. 89–92. 50 cents.
Alaska coal and its utilization, by A. H. Brooks. Bulletin 442–J, reprinted 1914. 10 cents.
The possible use of peat fuel in Alaska, by C. A. Davis. In Bulletin 379, 1909, pp. 63–66. 50 cents.
The preparation and use of peat as a fuel, by C. A. Davis. In Bulletin 442, 1910, pp. 101–132. 40 cents.
*Methods and cost of gravel and placer mining in Alaska, by C. W. Purington. Bulletin 263, 1905, 362 pp. (Abstract in Bulletin 259, 1905, pp. 32–46, 15 cents.)
Prospecting and mining gold placers in Alaska, by J. P. Hutchins. In Bulletin 345, 1908, pp. 54–77. 45 cents.
*Geographic dictionary of Alaska, by Marcus Baker; second edition prepared by James McCormick. Bulletin 299, 1906, 690 pp.
Tin mining in Alaska, by H. M. Eakin. In Bulletin 622, 1915, pp. 81–94. 30 cents.
Antimony deposits of Alaska, by A. H. Brooks. Bulletin 649, 1916, 67 pp. 15 cents.
*The use of the panoramic camera in topographic surveying, by J. W. Bagley. Bulletin 657, 1917, 88 pp.
The mineral springs of Alaska, by G. A. Waring. Water-Supply Paper 418, 1917, 114 pp. 25 cents.
Alaska's mineral supplies, by A. H. Brooks. Bulletin 666–P, 14 pp. 5 cents.

The future of Alaska mining, by A. H. Brooks. Bulletin 714–A, reprinted 1921. 25 cents.

Preliminary report on petroleum in Alaska, by G. C. Martin. Bulletin 719, 1921, 83 pp. 50 cents.

The Mesozoic stratigraphy of Alaska, by G. C. Martin. Bulletin 776, 1926, 487 pp. Free on application.

In preparation

The Upper Cretaceous flora of Alaska, by Arthur Hollick, with a description of the Upper Cretaceous plant-bearing beds, by G. C. Martin.

Tertiary flora of Alaska, by Arthur Hollick.

Igneous geology of Alaska, by J. B. Mertie, jr.

TOPOGRAPHIC MAPS

Map of Alaska (A); scale, 1:5,000,000; 1920, by A. H. Brooks and R. H. Sargent. 10 cents retail or 6 cents wholesale.

*Map of Alaska (B); scale, 1:1,500,000; 1915, by A. H. Brooks and R. H. Sargent.

Map of Alaska (C); scale, 1:12,000,000; 1916. 1 cent retail or five for 3 cents wholesale.

Map of Alaska showing distribution of mineral deposits; scale, 1:5,000,000; by A. H. Brooks. 20 cents retail or 12 cents wholesale. New editions included in Bulletins 642 (35 cents), 662 (75 cents), and 714–A (25 cents).

Index map of Alaska, including list of publications; scale, 1:5,000,000; by A. H. Brooks. Free on application.

Relief map of Alaska (D); scale, 1:2,500,000; 1923, by A. H. Brooks and R. H. Sargent. 50 cents retail or 30 cents wholesale.

Map of Alaska (E); scale, 1:2,500,000; 1923, by A. H. Brooks and R. H. Sargent. 25 cents retail or 15 cents wholesale.

SOUTHEASTERN ALASKA

REPORTS

Economic developments in southeastern Alaska, by F. E. and C. W. Wright. In Bulletin 259, 1905, pp. 47–68. 15 cents.

The Juneau gold belt, Alaska, by A. C. Spencer, pp. 1–137, and A reconnaissance of Admiralty Island, Alaska, by C. W. Wright, pp. 138–154. Bulletin 287, 1906, 161 pp. 75 cents.

Lode mining in southeastern Alaska, by F. E. and C. W. Wright. In Bulletin 284, 1906, pp. 35–53. 25 cents.

Nonmetallic deposits of southeastern Alaska, by C. W. Wright. In Bulletin 284, 1906, pp. 54–60. 25 cents.

Lode mining in southeastern Alaska, by C. W. Wright. In Bulletin 314, 1907, pp. 47–72. 30 cents.

Nonmetalliferous mineral resources of southeastern Alaska, by C. W. Wright. In Bulletin 314, 1917, pp. 73–81. 30 cents.

Reconnaissance on the Pacific coast from Yakutat to Alsek River, by Eliot Blackwelder. In Bulletin 314, 1907, pp. 82–88. 30 cents.

Lode mining in southeastern Alaska, 1907, by C. W. Wright. In Bulletin 345, 1908, pp. 78–97. 45 cents.

The building stones and materials of southeastern Alaska, by C. W. Wright. In Bulletin 345, 1908, pp. 116–126. 45 cents.

The Ketchikan and Wrangell mining districts, Alaska, by F. E. and C. W. Wright. Bulletin 347, 1908, 210 pp. 60 cents.

The Yakutat Bay region, Alaska: Physiography and glacial geology, by R. S. Tarr; Areal geology, by R. S. Tarr and B. S. Butler. Professional Paper 64, 1909, 186 pp. 50 cents.

Mining in southeastern Alaska, by C. W. Wright. In Bulletin 379, 1909, pp. 67–86. 50 cents.

Mining in southeastern Alaska, by Adolph Knopf. In Bulletin 442, 1910, pp. 133–143. 40 cents.

Occurrence of iron ore near Haines, by Adolph Knopf. In Bulletin 442, 1910, pp. 144–146. 40 cents.

Report of water-power reconnaissance in southeastern Alaska, by J. C. Hoyt. In Bulletin 442, 1910, pp. 147–157. 40 cents.

Geology of the Berners Bay region, Alaska, by Adolph Knopf. Bulletin 446, 1911, 58 pp. 20 cents.

Mining in southeastern Alaska, by Adolph Knopf. In Bulletin 480, 1911, pp. 94–102. 40 cents.

The Eagle River region, southeastern Alaska, by Adolph Knopf. Bulletin 502, 1912, 61 pp. 25 cents.

