MARBLE RESOURCES OF THE JUNEAU, SKAGWAY, AND SITKA DISTRICTS.

By ERNEST F. BURCHARD.

INVESTIGATION.

In the autumn of 1912 the writer made an examination of the marble areas on Prince of Wales, Kosciusko, Marble, Orr, Tuxekan, Heceta, Ham, and Revillagigedo islands, and in the autumn of 1913 this work was extended to deposits on the mainland bordering Blake Channel, Stephens Passage, and Glacier Bay, on several islands in Glacier Bay, and on Chichagof and Admiralty islands. About nine weeks in all was spent in the field work of the two seasons, which involved cruising along about 1,500 miles of shore line in small gasoline launches. The results of the work completed in 1912 were published in Survey Bulletin 542,[1] and in the following pages notes are given concerning the occurrence of the deposits examined in 1913 lying north of Frederick Sound. The marbles of the whole area will probably be described later in more detail in a single bulletin.

The petrologic character of the intrusive and metamorphic rocks associated with the marble deposits was determined by J. B. Mertie, of the United States Geological Survey, and the writer herewith expresses his appreciation for this service.

TYPES AND DISTRIBUTION OF MARBLE.

Several types of marble are found in the Juneau and Sitka districts, including fine and coarse grained white, gray, and green marbles, schistose, banded varieties, and dense, noncrystalline limestone of various mottled colors. This paper will treat only of the macroscopic character of the marbles and will group the deposits geographically rather than by varieties, but it is expected that in the proposed bulletin the marble deposits will be described according to grades of fineness, because with the assistance of microscopic data,

[1] Burchard, E. F., Marble resources of Ketchikan and Wrangell districts: U. S. Geol. Survey Bull. 542, pp. 52–77, 1913.

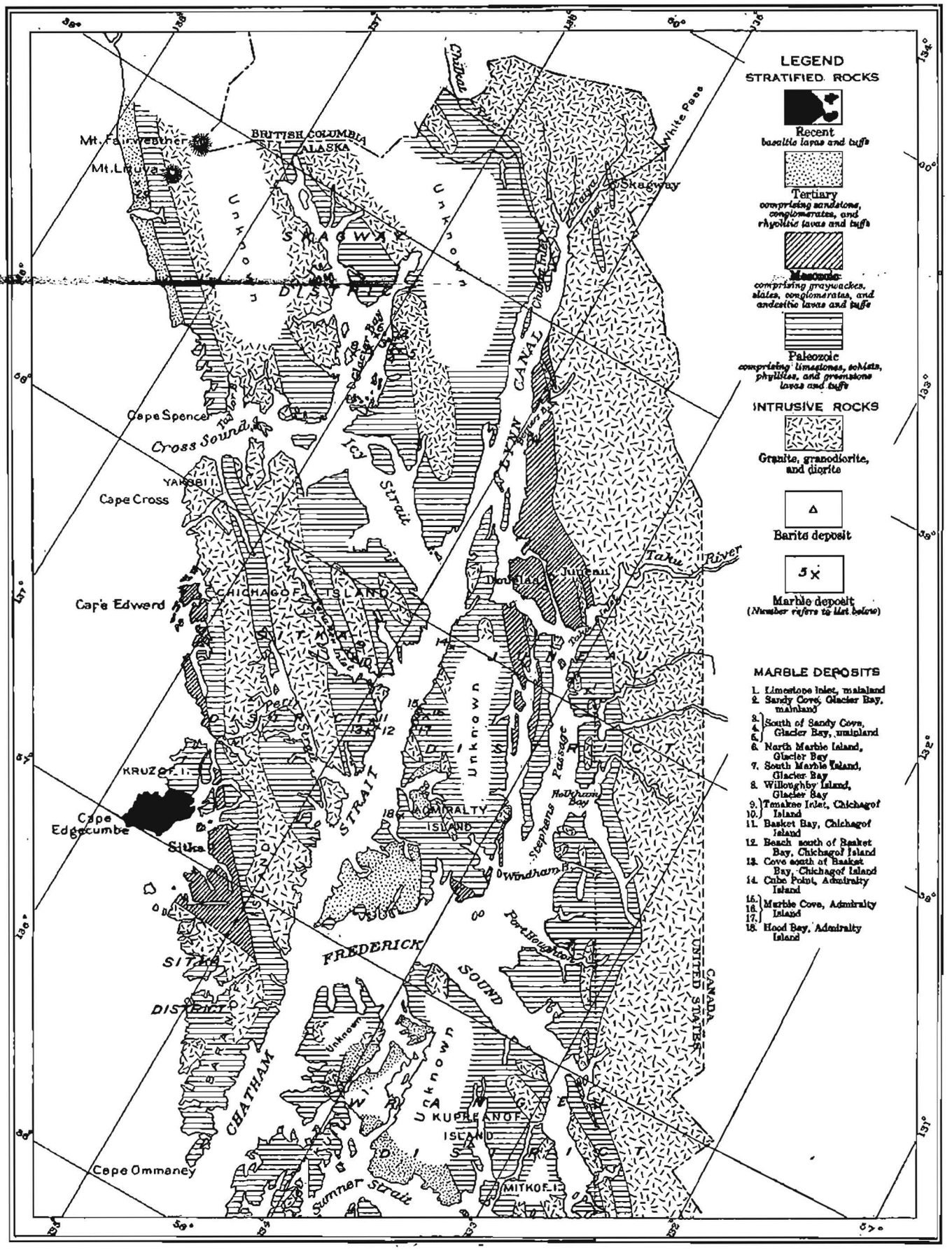
which will be available later, the marbles can be more accurately classified than they can be through visual examination. The following table gives a rough outline of the most important marbles noted in the reconnaissance of 1913. The terms fine, medium, and coarse, describing the grain, are here used rather loosely. A marble is described as having a fine grain if its grain is just visible to the unaided eye or if it is still finer. A coarse grain is one in which the grain diameters range generally between 0.5 and 2 millimeters. The medium grain falls between the fine and the coarse. These three grades correspond to the six grades established by Dale[1] in his study of Vermont marbles, which ranged, according to his classification, from extra fine to extra coarse.

