ARIZONA GEOLOGICAL SURVEY
Contributed Map 04-B
Varga, 2001, Grasshopper Junction SE

GEOLOGIC MAP OF THE GRASSHOPPER JUNCTION SE 7½' QUADRANGLE, MOHAVE COUNTY, ARIZONA

by Robert J. Varga

Arizona Geological Survey Contributed Map 04-B
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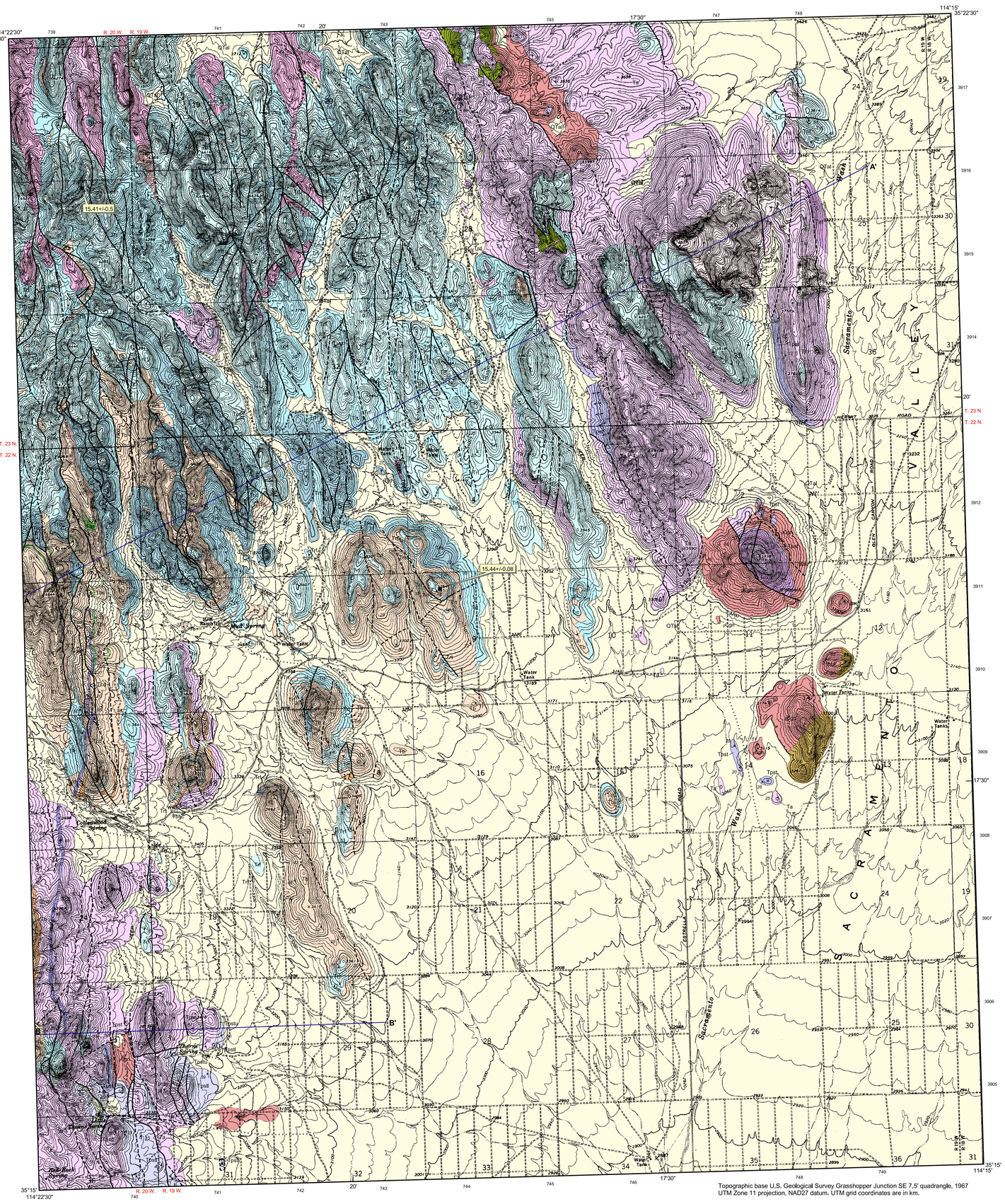


Topographic base U.S. Geological Survey Grasshopper Junction SE 7.5' quadrangle, 1967
UTM Zone 11 projection, NAD27 datum. UTM grid coordinates are in km.

