WATER-POWER INVESTIGATIONS IN SOUTHEASTERN ALASKA.[1]

By GEORGE H. CANFIELD.

INTRODUCTION.

The streams of Alaska have been important factors in its industrial growth. The success of placer mining in northern and central Alaska has depended primarily on the water available for hydraulicking and dredging, and in southeastern Alaska water power has long been used by mines, canneries, sawmills, and other industries, although until recently most of the plants have been small.

Since 1906 the United States Geological Survey has made systematic studies of the water resources of Alaska. Investigations with special reference to placer mining have been made in Seward Peninsula [2] and the Yukon-Tanana region,[3] and reconnaissance surveys for water power have been made about Prince William Sound, Copper River, Kenai Peninsula, and in other parts of southeastern Alaska.

In the summer of 1914 Leonard Lundgren, district engineer of the Forest Service, made a reconnaissance of water-power sites to determine the possibility of establishing the pulp industry in the Tongass National Forest, which covers a large part of southeastern Alaska. In connection with this reconnaissance a census of water powers was taken (see following table), which has been revised by Mr. Lundgren to January 1, 1917, and is here published by courtesy of the Forester.

Developed water powers in southeastern Alaska Jan. 1, 1917, in horsepower.

[Prepared by Leonard Lundgren, district engineer, U. S. Forest Service.]

Ketchikan region:		
Citizens Light, Power & Water Co.	2,000	
New England Fish Co.	2,200	
Miscellaneous plants	1,000	
		5,200
Wrangell region		0

[1] In cooperation with the United States Forest Service.

[2] Henshaw, F. F., and Parker, G. L., Surface water supply of Seward Peninsula, with a sketch of the geography and geology by P. S. Smith and a description of methods of placer mining by A. H. Brooks: U. S. Geol. Survey Water-Supply Paper 314, 1913.

[3] Ellsworth, C. E., and Davenport, R. W., Surface water supply of the Yukon-Tanana region, Alaska: U. S. Geol. Survey Water-Supply Paper 342, 1915; A water-power reconnaissance in south-central Alaska, with a section on southeastern Alaska by J. C. Hoyt: U. S. Geol. Survey Water-Supply Paper 372, 1915.

Sitka region:			
Sitka Wharf & Power Co		350	
Chichagoff Mining Co		750	
Miscellaneous plants		150	
			1,250
Juneau region:			
Alaska-Treadwell Mining Co.:			
Douglas Island plant	4,000		
Sheep Creek plant	4,100		
Nugget Creek plant	5,700		
		13,800	
Alaska-Gastineau Mining Co.:			
Salmon Creek plant, No. 1	5,000		
Salmon Creek plant, No. 2	5,000		
Annex Creek plant	5,000		
		15,000	
Alaska Electric Light & Power Co		1,000	
Miscellaneous plants		1,000	
			30,800
Skagway region			100
			37,350

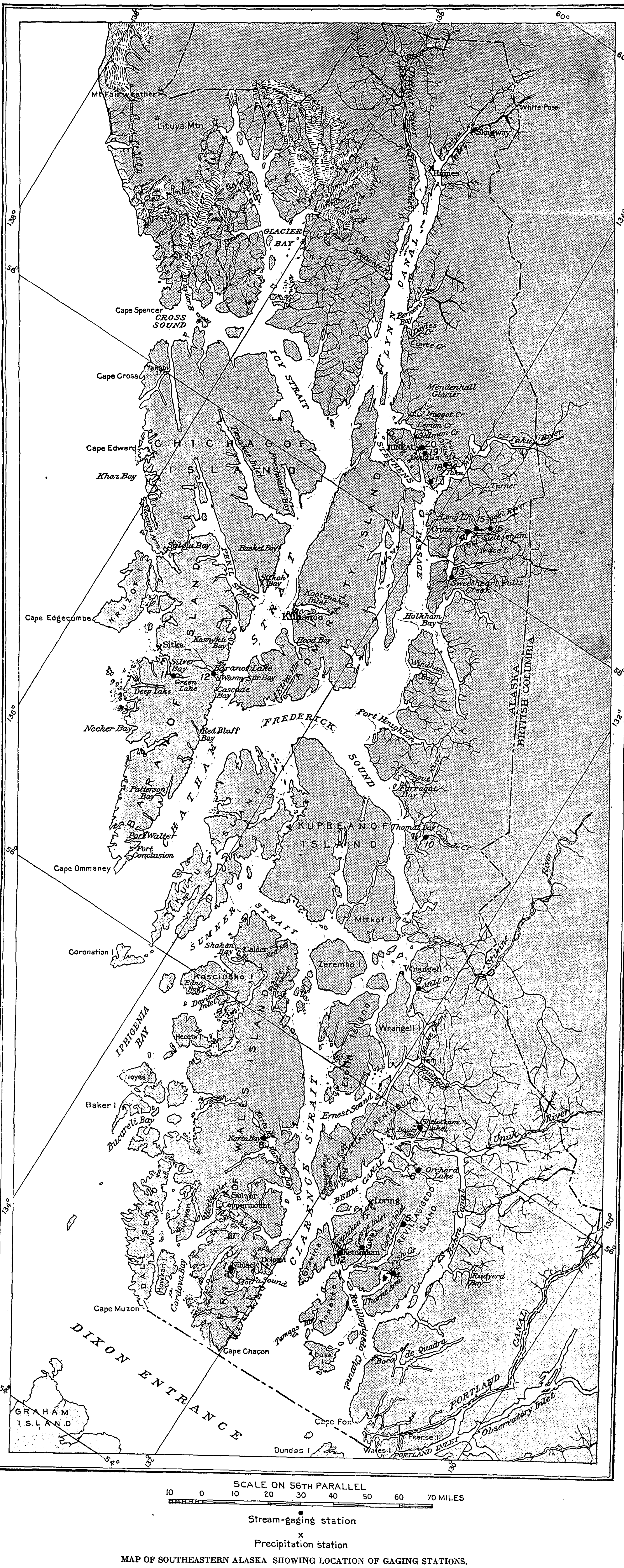
During the last few years some large water-power plants have been installed near Juneau to supply power for mining, and attention has been called to the feasibility of improving other power sites in that region and elsewhere in southeastern Alaska, to meet the increasing demand for power to be used in mining, lumbering, and fisheries, and the possible future demand for its use in the manufacture of wood pulp and electrochemical products. The streams on which it is possible to develop power and the bays or other water bodies into which these streams discharge are listed in the following table and shown on the map (Pl. I):

Streams affording power sites in southeastern Alaska, with position or water bodies into which they flow.

Mainland.

Porcupine River, near Porcupine.[1]
Endicott River, west coast of Lynn Canal.
Sherman Creek.[2]
Cowee and Davies creeks, Berners Bay.
Lemon Creek, near Juneau.[3]
Gold Creek, at Juneau.[4]
Sheep Creek, near Juneau.[4]
Carlson Creek, Taku Inlet.[4]
Turner Lake outlet, Taku Inlet.[5]
Speel River, Speel River project, Port Snettisham.[4]
Grindstone Creek, north shore of Stephens Passage.[4]
Rhein Creek, north shore of Stephens Passage.

[1] Gaging station maintained in 1909 by Porcupine Gold Mining Co.
[2] Gaging station maintained for short period by mining company of Juneau.
[3] Gaging station maintained by Kensington Mining Co., Aug. 17, 1914, to Dec. 31, 1916. See U. S. Geol. Survey Bull. 662, p. 102, 1918.
[4] See list of gaging stations, p. 46.
[5] Gaging station maintained in 1908 and 1909 by Alaska-Treadwell Gold Mining Co.



MAP OF SOUTHEASTERN ALASKA SHOWING LOCATION OF GAGING STATIONS.

Long Lake outlet, Speel River project, Port Snettisham.[1]
Crater Lake outlet, Speel River project, Port Snettisham.[1]
Tease Lake outlet, Speel River project, Port Snettisham.
Sweetheart Falls Creek, south arm of Port Snettisham.[1]
Port Houghton, Stephens Passage.
Farragut Bay, Frederick Sound.
Cascade Creek, Thomas Bay.[1]
Mill Creek, near Wrangell.[1]
Bradfield Canal, upper end of Cleveland Peninsula.
Smugglers Cove, southeast shore of Cleveland Peninsula.
Helm Bay, southeast shore of Cleveland Peninsula.
Shelockum Lake outlet, Bailey Bay.[1]
Chickamin River, east shore of Behm Canal.
Rudyerd Bay, east shore of Behm Canal.

Baranof Island.

Port Conclusion, southeast coast.
Port Walter.[2]
Patterson Bay, east coast.[2]
Red Bluff Bay, east coast.
Cascade Bay, east coast.[2]
Baranof Lake outlet, Warm Spring Bay, east coast.[1]
Kasnyku Bay, east coast.
Green Lake outlet, Silver Bay, west coast.[1]
Necker Bay, west coast.
Deep or Redoubt Lake, west coast.

Chichagof Island.

Slocum Arm, west coast.
Suloia Bay, Peril Strait.[2]
Khaz Bay, west coast.
Freshwater Bay, east coast.
Sitkoh Bay, southeast coast.
Basket Bay, southeast coast.
Penta Bay, west coast.

Admiralty Island.

Kootznahoo Inlet, west coast.
Hood Bay, west coast.

Kosciusko Island.

Davidson Inlet.[2]

Prince of Wales Island.

Karta River, Karta Bay.[1]
Whale Passage, behind Thorne Island, northeast coast.
Myrtle Lake outlet, near Niblack post office.[1]
Reynolds Creek, near Coppermount.

Revillagigedo Island.

Orchard Lake outlet, at Shrimp Bay.[1]
Beaver Falls, George Inlet.[1]
White River, George Inlet.
Swan Lake outlet, east shore near head of Carroll Inlet.[1]
Fish Creek, Thorne Arm.[1]
Gokatchin Creek, Thorne Arm.
Ketchikan Creek, at Ketchikan.[1]

Annette Island.

Tamgas Harbor.

[1] See list of gaging stations, p. 46.
[2] See list of miscellaneous measurements at end of report.

Lack of definite information in regard to the quantity of water available and other physical factors that determine the feasibility of a power site has been one of the principal impediments to development. For this reason a systematic investigation, designed to determine the location and the feasibility of water-power sites in southeastern Alaska, was begun by the Geological Survey, in cooperation with the Forest Service, in the spring of 1915.

The practicability of a water-power site depends on the quantity of water available, the fall, and the possibility of storing water. Information in regard to fall and storage can be obtained by surveys at any time, but the volume and distribution of flow can be determined only by observations extending over several years, as future flow must be predicted from that of the past. In beginning the investigations, therefore, the collection of stream-flow data was given precedence and constituted the principal work. Some general information, however, has been obtained, and in the fall of 1915 a few rainfall stations were established at higher elevations to supplement observations at mean sea level by the United States Weather Bureau. As a result of the investigations records of flow are now available for 20 gaging stations, as shown by the following list and indicated by corresponding numbers on Plate I. The date of establishment is indicated in parentheses.

1. Myrtle Lake outlet at Niblack, Prince of Wales Island (July 30, 1917).
2. Ketchikan Creek at Ketchikan (established November 1, 1909; discontinued June 30, 1912; reestablished July 1, 1915).
3. Beaver Falls Creek at George Inlet, Revillagigedo Island (Aug. 3, 1917).
4. Fish Creek near Sea Level, Revillagigedo Island (May 19, 1915).
5. Swan Lake outlet at Carroll Inlet, Revillagigedo Island (Aug. 24, 1916).
6. Orchard Lake outlet at Shrimp Bay, Revillagigedo Island (May 28, 1915).
7. Shelockum Lake outlet at Bailey Bay (June 4, 1915).
8. Karta River at Karta Bay, Prince of Wales Island (July 16, 1915).
9. Mill Creek on mainland, near Wrangell (June 17, 1915).
10. Cascade Creek at Thomas Bay, near Petersburg (Oct. 27, 1917).
11. Green Lake outlet at Silver Bay, near Sitka (August 22, 1915).
12. Baranof Lake outlet at Baranof, Baranof Island (June 28, 1915).
13. Sweetheart Falls Creek near Snettisham (July 31, 1915).
14. Crater Lake outlet at Speel River, Port Snettisham (Jan. 23, 1913).
15. Long River below Second Lake, at Port Snettisham (Nov. 11, 1915).
16. Speel River at Port Snettisham (July 15, 1916).
17. Grindstone Creek at Stephens Passage (May 6, 1916).
18. Carlson Creek at Sunny Cove, Taku Inlet (July 18, 1916).
19. Sheep Creek near Thane (July 26, 1916).
20. Gold Creek at Juneau (July 20, 1916).

In addition to the stations in this list, records for Long Lake outlet (Jan. 23, 1913, to Nov. 10, 1915) and for Sherman Creek at Kensington mine, Lynn Canal (Aug. 17, 1914, to Dec. 31, 1916) are contained in the report for 1916.[1]

[1] U. S. Geol. Survey Bull. 662, pp. 136–139, 150–153, 1918.

The available power sites in each area were carefully considered, and gaging stations were established at those which apparently afforded the greatest opportunities for development.

The records have been collected in accordance with the standard methods used elsewhere in the United States by the Geological Survey. Owing to the inaccessibility of the stations, water-stage recorders were used at all the stations except that on Ketchikan Creek, and cables have been installed from which discharge measurements are made. Special arrangements were made for observations through the winter to obtain a record of the low-water flow which occurs at that season.

The data collected at the gaging stations are presented in the following pages and include a general description of each station and tables showing the results of discharge measurements and the computed daily discharge.

Much of the work has been made possible by the use of the Forest Service launches, on which transportation has been furnished to the engineers and others engaged in installing and maintaining the stations. The local knowledge of the Forest Service employees has also been of great assistance in carrying on the work, and special acknowledgment is due to W. G. Weigle, forest supervisor at Ketchikan, who has represented the Forest Service in the cooperation; to Leonard Lundgren, district engineer; and to George L. Drake, J. W. Wyckoff, C. T. Gardner, George H. Peterson, James Allen, W. H. Babbitt, Lyle Blodgett, and Milo Caughrean, who have assisted in various ways.

During the winter of 1916–17 the field work was carried on by C. O. Brown, assistant engineer, United States Geological Survey.

The following individuals and organizations assisted in maintaining gaging stations as indicated:

T. J. Jones, Seattle, Wash., furnished a Stevens water-stage recorder, materials, and labor for installing a gage on Swan Lake outlet.

The Alaska Gastineau Mining Co. installed gages and furnished gage-height records for Gold Creek near Juneau, Sheep Creek near Thane, and Carlson Creek at Sunny Cove.

The Alaska Taku Mining Co. furnished a Lietz gage, labor, material, and transportation for the installation of a gage on Grindstone Creek at Taku Inlet.

The Speel River Project (Inc.), of Juneau, installed and maintained gages and furnished gage readings for Crater Lake outlet at Speel River, Long Lake outlet at Port Snettisham, Long River below Second Lake, and Speel River at Port Snettisham.

The Kensington Mining Co., of Comet, furnished gage readings for Sherman Creek at Kensington mine.

The Citizens Light, Power & Water Co., of Ketchikan, furnished gage readings for Ketchikan Creek at Ketchikan.

The G. M. Wakefield Mineral Lands Co. furnished gage, materials, and part of labor for the installation of a gaging station on Myrtle Lake outlet at Niblack; maintained gage, and furnished gage record. Mr. C. W. Bloodgood furnished gage and part of materials for installation of gaging station on Cascade Creek at Thomas Bay.

GAGING-STATION RECORDS.

MYRTLE CREEK AT NIBLACK, PRINCE OF WALES ISLAND.

LOCATION.—Halfway between beach and Myrtle Lake outlet which is one-third mile from tidewater, 1 mile from Niblack in north arm of Moira Sound, Prince of Wales Island, and 35 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 30 to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on right bank; reached by a trail which leaves beach near mouth of creek.

DISCHARGE MEASUREMENTS.—At medium and high stages from a cable across creek at outlet of lake; at low stages made by wading.

CHANNEL AND CONTROL.—The gage is in a pool 10 feet upstream from a contracted portion of channel at a rocky riffle which forms a well-defined and permanent control. At the cable section the bed is smooth, the water deep, and the current uniform and sluggish.

EXTREMES OF STAGE.—Maximum stage during the period 4.40 feet at 5 p. m. November 18; minimum stage, 1.27 feet at 7 a. m. August 10.

ICE.—Stage-discharge relation not affected by ice. Data inadequate for determination of discharge.

Myrtle Lake, the outlet of which is 800 feet from tidewater, is at an elevation of 95 feet above sea level and is 122 acres in area. Niblack Lake, the outlet of which is 5,700 feet from tidewater, is at an elevation of 450 feet above sea level and is 383 acres in area. Mary Lake, which is unsurveyed, is about 6,000 feet from tidewater and 650 feet above sea level.

Discharge measurements of Myrtle Creek at Niblack in 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
July 30	G. H. Canfield	1.39	42
Nov. 26	do	2.81	164

Daily gage height, in feet, of Myrtle Creek at Niblack for 1917.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.46	1.87	2.17	3.8	2.15	16		1.82	2.00	1.96	3.55	1.80
2		1.49	1.78	2.40	3.6	1.95	17		1.85	1.88	2.10	4.05	1.77
3		1.41	1.72	2.49	3.25	1.90	18		2.13	1.90	2.55	4.3	1.73
4		1.37	1.66	2.47	3.25	1.85	19		2.6	2.03	2.42	4.1	1.70
5		1,35	1.61	2.7	3.5	1.82	20		2.39	1.95	2.55	3.7	1.68
6		1.34	1.56	2.42	4.05	1.78	21		2.16	1.95	2.42	3.35	1.66
7		1.32	1.52	2.28	4.1	1.75	22		2.31	1.98	2.55	3.05	1.64
8		1.29	1.49	2.22	3.75	2.05	23		2.18	1.93	2.50	2.9	1.62
9		1.29	1.45	2.16	3.4	2.35	24		2.06	1.88	2.43	2.9	1.59
10		1.31	1.42	2.14	3.5	2.40	25		1.94	1.93	2.36	2.85	1.58
11		1.43	1.42	2.20	3.25	2.30	26		2.00	1.97	2.25	2.9	1.56
12		1.40	1.73	2.13	3.15	2.15	27		2.27	2.10	2.16	3.1	1.54
13		1.38	1.82	2.15	3.75	2.00	28		2.43	2.42	2.65	2.85	1.53
14		1.40	1.87	2.08	4.3	1.92	29		2.20	2.35	2.7	2.6	2.05
15		1.67	2.01	2.02	3.95	1.80	30	1.39	2.06	2.23	2.85	2.35	2.6
							31	1.38	1.96		3.1		3.1

NOTE.—Gage heights Nov. 29 to Dec. 15 and Dec. 21-31 estimated from maximum and minimum stages indicated by recorder and comparison with gage-height graph for Karta River.

KETCHIKAN CREEK AT KETCHIKAN.

LOCATION.—One-fourth mile below power house of Citizens Light, Power & Water Co., one-third mile northeast of Ketchikan post office, downstream 200 feet from mouth of Schoenbar Creek (entering from right), 1¼ miles from mouth of Granite Basin Creek (entering from left), and 1½ miles from outlet of Ketchikan Lake.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—November 1, 1909, to June 30, 1912; June 9, 1915, to December 31, 1917.

GAGE.—Vertical staff fastened to a telephone pole near board walk on left bank at bend of creek 200 feet downstream from mouth of Schoenbar Creek; read by employee of the Citizens Light, Power & Water Co. The gage used since June 9, 1915, consists of the standard United States Geological Survey enameled gage section graduated in hundredths, half-tenths, and tenths from zero to 10 feet. The original gage, established November, 1909, and read until June 30, 1912, is at same location and same datum. It is a staff with graduations painted every tenth.

DISCHARGE MEASUREMENTS.—At medium and high stages from footbridge about 500 feet upstream from gage; measuring section poor, as the bridge makes an angle of 20° with the current, and at high stages the flow is broken by large stumps near left bank and at middle of bridge. Low-stage measurements made by wading 50 feet below bridge or at another section 100 feet above gage. The flow of Schoenbar Creek has been added to obtain total flow past gage.

CHANNEL AND CONTROL.—Gage is located in a large deep pool of still water at a bend in creek. The bed of the stream at the outlet of this pool is a solid rock ledge, but changes in a gravel bar at lower right side of pool cause occasional changes in stage-discharge relation.

EXTREMES OF DISCHARGE.—Maximum stage recorded during year, 8.3 feet, November 18 (discharge not determined); minimum stage recorded, 0.08 foot December 27 (discharge not determined).

1909–1912 and 1915–1917: Maximum stage recorded 8.3 feet November 18, 1917; minimum stage recorded 0.28 foot September 24, 1915 (discharge, 34 second-feet). A stage of 0.08 foot recorded December 27, 1917, but rating curve is not sufficiently well defined to determine discharge at that stage.

ICE.—Ice forms along banks but control remains open.

DIVERSIONS.—A small quantity of water is diverted above the station for the use of the town of Ketchikan, the New England Fish Co., and the Standard Oil Co.

REGULATION.—Small timber dam and headgates are located at outlet of Ketchikan Lake. Water diverted through power house is returned to creek above gage but causes very little diurnal fluctuation. During low water the flow is increased by water from the reservoir.

ACCURACY.—Stage-discharge relation changed during high water August 19. Rating curve used January 1 to August 18 well defined below and poorly defined above 2,000 second-feet. Gage read to hundredths once daily. Daily discharge ascertained by applying gage height to rating table. Sufficient discharge measurements have not been made to define rating curve applicable August 19 to December 31. Records fair.

Discharge measurements of Ketchikan Creek at Ketchikan in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 24	C. O. Brown	1.13	151	Oct. 18	G. H. Canfield	0.94	172
Aug. 24	G. H. Canfield	1.23	218	Nov. 27	....do	2.20	615
26	....do	1.10	191				

Daily discharge, in second-feet, of Ketchikan Creek at Ketchikan for period Jan. 1 to Aug. 18, 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	118	61	54	42	125	228	720	180
2	69	54	54	42	93	196	382	200
3	71	54	61	245	90	196	493	160
4	66	108	66	241	74	196	720	180
5	64	176	69	125	76	220	616	160
6	74	249	66	99	160	308	357	160
7	142	232	61	82	160	216	382	160
8	262	285	54	79	523	436	285	160
9	87	212	50	76	285	262	180	142
10	262	216	50	76	220	196	160	241
11	267	168	52	71	216	200	160	142
12	115	125	54	76	220	204	142	125
13	82	523	52	76	212	204	142	108
14	79	450	48	64	200	204	142	160
15	74	740	44	64	180	204	142	285
16	64	377	44	64	180	196	139	241
17	66	180	66	66	180	204	139	332
18	66	118	61	90	285	553	142	1,290
19	85	108	54	142	220	493	142	....
20	74	69	61	176	200	332	125	....
21	61	66	54	142	180	382	125	....
22	64	66	71	139	172	357	125	....
23	102	64	69	142	160	220	125	....
24	142	64	56	142	176	220	285	....
25	204	61	54	142	180	180	155	....
26	125	61	54	142	176	180	125	....
27	122	64	44	142	180	180	180	....
28	90	54	44	139	180	160	142	....
29	66	....	46	142	216	160	142	....
30	64	....	44	139	220	180	142	....
31	61	....	42	....	220	....	180	....

Daily gage height, in feet, of Ketchikan Creek at Ketchikan for period Aug. 19 to Dec. 31, 1917.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	......	0.60	1.00	5.4	0.50	16	......	1.18	1.00	1.9	0.20
2	......	.60	1.80	4.4	.42	17	......	.90	1.00	3.5	.20
3	......	.50	1.84	1.8	.34	18	......	1.00	1.00	8.3	.20
4	......	.50	1.40	1.4	.20	19	6.0	.80	.90	5.3	.18
5	......	.50	3.30	1.2	.30	20	4.0	.60	1.40	2.9	.18
6	......	.50	1.70	4.0	.40	21	2.0	.60	1.50	2.0	.16
7	......	.46	1.20	7.7	.90	22	4.5	.60	2.5	1.2	.10
8	......	.40	.90	3.4	2.1	23	1.8	.58	2.4	1.2	.10
9	......	.40	.82	1.8	.90	24	1.3	.58	1.3	1.8	.10
10	......	.40	.70	2.4	.50	25	1.1	1.10	1.2	1.9	.10
11	......	.50	1.40	1.9	.30	26	1.0	.66	1.3	1.6	.10
12	......	.56	1.20	1.6	.20	27	1.4	1.10	1.2	2.5	.08
13	......	.60	1.00	6.3	.20	28	2.0	1.40	1.7	1.4	.10
14	......	.80	.90	7.8	.20	29	1.2	1.62	1.3	.9	1.12
15	......	1.10	1.00	3.7	.20	30	1.1	1.56	2.8	.64	1.30
						31	1.06	....	....	....	1.20

Monthly discharge of Ketchikan Creek at Ketchikan for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	267	61	106	6,520
February	740	54	179	9,940
March	71	42	54.8	3,370
April	245	42	114	6,780
May	523	74	192	11,800
June	553	160	249	14,800
July	720	125	240	14,800
August 1-18	1,290	108	246	8,780
The period	....	....	....	76,800

BEAVER FALLS CREEK AT GEORGE INLET, REVILLAGIGEDO ISLAND.

LOCATION.—Two hundred feet above diversion dam and flume for shingle mill and salmon cannery; 800 feet from beach on west shore of George Inlet; 10 miles by water from Ketchikan.

DRAINAGE AREA.—5.9 square miles (United States Forest Service survey made in 1917).

RECORDS AVAILABLE.—August 3 to October 10, 1917.

GAGE.—Stevens continuous water-stage recorder on left bank, a quarter of a mile from tidewater; reached by a corduroy trail which leaves beach back of cannery buildings. The gage was washed out by high water in November.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from log-gaging bridge across stream a quarter of a mile upstream from gage; at low stages made by wading under bridge.

CHANNEL AND CONTROL.—The gage is in a partly sheltered pool in a narrow, deep, rocky canyon, 15 feet upstream from a small rocky fall, which forms a well-defined and permanent control.

DIVERSIONS.—A small quantity of water is diverted about 200 yards below station into a flume for use of shingle mill and cannery.

Lower Silvis Lake, whose elevation is 790 feet above sea level, is 1½ miles from the beach, and its area is 62 acres. The elevation of upper Silvis Lake, whose outlet is only 1,100 feet from the upper end of the lower lake, is 1,100 feet above sea level, and its area is 234 acres. Drainage area above outlet of lower lake is 4.9 square miles; above outlet of upper lake, 3.6 square miles.

Data inadequate for determination of discharge.

Discharge measurements of Beaver Falls Creek at George Inlet in 1917.

[Made by G. H. Canfield.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
July 26	....	88	Oct. 13	1.71	149
Aug. 3	1.30	83	Oct. 18	1.32	98

Daily gage height, in feet, of Beaver Falls Creek at George Inlet for 1917.

Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.	Day.	Aug.	Sept.	Oct.
1	......	0.68	1.66	11	1.13	0.35	......	21	2.53	1.93	......
2	......	.60	2.80	12	1.08	.79	......	22	3.42	1.58	......
3	1.35	.57	2.31	13	1.00	1.28	......	23	2.34	1.18	......
4	1.17	.48	3.29	14	1.08	2.09	......	24	......	1.85	......
5	1.07	.43	2.01	15	2.16	2.42	......	25	......	2.50	......
6	.98	.39	1.28	16	3.05	1.85	......	26	......	1.68	......
7	.95	.36	1.03	17	3.10	1.28	......	27	2.63	3.08	......
8	.90	.33	.87	18	4.03	1.75	......	28	2.75	2.96	......
9	.86	.30	1.07	19	4.40	1.22	......	29	1.80	2.24	......
10	.90	.29	1.76	20	3.54	1.28	......	30	1.11	1.37	......
								31	.82	......	......

FISH CREEK NEAR SEA LEVEL, REVILLAGIGEDO ISLAND.

LOCATION.—In latitude 55° 24′ N., longitude 131° 12′ W., near outlet of Lower Lake on Fish Creek, 600 feet from tidewater at head of Thorne Arm, 2 miles northwest of mine at Sea Level, and 25 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 19, 1915, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on right shore of Lower Lake, 200 feet above outlet.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable across creek, 1 mile upstream from gage and 500 feet above head of Lower Lake; at low stages made by wading at cable. Only one small creek enters Lower Lake, at point opposite gage, between the cable site and control.

CHANNEL AND CONTROL.—The lake is about 500 feet wide opposite the gage. Outlet consists of two channels, each about 60 feet wide, separated by an island 40 feet wide. From the lake to tidewater, 200 feet, the creek falls 20 feet. Bedrock exposed at the outlet of the lake forms a well-defined and permanent control.

EXTREMES OF DISCHARGE.—Maximum stage during year, 5.33 feet at 6 p. m. November 1 (discharge, computed from an extension of rating curve, 4,600 second-feet); minimum stage 0.81 foot, March 16 (discharge, 57 second-feet).

1915–1917: Maximum stage 5.33 feet November 1, 1917 (discharge, 4,600 second-feet); minimum stage, 0.50 foot, February 11, 1916 (discharge, 22 second-feet).

ICE.—Lower Lake freezes over, but as gage is set back in the bank ice does not form in well, and the relatively warm water from the lake and the swift current keep the control open.

ACCURACY.—Stage-discharge relation affected by brush lodged at control January 1 to August 17; most of brush removed April 10 and remainder washed out on August 17. Rating curve used January 1 to April 10 well defined below and poorly defined above 400 second-feet; curve used April 11 to August 17 well defined; curve used August 18 to December 31 is open-water curve used May 19, 1915, to August 23, 1916, and is well defined below and extended above 1,500 second-feet. Operation of water-stage recorder satisfactory except for periods indicated by breaks in record shown in the footnote to daily-discharge table. Daily discharge ascertained by applying to rating table daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean daily gage heights for regular intervals of day. Records excellent, except for short periods of break in record and for period when control was obstructed by brush, for which they are fair.

There are three large lakes in the upper drainage basin: Big Lake, 2 miles from beach at elevation 275 feet, covers 1,700 acres; Third Lake, 250 acres; and Mirror Lake, at elevation 1,000 feet, 800 acres. Two-thirds of the drainage basin is covered with a thick growth of timber and brush interspersed with occasional patches of beaver swamp and muskeg. Only the tops of the highest mountains are bare. This large area of lake surface and vegetation, notwithstanding the steep slopes and shallow soil, affords a little ground storage and after a heavy precipitation maintains a good run-off. During a dry, hot period in summer, however, after the snow has melted, the flow becomes very low because of lack of ice or glaciers in the drainage basin.

Discharge measurements of Fish Creek near Sea Level in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 25	C. O. Brown	a1.48	243	June 23	G. H. Canfield	c1.89	557
Mar. 2	do	a.86	65	Oct. 12	do	d1.82	550
Apr. 16	G. H. Canfield	b1.16	164				

a Control obstructed by brush and logs.
b Part of obstruction on control removed Apr. 10.
c Obstruction on control.
d Control clear.

