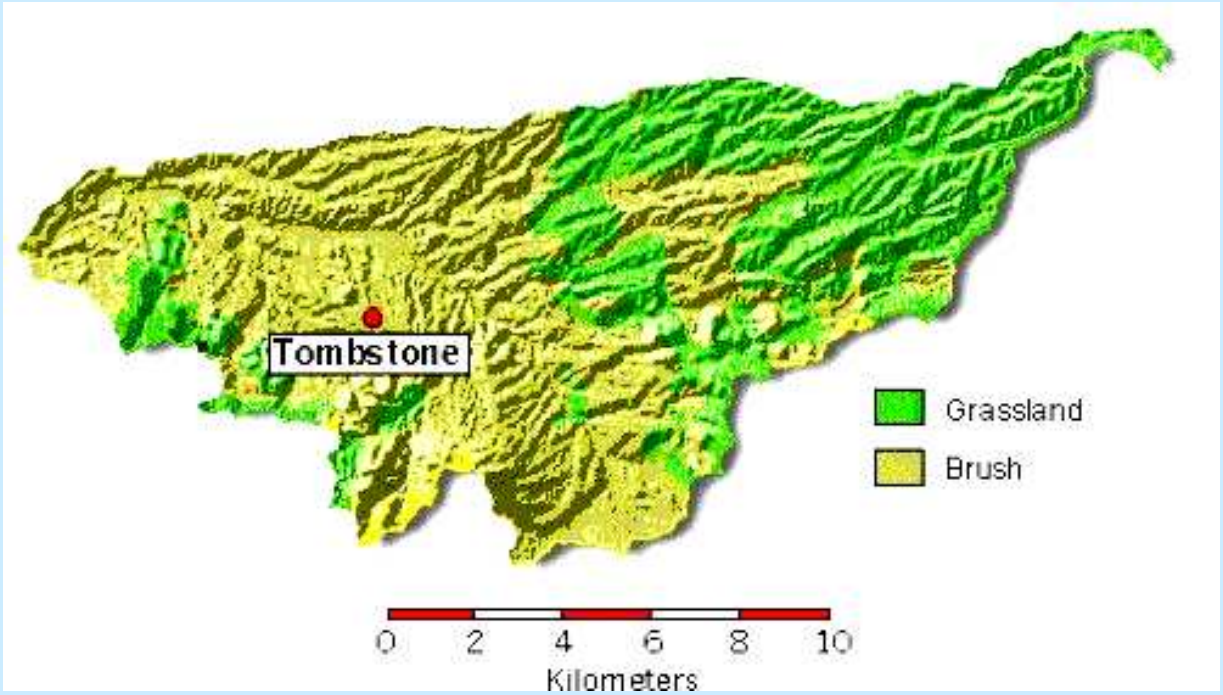
A SYNOPSIS OF GEOLOGIC AND GEOMORPHIC STUDIES IN THE WALNUT GULCH WATERSHED, SOUTHEAST ARIZONA

PURPOSES:

To summarize geologic and geomorphic knowledge of the Walnut Gulch area, Arizona, and to aid other watershed studies.

To review the geologic history of the Walnut Gulch area as a means of understanding large- and small-scale landforms.

Walnut Gulch Experimental Watershed, Tombstone, Arizona



USDA ARS
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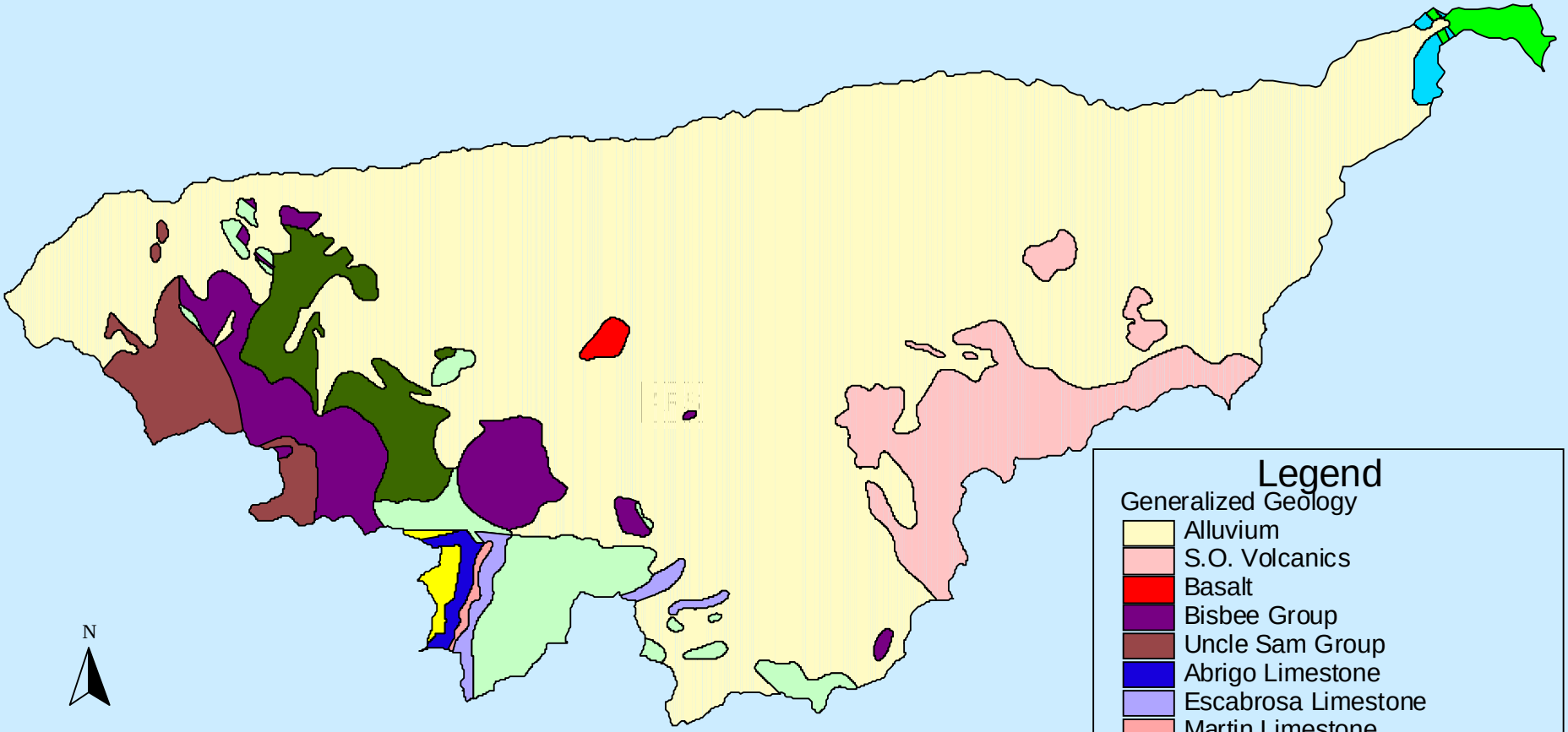
SUMMARY OF ROCK UNITS, WALNUT GULCH WATERSHED