Distribution of marble, by varieties, in Juneau, Skagway, and Sitka districts, Alaska.

Color.	Grain.	Locality.	No. on Pl. III.
White and nearly white.	Fine	Glacier Bay, south of Sandy Cove, mainland	3, 4
		South Marble Island	7
		Basket Bay, Chichagof Island	11
		Chichagof Island, cove south of Basket Bay	13
		Marble Cove, Admiralty Island	15
		Admiralty Island, Hood Bay	18
	Medium	South Marble Island	7
		Tenakee, Chichagof Island	10
		Marble Cove, Admiralty Island	17
	Coarse	North Marble Island	6
		Willoughby Island	8
		Tenakee, Chichagof Island	9
		Marble Cove, Admiralty Island	15
Gray	Fine	Glacier Bay, south of Sandy Cove, mainland	3, 4
		Basket Bay, Chichagof Island	11
		Cove South of Basket Bay, Chichagof Island	13
	Medium	Glacier Bay, Sandy Cove	2
	Coarse	Willoughby Island	8
		Marble Cove, Admiralty Island	15
White and gray, banded and veined.	Fine	South Marble Island	7
		Basket Bay, Chichagof Island	11
		Beach south of Basket Bay, Chichagof Island	12
		Cove south of Basket Bay, Chichagof Island	13
	Medium	Limestone Inlet, mainland	1
		Marble Cove, Admiralty Island	17
	Coarse	do	15
Schistose, varicolored bands.	Fine	do	15
	Medium	Limestone Inlet, mainland	1
		Point Hepburn, Admiralty Island	14
		Marble Cove, Admiralty Island	15
	Coarse	Tenakee, Chichagof Island	9
		Point Hepburn, Admiralty Island	14
		Marble Cove, Admiralty Island	15, 16
Mottled	Fine	Glacier Bay, south of Sandy Cove	3
		Tenakee, Chichagof Island	10
Green	do	Glacier Bay, east of Sandy Cove	5
Blue	do	Basket Bay, Chichagof Island	11

As shown in this table, masses of marble occur in places on the mainland in the Juneau and Skagway districts and on several of the islands in the Juneau, Skagway, and Sitka districts, including Chichagof Island, Admiralty Island and certain small islands in Glacier Bay. The approximate locations of the deposits described below are shown on Plate III.

