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VULTURE MINE

A Summary Prepared by Don White, C.P.G.S.

April, 1985

SYNOPSIS

The historic Vulture Mine is located in the desert about 15 miles SW of Wickenburg, Arizona. It is now comprised of 13 (?) patents and over 400 surrounding unpatented claims. Production was always poorly documented but was probably about 1 million tons of ore containing about 350,000 ounces of gold; 250,000 ounces of silver; 300,000 pounds of copper and 1,800,000 pounds of lead. Grades thus averaged 0.35 oz. Au, 0.25 oz. Ag, 0.015% Cu and 0.09% Pb with no allowance for recoveries or dilution. Most of this production was from 1870 to 1930 with a combination of stamp mill amalgamation and cyanide leaching of tailings.

The mine was developed by two inclined shafts, along the dip of the bedding and mineralization, about 35° North. The west incline extends to the 600-level and the east incline, through winzes, to the 1550-level. About 1800 feet of strike length have been drifted and stoped on two main NE plunging ore shoots.

Mineralization is free gold in quartz veins within and emanating from a quartz monzonite porphyry intrusive (qpi). The qpi is a semi-conformable sill-like apophysis from a stock to the west. Its intrusion led to wall rock silicification and pyritization. Gold also occurs with sulfides (pyrite and galena) within and adjacent to the qpi, or within its alteration halo.

Post-mineral faulting offsets the lode and accounts for its loss beyond the 1550-level. No one has tried to find the faulted extension since 1931.

Recent exploration has focused on open pit, heap leachable reserves and tailings with some consideration of placer potential.

HISTORY

The Vulture Mine is one of the most famous, rich and notorious gold mines in Arizona. Its high grade gold earned it the name, "The Comstock of Arizona."

The Vulture discovery is attributed to Henry Wickenburg in 1863. The next eighty years of classic boom and bust at the Vulture camp are outlined:

Mid 1860's:	Burro packing of high grade, near surface ores to arrastras on the Hassayampa River.
1870's:	Ups and downs; overall grade diminishing. Closed years at a time.
1880:	Water piped to the mine and an 80-stamp mill constructed.
1880's:	Orebody lost and rediscovered across several faults. Frenetic activiy alterated with complete closures.

1888 (?):	Main orebody lost at the Talmage fault on the 600-level.
1911:	Lode rediscovered by drifting on the 750-level. Much activity for four years.
1915:	Lost the lode on the Astor (Schoolhouse) fault on the 1050-level. Exploration to the 1550-level failed to relocate mineralization.
1888-1917:	Various operators and owners; 20 of the 80 stamps repaired, amalgamation used on the mortars with 70-80% recovery. Tails subject to cyanidation.
1917-1927:	Dormant.
1927-1942(?):	Lessee recovery of ore pillars, open pit mining to about 120-foot depth; flotation used with cyanidation of new and old tailings. Last hardrock mining in 1935.
1942(?) - Present:	Dormant nearly 50 years except for some recent exploration.

GEOLOGY

The country rock is a series of early Precambrian metasediments and/or metavolcanics (opinions with evidence are invited). They are dominated by various schistose combinations of quartz, sericite, and chlorite, some amphibolite, and some apparent epicalistics or reworked volcanics.

A stock of Laramide (?) quartz monzonite porphyry (qpi) is centered about one half mile west of the mine area. Apophyses of qpi cut semi-conformally into the mine area, altering the wall rock. Silicificaton is pervasive, sometime accompanied by pyrite plus or minus gold, especially in the hanging wall of the intrusive.

Tertiary volcanics (basalt flows and andesitic tuffs) blanket the Precambrian on the northeast portion of the property. Quaternary alluvium blankets much of the mine area.

The rock types are summarized by the accompanying stratigraphic section.

Gold occurs in the native state, as was characteristic of the old high grade quartz veins within and emanating from the qpi. Gold also occurs in solid solution with sulfides, mainly pyrite, but also in unusual association with galena. Underground mining followed the silicified, pyritized hanging wall and footwall zones of the qpi where the quartz veins and high grade gold are most commonly found. Rich pods ran in excess of one hundred ounces per ton. Open pit mining captured some remaining high grade pillars and most of the intervening qpi. The qpi graded 0.05 ounce to several ounces where mined.

All the Precambrian units and the comformable qpi and mineralized zones strike east-west in the main pit area, and dip about 35 degrees to the north. Folding is minimal, mostly distortion by the qpi intrusion and drag on faults. Faulting has much influenced the operating history of the Vulture. A series of northwest striking, northeast dipping reverse and normal faults, all post-mineral, offset the qpi and mineralization. Offsets of several feet to about 200 feet were successfully figured out and bridged. The lode was lost in 1915, however, on a normal fault with at least 500 feet of dip slip component.

EXPLORATION ACTIVITY

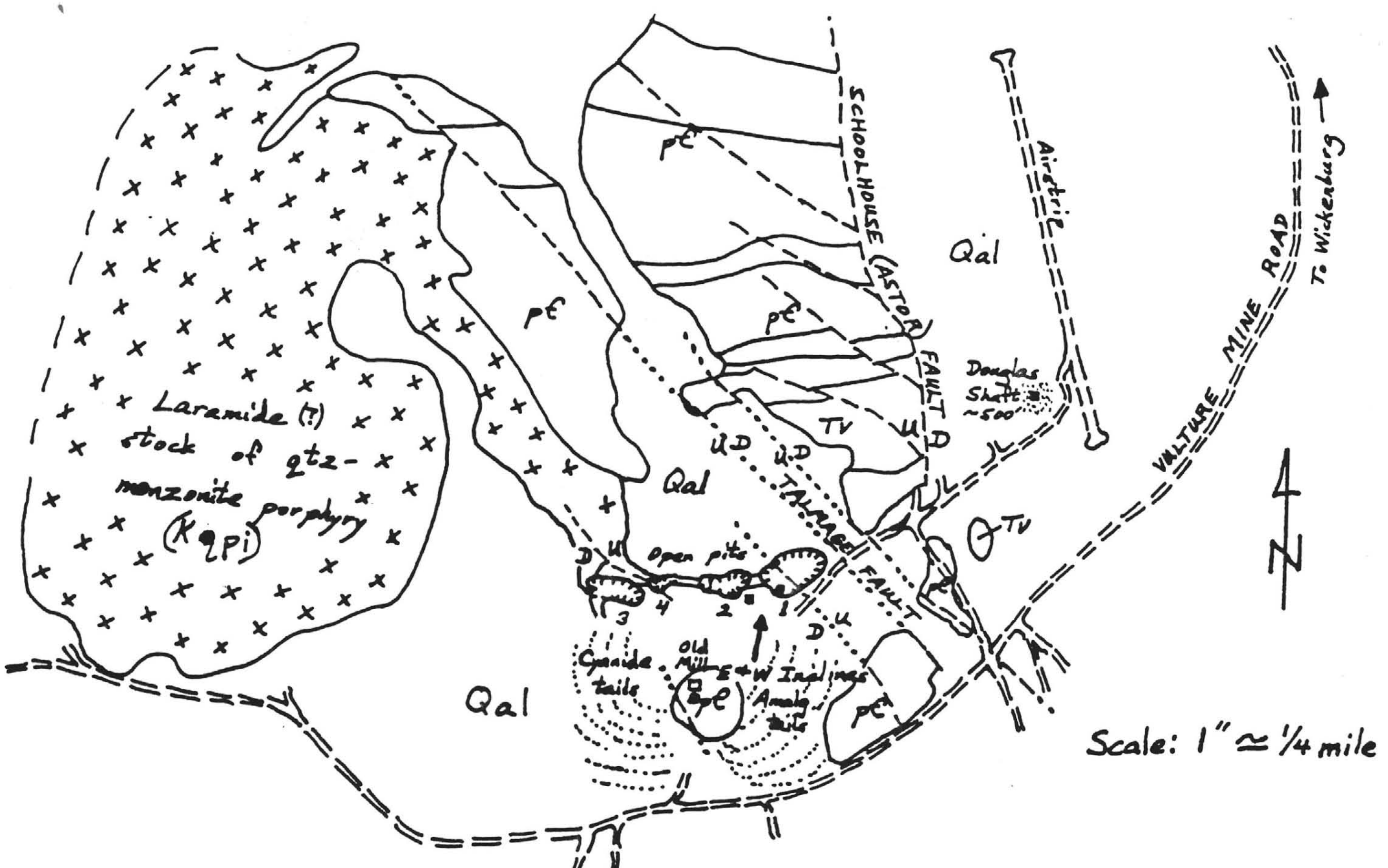
The faulted lode was the target of 1930-1931 exploration by the United Verde Extension Mining Company. Their 500-foot shaft and over 1000 feet of drifting east of the Astor fault failed to locate any major minerization. They were likely too shallow.

In 1970 Noranda took bulk samples from the pit areas, conducted an I.P. survey, and mapped the pit geology. Not much happened again until the Zortman/Landusky Mining Companies (Pegasus) leased the Vulture in 1982-1983. They extended the claim block, surveyed, did underground sampling (down to water which floods the 650-level) surface sampling and rotary drilling, a mercury-in-rock survey, and a pilot heap leach of some tailings. The latter did not work, principally because the vertical permeability of the unagglomerated tailing is nearly nil. Their drilling focused on down-dip extensions of the open pits. Quintana followed Pegasus' departure with some short evaluation of unknown substance.

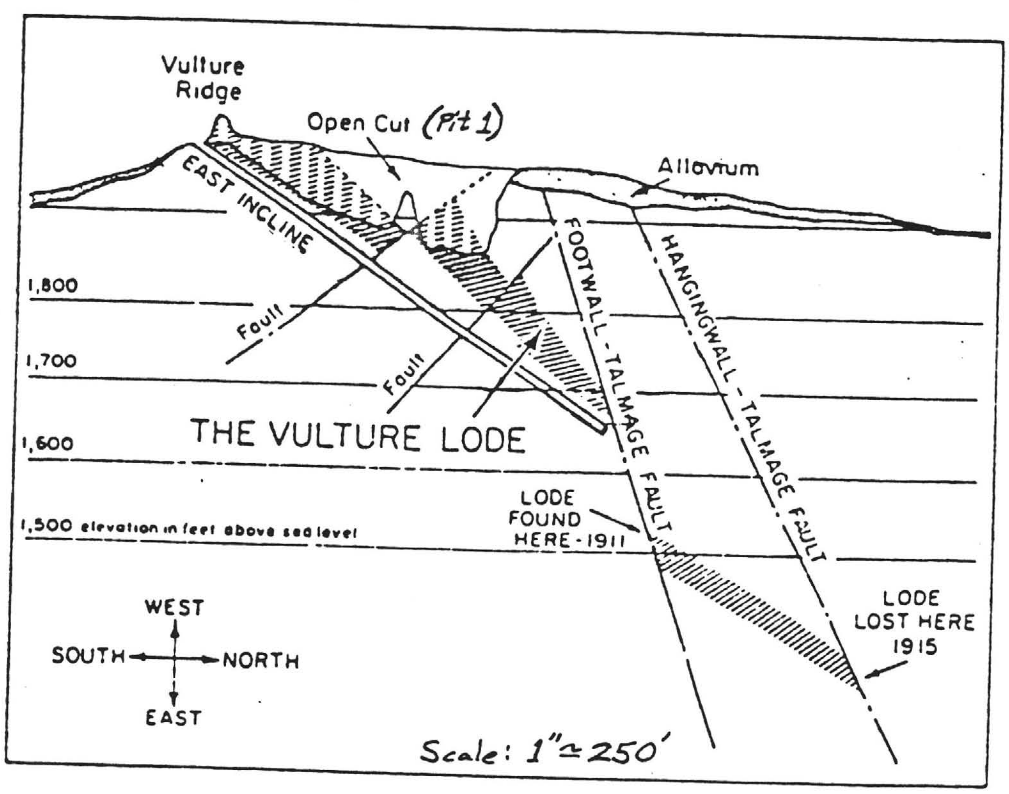
Since early 1984 the Vulture has been under lease to an indivdual represented by Ben F. Dickerson, III of DMEA, Ltd. in Scottsdale. Several aspects of the property have been further evaluated. Continued reverse circulation drilling north of (down dip from) each pit and between pits has indicated further reserves in place. Shallow drill sampling of the tailings has allowed estimation of the tailings reserves. Placer gold has been located by deep trenching and washing of vertical channel samples in a pilot plant. The deep underground potential is all that has not been tested of late.

Remaining gold potential at the Vulture is summarized as follows:

Occurence	Tonnage	Grade range	Remarks
Underground, high-grade fault extension	0.5 million or more tons (?)	0.3 ounce Au to several ounces	Requires core drillir in excess of 1200-foot holes.
Open pit extensions	0.1 to 0.4 million tons	0.04 to 3. ounces $\bar{x} \simeq$ 0.05 oz.	Leachability unknown: probably require fine ($\leq\frac{1}{2}$ inch) crushing
Tailings	0.2 million tons	0.04 oz/t	Require agglomentation
Placers	Yardage not yet estimable from existing trenching	Very erratic	Quarternary channels not mapped. Strippinc ratios high.



VULTURE MINE AREA SKETCH MAP

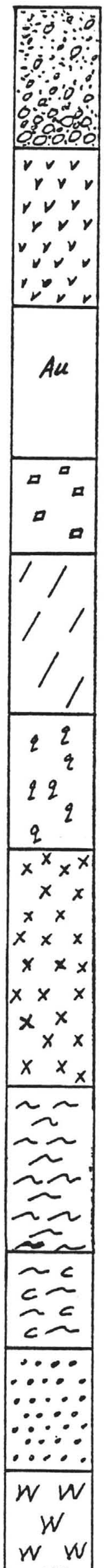


Schematic cross section, from The Mining Journal 11-30-1930

VULTURE MINE

GRAPHIC DRILL LOG LEGEND

Compiled from rotary-reverse circulation chips



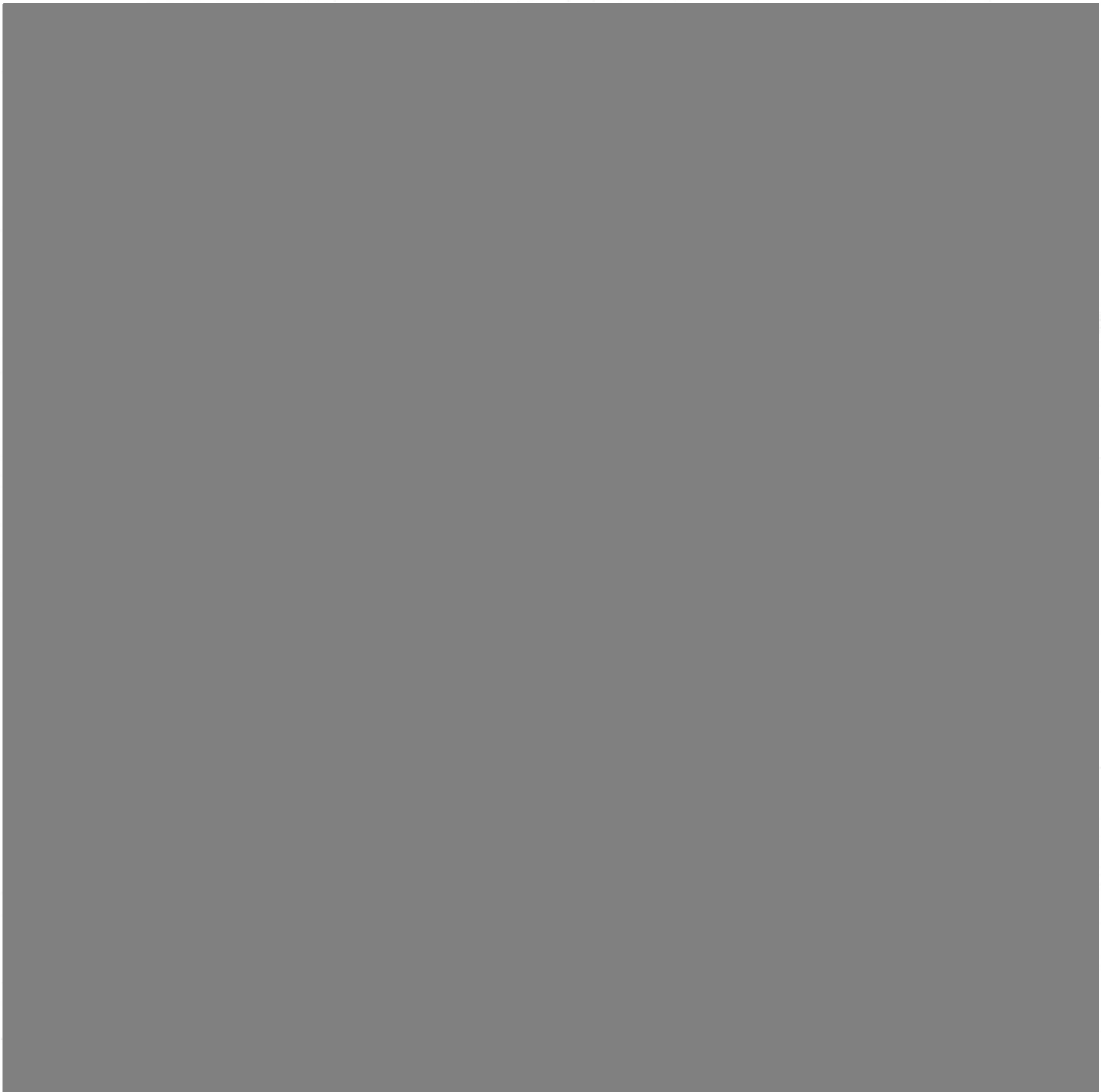
Age		Unit	Description
Quaternary		Qal	**ALLUVIUM**, colluvium; derived from the same rocks as in this sequence except for granodiorite from ≥2 miles NW. Varied but generally low degree of rounding, sorting, and stratification.
Tertiary		Trd	**RHYOLITE DIKE**; white, aphanitic, cross-cutting unit up to 15 feet in drill intercept thickness. Commonly contains black Mn dendrites on joint surfaces. Only known to occur in W portion of property near pits 3 and 4.
Cretaceous (?) (Laramide-?)	Alteration & mineralization	Au	**GOLD**; noted in graphic log where significant assays are reported. Thought to be cogenetic with other Laramide (?) events like qtz-pphy intrusion and associated pyritization, silicification, and quartz veining (see below).
		Py	**PYRITE**; generally tiny (≤0.5mm) disseminated cubes. Often in qtz or intensely silicified rocks.
		Si	**SILICIOUS ROCK**; thought to be introduced silica related to the qtz-pphy intrusive. Often obscures foliation and sometimes prevents identity of the original rock type. Intense silicification yields an amorphous quartzite.
		Qtz	**QUARTZ**; only used to designate vein or bull quartz and discrete, visible qtz as in qtz-rich siltite and qtz-pphy intrusive. May harbor sulfides (py, gal) and native gold.
		Kqpi	**QUARTZ-PORPHYRY INTRUSIVE**; med to coarse-grained, altered (sericitized, pyritized, silicified) granite to qtz-monzonite with qtz porphyroblasts (often up to 4mm dia). Quartz is typically a soft, pastel green (chloritic-?) or pale gray to milky. Emanates as an apophysis from stock to the W of pit 3. Generally semi-conformable, sill-like.
Precambrian		pЄqs	**QUARTZ-SERICITE SCHIST**; brown, gray, tan, or almost white, thin laminated, fine to med grained quartz and sericite. Often iron stained. Gradational to siltite or wacke (see below) and prone to silicification.
		pЄqsc	**QUARTZ-SERICITE-CHLORITE SCHIST**; same as above with the addition of a chlorite component (usually < 20%).
		pЄst	**SILTITE**; brown or tan to light gray, poorly foliated, very fine grained, meta-silt. Often a quartzite. Grades finer to quartz-sericite schist or coarser to wacke.
		pЄw	**WACKE**; brown, tan, or med to dark gray, poorly foliated, med grained, meta-wacke. Grades to siltite and qtz-ser schist. Prone to silicification.

