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Item 32

STRATIGRAPHIC CONTROL OF THE STRUCTURE IN THE ROBINSON MINING DISTRICT WHITE PINE COUNTY NEVADA

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January, 1965

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STRATIGRAPHIC CONTROL OF THE STRUCTURE IN THE ROBINSON MINING DISTRICT WHITE PINE COUNTY NEVADA

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GENERAL STATEMENT:

Thrust faulting is the major pre-intrusive structure in the Robinson Mining District, White Pine County, Nevada. In the Jurassic or early Cretaceous the large overturned Ward Mountain-Rib Hill-Radar Ridge anticlinal fold developed with attendant thrusting in rocks younger than the Devonian Guilmette formation. Approximately ten thousand feet of Paleozoic sedimentary rocks are represented in the stratigraphic section above the Devonian Guilmette formation. Thrust faulting occurred along incompetent zones in this stratigraphic sequence. Within the mining district the Guilmette limestones and dolostones may be considered the stable lower plate. The overlying Devonian Pilot formation, the Mississippian Joana and Chainman formations, the Pennsylvanian Ely formation, and the Permian Riepe Springs, Rib Hill, Arcturus, and Kaibab formations comprise the mobile thrust sequence.

At least nine stratigraphic thrust zones are recognized. These zones are related to shear within incompetent formations or shear between formations of differing lithologies. These multiple shear surfaces produced decken structure in the rocks of the Mississippian, Pennsylvanian and Permian in the Robinson Mining District, Fig. 1.

Most thrust faulting is "younger over older" accompanied by structural thinning of formational units. The one major exception to this generalization is the thrusting of the competent Joana limestone into the plastic Chainman shales. The present, 1962-1963, district mapping illustrates the complex nature of the thrusting.

STRATIGRAPHIC RELATIONSHIPS:

The youngest Paleozoic rocks within the district are the Kaibab limestones. The Kaibab formation is a competent unit and is usually thrust onto the upper Arcturus. Near the Deep Ruth and Star Pointer shafts (sec 10, T. 16N, R 62E) the Kaibab limestones rest upon the Rib Hill and Riepe Springs formations.

The upper Arcturus is an incompetent thin-bedded formation of siltstones and limestones. The upper Arcturus is thrust upon the lower Arcturus, the Rib Hill, and the Riepe Springs formations near the Deep Ruth Shaft (sec 10, T. 16N, R. 62E) on the east side of Ocher Valley. Along highway U.S. 50, one and one half miles northwest of Keystone Junction (sec 34, T. 17N, R 62E) the upper Arcturus is thrust upon the Chainman shale and probably the Ely limestones, as well as being thrust upon the lower Arcturus.

The lower Arcturus formation is a competent limestone interval which overlies the equally competent Rib Hill sandstone. In many structural blocks there is a discordance between the attitudes within the Rib Hill and the overlying lower Arcturus beds. Bedding plane thrusting of lower Arcturus over Rib Hill is well documented in (sec 31, T. 17N, R 62E), and is probably present near the Pole Line road (sec 35, T. 17N, R 62E) and north of Lane City (sec 7, T. 16N, R. 63E). In the Hayes Shaft area (sec 11, T. 16N, R 62E) bedding plane thrusting may also exist but is not obvious. The lower Arcturus limestones rest in thrust contact on the Chainman shale west of the New Ruth Townsite (sec 4, T. 16N, R. 62E). Drill Hole NRT-3 in the lower Arcturus block of the cliffs, south of the New Ruth Townsite, indicates that this block is also thrust onto the Chainman.

The Rib Hill formation is a competent, porous, sandstone. North of the Big Bend, (sec 31, T. 17N, R 62E), the Rib Hill sandstone is thrust onto the Ely limestones. The structural block north of Lane City (sec 7, T. 16N, R 62E), which is now surrounded by porphyry is probably also a thrust plate. The porphyry now occupies the position of the thrust plane. Drill Hole data (E 301, E 303) near Hayes Ridge (SE 1/4, sec 10, T. 16N, R. 62E), indicates the Rib Hill sandstone overlies the Chainman shale which is only 400 feet below the surface. These Rib Hill-Chainman contacts are interpreted as thrust relationships.

The Riepe Springs limestone is also a competent formation which in at least two structural slices remains intact with the upper Ely limestones. The Black Spot thrust (sec 20, T. 16N, R. 63E) is the best example of a Riepe Springs-Upper Ely thrust block. The Upper Ely limestones are thrust upon the lower and middle Ely limestones and upon the Chainman shale. A similar structural block is on the north side of Lane Valley (sec 12, T. 16N, R. 62E), also in (sec 6 & 7, T. 16N, R. 62E). The porphyry is interpreted to be occupying the thrust plane under this block. Small slices of Riepe Springs limestones are also caught between the thrusts that place the Rib Hill sandstone over the Ely formation in the Copper Flat area.

The Ely formation is a cyclical sequence of limestone types. Structural competency varies within the formation. The units, G, S, V, appear to have been most susceptible to shear and therefore localize thrusts. The thrusts in the upper Ely, Unit G, were mentioned in conjunction with the Riepe Springs formation. The thrust at Keystone Junction is an example of shearing in Unit S. This thrust has been intruded by a porphyry sill. Thrust faults within the lower Ely, related to Units U & V, are north and east of Saxton Peak (sec 18, T. 16N, R. 63E). It is the writer's observation that the Ely formation is rarely in normal stratigraphic contact with the underlying Chainman formation within the district. On the south side of Lane Valley lower Ely limestones overlie the Chainman shales. This contact has previously been mapped as a normal sedimentary sequence. However, the contact where exposed in adits is always a sheared zone. The attitudes in the Ely limestones are discordant with those in the Chainman and the lowermost Ely limestones and nearly all of the Chainman quartzites are missing. This Ely-Chainman contact on the entire south side of Lane Valley is interpreted to be a bedding thrust. In Copper Flat the thrusting between the Ely limestones and the Chainman shales is well substantiated by stratigraphy and mapping. On the north and east sides of Garnet Hill, outliers of Ely limestone are surrounded by porphyry. This porphyry is thought to be intruded into the thrust plane between the Ely and Chainman formations.

The Chainman formation has four major lithologic types: black fissile shales, siliceous sandstone, dark gray organic limestones, and siltstones. It is impossible to reconstruct the detailed Chainman stratigraphy within the mining district because of structural complexity and lack of adequate exposure. The siliceous sandstones in the upper Chainman formation are regionally named the Diamond Peak member. It is not feasible to map these sandstones in the district because outcrops are discontinuous. The discontinuous occurrences of the Diamond Peak sandstones previously have been attributed to stratigraphic variability. The present interpretation is that the sandstones are absent by thrusting of the Ely limestones onto the Chainman shales. Much structural thinning has occurred at the top of the Chainman formation as a result of thrusting.

Thrusting, which caused the juxtaposition of younger rocks of Pennsylvanian and Permian age directly onto the Chainman shales, developed an irregular surface that later became the structural control which localized the upward intrusion of the porphyry and the position of the ore bodies.

The Joana limestone is a competent unit between the incompetent Chainman and Pilot formations. The unfaulted Joana limestone is approximately 400 feet thick. In consequence to horizontal shortening, which occurred as the Ward Mountain-Rib Hill-Radar Ridge overturned anticline developed, the Joana limestone was duplicated and thrust through the Chainman shale. The thrusting of wedges of Joana limestone through the shale resulted in large scale boudinage structure. Slices of Joana limestone are splendidly displayed in the strike valleys north of Lyons Spring (sec 32, T. 17N, R. 62E). The same structural relationship is present in Lane Valley (sec 7, T. 16N, R. 63E).

The Pilot shale outcrops only in structural blocks which have the complete unthrusted Joana, Pilot, Guilmette sequence. These areas are in the east end of Lane Valley, in the Weary Flat structural block, and in the easternmost Copper Flat block. All three areas are structurally higher than adjacent blocks because of vertical faulting or tilting.

Figure 1, shows the stratigraphic positions of the thrust zones mentioned in the foregone discussion. Regional mapping by University of Washington students Woodward (1964) and Fritz (1960), have shown similar thrust relationships in the northern Egan Range. Regionally the thrusting involves lower and middle Paleozoic rocks as well as the upper Paleozoic which are present in the mining district.

AGE OF THRUSTING:

In the Robinson Mining District the youngest rocks involved in the thrusting are the Permian Kaibab limestones. In eastern Nevada the limestones of the Triassic Thaynes formation are also involved in the thrusting. The oldest rocks not involved in the thrusting are those of the Sheep Pass formation of Eocene age. The Tertiary volcanics are likewise not involved in the thrusting. This places age of the thrusting and the development of the Ward Mountain-Rib Hill-Radar Ridge overturned fold as Mesozoic, and probably Jurassic or earliest Cretaceous.

AGE OF INTRUSION OF THE MONZONITE PORPHYRY:

The porphyry intrusion is younger than the thrusting. The porphyry is also older than the Eocene Sheep Pass formation. The geologic evidence indicates a late Mesozoic age, which is confirmed by the radioactive assignment to the early Cretaceous.

SUMMARY:

The major thrust surface at the top of the Chainman formation localized the upward penetration of the main monzonite stocks. Faulting and imbrication in the decken above the shear zone in the Chainman brought rocks of both Pennsylvanian and Permian in contact with the Chainman shales.

The Lane Valley area is a large window (fenster). Rocks of Chainman and Joana are exposed beneath the thrust in the window. The unaltered porphyry on the north side of Lane Valley is interpreted to be in the plane of the major thrust and in between thrust blocks of the upper decken. The Smokey stock is within the Chainman shales of the lower plate. The Kimbley stock is exposed at the thrust contact between the Ely, Rib Hill and lower Arcturus of the upper plate and the Chainman of the lower plate.

The Deep Ruth area is interpreted to be essentially a faulted (High Grade and Queen faults) window through which the Chainman of the lower plate and monzonite porphyry are exposed.

The upper structural control in the Liberty, Tripp, and Veteran stocks is likewise the shear zone in the Chainman. In addition the overturned limb of the Rib Hill block forms the southwest margin to the monzonite stocks. The upper plate in the western portion of the district is the same as in the eastern portion. Arcturus, Rib Hill and Ely formations are in thrust contact with the Chainman formation.

The structural picture is in detail very complex because of imbrication and megabrecciation within the thrust plates. Above the Chainman shear surface the rocks are jumbled. The intrusions came into this complex and sought out the thrust surfaces which were the intervals of plastic yielding and the favorable planes for dynamic dilation.

Late Tertiary Basin and Range normal faulting has offset the Tertiary volcanics and has been superimposed on the Mesozoic structures of the district.

NAPPE STRUCTURAL PLATES

The planes of detachment are directly controlled by the variation in competency of rocks in the stratigraphic sequence. It is possible to define the nappes or structural plates directly from the stratigraphy. Enclosures, "Nappe and Intrusion Control, Upper Paleozoic Composite Stratigraphic Column," and "Tectonic Map, Upper Paleozoic Nappe Plates, Robinson Mining District" should be referred to in order to understand the following discussion.

Nappe I is the highest structural plate in the Robinson Mining District. This Nappe unit contains the rocks of the Kaibab and the Upper Arcturus formations. This plate is found in the heart of the district from the Deep Ruth Shaft to Keystone Junction and northward on either side of U. S. Highway 50. The field evidence for this nappe unit is convincingly illustrated by many excellent outcrops. At the north end of the plate the upper Arcturus limestones and siltstone directly overlie the Chainman shales. Just east of Keystone Junction the upper Arcturus beds rest upon the Riepe Springs limestone. Southwestward from Keystone Hill to the Deep Ruth Shaft the upper Arcturus rocks rest in thrust contact on the lower Arcturus limestones, the Rib Hill sandstones, and the Riepe Springs limestones. One small klippe of Kaibab limestone and upper Arcturus rocks is isolated east of the Deep Ruth Shaft near the water tanks.

The Kaibab limestones always are associated with the upper Arcturus beds, however they have been jostled by independent movement and are actually in thrust contact with the upper Arcturus. Because of the close association of the Kaibab and upper Arcturus rocks they are considered together as one nappe unit, but with the realization that the Kaibab limestone is also thrust. One of the two largest outcrops of the Kaibab limestone within the central portion of the district is west of the Star Pointer Shaft near the old Ruth townsite. Here the Kaibab limestones, completely unaltered, rest upon highly altered Rib Hill sandstone and Riepe Springs limestone. This anamolous change in the alteration is not satisfactorily understood. The upper thrust plate unaltered and the structural plate immediately below intensely altered and mineralized. Certainly this is suggestive evidence for post-mineralization thrusting, however the overwhelming evidence throughout the district is for intrusion and mineralization to have occurred post-thrusting.

The second outcrop of Kaibab of any size is immediately west of Keystone Junction just north of the Ruth road. Scattered remnants of Kaibab limestone are also found throughout the aerial extend of Nappe I.

Southwest of the Rib Hill-Radar Ridge overturned structure the Kaibab limestone crops out in a long northwest-southeast linear belt. Here the Kaibab is in normal upright position and the older rocks stratigraphically beneath the Kaibab to the northeast are overturned. It can be demonstrated that the Kaibab limestones in this area are thrust slightly onto the underlying upper Arcturus beds.

Some question may be raised as to the depth of burial of Nappe I at the time of the thrusting and at the time of formation of the large Radar Ridge-Rib Hill-Ward Mountain overturned fold. There is no evidence in the Egan Range or in eastern Nevada, as far as has been ascertained by other investigators, that these thrusts were erosional thrusts. No erosional debris has been found in front of the thrusts or over-ridden by the thrusts. In the Sonoma Range in western Nevada and in the central Utah and southern Nevada along the Wasatch-Las Vegas Hinge Line zone of the eastern most portion of the Basin and Range Province, erosion thrusts are well documented.

Regional stratigraphy does indicate that the Kaibab limestone was not the youngest rock in the Robinson District at the time of the dynamic development of the Nappe Structure. We are not looking at the top of the stratigraphic sequence which was undergoing deformation, but we are investigating only a portion of the mobile layers of the sedimentary pile.

How much thickness was above the Kaibab at the time of Nappe formation? The overlying Permian formations, the Plympton and Gerster crop out at the north end of Radar Ridge just beneath the Robinson Summit welded tuffs. Also Triassic rocks of the Thaynes formation once covered eastern Nevada and are now only locally preserved in major synclinal areas such as in the southern Butte Mountains. Mesozoic rocks of Jurassic and Cretaceous age were conceivably present but few outcrops remain to reconstruct their distribution. More probably the late Mesozoic rocks contained the orogenic deposits eroded for the highest nappes. These deposits have now been subsequently eroded during the pre-Tertiary and the record is lost. Considering this evidence, the greatest thickness of the stratigraphic load on Nappe I, of the district was certainly less than 5000 feet at the time of the thrusting.

Nappe II is the second highest structural plate in the Robinson District.. This plate contains the rocks of the lower Arcturus and the upper Rib Hill formation. The interbedded sandstones and limestones of the lower Arcturus form a competent sequence although the lithologies are alternating. Discordance or minor shearing developes at the base of the Arcturus within the Nappe unit. In many instances the attitudes of the Durhamina limestones at the base of the Arcturus show discordance with the underlying Rib Hill sandstones.