1. Granitic Precambrian basement rocks (> 1450 M yrs), mostly covered by younger rocks
2. Paleozoic carbonate and clastic rocks (540-250 M yrs), mostly in the Tombstone Hills
3. Clastic beds of the late-Jurassic to early-Cretaceous Bisbee Group (165-100 M yrs)
4. Igneous-intrusive and volcanic rocks of Mesozoic and Cenozoic age (< 165 M yrs)
5. Conglomerates (Emerald Gulch and Gleeson Road) and alluvium, mid-Cenozoic to Recent age

Generalized Geology

Walnut Gulch Basin



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2 0 2 4 6 Kilometers

Legend

Generalized Geology

- Alluvium
- S.O. Volcanics
- Basalt
- Bisbee Group
- Uncle Sam Group
- Abrigo Limestone
- Escabrosa Limestone
- Martin Limestone
- Naco Limestone
- Gneissic Granite
- Bolsa Quartzite
- Schieffelin Granodiorite
- Gleeson Quartz Monzonite

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PRECAMBRIAN BASEMENT ROCKS (> 1450 M yrs) are exposed in the Walnut Gulch Watershed only by a gneissic granite at a headwaters area of the Dragoon Mountains. Subsurface data show, however, that these covered rocks were faulted, folded, and intruded in late-Precambrian time; movement along the faults has occurred episodically since then.

PALEOZOIC CARBONATE AND CLASTIC ROCKS (540-250 M yrs) are exposed mostly in and near the Tombstone Hills.

Bisbee Group (165-100 M yrs) is mostly clastic beds ranging from conglomerate to mudstone that overlie Paleozoic rocks of the Tombstone Hills.

Igneous-intrusive and volcanic rocks of Mesozoic and Cenozoic age

Uncle Sam Porphyry

Schieffelin Granodiorite

S O Volcanics

Conglomerates and Alluvial Deposits

Emerald Gulch Conglomerate

Gleeson Road Conglomerate

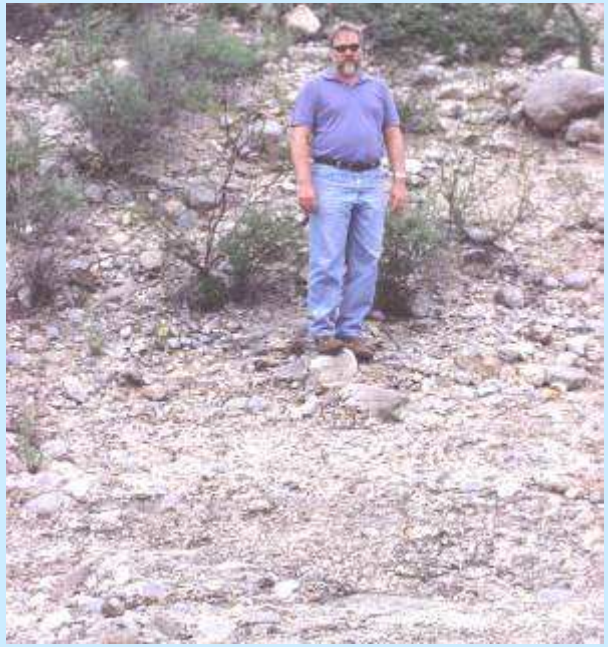
Jones Ranch Alluvium

- **cienega deposits**
- **terrace deposits**
- **mid-Holocene fan deposits**

Holocene alluvium

- **Recent swamp deposits**
- **Recent flood-plain, bar, &channel deposits**

EMERALD GULCH CONGLOMERATE (55–20 M yrs) is well cemented, disturbed, and mostly exposed along channels.



GLEESON ROAD CONGLOMERATE (5-0.1 M yrs) has poorly cemented beds that are tilted to various degrees and are commonly deformed by fractures and faults in underlying rocks.