Explanation

Contacts, Faults & Folds

geologic contact: solid where accurate, dashed where approximate, dotted where concealed by alluvium.

normal fault: solid where accurate, dashed where approximate, dotted where concealed by alluvium. Bar-and-ball symbol shows dip direction. Dip magnitude and slickenline trend shown where measured. Opposing arrows show strike-slip component of fault throw along oblique-normal faults.

thin (<1 m) basalt dike

local anticline produced by drag along faults

local syncline produced by drag along faults

Structure Symbols

volcanic flow foliation with dip magnitude

vertical volcanic flow foliation

sedimentary bedding with dip magnitude

gneissic foliation with dip magnitude

Volcanic & Sedimentary Rocks

Non-consolidated to moderately consolidated surficial deposits (Late Pleistocene(?)-Holocene).

QTal QTal--includes unconsolidated surficial clastic deposits of probable Holocene age comprising material of silt, sand and gravel size deposited within active washes. Generally erosionally inset into older, partially lithified alluvial fan material. Also includes probable Late Pleistocene to Holocene, unconsolidated to weakly consolidated alluvial fan and colluvial deposits comprising material of silt, sand and gravel size. Well-exposed within the steep, erosional faces of modern washes. Dominated by poorly sorted, clast-supported fluvial conglomerate with subrounded to angular clasts of locally derived Tertiary and older rock units.

Olivine basalt sequence (middle Miocene)

This unit comprises the uppermost part of the Tertiary section in the Grasshopper Junction area. The upper part of the unit is dominated by a thick (~1 km minimum thickness as top of unit not exposed) stack of 1-2 m thick, olivine-phyric basalt lava flows and rare basalt pyroclastic deposits. Within its lower part, the unit is interbedded with the Tuff of Bridge Spring (Tbs), arkosic sandstone and conglomerate (Tbsc), and local rhyolite dome/lava flows (Trf). The base of the unit is gradational into the underlying rhyolite sequence (Trf). Tb in the Grasshopper Junction SE Quadrangle is constrained by a 15.3 Ma age on a rhyolite flow within the basal, transitional part of the section and an age of 15.1 Ma on a basalt near the top of the exposed section (Varga et al., 1998). Tb is synextensional where exposed within the western limb of the Grasshopper Junction anticline. Fanning of dips in an area immediately to the east of the quadrangle shows that tilting began at about the time of deposition of the Tuff of Bridge Spring at ~15.2 Ma (dips of about 30°) and was still active at 15.1 Ma (basalt dips of ~15°). Tb is regionally equivalent to the Mount Davis Volcanics as defined by Anderson (1971).

Tb Tb--dark-medium gray and dark brown to brownish red lava flows, flow breccia and lesser amounts of scoriaceous pyroclastic material of basalt-trachyandesite composition best exposed in the western part of the area near Cottonwood Spring. Typical basalt lava flows contain 10-20% phenocrysts with olivine>/=plagioclase>pyroxene; some intermediate flows contain biotite. Numerous basalt-composition dikes (Tbd) that cut the Grasshopper Junction area are probably related to this unit. A cinder cone within this unit is well-exposed in the hangingwall of the Mud Spring fault near Mud Spring.

Tbsc Tbsc--layered, red-orange to orange colored, medium to coarse grained sandstone, matrix-supported conglomerate and minor siltstone. Unit contains channels cut into underlying volcanic units. Conglomerate contains clasts of Precambrian crystalline rocks, the Peach Springs Tuff and intermediate volcanics from the lower andesite sequence up to 3/4 m in diameter. Some fine-grained layers contain ripple marks. Thickness varies markedly from 0 to over 7 m where concentrated in large channels. Tbsc lies stratigraphically near the base of the olivine basalt sequence and indicates the emergence of considerable topography and exposure of older units probably as the result of extension.

Tuff of Bridge Spring (middle Miocene)

Tbs Tbs--distinctive gray to cream-colored unwelded to moderately welded tuff contained within the lower part of the olivine basalt sequence and correlated to Tuff of Bridge Spring of Anderson (1971). In the map area and immediately to the east, unit varies in thickness between 0-3 m, with ~0.5 m of basal, unwelded tuff with abundant scoriacous, mafic volcanic lithic fragments overlain by moderately welded tuff with medium gray colored pumice. Welded tuff carries approximately 15% phenocrysts of principally sanidine, up to 5 mm in length, and biotite. The unit has a reversed magnetic polarity and age (Varga et al., 1998) compatible with the 15.2 Ma Tuff of Bridge Spings in its type area (J. Faulds, personal communication, 1996). The source of the Tuff of Bridge Spring is believed to be from a caldera in the northern Eldorado Mountains (Gans et al., 1994).

