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GOLD POTENTIAL

of the

BOA PROSPECT

NYE COUNTY, NEVADA

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SUMMARY

The Boa Gold Prospect, in eastern Nye County, Nevada is virtually identical in its geologic setting (stratigraphy, structure, alteration and mineralization) to the Alligator Ridge Mine, a large, sediment-hosted, bulk-tonnage, high-grade gold deposit in east-central Nevada, and broadly similar to six other smaller deposits in the same area (Bald Mountain, Little Bald Mountain, Golden Butte, Illipah, Nighthawk Ridge and Green Springs).

The Alligator Ridge Mine produced approximately 600,000 ounces of gold ($240,000,000 gross value) from 5 million tons of altered carbonaceous/calcareous Pilot Shale lying in a relatively undisturbed sequence of Middle Paleozoic carbonates and siltstones. High-angle faults permitted fluids to rise through the carbonates, create permeability in the siltstones by acid destruction of carbonate cement and oxidation of contained sulfide and carbonaceous material, and deposit gold accompanied by jasperization and silica flooding.

At the Boa Prospect, the Pilot Shale (principal target) and secondary siltstone targets lie partly exposed, partly concealed in a broad belt surrounding a horst of the principal underlying limestone, the Guilmette Formation. The uppermost contact zone of the Guilmette contains scattered, gold-bearing jasperoids, while the limited outcrop area of Pilot Shale contains liesegang-banded siltstone (evidence of oxidative destruction of pyrite) and microveinlets of quartz (evidence of silica flooding).

The Boa Prospect offers 3 identifiable exploration target areas: a 1/5 sq. mile area west of the Guilmette horst, containing altered Pilot Shale; a 1/10 sq. mile area east of the horst, containing exposures of stratigraphically higher siltstones; and a 1/5 sq. mile area east of the horst containing both Pilot and higher siltstones, covered by an undetermined thickness of alluvium.

Each of these three areas can be explored successfully by a modest program of geochemical sampling and drill reconnaissance. The anticipated reward is discovery of a deposit of 5-7 million tons, grading .10 to .15 ounces per ton, containing approximately 600,000 ounces (gross value $240,000,000).

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I. INTRODUCTION

The modern "gold rush" which now consumes Nevada had its roots in the early 1960s, when several individual geologists and companies began to explore and/or re-evaluate erosional windows exposed in low-angle fault terrains in northern Nevada. The success of exploration programs in this area - particularly in the "Carlin Trend", "Cortez Trend", and "Getchell Trend" (all located near I-80) has resulted in the discovery of a plethora of large-tonnage, low to moderate grade, sediment-hosted gold discoveries, all clustered in well-defined geologic belts.

These successes have tended to obscure the fact that geographically isolated, unrelated discoveries have also been made during the same time. These isolated discoveries are especially significant because they have been achieved in areas with

- no prior exploration or production history;
- no self-evident volcanogenic cause; and
- no pre-existing or preconceived model to guide exploration.

They include, from north to south, the following significant discoveries (Figure 1):

	T	R	
Bald Mountain	24N	57E	(Placer Dome)
Little Bald Mountain	23N	57E	(Northern Dynasty)
Golden Butte	23N	61E	(Silver King)
Alligator Ridge	22N	57E	(BP/Nerco)
Illipah	18N	58E	(Echo Bay)
Nighthawk Ridge	15N	55E	(Echo Bay)
Green Springs	15N	57E	(USMX)

All seven deposits feature alteration and jasperization in proximity to carbonate/siltstone contacts in the Middle Paleozoic section, and mineralization hosted principally by carbonaceous and calcareous siltstones sandwiched between the carbonates.

The most exemplary of these "isolated" deposits is Alligator Ridge, a sediment-hosted, bulk-tonnage deposit credited with approximately 600,000 oz of gold production ($240,000,000 value @ $400/oz). It is a spectacular discovery, in light of the weak alteration and feeble mineralization evident at the surface, and the ease with which it was delineated, developed and put into

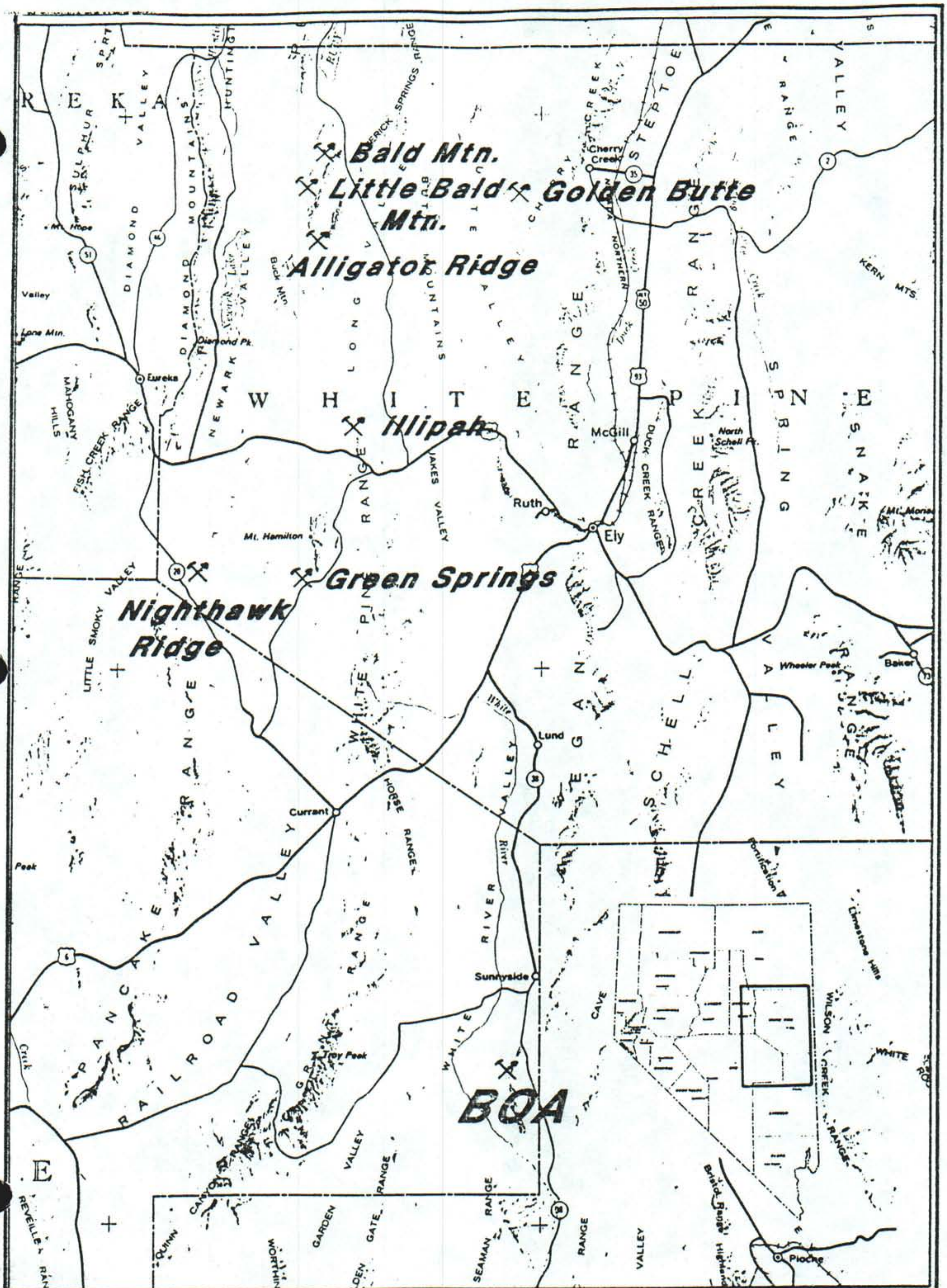

Figure 1. INDEX MAP

production after systematic exploration began.

The Boa Prospect presents a similar opportunity. In many respects, the Boa Prospect duplicates or mimics the geology of Alligator Ridge, and offers the perfectly reasonable chance of a multi-million ton discovery in another essentially unprospected and overlooked part of Nevada. This report briefly describes Alligator Ridge and illustrates the similarities of the Boa Prospect to it.

II. LOCATION, LAND STATUS AND ACCESS

The Boa Gold Prospect lies in T5N, R61-62E, along the extreme eastern boundary of northern Nye County, Nevada where Nye abuts Lincoln County. The prospect consists of 56 unpatented lode mining claims.

A paved road (Nevada 38) passes within 2 miles of the prospect and several dirt roads provide good access. The prospect is about 70 miles south of Ely and about 40 miles northwest of Pioche. Field work should be possible between 9-10 months of the year, and possibly longer, depending on snow accumulations.

III. SALIENT FEATURES OF THE ALLIGATOR RIDGE DEPOSIT

A. Discovery

Alligator Ridge was discovered in June, 1976 as the result of a grubstake agreement between a private-party prospector and a JV between Chevron/Amselco. The initial clue to mineralization lay in a suite of 17 jasperoid samples collected at the contact between the calcareous/carbonaceous Pilot Shale and the underlying Devil's Gate Limestone. The highest of these 17 samples assayed 450 ppb (0.45 ppm) Au.

Follow-up soil sampling throughout 1976/1977 generated Hg values of up to 1 ppm, As + Sb to 200 ppm, and Au in excess of 1.0 ppm. Drill targets defined by this sampling provided a discovery on the first hole drilled.

B. Reserves and Production

The mine was placed in production in April 1980, with announced reserves of 5 million tons at an average grade of 0.12 oz/ton, using a 0.02 oz/ton cutoff.

The mine was scheduled to operate at a throughput of 750,000 tpy (2500 tpd), with a stripping ratio pf 3.8/1.

Annual production of 60,000 ounces Au indicates that the run-of-mine grade averaged out at 0.08 oz/ton (60,000 oz ÷ 750,000 tons).

C. Stratigraphy

From bottom to top, the relevant lithologic units are:

- Devil's Gate Limestone (1000'), a massive micritic limestone;

- Pilot Shale (480'), the lower 2/3 of which is a calcareous/carbonaceous siltstone; the upper 1/3 of which is clay-rich;

- Joana Limestone (150'), a sparry, fossiliferous (crinoids, coral, brachiopods) limestone;

- Chainman Shale (1000'), the lower 1/2 calcareous siltstone, the upper 1/2 claystone.

D. Structure

The sequence described above is part of the lower Paleozoic "eastern facies carbonate assemblage", a package of continental-shelf carbonate rocks deposited east of the Antler orogenic highland during the Devonian and Mississippian.

These rocks were first folded into low-amplitude anticlines and synclines striking N-S, with limbs dipping gently east and west. These folds were truncated by high-angle Basin/Range faults that strike north-northeast, and subsidiary northwest and east-west faults.

E. Alteration and Mineralization

The orebodies lie in a down-faulted, topographically low block of Pilot Shale covering an area of approximately 3000 x 1000 feet. Within, this zone, three principal orebodies were distinguished:

	L		W		H	Grade
#1	250'	x	250'	x	250'	0.10 oz/ton
#2	800'	x	500'	x	300'	0.11
#3	200'	x	200'	x	150'	0.08

The individual orebodies were localized in the lower 300' of the 460' thick Pilot Shale, and were associated with this sequence of alteration:

- removal of carbonate from the lower Pilot (increasing permeability);

- deposition of gold;

- removal and remobilization of carbon;

- silicification;

- deposition of more gold.

The location of mineralization is controlled geographically by high-angle faults, and controlled stratigraphically by the uppermost claystone of the Pilot Shale acting as a cap or seal for fluids migrating up faults.

The alteration fluids entered the area along the contact zone above the Devil's Gate Limestone and selectively penetrated the overlying Pilot Shale along high-angle faults, allowing mineralizing fluids to deposit gold in permeable zones of the altered Pilot Shale. The principal alteration in the Pilot Shale which permitted the gold deposition to occur was acid-dominated removal of carbonate cement and oxidation of enclosed carbonaceous material.

The visible evidence of the alteration system consists of liesegang-banding (diffusion fronts of hematite) produced by oxidation of existing pyrite, and microveinlets of quartz (evidence of silica flooding), both occurring in the Pilot Shale, and scattered jasperoid development in and above the Devil's Gate Limestone.

IV. THE BOA PROSPECT AND ITS SIMILARITIES TO ALLIGATOR RIDGE

A. Discovery (Figure 2)

The Boa Prospect was discovered in the early 1980s by a private prospector. As at Alligator Ridge, the initial clue to mineralization lay in jasperoids scattered along and near the contact between the Pilot Shale and the underlying limestone.

Subsequent lessors of the property have conducted intermittent sampling programs at the prospect. The prospect file contains laboratory certificates documenting the analysis of at least 87 rock and 124 soil samples over a 3 year period (many more were reportedly collected). These are uncontrolled samples, as there are no maps available to permit recovery of the exact collection sites. In general, these certificates, for both soils and rocks, show these typical values for gold and pathfinder elements:

	Average	Max. Range (% of samples)
Au, ppb	10	30-230 (9%)
Ag, ppm	0.20	0.70-4.0 (10%)
As, ppm	100	300-1,000 (3%)
Hg, ppb	3,000	5,000-10,000 (12%)

B. Regional setting and stratigraphy

The Boa Prospect lies in the extreme eastern portion of northern Nye County. The rock sequence throughout this area consists, as at Alligator Ridge, of continental-shelf carbonates deposited in the Devonian and Mississippian east of the Antler Orogenic highland of central Nevada.

Except for 3 name changes, the sequences are identical:

Alligator Ridge	Boa Prospect
Unnamed tuff	Shingle Pass Fm
Diamond Peak Fm	Ely LS
Chainman Shale	Chainman Shale (host)*
Joana LS	Joana LS
Pilot Shale (host) jasperoid at contact	Pilot Shale (host) jasperoid at contact
Devil's Gate LS	Guilmette Fm

*the Chainman Shale is the principal host at the Nighthawk deposit, Sec 9, T15N R55E (5 million tons of 0.066 ounces per ton, or 330,000 ounces).

C. Structure

Low-amplitude folds deform the carbonate sequence into anticlines and synclines striking N-S with gently dipping flanks.

High-angle, north-striking faults truncate these folds and create horst and graben topography. The central core of the prospect is a horst of resistant Devonian Guilmette Fm; the flanks on both sides of the horst are underlain by topographically low sections of Pilot Shale, Joana Limestone, Chainman Shale, and Ely Limestone.

On the east side, the Pilot-Joana-Chainman-Ely sequence lies in one or more downdropped fault blocks, buried beneath unknown, but probably small, thicknesses of alluvium. Jasperoid occurs in various exposures of carbonate, and gold-bearing jasperoid has been found in the alluvium.

On the west side, the Pilot-Joana-Chainman-Ely sequence appears to occupy a regional, westward dipping dip slope but may lie partially in a fault-controlled basin. Scattered jasperoids occur at and near the contact zone of the lower Pilot.

The geologic map compiled for Nevada Bureau of Mines Bulletin 99A is almost certainly incomplete, in so far as the west side of the prospect is concerned, as the Joana Limestone is unaccounted for in what is mapped as a simple, homoclinal succession. It is probable that the Joana here is cut out by faulting, and these faults offer the most attractive targets as conduits for mineralizing fluids (Figure 3).

An early lessor of the prospect compiled a small sketch map suggesting that the main horst of Guilmette Fm was broken by numerous NW faults into smaller "piano key" compartments of westward-dipping carbonates. In this interpretation, the Guilmette forms the escarpments on the east side of the main mountain, the Joana forms much of the dip slope on the west side, and the Pilot is confined to ribbons of outcrop between them. Also, in this model, the low-lying areas of altered siltstone east and west of the mountain are actually Chainman. Only careful mapping can resolve this conflict, which does not change the fact that the exploration target remains the altered siltstones above and adjacent to jasperized limestones.

D. Alteration and Mineralization

In addition to the superficial similarities recorded in the duplication of stratigraphy and structure, the two most compelling arguments for comparing Boa to Alligator Ridge are:

- the prevalence of anomalous jasperoid along the contact zone of Devonian Guilmette Formation and overlying Pilot Shale;

- the occurrence of silicified ironstone southwest of the main hill of Guilmette. Ironstones are liesegang-banded Pilot Shale siltstones which locally litter the area. They consistently show secondary silicification in the form of minute, vertical quartz veinlets exactly like those described in the upper mineralized zone of Pilot Shale at Alligator Ridge.

V. EXPLORATION TARGETS AND EXPECTATIONS

On the basis of present knowledge, three exploration target areas exist. Ranked by priority, they are:

	Location	Size
1.	Pilot Shale outcrop belt southwest of Guilmette Hill	5000' x 1000'
2.	Alluvial strip bordering Guilmette hill on the east. Area may contain buried and mineralized Pilot and Chainman.	5000' x 1000'
3.	Chainman Shale outcrop belt between 2 masses of Guilmette. Area may contain exposed mineralized Chainman and buried mineralized Pilot.	5000' x 500'

Each one of these three prospective areas is nearly 50% larger than the single area which turned out to host the 3 individual orebodies of Alligator Ridge. There is no reason not to expect, and explore for, a reserve on the order of 5-7 million tons, at a grade of 0.10 oz/ton ($240-280 million).

A modest program of reconnaissance geochemical sampling, supplemented by follow-up soil geochemistry and exploration drilling, should be able to demonstrate the potential of the Boa Prospect to rival its apparent analogues in eastern Nevada.

History and Geology of the Alligator Ridge Gold Mine, White Pine County, Nevada

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INTRODUCTION

The Alligator Ridge Gold Mine is located in the northwest corner of White Pine County, in eastern Nevada (Figure 1). It is approximately 70 road miles northwest of Ely, Nevada, at the southern junction of the Ruby and Maverick Springs Mountains. The mine is jointly owned by Amselco Minerals Inc. and NERCO Minerals, and is operated by Amselco Minerals Inc.

HISTORY

The deposit was discovered in June of 1976 by a prospector operating under a grubstake agreement with American Selco Inc., while examining a series of jasperoid outcrops in the northwest corner of White Pine County (Figure 2). The results of his initial outcrop sampling of the Alligator Ridge jasperoid generated sufficient interest for American Selco Inc. to conduct further investigations.

The original sampling consisted of a set of seventeen outcrop samples which were taken from a series of jasperoids formed at the limestone and siltstone contact. The single greatest assay value was 0.45 ppm in gold. The encouraging results from this sampling lead to the initial claim staking.

Geochemical soil sampling was conducted using the claim lines as a grid. The soil sampling generated mercury values to 1 ppm, arsenic and antimony to 200 ppm, and gold locally in excess of 1.0 ppm. The preliminary soil sampling and the first pass geologic mapping concluded the field activities of 1976.

During 1977 an extensive soil geochemical sampling program, additional geologic mapping, and outcrop sampling, were conducted. The results of these activities generated several drill targets. Initial drilling was performed during November and December of 1977. Ore grade mineralization was encountered in the first drill hole.

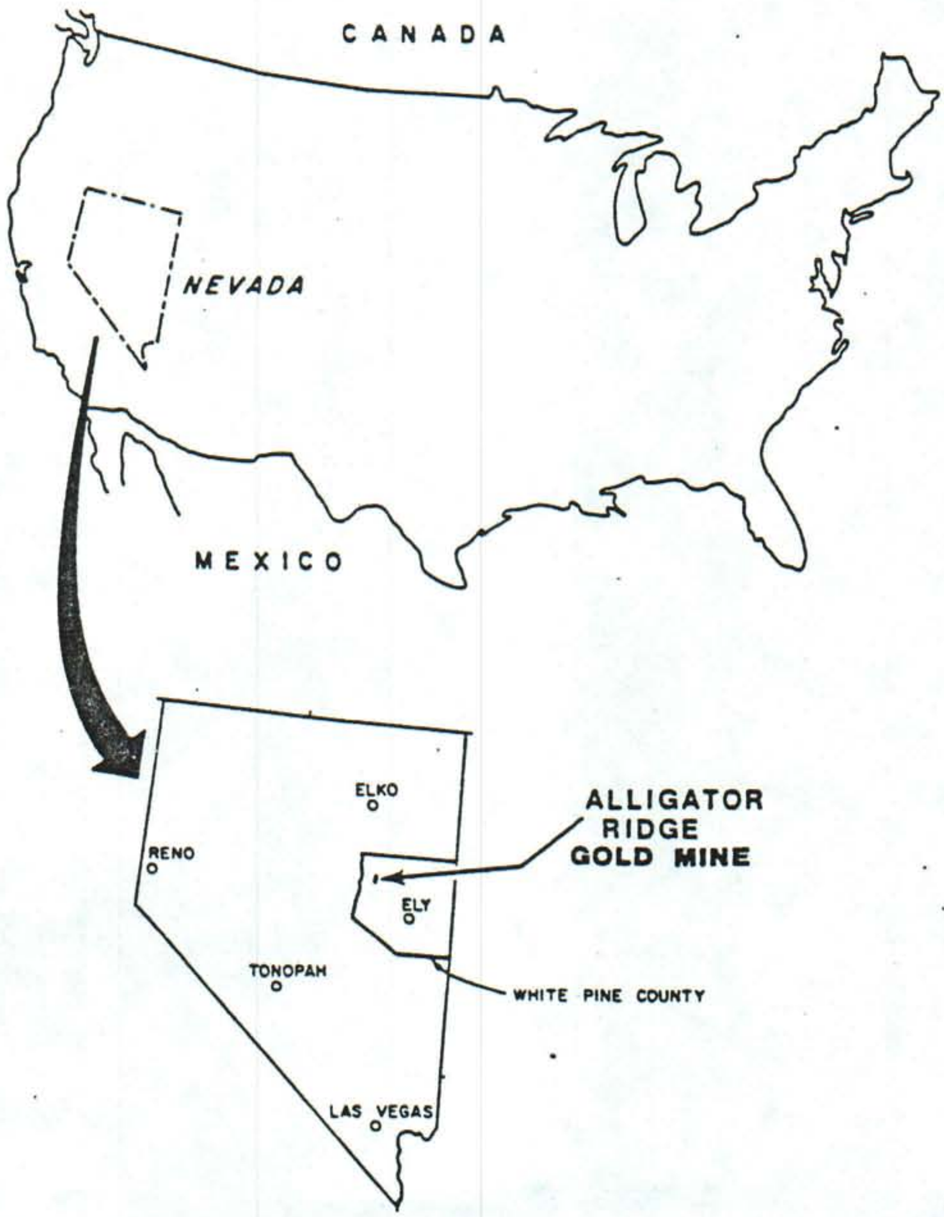
In 1978 additional land was acquired and the drilling program was intensified. A metallurgical study was conducted during January through March of 1979, followed by bulk sampling and test heap leaching. The data provided by the field and laboratory work were evaluated and assembled into a feasibility study during the winter of 1979 - 1980. Plant construction began in March and mining in April, 1980.

The original ore reserves for the deposit were established at 5 million tons at an average grade of 0.12 ounces of gold per ton using a cutoff of 0.02 ounces of gold per ton . Mine production was scheduled at the rate of 750,000 tons of ore per year, with an average stripping ratio of 3.8:1. Ore treatment is by heap leaching with cyanide solutions. The process plant produces approximately 60,000 ounces of dore' bullion per year.

The Alligator Ridge Mine is unusual in relation to the more recent western U. S. mineral discoveries in that it occupies an area of no previous exploration or mining history. The mine is approximately 12 miles south of the Bald Mountain mining district and approximately 35 miles north of the White Pine (Hamilton) mining district.