The Sitka mining district, Alaska, by Adolph Knopf. Bulletin 504, 1912, 32 pp. 5 cents.

The earthquakes at Yākutat Bay, Alaska, in September, 1899, by R. S. Tarr and Lawrence Martin, with a preface by G. K. Gilbert. Professional Paper 69, 1912, 135 pp. 60 cents.

A barite deposit near Wrangell, by E. F. Burchard. In Bulletin 592, 1914, pp. 109–117. 60 cents.

Lode mining in the Ketchikan district, by P. S. Smith. In Bulletin 592, 1914, pp. 75–94. 60 cents.

The geology and ore deposits of Copper Mountain and Kasaan Peninsula, Alaska, by C. W. Wright. Professional Paper 87, 1915, 110 pp. 40 cents.

Mining in the Juneau region, by H. M. Eakin. In Bulletin 622, 1915, pp. 95–102. 30 cents.

Notes on the geology of Gravina Island, Alaska, by P. S. Smith. Professional Paper 95–H, 1916, 9 pp. 10 cents.

Mining in southeastern Alaska, by Theodore Chapin. In Bulletin 642, 1916, pp. 73–104. 35 cents.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 642, 1916, pp. 105–127. 35 cents.

Mining developments in the Ketchikan and Wrangell districts, by Theodore Chapin. In Bulletin 662, 1917, pp. 63–75. 75 cents.

Lode mining in the Juneau gold belt, by H. M. Eakin. In Bulletin 662, 1917, pp. 71–92. 75 cents.

Gold-placer mining in the Porcupine district, by H. M. Eakin. In Bulletin 662, 1917, pp. 93–100. 75 cents.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 662, 1917, pp. 101–154. 75 cents.

*Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 692, 1919, pp. 43–83.

*The structure and stratigraphy of Gravina and Revillagigedo islands, Alaska, by Theodore Chapin. In Professional Paper 120, 1918, pp. 83–100.

*Mining developments in the Ketchikan mining district, by Theodore Chapin. In Bulletin 692, 1919, pp. 85–89.

*The geology and mineral resources of the west coast of Chichagof Island, by R. M. Overbeck. In Bulletin 692, pp. 91–136.

The Porcupine district, by H. M. Eakin. Bulletin 699, 29 pp. 20 cents.

*Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 712, 1920, pp. 53–90.

*Lode mining in the Juneau and Ketchikan districts, by J. B. Mertie, jr. In Bulletin 714, 1921, pp. 105–128.

Notes on the Unuk-Salmon River region, by J. B. Mertie, jr. Bulletin 714–B, 1921, pp. 129–142. 10 cents.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 714–B, 1921, pp. 143–187. 10 cents.

Marble deposits of southeastern Alaska, by E. F. Burchard. Bulletin 682, 1920, 118 pp. 30 cents.

Water-power investigations in southeastern Alaska, by G. H. Canfield. In Bulletin 722, 1922, pp. 75–115. 25 cents.

Ore deposits of the Salmon River district, Portland Canal region, Alaska, by L. G. Westgate. In Bulletin 722, 1922, pp. 117–140. 25 cents.

Mineral deposits of the Wrangell district, by A. F. Buddington. In Bulletin 739, 1923, pp. 51–75. 25 cents.

Mineral resources of southeastern Alaska, by A. F. Buddington. In Bulletin 773, 1925, pp. 71–139. Free on application.

Mineral investigations in southeastern Alaska in 1924, by A. F. Buddington. Bulletin 783, 1926, pp. 41–62. Free on application.

In preparation

Geology and ore deposits of the Juneau district, by H. M. Eakin.

Geology and mineral deposits of southeastern Alaska, by A. F. Buddington and Theodore Chapin.

TOPOGRAPHIC MAPS

Juneau gold belt, Alaska; scale 1: 250,000; compiled. In Bulletin 287, 75 cents. Not issued separately.

Juneau special (No. 581A); scale, 1: 62,500; by W. J. Peters. 10 cents retail or 6 cents wholesale.

Berners Bay special (No. 581B); scale, 1: 62,500; by R. B. Oliver. 10 cents retail or 6 cents wholesale. Also contained in Bulletin 446, 20 cents.

Kasaan Peninsula, Prince of Wales Island (No. 540A); scale, 1: 62,500; by D. C. Witherspoon, R. H. Sargent, and J. W. Bagley. 10 cents retail or 6 cents wholesale. Also contained in Professional Paper 87, 40 cents.

Copper Mountain and vicinity, Prince of Wales Island (No. 540B); scale, 1: 62,500; by R. H. Sargent. 10 cents retail or 6 cents wholesale. Also contained in Professional Paper 87, 40 cents.

Eagle River region; scale, 1: 62,500; by J. W. Bagley, C. E. Giffin, and R. E. Johnson. In Bulletin 502, 25 cents. Not issued separately.

Juneau and vicinity (No. 581D); scale, 1: 24,000; by D. C. Witherspoon. 20 cents.

In preparation

Hyder and vicinity (No. 540C); scale, 1: 62,500; by R. M. Wilson.

CONTROLLER BAY, PRINCE WILLIAM SOUND, AND COPPER RIVER REGIONS

REPORTS

Geology of the central Copper River region, Alaska, by W. C. Mendenhall. Professional Paper 41, 1905, 133 pp. 50 cents.

Geology and mineral resources of Controller Bay region, Alaska, by G. C. Martin. Bulletin 335, 1908, 141 pp. 70 cents.

Notes on copper prospects of Prince William Sound, by F. H. Moffit. In Bulletin 345, 1908, pp. 176–178. 45 cents.

Mineral resources of the Kotsina-Chitina region, by F. H. Moffit and A. G. Maddren. Bulletin 374, 1909, 103 pp. 40 cents.

Copper mining and prospecting on Prince William Sound, by U. S. Grant and D. F. Higgins, jr. In Bulletin 379, 1909, pp. 78–96. 50 cents.

