Geologic map of the North of Oracle 7½' Quadrangle, southeastern Pinal County, Arizona

by

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INTRODUCTION

The North of Oracle 7½' Quadrangle is located in southeastern Pinal County about 30 miles north of Tucson, Arizona, and lies north and northwest of the town of Oracle. The northeastern corner of the map area encompasses a portion of the western flank of the Black Hills. Signal Peak is just out of the map area in the adjacent Mammoth 7½' Quadrangle to the east. The southeast corner of the map area includes the northern outskirts of the town of Oracle and the large Tucson Wash drainage. The dominant physiographic feature in the map area, however, is Camp Grant Wash, the major drainage for the basin between the Black Hills and Black Mountains, which cuts through the northern part of the map area as it drains northeast to the San Pedro River. The maximum elevation in the map area is about 4,400 feet in the southwest corner, and the minimum elevation is about 3200 feet where Camp Grant Wash exits the map area to the north.

Bedrock and surficial geology in the study area were mapped between October 2001 to June 2002 as part of a multiyear mapping program directed at producing complete geologic map coverage for the Phoenix-Tucson metropolitan corridor. Additional mapping of bedrock, done by J. Spencer in 2003, outlined an extensive pediment developed on porphyritic granite near the center of the south edge of the map. This map is designated version 2.0, with a new publication date, because of this new mapping. Mapping was funded under the joint State-Federal STATEMAP program, as specified in the National Geologic Mapping Act of 1992, and was jointly funded by the Arizona Geologic Survey and the U.S. Geological Survey under STATEMAP Program Contract #01HQAG0098.

Previous geologic mapping in the North of Oracle 7½' Quadrangle is limited to reconnaissance studies by Dickinson (1993, 1994), who determined the basic structural and stratigraphic framework of the pre-Quaternary map units and outlined the structural significance of the Cloudburst detachment fault in the northeastern part of the map area, and the Star Flat detachment fault in the northwestern part (Dickinson, 1991).

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GEOLOGIC MAP UNITS

Quaternary deposits

d **Disturbed areas (<100 years)-** Areas where human activity has obscured the underlying geology, primarily by excavation of earthen water tanks for cattle ranching.

Qyc **Late Holocene active channel deposits (<100 years)-** Unit Qyc is composed of high gradient, braided and meandering, active channels. Qyc deposits are composed of coarse to medium sands, pebbles, cobbles, with occasional boulders. Clasts are typically angular to sub-

angular and dominated by granitic material with a minor volcanoclastic component. Incised meandering channels are generally low order streams with the higher order streams dominated by braided channels. Soil formation is minimal to absent from the active channel surfaces. Smaller channels located high on older terraces are commonly incised. Qyc is primarily vegetated by opportunistic grasses and flood damaged trees.

Qy **Late to older Holocene alluvium (<~2 to 10 ka)**- Unit Qy consists of low terraces and mid-channel bar deposits composed of sand, silt, and clay, with occasional cobbles. Qy deposits are located along, and less than 1 m above, active channels. Active channels, 1 to 2 m wide, commonly dissecting abandoned mid-channel bar deposits. Surfaces are commonly planner. Qy soils are weakly developed, dark to light brown, with some columnar peds. Minimal clay accumulation and stage I secondary carbonate accumulation (Machette, 1985). Organic accumulation horizons often mantel soil horizons. Qy is primarily vegetated by mesquite, palo verde, and desert broom.

Qyab **Holocene alluvium associated with abandoned channel (<10 ka)**- Unit Qyab consists of 10-20 m wide abandoned channel valleys. Qyab deposits are generally planar, with remnant drainage paths along the paleovalley. Paleovallies are perched above the incised active channels. Qyab soils are weakly developed, very dark brown, with some columnar peds. Silt to clay layers mantels much of the paleovalley, with portions dominated by organic accumulations. Channel abandonment most likely was the cause by alluvial fan dissection. Qyab is primarily vegetated by bushes, shrubs, and young mesquites and acacia trees.