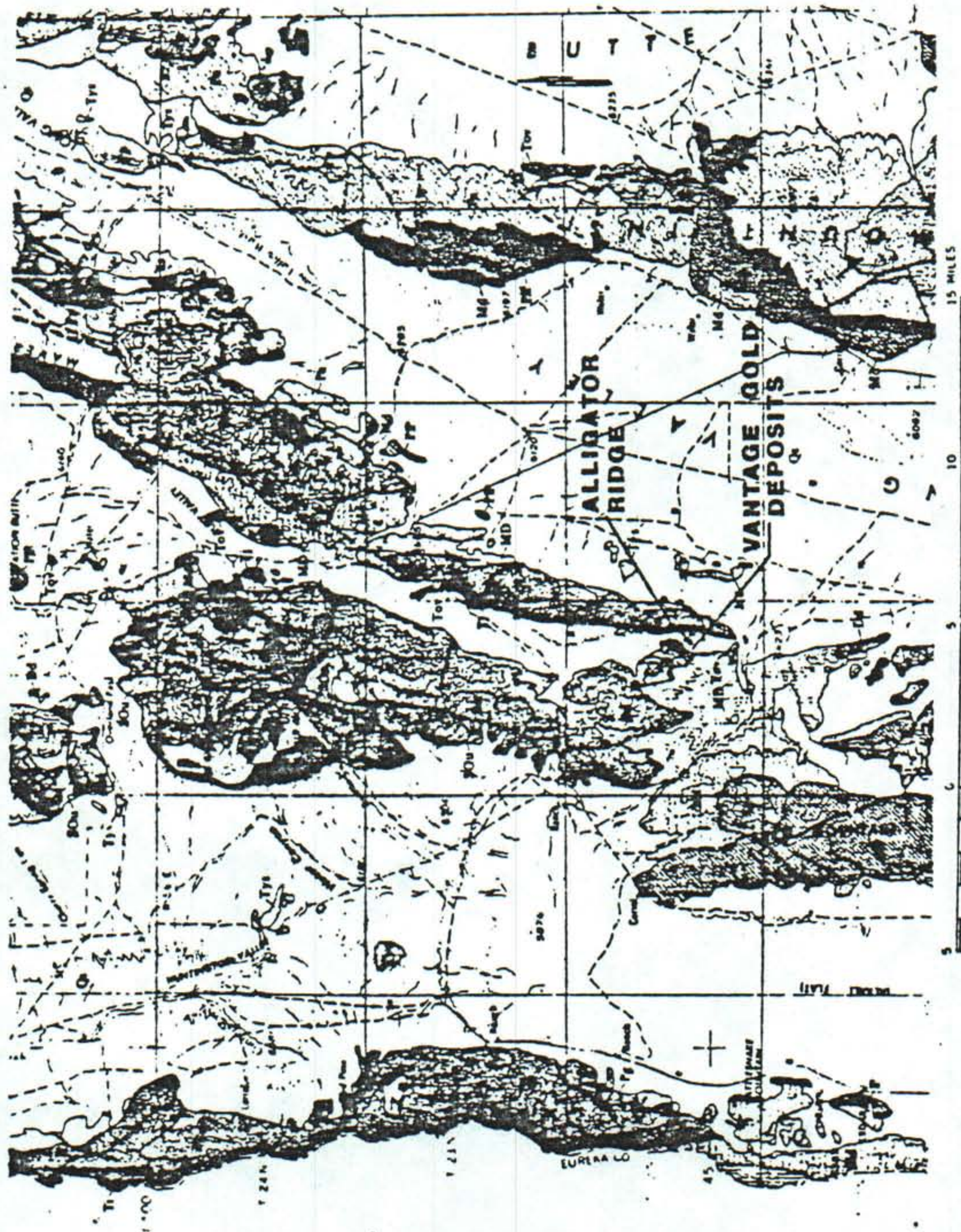
STRATIGRAPHY

The ore deposits are hosted in upper Paleozoic sedimentary rocks which consist predominantly of a thick carbonate sequence.



Location Map of Alligator Ridge, White Pine Co., Nevada

Figure 1.



From Geologic Map of White Pine County, Nevada R. K. Hose and M. C. Blake Jr., 1976.

Figure 2

In the immediate mine area Devonian, Mississippian, and Tertiary rocks crop out (Figures 3 and 4).

The oldest exposed rocks in the mine area are the Devonian Nevada Formation, a thin to medium bedded (10 cm to 1 m) saccharoidol dolomite, which forms the southern extremity of Alligator Ridge. This ledge forming dolomite weathers to a very light gray to tan, and is believed to be in excess of 1,000 feet thick.

The Nevada Formation is conformably overlain by the massive cliff forming Devonian Devils Gate Limestone, which at Alligator Ridge, is at least 1000 feet thick. It is predominantly a medium to medium dark gray massive micritic limestone that weathers to a light to medium light gray, and contains few fossils.

The Devils Gate Limestone is overlain by the Devonian-Mississippian Pilot Shale, which, locally, occurs as a sequence of thin bedded calcareous, carbonaceous siltstones, and claystones. The upper one third of the formation is generally clay rich, as compared to the lower two thirds which consists of calcareous, carbonaceous siltstones. The upper and lower portions of the formation are separated by a discontinuous zone of dark gray lenticular interbedded cherts and light colored clays. The lower siltstones locally host thin limestone lenses. The dark gray to grayish black unaltered rocks weather to a grayish orange, and being less resistant to erosion, result in slopes littered with small loose fragments, and sparse outcrops. The maximum observed thickness in the mine area is approximately 460 feet.

The Pilot Shale inturn is overlain by the Mississippian Joana Limestone, which is a medium to light medium gray, thick bedded, sparitic limestone rich in crinoids, corals, and brachiopods. The upper sections of the formation contain dark chert lenses up to several inches thick. The lowest member of the formation is a discontinuous light gray to very light gray, relatively clean, orthoquartzite which may be several tens of feet in thickness. At Alligator Ridge the formation does not exceed 150 feet in thickness.

The Joana Limestone is conformably overlain by the Mississippian Chainman Shale, which consists of an upper siltstone-claystone unit, a lower calcareous siltstone to silty limestone unit and discontinuous limestone lenses. The Chainman is dark gray to blackish gray and weathers to a light gray to grayish orange. It is generally an incompetent rock which results in poor surface exposures. The Chainman Shale at Alligator Ridge is probably thicker than 1000 feet.

The Chainman Formation is overlain by the Mississippian Diamond Peak Formation, which consists of conglomerates, sandstone, limestones, claystones, and siltstones. In the mine area only small blocks occur in fault zones.

In the immediate mine area the Chainman Formation is most often observed unconformably capped by Tertiary rhyolite tuffs, basalts, and minor sequences of fresh water limestones.

STRUCTURE

The rocks of the Alligator Ridge area have been folded into a series of low amplitude anticlines and synclines that strike north-south, plunge to the south at approximately 20 degrees, and have limbs that dip approximately 20 degrees.

The folds have been truncated and deformed by later high angle faults that generally strike northwest, northeast, and east-west. Although multiple stages of movement are evident on the several fault systems, the youngest period of activity is along the northeast trend. The predominant structural pattern in the area is that of the Basin and Range type high angle normal faults. The Alligator Ridge is a horst block between two Basin and Range faults.

The combination of folding and faulting has resulted in the formation of two drainage basins, Mooney Basin and the Vantage Basin, along the west side of Alligator Ridge. The lower, smaller, sub-basin has been termed the Vantage Basin, in which the ore deposits occur.

GEOLOGY OF THE VANTAGE ORE DEPOSITS

ORE BODIES

The Vantage gold deposits are hosted primarily by the Pilot Shale, although a small portion of the mineralization is in the upper 25 feet of the underlying Devils Gate Limestone.

There are three principal ore deposits within the Vantage Basin and several smaller satellite ore deposits. The three Vantage deposits form a mineralized zone that covers an area 3000 feet long by 1000 feet wide. These mineralized zones have been outlined by 600 rotary drill holes which averaged 500 feet in depth. Potential exists for a fourth minable deposit dependent upon future economic conditions. Mineralization occurs in both carbonaceous and oxidized rock. As the carbonaceous ore is not amenable to a cyanide leach system only the oxidized ore is treated. At the present, all carbonaceous ore is segregated and stockpiled.

The ore bodies occur along a north-northeast strike with mineralization becoming progressively deeper from north to south (Figures 5 and 6). The dimensions of the ore block in Vantage One were roughly 250 by 250

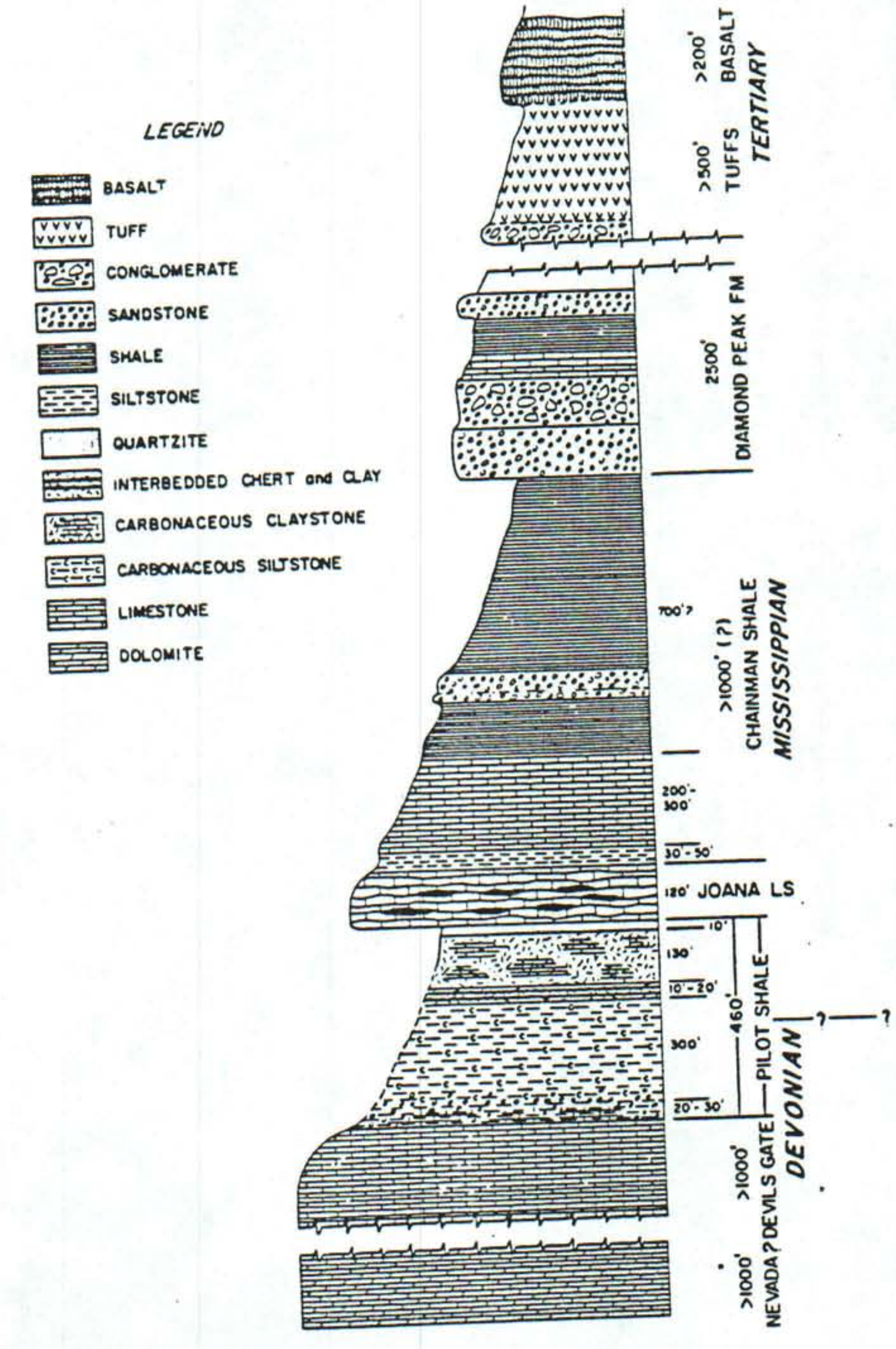


Figure 3. - Alligator Ridge lithologic section.

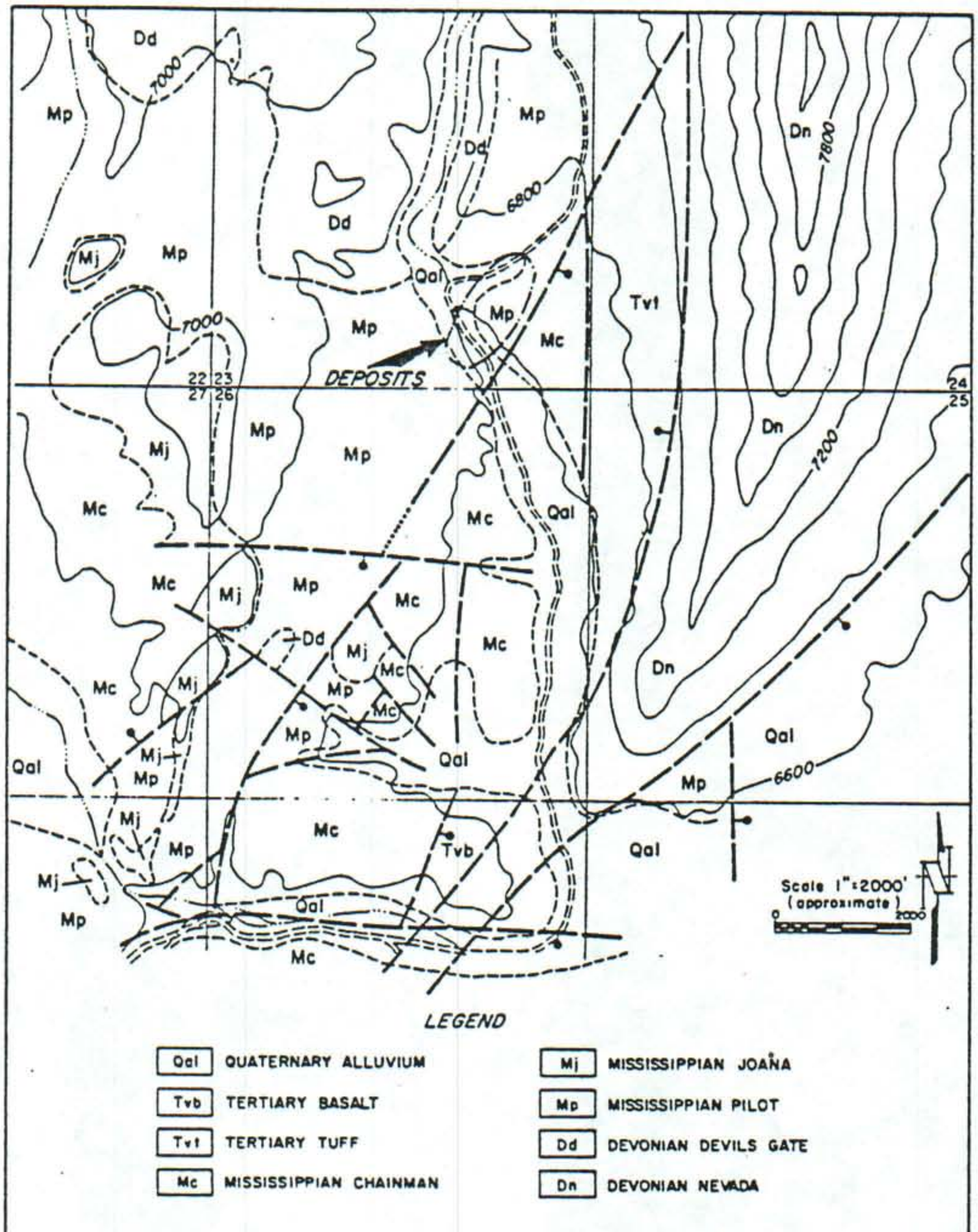


Figure 4.- Generalized Geologic Map of the Alligator Ridge Mine Area.

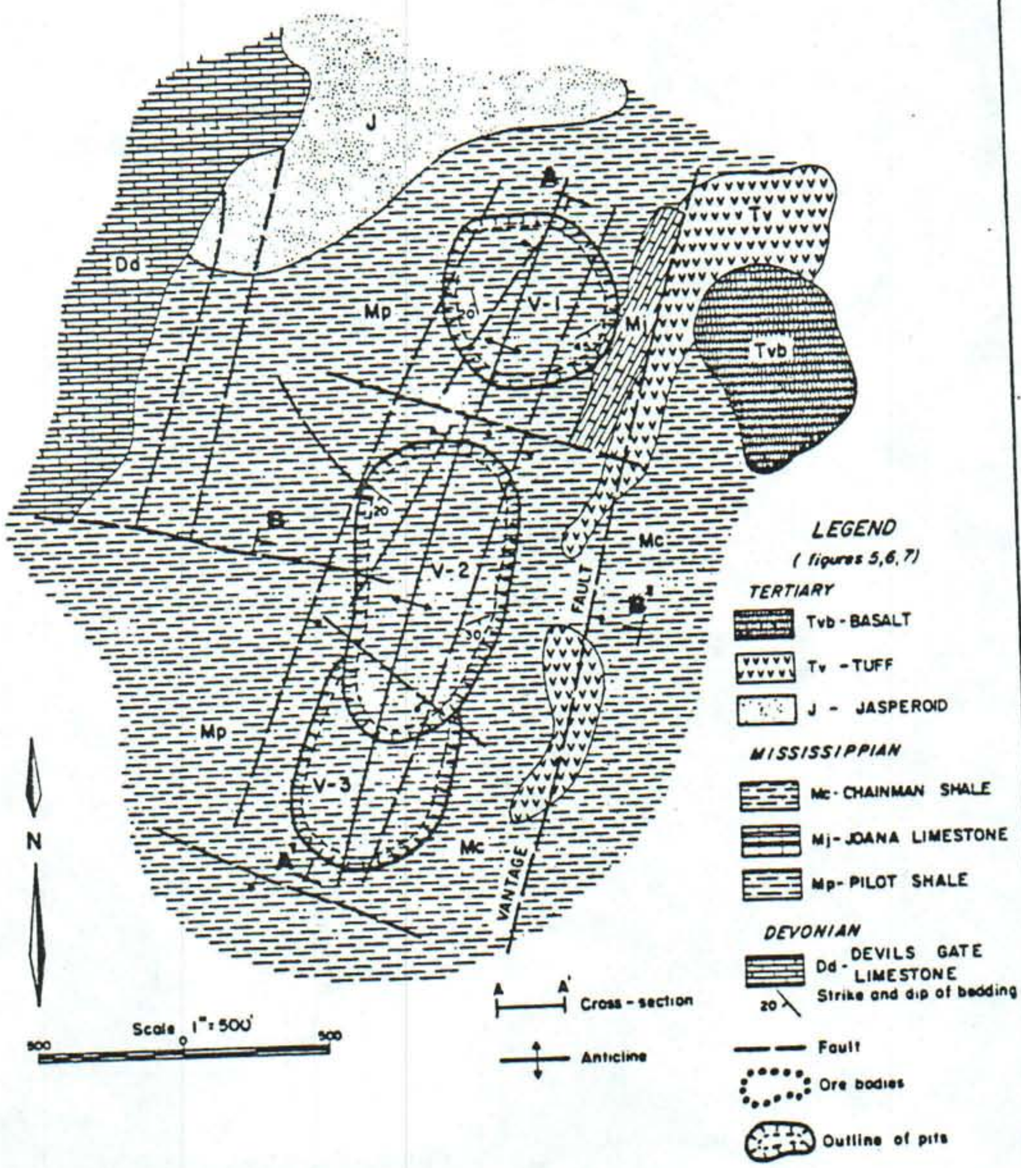


Figure 5.- Generalized geology of the Vantage ore deposits.

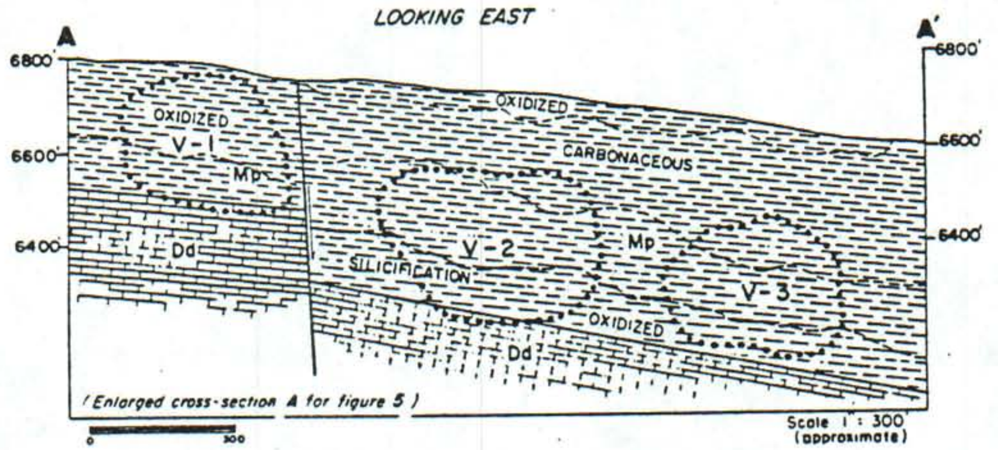


Figure 6.- Generalized mineralization cross-section.

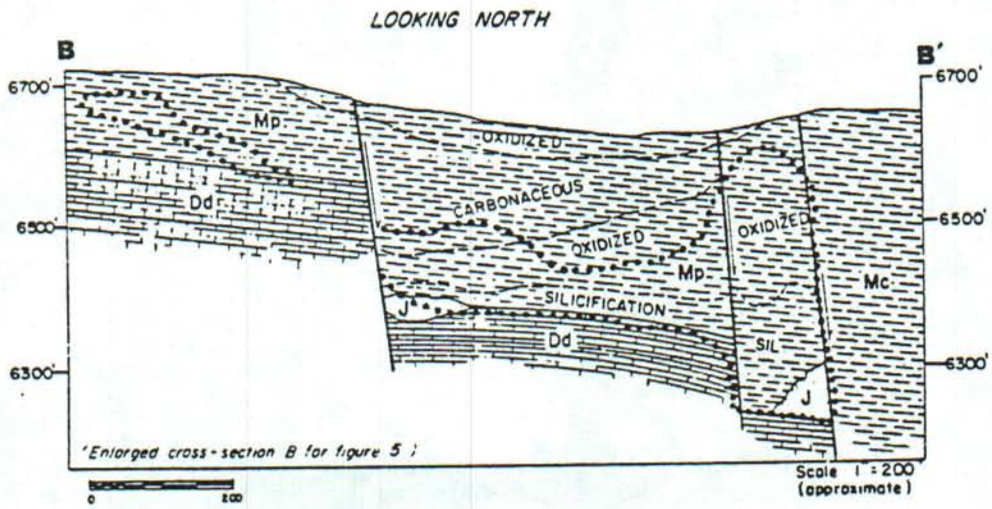


Figure 7.- Generalized cross-section through Vantage 2 showing the outline of mineralization and alteration.

by 250 feet with an average grade of 0.10 ounce of gold per ton. The largest of the three deposits is the Vantage Two ore body which covers an area approximately 800 feet long by 500 feet wide and 300 feet thick averaging 0.11 ounce of gold per ton. The Vantage Three deposit covers an area 200 feet long by 200 feet wide, and 150 feet thick with an average grade of 0.08 ounce of gold per ton. Remaining mineable reserves of oxide type ores are 4 million tons at 0.09 ounce of gold per ton with one million tons having been mined to date.

ALTERATION-MINERALIZATION

The greatest portion of mineralization occurs in the lower 300 feet of the Pilot Shale. Erosion of Vantage One left a section of Pilot Shale 250 feet thick and exposed the ore body. Alteration of this deposit removed nearly all the carbon from the ore resulting in a deposit that was 95% oxidized.

At Vantage Two and Three there was less erosion, therefore both of the deposits are contained in a nearly complete section of the Pilot. The greatest degree of oxidization is in the lower part of the Pilot which is separated by a zone of unoxidized rock from 50 feet below the surface to 150 to 200 feet below the surface. Twenty to thirty percent of the mineralization in the Vantage Two deposit is carbonaceous ore and in the Vantage Three deposit nearly 40% remains unoxidized.

The alteration associated with the deposits consists of decarbonization, local remobilization of carbon, decalcification, silicification, and oxidation.

Hypogene solutions which produced the majority of the alteration deposited gold, removed carbonate, deposited silica, and oxidized the sulfide minerals. Supergene alteration produced the pervasive iron oxides in the near surface environment. The paragenetic sequence of events is not completely understood but appears to be the removal of carbonate within the lower section of the Pilot (which increased the porosity and permeability of the siltstone), deposition of gold, removal of the carbon, silica addition, and further addition of gold.

Although the rocks through the deposit are altered vertically and laterally, the hypogene fluids seemed to have migrated along bedding planes. Vertically the alteration is zoned with silicification in the lower 100 feet of the Pilot, grading up into a 100 foot thick zone of oxidized gray siltstone, then into the unaltered claystones and siltstones (Figure 7). The supergene iron stained claystone lies above the carbonaceous clays and silts. Jasperoids are formed where the rock is totally replaced by silica. The occurrence of the jasperoids is discontinuous but commonly occurs at the contact between Devils Gate and Pilot Shale, or along major fault zones. Silica also forms minute quartz veins within the matrix of the gray oxidized siltstone.

Oxidized rock is often brecciated, ranging from crackling to a complete rotation of fragments. Along the margins of fragments haloes of hematitic or goethitic staining are common. The majority of brecciation appears to be the result of tectonic stresses and possibly hydrofracturing, as suggested by the angularity and well defined edges of the fragments.

Remobilized carbon which is most noticable in oxidized rock, occurs along fractures and faults as black clayey material filling openings. Areas where the carbon has been removed are typified by a 200 foot thick zone of leaching in the lower Pilot Shale, or by the red claystone at the top of the formation.

