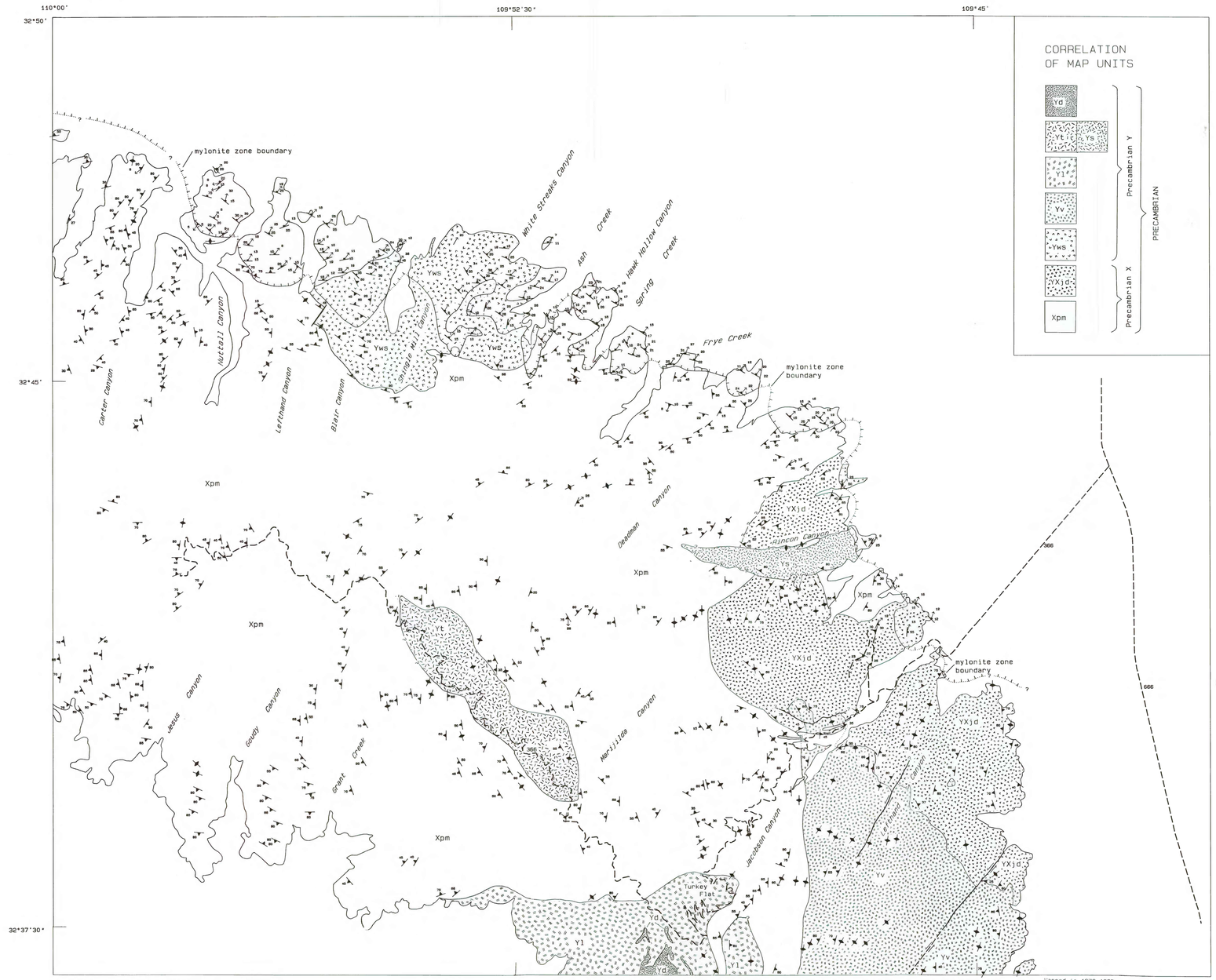
DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

OPEN FILE REPORT OF 87-0614
SHEET 1 of 1



Planimetric base from USGS Quadrangles
Thatcher, 1960, 1:62,500; Artesia, Gillespie, 1966,
Mt. Graham, Stockton Pass, Webb Peak, 1972, 1:24,000

SCALE 1:48,000
0 1 2 MILES

Mapped in 1979-1985
Map computer drafted by David Buscher

N

GENERALIZED BEDROCK GEOLOGIC MAP AND DISTRIBUTION OF MYLONITIC ROCKS IN THE EASTERN PINALENO MOUNTAINS, GRAHAM COUNTY, ARIZONA

By
C.H. Thorman and S.J. Naruk
1987

LOCATION MAP

DESCRIPTION OF MAP UNITS

Yd **Diabase (Middle Proterozoic)**--Diabase dikes and irregular-shaped bodies. Rocks composed of fine- to coarse-grained plagioclase (labradorite), clinopyroxene, and opaque minerals; clinopyroxene altered to chlorite, biotite, and hornblende

