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LITHOLOGIC LOG AND DRILLING INFORMATION FOR THE MARBLE EXPLORATION HOLE 3, U15 AREA, NEVADA TEST SITE, NYE COUNTY, NEVADA

By F. N. Houser and F. G. Poole

Trace Elements Memorandum Report 1031

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Frederick Drilling Co 1924

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This report is preliminary and has not been edited for conformity with Geological Survey format and nomenclature.

*This report concerns work done on behalf of Albuquerque Operations Office, U. S. Atomic Energy Commission.

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INTRODUCTION

The Marble exploration hole 3 is in the northern part of the Tippipah Spring NE 7-1/2 minute quadrangle at the north end of Yucca Valley (fig. 1). The collar elevation of the hole is about 5,316 feet and has the approximate Nevada State coordinates of N. 903,093 and E. 674,870. The hole was drilled to determine the physical and chemical properties of the marble within a radius of 200 feet of a point 950 feet below the surface.

The exploration hole is 978 feet deep and was drilled from June 12 to July 8, 1959, by Minerals Engineering Co. of Grand Junction, Colorado, using conventional NX coring equipment and a Portadrill 2,500 drill rig. Water-base bentonitic mud was used as the drilling fluid in the upper part of the hole. Clear water was used after circulation became unrestorable below 200 feet. The hole was cased from surface to 20 feet. The drilling rate during coring ranged from 2.0 to 19.3 minutes per foot and averaged 4.6 minutes per foot (table 1). The core recovered was excellent in quality and quantity. The average core recovery is 92.7 percent (table 2).