Daily discharge, in second-feet, of Fish Creek near Sea Level for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	137	130	76	70	394	710	482	256	254	857	4,240	302
2	135	119	67	69	382	616	623	354	208	686	3,680	243
3	127	107	69	70	370	547	670	370	168	830	3,940	192
4	119	96	83	127	342	495	870	315	142	766	1,200	161
5	109	87	83	159	337	502	978	265	126	1,060	1,300	142
6	107	93	76	176	354	766	906	234	108	1,030	1,620	123
7	156	169	72	190	382	879	734	212	96	694	2,500	126
8	284	278	72	162	595	1,150	630	188	87	539	2,620	200
9	408	290	70	137	897	1,150	528	170	82	428	1,780	302
10	499	284	67	132	897	822	436	152	76	368	1,400	351
11	492	284	65	130	670	609	382	148	73	395	974	296
12	408	284	64	130	540	502	354	152	91	525	750	243
13	316	300	64	130	560	450	320	162	197	588	1,380	192
14	244	420	62	130	567	456	290	168	384	553	3,000	161
15	202	788	58	136	521	456	270	265	870	486	2,680	139
16	166	874	57	162	469	436	265	581	1,730	440	1,730	123
17	143	748	69	180	436	406	275	1,150	1,250	440	1,820	116
18	127	541	98	194	443	514	275	1,960	814	486	3,220	108
19	127	338	91	242	495	942	275	2,380	618	454	3,900	101
20	132	227	89	270	514	1,050	265	2,260	480	532	3,060	96
21	137	179	87	256	495	942	252	1,510	384	588	1,840	89
22	198	162	91	242	443	806	242	1,040	368	806	1,160	84
23	198	143	107	229	394	616	229	857	525	947	830	80
24	198	127	102	224	370	502	275	618	460	947	702	76
25	249	114	98	251	400	436	388	447	473	848	602	73
26	263	102	107	275	482	406	388	351	694	655	602	69
27	244	91	100	305	581	376	337	318	726	512	774	61
28	198	83	93	337	670	354	295	492	1,190	574	734	61
29	169	....	87	365	742	342	260	525	1,680	744	574	180
30	153	....	82	388	766	337	234	414	1,300	1,080	414	606
31	140	....	76	....	726	....	220	324	....	2,690	....	1,730

NOTE.—Discharge Jan. 21–24, Jan. 29 to Mar. 1, Apr. 5–16, Oct. 3–11 estimated, because of stopping gage clock, from maximum and minimum stages indicated by the recording pencil, from weather records, and from comparison of the hydrograph for this stream with hydrographs of other streams in near-by drainage basins.

Monthly discharge of Fish Creek near Sea Level for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	499	107	212	13,000
February	874	83	266	14,800
March	107	57	80.2	4,930
April	388	69	196	11,700
May	897	337	524	32,200
June	1,150	337	619	36,800
July	978	220	418	25,700
August	2,380	148	601	37,000
September	1,730	73	524	31,300
October	2,690	368	727	44,700
November	4,240	414	1,830	109,000
December	1,730	61	220	13,500
The year	4,240	57	518	375,000

SWAN LAKE OUTLET AT CARROLL INLET, REVILLAGIGEDO ISLAND.

LOCATION.—Halfway between Swan Lake and tidewater; on east shore of Carroll Inlet, 1 mile from its head; 30 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 24, 1916, to October 13, 1917.

GAGE.—Stevens continuous water-stage recorder on left bank, half a mile from tidewater; reached by a trail which leaves beach back of old cabin one-fourth mile south of mouth of creek. Gage was washed out by extreme high water in November, 1917.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from a cable across stream 100 feet downstream from gage; at low stages made by wading.

CHANNEL AND CONTROL.—The gage well is in a deep pool 25 feet upstream from a contracted portion of channel, where a fall of a foot over bedrock forms a permanent control. The effect of the violent fluctuation of the water surface outside of gage well is decreased in the inner float well because the intake holes at the bottom are very small. At the cable section the bed is rough, the water shallow, and the current very swift. Point of zero flow is at gage height 0.0±0.2 foot.

EXTREMES OF DISCHARGE.—Maximum stage during period, 6.35 feet at 7 p. m. August 19, 1917 (discharge, computed from extension of rating curve, 1,900 second-feet); minimum stage, 1.01 feet at 10 p. m. April 2, 1917 (discharge, 39 second-feet).

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve fairly well defined between 50 and 900 second-feet. Operation of water-stage recorder satisfactory except January 1–25 and September 16–30. Daily discharge ascertained by applying to rating table daily gage height determined by inspecting gage-height graph. Records fair.

Swan Lake, whose area is about 350 acres, is 1½ miles from tidewater, at an elevation of 225 feet above sea level.

Discharge measurements of Swan Lake outlet at Carroll Inlet in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 26	C. O. Brown	1.72	205	Apr. 7	G. H. Canfield	1.52	141
Feb. 2	.....do	1.27	78	June 23	.....do	3.14	645

Daily discharge, in second-feet, of Swan Lake outlet at Carroll Inlet for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	104	92	82	44	452	799	816	388	319	
2	99	80	78	42	423	716	850	452	272	
3	96	76	71	40	407	633	918	426	238	
4	84	89	71	58	398	584	1,060	378	213	
5	78	145	67	102	404	633	1,020	344	173	
6	74	251	65	136	468	816	952	325	170	
7	169	356	62	148	534	850	782	294	154	
8	263	468	60	142	833	969	683	285	139	
9	340	468	58	133	969	969	600	260	127	
10	404	436	54	130	833	799	551	254	118	
11	388	391	52	133	650	666	518	254	115	
12	340	344	53	130	584	584	485	269	124	
13	272	414	52	130	666	567	452	282	288	683
14	216	518	49	133	650	633	423	306	468	
15	163	891	46	148	584	633	436	551	1,010	
16	136	901	44	172	551	617	430	910		
17	109	683	45	200	534	584	452	1,300		
18	96	502	53	229	568	666	452	1,600		
19	96	375	62	260	584	864	449	1,700		
20	99	294	60	278	584	884	426	1,600		
21	104	235	59	269	534	833	433	1,160		
22	124	191	59	263	485	765	388	986		
23	127	169	69	260	446	666	372	833		
24	127	145	65	282	452	584	468	650		
25	191	127	62	334	534	567	534	502		
26	206	112	62	375	650	551	502	430		
27	184	102	62	398	749	518	426	468		
28	154	89	58	433	816	502	394	600		
29	133		54	452	867	502	356	518		
30	115		53	485	850	502	337	420		
31	102		48		833		340	388		

NOTE.—Discharge Jan. 1–25 estimated from maximum and minimum stages indicated by recording pencil and comparison with gage-height graphs for Fish Creek near Sea Level; discharge Sept. 16–30 estimated at 1,100 second-feet by comparison with records of flow for Fish Creek.

Monthly discharge of Swan Lake outlet at Carroll Inlet for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	404	74	168	10,300
February	901	76	319	17,700
March	82	48	59.2	3,600
April	485	40	211	15,600
May	969	398	609	37,400
June	969	502	682	40,600
July	1,060	337	558	34,300
August	1,700	254	618	38,000
September			681	40,500
The period				238,000

ORCHARD LAKE OUTLET AT SHRIMP BAY, REVILLAGIGEDO ISLAND.

LOCATION.—In latitude 55° 50′ N., longitude 131° 27′ W., at outlet of Orchard Lake, one-third mile from tidewater at head of Shrimp Bay, an arm of Behm Canal, 46 miles by water from Ketchikan.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 28, 1915, to October 10, 1917.

GAGE.—Stevens continuous water-stage recorder on right bank 300 feet below Orchard Lake and 100 feet above site of timber-crib dam, which was built in 1914 for proposed pulp mill and washed out by high water August 10, 1915. Datum of gage lowered 2 feet September 15, 1915. Gage heights May 29 to August 10, 1915, referred to first datum; August 11, 1915, to August 17, 1916, to second datum. Datum of gage lowered 1 foot August 17, 1916. Gage heights August 18, 1916, to October 10, 1917, referred to this datum. Gage washed out in November, 1917.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable 50 feet downstream from gage; at low stages by wading near cable.

CHANNEL AND CONTROL.—From Orchard Lake, at elevation 134 feet above high tide, the stream descends in a series of rapids for 1,000 feet through a narrow gorge, then divides into two channels and enters the bay in two cascades of 100-foot vertical fall. Opposite the gage the water is deep and the current sluggish. At the site of the old dam bedrock is exposed, but for 30 feet upstream the channel is filled in with loose rock and brush placed during construction of dam. This material forms a riffle which acts as a control for water surface at gage at low and medium stages and is scoured down when ice goes out of lake; the rock outcrop at site of old dam acts as a control at high stages and is permanent.

EXTREMES OF DISCHARGE.—Maximum stage during period, 8.4 feet at 2 a. m. October 16, 1915 (discharge 6,230 second-feet); minimum discharge estimated, 20 second-feet February 11, 1916.

ICE.—Ice forms on Orchard Lake, but because of swift current and relatively warm water from lake the outlet and control remain open.

ACCURACY.—Stage-discharge relation changed January 12 when logs lodged on control; also on August 16, when logs were washed out and old gravel cofferdam under cable was scoured down farther. Rating curve used January 1–11 same as curve used April 13 to December 31, 1916, and is fairly well defined. Seven discharge measurements were made and six points for platting were computed by comparison with record of Fish Creek during the period January 1 to October 10 by means of which rating curves have been constructed which are applicable as follows: January 12 to August 16, well defined below and poorly defined above 500 second-feet; August 17 to October 10, poorly defined. Operation of water-stage recorder satisfactory, except January 15–29, when it stopped. Daily discharge ascertained by applying to rating tables daily gage height, determined by inspecting gage-height graph, or for days of considerable fluctuation by averaging the discharge for equal intervals of the day. Records fair.

The highest mountains on this drainage basin are only 3,500 feet above sea level and are covered to an elevation of 2,500 feet by a heavy stand of timber and a thick undergrowth of brush, ferns, alders, and devil's club. The topography is not so rugged as that of the area surrounding Shelockum Lake, and the proportion of vegetation, soil cover, and lake area is greater, so that more water is stored and the flow in the Orchard Lake drainage basin is better sustained.

Discharge measurements of Orchard Lake outlet at Springs Bay in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 30	Brown and Gardner	1.04	101	Aug. 1	Drake and Blodget	2.38	460
Mar. 6	do	.74	67	26	C. T. Gardner	2.09	358
Apr. 14	G. H. Canfield	1.39	180	Oct. 11	G. H. Canfield	3.26	880
June 21	do	4.22	1,070				

Daily discharge, in second-feet, of Orchard Lake outlet at Shrimp Bay for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	93	82	79	54	690	1,400	935	380	270	840
2	91	72	74	50	595	1,140	1,020	495	226	807
3	89	65	70	49	578	970	1,100	465	192	1,380
4	84	67	70	62	542	858	1,430	380	166	1,170
5	76	95	70	123	560	948	1,340	342	150	2,080
6	77	165	67	172	630	1,280	1,170	318	136	1,220
7	133	282	66	184	770	1,370	690	280	123	710
8	262	435	66	182	1,170	1,400	730	262	116	560
9	357	495	65	170	1,490	1,250	630	230	110	455
10	398	465	62	161	1,170	995	560	218	105	410
11	440	420	61	170	835	860	525	216	102	
12	322	355	61	170	690	790	510	235	112	
13	248	368	60	170	970	770	465	239	249	
14	196	495	56	174	1,020	880	420	300	450	
15	163	1,000	54	214	880	880	420	606	1,500	
16	125	1,400	51	264	835	790	405	1,150	2,370	
17	98	880	52	330	792	750	450	2,560	1,700	
18	78	578	60	380	880	790	435	2,860	1,180	
19	79	392	72	380	835	995	435	2,880	915	
20	83	290	75	405	835	1,020	435	2,420	630	
21	83	222	72	380	730	1,070	495	1,520	508	
22	83	183	74	368	650	1,070	420	1,300	840	
23	83	154	78	368	595	860	380	1,060	890	
24	85	130	75	432	630	750	510	730	690	
25	132	117	68	510	835	750	730	525	730	
26	216	106	70	578	1,070	750	710	410	890	
27	188	95	67	612	1,370	670	525	410	790	
28	154	86	65	670	1,520	612	435	508	2,000	
29	128		62	710	1,640	595	372	508	2,240	
30	112		56	770	1,550	595	318	410	1,480	
31	95		54		1,430		318	328		

NOTE.—Discharge Jan. 1-14 estimated, because of stopping of clock, from maximum and minimum stages indicated by the recorder, from weather records, and from records of flow for Karta River.

Monthly discharge of Orchard Lake outlet at Shrimp Bay for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	440	76	157	9,650
February	1,400	65	339	18,800
March	79	51	65.6	4,030
April	770	49	309	18,400
May	1,640	542	928	57,100
June	1,400	595	929	55,300
July	1,430	318	623	38,300
August	2,880	215	791	48,600
September	2,370	102	729	43,400
October 1-10	2,080	410	963	19,100
The period				313,000

SHELOCKUM LAKE OUTLET AT BAILEY BAY.

LOCATION.—In latitude 56° 00′ N., longitude 131° 36′ W., on mainland near outlet of Shelockum Lake, three-fourths mile by Forest Service trail from tidewater at north end of Bailey Bay, and 52 miles by water north of Ketchikan.

DRAINAGE AREA.—18 square miles (measured on sheets Nos. 5 and 8 of the Alaska Boundary Tribunal, edition of 1895).

RECORDS AVAILABLE.—June 1, 1915, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on right shore of lake, 250 feet above outlet. Gage house was pushed off the well by a snowslide January 4, 1917. Gage not put into operation again until May 23.

DISCHARGE MEASUREMENTS.—Made from cable across outlet of lake, 200 feet below gage and 50 feet upstream from crest of falls.

CHANNEL AND CONTROL.—Opposite the gage the lake is 600 feet wide; at the outlet bedrock is exposed and the water makes a nearly perpendicular fall of 150 feet. This fall forms an excellent and permanent control for the gage. At extremely high stages the lake has another outlet about 200 feet to left of main outlet. Point of zero flow is at gage height 0.6 foot.

EXTREMES OF DISCHARGE.—1915–1917: Maximum stage during year, 6.84 feet, at 8 a. m. November 1 (discharge, 2,780 second-feet); minimum discharge, estimated from climatic records, 2.5 second-feet, January 31.

ICE.—Ice forms on Shelockum Lake and at gage, but because of the swift current and relatively warm water from lake, the control remains open and stage-discharge relation is not affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined. Gage not in operation January 4 to May 22. Operation of water-stage recorder for rest of year satisfactory except for periods of break in record shown in the footnote to daily-discharge table. Daily discharge ascertained by applying to the rating table daily gage height determined by inspection of gage-height graph, or, for days of considerable fluctuation, by averaging the discharge for equal intervals of the day. Records January 4 to May 22 and June 2–20 poor; excellent for rest of year except those for October 1–10 and December 1–27, which are fair.

Shelockum Lake, at elevation 344 feet, is only 350 acres in area. The drainage basin above the lake is rough and precipitous and is covered with little soil or vegetation. There are no glaciers or ice fields at the source of the tributary streams. Therefore, as there is little natural storage, the run-off after a heavy rainfall is rapid and not well sustained, and during a hot, dry summer the flow becomes very low. The large amount of snow that accumulates during the winter months maintains a good flow.

Discharge measurements of Shelockum Lake outlet at Bailey Bay in 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Jan. 31	C. O. Brown	(a)	b2.5
Apr. 13	G. H. Canfield	(a)	42
June 21	.....do	3.30	420

a Gage buried in snow and was not read. b Discharge estimated.

Daily discharge, in second-feet, of Shelockum Lake outlet at Bailey Bay for 1917.

Day.	Jan.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	47			379	510	259	104	204	2,300	107
2	45				510	338	72	222	1,540	91
3	44				620	252	59	366	500	84
4					788	185	58	525	305	77
5					600	150	45	835	407	71
6					480	125	39	742	518	65
7					352	110	34	366	1,160	71
8					325	100	31	238	674	91
9					288	91	27	179	435	107
10					260	88	25	225	640	123
11					250	106	31	435	495	107
12					243	110	94	366	495	91
13		42			227	109	187	352	1,250	78
14					202	170	450	308	2,400	68
15					204	366	480	255	1,270	60
16					229	792	379	218	525	58
17					282	858	480	189	685	48
18					275	950	480	229	1,670	44
19					275	1,010	308	220	1,670	41
20					243	820	248	308	1,630	39
21				435	227	480	366	450	640	37
22				435	296	525	379	560	465	35
23			236	366	189	407	288	600	421	33
24			258	341	318	280	300	560	318	31
25			330	341	347	202	407	393	252	30
26			393	320	305	191	352	288	258	28
27			421	288	232	312	548	211	366	27
28			435	262	194	495	720	223	282	25
29			450	262	160	344	480	393	198	41
30			435	280	136	225	298	465	134	88
31	25		407		142	154		1,190		740

NOTE.—Discharge estimated, because of no gage-height record after Jan. 3, from flow Jan. 1-3, two discharge measurements, weather records, and comparison with records of flow for Orchard Lake outlet, as follows: Jan. 1-31, 16 second-feet; Feb. 1-28, 40 second-feet; Mar. 1-31, 16 second-feet; Apr. 1-30, 80 second-feet; May 1-22, 235 second-feet; June 2-20, 350 second-feet; estimates only roughly approximate and should be used with caution. Discharge Oct. 1-10 and Dec. 1-27 estimated from maximum and minimum stages indicated by the recorder and comparison of the hydrograph of this station with the hydrograph for Orchard Lake outlet.

Monthly discharge of Shelockum Lake outlet at Bailey Bay for 1917.

[Drainage area, 18 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January			16	0.889	1.02	984
February			40	2.22	2.31	2,220
March			16	.889	1.02	984
April			80	4.44	4.95	4,760
May			200	11.1	12.80	12,300
June			345	19.2	21.42	20,500
July	788	136	310	17.2	19.83	19,100
August	1,010	88	342	19.0	21.90	21,000
September	720	25	259	14.4	16.07	15,400
October	1,190	179	384	21.3	24.56	23,600
November	2,400	134	780	43.3	48.31	46,400
December	740	25	84.9	4.72	5.44	5,220
The year	2,400		238	13.2	179.63	172,000

KARTA RIVER AT KARTA BAY, PRINCE OF WALES ISLAND.

LOCATION.—In latitude 55° 34′ N., longitude 132° 37′ W., at head of Karta Bay, an arm of Kasaan Bay, on east coast of Prince of Wales Island, 42 miles by water across Clarence Strait from Ketchikan.

DRAINAGE AREA.—49.5 square miles (U. S. Forest Service reconnaissance map of Prince of Wales Island, 1914).

RECORDS AVAILABLE.—July 1, 1915, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on left bank, half a mile above tidewater, at head of Karta Bay and 1¼ miles below outlet of Little Salmon Lake. Two per cent of total drainage of Karta River enters between outlet of lake and gage.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable across river 50 feet upstream from gage; at low stages by wading at cable section.

CHANNEL AND CONTROL.—From Little Salmon Lake, 1½ miles from tidewater, the river descends 105 feet in a series of rapids in a wide, shallow channel, the banks of which are low but do not overflow. The bed is of coarse gravel and boulders; rock crops out only at outlet of lake. Gage and cable are at a pool of still water formed by a riffle of coarse gravel that makes a well-defined and permanent control.

EXTREMES OF DISCHARGE.—Maximum stage during year, 5.5 feet at 11 p. m. November 1 (discharge determined from extension of rating curve, 5,070 second-feet); minimum flow, estimated by a comparison with the record for Fish Creek, 80 second-feet on March 16.

1915–1917: Maximum stage, 5.5 feet November 1, 1917 (discharge, 5,070 second-feet); minimum flow, 21 second-feet, February 11, 1915.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 80 and 1,500 second-feet; extended below 80 second-feet to the point of zero flow and above 1,500 second-feet by estimation. Operation of water-stage recorded satisfactory except for periods indicated by breaks in record as shown in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graphs, or for days of considerable fluctuation by averaging results obtained by applying to rating table mean gage height for regular intervals of day. Records excellent except for periods of break in record and for discharge above 1,500 second-feet, for which they are fair.

The combined area of Little Salmon Lake at elevation 105 feet, and Salmon Lake at elevation 110 feet, is 1,600 acres. The slopes along the right shore of lakes and at head of Salmon Lake are gentle, and the area included by the 250-foot contour above lake outlet is 5,500 acres. The drainage area to elevation, 2,000 feet, is heavily covered with timber and dense undergrowth of ferns, brush, and alders. The upper parts of the mountains are covered with thin soil and brush. Only a few peaks at an elevation of 3,500 feet are bare. This large lake and flat area and thick vegetal cover affords considerable natural storage, which, after heavy precipitation, maintains a good run-off. The snow usually melts by the end of June, and the run-off becomes very low during a dry, hot summer.

The Forest Service in the summer of 1916 constructed a pack trail from tidewater to outlet of Little Salmon Lake.

Discharge measurements of Karta River at Karta Bay in 1917.

Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*
Feb. 6	C. O. Brown	1.48	289
June 25	G. H. Canfield	1.85	524

Daily discharge, in second-feet, of Karta River at Karta Bay for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	156	229	100	....	633	722	402	184	280	943	4,440	480
2	152	192	88	....	595	641	415	184	228	898	3,770	382
3	145	206	83	....	550	558	467	176	197	1,070	1,880	308
4	149	210	86	....	515	515	565	164	172	1,050	1,270	259
5	121	238	83	....	515	501	748	156	149	1,480	1,700	229
6	118	290	86	....	543	558	773	145	153	1,070	2,020	206
7	377	389	118	....	610	595	625	135	121	748	2,360	201
8	697	501	125	....	952	665	543	121	112	588	1,820	338
9	790	515	118	....	1,030	633	501	118	100	467	1,270	730
10	824	536	106	....	862	565	434	121	94	408	2,120	756
11	764	508	103	....	645	501	376	118	83	460	1,940	625
12	588	460	103	....	572	448	332	112	91	474	1,880	494
13	460	536	....	....	558	422	296	112	168	508	2,540	396
14	370	756	....	....	565	448	264	121	202	494	3,860	282
15	302	1,170	....	....	558	494	248	192	1,020	448	3,500	285
16	254	1,040	....	....	580	494	254	370	1,070	428	1,700	248
17	220	739	....	....	565	487	274	665	907	448	1,820	220
18	210	550	....	....	588	487	259	808	1,120	641	3,100	197
19	215	408	....	....	565	487	243	1,420	1,070	565	3,520	180
20	224	308	....	370	588	494	229	1,370	817	782	2,820	168
21	233	248	....	363	565	543	220	990	756	880	1,880	260
22	332	201	....	350	501	673	206	1,170	1,040	1,220	1,220	142
23	332	180	....	338	467	649	197	1,070	990	1,540	1,060	132
24	332	152	....	350	467	610	224	799	817	2,060	1,070	128
25	370	132	....	396	536	515	228	588	739	1,590	990	118
26	434	121	....	454	649	448	220	467	765	1,070	934	109
27	402	112	....	501	730	383	220	494	799	764	1,480	103
28	363	103	....	588	799	350	248	543	1,710	925	1,220	97
29	320	....	....	625	862	320	228	494	2,120	1,640	860	396
30	290	....	....	665	853	308	206	415	1,440	1,760	625	1,270
31	259	....	....	....	625	....	192	338	....	3,100	....	2,430

NOTE.—Discharge Jan. 28 to Feb. 5 estimated, because of stopping of clock, from maximum and minimum stages indicated by recorder and from a comparison of hydrograph for this station with that for Fish Creek. No gage-height record, owing to stick caught in float wheel; discharge estimated from a comparison of hydrograph for this station with that for Fish Creek: Mar. 13–31, 120 second-feet; Apr. 1–20, 140 second-feet. Discharge Dec. 27 interpolated.

Monthly discharge of Karta River at Karta Bay for 1917.

[Drainage area, 49.5 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	824	118	348	7.03	8.10	21,400
February	1,170	103	358	7.23	7.53	19,900
March	....	....	112	2.26	2.61	6,890
April	....	....	255	5.15	5.75	15,200
May	1,030	467	634	12.8	14.76	39,000
June	722	308	517	10.4	11.60	30,800
July	773	192	343	6.93	7.99	21,100
August	1,420	112	457	9.23	10.64	28,100
September	2,120	83	644	13.0	14.50	38,300
October	2,960	408	977	19.7	22.71	60,100
November	4,440	625	2,020	40.8	45.53	120,000
December	2,430	97	393	7.94	9.15	24,200
The year	4,440	....	587	11.9	160.87	425,000

MILL CREEK NEAR WRANGELL.

LOCATION.—In latitude 56° 28′ N., longitude 132° 12′ W., near outlet of Lake Virginia on east shore of Eastern Passage, a narrow channel between Wrangell Island and mainland, 6 miles by water from Wrangell.

DRAINAGE AREA.—50 square miles (measured on U. S. Coast and Geodetic Survey chart 8200).

RECORDS AVAILABLE.—June 17, 1915, to September 30, 1917.

GAGE.—Stevens water-stage recorder on left bank one-fourth mile below Lake Virginia and three-fourths mile above tidewater. Gage washed out by extreme high water November 14, 1917; record August 8 to November 14 lost with gage.

DISCHARGE MEASUREMENTS.—Made from cable across creek, 10 feet upstream from gage.

CHANNEL AND CONTROL.—From the outlet of the lake, at an elevation of 100 feet above sea level and at a distance of 1 mile from tidewater, the creek descends in a series of rapids and falls. The bed is glacial drift and boulders at the rapids and rock outcrop at points of concentrated fall. The gage is in a pool of still water created by a small fall at a contracted point of channel. This fall makes a well-defined, permanent, and sensitive control.

EXTREMES OF DISCHARGE.—1915-1917: Maximum stage, 8 feet October 16, 1915 (discharge, computed from extension of rating curve, about 3,310 second-feet, differs from that published in Bulletin 642 because of revision of rating curve); minimum stage, 0.02 foot February 11, 1916 (discharge, 15 second-feet).

ICE.—Ice forms on the lake, at gage, and along the banks, but the swift current and flow of relatively warm water from the lake keeps the control open.

ACCURACY.—Stage-discharge relation permanent; not affected by ice. Rating curve well defined below 1,200 second-feet; extended above 1,200 second-feet. Operation of water-stage recorder not satisfactory January 1 to May 18 and July 15 to August 1. Daily discharge, except for periods shown in footnote to daily-discharge table ascertained by applying to the rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by averaging discharge for equal intervals of the day. Results good except for periods when water-stage recorder was not operating satisfactorily.

The drainage basin is covered with a heavy stand of timber to an elevation of 2,500 feet and a dense undergrowth of ferns, brush, alders, and devil's-club, but because of the steep slopes and thin soil the run-off after heavy rains is rapid and the ground storage is small. During a dry, hot period in summer the flow is augmented by melting ice from glaciers at the headwaters of two of the tributary streams.

No discharge measurements were made at this station during the year.

Daily discharge, in second-feet, of Mill Creek near Wrangell for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	60	60	70	38	380	965	909	590
2	57	55	65	36	350	715	1,030	1,030
3	55	48	60	34	330	540	1,150	680
4	53	55	60	38	310	492	1,660	510
5	51	70	58	45	330	760	1,250	430
6	51	110	58	62	460	1,340	965	388
7	70	120	56	85	580	1,030	715	409
8	100	190	54	85	700	965	742	....
9	130	260	52	78	820	875	645	....
10	160	188	50	78	580	645	558	....
11	180	170	47	78	350	540	540	....
12	160	155	46	78	280	510	525	....
13	140	200	45	78	540	525	575	....
14	120	300	43	80	600	680	525	....
15	100	700	40	85	520	662	....	....
16	85	1,230	40	87	490	575	....	....
17	72	700	40	92	465	575	....	....
18	62	400	40	108	525	662	....	....
19	55	280	50	125	492	750	....	....
20	57	220	55	149	489	750	....	....
21	59	190	55	170	397	715	....	....
22	60	160	55	160	331	698	....	....
23	60	140	55	160	302	592	....	....
24	65	120	55	190	361	558	....	....
25	85	105	55	230	525	525	....	....
26	150	95	52	270	645	510	....	....
27	130	85	51	300	732	475	....	....
28	110	75	50	340	770	439	....	....
29	95	....	46	365	830	454	....	....
30	80	....	43	400	790	492	....	....
31	70	....	40	....	965	....	....	....

NOTE.—Water-stage recorder not working properly for the following periods: Jan. 1 to May 18; daily discharge estimated from discharge measurement Jan. 21, staff gage, readings Jan. 21, Feb. 10, Mar. 10, Apr. 20, May 11, maximum and minimum stages indicated by the recorder for each of periods Jan. 1-20, Jan. 22 to Feb. 9, Feb. 11 to Mar. 9, Mar. 13 to Apr. 19, Apr. 21 to May 10, and May 12-18, and from a comparison of hydrograph for this station with that for Orchard Lake outlet; discharge July 15-31 (625 second-feet) estimated from maximum and minimum stages indicated by recorder and by comparison with records for Baranof Lake outlet; discharge, Aug. 7-30, estimated at 850 second-feet and Sept. 1-30, 725 second-feet, by comparison with records of flow for Baranof Lake outlet.

Monthly discharge of Mill Creek near Wrangell for 1917.

[Drainage area, 50 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	180	51	89.7	1.79	2.06	5,520
February	1,230	48	231	4.62	4.81	12,800
March	70	40	51.2	1.02	1.18	3,150
April	400	34	137	2.74	3.06	8,150
May	965	280	524	10.5	12.11	32,200
June	1,340	439	667	13.3	14.84	39,700
July			723	14.5	16.72	44,500
August			a 788	15.8	18.22	48,500
September			a 725	14.5	16.18	43,100
The period						238,000

a Estimated.

CASCADE CREEK AT THOMAS BAY, NEAR PETERSBURG.

LOCATION.—One-fourth mile above tidewater on each shore of south arm of Thomas Bay; 22 miles by water from Petersburg. One small tributary enters the river from the left one-half mile above gage and 2 miles below lake outlet.

DRAINAGE AREA.—21 square miles (measured on the United States Geological Survey geologic reconnaissance map of the Wrangell mining district, edition of 1907).

RECORDS AVAILABLE.—October 27 to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on left bank, one-fourth mile from tidewater; reached by trail which leaves beach back of old cabin at mouth of creek.

DISCHARGE MEASUREMENTS.—At medium and high stages, made from log footbridge across stream one-fourth mile upstream from gage; at low stages, made by wading.

