

U.S. Department of the Interior
National Park Service
Natural Resource Stewardship and Science Directorate
Geologic Resources Division



Casa Grande Ruins National Monument

GRI Ancillary Map Information Document

Produced to accompany the Geologic Resources Inventory (GRI) Digital Geologic
Data for Casa Grande Ruins National Monument

cagr_geology.pdf

Version: 2/26/2018

Geologic Resources Inventory Ancillary Map Information Document for Casa Grande Ruins National Monument

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Geologic Resources Inventory Map Document



Casa Grande Ruins National Monument, Arizona

Document to Accompany Digital Geologic-GIS Data

[cagr_geology.pdf](#)

Version: 2/26/2018

This document has been developed to accompany the digital geologic-GIS data developed by the Geologic Resources Inventory (GRI) program for Casa Grande Ruins National Monument, Arizona (CAGR).

Attempts have been made to reproduce all aspects of the original source products, including the geologic units and their descriptions, geologic cross sections, the geologic report, references and all other pertinent images and information contained in the original publication.

This document contains the following information:

- 1) **About the NPS Geologic Resources Inventory Program** – A brief summary of the Geologic Resources Inventory (GRI) Program and its products. Included are web links to the GRI GIS data model, and to the GRI products page where digital geologic-GIS datasets, scoping reports and geology reports are available for download. In addition, web links to the NPS Data Store and GRI program home page, as well as contact information for the GRI coordinator, are also present.
- 2) **GRI Digital Maps and Source Citations** – A listing of all GRI digital geologic-GIS maps produced for this project along with sources used in their completion. In addition, a brief explanation of how each source map was used is provided.
- 3) **Map Unit List** – A listing of all geologic map units present on maps for this project, generally listed from youngest to oldest.
- 4) **Map Unit Descriptions** – Descriptions for all geologic map units. If a unit is present on multiple source maps the unit is listed with its source geologic unit symbol, unit name and unit age followed by the unit's description.
- 5) **Ancillary Source Map Information** – Additional source map information presented by source map. For each source map this may include a location map, map graphics or tables, and a report.
- 6) **GRI Digital Data Credits** – GRI digital geologic-GIS data and ancillary map information document production credits.

For information about using GRI digital geologic-GIS data contact:

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About the NPS Geologic Resources Inventory Program

Background

Recognizing the interrelationships between the physical (geology, air, and water) and biological (plants and animals) components of the earth is vital to understanding, managing, and protecting natural resources. The Geologic Resources Inventory (GRI) helps make this connection by providing information on the role of geology and geologic resource management in parks.

Geologic resources for management consideration include both the processes that act upon the Earth and the features formed as a result of these processes. Geologic processes include: erosion and sedimentation; seismic, volcanic, and geothermal activity; glaciation, rockfalls, landslides, and shoreline change. Geologic features include mountains, canyons, natural arches and bridges, minerals, rocks, fossils, cave and karst systems, beaches, dunes, glaciers, volcanoes, and faults.

The Geologic Resources Inventory aims to raise awareness of geology and the role it plays in the environment, and to provide natural resource managers and staff, park planners, interpreters, researchers, and other NPS personnel with information that can help them make informed management decisions.

The GRI team, working closely with the Colorado State University (CSU) Department of Geosciences and a variety of other partners, provides more than 270 parks with a geologic scoping meeting, digital geologic-GIS map data, and a park-specific geologic report.

Products

Scoping Meetings: These park-specific meetings bring together local geologic experts and park staff to inventory and review available geologic data and discuss geologic resource management issues. A summary document is prepared for each meeting that identifies a plan to provide digital map data for the park.

Digital Geologic Maps: Digital geologic maps reproduce all aspects of traditional paper maps, including notes, legend, and cross sections. Bedrock, surficial, and special purpose maps such as coastal or geologic hazard maps may be used by the GRI to create digital Geographic Information Systems (GIS) data and meet park needs. These digital GIS data allow geologic information to be easily viewed and analyzed in conjunction with a wide range of other resource management information data.

For detailed information regarding GIS parameters such as data attribute field definitions, attribute field codes, value definitions, and rules that govern relationships found in the data, refer to the NPS Geology-GIS Data Model document available at: <http://science.nature.nps.gov/im/inventory/geology/GeologyGISDataModel.cfm>

Geologic Reports: Park-specific geologic reports identify geologic resource management issues as well as features and processes that are important to park ecosystems. In addition, these reports present a brief geologic history of the park and address specific properties of geologic units present in the park.

For a complete listing of Geologic Resource Inventory products and direct links to the download site visit the GRI publications webpage http://www.nature.nps.gov/geology/inventory/gre_publications.cfm

GRI geologic-GIS data is also available online at the NPS Data Store Search Application: <http://irma.nps.gov/App/Reference/Search>. To find GRI data for a specific park or parks select the appropriate park

(s), enter "GRI" as a Search Text term, and then select the Search Button.

For more information about the Geologic Resources Inventory Program visit the GRI webpage: <http://www.nature.nps.gov/geology/inventory>, or contact:

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The Geologic Resources Inventory (GRI) program is funded by the National Park Service (NPS) Inventory and Monitoring (I&M) Division.

GRI Digital Map and Source Map Citations

The GRI digital geologic-GIS map for Casa Grande Ruins National Monument, Arizona (CAGR).

Digital Geologic-GIS Map of Casa Grande Ruins National Monument and Vicinity, Arizona (*GRI MapCode CAGR*)

The source maps used are listed below.

Huckleberry, Gary, 1992, Surficial Geology of the Eastern Gila River Indian Community Area, Western Pinal County, Arizona: Blackwater 7.5' Quadrangle: Arizona Geological Survey, Open File Report [OF 92-07, Sheet 6](#) of 6, scale 1:24,000. (*GRI Source Map ID 74379*).

Klawon, J.E., et.al., 1998, Geology and Geologic Hazards of the Casa Grande Area, Pinal County, Arizona: Geologic Map of the Coolidge 7.5' Quadrangle: Arizona Geological Survey, Open-File Report [OF 98-23, Sheet 4](#) of 6, scale 1:24,000. (*GRI Source Map ID 74372*).

