Spatial Digital Database for the Tectonic Map of Southeast Arizona

Map by Harald Drewes[1]
Digital database by Robert A. Fields[2], Douglas M. Hirschberg[3], and
Karen S. Bolm[2]

Miscellaneous Investigations Series Map I-1109
Digital database, version 2.0

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(Map originally published in 1980)

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U.S. DEPARTMENT OF THE INTERIOR
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[1] U.S. Geological Survey
[2] U.S. Geological Survey, 520 N. Park Ave., Tucson, Arizona 85719
[3] University of Arizona, 520 N. Park Ave., Tucson, Arizona 85719

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Introduction

A spatial database was created for Drewes' (1980) tectonic map of southeast Arizona: this database supercedes Drewes and others (2001, ver. 1.0). Staff and a contractor at the U.S. Geological Survey in Tucson, Arizona completed an interim digital geologic map database for the east part of the map in 2001, made revisions to the previously released digital data for the west part of the map (Drewes and others, 2001, ver. 1.0), merged data files for the east and west parts, and added additional data not previously captured. Digital base map data files (such as topography, roads, towns, rivers and lakes) are not included: they may be obtained from a variety of commercial and government sources.

This digital geospatial database is one of many being created by the U.S. Geological Survey as an ongoing effort to provide geologic information in a geographic information system (GIS) for use in spatial analysis. The resulting digital geologic map database can be queried in many ways to produce a variety of geologic maps and derivative products. Because Drewes' (1980) map sheets include additional text and graphics that were not included in this report, scanned images of his maps (i1109_e.jpg, i1109_w.jpg) are included as a courtesy to the reader. This database should not be used or displayed at any scale larger than 1:125,000 (for example, 1:100,000 or 1:24,000). The digital geologic map plot files (i1109_e.pdf and i1109_w.pdf) that are provided herein are representations of the database (see Appendix A).

The map area is located in southeastern Arizona (fig. 1). This report describes the map units (from Drewes, 1980), the methods used to convert the geologic map data into a digital format, the ArcInfo GIS file structures and relationships, and explains how to download the digital files from the U.S. Geological Survey public access World Wide Web site on the Internet. The manuscript and digital data review by Helen Kayser (Information Systems Support, Inc.) is greatly appreciated.

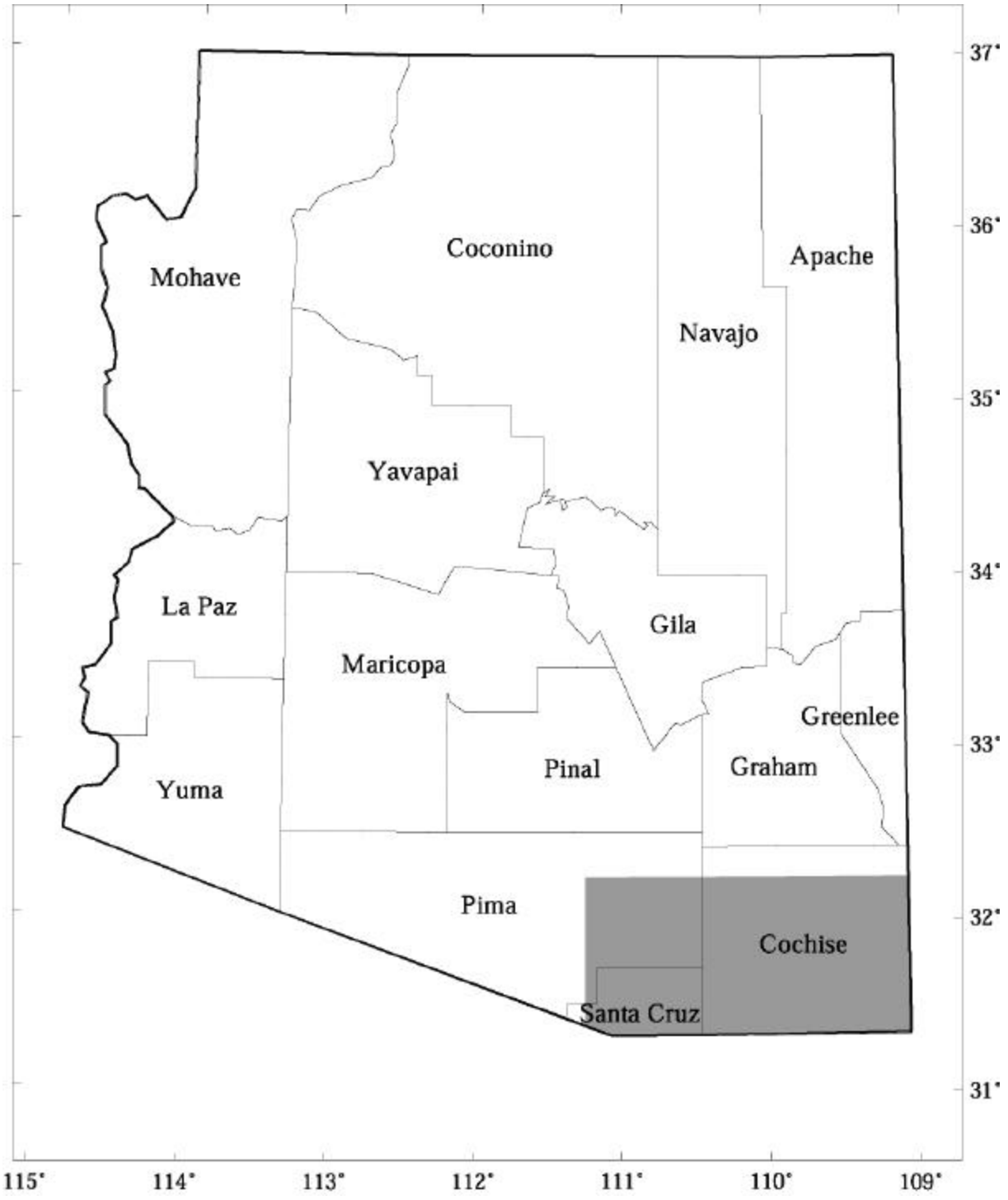

Figure 1. Index map showing the geographic extent of the mapped area (shaded fill) with respect to counties in Arizona

Description of Map Units

Drewes' (1980) descriptions of map units are included below. Radiometric dates presented herein cover primary rock ages.

SURFICIAL DEPOSITS

Qg Gravel, sand, and silt (Holocene and Pleistocene)—Alluvium pediments; includes some colluvium and soils. Deposits mostly light-gray, unindurated, and of poorly rounded and locally-derived clasts, except along larger valley-center rivers. Mostly several meters thick but as much as a hundred meters thick.

Qd Sand and silt (Holocene)—Eolian deposits, mainly of dunes but including beach ridges reworked into dunes. Unit is probably as much as several meters thick in most places.

Qp Gravel, sand, silt, and clay (Pleistocene)— Pluvial lake deposits, including beach gravel in low ridges. Deposits well sorted and mostly unconsolidated; gravel well rounded. Thickness unknown.

QTg Gravel, sand, and silt (Pleistocene and Pliocene)—Mainly alluvium of basins; includes some colluvium and landslide deposits. Generally light-pinkish gray, weakly indurated, and with poorly rounded clasts; locally well indurated. Thickness several meters to hundreds of meters.

QTgu Gravel, sand, and silt (Holocene to Miocene)—Alluvium of floodplains, terraces, pediments, and basins, undifferentiated. Commonly a few tens of meters to hundreds of meters thick.

QTb Basalt (Pleistocene to Pliocene)—Lava flows, pyroclastic rocks, and some intercalated gravel. Thickness several meters to a few hundred meters in most places. Radiometrically dated at 0.25, 1.0, and 3.2 m.y. old

Tuc Upper conglomerate, gravel, and sand (Pliocene and Miocene)—Alluvium; mainly deposits rich in volcanic fragments derived from underlying or nearby rhyolite rocks. Thickness several tens of meters to hundreds of meters.

