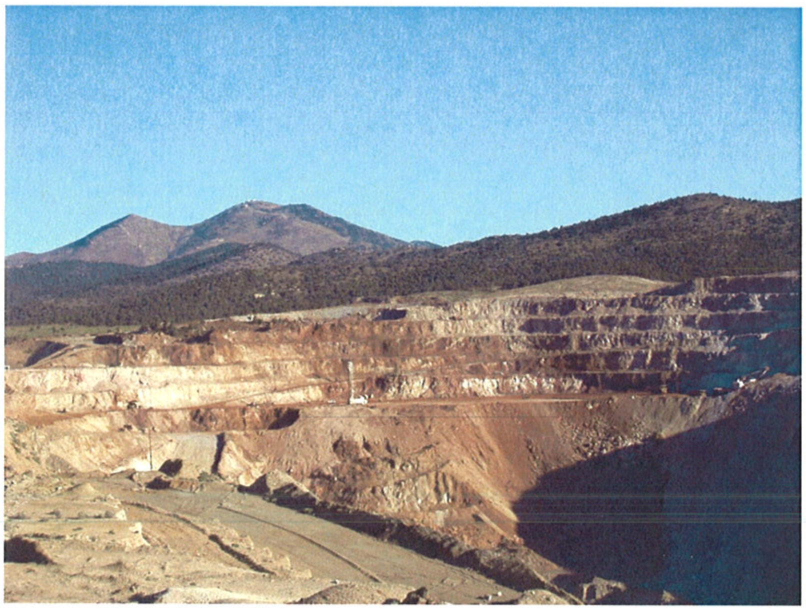
A Re-Evaluation of the Veteran Extension of the Robinson District of White Pine County, Nevada



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Abstract

The Veteran pit area of the Robinson District in White Pine County of Nevada has been studied significantly over the last 100 years and yet there are still questions that remain about its structural history. The Veteran Extension is the area northwest of the Veteran pit and is the next scheduled work area for the Robinson Nevada Mining Company. Despite historical and recent studies of the Veteran Extension there remains some doubt as to the credibility of the current geologic model of this area. Part of the doubt comes from incomplete database records, part from differing opinions of the genesis of the ore body and part from the interpretations of the unusual depth of oxidation. Original drill logs in the work area were compiled to test the accuracy of the drill hole data base and come up with a new set of cross sections to be compared to the current geologic model. No field work was performed since this project's goal is to create sections based on the original drill logs only, then to be compare later with other models.

Objective and Purpose

The purpose of this project is to interpret geology of the Veteran Extension based upon historical drill logs. The goal is to have a fresh set of eyes examine the data, without any preconceived knowledge to see if new information or interpretations are possible. Another purpose of the project is to test the quality of the historical accuracy of drill logs. My objective is to generate a number of cross sections around and across the Veteran Extension using the existing drill logs. The cross sections must rectify in two directions to ensure structural accuracy. A limited amount of information, beyond the drill logs, was provided to minimize any bias in the interpretation.

Acknowledgements

I would like to give thanks and recognition to the people that have helped me along the way with this project. My two biggest thanks go to Dr. David Jessey and the Robinson Nevada Mining Company. Dr. Jessey has not only inspired me to go into mining after college, but actually gave me the key to do so when he handed me the application for a summer internship at the Robinson Nevada Mining Company. Also as my Senior Thesis Advisor he has helped make corrections and guided me with this paper. To the Robinson Nevada Mining Company, I can not thank them enough for not only hiring me as a summer intern but keeping me on afterwards to start and complete this project. Furthermore, they have made it clear that I will have a permanent job afterwards. On a more personal level I would like to thank Tom John, the Senior Geologist, for coming up with a Senior Thesis Project, and talking with the right people to ensure my stay here. He is a great boss that provides challenging tasks to further my education in geology, mining and sometimes the bureaucracy. I appreciate the fact that he values my opinions and thoughts, as well as trusts my skills enough to drop me directly into blast hole chip logging. Finally, in no particular order I would like to thank Paul Stubbe for helping me understand the errors or mistakes made on the older drill logs, many of them dating back to the early 1990's and giving me guidance on troublesome blast hole chips. I would like to thank Richard Breitrick for giving me alternative genetic scenarios for the porphyry intrusion and for valuable district-wide structural interpretation and Jim Biggs

for generating maps and teaching me more about the in's and out's of a mine geologist, such as district remodeling. My appreciation goes to the staff of Magma Nevada Mining Company in the 1990's, including Eric Seedorff, Patrick Fahey, Marty Houloulis and David Maher who provided many of the district models. Also I would like to thank the countless people that have left records of their work in the Robinson District over the last several decades.

Introduction

The Veteran Extension is an area to the northeast of the Veteran pit in the Robinson Mining District. This district is a porphyry copper deposit located in the town of Ruth, in White Pine County, Nevada. The town of Ruth is about 8 miles north of the city of Ely and Ely is located approximately 250 miles north of Las Vegas, Nevada.

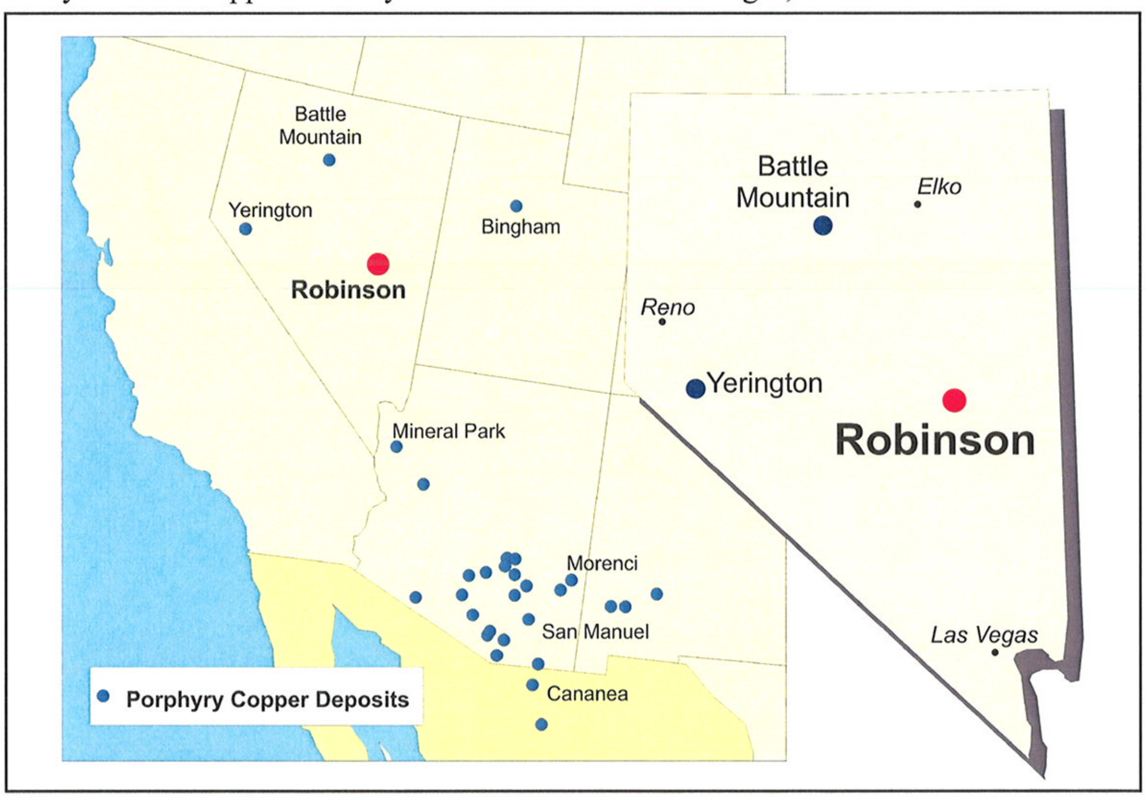


Figure 1. Location Map

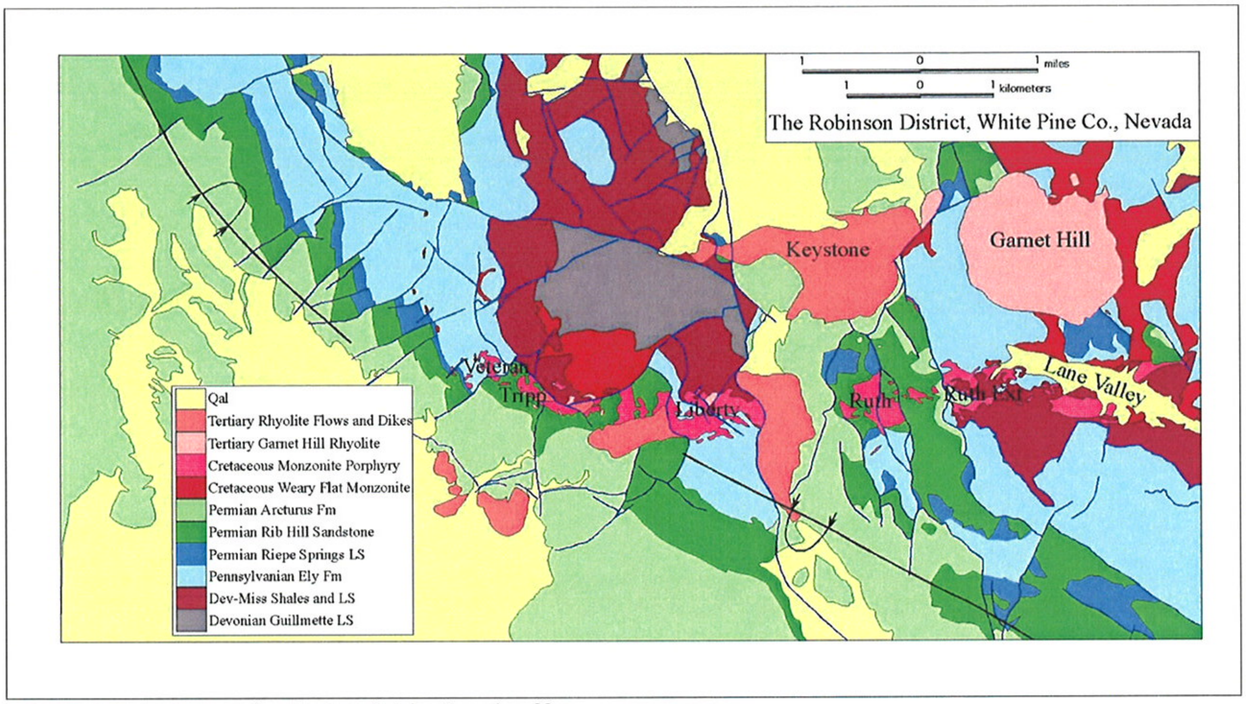


Figure 2. Location Map (Eric Seedorff)

The entire district is approximately 27 square miles. Within the Robinson District there are several open pit mines. Four large pits; the Ruth, Liberty, Veteran and Tripp were mined for copper and in addition there are several smaller peripheral pits that were mined for gold. The Tripp and Veteran pit are currently being mined in a manner that will combine the two in to a single large pit (Tripp-Veteran)

The Robinson District has a long history; mining began in the late 1860's when a small, marginal, silver deposit was discovered. In the early 1900's the oxidized copper ore body was discovered. Several underground mining operations were started by several different companies in numerous locations. Over the next few decades the different companies merged and in 1958 the entire district was unified by the Kennecott Copper Corporation.

