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SURVEYS IN NORTHWESTERN ALASKA IN 1926

BY

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Mineral resources of Alaska, 1926—D

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ILLUSTRATION

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By Philip S. Smith

NARRATIVE OF THE 1926 EXPEDITION

The revival of geologic and topographic mapping in northwestern Alaska that followed the designation of the naval petroleum reserve in that region in 1923 was marked by the sending of expeditions from the Geological Survey each year since that time to conduct surveys. Although nearly 25,000 square miles of new area had been mapped by these parties in 1923 to 1925, there still remained many tracts that had not been explored and many problems that required further study. In spite of the fact that the Navy Department did not place any additional funds at the disposal of the Geological Survey to continue work during 1926, the Geological Survey recognized the desirability of continuing the investigations within the reserve and adjacent country and made the necessary allotment of funds for another expedition.

Therefore, early in 1926 another party in charge of Philip S. Smith, geologist, and Gerald FitzGerald, topographer, was dispatched to survey an area lying between the Point Hope-Cape Lisburne region and the Noatak and extending along the western margin of the reserve and to make such supplementary surveys into hitherto unmapped areas adjacent to large streams as time permitted. The party sailed from Seattle February 13, 1926, for Seward, whence the geologist and topographer traveled over the Alaska Railroad to Nenana, arriving there February 23. At Nenana two dog teams of 10 dogs each were purchased, and Fred Clark was attached to the party as camp hand. With a light equipment the expedition left Nenana February 27 to follow the Nome-Nenana mail trail to the head of Norton Sound and thence to branch off for Kotzebue on the mail trail that cuts across the eastern neck of Seward Peninsula and then skirts the coast. At the head of Norton Sound the party was joined by W. R. Blankenship, who served during the rest of the field season as cook and camp hand. The run from Nenana to Kotzebue, a distance of about 725 miles, was made in 27 days, on three of which the party could not travel because of

storms, at the rate of about 30 miles a day of actual travel. Throughout most of the trip the weather was excellent and trail conditions were good. Road houses at which board and lodging could be obtained are situated about every 25 miles, so that in this part of the journey it was not necessary to camp out or carry many supplies except bedding and a little food for the dogs.

At Kotzebue, which was reached March 25, food and equipment sufficient to supply the party for about five months were bought, and two Peterborough canoes which had been sold at auction by the Geological Survey parties in 1925 were repurchased. After all these articles had been sorted and put into shape for trail conditions, a number of natives were hired to assist in freighting the supplies to Kivalina, a small settlement on the coast about 90 miles northwest of Kotzebue. Mr. Smith and the freighters left Kotzebue March 30 and were followed by the rest of the party the next day, proceeding by the Barrow-Kotzebue mail trail and the general route used for travel along the coast. After arrival at Kivalina arrangements were made for striking off across country with the object of placing the bulk of the equipment across the mountains, so that, with the break-up of the streams in the summer, the canoes could be used for further explorations. In accordance with this plan the freighters, together with Blankenship and Clark and an Eskimo, Chester Sevic, who had herded reindeer in that region, left Kivalina April 3. The geologist and topographer remained at Kivalina to make the necessary observations for commencing the new surveys and then started northward along the route taken by the freighters. On April 12, when they were some distance up Kivalina River, the freighters with Clark returned, having placed the supplies on Kokolik River and left Blankenship to safeguard them. After the freighters had been discharged, the work of surveying the country adjacent to the route was continued as rapidly as possible, but there were numerous delays owing to howling storms and biting winds, so that it was May 10 before the surveys were brought up to the cache which had been established on Kokolik River. By that time travel was beginning to be difficult because of the melting snow and the softening of the ice, but Mr. FitzGerald with Clark moved farther up Kokolik River to map more of its headwaters, while Mr. Smith and Blankenship established a new camp (P, May 15) farther down the river at a point where it was believed better conditions for the use of the canoes would be found. This was the place where the break-up would be awaited and where the use of dog teams and sleds would be discontinued. During many of the succeeding days the weather was very bad, and little could be accomplished in surveying the surrounding country. On May 23 Mr. FitzGerald and Clark returned and re-

ported that for almost 10 days it had been impossible to see anything because of the clouds and storms in the mountains, and as many of the streams were beginning to carry a large run-off of water they had been forced to give up the attempt to map more of the mountains that form the Noatak-Kokolik divide.

During the severe gales that had accompanied the stormy weather one of the canoes had been badly damaged, so that the next few days were spent in repairing it and making ready to leave this camp for the downstream journey as soon as conditions were favorable. By May 29 the river at the camp was practically free of ice, but a short distance downstream, where the valley walls narrowed so as to form a mild canyon, the ice still held and there was little or no surface water. At last on June 5, after waiting impatiently for several days, the start downstream in boats was made. The break-up was not marked by a period of wildly running ice in the river; instead, as the ice rotted out by water flowing over it or was undercut by water flowing under it, it collapsed and was carried away. Many of the huge snowdrifts along the walls of the gorge, where thus undercut, fell with stupendous splashes into the river and were a source of danger to navigation. This was especially notable at the camp of June 15, where great blocks of drifted snow and ice, many of them 20 to 50 feet high and 100 yards long, fell at frequent intervals with roars that could be heard for long distances.

The current of the river was swift, but there were few rapids or obstructions to navigation, so that the journey could have been made in a few days if it had not been necessary to stop frequently to make geologic observations or to establish topographic stations. As it was, the junction with the surveys of the lower part of the Kokolik made in 1923 by Messrs. FitzGerald and Foran was made on June 17, and the closure found to be excellent. Before the party left Washington the suggestion had been made that it might be advantageous to portage from this point to the Utukok and thence to the Kaolak, as the coastal portion north of the mouth of the Kokolik as far as Wainwright had already been surveyed in 1923. In the field, however, this plan seemed a less desirable way of reaching the unsurveyed country west of the Kaolak than continuing down the Kokolik and then proceeding by the Arctic Ocean and the lagoons to Wainwright. The latter plan gave a down-grade and sea-level route which avoided all portages, would allow the making of larger collections of rocks, would not force the party to discard valuable supplies and outfit to lighten the loads, and if conditions were favorable would probably take less time.

