GEOLOGY 180

A GRADUATE COURSE

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A STUDY OF THE LITERATURE ON THE COMSTOCK LODE AREA WITH SPECIAL EMPHASIS BEING PLACED ON THE GEOLOGY

Much of this could be stated in a much better manner. H.G.F.
Note the one sentence marked on p. 7 — is typical among others that need revision.

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The purpose of this report is to discuss the opinions of various men on the geology of the Comstock lode area. The divergence of opinion as shown in the various reposts made the study very interesting.

I spend two afternoons a week for the greater part of the semester studying the reports of the various geologists who had studied the area, and in preparing tables and drawings to provide a method of comparison. The time wasn't sufficient for a personal study of the region to compare and check the works on the district, but only sufficient to study the printed literature on the district.

The books, pamphlets and reports used as references were obtained from the University library.

Gold was discovered in gold canyon in 1849 and in Gold Hill in 1859. The mines were very productive, the major part of the bonanzas had been extracted by 1880. The lode continued to produce at a very fast rate until about 1906 when production waned. At the present time the activity on the Comstock is increasing. The lode produced over $400,000,000 in bullion.

The references used were;

1. New Features of the Geology of the Comstock Lode, by Vincent P.Gianella-Mining and Metallurgy July 1934

2. Bonanza Ores of the Comstock Lode by Edson S. Bastin-- United States Geological Survey Bulletin 735C.

3. The Structure and Genesis of the Comstock Lode by John A. Reid-- University of California Bulletin, vol4 #10 pp 177-179 1905

4. The Washoe Rocks by George F Becker- Bulletin #6 California academy of Science 1886

5. The Development of Crystallization in the Igneous Rocks of Washoe Nevada by Arnold Hague and Joseph P. Iddings, U.S.G.S. Bulletin # 17 1885

6. Surveys West of the 100th Meridian by Captain Wheeler, and the accompanying atlas, by Captain Wheeler 1887

7. Geology of the Comstock Lode and Washoe District and the accompanying atlas, by George F. Becker.-U.S.G.S. Monograph 111 1882

8. The Comstock lode, Its Formation and History by John A Church 1879 (this book wasn't available but his work was discussed by Wheeler)

9. Exploration of the Fortieth Parallel Vol VI, and atlas by Clarence H. King 1875

10. The Comstock Lode, Its Character and Probable Mode of Continuance to Depth. A report to the Board of Trustees of the Sutro Tunnel Co. by Ferdinand Baron Von Richthofen in 1865

The drawins to accompany this report are merely rough tracings of the geological maps found in the the various reports. Drawing #1 of the Sutro tunnel section as proposed by Von Richthofen and Stretch- was taken from the Sutro tunnel report of 1865. Stretch was at that time the State surveyor and mineralogist.

Tracing #2 is a tracing of Beckers geological map. This tracing wasn't colored because if necessary it could be blue-printed.

Drawing #3 shows the Sutro tunnel section as determined by Becker, and on the same sheet shows the conclusions of Hague and Iddings for the same section.

Table #4 is designed primarily to roughly contrast the ideas and conclusions of the various observers. Vincent P. Gianells and Beckers conclusions were used as the basis of comparison.

Von Richthofen's report was the earliest reference found. Von Richthofen wrote a short and concise report on the geology of the Comstock Lode area and the Sutro section. The chart #4 accompanying this report shows Von Richthofens conclusions. He considered the fact that the vein was a fault vein and in trachyte of special geological importance.

Becker's report was a very lengthy report based on two years study of the region. Becker made the most thorough study of the region. Becker was a good physicist and brought out several very interesting theories as to the parallelism of faulting along the east side of Mount Davidon, the relation of the composition of the mine waters to the ore deposits, the rate of temperature increase with depth and other conditions, and as to the process of alteration of the rocks. Becker observed that the face of Mt. Davidson at Virginia City was produced by a fault and that some of the canyons such as Ophir ravine followed east west faults. He recoginized that erosion had cut the face of Mt. Davidson down about 15 degrees since the fault producing the mountain. Becker evolved a very interesting theory that the sloping surface of the ground east of the Comstock lode was due to a parallel type of faulting very similar to the slip of sheets of paper.