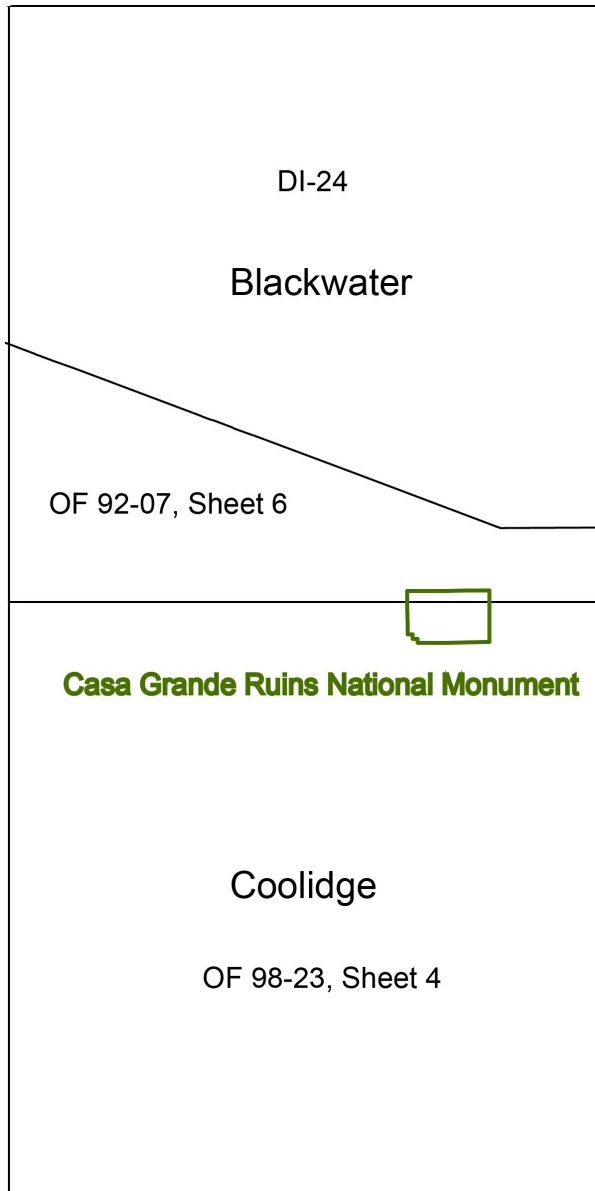
Richard, Stephen, Tim, Orr, Moore, Erin and Ferguson, Charles, 2006, Geologic Data for the Southeast Phoenix Metropolitan Area, Maricopa and Pinal Counties, Arizona: Arizona Geological Survey, unpublished digital data [DI-24](#), scale 1:24,000. (*GRI Source Map ID 74889*).

For each source map only a portion of the source map extent was used. See the index map below for an explanation of the extent used for each source map.

Additional information pertaining to each source map is also presented in the GRI Source Map Information (CAGRMAP) table included with the GRI geologic-GIS data.

Index Map

The following index map displays the boundary for Casa Grande Ruins National Monument (in dark green, as of February, 2018) and the extents of the Blackwater and Coolidge 7.5' quadrangles. The extent of the GRI digital geologic-GIS map for Casa Grande Ruins National Monument is defined by the extent of the two 7.5' quadrangles. Also indicated are the source maps used by the GRI in the completion of the GRI digital geologic-GIS map. For the Blackwater quadrangle, [DI-24](#) was used for the northern and central area of the quadrangle, whereas [OF 92-07, Sheet 6](#) was used for the southern area of the quadrangle. [OF 98-23, Sheet 4](#) was used for the Coolidge quadrangle extent of the map.



Index map produced by Stephanie O'Meara (Colorado State University).

Map Unit List

The geologic units present in the digital geologic-GIS data produced for Casa Grande Ruins National Monument, Arizona (CAGR) are listed below. Units are listed with their assigned unit symbol and unit name (e.g., Qd - Disturbed land). Units are listed from youngest to oldest. Information about each geologic unit is also presented in the GRI Geologic Unit Information (CAGRUNIT) table included with the GRI geologic-GIS data. Some source unit symbols, names and/or ages may have been changed in this document and in the GRI digital geologic-GIS data. This was done to consolidate differing unit symbols, unit names and/or unit ages between the contributing source maps, or to adopt a now recognized unit age.

Cenozoic Era

Quaternary Period

[Qd](#) - Disturbed land
[Qycr](#) - Modern river channel deposits
[Qyc](#) - Modern stream channel deposits
[Qal](#) - Surficial deposits, undivided
[Qy](#) - Piedmont alluvium, youngest
[Qyr](#) - River deposits, younger
[Qct](#) - Colluvium and talus
[Qyif](#) - Alluvium
[Qi3](#) - Piedmont alluvium, younger
[Qi3r](#) - River terrace and alluvium deposits
[Qmlr](#) - River deposits, older
[Qi2](#) - Piedmont alluvium, older
[Qor](#) - River deposits, oldest
[Qop](#) - Piedmont deposits, oldest

Tertiary Period

[Tby](#) - Gila Group, basalt
[Talt](#) - Apache Leap Tuff
[Tsm](#) - Superstition Tuff, Miners Needle break
[Twsc](#) - Whitetail Formation, sandstone and conglomerate
[Twx](#) - Whitetail Formation, granite breccia

Cenozoic or Mesozoic Era

Tertiary or Cretaceous Period

[TKbj](#) - Mafic dikes
[TKdi](#) - Intermediate dikes
[TKri](#) - Felsic dikes

Mesozoic Era

Cretaceous Period

[Kd](#) - Diorite
[Kg](#) - Quartz monzodiorite to quartz monzonite
[Kv](#) - Vein arrays

Precambrian

Proterozoic Eon

[Yd](#) - Diabase

[Yg](#) - K-feldspar porphyritic granite

[Yge](#) - Granite, equigranular phase

[Ygs](#) - Silicified granite

[Xp](#) - Pinal Schist, undifferentiated

Map Unit Descriptions

Descriptions of all geologic map units, generally listed from youngest to oldest, are presented below. Where a source unit symbol, unit name and/or unit age differ from the assigned GRI unit symbol, unit name and/or unit age these are indicated with the source map description.

Qd - Disturbed land (Recent)

d - disturbed ground (Recent) - Areas of significant recent surficial disruption due to various human activities. Includes dams, sand and gravel quarries, large cattle tanks, areas leveled for mining and other development activity, etc. (*GRI Source Map ID 74889*) ([DI-24](#)).

g - sand and gravel pits (Recent) - No additional unit description provided on source map. (*GRI Source Map ID 74372*). ([OF 98-23](#)).

Qycr - Modern river channel deposits (Holocene)

Qycr - Modern river channel deposits (Recent) - Deposits in active stream channels of major streams. Predominantly unconsolidated sand, pebbles, cobbles and boulders. Clasts are subrounded to well-rounded and deposits typically contain diverse lithologies representing both local and non-local rock type. (generally less than ~100 yr). (*GRI Source Map ID 74889*) ([DI-24](#)).

