GEOLOGY OF CEMETERY RIDGE, CLANTON HILLS, AND WESTERNMOST GILA BEIND MOUNTAINS, LA PAZ AND YUMA COUNTIES, ARIZONA

by

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Includes map, scale 1:24,000, and 16 page text.

INTRODUCTION

The area described in this study includes Cemetery Ridge, the Clanton Hills, and the westernmost Gila Bend Mountains (Picacho Hills), La Paz and Yuma counties, Arizona. The study area (Fig. 1) encompasses all of the Nottbusch Butte Quadrangle (1:24,000), the northern part of the Turtleback Mountain Quadrangle (1:24,000), and the southwestern part of the Eagletail Mountains West Quadrangle (1:24,000). Bedrock in this area consists of Proterozoic to Jurassic igneous and metamorphic rocks that are overlain by Miocene silicic volcanic rocks, subordinate mafic and intermediate volcanic units, and continental calcareous sedimentary rocks (Plate 1). Sources of data are shown in Figure 2, rock-unit correlations and relative ages are shown in Figure 3, and map symbols are shown in Table 1.

The area was mapped with funds provided to the Arizona Geological Survey by the U.S. Geological Survey COGEOMAP program, contract #14-08-0001-A0872. Field work was carried out in November and December, 1991. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the U.S. Government.

PREVIOUS INVESTIGATIONS

Previous geologic studies of the area include reconnaissance studies incorporated into State geologic maps by Wilson and others (1969) and Reynolds (1988), and reconnaissance mapping by Miller and others (1989) in Cemetery Ridge. The area directly to the west of the study area was mapped by Grubensky and Demsey (1991) and the area directly to the east was mapped by Gilbert and others (1992). Miocene sedimentary rocks in the Clanton Hills were studied by Scarborough and Wilt (1979) and interbedded tuff was dated by Eberly and Stanley. Some of the mineral deposits in Cemetery Ridge and the Gila Bend Mountains were described by Wilson (1933) and those in Cemetery Ridge were described by Lane (1986) and Miller and others (1989). The upper Cenozoic surficial deposits were mapped and described by Demsey (1990).

GEOLOGIC SETTING

The study area is within the Basin and Range physiographic and tectonic province which underwent moderate to severe Tertiary extension and magmatism in west-central Arizona (Spencer and Reynolds, 1989). The study area and surrounding areas are characterized by northwest-trending normal faults and fault blocks. Pre-Tertiary rocks consist of various mafic and felsic igneous rocks of probable Jurassic and Proterozoic age. Voluminous magmatism and normal faulting occurred in the early Miocene and were followed by middle Miocene basaltic magmatism. Calcareous sedimentary rocks were deposited during volcanism.

STRUCTURE

Northwest-trending faults generally mark the southwest and northeast margins of Cemetery Ridge and juxtapose Tertiary volcanic rocks (map units Tfx, Tf, Tlt, Tft) and Tertiary to early Proterozoic crystalline rocks (map units YXg, Jmi, JXd, JXdf, TXgd, Tg).

The fault on the southwest side of Cemetery Ridge can be traced for approximately 9 km southeast from the northwest boundary of the map area. For most of its length the fault is relatively straight and apparently steeply to moderately dipping, and juxtaposes Tertiary volcanic rocks to the southwest against older crystalline rocks to the northeast. In one area on the southwest side of the fault, rhyolite conformably overlies early Proterozoic granite. The southeast part of this fault is gently to moderately-dipping. The rarely exposed fault surface is generally marked by brecciated rhyolite (map unit Tfx) resting on shattered, iron-stained Jurassic to early Proterozoic crystalline rocks. With one exception, rhyolite breccia along the fault does not contain clasts of older crystalline rocks.

On the northeast side of Cemetery Ridge a high angle(?) fault is discontinuously exposed for about 7 km and juxtaposes Tertiary volcanic rocks (map units Tfx, Tf, Tb) to the northeast against older crystalline rocks to the southwest. Where exposed in sec. 7, T. 1 S., R. 11 W., the fault is marked by highly shattered and brecciated rhyolite (map unit Tfx) resting on shattered, iron-stained granite (map unit YXg).

Tertiary volcanic rocks rest on the older crystalline rocks of Cemetery Ridge northwest of the map area (Grubensky and Demsey, 1990) and rest above a moderate to low-angle fault just southwest of Nottbusch Butte. These relationships and the mirror geometry of the two faults bounding Cemetery Ridge suggest that Cemetery Ridge is a horst.

In the southeastern part of the map Tertiary rhyolite (Tf, Tft) is displaced into several horsts and grabens by northwestern-trending high-angle faults. Displacement of the rhyolite is generally several tens of meters. One of the faults juxtaposes fault blocks with contrasting stratigraphic sequences. On one side of this fault silicic volcanic rocks of map unit Tf rest on mafic volcanic rocks of map unit Tm, which in turn rest on Jurassic to early Proterozoic crystalline rocks of map units JXdf and JXgn. On the other side of the fault the mafic volcanic rocks are missing and silicic volcanic rocks rest directly on pre-Tertiary crystalline rocks. This relationship suggests that the fault was active before eruption of the silicic volcanic rocks. This fault may project northward to the fault along the southwest side of Cemetery Ridge.

MINERAL DEPOSITS

The northern part of the map area (Cemetery Ridge) lies within the Eagletail Mineral District, and the southern part within the Gila Bend Mountains Mineral District (Keith and others, 1983). The northern part of the area displays spotty and weak copper mineralization along fractures and faults cutting Tertiary and older rocks (Wilson, 1933; Keith, 1978). Most prospects on Cemetery Ridge (Wilson, 1933) are located near or along the fault that trends along the southwest side of Cemetery Ridge. Manganese production of 19,000 lbs. reported by Keith and others (1983) is probably from manganese prospects discussed by Wilson (1933) along the west side of Cemetery Ridge.

Four prospects examined in the southern part of the map area are also located along fractures and shear zones. Wilson (1933) reports spotty gold from prospects along the southeast edge of the map.

ACKNOWLEDGEMENTS

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DESCRIPTION OF MAP UNITS

Qs **Surficial deposits (Quaternary)**--Unconsolidated alluvium and colluvium, including talus, sand and gravel in modern washes, and unconsolidated to poorly consolidated gravel, sandy gravel, and sand, locally with silt or boulders that typically forms flat, locally incised surfaces up to 5 meters above modern drainages.

QTc **Pedogenic carbonate (Quaternary and Pliocene?)**--Caliche-cemented gravel and sedimentary breccia (talus deposits?).