[1] Dale, T. N., The commercial marbles of western Vermont: U. S. Geol. Survey Bull. 521, p. 54, 1912.



GEOLOGIC RECONNAISSANCE MAP OF THE JUNEAU, SKAGWAY, AND SITKA MINING DISTRICT.

TOPOGRAPHIC AND COMMERCIAL RELATIONS.

The mainland and islands of southeastern Alaska are generally mountainous, and there is little level land either as upland area or along the shores. Along much of the coast line the hills and mountains rise abruptly and the dense forest growth, extending down to the level of high tide, overhangs the steep banks. The islands are separated by an intricate system of waterways and fiords, known locally as straits, canals, channels, passages, sounds, narrows, inlets, bays, coves, and arms, some of which reach far inland. Many of these waterways are very deep and can be safely navigated by the largest ocean steamers, but some are so shallow as to be navigable only at high tide by boats of moderate draft. The coast and entrances to harbors are rocky, and in places the greatest care is necessary in order to avoid rocks that are barely submerged. The topography is so rough that only in favored localities or at great expense can wagon or tram roads be constructed. The waterways are therefore of great value in affording routes of communication between different portions of the region and between this region and the Pacific coast ports of the United States. Indeed, were it not for water transportation the mining and quarrying industries in southeastern Alaska could scarcely have been developed.

Some of the deposits of marble are situated on the shores of sheltered bays that are deep enough to afford anchorage or wharfage for ocean-going freight vessels. Others, however, are on rocky, exposed portions of the coast, and still others are a mile or more from the shore and at considerable altitudes. Naturally the deposits most convenient of access will be developed first. Freight rates have been much reduced in the last few years through competition, and are reported at present to be moderate.

The rock surface is in general thickly overgrown with small to medium-sized timber and dense underbrush and has a soil cover of decayed wood, moss, and mold, from a few inches to 3 or 4 feet thick as a rule, but thicker in hollows and crevices in the rock. The timber consists of hemlock, spruce, and cedar, which have in few places a maximum diameter of more than 4 feet. At the north, in the vicinity of Glacier Bay, the timber is much smaller but the underbrush is dense.

Several marble quarries have been opened in the Ketchikan and Wrangell districts, although only one is being operated on a commercial scale,[1] but as yet no quarries have been opened in the districts discussed in this paper.

GEOLOGIC RELATIONS.

Most of the marble beds in southeastern Alaska appear to be portions of extensive belts of limestone that have been metamorphosed

[1] U. S. Geol. Survey Bull. 542, pp. 52–77, 1913.

either at or near the contact of an intrusive mass of granodiorite or else by the general metamorphism of the region. Both the limestone and the marble are cut in many places by thin dikes, principally of basalt, andesite, dacite, and diabase, all more or less altered and containing secondary calcite, and in places the marble beds are interstratified with schists and lavas. The limestone beds associated with the marble masses are of Paleozoic age and at a few places, notably in northern Prince of Wales Island and vicinity, have yielded fossils that are regarded as Silurian or lower Devonian.

MARBLE DEPOSITS.[1]

LIMESTONE INLET.

The deposits of marble in the vicinity of Limestone Inlet are about 2½ miles inland from the mouth of the inlet, or 1 to 1½ miles from deep water (No. 1). Outcrops on the north bank of Limestone Creek consist of medium-grained grayish-white marble, banded in places with dark-gray streaks and veins of white calcite of coarser texture. Portions of the beds have a grayish-green color, possibly due to surface stains. Some parts of the mass are schistose and carry hornblende, mica, pyrite, and thin veins of quartz. The gray and green varieties are both susceptible of a fair polish. The marble is cut by two or more sets of joints into blocks from a few inches to 3 feet thick. The strike of the rocks is apparently between N. 25° W. and N. 30° W., and the dip is steep toward the northeast.

Two groups of marble claims have been located on this deposit, and two small prospect openings about 200 feet apart have been made near the creek bank. Between these two openings several natural exposures in the bank of the creek indicate the presence of schistose marble.

With the exceptions noted the marble deposit is covered by forest growth, and little could be ascertained as to its extent or structure beyond the indications afforded by the few exposures. In order to develop this deposit a tramway must be built from the property down the creek to deep water in Limestone Inlet, a distance of about 1½ miles. The cutting away of some rocky points and the building of half a mile or more of trestle would be involved in the construction of the tramway.