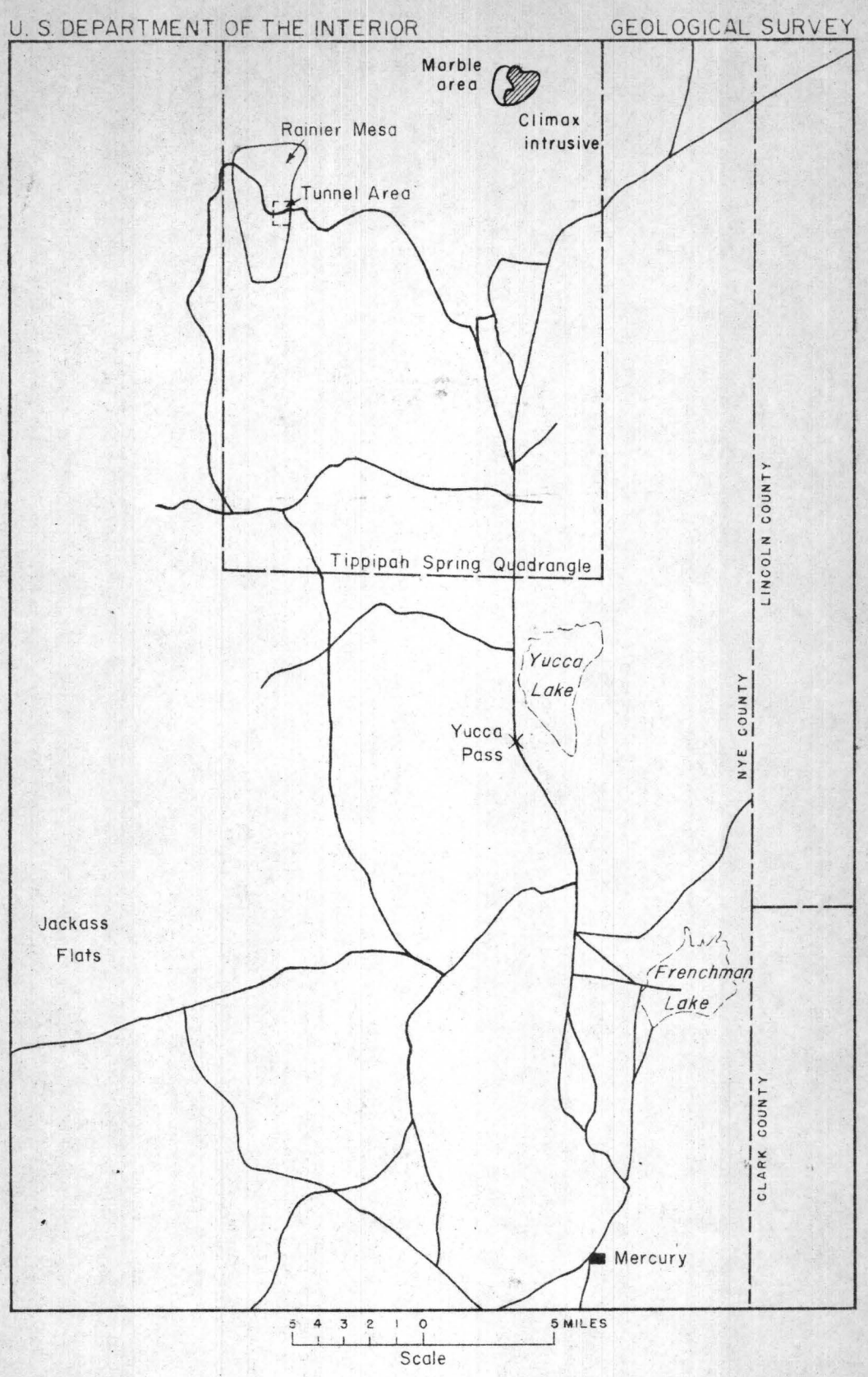

FIGURE 1–INDEX MAP SHOWING LOCATION OF TUNNEL AREA, RAINIER MESA, MARBLE AREA AND CLIMAX INTRUSIVE NEVADA TEST SITE, NYE COUNTY, NEVADA

Table 1.--Drilling record for the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada

Interval (feet)	Footage	Min	Min/ft	Interval (feet)	Footage	Min	Min/ft
20-25.3	5.3	15	2.8	294.5-309.5	15.0	40	2.7
30.3	5.0	12	2.4	324.5	15.0	40	2.7
35.3	5.0	10	2.0	331.3	6.8	21	3.1
45.3	10.0	24	2.4	346.3	15.0	51	3.4
55.3	10.0	51	5.1	353.0	6.7	49	7.3
65.3	10.0	42	4.2	355.8	2.8	6	2.1
66.3	1.0	6	6.0	361.3	5.5	24	4.4
70.0	3.7	30	8.1	376.3	15.0	71	4.7
76.1	6.1	29	4.8	387.3	11.0	48	4.4
86.0	9.9	37	3.7	392.9	5.6	29	5.2
88.0	2.0	17	8.5	396.1	3.2	18	5.6
90.6	2.6	10	3.8	408.5	12.4	56	4.5
98.0	7.4	25	3.4	414.0		Cavings	
108.0	10.0	22	2.2	419.4	5.4	45	8.3
116.7	8.7	25	2.9	428.5	9.1	54	5.9
117.0	0.3	5	17.0	434.0	5.5	38	6.9
117.9	0.9	2	2.2	441.4	7.4	42	5.7
128.0	10.1	38	3.8	453.0	11.6	101	8.7
138.1	10.1	33	3.3	458.8	5.8	56	9.7
143.9	5.8	21	3.6	465.0	6.2	52	8.4
153.1	9.2	34	3.7	468.8	3.8	46	12.1
161.1	8.0	26	3.3	476.8	8.0	41	5.1
168.5	7.4	77	10.4	482.0	5.2	20	3.8
171.5	3.0	58	19.3	485.5	3.5	15	4.3
178.5	7.0	21	3.0	501.5	16.0	64	4.0
191.3	12.8	39	3.0	512.0	10.5	56	5.3
199.8	8.5	33	3.9	521.0	9.0	38	4.2
209.8	10.0	49	4.9	527.6	6.6	34	5.2
210.2	0.4	3	7.5	533.3	5.7	31	5.4
218.9	8.7	44	5.1	542.0	8.7	59	6.8
234.0	15.1	70	4.6	552.0	10.0	58	5.8
240.0	6.0	26	4.3	568.0	16.0	78	4.9
249.9	9.9	38	3.8	583.0	15.0	62	4.1
251.8	1.9	10	5.3	597.5	14.5	69	4.8
264.3	12.7	25	2.0	631.6	34.1	159	4.7
267.4	2.9	39	13.0	639.0	7.4	31	4.2
274.0	6.6	21	3.2	659.0	20.0	96	4.8
283.6	9.6	31	3.2	663.0	4.0	34	8.5
294.5	10.9	32	2.9	671.6	8.6	29	(incomplete)