ALLUVIUM (mid-Holocene to Recent): sediment of cienegas, terraces, flood plains, and stream channels

PHYSIOGRAPHY AND LARGE-SCALE GEOMORPHIC (LANDSCAPE) FEATURES

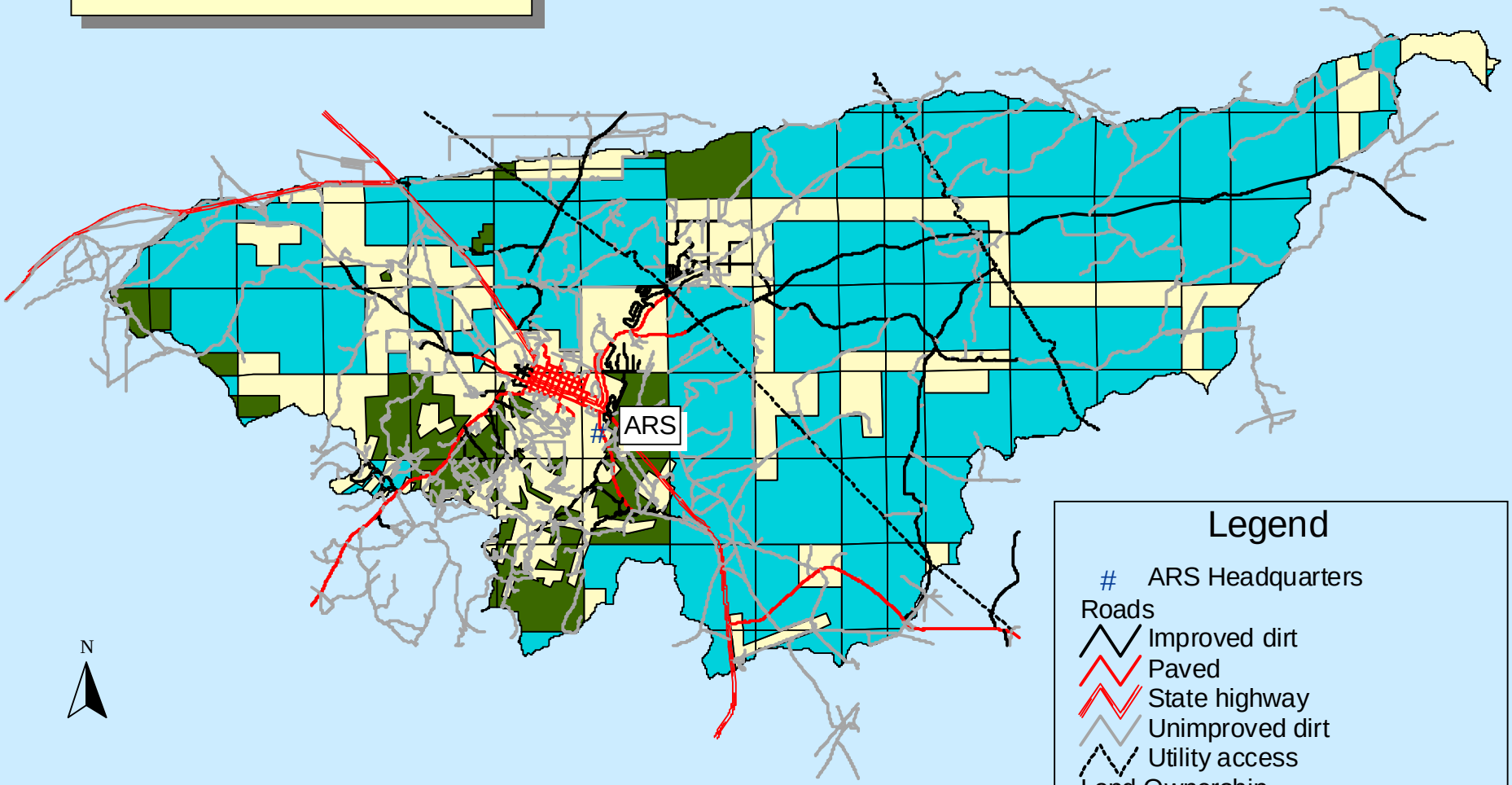
Basin and Range Physiographic Province – an effect of regional fault patterns

Tombstone Hills – a result of regional overthrust faulting of Paleozoic and Mesozoic rocks

Emplacement and erosion of igneous rocks – Uncle Sam Porphyry, Schieffelin Granodiorite, S O Volcanics