Mining in the Kotsina-Chitina, Chistochina, and Valdez Creek regions, by F. H. Moffit. In Bulletin 379, 1909, pp. 153–160. 50 cents.

Mineral resources of the Nabesna-White River district, by F. H. Moffit and Adolph Knopf; with a section on the Quaternary, by S. R. Capps. Bulletin 417, 1910, 64 pp. 25 cents.

Mining in the Chitina district, by F. H. Moffit. In Bulletin 442, 1910, pp. 158–163. 40 cents.

Mining and prospecting on Prince William Sound in 1909, by U. S. Grant. In Bulletin 442, 1910, pp. 164–165. 40 cents.

Reconnaissance of the geology and mineral resources of Prince William Sound, Alaska, by U. S. Grant and D. F. Higgins. Bulletin 443, 1910, 89 pp. 45 cents.

Geology and mineral resources of the Nizina district, Alaska, by F. H. Moffit and S. R. Capps. Bulletin 448, 1911, 111 pp. 40 cents.

Headwater regions of Gulkana and Susitna rivers, Alaska, with accounts of the Valdez Creek and Chistochina placer districts, by F. H. Moffit. Bulletin 498, 1912, 82 pp. 35 cents.

The Chitina district, by F. H. Moffit. In Bulletin 520, 1912, pp. 105–107. 50 cents.

Coastal glaciers of Prince William Sound and Kenai Peninsula, Alaska, by U. S. Grant and D. F. Higgins. Bulletin 526, 1913, 75 pp. 30 cents.

The McKinley Lake district, by Theodore Chapin. In Bulletin 542, 1913, pp. 78–80. 25 cents.

Mining in Chitina Valley, by F. H. Moffit. In Bulletin 542, 1913, pp. 81–85. 25 cents.

Mineral deposits of the Ellamar district, by S. R. Capps and B. L. Johnson. In Bulletin 542, 1913, pp. 86–124. 25 cents.

The mineral deposits of the Yakataga region, by A. G. Maddren. In Bulletin 592, 1914, pp. 119–154. 60 cents.

The Port Wells gold-lode district, by B. L. Johnson. In Bulletin 592, 1914, pp. 195–236. 60 cents.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 592, 1914, pp. 237–244. 60 cents.

The geology and mineral resources of Kenai Peninsula, by G. C. Martin, B. L. Johnson, and U. S. Grant. Bulletin 587, 1915, 243 pp. 70 cents.

Mineral deposits of the Kotsina-Kuskulana district, with notes on mining in Chitina Valley, by F. H. Moffit. In Bulletin 622, 1915, pp. 103–117. 30 cents.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 622, 1915, pp. 131–139. 30 cents.

The gold and copper deposits of the Port Valdez district, by B. L. Johnson. In Bulletin 622, 1915, pp. 140–188. 30 cents.

The Ellamar district, by S. R. Capps and B. L. Johnson. Bulletin 605, 1915, 125 pp. 25 cents.

*A water-power reconnaissance in south-central Alaska, by C. E. Ellsworth and R. W. Davenport. Water-Supply Paper 372, 173 pp.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 642, 1916, pp. 137–145. 35 cents.

Mining in the lower Copper River basin, by F. H. Moffit. In Bulletin 662, 1917, pp. 155–182. 75 cents.

*Retreat of Barry Glacier, Port Wells, Prince William Sound, Alaska, between 1910 and 1914, by B. L. Johnson. In Professional Paper 98, 1916, pp. 35–36.

Mining on Prince William Sound, by B. L. Johnson. In Bulletin 662, 1917, pp. 183–192. 75 cents.

Copper deposits of the Latouche and Knight Island districts, Prince William Sound, by B. L. Johnson. In Bulletin 662, 1917, pp. 193–220. 75 cents.

The Nelchina-Susitna region, by Theodore Chapin. Bulletin 668, 1918, 67 pp. 25 cents.

The upper Chitina Valley, by F. H. Moffit, with a description of the igneous rocks, by R. M. Overbeck. Bulletin 675, 1918, 82 pp. 25 cents.

*Platinum-bearing auriferous gravels of Chistochina River, by Theodore Chapin. In Bulletin 692, 1919, pp. 137–141.

*Mining on Prince William Sound, by B. L. Johnson. In Bulletin 692, 1919, pp. 143–151.

*The Jack Bay district and vicinity, by B. L. Johnson. In Bulletin 692, 1919, pp. 153–173.

*Mining in central and northern Kenai Peninsula in 1917, by B. L. Johnson. In Bulletin 692, 1919, pp. 175–176.

*Nickel deposits in the lower Copper River valley, by R. M. Overbeck. In Bulletin 712, 1919, pp. 91–98.

*Mining in Chitina Valley, by F. H. Moffit. In Bulletin 714, 1921, pp. 189–196.

The Kotsina-Kuskulana district, Alaska, by F. H. Moffit. Bulletin 745, 1923, 149 pp. 40 cents.

The metalliferous deposits of Chitina Valley, by F. H. Moffit. In Bulletin 755, 1924, pp. 57–72. 40 cents.

The occurrence of copper on Prince William Sound, by F. H. Moffit. In Bulletin 773, 1925, pp. 141–158. Free on application.

In preparation

Geology of the Chitina quadrangle, by F. H. Moffit.

TOPOGRAPHIC MAPS

Central Copper River region; scale, 1:250,000; by T. G. Gerdine. In Professional Paper 41, 50 cents. Not issued separately.

Headwater regions of Copper, Nabesna, and Chisana rivers; scale, 1:250,000; by D. C. Witherspoon, T. G. Gerdine, and W. J. Peters. In Professional Paper 41, 50 cents. Not issued separately.

Controller Bay region (No. 601A); scale, 1:62,500; by E. G. Hamilton and W. R. Hill. 35 cents retail or 21 cents wholesale. Also published in Bulletin 335, 70 cents.

Chitina quadrangle (No. 601); scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, and others. Sale edition exhausted. Also published in Bulletin 576, 30 cents.

