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J.H.C.

NOV 18 1966

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 18, 1966

TO: J. H. COURTRIGHT

FROM: B. N. WATSON

PIONEER PARKWAY GEOPHYSICAL TARGET
PINAL COUNTY, ARIZONA

On helicopter reconnaissance November 14, Bill Hoskins and I landed on a small hill composed of Laramide-aged intrusives isolated by several miles of pediment cover from the nearest outcrops of Pre-Cambrian granite. This small hill is not shown on the ABM Pinal County geologic map, and the USGS has only recently made available preliminary topographic sheets for the area. We feel the pediment around this outcrop is worthy of geophysical work and, for lack of a better name, have called the area the "Pioneer Parkway" target as the Florence-Tucson highway is but two miles southwest of the subject outcrop (see Attachment A).

Several north-south trending shears in Coolidge-type granite contain hydrothermal black manganese oxides on the western half of the hill. The manganese has been mined. On the eastern side of the hill, monzonite porphyry intrudes the granite and blue copper stain was found in quartz and sericite along the contact. Copper stain was also seen in Cretaceous (?) volcanics which cap a portion of the hill.

A small knob which looks to consist of dark volcanic material from the air is found a mile to the north. Three and one-half miles southeast a low range of hills are composed of PreCambrian granites intruded locally by a weakly pyritized Laramide (?) quartz monzonite porphyry. Four and one-half miles to the north-northeast are found more PreCambrian granites.

Although the monzonite porphyry intrusive is relatively fresh, the area is felt to be a valid geophysical target for 3 reasons: 1. The hydrothermal manganese deposits could be on the periphery of a mineralized zone; 2. The spotty alteration and copper staining which is not associated directly with the manganese mineralization suggests presence of copper-bearing hydrothermal fluids; 3. The existence of Laramide intrusives surrounded by pediment cover, then PreCambrian granites at some distance, present a generalized target in a region of proven porphyry copper deposits.

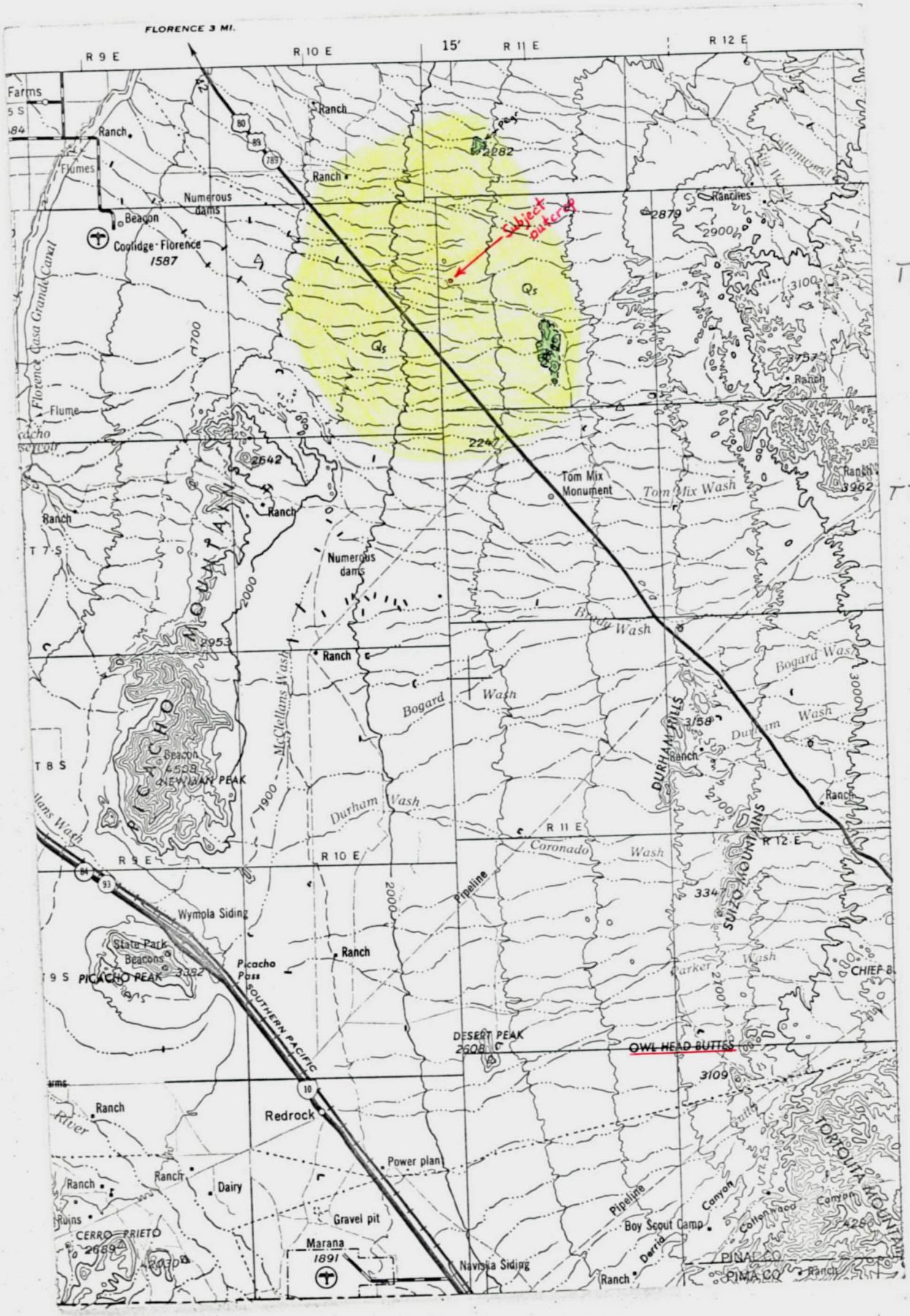
Mr. Wayne Farley is opening a program of I. P. geophysical exploration of pediments north of the Owl Head Buttes and I have brought this Pioneer Parkway target to his attention. He says

the area registers a gravity high making it favorable for I. P. work (cover is apparently shallow) and sees no reason why his survey cannot be extended northward to check the subject area.

Barry N. Watson
BARRY N. WATSON

BNW:pjc
Attachment
cc: WESaegart
WGFarley

Attachment A



Location of Pioneer Parkway geophysical target.

GSA Abstracts
Vol 12, No. 3, 1980

GSA abstract
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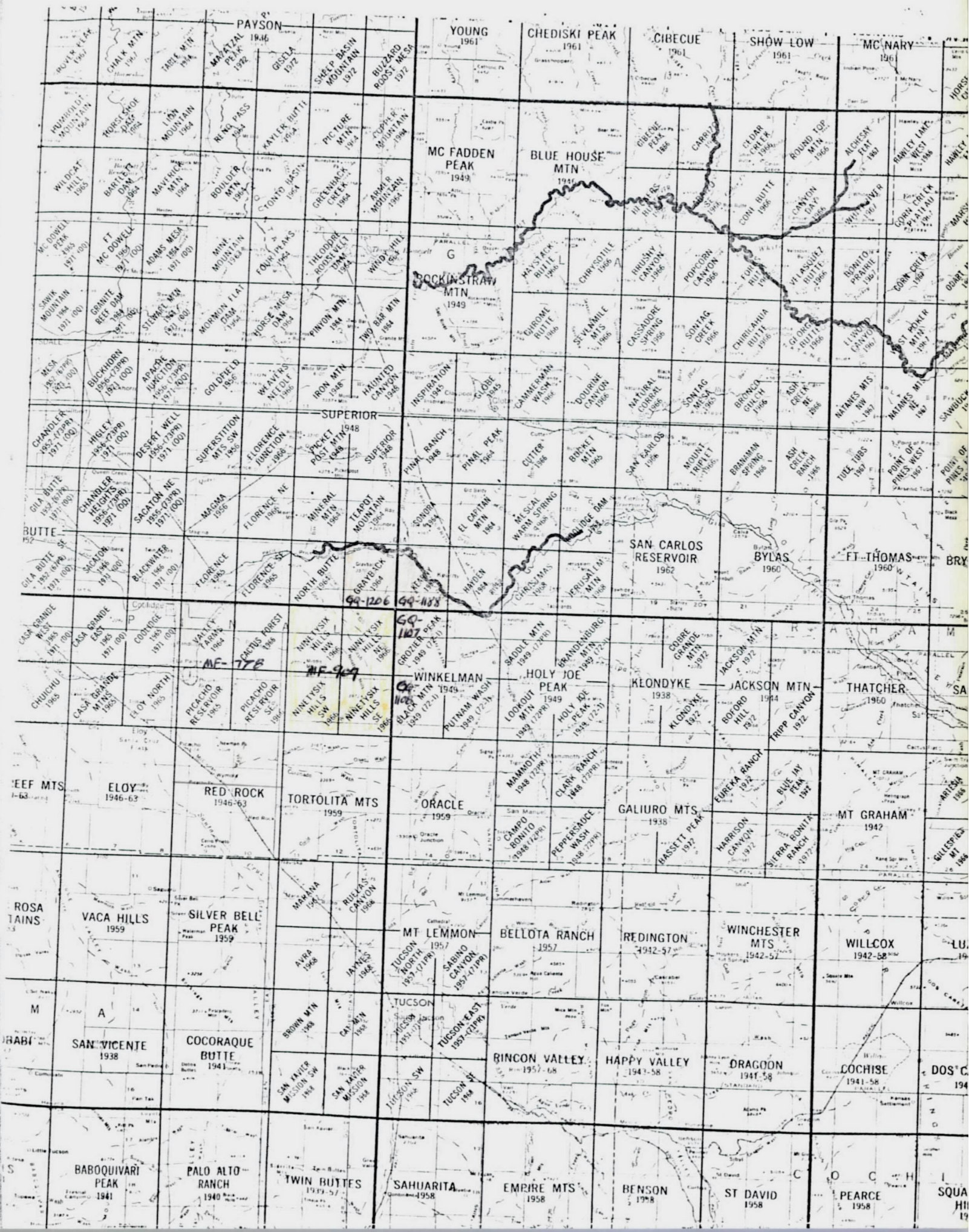

PAYSON 1946
YOUNG 1961
CHEDISKI PEAK 1961
CIBECUE 1961
SHOW LOW 1961
MC NARY 1961
MC FADDEN PEAK 1949
BLUE HOUSE MTN 1946
ROCKINSTRAW MTN 1949
SUPERIOR 1948
SAN CARLOS RESERVOIR 1962
BYLAS 1960
FT THOMAS 1960
WINKELMAN 1949
HOLY JOE PEAK 1949
KLONDYKE 1938
JACKSON MTN 1964
THATCHER 1960
ELOY 1946-63
RED ROCK 1946-63
TORTOLITA MTS 1959
ORACLE 1959
GALIURO MTS 1938
MT GRAHAM 1942
VACA HILLS 1959
SILVER BELL PEAK 1959
MT LEMMON 1957
BELLOTA RANCH 1957
REDINGTON 1942-57
WINCHESTER MTS 1942-57
WILLCOX 1942-58
SAN VICENTE 1938
COCORAQUE BUTTE 1941
TUCSON
RINCON VALLEY 1957-68
HAPPY VALLEY 1943-58
DRAGOON 1941-58
COCHISE 1941-58
BABOQUIVARI PEAK 1941
PALO ALTO RANCH 1940
TWIN BUTTES 1939-57
SAHUARITA 1958
EMPIRE MTS 1958
BENSON 1958
ST DAVID 1958
PEARCE 1958
GQ-1206
GQ-1188
GQ-1107
MF-778
MF-909

GEOLOGIC QUADRANGLE MAP
GRAYBACK QUADRANGLE, ARIZONA
GQ–1206

J. D. SELL

F MAP UNITS

e and
cene
ne } QUATERNARY

e } TERTIARY

e

ertiary
etaceous } TERTIARY OR CRETACEOUS

etaceous } CRETACEOUS

an Y
ian X } PRECAMBRIAN

F MAP UNITS

all angular blocks of Tortilla Quartz Diorite
e northeast corner of the quadrangle

deposits in stream channels and young,

osited from ground water or surface water.
t veneer (Qp)

rown soil and gravel veneer on gently slop-
argely on older gravel (Qog)

and deposited in channels cut in the San

Tah — ANDESITE — Medium- to dark-gray irregular dikes and sill-like bodies, most abundant in the Tea Cup Granodiorite. Fresh hornblende is abundant both as phenocrysts (0.5×3.0 mm) and, in a groundmass that is commonly trachytic, fine grained (0.05–1 mm grains). Other groundmass minerals are plagioclase (An_{28-35}), magnetite, pyroxene (pigeonite and augite), K-feldspar, quartz, and antigorite replacing olivine. Most of the minerals are euhedral to subhedral, but the quartz and K-feldspar are anhedral-interstitial. The plagioclase is moderately to intensely altered to sericite, montmorillonite, and kaolinite. A typical mode (volume percent) is: plagioclase 61.0, K-feldspar 2.7, quartz 1.3, hornblende 29.3, augite 2.7, magnetite 1.6, chlorite 1.3, and apatite 0.1

Tr2 — RHYODACITE PORPHYRY — Dikes of yellowish to medium-gray rhyodacite with prominent quartz phenocrysts are abundant here and in the Sonora (Cornwall and others, 1971) and Kearny (Cornwall and Krieger, 1974) quadrangles. Phenocrysts, 0.3–6 mm in diameter, making up approximately half of the rock, are in decreasing order of abundance: plagioclase (An_{24-38}, partly glomerophyritic), quartz, biotite, and hornblende. The groundmass, anhedral-granular in 0.01- to 0.15-mm grains, consists of K-feldspar and quartz plus the other minerals listed above and accessory apatite, allanite, zircon, and sphene. The plagioclase is partly altered to sericite, kaolinite, and montmorillonite, and the biotite and hornblende to chlorite and epidote. A typical mode (volume percent) is: andesine 53.8, quartz 22.4, K-feldspar 20.1, biotite 3.3, magnetite 0.4

Tr — RHYODACITE PORPHYRY — Medium-light-gray to light-olive-gray, moderately to intensely altered rhyodacite dikes. Phenocrysts 1–4 mm long make up 10 to 30 percent of the rock and consist of andesine, biotite, hornblende, magnetite, and sparse quartz in a fine-grained groundmass of the same minerals plus K-feldspar and apatite. The andesine has been moderately to intensely altered to sericite, montmorillonite, kaolinite, epidote, and calcite. The biotite and hornblende have been thoroughly altered to chlorite, epidote, and calcite

Ttca — APLITE, TEA CUP GRANODIORITE — Aplitic and locally pegmatitic facies of the Tea Cup Granodiorite occur mainly as dikes but also as larger irregular bodies. The aplites are sugary textured, hypidiomorphic, normally with 0.2 to 2.0-mm grains, but some as much as 6 mm. The color is grayish orange pink; the coarser grained aplites have a speckled appearance with grayish-orange-pink feldspar and light-gray quartz and muscovite. A typical mode (volume percent) is: plagioclase (An_{27}) 39.6, quartz 29.4, microcline 28.7, biotite 0.6, muscovite 1.4, magnetite 0.3. Several aplites and pegmatites, particularly on the east flank of Mount Grayback, contain as much as 0.6 percent garnet (probably almandine). Traces of sphene and zircon are also present, and part of the muscovite has been identified as phengite

Ttc — TEA CUP GRANODIORITE (Paleocene) — Granodiorite that underlies the west half of the quadrangle and extends west and south into adjoining quadrangles is here named the Tea Cup Granodiorite for the Tea Cup Ranch (headquarters in NW¼ sec.7, T. 5 S., R. 13 E.). Typical exposures along the wash in the SE¼ sec.36, T. 4 S., R. 12 E., which yielded rocks for petrographic study and chemical analyses, are designated its type locality. The rock is typically medium to coarse grained, hypidiomorphic with prominent medium-gray quartz crystals intergrown with light- to pinkish-gray plagioclase (An_{28-38}) and K-feldspar and black biotite and hornblende. The rock is porphyritic in places, with 6- to 12-mm feldspar and quartz phenocrysts in a fine-grained groundmass of K-feldspar, andesine, biotite, hornblende, and magnetite. Apatite, allanite, zircon, and epidote are accessory minerals. On Mount Grayback, and locally elsewhere, garnet (probably almandine) and muscovite are present and hornblende is absent. A typical modal analysis (volume percent) is as follows: plagioclase 45.3, quartz 31.5, K-feldspar 17.6, biotite 4.6, magnetite 0.5, apatite 0.1, sphene 0.4. Hornblende makes up as much as 3 percent of the rock in some areas. The plagioclase is fresh to slightly or moderately altered to sericite, kaolinite, montmorillonite, and the biotite is slightly chloritized. Damon (1970) obtained a K-Ar age of 62.9 ± 1.3 m.y. on biotite, and Stuckless (Banks and Stuckless, 1973) a fisson-track age of 61.4 ± 3.2 m.y. (Paleocene) on garnet.

TKmr — MELANOCRATIC RHYODACITE PORPHYRY — Dark-gray rhyodacite dikes containing 20–30 percent phenocrysts, 0.5–10 mm in diameter, of plagioclase (An_{32}) mostly altered to sericite, fresh quartz, biotite and hornblende,

ie northeast corner of the quadrangle

deposits in stream channels and young,

osited from ground water or surface water.
t veneer (Qp)

rown soil and gravel veneer on gently slop-
argely on older gravel (Qog)

and deposited in channels cut in the San
ash, in terraces along the Gila River, and
n part of the quadrangle

ver Miocene) — Named by Heindl (1963);
ks (1974) and Krieger (1974a, b, c, d). In this
uvial and playa deposits at least 2,000 feet
graben along Ripsey Wash extending south-
gle (Cornwall and Krieger, 1974). Biotite
(Tst) in the southwest part of the Kearny
y. (Cornwall and Krieger, 1974). Another
Peak quadrangle (Krieger, 1974c) has been
(sanidine). Fossil camel and bear tracks in
lomerate unit (Tst) in Ripsey Wash, SE¼
te a Miocene age (C. A. Repenning, oral

luvial granitic conglomerate (less than 1,000
sey Wash forms the upper part of the San
he overall olive-gray color results from a
ale-orange-pink, and grayish-red clasts of
of diabase. The unit is thick to thin bedded
bundant sandstone beds in its lower part to
art

thick lens of megabreccia, 500 feet long, is
ger granitic conglomerate (Tsgu) on the east
T. 4 S., R. 13 E.). The dark-gray breccia is
of diabase with a little granite in a finely
erial and is believed to be a landslide from
r to the west into the Ripsey Wash graben

ate — Tuffaceous sandstone and conglom-
thick. Underlie the upper granitic conglom-
astward near where the graben enters the
nant sandstone in this unit is white to pale
the conglomerate is yellowish brown. Most
but a few massive beds may have formed as
sting deposition in a playa, were observed in
lastic beds become coarser grained upward
the central part

are abundant in the tuffaceous sandstone
also present, but not abundant, in the upper
nglomerates. A few of the more conspicuous
e map. One bed of lapilli-tuff extends almost
the Ripsey Wash graben. In the Grayback
of the tuffaceous sandstone and conglomer-
unit (Tst) lenses out, this tuff is in the lower
pumice lapilli and small pebbles of Pinal
tuffs, where pure, are white; where impure,
ish orange pink. Pumice lapilli are sparse to
ension. Euhedral and fragmental crystals of
line, biotite, hornblende, magnetite, apatite,
nt in a glassy groundmass. The crystals are
meter; a few are 1–4 mm. The plagioclase is
indicate that the glassy groundmass has been
d clay

alluvial granitic conglomerate, 0–900 ft thick,
tuffaceous sandstone and conglomerate (Tst)
n Manuel Formation in this quadrangle. This
from 0 feet at the north end of the Ripsey
the south end where it enters the Kearny
wish gray and contains clasts of granite and
se. It is thin to thick bedded and ranges from
beds to very coarse grained. Beds become

0 – 150-ft.-thick unit composed of angular
ite in a fine matrix of similar material. Forms
the lower part of the San Manuel Formation
ward into the Kearny quadrangle

aphanitic to fine-grained rhyolite in the north-

45.3, quartz 31.5, K-feldspar 17.6, biotite 4.6, magnetite 0.5, apatite 0.1, sphene 0.4. Hornblende makes up as much as 3 percent of the rock in some areas. The plagioclase is fresh to slightly or moderately altered to sericite, kaolinite, montmorillonite, and the biotite is slightly chloritized. Damon (1970) obtained a K-Ar age of 62.9 ± 1.3 m.y. on biotite, and Stuckless (Banks and Stuckless, 1973) a fisson-track age of 61.4 ± 3.2 m.y. (Paleocene) on garnet.

TKmr — MELANOCRATIC RHYODACITE PORPHYRY — Dark-gray rhyodacite dikes containing 20–30 percent phenocrysts, 0.5–10 mm in diameter, of plagioclase (An_{32}) mostly altered to sericite, fresh quartz, biotite and hornblende, both chloritized, and magnetite. The fine-grained groundmass contains these minerals plus abundant K-feldspar and sericite (probably mainly altered from plagioclase), and accessory zircon and apatite. The dikes are dark gray owing to an abundance of magnetite and altered ferromagnesium minerals in the groundmass

TKrh — RHYODACITE PORPHYRY — Light-brownish-gray, greenish-gray, and dark-gray rhyodacite dikes with abundant hornblende. Contains 1- to 4-mm phenocrysts of andesine (An_{35}), hornblende, and sparse quartz. The phenocrysts make up 1–30 percent of the rock. The groundmass is fine grained, locally trachytic, and consists of plagioclase, hornblende, magnetite, K-feldspar, quartz, sphene, and apatite. The plagioclase is moderately to intensely altered to sericite, montmorillonite, kaolinite. The hornblende is commonly fresh or slightly altered, but in some dikes it is completely altered to chlorite and epidote. A typical mode (volume percent) is: plagioclase 54.3, quartz 0.5, K-feldspar 10.2, hornblende 31.1, magnetite 3.9

Kt — TORTILLA QUARTZ DIORITE (Upper Cretaceous) — Tortilla Quartz Diorite, a sizable pluton first described by Cornwall and others (1971), extends westward from the Kearny quadrangle into the northeastern quarter of this quadrangle, and a few small isolated bodies also crop out in this area. The rock is typically medium grained, light to medium gray, hypidiomorphic-granular, fresh or slightly altered, and ranges in composition from pyroxene-hornblende diorite to biotite-hornblende quartz diorite and locally aplitic granodiorite. Pyroxene and hornblende commonly form composite crystals as much as 5 mm in diameter, whereas biotite and plagioclase (andesine) are scattered more uniformly through the rock; interstitial orthoclase and quartz tend to poikilitically enclose the other minerals. Apatite, sphene, and zircon are accessory minerals. Banks and others (1972) have concluded that the most probable K-Ar age is 70.5 m.y. with a range of 2.8 m.y. (an average from four nearly pure biotite separates). Banks and Stuckless (1973, p. 660) obtained similar fission-track ages on zircon and apatite.

Ydb — DIABASE — North-trending, steeply dipping diabase sills or dikes are widely distributed cutting the Ruin Granite, especially in the east half of the quadrangle. This dark-gray to olive-gray rock is fine to coarse grained, with ophitic texture. Fresh specimens are composed of plagioclase (An_{40-55}), augite, pigeonite, olivine, hornblende, and magnetite-ilmenite. The minerals have been slightly to intensely altered to sericite, kaolinite, bowlingite, antigorite, limonite, iddingsite, hornblende, biotite, epidote, and pumpellyite. Intergrowths of quartz and K-feldspar occur locally

Yra — APLITE, RUIN GRANITE — The Ruin Granite contains steeply dipping aplite dikes and larger irregular bodies, most abundant in the southeastern part of the quadrangle. This very pale orange to moderate orange pink rock is fine to medium grained, hypidiomorphic-granular, and consists of microcline, albite-oligoclase, quartz, muscovite, and magnetite. A typical mode (volume percent) is: albite-oligoclase (An_{7-13}) 37.5, quartz 34.0, microcline 17.8, muscovite 10.6, magnetite 0.1

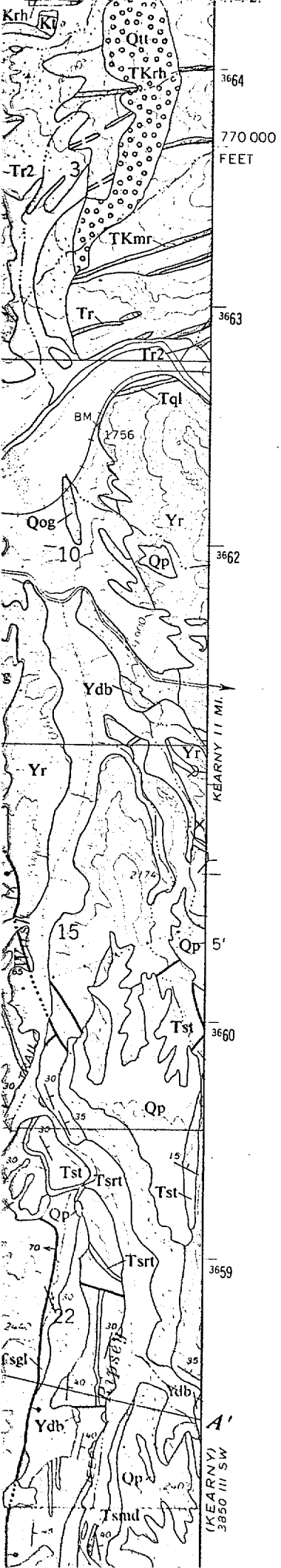
Yr — RUIN GRANITE — Yellowish-gray to grayish-orange granite and quartz monzonite with pale-pink to orange-pink orthoclase and microcline phenocrysts, partly perthitic, in a coarse-grained groundmass of quartz, plagioclase (An_{8-35}), biotite, and minor zircon, sphene, and magnetite. The plagioclase is partly sericitized; the biotite partly chloritized

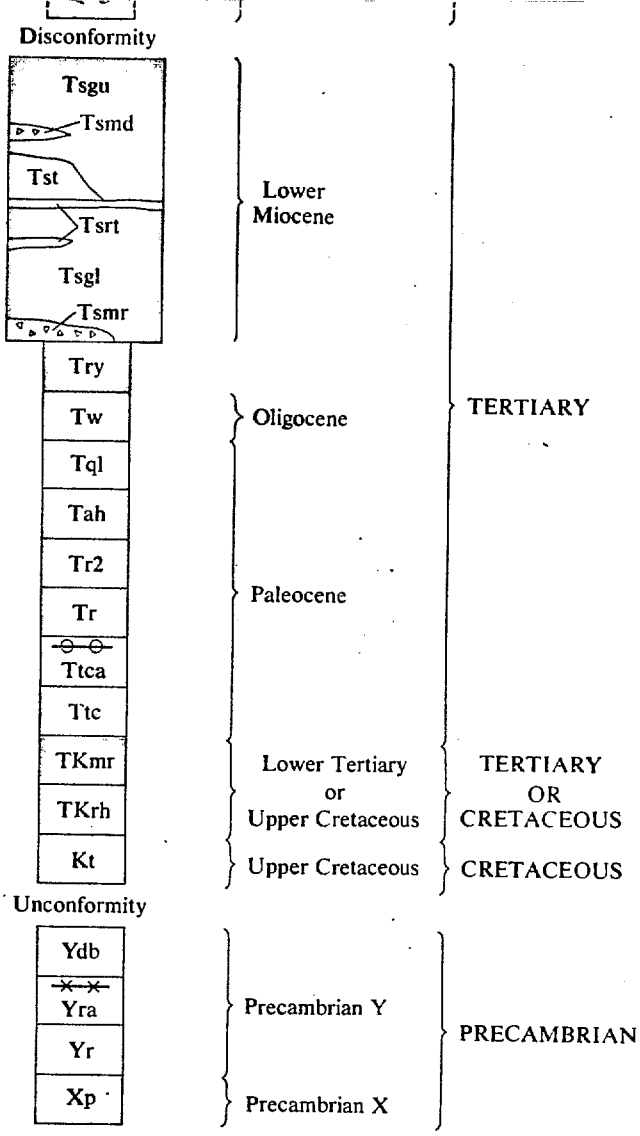
Xp — PINAL SCHIST — Crops out in a small area near the northwest corner of the quadrangle. The main rock type is quartz-muscovite-chlorite schist, with some biotite, K-feldspar, plagioclase, magnetite, and locally andalusite. The schist is commonly strongly foliated, partly contorted, light to medium gray or greenish gray with a silver-gray sheen due to the parallelism of muscovite defining schistosity. Clasts of the schist are a major component of the Whitetail Conglomerate, which overlaps the Pinal Schist in this area.

80 — Fissure zone with limonite, quartz, and locally copper oxides, showing dip where known

Contact

75 — Fault, showing dip where known—Dotted where concealed, bar and ball on downthrown side





DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qtt — Talus — Accumulations of large to small angular blocks of Tortilla Quartz Diorite on the west flank of mountain in the northeast corner of the quadrangle

Qal — Alluvium — Gravel, sand, and silt deposits in stream channels and young, low-lying terraces

Qtr — Travertine — Calcium carbonate deposited from ground water or surface water. May in part be older than pediment veneer (Qp)

Qp — PEDIMENT VENEER — Reddish-brown soil and gravel veneer on gently sloping pediment surfaces, developed largely on older gravel (Qog)

Qog — OLDER GRAVEL — Gravel and sand deposited in channels cut in the San Manuel Formation along Ripsey Wash, in terraces along the Gila River, and blanketing most of the southwestern part of the quadrangle

SAN MANUEL FORMATION (lower Miocene) — Named by Heindl (1963); see also Krieger, Cornwall, and Banks (1974) and Krieger (1974a, b, c, d). In this quadrangle, the unit consists of alluvial and playa deposits at least 2,000 feet thick and occupies a fault-bounded graben along Ripsey Wash extending southeastward into the Kearny quadrangle (Cornwall and Krieger, 1974). Biotite from a tuff in its middle member (Tst) in the southwest part of the Kearny quadrangle has a K-Ar age of 17 m.y. (Cornwall and Krieger, 1974). Another tuff in its upper part in the Crozier Peak quadrangle (Krieger, 1974c) has been dated at 18 m.y. (biotite) and 24 m.y. (sanidine). Fossil camel and bear tracks in the tuffaceous sandstone and conglomerate unit (Tst) in Ripsey Wash, SE¼ sec. 22, T. 4 S., R. 13 E., indicate a Miocene age (C. A. Repenning, oral commun., 1972)

Tsgu — Upper granitic conglomerate — An alluvial granitic conglomerate (less than 1,000 ft thick) along the east side of Ripsey Wash forms the upper part of the San Manuel Formation in this area. The overall olive-gray color results from a mixture of light-grayish-yellow, pale-orange-pink, and grayish-red clasts of Ruin Granite and dark-gray clasts of diabase. The unit is thick to thin bedded and ranges from fine grained with abundant sandstone beds in its lower

GEOLOGIC MAP OF THE CROZIER PEAK QUADRANGLE, PINAL COUNTY, ARIZONA

By Medora H. Krieger

J. D. SELL

REGIONAL GEOLOGIC SETTING

The broad regional geologic and structural setting of the Winkelman quadrangle, of which the Crozier Peak quadrangle is the northeast part, is discussed by Krieger (1974). Rocks within the general area range from Precambrian to Holocene, and all units are represented in this quadrangle except the Naco and Quiburis Formations. It is one of the most structurally complex quadrangles within the region.

STRATIGRAPHY

The oldest Precambrian rocks in the area of the larger scale index map are the Pinal Schist and intrusive rocks, largely the Ruin Granite (Oracle Granite of N.P. Peterson, 1938). Batholithic masses of Ruin Granite (1,430 m.y.) were intruded after a period of intense deformation that produced near-vertical east-trending foliation and bedding in the schist. The schist and granite are overlain with profound angular unconformity by Precambrian sedimentary rocks--the Apache Group and the disconformably overlying Troy Quartzite. Diabase, about 1,200 m.y. old (Silver, 1960; Damon and others, 1962), forms sills in the Apache Group and Troy Quartzite, sill-like masses in the schist and granite generally parallel to, and not more than 500 feet below, the pre-Apache surface (Shride, 1967, p. 56), and some dikes. The sills inflated, but did not perceptibly tilt, the Precambrian sedimentary rocks.

After a long period of erosion, Paleozoic formations were deposited paraconformably on the Precambrian sedimentary rocks.

Volcanic rocks of Late Cretaceous age disconformably overlie older rocks in the general area. In the Crozier Peak quadrangle they are the Williamson Canyon Volcanics of andesitic composition and a rhyodacitic to quartz latitic pyroclastic unit recognized only in the northwest part of the Crozier Peak quadrangle. The Williamson Canyon Volcanics have been considered either Late Cretaceous (Willden, 1964) or Late Cretaceous and(or) early Tertiary (Simons, 1964, Creasey, 1965, 1967). They are now considered Late Cretaceous because in the northeast part of the Crozier Peak quadrangle they are intruded by diorite that in the Winkelman 7 ½-minute quadrangle is dated as Late Cretaceous. The rhyodacitic to quartz latitic volcanic units are also considered Late Cretaceous because some of it resembles the Glory Hole Volcanics (Simons, 1964; Krieger, 1968b), which is intruded by granodiorite dated as 69 m.y. (Creasey, 1967).

Late Cretaceous diorite and granodiorite and Late Cretaceous and(or) early Tertiary (Laramide porphyry masses of several lithologic types) intrude the older rocks.

Cenozoic stratigraphy in eastern Pinal County has recently been revised by Krieger and others (1974). In the area of the larger scale index map Tertiary sedimentary deposits, formerly called Gila Conglomerate or Group, are now divided into three formations--in ascending order, the San Manuel, Big Dome, and Quiburis. In addition, Pleistocene and Holocene alluvial deposits, also formerly included in the Gila Conglomerate or Group, overlie these formations.

The San Manuel Formation consists of alluvial, lacustrine(?) and playa deposits, and interbedded andesite and megabreccias. It is Miocene (probably early Miocene) in age. Discordant dates on biotite and sanidine from a rhyodacite tuff bed in its upper part are 18 and 24 m.y., respectively (Joan Engels, written communication, 1968). The San Manuel Formation is unconformably overlain by the alluvial Big Dome Formation. In the Kearny quadrangle an interbedded nonwelded ash-flow yields late Miocene K-Ar ages of 14 m.y. on biotite and 17 m.y. on hornblende (Cornwall and others, 1971, and Banks, 1972). The youngest of these formations, the Quiburis Formation, which consists of an alluvial and a lakebed facies, was deposited in the basin now occupied by the San Pedro River. It contains Hemphillian vertebrate fossils (see Krieger, 1974a), indicating a middle Pliocene age.

STRUCTURE

The major structural features in the Winkelman 15-minute quadrangle southwest of the Gila and San Pedro Rivers are high-angle faults, north-northwest-trending en echelon ridges of steeply dipping to overturned diabase and Precambrian and Paleozoic sedimentary rocks, and low-angle gravity slides. As the tops of the beds in the en echelon ridges always face east, the structures are interpreted as partly eroded roots of a single monoclinal fold later separated by faults, or possibly as a series of monoclinal folds. Locally, the section within an individual ridge is repeated along what appears on a map as a high-angle fault, but which is inferred to be a tilted thrust. Some of the faulting, monoclinal folding, tilting of the thrusts, uplift, and the erosion of large areas now stripped of Precambrian and Paleozoic sedimentary rocks occurred before deposition of the San Manuel Formation, for the oldest unit in that formation in the Putnam Wash quadrangle is composed largely of Precambrian granitic clasts. Intense deformation also occurred after deposition of the San Manuel Formation, for adjacent to the monoclinal ridges, the formation dips steeply though somewhat less than the older rocks. The formation also has been cut by low-angle gravity slides and high-angle faults.

Faults that predate the San Manuel Formation are the thrusts, now tilted to vertical or overturned, and two sets of high-angle faults that trend east-northeast. Some east-northeast-trending faults resemble tear faults related to thrusting.

The Ripsey Wash fault, a tilted thrust, is a multiple-strand fault, in contrast to the Romero Wash fault in the Winkelman 7 ½-minute quadrangle, which is a single

strand fault. The fault zone consists of near-vertical, north-trending, east-facing slivers of basal Apache Group rocks that rest on granite and lie west of granite that underlies the main outcrops of the Apache Group. West of the point where the monoclinal swings abruptly east, successive slivers of basal Apache overlying granite too small to map are repeated in close succession by parallel faults. The long north-trending diabase masses in granite, apparently well below the pre-Apache surface, also suggests repetition by thrusting. Although there is no surface expression of the thrusts, the diabase is inferred to be sill-like masses that were intruded not more than 500 feet below the pre-Apache surface. Exposures in the area of the Ripsey Wash fault are mostly poor; many areas mapped as granite are covered by thin films of alluvium; some may conceal Apache Group rocks.

Faults that postdate the San Manuel Formation are west-dipping, low-angle gravity slides, high-angle, north-northwest-trending faults, and a few east-northeast-trending faults. Some high-angle faults, or some of the movement on them, postdate the Big Dome Formation; a few postdate the Quiburis Formation. The Indian Camp fault in the northeast part of the quadrangle may be a gravity slide similar to a major feature in the Putnam Wash quadrangle.

Although the monoclinal structures may have formed as separate en echelon folds, the alternative suggestion of a single monocline, later separated by faulting, is appealing. In the Crozier Peak quadrangle, the southern end of the ridge of steeply overturned strata swings abruptly east and abuts Ruin Granite, suggesting a strike-slip fault that caused the abrupt change in strike and dip of the Precambrian sedimentary rocks and separated the segment in the Winkelman quadrangle from the one in the Crozier Peak quadrangle. The segments were further separated by north-trending, high-angle faults. How much of the movement on the strike-slip and north-trending faults is older than the San Manuel Formation and how much is younger is uncertain. The fold in the older rocks is reflected in the younger deposits, which also swing east. Additional evidence for major strike-slip faulting is: (1) the east-trending high-angle faults and low-angle shear zones that separate Ruin Granite from diorite and Williamson Canyon Volcanics in the northeastern part of the Crozier Peak quadrangle, and (2) the fractured condition of the rocks in the north east corner of the Crozier Peak quadrangle that extends into the Kearny quadrangle. In this area of at least a square mile, few pieces on the surface are more than 6 inches in diameter and fractures are filled with carbonate, manganese minerals, specular hematite, and locally pyrite. Apache Group rocks are not in a normal sedimentary sequence. Other masses of brecciated rock with attendant chaotic repetition of small masses of Apache Group rocks and granite occur just north and northeast of the Crozier Peak quadrangle.

MINERALIZATION

The Winkelman 15-minute quadrangle, of which the Crozier Peak is a part, is adjacent to three major copper deposits: the San Manuel to the southeast, the Christmas to the northeast, and the Ray to the northwest. Although no economic deposits have yet been found within the 15-minute quadrangle, numerous prospect pits, shafts, and adits have explored the principal mineralized areas, which are in granitic rocks in the southeast corner and in the north-central and northwestern parts of the 15-minute quadrangle. Some of the mineralization may be Precambrian in age, but most of it probably is related to Laramide intrusive bodies.

In the Crozier Peak quadrangle, mineralization is confined to the Ruin Granite and Cretaceous diorite in the northeast part of the area and to Ruin Granite elsewhere. In the northeast corner, brecciated areas are veined with calcite, manganese oxide, specular variety of hematite, and goethite. Pyrite and copper staining is common in diorite. Quartz-sericite alteration with disseminated pyrite and a little copper mineralization is common in the northwest part of the quadrangle. In the southwestern part, two ages of quartz veins were noted: those that are older than the Precambrian diabase and those that are younger, probably of Laramide age. The younger quartz veins strike eastward, generally are 1 to 2 inches wide, locally 12 inches wide, and contain small pyrite cubes (as much as 4 mm). Associated with some of the shear zones and Laramide dikes are veins of calcite; one in the southeast corner of the quadrangle 5 to 10 feet wide, locally 20 feet wide, consists of coarsely crystalline (at least 1 cm) white and brown calcite and finer grained (less than 2 mm) pink calcite. Pink and white calcite are veined by brown calcite that has about the grain size of the pink calcite. X-ray examination proved that all the carbonate is calcite.

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qal *Alluvium (0-15 ft exposed).*—Flood-plain deposits along valley bottoms composed of clay, silt, sand, and some gravel; largely unconsolidated.

Qt *Talus (0-20 ft).*—Veneer of rock debris derived from adjacent bedrock. Many talus deposits, not identified on map, partly cover diabase, upper member of Dripping Spring Quartzite, and Pioneer Formation.

Qp *Soil and gravel veneer on pediments and younger terraces (0-25 ft).*—Subangular pebbles and cobbles in a generally reddish brown, fine- to coarse-grained matrix. Originally covered wide areas west and south of Ripsey Hill ridge, where present surface is only slightly below the pediment surface. The dark-red-brown soils were developed during one of the pre-Wisconsin interglaciations.

Qg *Undifferentiated gravel.*— Terrace or pediment gravels, talus, and alluvium; includes isolated exposures of underlying rocks.

Qsg **SAND AND GRAVEL (0–MORE THAN 100 FT EXPOSED)**

Poorly consolidated alluvial gravel and sand composed largely of granules and small pebbles in a finer grained matrix, derived largely from Ruin Granite and related rocks. Concealed in many places by alluvial and colluvial material on valley bottoms and slopes and by red soil developed on upper (pediment) surfaces. Gravels east of Hackberry Wash in the northern part of the quadrangle were deposited in channels that were cut in the San Manuel Formation during the formation of the present drainage system. Sand and gravel in the

southwestern part of the map area and east of Ripsey Ranch are tentatively included in this unit. Some or all of them may belong to an older formation.

Tbd **BIG DOME FORMATION**

(Thickness unknown, probably not more than a few hundred feet in this area). Named by Krieger and others (1974) for exposures at Big Dome, Sonora quadrangle, where it was mapped but not named by Cornwall and others (1971). Yellowish-gray, pale-olive, to grayish-orange pink; derived largely from Oracle Granite in the Crozier Peak quadrangle. Some lenses contain scattered to abundant clasts of diabase, Precambrian and Paleozoic sedimentary rocks and Late Cretaceous and(or) early Tertiary rocks, generally in a granitic matrix; local beds of rhyolite tuff. Clasts generally pebble to cobble sized, local large boulders; mostly subangular to subrounded. Well indurated along Hackberry Wash; elsewhere poorly indurated and poorly exposed.

