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ELLSWORTH DISTRICT

Location:

In La Paz County, this district arbitrarily takes in the broad zone of metal occurrences in the Granite Wash Mountains bordering the McMullen Valley on the west (Plate 1). This northwest-trending range joins the predominant NE-elongate Harcuvar Mountains at their extreme western end. U.S. Highway 60 passes through the Granite Wash Mountains at Granite Wash Pass between the small town of Salome and the Vicksburg road junction at Hope. The Ellsworth district area is mapped along the west margin of the Salome 15' quadrangle, the east margin of the Utting 15' sheet and a small, northwest portion of the Hope quadrangle.

Geology and History:

The regional geologic setting of the district is its position along the western margin of the Harcuvar metamorphic core complex. This margin is generally one of a rapidly prograded metamorphic front which increases eastward toward the Hercules thrust fault and affects Mesozoic and Paleozoic supracrustal rocks (Rehrig and Reynolds, 1980; Reynolds, 1980; Reynolds, 1985, personal commun.). Metamorphism varies from lower greenschist facies on the southwest to amphibolite facies at the northeast. Large scale thrusting has been recently proposed for complex, tectonically interleaved sequences of Paleozoic metasediments, Mesozoic clastic and volcanic sequences, and Precambrian gneisses and foliated granitoid rocks (Reynolds and others, 1983). The major thrust structure appears to be equivalent to the Hercules fault in the Little Harquahala-western Harquahala Mountain areas which places Precambrian basement on top of Mesozoic and Paleozoic metasedimentary rocks. The Hercules fault has recently been mapped through the southern Granite Wash Mountains where it places Precambrian rocks along the easternmost fringe of the range on top of an internally deformed and partially metamorphosed Mesozoic sedimentary section (Reynolds, 1985, personal commun.). Large plutons of mid-Cretaceous and early Laramide ages (Tank Pass granite, 87 m.y. and Granite Wash granodiorite, 65-70 m.y.) discordantly intrude the thrusts and deformed layered sequences. Tertiary rocks in the Granite Wash area consist of abundant NW-trending dikes and gently dipping basaltic rocks exposed along the west flank of the range.

Mineral occurrences in the Ellsworth district were discovered in the 1860's, but little production was recorded until the earliest 1900's when the Parker cut-off of the Arizona & California Railroad was built. Earliest production and expanded exploration resulted in some "spectacular" free gold occurrences (i.e. Glory Hole mine near Salome, 1909) and copper discoveries around Harcuvar Peak in the Harcuvar range. Total tonnages produced from the district are small and estimated at 14,000 tons from which were recovered 386 tons Cu; 14,700 oz Ag; 2,400 oz Au; 12 tons Pb; and 4.5 tons Zn (Keith, 1978). Tungsten occurs in the district but was not mined until the 1950's when some 1,000 short ton units of WO_3 was produced through 1974. A few carloads of hand picked barite are also reported for the district.

With the exception of a few quartz-siderite-hematite-copper-gold (± fluorite) veins associated with Tertiary diking that cuts gneiss and foliated granitic rocks in the westernmost Harcuvar Mountains (Cottonwood and Tank Pass areas), mineralization in the Granite Wash Mountains is somewhat variable as to type. From an assessment of literature descriptions and our own field observations, we recognize the following deposit types:

1. Veins, fracture fillings and lenses cutting silicified Paleozoic (?) carbonate, Mesozoic (?) schists, and Mesozoic granite carrying an assemblage of quartz-scheelite-siderite-barite and minor zinc and copper. Thrust faulting may have exerted some control on the mineralization.

2. Contact metasomatic or replacement mineralization of Cu-Fe (with or without Au-Ag) in favorable Paleozoic or Mesozoic metasedimentary horizons. Possible structural control by thrust faults or low-angle shear zones.

3. Quartz-carbonate-copper-gold fissure and fault veins similar to those in the Cunningham Pass district which appear associated with mafic or acidic (?) Tertiary diking that cuts all pre-Tertiary rocks.

4. Pyritic (± minor Cu or Au) mineralization suggestive of a stratiform nature, and thought to be controlled by volcanic or sedimentary lithologies in the Mesozoic section. Mineralization is believed to be augmented by thrusting and metamorphic processes. Alumino-silicate alteration (hydrothermal and/or metamorphic) which accompanies or hosts mineralization includes minerals such as sericite (muscovite), actinolite, kyanite, andalucite, dumortierite, garnet, tourmaline, epidote, amphibole, magnetite and scheelite.

The common association of tungsten with many of the occurrences through the district is distinct. The metal is thought to be of various origins including contact metasomatism by nearby Mesozoic intrusive bodies, metamorphic processes within carbonate-rich Paleozoic or Mesozoic sequences or perhaps even of exhalative derivation. In places the tungsten occurs with subordinate copper, iron, zinc and gold. A number of small gold placers should be noted which occur in terranes of Mesozoic metasediments which form a line from Vicksburg, north to Salome Peak. Some 300 ounces of production from gravels in many small washes is mentioned by Keith (1978).

Mines of Interest:

Desert mine: (T5N, R14W, Sec. 21) An area within arenaceous shales, argillites, etc. of the Granite Wash Mesozoic section are cut by a "wide" zone of small, discontinuous quartz and carbonate veins, stringers and masses of amorphous silica carrying gold and copper with varying iron and manganese oxides. Veining is roughly conformable to bedding or schistosity in the metasediments. A prominent felsic dike (Laramide K-Ar date, Rehrig, unpubl. data) intrudes the metasediments near the workings. The zone of quartz influx is thought to be the source of fairly rich but localized gold placers in adjacent washes. Depending on the extent, frequency and grade of the secondary quartz and carbonate flooding, the Desert mine area might be an attractive exploration target. About 700 tons of ore previously mined averaged 0.3 opt gold, 2% copper and 5 opt silver.

Three Musketeer - PeeWee - Jewel Anne mine group: (T6N, R15W, Secs. 24, 25) This group of workings are known mainly for their tungsten production which occurs as disseminations, pockets, discontinuous veins and stringers of scheelite cutting silicifed Paleozoic (?) carbonate, granitic dikes and Mesozoic schists. Quartz, siderite and barite accompany the tungsten. Minor copper, zinc and iron oxides are also mentioned. Quartz veins up to 16 ft thick trend northeast and dip only 30-45°E at the Three Musketeer property. The mineralization appears concentrated along a wide shear zone or thrust which separates Precambrian (?) metamorphic rocks from overlying Paleozoic sediments (Reynolds, 1985, pers. commun.). As late as the 1970's, tonnages were mined which ran from 0.5 to 0.7% WO_3. Reserves at the Three Musketeer mine were reported in 1977 to be about 3½ million tons of 0.5 to 1% WO_3. At the Jewel Anne, veins range from 1" to 2.5' with scheelite reported in the rocks through widths of from 1 to 15 ft for strike lengths up to 200 ft. There have been unsubstantiated reports that the mineralization in places carried low-grade gold. This possibility should be checked by further sampling.

Yuma mine: (T6N, R14W, Sec. 30) An early, fairly prominent producer (8,600 tons averaging 2.3% Cu, 0.3 opt Ag, 0.03 opt Au) of mainly copper derived from contact metasomatic mineralization in strongly tectonized carbonate beds that are sandwiched between metamorphosed siltstone, shales and graywackes and cut by numerous felsic and "post-mineral" mafic dikes. Over 7000 tons were produced from 1941 to 145. The main mass of the Cretaceous Tank Pass granite occurs just northeast of the mine area.

Mineralization appears to be roughly stratibound and is restricted to an unusual, thinly banded carbonate sequence with metamorphic mineral assemblages which include garnet, magnetite, scheelite, epidote, actinolite, and sericite (see Figure). The favorable stratigraphic sequence is thought to be Paleozoic rocks emplaced tectonically along major thrust faults (Reynolds, 1985; personal commun.). These rocks extend out of the local Yuma mine area and can be traced into adjacent canyons. Grades in gold at the mine are reported as high as 0.05 opt and 31 channel samples across 200 ft averaged 1%+ Cu, .04 opt Au (ADMR file data). Chalcopyrite and bornite stockworks and low-angle veins up to 10 ft thick are reported. A 1943 engineering report cites reserves of 10,000 tons measured and 216,000 tons indicated; with assays running 1.8% Cu, 0.03 opt Au and 0.30 opt Ag.

Although Yuma ores run lean in gold, the large extent to the productive stratigraphic interval (~400,000 tons of potential reserves), unusual metasomatic mineral assemblages (including extensive magnetite, quartz, actinolite at the nearby Iron Dyke workings), geochemically anomalous gold (i.e. > 0.05 ppm) over a wide area constitute reasons for considering the mine and surrounding area a prime exploration target.

Dandy mine group: (T5N, R14W, Sec. 6) Irregular, discontinuous fissure-quartz veins cut Mesozoic metasediments. Veins are gold-bearing with copper, silver, lead and zinc. The small reported production (190 tons) averaged quite high in gold (0.6 opt) with 4 opt Ag and 3% Cu.

Glory Hole mine: (T5N, R14W, Sec. 33) Multiple, discontinuous veins of quartz containing gold and other metals occur in Mesozoic metasediments with gangue of siderite, hematite and manganese oxides. A "wide" shear zone is mentioned. Amphibolite horizons (metavolcanic ?) conformable to foliation in the meta-graywacke section are described as is a dolomitic horizon which bears "beautiful free gold" (Bancroft, 1911). Bancroft also alludes to bulk mining possibilities for the mine area, based on the "frequent occurrence" of the small mineralized gash veins.

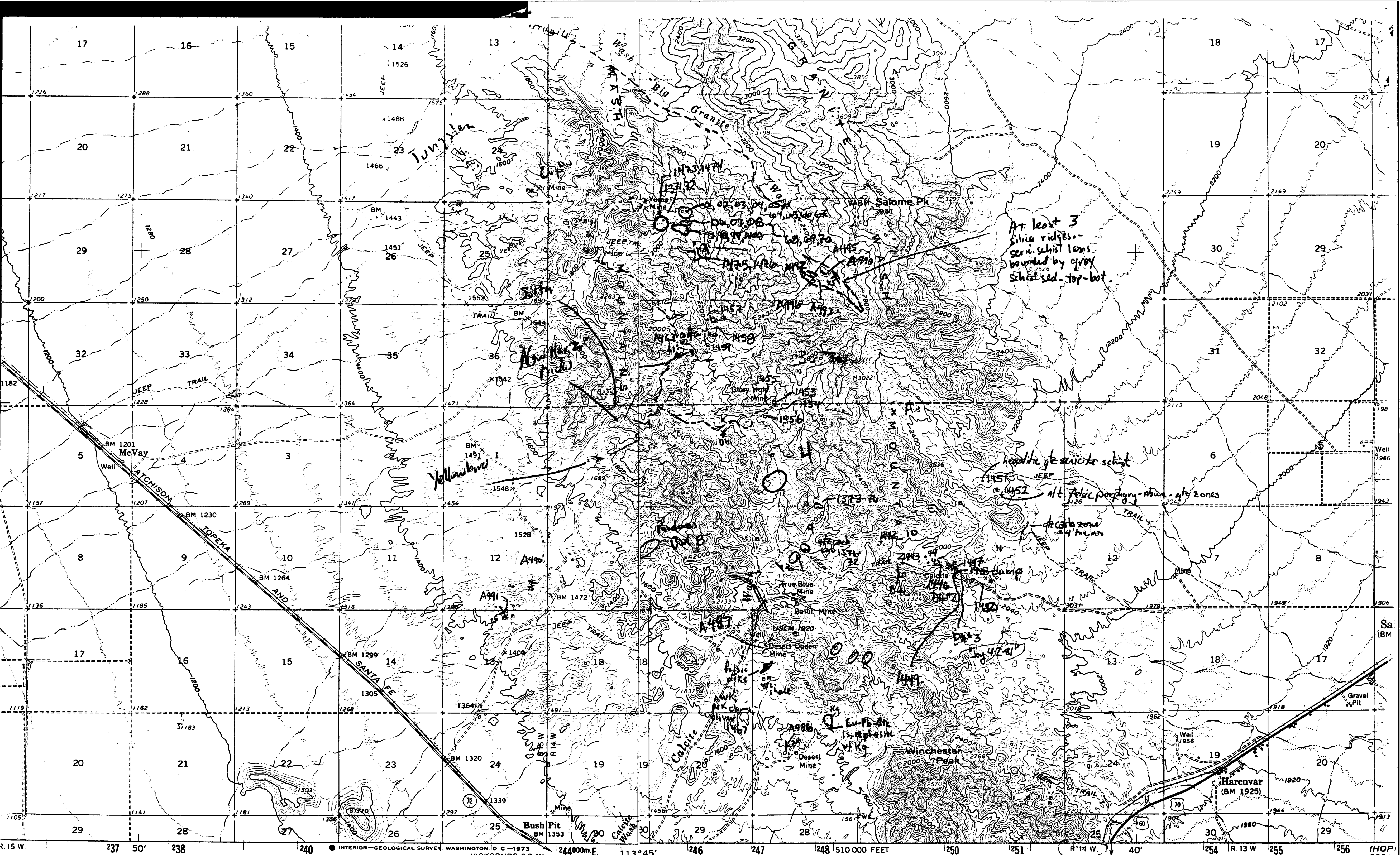
True Blue mine group: (T5N, R14W) Quartz seams and lenses carrying gold, silver and copper occur in a NW-striking breccia zone cutting Mesozoic sedimentary rocks. No size is given for the zone but 200 tons of production averaged about 0.7 opt Au.

Big Dyke Copper prospect: (T5N, R14W--2 mi N of Vicksburg) In foliated schist cut by thin dikes, lenses of quartz, generally quite thin and short in length, occur with small amounts of Cu, Au and Ag. Work has been done in two principal areas. The largest area has been explored by over 500 ft of lateral workings and a 25 ft shaft. Here a large open cut above the tunnel showed mineralization. Of five samples taken, the highest was 0.8 opt Ag, 0.10 opt Au and 1.37% Cu across 12½ ft. Lowest was 0.5 Ag, 0.02 Au and 0.91% Cu from 9 ft. At the other mineralized area, assays were of about the same grade except for a cut from which 15 tons of $131 ore had been taken. A sample at this locality, across 17 inches, assayed 5.1 opt Ag, 0.88 opt Au and 0.15% Cu. Property is old. A small mill operated here about 20 years ago and from indications of the tailings dump, milled about 1,000 tons of ore. Mine has been worked intermittently since 1891.

Calcite mine: (T5N, R14W, Sec. 14) Numerous prospect pits, cuts and several shallow shafts have explored a stratiform, quartz-sericite schist interval within Mesozoic metamorphic rocks just beneath the Hercules thrust. The altered stratigraphic sequence is moderately to strongly pyritic, iron-stained and bears secondary quartz, alumino-silicate minerals (i.e. kyanite, pyrophyllite, dumortierite) and anomalous gold. Tourmaline and andalucite horizons overlie the pyrite-muscovite schist interval. Tungsten mineralization is also reported. The mineralized stratigraphy is cross-cut by the later 65 to 70 m.y. granodiorite of Granite Wash Pass.

References:

Bancroft, 1911; Dale, 1959; Ciancanelli, 1965; Keith, 1978, Arizona Dept. Mineral Resources, file data.



ROAD CLASSIFICATION

Medium-duty — Light-duty

Unimproved dirt

State Route

QUADRANGLE LOCATION

ARDS

R WASHINGTON, D. C. 20242

ABLE ON REQUEST

UTTING, ARIZ.

N3345—W11345/15

1962

AMS 3251 IV—SERIES V798

Mapped, edited, and published by the Geological Survey

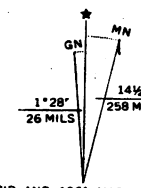
Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1951 and 1960. Field checked 1961

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Where omitted, land lines have not been established

bedding w/ ~ 4' of argilliz., leached
d FeOx and ~ 3 - 2" thk qtz vns.
oll. to bed. from adit. This is as
s here, thins rapidly. At shaft is compl.
qtz in folds. Alt. zns rare, but assoc.
tr. qtz as float, hence alter. zns. rare



UTM GRID AND 1961 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

A487 - grab of 'ore' - most dumps barren gray shale-schist. vein erratic, 1-3' thk, str. NNE, dip. 50 to E, no wallrx alter. qtz, clear, c.g. w/ abund wlrx. inclu. w/ CuOx, limo - fairly extensive dumps, workings

SCALE 1:

CONTOUR INTE

DOTTED LINES REPRESE

DATUM IS MEA

THIS MAP COMPLIES WITH NATION

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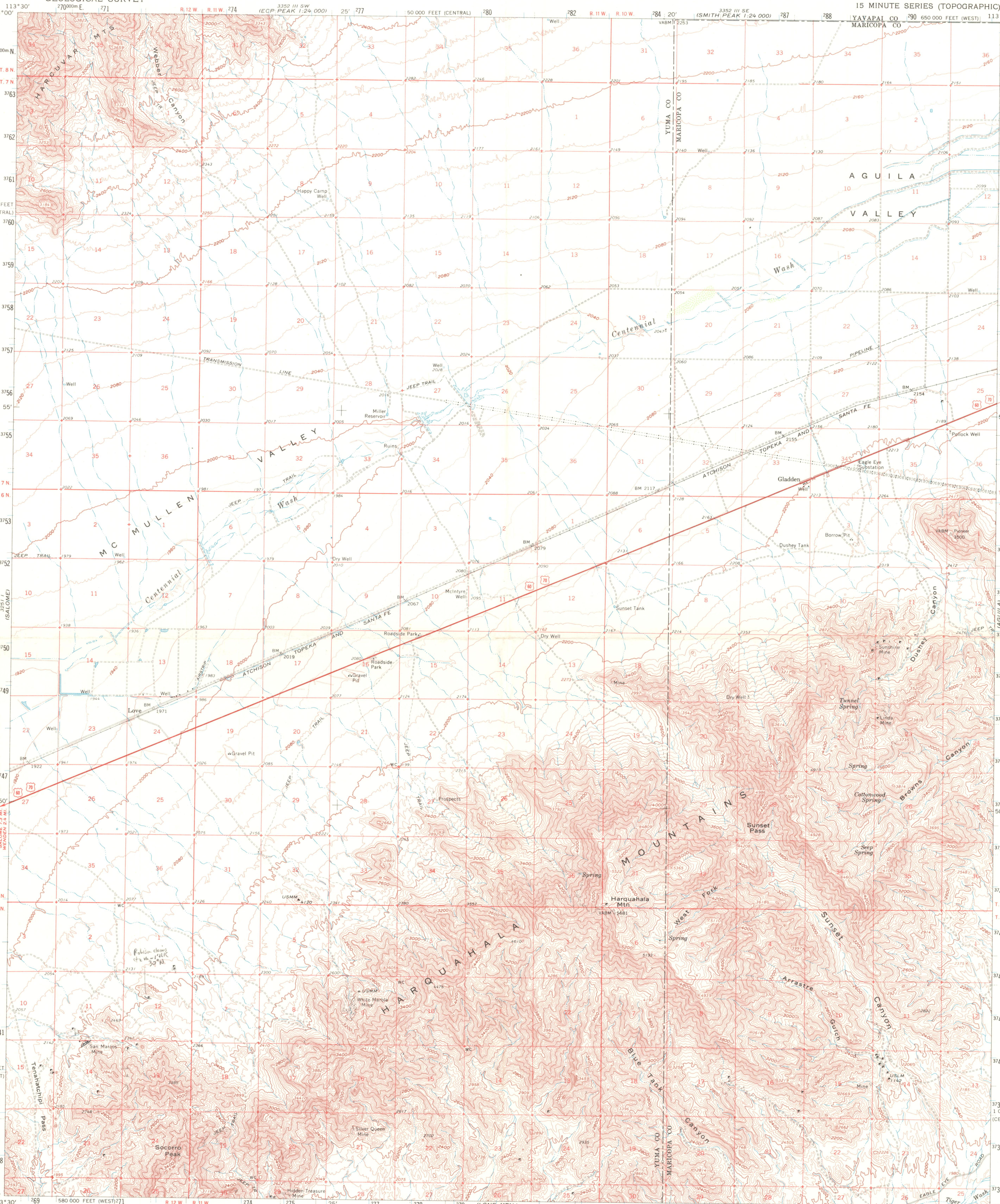
A FOLDER DESCRIBING TOPOGRAPHIC MAPS

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GLADDEN QUADRANGLE
ARIZONA
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

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Topography by photogrammetric methods from aerial photographs taken 1951 and 1960. Field checked 1961

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, west and central zones
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

1/15/86 - San Marcos Mine - sericite schist zone >10' thk in gran. gneiss. schist zn mineral. w/ qtz, FeOx & py, dips ~ 20° to NW
- no holes in immediate area at San Marcos.
some holes on Robison ground

UTM GRID AND 1961 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

GN MN 1°19′ 23 MILS 14½° 258 MILS

SCALE 1:62500

1 ½ 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION

Heavy-duty Light-duty
Unimproved dirt
U. S. Route

ARIZONA
QUADRANGLE LOCATION

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GLADDEN, ARIZ.
N3345—W11315/15

1961

AMS 3351 IV—SERIES V798

Steve Laubach
1301 W. Green St.
Univ. of Illinois
Urbana, Il. 61801

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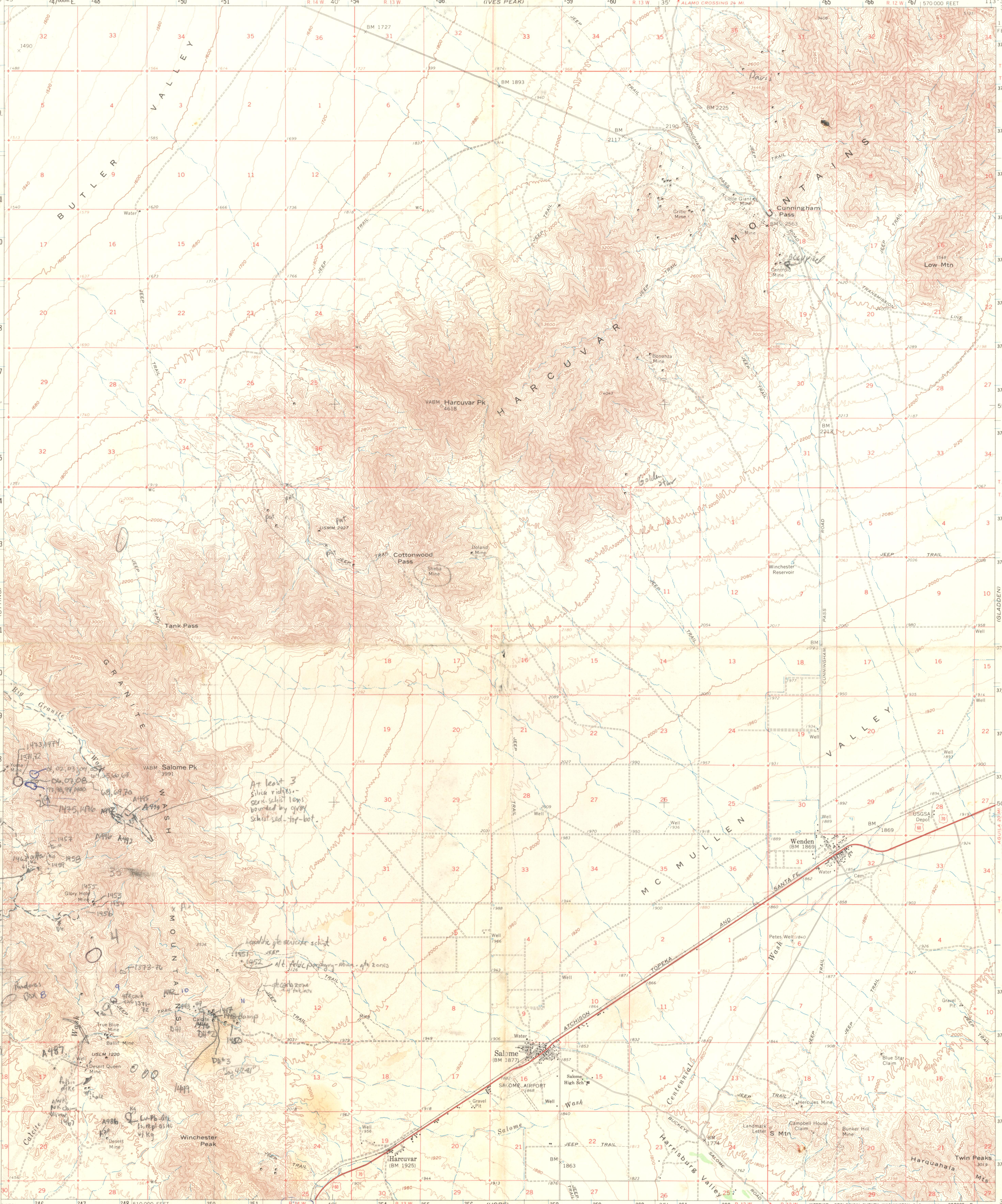
geology (217) 333-3540

780

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

SALOME QUADRANGLE
ARIZONA—YUMA CO.
15 MINUTE SERIES (TOPOGRAPHIC)



Sec 4 - Gibralta Pros. - All BLM, no pats. Many patents in T6NR14W, Secs. 1,2

A489 - grab from outcrops, rdcuts of seric-schist str. E-W, dip ~20S. - see thin qtz vnlts. - this unit quite pervasive along strike

Glory Hole - A488 active drilling - 5/22/85 - 4 core holes - dior ate phylite, unalt., ≥ 3-4 NE-SW strike - 30NW dip qtz ledges, each ~2-5' thk. - all holes in adit area - smpl. of qtz from dumps - white, mass-brec. w/ local abund FeOx - some py - grade helped by oxid - of area, ≤20% qtz

TrueBlue-Ballif - vert. shafts on thin erratic qtz veins w/ FeOx - not too exciting

A492 - grab from silic. outcrop - qtzite?, is massive - thin bedded, parall to bedd. Local FeOx

A493 - small pit - white musc. schist w/ thin qtz vns., local FeOx

A494 - Select grab of qtz, schist w/ FeOx, qtz vns parall schist.

