GEOLOGIC MAP OF THE EASTERN EAGLETAIL MOUNTAINS, MARICOPA, LA PAZ, AND YUMA COUNTIES, ARIZONA

by

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INTRODUCTION

The area described in this study includes the eastern Eagletail Mountains, Maricopa, La Paz, and Yuma counties, Arizona. The srudy area encompasses all of the Eagletail Mountains East Quadrangle (1:24,000) and is partially within the Eagletail Mountains Wilderness Area (Figure 1). Bedrock in this area consists largely of pre-Tertiary granitoid rocks of probable Jurassic age that are intruded by numerous Tertiary dikes and overlain by an extensive sequence of Miocene silicic volcanic rocks and subordinate mafic and intermediate volcanic units (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.

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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). The area directly to the south and southwest of the study area was mapped by Gilbert and others (1992) and Gilbert and Spencer (1992), and the area directly to the west was mapped by Grubensky and Demsey (1991). Mineral deposits in the eastern Eagletail Mountains 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, much of which underwent severe Tertiary extension and magmatism (Spencer and Reynolds, 1989). The region around the study area is characterized by northwest-trending normal faults and fault blocks and the northwest trend of the Eagletail Mountains is probably due to Tertiary normal faulting. Pre-Tertiary rocks in the Eagletail Mountains consist of Jurassic to Proterozoic granitoid rocks. Early Miocene magmatism produced a thick sequence of ash-flow tuffs that form the backbone of the range and numerous northwest-trending dikes within pre-Tertiary rocks. Felsic magmatism was followed by early to middle Miocene basaltic magmatism.

STRUCTURE

Pre-Tertiary shear zones and fabrics

Pre-Tertiary plutonic bodies along the northeastern flank of the Eagletail Mountains are separated by northeasterly trending zones of mylonitic gneiss. The contact zone between the diorite phase of the Frenchman Mine pluton (unit JXfd) and porphyritic granodiorite (unit JXg) is the best exposed. Gneissic rocks separating the Frenchman Mine pluton from the porphyritic granodiorite are interpreted to be high-temperature mylonites formed along an intrusive contact. Formation of fine-grained, thinly layered gneiss by deformation-induced grain size reduction and recrystallization is recorded in the gradational contacts between the largely undeformed main body of the porphyritic granodiorite and the gneiss zone on the west side of Granite Mountain. The mixed, gradational contact between the diorite phase of the

Frenchman Mine pluton and the gneiss zone, which has less pervasive and more complexly contorted gneissic foliation than the western contact of the gneiss, suggests that this is an older intrusive contact. Thus, the porphyritic granodiorite is interpreted to be the younger plutonic body.

Similar, but more poorly exposed, gneissic zones are present on the southeast side of the Frenchman Mine pluton at its contact with the metasedimentary gneiss and pegmatite (unit JXms), and on the northwest side of the porphyritic granodiorite at its contact with the Sore Fingers monzogranite (unit JXmg). The presence of mylonitic gneisses derived from Frenchman Mine granodiorite interleaved in the metasedimentary gneiss and quartzo-feldspathic gneiss of uncertain origin suggests that the Frenchman Mine pluton intruded the metasedimentary gneiss during or before formation of the high-strain zone. The contact zone between the porphyritic granodiorite and Sore Fingers monzogranite is very poorly exposed, but the presence of similar feldspar-quartz-biotite gneisses apparently derived in part from the adjacent plutonic rocks suggests a similar high strain zone between the plutons. The porphyritic granodiorite has a weakly developed linear fabric in most outcrops, defined by alignment of the long axis of feldspar phenocrysts and of recrystallized clots of biotite or hornblende. The Sore Fingers monzogranite has no fabric. On this basis, the porphyritic monzogranite is considered older than the Sore Fingers monzogranite.