Development of erosion surfaces – Tombstone surface; Whetstone Pediment

Cultural Features



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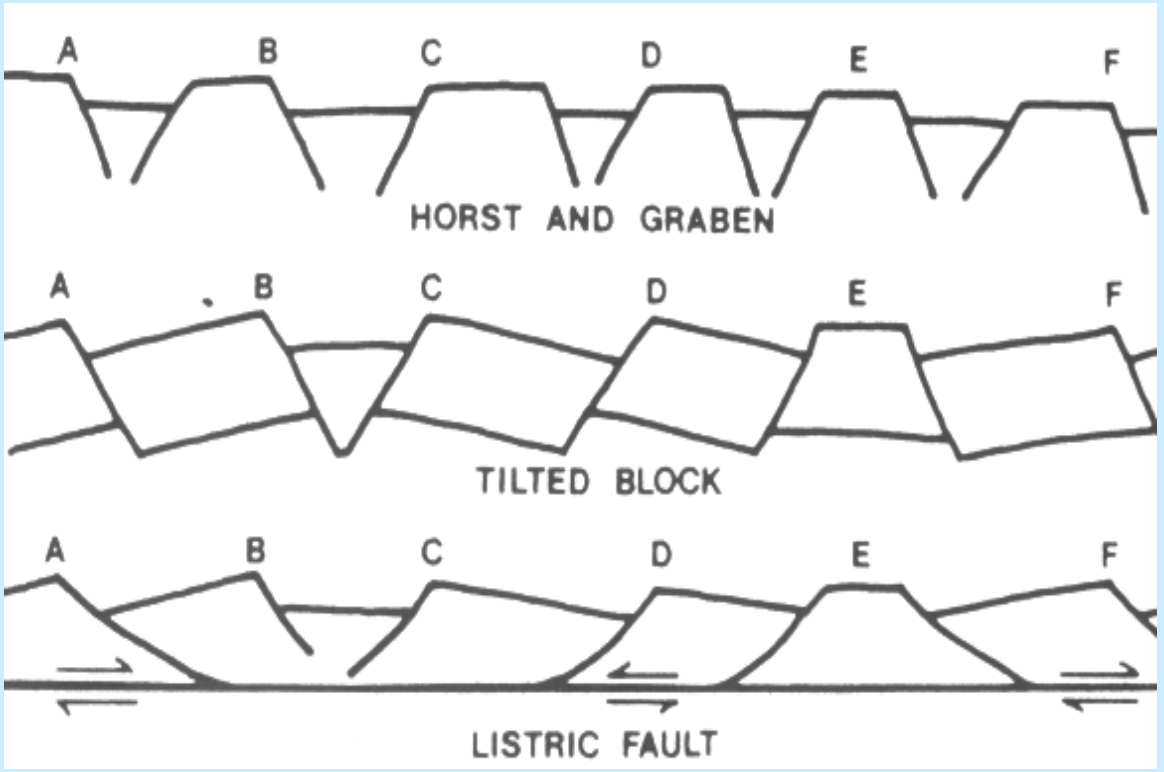
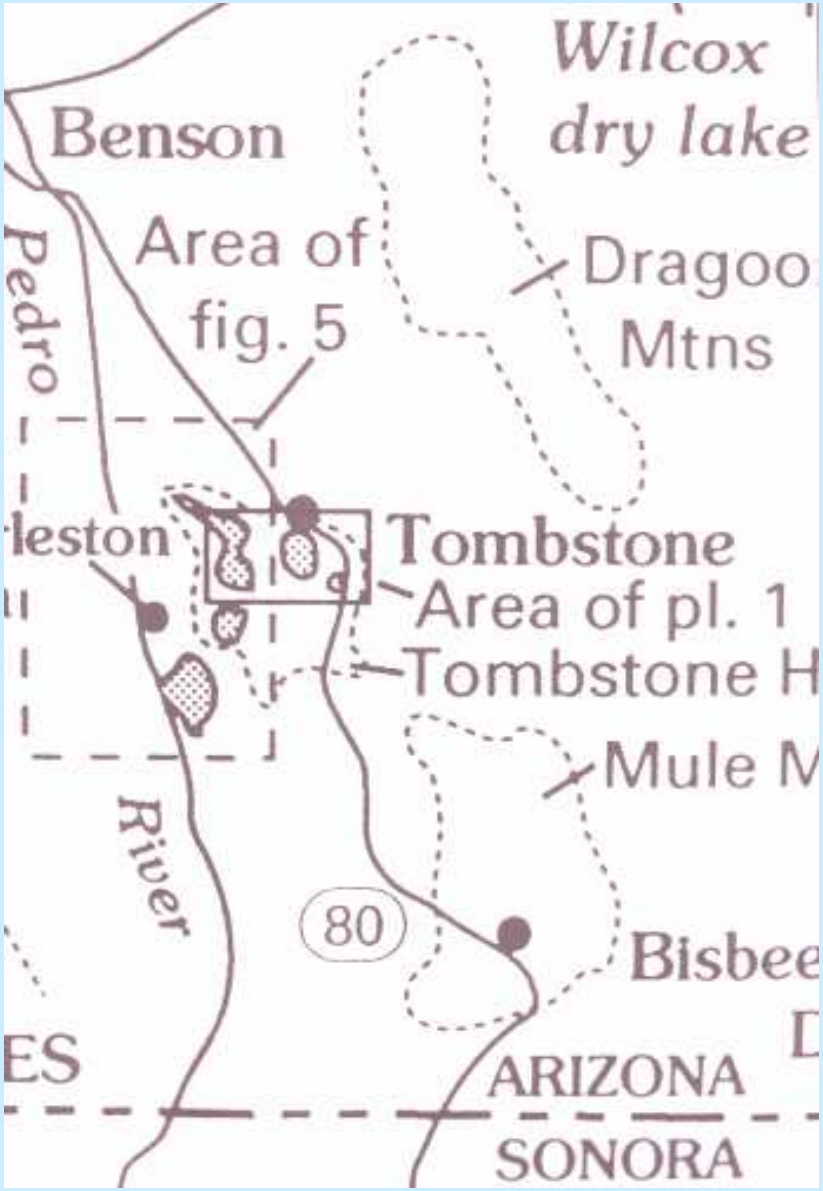
BASIN AND RANGE PROVINCE





TOMBSTONE HILLS

(map from Force, 1996)