For a short distance along Hackberry Wash south of its junction with Eagle Wash, an angular unconformity between gently dipping Big Dome Formation and more steeply dipping San Manuel Formation is exposed. Because of relief on the underlying gravel surface and the presence of several faults of small displacement, the unconformity was clearly recognizable only in this local area. Elsewhere, the contact between the two formations is very arbitrarily located, as compositions and bedding features are very similar. Where the unconformity is exposed, the Big Dome Formation is a little yellower in color and slightly finer grained than the underlying San Manuel Formation. The unit mapped as Big Dome Formation includes the poorly exposed ridge-top gravels, which could be weathered and slumped San Manuel Formation or younger sand and gravel.

SAN MANUEL FORMATION (Ts)

Thickness unknown, but at least 6,000 ft.–Named by Heindl (1963). Divided into following units in this quadrangle:

Tsg *Granitic alluvial deposits (thickness unknown, possibly 1,000 to 2,000 ft).*–Yellowish-gray, pale-olive, to grayish-orange-pink; derived largely from Ruin Granite and related rocks: granitic material largely light colored, locally red; some lenses with scattered to abundant clasts of Precambrian and Paleozoic sedimentary rocks, Late Cretaceous and(or) early Tertiary intrusive rocks, and Late Cretaceous or Tertiary andesite, generally in a granitic matrix. Local beds of rhyolite and rhyodacite tuff, concretionary tuff, and sandy beds with small rhyolite(?) lapilli. Table 1 gives chemical and normative compositions and location of the rhyodacite tuff bed from which K-Ar ages of 18 (on biotite) and 24 (on sanidine) m.y. were obtained. Clasts generally pebble to cobble sized, but some are 10 ft long; subangular to subrounded, except for angular cobbles and boulders of granite and Paleozoic rocks north of the east end of east-trending ridge of Precambrian sedimentary rocks. Interbeds of sand-sized particles, with or without scattered pebbles and cobbles, are mostly well and thin bedded; some can be traced for several hundred feet at least. In many places bedding is poor to indistinct, especially in southern part of area, and on ridge tops, where the unit is poorly indurated and poorly exposed. Beds with nongranitic material may be more indurated than adjacent granitic gravels. Near granitic bedrock, some granite clasts may have accumulated as talus. Near junction of Hackberry and Eagle Washes, well-bedded and well-indurated material, with few clasts larger than small cobbles, resembles the playa(?) deposits near Beehive Well on Putnam Wash.

TABLE 1.–*Chemical and normative composition of rhyodacite tuff bed on north side of Jim Thomas Wash, east edge of sec. 19, T. 5 S., R. 14 E.*
[Analysis under direction of Leonard Shapiro, methods given in U.S. Geol. Survey Bull. 1144-A]

Field No. W-158			
Chemical composition (in percent)		CIPW norms (wt percent)	
SiO_2	59.4	Q	32.0
Al_2O_3	15.8	C	4.2
Fe_2O_3	2.2	or	8.6
FeO	1.7	ab	24.5
MgO	2.0	an	19.2
CaO	3.7	en	5.6
Na_2O	2.6	fo	.5
K_2O	1.3	mt	3.6
H_2O-	4.6	il	1.4
H_2O+	5.6	ap	.5
TiO_2	.64	Total	100
P_2O_5	.17	Salic	88.6
MnO	.12	Femic	11.4
CO_2	<.05		
Sum	100	In calculating the norm, both H_2O+ and H_2O- were omitted	

Tsa *Nongranitic alluvial deposits.*–Present in two areas: (1) larger area lies east of the granitic deposits; (2) smaller area underlies granitic deposits on east side of Ripsey Hill ridge.

Larger area.–(Thickness probably as much as 3,000 ft based on outcrop width and attitude, if not repeated by faults.) Pale-brown, brownish-gray, and olive-gray, locally grayish-red, especially in northeastern exposures. Angular to subrounded clasts, from silt to boulders as much as 8 ft in longest dimension; composed of fragments of Paleozoic limestone and sandstone and Precambrian sedimentary rocks and diabase. Clasts of Williamson Canyon Volcanics or various Laramide intrusive rocks locally abundant near the contacts with these rocks. A few beds near the southeast margin contain granitic clasts. Escabrosa Limestone usually forms the largest clasts. Boulders generally are erratically distributed; bedding is poorly developed, especially in southern exposures, where ratio of sand and silt to clasts is small. Shallow channels are fairly common. Some beds, especially in northern exposures, are fairly well sorted with abundant closely packed, 2- to 4-in. pebbles. The formation is more indurated in the northern part of the quadrangle than in the southern part. The unit is part of a large area of dark non granitic alluvial deposits that are well exposed in the Kearny quadrangle and that grade into dark nongranitic playa deposits, similar to the nongranitic playa deposits in the Crozier Peak quadrangle.

Smaller area.—(Thickness probably as much as 1,000 ft, based on attitude and outcrop width.) Coarse-grained and brown to yellowish brown in the western part, somewhat finer grained and yellowish gray to pale olive to the east. Composed of fragments from Precambrian diabase and sedimentary rocks, Paleozoic limestone and sandstone, and Tertiary(?) mafic volcanic rocks, with local lenses containing clasts of Ruin Granite and Late Cretaceous volcanic and Laramide intrusive rocks.

Tsp *Nongranitic playa deposits.*—Beds up to 12 in. thick of light-olive-gray to light-brownish-gray sand and silt, alternating with conglomerate (mostly pebble sized). Same as the dark nongranitic playa deposits in the Kearny quadrangle.

Tsv *Andesitic volcanic rocks.*—Andesite or basalt crops out along the east side of Ripsey Hill ridge from upper Jim Thomas Wash, NW¼ sec. 30, T. 5 S., R. 14 E., south for 2.3 miles; it is also exposed east of Jim Thomas Wash in sec. 20, T. 5 S., R. 14 E. Along upper Jim Thomas Wash near-vertical, north-trending flows, about 300 ft thick, are dark gray and porphyritic, containing abundant 1-2 mm phenocrysts of light-brown olivine, pyroxene, and magnetite in a very fine grained groundmass of plagioclase laths, pyroxene, altered olivine, and magnetite. The unit consists of several flows with brecciated tops and bottoms that clearly flowed out over and baked the underlying gravels (to west). Locally, contact between andesite and overlying gravels is a high-angle fault; in other places, the contact appears to be sedimentary. Narrow band of andesite, extending south from near the center of sec. 31, T. 5 S., R. 14 E., tentatively correlated with the flows to the north. It is medium light gray, finely vesticular, and contains fewer phenocrysts than the flows to the north. Phenocrysts are hornblende and biotite, largely altered to granular magnetite, and a few fresh pyroxenes. Groundmass is altered, but plagioclase laths and mafic minerals are recognizable. East of lower Jim Thomas Wash light-brownish-gray vesicular andesite has phenocrysts to 2 mm in diameter of alterde mafic minerals (olivine?) in a groundmass of plagioclase laths, pyroxene, and altered olivine. It closely resembles some of the andesite of Depression Canyon (of the Galiuro Volcanics), especially the thin flows between Bear Springs and Whitewash Canyons that are about 25 m.y. old (Krieger, 1968a).

Tsb *Megabreccia.*—Lenses of megabreccia interbedded in granitic and nongranitic alluvial deposits; extremely well indurated, especially those composed of quartzite and limestone; mostly angular to subangular fragments in a matrix of ground-up material of the same composition. Probably formed as landslide blocks. Essentially monolithologic breccias of Ruin Granite occur in granitic and nongranitic deposits east of Ripsey Hill ridge. Small amounts of breccias of Precambrian sedimentary rocks and diabase are locally associated with them. Intermittent lenses of breccia, largely of Escabroas Limestone, in nongranitic deposits from north edge of map area on both sides of Jim Thomas Wash southward for nearly 1 ½ miles to east of Hackberry Wash near west edge of sec. 21, T. 5 S., R. 14 E. They are the southern end of extensive breccias interbedded in playa and alluvial deposits and composed of daiabas, Precambrian and Paleozoic sedimentary rocks, Late Cretaceous volcanic rocks, and Laramide intrusive rocks that extend north of the map area for more than 2 miles.

A north-northwest-trending compound lens of breccia, bounded on the west by a fault, separates granitic from nongranitic deposits between Jim Thomas and Hackberry Washes. Although most of the area is brecciated, at the highest point on the ridge, the lower member of the Abrigo Formation apparently rests conformably on upper member of the Troy Quartzite; neither unit appears to be appreciably brecciated. Other quartzite and the limestone masses are good monolithologic breccia. The base of the unit is a diabase breccia that rests on a thin layer of undisturbed sand and gravel, above unbrecciated andesitic flows.

The breccia mass east of Ripsey Hill ridge near the northern part of the area is a jumble of Dripping Spring and Troy Quartzites, diabase, Mescal Limestone, and basalt; some of it is not appreciably brecciated. The small lens of Escabrosa and Martin, shown as monolithologic breccia in NW¼ sec. 19, T. 5 S., R. 14 E., may be a landslide block younger than the tilted gravels, or it may result from unrecognized faults.

Along the north side of the diorite mass, between Indian Camp and Eagle Washes, brecciated diorite diorite grades northward into talus and sedimentary breccia and into nongranitic alluvial deposits composed largely of diorite. In some of the breccia just west of Indian Camp Wash, clasts are subrounded and the matrix is similar to that in the alluvial deposits.

DIKES AND IRREGULAR INTRUSIVE MASSES

TKap *Andesite porphyry.*—Dark-gray to grayish-black, very fine grained to aphanitic rock with plagioclase phenocrysts, as much as 8 mm in length, making up at least one-fourth of the rock. Mafic phenocrysts, few, inconspicuous, and usually less than 2 mm long, of pyroxene, partly altered to hornblende, epidote, or zoisite and smaller magnetite crystals. Groundmass of lathlike plagioclase, magnetite, and acicular hornblende. Intrudes Williamson Canyon Volcanics and diorite; an unmapped dike intrudes a small mass of older quartz latite porphyry in NE¼ sec. 1, T. 6 S., R. 13 E.

TKly *Younger quartz latite porphyry.*—Intrudes latite and rhyolite porphyries. Most latite(?) porphyries are dikes only a few feet wide, very light colored, with platy flow structure; a few very inconspicuous feldspar phenocrysts, mostly less than 2 mm long, and smaller altered mafic minerals, probably originally hornblende or biotite. Aphanitic to granular groundmass; granular phase probably represents devitrified glass. Distinct from these latite(?) porphyries are the larger (50 to 100 ft wide) dikes of quartz latite or rhyolite (NW¼ sec. 11, T. 6 S., R. 13 S., and N½ sec. 27, T. 5 S., R. 14 E.); very light yellowish, greenish, to pinkish gray with fairly abundant phenocrysts of euhedral to resorbed quartz (1-2 mm) and K-feldspar and altered plagioclase (1-3 mm), with or without a few tiny magnetite and altered mafic phenocrysts, in an aphanitic and devitrified groundmass. No age data or chemical analyses are available for any of these rocks. They intrude diorite and some of the rhyodacite porphyry dikes. Also mapped as younger quartz latite porphyry is the 200-ft-wide dike in west-central part of sec. 24, T. 5 S., R. 13 E. It is pale red with a very few tiny phenocrysts of feldspar (some are microcline and may be xenocrysts from the granite), biotite, and quartz in an aphanitic, devitrified groundmass with numerous

tiny vugs. Flow structure is well developed. It may be Miocene in age.

TKrq *Younger rhyodacite porphyry.*—Two dikes mapped: (1) one in NE¼ sec. 24, T. 5 S., R. 13 E., intruding older quartz latite porphyry (Klo) and an older rhyodacite porphyry (TKrq); (2) one in SE¼ sec. 25, T. 5 S., R. 13 E., intruding hornblende andesite porphyry (Kha). Both are medium greenish gray to olive gray with abundant phenocrysts of plagioclase, as much as 7 mm long, and smaller phenocrysts of hornblende and biotite in an aphanitic groundmass. Chilled margins of both dikes contain smaller and fewer phenocrysts.

TKh *Hornblende porphyry.*—Medium-gray to greenish- or olive-gray, fine-grained porphyritic to essentially nonporphyritic rocks of probable hornblende andesite to hornblende rhyodacite composition. Many of the dikes are less than 10 ft wide. Most hornblende and the rare feldspar phenocrysts are only slightly larger than groundmass size (1-2 mm), but locally hornblende needle- and lath like crystals are as much as 5 mm long. Some dikes are darker in color and are characterized by a fine-grained groundmass composed of feldspar and numerous small hornblende needles. The east-trending dike in sec. 27, T. 6 S., R. 14 E., and the north-northwest-trending one that extends from SW¼ sec. 29 to NE ¼ sec. 30, T. 6 S., R. 14 E., are of this type. The north-northwest-trending dike is cut by east-trending dikes of similar composition but lighter color that have fewer but longer (5 mm) hornblende crystals. Both types are probably closely related in time and probably of andesitic composition.

TKmr *Melanocratic rhyodacite porphyry.*—Medium-gray rock with a greenish tinge, phenocrysts of plagioclase, quartz, and hornblende. In the large mass north of Tecolote Ranch that intrudes older quartz latite porphyry, plagioclase phenocrysts and somewhat less abundant euhedral to resorbed quartz phenocrysts are 1-10 mm in diameter and scattered hornblende laths are as much as 8 mm, but mostly less than 3 mm. Groundmass generally granular, not aphanitic, as in most of the rhyodacite porphyry; composed of plagioclase, hornblende, K-feldspar, and magnetite; largely altered to chlorite, calcite, and epidote. Most hornblende phenocrysts are altered; and feldspar is sericitized and saussuritized. Some dikes, tentatively classes as melanocratic rhyodacite, have few or no quartz phenocrysts and (or) small sparsely distributed plagioclase. A few have biotite. As all intrude Ruin Granite and some contain xenoliths of the granite, it is possible that some fine-grained mafic rocks with xenocrysts have been mapped as melanocratic rhyodacite porphyry. Chilled margin of the dike along the road about ¾ mile southeast of Tecolote Ranch resembles dikes mapped as fine-grained quartz diorite in the Winkelman quadrangle (Krieger, 1974a), whereas the chilled margin of the dike that cuts diabase, near the center of west edge of sec. 35, T. 5 S., R. 14 E., resembles fine-grained hornblende porphyry (TKh).

TKr *Rhyodacite porphyry.*—Dikes, a few feet to more than 200 ft wide, and pluglike to irregular bodies. Mostly aphanitic rocks with abundant phenocrysts of feldspar, less abundant biotite and hornblende, with or without quartz. Those with obvious quartz phenocrysts (TKrq) are medium gray to greenish gray, but light brownish, yellowish, or olive gray where altered; surface weathers to a limonitic brown. Their feldspar and quartz phenocrysts are mostly 1-2 mm, locally 5 or more mm long; biotite and hornblende phenocrysts are mostly 1-2 mm. Groundmass is aphanitic and mostly creamy to greenish in color. Quartz is resorbed. Alteration products are epidote, chlorite, and opaques.

Dikes with little or no quartz as phenocrysts (TKr) are medium gray to brownish or olive gray with very abundant plagioclase phenocrysts and less abundant phenocrysts of hornblende and biotite in a creamy, aphanitic groundmass. Feldspar phenocrysts, mostly 1-2 mm in length, locally as much as 1 cm, make up approximately 30 percent of the rock. Hornblende and biotite phenocrysts, usually not more than 1-2 mm in in largest dimension, generally present in about equal amounts; locally, hornblende is the principal mafic mineral. Where badly altered, feldspar and mafic phenocrysts may be difficult to see on a freshly broken surface. The groundmass is composed of plagioclase, quartz, K-feldspar, hornblende, biotite, and magnetite. Both the groundmass and phenocryst minerals in some dikes are altered to chlorite, epidote, magnetite, and calcite.

TKu *Unclassified dikes*[1]

DIKES, SILLS, AND IRREGULAR INTRUSIVE MASSES

Kgd *Granodiorite.*—An irregular mass of granodiorite intrudes Precambrian rocks along the north edge of the quadrangle and east-trending dikes intrude granite and diorite. The granodiorite is identical to, and some of the dikes are offshoots of, an irregular mass in the Winkelman quadrangle. Biotite from the Winkelman mass dated by the K-Ar method 66.0±2.0 m.y. Damon and others (1964, Copper Hill quartz monzonite p. 48) obtained a date of 68 m.y. on biotite from this mass. The granodiorite is medium-light-gray with a brownish tinge; contains abundant 1-5 mm laths plagioclase. 1-3 mm books of biotite; 1-5 mm laths of hornblende, and small magnetite crystals. Fine-grained to aphanitic groundmass in narrower parts of dikes, but only slightly finer grained than the smaller phenocrysts in the larger mass. Groundmass of quartz, K-feldspar, plagioclase, and mafic, and opaque minerals. Most biotite is fresh, some is altered to chlorite; hornblende generally more altered than biotite. Much of the granodiorite in the irregular mass in this quadrangle is badly altered.

Khd *Hornblend Diorite.*—The dike near the center of the quadrangle (sec. 7, T. 6 S., R. 14 E.) closely resembles the hornblende diorite in the northeast corner of the Winkelman quadrangle; medium gray to medium light olive gray with abundant 1-2 mm phenocrysts of saussuritized plagioclase and smaller mafic minerals (now altered to chlorite and epidote), magnetite, and

[1] Numerous dikes, sills, plugs, and irregular igneous masses intrude Precambrian rocks, Abrigo Formation, Escabrosa Limestone, and Williamson Canyon Volcanics, and the earlier intrusive rocks. Many are only a few feet wide and greatly exaggerated on the map. Many small ones are not represented. The dikes were classified mainly by comparing hand specimens during the final stages of mapping. The classification was hampered by compositional variations of the dikes along strike and by alteration. Separation of narrow dikes was most difficult because they are multiple, branching, and offset. The intrusive rocks are classified as to relative age; some conclusions are tentative. Where insufficient data were collected, the dikes were lumped as unclassified (TKu).

very little quartz in a badly altered, very fine grained groundmass.

Kdi *Diorite.*—Medium-dark-gray, fine- to medium-grained (mostly less than 2 mm), composed of plagioclase, pyroxene, hornblende, biotite, magnetite, and some quartz and K-feldspar. Local alteration products are epidote, chlorite, and sericite. Hornblende from a specimen collected in the Winkelman quadrangle from the eastern extension of the mass north of Crozier Peak gave an age of 65.6±2.0 m.y. The diorite may be about the same age (71 m.y., biotite, 82 m.y., hornblende) as the Tortilla Quartz Diorite in the Sonora quadrangle (see also Banks and others, 1972).

Kda *Dacite porphyry.*—Medium-gray porphyry with olive tinge; phenocrysts of zoned, twinned, and altered plagioclase less than 1 to about 4 mm in length; of hornblende, less than 1 to more than 2 mm in length, and smaller pyroxene and magnetite. Smaller hornblende phenocrysts almost completely altered to granular magnetite; larger ones have narrow rims of magnetite. Groundmass of plagioclase laths, pyroxene(?), and magnetite; spotty areas of epidote, chlorite, and calcite. Joan Engels (written commun., 1968) has dated hornblende from this mass at 71.3±2.1 m.y. by the K-Ar method. The chemical and normative compositions (table 2) indicate a probable dacitic composition.

TABLE 2.—*Chemical and normative compositions of hornblende andesite porphyry and dacite porphyry*
[Analyses under direction of Leonard Shapiro, methods given in U.S. Geol. Survey Bull 1144-A]

Field No.	W-149	W-169		W-149	W-169
Chemical composition (in percent)			C.I.P.W. norms (wt percent)		
SiO_2	55.3	57.3	Q	11.4	9.4
Al_2O_3	18.5	15.6	or	8.5	11.2
Fe_2O_3	6.7	.80	ab	30.3	34.8
FeO	.84	6.0	an	31.3	20.8
MgO	2.5	3.8	wo	2.8	0.8
CaO	7.8	4.6	en	6.4	10.0
Na_2O	3.5	3.9	fs		9.8
K_2O	1.4	1.8	mt	0.5	1.2
H_2O	.25	1.3	hm	6.5	
H_2O+	1.7	2.9	il	1.8	1.6
TiO_2	.94	.82	ap	0.5	0.4
P_2O_5	.22	.18	Total	100.0	100.0
MnO	.17	.15			
CO_2	< .05	< .05	Salic	81.4	76.1
			Femic	18.6	23.9
Sum	100	99	In calculating the norms, both H_2O+ and H_2O- were omitted		

W-149 - Hornblende andesite porphyry, SE¼ sec. 25, T. 5 S., R. 13 E.
W-169 - Dacite porphyry, SE¼ sec. 1, T. 6 S., R. 14 E., just north of Hackberry Wash - Tecolote Ranch road.

Klo *Older quartz latite porphyry.*—Possibly latitic to rhyolitic in composition. Greenish- to yellowish- and very light brownish-gray rock that weathers nearly white, composed of scattered phenocrysts of plagioclase and altered mafic minerals, mostly 1-2 mm long. Groundmass devitrified and altered; some of it may have been perlitic. Mafic phenocrysts mostly of biotite, locally hornblende. A small mass in NE¼ sec. 1, T. 6 S., R. 13 E., containing fresh biotite and small magnetite phenocrysts, is correlated with older quartz latite porphyry.

Kha *Hornblende andesite porphyry.*—Medium-gray rock with a bluish tinge, containing scattered hornblende phenocrysts as much as 1 cm long. Very fine grained to aphanitic groundmass; abundant small phenocrysts of altered plagioclase, light-green clinoenstatite, and magnetite, mostly less than 1 mm in diameter; hornblende usually narrowly rimmed by granular magnetite. Spotty chloritization of the groundmass is common. The small offset southern part of the mass is more altered than the northern part, and hornblende phenocrysts are not as obvious. Chemical and normative compositions (table 2) indicate an andesitic to dacitic composition. Hornblende from an identical-appearing dike in the Sonora quadrangle gave a K-Ar age of 128 m.y., suggesting an Early Cretaceous age (Cornwall and others, 1971; Banks and others, 1972).

VOLCANIC ROCKS

Rhyodacitic to quartz latitic pyroclastic rocks and flows.—Occurs in two areas:

1. *South of upper Jim Thomas Wash* extending north from the Hackberry Wash-Tecolote Ranch road for about a mile and a half. Maximum thickness of about 300 ft. Poorly exposed, olive-gray to gray flows(?), flow breccias and intrusive(?) rocks containing phenocrysts of plagioclase (1-10 mm), green hornblende(?) (1-15 mm), and smaller magnetite. Plagioclase and hornblende(?) are badly altered. Epidote occurs in the groundmass and as large areas that probably represent volcanic fragments and (or) xenoliths; also with calcite in vugs. The unit does not resemble the volcanic rocks to the north but may be of essentially the same age. It lies on the east side of the andesite that occurs in the San Manuel Formation, apparently along a major fault, whereas the volcanics west of Jim Thomas Wash are west of (below) the andesite and associated nongranitic alluvial deposits.

2. *West of Jim Thomas Wash* (maximum thickness of about 1,000 ft).—Composed of volcanic clasts as much as a foot in diameter and smaller lithic and crystal fragments in a matrix of devitrified ash. Matrix mostly light to very light gray and brownish gray. Clasts, medium-light brownish-gray, purplish-gray and locally moderate-gray, composed of euhedral to resorbed quartz phenocrysts, as much as 3 mm in diameter; fresh to sericitized plagioclase, as much as 8 mm long; fresh to altered hornblende, about 1 mm long; larger altered biotite, and smaller magnetite; some mafics altered to chlorite, The groundmass of the clasts is cryptocrystalline. Crystal fragments of broken and fractured quartz and plagioclase, fresh hornblende, biotite (now largely altered to chlorite), magnetite, and a little microcline. Matrix, in addition to the finely comminuted lithic and crystal fragments, probably once consisted of shards and pumice, although none were recognized. No evidence of ash-flow origin or flow structure were noted, nor was bedding observed. Southern, wider part may contain latite or andesite flow or massive tuff. The local presence of conglomerate similar to that described below (Kc), beneath the Williamson Canyon Volcanics in the Saddle Mountain quadrangle suggests a correla-

tion, but those volcanic rocks are andesitic in composition. Some of the volcanic clasts in the pyroclastic rocks are similar in composition and general appearance to some of the flow breccias in the Glory Hole Volcanics (Krieger, 1968b; see also Simons, 1964). The volcanic rocks west of Jim Thomas Wash are intruded by hornblende porphyry and by unclassified dikes.

Basal conglomerate.—Composed of well-rounded large cobbles and small boulders of granitic rocks, quartzite, and a few of porphyry similar to the fragments in the volcanic rocks.

Williamson Canyon Volcanics.—Named by Simons (1964); Willden (1964), called these same rocks "unnamed volcanic and sedimentary rocks." Extend eastward from Eagle Wash to north of Crozier Peak. Dark-gray andesite(?) porphyry with phenocrysts of plagioclase as much as 6 mm long, hornblende rimmed with epidote(?), altered pyroxene, and magnetite, in a very fine grained to aphanitic groundmass of plagioclase, hornblende, pyroxene, biotite, and a little quartz; some chlorite alteration. Closely associated with and intruded by diorite. Contacts with diorite separate areas composed largely of diorite from those composed of volcanics and as much as 50 percent diorite. Abundant xenoliths of Troy Quartzite, granite, and epidotized fragments of Escabrosa(?) Limestone, pebbles to lenses of mappable size. In some places the unit is a volcanic breccia. Except for its finer grain size, the volcanics superficially resemble the diorite. In a few places the diorite is clearly intrusive into the volcanic rocks. Because of their probable andesitic composition, these volcanics are correlated with the Williamson Canyon Volcanics in the Saddle Mountain quadrangle,Christmas quadrangle, and Klondyke quadrangle (Simons, 1964).

ESCABROSA LIMESTONE (0-ABOUT 200 FT IN THIS AREA)

Massive, cliff-forming, thick-bedded, light-colored, fossiliferous, mostly coarse-grained, crystalline limestone, separated by slope- and ledge-forming, thin-bedded, dark-colored, fine-grained silty and dolomitic limestone. The basal 38 ft of the formation above the measured section of the Martin Formation is composed of these darker beds. Limestone lenses about one-half mile northwest of the top of Crozier Peak metamorphosed, especially the eastern end of the southern mass, to massive brown and yellow andradite in crystals 0.1-3.0 mm in diameter, associated with epidote. Limestone lens near Eagle Wash contains considerable epidote. Limestone in both lenses tentatively correlated with the Escabrosa. Because of brecciated character and occurrence in an area where Paleozoic formations in normal sequence are absent, these lenses may represent landslide blocks later caught up in volcanic and intrusive rocks.(Named by Ransome, 1904).

MARTIN FORMATION (MAXIMUM OF ABOUT 275 FT)

Upper member (0-120 ft thick).—Shale and siltstone, in part dolomitic and calcareous; very thin bedded, yellowish brown to light olive gray, weathers grayish orange. A few thin beds of limestone and dolomite, especially at top.

Lower member (0-155 ft thick).—Dolomite and limestone; brownish gray to olive gray and medium gray; dense to finely crystalline. A few quartzite and calcareous to dolomitic sandstone beds especially in lower part. The upper shaly unit is equivalent of most of the formation in the Holy Joe Peak area (Krieger, 1968a-d), where it is 100 to 250 ft thick, with locally as much as 50 ft of limestone at the top. The lower carbonate unit is equivalent to most of the formation in the Ray and Superior areas (Cornwall and others, 1971 and Peterson 1969).(Named by Ransome, 1904).

Section of Martin Formation measured in NW¼ sec. 30, T. 5 S., R. 14 E., due west where Jim Thomas Wash swings northeast	*Thickness (feet)*
Escabrosa Limestone	
Martin Formation	
Upper member	
Limestone, dense, platy, very light brownish gray; weathers light olive gray	10
Siltstone and shale, dolomitic, very thin bedded, moderate yellowish-brown to light-olive-gray; weathers grayish orange	110
Total thickness of upper member	120
Lower member	
Limestone, crystalline, light-brownish-gray; weathers light olive gray, moderately fossiliferous; beds as much as 18 in. thick, locally thin-bedded and silty	14.5
Limestone and dolomite, thin-bedded	30.5
Limestone, dense, olive-gray to medium-gray; weathers light olive gray to light gray; very fossiliferous at top; fossils include *Cyrtospirifer, Stropheodonta, Atrypa*, small spiriferoids, and crinoid stems	10
Sandstone, calcareous, yellowish-gray; weathers nearly white	10
Limestone, dense, light-olive to greenish-gray; weathers very light gray; scattered, rounded, frosted quartz grains	10
Dolomite, pale-red, thin-bedded	1
Dolomite and limestone, poorly exposed	15
Sandstone, or quartzite, very light gray with pinkish-tinge, medium-grained	23
Limestone, fine grained, brownish-gray; weathers light olive gray, thinly laminated	24
Red, hematitic bed	2
Limestone, crystalline, dark-gray (sparkly); weathers medium to dark gray, thinly laminated; probably equivalent to the host rock for ore bodies in the Magma mine at Superior and the Christmas mine [1]	14
Total thickness of lower member	154
Total thickness of Martin Formation	274
Abrigo Formation	

[1] In some places a light-gray dense carbonate bed underlies the dark-gray ore horizon, and a 10- to 25-ft bed of quartzite overlies it

Remarks on Abrigo Formation (About 268 ft)

The formation consists of three members east of the San Pedro River (Krieger, 1968a-c). Middle member unmapped, generally absent, or only a few feet thick; 52 feet thick below measured section of Martin Formation. Very fine grained, well-sorted orthoquartzite with a few silty interbeds.

LOWER MEMBER OF ABRIGO FORMATION

(216 ft measured, see measured section for location) Pale-yellowish-brown to olive gray sandy mudstone, claystone, and siltstone with some beds of dolomite and sandstone; thin-bedded, with very irregular bedding surfaces; very similar to the member in the Holy Joe Peak area (Krieger, 1968a-e). Dolomite most abundant near the middle of the member. Quartzite or coarse-grained sandstone with abundant phosphatic brachiopods; some dolomitic sandstone 50 ft below the top in the area where the Martin was measured. Locally, basal 5 ft and uppermost 10 ft are quartzite containing phosphatic brachiopods. At 5 ft mafic (trachytic) sill occurs about 100 ft above the base. Mudstone member generally rests directly on Troy Quartzite, but locally a few feet of thin-bedded, fine- to medium-grained banded sandstone overlies and appears to grade downward into typical pebbly Troy Quartzite. Most of this sandstone is believed to belong in the Troy, but some of it resembles thin beds at the top of the Middle Cambrian Bolsa Quartzite (not present in this quadrangle); in one place an angular clast of quartzite, probably Troy, was observed. (Named by Ransome, 1904).

DIABASE

Dark-gray to dark-greenish- or olive-gray, fine- to coarse-grained rocks with diabasic to ophitic texture; composed of plagioclase, pyroxene, olivine, magnetite, and ilmenite; little K-feldspar and quartz; some chlorite, epidote, sericite, and calcite alteration. The wider sills(?) (200-400 ft) that are well below the pre-Apache surface are identical to the known Precambrian diabase sills that occur in the Apache Group or within 500 ft below the pre-Apache surface. Their present distribution may be explained by known or probable faults. Some of the narrow (a few feet to 500 ft) dikes(?) or sill-like masses were questionably correlated with the Precambrian diabase, as they (Nos. 1-3, table 3) contain more SiO_2 than and about half the TiO_2 of known Precambrian diabase in the Sierra Ancha (Nos. 4-6, table 3) (A.F. Shride, written communication, 1968). Recent chemical analyses of thick diabase sills in the Brandenburg Mountain quadrangle (Nos. 7-9, table 3), however, are very similar to the narrow masses in this quadrangle in SiO_2 and TiO_2 content. No chemical analyses of the thicker sills in the Crozier Peak quadrangle are available, and none have been dated at yet. The constituent minerals in the narrow dikes and sills are usually too altered to give an age date on hornblende or biotite. Felsic dikes with hornblende needles that cut some of the large sills of diabase probably are differentiates of the diabase.

TROY QUARTZITE (ABOUT 700 FT)

Originally considered Cambrian in age (Ransome, 1915), but now known to be Precambrian, as it is intruded by diabase and unconformably overlain by Cambrian and (or) Devonian rocks (Krieger, 1961, 1968a-e; Shride, 1967). Roughly separated into two units, both probably equivalent to the Chediski Sandstone Member of the Troy Quartzite (Shride, 1967).

Upper unit (about 450 ft).—White to very light gray and grayish-red, thin- to thick-bedded, feldspathic and nonfeldspathic sandstone, quartzite, and conglomerate, with clasts largely of quartz, mostly less than ½ inch in diameter; granules and pebbles are concentrated in upper few inches of many beds. Locally fine to medium grained with thin beds and laminae of pinkish gray to very pale reddish brown sandstone near top of unit. Leisegang banding, not parallel to bedding, also common.

Lower unit (165 ft thick in SE¼ sec. 24, T. 5 S., R. 13 E.).—Dark-brownish-gray outcrops of medium-gray to pale-red conglomerate and sandstone, mostly thin-bedded and lenticular; thin beds of greenish-gray argillite; clasts of quartz and quartzite (some well rounded) and angular pieces of pink feldspar. Upper part consists of light-bluish-gray beds of fine-grained sandstone with scattered well-rounded pebbles. Local convolute laminations.

APACHE GROUP

Group, formations, and members named by Ransome (1903) except for Mescal Limestone (Ransome, 1915) and siltstone and arkose members of the Dropping Spring Quartz (Shride, 1967).

BASALT (0-ABOUT 50 FEET)

Local remnants between Mescal Limestone and Troy Quartzite, SE¼ sec. 13, to NE¼ sec. 25, T. 5 S., R. 13 E. Blackish-red to grayish-red and brownish-black porphyritic, amygdaloidal, vesicular basalt (see Shride, 1967, p. 42-44, for fuller discussion).

MESCAL LIMESTONE (200-300 FT)

Thin- to thick-bedded, brown to pale-red, dense to finely crystalline dolomite and cherty dolomite, some calcareous dolomite and silty dolomite; weathers brown to light gray. Locally metamorphosed by diabase to white silicate-bearing calcic limestone. Base of the formation is 0 to 15 ft of brown, coarse-grained sandstone in a dolomitic matrix. About 20 ft above the base is a dolomite with conspicuous irregular black chert layers and lenses parallel to bedding. It is separated from the underlying basal sandstone by about 2 ft of light-gray dolomite. Probably consists largely of the lower member of the Mescal (Shride, 1967, p. 25-42), as no algal structures, characteristic of the overlying algal (middle) member of the formation, were noted. The 293-ft section on the top of the east-trending ridge about 1,200 ft north of the southern border of sec. 24, T. 5 S., R. 13 E., is thicker than known sections of the lower member elsewhere.

DRIPPING SPRING QUARTZITE (350-500 FT)

Siltstone member (about 250 ft).—Thin-bedded, thinly laminated siltstone and very fine grained feldspathic to arkosic quartzite in shades of gray, brown, red, and yellow. A white to light-gray, medium- to coarse-grained quartzite, 25-50 ft thick, occurs near the middle of the member. It was not recognized everywhere but is prominent in the southernmost part of Ripsey Hill ridge, east of Tecolote Ranch. Granger and Raup (1964) subdivided the member into four units.

Arkose member (150-200 ft).—Mostly medium-grained thin- to thick-bedded, cross bedded, red to pink feldspathic to arkosic quartzite.

Barnes Conglomerate Member (10-50 ft).—Ellipsoidal, well-rounded pebbles (¼ - 6 in.) of quartzite, quartz, and red jasper, mostly closely packed, locally sparsely scattered, in a matrix of red to gray, coarse-grained arkosic sandstone or quartzite.

PIONEER FORMATION

(150 - nearly 300(?) ft; maximum thickness uncertain because of poor exposures, possibility of unmapped sills of diabase and Late Cretaceous and(or) early Tertiary intrusive rocks, and unmapped lenses of Pioneer within the sills.)

Upper member.—Dark-red to purple siltstone and very fine grained sandstone with numerous pale-red to

TABLE 3.–*Chemical and normative compositions of narrow sills or dikes of diabase, compared with large sills of Precambrian age in Gila County and Aravaipa Canyon*

[Analyses under direction of Leonard Shapiro, methods given in U.S. Geol. Survey Bull. 1144-A, except in Y-19-64, Y-9-64, and Y-24-64, analyzed by C.L. Parker, methods given in U.S. Geol. Survey Bull. 1170]

Field No.	1 W-181A	2 W-192	3 W-210	4 Y-19-64	5 Y-9-64	6 Y-24-64	7 A-10	8 A-11	9 A-12
				Chemical composition (in percent)					
SiO_2	52.3	52.4	49.9	45.50	46.23	46.70	49.3	51.2	49.2
Al_2O_3	13.1	13.4	15.3	16.69	16.07	18.78	16.2	14.5	15.9
Fe_2O_3	10.9	5.8	3.5	2.45	1.73	2.08	2.2	2.5	2.5
FeO	3.9	8.4	5.1	10.48	10.49	8.78	9.1	8.3	8.8
MgO	4.2	4.4	9.3	6.07	8.49	6.75	6.4	6.3	6.9
CaO	6.6	6.1	8.2	7.28	9.63	8.51	9.5	10.5	9.7
Na_2O	2.6	2.5	3.2	3.02	2.76	3.33	2.7	2.5	2.7
K_2O	1.9	2.2	.73	1.72	.61	.76	1.0	.79	.91
H_2O-	.15	.41	.14	.25	.08	.13	.20	.14	.19
H_2O+	2.1	1.8	3.0	2.90	1.00	1.51	1.1	1.0	.81
TiO_2	1.6	1.7	.97	2.79	2.43	2.09	1.3	1.1	1.3
P_2O_5	.26	.25	.21	.44	.27	.32	.20	.16	.20
MnO	.25	.46	.18	.19	.19	.16	.17	.18	.17
CO_2	.05	.05	.05	.01	.03	.04	.05	.05	.05
Cl	---	---	---	.19	.12	---	---	---	---
F	---	---	---	.05	.03	.04	---	---	---
Sub total	---	---	---	100.03	100.16	100.10	---	---	---
Less 0	---	---	---	.06	.04	.05	---	---	---
Total	100	100	100	99.97	100.12	100.05	99	99	99
				CIPW norms (wt percent)					
Q	13.5	8.9	---	---	---	---	---	2.3	---
or	11.5	13.3	4.5	10.5	3.6	4.6	6.0	4.8	5.5
ab	22.5	21.7	28.0	26.4	23.6	28.7	23.3	21.6	23.2
an	18.9	19.3	26.1	27.8	30.0	34.6	29.7	26.5	29.1
wo	5.4	4.2	6.1	2.7	6.8	2.5	7.1	10.7	7.7
en	10.7	11.2	19.0	1.9	4.4	1.9	12.3	16.0	12.8
fs	---	8.9	4.3	1.6	3.0	1.3	10.0	11.9	9.1
fo	---	---	3.5	9.6	11.9	10.6	2.8	---	3.3
fa	---	---	0.9	9.1	8.8	7.8	2.5	---	2.6
mt	9.0	8.6	5.3	3.7	2.5	3.1	3.3	3.7	3.7
hm	5.0	---	---	---	---	---	---	---	---
il	3.1	3.3	1.9	5.5	4.7	4.0	2.5	2.1	2.5
ap	.6	.6	.5	1.1	.6	.8	.5	.4	.5
cc	---	---	---	.02	.1	.1	---	---	---
Total[1]	100	100	100	99.92	100	100	100	100	100
Salic	66.2	63.2	58.6	64.8	57.2	67.9	59.0	55.2	57.7
Femic	33.8	36.8	41.4	35.7	42.8	32.1	41.0	44.8	42.2

[1] In calculating the norms, H_2O+ and H_2O- were omitted

W-181A - North-south dike or sill near east edge, SE¼ sec. 14, T. 5 S., R. 13 E.
W-192 - North-south dike or sill north edge of map area. NW¼ sec. 14, T. 5 S., R. 13 E.
W-210 - Northeast-trending dike, SE¼ sec. 34, T. 5 S., R. 14 E.
Y-19-64 - Diabase, chilled border, lower contact, 780-ft sill, Sierra Ancha; data from A.F. Shrider (written commun., 1968).
Y-9-64 - Fresh olivine diabase from 450 ft, above base of 780-ft sill; data from A.F. Shrider (written commun., 1968).
Y-24-64 - Coarse-grained diabase in olivine-rich lower one third of 780-ft sill, 200 ft above base; data from A.F. Shride (written commun., 1968).
A-10 - Middle or older sill, west of Aravaipa Canyon, southeast of Brandenburg Mountain, Brandenburg Mountain quadrangle; data from C.F. Wracke, (written commun., 1970).
A-11 - Upper chilled border of younger sill; same location and source of data as No. A-10.
A-12 - Younger sill 12 ft above base; same location and source of data as No. A-10.

yellowish-gray elliptical leached spots; interbedded with grayish-orange-pink, fine- to medium-grained, cross-bedded arkosic sandstone and some dark-red to purple, coarse-grained sandstone; many beds tuffaceous.

Scanlan Conglomerate Member (0- about 30 ft).—Subangular to round pebbles and cobbles of quartz and quartzite in a fine- to coarse-grained arkosic sandstone. Locally the conglomerate is very similar in appearance to the Barnes Conglomerate Member of the Dripping Spring Quartzite. In other places, it consists largely of fine- to coarse-grained arkosic sand that, except for scattered small angular to rounded pieces of quartz and granite, or some dark silty beds, could easily be mistaken for the underlying granite.

APLITE

Narrow dikes of pinkish- to yellowish-gray aplite in Ruin Granite; larger areas, shown as aplite, include porphyritic alaskite in an aplitic groundmass as well as Ruin Granite. Most of the aplite probably is related to the Ruin Granite, but some of it may be the younger aplites that cut Cretaceous granodiorite and diorite in adjacent areas.