Don White - Dec. 1984

Arizona - Vulture Mine

Geology of the Vulture Mine

Don C. White



GEOLOGIC MAP OF THE NORTHEASTERN VULTURE MOUNTAINS AND VICINITY, CENTRAL ARIZONA

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INTRODUCTION

This report presents 1:24,000-scale geologic mapping of the eastern Vulture Mountains and vicinity. This mapping, along with concurrent mapping of the Wickenburg Mountains and western Hieroglyphic Mountains (Stimac and others, 1987), was completed between January and April 1987 and was jointly funded by the U.S. Geological Survey and Arizona Bureau of Geology and Mineral Technology as part of the cost-sharing Cooperative Geologic Mapping Program (COGEOMAP). These areas were mapped because they were previously unmapped in detail, and were suspected to contain a highly faulted and potentially mineralized assemblage of Proterozoic crystalline rocks, Cretaceous granite, and middle Tertiary volcanic and sedimentary rocks. The Vulture Mountains represent an important link between previously studied middle Tertiary rocks and structures in the Big Horn Mountains (Capps and others, 1985; Stimac and others, 1987) and central Vulture Mountains (Rehrig and others, 1980) to the southwest and Hieroglyphic Mountains to the east (Capps and others, 1986). Together, the geologic studies in these mountain ranges provide a transect from the highly distended Basin and Range Province to the edge of the Transition Zone.

GEOLOGIC SETTING

The Vulture Mountains and vicinity are located within the Basin and Range Province in central Arizona, adjacent to the Transition Zone (Fig. 1). The area is topographically subdued compared to adjacent mountain ranges and consists of a series of north- to north-northwest-trending ridges, separated by areas with low, hummocky topography. Much of the area consists of broad pediments dotted with small inselbergs. The Vulture and Wickenburg Mountains are separated by the south-flowing Hassayampa River. The town of Wickenburg is located along the river.

The eastern Vulture Mountains contain more than 1.5 km of middle Tertiary volcanic and sedimentary rocks that rest unconformably on Proterozoic metamorphic and granitic rocks and Late Cretaceous granodiorite. Middle Miocene faulting has dissected the Tertiary volcanic rocks into a series of north-northwest-striking homoclines that dip steeply to the northeast or are vertical to slightly overturned. The steeply dipping Tertiary sections are truncated downward against pre-Tertiary crystalline rocks on a series of low-angle normal faults.

MIOCENE VOLCANIC COMPLEX IN THE EASTERN VULTURE MOUNTAINS

The Miocene volcanic rocks in the northeastern Vulture Mountains are almost exclusively the products of a moderately sized rhyolitic volcanic complex, whose products are informally referred to as the rhyolites of San Domingo Wash. The complex is constructed on a basement of Proterozoic and Cretaceous crystalline rocks overlain by conglomerates and basalt of Tertiary ages. Because all of the silicic volcanic rocks have steep northeastward to vertical dips, several transects through the stratigraphy of the volcanic complex are provided along the east-flowing drainages that feed the Hassayampa River. The relatively complete sections consist of as much as 1500m of interlayered rhyolite flows and hypabyssals, and pyroclastic deposits. Parts of the complex are also exposed between Cemetary Wash in the Vulture Mountains and the Hassayampa River.

Rhyolite lavas and irregularly shaped intrusions comprise as much as 70 percent of the Tertiary section, including as many as 7-9 lava flows. Some flows are up 300m thick, and most are separated from one another by pyroclastic deposits of air-fall or surge origin. Spherulitic devitrification is common near contacts with adjacent pyroclastic rocks, and locally flows and tuffs are intermixed or intertwinned with one another along complex intrusive contacts. Intrusive rhyolites are especially abundant along Cemetary Wash in the northeast Vulture Mountains. The more resistant lavas underlie north-south-striking ridges that dominate the topographic grain of the region. Intervening valleys and basins are underlain by pyroclastic rocks or intensely devitrified rhyolite.

The rhyolites of San Domingo Wash are crystal-poor, typically with 10 percent or fewer phenocrysts of sanadine and biotite. The youngest crystal-poor rhyolite flows have fresh-looking, euhedral phenocrysts of sanadine as much as 2mm across. Biotite occurs as <1mm plates that are in various degrees of oxidation to hematite. Phenocrysts are uncommon or absent in most of the pyroclastic deposits. The rhyolite lavas do not commonly include the lithic fragments that characterize the pyroclastic rocks. Flow banding with thin seams of vapor-phase quartz also help to distinguish flows from tuffs.

A variety of types of pyroclastic deposits are interlayered between the rhyolite flows and hypabyssal rocks. Most tuffaceous horizons are thinly to medium-bedded, unwelded, sorted lapillistones with abundant (5-20 percent) pebble-sized lithic fragments with volcanic textures. Most of the pumice lapilli is angular and free of phenocrysts. Sedimentary rocks are conspicuously absent. Normal and reverse grading of lithic fragments and pumice are common in lapilli tuffs. Monotonous layers of crystal-poor ash are interlayered with cross-bedded, lithic-poor tuffs. Welding is conspicuous only in one ash-flow tuff exposed along Cemetary Wash; this tuff is a partly to densely welded, sanadine-biotite phyric ash-flow tuff with abundant lithic fragments and basal vitrophyre up to 40m thick. Additional mapping may discover enough exposures of this tuff to warrant it as a separate map unit. Otherwise, all the tuffaceous deposits in the map area are probably air-fall or surge-related tuffs associated with the rhyolite flows with which they are interlayered.

The time period over which the rhyolites of San Domingo Wash were erupted is uncertain in part because our mapping does not yet include some radiometrically dated crystal-poor rhyolite flows that may or may not correlate with the rhyolites of San Domingo Wash. Rehrig and others (1980) obtained a 26 m.y. old date on biotite from rhyolite at the base of the Tertiary volcanic section at a location just west of our study area. They also obtained an 18.2 m.y. date from rhyolite near the top of the same section. Whole-rock K-Ar dates constrain basalt flows at the base of the Tertiary section in adjacent mountain ranges to be older than 21 to 18.7 Ma (Capps and others, 1985; Kortemier and others, 1986). In contrast to the eastern Vulture Mountains, crystal-poor rhyolite flows in the Big Horn Mountains are interbedded with basalt and andesite flows. Crystal-poor rhyolite flows and subordinate tuffs in the western Hieroglyphic Mountains are also interbedded with a basalt flow, mapped as lower basalt. At San Domingo Peak in the Wickenburg Mountains, a section of crystal-poor rhyolite that is 330 m thick is overlain by dacitic rocks of the Hells Gate volcanics, which yield K-Ar dates of 17.9, 17.4, and 16.1 m.y. (Shafiqullah and others, 1980; Capps and others, 1986; Kortemeier and others, 1986).

The immense 1.5 km thickness of rhyolite lavas and related tuffs on the west side of the Hassayampa River apparently represents a precipitous flow-dome complex. The presence of younger basalt directly on the rhyolites suggests this area was a local topographic high compared to areas east of the Hassayampa River where thick assemblages of sandstones and conglomerates overlie the volcanic rocks and underlie the upper basalt flows.

MAP UNIT DESCRIPTIONS

QUATERNARY SEDIMENTARY ROCKS

Qs: Younger alluvium

Unconsolidated sand and gravel in modern stream channels or on low terraces in or adjacent to these channels. This unit also includes thin aprons of colluvium found on some low slopes and spurs west of the Hassayampa River.

Qso: Older alluvium

Unconsolidated gravel-poor sand and sandy gravel deposits standing above modern stream channels and below partly consolidated alluvium of map unit QTs.

QTs: Sedimentary rocks

Unconsolidated to partly consolidated or caliche-cemented sands and gravels of dissected terraces standing more than 2 m above modern drainages. Deposits are generally flat-lying, although some deposits are dipping as much as 8°.

TERTIARY VOLCANIC AND SEDIMENTARY ROCKS

Tf: Fanglomerate

Brown- to buff-colored, consolidated to semi-consolidated conglomerate, sandstone, and siltstone with a discontinuous thin cover of QTs. Fanglomerate grades down into tilted sheet-flood deposits and debris flows with interbedded basalts and thin upper tuffs. Fanglomerate usually forms low hills with little or no outcrop, but steep cliffs 5 to 20 m high occur along major washes east of the Hassayampa River. These deposits are flat-lying to moderately tilted.

Tsc: Conglomerate and sandstone

Brown- to buff-colored, consolidated to poorly consolidated conglomerate, sandstone, and siltstone. This unit consists chiefly of matrix-supported, unsorted, conglomeratic arkose and arkose in beds that are 1m to 1cm thick, averaging 10-20cm, and are rarely graded and lack crossbeds. However, some of these deposits have clasts with diameters equal to the thickness the bed that contains them, and these may represent thin debris flows. Clasts consist of Proterozoic and Cretaceous crystalline rocks and Tertiary volcanic rocks. Exposures of these deposits are identical to fanglomerates found east of the Hassayampa River and are at least in part correlative in age.

Tbu: Upper basalt flows

Black to gray, vesicular, plagioclase-clinopyroxene-olivine phyric basalt in flows 2 m to 5 m thick. Maximum thickness of this map unit is 40m on a strike ridge north of the Hassayampa River. Total phenocryst content ranges between 1 percent and 25 percent. Unit unconformably overlies the rhyolites of San Domingo Wash in Turtleback Wash and in Cemetery Wash. Between Burg and the Hassayampa River, this basalt fills in channels at least 4m deep in map unit Tdf. This basalt is distinguished from the lower basalt (map unit Tbl) by the conspicuous phenocrysts of olivine that may reach 7mm across and comprise 10 percent of the rocks.

Tdf: Debris flows

Non resistant, massive deposits of unsorted boulders, cobbles, and pebbles of rhyolite and basalt, Cretaceous granitic rocks, and Proterozoic metamorphic rocks in a matrix of unsorted sand. In Mockingbird Wash, these debris flows grade downsection into several meters of well-layered, very thickly bedded arkosic and boulder conglomerates, which lie depositionally on rhyolitic rocks (map unit Trs). The lowest part of the map unit generally dips 45 , but dips decrease systematically upsection and are flat-lying in stratigraphically highest exposures.

Tif: Felsic dikes and plugs.

Tia: Intermediate dikes and plugs.

Tim: Mafic dikes and plugs.

Td: Dacitic intrusive and extrusive(?) rocks

Dikes and plugs of light- to dark-mauve-weathering, resistant, blocky weathering dacitic rocks with 10 percent to 30 percent phenocrysts of plagioclase, quartz, biotite, hornblende, and clinopyroxene. Conspicuous singular plagioclase phenocrysts and 2- and 3-grain aggregates of subhedral to euhedral plagioclase range up to 1 cm across and are typically chalky white colored, with a seive texture visible with a hand lens. Biotite occurs as altered books 2 to 3 mm across, whereas clinopyroxene occurs as fresh-looking grains about 1mm across. Xenoliths of fine-grained, phaneritic rock are scattered between the phenocrysts and range from 3 and 5 cm across. This unit occurs in or adjacent to low-angle normal faults between Tertiary volcanic rocks and Proterozoic or Cretaceous crystalline rocks. This lithology is texturally identical to dacitic rocks of the Hells Gate volcanics (map unit Tdh), which are common in Hieroglyphic Mountains.

San Domingo volcanics

The rhyolitic rocks of this rock unit have two members; rhyolitic igneous rocks (referred to as rhyolite) and associated rhyolitic pyroclastic rocks. These lithology are generally associated and complexly intermixed on the scale of tens of meters. The nature of each body of rhyolite is, more often than not, uncertain. Some are certainly intrusive because they crosscut and intrude the adjacent pyroclastic rocks, whereas others are texturally zoned lava flows with a basal vitrophyre and upper and lower spherulitic zone. Some exposures of massive intrusive(?) rhyolite arc more than 2km across and include only 1 to 2 m xenoliths of granite and schist.

Tr: Rhyolite flows, domes, sills, and dikes

Light-gray colored, resistant, flow-foliated, autobrecciated, +biotite-quartz-sandine phyric rhyolite that is interbedded with and intrudes associated pyroclastic rocks (map unit Tts). Spherulites are common in the lower portions of flows. Rhyolite flows low in the section are biotite-poor, whereas those high in the section have up to 3 percent biotite. The rhyolite contains 15 percent phenocrysts of sanadine and 5 percent quartz.

Ttl: Rhyolitic pyroclastic rocks

Light-yellow colored, nonresistant, thinly to thickly bedded, lapilli-poor, unwelded tuffs with variable amounts of pebble-sized lithic fragments of basalt, granitoid, and rhyolite. Lithic fragments compose only several percent of the tuffaceous exposures. Long-wavelength crossbeds in some horizons represent surge deposits. Well-sorted, ash-poor lapilli tuffs are also common and probably represent air-fall deposits. Some tuffaceous horizons contain 15 to 20 percent phenocrysts of 1 to 5 mm glomeroporphyritic aggregates of plagioclase and biotite, whereas others are aphanitic. Along Cemetary Wash, the unit includes massive, quartz-sanadine phyric ash flow tuff, which is locally welded and includes a basal vitrophyre over 10m thick.

Tbl: Lower basalt flows

Dark gray, reddish weathering, nonresistant flows of plagioclase-clinopyroxene-olivine phyric basalt and red-brown colored, nonresistant aphanitic scoria. Olivine, which is consistently altered to iddingsite, occurs as phenocrysts typically less than 1mm across and also occurs as a groundmass phase. Basalt also contains less than one percent clinopyroxene phenocrysts 1-2mm across, and white to clear and iron-stained plagioclase as sparse 1-3mm grains.

Tss: Conglomeratic arkose

Dark-red-brown-colored, variably resistant sedimentary rocks including conglomerate, conglomeratic arkose, and arkose. A particularly good section is exposed in Cemetary Wash, where the unit is an upward-fining sequence that is roughly 5m thick and bedded on the scale of 30 to 60m. Arkose in the upper half of the unit is in plane-parallel beds with few crossbeds. Elsewhere the redbeds are massive or inconspicuously layered, consisting of matrix-supported conglomerate with subangular clasts of quartz-rocks ranging in size from 3 to 10cm across, and finer grained clasts of granitoid and schist. The hematitic character of the unit increases toward the lower unconformable contact with metamorphic rocks, which are also hematitic within a few meters of the contact.

CRETACEOUS ROCKS

Kg: Granite

Light-colored, medium-grained, equigranular, leucocratic,biotite granite, which is locally flow foliated along intrusive contacts with Proterozoic schist (map unit Xs). Phenocrysts include pinkish K-spar, white plagioclase, clear quartz grains, and biotite that occurs as fine-grained pads up to 0.5mm across and 0.2mm wide, which define the foliation.

PROTEROZOIC ROCKS

Xg: Biotite quartz-monzonite to monzogranite

Orange-brown, light-gray- to white-colored, medium- and fine-grained, foliated, leucocratic, biotite granite. Phenocrysts include 15 percent quartz, 50 percent plagioclase, 30 percent K-spar (which can be slightly porphyritic grains 5mm to 1cm across), and 2-3 percent biotite. Biotite-muscovite-bearing varieties are common along Turtleback Wash where schist (map unit Xs) and the monzogranite are tectonically interleaved on the scale of decimeters. Zoned bodies of this unit in Cemetery Wash grade outward from a medium-grained core to a fine-grained border phase into a mixed zone with inclusions of amphibolite and dikes of aplite and pegmatite.

Xs: Schist

This unit is predominantly nonresistant, fine- to medium-grained schist of two varieties distinguished by the presence or absence of metamorphic muscovite. One variety with muscovite includes quartz and may include garnet, staurolite, biotite or chloritoid with an uneven distribution of staurolite, garnet, and chloritoid. Staurolite megacrysts are present near intrusive contacts with Proterozoic granite (map unit Xmg). Tourmaline-rich zones occur locally. The variety of schist without muscovite is gray-green in color, nonresistant, mesocratic, fine- to medium-grained, even-grained, biotite quartzo-feldspathic schist. Metaconglomerate with clasts of granitoid and black silica is also present. Map unit includes dikes of rhyolite, dacite, and basalt (map units Trs, Td, and Tbl or Tbu, respectively). The biotite- and muscovite-rich, pelitic varieties of this map units are mineralogically identical to schists in the southern Bradshaw Mountains, rocks correlated with the correlative with the Proterozoic Yavapai Supergroup.

Xam: Amphibolite

Very dark-gray to dark-greenish-gray, foliated, strongly lineated, fine- to medium-grained, ±plagioclase feldspar-epidote-amphibole schist, which occurs as lenticular pods within the biotite-rich schist (map unit Xs).

REFERENCES CITED

Capps, R. C., Reynolds, S. J., Kortemeier, C. P., Stimac, J. A, Scott, E. A., and Allen, G. B., 1985, Preliminary geologic maps of the eastern Bighorn and Belmont Mountains, west-central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 85-14, 25 p, scale 1:24,000.

Capps, R. C., Reynolds, S. J., Kortemeier, K. C., and Scott, E. A., 1986, Geologic map of the northeastern Hieroglyphic Mountains, central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 86-10, 16 p., scale 1:24,000.

Kortemeir, C. P., Jorgensen, M., and Sheridan, M. F., 1986, Volcanic geology of the Castle Hot Springs area, in Beatty, Barbara, and Wilkinson, P. A. K., eds., Frontiers in geology and ore deposits of Arizona and the Southwest: Arizona Geological Society Digest, v. 16, p. 473-477.

Rehrig, W. A., Shafiqullah, M., and Damon, P. E., 1980, Geochronology, geology, and listric normal faulting of the Vulture Mountains, Maricopa County, Arizona, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 89-110.

Shafiqullah, M., Damon, P. E., Lynch, D. J., Reynolds, S. J., Rehrig, W. A., and Raymond, R. H., 1980, K-Ar geochronology and geologic history of southwestern Arizona and adjacent areas, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 201-260.

Geologic Map of the Wickenburg, southern Buckhorn, and northwestern Hieroglyphic Mountains, central Arizona

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INTRODUCTION

This report describes the geology of the Red Picacho quadrangle and parts of the Wickenburg, Garfias Mountain, and Wittmann quadrangles (Fig. 1). Geologic mapping was completed between January and April of 1987, and was jointly funded by the U.S. Geological Survey and the Arizona Bureau of Geology and Mineral Technology as part of the cost-sharing COGEOMAP program. Mapping was done on 1:24,000-scale topographic maps and on 1:24,000-scale color aerial photographs provided by Raymond A. Brady of the U.S. Bureau of Land Management.

GEOLOGIC OVERVIEW

The map area includes the Wickenburg Mountains and contiguous parts of the Buckhorn and Hieroglyphic Mountains (Fig. 1). Adjacent parts of the Vulture Mountains were mapped by Grubensky and others (1987) and adjacent parts of the Hieroglyphic Mountains were mapped by Capps and others (1986). The overall geologic history of the area is complex, but the regional stratigraphy developed in these reports carries well from range to range.

The map area is composed of a metamorphic-plutonic basement unconformably overlain by Tertiary volcanic and sedimentary rocks. The oldest rocks, assigned to the Proterozoic (1.8-1.7 b.y.) Yavapai Supergroup, consist of amphibolite, schist, and gneiss, intruded by granite, leucogranite, and pegmatite. Protoliths for the amphibolite, schist, and gneiss include both volcanic and sedimentary rocks.

Proterozoic rocks are intruded by Late Cretaceous granodiorite, granite, pegmatite, and aplite. Basement rocks are cut by numerous felsic and mafic dikes and sills related to Tertiary volcanism. In places, these dikes account for more than half of the outcrop area.