CHANNEL AND CONTROL.—From the outlet of a lake at an elevation of 1,200 feet above sea level and 3 miles from tidewater the river descends in a continuous series of rapids and falls through a narrow, deep canyon. Gage is in a protected eddy above a natural rock weir, which forms a well-defined and permanent control. The bed of river under the footbridge is rough and the current swift and irregular, but this section is the only place on whole river where even at low and medium stages there are no boils and eddies.

EXTREMES OF STAGE.—Maximum stage during period, 7.65 feet at 11 p. m., November 18; minimum stage, 1.95 feet about December 31.

ICE.—Stage-discharge relation not affected by ice.

Data inadequate for determination of discharge.

The first site on this stream for a storage reservoir is at a small lake 3 miles from tidewater and at elevation of 1,200 feet above sea level. The drainage area above the gaging station is 21 square miles and above the lake outlet, 17 square miles. Flow during summer is augmented by melting ice from glaciers on upper portion of drainage area.

The following discharge measurement was made by G. H. Canfield:

October 29, 1917: Gage height, 3.24 feet; discharge, 181 second-feet.

Daily gage height, in feet, of Cascade Creek at Thomas Bay, near Petersburg, for 1917.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	......	5.65	2.79	11	......	4.65	2.33	21	......	5.6	......
2	......	6.6	2.67	12	......	4.55	2.25	22	......	5.05	......
3	......	4.95	2.55	13	......	5.2	2.20	23	......	4.55	......
4	......	4.25	2.43	14	......	6.8	2.15	24	......	4.0	......
5	......	4.05	2.37	15	......	5.85	......	25	......	3.7	......
6	......	4.2	2.33	16	......	4.9	......	26	......	3.6	......
7	......	4.75	2.32	17	......	5.2	......	27	2.9	3.65	......
8	......	4.2	2.5	18	......	7.2	......	28	3.4	3.35	......
9	......	3.8	2.47	19	......	7.25	......	29	3.2	3.15	......
10	......	4.6	2.38	20	......	6.6	......	30	3.7	2.93	......
								31	4.55	......	......

GREEN LAKE OUTLET AT SILVER BAY, NEAR SITKA.

LOCATION.—In latitude 56° 59′ N., longitude 135° 5′ W., at outlet of Green Lake, at head of Silver Bay, 10½ miles by water south of Sitka.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—August 22, 1915, to December 31, 1917.

GAGE.—Stevens water-stage recorder on right bank at outlet of lake, reached by trail which leaves the beach one-fourth mile north of mouth of stream, ascends a 600-foot ridge, and then drops down to the outlet of the lake. Gage datum lowered 1.0 foot December 27, 1916.

DISCHARGE MEASUREMENTS.—Made from cable across outlet 30 feet below gage.

CHANNEL AND CONTROL.—From Green Lake, 240 feet above sea level and 1,800 feet from tidewater, the stream descends in a series of falls and rapids through a narrow canyon whose exposed rock walls rise perpendicularly more than a hundred feet.

EXTREMES OF DISCHARGE.—Maximum stage during year, 10.74 feet at 12.30 a. m. November 20 (discharge, 2,220 second-feet); minimum stage, 0.12 foot April 2 (discharge, 15 second-feet).

1915–1917: Maximum stage, 11.22 feet (referred to datum used after December 27, 1916) on September 19, 1916 (discharge, 2,400 second-feet); minimum stage, 0.12 foot April 2, 1917 (discharge, 15 second-feet).

ICE.—Ice forms on lake and at gage, but because of current and flow of relatively warm water from the lake the control remains open.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 10 and 1,300 second-feet. Operation of water-stage recorder satisfactory except for periods indicated by breaks in record, as shown in the footnote to the daily-discharge table. Daily discharge ascertained by applying to the rating table mean daily gage height, determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table gage heights for regular intervals of day. Records good, except those for periods when gage was not operating satisfactorily, which are only roughly approximate.

In the fall and winter the flow is low because there is little ground storage, and on most of the drainage area the precipitation is in the form of snow. This accumulated snow produces a large run-off during the spring, and the melting ice from the glacier and the ice-capped mountains augment the run-off from precipitation during the summer. The area of Green Lake is estimated to be only 100 acres.

The following discharge measurement was made by G. H. Canfield:

August 12, 1917: Gage height, 3.82 feet; discharge, 377 second-feet.

Daily discharge, in second-feet, of Green Lake outlet at Silver Bay for 1917.

Day.	Jan.	Feb.	Apr.	May.	June.	July.	Aug.	Oct.	Nov.	Dec.
1	27	....	18	233	599	866	....	....	712	121
2	23	....	15	177	490	728	....	....	800	108
3	20	....	15	156	397	728	....	....	406	99
4	14	....	16	152	388	662	....	....	262	94
5	12	....	18	161	442	599	....	912	262	87
6	13	....	22	172	424	620	....	471	391	85
7	....	....	23	258	406	557	....	1,160	835	92
8	....	....	22	480	415	641	....	866	458	138
9	....	....	21	442	452	480	....	1,130	247	177
10	....	136	26	294	362	433	....	774	830	134
11	....	120	32	206	294	433	....	797	816	96
12	....	101	34	188	286	424	380	568	537	79
13	....	101	35	194	397	424	337	499	631	68
14	....	156	39	212	537	406	317	508	1,470	65
15	....	470	58	226	547	....	....	406	943	62
16	....	346	71	270	480	....	....	278	438	59
17	....	212	70	262	490	....	....	206	400	55
18	....	138	67	286	480	....	....	200	1,010	53
19	....	97	68	312	547	....	....	226	1,280	52
20	....	....	67	246	620	....	....	490	1,800	55
21	....	....	65	212	662	....	....	607	1,140	54
22	....	....	73	200	599	....	....	741	684	53
23	....	....	85	188	557	....	....	985	470	52
24	....	....	107	206	528	....	....	751	371	50
25	....	....	142	286	480	....	....	480	346	49
26	....	....	161	371	470	....	....	371	380	48
27	....	....	156	512	480	....	....	240	480	46
28	....	....	177	751	442	....	....	362	336	45
29	....	....	247	684	461	....	....	548	200	44
30	....	....	278	641	530	....	....	799	145	56
31	....	....	....	620	....	....	....	1,130	....	145

NOTE.—Water-stage recorder not working properly for the following periods: Jan. 1 to Feb. 9 and Feb. 20 to Apr. 1; discharge estimates from climatic records and comparison of hydrograph for this station with that for Baranoff Lake outlet, as follows: Jan. 7–31, 90 second-feet; Feb. 1–9, 110 second-feet; Feb. 20–28, 45 second-feet; Mar. 1–31, 50 second-feet; May 19–20, daily discharge estimated from maximum and minimum stages indicated by the recorder. Discharge estimated by comparison with records of flow for Baranoff Lake outlet as follows: July 15–31, 425 second-feet; Aug. 1–11, 400 second-feet; Aug. 15–31, 640 second-feet; Sept. 1–30, 620 second-feet; Oct. 1–4, 930 second-feet. Gage well frozen Dec. 22–28; discharge interpolated.

Monthly discharge of Green Lake outlet at Silver Bay for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	....	....	76.1	4,680
February	470	....	120	6,660
March	....	....	50	3,070
April	278	15	74.3	4,420
May	751	152	310	19,100
June	662	286	475	28,300
July	....	....	491	30,200
August	....	....	526	32,300
September	....	....	620	36,900
October	....	200	652	40,100
November	1,800	145	636	37,800
December	177	44	78.1	4,800
The year	....	....	343	248,000

BARANOF LAKE OUTLET AT BARANOF, BARANOF ISLAND.

LOCATION.—In latitude 57° 5′ N., longitude 134° 54′ W., at townsite of Baranof, at head of Warm Spring Bay, east coast of Baranof Island, 18 miles east of Sitka across island, but 96 miles from Sitka by water through Peril Strait.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—June 28, 1915, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on right bank 700 feet below Baranof Lake and 800 feet above tidewater at head of Warm Spring Bay.

DISCHARGE MEASUREMENTS.—Made from cable across stream 100 feet below lake and 600 feet above gage.

CHANNEL AND CONTROL.—From Baranof Lake, at elevation 130 feet above sea level and 1,500 feet from tidewater, the stream descends in a series of rapids and small falls and enters the bay in a cascade of about 100 feet concentrated fall. The bed is of glacial drift, boulders, and rock outcrop. The gage is in an eddy 50 feet downstream from the foot of a small fall and 100 feet upstream from a riffle which forms a well-defined control.

EXTREMES OF DISCHARGE.—Maximum stage during year, 4.90 feet at 6 p. m. November 19 (discharge, 2,780 second-feet); minimum stage, 0.40 foot April 3 (discharge, 31 second-feet).

1915–1917: Maximum stage, 5.3 feet August 10, 1915 (discharge, computed from extension of rating curve, 3,350 second-feet); minimum flow estimated by discharge measurement and climatic data, 28 second-feet on February 13, 1916.

ICE.—Because of the swift current and flow of relatively warm water from the lake, the stream remains open.

DIVERSIONS.—The flume to Olsen's sawmill diverts from the stream 200 feet below gage only sufficient water to operate a 25-horsepower Pelton water wheel.

ACCURACY.—Stage-discharge relation permanent; not affected by ice. Rating curve well defined below 2,000 second-feet. Operation of water-stage recorder satisfactory except for short periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging discharge for equal intervals of day. Records good except for periods when recorder did not operate satisfactorily and for periods when water was frozen in well, for which they are fair.

The drainage area is rough and precipitous, and the vegetable and soil cover is thin, even on the foothills of the mountains. The run-off is rapid, and the ground storage is small. During a dry, hot period, however, the flow is greatly augmented by melting ice from several small glaciers and ice-capped mountains.

No discharge measurements were made at this station during the year.

Daily discharge, in second-feet, of Baranof Lake outlet at Baranof for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	64	....	45	36	352	930	1,280	590	420	668	590	208
2	61	....	43	33	321	788	1,100	668	392	695	448	177
3	59	....	45	31	294	651	1,050	640	384	1,280	345	153
4	....	....	46	34	288	615	930	568	370	1,280	294	137
5	....	....	42	36	279	615	855	545	342	1,140	291	122
6	....	....	44	37	288	615	820	545	327	695	291	116
7	....	....	48	37	330	615	788	545	309	1,380	376	110
8	....	....	46	37	590	615	788	545	300	1,100	384	112
9	....	....	44	36	695	615	695	545	276	1,100	339	108
10	....	....	42	37	545	545	668	545	264	855	464	104
11	....	....	40	42	432	496	695	590	261	820	755	96
12	....	....	39	51	366	480	695	545	545	668	695	91
13	....	....	37	57	352	568	725	492	678	568	725	86
14	....	....	35	59	388	725	668	460	640	500	1,330	81
15	....	....	34	69	440	788	640	500	855	448	1,050	76
16	....	....	37	80	460	755	668	725	668	380	615	71
17	....	....	52	86	460	725	725	1,050	980	336	500	67
18	....	....	57	92	468	725	695	1,100	1,650	309	890	63
19	....	....	57	108	500	788	788	1,540	1,380	306	1,840	59
20	....	....	56	114	480	890	820	1,170	1,230	400	2,000	69
21	....	....	54	110	412	930	755	820	1,100	532	1,230	70
22	....	78	55	108	380	890	668	1,010	1,180	695	820	65
23	....	72	60	113	376	855	640	1,230	930	890	590	63
24	....	66	50	129	388	820	615	930	640	788	620	61
25	....	60	57	175	452	820	615	668	480	590	480	59
26	....	55	62	183	568	755	590	590	444	460	464	57
27	....	52	57	201	725	725	545	930	934	362	545	55
28	....	48	51	222	930	725	522	1,050	2,000	330	388	53
29	....	....	46	285	1,010	725	492	855	1,430	380	303	50
30	....	....	50	352	1,050	788	444	615	930	432	245	65
31	....	....	37	....	1,010	....	464	488	....	800	....	90

NOTE.—Discharge estimated for following periods, because of unsatisfactory operation of water-stage recorder: Jan. 4–31 (80 second-feet) and Feb. 1–28 (100 second-feet) from weather records and by comparison with records of flow for streams in near-by drainage basins. Discharge Dec. 12–18 interpolated and Dec. 23–31 estimated by comparison with records of flow for Green Lake outlet.

Monthly discharge of Baranof Lake outlet at Baranof for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	....	....	78.2	4,810
February	....	....	90.4	5,020
March	62	34	47.4	2,910
April	352	31	99.7	5,930
May	1,050	279	504	31,000
June	930	480	719	42,800
July	1,280	444	724	44,500
August	1,540	460	745	45,800
September	2,000	261	745	44,300
October	1,380	306	683	42,000
November	2,000	245	664	39,500
December	208	50	90.1	5,540
The year	2,000	31	434	314,000

SWEETHEART FALLS CREEK NEAR SNETTISHAM.

LOCATION.—In latitude 57° 56½′ N., longitude 133° 41′ W., on east shore 1 mile from head of south arm of Port Snettisham, 3 miles south of mouth of Whiting River, 7 miles by water from Snettisham, and 42 miles by water from Juneau. No large tributaries enter river between gaging station and outlet of large lake, 2½ miles upstream.

DRAINAGE AREA.—27 square miles (measured on the United States Geological Survey topographic map of the Juneau gold belt, edition of 1905).

RECORDS AVAILABLE.—July 31, 1915, to March 31, 1917.

GAGE.—Stevens water-stage recorder on right bank 300 feet upstream from tidewater on east shore of Port Snettisham. Gage washed out by high water in November, 1917, and record from April 20 last with the gage.

DISCHARGE MEASUREMENTS.—Made from cable across river one-fourth mile upstream from gage.

CHANNEL AND CONTROL.—From the outlet of lake at an elevation of 520 feet above sea level and 2½ miles from tidewater the river descends in a series of rapids and falls through a narrow, deep canyon. Gage is in a pool at foot of two falls, each 25 feet high, which are known as Sweetheart Falls; outlet of pool is a natural rock weir which forms a well-defined and permanent control for gage.

EXTREMES OF DISCHARGE.—Maximum stage during period, 4.2 feet August 14, 1915 (discharge, computed from an extension of the rating curve, 1,420 second-feet); minimum flow, estimated from discharge measurement and climatic data, 15 second-feet February 11, 1916.

ICE.—Stage-discharge relation not seriously affected by ice.

ACCURACY.—Stage-discharge relation practically permanent; affected by ice January 29 to February 16. Rating curve well defined between 40 and 1,300 second-feet, extended beyond these limits by estimation. Operation of water-stage recorder satisfactory except for periods indicated by breaks in record, as shown in footnote to daily discharge table. Daily discharge ascertained by applying to rating table mean daily gage height determined by inspecting gage-height graph. Records excellent except for periods of break in record, for which they are fair.

In the fall and winter the run-off is small because the precipitation is in the form of snow and because of the small amount of ground storage; during a hot, dry period the low run-off from the ground and lake storage is augmented by melting ice from one glacier.

Discharge measurements of Sweetheart Falls Creek near Snettisham in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Mar. 9	C. O. Brown	0.32	48	May 25	G. H. Canfield	1.71	412
Apr. 24	do	.66	94	Sept. 14	do	1.71	410

Daily discharge, in second-feet, of Sweetheart Falls Creek near Snettisham for 1917.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1	26	51	80	11	70	77	42	21	57	141	48
2	28	48	80	12	68	67	40	22	59	110	45
3	31	54	59	13	68	150	37	23	56	99	55
4	19	64	51	14	67	296	36	24	67	91	65
5	18	77	57	15	64	224	35	25	84	83	77
6	18	98	55	16	57	258	32	26	82	82	65
7	57	127	51	17	56	242	36	27	70	82	55
8	70	150	47	18	63	195	46	28	63	82	45
9	70	127	45	19	67	178	51	29	57		40
10	70	94	43	20	61	148	50	30	56		35
								31	54		30

NOTE.—Because of clock stopping or backwater from ice, discharge estimated from weather records at Juneau and from comparison of hydrograph for this station with hydrographs for Crater and Carlson creeks, Jan. 7-13, Jan. 29 to Feb. 16, and Mar. 23-31.

Monthly discharge of Sweetheart Falls Creek near Snettisham for 1917.

[Drainage area, 27 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	84	18	56.5	2.09	2.41	3,480
February	242	48	127	4.70	4.89	7,0[illegible]0
March	80	30	49.5	1.83	2.11	3,010
The period						13,500

CRATER LAKE OUTLET AT SPEEL RIVER, PORT SNETTISHAM.

Location.—At outlet of Crater Lake, 1 mile upstream from the edge of tide flats at head of north arm of Port Snettisham, 2 miles by trail from cabins of Speel River Project (Inc.), which are 42 miles by water from Juneau.

Drainage area.—11.9 square miles at outlet of Crater Lake and 13 square miles at mouth of stream at beach (measured on topographic maps of the Alaska Boundary Tribunal, edition of 1895).

Records available.—January 23, 1913, to December 31, 1917.

Gage.—Stevens water-stage recorder on left shore of lake, 100 feet upstream from outlet. A locally made water-stage recorder having a natural vertical scale and a time scale of 1 inch to 24 hours was used until replaced by Stevens gage June 29, 1916. The gage datum remained the same during the period. During the winter months, because of inaccessible location and deep snow, the operation of the gage at the lake was discontinued, and the stage read at staff gage in channel exposed at low tide at beach. The first gage at beach was set at an unknown datum and washed out in winter of 1915–16. Another staff gage was set at about the same location and used after November 24, 1916.

Discharge measurements.—Made from cable across outlet of lake, 100 feet downstream from gage and 10 feet upstream from crest of first falls. The rope sling from which discharge measurements were first made was replaced in fall of 1915 by a standard United States Geological Survey gaging car, making more accurate measurements possible.

Channel and control.—The gage is on left shore of lake, 100 feet upstream from outlet where the stream becomes constricted into a narrow channel, the bed of which is composed of large boulders and rock outcrop, which form a well-defined and permanent control.

Extremes of discharge.—Maximum stage during the year, 5.0 feet August 19 (discharge, 1,270 second-feet); minimum flow, 12 second-feet March 15–16 and April 13–15.

1913–1917: Maximum stage during the period, 5.9 feet August 13, 1915 (discharge, estimated from extension of rating curve, 1,680 second-feet); minimum flow, 5 second-feet February 1–13, 1916, estimated from one discharge measurement and weather records.

Accuracy.—Stage-discharge relation permanent. Rating curve defined by 19 discharge measurements, 13 of which were made by employees of the Speel River Project (Inc.) and 6 by an engineer of the United States Geological Survey, and is well defined below and extended above 1,000 second-feet. Rating curve used January 1 to May 25 for staff gage at beach, fairly well defined. Operation of water-stage recorder satisfactory except June 30 to July 3, when gage clock was run down, September 13–16, 19–30, and November 1 to December 31. Discharge record January 1 to May 25 computed from gage-height records for staff gage at beach. Daily discharge May 26 to October 31 ascertained by applying to rating table daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of the day. Discharge September 13–16, 19–30, and November 1 to December 31 estimated by comparison with records of flow for Long River. Records obtained from gage at lake, good; those from gage at beach, fair; those obtained by comparison with records for Long River only roughly approximate.

Crater Lake is at an elevation of 1,010 feet above sea level and covers 1.1 square miles. The sides of the mountains surrounding the lake are steep and barren, and the tops are covered by glaciers.

Discharge measurements of Crater Lake outlet at Speel River, Port Snettisham, in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 1	Grosseth and Hayes...	1.12	33.6	Mar. 29	C. N. Hayes...........	0.98	27.3
9	.....do..............	1.43	44.8	31	.....do...............	.87	19.7
10	Gust Grosseth.........	.10	37.4	Apr. 5	.....do...............	.75	14.5
10	Brown and Hayes.....	1.36	44.6	10	.....do...............	.69	13.1
12	.....do..............	1.16	32.2	12	.....do...............	.69	12.9
17	Grosseth and Hayes...	.96	20.9	18	.....do...............	.80	17.1
29	Gust Grosseth.........	.05	22.5	22	Brown and Hayes.....	.89	22.3
31	Grosseth and Hayes...	.97	19.7	23	C. O. Brown...........	.88	21.2
Feb. 7	.....do..............	1.38	48.6	24	.....do...............	1.06	34.5
24	C. N. Hayes...........	1.22	39.0	25	C. N. Hayes...........	1.00	32.4
26	.....do..............	1.10	30.8	27	.....do...............	1.11	42.2
Mar. 2	.....do..............	.93	19.9	29	.....do...............	1.28	70
10	.....do..............	a.84	14.8	May 10	.....do...............	1.68	211
14	.....do..............	a.75	13.9	12	.....do...............	1.50	128
17	Brown and Hayes....	a.69	13.4	16	.....do...............	1.54	136
24	.....do..............	1.17	44.4	24	G. H. Canfield.........	1.45	103
27	.....do..............	1.09	38.0	Dec. 7	.....do...............	b1.08	39

a Stage-discharge relation changed owing to blasting rocks out of channel.
b New gage and datum at same location as old gage at beach.

NOTE.—All discharge measurements except those made by Gust Grosseth Jan. 10 and 29 were made at the beach; gage heights referred to gage at beach.

Daily discharge, in second-feet, of Crater Lake outlet at Speel River, Port Snettisham, for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	37	21	20	19	65	304	402	697	223	186
2	30	18	20	17	60	280	487	642	198	231
3	27	22	20	15	60	245	642	416	184	408
4	25	28	19	15	60	241	547	316	183	443
5	24	32	19	15	65	304	472	272	184	338
6	46	39	18	15	100	350	388	265	191	282
7	69	46	17	14	150	306	472	272	194	517
8	58	53	16	14	200	253	443	282	191	502
9	50	47	16	14	270	223	327	282	189	710
10	46	41	15	13	211	200	293	293	192	517
11	39	36	16	13	150	183	304	362	221	675
12	33	37	17	13	125	193	375	362	414	416
13	30	38	14	12	129	229	388	316	....	429
14	26	60	14	12	132	269	350	293	....	293
15	25	82	12	12	136	362	402	429	....	212
16	23	78	12	13	140	338	429	648	....	143
17	21	74	13	14	130	304	472	955	402	105
18	25	71	15	17	140	327	723	885	780	90
19	28	68	16	28	145	443	692	1,050	....	90
20	32	60	24	26	150	416	562	1,070	....	86
21	41	54	25	24	120	362	429	724	....	90
22	39	48	32	22	100	388	338	728	....	87
23	37	43	39	28	105	362	338	815	....	103
24	36	36	45	29	108	338	532	594	....	101
25	45	33	43	30	118	350	610	375	....	90
26	40	30	40	36	127	338	594	293	....	84
27	36	26	37	42	167	316	444	709	....	70
28	32	24	32	54	200	316	327	955	....	70
29	30	....	28	67	221	304	267	698	....	94
30	27	....	24	70	241	316	229	416	....	106
31	24	....	20	....	280	....	381	280	....	203

NOTE.—Daily discharge for days when staff gage was not read during period Jan. 1 to May 25 estimated from weather records and records of flow for Long River. Daily discharge June 30 to July 3 estimated from maximum and minimum stages indicated by the recorder and records of flow for Long River. Records Jan. 1 to May 26 show discharge at beach; May 26 to Dec. 31 discharge at outlet of Crater Lake. Discharge estimated, because gage was not operating, by comparison with records of flow for Long River, as follows: Sept. 13-16, 330 second-feet; Sept. 19-30, 480 second-feet; Nov. 1-30, 250 second-feet; Dec. 1-31, 35 second-feet. Records for these periods only roughly approximate.

Monthly discharge of Crater Lake outlet at Speel River, Port Snettisham, for 1917.

[Drainage area 13.0 square miles at tidewater; 11.9 square miles at outlet of Crater Lake.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	69	21	34.9	2.68	3.09	2,150
February	82	18	44.5	3.42	3.56	2,470
March	45	12	22.5	1.73	1.99	1,380
April	70	12	23.8	1.83	2.04	1,420
May	280	60	142	10.9	12.57	8,730
June	443	183	305	25.6	28.56	18,100
July	723	229	441	37.1	42.77	27,100
August	265	265	539	45.3	52.23	33,100
September	....	183	361	30.3	33.81	21,500
October	710	70	251	21.1	24.33	15,400
November	....	....	250	21.0	23.43	14,900
December	....	....	35	2.94	3.39	2,150

NOTE.—Records Jan. 1 to May 25 show discharge at beach. Records May 26 to Dec. 31 show discharge at outlet of Crater Lake. See footnote to daily-discharge table.

LONG RIVER BELOW SECOND LAKE, AT PORT SNETTISHAM.

LOCATION.—One-half mile downstream from outlet of Second Lake, 1 mile downstream from outlet of Long Lake, one-half mile upstream from head of Indian Lake; 2½ miles by trail and boat across Second Lake from cabins of the Speel River project at head of the North Arm of Port Snettisham, 42 miles by water from Juneau.

DRAINAGE AREA.—33.2 square miles (measured on sheet No. 12 of the Alaska Boundary Tribunal maps, edition of 1895).

RECORDS AVAILABLE.—November 11, 1915, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on right bank one-half mile below outlet of Second Lake.

DISCHARGE MEASUREMENTS.—At medium and high stages made from cable across river at gage; at low stages made by wading one-fourth mile downstream.

CHANNEL AND CONTROL.—At the gage the channel is deep and the current sluggish; banks are low and are overflowed at extremely high stages; bed smooth except for one large boulder. A rapid, 500 feet downstream, forms a well-defined and permanent control.

EXTREMES OF DISCHARGE.—Maximum stage during year, 7.35 feet at 1 a. m. August 20 (discharge, 2,900 second-feet); minimum stage, 0.28 foot March 26 (discharge, 37 second-feet).

1916–17: Maximum stage, 7.35 feet August 20, 1917 (discharge, 2,900 second-feet); minimum flow, 23 second-feet, February 13, 1916.

ICE.—Stage-discharge relation affected by ice during January, February, and March.

ACCURACY.—Stage-discharge relation permanent; affected by ice or poor connection between well and river January 3–6, 21, 22, January 27 to February 7, February 19–28, and April 15 to May 5. Rating curve fairly well defined between 50 and 400 second-feet and well defined between 400 and 2,000 second-feet. Operation of water-stage recorder satisfactory throughout year except January 18–19, February 22–27, June 23–28, July 28 to August 3, November 21–25, and November 30 to December 31. Daily discharge ascertained by applying to the rating table daily gage height determined by inspecting the gage-height graph. Records good except for stages below 400 second-feet, for which they are fair.

The area draining to Long River between Long Lake outlet and this station comprises only 1.3 square miles, including First Lake and Second Lake. Because this area is at a low altitude and has no glaciers the run-off per square mile from it is greater early in the spring but much less in summer than that from the area above Long Lake, which is partly covered by glaciers.

Discharge measurements of Long River below Second Lake, at Port Snettisham, in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 11	C. O. Brown	1.10	95	May 23	Charles Hayes	2.10	271
20	Grosseth and Hayes	.77	57	24	G. H. Canfield	2.10	277
Mar. 22	Brown and Hayes	.40	47.1	July 5	.....do	4.56	1,190
Apr. 20	.....do	.62	57				

Daily discharge, in second-feet, of Long River below Second Lake, at Port Snettisham, for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	81	77	85	57		680	908	1,580	660	506	470	154
2	73	73	77	57		680	1,090	1,550	582	408	377	130
3	69	68	72	57		600	1,280	1,110	530	885	276	120
4	56	64	70	49		620	1,330	908	502	998	216	118
5	53	60	61	51		720	1,180	780	495	863	222	114
6	63	130	57	52	263	720	1,040	740	492	660	227	112
7	133	198	54	52	303	680	1,090	740	498	1,180	488	109
8	183	222	51	51	380	620	1,020	760	492	1,260	399	105
9	119	129	50	49	464	565	840	760	478	1,600	298	103
10	102	103	49	49	412	502	760	760	478	1,330	318	100
11	92	91	48	48	318	467	760	862	478	1,600	530	99
12	82	82	45	48	295	488	840	908	495	1,720	526	98
13	75	106	45	48	303	548	840	840	660	1,040	620	96
14	69	179	43	48	332	620	800	800	840	780	1,410	95
15	66	263	42		326	720	862	1,020	1,100	600	1,520	93
16	59	196	40		315	700	908	1,380	1,180	422	930	91
17	73	179	40		309	680	1,020	908	1,230	306	620	88
18	96	164	41		326	720	1,360	1,960	1,630	276	975	86
19	118	157	42		350	862	1,410	2,360	2,370	276	1,460	83
20	77	150	43		362	862	1,260	2,580	2,110	306	1,960	82
21	74	143	44		318	840	1,040	1,750	2,370	234	1,300	81
22	71	136	45		290	885	885	1,810	1,900	232	1,000	81
23	68	130	41		268	840	840	1,990	1,340	309	800	80
24	75	123	49		268	780	1,020	1,630	908	303	670	79
25	130	116	53		309	760	1,130	1,160	640	276	550	78
26	104	109	37		362	760	1,160	1,410	640	271	460	77
27	99	103	48		428	740	1,040	1,460	565	182	408	77
28	95	97	46		488	740	885	1,990	582	182	332	76
29	91		54		530	720	760	1,630	760	284	250	76
30	86		73		582	730	660	1,130	680	335	192	76
31	82		62		680		840	820		582		76

NOTE.—Water-stage recorder not working properly or stage-discharge relation affected by ice or poor connection between well and river for following periods: Jan. 3-6, 18-19, 21-22, Jan. 27 to Feb. 7, Feb. 19-28; daily discharge estimated from weather records and comparison with records of flow for Crater Creek. Discharge estimated from weather records and by comparison with records of flow for Crater Lake outlet as follows: Apr. 15-31, 80 second-feet; May 1-5, 160 second-feet. Discharge June 23-28, July 28 to Aug. 3, and Nov. 21-25 estimated from maximum and minimum stages indicated by the recorder and comparison with records of flow for Crater Lake outlet and Speed River. Discharge Nov. 29 to Dec. 31 estimated from readings of staff gage Dec. 10, 19, and 28 and from weather records.

Monthly discharge of Long River below Second Lake, at Port Snettisham, for 1917.

[Drainage area, 33.2 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	183	53	87.6	2.64	3.04	5,390
February	263	60	130	3.92	4.08	7,220
March	85	37	51.9	1.56	1.80	3,190
April	....	....	66.5	2.00	2.23	3,960
May	680	....	335	10.1	11.64	20,600
June	885	467	695	19.4	21.64	41,400
July	1,410	660	995	30.0	34.59	61,200
August	2,580	740	1,290	38.9	44.85	79,300
September	2,370	478	923	27.8	31.02	54,900
October	1,720	182	652	19.6	22.60	40,100
November	1,960	192	660	19.9	22.20	39,300
December	154	76	94.6	2.85	3.29	5,820
The year	2,580	37	501	15.1	204.66	362,000

SPEEL RIVER AT PORT SNETTISHAM.