To summarize, the Frenchman Mine pluton is interpreted to be the oldest plutonic body, and intruded the metasediment, muscovite granite, and pegmatite unit (JXms). A neodymium-samarium isotope analysis of the granodiorite phase of the Frenchman Mine pluton indicated that this pluton is Phanerozoic and not Proterozoic in age (S.J. Reynolds, oral communication, 1992, analysis by M. Felix Lerch). The porphyritic granodiorite intruded the Frenchman pluton on the northeast, and the Sore Fingers monzogranite intruded the porphyritic granodiorite on the northeast. Before or during intrusion of the Sore Fingers monzogranite, the contacts between these units became high strain zones within which the mylonitic gneisses formed. The shear zones between the porphyritic granodiorite and Frenchman Mine pluton dips moderately to steeply southeast, and the other two shear zones dip gently to moderately northwest. Mineral elongation lineations, where observed in the shear zones and present as weak 'l' fabrics in the Frenchman Mine pluton and porphyritic granodiorite, all consistently trend between about 020° and 050°. The lithologic similarity of the porphyritic granodiorite and Sore Fingers monzogranite suggests that they are part of the same plutonic suite. The Sore Fingers monzogranite is believed to be Jurassic in age in the Little Harquahala Mountains (Richard, unpublished U-Pb data from correlative monzodiorite in the northern Little Harquahala Mountains). If the correlation of these rock units is correct, the deformation of these rocks is Jurassic in age.

Other Faults

The contact between the Tertiary and pre-Tertiary rocks along the range front southwest of Granite Mountain is a moderately to steeply southwest-dipping fault zone. Where well exposed, the fault zone contains indurated, foliated cataclasite. The foliation is defined by irregular lenses of comminuted granitoid rock, volcanic rock, and red hematitic gouge. Weak striations in this foliation observed in one outcrop plunge down the dip of this fault. Tertiary hypabyssal intrusions at the base of Eagletail Mountain apparently intrude this fault zone; other intrusions along the range front to the north probably intrude this zone as well. No depositional contacts between the Tertiary and pre-Tertiary rocks along the northeast front of the range have been observed except at the southeastern edge of the map area where a Tertiary conglomerate forms the base of the Tertiary stratigraphic sequence.

Dikes

The Tertiary dikes intruding the pre-Tertiary rocks along the northeastern front of the range trend northwest and generally dip steeply northeast to vertical. The density of dikes increases towards the range front to form composite intrusions elongated in a northeasterly direction. Courthouse Rock is formed by one such intrusion; it is no larger than several of the other intrusions and is formed by similar dike rock. Its greater resistance to erosion may be due to deuteric alteration.

MINERAL DEPOSITS

Minor mineralization and alteration affected crystalline rocks along the northeast flank of the Eagletail Mountains. These areas are not, however, within a metallic mineral district as recognized by Keith and others (1983). Some mineral deposits in the map area are associated with brittle shear zones or mafic dikes and contain hematite, specular hematite, malachite, and chrysocolla, commonly with open-space filling textures (Lane, 1986; this report). These deposits resemble other deposits in west-central Arizona that are associated with shallow-level brittle shear zones and/or mafic dikes (Spencer and Welty, 1989), and all of these deposits are almost certainly middle Tertiary in age. Other deposits are quartz veins that contain hematite and locally manganese oxides and calcite. These deposits are possibly of pre-Tertiary age.

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 **Older surficial deposits (Quaternary to Miocene?)**--Poorly to moderately consolidated fanglomerate with subangular clasts, typically 1 to 10 cm, of mafic schist, granitoids, and Tertiary basalt.

Tb **Basalt (middle to early Miocene)**--Black to medium gray, fine-grained, locally porphyritic, olivine basalt. Typically occurs as mesa-capping flows. Textures consist of massive, vesicular to nonvesicular, platy, scoriaceous, and agglomeratic facies. Includes local red scoria. Generally very resistant to weathering and weathers into resistant blocks.

Tmu **Upper mafic volcanic rocks (early Miocene to late Oligocene)**--Gray, brown, and purple weathering, fine- to medium-grained, mafic to intermediate volcanic flows. Commonly contains plagioclase (altered) and hornblende phenocrysts. Massive to highly fractured or brecciated and locally amygdaloidal. Rocks of this unit are cut by locally abundant silica and calcite veins and veinlets. Red to purple liesegang banding is present locally.