GLACIER BAY.

Limestone and marble deposits outcrop on the mainland on the east shore of Glacier Bay in the vicinity of Sandy Cove. Along the north shore of Sandy Cove (No. 2) marble is exposed for 600 feet or more, and the deposit extends back into a low ridge 50 to 75 feet above the

[1] In the description of the deposits the numbers in parentheses refer to corresponding numbers on Pl. III.

water. This marble is hard, of a light-grayish color, and generally of medium grain but contains many small bodies of calcite of varying size. Nearly obliterated traces of fossil brachiopods were noted in it. The marble is brecciated in places and has been disturbed by the intrusion of dikes. Some of the brecciated portions contain magnesium carbonate. The beds here are 3 feet or more in thickness, strike northward, and dip about 40° W. Where exposed the material is so jointed and fractured that little stone of commercial size is obtainable.

Bordering the east shore of the cove next south of Sandy Cove (No. 3) are beds of variegated marble and partly metamorphosed limestone. The colors include gray with bluish veins, cream with yellow veins, reddish, mottled chocolate and pink, and mottled grayish green and drab. The rock is fine grained, hard, and brittle and takes a good polish. It is generally much fractured at the surface, especially the gray limestone. Traces of stylolites or suture joints were observed in the gray marble. The beds strike about S. 50° E. and dip steeply toward the northeast. This belt of rocks is about 500 feet thick and extends an indefinite distance southeastward into the mountains. The bedding of the rock is variable, but for the most part the rock is fairly massive. Dikes of diabase cut the beds in east and northeast directions, and the jointing runs generally in the same directions. The ridge which the marble forms is about 50 feet high at its northwest end, where a low cliff has been cut by the stream that flows into the cove, but toward the southeast the ridge rises to 500 feet or more in height within a quarter of a mile.

Three claims, aggregating 3,960 feet in length, were at one time located on the strike of these beds, although little assessment work appears to have been performed. The really desirable and commercially valuable stone is probably scarce, and much prospecting will be necessary in order to establish its true extent and value.

The bold cliffs on both sides of the entrance to the cove next south of Sandy Cove and also extending southward from it (No. 4) are composed principally of fine-grained, hard, brittle, much-fractured gray limestone, cut by many diabase dikes generally 2 to 10 feet thick. Along the contacts between the limestone and the larger dikes the limestone has been locally metamorphosed to white crystalline marble, but not much marble of this sort is available.

In the float near the mouths of the two creeks that flow into this cove, which drain mountain glaciers, there are many bowlders of good white and veined marble, and in the canyon of the northern of the two creeks, at about a mile from the mouth of the creek (No. 5), an outcrop of fine-grained grayish-green, partly metamorphosed limestone 10 to 12 feet thick was observed.

Two islands in Glacier Bay, North Marble Island and South Marble Island, are composed wholly of marble, and others, such as Willoughby and Sturgess islands, show areas of limestone and marble. The two Marble islands lie about 12½ miles south of the entrance to Muir Inlet and are about 1½ miles apart. According to Coast and Geodetic Survey chart No. 8306, North Marble Island (No. 6) is about half a mile in length from north to south and its greatest width is less than a third of a mile. The highest point is probably about 300 feet above the sea. The marble exposed in this island is yellowish to grayish and is stained along fracture planes. The rock is medium coarse in grain and on weathered surfaces is generally soft and friable. Some portions of the rock are cherty; other portions are brecciated. Thin dikes of a dark fine-grained volcanic rock which appears to be altered spessartite cut the marble beds. The strike of the beds is nearly north. The rock has been jointed and in places shows small folds. The island has been glaciated, but weathering has been active and has produced through solution of material along joint planes and rounding of intermediate portions a bowldery appearance over much of the rock surface. Most of the rock is bare, but in crevices there is a thin cover consisting of mossy soil and vegetation, and hollows where loose material can find lodgment contain small quantities of glacial clay, gravel, and bowlders. The island is surrounded by fairly deep water, but the shores are abrupt and afford no harbor.