QTs **Very old surficial deposits (Quaternary and Pliocene?)**--Unconsolidated, weakly consolidated, and caliche-cemented gravel, sandy gravel, and cobble- and boulder-bearing gravel. Commonly highly dissected and forms rounded hills with boulder lag.

Tb **Basalt (Miocene)**--Black to dark gray, resistant, olivine basalt that weathers into large, dark brown to dark gray, resistant blocks. This basalt is commonly vesicular, locally scoriaceous, and locally porphyritic, with phenocrysts of plagioclase, pyroxene and olivine. Individual flows range up to 10 m thick. The unit contains minor amounts of welded or friable rhyolite tuff. A K-Ar biotite date of 28.7 ± 4.2 Ma (Eberly and Stanley, 1978), reported from this unit (identified as sample-location ES102 in southwesternmost Clanton Hills), is considered to be of questionable accuracy because the basalt unit contains no biotite and the potassium content, reported as 1.18%, is much too low for biotite. This unit is correlative with the Basalt of Oakland Mine of Grubensky and Demsey (1991). Major element oxide chemistry of one sample from the unit within the map area is reported in Table 2 and Figure 4.

Tbs **Sandstone (Miocene)**--On the northwest side of Nottbusch Butte this unit consists of 5 m of finely layered, strongly iron-stained, well-sorted, hematitic sandstone that rests in sharp contact on sedimentary breccia (Tsb). The lower 2 m of the unit is very coarse to medium-grained and grades upward into 3 m of medium- to fine-grained sandstone. On the northwest side of Nottbusch Butte the sandstone is overlain conformably by basalt flow breccia (Tb), and on the east side of the butte the sandstone forms an interbed in the lower part of the basalt unit (Tb).

Tsb **Sedimentary breccia (Miocene)**--Light tan- to pinkish orange-weathering, crudely stratified, sedimentary breccia. Generally composed of subangular clasts, up to 25 cm across, of granite (90%; unit YXg) and rhyolite (10%) set in a poorly sorted, iron stained, lithic sandstone matrix. Near the top to the unit the ratio of rhyolite to granite clasts increases to 2:1. The unit includes at least one 1.0-1.5 m thick bed of friable, white lithic tuff.

Tnrt **Rhyolite of Nottbusch Valley (Miocene)**--Includes both hard and friable rhyolitic tuff that is pale yellowish tan to light pink to white and contains hornblende, biotite, feldspar, quartz, and volcanic lithic fragments (basalt and rhyolite) up to 10 cm long, and local, minor, granitic rock fragments. Includes minor medium-grained, well-sorted, tuffaceous sandstone. At one locality a scoriaceous basaltic bomb is embedded in the tuff. The thickness of the unit is highly variable and probably reflects accumulation of ash on an irregular surface. The unit is locally interbedded with the lower part of the overlying basalt unit (Tb) and is correlative with the tuff member of the Rhyolite of Nottbusch Valley of Grubensky and Demsey (1991).

Tf **Felsic volcanic rocks (Miocene to Oligocene?)**--Includes pyroclastic rocks and probable flows and hypabyssal intrusions. Commonly porphyritic, with phenocrysts of biotite, hornblende, plagioclase, iron oxides, and, locally, of quartz. Pyroclastic rocks include volcanic-lithic tuff with abundant 0.5 to 2 cm fragments of volcanic rocks in pink to pinkish-brown volcanic matrix that contains feldspar, quartz, and biotite. Layering in tuffaceous rocks is defined by variation in size, abundance, and composition of phenocrysts and volcanic rock fragments. Least resistant layers may be pumice rich. Bedding is defined by color and character of weathering (smooth vs. pitted). Local platy fracturing characterizes fine-grained layers. Light-gray, partially lithified, lapilli(?) tuff with biotite, hornblende, and feldspar locally forms base of massive, hard flows(?). Massive volcanics that may be flows, intrusions, or thick welded-tuff cooling units are typically resistant, weather gray, brown, white, or orange, and typically contain quartz, feldspar, biotite, and hornblende. Local gray glassy vitrophyre contains quartz, feldspar, biotite and hornblende. Dark-weathering, pale lavender (on fresh surfaces), massive, felsic to intermediate volcanic rocks that contain 2 to 3% biotite and 1 to 2% hornblende(?) form hills east of Clanton Hill and northwest of the Big M mine.

In the central and southeastern areas of Cemetery Ridge this map unit is variably laminated, fine to medium-grained biotite-hornblende rhyolite. It is lavender and light grey, weathers to dark brown, forms beds up to 2 m thick, and contains local accumulations of volcanic lapilli tuff and tuff-breccia. Locally, near the base of the unit, minor amounts of vesicular basalt or basaltic andesite and light tan to pale yellow, friable, rhyolite tuff and tuffaceous sandstone are interbedded with rhyolite. Locally grades into Tlt.

This lithologically diverse unit is considered to be broadly correlative with the Volcanics of Royal Arch of Grubensky and Demsey (1991). Major element oxide chemistry of these rocks (sample E within the map area) indicates that the composition of unit Tf ranges from dacite to trachydacite (Table 2; Fig. 4). Biotite from a sample of this unit from the Clanton Hills yielded a K-Ar date of 23.6$\pm$1.6 (Eberly and Stanley, 1978; sample location identified as ES101).

Tfg **Rhyolite and granite (Miocene to Oligocene?)**--In northwestern Cemetery Ridge this map unit consists predominantly of light tan, light pink, and light grey weathering, flow-banded, porphyritic rhyolite or fine-grained equigranular biotite-hornblende rhyolite and appears to grade into rocks of map unit Tg to northwest. In this area this map unit probably represents a dome buildup near an eruptive center, with fracturing increasing to the southwest.

Tft **Rhyolite tuff (Miocene to Oligocene?)**--Light-tan to yellow, fine-grained rhyolitic crystal tuff and lapilli tuff with minor rounded clasts of basalt up to 10 cm across. Locally it is conspicuously bedded, with individual beds up to 1 m thick, and in other areas it forms massive cliffs up to 30 m high. A probable vent for the unit is exposed just south of Big M Mine near the southeastern corner of the map area.

Tfv **Vitrophyre (Miocene to Oligocene?)**--Black vitrophyre zones within Tft. Major element oxide chemistry of vitrophyre (sample F within the map area) suggests that the unit is cogenetic with felsic flows and tuff of unit Tf (Table 2; Fig. 4).