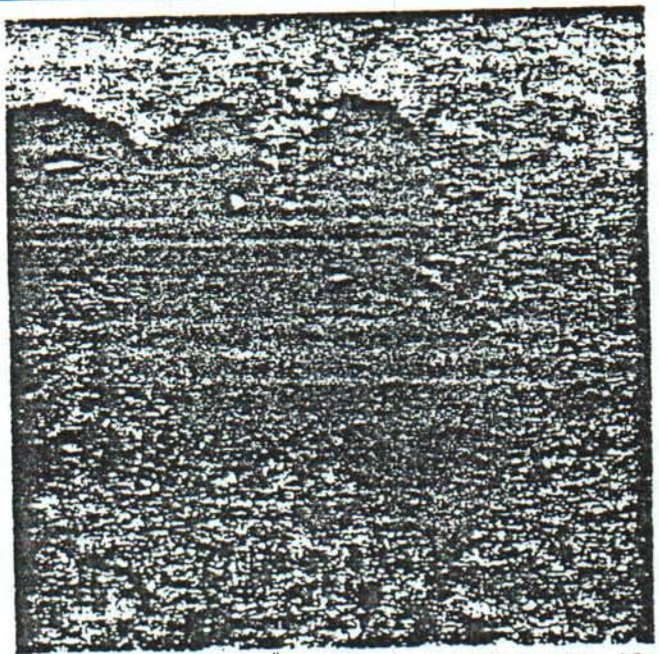
The upper 100 feet of the Pilot Shale typically does not host a significant amount of mineralization. This portion of the Pilot Shale is a less permeable claystone, that may have acted as a cap for the fluids. This may account for the lateral fluid flow along bedding planes, and deposition of the gold within the lower portion of the Pilot Shale. In the oxidized ore 85% of the gold occurs as finely disseminated microscopic gold, with 15% occurring as coarse visible gold (Figure 8). No visible gold has been observed in the carbonaceous ores.

Several minerals are associated with the gold mineralization. Within the oxidized ore specular hematite, jarosite, stibiconite, goethite, drusy quartz, barite, calcite, gypsum, alunite, and kaolinite have been observed. Within the carbonaceous ore stibnite, pyrite, orpiment, realgar, and calcite have been observed. Silver is also associated with both the oxidized and unoxidized ore, with an average gold/silver ratio of 9:1.

The most commonly observed mineral is jarosite, which often appears in areas of gold mineralization as amorphous or crystalline coatings on fracture surfaces in the siltstones. One millimeter to one centimeter long barite crystals are observed in association with the silicified siltstone and jasperoid. Quartz crystals are also found in association with the silicified siltstone and jasperoids. Geothite and hematite stains occur most commonly on fractures, whereas all remaining above noted minerals appear to be randomly distributed throughout the deposits.

STRUCTURE

There is evidence of a north-northeast striking asymetrical anticline running the length of the deposits (Figure 5). The axis of the anticline would lie along strike of



Dipyramid crystals from Vantage 1 Deposit 40x

Crystalline needles from Vantage 1 Deposit 40x

Figure 8.

the three deposits and plunges gently to the southwest. The east limb of the anticline dips 30-40 degrees to the southeast while the west limb dips 20 degrees to the southwest. The anticline is truncated by an east-west fault several hundred feet south of the southern limit of Vantage Three. Along the crest of the anticline numerous extensional fractures and extensive brecciation may have provided conduits for the ore bearing solutions.

Imprinted over the anticline are a series of north-northeast, north-northwest, and east-west trending normal faults. Vertical displacement on the majority of faults varies from 50 to 100 feet. Two of the north-northeast faults bound the greater area of mineralization on the east and west sides. The one fault which is apparently related to all the deposits is a north-northeast fault which transects the eastern side of all three deposits. Vertical displacement ranges from 100 feet in Vantage One to a throw of over 500 feet in the Vantage Three area. In the area of Vantage One the upper 100 feet of Pilot is displaced next to the lower 200 feet of Pilot. In Vantage Two and Vantage Three the Chainman is juxtaposed next to the Pilot on the east side of the deposits. For 50 to 100 feet on the footwall side of this fault the intensity of alteration increases, suggesting that the structure may have acted as one of the main fluid conduits. The significance of the north-northwest structures is unclear other than their role in aiding ground preparation.

CONCLUSIONS

The majority of geologic features suggest Alligator Ridge is similar to other Carlin-Type deposits. Those features in particular are the associated mineral assemblage, the high gold/silver ratio, the type of host rock, the formation of jasperoids, and the high angle fault system.

Any interpretation of the genesis of the deposits leaves room for future modification and changes. The Vantage deposits are thought to have formed by heat and gold derived from some deep seated source. As the meteoric and/or connate waters were heated, a convection cell started. These fluids migrated upward along several conduits. When the solutions came in contact with the Pilot Shale, conditions necessary for deposition were available. These would be a favorable host, a reducing agent along with a change in temperature and pressure that precipitated the gold, and a structurally favorable area.

The order of events may have occurred as follows. Assuming the Pilot Shale contained syngenetic pyrite, an increase in the acidity of the fluids occurred. This aided in the removal of carbonate. With the carbonate removed the porosity and permeability increased which allowed more fluid movement through the siltstone. This may also be when the majority of oxidation occurred. Silica deposition occurred as the fluids neared surface and the pressure and temperature decreased. Deposition of the gold may have occurred early on in the system when the fluids initially encountered the carbonaceous siltstone.

No age dates are available for mineralization. However, it is felt that the system is Tertiary. An active geothermal cell is known to exist in the area of the mine. The water supply for the mine is pumped hot at a temperature of 106 degrees fahrenheit. If this is a later phase of the system, it would be suggestive that the gold deposition is relatively young in age.

ACKNOWLEDGEMENTS

The author wishes to thank Amselco Exploration Inc. for allowing preparation of this paper. A special thanks to Jack Ainsworth, Steve Sutherland, Mel Essington, Mike Fitzsimonds, and the numerous other Amselco geologists who have contributed to the understanding of the Vantage geology over the past several years. I am grateful to Roger Steininger for his critical review of the manuscript and helpful suggestions.

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GEOLOGY AND GENESIS OF THE ALLIGATOR RIDGE MINE, WHITE PINE COUNTY, NEVADA

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INTRODUCTION

The purpose of this report is to describe the general geologic setting and some of the unique alteration and mineralization features of the Alligator Ridge disseminated gold mine. Although the Alligator Ridge deposits are similar to the other sedimentary rock-hosted or "Carlin-type" deposits in many ways, some of the unique features, such as the hydrothermal explosion breccias, suggest significant differences in genesis. A generalized genetic model will be presented to illustrate some of these differences and to describe how these deposits may have formed.

The Alligator Ridge gold mine is located approximately 40 miles northwest of Ely, Nevada, in the northwest corner of White Pine County. The mine can be reached from Ely by approximately 70 miles of paved highway. The mine is located in the Vantage Basin which lies between the southern Ruby Mountains to the West and Alligator Ridge, part of the Maverick Springs Range, to the East.

The disseminated gold ore deposits are hosted primarily in the Pilot Shale, part of the lower Paleozoic carbonate-and-transitional assemblage (fig. 1) of East-central Nevada. These rocks are continental-shelf carbonate deposits and clastic rocks shed eastward off of the Antler orogenic highland during the Devonian and Mississippian.

Previous, published work on the Alligator Ridge Mine includes deposit overviews by P. J. Klessig (1984a and 1984b), a published abstract by J. C. Ainsworth (1983) covering some of the findings of his geochemical study of the Alligator Ridge deposits. An unpublished MS thesis by R. P. Ilchik (1984) documented some of the effects of hydrothermal maturation of organic material in the Pilot Shale at the Alligator Ridge Mine.

The writer would like to acknowledge Ed Flood and Jeff Pontius of NERCO minerals and Ron Parratt, Wayne Bruce, and Wade Hodges of Santa Fe Mining for their encouragement in the preparation of this report. Acknowledgement is also extended to Ed Bartels and Clynt Naumann of NERCO Minerals and Alan Glaser of Amselco Exploration.

GEOLOGY

STRATIGRAPHY OF THE VANTAGE BASIN

The stratigraphy of the Vantage Basin (fig. 2) played an important role in localizing alteration and gold mineralization in the Alligator Ridge deposits. The lowermost exposed units are the Devonian Nevada Formation and Devils Gate Limestone. The Nevada Formation is exposed in Alligator Ridge, on the east side of Vantage Basin, but most exposures in the Vantage Basin are of the uppermost Devils Gate Limestone. The Devils Gate Limestone is overlain by the Mississippian-Devonian Pilot Shale, which is typically 480 feet thick in the Vantage Basin (Ilchik, 1984) and, where unaltered, consists of a lower calcareous, carbonaceous, pyritic siltstone unit that is approximately 300 feet thick. This is overlain by an upper calcareous, carbonaceous, pyritic claystone that is roughly 160 feet thick. The contact between the two units may be marked by a discontinuous interbedded chert and claystone unit (Klessig, 1984a). Limestone lenses are common in the lower Pilot Shale. The Pilot Shale is overlain by the Joana Limestone which is approximately 120 feet thick (Ilchik, 1984) in the Vantage Basin. The Joana Limestone is a sparry, crinoidal limestone typically containing abundant chert nodules. The Joana Limestone is overlain by the Chainman Shale, which is dominantly claystone and siltstone where exposed in the Vantage Basin.

Unconformably overlying an erosional surface that consists of at least the Pilot Shale, Joana Limestone, and Chainman Shale are Tertiary tuffaceous volcaniclastic sedimentary rocks that are at least 500 feet thick (Klessig, 1984a). The tuffaceous rocks likely are part of the Miocene-Oligocene tuffaceous sedimentary rocks that occur in the area (Hose and Blake, 1976), although Eocene-Paleocene ash-flow tuffs occur in areas north of and south of the Vantage Basin. These rocks are unconformably overlain by basaltic andesite flow rocks (Ilchik, 1984). The present surficial geology (fig. 3) resulted from erosion of the Tertiary and older rocks and deposition of alluvial gravels and valley fill of Quaternary age.

STRUCTURE OF THE VANTAGE BASIN

The Vantage Basin forms a gentle, south plunging anticline that is breached in the center to expose a core of Devils Gate Limestone. The Pilot Shale dips westward under the Joana Limestone and Chainman Shale on the west side of the basin. On the east side of the Vantage Basin, a large northeast trending graben, the "Vantage graben", juxtaposes Chainman Shale, on the downdropped side, and Pilot Shale. The boundary fault system, the "Vantage fault system", includes numerous strands and parallel faults, among which is the "PC fault". The PC fault cuts through the Vantage-1 and Vantage-2 workings downdropping the upper Pilot Shale against the lower Pilot Shale in the former and moving the Chainman Shale and Joana Limestone against Pilot Shale in the latter (fig. 4). The Vantage Basin is truncated on the east side by a large horst-block of Devonian Nevada Formation and Devils Gate Limestone. The faults were likely formed after the initiation of basin-and-range style faulting, which began approximately 17 m.y. ago (Stewart, 1980).

The ore deposits are localized along northeast-trending structures that are parallel to the Vantage fault system, including the PC fault, and at intersections between northeast-trending and west-northwest trending cross faults. A small-scale anticline parallels the strike of the Vantage fault system, and probably was formed as a result of drag along those faults. The axis of the anticline crosses the Vantage-1, -2, and -3 ore bodies and may have been a control on gold mineralization. A picture of the Vantage-1 and -2 openpits and the eastern side of the Vantage Basin is shown in figure 5.

ALTERATION

Alteration in the Alligator Ridge deposits is strongly zoned within the Pilot Shale and uppermost Devils Gate Limestone. The alteration zones form flat-lying horizons that are stacked vertically and grade laterally outward and upward from strongly altered rock into unaltered rock. Within the Vantage Basin, there is some overlap between

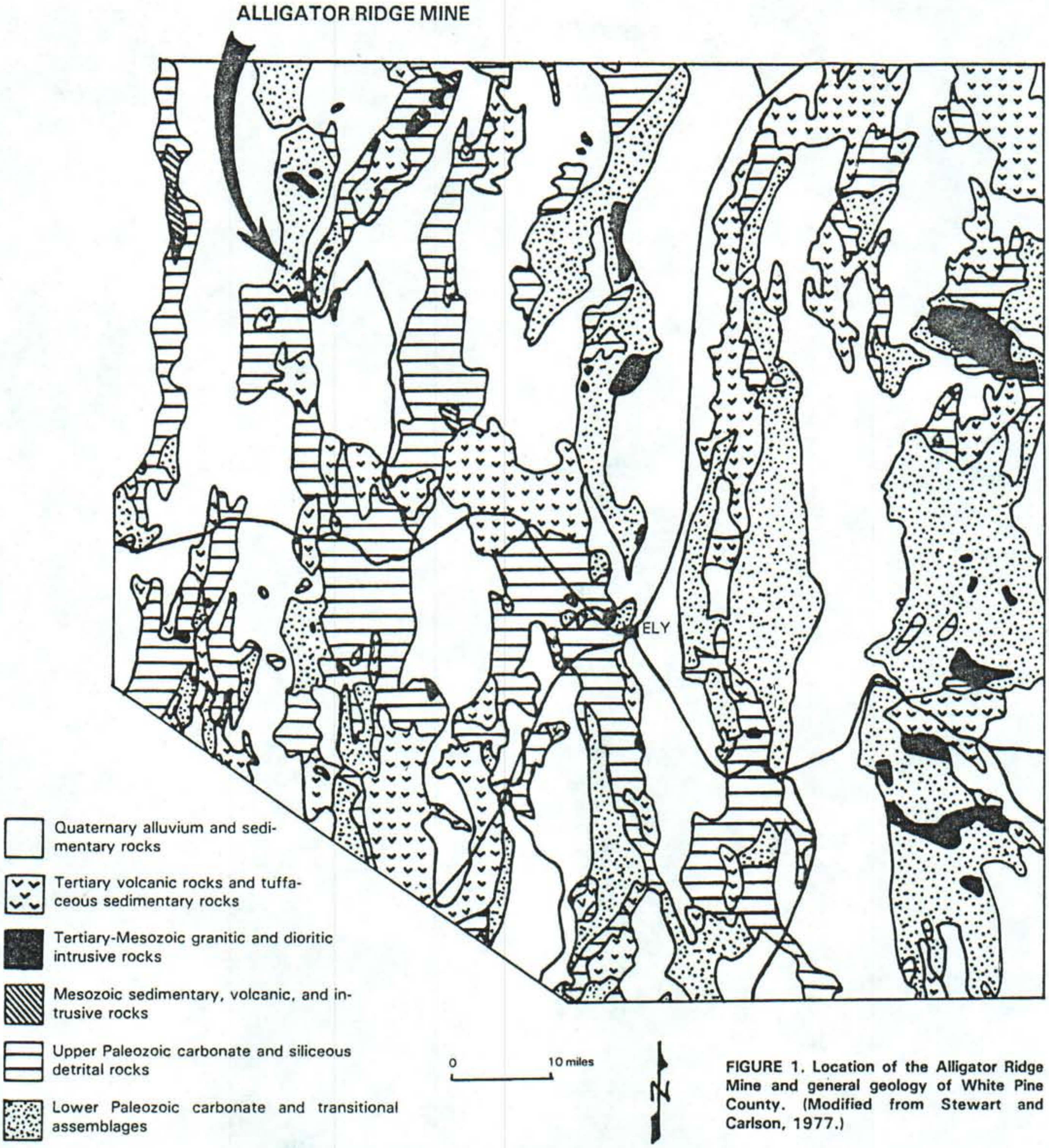
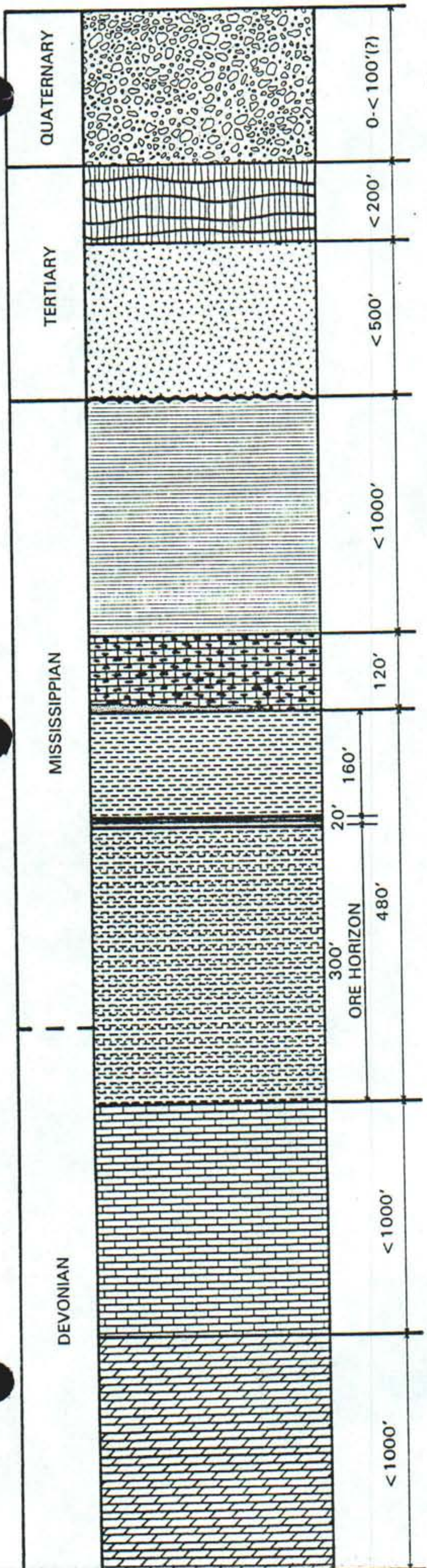


FIGURE 1. Location of the Alligator Ridge Mine and general geology of White Pine County. (Modified from Stewart and Carlson, 1977.)

alteration around the Vantage-0, -1, -2, -3 deposits, the A.R.M. deposit, and smaller hydrothermal centers on the west side of the basin. Also, the amount of alteration decreases as the Pilot Shale section dips southward.

The lowermost alteration zone is a jasperoid breccia developed at the Devils Gate–Pilot Shale contact and derived mainly from the Devils Gate Limestone. It is variable in thickness and distribution. Typically the jasperoid breccia is brownish black to reddish brown in color and a matrix-supported breccia. These rocks are well silicified and have a sucrosic texture. Stibnite, typically partially oxidized to stibiconite occurs in earlier-formed veins. The jasperoid breccia contains closely spaced fractures and abundant later-formed veins and open-space coatings of kaolinite, barite, jarosite, quartz, and calcite. Alunite may be present as veins, but is less common.

In the areas of strongest alteration, the jasperoid breccia is capped by a zone of strong hypogene oxidation and strong acid leaching ("strong hypogene oxide zone"). In this zone, the Pilot Shale is decalcified and argillized, punky, weakly to strongly silicified, and is bleached to a light gray color. Alteration minerals include jarosite, kaolinite, barite, hematite, and less commonly, alunite. Hydraulic fracture textures and hydrothermal brecciation is typical of rocks in the strong hypogene oxide zone. Hydrothermal explosion breccias extend upward from the



Alluvium and valley-fill gravels

Basaltic andesite flow rock: Dark green to black, hornblende-plagioclase-biorite-bearing basaltic andesite

Tuffaceous sedimentary rocks: White to yellow to pinkish water-lain volcanic sandstones and claystones

Chainman Shale: Non-calcareous, greenish-black, greasy claystone and interbedded siltstone. Lower part of unit may be calcareous shale or thin-bedded, platy, light-gray, micritic limestone

Joana Limestone: The lower contact may be marked by a calcareous quartzite, typically with well-rounded grains. The limestone is thin- to thick-bedded, medium-gray, crinoidal, cherty, sparry, and bio-clastic

Pilot Shale: Lower 300' is dominantly a calcareous, carbonaceous, pyritic siltstone with some limestone lenses. Discontinuous interbedded chert and claystone may separate the lower siltstones from the upper 160', which consists of calcareous, carbonaceous, pyritic claystone

Devils Gate Limestone: Light- to medium-gray, thin- to medium-bedded micritic limestone

Nevada Formation: Gray to tan to light-brown, saccharoidal, thin-bedded dolomite

FIGURE 2. Stratigraphic column for the Vantage Basin. (Modified from Klessig, 1984a, and Ilchik, 1984.)

strong oxide zone and crosscut the overlying, less altered rocks. The hydrothermal explosion breccias occur as dike-like bodies of clast-supported and/or matrix-supported heterolithologic breccias, typically consisting of clasts of Pilot Shale and the basal jasperoid breccia.

The strong hypogene oxide zone grades vertically and laterally into a transitional zone of weaker hypogene oxidation ("weak hypogene oxide zone"). Rocks of the weak hypogene oxide zone are characterized by pervasive hematite and/or jarosite stain, often in the form of liesegang banding. Rocks of the weak hypogene oxide zone are typically decalcified, although the decalcification and oxidation "fronts" rarely exactly coincide.

In the Vantage-2 and -3 deposits, where a more complete section of Pilot Shale is preserved and not completely oxidized, the weak hypogene oxide zone grades into carbonaceous Pilot Shale (the "carbon zone"). Some of the carbonaceous Pilot Shale is hydrothermaly altered (Ilchik, 1984) and apparently contains activated carbon. The hydrothermally altered Pilot Shale is typically also decalcified. Alteration minerals typical of the carbon zone are relatively rare occurrences of realgar-orpiment (typically in association with stibnite in calcite veins) and stibnite in calcite veins. Minor kaolinite may be present in hydrothermally altered carbonaceous rocks.

Along the southward, downdip extension of the Pilot Shale–Devils Gate Limestone contact, there is a decrease in the amount of jasperoid formed in the uppermost Devils Gate Limestone. The amount of hypogene oxidation decreases, but even deep drilling (400 feet or more) south of the Vantage-2 pit encountered a small weak hypogene oxidation zone developed in the lowermost Pilot Shale at the contact with the Devils Gate Limestone.

Hydrothermally altered carbonaceous material is also present in the Devils Gate Limestone. A hole drilled east of the Vantage-1 pit encountered 50 feet of "normal" Devils Gate Limestone and then entered carbon-enriched limestone that contained a large amount of "sooty", black carbonaceous material. This material resembled the hydrothermally altered carbon found in the Pilot Shale. Deep drilling in the area south of the Vantage-2 pit in 1984 intersected a breccia zone, apparently a hydrothermal breccia body, in the upper Devils Gate Limestone that contained clasts of limestone in a carbonaceous matrix that exhibited streaming textures. The carbonaceous material was apparently hydrothermally altered. The occurrance of this breccia is unique because breccia-body formation below the contact between the Devils Gate Limestone and the Pilot Shale is not observed in the Vantage-1 or Vantage-2 pits, or on Jasperoid Hill.

Surficial weathering of unaltered carbonaceous, calcareous, pyritic Pilot Shale resulted in the formation of a 20-to 40-foot zone of very weak oxidation. The shale becomes brownish black to orangish brown in color and was not decalcified. It is evident that surficial weathering did not cause the brightly colored (and commonly decalcified) rocks found in the mine workings.

An alteration map based on the fall 1983 pit configuration of the Vantage-1 and Vantage-2 pits is shown in figure 6. The alteration map shows the vertical zonation of the alteration (e.g. the small pit in the center of the Vantage-2 pit penetrated the carbon zone to expose the ore-bearing rocks of the strong oxide zone), the breccia bodies crosscutting the carbon zone, the decalcification "front", and the lateral zonation of the weak oxide zone around the breccia bodies and the PC fault zone in the southeast corner of the pit. The altered Chainman siltstone unit illustrates the higher permeability of siltstone relative to claystone. The alteration/geology cross sections (figs. 7 and 8) illustrate the vertical zonation of the alteration in the Vantage-2 deposit.