Rocks of the Nappe II occur in two large blocks east of the Eureka Fault. The southern area continues south to Murry Summit. The northern block forms the topographic hill known as the Cliffs and extends across the state highway to the north. The center axis of the Big Bend has outcrops of this Nappe. North and south of Garnet Hill there are also blocks of this structural unit.

Nappe III includes the lower Rib Hill formation "contact cherts," the Riepe Springs formation and the upper Ely formation. The Riepe Springs limestones are massive and competent beds. Therefore the lower shearing of this nappe is found in Unit G of the Ely formation and the upper shearing in or above the contact cherts of the Rib Hill formation.

The rocks of Nappe III crop out around the south end of the Big Bend syncline, a small outcrop lies west of the Ruth townsite, west of the Jupiter Fault trace is the largest exposure, north and south of Garnet Hill are blocks, and small outcrops are found in the thrust plates at the north end of the Squaw Peak salient.

Nappe IV contains about 1100 feet of the middle Ely formation. Unit G and V of the Ely formation are the incompetent intervals in which the shearing has most often occurred throughout the district. Although minor shearing does occur almost anywhere within the cyclical Ely formation, the S unit is sheared repeatedly within the Nappe IV unit.

The detailed mapping throughout the district shows the widespread re-occurrence of Nappe IV outcrops. Over and over again Unit U beds of the Ely formation are the oldest beds in the nappe and these usually rest upon the Chainman formation. This repetitious occurrence of the U-beds means that approximately 600 feet of limestones of Ely are missing because of the structural thinning at the base of Nappe IV.

The Kimbley-Wedge portion of the Lane Valley fenster illustrates Nappe IV in thrust position on the Chainman formation. Similarly north of Lyons Spring, klippen of Nappe IV rest on the Chainman and Joana formations.

Nappe V contains the lower few hundred feet of the Ely formation and the Diamond Peak sandstones of the Chainman formation. The rocks are structurally competent in contrast to the weak shales beneath the quartzites. The quartzose sandstones are very discontinuous in outcrops, however in (C sec 32, T. 17N, R 63E) they are well exposed beneath thrust klippen of the Ely formation. Drill holes in the Deep Ruth-Kimbley area have penetrated the Diamond Peak sandstones.

The best field outcrops of this Nappe unit V are found in the (SW 1/4, sec 33, T. 17N, R. 63E). At this location the Pilot siltstones rest conformably upon the Guilmette limestones. Overlying the Pilot siltstone are very thin discontinuous outcrops of Joana limestone. Overlying the Joana limestone is the Chainman formation, not the lower Chainman but the Diamond Creek sandstones and the lower Ely limestones. Here we have Nappe V thrust upon the Joana. The sandstones and lower Ely outcrops overlying the thin Joana are the evidence for this interpretation.

Nappe V is therefore present in many places in the district, however since it is the lowest in the sequence it may be absent or covered by the higher nappes. It is not shown separately on the tectonic map.

The contacts between the nappe units may be thrust faults or normal faults. Examples of both types of structural contacts can be well documented in the field. These two types of faults may be concurrent in development since outcrops of two different nappe units may be separated by a high angle normal fault and the entire block may be underlain by a flat thrust fault. Many of the normal faults in the district terminate at depth on a flat thrust fault.

THRUST FAULTING IN THE MIDDLE PALEOZOIC SEQUENCE
(Below the major Chainman Decollement)

Thrust faulting is not restricted to the Upper Paleozoic rocks above the Chainman formation in the Robinson Mining District. The structural thinning of stratigraphic units continues down the section to the Ordovician Pogonip group. The oldest rocks exposed in the Robinson District are the Pogonip Ordovician rocks on the east flank of Squaw Peak. The Squaw Peak Salient is the only structural block in the district with the Devonian, Silurian and Ordovician formations exposed.

The middle Paleozoic formations within the Squaw Peak structural block are in correct stratigraphic sequence but the formations are thinned and omitted by nearly bedding-plane thrusts. This block is essentially a monoclinal fold. The steep flank plunges southward into Robinson Canyon. The gentle northern flank of the monocline is segmented by large normal faults. The bedding plane thrusts are more effective in reducing the formational thicknesses in the gentle north flank of the monocline than in the steep southern flank.

At the very north end of the Squaw Peak salient the Simonson, Sevy, Laketown, Ely Springs, and Eureka formations are reduced in outcrop thickness thousands of feet by thrusting of younger over older. East and west of Squaw Peak these same units have thickened to nearly their correct stratigraphic thicknesses so that only hundreds of feet are missing. Then along the axis of the monoclinal fold the Guilmette limestones are essentially normal upon the Simonson dolomites.

Two major thrust horizons are present in the Middle Paleozoic. First, the Guilmette limestones are thrust upon the Simonson dolostones. As much as half or 500 feet of the Simonson may be missing at this contact. Second, the Eureka quartzite is thrust over the Pogonip. The Ely Springs dolostones may rest directly upon the Pogonip limestones with the Eureka, Lehman, and Kanosh formations missing. This is approximately a 500 foot shortening of section.

Also thrusting occurs between the Simonson, Sevy, Laketown, and Ely Springs formations. Thrusting within a formational unit is more difficult to establish but it exists, particularly within the Guilmette. It is very probable that the monzonite porphyry sills in the Guilmette of Robinson Canyon are located on thrust planes.

North of the monoclinal fold in Robinson Canyon the alteration rapidly decreases and the fault structures are barren to slightly mineralized.

The monoclinal structure in the Devonian rocks may possibly have significance at depth beneath the west end of the district. In the Veteran and Tripp the Mississippian and Devonian rocks plunge steeply toward the southwest.

EMPLACEMENT OF THE MONZONITE:

Localization of Intrusion

The emplacement and localization of the monzonite in the Robinson Mining District is controlled by the thrust faults or the nappe structures. The Chainman shale is the major host rock for the monzonite. The localization of the monzonite in the Chainman formation is strikingly illustrated in the Lane Valley area between the Kimbley Pit and the Smokey. Here the nappe structures have been "de-roofed" by erosion and it is possible to study the irregular distribution of the porphyry within the Chainman formation. Some theoretical petrologists might suggest that the monzonite developed directly from the Chainman as a result of kinesymatic reconstitution during the dynamic formation of the nappes. This is, however, not the situation because the monzonite and rhyolite are both localized by the thrust structures. The Chainman formation is the major zone of localization because it yields plastically, is readily assimilated, and forceful silling is readily accomplished at the interface with the overlying nappe plates.

North of Lane Valley the unaltered monzonite outcrops in a large area 180° around the east perimeter of Garnet Hill. Resting directly upon the monzonite are isolated klippen of the once continuous nappe sheet. Parts of three nappes or structural plates are present: Nappe II of the L. Arcturus and Rib Hill formations; Nappe III of the Rib Hill contact cherts, Riepe Springs and upper Ely formations; Nappe IV of the middle Ely formation.

In (sec 4, 5, T. 16N, R. 63E) an isolated klippe of Nappes III and IV illustrates the partial emplacement of the monzonite sill. The klippe rests in thrust contact upon the Chainman formation. Both quartzites and shale are present in the Chainman beneath the klippe. Monzonite has intruded into the Chainman and localized beneath the klippe, but still large outcrops of shale and quartzite are interspersed with the monzonite.

A great volume of monzonite is localized in the Chainman formation. Since rocks of any nappe unit younger than the Chainman formation may rest upon the Chainman the monzonite was capable of dynamically silling along the thrust or shear planes throughout the stratigraphic column. The positions of emplacement of the monzonite is illustrated Enclosure I, "Nappe and Intrusion Control, Upper Paleozoic Composite Stratigraphic Column."

The volume of the monzonite and the later rhyolite intrusions was certainly sufficient to dilate the section and dome the thrust faults. The High Grade and Queen faults of the Deep Ruth area may be the domed thrust faults. Accompanying this doming over the large intrusions the faults were reactivated and moved down dip as normal faults. This perhaps explains the normal movement on the Eureka, High Grade, Queen and other flat faults within the district.

Reaction with Wall Rock

Because the thrust faulting had positioned rocks of all the nappe plates younger than the Chainman formation in fault contact with the Chainman, the monzonite intrusions came in contact with a variety of rock types. The entire upper Paleozoic section is a sequence of limestones and sandstone. Some of the limestones are nearly all $CaCo_3$ and some sandstones are nearly all SiO_2 but of greater proportion are silty limestones and calcareous sandstones.

Essentially a chemical reaction was effected between the monzonite and either calcium carbonate or silica. Field evidence shows the carbonates of the Ely, Riepe Springs, and low Arcturus formations abruptly restricted the monzonite reaction to a few feet of skarn development. Silty limestones of the Ely were more receptive to reaction and more intensive alteration occurred within these horizons.

Two formations had appreciable sandstone adjacent to monzonite contacts, the upper Chainman Diamond Peak sandstones and the Rib Hill formation. The Diamond Peak sandstones or quartzites with the lowermost Ely limestones are in structural plate Nappe V. The sandstones are very discontinuous because of the structural ommission. The Rib Hill sandstones are part of structural plate Nappe II. These sandstones are intimately associated with the monzonite and the ore throughout the district: Veteran-Tripp area, west side Liberty Pit, Deep Ruth orebody, west side of Kimbley Pit, and north of Lane Valley (WC 7, T. 16N, R. 63E). Mr. Joe Swinderman has studied the petrographic aspects of the monzonite and the contact rocks. His conclusions indicate that the Rib Hill and Diamond Creek sandstones were reactive with the monzonite intrusions. Assimilation or "granitization" at these sandstone interfaces with the monzonite intrusions was volumetrically significant. The large addition of silica to the monzonite shifted the geochemical equilibrium of the monzonite producing the altered monzonite fractions adjacent to the sandstones.

Greater permeability of the Rib Hill sandstone, compared to carbonates, may have been significant in producing a distillation system by which the monzonite fractionated into fresh monzonite, altered monzonite, granitized sandstone.

Emplacement of the monzonite is unquestionably controlled by the nappe structure. It is theoretically probable that the ore localization is the result of geochemical reaction of the monzonite on the host rocks particularly the sandstones.

Emplacement of the Rhyolite

The Tertiary intrusive rhyolite and the Cretaceous monzonite always utilized the same structural zones of weakness for their emplacement. The rhyolite utilizes the contacts between the monzonite and the sediments for its avenue of access. Previously these contacts were the thrusts and normal faults of the nappe structure. The rhyolite therefore "sandwiches" in between the complex geometric blocks forming sills, small stock-like bodies, and laccolithic-shaped intrusions.

White Hill and the Stillwater volcanics were penetrated respectively by XD-9 and XD-7 drill holes proving their laccolithic shape. Garnet Hill was drilled on the south edge by Bear Creek Mining Company but was not penetrated. Ragsdale Spring volcanic field is another large area similar to Garnet Hill. Both are intrusive and probably laccolithic.

The rhyolite masses in the district are intrusive. Textural variations are gradational in all large bodies from 80% crystal to flow-banded aphanitic types. Chilled perlitic glass borders are common and so are glass diatremes.

The area between Ruth and Keystone Junction is underlain by white water-lain tuffs.

In marked contract to the intrusive rhyolites within the mining district are the welded tuff ignimbrite volcanic fields of Robinson Summit and Giroux Wash. In both of these areas welded tuffs are interbedded with water-lain tuffs. All the beds are pyroclastic.

The relationship, if any, between the ignimbrite sheets and the Tertiary plutons of the district is uncertain. They are not in contact with each other so no sequence can be established.

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PALEOZOIC
STRATIGRAPHY

ROBINSON MINING DISTRICT
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MIDDLE

PALEOZOIC

STRATIGRAPHY

ORDOVICIAN:

Lower Pogonip member

The top of this mappable member maintains a prominent cliff or ledge on the eastern slope of Squaw Peak. The lithology is a very silty limestone which is resistant to weathering because of the siliceous case-hardening of the rock surface. This topographic break is a well defined north-south lineament in Section 9. The outcrop ledge of the Eureka quartzite and this silty limestone ledge parallel each other on the east flank of Squaw Peak.

On the northeast the Pogonip is in normal fault contact with the Devonian rocks and on the east overlapped with the alluvium. Therefore the base of the Pogonip is not exposed. The two members of the Pogonip as mapped on Squaw Peak are in part equivalent to the Wah Wah and Juab formations of western Utah but no regional comparison is attempted. Only the mappability of the outcrops in Squaw Peak is considered.

The lower members of the Pogonip group are not exposed in the Robinson Mining District. Therefore the equivalents of the Filmore and House limestones of western Utah do not crop out.

It should be remembered that the Snake Range decollement of Misch and Hazzard occurs below rocks exposed within the Robinson Mining District.

Upper Pogonip member

Below the Kanosh shale is a medium-bedded argillaceous limestone unit. This unit maintains a uniform slope on the east side of Squaw Peak which is abruptly terminated at its base by a cliff forming silty limestone. Approximately 300 feet of limestone are included in this mappable member. The limestones are fine-grained, argillaceous and weather to mottled gray, brown, and buff colors. On the fresh break the limestones are gray to grayish-brown. Intraformational wedge-edge conglomerate occurs in some beds. Fossils are rare.

In section 33, rocks of this member crop out beneath the thrust slices of the Eureka and younger rocks.

Kanosh Shale

The Kanosh shale crops out in a north-south linear band on the east side of Squaw Peak. Outcrops of the shale are discontinuous except in the southeast corner of section 4. At this location the shale occurs on a west facing dip slope and excellent exposures are seen in the road cuts. At the very north end of the Squaw Peak salient, in the east center of section 33, discontinuous outcrops of the Kanosh shale occur beneath the Ely Springs-Eureka thrust slice and beneath the Sevy thrust slice.

The Kanosh shale is a thin-bedded, fissile, olive green shale. The shale fragments are easily recognized in the float and are distinctively different from the limestones and siltstones of the other Ordovician units. The Kanosh shale is estimated to be approximately 100 feet thick east of Squaw Peak, however outcrops are not frequent. At Cherry Creek in the northern Egan Range 275 feet of shale are reported.

Didymograptus graptolites are abundant in some shale beds.

Lehman formation

The Lehman formation occurs stratigraphically below the Eureka quartzite on the east flank of Squaw Peak. The topographic interval is mainly covered by talus and scree from the units higher in elevation.

The formation is a sequence of thin-bedded, fossiliferous gray to brown limestones. Many of the limestone beds are abundantly fossiliferous. Ostracods, Eoleperditia, and orthid brachiopods comprise coquinoid layers.

Eureka Quartzite

The Eureka quartzite crops out as a prominent marker bed on the east facing slope of Squaw Peak (C. sec 9, T 16N, R 63E). Here the light yellow to white quartzite forms a band beneath the dark overlying Ely Springs dolostone. The Eureka quartzite at this location is approximately 250 feet thick. The quartzite is strongly jointed and strike faulting of small displacement widens the outcrop width toward the south end of the exposure. At the northern end of the block the outcrops become discontinuous because normal strike faults have eliminated the Eureka quartzite between the Ely Springs dolostones and the Lehman limestones.

The only other outcrops of Eureka quartzite (E. C sec 33, T 17N, R 63E) are isolated lenses of various thickness. These lenses are mega-bondinage structures along the thrust contact of the Ely Springs dolostones and the Lehman limestones.