Becker stated that alteration was more intense in the hanging wall Basalt and granite had escaped with mere traces of decomposition. In alteration: hornblende passed directly into chlorite as in the case of augite and mica. Pyrite was in some places formed from hornblende, mica and augite. Chlorite passes into epidote, bisilicates alter to chlorite. Chlorite alters to quartz, calcite and limonite. He didn't know what was the alteration of feldspars with the exception of the propylite.

Becker recognized the fact that the Comstock vein was a fault vein and the noted two periods of faulting.

Church thought that the Comstock Lode was a substituted mass. Church summarized the epochs as follows;

1. The diorite
2. The subordinate pressure
3. The propylite
4. The principal elevation
5. The andesite
6. The opening of the strata
7. The siliceous.
8. The trachyte
9. The argentiferous

King in 1875 in reporting on the region gave very nearly the same rock classification as Von Richthofen

Captain Wheelers report in 1887 discusses the Washoe district and other observors conclusions as to the rocks of the district.

Hague and Iddings in 1885 performed microscopical work on Becker's thin sections and rock samples. Hague and Iddings started their wok with the avowed intention of proving by using The Sutro section that from the center of n igeous mass the degree of chrystallization decreases toward the margins. Their work was based entirely upon work with the microscope.

In 1886 Becker published a report for the purpose of challenging the conclusions of Hague and Iddings where they were contrary to his original conclusions.

Reids work in 1905 agreed with the conclusions of Hague and Iddings. Reid wrote a clear and concise report but didn't attempt to cover the whole district. His work seemed to be concerned mainly with the possibility of finding ore on the West side of Mount Davidson, and seemed to pay special attention to the Hale and Norcross tunnel. It is interesting to note that the Hale and Norcross tunnel passed through the West Mount Davidon fault and struck hot water but at the time of writing they hadn't struck any ore.

Professore V.P.Gianella has made a very thorough study of the region and has given several short papers on the subject. Professors Gianellas work has been limited to a certain extent by that the fact that a good many of the older and deeper workings are inaccessable. The conclusions of Professor Gianella have met with the approval of many other prominent geologists and may be considered as the latest and most correct works on the district.

Professor Gianellas ideas taken very largley from his article in "Mining and Metallurgy" are:

ROCKS OF THE COMSTOCK LODEZ

Formation	Age	Thickness in ft.
Basalt	Pleistocene	50
Mt Kate Volcanics	Pliocene	1500
Forman volcanics and Sutro tuffs	Miocene	3000+
Hartford Hill Rhyolite	Miocene?	400
American Ravine Andesite	Miocene?	600
Monzonite	Jurassic	
Meta-volcanics	Triassic	600+
Meta-sediments	Triassic	3000+

The oldest rocks, the sediments were steeply tilted and and eroded before the deposition of the volcanics. Then came the intrusion of the monzonite adding to the metamorphism of the older rocks. A long period of erosion ensued followed by the outpouring of the volcanic Tertiary lavas, mostly during the Miocene. These were faulted and mineralized, producing the Comstock lode and related veins. A long period of erosion removed several thousand feet of rock before the Pliocene vulcanism resulting in the deep flows of the Mt. Kate lavas. Following this period of volcanic activity basin range faulting followed closely the footwall of the lode through Virginia City and Gold Hill and thence along American Flat. This faulting uplifted Mt. Davidson forming the scarp which rises steeply from the outcrop of the lode at Virginia City.