A495 - somewhat sel. of quartz rib. local abund FeOx. - either qtzite or silic. schist.

A496 - 3' chip in pit across ~50% wht. qtz w/ FeOx and seric. schist. veins in bedding

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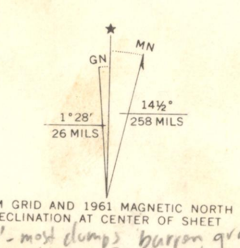
Topography by photogrammetric methods from aerial photographs taken 1951 and 1960. Field checked 1961

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Where omitted, land lines have not been established



UTM GRID AND 1961 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:62500

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

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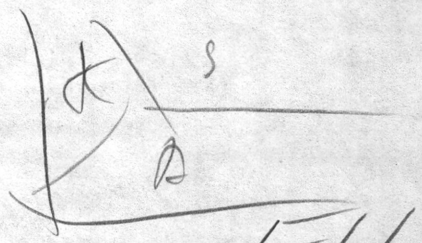
ROAD CLASSIFICATION
Heavy-duty — Light-duty
Unimproved dirt
U. S. Route

ARIZONA
QUADRANGLE LOCATION

SALOME, ARIZ.
N3345—W11330/15
1961
AMS 3251 I—SERIES V798

A486 - 5' chip across bedding w/ ~4' of argilliz., leached shale w/ abund FeOx and ~3 - 2" thk qtz vns. vns also parall. to bed. from adit. This is as good as gets here, thins rapidly. At shaft is complex folded, w/ more qtz in folds. Alt. zones rare, but assoc. w/ qtz. Only tr. qtz as float, hence alter. zns. rare

A487 - grab of 'ore' - most dumps barren gray shale-schist. vein erratic, 1-3' thk, str. NNE, dip ~50 to E, no wallrx alter. qtz, clear, c.g. w/ abund wlrx. inclu. w/ CrOx, limo. - fairly extensive dumps, workings



Ellsworth Dist.

MzV - Meso volc
SV - sed volc
S - seds.

Mzms - mica schist -

Mzad - andesite - diorite

JpEg - Jurrassic Monzodiorites
pE augen gneiss
alaskites, qtz diorites

Kg - granite wash pluton

Kt - Tank Pass

Livingston Hills fm is upper part of McCoy

"Red Beds" = Lower McCoy = Basal 1,2 of Harding

Granite Wash seds basal unit 2 of Harding

per Joe Stonehouse
– 5/20/85

Outside Salome – Granite Wash Mtns.
talked w/ consultant working for Inspiration Copper
toured Brewer and commented that in Granite Wash
Mtns. is little known gold occurance, stockwork that
he knows about, and is assoc. w/ Kyanite and other
stuff. This encouraged him to look at it again.

- Bill Daffron – was consultant who visited
- took place about first of this month - May, 1985

- John Madry ~~w/~~ Tenneco was working out of Salome in Harquahala Mtns.
- Dale Armstrong – consultant – also working there w/ John

TRAIL
BM
1644
36
1542
T6N
1471
T5N
BM
1491
1
1600
1548
1454
1577
1528
12
BM 1472
1380
1409
13
1364
1491
R15W R14W
JEEP
TRAIL
18
18
17
1600
1400
1689
2252
2651
1800
2000
2200
2400
2883
3425
2800
3022
2600
Glory Hole Mine
2133
Wash
1690
Well
USLM 1220
Desert Queen Mine
True Blue Mine
JEEP
TRAIL
MOUNTAINS
Calcite Mine
2324
1837
1 1/2 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

Aluminosilicate Alter =

Mzsv = Mesozoic seds + volc.

Mzs = Mesozoic sediments

Mzv = Mesozoic volcanics

Mzms = Mesozoic mica schist

Mzad = Mesozoic andesite-diorite

Kg = Granite Wash Pluton

Kt = Tank Pass granite

JpЄg = Jurassic-Precambrian intrusive rocks

UNITED STATES
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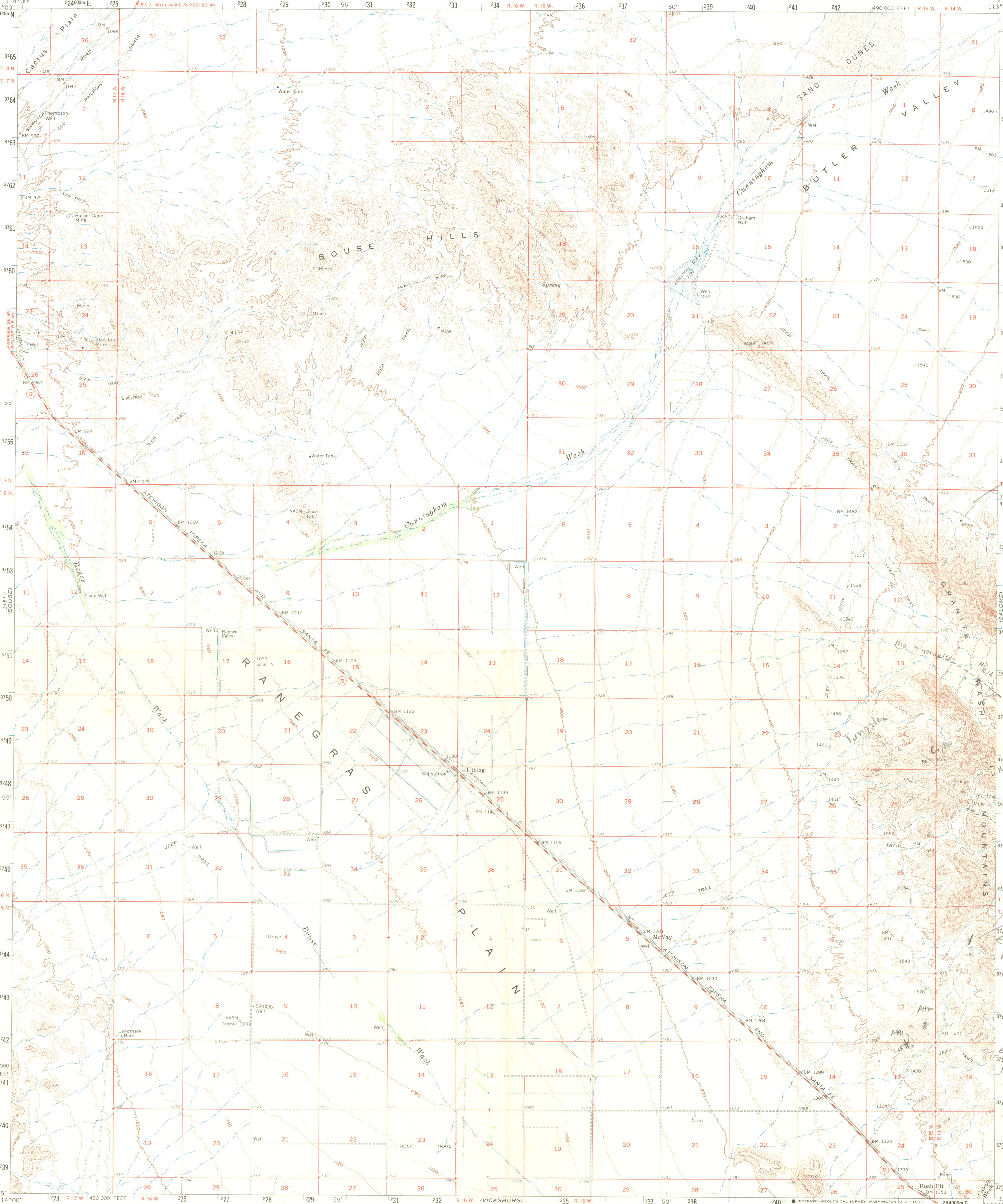
UTTING QUADRANGLE
ARIZONA—YUMA CO.
15 MINUTE SERIES (TOPOGRAPHIC)



Cobralla pros.

Yuma Mine

1/15/86 - Yellowbird - steep E dip, N-trend 2-12" white qtz vn w/ FeOx in gray metavolc - metased rx.

Sulfa claims

New Harz-Midas claims

Willmores Yellowbird Mine

← Dandy Mine

A490 - 2,3 veins in area - various trends largest up to ~3' wide but splays, possible lo-grade bet. veins. Qtz, lim, silic. wR. w/ CuOx. select of CuOx mat. on dumps - 1/15/86 - lots of grids, trenches, no holes, tho

← Big Dyke Cu

A491 - 2 composite chip smpls - 1-3½', 1-4½' sheared, altered seds and qtz w/ CuOx, FeOx. dips ~ 25° SW. At least 2 veins, this smpl. on lower. upper vein similar, about 20' above this one. Veins do not appear to persist far along strike. - Waters claims - 5/22/85 - recent aerial survey

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Topography by photogrammetric methods from aerial photographs taken 1951 and 1960. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Where omitted, land lines have not been established

GN MN
1°36' 28 MILS
14½° 258 MILS

UTM GRID AND 1962 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:62500

1 ½ 0 1 2 3 4 MILES
3000 0 3000 6000 9000 12000 15000 18000 21000 FEET
1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

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ROAD CLASSIFICATION
Medium-duty
Light-duty
Unimproved dirt
State Route

ARIZONA
QUADRANGLE LOCATION

UTTING, ARIZ.
N3345—W11345/15
1962

AMS 3251 IV—SERIES V798

TECTONICS OF AN ACTIVE FOLD-THRUST BELT

№ 102584

LADUZINSKY, Dennis M.; SEAVER, Din B. and KELLER, Edward A., Dept. of Geological Sciences, University of California, Santa Barbara, CA 93106

The north flank of the San Emigdio Mountains located at the southern end of the San Joaquin Valley is an active fold-thrust belt that has migrated to the north approximately 5 km during the late Pleistocene. The mid - to late Pleistocene range front is defined by the position of the Pleito fault while the present range front is underlain by the westward extension of the White Wolf - Wheeler Ridge fault. Alluvial fans emerging from the present mountain front are being actively folded and represent continued northward migration of the fold-thrust belt.

A late Pleistocene surface is broadly warped over the principal strand of the Pleito fault, but Holocene deposits are not deformed. Five kilometers to the north the late Pleistocene gravels at the surface are steeply dipping but not faulted where they cross the buried White Wolf - Wheeler Ridge fault zone. Stream terraces of Holocene age are deformed at that point and suggest an uplift rate for the front of approximately 2 mm/yr. Deformed alluvial fan surfaces over the Los Lobos folds suggest an uplift rate there of about 1.6 mm/yr. Total uplift at the present active front is therefore approximately 3.5 mm/yr.

Assuming that the uplift occurs during earthquakes, and assuming an uplift per event of 1 m (as was the case for the Ms = 7.3, 1952 earthquake on the White Wolf - Wheeler Ridge fault), then the recu interval for a 1952 type event is approximately 500 - 600 years.

GEOMETRY OF MAP-SCALE STRUCTURES IN THE PINE MOUNTAIN - OJAI AREA, WESTERN TRANSVERSE RANGES, CALIFORNIA

№ 94575

LAIRD, Brien A., Dept. Geol. Sci., Univ. Nevada-Reno, Reno, NV 89557

The Pine Mountain - Ojai area, mapped at 1:24000 by T.W. Dibblee Jr., contains a thick sequence of upper Cretaceous and Cenozoic marine and non-marine rocks that have been intensely folded and faulted by late Cenozoic deformation. Structural elements include high-angle, oblique (?) contraction faults and megascopic folds of complex character. Aspects of fold geometry include: 1) concentric, chevron-like fold styles with variable interlimb angles, 2) strong lithologic control upon fold styles, 3) inclined hinge surfaces closely related to nearby faults, 4) general WNW-ESE to E-W trends, often comprising en echelon or converging fold sets, and 5) generally subhorizontal eastward plunging hingelines with restricted zones of moderate to steep eastward plunge, defining monocline-like hingelines.

Mechanisms such as en echelon wrench folding, inhomogeneous crustal shortening, displacement transfer, and syn- to post-tectonic eastward tilting cannot explain the diversity of structural relationships. Data are consistent with a pre-existing, N-S trending, east-vergent monoclinal fold which has been deformed by transverse E-W folds. This monoclinal structure can be traced southward from Sespe Creek to near Ojai, where it is clearly expressed in vertically-dipping Eocene units. Since the "monocline" involves rocks of Pliocene age but is folded by Plio-Pleistocene folds it must be of Pliocene age. The location and orientation of this structure may reflect the presence of a basement fault beneath the "monocline".

The "monocline" crosses the Santa Ynez fault without appreciable offset, allowing only minor post-Pliocene strike-slip movement on this fault. With this assumption, cross-sections are being constructed using applied methods of balancing. Preliminary results indicate that this portion of the Western Transverse Ranges microplate has undergone only moderate amounts of shortening (about 30%).

AN ASSESSMENT OF TRIBUTARY DEVELOPMENT FLANKING IUS CHASMA, MARS

№ 102902

LAITY, Julie E., Geography Dept., Calif. State University Northridge, Northridge,CA 91330; PIERI, David C., Jet Propulsion Laboratory, Pasadena,CA 91109

The Ius Chasma region, Valles Marineris, Mars is flanked by deeply entrenched theater-headed valleys in networks that are best developed on the southern rim. Ground-ice or groundwater sapping are among the mechanisms invoked for their formation. If the valleys evolved from a non-flow process such as ground-ice sapping, there remains the question of why elongate networks are created. Problems in assessing the possible role of groundwater include an inability to determine the limiting boundaries of subsurface groundwater basins, lack of detailed topography, and masking of original processes by subsequent activity such as mass movement. Recent studies of Terrestrial sapping indicate that regional groundwater flow produces valley networks that differ in pattern and spatial and temporal evolution from surface fluvial systems. Groundwater flow is sensitive to changes in hydraulic gradient, to deep fractures that act as conduits for lateral flow, and to permeability boundaries that form erosional base levels. Several characteristics of the Ius Chasma tributaries appear incompatible with formation by groundwater sapping. These include 1) valley heads that converge, 2) highly complex branching patterns suggesting no relationship to regional groundwater flow, 3) networks that cross or intersect others, 4) multiple stratigraphic levels for valley floors and variable profile steepness, and 5) closed depressions along the profile length. Hence, theater-headed morphology does not necessarily provide a unique photogeologic criterion for groundwater sapping on Mars.

REVISED AGE FOR THE EMPEROR REVERSED POLARITY EVENT BASED ON K-AR AND PALEOMAGNETIC STUDIES OF BASALT FLOWS IN IDAHO

№ 100884

LANPHERE, Marvin A., U.S. Geological Survey, M/S 937, 345 Middlefield Road, Menlo Park, CA 94025, CHAMPION, Duane E., U.S. Geological Survey, M/S 937, 345 Middlefield Road, Menlo Park, CA 94025, and KUNTZ, Mel A., U.S. Geological Survey, P.O. Box 25046, DFC, M/S 913, Lakewood, CO 80225

K-Ar ages and paleomagnetic data for basalt samples from a new corehole (site E) at the Idaho National Engineering Laboratory (INEL) indicate that the age of the Emperor reversed polarity event, as recorded in Snake River Plain lavas is 565 $\pm$ 30 ka (1000 yr) rather than 465 $\pm$ 50 ka reported previously by Champion, Dalrymple, and Kuntz. Nine flows are recognized in the site E corehole; eight flows have normal polarity and one has reversed polarity. K-Ar ages for six of the normal flows range from 218 $\pm$ 49 ka to 641 $\pm$ 55 ka and are in correct stratigraphic order. The flows above and below the reversed flow have ages of 491 $\pm$ 80 ka and 580 $\pm$ 93 ka, respectively. The reversed flow at site E was not suitable for dating. The inclination of the paleomagnetic field direction of this reversed flow is -40.8 $\pm$ 2.7 degrees, which agrees with the inclination of the second of four reversed polarity flows in hole 77-1, located 10 miles SW of site E. Three samples from the reversed-polarity flows in drill hole 77-1 yielded a weighted mean age of 565 $\pm$ 30 ka. The vent from which these reversed lavas were erupted has not been identified.

THRUST-RELATED METAMORPHISM, GRANITE WASH MOUNTAINS, WEST CENTRAL ARIZONA

№ 87009

LAUBACH, S.E., Geol. Sciences, Lehigh Univ., Bethlehem, PA; REYNOLDS, S.J., SPENCER, J.E., Az. Bur. Geol. & Min. Tech., Tucson, AZ; RICHARD, S.M., Univ. Calif., Santa Barbara, CA.

Two episodes of Mz metamorphism (M1 & M2) are recorded in the western Granite Wash Mountains (WGWM) of Arizona. The M1 assemblage qtz+alb+chl+musc developed in pelites during the formation of slaty D1 cleavage and S-vergent large-scale D1 folding. Original mineralogy in metabasites is partly overprinted by M1 chl. D2 deformation involved SW-directed thrusting and mylonite formation (Hercules Thrust Zone-HTZ) which emplaced crystalline basement on WGWM Mz and Pz metasediments. M2 metamorphism is spatially associated with the HTZ, and prograde M2 assemblages are restricted to a 300 m thick zone below the lowest mylonites of the HTZ, even though D2 deformation is distributed over a wider zone. Preliminary evidence suggests grade of M2 metamorphism increases upward within the zone of M2 metamorphism. Syn-thrusting M2 assemblages superimposed on M1 at a distance from the base of the mylonite zone include bi+chl+qtz+olig in pelites; bi+chl+Fe-epi in metabasites and zoned Ca-epi+olig in Ca-rich pelites. Within the lowest part of the mylonite zone, but in rocks derived from the footwall, metabasites are converted to amphibolites and a qtz-ky assemblage replaces aluminous schists. Ky, gar and other ep-amphibolite facies index minerals are absent in normal composition pelites, however. The HTZ also displays evidence of syn-thrusting hydrothermal fluid migration and pG gneisses in the HTZ display evidence of retrogression. A sliver of metasediment within the HTZ contains andalusite, which is not seen in structurally lower WGWM rocks. The metamorphic pattern is most simply explained by D2 crustal thickening due to thrusting, superimposed on low greenschist facies M1, with localized thermal effects adjacent to D2 crystalline thrust sheets.

PETROLOGY AND DEPOSITIONAL HISTORY OF MIOCENE NONMARINE SEDIMENTARY ROCKS, CENTRAL SACRAMENTO MOUNTAINS, SAN BERNARDINO COUNTY, CALIFORNIA

№ 93944

LEACH, Brad R., Geology Dept., Vanderbilt University, Nashville, TN 37235; MILLER, Julia M.G., Geology Dept., Vanderbilt University, Nashville, TN 37235

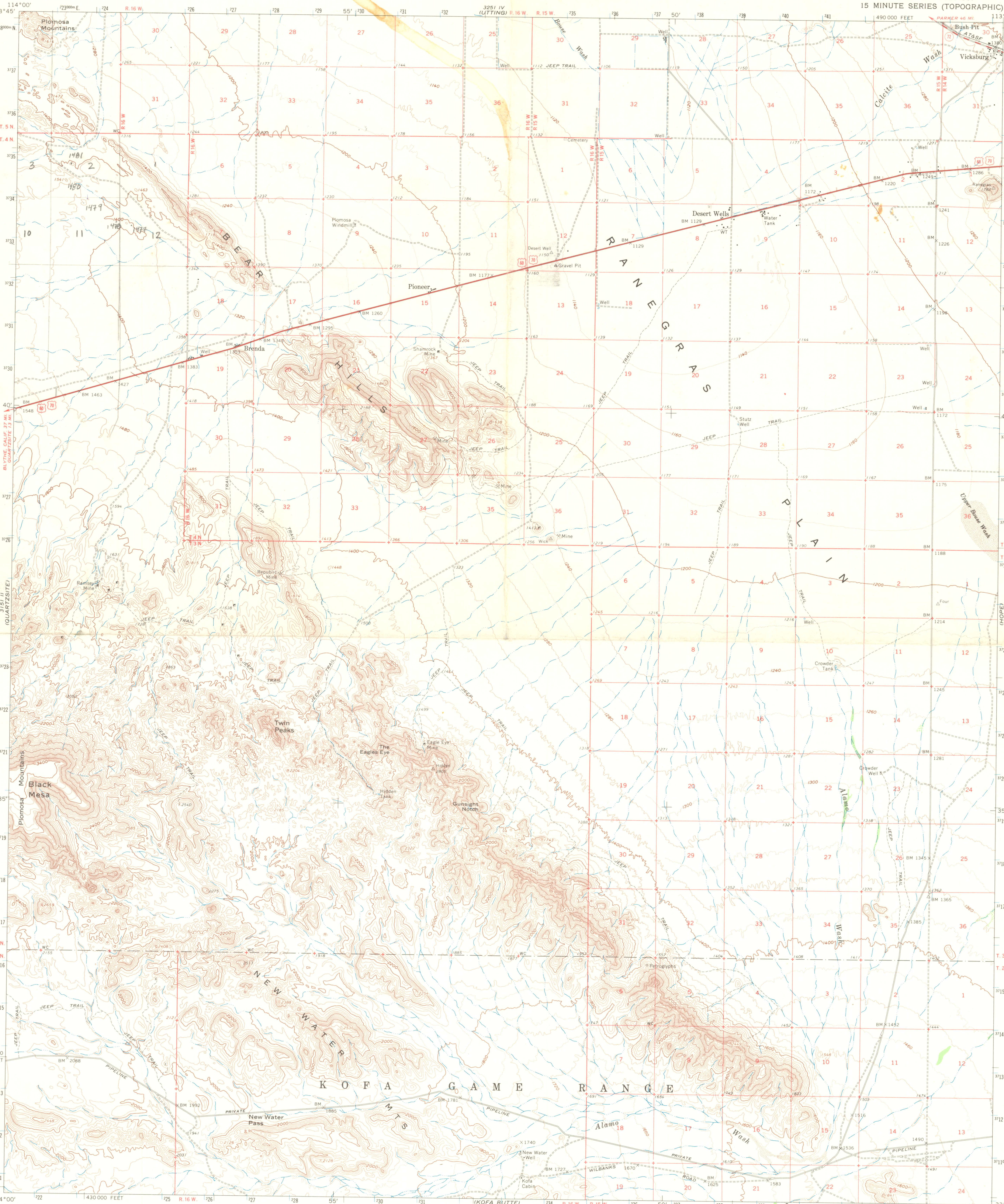
Exposed in the central portion of the Sacramento Mountains is a section of Tertiary rocks of diverse lithologies including andesites, basalts, dolostones, limestones, volcaniclastic sandstones, tuffs, calcareous and arkosic sandstones, lithic-rich conglomerates and shale. The Tertiary section is approximately 400 meters thick and is divided by low-angle faults into two structural "plates" (UPB and UPC) which are allochthonous with respect to the Precambrian and Mesozoic (?) crystalline basement rocks (McClelland, 1984).

