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Report of Investigations
No. 13

Dolomite Resources of Washington

Part I

PRELIMINARY REPORT ON OKANOGAN, LINCOLN, AND STEVENS COUNTIES

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FOREWORD

In anticipation of the importance of the production of metallic magnesium specific plans were made several years ago for the study of the dolomite and magnesite resources of Washington. The demand for information became so urgent, however, that studies of magnesite were completed and reported before dolomite investigations were begun.

This report, Part I of a series entitled "Dolomite Resources of Washington," constitutes the first unit of a more comprehensive study and covers only a few of the deposits which give promise of containing large tonnages of high-purity dolomite. Other units will follow as the work is finished.

The reader may notice that analyses are not reported for most of the sampling here recorded. The location of all samples is indicated on the detail maps so that a supplementary table of analyses to be published later will become an integral part of this report.

Mr. Bennett is responsible for both the organization and prosecution of the work on dolomite. After spending virtually all of the season of 1943 in the field he was able to complete final copy of the text before leaving the staff of the Division. Final drafting of the maps and checking of the tonnage estimates were done subsequently, and Mr. Bennett has had but limited opportunity to review the results. Especial credit is due his field assistants, L. T. Teir and R. E. Stevenson, for painstaking and conscientious effort to complete the report according to the original plans. Such discrepancies as may appear between the text and maps are largely due to these fortuitious circumstances.

Mr. Bennett's familiarity with the character of dolomite deposits leads to a confidence in the tonnage figures which may not be shared by the reader with industrial experience. It is well to point out, therefore, that the estimates submitted were calculated without benefit of complete chemical data. Drilling alone will give reliable results as to both the tonnage and the relative purity of any of these deposits.

Harold E. Culver

May 23, 1944

INTRODUCTION

Virtually all the dolomite of the State is found in the northeastern part, particularly in Stevens County as well as in Pend Oreille, Okanogan, and Lincoln counties. Ferry County has some small deposits near Republic, but most of its limited resources appear to be in the extreme northeastern part. Named formations that contain dolomite include the Metaline limestone in Pend Oreille County, and the Old Dominion limestone, the Northport limestone, and the Stensgar dolomite in Stevens County. Some of the dolomite occurs in formations of Cambrian age and some in those considered to be of pre-Cambrian and Triassic ages.

Production of dolomite has come from the old Tulare quarry east of Colville in Stevens County where as much as 500 tons per month has been reported.[1] The size of the excavations at the Tulare quarry suggests that between 75,000 and 100,000 tons have been removed, practically all of which has been used for the manufacture of paper. About 20,000 tons have been produced from a small quarry near Riverside since about 1938 and have probably been used for refractories. Since the start of the war dolomite has been produced on a large scale near Northport in Stevens County, and is being used by the Electro-Metallurgical Corporation to make magnesium at a plant near Spokane. At about the beginning of the century a little dolomite probably was shipped for building stone in Stevens and Lincoln counties.

The mineral dolomite is a double salt of calcium and magnesium carbonates containing theoretically 21.7 percent of magnesia (MgO) or 13 percent magnesium, 30.4 percent lime (CaO), and 47.9 percent of carbon dioxide (CO_2). In the rock mass it often contains iron, alumina, manganese, silica, and other impurities. With a decrease in the amount of magnesia, dolomite rock grades through magnesian or dolomitic limestone to limestone by increase in the proportion of calcite to dolomite. Layers of different composition may have sharp or gradational boundaries. Dolomite may be bedded and separated from limestone by bedding planes, or it may be a mass whose boundary lies at an angle to bedding.

The origin of dolomite is not entirely understood. It may have been formed as an original deposit in the sea. Other theories suggest replacement of limy muds by magnesium in the sea water, or replacement of limestone by circulating magnesium-bearing underground solutions moving along fractures and perhaps originating in a deep-seated intrusive mass.

Dolomite has long been used together with limestone for many purposes, including smelting, lime manufacture, agricultural stone, crushed stone, building stone, whiting for putty, paint, rubber, etc. Dolomite alone is used for refractories, technical carbonate and rock wool in insulation, and for certain cements. Particularly since the start of the war it has been used for production of magnesium metal, competing with magnesite, sea water, and brines from underground

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[1] Glover, Sheldon L., Nonmetallic mineral resources of Washington: Washington Div. Geology Bull. 33, p. 120, 1936.

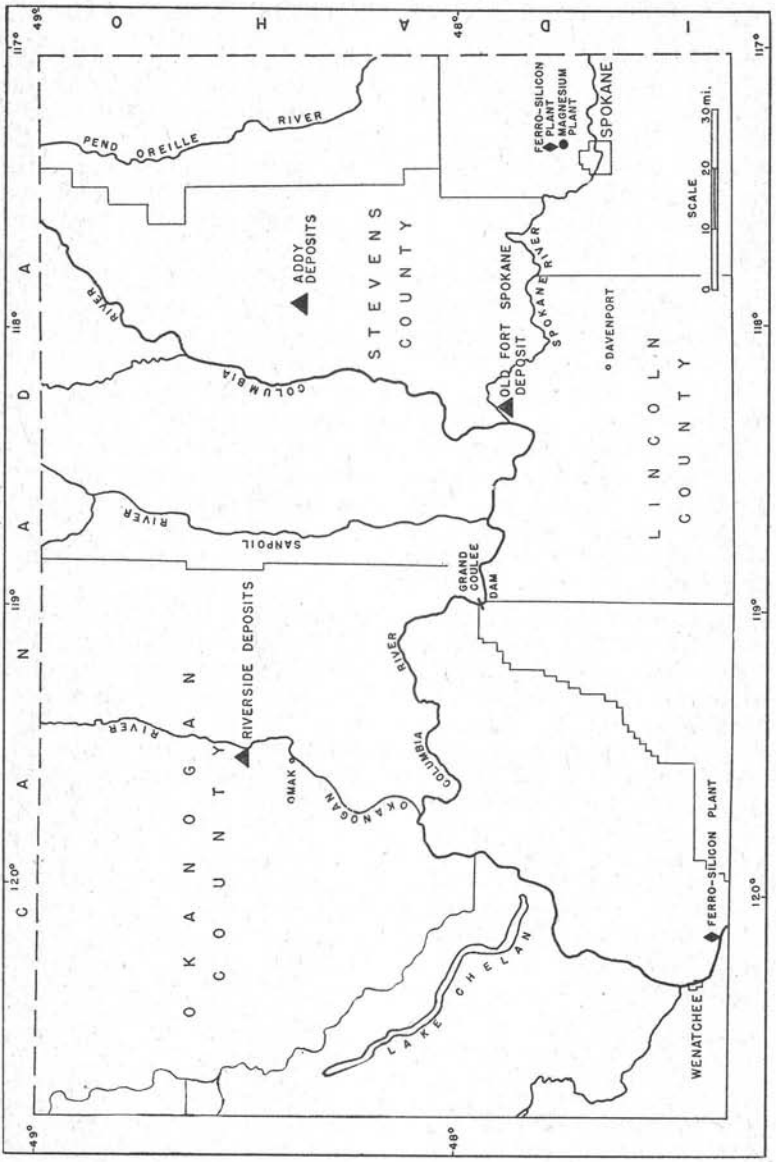

FIGURE 1—Index map of northeastern Washington showing location of Riverside, Old Fort Spokane, and Addy dolomite deposits.

salt deposits. For this last purpose as well as for certain others a rock having more than 97 percent total carbonates, that is, with no more than 3 percent impurities such as silica, iron, and alumina, and with not less than 20 percent magnesia, is preferred.[1]

[1] Willman, H. B., High-purity dolomite in Illinois: Illinois Geol. Survey Rept. of Inv. 90, 89 pp., 1943. Lamar, J. E., and Willman, H. B., A summary of the uses of limestone and dolomite: Illinois Geol. Survey Rept. of Inv. 49, 50 pp., 1938.

FIELD WORK AND ACKNOWLEDGMENTS

Work was carried on for 17 weeks, between May 13 and September 18, 1943. Deposits were mapped on a scale of 100 feet to the inch, using a 20-foot contour interval. Samples were collected on the surfaces of outcrops along compass and tape traverses. The horizontal lengths of these traverses are shown on the maps. Unweathered fragments of rock were taken every 5 feet for each sample, which usually included 50-foot lengths along the traverse.

Dolomite was identified in the field by immersion of an unweathered coherent fragment one-fourth to one-half inch across in a test tube containing 1:30 HCl. Cool acid of this strength will produce essentially no effervescence on a carbonate that has the proper lime-magnesia ratio of theoretical dolomite.

A total of 89 samples were collected for analysis from all three districts of which 67 representing deposits 4, 7, 8, and 9 at Riverside, the Old Fort Spokane deposit, and those in the Addy district, have been chemically analyzed. Of this number 15 fail to fall within the limits of high-purity dolomite, even though all deposits represented by analyses contain rock of that grade. The largest deposit at Riverside (deposit 7) is represented by 23 analyses, the largest number selected for any one deposit.

Plane table mapping was done by Marshall Huntting, Lennart Teir, and Robert E. Stevenson for the Riverside deposits, by Teir and Stevenson for the Old Fort Spokane deposit, and by Randolph Thomas and Irving Friedman for that near Dunn Mountain in the Addy district.

Residents in the several areas kindly contributed information and aided in various ways, particularly Messrs. Bart Robinson of Omak, S. J. Booher and Emmett Smith of Riverside, W. F. Pierce of Miles, and Lee Brooks of Addy.

For information and help in preliminary examination of some dolomite occurrences in Ferry and Stevens counties special thanks are due Messrs. Everett Hougland of Republic and John P. Thomson of Colville. Much benefit was obtained from a discussion of certain deposits with Mr. Roger Oscarson of Spokane and Dr. Charles Deiss of the U. S. Geological Survey.

RIVERSIDE DISTRICT

GENERAL STATEMENT

The dolomite deposits in the Riverside district of western Okanogan County all lie generally west of Riverside, and are about 150 miles via U. S. Highway 97 up the Columbia and Okanogan valleys from Wenatchee, with which they are also connected by a branch of the Great Northern Railway. (See fig. 1.) They are in the Okanogan and Chopaka quadrangles of the U. S. Geological Survey, mainly in secs. 4 and 8, (34-26 E.),* and secs. 3, 10, 14, 15, 22, 23, 26, 35, and 36, (35-26 E.).

* T. 34 N., R. 26 E.

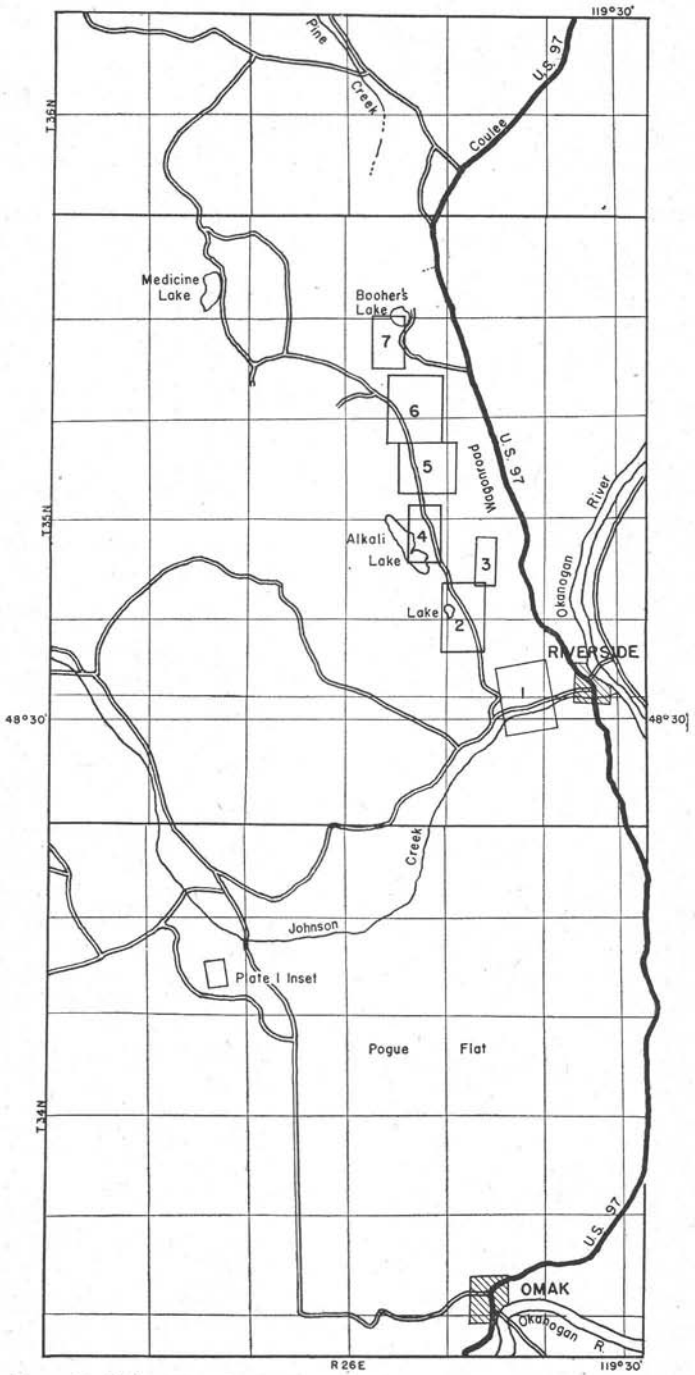

FIGURE 2—Index map show relative position of mapped areas (plates 1-7) in Riverside district.

GEOLOGY

Late Paleozoic rocks

The oldest rocks that lie within the area of dolomite deposits include sheared conglomeratic quartzite and slates or phyllites which are clearly unconformable beneath the dolomite, limestone, and other rocks making up the carbonate succession. All these rocks have been recently described by Waters and Krauskopf.[1] The older rocks called middle Anarchist by Waters and Krauskopf are exposed in sec. 32, (36-26 E.), secs. 3, 8, 9, 10, 15, and 23, (35-26 E.). It seems probable that they formed a buried ridge, now partly exposed, lying essentially parallel to the coulee wall. In general these rocks show considerable deformation and metamorphism. A late Paleozoic age is indicated by fossils found in limestone lenses within the series.

The limestone-dolomite series

The carbonate succession is composed predominantly of white and gray limestone, dolomitic limestone, and dolomite with subordinate shaly limestone, sandstone, pebble conglomerate, calcareous quartzite, and calcareous siltstone. The more clastic phases are particularly abundant in secs. 3 and 10, adjacent to the Anarchist rocks in secs. 9 and 10, (35-26 E.).

The main body of true dolomite seems to form a stratigraphic zone more than 500 feet thick at or near the base of the limestone-dolomite series, extending from sec. 36 northeastward into sec. 3, (35-26 E.). However, toward the north its continuity is made less definite by folding, faulting, and lateral gradation into both sandy and limy phases. Minor amounts of dolomite probably occur in various stratigraphic zones throughout the series, though on the west there seems to be a predominance of limestone.

The dolomite is mostly white to gray, fine grained, thick bedded to massive, and occasionally contains thin interbeds of buff limy dolomite. In places it contains sand or silt, and thin veinlets of cherty quartz which seem to occur only in the dolomite and not in the overlying gray limestone. In the vicinity of Alkali Lake where the dolomite shows a thick sequence of beds it is overlain by gray limestone. At only one place, secs. 14 and 15, (35-26 E.), the dolomite is underlain by gray argillite.

The limestone-dolomite series is apparently thousands of feet thick. The thickness between Medicine Lake and Hess Lake is more than 10,000 feet and between the Anarchist rocks in sec. 32, (36-26 E.) and the Tertiary volcanics east of Pine Creek it is about 4,000 feet. Along the Omak-Conconully road near its junction with the Riverside road, there is a 3,000-foot portion of the series consisting of sandy dolomite, limestone, and dolomite. The series seems to be overlain north of Hess Lake and west of Johnson Creek by an argillaceous formation that is strongly metamorphosed to various types of schist including hornblende schist with occasional coarse marble bands.

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[1] Waters, A. C., and Krauskopf, Konrad. Protoclastic border of the Colville batholith: Bull. Geol. Soc. America, vol. 52, pp. 1358-1366, 1941.

On the basis of fossils found by Waters and Krauskopf in the gray limestone, the series is regarded by them as of Triassic age.

Igneous rocks

With the exception of a small fine-grained light-gray dioritic mass located near the center of sec. 10, (35-26 E.), no intrusive igneous rocks have been found in the main belt of dolomite deposits. However, the southwest side of the limestone-dolomite series is intruded by stocks and smaller accompanying bodies of a large granitic batholith. An intrusive mass of serpentinized ultrabasic rock occurs on the southwest along the Omak-Conconully road, and another in the wall of Wagonroad Coulee where it turns eastward. This latter body contains a narrow vein of essentially pure magnesite.①

Structure

A principal structural feature of the limestone-dolomite series is an anticline whose axis trends northwest through secs. 9, 10, 14, and 15, (35-26 E.), being possibly localized by the Anarchist rocks in secs. 9 and 10. Most of the dips in the limestone series southwest of the Anarchist mass are southwestward at angles mainly between 30° and 60°. But dips in secs. 3, 10, 14, and 15, (35-26 E.) and farther northwest along the coulee wall are northeastward at angles up to 70°. The prominent half-dome-like hill of gray limestone in secs. 14 and 23 (elevation 2,100) is on an anticline whose axis trends southwest. In the northwest part of sec. 26 is a faulted anticline. (See pl. 2.) Most of these minor flexures are of drag fold type with pitching axes parallel to the main axis.