The party reached Point Lay, on the coast, June 20 and found that the ocean was still ice bound, with no open water in sight.

Fortunately there was a good deal of open water in the lagoon back of the reef, and although most of the anchor ice in the lagoon still held, there was enough water covering it to allow the boats to proceed. Many parts of the lagoon, however, were so shallow that there was not enough water to float even the shallow-draft canoes, and further progress could be made only by all hands wading and hauling on the boats. In fact, in several places no progress could be made even where all four men hauled on one boat at the same time, and in such places it was necessary to unload most of the articles from one boat into the other and then drag the lightened boat ahead a hundred yards or so and transfer the load from the rear to the forward boat by packing the things on the men's backs, and then repeating the process. These shallow places occurred very irregularly, so that many times the boats were aground a mile or more from either shore.

The north end of the long series of lagoons on the west coast is near Kilimatavik, which was reached June 28. Here further progress was blocked by the ice pack of the ocean, which was jammed up against the shore, leaving no open water in sight. The ice was much broken, however, and as it would probably go out quickly as soon as the wind was favorable, camp was established and another period of waiting ensued. After a few days a strong east wind opened up some leads through the ice near shore, but it made the sea too rough for travel in the canoes. Finally, on July 5, it became possible to push ahead, and by wriggling through narrow leads and occasionally shoving aside an obstructing cake of ice the party reached Wainwright Inlet but found progress up that body of water blocked by ice.

While the party was waiting for the ice in the inlet to open up, the first ship of the season arrived on July 7 with mail and newspapers from the States as recent as May 26. This was an exceptionally early arrival. On July 8 the party started up Wainwright Inlet to survey Avalik River and the adjacent region. The season had been exceptionally dry, however, and all the streams appeared to be in an exceedingly low stage, so that a short distance beyond the mouth of the Kaolak riffles and bars at frequent intervals made progress by rowing impracticable. Above this point advance could be made only by tracking the boats or wading alongside and lifting and hauling on them. In this way and often making an air-line distance of only 3 or 4 miles a day, a point was reached where even this method became impracticable, as the bottoms had been almost dragged out of the boats and the wood worn to paper thinness by the constant scour on the bars, so that camp July 18 was established. From that camp Mr. FitzGerald made traverses on foot into the adjacent country and determined its general features. Return to Wain-

wright was made as rapidly as conditions permitted, and the mouth of the inlet was reached July 27. During the absence of the party the sea ice had driven in again, so that no other ship had arrived, and it was not until July 31 that the next vessel, the U. S. Coast Guard ship *Bear*, was able to break through the pack and reach Wainwright. On August 4 the ice, which had been firmly jammed along the beach, began to open up, and the next day the Geological Survey party started northward along the coast for Peard Bay. Much of the way the lead of open water was only 100 feet wide, but eventually the narrow entrance through the sand spit east of Atanik was reached, and surveys of Peard Bay and of Kukroak River, which enters it, were started and carried as far upstream as was feasible in view of the low stage of the river.

On return to the coast, as it was nearly time for the arrival of the boat on which the trip to Nome was to be made, Mr. Smith and Mr. Blankenship returned to Wainwright, while Mr. FitzGerald and Mr. Clark went north to connect the topographic surveys with those made in earlier years in the vicinity of Barrow. The Smith party reached Wainwright August 12, and went aboard the *Boxer* for Barrow on the 15th. On arrival at Barrow it was found that the FitzGerald party had not yet come, and it was later learned that they were storm bound on the coast about 35 miles south of Barrow and ultimately had to return to Wainwright. Mr. Smith and Mr. Blankenship sailed south on the *Boxer*, until at Point Hope it was learned by wireless that the trading schooner *C. D. Brower* was a short distance behind and was headed directly for Nome, with the FitzGerald party, which had been picked up at Wainwright. Transfer of Mr. Smith to the *C. D. Brower* was therefore effected, and on August 25 the party landed at Nome. On September 2 it left on the *Victoria*, of the Alaska Steamship Co., for Seattle.

As a result of this exploration about 5,000 square miles of hitherto unmapped country was surveyed both geologically and topographically. (See pl. 3.) The surveys interlocked wherever practicable with the surveys made during the preceding three years of investigation of the naval petroleum reserve. They thus served interchangeably to check each other and give stronger basis for any adjustments necessary as well as establishing uniformity in method of interpretation and correlation over the entire tract. As the surveys of 1926 traversed a large area that lay between the surveys which had been made much earlier in the Cape Lisburne region, on the west, and the Noatak region, on the east, they bridge the gap between the two and supplement and coordinate the interpretation of observations made in those areas as bearing on the major features of northwestern Alaska.

TOPOGRAPHIC SURVEYS

The topographic surveys were executed by Mr. FitzGerald by the usual methods of plane-table and micrometer traverse that have been so generally used by the Geological Survey in its Alaska work. The work was done on a field scale of 1:180,000, which is the scale usually adopted for maps that are to be published on a scale of 1:250,000. In view, however, of the fact that any information regarding the topography of the remoter parts of the region would be of great value, Mr. FitzGerald made every effort to sketch even the most remote features as accurately as conditions warranted without unduly delaying the party. As a consequence, a large part of the area near the route of travel was surveyed with a detail fully up to the requirements for publication on a scale of 1:250,000, which is considered the standard reconnaissance scale. In addition he also mapped a large area in less detail, but with an accuracy at least equal to that required for publication on the standard exploration scale of 1:500,000, or approximately 8 miles to the inch.

Throughout the area surveyed the relief (the height of the country above the sea) was indicated by 200-foot contours—that is, by a series of lines each of which is drawn in its proper position on the map through all points having in nature the same elevation above sea level and separated from the next lower or higher contour line by a vertical interval of 200 feet in the field. By this means the height of all features in the area surveyed may be read from the map and their forms recognized by anyone skilled in map interpretation. Hundreds of points were specifically determined and the intervening areas sketched with relation to them.