IGNEOUS AND SEDIMENTARY ROCKS

Tb Basalt (Miocene)—Lava flows, pyroclastic rocks, and some dikes and intercalated gravel, of andesitic basalt. Mostly about 1 meter to several meters thick. Includes a younger group radiometrically dated at 13 and 14 m.y. old, and an older group dated at 20, 23, 24, 25, and 25 m.y.

Tc Conglomerate (Miocene to Eocene?)—Mostly reddish-gray poorly indurated to moderately indurated rock with subrounded clasts; locally includes some

landslide deposits, and some bodies of tuff and coarsely porphyritic andesite too small to be mapped separately. Commonly several tens to hundreds of meters thick.

Tva Extrusive andesite and dacite (Miocene and upper Oligocene)—Lava flows, pyroclastic rocks, some intercalated epiclastic rocks, and dikes. Mostly gray, fine-grained, porphyritic rocks; includes some very coarse feldspar porphyry andesite (Turkey track porphyry, an informal term of Cooper, 1961). Thickness mostly several meters to several tens of meters. Dated at 24, 25, 27, 33, and 39 m.y.

Tv Extrusive rhyolite and rhyodacite (Miocene and upper Oligocene)—Lava flows, weldedtuff, pyroclastic rocks, and some intercalated epiclastic rocks. Light-gray to grayish-pink, vitric to fine-grained, porphyritic. Commonly a few tens to a few thousands of meters thick. Dated at 23, 24, 25, 26, 26, 26, 26, and 27 m.y. An additional date of 47 m.y., if substantiated, may indicate the presence of Eocene rocks in the lower member of the S O Volcanics of Cochise Co.

Tug Granitoid rocks (Miocene and upper Oligocene)—Granite(?), quartz monzonite, and granodiorite in stocks and small intrusive bodies. Dated at 22(?), 26, 28, 29, 30, 31, 31, and 33 m.y.

Ti Intrusive rhyolite and rhyodacite (upper Oligocene)—Plugs, laccoliths, and dikes; probably genetically related to volcanic rocks nearby. Mostly gray to pink, vitric to fine-grained, porphyritic, massive to flow-laminated. Dated at 24, 25, 26, 26, 26, 27, and 29 m.y.

Ta Andesite (Oligocene and Eocene?)—Lava flows, pyroclastic rocks, and epiclastic rocks. Mainly greenish-gray propylitized pyroxene- or amphibole-bearing feldspar porphyries.

Tlc Lower conglomerate, gravel, and sand (Oligocene and Eocene?)—Alluvium; commonly grayish-red deposits of small, well rounded, nonvolcanic clasts. Mostly several meters to a few tens of meters thick.

CORDILLERAN (LARAMIDE) IGNEOUS AND SEDIMENTARY ROCKS

Tg Granitoid rocks (upper Paleocene)—Mostly quartz monzonite and granodiorite stocks and some quartz diorite stocks. Includes some aphanitic porphyries. Dated at 47(?), 51, 51, 52, 54, 54, 60, and 60 m.y.

Tlp Quartz latite porphyry (upper Paleocene)—Plugs, breccia pipes, and dikes. In many places associated with mineralization. Dated at 56, 56, and 56 m.y.

Tlv Lower volcanic rocks (lower Paleocene)—Rhyolite to andesite lava flows, pyroclastic rocks, and some intercalated epiclastic rocks. Dated at 57 m.y. Possibly younger age to east.

Tlg Lower granitoid rocks (lower Paleocene)—Granodiorite and quartz monzonite stocks. Locally associated with mineralization. Dated at 58, 58, 59, 59, 60, 62, and 64 m.y.

TKp Porphyritic and aplitic intrusive rocks (Paleocene and Upper Cretaceous)—Mostly latitic porphyry to dacitic porphyry in small stocks and plugs and aplitic bodies not associated with other granitoid stocks. Dated at 61, 63, 63, 64, and 65 m.y.

Kd Diorite and quartz diorite (Upper Cretaceous)—Stocks of dark-gray fine- to medium-grained rocks. Locally associated with mineralization. Dated at 67 and 67 m.y.

Kq Quartz monzonite (Upper Cretaceous)— Stocks of pinkish-gray medium-grained rock. Dated at 68, 69, and 70 m.y.

Kg Granodiorite (Upper Cretaceous)—Stocks of gray, medium-grained, locally porphyritic rock. Dated at 68 m.y.

Kus Upper sedimentary rocks (Upper Cretaceous)—Mainly conglomerate and sandstone; includes some tuffaceous rocks. Thickness as much as several hundreds of meters.

Kr Rhyodacite tuff and welded tuff (Upper Cretaceous)—Includes parts of Salero Formation, Sugarloaf Quartz Latite, and Bronco Volcanics, and all of Red Boy Rhyolite, Cat Mountain Rhyolite of Brown (1939) and Uncle Sam Porphyry. Includes local intrusive bodies and locally contains fragments of exotic rocks. Thickness commonly several tens of meters to several hundreds of meters. Dated at 66(?), 70, 72, 72, 73, and 73 m.y.

Ka Andesitic to dacitic volcanic breccia (Upper Cretaceous)—Includes parts of Salero Formation, Sugarloaf Quartz Latite, and Bronco Volcanics, and all of Demetrie Volcanics and Silverbell Formation of Courtright (1958). Commonly contains large blocks of exotic rocks and locally includes some sedimentary rocks and intrusive rocks. Several tens of meters to several hundreds of meters thick in most places.

Kuvs Volcanic and sedimentary rocks, undifferentiated (Upper Cretaceous)—Mainly andesitic to rhyolitic pyroclastic rocks, and epiclastic rocks. Commonly several tens of meters to several hundreds of meters thick.

Klq Lower quartz monzonite and granodiorite (Upper Cretaceous)—includes some quartz diorite; appears in small stocks. Locally associated with mineralization. Dated at 70, 71, 72, 73, 74, 74, 74, and 76 m.y.

Ks Sedimentary rocks (Upper Cretaceous)—Includes Fort Crittenden Formation and formation near Javelina Canyon of Epis (1956). Mainly conglomerate, sandstone,

and siltstone; includes some red beds, fossiliferous black shale, and tuffaceous rocks. Thickness several tens to several hundreds of meters.

Ki Rhyodacite porphyry (Upper and Lower Cretaceous)—Mainly stocks, sills, and some dikes but possibly includes some tuffs. Some of the rocks may be as young as rhyodacite tuff and welded tuff.

IGNEOUS AND SEDIMENTARY ROCKS

Kb Bisbee Formation or Group, undifferentiated (Lower Cretaceous)

Kbu Upper part of Bisbee Formation or Group, undifferentiated, and related rocks—includes upper part of Bisbee Formation, Mural Limestone, Morita, Cintura, Willow Canyon, Apache Canyon, Shellenberger Canyon and Turney Ranch Formations (not listed in stratigraphic sequence) of the Bisbee Group, Armole Arkose of Bryant and Kinnison (1954), and Angelic Arkose. Consists of brownish- to reddish-gray arkose, siltstone, sandstone, conglomerate, and some fossiliferous gray limestone. Commonly several hundred meters thick.

Kbg Glance Conglomerate of Bisbee Group, or Glance Conglomerate Member of Bisbee Formation—Typically limestone-pebble-and cobble conglomerate; locally granite or schist conglomerate. Mostly less than 10 meters thick; locally several hundreds of meters thick.

Klvs Lower volcanic and sedimentary rocks (Lower Cretaceous)—Andesitic to rhyolitic volcanic rocks, conglomerate, and sandstone. As much as several hundreds of meters thick.