RUIN GRANITE

Named by Ransome, (1903); same as Oracle Granite of N.P. Peterson (1938). Coarse-grained, porphyritic, pinkish- to yellowish-gray quartz monzonite, speckled with dark biotite books, as large as 5 mm, and containing euhedral, somewhat poikilitic and perthitic phenocrysts of microcline and microperthite, as large as 4x2 cm; zoned and sericitized plagioclase, mostly less than 1 cm; quartz as rounded crystals, about 6 mm, and as finer intergrowths with microcline; accessory magnetite and apatite; biotite locally altered to a mixture of magnetite and chlorite. Dikes, lenses, and irregular masses of pale-red to pinkish-gray aplitic alaskite porphyry and aplite associated with the granite. These finer grained rocks locally abundant in the granite and, because of their resistance to erosion, form many of the ridge tops. Biotite from the Ruin Granite near Oracle gave an age of 1,420 m.y. by the K-Ar method (Damon and others, 1962). According to Silver (1968), the age of granite (quartz monzonite) in Arizona, based on U-Pb isotope systems in zircon, is 1,430-1,460 m.y.

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GEOLOGIC MAP OF THE BLACK MOUNTAIN QUADRANGLE, ARIZONA

By Medora H. Krieger

REGIONAL GEOLOGIC SETTING

The broad regional geologic and structural setting of the Winkelman 15-minute quadrangle, of which the Black Mountain quadrangle is the southwest part, is discussed by Krieger (1974). Rocks within the area range from Precambrian to Holocene in age. Many of the units, however, are not now present in the Black Mountain quadrangle, and because of this, the geologic features appear structurally less complex than in the adjacent areas.

STRATIGRAPHY

The oldest Precambrian rocks in the area of the larger scale index map are the Pinal Schist and intrusive rocks, largely the Ruin Granite (Oracle Granite of N.P. Peterson, 1938). Batholithic masses of Ruin Granite (1,430 m.y.) were intruded after a period of intense deformation that produced near-vertical east-trending foliation and bedding in the schist. The schist and granite are overlain with profound angular unconformity by Precambrian sedimentary rocks--the Apache Group and the disconformably overlying Troy Quartzite. Diabase, about 1,200 m.y. old (Silver, 1960; Damon and others, 1962), forms sills in the Apache Group and Troy Quartzite, sill-like masses in the schist and granite generally parallel to, and not more than 500 feet below, the pre-Apache surface (Shride, 1967, p. 56), and some dikes. The sills inflated but did not perceptibly tilt the Precambrian sedimentary rocks.

After a long period of erosion, Paleozoic formations were deposited paraconformably on the Precambrian sedimentary rocks. Both the Precambrian and Paleozoic sedimentary rocks have been completely stripped from the Black Mountain quadrangle.

Remnants of volcanic and sedimentary rocks, the Cloudburst Formation of Late Cretaceous age, occur in the southeastern part of the quadrangle as a thin sheet of near-vertical units emplaced by gravity sliding. Late Cretaceous diorite and Late Cretaceous and(or) early Tertiary porphyry masses intrude the Precambrian granite; aplite intrudes the diorite.

Cenozoic stratigraphy in eastern Pinal County has recently been revised by Krieger and others (1973). In the areas of the larger scale index map Miocene and Pliocene sedimentary deposits, formerly called the Gila Conglomerate or Group, are now divided into three formations. In addition, Pleistocene and Holocene alluvial deposits, also formerly included in the Gila Conglomerate or Group, overlie these formations. None of the Miocene or Pliocene formations have been recognized in the area of the Black Mountain quadrangle.

STRUCTURE

The major structural features in the Winkelman 15-minute quadrangle are high-angle faults and north-northwest-trending en echelon ridges of steeply dipping to overturned Precambrian sedimentary rocks and diabase and, locally, Paleozoic rocks. As the tops of the beds in these ridges always face east, the structures are interpreted as partly eroded roots of a single monoclinal structure, or possibly a series of monoclinal structures. Locally, the section within an individual ridge is repeated along what appear on a map as high-angle faults but which are inferred to be tilted thrusts. Because the Paleozoic and Precambrian sedimentary rocks have been completely stripped from the area of the Black Mountain quadrangle, the only hint of these structures is the long north-trending dike-like masses of diabase in granite. Although they appear to have been intruded well below the erosion surface on which the sedimentary rocks were deposited, they are inferred to have been intruded as sill-like masses that were intruded not more than 500 ft. below the pre-sedimentary surface and later separated by faulting. The gravity slides that floor the Cloudburst Formation in the Black Mountain quadrangle may predate, or they may be related to post-early(?) Miocene gravity slides in the Putnam Wash quadrangle.

MINERALIZATION

The Winkelman 15-minute quadrangle, whose southwest one-quarter is the Black Mountain 7-½-minute quadrangle, is adjacent to three major copper deposits: the San Manuel to the southeast, the Christmas to the northeast, and the Ray to the northwest. Little evidence of mineralization was observed in the Black Mountain quadrangle. The mineralization is mostly associated with quartz veins in the Ruin Granite and locally in shear zones in the Cretaceous diorite.

DESCRIPTION OF MAP UNITS

SURFICIAL DEPOSITS

Qal *Alluvium (0-15 ft exposed).*—Flood-plain deposits along valley bottoms, composed of clay, silt, sand, and some gravel, largely unconsolidated

Qt *Talus deposits (0 - about 20 ft exposed).*—Veneer of rock debris derived from Pinal Schist; only deposits in sec. 27, T. 7 S., R. 13 E. are large enough to map.

Qp *Soil and gravel veneer on pediments and younger terraces (0-25 ft).*—Subangular pebbles and cobbles in a generally reddish-brown, fine- to coarse-grained matrix. Includes alluvium in valley bottoms, colluvium on slopes, and small unmapped exposures of granitic bedrock and of gravel and sand of Pleistocene age older than the pediment soils, especially in northwest corner of map area. The dark-red-brown soils were developed during one of the pre-Wisconson interglaciations.

Qg *Undifferentiated gravels.* Soil and gravel on pediments and terraces, talus, and alluvium; includes isolated exposures of older gravels and granite.

growths with microcline; accessory magnetite and apatite; biotite locally altered to a mixture of magnetite and chlorite. Intrudes Pinal Schist. According to Silver (1968), the age of granite (quartz monzonite) in Arizona based on U-Pb isotope systems in zircon is 1,430-1,460 m.y.; biotite from the Ruin Granite near Oracle gave an age of 1,420 m.y. by the K-Ar method, according to Damon and others (1962). (See also discussion of age of Ruin Granite and muscovite granite in Krieger, 1974d.)

TABLE 1—*Chemical and normative compositions of diabase.*

[Analyses W-99 and A-11 under the direction of Leonard Shapiro, methods given in U.S. Geol. Survey Bull. 1144A; Y-19-64 by C.L. Parker, methods given in U.S. Geol. Survey Bull. 1170

Field No.	W-99	A-11	Y-19-64		W-99	A-11	Y-19-64
Chemical composition (in percent)				CIPW norms (wt. percent)			
SiO_2	50.9	49.2	45.50	Q	0.5	---	---
Al_2O_3	14.5	15.9	16.69	or	7.3	5.5	10.5
Fe_2O_3	1.6	2.5	2.45	ab	21.7	23.2	26.4
FeO	9.6	8.8	10.48	an	25.4	29.1	27.8
MgO	6.4	6.9	6.07	wo	8.5	7.7	2.7
CaO	9.4	9.7	7.28	en	16.3	12.8	1.9
Na_2O	2.5	2.7	3.02	fs	15.2	9.1	1.6
K_2O	1.2	.91	1.72	fo	---	3.3	9.6
H_2O	.25	.19	.25	fa	---	2.6	9.1
H_2O+	1.9	.81	2.90	mt	2.4	3.7	3.7
TiO_2	1.1	1.3	2.79	hm	---	---	---
P_2O_5	.15	.20	.44	il	2.1	2.5	5.5
MnO	.19	.17	.19	ap	.4	.5	1.1
CO_2	.16	<.05	.01	cc	.4	---	.02
Cl	---	---	.19	Total[1]	100.20	100.00	99.92
F	---	---	.05	Salic	54.8	57.7	64.8
Sub total	---	---	100.03	Femic	45.2	42.2	35.2
Less 0	---	---	.06				
Total	100	99	99.97				

[1]In calculating the norms, both H_2O+ and H_2O- were omitted

W-99 - Black Mountain quadrangle, Bloodsucker Wash, SW¼ sec. 22, T. 7 S., R. 14 E.

A-11 - Younger sill, 12 ft above base, west side of Aravaipa Canyon, southeast of Brandenburg Mountain, Brandenburg Mountain quadrangle; data from C.T. Wrucke (written commun., 1970).

Y-19-64 - Chilled border, lower contact of 780-foot sill, Gila County; data from A.F. Shrider (written commun., 1968).

dg DIORITE GNEISS

A hybrid gneiss; fine- to medium-grained, nearly white and olive-gray, sheared and foliated to cataclastic gneiss and augen gneiss. Composed of plagioclase, biotite, chlorite, epidote, quartz, opaque minerals, and sphene. Probably mostly Ruin Granite contaminated with some Pinal Schist north of Rincon Ranch and Pinal Schist with some granite southwest of the Ranch.

pa PINAL SCHIST

Named by Ransome (1903). Character of original sedimentary and volcanic(?) rocks uncertain because of subsequent injection by granite, aplite, and vein quartz, preceded or followed by shearing. Much of the Pinal is a medium-light-gray schist, augen gneiss, migmatite, and locally a spotted schist. Some light-colored layers, lenses, and augen are of granitic material, but many are of quartz grains, some of which may represent original sandy beds and lenses; some probably is a quartz porphyry with 5-10 mm euhedral, somewhat strained quartz phenocrysts. Some probably was a conglomerate with 1-4 cm quartz and (or) quartzite pebbles. The matrix in most of these rocks is fine-grained and composed of quartz and sericite with or without biotite or chlorite and some epidote and calcite. Magnetite metacrysts(?) (3 mm) and biotite and muscovite metacrysts (5 mm) are common.

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Qsg SAND AND GRAVEL (AT LEAST 200 FT)

Poorly exposed, essentially unconsolidated gravel and sand along eastern and western edges of the quadrangle. Deposits in eastern part are composed largely of granitic rocks. Those in western part also contain abundant clasts derived from Pinal Schist, diorite gneiss, and, in northwest part, from the Cretaceous diorite. Isolated exposures with steeper dips may be older gravels.

DIKES

Tkly *Quartz latite or rhyolite porphyry.*—Rhyolite to quartz latite in composition. White to very light gray, very fine grained (probably originally aphanitic to glassy); with widely scattered phenocrysts (1-2 mm in diameter) of sericitized sanidine, making up perhaps 10 percent of the rock, less common quartz, in a groundmass of quartz, K-feldspar, sericite, and goethite or limonite specks. Age unknown, but rock does not resemble the less altered Miocene rhyolite dikes in the Putnam Wash quadrangle (Krieger, 1974d). Tentatively correlated with the younger quartz latite porphyry of Late Cretaceous and (or) early Tertiary age in the Crozier Peak quadrangle (Krieger, 1974b).

Tkap *Aplite.*—Light-colored aplitic to pegmatitic dikes intruding diorite. Some of the aplite mapped as Precambrian may be in this group

Tkh *Hornblende porphyry.*—Fine-grained rocks that range from andesite to melanocratic rhyodacite. Mostly olive- to greenish-gray, porphyritic to nonporphyritic rocks with needle-like laths of hornblende from slightly larger than groundmass size to rarely 2 mm long. Numerous very small unmapped dikes of this sort intrude Ruin Granite east and south of Black Mountain.

Tkr *Rhyodacite porphyry.*—Light-olive-gray and pale-olive to dusky-yellow rhyodacite porphyry. About 20 to 30 percent of rock is composed of altered plagioclase from 3 to 9 mm long. Altered euhedral hornblende and biotite phenocrysts from 1 to 2 mm long make up about 10 percent of the rock. The groundmass is aphanitic and altered.

Kdi DIORITE

Medium-dark-gray, fine- to coarse-grained, composed of plagioclase laths (zoned and locally sericitized), biotite, hornblende, magnetite, some pyroxene, and a little quartz. Some of the mafic minerals are altered to chlorite, epidote, and magnetite. Two small masses, near the south edge of sec. 32, T. 7 S., R. 14 E., are tentatively included in the diorite. Tentatively correlated with diorite in the Winkelman 7½ minute and Crozier Peak quadrangles.

Kc CLOUDBURST FORMATION (6,500 FT. EXPOSED, IF NOT DUPLICATED BY FAULTING)

Named by Pelletier (1957; see also Creasey, 1965, 1967). Mafic volcanic rocks of probable latitic composition and interbedded fanglomerate and megabreccia crop out in the southeast corner of the map area and are the northern tip of a larger unmapped mass. The Cloudburst Formation is included in the Late Cretaceous because Creasey (1965, 1967) considered it probably the same age as the volcanic rocks (Williamson Canyon Volcanics) in the Christmas quadrangle. These volcanic rocks were considered Late Cretaceous by Willden (1964) and Late Cretaceous and(or) early Tertiary by Creasey (1965, 1967). In the Crozier Peak quadrangle the Williamson Canyon Volcanics is intruded by diorite that in the Winkelman quadrangle is dated at 65 m.y. (Late Cretaceous).

Kcv *Volcanic rocks.*—Andesitic(?) and possibly latitic flows and flow breccias; the larger mass (secs. 3, 4, 9, 10, T. 8 S., R. 14 E.) consists mostly of flows to the west and of breccias with some interbedded volcanic conglomerate to the east. Flows are vesicular to amygdaloidal, grayish- to blackish-red and grayish-red-purple rocks with altered mafic phenocrysts, mostly less than 2 mm long.

Kcf *Fanglomerate.*—Subangular to subrounded pebbles to small boulders derived from volcanic rocks of the Cloudburst Formation, Ruin Granite, and locally some nongranitic clasts, including Pinal Schist and Apache Group, in a dark-reddish matrix.

Kcb *Megabreccias.*—Small lenses of megabreccia, 200 to 1,500 ft long and 50 to 300 ft wide, composed of a single rock type in an individual lens. Fragments are angular and mostly less than 2 ft long, in a finely comminuted matrix of the same material as the fragments. Ratio of fragments to matrix is high. Breccias of quartzite and granite are very well indurated.

db DIABASE

Mostly dikelike masses of dark-gray to greenish-gray or olive-gray, fine- to coarse-grained rock with diabasic to ophitic texture. Composed of plagioclase, pyroxene, olivine, magnetite, and ilmentite. Felsic dikes with hornblende needles, probably a differentiate of the diabase, in the SW¼ sec. 32, T. 6 S., R. 14 E. As most Precambrian diabase occurs as sills in, or slightly below the base of, the Apache Group, and as no Apache Group rocks are present in this quadrangle, correlation of these rocks with Precambrian diabase was originally questioned. Although the SiO_2 content is higher and the TiO_2 content lower than in known Precambrian diabase in the Salt River Canyon area (A.F. Shride, written communication, 1965), these constituents are present in amounts similar to content in known Precambrian diabase in the Brandenburg Mountain quadrangle (table 1). The diabase, therefore, is considered Precambrian; its present distribution may be due to unrecognized faults. The only faults suggested are the strands of Ripsey Wash tilted thrust (Krieger, 1974b, 1974).

t *Troy Quartzite.*—Present only as megabreccia (Kbt) in the Cloudburst Formation, where it was derived from white to light-gray, thin- to thick-bedded feldspathic to nonfeldspathic quartzite.

apl APLITE

Includes some muscovite granite and pegmatite; occurs as dikes and larger irregular masses. Many large areas are mixed zones of Ruin Granite, muscovite granite, and (or) aplite, with indefinite contacts against the Ruin Granite. Aplite dikes adjacent to rhyolite or quartz latite dikes on the east side of the Black Mountain are fine-grained granite with an aplitic texture and and with both muscovite and biotite. Some aplite is related to the Ruin Granite and some to the muscovite granite (see details of muscovite granite, Krieger, 1974d). Other aplites that have been shown as Precambrian, however, may be Late Cretaceous and(or) early Tertiary.

ru RUIN GRANITE

Named by Ransome (1903); same as Oracle Granite of N.P. Peterson (1938). Coarse-grained, porphyritic, pinkish- to yellowish-gray quartz monzonite, speckled with dark biotite books as large as 5 mm and containing euhedral, somewhat poikilitic and perthitic phenocrysts of microcline and microperthite, as large as 4 x 2 cm, locally larger; somewhat zoned plagioclase, mostly less than 1 cm, locally 3 cm, much of it sericitized; quartz as rounded crystals, about 6 mm, and as finer inter-

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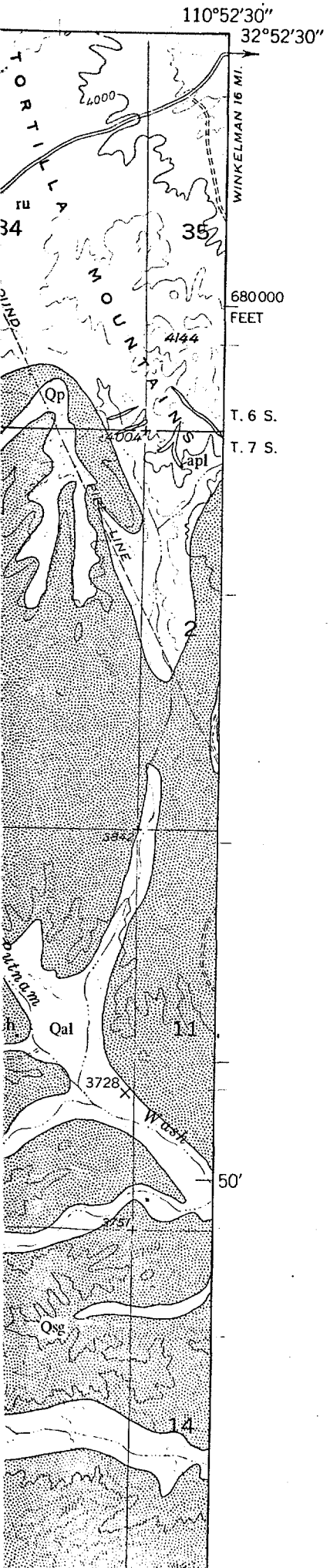
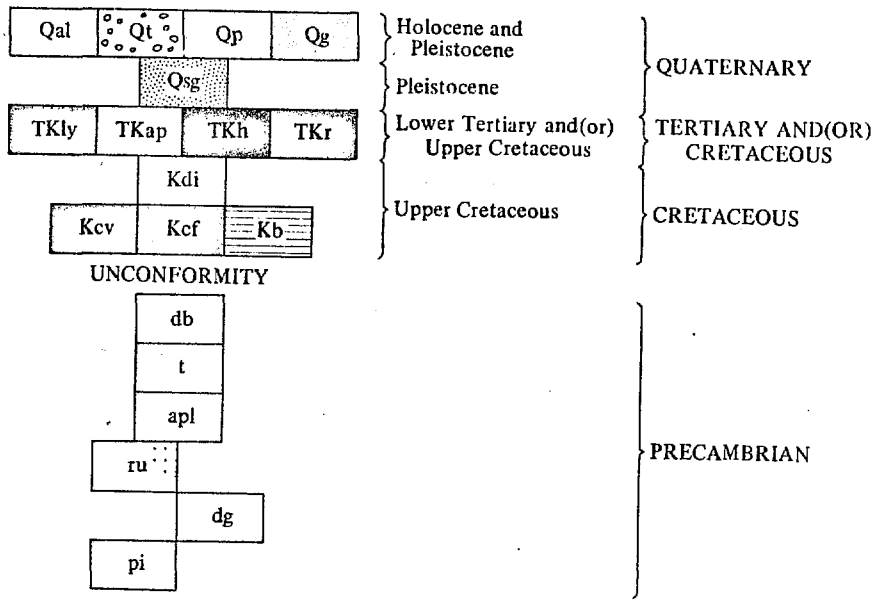


CORRELATION OF MAP UNITS



DEFINITION OF MAP SYMBOLS

SURFICIAL DEPOSITS

Qal	Alluvium
Qt	Talus deposits
Qp	Soil and gravel veneer on pediments and younger terraces
Qg	Undifferentiated gravels
Qsg	SAND AND GRAVEL

DIKES

TKly	Quartz latite or rhyolite porphyry
TKap	Aplite
TKh	Hornblende porphyry
TKr	Rhyodacite porphyry
Kdi	DIORITE

CLOUDBURST FORMATION (Upper Cretaceous)—Volcanic and sedimentary rocks and intercalated megabreccia.

Kcv	Volcanic rocks
Kcf	Fanglomerate
Kb	Megabreccia. Composition shown by map color of source rock and by the following letter symbols: Kbd, diabase Kbt, Troy Quartzite Kbr, Ruin Granite Kbp, Pinal Schist

db	DIABASE
t	TROY QUARTZITE (Precambrian)—Present only in megabreccia of the Cloudburst Formation (Kbt)
apl	APLITE
ru	RUIN GRANITE (Precambrian)—Stippled areas indicate abundant xenoliths of Pinal Schist
dg	DIORITE GNEISS
pi	PINAL SCHIST (Precambrian)

JDSell → File

ASARCO

Southwestern Exploration Division

January 28, 1977

F. T. G.
FEB 15 1977

TO: F. T. Graybeal

FROM: H. G. Kreis

Geologic Mapping
Pioneer Prospect

The Pioneer Prospect was mapped on a scale of 1" = 2,000' during late December, 1976, and early January, 1977. The area was rapidly mapped and evaluated so drilling could be completed prior to having to make large expenditures to hold the land (see "Progress Report, Pioneer-76 Prospect" dated 1-17-77).

Field data is summarized on the attached maps. Rock names, textures, ages, and alteration are tentative. Hand samples were collected so detailed studies could be made with the aid of thin sections.

The geology that remains to be done at this time includes the following:

yes a) detailed mapping and evaluation of the mineralized and altered outcrops,
yes b) more reconnaissance about the pediment area,
? c) age dates and good petrographic descriptions of Laramide type rocks, and
later d) the extent and origin of epidote alteration in the northeast corner of Section 12 (T6S, R11E) should be determined.

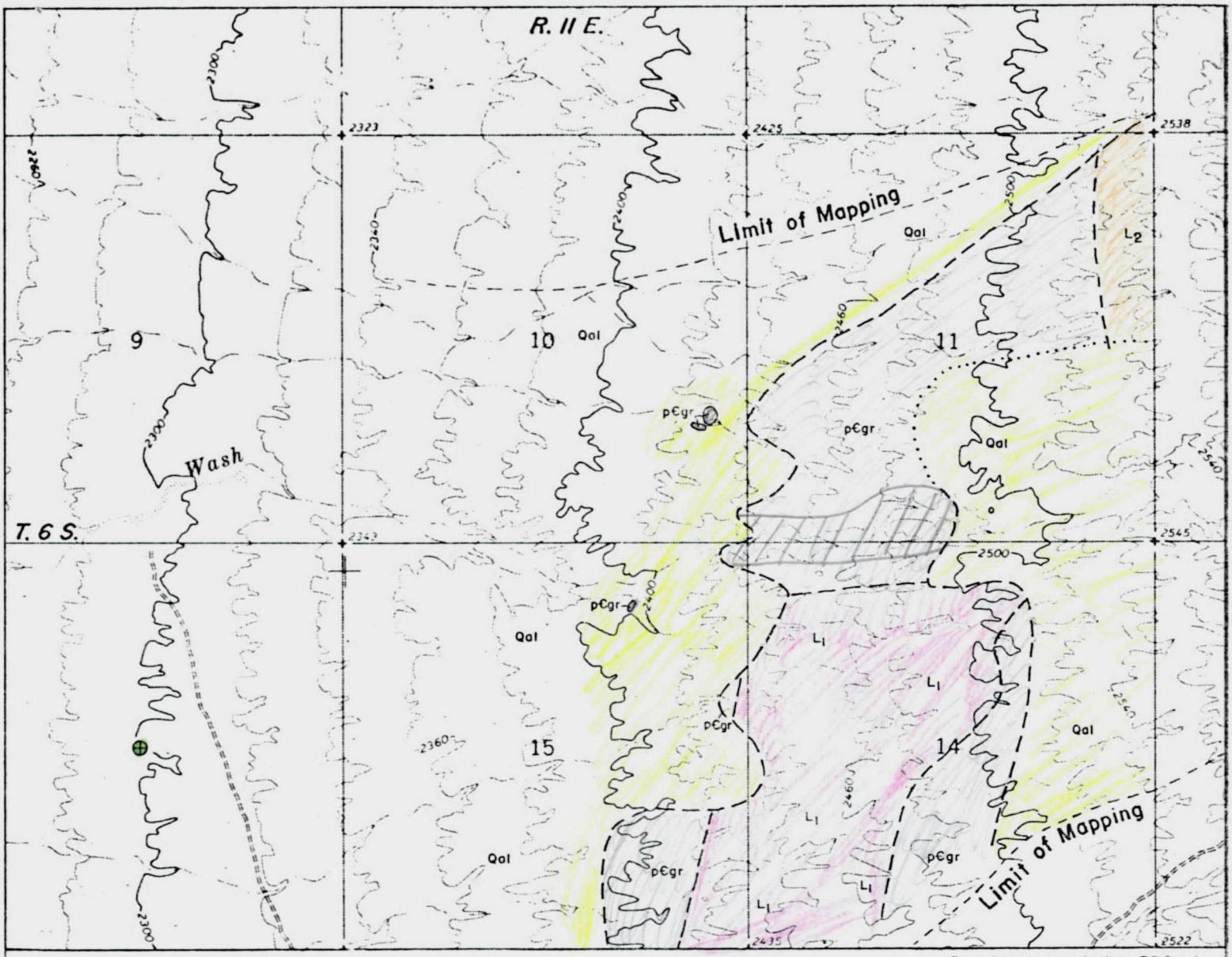
H. G. Kreis

H. G. Kreis

HGK:lb
Atts.

cc: DMSmith

Also see JHL report.



Base from Ninetysix Hills 7.5 Quad.

EXPLANATION

— MAJOR ROCK TYPES —

Qal — Post mineral alluvium, gravel & conglomerate cover.

L1 — Laramide (?) weakly porphyritic, medium-grained, equigranular rock of approximately quartz monzonite composition.

L2 — Laramide (?) medium-grained, equigranular rock of approximately biotite quartz monzonite compposition. Looks like Three Peaks rock.

pЄgr — Precambrian Oracle Granite. Porphyritic, coarse-grained quartz monzonite.

NOTE. Approximately 85% of the area shown as bedrock is covered by thin alluvium. Dikes such as porphyry & diabase dikes are not shown but are recorded in field notes.

⊕ Geodata Drill Hole

— MINERALIZATION – ALTERATION —
(SHOWN ON OVERLAY)

Moderate clay-sericite & 1-2% pyrite capping

Weak to moderate clay-sericite-epidote & ½-1% pyrite capping

Epidote & local chlorite, 1% (+), 2% (++) >3% (+++)

Fresh

TO ACCOMPANY Report

DATED Jan. 28, 1977

BY H. G. Kreis

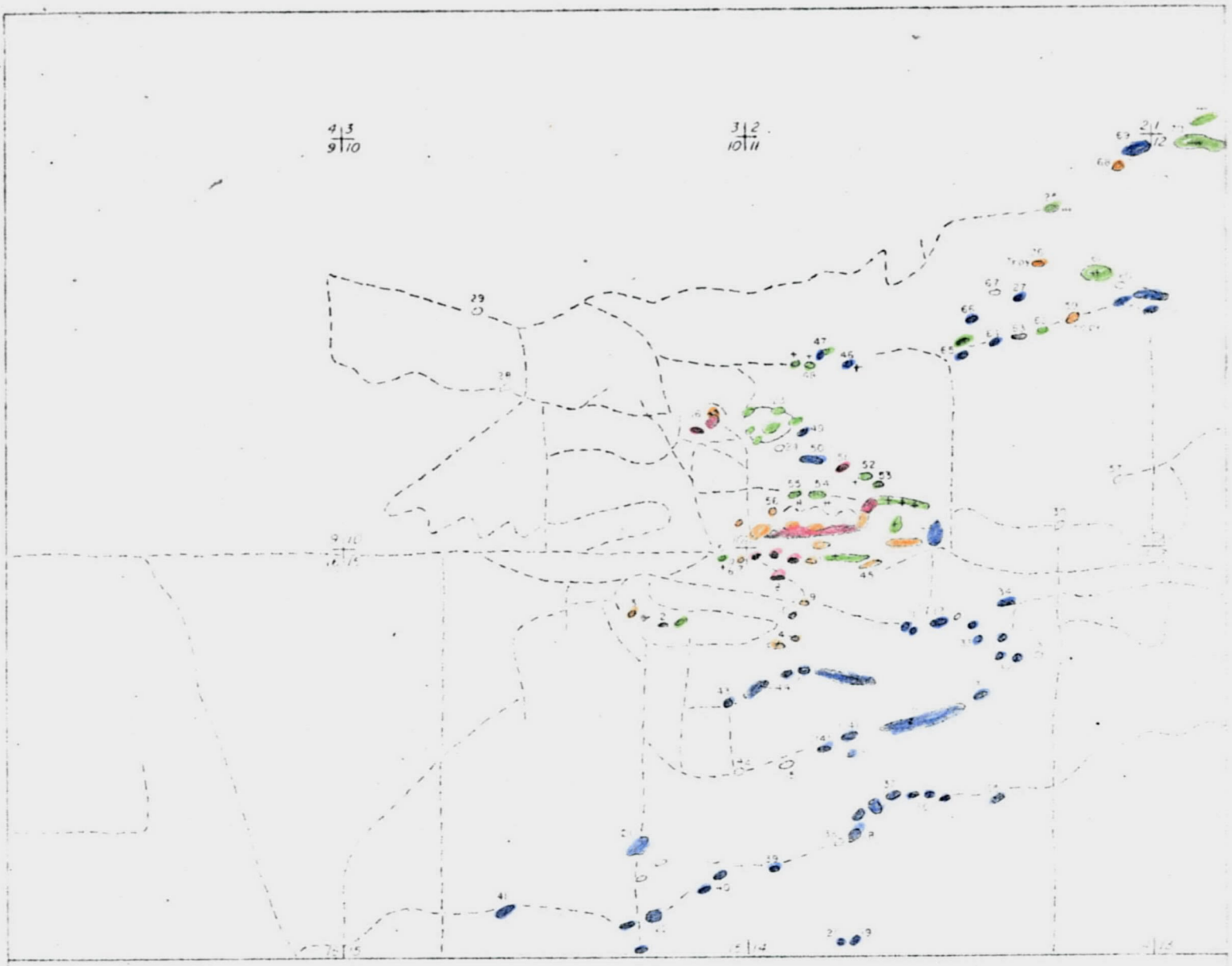
N

Geologic Map
PIONEER-76 PROSPECT
Pinal County, Arizona

SCALE: 1" = 2000'

HGK Jan. 12, 1977

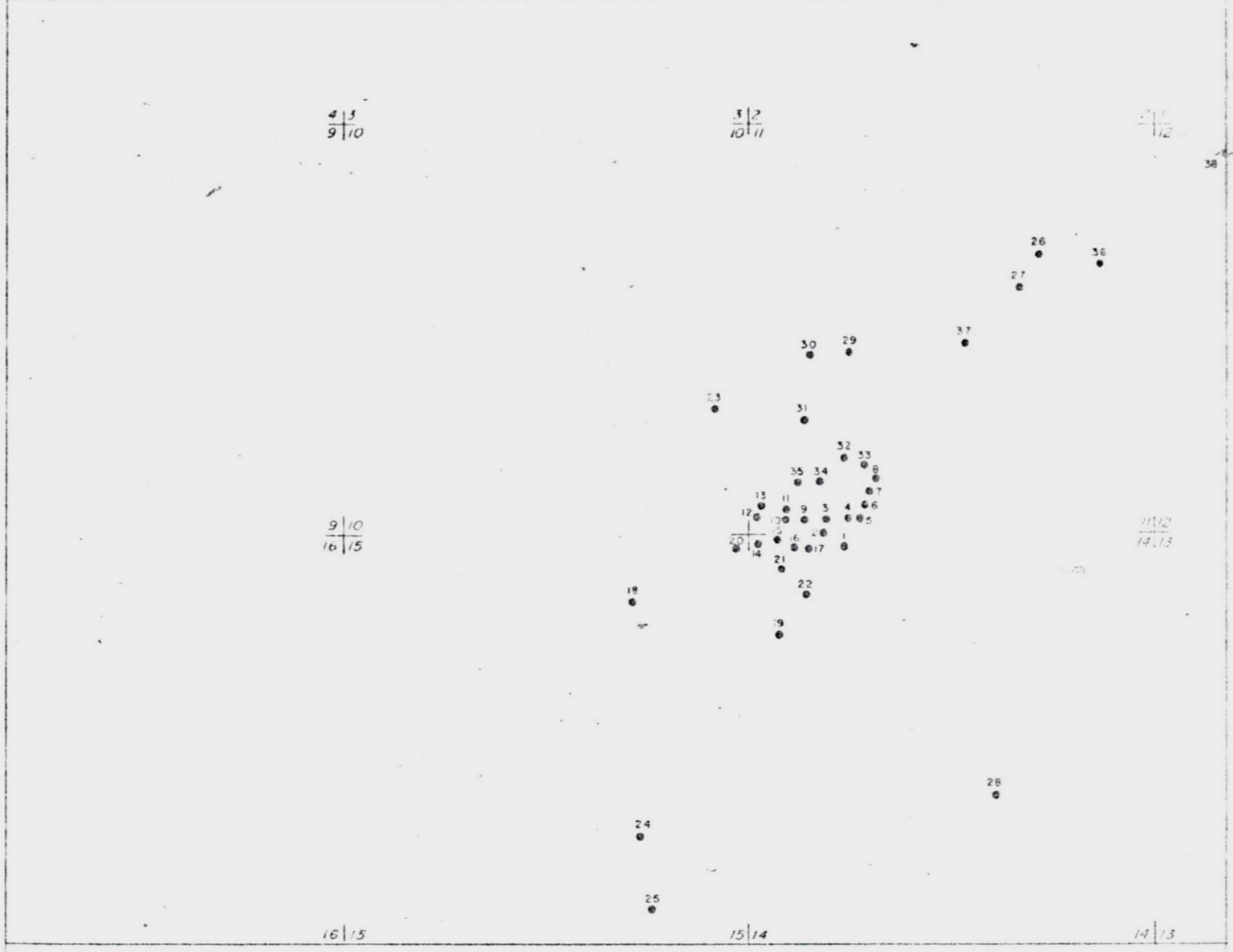
MVK-2988



Outcrops & observed alteration (see explanation of colors on geologic chart). The numbers are station locations for field notes

Field traverses over gravel & conglomerate cover

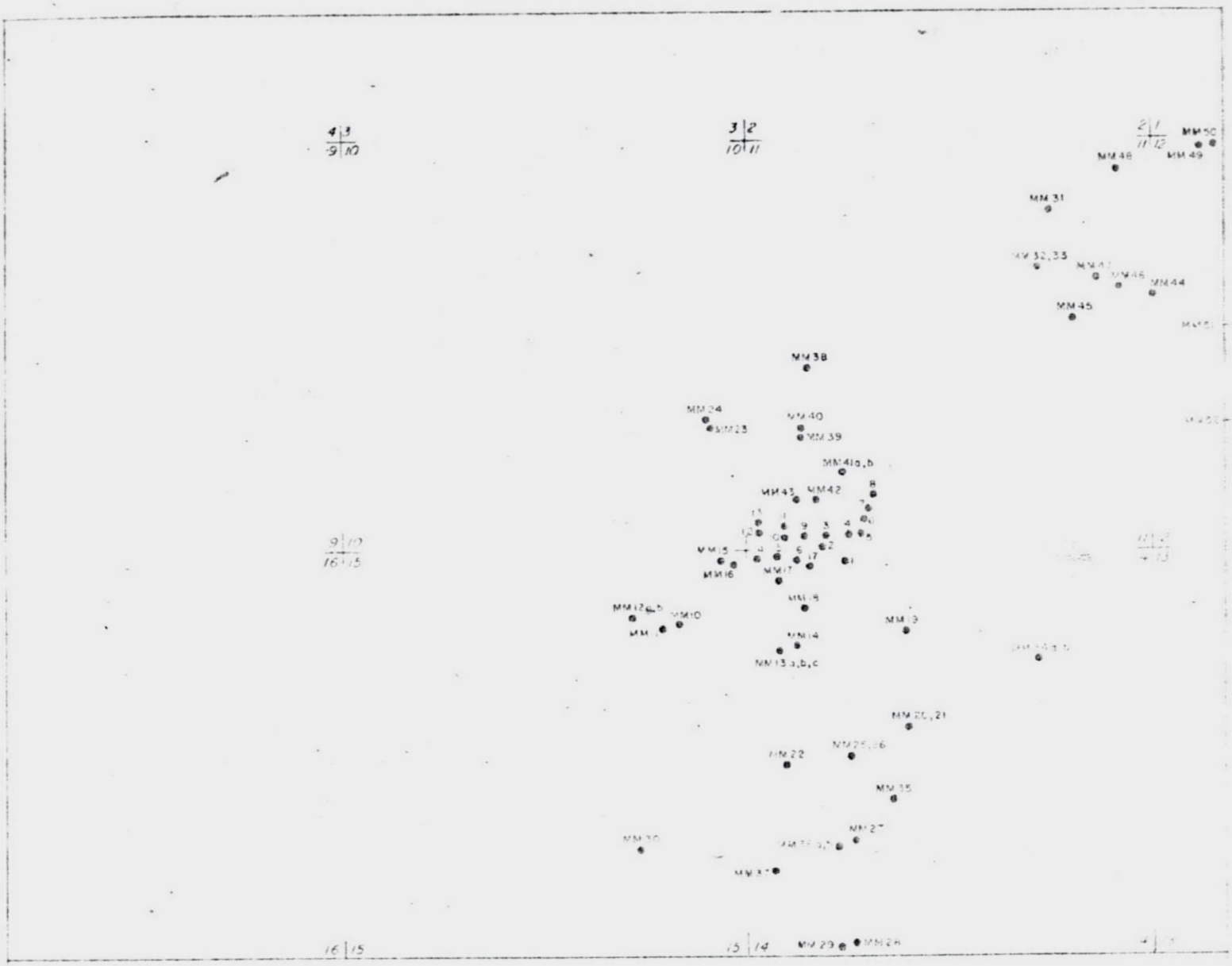
OVERLAY
TO PIONEER-76 GEOLOGIC MAP
Station Locations, Field Traverses & Outcrop Alteration



"SN" Series shown without prefix.

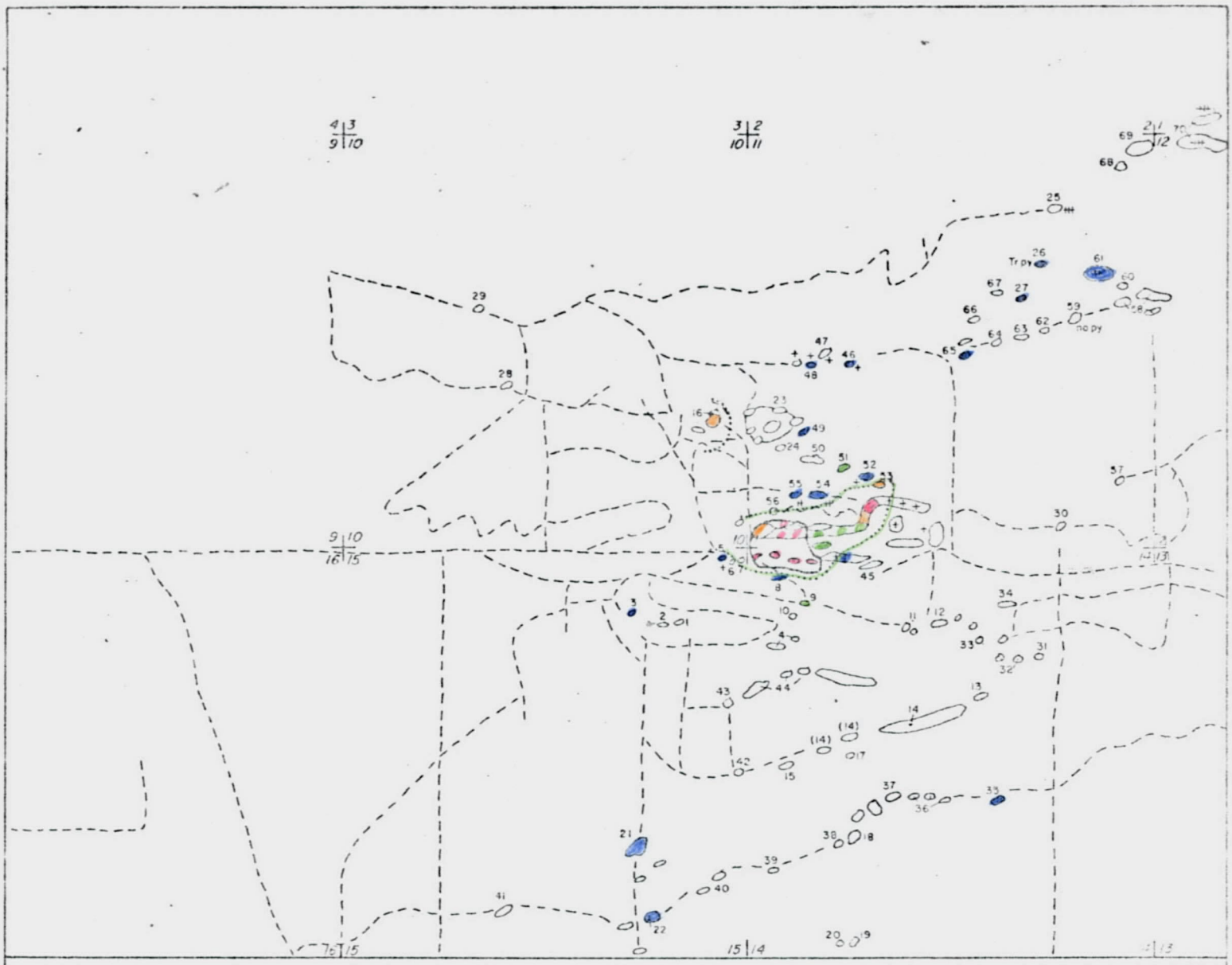
OVERLAY
TO PIONEER-76 GEOLOGIC MAP
Geochem Sample Location

MVK-2986 D



"SN" Series shown without prefix

OVERLAY
TO PIONEER-76 GEOLOGIC MAP
Hand Sample & Thin Section Location



31 Outcrops & observed alteration. (see explanation of colors on geologic base). The number is station location for field notes

Field traverses over gravel & conglomerate cover.