The topographic surveys were started from a point near the beach at Kivalina, whose latitude and azimuth were determined by observations with the transit and later checked by the observations and records of captains whose vessels have visited the place, supplemented by reference to the form of the coast as indicated on the maps of the shore that have been published by the Coast and Geodetic Survey. This part of the coast, however, has not been recently surveyed, and the published charts are largely based on surveys made early in the nineteenth century. The form of the coast is excellently shown on these maps, but its position may be somewhat in error. If any error exists, however, it is not great, and judged by exploratory standards it is doubtful whether more refined investigations would materially affect the position as laid down on the map on the scale that has been adopted.

From Kivalina the surveys were carried northward up the valley of Kivalina River, across the divide between that stream and Kuk-

puk River, up the Kukpuk and across into the valley of the Kukpowruk, down that stream until they practically connected with the surveys of the lower part of that stream made in 1923, thence across into the valley of the Kokolik and down that valley until a tie was effected with the surveys made in the northern part of the valley by Mr. FitzGerald in 1923. In the work in the upper part of the Kokolik Valley points in the Utukok Valley whose position had been mapped in the course of the surveys made by the expedition of 1925 were recognized and again intersected. Also farther down the Kokolik Valley intersections were made on points in the Kukpowruk Valley that had been located in 1923. These doubly identified points served as valuable tie points by which to connect the separate surveys.

After the surveys in 1926 had been tied to those made in 1923 near the mouth of the Kokolik, topographic surveys were temporarily discontinued, as for some distance the party traversed country that Mr. FitzGerald had already mapped on a scale of 1:96,000 in 1923. The party therefore traveled ahead as rapidly as conditions permitted without doing further topographic work until it reached the forks of Avalik and Kaolak Rivers, at the head of Kuk River. Here new surveys were begun from a point whose position had been determined by O. L. Wix, topographer with the Geological Survey party in charge of W. T. Foran, which traversed the region from Wainwright to Noatak River by way of Kaolak, Utukok, Colville, and Nimiuktuk Rivers in 1924. The topographic survey was continued up Avalik River for an air-line distance of 46 miles and came within 20 miles of points located on the surveys of Meade River made by E. C. Guerin, the topographer of the Geological Survey party in charge of Sidney Paige that ascended that stream in 1923. Doubtless points on the two surveys would have been interchangeably visible had there been any conspicuous features that could be recognized. The country, however, is topographically so undiversified that no point on the earlier survey could be positively identified to serve as a tie between the two.

With the completion of the surveys on Avalik River, topographic work was again temporarily discontinued while the party returned to Wainwright and thence went northward along the coast about 20 miles to Atanik. Here a new survey was started from points that had been mapped by O. L. Wix in the course of his surveys in 1924, which in turn had been started from points established near Wainwright by Mr. FitzGerald in 1923. From these points near Atanik topographic surveys were carried to the western head of Peard Bay and up Kukroak River, which enters the bay near its head. Sta-

tions were established as far up Kukroak River as it was navigable for a light-draft canoe, and the country was sketched as far as could be seen. Returning to Peard Bay, the topographer turned eastward and continued the survey of Peard Bay, in the course of which he located the starting point of the route that leads to Inaru River and that was followed by one of the parties in 1923. The point farthest north reached on these surveys was near Skull Cliff, about 35 miles south of Barrow. Work beyond that point, as already noted, was interrupted by storms. The short stretch of coast between Skull Cliff and Barrow is therefore the only gap in the recent topographic mapping of the country adjacent to the coast from Dease Inlet, east of Barrow, to Cape Beaufort, nearly 250 miles southwest of that town.

In order to maintain adequate control and check the work at intervals, observations of latitude and azimuth were made at several points with a small transit. All these determinations have been used in properly adjusting the field sheets in their correct position on the map in which they are incorporated. So closely, however, did the points thus determined coincide with their positions as platted by the plane-table methods that the adjustments were relatively minor and inconsequential and clearly prove that the work was well up to the requirements of the scale adopted. The accuracy of the topographic mapping and the exceedingly large area covered form an extremely creditable record even if no account is taken of the conditions under which the work was done. When, however, it is remembered that most of the time Mr. FitzGerald did not have even a station assistant to help carry his instruments and that between stations he, with one camp hand, had to drag his boat upstream or row it from point to point downstream or along the coast, backpack across portages or guide his own dog team across the country in the winter, and participate in many of the camp duties, the extent and quality of the topographic mapping are truly remarkable. Furthermore, this work was done in all kinds of weather, at temperatures from far below zero in winter to 90° above in summer, in rain and snow, sleet, fog, and sunshine, under extreme physical hardship and exertions, and yet at all times the only thing uppermost in the mind of the topographer and the only thing that really counted was to make the map grow and maintain its high standard of accuracy.

GEOLOGIC SURVEYS

The geologic surveys covered the same area as those which were topographically mapped with the exception of the eastern part of Peard Bay and the country to the north. This area had already been examined by the parties of 1923 in charge of Mr. Paige and did

not require reexamination. Geologic work was definitely commenced at Kivalina, although during the journey northward along the coast from Kotzebue to Kivalina opportunity was afforded to note many facts of geologic significance and to see some of the rocks that crop out in the hills from Cape Krusenstern northward. These same rocks were intersected during the traverse of the lower part of Kivalina River and furnish a tie with the geology of the Noatak region, to the east, and the Lisburne region, to the west.