Exposure of Igneous Rocks Emplaced during Periods of Faulting and Folding

Uncle Sam Porphyry

Schieffelin Granodiorite

S O Volcanics

Development of Erosion Surfaces

Tombstone Surface

Whetstone Pediment

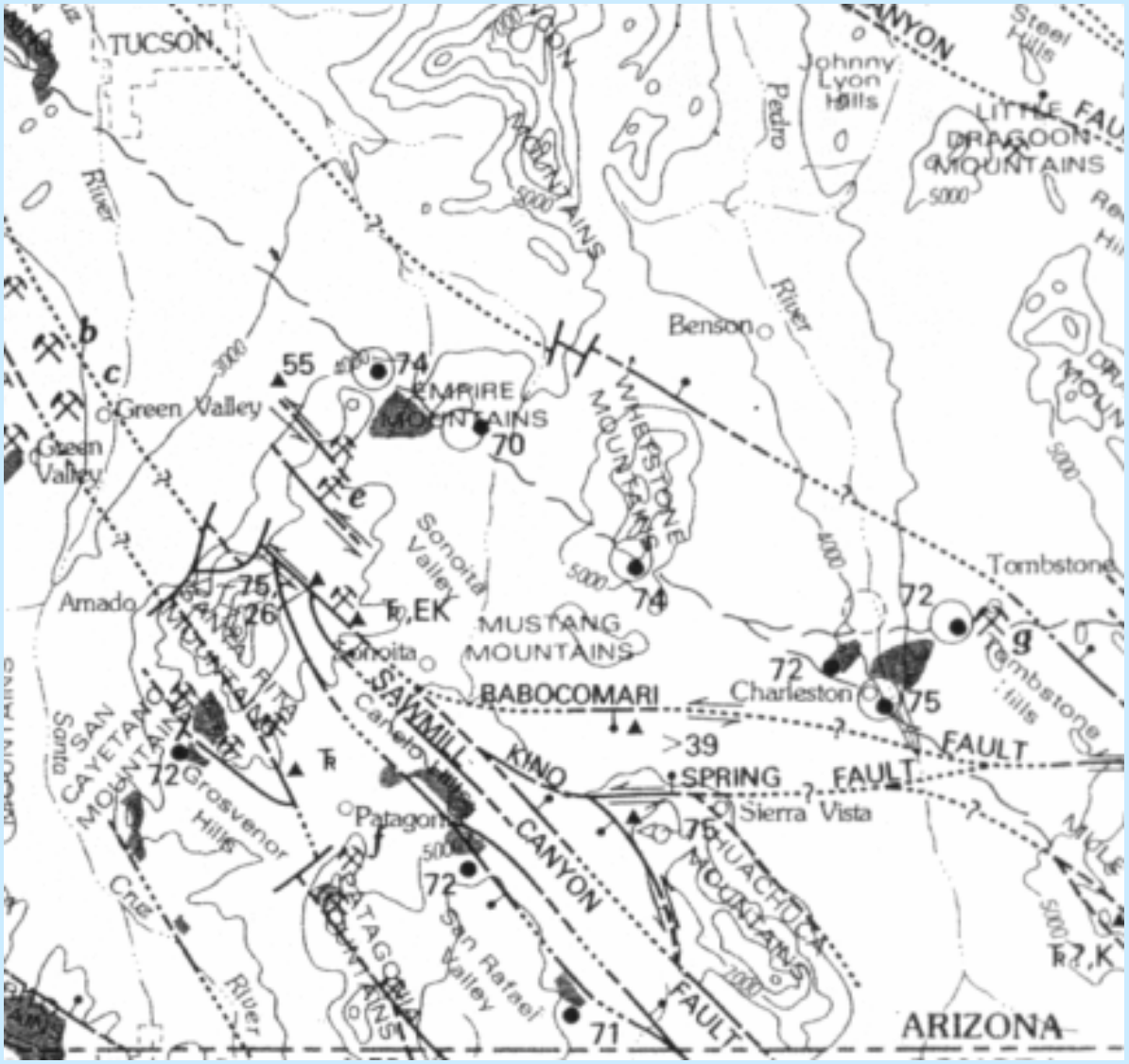
SUMMARY OF TECTONIC EVENTS IN SE ARIZONA

1. Precambrian (~ 1600 M yrs BP) faulting, folding, and granitic intrusions
2. Mesozoic (250-120 M yrs BP) block faulting by compressional deformation; igneous intrusions
3. Late-Cretaceous (65 M yrs BP) overthrust faulting **(of primary importance!)**
4. Mid-Tertiary (~55 M yrs BP) to recent tensional Basin and Range block faulting

MOST TECTONISM OF SOUTHEASTERN ARIZONA IS EXHIBITED BY FAULTS

1. Precambrian high-angle shears oriented NW to SE (passes east edge of Tombstone)
2. Mesozoic compressional block faulting and very low-angle overthrust faulting
3. Tertiary-age extensional normal faults forming Basin and Range mountain blocks

