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This report was taken from a report "Limestones of the Pacific Northwest" by Edwin T. Hodge, industrial raw materials consultant. It was made on September 1, 1944 for the Bonneville Power Administration.

SOUTHEASTERN COASTAL ALASKA LIMESTONE TERRAIN

INTRODUCTION

Many limestone and marble deposits occur adjacent to the coast of southeastern Alaska, of which more than 56 locations are noted in this report. The information upon which this report is based is taken largely from government reports and except for Dall Island no private commercial reports were available.

The reports deal at length with the scientific problems, especially the stratigraphy of the limestones. However, data upon quarry sites, purity and tonnage are meager or non-existent. The only interest in these deposits has been for their availability as sources of marble, and since the marbleized limestone is apt to be dolomitic and to carry injurious minerals introduced during the act of recrystallization, such information serves this report only to locate limestone possibilities.

The islands are tops of a submerged mountain range, and fronting the coast is the high barrier of the Coast Range, which is indented by long, deep fiords (or arms, channels, reaches, etc.). The barrier range prohibits consideration of any limestone deposits lying beyond it. However, the fiords furnish deep water navigation to limestone deposits that lie deep in the heart of the Coast Range.

The marbles have resulted from the pressures induced by strong deep-seated folding of old rocks (Devonian or older) and have the effect of cross-cutting igneous rocks. Adjacent to the marble areas, however, are unaltered limestones, in many places in great bodies and rarely of high chemical purity.

TRANSPORTATION

All of the limestone deposits herein recorded lie close to tidal waters. Many of the limestones outcrop as cliffs on the shores of sheltered waters where good quarry sites may be found and safe and economical wharfage is available.

The boats serving southeastern Alaska touch at many points and few of these boats make direct runs between Portland, Astoria, Tacoma or Seattle to an Alaskan port. Consequently, the usual tables in only a few cases give direct mileage. Indeed, for most of the localities listed in this report no reference at all is made to them in published navigation tables. Therefore, the nautical miles herein given are calculated and are only approximations of the true mileages.

The table compares all of the mileages. These mileages are also stated in the body of the report for each locality.

Nautical Miles from Limestone Deposits to United States

Place of Origin	Passage	Destinations			
		Seattle	Portland	Astoria	Victoria
Seldovia	Inside	1,471			
	Outside	1,297	1,391		
Port Graham		The same less 13			
Yakutat	Inside	1,105			
	Outside	997	1,096		
Glacier Bay		995	1,197	1,108	895
View Cove		770	920		

Mileages to Seattle

	Miles	
Brittisham	865	
Berners Bay (Jualn): Inside, 815; Outside,	912	
Grebier	837	
Lynn	813	
Tenakee Inlet: Inside, 933; Outside,	976	
Freshwater Bay - Tenakee plus 14		
Hoonah Bay - Tenakee minus 14		
Herbert Graves Island - via Juneau	1100	
Thomas Bay	793	
Hamilton Bay	843	
Duncan Canal	774	
Holly Arm	744	
Kuiu Island	843	
Seginaw Bay	857	Via Petersburg 867
Port Cornwallis	857	
Kan Island	746	
Wrangell Postoffice	745 - 778	
Carrol Inlet	768	
George Inlet - via Ketchikan	778	
Thorn Inlet	760	
Screen Islands	778	
Gravina	668	
Hasaan	701	
Clover Bay	668	
Chalmondeley Sound	655	
Delmi Postoffice	651	
Moira Sound	651	
Sulzer Postoffice	690	
Copper Mountain	685	
U. S. Boundary	612	
Klawak	789	
Tonowak	790	
Shakaan	812	
La Bouchere Bay	832	

	Miles
Red Bay	836
Edna Bay	804
Tokeen	826
Orr Island	824
Tuxekan Island	830
Heeeta Island	835
Hawkan Village	742

QUALITY AND COMPARISONS OF THE COMPOSITION OF THE LIMESTONES

Fairly satisfactory analyses are available for only one deposit (Dall Island at View Cove) and in this case the analyses were made of the limestones as cement rock. The few other analyses give little more than the calcium carbonate content. For purposes of comparison the following table of composition is offered, with the numbers on the left margin referring in all cases to locations on the maps.