Underground mining continued until the early 1970's. By then economics dictated that open pit mining was more profitable. The pits were begun above the highest grade underground mines. During this initial period, supergene copper oxides comprised the primary ore. Briefly during the mid 1980's the District was owned by Alta Gold who mined strictly for gold with limited success. In the early 1990's Magma Mining Company (later to become part of BHP Copper) purchased the district with the plan to mine the primary sulfide copper ore in the open pits. A crusher and mill were built and after a few years of mining the price of copper (and most commodities) declined and the mine was closed. Currently, Quadra Mining Limited owns the Robinson District and recommenced the mining of sulfide copper ore.

In its long history, volumes of information have been generated and retained. Unfortunately, as a result of the numerous ownership changes different lithologic descriptions were utilized for the same rock units, some descriptions were made before there was a uniformly accepted nomenclature for lithologic units, and individual prejudices and hypotheses colored the descriptions.

The Robinson District is located in the Basin and Range province of North America and has been affected by Cenozoic extension. The district itself lies within an accommodation zone of the Egan Range. North of the district the Egan Range tilts to the west, and to the south of the district the range dips to the east. In this accommodation zone, the units are compressed into folds and segmented by dozens of small faults. This has made the structure so complex that even after more than one hundred years there is still debate as to how the porphyry stock was intruded. One theory, proposed by Dr. Eric Seedorff of the University of Arizona, is that the stock intruded into the weakened accommodation zone to form the classic porphyry shape and alteration zones. The ore body was then faulted and extended at least three times. There appear to be three generations of normal faults gradually becoming older as interpreted by cross cutting relationships and low angle faults. It appears that as the area was extended high angle normal faults gradually shallowed (as the blocks rotated) and younger high angle normal faults developed crosscutting the older shallowed normal faults.

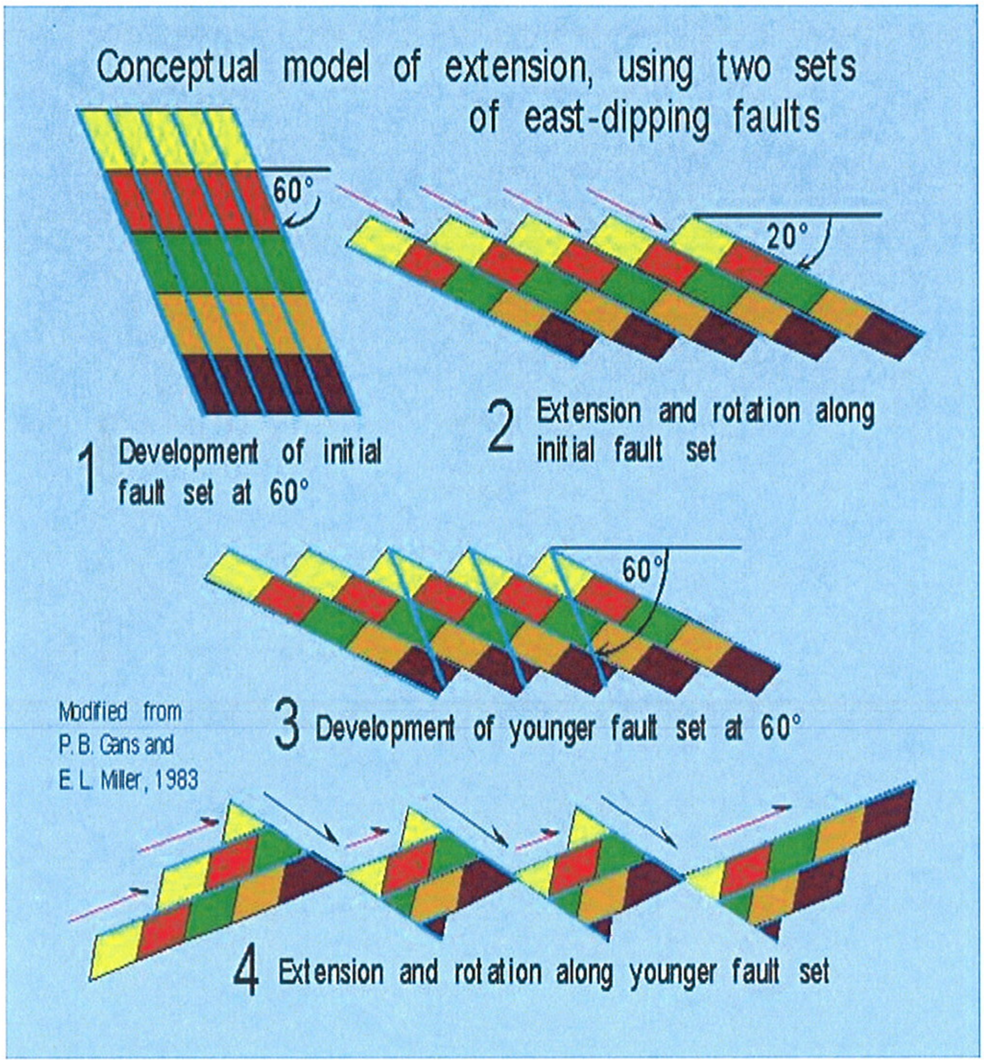
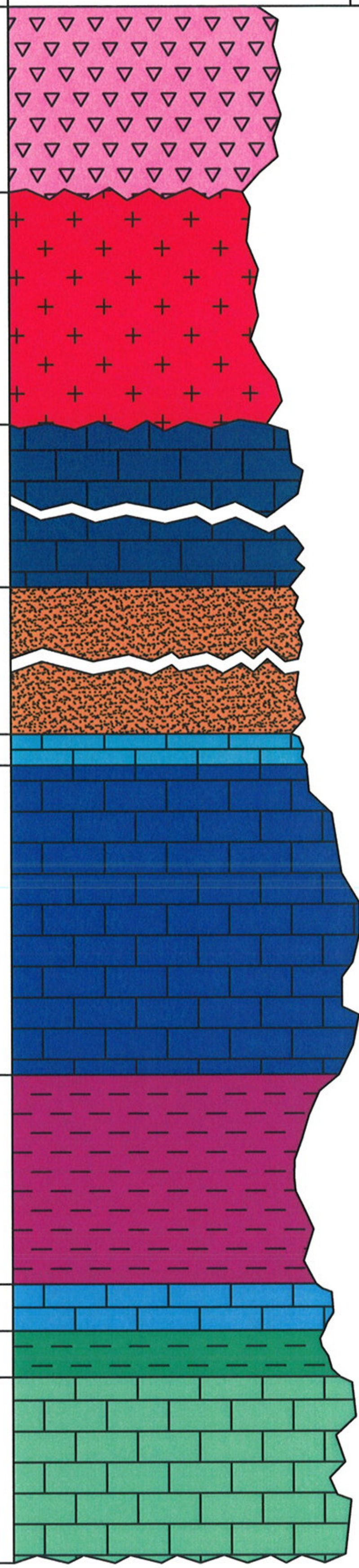


Figure 3. Low Angle Normal Fault Genesis

The evidence to support this model is the linear area the porphyry deposit covers; it is as if the porphyry has been laid on its side. An alternative theory proposed by Richard Breitrick, formerly with the Kennecott and Magma Copper Company, is that the porphyry intruded in to a fold in the accommodation zone, intercepted the Mississippian Chainman Shale (a structurally weak unit) and spread along the axis of the fold to create the linear ore body. The typical alteration halo that porphyry's form was distorted as the way fluids moved through the fold. There is significant structural information that lends credibility to this theory. It is based upon mid-1960's maps of the surrounding geology, including the Egan Ranges, by Arnold L. Brokaw of the USGS, Richard Breitrick and stratigrapher John Welsh of Kennecott. Regardless of the model, my focus lies in the area of the Veteran Extension on the western-most extent of the porphyry.

Era	Period	Age	Formation	Thickness	Rock Type	Description
Cenozoic	Tertiary	37Ma	Rhyolite			Porphyritic Rhyolite, Contains abundant clear and smoky sub-hedral quartz. Cloudy to clear Sanidine. Occurs as Diatremes, Breccias and Tuffs.
Mesozoic	Cretaceous	109 Ma	Monzonite Porphyry			Porphyritic intrusive, that has multiple alterations. The unaltered Weary Flats Pluton and the classic Lowell-Guilbert Porphyry Alteration Zones. Weary Flats is characterized with large feldspars phenocrysts and is unaltered. Most common alterations are Phyllic and Potassic.
Paleozoic	Permian		Arcturus	2800'		Tan to grey Limestone. Upper portion is a sandy limestone, the middle portion is a pure limestone with white calcite spotting with bryozoa fossils. The lower portion is a slightly sandy limestone with colonial coral fossils.
Paleozoic	Permian		Ribhill	1100'		Tan calcareous sandstone, weathers to brick red color. Small interbedded limestones contain fusulinded fossils.
Paleozoic	Permian		Reipe Springs	250'		Light brown to grey, massive-bedded limestone.
Paleozoic	Pennsylvanian		Ely	2300'		Light grey to dark grey, bedded sandy limestone. Major host rock for mineralization.
Paleozoic	Mississippian		Chainman	400' - 1500'		Characterized with four distinct lithologies, siliceous sandstones, black organic limestones, black fossile shales and calcareous siltstones.
Paleozoic	Mississippian		Joana	350'		Thickly Bedded Bioclastic Limestone
Paleozoic	Devonian		Pilot	400'		Calcareous Siltstone and Silty Shale
Paleozoic	Devonian		Guilmette	2500'		Argillaceaous Limestone



Data Section

Lithologic Units

The Robinson District has ten principle formations (as seen in Strat Column) but only five lie within the Veteran Extension; the Mississippian Chainman Shale, Pennsylvanian Ely Formation, Permian Reipe Springs Formation, Permian Rib Hill Formation and the Cretaceous Porphyry Monzonite. There are multiple periods of alteration overprinting the original lithology often making it nearly impossible to decipher the original lithology. Following is a detailed description of the pertinent lithologies and the common alteration types for each.