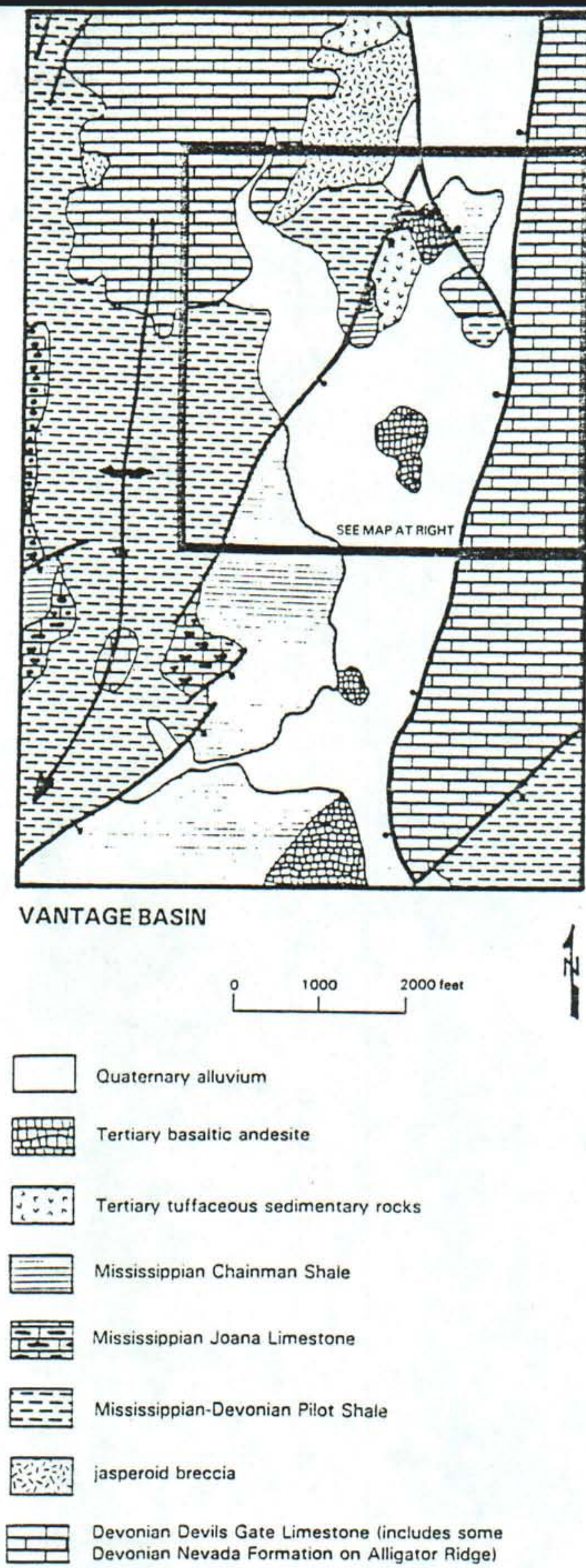
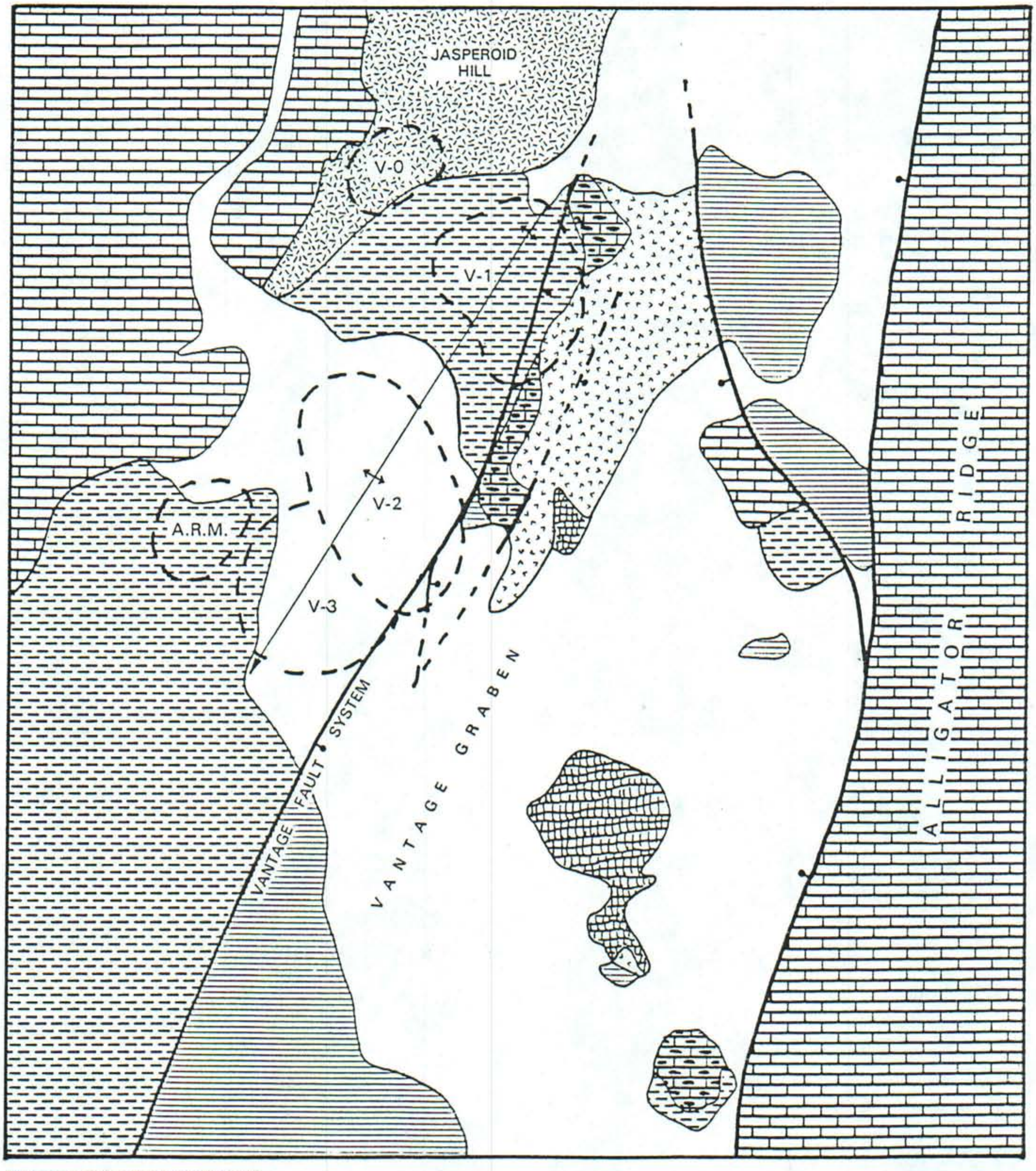
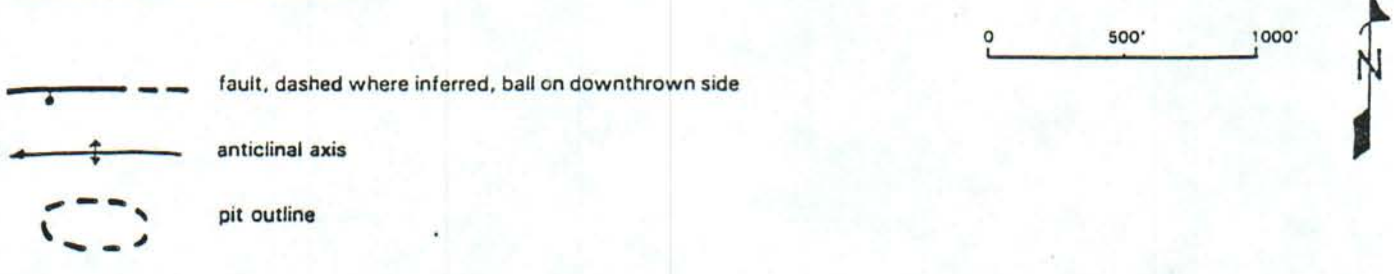


FIGURE 3. Geology of the Vantage Basin and the eastern Vantage Basin (inset) showing the location of ore deposits. (Modified from Ilchik, 1984, and Tapper, 1984a.)



EASTERN VANTAGE BASIN



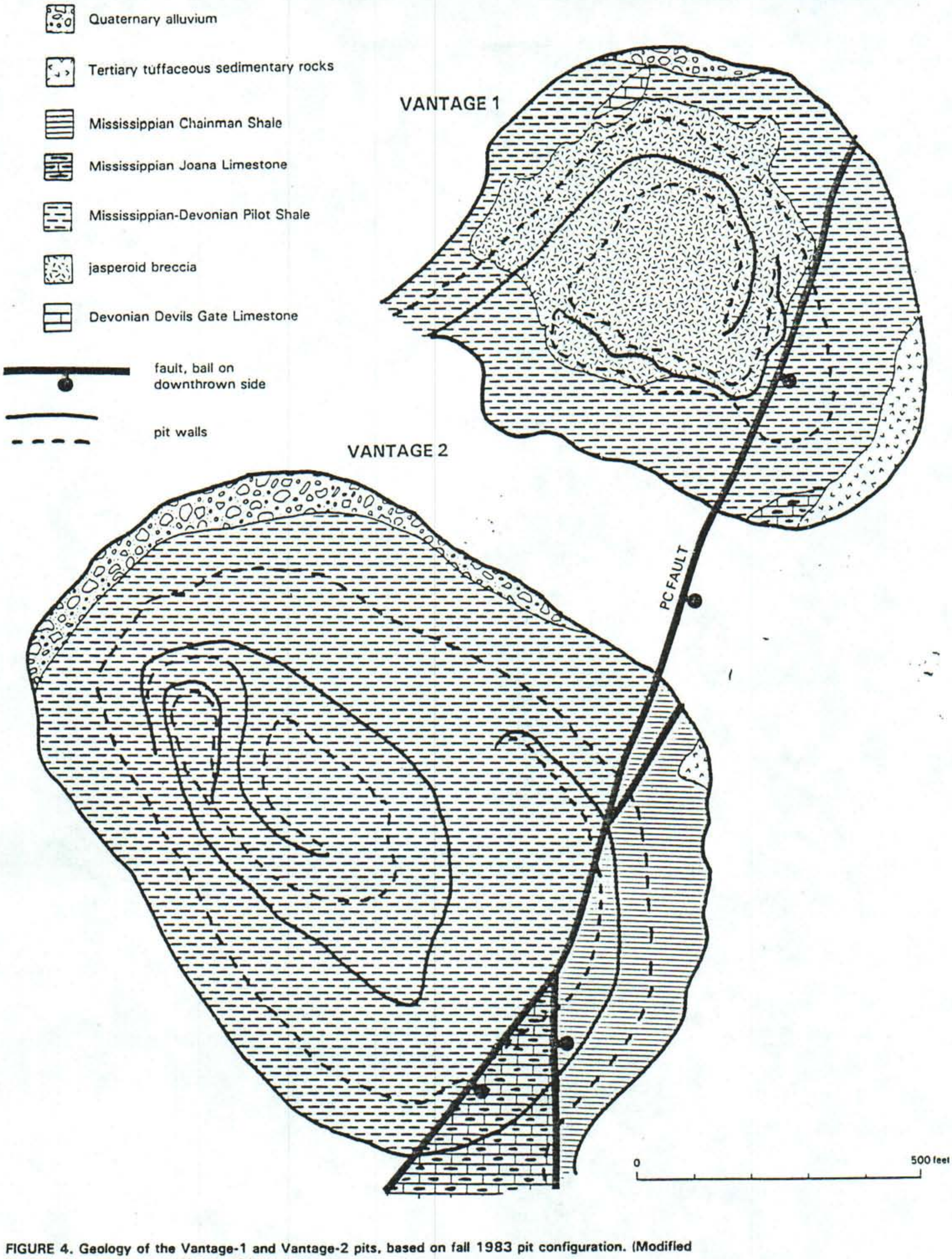


FIGURE 4. Geology of the Vantage-1 and Vantage-2 pits, based on fall 1983 pit configuration. (Modified from Tapper, 1984b, and Glaser, 1984.)

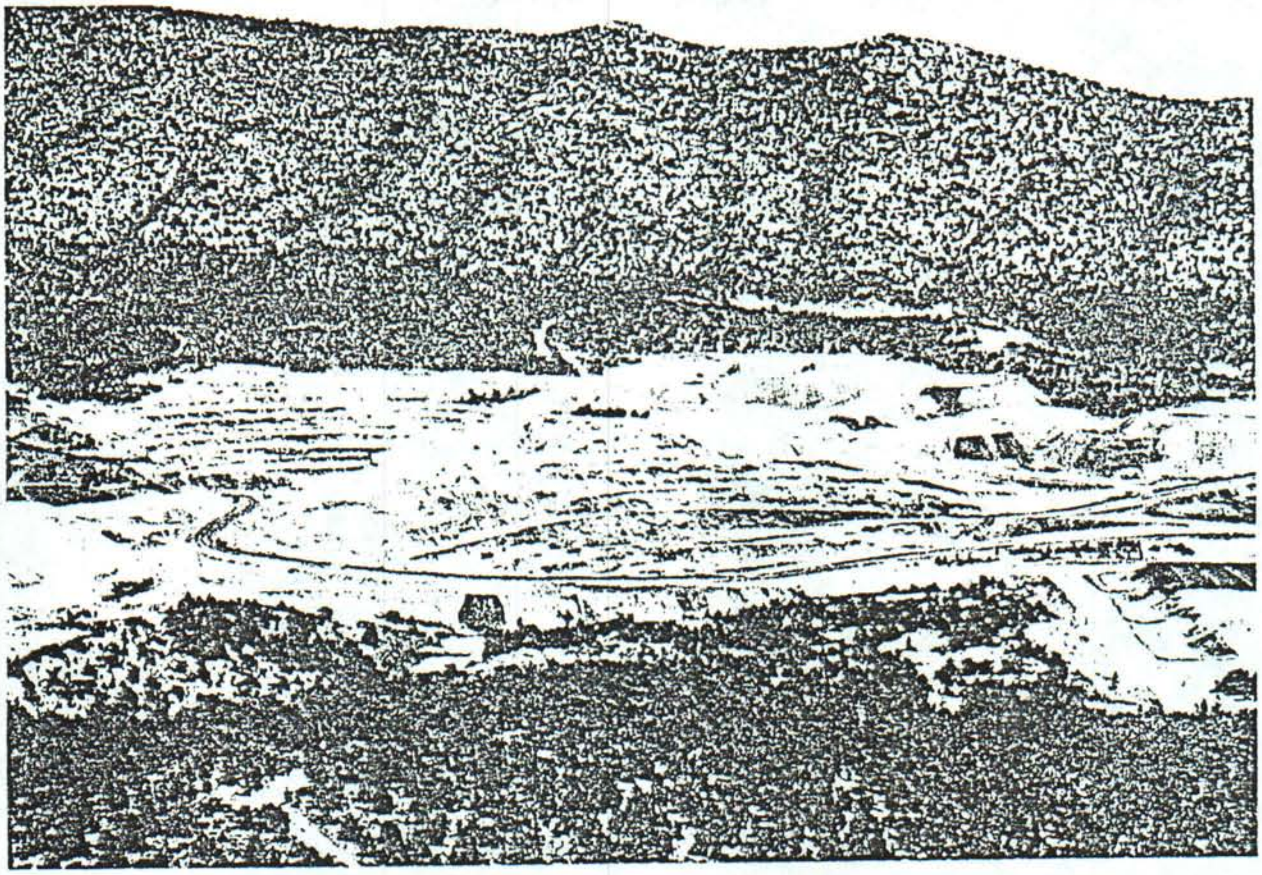


FIGURE 5. Photograph, looking east, of the Vantage-1 and -2 pits, June 1983.

HYDROTHERMAL BRECCIAS

The presence of abundant examples of hydrothermal brecciation at the Alligator Ridge deposits distinguishes these deposits from those at, for example, Carlin or Jerritt Canyon. Hydrothermal brecciation and hydrofracture textures are ubiquitous in the rocks of the strong hypogene oxide zone. Relatively large breccia bodies are found in the Vantage-1 and -2 pits to be localized along relatively minor fault zones. The breccia bodies tend to be localized more along the anticlinal axis crossing the Vantage-1 and -2 ore bodies. Very little tectonic brecciation is found at the Alligator Ridge deposits. That which is present is small scale and is found along the PC fault that cuts the Vantage-1 and -2 deposits. The small amount of tectonic brecciation that does occur along that fault consists of locally-derived clasts in a sheared matrix and are unlike the hydrothermal breccias.

The hydrothermal explosion breccias at the Alligator Ridge Mine are dike-like bodies of heterolithologic breccia that open downward into less disrupted rocks in the relatively flat-lying strong hypogene oxide zone (fig. 7). The examples described below are from the Vantage-1 and Vantage-2 pits. Figure 9 shows one of the breccia bodies in the north wall of the Vantage-2 pit. Typically, the breccia bodies are strongly hypogene oxidized and acid-leached and the alteration forms a continuum with the relatively stratabound part of the strong hypogene oxide zone.

Three main breccia types have been observed: 1) clast-supported, 2) matrix-supported, and 3) jigsaw-puzzle and crackle breccias. Clast-supported breccias (figs. 10 and 11) typically consist of strongly oxidized and acid-leached clasts of Pilot Shale and rounded clasts of the basal jasperoid breccia. The area between clasts typically is blown clean of rock flour and is partly filled by crystalline barite with or without drusy quartz, crystalline to earthy jarosite, alunite, kaolinite, and specular hematite. Matrix-supported breccias (figs. 12, 13, 14, and 15) typically consist of oxidized, acid-leached, silicified, angular to rounded Pilot Shale clasts and rounded clasts of the basal jasperoid breccia suspended in a matrix of silica and rock flour. Streaming textures are common in the silica and rock flour matrix. Alteration minerals, which may take the place of silica in the matrix, include barite, jarosite, and alunite. Some hematite or jarosite stain is common. Another type of matrix-supported breccia observed in the Vantage-1 pit and termed a "rubble breccia" (fig. 16) consists of a crumbly zone of uncemented rock flour and clasts of Pilot Shale and jasperoid breccia. Most clasts, including some up to boulder sized, exhibit some rounding. The clast-supported and matrix-supported breccias grade in to less mobilized breccia types, the jigsaw-puzzle and crackle breccias, and out to undisrupted rock.

The distribution of breccia types within the bodies appears to be related to the intensity of vapor streaming. In the breccia bodies in the north wall of the Vantage-2 pit, clast-supported breccias form in the narrow, upper part of the bodies where vapor streaming was most strongly focussed. The vapor stream transported jasperoid-breccia clasts as much as 200 feet vertically, typically rounding them, and removed the comminuted material from the interstices between clasts. The clast-supported zone grades downward into a broader zone dominated by matrix-supported breccias. Jigsaw-puzzle breccias and crackle breccias (fig. 17) are found at the margins of the breccia bodies where the well-mobilized breccias grade into undisrupted rock.

The rubble-breccia zone observed in the Vantage-1 pit was apparently formed by vigorous vapor streaming through a narrow structure near the contact between the

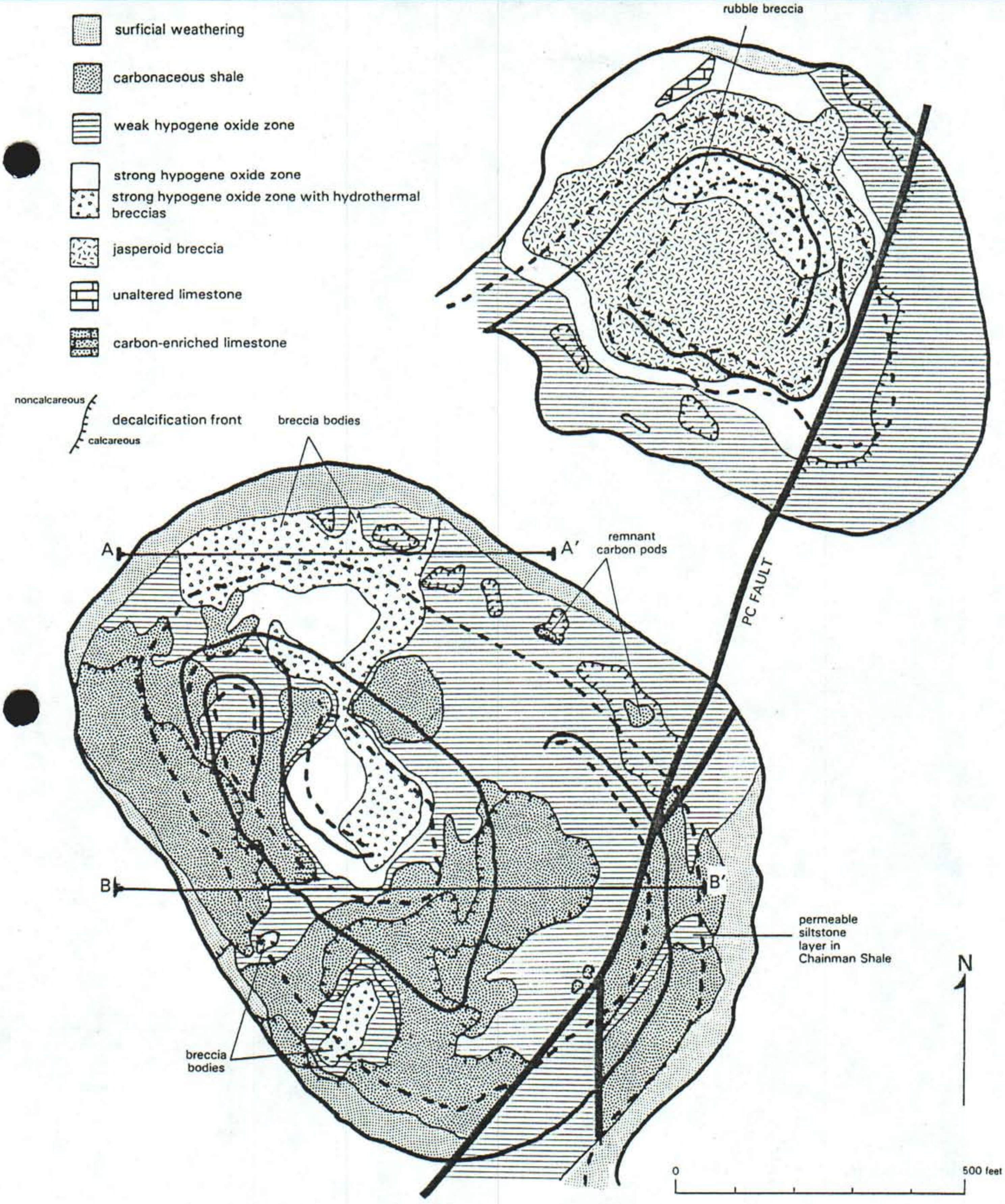


FIGURE 6. Alteration and geology map of the Vantage-1 and -2 pits, based on fall 1983 pit configuration. (Modified from Tapper, 1984b, and Glaser, 1984.)

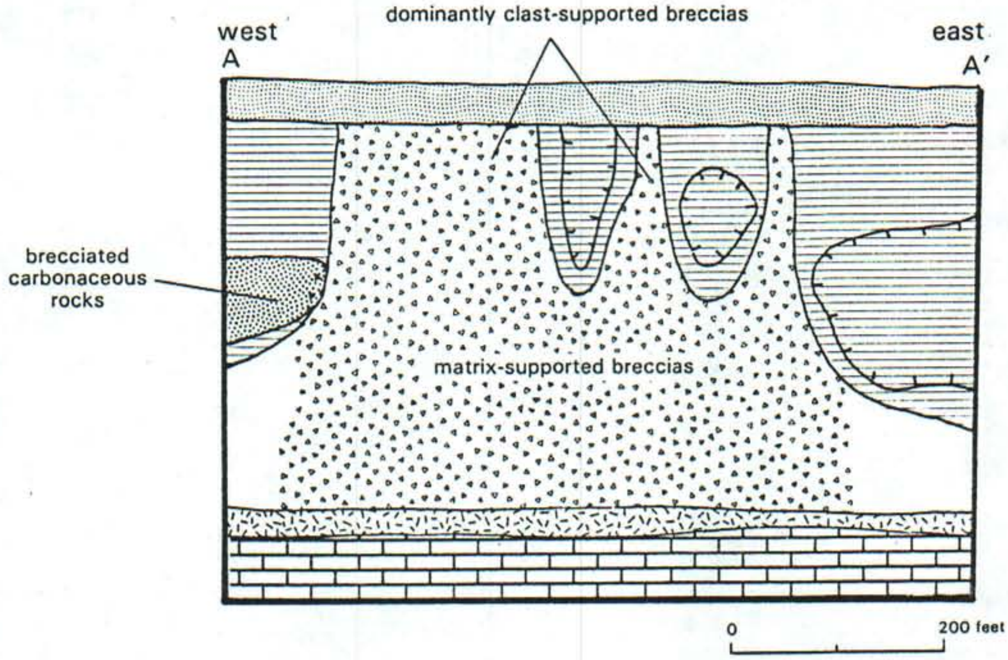
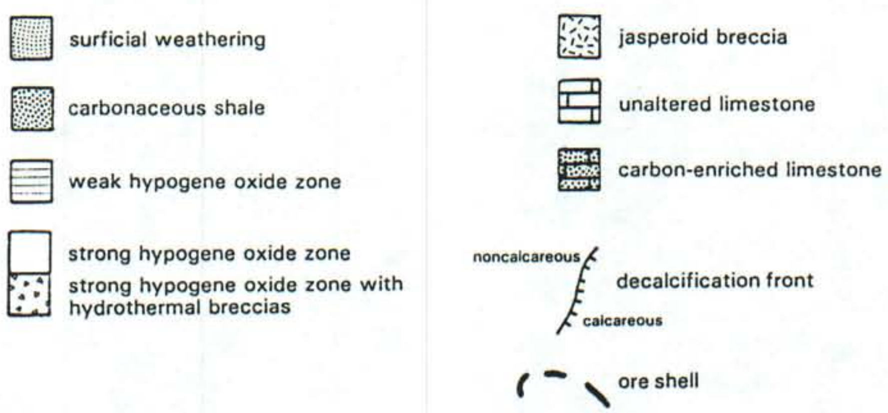


FIGURE 7. Cross section B-B′ through the northern part of the Vantage-2 deposit showing alteration zonation and hydrothermal breccias.