Comparison of Composition of Limestones of Southeastern Alaska

		$CaCO_3$	$MgCO_3$	Insolubles
4	Glacier Bay, south of Sandy Cove, mottled marble	96.16	0.89	2.56
12.	Admiralty Island, north side of Marble Cove, white marble	61.11	39.10	0.91
15.	Chichagof Island, Basket Bay, graphitic marble	63.68	8.90	28.19
21.	Beauclerc			
22.	Kuiu Island, bluff of Permain limestone at southeast end of island opposite the cannery on the east side of Saginaw Bay	96.82	0.63	2.79
22.	Kuiu Island, about 3 miles southwest of Point Cornwallis on Keku Straits, Triassic limestone	87.19	0.84	11.32
24.	Lake Virginia, mainland, east of Wrangell, Talcose marble	53.69	26.10	19.06
32.	Prince of Wales Island, Dickman Bay, marble	74.61	3.25	22.84
32.	Prince of Wales Island, Dickman Bay, dark-green marble	58.40	6.61	37.32
33.	Prince of Wales Island, near Jumbo mine, Copper Mountain region, limestone	82.75	15.62	1.84
36.	Marble Cove, north of Shakaan	99.26	0.30	trace
	Fe_2O_3 and SO_3 - trace; CaO, 55.59; MgO, 0.30; CO_2, 43.67; undeterminable, 0.44.			
39.	Prince of Wales Island, head of Red Bay, marble	96.90	2.59	1.70
43.	Marble Island, Tokeen, white marble	99.51	0.94	0.01
	Orr Island	95.90	1.40	3.50
	Orr Island	95.35	2.04	2.95

		$CaCO_3$	$MgCO_3$	Insolubles
44.	Orr Island, southwest end, limestone	98.99	1.01	0.12
45.	Hecata Island, north side, limestone	99.12	0.63	0.37
55.	Dall Island, near Waterfall Bay, marble	99.59	1.03	0.32
	Dall Island, average of all shipments to 1937 from View Cove	94.5		

Dall Island, View Cove, Range of Analyses

	A	B
SiO_2	1.22	1.09
Al_2O_3, Fe_2O_3	0.97	0.42
CaO	54.95	53.87
MgO	0.49	0.69
Ignition loss	42.33	42.37
$CaCO_3$	97.83	98.60
$MgCO_3$	trace	1.71	0.45
Soluble matter	0.04	0.84
Total	100.00	99.28

Analyses 4, 12, 15, 43 and 45 made by R. K. Bailey for E. F. Burchard; analysis 22 by J. G. Fairchild for A. F. Buddington; analysis 39 by E. F. Lass for the Alaska Marble Company; analysis 33 by George Steiger for C. W. Wright.

The above analyses were published in "Geology and Mineral Deposits of Southeastern Alaska" by A. F. Buddington and Theodore Chapin, U. S. Geological Survey Bulletin 800, 1929, page 393.

Analysis 55 was made by Pacific Coast Cement Company.

COSTS

The costs of quarrying in Alaska will be higher than in the United States because of seasonal limitations, the cost of shipping supplies and higher labor costs. The costs given for Dall Island will be fairly representative of postwar costs because the improved technologies will probably offset any other postwar mining expenditures.

For purposes of calculation it is assumed that a quarry will be operated on a large scale and the limestone will be loaded into large ore-boats at 50 cents f.o.b. boat.

The Dall Island haulage costs have been about 1.2 mills a ton per nautical mile, but it is reasonable that the costs might be reduced to one mill per ton per nautical mile.

RECOMMENDATIONS

The deposits recommended for consideration should be examined commercially as a second order of business after the British Columbia deposits have been examined.