Crystalline basement rocks are unconformably overlain by Tertiary clastic sedimentary and volcanic rocks. Basal Tertiary deposits usually include a sequence of conglomerate, arkosic sandstone, and thin tuffs. The sedimentary rocks probably represent stream deposits formed shortly before and during early volcanism. Locally, deposition of clastic sedimentary rocks composed almost exclusively of basement lithologies persisted throughout early volcanism, which indicates topographic relief on basement rocks.

Tertiary volcanic and sedimentary rocks of the area can be divided into several temporal-compositional packages of regional extent. Volcanism was strongly bimodal throughout its duration, with basaltic and rhyolitic to dacitic lava flows and related tuffs accounting for at least 90 percent of the eruptive volume of the system. Extensive ash flow tuffs are conspicuously absent in the map area, as they are in the Big Horn Mountains (Capps and others, 1985), northeastern Hieroglyphic Mountains (Capps and others, 1986), and northeastern Vulture Mountains (Grubensky and others, 1987). Rare andesite flows occur interbedded with basaltic sequences.

Early volcanism was dominated by basalt flows, but rhyolitic flows and related tuffs are locally present. Early basalts are overlain by the San

Domingo volcanics, a sequence of phenocryst-poor rhyolite flows and related lithic tuffs. This package is in turn overlain by the Hells Gate volcanics, a thick sequence of porphyritic dacite and rhyodacite flows and related tuffs. The volcanic section is cut by numerous silicic and mafic dikes that served as feeders to the extrusive rocks. Dikes are more abundant in the early erupted basalt and rhyolite flows and tuffs than in the overlying dacite flows and tuffs.

The uppermost dacite flows in the Hells Gate volcanics are interbedded with and overlain by debris flows with clasts derived mainly from the dacite. Many, if not all, of the early debris flows are eruption related. Later debris flows tend to be heterolithologic, and probably formed in response to fault-related tilting and seismic activity.

Debris flows overlying the dacite package are interbedded with olivine-bearing basalts, megabreccia blocks of lower stratigraphic units, and immature fluvial clastic rocks. This complex package is synvolcanic, but grades upward into conglomerate and sandstone typical of post-volcanic sedimentary sequences in nearby ranges. The entire package was deposited in irregular-shaped half grabens that formed during the main episode of extensional faulting.

Structure

Volcanism was accompanied and followed by low- to moderate-angle normal faulting produced by northeast-southwest-oriented regional crustal extension. Major north- to northwest-trending moderate-angle faults, which dip 30 to 50 degrees to the southwest, cut and tilt Tertiary rocks and crystalline basement rocks, producing domino-style repetition of section. The largest of these faults have displacements of several kilometers and produce north to northwest-trending ridges that are usually capped by resistant rhyolite and dacite flows. They cut another set of low-angle faults that dip 5 to 15 degrees to the southwest, and that are common to the eastern Hieroglyphic, Wickenburg, and Vulture Mountains. Northeast- to east-trending complex fault zones probably functioned as boundaries for domains of differential extension and tilting during displacement on both moderate- and low-angle fault sets.

The low-angle faults have fairly irregular surfaces, probably in part due to original corrugations in the faults. They are interpreted as normal faults because they commonly carry tilted Tertiary rocks in their hanging walls, and, where they juxtapose pre-Tertiary crystalline rocks, the intrusive margin of the Cretaceous granite is progressively displaced westward (see cross section B-B').

The change from northwest-striking to north-northeast-striking ridges in the west central Wickenburg quadrangle probably formed as the result of drag on a major low-angle structure that separates basement lithologies from the overlying, steeply tilted Tertiary section. This fault probably has on the order of 5 km of displacement (see cross section C-C').

Evidence that faulting occurred during volcanism includes (1) generally steeper dips on the early volcanic section than on stratigraphically higher units, and (2) fault zones intruded by Tertiary dikes and sills, with local brecciation of dike rocks due to subsequent movement on those faults.

Pre-Tertiary structures in the map area include isoclinal folds within the foliation of the Proterozoic rocks and megascopic open to tight folds that fold the Proterozoic foliation. The foliation-related isoclinal folds are certainly Proterozoic in age, and the megascopic folds are probably also of Proterozoic age.

Mineralization

Precious- and base-metal prospects occur in both the Tertiary volcanic and sedimentary rocks and the crystalline basement. Many of the prospects are localized along low- to moderate-angle faults characterized by intense brecciation and quartz, calcite, and iron-oxide veining. Such mineralization is middle Tertiary in age. Placer gold occurrences are common in several major drainages and their tributaries. The most productive deposits are in the San Domingo, Little San Domingo, and Ox Wash areas. Proterozoic metachert and metacarbonate lenses, interpreted as exhalites, are also potential prospecting targets for gold. Proterozoic Li-bearing pegmatites occur in the upper San Domingo Wash area.

QUATERNARY AND UPPER TERTIARY UNITS

Qs: Younger alluvium
Unconsolidated sand and gravel in modern channels or on adjacent low-lying terraces to these channels.

Qso: Mid-Level alluvium
Unconsolidated gravel-poor sand and sandy gravel deposits in flood plains elevated 0.5 to 2 m above modern channels. Deposits typically host mature mesquite trees.

QTs: Older alluvium
Unconsolidated to semi-consolidated and caliche-cemented sand and gravel deposits that commonly underlie dissected terraces elevated 2 m or more above modern drainages. The deposits are being incised by the present drainages and host palo verde trees, saguaro, and other cacti.

MIDDLE TERTIARY VOLCANIC AND SEDIMENTARY ROCKS

Tertiary rocks of the area overlie crystalline basement and consist of clastic sedimentary rocks, volcanic rocks, debris flows, and fanglomerate and related megabreccia. The volcanic rocks probably range in age from latest Oligocene to early Miocene. The youngest Tertiary rocks are fanglomerates and related megabreccia that accumulated during extensional faulting. Fanglomerate grades downward into a complex sequence of synvolcanic debris flows, megabreccia, clastic sedimentary rocks, thin tuffs, and olivine-bearing basalts. These units are underlain by a series of dacitic to rhyodacitic flows and tuffs, correlative with the Hells Gate volcanics of the northeastern Hieroglyphic Mountains (Ward, 1977; Capps and others, 1986). The Hells Gate volcanics also make up most of the Buckhorn Mountains in the adjacent Garfias Mountain and Copperopolis quadrangles. The Hells Gate volcanics are underlain by the San Domingo volcanics, a series of rhyolite flows and related tuffs.

The San Domingo volcanics are interbedded with, and underlain by a series of basalt flows and conglomeratic to arkosic sandstone lenses. The average thickness of the volcanic pile is roughly 1-2 km.

The volcanic stratigraphy has been subdivided into the following informal units (from youngest to oldest):

1) debris flows, deposited during and after the Hells Gate volcanics;

2) upper basalt flows, deposited during and after the Hells Gate volcanics;

3) upper tuffs, deposited after the Hells Gate volcanics;

4) Hells Gate volcanics, composed of dacite and rhyodacite flows, tuffs, and debris flows;

5) San Domingo volcanics, composed of rhyolite flows and tuffs;

6) lower basalt, basaltic andesite, and andesite flows; and

7) clastic sedimentary rocks, deposited prior to, during, and after volcanism.

A general stratigraphic section is shown in Figure 2. More detailed stratigraphic sections of the San Domingo Peak area and the Red Picacho area are shown in Figures 3 and 4, respectively.

Tf: Fanglomerate

Brown- to buff-colored consolidated to semi-consolidated conglomerate, sandstone, and siltstone with a discontinuous thin cover of QTs. Fanglomerate grades downward into tilted sheet-flood deposits and debris flows with interbedded basalts and thin upper tuffs.

Fanglomerate usually forms low hills with little or no outcrop, but steep cliffs 5 to 20 m occur along major washes in the Wickenburg quadrangle. The deposits are flat lying to moderately tilted.

Tbx: Megabreccia and sedimentary breccia; protolith of breccia indicated in parentheses where known

Shattered landslide blocks (megabreccia derived from various older rock units). Megabreccia blocks are locally associated with debris flows and fanglomerate.

Tut: Upper tuffs

Purplish-brown to lavender poorly to moderately welded lithic-rich ash flow tuffs. Phenocrysts includes 5 to 15 percent biotite and hornblende (1-4 mm) and 1 to 5 percent plagioclase (1-4 mm). The tuffs contain 25 to 40 percent lithic fragments, mainly consisting of Hells Gate volcanics and upper basalt. They reach maximum thicknesses of 10-20 m in the upper San Domingo Wash area, forming moderately steep ledges and slopes. The tuffs are interbedded with upper basalts and debris flows.

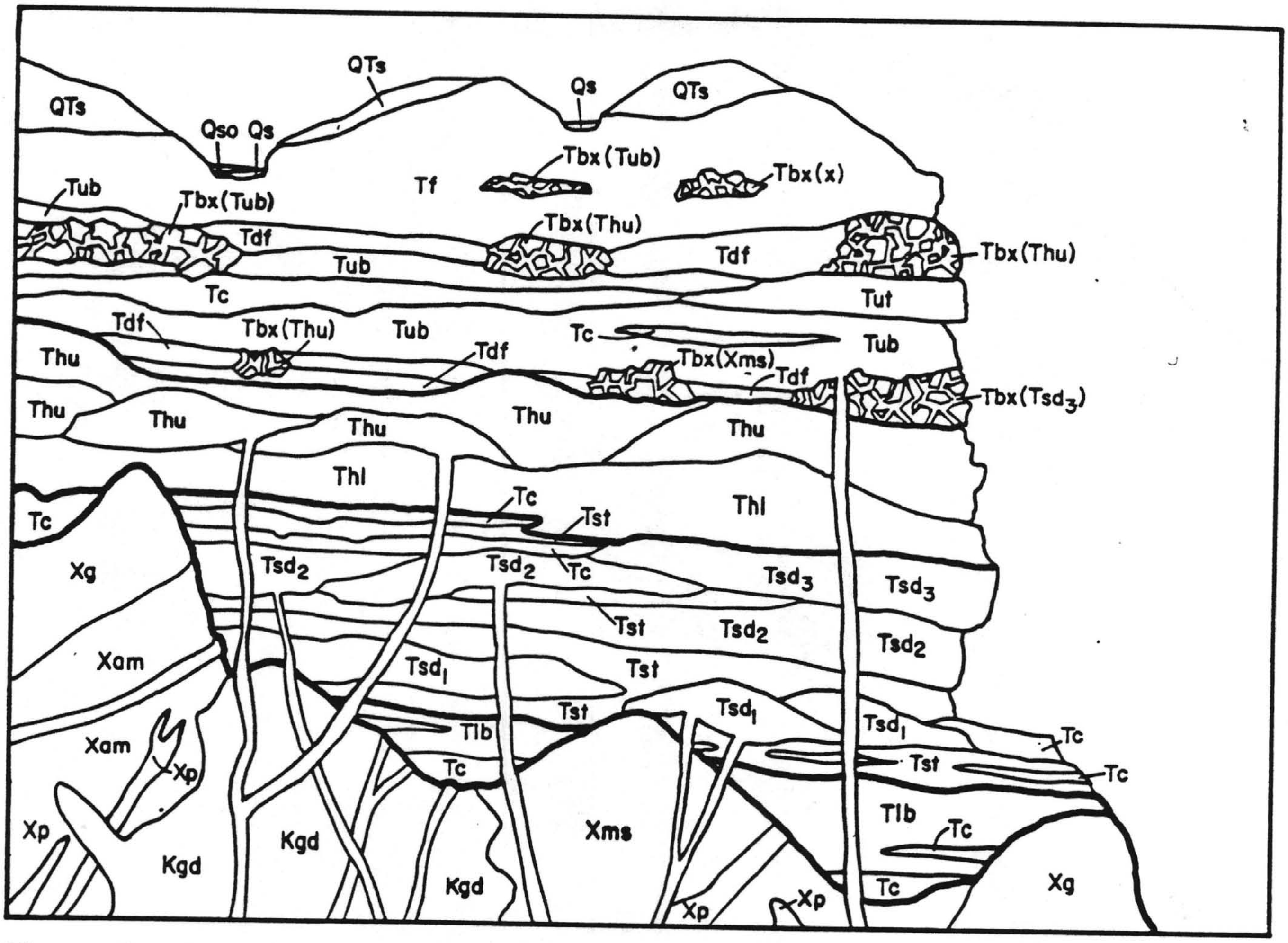


Figure 2. General schematic stratigraphic section for the Wickenburg, southern Buckhorn, and northwestern Hieroglyphic Mountains.

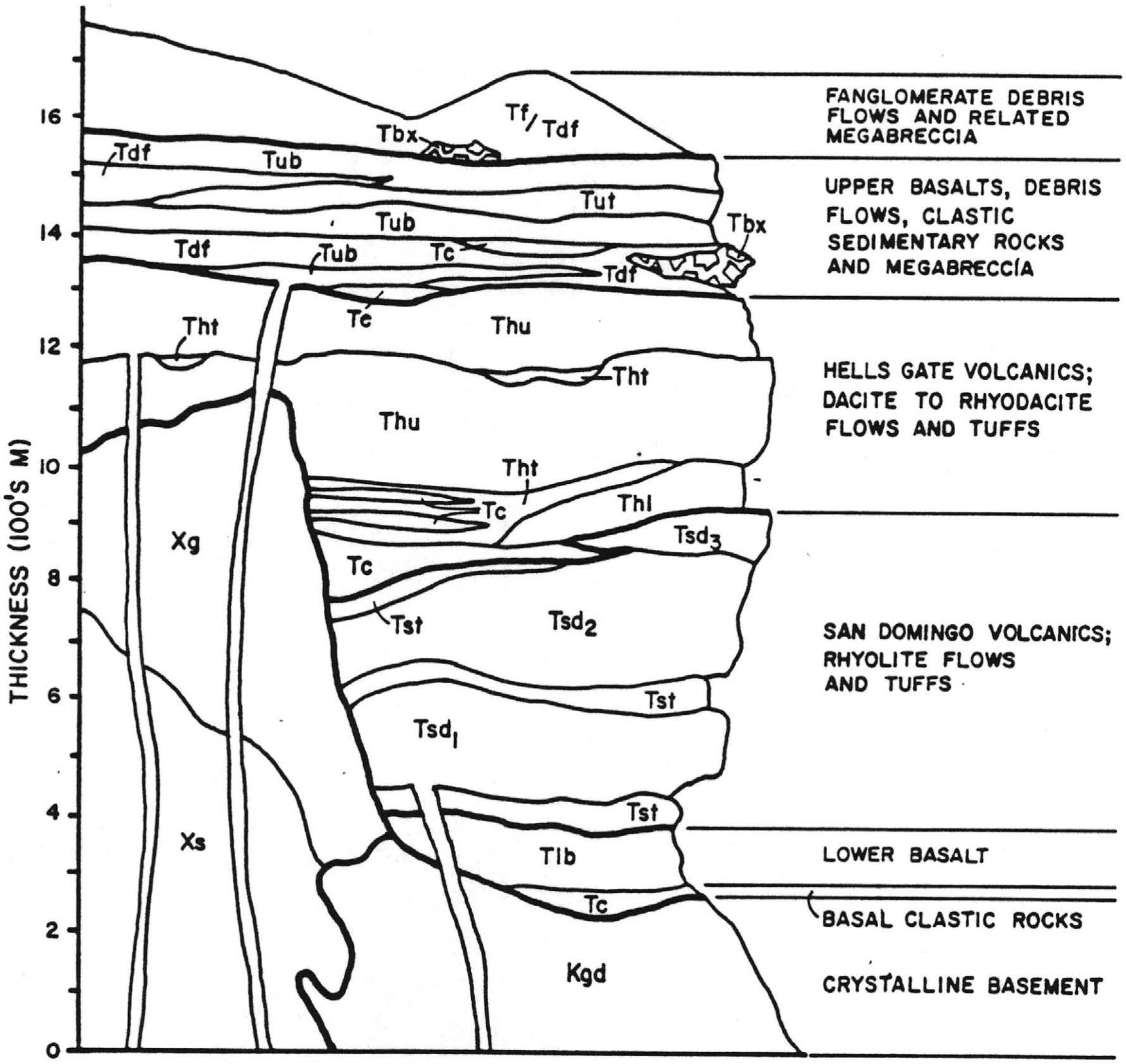


Figure 3. Schematic stratigraphic section for the San Domingo Peak area.

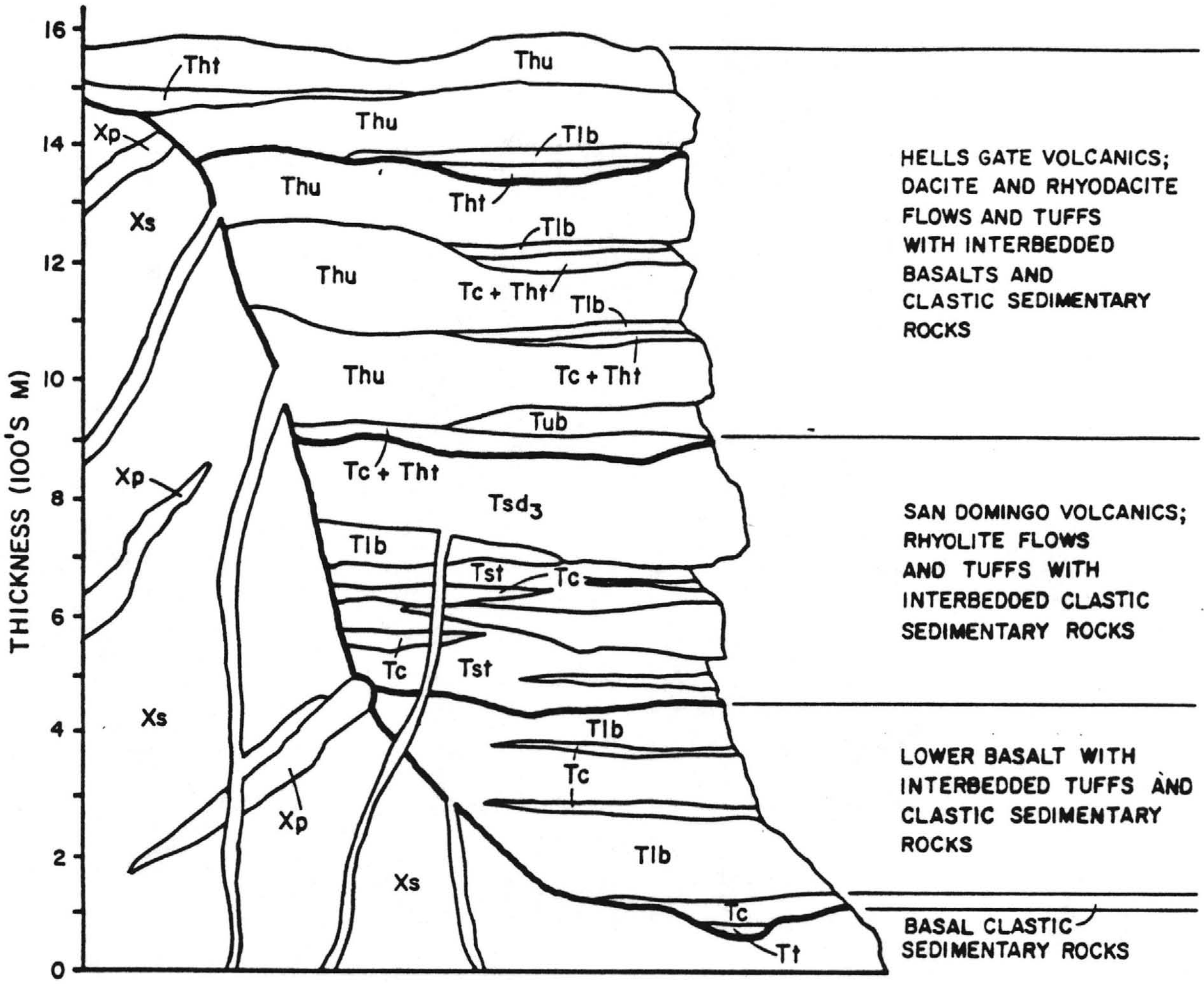


Figure 4. Schematic stratigraphic section for the Red Picacho and White Picacho area.