>90 ppm

60-90 ppm

30-60 ppm

< 30 ppm

Outline of >90 ppm Pb

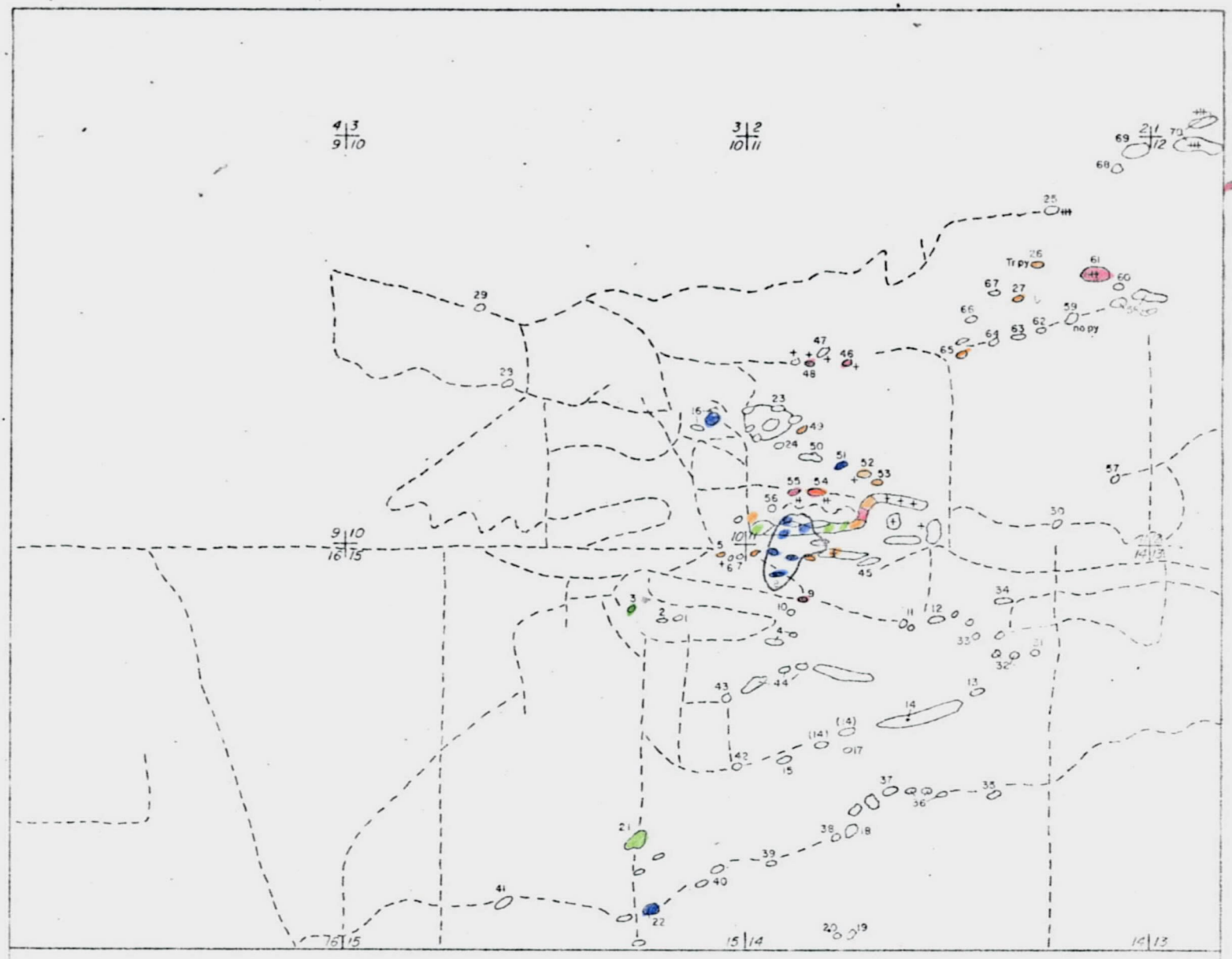
Outline of >30 ppm Pb

LEAD GEOCHEM

OVERLAY TO PIONEER-76 GEOLOGIC MAP

Station Locations, Field Traverses & Outcrop Alteration

MVK-2988 a



Outcrops & observed alteration. (see explanation of colors on geologic base). The number is station location for field notes

Field traverses over gravel & conglomerate cover.

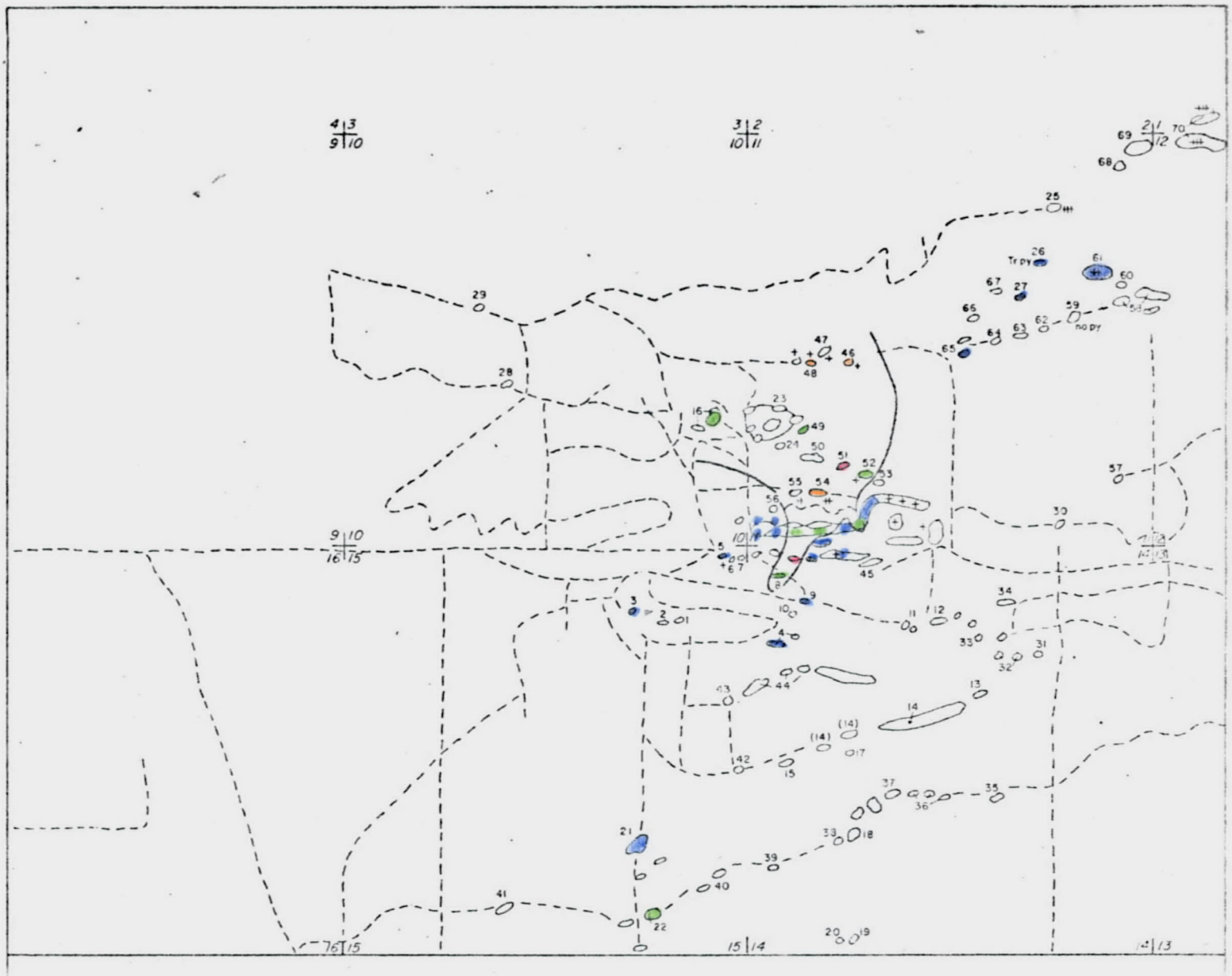
- > 50 ppm
- 35-50 ppm
- 25-35 ppm
- < 25 ppm

Outline of < 25 ppm Zn

ZINC GEOCHEM

OVERLAY TO PIONEER-76 GEOLOGIC MAP

Station Locations, Field Traverses & Outcrop Alteration



31 Outcrops & observed alteration. (see explanation of colors on geologic base). The number is station location for field notes

Field traverses over gravel & conglomerate cover.

> 10 ppm

6-9 ppm

3-5 ppm

1-2 ppm

Outline of ≥ 3 ppm Mo

MOLY GEOCHEM

OVERLAY TO PIONEER-76 GEOLOGIC MAP

Station Locations, Field Traverses & Outcrop Alteration

MVK-2988

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, Inc. DATE

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM	PERCENT IRON	
SN-1			30	17	49	2		
SN-2	.004	0.13	22	37	23	1		
SN-3	.001	0.06	70	41	26	4		
SN-4		0.08	23	56	25	2		
SN-5		0.14	21	38	43	4		
SN-6		0.07	25	79	113	2		
SN-7	Trace	0.05	19	194	36	2		
SN-8			32	63	44	2		
SN-9			21	255	22	3		
SN-10			22	711	8	1		
SN-11			19	192	10	1		
SN-12		0.05	32	286	27	2		
SN-13		0.09	31	83	37	2		
SN-14		0.02	27	110	38	3		
SN-15		0.17	25	96	13	2		
SN-16			18	1070	8	19		
SN-17			29	93	37	2		

Invoice # 14416 Anal. $147.50
Prep. 12.75

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, Inc.

DATE Jan. 14, 1977

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
SN-18			33	27	27	2		
SN-19			31	23	19	2		
SN-20			30	24	43	2		
SN-21			48	27	14	3		
SN-22			25	40	51	2		
SN-23	.002	0.07	15	68	10	3		
SN-24		0.01	17	20	30	2		
SN-25			21	25	19	3		
SN-26			22	26	43	2		
SN-27			25	22	50	2		

CHARGES $ 84.25

ASSAYER-CHEMIST

Pioneer-76

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, Inc.

DATE Jan. 25, 1977

SAMPLE-MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
SN-28			28	24	39	3		
29			27	21	57	8		
30			35	19	55	9		
31			22	22	42	4		
32			23	53	11	14		
33			21	15	36	3		
34			19	14	43	6		
35			33	25	61	3		
36			25	17	84	2		
37			28	20	44	2		
38			29	13	82	2		

REGISTERED ASSAYER 1/25/77

CHARGES $ 85.25

Ac-16A.16.0

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

May 6, 1970

Memo to: W. E. Saegart

From: W. G. Farley

Re: I.P.-RESISTIVITY
PIONEER PARKWAY PROJECT
PINAL COUNTY, ARIZONA

Introduction

On June 25, 1969 an I.P.-resistivity survey was initiated on the Pioneer Parkway Geophysical Target in a search for sulfide mineralization. This area was recommended by B. N. Watson in a memorandum to Mr. J. H. Courtright dated November 8, 1966. A copy of Mr. Watson's memorandum is attached to this report.

The target area covers (T6S, R11E), (T6S, R10E) and the south half of (T5S, R11E). This area lies approximately 10 miles southeast of the town of Florence along the Tucson-Florence Highway. The area was recommended for geophysical coverage following the discovery by an ASARCO geologist of a small hill of hydrothermal manganese oxides and blue copper stains in Section 18, T6S, R11E. A U.S.G.S. gravity map of the area suggested an extensive pediment.surrounding the subject hill, extending west to the north end of the Picacho Mountains and east to the Tortilla Mountains.

The Pioneer Parkway survey was completed on March 23, 1970. Twenty-five I.P.-resistivity traverse lines were run for a total of 188 line miles of survey. Figure 1 shows the locations of these traverse lines. Equipment used on this survey was the Hunter 7.5 kilowatt D.C. pulse transmitter and the Scintrex "Newmont Type" Receiver. All I.P. values were reduced to the Asarco Standard. Electrode configurations used on this survey were a Wenner 1000 and 2000 foot "a" and a three-electrode 1000 foot "a". Figure 2 shows the contoured I.P. and resistivity values obtained with the Wenner 2000 foot "a" and Figure 3 the contoured values obtained with the Wenner 1000 foot "a". The values obtained with the three-electrode 1000 foot "a" were almost identical to the values obtained with the Wenner 1000 foot "a", thus they have not been included in this report.

Interpretations

From the I.P.-resistivity survey in the Pioneer Parkway area, resistivity has confirmed the existence of a pediment extending from the weakly-mineralized hill in Section 18, T6S, R11E. This pediment extends eastward to the Tortilla Mountains, northward into the Price Prospect area (surveyed by Asarco in 1961 with a Wenner 1000 "a") and southward to the limits of the survey in that direction. To the west the pediment appears to be cut off abruptly by a north-south fault approximately one mile west of the weakly mineralized hill. The 400 ohm·foot contour line which is nearly coincidental on both the 1000 foot and 2000 foot Wenner is believed to mark the approximate location of the fault. West of the fault, bedrock is downdropped and beyond the reach of present I.P. which is limited to about 1000 feet of effective depth penetration. On the pediment area surrounding the weakly-mineralized hill, I.P. did not pick up any polarizers that were thought to be coming from a sulfide source. Background I.P. values in this area ranged from less than 1 m. v/v to a maximum of 4.9 m. v/v. The higher background values are believed due to clay polarizers.

North of the Picacho Mountains, resistivity indicated a second pediment area extending northward from the mountains for several miles. The 200 ohm·foot contour line on the 2000 foot Wenner contour map is believed to mark the line where bedrock depth is approximately 1000 feet. This line would be the limit of effective I.P. investigation of bedrock with present I.P. equipment. On this pediment area background values ranged from less than 1.0 m. v/v to 4.9 m. v/v. No anomalous I.P. zones were detected that were thought to be coming from a sulfide source.

Conclusions

With the present geological and geophysical information in the Pioneer Prospect area, there does not appear to be a mineralized zone worthy of drilling. I have recommended a low-level aeromagnetic survey over this area to be flown by the Salt Lake Geophysics Department. With the aeromagnetic data some of the weak I.P. responses may or may not have additional significance. I will review the I.P.-resistivity data following the Asarco aeromagnetic survey and report any changes in interpretation if they appear to be warranted.

Wayne G. Farley

WGF:mt
Att.
cc: R.J.Lacy
W.L.Kurtz
R.van Blaricom

AMERICAN SMELTING AND REFINING COMPANY
Tucson Arizona

November 18, 1966

TO: J. H. COURTRIGHT

FROM: B. N. WATSON

PIONEER PARKWAY GEOPHYSICAL TARGET
PINAL COUNTY, ARIZONA

On helicopter reconnaissance November 14, Bill Hoskins and I landed on a small hill composed of Laramide-aged intrusives isolated by several miles of pediment cover from the nearest outcrops of Pre-Cambrian granite. This small hill is not shown on the ABM Pinal County geologic map, and the USGS has only recently made available preliminary topographic sheets for the area. We feel the pediment around this outcrop is worthy of geophysical work and, for lack of a better name, have called the area the "Pioneer Parkway" target as the Florence-Tucson highway is but two miles southwest of the subject outcrop (see Attachment A).

Several north-south trending shears in Coolidge-type granite contain hydrothermal black manganese oxides on the western half of the hill. The manganese has been mined. On the eastern side of the hill, monzonite porphyry intrudes the granite and blue copper stain was found in quartz and sericite along the contact. Copper stain was also seen in Cretaceous (?) volcanics which cap a portion of the hill.

A small knob which looks to consist of dark volcanic material — same rock as hill to south but somewhat brecciated from the air is found a mile to the north. Three and one-half miles southeast a low range of hills are composed of PreCambrian granites intruded locally by a weakly pyritized Laramide (?) quartz monzonite porphyry. Four and one-half miles to the north-northeast are found more PreCambrian granites.

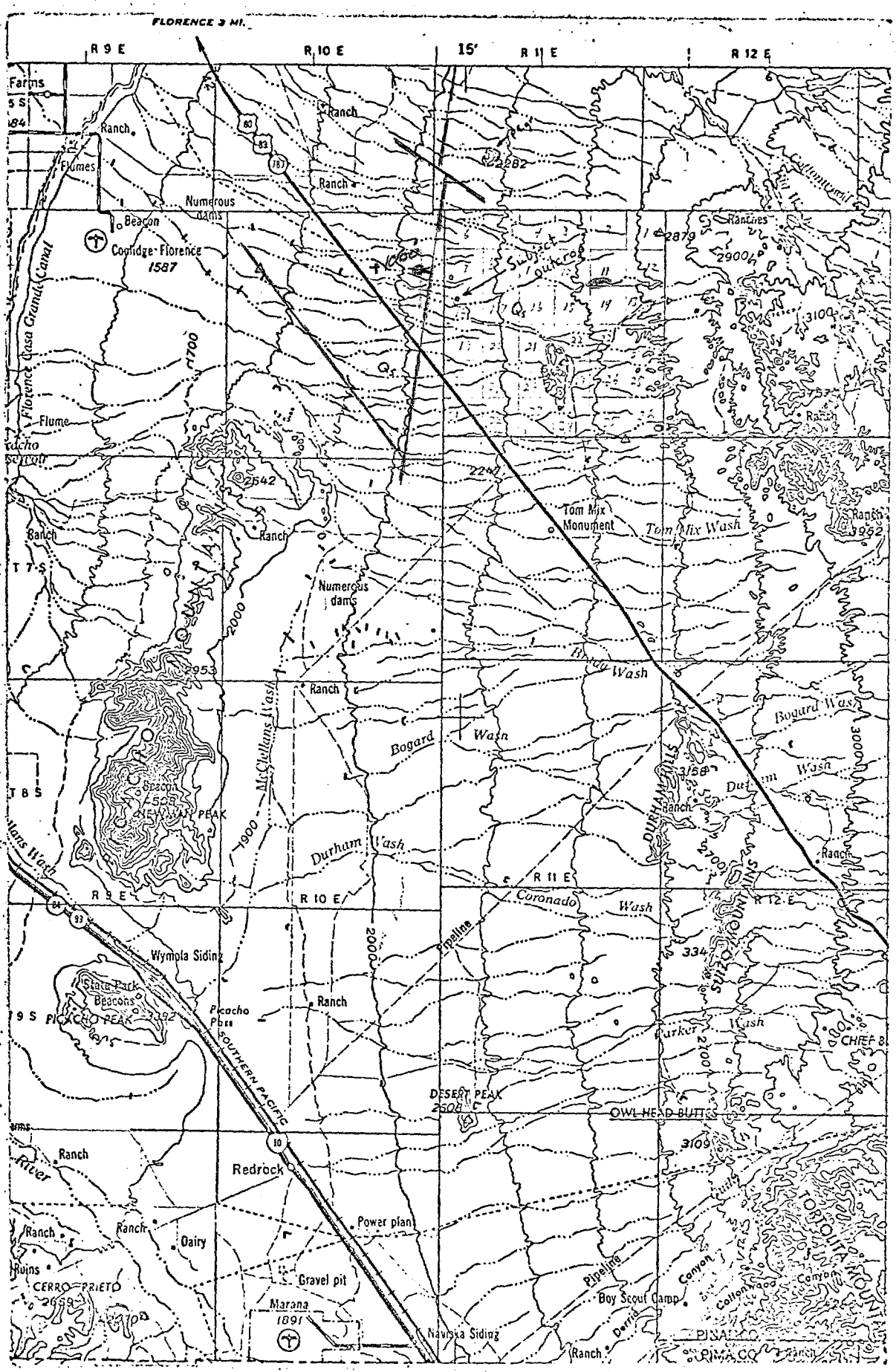
Although the monzonite porphyry intrusive is relatively fresh, the area is felt to be a valid geophysical target for 3 reasons: 1. The hydrothermal manganese deposits could be on the periphery of a mineralized zone; 2. The spotty alteration and copper staining which is not associated directly with the manganese mineralization suggests presence of copper-bearing hydrothermal fluids; 3. The existence of Laramide intrusives surrounded by pediment cover, then PreCambrian granites at some distance, present a generalized target in a region of proven porphyry copper deposits.

Mr. Wayne Farley is opening a program of I. P. geophysical exploration of pediments north of the Owl Head Buttes and I have brought this Pioneer Parkway target to his attention. He says

the area registers a gravity high making it favorable for I. P. work (cover is apparently shallow) and sees no reason why his survey cannot be extended northward to check the subject area.

Barry N. Watson
BARRY N. WATSON

BNW:pjc
Attachment
cc: WESaegart
WGFarley



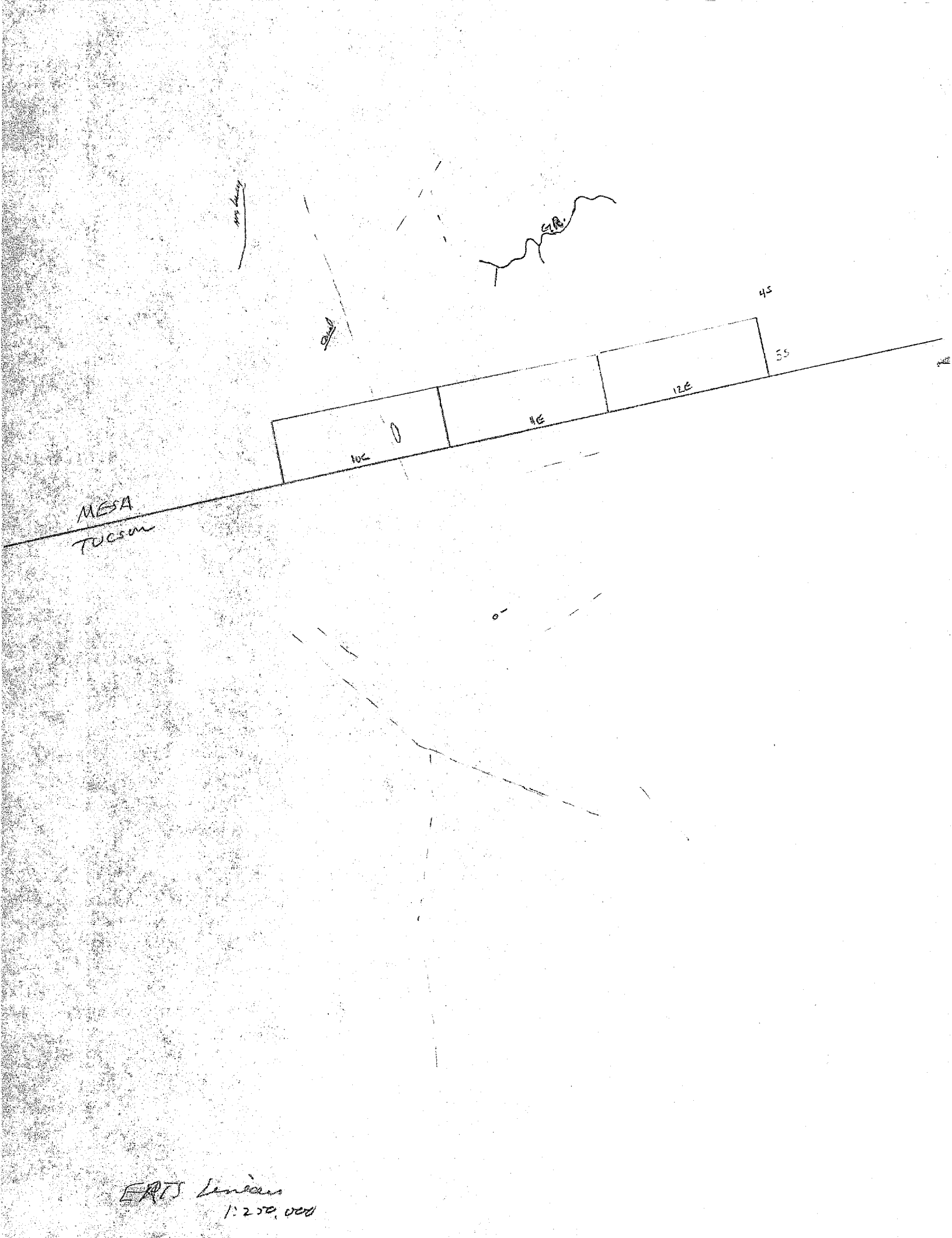
Location of Pioneer Parkway geophysical target.

See DMS for DDH's

Possible faults expressed by IP-Resestivity

WGF, May 6, 1970

HGK, Jan 28, 1977



ERTS Lineaus
1:200,000

4/11/77

FROM: F. T. GRAYBEAL

PIONEER PROJ
Pinal Cty, Ariz

TO: FILE

FTG Copy

Southwestern Exploration Division

April 4, 1977

Hole #1 should have been taken through fault zone - my fault for not clarifying all possibilities.
EOH is unmineralized, uninteresting fluid inclusions; pEgr has brown mineral which is probably recrystallized biotite typical of 2ndary biotite assoc. w. potassic alteration.
Samples of Oracle granite from Purcell window should be thin sectioned for comparison. I have several qmp dike samples from window.
Possibly JDS mapping of propylitic alteration to N. can do something with Fe/Mg ratios of chlorites
route: JDS, DMS, WLK

Drilling Results & Interpretation
Pioneer Project
Pinal County, Arizona

oping by H. G. Kreis (memo to F.T.G., EA-0113-00, was tested by one rotary itional 100' rotary holes were drilled l mining claims. Coring at the bottom a fault zone in Oracle Granite and shows traces of sericite alteration of ck displays recrystallization of its both of moderate intensity. Primary nt in quartz grains of the Oracle

My fault for not making clear not to stop hole in fault zone - FTG

oes fall within the background range s and Webb (1962).

- The drilling confirmed the existence of porphyry-copper-type alteration but no mineralization. 4000' west of the altered discovery outcrops. This prospect should be more intensively tested.

Drilling

All three holes were drilled by Shelton Drilling Company with a Failing 1500 Holemaster using the rotary and mud system. Spot cores were taken to aid in the location and identification of bedrock. Drilling of exploration hole PIO-1 (Figure 1, Table I) was commenced on February 8, 1977 and terminated on February 14, 1977. The two assessment work holes were drilled during the afternoon and evening of the 14th. Core samples for assay (Table II) were taken from the bottom of the hole. Total cost of the drilling phase of the project was $18,370.87 (Table III).

TABLE I - DRILL HOLE DATA

PIO-1 Feb. 8-14, 1977. SW1/4 S10, T6S, R11E.
Rotary: Surface to 1182.5 feet (excepting five cored intervals totalling 18.5 feet)
Core: 470-473.5, 40% recovery
740-743, 33% recovery
900-903.5, 74% recovery
908-911, 67% recovery
1177-1182.5, 42% recovery

JDS

ASARCO

Southwestern Exploration Division

April 4, 1977

TO: F. T. Graybeal

FROM: D. M. Smith, Jr.

Drilling Results & Interpretation
Pioneer Project
Pinal County, Arizona

Summary

Following reconnaissance geologic mapping by H. G. Kreis (memo to F.T.G., Jan. 17, 1977) the Pioneer Project, EA-0113-00, was tested by one rotary drill hole with spot cores. Two additional 100' rotary holes were drilled to validate a group of twenty federal mining claims. Coring at the bottom of the exploration hole was done in a fault zone in Oracle Granite and aplite. In thin section the aplite shows traces of sericite alteration of plagioclase while the Precambrian rock displays recrystallization of its mica and plagioclase sericitization, both of moderate intensity. Primary Type II fluid inclusions are prevalent in quartz grains of the Oracle Granite.

Geochemical values from both rock types fall within the background range for felsic rocks as defined by Hawkes and Webb (1962).

The drilling confirmed the existence of porphyry-copper-type alteration 4000' west of the altered discovery outcrops. This prospect should be more intensively tested.

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900-903.5, 74% recovery
908-911, 67% recovery
1177-1182.5, 42% recovery

Log: Surface-440 Gravels: weakly to moderately propylitized granitic rock, caliche, <15% fragments Fe stained.

440-780 Conglomerate: weakly propylitized granitic rock.

Core: 470-473.5 Conglomerate: well indurated, consisting of angular to subround boulders and subangular to subround gravel in buff-colored sandy matrix (80%) with calcitic cement. Fragments are gray unaltered fine-grained grd (95%) and dark greenish-brown andesite (5%).

Core: 740-743 Clay and broken boulder of light pink aplite.

780-800 Gravels: granitic rock; andesite dike (20% of cuttings).

800-920 Gravels: altered granitic rock (cuttings = 60% red-stained feldspar, 30% clean quartz, 10% weakly propylitized granite fragments).

Core: 900-903.5 Gravels: Oracle Granite and clay.

Core: 908-911 Gravels: Oracle Granite and clay.

920-1020 Gravels: weakly propylitized granite, <10% Fe stain.

1020-1040 Dike: dark greenish-black very fine-grained diorite(?), 20% red Fe stain.

1040-1140 Gravels: weakly propylitized granitic rock, dike material decreases from 40% to 10% of cuttings.

1140-1182.5 Bedrock: granitic

Core: 1177-1182.5 Light pink aplitic quartz monzonite separated by a 4" clay gouge fault zone from weakly iron-stained Oracle Granite (quartz monzonite in thin section). Mica in aplite is muscovite.

PIO-2 Feb. 14, 1977. NE1/4 S15, T6S, R11E.
Rotary: Surface to 100 feet, Gravels: fresh to moderately propylitized granitic rock. <5% red-stained feldspar.

PIO-3 Feb. 14, 1977. NW1/4 S14, T6S, R11E.
Rotary: Surface to 100 feet, Gravels: fresh to moderately propylitized granitic rock. Red-stained feldspar decreases from 30% to less than 5% of total cuttings.

TABLE II - GEOCHEMICAL AND PETROGRAPHIC DATA FROM HOLE PIO-1

Rock Type	Footage	Cu	Mo	Pb	Zn	Ag (ppm)	Au	Cu+Pb+Zn	Thin Section
qtz. monz. (aplite)	1182	35	<2	20	70	0.2	<0.02	125	X
qtz. monz. (Oracle)	1182.5	25	2	15	55	3.8	<0.02	95	X
background for felsic rocks (Hawkes and Webb, 1962)		30	1.9	48	60	0.15	0.01	138	

TABLE III - PROJECT COSTS

Field Charges	Cost	Cost/Foot
A. Direct Drilling (1382.5 feet)		
1. PIO-1 (1182.5')	$ 8,828.00	$ 7.47
2. PIO-2 (100')	550.00	5.50
3. PIO-3 (100')	550.00	5.50
B. Site Preparation and Cleanup	822.50	0.59
C. Field Administration		
1. Supervision and reports	3,216.59	2.33
2. Assaying and Petrography	204.38	0.15
3. Miscellaneous	1,639.40	1.18
4. Rental Payments (land)	2,560.00	1.85
TOTAL EXPENDITURES	$18,370.87	$13.29
Authorization EA-0113-00	17,000.00	
Overexpenditure	$ 1,370.87	

Petrography and Interpretations

Examination in thin section of the two rock types cored at the bottom of hole PIO-1 indicates that phyllic alteration although weak does indeed extend west of the discovery outcrops.

The Oracle Granite (actually a quartz monzonite) displays sericite-clay alteration of 40-50% of the plagioclase population, but less than 5% of the orthoclase. About half of the biotite is recrystallized. Primary fluid inclusions are abundant in quartz phenocrysts with Type II > Type I > Type III. Daughter products consist primarily of the opaque and prismatic crystal varieties.

The aplite was found to be a remarkably fresh quartz monzonite having a microgranitic texture. Less than 5% of the plagioclase has altered to a clay-sericite mixture. Accessory muscovite is unaltered. Primary fluid inclusions are rare and too small for good viewing.

Several traverses across S.2 and the northern half of S.11 (Figure 2) indicate a rather large area of propylitic alteration spacially related to EW trending feldspar porphyry andesite dikes. In the andesite hornblende and biotite are completely altered to calcite-chlorite-clinozoisite and plagioclase is more than 70% replaced by sericite. Biotite in the adjacent granitic rocks (not examined in thin section) is chloritized and epidote is common as veinlets and coating joint surfaces.

Miscellaneous Mapping

The ten-foot-wide massive quartz vein located in the north-central part of S.2 is weak to moderately stained with hematite, but carries only trace amounts of green copper oxides. No boxworks were found.

Small outcrops of bedded Whitetail-type conglomerate were mapped in the SE1/2 S.10 and center of S.11. Both strike to the northwest and dip about 45°NE suggesting that Late Miocene or younger faulting was active in the area.

Recommendation

Outcrops of strong phyllic and propylitic alteration on the Pioneer Project area imply that a porphyry-copper-type hydrothermal regime was active in the area. Late Tertiary faulting may have tilted the resultant deposit 45° to the northeast giving it a 45° dip to the southwest. The possibility of a buried porphyry system must be tested.

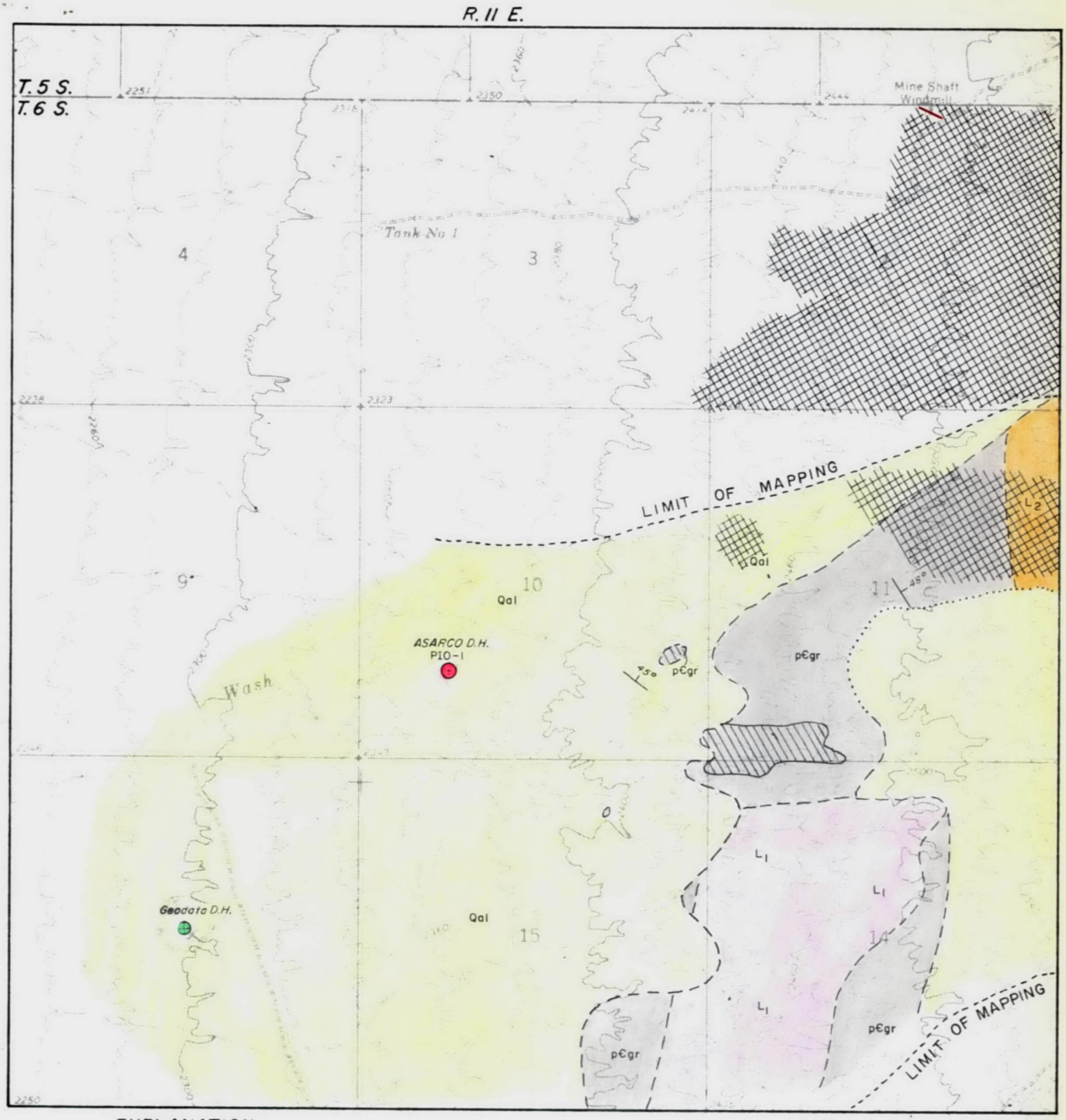
Mapping to be done by Jim Sell in the near future will tie Pioneer into the regional geologic picture and perhaps shed new light on the conclusions reached thus far by Hank Kreis and myself. At such time as surface studies can be termed complete at least one deep (3000-5000 ft.) hole should be drilled to seek out a blind ore zone.

Douglas M. Smith, Jr.

Douglas M. Smith, Jr.

DMS:lb
Atts.

cc: JDSell
HGKreis



EXPLANATION

Qal	Post mineral cover
L1	Laramide (?) quartz monzonite
L2	Laramide (?) biotite quartz monzonite
pЄgr	Precambrian Oracle Granite
	Quartz vein
	Moderate & weak clay-sericite-epidote alteration & ½ to 2 % pyrite capping
	Moderate to strong propylitic alteration
45°	Location, strike & dip of conglomerate outcrops

Base from Nientysix Hills NW 7.5 Quad.
Geology modified from Kreis (1977)

Note: Approximately 90 % of the area shown as bedrock is covered by thin alluvium, Dikes such as perphyry & diabase dikes are not shown.

TO ACCOMPANY Report

DATED April 4, 1977

BY R. M. Smith Jr.

Summary Map

PIONEER PROSPECT

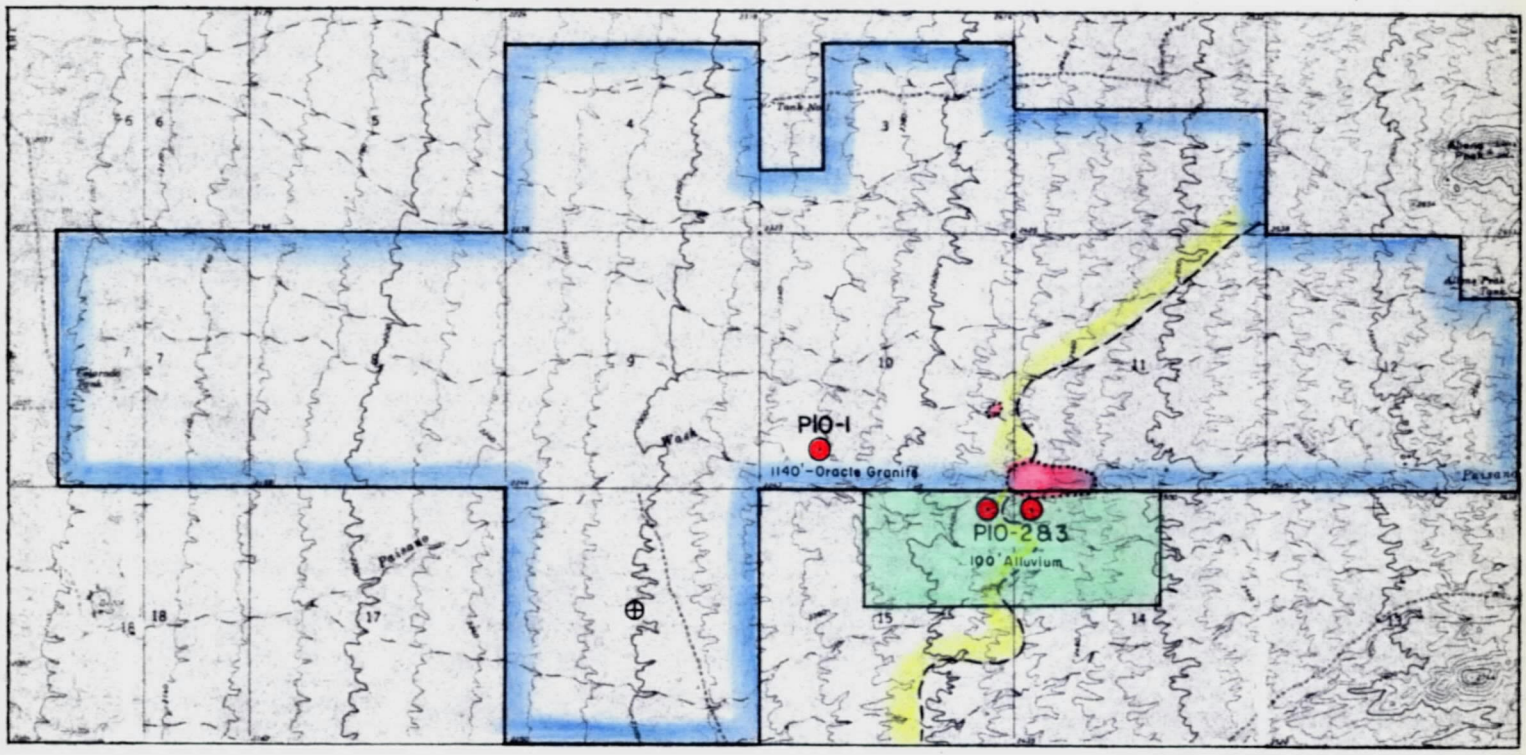
Pinal County, Arizona

SCALE: 1" = 2000'

DMS April, 1977

MVK-2987-A

T. 6 S. R. 11 E.



Base from Ninetysix Hills 7.5' Quad.

EXPLANATION

ASARCO Federal Lode Claims (Validated)

ASARCO-Arizona State Prospecting Permit

PIO-1 Current ASARCO Drilling (showing depth to bedrock & rock type)

⊕ Geodata drill hole

Pioneer-76 prospect

Western edge of continuous outcrop

N

TO ACCOMPANY Drilling Report

DATED March 31, 1977

BY D.M. Smith Jr.

ASARCO LAND STATUS

PIONEER PROJECT

Pinal County, Arizona

0 ½ 1 mile

RBC-HGK Jan. 19, 1977

Revised March 22, 1977

MVK-2989

ASARCO

Southwestern Exploration Division

May 18, 1978

TO: F. T. Graybeal

FROM: J. D. Sell

Ninetysix Hills SW Quadrangle
Regional Mapping
Pinal County, Arizona

SUMMATION

The 7-1/2 minute Ninetysix Hills SW quadrangle (Fig. 1) has been mapped as a part of the Pioneer project within the greater Kelvin-Red Hills-North Star-Tortolita problem.