Tfx **Rhyolite breccia (Miocene to Oligocene?)**--Dark brown and grey weathering, lavender and pink rhyolite tuff, tuff-breccia, and subordinate flow rocks of Tf, Tfx, and Tfs that have undergone extensive volcanic and tectonic brecciation. Welded and consolidated pyroclastic layers and flow rocks are commonly shattered and broken into angular clasts up to several meters across. The base of the unit is generally marked by highly shattered rhyolite resting on iron-stained, fractured granite of map unit YXg. Locally, near the base of the unit clasts are recemented with calcite.

Tlt **Limestone, tuffaceous limestone, and tuff (Miocene to Oligocene?)**--Includes (1) gray, limestone, (2) gray limestone with tuffaceous laminations, (3) gray limestone with lithic-vitric tuff stringers and 2 to 10 cm chert nodules, (4) black- to brown-weathering laminated calcareous lithic-vitric tuff with sparse 0.5 to 5 cm thick layers of recess-forming gray limestone (laminations defined by variations in color and resistance to weathering, with darker layers more resistant to weathering and presumably less calcareous). Orange-, brown- and black-weathering tuffaceous layers protrude on weathered surfaces, gray limestone forms recesses. Limestone is locally fetid. Fresh surfaces are generally gray. Orange-weathering massive tuff beds up to 5 meters thick are present locally. In southeastern Cemetery ridge the lower part of the unit is commonly fractured and brecciated above a low angle fault.

Tss **Sandstone (Miocene to Oligocene?)**--Bedded, reddish-brown, calcareous, moderately sorted, subrounded, fine-grained feldspatholithic sandstone. Clasts are approximately 20% feldspar, 30% quartz, and 50% volcanic rock fragments.

Txg **Breccia (Miocene to Oligocene?)**--Shattered granitoid rocks and biotite gneiss. Clasts typically 1 to 10 cm diameter. Interpreted as catastrophic debris avalanche deposits that were probably shed off active fault scarps. This unit is thought to be younger than the mafic volcanic rocks on the basis of the distribution of these two rock types in the westernmost Clanton Hills, but the absence of volcanic rock clasts in the breccia does not support this interpretation.

Tm **Mafic and intermediate volcanic rocks (Miocene to Oligocene?)**--Highly shattered, gray to black basalt, basaltic andesite, or andesite, locally (in Clanton Hills) includes basal bedded tuffaceous rocks. In easternmost part of map area unit is generally massive, purple weathering, and may include rocks of dacitic composition. Rarely weathers into pieces greater than 10 cm diameter in most exposures. Plagioclase phenocrysts are locally present, but mafic phenocrysts generally are not recognizable due to alteration. Pyroxene(?) was tentatively recognized in one sample. Secondary epidote is common in thin section. Unit appears to intrude overlying units at east side of small, isolated peak approximately 1 km west of Clanton Hill and at fault termination near center of Clanton Hills. Chemical analysis of these rocks (includes sample D within the map area) ranges from basalt to trachyandesite (Table 2; Fig. 4).

Tdf **Felsic dikes (Miocene to Oligocene)**--Aphanitic, porphyro-aphanitic, and fine-grained felsite dikes. Possibly feeders to unit Tf.

Tdm **Mafic dikes (Miocene to Oligocene?)**--Aphanitic, porphyro-aphanitic, and fine-grained mafic and intermediate dikes and small intrusions.

Ta **Aplite dike swarm (Miocene to Oligocene?)**--Area in northwest part of map containing many narrow, northwest-trending, aplite dikes, and subordinate quartz veins and felsite and mafic dikes.

Tg **Granite (Miocene to Oligocene?)**--Generally hypabyssal intrusive rock with up to 25% phenocrysts of quartz, feldspar, biotite, and minor hornblende in a leucocratic aphanitic groundmass. Biotite comprises up to 10 to 15 percent of the rock. Grades into light tan to orange-weathering, fine- to medium-grained, equigranular, hornblende-biotite granodiorite as in the Columbus Wash granodiorite to the southeast (Gilbert and others, 1992). Locally narrow dikes are composed of felsite. Forms irregular but generally northwest-trending, moderately to steeply northeast-dipping bodies up to 300 m across that intrude JXd and JXdf. Possibly intrusive equivalent of units Tf and Tfx. Major element oxide chemistry of two samples (A and B) are reported in Table 2 and Figure 4.

TXdg **Diorite and granite (Tertiary to early Proterozoic)**--A mixture of diorite (JXd) or biotite schist (JXdf) intruded by granitic dikes of unit Tg. Mapped where the two units are found in approximately equal amounts and are generally too intimately intermixed or poorly exposed to map separately. Includes minor amounts of megacrystic granite of unit

YXg.

Jmi **Mafic and intermediate metaigneous rocks (Jurassic)**--Dark green, medium- to fine-grained actinolitic greenstone and greenschist.

JXdf **Foliated Diorite and Biotite Schist (Jurassic to early Proterozoic)**--Dark-green to gray weathering, medium-grained, foliated biotite-quartz-plagioclase gneiss and biotite schist. In the northwest part of the map area the unit is in gradational contact (foliation dies out) over a few hundred meters with unit JXd, and the intensity of foliation increases toward the northwest.

JXd **Diorite (Jurassic to early Proterozoic)**--Medium to dark grey-weathering, medium-grained, equigranular, quartz-bearing, biotite-hornblende diorite and subordinate hornblende gabbro. Color index ranges from 25-50, with biotite:hornblende >1 in more leucocratic phases and <1 in more melanocratic phases. Locally the unit is weakly to moderately foliated and includes minor biotite schist. Resembles early Proterozoic diorite and gabbro in the eastern Gila Bend mountains (Gilbert, 1991), but may be correlative with Jmi metabasite to the south.

JXgn **Gneiss (Jurassic to early Proterozoic)**--Fine-grained, highly fractured, leucocratic granitoid rocks with undeveloped to moderately developed crystalloblastic foliation. Contains approximately 1% fine-grained biotite. Locally contains 2 to 5% biotite with K-feldspar augen up to 3 cm long and bull quartz veins 5 to 50 cm thick. Hematite staining on fractures is common. Includes minor fine- to coarse-grained biotite gneiss with mafic and felsic layers up to 5 mm thick.

YXg **Granite (early to middle Proterozoic)**--Brown to green weathering, biotite granite with abundant (15 to 40%) rounded K-feldspar megacrysts up to 6 cm long and abundant biotite. Fracture density and iron staining increases upward toward the depositional base of overlying volcanics. The granite is commonly overprinted with a weak to moderate mylonitic foliation. Locally, up to one third of the unit is composed of diorite of unit JXd, and the granite includes minor xenoliths of biotite schist. The granite crops out as narrow bands along the northeast and southwest sides of Cemetery Ridge, and is included as a minor component in unit TXgd. Small exposures are present in the western Clanton Hills.