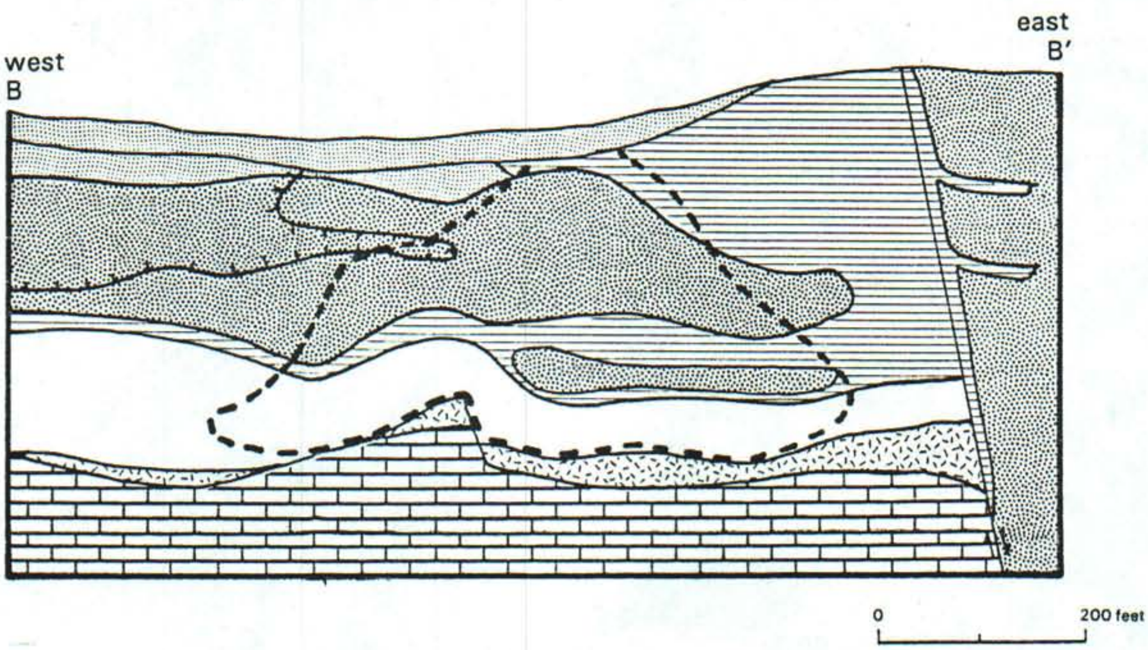


FIGURE 8. Cross section B-B′ through the central part of the Vantage-2 deposit showing alteration zonation. Note that the ore shell crosscuts the oxidation front. (Modified from Ilchik, 1984.)

FIGURE 9. Photograph of a hydrothermal explosion breccia body in the north wall of the Vantage-2 pit. The strongly oxidized and acid-leached rocks within the breccia body are surrounded by rocks of the weak hypogene oxide zone. The breccia body is widening at the bottom of the picture as it merges with the more flat-lying strong hypogene oxide zone.

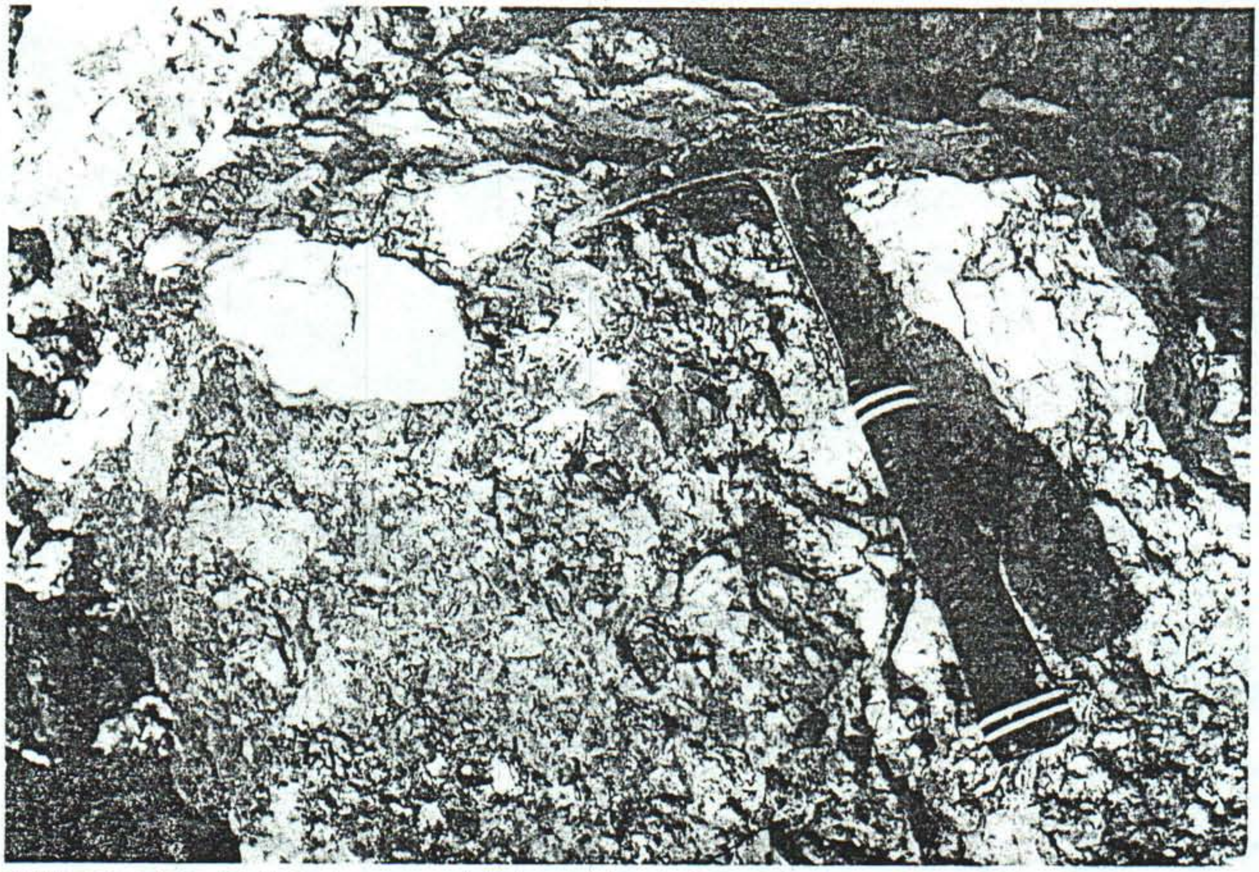


FIGURE 10. A heterolithologic clast-supported hydrothermal explosion breccia, Vantage-2 pit. The light colored clasts are strongly hypogene oxidized and argillized Pilot Shale and the dark gray clasts are jasperoid breccia. The jasperoid breccia has been transported approximately 180 feet vertically from its stratigraphic occurrence.

FIGURE 11. A heterolithologic clast-supported breccia, Vantage-2 pit, consisting predominantly of Pilot Shale clasts (light colored). Small clasts of jasperoid breccia (dark gray) are also present (several are located above the hammer in the upper left corner of the picture. Vertical transport of the jasperoid breccia clasts was approximately 180 feet.

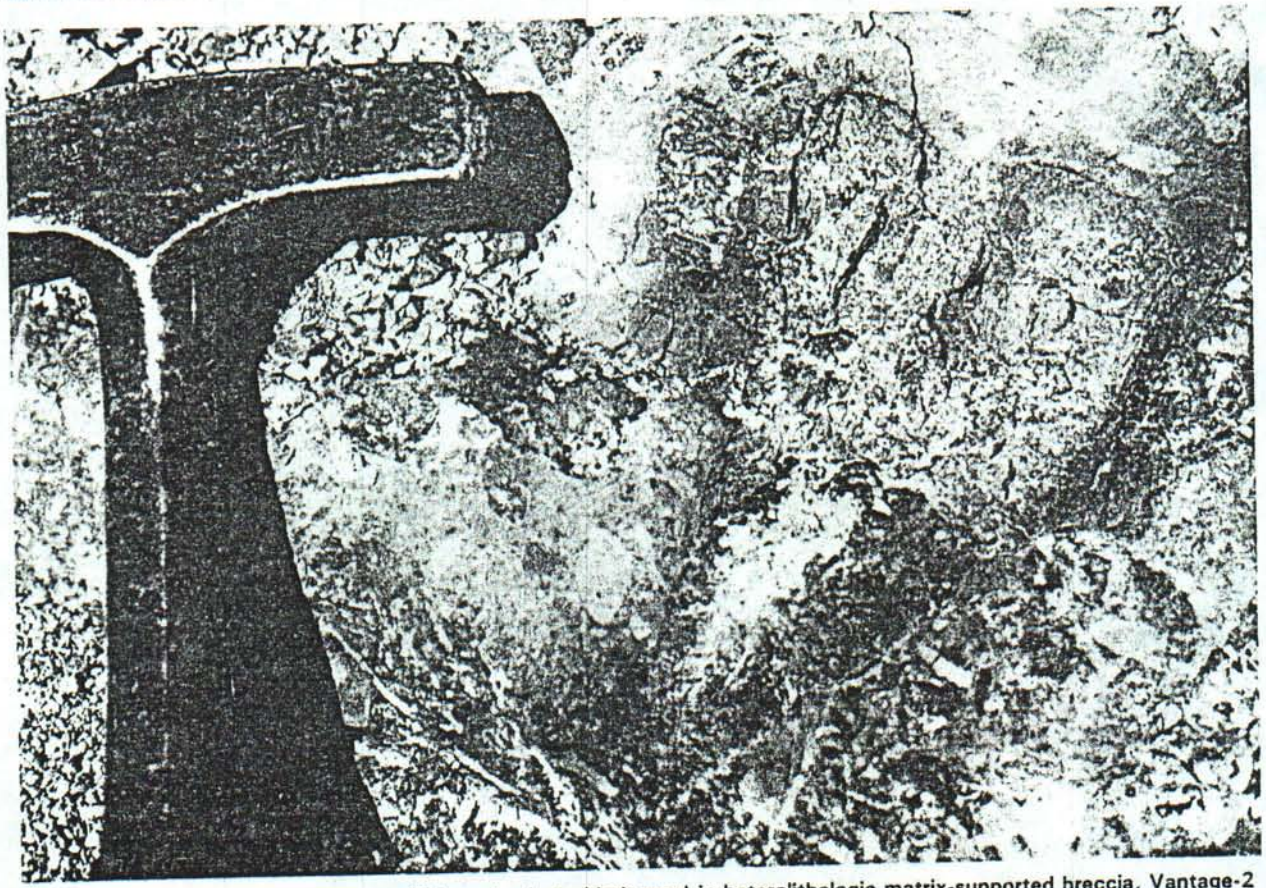


FIGURE 12. Transport-rounded jasperoid-breccia clasts (dark gray) in heterolithologic matrix-supported breccia, Vantage-2 pit. Note the Pilot Shale clasts (light gray), some of which have also been rounded. The matrix is silica and rock flour. The jasperoid breccias have been transported approximately 180 feet.

FIGURE 13. Matrix-supported breccia consisting entirely of Pilot Shale clasts that have been strongly hypogene oxidized and acid leached, Vantage-2 pits. Note that the rock grades from a crackle breccia at right into a matrix-supported breccia at left. Also note the cross-cutting vein of matrix-supported breccia (with a light gray matrix) that cuts across the picture left of center and right of the lense cap.

FIGURE 14. Vein with rounded Pilot Shale clasts in a silica and rock-flour matrix cross cutting crackle breccia, Vantage-2 pit. Crackle breccia has jarosite and barite on fracture surfaces.

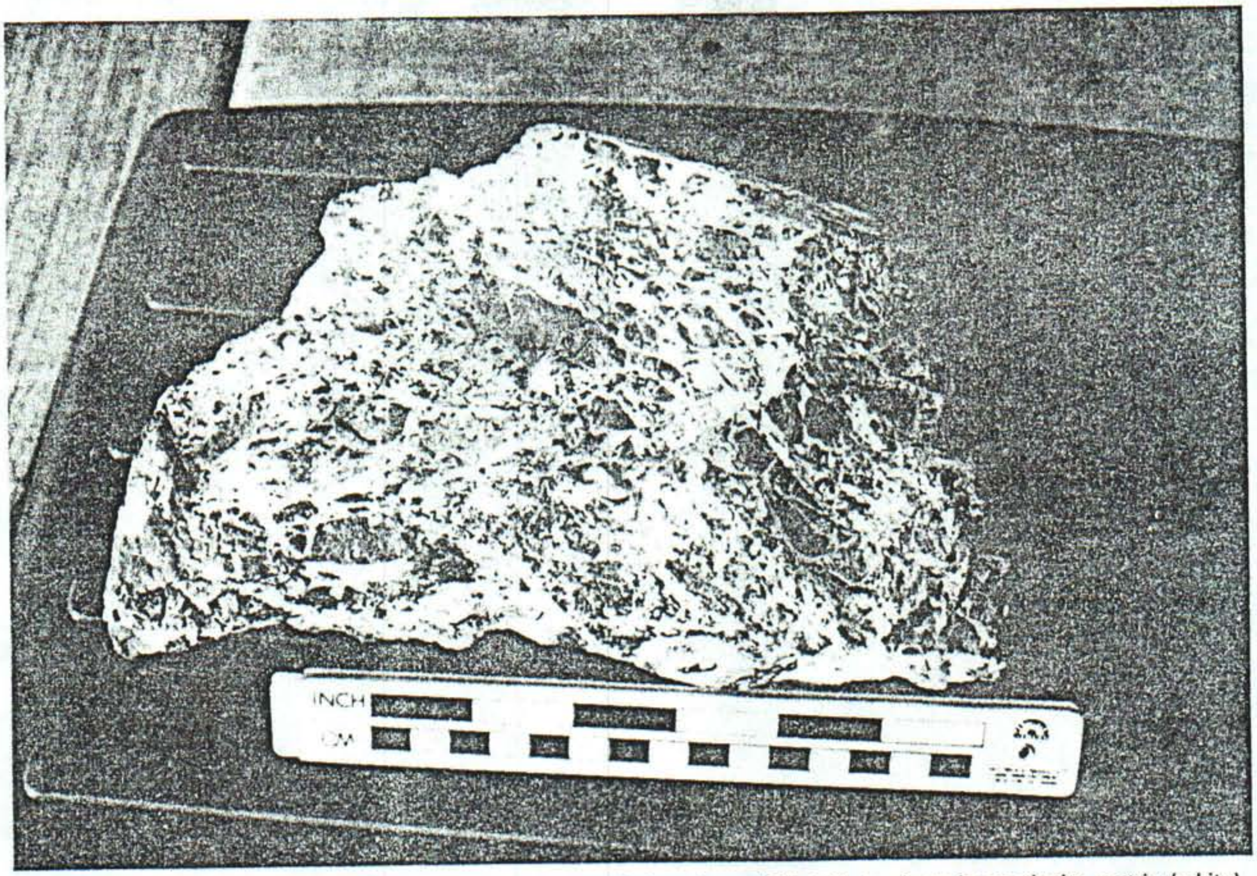


FIGURE 15. Matrix-supported breccia consisting of jasperoid breccia and Pilot Shale clasts in an alunite matrix (white), Vantage-1 pit.

FIGURE 16. Rubble breccia in Vantage-1 pit. Note the rounded boulder of jasperoid breccia. Breccia consists of rubbly zone of cobble- to boulder-sized jasperoid breccia and Pilot Shale clasts in a soft rock-flour matrix.

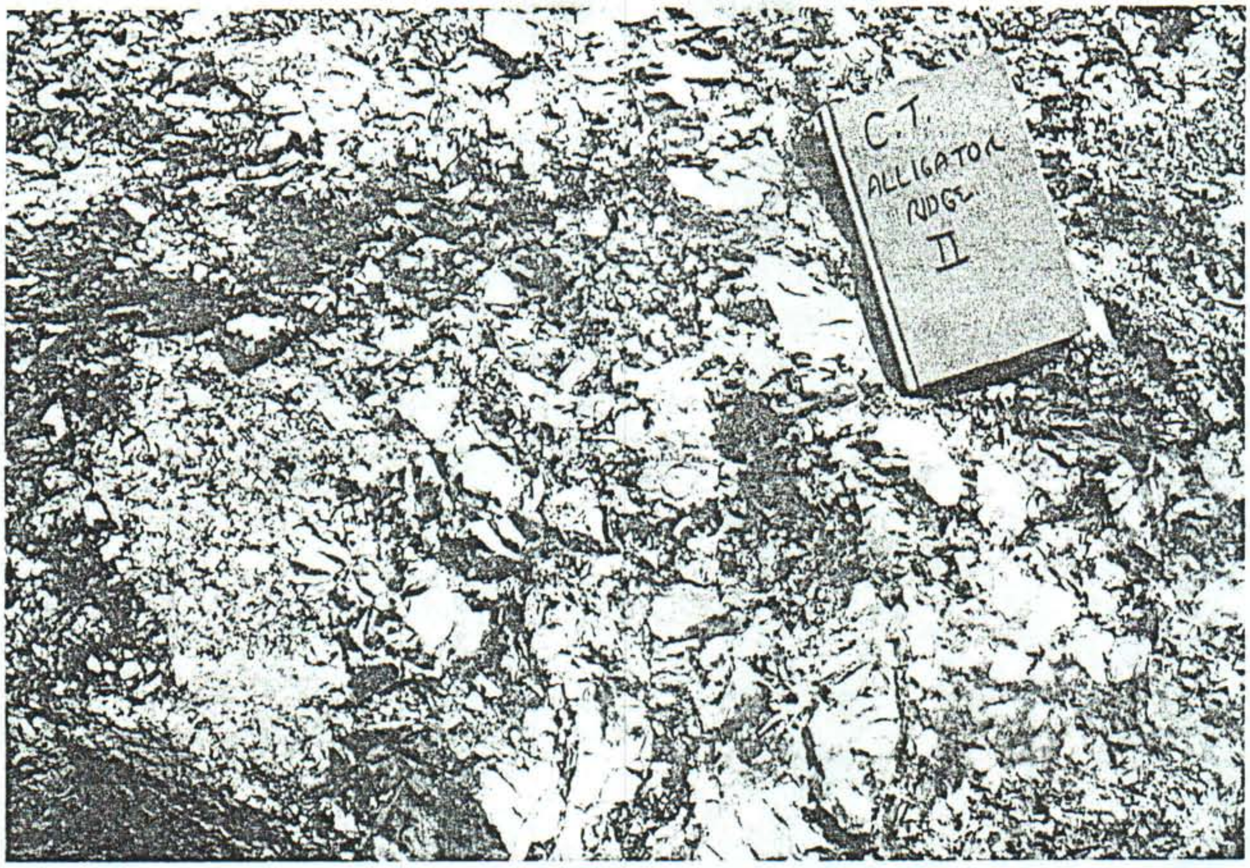


FIGURE 17. Crackle breccia in the north wall of the Vantage-2 pit, adjacent to a breccia body and grading into a clast-supported breccia. The fracture surfaces are coated with crystalline to earthy jarosite and hematite. The Pilot Shale fragments have been strongly hypogene oxidized and acid leached.

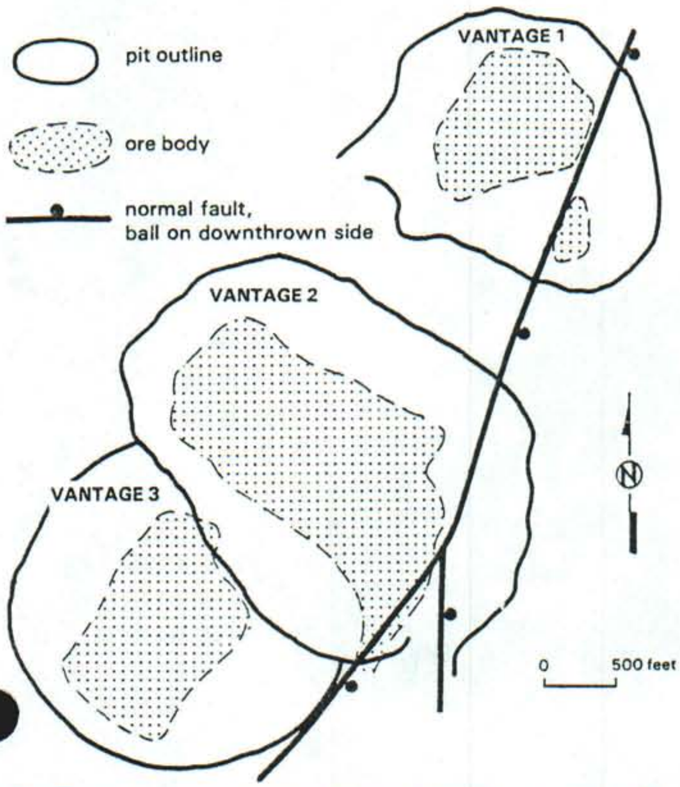


FIGURE 18. Map showing the outline of the Vantage-1, -2, and -3 pits and ore bodies. (Modified from Ilchik 1984, and Tapper, 1984a.)

jasperoid breccia–strong hypogene oxide zone to form a chaotic, rubbly zone of rounded jasperoid breccia and Pilot Shale clasts suspended in rock flour. The rubble breccia locally grades into clast-supported breccias where the rock flour has been removed by the vapor stream.

As mentioned earlier, some apparent hydrothermal breccias were discovered in the Devils Gate Limestone. These breccias were discovered during deep drilling of a deep, carbonaceous, subeconomic gold deposit located south of the Vantage-2 pit. These breccias are of a type not observed in workings from Vantage-2 northward or in exposures of the Devils Gate Limestone elsewhere in the Vantage Basin. The breccias contain limestone clasts in a carbonaceous silica and rock flour matrix. Unfortunately, little is known of this breccia type.

MINERALIZATION

Economic gold mineralization at the Alligator Ridge Mine is localized within the oxidized rocks in the lower part of the Pilot Shale and in the basal jasperoid breccia. The ore deposits are strata-bound and localized by northeast- and west-northwest-trending normal faults. The northeast-trending faults are parallel to those in the Vantage fault system. With the exception of some hanging-wall ore in the southeast corner of the Vantage-1 pit, and deep, subeconomic gold mineralization south of the Vantage-2 pit, mineralization is not localized directly along the Vantage fault system. The Vantage-1, -2, and -3 ore bodies also fall on the trend of the axis of the south- plunging anticline described earlier. The anticline may have played an important role in channeling fluids flowing within the Pilot Shale and thus acting as a control on mineralization.

The Vantage -1, -2, and -3 ore bodies and pit outlines are shown in figure 18. A cross section through the ore body in in the Vantage-2 deposit is shown in figure 8. The Vantage-0 ore body (see fig. 3) is in low-grade mineralization within structurally prepared zones in the basal jasperoid breccia that is exposed on Jasperoid Hill. The A.R.M. pit will reach a small satellite ore body formed in the lower Pilot Shale.

Gold mineralization in the oxidized rocks is dominantly microscopic and disseminated, but some coarse gold does occur. Coarse gold occurs as dipyramids or needles that may be visible using low-power optical microscopes (Klessig, 1984a), and rare occurrences of gold visible in hand-specimen have been reported. Gold-mineralized carbonaceous rocks occur in the Vantage-2 and -3 pits. In these carbonaceous rocks, gold is submicron and its mode of occurrence is unknown. The presence of activated carbon, which can scavenge cyanide-complexed gold from the leach solutions in the recovery circuit, and abundant diagenitic pyrite cause the gold-bearing carbonaceous material to be uneconomic at the present time.

Klessig (1984b) reports an overall 9:1 gold-to-silver ratio for the Vantage deposits. Ilchik (1984) notes that the gold-to-silver ratio in the carbonaceous rocks is 1:1 and in the oxidized ore is 5:1, showing that the oxidized ores contain less silver. This suggests that the gold was originally deposited as submicron gold in unoxidized, carbonaceous Pilot Shale and oxidized at a later time. The silver could have been leached out of the gold by the oxidizing solutions and the gold could have been coarsened at the same time.

GENETIC MODEL

The genetic model was developed to explain the alteration zonation and distribution of gold mineralization using well understood physical and geochemical processes. Unfortunately, since 1) the original surficial rocks at the Alligator Ridge deposits have been largely removed by post-mineral erosion and 2) insufficient geochemical data are available (particularly in geothermometry and fluid composition) to constrain the model of the system, some important assumptions had to be made to allow construction of the interpretive diagrams in figures 19 to 22.

