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Geology of the Marble Deposits Near Rutland

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TRIP D GEOLOGY OF THE MARBLE DEPOSITS NEAR RUTLAND.

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INTRODUCTION

The tour of the marble belt will show geological occurrence of the marble strata, metamorphic transformations of the original rocks, influence of these upon the structure of the original materials, and fabrication of stone for use. The general geological structure will be seen during the drive from Rutland to West Rutland, the detailed stratigraphy of the bottom of the marble belt will be seen at Proctor and the surface expression of the complex internal fabric will be very obvious at Pittsford Valley. The initial transformation of limestone with middle Ordovician fossils to white marble and of dolomite to green silicate bands is displayed best at West Rutland where those who wish may go into the Main Quarry #2 of the Vermont Marble Company. Carving and sawing of marble will be seen in the Center Rutland Shop. The variety of products is displayed in the marble exhibit at Proctor which may be done at leisure or in lieu of one of the other units of the trip.

GEOLOGY OF THE MARBLE BELT

The marble occurs in lower and middle Ordovician strata between thick bedded gray dolomite (Clarendon Springs dolomite) below and a black phyllite (Canajoharie or Hortonville slate) above. The Clarendon Springs dolomite (200 feet thick) is underlain by the crossbedded zone (Danby quartzite of some authors) which is the key horizon for identifying structure. All marbles have suffered close folding and flowage and have a major thrust fault along their east margin (Figure D-1). Metamorphism has been partly mechanical with development of good glide fabrics and partly hydrothermal attended by recrystallization of dolomite to ferromagnesian silicates and removal of graphitoid coloring matter. Distension joints strike E.W. and some are occupied by Monteregian dikes which have caused "fish-scale" flakes for up to twenty feet distant; chill borders and vesiculated centers of some dikes indicate that the rocks were cool and at relatively shallow depth at intrusion time.

Stratigraphy

Relevant stratigraphy of the marble belt is restricted to the strata between the crossbedded zone and the "Canajoharie" phyllite, except insofar as identification of the thrust faults is concerned. It is as follows:[1]

Middle and Upper Ordovician	Canajoharie phyllite True Blue marble

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[1] Readers who are unfamiliar with the correlation of Professor Bain's stratigraphic nomenclature with the standard names, used elsewhere in this Guidebook, may find the following chart helpful.

Bain	Elsewhere
Canajoharie phyllite	"Hortonville", Ira
True Blue marble	Whipple in part
Chazyan (?) West Rutland marble	
Blue marble and dolomite	Burchards (Chipman fm.); Upper Canadian
Westland marble	Beldens (Chipman fm.)
Upper Deposit	Beldens
Main Deposit	Beldens
West Blue marble	Bascom fm. (Upper to Middle Canadian)
Blue marble and dolomite	Bascom fm.
Beekmantown	
Columbian marble)	
Intermediate dolomite)	Shelburne formation
Sutherland Falls marble)	
Lower Dolomite (Clarendon Springs)	Clarendon Springs; Upper Cambrian
Crossbedded zone (Danby quartzite?)	Danby formation; Upper Cambrian
Cambrian	
Rutland formation	Winooski, Monkton, and Dunham fms.; Middle to Lower Cambrian
Cheshire quartzite	Cheshire quartzite
Pre-Cambrian Mendon Series.	Mendon series; Cambrian? Precambrian?

For references on correlation, see, for example, Cady (1945), Fowler (1950), Thompson (1952), Cady and Zen (in preparation); these are all given in connection with Trip A.

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	West	Blue marble and dolomite
	Rutland	Westland marble
Chazyan?	Marble	Upper deposit
		Main deposit
		West Blue marble
		Blue marble and dolomite

	Columbian marble
	Intermediate dolomite
Beekmantown	Sutherlands Falls marble (Shelburne marble)
	Lower dolomite (Clarendon Springs)
	Crossbedded zone (Danby quartzite?)