Nizina district (No. 601B); scale, 1:62,500; by D. C. Witherspoon and R. M. La Follette. In Bulletin 448, 40 cents. Not issued separately.

Headwater regions of Gulkana and Susitna rivers; scale, 1:250,000; by D. C. Witherspoon, J. W. Bagley, and C. E. Giffin. In Bulletin 498, 35 cents. Not issued separately.

Prince William Sound; scale, 1:500,000; compiled. In Bulletin 526, 30 cents. Not issued separately.

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Port Valdez district (No. 602B); scale, 1:62,500; by J. W. Bagley. 20 cents retail or 12 cents wholesale.

The Bering River coal fields; scale, 1:62,500; by G. C. Martin. 25 cents retail or 15 cents wholesale.

The Ellamar district (No. 602D); scale, 1:62,500; by R. H. Sargent and C. E. Giffin. Published in Bulletin 605, 25 cents. Not issued separately.

Nelchina-Susitna region; scale, 1:250,000; by J. W. Bagley, T. G. Gerdine, and others. In Bulletin 668, 25 cents. Not issued separately.

Upper Chitina Valley; scale, 1:250,000; by International Boundary Commission, F. H. Moffit, D. C. Witherspoon, and T. G. Gerdine. In Bulletin 675, 25 cents. Not issued separately.

The Kotsina-Kuskulana district (No. 601C); scale, 1:62,500; by D. C. Witherspoon. 10 cents. Also published in Bulletin 745, 40 cents.

In preparation

Prince William Sound region; scale, 1:250,000; by J. W. Bagley, D. C. Witherspoon, and others.

Valdez and vicinity; scale, 1:62,500; by J. W. Bagley and C. E. Giffin.

COOK INLET AND SUSITNA REGION

REPORTS

Gold placers of the Mulchatna, by F. J. Katz. In Bulletin 442, 1910, pp. 201–202. 40 cents.

Geologic reconnaissance in the Matanuska and Talkeetna basins, Alaska, by Sidney Paige and Adolph Knopf. Bulletin 327, 1907, 71 pp. 25 cents.

*The Mount McKinley region, Alaska, by A. H. Brooks, with description of the igneous rocks and of the Bonnifield and Kantishna districts, by L. M. Prindle. Professional Paper 70, 1911, 234 pp.

A geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz. Bulletin 485, 1912, 138 pp. 35 cents.

Geology and coal fields of the lower Matanuska Valley, Alaska, by G. C. Martin and F. J. Katz. Bulletin 500, 1912, 98 pp. 30 cents.

The Yentna district, Alaska, by S. R. Capps. Bulletin 534, 1913, 75 pp. 20 cents.

Mineral resources of the upper Matanuska and Nelchina valleys, by G. C. Martin and J. B. Mertie, jr. In Bulletin 592, 1914, pp. 273–300. 60 cents.

Mining in the Valdez Creek placer district, by F. H. Moffit. In Bulletin 592, 1914, pp. 307–308. 60 cents.

The geology and mineral resources of Kenai Peninsula, Alaska, by G. C. Martin, B. L. Johnson, and U. S. Grant. Bulletin 587, 1915, 243 pp. 70 cents.

The Willow Creek district, by S. R. Capps. Bulletin 607, 1915, 86 pp. 25 cents.

The Broad Pass region, by F. H. Moffit and J. E. Pogue. Bulletin 608, 1915, 80 pp. 25 cents.

The Turnagain-Knik region, by S. R. Capps. In Bulletin 642, 1916, pp. 147–194. 35 cents.

Gold mining in the Willow Creek district, by S. R. Capps. In Bulletin 642, 1916, pp. 195–200. 35 cents.

The Nelchina-Susitna region, by Theodore Chapin. Bulletin 668, 1918, 67 pp. 25 cents.

Mineral resources of the upper Chulitna region, by S. R. Capps. In Bulletin 692–D, 1919, pp. 207–232. 15 cents.

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Mineral resources of the western Talkeetna Mountains, by S. R. Capps. In Bulletin 692–D, 1919, pp. 187–205. 15 cents.
Platinum-bearing gold placers of Kahiltna Valley, by J. B. Mertie, jr. In Bulletin 692–D, 1919, pp. 233–264. 15 cents.
Chromite deposits of Alaska, by J. B. Mertie, jr. In Bulletin 692–D, 1919, pp. 265–267. 15 cents.
Geologic problems at the Matanuska coal mines, by G. C. Martin. In Bulletin 692–D, 1919, pp. 269–282. 15 cents.
*Preliminary report on chromite of Kenai Peninsula, by A. C. Gill. In Bulletin 712, 1920, pp. 99–129.
*Mining in the Matanuska coal field and the Willow Creek district, by Theodore Chapin. In Bulletin 712, 1920, pp. 131–176.
*Mining developments in the Matanuska coal fields, by Theodore Chapin. In Bulletin 714, 1921, pp. 197–199.
*Lode developments in the Willow Creek district, by Theodore Chapin. In Bulletin 714, 1921, pp. 201–206.
Geology in the vicinity of Tuxedni Bay, Cook Inlet, by F. H. Moffit. In Bulletin 722, 1922, pp. 141–147. 25 cents.
The Iniskin Bay district, by F. H. Moffit. In Bulletin 739, 1922, pp. 117–132. 25 cents.
Petroleum seepage near Anchorage, by A. H. Brooks. In Bulletin 739, 1922, pp. 133–147. 25 cents.
Chromite of Kenai Peninsula, Alaska, by A. C. Gill. Bulletin 742, 1922, 52 pp. 15 cents.
Geology and mineral resources of the region traversed by the Alaska Railroad, by S. R. Capps. In Bulletin 755, 1924, pp. 73–150. 40 cents.
An early Tertiary deposit in the Yentna district, by S. R. Capps. In Bulletin 773, 1925, pp. 53–61. Free on application.
Mineral resources of the Kamishak Bay region, by K. F. Mather. In Bulletin 773, 1925, pp. 159–181. Free on application.
Aniakchak Crater, Alaska Peninsula, by W. R. Smith. Professional Paper 132–J, 1925, pp. 139–145. 10 cents.
A ruby-silver prospect in Alaska, by S. R. Capps and M. N. Short. In Bulletin 783, 1926, pp. 89–95. Free on application.