UPB rocks represent initial lacustrine deposition on a thick basaltic /andesitic flow. Seasonal fluctuations in the lake level resulted in dolomite-producing marginal lacustrine mud flats. Increasing volcanic/pyroclastic activity resulted first in reworked sedimentary volcanic

GSA Cordill

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

VICKSBURG QUADRANGLE
ARIZONA—YUMA CO.
15 MINUTE SERIES (TOPOGRAPHIC)



Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

Topography by photogrammetric methods from aerial photographs taken 1951 and 1960. Field checked 1962

Polyconic projection. 1927 North American datum
10,000-foot grid based on Arizona coordinate system, west zone
1000-meter Universal Transverse Mercator grid ticks, zone 12, shown in blue

Where omitted, land lines have not been established

UTM GRID AND 1962 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:62500

CONTOUR INTERVAL 40 FEET
DOTTED LINES REPRESENT 20-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

ROAD CLASSIFICATION
Heavy-duty — Light-duty
Medium-duty — Unimproved dirt
U. S. Route — State Route

QUADRANGLE LOCATION

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER, COLORADO 80225 OR WASHINGTON, D. C. 20242
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

VICKSBURG, ARIZ.
N3330—W11345/15

1962

AMS 3251 III—SERIES V798

Yellowbird Mining Corp.

315 STANFORD S.E.
ALBUQUERQUE, NEW MEXICO 87106
TELEPHONE (505) 268-3534

FOREWORD

The following summary of geologic and mineralization characteristics pertains to a particular area in Arizona with which I first became acquainted in 1955. Individually, and in connection with my employment over the years with various exploration companies and drilling companies, I examined many prospects in Arizona, New Mexico, Utah, and Colorado. The properties described in this summary are those which I have obtained over a number of years and have survived my own process of elimination.

If this summary describes a property in which you may be interested, it will, of course, be necessary for you or your consultant to review the data upon which I have based my conclusions. A physical examination of the properties would also be advisable. Any data which I have are available to you or your representative, and I would be pleased to accompany you on an examination of the properties if a mutually convenient time can be arranged. Please contact me at the above address or telephone number if I can be of further aid to your investigation.

Sincerely,

Charles S. Willmore

Charles (Ted) Willmore

Enclosures

SUMMARY

1. This is an extensive gold property covering more than 800 acres with a number of gold-silver outcrops.

2. The Yellowbird Gold Mine consists of 56.34 acres of patended land with more than 900 feet of underground workings at three different levels. Assays of the dump of this old mine indicates high gold values. This mine should be re-entered and evaluated.

3. No exploration core drilling has been done on this property. A number of trenches and test pits have been dug, sampled and assayed, indicating good gold-silver values. Bulk sampling of up to 60 tons has indicated commercial ore values averaging more than 35/100 ounce of gold and 5.5 ounces of silver per ton.

4. A 20 ton gravity gold mill has been installed.

5. Miles of access roads are in place and six sites selected for development. For a long time these sites can be mined through use of back hoes without much deadwork involved.

6. Pandora's Box should initially be mined by stripping about 20 feet from the ridge top and open pit operations from then on. The hogback on Midas should be mined in a quarry or open pit operation, similar to Pandora's Box.

The gold-silver, base metal deposits covered by this report lie in the Granite Wash Mountains in west-central Arizona, La Paz County. These mountains trend northeast to southwest. Drainage is to the west into the Colorado River. The annual rainfall is from 3 to 5 inches. The climate is ideal in the winter, but quite hot during the summer. The site is about 42 miles south of Parker, Arizona, which is on the Colorado River opposite San Bernardino County, California.

In 1911, a reconnaissance report, U.S.G.S. Bulletin 451 by H. Bancroft, covered 5,000 square miles of northern Yuma (now La Paz) County, including this area. For years the area lay virtually unnoticed. Although the state of the art of geology changed considerably over the intervening years, nothing more on the area was reported until, with the exception of a thesis by Ciancanelle (1965), geologic reconnaissance studies were done by Wilson, 1960; Marshak, 1979; Rehrig and Reynolds, 1980; Reynolds, 1980, 1982; Reynolds, Spencer, and Richard, 1983; and a "somewhat cursory" examination of gold mines of the area by Keith, 1978. At the time of this writing, August 1984, the geology and mineral deposits are being further studied as part of an Arizona Bureau of Geology and Mineral Technology geological mapping project.

There seems to be a consensus among geologists that the Granite Wash Mountains, a part of the Basin and Range Province, is "one of the most structurally complicated mountain ranges in Arizona" and "geologically complex and poorly understood. . . ." A copy of the State of Arizona Bureau of Geology and Mineral Technology Open file Report 83-23, from which the above comments were taken, is included in this report as an addendum. Another open file report covering additional geological research of this area so far in 1984 will be available shortly.

The Granite Wash Mountains have long been considered by many geologists to be merely an extension of the Harcuvar Mountains themselves and are sometimes referred to as "The southwest extension of the Harcuvar Mountains." But recently some geologists are having second thoughts about this and consider them as a separate entity. Regardless, there are close geologic relationships between the Granite Wash Mountains and the Southern Little Harquahala Mountains which extend contiguously to the southeast as well as to the Harquahala Mountains themselves. A report by Stephen J. Reynolds entitled "Multiple Deformation in the Harcuvar and Harquahala Mountains, West-Central, Arizona" and a report by Stephen M. Richard entitled "Preliminary Report on the Structure and Stratigraphy of the Southern Little Harquahala Mountains, Yuma County Arizona" cover these adjacent mountain ranges. The first two pages of both of these reports have been reproduced and included in the addendum to this report.

The immediate area of our property is unmapped and unsurveyed as well in some places, but is shown on the Salome and Utting topographic quadrangles of the U.S.G.S., having been plotted from aerial photographs. The area was considered but rejected as a wilderness area during the wilderness inventory study by BLM. Elevations range from 1,600 to 2,200 feet above sea level.

Access to the claims covering the deposits is good; down about 5 miles of gravel road which connects to a paved State highway--paralleled by Santa Fe railroad tracks. The property is located in an old gold mining district which was worked, somewhat superficially, at the turn of the century. In years past, scheelite has been sporadically mined about a mile to the north-west. Copper-gold ore was mined primarily for its copper values from the Yuma mine about a mile north of us during the Second World War through the late forties. The ore was removed from what is essentially a limestone replacement deposit. The nearest gold bonanza mine to our property was the Harquahala mine about twelve miles airline to the southeast in the Little Harquahala Mountains. About 120,000 ounces of gold was recovered from this mine in 1893.

Locally, on our property and of great interest to us are some anomalies whose importance is yet to be ascertained. There is, for example, a massive deposit of quartzite kyanite extending over the surface of a portion of the northeastern end of our property. This is especially noteworthy because in many areas both in Canada and the United States, substantial gold lode deposits and kyanite deposits coexist in close proximity. This situation exists at Thompson and Hemlo, Ontario; several location in Idaho; Imperial, California; the Piedmont area of North Carolina; and elsewhere. When silli-manite grade rocks are massively found resting on top of the pile, one is led to speculate about the events that put it there. Is "cordilleron defor-mation manifested by ductile thrusting and isoclinal folding which places an enormous mass of precambrian basement above post-paleozoic strata?" Then too, we are told that "The Granite Wash Mountains lie near or on the tec-tonic boundary between cratonic North American and the McCoy Terrain."

At the terminus of the west end of the massive kyanite, there is a mass of microcrystalline dark quartz (neochert). This hill of quartz intrudes hill-ocks composed of alunite-jarosite gypsum; these extend westward for about a half mile. Samples taken of the neochert have in a few cases indicated traces of gold. With the exception of the Calor group of six radioactive claims (thorium rare earths), all of our claims are contiguous. The six Calor claims lie about two miles south of the main claim group.

Yellowbird Mine

The Yellowbird patented mine, comprising 56.34 acres is geographically speaking the centerpiece of our property. Here auriferous quartz-siderite veins outcrop through a greenish rock of questionable type, although it appears to be either a grey wacke or andesite. On the eastern side of the Yellowbird the terrain rises abruptly to crest about 600 feet above the sur-rounding terrain. A number of quartz-siderite veins crop out on both the western and eastern slopes of this hill. Visible gold occurs in these veins in chalcopyrite and is also found as visible blotches in the quartz; some specimens have been found in which the gold, from pressure, oozed into fractures much like drops of solder from the mahogany-colored quartz.

The Yellowbird mine was operational from 1901 to 1904, according to the patent application. It was at this time that a vertical 250 foot shaft was sunk on a vein striking north-south and dipping nearly vertically. Also, three levels of drifts totaling about 975 feet were driven before 1904. Howland Bancroft in his 1911 U.S.G.S. Bulletin 451 claims to have looked over the Yellowbird in 1908 but it is hard to see how he missed seeing the conspicuous mine dump which is visible for a mile in any direction. His writing does not mention any workings of any kind. The field notes of U.S. Mineral survey no. 1888 conducted on June 24-28, 1904 describe the discovery shaft of the Mendota claim as follows:

> The discovery shaft No. 1 which bears from north end center S 90 40' W 750 feet and is 250 feet deep in rock, with drifts at 125 feet that run N 10 E 138 feet and S 10 W 60 feet. Also drifts at 200 feet that run N 10 E 294 feet and S 10 W 80 feet. Also drifts at bottom of shaft that run S 80 E 88 feet N 10 E 50 feet, N 80 W 60 feet and N 10 E 80 feet.

At present, and for many years past, it has not been possible to enter the mine due to the collapse of head frame timbers into the shaft which have bridged it over about 15 feet down. The waste dump consists of several thousand tons of the greenstone host rock.

About 75-80 tons of ore were gleaned from the remains of an old ore pile. In 1980 we erected a 20 ton/day gravity mill at the Yellowbird mine site. About 35 tons of the ore was run through this mill and yielded a concentrate which contained about 11 ounces of gold. The tailings in the pond assayed at .11 oz. per ton. A vein sample cut from the vein surface alongside the shaft assayed 19 ppm gold (approximately 56/100 oz/ton). See assay, February 4, 1977, Skyline Labs, Tucson, AZ, Job No. 770051.

Pandora's Box Claims

About a mile south of the Yellowbird Mine site there is a northeast-southwest trending wash and ridge which parallels it. This is the wash from which H. Bancroft in Bulletin 451, dated 1911, stated that Dutch Henry removed several thousands of dollars of placer gold. The present state of the terrain appears to be the result of compressional thrust faulting, folding, and block faulting. Here are phyllites, shales, schists, dacite, and grey wacke (andesite?) in a seemingly very disorderly jumble. Along the ridge the phyllites are fractured, warped, and curled. Through it in places are outcropping quartz veins containing inclusions of these phyllites and shales as well as barite. Some of the shales are red, some black, some grey, with these strata ranging upwards from five or six feet in thickness. The gold-carrying quartz veins in the wash separate these strata. The vein fillings of quartz, hematite, limonite, and barite with some pyrolusite carry gold, copper, and argentiferous lead both as sulphides and oxides. Wulfenite crystals sometimes in small clusters are scattered through the vein filling. There are northwest-southeast striking gold-silver quartz veins exposed in both the wash and along the ridge. To discover and expose these veins in the wash it was necessary to bulldoze and remove about ten feet of alluvia. Exhibits 1 through 5 are of assays obtained from these veins. About 15 tons of ore removed from these veins averaged about .5 oz. of gold and about 5.5 oz. silver per ton. The ridge which contains this zone is about 1,100 feet wide at its base and about 2,500 feet long. In one place a fairly sizeable cut made by bulldozer into the ridge reveals a brecciated shear zone whose full dimensions have yet to be determined. However, where exposed, this zone extends for several hundred feet along the SW-NE strike and about 20 feet across at the maximum exposure. Air Force photographs 5-211, 5-212, and 5-213 taken from 25,000 feet on Flight 35, September 8, 1978, clearly indicate an extensive anomaly which strikes NW-SE across this ridge and corresponds exactly to the cross sections in Figures 1, 2A, and 2B of this report. Copies of these photographs may be gotten from Aerial Mapping Photography Section, U.S.G.S., Eros Data Center, Sioux Falls, SD 57198.

A 10-pound localized sample taken from one point of this area assayed 9/100 oz. of gold and 28 oz. of silver (Exhibit 7). An emission spectrograph of this sample (Exhibit 8) indicated lead, silver, strontium, barium, arsenic, copper, and zinc with lesser amounts of antimony, bismuth, and chromium. Another sample taken by cutting a channel across 17 feet of this zone assayed 18/100 oz. of gold and 5.21 oz. of silver per ton (Exhibit 9). Recent bulldozing into this zone indicates a mass of vein filling consisting of small grains and medium-to-large crystals of galena. A nearby quartz-siderite vein sampled by Freeport Exploration (Tucson) assayed 784/1000 oz. of gold and 2.34 of silver per ton (Item 14510, Exhibit 10). A sample taken of another vein on the northern slope of the ridge assayed 245/1000 oz. of gold and 5.95 oz. of silver per ton (Item 3, Exhibit 6). No exploration holes have yet been drilled into this extremely weathered area. The surface mineral exposures point to the feasibility of glory-holing into the side of the ridge with good expectations.

It is about a mile back northward from this ridge to the Yellowbird Mine. A large portion of the intervening area is littered with quartz lag. In some of this quartz lag free gold can be seen. Topographically, the area ranges from gently sloping to low undulating hills. Detritus covers a portion of the area with phyllites and andesite (green stone) surfacing here and there through the detritus. Very little exploration has been carried on over this area.

New Harz and Midas Claims

Northeastward from the Yellowbird Mine are eight claims all contiguous to each other and to the Yellowbird Mine. Four of these are called New Harz 1 through 4, the other four, Midas 1 through 4. The Midas and New Harz claims occupy terrain whose topography is more rugged than that of the Yellowbird. A road was constructed from the Yellowbird to a conspicuous, nearly 200 foot vertical hogback which juts westward for about 500 feet out of the mountainside. This hogback is a little less than a half mile to the east of the Yellowbird. Where the hogback merges into the mountain there is a substantial showing of copper carbonates of the mountainside which assays 40/100 oz. of gold. The hogback itself consists of a series of nearly vertical quartz stringers separated by limey sandstone and intercalated sandy limestone. The quartz veins are mineralized with bornite and calcopyrite containing gold. Another series of quartz outcroppings occur on the New Harz claims, which lie immediately to the north of the Midas group. One sidehill cut made into these quartz veins yielded beautiful hand specimens of chalcopyrite and bornite. Other nearby cuts into an en-echelon series of quartz veins separated by shales reveals abundant malachite (or antlerite) and bornite. Nearly all of the outcroppings on both New Harz and Midas are gold-bearing veins of copper sulphides. The abundance and high degree of mineralization of these veins calls for extensive drilling and sampling.

Sulfa Claims

Immediately to the north of and contiguous to the New Harz group lies the Sulfa 1 through 4 group of claims. A large area of these claims is covered with hills consisting of a mixture of gypsum and jarosite. Selenite crystals and satin spar veins are common in these hills. Underlying these hills and to be seen along the cut banks of the washes are tuffaceous sediments. Within the tufts and gypsum occasional weak copper stains occur.

The effects of vulcanism accompanied by emanating sulphide gases apparently converted many of the original calcite and limestone rocks of the area to sulfates. A large mass of highly siliceous quartzite forms a conspicuous ridge which rises a hundred feet or so and runs SW-NE diagonally through Sulfa No. 3. Samples taken of the quartzite indicate about 2/100 oz. of gold and low grade copper. Several quartzitic gold veins course through these claims in a NE-SW direction. This highly altered area is considered to be a prime drilling target for the possibility of a sizeable sulfide ore body.

Calor Claims

These six contiguous claims lie in Sections 15 and 16 of Township 5 north, range 14 west. They are about 2 miles southeast of the Pandora's Box

Calor consists of a series of radioactive quartz intrusive veins of the hydrothermal fault fissure type. These veins outcrop through and along the contacts of laramide granites, rhyolites, and other related crystalline intrusives, all of these having invaded an area of mesozoic metamorphosed sediments. The stockwork of veins is filled with highly weathered geothite, hematite, and limonite, with considerable manganese and copper carbonate staining. Mortimer Staatz, geologist with the U.S.G.S., Office of Energy Resources, determined that the radioactivity is due to rare earth-thorium phosphate monazite and thorium-rare earth silicates allanite and thorite. Spectrographic analysis has determined the presence of considerable lanthanides--especially yttrium. The host rock granite contains porphyritic chalcocite. Assays indicate a considerable variance in the amount of gold and silver in these veins with most values in the 20/100 to 35/100 range.

THE UNIVERSITY OF ARIZONA

TUCSON, ARIZONA 85721

ARIZONA BUREAU OF MINES

TEL. (602) 884-2733

July 11, 1974

Ted Willmore
315 Stanford Dr. SE
Albuquerque, N. M. 87106

Dear Mr. Willmore:

The 87-lb. sample of ore you delivered to me from Yuma County assayed 0.44 ounces of gold per ton. The material is principally a weathered altered quartz schist with oxidized copper showings. No determination was made of the copper content (which is evidently a percent or so) nor of the silver (which is improbable).

A panning test of a pulverized sample of the ore revealed a small quantity of free gold. Consequently, a simple amalgamation test was performed, results of which indicated less than 25 percent of the total gold present was recovered. Amalgamation does not appear to be a favorable approach to beneficiation of this ore.

Since the ore evidently contains appreciable copper, cyamidation is not recommended as a method to recover the gold. Too expensive. Copper consumes expensive cyamide rapidly.

An alternative may be flotation, if sufficient ore reserves warrant a mill and if water is available. If you wish we could run some flotation tests on the remaining sample we have on hand to determine if the gold can be concentrated by this method and to what extent.

The cost to you would be approximately $50.00 for tests, assays and report. I recommend this additional testing only if you know there are several thousand tons of ore proven or probable and if you have a usable mill site with water near by.

In the meantime, the total charges to date for assays and the ore examination is $15.00. Please remit payment to the Arizona Bureau of Mines.

EXHIBIT 1

If there are questions or if we can be of further service please let me know.

Very truly yours,

David D. Rabb
Mining Engineer

DDR:nb
cc: Dr. Dresher

EXHIBIT 1

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

ARIZONA BUREAU OF MINES

November 6, 1974

Ted Willmore
315 Stanford Drive S.E.
Albuquerque, New Mexico 87106

Dear Mr. Willmore:

First may I apologize for the delay in reporting these ore test results. I have been hoping you would visit Tucson in the interim, as you indicated last August you would. You may wish to discuss the results of these tests. If so, please let me know.

As previously reported in my letters of July 11 and August 2, the 87-lb. sample of ore you delivered to me from Yuma County assayed 0.44 ounces of gold per ton, 5.5 ounces of silver, 1.75 per cent copper and (later results) 1.3 per cent lead.

A simple panning test of a pulverized sample of the ore showed the presence of free gold. In addition, a spectroscopic analysis of the panned concentrate indicated the presence of barium and lead presumably as the sulphates, barite and anglesite, or as carbonates, though acid tests were not conformatory. Neither of these minerals are expected to concentrate by flotation.

As agreed, we proceeded with standard laboratory flotation tests; in fact, three tests were run in order to compare results of different reagents and concentration ratios. Results are as tabulated on the enclosed test-data sheet.

As shown in tests 1 and 2, over 70 per cent of the gold and 60 per cent of the silver can be recovered in a relatively small weight of high-grade concentrate. If excess collector and frother is added, the concentration ratio drops from 40:1 to 10:1 and the recovery as well as grade suffers (note Test 3). Some collector 208 seems beneficial (Test 1 vs. Test 2) but additional collector and frother only lower the grade of concentrate and also the recovery.

No accounting was made of either copper or lead because these metals would not increase the salable value of the concentrate.

The grind was relatively fine, i.e., less than 1 per cent plus 65 mesh, but it is felt that recovery and grade would suffer if the grind were coarser, say 2-3 per cent plus 65 mesh.

In spite of the presence of almost 2 per cent copper in the ore, a

EXHIBIT 2

cyanide leach feasibility test was performed which indicated cyanide consumption was quite high, approximately 6.5 lbs. per ton of ore.

Less than 10 per cent of the gold reported with the leach solution.

Table 1--Cyanide leach test results

	oz. per ton	
	Au	Ag
Heads	0.44	5.5
+65 mesh Tails	0.38	2.8
-65 mesh Tails	0.42	6.8

Lime requirements were minimal but the high cyanide loss plus low gold recovery were about as expected from an ore of this type. The silver recovery was also only 10 per cent of the material in the heads. Cyanidation is therefore not recommended.

An amalgamation test on another sample of the ore recovered 7 per cent of the available gold, so amalgamation is not recommended.

These results clearly indicate flotation appears to be the most reasonable beneficiation process. Further testing may discover an optimum grind, conditioning time, and choice of reagents, but it is believed the recovery of the gold and silver will not improve appreciably beyond the 75 and 60 percentage marks attained in these tests. No further tests are recommended at this time on this ore.

If there are questions, I hope you will stop by when you next come to Tucson. Please let me know if and when you are coming so I can be sure to be available.

The total charges to date have been paid by your pre-payment check last August. Thank you. It was a pleasure to be of service.

Very truly yours,

David D. Rabb

David D. Rabb
Metallurgist

DDR:jg
CC: Dr. Dresher
Enc.

EXHIBIT 2

UNIVERSITY OF ARIZONA

ARIZONA BUREAU OF MINES

ORE TESTING SERVICE

Ore No. 2239 Test Nos. 1, 2, and 3

Conditions and Reagents

Point of Addition	Conditions			Reagents Pounds Per Ton			
	Time Mins.	% Solids	pH	P.O.	208	301	15
Mill	14	60	7.5	0.05			
t	10	23	7.5		0.1		
Mill	14	60	7.5	0.05	0.2		
t	10	23	7.5			0.1	
Mill	14	60	7.5	0.3	0.1		
t	10	23	7.5			0.1	0.1

marks:

Metallurgical Products

roduct	Tons in 100 Tons Feed	Assays oz. per ton Au	Ag	Cu,%	Pb,%	concentration ratio	% of Total Au	Ag	Cu	Pb
onc.	2.5	12.75	136.34	ND	ND	40:1	74	62	--	--
ails	97.5	0.12	2.1	--	ND		26.	38	--	--
onc.	2.5	12.70	131.72	--	1.4	40:1	73	60	--	--
ails	97.5	0.12	2.1	--	1.3		27	40	--	--
onc.	10.0	3.02	37.7	2.1	1.4	10:1	59	66	5	3
ails	90.0	0.21	2.0	1.5	1.3		41	34	95	97
ead	100.0	0.44	5.0	1.75	1.3					

emarks: P.O. = Pine Oil
208 = Aeroflot Reagent 208 collector
301 = 301 collector
15 = 15 frother

EXHIBIT 2

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

ARIZONA BUREAU OF MINES TEL. (602) 884-2733

August 22, 1975

Mr. Ted Willmore
315 Stanford Drive S.E.
Albuquerque, New Mexico 87106

Dear Mr. Willmore:

This will acknowledge the receipt last July of approximately 50 pounds of ore in a paper sack marked "H-W Light Weight Castable 30" with the note on the sack that you would phone me later. As of this date I have not heard from you, but the results of assays of a representative sample are:

Gold 7.20 ounces per ton; Silver 6.5 ounces

The ore appears to be a partially rusty weathered vein quartz with some open "box-work" and no evident mineralization.

