Mr Hawkins MR 192-6
Lower Yukon

Notes on the General Geology of the Kako Creek Valley in the Anvik-Andreafski Region of Alaska.

The following notes refer to an area of approximately one hundred and twenty square miles on lower Kako Creek and the upper drainage of the Kuyukutuk River, north of Russian Mission, on the lower Yukon. This area constitutes a part of the unsurveyed country shown on the map by George T. Harrington and R. H. Sargent accompanying U. S. Geological Survey Bulletins 683 (Plate I of this report). As indicated on this map the geology of the adjoining country on the east, west, and south was surveyed by Harrington in 1916 and reported in the Bulletin referred to. These notes are intended to supplement Harrington's work in the vicinity of the area investigated.

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OCT 1 - 1940
B. D. STEWART
Commissioner of Mines

E. T. Fox, August 1, 1940.

1946

FIELD WORK

Forty three days during the period June 26 to August 7, 1940 were spent in the area. Of this time 22 days were spent in actual field surveying, 8 days were spent packing, 6 days were spent on measurement of a base-line, erection of triangulation beacons, general reconnaissaince, etc., and 7 days were spent on maps, samples, and general office or camp work. For 12 days the writer had the assistance of one man. There were 19 rainy days during the period when plane-table work was either completely or partly stopped.

The survey was made by plane-table with open-sight alidade and aneroid. It is accurate therefore only to the usual limits of reconnaissaince work with these instruments.

~~Drainage~~

All of the central and northeastern part of the area under discussion is drained through many minor tributaries into Kako Creek which flows southward into the Yukon River (Plate II). All of the northwestern part of the area is drained by various, mostly unnamed, headwater tributaries of the Kuyukutuk River which flows westward and enters the Yukon through Five Day Slough below Marshall. A small bit of the southeastern part of the area drains directly south into the Yukon through minor channels, notable among them being Eight ~~Horn~~ HOUR Creek. That part of the area shown on the map south of the Yukon is part of the swampy flatland extending between the Yukon and the Kuskokwim. This part of the area was not visited excepting that it was observed from the air on several different flights over the region.

This drainage imposes upon the district a mature topography of low to comparatively moderate relief. The valleys are mostly broad and of flat profile. The hills are rounded excepting for the terracing mentioned below. Assuming an elevation of 130 feet on the bank of the Yukon at the mouth of Kako Creek, this being based on averaged aneroid readings, the maximum elevation of the hills is about 2,000 or slightly higher. A notable exception is Mt. Chiniklik which ~~starts~~ STANDS at the eastern edge of the surveyed area and reaches an elevation of about 2,700 feet. The elevation of Mt. Chiniklik was determined by Sargent in 1916. All other elevations shown on the map

are based on averaged aneroid readings made during the present survey. Where comparisons are possible the aneroid elevations correspond reasonably closely to the elevations shown on Sargent's map.

The main highland area covered by this survey constitutes the divide between Kako and Kuyukutuk drainage and extends from Arctic Castle and Base Hill in the southwest to Kako Dome in the north. Arctic Castle reaches an elevation of approximately 2,125 feet; other domes in its vicinity are only slightly lower. Base Hill and Kako Dome each reach an elevation of about 2,000 feet. Midway between them Windy Creek flows through a gap that is reduced to less than five hundred feet.

A minor highland area lies north of the East Fork of the Kuyukutuk and reaches elevations of 1,000 feet or slightly more.

As mentioned above Mt. Chiniklik in the east reaches a higher elevation than any other point in the region. Only the western spurs of this highland mass are included in this survey however. Of these, the dome west of Eight ~~Horn~~ Hour Creek reaches an elevation of over 2,300 feet, and other points near the head of Eight ~~Horn~~ Hour are higher. Lower ridges extend from this high area to the west and southwest into Kako valley.

As previously stated the hills are mostly rounded, but there are some notable exceptions. Chiniklik is conspicuously conical; so is the small hill at the southern edge of the swampy flat land in the northwest. Arctic

Castle, Base Hill, and other high points in their vicinity are conspicuously terraced by the process which H. M. Eakin has termed altiplanation, (U. S. G. S. Bull. 631, 1916; p. 78). Within the area under discussion this terracing is confined either to igneous rocks or to rocks with general physical properties similar to igneous rocks, e.g. greenstone and contact hornfels. Also the terraces have formed only above timber line.