Jg Granite and quartz monzonite (Jurassic)—Stocks of pinkish-gray coarse-grained rock. Locally associated with mineralization. Dated at 140, 148, 148, 149, 149, 150, 153, 160, 161, 167, 178, and 185 m.y.

JTRi Intrusive rocks (Jurassic and Triassic)—Rhyolitic porphyry plutons, dikes, and sills.

JTRvs Volcanic and sedimentary rocks (Jurassic and Triassic)—Rhyolitic tuff, welded tuff, lava, sandstone, and conglomerate. As much as several hundreds of meters thick. Dated at 143 and 173 m.y.

TRm Monzonitic rocks (Triassic)—Stocks of dark-gray very coarse-grained monzonite and quartz monzonite. Dated at 184, 190, and 210 m.y.

TRs Sedimentary rocks (Triassic)—Red mudstone, sandstone, and conglomerate, and intercalated rhyodacite volcanic rocks. As much as several hundreds of meters thick. Dated at 192 m.y.

TRvs Volcanic and sedimentary rocks (Triassic)—Rhyolitic to andesitic lava and pyroclastic rocks and intercalated sandstone, quartzite, and some conglomerate. As much as 3000 meters thick. Dated at 220 m.y.

PZs Sedimentary rocks (Paleozoic)—Rainvalley Formation (Lower Permian) to Bolsa Quartzite (Middle Cambrian), undifferentiated.

PPn Naco Group (Lower Permian and Pennsylvanian)—Rainvalley Formation, Concha Limestone, Scherrer Formation, Epitaph Dolomite, Colina Limestone, Earp Formation, and Horquilla Limestone, undifferentiated.

Ps Sedimentary rocks (Lower Permian)—Consists of Rainvalley Formation, Concha Limestone, and Scherrer Formation, undifferentiated. Rainvalley Formation is a sparsely fossiliferous limestone, dolomite, and some sandstone, 90-120 meters thick. Concha Limestone is dark-gray, cherty, fossiliferous limestone, 120-180 meters thick. Scherrer Formation is a light-pinkish-gray fine-grained quartzite with some basal reddish-gray siltstone and a medial gray dolomite unit 240-310 meters thick.

PPs Sedimentary rocks (Lower Permian and Upper Pennsylvanian)—Consists of Epitaph Dolomite (Lower Permian), Colina Limestone (Lower Permian), and Earp Formation (Lower Permian and Upper Pennsylvanian), undifferentiated. Epitaph Dolomite is a dark- to light-gray slightly cherty dolomite, limestone, marl, siltstone, and gypsum, 120-280 meters thick. Colina Limestone is a medium-gray, thick-bedded, sparsely cherty, and sparsely fossiliferous limestone 120-280 meters thick. Earp Formation is a pale-red siltstone, mudstone, shale, and limestone, 120-240 meters thick.

PPh Horquilla Limestone (Upper and Middle Pennsylvanian)—Light-pinkish-gray, thick- to thin-bedded, cherty, fossiliferous limestone and intercalated pale brown to pale reddish-gray siltstone that increases in abundance upward. Typically 300-490 meters thick.

MDs Sedimentary rocks (Mississippian and Devonian)—Consists mainly of Escabrosa Limestone (Mississippian)—locally (Armstrong and Silberman, 1974) called Escabrosa Group—and Martin Formation (Upper Devonian), undifferentiated. In part of the Chiricahua Mountains also includes Paradise Formation (Upper Mississippian) and Portal Formation of Sabins, 1957a (Upper Devonian). In the Little Dragoon Mountains and some adjacent hills also includes Black Prince Limestone, whose fauna and correlation show strongest affinities with Mississippian rocks but which may include some Pennsylvanian rocks. Escabrosa Limestone is a medium-gray, massive to thick-bedded, commonly crinoidal, cherty, fossiliferous limestone 90-310 meters thick. Martin Formation is thick- to thin-bedded, gray to brown dolomite, gray sparsely fossiliferous limestone, and some siltstone and sandstone, 90-120 meters thick. Paradise Formation is a brown, fossiliferous, shaly limestone. Portal Formation is a black shale and

limestone 60-105 meters thick. Black Prince Limestone is a pinkish-gray limestone with a basal shale and chert conglomerate, as much as 52 meters thick.

O€s El Paso Limestone (Lower Ordovician and Upper Cambrian), Abrigo Formation (Upper and Middle Cambrian), and Bolsa Quartz (Middle Cambrian), undifferentiated—El Paso Limestone is a gray, thin-bedded cherty limestone and dolomite 90 meters to about 220 meters thick. Abrigo Formation is a brown, thin-bedded fossiliferous limestone, sandstone, quartzite, and shale, 210-240 meters thick. Bolsa Quartzite is a brown to white or purplish-gray, thick-bedded, coarse-grained quartzite and sandstone with a basal conglomerate, 90-180 meters thick. To the east, equivalents of part of the Abrigo Formation and Bolsa Quartzite are known as the Coronado Sandstone.

€s Sedimentary rocks (Upper and Middle Cambrian)—Abrigo Formation (Upper and Middle Cambrian), and Bolsa Quartzite (Middle Cambrian), undifferentiated.

Yd Diabase (Precambrian Y)—Includes metadiabase, in sills, dikes, and possibly a small pluton.

Ya Apache Group (Precambrian Y)— Mainly Dripping Spring Formation and Pioneer Formation. Dripping Spring Formation is a pale to dark-brown arkosic sandstone and quartzite, as much as 90 meters thick. Barnes Conglomerate Member locally at base of Dripping Spring is a round-pebble conglomerate with clasts of quartzite and jasper, as much as 5 meters thick. Pioneer Formation is a grayish-red to purplish-gray siltstone and mudstone, as much as 90 meters thick. Scanlan Conglomerate Member locally at base of Pioneer is a subangular-pebble conglomerate with clasts of granitoid rocks and vein quartz. Member is as much as 10 meters thick.

Yg Mainly granodiorite and quartz monzonite (Precambrian Y)—Unfoliated to foliated, in part metamorphosed. Generally in stocks, which have been little studied.

Yw Wrong Mountain Quartz Monzonite (Precambrian Y)—A 2-mica gneissic rock thermally metamorphosed during the Oligocene and possibly related to a Paleocene magmatic event, but with relicts of Precambrian(?) age recorded locally.

Yr Rincon Valley Granodiorite (Precambrian Y)—Typically unfoliated biotite granodiorite and locally hornblende-biotite granodiorite. Dated at 1450, 1540, and 1560 m.y.

Yc Continental Granodiorite (Precambrian Y)—Very coarsely porphyritic granodiorite, metagranodiorite, and gneissic granodiorite, possibly of batholithic-sized bodies. Dated as 1360 and 1450 m.y., and possibly slightly older.

Yt Tungsten King Granite (Precambrian Y)—Coarse-grained porphyritic biotite granite.

Xj Johnny Lyon Granodiorite (Precambrian Y)—Commonly an altered, massive, hornblende-biotite granodiorite; locally a biotite granodiorite and locally metamorphosed. Dated at 1630 m.y.

Xp Pinal Schist (Precambrian X)—Chlorite schist, phyllite, and some metavolcanic rocks, metaquartzite, metaquartzite conglomerate, and gneiss. One metavolcanic rock dated at 1715 m.y.

Xi Rhyolite porphyry (Precambrian X)—Stocks and intrusive sheets; mainly older than regional metamorphism but some sheets younger than metamorphism.

Data Sources, Processing, and Accuracy

Optronics Specialty Co., Inc. (Northridge, CA) scanned contacts and faults from the published paper maps by Drewes (1980) under contract to the U.S. Geological Survey in 2000 and 2001. Because neither original mylars nor unfolded maps were available, folded maps were pressed with a dry iron prior to being scanned. Contractors at the Spokane Field Office developed a registration tic file from the original map sheets (Drewes, 1980) and transformed the data (Appendix B). The spatial digital database in version 2.0 contains revisions to the version 1.0 database, new GIS for the east half of the Drewes (1980) tectonic maps and additional data such as structural attitude of bedding, foliation, lineation and fault planes, rock sample collection sites, marker beds and geomorphic feature data.