The Eureka quartzite is reported to be approximately 300 feet thick in the central northern Egan Range (Woodward 1964) and approximately 500 feet thick in the southern most Egan Range (Kellog 1960). Regional changes in thickness of the Eureka quartzite are less important than the structural thinning of the unit. The Eureka may be absent as the result of thrusting.

Ely Springs or Fish Haven formation

The Ely Springs dolostones crop out in a linear north-south belt near the summit of Squaw Peak. The contacts with the overlying Laketown dolostones and the underlying Eureka quartzite are often normal strike faults instead of depositional normal contacts. The thickness of the Ely Springs dolostones is approximately 450 feet. Within the Egan Range thicknesses of 400 to 600 feet are reported.

The dolostones of the Ely Springs are gray to dark gray fine to medium-crystalline. Faunal elements are useful in identifying the formation. Stromotoporoids, Favosites and Halysites coral colonies, Streptelasma solitary corals, and Rhynchotrema and Resserella brachiopods may be abundant in the upper part of the formation.

In a sequence of rocks with an unfaulted sedimentary contact with the overlying Laketown formation, a marked topographic bench would separate the two formations. This bench is eroded on silty dolomites which are less resistant. These silty dolomites contain fossils of Ordovician age so are included in the Ely Springs formation.

Two other outcrops of Ely Springs dolostones were mapped in (sec 33, T 17N, R 63E). Both of these outcrops are slices of the Ely Springs dolostones between thrust faults.

SILURIAN:

Laketown formation

The Laketown dolostones form a continuous north-south outcrop on the west flank of Squaw Peak. The summit of Squaw Peak is of the Laketown dolostone. The outcrop thickness of the Laketown dolostones is not more than 500 feet, however strike faults have reduced the actual thickness which is approximately 1000 feet. The Laketown was measured by the writer on the ridge south of Rowe Canyon (S 1/2, sec 24, T 4N, R 63E) in the central Egan Range south of the mining district and is 1077 feet thick at this locality. Two thin thrust-bounded outcrops of the Laketown dolostones occur in (SE 1/4, sec 33, T 17N, R 63E).

The Laketown dolostones in the Squaw Peak area have two distinctive lithologies. The lower dolostones are dark medium-crystalline and fossiliferous. Recrystallized dolomitized biostromal beds containing pentameroid brachiopods, Halysites, Favosites, and Syringopora colonial corals are dark gray units. The upper dolostones are light gray, coarse-crystalline and massive. Laketown dolostones of both types are often veined by a siliceous network. The upper coarse-crystalline dolostones of the Laketown are easily confused with the lowest dolostone member of the Simonson formation. However the siliceous network is typical of the Laketown and the stratigraphic separation of these two similar dolostones by the Sevy formation makes identification certain.

The upper contact of the Laketown with the Sevy dolostones changes from a normal depositional contact, to a thrust fault contact, to a normal strike fault contact.

DEVONIAN:

Sevy formation

The Sevy dolostones crop out in a north-south linear belt through the saddle on the west side of Squaw Peak. The lower contact with Laketown formation is more often a strike fault contact while the upper contact with the lower Simonson member is usually a normal sedimentary contact with minor strike fault contacts. In (S C sec 4, T 16N, R 63E) there is an outcrop of Sevy formation bounded by high angle normal faults on the south and east, a thrust fault on the west with the middle Simonson, and a normal contact on the north with the lower Simonson. In (SE 1/4, sec 33, T 17N, R 63E) is a third outcrop of the Sevy formation. At this location the Sevy formation is bounded above and below by thrust faults.

The Sevy dolostones are light gray, very fine-crystalline, and thinly laminated. Jointing is closely spaced and developes elongate polygonal fragments. In the upper part of the Sevy formation floating rounded sand grains occur in a number of the beds. These sandy dolostones are useful in the field mapping and may be seen immediately below the overlying Simonson dolostones if the contact is a sedimentary contact.

The thickness of the Sevy cannot be determined in the Squaw Peak area. At Rowe Canyon (S 1/2 sec 24, T 4N, R 63E) the writer measured 900 feet. At this same locality Osmond 1954, reported the Sevy to be 600 feet thick. In the central northern Egan Range (Woodward 1964) the thickness is given as 900 feet in one structural plate and 425 feet in a second structural plate. Obviously the structural setting is again more important than the regional thickness variation.

Simonson formation

The Simonson dolostones are more widespread than the older Sevy, Laketown and Fish Haven dolostones. North of Ely Peak is a narrow belt of Simonson outcrops and south of Ely Peak is a broad outcrop area. From the (SE 1/4 sec 33, T 17N, R 63E) to the (C sec 4, T 16N, R 63E) there is an elongate outcrop belt. Also northwest from the Baltimore Mill (NW 1/4 xec 3, T 16N, R 63E) there is a wide outcrop paralleling the range front.

The writer found Osmond's 1954 report of the Dolomites of East Central Nevada useful in dividing the Simonson. Osmond states p. 1931, "The Simonson is readily subdivided into four members. The lowest member is a massive cliff forming unit of tan coarse-crystalline dolomite. Above this is a distinctive sequence of alternating light gray and dark brown dolomite beds. Lower and upper alternating members are separated by a massive brown cliff forming dolomite member."

In the mapping of the Squaw Peak area it was found to be necessary to subdivide the Simonson in order to recognize the structural complications. The following three members were mapped separately:

Brown and gray alternating dolostones Dark Brown biostromal dolostones	))	Dsi I
Brown and gray alternating dolostones	)	Dsi II
Light gray coarse crystalline massive dolostone	)	Dsi III

The lower coarse-crystalline dolostone member where present overlies the upper Sevy in depositional contact except where strike faulted. However this coarse member is entirely missing in the (SE 1/4 sec 33, T 17N, R 63E) and the alternating dolostones rest in thrust contact upon the Sevy dolostones.

The lower alternating dolostones Dsi II underlie, in thrust contact, the Guilmette limestones in the two structural blocks in (sec 3, 4; T 16N, R 63E).

The upper alternating dolostones and the dark brown biostromal dolostones underlie the Guilmette limestones below Ely Peak, in the monoclinal axis south of the Four Ace and Deuce Mine and in the NE 1/4, sec 17, T 16N, R 63E. At this last mentioned locality the Simonson formation is essentially complete although there is evidence of internal sliding and movement along the Guilmette-Simonson boundary. The Simonson dolostones are on both sides of the large normal fault on the east side of Ely Peak and recognition of this fault depends upon mapping of the Simonson members.

The dark brown biostromal dolostone member is extremely fossiliferous. Stromatoporoid masses and Amphipora Thamnopora "spaghetti," are major rock formers. In addition Stringocephalus brachipod and gastropod outlines are common in the dark dolostone.

The Simonson formation is approximately 900 feet thick in the central Egan Range but unfaulted complete sequences are exceptional.

Guilmette formation

The Devonian rocks of the eastern Great Basin are most conveniently and realistically subdivided into three formations: Sevy, Simonson and Guilmette. Historically in the Robinson Mining District all rocks between the Eureka quartzite and the Pilot siltstones were mapped as the Nevada formation. Even as late as 1960 (Bauer, et al in the I.A.P.G. Guidebook) followed Spencer's initial stratigraphic divisions. The Nevada formation of the district now includes the Guilmette, Simonson, Sevy, Laketown, and Ely Springs formations. Therefore the name Nevada formation is dropped in preference to more current stratigraphic nomenclature. The Guilmette formation is the current stratigraphic term for the interbedded limestones and dolostones of the middle and upper Devonian.

Both the upper and lower boundaries of the Guilmette formation are gradational. The upper boundary is characterized by limestones interbedded with the Pilot siltstones. The lower boundary is characterized by limestones interbedded with the Simonson dolostones. In the district mapping the first and last appearance of limestones constitute the Guilmette boundaries. Dolostones identical with the Simonson dolostones occur interbedded with the gray argillaceous limestones of the Guilmette. The dolostones of the lower Guilmette and the Simonson contain the same middle Devonian faunal elements so the criteria in mapping is that the first limestone marks the base of the Guilmette, and all limestone beds are consequently part of the Guilmette formation.

In the eastern portion of the Robinson Mining District the Guilmette formation is known to be in thrust contact with the Simonson. The evidence for this relationship is that the upper members of the Simonson are truncated by the overlying Guilmette limestones. This is definitely a fault contact and not an angular unconformity. Therefore the imbrication of the thrust slicing complicates the Simonson-Guilmette field contacts.

Isolated outcrops of the Guilmette formation of one to two square miles in area indicate structural blocks separated by large normal faults. Four of these blocks are present in the east portion of the district and one large complex block occurs in the western portion of the district adjacent to Weary Flat. There is geometric evidence that at least some of these normal faults are older than the thrusting.

The structure within the Guilmette formation is complex. Sufficient effort was not extended to delineate this internal faulting. However, the intrusive sill-like masses of porphyry and the large tabular limonitic gossans east of Lane Valley and north of Robinson Canyon are clearly controlled by bedding plane shearing. The structural detail within the Guilmette is more complex than illustrated by the mapping.

The Guilmette formation is approximately 2500 feet thick in the central Egan Range.

DEVONIAN-MISSISSIPPIAN:

Pilot formation

The Pilot formation is estimated to be 600 feet thick. Calcareous siltstone and silty shale are the predominate lithologies. Thin argillaceous limestones similar to the Guilmette occur in the lower portion.

The Pilot shale forms a strike valley adjacent to the normal sequences of Joana limestone above and the Guilmette limestones below. Exposures of Pilot crop out north of Ruth toward Copper Flat, south of Highway 50 near Ely, northeast of Squaw Peak along the range front, and north of Squaw Peak on the northwest side of the topographic salient.

In Lane Valley immediately east of Lane City there is an altered outcrop which is questionably identified as Pilot. No fossils were found to positively confirm this assignment.

The outcrops of Pilot in numerous areas have yielded upper Devonian brachiopods. This has made it possible to recognize the Pilot in several additional areas such as east of Squaw Peak. Leiorhynchus walcotti is a common brachiopod of the Pilot siltstones in the Robinson district.

The Pilot formation is not involved in the thrust relationship between the Joana and Chainman formations. The Joana apparently sheared away from the Pilot and then proceeded to be thrust through the Chainman shales.

MISSISSIPPIAN:

Joana limestone

Complete stratigraphic sections of the Joana limestone crop out north of Ruth in cuestas which extend to Copper Flat. North and east of Lyons Springs in sections 29 and 32, the Joana limestone is approximately 400 feet thick and is in normal sedimentary contact with the Chainman formation above and the Pilot formation below. West of these unfaulted sections are repeated outcrops of Joana limestone. Some ridges are thin slices thrust through the Chainman shales and other outcrops are faulted segments of the eastern most Joana cuesta.

The many outcrops of Joana in Lane Valley are incomplete due to structural complications.

The Joana is a structurally competent unit between the incompetent Chainman and Pilot formations. The upper 100 feet of the Joana is medium dark limestone, the middle 250 feet massive crinoidal limestone, and the lower 50 feet thin-bedded limestone with bedded chert. The formation was not measured so thicknesses are estimated. Thrusting through the Chainman may structurally thin the Joana to less than 50 feet or even develop mega-boundinage lenses of the limestone.

The structurally thinned sheets and the boudins of Joana were interpreted to be limestone beds in the Chainman in the previous district mapping. The present writer was the first to recognize the thrust slices of Joana in the district and paleontologically identify the thinned and boudin limestones as part of the Joana and not the Chainman formation.

The corals of the Joana limestone Lithostrotion, Lithostrotionella, Triplophyllites, Caniniophyllum are distinctive. These are useful in recognizing isolated structural blocks as part of the Joana formation.

Chainman formation

Within the Robinson Mining District the Chainman formation is so completely involved in the thrust structures it is not possible to reconstruct the exact stratigraphy. Four lithologies characterize the Chainman formation. The upper siliceous sandstones of the Diamond Peak member, the black organic limestones bearing the Cravenoceras cephalopods, the black fossile shales, and the lower calcareous siltstones. The total thickness of the Chainman in the district is unknown, 1500 feet is a conservative estimate. The thickness of the Diamond Peak sandstones is at least two hundred feet but as most of the contacts between the Ely formation and the Chainman formation are structural, the Diamond Peak may be locally missing.

The Chainman Diamond Peak sandstones are important hosts for mineralization where they are adjacent to the porphyry intrusives. In the east end of the district between the Deep Ruth and the Kimbley it is probable that mineralization below the major thrust will be found in the Diamond Peak sandstones.

The Chainman formation is the zone of major decollement shearing in the district. Structures in the section above the Chainman do not have to be reflected in the Devonian Guilmette and older formations. Stating this conclusion in another manner, the intense normal faulting and other structures in the rocks younger than the Chainman formation do not penetrate at depth below the major Chainman decollement.

PENNSYLVANIAN

STRATIGRAPHY

PENNSYLVANIAN CORRELATION CHART:

The Pennsylvanian correlation chart is a masterpiece of stratigraphic detail. Three important phases of the Pennsylvanian stratigraphy are illustrated: the mappable lithologic beds; the paleontological occurrences; and the sedimentary components, structures and textures.

The central portion of the chart shows four stratigraphic columns. These are partial sections of the Ely formation which were measured in the proximity of the Robinson Mining District. The Pennsylvanian rocks characteristically are cyclical and these repetitions in lithologic types naturally lend themselves to division into members. The alphabetical sequence C-W, is used for the mappable members of the Ely formation. These members are natural expressions of the cyclical rock units, they are not chosen arbitrarily but represent the ledge-slope outcrops of the rock types.

The paleontological data is plotted in stratigraphic position on the left side of the chart. The occurrences of fossil groups is plotted. The fusulinids are the most important microfossil. The fusulinids also help in recognition of the Ely stratigraphic units in the subsurface. Corals, brachiopods and bryozoa are useful in the recognition of certain members of the Ely formation.

The sedimentary data is plotted on the right side of the chart. Topographic expression, types of chert, clastic grains, cross-bedded sandy beds, and silty "muddy" limestone beds are plotted in their respective stratigraphic positions. These physical paremeters are critical for the recognition of the mappable members of the Ely formation.

The location of each reference section is plotted on an index map at the base of the chart.

The most important fact to be remembered by the geologist is that these stratigraphic criteria have absolute aerial continuity throughout the Robinson Mining District. This is an area of four 7-1/2 minute quadrangles or over 250 square miles.

PENNSYLVANIAN ELY FORMATION

(Composite Description)
(Thickness 2190 Feet)

Robinson Mining District
White Pine County
Nevada

John E. Welsh
R. A. Breitrick
1964

General Statement:

This composite description of the Ely formation includes the information derived from three measured sections: Radar Ridge, East Radar Ridge and Keystone Junction. In addition mapping within the Robinson Mining District has demonstrated the continuity of members and beds within the Ely formation. All designated members are aerially continuous and essentially all beds may be recognized, allowing only for necessary outcrop exposure, throughout the district.

A combination of textures, structures, and faunal and lithologic characteristics gives each member or bed its physical peculiarity. The most useful indentifiable characteristics are: size, shape and textures of chert beds and nodules, amount and weathering textures of sand and silt, bedding, and occurrence of fossils.

Slight discrepencies in thicknesses and descriptions were introduced through mechanical errors and limited outcrop exposures.

The correlation chart summarized the stratigraphy of the Ely formation.