Tt **Bedded to massive, variably welded tuffs (early Miocene to late Oligocene)**--Generally pale yellow weathering, weakly bedded tuff and lapilli tuff. Commonly white or pale red or tan on fresh surfaces. Unit is moderately consolidated and typically forms cliffs or steep slopes. Weathering of cliff faces may produce cavities (tafone) up to several meters diameter. Commonly contains biotite phenocrysts up to 3 mm diameter and locally contains hornblende and feldspar phenocrysts up to 3 mm long. Locally grades into welded tuff and contains minor amounts of tuffaceous sandstone. Locally contains low-angle cross stratification.

Tf **Felsic volcanic rocks (early Miocene to late Oligocene)**--Generally massive, cliff forming, and brown weathering, with fractures perpendicular to bedding that crudely resemble columnar jointing. Interpreted as welded tuffs and, possibly, rheomorphic tuffs, and flows. May contain fresh biotite phenocrysts up to 3 mm diameter and slightly altered hornblende up to

4 mm long. Weathering color varies; may be tan or light gray.

In SW1/4, sec. 34, T. 1 N., R. 10 W., includes reddish tan, aphyric rhyolite(?) with highly flattened, gray pumice fragments. High-temperature slip surfaces(?) in this area are lineated and have undulations with axes parallel to lineations. Both are perpendicular to tension gashes.

Tfv **Vitrophyre (early Miocene to late Oligocene)**--Dark gray to black vitrophyre flows and breccia. Up to 30% of the rock consists of phenocrysts of hornblende, biotite, and plagioclase set in a glassy groundmass. Commonly light grey where partially devitrified. Locally grades into partially devitrified vitrophyre and then into map unit Tf.

Tfvt **Vitrophyre and tuff (early Miocene to late Oligocene)**--Heterogeneous unit characterized by dark gray to black vitrophyre and vitrophyre breccia interbedded with lapilli-crystal tuff as in unit Tt and crystal-vitric welded tuff as in unit Tf.

Tfts **Felsic tuff and sandstone (early Miocene to late Oligocene)**--Felsic tuff interbedded with medium-grained pebbly sandstone and conglomerate.

Tap **Andesite Porphyry (early Miocene to late Oligocene)**--Brown weathering, light-tan, porphyritic, intermediate intrusion. Typically contains 30% to 40% phenocrysts of plagioclase up to 2 cm long and of biotite and hornblende up to 1 cm long set in a light tan aphanitic groundmass. Probably hypabyssal equivalent of Tm.

Tfd **Felsic dike rocks (early Miocene to late Oligocene)**--Light-gray to pinkish grey dikes intruding pre-Tertiary rocks. Rocks of this map unit typically contain phenocrysts of quartz, feldspar, and chloritized biotite in an aphanitic groundmass, and are generally distinguished from rocks of map unit Tid by the presence of quartz.

Tid **Intermediate to felsic dike rocks (early Miocene to late Oligocene)**--Includes white, gray, greenish gray, tan, and brown aphanitic dikes, locally with 1 to 3 mm phenocrysts of quartz, feldspar, biotite, and hornblende. Rocks of this unit generally do not contain quartz.

Some thick dikes are composite, with fine-grained, equigranular, dark-grey basaltic or andesitic margins, and a more felsic interior zone. Many of the andesitic dikes contain rounded inclusions of mafic dike rock interpreted to result from magma mixing.

These dikes locally form lensoid and irregular (in map view), resistant silicic intrusions that form steep cliffs and resistant rock spires, such as at Courthouse Rock in the northwestern part of the map area. Steep flow foliation and steeply plunging lineation characterize this rock unit near its intrusive margins. Wall rocks and rocks of this unit may be brecciated along contact zones and in some areas are mixed.

Tmd **Mafic dikes (early Miocene to late Oligocene)**--Dark greenish grey to black, fine-grained basaltic or andesitic dikes. Generally equigranular, but some dikes contain 1 mm hornblende or plagioclase crystals.

Tml **Lower mafic volcanic rocks (early Miocene to late Oligocene)**--Brown-weathering, medium gray, intermediate to mafic volcanic flows with fine-grained plagioclase and pyroxene(?) phenocrysts. Locally contains quartz (unsurveyed NE1/4, sec. 33, T. 1 N., R. 10 W.).