Tub: Upper basalts

Black to gray basalt flows. These flows contain up to 25 percent phenocrysts including 5 to 20 percent olivine (1-6 mm), trace to 10 percent clinopyroxene (1-8 mm), trace to 10 percent plagioclase (2-6 mm), and 1 to 5 percent opaque oxide minerals (1-5 mm).

Individual flows are usually thin (2-5 m) with well-developed agglomerate horizons at flow contacts. They are stratigraphically equivalent with the upper aphyric basalts in the Bighorn Mountains, dated at 16.1 Ma (Capps and others, 1985) and upper basalts in the northeastern Hieroglyphics, dated at 16.2 Ma (Capps and others, 1986).

Tdf: Debris flows and avalanche deposits

Tan, pinkish, and white massively bedded, unsorted, matrix-supported debris flow and avalanche deposits. They contain clasts of volcanic and crystalline basement rocks, but are usually dominated by a specific lithology, especially Hells Gate dacites and upper olivine-bearing basalts.

The debris flows are interbedded with upper basalts and clastic sedimentary rocks. They form low hills with sporadic outcrop. Good exposures occur along washes and in roadcuts. Individual flows rarely exceed 20 m, but very thick debris flow sequences occur in the Buckhorn, northern Hieroglyphic, and northeastern Wickenburg Mountains. The debris flow sequence grades upward into less consolidated, finer-grained conglomerate, sandstone, and siltstone.

In the San Domingo Peak area, debris flows composed mainly of fragments of Hells Gate dacite are interbedded with megabreccias of first-erupted Hells Gate dacite and older lithologies. These megabreccias show internal shattering and are interpreted as landslide-avalanche deposits related to tilting during faulting.

In the southern Buckhorn Mountains, large (up to several hundred meters) blocks of dacite flow rock is surrounded by massive, unsorted matrix. Blocks do not show internal shattering characteristic of megabreccias associated with faulting and are interpreted either as interbedded dacite flows or rockslide-avalanche deposits intimately associated with eruptions of dacite lavas.

Th: Hells Gate volcanics

Pink, gray, purple-gray, and reddish-brown phenocryst-rich dacite and rhyodacite flows and related tuffs and debris flows. The unit name is carried over from mapping by Capps and others (1986) in the northeastern Hieroglyphic Mountains. The unit has yielded dates of 17.98 Ma in the northern Buckhorn Mountains (Shafiqullah and others, 1980) and 17.4 and 16.1 Ma in the northeastern Hieroglyphic Mountains (Capps and others, 1986; Kortemeier and others, 1986). The Hells Gate volcanics are divided into two informal members based on phenocryst size and abundance. The lower Hells Gate flows are finer grained and less phenocryst-rich than the upper Hells Gate flows.

Thl: Lower Hells Gate flows

Pink, orangish-brown, and reddish-brown porphyritic rhyodacite flows. Phenocrysts include 5 to 10 percent plagioclase (1-3 mm), 10 to 15 percent hornblende (1-2 mm), less than 5 percent biotite (1-3 mm), trace clinopyroxene (1-2 mm), and less than 2 percent opaque oxide minerals (0.5-1 mm).

Hornblende and biotite phenocrysts are strongly oriented along flow foliation.

These flows appear to be transitional in mineralogy between the rhyolites of the San Domingo volcanics and the upper Hells Gate dacites. They mark the first major appearance of hornblende and biotite (greater than 2 percent), and signal an increase in both the crystallinity and size of phenocrysts in the eruptive sequence.

Thu: Upper Hells Gate dacite and rhyodacite flows

These flows contain from 20 to 45 percent phenocrysts with younger flows generally being most phenocryst rich. Phenocryst assemblages usually include 10 to 20 percent plagioclase (2 mm-1.5 cm), 5 to 15 percent biotite and hornblende (2-8 mm), trace to 3 percent clinopyroxene (1- 3 mm and in cumulophyric clumps with plagioclase), 1 to 3 percent opaque oxide minerals (1-3 mm), and trace to 2 percent quartz (2-5 mm). Quenched mafic inclusions are common in the early dacites, especially in the Red Picacho area.

Tht: Hells Gate tuffs

White, pinkish, and buff-colored lithic-rich tuffs. Phenocrysts include 10 to 25 percent feldspar and 10 to 20 percent biotite and hornblende. Lithic fragments are mainly of Hells Gate flows and olivine-bearing basalts. Most of the tuffs are thin, but thicknesses up to 40 m occur in a paleovalley at the extreme northwestern corner of the Garfias Mountain quadrangle.

The Hells Gate volcanics form major ridges and cliffs in the Red and White Picacho area, and throughout the Buckhorn Mountains. The average thickness of the unit is approximately 200 to 500 m.

Tsd: San Domingo volcanics

Brown, purplish-brown, reddish-brown, pink, and gray aphyric and phenocryst-poor rhyolite flows. These flows are characterized by flow brecciated bases with very poorly preserved vitrophyre, and flow-banded bodies that grade upward into lithophysae-rich tops. The flow rhyolites form prominent ridges and cliffs throughout the map area. The total thickness of the package averages several hundred meters.

The San Domingo volcanics are stratigraphically equivalent to the Morgan City rhyolite of Capps and others (1986). Rhyolite flows and tuffs are mainly aphyric or crystal poor. Most of the flows in this package are K-metasomatized and are unsuitable for either chemical analysis or K-Ar age dating.

San Domingo volcanics are composed of many coalescing flows and domes, with pyroclastic aprons. At least three informal members can be distinguished locally based on mineralogy:

Tsd_1: Aphyric rhyolite flows.

Tsd_2: Phenocryst-poor rhyolite flows with 5 to 10 percent feldspar (dominantly sanidine 1-4 mm in length) and trace to 2 percent biotite and hornblende (1-3 mm) phenocrysts.

Tsd_3: Quartz-bearing rhyolite flows with 5 to 15 percent feldspar (dominantly sanidine 1-4 mm in length) and 5-10 percent quartz (1-3 mm).

These flows form major ridges and cap hills east of Trilby Wash. They reach maximum thicknesses of 50 to 150 m in the Red Picacho area, and are present locally as far west as the San Domingo Peak area.

Tst: Lithic tuffs and related sedimentary rocks

White, pink, and buff-colored aphyric to phenocryst-poor lithic ash-flow, surge, and air fall tuffs, and clastic sedimentary rocks derived mainly from volcanic rocks. The tuffs occur in packages and separate individual flow rhyolites. They form poor outcrops compared to the rhyolite flows, making up moderate to steep slopes generally covered by talus of the overlying rhyolite flows. The tuff sequence reaches thicknesses of 40 to 100 m in the San Domingo Peak and upper Trilby Wash areas and includes at least two moderately welded lithic-rich ash flow tuffs. These tuffs form prominent 3 to 10 m ledges in the San Domingo Peak area. One of these tuffs also forms 5 to 15 m ledges underlying Tsd_3 in the upper Trilby Wash area.

Tlb: Lower basalt, basaltic andesite, and andesite flows

Black, gray, brown, and reddish-brown vesicular to massive basaltic to andesitic flows and agglomerate. The phenocryst assemblage and thin, tabular nature of these flows indicate that the vast majority are basaltic in composition, but, rare basaltic andesite and andesite flows are also present. In the map area, the lower basalt sequence reaches a maximum thickness of 200-400 m in the upper Trilby Wash area, near the Maricopa-Yavapai County line.

The mafic flows contain 5 to 30 percent phenocrysts, including 2 to 10 percent olivine (1-4 mm), 2 to 20 percent clinopyroxene (1-6 mm), 2 to 10 percent plagioclase (1-8 mm), and 1 to 5 percent opaque oxide minerals (1-4 mm). Rare flows contain up to 20 percent orthopyroxene megacrysts (5-15 mm).

The mafic flows are interbedded with the first erupted rhyolitic flows and tuffs of the San Domingo volcanics and with clastic sedimentary rocks composed mainly of clasts of basement lithologies. The basalts form slopes with sporadic outcrop and are commonly covered by talus of more resistant overlying rhyolite flows.

The basaltic sequence appears to be part of a regional episode of dominantly basaltic volcanism that preceded and overlapped with silicic volcanism. It is stratigraphically equivalent to the Deadhorse Wash basalt of the Big Horn Mountains and undifferentiated lower basalts of the Hieroglyphic Mountains. The age of this sequence remains poorly constrained, but it is older than 21 Ma in the Big Horn Mountains (Capps and others, 1985), and older than 18.7 Ma in the Hieroglyphic Mountains (Kortemeier and others, 1986).

Ta: Andesite flow

Gray biotite- and hornblende-bearing flow foliated andesite. This distinctive flow occurs in the Red Picacho area, where it reaches a maximum thickness of 30 to 40 m.

Tc: Clastic sedimentary rocks

Reddish-brown, brown, tan, greenish-gray, and white conglomerate, coarse sandstone, and sandstone. Clasts are mainly of Proterozoic and Cretaceous rocks, but clasts of volcanic units are locally abundant, especially in lenses interbedded with the volcanic section. These deposits unconformably overlie basement rocks and occur interbedded with and overlying the volcanic section. They form moderately resistant ledges and steep slopes. The thickest deposits (20-50 m) occur in the lower Trilby Wash area. Basal deposits rarely exceed 15 m, but clastic lenses from 1 to 10 m occur intercalated with lower basalts, San Domingo volcanics, and debris flows and upper basalts throughout much of the Red Picacho quadrangle.

TERTIARY ALTERATION ZONES

Tqz: Intensely silicified rocks
White to gray intensely silicified rocks composed of fine-grained quartz and chalcedony. These deposits probably represent near-surface levels of fossil hot-spring systems.

Stippled pattern: Hydrothermal alteration
The stippled pattern denotes areas of local and regional hydrothermal alteration characterized by silicification, and argillic or propylitic alteration. Regional hydrothermal alteration has affected much of the northwestern Hieroglyphic Mountains and the adjacent southern Buckhorn Mountains. This alteration is restricted mainly to the lower part of the section and is probably related to emplacement of upper Hells Gate dacite flows. Some of the alteration in crystalline basement rocks may be pre-Tertiary in age.

PRE-TERTIARY ROCK UNITS AND STRUCTURES

Cretaceous intrusive rocks

Granodiorite, granite, aplite, and pegmatite of Late Cretaceous age occurs throughout the map area as well as in adjacent ranges. This intrusive sequence is equivalent with the Wickenburg granodiorite (Rehrig and others, 1980) and granitic rocks in the Big Horn Mountains (Capps and others, 1985). The suite rarely forms good outcrops, weathering to low, grus-covered hills in most areas. However, good outcrops occur in the southeastern corner of the Red Picacho quadrangle. In some areas, mafic minerals have been completely replaced by chlorite and epidote.

The suite includes small aplite and pegmatite bodies that are similar to those found in the Precambrian rocks of the area, but they usually contain less muscovite and little or no tourmaline.

Kgd: Granodiorite
White to gray porphyritic to equigranular granodiorite. The mineral assemblage includes 10 to 25 percent plagioclase, 10 to 25 percent potassium feldspar (either microcline or orthoclase), 5 to 15 percent quartz, 10 to 20 percent biotite, 5 to 20 percent hornblende, 5 percent opaque oxides, and trace sphene and zircon.

Kg: Granite

Gray to white porphyritic to equigranular granite. This unit is similar to the granodiorite, but contains more quartz and less amphibole. Quartz aggregates up to 15 mm in diameter are common in the northern Red Picacho quadrangle.

Kp: Pegmatite

Ka: Aplite

Proterozoic Rocks

Proterozoic rocks in the map area include metavolcanic and metasedimentary rocks, deformed and undeformed granites, and pegmatite dikes and sills. All of these rocks are intruded to varying degrees by Tertiary felsic and mafic dikes. In places, these dikes compose up to about 70 percent of the outcrop area. Even in these highly intruded areas, however, foliation in the Proterozoic rocks remains consistent in orientation.

Xs: Metamorphic Rocks

Metamorphic rocks in the map area are correlative with the Proterozoic Yavapai Supergroup, and appear to be continuations of lithologies found in the southern Bradshaw Mountains. In the most extensive exposures of Proterozoic rocks, in the northern Red Picacho quadrangle, the metamorphic rocks have been divided into two units: a predominantly mafic unit (Xam) and a predominantly pelitic unit (Xms). Both units are heterogeneous, with lithologies interlayered on a scale of tens of meters to a meter or less. This interlayering may be due to original depositional variation or to deformation. In other parts of the map area units Xam and Xms were not mapped seperately, but were mapped as Xs (metamorphic rocks including schist, amphibolite, and gneiss).

Xam: Metavolcanic Rocks

Black, dark-greenish, to gray-green amphibolite, and light gray to tannish well foliated and lineated gneiss.

The most abundant lithologies are biotite-amphibole schist, amphibole-feldspar schist and gneiss, and massive amphibole-epidote gneiss. These rocks are fine to medium grained, well foliated, and usually have a well-developed mineral alignment-lineation in the foliation plane. One amphibolite shows a well-developed lineation, but no foliation.

The amphibolite commonly contains thick layers to small pods of silicic metavolcanic rock, and metacarbonate and metachert that appear to be of exhalative origin. The silicic metavolcanic rocks are very fine grained, well-foliated and lineated gneisses. Thin layers of this lithology can be found within the amphibolite throughout its extent. Good exposures of this lithology are in sections 11, 14, and 15, T7N, R3W, in the Red Picacho quadrangle, where they form east-west-trending bands through the amphibolite.

Xmch: Metacherts

Red, purplish-brown, and black quartzite. These rocks are interpreted as cherts whose grain-size has coarsened through metamorphism. They occur as pods and stringers interlayered with amphibolite and small bodies of carbonate breccia. Quartzites are common in sections 14 and 15, T7N, R3W, in the Red Picacho quadrangle.

Xmc: Metacarbonate

Dark-greenish-brown carbonate. These rocks occur as small bodies of carbonate breccia, commonly with siliceous stringers concentrated around their margins. These rocks occur together with metachert, and both rock types probably originated as exhalites.

Xms: Metasedimentary Rocks

Gray to reddish-gray schist, white, tan, and gray stretched-pebble conglomerate, and light-gray to medium-gray banded paragneiss.

The most common rock type in this unit is muscovite schist that varies in mineralogy from muscovite-garnet-biotite-quartz-feldspar, muscovite-andalusite-biotite-chloritoid(?)-quartz-feldspar, muscovite-cordierite(?)-biotite-quartz-feldspar, and muscovite-quartz-feldspar. These lithologies are fine to coarse grained, and well foliated and lineated. A local crenulation is unique to these metamorphic rocks in the study area. A striking variant to the muscovite schist assemblage contains andalusite porphyroblasts up to 10 cm long.

The stretched-pebble conglomerate contains clasts of felsic igneous rocks, probably volcanic lithologies. The matrix is composed of fine-grained muscovite, chlorite(?), quartz, and feldspar.

The paragneiss in this unit may be a transitional unit between the metasedimentary and the metavolcanic packages; it is certainly transitional in mineralogy, although it usually crops out in association with the metasedimentary rocks. The gneiss is composed of fine-grained amphibole, quartz, feldspar, muscovite, and pyrite. It is well foliated and moderately to well lineated.

Xps: Psammitic Schist

These rocks are derived from a lithic sandstone, are similar to the metaconglomerate, but lack the igneous rock clasts, and usually crop out near the metaconglomerate.

The fabrics developed in this unit include a well-developed foliation and a mineral and stretching lineation in the foliation plane. Pebbles in the metaconglomerate are flattened into the foliation plane and highly elongated in the lineation direction. Pebbles presently range from 1 to 20 cm in length, 1 to 3 cm in width, and 0.5 to 3 cm in height.

Xg: Granitic Rocks

Orangish-brown, tan, and gray- to light-gray, foliated biotite granite, light-gray to white biotite-muscovite granite. This unit includes several granitic lithologies, the most common of which is a fine-grained, foliated and lineated, biotite granite. This granite is commonly interlayered with metamorphic rocks on the scale of a few meters.

The next most abundant lithology is a medium-grained biotite-muscovite granite. This lithology has a deformed border zone with amphibolite in sections 32 and 33, T8N, R3W in the Red Picacho quadrangle. It appears to grade into a porphyritic version with microcline phenocrysts (1-3 cm in length), aligned in the plane of foliation. This lithology rarely shows a lineation, and the foliation is commonly less well developed than in the orangish-brown-weathering biotite granite, or in the other Proterozoic rocks.

Medium- to coarse-grained equigranular to porphyritic biotite or biotite-muscovite granites outcrop in the northeastern corner of the Wickenburg quadrangle and the northwestern corner of the Red Picacho quadrangle. Foliation in these rocks is generally not well developed, and is confined to higher strain zones, with undeformed granite and related pegmatite between these zones. Undeformed portions of these granites can closely resemble the Cretaceous granite. The Proterozoic granites tend to be more resistant, forming large hills and ridges. They are also interlayered with sparse amphibolite and schist stringers, and are more variable in both grain size and mineralogy.

Xal: Leucogranite, pegmatite, and interlayered schist and amphibolite

White to gray, fine-grained, weakly foliated leucogranite and pegmatite. This lithology differs from other granitic rocks in the area in its almost complete lack of mafic minerals. Good exposures occur along the Castle Hot Springs road northeast of Trilby Wash.

Xp: Pegmatite

White, pink, and gray pegmatite. The mineral assemblage normally includes very coarse-grained microcline, quartz, muscovite, and tourmaline. Tourmaline commonly pervades rocks adjacent to the dikes, especially amphibolites and schists.

Pegmatite bodies intruded all Proterozoic units. The pegmatites usually occur in elongate bodies parallel to foliation of the host rock, although some pegmatites also cross-cut foliation. Only a few of the pegmatite bodies show evidence of deformation.

Lithium-bearing pegmatites occur in both the Red Picacho and Wickenburg quadrangles. Lithium-bearing minerals documented from the White Picacho District, the largest group of lithium-bearing pegmatites in the area, include spodumene, lepidolite, lithiophilite, amblygonite, and, eucryptite. Other minerals of interest include beryl, tourmaline, scheelite, columbite-tantalite and garnet (Jahns, 1952; London and Burt, 1978). K-Ar dates (Laughlin, 1969) on pegmatite minerals from the area yielded apparent ages ranging from 750-1580 Ma, with muscovite giving a minimum age of 1270 Ma.

Proterozoic Structures

Proterozoic rocks of the area contain large- and small-scale structures of known or suspected Proterozoic age that include interfolial rootless fold noses with axes parallel to the mineral-alignment lineation in the rocks. The presence of an isoclinal folding event implies that folding may pervade the Proterozoic section, and some (or all) of the lenticular map patterns may in fact reflect isoclinal folds.

A tight fold nose crops out in sections 5 and 6, T7N, R3W of the Red Picacho quadrangle. The axial plane of this fold is subvertical and strikes east-west, the axis dips about 60 degrees west, and the fold closes westward. This structure folds pre-existing foliation, but is not associated with an axial-planar cleavage or crenulation. Just northeast of this fold, in sections 32 and 33 of T8N, R3W, a broad, very open fold gently the foliation in and around the border zone of granite and amphibolite. The axis of this open-fold plunges steeply northwest, with the fold closing southeast. Another such open fold that crops out just to the west, has a nearly vertical axis and closes to the northwest.