Ql **Late Pleistocene alluvium (~10 to 130 ka)**- Unit Ql consists of weakly to moderately dissected alluvial fan deposits, which commonly flank active channel valleys, although channels are incised a few meters below. Ql terraces are typically lower in elevation than Qm surfaces and other older surfaces. Ql surfaces appear light orange in aerial photos. Ql soils are yellowish orange with minimal clay accumulation. Stage I to II secondary carbonate accumulation. Ql represents a period of aggradations within the paleovalleys, with limits its elevational reach. Ql is primarily vegetated by small shrubs and cacti.

Qm **Middle Pleistocene alluvium (~130 to 500 ka)**- Unit Qm consists of moderately to deeply dissected alluvial fan deposits. Small patchy Qm deposits commonly mantel's Tcg, suggesting past burial of Tcg by Qm. Qm is representative of an aggradational event that overfilled the paleovalleys within the Tcg and some Qo in the western portion of the map area. Ridges are rounded with organic rich surfaces in the upper reached of the drainages. Qm surfaces are topographically below Qo and older deposits. Qm soils are reddish orange, angular blocky peds, cutans, with moderate clay accumulation and stage II to III secondary carbonate accumulation. Qm surfaces appear dark orange on aerial photos and often are seen as spotty patchwork on white Tcg deposits. Qm is primarily vegetated by grasses, bursage, and cacti.

Qmo **Middle to early Pleistocene alluvium (~500 to 1 Ma)**- Unit Qmo consists of moderately dissected alluvial fan deposits, which back fill previously incised valleys within the Qo, Tsmk, and Yo. Qmo surfaces are typically topographically above the Qo surfaces in the southern portion of the map area.. Qmo has dark reddish brown soils and contains moderate to well developed clay accumulation with angular blocky peds and cutans. Stage II secondary carbonate accumulation is present in some areas, however it is absent to rare. This surface blends in with the Qo and Tsmk units and is difficult to distinguish, except for the color difference and general lack of soil carbonate. Qmo surfaces support desert sage, creosote, and barrel cactus

Qo **Early Pleistocene alluvium (~1 to 2 Ma)-** Unit Qo consists of deeply dissected alluvial fan deposits. Qo surfaces are found in the southeastern portion of the map area. Qo surfaces are erosional remnants of a large alluvial fan complex shedding off the uplifted. Tertiary highlands. Qo surfaces appear as white ridges with reddish brown flanks on the aerial photo. Qo soils are dark reddish brown, angular blocky peds, cutans, and thick clay accumulations below a stage IV secondary carbonate accumulation less than a meter thick. Laminated carbonate horizons cap the ridges of the Qo deposits. Minor plant growth on this surface expressed as mature cacti and mesquite trees.

Qc **Colluvium and talus (< 2 Ma)** – Unconsolidated to moderately consolidated colluvium and talus hillslope deposits. This unit typically includes subangular to angular, poorly sorted, sand- to boulder-sized clasts. Adjacent bedrock lithologies dominate the clast compositions. These deposits probably range in age from Holocene to middle Pleistocene.

Quaternary to late Tertiary deposits

QTs **Surficial deposits, undivided (Quaternary to late Tertiary) –** Undivided early Quaternary and late Tertiary consolidated to unconsolidated sediments. QTs includes highly eroded carbonate-bearing deposits that underlie much of the map area and support the Falcon Divide, which runs NE-SW across the southeastern portion of the map area. QTs appears white and gray in aerial photos and is evidenced by petrocalcic chip lag on surfaces stripped of overlying soil horizons. This unit often encompasses eroded QTcr remnants, and is occasionally traceable above and between outcrops of QTcr in gullies and on cut bank exposures. Creosote and ocotillo frequent areas of high carbonate exposure, and yucca, cholla, mesquite, grass, prickley pear, and other cacti are common to these deposits.

QTcr **Mixed soils and regolith developed from conglomerate and sandy conglomerate (Quaternary to late Tertiary)**- QTcr is a mixed unit that includes soil and regolith developed on conglomerate and sandy conglomerate of map unit QTcs, and includes poorly exposed outcrops of QTcs. QTcr also locally includes soil and regolith developed on San Manuel conglomerate. QTcr forms low hills throughout the north-western portion of the map area with actively forming soils.