Lithologic Description:

Limestone:	Gray, coarse-grained, fusulinid coquina	5
Conglomerate:	Brown, chert pebble and coarse-grained grit.	1

PENNSYLVANIAN ELY FORMATION

UNIT "C"

		Thickness
Limestone:	Light gray, medium-grained, bioclastic, 5% sandy.	2
Limestone:	White, light color is distinctive of the top beds of Unit C, and this suggests some bleaching due to slight dolomitization, fine-grained, silty, platy	6
Limestone:	Gray, medium-grained, bioclastic, abundant silicified spiriferoid brachiopods: _Anthracospirifer occiduus_	3
Limestone:	Light gray, argillaceous, silty, thin-bedded to platy but may be cliff former if horizontal, abundant light brown chert nodules with 6-12 inch diameter spheres and 3-4 foot elongate ellipsoids, few chert bands.	30
Limestone:	Gray, coarse-grained, bioclastic, massive, light tan chert nodules, _Wedekindellina_ "diamond shaped" fusulinids, _Tabulipora_ massive stem-form bryozoa.	10

Unit C (Cont'd.)

Limestone: Light gray, argillaceons, 30% isolated tan-"orange" chert nodules with distinctive light rind; tan calcareous sandstone beds near top; outcroping may be a cliff or in step-like ledges. 40

Unit C, is recognized by its generally light gray color beneath the darker overlying Riepe Springs limestones.

A thin one-foot chert pebble conglomerate seperates the Ely and Riepe Springs formations.

Tan to orange brown chert nodules are distinctive. The faunal elements: massive bryozoa, silicified spiriferoid brachiopods and fusulinids are abundant in this unit. Near the base occur 6"-12" spheres of "zebra" type chert, alternating chert and limestone laminations, which contain fusulinids. Unit C is 91 feet at the Radar Ridge Section. Unit C outcrops below the Riepe Springs on the north side of Lane Valley and on the Black Spot Hill.

UNIT "D"

		Thickness
Limestone:	Light gray, medium-grained, massive, jointed, 4 inch chert band at top and few scattered black chert nodules, Minor ledge former may be locally 10 feet thick.	4
Limestone:	Gray, fine-grained, medium-bedded, biostromal with abundant solitary Caninia corals, colonial Syringopora corals locally abundant, and massive Tabulipora bryozoa. Canina Coral bed 6 inches thick at top is useful marker. Mapping indicates that several Caninia Coral beds are within Unit "D".	14
Limestone:	Light gray, fine-grained, slightly argillaceous, thin-bedded, elongated ellipsoids of chert near top but 40% black isolated "S-type" chert nodules and stringers throughout, fossiliferous with bryozoa, solitary and colonial corals Caninia and Syringopora. A bed of abundant small productid brachiopods Desmoinesia "Marginifera" occurs near the base of Unit "D".	43

Unit D, is recognized by the thin-bedded platy "S-type" cherty limestone. The _Caninia_ corals are useful guides especially the bed near the top of the unit. Also the _Desmoinesia_ bed near the base may be useful if exposed in outcrop. Unit D is 61 feet thick at the Radar Ridge Section. The best accessible exposures are on the northeast side of the canyon in NW 1/4, Sec. 12, T. 16N., R62E.

UNIT "E"

		Thickness
Limestone:	Gray, medium-grained, massive ledge former, isolated 8 inch black chert spheres.	10
Siltstone:	Brown, fine-grained, calcareous, 30% brown nodular cherts, very sandy at the top with 1-foot coquina of Fusulinella fusulinids.	34
Sandstone:	Brown, fine-grained, calcareous, cross-bedded, ledge former.	10
Limestone:	Gray, fine-grained, silty, 20% isolated purplish brown rind chert nodules.	20

Unit E, is recognized by the greater proportion of silt and sand. The beds of Unit E, weather brown, The sandy bed with the abundant Fusulinella fusulinids is a persistant marker. The brown rind chert of the lower beds is distinctive. Unit E is well exposed in fault blocks on the northeast side of the canyon in ENE 1/4, Sec. 11, T16N., R62E. Unit E, is 74 feet thick.

UNIT "F"

		Thickness
Limestone:	Light grayish brown, bioclastic, medium-grained, dense, two foot ellipsoids and bands of liezegang "zebra" chert with silicified Wedekindellina fusulinids. Liezegang banding of chert is the distinctive structure in Unit F.	3
Limestone:	Gray, fine-grained, covered, solitary Caninia corals and colonial Syringopora corals.	26
Limestone:	Light gray, medium-grained, dense, massive, bioclastic, pelletal, large 3-foot spherical chert nodules near the top.	12
Limestone:	Brown, fine-grained, 20% fine-grained sand, cross-bedded wedges of calcareous sandstone at base. This sandstone structure was not found in mapping throughout the Ruth district.	6

Unit F, is recognized by the presence of the liezegang "zebra" chert bands with the associated silicified fusulinids which occur directly beneath Unit E. Unit F, is 47 feet thick. The upper ledges of Unit F, are well exposed in the C, Sec. 20, T16N., R63E.

UNIT "G"

		Thickness
Limestone:	Gray, fine-grained, argillaceons, silty, platy, abundant black nodular chert, fossiliferous Fusulinella fusulinids, massive Tabulipora bryozoa, productid brachiopods, solitary and colonial corals Caninia and Syringopora. Chert spheres and ellipsoids 6-12 inches in diameter are characteristic.	65
Limestone:	Gray, medium-grained, bioclastic, large 12 - inch chert spheres and ellipsoids.	7
Limestone:	Gray, argillaceous, very fine-grained, platy, silty abundant brown nodular "S-type" chert 1-1 1/2 inches in diameter, productid brachiopods are common, usually forms a covered slope.	160

Unit G, is a less resistant member of the upper Ely formation. Thin-bedded, platy, fossiliferous limestones predominate. The symmetrical black 6"-12" inch chert spheres and ellipsoids are distinctive in the more massive beds. Unit G, is 232 feet thick at the Radar Ridge Section. Within the district Unit G may be reduced in thickness by faulting.

UNIT "H"

		Thickness
Sandstone:	Brown, very-fine-grained, siliceous, 15% calcareous, cross-bedded. Well exposed on Radar Ridge but Unit H, is not well represented in outcrops within the Ruth district.	14
Limestone:	Gray, argillaceous platy.	30

Unit H, on Radar Ridge outcrops as a prominent ledge in the overturned section. Unit H, is 44 feet thick. The cross-bedded sandstone has not been observed to outcrop within the district, because Unit H is not present.

UNIT "I"

		Thickness
Limestone:	Gray, fine to medium-grained, bioclastic, dense, massive, large concentrically banded elliptical "cannonball" nodules of chert 2-3 feet in diameter in middle of bed, at base the nodules are double and triple clusters - 1-3 feet in diameter.	17
Limestone:	Light gray, weathers brown, argillaceous and silty, undulating bedding, brown nodular and bedded chert stringers, flagged, platy.	49
Limestone:	Dark brown, medium-grained, sandy, weathers brown, with sandy ellipsoidal patterns, one foot bed of concentrically banded chert.	4
Limestone:	Gray, silty and argillaceous, undulating bedding, abundant silicified spiriferoid brachiopods which weather in high relief.	54

Unit I, is recognized by the distinctive concentrically banded ellipsoidal "cannonball" nodules and the greater proportion of fine sandy limestone which weathers a brownish color on the out crop.

The most excessible outcrops of the Unit are the ledges, WNW 1/4, Sec. 12, T16N., R62E., adjacent to Garnet Hill, northeast of Gleason Creek.

Unit "I" (cont'd.)

Unit I, is 124 feet thick at the Radar Ridge Section.

UNIT "J"

		Thickness
Limestone:	Light gray, massive, fine to medium-grained, pelletal, crinoidal, 5% quartz sand grains.	7
Siltstone:	Light brown, very fine-grained, wavy undulatory bedding, thin-bedded, calcareous, 20% dark brown chert stringers.	43

Unit J, is an easily recognized member of the Ely formation. The Siltstones are quite different from any other bed and make a good mappable horizon. Unit J, outcrops east of Gleason Creek along Highway 50. Unit J, is 50 feet thick.

UNIT "K"

		Thickness
Limestone:	Brown, fine to medium-grained, medium-bedded sandy with a one foot cross-bedded calcaeous sandstone near the top, bioclastic, fossiliferous brachiopods, bryozoa and corals. Two beds of concentrically banded ellipsoidal chert nodules, 2-4 feet in diameter, one bed in the middle of the ledge and the other at the base.	20
Limestone:	Gray, brown weathering, argillaceous and silty, 40% brown nodular chert, platy undulating bedding and cross-bedding fossiliferous solitary corals and bryozoa.	31
Limestone:	Light gray, 20% silty, scattered white columnals of crinoids.	12
Limestone:	Gray, fine-grained, lithographic	1
Chert:	Dark brown, bedded, concentrically banded, good marker bed if exposed.	2
Limestone:	Grayish brown, very fine-grained, argillaceous and silty.	13

Unit K, may be recognized by the concentrically banded ellipsoidal chert nodules. These structures are similar to those in Unit I, but have

UNIT "K" (cont'd.)

their own peculiarity. Most beds in Unit K, have a high percentage of fine sand and silt and as a result weather light brown.

Unit K is exposed on Elijah Hill, and is 79 feet thick.

Fusulinella fusulinids were collected from the upper limestone beds of Unit K in outcrops on north side of tributary valley of Gleason Creek, N E 1/4, Sec. 11, T16N., R62E.

UNIT "L"

		Thickness
Limestone:	Light gray, fine-grained, sublithographic, at the top are large dark brown cannonballs of chert 3-5 feet in diameter and usually about 1 foot thick. These cannonballs are most conspicuous on the bedding surface.	2
Limestone:	Light gray, fine to coarse-grained, large 3-4 foot cannonball chert and 3-4 feet silicified Chaetetes colonies near base.	25
Limestone:	Light gray, argillaceous, platy, nodular chert, fusulinids Profusulinella.	12

Unit L, is recognized by its two horizons of massive brown cannonball chert. The top horizon is within the upper bedding plane of the upper limestone. The diameter of these nodules, 3-5 feet, is much greater than their thickness of 1 foot. The second horizon has ellipsoidal nodules 2-4 feet in maximum diameter associated with the largest silicified Chaetetes colonies 3-4 feet in diameter. The Chaetetes colonies are found at the base of the ledge forming limestone. Unit L is well exposed in the valley south of Elijah Hill or at the Keystone Section. At both the Radar Ridge Section and at the Keystone Section the L unit is 39 feet thick. Unit L has two beds of Profusulinella fusulinids.

UNIT "M"

		Thickness
Limestone:	Gray, brown weathering, fine-grained, thin-bedded but stands as resistant cliff, 50% silty siliceous "muddy" chert stringers.	11
Limestone:	Gray, very fine-grained, 10% argillaceous, 30% silty, platy, "S-type" , abundant chert stringers and nodules, black chert nodules, 1/2 - 1 inch in diameter, black chert nodules usually have a silty brown rind.	46

Unit M, is a major slope forming member between L and N. The lower part is usually poorly exposed. The ledge forming units are the better mappable members in the middle of the Ely formation therefore, recognition of the slope forming members is sometimes based on stratigraphis position. Unit M is 57 feet at Radar Ridge and 62 feet at Keystone Junction Sections.

UNIT "N"

		Thickness
Limestone:	Gray, weathers light gray, fine-grained to sublithographic, 10% pelletal, 5% silty fine-grained rounded sand grains, large 2-3 foot silty brown spherical cannonball nodules within upper bed of ledge. Unsilicified <u>Chaetetes</u> colonies are difficult to locate in most exposures, medium-bedded ledge former, scattered 2"-6" inches black nodules in beds below the upper cannonball bed.	9
Limestone:	Brown, weathers gray, sublithographic, medium-grained, 25% pelletal.	7
Limestone:	Brown, medium-grained, 50% pelletal, 5% well-rounded floating sand graines, sandy chert nodules at top of bed, massive ledge.	3
Limestone:	Brown, fine-grained with some medium-grained beds, 10%-15% very fine-grained sand grains, few pellets, 10% chert nodules 6"-2' in diameter.	31

UNIT "N" (cont'd.)

Thickness

Limestone: Light gray, sublithographic, 5% medium-grained floating rounded sand grains, large 1-3 foot diameter chert nodules. 2

The upper ledge of Unit N, is distinctive as a marker bed. The silty brown cannonball cherts in the upper limestone bed with the scattered small black chert nodules in the bed below are sufficient criterea to identify the N unit. The N-unit is well exposed at the Keystone Section. 49 feet were measured at Radar Ridge and 52 feet at Keystone Junction. Unit N, has rare Profusulinella fusulinids.

UNIT "O"

		Thickness
Sandstone:	Brown, very fine-grained, silty, 30% calcareons, thin-bedded, 10% - 20% brown silty chert.	8
Limestone:	Brown, medium-grained, 5% sandy, bioclastic crinoidal, fusulinids <u>Profusulinella.</u>	2
Limestone:	Brown, very-fine-grained, 30% very fine-grained sand grains, thin-bedded but resistant, 5% brown chert nodules 2"-3" inches in diameter with tan weathered rinds.	2
Limestone:	Grayish brown, fine-grained, 20% silty, thin-bedded 15% silty brown chert stringers.	12
Sandstone:	Brown, very fine-grained, 20% calcareous, upper part is more calcareous, 5% brown chert with tan rinds, ledge former.	3
Siltstone:	Gray, weathers light brown, very fine-grained, argillaceous, 40% calcareous, thin-bedded platy, 15%-20% bands of 1" diameter black chert and 1/2" spheres of black chert which weather brown, usually covered interval.	45

UNIT "O" (cont'd.)

Unit O, is a prominent slope former and is usually poorly exposed. The chert is of the "S-type", but is browner in color. The bedding is also less platy than Unit S, the thin-bedded units being more cohesive. A higher proportion of silt and fine-grained sand is a characteristic of Unit O. Unit O, is 86 feet at Keystone Junction and 78 feet thick at Radar Ridge.

UNIT "P"

		Thickness
Limestone:	Dark gray, fine to medium-grained, bioclastic crinoidal, fusulinids Profusulinella, silicified Chaetetes colonies, medium-bedded, huge 4'-6' feet diameter brown chert nodules at top of bed.	6
Limestone:	Light cream gray, fine-crystalline to sublithographic aphanitic, ledge former.	6
Limestone:	Dark gray, fine-grained, medium-bedded , fossiliferous fusulinids Profusulinella and unsilicified to partly silicified Chaetetes colonies 1' - 2' feet in diameter. Chaetetes colonies occur in the same bed with 1' - 2" foot ellipsoids of black chert.	6
Limestone:	Light cream gray, fine-grained, 50% pelletal, Medium-bedded.	6

Unit P, is a prominent ledge forming member. The largest cannon-ball chert nodules of any limestone are found at the top of this unit associated with Chaetetes colonies. The second horizon of Chaetetes colonies in the P unit occurs with large black chert nodules below a massive limestone bed.

UNIT "P" (cont'd.)

These chert characteristics make the P unit an easily recognized member. Unit P forms a well exposed ledge between Keystone Junction and Garnet Hill. Unit P, measured 26 feet in Radar Ridge and 24 feet at Keystone Junction. Profusulinella fusulinids are found in the upper beds.