REFERENCES CITED

Capps, R. C., Reynolds, S. J., Kortemeier, C. P., Stimac, J. A, Scott, E. A., and Allen, G. B., 1985, Preliminary geologic maps of the eastern Bighorn and Belmont Mountains, west-central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 85-14, 25 p, scale 1:24,000.

Capps, R. C., Reynolds, S. J., Kortemeier, K. C., and Scott, E. A., 1986, Geologic map of the northeastern Hieroglyphic Mountains, central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 86-10, 16 p., scale 1:24,000.

Grubensky, M. J., Stimac, J. A., Reynolds, S. J., and Richard, S. M., 1987, Geologic map of the northeastern Vulture Mountains and vicinity, central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 87-10, 8 p., scale 1:24,000.

Jahns, R. H., 1952, Pegmatite deposits of the White Picacho district, Maricopa and Yavapai County, Arizona: Arizona Bureau of Mines Bulletin 162, 105 p.

Kortemeir, C. P., Jorgensen, M., and Sheridan, M. F., 1986, Volcanic geology of the Castle Hot Springs area, in Beatty, Barbara, and Wilkinson, P. A. K., eds., Frontiers in geology and ore deposits of Arizona and the Southwest: Arizona Geological Society Digest, v. 16, p. 473-477.

Laughlin, A. W., 1969, Excess radiogenic argon in pegmatitic minerals: Journal Geophysical Research, v. 74. p. 6684-6690.

London, D., and Burt, D. M., 1978, Lithium pegmatites of the White Picacho district, Maricopa and Yavapai Counties, Arizona, in Burt, D. M., and Pewe, T. L., eds., Guidebook to the geology of central Arizona: Geological Society of America Cordilleran Section, 74th annual meeting, Arizona Bureau of Geology and Mineral Technology Special Paper 2, p. 61-73.

Rehrig, W. A., Shafiqullah, M., and Damon, P. E., 1980, Geochronology, geology, and listric normal faulting of the Vulture Mountains, Maricopa County, Arizona, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 89-110.

Shafiqullah, M., Damon, P. E., Lynch, D. J., Reynolds, S. J., Rehrig, W. A., and Raymond, R. H., 1980, K-Ar geochronology and geologic history of southwestern Arizona and adjacent areas, in Jenney, J. P., and Stone, Claudia, eds., Studies in western Arizona: Arizona Geological Society Digest, v. 12, p. 201-260.

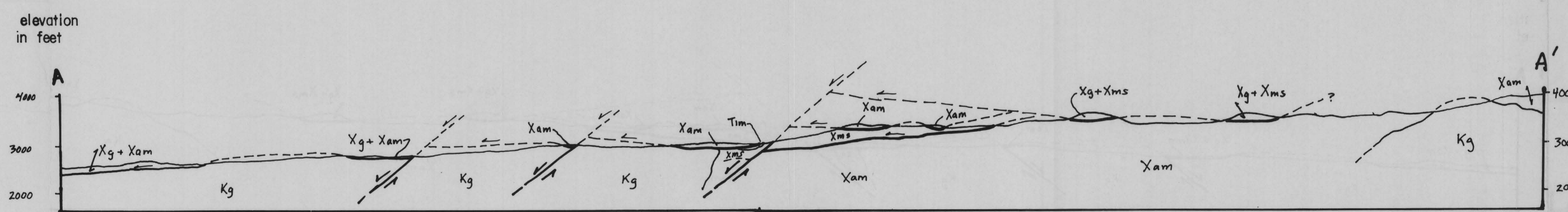
Ward, M. B., 1977, The volcanic geology of the Castle Hot Springs area, Yavapai County, Arizona: Tempe, Arizona State University, M.S. Thesis, 74 p.

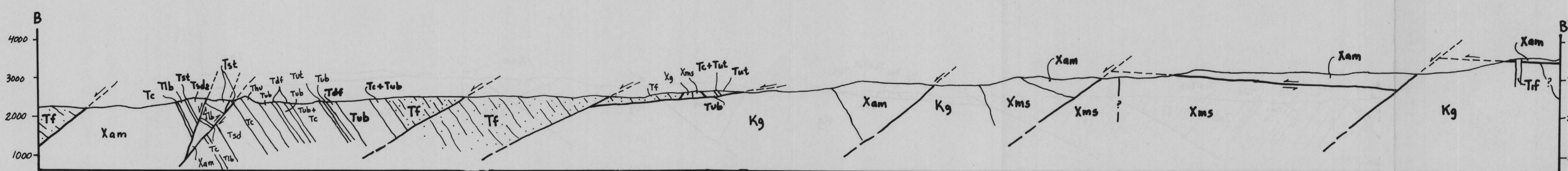
GEOLOGIC CROSS SECTIONS OF THE WICKENBURG, SOUTHERN BUCKHORN, AND NORTHWESTERN HIEROGLYPHIC MOUNTAINS, CENTRAL ARIZONA

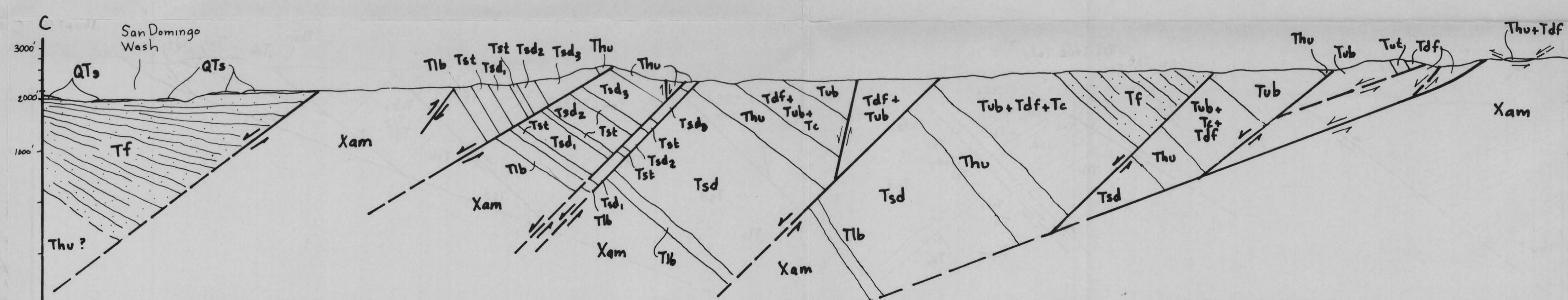
by

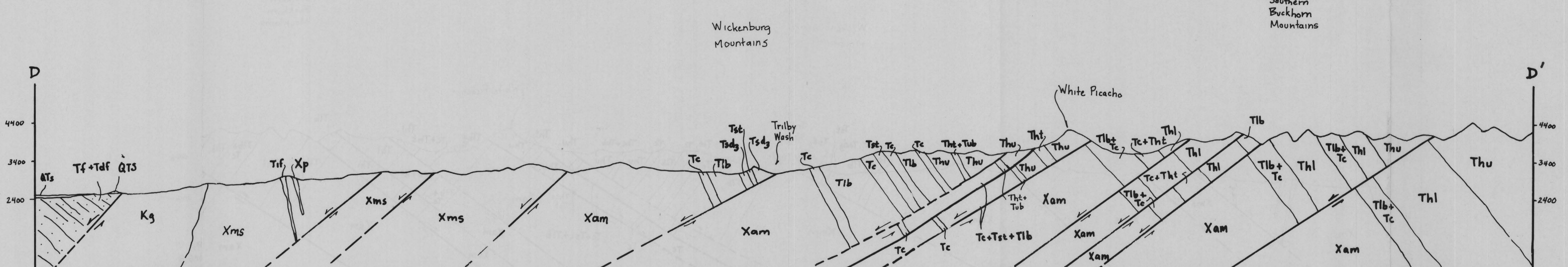
James A. Stimac and Joan E. Fryxell

1987









$\frac{1}{2}$ 0   1 mile

1: 24,000

no vertical exaggeration

ARIZONA BUREAU OF GEOLOGY
AND MINERAL TECHNOLOGY
OPEN-FILE REPORT 87-9
SHEET 2 OF 2

MAP UNITS AND SYMBOLS

MAP UNITS

Qs YOUNGER ALLUVIUM (Quaternary)
Qso OLDER ALLUVIUM (Quaternary)
QTs SEDIMENTARY ROCKS (Quaternary and (or) Tertiary)
Tf FANGLOMERATE (Tertiary)
Tsc CONGLOMERATE AND SANDSTONE (Tertiary)
Tbu UPPER BASALT FLOWS (Tertiary)
Tdf DEBRIS FLOWS (Tertiary)
Tif FELSIC DIKES AND PLUGS (Tertiary)
Tia INTERMEDIATE DIKES AND PLUGS (Tertiary)
Tim MAFIC DIKES AND PLUGS (Tertiary)
Td DACITIC INTRUSIVE AND EXTRUSIVE ROCKS (Tertiary)

RHYOLITIC ROCKS OF SAN DOMINGO WASH
Trs RHYOLITE FLOWS, DOMES, SILLS, AND DIKES (Tertiary)
Tts RHYOLITIC PYROCLASTIC ROCKS (Tertiary)

Tbl LOWER BASALT FLOWS (Tertiary)
Ts SANDSTONE AND CONGLOMERATE (Tertiary)
Kg GRANITE (Cretaceous)
Kgd GRANODIORITE (Cretaceous)
Kd DIORITE (Cretaceous)
Xs SCHIST (Precambrian X)
Xg BIOTITE QUARTZ MONZONITE TO MONZOGRANITE (Precambrian X)
Xsg SCHIST AND GNEISS (Precambrian X)
Xam AMPHIBOLITE (Precambrian X)

MAP SYMBOLS

GEOLOGIC CONTACT--Solid where crossed on a traverse; dashed where extended between traverses; dotted where buried.

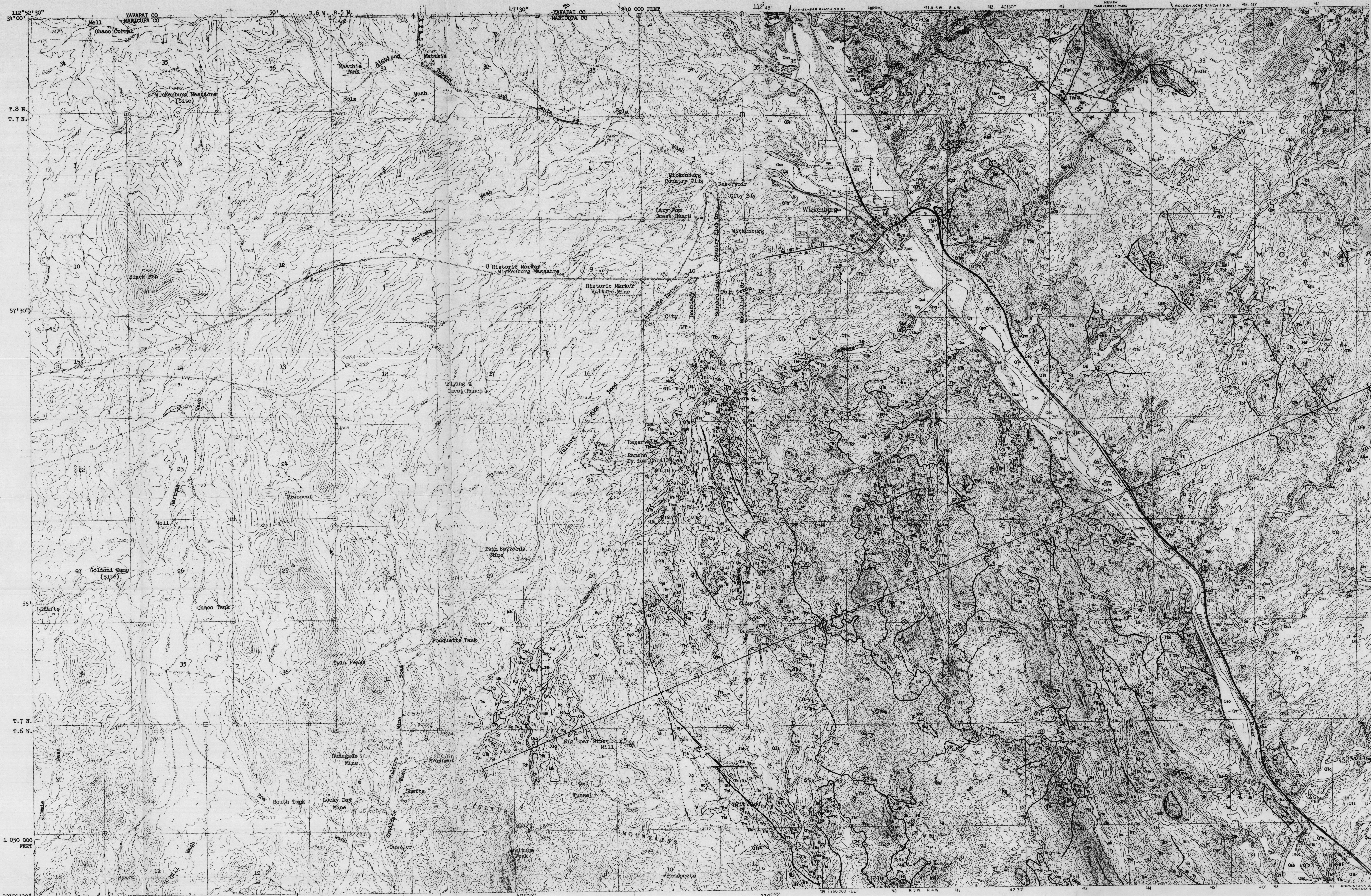
FAULT--showing dip. Solid where crossed on a traverse; dashed where extended between traverses; dotted where buried. Bar and ball on downthrown block.

LOW-ANGLE FAULT--showing dip. Hachures on upper plate. Solid where crossed on a traverse; dashed where extended between traverses; dotted where buried.

STRIKE AND DIP OF BEDDING
- Horizontal
- Inclined
- Overturned

EUTAXITIC FOLIATION IN ASH FLOW TUFF
FLOW FOLIATION IN LAVA FLOWS AND INTRUSIONS
FOLIATION IN METAMORPHIC ROCKS
- Inclined, showing bearing and plunge of lineation.
- Vertical
- Horizontal

LINE OF CROSS SECTION



Mapped by Pacific Area, Geological Survey

This is an unedited copy of an original manuscript including field additions made in 1961

APPROXIMATE MEAN DECLINATION, 1961

SCALE 1:24000

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

WICKENBURG 2 NE., ARIZ.

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 1964
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
To place on the predicted North American Datum 1983 move the projection lines 1 meter south and 47 meters east as shown by dashed corner ticks

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24 000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
NATIONAL GEODETIC VERTICAL DATUM OF 1929

QUADRANGLE LOCATION

GEOLOGIC MAP OF THE NORTHEASTERN VULTURE MOUNTAINS AND VICINITY, CENTRAL ARIZONA.

by Michael J. Grubensky, James A. Stimac, Stephen J. Reynolds, Stephen M. Richard

1987

ARIZONA BUREAU OF GEOLOGY
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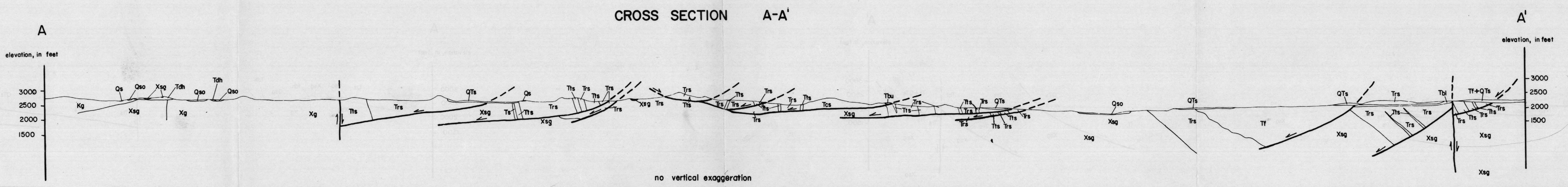
OPEN-FILE REPORT 87-10

CROSS SECTION A-A'



87-10

MAP UNITS AND SYMBOLS

MAP UNITS

- Qs YOUNGER ALLUVIUM (Quaternary)
- Qso MID-LEVEL ALLUVIUM (Quaternary)
- QTs OLDER ALLUVIUM (Quaternary and Tertiary)
- Tf FANGLOMERATE (Tertiary)
- Tbx MEGABRECCIA AND SEDIMENTARY BRECCIA (Tertiary)
- Tut UPPER TUFFS (Tertiary)
- Tub UPPER BASALTS (Tertiary)
- Tdf DEBRIS FLOWS AND AVALANCHE DEPOSITS (Tertiary)
- Tif FELSIC DIKES AND PLUGS (Tertiary)
- Tia INTERMEDIATE DIKES AND PLUGS (Tertiary)
- Tim MAFIC DIKES AND PLUGS (Tertiary)
- Th HELLS GATE VOLCANICS (Tertiary)
- Thu UPPER HELLS GATE DACITE AND RHYODACITE FLOWS (Tertiary)
- Thl LOWER HELLS GATE FLOWS (Tertiary)
- Tht HELLS GATE TUFFS (Tertiary)
- Tsd SAN DOMINGO VOLCANICS (Tertiary)
- Tsd_1 APHYRIC RHYOLITE FLOWS (Tertiary)
- Tsd_2 PHENOCRYST-POOR RHYOLITE FLOWS (Tertiary)
- Tsd_3 QUARTZ-BEARING RHYOLITE FLOWS (Tertiary)
- Tst LITHIC TUFFS AND RELATED SEDIMENTARY ROCKS (Tertiary)
- Tlb LOWER BASALT, BASALTIC ANDESITE, AND ANDESITE FLOWS (Tertiary)
- Ta ANDESITE FLOW (Tertiary)
- Tc CLASTIC SEDIMENTARY ROCKS (Tertiary)
- Tqz INTENSELY SILICIFIED ROCKS (Tertiary)
- Kp PEGMATITE (Cretaceous)
- Ka APLITE (Cretaceous)
- Kgd GRANODIORITE (Cretaceous)
- Kg GRANITE (Cretaceous)
- Xp PEGMATITE (Precambrian X)
- Xg GRANITIC ROCKS (Precambrian X)
- Xal LEUCOGRANITE, PEGMATITE, AND INTERLAYERED SCHIST AND AMPHIBOLITE (Precambrian X)
- Xm METAMORPHIC ROCKS (Precambrian X)
- Xs SCHISTOSE METAMORPHIC ROCKS (Precambrian X)
- Xam METAVOLCANIC ROCKS (Precambrian X)
- Xmch METACHERTS (Precambrian X)
- Xmc METACARBONATE (Precambrian X)
- Xms METASEDIMENTARY ROCKS (Precambrian X)
- Xps PSAMMITIC SCHIST (Precambrian X)

MAP SYMBOLS

- GEOLOGIC CONTACT--dashed where inferred; dotted where buried.
- HIGH- TO MODERATE-ANGLE FAULT, WITH ARROW SHOWING DIRECTION AND AMOUNT OF DIP DIP--dashed where inferred; dotted where buried. Bar and ball on downthrown block.
- LOW ANGLE FAULT, WITH ARROW SHOWING DIRECTION OF DIP--dashed where inferred; dotted where buried. Hachures on upper plate.

STRIKE AND DIP OF BEDDING

- Horizontal
- Inclined
- Vertical

STRIKE AND DIP OF FOLIATION, AND LINEATION

- Horizontal
- Inclined
- Vertical

LINEATION

STRIKE AND DIP OF CLEAVAGE

- Vertical
- Inclined

LINE OF CROSS SECTION

GEOLOGIC MAP OF THE WICKENBURG, SOUTHERN BUCKHORN, AND NORTHWESTERN HIEROGLYPHIC MOUNTAINS, CENTRAL ARIZONA

by

James A. Stimac, Joan E. Fryxell, Stephen J. Reynolds, Stephen M. Richard, Michael J. Grubensky, and Elizabeth A. Scott

1987

ARIZONA BUREAU OF GEOLOGY
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OPEN-FILE REPORT 87-9
SHEET 1 OF 2

Property: Vulture Mine

Location: Subject property is located 14 miles southwest of Wickenburg in Maricopa County, AZ. It is accessable by a well maintained all weather county road.