Tertiary Rhyolite – various in color and texture to a degree that it is often confused with other lithologies in the district (most misidentified unit in the district). The colors range from light grey, to greenish-yellow, to brown, to pinkish orange. It can appear as massive tuffs, diatremes or breccias. Occasionally small phenocrysts of plagioclase are found in it as well as sulfide mineralization. The sulfide mineralization is mostly pyrite and usually has no economic grade copper mineralization. The most distinguishing (and sometimes overlooked) identifier is small euhedral quartz eyes. White silica flooding is also typical of the Rhyolite.

Cretaceous Monzonite Porphyry – light grey to dark grey in color with white plagioclase feldspars. The feldspars are rarely larger than 1/8 of an inch (~2mm) and are often argillically altered. Sulfide minerals often make up a few percent of the rock mass, pyrite is usually the dominate sulfide with copper sulfides appearing in low but economic amounts. Occasionally the porphyry may have no sulfides present at all.

Permian Rib Hill Formation – fine sandstone with interbedded thin, sandy limestones and local silty dolomite. The sandstones weather to a distinctive brick red color. The Rib Hill sandstones are calcareous and very porous. Of all the sediments in the district the Chainman Shale and the Rib Hill sandstone are the most reactive and most readily assimilated by the intrusive porphyry (Welsh, 1965). In the Veteran Extension, the Rib Hill is a clean sandstone that has been leached. There are abundant crystal molds (most likely pyrite) and iron oxide staining.

Permian Reipe Springs Formation – massive bioclastic and biostromal limestones which are very competent. Large fusulinids that are distinctly different from the small Pennsylvanian fusulinids of the Ely Limestone (Welsh, 1965). In many places, this relatively thin unit is faulted out to place Rib Hill Sandstone directly above Ely Limestone.

Ely Formation – massive limestone unit, up to 2300 feet thick, mapped in detail by Welsh in the 1960's. He has divided it into twenty one separate units. In the Veteran Extension, the individual units are rarely differentiated. The Ely Limestone is usually identified by the fact it is a massive limestone between the Rib Hill Sandstone and the Chainman Shale. The Ely is usually dark grey and occasionally contains pyrite crystals.

It can be altered to not only marble but also jasperoid. It is best described as a skarn near ore-grade mineralization.

Mississippian Chainman Formation – a large shale unit, conservatively estimated to be 1500 feet thick (Welsh, 1965). Its total thickness is unknown because it lies in a zone of weakness and is extensively sheared. Four lithologies characterized the Chainman Formation; the upper siliceous sandstones, the black organic limestones, the black fossile shales, and the lower calcareous siltstones (Welsh, 1965). Where the Chainman Shale was intruded by the Cretaceous porphyry, the abundant hornblende altered to secondary biotite.

Lithologic Alterations

There are two general types of alteration that affect multiple rock units; these are jasperoid alteration and silicification.

Jasperoid – by definition a jasperoid is a dense, usually gray, chert like siliceous rock, in which chalcedony or cryptocrystalline quartz has replaced the carbonate minerals of limestone or dolomite. In the Veteran Extension intense iron oxide staining has made most the jasperoid dark brown, but there are places were the jasperoid has been bleached white. The Veteran Extension is distinguished by its jasperoid alteration, lying in a zone 600-800 feet thick (Maher, 1995). This alteration affects two different units (Ely and Rib Hill). At times the alteration is so pervasive it is impossible to determine the original lithology, but is primarily associated with the Ely Formation. The Rib Hill Sandstone usually makes up the whiter jasperoid as it is more porous and leaches more readily. Silicification – hydrothermal alteration occurring when fine grain silica is added to the rock. When the Tertiary Rhyolite was intruded, hydrothermal fluids moved through the area and silicified parts of different units. Silicification of the monzonite is the easiest to recognize as phenocrysts are absent but the sulfides remain, and quartz becomes the most abundant mineral in the rock bleaching it to a light grey. Small red rutile crystals survive the silicification process to also identify the monzonite. Silicification in the Ely is a more difficult to distinguish but it is often characterized by a dark gray color, small euhedral pyrite crystals and inability to react with HCl. Silicification of the Rib Hill Sandstone is the most difficult to recognize as it is already a quartz sandstone, but it can usually be identified by quartz flooding between the sand grains.

There are certain types of alteration that only effect specific formations. Below I describe the formations and their unique alteration.

Cretaceous Monzonite Porphyry – the most common alteration for the porphyry in the Veteran Extension is phyllic alteration, in which the phenocrysts are altered to sericite and the bulk of the groundmass is replaced by quartz. Sulfides survive this alteration intact usually in the form of pyrite. Argillic alteration is not as common but occurs when the feldspar phenocrysts are altered to clay. The least common type of alteration in the Veteran Extension is the potassic alteration; this is identified by the higher than normal presence of secondary biotite.

Ely Limestone – the limestone can be metamorphosed to marble, altered to a jasperoid, silicified or completely altered to a skarn. The easiest to identify is the marble which is almost always pure white with some MnO dendrites. The jasperoid and silicification were discussed above; the last change is skarnification. There are two types of skarns in the Robinson District, magnetite and garnet skarn. The garnet skarns are identifiable by higher than normal sulfide content, green actinolite crystals, and either red or green garnets. Sulfide minerals are not always abundant. Copper assays usually spike upward in the skarn. Magnetite skarn is easily identifiable with a magnet but can also be identified by its usually dark black or a rusty red color and has the mineral assemblage of magnetite, hematite and biotite with moderate sulfides.

Chainman Shale – though not extensive in the Veteran Extension, the Chainman Shale is easily altered to hornfels and skarn. In other parts of the district the Chainman Shale is the primary host for mineralization. Since it is not altered in the Veteran Extension its alterations are not discussed.

Geologic Structures

My study area lies within an anticlinal fold; the beds dipping to the northeast in the north and to the southwest in the south. The complex structure often causes abrupt changes in the strike and dip of the beds over very short distances so that the anticlinal trend is really only seen when looking at the area as a whole.

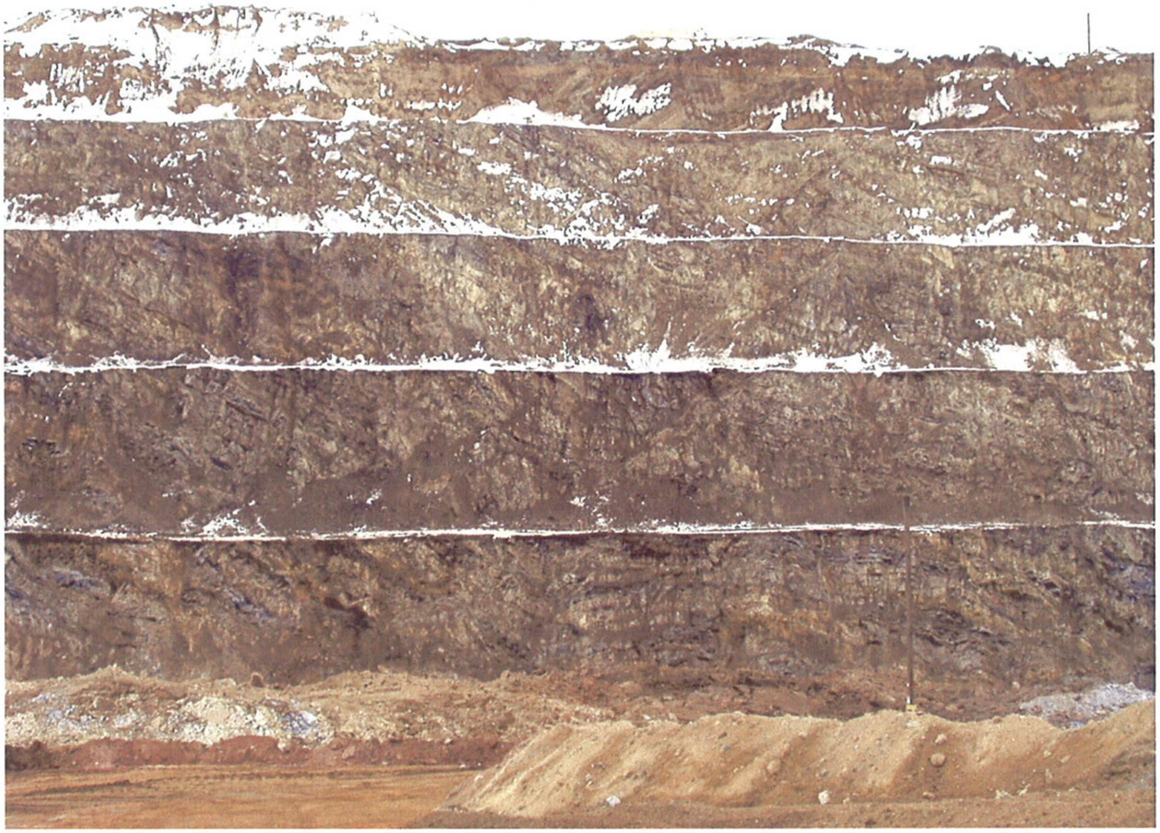


Figure 4. Small Anticline and Synclines in the Ribhill Sandstone just south of the Veteran Extension.

There are several major faults and many smaller unmapped and unnamed faults that are probably sympathetic to the major ones within the field area. The two most important faults are the Footwall West (FWW) Fault and the Alpha Fault. Mineralization is bounded to the north by the Footwall West Fault and to the south by the Alpha Fault. The western boundary of the porphyry is the limit of the alteration halo and the eastern boundary is the Tripp-Veteran pit. The Footwall West Fault is a normal fault that has the Veteran Extension down-dropped over an estimated 2300 feet (R.A. Breitrick) relative to the unaltered Ely Limestone to the north. The Alpha Fault to the south is also a normal fault that places the Veteran Extension adjacent to unaltered Reipe Springs, Ribhill and Arcturus Formations. The Footwall West Fault strikes northwest along the current north wall of the Veteran Pit and dips to the southwest. The Alpha Fault nearly parallels the Footwall West Fault but has a slightly more westerly strike and also dips toward the southwest.

There is a parallel fault between the Footwall and Alpha Fault known as the "S" Fault that has lesser displacement than the two bounding faults. There are also two younger faults, the Ball Park and Real Deal, striking northeasterly that cross cut and slightly offsets all older faults. The Ball Park is a very low angle (~18^{o}) fault while the Real Deal is slightly steeper (~38^{o}) fault. Both faults dip to the west.

Data Provided

I was provided a base topographic map with drill hole collar locations and access to the vault containing the historical paper drill logs. The topographic map was useful in defining drill hole density for more detailed maps and to provide the surface elevation for the cross sections. Utilizing the map I drew cross section lines based on drill hole density and area coverage. Later I received and used a topographic map with fault contours on it as some surface data was required to understand the dip directions of major faults. I did not, however, receive any surface geology or other structural information.