U.S. Geological Survey staff and contractors edited the spatial and attribute data, standardized the database, and compared plots of the database with the original published maps to identify and correct digitizing and attribution errors. In a few instances, map units with a very small areal extent had to be interpreted since they could not be conclusively identified on the original map. Due to the cartographic nature of line decorations on the original map, segments of particular faults had to be interpreted as to where a given fault type started and ended. Fault lines on the Drewes (1980) map that were decorated with a ball and bar and no dip arrow were attributed as faults with normal movement. A few bedding symbols did not have a dip value and were excluded from the database. Final processing at the US Geological Survey was done in ArcInfo (version 7.2.1) installed on Sun Ultra and Microsoft NT workstations.

The overall accuracy (with respect to the location of lines, points and polygons) of the digital geologic map is probably no better than ± 187 meters. This database should not be used or displayed at any scale larger than 1:125,000 (for example, 1:100,000 or 1:24,000). Figure 2 is a simplified page size explanation of the map units and figure 3 is a page size plot of a simplified portion of this database.

Figure 2. Explanation of the simplified tectonic map of southeast Arizona

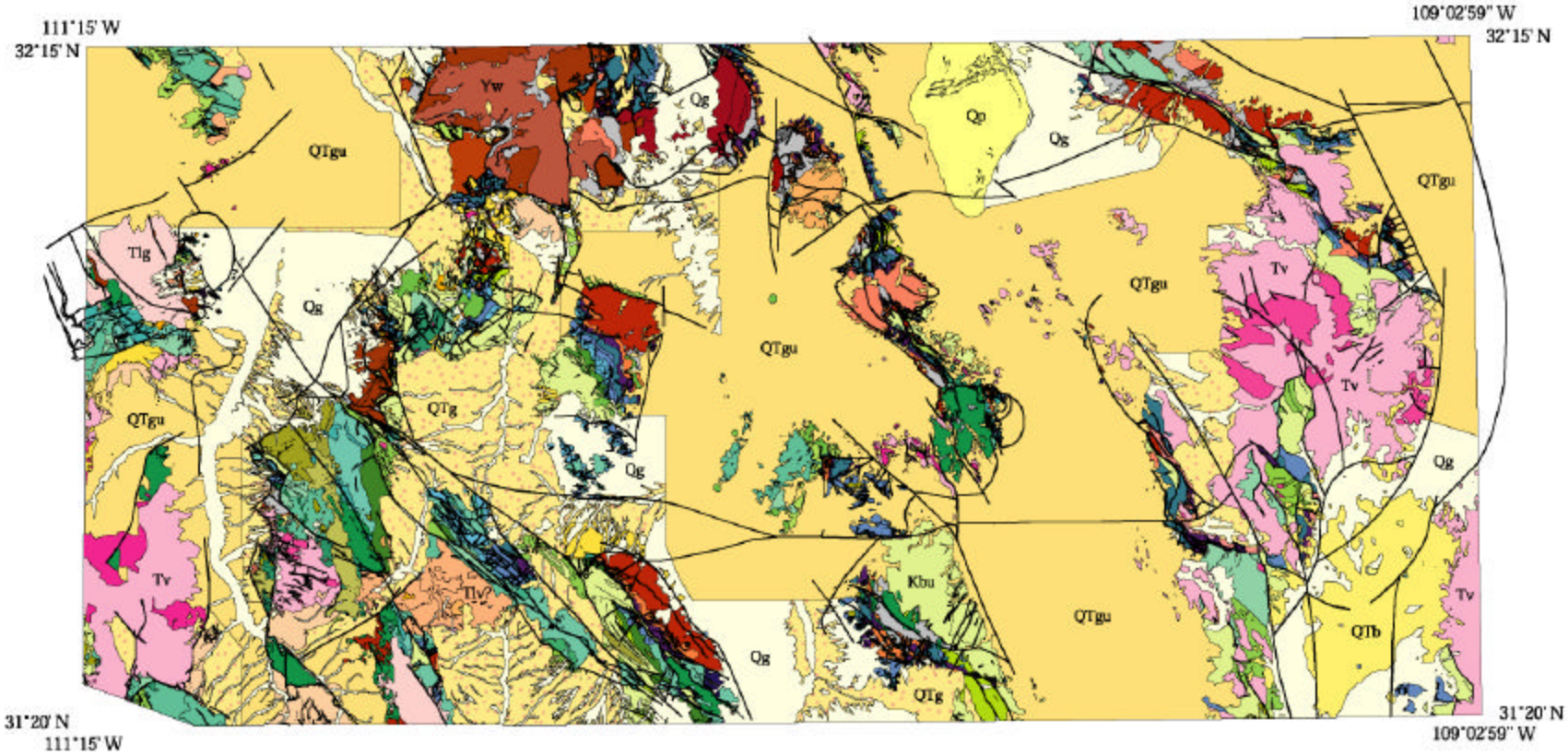

Figure 3. Simplified tectonic map of southeast Arizona

GIS Documentation

The primary database for the digital tectonic map of southeast Arizona includes a linear feature attribute table, i1109.aat, that relates to the i1109.con, i1109.st2, i1109.lgu and i1109.ref files and a rock unit (areal features) polygon attribute table, i1109.pat, that relates to the i1109.ru and i1109.ref files. Point features representing structural attitudes of fault planes, bedding, foliation and lineation are located in the point attribute table, i1109sdp.pat, which relates to the i1109sdp.ref file. Geomorphic features such as paleoplayas, exotic breccia zones and maar craters are stored in the polygon attribute table, i1109gm.pat, which relates to the i1109gm.ref file. Points representing cinder cones are located in the point attribute table, i1109cin.pat, which relates to the i1109cin.ref file. Points representing rock sample sites are contained in the point attribute table, i1109sam.pat, which relates to the i1109sam.ref file. These data files are described below. The relationships between the feature attribute files and related look-up tables are shown in Figure 4.

Linear Features

Geology dataset

Descriptions of the items identifying linear features such as contacts, boundaries (lines of latitude and longitude, state boundaries) and structures in the geology arc (or line) attribute table, i1109.aat, are as follows:

i1109.aat			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code used to identify type of linear feature. Linecodes < 100 are used for contacts and boundaries, which are described in the i1109.con file. Linecodes > 100 and < 600 represent structural features, which are described in the i1109.st2 file. Line codes >800 represent geologic units such as dikes, sills and marker beds.
name	character	30	Name given to structural feature.
source	integer	4	Numeric code used to identify the data source for the linear feature. Complete references for the sources are listed in the i1109.ref file.