This megacrystic granite is possibly correlative with the Sore Fingers monzogranite of Spencer and others (1992) in the nearby Eagletail Mountains and resembles the Maricopa granite of Gilbert (1991) in the eastern Gila Bend Mountains. Small exposure in western Gila Bend Mountains contains K-feldspar phenocrysts up to 3 cm diameter and resembles the Granite of the Centennial Plate in the Little Harquahala Mountains 50 km to the north (Spencer and others, 1985).

DESCRIPTION OF MINERAL DEPOSITS (The following descriptions correspond to numbered locations on the geologic map.)

(1) NW 1/4 sec. 34, T. 1 S., R. 12 W. A 2x3x3 m pit in tremolitic alteration at margin of a crudely foliated, mafic-ultramafic dike. Probably the actinolite asbestos prospect described by Wilson (1933).

(2) SE 1/4 sec. 2 (unsurveyed), T. 1 S., R. 12 W. Two-meter wide swarm of granitic dikes which includes dikes up to 1 m thick. Intrusion of dikes was accompanied by brecciation and open space filling by quartz, hematite, and minor pyrite.

(3) NE 1/4 sec. 12 (unsurveyed), T. 1 S., R. 12 W. Shaft in malachite-stained, chloritic gabbro dike with minor chalcopyrite. Previously examined by Miller and others (1991, p. c-6, table 1, map no. 1)

(4) SE 1/4 sec. 14 (unsurveyed), T. 1 S., R. 12 W. Van Buskirk prospect. 2x2x2 m pit exposing a 0.5-1.5 meter-wide, northwest-trending and southwest-dipping shear zone. The shear zone contains limonitic gossan (dike?) with chrysocolla.

(5) SE 1/4 sec. 13 (unsurveyed), T. 1 S., R. 12 W. Limonitic, sheared contact of mafic dike with minor malachite stain. Shear trends northwest. Near the Collins prospect described by Wilson (1933).

(6) SE1/4 sec. 35 (unsurveyed), T. 1 S., R. 12 W. Two-meter deep prospect in shattered crystalline rocks contains minor, fracture-filling brown calcite and rare hematite.

(7) SE1/4 sec. 2, T. 2 S., R. 12 W. Three-meter deep shaft on northwest-trending, vertical fracture zone with fracture-filling hematite and sparse chrysocolla and malachite.

(8) SE1/4 sec. 2, T. 2 S., R. 12 W. Sparse, fracture-coating white calcite in crystals up to 3 mm and very sparse iron oxides interpreted as relict sulfides.

(9) SW1/4 sec. 15, T. 2 S., R. 11 W. Big M Mine. Trenching and excavation of foliated greenstone (JXdf), particularly in red fault gouge along brecciated, hematite-stained, fault contact between JXdf and Tf. Near approximate location of Bill Taft group and Belle Mackeever group discussed in Wilson (1933). Identified as Yellow Breast Mine by U. S. Bureau of Land Management (1987).

REFERENCES CITED

Demsey, K.A., 1990, Geologic map of Quaternary and upper Tertiary alluvium in the Little Horn Mountains 30 x 60-minute quadrangle, Arizona: Arizona Geological Survey Open-File Report 90-8, scale 1:100,000.

Gilbert, W.G., 1991, Geologic map of the eastern Gila Bend Mountains, Maricopa County, Arizona: Arizona Geological Survey, Map 31, scale 1:24,000, 14 p.

Gilbert, W.G., Laux, D., Spencer, J.E., and Richard, S.M., 1992, Geology of the western Gila Bend and southern Eagletail Mountains, Maricopa and Yuma counties, Arizona: Arizona Geological Survey Open-File Report 92-5, scale 1:24,000.

Grubensky, M.J., and Demsey, K.A., 1991, Geologic map of the Little Horn Mountains 15' Quadrangle, southwestern Arizona: Arizona Geological Survey Map 29, scale 1:50,000, 10 p.

Eberly, L.D., and Stanley, T.B., 1978, Cenozoic stratigraphy and geologic history of southwestern Arizona: Geological Society of America Bulletin, v. 89, p. 921-940.

Keith, S.B., 1978, Index of mining properties in Yuma County, Arizona: Arizona Bureau of Geology and Mineral Technology Bulletin 192, 185 p.

Keith, S.B., Gest, D.E., DeWitt, Ed, Woode-Toll, Netta, and Everson, B.A., 1983, Metallic mineral districts and production in Arizona: Arizona Bureau of Geology and Mineral Technology Bulletin 194, 58 p.

Lane, M.E., 1986, Mineral investigation of a part of the Eagletail Mountains Wilderness Study Area (AZ-020-128), La Paz, Maricopa, and Yuma Counties, Arizona: U.S. Bureau of Mines Open-File Report MLA 45-86, 16 p.

Le Bas, M.J., Le Maitre, R.W., Streckeisen, A., and Zanettin, B., 1986, A chemical classification of volcanic rocks based on the total alkali-silica diagram: Journal of Petrology, v. 27, pl 745-750.

Miller, R.J., Gray, F., Hassemer, J.R., Hanna, W.F., Pitkin, J.A., Hornberger, M.I., Jones, S.L., and Lane, M.E., 1989, Mineral resources of the Eagletail Mountains wilderness study area, La Paz, Maricopa, and Yuma Counties, Arizona: U.S. Geological Survey Bulletin 1702, scale 1:50,000, 18 p.

Reynolds, S.J., 1988, Geologic map of Arizona: Arizona Geological Survey Map 26, scale 1:1,000,000.

Scarborough, R., and Wilt, J.C., 1979, A study of uranium favorability of Cenozoic sedimentary rocks, Basin and Range Province, Arizona, Part I, General geology and chronology of pre-late Miocene Cenozoic sedimentary rocks: Arizona Bureau of Geology and Mineral Technology Open-File Report 79-1, 101 p.

Spencer, J.E., Gilbert, W.G., and Richard, S.M., 1992, Geologic map of the eastern Eagletail Mountains, Maricopa, La Paz, and Yuma counties, Arizona: Arizona Geological Survey Open-File Report 92-3, scale 1:24,000.

Spencer, J. E., and Reynolds, S. J., 1989, Middle Tertiary tectonics of Arizona and the Southwest, *in* Jenney, J. P., and Reynolds, S. J., eds., Geologic evolution of Arizona: Arizona Geological Society Digest, v. 17., p. 539-574.