LOCATION.—At entrance of canyon one-fourth mile downstream from mouth of Long River, and 8 miles upstream from tide flats and the cabins of the Speel River Project (Inc.), which are at head of north arm of Port Snettisham and 42 miles by water from Juneau.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—July 1, 1916, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder 150 feet to the left of the constriction of the river at the entrance of the canyon. The gage is reached from cabins of the Speel River Project by trail to head of Second Lake, boat across Second Lake, trail to head of Indian Lake, boat across Indian Lake, trail down Long River and Indian River to canyon, and cable across river near entrance of the canyon—a total distance of about 7 miles.

DISCHARGE MEASUREMENTS.—At all stages made from cable having a clear span of 400 feet across river, one-half mile below gage and one-fourth mile below lower end of canyon.

CHANNEL AND CONTROL.—For several miles above the canyon the river flows in several channels through a wide, flat, sandy valley in which the channels are continually shifting. The river is constricted from a width of 500 feet to 75 feet at entrance of canyon. This constriction of channel and rock outcrop at entrance of canyon form a very sensitive and permanent control. The extreme range in stage is 28 feet. Above a stage of 22 feet part of the flow passes through a secondary channel (the bed of which is rock overgrown with brush) which begins near gage and rejoins main channel at lower end of canyon. Below a stage of about 4 feet (discharge, 920 second-feet) water from stream does not reach the well except by seepage through gravel and water in well does not assume the level of the water in river. At the gaging cable the bed of the river is gravel, with one large rock outcrop near middle of stream. The current is very swift and carries a large quantity of sand in suspension.

EXTREMES OF DISCHARGE.—Maximum stage during period of record, 21.5 feet, September 19, 1917 (discharge determined from an extension of the rating curve, 18,000 second-feet); minimum flow, 150 second-feet April 14, 1917, estimated by aid of discharge measurement March 25 and by comparison with record of flow of Long River.

Ice.—Ice does not form at control, but so much frost forms in gage shelter and on metal parts of gage that the gage does not operate satisfactorily during the winter.

Accuracy.—Stage-discharge relation permanent, but for stages below 4 feet (920 second-feet) water from river does not reach gage well except by seepage through gravel. For low stages, therefore, water in the well does not assume the level of the water in the river and frequent measurements are necessary to estimate the flow. Rating curve fairly well defined between 1,200 and 10,000 second-feet; extended above 10,000 second-feet. Operation of water-stage recorder not satisfactory for periods indicated in footnote to daily-discharge table because of the frequent stopping of clock, due to the binding of paper-supply roll or to running down at times when ice on lakes was unsafe for crossing. Daily discharge ascertained by applying to rating table daily gage height determined by inspecting gage-height graph. Records fair for periods when gage was operating satisfactorily; poor for periods when clock was not running.

Discharge measurements of Speel River at Port Snettisham in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 13	C. O. Brown	1.82	302	Apr. 21	C. O. Brown	2.25	334
Mar. 25	do	.94	185	Sept. 15	G. H. Canfield	13.9	5,910

Daily discharge, in second-feet, of Speel River at Port Snettisham for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	410	500	165	180	1,040	3,530	6,100		3,800	5,500	2,720	500
2	410	500	165	180	980	3,330	6,100		3,800	5,500	2,470	500
3	410	500	165	180	950	3,280	6,100		3,800	5,500	2,270	500
4	410	500	165	210	920	3,530	6,100		3,800	5,500	2,050	500
5	410	500	165	210	920	3,710	6,100		3,280	5,500	1,910	500
6	410	500	165	210	980	3,590	4,690		3,230	5,500	1,770	500
7	410	500	165	210	1,380	3,380	5,770		3,230	5,500	1,980	500
8	410	500	165	210	1,630	3,600	4,900	5,060	3,180	5,500	2,230	500
9	410	500	165	210	1,700	3,600	4,370		3,180	5,500	2,050	500
10	410	500	165	210	1,630	3,600	4,550		3,130	6,800	1,940	500
11	340	500	165	210	1,420	3,600	4,310		3,130	8,050	2,230	500
12	330	500	165	210	1,350	3,600	4,620		3,250	5,220	2,310	500
13	290	500	165	210	1,520	3,600	4,490		3,300	4,900	3,040	500
14	265	500	165	210	1,740	3,600	4,490		4,000	4,430	8,050	500
15	260	500	165	210	1,770	3,600	4,980		5,300	4,250	4,690	500
16	340	500	165	210	1,700	3,600	5,140		5,060	4,070	3,590	500
17	340	500	165	210	1,630	3,600	5,390		5,140	3,890	3,180	500
18	340	500	165	210	1,630	3,600	9,600		9,050	3,650	5,140	500
19	340	500	165	210	1,630	3,600	6,000		16,000	3,530	9,400	500
20	340	500	165	210	1,560	3,600	6,000		6,800	3,330	12,100	500
21	340	500	165	340	1,420	3,600	6,000		6,800	3,180	6,800	500
22	340	500	165	340	1,380	3,600	6,000		6,800	3,040	4,760	500
23	340	500	165	380	1,420	3,600	6,000		6,800	2,900	4,010	500
24	340	500	185	540	1,560	3,600	6,000		6,800	2,810	3,530	500
25	340	500	185	620	1,800	3,600	6,000		6,800	2,720	3,230	500
26	340	500	185	700	2,190	3,600	6,000		6,800	2,230	1,800	500
27	340	500	185	700	2,430	3,600	6,000		6,800	2,510	1,800	500
28	340	500	185	700	2,680	3,600	6,000		6,800	2,430	1,800	500
29	340		185	950	2,950	3,600	6,000		6,800	2,390	1,800	500
30	340		180	1,040	3,180	3,600	6,000		6,800	2,350	1,800	500
31	340		180		3,530		6,000			2,820		500

Note.—Discharge estimated by comparison with records of flow for Long River as follows: Jan. 1–10; Jan. 16 to Mar. 23; Apr. 4–20; June 8 to July 5; July 19 to Sept. 4; Sept. 12–14; Sept. 20 to Oct. 9; Nov. 16–17; and Nov. 26 to Dec. 31. Braced figures show mean discharge for periods included. Discharge Aug. 1-31 estimated 8,500 second-feet.

Monthly discharge of Speel River at Port Snettisham for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January			356	21,900
February			500	27,800
March			170	10,500
April			329	19,600
May	3,530	920	1,700	105,000
June			3,570	212,000
July			5,670	349,000
August			8,500	523,000
September	16,000		5,120	305,000
October			4,230	260,000
November	12,100		3,550	211,000
December			500	30,700
The year	16,000		2,860	2,080,000

GRINDSTONE CREEK AT TAKU INLET.

LOCATION.—On north shore of Taku Inlet between Point Bishop and Point Salisbury, one-fourth mile west of mouth of Rhine Creek and 11 miles by water from Juneau.

DRAINAGE AREA.—Not measured.

RECORDS AVAILABLE.—May 6, 1916, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on left bank, 200 feet from tidewater, installed September 16, 1916. A Lietz seven-day graph water-stage recorder was used May 6 to June 17, 1916.

DISCHARGE MEASUREMENTS.—At all stages made by wading either in the channel on the beach, which is exposed at low tide, or 100 feet below gage at high tide.

CHANNEL AND CONTROL.—For a distance of one-fourth mile from tidewater the stream descends in a series of rapids and falls through a narrow, rocky channel. The gage is at upper end of a turbulent pool between two falls, the lower of which forms a well-defined control. When gage was installed, logs were jammed in channel near upper end of pool.

EXTREMES OF DISCHARGE.—1916–17: Maximum stage, 5.33 feet at 5 p. m., August 19, 1917 (discharge, estimated from extension of rating curve, 600 second-feet); minimum stage, −0.03 foot, estimated from climatic records to have occurred April 2, 1917 (discharge, 5 second-feet).

ICE.—Stage-discharge relation not affected by ice.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined below 150 second-feet; extended above 150 second-feet by estimation. Operation of water-stage recorder satisfactory except for periods shown in the footnote to daily discharge table. Daily discharge ascertained by applying to rating table daily gage height determined by inspecting gage-height graph or for days of considerable fluctuation by averaging results obtained by applying to rating table mean gage heights for regular intervals of day. Records excellent except those for periods of break in record and discharge above 150 second-feet, which are fair.

Discharge measurements of Grindstone Creek at Taku Inlet in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Jan. 5	C. O. Brown	0.23	10.6	Sept. 7	G. H. Canfield	0.73	23
Feb. 14	do	.63	20.5	Nov. 13	do	1.24	68
June 13	G. H. Canfield	1.24	66	Dec. 7	do	.64	21

Daily discharge, in second-feet, of Grindstone Creek at Taku Inlet for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14	6.8	7.7	5.4	35	100	76	119	....	43	46	28
2	13	6.6	7.5	5.0	27	76	71	78	....	40	37	26
3	12	6.4	7.3	5.5	24	65	79	61	....	46	31	24
4	11	6.4	7.1	11	25	80	128	51	....	72	39	23
5	10	6.6	6.8	11	25	109	98	47	....	65	21	22
6	9.0	8.1	6.6	7.7	27	131	111	47	....	70	52	21
7	8.6	23	6.4	6.4	39	110	205	43	25	168	60	21
8	16	17	6.2	5.7	53	88	115	43	24	105	43	20
9	18	11	6.0	5.5	51	82	84	36	23	99	41	19
10	11	11	6.0	5.5	42	70	73	35	22	94	60	18
11	10	11	5.9	5.5	36	63	65	43	22	80	70	18
12	10	11	5.9	5.5	40	63	82	37	22	67	70	16
13	9.4	12	5.7	5.5	44	67	65	30	29	65	80	14
14	9.0	25	5.9	5.5	49	78	63	32	25	61	196	14
15	8.8	83	6.4	5.9	47	112	60	49	42	55	129	14
16	8.4	44	7.9	6.6	46	90	60	71	29	49	60	14
17	8.2	18	8.1	7.5	46	79	74	70	35	49	46	14
18	8.4	12	8.1	8.4	47	97	118	61	82	50	151	14
19	8.8	11	8.1	9.8	50	107	93	358	118	57	214	14
20	8.2	11	8.2	12	60	95	94	....	83	68	202	14
21	7.9	10	8.2	16	51	96	77	....	67	53	151	13
22	7.3	9.6	8.2	33	46	95	64	....	59	63	102	12
23	6.8	9.2	8.2	21	43	76	78	....	63	70	85	13
24	6.6	9.0	8.1	25	47	68	95	....	53	67	67	13
25	8.2	8.8	7.9	32	52	66	103	....	49	57	75	12
26	9.0	8.4	7.5	32	57	62	128	....	50	49	96	12
27	8.6	8.2	7.1	31	62	61	83	....	46	42	112	11
28	7.7	7.9	6.8	35	65	58	66	....	49	46	62	11
29	6.9	....	6.4	46	70	56	56	....	46	41	39	11
30	6.9	....	6.0	44	72	57	50	....	48	63	33	10
31	6.9	....	5.7	....	142	....	79	....	....	53	....	10

NOTE.—Gage-height record Jan. 5 to Apr. 24 condensed so that it covered only about a foot of record paper; sticking of the supply paper on guides caused paper to feed too slowly; gage-height record for this period redrawn to normal time scale by aid of the peaks and troughs of the condensed graph, readings of staff gage Jan. 5, Feb. 14, and Mar. 16, and comparison with gage-height graphs for Sheep, Gold, and Carlson creeks. Discharge July 15 and 16 interpolated. Gage float caught Aug. 20 to Sept. 6; discharge estimated by comparison with records of flow for Carlson Creek as follows: Aug. 21–31, 125 second-feet; Sept. 1–6, 30 second-feet. Discharge Nov. 18 to Dec. 6 estimated from maximum and minimum stages indicated by the recorder and comparison of gage-height record for this station with that for Carlson Creek. Discharge Dec. 26–31 estimated from weather records.

Monthly discharge of Grindstone Creek at Taku Inlet for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	18	6.6	9.50	584
February	83	6.4	14.7	816
March	8.2	5.7	7.03	432
April	46	5.0	15.2	904
May	142	24	49.0	3,010
June	131	56	81.9	4,870
July	205	50	86.9	5,340
August	358	30	90.7	5,580
September	118	22	43.0	2,560
October	168	40	64.7	3,980
November	214	21	82.3	4,900
December	28	10	16.0	984
The year	358	5.0	46.9	34,000

CARLSON CREEK AT SUNNY COVE.

LOCATION.—At Sunny Cove on west shore of Taku Inlet, 20 miles by water from Juneau.

DRAINAGE AREA.—22.26 square miles (determined by engineering department of Alaska Gastineau Mining Co. from surveys made by that company).

RECORDS AVAILABLE.—July 18, 1916, to December 31, 1917.

GAGE.—Stevens water-stage recorder on left bank, 2 miles from tidewater; inspected several times a week by employees of the Alaska Gastineau Mining Co.

DISCHARGE MEASUREMENTS.—At high stages, made from cable across river one-half mile downstream from gage; at medium and low stages, by wading 500 feet upstream from gage.

CHANNEL AND CONTROL.—Above the gage the stream meanders in one main channel and several small channels through a flat, sandy basin about a mile long; just below gage channel contracts and stream passes over rocky falls that form a well-defined and permanent control. Point of zero flow, gage height −1.5 feet.

EXTREMES OF DISCHARGE.—1916–17: Maximum stage during the year, 6.65 feet at 4 p. m., August 19, 1917 (discharge, computed from extension of rating curve, 3,800 second-feet); minimum flow estimated from climatic data and hydrographs for streams in near-by drainage basins, 28 second-feet, April 4, 1917.

ICE.—Stage-discharge relation affected by ice January 1 to April 28 and December 1–31.

ACCURACY.—Stage-discharge relation permanent. Rating curve well defined between 90 and 2,400 second-feet, extended below 90 second-feet to point of zero flow and above 2,400 second-feet by estimation. Operation of water-stage recorder satisfactory except for a few days; as gage was visited several times a week, breaks in record caused by clock stopping were short. Daily discharge ascertained by applying to rating table daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of the day. Records good except for stages below 90 second-feet and above 2,400 second-feet, for which they are fair.

Discharge measurements of Carlson Creek at Sunny Cove in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 27	C. O. Brown	−0.08	[a] 52.8	Sept. 19	G. H. Canfield	4.53	1,970
May 1	do	.38	173	Nov. 13	do	1.30	363

[a] About 1.8 second-feet should be deducted to give flow past the gage. Stage-discharge relation affected by ice.

Daily discharge, in second-feet, of Carlson Creek at Sunny Cove for 1917.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	177	840	1,120	1,720	292	330	268
2	142	620	1,100	832	264	344	196
3	128	495	1,330	525	242	1,300	156
4	125	610	1,120	428	231	692	134
5	136	908	760	408	231	495	128
6	159	885	708	450	231	510	143
7	169	725	1,150	430	223	1,400	151
8	780	570	785	416	204	711	249
9	540	550	585	403	200	1,530	164
10	311	465	620	417	188	964	198
11	238	465	638	672	183	682	248
12	240	585	840	510	212	638	335
13	306	725	666	373	495	558	444
14	360	725	555	408	474	416	2,440
15	350	885	708	955	729	338	931
16	330	708	735	1,200	422	251	360
17	325	690	950	1,190	634	216	265
18	384	780	1,830	1,120	2,080	260	622
19	414	1,020	1,020	2,510	2,520	301	1,550
20	403	800	908	1,550	1,080	249	1,500
21	306	908	638	655	1,400	196	1,000
22	272	930	525	1,270	1,300	168	725
23	274	725	628	885	780	183	480
24	332	725	952	690	492	186	320
25	414	742	1,160	430	330	179	267
26	534	638	1,182	622	453	168	376
27	570	620	708	2,040	342	138	386
28	620	602	495	1,400	527	177	248
29	672	602	430	690	760	216	153
30	655	585	389	436	513	665	136
31	930	....	1,060	338	....	651	....

NOTE.—Because of clock stopping or backwater from ice, discharge estimated from weather records at Juneau and from comparison of hydrograph for this station with those for Gold, Sheep, and Grindstone creeks as follows: Jan. 1-31, 50 second-feet; Feb. 1-28, 80 second-feet; Mar. 1-31, 40 second-feet; April 1-28, 50 second-feet; Nov. 20-21, daily discharge; Dec. 1-31, 64 second-feet.

Monthly discharge of Carlson Creek at Sunny Cove for 1917.

[Drainage area, 22.26 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January			50	2.25	2.59	3,070
February			80	3.59	3.74	4,440
March			40	1.80	2.08	2,460
April			60	2.70	3.01	3,570
May	930	125	374	16.8	19.37	23,000
June	1,020	465	704	31.6	35.26	41,900
July	1,830	389	848	38.1	43.93	52,100
August	2,510	338	838	37.6	43.35	51,500
September	2,520	183	601	27.0	30.13	35,800
October	1,530	138	487	21.9	25.25	29,900
November	2,440	128	486	21.8	24.33	28,900
December			64	2.88	3.32	3,940
The year	2,520		388	17.4	236.36	281,000

SHEEP CREEK NEAR THANE.

LOCATION.—At lower end of flat basin, above diversion dam for flume leading to Treadwell power house at beach, and 1 mile by tramway and ore railway from Thane.

DRAINAGE AREA.—4.57 square miles above gaging bridge (measured on United States Geological Survey map of Juneau and vicinity, edition of 1917).

RECORDS AVAILABLE.—July 26, 1916, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on right bank at pool formed by an artificial control just below small island three-tenths mile upstream from diversion dam. Recorder inspected once a week by an employee of the Alaska Gastineau Mining Co.

DISCHARGE MEASUREMENTS.—At extremely high stages made from gaging bridge two-tenths mile downstream from gage; at low stages made by wading near bridge section. No streams enter between gage and measuring section, but seepage inflow varies from a small amount to 10 per cent of total flow, the per cent of inflow usually being large after periods of heavy precipitation.

CHANNEL AND CONTROL.—The station is near lower end of flat basin through which the stream meanders in a channel having low banks and bed of sand and gravel. An artificial control was built 2 feet below intake for gage well to confine the flow in one channel during high water and to insure a permanent stage-discharge relation. The spillway of the control at low stages consists of a timber, 16 feet long, set in the bed of the stream. During medium and high stages another timber, 8 feet long, bolted at top near right end, forms part of the control. A 3-foot cut-off wall is driven at upstream face of spillway. There are wing walls at each end and an 8-foot apron extends downstream from control.

EXTREMES OF DISCHARGE.—Maximum stage during year, 2.47 feet at 5 p. m., November 14 (discharge, from extension of rating curve, 580 second-feet); minimum stage, 0.15 foot April 7 (discharge, 0.8 second-foot).

ICE.—Ice forms in the channel above and below but not on the spillway of the control.

ACCURACY.—Stage-discharge relation permanent, but from August 19 to September 7 and September 20–24 intake pipe was obstructed with gravel, so that water surface in well was maintained at level of water surface in creek 10 feet upstream from control by seepage through gravel. Rating curve used August 19 to September 7 and September 20–24 based on three discharge measurements and is fairly well defined below 150 second-feet; curve used remainder of year based on 14 discharge measurements and is well defined below 250 second-feet. Operation of water-stage recorder satisfactory except for short periods indicated in footnote to table of daily discharge. Daily discharge ascertained by applying to rating table daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging results obtained by applying to rating table mean gage heights for regular intervals of the day. Records fair.

Discharge measurements of Sheep Creek near Thane in 1917.

Date.	Made by—	Gage height.	Discharge.	Date.	Made by—	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 22	C. O. Brown	0.70	21.2	Sept. 7	G. H. Canfield	0.83	40
Apr. 7	....do	.15	.8	22	....do	a 1.18	115
May 3	G. H. Canfield	.78	38	26	....do	1.02	83
June 5	....do	1.17	125	Oct. 3	....do	1.10	102
9	....do	1.05	95	Dec. 22	....do	.53	12.9
July 18	....do	1.35	176				

a Intake pipe clogged; elevation of water surface in gage well higher than that in river.

Daily discharge, in second-feet, of Sheep Creek near Thane for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10.8	2.8	17.0	2.2	41	106	98	161	63	62	53	40
2	10.4	2.6	16.5	2.0	38	85	90	90	52	64	53	41
3	9.6	2.8	15.5	1.8	36	70	101	70	48	96	40	36
4	8.8	3.0	15.0	1.8	36	90	128	64	39	110	31	33
5	8.0	3.0	14.5	1.4	36	125	98	66	40	111	41	30
6	7.6	3.0	14.0	1.0	38	139	96	66	42	118	39	27
7	8.8	3.7	13.0	1.0	55	120	176	64	42	222	75	26
8	9.2	7.0	12.5	1.0	88	101	111	60	43	155	55	24
9	9.2	11.2	12.5	1.2	75	93	88	57	43	236	47	22
10	9.2	14.5	12.0	1.2	62	78	80	60	43	152	75	20
11	8.8	15.5	11.2	1.2	53	75	73	73	43	125	80	19
12	8.0	15.5	10.4	1.4	49	75	78	66	45	125	101	18
13	6.7	15.5	10.0	1.4	53	83	66	55	93	106	125	17
14	5.8	17.5	9.6	1.2	60	93	64	55	64	98	387	16
15	4.9	74	10.0	1.2	62	111	73	85	96	80	176	15
16	4.3	62	9.6	1.2	62	88	85	117	62	66	111	15
17	4.0	47	9.2	1.4	64	85	90	111	80	57	93	14
18	3.7	32	8.8	1.6	68	96	167	93	185	55	147	14
19	3.4	27	8.0	2.2	70	111	120	219	216	51	265	13
20	3.2	25	7.0	2.8	68	96	117	208	270	64	265	13
21	2.8	23	6.4	3.7	55	96	96	122	134	51	191	13
22	2.6	22	5.8	5.8	49	98	78	124	124	57	147	12
23	2.2	22	5.5	9.6	47	83	96	114	108	64	120	12
24	1.6	21	5.2	16	43	80	101	100	86	60	93	11
25	2.8	20	4.9	25	62	80	114	80	73	55	78	10
26	4.0	20	4.6	30	75	73	161	82	85	45	80	10
27	3.4	19.0	4.0	31	70	70	104	149	68	43	85	9.6
28	3.2	18.0	3.7	38	60	70	83	144	73	45	68	9.2
29	3.2	....	3.4	43	70	68	73	94	90	41	53	9.2
30	3.0	....	3.0	43	75	70	66	77	78	84	38	9.0
31	3.0	....	2.6	....	141	....	109	67	....	83	....	9.0

Monthly discharge of Sheep Creek near Thane for 1917.

[Drainage area, 4.57 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	10.8	1.6	5.68	1.24	1.43	349
February	74	2.6	19.6	4.29	4.47	1,090
March	17	2.6	9.21	2.02	2.33	566
April	43	1.0	9.18	2.01	2.24	546
May	141	36	60.0	13.1	15.10	3,690
June	139	68	90.3	19.8	22.09	5,370
July	176	64	99.4	21.8	25.13	6,110
August	219	55	96.5	21.1	24.33	5,930
September	270	39	84.3	18.4	20.53	5,020
October	236	41	89.7	19.6	22.60	5,520
November	387	31	107	23.4	26.11	6,370
December	41	9.0	18.3	4.00	4.61	1,130
The year	387	1.0	57.6	12.6	170.97	41,700

GOLD CREEK AT JUNEAU.

LOCATION.—At highway bridge at lower end of Last Chance basin, 200 feet upstream from diversion dam of Alaska Electric Light & Power Co., and one-fourth mile from Juneau.

DRAINAGE AREA.—9.47 square miles (determined by engineering department of Alaska Gastineau Mining Co., from surveys made by that company).

RECORDS AVAILABLE.—July 20, 1916, to December 31, 1917.

GAGE.—Stevens continuous water-stage recorder on left bank at upstream side of highway bridge. A staff gage was installed September 19, 1916, on left wing wall of diversion dam 200 feet downstream and used in determining the time of changes in stage-discharge relation at the well gage.

DISCHARGE MEASUREMENTS.—At medium and high stages made from gaging bridge suspended, at right angles to current, from floor of highway bridge; at low stages, made by wading near gage.

CHANNEL AND CONTROL.—Station is at lower end of a flat gravel basin three-fourths mile long. For 20 feet upstream from gage the stream is confined between the abutments of an old bridge, and for 15 feet downstream it is confined between the abutments of present bridge. For a distance of 130 feet farther downstream the stream is confined in a narrow channel which is not subject to overflow. Because of the steep gradient of channel opposite and for 150 feet below gage, a short stretch of the channel immediately below the gage acts as the control. The operation of the head gates of flume at diversion dam, 200 feet downstream, does not affect the stage-discharge relation at gage, but the swift current during high stages shifts the gravel in bed of stream, thereby causing changes in the stage-discharge relation.

EXTREMES OF DISCHARGE.—1916–17: Maximum mean daily discharge, 600 second-feet, August 19, 1917; minimum mean daily discharge, 4 second-feet February 5 and April 1, 1917.

ICE.—Stage-discharge relation affected by ice in December.

DIVERSION.—Water diverted at several points upstream for power development is returned to creek above gage, except about 20 second-feet for 7 months (when there is a surplus over the amount used by the Alaska Electric Light & Power Co., which has the prior right) and 1 second-foot the remainder of the year used by the Alaska Juneau Gold Mining Co. The dam 200 feet downstream diverts water into the flume of the Alaska Electric Light & Power Co.

REGULATION.—No storage reservoir above station that regulates the flow more than a few hours in low water.

ACCURACY.—Stage-discharge relation changed during periods of high water; 11 discharge measurements and 3 simultaneous readings of water-stage recorder and staff gage at diversion dam were made during the period, by use of which rating curves have been constructed which are applicable as follows: January 1 to April 24, well defined; April 25 to August 19, well defined below and fairly well defined above 500 second-feet; August 20 to noon, September 19, poorly defined; September 19–21, poorly defined; September 22 to October 8, poorly defined; October 9 to December 31, well defined. Operation of water-stage recorder satisfactory, except for short periods indicated in footnote to daily-discharge table. Daily discharge ascertained by applying to the rating table daily gage height determined by inspecting gage-height graph, or, for days of considerable fluctuation, by averaging the results obtained by applying to rating table mean gage heights for equal intervals of the day. Records fair.

Discharge measurements of Gold Creek at Juneau in 1917.

Date.	Made by—	Staff gage of dam.	Gage height.[a]	Discharge.	Date.	Made by—	Gage height.[a]	Discharge.
		Feet.	*Feet.*	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
Feb. 23	C. O. Brown		0.34	19	Sept. 6	G. H. Canfield	1.23	58
Apr. 12	do		.01	5.4	20	do	2.39	255
30	do	−0.05	.80	65	25	do	1.65	116
May 5	do		.61	44	Oct. 4	do	1.88	151
8	do	.67	1.59	228	Nov. 6	do	.88	46
31	G. H. Canfield	1.03	1.98	350	20	do	2.46	439
Sept. 1	do		1.48	96	Dec. 21	do	.33	7.6

[a] Gage at highway bridge.

Daily discharge, in second-feet, of Gold Creek at Juneau for 1917.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.0	5.0	13	4.0	58	260	302	462	102	93	79	58
2	9.0	4.7	12	4.4	46	195	266	230	92	85	76	52
3	8.1	4.5	11.5	4.8	51	151	325	162	80	277	62	47
4	7.3	4.3	11.5	5.2	50	190	378	135	93	235	42	43
5	6.1	4.0	11	7.7	43	289	263	127	72	170	55	38
6	5.2	5.0	11	7.0	50	308	273	145	70	145	51	35
7	13	8.0	10	6.1	107	263	411	135	72	395	97	32
8	13	9.0	9.5	5.8	210	202	283	124	59	230	65	28
9	10	11	9.0	5.5	162	180	200	120	51	470	45	25
10	10	13	8.5	5.5	109	145	183	129	50	315	69	23
11	9.5	15	8.5	5.8	83	139	178	197	55	115	105	21
12	9.0	15	8.5	5.5	80	164	197	147	65	186	124	18
13	8.5	17	7.7	5.5	100	183	178	107	160	177	152	16
14	8.1	33	7.7	5.8	118	224	157	116	121	128	587	15
15	7.7	206	7.7	6.7	111	279	192	254	180	101	247	13
16	7.7	86	7.3	7.3	111	213	226	360	100	72	94	10
17	6.0	59	7.7	9.0	114	216	243	325	128	62	69	9
18	7.7	44	7.7	10	129	242	444	260	431	62	179	8
19	7.3	42	7.7	12	135	299	315	600	560	63	446	8
20	6.0	35	7.7	13	135	251	282	348	280	82	505	8
21	6.4	27	7.7	13	102	266	208	235	298	58	362	8
22	5.8	21	7.7	14	91	295	171	235	370	72	279	7
23	5.8	17	7.7	18	90	227	213	185	270	86	177	7
24	10	16	7.7	25	107	202	276	156	170	75	142	7
25	11	14	7.3	38	129	202	302	111	110	58	117	7
26	7.0	13	6.7	43	141	183	376	137	135	48	130	6
27	6.5	14	6.7	46	157	176	224	390	93	41	150	6
28	6.2	13	6.4	54	176	169	171	382	118	46	96	6
29	5.8		6.1	65	192	171	133	227	173	51	76	6
30	5.5		6.1	68	185	192	116	154	140	151	66	6
31	5.2		5.8		295		280	114		158		6

NOTE.—Discharge Jan. 3-6 and Jan. 22 to Feb. 11 estimated, because of clock stopping, from weather data and comparison of hydrograph for this station with that for Sheep Creek. Discharge Nov. 29 to Dec. 31 estimated, because stage-discharge relation was affected by ice, from weather records and one discharge measurement.

Monthly discharge of Gold Creek at Juneau for 1917.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	13.0	5.2	7.85	483
February	206	4.0	27.0	1,500
March	13.0	5.8	8.42	518
April	68	4.0	17.3	1,030
May	295	43	118	7,260
June	308	139	216	12,900
July	444	116	251	15,400
August	600	107	220	13,500
September	560	50	157	9,340
October	470	41	139	8,550
November	587	42	158	9,400
December	58	6	18.7	1,150
The year	600	4.0	112	81,000

STORAGE RESERVOIRS IN SOUTHEASTERN ALASKA.

In 1917 reconnaissance was made of some of the streams in southeastern Alaska for the purpose of ascertaining the location, size, and elevation of lakes which may be used as storage reservoirs. The result of this investigation is shown in the table which follows. Elevations of the lakes above sea level were determined by aneroid barometer. Areas and distances were estimated.

Lakes available for storage reservoirs in southeastern Alaska.