South Marble Island (No. 7) is similar in character to North Marble Island, but is a trifle longer, being about three-fifths of a mile in length. The maximum width is less than half the length, and there is one indentation where the island is nearly cut in two at high tide. The maximum height probably does not exceed 250 feet. The marble here is mostly fine to medium-grained white material, although there is a little that is veined with gray, and a little is brecciated. A few small inclusions of fine-grained nonmetamorphosed limestone were noted. The marble takes a good polish. The rock is cut by a few dikes of diabase ranging from less than 1 foot to 3 or 4 feet thick. The general strike is north, and joints cut the rock in several directions. These joints are so numerous as probably to interfere with quarrying the marble at the surface. It is possible, however, that all of them may not extend to great depths. Part of the surface is bare and part is covered to a depth of a few inches to 3 feet with glacial débris supporting a growth of mossy turf and shrubs. There is some shoal water in the vicinity of South Marble Island.

Willoughby Island (No. 8) is in the western part of Glacier Bay, about 13 miles north of Icy Strait. It is about 4⅓ miles in length and 2 miles in width, and reaches a height of nearly 1,600 feet. The

south half of the island is composed mostly of gray limestone. At about the middle of the east side a small area of marble projects into the bay. This marble is coarse grained, of cream and light-gray colors, and brecciated in places. Some patches of chert show on weathered surfaces. The marble is cut by dikes of greenish-gray micaceous, pyritiferous rock, probably dacite, and is jointed. In some places the joints are closely spaced, but in others there are masses of marble that show no joints for 20 to 30 feet. The gray brittle limestone south of the marble outcrop is closely fractured and jointed. The exposed marble extends for about 500 feet along the shore and rises to a height of 60 to 70 feet above the water. Near the shore the surface of the marble shows glacial grooves and striæ. Back of the wave-washed exposure there is a growth of shrubs and small trees.

CHICHAGOF ISLAND.

The eastern shore of Chichagof Island from Peril Strait northward to Icy Strait is composed largely of Paleozoic rocks, including limestone, sandstone, phyllite, schists, and greenstone lavas and tuffs. Between Peril Strait and Point Augusta there is considerable limestone and some marble. The most promising deposits were noted in Tenakee Inlet and in Basket Bay and vicinity.

TENAKEE INLET.

In the north side of Tenakee Inlet, from 1 to 2 miles east of Tenakee post office, marble is exposed at several places, in some of which it forms low bluffs 30 to 50 feet above the beach. There are also exposures on the banks of the large creek that flows into the inlet about a mile east of the village (No. 9). From a quarter to half a mile above the mouth of the creek the marble forms low steep bluffs. It is coarse grained and much fractured, and some of it is schistose. The color is mostly white, but some of it, especially the schistose parts, is white and green. This deposit was at one time located as a marble claim by persons sojourning at the Tenakee hot springs. On the beach (No. 10), about 1½ to 2 miles east of Tenakee post office, the marble exposed is brittle and hard and ranges from white to gray in color, some being gray and white banded, and there is also a little that shows mottlings of green and pink. It is generally of medium grain, but some, particularly the mottled stone, is fine grained. Specks of pyrite are present in places. The general strike of the rocks is northward, but the bedding is obscured by the folds and fractures, which are very prominent. The fractures are locally so close together that good hand samples can hardly be obtained from surface material. The marble is cut and impregnated by so much altered volcanic rock as to be of little value in some places, but

in others it may be possible to find material suitable for quarrying. Except where exposed on the beach and in stream cuttings the marble is concealed by a heavy forest growth.

BASKET BAY AND VICINITY.

Basket Bay (No. 11) is a short, narrow arm of Chatham Strait about 8 miles south of Tenakee Inlet. Although only about a third of a mile wide and 1½ miles long, it affords good anchorage and good protection to vessels. The marble in the vicinity of Basket Bay is chiefly of fine grain. With reference to color there are four principal varieties—gray, gray and white banded, white, and dark blue with calcite streaks. On the southwest shore of the bay the marble is exposed almost continuously. Here the rock is massively bedded but weathers to thin spalls. The strike is N. 30° W., and the dip is steep toward the northeast. Myriads of small fractures cut the surface rock into small rhombohedral blocks, and the seamed condition extends up into the bluffs back of the bay. The marble is cut and impregnated in many places with seams of altered hornblende andesite. There is probably an enormous quantity of marble in this vicinity. The deposit on the southwest shore of Basket Bay appears to extend to the top of the 2,400-foot peak southwest of the bay. The 4,000-foot mountain to the northwest, 4 miles from the head of the bay, appears to be composed of limestone or marble. This was not proved, but the appearance of the weathered summit and slopes strongly suggests calcareous rock, and the mountain is directly in the line of strike between the Basket Bay and Tenakee marble areas.