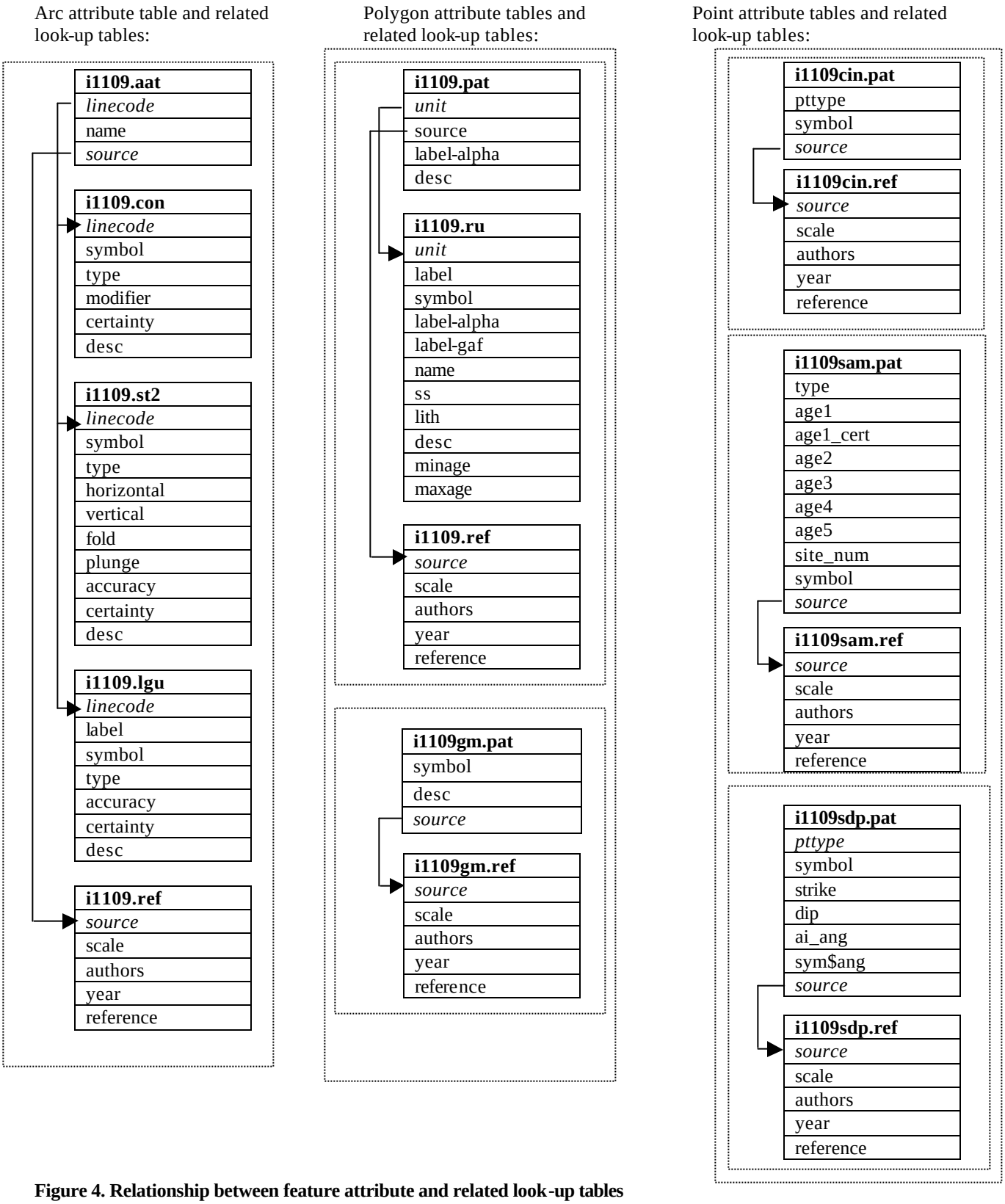

Figure 4. Relationship between feature attribute and related look-up tables

Attribute descriptions for items in the contact (and boundary) look-table, i1109.con, are as follows:

i1109.con			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code (a value < 100) used to identify type of contact or boundary. (This item also occurs in i1109.aat).
symbol	integer	3	Line symbol number used by ArcInfo to plot lines. Symbol numbers refer to the geol_dia.lin lineset.
type	character	10	Major type of line, for example, contact, marker horizon, state boundaries, lines of latitude and longitude used for neatlines.
modifier	character	20	Line type modifier, for example, approximate, concealed, gradational. No entry implies 'known'.
certainty	character	15	Degree of certainty of contact or boundary, inferred, uncertain. No entry implies 'certain'.
desc	character	100	Written description or explanation of contact or boundary.

Attribute descriptions for items in the structure look-up table, i1109.st2, are as follows:

i1109.st2			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code (a value > 100 and < 600) used to identify type of structural feature. (This item also occurs in i1109.aat).
symbol	integer	3	Line symbol number used by ArcInfo to plot arc (line). Symbol numbers refer to the geol_dia.lin lineset.
type	character	10	Major type of structure, for example, fault, fracture, fold, other.
horizontal	character	20	Type of horizontal fault movement, for example, left lateral, right lateral. No entry implies 'unknown'.
vertical	character	20	Type of vertical fault movement, for example, normal. No entry implies 'unknown'.
fold	character	15	Type of fold, for example, anticline, syncline.
plunge	character	15	Type of plunge on fold, for example, horizontal, plunging, plunging in, plunging out.
accuracy	character	15	Line type modifier indicating degree of accuracy, for example, approximately located, concealed, gradational. No entry implies 'known'.
certainty	character	15	Degree of certainty of contact or boundary, for example, inferred, uncertain. No entry implies 'certain'.
desc	character	100	Written description or explanation of structural feature.

Attribute descriptions for items in the linear geologic unit look-up table, i1109.lgu, are as follows:

i1109.lgu			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
linecode	integer	3	Numeric code (a value > 800) used to identify type of linear geologic unit. (This item also occurs in i1109.aat).
label	character	10	Map label used in the map proper to identify map unit.
symbol	integer	3	Line symbol number used by ArcInfo to plot linear geologic unit. (Symbol numbers refer to the geol_dia.lin lineset).
type	character	10	Major type of linear geologic unit, for example, dike, vein, marker bed or other.
accuracy	character	15	Line type modifier indicating degree of accuracy, for example, approximate, concealed, gradational. No entry implies 'known'.
certainty	character	15	Degree of line type certainty, for example, inferred, uncertain. No entry implies 'certain'.
desc	character	100	Written description or explanation of linear geologic units.

Areal Features

Geology dataset

Descriptions of the items identifying geologic units in the polygon attribute table, i1109.pat, are as follows:

i1109.pat			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
unit	integer	4	Numeric code used to identify the rock unit described in the i1109.ru look-up table. (This item also occurs in i1109.ru.)
source	integer	4	Numeric code used to identify the data source for the rock unit. Complete references for the sources are listed in the i1109.ref file.
label-alpha	character	10	Rock unit label (abbreviation) used to label unit on map with standard alphabetic characters. (This item was joined from the i1109.ru look-up table.)
desc	character	250	Formal or informal unit name. (This item was joined from the i1109.ru look-up table.)

Attribute descriptions for items in the lithology (rock unit) look-up table, i1109.ru, are as follows:

i1109.ru			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
unit	integer	4	Numeric code used to identify rock unit (this item also occurs in i1109.pat).
label	character	10	Rock unit label (abbreviation) used to label unit on the map. This item was calculated equal to 'label-gaf'.
symbol	integer	3	Shadeset symbol number used by ArcInfo to plot a filled/shaded polygon. The symbol numbers used in this file refer to the calcomp1.shd shadeset.
label-alpha	character	10	Rock unit label (abbreviation) for use with standard alphabetic characters (for example, TR for Triassic).
label-gaf	character	10	Rock unit label (abbreviation) that uses the GeoageFullAlpha font, version 1.1 (for example, T̄R for Triassic.
name	character	7	The prefix portion of the rock unit label that does not include subscripts. (If subscripting is not used in the original unit label, then the 'name' item is the same as the 'label' item.)
ss	character	3	The suffix portion of the rock unit label that includes subscripts.
lith	character	20	Major type of lithostratigraphic unit, for example, unconsolidated sediments, sedimentary rocks, metasedimentary rocks, intrusive rocks, extrusive rocks, metamorphic rocks, water, ice.
desc	character	250	Formal or informal unit name. This is an abbreviated rock unit description. See description of map units in this report or in the *.jpg files for the full description used in Drewes, (1980).
minage	character	7	Minimum statigraphic age of lithologic unit, for example, CRET, TERT, M PROT.
maxage	character	7	Maximum stratigraphic age of lithologic unit.