Faults include the thrust or thrusts along the axis of the minor fold in the NW¼ sec. 26, (35-26 E.) (see pl. 2), which trend northwest and dip southwest. Other faults were observed in the coulee wall, particularly in a zone where gray limestone is dropped down against the dolomite in secs. 14 and 15, (35-26 E.).

The main area of dolomite deposits is very little affected by metamorphism compared to the west side of the limestone-dolomite series which is rather uniformly transformed into coarse marble. The argillaceous interbeds in this latter area are correspondingly changed into rather coarse hornblende schist and hornfels.

DOLOMITE DEPOSITS

Deposit 1

Location, size, and access.—Deposit 1 (see pl. 1) lies mainly in sec. 36 and partly in secs. 25, 26, and 35, (35-26 E.), approximately half a mile southwest of Riverside. It is roughly 1,200 feet long, 800 feet wide at the south, and 400 feet wide at the north. It lies a few hundred yards south of the Johnson Creek road that connects with U. S. Highway 97 at Riverside.

Ownership.—The county recorder's records as of July 1943 showed that sec. 25 is owned by H. F. Hubbard, sec. 26 by N. W. L.

① Huntting, M. T., personal communication.

Brown, sec. 35 by Dorothy A. Liggett who has leased to Ross E. Smith, and sec. 36 is State land.

Topography.—The deposit forms a barren steep-sided hill (locally called Mount Olive), whose elevation is 1,543 feet. This is 280 feet above a broad bench on the east, and about 400 feet above Riverside and the Great Northern tracks on the east side of the Okanogan River.

Description.—On the south side and probably also on the west the dolomite is apparently overlain by volcanics, and elsewhere by glacial outwash sands and gravels. In most places it is dense and light gray. The beds range up to 6 feet or more in thickness, and may be observed from the highway, a mile to the southeast.

Impurities include thin limy dolomite beds, reddish lenses of cherty quartz along faults, and more or less paper-thin veinlets of gray to white quartz that cut across the bedding in all directions.

The maximum stratigraphic thickness exposed is about 550 feet.

Structure.—At the south end the beds strike N. 30° W. and dip 40° SW., forming the west limb of an anticline. At the north they dip gently both toward the northeast and southwest, forming the nose of an anticline that pitches northwestward.

Sampling.—This deposit, although sampled (see pl. 1), is not represented by chemical analyses. Field tests indicate that it is all dolomite except for the impurities already mentioned.

Tonnage estimate.—About 5,300,000 short tons of dolomite including minor impurities have been calculated for the deposit. This estimate is made in advance of drilling data, and since a considerable part of the mass used for the calculation may be seen in the third dimension, there is practically no reason to doubt that the amount calculated is all dolomite.

Quarry sites.—A desirable location for a quarry is at the north, where the face would be advanced against a moderate slope as well as along the strike of the beds. Space for buildings and equipment is adequate, and this location is nearest the Johnson Creek road.

Drilling.—To prove that the dolomite extends down the dip, a hole should be put down from the west side at the edge of the outcrop. (See pl. 1.) If started N. 50° E. at an angle of 50° it would cross the beds essentially at right angles to both strike and dip, and would cross the exposed section in about 550 feet.

Deposit 2

Location, size, and access.—Deposit 2 (see pl. 1), located about 1¼ miles by graveled road west of Riverside, is mostly east of the west line of the SE¼SE¼ sec. 26, (35-26 E.). It is 800 feet long and 400 feet at its widest place in the center.

Ownership.—N. W. L. Brown is the owner and also the operator of a small quarry located at the south end.

Topography.—The deposit forms a short knob-like ridge on the north side of Johnson Creek, rising from near the stream level at about 1,100 feet elevation to a maximum of a little more than 1,300

feet. It projects about 50 feet above a surrounding eastward-sloping dissected bench.

Description.—The dolomite is overlain by glacial outwash of which enough has been eroded away on the west to expose a stratigraphic thickness of about 400 feet. Beds 3 to 4 feet thick are most easily observed in the quarry. Elsewhere bedding is obscured by numerous fractures.

Much of the rock is light gray and fine grained. It includes occasional films of iron or manganese oxides on surfaces of fractures, and there is a local zone of thin cherty quartz veinlets that lies northwest of the quarry at the edge of the outcrop.

Structure.—In the west wall of the quarry at floor level the beds strike N. 30° W. and dip 60° SW. That this trend holds throughout is supported by data from deposit 3, which lies adjacent on the northwest.

Sampling.—Samples were taken of this deposit but none has been analyzed. According to the operator the zone now being worked is of exceptional purity. Most of the deposit appears to be high-grade dolomite.

Tonnage estimate.—The following estimate of tonnage is based on a block whose triangular surface dimensions are 750 by 450 feet. The average vertical dimension of this block above Johnson Creek is 90 feet. A factor of 0.088 short tons per cubic foot gives a total of 1,336,500 short tons of dolomite.

Deposit 3

Location, size, and access.—Deposit 3 (see pl. 1) underlies about 20 acres in the NW¼SE¼ sec. 26, (35-26 E.). A narrow dirt road leads along the west side from a junction with the Johnson Creek road one-fourth mile west of deposit 2.

Topography.—The major outcrop is roughly a flat-topped hill that rises between 50 and 75 feet above a surrounding dissected terrace. Its maximum elevation is about 1,450 feet, approximately 300 feet above Johnson Creek, and 600 feet above Riverside. The drainage is southward on the west and northeastward on the east.

Description.—A part of the glacial outwash that nearly covered the dolomite has been eroded away, exposing several small outcrops at different levels. These exposures are shown on the map by dashed lines. Altogether they show a stratigraphic section of about 700 feet, of which the upper 300 feet on the south is mostly fine-grained gray dolomite in places showing beds up to 4 feet thick. The underlying 400 feet is not so well exposed but is dominantly fine grained, light gray to white, and less distinctly bedded.

Impurities noted in the field include a local zone of cherty quartz veinlets on the southeast and a narrow bed of dolomitic limestone on the northwest adjacent to a marsh.

Structure.—In general the dolomite strikes west to northwest and dips between 30° and 50° south. The abrupt change in strike

at the southeast suggests a minor anticlinal cross fold on the southwest limb of a major anticline.

Sampling.—None of the 12 samples taken of this deposit has been analyzed. Except for a local zone of silica and a bed of dolomitic limestone, the rock is apparently high-grade dolomite as indicated by field tests.

Tonnage estimate.—The following estimate of tonnage is made in advance of analytical results and drilling data. It is very probable, however, that the dolomite extends much farther down dip than the relatively shallow depth factor used for calculation. For the main body a block 1,100 feet long, 700 feet wide, and 155 feet deep has been used. The projecting ridge on the southeast was assumed to be 400 feet long, 200 feet wide, and 66 feet in average depth. A total of 10,967,000 short tons has been calculated, using a factor of 0.088 tons per cubic foot and neglecting minor impurities. It is further assumed that only a minor amount of stripping of overburden, principally at the north, will be necessary. With some additional stripping of overburden on the south the deposit might be worked to the level of Johnson Creek, in which event the above total should be increased by approximately 10,000,000 tons.

Quarry sites.—A quarry opened on the southwest would be easily accessible to the Johnson Creek road, would interfere less with operations in deposit 2, and would be advanced along the strike and north of a local siliceous zone. An alternative site on the northeast is favorably situated with respect to room for buildings, equipment, and transportation of rock via an aerial tram.

Drilling.—A hole started on the 260-foot level on the south side (see pl. 1), drilled 300 feet north at 50° from the horizontal, would cross beds essentially normal to their strike and dip and extend to about an elevation of 300 feet below the top of the deposit. A second hole located 500 feet north of the first, drilled 400 feet in the same direction and at the same angle would also penetrate to the same elevation. It should cross beds at right angles to their strike and dip, in the upper part at least, and if the structure holds throughout, an uninterrupted stratigraphic section of 700 feet would be represented by both holes.

Deposit 4

Location, size, and access.—Deposit 4 (see pl. 2) is located about 1¼ miles by air west-northwest of Riverside in the NW¼ sec. 26 and the SW¼ sec. 23, (35-26 E.). The distance via the Johnson Creek road and the same branch of it that passes deposit 3, is about 2½ to 3 miles from Riverside. The mass extends 4,200 feet northward with an average width of about 600 feet.

Ownership.—The land ownership as shown by the county recorder as of July 1943 is as follows:

SE¼NW¼ sec. 26, (35-26 E.), Emmett and Omar Smith
NE¼NW¼ sec. 26, (35-26 E.), N. W. L. Brown
NW¼NW¼ sec. 26, (35-26 E.), Ross E. Smith
SW¼SW¼ sec. 23, (35-26 E.), Emmett and Omar Smith
NE¼SE¼ sec. 22, (35-26 E.), W. R. Forbes

Topography.—The south half of the deposit forms a ridge that rises from south to north, reaching its maximum elevation of 1,750 feet in a rounded knob immediately east of the NW. cor. sec. 26. (See pl. 2.) This knob is about 390 feet above the base of the deposit on the southeast. The north half, that is, north of the knob, consists of ridges that are between 180 and 240 feet above the base on the southeast. The deposit is drained to the southeast and east.

Description.—Most of the rock is light gray to gray to brownish gray. Cherty quartz veinlets occur in places in the south half of the deposit, and are more common in most of the north half. Buff-weathering limy dolomite beds, from a few inches up to 1½ feet thick, occur in places interbedded with the gray-weathering thicker dolomite. The north half of the mass contains a lens of sandy, buff-weathering dolomite 400 feet east and 100 feet south of the NW. cor. SW¼SW¼ sec. 23. Most of the buff-weathering sandy dolomite is restricted to the stratigraphic top of the deposit.

The dolomite appears to be about 450 to 500 feet thick at least, about the same as that of deposits 2 and 3. The immediately overlying beds are gray limestone, sandy buff dolomite, argillaceous limestone or limy dolomite, and include an apparent faulted repetition of the upper part of the main dolomite which lies on the west side of the high knob.

Structure.—The dolomite has been folded into an anticline that becomes more closely compressed from southeast to northwest, finally passing into overthrust faults along its axis. Three thrust planes are easily visible showing breccia and slickensides. These faults have cut out 200 to 300 stratigraphic feet of the dolomite section. A few hundred feet north of the high knob the underlying Anarchist quartzite has been faulted up against the dolomite. Along the road northeast of the high knob the dolomite strikes east with a north dip. On the west side of the road it strikes north and dips steeply westward, suggesting an asymmetric anticline that pitches northward.

Sampling and analyses.—From this deposit 82 samples have been taken (see pl. 2), of which 64, 65, 66, and 79-84 inclusive have been analyzed with the results included in the subjoined table.

ANALYSES OF DOLOMITE FROM DEPOSIT 4

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)	Remarks
64		1.44		30.8	21.7	0–50 feet
65		1.92		30.6	21.6	50–100 feet
66		1.80		30.5	21.2	100–150 feet
79	44.36	3.42	1.52	29.59	21.11	
80	44.04	4.74	1.54	29.88	19.80	
81	43.73	4.42	1.38	29.00	21.47	
82	44.62	3.48	1.16	29.71	21.03	
83	45.09	2.36	1.22	30.23	21.10	
84	44.28	1.90	.98	30.64	22.20	

Tonnage estimate.—Seven blocks were calculated separately in arriving at an estimate of tonnage. The base is that of the low point on the deposit, the southeast end. From southeast to northwest, therefore, these blocks are as follows:

550 × 550 × 140	= 42,350,000 cu. ft.
500 × 600 × 168	50,400,000
500 × 460 × 190	43,700,000
500 × 600 × 175	52,500,000
500 × 700 × 150	52,500,000
500 × 700 × 250	71,750,000
500 × 550 × 180	49,500,000

0.088 t. × 362,700,000 = 31,917,000 short tons

Quarry sites.—Quarrying probably should start at the southeast end, working in from the lowest point on the deposit.

Drilling.—Drill holes ought to be made from the east side, directed southwest, and inclined at relatively steep angles, at the east end of the first five sample rows (south to north). The set-up at the north end of the deposit should be located about on the location of sample 124 and inclined southeastward.

Deposit 5

Location, size, and access.—Deposit 5 (see pl. 4) is located in the SE¼NE¼ sec. 22, (35-26 E.). It is 2 miles northwest of Riverside, with which it is connected by the same road that passes deposits 3 and 4, connecting with the Johnson Creek road at a point 1½ miles west of Riverside. It is about 1,000 by 350 feet in surface dimensions.

Topography.—The outcrop lies along the southeast shore of Alkali Lake, and consists of two knobs joined by a low saddle. The highest of these is about 150 feet above Alkali Lake, whose elevation is approximately 1,600 feet.

Description.—The dolomite is gray but shows many cherty quartz veinlets, particularly on the north. It is mainly thick bedded to massive.

Structure.—The general strike is about N. 60° W. and the dip is 40° SW. The deposit passes under Alkali Lake and limestone beds on the west. East of the road (see pl. 4) are sandy dolomite and limestone beds that are structurally discordant with the dolomite, suggesting a fault, probably the same fracture or combination of fractures that passes through the north half of deposit 4.

Sampling.—A total of 13 samples was taken from this deposit but none has been analyzed. The rock that forms most of the south knob probably is the better grade of dolomite, since that one on the north is abundantly siliceous in certain beds.

Tonnage estimate.—Approximately 1,848,000 short tons of dolomite including minor impure portions have been calculated for this deposit.

Quarry site.—The south knob is the most suitable place to open a quarry.

Deposit 6

Location, size, and access.—Deposit 6 is immediately north of deposit 5. (See pl. 4.) It includes about 40 acres in the SE¼ sec. 15 and the NE¼ sec. 22, (35-26 E.). It lies about 2½ miles by air northwest of Riverside and is served by the same unimproved road that passes deposits 4 and 5.

Ownership.—The SW¼SE¼ sec. 15 and the NW¼NE¼ sec. 22, (35-26 E.) are owned by Mrs. W. V. West. The SE¼SE¼ sec. 15 and the NE¼NE¼ sec. 22 are owned by Ross E. Smith.

Topography.—Most of deposit 6 lies west of a north-south rather shallow ravine which is followed by the road. This ravine widens northward and is partly filled with alluvium. The high point of the deposit, on the northwest, is about 280 feet above Alkali Lake, whose elevation is approximately 1,600 feet. Most outcrops are large but separated from one another by soil or a thin veneer of glacial gravel. The dolomite presents a series of rounded parallel ridges elongated northeastward athwart the valley and road.

Description.—Most of the rock in this deposit is gray dolomite, little different from that of deposits 4 and 5. On the southwest side there is a zone of siliceous dolomite beds which overlies the gray dolomite. Much of the dolomite, except the siliceous beds, appears to be massive, especially on those outcrop surfaces that have been rounded by glacial action. In general the beds dip southwestward toward Alkali Lake, as indicated by the zone of siliceous dolomite. On the east the dolomite shows a relatively sharp contact with gray limestone but on the west it seems to grade laterally into white limy dolomite and limestone.

Structure.—The beds of the siliceous zone strike about N. 40° W. and dip from 35°-55°SW. East of the road the strike is north of east and the dip is northwestward at a steep angle, suggesting continuation of the fault mentioned in connection with deposits 4 and 5.

Sampling.—A total of 60 samples was collected from this deposit but none has been analyzed.

Tonnage estimate.—The surface dimensions of 1,700 by 1,025 feet, assuming a depth factor of 120 feet (to the level of the lake), give 18,400,800 short tons of dolomite of both poorer and higher grades.

Quarry sites.—Quarrying ought to start at the south end on about the level of the lake and extend northward on the east side of the siliceous zone.

Drilling.—Drilling might be undertaken on the east and west sides to determine both extent and grade of dolomite below the surface and also to determine the depth to the underlying pre-dolomite quartzites and slates (Anarchist rocks) that are exposed both to the north and south.

Deposit 7

Location, size, and access.—Deposit 7 lies mainly in secs. 10 and 15, (35-26 E.) (see pls. 5 and 6), 2½ to 3½ miles northwest of Riverside. This deposit in ground plan is roughly triangular whose east-

ern side is 6,800 feet long, forming the cliff-like west wall of Wagonroad Coulee. The south boundary is 1,600 feet long. The entire east side is easily reached by short unimproved farm roads leading from U. S. Highway 97. The west side is most easily reached from a branch of the Johnson Creek road, the same that extends to deposits 3 to 6 previously described.

Ownership.—The ownership at present is divided as follows: The NW¼SE¼, SW¼NE¼, NW¼NE¼, and the NE¼NE¼ sec. 15, (35-26 E.) is owned by Tim Bernard, also the SW¼SE¼ and the SE¼SW¼ sec. 10 adjoining; the NE¼SW¼ by S. J. Booher; the NW¼SE¼ sec. 10, and the SE¼NE¼ and the NE¼SE¼ sec. 15, by Ross E. Smith; a small portion of the SE¼SE¼ sec. 10, by James E. Smith.

Topography.—The mass forms part of the precipitous wall on the west side of Wagonroad Coulee, rising a little over 1,000 feet above the coulee floor at its highest point. The total relief is a little more than 1,000 feet, the high point being a rounded prominent knob in the center of the deposit, one side of which is the coulee wall. The south side, which essentially is a continuation of deposit 6, has a general elevation of 800 feet above the floor of Wagonroad Coulee.