In preparation

Geology and mineral resources of region tributary to the Alaska Railroad route, by S. R. Capps.
Geology of the Iniskin-Chinitna Peninsula, by F. H. Moffit. (Bulletin 789.)
Geology of the upper Matanuska Valley, by S. R. Capps and J. B. Mertie, jr. (Bulletin 791.)

TOPOGRAPHIC MAPS

Kenai Peninsula, southern portion; scale, 1:500,000; compiled. In Bulletin 526, 30 cents. Not issued separately.
Matanuska and Talkeetna region; scale, 1:250,000; by T. G. Gerdine and R. H. Sargent. In Bulletin 327, 25 cents. Not issued separately.
Lower Matanuska Valley; scale, 1:62,500; by R. H. Sargent. In Bulletin 500, 30 cents. Not issued separately.
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*Mount McKinley region; scale, 1:625,000; by D. L. Reaburn. In Professional Paper 70. Not issued separately.
Kenai Peninsula; scale, 1:250,000; by R. H. Sargent, J. W. Bagley, and others. In Bulletin 587, 70 cents. Not issued separately.

Moose Pass and vicinity; scale, 1:62,500; by J. W. Bagley. In Bulletin 587, 70 cents. Not issued separately.

The Willow Creek district; scale, 1:62,500; by C. E. Giffin. In Bulletin 607, 25 cents. Not issued separately.

The Broad Pass region; scale, 1:250,000; by J. W. Bagley. In Bulletin 608, 25 cents. Not issued separately.

Lower Matanuska Valley (No. 602A); scale, 1:62,500; by R. H. Sargent. 10 cents.

Nelchina-Susitna region; scale, 1:250,000; by J. W. Bagley. In Bulletin 668, 25 cents. Not issued separately.

Iniskin-Chinitna Peninsula, Cook Inlet region; scale, 1:62,500; by C. P. McKinley, D. C. Witherspoon, and Gerald FitzGerald (preliminary edition). Free on application.

The Alaska Railroad route: Seward to Matanuska coal field; scale, 1:250,000; by J. W. Bagley, T. G. Gerdine, R. H. Sargent, and others. 50 cents retail or 30 cents wholesale.

The Alaska Railroad route: Matanuska coal field to Yanert Fork; scale, 1:250,000; by J. W. Bagley, T. G. Gerdine, R. H. Sargent, and others. 50 cents retail or 30 cents wholesale.

The Alaska Railroad route: Yanert Fork to Fairbanks; scale 1:250,000; by J. W. Bagley, T. G. Gerdine, R. H. Sargent, and others. 50 cents retail or 30 cents wholesale.

Iniskin Bay-Snug Harbor district, Cook Inlet region, Alaska; scale, 1:250,000; by C. P. McKinley and Gerald FitzGerald (preliminary edition). Free on application.

SOUTHWESTERN ALASKA

REPORTS

A reconnaissance in southwestern Alaska, by J. E. Spurr. In Twentieth Annual Report, pt. 7, 1900, pp. 31–264. $1.80.

Gold mines on Unalaska Island, by A. J. Collier. In Bulletin 259, 1905, pp. 102–103. 15 cents.

*Geology and mineral resources of parts of Alaska Peninsula, by W. W. Atwood. Bulletin 467, 1911, 137 pp.

A geologic reconnaissance of the Iliamna region, Alaska, by G. C. Martin and F. J. Katz. Bulletin 485, 1912, 138 pp. 35 cents.

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The Lake Clark-central Kuskokwim region, by P. S. Smith. Bulletin 655, 1918, 162 pp. 30 cents.

Beach placers of Kodiak Island, Alaska, by A. G. Maddren. In Bulletin 692–E, 1919, pp. 299–319. 5 cents.

Sulphur on Unalaska and Akun islands and near Stepovak Bay, Alaska, by A. G. Maddren. In Bulletin 692–E, 1919, pp. 283–298. 5 cents.

The Cold Bay district, by S. R. Capps. In Bulletin 739, 1922, pp. 77–116. 25 cents.

The Cold Bay-Chignik district, by W. R. Smith and A. A. Baker. In Bulletin 755, 1924, pp. 151–218. 40 cents.

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The outlook for petroleum near Chignik, by G. C. Martin. In Bulletin 773, 1925, pp. 209–213. Free on application.

Geology and oil developments in the Cold Bay region, by W. R. Smith. In Bulletin 783, 1926, pp. 63–88. Free on application.

Mineral resources of the Kamishak Bay region, by K. F. Mather. In Bulletin 773, 1925, pp. 159–181. Free on application.

Aniakchak Crater, Alaska Peninsula, by W. R. Smith. Professional Paper 132–J, 1925, 11 pp. 10 cents.

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*Herendeen Bay and Unga Island region; scale 1:250,000; by H. M. Eakin. In Bulletin 467. Not issued separately.

*Chignik Bay region; scale, 1:250,000; by H. M. Eakin. In Bulletin 467. Not issued separately.

Iliamna region; scale, 1:250,000; by D. C. Witherspoon and C. E. Giffin. In Bulletin 485, 35 cents. Not issued separately.

Kuskokwim River and Bristol Bay region; scale, 1:625,000; by W. S. Post. In Twentieth Annual Report, pt. 7, $1.80. Not issued separately.

Lake Clark-central Kuskokwim region; scale, 1:250,000; by R. H. Sargent, D. C. Witherspoon, and C. E. Giffin. In Bulletin 655, 30 cents. Not issued separately.

Cold Bay-Chignik region, Alaska Peninsula; scale, 1:250,000; by R. K. Lynt and R. H. Sargent (preliminary edition). Free on application.

In preparation

Kamishak Bay-Katmai region, Alaska Peninsula; scale, 1:250,000; by R. H. Sargent and R. K. Lynt.