Y2 - Modern channel of the MGR and of the Santa Cruz River where the natural channel is still extant (Recent) - Y2 represents the modern channel of the MGR and of the Santa Cruz River where the natural channel is still extant. Streamflow in the MGR is generally confined to a single channel (referred here as the low-flow channel) that is incised 1 to 3 m below the adjacent terraces ([Table 1](#)). In places, however, channel depth decreases and the low-flow channel diverges into several subchannels resulting in a distributary to anastomosing stream pattern. Banks of the low-flow channel are lined with *Tamarix*. The low-flow channel cross-sectional area decreases downstream within the eastern GRIC area reflecting seepage losses within the channel during infrequent streamflow.

The main channel of the MGR has formed since 1905 when a large flood destroyed much of the riparian community and converted a narrow stream channel into a broad, braided channel (Rea, 1981). Since 1905, *Tamarix* has invaded the flood plain, and the low-flow channel has become re-established. Although the modern channel dates to 1905, historical maps and the distribution of Pima archaeological sites indicate that the pre-1905 channel was located more or less in the same location. The Y2 channel is estimated to be less than 1 ka ([Table 2](#)). (*GRI Source Map ID 74379*). ([OFR 92-07](#)).

Y2' - Secondary channels of the MGR, Santa Cruz River, Santa Rosa Wash, and Queen Creek (Recent) - Y2' represents secondary channels of the MGR, Santa Cruz River, Santa Rosa Wash, and Queen Creek* that support flood flow. The Y2' designation is also applied to former primary channels of the Santa Cruz River and Santa Rosa Wash that have been leveled and replaced by agricultural fields. On the MGR, streamflow within Y2' channels is generally confined and inset less than 3 m below adjacent terraces ([Table 1](#)). Streamflow is less confined in the Y2' channels in the Santa Cruz River resulting in distributary to anastomosing drainage patterns.

Y2' channels are also less than 1 ka ([Table 2](#)). The most prominent Y2' channel within the eastern GRIC area is the Little Gila River, which is ethnohistorically documented (Russell, 1908). There is some question as to whether the Little Gila River is natural channel or a former Hohokam/Pima canal subsequently enlarged by MGR floods. Although a canal was diverted from the terminus of the Little Gila River and extended to McClellan Wash and the Sacaton area, the Little Gila River proper is a natural

flood channel incised into adjacent Holocene terraces in the Blackwater area.

A paleochannel of Queen Creek is identified in the northern part of the Gila Butte and Gila Butte Northwest quadrangles based on soil survey data (Adams, 1974). (GRI Source Map ID 74379). ([OFR 92-07](#)).

Qyc - Modern stream channel deposits (Holocene)

Qyc - Modern stream channel deposits (Holocene) - Compilation unit for sand and gravel deposits in active, open channels of tributary washes on the piedmonts that could be delineated at a scale of 1:24,000. This unit is composed of moderately-sorted sand, gravel, and pebbles with some cobbles in the lower piedmont areas to poorly-sorted sand, gravel, pebbles, and cobbles in the upper piedmont areas. Channels are generally incised less than 0.5 to 1 meter below adjacent Holocene terraces. Channel morphologies generally consist of a single thread deep high flow channel or multi-threaded shallow low flow channels with adjacent gravel bars. The channels are flood prone and are subject to deep, high velocity flow during moderate to large flood events. Channels are subject to scouring and bar deposition. Banks are subject to lateral erosion. There is no soil development in this fluvially active unit, and little or no vegetation within the channels. (GRI Source Map ID 74889) ([DI-24](#)).

Ya2 - modern ephemeral streams draining the bajada surrounding the MGR (Holocene) - Ya2 denotes modern ephemeral streams draining the bajada surrounding the MGR. These channels are lined with palo verde (*Cercidium*), mesquite (*Prosopis*), and ironwood (*Olneya*). Both distributary and anastomosing drainage patterns are present within Ya2 channels (Table 1). These channels tend to flow after locally heavy rainstorms. Ya2 channels are estimated to be less than 1 ka. (GRI Source Map ID 74379). ([OFR 92-07](#)).

Qal - Surficial deposits, undivided (Holocene)

Qal - Quaternary deposits, undivided (Quaternary) - Poorly-sorted sand- to cobble-sized material on pediment surfaces and other areas of low relief and along drainages where recent incision is not severe. This unit also includes relatively thick soils developed on gently dipping erosional surfaces. (GRI Source Map ID 74889) ([DI-24](#)).

Qy - Piedmont alluvium, youngest (Holocene)

Qy - Holocene piedmont alluvium, undivided (Holocene) - Mostly alluvium, may include some eolian deposits. This unit is characterized by unconsolidated, stratified, poorly to moderately sorted sand, gravel, cobble, and boulder deposits that underlie small active channels, low terraces, and alluvial fans. In some places this designation is used where the Qy1 and Qy2 surfaces are too intricately intermingled to map separately at this scale. These areas may be subject to occasional to frequent flooding. Terraces and alluvial fan surfaces are 0 to 2 m above active channels. Terrace surfaces are frequently mantled by sandy loam sediment. Alluvial surfaces exhibit bar-and-swale topography, with the ridges typically being slightly more vegetated. Surfaces have minimal or no rock varnish or desert pavement development, and may be subject to inundation during large floods. Late Holocene soils are minimally developed, but Middle and Early Holocene soils typically contain cambic horizons, weak calcic horizons (not more than Stage I), and are noticeably reddened. Surface colors are light brown to yellowish brown, with a slight reddening with depth due to oxidation. Some of the older soils may contain weakly developed argillic horizons. Soils are classified as Torrifluvents, Torriorthents, Camborthids, and Calciorthids. Surface soils are not indurated with clay or calcium carbonate, so surfaces have relatively high permeability and porosity. (GRI Source Map ID 74889) ([DI-24](#)).

Ya1a - Late Holocene alluvial surfaces adjacent to Ya2 channels (Holocene) - Ya1a represents late Holocene alluvial surfaces adjacent to Ya2 channels and are located generally in the distal portions of alluvial fans. In places, Ya1a alluvium overlies pediment. These surfaces are only slightly dissected ([Table 1](#)) and support both sheetflow and distributary drainage. Soil development is slight: oxidation (slight reddening) and incipient calcification are the predominant pedogenic processes on Ya1a surfaces. Soils classify as Torrifluvents and Camborthids (Soil Survey Staff, 1975:170, 189; Appendix A: Soil 2). The cambic horizons in these soils are based on slight reddening and probably should be considered oxidized C horizons [see Birkeland's (1984:8) "Cox" horizon].