Marble beds form the shore of Chatham Strait southward from Basket Bay to the next small cove, a distance of more than a mile. Some of the marble exposed here (No. 12) is of excellent quality and is susceptible of a good polish. It is all fine grained and is generally banded with bluish gray and white. The beds strike N. 30°–35° W. and dip steeply toward the northeast. The rock is cut by many minute fractures above tide level, has been closely folded, and commonly shows flow structure. Small faults are strikingly brought out on polished surfaces. The banding, the folds, and the flow structure are beautifully shown on the wave-scoured beach. Nowhere, however, is the marble for any considerable distance free from joints or from basaltic dike material. The bluffs are steep here and are surmounted with forests.

At the point (No. 13) on the north side of the small cove mentioned above the marble is mostly fine grained and white, although there is a little interbedded light gray. It is rather soft and friable above tide level in the cliffs, where it has been subjected to severe exposure, but it presents a handsome appearance. The characteristic jointing, fracturing, and intrusion by dikes have affected the beds

here in no less degree than in other places along this shore. At the head of the cove is exposed a fine-grained gray and white banded marble, which was traced three-quarters of a mile or more up the creek that empties into this cove. The beds are massive where unweathered, as, for instance, below high-tide level or below the level of the creek, but they show much fracturing where exposed to the weather. This condition suggests that the action of frost may have played an important part in opening fractures caused by strains. Flow structure and beautiful examples of folding are common. The whole area seems to have been impregnated with thin dikes of hornblende andesite and stringers after the folding occurred.

In order to definitely appraise the value of this interesting area of marble, considerable prospecting with the core drill will be necessary, trails must be cut into the interior, and the marble must be explored on the slopes of the mountains.

ADMIRALTY ISLAND.

The shores of Admiralty Island from Mansfield Peninsula to Chaik Bay and from Pybus Bay to the head of Seymour Canal are made up largely of limestone and schist. The general distribution of rocks along the shore line of this island is shown in Plate XXXIII of Bulletin 287,[1] although slight modifications should be made in this map as a result of recent observations. For instance, the "Marble Bluffs" on Chatham Strait, nearly opposite Tenakee Inlet on Chichagof Island, have been found to be composed of quartz monzonite, a light-colored granite rock, instead of marble, as heretofore popularly supposed. In parts of the limestone belts the limestone has been metamorphosed to marble, some of which is of good quality and some of which is schistose. Exposures of marble were examined on the west shore between Cube Point and Point Hepburn, also south of "Marble Bluffs" and in Hood Bay, and search for marble was made at many intermediate points and in Pybus Bay.

POINT HEPBURN.

From 1 to 1½ miles north of Point Hepburn (No. 14) extends an area of medium to coarse grained schistose marble, which is white with gray, green, and black schistose bands. It includes nodules and lenses of fine-grained rock that probably contain magnesium carbonate. In places along the schistose planes pyrite is abundant. The rock occurs generally in beds 2 to 5 feet thick, but owing to the schistose structure it weathers to thin bands on the edges of the beds. The

[1] Spencer, A. C., The Juneau gold belt, Alaska; and Wright, C. W., A reconnaissance of Admiralty Island, Alaska: U. S. Geol. Survey Bull. 287, 1906. This bulletin is out of stock at the Survey but may be purchased from the Superintendent of Documents, Washington, D. C., for 75 cents.

beds are cut by quartz veins and are interbedded with green schist. The rock takes a fair polish, but owing to the presence of the schistose bands the polish is uneven. The beds strike N. 50° W., and stand almost vertical. There has been some close folding, but for the most part the bedding or schist planes are flat. This exposure forms a low bluff for about half a mile along Chatham Strait, and the direction of strike carries the beds into a prominent ridge toward the southeast. On the beach the beds are not well situated for quarrying, as the bluff is steep and high tide reaches its base, but if the quality of the material should warrant exploitation, a quarry could probably be opened in the slope of the ridge and the product trammed to the cove near Point Hepburn, where anchorage for boats of medium draft is available.