QTcs **Conglomerate and sandy conglomerate (Quaternary to late Tertiary)** – Light gray, poorly sorted to massive, matrix supported conglomerate and sandy conglomerate. Clasts lithologies vary across the basin and are commonly dominated by locally derived granitic and volcanic clasts with minor Precambrian sedimentary clasts. The matrix is composed of medium to coarse sand and granules and cemented by carbonate. QTc is typically a crudely bedded, moderately well- indurated, coarse sand to small boulder conglomerate. Clasts sizes decrease toward Camp Grant Wash in the center of the map area where the unit becomes weakly consolidated sands, gravels, and granule to cobble conglomerate. QTc deposits outcrop throughout dissected drainage valleys of Qm and Qo but have only been mapped separately in a few areas. Though no obvious tilting of the outcrop has occurred, this unit may be equivalent in part to the granite-clast conglomerate (Tcg) exposed to the east along the Cowhead fault, and to similar faulted conglomerates in the Fortified Peak Quadrangle to the west, but a definitive correlation can not be made.

QTsm **Mixed soil and regolith developed on San Manuel conglomerate (Quaternary to middle Tertiary)** - QTsm is a mixed unit composed of soil and regolith developed on San Manuel conglomerate in the northwest part of the map area, and may include poorly exposed outcrops of Tsm.

Tertiary map units

Tcg **Granite-clast conglomerate -** Light gray, poorly sorted, matrix supported conglomerate dominated by locally derived clasts. This unit may be equivalent to unit QTc but an unequivocal determination of Tcg as a Tertiary unit can only be made where it is faulted against granodiorite (map unit YXg) by the Cowhead Fault.

Thc **Hydrothermal carbonate (middle to late Tertiary) –** Brown, fine- to coarse-grained, hydrothermal carbonate with open-space-filling textures. Unit forms 5 by 30 m outcrop and discontinuous outcrops to northeast along contact between Oracle granite and Tertiary conglomerate, in southeastern corner of map area. This is interpreted as low-temperature hydrothermal carbonate precipitated in a fault zone.

San Manuel Formation sedimentary rocks

Tsm **San Manuel conglomerate, undivided (middle Tertiary) –** This unit is exposed in three areas, as follows: (1) By far the most widespread exposures are in the southeastern corner of the quadrangle in the upper Tucson Wash area. Most of the unit consists of boulder-strewn hillsides with no outcrop or, rarely, exposures of massive conglomerate rich in sandy and silty, medium reddish brown matrix. In sparse exposures bedding is visible in sandy and gravelly beds between cobble and boulder beds. Clasts are 80-90% Oracle granite, with some feldspar porphyries and mafic volcanics that resemble locally derived Cloudburst conglomerate. Feldspar porphyry clasts consist of 15-25%, 1-10 mm white plagioclase in a medium gray to greenish gray matrix with 2-4% chloritized biotite. No quartz was seen. This feldspar porphyry was possibly derived from the Rice Peak porphyry which is widely exposed to the south in the northern Santa Catalina Mountains (Creasey, 1965; Force, 1997; Spencer et al., 2000). (2) In the northwestern corner of the quadrangle, this unit consists of pale gray, poorly sorted sandy conglomerate and conglomerate that is poorly to moderately lithified (Bloodsucker Wash). Pale gray color is distinctly different than dark brown and gray of Cloudburst conglomerate. (3) In the northeastern corner of the quadrangle, west of Corner tank, this unit consists of weakly to moderately lithified, stratified gravels, tan to pale reddish tan, to light brown to light reddish brown, with 1-10 cm clasts and much mafic volcanic debris. Clasts rarely exceed 50 cm. It is weakly channelized, with 10-30 cm deep channels 2-4 m across. This unit is inferred to have been deposited in a medial alluvial fan environment.

Cloudburst Formation and related volcanic and sedimentary rocks – Cloudburst Formation of Heindl (1963) and Creasey (1965; see also Dickinson, 1991).

Tt **Welded tuff (middle Tertiary) –** Pinkish tan to pinkish gray welded tuff with abundant subangular lithic and pumice fragments. The rock is heavily weathered and contains 5-10% calcite- and chlorite-altered phenocrysts of plagioclase, sanidine, quartz, and biotite. The tuff is a single, poorly exposed bed about 5 m thick within Cloudburst Formation conglomerate that is strongly jointed and breaks readily into small, angular fragments. Weibel (1981) obtained a

K-Ar date of 22.5 ± 0.5 Ma from a tuff bed in the upper part of the Cloudburst Formation that may be equivalent to the tuff described here. Weibel (1981) tentatively suggested a correlation between this tuff and the Hell's Half Acre Tuff, part of the Galiuro Volcanics.