Spencer, J.E., Richard, S.M., and Reynolds, S.J., 1985, Geologic map of the Little Harquahala Mountains, west-central Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 85-9, scale 1:24,000, 18 p.

U.S. Bureau of Land Management, 1987, Lower Gila South final wilderness environmental impact statement, 321 p.

Wilson, E.D., 1933, Geology and mineral deposits of southern Yuma County, Arizona: Arizona Bureau of Mines Bulletin 134, 236 p.

Wilson, E.D., Moore, R.T., and Cooper, J.R., compilers, 1969, Geologic map of Arizona: Tucson, Arizona Bureau of Mines and U.S. Geological Survey, Scale 1:500,000.

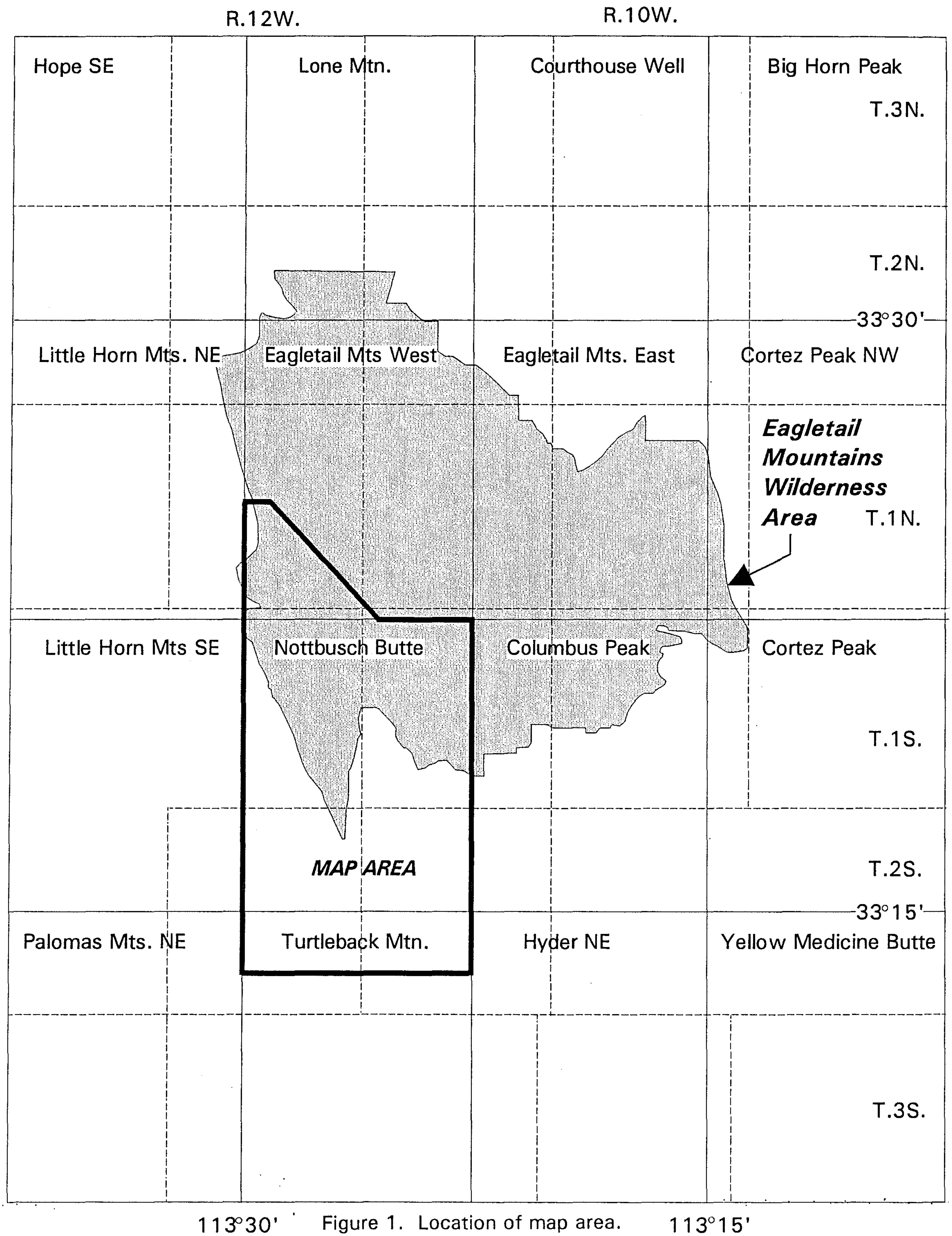

Figure 1. Location of map area.