These Alaska limestones will be the lowest cost limestones available under the following conditions: (1) If tariff or other barriers to a free movement of limestone across the International Boundary continues to exist or appears to be a probable hindrance; (2) if commercial examination indicates that the known large bodies of limestone in Alaska are available in large quarry units of uniform high purity to serve not only the chemical industries, but, in addition, to serve all other users of limestone; (3) if conditions (1) and (2) are not, the same organization will be justified in opening a large quarry, using large ore-boats and setting up large receiving bins in Washington and Oregon to supply the very great market for agricultural and industrial limestone that exists. The market will grow rapidly as soon as a source of low-cost, high-quality limestone is dependably available.

INDEX TO PLATE 1

COASTAL ALASKA LIMESTONE TERRAIN

1. Seldovia, Kenai Peninsula, north shore.
2. Port Graham (Bay), Kenai Peninsula.
3. Cape Enchantment, Marble Point, Russell Fiord, Yakutat Bay.
4. Glacier Bay.
5. Berners Bay, on mainland, east side of Lynn Canal.
6. Port Snettisham, on mainland east of Admiralty Island.
7. Brides Point, north arm of Port Snettisham.
8. Whiting River, head of Port Snettisham.
9. Tracey Arm, extension of Holkham Bay.
10. Fords Terror, north branch of Endicott Arm.
11. Dawes Glacier, head of Endicott Arm.
12. Marble Cove, Chaik Bay, Pybus Bay and Gambier Bay, Admiralty Island.
13. Admiralty Island, opposite Tenakee Inlet.
14. Freshwater Bay, Chicagof Island.
15. Basket Bay, Chicagof Island.
16. Herbert Graves Island, west of Chicagof Island in Salisbury Sound.
17. Thomas Bay, mainland east of Kupreanof Island.
18. Hamilton Bay, Kupreanof Island.
19. Duncan Canal, Emily Arm, Kupreanof Island.
20. Kuiu Island in Keku Strait.
21. Beauclerc, Edwards Island, Kuiu Island.
22. Saginaw Bay, Point Cornwallis and Peninsula, Kuiu Island.
23. Wrangell Island, Ham Island and Bradfield Channel in mainland.
24. Lake Virginia, east of Wrangell.
25. George Arm, Carroll Inlet and Thorne Arm, Revillagigedo Island.
26. Screen Island, and Kaswarof group, Clarence Strait.
27. Cravina Island in Clarence Strait.
28. Kasaan, Prince of Wales Island.
29. Clover Bay, Prince of Wales Island.
30. Chalmondeley Sound, Prince of Wales Island.
31. Dolomi, Prince of Wales Island.
32. Dickman Bay, Meira Sound (north arm), Shamrock Inlet (south arm), Prince of Wales Island.
33. Hetta Inlet, Sulzer (head of inlet), Copper Mountain (east side of inlet), Prince of Wales Island.
34. San Alberto Bay, opposite Klawak, Prince of Wales Island.
35. Tonowak Bay, east side of Tuxekan Passage, Prince of Wales Island.
36. Marble Cove, Calder region, north of Shakaan.
37. Labourchere Bay, Prince of Wales Island, Port Protection.
38. Point Baker, Prince of Wales Island.
39. Red Bay, head of, Prince of Wales Island.
40. Aneskett, Kosciusco Island.
41. Shakaan Bay, Pyramid Peak, Kosciusco Island.
42. Edna Bay, southwest shore, Kosciusco Island.
43. Marble Island, Davidson Inlet, Tokeen, south of Kosciusco Island.
44. Orr Island, also Hoot, Green and Owl islands, between Kosciusco and Prince of Wales islands; also Sea Otter Sound.
45. Tuxekan Island, north side.

46. Stanley Island in Tuxekan Passage.
47. Haceta Island.
48. Barrier and Round islands, in Cordova Bay, between Prince of Wales Island and Dall Island.
49. Long Island.
50. Hawkon Village to Waterfall Bay, Dall Island.
51. View Cove, Dall Island.
52. Breezy Bay in Tlevak Strait.
53. Diver Island, in Hearse Passage off Dall Island.
54. Cape Lookout, Dall Island.
55. Waterfall Bay and Cape Augustine, Dall Island.
56. Port Bazan, Dall Island.