Rutland formation Pittsford Valley dolomite

Cambrian	Cheshire quartzite	Florence dolomite Clarendon dolomite
Pre-Cambrian	Mendon Series	

The CROSSBEDDED ZONE is a dolomitic feldspathic sandstone characterized by crossbedding throughout its 250 feet of thickness in the area of study. It thins to 10 feet at E. Dorset and is thicker near Middlebury. Beds are generally less than 5 inches thick. The sand grains are subspherical and include principally quartz, microcline, albite and obigoclase but rock fragments, zircon, tourmaline and vesuvianite have been recognized.

The LOWER DOLOMITE or Clarendon Springs dolomite is gray weathering gray dolomite in beds about 8" thick and it contains very little detrital matter. Total thickness is 160 to 200 feet. Locally a disconformity separates it from the crossbedded zone. It is a folded, very brittle rock, but shows no flowage effects.

The SUTHERLAND FALLS MARBLE or Shelburne marble is a 90 foot, creamy white colored zone with contorted chains of gray dolomite grains across almost any surface. It has a single central silicate band (Henhawk layer). The entire zone is thinned to inches locally and at other places is thickened to more than 300 feet.

The INTERMEDIATE DOLOMITE is thick bedded, light gray weathering gray dolomite about 200 feet thick. A silicified band occurs near the mid section at most places; this is due to groundwater and the formation contains less than 15 per cent arenaceous matter.

The COLUMBIAN MARBLE is 500 to 600 feet thick but flowage locally thins this to inches and at other places increases it to over 1000 feet; even where thickness is average some layers are thickened locally serveralfold and others thinned..The lower 50 feet of this marble is dolomitic like the Sutherland Falls marble but the dolomite chains are not so contorted. Green silicate and white or light gray marble continue stratigraphically upward to a thick dolomite bed at the base of the West Rutland group of marbles; no dolomite beds are know within the Columbian marble. All Columbian marble weathers white with dark lines and within our tour area is characterized by "S" tectonite fabric.

The WEST RUTLAND MARBLE ZONE extends from the dolomite at the top of the Columbian marble through the dolomite at the base of a dark blue gray marble adjacent to the phyillite. The zone is intimately and finely crumpled so that the stratigraphic thickness has not been measured. Dolomite beds alternate with blue marble and are deformed to folds with much cross fracturing, or are stretched out into boudins; fractures are filled with calcite veins or flowage masses of blue marble. Locally deformation is on a sightly larger scale and there hot solutions have entered along fractures to bleach the gray marble; bleaching is displayed in West Rutland at Main Quarry #1 (stop) and silication is shown in the Sherman Quarry and Main Quarry #2 (stop).

Most of the blue marble is mixed too intimately with dolomite to be recoverable and is shown in a tunnel and drill core westward from Main Quarry #1. The upper part of the lower blue marble (West Blue layers) has fossil gastropods resembling Maclurea. This marble is separated from the West Rutland deposit by a thick dolomite. Most operations are in the Main West Rutland deposit (stratigraphy given in tour stops). The Green Mountain Marble Corporation works the Upper Deposit. This is overlain by blue marble with turritelliform and planiform gastropods and crinoid stems. A part of it is bleached to make the Westland deposit.

A thin band of **TRUE BLUE MARBLE** lies immediately below the black graphitic Canajoharie phyllite. Everywhere layers and boudins of dolomite appear within the blue marble. Only locally is it thickened adequately to make a commercial deposit and at each place it has an infolded syncline of the phyllite. At the True Blue Quarry, the phyllite syncline was squeezed off as a sock shaped enclave within the marble.

The **CANAJOHARIE PHYLLITE** is very black and graphitic adjacent to the marble but becomes dark and micaceous at over 100 feet above. This upper part is not easily distinguishable from the Mendon Series in the overthrust slices to eastward.