UNIT "Q"

		Thickness
Limestone:	Brownish gray, weathers brown, fine-grained, 20% - 40% silty, irregular thin to platy bedding, resistant cliff former if horizontal, typical "muddy" marker unit, scattered silty brown chert but mostly silty siliceous surface hardening.	40

Unit Q, is an excellent mappable member, which stands in bold contrast to the massive limestones of Units P above and R below. Unit Q, measured 40 feet at Keystone Junction and 34 feet at Radar Ridge.

UNIT "R"

		Thickness
Limestone:	Very light cream gray, sublithographic very fine-grained, massive, 5% small 6" black isolated chert nodules, pseudo-oolitic, unsilicified Chaetetes colonies at top of bed, and in a lower horizon, fusulinids Profusulinella.	10
Limestone:	Gray, fine-grained, thin to medium bedded, 20% black scattered chert nodules, productid brachiopods Desmoinesia and Linoproductus.	12
Limestone:	Gray, medium-grained, with brown silty cannonball chert spheroids 1'-2' feet in diameter, fusulinids.	3

Unit R, usually forms a ledge between P and S, however, it is not always well exposed. The base of R is least apt to be exposed. R has two unsilicified Chaetetes horizons, and an abundance of productid brachiopods may occur if the outcrops expose those beds. The Chaetetes colonies in the unit are encrusted with the colonial composite coral Multithecopora, and associated with fasiculate corals Crataniophyllum? . Excellent exposures of R may be studied in the ledges south of Keystone Hill. The thickness of R is 24 feet at East Radar Ridge Section, 22 feet at Radar Ridge Section, and 28 feet at Keystone.

UNIT "S"

		Thickness
Limestone:	Brown, fine-grained, very silty, flagged bedding siliceous irregular chert fretwork.	31
Limestone:	Light gray, fine-grained, oolitic and pelletal, massive cannonballs of chert 1-2 foot diameter with <u>Chaetetes</u> colonies at top of ledge (Sa), scattered black flat disk shaped chert nodules 6" to 12" inches in diameter. At base of ledge are two coquinoid beds of <u>Profusulinella</u> fusulinids: an upper 1 foot bed in dark limestone and a lower 1 foot bed in calcareous sandstone.	13
Limestone:	Grayish brown, very fine-grained, silty platy, abundant black nodular and stringers of chert 1/2" to 1" inch in diameter.	12
Limestone:	Grayish brown, fine-grained, alternating 6" - 10" inch bands of brown silty siliceous limestone and gray limestone, (Sb) ledge forming bed, lower part becomes progressively more sandy and weathers brown.	10

UNIT "S" (cont'd.)

		Thickness
Limestone:	Gray, very fine-grained, argillaceons and silty, abundant 1/2 - 1 foot elliptical black nodular and stringers of botryoidal chert, particular abundance of 1/2"-1" inch black chert spheroids. This distinctive lithology is called "S-type", within this slope forming interval is one bed of black chert 1 to 2 feet thick which occurs immediately above a 5 foot light gray, medium gray, limestone, this black chert is the (Sz) bed.	67

Unit S, is an aerially wide spread member of the Ely formation. The over all topographic expression is that of a slope forming member with three minor ledge forming beds. Because of the recurrence of S outcrops in structually complex areas the individual ledge forming beds have been designated Sa, Sb, and Sz. These beds occur throughout the district and are extremely useful in large scale mapping.

The _Chaetetes_ colonies of Sa bed are encrusted with the coral _Multithecopora_. Unit S, is 133 feet thick at the Radar Ridge section.

UNIT "T"

		Thickness
Sandstone:	Brown, fine-grained, chert grains, cross-bedded, only in Saxton Peak part of district. Chert and pelletal grains on upper bedding plane of limestone.	1
Limestone:	Light brown weathers gray, sublithographic to fine-grained, medium-bedded to massive, topographically outcrops as a series of ledges, 5% scattered black to light gray chert nodules averaging 6" inches in diameter, several bands of "zebroid" banded chert, zare fossil coral or brachiopod.	60
Limestone:	Grayish brown, fine-grained, thin-bedded bioclastic, crinoidal, 2% sandy.	15
Chert:	White bedded, in some localities two beds of the white chert are close together, excellent marker which may be found in covered areas.	1
Limestone:	Grayish brown, weathers gray, sublithographic to fine-grained, medium-bedded, light gray sand, irregular silty chert in middle of bed.	12

UNIT "T" (cont'd)

		Thickness
Limestone:	Gray, fine-grained, 50% - 70% light tan irregular silty chert on bedding planes, "muddy" chert bed, slope former.	32

Unit T, has three distinctive lithologies. The top of the unit is a cross-bedded brown sandstone in the Saxton Peak part of the district, elsewhere the top bedding plane of the upper limestone is speckled with white to light tan pellets and coarse chert grains. The upper half of the unit has ledges of limestones in which are isolated black chert spheres and nodules. In the lower half of the unit, which is usually a slope former, one or two beds of white chert are unique markers.

Unit T, measured 122 feet thick at the Radar Ridge Section and 120 feet at the East RadarRidge Section.

UNIT "U"

		Thickness
Limestone:	Light grayish brown, weathers gray, sublithographic, massive, bioclastic, major ledge forming bed, at top of bed are 2 foot cannonball chert nodules, the nodules have an approximately spherical upper part which is light brown and silty, the lower part is a banded elongate ellipsoid.	4
Limestone:	Gray, fine-grained, 30% discontinuous siliceous silty stringers.	6
Siltstone:	Brown, siliceous silty stringers with interbeds of gray limestone, massive unit usually part of cliff.	11
Limestone:	Gray, fine-grained, _Caninia_ coral biostrome.	2
Limestone:	Gray, fine-grained, siliceous silty stringers.	3
Limestone:	Gray, fine-grained, 1' foot elongate ellipses of concentrically banded chert, at base of cliff if unit is horizontal.	2
Limestone:	Gray, fine-grained, 70% light brown, weathering silty "muddy" chert.	14

UNIT "U" (cont'd.)

		Thickness
Limestone:	Brown, weathers gray, fine-grained, pelletal, medium-bedded.	4
Limestone:	Grayish brown, 70% silty irregular crenulated "muddy" chert, thin-bedded.	7
Limestone:	Brown, sublithographic, massive, one tan chert band.	4
Limestone:	Dark gray, weathers gray, very fine-grained sublithographic smooth weathering, 5% brown scattered chert nodules.	17
Limestone:	Grayish brown, fine-grained, sublithographic 5% floating medium-grained chert and sand grains, marker bed.	3
Limestone:	Brown, weathers gray, fine-grained, 10% very fine-grained sandy silt, 30% small irregular angular fossilferous chert nodules, rough differentially weathered surface, fossiliferous spiriferid and productid brachiopods, fenestellid bryozoa, marker bed.	35
Limestone:	Grayish brown, weathers gray, fine-grained, dense, 5% sandy, 5% oblate chert nodules 2"- 6" inches in diameter, ledge former.	6

UNIT "U" (cont'd.)

		Thickness
Limestone:	Gray, fine-grained, thin-bedded, very fine-grained, 30% brown silty irregular "muddy" and banded chert.	5
Limestone:	Bluish gray, very fine-grained, 15% silty sand, thin-bedded, 40% silty siliceous irregular patchy chert, one interbedded 10% sandy dark gray limestone, fossiliferous brachiopods productids and spirifers, marker bed.	43
Limestone:	Gray, coarse-grained, medium-bedded, 5% brown chert nodules, bioclastic, crinoidal.	6

Unit U, has several excellent marker beds. At the top of the unit is the horizon of distinctive cannonball cherts with banded ellipsoidal bases. The Caninia solitary horn coral zone is at the base of the upper cliff forming part of U. In the middle of the unit is the limestone with floating chert and quartz grains which weather to high relief. The lower portion of Unit U has interbedded gray limestone ledge-formers and brown "muddy" silty beds forming slopes.

Unit U is widespread throughout the district and is an important datum in the lower Ely formation. Unit U, is 172 feet thick at the East Radar Ridge Section.

UNIT "V"

		Thickness
Limestone:	Gray, very fine-grained, 40% silty "muddy" abundant tan brown irregular chert.	16
Limestone:	Dark, grayish brown, fine-grained, 10% silty medium-bedded.	4
Limestone:	Grayish tan, very fine-grained, argillaceous, 30% silty, thin-bedded platy, smooth weathering surface, dark gray botryoidal and 1/4"-1" diameter spherical chert nodules with white weathered rinds, the botryoidal chert and the high weathering relief of the silt stringers is characteristic of this unit, few coarse-grained bioclastic limestones interbedded.	115

The upper part of Unit V, has distinctive chert structures in the silty units. These cherts exhibit convex curves on the plan view of the bedding and botyrioidal cross sections. The silt lenses in these beds weathers to high relief. Associated with these botyrioidal beds are limestone beds with abundant silicified Antracospirifer occiduus brachiopods. In the Saxton Peak structural block at the eastern-most end of the district the Crataniophyllum coral biostrome was found at the base of the botyroidal chert beds.

Unit V, is 135 feet at the east Radar Ridge Section.

UNIT "W"

		Thickness
Limestone:	Gray, medium to coarse-grained, massive, bioclastic fossiliferous crinoidal, corals, brachiopods.	17
Limestone:	Gray, to light gray 15% - 30% sandy silty, thin to medium-bedded, interbedded coarse-grained bioclastic beds with silicified fossils crinoids, brachiopods Linoproductus productids and spirifers, corals Michelina.	105
Limestone:	Dark gray, medium-grained, ledge former, 20% black weathering brown chert 1" - 6" inches in diameter, also discontinuous chert bands, bioclastic.	15
Siltstone:	Grayish brown, weathers light yellowish brown, very fine-grained, well sorted, angular grains, calcareous, thin-bedded.	4
Limestone:	Light brown, fine-grained, 10% silty layers, medium-bedded, 15% black chert nodules and layers.	13
Limestone:	Dark gray to black, fine-grained, medium-bedded, black chert nodules and bands, bioclastic crinoidal.	24

UNIT "W" (cont'd .)

		Thickness
Covered:		17
Limestone:	Grayish brown, fine-grained, 10% gray chert, biolastic, partly covered.	16
Limestone:	Gray, coarse-grained, medium-bedded, 5% silty, bioclastic, crinoidal, abundant stem branching bryozoa, useful marker bed, 5% dark grayish brown chert nodules.	14
Covered:		39
Limestone:	Gray, fine-grained, smooth weathering, black chert.	6
Limestone:	Grayish brown weathers gray, medium to coarse-grained, medium-bedded ledge former, 5% black chert nodules, bioclastic crinoidal fossiliferous brachiopods <u>Antiquatonia</u>, <u>Antracospirifer</u>, <u>Punctospirifer</u>, <u>Derbyia</u>.	26
Limestone:	Light gray, fine-grained, silty, medium-bedded, gray chert with light tan borders, irregular silty chert stringers 3" - 4" inches in diameter.	32
Limestone:	Brown, weathers gray, medium to coarse-	51

UNIT "W" (cont'd.)

		Thickness
	grained, medium-bedded, less than 5% chert nodules, bioclastic fossiliferous silicified brachiopods Antiquatonia. Linoproductus, Punctospirifer, Composita, Rhipidomella.	
Covered:	Limestone medium-grained, medium-bedded.	36
Limestone:	Brown, weathers gray, coarse-grained, bioclastic, medium-bedded.	9
Chert:	Brown to white, dense, banded, limonite stained.	2
Limestone:	Gray, medium to coarse-grained, medium-bedded, bioclastic crinoidal, rare brown chert nodules, silicified fossil brachiopods Rhipidomella nevadensis, Antracospirifer occiduus, Antiquatonia.	22
Covered:		30
Siltstone:	Gray, weathers yellowish brown, fine-grained, calcareous fossiliferous.	4

UNIT "W" (cont'd.)

		Thickness
Limestone:	Brown, weathers grayish brown, coarse-grained, coquinoid, fossiliferous brachiopods Antracospirifer occiduus, Spirifer rockymontanus, Linoproductus, Antiquatonia.	12
Limestone:	Brown, fine-grained, 40% yellowish brown weathering silt, bioclastic, bryozoa Archimedes.	8
Limestone:	Grayish brown, medium-grained, bioclastic	3
Siltstone:	Brown, weathers yellowish brown, very fine-grained medium-bedded, 40% calcareous.	11
Limestone:	Grayish brown, coarse-grained, bioclastic fossiliferous crinoidal brachiopods productids, Antracospirifer occiduus, solitary corals Amplexizaphrentis.	12

Unit W, is completely exposed only on the east flank of Radar Ridge. Elsewhere the lowermost beds are involved in structural complications, usually thrusting of the Ely limestone upon the Chainman shales. At the East Radar Ridge Section, Unit W is 528 feet thick.

UNIT "W" (cont'd.)

In the middle of the Unit W, there are beds of abundant stem bryozoa Tabulipora, Rhombopora. This zone of bryozoa appears to be laterally persistant.

The lower 300' feet of Unit V are distinctive and if exposures were better this interval could be a separate member. The limestones are coarse-grained to coquinoid. Silicified fossils are abundant and fossil trash is a major constituent. Two brachiopods are indicative of this interval: Rhipidomella nevadensis and Punctospirifer campestris. Associated with these are Antiquatonia, Linoproductus, Antracospirifer, and Composita.

The lower coarse-grained limestones weather with a brown cast and are interbedded with a few yellowish brown siltstones.

The base of the East Radar Ridge Section is thought to be the base of the Ely formation. At the very most the lowest limestone is only a few tens of feet stratigraphically above Chainman black shales.

It should be stated that in mapping and in interpretation of sub-surface information, black shales and siliceous sandstones are placed in the Chainman formation, and are not included in the Ely formation.

PERMIAN

STRATIGRAPHY

PERMIAN CORRELATION CHART:

The Permian correlation chart summarizes the stratigraphic data of the Permian rocks of the Robinson Mining District. The Permian formations of the Egan Range are the Gerster, Plympton, Kaibab, Arcturus, Rib Hill-Reiptown, and Riepe Springs. The Gerster and Plympton formations do not crop out in the district and were not included in the stratigraphic study.

The reference stratigraphic columns show the lithologic detail of the formations. On the right side of the chart the topographic expression, paleontologic data, and sedimentary data are plotted. The physical and paleontological data are necessary criteria for recognition of rock units. Familiarization with these specific occurrences of sedimentary features and paleontologic objects greatly enhances the facility of structural geological mapping and subsurface interpretation.

PERMIAN:

Riepe Springs formation

The Riepe Springs formation has massive bioclastic and biostromal limestones which are very competent. Massive colonial corals Lithostrotionella and Thysanophyllum associated with Omphalotrochus gastropods are abundant faunal elements. Large fusulinids are distinctly different from the small Pennsylvanian forms in the Ely limestones.

The Riepe Springs formation is approximately 250 feet thick but may be thickened or thinned by faulting. The Riepe Springs limestones are structurally associated with the Rib Hill contact cherts and the upper Ely limestones. These three components form Nappe plate III.