In one area (north-facing cliff face 1.3 miles N7°W from Anvil Mountain) this unit is shattered, appears to be a debris avalanche deposit, and locally contains 5- to 50-cm-thick dikes of granitoid-clast conglomerate that were apparently intruded as a slurry from beneath at the time of avalanche emplacement. The lower 20 meters of overlying tuff (map unit Tt) contain numerous basalt clasts. Tuff is draped over irregular top of brecciated basalt and contact is locally interdigitated. Possibly basalt breccia was locally mechanically fluidized and intruded into tuff at the time of tuff emplacement.

Tfu **Bedded to massive, variably welded tuffs, rheomorphic tuffs, and flows, undivided (early Miocene to late Oligocene)**--Rocks of map units Tf and Tt, undivided. May locally include hypabyssal intrusions. Commonly consists of red to purplish tan, flow-banded rhyolite that is generally brecciated. Includes flow-banded rhyolite(?) with local disharmonic folds with 10 to 100 cm long limbs. Locally grades into dark gray vitrophyre (map unit Tfv).

The spectacular cliff-forming outcrops along the range front in the area approximately 1 to 2 miles southeast of Eagletail Peak include massive, pale gray, pale red, or tan, aphyric rhyolite(?) breccia with fragments typically 1 to 10 cm diameter. Brecciation was not tectonic as throughgoing fractures are generally absent. The brecciated rocks were not produced by catastrophic debris avalanches as they do not contain a crushed-rock matrix and are not porous. Brecciation is interpreted as either high-temperature volcanogenic or diagenetic.

Ts **Sedimentary rocks, undivided (early Miocene to late Oligocene)**--Conglomerate and sandstone. Light tan to red, medium- to coarse-grained, moderately to poorly sorted, feldspatholithic pebbly sandstone and granule to pebble conglomerate interbedded with volcanic rocks. Approximately 2.7 miles northwest of Eagletail Peak, near range crest, rocks of this unit consist of pebble to cobble conglomerate with clasts of Tertiary volcanic rocks and pre-Tertiary crystalline rocks.

Tbx **Debris avalanche deposits (early Miocene to late Oligocene)**--Light colored, angular to subangular, gneissic and granitoid rock fragments in an unsorted matrix.

TJqp **Silicic dikes (early Miocene to Jurassic)**--Very fine-grained, light gray or greenish gray groundmass with about 10-20% 3-6 mm diameter quartz phenocrysts, 5-10% subhedral K-feldspar and 1-3% chloritized biotite. These intrude pre-Tertiary crystalline rocks. Intermediate to felsic dikes (unit Tid) intrude these silicic dikes.

TXg **Granite to granodiorite (early Miocene to early Proterozoic)**--Reddish-brown weathering, medium to fine-grained leucocratic granitoids, equigranular, nonfoliated to moderately foliated. Mafic minerals are altered to iron oxides except locally where some biotite is preserved. Mineral grains are sutured, rock weathers into angular fragments. Quartz content is possibly low enough that this unit is a quartz monzonite.

JXfgn **Feldspathic gneiss (Jurassic to early Proterozoic)**--Generally reddish weathering, fine-grained, light gray, microcline gneiss with approximately 1% apatite and laminations of chlorite, epidote and opaques.

JXmg **Sore Fingers monzogranite (Jurassic to early Proterozoic)**--Medium- to coarse-grained monzogranite, with 20-50% K-feldspar in phenocrysts up to 7 cm in diameter, 20-25% quartz in anhedral grains up to 8 mm diameter, 30-35% plagioclase in 2-5 mm subhedral crystals, and 5-10% biotite generally greatly in excess of hornblende. Biotite is variably recrystallized to very fine-grained aggregates. K-feldspar phenocrysts are irregularly distributed in rock body; locally they occur packed together in cumulate zones which may consist of >50% phenocrysts. Sparse aplite dikes intrude the monzogranite. Correlated with the Sore Fingers Monzogranite (Spencer and others, 1985) of the southern Little Harquahala Mountains based on lithologic similarity. A sample of this rock in the southern Little Harquahala Mountains yielded a K-Ar minimum age of 140 Ma (Rehrig and Reynolds, 1980). U-Pb data from a probably correlative monzodiorite in the northern Little Harquahala Mountains indicates an age of near 160 Ma (S. M. Richard and N. R. Riggs, unpublished data).