Major Structure

The Taconic disturbance caused the sub-marble sequence to be overthrust on the marble along Boardman Hill, through Center Rutland, along the west face of Pine Hill in Proctor and near Coxe Mt. Cheshire quartzite and mylonite rests on dolomite in the Otter Creek at Center Rutland and mylonitized Mendon Series transgresses Sutherland Falls marble Lower Dolomite, and the Crossbedded Zone near the Proctor town line. A very complex klippe covers the marble from Boardman Hill to Danby but otherwise no great thrust planes enter the marble zone to be visited.[2]

"Overfolds" on the Lower or Intermediate dolomite, approaching nappes in size, are attended by development of flowage folds in the Sutherland Falls and Columbian Marble. Flowage off the main arch folds in the West Rutland Valley develop local thickening or flowage folds on their east limbs. They will be seen in the Main Quarries.

[2] Editor's Note:
See Also the descriptions given by Thompson, Trip H.

Trip D Road Log

This tour is planned for four hours and a departure time of 8:15 a.m. is assumed.

Assemble at the north end of the Municipal Parking Lot to leave by Evelyn Street. Turn left on West St. and proceed west through the traffic light at Pine St. cross the Rutland R.R. and enter Route U.S. 4 after recrossing the Rutland R.R.; distance 0.8 mi. Clarendon dolomite outcrops behind the houses to right (north).

Mileage

1.3 Route Vt. 3 turns right to Proctor. Continue on U.S. 4.

1.5 Cross Otter Creek. Note Cheshire quartzite outcropping falls at left. This is part of the upper plate of the Pine Hill-Boardman Hill thrust.

2.15 Intermediate dolomite outcropping to right.[3] Sutherland Falls marble is concealed from Proctor line to Boardman Hill. To westward the Intermediate dolomite, Columbian and Blue marble zones are squeezed down to inches thickness.

2.2 Black Canajoharie phyllite north of the highway. This rock continues to outcrop for the next 0.8 miles to the railroad crossing.

3.4 Route Vt. 3 comes in on left; continue on U.S. 4 to traffic light.

3.5 Traffic light; turn right and continue past D & H. R.R. station at 3.9 miles, across C & P. R.R. at 4:05 miles.

4.2 Leave paved highway by gravel road to right; take first left after V.M. Co. stock room and proceed north to Main Quarry #1.

4.45 Main Quarry No. 1.. 8:30 stop #1. 5 minutes.

The roof layers separating the West Rutland Main deposit from the upper deposit are gray in the north end of the roof and white at the south. Thin green silicate bands form the axis of the bleaching: this is the second stage in transformation of limestone to marble. (See Bain 1, p. 137).

4.6 Main Quarry No. 2. 8:40, stop #2; duration one hour. By courtesy of the Vermont Marble Company the party will be lowered by derrick to the main floor at 156 feet below. Departure time 9:45.

The Main Deposit is on a flowage fold which carried the Hard Layer forward from a 20° slope eastward to be vertical for 86 feet as seen in the south wall of the shaft; a perspective diagram (fig. D-2) shows this structure. The roof layers continue at nearly uniform dip eastward and in consequence the intermediate marble is thickened. The sequence of marble layers is as follows:

Thin Statuary - in roof; is mainly blue here
Green silicate layer (thin)

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[3] Editor's note: Fresh road cuts revealed quartzite beds in this outcrop and is now mapped by Zen as Danby formation. See road log to Trip A.

Green strip	
	Green silicate layer (thin)
Monumental	
Statuary	
White average	
Brocadillo thin	green stripes uniform over a wide zone
Crinkly layer	
	Mainly irregular green stripe with mixed white
Smith layers	
	5" dark green stripe
Jackman	
Striped Smith	
Hard layer	
	Dolomite with some silication
Double belt two	4" green silicate layers separated by up to 2' of white
Rutland Italian	
Bottom Blue	
Dolomite	

Proceeding to the south tunnel, a 9 foot Monteregian dike, with chilled border, is exposed. (See polished slab in Proctor Marble exhibit.) The dike follows a distension joint system. Only slight displacement of strata occurs across its width. Thermal effects have produced "fish scale" checks in the marble for 20' on either side and have rendered the stone worthless.

South of the dike, a tunnel to eastward follows the deposit down dip past the flowage fold responsible for most metamorphism and thickening.