The Ya1a surface correlates with Bull's (1991) Q4a surface which he age-estimates at 0.1-2.0 ka. Ya1a deposits are comparable in topographic position and soil development to the younger Fillmore alluvium age estimated at 0.1-7.0 ka (Gile and others, 1981). Ya1a sediments are age estimated at less than 1 ka (Table 2). (GRI Source Map ID 74379). ([OFR 92-07](#)).

Qyr - River deposits, younger (Holocene)

Qyr - Holocene river deposits, undivided (Holocene) - Generally includes young terrace deposits that are above the active channels but subject to inundation and fine-grained deposition during large flood events. Deposit lithology includes sand and gravel equivalent to material in channel deposits, as well silt and clay deposited by overbank flow during floods. Locally includes Qyc or Qycr. (GRI Source Map ID 74889) ([DI-24](#)).

Y1 - Main fill terrace within the MGR's Holocene geologic flood plain (Holocene) - Y1 is the main fill terrace within the MGR's Holocene geologic flood plain. Y1 also represents interfluvies within the Santa Cruz and Santa Rosa drainages. Along the MGR, the boundaries of the Y1 terrace are well delineated by surrounding Pleistocene terraces. Y1 terraces characteristically contain channel deposits with a 1-3 m cap of lower energy, overbank sediments. Overbank alluvial particle sizes are commonly fine sand and smaller. Drainage patterns and soil development are similar to the Y2/Y1 surfaces ([Table 1](#)), although cambic and incipient calcic horizons are more common. Some of the Y1 soils also contain natric horizons (Soil Survey Staff, 1975:28). It is important to note that the Y1 terrace has experienced approximately 2,000 years of irrigation agriculture (see Haury, 1976) which may have modified the natural soil morphology by salinization, alkalization, and the accumulation of silts and clays in the upper soil (Huckleberry, 1992).

There is little stratigraphic age control for Y1 alluvium. A Proboscidean tusk (probably *Mammuthus*) was retrieved from ca. 7.0-9.0 m below the Y1 surface at a gravel quarry (SW1/4, Sec. 22, T. 3 S., R. 5 E.) suggesting that late Pleistocene alluvium occurs at depth (Kevin Moody, oral commun., 1992). However, the uppermost alluvium contains immature soils indicating a Holocene age. Ethnographic records by the Pima (Russell, 1908) indicate that floods in 1833 and 1868 covered much of this surface. On the basis of soils and topographic position, the Y1 terrace is correlatable with the Salt River's Lehi terrace (Pewe, 1978) which is estimated to be late Holocene to modern (Graybill and Nials, 1989). Y1 deposits correlate with Fillmore deposits of the middle Rio Grande River (Gile and others, 1981), which have been dated at 1.0-7.5 ka. The Y1 terrace is estimated to be less than 10 ka ([Table 2](#)). (GRI Source Map ID 74379). ([OFR 92-07](#)).

Qy1r - Holocene floodplain and terrace deposits (<10 ka) (Holocene) - The Qy1r units consists of floodplains and terraces that are spatially separated from the main channel system. Qy1r deposits consist of sand, silt, and clay. Soils are classified as Torrifluvents and Camborthids, which are deep, weakly developed soils with some carbonate filaments and fine masses and weak soil structure in near surface horizons. Qy1r surfaces which may experience sheetflooding during large flow events. (GRI Source Map ID 74372). ([OF 98-23](#)).

Qct - Colluvium and talus (Pleistocene to Holocene)

Qct - Colluvium and talus, undivided (< 750 ka) (Quaternary) - No additional unit description provided on source map. (GRI Source Map ID 74889) ([DI-24](#)).

Qyif - Alluvium (Pleistocene to Holocene)

Qyif - Holocene to Pleistocene alluvium (Holocene to Pleistocene) - Fine-grained sheet-flood and overbank deposits that mantle much of the lower piedmont area in the southeast part of the Union Hills quadrangle and adjacent Paradise Valley. Urban development in this area precludes subdivision into separate units. Deposits consist of sand, silt, and clay, with some fine gravel. This unit includes many small channels, but also typically surround younger Qy channels. Soil development is generally weak to moderate, consisting mainly of minor silt, clay, and carbonate accumulation (Stage I). Soils are classified as Torrifluvents, except where the deposits are thin (<50 cm) over older soils. Surfaces may be prone to flooding. Typically found in lower piedmont areas, possibly mantling older deposits. Differentiated from basin center deposits by sedimentological evidence of surface slope sufficient to keep water flowing on the depositional surface. Qlyf unit of Holloway and Leighty, 1998 (Union Hills, AZGS OFR 98-20). (GRI Source Map ID 74889) ([DI-24](#)).

Qi3 - Piedmont alluvium, younger (late to latest Pleistocene)

Qi3 - Late to latest Pleistocene piedmont alluvium (Pleistocene) - Late Pleistocene alluvial fan surfaces and terraces consisting of moderately sorted, clast-supported sandstone and conglomerate with abundant granitic or metamorphic gravel clasts in a tan to brown sandy to silty matrix. Surfaces are moderately incised by stream channels, but still contain constructional, relatively flat, interfluvial surfaces. Subdued bar and swale topography is common. Desert pavement and rock varnish development ranges from nonexistent to moderate. Surface colors are slightly more red (light brown to reddish yellow) than Qy surfaces. Qi3 soils are also more strongly developed than Qy soils. Qi3 soils commonly contain tan to red-brown argillic horizons that are weakly to moderately strongly developed. These soils typically have Stage II-III calcium carbonate development, and are classified as Haplargids, Camborthids, and Calciorthids. The low infiltration rates of these surfaces favor plants that draw moisture from near the surface. Qi3 surfaces are generally not prone to flooding, except immediately adjacent to active washes. (GRI Source Map ID 74889) ([DI-24](#)).

Ma2 - Late Holocene alluvial surfaces adjacent to Ya2 channels (Holocene) - Ma2 fan surfaces are late Pleistocene in age and located generally in proximal fan positions. These surfaces are moderately dissected and have dendritic drainage patterns ([Table 1](#)). In places, a moderate desert pavement is developed. Soils are quite variable and contain cambic, calcic (Stage I-II), and argillic horizons. Ma2 soils classify as Camborthids, Calciorthids, and Haplargids (Soil Survey Staff, 1975:159; Appendix A: Soils 5 and 6).

Ma2 surfaces correlate with Bull's (1991) Q3a (8-12 ka) and possibly some of the younger Q2c surfaces (12-70 ka). Ma2 surfaces also correlate with Gile and others' (1981) Isaac's Ranch surface which they age-estimate at 8-15 ka. The Ma2 surface probably dates to the last full glacial and is age-estimated at 10-20 ky ([Table 2](#)). (GRI Source Map ID 74379). ([OFR 92-07](#)).