Rib Hill-Reiptown formation

The Rib Hill formation is approximately 1000 feet thick. The lower 250 feet are locally named the "contact cherts." This unit is a thin-bedded silty limestone with abundant brown nodular and bedded chert. The upper 750 feet of the formation is fine sandstone with thin sandy interbedded limestones and usually a few silty dolomites. The sandstones weather to a distinctive brick red color. Mineralized Rib Hill sandstones form resistant siliceous cappings.

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 most reactive and most readily assimilated by the intrusive porphyry.

The Rib Hill limestones contain large globular Pseudeschwagerina fusulinids, echinoid fragments, brachiopods, and bioclasts are abundant in the more calcareous beds.

Structurally the upper part of the Rib Hill formation remains attached to the lower Arcturus formation in Nappe II. while the "contact chert" member is in Nappe III with the Riepe Springs and the upper Ely limestones.

Lower Arcturus formation

The lower Arcturus formation crops out in a north northwest trend on the west side of the Rib Hill-Radar Ridge overturned structure. Within the center of the Robinson district extensive outcrops are found south of the Ruth townsite in the area known as the Cliffs, in a broad belt between the Eureka and Jupiter faults, and in structural blocks north and south of Garnet Hill.

The lower Arcturus is a structurally competent formation, which with the upper Rib Hill sandstone, forms the Nappe Plate II, in the district structure.

The lower Arcturus formation has two predominate lithologic types: massive argillaceous limestones and medium-bedded calcareous sandstones. The only distinctive minor sedimentary features are the pelletal-oolitic limestones and crystal fleck limestones. Paleontologic occurrences are useful mappable criteria. The large Omphalotrochus gastropods, the Tabulipora bryozoa, and the fasiculate coral Durhamina are faunal zones of the lower Arcturus limestones. The Leonardian fusulinid Parafusulina with a specific structure termed cunniculi is a useful microfossil identifiable only in thin sections. Echinoid fragments are common in the lower Arcturus but also are abundant in the Rib Hill and Riepe Springs formations.

Evaporite member

Southwest of Murry Summit and Rib Hill, and west of Radar Ridge one gypsum bed is found to be present at exactly the same stratigraphic position for a distance of over fifteen miles. The platy siltstones below the gypsum and the limestones above the gypsum are also distinctive for this distance.

Solution brecciated siltstones are found in the upper Arcturus but no other evaporites were seen in the district. Some investigators have referred to the red siltstones as evaporites but this is not accepted by this writer.

Because of the proven continuity of the gypsum and the recognizable lithologic differences between the siltstones and limestones above the evaporite from the limestones and sandstones below, the Arcturus is separated into lower and upper members at the gypsum.

Within the center of the Robinson district the upper Arcturus is found in structural companionship with the Kaibab limestone. The lower Arcturus is associated with the Rib Hill sandstone.

The stratigraphic position of the evaporite is a shearing surface between nappe plates.

The gypsum bed is between 50 and 100 feet thick.

Upper Arcturus formation

The upper Arcturus formation is a siltstone and silty limestone sequence. The rocks are light pastel shades of yellow, brown, and gray, or brick red. The red siltstones are known as the "Indian Red" beds in the district. The only other red beds of the district stratigraphic sequence are some sandstones of the Rib Hill formation.

The upper Arcturus rocks are incompetent and usually occur in folds of small amplitude. The Kaibab limestone and the upper Arcturus rocks are structurally associated in Nappe Plate I, the highest structural plate in the district.

The molluscan fauna of the upper Arcturus is distinctive and a useful criteria for recognizing the unit. The molluscan fauna also occurs for approximately 200 feet below the gypsum bed, which separates the lower and upper Arcturus. The gastropods Euphemitoides ("Euphemites") and Amphiscapha are the most easily recognized.

Kaibab formation

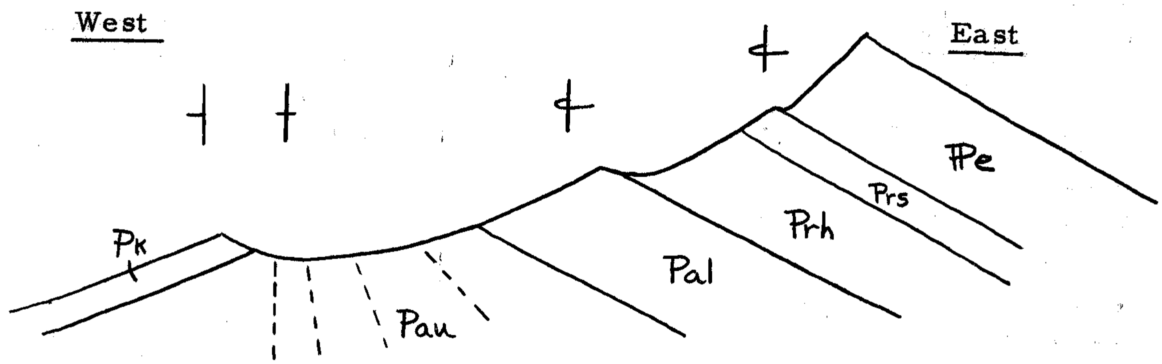
The Kaibab formation occurs in continuous and discontinuous outcrops from the northwest side of Radar Ridge southward, paralleling Radar Ridge then Rib Hill, to a point at which the outcrop crosses U. S. Highway 6, west of Murry Summit. Throughout this distance the Kaibab limestone is in normal position, quite in contract to the older rocks which are overturned on both Radar Ridge and Rib Hill.

The only large exposure of Kaibab limestone within the center of the mining district crops out on the hill immediately west of the Star Pointer Shaft on the boundary of sections 10 and 15. Small outcrops of Kaibab limestone are found scattered northward from this locality through Keystone Junction to Copper Flat. Isolated blocks rest upon the upper Arcturus siltstones.

The hill of Kaibab limestone near the Star Pointer Shaft and a small outcrop resting on the silicified Rib Hill sandstone east across the drainage are of specific interest. The Kaibab limestones are unaltered but these rest in thrust fault contact upon highly latered and mineralized Rib Hill sandstone. This situation is not adequately explained.

The Kaibab limestone outcrops within the district are eratically distributed upon the upper Arcturus bed. This illustrates the structural shearing of the competent Kaibab limestones upon the incompetent upper Arcturus beds.

The Kaibab outcrops west of the district illustrate the rapid inflection of



the overturning. The Kaibab limestones dip normally to the west while the older sequence is overturned. This type of structure is not unique to the Robinson district, but is repeated many places in the eastern Great Basin.

The limestones of the Kaibab are light brown, cream to white. Usually the limestones are both bioclastic and fossiliferous. Crinoid columnals and bryozoan clasts are common. The Kaibab productid Dictyoclostus brachiopods are distinctive. Chalcedonic variegated pastel colored chert nodules are abundant in certain of the limestone beds.

Plympton formation

The Plympton bedded spicular cherts are found in Sec. 31, T. 10N, R 61E, on the east side of the stream course which follows the volcanic limestone contact.

The Plympton formation is characterized by bedded syngenetic chert. The chert is light cream to white, aphanitic, and spicular.

No phosphatic beds were noted at this locality above the Plympton.

Gerster formation

At the extreme northwest end of Radar Ridge the volcanics of the Robinson Summit area overlap the Permian rocks. Just east of the stream course which follows the volcanic contact rocks of the Gerster and Plumpton formations crop out.

The Gerster limestones at this locality are similar to the other outcrops of the formation in eastern Nevada. The limestones are light yellow brown, fossiliferous and contain abundant brown chalcedonic chert.

The fauna collected at this locality contains Punctospirifer pulchra and productid brachiopods found only in the Gerster formation.

This locality of interest because it illustrates that the Tertiary ignimbrites here rest upon the late Permian rocks of the Kaibab to Gerster formations.

REFERENCE STRATIGRAPHIC SECTION

ROBINSON MINING DISTRICT

PALEONTOLOGICAL

DATA

PALEONTOLOGIC INDEX MAP

The paleontologic index map refers to specific collections of fossils made in the field mapping and identified in the laboratory. These collections contain both macrofossils and microfossils. Fusulinids were studied in thin sections.

Many of the paleontologic collections were obtained early in the schedule of remapping the district geology. As the stratigraphic information improved and the revised mappable units proved continuous over the area of the mining district, more reliance was placed on physical criteria rather than paleontologic criteria.

Even up to the final weeks of field mapping the fossils again and again proved to be indispensable in deciphering the correct formations in fault blocks. Hundreds of additional fossil localities were observed and identified in the process of field mapping. Those specifically identified are only those for which collections are available.

Without the combination of paleontology and stratigraphy the district structure would be undecipherable.

PALEONTOLOGICAL DETERMINATIONS

Robinson Mining District

White Pine County, Nev.

Part I. Surface Samples

Part II. Drill Hole Samples

PART I. PALEONTOLOGICAL SURFACE SAMPLES:

COLLECTION NO.	IDENTIFICATION	AGE
W - 1 NE 1/4 sec. 12, T. 16N., R. 61E.	Profusulinella sp. Millerella sp. small foraminifera	Early Atoka Middle Ely formation
W- 2 NE 1/4 sec. 12, T. 16N., R. 61E.	Wedekindellina sp. small foraminifera	Early Des Moines Upper Ely formation, Unit E
W - 3 NE 1/4 sec. 12, T. 16N., R. 61E.	Fusulinella sp.	Early Des Moines Upper Ely formation, Unit E.
W - 4 NE 1/4 sec. 12, T16N., R. 61E.	Schwagerina sp. Lithostrotionella sp.	Wolfcamp Riepe Springs formation
W - 5 NNW 1/4 sec. 12, T. 16N., R. 61E.	"Corwenia" - Durhamina sp.	Leonard Lower Arcturns formation
W - 6 SSC 1/4 sec., 6, T. 16N., R. 62E.	Profusulinella sp. Millerella sp.	Early Atoka Middle Ely for- mation, Unit P.
W - 7 SSE 1/4 sec. 6, T. 16N., R. 62E.	Fusulinella - Wedekindellina sp.	Early Des Moines Upper Ely for- mation
W - 8 SE 1/4 sec. 12, T. 16N., R. 61E.	Fusulinella? sp.	Early Des Moines Upper Ely for- mation

COLLECTION NO.	IDENTIFICATION	AGE
W - 9 SE 1/4 sec. 12, T.16N., R.61E.	Schwagerina sp.	Wolfcamp Riepe Springs formation
W - 10 SE 1/4 sec. 12, T.16N., R.62E.	Lithostrotionella sp. Thysanophyllum sp.	Wolfcamp Riepe Springs formation
W - 11 EC sec. 12, T.16N., R.62E.	Schwagerina linearis	Wolfcamp Riepe Springs formation
W - 12 ENE 1/4 sec. 12, T.16N., R.62E.	Schwagerina aff. neolata	Wolfcamp Rib Hill formation
W - 13 EEC 1/4 sec. 12, T.16N., R62E.	Wedekindellina sp.	Early Des Moines Upper Ely formation, Unit C.
W - 14 EC 1/4 sec. 12, T.16N., R62E.	Wedekindellina sp.	Early Des Moines Upper Ely formation, Unit C.
W - 15 SC, sec. 18, T.16N., R63E.	Profusulinella sp. Millerella sp. Pseudostaffella sp.	Early Atoka Unit S or R
W - 16 NE 1/4 sec. 18, T.16N., R62E.	Tabulipora sp. productid brachiopods	Permian Lower Arturus formation
W - 17 C sec. 18, T.16N., R62E.	Amphiscapha sp. Bellerophon sp. Leda obesa	Permian Upper Arcturus formation

COLLECTION NO.	IDENTIFICATION	AGE
W-18 C sec. 18, T. 16N., R. 62E.	Dictyoclostus bassi Punctospirifer sp. Fistulipora sp. Composita sp. small solitary corals	Guadalupian Kaibab formation
W-19 SC sec. 16, T. 16N., R62E.	Profusulinella sp.	Early Atoka Middle Ely formation Unit, L?
W-20 SC sec. 16, T. 16N., R62E.	Fusulinella - Wedekindella sp.	Early Des Moines Middle Ely formation, Unit E?
W-21 SC sec. 16, T. 16N., R. 62E.	Wedekindellina sp.	Early Des Moines Upper Ely formation, Unit C.
W-22 SC sec. 16, T. 16N., R62E.	Schwagerina sp.	Wolfcamp Riepe Springs formation
Collection above Riepe Springs Limestone in lower Rib Hill formation	Pseudoschwagerina texana	Late Wolfcamp Rib Hill formation
Collections from Riepe Springs formation on Rib Hill, Sec., 16, T. 16N. R. 62E.	Omphalotrochus sp. Tabulipora sp. Thysanophyllum sp. Lithostrotionella sp. Syringopora sp. Lonsdalia sp. Caninia sp. Schubertella sp. Schwagerina sp.	Wolfcamp

COLLECTION NO.	IDENTIFICATION	AGE
Collection Arcturus Claim CS, sec. 15, T. 16N., R. 62E.	Dictyoclostus sp. Tabulipora sp. Composita sp. Parafusulina sp. echinoid spines and plates	Leonard Lower Arcturus formation

Traverse from near old Lincoln Highway, N. 48E., up south wast side of Rib Hill. (Sec. 20, 21, 16, T. 16N., R62E.) 2 September, 1960.