Return to cars.

Retrace route past Proctor road to Center Rutland shops.

8.3 Turn off right (south) to Center Rutland shops. Stop #3. Arrival time 9:55, departure time 10:25. This will afford an opportunity to see some carving, turning and various fabrication work on architectural marble. (For some problems see Bain 2.)

8.9 Turn right on Vt. 3 to Proctor.

9.7 Phyllonite of thrust plane outcrops on right (east) for 0.1 miles.

10.1 Sutherland Falls marble quarry dump visible on hillside ahead and slightly to right. Cheshire quartzite above thrust plane appears in cliffs to right.

11.1 Small area of Intermediate dolomite on right and in railroad cut to left. Sutherland Falls marble in quarries to east.

11.3 Abandoned Riverside Quarry in Columbian Marble is just west of the railroad on the left (west).

11.5 Crossbedded zone on right. Lower dolomites from here to Proctor.

13.3 Turn left from Route Vt. 3 to cross Marble bridge over Otter Creek and follow signs to marble exhibit at 13.5. Continue to near 13.7.

13.7 C & P R.R. tracks. Stop, #4. Time 15 minutes, departure 10.55. The Crossbedded zone is exposed west of this crossing and the strata are inverted. Farther west is the Lower Dolomite; beyond it is the original Sutherland Falls Quarry and birthplace of the Vermont Marble Company. The Hen Hawk layer can be seen dividing the deposit into the East layers (poor) and West layers. Return to cars and depart to right following Brandon road; keep left after crossing C & P tracks.

14.0 Sutherland Falls marble on left.

14.1 Intermediate Dolomite.

14.3 Columbian Marble found in drill holes. No exposures. The ridge to westward is the Canajoharie phyllite. The entire marble zone is thinned here by an overfold of the dolomites.

15.3-15.5 Marbles in Columbian Marble on the left or north. Note straight lining on marble outcrop just east of the quarries.

16.5 Abandoned Florence Plant. White pigment operations carried out on Sutherland Falls deposit to left (west).

19.7 Turn left off paved road to go to Pittsford Valley quarries.

20.2 Crossbedded zone on left.

20.4 Pittsford Valley Quarries. Stop #5. Departure 12:00.

The Pittsford Valley quarries extract the lower layers of Columbian Marble and east of them is a 200 foot deep glacial gorge which presents a few problems. Pittsford Valley Quarry No. 7 is the northernmost of the series and its light gray marble is between two yellowish silicate bands (See Fig. D-3). The north wall of the quarry shows the west wall band encroaching eastward toward the bottom of the quarry. The east wall band is within three feet of the west band at the northwest corner and descends for seven floors before turning up to the roof and striking diagonally southeast; this band forms another syncline at the beginning to the tunnel roof, rises on an arch and then drops down at the cliff face. This accordion folding or flowage folding is responsible for the thickening of 3 feet to 100 feet of marble at this section.

The quarry shows the appearance of a flowage fold in cross section. The outcrop on the top of the hill shows it in plan and the west wall and east wall silicate bands can be followed in detail on the stripped hill top (Figure D-3).

This marble has well developed shear fabric which renders it almost as stress anisotropic as Colorado Yule. Sonder's glide lines of "a" axes are displayed on the cliff four feet north of the tunnel wall. These pitch northward at the angle of the thickened body of marble. The "ab" plane is a plane of near foliation in this homogeneous rock. Slabs cut on the "ab" plane are extremely resistant to weather and for this reason you will see many glacial striations on the cliff face. Surfaces at right angles to the "ab" plane are less resistant to weather as you may note on the hilltop. These S tectonite marbles have extremely low porosity, very high elasticity, and low inter-granular pore width.

To join your next tour, return to within 1/2 mile of Florence and turn left on a dirt road by the "Covered Bridge" to U.S. 7. Turn right on U.S. 7 and continue to Pittsford and Rutland.[4]

BIBLIOGRAPHY

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2. Geological, chemical and physical problems in the marble industry. A.I.M.E., Trans. V.144, pp. 324-339, 1941.