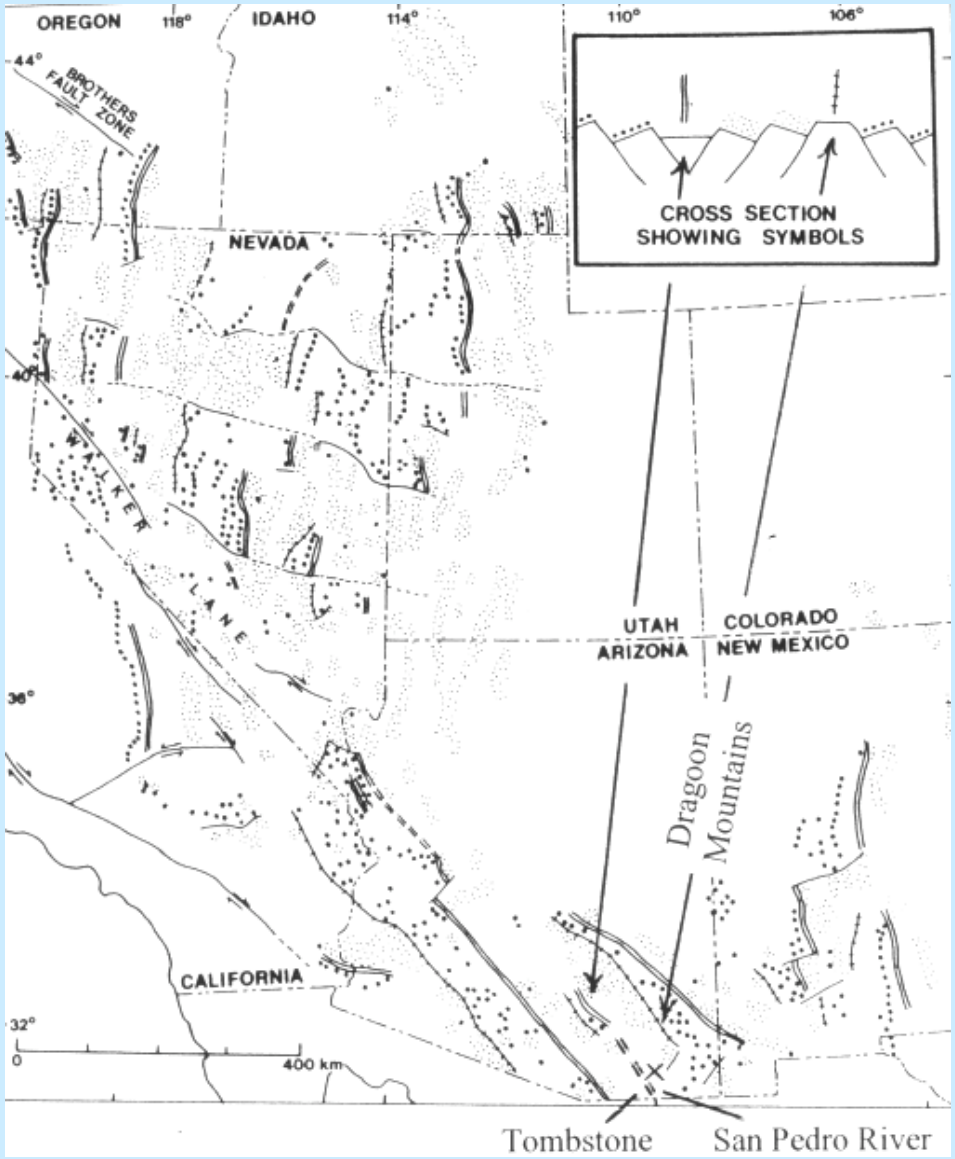
Complex of Precambrian faults, southeastern Arizona. The fault trending NW from near Tombstone to Tucson, passes through the Walnut Gulch watershed.



(from Drewes, 1981)