The Davidson diorite is found to be clearly intrusive in nature but its precise place in the geological events is, as yet, undetermined. Of these rocks the Forman series is most closely associated with the veins. It forms the hanging wall of the Comstock throughout most of its length and entirely encloses the Silver City system of veins. The Sutro tuffs, about 400 ft. thick, are water-laid and interbedded with the Forman volcanics. This tuff gives the attitude of this formation which in general trends northerly and southerly and dips westerly with and inclination of 30 to 55 degrees. The tuff member proves of value in determination of the magnitude of faulting.

A determination of the ages of the rocks and of the period of erosion which beveled the Forman volcanics and the veins gives a close determination , within rather narrow limits, of the period of vein formation. This falls in the early Pliocene as the upper Miocene Forman volcanics are the youngest rocks to be mineralized and after a prolonged period of erosion the veins are covered, in places, by the Mt. Kate lavs which in turn are faulted by the Davidson fault.

The veins have been grouped into two systems. The Comstock vein system includes all those veins which are in the lode or its branches. The north east trending veins in the neighborhood of Silver City have been named the Silver City vein system. Both groups of veins are similar in mineralization and are of the same age.

The Mt. Kate lavas are not mineralized and cover large areas w where they may conceal veins.

Three distinct periods of faulting have an important application to mining problems. The oldest period, in which there were several faultings, occurred before and during the period of mineralization. Then followdied a post-mineral faulting which crushed and in some places, displaced the veins. A long erosion interval effaced the scarps of these earlier faults and produced a surface of moderate relief upon which the Pliocene lavas were extruded. The earlier workers were of the opinion that but little erosion had taken place since the formation of the lode. The Pleistocene faulting which elevated Mt. Davidson appears not to have affected the veins except that part of the lode which lies in the vicinity of Virginia City and Gold Hill. It does not follow along the lode southeastward from Gold Hill to Silver City and beyond. Previously only the Davidson fault was recognized and it was thought to be the seat of ore deposition, wheras it long post-dates the period of mineralization.

The Davidson faulting has a throw of 1500 to 2000 ft. wheras that of pre-Davidson faulting is upwards of 2000 ft.

Most of the larger, and many of the smaller, oreshoots are found at or near intersections of smaller veins with the larger, or near forks in the main lode. The Big Bonanza at Virginia City, the productive area at Gold Hill, and the Justice orebody all occurred near intersections or near branches in the vein. In many mines the better ore is found where small fractures trend diagonally across the vein.

On the mine dumps above the Overman shaft one can see the the slate from the footwall and parts of the blakd dyke, and can see pieces of the biotite andesite dike which at the Woodville shaft occurs as a dike in apothoces of other rocks.

At Silver City you can see the monzonite and the American Ravine Andesite which lies on the monzonite and under the Hartford Hill rhyolite.

At the Dayton mine you can see the American Ravine and Forman andesites.

The Mt. Kate andesite can be seen at the Knickerbocker shaft.

The Silver Hill and St. Lous mines are in hanging wall fractures. The Brown mine is in a horizontal vein on the wst side.

At the Spring Valley Mine you can see the Hartford Hill Andesite and American Ravine andesitye

St the Kossuth shaft you can see the rock cuts just south of the Dayton and see the Hartford Hill rhyolite and see displacement.

By going around to Crown Point ravine one finds evidence of metamorphism (tourmaline)

At the Justice one can see the Hartford Hill rhyolite with the Forman andesite on top.

Up American Ravine one can see the monzonite with dikes into the metamorphisc, and further up the ravine you can see the American Ravine Andesity. Near the top you can see the

basalt and can see evidence that the basalt flowed down the canyon, and then rejuvination (slope steeper).

NORTH END list of mines taken from Becker

Utah

Sierra Nevada

Union Con

Mexican

Ophir

California

Con Virginia

Best and Belcher

Gould and Curry

Savage

Hale and Norcross

Chollar

Potasi

Bullion

Gold Hill

Imperial

Yellow Jacket

Crown Point.