Table 1.--Drilling record for the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada--Continued

Interval (feet)	Footage	Min	Min/ft
671.6-686.9	15.3	77	5.0
693.6	6.7	30	4.5
699.5	5.9	30	5.1
711.0	11.5	71	6.2
712.0	1.0	18	18.0
723.4	11.4	76	6.7
742.6	19.2	85	4.4
760.5	17.9	95	5.3
779.7	19.2	90	4.7
799.0	19.3	83	4.3
818.0	19.0	77	4.1
833.0	15.0	66	4.4
849.0	16.0	72	4.5
867.8	18.8	72	3.8
878.7	10.9	46	4.2
893.7	15.0	59	3.9
908.7	15.0	62	4.1
925.0	16.3	44	2.7
944.0	19.0	62	3.3
951.2	7.2	33	4.6
958.7	7.5	52	6.9
964.6	5.9	34	5.8
970.6	6.0	40	6.7
973.8	3.2	26	8.1
978.0	4.2	18	4.3

Table 2.--Core data from the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada

Interval (feet)	Footage	Core recovered		
		Amount (feet)	Percent	Condition
0-20	20	Not cored		
50	30	30	100	Good
60	10	9.5	95	Do
80	20	20	100	Do
90	10	9.2	92	Do
120	30	30	100	Do
130	10	9.6	96	Do
180	50	50	100	Do
190	10	9.3	93	Partly broken
220	30	30	100	Good
230	10	9.7	97	Do
240	10	9.8	98	Partly broken
250	10	9.7	97	Good
260	10	9.4	94	Do
270	10	8.5	85	Partly broken
280	10	9.1	91	Broken
290	10	9.6	96	Good
320	30	30	100	Do
330	10	9.3	93	Do
340	10	9.7	97	Do
350	10	9.0	90	Partly broken
360	10	7.5	75	Broken to badly broken
380	20	20	100	Good
387.3	7.3	7.3	100	Do
396.1	8.8	6.0	68	Badly broken
407.5	11.4	11.4	100	Broken
412.9	5.4	2.8	52	Badly broken
420	7.1	5.9	83	Broken
430	10	8.9	89	Partly broken
440	10	8.4	84	Do
450	10	10	100	Good
460	10	8.9	89	Badly broken
470	10	6.8	68	Partly to badly broken
480	10	8.6	86	Good
490	10	10	100	Do
500	10	9.4	94	Do
510	10	6.2	62	Do
520	10	7.5	75	Broken

Table 2.--Core data from the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada--Continued

Interval (feet)	Footage	Core recovered		
		Amount (feet)	Percent	Condition
530	10	6.0	60	Badly broken
540	10	6.6	66	Broken
600	60	60.0	100	Mostly good
650	50	50.0	100	Good
660	10	9.0	90	Do
670	10	9.9	99	Do
680	10	9.7	97	Do
690	10	9.7	97	Do
700	10	10.0	100	Do
710	10	9.4	94	Partly to badly broken
720	10	8.9	89	Partly broken
730	10	9.4	94	Good
740	10	10.0	100	Do
750	10	9.7	97	Do
770	20	20.0	100	Do
780	10	8.6	86	Do
790	10	10.0	100	Do
800	10	9.7	97	Do
900	100	100.0	100	Do
910	10	9.8	98	Do
920	10	10.0	100	Do
930	10	10.0	100	Do
940	10	9.6	96	Do
945	5	5.0	100	Do
951	6	4.7	78.3	Broken
958.7	7.7	6.2	80.5	Badly broken
970.7	12.0	10.5	87.5	Good
978.0	7.3	7.3	100	Do

GEOLOGY

Marble

Exploration hole 3 is in marble formed by metamorphism of limestone and dolomite of the Pogonip group of Ordovician age on the west side of the Climax intrusive mass.