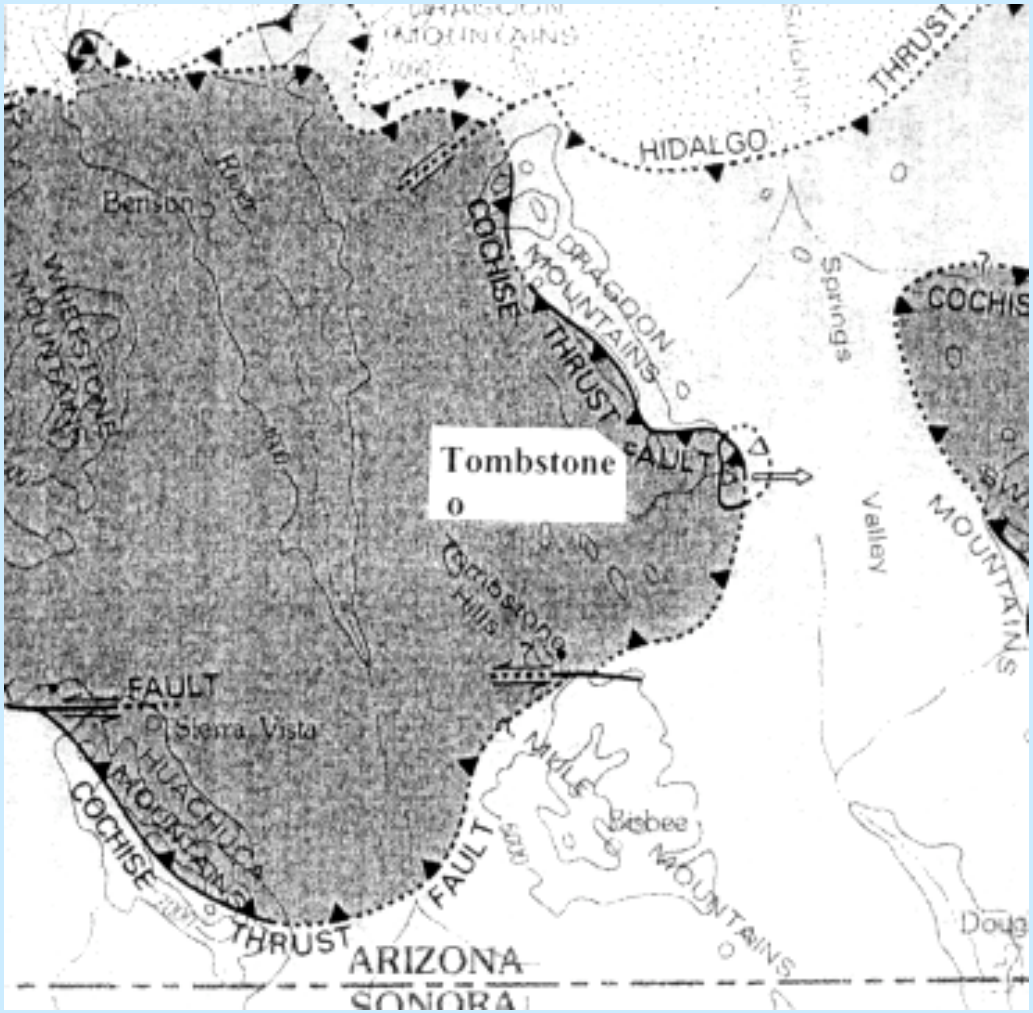
MESOZOIC FAULT REACTIVATION AND HIGH-ANGLE COMPRESSIONAL BLOCK FAULTING

(from Stewart, 1980)



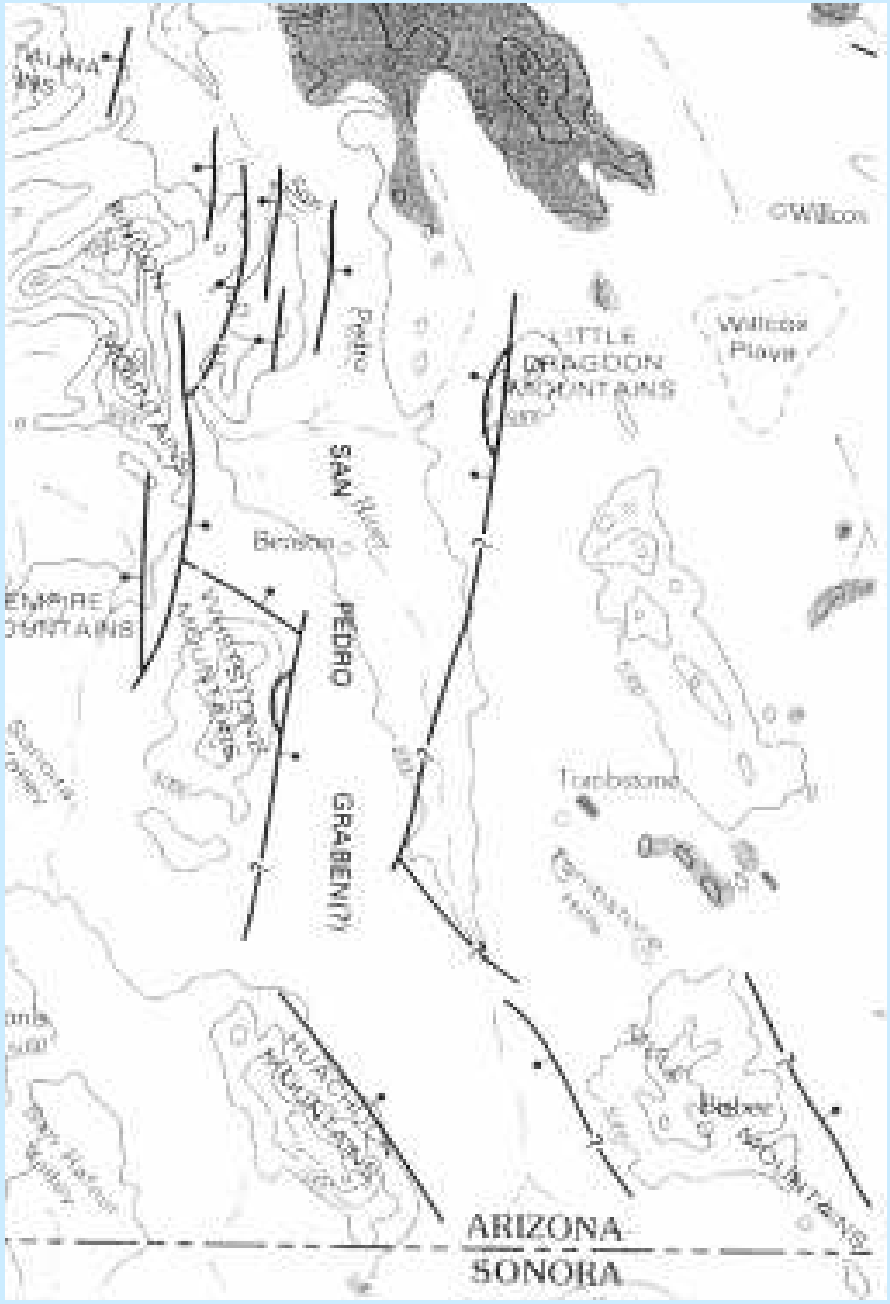
LATE-CRETACEOUS (MESOZOIC) LOW-ANGLE OVERTHRUST FAULTING

(from Drewes, 1981)



TERTIARY EXTENSIONAL NORMAL FAULTING FORMING PRESENT BASIN AND RANGE FEATURES

(from Drewes, 1981)



RECAP OF GEOLOGIC AND GEOMORPHIC DYNAMICS, SOUTHEASTERN ARIZONA

Faulting and folding of Precambrian granitic rocks, accompanied by intrusion of coarse-grained igneous rocks (1700 - 1450 M yrs BP)

Relative stability, erosion, and marine transgression, resulting in deposition of Paleozoic clastic and carbonate rocks (1450 - 250 M yrs BP)