JXg **Porphyritic granodiorite (Jurassic to early Proterozoic)**--Medium- to fine-grained biotite and hornblende-biotite granodiorite to monzogranite with gray potassium feldspar phenocrysts up to 4 cm long. Large K-feldspar phenocrysts may be rounded with long axes subparallel to local tectonic lineation. Local foliation and lineation are not obviously mylonitic, and are crosscut by younger quartz veins up to 5 cm thick. Locally includes medium- to fine-grained hornblende diorite(?) with up to 40% mafic minerals in bodies ranging from enclaves with diameters <1 m to pendants up to several 10's of m long. In more highly deformed zones near the margins of the body, the large K-feldspar phenocrysts are commonly recrystallized to rounded quartz-feldspar aggregates, which appear granitic; hornblende is typically moderately to completely replaced by biotite in these zones as well. Contacts on both the northwest and southeast are gneissic shear zones (shown as unit JXgn).

JXgg **Granodiorite gneiss (Jurassic to early Proterozoic)**--Feldspar-quartz-biotite gneiss; medium gray, fine grained, and very thinly layered. Interpreted to be derived from granodiorite unit.

Frenchman Mine pluton

JXfg **Hornblende biotite granodiorite (Jurassic to early Proterozoic)**--Medium grained, equigranular hornblende to hornblende-biotite granodiorite. Consists of approximately 3-10% hornblende in stubby prismatic crystals 3-7 mm long; 1-5% biotite in 1-2 mm variably recrystallized crystals; 10% 3-5 mm subhedral potassium feldspar; 50-60% plagioclase; 10-20% quartz in anhedral grains 1-3 mm in diameter, some of which contain plagioclase inclusions; 2-4% secondary(?) epidote in aggregates of anhedral .5-1 mm grains. Sphene is a common accessory mineral. Hornblende crystals give the rock a slightly speckled look. Granodiorite is cut by sparse aplite dikes; these are fine-grained, equigranular and consist of quartz and feldspar with rare muscovite. The aplite locally grades into medium- to coarse-grained quartz-rich pegmatite irregularly distributed within the dike.

JXfd **Diorite (Jurassic to early Proterozoic)**--Texturally variable hornblende diorite to hornblendite. Diorite is typically fine-grained, equigranular, and unfoliated, but grades to medium-grained hornblende gabbro, with local pods of coarse-grained hornblendite. All of these varieties are locally gneissic. Contact with the gneiss (unit JXgn) is gradational over 10-20 m, with mixing of gneiss and massive to gneissic diorite; the contact is placed where diorite becomes the predominant rock. Contact with hornblende granodiorite (unit JXfg) is gradational over about 10 m.

JXlg **Fine-grained, equigranular, leucocratic granite (Jurassic to early Proterozoic)**--In some areas contains up to 2 to 3 percent biotite. Commonly contains pegmatite dikes.

JXms **Metasedimentary gneiss, muscovite granite, and pegmatite (Jurassic to early Proterozoic)**--Schist and gneiss abundantly intruded by pegmatite. Metamorphic rocks contain variable proportions of quartz, feldspar, muscovite, biotite and garnet, and are typically fine grained and gneissic. The protolith was apparently mostly sandstone. These are abundantly intruded by medium- to fine-grained equigranular muscovite granite, containing up to about 10% 1-2 mm muscovite grains, and by quartz-feldspar-muscovite pegmatites.

JXgn **Gneiss (Jurassic to early Proterozoic)**--Fine-grained feldspar-quartz-biotite ($\pm$hornblende) gneiss. Typically very thinly layered (2-5 cm), with layering defined by compositional variations. Unit includes irregular small intrusions of medium- to fine-grained equigranular leucogranite, granodiorite and diorite. These are sub-concordant to cross-cutting. The contact between gneiss and granodiorite at the northeast end of Granite Mountain is an irregular mixed zone with 5-15 cm diameter, partially resorbed, rounded inclusions of gneiss in texturally highly variable granodiorite. Granodiorite layers are interleaved in the gneiss near the contact, and are concordant to subconcordant.

Gneiss zones along the boundaries of the porphyritic granodiorite (unit JXg) locally include muscovite-rich gneiss (similar to unit JXms), diorite and diorite gneiss lenses. Contacts with the porphyritic granodiorite are typically gradational over 1-5 m; phenocrysts are deformed and recrystallized into thin quartzo-feldspathic layers and then obliterated across this boundary.