Tc **Conglomerate, undivided (middle Tertiary) –** Medium brown to reddish brown conglomerate and, locally, sandy conglomerate. Most of the conglomerate is massive to poorly bedded and poorly sorted. Clasts mostly consist of subangular to subrounded pebbles and cobbles of granite, quartzite, and mafic to intermediate volcanics that were probably derived from the Cloudburst volcanics. In some areas, almost all clasts were derived from mafic to intermediate, variably vesicular, aphyric volcanics, often making this unit difficult to distinguish from flow breccias of map unit Tm. This unit also locally contains thin, mafic lava flows, thin beds of brown colored, pumiceous coarse sand, and small deposits of granite-clast avalanche breccia

Txq **Rock avalanche breccia derived from quartzite (middle Tertiary) -** Breccia fragments typically < 50 cm diameter. Protolith is probably Paleozoic to Precambrian quartzite.

Txg **Rock avalance breccia derived from quartzite (middle Tertiary) -** Breccia fragments typically < 50 cm diameter. Protolith is fine grained, orangish red leucogranite.

Ts **Pebbly sandstone (middle Tertiary) –** Brown colored, medium-grained, pebbly sandstone. Pebbles are sparse and consist of granite, quartzite, and mafic to intermediate volcanics.

Tp **Dacitic lava and pyroclastic rocks (middle Tertiary) –** Light gray, fine-grained, dacitic lava. Porphyritic with sparse phenocrysts of biotite (< 2 mm), plagioclase (< 5 mm), and opaques (< 1 mm). Occurs with pyroclastic rocks composed of dacitic lava fragments with a medium brown lithic sandstone matrix.

Tm **Mafic to intermediate volcanic rocks, undivided (middle Tertiary) –** Medium brown to dark gray, mafic to intermediate lava flows, flow breccias, and massive volcanic-lithic, clast-supported breccias (2-20 cm fragments) that are probably autoclastic breccias. Many of the flow breccias and the tops of some flows are oxidized to a brick-red color. These fine-grained to coarsely crystalline, seriate-textured volcanic rocks are petrographically similar to lavas found to the west in the Chief Butte quadrangle that chemically range from basalts to trachyandesites. The fine-grained lavas are locally porphyritic with phenocrysts of altered plagioclase up to 8 mm, especially in exposures of this map unit along the east edge of the map area (east side of prominent ridge, sections 19 and 30, T. 8 S., R. 16 E.). The more coarse-grained lavas contain phenocrysts of green-colored clinopyroxene ranging in size from about 0.5 mm to 3 mm, and reddish brown olivine, mostly altered to iddingsite, that range in size from about 0.25 mm to 2 mm, with a matrix composed of plagioclase laths that range in length from about 0.5 mm to 2 mm. The lavas are typically vesicular to amygdaloidal with round to flattened vesicles and cavities up to 15 cm in diameter. The amygdules, composed of calcite or silica, often weather out, and in many areas the ground is littered with white, egg-shaped silica nodules from less than 1 cm up to several cm in diameter. Locally includes bedded pyroclastic rocks or reworked basaltic pyroclastic rocks, including thin beds of brown colored, pumiceous coarse sand, conglomerate,

and granite-clast avalanche breccia. Sparse massive conglomerate beds derived from mafic to intermediate lava flows, where not mapped separately, are also included in this unit. Shafiqullah and others (1978) obtained a K-Ar date of 28.3 ± 0.63 Ma from the lower part of this unit a few km to the east of the map area in the Mammoth 7½' Quadrangle.

Tm_1 **Mafic to intermediate volcanic rocks, fine-grained (middle Tertiary) –** Fine-grained variety of undivided mafic to intermediate volcanic rocks described above.

Tm_2 **Mafic to intermediate volcanic rocks, medium-grained (middle Tertiary) –** Coarsely crystalline variety of undivided mafic to intermediate volcanic rocks described above.

Tertiary to early Proterozoic map units

TXh **Hornblende diorite (Tertiary to early Proterozoic)** – Dark colored, fine- to medium-grained, hornblende diorite. Sphene is common. Occurs as a small, crumbly outcrop intruding granodiorite (YXg) and cut by the Cowhead fault.