A preliminary panning test of a pulverized portion of the ore resulted in a significant showing of very fine free gold. In addition, spectroscopic analysis of the heavy fraction revealed traces of barium and lead; probably as carbonates or sulphates. There were no other apparent mineral values. One approach to the determination of a treatment method is to attempt a simple shaking table test and check the recoveries of the gold and silver. As finely divided as the gold appears to be, I don't anticipate a high (80 or 90 per carat) recovery but we might try it.

From the appearance of this sample I believe cyanidation would be most effective, but I shall wait for work from you before proceeding. Expenses thus far are less than ten dollars ($10.00) and a cyanidation test plus additional assays would bring the total amount to about $45.00. Please let me know what you wish.

NOTE: This sample appears to be relatively high grade compared to your other samples and could stand the more expensive leaching treatment if there is sufficient tonnage in sight.

EXHIBIT 3

Mr. Ted Willmore
August 22, 1975
Page Two

If there are questions, please let me know. Otherwise, I shall look forward to seeing you when you are next in Tucson.

Very truly yours,

David D. Rabb

cc: W. H. Dresher

EXHIBIT 3

THE UNIVERSITY OF ARIZONA

ARIZONA BUREAU OF MINES
MINERAL TECHNOLOGY BRANCH
TUCSON, ARIZONA 85721

TEL. (602) 884-1943

May 21, 1976

Mr. Ted Willmore
315 Stanford Drive SE
Albuquerque, New Mexico 87106

Dear Mr. Willmore:

This will acknowledge the receipt of your check and assure you that your account is paid in full.

I am still holding the sample of ore received last September via Continental Trailways, a rusty, weathered quartz which assayed an average value of 0.37 ounces of gold per ton and 3.7 ounces of silver. These numbers were reported to you in my letter of September 22, 1975. I shall look forward to seeing you again if you come to Tucson.

Thank you.

Sincerely,

David D. Rabb

David D. Rabb
Metallurgist

cc: W. H. Dresher
Director

EXHIBIT 4

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

ARIZONA BUREAU OF MINES TEL. (602) 884-2733

September 22, 1975

Ted Willmore
315 Stanford Drive SE
Albuquerque, New Mexico 87106

Dear Mr. Willmore:

Your most recent shipment of ore, the 135-lb sample in a can, was received from Continental Trailways on September 10, 1975. The material was principally a rusty weathered quartz, and panning a pulverized sample of the material did not reveal any visible free gold. Further, there were no other evident minerals of value except for a trace of white heavy fines. A spectroscopic test of this white material indicated the presence of lead and barium, but in very minor concentrations.

Results of assays of duplicate representative samples were as follows:

	ounces per ton	
	gold	silver
Sample 1	0.36	3.8
Sample 2	0.38	3.6

Though the assay results are not in exact agreement, I believe re-assays are not necessary. This particular ore might be amenable to treatment by cyanidation but only if there is a sufficiently large tonnage to warrant the expenses of sampling, shipment, and treatment. Judging from the wide disparity between the values of the three ore samples you sent us in the past year, I imagine the deposits are typical surface-weathering enrichment of relatively small tonnages, erratic in values. Mining should probably be accompanied by frequent sampling and should be selective, taking only the higher-grade ores.

I shall wait until I hear from you but at this moment I do not feel further testing is worthwhile. Please let me know what you want.

Total charges for work thus far, including assays and examination of the 7.2 ounce gold sample last August, amount to fourteen dollars ($14.00). Please remit payment to the Arizona Bureau of Mines. An invoice is enclosed for your convenience. Thank you.

Very truly yours,

David D. Rabb

David D. Rabb
Metallurgist

DDR:jg
CC: W.H. Dresher

EXHIBIT U

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427
William L. Lehmbeck
Arizona Registered Assayer No. 9425

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION	GOLD oz/ton	SILVIR oz/ton	COPPER %	LEAD %	ZINC	MO			
Float #1 Pandoras Box	0.640	5.86	1.31	10.7					
Float #2 Pandoras Box	1.530	[illegible]	0.24						

PAID
Check No. Money Order
Date

TO:
Mr. Ted Willmore
315 Stanford S.E.
Albuquerque, New Mexico 87106

REMARKS:
Single analysis

CERTIFIED BY:

CHARGES:
PREPARATION $
ANALYSIS $ 27.25

DATE REC'D:	DATE COMPL.:	JOB NUMBER:	$
6/10/75	6/17/75	751236	27.25 Pd.

EXHIBIT 5

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W Grant Rd., P.O. Box 50106 Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427
William L. Lehmbeck
Arizona Registered Assayer No. 9425

EXHIBIT 6

CERTIFICATE OF ANALYSIS

ITEM NO.	SAMPLE IDENTIFICATION	Au oz/ton	Ag oz/ton	Au * oz/ton	Ag * oz/ton	Cu * %	Pb * %	Mo * %
1	Cap	0.095	0.41					
2	Average	0.800	2.74			0.71	0.91	0.023
3	Hillside			0.245	5.95			
4	Garbage			<0.005	<0.01			
5	Backroad #1			<0.005	<0.01			
6	Backroad #2			<0.005	<0.01			

Mr. Ted Willmore
Pandoras Box
Box 61
Salome, Arizona 85348

cc: Charles Willmore
Albuquerque, New Mexico

REMARKS:

Fire Assay

*Single analysis by Atomic Absorption

CERTIFIED BY [signature]

REGISTERED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK DATE SIGNED 5-3-76 Arizona U.S.A.

DATE REC'D:	DATE COMPL.:	JOB NUMBER:
4/21/76	5/3/76	760837

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
1700 W. Grant Rd., P.O. Box 50106, Tucson, Arizona 85703
(602) 622-4836

Charles E. Thompson
Arizona Registered Assayer No. 9427
William L. Lehmbeck
Arizona Registered Assayer No. 9425

CERTIFICATE OF ANALYSIS

SAMPLE IDENTIFICATION	GOLD oz/ton	SILVER oz/ton	COPPER	LEAD	ZINC	MO		Emission Spectrographic Analysis
Upper Bench	0.090	28.07						**

TO:
Mr. Ted Willmore
PANDORA'S BOX
315 Stanford, S.E.
Albuquerque, New Mexico 87106

REMARKS:
Single analysis by A.A.
** To follow
Check #1264

CERTIFIED BY:

CERTIFIED ASSAYER CERTIFICATE NO. 9425 WILLIAM L. LEHMBECK

CHARGES:
E-spec 11.00
PREPARATION $ 1.25
ANALYSIS $ 4.25

DATE REC'D:	DATE COMPL.:	JOB NUMBER:	$
2/10/77	3/2/77	770332	16.50 PAID

EXHIBIT 7

SKYLINE LABS, INC.
Hawley & Hawley, Assayers and Chemists Division
P.O. Box 50106 • 1700 West Grant Road
Tucson, Arizona 85703
(602) 622-4836

REPORT OF SPECTROGRAPHIC ANALYSIS

Job No. 122626
H&H No. 770332
February 26, 1977

Mr. Ted Willmore
Pandoras Box
315 Stanford S.E.
Albuquerque, New Mexico 87106

Values reported in parts per million, except where noted otherwise, to the nearest number in the series 1, 1.5, 2, 3, 5, 7 etc.

Element	Sample Number Upper Bench
Fe	3%
Ca	.2%
Mg	.07%
Ag	500
As	<500
B	15
Ba	500
Be	<2
Bi	100
Cd	<50
Co	<5
Cr	200
Cu	1,500
Ga	<10
Ge	<20
La	30
Mn	20
Mo	50
Nb	<20
Ni	5
Pb	>10,000
Sb	200
Sc	<10
Sn	<10
Sr	5,000
Ti	500
V	50
W	<50
Y	10
Zn	500
Zr	50

William L. Lehmbeck
Manager

EXHIBIT 8

Charles E. Thompson
Arizona Registered Assayer No. 9427

William L. Lehmbeck
Arizona Registered Assayer No. 9425

ROCKY MOUNTAIN GEOCHEMICAL CORP.
P. O. BOX 337 • 1323 W. 7900 SOUTH • MIDVALE, UTAH 84047 • PHONE: (801) 255-3558

MIDVALE OFFICE

Certificate of Analysis

RMGC Numbers:
Local Job No.: 77-41-27-S1
Foreign Job No.: 77-41-9T
Invoice No.: M 90412

April 13, 1977

Newmont Exploration
200 West Desert Sky Road
Tucson, Arizona 85704

Client Order No.: none

Report On: 1 Sample

Submitted by: M. A. Enright

Date Received: 3/30/77

Analysis: Silver

Analytical Methods: Determined by fire assay.

Remarks:

cc: enc.
file (2)
report: RMGC - Reno
LRR/lw

Sample No.	oz/ton Silver
7135	5.21

By Lawrence R. Reid
Lawrence R. Reid

EXHIBIT 9

All values are reported in parts per million unless specified otherwise. A minus sign (—) is to be read "less than" and a plus sign (+) "greater than." Values in parenthesis are estimates. This analytical report is the confidential property of the above mentioned client and for the protection of this client and ourselves we reserve the right to forbid publication or reproduction of this report or any part thereof without written permission.
ND = None Detected   1 ppm = 0.0001%   1 Troy oz./ton = 34.286 ppm   1 ppm = 0.0292 Troy oz./ton

ROCKY MOUNTAIN GEOCHEMICAL CORP.

2561 EAST FORT LOWELL ROAD · TUCSON, ARIZONA 85716 · PHONE: (602) 795-9780

TUCSON OFFICE

Certificate of Analysis

RMGC Numbers:

Local Job No.: 77-41-9TP

Foreign Job No.:

Invoice No.: T 6813

Date: March. 25, 1977

Client: Newmont Exploration
200 Desert Sky Rd.
Tucson, Arizona 85704

Client Order No.:

Report On: 3 samples

Submitted by: M. Enright

Date Received: Mar. 22, 1977

Analysis: Gold, Silver

Analytical Methods: Determined by atomic absorption.

Remarks: Spec. result to follow.
Ag fire-assay on sample 7135 to follow from SLC.

cc: Enc.
RMGC: SLC
file
PDW/sl

Sample No.	ppm Gold	oz/Ton	ppm Silver	oz/ton
7134	5.9	.17	11	.32
7135	6.5	.18	+100	See second sheet for fire assay.
[redacted]				

By Parry D. Willard

Parry D. Willard

EXHIBIT 9

All values are reported in parts per million unless specified otherwise. A minus sign (—) is to be read "less than" and a plus sign (+) "greater than." Values in parenthesis are estimates. This analytical report is the confidential property of the above mentioned client and for the protection of this client and ourselves we reserve the right to forbid publication or reproduction of this report or any part thereof without written permission.

ND = None Detected 1 ppm = 0.0001% 1 Troy oz./ton = 34.286 ppm 1 ppm = 0.0292 Troy oz./ton

ORAL REPORT FROM FREEPORT COMPANY

TO CHARLES WILLMORE

Freeport Company by its Senior Geologist, Joseph A. Kantor, made an oral report of Pandora's Box based on two days of on-site inspection by Mr. Kantor.

Their report is that of the total of about 25 surface samples taken in the area, six samples indicated appreciable values in gold and silver ranging from 0.3 oz. to 1.3 oz. of gold per ton and from 1.0 oz. to 7.5 oz. of silver per ton.

All of these values occurred in quartz veins and were taken over an area of one-half square mile. The prevailing shales in which the quartz veins occur did not indicate worth-while values. Since Freeport is primary interested in developing a large low-grade ore body amenable to open-pit operations, they are not interested in developing this ore body. However, in their judgment this does not preclude a successful underground mining operation which would selectively mine the gold-quartz vein.

Mr. Kantor works at 655 North Alvernon, Suite 121, Tucson, Arizona 87511. Phone number is (602) 881-6070.

Ed Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SUBMITTED BY Freeport Exploration Company

DATE June 13, 1977

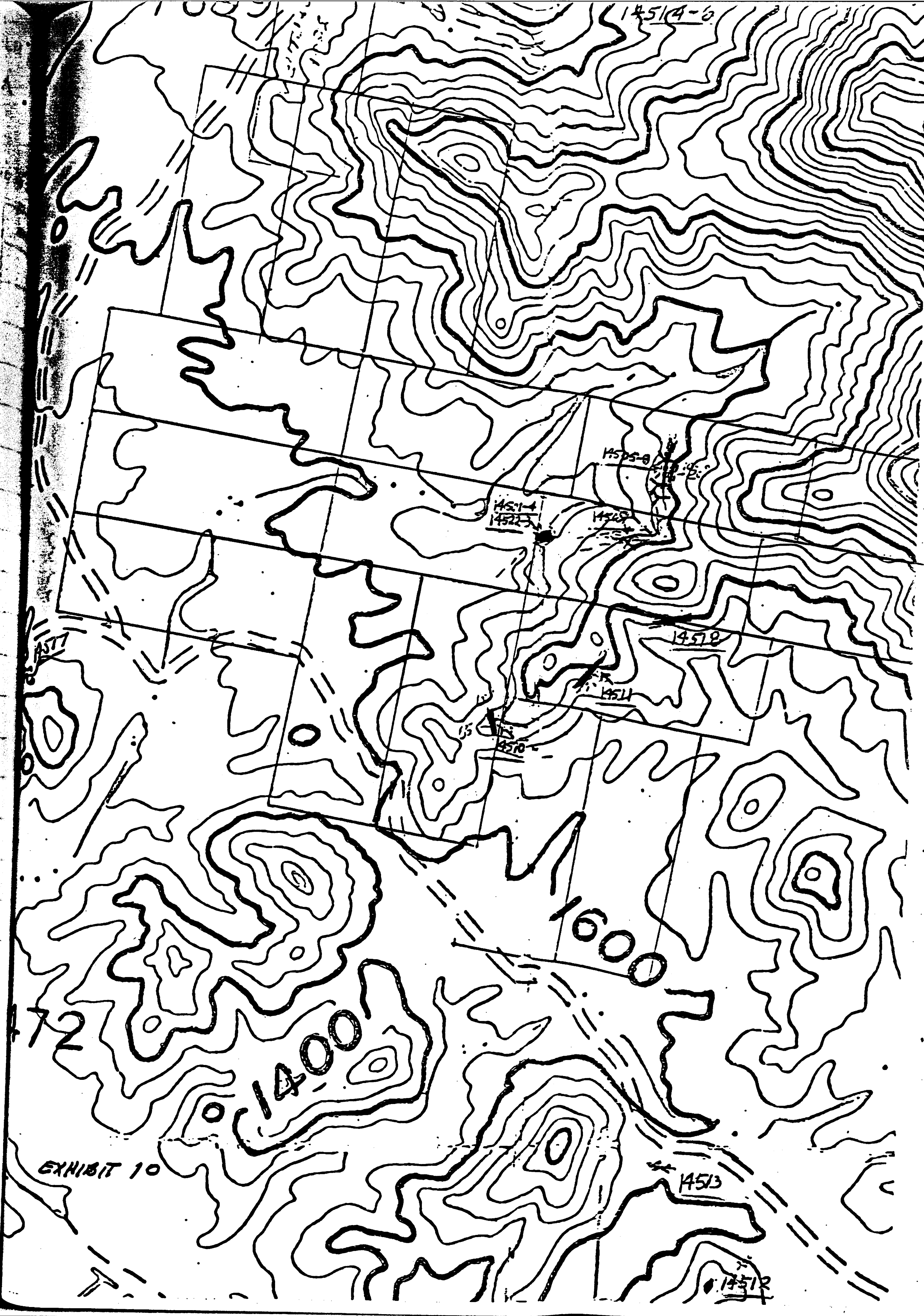
FIRE ASSAYS

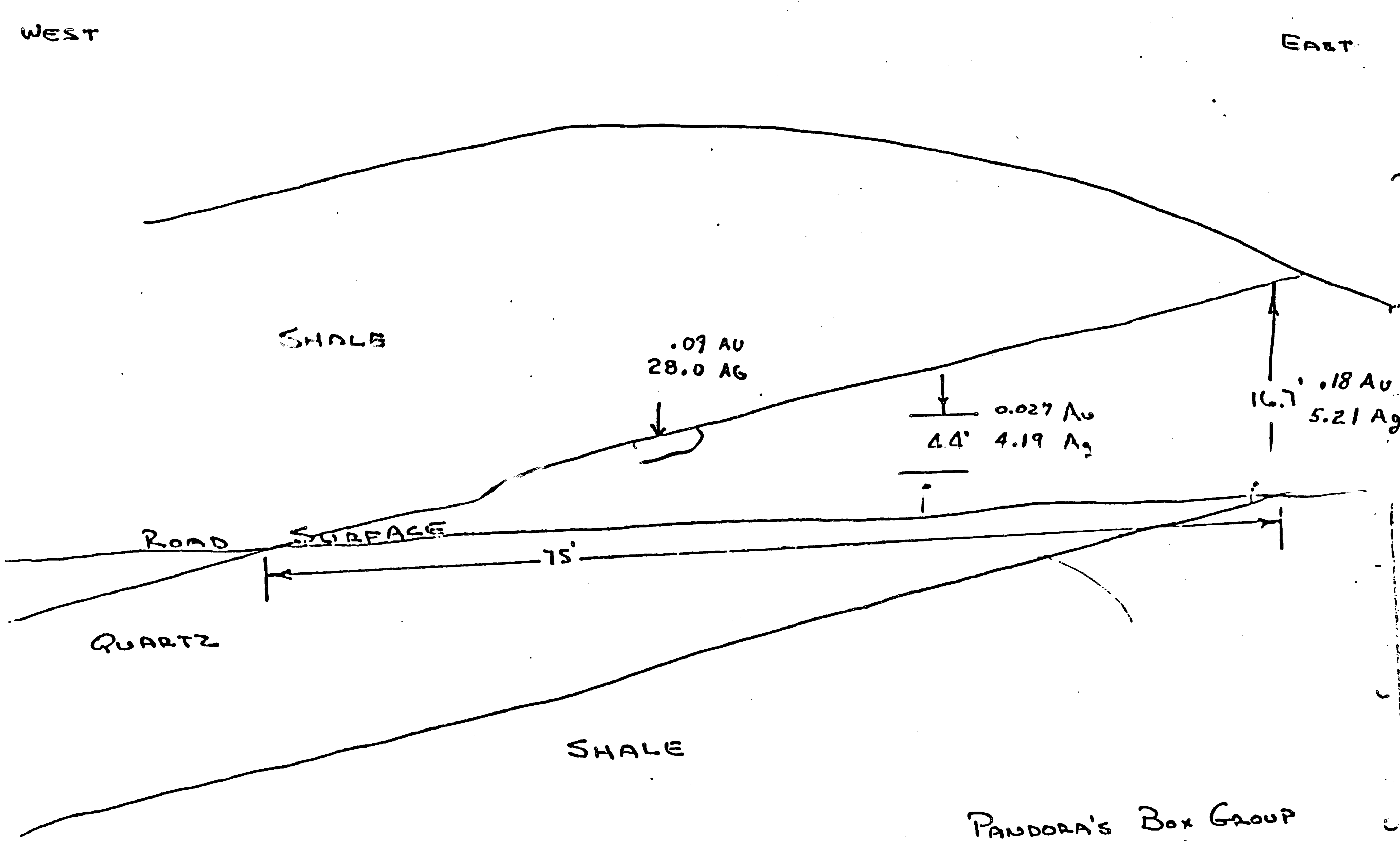
A.A.

MARKED	GOLD OZ./TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PPM As	PPM Sb
	.001	0.03	Prospect Pit - qtz-goethite				10	< 5
	.001	0.02	" channel				71	6
	.003	0.08	" grey shales above				94	< 5
	.002	0.22	" brown shales below				25	< 5
	.016	0.74	Adit - channel				25	< 5
	.006	0.54	" "				19	< 5
	.003	0.36	channel above (shale)				10	6
	.228	3.91	Mixed hi grade - vis. gold removed				106	10
	.004	0.21	channel shale (15')				34	8
	.784	2.34	Small vein above adit.				92	< 5
1	.027	4.19	channel, 8',				60	14
2	.001	0.06	Red shale.				34	< 5
3	.002	0.09	" "				17	< 5
4	.003	0.17	Laxton dump				34	< 5
5	.005	0.16	" "				40	< 5
6	.454	0.83	Laxton 60 vein outcrop				19	< 5
7	.001	0.05	channel shale				50	< 5
8	.003	0.84	Stringer vein embolite ? (W)				80	10
22	.810	1.97	Pandora's Box · Pit [illegible] visible Au [illegible]				107	10
23	1.303	7.36	" " " "				152	16