The main features which have been mapped within the quadrangle include:

1) A muscovite-rich granite (Middle Mountain granite of probable Precambrian age) having an equigranular texture suggesting a deep level exposure.
2) A number of dikes of different textural characteristics (probably all from a differentiating Laramide pluton) cut the muscovite granite. The dikes have a weak and variable alteration-fluid inclusion constituency.
3) A probable late Laramide granite with an overprint of a gneissic, cataclastic, deformation phase.
4) An extension of the mid-Tertiary Samaniego granodiorite complex (border phase and dike) which is the suggestive causative source for the overprint gneissic-cataclastic phenomenon.
5) A late Miocene(?) or younger Palo conglomerate containing gneissic granite, hornblende volcanic, and other volcanic clasts, with the unit being involved in large-scale tilting.
6) Minor copper oxide is found mainly associated with quartz granite aplite pegmatites and/or fault structures.
7) Hematite, in pseudo-leached capping texture, on shears, fractures, and slips in generally crushed or brecciated blocks, is found in several zones within the Laramide gneissic granite phase and in general proximity to outcrops containing diabase dikes or masses.
8) Tourmaline is found as clots and disseminated rosettes within the westernmost outcrop of Middle Mountain granite.

RECOMMENDATIONS

Mapping should be carried on in the northern quadrangle (Ninetysix Hills NW), which contains the Pioneer prospect, as time and personnel become available. As expressed by H. G. Kreis (1977), the additional study of the entire region and especially the dating of suspected Laramide intrusive units will provide the necessary information to tie the history of the region together and place the outcrops of favorable or potentially favorable units into a meaningful relationship. The mapping can be accomplished quadrangle by

quadrangle -- the four Ninetysix Hills quadrangles and the Paisano Hills portion of the Cactus Forest quadrangle -- which, added to the quadrangle mapping by Asarco and the USGS to the north and the USGS to the east and south, will provide the base for resolving the numerous problems now known to be present in the greater Kelvin-Red Hills-North Star-Tortolita region.

Around the Pioneer prospect are several small outcrops of tilted conglomerates which resemble the extensive outcrops of Palo conglomerate to the south and are undoubtedly related. Both groups of conglomerates are tilted steeply to the east and indicate that the Pioneer area is within a tilted fault block with ramifications of the Red Hills problems to the far north.

The low geochemical values in the hematite-limonite of the Pioneer outcrop area are comparable to those of the hematite zones in the SW quadrangle. The brecciated and broken character of the rock units of the hematite zones is also characteristic in both areas. The association of diabase dikes near to the hematite zones in the SW quadrangle suggests a possible genetic relationship. Diabase is found within, south, and east of the Pioneer outcrop and further study is recommended on this relationship.

The rather extensive and complex dike systems found in the southern end of the Middle Mountains extend into the NW quadrangle but apparently are less in number. This complex coupled with the tourmaline addition and the red color impartation to the western outcrops in both the SW and NW quadrangles hint at far more activity, which is commingly associated with porphyry copper systems, than has been previously noted for this section of Arizona. Continued investigation of this phase is warranted. Although the manganese workings in the Paisano Hills are located 2-1/2 miles NNW of the northern end of the Middle Mountains, this mineralization may also be related to the igneous dikes-tourmaline system mentioned above.

ROCK UNITS AND PETROGRAPHIC SAMPLES

A number of rock samples were collected for petrographic determination and some were assayed geochemically. Table One lists the assay (A) and thin-section (T) samples from within the quadrangle, as well as those secured outside the 96 Hills SW quadrangle. A number of additional samples had been previously collected for study of the various phases of the Grayback granodiorite in the quadrangles to the north. All of these thin sections are stored together under the 96 Hills label.

Mapping of the Ninetysix Hills SW quadrangle was completed at the map scale of 1:24,000, and the compilation is submitted as Attachment A. The main units include the Precambrian Pinal Schist and Middle Mountain granite with several dike units; the Laramide gneissic granite and a half dozen dike units; and the Tertiary Samaniego granodiorite complex and the Palo conglomerate along with a hornblende dike. Various types of alluvial fill material were also noted but not mapped.

Descriptions of the units at various outcrop locations, from oldest to youngest, are recorded in Table Two and listed on the Legend of Attachment A.

MINERALIZATION, ASSAYS, AND BLACK SAND

Mineralization is sparse within the quadrangle. Noted copper oxide was found in two areas within the Fletcher Tank Hills in the southeast portion of the map. Both were associated with quartz near a quartz-feldspar pegmatite zone. Also in the west side of the Middle Mountains (north central portion of the quadrangle) is a minor show in a quartz-sericite shear near a diabase mass. Within the Laramide gneissic granite near sample site AT-96-10, center portion of Sec. 31, T6S, R12E, is a limited amount of copper oxide-silicate in fractures, along a fault zone, and in breaks with copper stain soaking into the tectonic breccia fragments along the fault.

Also in this latter area is a zone of general hematite coatings with the copper oxide as well as within the adjacent fractured gneissic granite. At sample site AT-96-19, a mile southeast of site #10, is a small outcrop having maroon limonite on fractures cutting gneissic granite and a disrupted diabase sill. These fractures and cross-shears strike N30°-40°W and dip vertically to 45° east and west. The outcrop is moderately altered with clay and silica additions.

The isolated hill in Sec. 33, T6S, R11E, of the Middle Mountain area has a general reddish coloration as a result of biotite destruction and breakdown of the tourmaline content of the unit. A similarly colored hill lies to the northwest in the adjacent quadrangle. The tourmaline rosettes are unusual for rocks in this part of Arizona and may suggest a fluorine increase in this type of granite.

As noted under Petrography (Table One), several of the dike types in the Middle Mountain area are rust-stained and show pyrite pseudomorphs in thin sections.

In the east side of Middle Mountain (NE1/4 NW1/4 of Sec. 34, T6S, R11E) on the south side of a diabase mass is a zone of carbonated Middle Mountain granite. The carbonated zone (sample AT-96-7) is a porous zone of calcium carbonate replacement of feldspars and has a variable amount of shiny black manganese. The zone is 20-30 feet wide on the south side and trends north-south to north-northwest. To the south it terminates in granite at about the projection of the east-west swarm of andesite dikes. Northward the carbonate-manganese splits around the diabase dike and extends for some distance along the west side of the diabase before becoming a mixed rubble of carbonated granite and oxidized andesite dike (of the T-96-6 affinity). (Further north the andesite dike becomes an entity within the granite bedrock.) The east split of the carbonate-manganese follows the southeast side of the northeast spur of diabase to the northeast where both give way to the extension of granite aplite pegmatite. Based on the general association of diabase with the carbonate-manganese, it would appear that the diabase may be the causative force.

As noted previously, Table One notes which samples were geochemically assayed. Table Three is the AARL Geochemistry report sheets with the values determined.

The entire quadrangle is covered by placer claims of the Great Western Corporation for the magnetite or black sand content of the alluvial units. The best surface examples are in the southeast quarter of the map and the Red Rock Mine is a black sand recovery area. The separation plant is located at the landing strip area in the lower right part of the map. The main drilling and evaluation are east of the map area.

In the March 2, 1978 copy of The Northern Miner is an article by D. F. Strong which discussed the mineralization associated with "2-mica" granites of lower Paleozoic age; tin-tungsten-uranium-fluorite-beryllium-molybdenum-antimony-bismuth being commonly associated with the granite, and the first three named being in general the most economic. A copy of the article is attached as an addendum (Att. B). The possible association in the 96 Hills SW (and NW) area would be with the reddish tourmaline-bearing granite masses in the western portion of the Middle Mountain granite mass. The sample AT-96-1 is the only sample originally assayed of the reddish phase and it showed no increase in the molybdenum content over other samples in the granite. The other assayed samples in the white-phase granite were AT-96-7 and AT-96-8. Only the carbonated manganese-bearing sample (-7) had a minor increase in moly and slightly more lead-zinc (Table Three sheets). No increase in uranium count was found when hand-specimens of both phases of granite were scanned. Future investigations of these granites, and especially in the Paisano Hills to the north, should include a spectroanalysis of the sample types in checking for unusual elements.

DRILL HOLES

A rotary-type drill hole, possibly to check for the black sand content, was found in the northeast corner of Sec. 36, T7S, R11E. The site was clean and suggested only a minor amount of drilling.

H. G. Kreis (verbal) reported the drill hole in the southwest corner of Sec. 9, T7S, R11E. It was apparently drilled by an exploration company as part of their claim assessment and reported to be 1500 feet deep. Only schist gravel type material is suggestive from the available spoil piles.

STRUCTURAL INTERPRETATIONS

The eastern part of the area is a portion of the 96 Hills SE and Tortolita complex which has been effected by a mid-Tertiary heating-metamorphic event. This event has been discussed by Creasey, et al (1976) and Banks, et al (1977). Sell (1977) related a portion of this event to the possible relationship of minor copper mineralization in the Owl Head District to the south. Other companies (Conoco-St.Joe) have also checked these thermal event centers throughout central Arizona, as a possible mechanism-source-remobilization-wall rock trap for uranium mineralization.

The heating-metamorphic event has been dated as between 22 and 24 m.y. The unmetamorphosed Palo conglomerate apparently overlies these metamorphic units mapped as Laramide gneissic granite on Attachment A. The high dips determined on the Palo conglomerate beds suggest that they and the underlying granitic units have been involved in large-scale tilting of the involved

blocks. This tilting is probably of the same style and possible magnitude as suggested for tilted units in the adjacent quadrangles to the north and south. The sample of Tertiary basalt (T-96-13), from the Tortolita quadrangle to the south, has an age date of 21 m.y. (Banks, et al [1977]). These dikes are vertical and intrude part of the mid-Tertiary heating-metamorphic terrain. Thus this would suggest that the age of the tilting and the Palo conglomerate is probably in the narrow range between 22-24 m.y. and the 21 m.y. date. However, as the conglomerate contains fragments of basalt-looking units, as well as the needle hornblende volcanic dike units, this line of reasoning would suggest that the Palo conglomerate is younger than 21 m.y., and as it has been involved in the tilting then the tilting is also younger than 21 m.y. Thus the present mapping cannot resolve this apparent discrepancy of event-timing.

Within the Middle Mountain area, the dikes noted tend to have a very steep dip -- suggesting that this area was not involved in rotational tilting. Also the large expanse of similarly textured, double mica granite suggests that the block is of a deep erosion level.

RECENT U.S.G.S. MAPPING

Yeend, et al (1977) recently published a map of the Ninetysix Hills quadrangles at the scale of 1:62,500. The mapping was very rapid and only gross features recorded. They included the Middle Mountain granite with their Laramide granite further east and north and equated them with the Laramide Tea Cup Granodiorite of the Grayback quadrangle. They indicated no dikes within the Middle Mountain area and did not note the Pioneer outcrop. They split out a few conglomerate outcrops which may in part be my mapped Palo conglomerate, but they also included abundant alluvial rubble-type deposits within their conglomerate label. This mapping (and the adjacent Picacho quadrangle to the southwest) is probably the most useless and uninformative mapping released by the U.S.G.S.

James D. Sell

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Atts.

References:

Banks, N.G., et al, 1977, Reconnaissance geologic map of the Tortolita Mountain quadrangle, Arizona: U.S.G.S. Map MF-864 (1:62,500), 1 sheet.

Creasey, S.C., et al, 1976, Middle Tertiary plutonism in the Santa Catalina and Tortolita Mountains, Arizona: U.S.G.S. open-file Report 76-262, 20 p. (Note, also published in Journal of Research, U.S.G.S., vol. 5, no. 6, p. 705-717 [1977].)

Kreis, H.G., 1977, Geologic Mapping--Pioneer Project: Asarco memorandum, Jan. 28, 1977, 1 p.

Sell, J.D., 1977, Durham Hills--A zoned mid-Tertiary intrusive and associated mineralization, Owl Head district, Pima County, Arizona: Asarco memorandum, 3 p.

Strong, D.F., 1978, Mineral potential of Appalachian granites long ignored but worthy of investigation: The Northern Miner, March 2, 1978, p. B-1, -18, -19.

Yeend, W., et al, 1977, Reconnaissance geologic map of the Ninetysix Hills NW, NE, SE, and SW quadrangles, Arizona: U.S.G.S. Map MF-909 (1:62,500), 1 sheet.

TABLE ONE. Tabulation of Assay (A) and Thin-Section (T) Samples from the 96 Hills Area.

Sample Number	Location 1/4	1/4	Sec.	T-S	R-E	Unit*	Fluid Inclusion	Slab K-Stained?	Notes
AT-96-1	NW	NE	33	6	11	mmg	small, type 1	yes	red coloration, with tourmaline
T-96-1A	NW	NE	33	6	11	mmg	small, type 1	yes	white equivalent, no tourmaline
T-96-2	SW	SE	28	6	11	db	cruddy, none visible	yes	
AT-96-3	SE	SE	28	6	11	Tql	not visible	yes	abundant pyrite pseudomorphs
T-96-4	NW	NW	34	6	11	Tr	none	yes	strongly altered groundmass
T-96-5	SW	NW	34	6	11	Tqp	few type 1	yes	feldspars altered
T-96-6	NE	NW	34	6	11	Ta	not visible	yes	pyrite pseudomorphs
AT-96-7	NE	NW	34	6	11	mmg	not visible	yes	carbonate-manganese replacement
AT-96-8	NE	NW	34	6	11	mmg	abundant, type 1	yes	typical, coarse muscovite
T-96-9A	SE	SE	28	6	11	Tdp	not visible	yes	pyrite pseudomorphs
T-96-9B	SE	SE	28	6	11	Tlp	not visible	yes	zoned feldspars, pyrite pseudomorphs
AT-96-10	NE	SW	31	6	12	Lgg	not visible	no	sheared, grungy
T-96-11	NW	NE	31	6	12	Lgg	moderate, type 1	yes	weakly gneissic
T-96-12A	SW	NE	6	7	12	Lgg	not visible	yes	border granodiorite to diorite phase
T-96-12B	SW	NE	6	7	12	Lgg	moderate, type 1	yes	strongly gneissic
T-96-12C	SW	NE	6	7	12	Lgg	not visible	no	mafic-rich, diabasic textured gneiss
T-96-13	SW	SW	1	9	12	Tb**	not visible	no	basalt with 21 m.y. age date
T-96-14A	NE	NE	34	8	12	μ(Yo)**	broken inclusions	yes	schistose granite, thermally metamorphosed
AT-96-14B	NE	NE	34	8	12	μ(Yo)**	broken inclusions	yes	granitic gneissic, with hematite films
AT-96-15	NW	SE	7	8	12	Tsgd**	not visible	yes	border phase, weak iron stain
T-96-16A	NW	SE	18	8	12	Tsqm**	rare type 2 in feldspar	yes	cataclastic texture
T-96-16B	NW	SE	18	8	12	Tsqm**	good type 2 in feldspar	yes	granite aplite dike cutting #16A
AT-96-17	SE	NE	36	7	11	pi	no slab	no slab	arkosic, quartz-rich
AT-96-18	SW	SW	32	6	12	Lgg	moderate, type 1	yes	weakly gneissic, high muscovite content
AT-96-19	SW	NW	5	7	12	Lgg	moderate, type 1	yes	graphic texture, maroon limonite
T-96-20	NW	NW	32	6	12	Lgg	small, type 1	yes	weakly porphyritic core zone
96NW-D2A	SE	SE	17	6	11	---	---	yes	clast from conglomerate from drill core ***
96NW-D2B	SE	SE	17	6	11	---	---	yes	porphyritic qtz monz from drill core (bedrock?)***

*See legend on Attachment A map
**See map MF-864, Geol. of Tortolita Mountains quadrangle (Banks, et al, 1977, 1:62,500)
***From reject pile at cored hole in 96 Hills NW quadrangle

TABLE TWO. Description of Rock Units and Dikes. 96 SW quadrangle

Precambrian Pinal Schist (pi) and quartz granite aplite (qga) pegmatite (peg) dikes.

Fletcher Tank Hills. Section 36, T7S, R11E.
East Hill. The schist is a quartz-muscovite spotted schist with abundant quartz lenses; it is isoclinally folded, has disrupted folds, and is generally contorted. Schistosity on west side strikes N20°-30°E and dips steeply to 70°E.

Schist on the east side of hill strikes N60°E and dips steeply to the northwest and is generally more planar than main part of hill.

Numerous quartz granite aplite dikes cut the schist from east to west, then include:

a) a ten-foot zone composed of 2'-3' granite aplite zones which strike N45°-50°E
b) on about twenty to thirty-foot intervals, to west, have several five-foot dikes then a ten-foot dike
c) about fifty-five feet further west is a twenty-foot dike contact which dips 25°-75° east, with dump-pit on dike; followed westward by a twenty to thirty-foot wide dike of granite aplite dipping steeply and striking N40°E
d) along this main western side dike swarm on the northeast end, a 3" disrupted quartz vein has minor copper oxide and minor specularite exposed in a pit and on the dump.

Both the schist and the dikes are cut by several N15°W-striking, 45°-55° SW-dipping faults showing offset to the northwest. The schist and dikes are also cut by steep to 70° south-dipping tension faults with no apparent offset.

East hill also cut by a Tertiary Samaniego granodiorite dike.

Sample Number A-96-17 of Pinal Schist taken for reference. The sample contains no alteration-mineralization and is an arkosic, quartz-rich variety, tightly isoclinally folded, etc. The unit has no resemblance to the mylonitic or ultra-mylonitic and schistose unit [y(Yo)] of Banks, et al, in quadrangles to the south.

In the Middle Mountain area, north central edge of map, the oldest set of fracture-filled dikes appears to be a northeast-trending Precambrian-type granite aplite pegmatite (NW1/4 NE1/4 Sec. 34, T6S, R11E). The dike mass extends along and beyond the diabase dike-carbonated granite zone.

The Pinal Schist in the southeast corner of Sec. 6, T7S, R12E strikes north-south and dips 55°-70°E. It is the typical grey, quartz-rich, muscovite, phyllite schist. Five similar outcrops or sub-outcrops are found in Sec. 5, T7S, R12E.

The smaller outcrop in the NE1/4 NW1/4 SW1/4, Sec. 5 has an undulating schistosity striking north-south and dipping 40°E. The texture suggests a granitoid-derived source.

To the north along the road (SE1/4 SW1/4 NW1/4, Sec. 5) the small outcrop is a phyllite muscovite schist with schistosity of N10°E, dipping 30°E.

In a pit to the east (SE1/4 SE1/4 NW1/4, Sec. 5) the schist is more mafic-rich and no trend could be determined. The surrounding area is covered by sub-outcrop of schist rubble.

(NOTE: The schist rubble hills on the east edge of the map appear to be a cover of schist debris with granite and granite aplite mixed in. Along the wash edges it appears to be 80% schist and 20% granite-granite aplite rubble set in a caliche and mud-granite debris matrix, and has a dumped depositional appearance. It also contains minor Tertiary basalt fragments. It is not a good conglomerate even though some fragment blocks are 1"-3" and up to 3 feet in dimensions. I do not consider the schist rubble to be the Palo conglomerate type although it may be derived from reworked Palo.)

In the northeast portion of the map, the southern schist outcrop (SE1/4 SW1/4 SW1/4, Sec. 5) is a very broken unit but has a N30°E schistosity trend with dips ranging for 80°E to 80°W.

Several pegmatite granite dikes occur in Sec. 32, T6S, R12E. The southern pegmatite strikes N10°E to N10°W and has a vertical dip. The northern one is similar with a N70°E branch joining the main trend. All are narrow, 6"-18", and discontinuous with large muscovite plates set in a quartz-feldspar-graphic granite matrix which grades into the wall rock.

Precambrian Middle Mountain granite (mmg).

The Middle Mountain granite (mmg) is found in the north central portion of the map in Sections 27, 28, 33, and 34 of T6S, R11E. It is an equigranular double mica granite of 2-3 mm size grains of the approximate composition: 10-20% quartz, 30-40% K-spar orthoclase, 10-20% plagioclase, 10% biotite, and 15-25% muscovite, all of which interlock.

In the northeast quarter of Sec. 33, the master joint strikes N5°E, dips 40°W with secondary joint systems at N70°W, steep north dip, and at N45°E, steep southeast dip. The joint system tends to release the blocks into 2"x3"x4" cobble-sized units in this red-colored granite. The southwestern hills have a decided pinkish-red coloration and stain (stippled on the map) with tourmaline rosettes scattered throughout the rock. Also some hematite stain and some quartz, mainly along the master joint or shear, as in sample AT-96-1. This sample was tested for radioactivity but no counts exceeded normal background.

Elsewhere the granite is generally a white to cream-colored unit as shown in samples T-96-1A and AT-96-8. In the SE1/4 of Sec. 28, the master joint is N70°W, dip 70°N, with the secondary at N10°E, steep east dip, and N50°E, deep east dip.

Overall the Middle Mountain granite has the joint system on the theme of N5°-10°E, N70°W, and N45°-50°E, with one then another being dominant.

Only a smidge of copper oxide was found in a half-inch quartz-sericite joint-fracture trending N80°E just south of the diabase in SW1/4 SE1/4 of Sec. 28.

The age of the granite is unknown but its similarity to some dated double mica granites, and its dissimilarity to the Tertiary double mica (at times) granites, suggests a Precambrian origin. Also it is cut by diabase which elsewhere has a Precambrian age.

Precambrian Diabase (db).

The diabase within the quadrangle is typical of that within Central Arizona which has a Precambrian age.

In the Middle Mountain complex, SW1/4 SE1/4 Sec. 28, T6S, R11E, the diabase (db) strikes N70°-80°E and has a steep dip and is 30-40 feet in width. Sample AT-96-2 is taken from this dike. The dike contains minor Middle Mountain granite inclusions and has chilled borders on both walls. Its general texture is medium diabasic with fine to ultrafine diabasic on the chilled borders. Along trend are several chilled border diabase masses in the adjacent quadrangle to the north.

Further east, in the NW1/4 NE1/4 Sec. 34, T6S, R11E, is a dike complex composed of a 30-40 foot chilled border diabase dike trending N10°-20° E with a spur trending N50°E. Along the west side of the southern half of the dike is one of the oxidized andesite-type dikes (T-96-6) which ultimately breaks away and cuts N10°-20°W to join the north-trending swarm of andesite dikes (See Tertiary dike complex description). Along the northeast extension of the northeast spur is the zone of aplite pegmatite (qga) previously described.

The above zone of diabase is believed to be related to the carbonated granite zone which is discussed in more detail under Mineralization.

Within the northeast quadrant of the map are several chilled diabase dike-masses trending northeasterly and northwesterly within the sheeted cataclastic deformed granite gneiss of Sec. 31, T6S, R12E and Sec. 6, T7S, R12E. Generally the diabase has minor epidote on the shear faces parallel to the elongation of the mass.

In the NW1/4 SW1/4 NW1/4, Sec. 5, T7S, R12E are several 1'-3' wide, somewhat discontinuous, chilled diabase dikes trending N60°-70°E in the wash bottom. They cut very grungy granite gneiss. East of these outcrops is a small outcrop with limonite shears (sample AT-96-19) cutting a 3"-6" diabase sill which trends N50°-60°W and dips 10°-15° southwest. The sill is very discontinuous and is disrupted by the strong shearing (striking NNW) containing limonite stain. A small sub-outcrop of similar material is located in the alluvial rubble material just to the south.

The dike shown in Sec. 32 (T6S, R12E) strikes parallel to the pegmatite dikes to the north-south. It strikes N10°E, probably has a vertical dip, and is 10'-15' wide and perhaps fifty feet long before being lost in local wash and grus.

Laramide gneissic granite (Lgg).

The large unit of Laramide gneissic granite (Lgg) is a composite type granite with variable shearing, crushing, brecciation, and general broken character

giving most outcrops a grungy cataclastic appearance. It has a variable but noticeable amount of muscovite as books and smears. It most closely resembles the double mica granite of Middle Mountain but has been separated out because of its general more porphyritic character and its cataclastic nature.

The Tertiary Palo conglomerate west of the main unit contains gneissic granite fragments suggestive of being derived from this terrain. Although no Palo conglomerate was found overlying the gneissic granite it does appear that the granite was involved in the same titled block style of movement. Thus the granite may be tilted as much as 25°-45°.

At sample AT-96-10, central portion of Sec. 31, T6S, R12E, the granite is a sheared, broken, grungy, slightly gneissic granite. The sheeting trends N20°-35°E, with near vertical dip. Hematite stain and films occur on the sheeting planes and broken edges. In the center of the section is a shattered, sheeted fault zone trending N40°-50°W, dipping 50° southwest, which appears to end in a small diabase outcrop to the northwest. The reddish granite (hematite addition and biotite breakdown) is mainly west of the northwest-trending fault and extends over into the sample site #10 hill area.

Sample T-96-11 is an equigranular weakly gneissic granite of the Precambrian Middle Mountain granite affinity.

Within the west central outcrops of Sec. 6, T7S, R12E, is a dirty, crushed, sheared gneissic granite, with shears on N35°E to N60°E. Abundant Quaternary alluvial rubble of schist-gneissic granite cover in the area. On the southern side of outcrops, the sheared gneissic granite is cut by a fault which strikes N10°W, dips 55° west, and has 2'-4' of crushed gneissic granite with clay-mud walls of gouge. A hornblende volcanic dike parallels the fault both above and below. The northern segment of the fault has a strike of N15°W and appears to dip nearly vertical. Upstream (east) from the northern segment some hundred feet is another hornblende volcanic dike dipping east, and an additional hundred feet upstream is a six-inch crushed zone striking N45°W and with a vertical dip.

Sample T-96-12A is a gneissic granite to granodiorite to diorite and shows a border phase type which is sheared, sheeted, crushed, broken, and faulted. The more typical equigranular white to grey gneissic granite is represented by sample T-96-12B. At "The Buttes", near sample site T-96-12C, the gneissic granite is also white to light grey and is highly sheeted by N10°E and N30°W shears. It exhibits good cataclastic textures with an older N50°-60°E-trending group of shears showing up in elongated patches.

Diabasic granite-gneiss zones (sample T-96-12C) are found in the north center of Sec. 6, T7S, R12E. These mafic-rich zones strike north and dip 15° to the west. They are three to six feet wide and are cut and displaced two to six inches by shears of "The Buttes" type.

In the area of sample T-96-18, the unit is an equigranular, massive, nearly a graphic granite with moderate cataclastic texture throughout in outcrop and numerous lenses within the unit. It has small to medium interstial biotite books and a variable muscovite content. Weak hematite occurs on the N to N20°W-trending shears.

Throughout the areas of gneissic granite, the surface is a grus. A few diabase masses and a hornblende volcanic dike which trend northeasterly were mapped. Additional outcrops of these may also occur in the main mass within the northeast quadrant of the map.

The granite in and along the roads of Sec. 32 of the northeast sector has a slight grungy appearance but is relatively unsheared and lacks the distinctive gneissic texture. It also tends to have a more porphyritic texture as shown in sample T-96-20. Probably this phase of the granite is a central core zone with the more gneissic and grungy phases on the outer zone. This more porphyritic phase is similar to the Southern Grayback Granodiorite found further north (see thin-section collection of JRK). It does contain some muscovite but is not as noticeable as at Middle Mountain and overall the muscovite content appears to decrease from the outer gneissic zone inward toward the interior more porphyritic core. All outcrops weather rapidly to a grus surface with the interior phase having somewhat more relief and nubbins projecting above the general land surface.

Tertiary dike complex of Middle Mountain.

A complex of dikes of probable Laramide age cut the Middle Mountain double mica granite (mmg) in Sections 27, 28, 33, and 34, T6S, R11E. None of these types were found in the Laramide gneissic granite (Lgg) complex to the east.

The oldest set appears to be the northeast-trending with east-west dog legs, quartz latite dikes (Tgl, T-96-3). The dike appears sheeted and on the south end it strikes N50°E with a steep dip and is 10-12 feet wide, although somewhat discontinuous and distorted. As shown on the map, the dike turns east-west and becomes as narrow as two feet before returning back to N60°E to N40°E with a variable width before terminating. Further northeast, in the adjacent 96 NW quadrangle, the latite appears as a few small patches and one 5-foot by 25-foot mass trending N70°E. The offset or dog-leg area appears to be broken and somewhat offset by N30°W sheeting zones which cut both the granite and the quartz latite dike.

Extending eastward from the east-west jog of above is a dacite porphyry-latite porphyry-diabase complex dike zone trending N70°E and dipping steeply. From west to east the sequence is a) a 2'-5' wide dike of dacite porphyry (Tdp, T-96-9A), with further to the east an adjacent dike of b) 5'-8' wide latite porphyry (Tlp, T-96-9B), followed by c) a chilled border diabase dike of 20'-30' width on the south side of the complex. The complex zones do not cross the sandy alluvium along the section boundary of Sec. 27-28.

An additional east-west dike type is exemplified by a number of dikes in Sec. 34, T6S, R11E, of a rhyolite affinity (Tr, T-96-4). These purplish-tan fine-grained dike segments are 1'-3' wide and trend N60°E to N85°E and N85°W. They also are cut by a number of the N30°W sheeted zones as noted previously cutting the quartz latite. For the most part the rhyolite dikes form an east-west trending zone which nearly cuts the entire southern part of the Middle Mountains.

Cutting, offsetting, and terminating the rhyolite dikes are segments and zones of oxidized black-grey to purple to brown dikes of andesite affinity (Ta, T-96-6) which mainly strike N to N10°W in the northcentral part of Sec. 34 and extend off of the map into the adjacent quadrangle. The andesite dikes

vary from 1 to 2 feet in width and dip steeply, and occur as disrupted masses. Several individual masses as well as one elongated zone trend N30°-35°W in the central part of Middle Mountain (NW1/4 of Sec. 34).

The largest dike, and probably the latest in the series, is a quartz eye, sugar-textured, porphyry (Tqp, T-96-5) in the center of the NW1/4, Sec. 34. The grey-white, laminar porphyry is thirty feet wide and strikes east-west, dips steeply north, on the east side of the hill, then turns abruptly and trends north-south (dipping 65°-70°E) on the north side of the hill. The dike has distinct hexagonal outline quartz eyes.

Tertiary Samaniego granodiorite (Tsgd).

In the Tortolita Mountains quadrangle to the south is a complex intrusive group with border phase granodiorite, quartz diorite, monzodiorite, to diorite. One such dike was found along the northwest extension of the main complex in the southern Fletcher Tank Hill, Sec. 36, T7S, R11E. Here the Samaniego granodiorite dike (Tsgd) trends northwesterly as somewhat discontinuous masses cutting the Pinal Schist and the cross-cutting granite-quartz-aplite dikes on the hill. No sample was taken here but AT-96-15 was taken in the equivalent hard rib in an exposure in Sec. 7, T8S, R12E.

Tertiary hornblende volcanic dike (Thv).

The hornblende volcanic (Thv) is a greyish purple hornblende needle volcanic occurring as narrow, 2'-4', dikes along fault zones as in Sec. 6, T7S, R12E, and along apparent faults or reactivated zones such as in Sec. 31, T6S, R12E where it occurs along the projection of one of the diabase masses.

Tertiary Palo conglomerate (Tpc).

The Tertiary Palo conglomerate is named for the exposures found near Palo Tank in the SE1/4, Sec. 36, T6S, R11E.

At the small exposure north of the Palo Tank, the conglomerate trends N30°W, dips 30° east. It is a pebble conglomerate with semi-angular clasts from 1" to plus 1 foot, and some 1' by 2' slabs, of principally a biotite-muscovite granite with dense quartz-feldspar mixture having diffuse boundaries and biotite books 2-3 mm, with minor muscovite books. The granite has a weak gneissic texture and is undoubtedly derived from the Laramide gneissic granite unit. The conglomerate also contains rare diabase and the needle hornblende volcanic clasts. All are set in a matrix of fine crushed gneissic granite debris (grus).

North and east across the wash, the conglomerate strikes N30°-40°W, dips 25°E, and has a volcanic tuffaceous matrix. Here it has the character of a sheet-flood depositional facies with an apparent easterly source direction.

Overall the conglomerate has a grey outcrop color with reddish streaks. It is indurated.

Upstream (easterly) the matrix and general texture become more sandy-arkosic. In the small outcrop in SW1/4 Sec. 31, T6S, R12E, the conglomerate has a landslide-dumped appearance and a redder cast. As noted on the map, a fault with a trend of N10°E, 80°W dip, cuts this outcrop.

In general, the Palo conglomerate outcrops are overlain by similar debris of reworked conglomerate with a weakly cemented caliche matrix and has a sheetflood depositional feature.

West of Palo Tank, on the north side of the wash, is a caliche mudstone sediment having a flattish dip. Several other small patches of caliche mudstone were noted resting on Palo conglomerate. The dip of the mudstone is 2°-5° flatter than the present drainage baselevel inclination.

The Palo conglomerate in the SW1/4, Sec. 30, T6S, R12E, is mainly rubble and debris with faint indurated outcrops throughout. They have a general northwest strike and a moderate east dip.

In Sec. 6, T7S, R12E, the small disconnected conglomerate outcrops strike N10°E to N30°E and dip generally 25° east. They are composed of fifty percent clast material of schist, gneissic granite, volcanic, and diabase parentage set in fifty percent matrix of gritty tuff. A few very fine sandy zones are also present. Though poorly represented, the points available suggest a source from the northeast to east.

In the NE1/4 NW1/4 of Sec. 6, T7S, R12E, the outcrop is a fine to medium coarse gravel conglomerate with schist, gneiss, and abundant hornblende volcanics set in 80% matrix. The unit strikes north and dips 65°-70°E. This facie may be the upper portion of the total Palo conglomerate sequence.

The conglomerate outcrop in the east center of Sec. 7 has a strike of N25°-30°W and dips 75°-80°E. It is mainly clasts (60%) of Pinal Schist (80%) and gneissic granite (20%) set in a gritty, minor tuff matrix (40%). Minor fine hornblende volcanics and diabase clasts are also present. The Pinal clast attains a size of up to two feet with the granite up to 6 inches and others around 2"-3" in size. Color is grey to tan buff.

A large expanse of conglomerate type rubble and debris occurs north and east of the small wash outcrops, but no real conglomerates were found in the rubble.

In the southern part of Sec. 5, T7S, R12E, along a wash cut bank are exposed outcrops of Palo-type conglomerate. The eastern exposure has 6"-3' clasts of Pinal (90%) and 4"—1-1/2' gneissic granite (10%) with minor vesicular andesite and andesite porphyry clasts set in a matrix (10%-15%) of sand, silt, and muddy tuffs. Poorly defined bedding strikes N10°-20°E, dips 60°-70° east. The middle exposure has similar clast composition with an increase to 20-25% of matrix material. The strike is N10°-20°E, dips 30°-35°E. The western outcrop is very schist-rich and may in fact be a rubble schist sub-outcrop.

Table Three. Geochemical Report Sheets

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE May 23, 1977

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM	PPM Mn	
AT-96-1			31	10	29	2		
AT-96-3			126	18	61	1		
AT-96-7	.001	0.06	85	105	100	3	0.27% 2000+	
AT-96-8			40	43	46	1		
AT-96-10			703	13	32	3		

CHARGES $ 48.00

Invoice # 14075

ASSAYER - CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE May 23, 1977

OVER 2000 PPM

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PER CENT COPPER	PERCENT LEAD	PERCENT ZINC	PERCENT MOLYBDENUM	PERCENT Mn	Percent Ba
AT-96-7							0.27	
A-9-247							20.7	2.15

INVOICE NO. 14975

CHARGES $ 21.25

REGISTERED ASSAYER CERTIFICATE ARIZONA 5/23/77

ASSAYER-CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE Oct. 17, 1977

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
AT-96-14B			42	34	67	4		
AT-96-15			96	21	58	2		
AT-96-17			30	12	80	1		
AT-96-18			362	11	42	1		

REGISTERED ASSAYER CERTIFICATE NO. 6152 EDUARDO S. FLORES Date 10/17/77 Signed Arizona U. S. A.

CHARGES $ 31.00

INVOICE NO. 15414

ASSAYER - CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE Nov. 14, 1977

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
AT-96-19			109	68	50	5		

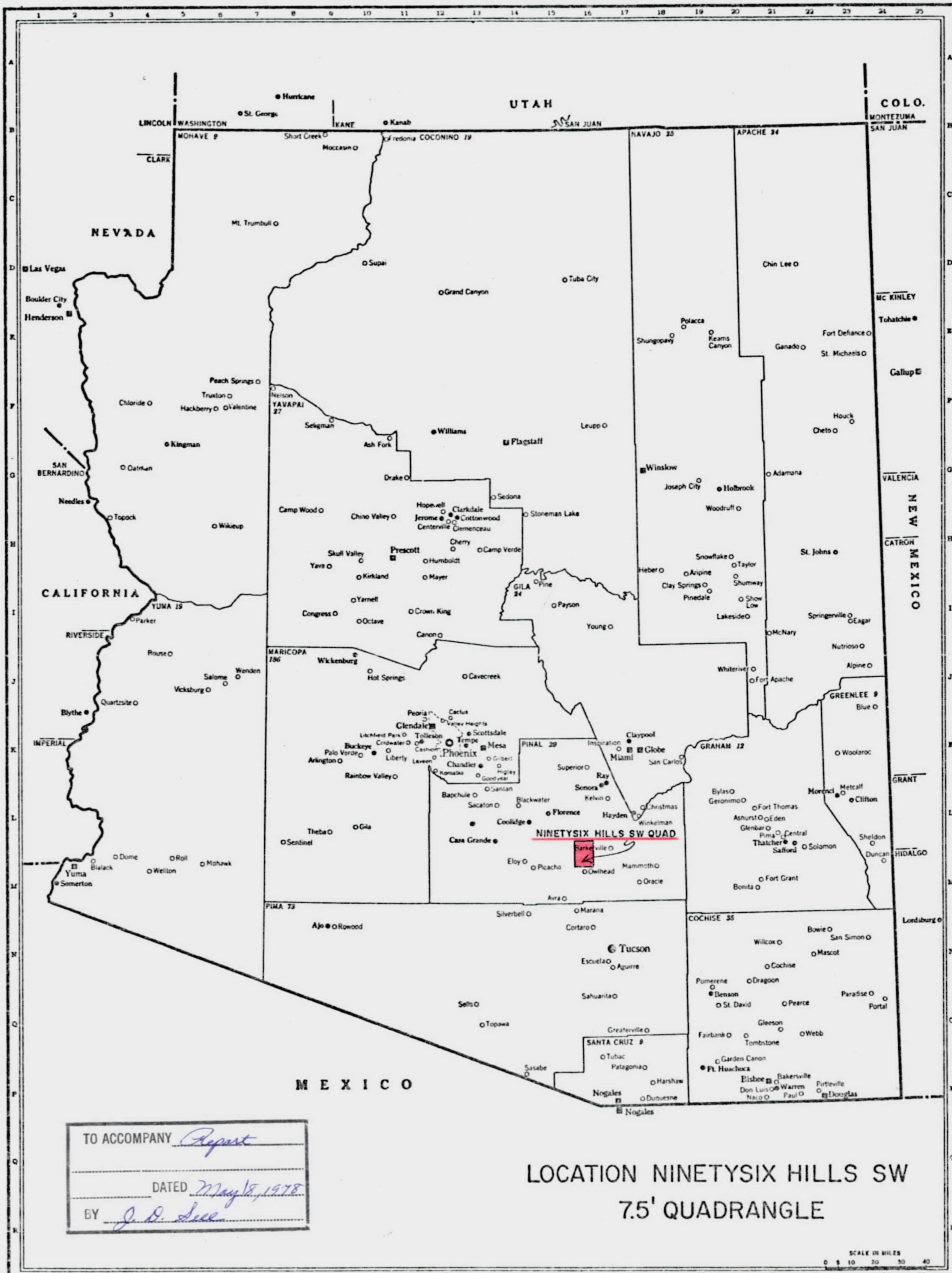
CHARGES $ 7.75

INVOICE NO. 15463

REGISTERED ASSAYER Arizona U. S. A. 11/14/77

ASSAYER-CHEMIST

FIGURE 1.



TO ACCOMPANY Report

DATED May 18, 1978

BY J. D. Seel

LOCATION NINETYSIX HILLS SW 7.5' QUADRANGLE

ATTACHMENT B. From The Northern Miner, March 2, 1978, p. B-1, -18, -19.