History & Description: Gold was discovered at the Vulture in 1863 and mining commenced in 1866. Production from 1866 through 1917 was estimated at $6.8 million. This would amount to 329,000 ounces @ $20.67/oz. Some mining from open pits and underground along with cyanide treatment of old tails was done in the 1930's.

The property consists of 14 patented claims, 451 unpatented lode claims and 50 unpatented placer claims. An advance royalty of $10,000/mo is payable to the owner and is deductable from production royalties. Production royalties are NSR and fluctuate with the price of gold according to the following schedule:

Price of Gold/oz.	Royalty (% NSR)
Less than $400	5%
$400-600	6%
$601-800	7%
$801-1000	8%
$1001-1200	9%
$1201-1400	10%
$1401-2000	11%
$2001 & Up	12%

Reserves: There are approximately 1.9 million tons of ore in the proven category at the Vulture Mine. These consist of the following:

1. Stamp mill tails 450,000 tons @ 0.045 o.p.t. Au.
2. Open pit ore @ 3.0:1.0 SR 1,525,000 tons @ 0.083 o.p.t. Au.

In addition to these reserves, there appears to be excellent potential for development of more ore of the following types.

Placer material
Additional open pit ore
Underground high grade ore

Metallurgy: Metallurgical test work by Dawson Metallurgical Labs, CSMRI, and Kappes, Cassiday & Associates indicate that both the tails and open pit ore are treatable by cyanide leaching with an expected recovery of about 70% of the contained gold. Further testing will be carried out during the option period.

Acquisition & Development: The property would be optioned for a 90-day period at a cost of $30,000. During the option period a sampling program would be carried out to verify tonnage, grade and metallurgy of the tailings. This sampling and metallurgical testing, along with flowsheet design, equipment sizing and selection is estimated to cost about $60,000 and could be at the go/no go decision point within 60 days of signing the option.

First phase development would consist of processing the stamp mill tailings. This would be carried out at an average rate of 50,000 tons per month. It is estimated that the first production could be realized 6 months from execution of the option agreement if no complications arise.

As soon as production starts from the tails, development work on the open pit ore would commence. This would consist mainly of pad preparation and mining and placing the ore on the pads. Very little additional equipment would be required if pad preparation and mining is done by a contractor.

The first pad would be built in two stages. The first 50,000 tons would be placed on the pad and leaching started and the second stage would follow. This procedure would minimize the funds required to move the project through startup.

VULTURE MINE

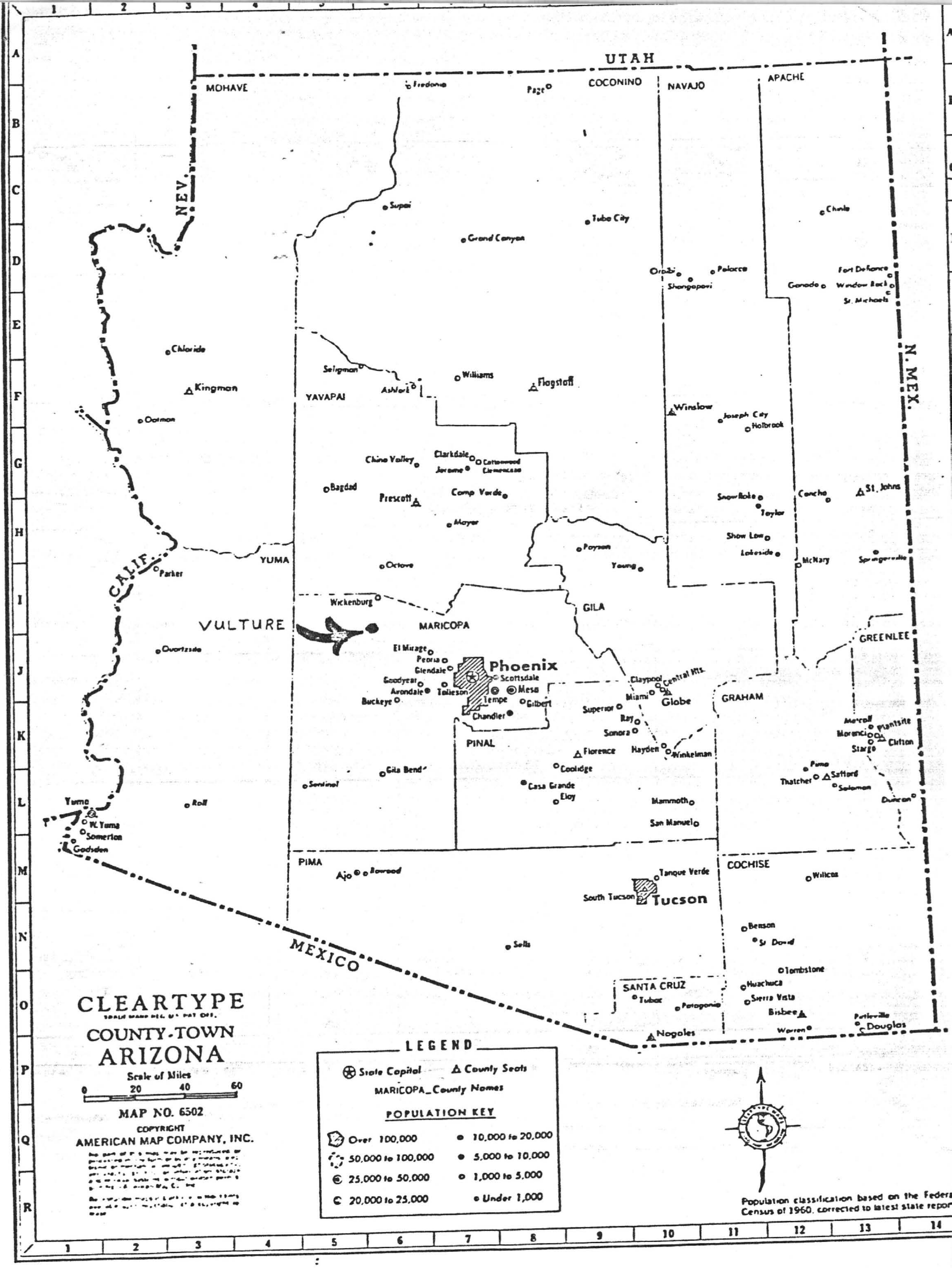
$350

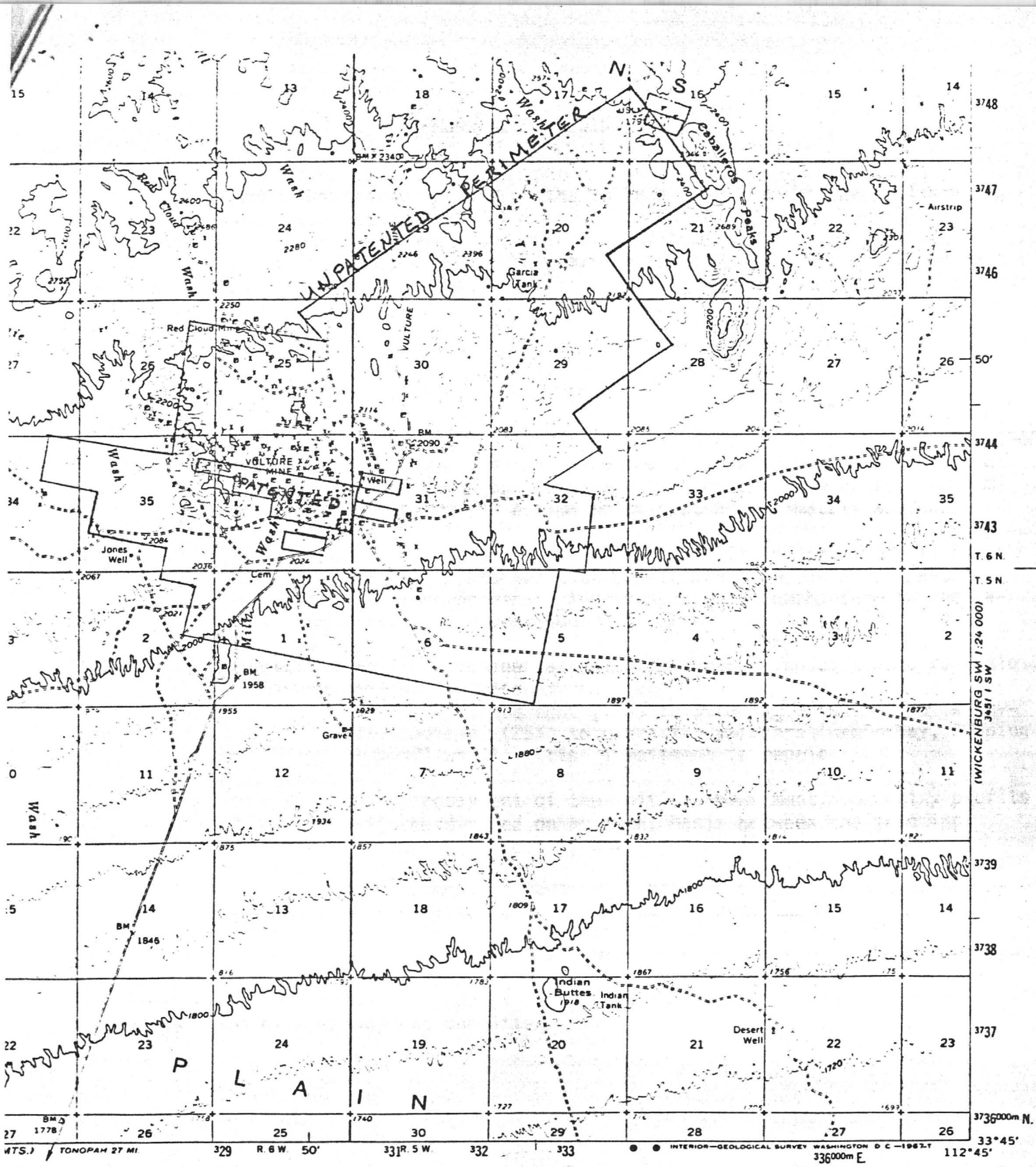
ESTIMATE OF OPERATING CASH GENERATED

MONTH	1	2	3	4	5	6	7	8
Land Payment	30,000			30,000			30,000	
Eval & Eng	10,000	10,000	10,000	10,000	10,000	10,000		
Tons Mined-Tails							50,000	50,000
Tons Mined-Ore								
Leach Pad Const						75,000		75,000
Other Capital						270,500		
Royalty 5%								
Mining							50,000	50,000
Preparation							87,500	87,500
Leaching								75,000
Stripping								25,000
Office & G&A								37,500
Lab								12,500
Exploration								
Total Cost-Tails	40,000	10,000	10,000	40,000	10,000	355,500	167,500	362,500
Total Cost-Open Pit								
OZ Recovered								1,575
Revenue @ $350/oz								
OP Cash Gen-Tails	-40,000	-10,000	-10,000	-40,000	-10,000	-355,500	-167,500	-362,500
Cum Cash Gen-Tails	-40,000	-50,000	-60,000	-100,000	-110,000	-465,500	-633,000	-995,500
Op Cash Gen-Ore								
Cum Cash Gen-Ore								

TLD/1/17/84

9	10	11	12	13	14	15	16	17	18	19-51	52	53
,000	50,000	50,000	50,000	50,000	50,000	50,000						
							44,000	44,000	44,000	1,368,000		
	75,000		117,500						37,500	513,000		
	13,000							50,000		100,000		
			20,248	27,562	27,562	27,562	27,562	27,562	43,663	1,357,405	43,663	43,663
.000	50,000	50,000	50,000	50,000	50,000	50,000	264,000	264,000	264,000	8,208,000	—	—
.500	87,500	87,500	87,500	87,500	87,500	87,500	88,000	88,000	88,000	2,736,000	—	—
,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	66,000	66,000	2,052,000	66,000	
,000	25,000	25,000	25,000	25,000	25,000	25,000	25,000	22,000	22,000	684,000	22,000	
,500	37,500	37,500	37,500	37,500	37,500	37,500	37,500	33,000	33,000	1,026,000	33,000	33,000
,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	11,000	11,000	342,000	11,000	
		25,000	25,000	25,000	25,000	25,000	25,000	—	—	—	—	—
,500	375,500	313,500	450,248	340,062	340,062	340,062	202,562	27,562				
							352,000	534,000	565,163	17,018,405	175,663	76,663
,575	1,575	1,575	1,575	1,575	1,575	1,575	1,575	2,495	2,495	77,566	2,495	
,250	551,250	551,250	551,250	551,250	551,250	551,250	551,250	523,688	873,250	27,148,100	873,250	873,250
,750	+175,750	+238,750	+101,002	+211,188	+211,188	+211,188	+348,688	+551,250				
,750	-556,000	-317,250	-216,248	- 5,060	+206,128	+417,316	+766,004	+1,289,692				
							-352,000	-534,000	+308,087	+10,129,695	+697,587	+796,587
							+414,004	+403,692	+711,779	+10,841,474	+11,539,061	+12,335,648


UTAH
NEV.
CALIF.
N. MEX.
MEXICO
MOHAVE
COCONINO
NAVAJO
APACHE
YAVAPAI
YUMA
MARICOPA
GILA
GREENLEE
GRAHAM
PINAL
PIMA
SANTA CRUZ
COCHISE
VULTURE
Fredonia
Page
Supai
Grand Canyon
Tuba City
Chinle
Oraibi
Shongopovi
Polacca
Fort Defiance
Ganado
Window Rock
St. Michaels
Chloride
Kingman
Oatman
Seligman
Ashfork
Williams
Flagstaff
Winslow
Joseph City
Holbrook
Chino Valley
Clarkdale
Cottonwood
Clemenceau
Jerome
Bagdad
Prescott
Camp Verde
Mayer
Snowflake
Taylor
Concho
St. Johns
Show Low
Lakeside
McNary
Springerville
Payson
Young
Parker
Octave
Wickenburg
Quartzsite
El Mirage
Peoria
Glendale
Goodyear
Avondale
Tolleson
Buckeye
Phoenix
Scottsdale
Mesa
Tempe
Gilbert
Chandler
Claypool
Central Hts.
Miami
Globe
Superior
Ray
Sonora
Florence
Hayden
Winkelman
Coolidge
Casa Grande
Eloy
Gila Bend
Sentinel
Roll
Yuma
W. Yuma
Somerton
Gadsden
Mammoth
San Manuel
Morenci
Plantsite
Clifton
Stargo
Pima
Thatcher
Safford
Solomon
Duncan
Ajo
Rowood
Tanque Verde
South Tucson
Tucson
Sells
Willcox
Benson
St. David
Tombstone
Huachuca
Sierra Vista
Bisbee
Tubac
Patagonia
Nogales
Warren
Douglas
CLEARTYPE
COUNTY-TOWN
ARIZONA
Scale of Miles
0 20 40 60
MAP NO. 6502
COPYRIGHT
AMERICAN MAP COMPANY, INC.
LEGEND
State Capital
County Seats
MARICOPA_County Names
POPULATION KEY
Over 100,000
50,000 to 100,000
25,000 to 50,000
20,000 to 25,000
10,000 to 20,000
5,000 to 10,000
1,000 to 5,000
Under 1,000
Population classification based on the Federa
Census of 1960, corrected to latest state repor



2500

2 3 4 MILES

12000 15000 18000 21000 FEET

3 4 5 KILOMETERS

VAL 40 FEET
T 20 FOOT CONTOURS
SEA LEVEL

MAP ACCURACY STANDARDS
OLORADO 80225 OR WASHINGTON, D. C. 20242
ID SYMBOLS IS AVAILABLE ON REQUEST

QUADRANGLE LOCATION

ROAD CLASSIFICATION

Heavy-duty		Light-duty	
Medium-duty		Unimproved dirt	

U. S. Route — State Route

VULTURE MOUNTAINS, ARIZ.

N3345—W11245/15

1961

AMS 3451 IV—SERIES V798

PROPOSAL FOR JOINT VENTURE

Mr. George Hennessey, Lessee of the Vulture Mine Property near Wickenburg in Maricopa County, AZ, has agreed to cooperate with Mr. Terry Downing and Milton Hood in the development and operation of the Vulture Mine. As their contribution to this undertaking, Mr. Downing and Mr. Hood will obtain project financing and contribute necessary technical and management expertise to develop and operate the mine(s).

It is proposed that the property be developed as a joint venture between the incoming financial backer and Messers Hennessey, Downing and Hood. The basis of a deal would be:

1. Incoming partner to furnish funds for option period of 90 days ($30,000) and cost of sampling and metallurgical testing program during option period to verify tonnage, grade and treatment flowsheet for stamp mill tails. This program is estimated to cost approximately $60,000.

2. If the sampling program confirms the viability of the project, and a decision is made to proceed with development, the incoming partner will provide funds necessary for project development through completion and commercial production.

3. Operating revenue, defined as sales less operating costs and royalties, would be divided as follows:
   a. Seventy-five percent (75%) to incoming partners and twenty-five percent (25%) to operating partners (Hennessey, Downing & Hood) until initial investment is repaid.

   b. After repayment of the initial investment, operating profits will be divided on an equal basis between the incoming partners (Hennessey, Downing & Hood).

   c. The incoming partner will receive credit for all allowable depreciation and investment tax credits.

An operating agreement between the joint venture partners would be executed. This would set forth the manner in which the property would be developed and operated. It would include duties and obligations of all partners including composition of a management committee.

VULTURE MINE
MARICOPA COUNTY, ARIZONA

SCALE	DRAWN BY	
	REVISED	
DATE	APPROVED BY	DRAWING NUMBER

K+E CRYSTALENE ® 24x36
ARCHITECTS' STANDARD FORM

MADE IN U.S.A.

Introduction

The Vulture Mine is a past productive gold mine near Wickenburg, Arizona. The property is presently under lease to a Mr. George Hennessey who has most recently had the property under option to Quintana. Two former employees of Quintana, Milton Hood and Terry Downing and Mr. Hennessey have now agreed to cooperate in the development and operation of the property. This group has approached NICOR to determine our interest in a possible joint venture with them to explore, develop and operate the property.

Graham Matheson, mining engineer with Golder Associates in Golden, Tom Kuhl from NICOR's Sparks office and Steve Dubyk from NICOR's Albuquerque office made an on-site visit to the property on January 24-25, 1984. This visit was to determine NICOR's possible interest in entering into an agreement regarding this property. They were accompanied and aided by Mr. George Hennessey.

Geology

The Vulture Mine exploits a thick series of stratified, gold-bearing metasediments of Precambrian age. A schematic geologic column is presented in Figure 1. Previously mined orebodies are a series of northerly dipping, overlapping and coalescing silicious bodies (sinters) that are parallel to bedding and rake to the northeast. These sinters comprise the Upper Mine Series and virtually all previous production has come from this upper sequence. The Lower Mine Series is gold-bearing but of lower grade and has not been extensively exploited.

Rock units below and above the Mine Series are thinly laminated chloritic greenstones, amphibolites, and shaley sediments.

The metasediments of the mine sequence are pervasively gold mineralized, although grade varies greatly from one rock type to another. Ore deposition was possibly related to an influx of gold-bearing brines and therefore rock-type does not necessarily reflect grade in all cases. This type of mineralization is transitional between the massive-sulfide and the exhalitive environments; geochemistry and lithologic sequence substantiate this. Such pervasive mineralization of metavolcanic piles is common; it is unusual, though, for such thick sequences to approach ore and sub ore-grade.