Location of lakes.	Area.	Elevation above sea level.
	Acres.	*Feet.*
First lake above mouth of Mahoney Creek tributary to the west shore of George Inlet, Revillagigedo Island, one-fourth mile from tidewater	600	75
Second lake above mouth of Mahoney Creek, 2 miles from tidewater	180	2,000
A lake 2 miles upstream from mouth of unnamed creek tributary to Thomas Bay near Petersburg. Mouth of creek is 1½ miles north of Wind Point on west shore of Thomas Bay	400	400
First lake above mouth of unnamed creek tributary to head of Cascade Bay, Baranof Island, 300 feet from tidewater	100	80
Second lake above mouth of the foregoing creek, 1½ miles from tidewater at head of Cascade Bay	....	185
Lake 500 feet above mouth of unnamed creek tributary to southern entrance to Patterson Bay, Baranof Island	500	350
Lake 300 feet above mouth of unnamed creek tributary to head of west arm of Patterson Bay, Baranof Island	200	110
Lake 1,000 feet above mouth of unnamed creek tributary to head of Big Port Walter, Baranof Island	450	500
First lake, one-fourth mile above mouth of unnamed creek tributary to head of Port Armstrong, Baranof Island, near whaling station	200	260
Second lake above mouth of the foregoing creek, 1 mile from tidewater	400	265
A lake, 1 mile above mouth of unnamed creek tributary to head of Davidson Inlet, Kosciusko Island	....	520

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements in southeastern Alaska in 1917.

Date.	Stream.	Tributary to—	Locality.	Discharge.
				Sec.-ft.
Mar. 7	Mahoney Creek	George Inlet, Revillagigedo Island.	One-fourth mile above first lake, 1½ miles above beach on west shore of George Inlet 1 mile north of Beaver Falls.	2
Oct. 13	do	do	300 feet upstream from beach	95
Aug. 9	Unnamed creek	Thomas Bay, mainland near Petersburg.	Mouth at low tide, 1½ miles north of Wind Point on west shore of Thomas Bay.	45
13	do	Suloia Bay, Chichagof Island.	Mouth at low tide, at head of small bay at north end of Suloia Bay.	18
14	do	Cascade Bay, Baranof Island.	At narrows near middle of first lake, half a mile from tidewater at head of Cascade Bay.	528
15	do	Patterson Bay, Baranof Island.	Mouth at low tide, at south entrance of Patterson Bay.	90
15	do	do	Stream at head of small cove near southern entrance of Patterson Bay.	[a] 50
16	do	do	Mouth, at low tide, at head of west arm of Patterson Bay.	110
17	do	Big Port Walter, Baranof Island.	Near outlet of lake on stream at head of Big Port Walter.	72
20	do	Davidson Inlet, Kosciusko Island.	Half a mile upstream from beach, at head of Davidson Inlet.	57

[a] Estimated.

MINING DEVELOPMENTS IN THE KETCHIKAN DISTRICT.

By Theodore Chapin.

INTRODUCTION.

The mineral output of the Ketchikan district was smaller than in 1916. Six copper mines were in operation and at two other places mills were in course of construction. A molybdenum lode was opened up near Shakan on Prince of Wales Island and is in course of development. One gold lode mine was operated for a part of the year, and gold and silver were also won from ores mined primarily for copper. The decrease in mineral production is due in part to the closing of the Mamie mine for some months during the year, in part to the failure of several small mines to make any production, and to a general decrease in production at nearly all the large mines.

PRODUCTION.

The gold, silver, and copper production of the Ketchikan district is shown in the following table:

Copper, gold, and silver produced in the Ketchikan mining district in 1915, 1916, and 1917.

Year.	Ore mined.	Copper.		Gold.		Silver.		Total value.
		Quantity.	Value.[a]	Quantity.	Value.	Quantity.	Value.[b]	
	Tons.	*Pounds.*		*Fine oz.*		*Fine oz.*		
1915	50,997	1,728,182	$302,431	1,727.38	$35,708	11,666	$5,914	$344,053
1916	76,111	3,526,703	867,569	2,769.61	57,253	19,361	12,640	937,462
1917	41,768	2,643,543	721,686	2,545.71	52,623	20,218	16,658	790,967

[a] Computations based on average price of copper in 1915 ($0.175), 1916 ($0.246), and 1917 ($0.273).
[b] Computations based on average price of silver in 1915 ($0.507), 1916 ($0.658), and 1917 ($0.824).

PRINCE OF WALES ISLAND.

KASAAN BAY AND VICINITY.

The Granby Consolidated Mining, Smelting & Power Co. (Ltd.) were the largest operators in the vicinity of Kasaan Bay. The Mamie mine, which was taken over by the Granby Co. in 1913, was closed down in the spring, and work was increased at the It mine. The ore bodies at the It occur in limestone near the contact of a large intrusive mass of quartz diorite and appear to have formed along the borders of an older dioritic dike now largely altered to epidote and other secondary minerals. The ore occurs as bunches of chalcopyrite in the altered dike and in the garnet rock formed by the replacement of the limestone. The power plant at the beach is equipped with a coal-burning boiler and air compressor. During the summer of 1917 a geologic map of the vicinity was made and prospecting was carried on which has led to the discovery of other surface outcrops.

The Goodro mine near the head of Kasaan Bay changed hands during the year and is now operated by the Salt Chuck Mining Co. No production was made during 1917. Development work was carried on, and a flotation mill that was started in the spring was completed before the end of the year. The mill is situated on the edge of the salt chuck. The ore is trammed from the mine to the mill, dumped into bins, passed over a grizzly into a crusher, and conveyed to a 75-ton bin, from which it is automatically fed to the ball-mill (using four sizes of chilled steel balls), whence it is taken by a bucket conveyor to the flotation tank for treatment. Mixtures of pine tar and creosote will be used. The fines are frothed off and go to settling tanks. A scraper belt conveys the coarse ore and gangue on bottom to a trommel. The oversize from trommel goes to the mill, and the undersize to a Deister-Overstrom table, where the ore is separated from the gangue. The capacity of the mill is 60 tons a day. The ore bodies are in gabbro, and the ore minerals are essentially bornite and chalcocite and lesser amounts of other copper sulphides. The ore also carries gold and traces of platinum and palladium. Mine assays of the concentrates show copper content as high as 81 per cent, indicating the presence of some native copper.

The Rush & Brown mine near the head of Karta Bay was operated on about the usual scale. The mine is developed on two lodes, a contact deposit of copper-bearing magnetite and a shear zone mineralized with copper sulphides. The new working shaft on the sulphide ore body has been deepened to the 350-foot level and drifts extended each side of the shaft. At the foot of the shaft is an ore lens from 2½ to 3½ feet wide composed of high-grade chalcopyrite together with a little pyrite. The entire width of the ore body at this level is not evident but in the upper levels it is from 4 to 14 feet and carries lenses of ore from 2 to 4 feet wide. The magnetite ore body is a contact deposit occurring along the border of intrusive diorite and altered sediments. It has been developed by a glory hole 100 feet deep and by workings on the underground levels for 250 feet in depth. In the fall of 1917 a boiler for a compressor plant was being installed.

The Paul Young prospect is about a mile southwest of the Rush & Brown mine on the first stream west of Iron Creek, at an elevation of 100 feet. It is about three-quarters of a mile northwest of the Venus claim and 2 miles from the coast. The deposit occupies a shear zone that strikes northwest nearly parallel to the stream and is exposed along the northeast bank. The only work done is surface stripping along the stream. The country rock is black slate, and the ore occurs in calcite veins that follow an intrusive porphyry dike. The calcite veins carry chalcopyrite and pyrite, and the bordering black slate is impregnated and veined with these sulphides. The width of the deposits is not evident, but they appear to extend beneath the creek bottom. The water was turned from its course for a short distance to uncover the deposit in the creek bottom, but the exposed rock is again covered with gravel. The deposit is exposed in the creek bank 250 feet lower down. Here the black slate is impregnated with pyrite and chalcopyrite which accompany tiny reticulating quartz veinlets.

The Rich Hill group of claims, comprising the Rich Hill, Magnet, Buffer, Ouray, Interval, and Red Snapper, has recently been opened up and is now being developed by the Granby Co., who have the property bonded. The claims are on Kasaan Peninsula, about 2 miles southeast of Kasaan. The main workings are on the Rich Hill claim and are confined to a single lens of very rich chalcopyrite ore. This lens was opened by a cut 50 feet long and 20 to 30 feet deep and yielded 160 tons of ore, which brought $20,000. The mineralized zone can be traced northwest and southeast of the open pit for some distance, and a short adit is now being run to cut the deposit below the floor of the open cut. On the adjoining claims prospecting has been carried on and a number of mineralized lodes have been opened. On the Ouray claim a wide contact zone extends from the beach to an elevation of 450 feet. The rock of this zone is a garnet-epidote-magnetite contact rock that carries chalcopyrite. Several openings have been made, which disclose bodies of commercial ore.

South of Karta Bay and northwest of Twelvemile Arm, including the vicinity of Hollis, is a mineralized area in which gold lodes predominate. The country rock is a complex assemblage of igneous and sedimentary rocks. The bedded rocks include tuff, breccia, schist, limestone, black slate, argillite, and graywacke, and are cut by a large boss of quartz diorite and associated porphyritic dikes. The lodes are quartz veins that occur in the intrusive and the bedded volcanic rocks as well as in the sediments.

A number of lodes have been opened in this gold quartz belt and several small plants installed, but none has made a large production. This strongly mineralized region has never received the attention which it has deserved, and no doubt will be developed in the future. One large company might consolidate a number of these small properties and operate them to advantage.

The only mine in this region that was operated in 1917 was the Dutton mine, on Harris Creek. The Crackerjack claims join the Ready Bullion and extend south and southeast. On the surface three veins are recognized, known as the lower, middle, and upper veins. These are approximately parallel and form a lode system following intrusive porphyry dikes that cut the black slate. The dikes and black slate strike N. 25° W. and dip 35°–60° SW. The principal work has been done at an elevation of 850 feet at No. 1 tunnel. This tunnel penetrates black slate for 300 feet, until it cuts the vein and drifts on it for 700 feet along the hanging wall of the porphyry dike. The quartz vein borders the porphyry for a footwall and follows a well-defined hanging wall, although above the wall occur parallel quartz stringers that cut pyritized slate, which is said to carry both gold and silver. The hanging-wall vein averages about 5 or 6 feet across and at one place is over 12 feet. Along the footwall of the dike a smaller quartz vein occurs. A number of other adits have been opened on this lode system.

The Lucky Nell claim, formerly known as the Flora and Nellie, is about 8 miles northwest of Hollis on the divide between Maybeso and Harris creeks, at an elevation of about 1,400 feet. The lode is a quartz fissure vein in porphyry. It is being developed by an open cut and two adits with a connecting winze. The principal work has been done on the lower adit, which has been driven along the vein for 500 feet. The vein strikes about N. 70° E. and dips 65°–80° SE. The vein is marked by two strong walls and averages about 4 feet in width. It is strongly metallized with pyrite, chalcopyrite, galena, and sphalerite, and is reported to carry high values in gold and silver.

HETTA INLET.

The Jumbo mine on Copper Mountain, near the head of Hetta Inlet, was operated on about the usual scale but experienced some difficulty in getting shipping facilities for the transportation of ore to the smelter. The mine is developed on large contact deposits along intrusive diorite that forms the footwall of the deposits. The hanging wall is crystalline limestone and metamorphosed sediments. The copper deposits are irregular-shaped bodies of chalcopyrite-pyrrhotite ore and chalcopyrite-magnetite ore set in a gangue of garnet, calcite, epidote, and diopside.

Copper prospects were being opened by Hal Gould on the south end of Sukkwan Island, about 3 miles northeast of Jackson Passage. The prospects occur in a zone of contact schist along the border of the large mass of intrusive granite that occupies the interior of the island. This schist has been prospected along the granite contact for about a mile, and throughout this distance shows more or less mineralization. In places it is impregnated with pyrite and in others is veined with stringers of chalcopyrite and pyrrhotite that follow the schistosity of the rock and cut across it. Only surface work had been done in 1917.

WEST COAST.

Development work was continued on the Big Harbor mine in Trocadero Bay, but no production was made.

A molybdenite lode has recently been opened up near Shakan. The property is three-quarters of a mile south of Shakan, at an elevation of 600 feet. The deposit has been known for several years, but when first discovered the molybdenite was mistaken for galena, and when the assays showed negative results for lead the property was abandoned. It has recently been relocated by W. H. Butt and bonded to the Alaska Treadwell Mining Co., who are installing machinery for its development.

The deposit is a fissure vein of quartz, about 6 feet wide, that cuts diorite but occurs near the contact of the diorite and tuffaceous sediments. The quartz vein contains considerable feldspar, especially along the footwall, where in places it resembles an igneous rock. The diorite from the footwall is also mineralized. The vein carries molybdenite and also chalcopyrite and pyrite. The vein strikes N. 85° E. and 25° S. The deposit is covered by two claims, the Alaska Chief Nos. 1 and 2.

Aside from the output of the Vermont Marble Co., who operated on about the usual scale, there was no production of marble. Development work was continued at the El Capitan quarry, on Dry Pass, for a part of the summer, and a number of diamond-drill holes were put down, aggregating 1,000 feet. The cores show white crystalline marble, with some beds of blue and some of black and white.

GEOLOGY AND MINERAL RESOURCES OF THE WEST COAST OF CHICHAGOF ISLAND.

By R. M. Overbeck.

INTRODUCTION.

Chichagof Island is the northernmost of the larger islands of the Alexander Archipelago of southeastern Alaska. It lies in the northern part of the Sitka mining district between latitude 57° 22′ and 58° 17′ N., and between longitude 134° 50′ and 136° 33′ W. The geography, geology, and mineral resources of the west coast of the island are discussed in this report. The mining activity in the region during 1917 was as follows: One gold quartz mine was operating; steps were being taken toward opening another during 1917–18; and some development work was being done on a copper-nickel property north of Portlock Harbor, and on copper claims near the head of Pinta Bay. The metals found so far on the west coast are gold, copper, and nickel. An important gypsum mine is on the east side of the island outside the district discussed here.

Investigations of the geology of the west coast of Chichagof Island were made by C. W. Wright[1] in 1905 and by Knopf[2] in 1910. The reports and notebooks of these men have been consulted in the preparation of this report. This report, though supplementary to the earlier work, is in a sense preliminary to a study of the geology of the whole island.

During 1917, about two months of actual field work was done on the west coast of Chichagof Island, and another month was spent in carrying the work along Peril Strait, in making a trip to Sitka, and in making the run from Juneau to the field and from the field to Ketchikan. The field season extended from August 25 to November 9. The party consisted of one geologist and two boatmen. The chief object of the work was the investigation of deposits of the war minerals—copper and nickel. The areal geologic work, therefore, was incidental to the main object of the expedition. The shores of the island from Cross Sound to the head of Hooniah Sound were mapped geologically, but only a small amount of work could be done in the hills back from the shore because of an exceptionally early fall of

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, pp. 38–43, 1908.

[2] Knopf, Adolph, The Sitka mining district, Alaska: U. S. Geol. Survey Bull. 504, 1912.

snow. The base maps used were charts of the Coast and Geodetic Survey, some of which have been published and some of which were being made during 1917. Capt. C. G. Quillian, of the U. S. S. *Patterson,* aided materially in the work of mapping by supplying base maps and the data which had been collected by his parties. Acknowledgments are also due to Mr. Stuart Fleming, Mr. J. Freeburn, Mr. Wm. Freeburn, Mr. T. Baker, Mr. W. H. Roessel, and Mr. Nordley.

GEOGRAPHY.

Chichagof Island and Baranof Island together form a triangular land mass which has its base along Cross Sound and Icy Strait and its vertex 150 miles south-southeast of the center of the base. Peril Strait, which in its narrowest part is only a quarter of a mile wide, separates Chichagof Island from Baranof Island. Lisianski Strait cuts Yacobi Island, the northwest corner of the land mass, from Chichagof Island. Chatham Strait, a long fiord about 7 miles wide, runs along the east side of the island, the Pacific Ocean is on the west, and Cross Sound and Icy Strait are on the north. Chichagof Island is irregularly shaped; its greatest dimension, from northwest to southeast, is about 80 miles. The fiords, Lisianski Inlet, Idaho Inlet, Port Frederick, Tenakee Inlet, Peril Strait, Hooniah Sound, Slocum Arm, and Lisianski Strait, penetrate far into the island and give it a very long shore line. The straightness of these fiords and the parallelism of some of them is a noticeable feature of the map of the island. Two types of shore line are also evident on the map—one the ragged, island-fringed outer coast; the other the straight, relatively unindented shores of the fiords. The water along the outer coast is comparatively shallow, and 16 miles offshore is only 600 feet deep. Along the straight fiord shores the 600-foot depth contour is at most places not more than half a mile from shore. Navigation near the outside coast is somewhat hazardous, owing to the numerous rocks and reefs, but a detailed chart of the southern part of the coast has been published and one of the northern part is being prepared.

The west coast region of Chichagof Island is extremely rugged. The mountains rise steeply to a general elevation of about 2,300 feet and here and there a peak rises to a height of more than 3,000 feet. The mountain slopes are precipitous and in many places give foothold to only the most scanty vegetation. Countless lakes fill the valleys and the hollows between the ridges. Streams are numerous, and owing to the heavy rainfall are large compared to the size of their drainage basins. Most of the streams head in lakes and run over series of waterfalls into the sea.

A prominent physiographic feature of the west coast of the island is the coastal plain, which extends from Cross Sound to Khaz Head at the entrance to Slocum Arm. This plain at Nickel is about 2 miles wide, and has a general elevation near the shore of less than 100 feet and a maximum elevation of about 300 feet. The plain consists of rounded hills and low knobs, which rise above a terrain of swamps and small ponds. The land slopes gently upward toward the inner edge of the plain and then rises abruptly to elevations of over 2,000 feet. A scant growth of jack pine covers the plain in some of its drier portions, and a fair growth of spruce and hemlock covers most of the higher hills. Just south of Nickel this plain leaves the main part of the island, and it is continued in the islands offshore southward to Khaz Head, beyond which the mountains descend steeply into the sea. A continuation of the coastal plain is found beneath the sea in the coastal shelf, which extends offshore for about 16 miles, beyond which the sea bottom descends steeply in the next 4 miles to a depth of 3,300 feet.

The long, narrow arms of the sea, such as Slocum Arm, Lisianski Inlet, Hooniah Sound, and Tenakee Inlet, are typical fiords. The sides are straight and steep, and the water reaches depths such as are not again encountered for 16 miles offshore. Slocum Arm, for example, is nearly 700 feet deep. This fiord shows another characteristic of fiords in that it has a deep central portion and a relatively shallower portion, or threshold, near its entrance. Broad, low valleys extend from the head of the fiords. The one at the head of Slocum Arm was once selected as a mail route, so that mail might be carried from Sitka to Chichagof without necessitating an outside trip. Low valleys connect the heads of Lisianski Inlet with Hooniah Sound and Port Frederick with Tenakee Inlet. Small streams enter all these fiords at their heads. Deep submarine channels can be traced in the submerged coastal shelf for some distance from the entrance of these fiords. Such channels were noted at the entrance to Peril Strait, Slocum Arm, and Lisianski Strait.

A view of the west coast of the island from several miles out at sea shows a number of broad valleys whose ends appear to be shut off from the sea by a relatively low barrier. A near view of one of these valleys north of Nickel from the mountains surrounding it shows the whole floor to be occupied by a lake of apparently great depth. The barrier is a low row of hills about 700 feet high. A stream runs from the lake to the sea over a series of waterfalls. Such a valley, if drowned, would form a typical fiord with its steep sides, its deep central portion, and its threshold, or barrier, at its entrance.

The population of Chichagof Island is small, possibly 800, white and native. Chichagof, the only town on the west coast, has a population of about 200. Tenakee is a health resort on the east side of the island. Gypsum, a mining camp on the east side, has a population of about 50. Hooniah is a native town at the entrance to Port Frederick. There are canneries at Hooniah, on Ford Arm, and

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at Chatham; and new ones are being built at Stag Bay and at Port Althorp. Sawmills have been installed on Suloia Bay and in Pavlof Harbor. Logging is carried on in a small way, for timber is needed in driving fish traps, making boxes, and timbering mines.

Weekly boat service connects the towns on the east and north sides of the island with Juneau. The Chichagoff Mining Co. operates a boat between Chichagof and Juneau, which carries a few passengers and which makes trips about once a week. Sitka, on Baranof Island, is a port of call for some of the larger steamers, and has besides a regular weekly service to Juneau. Motor boats may be hired at Juneau and at Sitka to make the trip to Chichagof.

Prospecting on the west coast of Chichagof Island should be carried on from a motor boat, for the many arms and fiords make much of the island accessible from a small boat. The shores of the island have already been rather extensively prospected, but the country a short distance back from the shore seems to be relatively unexplored and unknown. The west coast of the island is rocky, and the weather is often stormy, but by those with local knowledge of the waters much of this coast may be examined from the smooth water behind the islands. In about 50 miles of coast, from the head of Slocum Arm to the southwest entrance to Lisianski Inlet, only about 8 miles of outside water need be traversed. Almost any point within the island could be reached on a two days' trip.

Timber is in general not abundant in the western part of Chichagof Island. The character and abundance of timber, however, depends on local conditions. Timber line lies anywhere from 1,500 to over 2,000 feet in elevation. Two conditions restrict the growth of the trees, the precipitousness of the slope and the marshiness of the ground. The more central portion of the island, visible from the high peaks near the shore, is almost barren of trees. Much timber near enough to the shore to be dropped into the water has been already cut. Timber for the Chichagoff mine and for the sawmill in Suloia Bay comes from Baranof Island. Spruce, hemlock, and cedar are the principal trees, and their height, thickness, and soundness vary greatly in different localities.

The climate of the region is cool and moist, and precipitation is frequent and heavy. No weather records have been kept for the west coast of Chichagof Island, and since there are great seasonal and local variations in temperature and precipitation, the observations that extend over only a few seasons are of little value. Although the average annual precipitation at Sitka, for instance, is about 88 inches, during the summer of 1917 there was a precipitation in one month of over 23 inches.

The game on the island should furnish the prospector, at certain seasons of the year, with a considerable part of his food supply.

The principal large game is deer and bear. Deer are very plentiful. Minks seem to be rather plentiful, for a number of them were seen during the summer of 1917. Ducks and geese are abundant during certain seasons.

GEOLOGY.

PRINCIPAL FEATURES.

The geology of the west coast of Chichagof Island is complex. This complexity is the result largely of extensive intrusion, which has metamorphosed the rocks cut by the intrusive bodies and has complicated their structure. Both dynamic and contact metamorphic rocks are found along the coast north of Dry Pass and along Peril Strait; dynamic metamorphic rocks prevail in Portlock Harbor and on Slocum Arm. The dynamic metamorphism is probably directly related to the intrusion of the larger igneous bodies. The geology of the island will be discussed under the following heads: (1) Undifferentiated metamorphic rocks; (2) graywacke; (3) igneous rocks; (4) development of the topographic features. The rocks of the undifferentiated metamorphic series are sheared conglomerate, limestone, argillite, tuff, flow rock, and intrusive rock, and several types of schist. No determinable fossils were found in these rocks; and although the rocks constituting this series may be of different ages, they are probably older than Jurassic or Lower Cretaceous. The graywacke series consists of graywacke, of some slaty and argillaceous beds, and of a little greenstone. The igneous rocks are both intrusive rocks and flow rocks. Granite, quartz diorite, diorite, alaskite, aplite, hornblende gabbro, norite, greenstone, and possibly some andesite are the types of rock represented. Quaternary deposits are practically absent, but the results of the action of the ice are remarkably well shown by the topographic features.

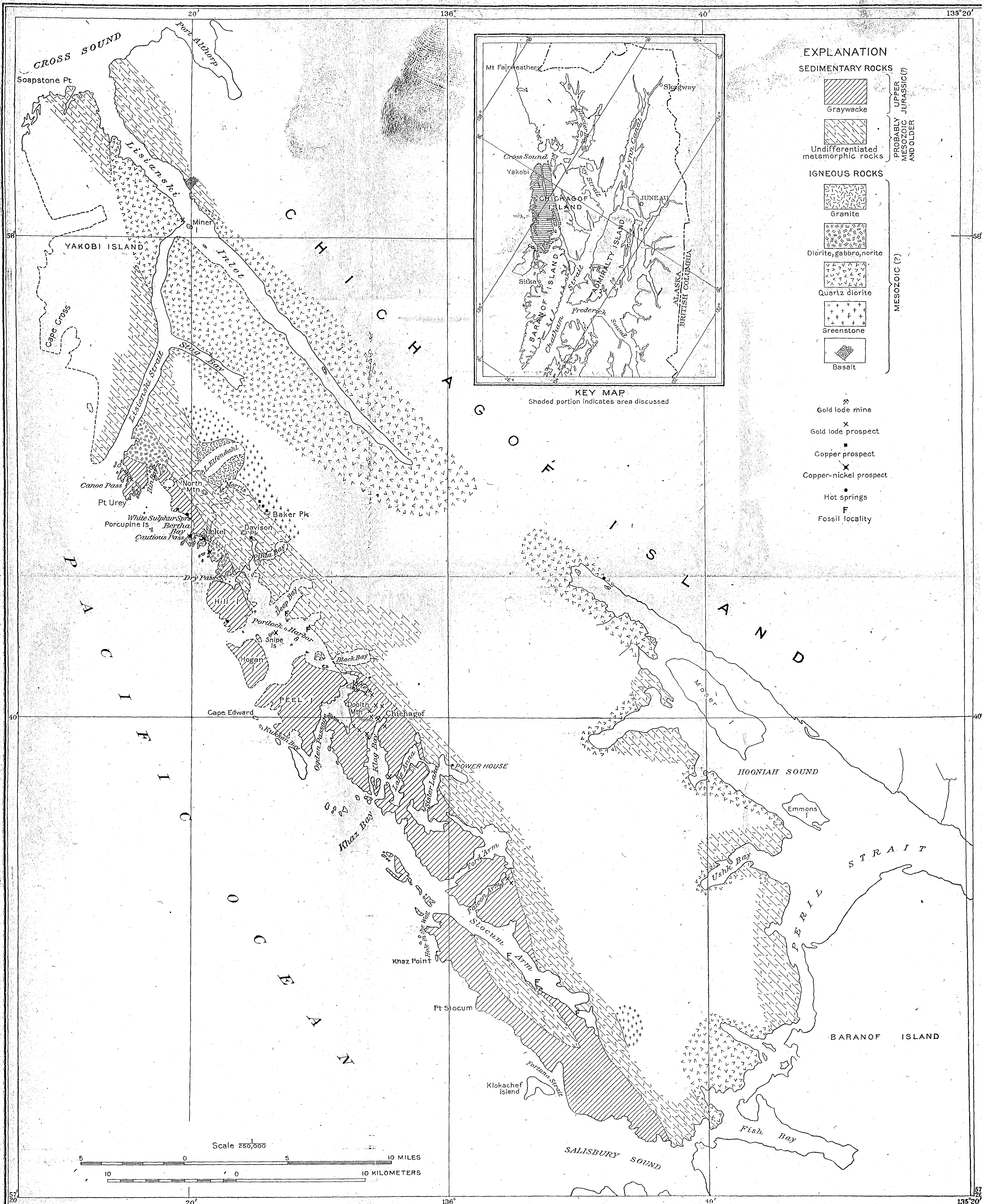
UNDIFFERENTIATED METAMORPHIC ROCKS.

DISTRIBUTION AND CHARACTER.

The undifferentiated metamorphic rocks occur on Lisianski Strait and Inlet, in the bays on the east side of Portlock Harbor, and at places on Slocum Arm and on Peril Strait. (See Pl. II.) The quartz-mica schist at the south entrance to Lisianski Strait (at Canoe Pass) and the rocks along the seashore from Canoe Pass to Dry Pass are mapped as graywacke, because gradations from graywacke into these rocks can be traced, and these rocks consequently are believed to be the metamorphic equivalents of the graywacke. The rocks of the east and west shores of the north end of Lisianski Strait and those along Peril Strait and Hooniah Sound, which are of somewhat different appearance from the rocks along the outer coast, may be of different age.

Under the heading of undifferentiated metamorphic rocks will be considered all those rocks that seem to underlie the graywacke. Metamorphosed sedimentary, volcanic, and intrusive rocks are included in the group, but at most places it is difficult and at many places impossible to tell whether the rock was originally sedimentary or igneous. The rocks in their present metamorphosed state are chlorite schist, hornblende schist, schistose greenstone, quartz-mica schist, schistose limestone, sheared conglomerate, and tuff. The chlorite schist, hornblende schist, and schistose greenstone are green and at some places show contorted banding. The quartz-mica schist is a fine-grained dark-brown rock (gray on weathered surface) which breaks into flat pieces, and the original bedding is represented by wavy bands of slightly different shades of brown. The schistose limestone is dark blue where impure and white where pure; the impure variety shows banding and some augen texture, and the white limestone, or marble, is greatly fractured but does not show banding. The sheared conglomerate have augen texture. The tuffs are red, gray, and nearly black, and show shearing and confused and contorted banding.

Green rocks—hornblende schist, chlorite schist, and sheared greenstone—are numerous in the group of the undifferentiated metamorphic rocks. They occur wherever these rocks are found but are particularly abundant in Portlock Harbor. Most of the rocks of Portlock Harbor are sheared greenstone, although in the field it is not always possible to tell the altered greenstone from a green conglomerate or a green graywacke. Some of the greenstones are seen under the microscope to be very amygdaloidal, and these are probably flows; others are porphyritic and fairly coarse grained and may represent either flows or intrusives. Chlorite is the most abundant green mineral to form and in the amygdaloidal greenstones both chlorite and epidote fill the amygdules. Calcite is fairly abundant as an alteration mineral but is not nearly so abundant in these rocks as in the altered greenstones of the Eagle River region. The green schist at the Snowball prospect consists of chlorite and quartz, and its original nature can not be told. The dark-green rocks at the entrance to Lisianski Strait, in Canoe Pass, and near Porcupine Harbor probably represent altered basic intrusives. The green rocks at the head of Sister Lake and at the head of Deep Bay may be greenstone. The light-green chlorite schist at the entrance to Stag Bay and on Soapstone Point are highly altered rocks and do not preserve enough of their original characteristics to enable a definite determination to be made. The rocks on Soapstone Point somewhat resemble greenstones in texture. Variegated black and green rocks were seen at a number of places, but no satisfactory identification of them has yet been made. The apparent abundance of green rock is believed to be due partly to the action of sea water on the rock. At many



GEOLOGIC SKETCH MAP OF THE WEST COAST OF CHICHAGOF ISLAND, SITKA DISTRICT.

places where green rocks are exposed at the water line, gray rocks occur in outcrops away from the water line.

The rocks along the shore from Dry Pass to Canoe Pass are chiefly dark-colored schists of rather fine grain and of uniform appearance, in which an abundance of mica (mainly biotite) has developed and in which quartz is also very abundant. At places the typical metamorphic minerals, such as andalusite and corundum, occur. These schists weather light gray and tend to break into rather smooth blocks. They do not show extensive crinkling, such as is seen in some of the other schists. The gradation of this type of schist into the rocks of the graywacke series can be traced along the shores of Dry Pass, and there can be little doubt that this schist represents the product of the alteration of graywacke, and as such it is indicated on the map (Pl. II). A similar type of alteration was found on the outer sides of Hill Island and of Peel Island.