3. The Central Vermont Marble Belt. Guidebook. 34th Field Trip, N.E. Intercoll. Geol. Assn., 1938.

Brace, W.F. Geology of the Rutland Area, Vermont. Vt. Geol. Sur., Bull 6, 124 pp., 1953.

[4] Editor's note: Those who wish to join Professor Kay's Trip B should follow Route 7 north to Brandon, then take Rte. 73 west to Rte. 30. Take Rte. 30 south (left) to Sudbury.

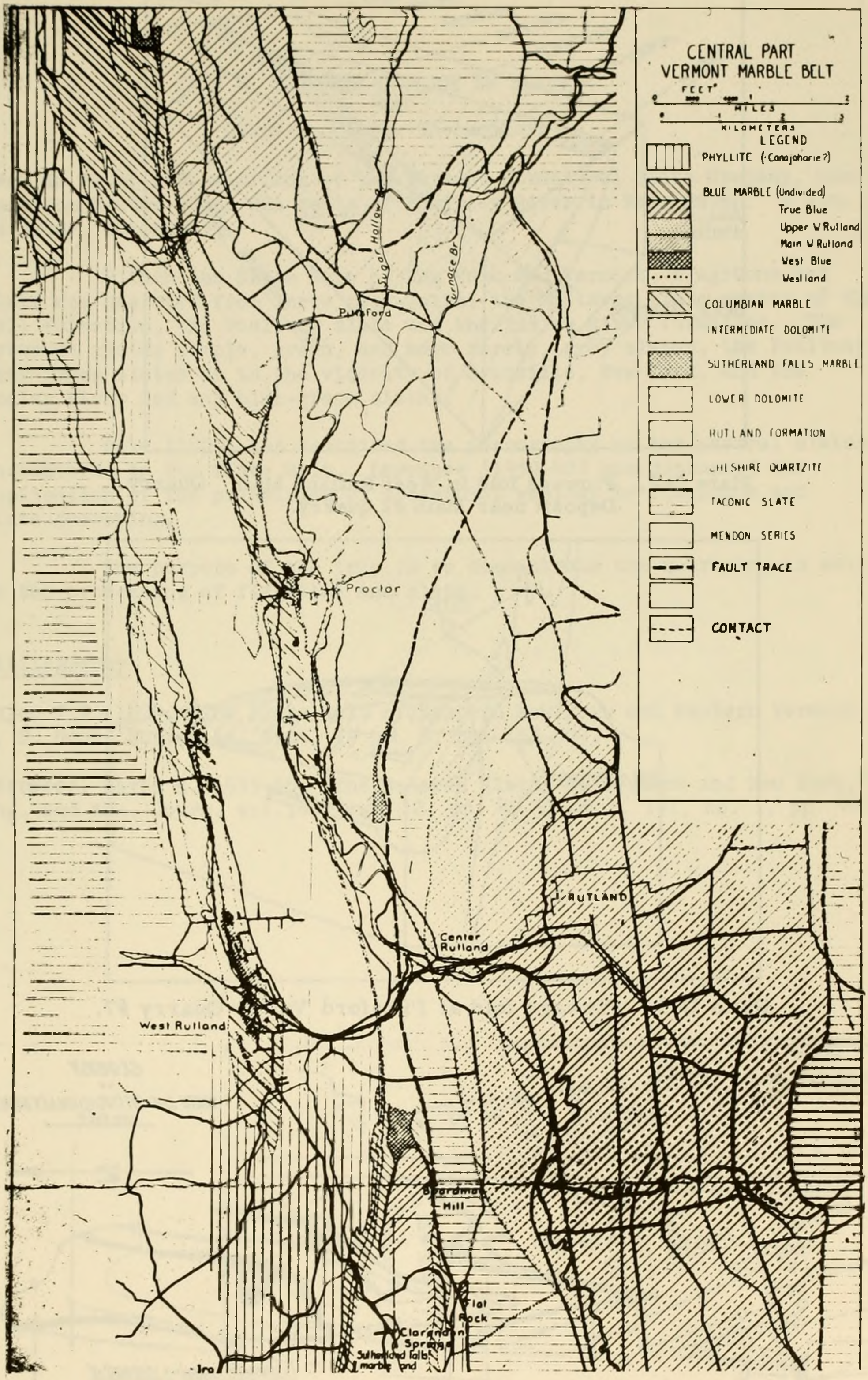

Plate D-1 Geology of the northern part of the Marble belt.