Description.—The prevailing rock is a dense light- to dark-gray dolomite that is both distinctly bedded and massive. It appears to merge laterally into massive phases or into zones of intense fracturing. Where beds are distinct and continuous for appreciable distances they are usually more than a foot to several feet thick, and uniform in thickness as far as they can be observed.

The rock which crops out along the coulee wall, and which forms most of the high knob already mentioned, is unusually free of visible impurities such as ramifying cherty quartz veinlets or lenses of fine sand. A few thin buff siliceous dolomite beds were, however, found in the mass. These together with the quartz veinlets are characteristic of the Riverside dolomite deposits.

Structure.—The structure of the deposit is complex in that the beds appear to have been folded along more than one axis with resulting complications, combined with numerous, more or less small-scale faults. As a result certain lithologically distinct zones are juxtaposed against others. Gray limestone beds that overlie the dolomite have been faulted down against it on the south. The trace of this fault may be observed at the cliff edge from which the fault is interpreted as extending westward for 600 feet. (See pl. 5.) Other faults have been mapped as shown in the SE¼NE¼ sec. 15. The southwest side of the high knob, whose summit lies in the NW¼NE¼ sec. 15, probably is faulted, as inferred from gullies that mark the contact between distinctly bedded zones on one side and massive dolomite on the other.

The northwest side of the deposit, north of the high knob, is bordered by several hundred feet of buff-weathering cherty dolomite, which appears to be faulted.

As a general picture of the prevailing structure, it appears that northeastward-trending beds dipping northwestward at the south

end of the deposit have dominantly northwest trends with steep northeastward dips at the north end.

Sampling and analyses.—Of 183 samples collected from deposit 7, 23 have been analyzed. These are numbers 266-288, inclusive, representing the east slope of the high prominent knob on the coulee wall. (See pl. 5.) The results are presented in the following table:

ANALYSES OF DOLOMITE FROM DEPOSIT 7

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)
266	42.92	6.62	1.50	28.95	20.01
267	44.30	5.34	1.36	29.10	19.90
268	45.62	2.96	.84	30.28	20.30
269	45.94	1.56	.94	30.72	20.84
270	46.54	.76	.75	30.97	20.98
271	46.48	.24	.52	30.97	21.79
272	44.85	5.02	.70	30.47	18.97
273	46.52	.80	.69	30.72	21.27
274	46.37	.96	.84	30.92	20.91
275	46.61	.58	.68	31.31	20.82
276	46.90	.76	.62	31.12	20.60
277	46.88	.86	.61	30.92	20.73
278	46.98	.58	.68	30.97	20.79
279	46.66	1.22	.72	30.77	20.63
280	46.83	.74	.78	31.12	20.53
281	46.73	1.08	.66	31.02	20.51
282	46.48	1.16	1.10	30.82	20.44
283	46.81	.96	.68	30.82	20.73
284	46.26	1.61	1.18	30.47	20.48
285	46.62	1.02	1.06	30.57	20.73
286	45.50	2.82	1.36	29.97	20.25
287	46.14	1.76	1.30	30.34	20.46
288	46.56	1.22	.92	30.72	20.58

Tonnage estimate.—In calculating the tonnage, allowance was made for a shallow depth of the dolomite at the south and because of the presence of a pre-dolomite basement on which the dolomite or carbonate beds were laid down in the sea. It has been assumed that this old surface lies as a north-south buried ridge with a 30° slope eastward. The deposit at the south end probably is underlain by shale which crops out at about 600 feet above the coulee floor. Its thickness there averages about 165 feet, but at the north the thickness increases to over 1,000 feet. Taking into consideration all factors of limited depth and surface irregularities, a total of about 176,000,000 short tons of dolomite has been calculated.

Quarry sites.—Because of easy access to both the highway and railroad, quarries, if possible, should be opened from the east. The great cliff whose average east slope is about 43° and whose summit is 1,000 feet above the coulee floor, however, may make quarrying on the east hazardous and expensive. On the north, the length to which the mass can be worked is limited by a relatively thick bed of siliceous dolomite, which probably would be much too thick to be removed by stripping. A railroad spur could be extended from Riverside, requiring a bridge across the Okanogan River plus about a 200-foot rise to surmount the sand terrace that makes up the floor of Wagonroad Coulee, and the west side of the Okanogan Valley near Riverside. The shortest distance for a tram would be about 2 miles, connecting with the Great Northern Railway at a point about 2 miles north of Riverside.

Drilling.—Exploration by drilling at the south end would consist of determining the depth to the old pre-dolomite quartzite land surface. As the deposit is worked inward and to successively lower levels from the cliff face, the old land surface, if present, would probably be encountered. The great cliff face is thus of convenience since it presents an optimum grade of dolomite of much lateral length as well as vertical dimension and the probability of hundreds of feet of continuity westward into the cliff wall, particularly at the south.

Deposit 8

Location, size, and access.—Deposit 8 (see pl. 3) lies 1¼ to 1½ miles northwest of Riverside in the NE¼NW¼, SE¼NW¼, and NE¼SW¼ sec. 23, (35-26 E.). It forms a series of outcrops that outline an area about 2,400 by 350 feet elongated northward. It may be reached by U. S. Highway 97, which passes less than half a mile to the eastward. The shortest air line distance to the Great Northern tracks is about 1 mile.

Ownership.—In 1943 the land was owned by three brothers, Emmett, Omar, and Ross E. Smith, according to the records of the county recorder.

Topography.—The deposit is part of the west cliff front that faces Wagonroad Coulee at its junction with the Okanogan Valley. The base of the outcrop on the north is about 250 feet above the floor of the coulee, which is about the same elevation above the Okanogan. However, the top at the south is about on the same level as the base on the north. A sloping bench of sand lies immediately east of the dolomite at the south and merges into a talus slope on the north. From the upper edge of the sand and talus the outcrop rises steeply for 200 feet to an upper undulating bench that slopes southeastward.

Description.—The section exposed ranges from about 200 to 300 feet in stratigraphic thickness, with the maximum at the south where a deep gully has been cut in the adjacent sand terrace. The uppermost beds in places at or near the contact with overlying gray limestone are cut by thin siliceous veinlets. This siliceous zone

widens abruptly at the north and follows the edge of the high cliffs of the west coulee wall. This extension of the dolomite was not mapped.

Most of the rock is light gray and fine grained, with little or no silicification.

Structure.—The beds dip from 30° to 50° southwest and are apparently dislocated by landsliding at the north where deep crevices occur between 100 and 200 feet from the cliff's edge. A large block has therefore moved eastward, but not recently.

Sampling.—Samples 362-388, inclusive, representing five rows (see pl. 3), have been taken from the deposit. All rows of samples are horizontal plots on the map.

Analyses.—The northernmost row of samples, Nos. 383-388, inclusive, is regarded as representative of the deposit, and has been selected for analysis with the following results:

ANALYSES, NORTH END OF DEPOSIT 8

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)
383	46.18	2.28	.80	30.02	20.72
384	46.78	1.14	.90	29.62	21.56
385	47.08	.54	.84	29.87	21.67
386	47.26	.36	.62	30.11	21.65
387	47.23	.42	.56	30.31	21.48
388	47.19	.60	.56	29.92	21.73

Samples 383 and 384 show the beginning of a gradation to an overlying zone of siliceous dolomite.

Tonnage estimate.—A block 1,800 feet long (measured from the south), 330 feet wide, and 135 feet in vertical dimension, gives 80,190,000 cu. ft. A north block, 600 feet long, 290 feet wide, and 180 feet in vertical dimension gives 31,320,000 cu. ft. Combining these totals and assuming 0.088 tons per cu. ft. there is obtained 9,813,000 short tons. Owing to dip the top of the dolomite zone on the north is 140 feet above that on the south. From this it is inferred that those beds at the base of the outcrop on the south occupy a position on the north which is about 100 feet horizontally downslope from the upper edge of the talus. If the slope of the cliff front there is the same under the talus, the vertical depth to those beds is about 50 feet.

Quarry sites.—The north end of the deposit is perhaps the most suitable place to open a quarry, as the relatively flat coulee floor is near at hand and provides not only adequate space but also an easy grade to the highway. An alternative location is the south end, which is most easily accessible from the highway via a deep ravine. A quarry started here would be extended northward from the gully

level, but space for buildings and equipment probably is inadequate for large-scale operations.

Drilling.—Any diamond drill holes should be put down from the west side of the outcrop near the contact of the limestone. Inclined at about 70° eastward they would reach the bottom of the block used for the estimate of tonnage in about 300 feet. Holes inclined at this angle will cross a greater stratigraphic thickness than will be crossed by vertical holes of the same length. Holes inclined about 45° so as to cross the greatest stratigraphic thickness would be too close to the surface.

Deposit 9

Location, size, and access.—Deposit 9 lies immediately north of deposit 7 in sec. 10, (35-26 E.) and is reached from U. S. Highway 97 by farm roads. It overlooks a small lake, which may be referred to as Booher's Lake. The length of the deposit, south to north, is 2,700 feet and the maximum width, in the center, is 1,100 feet. It lies between contours 300 and 1,060. (See pl. 7.)

Ownership.—The entire deposit is owned by S. J. Booher, and is included within the SE¼NW¼ and the NE¼NW¼ sec. 10. Only small patches extend into adjacent 40-acre tracts, also owned by Booher. A small strip on the south, which was not surveyed, joins deposit 9 with deposit 7, and extends along the coulee wall from the floor level up about 400 feet where there is a thick siliceous bed that extends north from deposit 7.

Topography.—Much the same physical features prevail on deposit 9 as on deposit 7 to the south. Rising from Booher's Lake there is first the coulee wall, that like deposit 7 is covered by much talus. At a little over 700 feet a bench is reached which is 600 to 800 feet across, and finally the second or final coulee wall is reached at an elevation of nearly 1,100 feet above the coulee floor. This topographic discordance is due to a gigantic landslide block that has moved hundreds of feet downward and outward toward the coulee. Small blocks of the same kind occur on both deposits 7 and 8. No rock masses in this or other deposits along Wagonroad Coulee seem to be moving at present. Characteristic features are undrained depressions, cracks, and giant blocks of siliceous dolomite that have tumbled down from the high cliff to the west and now rest on the 700-foot bench, some of them rolling all the way to the coulee floor north of Booher's Lake.

Description.—Most of the rock is dark-gray dense dolomite. Cherty quartz veinlets were not observed, although sandy beds appear at the north end beyond the line drawn on the map limiting the deposit in that direction. The southwest side is bordered by the thick, prominent, buff-weathering siliceous bed that extends northward across a deep gully from deposit 7. On the west the dolomite is underlain by zones of siliceous beds.

Structure.—The structure is more regular than that of deposit 7. Beds in the cliff west of the 700-foot bench strike about N. 30° W. and dip 50°-60° NE. At the southeast end the strike is east of north

with 60°-70° SE. dips. Dips in the slumped block are lower, from 30°-50° NE.

Sampling and analyses.—Of 55 samples taken from deposit 9, numbers 420-425, inclusive, were selected for analysis, representing the center of the outcrop that makes up the east half of the deposit. (See pl. 7.) The results are included in the table which follows:

ANALYSES OF DOLOMITE FROM DEPOSIT 9

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)
420	46.55	.66	.56	31.31	20.92
421	45.98	1.28	.66	31.26	20.82
422	46.40	.92	.69	31.01	20.98
423	46.27	.71	.56	31.03	21.43
424	46.37	.92	.60	30.81	21.30
425	46.43	.82	.53	30.82	21.40

Tonnage estimate.—For tonnage calculation, the plan of the deposit was considered as two triangles whose common base is the maximum width of the outcrop. The thickness of the block was not extended below the top of the talus. Dolomite may underlie the talus but was not used in the tonnage estimate. A uniform dip of about 60° was assumed for underlying siliceous beds. With these assumptions an estimate of 33,600,000 short tons has been made.

Quarry sites.—Quarrying probably should start on the southeast, where the talus bank is small, and work northwestward to the knob at the east side of the bench. (See pl. 7.)

Drilling.—Drilling through from the upper edge of the talus above Booher's Lake would determine the thickness of the slide block and the depth of the underlying siliceous beds. This, however, would be determined eventually by quarrying. Siliceous interbeds may be present in the deposit at depth and might be encountered in a drill hole inclined westward into the coulee wall.

Deposit 10

Location, size, and access.—Deposit 10 (see pl. 1) is located about 4 miles northwest of Omak and about 4½ miles south-southwest of Riverside. It underlies about 8 acres in the NW¼SE¼ sec. 8, (34-26 E). It may be reached via the Johnson Creek road from Riverside, or via the Omak-Conconully road, turning west on the Brown Lake road at the north end of Pogue Flat.

Ownership.—The deposit is owned by Mr. Beechenow of Riverside whose residence is in sec. 5 about half a mile toward the north.

Topography.—The dolomite crops out on a low southeastward-sloping hill whose maximum elevation is about 1,700 feet, or 400 feet above Johnson Creek.

Description.—The deposit is bounded by glacial outwash on the northeast, by gray limestone on the northwest, and by limestone with some intrusive granite on the southwest. The dolomite beds are best exposed at the north, where their stratigraphic thickness is about 250 feet. Most of the rock is a white dolomitic marble whose upper part contains scattered narrow chert veins together with alternations of narrow zones of limy dolomite.

Structure.—Generally the strike is northeast and the dip southeast at 30°-35°. Variations from this probably are only local flexures.

Sampling.—On the map (see pl. 1) have been plotted samples 445a-460a, which remain to be analyzed. Numbers 450a-455a, inclusive, represent the greatest width of section and probably will show the highest grade of rock.

Tonnage estimate.—In a block 500 by 300 by 100 feet under the top of the hill there are 1,320,000 short tons. This does not include a 100-foot extension westward and southward, which on the surface appears a little limy and which may be underlain by granite not far below the surface.

Quarry sites.—The best place to open a quarry is at the north end, where the vertical height of the exposure is about 100 feet. Extension of the quarry should be southwestward along the strike.

Drilling.—Before opening a quarry several holes should be drilled around the south and west margins to determine the thickness of the zone of alternating dolomite and limy dolomite, also to determine if any granite lies just under the surface.

To cross the bedding at right angles these holes should be inclined northwestward at angles of 60°. Probably no holes should be drilled deeper than 250 feet, if granite is not encountered, as this is the valley level on the south.

Other deposits

About 1 to 1½ miles northeast of deposit 10, in sec. 4, (34-26 E.) is a thick section of the Riverside series (at least 3,000 feet stratigraphically) in which there is considerable dolomite alternating with gray limestone, sandy dolomite, and dolomite with numerous quartz veinlets. The east slope of the 1,970-foot hill (see Okanogan quadrangle sheet), particularly near the Riverside road, shows dolomite beds with the greatest thickness, although some of them contain numerous cherty quartz veinlets.

Some beds of white dolomitic marble are exposed on the south side of the hill in the NE¼ sec. 4. A good exposure near the road appears to have few impurities either of limy interbeds or of silica.

The north-south-trending ridge in the W½ sec. 3, (34-26 E.) apparently contains no rock having the composition of a true dolomite.

Across the ravine, west of deposit 3 in sec. 26, (35-26 E.) is a small outcrop of light-gray to white dolomite. This very probably is the continuation under overburden of the beds composing deposit 3, also the southward extension of deposit 4. The stratigraphic thickness of the deposit above the terrace on the east is about 124

feet. The dolomite is overlain by gray limestone, although the contact is marked by a narrow interbed of sandy dolomite.

About 575,000 tons of dolomite may be quarried with little or no stripping of overburden being necessary.

Summary of tonnage

For the 10 deposits in the district there has been estimated a total of about 290,000,000 short tons of dolomite, of which about 251,000,000 tons are from 4 deposits represented by 44 analyses, including 32 of high-purity dolomite. It is to be emphasized that these estimates of tonnage are made in advance of drilling, and that they are not all of high-purity dolomite.

OLD FORT SPOKANE AREA

GENERAL STATEMENT

The Old Fort Spokane area is located at the north border of Lincoln County about 45 miles west-northwest of Spokane and some 25 miles north-northwest of Davenport. (See fig. 1.) It is most easily reached from Spokane via U. S. Highway 10 to Davenport, thence via State Highway 22.

The main topographic features are the Spokane and Columbia valleys, which divide the Columbia Plateau on the south (elevation about 2,500 feet) from a low mountainous terrane on the north. Immediately to the southeast of the area, on the south side of the Spokane River, is Pitney Butte, which rises 500 to 1,000 feet above the general level of the plateau.

GEOLOGY

Metasedimentary rocks

A quartzite formation at least 3,000 feet thick is exposed on the north and west slopes of Pitney Butte as well as in a knob on the north side of the Spokane River. It underlies the dolomite. Other quartzite beds are exposed farther east along the Spokane River and along the lower slope of Pitney Butte. Rather than being a possible continuation of the quartzite section to the west they are more likely to be extensions of the Deer Trail group to the north in Stevens County.[1]

Most of the dolomite formation is included in the area mapped for this report, extending along the south side of the Spokane River for 1½ miles northeast from Miles. A few outcrops are found along the west side of Pitney Butte at the margin of the highest terrace (elevation about 1,950 feet) and one other on the north side of the Spokane River at the west end of the quartzite knob already mentioned.