Aniakchak district, Alaska Peninsula; scale, 1:250,000; by R. H. Sargent.

YUKON AND KUSKOKWIM BASINS

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The coal resources of the Yukon, Alaska, by A. J. Collier. Bulletin 218, 1903, 71 pp. 15 cents.

The Fortymile quadrangle, Yukon-Tanana region, Alaska, by L. M. Prindle. Bulletin 375, 1909, 52 pp. 30 cents.

Water-supply investigations in Yukon-Tanana region, Alaska, 1907–8 (Fairbanks, Circle, and Rampart districts), by C. C. Covert and C. E. Ellsworth. Water-Supply Paper 228, 1909, 108 pp. 20 cents.

The Innoko gold-placer district, Alaska, with accounts of the central Kuskokwim Valley and the Ruby Creek and Gold Hill placers, by A. G. Maddren. Bulletin 410, 1910, 87 pp. 40 cents.

Mineral resources of the Nabesna-White River district, Alaska, by F. H. Moffit and Adolph Knopf, with a section on the Quaternary by S. R. Capps. Bulletin 417, 1910, 64 pp. 25 cents.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth. In Bulletin 442, 1910, pp. 230–245. 40 cents.

Occurrence of wolframite and cassiterite in the gold placers of Deadwood Creek, Birch Creek district, by B. L. Johnson. In Bulletin 442, 1910, pp. 246–250. 40 cents.

Placer mining in the Yukon-Tanana region, by C. E. Ellsworth and G. L. Parker. In Bulletin 480, 1911, pp. 153–172. 40 cents.

Gold-placer mining developments in the Innoko-Iditarod region, by A. G. Maddren. In Bulletin 480, 1911, pp. 236–270. 40 cents.

Placer mining in the Fortymile and Seventymile river districts, by E. A. Porter. In Bulletin 520, 1912, pp. 211–218. 50 cents.

Placer mining in the Fairbanks and Circle districts, by C. E. Ellsworth. In Bulletin 520, 1912, pp. 240–245. 50 cents.

Gold placers between Woodchopper and Fourth of July creeks, upper Yukon River, by L. M. Prindle and J. B. Mertie, jr. In Bulletin 520, 1912, pp. 201–210. 50 cents.
The Bonnifield region, Alaska, by S. R. Capps. Bulletin 501, 1912, 162 pp. 20 cents.
A geologic reconnaissance of a part of the Rampart quadrangle, Alaska, by H. M. Eakin. Bulletin 535, 1913, 38 pp. 20 cents.
A geologic reconnaissance of the Fairbanks quadrangle, Alaska, by L. M. Prindle, with a detailed description of the Fairbanks district, by L. M. Prindle and F. J. Katz, and an account of lode mining near Fairbanks, by P. S. Smith. Bulletin 525, 1913, 220 pp. 55 cents.
The Koyukuk-Chandalar region, Alaska, by A. G. Maddren. Bulletin 532, 1913, 119 pp. 25 cents.
A geologic reconnaissance of the Circle quadrangle, Alaska, by L. M. Prindle. Bulletin 538, 1913, 82 pp. 20 cents.
Placer mining in the Yukon-Tanana region, by C. E. Ellsworth and R. W. Davenport. In Bulletin 542, 1913, pp. 203–222. 25 cents.
The Iditarod-Ruby region, Alaska, by H. M. Eakin. Bulletin 578, 1914, 45 pp. 35 cents.
Placer mining in the Ruby district, by H. M. Eakin. In Bulletin 592, 1914, pp. 363–369. 60 cents.
Placer mining in the Yukon-Tanana region, by Theodore Chapin. In Bulletin 592, 1914, pp. 357–362. 60 cents.
Lode developments near Fairbanks, by Theodore Chapin. In Bulletin 592, 1914, pp. 321–355. 60 cents.
Mineral resources of the Yukon-Koyukuk region, by H. M. Eakin. In Bulletin 592, 1914, pp. 371–384. 60 cents.
Surface-water supply of the Yukon-Tanana region, Alaska, by C. E. Ellsworth and R. W. Davenport. Water-Supply Paper 342, 1915, 343 pp. 45 cents.
Mining in the Fairbanks district, by H. M. Eakin. In Bulletin 622, 1915, pp. 229–238. 30 cents.
Mining in the Hot Springs district, by H. M. Eakin. In Bulletin 622, 1915, pp. 239–245. 30 cents.
Quicksilver deposits of the Kuskokwim region, by P. S. Smith and A. G. Maddren. In Bulletin 622, 1915, pp. 272–291. 30 cents.
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An ancient volcanic eruption in the upper Yukon basin, by S. R. Capps. Professional Paper 95–D, 1915, pp. 59–64. 5 cents.
Mineral resources of the Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington. In Bulletin 642, 1916, pp. 228–266. 35 cents.
The Chisana-White River district, Alaska, by S. R. Capps. Bulletin 630, 1916, 130 pp. 20 cents.
The Yukon-Koyukuk region, Alaska, by H. M. Eakin. Bulletin 631, 1916, 88 pp. 20 cents.
The gold placers of the Tolovana district, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 221–277. 75 cents.
Gold placers near the Nenana coal field, by A. G. Maddren. In Bulletin 662, 1917, pp. 363–402. 75 cents.
Lode mining in the Fairbanks district, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 403–424. 75 cents.
Lode deposits near the Nenana coal field, by R. M. Overbeck. In Bulletin 662, 1917, pp. 351–362. 75 cents.

The Lake Clark-central Kuskokwim region, Alaska, by P. S. Smith. Bulletin 655, 1918, 162 pp. 30 cents.

The Cosna-Nowitna region, Alaska, by H. M. Eakin. Bulletin 667, 1918, 54 pp. 25 cents.

The Anvik-Andreafski region, Alaska, by G. L. Harrington. Bulletin 683, 1918, 70 pp. 30 cents.

The Kantishna district, by S. R. Capps. Bulletin 687, 1919, 116 pp. 25 cents.