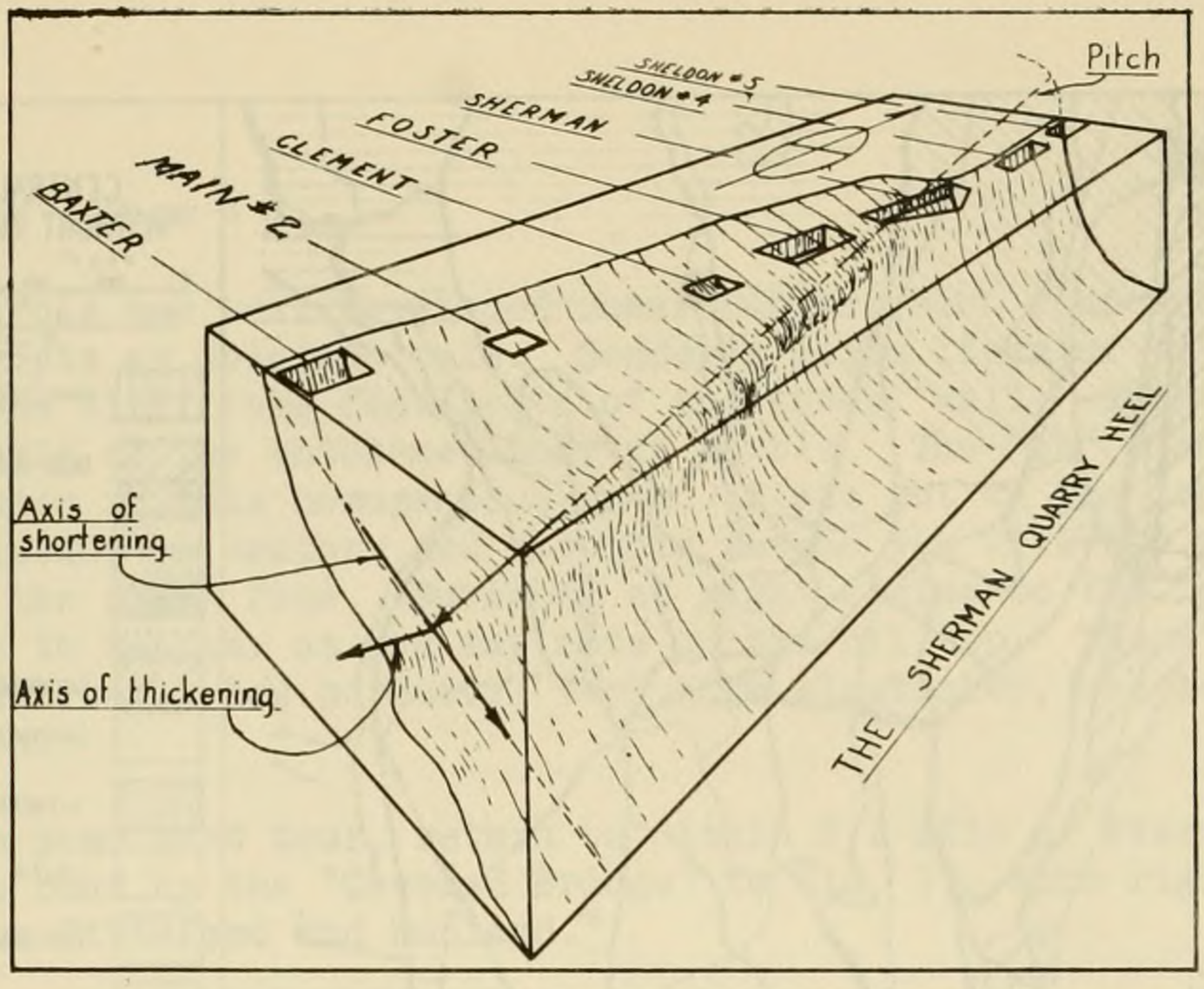

Plate D-2. Flowage fold in West Rutland Main Quarry. Deposit near Main #2 quarry.