Middle Proterozoic map units

Ylg **Muscovite leucogranite (middle Proterozoic) –** Medium grained, equigranular, muscovite (3-5%) leucogranite, whitish in color. This map unit is contiguous with the "muscovite granite" unit of Krieger (1974) mapped directly to the north on the Putnam Wash 7 ½' Quadrangle. A sample of this granite collected by Krieger (1974; sample USGS(D)-W-38) was analyzed by Marvin and Dobson (1979) who determined a muscovite K-Ar date of 1320 ± 40 Ma and, on the basis of a single whole-rock analysis (Rb/Sr = 8.96) and an assumed $^{87}Sr/^{86}Sr = 0.703$, a calculated age of 1520 ± 80 Ma (Marvin and Dobson, 1979; recalculated by Reynolds and others [1986], as 1605 ± 80 Ma). Reynolds and others (1986) gave the name Palmer Wash granite to the rock dated by the Rb/Sr method, but gave the name Oracle Granite (?) to the rock dated by the K-Ar method. Field relationships mapped by Krieger (1974), however, suggest that the muscovite granite intrudes the K-feldspar porphyritic granitoid (Yg). If this granite is intrudes a 1.4 Ga granite, and has yielded a 1.32 Ga K-Ar date, then it is very likely that it is part of the 1.4 Ga granite suite and is related to the 1.4 Ga granite that it appears to intrude.

Ylga **Altered muscovite leucogranite (middle Proterozoic) –** Medium and fine grained muscovite (3-5%) leucogranite, fractured and iron stained, pale gray to brownish gray. This map unit is contiguous with the "muscovite granite" unit of Krieger (1974) mapped directly to the north on the Putnam Wash 7 ½' Quadrangle.

Yd **Diabase dikes (middle Proterozoic)** – Dark colored, fine- to coarse-grained diabase dikes composed of plagioclase and mafic minerals, including magnetite. Texture is diabasic. Intrudes granodiorite (YXg).

Yg **K-feldspar porphyritic granitoid (middle Proterozoic) –** Light gray to medium gray, coarse-grained, K-feldspar porphyritic monzogranite to granodiorite. Phenocrysts visible in

hand sample include light-colored, anhedral to tabular crystals of K-feldspar up to about 3 cm in length; white to greenish, anhedral, sericitized plagioclase up to about 1 cm; rounded quartz crystals less than 1 cm; and 20-40% fresh, anhedral crystals of dark biotite forming thin books up to 3-4 mm in width and irregular clots up to 2 cm across. The granitoid typically weathers into outcrops of large, rounded boulders. The granitoid is contiguous with the Oracle Granite of Peterson (1938), and is contiguous with the Ruin Granite unit of Krieger (1974) on the adjacent Putnam Wash 7 ½' Quadrangle in the northwest part of the map area. The K-feldspar porphyritic granitoid intrudes YXg granodiorite (Krieger, 1974).

Middle or Early Proterozoic igneous rocks

YXg **Granodiorite (early to middle Proterozoic)** – Medium- to fine-grained granodiorite with ~10-15% mafic minerals consisting primarily of biotite and hornblende. Rocks of this unit are contiguous with the granodiorite unit of Krieger (1974) on the adjacent Putnam Wash 7 ½' Quadrangle, and with the granodiorite unit of Creasey (1965) on the adjacent Mammoth 7 ½' Quadrangle. This unit may also include K-feldspar porphyritic granitoid (Yg) contiguous with Krieger's (1974) intrusive Ruin Granite unit, and Creasey's (1965) intrusive quartz monzonite unit, but this was not determined from this mapping.

Early Proterozoic igneous rocks

Xd **Dioritic granitoid (early Proterozoic)** – Dark colored, fine- to medium-grained dioritic granitoid with 20% to 40% mafic minerals including biotite(?), hornblende(?), and magnetite(?). Possible epidote alteration imparts a greenish color. Intruded by muscovite leucogranite (Ylg) and K-feldspar porphyritic granitoid (Yg). This unit is contiguous with the Pinal Schist unit of Krieger (1974) on the adjacent Putnam Wash 7 ½' Quadrangle, but it is clearly not Pinal Schist.

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