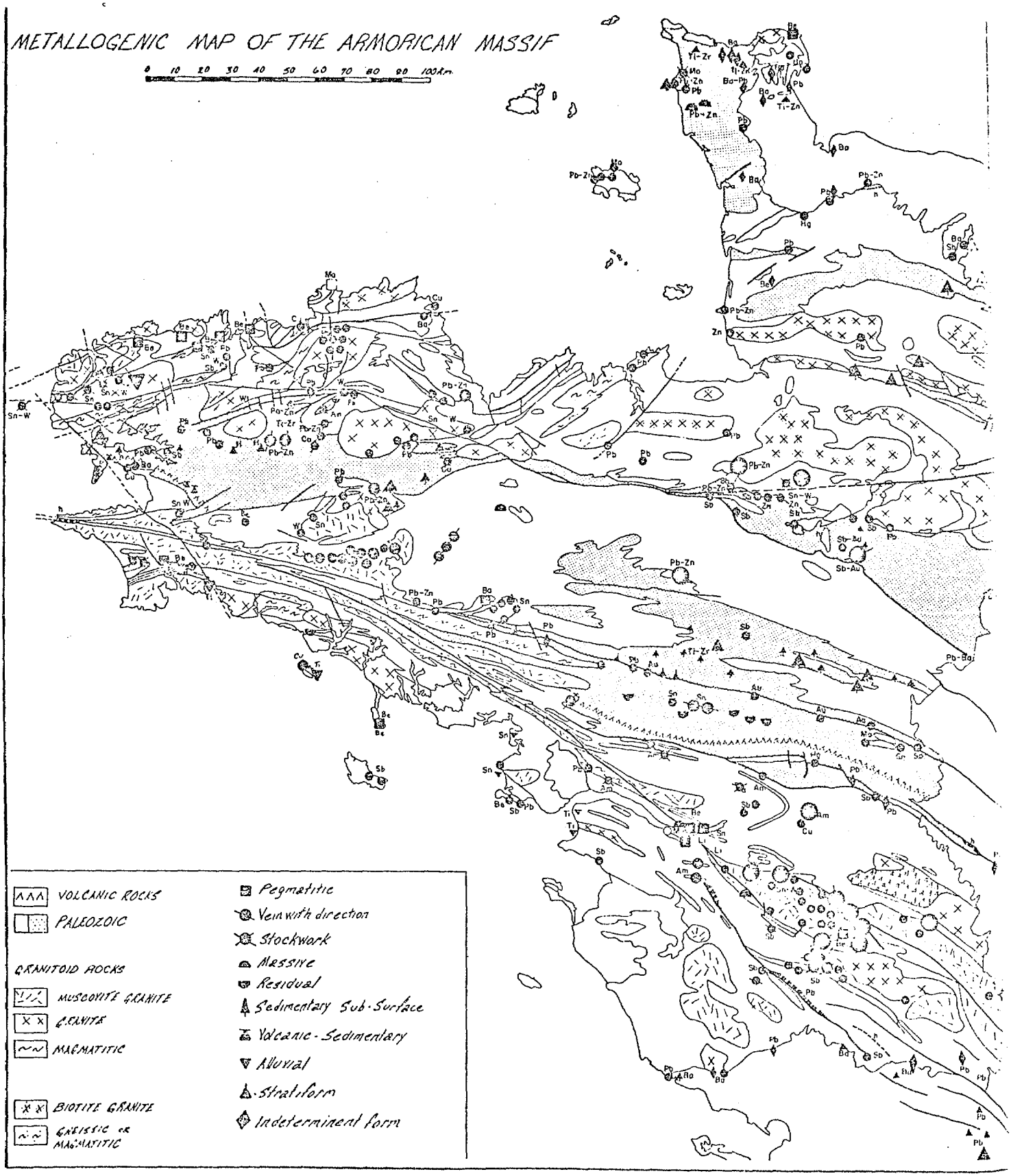
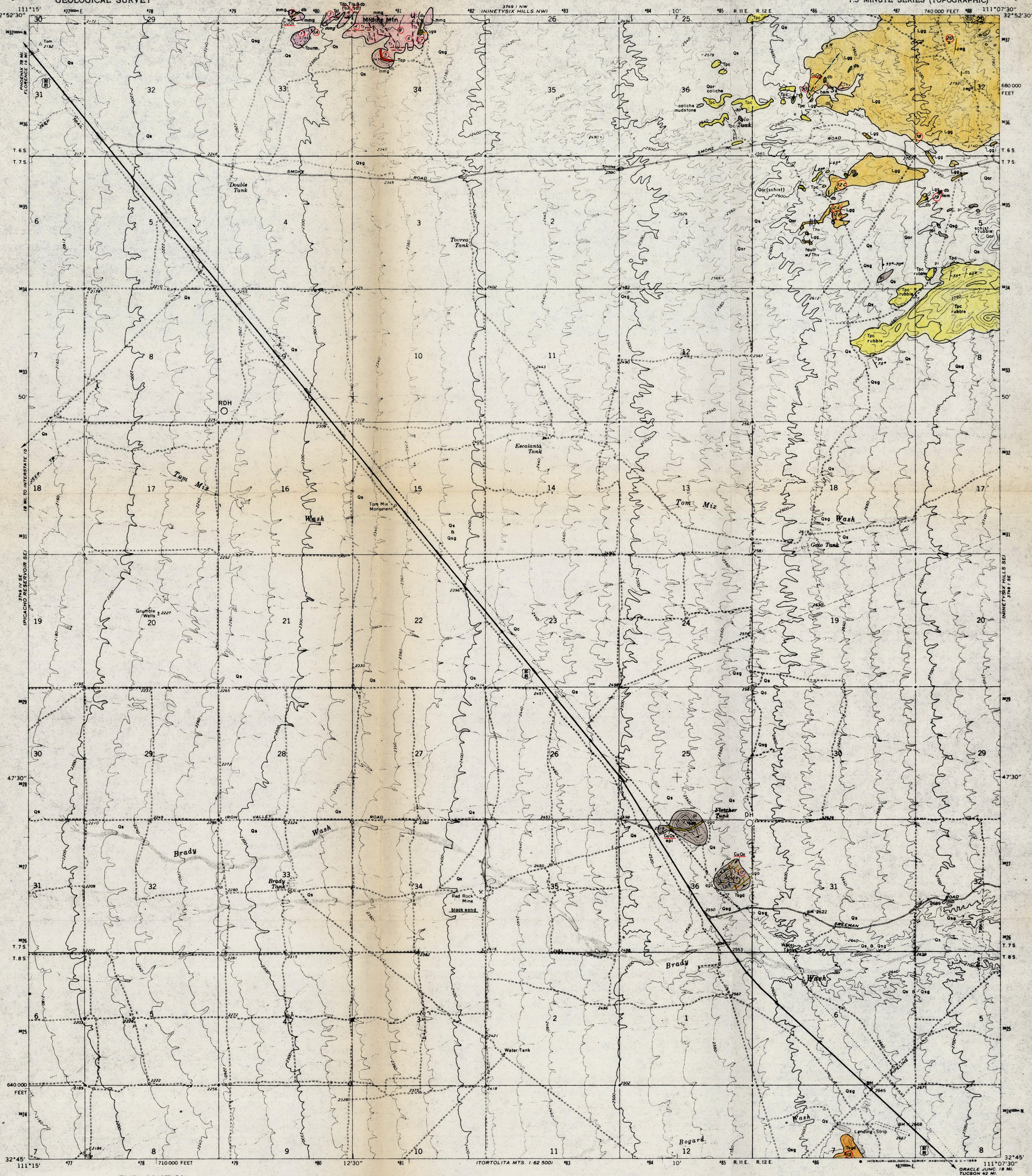


FIGURE 2: Mineral occurrences of the Armorican Massif (after Chauris and Guigues, 1969).

ATTACHMENT A

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

NINETYSIX HILLS SW QUADRANGLE
ARIZONA – PINAL CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



EXPLANATION

QUATERNARY

- Qs
- Qsg
- Qc — Sand, sand & gravel, caliche, & alluvial rubble & related material of surficial cover.
- Qar

TERTIARY

- Tpc — Palo conglomerate
- Thv — Hornblende volcanic dikes
- Tsgd — Samaniego granodiorite complex

LARAMIDE

- Tqp — Quartz porphyry dike
- Ta — Andesite dikes
- Tr — Rhyolite dikes

(LARAMIDE CONTINUED)

- Tdp — Dacite porphyry dikes
- Tlp — Latite porphyry dikes
- Tql — Quartz latite dikes
- Lgg — Gneissic granite

PRECAMBRIAN

- qga — Quarty granite aplites & pegmatites (may in part be of younger age)
- db — Diabase
- mmg — Middle Mountain granite
- pi — Pinal schist

Fault

Cuox — Copper oxide mineral

hem — Hematite stain

tour — Tourmaline

DH — Drill hole

Schistosity

Bedding

X 12a — Sample site & number (with T-96 or AT-96 prefix)

TO ACCOMPANY Report
DATED May 15, 1978
BY J. D. Sell

GEOLOGY OF
NINETYSIX HILLS SW, ARIZ.

N3245—W11107.5/7.5

1966

AMS 3749 I SW—SERIES V898

SCALE 1:24000
1" = 2000 Approx.

J.D. Sell May, 1978

MVK-4082

See Price Prospect – Red Hills file As-14A.2.18
for JRK info.

Conoco (Bill Rehing) reports basalt at Pastor Butte ≅ 8 m.y.
" " " " " " Pecten Rock ≅ 13 m.y.

Blucher's map of Blackwater district contains Price Prospect. See WES memo of April 20, 1961 (last paper in folder behind).

Red Hills Prospect, by JRKing Oct. 25, 1972
Addenda to Red Hills Report by JRKing April 24, 1973
See Reconn. Geol. Map MVK 2599 of JRK.

Note: East bookshelf has JPK thin section & location of Grayrock & Southern Grayrock Gd.
recheck Addendum report for partial particulars.

INVOICE

WESTERN PETROGRAPHIC

20 West Flores
Tucson, Arizona 85705

C. D. N.
JUN 13 1977

INVOICE NO. 77525

INVOICE DATE June 8, 1977

SOLD TO
ASARCO, INC.
P. O. Box 5747
Tucson, Arizona 85703

SHIPPED TO J. D. Sell

OUR ORDER NO.	YOUR ORDER NO.	TERMS	SHIPPED VIA	SURPLUS MATERIAL
77525		net 30 days	picked up	returned

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
16	ea	Standard petrographic thin sections	3.75	60.00
11	ea	K-feldspar stain (slabs only)	.75	8.25
15	ea	Impregnation with epoxy	.50	7.50
15	ea	Grinding in oil	.50	7.50
		TOTAL		$83.25

APPROVED FOR PAYMENT

By: James D. Sell
(Signature)

N. Keen
Exc. General

Sec 14-23 T6S R12E

Pioneer Ave

Claim block partially held by Ambrosia

3441 East Milber

INVOICE NO.
15414

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE Oct. 17, 1977

Mr. J. D. Sell

SAMPLE MARKED	ANALYSIS	CHARGES
AT-96-14B		
AT-96-15		
AT-96-17		
AT-96-18	Geo-Chem Cu, Pb, Zn, Mo	$ 28.00
4 Samples	Preparation	3.00
	TOTAL	$ 31.00

OK for Payment
Tuc. General
James D. Sell

96-Reconn.

THANK YOU MUCH!!

REGISTERED ASSAYER
CERTIFICATE NO.
RUTH S. FLORES
Date Signed 10/17/77
Arizona U. S. A.

CHARGES $ 31.00

INVOICE NO. 15414

ASSAYER-CHEMIST

5441 East Milber

INVOICE NO.
15414

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

DATE Oct. 17, 1977

Mr. J. D. Sell

SAMPLE MARKED	ANALYSIS	CHARGES
AT-96-14B		
AT-96-15		
AT-96-17		
AT-96-18	Geo-Chem Cu, Pb, Zn, Mo	$ 28.00
4 Samples	Preparation	3.00
	TOTAL	$ 31.00

OK for Payment
Tuc. General
James O. Sell

96-Recom.

THANK YOU MUCH!!

REGISTERED ASSAYER
CERTIFICATE NO.
REYES
FLORES
Date 10/17/77
Signed
Arizona U. S. A.

CHARGES $ 31.00

INVOICE NO. 15414

ASSAYER - CHEMIST

H. Kreis
12-28-76

GEODATA CLAIMS

No record in 1974 for Betty claim

Checked I. Index to Mines a) Name of claim ✓
b) Name of Locator ✓ (Geodata

II Aff. of Labor a) owner ✓
b) Mine ✓

Check: Geodata claims.

Sec 29 T6S R11E
- Tom Mix 1-61, 63, 65, 67, 69, 71, 73, 75, 77, 79, 81, 83, 85, 87, 89, 91, 93, 109, 110
- 10-16-74 Loc
- 10-18-74 Record.
- Doc 763 p.940 to Doc 764 p.20

Sec 5 T7S R11E
- Cat 1 et al 12-3-74 (Loc); 12-6-74 (Rec)
- Doc 768 598-723
- Cat 127 etc 1-7-75 (Loc); 1-7-75 (Rec)
- Doc 771 314-341

Sec 35 T10S R6E
- Aguirre 150-177 11-24-76 (Loc)
- 12-2-76 Rec Doc 846 p. 204-208

Note: Geodata claims
Desert Peak & Copper Creek } 8-73
Ripsey 5-73

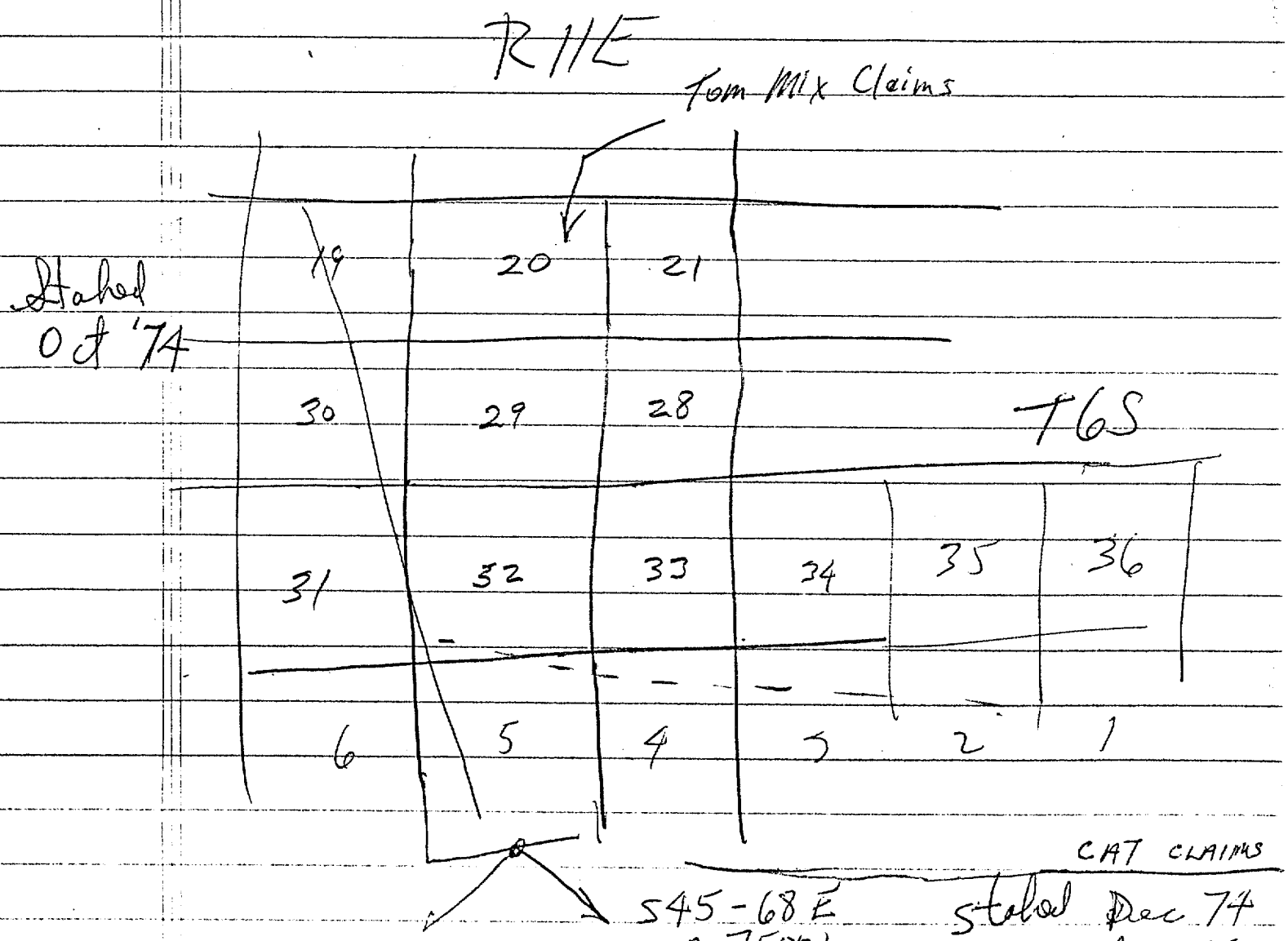
No claims of Geodata in Index to Aff of Labor

SAMPLE NOTICES

GEODATA'S TOM MIX CLAIMS

General Area

Tom Mix	#7	1500'	No. of NW cor	Sec 29	T6S	R11E
	15	900'	So. of NW cor	"	"	"
	38	3350'	N 63 E of	"	"	"
	87	7400	S53E of	"	"	"



H. Kreis
12-28-76

GEODATA CLAIMS -- SAMPLE LOCATION

CAT 152 4700 S17E from NE Cor Sec 16
T7S R11E

CAT 118 7500' S68E from S¼ Cor Sec 5
T7S R11E

CAT 125 7600' S47E S¼ Cor Sec 5
T7S R11E

ASARCO

Southwestern Exploration Division

November 10, 1977

TO: J. D. Sell
H. G. Kreis
D. M. Smith

FROM: F. T. Graybeal

Pioneer Project
Pinal County, Arizona

In several conversations over the past 6 months (mostly with JDS and HGK) it was generally agreed that the next step on this project will be to diamond drill a vertical hole in the altered outcrop. Accordingly, I have budgeted for a single 1000-ft. hole to be collared early in 1978 (like Jan. 2-3) so it can be completed by Feb. 15, 1978 when our State Prospecting Permits expire.

Please review the early drill data, geophysical data, recent JDS mapping, and agree on a location for the drill hole -- or give me an alternate proposal.

F. T. Graybeal

F. T. Graybeal

FTG:lb

ASARCO

Southwestern Exploration Division

November 17, 1977

TO: F. T. Graybeal

FROM: H. G. Kreis

Pioneer Project
Pinal County, Arizona

In view of the proposed drilling on the Pioneer Project I recommend that the hole be placed 500' due east of the southwest corner of Section 11 (T6S, R11E). The location of the hole could be moved up to 150' north of that point depending upon the location of the wash. This drill site location is based upon the alteration and mineralization exposed in outcrop and described in my memos of January 17 and 28.

It is my understanding that the intent of the drilling is to acquire sufficient justification to hold the property for possible future deep drilling. The geology of the outcrops and the negative results of OL-1 suggest that if porphyry copper mineralization is associated with the altered and mineralized outcrops it would have to be at least 1500' to 3000' deep. The proposed drill hole should be drilled sufficiently deep to eliminate the possibility of flat fault truncation of the sulfide system and to check for the existence of pervasive alteration and mineralization in the third dimension. Such a hole would be on the order of 2500' deep.

I have discussed the proposed drill hole with Mr. Sell and Mr. Smith. We are in agreement that the mineralized outcrops should be drilled to a moderate depth.

Henry G. Kreis

Henry G. Kreis

HGK:lb

cc: JDSell
DMSmith

ASARCO

Southwestern Exploration Division

December 27, 1977

TO: N. P. Whaley
H. G. Kreis
H. M. Stone

Pioneer Project
Pinal County, Arizona

This morning Mr. Crist informed me that there have been sufficient expenditures on the Pioneer Project to keep our state prospecting permits valid through February 1979. Therefore, drilling early in 1978 will not be required and all plans should be revised accordingly. We will have to do some work this summer for assessment purposes on the 20 unpatented claims. I have called Jack Lloyd and informed him of our plans to cancel the Pioneer hole.

If everything goes as currently planned, we will attempt to deepen QDC-5 as soon as the Superior East hole is completed -- sometime in early January.

F. T. Graybeal

F. T. Graybeal

FTG:lb

cc: RBCrist
JDSell

INVOICE

WESTERN PETROGRAPHIC

20 West Flores
Tucson, Arizona 85705

C. D. N.
JAN 6 1978

INVOICE NO. 771370

INVOICE DATE DECEMBER 19, 1977

SOLD TO
ACCOUNTS PAYABLE
ASARCO INC.
P.O. BOX 5747
TUCSON, AZ. 85703

SHIPPED TO J. D. SELL

OUR ORDER NO.	YOUR ORDER NO.	TERMS	SHIPPED VIA	SURPLUS MATERIAL
771370	T-96	NET 30 DAYS	PICKED UP	RETURNED

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
2	EA	STANDARD PETROGRAPHIC THIN SECTIONS	3.75	7.50
2	EA	K-FELDSPAR STAINING	.75	1.50
		RUSH CHARGES FOR ABOVE	+50%	4.50
		TOTAL:		$13.50

APPROVED FOR PAYMENT
By: James D. Sell (Signature) Tucson General 96 Hall Recon.

INVOICE

WESTERN PETROGRAPHIC

20 West Flores
Tucson, Arizona 85705

C. D. N.

JAN 6 1978

INVOICE NO. 771370

INVOICE DATE DECEMBER 19, 1977

SOLD TO
ACCOUNTS PAYABLE
ASARCO INC.
P.O. BOX 5747
TUCSON, AZ. 85703

SHIPPED TO J. D. SELL

OUR ORDER NO.	YOUR ORDER NO.	TERMS	SHIPPED VIA	SURPLUS MATERIAL
771370	T-96	NET 30 DAYS	PICKED UP	RETURNED

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
2	EA	STANDARD PETROGRAPHIC THIN SECTIONS	3.75	7.50
2	EA	K-FELDSPAR STAINING	.75	1.50
		RUSH CHARGES FOR ABOVE	+50%	4.50
		TOTAL:		$13.50

APPROVED FOR PAYMENT

By: James D. Sell (Signature) Tucson General 96 Hall Room.

IMPORTANT MESSAGE

FOR ~~FTG~~ JDSell / HGKeys

DATE 4/4/78 TIME 9:45 (A.M.) P.M.

WHILE YOU WERE OUT

M Larry Bradfish

OF

PHONE No. 327-0027
Area Code Number Extension

TELEPHONED	✓	PLEASE CALL	✓
CALLED TO SEE YOU		WILL CALL AGAIN	
WANTS TO SEE YOU		URGENT	
	RETURNED YOUR CALL		

MESSAGE

Re: Jeacup graccodiorite

Bradfish has spent 30 days mapping all 96 Hilb quads, Grayback, N+S Bottle areas. Mapping all done. MS thesis. Object to study genesis of 2 nova assemblage in Grayback qd. ~~Wanted any info we might have. He is now~~ starting to write.

SIGNED Lara

FTG

No.149P 4/4/78 VIKING OFFICE PRODUCTS

No need to contact
FTG says for our info only.
Will follow up on thesis work

PETROGRAPHIC ANALYSIS

96 Hills Reconn.

Section No. 96-1

Middle Mountain granite

Rock Name pE granite, two mica mmg

Megascopic description white to pink gray to reddish

Equigranular muscovite-biotite granite

2-3 mm K-spar — 50%
2 mm. Plagioclase — 20-25%
2 mm Quartz — 20-25%
2 mm Muscovite — 5-10% (books 1x2)
1-2 mm Biotite — 2-5% (interstitial)
minor tourmaline rosettes, 4-6 mm.

K-stained

Microscopic description

Minerals

K-spar - microcline
Plag - slightly biotite/muscovite inclus

FI - very small Type I.

Textures

PETROGRAPHIC ANALYSIS

96 Hills Recon.

Section No. 96-1A

Middle Mountain granite

Rock Name pE granite, tourmaline mmg

Megascopic description white to pink gray
Equigranular muscovite-biotite granite

K-stained

2 mm K-spar — 40-50%
2 mm Plagioclase — 20-25%
2 mm Quartz — 20-25%
1-2 mm muscovite — 5-10% (books 1x2)
1-2 mm Biotite — 2-5% (interstitial)
extremely rare tourmaline rosettes.

Microscopic description

Minerals

Kspar - microcline

sericitic repl. of Kspar & Plagio.

FI - abundant primary very few small F.I.

Textures

PETROGRAPHIC ANALYSIS

96 Hills Reconn.

Section No. 96-2

Rock Name Diabase
db

Megascopic description greenish black
Diabasic texture
mosaic of 1/4x2 needles of Plagioclase — 60-70%
in interstitial magnetite-ilmenite
glass (1-2mm). — 30-40%

K-stained
No- K-spar

Microscopic description

Minerals labradorite andesine
mainly hornblende w/mag-hem blebs
rare very small qtz - cuddly

Textures

PETROGRAPHIC ANALYSIS

96 Hill Recon.

Section No. 96-3

Rock Name quartz latite

Tgl

Megascopic description whitish Tan brown.

K-Stained

60% Phenos: 1 to 2mm ~~K-fspar~~ Plagioclase — 60%

intergranular Quartz — 40%

1/2mm Biotite — 2-3%

dike rock

40% matrix - qtz-feldspar micro.

Microscopic description

weak yellow coloration

Minerals

very much overcooked & edges altered by devitrification etc. shreddy rocks, or devitrified sericite? including qtz.

may have abundant Plagioclase.

abundant pyrpseudo

Textures

PETROGRAPHIC ANALYSIS

94 Hills Reconn.

Section No. 96-4

Rock Name Rhyolite

Tr

Megascopic description Pinkish tan, purplish tinge

10% phenos: 1x3 mm, 2x2 K-spar 60-70% K-Stained

1-2 mm qtz flakes 30-40%

90% matrix fine silic flow textured qtz-feldspar 90% K-spar. dike rock

(strong stain.

Microscopic description

Minerals

overall altered, incl. transition zone, except qtz and some inclusions. Incl. sericite

NOFI, abund. jeb.

Textures

PETROGRAPHIC ANALYSIS

96 Hills Reconn.

Section No. 96-5

Rock Name

Megascopic description Grey White, laminar

TGP

20% phenos: 1-2mm. Qtz eyes — 60%
2 mm blocky Plagioclase-40% K-stained
some 1x2
minor biotite, stringy.

80% gm. fine K-spar

dike rock

Microscopic description

Minerals

Quartz
eye, rounded + hex outline
Feldspars anhedral not hex outline
P.I. - minor weathering T.I.

Textures

PETROGRAPHIC ANALYSIS

94 Hills Reconn.

Section No. 94-6

Rock Name hornblende porphyry

Ta

Megascopic description dirty black grey w/bluishness. oxidized

20-30% phenos. oxy-hematite Hornblende-biotite – 80% K-Stained
1x2, 1x3 mm.

1-2 mm quartz ——— 20%

dike rock

70-80% gm. fine felsitic qtz-feldspar ?
↳ K-spar stain, strong

Microscopic description

Minerals

maybe augite type, pseudohex outline etc
nacline under rotation.

10-20% py pseudo.

? feldspathoid ?

Textures

PETROGRAPHIC ANALYSIS 96 Hills Reconn.

Section No. 96-7

Middle Mtn granite

Rock Name pt granite, two mica mmg

Megascopic description Mn-carbonate replaced equigranular granite of 96-1, 14, 15.
No apparent K-stain on slab!

2-4 mm aggregate of	K-spar	— 55-60%	K-stain
2 mm	Quartz	— 30-40%	
1 mm	Muscovite	— 2-10%	
trace	Biotite	— tr	
manganese filling & repl.		2-10%	

Microscopic description

Minerals

very ragged edges on all xl forms,
replaced by grungy grainy light brown carbonate (?)
with quartose extinction

K spar mainly microcline tho one orthoclase remnant.

dirty grungy gbz, no noticeable FI.

Textures

PETROGRAPHIC ANALYSIS

94 Hills Reconn.

Section No. 94-8

Middle Mountain granite

Rock Name pt-granite, two mica mng

Megascopic description White grey pinkish equigranular muscovite-biotite granite

2-3 mm. K-spar — 40-50% K-Stain
2-3 mm Plagioclase — 20-25%
2-3 mm. Quartz — 15-20%
1x2-3 mm Muscovite — 5-10%
1-2 mm Biotite — 3-5+%

Microscopic description

Minerals

Kspar — microcline
Plag light grithy brown (-sericed?) few ext.

FI — abundant small T-1.

Textures

PETROGRAPHIC ANALYSIS

94 Hills Recon.

Section No. 96-9A

Rock Name dacite porphyry

Tdp

Megascopic description dirty brown grey

70-80% phenos. 2-4 mm. Plagioclase (Non stained) — 70%

1-2 mm Hornblende ~~biotite~~ — 10%

2 mm books Biotite — 20%

K-Stain

Dicke Rock.

30% gm granular qtz-feldspar.

Microscopic description

Minerals

labradorite

abundant & rampant conversion angles by sericite, including qtz granule.

5-10% py pseudo

hydacite-dacite

Textures

PETROGRAPHIC ANALYSIS 96 Hills Reconn.

Section No. 96-9B

Rock Name latite porphyry Tlp

Megascopic description green gray, med.

40-50% Phenos. ½-1mm. Kspar — 50%
1-2, 5 mm Plagioclase - 45%
1 mm Quartz — 5%

K-stained

50% gm of finer gtg - Kspar

dito. rock

Microscopic description

Minerals

large plagio = andesine-labradorite
ragged, eqh by gm.

zoned Kspar.

5-10% py pseudo.

Textures

PETROGRAPHIC ANALYSIS

94 Hills Reconn.

Section No. 94-10

Rock Name granite gneiss %

Megascopic description grungy whit-pinkish-greenish granite
granulated, weakly sheared.

2-3mm feldspar — 70% K-spar 35% Plagioclase 35% No K stain
2-3mm quartz — 25%
streaked biotite — 5%
minor muscovite

See Sec. 11 stain

Microscopic description

Minerals

deested through on feldspars & biotite.

Textures

PETROGRAPHIC ANALYSIS

94 Hill Recon.

Section No. 94-11

Rock Name

Megascopic description White to creamy sheared. granulated

1-3mm. Kspar — 30-35%
1-3mm Plagioclase — 30-35%
2-3mm. Quartz — 20-25%
1— streaky Biotite — 5-10%
1/2-1 mm books Muscovite — 2-3%

K-stained

Microscopic description

See Sec. 10.

Minerals

Cores of Feldspars altered & altered by sericitic-glycolitic?

FI- moderate sized, well and type 1.

Textures

PETROGRAPHIC ANALYSIS

96 Hills Reconn.

Section No. 96-12A

Rock Name

Megascopic description Dirty grungy greenish grey sheared. granulated mosaic of.

No K-stain on glob!

2-3 mm. Plagioclase ——— 40-60%

1/2x2 mm. Hornblende needle ——— 20-30%

1x2 mm. Mag-hematite (sphene?) - 20-30%

1 mm quartz ? ——— 5%

flakes Muscovite ——— 2%

K-stained

Border phase (?)

Microscopic description

Minerals

wholesale replacement of feldspar & hornblende + most of qtz by sericite

mag-hema value probably close to 5-10%

brn-greenish hornblende 50-60%

96-11

See 96-12B

-12C

-18

-14A

-14B

Textures

PETROGRAPHIC ANALYSIS 96 Hills Recon.

Section No. 96-12 B.

Rock Name

Megascopic description Greyish white, cataclastic granulated

2-4 mm Plagioclase — 40-50%
½-1 mm K Spar — 2-3%
2-5 mm Quartz — 40%
½x2, 1x1, aggregate smears Biotite — 10-15%
flakes Muscovite — 2-3%

K stained

Microscopic description

Minerals

oligoclase

FI, numerous euhedral inclus., some second. olig.
T-1.

Textures

PETROGRAPHIC ANALYSIS

96 Hills Reconn.

Section No. 96-12 C.

Rock Name

Megascopic description Dirty Grungy greenish grey
sheared, cataclastic, granulated

mosaiced ½x1mm Plagioclase — 40%
½x1, 1x1 Mag-hematite — 20%
½x1 biotite ? hulled ? tan or grey-blue 40%
trace quartz — tr.

No K stain

Microscopic description

Minerals

carbonate ? - sericitic dusting, alignment of zones throughout.

small intragranular qtz; perhaps up to 10% in gmm.

no particular F.I.'s

Textures

Intrudes 96-12A, or a phase of.

PETROGRAPHIC ANALYSIS

Hills Recon
Tortolita Mtn

Section No. T-96-13

Rock Name Tertiary basalt
MF-844
Sec. 1, T9S, R12E

Megascopic description

Black lumps, vesicular basalt

No K-stain

Microscopic description

Minerals

Tb BASALT FLOWS--Three or more flows of black to dark-gray, dense to vesicular porphyritic basalt. Phenocrysts are 5-10 percent euhedral to resorbed, partly glomerocrystic, glassy plagioclase (An_{60-65}, as much as 15 mm long); 4-8 percent euhedral to resorbed, glassy clinopyroxene and orthopyroxene (as much as 15 mm long); 3-9 percent euhedral glassy olivine (as much as 3 mm long); and <1 percent subhedral magnetite (as much as 0.8 mm long). Groundmass has intergranular texture, makes up 75-85 percent of the rock, and consists of about 40 percent plagioclase laths, 25 percent olivine and pyroxene, and 15 percent opaque minerals. Apatite is the accessory mineral. Vesicles and quartz amygdules occur locally. Unit has been dated by K-Ar methods on whole rock at 21.0±0.5 m.y. by Jennison (1976), who reports its chemistry to be alkali basalt

Textures

PETROGRAPHIC ANALYSIS

94 Reconn.
Tortolita Mtn

Section No. T-94-14A

Rock Name Schistose Oracle Granite
NE 1/4 Sec. 34, T8S, R12E.
MF-844

K-stained

Megascopic description Schistose grey

More schistose of unit
weak K-stain in 30-40% of gm.

fine grained matrix and increased matrix of sheared muscovite-chlorite

Microscopic description

Minerals

μ(Yo)

mylonitic to ultramylonite and schistose at greenschist

ORACLE GRANITE OF PETERSON (1938) (Precambrian Y)--Coarse- to very coarse-grained porphyritic quartz monzonite to medium-grained hypidiomorphic quartz monzonite. Unit includes unmapped diabase, pegmatite, and aplite dikes. Aplite dikes are especially numerous northeast of Owl Head Buttes. Pegmatite dikes commonly contain schorl; in contrast, pegmatite dikes associated with the Tertiary intrusive complex rarely do. Potassium feldspar phenocrysts in exposures around Antelope Peak sometimes exceed 10 cm in length and grain size of groundmass is about 1 cm. East of Guild Wash, beneath the Apache Group, unit is medium-grained hypidiomorphic granular to medium-grained porphyritic. Overall grain size, crystal form, and composition of unit varies. Plagioclase (An_{20-40}, 20-40 percent of the rock) is generally subhedral to euhedral. Microcline phenocrysts are subhedral to euhedral and groundmass potassium feldspar is anhedral; together they make up 20-50 percent of the rock. Quartz and biotite are anhedral and compose 30-40 percent and 3-15 percent of the rock respectively. Magnetite is generally euhedral and constitutes <1 percent of the rock. Sphene, unlike sphene in the Tertiary rocks, is rare, metamict, and anhedral. Apatite, zircon, and, rarely, hornblende are accessory minerals, and biotite is in some places converted to muscovite as well as to ubiquitous chlorite. At the margins of the Tertiary plutons and also in inclusions in the plutons the Oracle Granite is progressively converted to augen gneiss and schistose mylonite. The mylonitic rocks are strongly foliated and tightly folded and except for their lack of variety resemble some facies of Pinal Schist. Banks, Dockter, and Briskey recognize that xenoliths of Pinal Schist might be present in exposures mapped as mylonitic Oracle Granite, particularly the one on the north flank of the Tortolita Mountains because of nearby outcrop of unequivocal Pinal Schist. However, such xenoliths were not recognized by variations in composition or foliation, and they feel that it is doubtful whether positive identification of such xenoliths could be made where their host rocks have been converted from coarse-grained igneous rock to schistose mylonite. Davis, Keith, Budden, Kiven, and Anderson originally mapped the strip of rocks shown as mylonitic Oracle Granite along the northern flank of the Tortolita Mountains as Pinal Schist, locally bounded on the north by sheared Oracle Granite. Although they now recognize that Oracle Granite can grade into schistose rocks, Davis, Keith, Budden, and Kiven feel that both alternative interpretations of these rocks are possible and prefer that this strip of rocks be mapped simply as schist without designation of the percursor rock, pending further investigations. Anderson considers that the southern half of this strip is Pinal Schist

Textures

PETROGRAPHIC ANALYSIS

94 Reconn
Tortolita Mtns

Section No. T-94-14B

Rock Name Schistose Oracle Granite
MF-844
~~[illegible]~~.
NE 1/4 Sec. 34, T8S, R12E

Megascopic description schistose grey

More granitoid of the two sections.

very weak scattered 1/2-1 mm granules in light streaks of "schist". 20-40% in gm.

K-Stained

mainly qtz granules 1/4-1/2 mm sheared & granulated with minor Plagioclase granules in sheared muscovite-albite.

Microscopic description

Minerals

μ(Yo) mylonitic & ultramylonitic and schistose to gneissic

ORACLE GRANITE OF PETERSON (1938) (Precambrian Y)--Coarse- to very coarse-grained porphyritic quartz monzonite to medium-grained hypidiomorphic quartz monzonite. Unit includes unmapped diabase, pegmatite, and aplite dikes. Aplite dikes are especially numerous northeast of Owl Head Buttes. Pegmatite dikes commonly contain schorl; in contrast, pegmatite dikes associated with the Tertiary intrusive complex rarely do. Potassium feldspar phenocrysts in exposures around Antelope Peak sometimes exceed 10 cm in length and grain size of groundmass is about 1 cm. East of Guild Wash, beneath the Apache Group, unit is medium-grained hypidiomorphic granular to medium-grained porphyritic. Overall grain size, crystal form, and composition of unit varies. Plagioclase (An_{20-40}, 20-40 percent of the rock) is generally subhedral to euhedral. Microcline phenocrysts are subhedral to euhedral and groundmass potassium feldspar is anhedral; together they make up 20-50 percent of the rock. Quartz and biotite are anhedral and compose 30-40 percent and 3-15 percent of the rock respectively. Magnetite is generally euhedral and constitutes <1 percent of the rock. Sphene, unlike sphene in the Tertiary rocks, is rare, metamict, and anhedral. Apatite, zircon, and, rarely, hornblende are accessory minerals, and biotite is in some places converted to muscovite as well as to ubiquitous chlorite. At the margins of the Tertiary plutons and also in inclusions in the plutons the Oracle Granite is progressively converted to augen gneiss and schistose mylonite. The mylonitic rocks are strongly foliated and tightly folded and except for their lack of variety resemble some facies of Pinal Schist. Banks, Dockter, and Briskey recognize that xenoliths of Pinal Schist might be present in exposures mapped as mylonitic Oracle Granite, particularly the one on the north flank of the Tortolita Mountains because of nearby outcrop of unequivocal Pinal Schist. However, such xenoliths were not recognized by variations in composition or foliation, and they feel that it is doubtful whether positive identification of such xenoliths could be made where their host rocks have been converted from coarse-grained igneous rock to schistose mylonite. Davis, Keith, Budden, Kiven, and Anderson originally mapped the strip of rocks shown as mylonitic Oracle Granite along the northern flank of the Tortolita Mountains as Pinal Schist, locally bounded on the north by sheared Oracle Granite. Although they now recognize that Oracle Granite can grade into schistose rocks, Davis, Keith, Budden, and Kiven feel that both alternative interpretations of these rocks are possible and prefer that this strip of rocks be mapped simply as schist without designation of the percursor rock, pending further investigations. Anderson considers that the southern half of this strip is Pinal Schist

Textures

apparently lot of former FI's but none now filled.

Plag 20-40%
Kspar 20-50%
Qtz 30-40
Musc 3%

note: not at all ≅ to grgn of 11 et

PETROGRAPHIC ANALYSIS

96 Hills Recom.
Tortolita Mtns

Section No. T-96-15

Rock Name fine grained diorite

Sec. 7, T8S, R12E
Tsgd MF-864

K-Stained

Megascopic description dark greenish black

Phenos: 35-40% biotite clasts, 1, 2-3 mm — 60-70%

K-spar 2-5 mm — 30-40%

Plagioclase 5-10%

gm 60-65% K-spar 15-20% and about biotite 20-30%

Quartz 40-50%

Microscopic description Oligoclase

Minerals

Tsgd GRANODIORITE, QUARTZ DIORITE, MONZODIORITE, AND DIORITE--Composition and texture of unit vary from fine- and medium-grained hypidiomorphic granular diorite to medium-grained porphyritic granodiorite. Approximate rock composition is: Plagioclase (An_{30-50}), 35-65 percent; potassium feldspar (orthoclase and locally microcline), trace to 20 percent; quartz, 2-20 percent; hornblende (some with remanent pyroxene), 6-18 percent; biotite, 10-26 percent; opaque minerals, 1-4 percent; sphene, 1-4 percent; accessory apatite and zircon; and locally abundant epidote replacing mafic minerals. Foliation is present in most exposures and the rock is commonly gneissic. Highly folded schistose mylonitic equivalents occur in an east-west-trending strip south of the pegmatite complex in the Tortolita Mountains. This strip is predominantly mylonitic border phase rock and mylonitic pegmatite; on the north it grades into gneissic pegmatite and quartz diorite. Davis, Keith, Budden, and Kiven prefer that this strip be designated a schist without designation of the protolith pending further investigation, and Anderson considers it to be Pinal Schist

Textures

Hard ribs of ~~granodiorite~~-diorite in equivalent equigranular mafic-rich, sugary textured unit which disintegrate readily.

PETROGRAPHIC ANALYSIS

94 Hills Recon
Tortolita Mtns

Section No. T-96-16A

Rock Name T ~~Samaniego~~ Samaniego gtz monzonite

MF-844

Ecentr Sec. 18
T8S, R12E.

Megascopic description Speckled med grey
"Coolidge Type" gr. Large phenos.
± equigranular w/ 3-5 mm K-spars
2-3mm K-spar. —— 30-40
1x2, 2x2mm Plagioclase — 30-40
1x2 flakes biotite — 10-20
2 mm quartz — 5-10

K Stained

Microscopic description

Minerals

Oligoclase-Andesine
well zoned feldspars.

Cataclastic texture
intragranular gtz
granulation & biot-chlorite
shearing.

rare T-2 FI's mainly within feldspar phenos.
abundant trails - biot dem?

Tsqm QUARTZ MONZONITE OF SAMANIEGO RIDGE--Texture, grain size, and composition are variable; most commonly medium to coarse-grained porphyritic quartz monzonite with potassium feldspar phenocrysts as much as 5 cm long, but equigranular textures and granite and granodiorite facies or phases are not uncommon. One or more phases are locally garnet-bearing two-mica gneiss (indicated by parentheses enclosing symbol) and locally protomylonitic, mylonitic, or ultramylonitic rock (indicated by Greek letter μ). Rock in the gneissic and mylonitic exposures is strongly foliated and lineated and locally contains as much as 30 percent unmapped pegmatite dikes. Composition of undeformed quartz monzonite rock varies as follows: Subhedral to euhedral plagioclase (An_{15-25}), 25-40 percent; orthoclase, perthite, or microcline, 25-40 percent; quartz, 15-30 percent; biotite, 3-10 percent; hornblende, 0-2 percent; opaque minerals, <1-1 percent; accessory apatite, zircon, and locally abundant sphene. The gneissic quartz monzonite contains muscovite that replaces biotite; garnet; plagioclase; potassium feldspar; magnetite; and accessory apatite, zircon, and sphene. The grain size of the igneous minerals has been reduced by cataclasis. Potassium feldspar and apatite appear most resistant to cataclasis; plagioclase and magnetite are less resistant; and quartz, sphene, and biotite, least resistant

Textures

PETROGRAPHIC ANALYSIS

96 Recorn
Tortolita Mtns

Section No. T-96-14B

Rock Name

granit aplite dike cutting
75 yrs of Sec. T-96-14A.
MF-844
Eccalta Sec. 18, T8S, R12E.