Potential

It is obvious that the 100' thickness of gold-bearing Mine Series metasediments around the present Pit #1 and Pit #2 offers significant potential for low-cost bulk mining. Extension of ore-grade material along strike does not appear likely due to normal (down) faulting on either side of the pits. Using a conservative strike length of 600' and a stripping ratio of 3/1, the tonnage potential (minus previously mined ground) is about 1.5 million tons. Present data suggests an average grade of 0.08 oz/ton gold; assuming 75% recover-ability, potential Au production is 90,000 ounces.

If the Upper Mine Series is found to be the only pittable target, tonnage is drastically reduced, and Au production might be roughly 50,000 ounces.

Data is scant for the western area around Pit #3 and Pit #4. After making many assumptions of the geometry of the ore in this zone, we consider an average tonnage of 230,000 tons grading 0.10 oz/ton geologically reasonable figures. 17,000 ounces of gold may be recoverable from this area.

Tails provide an immediately recoverable reserve if sufficient hardrock ore is indicated after Phase I. It appears at least 450,000 tons are of leachable grade; about 15,000 ounces of gold could be recoverable.

We have not considered possible additional production from high-grade zones underground or placers surrounding the Vulture Pits; however, they may increase reserves by as much as 30% or more.

Exploration Proposal

For our purposes, two phases of exploration are proposed. Phase I will include drilling, trenching, sampling and metallurgical testing. This phase will justify further feasability studies, confirm the potential of the known ore zones and bring some ore zones into the probable ore catagory. It is designed to be completed within ninety days of entering into an agreement. Phase II will include further drilling and metallurgical tests to prove hardrock reserves and determine the value of the tails.

Phase I

1) Metallurgical testing to start immediately to determine heap-leach potential of hardrock ore and tailings.

2) 6000 feet of drilling, on about 100 foot centers around presently defined zones of highest potential. Average hole depth is 200 feet. Total number of holes is 22 (15 east, 17 west).

3) 4500 feet of trenching with D-8 or backhoe on or very near drill lines to provide two-dimensional "probable-ore" blocks. Trenches sampled at five foot intervals.

4) Limited underground sampling to verify previous work and to better define the stratigraphic sequence.

5) Fill in trenching or auger drilling of amalgamation processed tails to verify previous work and determine true depth. Pending favorable results of a feasibility study based on Phase I, Phase II will be instigated.

Phase II

This phase will involve intensive drilling to prove reserves, additional metallurgical tests and a preliminary pit and mill circuit design.

All anticipated activities and operations will be on patented claims.

Problems

1) The current lease holders consider this property to have proven reserves of 0.5 million tons of tailings and 1.8 million tons of hardrock ore. While the tails reserve is reasonable, hardrock reserve is based on inadequate and unreliable sampling techniques. Therefore, NICOR should approach the Vulture Mine as an exploration rather than a developmental property.

2) Metallurgical problems with low-grade ore and tailings from the Vulture Mine may reduce ore-amenability to 50% recovery. Laboratory leach-tests performed to date on tailings have been inconclusive; on-site heap leach tests appear to have failed. Metallurgical tests will therefore be necessary to determine if recovery can be increased economically.

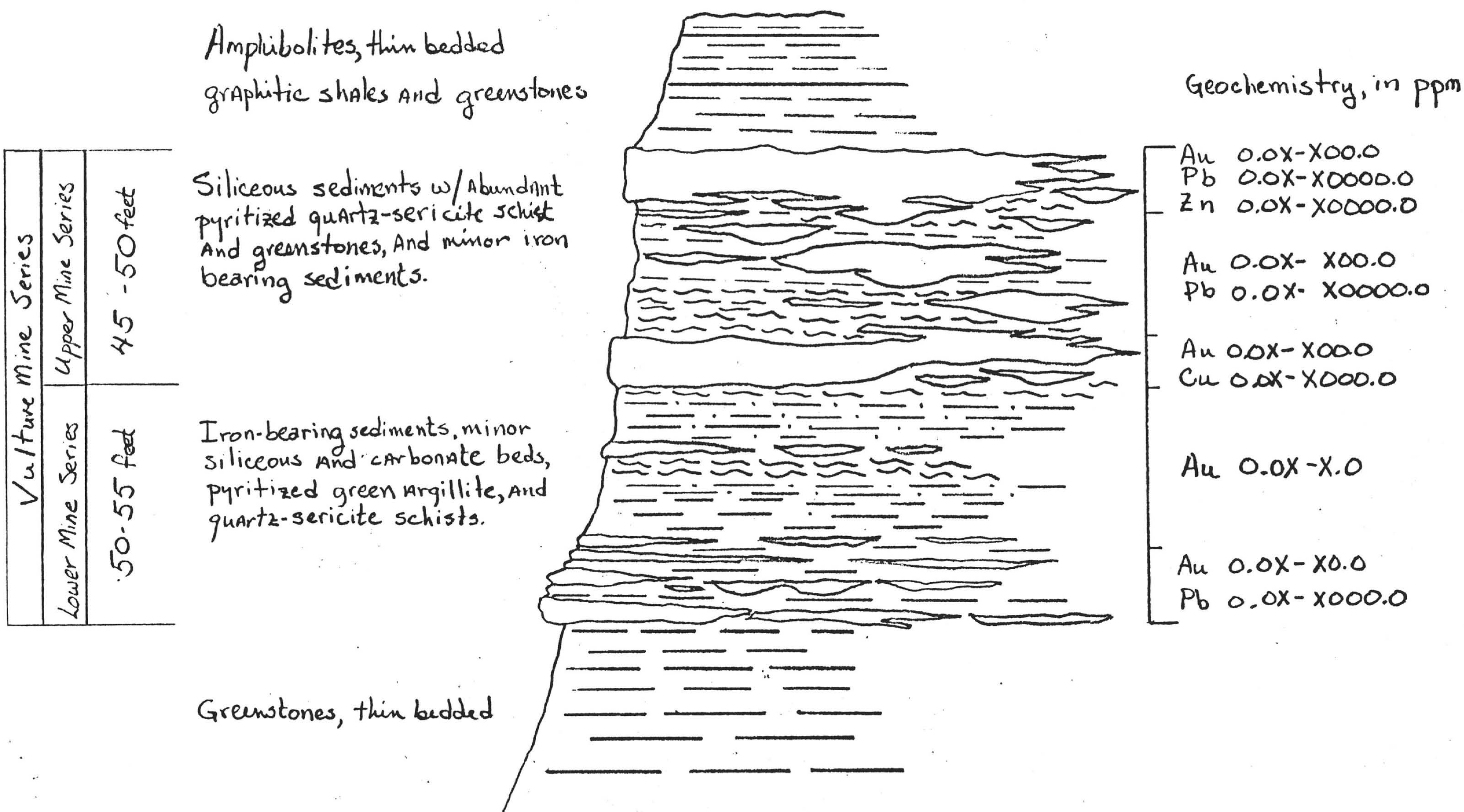
3) The proposed joint venture agreement does not allow for a reasonable return on investment.

Phase I Exploration Costs

Acquisition	$ 30,000.00
Drilling - 6000' of reverse circulation hammer drilling, total cost - $11.00/foot	66,000.00
Sample Analysis - drilling, trenching and other, 2000 samples @ $12.00/sample	24,000.00
Dozer for trenching - D-8 or larger - 45 hours @ $100.00/hour	4,500.00
Auger drill or backhoe - 8 pits	500.00
Metallurgical Testing	12,000.00
Man Hours - sampling	6,500.00
- supervision, etc.	22,500.00
Feasibility Study	5,000.00
TOTAL	$166,500.00

Figure 1. Vulture Mine Stratigraphy

PЄb-X age volcanogenic sediments



One of the NICOR basic energy companies

NICOR MINERAL VENTURES

2659-G Pan American Freeway, N.E. Albuquerque, New Mexico 87107 Phone 505 344 7803

January 27, 1984

FROM: Steve Dubyk and Gary Parkison

TO: Alex Bissett

SUBJECT: Vulture Mine Report

Summary and Conclusions

The Vulture Mine exploits a 100' thick stack of gold-bearing Precambrian-age metasediments. While tonnage estimates are not proven, the mine area has potential for at least 1.75 million tons of hardrock ore amenable to bulk tonnage open-pit mining methods. Potential gold production from hardrock ore is 107,000 ounces. In addition, potential gold production from about 500,000 tons of mill tails is about 15,000 ounces.

The Vulture Mine should be acquired on a short-term basis to determine if mineable reserves exist. Major metallurgical problems exist in Au recovery and they must be investigated to assure production levels. In addition, lease proposals are unacceptable to NICOR in their present form.

Phase I exploration plans include drilling, trenching and sampling and should cost at least $166,500 to complete, including initial acquisition costs.

THE AMERICAN MINERALOGIST, VOL. 55, NOVEMBER DECEMBER, 1970

ALUNITE: A NEW OCCURRENCE NEAR WICKENBURG, ARIZONA

MICHAEL F. SHERIDAN AND CHESTER F. ROYSE, JR.,
Department of Geology, Arizona State University, Tempe, Arizona 85281.

ABSTRACT

A new occurrence of alunite is located about 3 miles west of Morristown and 10 miles south of Wickenburg, Maricopa County, Arizona. It is associated with clay deposits and constitutes the major mineral of several outcrops within a one half mile area. The host rock containing the alunite is a rhyolite which has undergone hydrothermal alteration. In hand specimen, pink patches of alunite up to 5 mm in diameter are surrounded by a matrix of clay and quartz. The unit cell content calculated from chemical analysis is: $(K_{2.54}Na_{0.46})(Al_{10.21}Fe_{0.01})[SO_4]_{5.52}(OH)_{17.22}$ The refractive indices ($\omega = 1.577 \pm .002$, $\epsilon = 1.593 \pm .002$) and unit cell dimensions ($a = 6.986 \pm .002$, $c = 17.332 \pm .005$) are compatible for alunite with 15 atomic percent Na substituted for *K*.

INTRODUCTION

A significant amount of alunite was detected in several samples taken near Wickenburg, Arizona during routine investigation of a clay deposit. Subsequent study revealed that alunite constitutes a major phase within an area of about one-half square mile of hydrothermally altered rhyolite. This report is based upon samples obtained from four patented claims located on the west side of the Hassayampa River about 3 miles west of Morristown and 10 miles south of Wickenburg, Arizona (Fig. 1).

This occurrence is in the eastern part of the Vulture mining district near the northern boundary of the Basin and Range physiographic province of central Arizona. The geologic history of this district is complex and the ages of most rock units are uncertain. The basement is composed of highly-deformed Precambrian gneiss, schist, greenstone and metasediment. Overlying Cenozoic lavas, tuffs, and breccias of intermediate to silicic composition have gentle to moderate dips.

The Wickenburg alunite is found within a grayish-pink rhyolite. Hydrothermal alteration of the host rock and concealment of contacts by alluvium obscure the field relations, but relic textures showing primary flow banding and brecciation are apparent at several localities. The rhyolite texture varies from uniform felsite to coarse breccia with fragments of lava and a few clasts of Yavapai Schist. Irregular jointing is well developed throughout the area. A red rhyolite that surrounds the kaolinite alunite deposit appears to be an older sequence of flows into which the altered rock has been down-faulted. Kaolinite is presently mined at this location, but no alunite is being produced.

Two other sizeable deposits of subcommercial-grade alunite are known in Arizona

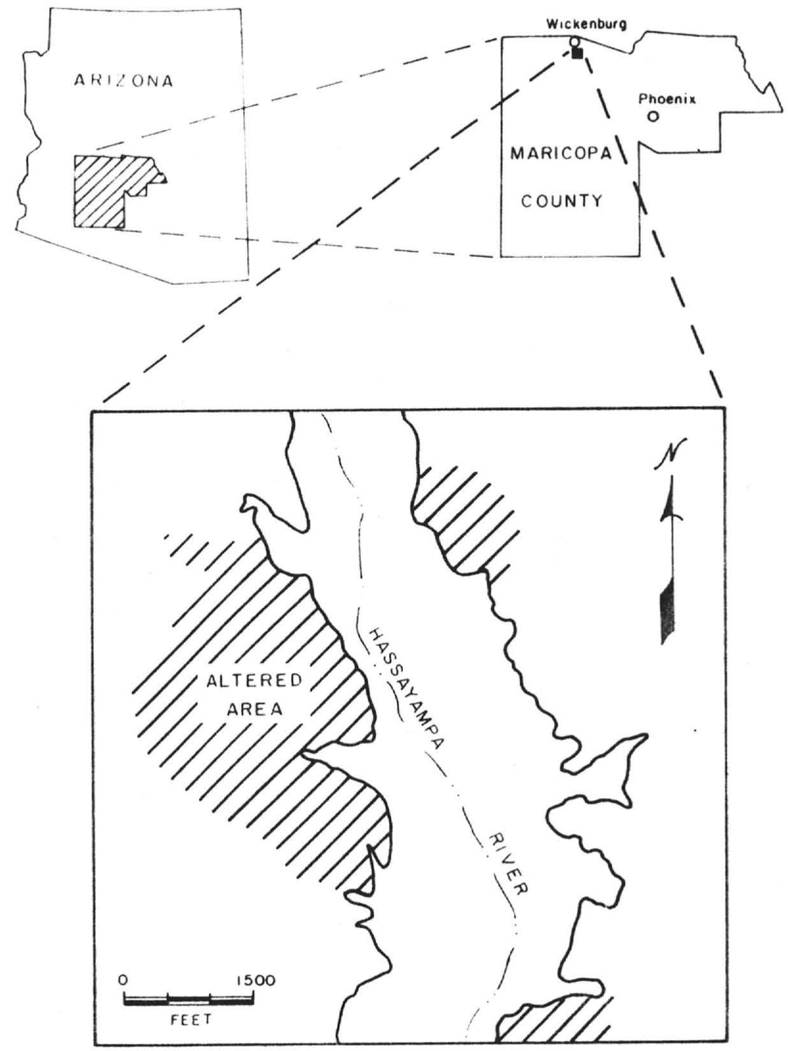


FIG. 1. Index to study area.

Natroalunite from Sugarloaf Butte, 5 miles west of Quartzite in Yuma County, occurs in a complex of veins cutting schist and prophyritic dacite (Heineman, 1935; Thoenen, 1941). Most veins are small and contaminated by quartz and minor gypsum, but several attain widths of a foot or more and appear to be relatively pure alunite. Schrader (1914, 1915) reports alunite in the wall rock of the Evening Star prospect (Three R mining group) 5 miles south of Patagonia in Santa Cruz County. This occurrence is the result of feldspar alteration adjacent to a sulfide vein in pegmatitic granite. The altered zone is several feet wide and may contain as much as 30 percent alunite.

1/7/85

Oroquande Mine – very thick file – if interested, should look over, the lots of old repts, many by Colvocoreses. Prop. now held by McFarland & Hullinger & Global Energy
Mr. J.D. Ingram, V.P., Global Energy Ltd.
6005 S. Palomino Rd., Tucson, AZ (602) 883-7556
– says drilled lots of holes, 150-200' deep
– thesis at CSU by Mary Post
– ore assoc. w/ MnOx, FeOx

rept. of Carleton Bray, Texas, 9/15/32
635,000 Tons @ $3,175,000 to 300' level
add 340,000 tons @ 1,700,000 to 400' level
ore bodies in Copperhead and Frenchman's claim

Pilgrim Mine – not too much – engineers rept by AZ Dir., Elgin Holt, 5/8/41 – some old repts.

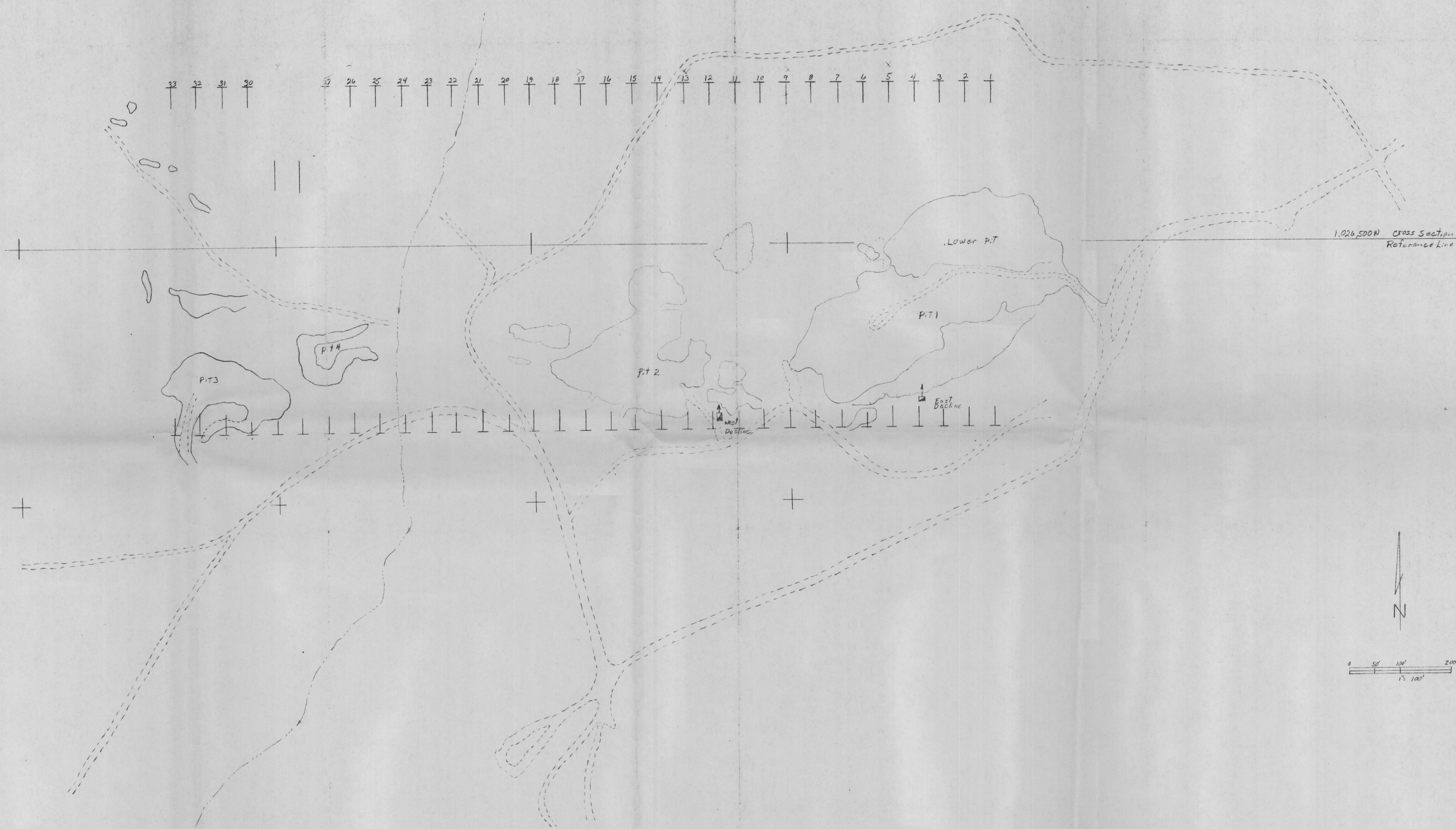
Clementine Prop. – owned by United Mining – Carl Tripalin and Robert Hicks – Phoenix Area
– property is in center of Sec. 10, NE of White Rock Mine
– file has lots of press crap on Copper Lake
– Copper Lake rept in Ann. rept.

Proven	1,110,272 t	.052 Au
Probable	5,520,000 t	.055
Possible	17,700,000 t	.050

no geology, etc in file

Papago – only Tenney's published account

Story Mine – Per U.S.F.S., 7/31/85 – TG and Freeport planning Exploration drilling on claims at Story Mine. Planning to use helicopter rig.