Both the dolomite and quartzite immediately underlying are very probably strike continuations of the Old Dominion limestone and Addy quartzite from Dunn and Huckleberry mountains in

[1] Weaver, Charles E., Mineral resources of Stevens County: Washington Geol. Survey Bull. 20, pp. 59-61, 1920. Bennett, W. A. G., Preliminary report on magnesite deposits in Stevens County: Washington Div. Geology Rept. of Inv. 5, pp. 7-8, 1941.

southwestern Stevens County. The Addy and Old Dominion contain fossils of Cambrian age.

Igneous rocks

A considerable part of the area including and immediately surrounding Pitney Butte, and including that north of the Spokane River is occupied by a batholith, which in Stevens County has been called the Loon Lake granite. It is intrusive into the metasedimentary formations, including the dolomite. Dikes, perhaps in places sills, of felsite porphyry are associated with the batholith and occur partly in the quartzite but mostly in the dolomite, particularly in its lower portion.

The basalt of the Columbia Plateau, although not known to cover the dolomite, caps granite at about the same level a quarter of a mile toward the west.

Structure

Both the dolomite and quartzite constitute the steeply-dipping west limb of an anticline that strikes generally north-northeast. The quartzite is in places overturned toward the west. The west side of the dolomite is either involved in a large-scale drag fold or is repeated in part by faults across the strike. Perhaps the latter alternative is the most plausible.

THE DOLOMITE DEPOSIT

Location, size, and access.—The Old Fort Spokane dolomite (see pls. 8 and 9) lies on the south side of the Spokane Valley between 3 and 4½ miles above its junction with the Columbia Valley. It is an area comprising four groups of outcrops about 1½ miles long and less than half a mile wide extending from the village of Miles northeastward through secs. 15, 16, 21, and 22, (28-36 E.). State Highway 22 connects the area with Davenport, the nearest railroad point, lying 26 miles to the south-southeast. More or less abandoned farm roads lead eastward from Miles along the north side of the area, eventually ending at the edge of the backwater from Coulee Dam.

Ownership.—As shown by the county recorder's records in Davenport the dolomite in the W½NW¼SW¼, and SW¼SW¼ sec. 15, in the S½NE¼SE¼, E½SW¼SE¼, and SE¼SE¼ sec. 16, and in the NW¼NW¼NW¼ sec. 22 is owned by the Pacific Coast Marble Co. The NW¼SW¼ sec. 21 is owned by W. F. Pierce, and the remaining outcrops, located in the N½NE¼SW¼, SE¼NW¼, S½NE¼NW¼, SW¼NE¼, NW¼NE¼, and NE¼NE¼ of sec. 21 belong to Carl A. Olsen.

Topography.—The deposits lie mainly between elevations of 1,500 and 1,900 feet, or between 200 and 600 feet above the backwater from Coulee Dam. The maximum relief is at the east end of the area. Several terraces of sand are found along the Spokane Valley in this locality at elevations of about 1,420, 1,510, 1,575, and 1,800, the highest of all being at about 1,950. Numerous gullies, some of them rather wide and deep, have been cut across the terraces, and in places in their bottoms bedrock is exposed.

Description.—The various outcrops of dolomite are presumably protruding knobs of a much larger mass that lies beneath sandy overburden. Their trend is northeast across the strike of essentially vertical beds which strike between north-northeast and north-northwest. The mass appears to be 5,000 to 6,000 feet thick of which 2,000 feet on the west may have been repeated by faults.

To the southeast the dolomite is underlain by quartzite which makes up Pitney Butte.

Granite intrudes the dolomite at both ends of the area, and is exposed at many other places in the immediate vicinity. This and various other evidence indicate that the granite is not far below anywhere throughout the area.

The four groups of outcrops, designated A, B, C, and D (west to east) on the maps contain small individual knobs, but all are close enough together to indicate a fairly large body covered by a relatively shallow cover of overburden. The largest mass in group A is 1,700 by 350 feet. The overall dimensions of the mass in group B are 1,750 by 700 feet; those in group C, 750 by 450 feet; and those in group D, 2,300 by 1,300 feet.

The dolomite, or dolomitic marble, ranges from white, through light gray, gray, tan, and red, but most of it is white and medium to coarse grained. Some of it is schistose with grains oriented parallel to bedding.

The recrystallization of the dolomite mass was accompanied by the development of new minerals, including some ore minerals in the Crystal mine, which lies in group A and shows several small replacement ore bodies together with areas of disseminated ore. The ore bodies consist of galena, pyrrhotite, chalcopyrite, and pyrite. Other minerals include kaolin, a pearly white micaceous mineral, which often occurs with tremolite.

The dolomite mass includes a lime-silicate body between 50 and 100 feet thick, and several porphyry sills 35 to 75 feet thick.

Structure.—In the westernmost outcrop area of body A (see pl. 8) the dolomite and accompanying lime silicate strike N. 20° E. with steep westerly dips. In the next outcrop area to the east the strike remains the same but the beds are dipping steeply to the east. The dolomite beds of body B are nearly vertical and the strike varies from N. 20° E. to N. 10° E. At body C the strike is N. 80° E. with steep easterly dips. At the western end of body D the beds strike N. 10° E. and dip 82° W.; in the center the strike has changed to N. 3° W., and the dip is still steep to the west. At the eastern edge of the body the steep west dip persists but the strike swings to N. 25° W. Body C is apparently a strike continuation of body B. No minor flexures were noted.

An examination of the underground workings of the Crystal mine indicate that there has been considerable minor faulting in the area. Some of the contacts between the felsite porphyry and its border rocks near body A are fault contacts. A fault contact between the lime silicate and the dolomite appears in the adit. From the surface distribution of the dolomite and its associated rocks, it

is apparent that the dolomite has been faulted horizontally several times at nearly right angles to the strike. Body B is the south-faulted continuation of body A. The westernmost outcrops of body D are south-faulted continuations of body C. These two faults are undoubtedly nearly parallel to one another. A possibility exists that there is another fault parallel to the first two between the westernmost outcrop of body D and the rest of body D, having an offset to the south of about half a mile.

Sampling and analyses.—Of samples 445-500 taken from the deposit (see pls. 8 and 9) Nos. 447-449, 458-460, and 467-469, inclusive, have been analyzed and represent outcrop groups A, C, and D respectively.

ANALYSES OF OLD FORT SPOKANE DOLOMITE

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)	Remarks
447	46.20	1.28	.56	30.87	21.09	Group A outcrops upper part of formation
448	45.65	1.84	.84	30.92	20.75	
449	46.63	.68	.47	31.03	21.19	
458	46.69	.31	.46	31.33	21.21	Group C
459	46.30	.80	.80	31.05	21.05	
460	46.54	.72	.52	30.67	21.55	
467	46.75	.39	.40	30.80	21.66	Group D
468	46.33	.64	.66	30.95	21.42	
469	46.71	.54	.44	30.81	21.50	

Tonnage estimate.—An accurate tonnage estimate at this deposit becomes relatively difficult because of the several unknown quantities involved. Although unknowns are generally always to be reckoned with in any tonnage estimation, a glance at the map will reveal the major difficulty. The covered areas are uncommonly large. With this fact in mind, a minimum estimate of about 28,000,000 tons was obtained. The distribution is as follows: Body A, 1,100,000; body B, 1,800,000; body C, 1,300,000; body D, 23,800,000.

A maximum estimation, based on the assumption that several fairly closely spaced outcrops are continuous beneath a thin cover of sand, gives a total of 53,400,000 tons. In this second estimation bodies B and C were assumed to be one, and a maximum area, as controlled by outlying crops, was assumed for D. Body A was not affected materially in total tonnage; however, the sum of bodies B, C, and D was doubled in tonnage. The area for the maximum estimation of body D is shown on the map (pl. 9). For bodies A, B, and C the minimum areas are shown. (See pl. 8.)

Although this second estimate is called a maximum, it is entirely possible that systematic mining will uncover far more dolomite for which there are no present surface indications. A mining level of 50 to 75 and possibly 100 feet deeper is practical at body D, if condi-

tions prove favorable. A 100-foot increase here would still leave the base of the quarry 100 feet above the lake level or at about the 1,400-foot elevation. This would bring body D's tonnage alone to about 75,000,000.

Quarry sites.—Quarry sites will somewhat depend upon the magnitude of the operations involved. If a limited amount of dolomite (somewhat less than the minimum tonnage estimate) is to be extracted with the least removal of overburden, then eight possible small quarry sites are available.

At body A the quarry would be located 800 feet northeast of the Crystal mine at the 1,520-foot level.

At body B the quarry would be started 400 feet north of the center of sec. 21 at the 1,600-foot level.

Body C could be most easily handled by a quarry in the SW. cor. NW¼NE¼ sec. 21.

Body D has five possible small quarrying units. The westernmost is located 1,300 feet west and 600 feet north of the NE cor. sec. 21. This quarry is ideally suited for direct gravity feed from the quarry face to the lake. The next possible small quarrying unit is 1,500 feet north and 600 feet west of the NE. cor. sec. 21.

Probably a slightly larger tonnage will be available with very little removal of overburden at the next quarry site 1,100 feet north and 200 feet west of the NE. cor. sec. 21.

Five hundred feet northeast of the last-mentioned quarry site is another easily available mass, which may, however, require a little more removal of overburden. These last two sites could best be combined as one large quarry with a 900-foot working face, the westernmost "felsite" sill forming the eastern wall of the quarry.

Between this sill and the next sill to the east lies a mass of dolomite 200 feet wide which should be rather easily extracted.

From surface observations it seems entirely practical to combine all the small quarry sites mentioned for body D into one huge operation with the exception of the inter-sill mass which would perhaps be best extracted separately.

Drilling and development.—The quarrying of the deposit as a whole will be handicapped by extensive sandy overburden, which may be too thick in some places to be economically removed, whether by pumping and hydraulicking or by other methods. Where there are numerous separate outcrops, as in group D (see pl. 9), the overburden probably is relatively shallow. To test this part by drilling, it is suggested that a hole be drilled due east from the open cut at the location of sample 471 and at an angle of 20° for 600 feet. The bottom of the hole should be on lake level and under the outcrop with a small open cut. A second hole started there and drilled due east for 500 feet at 40° should extend to lake level again and stop in beds that crop out in the area represented by samples 488-497. A third hole started on the west side of the area represented by samples 488-497, and drilled east at 30° for 600 to 800 feet, or until the porphyry dike is reached, should, together with the first two

holes, present a complete 2,000-foot section across this part of the dolomite formation.

A fourth hole located about 600 feet northeast of the portal of the Crystal mine adit (group A) and drilled due east at an angle of 15° for 1,150 feet would stop on about lake level and under the westernmost outcrop of group B. A fifth hole started there and drilled due east at an angle of 45° for 700 feet would penetrate to lake level again at a point about 200 feet west of the center line of sec. 21.

A sixth hole started 200 feet west of the center of sec. 21 and drilled due east at an angle of 30° for 1,000 feet would extend to lake level at a point 600 feet beneath the outcrop which lies 600 to 850 feet east of the center of sec. 21.

These six holes would fall about 600 feet short of completing a record across the entire deposit. There is an alternative interpretation that beds in group A are more or less the same as those in group B due to repetition by either folding or faulting, but in either case the ground remains to be tested, so holes 4 and 5 are therefore recommended to be drilled as already indicated.

ADDY DISTRICT

GENERAL STATEMENT

The Addy dolomite district lies in central Stevens County about 70 miles north-northwest of Spokane (see fig. 1), with which it is connected by U. S. Highway 395 and a branch of the Great Northern Railway. It is partly included in the north half of the Chewelah quadrangle of the U. S. Geological Survey, and is defined roughly as those areas underlain by the Old Dominion limestone and drained by Stranger and Haller creeks. Addy, the railroad point, is situated on the Colville River just south of its junction with Stranger Creek. Dunn Mountain (elevation 5,340 feet) is the dominant physical feature, rising about 3,700 feet above Addy and between 1,000 and 1,500 feet above hills and ridges underlain by dolomite to the northwest and northeast.

GEOLOGY

The three principal formations that need to be mentioned in connection with the dolomite deposits are the Addy quartzite, the Old Dominion limestone, and the Chewelah argillite. These formations, named in order of age (Cambro-Ordovician), were originally named and described by Weaver[1] and by Jones[2] and will be described only briefly here.

Addy quartzite

The Addy quartzite makes up most of Dunn Mountain, 6 miles west of Addy, parts of hills and low mountains immediately surrounding the town, and the east end of the ridge that extends northwest from sec. 3, (33-39 E.). It is well bedded, banded, reddish to

[1] Weaver, Charles E., The mineral resources of Stevens County: Washington Geol. Survey Bull. 20, pp. 61-68, 1920.

[2] Jones, R. H. B., Notes on the geology of the Chewelah quadrangle, Stevens County, Washington: Northwest Sci., vol. 2, pp. 111-116, 1928; Geology and mineral resources of the Chewelah quadrangle (unpublished manuscript in files of Division of Geology).

grayish white, generally even grained in most of its exposures, although in its upper part there is a zone hundreds of feet thick that consists of alternating quartzite and argillite. This zone grades by increasing calcareous content into the overlying Old Dominion limestone. The Addy is at least 5,000 feet thick. Fossils, including trilobite fragments and brachiopods, have been found about 1,500 feet below the top of the Addy at the south end of the ridge west of town, and Lower Cambrian fossils have been found in overlying limestone beds[1] so that its age is no younger than the Lower Cambrian.

Old Dominion limestone

The Old Dominion limestone extends from Addy northwestward for 5 miles along the Stranger Creek Valley to sec. 32, (34-39 E.) where the trend of outcrop swings northward for 4 miles as a strip about a quarter of a mile wide. The principal area of outcrop, however, is in the eastern part of Tps. 32, 33, and 34 N., R. 38 E., to the north, west, and south of Dunn Mountain.

Most of the rock is a white, grayish-white to gray banded dolomite. In places it is fine grained, but is generally of medium to coarse texture as a result of intrusive granitic masses. In places where the rock is recrystallized there are coarser lenses or vein-like masses which lie parallel to bedding. Where contact metamorphism is strong, especially in zones apparently containing considerable silica of original sedimentary origin, more or less tremolite has been formed.

In at least three places the base of the formation is made up of limestone or sandy limestone with limy argillite up to about 400 feet thick. This zone is gradational into the underlying Addy quartzite.

The age of the Old Dominion is Cambrian, as it contains definite Lower Cambrian fossils in its lower part and is overlain by Ordovician graptolitic argillite.

Chewelah argillite

The Chewelah argillite is principally exposed in the district north of Stranger Creek along the west side of T. 34 N., R. 39 E., and along the divide west of Dunn Mountain. It consists mostly of black and gray slaty argillite.

Structure

The Old Dominion and underlying Addy quartzite are involved in a broad synclinal fold that trends northward between Addy and Dunn Mountain. Dunn Mountain is on a faulted anticline that pitches northward. This fault was described by Jones as being at the base of the Addy, but it involves other rocks that are older than the Addy, and these have been faulted up into essential juxtaposi-

[1] Branson, C. C., New paleontological evidence on the age of the metamorphic series of northeastern Washington: Science, new ser., vol. 74, p. 70, 1931.

tion with the Chewelah argillite, cutting out the Old Dominion and making the amount of displacement at least 10,000 feet.

DOLOMITE DEPOSITS

Deposit 1

Location, size, and access.—Deposit 1 (see pls. 10 and 11), near Dunn Mountain, was quarried about 40 years ago for building stone by the old Crystal Marble Company. It is located about 11 miles west-northwest of Addy, the nearest railroad station, and underlies about 225 acres in secs. 34 and 35, (34-38 E.). It can be reached from Addy via the Stranger Creek road, or from Colville, 13 miles toward the northeast, via the Haller Creek road.

Ownership.—The county recorder's records in Colville show that the N½NW¼ (enclosing the old quarries) and W½W½NE¼ in sec. 35 are owned by W. G. Merryweather of Spokane; the S½NW¼ and W½SW¼ are owned by Essie Taylor; and the remainder of the deposit in sec. 34 is owned by L. E. Gotham.

Topography.—The dolomite lies between 2,300 and 2,900 feet in elevation, forming the end of a broad northeastward-sloping timbered ridge which is drained by Stranger Creek and its tributaries.

Description.—The dolomite forms the upper 3,600 feet of the Old Dominion limestone of Weaver (Cambrian), which in this locality is about 4,000 feet thick stratigraphically. It is underlain by marble and argillaceous limy beds which grade into the underlying Addy quartzite of Dunn Mountain, and it is overlain by the Chewelah argillite of Weaver which includes minor impure basal beds of limestone.

The dolomite is dominantly light gray to white with minor banding or mottling in the center, and is medium to coarsely crystalline.

Tremolite, the chief impurity, is most abundant in the upper 1,000 feet of a 1,400-foot stratigraphic zone that lies between the old quarries and the county road on the southeast, and is least abundant above that zone, especially the first 600 feet of beds including all but one of the old quarries. (See pl. 10.) It occurs finely disseminated, or in coarser irregular vein-like segregations that usually lie parallel to bedding. Both types may occur together in the same bed, and there may be an alternation of tremolitic with non-tremolitic beds.

Structure.—Beds that generally strike north-northeast with 40°-50° northwest dips on the east side of the deposit gradually change to a north-northwest strike with 50°-60° southwest dips on the west side. Local variations from these trends seem to result from drag folds, which are particularly common in the area between the old quarries and the county road.

Sampling and analyses.—The deposit is represented by samples 501-543 inclusive, which have been taken across the northeast end. (See pl. 10.) Of these, 501, 508, 509, 515, 522, 524, 530, 531, and 533 have been analyzed, and are included in the subjoined table.