There are at least three beds of limestone in the rocks of the undifferentiated series. One bed, about 50 feet thick, more or less, occurs at the mouth of Didrickson Bay and on both sides of Deep Bay; a thinner bed of dark-bluish impure limestone, in which indeterminate fossils were found, lies north of the entrance to Didrickson Bay and again just within the mouth of Deep Bay. A thin bed of limestone lies close to the contact with graywacke, both in Portlock Harbor and in Slocum Arm. A rather thick bed of limestone occurs on the ridge that runs between Davison Peak and Baker Peak and at the head of Pinta Bay. This bed of limestone can probably be correlated with the so-called limestone "dike" that stretches apparently uninterruptedly from Baker Peak to White Mountain. Marble was found on Peril Strait near Poison Cove, in Ushk Bay, Patterson Bay, and at the head of Hooniah Sound.

The schistose rocks near the north end of Lisianski Strait are mostly obscure, but they are thought to be in large part of sedimentary origin. They are dark and are extensively cut by dikes and by rather abundant quartz and calcite stringers. The rocks along Peril Strait are somewhat similar in appearance, although these are known to be partly sedimentary because of the presence of limestones. At most places it is difficult to differentiate these rocks from the igneous rocks with which they are associated. It would seem that these rocks might be of different age from the rocks of Portlock Harbor, both because they are of somewhat different appearance and because they lie to the east and apparently under the beds of Portlock Harbor.

Many of the gray schistose rocks are indeterminate in character, but some of them are closely associated with flow rocks, and these are believed to be in part tuffs. A rock of this kind from Pinta Bay is seen under the microscope to consist of crushed pieces of fine-grained igneous rocks.

The metamorphic rocks are probably of two types—dynamic-metamorphic rocks and contact-metamorphic rocks. Weathering, as a type of metamorphism, will not be discussed here. By dynamic metamorphism is meant alteration in the rocks, as originally deposited or intruded, brought about by the action of differential pressures. Under differential pressure rock cleavage is developed and new minerals are formed in the original rocks. The rocks consequently lose much of their original character, and rocks entirely different in color, texture, and mineral composition are formed. It is impossible in many specimens to determine what the original character of the rocks really was. In contact-metamorphism changes in the rocks intruded by an igneous body are brought about by pressure due to the intrusion, by rise in temperature, and by addition of material from the igneous body. The results of contact metamorphism and dynamic metamorphism are commonly the same; so that it may be impossible to tell whether a specimen is the result of one or the other process. No attempt has been made here to differentiate the two types.

In the metamorphic rocks under discussion chlorite is one of the most abundant secondary minerals formed, but hornblende, mica, corundum, and staurolite are locally abundant. Schistosity has developed extensively, and where bedding can be recognized it is approximately parallel with the schistosity. Bedding was seen in the quartz-mica schist and in the sheared conglomerates and limestone.

These rocks are naturally faulted and jointed, and secondary cleavage has developed. Faulting was noticed at the entrance to Black Bay. Joints or secondary cleavage planes have at places formed rather extensively, perpendicular to the schistosity. The dip of the schistosity and of the beds at most places on Slocum Arm and in Portlock Harbor is steep toward the southwest; the strike is nearly northwest. Along Lisianski Strait the dip of the schistosity is toward the northeast, and the strike varies between northwest and north. Even at the contact with the batholith the dips are northeast and hence toward the batholith. Along Peril Strait the beds are extensively intruded by bodies of igneous rock, and, as might be expected, strikes and dips differ greatly in direction and amount from place to place.

The present structure of the rocks is thought to be due to the intrusion of a great mass of granodioritic rock on the island, which, in forcing its way up through the rocks, squeezed and folded them. The rocks at most places dip away from this batholith. The apparently anomalous dip of the rocks along Lisianski Strait may have been caused by a still later intrusion of igneous rock represented by the dioritic intrusion at the entrance to the strait or it may have been caused by slumping at the edge of the batholith.

AGE AND CORRELATION.

Rocks of different ages are probably included in the group of undifferentiated metamorphic rocks. No determinable fossils were found in these rocks, and their relationships to rocks of known geologic age are not everywhere clear; consequently their position in the geologic column can not be assigned with any degree of certainty. At all places except one these rocks appear to underlie the graywacke; but as the rocks at this one place where they overlie the graywacke are lithologically similar to the rocks that everywhere else underlie the graywacke, it is assumed that faulting has occurred. At most places transitional beds lie between the typical metamorphic rocks and the typical graywacke. Structurally the two groups appear to be conformable, for the strikes and the dips are the same in both. The underlying beds seem to be more metamorphosed than the graywacke, but metamorphism is a function of the original character of beds that are altered as well as of the intensity of the metamorphosing forces. Very hard quartzose rocks like sandstone would probably undergo less change than the soft and relatively complex volcanic rocks and shaly and calcareous sedimentary rocks. These highly metamorphosed rocks, too, lie nearer the batholith, which is thought to be the cause of much of the metamorphism, than the graywacke. Nothing definite can be known about the relations of the metamorphosed rocks of Lisianski Inlet and Peril Strait to the metamorphosed rocks that immediately underlie the graywacke. The two groups are lithologically different, but this difference may be due either to an original difference in type or to more intensive metamorphism. If the beds along the outer part of Chichagof Island are part of the west limb of an anticline [1] the beds on Peril Strait and Lisianski Inlet, which lie nearer the center of the anticline, would be older than the beds of Slocum Arm and Portlock Harbor and probably of a different geologic age.

Lithologic correlation of these rocks with the rocks of other districts may be suggestive but can not be of great scientific value. In the Juneau district [2] is a series of tuffs, slates, flows, and limestone in which Triassic fossils have been found. Chapin [3] correlates some of these rocks of the Juneau district with the beds along the east side of Gravina Island and some of them with the rocks along the west coast of Gravina Island. The beds along the east side of Gravina Island are thought to be of Triassic and Jurassic age and those along the west coast are of Triassic age. The lithologic similarity of the sections of the Juneau district, of Gravina Island, and of the west coast

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, p. 38, 1918.
[2] Brooks, A. H., unpublished notes.
[3] Chapin, Theodore, unpublished notes.

of Chichagof Island is at once evident. Chapin [1] separates the rocks that immediately underlie the graywackes of Gravina Island into two parts—"a lower series of purely igneous material, mainly coarse pyroclastic rocks and breccias, and an upper series of mixed water-laid tuffs and black slates and limestone, with porphyritic basic rocks of similar composition, evidently partly intrusive and partly explosive." [2] In Portlock Harbor the rocks near the contact are chiefly water-laid and those in the bays are most generally igneous. Tentatively, then, the rocks that underlie the graywacke on the west coast of Chichagof Island are correlated with the rocks that underlie the slate and graywacke of Gravina Island and which are placed by Chapin [3] in the Upper Triassic or Jurassic. The Wrights,[4] however, correlate the series of slate, greenstone, lava, tuff, and other material, on the west coast of Baranof and Chichagof islands, with lithologically similar rocks on Douglas Island, Cleveland Peninsula, and Gravina Island which they class as of Permian or Pennsylvanian age. To the north of Icy Strait, in Glacier Bay, the Silurian is represented by great thicknesses of limestone which are underlain by a thick argillite series of rocks. No thick limestones and no great amount of argillite were seen on the west coast of Chichagof Island. On the east side of Chichagof Island the lower Carboniferous is represented by a thick series of limestone of a distinctive character. No rocks of this type were seen here. These facts do not assist much in determining the age of the rocks, but they at least indicate possible correlations.

GRAYWACKE.

DISTRIBUTION AND CHARACTER.

Graywacke extends along the west coast of Chichagof Island from Peril Strait to Dry Pass. The term graywacke is used here in the sense of a group of rocks in which graywacke is the prevailing rock type. North of Dry Pass the graywacke has been metamorphosed to a quartz-mica schist; south of Peril Strait it continues beyond the region mapped. The graywacke proper forms a band that has a maximum width of about 5 miles, an average width of 3 miles, and a length of 35 miles. The actual width of this band may be greater, for on its western side it passes beneath the sea. The metamorphic graywacke, or quartz-mica schist, extends from Dry Pass to Lisianski Strait, the northern limit of the area mapped, a distance of 7 miles. Exposures of these rocks are almost continuous along the shores within the belt. The outer coast from a point about a mile south

[1] Chapin, Theodore, The structure and stratigraphy of Gravina and Revillagigedo Islands, Alaska: U. S. Geol Survey Prof. Paper 120-D, pp. 83-100, 1918.

[2] Idem, p. 95.

[3] Chapin, Theodore, op. cit.

[4] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, p. 35, 1908.

of Khaz Head to Leo Anchorage could not be approached because of stormy weather, but from its general appearance and from the reports of prospectors it is believed to form a part of the graywacke area and is so mapped.

In the general group term "graywacke" are included, besides graywacke, some slate, argillite, conglomerate, and greenstone. Graywacke is naturally the prevailing rock type, and the other types occur in relatively small amount. Uniformity in appearance characterizes the outcrops of these rocks, which at most places are weathered a somber reddish brown, greenish gray, or ash-gray. The rocks are massive and are greatly fractured and jointed. Where the rather coarse sandy graywacke predominates bedding can rarely be detected, but where the rocks are argillaceous parallel bedding is fairly common. Thin stringers of argillitic material run through the massive graywacke, and these weather out and allow the graywacke to break down into rather large lenticular pieces. At other places series of parallel joints are common, and here the graywacke breaks into large flat-sided blocks.

Variations in outcrop from the one just described naturally exist. In places the beds are fine grained, sandy, and argillaceous, and in these places a type of ribbon structure occurs which is formed by an alternation of sandy and argillaceous beds, an inch or less thick, of somewhat different color. Along the southwest side of Slocum Arm the rocks are typical dark slates which contain concretions of limestone. Near the head of Slocum Arm are dark beds of fine graywacke and argillite, in which fossils were found. On Ford Arm near the head is a very coarse conglomerate. In Ogden Passage a little greenstone is included in the graywacke.

Fresh graywacke is a dark massive rock of medium grain, whose color and granularity do not differ greatly in different specimens. The rock is hard and fresh looking, and in the medium-grained varieties glassy quartz and angular particles of slate set in a dense, dark groundmass can be seen. The rock is an indurated impure sandstone, but the fine-grained varieties may easily be mistaken for a fine-grained igneous rock. A specimen from the mountain between the head of Slocum Arm and Leo Anchorage is a breccia in which are large angular particles of slate in a brownish sandy groundmass. Conglomerate occurs on Ford Arm, in Ogden Passage, and on Slocum Arm. The conglomerate on Ford Arm consists of rounded pebbles and boulders in a sandy matrix. The pebbles in the conglomerate are 3 inches or less in diameter, but many boulders from 3 inches to 6 inches in diameter occur. The pebbles are graywacke, sandstone, chert, light, fine-grained igneous rock, and limestone. Quartz is not abundant. Many pebbles are sheared across. The conglomerate is at least a hundred feet thick here, but it could not be found along its strike on the west side of the Arm. Conglomerates were found in other places, but none could compare with this one in thickness or in coarseness of grain. A conglomerate seen on Peril Strait contains rather abundant pebbles of coarse-grained igneous rock.

The microscope gives a better idea of the composition and texture of the rock than the examination with a hand lens. The graywacke is seen to consist of mineral grains and fragments of rock set in a very fine carbonaceous groundmass of undeterminable material. The grains are somewhat rounded, but characteristically they are angular. The mineral grains are quartz, feldspar, and hornblende. The rock fragments are fine grained and for the most part indeterminate, but some fine-grained igneous rocks were seen. The dark carbonaceous pieces are probably particles of slate. A little calcite and some particles of schist were noted in some of the thin sections.

At fairly close intervals white quartz veins of various sizes cut the rocks of the graywacke series. These quartz veins are of two types—one occurs in shear zones and recements the crushed material, the other, known as "frozen veins" by the prospectors, is composed of simple quartz stringers that cut across the beds of the formation and are not related to recognizable shear zones. Mineralization has taken place in veins of the first type. The "frozen" stringers rarely show the iron stain that indicates the presence of sulphides and possible gold mineralization, and they do not seem to be of more than local extent.

The source of the material of which the graywacke is formed is not known. The angularity of the particles would indicate that they have not been transported for a long distance. The presence of the quartz, of the relatively little-altered feldspar fragments, and of the pieces of fine-grained igneous rock would indicate that an area of igneous rock furnished a part of the material. The conglomerates, however, carry but little coarse-grained igneous material, such as is found in the interior of the island at the present time. As little dark slate is found in the rocks that underlie the graywackes, the source of the particles of slate in the graywackes is not known. It is possible that an unconformity may exist between the two series and that the slaty rocks have been removed by later erosion. The rounded limestone pebbles in the conglomerates might well have been derived from the limestone in the underlying metamorphic rocks. The hornblende may have come from either schist or igneous rocks.

The alteration of the rocks is of two kinds—weathering and contact or dynamic metamorphism. As the rocks have been swept clean rather recently by the ice, weathering has not been extensive. The chief effect of the weather has been the breaking up of the rocks by purely mechanical means, and this has been aided by the weathering out of the argillaceous stringers in the rocks. The chief chemical effect on the graywackes has been to color them slightly reddish, brownish, or greenish. The surfaces are somewhat pitted and gashed where the stringers of the softer material have been removed. On the mountain tops this process has gone a little farther than it has along the seashore. Where the graywackes have been intruded by igneous rocks or where they have undergone great differential pressures they have been altered to fine-grained dark-brown quartz-mica schists. At places where the bedding has been preserved it is seen to coincide rather closely with the secondary structure formed by pressure. The metamorphic minerals, such as andalusite, are particularly abundant in the schist at some places.

STRUCTURE AND THICKNESS.

The graywacke rocks, as previously pointed out (see p. 100), stretch along the west coast of Chichagof Island from Peril Strait to Dry Pass. The actual width of the band of graywacke can not of course be told, as its western boundary lies under the sea. The greatest known width of the belt is 5 miles. The inner contact of the rocks strikes approximately N. 30° W. to Mine Cove, then swings to N. 60° W. in Portlock Harbor, and then N. 30° W. to Dry Pass, beyond which the graywacke has been altered to schist. Graywacke can not be certainly recognized north of Canoe Pass at the entrance to Lisianski Strait. Along the seaward side of the belt on Hill Island, on Kukkan Bay, and at the entrance to Khaz Bay, a schist was found. The schist on Hill Island is believed to be altered graywacke, for the gradation from graywacke to schist can be traced along the north side of Imperial Passage. The agents of metamorphism were active along this outer coast, but whether the metamorphism is due to pressure or to the nearness of a large igneous body could not be told. On the islands at the entrance to Khaz Bay the metamorphism is undoubtedly due to the presence of the igneous body that is seen on some of the islands. The schist on Kukkan Bay appears to be altered greenstone that was intruded into the graywacke.

Reliable strike and dip readings are difficult to get at many places because of the lack of bedding and because of the extensive jointing. In general the strikes lie between west and N. 45° W. A few strikes reach N. 30° W. The dips are almost universally to the south and range from 40° to 70°. At some places the beds stand vertical, and even (in a very few places) dip steeply to the north.

The rocks are greatly fractured and jointed, and it is very often difficult to distinguish bedding from jointing. Faulting is common and extensive, but it can not always be recognized, as the nonhomogeneity of the beds and the frequent occurrence of minor fracturing do not permit one to tell what movement, if any, has taken place. Major faults are recognized by the great quantity of crushed material that occurs in the shear zones, and also by the presence of quartz, which at places has recemented the crushed rock. Such faults are very common and where they have been followed they seem to be persistent. The Chichagoff mine and most of the prospects of the district are located along such faults. The fault in the Chichagoff mine has been followed underground without a break for about a mile, and the strike and the dip of the fault plane are remarkably constant. The Hirst-Chichagof mine lies on another such fault which seems to run nearly parallel to the first one. These crushed zones are of varying width; the same fault zone may be a foot or more wide in one place, and at another it may be 15 or 20 feet wide. Movement along these faults did not take place all at one time, and possibly movement still takes place along them, for much of the quartz along the zones has been crushed and recrushed since its deposition. The dike near the Chichagoff mine and the dike in the upper tunnel of the Hirst mine are crushed. The graywacke in the shear zones is comminuted, and the slaty bands have been reduced to shiny slickensided pieces that look much like pieces of coal. At most places one wall of the zone is well defined and is followed by a sticky clay gouge; the other wall is poorly defined and grades over into the country rocks. The faults dip steeply in the Chichagoff mine and in the Hirst mine. This dip shows only a slight variation. At the Smith prospect the fault plane dips about 62° S., but in depth it flattens to 45° S. All the fault planes so far examined dip to the south.

Strike and dip readings show that the graywacke beds have nearly parallel strikes throughout the belt and that they all dip steeply to the south. It is impossible to interpret the structure of the region from observations over such a limited area, and more work will have to be carried on in the neighboring areas. From the few facts at hand it would seem that the beds may form one limb of an anticline, for they seem to be resting on rocks of greater age. The beds do not possess sufficient peculiarities to enable one to trace recognizable beds and thus to detect reduplication of beds. In such a highly disturbed region reduplication of beds almost surely exists, and this may be due to close folding or to faulting, or to both. Extensive faulting has taken place. The suggestion naturally comes that the structure of the rocks is related to the large intrusive body that makes up the interior of the island. It is interesting to note in this connection that the highly schistose rocks along Lisianski Strait all dip toward that intrusive body. The similarity of the strikes and dips of the graywackes and the older schists suggests a common origin for their later structure—a structure that, in some of the schists, must have been imposed on an earlier structure.

As the structural relations of the rocks are not very definitely known, no determination of their thickness can be made. The belt in its widest part is exposed continuously for 5 miles. Assuming a dip of 60° the resultant thickness of the beds exposed would be 23,000 feet, but there is every reason to believe that reduplication of beds has occurred and that the actual thickness of the exposed formation is much less. On the other hand, it is not possible to tell how far beneath the sea the graywacke extends. The series is apparently thick, although no actual figures can be given. An estimate of the thickness of this series of rocks made by the Wrights,[1] who correlated it with similar rocks on Douglas Island and Glass Peninsula, is 3,000 feet, more or less.

AGE AND CORRELATION.

In a consideration of the age of the graywacke the first question that arises is whether the argillitic graywacke beds along the southwest side of Slocum Arm, which are fossiliferous, should be included in the graywacke series. The reasons for not including them would be that their relationships with the typical graywacke are not known; that they are somewhat different in appearance from the graywacke; and that fossils have not been found anywhere in the typical graywacke, although they were carefully looked for. The reasons for including them are that the rocks are graywackes although of somewhat different appearance; that the pelecypods found, although abundant numerically, seem to be limited to one or two species of *Aucella*, which fact would seem to indicate a peculiarly local condition of deposition (a similar condition apparently of the occurrence of a single fossiliferous bed in a great series of unfossiliferous rocks has been observed at Pybus Bay); and that the rocks appear to be interbedded with tuffs, flows, and limestones similar to those rocks at the base of the typical graywacke. Whether this apparent transition is due to infolding or whether such a transition series to the underlying schist is actually present is not known.

On the peninsula southeast of the Hole in the Wall at Khaz Head the graywacke is massive and coarse grained and breaks down into large, smooth, angular blocks. A little farther down the peninsula, in Slocum Arm, the graywacke becomes finer grained and even somewhat cross-bedded but shows large, rounded pieces of light-colored limestone several inches in diameter and black slate pebbles and slivers. The general tone of the graywacke is greenish gray on the weathered surface. After a short concealed interval comes highly contorted greenish, reddish, and grayish schistose rocks, which are in part

[1] Wright, F. E. and C. W., The Ketchikan and Wrangell mining districts, Alaska: U. S. Geol. Survey Bull. 347, p. 35, 1908.

volcanic and in part sedimentary. These rocks extend for 2 miles along the shore with which their strike seems to be nearly parallel. The schistose beds are followed here by a rather massive graywacke, which is at places a grit, and then by the rather fine-grained graywacke in which Jurassic fossils were found. For about a mile the rocks exposed are chiefly the variegated greenish ones of the preceding 2 miles, in which are some argillitic rocks. The occurrence of a limestone bed indicates a sedimentary origin for some of the rocks. Beyond the green rocks is slate. The slaty rocks carry some limestone concretions and throughout most of their extent are markedly parallel banded. The bands are about 2 inches wide and are indicated by differences in color. The slates follow the shore for about a mile and are then succeeded by the fossil-bearing graywacke, which continues to the head of the Arm. A small bed of limestone was found at this second fossil locality.

The contact of these beds with the greenish volcanic and sedimentary beds is believed to lie close to the shore along this side of Slocum Arm. From the strike and dip it would appear that the slates and graywackes lie under the greenish rocks, but faulting has probably disturbed the relationships.

The graywacke extends unbroken along the northeast side of Slocum Arm to a point within 4 miles of the head. A limestone bed, 15 to 25 feet thick, follows the graywacke and is followed in turn by tuffaceous beds, flows, and the contorted green and gray schists. Graywacke occurs in Flat and Hidden coves apparently interbedded with the tuffaceous beds and with the limestone. At one place it even seems to underlie the schist. The strikes and dips observed along this shore would indicate that the graywacke overlay the tuffs and flows.

The section up to the 2,800 and 2,360 foot peaks at the head of the arm shows no graywacke but only highly contorted green and gray schist up to an elevation of 2,390 feet and then greenstone.

In the southeast bay at the head of Ford Arm the graywacke series is interbedded with green and red volcanic rocks. Along the northeast shore of the northwest bay the rocks are schistose and probably are in large part of sedimentary origin. The strikes and dips here would seem to throw the graywackes over the tuffs and schists.

In Sister Lake the underlying rock is a thinly laminated, extremely contorted schist, greenish and grayish in color, and at places very quartzose. The shore of the northeast bay of the lake is almost entirely a light-green schistose rock. In the narrows between the two lakes the rocks are gray schist and chert.

On the eastern side of Lake Anna, near the entrance to the narrows, some greenstone tuff and limestone occur apparently within the graywacke series.

All along the northeast side of Slocum Arm, then, the rocks of the graywacke series appear to overlie the tuff, flows, and schists and in part to be interbedded with the volcanic rocks. The extreme metamorphism of the variegated rocks would seem to point to a greater age for them as compared with the graywacke. The tuffs may well be interbedded with the lower beds of the graywacke series. The relations on the southwest side of the arm may indicate that the fossil beds do not belong to the graywacke series; that faulting has taken place along this side of the arm; or that the volcanic and schistose rocks there are not the same series represented on the north side, but that they are considerably younger and actually do overlie the graywackes. As none of the schistose rocks are fossiliferous and as at no place could the structural relations of the schist to the fossiliferous beds or the fossiliferous beds to the typical graywacke formation be observed, only a surmise of the actual relations can be made now. The question whether the fossiliferous beds should be included with the graywackes has already been considered. The only evidence for faulting, other than that considered below, is the occurrence of brecciated graywacke at the head of the arm about on the line of the supposed fault. The rocks on the outer side of the peninsula could not be visited because of the stormy weather, but they are reported to be graywacke. This is borne out by the graywacke observed at Khaz Head and in Peril Strait. If this is true, then the graywackes of the outer coast would overlie the schistose beds, as they do on the north side of the arm, and a fault along the southwest side would appear probable. So far as lithologic resemblance can be used as a criterion, the schistose rocks on the north and the south sides of the arm are very much alike, and on the lack of other evidence of correlation they would undoubtedly be placed together. On Peril Strait schist is found on the line of strike of the schist on the north side of the arm, and graywacke is found on the strike of the schist south of Slocum Arm.

In Portlock Harbor the contact between the graywacke and the underlying series of rocks is exposed at half a dozen places. In the narrow strait between Portlock Harbor and Ogden Passage a reddish gritty sandstone, which contains angular particles of slate, lies at the base of the graywacke rocks. Under the grit is a bluish-gray limestone about 50 feet thick. On the large island in Portlock Harbor northwest of the entrance to Black Bay the contact is exposed at two places; on the southeast side of the island the contact seems to be somewhat gradational, for the upper beds of the green variegated rocks seem to be somewhat sandy in character; on the northwest side the contact is rather of the same type. The one point of contact on Peel Island shows the graywacke in contact with an intrusive body. At the Snipe Islands the contact passes between the eastern island and the two western ones and is concealed in the narrow strait between them. On the eastern island the rocks are greatly sheared conglomerate, quartzite (?), and limestone. On the southeast side of Hill Island the rocks at the contact are argillitic rocks, limestone, and a sheared conglomerate. On the northwest side of the island the rocks at the contact are greenish schist, or greenstones, and limestone. Beyond this point the rocks all become schistose, and the graywackes are not again recognized as such.

The question whether the metamorphic series and the graywacke series are separated by an unconformity can not be definitely settled. The graywackes rest on rocks that are in part sedimentary. On Slocum Arm the underlying beds are tuffs and limestones; in Portlock Harbor the underlying beds are so greatly altered that tuffs can not be definitely recognized, although many of the beds are extremely obscure and may be tuffs. Limestones are almost universally present under the graywacke in Portlock Harbor. In the absence of fossils it is not possible to say whether the underlying beds of Slocum Arm and those of Portlock Harbor are of the same age. It should be noted that in Slocum Arm the graywacke beds are apparently interbedded with the tuffs of the underlying series, and they do not seem to be so in Portlock Harbor. The strikes and dips of the two series of rocks appear to conform, but the rocks have undergone great structural disturbances since their deposition, and the result of the action of the same force would result in imposing a somewhat similar structure on the rocks of both. The chief reason for placing an unconformity between them would be the great difference that exists in appearance and degree of alteration, but this difference may be a result of the character of the rocks. The most that can be said, then, from field observations is that an unconformity may exist between the two series.

The age of the graywacke, determined by Stanton from fossils collected on the shore of Slocum Arm, is probably Upper Jurassic. The report on the fossils follows:

10147. No. 17AOF7: First prominent bight on southwest side of Slocum Arm, 3 miles southwest of Falcon Arm.

Aucella sp., related to A. fischeriana (D'Orbigny).

Belemnites sp., fragments of a small slender form.

10148. No. 17AOF8: Second prominent bight on southwest side of Slocum Arm, 5 miles southwest of Falcon Arm.

Aucella sp., small distorted specimens possibly belonging to two species, one of which may be the same as the species in 10147.

The form of *Aucella* in these two lots appears to be distinct from the forms identified as *A. piochi* Gabb and *A. crassicollis* Keyserling in previous collections from Pybus Bay, Admiralty Island. The present collections are believed to be of Upper Jurassic age. It should be remembered, however, that the distinction between Jurassic and Lower Cretaceous on the basis of *Aucella* alone is not always safe. It is possible that all the *Aucella*-bearing rocks of southeast Alaska may belong in the same series.

Correlations of the rocks of the graywacke series with similar rocks of southeastern Alaska are at once suggested. The rocks of the Berners formation (Upper Jurassic or Lower Cretaceous) of Eagle River in the Juneau district are lithologically similar to the rocks of the west coast of Chichagof Island, and fossils show them to be of the same age. Knopf [1] believed the Berners formation to be found on the Glass Peninsula and at Point Young on Admiralty Island. That the correlation of these rocks with the rocks of Pybus Bay at the south end of Admiralty Island is open to some doubt is indicated in the report made by Stanton. In the Ketchikan district the rocks would be correlated with the "conglomerate, slate, and graywacke" of Chapin,[2] which are found on Gravina Island and in the western part of the town of Ketchikan and at Wards Cove on Revillagigedo Island. This correlation is suggested by fossils, by lithographic similarity, and by relationship to other rocks. The suggestion has already been made that these rocks may be correlated with the graywacke of the Prince William Sound region, but as nothing conclusive is known about the age of those rocks the correlation will have to remain a suggestion.

IGNEOUS ROCKS.

The largest bodies of igneous rock in the region are those that are believed to be part of the Coast Range batholith. These rocks occupy much of the interior of the island, and in this brief report no attempt can be made to describe the various types that are found. Most of the area mapped is not far from the contact between these rocks and other rocks, and consequently the rocks of the intrusive body are very greatly sheared. Thin sections show that most of these rocks are considerably crushed and are extensively altered. The rocks seem to be normally quartz diorites, but types from granite to hornblendite can be found. A specimen from Stag Bay that in the hand specimen appears to be a greenstone is seen under the microscope to consist of feldspar (near albite), quartz, green hornblende, chlorite, and epidote. This rock was probably originally a diorite. On Lisianski Strait, near Miner Island, the rock is a crushed albite granite. A little farther up the strait the rock consists entirely of crushed, coarsely crystallized hornblende. A specimen taken on Lisianski Inlet consists chiefly of crushed and recemented quartz and a little plagioclase feldspar. The rocks on Peril Strait and in Hooniah Sound seem to be somewhat more basic than the rocks on the west coast. They contain some quartz, plagioclase feldspar (near andesine), hornblende, and the usual alteration minerals. These

[1] Knopf, Adolph, The Eagle River region, southeastern Alaska: U. S. Geol. Survey Bull. 502, pp. 17-18, 1912.

[2] Chapin, Theodore, The structure and stratigraphy of Gravina and Revillagigedo Islands, Alaska: U. S. Geol. Survey Prof. Paper 120-D, pp. 97-98, 1918.

rocks appear to be similar to the contact rocks of the Coast Range batholith of the mainland, and they are correlated with them. The age of the Coast Range batholith is not yet definitely determined, but it is generally thought to be Jurassic or Cretaceous. In this area these rocks cut the rocks of the metamorphic series, whose age has not been determined.

An intrusive body of large size, which consists of a coarse-grained granite, cuts the greenstones and schists of Morris and Elfendahl lakes. The rocks of this body are very light in color and are of very coarse grain. They are somewhat weathered, but otherwise are not greatly altered. They differ from the other granites of the region in their coarseness of grain, their light color, their uniformity in character, and in the fact that the alkali feldspar is orthoclase instead of albite. Part of the contact between this body and the greenstone was carefully examined, but no signs of mineralization were found.

Coarse granite was found on the Porcupine Islands and on the island that forms the outer side of Cautious Pass. A specimen of the rock shows coarsely granular quartz, feldspar that ranges in composition from albite to albite-oligoclase, greenish biotite, muscovite, garnet, and sericite. This rock is an albite granite. Whether it represents the same period of intrusion as the orthoclase granite above can not be determined.

The rocks represented by the intrusive body at Nickel are somewhat variable. They are fairly light gray but at places become a rather dark brown. Diorite and gabbro (norite) are the chief types represented. Nickel ore occurs with these rocks and a more detailed description of them is given under the discussion of the nickel ores. (See p. 129.) A similar body of diorite occurs on Lisianski Strait north of Canoe Pass.