Rhyolite volcanic sequence (middle Miocene)

An extensive section of rhyolite lava flows, obsidian flows and pyroclastic units generally correlated regionally to the middle part of the Patsy Mine volcanics of Anderson (1971) and the Volcanics of Red Gap Mine (Faulds, 1993). This unit is transitional in its upper part with the overlying olivine basalt sequence. This is manifest by an interlayering of thin, olivine basalt (Tb) layers with rhyolite-composition layers. The northern half of map area represents the concentration of volcanic centers related to the rhyolite volcanic sequence. Evidence for this are exposed exogenous domes, numerous rhyolite dikes of composition similar to the felsic volcanic sequence and the dramatic change in thickness of this unit; The sequence is about 1.5 km thick in the central part of the map area and thins to 1-2 m of pyroclastic material in areas to the south, near Little Thorne Spring (compare cross sections A-A' and B-B'). The age of the rhyolite volcanic sequence is bracketed by a 16.35 Ma age on the Highway tuff that occurs near the base of the section in eastern exposures and a 15.4 Ma age of a rhyolite flow interbedded with olivine basalt flows in the transition sequence with the olivine basalt sequence (Varga et al., 1998). Fanning of east dips within exposures along the northern part of the map area indicate that, at least locally, the east tilting and formation of the eastern limb of the Grasshopper Junction anticline began during eruption of the rhyolite volcanic sequence. As much as 20° of tilting occurred after the 16.3 Ma Highway tuff and prior to a 15.46 Ma-old rhyolite flow.

Trf Trf--dominantly light grey to pink rhyolite lava flows and lesser amounts of obsidian and rhyolite pyroclastic layers. The lava flows are generally sparsely phyric containing 5-20% phenocrysts comprising plagioclase>biotite+/-sanidine+/-clinopyroxene+/-quartz. The flows are typically linsested on their exposed and weathered surfaces and flow folds are common. The bases of individual flows within this unit contain obsidian.

Tro Tro--dark-gray to black-colored, commonly flow-folded obsidian. Similar phenocryst assemblages to related rhyolite lava flows. Occurs near the bases of individual rhyolite lava flows, as obsidian flows or as exogenous domes.

Trt Trt--white to tan-colored pyroclastic material including thin layers of pumice-rich ash fall tuff, unwelded to moderately welded ignimbrite, block & ash flow, and probable surge deposits of rhyolite composition. Most of this unit is probably locally derived. Some tuffaceous units can be traced laterally into individual exogenous domes. The ash fall and ash flow units contain variable amounts of lithic fragments derived from older local units. In some areas the tuff encases angular blocks of Precambrian crystalline rock and blocks of intermediate-composition volcanic rock 1-2 m in diameter. In several areas, thick sections of ash fall deposits contain abundant xenocrysts of olivine and pyroxene as well as probable basalt melt droplets which increase in abundance upsection where the sequence is capped by basalt (Tb). This is taken as evidence for magma mixing and possible triggering of eruptions by periodic injection of basalt into rhyolite magma.

Trfr Trfr--distinctive brick-red colored, quartz-phyric rhyolite lava flow cropping out in the northern part of the area. Contains ~35% phenocrysts of plagioclase>>biotite>quartz=clinopyroxene. May comprise more than one flow of slightly different ages across individual fault blocks.

Trafr Trafr--minor red to orange-colored ashflow laterally equivalent to Trfr.

Highway tuff (middle Miocene)

Tht Tht--distinctive brown-orange weathering welded, crystal-rich tuff with black fiamme informally named for excellent exposures within the eastermost fault blocks of the Grasshopper Junction area. In its type section, the Highway tuff rests upon lava flows of the lower andesite sequence and contains ~2-12 m of unwelded ash flow and ash fall tuff at its base followed by approximately 30 m of welded tuff including thick zones of black vitrophyre. Typical welded tuff samples carry about 30-40% phenocrysts of plagioclase>/=biotite>clinopyroxene=sanidine. Biotite from the Highway tuff has been dated at 16.35 Ma (Varga et al., 1998) and has normal thermoremanent magnetic polarity. The tuff has no known correlative outside of the Grasshopper Junction area. The Highway tuff locally is overlain by rhyolite lavas of the rhyolite volcanic sequence.