RECEIVED FREEPORT-TUCSON 1977

EXHIBIT 10

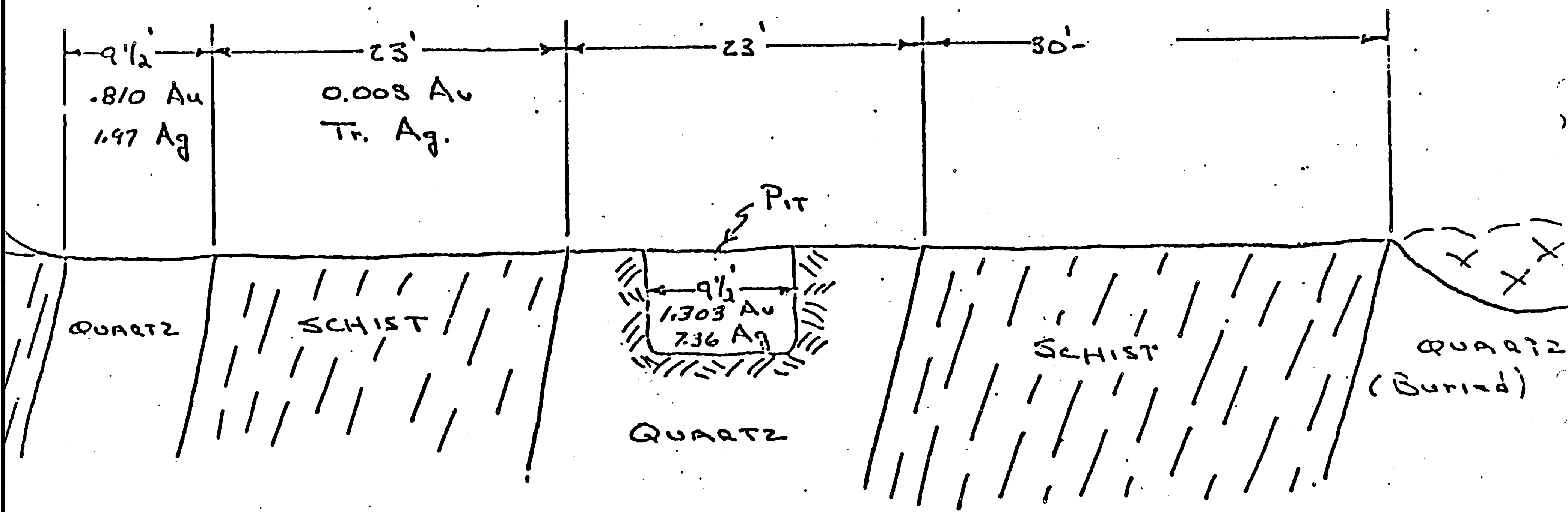

14514-6
14518
14511
14510
1600
1400
472
EXHIBIT 10
14513
14512



PANDORA'S BOX GROUP
YUMA COUNTY, ARIZONA

CROSS SECTION
AREA II

FIGURE 2B

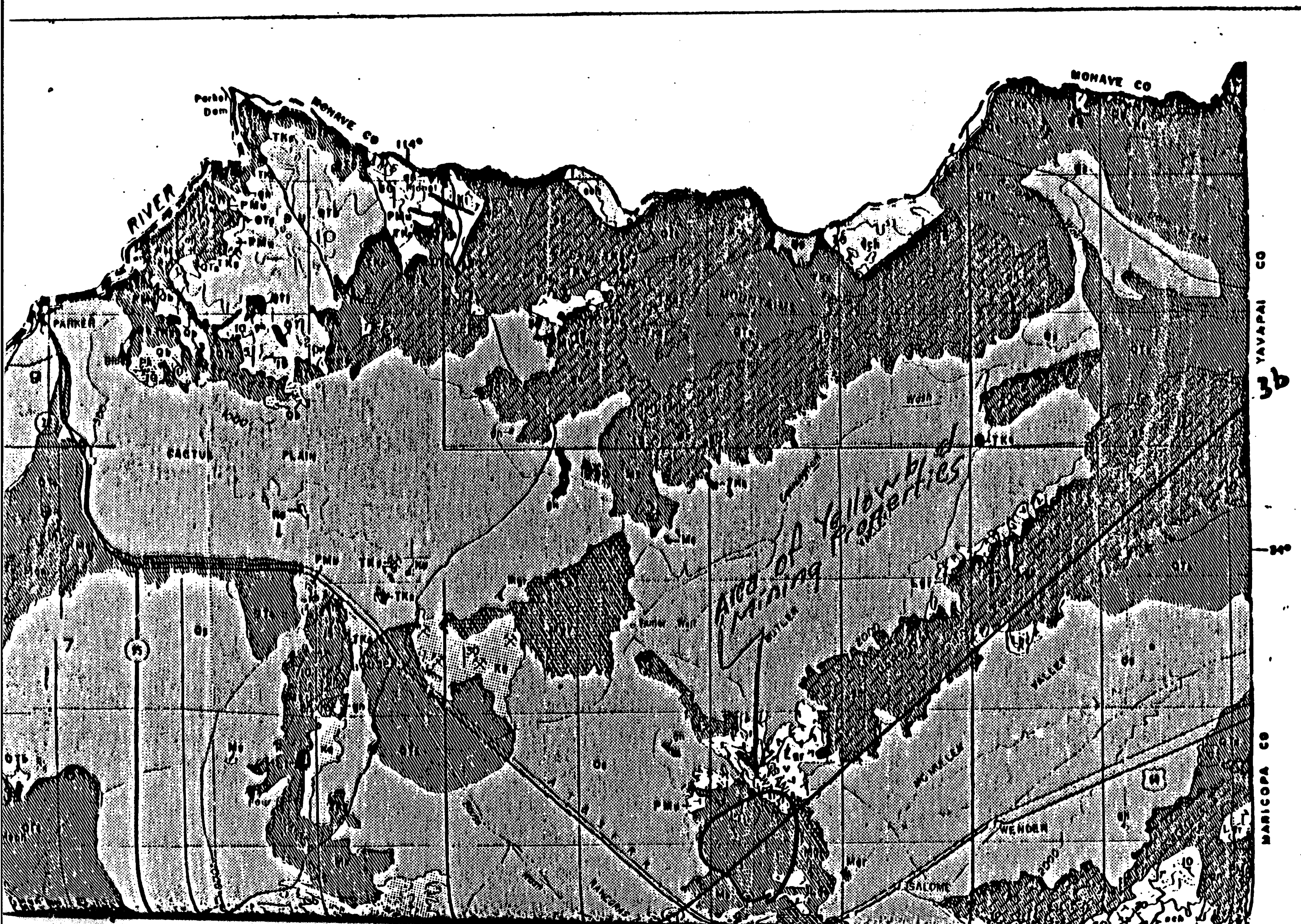


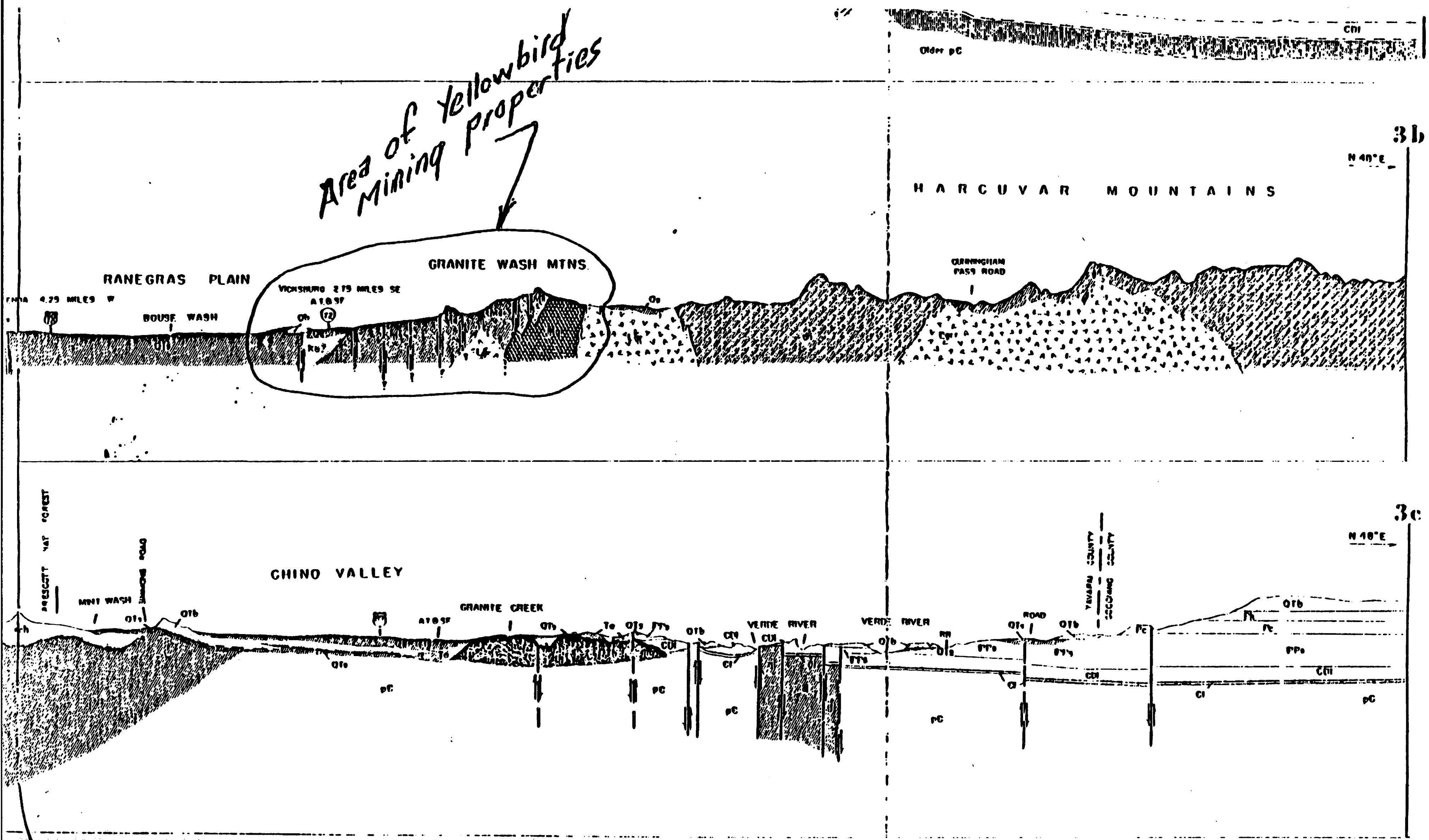
PANDORA'S BOX GROUP
YUMA COUNTY, ARIZONA

CROSS. SECTION
AREA I

FIGURE 3

UNIVERSITY OF ARIZONA
ARIZONA BUREAU OF MINES
J. D. FORRESTER, DIRECTOR





Older pC
CDl
3b
N 40°E
HARCUVAR MOUNTAINS
Area of Yellowbird Mining properties
GRANITE WASH MTNS.
RANEGRAS PLAIN
VICKSBURG 2.75 MILES SE
BOUSE WASH
CUNNINGHAM PASS ROAD
3c
N 40°E
CHINO VALLEY
PRESCOTT NAT FOREST
MINT WASH
GRANITE CREEK
VERDE RIVER
YAVAPAI COUNTY
COCONINO COUNTY
ROAD
pC

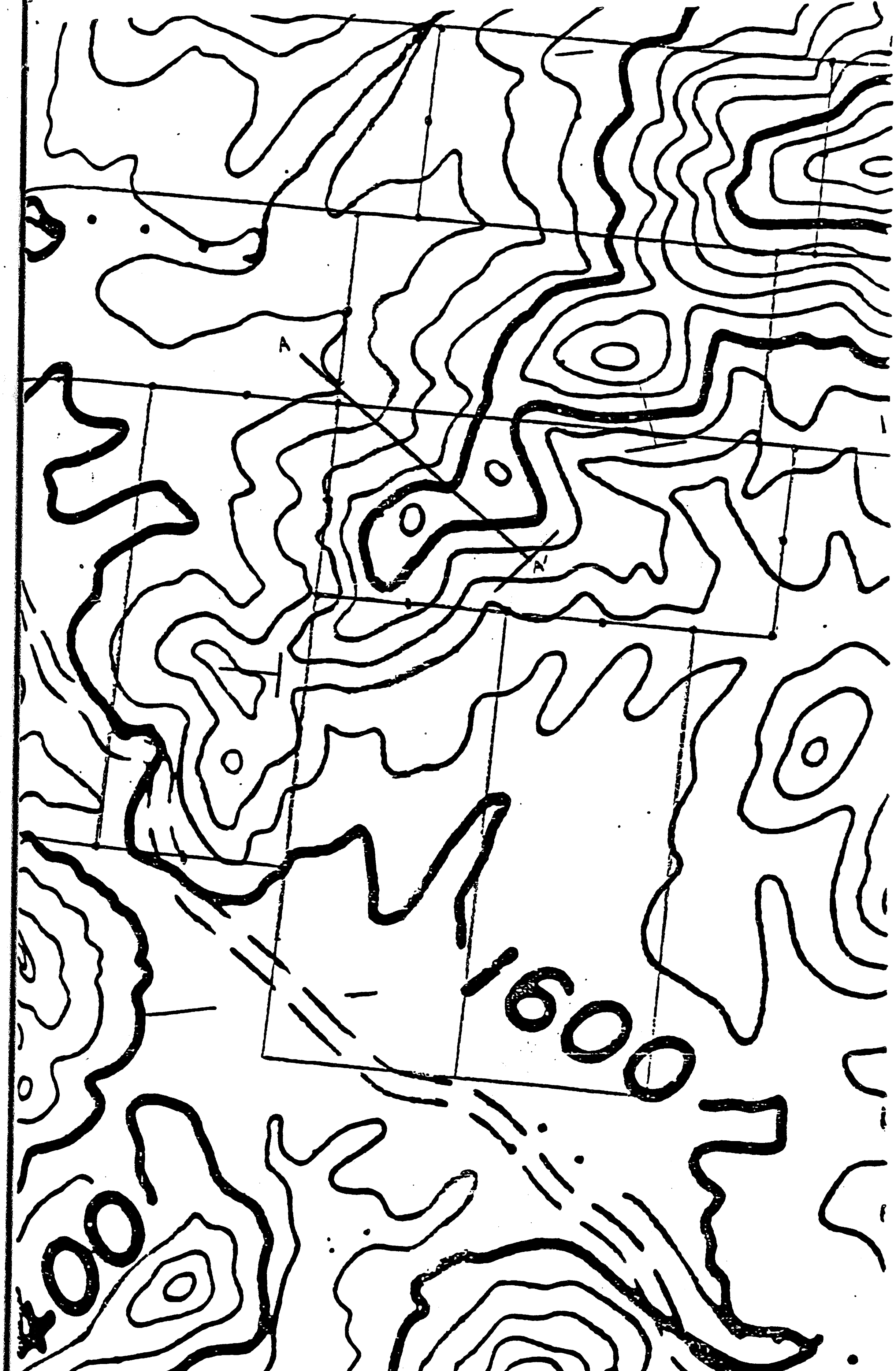
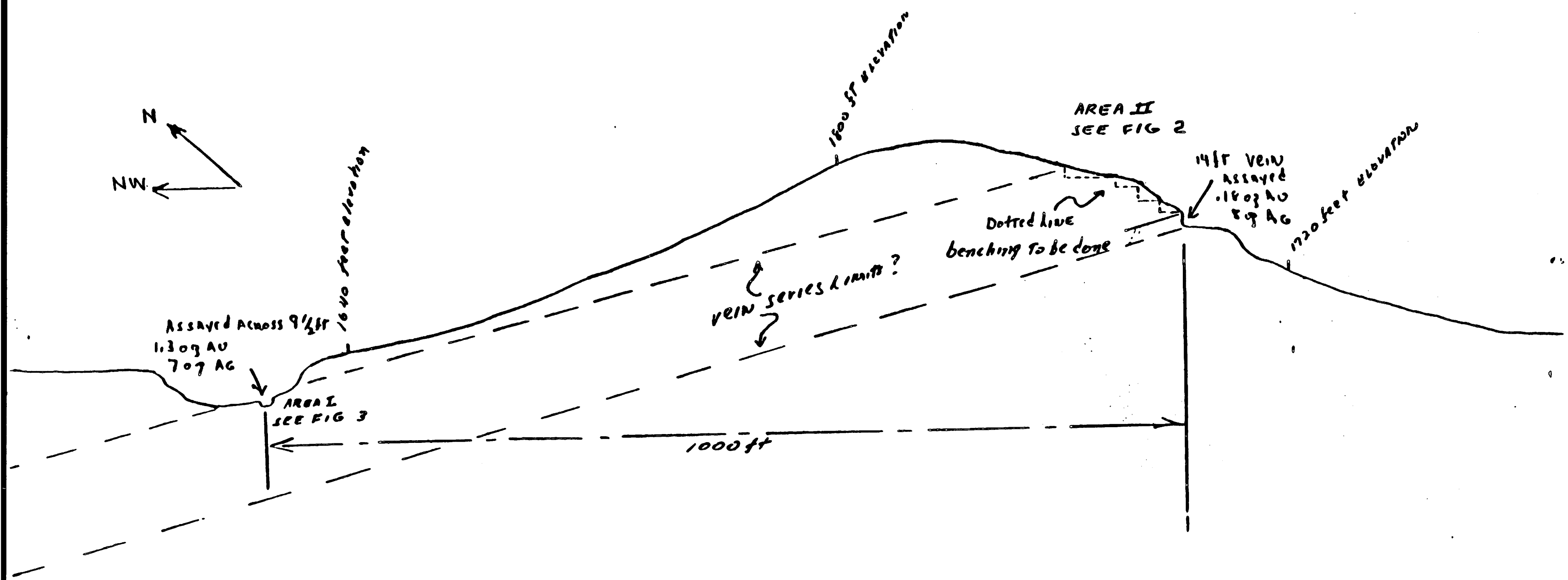


FIGURE 2A



CROSS SECTION OF Ridge THRU AA'

Fig 1

PRELIMINARY REPORT ON THE STRUCTURE AND STRATIGRAPHY OF THE SOUTHERN LITTLE HARQUAHALA MOUNTAINS, YUMA COUNTY, ARIZONA

Stephen M. Richard
Department of Geosciences
University of Arizona
Tucson, Arizona 85721

ABSTRACT

Precambrian through Tertiary rocks in the south- Little Harquahala Mountains record a complex his- of Mesozoic and Tertiary deformation. Precam- quartz monzonite is overlain by: 1) about m of Paleozoic strata correlated with the Bolsa, go, Martin, Redwall, Supai, Coconino and Kaibab ations; 2) up to 1000 m of Mesozoic dacitic to litic volcanic and volcaniclastic rock; 3) at 750 m of Mesozoic lithofeldspathic sandstone, lomerate and siltstone. Probable high-angle lting prior to deposition of the Mesozoic sand- is indicated by rapid facies changes, massive lomerate and basal onlap onto older units to the heast. Subsequently, the strata were folded into rge southeast-vergent fold limb. This fold was lded about steep axes trending N-NE. In Late aceous time the deformed rocks were thrust over zoic clastic, volcaniclastic and volcanic rocks g the Hercules thrust. Mesozoic strata below the ules thrust are lithologically and stratigraphic- y different from Mesozoic strata above the fault. zoic structures are strongly overprinted by Ter- ry(?) NW-dipping, moderate to low-angle, normal- ration faults and associated northerly trending lts. The youngest structures are north- to north- t-trending, near-vertical oblique- or strike-slip lts with an associated northeast-dipping normal lt. One of the near-vertical faults cuts poorly rated east-dipping Tertiary(?) gravel.

INTRODUCTION

The Little Harquahala Mountains are located hin the Basin and Range province in west central zona. Access to the area is excellent, either by Hovatter Road, which connects Salome with I-10 ough the western edge of the study area, or by the eye-Salome Road through the northeast edge of the a (Fig. 1).

The Little Harquahala Mountains occupy an area overlapping Mesozoic and mid-Tertiary tectonism. purpose of this project is to determine the uctural geometry of Paleozoic rocks in the Little quahala Mountains in an attempt to define the ki- atics of Mesozoic and Tertiary deformation in the a. To this end, a geologic map of the southern t of the range was made. The base map used was a 2,000 enlargement of part of the Hope, Arizona 15' ies U.S.G.S. quadrangle (1961). This paper con- ns descriptions and preliminary interpretations of rocks and structures of the Little Harquahala ntains. A more complete discussion will be pre- ted in a forthcoming circular to be published by Arizona Bureau of Mines and Mineral Technology.

GENERAL GEOLOGY

Precambrian quartz monzonite in the central part the range is overlain by a highly faulted north- t-trending, steeply dipping cratonic Palezoic

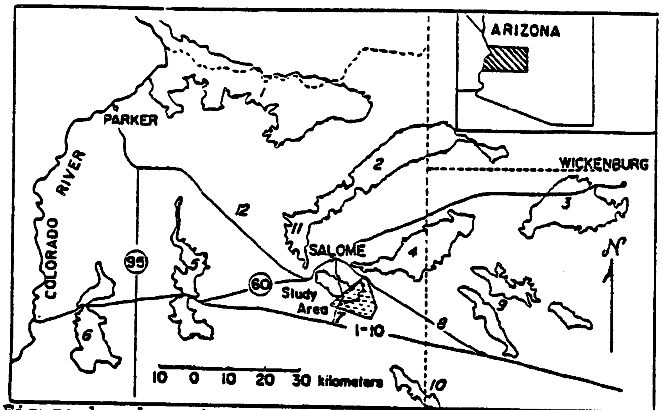


Figure 1. Location map showing study area and points referred to in text, numbered as follows: (1) Buckskin Mtns.; (2) Harcuvar Mtns.; (3) Vulture Mtns.; (4) Harquahala Mtns.; (5) Plomosa Mtns.; (6) Dome Rock Mtns.; (7) Hovatter Road; (8) Buckeye-Salome Rd.; (9) Big Horn Mtns.; (10) Eagle Tail Mtns.; (11) Granite Wash Mtns.; (12) Ranegras Plain.

section. Depositionally above the Paleozoic rocks are Mesozoic volcanic and volcaniclastic rocks and Mesozoic lithofeldspathic sandstones. On the south, the sedimentary rocks overlie an assemblage of altered crystalline rocks of uncertain age along the complex steep to low-angle Sore Fingers fault zone (Fig. 2). On the north, the Precambrian quartz monzonite structurally overlies Mesozoic clastic, volcaniclastic and volcanic rocks informally known as the Harquar section. The lower plate Mesozoic rocks are lithologically and stratigraphically different from Mesozoic rocks in the upper plate. The Harquar section is intruded in the northern part of the range by the Granite Wash Granodiorite, dated at 65 m.y. (Damon, 1968) and 69 m.y. (Eberly and Stanley, 1978). Along the western edge of the range, southwest-dipping volcanic rocks of probably Miocene age overlie the Harquar section. The range is structurally bounded on the northeast by an inferred northwest-trending oblique-slip fault in the vicinity of Centennial Wash. A complete summary of the regional geology of west central Arizona is presented by Reynolds (1980, and this volume).

STRATIGRAPHY

The Little Harquahala Mountains contain rock units ranging in age from Precambrian to Tertiary. The pre-Cenozoic stratigraphic column includes approximately 1000 m of Paleozoic rocks, a highly variable thickness of Mesozoic volcanic and volcaniclastic rocks up to 900 m thick and Mesozoic lithofeldspathic sandstones with a maximum exposed thickness of 750 m. For lithologic descriptions of the Paleozoic and Mesozoic section in the central part of the area, see the accompanying stratigraphic column (Fig. 4). In addition, a variety of igneous and metamorphic rocks of uncertain age are exposed in the Sore Fingers area, and Precambrian quartz monzonite and amphibolite gneiss underlie the Paleozoic section. The rock units are divided into five major groups reflecting the geologic development of the area. These are: 1) Precambrian basement consisting of intrusive and metamorphic rocks; 2) Paleozoic cratonic sediments; 3) Mesozoic continental deposits; 4) the Sore Fingers Complex; and 5) Cenozoic deposits which are only briefly described. Thicknesses of rock units were determined using measurements from the geologic map.

Precambrian Rocks

Granitic rocks occupying the northeast boundary of the map area are depositionally overlain by the Bolsa Quartzite and thus are known to be of Precambrian age. North of Martin Peak, gneissic rocks intruded by this granite crop out over a small area and are also considered Precambrian.

Quartz monzonite underlying the Bolsa Quartzite is ubiquitously altered in the vicinity of the unconformity to an assemblage of light green argillized or epidotized feldspar set in a red stained argillic groundmass with abundant quartz eyes. Sericite and epidote are common. In less intensely altered zones, further from the unconformity, the quartz monzonite consists of a medium-grained quartz, plagioclase and minor biotite groundmass with 1-3 cm potassium feldspar phenocrysts. Some of the alteration at the contact may be due to pre-Bolsa weathering, but the presence of similar alteration within the Bolsa requires post-Paleozoic chemical changes as well. The contact between the Bolsa and quartz monzonite commonly is faulted.

Amphibolite gneisses consisting of medium-grained hornblende and plagioclase crystals occur at the northwest edge of the map area above the Hercules thrust (Fig. 2). Near-vertical, northeast-trending foliation in these gneisses is characteristic of early proterozoic gneisses in west central Arizona (Reynolds, 1980). This foliation is disrupted and folded within 10-15 m of the Hercules thrust.

Paleozoic Rocks

A cratonic Paleozoic section overlies the Precambrian basement in the Little Harquahala Mountains. The stratigraphy of these rocks resembles the southeast Arizona Paleozoic section in its lower part and the Grand Canyon section in its upper part. Miller (1970) described a similar section in the southern Plomosa Mountains and noted its resemblance to the section in the Little Harquahala Mountains. He recognized the Bolsa, Abrigo, Martin, Escabrosa, Supai, Coconino and Kaibab Formations. Varga (1977) reported an essentially identical section in the western Harquahala Mountains, except the Abrigo and Martin Formations are apparently absent due to a bedding plane fault. Varga (1977) favored correlation of the carbonate unit below the Supai with the Redwall Limestone instead of the Escabrosa Limestone. In the absence of definitive evidence for either correlation, I have chosen to continue Varga's usage. Except for this change, Miller's (1970) correlations are used in this report.

The Kaibab Formation in the Little Harquahala Mountains is unique in western Arizona. Miller (1970) and Varga (1977) described strata resembling units 1 and 2 of this report, but units 3, 4 and 5 are absent in all other sections described in west central Arizona. Quartz-chert sandstone and conglomerate at the top of unit 5 are probably Mesozoic but are too thin and poorly exposed to map separately.

Mesozoic Rocks

Two distinct Mesozoic sequences are present in the Little Harquahala Mountains--the Harquar section and the southern Little Harquahala section. Formal nomenclature for these rocks is lacking. A Mesozoic age is inferred from stratigraphic position above Paleozoic rocks and involvement in late Cretaceous deformation (see Tectonic Interpretations).

The Harquar section includes volcanic and sedimentary rocks lying below the Hercules thrust. These were not studied in detail. Within the area mapped, porphyritic andesite flows overlie lithic sandstone, siltstone and conglomerate. The section is distinguished from the southern Little Harquahala section by the more intermediate composition of the volcanic rocks, the greater abundance of conglomerate and the predominance of volcanic clasts in the conglomerate.