MARBLE COVE AND VICINITY.

On Chatham Strait from 2 to 4 miles south of "Marble Bluffs," 1 mile north of a small notch in the shore which will here be called Marble Cove, is a deposit of marble possessing considerable scientific interest and possibly some commercial value. At this locality (No. 15) the marble is interbedded with bands of gray and green mica schist and white to gray, variously banded quartzite. The marble layers range from 1 inch to 3 or 4 feet in thickness. The schist bands are generally 1 inch to 5 or 6 inches thick, and some of the bands of quartzite are a little thicker, but rarely exceed 1 foot. The marble is medium to coarse grained and is gray, white, pink, and green. All of it is susceptible of a fair polish, and the quartzite takes a glassy polish. The beds strike N. 60°–65° W. and are nearly vertical. They are cut by small dikes of dark-green hornblende dacite which send out stringers between the schistose layers. Folds are also exhibited by the varicolored bands. This outcrop is exposed in a strip about 50 feet wide along the beach for a quarter of a mile or more and is partly submerged at high tide. It is bounded by a bluff which also contains alternate bands of marble and schist, the latter predominating. In strike with these beds, 1 to 1½ miles toward the southeast (No. 16), a similar body of banded marble, schist, and quartzite is exposed by a steep mountain stream.

The wave-washed beach exposures of this banded rock afford some sections of very attractive material, and if it can be quarried advantageously it should be possible to obtain a large quantity of material here that might be suitable for certain classes of interior decorative work. The matter of sawing and polishing this rock, which consists of alternating bands of material of variant degrees of hardness, is not so simple as in the case of a more homogeneous rock. However, large blocks of similarly banded schistose marble found on Moira

Sound, Prince of Wales Island, have been cut and polished and yielded very handsome finished slabs.

About a quarter of a mile to a third of a mile north of Marble Cove occurs another strip of attractive marble. The beds here also strike N. 60°–65° W. and stand nearly vertical. The total width (or thickness) of the exposure is 115 to 130 feet. It extends 500 to 600 feet along the beach and in places forms a bluff 40 feet high. From 40 to 50 feet of these beds at the northeast side consist of medium-grained gray marble, closely banded with thin dark-gray layers. The southwest 75 to 80 feet is coarse-grained yellowish-white and greenish-white marble. Dikes of basaltic rock cut the beds, but not so closely as to seriously interfere with quarrying.

At the north side of the entrance to Marble Cove is exposed a fine-grained white marble. The rock strikes N. 60°–65° W. but is so badly fractured that the bedding is indistinct. The quantity of this grade of stone seems to be small, as the material passes toward the north into coarser yellowish marble.

Another deposit of marble was noted on this part of the Admiralty Island shore (No. 17) about a third of a mile south of Marble Cove, just south of the mouth of a large creek. The marble is of medium grain and comparatively hard. Some of it is white and some is white and gray banded. Both varieties take a good polish. The outcrop extends for half a mile or more along the beach and forms a bluff about 50 feet high, back of which is a flat wooded terrace several hundred feet wide, developed on the marble. The marble at the base of the bluff is of a dazzling white color, having been smoothed and polished by the surf. The rock is massively bedded and strikes northwest. Joints and dikes cut the beds, but not closely enough to interfere with quarrying. A quarry could probably be opened conveniently on the terrace above the beach, but as there is no harbor at this point boats could be loaded only at times of calm water.

Adjoining this deposit on the south is an area of altered quartz diorite, shown on Plate XXXIII of Bulletin 287 as extending southward nearly to Parker Point. South of Parker Point to Chaik Bay is an area in which schist predominates and in which no desirable marble was noted except at Hood Bay.

HOOD BAY.