The hole penetrated marble from surface to 951 feet and granodiorite from 951 to 978 feet. The marble, based on megascopic study, is finely crystalline and locally coarsely crystalline and nodular. In composition, it is dolomite from the surface to about 540 feet and limy dolomite from 540 to 951 feet. Silicate minerals and sulfide minerals have replaced the marble mainly along premineral fractures. Replacement was intense in the intervals 220 to 255 feet and 388 to 550 feet. Nodular masses of silicate minerals scattered through unfractured marble are common to abundant in these intervals and from 775 to 951 feet. Hematite and limonite formed by oxidation is closely associated with pyrite, occurs along fractures, and is abundant at the contact with the granodiorite at 951 feet.

Structure

Because the abundance, apparent strength, attitude, and character of the bedding planes, joints, and faults determine in a large degree the structural anisotropism of a rock, special care was taken to obtain these data for the marble from megascopic study of the core.

Bedding, which at Dolomite Hill (U12 area) gave the bedrock a distinct structural grain, is not prominent in the marble. In the vicinity of the exploration drill hole, the marble strikes N. 10° W. and dips 50° to 80° SW. Dips of probable bedding observed in the core range from 22° to 85°. Original bedding planes, like many of the premineral fractures, were healed by recrystallization during metamorphism.

Prominent joints and faults are noted in the detailed lithologic log (table 3)--most were found from the surface to depth of about 550 feet. For selected intervals of the core, the relative abundance of fractures including both sealed and open joints and faults was determined (table 4). Although the total number of fractures appears to be less with depth, those which are open comprise a greater proportion.

Table 4.--Fracture data for selected intervals in the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada

Interval examined	Lithology	Number of fractures		Open fractures (percent)	Average number of fractures/ft
		Sealed 1/	Open		
20-30	Marble	55	4	6.7	5.9
90-100	do	196	11	5.1	20.7
190-200	do	164	5	3.0	16.9
290-300	do	182	5	2.7	18.7
375-385	do	96	8	7.7	10.4
485-495	do	134	1	0.7	13.5
590-600	do	72	8	10.0	8.0
690-700	do	69	12	14.8	8.1
785-795	do	70	0	0.0	7.0
890-900	do	86	12	12.2	9.8
951-961	Granodiorite	57	39	40.6	9.6
961-978	do	79 2/			4.6

1/ Sealed fractures in marble include those healed by recrystallized marble and silicate minerals, and those filled with calcite. In granodiorite they are filled with sulfide minerals and their oxidation products.

2/ No breakdown as to whether joints were open or sealed.

The joints observed are of at least two ages--early and late. Most of the early joints dip an average (arithmetic mean) of 37.5 degrees (fig. 2) and are healed by recrystallized marble and silicate minerals. The right skewed frequency distribution of the sealed joints is shown in figure 2. Many of the late joints are open and lined with calcite; about two-thirds of these joints dip at angles greater than 45°.

The known faults intersected by the drill hole are high angle--most dip from 60° to 80° and are open or sealed with calcareous clay or talclike material. Vertical displacements of .03 to .3 foot were measured along the faults where they cut sealed joints.

Alteration

Where the marble in the core from the exploratory hole has been replaced the silicate minerals are predominant and the sulfide minerals are subordinate. The replacement was mainly along pre-mineral fractures, although silicate minerals replaced siliceous nodules in the original rock. The intervals of core showing the highest content of silicate and sulfide minerals are from 220 to about 255 feet and from 388 to 550 feet. In these intervals the marble is also highly fractured and is incompetent owing partly to its brittleness.

The results of oxidation, primarily hematite, were observed in all the zones that contain sulfide minerals. The silicate minerals, on the other hand, were only slightly oxidized.