For the most part all of the highland areas are either composed of rock outcrop, or bedrock occurs at shallow depths below the moss. All of the highland areas are above timber line, and are mostly covered with various mosses.

In the valleys on the other hand there are few outcrops and bed rock occurs generally beneath a considerable thickness of muck and silt. In the drainage ditch leading from the Yukon Mining Company's open cut on Bobtail Creek to Windy Creek there is more than 10 feet of gray to black, rudely stratified, silty muck containing an abundance of undecomposed sticks and logs. This thickness increases as the elevation rises away from the valley. Below this there is about 6 feet of gravel in the lower end of the open cut and about half this thickness at the upper end of the cut. Drill profiles on Buster Creek show a thickness of 20 to 40 feet of muck underlain by 4 to 25 feet of gravel. The gravel is reported to be ~~coarse only~~ commonly unwashed, i.e. it is mixed with muck. On the ridge between

Buster Creek and Montezuma Creek one drill hole is reported to have encountered 58 feet of muck underlain by 32 feet of gravel. At other points in Kako Valley, notably on the small bluffs or hillocks located as stations numbered 40, 41, and 42 bedrock outcrops at the surface (Plate III). Similar low headlands and ridges east of Kako Creek were not visited. A rather conspicuous ridge north of Arctic Island and Johnson Island contains a rock core where undercut by the Yukon River.

Most of the valleys are wooded with spruce, with some poplar and birch. Willow thickets follow most of the meandering streams. Alder thickets occur commonly near timber line. In most of the area timber line occurs at approximately the lower ~~from~~ form line shown on Plate II. This is not entirely true east of Kako Creek Where a minor piedmont on the west of the Chiniklik highlands is free of trees. Likewise the flats southeast of the Yukon and the similar flats in the northwest part of the area are not wooded.

General Geology

Sufficient data are not available to warrant any complete systematic description of the geology of the Kako district. But sufficient exposures have been located and mapped to satisfactorily extend Harrington's work into this district. The following general description of formations encountered, therefore, is to a certain extent a reconsideration of formations previously described more fully by Harrington in h's discussion of the Marshall district. Also it should be stated clearly that the following is entirely a field description as no laboratory investigation has been made of any of the rocks at the time of this writing.

Sedimentary Rocks

The main area of exposed sedimentary rocks in this region constitutes a belt extending from Kako Dome southwestward to the junction of the main branch and the East Fork of the Kuyukutuk River. Another small area of sedimentary rocks is exposed near Arctic Castle in the southwest; and sediments are exposed throughout most of those parts of the Chiniklik highland that were visited.

Throughout the main belt of sediments first referred to various indefinite silicous ~~types~~ rocks are most commonly encountered in weathered outcrop. Near survey stations 20, 21, and 22 the rock exposed consists of dense silicious material resembling grey chert and red jasper in appearance and general physical properties. The weathered surface

of this rock , however, in some places in this vicinity is so distinctly fluted in the manner characteristic of weathered limestone that there is a strong suggestion that the rock now exposed represents surface silicification of an underlying limestone formation. Or it may be suggested that some of the chert exposed occurs in the limestone in the manner so common in many other regions.

At stations 23 too, there is abundant chert rubble exposed but here there is other red and yellow weathered material possibly derived by decomposition from impure argillaceous beds.

Similar rocks are exposed on the ridge between stations 24, 25, and 26, although here some alterations are imposed by the minor intrusives in this vicinity.

In the hill area from survey stations 27 and 30 to 38 and 39, which includes Kako Dome, chert, jasper, and flinty rocks still predominate, although these rocks show a very slight change in character from about stations 32 northward. For the most part the rocks exposed near and south of station 32 megascopically appear to be composed entirely of cryptocrystalline or amorphous silica. In some of the exposures north of this location there is some suggestion of very fine grained granular texture indicating probably that much of the so called "chert" here represents either complete silicification of fine-grained arenaceous sediments or completely recrystallized quartzite. In the vicinity of Kako Dome the silicious rocks are apparently very fine grained quartzites.

West of station 33 and north of 37 are some exposures of unsilicified arenaceous and argillaceous beds. Some of these beds north of 37 consist of reddish to chocolate-brown shale only partly silicified. By association in the field the definite impression is gained that this red shale is parent to the red jasper.