After making a list of one-hundred-sixty-eight drill hole logs needed to create the sections I found many to be only assays, poorly logged or even missing altogether. Many drillholes were angled off nearly perpendicular to the section lines and it was decided they would only be used if needed. The final total of drill logs used was cut in half to eighty-one. The logs span 34 years (1963-1997) and were created by five different companies and about a dozen different geologists. Interpreting the logs was not always easy. Fortunately many were relogged by Paul Stubbe, with whom I was able to consult to identify patterns, habits and common misidentifications by the different loggers.

Discussion and Interpretation

Background information

The computer model of the Veteran Extension does not take into account the alterations of the lithologies. Meaning in plan or section view of the model the jasperoids, skarns and marbles are labeled simply as the host Formation, same with the porphyry alterations. Outside of this project there have been several unpublished reports on the Veteran area defining the alterations and structures. Though not computer modeled there is prior information and mapping of the Veteran Extension subsurface. However the purpose of this project is to rely solely on the drilllogs and much of the data was not available to me. I did consult R. Brietrick and P. Stubbe as to the regional structure and geology to get a better handle on how the fault planes had moved and the results of their movement.

Drill holes and Logs

Of the eighty-one drill logs there were several layouts used, this slightly complicated things as there was no standard form to describe lithologies, alterations, minerals and structures. The combination of different geologist and different formats meant that information was missing out of the geologic logs. Fortunately Paul Stubbe (with Magma Copper Co.) had relogged many of the drill holes in the project area with a standardized method. The relogging effort was partially necessary to verify the geology and to standardize the information for database entry. Even with the relogging there is an interpretive variable simply based on what kind of sample the drill rig returned for logging. Most the drill holes were made with a reverse circulation drill rig (RC) which return samples as crushed up pebbles (Figure 5) making structural and textural

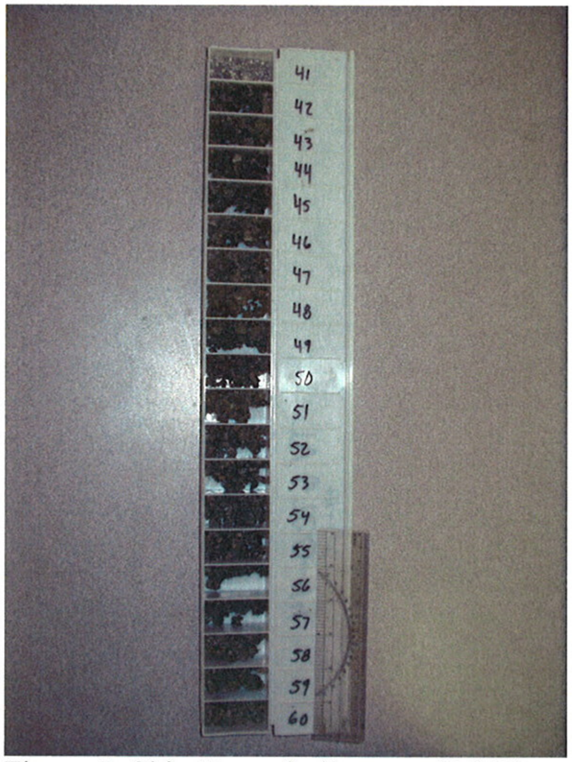


Figure 5. Chip Tray, similar to an RC Rig

Figure 6. Whole Core of Kmp.

Figure 7. Contact between Kmp and Trh

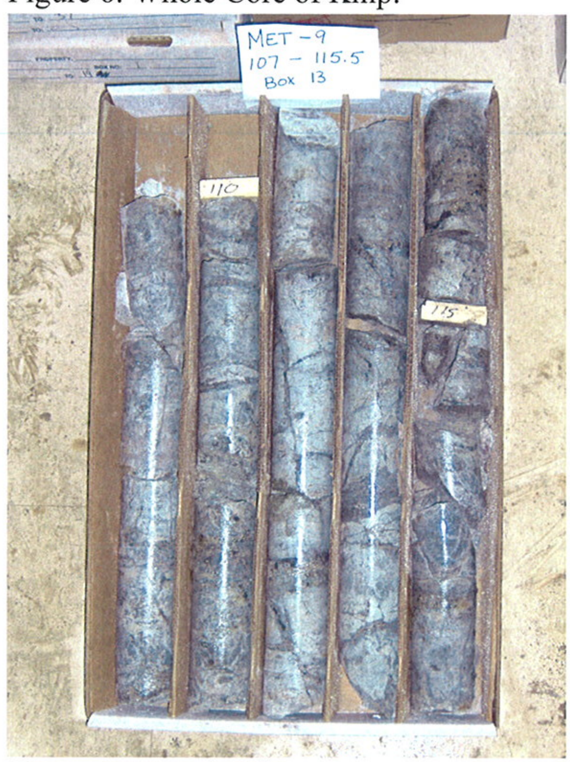


Figure 8. Brecciated Kmp

interpretation challenging. The other type of drill rig used was a core rig that return a whole rock sample of a predetermined size, most often about 2" diameter (HQ) (Figures 6,7 & 8). The core sample makes it much easier to interpret structure, texture and bedding but due to costs is used less often. This was taken into account when interpreting the drill logs for the cross sections, with more weight given to the core rig logs for fault dips and tilted bedding.

Rock Units, Alterations and Structures

The dominate Formation in the Veteran Extension is the Ely Limestone, it is host to the porphyry and the majority of the alterations. The dominate alteration is silica replacement of the carbonate resulting in jasperoid. The genesis of the jasperoid is amply covered by D. Maher master's thesis (1995). An over simplification of Maher's study of the formation of the jasperoid is that the original Ely Limestone was host to a silica rich aquifer which interacted with magmatic fluids to result in quartz, pyrite and chalcopyrite rich rock. Subsequent Tertiary faulting and tilting (due to being in the Egan Range accommodation zone) exposed the Veteran Extension to the oxidizing ground waters of superficial origin. Then Tertiary volcanism moderately heated the ground water causing it to further leach the jasperoid of all sulfides. The faulting and tilting would explain why the oxidized jasperoid extends so deep and why the base of it is variable.

Unfortunately nearly every log blanketed all skarns under the simple title skarn so segregating them out in the cross sections was impossible with out finding the original drill hole samples, which was beyond the scope of this project, so skarns drawn on the cross sections could be either magnetite or garnet skarns. Similarly the porphyry was labeled simply porphyry and alterations too were ignored. All porphyry drawn on the cross sections could be unaltered (though unlikely), phyllically or potassically altered porphyry. Again finding the original drill samples was beyond the scope of this project.

The fault structures in the cross sections were generated through correlation of faults identified in the drill holes and from approximate locations of faults on the topographic map. The key faults are described previously and are accompanied by many minor, small offset faults. The key faults, namely the Footwall West and the Alpha Faults are more like zones rather than razor edged faults. The zones can vary from twenty feet to well over two-hundred feet wide. The fault lines drawn on the cross sections are representative of the where the faults lie but probably encompass a greater area.

Cross Sections

My original cross sections were made to a 1"=50' scale, and then were digitized into AutoCAD, so that the scale can be changed based upon the parameters set for printing. I found no other cross sections made to this small of scale; the nearest ones are made to 1"=100' and span a much greater area. The downside to 1"=100' is the loss of smaller structures, like dikes and small alteration zones, but the upside is that they can show the regional structures, namely the full anticline. My sections only cover a small portion of the regional anticline.

Once the drill logs were narrowed down by pertinence and quality a cross sectional sketch was made with the drill hole traces on it. The lithology, alteration, structure and mineralizations were marked out then correlated between the holes. Faults were correlated first followed by geology. The following assumptions were made in generating the cross sections due to information deliberately not used (namely surface structure and geology); most alteration followed bedding planes, bedding plane information of one drill hole extended across the section unless otherwise modified by information in another drill hole and geology below the depth of drilling is assumed.

Interpretation

The geologic interpretation of the Veteran Extension subsurface was based on very limited resources. In the course of my day to day work I learned more about the geology of the project area and tried to minimize the impact of this information on the purpose of this project, which is to rely solely on the drill hole record.

Cross section 1 is drawn on the hanging wall of the Footwall West Fault and does not contain significant ore bodies. Due to the large area the porphyry covers and faulting there are small occasional block of mineralize rock in the hanging wall, but none large enough to justify mining. There are two faults present on this cross section, a low angle and high angle fault. None of the logs identified these faults, nor where there any faults outlined on the topographic map to indicate a name. Following Seedorff's theory of rotated normal faults it is probable that the high angle fault is younger than the low angle fault and consequently cuts the low angle fault. Both faults are probably sympathetic to major ones. It may be noted that on the northwest side of the high angle fault the geology is flipped from the right side, from the drill logs it is impossible to give an indication as to why. Since this contradiction begs an answer I asked Breitrick about the structure in the area. He described the bedding north of the Footwall West Fault as near vertical with some small scale folding. With enough offset on a fault through the folds would bring down a section that has reversed stratigraphy (Figure 9).