The southern Little Harquahala section is described in the stratigraphic column (Fig. 4). Conglomerates and rapid facies changes at the base of the lithofeldspathic sandstone unit indicate a period of deformation and erosion prior to deposition of the sandstone. The contact between the sandstone and underlying volcaniclasts is conformable along a northeast-trending zone southeast of the Needle. In this area the volcaniclastic rocks fine upward into a shale horizon overlain by the sandstones. To the south, a rapid facies change occurs, possibly involving telescoping of facies on hidden faults, and the base of the section becomes conglomeratic. The volcanic and volcaniclastic units apparently pinch out, and in the Limestone Hills (Fig. 2), a massive limestone conglomerate overlies Paleozoic rocks at the base of the sandstones. The contact there is sheared and is interpreted to be a minor fault. Thinning of the volcanic unit, coarsening of the basal sandstone section and overlap onto Paleozoic rocks are indicative of uplift in the southern part of the area during or after deposition of the volcanics and before deposition of the Mesozoic sandstones.

Sore Fingers Crystalline Complex

The Sore Fingers crystalline complex is an informal name assigned to an assemblage of intrusive and metamorphic rocks in the southern part of the map area. The complex is named after two low hills in the southernmost Little Harquahala Mountains called the Sore Fingers on the Hope 15' quadrangle. The complex is bounded by faults on the northwest, southwest and northeast and covered by alluvium on the southeast. The age of the complex is uncertain but is probably Precambrian and Mesozoic.

The most abundant lithology in the Sore Fingers complex is a quartz monzonite porphyry. Equant to slightly elongate light flesh-pink potassium feldspar phenocrysts up to 8 cm long occur in a groundmass of 1-5 mm quartz, plagioclase and altered biotite. This rock has yielded a minimum age of 140 m.y. (K-Ar, biotite, Rehrig and Reynolds, 1980). Slight alteration is concentrated along joints throughout the intrusion but is locally intense and extensive, converting large areas of quartz monzonite to a dense black siliceous alteration product in which 1-3 mm quartz eyes and 3-5 mm white feldspar "spots" are all that is left of the original texture. Silicification

MULTIPLE DEFORMATION IN THE HARCUVAR AND HARQUAHALA MOUNTAINS, WEST-CENTRAL ARIZONA

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845 N. Park Ave.
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INTRODUCTION

Harcuvar and Harquahala Mountains are two of prominent mountain ranges in western Arizona 1). They are distinct from adjacent ranges of their anomalous northeast trend and rela- high elevation. In spite of their prominence eness, little has been written about the of either range.

most important early studies of the overall were by Darton (1925) and Wilson (1960). More y, both mountain ranges were discussed by and Reynolds (1980) as part of their reconnais- metamorphic core complexes in Arizona. al articles have been published on specific of one or both ranges (Kam, 1964; Varga, 1977; 1978; Reynolds, 1980; Reynolds and others, 1980).

purpose of this report is to summarize the ral geology of the Harcuvar and Harquahala s, with special emphasis on geometry and age generation of structures. Conclusions ed here must be considered preliminary, because range has been completely mapped.

GENERAL GEOLOGIC RELATIONSHIPS

Each mountain range is composed of a central core of plutonic and metamorphic rocks that probably range in age from 1.7 b.y. to 25 m.y. (Figure 2). Plutonic rocks vary in composition from granite to diorite and are commonly foliated. Metamorphic rocks are primarily amphibolite-grade gneiss, schist, and migmatite, but also include lower-grade Paleozoic and Mesozoic metasedimentary units. In the Harquahala Mountains, metamorphosed Paleozoic rocks occur beneath a large overthrust sheet of Precambrian crystalline rocks (Reynolds and others, 1980).

Several types of fabrics are present within metamorphic and foliated plutonic rocks. Crystallo- blastic fabrics are common in deeper structural levels, whereas mylonitic fabrics are more common in higher structural levels. Both types of foliation define broad, doubly plunging anticlines that trend east- northeast, parallel to the topographic axis of each range (Figure 2).

Along the northeast end of each range, metamorphic and plutonic rocks are overlain by a major, low-angle

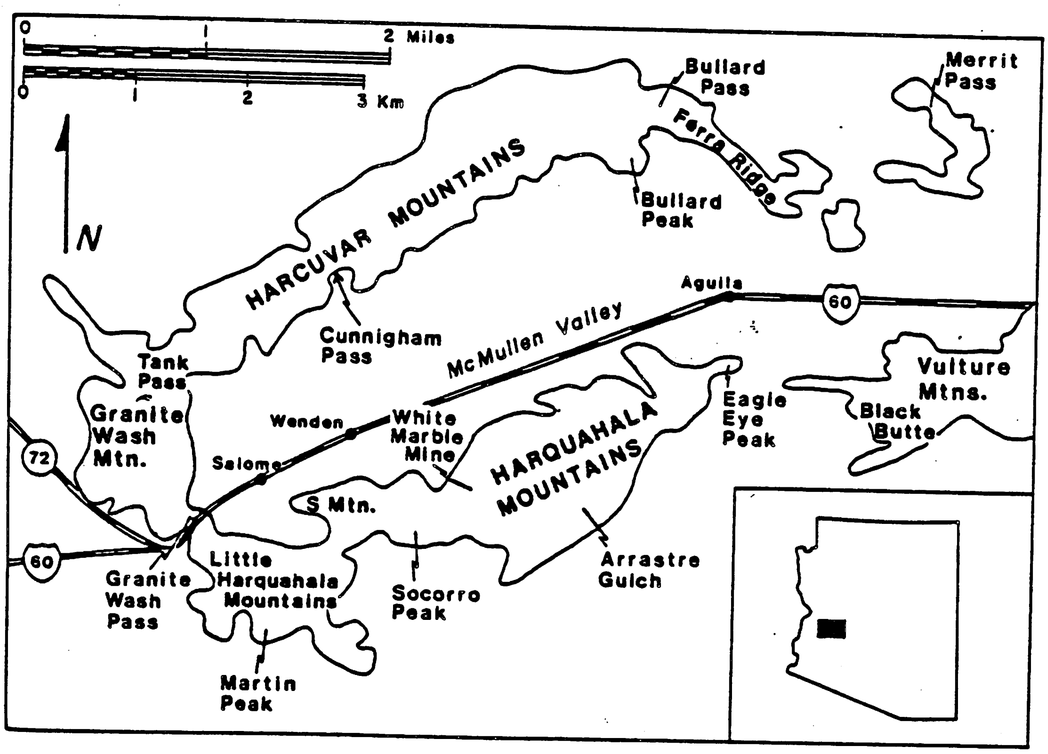


Figure 1. Physiographic features of the Harcuvar and Harquahala Mountains and vicinity.

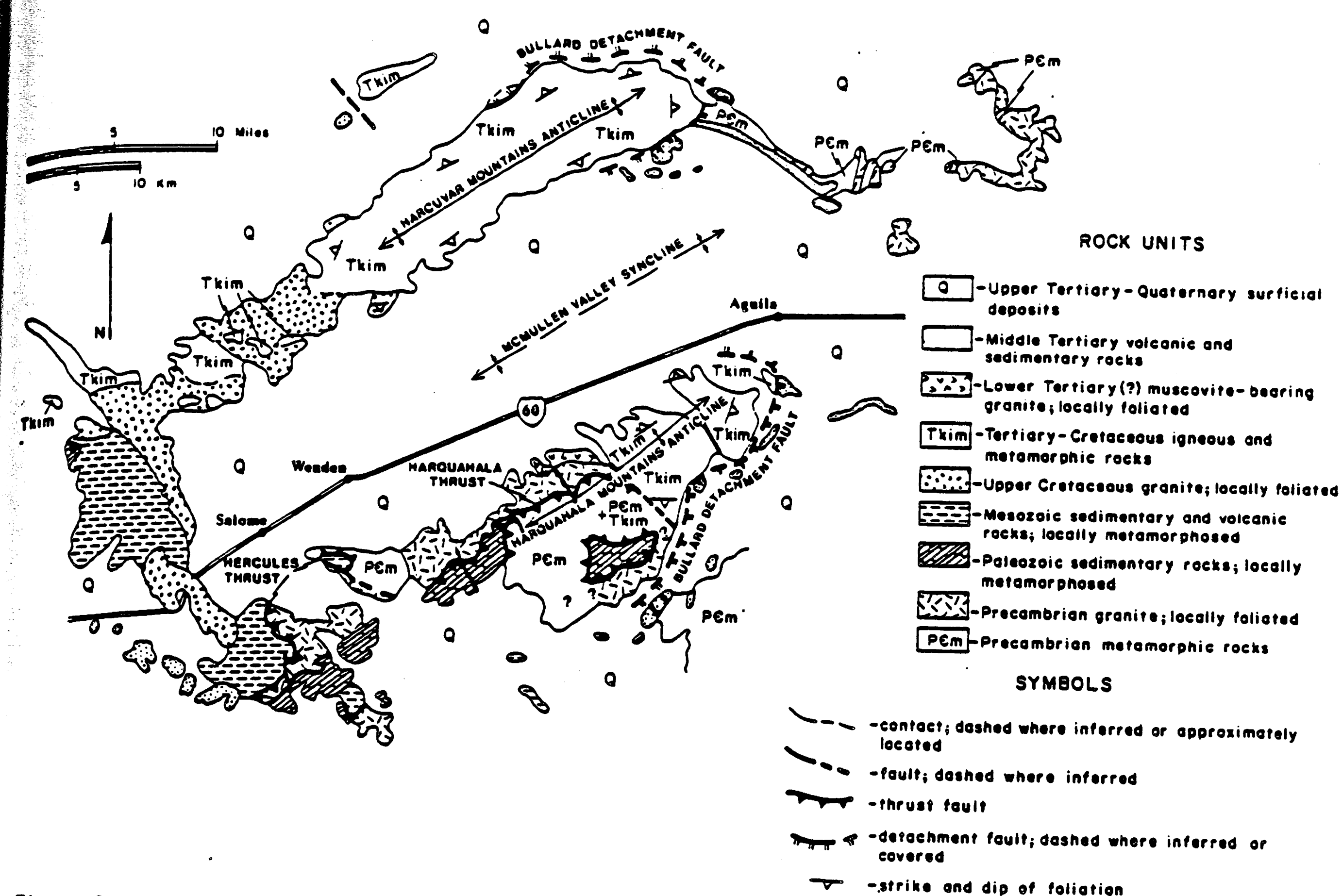


Figure 2. Reconnaissance geologic map of the Harcuvar and Harquahala Mountains and vicinity. Sources of information include Reynolds (1980), Reynolds and others (1980), Rehrig and Reynolds (1980), Wilson (1960), Coney and Reynolds (1980), Varga (1977), S. Richard (1982, pers. comm.), and unpublished geologic mapping by S. Reynolds.

detachment fault. Upper plate rocks include Precambrian crystalline rocks and strongly tilted, middle Tertiary volcanic and sedimentary rocks.

Bedrock exposures of the ranges are surrounded by late Tertiary-Quaternary surficial deposits.

DEFORMATIONAL EVENTS

The Harcuvar and Harquahala Mountains contain evidence for at least nine episodes of deformation. They are, from oldest to youngest:

1) Precambrian deformation, accompanied by plutonism and high-grade metamorphism;
2) Mesozoic, southeast-vergent folding of Paleozoic and Mesozoic rocks in western Harquahala Mountains;
3) Late Cretaceous, northeast-vergent, ductile deformation synchronous with plutonism and high-grade metamorphism;
4) Late Cretaceous-early Tertiary, north-directed overthrusting;
5) Intrusion of early Tertiary (?) muscovite-bearing granites into northeast-striking fractures;
6) Tertiary mylonitization which formed a gently dipping foliation and east-northeast-trending lineation;
7) Intrusion of middle Tertiary microdiorite dikes into northwest-striking fractures;
8) Northeast-directed detachment faulting, accompanied by antithetic rotation of upper-plate rocks and by formation of the main northeast-trending anticlines;
9) Late Tertiary Basin and Range (?) faulting.

Salient features of each deformational event are summarized below.

Precambrian Deformation, Metamorphism and Plutonism

The earliest deformational event is recorded in Precambrian metamorphic and plutonic rocks that occur near Merrit Pass, Ferra Ridge, and in the Vulture, Bighorn, and Harquahala Mountains (Figures 1 and 2). These rocks consist of high-grade gneiss, schist, granofels, migmatite, quartzite, and foliated plutonic rocks. They possess a crystalloblastic foliation defined by compositional layering and by preferred orientation of minerals, such as biotite and hornblende. Where unaffected by later deformation, foliation usually strikes northeast and is nearly vertical (Figures 3 and 4). Some granites have been injected parallel to foliation, and are themselves foliated. The steep crystalloblastic foliation is similar in style and orientation to Precambrian fabrics elsewhere in Arizona.

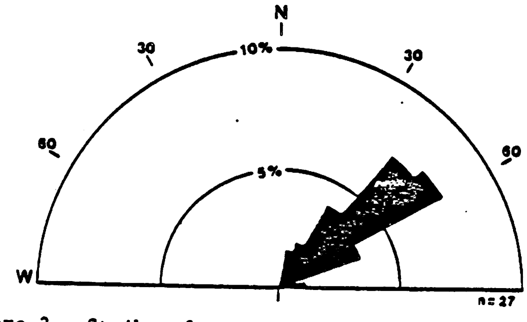


Figure 3. Strike of steep Precambrian foliation near Merrit Pass.

A FIELD GUIDE TO THE NORTHWESTERN GRANITE WASH MOUNTAINS,

WEST-CENTRAL ARIZONA

STEPHEN J. REYNOLDS*, JON E. SPENCER*, AND STEPHEN M. RICHARD+

* - Arizona Bureau of Geology and Mineral Technology
+ - Univeristy of California, Santa Barbara

November 6, 1983

STATE OF ARIZONA
BUREAU OF GEOLOGY
AND MINERAL TECHNOLOGY
OPEN-FILE REPORT

83-23

Interpretations and conclusions in this report are those of the consultant and do not necessarily coincide with those of the staff of the Bureau of Geology and Mineral Technology.

INTRODUCTION

The Granite Wash Mountains are one of the most structurally complicated mountain ranges in Arizona. The northern part of the range is composed of an imbricate stack of structurally interleaved Mesozoic sedimentary and volcanic rocks, Paleozoic strata, and Precambrian crystalline rocks. As part of the 1983 AGS Fall field trip, we will briefly examine the lithologies, structures, and mineralization in the northern part of the range. The geology and mineral deposits of the Granite Wash Mountains are currently being studied as part of an Arizona Bureau of Geology and Mineral Technology geological mapping project in the Phoenix 1x2 degree sheet. Geologic research in the range is not yet finished, so all conclusions and opinions discussed in this field trip guide must be considered PRELIMINARY.

With the exception of a thesis by Ciancanelli(1965), previous geologic research in the area is limited to reconnaissance studies (Wilson, 1960; Marshak, 1979; Rehrig and Reynolds, 1980; Reynolds, 1980, 1982) and somewhat cursory examinations of gold mines of the area (see references in Keith, 1978).

REGIONAL GEOLOGIC SETTING

The Granite Wash Mountains are located in west-central Arizona, a geologically complex and poorly understood part of the southern Basin and Range Province. The region is situated northeast of the Mesozoic batholith belt and southwest of the relatively stable Colorado Plateau, and has geologic characteristics intermediate between those of the two flanking areas. Precambrian crystalline rocks are widely exposed in this medial belt, whereas they have been largely obliterated by plutonism in the batholith belt and are covered by flat-lying Paleozoic and Mesozoic strata in the Colorado Plateau. Consistent with this medial position, west-central Arizona was the site of scattered Mesozoic-Cenozoic plutonism and metamorphism. The region also experienced multiple episodes of post-Paleozoic thrusting and deformation. The Paleozoic stratigraphy of the region is thin and cratonic, and Precambrian crystalline rocks are clearly involved in thrusting.

uplifted? covered?

West-central Arizona can be subdivided into three lithologically distinct tectonic terranes whose boundaries are zones of intense deformation (Harding and others,1983). The northernmost terrane, consisting of Precambrian crystalline rocks with an overlying cover of cratonic Paleozoic strata and Mesozoic volcanic and sedimentary rocks, represents the southwestern limit of unequivocal North American craton. In at least two mountain ranges, this terrane has been thrust southward over Mesozoic volcanic and sedimentary rocks of the McCoy terrane. On its southern margin, the McCoy terrane has been overthrust by the composite San Gabriel-Joshua Tree terrane along the north- to northeast-vergent Mule Mountains Thrust and related structures

1983 AGS Fall Field Trip Route

Led by

Bob Scarborough, Steven Reynolds, and Jon Spencer
Arizona Bureau of Geology and Mineral Technology

Organized by

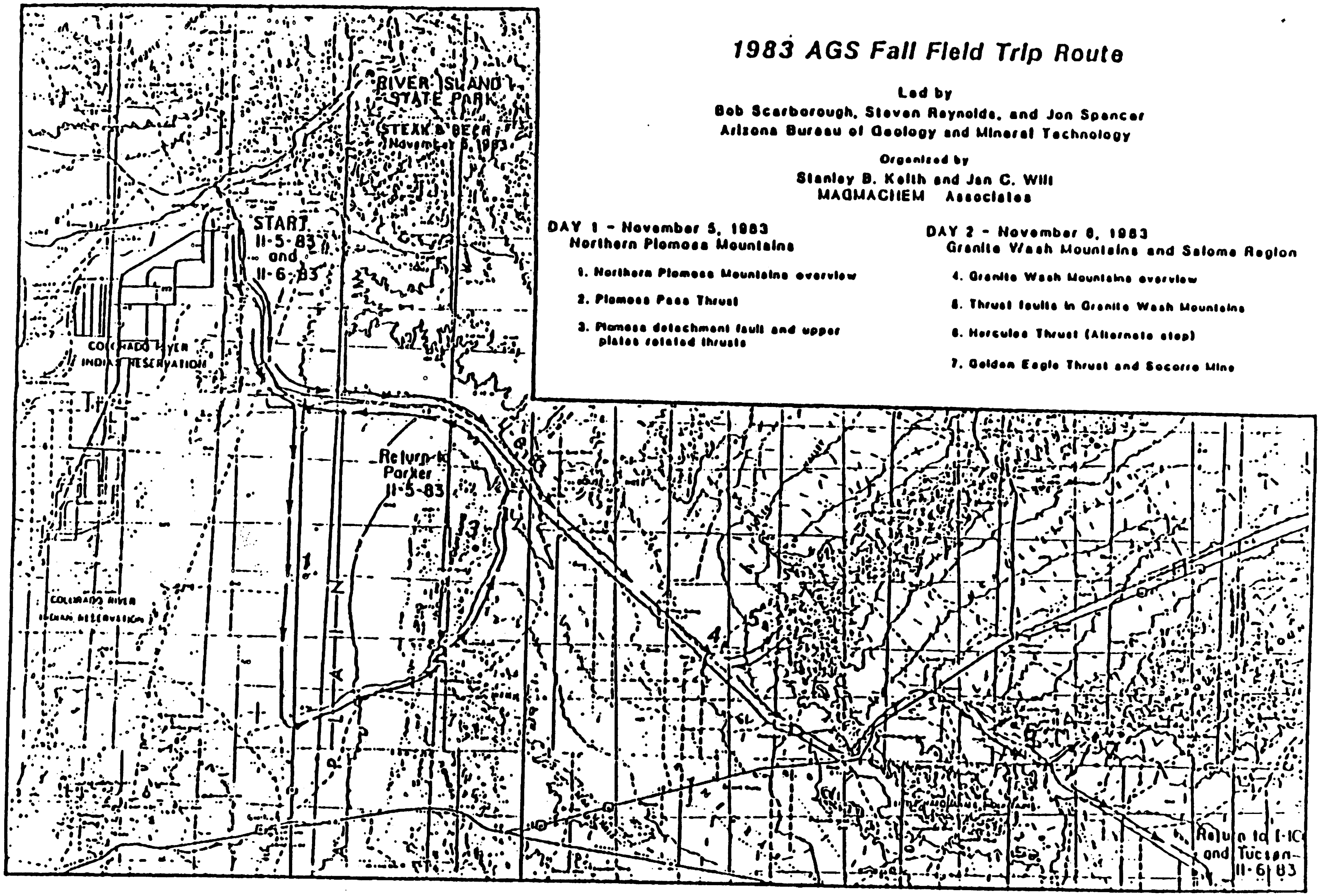
Stanley B. Keith and Jan C. Will
MAGMACHEM Associates

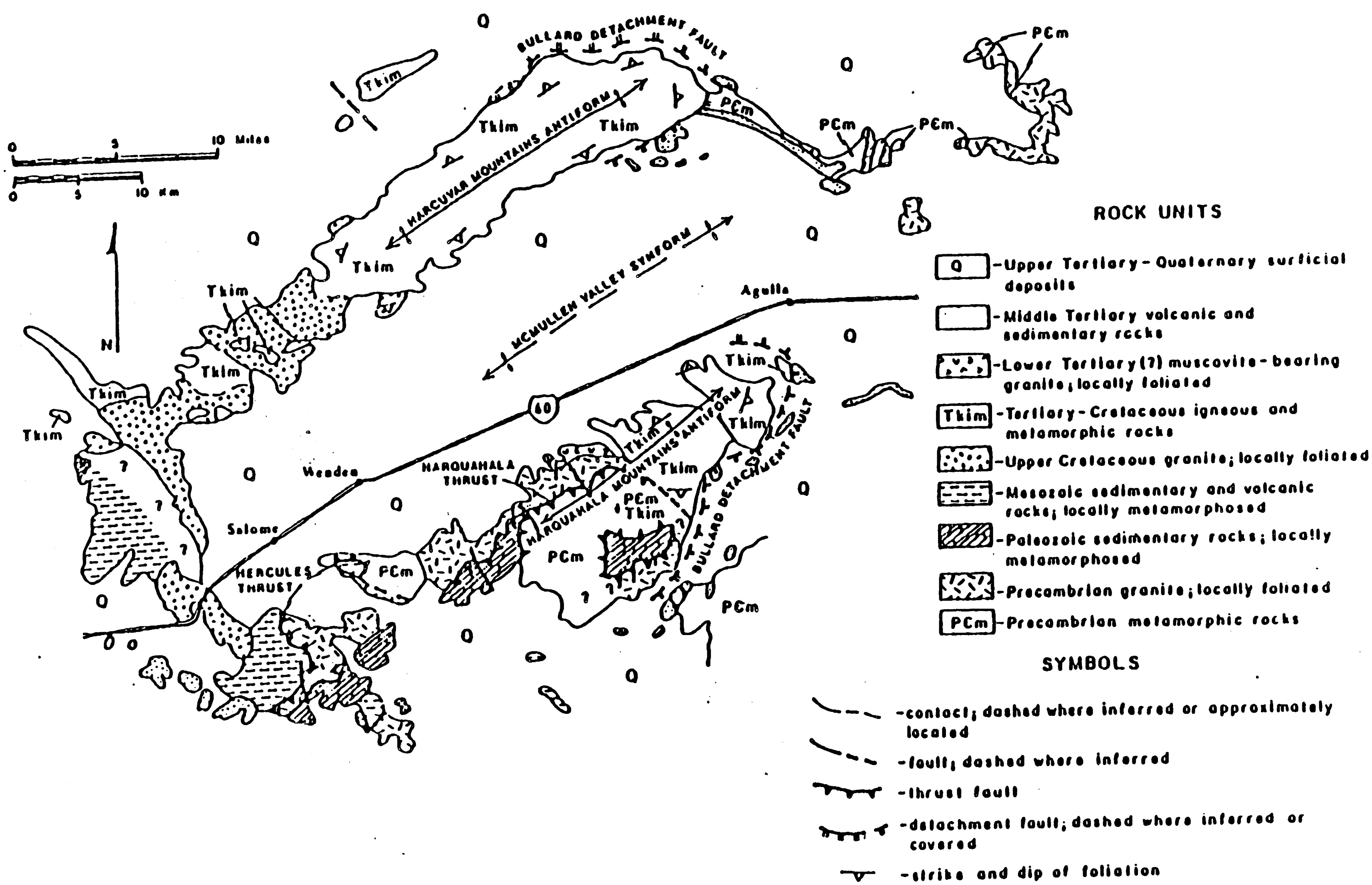
DAY 1 - November 5, 1983
Northern Plomosa Mountains

1. Northern Plomosa Mountains overview
2. Plomosa Pass Thrust
3. Plomosa detachment fault and upper plates related thrusts

DAY 2 - November 6, 1983
Granite Wash Mountains and Salome Region

4. Granite Wash Mountains overview
5. Thrust faults in Granite Wash Mountains
6. Hercules Thrust (Alternate stop)
7. Golden Eagle Thrust and Socorro Mine




BULLARD DETACHMENT FAULT
MARCUVAR MOUNTAINS ANTIFORM
MCMULLEN VALLEY SYNFORM
HARQUAHALA MOUNTAINS ANTIFORM
HARQUAHALA THRUST
HERCULES THRUST
Aguila
Wenden
Salome
60
Tkim
PCm
Q
N
0 5 10 Miles
0 5 10 Km
ROCK UNITS
Q -Upper Tertiary - Quaternary surficial deposits
-Middle Tertiary volcanic and sedimentary rocks
-Lower Tertiary (?) muscovite-bearing granite; locally foliated
Tkim -Tertiary - Cretaceous igneous and metamorphic rocks
-Upper Cretaceous granite; locally foliated
-Mesozoic sedimentary and volcanic rocks; locally metamorphosed
-Paleozoic sedimentary rocks; locally metamorphosed
-Precambrian granite; locally foliated
PCm -Precambrian metamorphic rocks
SYMBOLS
-contact; dashed where inferred or approximately located
-fault; dashed where inferred
-thrust fault
-detachment fault; dashed where inferred or covered
-strike and dip of foliation

sdal, 1982; Harding, 1982). The San Gabriel-Joshua Tree terrane is largely posed of Precambrian crystalline rocks of uncertain affinity to North rica (Powell, 1981).