K-Stained.

Megascopic description Light tan
Mosaic
1-4mm Kspar ——— 40-50%
1-2mm Plagioclase — 20-30%
1/4-1 mm flakes Biotite — 5%
1-2mm Quartz ——— 20-30%
8 gm. (± 20%).

Microscopic description

Minerals

albite to Oligoclase

abundant trashy blk biotite ~~to~~ in gb. fair-fang FI's.

small qtz eyes in K-spar show good T-2 (large gas) FI's

PEGMATITE AND APLITE DIKES--Individual pegmatite and aplite dikes. Aplite dikes are both cut by and widen into pegmatite dikes; some are porphyritic. Pegmatite dikes range in thickness from 5-10 cm to 3 or more meters and are concentrated in and near the pegmatite complex and near and parallel to margins of individual intrusive bodies. Aplites are composed of about one-third each of plagioclase (An_{10-25}), orthoclase, and quartz plus 1-3 percent biotite and magnetite. Accessory minerals are apatite, zircon, and allanite

Textures

PETROGRAPHIC ANALYSIS 96 Hills Reconn.

Section No. 96-18

Rock Name

Megascopic description grey-white - blk speckled
somewhat greenish, cataclastic, sheared

2-4 mm	K-spar	—	25-30%
2-4 mm	Plagioclase	—	25-30%
2-4 mm	Quartz	—	25-30%
interstitial	Biotite	—	10-15%
bookish	Muscovite	—	2-3%

K stained

Microscopic description

Minerals

96-11
See 96-12A
-12B
-12C

abundant greenish & sericitic in plagioclase cores & edges. also in K-spar & some qtz.

-14A
-14B

FI's, abund and with nice FI of moderate extent.

11 & 18 main phase.

Textures

PETROGRAPHIC ANALYSIS

Section No. AT-96-19

Rock Name gr gn

Megascopic description

graphic granite, granulated, weakly gneissic

2-4mm. Plagioclase 40-50%
2-3mm Qtz 30-40%
1/2-1mm o interstitial K-fsp 5-10%
biotite shreds 3-5%

K-stained

narrow stained fracture system
apparent silica cement in granulated fragment.

should be gr gn.

Microscopic description

Minerals

individual fragments set in
crushed dark matrix of fb?-feldspar?
(i.e. Plagioclase of above).
angle of fragments = 15°-20° = albite Carlsbad
& Albite-twin (+30°)

FI's. abundant small gas bubbles
of T-1 type.
few T-2.

Textures

PETROGRAPHIC ANALYSIS

Section No. T-96-20

Rock Name gr gn.

Megascopic description

Equigranular granite, widely porphyritic texture
weakient granulation

2-3,5mm K-spar granule 60%
2-3mm Quartz 35%
2-3mm Plagioclase 10%?
1x2mm bochish blk biotite 5%

K-stained

Microscopic description

Minerals

tr muscovite
zones K spar
sway qtz - Kspar %

serated chewed edges on qtz granules

very trashy gb's w/ trash along growth lines etc
rare small T-1's.

Textures

PETROGRAPHIC ANALYSIS 96 Hills Reconn.

Section No. 96NW-D 2A

Rock Name Granite type

Megascopic description milky chalky-grey white

2-4 mm. K-spar ——— 30-40%
2-4 mm Plagioclase ——— 30-40%
2-4 mm Quartz ——— 20-30%
1/2-1 mm bookish Biotite ——— 10-15%
1/2-1 mm bookish Muscovite — 1-3%

K-stained

Microscopic description

Minerals

Oligoclase
Feldspar partially altered & incipient red by gb-seri.
Some zoned feldspars.

Textures

Cobble from conglomerate drill core.

PETROGRAPHIC ANALYSIS

94 Hills Recon.

Section No. 94NW-D2B.

Rock Name Chocolate type.

Megascopic description grey-white, spotted, gr.

5-10 mm K Spar ——— 30-35%
3-5 mm. Plagioclase ——— 30-35%
3-5 mm. Quartz ——— 30-35% K stained
2-4 mm bochesh. Biotite ——— 10-15%

Microscopic description

Minerals

Labradorite.
all plag. thoroughly alt & sucked w/sericite.
minor epidote.

FI - mod amt of both T-1 & T-2.

Textures

Bedrock (?) drill core.

PETROGRAPHIC ANALYSIS

JRK's Red Hills Room

Section No. 11-20-1

Rock Name

Megascopic description

Microscopic description

Minerals

zoned feldspar, mainly plagioclase?
small, interstitial muscovite

Textures

JRK's PE-S9 double mica

PETROGRAPHIC ANALYSIS

JRK's Red Hills Recon.

Section No. 11-20-11

Rock Name

Megascopic description

Microscopic description

Minerals

greenish hornblende interstitial
labradorite ind.
zoned feldspars.

Textures

JRK's Lgyd Lavanda Greyhook sandstone.

PETROGRAPHIC ANALYSIS JRK's Red Hills Recon.

Section No. 11-20-7

Rock Name

Megascopic description

Microscopic description

Minerals greenish augite & hornblende biotite

Textures

JRK's Lpgm Laramid (Graybeck granodiorite) porphyritic monzonite core.

PETROGRAPHIC ANALYSIS JRK Red Hill Reconn.

Section No. 11-29-1

Rock Name

Megascopic description

Microscopic description

Minerals greenish hornblende bodies with alteration?

Oligoclase

Textures

JRK's Lsgs Laramide (?) southern Grayback granodiorite.

PETROGRAPHIC ANALYSIS JRK-Red Hills Reconn.

Section No. 11-29-4

Rock Name

Megascopic description

Microscopic description

Minerals minor hydrodar muscovite ? intergrowth intergrowth of feldspar.
rare brown biotite altered to chlorite
Oligoclase.

Textures

JRK's L tmg Laramide(?) thus mica granite.

Note # 12-1-7 has abundant hydrodar muscovite as books. also zoned feldspar. Oligoclase

PETROGRAPHIC ANALYSIS

JRK's Red Hill Recon

Section No. 11-9-9

Rock Name

Megascopic description

Microscopic description

Minerals

- abundant biotite
- some green hornblende
- zoned feldspars
- Oligoclase

Textures

JRK's Lgd Laramide quartz diorite (borderline Granodiorite?)

JRK Thin-Section Points.

Southern Grayback & SG two mica

✓ 11-16-5

✓ 11-16-17

✓ 11-20-1

✓ 11-29-1

✓ 11-29-4

✓ 12-1-7

✓ 12-7-1

Logs
moved to cards.
Lt mag

moved all to cards

Grayback & qtz diorite

✓ 11-9-9

Lgd (hook? phase).
moved to card.

✓ 11-18-3

✓ 11-20-5

✓ 11-20-7

✓ 11-20-11

Lgd (main phase).
moved to cards.
Lgd (main phase).

✓ 11-20-12

✓ 11-20-10

✓ 12-1-2

✓ 12-1-3

Call Conoco 622-2895

Bill Rehrig
~~Gordon Pine~~ → to Reno

? age date of double mica granite NW of
Mt Greyback (63 my). Gila River, W of Kelvin.

Rumor KCC dated a double mica granite
south of the Kelvin-Florence road and
came out with a compatible Greyback ±63 my
date. Valal B Rehrig 1/13/78

96 Hills SW Quad

Legend

Quaternary

Qs, Qsg, Qc, Qar — sand, sand & gravel, caliche, and alluvial rubble & related materials of surficial cover.

Tertiary

735½ — Tpc — Palo ~~Co~~ conglomerate

[illegible] — Thv — hornblende volcanic dikes

737 — Tsgd — Samaniego granodiorite complex.

Laramide

736½ — Tqp — quartz porphyry dike

752 — Ta — andesite dikes

745½ — Tr — rhyolite dikes

739, 745½ — Tdp — dacite porphyry dikes (epidot)

Tlp — latite porphyry dikes

739 — Tl — latite dikes

755 — ~~Lgn~~ Lgg — gneissic granite

~~Precambrian~~

~~mmg — Middle Mountain granite~~

Precambrian

735 — qga — quartz granite aplites (may in part be of younger age)

738½ — db — diabase

743½ — mmg — Middle Mountain granite

734½ — pi — Pinal Schist

740 — F — fault

744 — CuOx — copper oxide mineral

744 — hem — hematite stain

DH — drill hole

schistosity

bedding

x-⑧ sample site and number

96 SW Units

Qs, Qsg, Qc, Qar
sand, sand & gravel, caliche, alluvial rubble general trend makeup of the covering surficial material.

139	Thv, hornblende volcanic.		(dikes)	(light violet, polyg)
735½	Tpc, Palo conglomerate			(lemon yellow)
736½	Tqp, quartz porphyry	T-96-5	(dike)	(orange ochre)
752	Ta, andesite	T-96-6	(dike)	(purple)
745½	Tr, rhyolite	T-96-4	(dikes)	(terracotta)
739	Tdp, dacite porphyry	T-96-9A	(dikes)	(green)
745½	Tlp, latite porphyry	T-96-9B	(dikes)	(terracotta)
739	Tl, latite	T-96-3	(dikes)	(green)
737	Tsgd, Samaniego granodiorite complex	AT-96-15		(orange)

Precambrian:

173	db, diabase	T-96-2	(dikes & masses)	(dirty grn, polygon)
735	qga, quartz granite aplite		(dikes)	(canary yellow)
755	Lgngr ~~gn~~, gneissic granite, ~~gneiss~~, cataclastic, ped. equivalent to ~~mmg~~	T-96-10, 11, 12A, 12B, 12C, 18, 19, 20.	JRK's Southern Granite (Golden brown)	
743½	mmg, Middle Mountain granite, equigranular double mica granite	T-96-1, 1A, 7, 8.		(rose)
734½	pi, Pinal Schist	T-96-17.		(light grey)

940	f, fault	(ultramarine blue)
744	CuOx, mineral	(scarlet red)
744	Hematite (hem)	
	DH, drill hole.	

schistosity

bedding

Geochem Comparisons

		Cu	Pb	Zn	Mo	
AT-96-1	mmg, tourm	31 } 35	10 } 25	29 } 35	2	
AT-96-8	mmg	40	43	46	1	
AT-96-7	mmg w/carb/mn	85	105	100	3	0.27% Mn low Au Ag.
~~gr~~ gn-gr						
AT-96-10	~~Cox~~					
AT-96-18		703 } 530	13 } 12	32 } 37	3 } 2	
↓		362	11	42	1	
AT-96-19 (core/none)		109 } 391	68 } 31	50 } 41	5 } 3	
ℓ (Yd)						
AT-96-14B		42	34	67	4	
Tsgd						
AT-96-15		94	21	58	2	
Grind Schr						
A-96-17		30	12	80	1	
96-3 Tgl		126	18	41	1	

Addenda to Red Hills Report
JR King

2599

Aa-16A.2.18

REGIONAL GEOLOGY

Attachment A shows the geology of the Grayback, North Butte, Ninety-Six Hills N.W., and Ninety-Six Hills N.E. quadrangles at a scale of one inch to the mile. The geology shown in the northeast corner of the map is in part a compilation from work by E.A. Schmidt and H. Cornwall. The geology along the southern quarter of the map was compiled from field work restricted to road reconnaissance.

Precambrian Oracle "granite" (1420 my, K-Ar) and associated aplite are the oldest rocks found in the map area. Diabase sills intrude the Oracle granite and aplite and are Precambrian in age (1140 my, K-Ar at Ray). The aplite and diabase are not differentiated on the regional map. In the southern part of the map area, east of Ninety-Six Hills, the Oracle granite displays a gneissoid texture and an unusually high biotite content.

A distinctive medium to fine-grained, two-mica granite is found cropping out in the Ninety-Six Hills - Middle Mountain area, and to the northwest of Mt. Grayback. These rocks are equigranular, gneissic granites and are felt to be Precambrian in age, roughly equivalent to the "Solitude" granite (800-900 my, K-Ar).

To the north of Ninety-Six Hills lies a coarse-grained two-mica granite stock (Ltmg), which is considered to be the oldest Laramide(?) stock in the area. It displays a very gradational contact with the Laramide(?) Southern Grayback "granodiorite" (Lsgg) to the north.

The Southern Grayback "granodiorite" is a coarse-grained, one-mica (biotite), quartz monzonite that crops out along the Florence-Kelvin highway in the vicinity of Box-O Wash and to the east of Red Hills. This stock, along with the previously mentioned Laramide(?) two-mica granite stock, weathers to a distinctive grayish-white grus leaving characteristic boulder-field appearing outcrops. Numerous barren andesitic sills and dikes are intruding the Southern Grayback "granodiorite" in Sections 17, 20, and 21, and are not differentiated on the geologic map. Both the Southern Grayback "granodiorite" and the Laramide(?) two-mica granite could easily be Precambrian in age.

A previously unrecognized Laramide(?) granite porphyry stock is shown cropping out in Box-O Wash north of the Florence-Kelvin road. This porphyritic intrusive is anomalous in that it appears either to be a crystal "mush" intrusion or in part a granitized sedimentary rock. Large subhedral and anhedral phenocrysts of orthoclase, quartz, and plagioclase are suspended in an anhedral groundmass of orthoclase, quartz, plagioclase, biotite and muscovite. To the southeast this intrusive is in fault contact with the Southern Grayback granodiorite and to the northwest it displays ambiguous gradational contacts with the Precambrian Oracle granite.

Three quartz diorite stocks crop out in the map area. These rocks are medium to fine-grained, equigranular hornblende-biotite quartz diorites and are probably correlative to the Sonora diorite (69 my, K-Ar) as described by E.A. Schmidt. With older rocks, the quartz diorite shows sharp intrusive contacts; however, with the Grayback granodiorite stock, the quartz diorite shows a non-definable gradational contact. It is possible that the quartz diorite may be an intrusive phase of the Grayback stock.

The Grayback granodiorite stock is an internally zoned Laramide intrusive (62 my, K-Ar, 63 my fission track) and is correlated to the Granite Mountain porphyry at Ray. The Grayback varies from a medium-grained, equigranular granodiorite border phase; to a coarse-grained, equigranular granodiorite phase; to a coarse-grained, porphyritic quartz monzonite core phase. The Grayback stock is cut by numerous genetically related aplitic bodies (Sections 23 and 14), by Tertiary(?) andesitic sills and dikes, and by Tertiary(?) porphyritic rhyolite dikes.

The Laramide porphyritic granodiorite dikes intrude only Precambrian Oracle granite and diabase. In the Red Hills area, porphyritic granodiorite dikes form a dike swarm which is delineated by the abundance, the wrapping outcrop patterns, and the areally restricted occurrence of the dikes. The porphyritic granodiorite dikes control hydrothermal alteration and mineralization and, as such, delineate a center of weak propylitic alteration and weak sulfide vein mineralization. These dikes at the Red Hills prospect are exact duplicates (in hand specimen) to the porphyritic granodiorite dikes at San Manuel and at the Kalamazoo window.

Porphyritic quartz monzonite and porphyritic rhyolite dikes are present in parts of the district, but these dikes show neither genetic control of hydrothermal mineralization and alteration, nor anomalous outcrop distribution. The porphyritic quartz monzonite dikes intrude most pre-mineral rocks and some may be Laramide in age. All of the porphyritic rhyolites are post-mineral and are considered mid-Tertiary in age.

Other mid-Tertiary (32-11 my) units mapped are the Miocene Whitetail conglomerate and the younger dacite volcanic sequence. The Whitetail conglomerate strikes north-northwest and dips between 25° and 85° to the east. Each Whitetail block is bounded on the east by west-dipping antithetic faults and on the west by an assumed east-dipping erosional surface. The dips of the conglomerates in each block are generally steeper (up to 85°) near the erosional surface and become shallower (25° minimum) to the east. This indicates deposition of the Whitetail occurred in local basins which were forming during mid-Tertiary rotational tectonism. Included as part of the Whitetail conglomerate are several monolithologic brecciated masses composed of pre-Whitetail rocks. The true nature of these units is speculative since Precambrian Oracle granite and diabase compose most of the mega-breccias and these rocks, by typically weathering to a grus, do not readily form interpretable outcrops. However, the few old pits and adits still open in these areas always exposed monolithologic breccia in the walls. It is proposed that these units are mega-breccias and are therefore fault slivers or blocks which moved onto (or into) Whitetail basins during basin formation. These mega-breccias would be similar to those described by E.A. Schmidt in the Ripsey Wash area; by M. Krieger in the Kelvin area; and by S. Creasey in the San Manuel area.

The dacite volcanic sequence is a catch-all term used to refer to any dacitic volcanic or volcani-clastic unit older than the Gila conglomerate, but younger for the most part than Whitetail conglomerate. This sequence is felt to be correlative to the Apache Leap tuff of the Superior area. In the map area, dacite is in part volcanic and younger than Whitetail, and in part volcani-clastic and interbedded in upper Whitetail. The dacite usually dips between 20° and 30° to the east and is usually bounded on the east by west-dipping antithetic faults.

96 Hills SW Quad

Legend

Quaternary

Qs, Qsg, Qc, Qar — sand, sand & gravel, caliche, and alluvial rubble & related materials of surficial cover.

Tertiary

735½	Tpc	Palo Verde conglomerate	735½ lemon yellow
	Thv	hornblende volcanic dikes	139 lt violet, polychrome
737	Tsgd	Samaniego granodiorite complex	737 orange

Laramide

736½	Tqp	quartz porphyry dike	736½ orange ochre
752	Ta	andesite dikes	752 purple
745½	Tr	rhyolite dikes	745½ terra cotta
739 / 745½	Tdp / Tlp	dacite porphyry dikes (solid) / latite porphyry dikes	739 / 745½ green & terracotta
739	Tl	latite dikes	739 green
755	~~Lgn~~ Lgg	gneissic granite	755 golden brown

~~Precambrian~~

~~mmg Middle Mountain granite~~

Precambrian

735	qga	quartz granite aplites (may in part be of younger age)	735 canary yellow
738½	db	diabase	738½ light green
743½	mmg	Middle Mountain granite	743½ rose
734½	pi	Pinal Schist	734½ light grey

940	F	fault	940 ultramarine blue
744	CuOx	copper oxide mineral	744 scarlet red
744	hem	hematite stain	744 " "
	DH	drill hole	
		schistosity	
		bedding	
	x-⑧	sample site and number	

96 Hills SW Quad

Legend

Quaternary

Qs, Qsg, Qc, Qar — sand, sand & gravel, caliche, and alluvial rubble & related materials of surficial cover.

Tertiary

735½ — Tpc — Palo ~~Co~~ conglomerate

139(Pdy) — Thv — hornblende volcanic dikes

737 — Tsgd — Samaniego granodiorite complex.

Laramide

736½ — Tqp — quartz porphyry dike

752 — Ta — andesite dikes

745½ — Tr — rhyolite dikes

739 — Tdp — dacite porphyry dikes

745½ — Tlp — latite porphyry dikes

739 — Tql (Quartz) — latite dikes (quartz)

755 — ~~Lgrg~~ Lgg — gneissic granite

~~Precambrian~~

~~mmg Middle Mountain granite~~

Precambrian

735 — qga — quartz granite aplites and pegmatites (may in part be of younger age)

738½ — db — diabase

743½ — mmg — Middle Mountain granite

734½ — pi — Pinal Schist

740 — F — fault

744 — CuOx — copper oxide mineral

744 — hem — hematite stain

DH — drill hole

schistosity

bedding

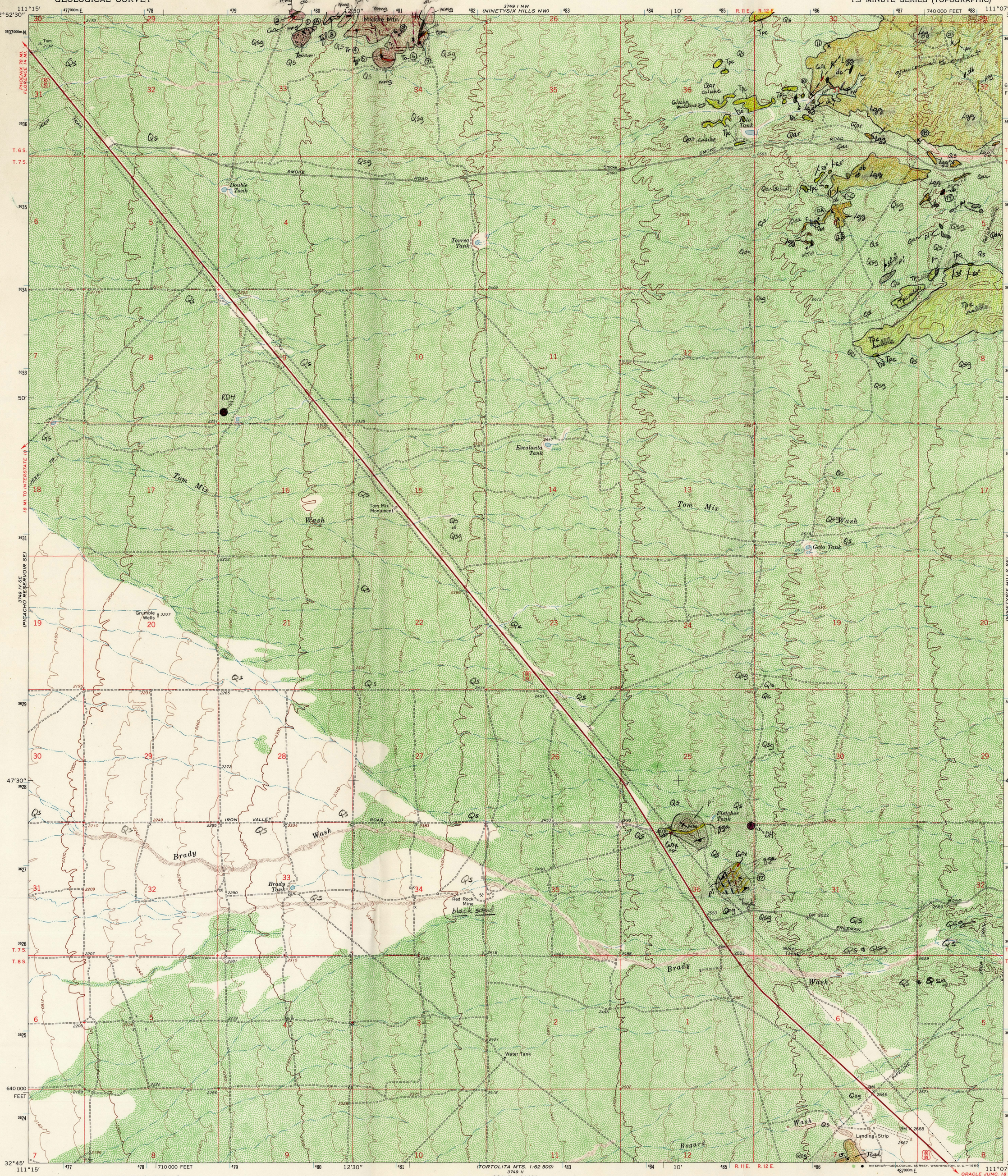
X-⑨ — sample site and number

tourm — tourmaline

Buckskin

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

NINETYSIX HILLS SW QUADRANGLE
ARIZONA—PINAL CO.
7.5 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 1962. Field checked 1966

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

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

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

QUADRANGLE LOCATION

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

NINETYSIX HILLS SW, ARIZ.
N3245—W11107.5/7.5
1966
AMS 3749 I SW—SERIES V898

Compilation

A-Assay T-Thin Section 96 Samples.

AT-96-1 Red, tourmaline granite mmg
AT-96-1A White equivalent gr of 96-1 mmg
T-96-2 slate dike, qtz Tgl
AT-96-3 diabase db
T-96-4 rhyolite dike feldspar. Tr
T-96-5 qtz eye sugar porphyry Tqp
T-96-6 brown coated rhyolite (type 96-4) Fe rich carbonate. Ta
AT-96-7 carbonated gr w/ Mn.
AT-96-8 Typical muscovite, coarse xln, white granite
T-96-9A biotite-feldspar granitoid dacite porphyry Tdp
T-96-9B dike rock, light grey, very fine xln, glassy feldspars, speckled no quartz Tlp
AT-96-10 Sheared, broken, grungy, slightly gneissic granite. gngr
AT-96-11 Equigranular, weakly gneissic pt type granite hi musc.
T-96-12A gneissic gr to gd to dark border phase (?). sheared, sheated
T-96-12B strongly gneissic white, more equigranular (alaskite?), biotite rich. hi musc.
T-96-12C mafic rich diabasic type gr-gn. see AT-19-18
T-96-13 Tb of Sec. 1, T 9S, R 12E Mt 864. 21 MY
T-96-14A u(40) of Sec. 34 T 8S, R 12E (schistose-granite) NE¼ of block musc.
AT-96-14B u(40) of " " " " (granite gneiss) NE¼ w/ hematite
AT-96-15 Tsgd of Sec. 7, T 8S, R 12E. weak Fe stain
T-96-16A Tsgm of Sec. T S, R E.
T-96-16B Tsgm granite aplite dike cutting 16A.
A-96-17 pt Quad Schist, arkosic-phyllic [illegible] (not, u 1/0)
AT-96-18 equigranular, weakly gneissic pt. type granite. gngr. hi musc.
AT-96-19 weakly gneissic granite, some graphic texture, cut by strong system of shears w/ manganese lenses.
T-96-20 gdsr gn. 3-4 mm equigranular fly feldspar granite (80%) with 20% 1-2 mm bladed type biotite with few irregular muscovite flecks. Has weak porphyritic texture. Weathers quickly to grus. Cut by large muscovite plates of granite pegmatite. (Rock core gone to more gneissic border zone of gngn.

EVENT - REVEILLE RACE

Four members must enter this contest, more may participate but in multiples of two.

Each team of two must have a two-man tent set up, 2 sleeping bags in the tent, and other equipment as listed, unpacked and in the tent. Upon the signal, each boy leaps from his sleeping bag, dresses, packs, and presents himself ready for a hike as a patrol at the lowest judging point.

Here are the rules:

1. The sleeping bag must be stuffed or rolled and attached to the pack by straps or tied with cord - no rubber or spring hooks.

2. The Scout will wear a swim suit while in the sleeping bag - that's all!

3. He must dress in a complete Scout uniform, including T-shirt, lace up boots or shoes and neckerchief.

4. Items to be carried in the pack
   a. 1 tent per 2 boys
   b. first aid kit
   c. canteen
   d. ax
   e. fieldbook or handbook
   f. note pad and pencil
   g. towel and toilet kit
   h. ground cloth
   i. eating utensil and plate
   j. raincoat or poncho
   k. jacket
   l. flashlight
   m. compass

Speed is important, but zippers must be zipped, pockets buttoned, etc. Things should not be hanging loosely from the pack and all pockets fastened. Each patrol must bring their own equipment.

The top two patrols from each district will compete in the afternoon council events.

Geodata drilling ??

FTG 5/5/77

CORE SAMPLE (4/28/77)

from D.H. # 2 (APPROX. LOC)

SE corner

SEC. COR. SEC. 17 ~~T. 10 S. R. 6 E~~ T. 6 S, R 11 E

D.H. #1 3000'

" # 3 200'

See map below.

several fragments of 1" to 3" section of NX core suggest red oxidized gravels with large clasts of weathered reddish granite (L?) (or cgl.) possible dip of 45° in layering fine 1/2 mm. hematite bodies

96 NW D#2A

2nd core piece is 8" of greenish, weakly epidotized light, dusty grey granite (PE?). large 2-3" interstitial hematite

Thin Sec. 96 NW D#2B

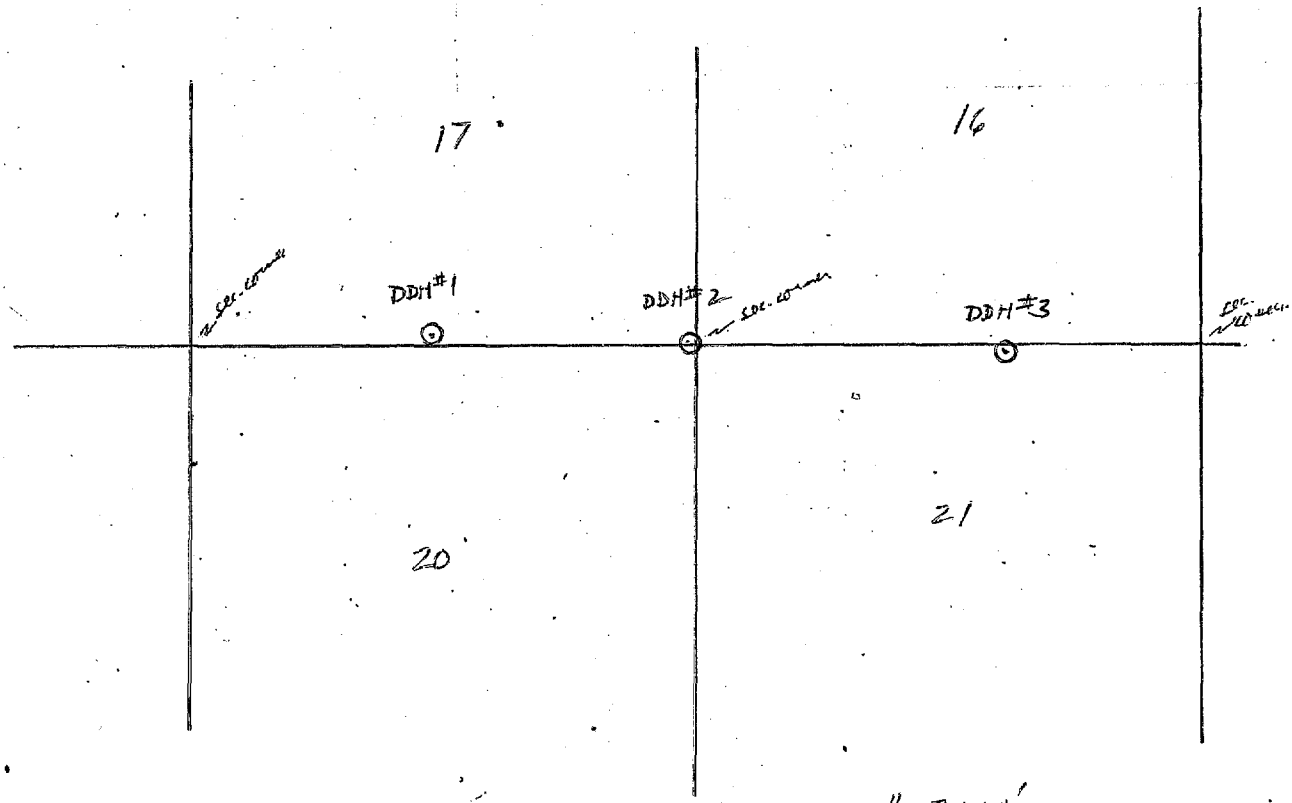
ASARCO'S AREA of INT.

SAME T. & R.

SEC. 7, 8, 9, 10, 11,

14 (10 CLS), 15 (10 CLS)

16, 17 & 18



1" = 2000'
96 Hills NW.

30		
31		
32	5/13/77	
33		
34	96-1	
35	-1A	
36	2	
37	3	X
38	4	X
39	5	
40	6	X
41	7	
42	8	
43	9A	
44	9B	
45	10	
46		
47	12A	
48	12B	
49	12C	
50		
	TOTALS	

36	
37	
38	
39	
40	
41	
42	
43	Sept 68
44	
45	T-96-13
46	-14A
47	-14B
48	-15
49	-16A
50	-16B
	TOTALS

37	
38	
39	
40	
41	10/14/97
42	
43	
44	
45	
46	T-96-18
47	
48	
49	
50	
TOTALS	

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS · CHEMISTS · METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY _____ DATE 11/11/77

SINGLE ANALYSIS ☑ Geochem

VERIFIED ANALYSIS ☐

UMPIRE QUALITY ☐

SAMPLE	Au	Ag	Cu	Pb	Zn	Ox Cu	Fe	Insol	Al_2O_3	SiO_2	Mo	S.
AT-96-19												
QDC-5-15												
-5-16												
	Sto.TS	&	K Stain									
AT-96-19	X		X					11/10/77				
T-96-20	X		X									

ASARCO

Southwestern Exploration Division

April 4, 1977

TO: F. T. Graybeal

FROM: D. M. Smith, Jr.

Drilling Results & Interpretation
Pioneer Project
Pinal County, Arizona

Summary

Following reconnaissance geologic mapping by H. G. Kreis (memo to F.T.G., Jan. 17, 1977) the Pioneer Project, EA-0113-00, was tested by one rotary drill hole with spot cores. Two additional 100' rotary holes were drilled to validate a group of twenty federal mining claims. Coring at the bottom of the exploration hole was done in a fault zone in Oracle Granite and aplite. In thin section the aplite shows traces of sericite alteration of plagioclase while the Precambrian rock displays recrystallization of its mica and plagioclase sericitization, both of moderate intensity. Primary Type II fluid inclusions are prevalent in quartz grains of the Oracle Granite.

My fault for not making clear not to stop hole in fault zone - F

Geochemical values from both rock types fall within the background range for felsic rocks as defined by Hawkes and Webb (1962).

The drilling confirmed the existence of porphyry-copper-type alteration but no mineralization 4000' west of the altered discovery outcrops. This prospect should be more intensively tested.

Drilling

All three holes were drilled by Shelton Drilling Company with a Failing 1500 Holemaster using the rotary and mud system. Spot cores were taken to aid in the location and identification of bedrock. Drilling of exploration hole PIO-1 (Figure 1, Table I) was commenced on February 8, 1977 and terminated on February 14, 1977. The two assessment work holes were drilled during the afternoon and evening of the 14th. Core samples for assay (Table II) were taken from the bottom of the hole. Total cost of the drilling phase of the project was $18,370.87 (Table III).

TABLE I - DRILL HOLE DATA

PIO-1 Feb. 8-14, 1977. SW1/4 S10, T6S, R11E.
Rotary: Surface to 1182.5 feet (excepting five cored intervals totalling 18.5 feet)
Core: 470-473.5, 40% recovery
740-743, 33% recovery
900-903.5, 74% recovery
908-911, 67% recovery
1177-1182.5, 42% recovery

Log:	Surface-440	Gravels: weakly to moderately propylitized granitic rock, caliche, <15% fragments Fe stained.
	440-780	Conglomerate: weakly propylitized granitic rock.
Core:	470-473.5	Conglomerate: well indurated, consisting of angular to subround boulders and subangular to subround gravel in buff-colored sandy matrix (80%) with calcitic cement. Fragments are gray unaltered fine-grained grd (95%) and dark greenish-brown andesite (5%).
Core:	740-743	Clay and broken boulder of light pink aplite.
	780-800	Gravels: granitic rock; andesite dike (20% of cuttings).
	800-920	Gravels: altered granitic rock (cuttings = 60% red-stained feldspar, 30% clean quartz, 10% weakly propylitized granite fragments).
Core:	900-903.5	Gravels: Oracle Granite and clay.
Core:	908-911	Gravels: Oracle Granite and clay.
	920-1020	Gravels: weakly propylitized granite, <10% Fe stain.
	1020-1040	Dike: dark greenish-black very fine-grained diorite(?), 20% red Fe stain.
	1040-1140	Gravels: weakly propylitized granitic rock, dike material decreases from 40% to 10% of cuttings.
	1140-1182.5	Bedrock: granitic
Core:	1177-1182.5	Light pink aplitic quartz monzonite separated by a 4" clay gouge fault zone from weakly iron-stained Oracle Granite (quartz monzonite in thin section). Mica in aplite is muscovite.

PIO-2 Feb. 14, 1977. NE1/4 S15, T6S, R11E.
Rotary: Surface to 100 feet, Gravels: fresh to moderately propylitized granitic rock. <5% red-stained feldspar.

PIO-3 Feb. 14, 1977. NW1/4 S14, T6S, R11E.
Rotary: Surface to 100 feet, Gravels: fresh to moderately propylitized granitic rock. Red-stained feldspar decreases from 30% to less than 5% of total cuttings.

TABLE II - GEOCHEMICAL AND PETROGRAPHIC DATA FROM HOLE PIO-1

Rock Type	Footage	Cu	Mo	Pb	Zn	Ag (ppm)	Au	Cu+Pb+Zn	Thin Section
qtz. monz. (aplite)	1182	35	<2	20	70	0.2	<0.02	125	X
qtz. monz. (Oracle)	1182.5	25	2	15	55	3.8	<0.02	95	X
background for felsic rocks (Hawkes and Webb, 1962)		30	1.9	48	60	0.15	0.01	138	

TABLE III - PROJECT COSTS

Field Charges	Cost	Cost/Foot
A. Direct Drilling (1382.5 feet)		
1. PIO-1 (1182.5')	$ 8,828.00	$ 7.47
2. PIO-2 (100')	550.00	5.50
3. PIO-3 (100')	550.00	5.50
B. Site Preparation and Cleanup	822.50	0.59
C. Field Administration		
1. Supervision and reports	3,216.59	2.33 — seems rather high
2. Assaying and Petrography	204.38	0.15
3. Miscellaneous	1,639.40	1.18
4. Rental Payments (land)	2,560.00	1.85
TOTAL EXPENDITURES	$18,370.87	$13.29
Authorization EA-0113-00	17,000.00	− 1.85
Overexpenditure	$ 1,370.87	$ 11.44

Petrography and Interpretations

Examination in thin section of the two rock types cored at the bottom of hole PIO-1 indicates that phyllic alteration although weak does indeed extend west of the discovery outcrops.

The Oracle Granite (actually a quartz monzonite) displays sericite-clay alteration of 40-50% of the plagioclase population, but less than 5% of the orthoclase. About half of the biotite is recrystallized. Primary fluid inclusions are abundant in quartz phenocrysts with Type II > Type I > Type III. Daughter products consist primarily of the opaque and prismatic crystal varieties.

The aplite was found to be a remarkably fresh quartz monzonite having a microgranitic texture. Less than 5% of the plagioclase has altered to a clay-sericite mixture. Accessory muscovite is unaltered. Primary fluid inclusions are rare and too small for good viewing.

Several traverses across S.2 and the northern half of S.11 (Figure 2) indicate a rather large area of propylitic alteration spatially related to EW trending feldspar porphyry andesite dikes. In the andesite hornblende and biotite are completely altered to calcite-chlorite-clinozoisite and plagioclase is more than 70% replaced by sericite. Biotite in the adjacent granitic rocks (not examined in thin section) is chloritized and epidote is common as veinlets and coating joint surfaces.

thin section yes

Vein/joint control suggests hydrothermal origin

Miscellaneous Mapping

The ten-foot-wide massive quartz vein located in the north-central part of S.2 is weak to moderately stained with hematite, but carries only trace amounts of green copper oxides. No boxworks were found.

Small outcrops of bedded Whitetail-type conglomerate were mapped in the SE1/2 S.10 and center of S.11. Both strike to the northwest and dip about 45°NE suggesting that Late Miocene or younger faulting was active in the area. JRK antithetic fault basin

Recommendation

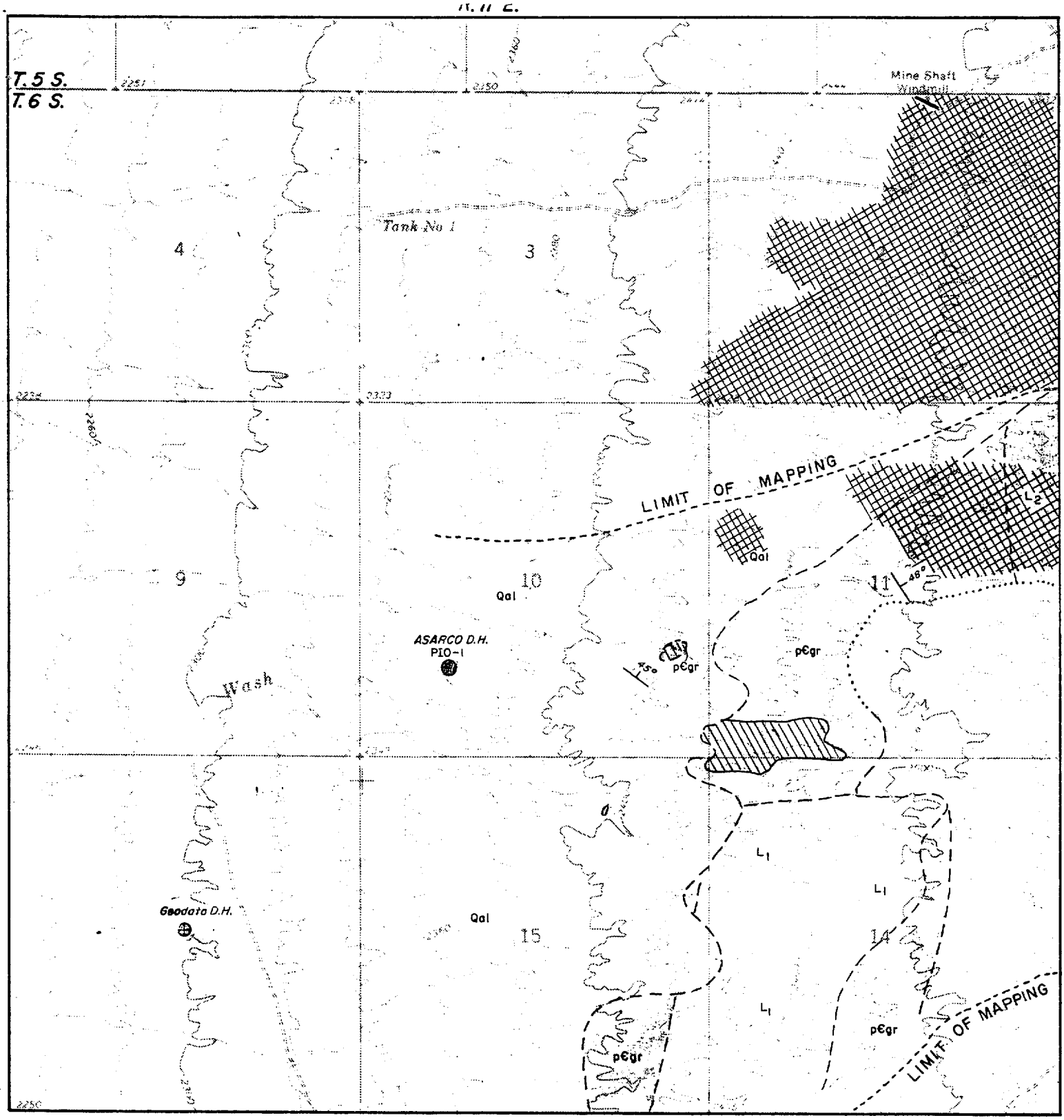
Outcrops of strong phyllic and propylitic alteration on the Pioneer Project area imply that a porphyry-copper-type hydrothermal regime was active in the area. Late Tertiary faulting may have tilted the resultant deposit 45° to the northeast giving it a 45° dip to the southwest. The possibility of a buried porphyry system must be tested.