THE DEPOSITS

Limestone occurrences which appear from the record to be large and to have a purity of 98+% $CaCO_3$ and where the estimated cost of delivery in bins at Portland will be not more than $2 are shown below.

Note: The reference number refers to location designations on accompanying maps.

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16. Herbert Graves Island, west of Chicagof, 57° 40' N.; 136° 15' W. See Kuiu Island for Edwards Island.

Rocks: On southwest side of island opposite mouth of Kukkan Bay; Silurian limestone on Edwards Island.

Quality: Pure.

Commercial Considerations: Thick; via Juneau to Seattle - 1100 miles.

20. Kuiu Island in Keku Strait.

Rocks: Permian limestone.

Commercial Considerations: To Seattle, 843 miles.

21. Beauclerc Peak and range of mountains along southwest side.

Quality: Pure limestone.

21. Edwards Island in Port Beauclerc.

Rocks: Silurian limestone.

Quality: High-grade.

Commercial Considerations: Thick.

22. Saginaw Bay, bluffs along east side opposite cannery.

Rocks: Pre-Silurian.

Quality: Intercalated beds of chert but pure limestone is present.

Commercial Considerations: 1,000 feet thick.

22. Head of Saginaw Bay, on northeast side.

Rocks: Limestone cut by diorite dikes; strikes inland to southwest.

Quality: $CaCO_3$, 96.82; $MgCO_3$, 0.63; insoluble, 2.79.

Commercial Considerations: To Seattle, 857 miles via Petersburg, outside passage, 867 miles.

26. Prince of Wales Island. Description starts at the northeast, goes south, west and on around island. Adjacent islands mostly given separate descriptions.

Clarence Sound (Strait) Islands, Kaswarof group, Screen Island.

Rocks: Silurian.

Quality: Pure limestone.

Commercial Considerations: Thick. To Seattle, 675 miles.

35. Tonowak Bay, east side of Tuxekan Passage.

Quality: Pure.

Commercial Considerations: Thick. To Seattle, 790 miles.

36. Calder Region. Limestone occurs in Calder Range and extends northward to Labouchere Bay. Vermont Marble Company.

Rocks: Pre-Silurian. Marble belt 3,000 feet wide strikes northwest and dips southwest, extends south across Dry Pass to Marble Island; cut off on northeast and just back of Shakaan by granite. To northwest crosses Calder Bay and reappears to north and beyond. Cut by diabase dikes which contain pyrite and pyrrhotite.

Quality: Pure. Marble Creek, north of Shakaan.

SiO_2	trace
* R_2O_3	trace
CaO	55.59
MgO	0.30
$CaCO_3$	99.26
$MgCO_3$	0.63
CO_2	44.67
Insolubles	trace
	100.56

* R_2O_3 includes Fe_2O_3 + FeO + Al_2O_3.

Commercial Considerations: Limestone beds 100 - 1,000 feet thick. Calder quarry on south side and near head of Marble Creek. Quarry connected with deep water at Marble Cove by tram (1935). Elevation, 100 feet. To Seattle, 812 miles.

Dry Pass, 25 miles long, extends east from Calder and Shakaan Strait to El Capitan Strait. El Capitan Marble Co.; Vermont Marble Company.

Rocks: Limestone occurs on two small islands and at the north side of the entrance. Pre-Silurian in age. Part of a large area covering Prince of Wales and adjacent islands. Extends north to Red Bay and south to Marble Island. Associated with greenstones, schists, and gneisses. Strike: N. 60° E. Cut by dikes which have marbleized adjacent limestone. Forms bluff 200 - 400 feet high.

Dry Pass, continued.

Quality: Uniformly pure crystalline marble, white to blue-gray limestone; some quartz seams.

Commercial Considerations: Quarries at 100-foot elevation.