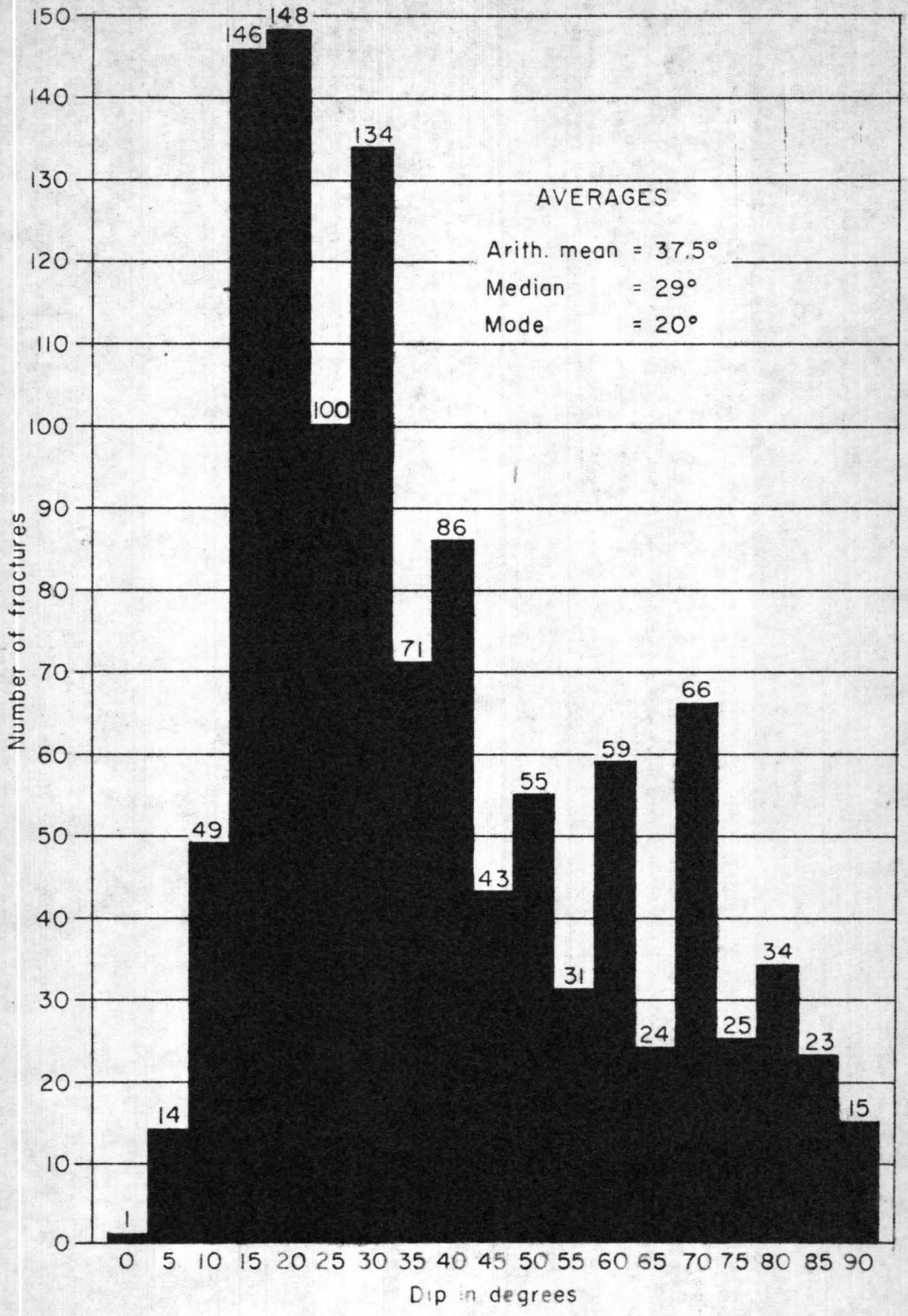

FIGURE 2 —FREQUENCY DISTRIBUTION OF SEALED FRACTURES IN MARBLE EXPLORATION HOLE 3, NEVADA TEST SITE, NYE COUNTY, NEVADA

Granodiorite

Granodiorite was encountered at a depth of 951 feet. A zone 6 feet above this point was composed of brecciated and highly fractured marble containing much hematite. The upper 8 feet of granodiorite is highly fractured and the biotite has been altered in part or wholly to chlorite and the feldspars to clay. From about 959 to 978, the granodiorite is megascopically similar to the granodiorite mapped in the adjacent Climax stock. It is medium grained, light gray, and pyrite is conspicuous occurring along fractures and as disseminated masses throughout the rock. Pyrite in the interval from 951 to 959 has been oxidized to hematite and limonite.

Dips of joints in the granodiorite range between 20° and 90° with a distinct mode occurring at 35°. The joints range in width from hairline to as much as 0.05 foot. The most common minerals lining the walls of the joints are a talclike mineral, limonite, and calcite with minor quantities of quartz and chlorite. Most of the early joints are filled with sulfide minerals and their oxidation products--hematite and limonite. Most of the late joints, on the other hand, are lined with white calcareous clay and calcite.