ANALYSES OF DOLOMITE NEAR DUNN MOUNTAIN

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)	Remarks
501	45.95	2.50	.42	30.22	20.91	Base of 400-foot zone, near road
508	38.29	13.00	5.56	25.79	17.36	Base of 1,000-foot zone
509	41.42	9.28	3.32	27.18	18.80	Middle of lower half of 1,000-foot zone
515	36.79	14.78	6.50	25.16	16.77	Base of upper half of 1,000-foot zone
522	46.73	.60	.38	31.01	21.28	Base of 600-foot high-grade zone
524	46.68	.68	.42	30.82	21.40	In old quarry; high-grade zone
530	46.84	.36	.34	30.88	21.58	About center of high-grade zone
531	47.15	.44	.60	30.42	21.39	Upper part of high-grade zone
533	47.17	.44	.48	30.62	21.29	Top of 600-foot zone

Tonnage estimate.—Approximately 200,000,000 tons have been estimated for the entire deposit, of which about 2,000,000 tons, regarded as of fair grade, are contained in the lower or 400-foot zone; 30,000,000 tons of lower grade in the 1,000-foot zone; 45,000,000 tons in the high-grade zone; and 135,000,000 tons in the upper or major portion of the deposit, which is not represented by samples but may contain in places considerable high-grade dolomite.

Quarry sites.—Before selecting the site for a quarry the high-grade dolomite, indicated near the old quarries, should be drilled along the zone that is roughly outlined on the map. (See pl. 10.) If this zone is generally low in silica throughout, the southern alternative for a quarry site should be selected, because of greater accessibility, room for buildings and equipment, and a lower floor level above overburden.

Drilling.—On the maps (see pls. 10 and 11) is shown the location, direction, and projected length of suggested diamond drill holes. They are arranged to give a complete stratigraphic section in a zone apparently of high-grade or high-purity dolomite at three places along the strike, and above a quarrying level considered to be that of the county road on the south.

Deposit 2

Location, size, and access.—Deposit 2 is located immediately northwest of Addy on the opposite bank of the Colville River. It includes an area of about 130 acres in secs. 11, 12, 13, and 14, (33-39 E.), of which the eastern side, next to the Great Northern Railway, has been mapped. (See pl. 12.)

Ownership.—A. B. Lind owns the NW¼NW¼ sec. 13 and NE¼NE¼ sec. 14; Emma Weatherman, the SW¼SW¼ sec. 12; and Cecil Parker, the E½SE¼ sec. 11, (33-39 E.).

Topography.—The dolomite makes up the north half of a broad partly timbered ridge, about 1½ miles long, which lies mainly between 1,630 and 1,800 feet in elevation. A part of it on the west that lies between projecting knobs and low ridges is cultivated.

Description.—Of many scattered outcrops all, except an andesitic dike, are dolomite. About 2,000 feet of beds are exposed, and these represent the lower part of the Old Dominion limestone. They are underlain at the south end of the ridge by an argillaceous upper phase of the Addy quartzite. Between the outcrops of quartzite and dolomite, however, is glacial drift which presumably conceals about 400 feet of beds and together with alluvium surrounds the deposit.

Most of the dolomite is light gray or gray and is fine to medium grained. It shows little if any recrystallization, and no secondary metamorphic minerals.

Structure.—Beds at the south strike N. 40° E. and dip 40° NW., the same as the underlying Addy quartzite, but toward the west they flatten to 25° or 30°. On the north they flatten still more and their strike swings toward the north.

Sampling and analyses.—Eight samples (544-551) have been collected beginning on the southeast at the edge of the alluvium. Between the ends of the row of samples (see pl. 12) is represented a section about 800 feet thick, of which about 300 feet is beneath a field. That this portion, however, is dolomite is indicated by several dolomite outcrops that are exposed in a strikewise direction (northeast) at the edge of the alluvium.

ANALYSES OF DOLOMITE NEAR ADDY

Sample number	Ignition loss	Insoluble	R_2O_3	CaO	MgO (calc.)	Remarks
544	46.68	1.52	.56	30.03	21.21	Basal 100 feet of dolomite
545	46.09	2.80	.52	29.68	20.91	
546	47.26	.36	.44	30.50	21.44	From 210–430 feet above base
547	47.00	.76	.56	30.41	21.27	
548	46.95	.68	.76	30.32	21.29	
549	47.00	.72	.64	30.33	21.31	
550	47.16	.50	.60	30.21	21.53	From 750–800 feet above the base
551	47.10	.40	.56	30.52	21.42	

Tonnage estimate.—The area underlain by dolomite, including some farm land, above the alluvial flat on the east is about 3,700 feet by 2,100 feet. For calculation an estimated depth factor of 100 feet has been used. Such a block contains about 68,000,000 short tons of

dolomite. A strip along the east side 2,600 feet long and 600 feet wide, including about 10 acres of farm land, contains about 13,700,000 tons.

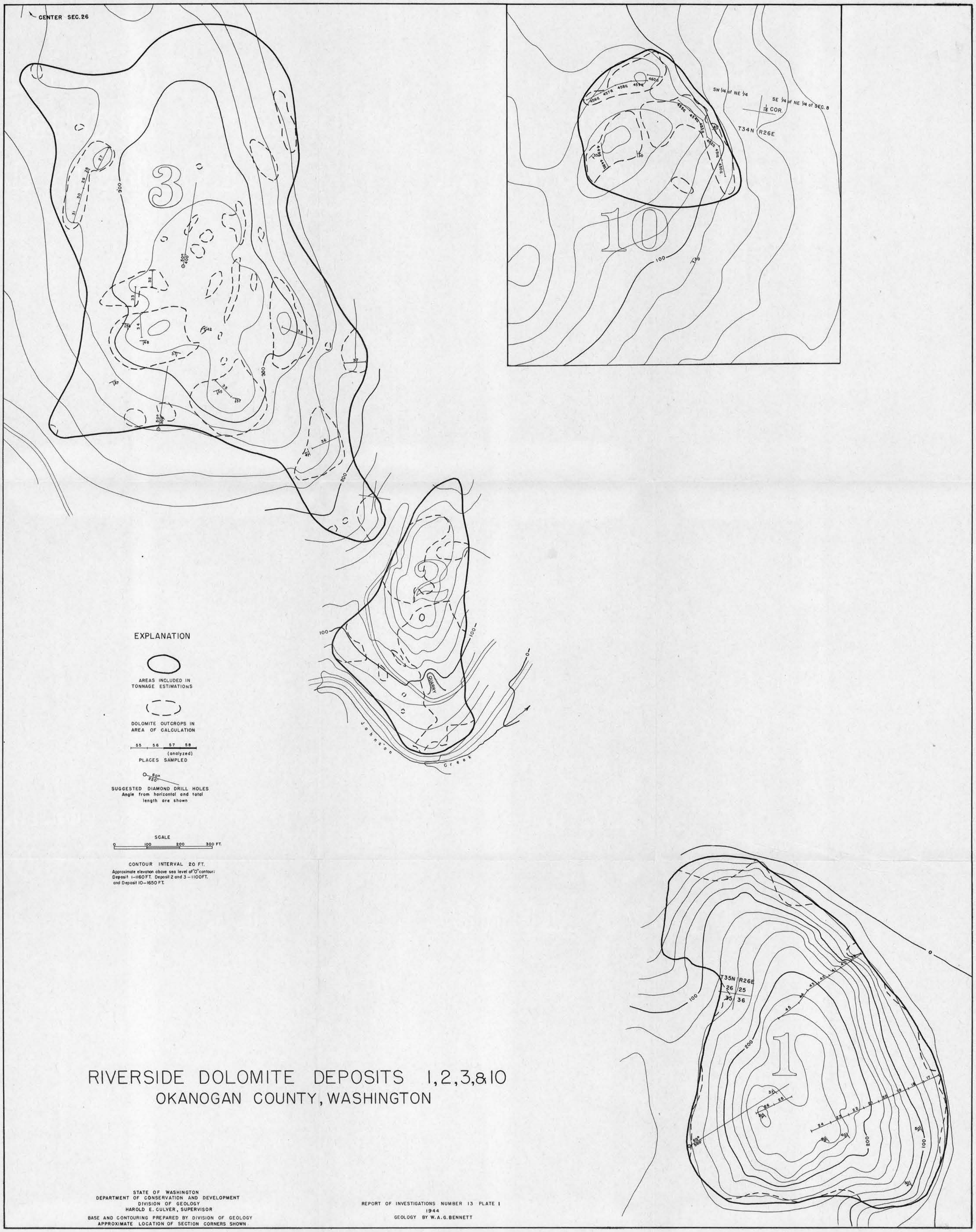
Quarry sites.—A quarry opened near the center of the ridge on the east side, at the mouth of the prominent gully (see pl. 12), would be nearest to the railroad and highway. It could be expanded in three directions with a 150- to 175-foot face and its entrance would be located between two closely swinging meanders of the Colville River.

Drilling.—On the map (see pl. 12) are three diamond drill hole locations showing the direction, angle, and projected length for each. They are arranged so that 780 continuous stratigraphic feet may be tested down to the most siliceous beds represented by samples 544 and 545.

Summary of tonnage

Of the 268,000,000 tons of dolomite estimated for both deposits 1 and 2, 63,000,000 tons is represented to some extent by samples and is considered to be high-grade or high-purity dolomite. About 185,000,000 tons is not represented by samples but is probably of high grade.

RIVERSIDE DOLOMITE DEPOSITS 1, 2, 3, & 10
OKANOGAN COUNTY, WASHINGTON



EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

DOLOMITE OUTCROPS IN AREA OF CALCULATION

55 56 57 58 (analyzed)
PLACES SAMPLED

60° 220'
SUGGESTED DIAMOND DRILL HOLES
Angle from horizontal and total length are shown

SCALE
0 100 200 300 FT.

CONTOUR INTERVAL 20 FT.
Approximate elevation above sea level of "0" contour: Deposit 1 – 1160 FT. Deposit 2 and 3 – 1100 FT. and Deposit 10 – 1650 FT.

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR
BASE AND CONTOURING PREPARED BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

REPORT OF INVESTIGATIONS NUMBER 13 PLATE I
1944
GEOLOGY BY W. A. G. BENNETT

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 10
1944

EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

DOLOMITE OUTCROPS IN AREA OF CALCULATION

55 56 57 58 (analyzed)
PLACES SAMPLED

60°
220'
SUGGESTED DIAMOND DRILL HOLES
Angle from horizontal and total length are shown

SCALE
0 100 200 300FT.

CONTOUR INTERVAL 20 FT.
Approximate elev. of "0" contour is 2300ft. above sea level

QUARRY
CENTER NW 1/4 of SEC. 35
SEC. 26 1/4 COR
SEC. 35
T34N R38E

BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

ADDY DOLOMITE DEPOSIT I, EAST HALF
STEVENS COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE II
1944

EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

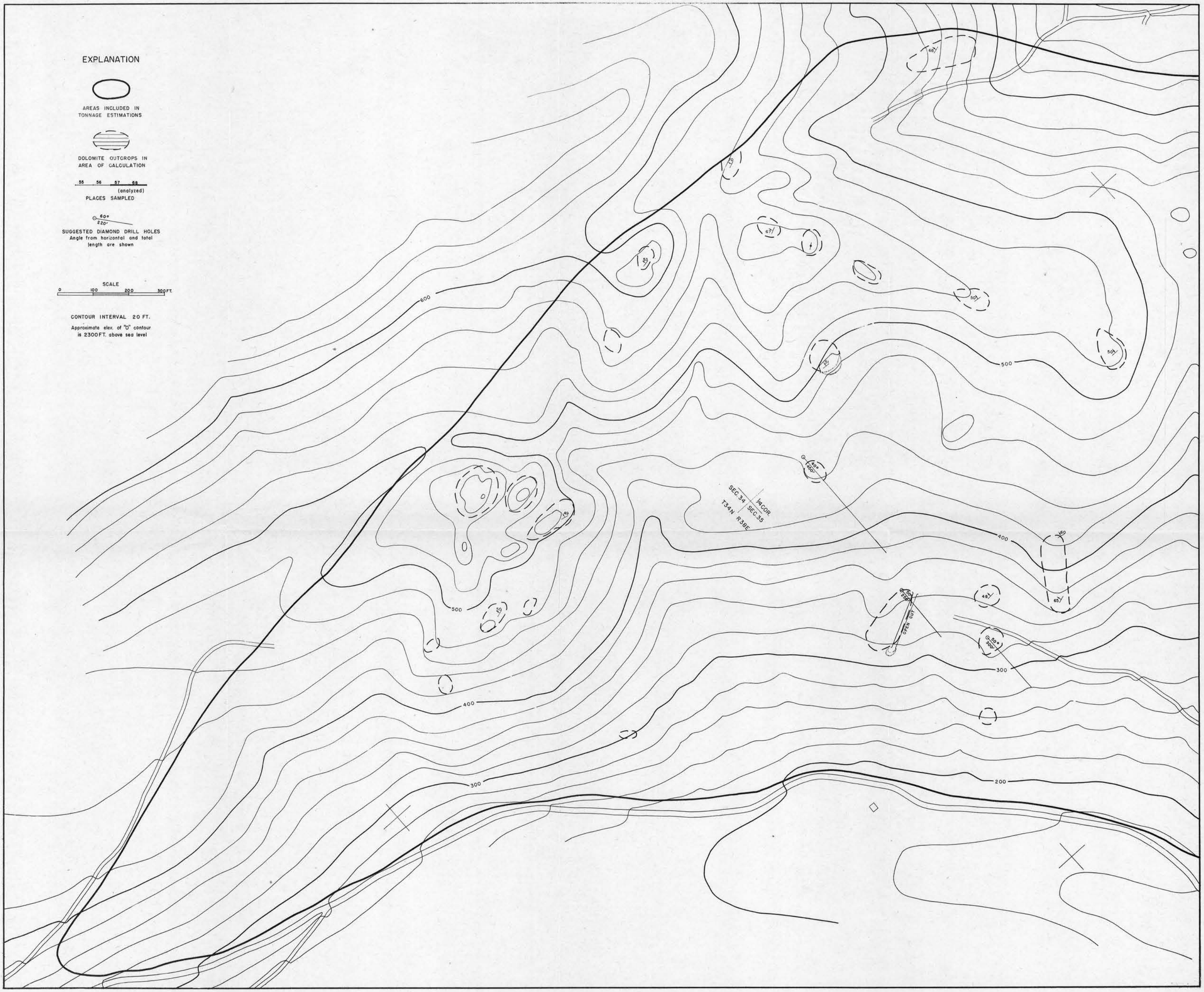
DOLOMITE OUTCROPS IN AREA OF CALCULATION

55 56 57 58
(analyzed)
PLACES SAMPLED

60°
220'
SUGGESTED DIAMOND DRILL HOLES
Angle from horizontal and total length are shown

SCALE
0 100 200 300 FT.

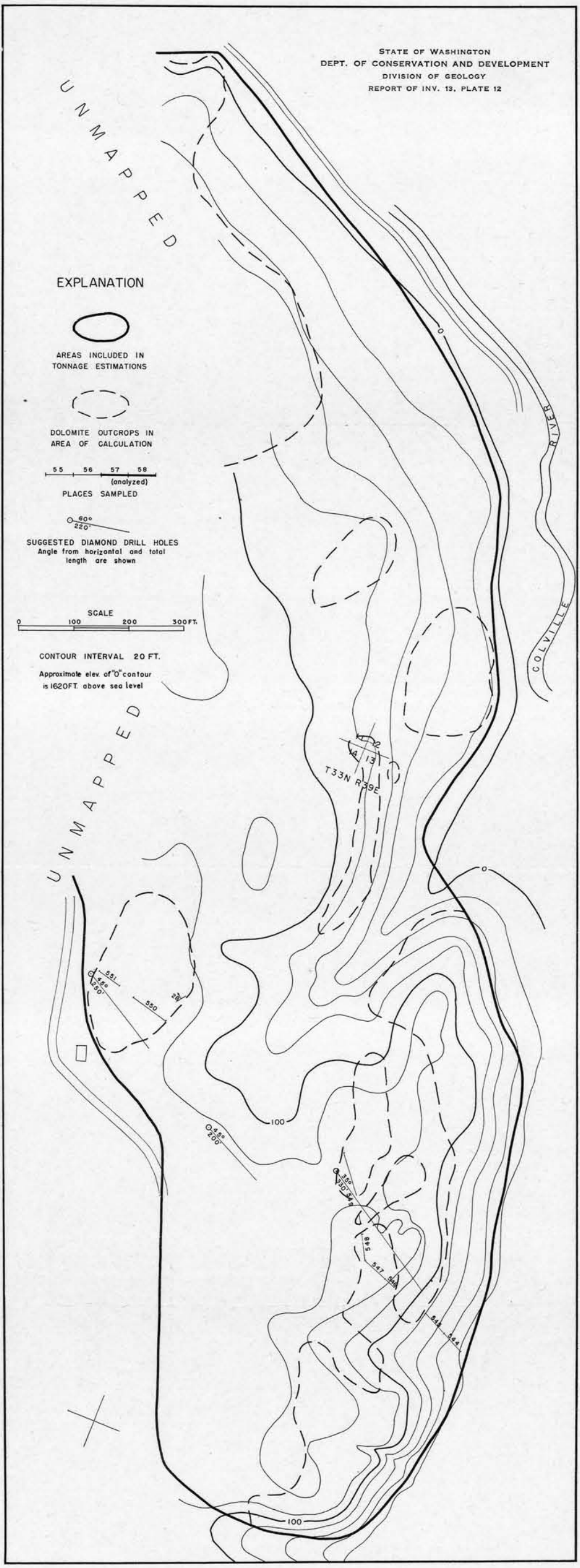
CONTOUR INTERVAL 20 FT.
Approximate elev. of "0" contour is 2300 FT. above sea level



BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

ADDY DOLOMITE DEPOSIT I, WEST HALF
STEVENS COUNTY, WASHINGTON



BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

ADDY DOLOMITE DEPOSIT 2
STEVENS COUNTY, WASHINGTON

RIVERSIDE DOLOMITE DEPOSIT 4
OKANOGAN COUNTY, WASHINGTON

EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

DOLOMITE OUTCROPS IN AREA OF CALCULATION

OUTCROPS OTHER THAN DOLOMITE IN AREA OF CALCULATIONS

55 56 57 58 (analyzed)
PLACES SAMPLED

60° 220'
SUGGESTED DIAMOND DRILL HOLES
Angle from horizontal and total length are shown

SCALE
0 100 200 300 FT.