Geomorphic features dataset

Descriptions of the items identifying geomorphic features in the polygon attribute table, i1109gm.pat, are as follows:

i1109gm.pat			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
geomorph	character	1	Letter abbreviation for the type of geomorphic feature: E-exotic block breccia, M-maar crater, P-paleoplaya and W-Wilcox playa.
symbol	integer	3	Shadeset symbol number used by ArcInfo to plot a filled/shaded polygon. Symbol numbers refer to the calcomp1 shadeset.
desc	character	250	A detailed description of the geomorphic feature, from Drewes (1980).
source	integer	4	Numeric code used to identify the data source. Complete references for the sources are listed in the i1109gm.ref file.

Point Features

Cinder cone dataset

Descriptions of the items in the cinder cone point attribute table, i1109cin.pat, are as follows:

i1109cin.pat			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
pttype	character	50	Type of cinder cone: "cinder cone" for known location and "cinder cone, uncertain" for uncertain location.
symbol	integer	3	Marker symbol number used by ArcInfo to plot the location of cinder cones. Symbol numbers refer to the scamp2d.mrk markerset (after Matti and others, 1997).
source	integer	4	Numeric code used to identify the data source. Complete references for the sources are listed in the i1109cin.ref file.

Rock sample dataset

Descriptions of the items in the rock sample point attribute table, i1109sam.pat, are as follows:

i1109sam.pat			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
type	character	18	Collection site: “collection site” for known location, “collection site ?” for uncertain location.
age1	integer	4	Radiometric age (in millions of years).
age1_cert	character	2	Certainity of the radiometric age: “?” indicates the age is uncertain.
age2	integer	4	Radiometric age (in millions of years) of the second sample.
age3	integer	4	Radiometric age (in millions of years) of the third sample.
age4	integer	4	Radiometric age (in millions of years) of the fourth sample.
age5	character	24	Radiometric age that was shown on the Drewes (1980) map with character attributes (for example P€, >800 or Yg stock).
site_num	integer	5	An arbitrary number assigned to each collection site location. This was not on the Drewes (1980) maps.
symbol	integer	3	Marker symbol number used by ArcInfo to plot sample point location. Symbol numbers refer to the scamp2d.mrk markerset (after Matti and others, 1997).
source	integer	4	Numeric code used to identify the data source. Complete references for the sources are listed in the i1109sam.ref file.

Structural map symbols dataset

Descriptions of items in the geologic map symbols point attribute table, i1109sdp.pat, are as follows:

i1109sdp.pat			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
pttype	character	50	The type of point feature observation displayed on the map, for example, fault attitude indicator, fold plunge, inclined, horizontal or vertical bedding, inclined or vertical foliation, lineation.
symbol	integer	3	Marker symbol number used by ArcInfo to identify type of geologic map symbol. Symbol numbers refer to the scamp2d.mrk markerset (after Matti and others, 1997).
strike	integer	3	Strike of bedding, fault, foliation or other structural plane; bearing of lineation; or direction of plunge. The value in strike is an azimuthal angle (measured in degrees from 0 to 360 in a clockwise direction from north). The value in "strike" is approximate, because it was calculated by digitizing the cartographic symbol from the map.
dip	integer	3	Dip of bedding, fault, fold plunge, foliation or lineation. This value is an angle measured (in degrees from 0 to 90) down from the horizontal; thus a horizontal dip is 0 degree and a vertical dip is 90 degrees.
ai_ang	integer	3	An interim value used to calculate sym$angle. The various structural map symbols in the scamp2d.mrk markerset (Matti and others, 1997) had to be rotated by different amounts to achieve their proper map orientation. For the strike and dip symbols, ai_ang = strike – 270.
sym$ang	integer	3	The angle used to complete the mathematical rotation of the structural map symbol to its proper orientation on the map. This value is the $angle pseudoitem value for the point.
source	integer	4	Numeric code used to identify the data source for the structural map symbol. Complete references for the sources are listed in the i1109sdp.ref file.

Source Attributes

Descriptive source or reference information for the i1109, i1109cin, i1109gm, i1109sam, and i1109sdp ArcInfo datasets is stored in the i1109*.ref files respectively. Attribute descriptions for items in the *.ref data source files are as follows:

i1109.ref /i1109cin.ref/i1109gm.ref/i1109sam.ref/i1109sdp.ref			
ITEM NAME	ITEM TYPE	ITEM WIDTH	ATTRIBUTE DESCRIPTION
source	integer	4	Numeric code used to identify the data source. (This item also occurs in the i1109.aat, i1109.pat, i1109cin.pat, i1109gm.pat, i1109sam.pat, and i1109sdp.pat files.)
scale	integer	8	Scale of source map. (This value is the denominator of the proportional fraction that identifies the scale of the map that was digitized or scanned to produce the digital map.)
authors	character	200	Author(s) or compiler(s) of source map entered as last name, first name or initial, and middle initial.
year	integer	4	Source (map) publication date.
reference	character	250	Remainder of reference in USGS reference format.

Obtaining Digital Data

The digital version of the geologic map is available in ArcInfo exchange (*.e00) format (see Appendix A). These data are maintained in a Universal Transverse Mercator map projection:

Projection:	UTM
Zone:	12
Datum:	NAD27
Units:	meters
Spheroid:	Clarke1866

Note that this projection can also be described in the following manner:

Projection:	Transverse Mercator
Units:	meters
Parameters:	
scale factor at central meridian:	0.99960000
longitude of central meridian	-111 0 0.00
latitude of origin	0 0 0.000
false easting (meters)	500000.0
false northing (meters)	0.00000

To obtain copies of the digital data, do one of the following:

1. Download the digital files from the USGS public access World Wide Web site on the internet: URL = http://geopubs.wr.usgs.gov/i-map/i1109 **or**
2. Anonymous FTP from geopubs.wr.usgs.gov, in the directory:
   pub/i-map/i1109

The Internet sites contain the digital geologic map both as ArcInfo interchange-format files (*.e00) and as plot files (i1109_e.pdf and i1109_w.pdf). To utilize the spatial database you must have a GIS that is capable of reading ArcInfo interchange-format files.

Obtaining Paper Maps

Paper copies of the digital geologic map are not available from the USGS. However, with access to the Internet and a large-format color plotter a 1:125,000-scale plot of the map can be made as follows:

1. Download plot files of the map (i1109_e.pdf and i1109_w.pdf) that were derived from the spatial database. You can also download the i1109_e.jpg and i1109_w.jpg scanned image files of the original publication (Drewes, 1980). All of these files can be obtained from the USGS public access World Wide Web site on the Internet using the **URL=**http://geopubs.wr.usgs.gov/i-map/i1109/ **or**

2. Anonymous FTP the plot files from: **geopubs.wr.usgs.gov**, in the directory: **pub/i-map/i1109**

The .pdf plots are approximately 41 by 35 inches and the .jpg plots are approximately 41 by 58 inches.

References Cited

Armstrong, A. K., and Silberman, M. L, 1974, Geologic map of the central Peloncillo Mountains, Hidalgo County, New Mexico: U.S. Geological Survey, Open-File Report 74-11.

Brown, W. H., 1939, Tucson Mountains, an Arizona Basin Range type: Geological Society of America Bulletin, v. 50, no. 5, p. 697-760.

Bryant, D. L, and Kinnison, J. E., 1954, Lower Cretaceous age of the Amole Arkose, Tucson Mountains, Arizona: Geological Society of America Bulletin, v. 65, no. 12, pt. 2, p. 1235.

Cooper, J. R., 1961, Turkey-track porphyry-A possible guide to Miocene rocks in southeastern Arizona: Arizona Geological Society Digest, v. 4, p. 17-33.

Courtright, J. H., 1958, Progress report on investigations of some Cretaceous - Tertiary formations in southeastern Arizona: Arizona Geological Society Digest, v. 1, p. 7-9.

Drewes, Harald, 1980, Tectonic map of southeast Arizona: U.S. Geological Survey, Miscellaneous Investigations Series I-1109, 2 sheets, scale 1:125,000.