Dikes are fairly abundant in the region. They cut the graywacke, the rocks of the metamorphic series, and the greenstones. Most of the dikes are rather small and are light in color, and all except the dike at the entrance to Deep Bay seem to be of the same type. One of these dikes occurs on the property of the Chichagoff Mining Co., at the Golden Gate mill, but no dikes were encountered in the mine itself. Another forms the footwall in the lower tunnel of the Hirst prospect. The dikes are rather abundant in the graywacke on Slocum Arm between Ford Arm and Falcon Arm. Similar dikes cut the greenstone at the copper property at the head of Pinta Bay, and dikes that are of somewhat different appearance cut the greenstone on the ridge to the north of Morris Lake. The dike rock in the lower tunnel on Baker Peak is highly mineralized with pyrite, and the chalcopyrite of the upper prospects seems to be in a greatly altered dike of this type.

The dike rocks are fine grained and light in color. The minerals that form the rock can not be determined with the naked eye, but the rocks are light colored, and consequently the ferromagnesian minerals are practically absent. Pyrite is rather abundant in some of the dikes, and these weather deep red-brown on the surface.

Under the microscope these dike rocks are all seen to be rather extensively altered. A specimen of the rock from the Golden Gate mill is coarser grained than most of the dike rocks and seems to be somewhat less altered. These rocks, so far as can be determined, carry a little quartz, plagioclase feldspar, and a few dark minerals. The plagioclase in the dike of the Golden Gate appears to be near albite-oligoclase, and the rock is apparently an aplite. Alteration, chiefly to sericite and to chlorite, is extensive. Although there is a great similarity in appearance of these dike rocks, there is probably considerable variation in their character. The aplite dikes are at most places mineralized rather highly with pyrite, and as a consequence several of them have been staked as prospects. It is not known whether they carry gold.

The dike at the entrance to Deep Bay is of a markedly different type from that of the other dikes. The rock is rather dark in color, and is porphyritic. The phenocrysts are feldspar and hornblende. The groundmass is fairly fine grained, and contains both lath-shaped crystals and closely spaced irregular grains. The feldspar phenocrysts are about labradorite, although some albite appears to be present. This rock is an andesite. The dikes that cut the greenstones north of Morris Lake are of a somewhat similar type.

Greenstones are widespread in the region, including both intrusive and extrusive rocks. As their name implies, they are extensively altered, and it is no longer possible to tell exactly the type of basic rock from which they are derived. As it is not always possible in the field to distinguish the true greenstone from altered sedimentary rocks that are green in color, especially where they have been rendered schistose, no attempt has been made to show on the map all the greenstone areas of the region. Greenstones included with the metamorphic rocks were seen in Portlock Harbor, in Didrickson Bay, and in Deep Bay. The greenstones which have been indicated north of Morris Lake (see Pl. II) appear to be of a different age from the green schists and greenstones included with the schist, for they do not show the excessive metamorphism of the other rocks. They appear to have a rather gentle dip to the east and to rest on the steeply dipping beds of the schistose series. They are massive fine-grained rocks which are in large part amygdaloidal. They are notably homogeneous. Epidote is widespread in the rocks, and small amounts of chalcopyrite are present in nearly every specimen of the greenstone collected. The amygdaloidal character of the greenstone would indicate that it is, in part, a flow. That some may be intrusive, however, is suggested by the fact that in the green schist only a short distance from the supposed contact with the greenstone is a coarse-grained greenstone which appears to cut the schist and is hence of a later age. An amygdaloidal greenstone carrying chalcopyrite occurs on the peak at the head of Slocum Arm. A similar relationship to that on the Baker Ridge is seen in that a limestone bed lies in both places almost at the contact between schist and greenstone. Greenstone is reported from Rust Lake, near Chichagof.

The age of the greenstones is not known. They may be of the same age as the greenstones of the Orca group of Prince William Sound, which are probably of Mesozoic age.

A fresh-looking basalt was seen on Lisianski Strait opposite Miner Island. The rock in outcrop shows columnar jointing, and it has not been greatly disturbed since its deposition. The rock is porphyritic, vesicular, and has a fine-grained groundmass. The phenocrysts are altered hornblende crystals. This body of igneous rock may be the youngest in the region.

DEVELOPMENT OF TOPOGRAPHIC FEATURES.

Most of the physiographic features of Chichagof Island are due primarily to glaciation, although structure and the character of bedrock have had some effect in modifying the action of the ice. The fiords probably owe their straightness and parallelism to the directive action of bedrock structure on the moving ice. The characteristic features of the fiords, the lakes, the hanging valleys, the broad U-shaped valleys, the steepened slopes, the through valleys at the heads of the fiords, and the holes and deepened channels off the coast are all undoubtedly due to the ice action. The coastal plain appears to be a structural feature and to represent an uplift of this part of the coast. Minor topographic features, such as the rounding of the granite peaks and the pointing of the greenstone peaks, are due secondarily to the nature of the bedrock.

MINERAL RESOURCES.

GOLD.

OCCURRENCE.

Prospecting for gold on the west coast of Chichagof Island has been carried on from time to time since 1905. A number of prospects have been located, but at the present time only one mine is being operated. Most of the prospects are along shear zones in the graywacke.

The most active prospecting for gold has been done near Klag Bay. Klag Bay is about 54 miles northwest of Sitka by boat. It is connected with Juneau by a motor boat which makes regular trips about once a week. The center of mining activity is at the head of Klag Bay at Chichagof, where the Chichagoff mine is located. Prospects have been located on Klag Bay, on Mine Cove to the north, and on Slocum Arm to the south. Practically all these prospects are gold quartz prospects, and most of them have been held for a number of years. Only one mine is being operated at the present time, although another may be opened shortly. Gold was first found by a native in 1905 in one of the streams near the head of Klag Bay. He carried the news to Sitka, a small stampede followed, and a number of claims were located. The history of the Klag Bay region has been given by Knopf.[1]

The claims on Klag Bay all lie near the shore. The coast here is similar to that to the north. The coastal plain is confined here chiefly to the islands, which consist of low rounded hills and marshy flats. A line between the coastal plain and the mountain belt passes south of Doolth Mountain, between Lake Anna and Sister Lake, and into the sea at Khaz Head. The shore line is extremely irregular and throughout its extent is rocky, and the bottoms near the shore are foul. Rocks and reefs extend offshore for about 5 miles between Kukkan Bay and The Hole-in-the-Wall. Lake Anna and Sister Lake are tidal basins which can be entered with safety only at slack water. Doolth Mountain, in which the Chichagoff mine lies, is a smooth, rounded mountain about 2,120 feet in elevation.

The rocks of the Klag Bay region are of two general types—the undifferentiated metamorphic rocks and the graywacke. The only igneous rocks seen in the vicinity of Klag Bay (except the altered igneous rocks in the schistose series) were the light-colored dikes, which are fairly abundant in the graywacke. The graywacke, as pointed out above (p. 108), is believed to be of Upper Jurassic age. The age of the dike rocks is not known, but they must be post-Jurassic.

Graywacke is economically the most important rock of the region at the present time, because all the prospects so far located are in graywacke, although there is no apparent reason why mineralization should not have taken place in the schistose series as well. One possible reason for the seeming localization of the mineralization in the graywacke is that the physical properties of the massive graywacke under great forces may have caused it to break with big clean fractures that were of great extent and that furnished excellent pathways for the ore-bearing solutions. The soft schistose rocks, on the other hand, would not give clean breaks or persistent pathways, so the solutions would dissipate through the schist and would not concentrate at any one place. Although the geology of the district appears to be simple, the interpretation of the structure is difficult.

[1] Knopf, Adolph, The Sitka mining district, Alaska: U. S. Geol. Survey Bull. 504, pp. 18, 23, 1912.

As the beds are not fossiliferous in the Klag Bay region, fossil-bearing horizons can not be traced, and no beds were found that have persistent lithologic characteristics. Observations of the strike and dip show that the beds have a rather constant strike toward the northwest and a steep dip toward the south. The rocks northeast of the slate-graywacke series shown on the map belong to the complicated series of schists and volcanic rocks whose exact nature is in many places difficult to determine.

CHICHAGOFF MINE.

The Chichagoff mine is at the head of Klag Bay. The entrance to the mine is on the southeast side of Doolth Mountain, and the end of the main tunnel is now past the center of the mountain.

Thirty stamps are operated at the mill at the present time, and the ore is concentrated both by amalgamation and by flotation. Electric power is brought from the generating station at the north end of Sister Lake. The source of the power is in Rust Lake, 1¼ miles above the power station on Sister Lake.

The early history of the mine, taken from the report by Knopf,[1] is inserted here.

> The ore body was found in 1905, * * * by tracing to its source the quartz float so abundantly strewn in the bed of the small stream. The lode did not outcrop along the shore but was found in place one-quarter of a mile inland, at an elevation of 275 feet. At the outcrop the lode ranged from 2 to 4 feet in width. The float ore was carefully gathered and shipped to the smelter at Tacoma. This ore was rich enough to yield between $15,000 and $20,000. The proceeds were applied to development work and the mine has paid its own way from the start. A drift tunnel 220 feet long was run on the ledge, and two ore shoots were encountered, the second of which was 18 feet wide at a maximum and averaged $63 a ton across this width. Later a second tunnel was driven 162 feet vertically beneath the upper tunnel, commencing behind the mill, which is situated at the beach. Ore was encountered at 800 feet from the portal, apparently belonging to the bottom of the first ore shoot. A raise was put through to the upper tunnel, and the ore thus developed is now being stoped.

The present Chichagoff Mining Co. controls both the original Chichagoff or De Groff mine and the Golden Gate mine. The consolidation took place in 1912. Since Knopf wrote his report it has been definitely proved that both mines are on the same lode.

A few facts collected concerning the occurrence of the ore might be of general interest, as this mine is the only one in the district that has been extensively developed, and as it is probable that if other mines are opened up in the region the occurrence of the ore will be similar. Of course, it can not be argued that because the Chichagoff mine is successful every mine in the district of a similar type, or even one whose ore tenor may be as high or higher than that of the Chichagoff, will be likewise successful. It must be remembered

[1] Knopf, Adolph, The Sitka mining district, Alaska: U. S. Geol. Survey Bull. 504, p. 23, 1912.

that in mining relatively low grade ore the management of a mine is always an extremely important factor in determining its success or failure.

The Chichagoff ore body is a vein deposit that has formed along a shear zone in the argillitic graywacke. The shear zone is a persistent one, and it has been followed continuously for over 4,500 feet. The strike of the zone is rather constant, and the dip is steep although somewhat variable. The shear zone may range in width from less than a foot to 10 feet. The ore does not occur continuously along the shear zone but is distributed in shoots. Five such shoots have been encountered in the main tunnel of the mine. Three of the shoots have been already worked out. In one of the shoots the ore gave out about 550 feet below sea level; in another at 400 feet. Both shoots reached the surface—one at 230 feet above sea level, the other at 1,370 feet. The shoots are tabular and are irregular in outline. One dips about 80° S. and the other stands about vertical. The third ore shoot was small and is really part of one of the other shoots. The other two ore shoots are not yet fully developed, so their extent is not known.

The gold is associated with the quartz, which is white and glassy in appearance. Where there is no quartz there is no gold, although there may be abundant iron sulphide. Extreme irregularity characterizes the occurrence of the gold; it is irregularly distributed in irregularly shaped ore shoots. The thickness of the vein averages 2½ feet, but the actual thickness differs greatly from place to place. There is said to be no relation between the thickness of the vein and the distribution of the gold. The value of the gold in a thick part of the vein may be high or it may not. It seems to be true, however, that where the quartz contains abundant sulphides it is likely to be richer in gold than at places where the sulphides are not so abundant. Sulphide mineralization and gold mineralization in the quartz seem to be genetically connected, although heavy pyrite mineralization in the black slate does not seem to be related to the gold mineralization. The quartz is in rather lenticular bodies, and their thickness varies greatly in short distances. At places the quartz bodies are twisted about and even seem to be cut off sharply. This feature suggests that movement has taken place subsequent to the formation of the bodies, and this is further borne out by the fact that in thin sections the quartz is seen to be very greatly crushed. In the shoot where the bodies of quartz are very irregular and appear to have been subjected to movement this disturbed part of the body is followed by a regular vein of quartz that has a uniform thickness of about 3 feet. Another characteristic way in which the quartz occurs is in the ribbon structure already described by Knopf.[1] This type of

[1] Knopf, Adolph, op. cit., p. 21.

structure is caused by parallel stringers of quartz, which are separated by black slaty or carbonaceous layers. These stringers of quartz break away so cleanly from the slaty layers that the slaty layer has every appearance of being one of the walls of the shear zone. It seems to be advisable to put in a short crosscut here and there to make sure that the vein is not really thicker than it appears to be.

A thin section of the vein matter shows crushed coarsely granular quartz, which together with some calcite surrounds and replaces the crushed slate and graywacke. Calcite is not abundant, and in the specimen examined was seen only with the fine-grained quartz, which was replacing the country rock. Some of the quartz shows wavy extinction, due to the pressure to which it was subjected. A thin section of the ore which shows free gold, pyrite, galena, and quartz does not exhibit features which would indicate the relative order of formation of the different minerals. The pyrite is well crystallized and fits in with the quartz mosaic in such a way that simultaneous crystallization is suggested. The gold is in the form of a small stringer that appears to cut across a quartz grain, and hence from this single occurrence it would appear to be later than the quartz. A single example of the relationship between minerals is not sufficient, however, to establish a definite order of succession. The galena occurs between the quartz grains, and there is nothing to suggest whether it is older or younger than the quartz, or of the same age. The quartz, although crushed, does not show nearly the same amount of crushing that the dike rocks show; so it seems possible that the gold mineralization took place subsequent to the intrusion of the dike.

The source of the ore-bearing solution is not known, although it probably had an igneous origin. The presence of a possible igneous source is indicated by the dike rocks. The Coast Range batholith is not far away, and that ore-bearing solutions could come from these rocks is shown by the fact that at many other places in southeastern Alaska the rocks near this batholith are mineralized. The distance of the deposits from the contact would not necessarily indicate their distance from the igneous body, which may lie only a short distance under the surface. It is at least probable that the dikes and the ore-bearing solution had a common origin, and that the ore-bearing solution represents a later stage of effusion from the parent igneous mass. There seems to be no good evidence to show that the gold may have been leached from the graywacke and redeposited in the shear zones, for the graywacke is fresh and shows no effect of weathering or leaching.

HIRST PROPERTY.

The Hirst property lies on the northwest side of Doolth Mountain in Mine Cove. The property consists of three claims owned by Bernard

Hirst, of Sitka. These claims, together with the Bahrt claims on the opposite side of Doolth Mountain, are now under lease by the Hirst-Chichagof Mining Co. A considerable amount of work has been done on this property but nothing within the past few years. The Hirst-Chichagof Co. proposes to open the property as soon as financial matters can be arranged.

There are two tunnels on the property—one at an elevation of about 255 feet above sea level, the other at 430 feet. These are called the 250 and the 450 foot levels. The 250-foot or lower tunnel is about 725 feet long; the upper about 427 feet. A tunnel at 100 feet above sea level, which is expected to intersect the ore body at about 900 feet from the entry, is projected.

The rocks of Mine Cove belong to the graywacke series, but they are somewhat more carbonaceous and argillaceous than the rocks on Klag Bay. On the island at the entrance to the cove there is a shear zone cut by numerous quartz and calcite stringers. An old prospect, the Monte Cristo, lies on the main shore just south of this island. Several hundred yards west of the Hirst mine a tunnel about 30 feet long has been driven into the hillside along a small shear zone. A quartz stringer about 6 inches wide at the mouth of the tunnel diminishes at the face to about an inch wide.

The lower tunnel on the Hirst property shows in sections across its face and roof a few inches of soft gray clay gouge, about a foot of crushed rock, through which run quartz stringers parallel to the footwall, and several feet of crushed argillitic rock containing small gnarled quartz stringers a fraction of an inch thick. The crushed slate is very much slickensided and carbonaceous and contains in the carbonaceous material considerable pyrite. A dike of much-altered porphyry, probably alaskite, similar in appearance to the other dikes of the region, runs along the footwall for most of the way through the ore shoot. The band of parallel quartz stringers differs in width from place to place and at the end of the ore shoot disappears entirely. These stringers follow the well-defined footwall. That the quartz was deposited later than the movement that produced the shear zone is shown by the fact that it occupies the shear zone; and that some movement has taken place since the original movement is shown by the crushed condition of the quartz.

In the upper tunnel thin quartz stringers occur in the face. The footwall is hard and quartzitic. Quartz bands are abundant for about 8 inches from the footwall, which here strikes about N. 35° W. and dips about 78° S. The rock toward the hanging wall, as in the lower tunnel, is greatly crushed and contains but little quartz. The width of the band of parallel quartz stringers ranges between a foot and 3 feet in the ore shoot. This quartz occurs chiefly in parallel bands about 3 or 4 inches wide, which are separated from one another by narrow dark bands of argillitic material. Small quartz stringers cut out in places at right angles to the footwall, but these probably do not carry gold. The footwall is at most places a light-colored clayey gouge and is well defined. There is abundant pyrite with this gouge and with the quartz of the gouge. Pyrite is rather abundant, too, in crushed material along the hanging-wall side of the vein. A light-colored dike, possibly 5 feet wide, occurs in the graywacke of the footwall near the north end of the ore shoot. It is cut sharply off by the fault. The lode proper in this tunnel has a maximum width of a little over 3½ feet and a stope length of about 225 feet. The dip of the shoot at its north end is about 79° W. and its pitch is not known.

Quartz crops out on the hillside about 60 feet above the mouth of the upper tunnel, and about a hundred feet higher in the stream some quartz is exposed as stringers in the graywacke.

The quartz in the tunnel does not show much sulphide mineralization. The chief sulphide mineralization occurs in the crushed rock of the hanging-wall side of the vein, but it is generally reported that this sulphide does not carry the gold. The pyrite may be syngenetic—that is, it may have been originally in the slate in the form of iron, and under the physical and chemical conditions to which it was subjected it formed coarsely crystalline pyrite. It might in this way have formed independently of the action of the solution which brought in the gold. One assay, for instance, is reported to show $9 in gold in the quartz portion of the vein and only $0.85 in the pyrite-bearing slaty portion. Values as high as $56 in the upper level and $57 in the lower level are reported by the company. The gold appears to be irregularly distributed. The ore in this mine probably occurs in shoots. New shoots may be expected along the shear zone if it is followed, but nothing can be said about the distance that may have to be traversed before another shoot is reached, or about its tenor.

OTHER PROSPECTS.

A prospect from which some of the richest ore of the region has been taken is the Jumbo claim on the west side of Klag Bay about half a mile south of Chichagof. This is one of a group of four claims that extend over the hill to Ogden Passage, and it was staked in the early days. At the present time the workings consist of a tunnel about 35 feet long and an inclined shaft 48 feet deep that is now filled with water. In the face of the tunnel there is a small crushed zone about 6 inches wide that is filled with crushed slate and small quartz stringers. Two large quartz stringers cut across the face at an angle to the small crushed zone. Pyrite is fairly abundant in association with quartz, and also occurs in stringers that cut the slaty country rock. The country rock is a much-broken argillitic graywacke. The strike and dip of the fault plane is variable. Where measured at the surface it strikes N. 54° W. and dips 62° S. The plane flattens to about 45° S. at the bottom of the incline. The material in the dump shows brecciated slaty particles cemented by quartz in which are rather abundant well-crystallized pyrite, some galena, and some sphalerite. It is said that the quartz which shows rather abundant sphalerite is as a rule not very rich in gold. Some of the best specimens of free gold in the region came from this prospect.

The prospects Sitka No. 1 and No. 2 are on the east slope of Doolth Mountain about a quarter of a mile north of the Chichagoff lode. Development only is reported. The upper tunnel lies at an elevation of about 950 feet. At the entrance to the tunnel in the creek bed a dozen or more quartz stringers cut across the direction of the tunnel. The tunnel is approximately 150 feet long and follows a shear zone of variable width. Almost no quartz occurs in this tunnel. A little pyrite was noted in the crushed rock of the shear zone. The strike of the tunnel is about N. 62° W., and the dip of the fault plane is 52° S. Sticky clay gouge follows the footwall at some places and the hanging wall at other places. The lower tunnel is at an elevation of about 670 feet. The shear zone that it follows strikes about N. 52° W. and dips 52° S. A little quartz occurs in the crushed zone. The footwall is graywacke and the hanging wall is a carbonaceous argillite. At the face of the drift cross stringers of quartz occur in fractures, and a little pyrite mineralization was seen there. The quartz stringers are on the footwall of the shear zone.

The Flora claim lies on the east slope of Doolth Mountain, about 800 feet west of the Golden Gate tunnel of the Chichagof mine. The tunnel is in a shear zone that contains some quartz.

The Bahrt claims, Anna, Rose, and Henrietta, are on the south side of Doolth Mountain at the head of Klag Bay. These claims are thought to lie on the continuation of the Hirst-Chichagof shear zone, and the Hirst-Chichagof Co. has secured a lease on the property.

The Handy property, consisting of two claims, is on the east side of Klag Bay opposite Chichagof. Considerable prospecting has been done on these claims. There is at the present time a tunnel about 45 feet long and an inclined shaft about 175 feet long. Work had been suspended at the time of visit. The dump consists chiefly of carbonaceous slate, most of which is slickensided and highly graphitic. Some pieces of the quartz show mineralization with iron sulphide. The pyrite in most of the specimens occurs at the edge of a quartz band or in the slaty stringers in the quartz. About 40 feet above the tunnel mouth (80 feet above sea level) an outcrop shows quartz. The country rock is graywacke. The quartz stringers are lenticular and are practically confined to the footwall. The strike of the rocks is about N. 50°–70° W. and the dip is very steep to the south. The strike of the Chichagoff shear zone should carry it across the bay somewhere near this point. The work on this prospect was started in September, 1916, and was discontinued in May, 1917.

A prospect is located on the island between Chichagof and the Handy mine. This island has been located a number of times. It is now called the Submarine claim. Its workings consist of a shallow water-filled pit.

Another prospect from which some rather rich specimens have been taken lies just within the entrance to Lake Anna and continues through to Klag Bay. This prospect was located in April, 1914. It lies along a fault zone in slaty rock. Small iron-stained stringers of quartz occur in the rocks on the dump. A remarkably smooth fault plane, which strikes about N. 20° E. and stands about vertical, forms the south side of the tunnel. The crushed zone as exposed in the tunnel is about 3 to 5 feet wide. The tunnel is about 100 feet long, but no recent work has been done in it. Considerable pyrite occurs with the quartz. Some quartz was found which contains pyrite, galena, pyrrhotite, and sphalerite. Several other prospects of the types just described occur in the region, but they were not visited.

Four claims at the head of Falcon Arm extend from the beach to the top of the peak, a distance of about 4,500 feet. A trail runs from the head of Falcon Arm to the claims, and they can also be reached without much difficulty from the head of Ford Arm. The claims are about 14½ miles by water from Chichagof. At an elevation of about 400 feet above the beach a cabin has been built, and a short tunnel has been run in on a mineralized dike. This dike is an altered diorite aplite, and contains rather abundant pyrite. The main outcrop, apparently a mineralized dike, on these claims lies in a narrow gully at about 1,650 feet above sea level. Below the outcrop a tunnel about 30 feet long has been started into the crushed slate and graywacke to intersect the dike. Shots have been put into the outcrops of several other iron-stained dikes.

The geology of the ridge is relatively simple. The country rock is graywacke, which here has been rather extensively intruded by light-colored dikes that range from 3 to 15 feet in width. The dike at the cabin is mineralized with pyrite and is reported to carry gold. The outcrop at 1,550 feet is greatly weathered, and as no development work has been done here its extent or relationships are not known. The prospecting tunnel is in crushed slate, and it does not cut the mineralized dike above it. A few scattered quartz stringers were seen in the tunnel.

Galena, pyrite, and sphalerite occur in stringers in the rock from the outcrop. Samples from this outcrop are reported to carry gold and some silver. The claims were located in the fall of 1916.

A group of four claims is in the angle between Lisianski Strait and Lisianski Inlet, on Yacobi Island. The claims were located in 1917. The quartz vein along which the claims lie was first located about 30 years ago, and a tunnel about 35 feet long was run. It is reported that about $1,100 worth of gold was taken from the tunnel at that time. The exposure of the quartz is at tide level, and it appears to be in a shear zone, associated with a clay gouge. The width of the stringer ranges from less than a foot to about 3 feet. The country rock is a rather basic intrusive that belongs in the Coast Range batholith. A few feet away from the tunnel entrance is a coarsely grained hornblendite. Both the country rock and the quartz are greatly fractured. In the face of the tunnel the quartz has pinched out, but on the hillside at an elevation of about 75 feet, apparently on the strike of the vein, quartz is exposed. The quartz is white, fairly coarse grained, and except for a little chalcopyrite is practically free from sulphides. A little free gold was seen in the pure white quartz.

A gold claim on the north side of Stag Bay, about one-fourth mile northwest of the cannery, was located in 1917. The lode is in diorite and occurs as a quartz vein, which is about 3 feet wide at one place and about 1 foot wide a little lower down and is reported to extend about 200 feet up the cliff. This quartz is said to yield colors when crushed and panned. No development work has been done on the claim. The approximate strike of the quartz stringer is N. 30° E. and the dip about vertical. No metallic minerals were seen in the quartz. Quartz veins of similar appearance cut the diorite at a number of places.

COPPER.

GOLD-COPPER GROUP.

A group of six claims called the Gold-Copper group lies about 3 miles by trail from the head of Pinta Bay. The metals reported from these prospects are gold, silver, copper, and lead. Seven claims were first located in 1910 and were held by the Portlock Harbor Mining Co. This company is said to have failed to do necessary assessment work and the ground was relocated on January 2, 1916, by T. Baker, James Toby, and George Bolyan. Six claims were located and were called the Gold-Copper group. At the present time the claims are under litigation.

The claims are reached by trail from the head of Pinta Bay. Pinta Bay lies about 18 miles northwest of Chichagof, and about 70 miles from Sitka. The bay is a good harbor, as it is protected from the sea by Hill Island, and it has plenty of water. No reliable charts of the region exist at the present time, but it is hoped that one will be published shortly. The claims lie at elevations of 1,370 to 2,360 feet, and a pack trail about 3 miles long connects them with the head of Pinta Bay. A tram about 1½ miles long could be built to connect the prospects with Baker Arm. An abundant supply of water for power is available in the stream that enters Pinta Bay at its head.

The development work on these properties is not extensive. It consists of two tunnels at elevations of 1,360 and 1,440 feet, which were driven by the original holders of the property, the Portlock Harbor Copper Mining Co. The 1,440-foot tunnel is about 130 feet long and has about 30 feet of crosscuts. The 1,360-foot tunnel is about 50 feet long. Recent work has been done at a number of places on the hillside. At the elevation of 1,850 feet there is a shaft about 10 feet deep, at 1,935 feet a cut about 25 feet long, at 1,875 feet a 91-foot tunnel, and at 1,880 feet a small open cut.

The prospects lie near the western edge of the greenstone area shown on the map. (See Pl. II.) The hills to the north are all greenstone, and the rocks along the ridge to the southwest belong to the undifferentiated metamorphic series. The country rock on top of Baker Peak is amygdaloidal greenstone, and that in the immediate neighborhood of the prospects is a hard fine-grained, somewhat sheared greenstone. This rock is very much altered near the lode. Light-gray dikes of fine-grained igneous rock cut the greenstone. The dikes are highly mineralized with pyrite and are so badly altered that their original nature can not be definitely told. They appear under the microscope to be altered aplites. Such iron-stained dikes are rather common on this hill and along the ridge toward the sea. Although mineralization has taken place both in the greenstone and in the dikes, it appears to be connected genetically with the dikes. The source of the copper may be in the greenstone, but the dikes appear to have had some influence on its concentration. Small amounts of chalcopyrite were seen in similar-looking greenstone north of Morris Lake and above Slocum Arm. The chief visible metallic minerals of the lode are pyrite and chalcopyrite. Assays are reported to show gold, silver, and lead.

The most promising showing of ore is in a new cut made in the fall of 1917, in which a zone heavily mineralized with chalcopyrite about 10 feet wide is exposed. At this place the country rock is altered iron-stained greenstone, and the lode rock is altered dike (?) rock impregnated with and cut by stringers of chalcopyrite. This lode rock is followed by about 10 feet of rather massive chalcopyrite. The mineralized zone appears to strike about N. 30°–40° W. and dip 70° W. Along the strike of this zone about 250 feet to the northwest a 10-foot shaft shows a mineralized zone about 2 feet wide.

A small open cut made on a dike about 100 yards east of the tunnel of the new workings discloses a rock strongly mineralized with pyrite. The more highly mineralized portion is about 6 feet wide, and its strike is N. 50°–60° W. This mineralized rock is reported to carry silver and lead.

SNOW SLIDE CLAIMS.

A copper prospect is located in Pinta Bay at the head of Baker Arm. The prospect consists of two claims called the Snow Slide claims. They were located in 1916 by the present locators of the Gold-Copper group. The prospect is on the steep hillside at an elevation of about 650 feet and about 1,100 feet in a straight line from the beach. Substantial cabins have been built on the beach and at the prospect. The outcrop is exposed in the bed of a small stream. It consists of a zone of thin-banded quartzose green schist highly mineralized with pyrite, chalcopyrite, and possibly some pyrrhotite. The zone where exposed is about 6 feet wide. The country rock is green schist. A tunnel 171 feet long has been driven to intersect this mineralized zone, but work on it was stopped before the zone, if it continues in depth, was reached. No very recent work has been done on this prospect.

LITTLE BAY CLAIMS.

At the head of Little Bay, between Dry Pass and Nickel, four claims were located in 1916. The claims extend from the beach up the small creek which runs from Davison Mountain. Assays of specimens from these claims are reported to show copper, silver, gold, and in one specimen a trace of nickel. The only work done at the prospect on the beach consists of a few shots put into the outcrop. The minerals seen in the beach specimens were chalcopyrite and pyrrhotite. These minerals occur in a very fine grained quartzitic rock, whose exact nature is not known. The immediate country rock is not exposed, but the nearest exposed country rock is the granitic and dioritic intrusive body which extends from Dry Pass to Cautious Pass. Near the head of the bay this rock shows considerable variation in character, and it is probable that the contact between the intrusive body and the intruded body is not far away. Owing to the lack of exposures the type of mineralization that has taken place here can not be told. The mineral specimens resemble those from the prospect at Hot Springs more than they do those from Nickel.

CONGRESS CLAIMS.

The Congress claims lie on the west side of Hill Island in the second bight north of Imperial Passage. A trail leads to them from a bight on Imperial Passage. These claims were located or relocated in 1916. The workings consist of a tunnel about 25 feet long, which is on the rocky seashore a few feet above sea level. The country rock is a gray schist, somewhat micaceous and quartzose, and is probably a schistose phase of graywacke. The workings expose a quartzose schist zone body about 11½ feet wide mineralized with chalcopyrite and pyrrhotite. The sulphides coat the thin plates of schist. On the south side of the zone is a band of green chloritic and hornblendic schist, which is somewhat quartzose and contains a few specks of chalcopyrite. On the north side of the zone is a thinly plated and quartzose gray schist. The green schist may represent an altered intrusive with which the mineralization is genetically connected. The type of ore body is similar to that near White Sulphur Springs. (See below.) No very recent work has been done on the prospect.