The route of travel northward first traversed complexly folded rocks, which on the whole, however, appear to represent successively higher and higher formations. Farther north, beyond the areas occupied by the older rocks, the structure is less complex and the rocks more uniform. This condition characterized the formations seen on Kokolik, Avalik, and Kukroak Rivers. The 1926 geologic surveys came close to those made by Mr. Foran on Kukpowruk River, so that confidence is felt that the rocks in each are essentially identical. The surveys made during 1926 also came near enough to the surveys made in 1925 to permit correlation of the rocks in the two areas. It thus turned out that the rocks in the upper Kokolik are identical with certain of the rocks in the Utukok Valley that were identified by W. R. Smith in the course of the work of the 1925 party, of which he was a member. The traverse of Wainwright Inlet allowed an investigation of the coals of that region and an opportunity to examine some of the rocks which Mr. Foran had described on his trip in 1924 as extending from that valley throughout part of the Utukok Valley and even into the upper part of the Colville Valley. The geologic observations at the highest point reached on Avalik River gave opportunity to see the rocks in a region not very far distant from those examined by Mr. Paige on Meade River and served to prove that the rocks on the Avalik were undoubtedly the same as those occurring on the Meade and continuous with them. It will thus be seen that the writer had an opportunity to see for himself many of the exposures in hitherto geologically unmapped parts of the area and yet at the same time to tie in at intervals with the work of others so as to coordinate his work with that of others and to assure himself that all the results were in accord.

Fortunately, through much of the area traversed by the 1926 expedition fossils were fairly common in the rocks, so that correlations of the rock exposures seen on that trip with each other as well as with those seen on other expeditions could be substantiated by them as well as by other kinds of geologic evidence. The fossils found in the different formations ranged in age from Mississippian to Recent, but plants of Cretaceous age were the most numerous and

widespread, especially in the northern two-thirds of the area, where coal beds are common.

The general geologic exploratory work in the region has now been carried over so large an area that further work of that kind does not seem to be essential unless further prospecting in the search for oil is to be done. Many geologic problems still remain unsolved, but the principal features of the region, both geographic and geologic, have been fairly definitely determined. Although there are still broad areas which have not been traversed, their margins have been studied, and the general geologic structure is such that the kinds of rocks in the areas that have not been visited, as well as their major features, can be predicted with considerable assurance. Consequently, a comprehensive report on all phases of the geology and geography of the region, based on the work that has been done in northern Alaska since 1900, is being prepared for publication, but as it will be some time before the report can be printed and distributed, it has seemed desirable to summarize here the principal conclusions that have been reached. In this summary statement details are omitted, as well as observations that do not bear directly on the economic resources of the region. In order to keep the discussion within reasonable bounds of space, some of the conclusions are perhaps stated with an appearance of finality that is not warranted by the evidence, though in the writer's opinion they are true. The following statements should therefore not be regarded as more than preliminary expressions of opinion and as such are subject to further review and reconsideration. They are set forth at this time mainly as a report of progress.

The general facts regarding the larger features of the topography of the region have now been firmly established. In northwestern Alaska there is a main mountain mass, the Brooks Range, which is made up of a number of subordinate mountain groups. This range is 100 to 150 miles wide and is formed dominantly of Paleozoic rocks. The southern limit of this range is approximately marked by the course of Kobuk River and farther east is near the sixty-seventh parallel. Its northern boundary may be defined by a line passing from the vicinity of Cape Lisburne and in about that latitude eastward to Colville River and thence eastward more or less along or south of the sixty-ninth parallel as far east as longitude 150°. The mountains form a rugged highland whose highest peaks west of the one hundred and fiftieth meridian rise to altitudes of about 8,000 feet and whose average altitude in that part is probably between 5,000 and 6,000 feet.

MINERAL RESOURCES

METALLIC MINERALS

In the mountain belt the probability of finding oil in any appreciable quantity is regarded as negligible. There is, however, a probability that gold deposits of value occur in these mountains. Some gold placers are at present mined near the southern border of the mountains in both the Koyukuk and Kobuk regions. On the whole, however, the areas that appear most promising for gold lie south of the Noatak rather than north of that stream. Although mineralization appears to have been fairly extensive near the southern margins of the mountains, placer concentrations of the gold that may have been effected during former geologic ages have been considerably disturbed or entirely removed by the glaciers that originated in these mountains in the relatively recent past and flowed down most of the larger valleys. As a consequence search for placers is likely to be difficult, because the gold is probably very irregularly distributed and occurs in or under deposits containing many large boulders that will be difficult to handle in mining operations. The concentration of valuable minerals subsequent to the glaciation has probably been relatively slight, and therefore placers formed in that period are likely to be small and not very rich.

The mineral deposits from which all the gold in the placers came appear to have been in small but numerous stringers and veins. Large veins carrying gold are known in the region, however, but the necessity for considerable equipment both for mining and milling the ores makes it improbable that lode mining can be successfully developed here until better and cheaper means of transportation than now exist are provided. The most likely place to search for gold lodes is in the vicinity of the intrusive igneous rocks, such as have been seen in places in the divide between the Kobuk and the Alatna and, to judge from the float in other streams, probably also occur at irregular intervals in the unsurveyed parts of the mountains that form the divide between the Kobuk and the Noatak. On general grounds the mountains north of the Noatak are not regarded as a promising place to seek either lode or placer deposits until the possibilities of other more accessible and more likely areas have been exhausted.

Some copper and lead minerals have been recognized at several points in the mountains between the Kobuk and the Noatak, but the difficulties of profitably developing ores of these kinds are even greater than those accompanying the mining and milling of gold ores, because of the need of even more extensive machinery and equipment and the consequently higher costs. These, however, are

temporary conditions that should be lesser handicaps as the region becomes more settled. For the present or even for the near future search for lodes of these minerals does not seem to hold as much encouragement for profit as similar effort expended in prospecting for other minerals or for these minerals in more accessible regions.

