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

by

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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.