CONCLUSIONS

From the surface to 540 feet the marble is highly fractured, contains open faults, and is structurally anisotropic. Between 540 and 945 feet, the marble, based on megascopic study of the core, is physically and chemically homogeneous. These data suggest that from a point at a depth of 750 feet below the surface the marble is homogeneous for a minimum distance of 200 feet.

The amount and type of alteration have had a pronounced effect upon the structural continuity of the marble. The gross effect of the recrystallization and the replacement of the marble by the silicate minerals has been to strengthen the rock by healing the numerous premineral fractures and bedding surfaces. Conversely, replacement by sulfide minerals especially where oxidized to hematite has apparently weakened materially the natural strength of the marble. However, the sulfide minerals do not make up a large part of the marble, particularly from 550 to 900 feet where they occur only in trace quantities and are less oxidized. The calcite that fills many of the closed fractures probably is not effective in most places in restoring the rock to original competence.

Table 3.--Lithologic log of the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada

Interval (feet)	Lithologic description
0-20	Not cored. Probably same as 20-50.
20-50	Marble, dolomitic, very light gray to medium dark-gray, finely crystalline (0.01-0.25 mm with subordinate 0.25-0.5 mm).
50-100	Marble, dolomitic, white to medium-gray, finely crystalline (0.01-0.5 mm); fault at 97-98.8 is filled with white finely crystalline calcite and offsets silicate-lined joints about 0.05 foot--slickensides at 98.8 indicate normal movement.
100-150	Marble, dolomitic, white to light-gray, finely crystalline, grades to medium dark-gray, finely crystalline marble at about 112; breccia composed of fragments of silicated marble and hematite-stained calcareous clay at 100-102 and 112; 1-inch hematite-rich marble at 109.
150-229	Marble, dolomitic, medium dark-gray with some very light gray (associated spatially with silicate minerals), finely crystalline; calcite-filled fracture at 162 (partly open); fault at 206 dips 70° and has calcareous clay gouge; fault at 209-211 dips 85°; slickensides indicate normal movement on plunge of ± 15°; bedding at 190-191 and 196 dips 75°; common silicated nodules in intervals 0.5 to 1.5 feet thick; silicate minerals increase below 227.
229-257	Marble, dolomitic, very light gray to white with brown and tan mottling due to silicate minerals, finely crystalline; breccia composed of fragments of silicated marble in open fracture partly filled with calcite (many crystals are as large as 5 mm) and lined with brittle mineral--slickensides indicate normal movement on plunge of 50° on a fault plane which dips 60°; breccia at 235-239.5 composed of fragments of silicated marble in calcareous finely grained gouge; open fracture lined with calcite from 241.9-244.

Table 3.--Lithologic log of the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada--Continued

Interval (feet)	Lithologic description
257-299	Marble, dolomitic, medium dark-gray, finely crystalline; breccia and open fractures at 267-273 and 278-280; fault at 293 is filled with white finely crystalline calcite gouge and silicate veinlets and shows a normal displacement of 0.3 foot.
299-311	Marble, dolomitic, white to light-gray, finely crystalline; open fracture lined with calcite at 303.
311-321.5	Marble, dolomitic, medium-gray to medium dark-gray, finely crystalline; open fracture lines with calcite at 309.5-310.5 dips 60°.
321.5-387.3	Marble, dolomitic, very light gray to white with medium-gray mottling, finely crystalline; irregular-shaped masses of silicated marble at 328-330; fracture lined with very fine grained calcite at 324.5; open fracture lined with calcite at 346.5-347.5 dips 70°; additional open fractures lined with calcite at 349-350 and in places from 351-361; rare open fractures lined with silicate minerals.
387.3-396.1	Marble, light-gray, finely crystalline and dark-brown intensely silicated marble, highly fractured.
396.1-407.5	Same as above, except silicated proportion is less; breccia with very fine grained calcite matrix at 402; open fracture lined with calcite from 402.5-403.5.
407.5-412.9	Same as 387.3 to 396.1, except almost entirely silicated marble.
412.9-420	Marble, light-gray, finely crystalline; about 20 percent silicated.
420-428	Same as 420-428, except some breccia composed of fragments of silicated marble with calcite matrix at 420.5.

