Geologic Map of the Sentinel-Arlington Volcanic Field, Maricopa and Yuma Counties, Arizona

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Oatman low shield volcano from the central part of the Sentinel-Arlington volcanic field

CONTRIBUTED MAP CM-14-A

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Includes one 1:100,000 scale map and 11-page text.

INTRODUCTION

The Sentinel Plains lava field and associated small shields are early Pleistocene-age, mantle-derived alkali olivine basaltic lavas in the vicinity of the Gila Bend and Painted Rock Mountains, 65 km to 100 km southwest of Phoenix, Arizona (please see 1:100,000-scale map). These volcanic centers are collectively referred to as the Sentinel-Arlington Volcanic Field (SAVF). The SAVF covers ~600 km^2 and consists of more than 2 dozen volcanic centers ranging from 4-6 km in diameter and 30-200 m in height. The lavas are partially eroded and dissected by peripheral ephemeral washes, the Hassayampa River, and the Gila River, as well as lightly mantled by aeolian dust, pedogenic calcium carbonate, and basaltic rubble, with a few areas covered by alluvium.

PREVIOUS INVESTIGATIONS

The Sentinel-Arlington Volcanic Field has been mapped at 1:1,000,000 scale on the geologic map of Arizona (Richard et al., 2000; Reynolds, 1988); 1:375,000 scale on Maricopa and Yuma county maps (Wilson et al., 1960; Wilson et al., 1957); and 1:100,000 scale on 30' by 60' quadrangle geologic and surficial maps (Spencer, 1995; Reynolds and Scotnicki, 1993; Demsey, 1989, 1990). Several peripheral low shields were partially mapped at 1:50,000 to 1:24,000 scale (Scotnicki 1993a, 1993b, 1994; Peterson et al., 1989). The Sentinel Plains and the Warford Ranch, Woolsey, Gillespie, and Arlington small shields were dated as Pliocene to early Pleistocene by K-Ar methods in the late 1970's (Reynolds et al., 1986; Shafiquallah et al., 1980; Schoustra et al., 1976; Spencer, 2013), though the data often exhibit a range of 2-3 Ma for the same lava flow or a single edifice assumed to be monogenetic due to lack of intercalated paleosols or weathering horizons between units (Cave, 2004; Cave and Greeley, 2004; Cave et al., 2007; Greeley and Cave, 2007). The Sentinel Plains and the associated low shields were mentioned briefly in descriptions of Arizona Cenozoic tectonism and/or volcanism (Lynch, 1989; Reynolds et al., 1986; Morrison, 1985; Damon et al., 1984; Lee and Bell, 1975).

GEOLOGIC SETTING

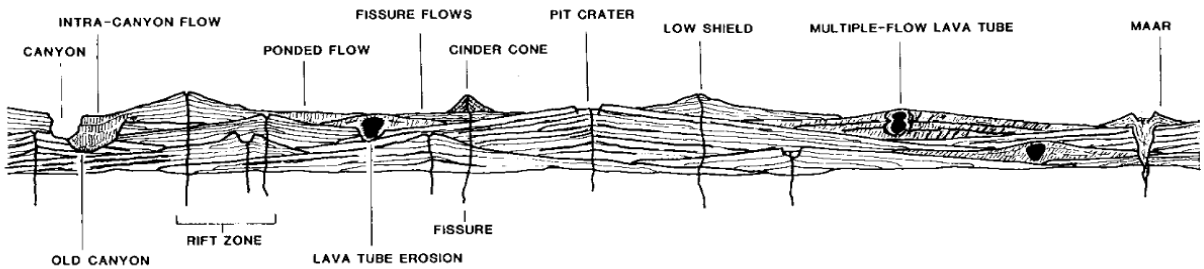
The SAVF lies on the eastern terminus of the Gila River trough (Eberly and Stanley, 1978). Northwest-trending normal faults cut the surrounding terrain (Richard et al., 2000; Skotnicki, 1993a, 1993b, 1994; Reynolds and Scotnicki, 1993; Reynolds, 1988; Scarborough et al., 1986). SAVF potentially represents basaltic plains-style volcanism (Greeley, 1977, 1982), an emplacement style of volcanism intermediate between classic flood volcanism and large shield-building volcanism (Fig. 1). The SAVF basal contact rests on mid-Tertiary volcanic deposits in the Painted Rock and Gila Bend Mountains, alluvium, alluvial/colluvial pediment deposits, or on a QTg gravel terrace in lower elevations. The latter is typically a conglomerate of rounded polymictic gravels and cobbles, with laminar interstitial calcrete cementing and partially brecciating the clasts (similar to Stage IV calcrete morphologic development of Machette, 1985; Bachman and Machette, 1977; after Gile et al., 1966). The basal contact is up to ~30 m above the modern Gila River channel. K-Ar and $^{40}Ar/^{39}Ar$ dating indicate the field is ~1-3 Ma in age (Table 1; Spencer, 2013; Cave et al., 2007).