CONTOUR INTERVAL 20 FT.

Approximate elev of "0" contour is 1350 ft. above sea level

Lake

FAULT

FAULT

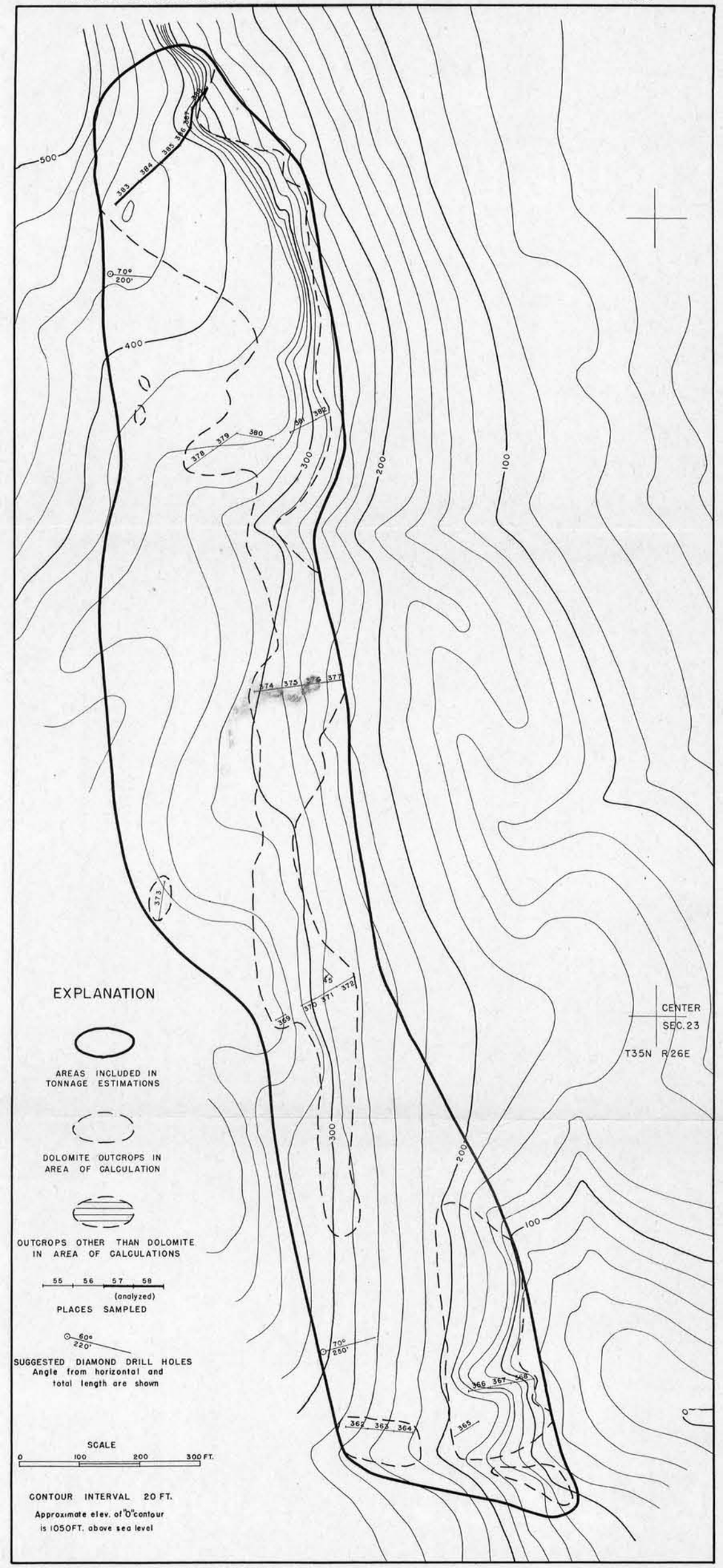
22 | 23
27 | 26
T35N R26E

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR
BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

REPORT OF INVESTIGATIONS NUMBER 13 PLATE 2
1944
GEOLOGY BY W. A. G. BENNETT

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 3
1944



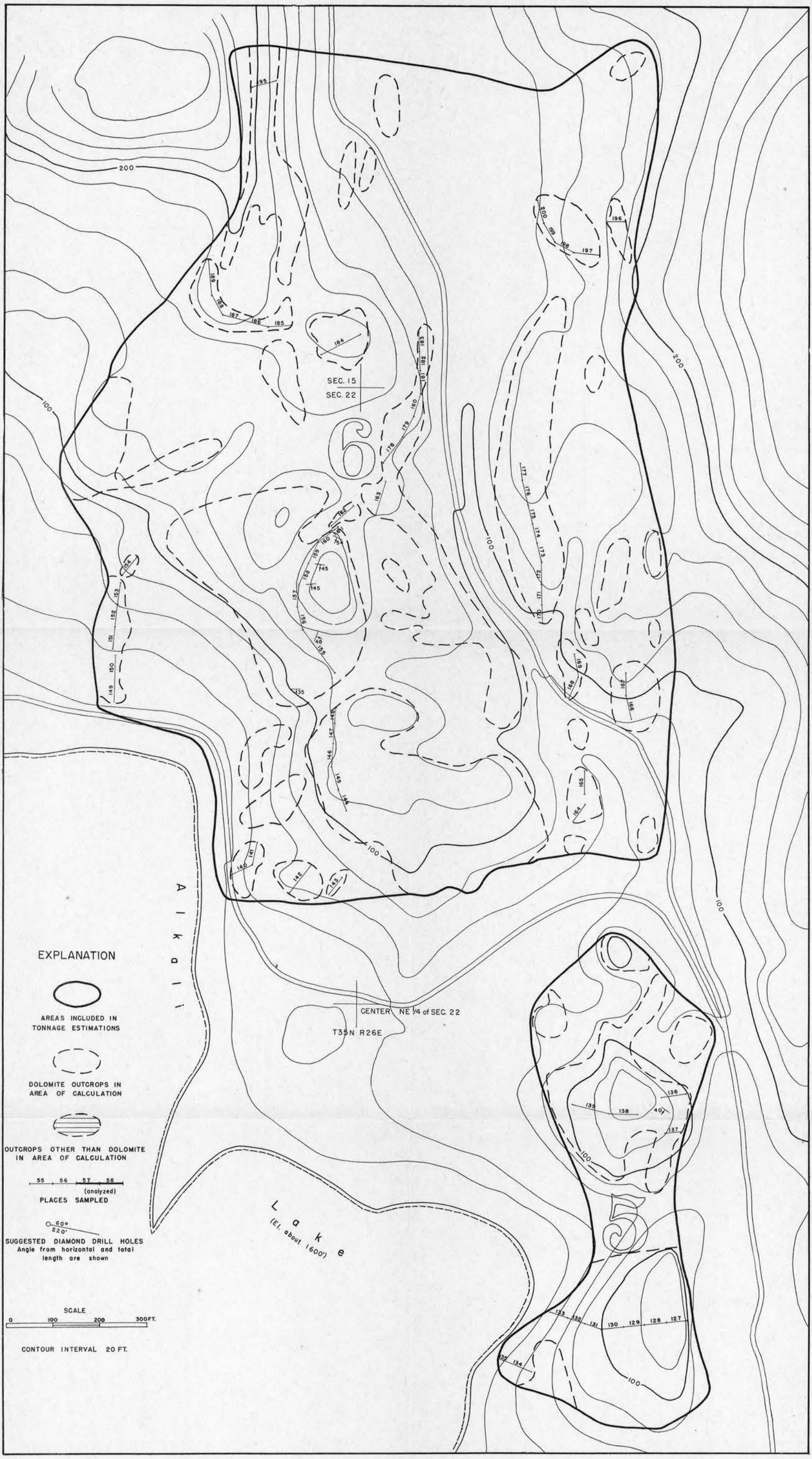
BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

RIVERSIDE DOLOMITE DEPOSIT 8
OKANOGAN COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 4
1944



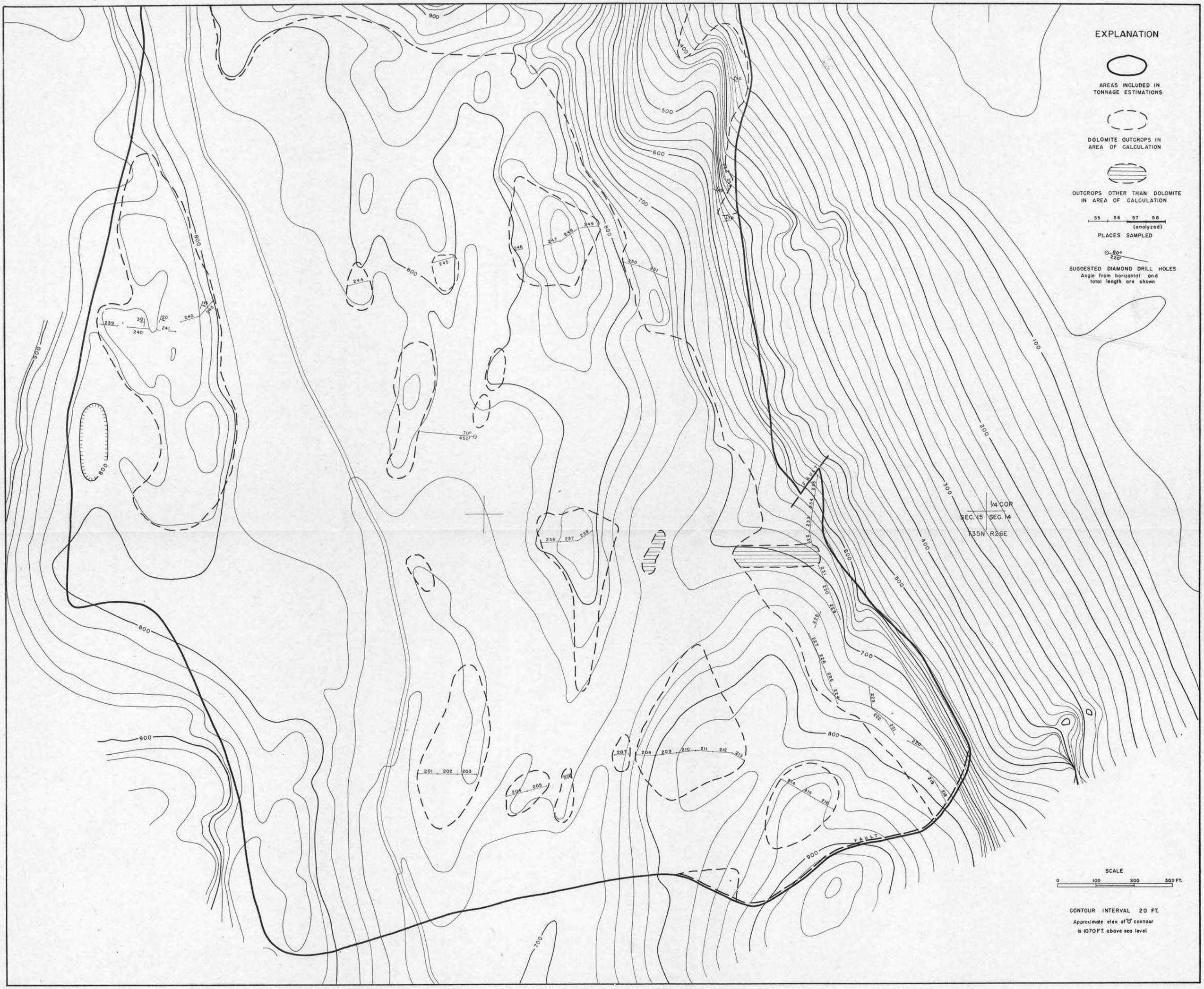
BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

RIVERSIDE DOLOMITE DEPOSITS 5 AND 6
OKANOGAN COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 5
1944



BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

RIVERSIDE DOLOMITE DEPOSIT 7, SOUTH HALF
OKANOGAN COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 6
1944

RIVERSIDE DOLOMITE DEPOSIT 7, NORTH HALF
OKANOGAN COUNTY, WASHINGTON

EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

DOLOMITE OUTCROPS IN AREA OF CALCULATION

55 56 57 58
(analyzed)
PLACES SAMPLED

60°
220'
SUGGESTED DIAMOND DRILL HOLES
Angle from horizontal and total length are shown

SCALE
0 100 200 300FT.

CONTOUR INTERVAL 20 FT.

Approximate elev. of "0" contour is 1070 FT. above sea level

CENTER SE 1/4 of SEC. 10

1/4 COR.
SEC. 10 | SEC. 15
T35N R26E

TO RIVERSIDE

BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 7
1944

1/4 COR.
SEC. 3
SEC. 10
T35N R26E

Booher's
Lake
(El. about 1075')

TO U.S. HY. 97

CENTER SEC. 10
T35N R26E

EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

DOLOMITE OUTCROPS IN AREA OF CALCULATION

OUTCROPS OTHER THAN DOLOMITE IN AREA OF CALCULATION

55 56 57 58
(analyzed)
PLACES SAMPLED

SCALE
0 100 200 300 FT.

CONTOUR INTERVAL 20 FT.

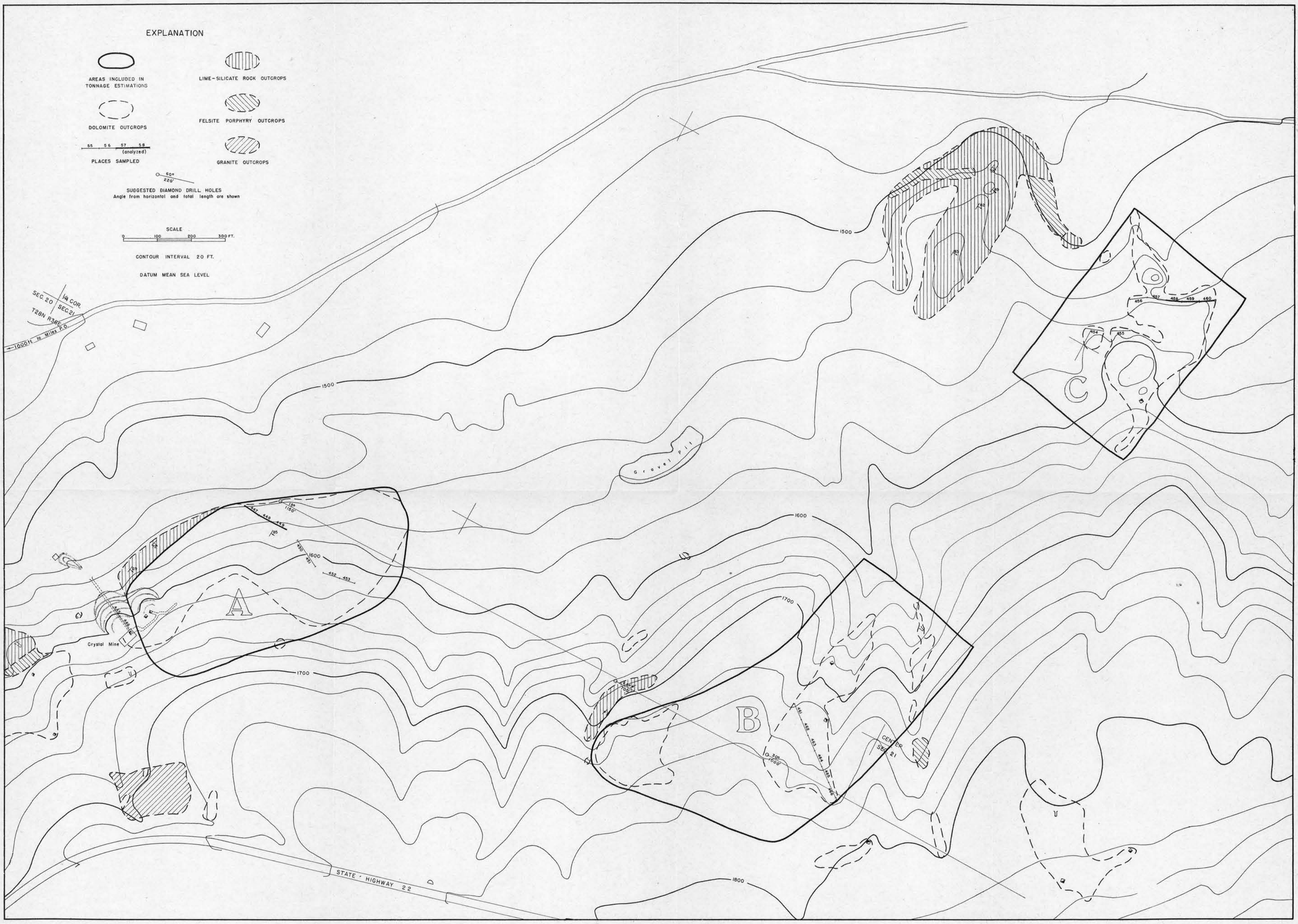
BASE AND CONTOURING BY DIVISION OF GEOLOGY
APPROXIMATE LOCATION OF SECTION CORNERS SHOWN

GEOLOGY BY W. A. G. BENNETT

RIVERSIDE DOLOMITE DEPOSIT 9
OKANOGAN COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 8
1944



BASE AND CONTOURING BY DIVISION OF GEOLOGY

GEOLOGY BY L. T. TEIR AND R. E. STEVENSON

OLD FORT SPOKANE DOLOMITE DEPOSIT, WEST HALF
LINCOLN COUNTY, WASHINGTON

STATE OF WASHINGTON
DEPARTMENT OF CONSERVATION AND DEVELOPMENT
DIVISION OF GEOLOGY
HAROLD E. CULVER, SUPERVISOR

REPORT OF INVESTIGATIONS
NUMBER 13 PLATE 9
1944

EXPLANATION

AREAS INCLUDED IN TONNAGE ESTIMATIONS

LIME-SILICATE ROCK OUTCROPS

DOLOMITE OUTCROPS

FELSITE PORPHYRY OUTCROPS

55 56 57 58
(analyzed)
PLACES SAMPLED

60°
220'
SUGGESTED DIAMOND DRILL HOLES
Angle from horizontal and total length are shown

SCALE
0 100 200 300 FT.