37. Labouchere Bay.

Rocks: Silurian limestone extends from Calder to Labouchere and includes Point Protection, Point Baker and Red Bay.

Quality: Pure.

Commercial Considerations: Thick. To Seattle, 832 miles.

38. Point Protection, east side.

39. Point Baker. Along coast and for 1½ miles to east.

40. Koscuisko Island.
Aneskett, easternmost point, 56° 9' N.; 133° 16' W.

Rocks: Silurian limestone covers most of the island; jointed and sheared; cut by dikes which have produced marbleizing effects.

Quality: Gradually changes to marble from Aneskett westward; limestone dense, massive, nodular and shaly; 95-99% $CaCO_3$; some contact metamorphic minerals.

Commercial Considerations: Large, thick. Quarries. Port of occasional call by steamers.

Sarhini (Sarheen) Cove, west of Aneskett and on north side of island.

Rocks: Same as above.

Quality: Same as above.

Commercial Considerations: Same as above.

Klawak Passage, between Koscuisko and Calder. El Capitan Mining Company (Seattle).

43. Marble Island, in Davidson Inlet and south of Koscuisko.

Rocks: Extension of Shakaan belt; developed quarries; associated with gneisses and schists.

Commercial Considerations: Island 3 miles east-west, 4 miles north-south. Elevation 1,528 feet.

Tokeen, northwest shore. Vermont Marble Company.

Rocks: Belt 2,500 feet wide extends southeast across Orr Island. Dip: 38° - 40° N.E., much jointed, cut by andesite and porphyry dikes.

Quality: Dark-blue limestone altered to marble; much pyrite.

	White Marble	Veined Marble
$CaCO_3$	99.51	81.90
$MgCO_3$	0.94	14.93
Insoluble	0.01	0.20
Total	100.46	97.03

Commercial Considerations: Quarry near wharf. To Seattle, 826 miles.

Marble Island, southeast of Tokeen, 1 - 1½ miles.

Rocks: Marble as at Tokeen.

43. Davidson Inlet and islands therein; south and southwest of Marble Island.

Commercial Considerations: Thick. To Seattle, 790 miles. Head of Eagle Harbor - pure.

43. White Cliff, 55° 55' N.; 133° 29' W.

Quality: Pure.

Commercial Considerations: Thick.

Orr Island, between Davidson Inlet and Sea Otter Sound. Mission Marble Company.

Description: Marble covers most of island, 25 feet above high tide level; much jointed. Strike: N.W.; steep dip.

Quality: Pure.

	1.	2.	3.
$CaCO_3$	95.90	95.35	98.99
$MgCO_3$	1.40	2.04	1.01
Insoluble	3.50	2.95	0.12
Total	100.80	100.34	100.12

1. Veined marble.
2. Dark marble.
3. Limestone at southwest end of island.

Commercial Considerations: Quarry at water's edge, but must be moved by scows one mile to deep water.

47. Hoceta Island.

Rocks: At middle of north side of island.

Quality: Mottled, fine-grained, dense, hard limestone.

$CaCO_3$	99.12	84.46
$MgCO_3$	0.63	13.18
Insoluble	0.37	3.18
Total	100.12	100.82

Commercial Considerations: At edge of small bay and 50 feet above high tide level. To Seattle, 835 miles.

48. Cordova Bay, southwest side of Prince of Wales Island between Prince of Wales and Long islands; Barrier Island.

Rocks: Silurian.

Quality: Pure.

Commercial Considerations: Thick.

49. Round Island, east side of Long Island, 54° 47' N; 132° 32' W.

Rocks: Pre-Silurian and Silurian.

Quality: Two belts strike northwest into Dall Island.

Commercial Considerations: Pure and thick.

Dall Island, northern part is called Quadra. Deposits which have been demonstrated to contain a large volume of high-grade rock. It is recommended, however, that investigations be made to determine if by selective mining a substantial amount of limestone bearing 98% $CaCO_3$ or better and low in compounds contre-indicated in the chemical industries is available.