DESCRIPTION OF MINERAL DEPOSITS--Descriptions correspond to numbered locations on Plate 1.

1. Quartz-hematite vein with minor calcite. Approximately 30 cm thick with silicified border zone. Veinlets of reddish brown and orange iron oxides cut the quartz. Locally abundant pits containing iron oxides are interpreted as oxidized pyrite or chalcopyrite(?). Sparse malachite and dioptase(?) are present.
2. Quartz-hematite-manganese oxide vein. Drusy quartz with black spongy manganese oxides and dark brown to orange iron oxides. Vein strikes 146°, dips 62°SE, and forms margin of fine-grained andesite dike. The vein and associated alteration zone in the dike and adjacent wall rock thickens down hill to east. Sericite-silica alteration zone up to 1 to 2 m thick contains a network of quartz-iron oxide veinlets and local hematite after octahedral mineral (fluorite?, magnetite?). No copper minerals or relict sulfides were seen.
3. Mineralized shear zones. Shear zones containing fault gouge trend northwest, dip steeply to the southwest, and cut dacite(?) intrusion (composite dike). Thin mafic dikes intrude along shear zones. Hydrothermal minerals in shear zones include earthy iron and manganese oxides, cuprite(?), minor malachite and trace barite. Chlorite and sparse sericite form alteration zones around shear zones. Mafic dikes locally contains specular hematite-epidote alteration. Prospect is 20 foot deep pit.
4. Mine shaft in mafic dike. Fifteen-foot-thick chloritically altered mafic dike with veins of variably silicified earthy hematite along sheared contacts with porphyritic granodiorite. Drusy quartz and sparse malachite are present in open spaces, and disseminated malachite and chrysocolla are present in the hematite. Waste heap contains silicified and iron-stained dike and porphyritic granodiorite. Dike trends 141°, dips 70°NE. Shaft is approximately 50 feet deep. Numerous bulldozer cuts have been made along dike to southwest of shaft. Shaft shown on map about 300 feet northeast of this mine is unmineralized and is probably a water well.
5. Frenchman Mine. No mineralization recognized.
6. Many dikes in this area (more than shown on map). Weak to moderate sericitic alteration with numerous thin quartz-hematite veins characterizes porphyritic granodiorite in this area. Mine shaft not visited.