CONTOUR INTERVAL 20 FT.

DATUM MEAN SEA LEVEL

BASE AND CONTOURING BY DIVISION OF GEOLOGY

GEOLOGY BY L. T. TEIR AND R. E. STEVENSON

OLD FORT SPOKANE DOLOMITE DEPOSIT, EAST HALF
LINCOLN COUNTY, WASHINGTON

State of Washington
MON C. WALLGREN, Governor
Department of Conservation and Development
ART GARTON, Director

DIVISION OF GEOLOGY
HAROLD E. CULVER, Supervisor

Report of Investigations
No. 13

Dolomite Resources of Washington

Part I--Supplement

PRELIMINARY REPORT ON OKANOGAN, LINCOLN, AND STEVENS COUNTIES

CHEMICAL ANALYSES

OLYMPIA
STATE PRINTING PLANT
1945

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INTRODUCTION

This report is presented as a supplement to Report of Investigations No. 13, Dolomite Resources of Washington, Part 1, Preliminary Report on Okanogan, Lincoln, and Stevens Counties. It contains the results of chemical analyses of 545 samples of dolomite collected during the field studies of the Riverside, Old Fort Spokane, and Addy dolomite deposits. Results of chemical analyses of 70 of the samples were given in R. I. 13, Pt. 1, and for the convenience of the reader they are again presented in this supplementary report. Field locations of all samples are shown on plates 1-12, R. I. 13, Pt. 1. The column headed "Insoluble" in the analytical tables of R. I. 13, Pt. 1, is here more properly headed "SiO_2".

As stated on page 8 of R. I. 13, Pt. 1, the samples were collected from outcrop surfaces along compass and tape traverses, and the horizontal lengths of the traverses are shown on the maps. Unweathered fragments of rock were taken every 5 feet for each sample, which usually included 50-foot lengths along the traverses. In preparation for analysis the samples were crushed to pass 3 mesh and then quartered in a riffle sampler. The quartered fractions for analysis were pulverized in a disc pulverizer to pass 80 mesh and were then thoroughly rolled. The analytical procedure was as follows: 0.5 gram samples, of the pulverized and rolled material, were ignited at 950°-1000° C. for 2.5 hours to determine the ignition loss or CO_2 content. The samples were then fused with sodium carbonate and the silica determined. The R_2O_3, including iron and alumina, was determined by the single precipitation method. The CaO was determined by double precipitation followed by permanganate titration. The MgO was determined by calculation and represents the difference between 100 and the sum of the CO_2, SiO_2, R_2O_3, and CaO percentages.

The analytical data, including percentages of ignition loss (CO_2), SiO_2, R_2O_3, CaO, and MgO, are presented in the following tables. The tables are arranged to show samples from the individual deposits as described in R. I. 13, Pt. 1. The C. M. Fassett Company of Spokane is responsible for all chemical analyses except Nos. 64, 65, and 66, which were made by the Ott Metallurgical Laboratory of Seattle.

RIVERSIDE DISTRICT

Analyses of dolomite from deposit 1

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
17	46.39	.56	1.16	29.96	21.93
18	46.77	.65	1.40	29.63	21.55
19	45.21	3.06	2.22	28.81	20.70
20	46.60	.76	1.68	29.44	21.52
21	46.11	2.00	1.34	29.54	21.01
22	45.99	2.41	1.30	29.05	21.25
23	45.49	2.74	1.42	30.82	19.53
24	45.36	2.70	1.70	30.18	20.06
25	44.21	4.74	1.96	29.25	19.84
26	44.42	4.14	1.72	30.04	19.68
39	45.72	1.70	1.88	31.14	19.56
40	46.05	1.22	1.70	31.18	19.85
41	46.01	1.03	2.00	31.36	19.60
42	45.31	2.21	2.25	31.07	19.16
43	45.43	1.60	2.70	30.78	19.49
44	44.98	2.08	3.16	30.50	19.28
45	45.66	1.77	2.10	30.75	19.72

Analyses of dolomite from deposit 2

Fifteen samples, ten of which were analyzed, were taken from deposit 2. The locations of these samples are not shown on the map of deposit 2 (plate 1, R. I. 13, Pt. 1) and at the request of the owner the analyses are not being made public.

Analyses of dolomite from deposit 3

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
27	46.81	.46	.92	31.51	20.30
28	46.35	1.00	1.36	30.87	20.42
29	46.34	1.02	1.08	31.56	20.00
30	46.45	.80	1.00	31.66	20.09
31	46.52	.82	1.21	31.46	19.99
32	46.29	1.38	.83	31.22	20.28
33	46.04	1.56	1.42	31.32	19.66
34	46.40	1.48	1.10	31.12	19.90
35	46.32	.92	1.44	31.46	19.86
36	46.18	1.78	.88	31.56	19.60
37	43.73	4.72	2.28	32.44	16.38
38	46.18	1.52	1.10	31.51	19.69

Analyses of dolomite from deposit 4

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
46	45.90	2.10	1.14	31.27	19.59
47	45.67	1.94	1.65	31.42	19.32
48	46.62	.76	1.04	31.51	20.07
49	46.49	.84	1.19	31.56	19.92
50	46.59	.93	.85	31.76	19.87
51	46.31	1.37	.80	31.61	19.91
52	46.15	1.78	1.05	30.87	20.15
53	46.20	.95	1.66	31.56	19.63
54	45.81	2.06	1.38	31.17	19.58
55	45.72	1.48	2.00	31.21	19.59
56	46.06	.68	2.23	31.31	19.69
57	46.05	.76	1.85	31.78	19.56
58	46.42	.63	1.54	31.61	19.80
59	46.45	.25	1.66	32.20	19.44
60	46.88	.30	.92	31.85	20.05
61	46.31	1.24	1.02	32.00	19.43
62	46.58	.64	1.28	31.74	19.76
63	46.60	.74	1.00	31.61	20.05
64	.....	1.44*	.....	30.8	21.7
65	.....	1.92*	.....	30.6	21.6
66	.....	1.80*	.....	30.5	21.2
67	45.80	2.10	1.32	30.82	19.96
68	45.42	2.64	1.76	30.47	19.71
69	34.60	20.42	6.60	23.04	15.34
70	44.36	3.88	2.74	29.69	19.33
71	45.25	2.86	1.72	31.26	18.91
72	37.59	15.54	5.06	25.35	16.46
73	45.45	2.40	1.68	31.07	19.40
74	44.16	4.74	1.93	31.11	18.06
75	45.39	2.76	1.52	31.16	19.17
79	44.36	3.42*	1.52	29.59	21.11
80	44.04	4.74*	1.54	29.88	19.80
81	43.73	4.42*	1.38	29.00	21.47
82	44.62	3.48*	1.16	29.71	21.03
83	45.09	2.36*	1.22	30.23	21.10
84	44.28	1.90*	.98	30.64	22.20
85	44.44	4.35	2.00	30.23	18.98
86	44.82	3.50	1.75	30.43	19.50
87	44.37	4.00	2.54	29.93	19.16
88	44.69	3.88	2.08	29.93	19.42
89	43.04	5.12	2.35	28.95	19.54
90	44.76	3.21	2.42	29.34	20.27
90a	45.27	2.88	2.07	29.54	20.24
91	43.69	6.38	2.58	29.83	17.52
92	45.77	1.86	2.10	30.08	20.31
93	44.47	4.11	2.30	29.74	19.38
94	44.12	4.30	2.54	30.58	18.46
95	44.10	5.05	2.00	29.49	19.36
96	40.68	10.84	3.14	28.75	16.59
97	36.10	20.30	3.18	26.14	14.28
98	43.90	5.00	2.35	30.08	18.67
99	42.06	8.95	2.54	28.52	17.93

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from deposit 4—Continued

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
100	44.16	4.60	2.20	30.52	18.52
101	41.78	9.00	2.90	28.65	17.67
102	44.44	4.41	2.01	30.80	18.34
103	36.13	18.70	3.92	28.91	12.34
104	34.51	23.18	3.76	24.78	13.77
105	38.70	14.74	3.64	26.64	16.28
106	41.54	9.38	3.04	28.56	17.48
107	40.78	10.84	3.34	27.38	17.66
108	35.42	20.10	5.10	24.74	14.64
109	41.36	10.24	2.50	27.78	18.02
110	26.25	39.20	5.26	18.62	10.67
111	43.51	6.18	1.94	30.16	18.21
112	40.97	9.48	3.76	29.66	16.13
113	37.93	15.80	4.10	26.50	15.67
114	42.26	7.74	2.98	29.50	17.52
115	30.94	29.26	5.38	21.56	12.86
116	36.04	19.64	4.83	25.12	14.37
117	24.20	42.86	6.09	16.74	10.11
118	39.37	13.76	4.96	27.68	15.23
119	39.89	12.64	3.42	26.86	17.19
120	42.51	8.20	2.24	29.06	17.99
121	38.23	15.44	4.50	25.02	16.81
122	38.50	15.48	3.34	26.36	16.32
123	34.92	22.40	4.02	23.88	14.78
124	35.28	22.42	3.24	24.04	15.02
125	35.85	21.00	3.46	24.38	15.31
126	30.72	31.42	3.80	21.18	12.88

Analyses of dolomite from deposit 5

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
127	40.84	11.52	2.42	27.76	17.46
128	40.16	12.28	3.09	27.37	17.10
129	37.94	17.58	2.55	25.56	16.37
130	42.89	6.74	2.76	29.55	18.06
131	37.12	19.66	2.33	24.54	16.35
132	40.04	13.53	2.16	26.98	17.29
133	35.61	21.74	3.24	24.04	15.37
134	41.94	8.74	2.85	28.56	17.91
135	42.89	7.14	2.60	28.66	18.71
136	37.96	16.94	3.20	25.42	16.48
137	45.33	2.45	2.00	30.84	19.38
138	44.79	4.64	2.04	30.06	18.97
139	44.20	4.80	2.10	30.00	18.90

Analyses of dolomite from deposit 6

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
140	46.64	.30	1.04	32.88	19.14
141	46.33	.18	1.72	33.20	18.57
142	46.09	1.12	1.84	31.22	19.73
143	42.69	8.90	1.44	28.46	18.51
144	43.52	6.56	1.82	29.36	18.74
145	42.70	8.53	1.62	28.76	18.39
146	43.01	7.81	1.58	29.24	18.36
147	36.44	21.48	2.05	23.82	16.21
148	39.11	15.90	1.76	26.54	16.69
149	46.17	1.56	1.20	31.30	19.77
150	45.93	2.14	1.12	31.10	19.71
151	46.39	1.03	1.24	31.48	19.86
152	46.25	1.28	1.45	31.10	19.92
153	45.36	2.52	1.79	31.30	19.03
154	43.92	4.70	2.81	29.70	18.87
155	33.60	6.75	1.66	28.76	19.23
156	40.50	12.31	2.43	27.22	17.54
157	40.98	11.68	1.82	28.44	17.08
158	38.66	16.35	2.14	26.72	16.13
159	41.12	11.56	1.63	28.60	17.09
160	39.92	13.35	2.12	28.70	15.91
161	43.68	5.70	1.68	31.58	17.36
162	31.94	28.08	4.34	22.52	13.12
163	42.77	7.38	2.58	28.68	18.59
164	42.65	7.81	2.25	29.20	18.09
165	35.96	20.96	3.56	24.54	14.98
166	40.02	11.70	3.96	27.42	16.90
167	40.64	11.64	2.83	27.38	17.51
168	36.30	19.74	3.84	24.44	15.68
169	34.35	23.82	3.99	22.76	15.08
170	35.88	20.45	3.90	24.60	15.17
171	36.59	19.46	3.48	24.76	15.71
172	41.24	10.09	3.10	27.76	17.81
173	42.27	7.22	3.08	29.76	17.47
174	43.15	5.70	3.16	30.20	17.79
175	43.58	5.50	2.68	29.22	18.52
176	40.86	10.14	3.74	27.92	17.30
177	43.25	6.04	2.71	29.80	18.20
178	40.88	10.43	3.54	27.62	17.53
179	35.43	20.90	4.39	24.24	15.04
180	41.15	9.00	4.44	27.62	17.79
181	43.81	4.90	3.00	29.20	19.09
182	42.20	8.00	3.16	28.16	18.48
183	44.19	4.15	2.78	29.90	18.98
184	43.39	5.50	3.14	29.20	18.77
185	42.11	7.33	3.98	28.62	17.96
186	42.74	6.45	3.62	28.52	18.67
187	42.41	7.38	3.35	28.46	18.40
188	43.60	5.18	2.84	29.96	18.42
189	40.63	10.70	3.48	28.32	16.87
195	42.79	6.60	3.25	29.02	18.34
196	40.49	11.29	3.12	27.62	17.48
197	43.49	6.44	1.86	29.80	18.41
198	44.46	4.52	1.80	30.90	18.32
199	44.69	3.38	2.34	30.74	18.85
200	43.91	5.35	1.92	30.60	18.22

Analyses of dolomite from deposit 7

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
201	43.13	7.14	2.27	28.46	19.00
202	42.70	7.36	2.58	29.54	17.82
203	43.13	7.36	1.86	28.90	18.75
204	43.72	4.70	2.12	29.80	19.66
205	43.26	6.81	2.14	29.00	18.79
206	42.58	8.05	2.36	28.68	18.33
207	44.30	4.86	1.90	29.70	19.24
208	44.13	5.35	1.62	30.18	18.72
209	44.86	3.78	1.77	30.46	19.13
210	40.51	11.00	3.50	28.12	16.87
211	43.06	6.20	2.95	29.70	18.09
212	43.32	6.08	2.55	29.88	18.17
213	41.28	9.94	2.96	28.60	17.22
214	43.45	5.53	2.82	29.82	18.38
215	44.10	5.24	2.70	30.20	17.76
216	42.40	7.48	2.94	29.85	17.33
218	44.06	4.48	2.45	30.64	18.37
219	43.46	4.38	2.82	30.68	18.66
220	44.64	3.88	1.90	30.89	18.69
221	45.06	3.49	1.55	30.78	19.12
222	45.28	2.92	1.85	30.42	19.53
223	42.47	7.80	2.72	29.03	17.98
224	43.42	5.50	2.84	30.30	17.94
225	44.46	4.12	1.91	31.20	18.31
226	43.82	5.01	2.56	30.11	18.50
227	44.67	3.14	2.60	30.90	18.69
228	40.85	10.30	3.61	27.74	17.50
229	42.97	6.72	2.78	28.92	18.61
230	43.07	4.75	2.62	29.84	18.82
231	42.99	6.44	2.94	29.46	18.17
232	43.43	4.94	3.49	29.55	18.59
233	41.74	8.58	3.26	28.98	17.44
234	43.01	5.86	3.30	29.85	17.98
235	43.02	6.25	2.66	30.20	17.87
236	44.35	3.54	2.94	30.36	18.81
237	44.25	4.14	2.68	30.00	18.93
238	42.81	5.90	4.16	29.16	17.97
239	42.61	8.42	1.68	29.41	17.88
240	45.08	3.12	1.98	30.44	19.38
241	43.38	6.10	2.55	29.35	18.62
242	41.64	8.60	3.72	28.32	17.72
243	44.26	4.90	1.94	29.64	19.24
244	41.76	9.91	2.45	28.18	17.70
245	41.38	9.50	3.59	28.18	17.35
246	42.83	6.78	2.84	29.69	17.86
247	41.52	9.70	2.78	28.42	17.58
248	43.09	6.85	2.22	29.85	17.99
249	42.95	6.89	2.60	29.36	18.20
250	40.23	11.66	3.45	27.78	16.88
251	43.24	6.14	2.68	29.72	18.22
253	42.26	7.37	3.66	28.80	17.91
254	44.35	4.12	2.38	30.34	18.81
255	42.86	7.62	2.14	29.14	18.24
256	44.06	5.30	1.98	29.58	19.08
257	41.50	9.56	3.20	27.62	18.12