50. Hawkon Village; belt strikes northwest to Waterfall Bay.

Rocks: Pre-Silurian associated with schists, gneisses and greenstones.

Quality: Limestone grades into dolomitic marble.

51. View Cove; Pacific Coast Cement Co., S. E. Hutton, manager, 1003 Seaboard Bldg., Seattle. Operated by Pacific Coast Cement Co. The property consists of 40 acres of high-grade limestone leased from the U. S. government, containing millions of tons of very uniform rock.

Rocks: Limestone strikes northwest to Cape Lookout.

Quality: Limestone proven by drilling to be uniform in composition and ranging from 95% to 99% $CaCO_3$ and to average 97.5%. Phosphorus ranges between 0.004 and 0.013%.

	1.	2.	3.
SiO_2	1.22	1.09	
Fe_2O_3 } Al_2O_3 }	0.97	0.42	
CaO	54.95	53.87	
MgO	0.49	0.69	
$CaCO_3$	96.13	-	94.5
Ig. Ls.	42.33	42.37	

1 and 2 = Range of many analyses.
3 = Average of several years' shipments.

Commercial Considerations: Nautical miles from Dall Island (View Cove) to Ketchikan, 65; Prince Rupert, 115 miles; Seattle, 770 miles; Portland, 920 miles.

The limestone is carried 770 miles to Seattle in 6,200-6,400-ton cargoes in a towed hull. The monthly capacity of approximately 25,000 tons is dependent largely on weather conditions. Shipments can be made the entire year except perhaps in February. About 100,000 tons are shipped a year, which are crushed at Seattle to 3/4-inch size. From 8 to 10 days are required for the round trip and the average for the season is approximately 8½ days. The ship is loaded in 8 to 12 hours, and its cargo is discharged in 30 to 36 hours. The largest production was in 1935 when 142,000 tons were shipped. In 1936 shipping opened in April and closed October 1. The freight cost is said to be about $.90 per ton.

A modern quarry with power plant, drilling equipment, power shovels, crushing plant, storage bins and ship-loading equipment gives low-cost f.o.b. ships. The quarry is operated from April to September.

The Pacific Coast Steamship Company contracts the transportation of the rock from Dall Island, Alaska, to the Diamond Plant in Seattle at a fixed rate per ton of 2,000 pounds, and they load and unload the boat with a time limit set for each operation, before demurrage begins.

The equipment at the quarry is so planned that they produce rock under one and one-half (1½) inch maximum size for transportation to the Diamond Plant in Seattle. It is said to cost $.35 to mine and $.40 to $.50 loaded in a hull. Cost per ton, crushed and ready for transportation to the Diamond Plant is somewhat higher than at Concrete, Washington, because of smaller equipment and high freight.

About 25 men produce 100 tons per hour. They produce between 25,000 and 30,000 tons per month when operating, but the quarry capacity is said to be 275,000 tons per month. Production is limited by transportation facilities, and if another ship were added to haul rock, 50,000 to 60,000 tons of rock per month could be produced easily. Quarrying operations can be carried on during the entire year.

The rock is shipped only to the cement plant on Boundary Way and Spokane Street, Seattle. The company expressed the probability that the rock could be sold in Seattle at $1.50 per ton to which the buyer would add the unloading charge. Equipment at the Diamond plant in Seattle would permit them to load from stock pile storage to car at the rate of 200 tons per hour.

Estimates given for delivery unloaded at Portland ranged between $2 and $2.25 per ton. A number of persons familiar with the Northwest limestone expressed the opinion that no limestones of western Washington could be delivered to Portland as cheaply as rock from Dall Island. The company has expressed willingness to ship at the rate of 150,000 tons per month and a million tons over a six months' period.

52. Breezy Bay in Tlevak Strait. Belt strikes northwest to Diver Island.

53. Diver Island.

54. Cape Lookout.

55. Waterfall Bay and Cape Augustine.

Rocks: Marble.

Quality:

$CaCO_3$	99.59
$MgCO_3$	1.03
Insol.	0.32
	100.94

56. Port Bazaan.