Belcher

Overman

Woodville & Justice

Silver City

To properly discuss the findings, methods of reasoning, and fallicies of reasoning of many of the geologists who worked on this area would take many many pages and in the final analysis would be useless except in the evolution of a new set of rock designations from the previous work. The work of Professore Gianella should be taken as correct and the other references used only when referring to something which they studied in particular or is inaccessable at the present time.

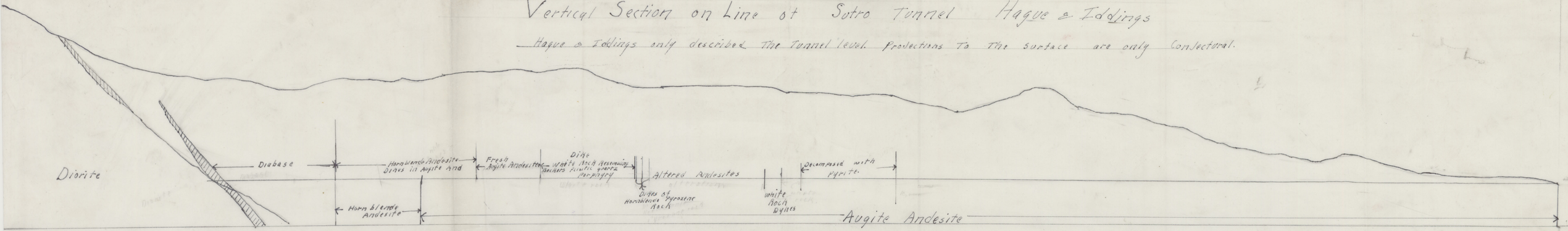
Most of the earlier geologists recognized the differences in the rocks but failed to properly classify the different rocks. A careful study of the three Sutro tunnel sections impresses one with the similarity of the lines of demarcation but the divergence of opinion in naming the rocks.

Professore Gianella states that his geological map corresponds fairly closely in outline of the rock areas with Beckers report with the exception that the rock classifications are in most cases different.

This study was very interesting, the drawings and tables were made to allow one to make a visual comparison of the rock delineation and classification without the necessity of long and detailed written discussion. The mass of material available to be put into this report had to be condensed so in a good many cases statements of the various observors which were very interesting had to be omitted.

Vertical Section on Line of Sutro Tunnel Hague & Iddings

Hague & Iddings only described The Tunnel level. Projections To The surface are only Conjectural.



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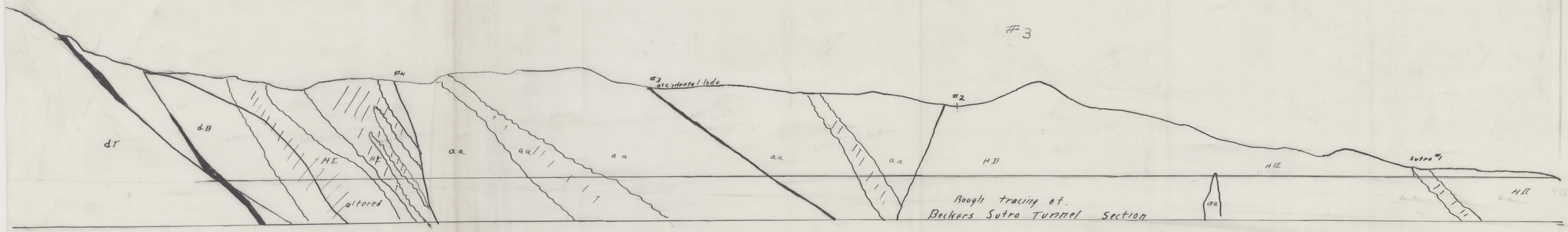

Rough tracing of. Beckers Sutro Tunnel Section

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#4. The Comstock Rocks and Ages