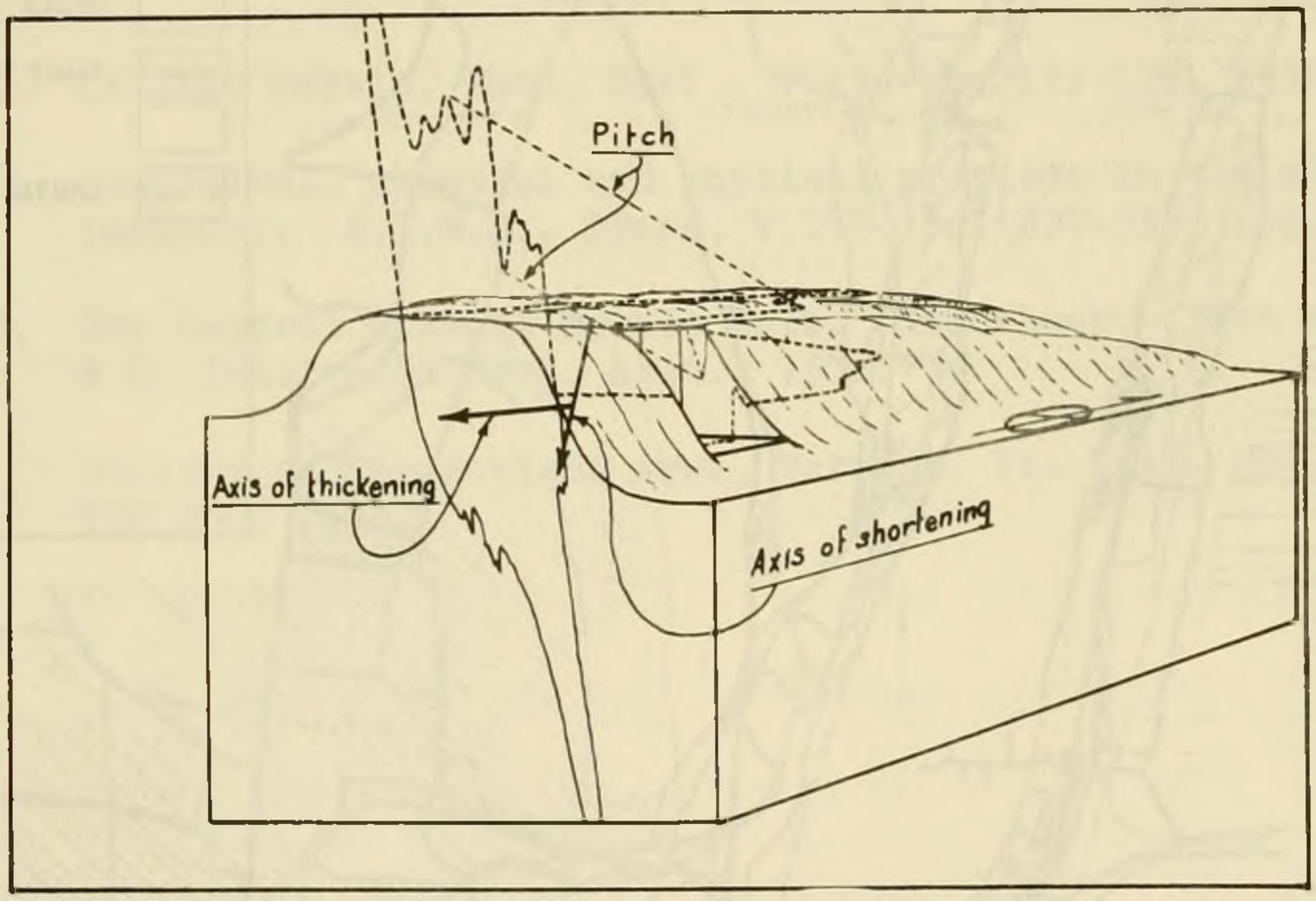

Plate D-3. Flowage fold at Pittsford Valley Quarry #7.