Qi3r - River terrace and alluvium deposits (late Pleistocene)

Qi3r - Late Pleistocene river terrace and alluvium deposits (Pleistocene) - late Pleistocene river terrace deposits; Alluvium on river floodplains (Late Pleistocene (~10 to 130 ka). AzGS regional Surficial deposit unit, equivalent to Qlr on some older maps. (*GRI Source Map ID 74889*) ([DI-24](#)).

M - MGR Pleistocene terrace in the eastern GRIC area (Pleistocene) - M represents the only MGR Pleistocene terrace in the eastern GRIC area. This terrace grades into adjacent basin floors in the Casa Grande National Monument, Santan, Casa Blanca, and Snaketown areas. The M terrace is situated 3-6 m above the Holocene flood plain (Y1). As revealed near the surface, M sediments are predominantly fine textured (sand, silt, and clay), but it is probable that MGR cobbles and gravels occur at greater depth. Due to the paucity of gravels, the M surface tends to lack desert pavements. Soils tend to be clayey and calcareous with calcic horizons having Stage II-III carbonate morphology ([Table 1](#)). These soils classify as Haplargids and Natrargids.

Soil development and topographic position indicate that the M surface is late Pleistocene in age. The red, argillic soils record at least the last full glacial episode approximately 20 ka and provide a minimum age for the surface. Estimating an upper age for the M surface is more problematic. Since it grades into the floors of the Picacho and Phoenix basins, it is probable that the M surface is spatially diachronous. In age-correlating the M surface, it is easier to correlate that part which is MGR stream terrace. As a stream terrace, the M surface correlates with the Rio Grande's Picacho terrace which is estimated to be 25-75 ka (Gile and others, 1981). As a basin floor surface, the M surface may be older. A relatively wide age range of 20-200 ka is estimated for the M surface ([Table 2](#)). (*GRI Source Map ID 74379*). ([QFR 92-07](#)).

Qlrg - Late Pleistocene gravel deposits (10 to 130 ka) (Pleistocene) - Relatively coarse-grained Pleistocene river terraces and alluvial fans that are slightly higher than the surrounding younger surfaces. Qlrg deposits typically consist of pebbles, some cobbles, and sand. Soils associated with the deposits are classified as a Typic Calciorthids, with loam to sandy loam textures, massive to subangular blocky structure, and carbonate coated clasts and nodules with medium soft carbonate masses at a starting depth of 36-76 cm. Extremely gravelly soils in this unit have silica-lime cemented pan fragments at an average depth of 61 cm. (*GRI Source Map ID 74372*). ([OF 98-23](#)).

Qmlr - River deposits, older (middle to late Pleistocene)

Qmlr - Middle to late Pleistocene river deposits (10 to 500 ka) (Pleistocene) - Late or middle Pleistocene river terraces and alluvial fans on the basin floor. In areas that have been cultivated, topographic differences between Pleistocene and Holocene surfaces may be undetectable, but on historical aerial photos Pleistocene surfaces appear to be higher than surrounding younger surfaces. In addition to topographic relief, Qmlr soils are substantially more developed than younger soils. Qmlr soils are classified as Calciorthids, Haplargids and Natrargids; they are fine-grained, and generally have well developed structure and reddened argillic horizons and common soft carbonate nodules at a starting depth of 33 to 66 cm. Soils of the Casa Grande series, included in this unit have natric horizons. (*GRI Source Map ID 74372*). ([OF 98-23](#)).

Qi2 - Piedmont alluvium, older (middle to late Pleistocene)

Qi2 - Middle to late Pleistocene piedmont alluvium (Pleistocene) - Alluvial deposits that include sand, loamy sand, gravelly sand and minor gravel, poorly sorted with sand- to boulder-sized clasts. Preserved depositional surfaces in the upper piedmont form flat ridges separated by incised channels in shallow valleys, and deposits tend to be coarsely textured given their proximity to mountain slopes. Qm

surfaces are typically 2 to 10 m above modern channels. Desert pavement and rock varnish development is moderate to strong on stable surfaces, but variable to weak on highly eroded surfaces. Soils are thick and well developed with argillic, duric, and local petrocalcic horizons and brown to reddish brown surface colors. These soils typically contain reddish argillic horizons moderately to strongly enriched in pedogenic clay. Calcic horizon development is fairly strong (Stage II-IV), but soils generally do not have cemented petrocalcic horizons (caliche). These soils classify as Calciorthids, Haplargids, Petroargids, Paleargids, and Petrocalcids (Leighty, 1998; Soil Survey Staff, 1994). The combination of indurated soil and moderate to steep slope precludes substantial surface infiltration into these deposits. Surfaces are not prone to flooding, except near active washes. (GRI Source Map ID 74889) ([DI-24](#)).

Ma1p - Alluvial surface of soil number 3 (Pleistocene) - No additional unit description provided on source map. (GRI Source Map ID 74379). ([OFR 92-07](#)).

Qor - River deposits, oldest (early to middle Pleistocene)

Qor - Middle to early Pleistocene river deposits (-500 ka to 1 Ma) (Pleistocene) - Relict very old river terraces. These surfaces are distinguished by strong carbonate accumulation. Their soils are classified as Petrocalcic Paleargids. Typically, they have saline-sodic fine sandy loam argillic horizons with well developed prismatic to subangular blocky structure, which are underlain by petrocalcic horizons with a thin laminar cap at its top. These surfaces are altered by agricultural activity, and no stratigraphic exposures were observed. It is possible that the petrocalcic horizons are buried by thin packages of much younger surface deposits. (GRI Source Map ID 74372). ([OF 98-23](#)).

Qop - Piedmont deposits, oldest (early Pleistocene)

Qo - Early Pleistocene piedmont deposits (Pleistocene) - Alluvial fan surfaces and deposits that consist of typically very poorly sorted cobbles to clay, including angular to subangular cobbles and pebbles and clay. Deposits typically are very poorly sorted, including angular to subangular cobbles and pebbles with sand and minor silt and clay. These deposits are moderately consolidated and commonly are indurated by soil carbonate. Surfaces are moderately to deeply dissected, with 2 to 10 m of relief between channels and ridge crests. This unit occupies the highest topographic positions on the piedmonts and occurs only on the upper piedmont. Original fan surfaces have been removed by erosion, so the characteristic topographic expression of these deposits are alternating ridges and valleys. Soil development is moderate to strong, depending on local preservation. Reddish-brown argillic horizons are moderately- to well-developed on planar, relatively well-preserved alluvial surface remnants in the Daisy Mountain area. All soils are dominated by carbonate accumulation. Surfaces typically are littered by carbonate fragments derived from eroded or perturbed petrocalcic horizons; this gives Qo surfaces a light appearance on aerial photographs. Cemented petrocalcic horizons are commonly exposed on side slopes below ridge crests. (GRI Source Map ID 74889) ([DI-24](#)).