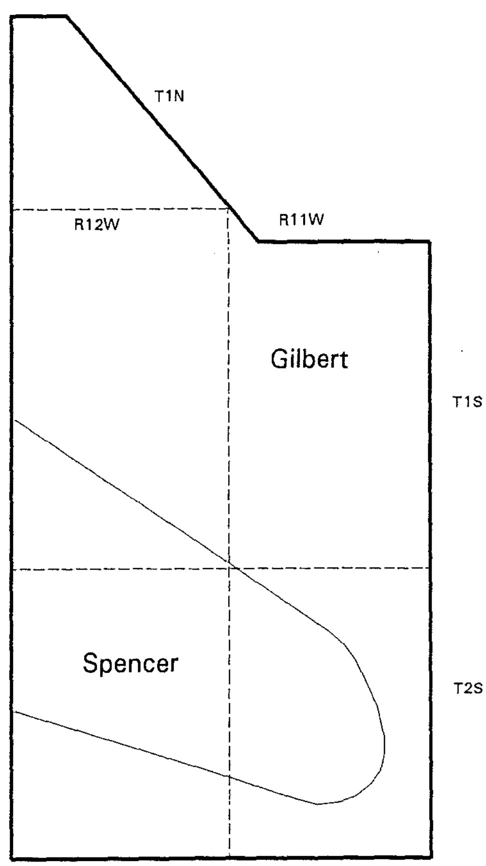

Figure 2. Respective areas mapped by authors

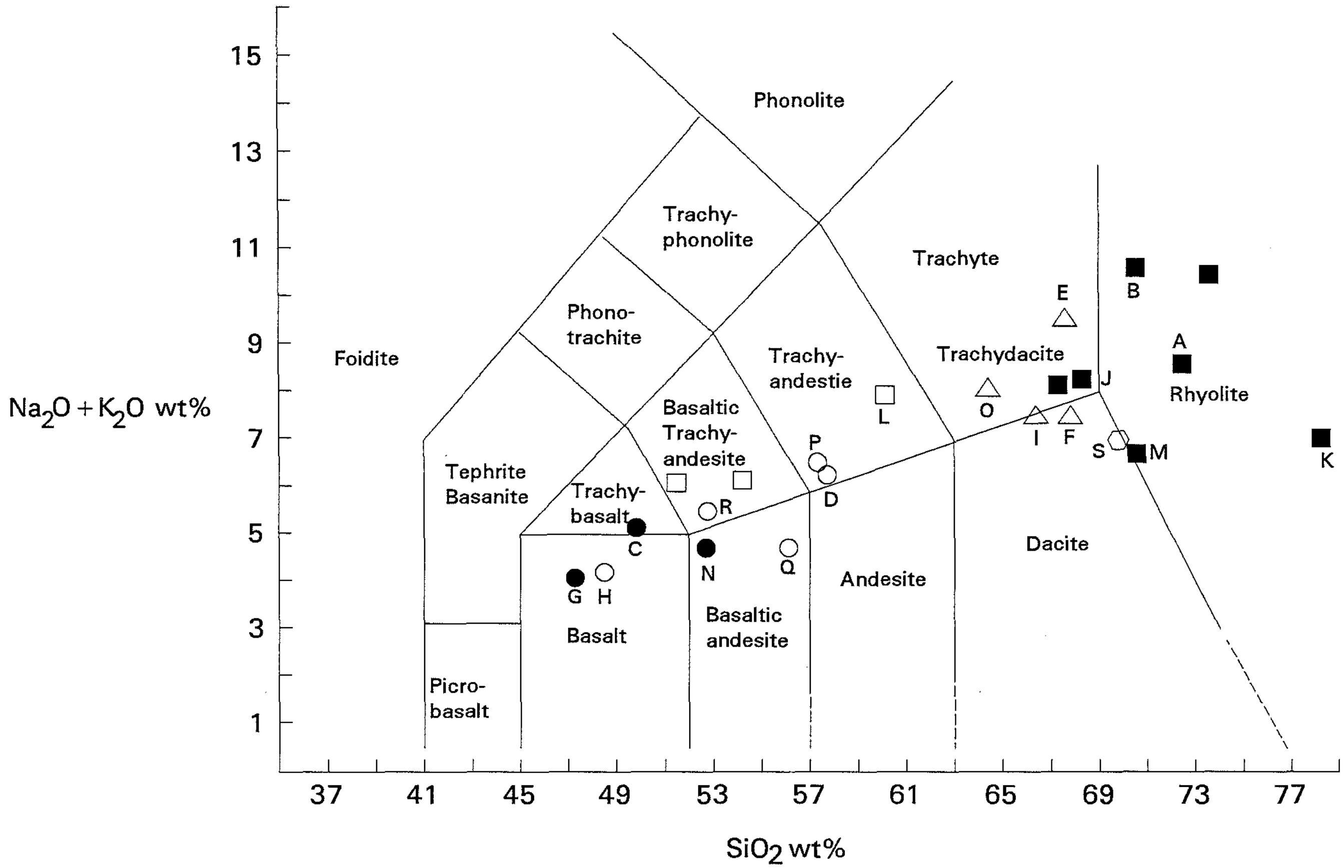

Figure 4. Total alkalies vs. SiO_2 for rocks from Cemetary Ridge, Clanton Hills, and western Gila Bend Mountains, Maricopa and Yuma Counties, Arizona. ● - unit Tb; ○ - unit Tm; △ - felsic volcanic rocks (Tf, Tfv); ■ - unit Tg; □ - unit Tmd in Gilbert and others (1992); ⬡ - unit YXgn in Gilbert and others (1992); Classification scheme for volcanic rocks from Le Bas and others (1986). Map symbols A-F in this report, symbols G-S reported in Gilbert and others (1992).