Table 3.--Lithologic log of the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada--Continued

Interval (feet)	Lithologic description
428-434	Marble, highly silicated (about 50 percent), highly fractured, and stained with hematite; post-silication breccias common.
434-439	Same as 434-439, except less strongly silicated (about 30 percent); open fractures common.
439-453	Marble, light-gray to white, finely crystalline; slightly to moderately silicated.
453-466	Same as 428-434.
466-469	Same as 434-439.
469-472	Same as 426-434.
472-508	Marble, very light gray to white, finely crystalline; nodules replaced commonly by coarsely crystalline (0.5-2.0 mm) silicate minerals; laminae (probable bedding) at 492-494 dips $\pm 55^{\circ}$; fractures filled with calcite at 481-484; highly silicated marble (about 80 percent silicates) at 496.5-497 and 498-499; veins of silicate minerals and calcite along fractures are as much as 0.07-foot thick.
508-533	Same as 428-434, except includes some white finely crystalline marble; contains sparse pyrite and black soft metallic sulfide.
533-539	Marble, limy dolomitic, white, finely crystalline; moderately silicated (about 25 percent).
539-653.5	Marble, limy dolomitic, white, tan-gray to very light gray with gray mottling; finely crystalline, slightly to moderately silicated; rock is a coarsely crystalline (0.5-2.0 mm) limestone where tan silicates(?) are abundant; laminae (probable bedding) at 639-640, which dip 25° to 40° are paralleled by tan silicates(?) and veins containing black powdery material.

Table 3.--Lithologic log of the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada--Continued

Interval (feet)	Lithologic description
653.5-750	Marble, dolomitic to limy dolomitic, very light gray to white with mottled brown-gray and dark-gray silicate(?) minerals; finely crystalline to coarsely crystalline where silicated, particularly near nodules; contains interbedded(?) blue-gray, finely crystalline marble from 690 to 693 and from 704 to 711; few silicated nodules below 790; 2-inch hematite-rich zone at 688; much soft black material associated with pyrite veinlets at 734 and 750; open fracture at 751-753 dips 85°; laminae (probable bedding) at 690-692 dips about 70°; one open fracture as much as 1 inch wide lined with calcite at about 695; fault at 694 dips 80°, slickensides indicate 45° plunge with normal movement.
750-908	Marble, dolomitic to calcitic, white--coarsely crystalline to light-gray finely crystalline, rare mottling with blue-gray laminae; silicated nodules common below about 775; veinlets containing black material are common down to 785 and from 845 to 860; laminae (probable bedding) dip between 22° and 85° from 762 to 887; fracture filled with calcite dips 70° and cuts silicated nodule about 760; another such fracture, which dips 80°, offsets silicate-filled fracture 0.03 foot at 889; open fracture lined with calcite at about 895 dips 35°, slickensides indicate plunge of 20°.
908-945	Marble, blue-gray to white mottled and banded, finely crystalline; silicate nodules (partly coarsely crystalline) and silicate minerals along low angle (25° to 35°) joints and are associated spatially with black and dark-gray minerals along high-angle joints; serpentine(?) and pyrite common along low-angle joints in lower part.

Table 3.--Lithologic log of the Marble exploration hole 3, U15 area, Nevada Test Site, Nye County, Nevada--Continued

Interval (feet)	Lithologic description
945-951	Marble, light-gray to white, finely to coarsely crystalline; much hematite; highly fractured and brecciated; hematite-rich friable material at 950-951 suggests fault contact.
951-958.7	Granodiorite, light-gray, medium-grained; much hematite; biotite is chloritized and feldspar argillitically altered; at 953 a hematite-filled fracture dipping 50° is offset 0.02-foot by a open fracture that dips 70° and contains some calcite.
958.7-960.4	Granodiorite; light orange-gray, medium-grained; biotite chloritized and feldspar argillitically altered; pyrite and hematite along joints of moderate dip; frequency of fractures is less than in granodiorite above.
964-978	Same as 960.4-964.0, except biotite only slightly chloritized; trace of fine-grained granodiorite(?) at 970; frequency of fractures is about 50 percent less than the granodiorite between 951 and 961.