The Nenana coal field, Alaska, by G. C. Martin. Bulletin 664, 1919, 54 pp. $1.10.

*Mining in the Fairbanks district, by Theodore Chapin. In Bulletin 692, 1919, pp. 321–327.

*A molybdenite lode on Healy River, by Theodore Chapin. In Bulletin 692, 1919, p. 329.

*Mining in the Hot Springs district, by Theodore Chapin. In Bulletin 692, 1919, pp. 331–335.

*Tin deposits of the Ruby district, by Theodore Chapin. In Bulletin 692, 1919, p. 337.

*The gold and platinum placers of the Tolstoi district, by G. L. Harrington. In Bulletin 692, 1919, pp. 338–351.

*Placer mining in the Tolovana district, by R. M. Overbeck. In Bulletin 712, 1919, pp. 177–184.

*Mineral resources of the Goodnews Bay region, by G. L. Harrington. In Bulletin 714, 1921, pp. 207–228.

Gold lodes in the upper Kuskokwim region, by G. C. Martin. In Bulletin 722, 1922, pp. 149–161. 25 cents.

Supposed oil seepage in Nenana coal field, by G. C. Martin. In Bulletin 739, 1922, pp. 137–147. 25 cents.

The occurrence of metalliferous deposits in the Yukon and Kuskokwim regions, Alaska, by J. B. Mertie, jr. Bulletin 739–D, 1922, 17 pp. 5 cents.

The Ruby-Kuskokwim region, by J. B. Mertie, jr., and G. L. Harrington. Bulletin 754, 1924, 129 pp. 50 cents.

Geology and gold placers of the Chandalar district, by J. B. Mertie, jr. In Bulletin 773, 1925, pp. 215–263. Free on application.

The Nixon Fork country; Silver-lead prospects near Ruby; papers by J. S. Brown. In Bulletin 783, 1926, pp. 97–150. Free on application.

In preparation

Geology of Fairbanks and Rampart quadrangles, by J. B. Mertie, jr.

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Circle quadrangle (No. 641); scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, and others. 50 cents retail or 30 cents wholesale. Also in Bulletin 538, 20 cents.

Fairbanks quadrangle (No. 642); scale, 1:250,000; by T. G. Gerdine, D. C. Witherspoon, R. B. Oliver, and J. W. Bagley. 50 cents retail or 30 cents wholesale. Also in Bulletin 337, 25 cents, and Bulletin 525, 55 cents.

Fortymile quadrangle (No. 640); scale, 1:250,000; by E. C. Barnard. 10 cents retail or 6 cents wholesale. Also in Bulletin 375, 30 cents.

Rampart quadrangle (No. 643); scale, 1:250,000; by D. C. Witherspoon and R. B. Oliver. 20 cents retail or 12 cents wholesale. Also in Bulletin 337, 25 cents, and part in Bulletin 535, 20 cents.

Fairbanks special (No. 642A); scale, 1:62,500; by T. G. Gerdine and R. H. Sargent. 20 cents retail or 12 cents wholesale. Also in Bulletin 525, 55 cents.

Bonnifield region; scale, 1:250,000; by J. W. Bagley, D. C. Witherspoon, and C. E. Giffin. In Bulletin 501, 20 cents. Not issued separately.

Iditarod-Ruby region; scale, 1:250,000; by C. G. Anderson, W. S. Post, and others. In Bulletin 578, 35 cents. Not issued separately.

Middle Kuskokwim and lower Yukon region; scale, 1:500,000; by C. G. Anderson, W. S. Post, and others. In Bulletin 578, 35 cents. Not issued separately.

Chisana-White River region; scale, 1:250,000; by C. E. Giffin and D. C. Witherspoon. In Bulletin 630, 20 cents. Not issued separately.

Yukon-Koyukuk region; scale, 1:500,000; by H. M. Eakin. In Bulletin 631, 20 cents. Not issued separately.

Cosna-Nowitna region; scale, 1:250,000; by H. M. Eakin, C. E. Giffin, and R. B. Oliver. In Bulletin 667, 25 cents. Not issued separately.

Lake Clark-central Kuskokwim region; scale, 1:250,000; by R. H. Sargent, D. C. Witherspoon, and C. E. Giffin. In Bulletin 655, 30 cents. Not issued separately.

Anvik-Andreafski region; scale, 1:250,000; by R. H. Sargent. In Bulletin 683, 30 cents. Not issued separately.

Marshall district; scale, 1:125,000; by R. H. Sargent. In Bulletin 683, 30 cents. Not issued separately.

Upper Tanana Valley region; scale, 1:125,000; by D. C. Witherspoon and J. W. Bagley (preliminary edition). Free on application.

Lower Kuskokwim region; scale, 1:500,000; by A. G. Maddren and R. H. Sargent (preliminary edition). Free on application.

Ruby district; scale, 1:250,000; by C. E. Giffin and R. H. Sargent (preliminary edition). Free on application. Also in Bulletin 754. 50 cents.

Innoko-Iditarod region; scale, 1:250,000; by R. H. Sargent and C. G. Anderson (preliminary edition). Free on application. Also in Bulletin 754. 50 cents.

SEWARD PENINSULA

REPORTS

The Fairhaven gold placers of Seward Peninsula, Alaska, by F. H. Moffit. Bulletin 247, 1905, 85 pp. 40 cents.

Gold mining on Seward Peninsula, by F. H. Moffit. In Bulletin 284, 1906, pp. 132–141. 25 cents.

The gold placers of parts of Seward Peninsula, Alaska, including the Nome, Council, Kougarok, Port Clarence, and Goodhope precincts, by A. J. Collier, F. L. Hess, P. S. Smith, and A. H. Brooks. Bulletin 328, 1908, 343 pp. 70 cents.

Investigation of the mineral deposits of Seward Peninsula, by P. S. Smith. In Bulletin 345, 1908, pp. 206–250. 45 cents.

Geology of the Seward Peninsula tin deposits, by Adolph Knopf. Bulletin 358, 1908, 72 pp. 15 cents.