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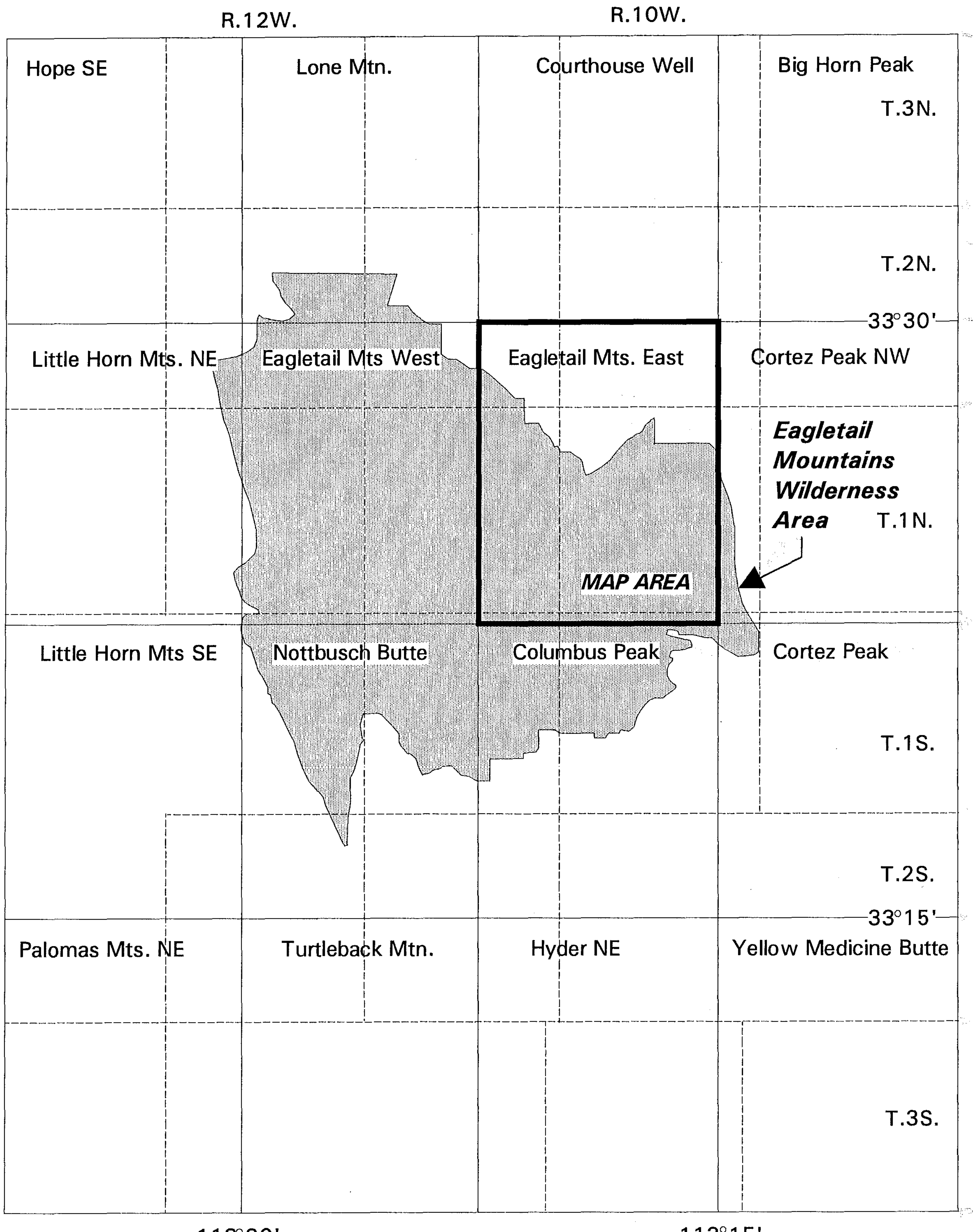

Figure 1. Location of map area.