PETROLEUM

North of the Brooks Range, in some places extending to the coast and in other places terminated by a coastal plain that ranges from a narrow strip to a tract 75 miles wide, is a plateau region in which the rocks are dominantly sandstone and shale. This is the region in which any commercial pools of oil that may occur in the region are likely to be found, and this is the region in which the recent surveys have spent the most time in the search for oil. It is certain that some oil occurs in the region, because seepages of it have been actually examined in that part of the region near Cape Simpson, a point on the coast about 60 miles east of Barrow. In spite of all the search that has been made by the Government geologists no other authenticated seepages of petroleum have been found. Even the natives who used to roam extensively over the region do not seem to have knowledge of any other seepages than those at Cape Simpson in the entire region west of Ikpikpuk River. It is true that oil claims have been staked and oil-prospecting permits applied for covering much additional country in the vicinity of Cape Simpson and on Meade, Kokolik, and Kukpowruk Rivers and along the coast south of Barrow. At most of these places the claimants have reported showings of oil, but all such places have been examined by the geologists of the Geological Survey, who not only fail to confirm the reports but have found that the signs which had been mistaken for petroleum are really films of iron oxide on stagnant pools. It has been reported that a petroleum residue has been found on the south shore of Lake Teshkpuk, and nine permits to prospect for oil have been granted in the vicinity of this lake. This place has not been examined by the Government geologists or engineers, but the presence of petroleum residue there was not confirmed by the natives or the whites who are most familiar with that region, though many of them have grazed reindeer over wide tracts of the adjacent country.

The seepages at Cape Simpson occur only a short distance from the coast, and the bedrock in the vicinity is so masked or buried by the later unconsolidated coastal-plain deposits that there is some uncertainty as to whether the rocky fragments near the seepages are really in place or not. In consequence, little can be said from direct observations as to the character and structure of the bedrock. Even the quality of the oil is not adequately known, for the oil collected in the

seepages is undoubtedly weathered and probably has a very different composition from the live oil in the rocks. The petroleum from the seepages is a light oil in which gasoline and other highly volatile constituents are entirely absent. It has a naphthalene base, a specific gravity of 0.943, and a gravity according to the standards of the American Petroleum Institute of 18.6°.

Under the conditions that prevail at Cape Simpson it is impracticable to make any unequivocal statement as to the origin, mode of occurrence, or quality of the oil. It has, however, seemed desirable to set forth the inferences that may be drawn regarding petroleum at this place as well as within the naval petroleum reserve, even though many of them are little more than thoughtful guesses or surmises. All the geologists who have been in the vicinity of the known seepages agree that the nearest bedrocks to the seepages are a group of sandstones and shales. These rocks have been traced throughout a wide tract of country east and west and as far south as the central section of the Colville River valley. They form a sequence whose thickness is estimated as about 15,000 feet. The rocks have been folded into a number of anticlines and synclines, so that at many places north of the Brooks Range the structure is favorable for the accumulation of any oil that may be in the rocks.

Although folded the sequence as a whole appears to have a general dip toward the north, so that in the main progressively higher beds are encountered in that direction. The rocks near the seepages at Cape Simpson therefore are probably toward the top rather than toward the base of the section. If the oil in the seepages originated in this part of the section, its distribution would be limited to a rather narrow belt near the coast or to those areas farther south where these higher rocks have been downfolded in synclines. Synclinal structure, however, is not favorable for the accumulation of oil.

On the other hand, if oil originated in the lower part of the sequence of these rocks, it would be too deeply buried through much of the area to be within reach of the drill except at those places where anticlines have brought these underlying rocks above the level to which their original depth would have carried them, or unless the oil had migrated into rocks higher in the sequence. The absence of seepages or other indications of oil in the areas where these rocks are exposed at the surface or in the anticlines by which these rocks have been brought up above their normal level, in structural features that should be favorable for the accumulation of oil, serves to cast considerable doubt on the possibility of these rocks being really the source of the oil. Furthermore, doubt is raised because the character of all these rocks is such that they do not appear likely to be mother rocks for oil. In general the lower

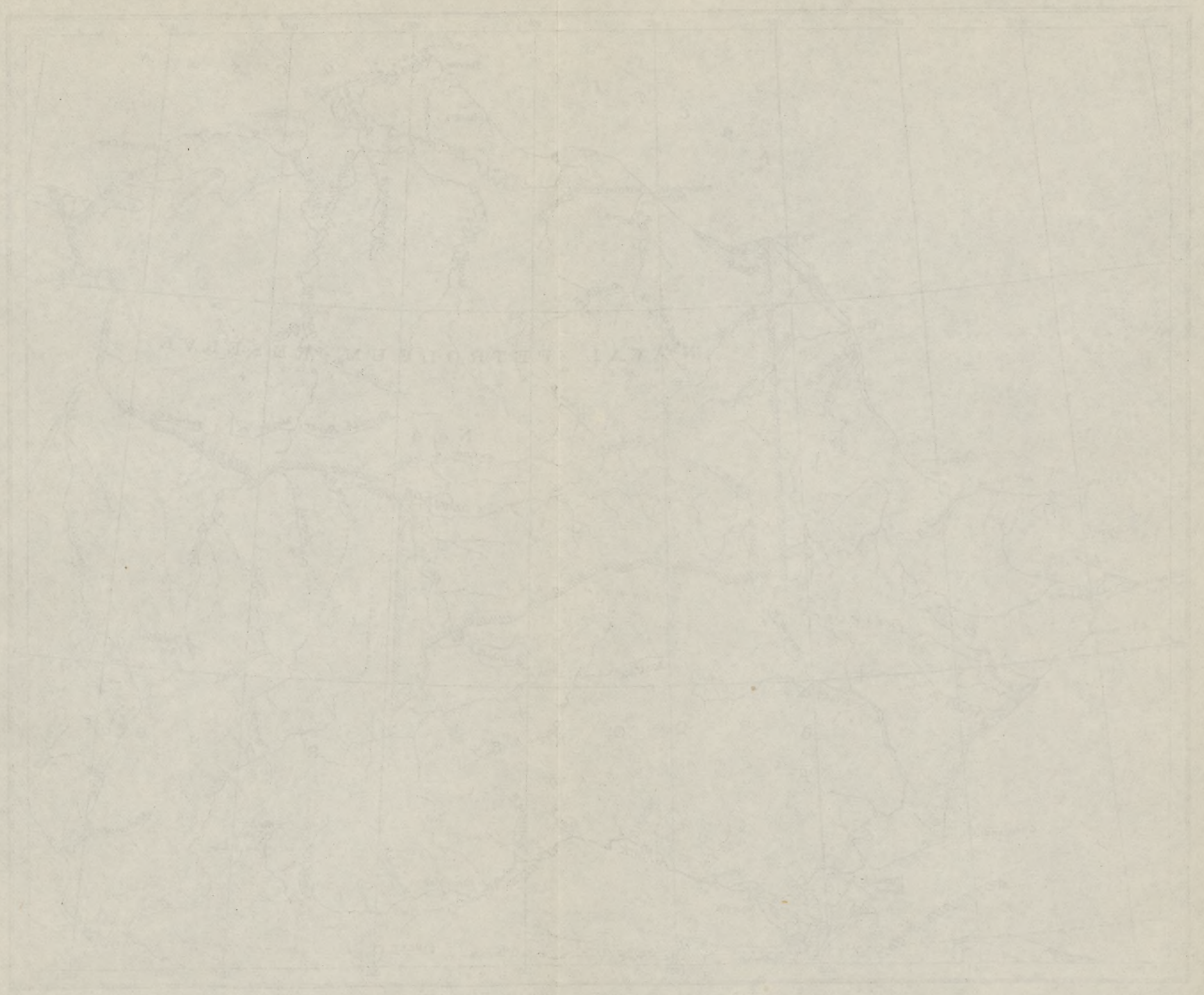
part of this sequence of rocks was laid down in shallow marine waters, but nowhere have any extensive deposits of organic material been recognized, and even isolated fossils are rare. Above these marine beds and forming the middle and upper part of the sequence are beds that were laid down mainly in swamps and quiet water on the land or close to it. In these deposits are large accumulations of coal, but deposits of this type are usually not regarded as favorable for the production of petroleum.