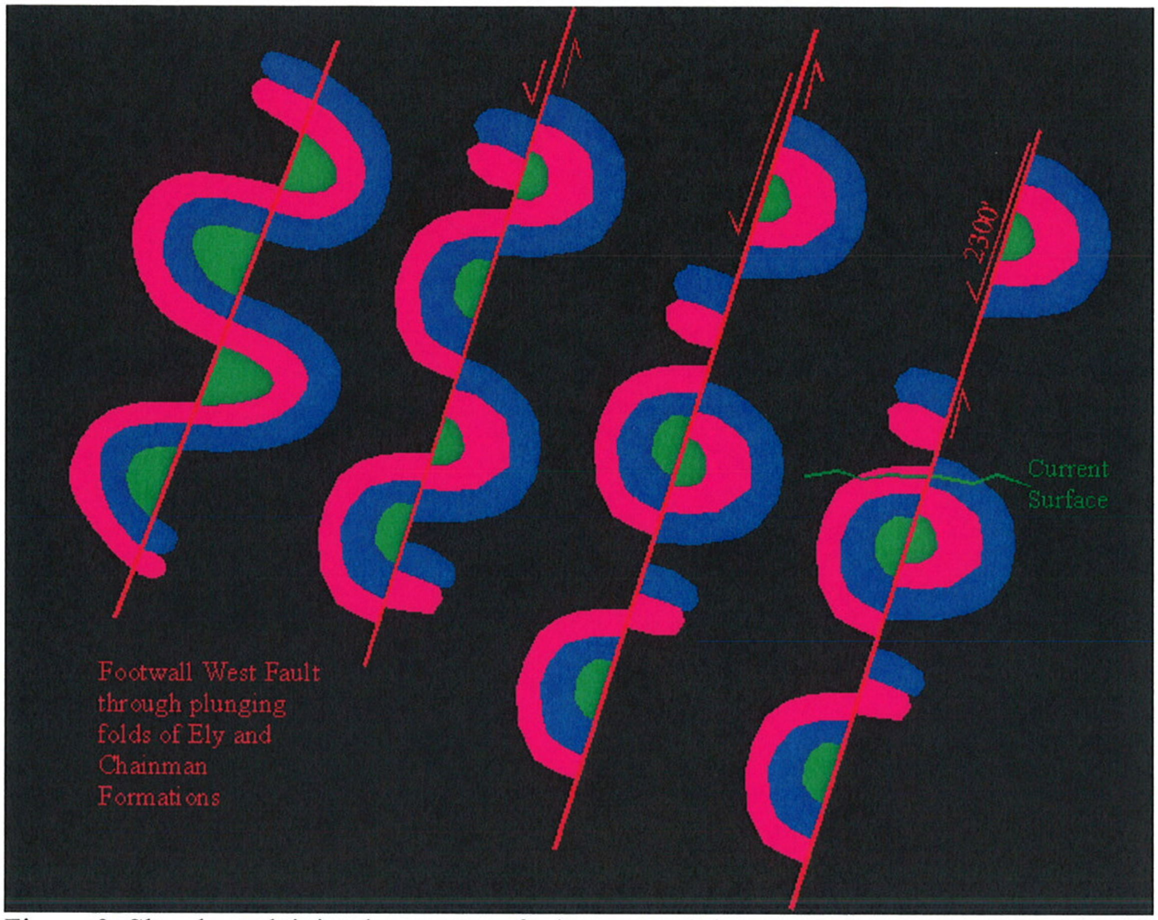


Figure 9. Sketch explaining how FWW fault can result in reversed stratigraphy.

Cross section 2 crosses the Footwall West Fault. The steep fault to the southeast is the Footwall West fault. The two to the northwest are probably sympathetic faults or simply part of the Footwall West fault zone. Though it is not shown on the cross section, just out side of the southeast boundary is the Pilot Knob fault, this fault offsets the FWW fault and is likely the reason for mineralization showing up in the hanging wall side of the FWW. The large amount of marble present indicated that there should be a large amount of monzonite porphyry around. In fact drilling to the south indicates a large amount of potassically altered porphyry. Section 3 shows significantly more Kmp.

Cross section 3 crosses both the Real Deal and Ballpark low angle faults. Neither fault has much relative offset and were probably formed as stress faults caused by the rotation of the area between the Footwall West and Alpha faults. Figure 4 was taken just to the southwest of section 3 with the lower bench being at the 6900ft elevation, this is relevant because the bedding. Though the beds undulate in small folds they run parallel to the Real Deal and Ballpark faults. Thus these two faults could be slip planes with in the beds of the Ely, but are more likely to have formed at the contact between the Ely and another lithology (i.e. Monzonite Porphyry). Drill hole V45 identifies the porphyry as being potassically altered, this large stock of magma resulted in the first alterations (in the Veteran Extension) of the Ely Limestone into marble, skarn and jasperoid. Another interesting point is the depth of oxidation that drill hole SKVE-90 verifies. Eight-hundred and seventy feet down a 60° hole is the oxidation boundary, easily eight-hundred vertical feet down. The jasperoid at this depth is described as gossanous. There are two ways the oxidized minerals can be found at this depth, first is by actual oxygen rich meteoric waters flowing down along fault lines and the second is by oxidation taking place much closer to the surface and fault movement moving the oxidized minerals deeper. Since the oxidized material is well below the local water table it is more likely that the minerals were oxidized near the surface and faulted down deeper.

Cross section 4 also shows the Real Deal and Ballpark faults. Again here the oxidized jasperoid is found at depth as verified by drill hole SKVE-007. There is still a stock of monzonite porphyry and abundant jasperoid and skarn material present.

The most noticeable thing about cross section 5 is the four near parallel faults. Section 5 nearly parallels the Alpha fault and catches the interaction of the Alpha fault with the Real Deal and Ballpark faults. Two of the faults are probably the Real Deal and Ballpark where as the other two are probably smaller sympathetic faults. In the northwestern part of the section the Riepe Springs and Rib Hill Formations occur. Both will show up again in sections 7 and 8. The bulk of the Riepe Springs is fault bounded above and below, which supports Breitrick's assertions that the Riepe Springs is thinned out to nothing before it reaches into the Veteran Pit. There is an inconsistency of the Riepe Springs being surrounded by Ely Formation (Limestone and Marble) in the second block from the left. I can only explain this in one of two ways, first is that the Riepe Springs is in the center of a fold with the Ely surrounding it and two faults cut this section out. More likely is the possibility that Ely formation above or below the Riepe Springs is actually Riepe Springs mis-identified as Ely.

Cross section 6 runs approximately perpendicular to sections 1 through 5. There are two faults shown here. The fault shown on the right is the Footwall West fault while the one on the left is probably a sympathetic fault. On the hanging wall side of the FWW fault is Chainman Shale on top of Ely Limestone. Since no fault was identified in SKNV-004 it is assumed that the beds are overturned here from folding and faulting outside the project area. Similarly to sections 2, 3 and 5 there is a stock of Monzonite Porphyry with abundant jasperoid above it and skarns around it. The oxidized jasperoid goes down a verified 800 feet here. This section in the area of the footwall of the FWW fault further supports the likelihood of the minerals being oxidize near the surface and faulted down lower.

Cross section 7 covers the Alpha and "S" faults. The Alpha fault as expected is the boundary of the Ely Formation and mineral bearing rocks. The "S" fault is interpreted as being a normal fault with some displacement on it, but not nearly as much as the Footwall West and Alpha faults. Seven drill holes intercepted the "S" fault pinning its location down quite well. The boundary of the Riepe Springs and Ely Limestones can usually be considered the Alpha fault, SKVW-58 and SKVW-62 ascertain that it is for sure. The amount of jasperoid alteration in this area is significant, extending to at least 700 feet below the surface. All this suggests substantial volumes of heated silica-rich water altered a large area of the Ely Limestone near the surface to form this much jasperoid. At some point before the Tertiary it had been oxidized then in the Tertiary faulted, tilted and down dropped to depth.

Cross Section 8 as expected is very similar to section 7 due to its proximity. There is more drill hole coverage, and most of it is jasperoid. In this section SKVE-2 drilled 965ft down and still did not reach the bottom of the oxidized jasperoid. According to reports I have read and talking with Breitrick and Stubbe there are two ultra deep oxidation cones in the Veteran Area. The Veteran Shaft went down 1200 vertical feet and still did not encounter unoxidized minerals. No one theory has satisfactorily answered how the two cones formed, but most agree it has to do with faulting and/or block rotations.

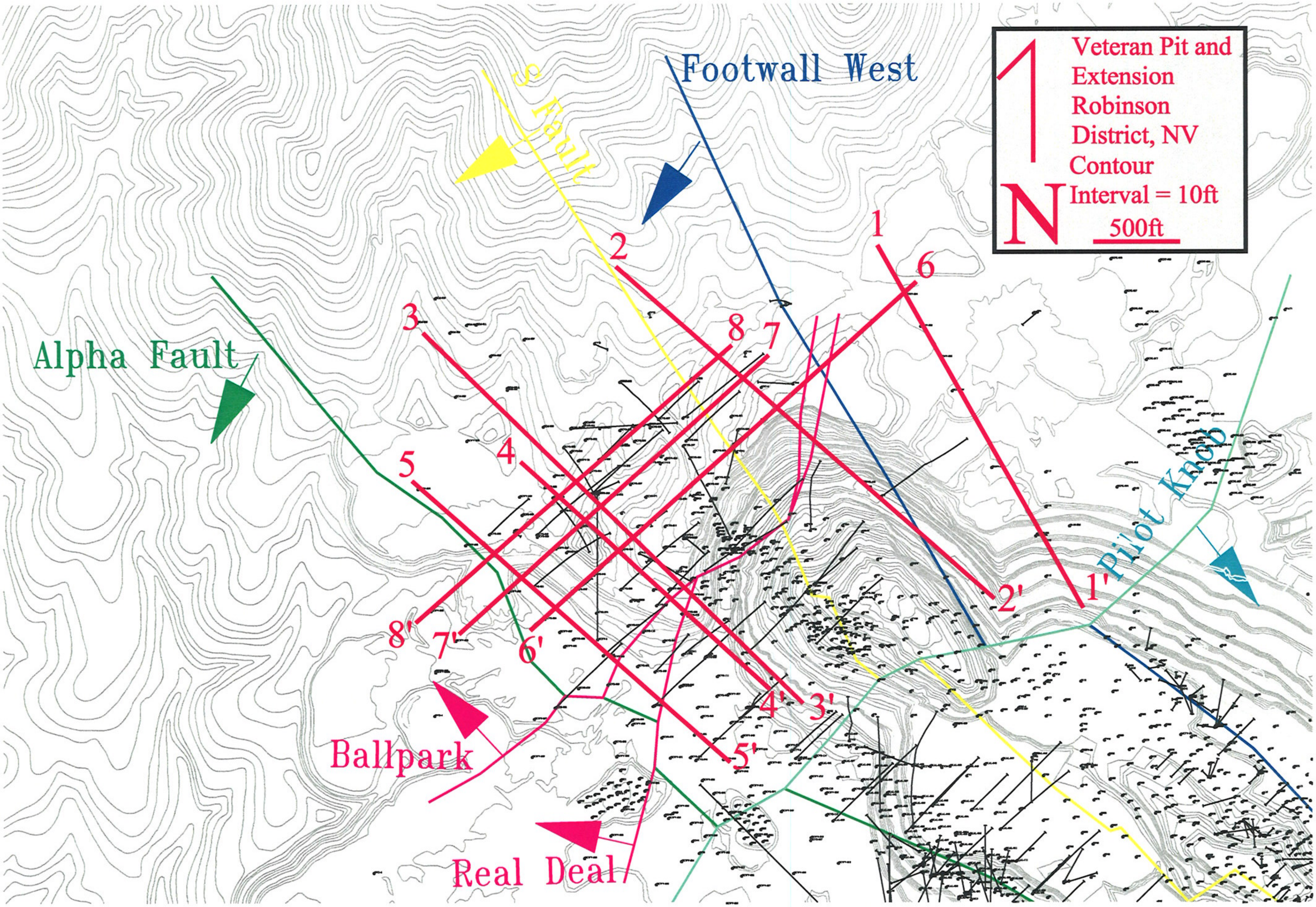
The completed view the sections give of the Veteran Extension subsurface show a complex history, and yet the drill logs alone are not quite enough to tell the whole story. From the drill logs it is possible to see that there was intense alteration of the Ely Limestone and complex faulting in the project area. The drill logs verify the Footwall West as the northern mineralization boundary and the Alpha fault as the southern

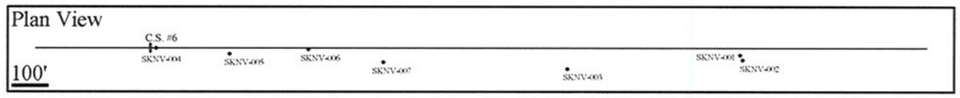
Structurally there seems to be two directions of stress in the area, to create two different sets of faults that run nearly perpendicular. The Footwall West, "S" and Alpha faults appear to be offset by the Real Deal, Ballpark and Pilot Knob faults. This would lead me to believe there were extensional stresses approximately north-south then changed to an east-west extensional environment. This is not surprising since the Robinson District is located in an accommodation zone between two dipping directions of the Egan Ranges and many blocks in the district have been rotate, tilted and folded.