The first assumption is that the mineralization at Alligator Ridge occurred after basin-and-range faulting. This assumption is supported by strong evidence that mineralization used the normal faults as conduits, including the PC and other northeast-trending faults in and parallel to the Vantage fault system. These faults cut tuffaceous sedimentary rocks that are likely of Miocene to Oligocene in age, although definitive age dates are not available. The Tertiary tuffaceous rocks are shown as the premineral surficial rocks, and although the actual surficial rocks have been removed, it is likely that the geologic section could have been close to the one represented in the diagrams.

The second assumption is that the Tertiary tuffaceous rocks in the area of Vantage basin were originally approximately 500 feet thick, although the exact thickness of these rocks cannot be determined. This implies a shallow depth of formation in the roots of a "hot-springs"-type system. A "hot-springs" type origin for this deposit is also suggested by the alteration mineral assemblages, the presence of hydrothermal breccias, and the presence of abundant acid-leached rock.

The third assumption is that the mineralizing solutions which formed the Alligator Ridge ore deposits were alkaline to slightly acidic, were at a temperature of 150 to 200 degrees Celsius, and were of low salinity. This approximates data reported by Rye (1985) for the ore-stage fluids at the Carlin disseminated gold mine. The acid leaching therefore could only be from formation of acidic solutions by condensation of vapor from boiling and effervescing solutions. It is thought that at these low temperatures gold is transported as a thiosulfate complex.

Based on the previous assumptions, a best-fit genetic model for the formation of a Vantage-2-type ore body at the Alligator Ridge Mine consists of three stages: 1) a premineral jasperoid-formation stage, 2) a main ore stage, and 3) an acid-leaching and hypogene oxidation stage. Idealized cross sections through a Vantage-2-type ore body are shown in figures 19, 20, and 21.

Stage 1, premineral jasperoid formation: jasperoid forms preferentially at the Devils Gate Limestone–Pilot Shale contact, dominantly replacing the limestone below the contact but also apparently replacing some of the lowermost Pilot Shale (fig. 19). Weak silicification of the lower Pilot Shale also occurred in this early stage. No silica veining is present in the Devils Gate Limestone below the jasperoid suggesting that physical and/or geochemical changes at the contact forced silica precipitation and enhanced carbonate soluability. A possible process for this is pressure loss and cooling of solutions due to expansion of ascending solutions that were confined to narrow conduits in the Devils Gate Limestone outward into the more permeable Pilot Shale. This process, called "throttling", would have caused the precipitation of silica to occur at or above the contact, as observed.

Stage 2, main ore stage: The main gold mineralization event seems to have occurred prior to extensive hypogene oxidation and acid leaching of the Pilot Shale, but after formation of the jasperoid breccia (fig. 20). This is suggested by the occurrance of ore-grade mineralization that cross cuts the oxidized zones and extends into the carbon zone in Vantage-2 (fig. 8), and Vantage-3. Mineralization in the jasperoid breccia is low in grade and tends to be restricted to fault zones, suggesting that the jasperoid breccia was pre-ore and that it was impermeable except where structurally prepared. Extensive hydrothermal alteration of the organic material in the Pilot Shale likely occurred at this time, forming activated carbon in the lower Pilot Shale.

Gold deposition may have occurred due to 1) reduction of the ascending solutions, 2) by scavenging of the complexed gold from solution by activated carbon, and 3) by boiling. Gold could be precipitated from a gold-thiosulfate complex by reduction of the solution by the carbonaceous material in the Pilot Shale. The scavenging of gold from solution as a gold concentrating mechanism is suggested by the abilility of the activated carbon in the carbonaceous ore to remove cyanide-complexed gold from solution. Perhaps the thiosulfate-complexed gold was removed from solution by the same process. Boiling, perhaps in response to the pressure change at the Devils Gate Limestone–Pilot Shale contact, could have caused precipitation of gold from solution. The oxidizing effect of the boiling would have been offset by the reducing environment created by the large amount of carbonaceous material in the Pilot Shale. Also, if boiling occurred beneath the water table, low pH and strongly oxidizing conditions would be less likely to occur. No data are available at this time to indicate which process or processes directly caused gold mineralization.

Stage 3. Acid leaching and hypogene oxidation: gentle boiling of solutions streaming into the lower Pilot Shale from conduits in the Devils Gate Limestone due to throttling (pressure loss) formed the bulk of the hypogene oxidation (fig. 21). Condensation of the vapor phase and effervesced gases resulted in precipitation of acid-leaching solutions. The strong oxidizing and acid-leaching environment likely occurred as a later stage simply due to the large amount of carbonaceous material present in the Pilot Shale that had to be destroyed by oxidation and the ability of the calcareous Pilot Shale to buffer low-pH solutions. Once the carbon was destroyed and the Pilot Shale decalcified,

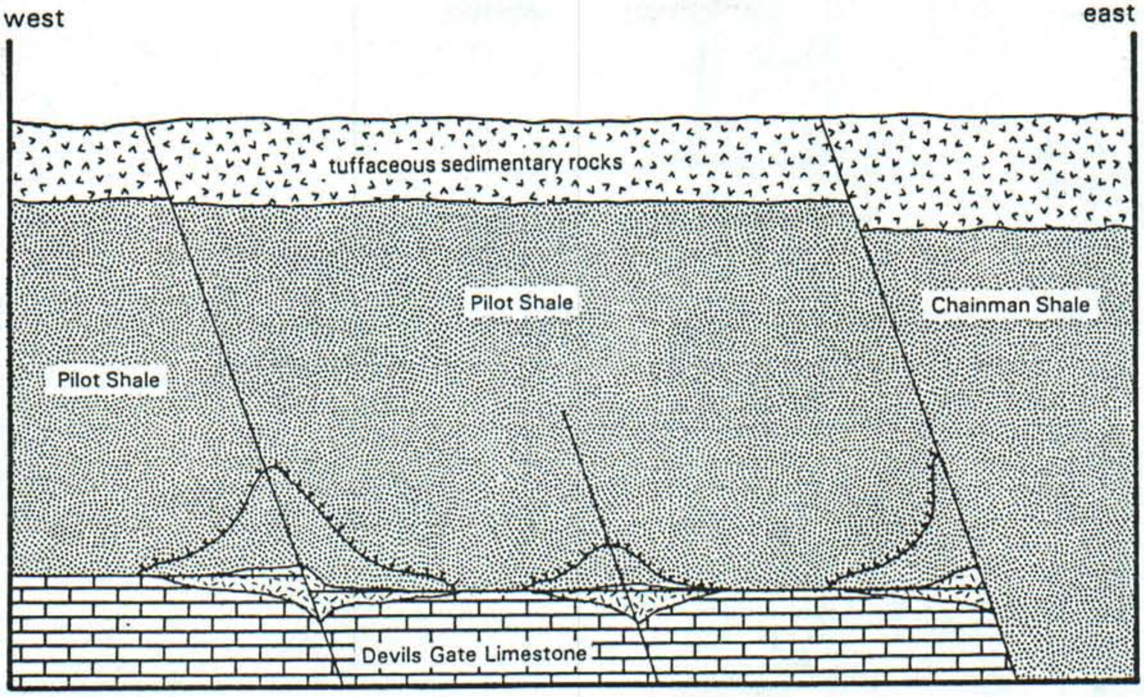
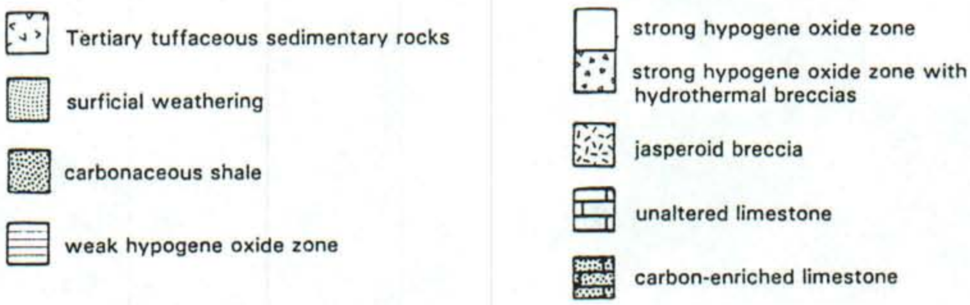


FIGURE 19. Hypothetical cross section through a Vantage-2-type ore body showing early stage jasperoid formation and decalcification.



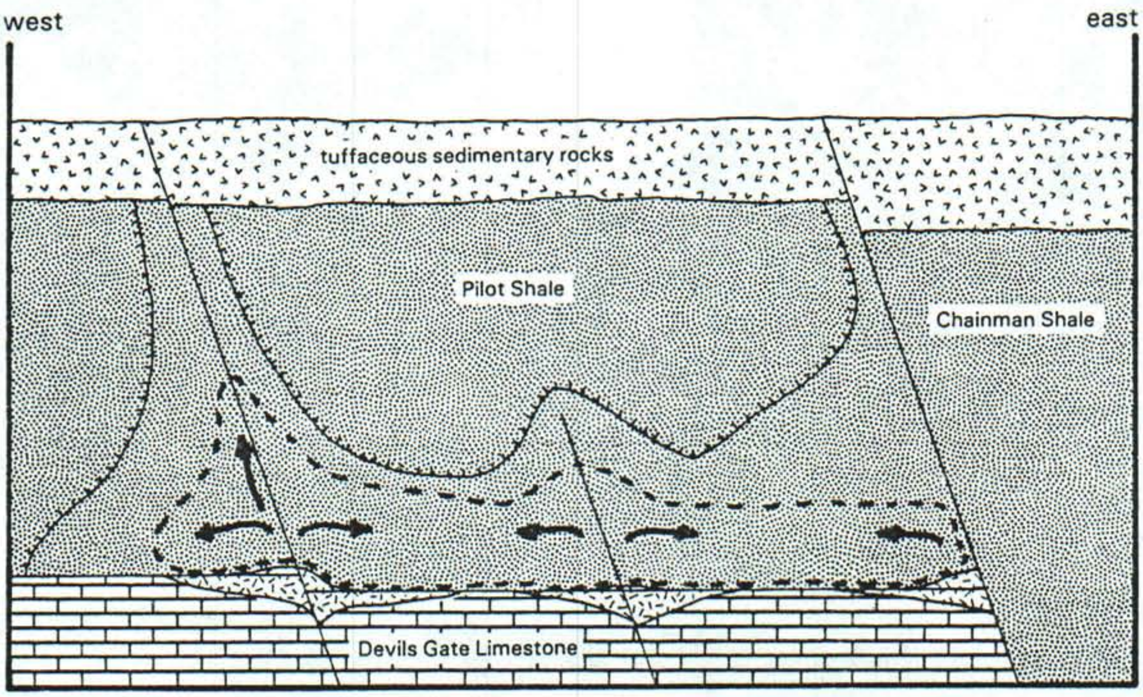


FIGURE 20. Hypothetical cross section through a Vantage-2-type ore body showing the main ore-forming stage.

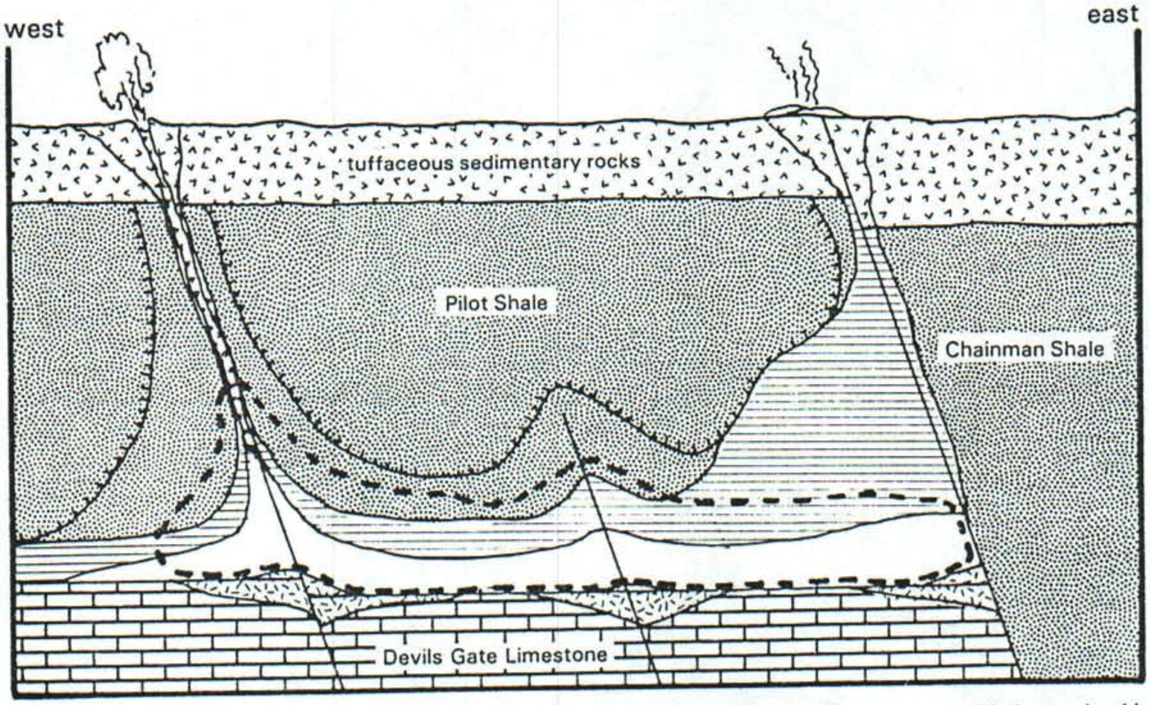
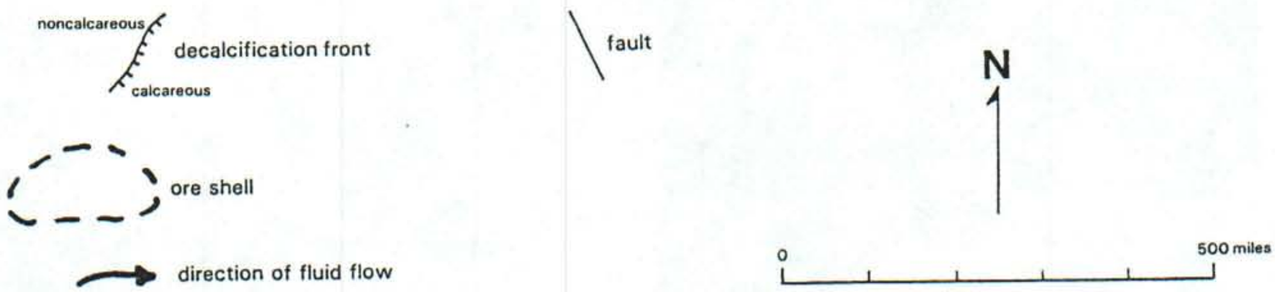


FIGURE 21. Hypothetical cross section through a Vantage-2-type ore body showing strong oxidation and acid leaching as the result of boiling. Explosive brecciation has formed a hydrothermal breccia body.



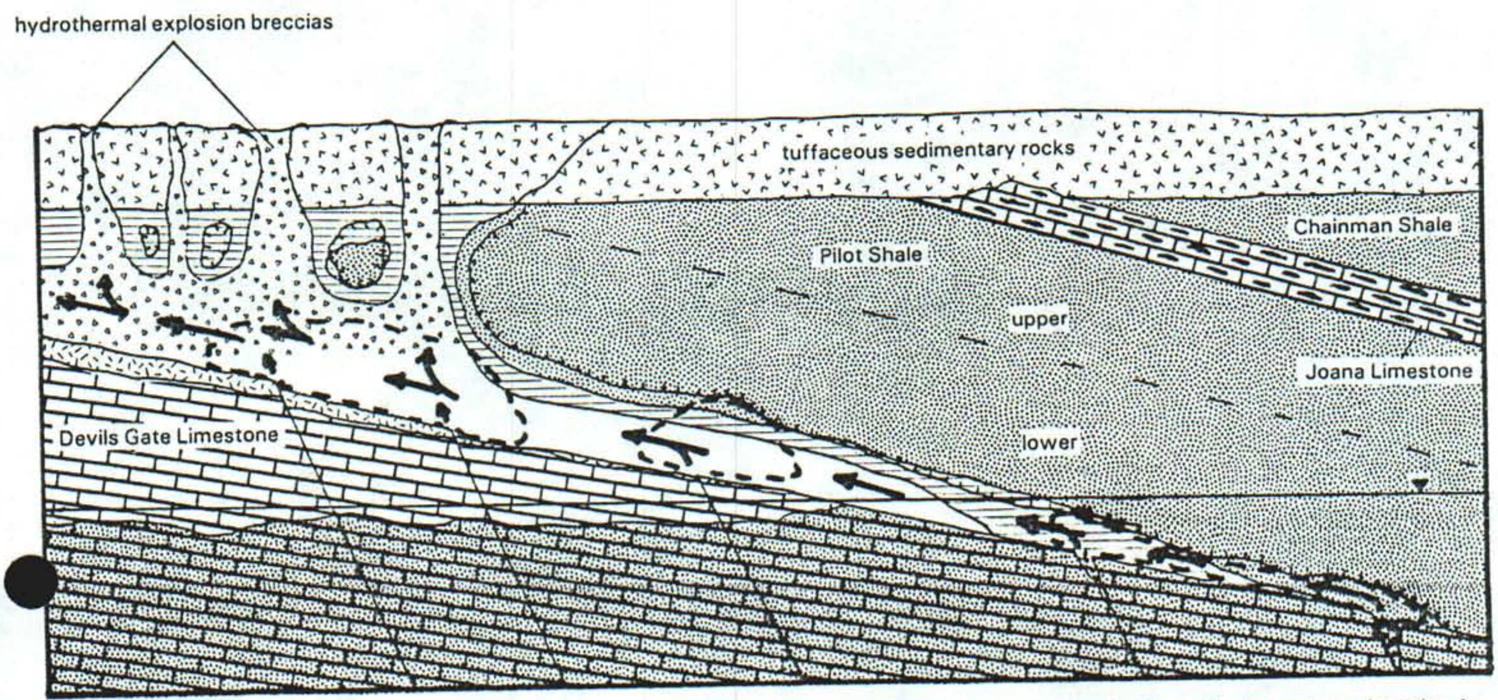


FIGURE 22. A hypothetical cross section through an Alligator Ridge–type hydrothermal system showing how the late stage alteration is controlled by updip migration of hydrothermal fluids.

oxidation and acid leaching could be carried to extremes. Another possible cause of later stage hypogene oxidation and acid leaching could be a drop in the paleo–water table. Boiling occurring above the water table would enhance the ability of the solutions to become strongly oxidizing and would promote the formation of extremely low pH solutions.

A more violent phase of boiling resulted in extensive hydraulic fracturing of the lower Pilot Shale and the formation of hydrothermal explosion breccias. This explosive activity may have been the result of self-sealing of the system by the precipitation of silica in the upper parts of the fault conduits (Berger and Eimon, 1982). Self-sealing of the conduits would have allowed the lower, permeable Pilot Shale to be flooded by solutions under lithostatic load. The relatively impermeable upper Pilot Shale claystones, presumably already folded into an anticline, could have aided in the ponding of solutions in the lower Pilot Shale. Pressure release caused by rupturing of the seal by renewed fault movement or by pressure buildup exceeding the lithostatic load plus the rock tensile strength, would result in decompression of the fluid-saturated lower Pilot Shale and flashing of the confined solutions to steam. Decompression would also promote rapid effervescing of dissolved gases such as CO_2. The pore fluid in the lower Pilot Shale, flashed to steam, hydraulically fractured the rock as it expanded. Where a pathway existed to the surface, vapor and gas streaming could have occurred, brecciating the rock and transporting rock fragments upward to form hydrothermal breccia bodies. At the Alligator Ridge deposits, the vapor streaming carried fragments of the early-formed basal jasperoid breccia at least 200 feet upward from the base of the Pilot Shale and rounded them during transport.

Another possible mechanism for breccia-body formation could be formation of a "gas cap" (Hedenquist and Henley, 1985). Since the concept of self-sealing is not universally accepted, Hedenquist and Henley (1985) proposed that once self-sealing closed off a conduit and the hydrothermal system diverted to another, vapor, steam, and CO_2 from boiling and effervescing could collect under the seal creating local overpressurized zones. Rupturing of the seal by the processes described above would initiate a hydrothermal explosion followed by gentle boiling. Either mechanism would result in the observed features.

Some gold may have been deposited due to destabilization of thiosulfate complexes during boiling. Pre-existing gold was coarsened and leached of silver in the oxidizing environment created by boiling, resulting in the change in the gold-to-silver ratio mentioned earlier.

Updip fluid flow in the lower Pilot Shale may be responsible for some of the larger scale alteration zonation and features observed in the Alligator Ridge deposits (fig. 22). It seems likely, based on alteration zonation, that the Pilot Shale was dipping to the south during alteration and gold mineralization. Some of the features that this process explains are: 1) the increase in thickness and continuity of the basal jasperoid-breccia sheet, 2) The overall zonation of hypogene alteration in the deposits, and 3) the localization of the explosive activity in the Vantage-1 and -2 hydrothermal explosion breccias above the basal jasperoid breccia sheet.

Precipitation of silica from solutions flowing upward along the Devils Gate Limestone–Pilot Shale contact would have been promoted by simple cooling and by pressure release as fluids approached the surface. Boiling, hypogene oxidation and acid leaching, may have been caused by updip flow of the solutions and the resulting change in pressure. It is also likely that below the ancient water table reducing conditions were more likely to occur. A hypothetical water table is shown in the idealized cross section in figure 16. The explosive hydrothermal activity was localized in the lower Pilot Shale because the updip-flowing solutions passed through the lower Pilot Shale and above the earlier formed jasperoid-breccia zone. Self-sealing or gas-cap formation, discussed above, would have released pressure on solutions mainly contained in the Pilot Shale and uppermost part of the jasperoid-breccia zone, hence the apparent lack of Devils Gate Limestone clasts and apparent "rootless" nature of the hydrothermal breccias. The carbonaceous hydrothermal breccias in the Devils Gate Limestone are the result of boiling of solutions and of solutions at and not above the Pilot Shale-Devils Gate Limestone contact. Because the boiling occurred below the water table, and because of the abundance of carbonaceous material and carbonate, the solutions were unable to become strongly oxidizing (low pH), except locally. The presence of hydrothermally altered carbonaceous material in the Devils Gate Limestone and the breccia bodies suggests that organic complexes could have been important transport mechanisms for gold.

SUMMARY AND CONCLUSIONS

Apparently, the Alligator Ridge disseminated gold deposits are apparently relatively young and represent the root zones of a hot-springs-type system. This is suggested by the alteration zonation, the types of alteration present (especially hypogene oxidation and argillization), the alteration mineral suite present (especially jarosite, alunite, and kaolinite), and the presence of hydrothermal explosion breccias.

Ore-body genesis can be divided into three phases: 1) an initial barren phase of jasperoid-breccia formation, 2) a phase of gold deposition within the carbonaceous Pilot Shale, and 3) a final phase of boiling, acid leaching, strong hypogene oxidation, and explosive hydrothermal brecciation. During the final stage some gold deposition may have occurred, but it is evident that much of the coarse gold in the oxidized ore is reworked, submicron gold originally deposited in carbonaceous rock.

The genetic model developed for the Alligator Ridge deposits, although not definitive, uses updip flow of the hydrothermal solutions through the Pilot Shale to explain the large-scale overall alteration zonation. On a smaller scale, physical processes such as throttling and self-sealing (or formation of a gas cap) controlled boiling and explosive brecciation.

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Northwall, Vantage-2 pit, Alligator Ridge gold mine.

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May 29, 1990

Tyler J. Gilmore
Geologist
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Box 999
Richland, Washington 99352

Dear Mr. Gilmore.

I was interested to read your recent Mountain Geologist paper on the Joana in east-central Nevada.

As you may or may not know, the Joana and related rocks (upper Guilmette, Pilot Shale, and Chainman Shale) are, in addition to their relevance to petroleum, also hosts for disseminated gold deposits throughout east-central Nevada. These deposits are on the small side, generally running to several hundred thousand ounces of gold. Chief occurrences known to date are:

Bald Mountain	24N	57E
Little Bald Mt	23N	57E
Golden Butte	23N	61E
Alligator Ridge	22N	57E
Illipah	18N	58E
Nighthawk Ridge	15N	55E
Green Springs	15N	57E

In general, the ore occurs in silicified (jasperized) breccia zones at the carbonate/clastics unconformities, or in decalcified, bleached portions of the clastics.

I own a gold prospect just south of Sunnyside, in 5N, 61E, near where you most probably measured your Sunnyside section. It is being worked on intermittently this year, mostly in surficial sampling of altered Chainman and silicified Joana. A good bit of our target area is the CONCEALED Chainman/Joana contact, concealed on the west side of our little massif under a dip slope, and on the east side in a graben.

I was wondering whether you could provide me with a copy of the strat section measured at Sunnyside, either a photocopy of your section or an abridged version. That information alone would be valuable to us in deciphering the reverse circulation drilling that is planned for later in the year. I am especially interested in knowing whether you would characterize the Joana in that area as predominantly Facies 1 (wackestone, grainstone, packstone) or Facies 2 & 3 (wackestone & mudstone). A higher proportion of mudstone is, for us, a more encouraging sign of a potential host rock.