Some fine-grained white marble was noted in two places on the northeast shore of Hood Bay (No. 18), almost due east of Distant Point. In hand samples this is a very beautiful marble which takes a good polish, but its availability in large blocks and in large quantity is questionable. The marble is associated with schist and becomes

schistose in the direction of the strike, which is apparently N. 70° E. The beds are rather slabby and dip about 20° SE., although the angle of dip is variable. The surface rock is jointed into small rectangles, a few inches to 2 or 3 feet across. Veins and eyes of quartz were noted in the marble. The first exposure measured about 500 feet between its borders of schist and possibly 100 feet on the strike, between mean tide level and the wooded bluff. When traced up the hill the texture was found to become schistose. At the second exposure, about a quarter of a mile to the southeast, the material is similar in character, but has been much fractured and carries considerable quartz in eyes and veins.

SUMMARY.

Factors controlling value.—The value of a marble deposit in southeastern Alaska can not be judged by small surface samples alone, although tests of such samples may be of considerable significance. The character of the deposit as a whole, or at least so much of it as will be required for a quarry, must be considered, as well as extent, color, lack of objectionable impurities, such as silica, pyrite, and argillaceous or organic matter, soundness, absence of fractures or joint planes and of intersecting dikes, facility of quarrying and loading on vessels, distance and freight rates to markets, and competition.

The feature that will probably cause the most serious hindrance to profitable quarrying in southeastern Alaska is the fracturing and jointing of the beds. Observations have shown that this condition is very prevalent at the surface in this region, and such quarrying as has been done has shown that the cracks extend 60 feet or more below the surface. It is, of course, possible that at greater depths sounder stone will be found, but it is not profitable to be obliged to reject a large percentage of waste simply because the percentage of available blocks of the requisite size is limited by the structure of the deposit. The excessive moisture and the influence of the dense vegetation in this region have softened the surface marble in places to surprising depths compared with those in other well-known marble regions.

The practical judgment of a competent marble quarryman is necessary to decide many of the questions relating to the availability of the stone. Cross trenching, a common form of prospecting to determine the surface extent of a marble deposit, must be supplemented in southeastern Alaska by the core drill. A careful study should be made, at the surface, of the directions or strikes of the various systems of joints, their minimum, maximum, and average spacing, the direction and angle of their dip, and the nature of the fracturing that is not related to the systematic jointing. A sufficient number of holes should then be drilled to such depths and in such direc-

tions that a definite idea may be obtained as to the character of the beds below the surface, especially in relation to fracturing and jointing and the hardness of the marble.

Tests of the cores, including chemical analyses, measurement of size of grain, absorption, porosity, compressive strength, and polish, are all of great value, but satisfactory tests for strength and polish may not be practicable unless the core is 2 inches or more in diameter.

Deposits of possible economic importance.—While some of the deposits of marble described in this paper possess elements of possible value, not all of them seem to warrant prospecting, and even those which have appeared most favorable on cursory inspection may prove on prospecting to be totally unfit for exploitation.

Of the deposits whose surface appearances suggested that further investigations might be warranted whenever the demand for marble on the Pacific coast exceeds the present production, the white to white and gray, moderately coarse grained marble a third of a mile south of Marble Cove, on the Chatham Strait shore of Admiralty Island (No. 17), seems to rank first. The terrace form of this deposit suggests a favorable site for a quarry. There is an abundance of timber and fresh water here, and although the harbor near by is small, breakwaters and docks could be constructed that would afford protection and facilities for loading vessels. Next in importance to this deposit is the white and gray banded marble in the vicinity of Basket Bay and the neighboring cove to the south, on Chichagof Island (Nos. 11, 12, 13). As is suggested on page 102, there appears to be a very large body of marble in this vicinity, and the larger the deposit the better should be the chances of finding a portion of it workable.

Limestone Inlet opens directly on one of the highways of travel, Stephens Passage, and is close to a base of supplies at Juneau; therefore, although the surface appearance of the marble 1 mile above the head of this inlet (No. 1) does not suggest a high quality of stone, it is possible that the hope of finding a good marble deposit in this advantageous location may warrant more thorough prospecting.

As to the remaining deposits little encouragement can be given regarding the possibilities of their exploitation under present conditions. For special ornamental purposes, where cost is a minor consideration, some very unusual marble may be obtained from the schistose deposits on Admiralty Island near Point Hepburn and north of Marble Cove, but it is doubtful whether these deposits can now be quarried profitably. About the shores and islands of Glacier Bay there are indications of an abundance of marble, but it is probable that the uncertainties of navigation in this bay and the scarcity of large timber will long retard active quarrying there.