V. P Gianella 1934			Becker 1882		Hague and Iddings 1885		Von Richthofen 1865		Church 1879	King 1875
Age	No.	Rock	No	Rock	vpg	Rock		Rock	No	Rock	Rock
Pleistocene	1	Basalt	A	Basalt	1	Diabase & Basalt	EA1	Basalts	C 1	Trachyte	Trachite
			B								
Pliocene	2	Mt Kate Series	B	Later Hornblend Andesite	2	Hornblende Mica Andesite	BIL	Trachyte	B,C D,5,4,3,2	propylite	propylite
P~~~~	2	mineralization									
						Dacite, Rhyolite, tuffs		Propylite	B,c, 7,6,5,4		
	3	Biotite Andesite	C	Augite Andesite	4, 2	Breccias, & solfateric action	g-2				
								Quartzose porphyry	D-3		
						Later Hornblend Andesite	I 4			Andesite	Mt Davidson Syenite
Miocene	4	Forman Volcanics & Sutro tuffs	D	Early Hnb And	4			Syenite	J 7		
						Hornblende & Pyroxene Andesite	IQ,F,4,5				Meta Sediments.
Miocene	5	Hartford Hill Rhyolite									
						Diabase	F-4	Metamorphics	C,9H,K,1,9,8	Diorite	~~Trachyte~~. Granite
Miocene	6	American Ravine Andesite	E	Late Diabase	2						
						Diorite	J-7				
?	7	Diorite									
Jurassic	8	Monzonite	F	Early Diabase	4						
Triassic?	9	Meta Volcanics	G	Quartz Porphyry	5						
Triassic?	10	Sediments	H	Meta - Diorites	2, 9						
			I	Mica Diorites	3						
			J	Granular Diorite	3, 9						
			K	Meta Sediments	9						
			L	Granite	7.						

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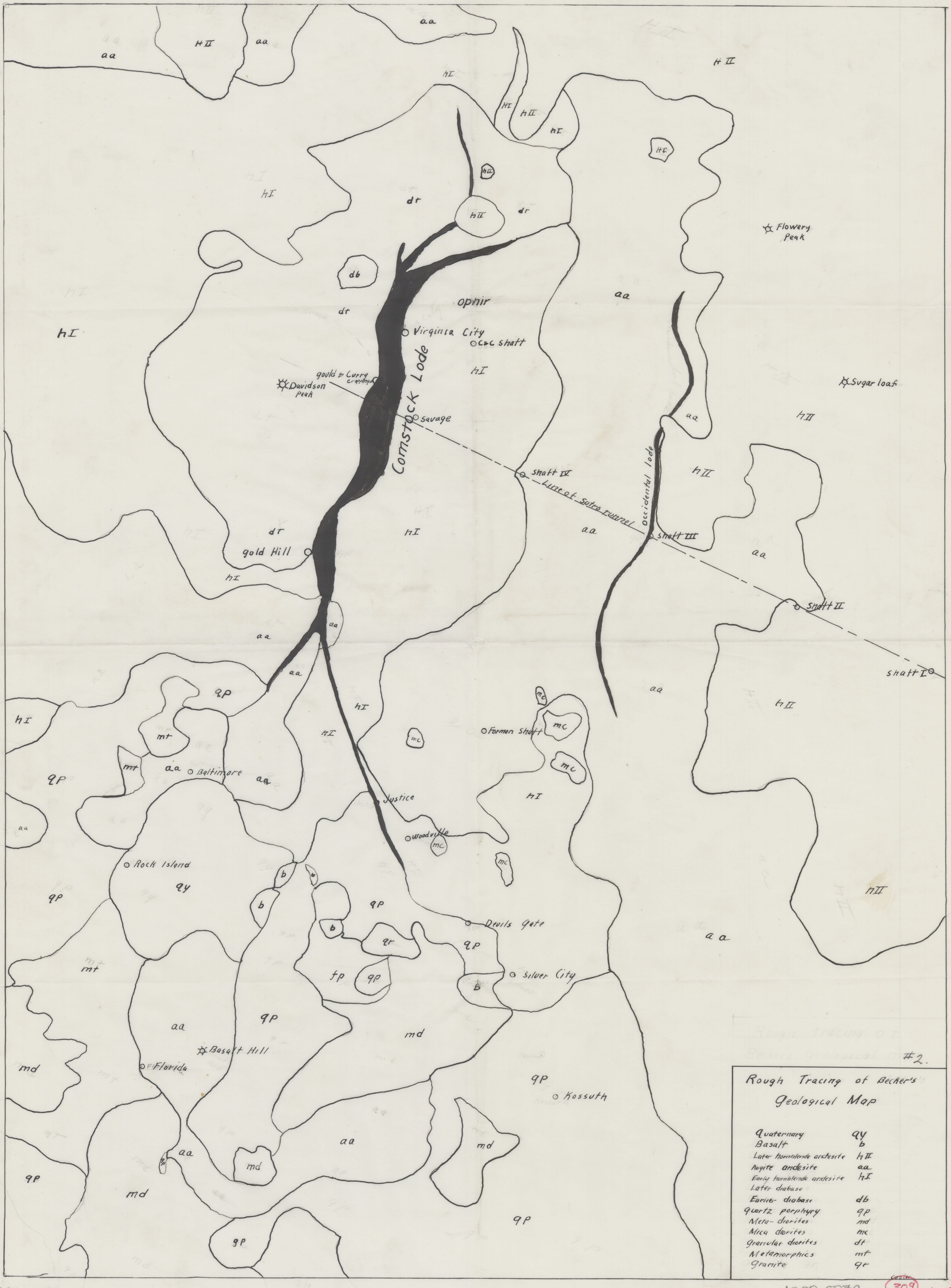