VULTURE MINE
MARICOPA COUNTY, ARIZONA

SCALE	DRAWN BY	REVISED
DATE	APPROVED BY	DRAWING NUMBER

K+E CRYSTALENE ® 24x36
ARCHITECTS' STANDARD FORM

MADE IN U.S.A.

K+E CRYSTALENE ® 24x36 ARCHITECTS' STANDARD FORM
MADE IN U.S.A.

SOCIETY OF MINING ENGINEERS

P.O. BOX 625002, LITTLETON, COLORADO 80162-5002

PREPRINT NUMBER

88-44

GEOLOGY OF THE VULTURE MINE, ARIZONA

D. C. White

Prescott, Arizona

For presentation at the SME Annual Meeting
Phoenix, Arizona - January 25-28, 1988

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Abstract. The Vulture Mine near Wickenburg, Arizona was a major gold producer from 1863 to 1942, having yielded about 11,000 kg Au and 8,000 kg Ag. Gold occurs as coarse native metal and electrum in quartz veins and also finely disseminated within a quartz monzonite sill and its silicified wall rock. The sill is semi-conformable within a Proterozoic volcaniclastic-dominated sequence, all dipping north about 35°. Early mining focused on the vein-hosted gold, particularly in the immediate hanging wall and footwall of the sill. Later efforts included some open-pitting of the outcropping sill and adjacent altered and mineralized rock. Two sets of post-mineral faults have complicated the orebody geometry.

The sill is a 350m long apophysis from a quartz monzonite stock to the west of the mine area. The stock has been dated at 85 my and contains abundant lesser gold occurrences in its core and about its margins. The Proterozoic rocks are notably lean in precious metals except where altered in proximity to the Cretaceous stock and sill. Circumstances dictate an interpretation of epigenetic mineralization related to the Laramide intrusion.

Introduction

The Vulture Mine is 17 km southwest of Wickenburg in Maricopa County, Arizona and accessible by the Vulture Mine Road south from State Highway 60 (Figure 1). Despite its preeminence as a gold producer, it has not been well understood because very little geology was recorded during its major period of production in the late nineteenth century, and because it has long been patented and guarded, effectively preventing modern-day study. Only exploration in the 1930's and 1980's accumulated much information of substance on the nature of the gold occurrence and much of that has been proprietary. This paper is an effort to consolidate and share what is known for the benefit of the entire geologic community.

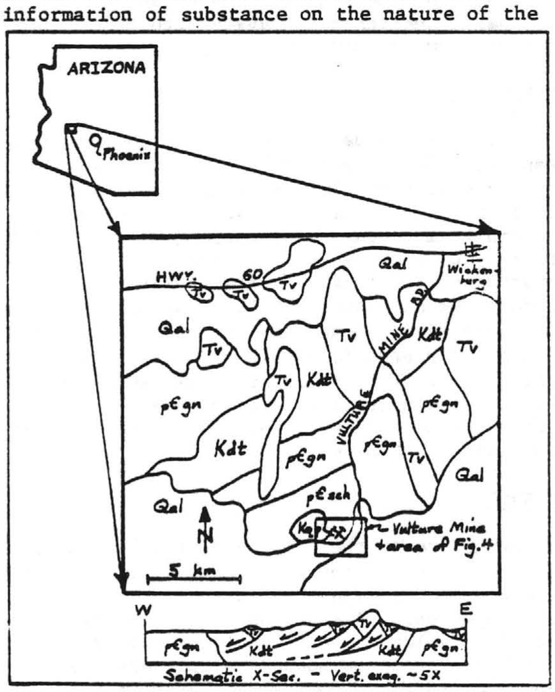


Figure 1: Location Map, and regional geology of the Vulture Mtns after Rehrig, et. al., 1980.

History and Production

Henry Wickenburg is credited with discovery of native gold in outcrop in 1863. For the next 80 years, the camp experienced the classic booms and busts of western mining including problems of Apache raids, no water, diminishing grade, and discontinuities caused by faults. Milling was by arrastras on the Hassayampa River, a 21 km haul by burro or wagon train, until water was piped to the mine in 1880 and an 80-stamp mill installed. Early amalgamation was eventually replaced by cyanidation. Stopes caved to the surface and openings so formed were enlarged into open pits to include low grade material during the 1930's. Tailings reprocessing and pillar robbing completed production to 1942 from which time it has remained closed. Scenic residences, offices, shops, and mill structures remain as does a vintage headframe (Figure 2).

Production figures are approximate because accounts were either not kept or were lost. Overall value of production by various operators from 1863 through 1942 is estimated at 900 metric tons (1 million s.t.) containing about 11,000 kg (350,000 ounces) of gold and 8,000 kg (250,000 ounces) of silver. Grade hence averaged 12 grams Au and 9 grams Ag, .35 and .25 oz. respectively. There was minor copper and lead production. These figures do not include the undocumented but likely small placer gold production.

Geology

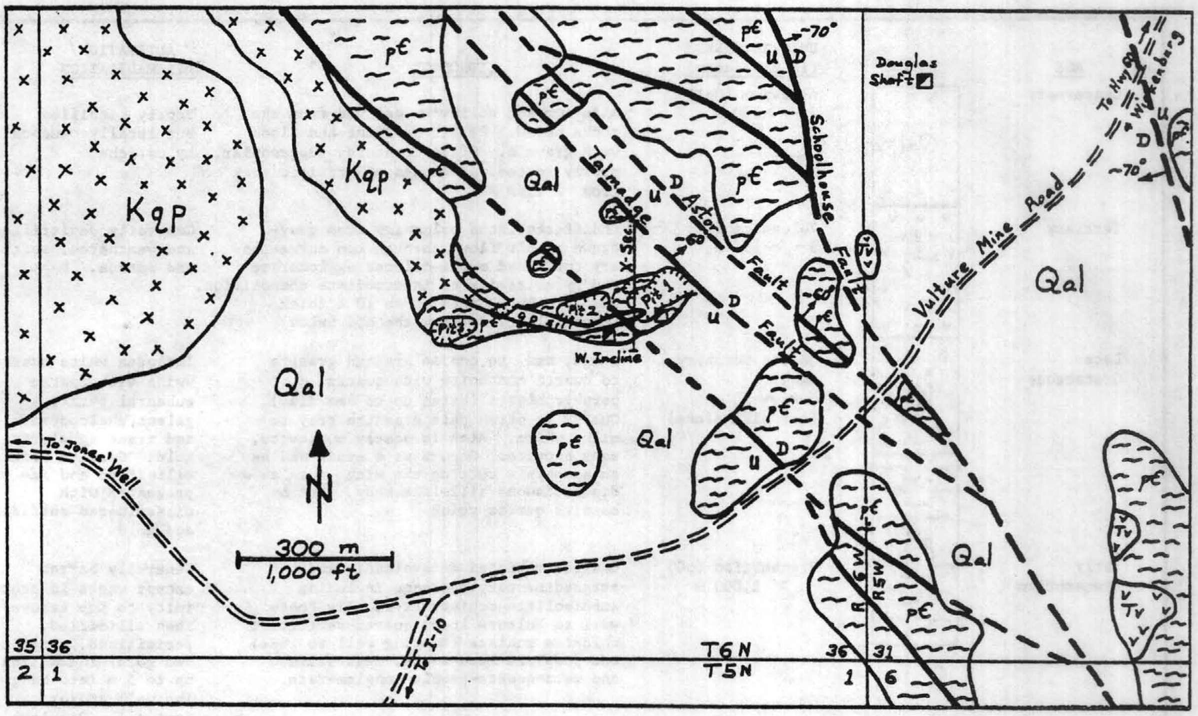


Figure 4: Sketch geologic map of the immediate Vulture Mine vicinity. See Figure 3 for geologic explanation. Note mining centered around apophysis of Kqp into pЄ sequence and cutting of the lode by NW-trending normal faults.

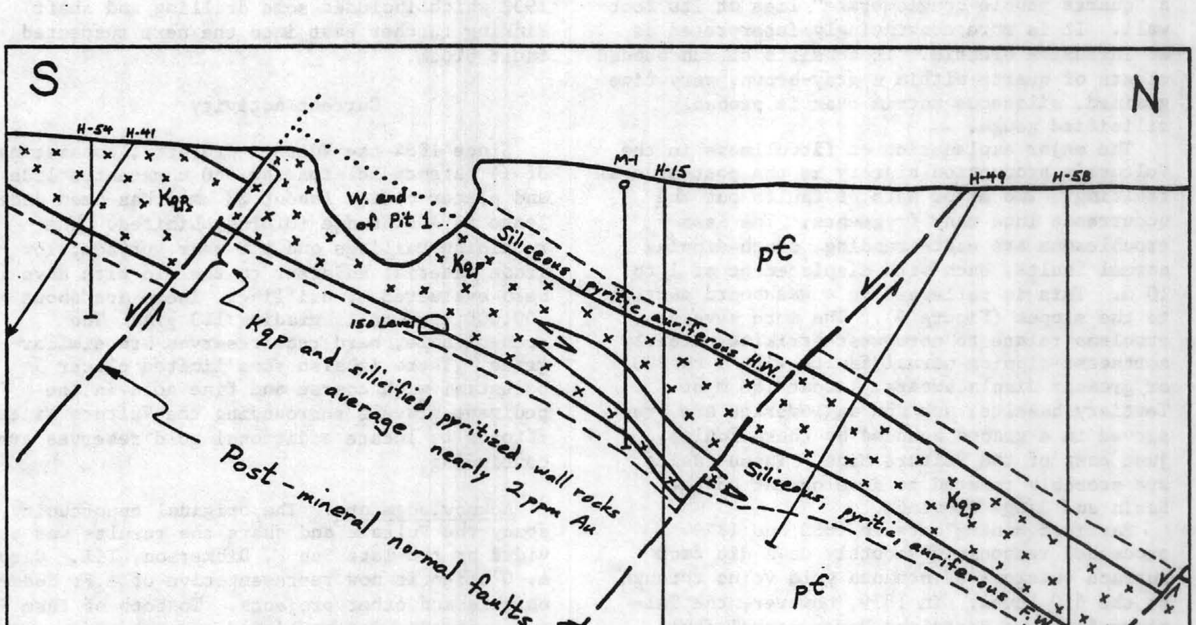


Figure 5: Vertical cross section, looking west. Note north-dipping Kqp sill and its silicified, auriferous envelope. Post-mineral faults offset lode.

NOMAD ENERGY & RESOURCES LTD.

FIVE GOLD SILVER PROPERTIES PLANNED FOR FURTHER EXPLORATION - Nomad Energy & Resources Ltd. president A.Ashton, P.Eng., has reported on exploration of the property 4 miles south of the Vulture gold mine, 16 miles southeast of Wickenburg, Arizona. The 200 tons of placer material shipped in 1981 from Nomad's property to the Helo plant in Moapa, Nevada, was processed with cyanide to recover 12.87 ounces of gold and 13.49 ounces of silver, or 0.064 oz.gold/t and 0.067 oz.silver/t. However, only 50% of these values were recovered by this method.

Recent Results	Sample	Gold Oz/Ton	Silver Oz/Ton
J & J Research	1 lb.	0.10	1.10
R.Backler Research	60 lbs.	0.12	1.8
David Bauer, Chemist	Random	0.27	0.06
Americhem Engineering	300 lbs.	0.56	0.041

M.J.Skopas, consultant, recently inspected the property where a small test plant had been in operation in an attempt to extract the precious metals. He concludes that samples from the main pit averaged 0.195 oz.gold, 0.93 oz.silver and 0.16 oz.platinum per ton. Mr.Skopas states that recoverable rates were 0.56 oz. gold and 0.041 oz. silver per ton from 300-pound test using cyanide and 0.28 oz.gold and 0.289 oz.silver per ton using the chemical agent thiourea. Another test from 60 lbs. using a different method of electrolytic ionization recovered 0.12 oz. gold and 1.8 oz. silver per ton. A further $125,000 exploration program has been recommended. Nomad is considering a farm-out proposal.

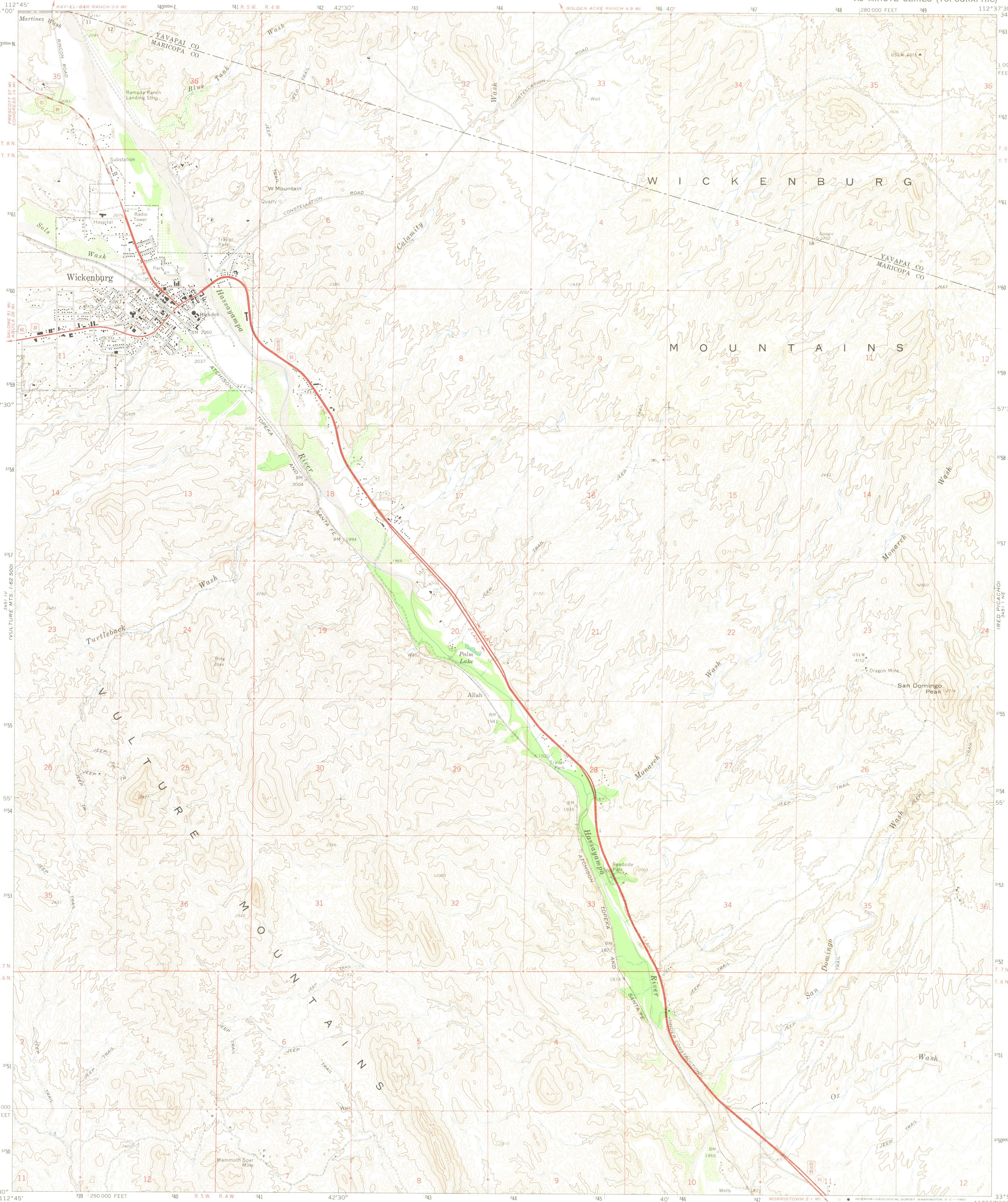
Nomad has acquired the formerly producing silver-lead-zinc Zincton properties located 15 km northeast of New Denver, B.C. A recent program of soil geochemistry has revealed a zinc-silver anomaly. Further work is recommended. Nomad has also acquired 50% interest in two blocks of claims in the area of the Erickson gold operation and Cusac Industries near Cassiar, B.C. A preliminary work program is now underway.

Nomad continues to hold the Sarita River property, Vancouver Island, which, hopefully, can be optioned to a major company. A large bulk sample from the Happy Sullivan property, Tagish Lake, B.C., was run through a mill in Whitehorse last year to confirm its high grade potential. Assays from the bulk sampling were: Upper vein material 4.70 oz.gold, 1.99 oz. silver per ton; upper adit feed 7.39 oz.gold, 5.36 oz.silver per ton; lower adit feed 0.51 oz. gold, 0.37 oz. silver per ton.

A unit financing by Nomad is being considered.

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WICKENBURG QUADRANGLE
ARIZONA
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 1964

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

UTM GRID AND 1964 MAGNETIC NORTH DECLINATION AT CENTER OF SHEET

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
DOTTED LINES REPRESENT 10-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

ARIZONA
QUADRANGLE LOCATION

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

THIS MAP COMPLIES WITH NATIONAL MAP ACCURACY STANDARDS
FOR SALE BY U. S. GEOLOGICAL SURVEY, DENVER 25, COLORADO OR WASHINGTON 25, D. C.
A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

WICKENBURG, ARIZ.
N3352.5—W11237.5/7.5
1964
AMS 3451 I NW—SERIES V898

THE SUPERIOR OIL CO.
DEC 6 1965
MINERALS DIVISION
TUCSON

BUDGE

A. F. Budge (Mining) Limited
7340 E. Shoeman Lane, Suite 111 "B" (E)
Scottsdale, AZ 85251-3335
(Business Office)
Telephone: (602) 945-4630
Telex: 751739

Confidentiality Agreement

Vulture Project

Gentlemen:

This is in response to your inquiry regarding information concerning the subject project.

We will make available to WESTMONT MINING INC. (including its subsidiaries and affiliates, herein called the "Company") information necessary for review of the above project, subject to the following conditions:

1. The Company will hold all information in strict confidence for two years from the date of acceptance of this letter agreement.

2. The Company will use the information only for the purpose of evaluation of the project and for no other purpose.

3. In evaluating the project, the Company may disclose the information only to persons and entities employed by or consulting with it and engaged in the evaluation.

4. Upon written request, and within 30 days of receipt of such request, the Company will return the information, including all copies, reproductions, summaries or extracts thereof, including interpretations made by the Company or its representatives based on the information received.

cont'd...

5. Neither the Company nor any person or entity to whom the information is disclosed shall, within two years from the date of acceptance of this letter agreement, acquire any interest, direct or indirect, in any mining claims, leases, mining rights or fee lands within one mile from any mining claims, leases, mining rights and fee lands included in the above project held by or on behalf of A.F. Budge (Mining) Limited on the date of acceptance of this letter agreement. Any interest acquired in violation of this paragraph shall, at Budge's request and at no cost to Budge, be conveyed to Budge.

Yours very truly,

A.F. Budge (Mining) Limited

By ____________________

Donald C. White
Consulting Geologist

Accepted and Agreed to

this 13 th day of MAY, 1988

[signature]

By H.T. DUMMETT

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

VULTURE MOUNTAINS QUADRANGLE
ARIZONA
15 MINUTE SERIES (TOPOGRAPHIC)

Mapped, edited, and published by the Geological Survey

Control by USGS and USC&GS

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

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

TRUE NORTH
MAGNETIC NORTH
14½°
APPROXIMATE MEAN DECLINATION, 1961

SCALE 1:62500

1 ½ 0 1 2 3 4 MILES

3000 0 3000 6000 9000 12000 15000 18000 21000 FEET

1 .5 0 1 2 3 4 5 KILOMETERS

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

ROAD CLASSIFICATION

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

ARIZONA
QUADRANGLE LOCATION

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A FOLDER DESCRIBING TOPOGRAPHIC MAPS AND SYMBOLS IS AVAILABLE ON REQUEST

VULTURE MOUNTAINS, ARIZ.
N3345—W11245/15

1961