Tby - Gila Group, basalt (Tertiary)

Tby - Basalt, Gila Group (Tertiary) - No additional unit description provided on source map. (GRI Source Map ID 74889) ([DI-24](#)).

Talt - Apache Leap Tuff (Tertiary)

No additional unit description provided on source map. (GRI Source Map ID 74889) ([DI-24](#)).

Tsm - Superstition Tuff, Miners Needle break (Tertiary)

Tsm - Miners Needle break of the Superstition Welded Tuff (Tertiary) - This unit is named for a package of several (2-5) thin, welded or poorly welded flow units that crop out through the middle of Miners Needle (in the Weavers Needle Quadrangle). The flow units are bounded by sharp contacts. (*GRI Source Map ID 74889*) ([DI-24](#)).

Twsc - Whitetail Formation, sandstone and conglomerate (Tertiary)

Twsc - Sandstone and conglomerate, Whitetail Formation (Tertiary) - No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Twx - Whitetail Formation, granite breccia (Tertiary)

Twx - Granite breccia, Whitetail Formation (Tertiary) - No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

TKbi - Mafic dikes (Tertiary or Cretaceous)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

TKdi - Intermediate dikes (Tertiary or Cretaceous)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

TKri - Felsic dikes (Tertiary or Cretaceous)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Kd - Diorite (Cretaceous)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Kg - Quartz monzodiorite to quartz monzonite (Cretaceous)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Kv - Vein arrays (Cretaceous)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Yd - Diabase (middle Proterozoic)

Yd - Diabase (middle Proterozoic) - Dark grey-green diabase composed of 1-5 mm, interlocking, tabular, subhedral phenocrysts of green to black pyroxene, clear to white plagioclase, and 1-3 mm opaque minerals (magnetite?). The opaque minerals are commonly altered to red iron oxides. (*GRI Source Map ID 74889*) ([DI-24](#)).

Yg - K-feldspar porphyritic granite (middle Proterozoic)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Yge - Granite, equigranular phase (middle Proterozoic)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Ygs - Silicified granite (early to middle Proterozoic)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Xp - Pinal Schist, undifferentiated (early Proterozoic)

No additional unit description provided on source map. (*GRI Source Map ID 74889*) ([DI-24](#)).

Ancillary Source Map Information

AZGS OF 92-07, Sheet 6

Huckleberry, Gary, 1992, Surficial Geology of the Eastern Gila River Indian Community Area, Western Pinal County, Arizona: Blackwater 7.5' Quadrangle: Arizona Geological Survey, Open File Report OF 92-07, Sheet 6 of 6, scale 1:24,000. (*GRI Source Map ID 74379*).

Location Map

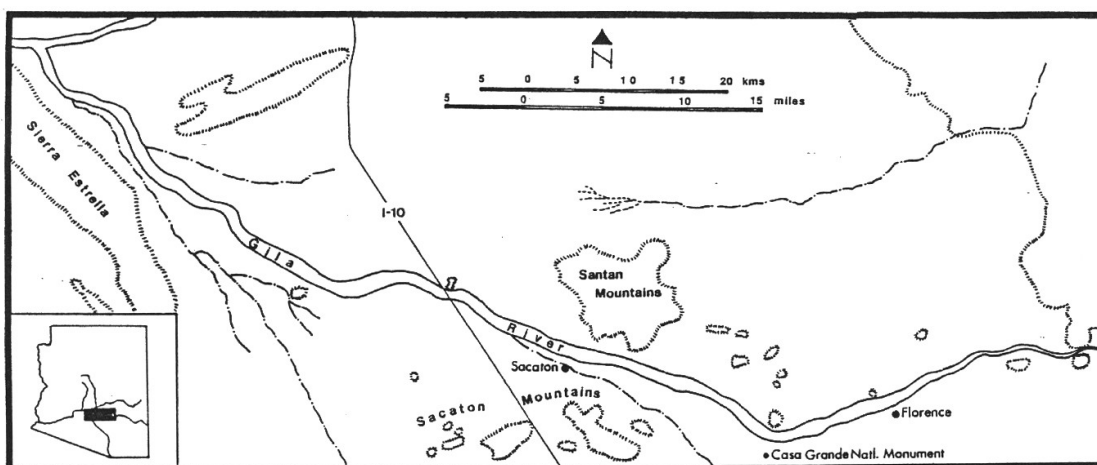


Figure 1. The middle Gila River area, south-central Arizona.

Extracted from: [OF 92-07](#) (*GRI Source Map ID 74379*).

Table 1. Physical Characteristics of Geomorphic Surfaces

Table 1. Physical characteristics of geomorphic surfaces.

MOUNTAIN UPLAND/PIEDMONT

Surface	Dissection	Drainage	Soil Horizons	CO3 Stage	Pavement/Varnish	Type Locality	Soil Description #
Ya2		dist. - anast.	C	0	none	ephemeral drainages	
Ya1a	< 1m	dist.	Bw,Bk,Cox	0	none	S of Twin Buttes	2,7
Ya1b	> 1m	dist. - dend.	Bw, Bk, Cox	I	none	Pit by I-10 rest area	4
Ma2	< 2 m	dendritic	Bw, Bk, Bt, Cox	I-II	none to moderate	Upslope from Olberg	5,6
Ma2'	> 3 m	dendritic	Bw, Bk, Cox	I	none to weak	Base of Sacaton Mts.	1
Ma1	> 3 m	dendritic	Bt, Bk, Bkm	II-III	moderate to strong	E of San Tan	3
Oa	> 6 m	dendritic	Bkm	III-V	moderate to strong	Upslope from Olberg	8

RIVER VALLEY/BASIN FLOOR

Surface	Dissection	Drainage	Soil Horizons	CO3 Stage	Pavement/Varnish	Type Locality
Y2		dist. - anast.	C	0	none	Gila River
Y2'		dist. - anast.	C	0	none	Little Gila River
Y2/Y1	< 3m	dist. - dend.	Bw, Bk, Cox	I	none	McClellan Wash
Y1	< 3m	dist. - dend.	Bw, Btn, Bk, Cox	I	none	Gila River floodplain
M	<4m	dendritic	Bt, Btn, Bk	II-III	none	Snaketown

Extracted from: [OF 92-07](#) (GRI Source Map ID 74379).**Table 2. Surface Correlation and Age Estimates**

Table 2. Surface Correlation and Age Estimates.