Lower andesite sequence (lower and middle Miocene)

Older, pre-extensional sequence of mafic to intermediate composition volcanics and minor silicic tuffs. The unit is approximately 1 km thick and is bracketed in age by the 18.5 Ma Peach Springs Tuff at or near its base and the overlying 16.35 Ma Highway tuff.

Ta Ta--mafic to intermediate composition lava flows, flow breccias and minor, thin, rhyolite air fall tuff generally correlative to the lower part of the Patsy Mine volcanics of Anderson (1971). The sequence either rests upon, or contains the Peach Springs Tuff (Tps) at its base. Typical lava flows in this sequence contain ~30-40% small (<3 mm) phenocryts of plagioclase>clinopyroxene>orthopyroxene>>olivine with abundant petrographic evidence for magma mixing. Most exposures are variously altered.

Tat Tat--thicker sequences of unwelded to slightly welded rhyolite ash fall tuff.

Peach Springs Tuff (lower Miocene)

Medium gray to pink, unwelded to highly welded ash flow tuff and related ash fall tuff exposed at or near the base of the volcanic section. Typical welded ash flow contains 5-40% phenocrysts of sanidine>>>plagioclase=biotite>sphene. Sanidine phenocrysts often contain distinctive blue chatoyancy in the field. This unit is correlated with the 18.5 Ma Peach Springs Tuff as described by Glazner et al. (1986) because of its field characteristics, stratigraphic position and thermoremanent magnetic pole position close to that defined by Wells and Hillhouse (1989) for the type areas of the unit near Kingman, AZ. In the northern and eastern Grasshopper Junction area, the Peach Springs Tuff consists of a single, ~25 m thick cooling unit with variable amounts of unwelded ash flow and ash fall tuff at its base or overlying it. In the southwestern area, near Little Thorne Spring, the tuff is considerably thicker and locally contains more unwelded component and two cooling units with similar, sanidine-dominant mineralogy.

Tpst Tps--undivided Peach Springs Tuff containing variable amounts of welded tuff and unwelded ash fall and ash flow. Unit includes unwelded, white-colored ash fall and ash flow lying at the base of the Peach Springs Tuff, overlying the Peach Springs Tuff, or occuring between cooling units. Some or all of this ash fall may not be related to the Peach Springs eruption.

Tpstu Tpsu--Locally exposed upper cooling unit of the Peach Springs Tuff distinctive due to its pink color, lower phenocryst content (5-30%) and blocky weathering pattern

Tpstl Tpsl--Locally exposed lower cooling unit of the Peach Springs Tuff distinctive due to its orange color, greaterphenocryst content (~40%), dark-colored fiamme and flaggy weathering foliation.

Basal arkosic sandstone (lower Miocene)

Tas Tas--thin, 0-3 m thick arkosic sandstone lying below the Peach Springs Tuff and upon Precambrian crystalline rock; only preserved in one area of the eastern Grasshopper Junction SE Quadrangle. Medium to fine-grained sandstone is similar to that found in a similar stratigraphic position throughout the northern Colorado River extensional corridor.

Intrusive/Metamorphic Rocks

Basalt Dikes (Miocene)

Tbd Tbd--dark gray, fine-grained, generally aphyric mafic dikes cutting the olivine basalt sequence and rhyolite volcanic sequence. The dips of these dikes are often perpendicular to bedding and some dikes follow older normal fault zones. These relationships suggest that they may have been injected immediately prior to and during the early phases of extension. Limited geochemical analyses suggest that they represent the feeder dikes for the olivine basalt sequence.

Rhyolite dikes and stocks (Miocene)

Trd Trd--brown to pink-colored, fine-grained rhyolite dikes mapped cutting the rhyolite volcanic sequence and olivine basalt sequence. These dikes typically contain <5% phenocrysts of sanidine=plagioclase>biotite and are undoubtedly the source dikes for the rhyolite volcanic sequence.