Table 1. $^{40}Ar/^{39}Ar$ dates from the Sentinel volcanic field

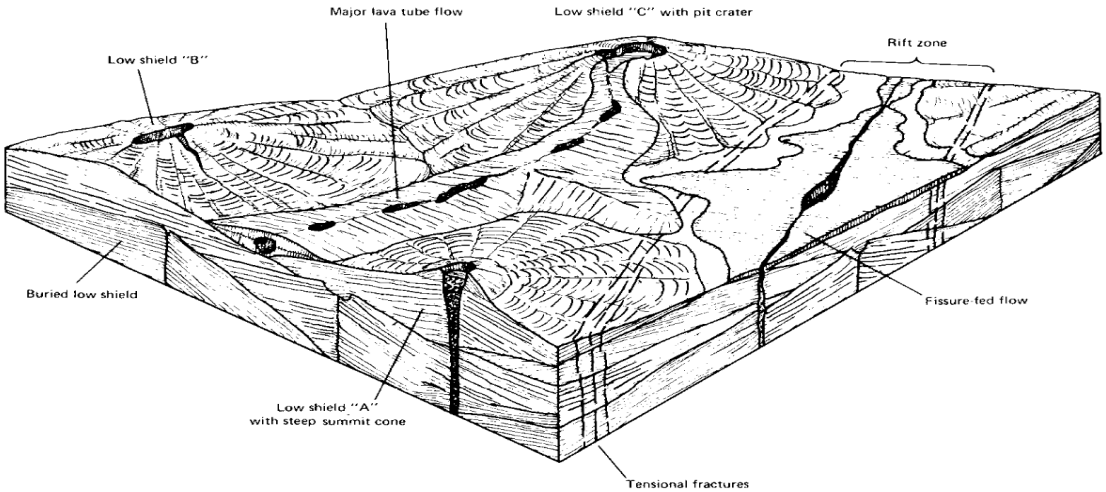
	$^{40}Ar/^{39}Ar$ date	vent	UTME NAD27	UTMN NAD27
S-06-183-D	1.08±0.15 Ma	Malpais	290630	3639792
S-06-194-A	1.25±0.024 Ma	Wildhorse	300869	3648907
S-06-186-C	1.71±0.054 Ma	Theba	317303	3641590
S-06-180-C	2.30±0.035 Ma	Oatman*	297002	3654101
S-05-057	1.91±0.59 Ma	Painted Rock	304925	3651830
S-06-166	2.37±0.02 Ma	Arlington	337526	3690897
S-05-066	22.4±1.0 Ma	kipuka	307033	3651403

*Reverse magneto-polarity suggests that site is actually a distal part of the Wild Horse low shield volcano

Figure 1: Plains-style volcanism



A. Vertically exaggerated schematic cross-section of major features of basaltic "plains" style volcanism, as characterized by Greeley (1982) in Eastern Snake River Plain, Idaho. The majority of the lava flows is typically pahoehoe and seldom exceed ~10 m in thickness except where ponded in topographic lows. The Sentinel-Arlington Volcanic Field exhibits the same style of volcanism, but over a smaller area and cumulative thickness, and the flows have been subsequently weathered, incised, and mantled by aeolian fines and discontinuous alluvium.



B. Block diagram showing typical development of terrain in basaltic "plains" style volcanism as characterized by Greeley (1982) in the eastern Snake River Plain, Idaho.