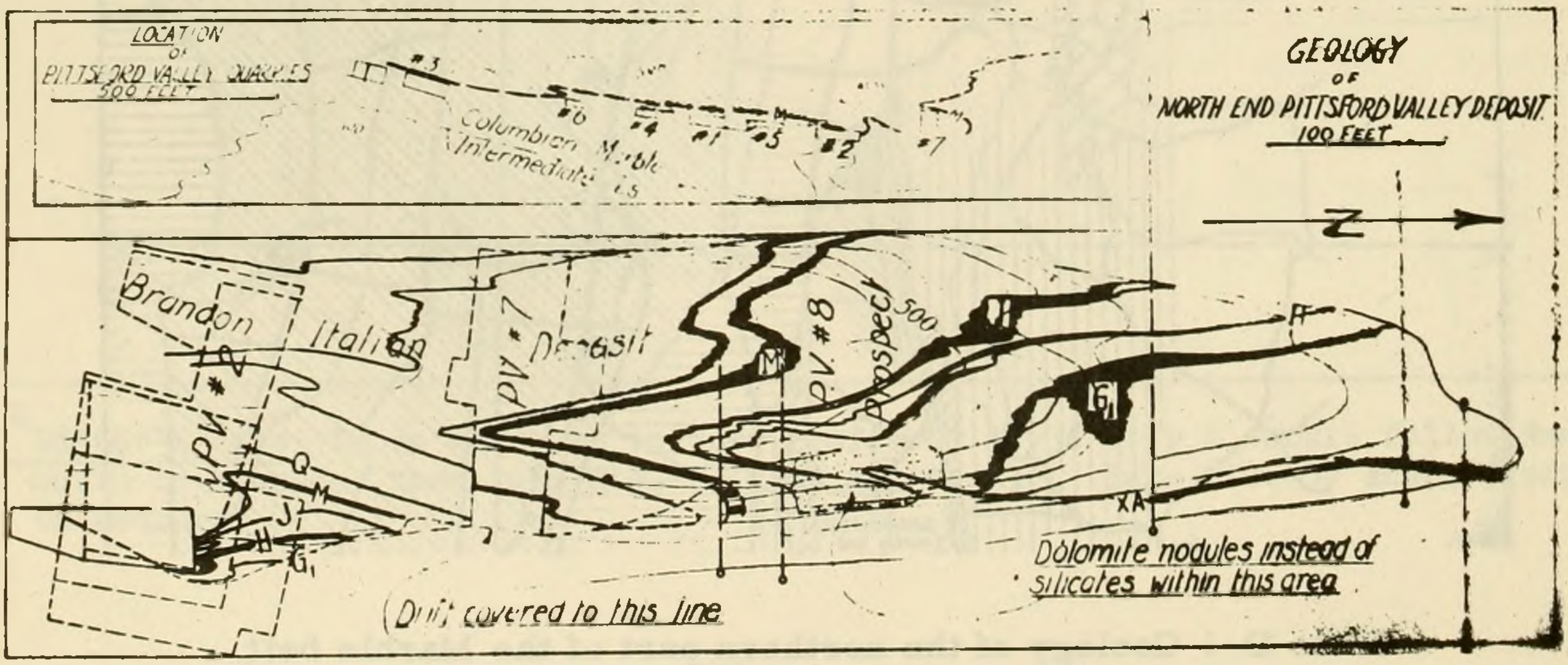

Plate D-4. Intercept of flowage bands of silicates with surface above Pittsford Valley #2 Quarry.