MOUNTAIN UPLAND/PIEDMONT

Middle Gila River (Huckleberry; this report)	Lower Colorado River Region (Bull 1991)	Las Cruces, N.M. (Gile and others 1981)	Estimated Landform Age
Ya2	Q4b	-	< 1 ka
Ya1a	Q4a	Fillmore	< 1 ka
Ya1b	Q3c	Fillmore	1-10 ka
Ma2 & Ma2'	Q3a	Isaac's Ranch	10-20 ka
Ma1	Q2a	Jornada I	100-500 ka
Oa	Q1	Dona Ana	> 500 ka

RIVER VALLEY/BASIN FLOOR

Middle Gila River (Huckleberry; this report)	Lower Colorado River Region (Bull 1991)	Las Cruces, N.M. (Gile and others 1981)	Estimated Landform Age
Y2	Q4b	-	< 1 ka
Y2'	Q4b	-	< 1 ka
Y2/Y1	Q4a	Fillmore	< 1 ka
Y1	Q3c	Fillmore	< 10 ka
M	-	Picacho	20-200 ka

Extracted from: [OF 92-07](#) (GRI Source Map ID 74379).

Report

The report associated with OF 92-07 is provided as a PDF.

[azgs_of_92-07.pdf](#) (double-click link to open embedded report document)

AZGS OF 98-23, Sheet 4

Klawon, J.E., et.al., 1998, Geology and Geologic Hazards of the Casa Grande Area, Pinal County, Arizona: Geologic Map of the Coolidge 7.5' Quadrangle: Arizona Geological Survey, Open-File Report OF 98-23, Sheet 4 of 6, scale 1:24,000. (GRI Source Map ID 74372).

Location Map

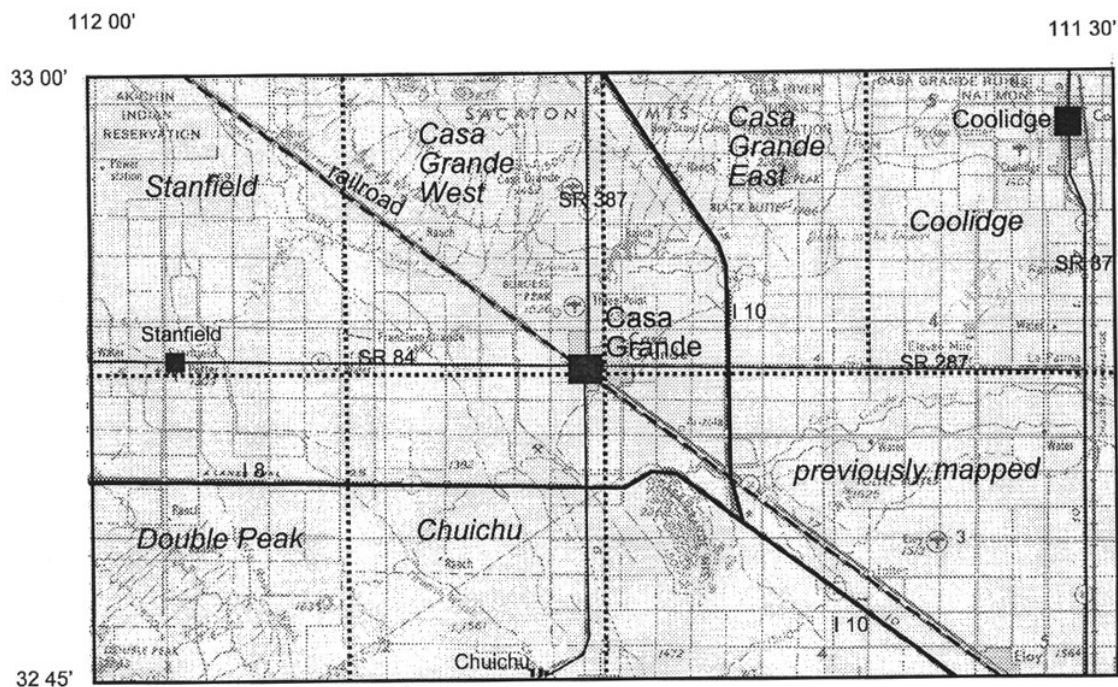


Figure 1. Location map for geologic mapping in the Casa Grande area. The six quadrangles mapped for this project are labeled. The Casa Grande Mountains and Eloy North quadrangles in the southeastern part of the index map were mapped previously by Jackson (1990).

Extracted from: [OF 98-23](#) (GRI Source Map ID 74372).