S sec. 20, T. 16N., R62E.	Dictyoclostus bassi Dictyoclostus occidentalis Avonia sp. Composita sp. Pecten sp. silicified sponge	Guadalupian Kaibab formation
S sec. 20, T. 16N., R. 62E. 100'-200' below Kaibab	Amphiscapha sp. indeterminate gastropods	Permian Upper Arcturus formation
SE 1/4 sec. 20, T. 16N., R62E.	Murchinsonia terebra	Permian Upper Arcturus formation
W-23 SE 1/4 sec. 20, T. 16N., R62E.	Euphemites subpapillosus Aviculopecten sp. Amphiscapha sp. Leda obesa	Permian Upper Arcturus formation
W-24 EE sec. 20, T. 16N., R62E.	Omphalotrochus sp.	Permian Lower Arcturus formation
W-25 SW 1/4 sec. 29, T. 19N., R62E. 600 feet east of Hill 7175	Millerella sp.	Early Pennsylvanian (Morrow) Ely formation

COLLECTION NO.	IDENTIFICATION	AGE
W-26 SC 1/2 sec. 34, T. 16N., R62E. @7200 below gypsum	Murchinsonia terebra Amphiscapha sp. Euphemites sp. gastropods pectinid pelecypod scaphopod	Middle Permian Lower Arcturus formation
W-27 SC 1/2 sec. 34, T. 16N., R62E. @7200 above gypsum	Avonia sp. small productid brachiopods bryozoa	indeterminate Upper Arcturus formation
W-28 NE 1/4 sec. 15, T. 17N., R62E.	Lithostrotionella sp. Euomphalus sp. Rhipidomella sp. Caninophyllum sp. Productus sp. Eumetria sp. Triplophyllites sp.	Middle Mississi- ppian - Joana formation
W-29 C sec. 8, T. 17N., R62E. 7400 contour	"Corwenia"- Durhamina sp. Parafusulina sp. Schwagerina sp.	Leonard Lower Arcturus formation
W-30 SE 1/4 sec., 35, T. 17N., R62E.	Cytherella sp. Euphemites subpapillosus Amphiscapha sp.	Middle Permian Upper Arcturus formation
W-31 NE 1/4 sec., 2, T. 16N., R62E.	"Corwenia"-Durhamina sp. Parafusulina sp.	Leonard Lower Arcturus formation
W-32 NE 1/4 sec. 2, T. 16N., R. 62E.	Lithostrotionella sp. Thysanophyllum sp. Schwagerina sp.	Middle-Late Wolfcamp- Riepe Springs formation
W-33 NW 1/4 sec. 2, T. 16N., R62E.	Euphemites subpapillosus Amphiscapha molluscan fanna	Middle Permian Upper Arcturus formation

COLLECTION NO.	IDENTIFICATION	AGE
W-34 C sec. 10, T. 16N., R62E.	Amphiscapha sp. Murchinsonia sp. high spired gastropods pelecypods	Middle Permian Upper Arcturus formation
W-35 NW 1/4 sec. 34, T. 17N., R62E.	Lithostrotionella sp. Schuchertella sp. Euomphalus sp. Triplophyllites sp.	Middle Mississipp- ian - Joana form- ation
W-36 NW 1/4 sec. 34, T. 17N., R62E.	Rayonnoceras sp. Cravenoceras sp. Diaphragmus sp. Leiorhynchus sp.	Late Mississippian (Chester) Upper Chainman formation
W-37 SE 1/4 sec., 11, T. 17N., R61E.	Euphemites subpapillosus	Middle Permian Upper Arcturus formation
W-38 N sec. 28, T. 16N., R62E.	Euphemites subpapillosus high spired large gastropods	Middle Permian Upper Arcturus formation
W-39 SW 1/4 sec. 22, T. 16N., R62E.	"Corwenia"-Durhamina sp.	Leonard Lower Arcturus formation - 100' ± above Rib Hill
W-40 EC 1/4 sec, 22, T. 16N., R62E.	"Corwenia"-Durhamina sp.	Leonard Lower Arcturus formation - 100' ± above Rib Hill
W-41 SC sec. 16, T. 16N., R62E.	Wedekindellina sp.	Early Des Moines Unit C, Ely for- mation just below conglomerate

COLLECTION NO.	IDENTIFICATION	AGE
W-42 SC sec, 16, T. 16N., R62E.	Wedekindellina sp. Eoschubertella sp.	Early Des Moines Unit C, Ely formation just below conglomerate
W-43 NE 1/4 sec. 2, T. 16N., R62E.	Schwagerina sp. Schubertella sp.	Middle-Late Wolfcamp -Riepe Springs formation
W-44 NE 1/4 sec. 2, T. 16N., R62E.	Schwagerina sp.	Middle-Late Wolfcamp - Riepe Springs formation
W-45 NE 1/4 sec. 2, T. 16N., R62E.	Lithostrotionella sp.	Early Permian Riepe Springs formation
W-46 SE 1/4 sec. 2, T. 6N., R62E.	Fusulinella	Atoka Upper Ely formation, Unit K?
W-47 NE 1/4 sec. 2, T. 16N., R62E.	Profusulinella sp. Chaetetes sp.	Early Atoka Middle Ely formation-Unit P.
W-48 NW 1/4 sec. 2, T. 16N., R62E.	Profusulinella sp. Chaetetes	Early Atoka Middle Ely formation-Unit Sa
W-49 NE 1/4 sec. 11,	Fusulinella sp.	Atokan Upper Ely formation-Unit K.
W-50 NE 1/4 sec. 11, T. 16N., R62E.	Wedekindellina sp.	Early Des Moines Upper Ely formation-Unit F.

COLLECTION NO.	IDENTIFICATION	AGE
W-51 SE 1/4 sec. 2, T. 16N., R62E.	Chaetetes sp.	Atokan Middle Ely formation-Unit L.
W-52 SC sec. 16, T. 16N., R62E.	Schwagerina sp.	Late Wolfcamp Rib Hill for- mation
W-53 NE 1/4 SW 1/4 Sec. 36, T. 17N., R60E.	Schwagerina sp.	Wolfcamp Riepe Springs formation
W-54 NW 1/4 sec. 36 T. 17N., R60E.	Wedekindellina sp.	Early Des Moines Unit C., Upper Ely formation
	Schwagerina sp.	Wolfcamp Riepe Springs formation
W-55 NW 1/4 sec, 2, T. 16N., R61E.	Parafusulina sp.	Leonard Lower Arcturus formation
W-56 ESE 1/4 sec. 1, T. 16N., R61E.	Rhipidomella nevadensis Cleiothyrindian sp. Hustedia sp. Punctospirifer sp. Antracospirifer sp. Composita sp. Linoproductus sp. Amplexizaphrentis sp. bryozoa	Late Mississ- ippian (Chester) Lower Ely for- mation-Unit W.
W-57 WSW 1/4 sec. 6, T. 16N., R62E.	Derbyia sp. Composita sp. Hustedia sp. Dictyoclostus sp. Buxtonia sp. Cleiothyridina sp.	Early Pennsyl- vanian (Morrow) Lower Ely for- mation-Unit W

COLLECTION NO.	IDENTIFICATION	AGE
W-57 (Cont'd.)	Stereostylus sp. Fistulipora sp.	
W-58 SC sec. 33, T. 17N., R. 62E.	Euomphalus sp.	Mississippian Joana formation
W-59 SW 1/4 sec. 33, T. 17N., R. 62E.	Amphipora sp. Stromatopora sp.	Middle Devonian Guilmette formation
W-60 SE 1/4 sec. 35, T. 17N., R62E.	"Corwenia"-Durhamina sp.	Leonard Lower Arcturus formation
W-61 NE 1/4 sec. 35, T. 17N., R62E.	Chaetetes sp.	Middle Pennsylvanian- Middle Ely formation
W-62 SE 1/4 sec. 35, T. 17N., R62E.	"Corwenia"-Durhamina sp.	Leonard Lower Arcturus formation
W-63 SE 1/4 sec. 35, T. 17N., R62E.	"Corwenia"-Durhamina sp.	Leonard Lower Arcturus formation
W-64 SW 1/4 NE 1/4 sec. 2, T. 16N., R62E.	Schwagerina sp.	Late Wolfcamp Rib Hill formation
W-65 SW 1/4 sec. 36, T. 17N., R62E.	"Corwenia"-Durhamina sp. Orionastrea? sp.	Leonard Lower Arcturus formation
W-66 NE 1/4 sec. 2, T. 17N., R62E.	Schwagerina sp.	Wolfcamp Riepe Springs formation

COLLECTION NO.	IDENTIFICATION	AGE
W-67 NE 1/4 sec. 2, T. 17N., R62E.	Wedekindellina sp.	Early Des Moines UpperEly for- mation-Unit C.
W-68 NE 1/4 sec. 11, T. 16N., R62E.	Fusulinella sp.	Atokan Upper Ely for- mation-Unit K.
W-69 NE1/4 sec. 11, T. 16N., R62E.	Wedekindellina sp.	Early Des Moines Upper Ely for- mation-Unit C.
W-70 C NW 1/4 sec. 12, T. 16N., R62E.	Wedekindellina sp.	Early Des Moines Upper Ely for- mation - Unit C.
W-71 CNW 1/4 sec. 12, T. 16N., R62E.	Fusulinella sp.	Early Des Moines UpperEly for- mation-Unit E.
W-72 S SE 1/4 sec. 2, T. 16N., R62E.	Fusulinella sp.	Atoka Upper Ely for- mation Top - Unit K.
W-73 C SW 1/4 sec. 33, T. 17N., R62E.	Atrypa sp. Spirifer sp.	Middle Devonian Guilmette for- mation
W-74 SE 1/4 sec. 32, T. 17N., R62E.	Tabulipora sp.	Pennsylvanian Lower Ely formation-Unit W.
W-75 C SE 1/4 sec. 17, T. 16N., R62E.	Parafusulina sp.	Leonard Lower Arcturus formation

COLLECTION NO.	IDENTIFICATION	AGE
W-76 SE 1/4 sec. 17, T. 16N., R62E.	*Orionastrea* sp. compound coral	Leonard Lower Acturus formation
W-77 SE 1/4 sec. 17, T. 16N, R. 62E.	*Omphalotrochus* sp. *Parafusulina* sp. *Orionastrea* sp. ?	Leonard Lower Arcturus formation
W-78 SW 1/4 sec. 17, T. 16N., R63E. SE side 7245	*Atrypa* sp. *Spriifer* sp. *Alveolites* sp.	Middle Devonian Upper Guilmette formation
W-79 NW 1/4 NW 1/4 sec. 21, T. 16N., R63E.	*Rhipidomella nevadensis* *Antracospirifer occiduus*	Upper Mississ- ippian (Chester) Lower Ely for- mation -Unit W.
W-80 NC 1/4 sec. 29, T. 16N., R63E.	*Wedekindellina* sp. *Caninia* sp.	Early Des Moines Upper Ely for- mation-Unit C?
W-81 EC 1/4 sec. 4, T. 16N., R63E.	*Leiorhynchus walcotti*	Late Devonian Pilot formation
W-82 SE 1/4 sec. 4, T. 16N., R63E.	*Didymograptus* sp.	Middle Ordovician Kanosh Shale
W-83 SW1/4 sec. 13, T. 16N., R62E.	*Crataniophyllum* sp. *Syringopora* sp.	Early Pennsyl- vanian- Lower Ely formation Unit V.
W-84 SC 1/4 sec. 18, T. 16N., R63E.	*Crataniophyllum* sp. *Syringopora* sp.	Early Pennsyl- vanian-Lower Ely formation Unit V.

COLLECTION NO.	IDENTIFICATION	AGE
W-85 SE 1/4 sec. 18, T. 16N., R63E.	Rhipidomella nevadenesis	Late Mississippian (Chester) Lower Ely formation
W-86 N 103, 650 E 99, 750 EL 7070	a) Fusulinids cf. Fusulinella suggests Upper Ely formation. b) Chaetetes? sp or bryozoa? suggests middle Ely formation.	Pennsylvanian Middle or Upper Ely Formation
W-87 WNW 1/4 sec. 4 T. 16N., R62E.	Cravenoceras sp.	U. Mississippian (Chester) Upper Chainman formation

PART II. PALEONTOLOGICAL DRILL HOLE SAMPLES:

DRILL HOLE	DEPTH	IDENTIFICATION	AGE
NRT 1	370	*Tabulipora* sp.	Permian Lower Arcturus formation
NRT 2	45	*Tabulipora* sp.	Permian Lower Arcturus formation
NRT 2	53	*Schwagerina* sp.	Riepe Springs Wolfcamp ? formation
NRT 2	90	*Schwagerina* sp.	Riepe Springs Wolfcamp ? formation
E-302	325-330	*Profusulinella?* sp.	Atoka Middle Ely formation
E-502	570-575	fusulinid	Permian Rib Hill formation?
	585-590	fusulinid	
	605-610	fusulinid	
E-522	650 725-730	*Fusulinella*	Atoka Upper? Ely formation
E-525	295-300	fusulinid	Permian?
E-530	520-525	bryozoa	Pennsylvanian
	520-525	fusulinid	Ely formation
	915-920	fusulinid	Atokan Middle Ely formation
E-531	160-165	fusulinid	Permian
	320-340	*Schwagerina* sp.	Wolfcamp Rib Hill formation

DRILL HOLE	DEPTH	IDENTIFICATION	AGE
	420-425	*Fusulinella*? sp	Atoka Upper Ely formation
	1015-1020	*Profusulinella*? sp	Atoka Middle Ely formation
E-564	460	fusulinid	Pennsylvanian Ely formation
XD-5	938	*Chaetetes* sp	Middle Pennsylvanian Middle Ely formation
	1393	*Chaetetes* sp	Middle Pennsylvanian Middle Ely formation
XD-9	967	*Fusulinella*	Atoka? Upper Ely formation
	1003-1009	*Fusulinella*	Atoka? Upper Ely formation
	1150	*Fusulinella*-*Wedekindellina*	Early Des-Moines? Upper Ely formation
	1161	*Fusulinella*	Atoka? UpperEly formation
XD-10	81	*Fusulinella*?	Atoka Upper Ely formation
	121	fusulinid	Pennsylvanian Ely formation

EXPLANATION

SEDIMENTARY ROCKS

		Nappe plates		
CENOZOIC	Quaternary		Qal	Alluvium
			Qt	Terrace gravels
	Tertiary		Tt	Tuff, water-lain
			Tsp	Sheep Pass formation (conglomerate, siltstone, and fresh water limestone)
PALEOZOIC	Permian	I	Pk	Kaibab limestone
			Pau	Upper Arcturus formation (sandstone and siltstone with some interbedded limestone)
		II	Pal	Lower Arcturus formation (limestone with interbedded siltstone and sandstone)
			Prh	Rib Hill sandstone
		III	Prs	Riepe Springs limestone
	Pennsylvanian		IPe	Ely limestone (undifferentiated)
			IPe-1	Member No. 1, Ely limestone
		IV	IPe-2	Member No. 2, Ely limestone
			IPe-3	Member No. 3, Ely limestone
			IPe-4	Member No. 4, Ely limestone
		V	IPe-5	Member No. 5, Ely limestone
	Mississippian		Mc	Chainman shale
				DECOLLEMENT
			Mj	Joana limestone
	Devonian		Dp	Pilot shale
			Dg	Guilmette limestone (Dn Nevada limestone)
			Dsi	Simonson dolomite (Dn Nevada limestone)
			Dse	Sevy dolomite (Dn Nevada limestone)
	Silurian		Sl	Laketown dolomite
	Ordovician		Oes	Ely Springs dolomite
			Oe	Eureka quartzite
			Ol	Lehman limestone
			Ok	Kanosh shale

IGNEOUS ROCKS

MESOZOIC CENOZOIC	Tertiary	Tgh	Garnet Hill rhyolite (garnet-bearing rhyolite)
		Tr	Rhyolite, undifferentiated (includes intrusive and extrusive rhyolites, ignimbrite, tuff, obsidian, and diatreme material)
	Cretaceous	Km	Quartz monzonite porphyry (shaded where altered)

CONTACTS

- Approximate Contact
- Gradational and Indefinite Contact
- Edge of Dump

FAULTS

- Definite (dashed where approximately located)
- Probable (dotted where concealed)
- Concealed (covered by alluvium, gravels and dumps)
- Fault (shows relative movement)
- Thrust (teeth on side of upper plate)

FOLDS

- Anticline (axial plunge indicated)
- Syncline (axial plunge indicated)
- Overturned Anticline (shows direction of dip of limbs)
- Overturned Syncline (shows direction of dip of limbs)

BEDDING and JOINTS

- 25 Strike and Dip of Beds
- 45 Strike and Dip of Overturned Beds
- Horizontal Beds
- 75 Strike and Dip of Joints
- 60 Strike and Dip of Lineation

KENNECOTT COPPER CORPORATION
NEVADA MINES DIVISION

GEOLOGIC MAP OF THE ROBINSON MINING DISTRICT

WHITE PINE COUNTY, NEVADA

JUNE 1964

0' 4000' 8000'
SCALE

MAPPING BY: H. BAUER, R. BREITRICK, J. COOPER, J. SWINDERMAN,
J. WELSH, Stratigraphic Consultant.
(Beneath Dumps By: SPENCER and C.C.C.)