Figure 3. Correlation of Map Units

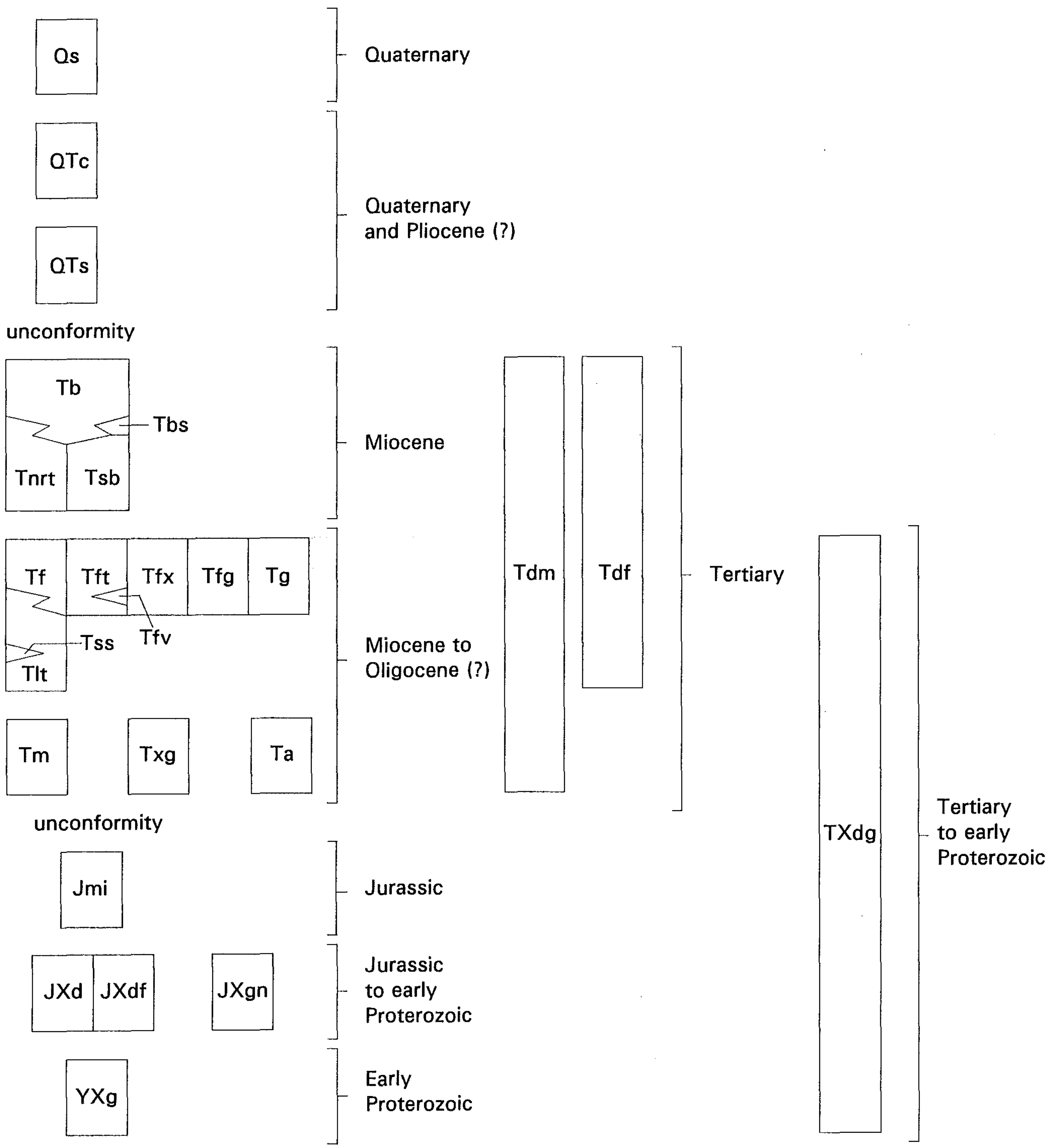

Table 1

MAP SYMBOLS

Contact, dashed where approximate

Gradational contact

Fault, dashed where approximate, dotted where concealed

Crushed rock

Syncline

Strike and Dip of Bedding

25 inclined

horizontal

vertical

Strike and Dip of Foliation

inclined

vertical

Strike and dip of Cleavage

inclined

vertical

Mineral deposit locality

Major-element oxide sample locality

Felsic dike (Tdf)

Mafic to intermediate dike (Tdm)

Zone of numerous aplite dikes

Table 2 (part 1). Major element oxide analyses from Cemetery Ridge, Clanton Hills, and western Gila Bend Mountains, Yuma and La Paz Counties, Arizona.

Rock Unit	Tb			Tm					Tf		Tfv		Tdf
Map Symbol	C	G	N	D	H	P	Q	R	E	O	F	I	--
Sample #	91WG33b	2-6-92-1	CFB	11-18-91-5	92WG16	91-32	91-27	92WG104	11-21-91-6	CWPP	91WG96a	92WG13	GD-RHY
Laboratory	CH	CH	ACME	CH	CH	ACME	ACME	CH	CH	ACME	CH	CH	BC
Quadrangle	NB	COP	COP	NB	COP	HNE	HNE	HNE	NB	COP	NB	HNE	CRP
SiO_2	49.50	46.95	52.57	57.71	48.13	57.29	56.20	52.50	67.63	64.41	67.86	66.35	73.56
TiO_2	1.15	1.13	1.04	0.82	1.24	0.88	0.94	1.02	0.34	0.47	0.38	0.34	0.08
Al_2O_3	15.50	14.72	16.98	16.38	17.32	16.70	16.53	17.05	15.79	15.79	15.01	14.52	13.46
Fe_2O_3	9.30	9.51	8.63	6.36	10.50	6.90	7.89	8.92	2.91	3.57	2.67	2.58	0.51
FeO	0.39	6.05	--	4.19	2.24	--	--	4.66	2.07	--	1.04	0.29	0.19
MgO	8.30	10.54	5.39	3.55	3.93	3.03	3.74	4.75	1.05	1.56	1.04	1.03	0.13
MnO	0.14	0.15	0.13	0.12	0.15	0.08	0.09	0.14	0.06	0.07	0.06	0.05	0.03
CaO	8.18	10.65	7.74	6.55	9.40	4.84	6.24	7.63	1.69	2.81	2.61	2.46	0.60
Na_2O	3.38	3.01	3.60	3.78	2.97	4.19	3.68	3.84	3.36	3.63	4.20	3.42	5.20
K_2O	1.64	1.04	1.18	2.54	1.18	2.34	0.99	1.58	6.25	4.41	3.39	4.17	5.30
P_2O_5	0.48	0.63	0.26	0.33	0.34	0.20	0.19	0.33	0.22	0.19	0.18	0.19	0.13
LOI	0.65	0.40	2.20	1.80	3.46	3.10	3.20	0.67	1.23	3.00	2.98	5.30	0.70
Cr_2O_3	--	--	0.017	--	0.03	0.002	0.022	0.01	--	0.002	<0.01	<0.01	--
BaO	0.08	0.08	--	0.10	--	--	--	--	0.19	--	--	--	--
Total	98.30	98.80	99.74	100.05	98.65	99.55	99.55	98.42	100.70	99.63	100.40	100.40	99.89
Comments													Lat. 33° 16' 00" Long. 113° 14' 25"

-- Not Analyzed

Laboratory: CH - Chemex Labs, Ltd.; ACME - ACME Analytical Labs.; BC - Bondar-Clegg, Inc.

Quadrangle: COP - Columbus Peak; CRP - Cortez Peak; NB - Nottbusch Butte; HNE - Hyder NE

Samples A-F located on map in this report; samples G-S located in Gilbert and others (1992).

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Table 2 (part 2). Major element oxide analyses from Cemetery Ridge, Clanton Hills, and western Gila Bend Mountains, Yuma and La Paz Counties, Arizona.

Rock Unit	Tg						Tmd			YXgn
Map Symbol	A	B	J	K	M	--	L	--	--	S
Sample #	91WG46	91WG12	92WG74	9174	90117	GD-13b	88-1	L-5	89-4	92WG102
Laboratory	CH	CH	CH	ACME	ACME	BC	BC	BC	ACME	CH
Quadrangle	NB	NB	COP	COP	COP	CRP	COP	CRP	CRP	HNE
SiO_2	72.47	70.30	68.31	78.37	70.73	67.45	59.95	51.03	54.10	69.95
TiO_2	0.23	0.27	0.35	0.11	0.36	0.37	0.73	1.14	1.03	0.30
Al_2O_3	14.01	14.15	15.32	12.59	13.96	15.09	16.89	17.48	15.73	16.02
Fe_2O_3	1.80	2.11	2.77	0.73	2.57	0.49	5.33	3.79	7.21	2.77
FeO	0.52	0.17	0.85	--	--	0.38	--	3.46	--	1.40
MgO	0.48	0.73	1.11	0.13	1.24	1.10	2.27	4.74	7.39	0.99
MnO	0.05	0.05	0.05	0.01	0.06	0.03	0.08	0.13	0.15	0.05
CaO	1.14	0.65	2.45	0.60	2.84	3.42	4.15	8.10	6.17	3.12
Na_2O	3.74	2.22	4.25	3.29	4.02	5.64	4.46	4.05	3.31	4.50
K_2O	5.02	8.33	3.98	3.80	2.77	2.51	3.44	1.85	2.74	2.49
P_2O_5	0.14	0.16	0.19	0.01	0.14	0.22	0.35	0.54	0.26	0.16
LOI	0.46	1.06	0.58	0.30	1.00	1.30	2.00	1.60	1.50	0.54
Cr_2O_3	--	--	--	0.002	0.006	--	0.002	--	0.039	0.02
BaO	0.15	0.19	0.14	--	--	--	--	--	--	--
Total	99.69	100.20	99.49	98.00	99.70	98.00	99.65	97.91	99.59	100.90
Comments				Aplite dike	K/Ar sample	Lat. 33° 16' 16" Long. 113° 14' 36"		Lat. 33° 16' 16" Long. 113° 14' 00"	Lat. 33° 15' 56" Long. 113° 14' 35"	