Any other information you have bearing on the alteration (if any) you saw in that area would be greatly valued.

Thank you.

Sincerely,

Vic Ridgley
President

Sample descriptions for the Sunnyside section.
Sec 1,2 T6N R62E, Lincoln County, Nevada.

Meters above base	Sample number	Descriptions
9m	SL 1	Peloidal Wackestone: Dusky yellowish brown to brownish gray (10YR 2/2-5YR 4/1). Large (>5cm) limestone clasts in a brecciated matrix of smaller (~5mm) limestone clasts and drusy quartz. Clasts often have moderate red (5YR 4/6) jasperoid rinds. Original limestone very recrystallized with micrite altered to microspar and spar. Allochems consist of echinoderms 17%, intraclasts 15%, peloids 7%, brachiopods 5% and bryozoans 1%. The echinoderms are often micritized. The brachiopods are generally thin shelled and occasionally show fibrous cement on the stratigraphic down side of the shell and spar cement on the up side. Mesopore .125-.25mm fracture porosity, 2%
14.5m	SL 2	Peloidal Wackestone: Medium gray to brownish gray (N4-5YR 4/1) with blotches of very dusky red (10R 2/2). Very gradual fining upward with no apparent bedding. Fining upward of pellet sizes from .05-.2mm. Allochems consist of peloids 35%, echinderms 11%, brach-iopods 3%, bryozoans and ostracods 1%. The allochems have often been micritized. The brachiopods and ostracod shells are generally thin. Whole ostracod shells often filled with spar cement. Abundant to occasional fractures, predominately with no fill. Mesopore <.125mm fracture porosity, <1%
21m	SL 3	Pelmatozoan Wackestone: Pale yellowish brown to medium light gray (10YR 6/2-N6). Moder-ately recrystallized; micrite to microspar. Thin bedded 1-3cm thick, with allochems forming lag layers. Allochems consist of echinoderms 27%, peloids 12%, brachiopods, bryozoans and ostracods 1%. Some echinoderms micritized forming peloids. Rare encrusting bryozoans. Occasional fracturing with no fill, occasional stylolites with Fe staining. Mesopore .125-.33mm vug porosity, 1%
27m	SL 4	Pelmatozoan Wackestone: Medium dark gray to brownish gray (N4-5YR 4/1) moderately recrystallized with micrite altering to microspar. Allochems occur in "clots". Faintly defined horizontal bedding. Allochems consist of echinoderms 28%, peloids 15%, brach-iopods 7%, bryozoans 1%. Allochems often micritized obscuring original structure and are often classified as peloids. Peloids size range from .3-.6mm. There are many large (~2cm) brachiopods in sample. The brachiopods are occasionally slightly silicious and often thin shelled. Occasional to abundant fractures, generally with no fill, occasional silica fracture fill. Mesopore .125-.25mm fracture and vug porosity, 1%
33m	SL 5	Pelmatozoan Wackestone: Medium dark gray to dark yellowish brown (N3,4-10YR 4/2). Moder-ately mottled texture with light colored allochems forming clots, no apparent bedding. allochems consist of; echinoderms 51%, peloids 3%, and brachiopods 1%, some of the clasts partially silicified. A thin 1-2cm tectonic breccia zone has been silicified and oxidized. abundant fracturing, generally with no fill. Abundant styloloites with Fe stain. Mesopore .125-.25mm fracture porosity, 3%.
39m	SL 6	Sparse Wackestone: Medium gray to brownish gray (N5-5YR 4/1) Allochems form thin 1-3mm bedding planes with an overall coarsening upward into a mottled coarse grained rock with allochems forming clots in micrite/microspar matrix. Allochems consist of; echinoderms 22%, peloids 2%, bryozoans 2%, and brachiopods 1%. Echinoderms often micrit-ized bryozoans often fragmented. There are some geopetal structures in brachiopod shells consistant with stratigraphic up. Mesopore .125-.33mm fracture and vug porosity, 2%
45m	SL 7	Sparse Wackestone: Light gray to medium gray (N7-N4). Moderately to very recrystallized with nearly all micrite altered to microspar. Very mottled texture, allo-chems form light colored clots with a darker color matrix of micrite/microspar. Micrite also forms intraclasts. No indications of bioturbation. No apparent bedding. Allochems composed of echinoderms 21%, bryozoans 3%, and brachiopods 1%. Often the outline of the allochems very faint due to micritization and recrystallization. The brachiopods are thin shelled. Occasional to abundant fracture, generally no fill. Occasional stylolites with Fe staining. Mesopore .125-.25mm fracture and vug porosity, 2%.
52m	SL 8	Wackestone: Brown to medium dark gray (10YR 6/2-N4). Slightly recrystallized micrite altering to microspar. Mottled texture with micrite forming intraclasts and matrix and allochems forming lighter colored clots. Occasional thin bedding planes. allochems consist of echinoderms 23%, bryozoans 8%, brachiopods 6%, and peloids 3%. Bryozoans

often frag- mented. Brachiopods are thin shelled. Abundant stylolites and pressure solution features, often with Fe staining. Mesopore .125-.33mm frature porosity, 3%.

57m	SL 9	Pelmatozoan Packstone/Wackestone: Medium gray to browinish gray (N5-5YR 4/1). Moderately to very recrystallized: micrite altering to microspar. Small scale (.5-3cm) fining upward laminations with overall coarsening upward to a Packstone. Allochems consist of echinoderms 50%, peloids 15%, bryozoans 4%, and brachiopods 1%. Nearly all allochems have been micritized leaving faint relic structures. Occasional to abundant fractures, predominately no fill. Mesopore .125-.25mm fracture with trace interparticle porosity, 3%.
63m	SL 10	Sparse Wackestone: Browinish gray (5YR 4/1). Predominately recrystallized micrite to microspar. No apparent bedding. Slightly mottled texture with the coarser grained, lighter material forming "Clots". Sparse allochems consist of echinoderms (5%). brachiopods 3%, bryozoans 2% and a rare trilobite 1%. The brachiopods are generally thin shelled. The bryozoans are small (.5-.7mm) are fragmented and often sightly abraided. Abundant fracture generally with no fill. Mesopore-micropore .125- <.125mm fracture porosity, 1%.
69m	SL 11	Pelmatozoan Sparse Wackestone: Pale-dark brown (10YR 6/2-4/2) to brownish gray (5YR 4/1). Very recrystallized with micrite altered to microspar and occasionally approaching spar (>5mm). Faint bedding observed, predominately mottled texture of coarser grained clots of allochems and the matrix and some inraclasts composed of the darker colored micrite/ microspar. Overall fining upward in sample. Allochems consist of echinoderms 21%, brachiopods 4%, bryozoans and ostracods 1%. Some allochems are partially silicified, many of the shells have been broken and abraided. Two distinct sets of fractures; one with no fill, the other with sparry cement fill. Mesopore .125mm fracture porosity, 1%.
120m	SL 12	Wackestone: Dark gray to brownish gray (N3-5YR 4/1). Very to moderately recrystallized with micrite altering to microspar and spar. No apparent bedding. Allochems consist of echinoderms 19%, brachiopods 14%, bryozoans 8%, peloids 5%, ostracods 3% and rare foraminefera 1%. Abundant thin walled shell fragments. Occasional fratures with no fill. Occasional geopetal fill in some shells Mesopore-micropore .125- <.125mm fracture porosity, <1%.
130m float	SL 13	Fossiliferous Mudstone: Medium dark gray to yellowish gray (N4-5Y 7/2). Moderately recrystallized with micrite altering to microspar. Very mottled texture of light and dark colors. Sparse allochems consist of echinoderms 3%, brachiopods 2%, and bryozoans 2%. Platy nature in the field. Very few fractures. No visible porosity.
135m	SL 14	Wackestone: Light gray grading upwards to dark gray (N7-N3). Moderate to very recrystallized with micrite altering to microspar. Small scale (2-12mm) horizontal to wavy bedding. There is an overall fining upward. Occasional micrite ripups in lower portion of sample. Allochems consist of peloids 15%, echinoderms 10%, brachiopods 4%, bryozoans 4%, ostracods and intraclasts 3%. Many allochems micritized and then altered to microspar. Bryozoans are more common in the finer grained material. Shelly material is generally thin walled. Mesopore .125mm fracture porosity, 1%.
141m	SL 15	Sparse Wackestone: Medium dark gray to brownish gray (N4-5YR 4/1). Moderately to very recrystallized with micrite altered to microspar. Thin millimeter laminations with an overall coarsening upward. In general the rock is very fine grained. Many allochems micritized. Allochems consist of peloids 24%, echinoderms 9%, brachiopods 3%, bryozoans 1% and ostracods 1%. The bryozoans are small and fragmented. Two distinct sets of fractures are present; one with no fill and the other with spar cement. Mesopore .125mm fracture porosity, 1%.
162m	SL 16	Sparse Wackestone: Brownish gray (5YR 4/1). Moderately to very recrystallized; micrite to microspar. Thin millimeter laminations alternating light and dark. Occasional thin disarticulated brachiopod shells oriented in bedding planes. Allochems consist of brachiopods 10%, peloids 9%, echinoderms 8%, bryozoans 2%. Occasional to rare fractures with no fill. Occasional fibrous cement on shells. No visible porosity.
178m	SL 17	Sparse Wackestone: Medium gray to brownish gray (N5-5YR 4/1). Moderately recrystallized with micrite altering to microspar, abundant silica replacement. Faint gradational bedding averaging 2cm thick. Allochems consist of echinoderms 18%, bryozoans 11%, brachiopods 5%, forams, 3%, corals and peloids 1%. Some crinoid columnals partially intact. Two distinct sets of fractures; one with no fill the other with spar cement. No visible porosity.

185m SL 18 Peloidal Wackestone: Brownish gray (5YR 4/1). Moderate to very recrystallized; micrite to microspar. One erosional surface with 1-2mm relief in sample, predominately no bedding. Allochems consist of peloids 25%, bryozoans 9%, echinoderms 7% and brachiopods 4%. Many of the peloids represent micritized skeletal fragments. One solitary rugose coral was also observed in sample. Two sets of fractures apparent; one with no fill, the second with spar cement fill. Spar filled fractures not as common. No visible porosity.

204m SL 19 Peloidal Wackestone: Brownish gray (5YR 4/1). Predominately recrystallized micrite to microspar. No apparent bedding. Very sparse skeletal fragments. Allochems dominated by peloids 30%, with bryozoans 9%, echinoderms 5%, brachiopods 4%, and foraminiferas 1%. Allochems average a very fine grained .05mm. Many of the brachiopod shells altered to spar. Allochems often show relic micrite envelopes. Bryozoans are predominately fenestrae, micritized and fragmented. Occasional fractures, some with no fill and others with spar cement fill. No visible porosity.

210m SL 20 Wackestone: Medium gray (N5). Very to moderately recrystallized with micrite altered to microspar. Faint horizontal bedding. Allochems consist of echinoderms 41%, peloids 15% and bryozoans 7%. Many of the allochems micritized. Often the allochems have millimeter size micrite envelopes. Approaching quiet water ooids. Occasional to abundant fracture and channelling with spar fill. Mesopore .125mm fracture porosity 2%.

216m SL 21 Sparse Wackestone: Medium dark-dark gray (N4-N3). Very recrystallized with micrite altering to microspar. Slightly mottled texture. Faint bedding surfaces with modest (.5mm) relief. Sparse allochems consist of echinoderms 8%, peloids 7%, brachiopods 5% and bryozoans 4%. Abundant fracturing and channelling with clay infilling. Occasional stylolite with faint Fe staining. Mesopore .125mm fracture porosity, 1%.

228m SL 22 Sparse Wackestone: Brown gray to medium dark gray (N4-5YR 4/1). Slightly to moderately recrystallized. No apparent bedding. Sparse allochems consist of bryozoans 11%, peloids 8%, brachiopods 4% and echinoderms 2%. Many of allochems micritized creating peloids. bryozoans very fragmented. Occasional small fractures some with no fill others with spar fill. Mesopore .125mm fracture porosity, 2%.

243m SL 23 Wackestone: Brownish gray to medium gray (5YR 4/1-N4). Moderately to very recrystallized with micrite altering to microspar. Slightly mottled texture with allochems occurring in clots. No apparent bedding. Allochems consist of bryozoans 18%, echinoderms 13%, peloids 7%, corals and ostracods 1%. Mesopore .125mm fracture porosity, 1%.

Appendix B

Plate Explanation

Carbonate Rock Type

- M — Mudstone
- FM — Fossiliferous Mudstone
- SW — Sparse Wackestone
- W — Wackestone
- P — Packstone
- G — Grainstone

Allochems

- Brachiopods
- Bryozoan
- Burrowing
- Chert
- Crinoids
- Branching Coral
- Colonial Rugose Coral
- Solitary Rugose Coral
- Foraminifera
- Gastropods
- Ostracods
- Ooids
- Peloids
- Silt

Bedding

- Faint Laminations
- Gradational Bedding
- Thin Laminations
- Lenticular Bedding
- Smallscale Crossbedding
- Trough Crossbedding
- Bioturbation

Contacts

- Fault
- Gradational
- Erosional

Key to facies and microfacies designations on plates

1) Unbedded Subtidal Facies

Microfacies:
a) Bioclastic Wackestone

b) Massive Wackestone

c) Grainstone Cap

d) Grainstone/packstone Flank

2) Bedded Subtidal Facies

Microfacies:
a) Bedded Wackestone

b) Mud Mounds/Banks

c) Mudstone/shale

3) Restricted Subtidal

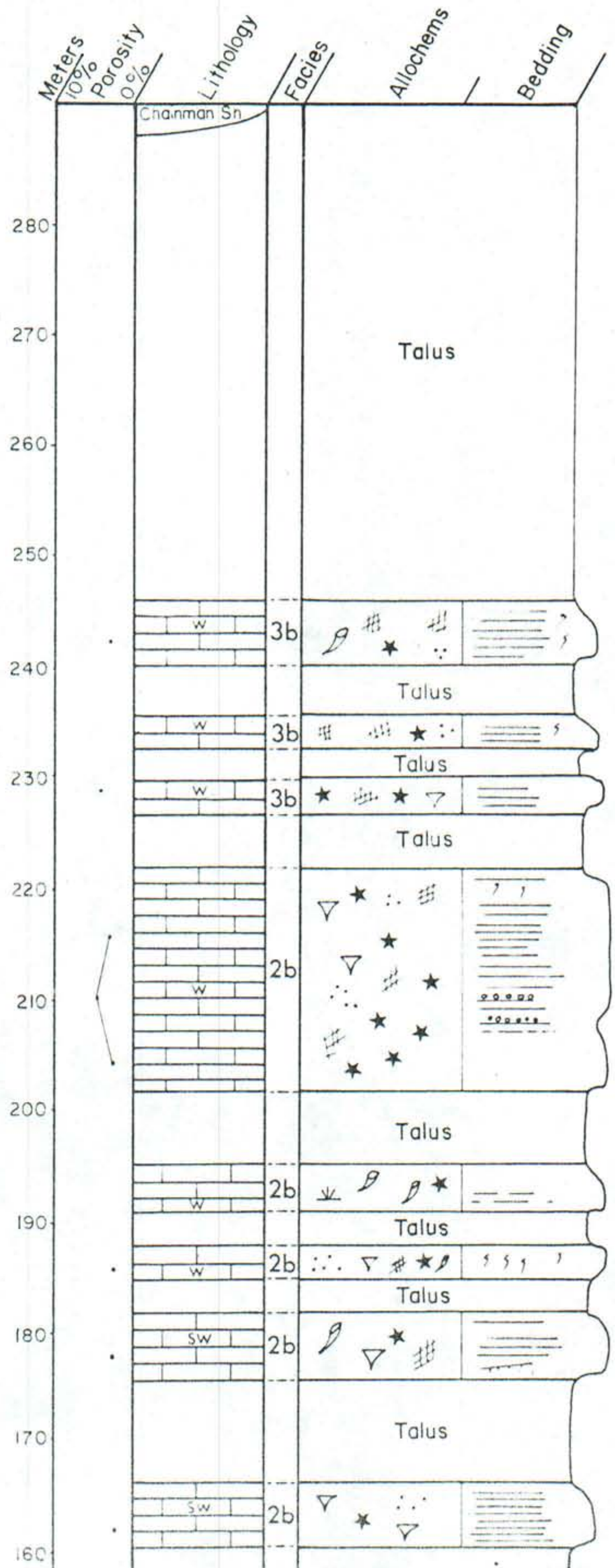
Microfacies:
A) Ooid Packstone

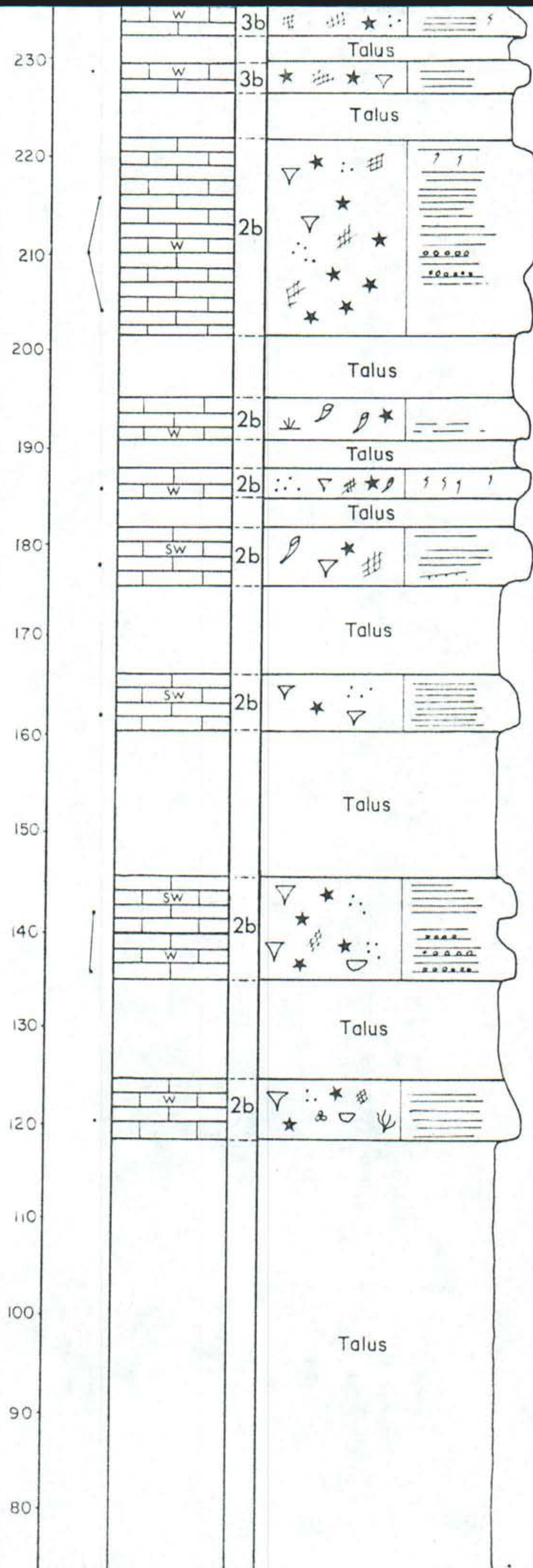
B) Bryozoan-rich Sparse Wackestone

C) Mudstone/shale

Plate IV

Sunnyside





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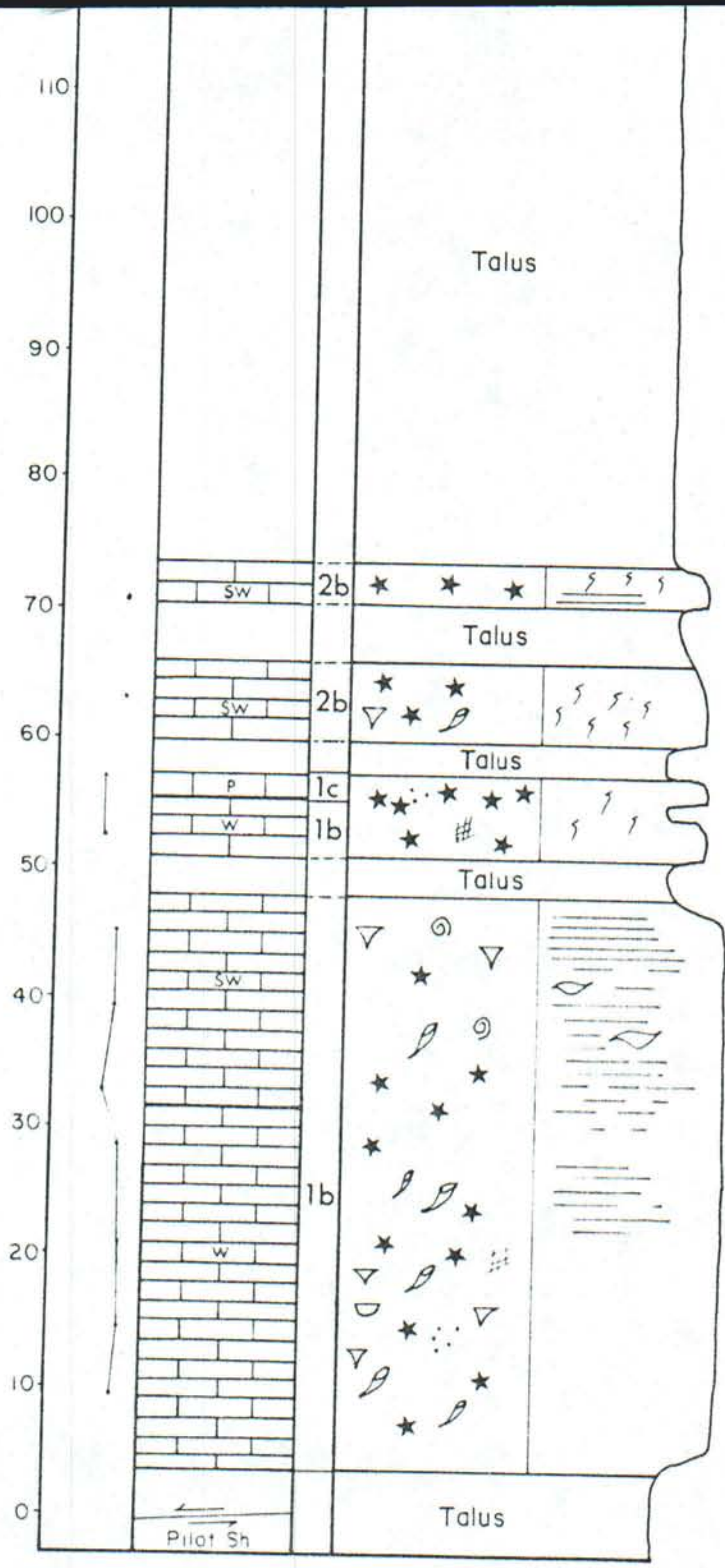

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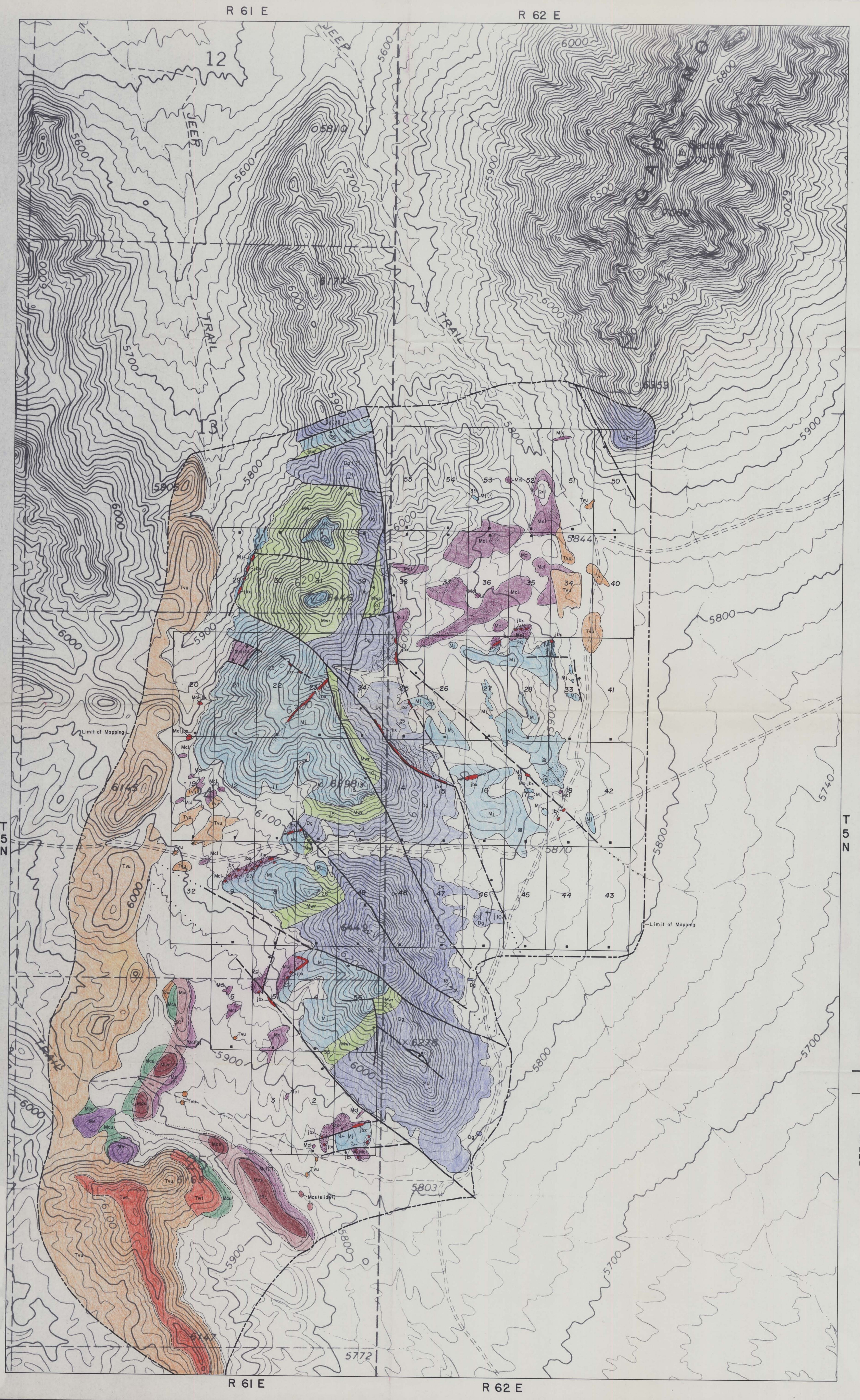
Talus
Pilot Sh

GEOLOGIC MAP OF THE BOA PROSPECT

NYE COUNTY, NEVADA



LEGEND

QUATERNARY

Qal — Quaternary Alluvium

TERTIARY

jbx — Jasperoid Breccia. Silicified limestone or shale clasts in chalcedonic matrix.