Conclusions

In the course of this project I learned many things about research, mining, geology and history. In the research department there never seemed to be enough information, mainly because it was intentionally limited. The hardest part was trying to keep all the background information I was told about the geology in the district from significantly influencing the cross sections. Finding the different style drill logs and the complete lack of uniform logging was the second biggest challenge following the lack of outside field geology. My expectation of enjoying the work at the mine while working on this project was far surpassed. Between the people and the work performed I have certainly found what I want to do with a degree in geology. The geology of the Robinson District is about as complicated as it gets. Even after one-hundred years of corporate mining in the area the over all structural geology is not fully understood, and surprises are found regularly as we dig deeper. It does not help that a Tertiary Rhyolite wiped out most of the cross cutting relationships. Then the history of the district, founded in 1867, with maps on site as old at 1906 there is a lot of research material available. The history is not only interesting but useful.

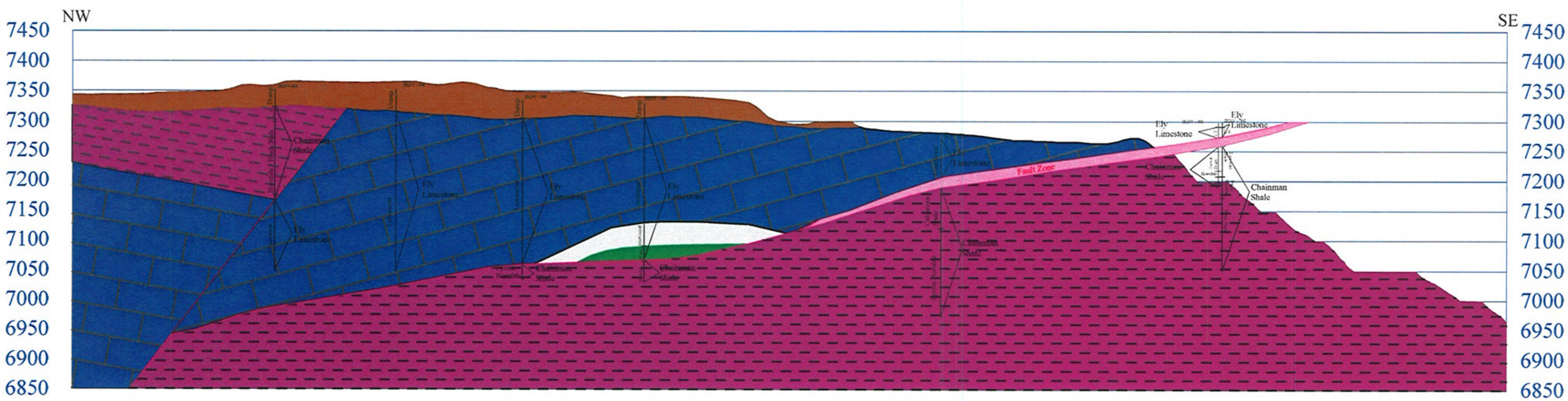
Though on a smaller scale the sections will be compared with the Magma model, some unpublished work by M. Houhoulis, the current Robinson Nevada Mining Co. model and the model currently in the works to maximize the knowledge of the Veteran area for the new model. My sections also highlight the alterations of the Ely Formation, something that is not currently modeled but is found to be important. This project also brought to light gaps in drill hole coverage in the area. Targeting these empty areas with exploration drilling could yield new clues into the structure of the Veteran Extension and overall district reconstruction


Veteran Pit and
Extension
Robinson
District, NV
Contour
Interval = 10ft
500ft
N
Footwall West
S Fault
Alpha Fault
Ballpark
Real Deal
Pilot Knob
1
1'
2
2'
3
3'
4
4'
5
5'
6
6'
7
7'
8
8'