Analyses of dolomite from deposit 7—Continued

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
258	43.04	7.15	2.21	29.25	18.35
259	44.03	5.21	2.25	29.28	19.23
260	41.76	9.46	2.76	27.80	18.22
261	38.97	14.56	3.66	25.50	17.31
262	42.45	8.45	2.24	28.56	18.30
263	37.32	17.74	3.70	25.16	16.08
264	41.74	10.20	2.06	28.08	17.92
265	42.02	9.14	2.30	28.54	18.00
266	42.92	6.62*	1.50	28.95	20.01
267	44.30	5.34*	1.36	29.10	19.90
268	45.62	2.96*	.84	30.28	20.30
269	45.94	1.56*	.94	30.72	20.84
270	46.54	.76*	.75	30.97	20.98
271	46.48	.24*	.52	30.97	21.79
272	44.85	5.02*	.70	30.47	18.97
273	46.52	.80*	.69	30.72	21.27
274	46.37	.96*	.84	30.92	20.91
275	46.61	.58*	.68	31.31	20.82
276	46.90	.76*	.62	31.12	20.60
277	46.88	.86*	.61	30.92	20.73
278	46.98	.58*	.68	30.97	20.79
279	46.66	1.22*	.72	30.77	20.63
280	46.83	.74*	.78	31.12	20.53
281	46.73	1.08*	.66	31.02	20.51
282	46.48	1.16*	1.10	30.82	20.44
283	46.81	.96*	.68	30.82	20.73
284	46.26	1.61*	1.18	30.47	20.48
285	46.62	1.02*	1.06	30.57	20.73
286	45.50	2.82*	1.36	29.97	20.25
287	46.14	1.76*	1.30	30.34	20.46
288	46.56	1.22*	.92	30.72	20.58
289	46.16	1.82	1.06	30.90	20.06
290	45.69	2.60	1.25	30.74	19.72
291	45.81	2.35	1.10	31.15	19.59
292	46.54	.76	1.30	31.28	20.12
293	46.71	.72	1.01	31.35	20.21
294	46.98	.22	1.02	31.52	20.26
295	46.65	1.00	.92	31.20	20.23
273a	46.22	1.35	1.44	31.04	19.95
274a	46.13	1.64	1.38	30.82	20.03
275a	46.08	1.50	1.56	31.05	19.81
276a	46.76	.63	1.00	31.19	20.42
277a	45.71	2.45	1.46	30.42	19.96
278a	45.78	2.26	1.36	30.98	19.62
279a	46.29	1.42	1.16	30.94	20.19
280a	46.42	.95	1.42	31.00	20.21
281a	46.10	2.00	.94	31.20	19.76
282a	46.73	.55	1.11	31.55	20.06
283a	45.97	2.02	1.08	31.42	19.51
284a	46.55	.90	1.19	31.26	20.10
285a	46.56	.76	1.35	31.05	20.28
286a	46.99	.66	.78	30.42	21.15
287a	46.91	.30	1.08	31.22	20.49
288a	47.02	.28	.80	31.36	20.54

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from deposit 7—Continued

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
289a	47.06	.26	.66	31.80	20.22
290a	47.00	.29	.78	31.35	20.58
291a	47.54	.30	.82	31.14	20.20
292a	46.83	.33	1.12	31.32	20.40
293a	46.98	.31	.84	31.40	20.47
294a	46.19	.58	2.23	30.92	20.08
295a	46.60	.26	1.60	31.46	20.08
296	46.88	.32	.95	31.70	20.15
297	46.83	.25	1.26	31.46	20.20
298	46.65	.88	1.00	31.29	20.18
299	46.70	.90	.85	31.36	20.19
300	46.63	.78	1.06	31.20	20.33
301	46.23	1.23	1.56	31.03	19.95
302	46.22	1.10	1.60	31.12	19.96
303	44.57	3.38	2.45	30.42	19.18
304	45.79	1.52	2.02	31.10	19.57
305	46.17	1.10	1.96	30.96	19.81
306	45.09	3.01	1.94	31.04	18.92
307	45.94	2.05	1.34	30.96	19.71
308	46.33	1.20	1.25	31.16	20.06
309	46.61	.48	1.43	31.20	20.28
310	43.25	6.57	2.36	29.14	18.68
311	44.38	4.24	2.40	29.72	19.26
312	45.57	2.36	1.85	30.14	20.08
313	46.59	.84	1.26	30.70	20.61
314	45.73	1.65	2.12	30.70	19.80
315	45.73	1.91	1.80	30.80	19.76
316	46.38	.72	1.72	31.08	20.10
317	46.75	.58	1.08	31.38	20.21
318	43.17	6.57	2.38	29.54	18.34
319	45.76	2.08	1.46	31.28	19.42
320	45.83	1.86	1.60	31.28	19.43
321	45.70	1.69	2.09	30.80	19.72
322	46.26	1.30	1.37	31.00	20.07
323	46.38	1.26	1.07	31.48	19.81
324	46.85	.56	.85	31.68	20.06
325	46.96	.30	.90	31.58	20.26
326	46.35	.98	1.24	31.86	19.57
327	46.55	.42	1.40	32.02	19.61
328	46.73	.28	1.35	31.64	20.00
329	46.66	.46	1.34	31.54	20.00
330	46.97	.24	.96	31.58	20.25
331	46.77	.38	1.20	31.36	20.29
332	46.74	.50	1.15	31.40	20.21
333	46.11	2.10	1.76	30.94	19.09
334	46.44	.64	1.54	31.40	19.98
335	46.51	.73	1.34	31.48	19.94
336	46.54	.68	1.32	31.30	20.16
337	46.74	.32	1.48	30.80	20.66
338	46.30	.96	1.50	31.40	19.84
339	46.44	1.65	1.23	28.92	21.76
340	46.66	.47	1.31	31.46	20.10
341	45.34	1.82	1.60	31.16	20.08
342	46.18	1.74	1.28	31.00	19.80
343	45.86	2.32	1.44	30.66	19.72
344	45.99	1.52	1.74	30.94	19.81

Analyses of dolomite from deposit 7—Continued

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
345	46.27	1.65	1.04	31.00	20.04
346	45.74	1.95	1.64	31.42	19.25
347	46.57	1.22	.86	31.06	20.29
348	46.12	.66	2.22	31.40	19.60
349	46.69	1.10	1.25	29.42	21.54
350	46.91	.40	1.00	31.70	20.09
351	46.87	.48	1.68	28.64	22.33
352	46.29	.35	1.93	32.28	19.15
353	46.77	.50	.98	31.94	19.81
354	46.98	.36	.72	31.76	20.18
355	46.76	.40	1.10	31.80	19.94
356	46.97	.58	.97	31.58	19.90
357	46.86	.42	1.20	31.32	20.20
358	46.69	.30	1.45	31.58	19.98
359	46.67	.55	1.23	31.16	20.39
360	46.58	1.27	.84	30.84	20.47
361	45.85	1.80	1.56	31.20	19.59

Analyses of dolomite from deposit 8

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
362	41.28	10.90	1.40	30.80	15.62
363	43.71	5.92	1.82	30.16	18.39
364	43.89	5.35	2.21	29.86	18.69
365	45.24	3.38	1.35	30.62	19.41
366	45.56	2.72	1.56	30.50	19.66
367	44.63	5.41	1.52	30.20	18.24
368	45.49	2.18	2.09	30.40	19.84
369	42.55	7.66	2.26	30.30	17.23
370	42.56	8.00	1.98	30.40	17.06
371	44.63	4.20	1.78	30.35	19.04
372	45.69	2.48	1.50	30.20	20.13
373	43.05	7.39	2.12	28.56	18.88
374	46.20	1.70	1.02	31.38	19.70
375	46.51	.75	1.22	31.84	19.68
376	46.65	.68	1.08	31.78	19.81
377	45.85	2.48	1.32	31.08	19.27
378	44.84	3.12	2.24	31.04	18.76
379	46.21	.72	1.88	31.52	19.67
380	46.71	.86	1.84	31.18	19.41
381	45.82	1.22	2.24	31.24	19.48
382	44.65	2.91	3.02	30.34	19.08
383	46.18	2.28*	.80	30.02	20.72
384	46.78	1.14*	.90	29.62	21.56
385	47.08	.54*	.84	29.87	21.67
386	47.26	.36*	.62	30.11	21.65
387	47.23	.42*	.56	30.31	21.48
388	47.19	.60*	.56	29.92	21.73

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from deposit 9

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
390	46.48	.78	1.56	30.98	20.20
391	46.47	1.02	1.20	31.16	20.15
397	17.05	54.90	9.34	11.00	7.71
398	46.62	.58	1.28	31.50	20.02
399	46.84	.37	1.20	31.36	20.23
400	45.49	2.33	1.94	30.62	19.62
401	46.28	1.00	1.56	31.22	19.94
402	46.34	.74	1.76	31.06	20.10
403	46.56	.66	1.31	31.40	20.07
404	46.53	.38	1.58	31.70	19.81
405	45.77	1.78	1.92	30.64	19.89
406	45.96	1.68	1.68	30.56	20.12
407	45.93	1.34	1.84	31.48	19.41
408	46.20	1.02	1.45	31.76	19.57
409	46.71	.79	.79	31.82	19.89
410	46.02	1.44	1.42	32.10	19.02
411	46.22	1.30	1.32	31.44	19.72
412	46.28	1.48	1.40	30.04	20.80
413	46.34	1.42	1.13	31.10	20.01
414	46.62	.73	1.12	31.56	19.97
415	45.03	3.20	1.86	30.82	19.09
416	46.20	1.84	.94	31.06	19.96
417	46.08	2.00	.99	31.12	19.81
418	47.09	.31	.66	31.32	20.62
419	46.96	.35	.80	31.70	20.19
420	46.55	.66*	.56	31.31	20.92
421	45.98	1.28*	.66	31.26	20.82
422	46.40	.92*	.69	31.01	20.98
423	46.27	.71*	.56	31.03	21.43
424	46.37	.92*	.60	30.81	21.30
425	46.43	.82*	.53	30.82	21.40
426	46.57	.78	1.16	31.60	19.89
427	44.55	6.58	1.70	29.34	17.83
433	46.90	.48	.79	31.40	20.43
434	46.91	.34	.98	31.36	20.41
435	46.87	.31	1.06	31.40	20.36
436	45.75	1.96	1.74	30.86	19.69
437	46.30	1.48	1.21	30.60	20.41
438	46.95	.49	.78	31.44	20.34
439	46.50	.84	1.26	31.30	20.10
440	46.52	.56	1.44	31.60	19.88
441	46.83	.52	.90	31.68	20.07
442	45.50	2.96	1.22	30.72	19.60

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from deposit 10

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
448a	31.15	25.86	4.70	34.66	3.63
449a	42.65	8.00	2.47	27.76	19.12
450a	44.06	3.86	1.76	35.46	14.86
451a	44.69	3.38	1.44	33.98	16.51
452a	44.56	2.76	1.68	36.30	14.70
453a	36.32	19.14	3.40	27.94	13.20
454a	41.92	8.46	1.72	33.78	14.12
455a	39.73	11.80	2.73	33.16	12.58
456a	45.90	1.44	1.01	34.14	17.51
457a	43.65	4.17	1.24	38.76	12.18
458a	42.70	6.46	1.28	37.16	12.40
459a	43.55	4.20	1.86	37.50	12.89
460a	39.41	10.00	2.79	41.48	6.32

OLD FORT SPOKANE AREA

Analyses of dolomite from outcrop group A

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
445	46.73	.82	.86	31.56	20.03
446	46.50	1.30	.80	31.60	19.80
447	46.20	1.28*	.56	30.87	21.09
448	45.65	1.84*	.84	30.92	20.75
449	46.63	.68*	.47	31.03	21.19
450	46.81	.82	.70	31.32	20.35
451	47.09	.53	.44	31.40	20.54
452	47.20	.35	.47	31.26	20.72
453	47.16	.20	.64	31.50	20.50

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from outcrop group B

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
461	47.27	.14	.40	31.78	20.41
462	47.23	.18	.47	31.60	20.52
463	47.21	.28	.42	31.65	20.44
464	47.03	.32	.76	31.70	20.19
465	47.14	.44	.38	31.70	20.34
466	46.88	.72	.66	31.35	20.39

Analyses of dolomite from outcrop group C

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
454	46.30	1.18	1.22	31.84	19.46
455	46.28	1.46	1.06	31.56	19.64
456	46.54	1.06	.98	31.44	19.98
457	46.66	.64	1.02	31.72	19.96
458	46.69	.31*	.46	31.33	21.21
459	46.30	.80*	.80	31.05	21.05
460	46.54	.72*	.52	30.67	21.55

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from outcrop group D

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
467	46.75	.39*	.40	30.80	21.66
468	46.33	.64*	.66	30.95	21.42
469	46.71	.54*	.44	30.81	21.50
470	47.19	.34	.48	31.40	20.59
471	46.95	.60	.64	31.62	20.19
472	46.90	.38	.82	31.72	20.18
473	46.87	.58	.78	31.50	20.27
474	46.85	.56	.86	31.50	20.23
475	47.15	.30	.50	31.65	20.40
476	47.25	.20	.44	31.50	20.61
480	46.52	.96	.99	31.74	19.79
481	47.14	.30	.48	31.59	20.49
482	46.98	.56	.65	31.40	20.41
483	46.94	.68	.62	31.11	20.65
484	46.99	.50	.56	31.45	20.50
485	47.12	.34	.52	31.69	20.33
486	47.01	.30	.77	31.61	20.31
487	46.90	.46	.92	31.30	20.42
488	47.27	.22	.43	31.40	20.68
489	47.18	.41	.32	31.50	20.59
490	47.09	.55	.44	31.45	20.47
491	46.85	.88	.51	31.65	20.11
492	46.97	.44	.78	31.61	20.20
493	46.80	.62	.86	31.65	20.07
494	47.26	.06	.52	31.60	20.56
495	46.94	.40	.83	31.55	20.28
496	47.03	.30	.74	31.50	20.43
498	47.13	.30	.54	31.60	20.43
499	47.17	.36	.47	31.65	20.35
500	46.85	.48	.88	31.60	20.19

* Reported as "Insoluble" in R. I. 13, Pt. 1.

ADDY DISTRICT

Analyses of dolomite from deposit 1

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
501	45.95	2.50*	.42	30.22	20.91
502	46.79	.72	.82	31.50	20.17
503	44.11	6.10	.93	30.45	18.41
504	45.64	2.90	.86	31.20	19.40
505	46.55	1.42	.64	31.45	19.94
506	44.42	5.28	.99	30.70	18.61
507	45.84	2.46	.92	31.35	19.43
508	38.29	13.00*	5.56	25.79	17.36
509	41.42	9.28*	3.32	27.18	18.80
510	39.25	15.50	1.22	28.75	15.28
511	31.43	30.88	1.34	26.90	9.45
512	39.79	14.56	.73	30.15	14.77
513	45.72	3.20	.58	30.85	19.65
514	43.05	8.18	.84	30.45	17.48
515	36.79	14.78*	6.50	25.16	16.77
516	46.92	.70	.59	31.60	20.19
517	46.78	1.02	.54	31.50	20.16
518	47.13	.58	.26	31.45	20.58
519	47.09	.31	.72	31.15	20.73
520	46.95	.48	.75	31.55	20.27
521	47.05	.40	.62	31.50	20.43
522	46.73	.60*	.38	31.01	21.28
523	46.78	.90	.66	31.40	20.26
524	46.68	.68*	.42	30.82	21.40
525	47.12	.52	.36	31.45	20.55
526	46.60	.94	.96	31.35	20.15
527	46.78	.80	.69	31.55	20.18
528	46.95	.22	.94	31.50	20.39
529	47.04	.34	.70	31.50	20.42
530	46.84	.36*	.34	30.88	21.58
531	47.15	.44*	.60	30.42	21.39
532	46.02	1.90	1.14	31.20	19.74
533	47.17	.44*	.48	30.62	21.29
534	46.92	.35	.96	31.30	20.47
535	47.02	.44	.64	31.70	20.20
536	46.52	1.18	.98	31.14	20.18
537	42.88	8.38	.91	30.52	17.31
538	39.24	15.59	1.02	29.20	14.95
539	39.87	14.04	1.38	29.15	15.56
540	45.37	3.58	.72	31.15	19.18
541	44.36	5.28	1.16	31.00	18.20
542	40.10	13.82	1.22	29.03	15.83
543	44.60	4.37	1.34	31.20	18.49

* Reported as "Insoluble" in R. I. 13, Pt. 1.

Analyses of dolomite from deposit 2

Sample number	Ignition loss	SiO_2	R_2O_3	CaO	MgO (calc.)
544	46.68	1.52*	.56	30.03	21.21
545	46.09	2.80*	.52	29.68	20.91
546	47.26	.36*	.44	30.50	21.44
547	47.00	.76*	.56	30.41	21.27
548	46.95	.68*	.76	30.32	21.29
549	47.00	.72*	.64	30.33	21.31
550	47.16	.50*	.60	30.21	21.53
551	47.10	.40*	.56	30.52	21.42

* Reported as "Insoluble" in R. I. 13, Pt. 1.