OTHER PROSPECTS.

A mining claim has been staked on the shore of Bertha Bay about half a mile northwest of White Sulphur Springs. This claim, or claims, was located in 1916. A few shot holes represent the work done. The prospect is on the seashore, which here consists of jagged rocks that rise about 20 feet above the water and which is deeply cut by narrow ravines. Bare rock is exposed for about 50 feet from the edge of the water to the line of vegetation.

The rocks along this shore are very highly metamorphosed, and the ordinary metamorphic minerals, such as andalusite and mica, are highly developed. The nickel-bearing gabbro of the Sea Level property lies about 7,000 feet to the southeast. Granite lies on the Porcupine Islands about 8,000 feet southwest and on the shore about 2,000 feet north. The schist rocks that form the country rock here probably owe their schistose character to the dynamic contact action of the deep-seated intrusive rocks. The schist is dark gray and contorted. At the point of discovery on the shore is a belt of light-colored quartzitic rock, iron-stained in places, which is parallel to the strike of the schistosity. It is separated from the schist by a sharp contact, and faulting may have taken place. This belt of quartz rock disappears under the moss at one end, and at the other end it pinches down to nothing. At the southeast end of the belt the rock in contact with the quartz rock is a medium-grained dark hornblende rock, which seems to be an altered basic intrusive in the schist. Mineralization is in the green rock at the contact and consists of stringers of chalcopyrite and pyrrhotite.

Similar types of mineralization in which chalcopyrite occurs in schist associated with greenstone were seen in Canoe Pass, at the entrance to Khaz Bay, on Hill Island, and in Little Bay. This type is different from that at the Alaska Nickel Mines property, and although the mineral association of chalcopyrite and pyrrhotite is the same, little or no nickel seems to be present. None of these bodies examined appeared to have more than local extent.

NICKEL.[1]

ALASKA NICKEL MINES.

Nickel is known to be present in only one locality on the west coast of Chichagof Island. The claims of the Alaska Nickel Mines lie on the outside coast between Portlock Harbor and Lisianski Strait. The principal prospects are on Fleming Island, a small tidal island, about 25 miles by water northwest of Chichagof. The property in 1917 consisted of 18 claims and two fractions. The original locations were made in 1911, and a relocation was made in 1915. The company holding the property was called the Juneau Sea Level Copper Mines until 1917 when the name was changed to the Alaska Nickel Mines. The developments in 1917 consisted of a 180-foot shaft with levels at 80 feet and 180 feet (drifts totaled about 155 feet) and prospect holes at several places. A wharf site and water-power sites have been located by the present company.

GENERAL CHARACTER OF THE DEPOSIT.

Exposures of rock in this part of the coastal plain are confined to the seashore, for everywhere else the rocks are concealed by a heavy growth of vegetation and by swamps. Three outcrops, heavily stained with iron, were noted on the shore. These outcrops form irregular areas whose maximum diameter is about 70 feet and project somewhat above the surrounding rock. The extreme outcrops are about a mile apart. The northwest cropping shows limonite, and although no sulphides were seen it is probable that they would be found under the leached zone. The 180-foot shaft was sunk beside the central outcrop, and ore is reported on the 180-foot level. No work has been done on the southeast outcrop, but the ore minerals are found on the surface. At a number of other places the ore minerals have been found disseminated through the country rock in small amounts, but it is not yet known whether this type of so-called "disseminated ore" can be handled profitably. Two of the principal outcrops are close to the contact between the igneous rock in which the ore bodies occur and the quartz-mica schist which these igneous rocks intrude. The northwest outcrop is several hundred feet from the contact; the central outcrop is a few feet from the contact; and the southeast outcrop also may be near a contact, but the heavy cloak of vegetation conceals the rock a few feet away from the outcrop. From the surface outcrops, then, it would appear that the distribution of the ore bodies is to some extent related to the contact between the igneous body and the schist. Most of the "disseminated ore" has been found near the contact, but some of it is farther away from the

[1] Nickel is definitely known to occur at only one other place in Alaska. The occurrence is on Canyon Creek, Copper River valley, and a brief description of the prospect is given in U. S. Geol. Survey Bull. 576, pp. 52–53, 1914.

contact than are the two main outcrops. The only chance for underground observation was in the 80-foot level of the central outcrop. The shaft is in light-colored diorite that is free from ore minerals. The drift for about 30 feet from the shaft is in barren hornblende gabbro, but the last 20 feet are in massive ore. The contact between the barren rock and the ore-bearing portion appears to be an irregular line. There is a rather rapid transition from barren rock to rock in which there are a few disseminated sulphides and then to massive ore. The change does not appear to occur progressively but irregularly. In the face of the tunnel and in a crosscut near the face are some blocks of barren rock, but the drill holes in the face of the main tunnel are apparently in sulphides. Some movement has taken place in this tunnel, but its extent is not known. The 180-foot level could not be visited, but it is reported that ore was encountered on this level. The report that a clay gouge occurs in this level indicates that movement has taken place. The presence of niccolite on the 180-foot level indicates a secondary origin for some of the ore on that level.

MINERALOGY.

The chief metals that may be of commercial importance found in this deposit are copper and nickel. Assays furnished by the company show small amounts of gold and silver. The principal sulphide minerals are pyrrhotite, chalcopyrite, and pentlandite. In the hand specimen of the rock chalcopyrite and pyrrhotite are the only minerals that can be recognized, but in a polished specimen of the ore the pentlandite can be plainly seen. A few specimens of niccolite have been obtained from both levels. The niccolite is a secondary mineral and lines crevices in the country rock. Insufficient underground work has been done to afford data on the relative abundance of the ore minerals. In some hand specimens chalcopyrite is more abundant than pyrrhotite, in other specimens the reverse is true.

The minerals chalcopyrite and pyrrhotite have so often been described and are so common that they are known to all prospectors. Pentlandite, however, is a rare mineral and besides is not often distinguishable from pyrrhotite in an ore specimen. As the mixture of chalcopyrite, pyrrhotite, and pentlandite looks just like the mixture of chalcopyrite and pyrrhotite, the only way of determining definitely whether nickel is present is to make a chemical test. A simple chemical method of testing for nickel is as follows:[1]

Grind to a fine powder a sample—2 or 3 grams (30 to 40 grains); treat in a test tube with a few cubic centimeters of aqua regia (a mixture of 1 part nitric acid and 3 or 4 parts hydrochloric acid), and boil nearly to dryness; then add enough nitric acid and water to dissolve all soluble substances. Filter if necessary. Dilute to

[1] Hess, F. L., Nickel: U. S. Geol. Survey Mineral Resources, 1914, pt. 1, pp. 929-930, 1916.

10–15 cubic centimeters (about one-third the contents of a test tube 6 inches long and three-fourths of an inch in diameter), add a gram or more (half a teaspoonful) of citric acid (solid), and dissolve by heating. Make the solution slightly ammoniacal, noting that it should contain no precipitate. To the slightly ammoniacal solution add about 2 cubic centimeters (a half teaspoonful) of 1 per cent alcoholic solution of dimethylglyoxime. A voluminous scarlet precipitate indicates nickel.

The aqua regia solution is boiled nearly to dryness to remove from it the large excess of acid and anything, such as hydrogen sulphide, that would cause the precipitation of iron, cobalt, nickel, etc., in the ammoniacal solution.

The citric acid will prevent the precipitation of iron and aluminum as hydroxides, but will not prevent the precipitation of sulphides of iron, cobalt, nickel, and some other metals in the ammoniacal solution.

If a brown precipitate of iron forms after the solution is made ammoniacal, it contains an insufficient quantity of citric acid.

At the present time dimethylglyoxime may be difficult to obtain. The price for it is very high, but a small quantity (as much as will go on the blade of a pocket knife) should provide the prospector with enough solution to last a year. If copper is present the acid solution will turn deep blue when ammonia is added to it.

Pentlandite is an iron-nickel sulphide, (Fe, Ni)S. It is brittle and has a hardness of 3.5–4. It has a metallic luster and a light bronze-yellow color. Pentlandite carries about 22 per cent nickel. Except on polished surfaces none could be recognized in the rough hand specimens of the ore.

Niccolite is an arsenide of nickel, NiAs, and contains about 43.9 per cent nickel. It is very brittle and has a pale copper-red color. It was found in small amount lining crevices in the rock.

TYPE.

One of the purposes of the rather close study of a deposit that is not very extensively developed is to determine the type of the deposit if possible and so compare it with known deposits of similar type that have been extensively developed. Much of the experience gained in the development of the known deposit can then be applied to the development of the relatively unknown deposit. One can not argue, however, that if one deposit is large, every one of similar type is equally large. The similarity between the nickel deposit on Chichagof Island and the deposits at Sudbury, Canada, is at once evident.

A comparison between the deposit on Chichagof Island and the Sudbury deposits can best be shown in the form of a comparative table. The description of the Sudbury deposits is drawn largely from the report of the Royal Ontario Nickel Commission.[1]

[1] Report of the Royal Ontario Nickel Commission, pp. 95–286, 1917.

Comparison of Chichagof nickel deposit and the Sudbury deposits.

Alaska Nickel Mines deposit.	Sudbury deposits.
1. Two of the outcrops are marginal in igneous rock, norite or diorite. The relations of the third outcrop are not known.	1. Ore bodies are near or in norite. The chief commercial deposits are marginal bodies outside the norite.
2. Predominating sulphides are pyrrhotite, chalcopyrite, and pentlandite.	2. Same.
3. Ore minerals occur in places as blebs disseminated in norite.	3. Same.
4. Later granitic intrusive bodies cut the norite.	4. Same.
5. In general the rocks at the margin of the large intrusive body appear to be more basic than the rocks at a greater distance from the margin.	5. Same.
6. Barren blocks of rock seem to be included in the ore on the 80-foot level.	6. Ore is rocky.
7. No micropegmatite found. Acidic rocks are chiefly albite bearing.	7. Micropegmatite is abundant.
8. Freshest hypersthene occurs with the ore.	8. Same.
9. Transition from nonore to ore is rather sharp.	9. Transition from nonore to ore is sharp in Creighton ore body.
10. Little secondary quartz and no calcite has been observed.	10. Secondary quartz and calcite is reported from some of the deposits.
11. The shape of the ore body is not known.	11. The shape of the commercial ore bodies is for the most part rudely lenticular. Some are in irregular cylinders or tubes; some are in distinct veins.
12. The sulphides are later than the silicates. The pentlandite is apparently in part later than the pyrrhotite.	12. Same.

The nickel deposits of Chichagof Island and those of Sudbury are seen from the above comparative table to be essentially alike both in the general type of occurrence of the deposits and in the mineralogy of the ores. On the assumption, then, that the two deposits are genetically similar facts determined with regard to the Sudbury deposits may be applied to these deposits. Two types of occurrences have been recognized at Sudbury—"marginal" deposits and "offset" deposits. Of the marginal deposits those that occur in the rocks adjacent to the norite contain the commercially important ore bodies. The ore bodies found on Chichagof Island are in the igneous rock—norite, hornblende gabbro, or diorite—but by analogy there seems to be no reason why the deposits should not be looked for in the adjacent mica schist also. At Sudbury some of the commercial deposits are surrounded by rock in which the ore minerals are disseminated;

on Chichagof, consequently, outcrops of ore bodies should be looked for wherever so-called "disseminated ores" are seen. The outlines of the partly developed ore body on Chichagof have not been sufficiently delimited to afford comparison with any of the Sudbury ore bodies. The ore body appears to stand nearly vertical and to be somewhat disturbed by faulting.

Other points to be noted in prospecting on Chichagof Island are that ore so far has not been found in the very coarse grained dark norite, and that if a very coarse grained diorite—chiefly one containing large hornblende crystals and feldspar—is found, some disseminated ore minerals will be found in the rocks near by. A diorite that resembles the diorite of the nickel intrusive and differs from the other diorites of the region is shown on the map near the southwest entrance to Lisianski Strait, and prospecting may reveal some nickel deposits near this diorite. The irregularity of the occurrence of the Sudbury ore deposits suggests the necessity of careful underground exploration by means of the diamond drill to determine the extent of the ore bodies.

PETROGRAPHY.

As the general type of occurrence of these deposits has already been discussed, a description of some thin sections of rock and polished surfaces of ore will be given here. The deposits are found in a body of medium to coarse grained igneous rock that shows considerable variations in type—variations that extend all the way from granite to gabbro. This igneous body, or bodies, intrudes quartz-mica schist, which is supposed to be the metamorphic phase of the graywacke that occupies much of the west coast of Chichagof Island.

A thin section of this quartz-mica schist shows biotite in parallel arrangement making up much of the slide; muscovite also occurs, both as the coarse-grained variety and as the fine-grained variety (sericite); quartz is fairly abundant as grains between the mica laths. A more intensely altered phase of this schist taken from the contact with the intrusive body shows a strong development of biotite, quartz, plagioclase (about oligoclase-andesine), garnet, muscovite, and accessory apatite. The minerals all show undulatory extinction. Small grains of zircon surrounded by pleochroic haloes occur in the biotite.

In general a gradation in rock type from more acidic away from the contact to less acidic near the contact appears to exist. That this gradation is due entirely to differentiation, however, is doubtful; for the most acidic bodies of rock, such as those in Cautious Pass and those in Mirror Harbor, seem to be later than the diorite and intrusive in it. The acidic dikes are definitely later than the diorite and norite. A thin section of a specimen of the coarse granite of the type similar to that found in Cautious Pass consists of coarsely granular quartz, feldspar, greenish biotite, muscovite, and garnet. The feldspar is albite and albite-oligoclase. The rock gives evidence of having undergone considerable pressure. The smaller light acidic dikes and bodies that cut the diorite are aplites and granites. The feldspar is albite and oligoclase. One of these dikes shows in thin section quartz, biotite, feldspar, and sericite. The feldspar is variable in composition, showing great variation in a single crystal, and ranges from albite to andesine. The feldspar crystals in the specimens examined show some alteration. One very coarse grained rock has feldspar crystals an inch or more in length. Practically no opaque minerals—sulphides or oxides—are present in these rocks.

The rock that makes up most of the intrusive body falls under the general term of diorite. Different specimens show, however, great variation in color, texture, and mineral composition. The descriptions of only a few specimens can be given. A sample taken about 1,800 feet south of the main nickel outcrop is a light-colored, coarse-grained, somewhat gneissic rock containing a few scattered phenocrysts of feldspar. The microscope shows the rock to be somewhat crushed, although the minerals are relatively fresh in appearance. The mineral constituents of the rock are plagioclase, biotite, garnet, apatite, chlorite, and actinolite (?). The plagioclase crystals are zonal and hence are of variable composition, which ranges from that of oligoclase-andesine to andesine-labradorite. Biotite is almost free of inclusions. A few magnetite grains gathered along the edges of the biotite may represent the alteration of some of the biotite. The chlorite is secondary and replaces the garnet. Many needle-like crystals (actinolite?) occur as inclusions in the garnet and the feldspar. The absence of hornblende is to be noted. This rock is a diorite. Specimens of another type of diorite collected from several places are of a fairly dark greenish-gray rock, which is coarse grained and porphyritic. The thin section shows feldspar and hornblende phenocrysts set in a fairly fine grained groundmass. The feldspar is zonal, is variable in composition, and is considerably altered. The average composition of the feldspar is about andesine. The hornblende phenocrysts are fresh and unaltered. The groundmass consists of altered feldspar, hornblende, and alteration products. Sericite, chlorite (pennine), and a small amount of epidote are the alteration products. A type of diorite that has been noted at a number of places near occurrences of "disseminated ore" is a very coarse grained hornblende-feldspar rock. This rock in thin section shows hornblende crystals an inch long, set in a quartz-feldspar matrix. The hornblende crystals are fresh in appearance but are replaced by a little chlorite; they are lath-shaped and seem to be eaten into or corroded by the feldspar. At one place feldspar or quartz appears to have replaced the whole central portion of the hornblende crystal. The feldspar, which is near oligoclase in composition, is extensively altered and replaced by sericite. Some of the feldspar is broken and shows bent twinning lamellae. This rock is quartz diorite porphyry.

The most basic of the rocks—hornblende gabbro and norite—are found close to the outcrops of the ore bodies. A common rock of characteristic appearance that occurs near the ore bodies is a very coarsely grained hornblende gabbro or norite. The rock weathers to large rounded boulders with rough and pitted surfaces. Small amounts of ore minerals scattered in blebs are seen at some places in these rocks. A thin section of this type of rock shows it to consist chiefly of altered hornblende and pyroxene. Fresh-looking plagioclase occurs in small amount and is very basic in composition, being near labradorite-bytownite. The hornblende and pyroxene has altered almost entirely to a fine-grained aggregate that may be talc or uralite. Small amounts of biotite, chlorite, and sulphide were also noted. Another specimen of rock taken from a locality near the main nickel outcrop is a hornblende gabbro. The rock is medium to coarse grained and is greenish-gray in color. The light minerals and the dark minerals are nearly equal in amount. The thin section shows a rock consisting of mineral grains one twenty-fifth of an inch or less in diameter. The chief minerals are feldspar and hornblende; accessory minerals are sericite, chlorite, and quartz. The feldspar is near labradorite in composition; the crystals are crushed, show undulatory extinction, and have bent twinning lamellae. The hornblende is pale greenish and yellowish and is not strongly pleochroic. Small stringers of sericite cut and replace the plagioclase. The quartz is present in the form of a stringer that cuts across a feldspar crystal. A specimen of rock from a point about 75 feet from the outcrop of the main ore body is a fresh light-colored hornblende diorite. The thin section shows hornblende, feldspar, and quartz. The hornblende is green and strongly pleochroic and is fresh and somewhat shreddy. The feldspar is partly altered and has the composition of andesine-labradorite. A specimen of the rock from the shaft sunk alongside the main ore body is hornblende gabbro. This rock consists largely of plagioclase that has a composition near that of labradorite. The mafic minerals are interstitial and are chiefly common hornblende. The apparently homogeneous crystals of hornblende in this rock and in many of the other rocks examined are really made up of differently oriented crystals, so that the extinction takes place at different times in different parts of the crystal. A specimen of rock from the 80-foot level, about 10 feet from the shaft, is a dark-greenish medium-grained hornblende gabbro. The microscope shows altered hornblende, plagioclase, and a little sulphide. The hornblende is greatly altered; the feldspar crystals are broken and are cut by stringers of chlorite (?). The composition of the plagioclase is near that of labradorite. Another specimen taken from the 80-foot level, about 30 feet from the shaft, is a coarse-grained greenish hornblende gabbro. The plagioclase crystals, which have a composition about that of labradorite, are somewhat broken and bent and are replaced in part with sericite. Some of the hornblende crystals show bending. A specimen of the "disseminated ore" is a dark-brown fairly coarse grained rock. It consists chiefly of hornblende, pyroxene, and feldspar, together with disseminated pyrrhotite and chalcopyrite and a little biotite. The hornblende is brownish and is strongly pleochroic. The pyroxene is orthorhombic; it occurs in lath-shaped crystals rounded at the ends and has altered somewhat to hornblende. Where the pyroxene crystals are cut by the ore minerals there is a narrow border of an alteration mineral (sericite?). Pyroxene makes up about one-quarter of the section. The feldspar is plagioclase that has an average composition near that of labradorite. The feldspar is clear and relatively unaltered and shows zonal arrangement. One of the crystals has been broken across, and the fracture is occupied by a differently oriented crystal of plagioclase; another crystal has bent twinning lamellae. A little chlorite was noted replacing the feldspar. Most of the opaque minerals replace and are definitely later than the principal silicates in the section. The replacement of the pyroxene by sulphide is particularly evident. The opaque minerals also occur as grains in the original minerals. Nickel was found in this specimen.

A thin section of a specimen of the ore consists chiefly of opaque minerals with a little hornblende, pyroxene, and feldspar. The crystals of hornblende and pyroxene are rounded and are replaced in part by the ore minerals, which have entered the cleavage cracks of these minerals. The rounding of the hornblende and the pyroxene crystals may have been caused by their replacement by ore minerals, but this same type of rounding has been noted in specimens of norite and hornblende gabbro in which there are no ore minerals. If selective replacement of feldspar alone had taken place the resulting appearance of the mafic minerals would have been the same.

A polished surface of the ore shows pyrrhotite, pentlandite, and chalcopyrite. The pentlandite is of two kinds, one of which is in large grains that show cleavage and that surround and appear to be later than grains of pyrrhotite, and the other is in stringers, shreds, and patches in the pyrrhotite grains. The grains of pyrrhotite show blading similar to that seen in polished surfaces of chalcopyrite. Chalcopyrite in this particular specimen replaces the gangue minerals more extensively than do the other minerals. At no place in a dozen specimens examined could any decisive evidence as to the relative time of formation of the sulphides with reference to one another be obtained. At one or two places the pentlandite appears to be possibly later than the pyrrhotite, but at most places there is no indication which mineral was formed later. The same is true with regard to the relations of the chalcopyrite to the pentlandite and pyrrhotite. In places small stringers of pyrrhotite definitely cut chalcopyrite, and there can be no doubt about this particular bit of pyrrhotite being later than the chalcopyrite. Until more evidence is available than is afforded by the polished specimens examined, a decision as to the relative age of the opaque minerals to one another will have to be postponed. They are, however, definitely later than the original silicates.

USES OF NICKEL.[1]

The uses of nickel depend on its properties of toughening, whitening, hardening, increasing the elasticity, and preventing the oxidation of certain alloys; on its own resistance to alteration under atmospheric conditions; its beautiful white luster; the high polish it takes; and the ease with which it is electroplated. As with all other metals, its use depends on the fact that it is isolated from its ores with comparative ease and cheapness. * * *

The crystalline structure of nickel steel is more minute and the modulus of elasticity is about the same as that of carbon steel, and it is harder.

The alloy of iron and nickel known as "invar" is called a steel. Invar containing 36 per cent of nickel is practically without expansion or contraction when exposed to varying temperatures. It is used for scientific instruments, pendulums, and steel tapes.

An alloy of 25 per cent nickel and 75 per cent copper is used in the 5-cent piece or "nickel" of United States coinage. The small coins of Belgium, Denmark, England, France, Sweden, and Switzerland contain some tin and zinc, the Italian coins only tin, and Chilean coins contain copper 70 per cent, nickel 20 per cent, and zinc 10 per cent.[2] Some other countries use pure nickel for their subsidiary coins. From 1857 to 1864 the United States used a composition of 12 per cent nickel and 88 per cent copper in 1-cent pieces, a very much better alloy than that now in use, which is 95 per cent copper and 5 per cent tin and zinc.[3]

Monel metal is an alloy of nickel and copper made by the International Nickel Co. by smelting the Sudbury ores without separating the two metals. As stated by the Bayonne Casting Co. the composition is 67 per cent nickel, 28 per cent copper, and 5 per cent other metals, probably mostly iron and a little cobalt. It has a tensile strength equal to good nickel steel, resists many corrosive agents, and has a color and takes a polish equal to that of nickel. It is used for propellers for warships and smaller craft, including racing motor boats; for valves on high-pressure steam lines; valve stems; pump rods and liners; acid pumps; burning points in enameling and japanning ovens; pickle frames and rods in tin-plate mills; wire cloth; golf-club heads; and roofing materials.

The addition of a small percentage of nickel makes a silver-white alloy with copper, and considerable quantities of nickel are used in the alloy known as German silver, used for the more valuable metal. German silver is used direct for table ware and other utensils and as a base for silver-plated ware.

Nichrome is a proprietary name for an alloy of nickel and chromium whch was first used for resistance wires in electrical work. It stands temperatures considerably above a red heat with little oxidation and without melting, so that it is used in small resistance furnaces in place of platinum. It is also used for chemist's triangles, etc.,

[1] Hess, F. L., Nickel: U. S. Geol. Survey Mineral Resources, 1915, pt. 1, pp. 761-763, 766, 1917.
[2] Brannt, W. T., The metallic alloys, pp. 307-308, 1908.
[3] Ann. Rept. Director of Mint, 1911, p. 9, 1912.

for making carbonizing pots, and in wire cloth for dipping baskets where articles are to be dipped in acid solutions. * * *

Great quantities of nickel are used for plating iron and other articles where a beautiful protective finish is desired.

It seems remarkable that, with its toughness, resistance to corrosion, and good color, pure nickel cooking utensils are not manufactured.

HOT SPRINGS.

Two hot-spring localities were visited in the western part of Chichagof Island. Both places had been previously visited by Waring[1] and are described as follows:

HOT SPRINGS ON NORTH ARM OF PERIL STRAIT.

On the north shore, about three-quarters of a mile eastward from the head of North Arm of Peril Strait (Hooniah Sound), heated water issues at about half-tide level from the mussel and kelp covered rocks. As the warm water rises beneath or flows into the cold sea water, its presence is betrayed by convection currents, which give an oily appearance to the surface; but when examined at low tide the warm water has no noticeable taste nor odor. There is only a little bubbling, as of gas, and a small amount of dark-green vegetable growth, either algae or a seaweed.

The three principal springs found issue from fissures in the rock, separated by spaces of 5 and 2 feet, about 100 yards northwest of a small cold-water stream. The temperature of the springs was 101° F., and their flow per minute, as near as it could be measured, was, respectively, about 1½ gallons, a quarter of a gallon, and three-quarters of a gallon, but the discharge appeared to diminish as the tide fell, perhaps in part because of the draining off of contaminating sea water from the adjacent rocks above the springs, but probably in greater part because of the lowering of the hydrostatic pressure by the falling tide and the escape of the warm water from lower crevices.

The analysis of the water of the largest of the three springs * * * shows that it has a high total mineral content and is of the sodium sulphate type. Although the sample collected contained considerable chloride it seems not to have been greatly contaminated with sea water left in the moss and gravel by the receding tide, for if it had been so contaminated it would have contained more chloride than sulphate.

Beneath a low cemented gravel bank, near a large boulder 100 yards northwest of the principal group of springs, slightly warmer water (temperature 103° F.) forms oil-like convection currents over an area of several square yards in the adjacent bay water, but the outlet of this spring lowers with the tide, so that its discharge is not measurable. No other warm springs were found in a search extending from the head of the bay to a point a quarter of a mile east of the cold-water stream near the main spring group.

Cliffs of massive granitic material rise from the narrow bouldery talus slope along the shore. In the main the rock seems to be comparatively unaltered, but near the springs there is a zone, possibly a dike, of fractured and altered dioritic rock. In the hand specimen this material shows considerable epidote and chlorite, products of the alteration of the original hornblende, and F. L. Hess, of the United States Geological Survey, noted that it contains much sphene. The escape of the spring water, probably heated either by the depth from which it rises or by chemical reactions in the altered rock, is apparently facilitated by the presence of this fractured mass of rock in the larger mass of intrusive crystalline material of the region.

Because of their inconspicuous issuance and their inaccessible location for bathing, the springs are little known, and no attempt has been made to improve them.

[1] Waring, G. A., Mineral springs of Alaska: U. S. Geol. Survey Water-Supply Paper 418, pp. 33–35, 1917.

HOONIAH WARM SPRINGS.

Hooniah Warm Springs are on the oceanward coast of Chichagof Island, about 70 miles northwest of Sitka. They may be reached by launch in calm weather, but as the coast is rocky and there is usually a heavy surf they have not been often visited. A log bathhouse or sweat chamber has been built over the principal spring, however, and the locality is the occasional camping place of hunters and trappers. The springs are in a small rock cove, in which much driftwood is cast up on a beach of large rounded stones.

The principal spring issues at the edge of the forest, a few feet above the limit of drift logs and about 25 yards from and 15 feet above normal high-tide level. The water issues at a temperature of 111° F. from a vertical opening the size of one's hand, in dark, hard schistose rock. After flowing through a natural rock pool, over which the bath chamber has been built, the discharge—30 gallons a minute—cascades down to tidewater.

The spring water tastes only faintly sulphureted, and there appears to be no escape of gas. A noticeable bubbling in the water below a small cascade in the run-off channel is probably due to air trapped in the cascade rather than to gas escaping from the water. Much pale salmon-colored to white, stringy algal growth forms along the run-off channel, as is usual at sulphureted warm springs.

The analysis of water from this spring * * * shows that it is a moderately concentrated sodium chloride water containing considerable sulphate. Silica forms more than a third of the total content, possibly in part as a soluble silicate.

A second spring, with a temperature of 110° F. and a discharge of about a gallon a minute, issues among the cobbles 20 yards east of and 7 feet lower than the main spring, and vapor, possibly from the same spring or fissure, issues from openings in the forest soil 15 yards shoreward. A third spring, with a temperature of 84° F. and a flow of half a gallon a minute, rises with slight bubbling in the muck of a small stream channel 50 yards west of the principal spring.

Conditions at the main spring, where the water appears to issue directly from a fissure in the schist, indicate that the thermal water rises along such seams in the rock, which dips 80° S. 20° W. The abnormal temperature of the water may be due solely to the depth from which it rises, but it seems probable that it is due, in part at least, to the presence of intrusive rocks, which form a wide zone east of the springs. The schist from which the warm water issues is a common alteration phase of the Paleozoic or Mesozoic sediments near their contact with intrusive rocks throughout southeastern Alaska.

The hot springs on the north arm of Peril Strait (Hooniah Sound) were visited at high tide, so the actual openings could not be observed. These springs issue at or near a contact, for although the rocks on both sides of the arm for several miles are granite, the small island just south of the spring is composed of marble. Other springs probably occur on the hillside, for steam could be seen rising now and then above the trees several hundred feet up the slope. Time was not available for an extended search for these springs. The writer was told of these springs by an old Indian, who said that he had found them 40 years ago.

The White Sulphur Springs, formerly called the Hooniah Warm Springs, have been surveyed by the Forestry Bureau, and some attempt is being made to attract attention to them. Two cabins have been built, and a bathhouse has been constructed over a pool made in the native rock. This work was started in the fall of 1916. The temperature in the bath is 100° to 105° F. A good trail runs to the small bay at Nickel.

The water issues from fissures in the schist. The schist is a dark-gray contorted rock, which contains large metamorphic minerals—mica, garnet, staurolite, corundum, and others. It seems to have undergone later movement, for it is broken and recemented. Light and dark colored dikes cut the schist. The nature of the coastal plain to the east is for the most part concealed by muskeg swamps, but the few exposures show the same type of schist. A fairly large body of igneous rock occurs about 4,500 feet southeast of the springs, and a smaller body about 3,500 feet northwest. The rock of the Porcupine Islands off the coast, 1½ miles southwest of the springs, is schist intruded with granite rocks. Copper-nickel ore occurs in the igneous body to the southeast, and a copper-nickel (?) claim has been located about 2,000 feet northwest of the springs.

A hot spring is reported by Waring from Lisianski Inlet, but this spring was not found.