Marine regression, compressional block faulting, and igneous intrusions (250 - 120 M yrs BP); the faulting caused increased relief, erosion, and initial deposition of the Bisbee Group (165 - 100 M yrs BP)

Late-Cretaceous overthrust faulting, moving large slabs of Paleozoic and Mesozoic rocks northeastward into and over the Walnut Gulch watershed (~ 65 M yrs BP)

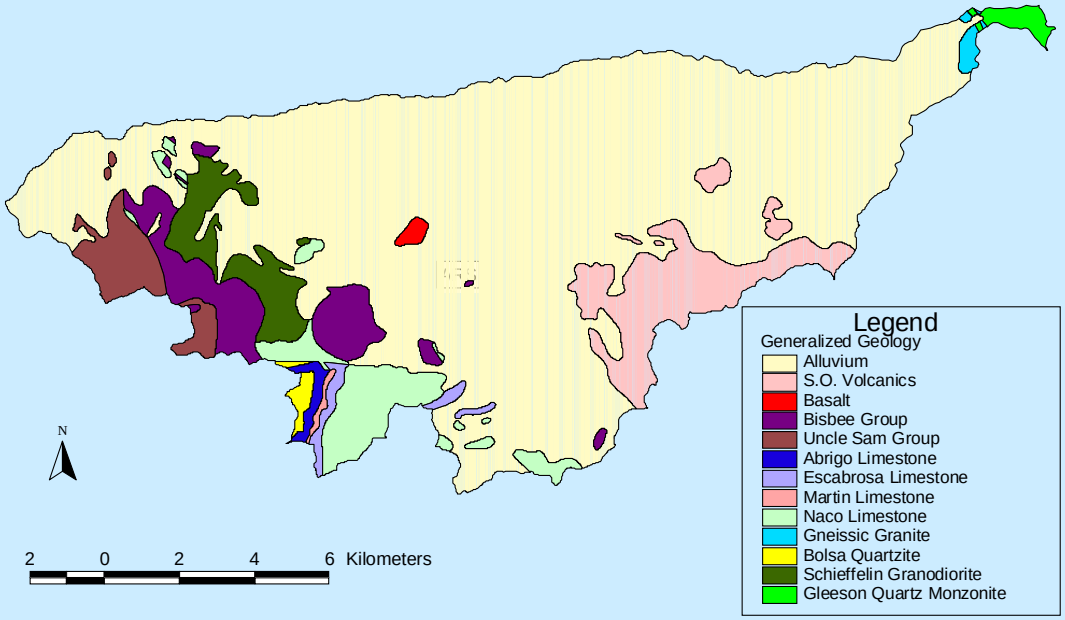
Tensional high-angle normal faulting and igneous activity, causing modern Basin and Range physiography, erosion of elevated mountain blocks, and deposition of Emerald Gulch Conglomerate (55 - 20 M yrs BP)

Reduced but continuing tectonic activity, resulting in disturbance of Emerald Gulch beds and minor erosion and deposition (20 - 5 M yrs BP)

Renewed extensional block faulting, resulting in erosion and deposition of Gleeson Road Conglomerate, followed by epeirogenic uplift (important!), tilting of Gleeson Road beds, and stream incision of erosion surfaces (5 - 0.1 M yrs BP)

Continuing incision by San Pedro River and its tributaries, and deposition of Recent alluvial deposits

Generalized Geology



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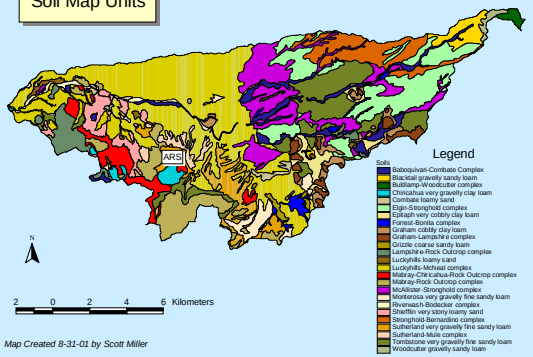
Soil Map Units



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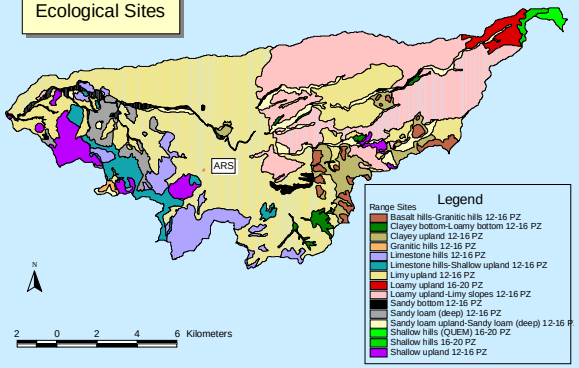
Ecological Sites



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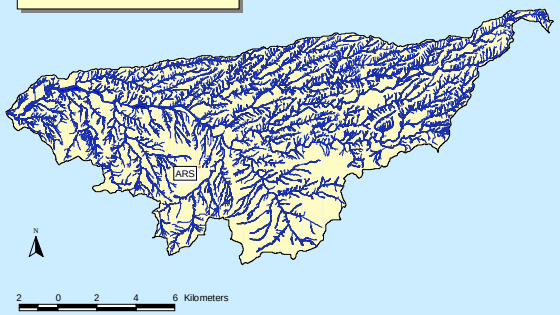
Without knowledge of geologic history, rock exposures are not understood; with knowledge of geology, soils, ecology, and drainage network become understandable.

Stream Channel Network



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