Epis, R. C., 1956, Geology of the Pedregosa Mountains, Cochise County, Arizona: Berkeley, University of California, Ph.D. thesis, 263 p.

Matti, J.C., Miller, F.K., Powell, R.E., Kennedy, S.A., Bunyapanasarn, T.P., Koukladas, C., Hauser, R.M., and Cossette, P.M., 1997, Geologic-point attributes for digital geologic-map data bases produced by the Southern California Areal Mapping Project (SCAMP): U.S. Geological Survey Open-File Report 97-859, 7 p.

Sabins, F. E., Jr., 1957, Geology of the Cochise Head and western part of the Vanar quadrangles: Geological Society of America Bulletin, v. 68, no. 10, p. 1315-1342.

Appendix A - List of digital files in the southeast Arizona GIS

— Use the 'import.aml' to IMPORT all of the *.E00 files for use in ArcInfo.

Report text in Adobe portable document format:

- i1109.pdf

Primary ArcInfo interchange-format (*.e00) and metadata(*.txt) files for the spatial digital database:

- i1109.e00 – geologic map (contacts, structures and map units)
- i1109cin.e00 – cinder cones
- i1109gm.e00 – geomorphic features
- i1109sam.e00 – rock samples with radiometric age dates
- i1109sdp.e00 – structural map symbols
- i1109met.txt – metadata

Adobe portable document format (*.pdf) plot files derived from the spatial digital database:

- i1109_e.pdf – east part of map
- i1109_w.pdf – west part of map

- **ArcInfo AML necessary to setup the GIS:**
- import.aml – program to import ArcInfo interchange-format (*.e00) files

Grayscale raster image files (*.jpg) for map sheets 1 and 2 (Drewes, 1980):

- i1109_e.jpg – sheet 1 (east part of map)
- i1109_w.jpg – sheet 2 (west part of map)

Appendix B - Transformation File Listing For the East and West Maps

SHEET 1 – EAST MAP

Arc: |> transform tmash1 i1109sh1v1 <|
Transforming coordinates for coverage tmash1
Scale (X,Y) = (3185.679,3186.759) Skew (degrees) = (-0.005)
Rotation (degrees) = (0.726) Translation = (587544.049,3465744.897)
RMS Error (input,output) = (0.022,69.649)
Affine X = Ax + By + C
Y = Dx + Ey + F
A = 3185.423 B = -40.636 C = 587544.049
D = 40.359 E = 3186.499 F = 3465744.897

tic id	input x / output x	input y / output y	x error	y error
345	2.425	0.384		
	595080.938	3467085.750	172.600	-20.352
321	3.858	1.912		
	599701.375	3472024.250	54.730	-30.472
319	3.820	4.929		
	599551.625	3481634.000	-37.970	-28.903
317	3.833	7.959		
	599457.500	3491278.250	-26.942	-15.871
315	3.834	11.033		
	599368.625	3501075.250	-59.937	-18.170
313	4.166	14.087		
	600277.375	3510767.750	-34.239	32.527
322	6.837	1.916		
	609290.188	3472142.250	-46.213	-15.385
320	6.874	4.943		
	609270.625	3481821.750	-29.464	-49.228
341	9.898	1.905		
	619052.500	3472224.000	-57.397	-10.742
339	16.019	2.877		
	638398.500	3475535.750	54.605	22.173
316	7.190	11.030		
	610002.750	3501154.500	-4.828	28.706
318	6.885	7.959		
	609154.812	3491388.500	-2.996	-5.771
******	9.873	6.084		
	618712.188	3485507.500	35.827	22.640
314	6.915	14.088		
	609032.188	3510896.500	-33.140	17.550
******	9.883	14.782		
	618395.125	3513218.500	28.526	29.426
335	16.039	7.933		
	638254.562	3491822.000	57.662	-152.707
331	15.993	10.990		
	638086.375	3501418.250	-43.217	-7.412
330	12.790	14.063		
	627667.312	3511036.250	45.495	36.217
311	4.178	17.125		
	600151.688	3520537.750	4.193	-55.502

200	4.032	23.224		
	599441.000	3539839.000	3.666	70.686
310	5.031	21.699		
	602640.750	3535016.000	48.153	76.540
305	4.128	26.228		
	599619.312	3549558.000	9.481	-72.283
******	2.501	32.197		
	594202.250	3568397.000	0.001	45.768
312	6.938	17.137		
	608967.312	3520593.000	-17.926	40.113
306	9.531	25.190		
	616837.938	3546434.750	41.249	-37.223
323	13.062	23.224		
	628226.812	3540187.500	-20.020	86.414
300	7.202	29.224		
	609323.438	3559197.250	-24.750	-37.984
******	9.897	32.183		
	617754.250	3568643.750	7.915	51.117
301	13.239	29.214		
	628591.438	3559446.500	-62.804	-78.263
******	17.318	6.076		
	642456.938	3485805.250	5.453	0.007
342	19.045	0.301		
	648285.438	3467438.500	-87.965	33.702
343	25.396	0.282		
	668519.812	3467661.750	-90.028	7.142
336	19.164	7.911		
	648247.750	3491736.750	20.649	-9.571
332	19.143	10.962		
	648076.188	3501402.750	-0.330	46.124
******	17.310	14.780		
	642076.438	3513517.750	6.485	22.545
337	22.205	7.922		
	657971.062	3491835.750	-17.898	49.307
333	22.488	10.914		
	658777.188	3501415.000	-43.679	14.941
******	24.784	6.092		
	666202.875	3486157.250	41.830	-1.256
******	24.765	14.796		
	665758.875	3513871.250	70.585	22.021
344	30.801	0.308		
	685638.500	3467976.750	7.303	-8.826
340	28.287	4.911		
	677522.562	3482561.750	-70.669	-26.814
338	30.762	7.859		
	685204.750	3492045.750	11.194	-16.358
327	19.119	17.126		
	647748.438	3521072.500	2.861	16.157
324	19.109	22.205		
	647459.250	3537205.500	53.435	67.971
307	19.082	26.229		
	647325.500	3550175.250	-64.036	-82.555
308	22.308	26.087		
	657458.938	3549746.500	84.408	26.524
325	25.611	22.990		
	668152.688	3540022.000	39.216	14.931

309	25.379	26.087		
	667384.500	3549991.000	-56.712	-94.007
302	19.297	29.228		
	647865.688	3559721.500	-41.191	-61.741
******	17.286	32.170		
	641307.250	3568945.500	-5.828	7.356
303	22.308	29.048		
	657446.438	3559251.000	-23.379	-45.716
******	24.673	32.196		
	664861.438	3569302.000	-32.304	30.323
328	28.583	19.911		
	677769.062	3530295.250	13.590	48.724
329	30.744	17.035		
	684699.875	3521235.000	84.352	33.388
326	28.535	23.006		
	677520.562	3540104.000	-16.832	100.374
304	30.652	29.178		
	683949.500	3560076.500	47.234	-118.303