From station 33 westward for about one fourth mile is a ledge of unaltered crystalline limestone. One other exposure of unaltered crystalline limestone occurs near Arctic Castle in the southwest.

For the most part there is very little structural evidence revealed anywhere in this sedimentary belt. Where there is any evidence of the true altitude of the formations they invariably appear to be steep dipping, commonly near vertical, and at a few places there is indication of contorted folding. In some places tight folding has led to granulation of the silica rocks; elsewhere it has led to the deveolpment of chert breccia.

The sediments exposed near Arctic Castle, with the exception of the crystalline limestone already referred to, are mostly metamorphosed to hornfels. Originally they consisted of laminated shale with small lenticles of fine sand (or tuff?). One section exposed at this location shows these beds over a thickness of about 60 yards across the formation which stands nearly vertical. The almost complete induration of the sediments here is without much doubt due to the proximity of the intrusive rocks.

Hornfels outcrop also on the east side of the area near station 43 where they again occur in close relation to intrusive bodies. These rocks here appear to be derived from siltstone. Other sediments observed along the ridge north of station 46 consist of shale or siltstone, greywacke, and small-pebble conglomerate or grit. These clastics were observed mostly as float, and all were confined to a small area suggesting probably a thin-bedded series.

Fine grained sediments near station 46 are much altered by the adjacent intrusive with the conspicuous development a green mineral--probably (?) epidote.

Volcanic and Associated Rocks

Rocks considered under this heading include a number of varieties which, for want of closer correlation, are assigned to three general groups as follows: 1)-Greenstone, including metamorphic rocks probably derived from lava flows, 2)- Pyroclastics, including fragmental rocks coarse enough to be identified without microscopic examination as probably pyroclastic, and 3) "Undifferentiated", a group including those outcrops which probably belong to Harrington's "Greenstones and Associated Sediments", but which do not definitely fall under either of the first two groups mentioned.

There are three locations where the greenstone is well exposed. The best of these is on Arctic Castle in the southwest, and on the spur across Reed Creek northeast of Arctic Castle. At this location the formations

consist of very dense green rock showing no particular identifying structure or texture in hand specimens. On a larger scale however, particularly on Arctic Castle, the expression of the outcrop indicates a number of steep-dipping flows trending from southwest-northeast to east following the conformation of the hill. A second good exposure occurs at station 31 where several flows (?) are exposed trending southwest-northeast. The rock in the several horizons at this location varies from dense, green (epidote?) material to coarser grained phases of the same, with one broad horizon of dense greenstone containing relict quartz and chlorite amygdals. The third location referred to is at station 40 where amygdaloidal greenstone is again exposed in one small outcrop.

Around stations 13, 15, 16, and 17 the several types mentioned above were all observed, but exposures are poor and to some extent here these formations near the intrusive bodies are so indurated that identification is uncertain. Rocks mapped as greenstone here also include some bodies too small to be shown separately, which may be intrusive dolerites.

Pyroclastic rocks are prominently exposed west of Kako Creek in a belt trending southwest-northeast between stations 16 and 17 north of Arctic Castle, and in another belt probably (?) trending east-west at station number 7, north of Base Hill. A coarse fragmental formation occurs also east of Kako Creek in the Chiniklik area as noted on Plate III.

This formation east of Kako Creek consists of greenish-gray breccia with angular fragments of dense volcanic rock up to one half inch in size. No sorting or stratification was observed in any exposure.

In the Chiniklik area, near station 45, a similar formation is considerably coarser, with fragments up to several inches in size. The included fragments here consist partly of chert and hornfels in addition to volcanic material. The formation here is very dense and there are some included crystals which may be xenoblasts.

Across the saddle north of this location this formation, or an older formation similar to it, is considerably contorted and in part schistose. In the field one gains the impression that at both locations contact metamorphism or dynamic metamorphism resulting from the nearby intrusion, is responsible for the present character of the rock.

The "undifferentiated" group of rock referred to is exposed on the ridge at the head of Bobtail Creek, and in outcrops at stations 41 and 42. At stations 8 and 11, south of the head of Bobtail, is more chert similar to the denser varieties of silica rock in the sedimentary belt southwest of Kako Dome. This correlates with nothing in this immediate region and possibly represents contact silicification of country rock near the quartz-felsite body above this location. Many thin quartz seams through the rock favor this view.