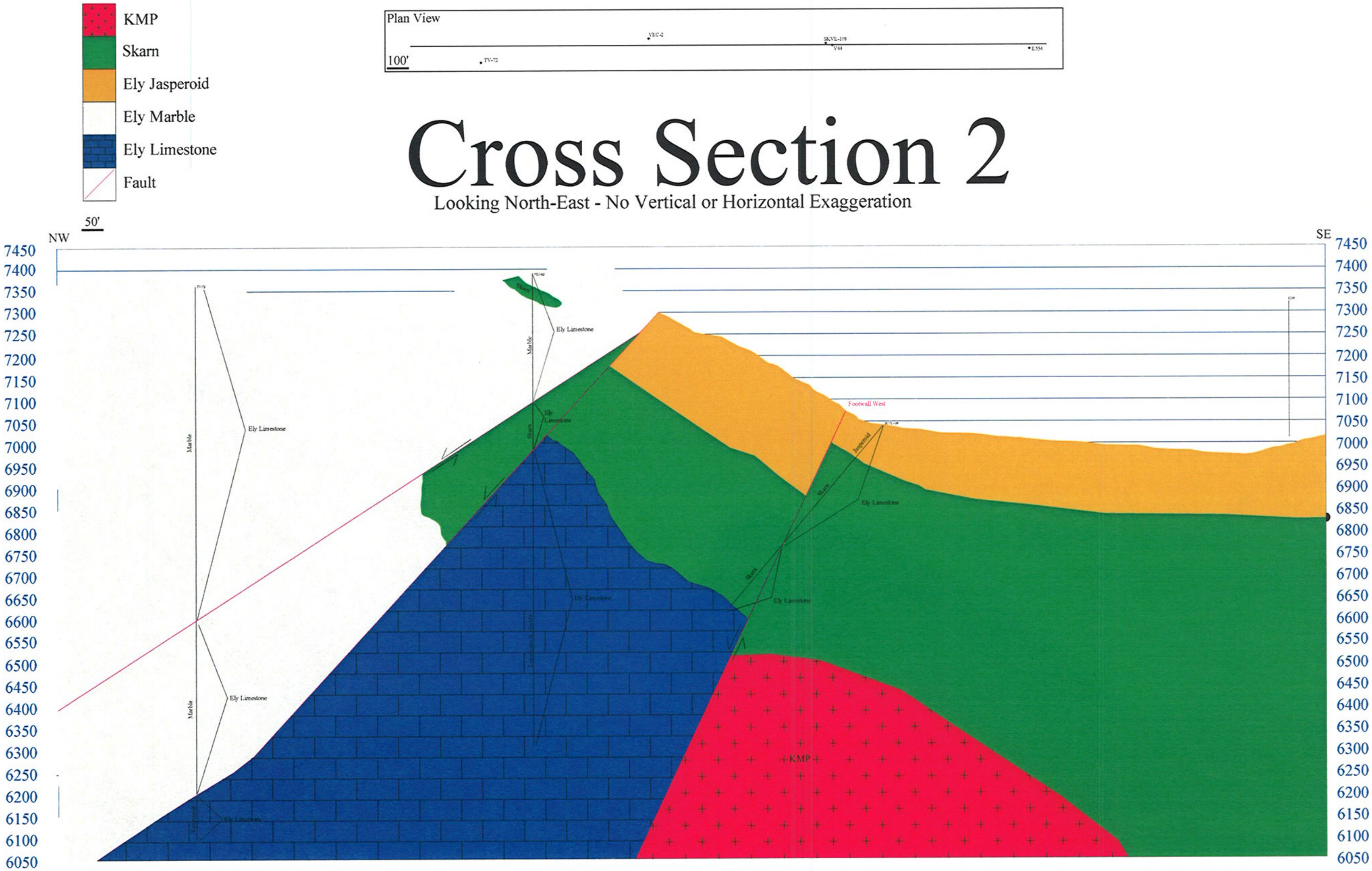
Cross Section 1

Looking North-East - No Vertical or Horizontal Exaggeration



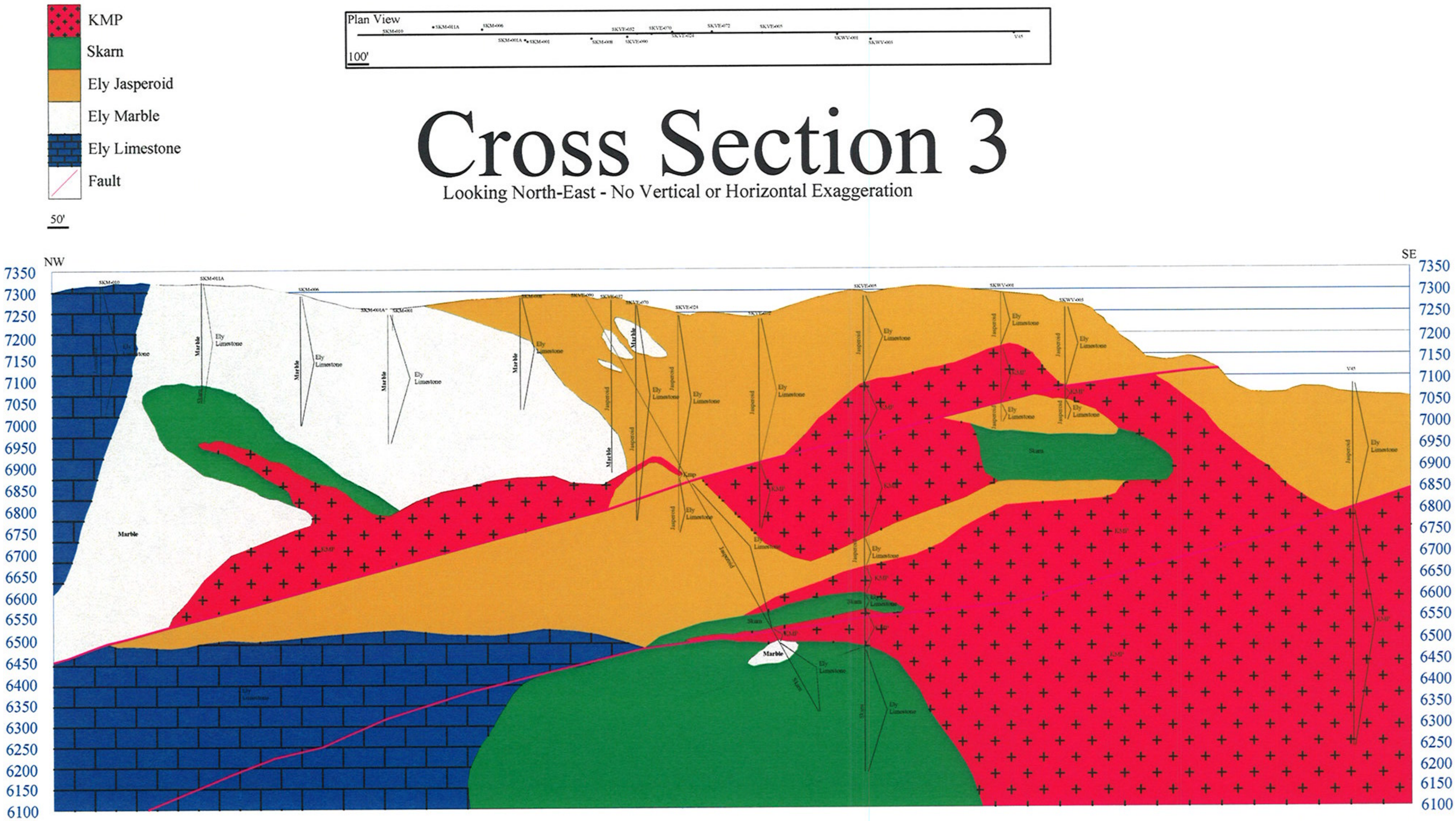
Cross Section 2

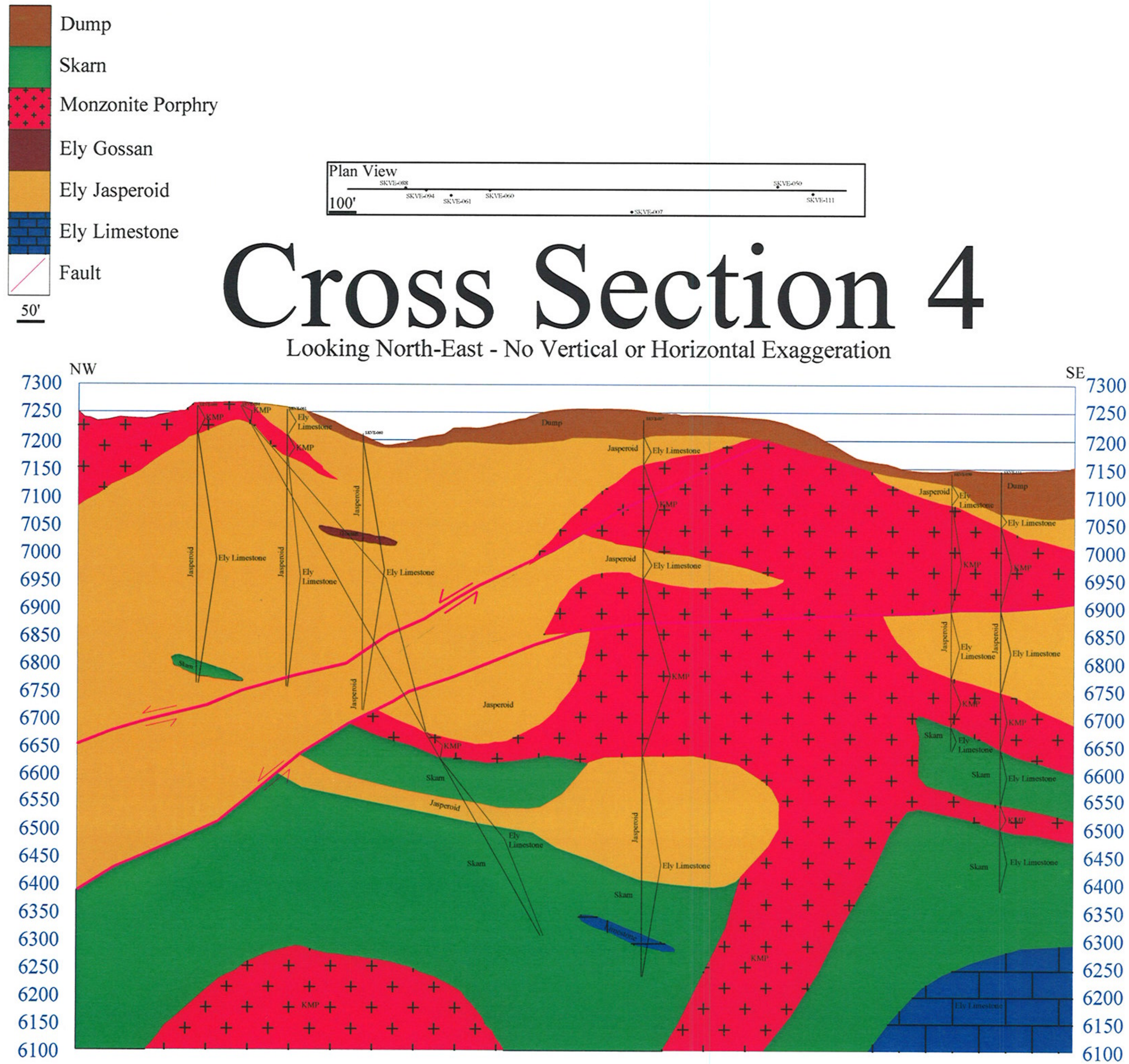
Looking North-East - No Vertical or Horizontal Exaggeration



Cross Section 3

Looking North-East - No Vertical or Horizontal Exaggeration




Dump
Skarn
Monzonite Porphry
Ely Gossan
Ely Jasperoid
Ely Limestone
Fault
50'
Plan View
100'
Cross Section 4
Looking North-East - No Vertical or Horizontal Exaggeration
NW
SE
7300
7250
7200
7150
7100
7050
7000
6950
6900
6850
6800
6750
6700
6650
6600
6550
6500
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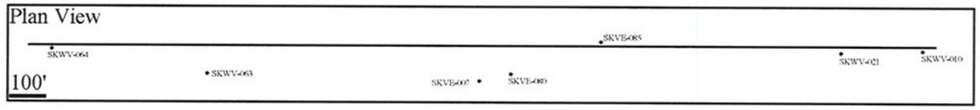
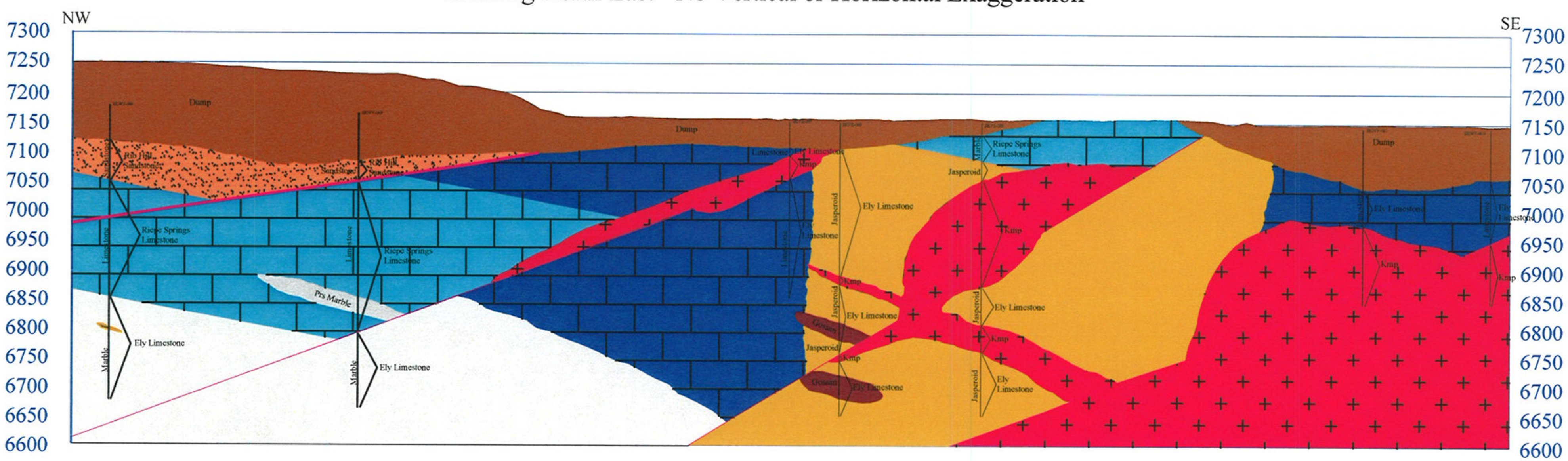
Jasperoid
Ely Limestone
KMP
Skarn
Dump