Mapping to be done by Jim Sell in the near future will tie Pioneer into the regional geologic picture and perhaps shed new light on the conclusions reached thus far by Hank Kreis and myself. At such time as surface studies can be termed complete at least one deep (3000-5000 ft.) hole should be drilled to seek out a blind ore zone.

Douglas M. Smith, Jr.

DMS:lb
Atts.

cc: JDSell
HGKreis



Base from Nientysix Hills NW 7.5 Quad.
Geology modified from Kreis (1977)

EXPLANATION

Qal	Post mineral cover
L1	Laramide(?) quartz monzonite
L2	Laramide(?) biotite quartz monzonite
pЄgr	Precambrian Oracle Granite
	Quartz vein
	Moderate & weak clay-sericite-epidote alteration & ½ to 2 % pyrite capping
	Moderate to strong propylitic alteration
75°	Location, strike & dip of conglomerate outcrops

Note: Approximately 90 % of the area shown as bedrock is covered by thin alluvium, Dikes such as porphyry & diabase dikes are not shown.

TO ACCOMPANY Report

DATED April 4, 1977

BY R. M. Smith Jr.

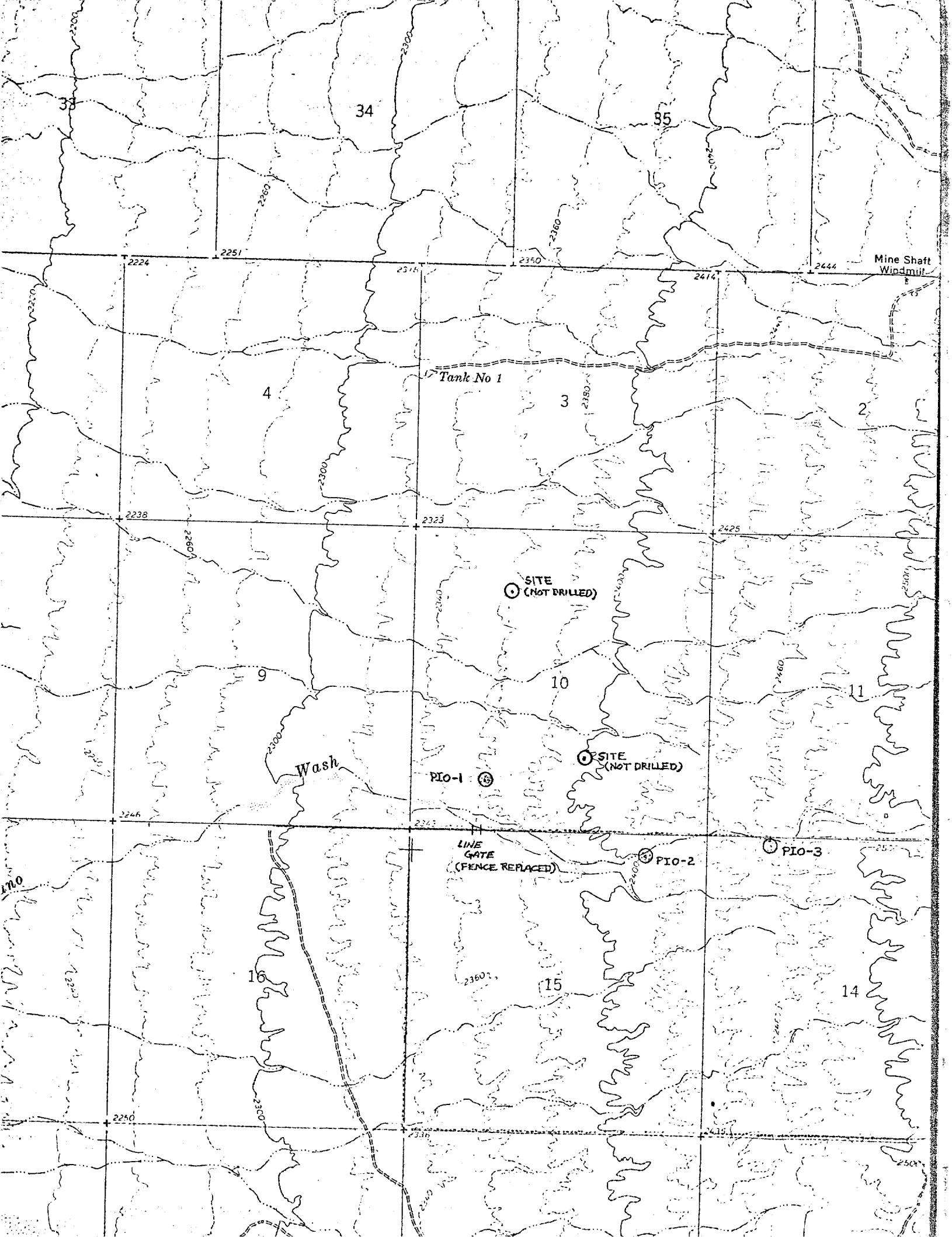
Summary Map

PIONEER PROSPECT

Pinal County, Arizona

SCALE: 1" = 2000'

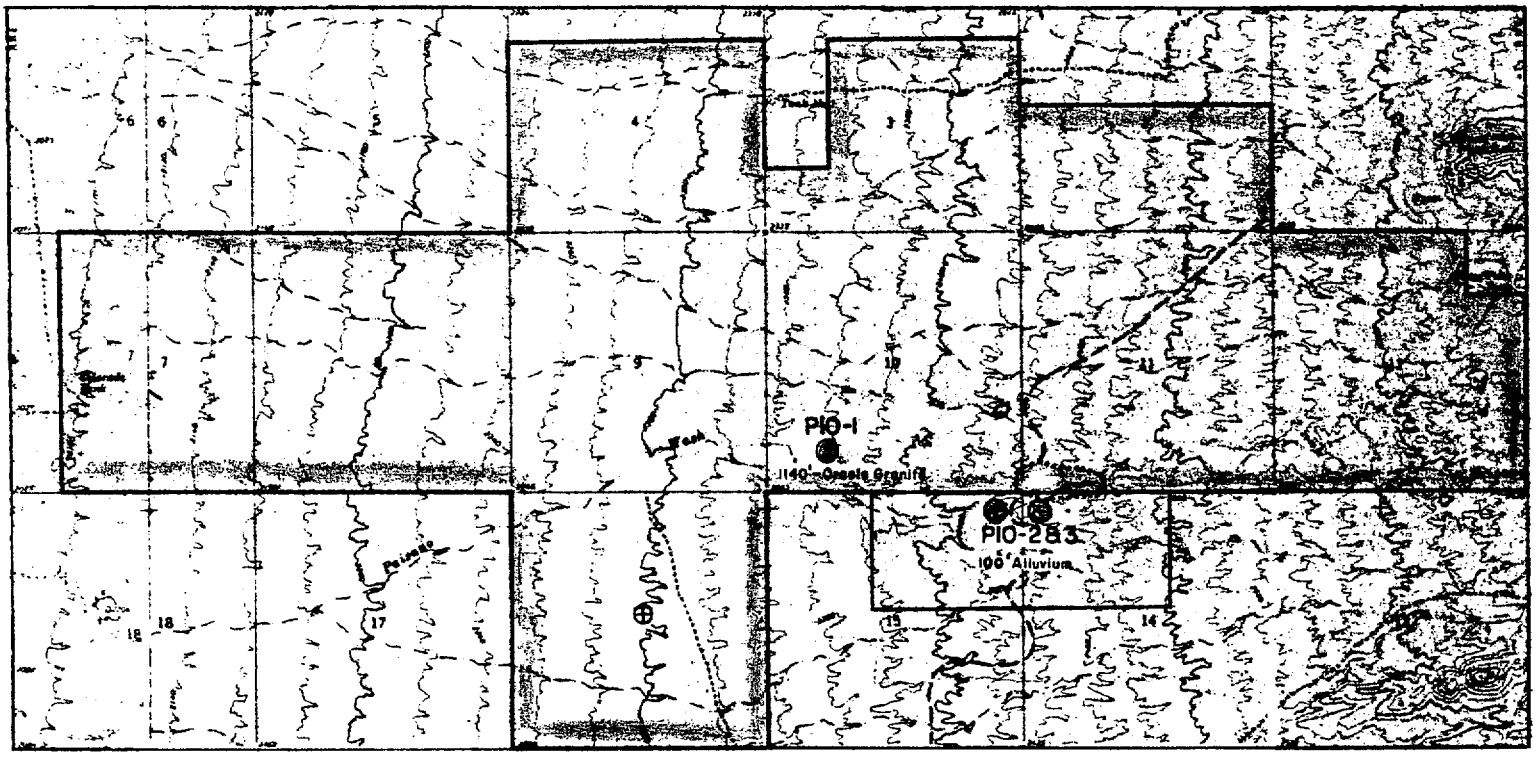
DMS April, 1977


33
34
35
Mine Shaft
Windmill
Tank No 1
4
3
2
SITE
(NOT DRILLED)
9
10
11
Wash
PIO-1
SITE
(NOT DRILLED)
LINE
GATE
(FENCE REPLACED)
PIO-2
PIO-3
16
15
14

Abbey Peninsula 14A. 3. 15B

Red Hill 14A 2.18

T. 6 S. R. 11 E.



Base from Ninetysix Hills 7.5' Quad.

EXPLANATION

ASARCO Federal Lode Claims (Validated)

ASARCO-Arizona State Prospecting Permit

PIO-1 Current ASARCO Drilling (showing depth to bedrock & rock type)

Geodata drill hole

Pioneer-76 prospect

Western edge of continuous outcrop

N

TO ACCOMPANY Drilling Report

DATED March 31, 1977

BY D. M. Smith Jr.

ASARCO LAND STATUS

PIONEER PROJECT

Pinal County, Arizona

0 ½ 1 mile

RBC-HGK Jan. 19, 1977

Revised March 22, 1977 NVK-2888

F.T.G.

F.T.G. / Pioneer Proj.

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE April 26, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
Pio-1 60-80			294					
80-100			95					
120-140			165					
140-160			52					

REGISTERED ASSAYER CERTIFICATE NO. 1002 PETER S. FLORES 4/26/79 Date Signed Arizona U. S. A.

CHARGES $ 10.00

INVOICE NO. 16320

ASSAYER - CHEMIST

1026. / Pioneer Files

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE April 17, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
Pio-1 100-120			164					
200-220			39					
300-320			35					
400-420			34					
500-520			35					
600-620			42					
700-720			41					
800-820			42					
820-840			40					
840-860			31					
860-880			33					
880-890			50					
900-920			51					
1000-1020			54					
1020-1040			63					
1100-1120			54					
1140-1160			55					

CHARGES $ 42.50

INVOICE NO. 16284

REGISTERED ASSAYER CERTIFICATE NO. 6532 PETE S. FLORES Date Signed 4/17/79 Arizona-U.S.A.

ASSAYER-CHEMIST

F.T.G / Pionecr

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE May 5, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
Pio-1 0-20			98					
20-40			97					
40-60			150					
160-180			82					
180-200			70					

CHARGES $ 12.50

16240

REGISTERED ASSAYER ARIZONA U.S.A. 6652 PETE S. FLORES Date Signed 5/3/79

ASSAYER-CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

COMPOSITE

SAMPLE SUBMITTED BY ASARCO, INC. DATE May 11, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
Pio-1 800-920				18	715	6		

CHARGES $ 7.30

INVOICE NO. 16352

REGISTERED ASSAYER CERTIFICATE NO. 5054 PETE S. FLORES Date Signed 5/11/79 Arizona U. S. A.

PETE S. FLORES - CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE May 5, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
Pio-2 0-20			107					
20-40			116					
40-60			129					
60-80			122					
80-100			87					

REGISTERED ASSAYER CERTIFICATE NO. 6892 PETE S. FLORES 5/15/79 Date Signed Arizona U. S. A.

ASSAYER-CHEMIST

CHARGES $ 12.50

INVOICE NO. 16340

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS • CHEMISTS • METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC. DATE May 5, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PPM COPPER	PPM LEAD	PPM ZINC	PPM MOLYBDENUM		
Pio-3 0-20			88					
20-40			80					
40-60			69					
60-80			56					
80-100			62					

CHARGES $ 12.50

INVOICE NO. 16340

5/5/79

ASSAYER-CHEMIST

3441 East Milber

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

F.T.G.

TUCSON, ARIZONA 85714

COMPOSITES

SAMPLE SUBMITTED BY ASARCO, INC.

DATE March 30, 1979

SAMPLE MARKED	GOLD OZ./TON	SILVER OZ./TON	PERCENT COPPER	PPM LEAD	PPM ZINC	PERCENT MOLYBDENUM	PERCENT IRON	Percent S--
PIO-5 83-130	Trace	0.13		43	90			1.95
130-151	Trace	0.08		21	39			1.27
151-161+167-171+ 185-188+213-231+ 243-260	Trace	0.03		89	77			1.35
161-167+171-185 188-213	Trace	0.08		26	52			3.71
260-291	.001	0.07		55	168			
291-368	Trace	0.16		43	95			2.83

REGISTERED ASSAYER CERTIFICATE NO. 6852 PETE S. FLORES Date Signed 3/23/79 Arizona U.S.A.

ASSAYER-CHEMIST

CHARGES $ 74.50

INVOICE NO. 16242

ASARCO Southwestern Exploration Division

F.T.G.

June 2, 1978

TO: F. T. Graybeal

FROM: H. G. Kreis

Pioneer Project
Monthly Report
May, 1978

On May 9 and 10, a 300' hole (Pio-4) was air hammer drilled to meet assessment work requirements. Casual inspection of the cuttings showed the following:

Pio-4 Drill Results

From	To	Int.	ppm Cu	Geology
0	60'	60'	21	pЄ granite. Strong clay-sericite alteration of biotite and feldspars. Leached capping after several percent former total sulfides in disseminated form.
60'	98' 100'	40'	45	85% of the interval is the same as described from 0 to 60' and 15% of the interval is the same as described from 100' to 130'.
98' 100'	130'	30'	115	Fine-grained intrusive rock formerly having 15% mafic mineral (elongate, up to 3mm in length). Approximately 20% combined epidote and chlorite associated with trace to 2% disseminated pyrite. Locally (120-130') strong sericite(?) alteration with 5 to 8% disseminated pyrite. *
(130')				(Sharp contact. No clay observed in raw samples for assay.)
130'	300'T.D.	170'	41	pЄ granite. 0.5% disseminated epidote, very weak chloritization of biotite, and 0.2% disseminated pyrite.

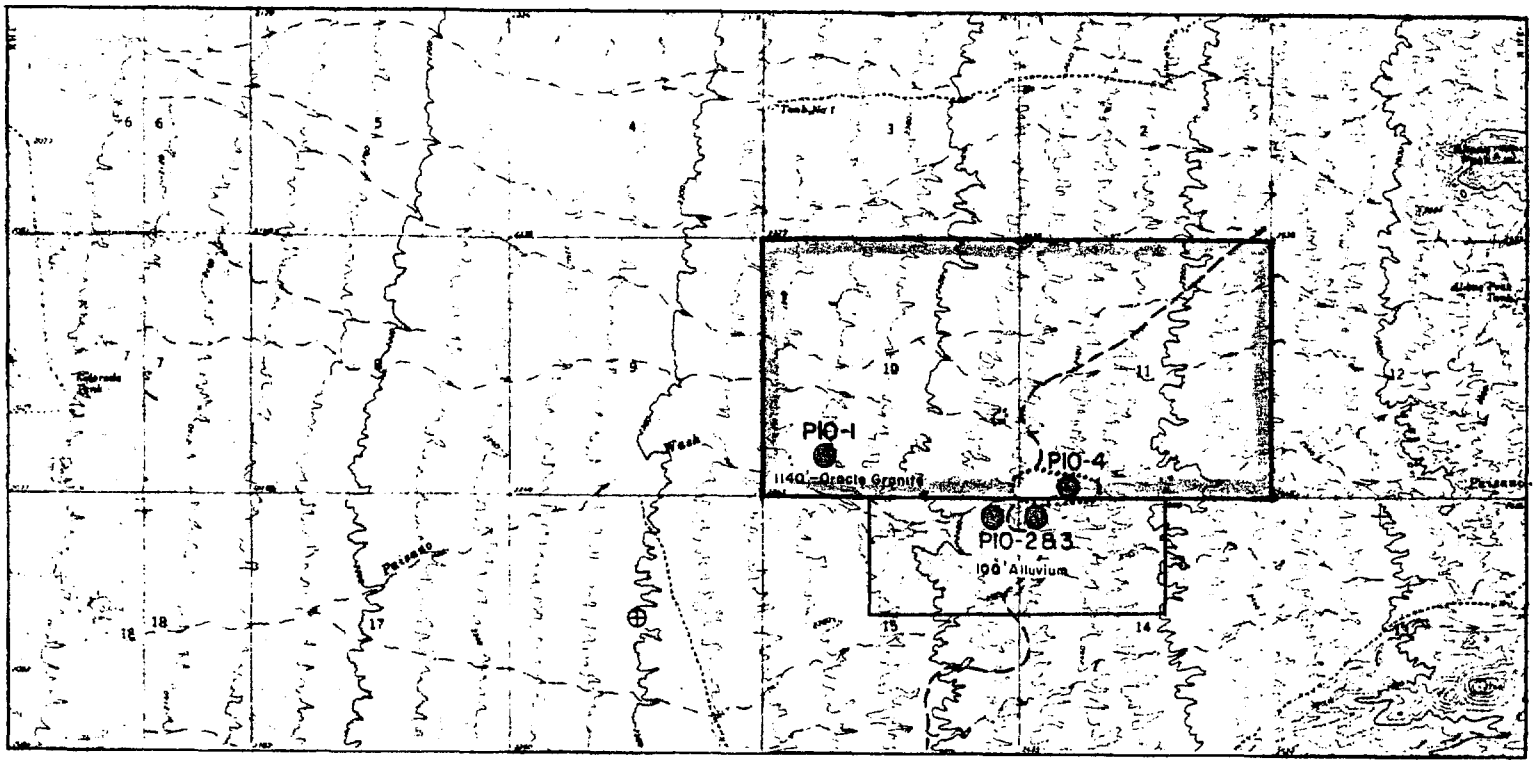
The drill hole is located 700' east and 70' north of the southwest corner of Section 11 (T.6S.,R.11E.)

H. G. Kreis

H. G. Kreis

HGK:jlh

T. 6 S. R. 11 E.



Base from Ninetysix Hills 7.5' Quad.

EXPLANATION

ASARCO Federal Lode Claims (Validated)

ASARCO-Arizona State Prospecting Permit

PIO-1 Current ASARCO Drilling (showing depth to bedrock & rock type)

Geodata drill hole

Pioneer-76 prospect

Western edge of continuous outcrop

TO ACCOMPANY Monthly Report

DATED June 2, 1978

BY H. G. Greis

ASARCO LAND STATUS

PIONEER PROJECT

Pinal County, Arizona

0 ½ 1 mile

RBC-HGK Jan. 19, 1977

Revised May 30, 1978

MVK-2989

ASARCO

Southwestern Exploration Division

December 26, 1978

TO: F. T. Graybeal

FROM: H. G. Kreis

Monthly Progress Report
Pioneer Project
December, 1978

Core drill hole Pio-5 was collared on December 14th at a location 250' east and 150' north of the northwest corner of Section 14 (T6S, R11E). From the collar to 176' (depth to date) Precambrian Oracle granite, porphyry, and diabase are mineralized by pyrite in quantities varying from 1 to 7% by volume. The rock is totally oxidized and leached to a depth of about 70'. No copper mineralization has been observed in the core. The core is moderately to locally strongly brecciated, and two moderately to shallow dipping faults are present.

H. G. Kreis

H. G. Kreis

HGK:lb
Att.

ASARCO

Southwestern Exploration Division

January 30, 1979

F.T.G.

TO: F. T. Graybeal

FROM: H. G. Kreis

what was the geology between last month depth and now?

Monthly Progress Report
Pioneer Project
January, 1979

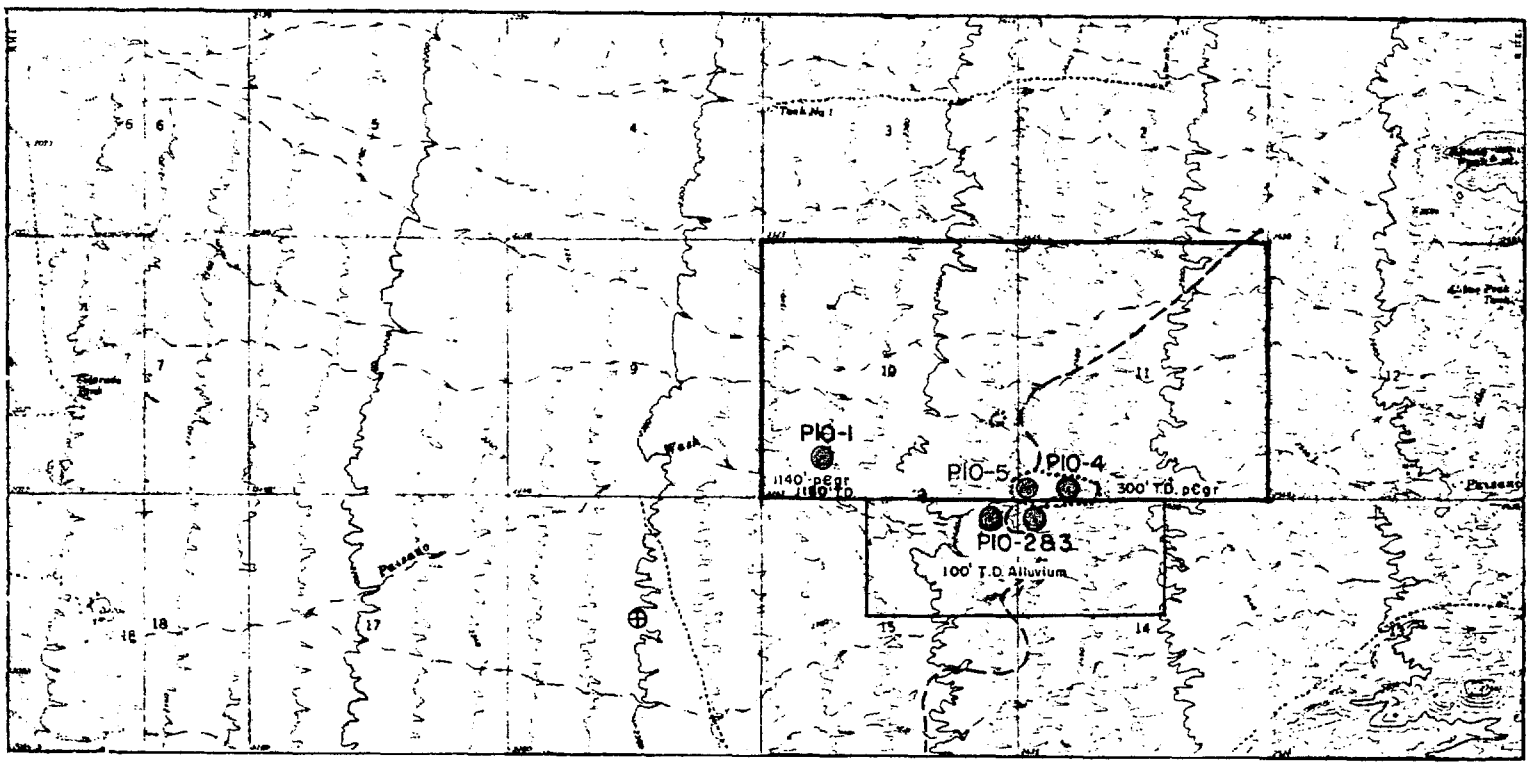
? Core drill hole Pio-5 was bottomed at a depth of 536' in diabase with 0.1% total sulfides (pyrite), and the rig was released. The geology of Pio-5 will be logged in detail, the core will be split and assayed, and the exploration potential of the Pioneer Project will then be reviewed. A total expenditure of $9,400 was spent on drilling, materials, and road work for Pio-5; there is an estimated balance of $14,700.

H. G. Kreis

H. G. Kreis

HGK:lb

T. 6 S. R. 11 E.



Base from Ninetysix Hills 7.5' Quad.

EXPLANATION

ASARCO Federal Lode Claims (Validated)

ASARCO-Arizona State Prospecting Permit

PIO-1 Current ASARCO Drilling (showing depth to bedrock, rock type & total depth)

Geodata drill hole

Pioneer prospect

Western edge of continuous outcrop

N

TO ACCOMPANY Monthly Report
DATED Dec. 26, 1978
BY H.G. Kreis

ASARCO LAND STATUS

PIONEER PROJECT

Pinal County, Arizona

0 ½ 1 mile

RBC-HGK Jan. 19, 1977
Revised Dec. 1978

MVK-2989

MF-864 (Tortolita Mtns 15' quad).

μ = where unit is mylonitic or ultramylonitic and schistose.

( ) = where unit is gneissic

Precambrian Oracle Granite, Yo, coarse to very coarse grained porphyritic qtz monzonite to med. grained. See description.

T-94-14A. μ (Yo) of Sec. 34 (NE¼), T8S, R12E. More schistose of unit with granitic parentage to hand lens view.

AT-94-14B. μ (Yo) of Sec. 34 (NE¼), T8S, R12E. More granitoid of unit, with abundant hematite limonite coated shears and disseminated magnetite in qtz-feldspar gneissic rock.

Ts gm

MF-864 (Tortolita 15' quad).

See description, Mid-Tertiary K-Ar & fission track ages).

T-96-16A. Tsgm of Eccentr., Sec. 18, T8S, R12E.

Sandiego Ridge granite (Cordillera type texture) with 1/2"+ feldspars randomly scattered in med to coarse equigranular, biotite rich interstitial, partly bodly granite. Matrix may have a weak gneissic texture.

(Rank: qtz 15-30%, biotite 3-10%; hornblende 0-2%, opaque minerals <1-1%; accessory apatite, zircon & locally sphene?, plagioclase An 15-25 25-40%; orthoclase, perthite or microcline 25-40%).

T-96-16B. Granite aplite dikes, gneissic cutting Tsgm above, in long linear zones. Dike up to 10' wide, numerous, and appear to be late stage features of Tsgm. Dikes have much of underlying & bordering Tsgm on hillside noted. (Note: very similar 1" dike cuts Tsgd of sample AT-96-15 as projected along strike of graphite zone.).

MF-844

Ts of Sec. 17, T9S, R13E (Tortolita Mtn 15' quad).
Strike N15°-20°W, dips 15°-20°E
Sandy gritty tuffaceous light gray matrix with predominately epidote-chlorite altered weakly gneissic granite, white, Oracle type, smeared biotite (partly alt.) in 2"-14" clasts, subangular. Also few schist clasts & two type of fine grained purple volcanics (one oxidized Fe); few dk clasts. Bedded, probably sheet flood type.

pod ≅ Tas

Ts of Sec. 12, T9S, R12E (Cadillac Wash).
Strike N5°-10°W, dips 10°E.
Red-brown indurated, sandy, gritty matrix. Abundant sand lenses between cobble zones. Clast predominately purple volcanics 1) fine xln oxidized Fe type & 2) coarse glassy feldspar vesicular rhyolite, & 3) a purdy gey-purple fine xln vole. Also some Laramide, white, coarse biotite, large feldspar granite (Tsgm), quartzite, and schist.

Tys of below Th in Sec. 1, T9S, R12E is very unconsolidated but has color and rock clast of the Cadillac Wash Ts material.

Tb

MF-864 (Tortolita Mtns 15' quad).

T-96-13 Tb of sec. 1, T9S, R12E

Dark grey black ~~with~~ vesicular porphyritic, with qtz, feldspar, and magnetite blebs up to 1/2"-1/4" (euhedral to resorbed, partly glomerocrystic plagioclase & qtz). Weakly magnetic. Weathers very lumpy on surface.

See description in MF-864

Age date of 21 my. ± 0.5.

Ts gd

MF-364 (Toitolita 15' quad).

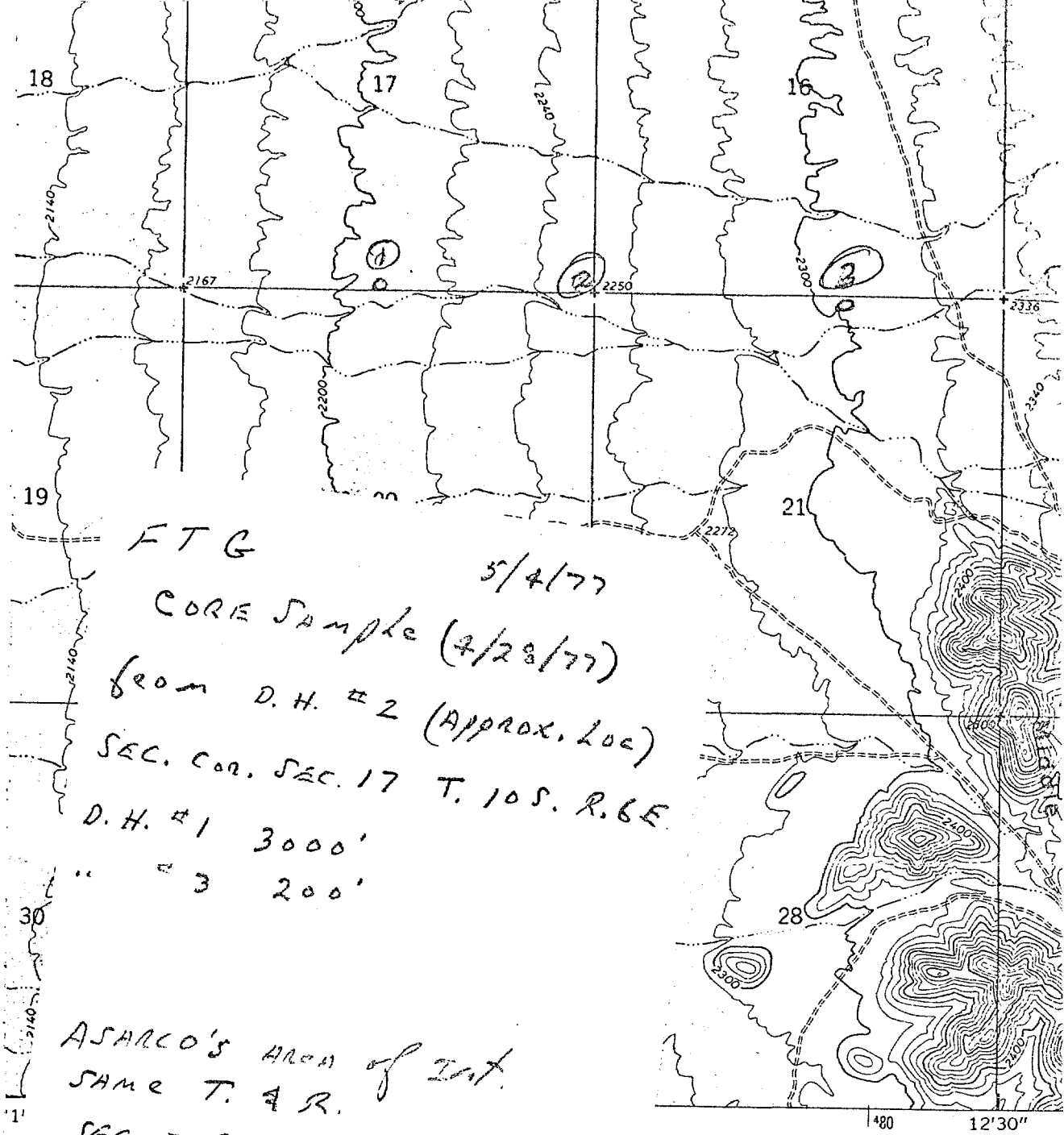
AT-96-15 Tsgd of Sec. 7, T8S, R12E. (granodiorite, quartz diorite, monzodiorite, and diorite) (border phase of qtz monzonite of Samaniego Ridge) (Tsqm) (See descriptions).
Hard ribs of granodiorite-diorite in equigranular mafic-rich, sugary textured equivalent which disintegrates readily. Unit includes more schistose zones and "Crude" type thin dikes 1" (maybe granite aplite of the Tsqm to SE), all of which are sheared in zones. Minor Fe stain.

Tsgd of Sec. 36, T7S, R 11E.
Granodiorite to diorite dikes and plug like masses of fine chilled material of ± 10% qtz, 40% feldspar, & 50% biotite shreds. Up to 20'-30' wide, strike N5°-10°W, dips steep. plug like masses 3'-4' or 4'-6' elongated similar direction as main dike but mainly shown northeast of dike. Cuts & offsets granite aplite dikes. Often has very fine diabasic look.

Granite - 2 mica

The Northern Miner March 2, 1978
p. B-1[redacted]

derived from European mines and



FTG 5/4/77

CORE Sample (4/28/77)

from D.H. #2 (Approx. Loc)

SEC. Cor. SEC. 17 T. 10S. R. 6E

D.H. #1 3000'

" #3 200'

ASARCO's Area of Int.

SAME T. & R.

SEC. 7, 8, 9, 10, 11,

14 (10 CLS), 15 (10 CLS)

16, 17 & 18

Sent for thinsect & geologic & base

GN MN.

0°06' 2 MILS

13½° 240 MILS

UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

FOR

96 Hills NW Quad

FTG
JOS

Anschutz Corp Test

I have learned that the deep test scheduled by Anschutz Corp will be the
"Anschutz Texoma"
in T 7S, R 10E, Sec. 2.

No further details are known except that the "closure" they are drilling is 30 miles long by 15 miles wide with 5000 feet of closure. The top interface of reflective material at the drill site location is at a depth of 5000 feet.

The other deep hole in the area is the
"Western Oilfield No. 1 - Federal
in SWSW of Sec. 31, T5S, R10E
drilled in 1953 to a depth of 5142 feet,
ending in "granite".
The Oil & Gas Commission permit was #15;
the sample of cuttings held by the Az Bur of Geology is #260. The ABG cannot definitely identify the end of conglomerate & start of granite but indicates they indeed ended in granite of the type in the granite hills - Prescott area.
The Anschutz hole is about 3 miles ENE of the North Star Mine as shown on the attached map.

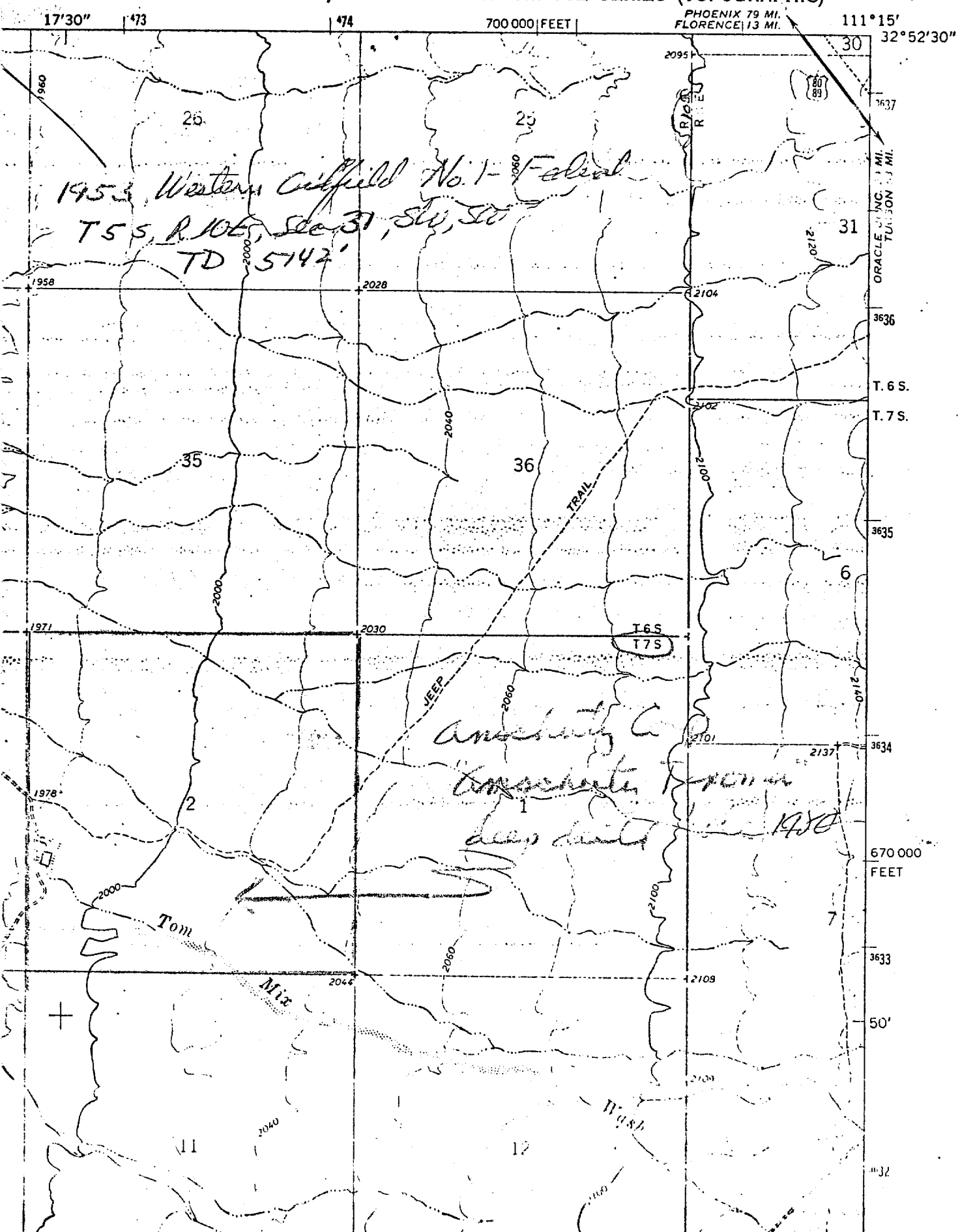
James R. Bell

PICACHO RESERVOIR SE QUADRANGLE

ARIZONA – PINAL CO.

7.5 MINUTE SERIES (TOPOGRAPHIC)

3749 I NW (NINETYSIX HILLS NW)



UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

NINETYSIX HILLS SW QUADRANGLE
ARIZONA–PINAL CO.
7.5 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 1962. Field checked 1966

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

Fine red dashed lines indicate selected fence lines

UTM GRID AND 1966 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

ARIZONA
QUADRANGLE LOCATION

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

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

NINETYSIX HILLS SW, ARIZ.
N3245—W11107.5/7.5

1966

AMS 3749 I SW—SERIES V898

INVOICE

WESTERN PETROGRAPHIC

20 West Flores
Tucson, Arizona 85705

C.D N
NOV 10 1977

INVOICE NO. 771294

INVOICE DATE NOVEMBER 7, 1977

SOLD TO
ACCOUNTS PAYABLE
ASARCO INCORPORATED
P.O. BOX 5747
TUCSON ARIZONA 85703

SHIPPED TO
J. D. SELL

OUR ORDER NO.	YOUR ORDER NO.	TERMS	SHIPPED VIA	SURPLUS MATERIAL
771294	96	NET 30 DAYS	PICKED UP	RETURNED

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
3	EA	K-FELDSPAR STAINING	.75	2.25
		TOTAL:		$2.25

APPROVED FOR PAYMENT
By: James W. Sell
(Signature)
Tuc. General 94 SW Hills Reconn.

3441 East Milber

INVOICE NO.
15463

Phone 889-5787

AMERICAN ANALYTICAL and RESEARCH LABORATORIES

ASSAYERS - CHEMISTS - METALLURGISTS

TUCSON, ARIZONA 85714

SAMPLE SUBMITTED BY ASARCO, INC.

Mr. J. D. Sell

DATE Nov. 14, 1977

SAMPLE MARKED	ANALYSIS	CHARGES
B. (AT-96-19	Geo-Chem Cu, Pb, Zn, Mo	$ 7.00
	Preparation	0.75
A. (QDC-15		
QDC-16	Geo-Chem Cu, Pb, Zn, Mo	14.00
	Preparation	1.50
	TOTAL	$ 23.25

OK for Payment
James D Sell

A. Devils Canyon Project EA-0139 —— $15.50
B. Toc General, 94 Hill Reemn. —— 7.75
$23.25

THANK YOU MUCH!!

CHARGES $ 7.75

INVOICE NO. 15463

REGISTERED ASSAYER CERTIFICATE NO. 6832 PETE S. FLORES Date Signed 11/14/77 Arizona U. S. A.

ASSAYER-CHEMIST

INVOICE

WESTERN PETROGRAPHIC

20 West Flores
Tucson, Arizona 85705

C. D. N.

NOV 16 1977

NOV 1977
RECEIVED
ACCT. DEPT.

INVOICE NO. 771162

INVOICE DATE NOVEMBER 11, 1977

SOLD TO
ACCOUNTS PAYABLE
ASARCO INCORPORATED
P.O. BOX 5747
TUCSON ARIZONA 85703

SHIPPED TO
J. D. SELL

OUR ORDER NO.	YOUR ORDER NO.	TERMS	SHIPPED VIA	SURPLUS MATERIAL
771162		NET 30 DAYS	PICKED UP	RETURNED

QUANTITY	UNIT	DESCRIPTION	UNIT PRICE	AMOUNT
6	EA	STANDARD PETROGRAPHIC THIN SECTIONS	2.75	16.50
5	EA	K-FELDSPAR STAINING	.75	3.75
5	EA	IMPREGNATION WITH EPOXY	.50	2.50
5	EA	GRINDING IN OIL	.50	2.50
		TOTAL:		$25.25

APPROVED FOR PAYMENT

By: James D Sell
(Signature)

Tuc. General 96 SW Hills Reeves.