The Granite Wash Mountains lie near or on the tectonic boundary between atonic North America and the McCoy terrane. Regionally, this boundary is ked by a gently to moderately dipping thrust fault that separates two damentally distinct lithologic assemblages. The pre-Cenozoic atigraphic sequence of the North American block includes: 1) a basement of ecambrian metamorphic and granitic rocks; 2) a 1-1.5 km-thick sequence of atonic Paleozoic strata; 3) up to 2 km of intermediate to felsic volcanics f probable Jurassic age; and 4) a clastic unit of Jurassic or Cretaceous age at is nowhere more than 3 km thick. In contrast, the McCoy terrane is posed entirely of Mesozoic rocks, consisting of a thick lower unit of lcanic rocks whose base is not exposed, and an upper clastic sequence that s locally in excess of 7 km thick. The upper clastic sequences of the McCoy d North American terranes, although in similar stratigraphic positions, are ratigraphically and petrographically distinct (Harding, 1982). The name Coy Mountains Formation is applied to the thick clastic sequences in the Coy terrane, whereas the thinner sequences of the North American block are eferred to as Apache Wash Formation (Harding, 1982). Both terranes and their tual tectonic boundary have been locally intruded by late Mesozoic anitoids and depositionally overlapped by mid-Cenozoic volcanic and dimentary rocks.

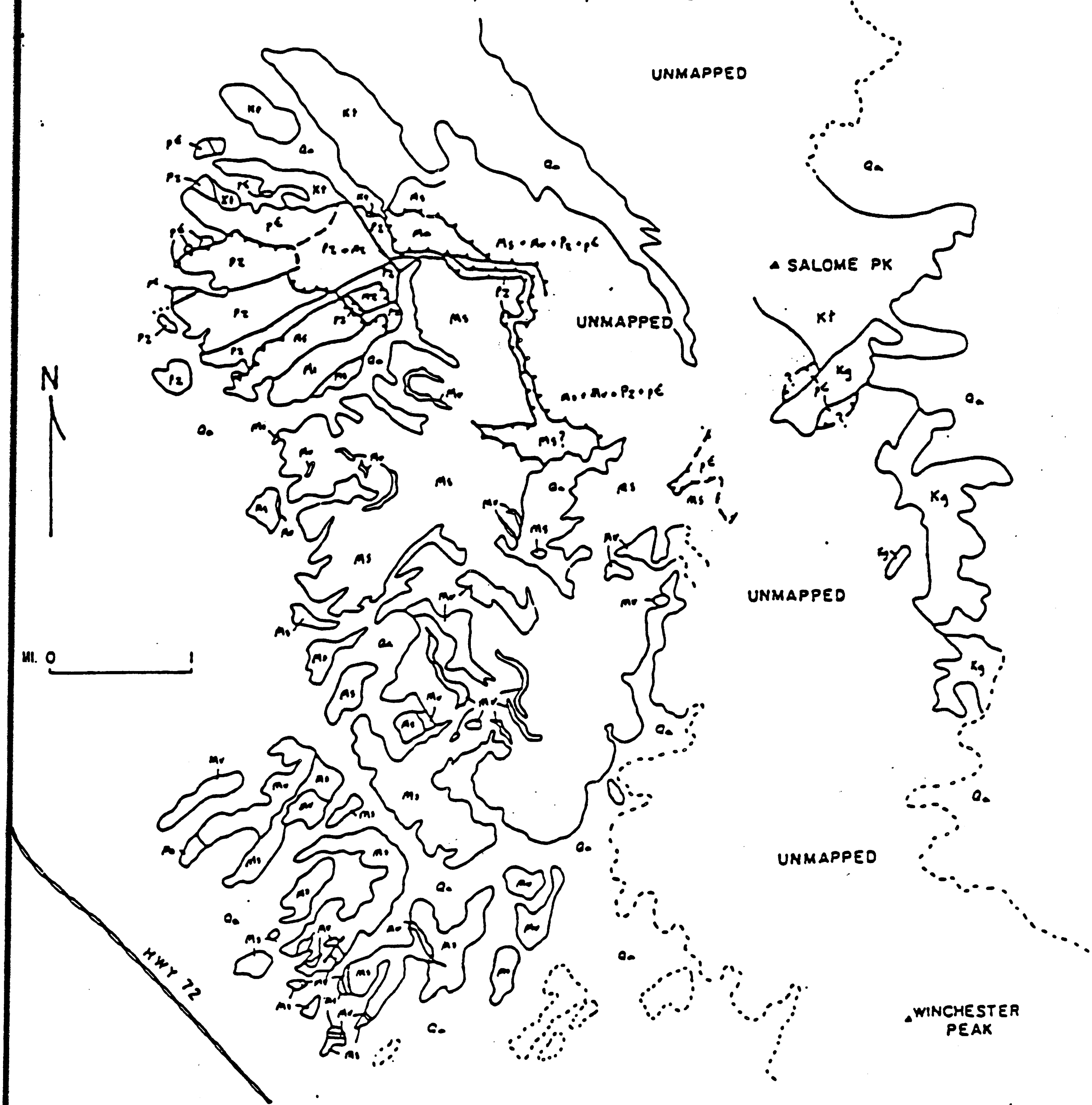
OLOGY OF THE GRANITE WASH MOUNTAINS

The Granite Wash Mountains are primarily composed of Mesozoic sedimentary, lcanic, and granitic rocks (Figures 1 and 2). The most widely exposed ithologic unit is an interlayered sequence of immature clastic rocks and ntermediate to felsic volcanic rocks. The clastic lithologies include artzofeldspathic and lithic sandstone, siltstone, and conglomerate. The lcanic rocks include andesitic flows and subvolcanic intrusions, quartz rphyry (ash-flow tuffs(?)), and bedded tuffs. The clastic and volcanic ocks are more highly metamorphosed in the eastern, structurally highest rts of the range. At present, it is unknown whether these Mesozoic rocks re correlative with 1) the McCoy Mountains Formation of the McCoy terrane,) the Apache Wash Formation of the North American block, or 3) some other esozoic unit.

The Mesozoic rocks described above are in tectonic contact with Paleozoic etasedimentary rocks and Precambrian(?) crystalline rocks. The Paleozoic etasedimentary rocks are correlative with lithologically similar middle and pper Paleozoic formations of the region, including (from bottom to top) evonian Martin Formation, Mississippian Redwall Limestone, ennsylvanian-Permian Supai(?) Formation, Permian Coconino Sandstone, and ermian Kaibab Formation. We emphasize that these correlations are based oley on lithology and stratigraphic succession, not on any paleontologic ata. Precambrian crystalline rocks of the area include 1) high-grade,

SIMPLIFIED GEOLOGIC MAP OF THE GRANITE WASH MTNS.

MAPPED BY S. REYNOLDS, J. SPENCER, AND S. RICHARD



CORRELATION OF MAP UNITS

Qa				QUATERNARY	CENOZOIC
Kg				CRETACEOUS	MESOZOIC
Kt					
Ms	Mv	Mi	Ma		
Pz					PALEOZOIC
pЄ					PRECAMBRIAN

DESCRIPTION OF MAP UNITS

Qa Quaternary alluvium

Kg Granite Wash Granodiorite - Medium-grained, equigranular, hornblende-biotite granodiorite with dioritic border phase. Dated at 65 and 69 m.y. (K-Ar biotite, Damon, 1968; Eberly and Stanley, 1978).

Kt Tank Pass Granite - Medium- to fine-grained, leucocratic, biotite granite. Dated at ≈ 85 m.y. (3-point Rb-Sr isochron, S. J. Reynolds, unpublished data).

Ms Mesozoic metasedimentary rocks - Primarily poorly- to very poorly-sorted litho-feldspathic sandstone and locally interbedded phyllite and conglomerate.

Mv Mesozoic volcanic and hypabyssal rocks - Primarily massive flows 1-30 m thick of dark aphanitic metavolcanic rocks and associated fine-grained hornblende diorite(?) hypabyssal intrusives.

Mi Mesozoic igneous rocks - Porphyritic, hypabyssal(?) intrusive with abundant .3 to 3 cm K-spar phenocrysts in dark, microcrystalline groundmass.

Ma Mesozoic alaskite - Fine-grained, leucocratic, altered, granitic intrusives.

Pz Paleozoic metasedimentary rocks - Recognized formations include Martin, Redwall, Coconino, Supai, Kaibab, and evaporites at the top of the Kaibab.

pЄ Precambrian granite-gneiss - Includes medium- and fine-grained, equigranular and porphyritic, biotitic granitic and gneissic rocks.

compositionally layered, quartzofeldspathic gneiss; 2) locally porphyritic medium- to coarse-grained granitic gneiss; and 3) equigranular medium-grained, foliated granitoid rocks. We have not, as yet, recognized any depositional contacts between Precambrian, Paleozoic, and Mesozoic rocks.

The structure of the Granite Wash Moutains is very complex. The Mesozoic rocks are multiply deformed and weakly to strongly metamorphosed. The dominant structural fabrics are a steep, northwest-striking fracture cleavage and a well-developed subhorizontal cleavage or schistosity that contains a northeast-trending lineation. Refolded folds are locally common. Lithologic units in the Mesozoic section are commonly lenticular and erratic in distribution, possibly due to isoclinal folding. In addition, the Paleozoic section is locally attenuated and interfolded on a fine scale within the Mesozoic units. Many Paleozoic-Mesozoic contacts are faults and ductile shear zones, probably with significant amounts of tectonic transport. Other contacts may represent attenuated limbs of large-scale isoclinal folds and nappes. Isolated fault slivers and tectonic "fish" of Precambrian(?) crystalline rocks occur along some Paleozoic-Mesozoic contacts. In addition, preliminary mapping suggests the presence of a major thrust that places Precambrian crystalline rocks over all Mesozoic and Paleozoic rocks in the range.

The youngest pre-Cenozoic rocks in the range are two Upper Cretaceous plutons, the Tank Pass Granite and Granite Wash Granodiorite (Rehrig and Reynolds, 1980). Both plutons appear to intrude discordantly across all structures in the range, including the suggested major thrust. The ages of the Tank Pass Granite and Granite Wash Granodiorite are both constrained to 85-70 m.y.B.P. by published and unpublished K-Ar and Rb-Sr dates (Reynolds, 1982).

Cenozoic rocks in the range are limited to 1) numerous, northwest-trending dikes; 2) gently dipping, intermediate to mafic flows and pyroclastic deposits exposed on the western flank of the range; and 3) various generations of gravels.

Mineralization in the range consists mostly of (Keith, 1978):

1) Scheelite in quartz veins and pockets in metamorphosed Paleozoic and Mesozoic rocks adjacent to the Tank Pass Granite and Granite Wash Granodiorite; and

2) gold- and copper-bearing veins (locally accompanied by lead and silver) in Mesozoic, Paleozoic, and Precambrian rocks, commonly near intermediate to felsic dikes.

FIELD TRIP STOPS

The main emphasis of the Granite Wash segment of the field trip is to present a broad overview of the rock units, structure, and mineralization of the range. We will examine the lithology and structure of the Mesozoic sedimentary and volcanic rocks in both weakly and moderately metamorphosed conditions. Depending on the difficulty of access (due to the great flood of 83), we will also examine the tectonic interleaving of Paleozoic and Precambrian rocks within the Mesozoic section. If roads permit, we will do the latter at the Yuma Mine, a site of copper-silver-gold mineralization. The mineralization, including copper oxides and carbonates, is localized in strongly deformed Paleozoic carbonates that occur as tectonic lenses completely enclosed by Mesozoic metasedimentary rocks. Crystalline rocks, such as augen gneiss, locally occur along the Paleozoic-Mesozoic contact.

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One of the NICOR basic energy companies

NICOR MINERAL VENTURES

Suite 12 2341 South Friebus Avenue Tucson, Arizona 85713 602-881-8871

July 2, 1985

Mr. Ted Davis
Strategic Resources, Inc.
315 Stanford S.E.
Albuquerque, NM 87106

Dear Mr. Davis:

Thank you for sending to me the information regarding your kyanite property in the Granite Wash Mountains near Salome. I forwarded the information on to Mr. Periera, our industrial minerals manager up in Denver. Mr. Periera related to me that he felt that while you probably did have a significant kyanite deposit the total domestic market for kyanite is quite small and market penetration could be difficult. For these reasons he did not feel that NICOR should pursue this situation at this time.

Again, thank you for letting us take a look at the property. If you have any other mineral properties in which you think we may be interested, please do not hesitate to call or write.

Sincerely yours,

Gary A. Parkison

GAP:gsl

Talked w/ Joe Davis ~ 6/3/95

- Joe Davis -

505

~~[illegible]~~ ?

266 8408 Kagenite

Go to Yuma Mine Rd.

Steve Radvak -

Baroque Resources

- Barrick? -

- first large wash you pass going - Granite south wash from junction

- follow up wash ~1/2 mi. →

Strategic Resources Inc.

315 STANFORD S.E., ALBUQUERQUE, NEW MEXICO 87106
(505) 268-3534

FOREWORD

Stategic Resources, Inc. is the sole owner of a large, massive kyanite orebody located in Western Arizona. This newly discovered kyanite orebody contains a substantial quantity of high alumina (60% +), remarkably pure lump kyanite which in its natural state is at least the equal of the kyanite shipped from India over a number of years. The low iron and titanium content of this ore makes it especially attractive and places it in a class by itself. In addition, the ore contains silica,muscovite mica, and pyrophyllite which will probably equal the value of the kyanite, leaving very little waste material.

The orebody is ideally situated with respect to economic considerations. It lies approximately six miles down an easily maintained all-weather gravel road which connects to a good, hard-surfaced, State maintained highway. This road is paralleled by Santa Fe Railroad trackage with nearby siding.

The orebody itself is exposed over large areas with little or no overburden in most places and will readily lend itself to a quarrying or open pit type operation. It immediately becomes apparent to a qualified observer that this orebody is so extensive as to become practically inexhaustible to supply worldwide needs for many decades to come.

Strategic Resources, Inc. is now prepared to lease or sell this property to a qualified operator.

If you are seriously interested in looking into this matter, please contact us for futher information.

Strategic Resources, Inc., a New Mexico Corporation, owns a large quartzite kyanite deposit in western Arizona near the California border. The economics of producing a commercial kyanite concentrate from this deposit are very favorable and we have several Japanese trading companies wanting to import all that we would be able to produce in the first year or two of production. Strategic Resources, Inc. was formed solely to develop this kyanite ore body. The company has few other assets and no liabilities, other than its outstanding stock, issued in return for the kyanite deposit.

Kyanite, a mined and beneficiated commodity, is one of a group of anhydrous alumino silicates (kyanite, sillimanite, andalusite, and dumortierite) all having the same chemical composition ($Al_2O_3 \cdot SiO_2$). These minerals convert to a mixture of mullite and silica when heated to high temperatures. Mullite is a highly desirable refractory material. During the heating process kyanite increases its volume 16-18%, while andalusite and sillimanite only change by about 4% and 6% respectively. This volume change is a desirable property. The principal use of kyanite is in refractory products with other applications in sanitary ware, tile and precision castings molds. The Japanese Ministry of International Trade and Industry (MITI) has pledged $450 million to a 10-year research project on high performance ceramics. Kyoto Ceramic Co. is already demonstrating a ceramic car engine. Ceramic specialists at the Nomura Research Institute are predicting that the ceramics market will be as high as $5 billion a year by 1990. Although actual selling prices are negotiated between producers and buyers and depend upon quantity, quality and grain size, the July 1982 Engineering and Mining Journal lists prices for kyanite f.o.b. minesite, Georgia, ranging from $85 to $137 per short ton for raw bulk material depending on grain size. The United States is the world's largest producer of kyanite. All commercial production in the United States, until now, has been from Virginia (Kyanite Mining Co.) and Georgia (CE-Minerals). There are also commercial deposits of andalusite in South Africa and France of kyanite in India and Brazil.

To a great extent the usefulness of kyanite depends on its refractoriness, and its refractoriness depends on its alumina content (Al_2O_3). Kyanite can contain a maximum of about 63% alumina for the chemically pure substance (which is never actually attained). Impurities such as iron titanium and the alkalies impair the refractory properties of kyanite and must be kept to a minimum. There must also be a fairly high percentage (perhaps 60% of coarse grain size material. In all these respects our kyanite deposit is superior to the kyanite being mined in Virginia and Georgia.

Synthetic mullite has been produced for years not as a direct competitor to kyanite but rather for use under more demanding refractory conditions. Synthetic mullite is expensive. In June 1977 the cost of synthetic mullite into United Kingdom ports was $470-520 per short ton for sintered materials and $550-600 per short ton for fused material. Today, it is probably priced much higher. Kyanite (or andalusite) provide the so-called medium-alumina (45-75% Al_2O_3) range of alumino silicate refractories. Refractories containing less than 45% alumina are based on fire clays. Those above 75% are based on calcined bauxite and alumina. Natural kyanite gets some competition from super duty fireclays at the lower end of the range and from synthetic mullites at the top end. Refractory users look to performance as well as cost and availability. Kyanite is used extensively because it meets these requirements.

Since kyanite must be delivered to the consumer at competitive prices, geographic location is of primary importance. The Strategic Resources kyanite deposit of 10,000,000 tons or more is located about 40 miles south of Parker, Arizona, which is on the Colorado River opposite San Bernardino County, California. The deposit is only 6.3 miles down a gravel all-weather road which connects to a paved state highway paralleled by Santa Fe railroad track. This places the railroad siding about ten miles from the mine site. The deposit was discovered and located by C.E. Willmore and acquired under the laws and regulations of government acquisition of mineral rights in Arizona. It lies on U.S. government land administered by the Bureau of Land Management (BLM).

The deposit which is estimated to contain at least 10 million tons of 35% kyanite will be mined as an open pit quarrying operation. It will be drilled and blasted, crushed and screened. After screening the 28-30 mesh pulp, it will be sent to a nearby froth flotation mill. Here it will be deslimed, conditioned and floated to recover a 91+% kyanite concentrate. About fifty percent of the ore consists of high grade silica sand and pyrophyllite, both of which can be considered salable by-products. It is probable that we will recover between 100-200 lbs. of marketable flake mica from each ton of ore.

The cost of mining and milling is estimated at about half of the cost of rail transportation and handling. The rate quoted by the Santa Fe Railroad of $18.70 to port of San Diego or $17.50 to Port of Long Beach or Port of Los Angeles is the single largest cost in getting kyanite from out of the earth to shipboard. Following is our estimated cost breakdown:

	Per Ton	
	BULK	BAGGED
Overhead	1.00	1.00
Mining	3.00	3.00
Crushing	3.00	3.00
Flotation	8.00	8.00
Mill to Railhead	5.50	5.50
Railhead to Port Long Beach, San Diego, Los Angeles	19.00	19.00
Warehousing & Loading on Ship	5.50	19.00
	$45.00	$58.50

The annual Japanese market for kyanite is presently about 10,000 tons. This translates to about $900,000 or about $90 per short ton f.o.b. minesite. This market is expected to expand. Another market to be serviced from West Coast ports is Taiwan, although much smaller. The Mexican market is best served by rail. The West Coast market around Los Angeles which consists of about 2,500 tons per year will be serviced by bulk shipments to Los Angeles port. There the kyanite will be bagged and palletized at a cost of $18 per ton (Cresent

Wharf & Warehouse Co.). Other buyers who use 75 tons or more per year will be serviced by bulk carload shipments.

West Coast refractory users are presently paying about $155 to $220 per ton for kyanite shipped out of the East. These users will save about $50 per ton on western Arizona kyanite.

Kaiser Chemical Company and A. P. Green in Mexico, Missouri, each use several thousand tons of kyanite per year. We believe we can compete effectively with eastern shippers for this business.

Although we have in our mine a considerable but unknown tonnage of high grade natural kyanite (85-90%), on average the kyanite runs about 35%. It must be beneficiated to produce a 91+% kyanite concentrate. In order to accomplish this the following milling steps must be taken: crush and grind to 28-mesh, deslime, condition, two stage flotation (rougher and cleaner), drain and dry, screen and grind to customer specification. It will probably be necessary to remove flake mica by cationic flotation prior to the kyanite float. The mica so removed will be good marketable product. A flotation mill constructed to produce 300-350 tons per week of concentrate will need to process from 200-250 tons of raw kyanite per day. Several flotation mills of this or larger capacity are currently for sale in the western states. They range in asking price from $500,000 up to $650,000. To the cost of such a mill one must add the cost of moving and erection, site preparation, water well drilling and storage, electrical generation and fuel storage, haulage and loading equipment, utility buildings, etc. One million dollars will be required to acquire, install, and debug such a mill together with its associated materials handling equipment. Such a mill would produce from 10-12,000 tons of concentrate per year and gross from 1.1 to 1.35 million per year.

Spectrochemical Laboratories Inc.

Telephone: 412-371-2345
TWX: 710-664-4439

8350 FRANKSTOWN AVENUE
PITTSBURGH, PA. 15221

September 28, 1982
Sample Recd. 9-8-82

Strategic Resources Inc.,
315 Stanford S.E.
Albuquerque, NM 87106

Attn: Mr. C.E. Willmore

ANALYSIS REPORT
IN WEIGHT %
ON CALCINED BASIS

Sample of natural kyanite
OUR LAB #W 9295

Fe_2O_3	.10
CaO	.31
MgO	*.01
TiO_2	.63
K_2O	.36
SiO_2	61.37
Al_2O_3	37.13
Na_2O	.07
ON AS RECEIVED BASIS	
Loss On Ignition	1.40

*Not detected. The number indicates the minimum limit of detection.

SPECTROCHEMICAL LABORATORIES, INC.,

T.L. Fulton

T.L. Fulton

As a mutual protection to clients, the public and ourselves, all reports are submitted as the confidential property of clients, and authorization for publication of statements, conclusions or extracts from or regarding our reports is reserved pending our written approval.

Hazen Research, Inc.
4601 Indiana St. • Golden. Colo. 80401
Tel: (303) 279-4501 • Telex 45-860

July 16, 1982

Mr. Charles Edward Willmore
President
Strategic Resources, Inc.
315 Stanford S.E.
Albuquerque, NM 87106

Dear Mr. Willmore:

Thank you for calling regarding tests on your kyanite ore samples. Please give my regards to Dave Rabb when you see him again.

We understand that your company owns a large kyanite deposit in Yuma County, Arizona, with reserves in the tens of millions of tons range. You indicated that the ore averages about 35% kyanite and that the gangue minerals include muscovite. Fortunately, as you indicated, the ore is low in iron and titanium minerals.