Up the slope west of station 8 there are clastic sediments varying from conglomerate, with small black chert pebbles , to fine grained quartzite. On the top

and west side of the ridge is a fine grained fragmental rock resembling very closely the pyroclastic at station 7. Over most of the rest of the ridge near station 9 and station 10 is dense, structureless, greenish-gray rock, cut by limonite-stained joints, which resembles a deeply weathered basic igneous rock. On the weathered surface however, the rock has the appearance of a basic clastic, and on one surface near station 9 faint bedding was observed. Near Windy Creek below station 10 one outcrop resembles greenstone (this outcrop is pyritized), and another outcrop nearby resembles andesite breccia. In summary it may be said that this group of rocks in the ridge above Bobtail probably consists of some greenstone, with considerable volcanic tuff and breccia, and some associated sediments. All of these formations are deeply weathered and very poorly exposed; practically no fresh rock and no formational contacts were observed.

Intrusive Igneous Rocks

The most important occurrence of intrusive igneous rock in the district is that exposed on Base Hill. Other minor bodies which are probably related to this same intrusive are exposed, 1) west of Base Hill, 2) near station 24 north of the East Fork of the Kuyukutuk, and 3) in the Chiniklik district. As indicated on Plate III these intrusives are all mapped as probably quartz-diorite and associated species.

Over most of Base Hill this intrusive consists of

medium to coarse grained wholly crystalline rock, with whitish-gray to glassy feldspars, and considerable quartz; it contains here a little biotite and a minor quantity of other dark accessory minerals not identified. The rock weathers slightly yellowish or brownish gray. Locally on Base Hill the felspars have developed as euhedral rectangular phenocrysts up to 1/4 inch long. In places quartz is abundant in irregular grains nearly as large as the felspar phenocrysts. In other places quartz apparently is not present at all. In general the rock tends to become darker, more dense, and more basic, i.e., with less visible quartz, near exposed contacts. Most of the small exposures west of the Base Hill body are of the darker more basic phase.

The exposure south of station 24 is almost felsitic in texture but contains some felspar and a little quartz in grains large enough to be observed with a hand lens. More notably, this outcrop is mineralized with finely disseminated pyrite. Another small body between station 24 and 26 is similar to the one just described excepting that no pyrite was observed.

The intrusives in the Chiniklik area have the same general appearance as the more basic phase of the intrusive referred to above, and the impression gained in the field is that they are probably derived from the same magma.

For the most part the actual form of the various intrusive bodies is not fully apparent. Many of the

smaller bodies appear to be dike-like and have been so indicated on the map, but actually very few contacts have been observed, and the form of the various bodies has been largely surmized.

On the north side of Base Hill, near stations 7, 11, and 12 are scattered exposures of dense white felsite which may be an acid differentiate of the dioritic intrusive described above. Mostly the texture of this rock is too fine to be observed with a hand lens., but in places it contains small euhedral quartz crystals, and less commonly small euhedral felspar phenocrysts are visible. Narrow dikes of this felsite have been uncovered in the Yukon Mining Company's open cut on Bobtail where they cut greenstone country rock. The gravel and cobbles carried by Montezuma and Buster Creeks are largely composed of similar felsite, and the probability is that intrusive bodies of this rock are more extensive in this part of the area than the outcrop map (Plate III) indicates.

There is a natural tendency to associate the occurrences of gold in the Kako Creek area with the Quartz-felsite. It may very well be that there is such a genetic relationship, particularly as all the important, known placer deposits in the area occur in creeks (Bobtail, Montezuma, and Buster) that drain from the exposed felsite, or apparently cross felsite dikes. There is no direct field evidence bearing on this subject however, and there is little reason to believe therefore that any occurrence of diorite or quartz-diorite in the area may not have been

as closely related to gold deposition as the more acid intrusive. Quartz Creek in the west and Eight ~~Horn~~ Navy Creek in the east, both of which are known to carry some placer gold, each drain from parts of the area where only the more basic phase of the intrusive has been observed.

Basic intrusives no doubt are more common in the area than the map (Plate III) indicates. As previously stated some basic intrusives probably are included among rocks mapped as greenstone. One doubtful occurrence (doubtful because of extensive weathering and decomposition) is located at station 25 in the hills north of the East Fork of the Kuyukutuk. The rock here may have been dolerite. It intrudes the silicious sediments previously described and has given rise to heavy ferruginous material on both margins. Both the marginal deposit and the doubtful rock must be further examined in the laboratory before fully identified.