Because of the apparent great thickness of the rocks that have just been described and that are believed to be the ones lying nearest the surface at Cape Simpson, it is with considerable hesitancy that the possibility of the oil having originated in still lower rocks is suggested. The absence of a probable source of oil in the upper rocks, however, makes it necessary to consider all other possible sources. Although in the main these lower rocks where exposed at the surface show no indications of oil, they contain near their base some oil shale that might afford a source for oil in the overlying rocks. Some of the oil shale that has been found would yield at least 50 gallons of oil to the ton, so that it may well afford an adequate supply for considerable quantities of petroleum. At several localities the shale has been found only as float, but elsewhere it has been found in place and occupies a fairly definite position in the stratigraphic column.

There are many objections to considering this oil shale as the source of the oil near Cape Simpson. The beds probably lie at least 20,000 feet below the surface at that place, so that petroleum rising from that depth would presumably find many sands in which it would be trapped before it reached the surface, and consequently signs of it should be fairly widespread. If the oil shale really were the source of the petroleum, it seems almost inevitable that petroleum should be apparent in seepages farther south, where the structure is favorable and the shale less deeply buried, but no such seepages have been found. The absence of seepages in these places may possibly be due to the erosion and removal of these older rocks prior to the laying down of the younger rocks. It is certain that there is some unconformity between the two groups, but the actual distribution of the lower rocks in the region where they are deeply buried can not, of course, be determined except by the drill.

The rather indefinite suggestions made in the preceding paragraphs may be summed up as follows: The lack of sources of oil in the older rocks that make up the mass of the Brooks Range and the broken and dislocated structure of those rocks make the probability of finding oil pools in them extremely doubtful. A strongly indicated source of oil has been found in shale near the base of the lower group of

SKETCH MAP OF NORTHWESTERN ALASKA



sandstones and shales of the plateau province north of the Brooks Range. This shale is likely to be widespread and therefore likely to have supplied extensive pools in widely distributed favorable structural features in the overlying rocks, some of which should doubtless be found at depths within reach of the drill. No promising source of oil has been recognized in the upper group of sandstones and shales, so that if oil pools have originated from sporadic deposits in these rocks they are likely to be small and of extremely sparse distribution, though structural features favorable for retaining the petroleum are widespread.

The foregoing discussion has been directed only toward attempting to interpret the geologic conditions and their relation to the finding of oil in the region. There are, however, many geographic features that will have nearly as important a bearing on the development of any pools that are found here and that must be carefully weighed by anyone undertaking commercial development of the oil. The more important of these factors are transportation, labor, supplies, and working conditions.

There are no regular lines of transportation to or from or within the region, which is accessible now only by long, arduous overland journeys or by occasional trading vessels in the short open season. There are no harbors within several hundred miles for ocean-going vessels, and frequent storms, fog from the ice pack, and the pack itself make navigation dangerous at all times. The sea is closed to navigation for fully 10 months a year, and even during the other two months there is no certainty that the ice pack may not be driven in against the coast. The ocean is so shallow that vessels must lie a mile or more off the coast in the open roadstead and send goods ashore in small boats that can land directly on the beach, as wharves or loading devices can not be maintained because of the ice. The rivers are shallow and swift, so that they can be utilized for transportation only by small boats. There are no roads or even trails that are marked on the ground. Horses can not subsist on local forage, even during the summer. The use of wheeled vehicles or tractors across country in the summer is attended with serious difficulty, because of the soft surface of the ground and the spongy mat of vegetation.

Outside of wild meat and reindeer the region produces no food supplies that would be required in oil development. No foodstuffs can be grown in the area included within the naval petroleum reserve. The nearest trees that could be used for construction, even for shelters, grow nearly 300 miles south of Barrow. Coal could probably be obtained at many places of sufficiently good quality to meet all demands that might be made for local supplies of fuel or for such

power as is needed in operating drill rigs. Even water for the operation of boilers may be difficult to obtain except during the short open season or by melting ice. Stores in Alaska at which machinery, tools, and less ordinary supplies can be obtained or repairs made are a long distance from the reserve, and many necessary things could probably be obtained only from the States, which, in terms of time for a round trip, are a year or more distant. Large stocks of spare parts must therefore be maintained at all times and wants anticipated for a year or more, thus adding materially to the cost of operation.