Recent developments in southern Seward Peninsula, by P. S. Smith. In Bulletin 379, 1909, pp. 267–301. 50 cents.

The Iron Creek region, by P. S. Smith. In Bulletin 379, 1909, pp. 302–354. 50 cents.

Mining in the Fairhaven district, by F. F. Henshaw. In Bulletin 379, 1909, pp. 355–369. 50 cents.

Geology and mineral resources of the Solomon and Casadepaga quadrangles, Seward Peninsula, Alaska, by P. S. Smith. Bulletin 433, 1910, 227 pp. 40 cents.

Mining in Seward Peninsula, by F. F. Henshaw. In Bulletin 442, 1910, pp. 353–371. 40 cents.

A geologic reconnaissance in southeastern Seward Peninsula and the Norton Bay-Nulato region, Alaska, by P. S. Smith and H. M. Eakin. Bulletin 449, 1911, 146 pp. 30 cents.

Notes on mining in Seward Peninsula, by P. S. Smith. In Bulletin 520, 1912, pp. 339–344. 50 cents.

Geology of the Nome and Grand Central quadrangles, Alaska, by F. H. Moffit. Bulletin 533, 1913, 140 pp. 60 cents.

Surface water supply of Seward Peninsula, Alaska, by F. F. Henshaw and G. L. Parker, with a sketch of the geography and geology by P. S. Smith and a description of methods of placer mining by A. H. Brooks; including topographic reconnaissance map. Water-Supply Paper 314, 1913, 317 pp. 45 cents.

Placer mining on Seward Peninsula, by Theodore Chapin. In Bulletin 592, 1914, pp. 385–396. 60 cents.

Lode developments on Seward Peninsula, by Theodore Chapin. In Bulletin 592, 1914, pp. 397–407. 60 cents.

Iron-ore deposits near Nome, by H. M. Eakin. In Bulletin 622, 1915, pp. 361–365. 30 cents.

Placer mining in Seward Peninsula, by H. M. Eakin. In Bulletin 622, 1915, pp. 366–373. 30 cents.

Lode mining and prospecting on Seward Peninsula, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 425–449. 75 cents.

Placer mining on Seward Peninsula, by J. B. Mertie, jr. In Bulletin 662, 1917, pp. 451–458. 75 cents.

*Tin mining in Seward Peninsula, by G. L. Harrington. In Bulletin 692, 1919, pp. 353–361.

*Graphite mining in Seward Peninsula, by G. L. Harrington. In Bulletin 692, 1919, pp. 363–367.

*The gold and platinum placers of the Kiwalik-Koyuk region, by G. L. Harrington. In Bulletin 692, 1919, pp. 368–400.

*Mining in northwestern Alaska, by S. H. Cathcart. In Bulletin 712, 1919, pp. 185–198.

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Pliocene and Pleistocene fossils from the Arctic coast of Alaska and the auriferous beaches of Nome, Norton Sound, Alaska, by W. H. Dall. Professional Paper 125–C, 1921, 15 pp. 10 cents.

Metalliferous lodes of southern Seward Peninsula, by S. H. Cathcart. In Bulletin 722, 1922, pp. 163–261. 25 cents.

The geology of the York tin deposits, Alaska, by Edward Steidtmann and S. H. Cathcart. Bulletin 733, 1922, 125 pp. 30 cents.

TOPOGRAPHIC MAPS

Seward Peninsula; scale 1:500,000; compiled from work of D. C. Witherspoon, T. G. Gerdine, and others, of the Geological Survey, and all available sources. In Water-Supply Paper 314, 45 cents. Not issued separately.

Seward Peninsula, northeastern portion, reconnaissance map (No. 655); scale, 1:250,000; by D. C. Witherspoon and C. E. Hill. 50 cents retail or 30 cents wholesale. Also in Bulletin 247, 40 cents.

Seward Peninsula, northwestern portion, reconnaissance map (No. 657); scale, 1:250,000; by T. G. Gerdine and D. C. Witherspoon. 50 cents retail or 30 cents wholesale. Also in Bulletin 328, 70 cents.

Seward Peninsula, southern portion, reconnaissance map (No. 656); scale, 1:250,000; by E. C. Barnard, T. G. Gerdine, and others. 50 cents retail or 30 cents wholesale. Also in Bulletin 328, 70 cents.

Seward Peninsula, southeastern portion, reconnaissance map; scale, 1:250,000; by D. C. Witherspoon, D. L. Reaburn, H. M. Eakin, and others. In Bulletin 449, 30 cents. Not issued separately.

Nulato-Norton Bay region; scale 1:500,000; by P. S. Smith, H. M. Eakin, and others. In Bulletin 449, 30 cents. Not issued separately.

Grand Central quadrangle (No. 646A); scale, 1:62,500; by T. G. Gerdine, R. B. Oliver, and W. R. Hill. 10 cents retail or 6 cents wholesale. Also in Bulletin 533, 60 cents.

Nome quadrangle (No. 646B); scale, 1:62,500; by T. G. Gerdine, R. B. Oliver, and W. R. Hill. 10 cents retail or 6 cents wholesale. Also in Bulletin 533, 60 cents.

Casadepaga quadrangle (No. 646C); scale, 1:62,500; by T. G. Gerdine, W. B. Corse, and B. A. Yoder. 10 cents retail or 6 cents wholesale. Also in Bulletin 433, 40 cents.

Solomon quadrangle (No. 646D); scale, 1:62,500; by T. G. Gerdine, W. B. Corse, and B. A. Yoder. 10 cents retail or 6 cents wholesale. Also in Bulletin 433, 40 cents.

NORTHERN ALASKA

REPORTS

A reconnaissance in northern Alaska across the Rocky Mountains, along Koyukuk, John, Anaktuvuk, and Colville rivers and the Arctic coast to Cape Lisburne in 1901, by F. C. Schrader, with notes by W. J. Peters. Professional Paper 20, 1904, 139 pp. 40 cents.

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