Flood Hazards Map

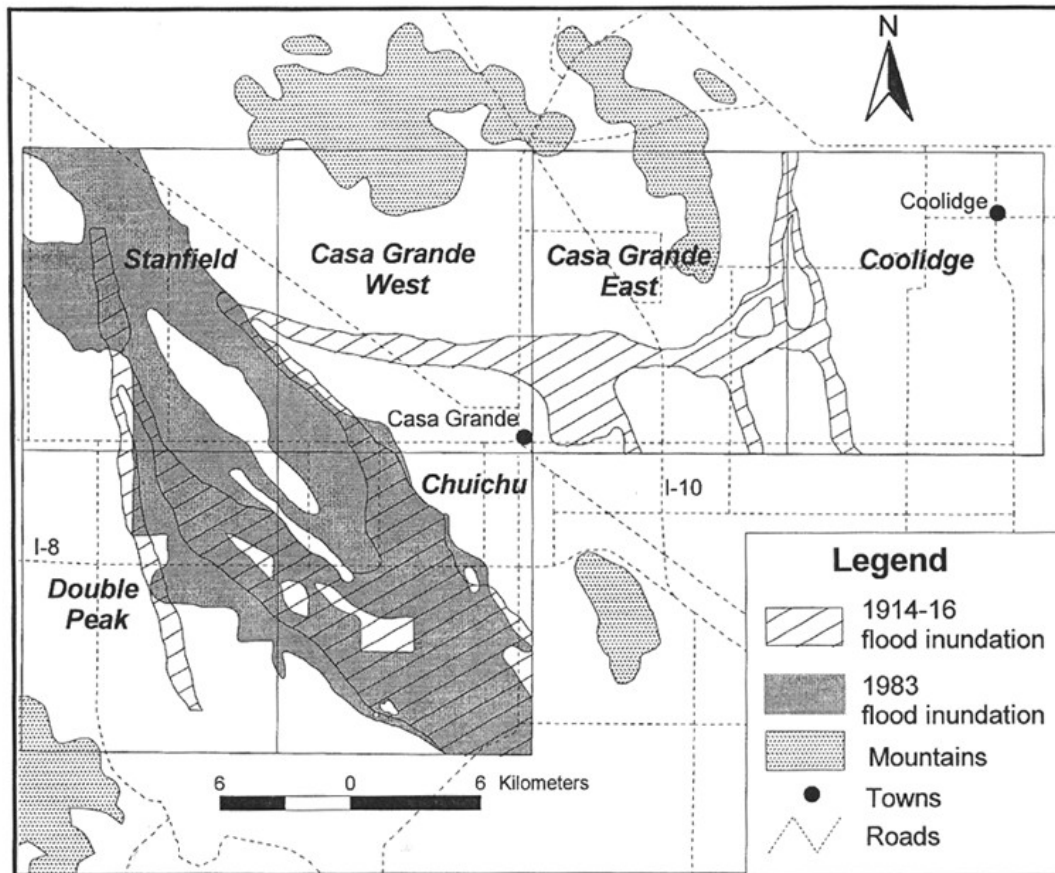


Figure 2. Flood Hazards of the Casa Grande area

The most significant floods which have affected the study area include those of 1914-16, mapped by Smith (1938; 1940) and 1983, mapped by Roeske et al (1989). Present flood hazards are reflected most accurately by the extent of flooding in 1983 due to channel changes in the early 1900's. (modified from Wood, et al, 1996).

Extracted from: [OF 98-23](#) (GRI Source Map ID 74372).

Report

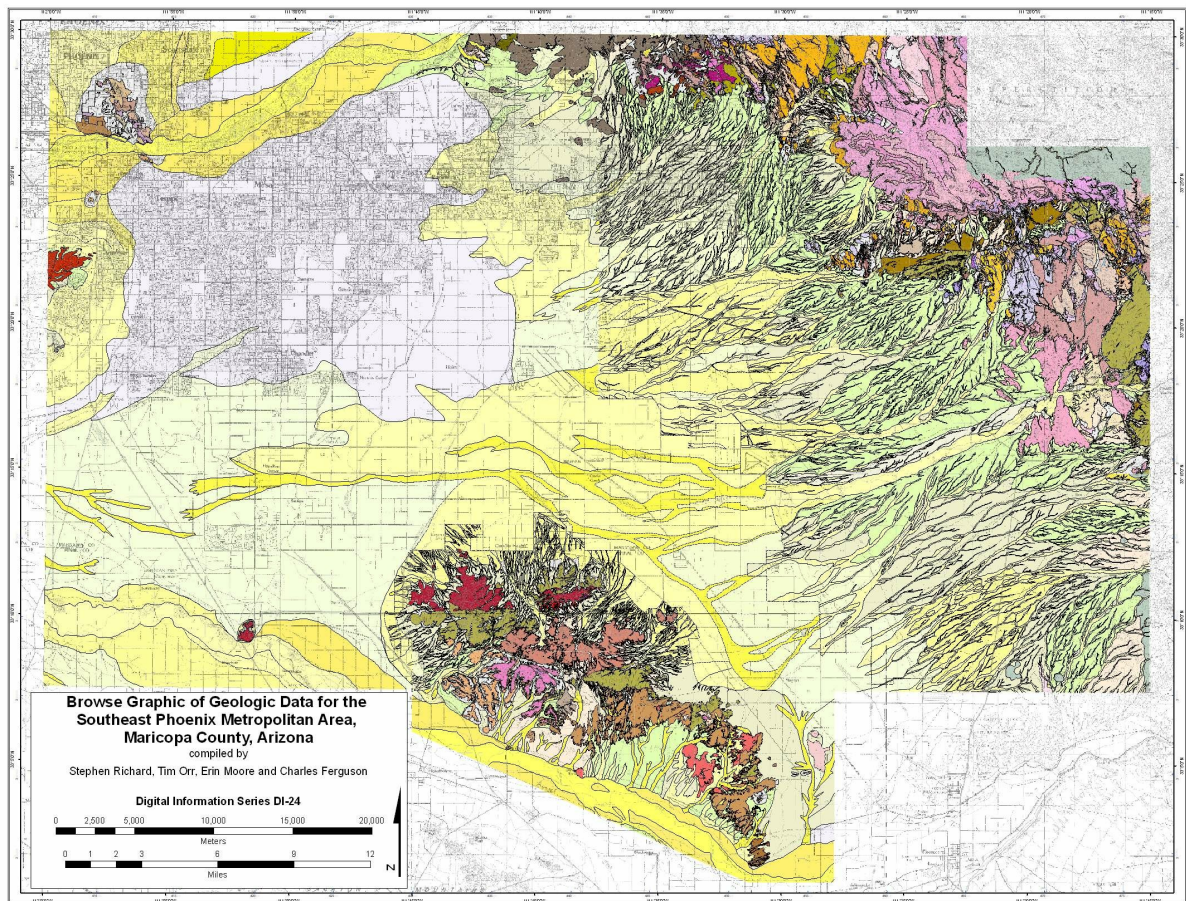
The report associated with OF 92-07 is provided as a PDF.

[azgs_of_98-23.pdf](#) (double-click link to open embedded report document)

AZGS DI-24

Richard, Stephen, Tim, Orr, Moore, Erin and Ferguson, Charles, 2006, Geologic Data for the Southeast Phoenix Metropolitan Area, Maricopa and Pinal Counties, Arizona: Arizona Geological Survey, unpublished digital data DI-24, scale 1:24,000. (*GRI Source Map ID 74889*).

Map Graphic



Extracted from: [DI-24](#) (*GRI Source Map ID 74889*).

GRI Digital Data Credits

This document was developed and completed by Stephanie O'Mewara for the NPS Geologic Resources Division (GRD) Geologic Resources Inventory(GRI) Program. Quality control of this document by Stephanie O'Meara and James Winter.

The information in this document was compiled from GRI source maps and is intended to accompany the digital geologic-GIS map and other digital data for Casa Grande Ruins National Monument, Arizona (CAGR) developed by Stephanie O'Meara (see the [GRI Digital Map and Source Map Citations](#) section of this document for all sources used by the GRI in the completion of this document and related GRI digital geologic-GIS map). GRI digital geologic-GIS data was derived from an earlier 2008 GRI version of the dataset produced by Phillip Reiker (NPS GRD) and Stephanie O'Meara.

GRI finalization by Stephanie O'Meara.

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