-- Not Analyzed

Laboratory: CH - Chemex Labs, Ltd.; ACME - ACME Analytical Labs.; BC - Bondar-Clegg, Inc.

Quadrangle: COP - Columbus Peak; CRP - Cortez Peak; NB - Nottbusch Butte; HNE - Hyder NE

Samples A-F located on map in this report; samples G-S located in Gilbert and others (1992).

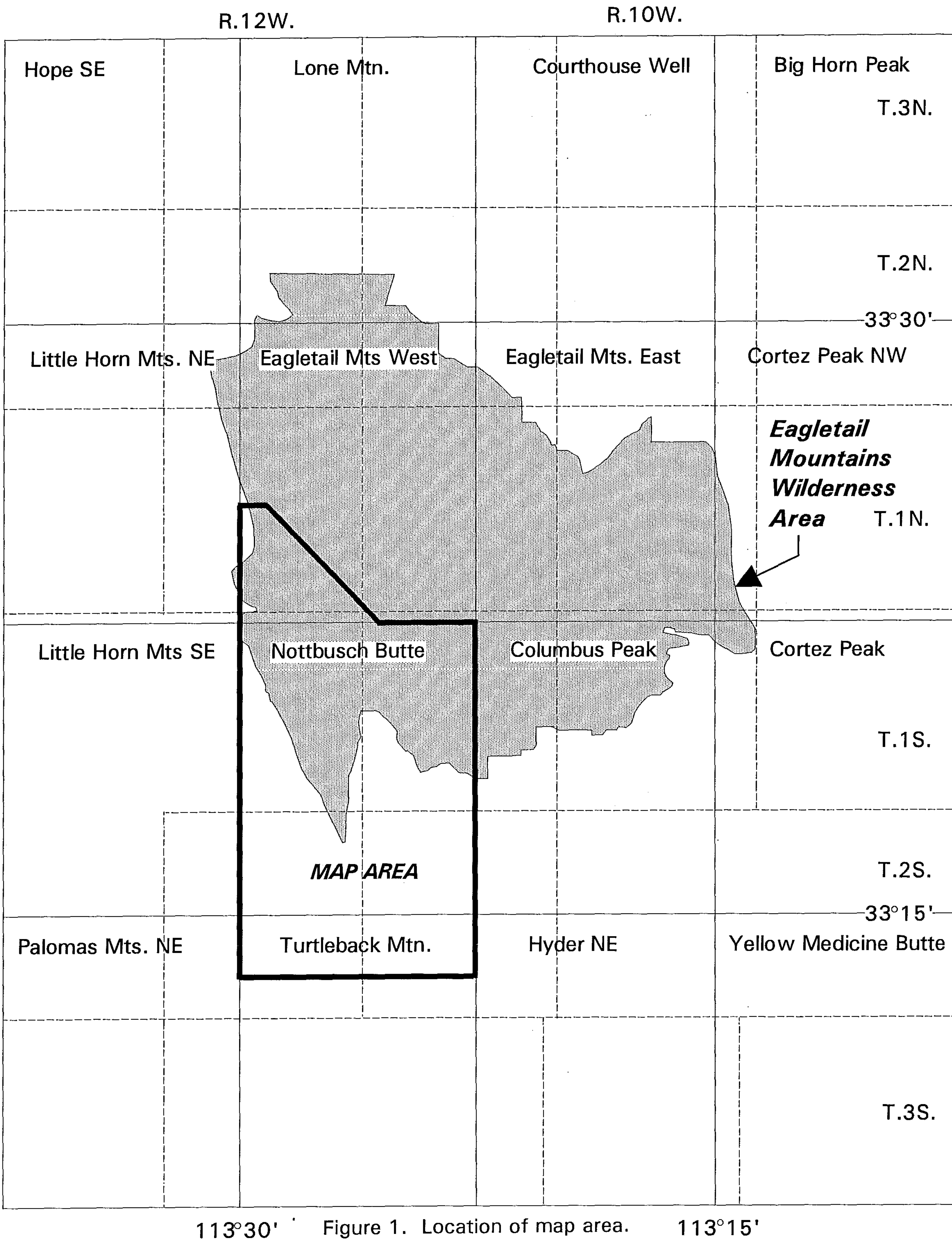

Figure 1. Location of map area.

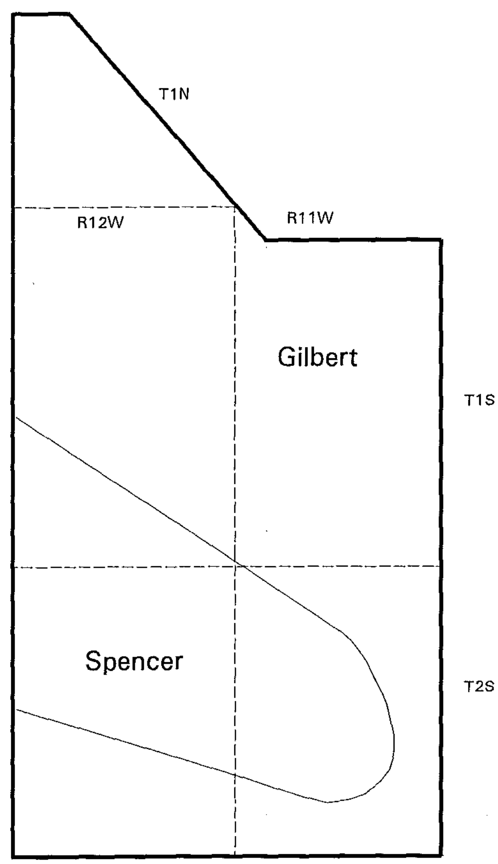

Figure 2. Respective areas mapped by authors