EXTRUSIVE AND HYPABYSSAL IGNEOUS ROCKS

Summit region lava flows and tephra deposits

Description: Summit regions are defined by a distinct surface texture in the aerial photographs that corresponds to a steeper surface gradient (typically >6°); conical and radial, 0.5 m to 1.5 m thick, subvertical dikes, often exposed at up to 2-3 m positive relief; relatively short, thin lava flows 0.5 to 2 m thick; and limited exposures of oxidized spatter or tephra. Summit regions typical have 1 to 2 mm phenocrysts of needle-like, translucent plagioclase feldspar.
Interpretation: Possible extent of pyroclastic deposits and shelly pahoehoe lava flows that have been weathered, often revealing the vent-area feeder dikes.

Midflank lava flows

Description: The midflank stratigraphic units are composed of lava flows with moderate surface angles and occasional relict flow festooning at 25 m to 75 m spacing that is visible in aerial photographs. There are rare skylights formed from collapse of partially drained lava tubes.
Interpretation: The midflank units are interpreted to be an accumulation of edifice-building lava flows. The majority of these flows are interpreted to be typically pahoehoe flows, with some a'a flows (sometimes with transverse flow buckling) where flows encountered steep paleoslopes or pre-existing topographic barriers during emplacement that caused the flows to at least locally have evidence of higher internal shear.

Distal lava flows

Description: The lowest stratigraphic units are broad, flat (>2° grade) lava flows forming the base of the shields. In the very flat topographic saddles between shields there are typically 5 to 8 m high hills and ridges as well as circular high-albedo features ~20 m in diameter. The distal units are usually 3 to 8 m thick, with a 0.5 m frothy vesicular capping layer underlain by a massive interior with dispersed vesicles, vesicle pipes, and discontinuous basal breccias. Where the distal units are ponded in pre-existing topographic lows they can be 10-12 m thick and form 0.5 to 1 m diameter columnar jointing, with rare basal palagonitic rinds and sub-meter pillow lavas. Cross-sectional exposures of distal units also reveal rare 1 to 2 m diameter lava tubes (typically completely filled with cooled lava).
Interpretation: The distal units are interpreted to be degassed pahoehoe lava flows fed by a system of lava-tube conduits. This unit can develop inflationary features such as tumuli, pressure ridges, and collapse pits when crossing very flat regions. Along the margins of the field where these flows are deposited onto alluvium and not subsequently capped by later lava flows, they often typically exhibit reverse topography. In areas where the original flows form long thin fingers of lava, with a high length-to-width ratio in plan view (indicating that it may have followed a pre-existing surface drainage and a topographic low) it now typically creates a ridgeline as the surrounding base level drops and the less-resistant alluvium weathers away or deflates, leaving the lava flow as a more-resistant topographic high.

Kipukas

Description: Completely embayed basaltic islands with textures, phenocryst assemblages, etc., that do not match the embaying lava flow.
Interpretation: Underlying basaltic units that can represent a pre-existing SAVF volcanic unit or an older Miocene to Pliocene-age basaltic remnant.

Late Tertiary basaltic rocks and cinder deposits

Description: Dark-gray, fine-grained basaltic lava flows and rare welded agglutinate and tephra deposits that have not been tectonically altered (unlike the faulted Miocene basaltic units of the Painted Rock Mountains). Typically exhibits vesicular flow exteriors and massive or vuggy interiors, typically porphyritic with varying phenocryst assemblages, rarely exhibits diktytaxitic texture.
Interpretation: Very dissected Pliocene-age (?) cinder cones and lava flows.

SEDIMENTARY UNITS

Mantling fines

Description: Silt and clay, sometimes indurated by pedogenic calcium carbonate.
Interpretation: Aeolian fines and locally derived clays, sometimes asymmetrically accumulated on edifice related to dominant wind patterns, with varying stages of pedogenic calcium carbonate accumulation. Often an active component of desert pavement, and clay swelling may slowly loft surface basalt rubble as mantle accumulates (Anderson et al., 2002; Wells et al., 1985, Gile et al., 1966).

Surficial deposits

Description: Subangular heterolithic gravel to sand-sized alluvium on SAVF basaltic units.
Interpretation: Pleistocene-Holocene alluvial cover, some active and some stranded on SAVF basaltic units from washes and flood stages of the Hassayampa and Gila Rivers.

Gila River gravels

Description: Rounded heterolithic gravel and cobble-sized river gravels and polymictic conglomerates cemented by laminar interstitial calcrete at base of the SAVF or forming heavily-varnished lag terraces ~15 to 30 m above current river channel bottom.
Interpretation: Paleo-channel terraces of the Gila River.