There is practically no near-by supply of labor of any kind. Probably less than a hundred whites and a few thousand natives live within many hundred miles of the area that may be oil bearing. The natives as a rule are not accustomed to regular routine types of work, and probably only a few could be counted on to remain steadily at work, even if they were induced to start. The inaccessibility and remoteness of the region, the lack of relaxing interests, and the rigorous climate, with its long winter of darkness and cold, would deter people from accepting employment there unless unusual attractions in the way of pay or accommodations were offered as inducements, and these would increase operating costs. Doubtless some of the adverse climatic conditions of the region are overemphasized in the minds of many people, because it is believed that with proper preparation and precautions much work could be carried on effectively and with reasonable comfort throughout the year except during periods of storm. But the climate at best is not attractive, though unquestionably it is far healthier than that of many regions where people live and work.

The foregoing analysis of the more important geologic and geographic conclusions is obviously incomplete and inconclusive in many details. Many more data are required, so that further scouting through the region would be highly desirable. If in such explorations the party were fortunate enough to obtain evidence bearing directly on the occurrence of petroleum in the region, it would be of inestimable value. Some doubt is felt, however, as to whether at this time general scouting of this sort is the best method of obtaining significant data. Instead, it seems that the general features of the region have been sufficiently well determined, so that the next step should be the drilling of several shallow holes near the known seepages, not with the aim of bringing in a productive well but rather of acquiring essential geologic data. After enough data have been obtained from these drill records to indicate the mode of occurrence or source of petroleum, further scouting should be vigorously prosecuted by reconnaissance and detail methods of geologic investigation, and where necessary this should be followed

up by further drill tests or such other methods as are indicated. This program necessarily involves considerable expenditure, but it should be realized that the stakes being sought are high. An oil field in this general region that would yield only a few million barrels of oil might, for all practical purposes, be regarded as of no present importance. Unless a very large potential field is indicated, therefore, development is not justified, so that the relatively large sums that would be necessary to find out the real situation will be only an insignificant part of the investment that may be eventually needed. Consequently, search for oil in this region should not be undertaken by any organization that is not able and willing to finance adequately the necessary preliminary work, even though that work should prove that the field is not capable of commercial development. Prospecting for oil in this region at the present time is "wildcatting" of the most speculative kind. For a person or company that can afford to enter the field with all these conditions in mind, it does hold attractions. Some oil occurs in the region. How much and where it is are questions that still challenge the resourcefulness of geologists, petroleum engineers, and leaders of business enterprise.

COAL

The only other mineral product in the plateau region north of the Brooks Range that is likely to have commercial value is the coal. The coal resources are very great, and though at present they are practically untouched, they are an asset whose value will be manifest whenever any extensive development of the resources of this or of near-by areas is undertaken. In quality the coals are dominantly of subbituminous rank. Throughout a more or less rectangular tract of country north of the Brooks Range and extending from Corwin on the west to Colville River on the east, a stretch of nearly 300 miles east and west and 120 miles north and south, coal can be found almost anywhere within a relatively short distance of the surface. The tremendous quantities of coal that occur in places in this region are indicated by geologic sections that have been measured near Corwin and near Kukpowruk River. In the measured sections near Corwin there are 34 coal beds which represent an aggregate thickness of more than 135 feet; 15 of these beds are more than 3 feet thick, including one 30 feet thick, and represent 115 feet of coal. In the Kukpowruk-Utukok section 69 coal beds were recognized, each of which is at least 3 feet and the largest 20 feet thick, that altogether represent 187 feet of coal.

In the northern part of this large tract the structure is rather simple with broad, gentle warpings, but farther south the beds are more closely folded and dips as high as 90° have been observed.

The coals in the different parts of the region have been affected by these different amounts of folding, and their quality and heating value have a more or less close relationship to these conditions. Thus, in the slightly folded areas the coals are less compact and their fuel ratio and heating value are less than in the more closely folded areas. Doubtless the coal beds in the areas of close folding show more squeezing and breaking, but so far as could be judged from the surface exposures the beds as whole have not been badly broken, and faults of considerable throw appear to be rare. The physical conditions for mining them therefore seem to be favorable, and relatively little expense need be incurred in tracing the beds and planning their method of development. The actual expense of mining, however, will necessarily be high when compared with costs in more accessible regions, in more inviting climates, where supplies and equipment are more readily at hand.

Unfortunately, throughout most of northwestern Alaska the higher-grade coals are in the least accessible parts of the region, so that they will be especially expensive to develop, and whether their quality is enough better than that of the coals in the tracts near the coast to offset the additional cost can not be determined until more data on the cost of the several items involved are available. Fortunately some of the better coals are exposed near the coast in the western part of the field, so that as less expensive transportation by sea is available to them, they will doubtless be among the first to be commercially developed. Even there, however, all costs will be high, and until a suitable market demand has been developed, sound economic policy does not appear to justify any extensive development of these coals in the near future, except to supply purely local needs. It is a liberal estimate to place the amount of coal now consumed within a radius of 500 miles of these coal fields, as measured along the usual routes of transportation, at 10,000 tons a year. It is evident, therefore, that under present conditions, with so small a local market, there is little probability of developing these fields on any considerable scale in the near future.

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GEOLOGIC MAP OF A PORTION OF SOUTHEASTERN ALASKA

Scale 1:500,000

10 0 10 20 30 Miles

1929

Base compiled from maps by Alaskan Branch U. S. Geological Survey, U. S. Coast and Geodetic Survey and International Boundary Survey,

Geology by Arthur F. Buddington, 1921–1925 and Theodore Chapin, 1915–1917
Geology unknown in blank areas of map

EXPLANATION

BEDDED ROCKS

QUATERNARY

Qb — Basalt and tuff

UNCONFORMITY

TERTIARY

Eocene

Tba, Tdb — Basaltic and andesitic lava with minor amounts of interbedded breccia and conglomerate (Tba), locally intrusive masses of diabase (Tdb)

Tra — Rhyolitic and andesitic volcanics, conglomerate, and locally intrusive sills of dacite porphyry

Tsc — Sandstone with basal and intercalated beds of conglomerate; thin coal seams at many places

UNCONFORMITY

JURASSIC OR CRETACEOUS

Lower Cretaceous (?)