Ys **Granite of Slick Rock (Middle Proterozoic)**--Two-mica granite. Crosscuts foliation of gneiss of Pinaleno Mountains. Medium-grained rock with hypidiomorphic-granular texture, typically containing quartz (31%), microcline (27%), plagioclase An_{30} (35%), biotite (2%), muscovite (2%), epidote (2-3%), sphene (<0.5%), and trace amounts of zircon, apatite, and opaque minerals. Mafic minerals occur chiefly in clots

Yt **Granite of Treasure Park (Middle Proterozoic)**--Porphyritic two-mica granite. Massive to weakly foliated, medium-grained porphyritic rock with hypidiomorphic-granular texture. Typical mineral assemblage is quartz-microcline-saussuritized plagioclase-chloritized biotite-muscovite-epidote with trace amounts of zircon, sphene, apatite, and opaque minerals. Rock is typically moderately to deeply weathered in contrast to fresh country rock

Yl **Granite of Ladybug Saddle (Middle Proterozoic)**--Porphyritic biotite granite. Massive to weakly foliated pluton that crosscuts foliation of gneiss of Pinaleno Mountains; the crystalloblastic foliation in the pluton is subparallel to foliation in the gneiss. Rocks are medium- to coarse-grained with hypidiomorphic-granular texture and microcline phenocrysts. Typical rock includes quartz (27-35%), microcline (24-26%), plagioclase An_{30-34} (35%), biotite (4-12%), sphene (1-1.5%), epidote (1-2%), and trace amounts of zircon, apatite, allanite, and opaque minerals. Mafic minerals occur primarily in clots. Xenoliths and schlieren present mainly along margin, where they are oriented parallel to foliation in country rock

Yv **Granite of Veach Ridge (Middle Proterozoic)**--Biotite granite. Massive to weakly foliated pluton that crosscuts foliation of the gneiss of Pinaleno Mountians; crystalloblastic foliation of the pluton is subparallel to foliation in the gneiss. Rocks are medium- to coarse-grained with hypidiomorphic-granular texture. Typical rock includes quartz, microcline, plagioclase, biotite (1-15%), and epidote with trace amounts of sphene, allanite, zircon, apatite, and opaque minerals. Xenoliths, 0.5 to 100 m across by 1 to 300 m long, of gneiss of Pinaleno Mountains are scattered throughout pluton and are aligned parallel to foliation in the country rock

Yws **Granodiorite of White Streaks Canyon (Middle Proterozoic)**--Biotite-hornblende granite to granodiorite. Massive to moderately foliated, fine- to medium-grained pluton that both crosscuts and is parallel to foliation of gneiss of Pinaleno Mountains. Pluton ranges in composition from diorite to aplite, but is dominately granodiorite to granite. Dominant lithologies are: (1) hornblende-biotite granodiorite contains quartz (21-30%), plagioclase (33-53%), potassium feldspar (9-18%), biotite (4-18%), horablende (0.5-4%), epidote (0.2-11%), sphene (0.3-1.5%), muscovite (0.1-1.1%), and chlorite, apatite, zircon and opaque minerals in trace amounts; and (2) biotite granite contains quartz (27-35%), plagioclase (0-4.5%), potassium feldspar (21-30%), biotite (0.3-5%), epidote (0.2-0.7%), muscovite (0.1-1.5%), and hornblende, chlorite, apatite, zircon, and opaque minerals in trace amounts. The two lithologies are distinguished primarily on the abundance of hornblende

YXjd **Gneiss of Johns Dam (Early to Middle? Proterozoic)**--Intercalated granitic gneiss and gneiss of Pinaleno Mountains. Granitic gneiss is medium-grained biotite-rich rock with coarse- to very coarse-grained microcline phenocrysts, having augen texture where rock is foliated. This rock intruded finer grained gneiss of Pinaleno Mountains; individual units are as much as 50 m thick, giving pronounced banded appearance on aerial photographs. Typical granitic gneiss mineral assemblage is quartz-microcline-plagioclase (An_{20-50})-biotite-epidote-sphene

Xpm **Gneiss of Pinaleno Mountains (Proterozoic)**--Compositionally layered felsic, leucocratic gneiss and minor amphibolite that underlies most of the Pinaleno Mountains and is the oldest unit in the range. The rocks are fine to medium grained and include the following mineral assemblages: quartz-microcline-plagioclase-biotite gneiss; quartz-plagioclase-biotite gneiss; quartz-plagioclase-microcline-muscovite gneiss; quartz-two mica-plagioclase-microcline gneiss; plagioclase-hornblende gneiss; and muscovite-bearing quartzite. Foliation defined by compositional banding or layering, aligned disseminated mafic minerals, and elongation of normally equant or stubby minerals. Excellent exposures along Arizona State Highway 366 from Swift Trail Junction, seven miles south of Safford, Arizona, to the crest of the range