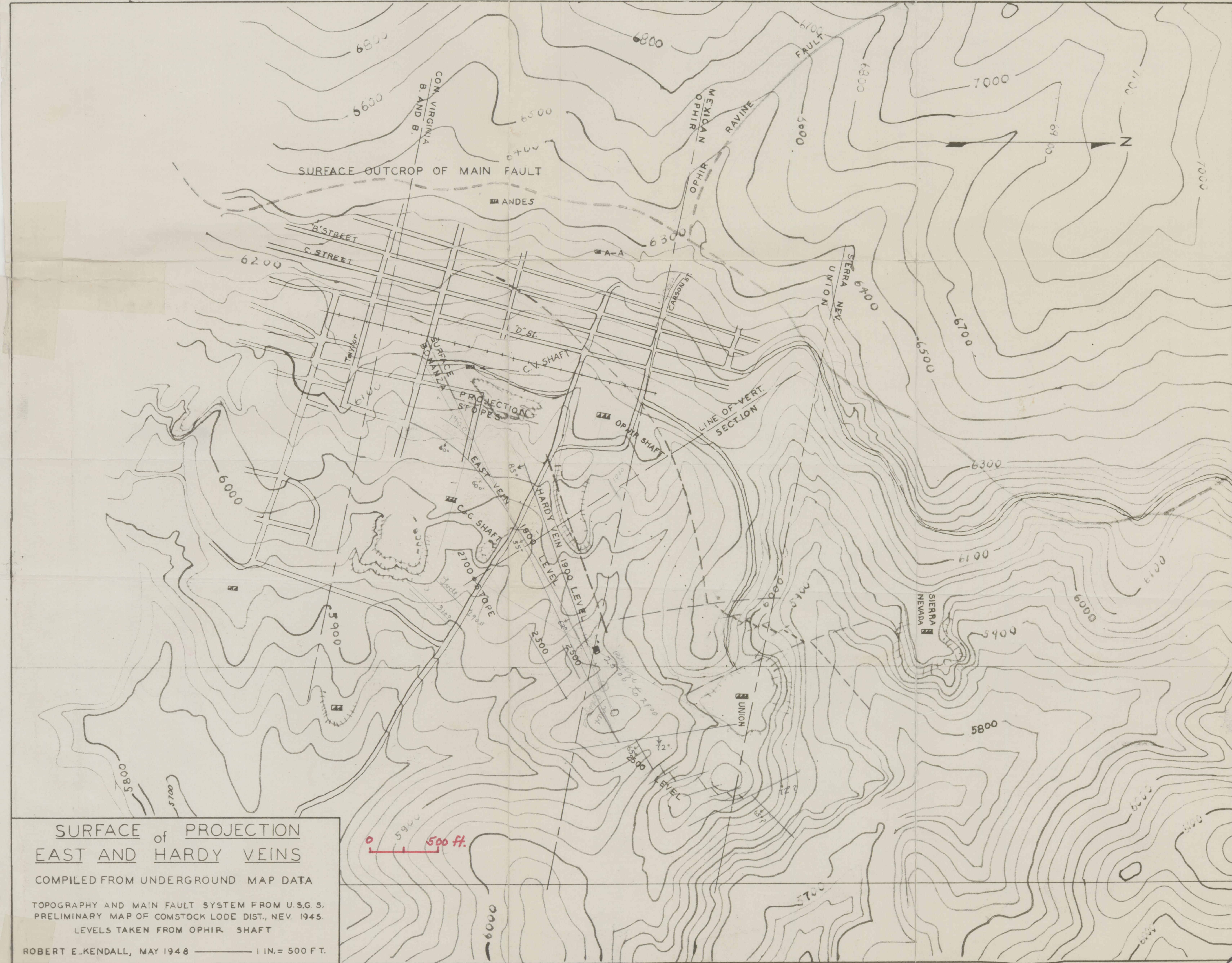

SURFACE PROJECTION of EAST AND HARDY VEINS

COMPILED FROM UNDERGROUND MAP DATA

TOPOGRAPHY AND MAIN FAULT SYSTEM FROM U.S.G.S. PRELIMINARY MAP OF COMSTOCK LODE DIST., NEV. 1945

LEVELS TAKEN FROM OPHIR SHAFT

ROBERT E. KENDALL, MAY 1948 ——— 1 IN. = 500 FT.