Ksg — Slate and graywacke with occasional chert nodules and thin layers of impure limestone, locally intercalated beds of conglomerate

Jurassic or Cretaceous

Kgs — Greenstone volcanics (Predominantly hornblende and rarely augite porphyry breccia with intercalated beds of tuff and lava flows, black slate, and graywacke)

Kgs — Graywacke, dark-gray slate, and conglomerate, with some intercalated beds of tuff, thin layers of limestone, and small limestone lentils. May be in part same as Kgg

UNCONFORMITY

TRIASSIC

Upper Triassic

Trav — Andesitic volcanics, including breccia with limestone matrix and lava flows locally interbedded with sediments

UNCONFORMITY

Trcl, Trs — Trcl, conglomerate, sandstone, and limestone; Trs, in Ketchikan district, slate with interlayered sandstone in upper portion

UNCONFORMITY

CARBONIFEROUS

Permian

Cpl — Limestone with intercalated layers of white chert

Cgs — Conglomerate, limestone, sandstone, andesitic and basaltic volcanics, and, locally, felsite volcanics

UNCONFORMITY

Mississippian

Cmc — Lower part, black thin-layered chert interbedded with coarsely crystalline limestone; upper part, interlayered chert, gray quartzite, and cherty limestone

DEVONIAN

Upper Devonian

Dulb — Limestone, sandstone, argillite, conglomerate, basalt, and tuff

UNCONFORMITY ?

Middle Devonian

Dl — Limestone

Dsv, Dgt — Dsv, sediments, including graywacke, conglomerate, slate, limestone, and, locally, chert, with associated volcanics, including andesitic lava, breccia, and tuff; Dgt, predominantly graywacke and tuffaceous beds

De — Andesitic lava, breccia, and conglomerate with cobbles of limestone

Dss, Dcg — Dss, slate, limestone, and chert with interbedded andesitic volcanics; Dcg, conglomerate and graywacke

UNCONFORMITY

SILURIAN

Sgs — Predominantly graywacke; locally red, green-gray, and gray sandstones, or interbedded conglomerate and sandstone, or shale.

Sl, Sc — Limestone (Sl), locally intercalated with thick coarse conglomerate, sandy beds, or argillaceous beds (Sc)

Sav — Andesitic volcanics and conglomerate, with some associated graywacke, black slate, limestone, and tuff

UNCONFORMITY ?

ORDOVICIAN

Lower and Middle Ordovician

Dgs — Dark to black slate with intercalated beds of graywacke. May include some Ordovician

UNCONFORMITY ?

Ogs — Indurated graywacke with associated dark slate, andesitic volcanics, thin-layered black chert, and layers of conglomerate and limestone. May include some Silurian

METAMORPHIC ROCKS

PROBABLY ORDOVICIAN TO JURASSIC OR LATER

Wrangell–Revillagigedo belt

gn, mb — Layered gneisses with intercalated beds of marble (mb); many beds with disseminated flake graphite

sph, mb — Crystalline schist and phyllite with interca-lated beds of marble (mb)

ph — Phyllite, quartz phyllite, foliated quartzite, argillaceous and micaceous phyllite, and, locally, slate

plb — Black slate and phyllite

gs — Schistose greenstone and green phyllite interbedded with black and gray sericitic slaty phyllite and, rarely, with limestone and beds of schistose chert

PROBABLY PRE-ORDOVICIAN TO DEVONIAN

Prince of Wales and Etolin Islands Wales group

gs — Greenstone schist with intercalated or interbedded limestone

ml — Limestone

mls — Schist with beds of limestone and slate

ms — Schist

INTRUSIVE ROCKS

UPPER JURASSIC OR LOWER CRETACEOUS

gr — Granite

gd, qm — Granodiorite (gd) and quartz monzonite (qm), locally approaching quartz diorite

qd — Quartz diorite; locally varying toward granodiorite

dt, md — Diorite (dt), monzodiorite (md), and quartzose variants; locally quartz diorite and granodiorite; includes small areas of gr, gd, and qd

gb — Gabbro and gabbro-diorite

ub — Ultrabasic rocks (ub); dunite (du), pyroxenite (px), hornblendite (hb), and intermediate types

MINERAL DEPOSITS

- Gold predominating
- Silver and lead (locally with gold and copper) predominating
- Copper predominating
- Zinc predominating
- Nickel-copper
- Antimony
- Molybdenum
- Iron
- Marble
- Gypsum
- Barite
- Garnet
- Coal seam
- Spring

GENERALIZED GEOLOGIC MAP OF SOUTHEASTERN ALASKA

1929

EXPLANATION

- Quaternary volcanics
- Tertiary sediments and volcanics
- Lower Cretaceous or Upper Jurassic intrusives
- Mesozoic sediments and volcanics
- Mesozoic and Paleozoic sediments
- Gneiss, crystalline schist, phyllite, and marble; wholly or partly medium to coarsely crystalline (*Chiefly Mesozoic and Paleozoic sediments*)
- Phyllite, slate, limestone, and dynamometamorphic schist (*Mesozoic and Paleozoic sediments and volcanics*)
- Paleozoic sediments and volcanics (*Includes Wales group of metamorphic rocks on Prince of Wales and Dall Islands*)

APPROXIMATE POSITION OF EASTERN CONTACT COAST RANGE BATHOLITH

Base compiled from maps by Alaskan Branch U. S. Geological Survey
U. S. Coast and Geodetic Survey and International Boundary Survey.

0 10 20 30 40 50 Miles

Geology by Arthur F. Buddington, 1921–1925 and Theodore Chapin, 1915–1917 from all authoritative sources. Geology unknown in blank areas of map

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