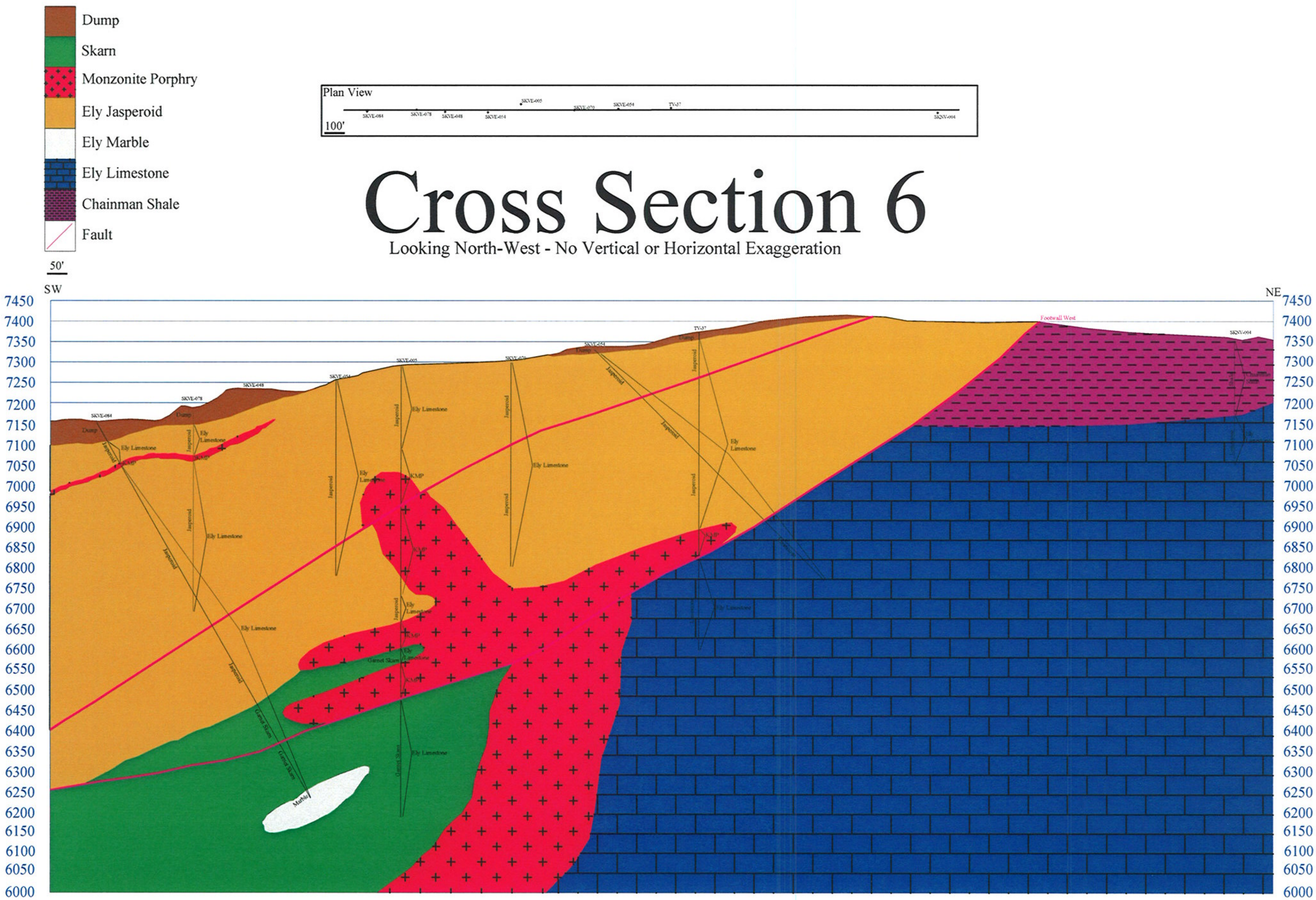
Cross Section 5

Looking North-East - No Vertical or Horizontal Exaggeration



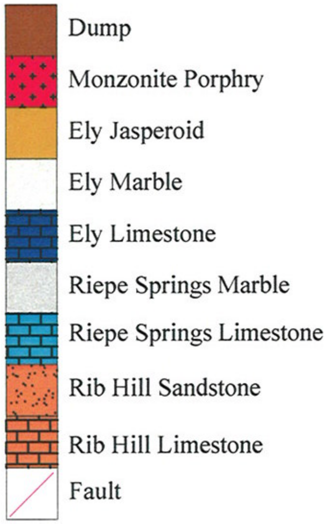
Cross Section 6

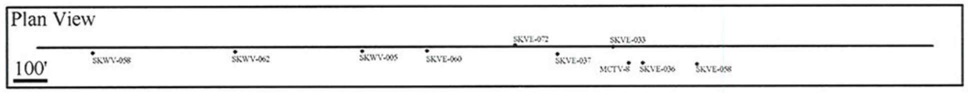
Looking North-West - No Vertical or Horizontal Exaggeration

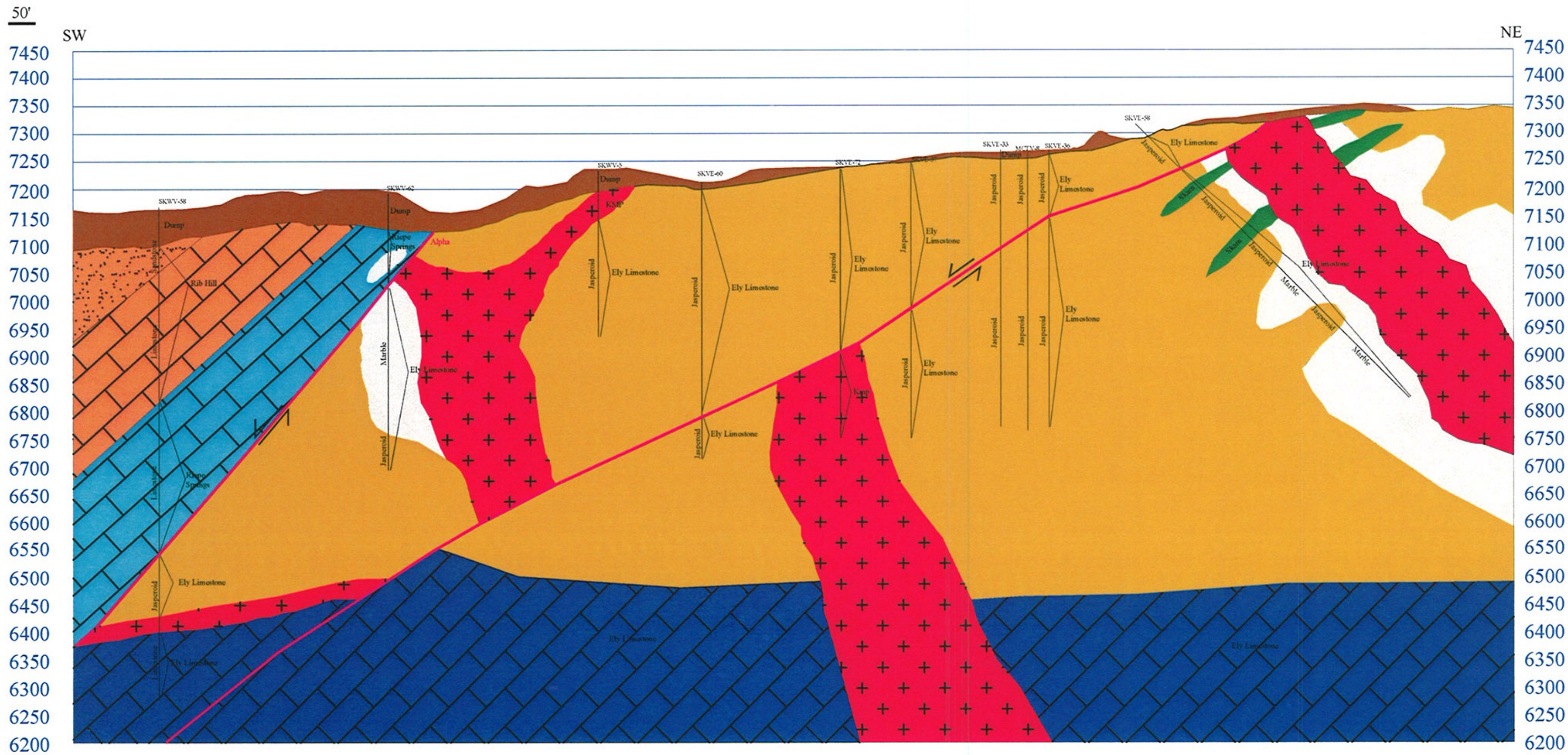


Cross Section 7

Looking North-West - No Vertical or Horizontal Exaggeration

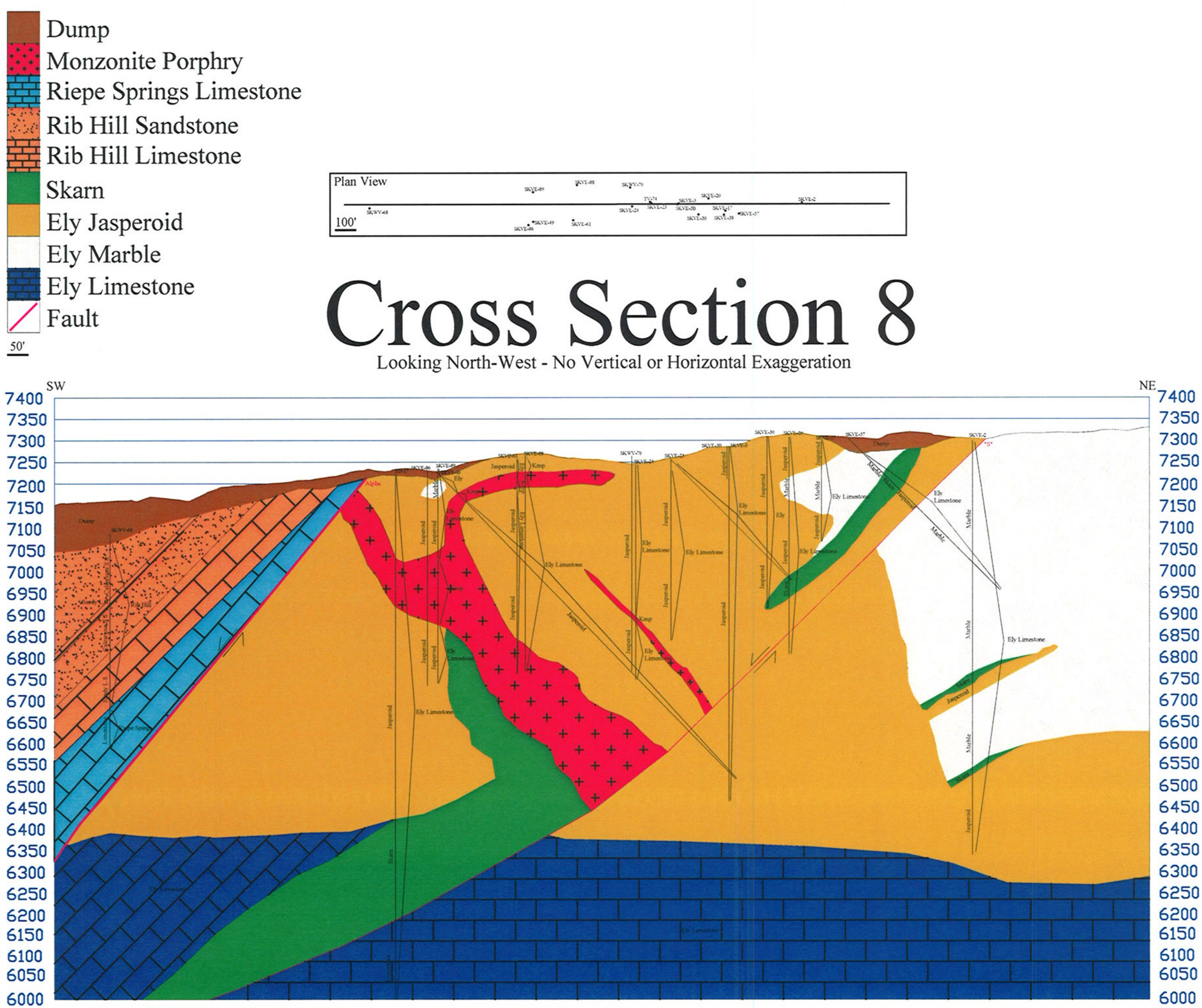






Cross Section 8

Looking North-West - No Vertical or Horizontal Exaggeration



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