STRUCTURE

SAVF lava flows exhibit no obvious tectonic post-emplacement offset, though there are strong NW-trending erosional re-entrants that correspond to mapped faults in nearby terrain. Also SAVF vent locations sometimes exhibit NE or NW alignment, especially in the Oatman and Painted Rock Mountains pediment areas. This alignment could potentially represent the influence of pre-existing structures crossing the underlying bedrock, similar to structural control of vent alignments observed in other basaltic fields in Arizona (Conway et al., 1997; Crumpler et al., 1994; Connor et al., 1992).

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UNIT DESCRIPTIONS

Qo **Surficial deposits -** Pleistocene-Holocene alluvial cover overlying Sentinel-Arlington Volcanic Field units

Qba **Tephra deposits -** Remnant basaltic ash, lapilli and cinder as intercalated lenses or remnant phreato-magmatic cones and cinder cones.

QBSNs **Sentinel Peak low shield secondary vent summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the secondary Sentinel Peak vent +/- radial and concentric feeder dikes

QbSSs **Sentinel Peak low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Sentinel Peak vent +/- radial and concentric feeder dikes

QbSSm **Sentinel Peak low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Sentinel Peak vent

QbSSd **Sentinel Peak low shield distal -** Basaltic pahoehoe flows of the Sentinel Peak vent with <0-2º slope angle and alluvial cover

QbMLs **Malpais low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle +/- radial and concentric feeder dikes of the Malpais vent

QbMLm **Malpais low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Malpais vent, 40Ar/39Ar radiogenic age of **1.08 ± 0.15 Ma**

QbMld **Malpais low shield distal -** Basaltic pahoehoe flows of the Malpais vent with <0-2º slope angle

QbSEd **Sent 774 low shield distal -** Basaltic pahoehoe flows with ~0º-5º slope of the Sent 774 vent, possible fissure-style eruption, very low aspect ratio, lacking typical low shield edifice

QbMEs **Midway low shield secondary summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the secondary Midway vent +/- radial and concentric feeder dikes

QbMWs **Midway low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Midway vent +/- radial and concentric feeder dikes

QbMWm **Midway low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope angle of the Midway vent

QbMWd **Midway low shield distal -** Basaltic pahoehoe flows of the Midway vent with <0-2º slope angle and possible alluvial cover

QbSTs **Stanwix low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Stanwix vent +/- radial and concentric feeder dikes

QbSTm **Stanwix low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Stanwix vent

QbSTd **Stanwix low shield distal -** Basaltic pahoehoe flows of the Stanwix vent with <0-2º slope angle

QbCTs **Control Tower low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Control Tower vent +/- radial and concentric feeder dikes

QbCTm **Control Tower low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Control Tower vent

QbCTd **Control Tower low shield distal -** Basaltic pahoehoe flows of the Control Tower vent with <0-2º slope angle and alluvial cover

QbWSs **Wild Horse low shield secondary summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the southeastern Wild Horse vent +/- radial and concentric feeder dikes

QbWNs **Wild Horse low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the northwestern Wild Horse vent +/- radial and concentric feeder dikes, one dike 40Ar/39Ar radiogenically dated as **1.25 ± 0.024 Ma**

QbWNm **Wild Horse low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Wild Horse vent

QbWNd **Wild Horse low shield distal -** Basaltic pahoehoe flows of the Wild Horse vent with <0-2º slope angle and alluvial cover

QbTMs **Ten Mile low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Ten Mile vent +/- radial and concentric feeder dikes +- underlying tuff ring

QbTMm **Ten Mile low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Ten Mile vent

QbTMd **Ten Mile low shield distal -** Basaltic pahoehoe flows of the Ten Mile vent with <0-2º slope angle and alluvial cover

QbTHs **Theba low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Theba vent +/- radial and concentric feeder dikes

QbTHm **Theba low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Theba vent

QbTHd **Theba low shield distal -** Basaltic pahoehoe flows of the Theba vent with <0-2º slope angle and alluvial cover, 40Ar/39Ar radiogenically dated at **1.71 ± 0.054 Ma**

QbTRs **Tartron low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Tartron vent +/- radial and concentric feeder dikes