Contact

Fault--Arrows show direction of relative movement

Limit of mylonitic rock--Hachures on mylonite side of contact. Solid line in bedrock, dotted line where projected beneath Cenozoic valley fill

Strike and dip of foliation

Inclined crystalloblastic foliation

Vertical crystalloblastic foliation

Inclined mylonitic foliation

Bearing and plunge of lineation

Inclined lineation, showing plunge

Inclined lineation with strike and dip of mylonitic foliation, showing plunge of lineation

366 Arizona state highway

GEOLOGY

The Pinaleno Mountains, commonly referred to as the Graham Mountains, are underlain by Precambrian rocks ranging in age from 1,700 to 1,100 Ma, including gneisses probably of sedimentary and volcanic origin, synorogenic to anorogenic granite plutons, metarhyolite dikes, and diabase bodies (Thorman, 1981). A widespread and major orogenic event about 1,400-1,650 Ma accounted for the regional synkinematic metamorphism of the gneiss of Pinaleno Mountains. Plutonic activity ranged from synorogenic to postorogenic or anorogenic, based on structural and field relationships. Swan (1976) dated the granite of Veach Ridge as 1,363 ± 14 Ma and the granite of Ladybug Saddle as 1,384 ± 39 Ma based on whole rock Rb-Sr analyses. The other granite plutons have not been dated, but are thought to be of the same general age because of their similar compositions and field relations. Their relative ages, as shown on the correlation of map units, is based on relative degree of crystalloblastic foliation and the intrusive crosscutting relationships of the plutons with the gneiss of Pinaleno Mountains. The granodiorite of White Streaks Canyon is considered to be older than the granite plutons because it is more mafic and displays a very wide range in chemical composition, whereas the granitic plutons are very uniform compositionally, both as a group and individually.

The purpose of this map is to show the distribution of mylonitic rocks that occur on the northern flank of the range. The bulk of the geology of the range was mapped by Thorman. Naruk mapped much of the mylonitic terrane and some of the underlying undeformed bedrock along part of the range front (Naruk, 1986) and subsequently has done additional work on the mylonites (Naruk, 1987). Thorman originally suggested that the mylonitic fabric was the result of late Mesozoic to early Tertiary deformation, but has retreated from this position and is in agreement with Naruk (1986, 1987) that the mylonites probably formed during mid-Tertiary extensional faulting.

A northwest-striking, northeast-dipping zone of S-C mylonites, derived from gneisses of Pinaleno Mountains and Johns Dam and the granites of White Streaks Canyon and Slick Rock, is present along the foot of the range. The lower boundary of the mylonitic rocks is shown by a hachured line and the mylonitic foliations and lineations are shown with a separate symbol to distinguish them from crystalloblastic foliation in the main part of the range. The mylonites are pervasively foliated and lineated, and range from protomylonites to ultramylonites in degree of deformation and grain-size reduction. Foliation surfaces (S-surfaces) are a pervasive planar fabric defined by the alignment of quartz ribbons, feldspar ribbons, mica ribbons, and the long dimensions of feldspar porphyroclasts. The C-surfaces are a spaced planar fabric defined by systematic alignments of the ends, or tails, of sigmoidally-shaped and retort-shaped porphyroclasts and ribbons. Lineations are streaky mineral lineations defined by the linear alignment of extremely elongate quartz ribbons and mica and feldspar porphyroclasts on both the S- and C-surfaces. In the least-deformed mylonites, quartz exhibits undulatory extinction and only limited subgrain development. Quartz defines a mortar texture interstitial to feldspar grains, and is present as limited ribbons with core-and-mantle textures. In the more deformed mylonites, quartz occurs entirely as elongate ribbons composed of oblique subgrains. Plagioclase and microcline occurs as micron- to centimeter-scale fractured porphyroclasts. In fine-grained rocks, laminae of micron-size feldspar porphyroclasts define feldspar ribbons. In coarse-grained rocks, centimeter-size feldspar porphyroclasts define augen textures.

REFERENCES

Naruk, S.J., 1986, Strain and displacement across the Pinaleno Mountains shear zone, Arizona, USA: Journal of Structural Geology, v. 8, p. 35-46.
_____1987, Displacement calculations across a metamorphic core complex mylonite zone: Pinaleno Mountains, southeastern Arizona: Geology, v. 15, p. 656-660.
Swan, M.M., 1976, The Stockton Pass fault: an element of the Texas lineament: University of Arizona, Tucson, unpublished M.S. thesis, 119 p.
Thorman, C.H., 1981, Geology of the Pinaleno Mountains, Arizona: a preliminary report: Arizona Geological Society Digest, v. 13, p. 5-12.