– AREA MAPPED BY: N. TURNER

327 Item 52-F

3950 0050

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Holladay, UT 84117

STRUCTURE SECTION
ROBINSON MINING DISTRICT

Veteran – Pilot Knob – Ruth – Gleason Creek

Sec. 13, T.16N., R61E – sec 25, T.17N. R.62E.

John E. Welsh 1964

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STRUCTURE SECTION
ROBINSON MINING DISTRICT

Big Bend - Copper Flat - Pole Line

sec. 1, T.16N., R.62E. - sec 6, T.16N., R.63E.

John E Welsh View north 327 Item 52-E

3950 0050

NAPPE AND INTRUSION CONTROL

UPPER PALEOZOIC COMPOSITE STRATIGRAPHIC COLUMN

CENTRAL EGAN RANGE

ROBINSON MINING DISTRICT

WHITE PINE COUNTY

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JOHN E. WELSH 1964

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Holladay, UT 84117

(327) Item 52-E

3950 0050

0 1000 2000 3000 4000 5000 Feet
0 1.0 Mile

STRUCTURE SECTION
ROBINSON MINING DISTRICT
Giroux Wash - Tripp Pit - Weary Flat - The Cliffs
sec 18, T.16N., R.62E. to sec 26 T.17N., R.62E.
1964 view northwest John E. Welsh

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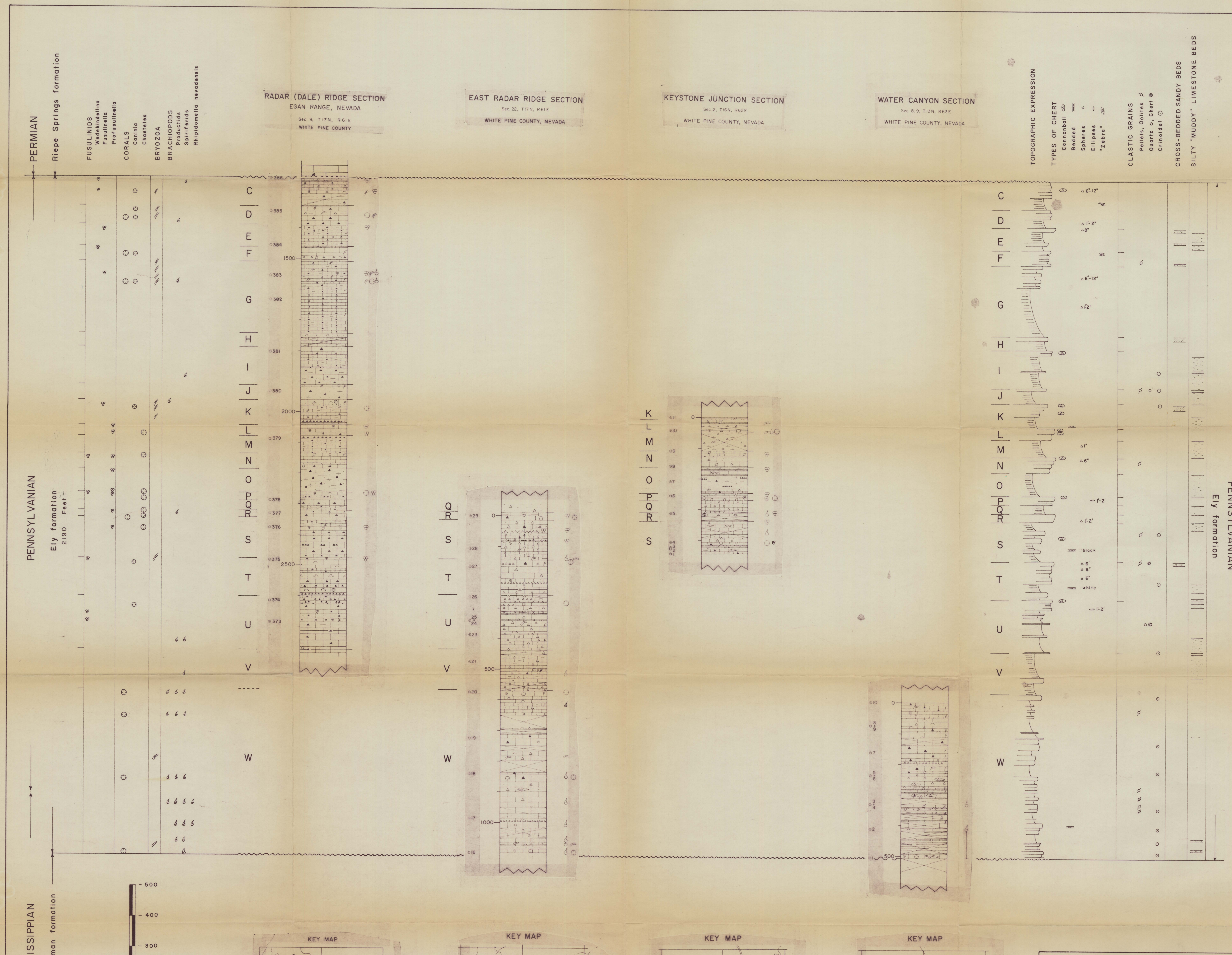
STRUCTURE SECTION

ROBINSON MINING DISTRICT

Giroux Wash - White Hill - Garnet Hill

Sec. 19, T.16N., R62E - sec 36, T.17N. R62E

John E. Welsh view northwest 1964



KENNECOTT COPPER CORPORATION

STRATIGRAPHIC CORRELATION CHART
PENNSYLVANIAN ELY FORMATION
ROBINSON MINING DISTRICT
WHITE PINE COUNTY, NEVADA

NEVADA MINES DIVISION
GEOLOGY DEPARTMENT

JOHN E. WELSH
R. A. BREITRICK

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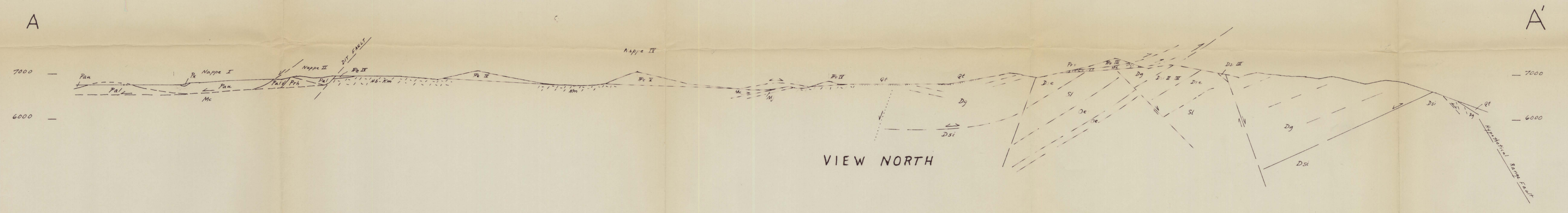
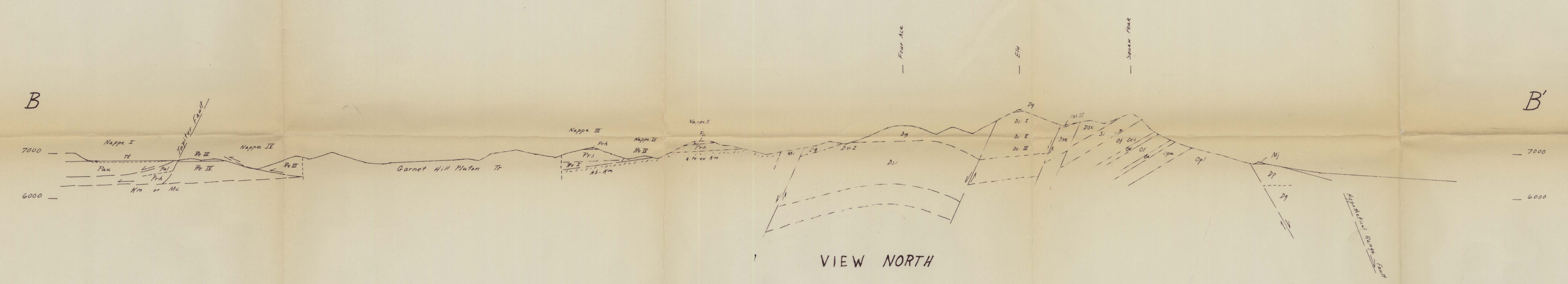
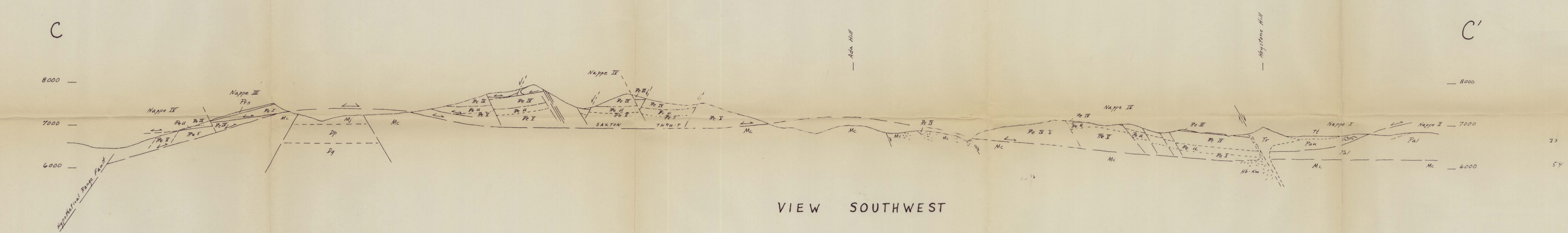
1964







STRATIGRAPHIC COLUMN

UPPER PALEOZOIC

Pk	Kaibab limestone
Pau	Upper Arcturus
Pal	Lower Arturus
Prh	Rib Hill formation
Prs	Riepe Springs limestone
Pe (I, II, III, IV, V)	Ely formation
Mc	Chainman formation
Mj	Joana limestone

MIDDLE PALEOZOIC

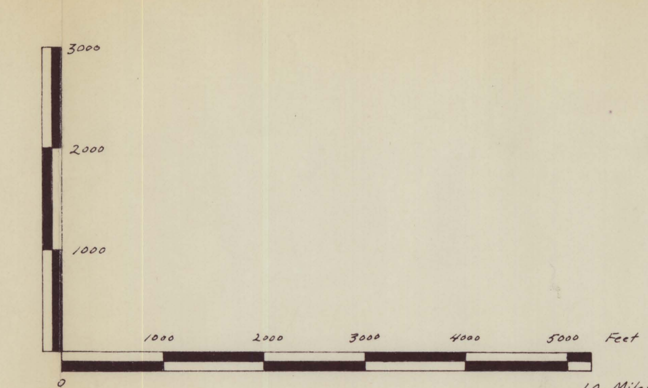
Dp	Pilot formation
Dg	Guilmette formation
Dsi (I, II, III)	Simonson dolostone
Dse	Sevy dolostone
Sl	Laketown dolostone
Oes	Ely Springs dolostone
Oe	Eureka quartzite
Ol	Lehman limestone
Ok	Kanosh shale
Opu	Upper Pogonip
Opl	Lower Pogonip

SURFICIAL

Qt	Allurium
Tt	Tuff, sedimentary

IGNEOUS

Tr	Rhyolite
Km	Monzonite



GEOLOGIC STRUCTURE SECTIONS
EASTERN HALF OF THE
ROBINSON MINING DISTRICT
EGAN RANGE
NEVADA

John E. Welsh
1964

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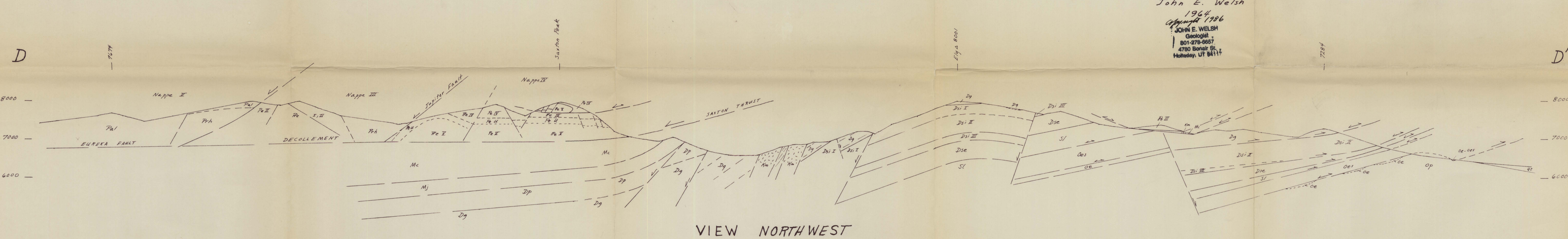

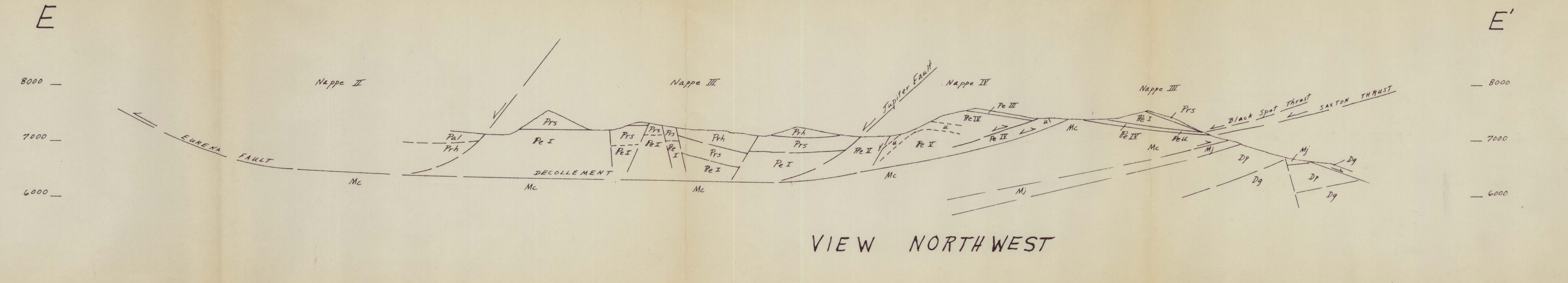

(327) Item 52 – 6

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PALEONTOLOGICAL COLLECTIONS

ROBINSON MINING DISTRICT

WHITE PINE COUNTY, NEVADA

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Paleo Collections:


GEOLOGIC MAP
EASTERN HALF OF ROBINSON MINING DISTRICT
EGAN RANGE, WHITE PINE COUNTY,
NEVADA
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JOHN E. WELSH
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Holladay, UT 84117
JANUARY 1965
Ragsdale Spr.
Keystone Junction
Garnet
Fields
GARNET HILL
PLUTON
Keystone
Hill
Lane
Valley
Four Ace Mine
Deuce Mine
TV Relay Sta
Calumet
Baltimore
Mill
Ely Centennial
Tunnel
ELY
Ada Hill
Willard Hill
Twin
Peaks
Fossil Hill
Bell Shaft
The Big Bluff
CANYON
MURRY
WELSH
SWINDERMAN
BREITRICK

327 Item 52-K

STRUCTURE SECTION
ROBINSON MINING DISTRICT
Giroux Wash - Rib Hill - Garnet Hill
Sec. 29, T.16N., R.62E. - Sec. 31, T.17N., R63E.
John E. Welsh View northwest 1964