QbTRm **Tartron low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Tartron vent

QbTRd **Tartron low shield distal -** Basaltic pahoehoe flows of the Tartron vent with <0-2º slope angle and alluvial cover

QbWTs **White Hills low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the White Hills vent +/- radial and concentric feeder dikes

QbWTm **White Hills low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the White Hills vent

QbBGs **Black Gap low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Black Gap vent +/- radial and concentric feeder dikes

QbBGm **Black Gap low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Black Gap vent

QbSCm **Sauceda tuff ring lava pond/flows -** Late-stage basaltic lava flows and remnant lava pond partially covering or infilling the phreatomagmatic Sauceda tuff ring (most of the tuff deposit(s) subsequently weathered away)

QbWRs **Warford Ranch low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Warford Ranch vent +/- radial and concentric feeder dikes

QbWRm **Warford Ranch low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Warford Ranch vent

QbWRd **Warford Ranch low shield distal -** Eroded and undercut basaltic pahoehoe flows of the Warford Ranch vent with <0-2º slope angle and possible alluvial cover

QbGLs **Gillespie low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Gillespie vent +/- radial and concentric feeder dikes

QbGLm **Gillespie low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope angle +/- possible festooned a'a flows around granitoid kipuka, of the Gillespie vent, the latter evidenced by partially concealed ~25 m to 75 m wavelength transverse flow buckling

QbGLd **Gillespie low shield distal -** Basaltic pahoehoe flows of the Gillespie vent with <0-2º slope angle and alluvial cover

QbOVs **Overlook low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Overlook vent +/- radial and concentric feeder dikes

QbOVm **Overlook low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Overlook vent

QbWLs **Woolsey low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Woolsey vent +/- radial and concentric feeder dikes

QbWLm **Woolsey low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope +/- possible a'a flows as evidenced by remnant ~10-50 m wavelength transverse buckling of the Woolsey vent

QbWLd **Woolsey low shield distal -** Basaltic pahoehoe flows of the Wild Horse vent with <0-2º slope angle and possible alluvial cover

QbRTs **RadioTower low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the Radio Tower vent +/- radial and concentric feeder dikes

QbRTm **RadioTower low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope of the Radio Tower vent

QBPSs **Painted Rock low shield secondary vent summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the southern Painted Rock vent +/- radial and concentric feeder dikes

QbPNs **Painted Rock low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the northern Painted Rock vent +/- radial and concentric feeder dikes, 40Ar/39Ar radiogenically dated at **1.91 ± 0.59 Ma**

QbPNm **Painted Rock low shield vent midflank -** Basaltic pahoehoe flows with ~2º-5º slope angle of the northern Painted Rock vent

QbPNd **Painted Rock low shield distal -** Basaltic pahoehoe flows of the Painted Rock vent with <0-2º slope angle and alluvial cover

QbONs **Oatman low shield secondary vent summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the northern Oatman vent +/- radial and concentric feeder dikes

QbOSs **Oatman low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits with 6º-22º slope angle of the southern Oatman vent +/- radial and concentric feeder dikes

QbOSm **Oatman low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope angle of the southern Oatman vent

QbOTd **Oatman low shield distal -** Basaltic pahoehoe flows of the Oatman vent with <0-2º slope angle and alluvial cover

QbALd **Arlington low shield distal -** Basaltic pahoehoe flows of the Arlington vent with <0-2º slope angle and stranded alluvial cover on northern and southern flanks

QbALm **Arlington low shield midflank -** Basaltic pahoehoe flows with ~2º-5º slope angle +/- possible festooned a'a flows of the Arlington vent, the latter evidenced by partially concealed ~25 m to 75 m wavelength transverse flow buckling

QbALs **Arlington low shield summit -** Basaltic pahoehoe flows and near-vent pyroclastic deposits and intercalated tephra deposits of the Arlington vent with 6º-22º slope angle +/- radial and concentric feeder dikes, radiogenically dated as **2.37 +- 0.03 Ma**

QTg **Gila River Gravels -** Plio-Pleistocene Gila River deposits/terraces ~30 m above current river profile

Tb **Tertiary basaltic units -** Basaltic to basaltic andesite flows and pyroclastic deposits, often tectonically rotated and/or embayed by SAVF units