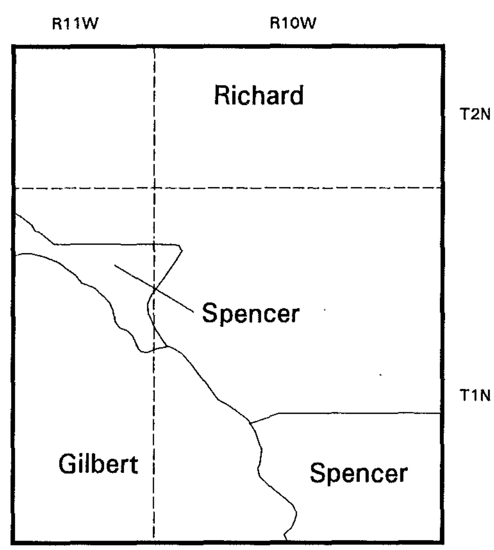

Figure 2. Respective areas mapped by authors

Figure 3
Correlation of Map Units

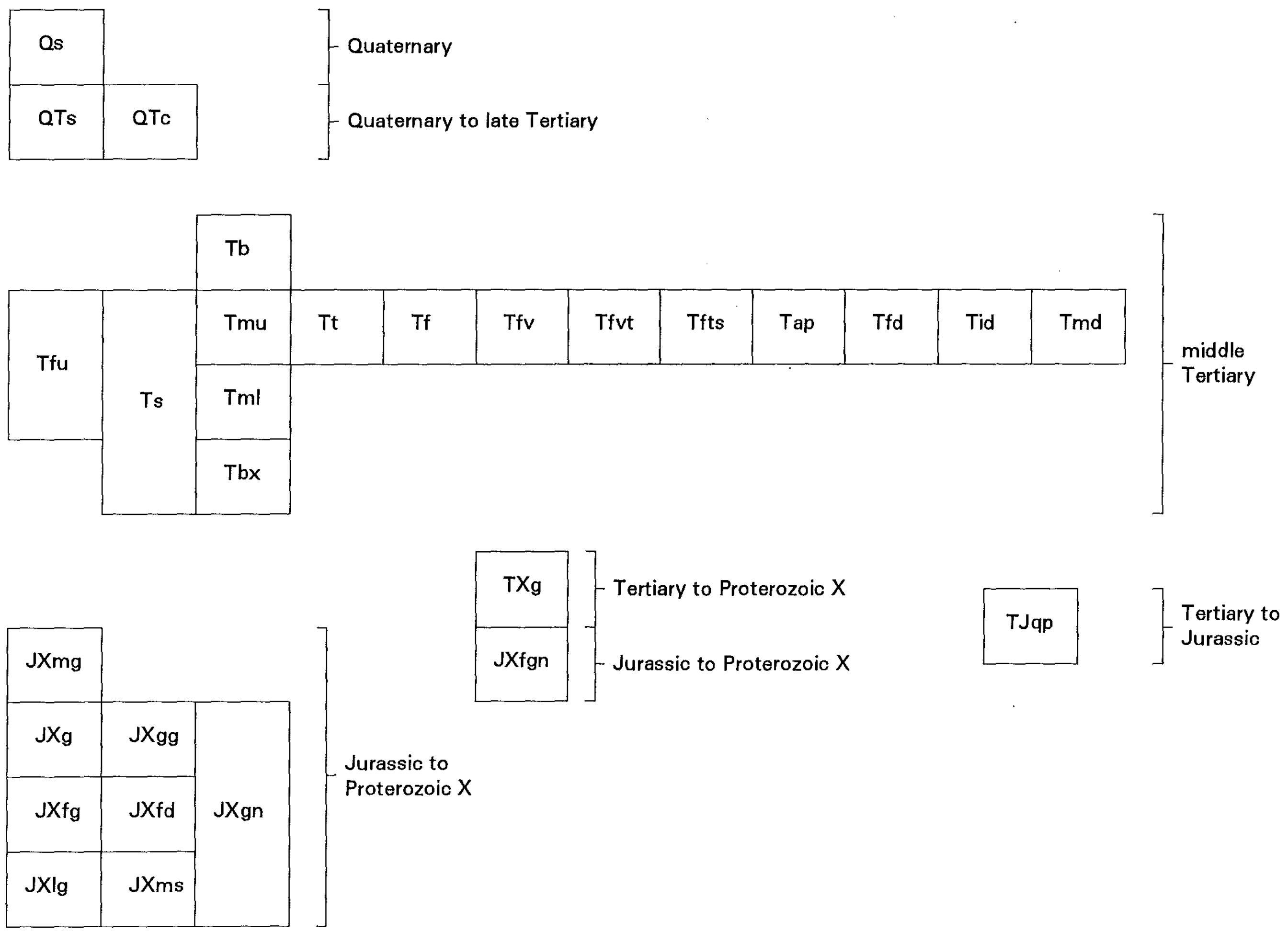

Table 1

MAP SYMBOLS

14

INTRUSIVE OR SEDIMENTARY CONTACT -- Arrow represents dip. Dashed where approximately located.

INTRA-UNIT CONTACT OR MARKER BED

65

FAULT -- Arrow represents dip. Dashed where approximately located, dotted where concealed.

ORIENTATION OF BEDDING, GNEISSIC LAYERING, AND FOLIATION -- Broken lines indicate approximate orientation. Wavy lines indicate curviplanar orientation.

BEDDING

HORIZONTAL BEDDING

GNEISSIC LAYERING

VERTICAL GNEISSIC LAYERING

VERY THIN GNEISSIC LAYERING -- Not clearly related to original mineralogical layering in protolith

FRACTURE CLEAVAGE

VERY WEAK MYLONITIC FOLIATION AND LINEATION

WEAK MYLONITIC FOLIATION AND LINEATION

MODERATE TO STRONG MYLONITIC FOLIATION -- Grain size reduction associated with fabric development

SECOND GENERATION WEAK MYLONITIC FOLIATION

LINEATION

FLOW OR FLATTENING FOLIATION AND LINEATION IN VOLCANIC ROCKS

VEINS AND ALTERATION

QUARTZ VEIN

PEGMATITE VEIN

HEMATITE STAINING AND SERICITIC ALTERATION