As you know, kyanite is mined and processed at three locations in the United States. Kyanite Mining Corporation operates the Willis Mountain and East Ridge Mines in Virginia and C-E Minerals, Inc. operates the Graves Mountain Mine in Georgia. All three operations use flotation as the primary beneficiation method.

Based on the present technology and the information you provided on your ore, we anticipate that a process for treating your ore will include most of the following steps, and possibly other steps:

1. Size reduction to approximately minus 28-mesh. (This would normally be accomplished by a rod mill in closed circuit with a screen. However, other equipment which you indicated is available may serve the purpose.)

2. Desliming: In a plant, this step will probably be performed in a cyclone.

3. Conditioning with sulfuric acid at pH 3.5.

4. Conditioning with a petroleum sulfonate collector.

5. Rougher flotation of kyanite.

6. Cleaner flotation of kyanite (2 to 4 stages).

7. Draining concentrate to remove most of water.

8. Drying concentrate: Solar drying might be considered in this case; otherwise, a fluid-bed dryer will probably be needed.

9. Magnetic separation, using an induced-roll magnetic separator. (If iron is very low, this step may not be required.)

10. Screening, regrinding, etc., as required for customer specification. This work would be done dry.

If pyrite is present in more than trace amounts, it should be floated before the kyanite float. Gravity concentration may also be needed if much coarse pyrite is present.

If a large amount of mica is present, it may be necessary to remove the mica by cationic flotation prior to the kyanite float. It may be possible to market the mica as a by-product.

You also indicated that the ore body includes one horizon of ore containing several million tons and averaging 75-80% kyanite, which you may want to mine selectively and process in the early stages of the project.

The process for treating this ore would probably be basically similar to that for the low-grade ore, but treatment costs per ton of product would be substantially less, the precentage recovery of kyanite would be higher, and the product quality would be higher. The optimum sizing of the process equipment would be different than in the case of the 35% kyanite ore.

We agreed that it would be desirable to conduct tests both on the average ore and on the high-grade material.

The test program we propose for both samples consists of the following work:

1. Preparation of samples for testing and analysis.

2. Chemical analysis of each sample, including quantitative assays for Al_2O_3, SiO_2, CaO, MgO, Na_2O, K_2O, Fe_2O_3, TiO_2, and sulfide S, as well as semi-quantitative X-ray fluorescence scan for other heavy elements.

3. A mineralogical examination to identify the major minerals and liberation size of the kyanite.

4. Grind tests to determine the required grind time in a laboratory ball mill.

5. Several flotation tests on each sample, including grinding, desliming, pyrite flotation, if necessary, kyanite conditioning, and flotation with cleaning. Products will be dried, weighed and analyzed for critical elements.

6. Induced-roll magnetic separation tests on selected kyanite concentrates, to remove iron minerals.

A detailed report will be prepared on completion of the work.

We estimate that the work as outlined above can be completed in 4 to 6 weeks at a total cost of not more than $7,500. This assumes that work on both samples is performed concurrently. If you should prefer to test only one sample initially the estimated time would be the same, i.e., 4 to 6 weeks, and the estimated cost would be $5,000.

We suggest that you supply samples of approximately 500 pounds of the average grade ore and about 200 pounds of the high-grade ore.

The return of an executed copy of the enclosed agreement along with the requested advance payment will serve as our authorization to proceed.

We look forward to being of service to you on this project. If you have any questions or comments on this proposal, please call.

Sincerely,

R. J. Brison

R. J. Brison
Assistant Vice President

RJB:mhg

Enclosures

A. P. GREEN REFRACTORIES CO.
SUBSIDIARY OF UNITED STATES GYPSUM COMPANY
MEXICO, MISSOURI 65265

J. A. CROOKSTON
VICE-PRESIDENT
RESEARCH

June 18, 1982

Mr. Charles E. Willmore
President
Strategic Resources Inc.
315 Stanford S.E.
Albuquerque, NM 87106

Dear Mr. Willmore:

We have completed our investigation of the samples of kyanite ore which you sent to us. There were three lumps which I understand you picked up off the surface.

Our results indicate that two of the three samples would require considerable beneficiation to recover kyanite of sufficient purity for refractory purposes. The third sample contained much more kyanite but would also require beneficiation. We estimated that sample 1 contained 60% kyanite, sample 2 30%, and sample 3 about 90% kyanite. Sample 3 had a chemical analysis similar to eastern kyanite and lower in iron oxide and titania. It also contained an estimated 5-10% muscovite mica.

Our opinion is that kyanite ore as represented by the samples submitted could probably be treated to provide a useful kyanite product. The economics would depend on the nature of the main ore body and, of course, the market for the ore.

At this time we would not be interested in proceeding further in the possible exploitation of the deposit. However, if it is ever worked commercially we would be interested in examining the product for our possible use.

Very truly yours,

J. A. Crookston

J. A. Crookston

JAC:jw

KAISER ALUMINUM
& CHEMICAL CORPORATION

June 15, 1982

Mr. Ted Willmore
Strategic Resources, Inc.
315 Stanford, S.E.
Albuquerque, N. M. 87106

Dear Ted:

Clarence Bingham and I appreciated the opportunity to visit your Kyanite prospect in Arizona last month.

As you recall, we took four samples of rock which we have examined petrographically and by x-ray diffraction. The test results are attached.

I believe these results are encouraging, but more development work needs to be done to prove a mine.

Kaiser Aluminum and Chemical Co. is not interested in an equity position in this venture, but would be interested in evaluating a commercial concentrate for purchase for our refractory operations if the quality and price were competitive.

The current price of raw Kyanite, -35 mesh is approximately $120/Ton, and -100 mesh is $130/Ton, delivered Missouri.

I'm also enclosing our Kyanite purchase specifications for your general information.

Best of luck with your deposit!

Very truly yours,

Jan Bowman
Commercial Development

JB:jm
encl.

300 LAKESIDE DRIVE OAKLAND CALIFORNIA 94643

KAISER ALUMINUM
CHEMICAL CORPORATION

Recipient Corporation:

OUTLINE –

Product Description

1.1 General

1.2 Intended Use

Applicable Specifications and Quality Standards

Product Quality Assurance

Packaging and Shipping

4.1 Packaging Instructions

4.2 Shipping and Routing

Notes

5.1 Receiving

5.2 Special Markings

5.3 Other

2.2 Sieve Analysis, %, (Tyler):

	Type I (35 Mesh)	Type II (100 Mesh)
+35	0-16	0-Tr.
-35+48	9-16	Tr.
-48+65	16-32	0.5-1.5
-65+100	17-29	2-10
-100+200	20-43	20-35
-200	2-7	55-85

2.3 P.C.E.: Cone 36, Minimum

2.4 Description

a. Form: Translucent long bladed crystals.
b. Color: White, grey, green, yellow, pink.
c. Crystal Structure: Triclinic.

3. PRODUCT QUALITY STANDARDS

3.1 Upon receival, Plant Quality Assurance should audit the following:

a. Nomenclature
b. Visual check for contamination
c. Check bag weights
d. Lot number(s)
e. Assign a lot number(s) if not marked by vendor, i.e., Lot 79-1, 79-2, ...
f. Water damage

3.2 Acceptance Testing - Plant Quality Assurance should test as follows in lieu of certified analysis from the vendor(s).

a. Sieve analysis
b. Chemical analysis: Al_2O_3, SiO_2, Fe_2O_3

Confidentiality:

By accepting these specifications, the recipient corporation agrees to hold such information confidential and to use the information contained herein solely for the purpose for which these specifications have been supplied by Kaiser.

Recipient Corporation:

OUTLINE –

1. Product Description
1.1 General
1.2 Intended Use
2. Applicable Specifications and Quality Standards
3. Product Quality Assurance
4. Packaging and Shipping
4.1 Packaging Instructions
4.2 Shipping and Routing
5. Notes
5.1 Receiving
5.2 Special Markings
5.3 Other

KYANITE: RAW
(Ingred. Code: 0045, 0046)

1. PRODUCT DESCRIPTION

1.1 General

Kyanite is a mined and beneficiated commodity. It is an anhydrous aluminosilicate ($Al_2O_3 \cdot SiO_2$) formed through the metamorphism of aluminous sedimentary deposits. Kyanite is principally contained in micaceous schists and gneisses and hence associated with quartz in the deposits. Commercial deposits are worked in Virginia and Georgia using open pit mining techniques. The ore is ground (-35 mesh) to allow processing by froth flotation. The principal use of Kyanite is in refractory products with other applications in sanitary ware, tile and precision casting molds. Kyanite is available in several size fractions and is usually packaged in multiwall paper bags.

1.2 Intended Use

In various refractory products.

2. APPLICABLE SPECIFICATIONS AND QUALITY STANDARDS

2.1 Chemical Analysis, %, Typical:

SiO_2	39-41
Al_2O_3	55-57
Fe_2O_3	1-2
TiO_2	1-2
CaO	< 1
MgO	< 1
K_2O	< 1
Na_2O	< 1
LOI	0.3-1.0

Confidentiality:
By accepting these specifications, the recipient corporation agrees to hold such information confidential and to use the information contained herein solely for the purpose for which these specifications have been supplied by Kaiser.

INTERPACE
CORPORATION

LOS FELIZ BOULEVARD, LOS ANGELES, CALIFORNIA 90039 213-663-3361 TWX 9103214290 INTERPACE LSA
BOX 1111, GLENDALE, CALIFORNIA 91209 CABLE: INTERPACE

t data on the kyanite ore deposit are compiled in the tables below.

ble 1 - Mineralogy of a kyanite-rich sample, quartzite-rich sample, -4 +14 fraction of the composite, and -14F fraction of the composite

	Kyanite-rich sample	Quartzite sample
jor:	qtz (57%), kyanite	qtz (88%)
nor:	pyrophyllite, kaolinite	andalusite
ace:	mont., mica	kyanite, montmorillonite

	-4 +14 fraction	-14F fraction
jor:	qtz (60%), kyanite	qtz (58%), kyanite
nor:		pyrophyllite, kaolinite, mica
ace:	feldspar, mica, kaolinite montmorillonite, pyrophyllite	montmorillonite

ble 2 - % Expansion (2500°) - The composite sample was ground to -35, -65, -100 & -200 mesh, mixed with orzan, pressed into a pellet and fired to 2500°F

5 = 8.40 -65 = 5.89 -100 = 2.45 -200 = 1.84

ble 3 - Mineralogy of the samples ground to -35, -65, -100 & -200 mesh and fired to 2500°F

	-35m kyanite ore (2500°F)	-65 mesh
jor:	qtz (67%), mullite (18%), crist. (6%)	qtz (77%), mullite (19%), crist. (8%)

	-100 mesh	-200 mesh
jor:	qtz (48%), mullite (18%), crist. (16%)	qtz (50%), mullite (17%), crist. (11%)

ble 4 - PCE of the composite sample

cone 29

rt applies only to the sample, or samples, investigated and is not necessarily indicative of the quality or condition of apparently l or similar products. As a mutual protection to clients, the public and these laboratories, this report is submitted and accepted exclusive use of the client to whom it is addressed and upon the condition that it is not to be used, in whole or in part, in any ing or publicity matter without prior written authorization from these laboratories.

Corporation assumes no responsibility or liability for results or damages resulting from faulty sampling procedures or misuse of

INTERPACE
CORPORATION

2901 LOS FELIZ BOULEVARD, LOS ANGELES, CALIFORNIA 90039 213-663-3361 TWX 9103214290 INTERPACE LSA
P.O. BOX 1111, GLENDALE, CALIFORNIA 91209 CABLE: INTERPACE

January 12, 1979

Mr. Ted Willmore
315 Stanford Southeast
Albuquerque New Mexico 87106

Dear Mr. Willmore:

Preliminary tests on a composite sample of your kyanite ore deposit have been completed. Mineralogically, the deposit consists of major quartz (60%) and kyanite with minor and trace amounts of pyrophyllite, kaolinite, andalusite, mica, feldspar, and montmorillonite. Although this deposit contains trace amounts of undesirable minerals, thermal and physical tests indicate that the material could be of value to us. Further testing is currently being conducted to determine the material's feasibility as a refractory.

In the near future, our Mining Department would be interested in conducting a geological investigation of this deposit.

Sincerely yours,

Douglas Yoshida by ord

Douglas Yoshida
Mineralogist

DY/ba

This report applies only to the sample, or samples, investigated and is not necessarily indicative of the quality or condition of apparently identical or similar products. As a mutual protection to clients, the public and these laboratories, this report is submitted and accepted for the exclusive use of the client to whom it is addressed and upon the condition that it is not to be used, in whole or in part, in any advertising or publicity matter without prior written authorization from these laboratories.

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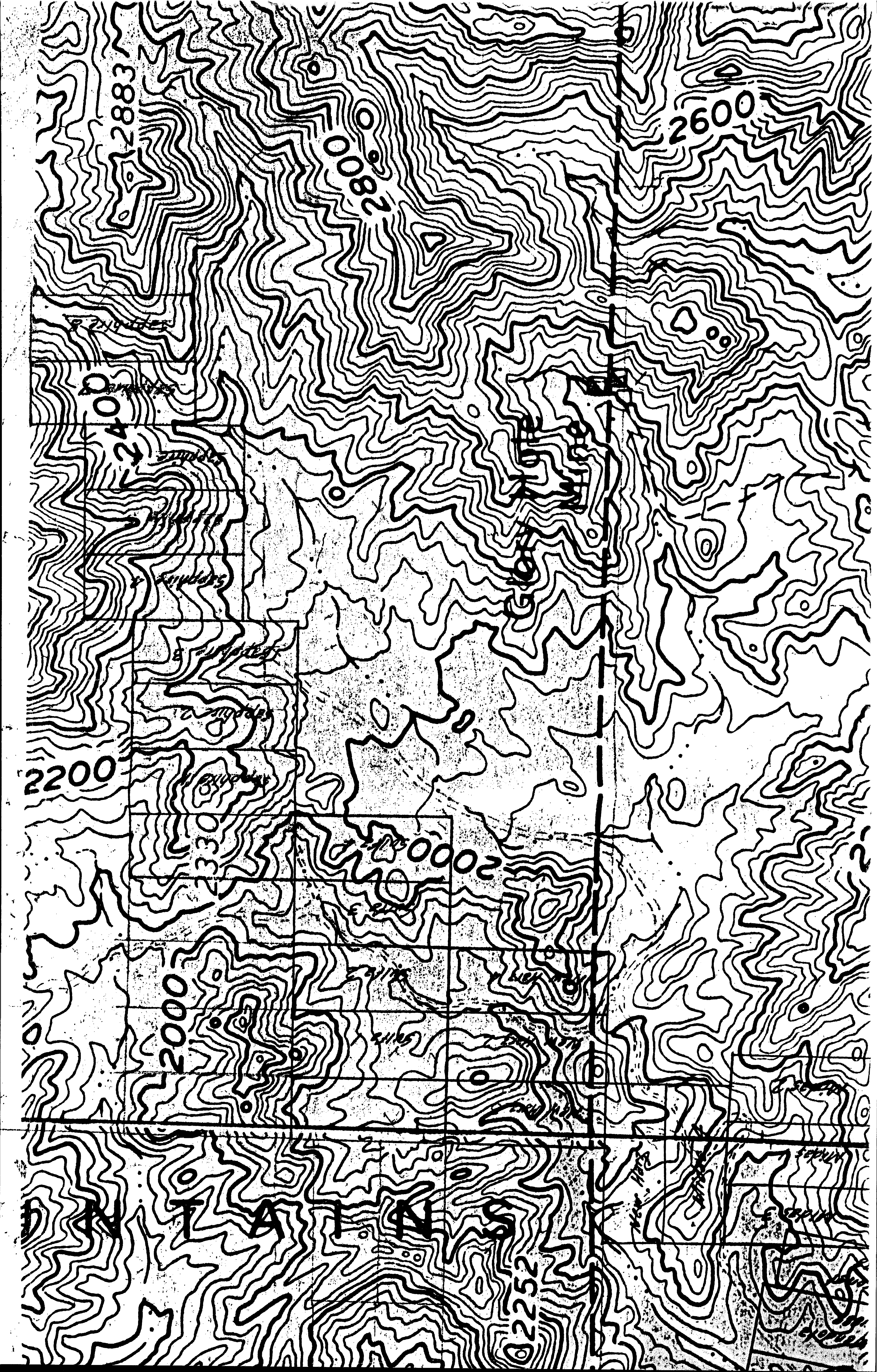
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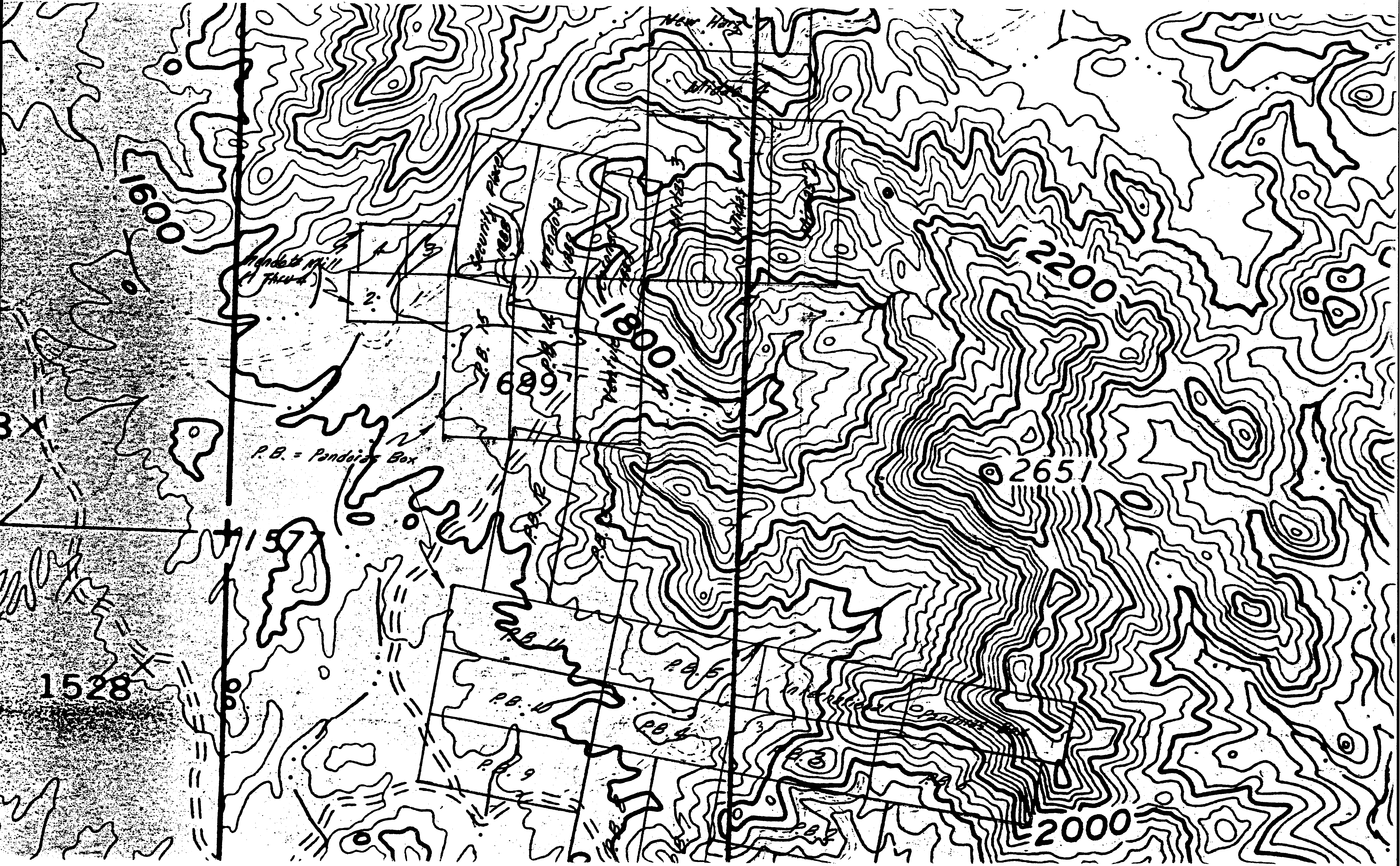

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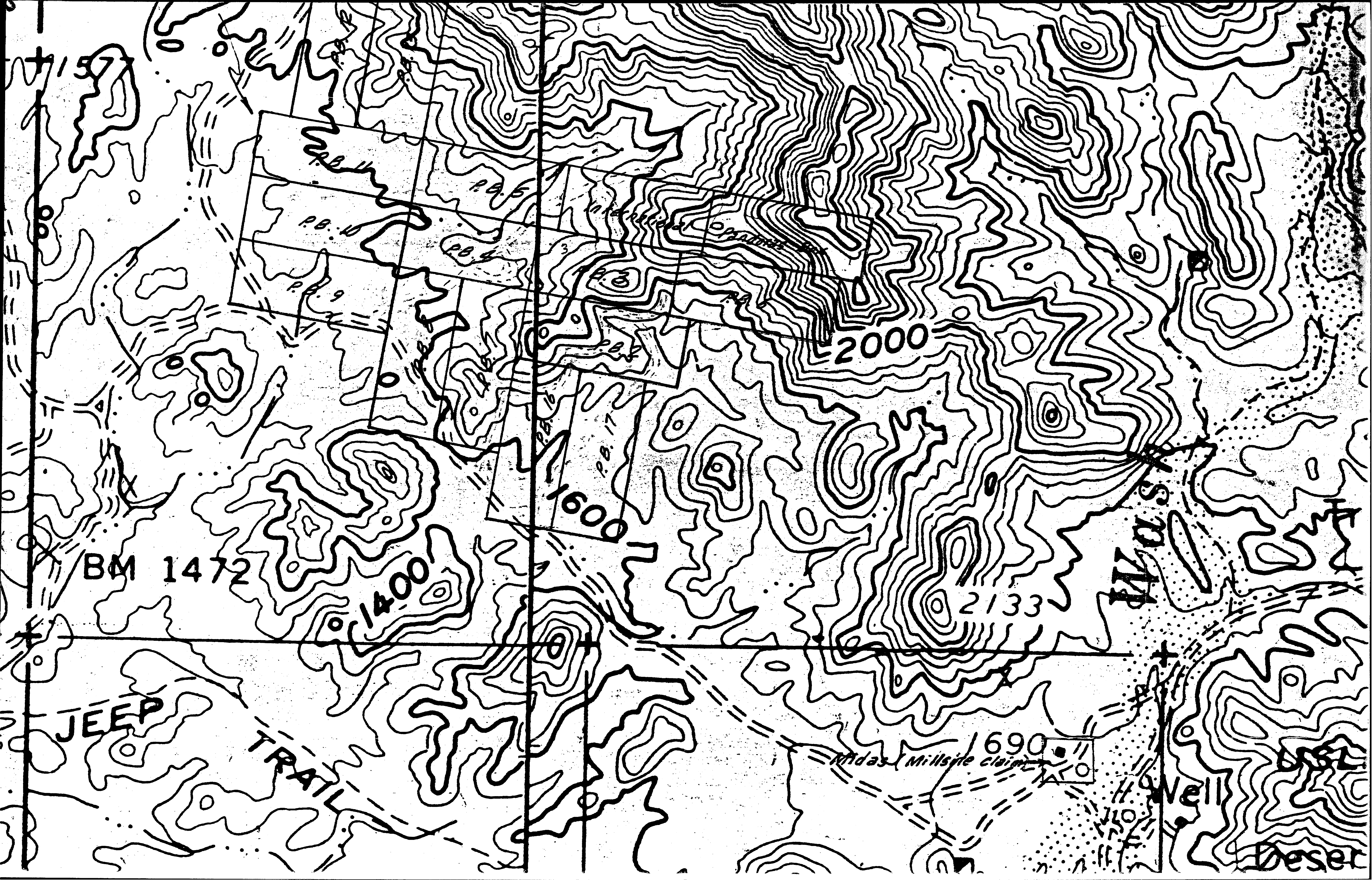
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Midas (Millsite claim)
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