Tvu/Twt — Tertiary Volcanic Rocks. Tvu, Ash flow tuff (undifferentiated), 23-25 million years old; Twt, Welded ash flow tuff.

MISSISSIPPIAN

Me — Ely Limestone. Massive, light gray limestone.

Mcu — Upper Chainman Shale. Light olive green, calcareous shale.

Mcs — Diamond Peak Sandstone. Massive, medium-grained, well-indurated, dark reddish brown sandstone, 100'+ thick.

Mcl — Lower Chainman Shale. Thinly laminated and thinly bedded, black, fissile carbonaceous shale and siliceous siltstone; weathers light reddish-tan; (stippled areas: strongly bleached with liesegang banding).

Mj — Joana Limestone. Upper: fine to medium-grained, thin bedded, dark gray limestone; (stippled area: fractured with jasperoid veinlets). Lower: massive, course-grained, gray crinoidal limestone.

Mwr — West Range Formation. Thin bedded, argillaceous limestone with subordinate intecalated shale, and thin bedded quartzose sandstone; weathers yellowish-gray.

DEVONIAN

Dg — Guilmette Limestone. Massive, thick bedded, dark gray, medium-grained limestone; (stippled areas: fractured with jasperoid veinlets).

Fault (dashed where inferred, dotted where concealed)

Contact (dashed where inferred, dotted where concealed)

Horizontal Beds

Map compiled from field mapping by Michael D. Russ 4/5-4/12/89 on 3x enlargement (1" = 660') of natural color photography flown 4/14/85 by Intrasearch (Denver, CO); Roll 3301, Frame 006. Original scale 1/24000. Nye County Map (Nevada Bureau of Mines Bulletin 99A) is materially incorrect.

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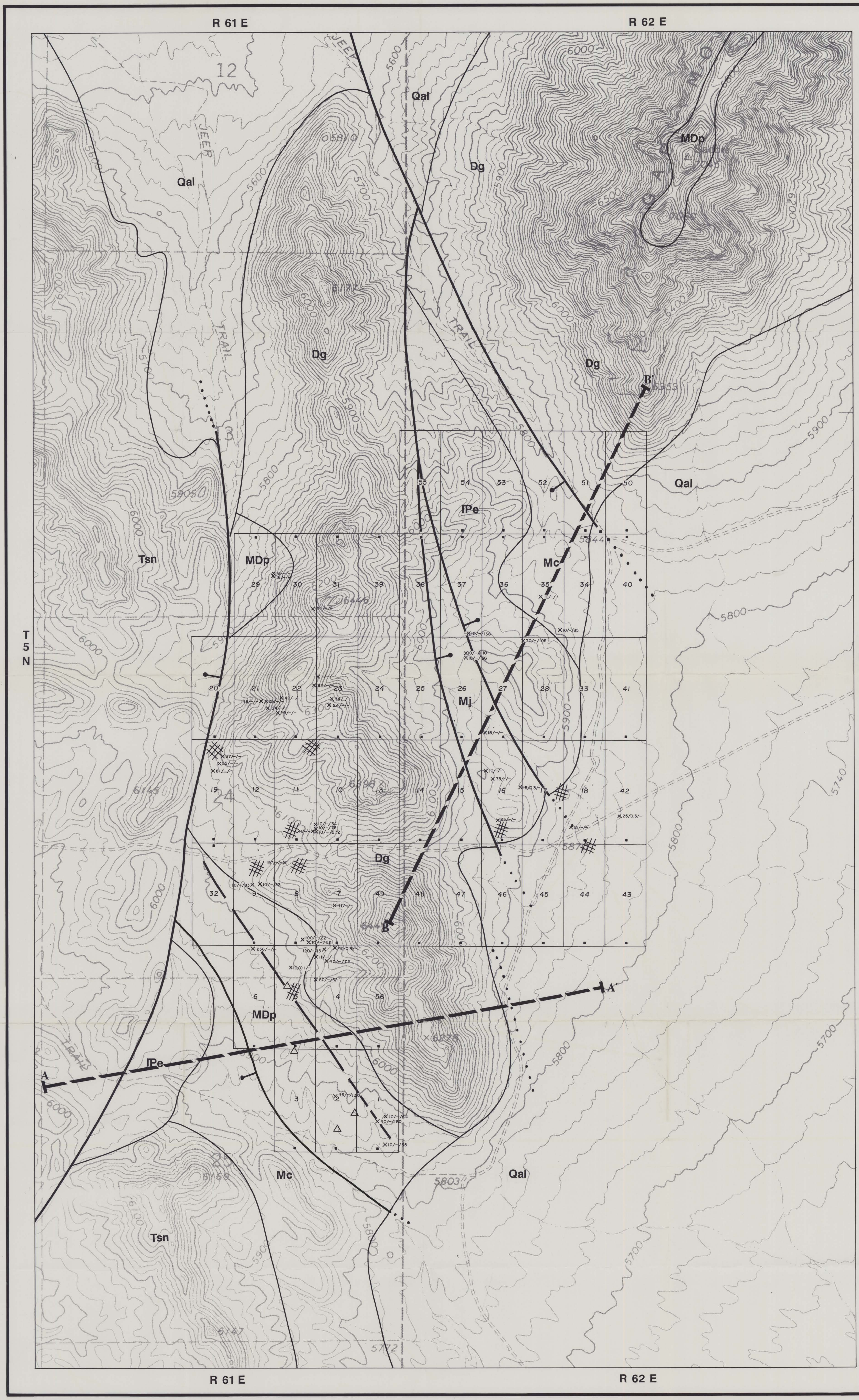

Figure 2

GEOLOGIC MAP OF THE BOA PROSPECT

Nye County, Nevada

LEGEND

Qal	Quaternary Alluvium
Tsn	Tertiary Shingle Pass and Needles Range Fm. (undifferentiated ash flow tuff)
IPe	Ely Limestone (thin-bedded limestone)
Mc	Chainman Shale (black shale & grey siltstone)
Mj	Joana Limestone (crinoidal, petroliferous limestone)
MDp	Pilot Shale (carbonaceous siltstone)
Dg	Guillmette Formtion (dolomitic limestone)

Map modified from Nevada Bureau of Mines Bulletin 99A, Geology of Northern Nye County (1985)

- Fault (dashed where inferred, dotted where concealed)
- Jasperoid occurrences
- △ Ironstone (liesegang-banded Pilot shale)
- X Au(ppb)/Ag(ppm)/As(ppm)

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Nye Co. General
145

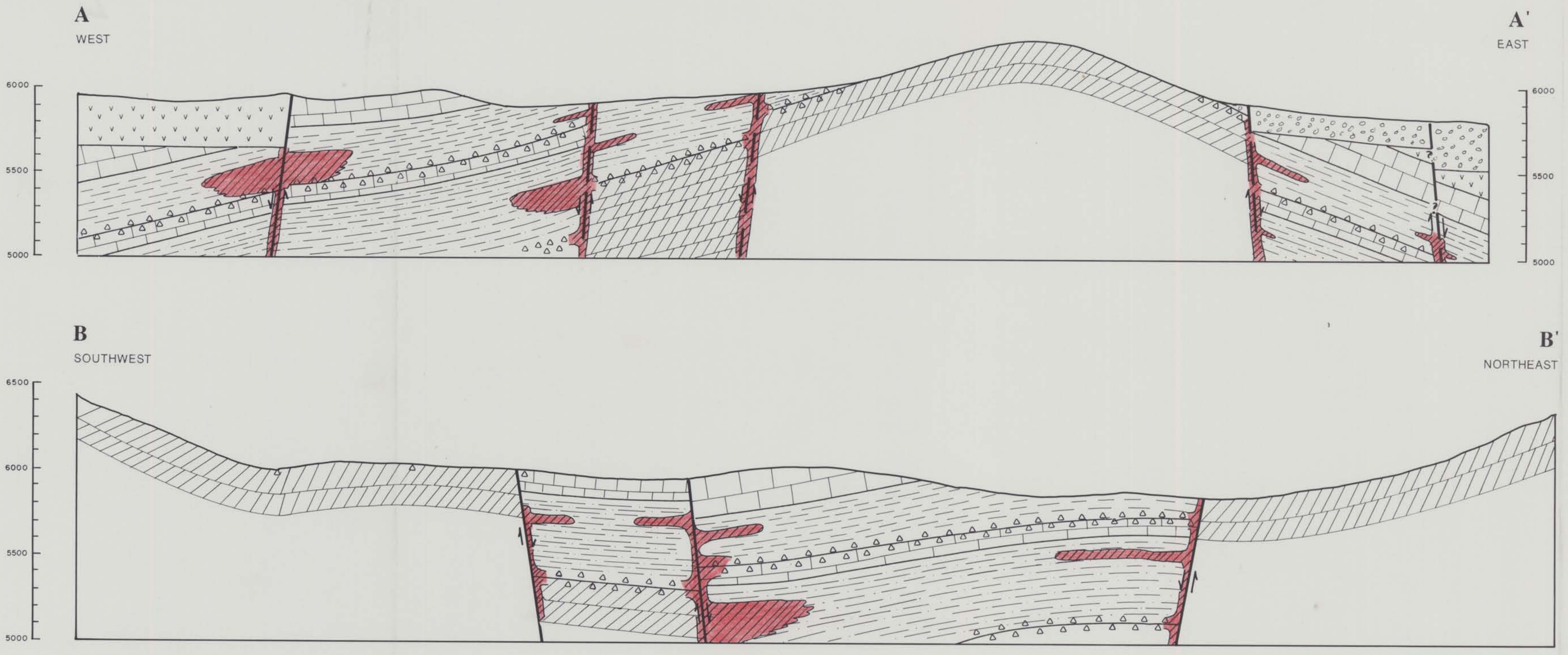
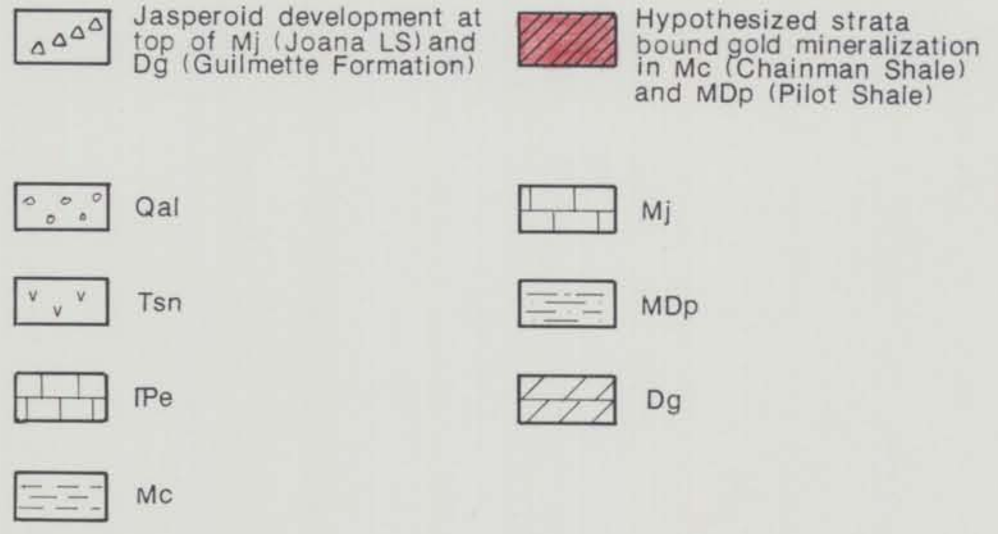


Figure 3

CROSS-SECTION OF BOA PROSPECT

(Interpreted from Nevada Bureau of Mines Bulletin 99A mapping; formation thicknesses estimated)



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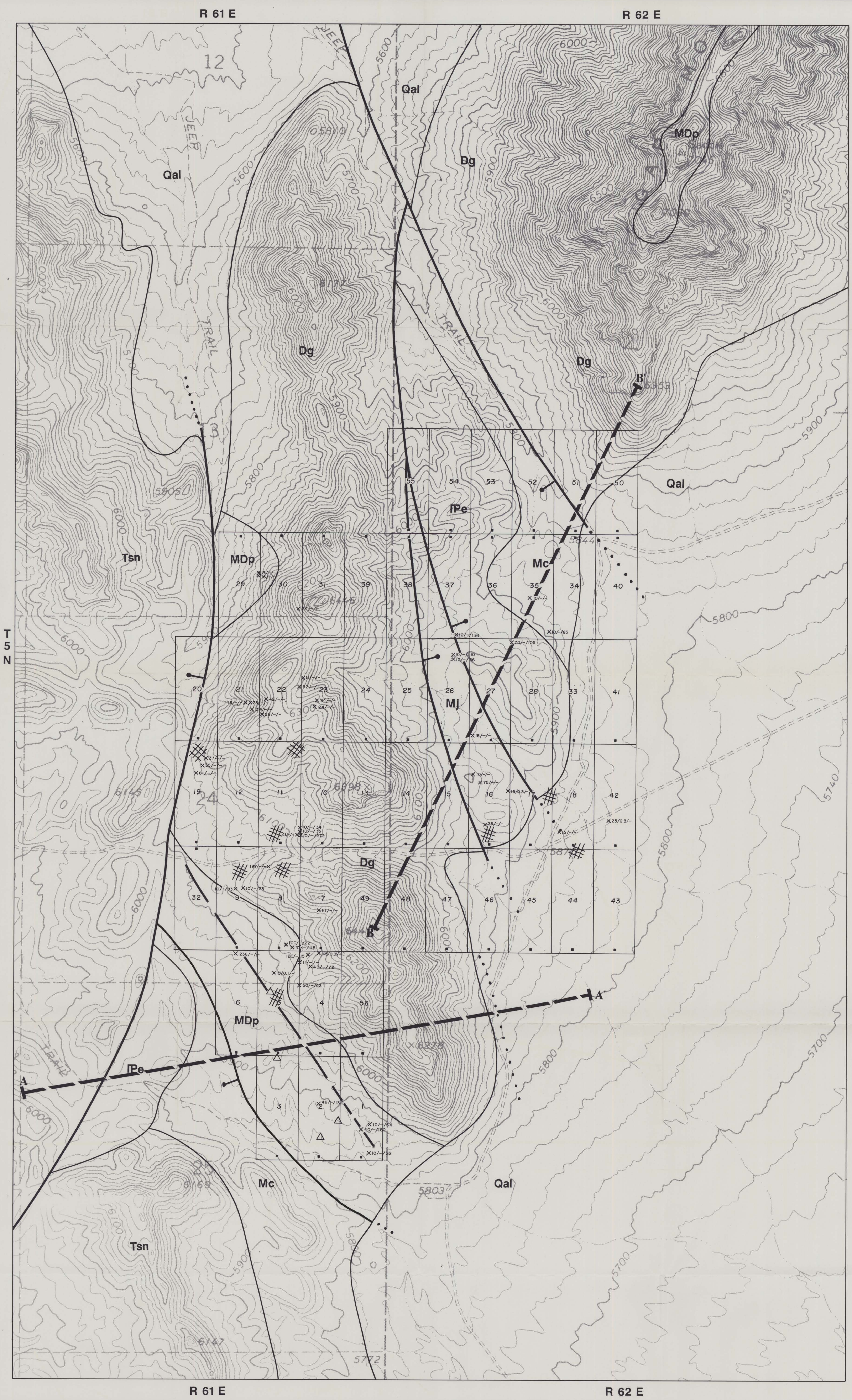

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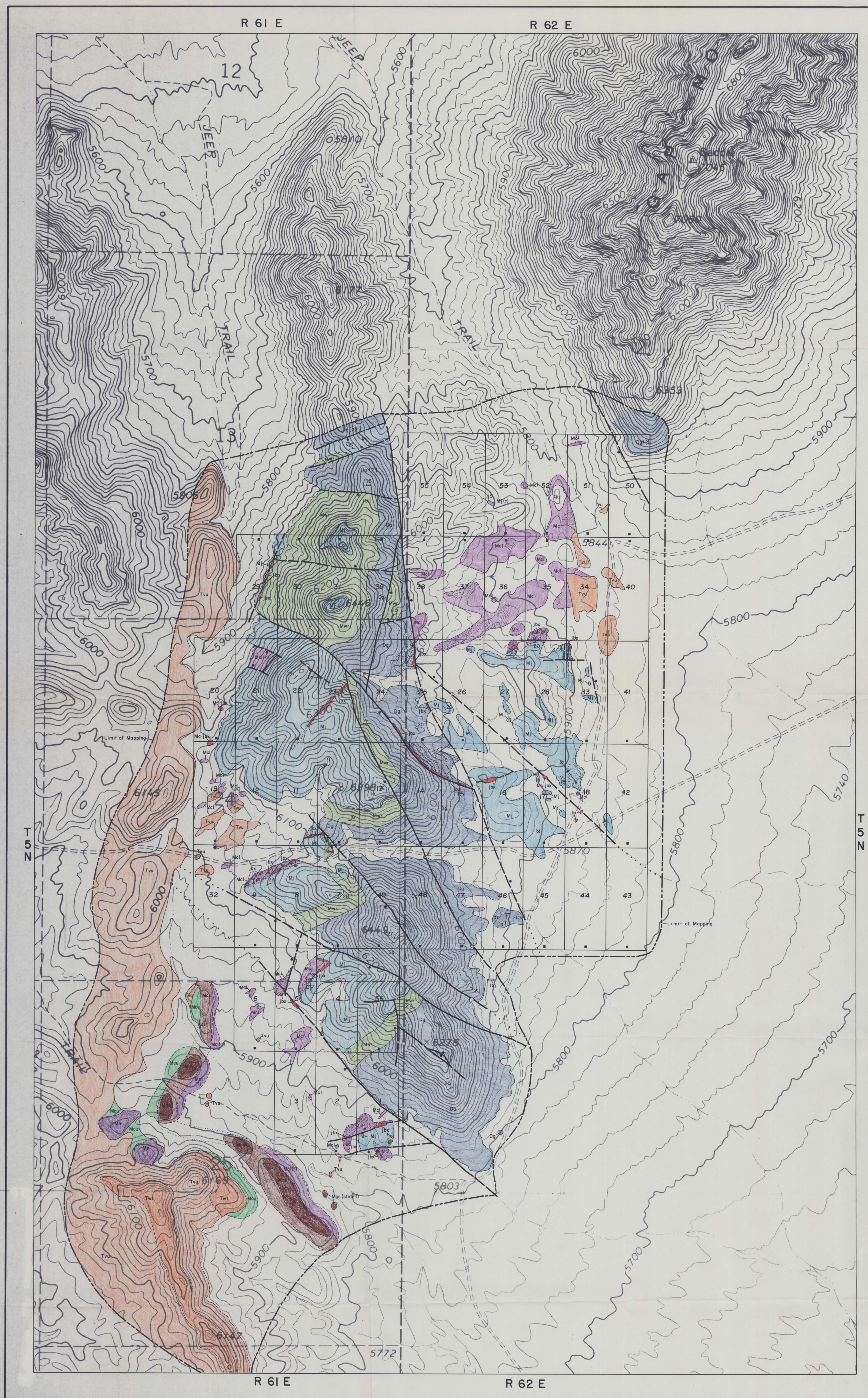

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NYE COUNTY, NEVADA

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N

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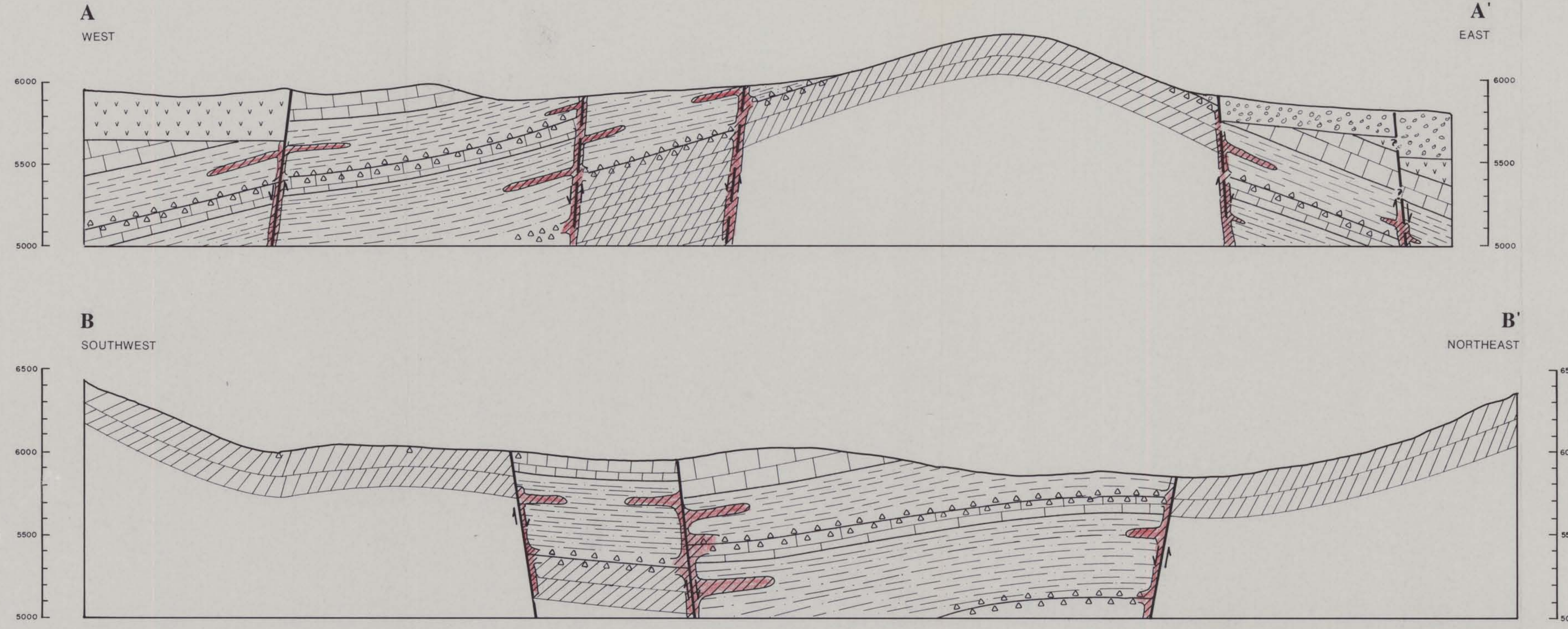

Figure 3

CROSS-SECTION OF BOA PROSPECT

(Interpreted from Nevada Bureau of Mines Bulletin 99A mapping; formation thicknesses estimated)

- Jasperoid development at top of Mj (Joana LS) and Dg (Guilmette Formation)
- Hypothesized strata bound gold mineralization in Mc (Chainman Shale) and MDp (Pilot Shale)
- Qal
- Tsn
- IPe
- Mc
- Mj
- MDp
- Dg