Tcd Tcd-Cottonwood dike. Light gray to pink-colored rhyolite dike up to 20 m thick locally and traced consistently for a distance of ~5.5 km from Little Thorne Spring area to north of Cottonwood Spring. This is the largest, most continuous dike in the Grasshopper Junction area and contains approximately 20-25% phenocrysts of plagioclase=biotite. It cuts the lower part of the olivine basalt sequence and probably fed localized rhyolite lava flows and domes within the transition beween the olivine basalt and rhyolite volcanic sequences. Offset of the dike across the Cottonwood Spring fault system is less than the total throw, suggesting that the dike may be synextensional.

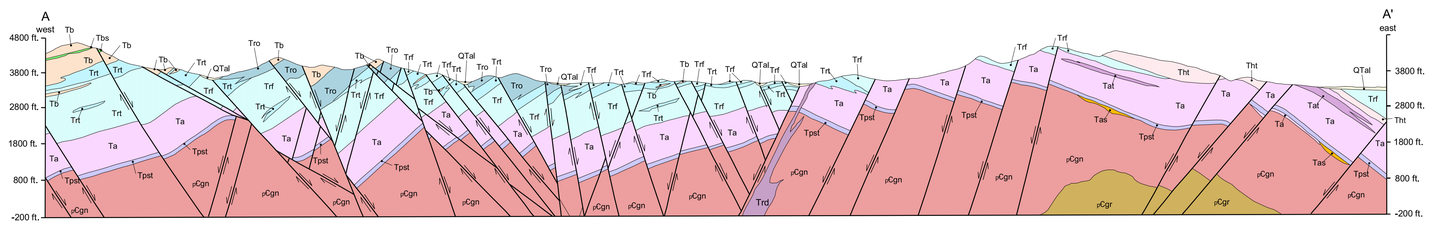
Tdts Tts--Little Thorne Spring intrusion. Rhyolite stock exposed at Little Thorne Spring in the southeastern part of the map area. The rhyolite carries 20-30% phenocrysts comprising plagioclase>>biotite. Cuts Little Thorne Spring fault and is considered synextensional. May be related to Cottonwood dike, the south end of which is exposed immediately to the north.

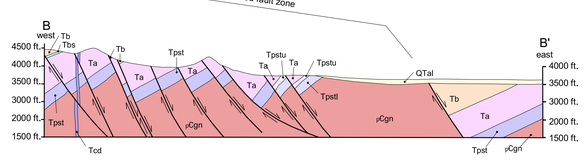
Tir Tir--biotite-rhyolite stocks. Small intrusive stocks found in the north central part of the map area. The stocks are light to dark pink in color and contain 30-40% phenocrysts of plagioclase=biotite>sanidine=clinopyroxene>hornblende. These rocks are undated, but cut the lower andesite sequence and the lowermost part of the rhyolite volcanic sequence.

Precambrian crystalline rocks

$_p$Cgr $_p$Cgr--Precambrian granite. Megacrystic granite containing large (several cm) phenocrysts of potassium feldspar; locally foliated. Similar in appearance to regionally extensive ~1.4 Ga anorogenic granite described in surrounding areas (Anderson, 1983).

$_p$Cgn $_p$Crn--Precambrian gneiss. Quartzo-feldspathic granitic orthogneiss with abundant biotite.





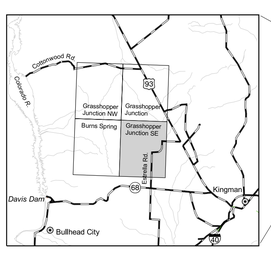
SCALE 1:24,000

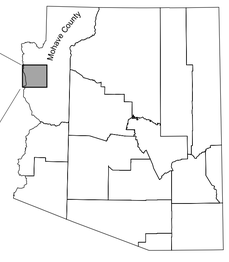
1 1/2 0 1 MILE

1000 0 1000 2000 3000 4000 5000 6000 7000 FEET

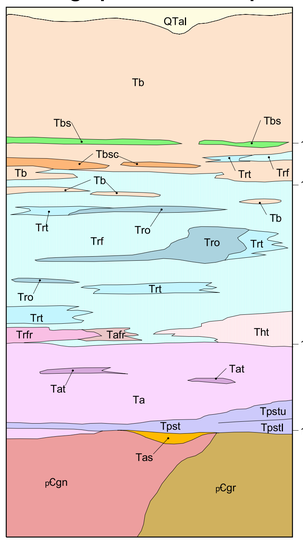
1 1/2 0 1 KILOMETER

1 inch equals 2,000 feet





Stratigraphic Relationships



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