0 500 ft.

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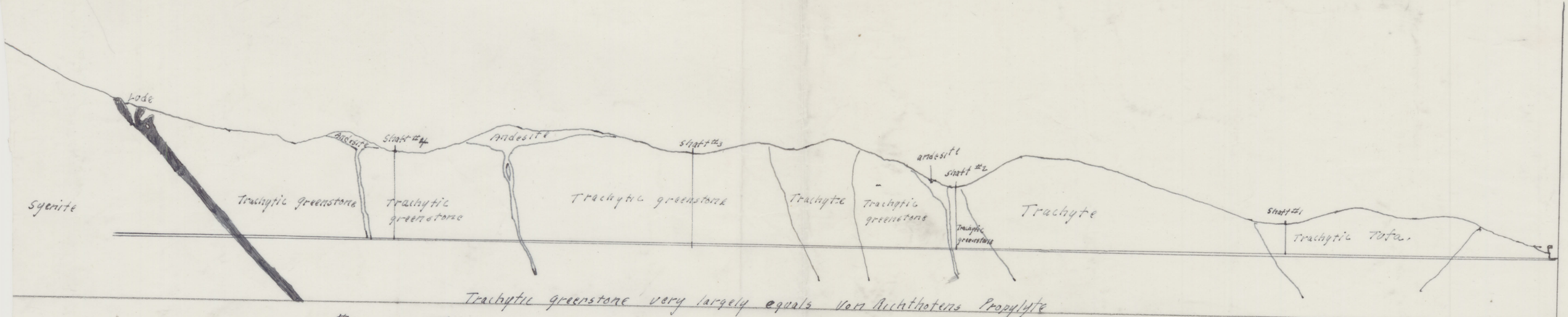

Trachytic greenstone very largely equals Von Richthotens Propylyte

#1 The Sutro Tunnel Section as proposed by. Von Richtofen & Stretch.

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