SHEET 2 – WEST MAP

Arc: transform mapi1109v1 mapi1109v2
Transforming coordinates for coverage mapi1109v1
Scale (X,Y) = (3178.721,3180.983) Skew (degrees) = (0.138)
Rotation (degrees) = (0.247) Translation = (469839.445,3461329.589)
RMS Error (input,output) = (0.059,186.041)
Affine X = Ax + By + C
Y = Dx + Ey + F
A = 3178.692 B = -6.064 C = 469839.445
D = 13.712 E = 3180.987 F = 3461329.589

tic id	input x	input y		
	output x	output y	x error	y error
135	1.991	3.519		
	476242.625	3472546.500	-95.515	5.113
137	4.554	2.538		
	484534.594	3469383.750	-234.092	81.235
139	5.100	5.020		
	486044.625	3477377.000	-23.417	-8.746
******	2.013	7.407		
	476258.375	3484858.000	-66.127	59.866
124	3.810	12.575		
	481831.125	3501386.750	41.591	-5.287
******	2.080	16.107		
	476321.781	3512566.000	33.103	29.832
138	7.621	1.513		
	494142.844	3466235.750	-87.994	10.499
140	9.454	1.520		
	499929.281	3466296.750	-48.568	-1.538
133	13.725	4.914		
	513559.906	3477131.750	-122.427	17.170
141	16.963	1.540		
	523755.625	3466452.500	-5.114	6.812
******	9.481	7.348		
	500000.000	3484830.750	-68.301	2.846

```
******      9.519      16.071
      500000.000 3512539.000       0.105      41.571
  131      12.788       8.094
      510404.375 3487345.750      34.688     -93.211
******     16.952       7.333
      523741.625 3484858.000     -62.128      28.901
  149      13.852      15.398
      513715.250 3510464.250      61.304      35.118
  125      16.990      12.359
      523699.000 3500835.250      70.018      39.836
******     16.973      16.041
      523678.219 3512566.000      14.658      21.442
  118       3.617      21.723
      481149.250 3530496.500      55.794     -16.035
******      2.129      24.770
      476385.625 3540275.250      69.634    -125.018
  108       4.664      27.400
      484514.875 3548600.000     -17.053     -46.593
  104       4.788      29.649
      484844.031 3555800.750      36.171     -92.583
  101       3.116      32.665
      479675.156 3565366.500    -127.656     -88.514
  150       2.168      33.499
      476412.125 3567837.000     114.912      82.643
  114      10.475      24.306
      503490.250 3538812.500    -500.632     -21.351
******      9.550      24.766
      500000.000 3540248.000      45.293      -7.938
  109      12.110      26.386
      508118.406 3545538.500      53.726    -108.046
  115      16.799      24.520
      522801.281 3539228.000     289.569     329.032
******     16.989      24.741
      523614.375 3540275.250      77.651     -12.619
  151       9.348      33.422
      499317.344 3567785.250      32.879     -12.009
******     16.989      33.445
      523550.062 3567985.750      88.677     -36.253
  102      17.396      32.924
      524803.375 3566438.250     132.636    -139.385
  142      19.559       1.510
      532085.938 3466352.500     -83.109      49.498
  143      24.434       1.507
      547582.188 3466481.000     -84.166     -24.078
  144      29.077       1.578
      561113.188 3466823.000    1142.334     -76.030
  136      32.687       3.652
      573785.812 3473403.000     -66.041      -9.491
  145      31.893       1.522
      571281.375 3466636.750     -72.377     -29.887
******     24.419       7.322
      547483.438 3484939.000     -67.826      18.002
  126      25.492      11.160
      550788.812 3497144.750      14.393      34.062
  122      19.761      16.489
      532428.375 3514113.250     125.850     -61.731
```

******		24.422	16.043		
	547356.625	3512647.750	15.425	49.783	
148		23.338	15.376		
	543843.375	3510554.750	88.382	7.036	
******		31.885	7.324		
	571225.688	3485074.500	-77.682	-11.157	
130		31.711	9.788		
	570592.500	3492925.750	-11.961	-24.611	
147		29.237	13.512		
	562690.000	3504755.000	4.036	-42.134	
127		32.489	12.235		
	573050.438	3500672.500	-12.634	21.908	
******		31.858	16.039		
	571035.438	3512783.500	-27.598	4.060	
146		35.372	1.601		
	582357.875	3466942.500	-92.881	-33.755	
134		34.657	5.232		
	580013.625	3478475.750	-42.309	-27.034	
132		37.477	8.238		
	588896.625	3488099.250	20.474	-51.934	
128		35.086	12.442		
	581271.000	3501387.000	20.551	1.480	
123		36.188	16.096		
	584763.938	3513038.750	9.800	-13.067	
129		37.683	12.332		
	589608.125	3501064.000	-59.986	11.648	
121		22.862	18.369		
	542348.875	3520090.250	49.100	-14.784	
111		19.946	26.912		
	533084.000	3547203.500	-4.090	6.144	
******		24.419	24.741		
	547228.938	3540357.250	79.494	8.684	
112		30.477	25.474		
	566557.375	3542633.500	5.738	145.486	
******		31.829	24.763		
	570843.938	3540493.750	20.278	43.841	
******		24.389	33.465		
	547100.375	3568068.000	60.058	46.509	
105		30.692	30.788		
	567166.688	3559579.250	44.985	106.313	
******		31.794	33.496		
	570651.000	3568205.000	49.138	110.335	
120		35.422	19.132		
	582277.312	3522674.250	40.941	1.131	
119		37.784	21.474		
	589969.062	3530194.500	-157.730	-36.771	
116		34.888	24.499		
	580863.000	3539755.000	-273.967	-17.444	
113		35.848	25.935		
	583586.875	3544315.500	46.542	3.921	
117		37.795	24.520		
	589930.312	3539949.000	-99.686	-104.080	
110		37.813	27.565		
	590035.125	3549576.250	-165.561	-44.055	
106		34.827	30.563		
	580414.875	3559092.250	-55.851	-64.879	

107	37.818	30.567		
	589983.875	3559077.500	-119.088	2.773
103	37.831	33.512		
	589945.812	3568412.250	-56.361	37.517

Appendix C - Metadata file (i1109met.txt) for the southeast Arizona GIS

Identification_Information:
Citation:
Citation_Information:
Originator: Harald Drewes, Robert A. Fields, Douglas M. Hirschberg and Karen S. Bolm
Publication_Date: 2002
Title: Spatial Digital Database for the Tectonic Map of Southeast Arizona
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: USGS Miscellaneous Investigations Series
Issue_Identification: Map I-1109
Publication_Information:
Publication_Place: Menlo Park, California
Publisher: U.S. Geological Survey
Online_Linkage: URL:http://geopubs.wr.usgs.gov/i-map/i1109/
Description:
Abstract:

A spatial database was created for the Drewes (1980) tectonic map of southeast Arizona: this database supercedes Drewes and others (2001, ver. 1.0). The west tectonic map (Drewes, 1980) was converted to digital format by Optronics Specialty Co., Inc. and published in 2001. Staff and a contractor at the U.S. Geological Survey in Tucson, Arizona developed a digital geologic map database for the east map in 2001, made revisions to the previously released digital data for the west map (Drewes and others, 2001, ver. 1.0), merged data files for the east and west sheets, and added additional data not previously captured.

Purpose:

This digital geospatial database is one of many being created by the U.S. Geological Survey as an ongoing effort to provide geologic information in a geographic information system (GIS) for use in spatial analysis. The resulting digital geologic map database data can be queried in many ways to produce a variety of geologic maps and derivative products. This database should not be used or displayed at any scale larger than 1:125,000 (for example, 1:100,000 or 1:24,000).

Supplemental_Information:

Contractors at the U.S. Geological Survey in Spokane, Washington, completed an interim Digital database, version 1.0, with line and polygon features for Sheet 2 in 2001. The database in version 2.0 contains revisions to the Sheet 2 database and additional data such as structural strike and dip, collection sample, marker bed, marker horizon and geomorphic feature data for both Sheets 1 and 2. Digital base map data files (topography, roads, towns, rivers and lakes, etc.) are not included. Since the Drewes (1980) east and west map sheets have additional data that was not included in this database, scanned images are included as a courtesy to the reader. The digital geologic map plot files (i1109_e.hp/.eps/.pdf and i1109_w.hp/.eps/.pdf) provided in the digital package are a representation of the database. These files will not print a copy of the original Drewes (1980) Tectonic Map of Southeast Arizona.

The text report (i1109.pdf) describes the map units, the methods used to convert the geologic map data into a digital format, the ArcInfo GIS file structures and relationships, and explains how to download the digital files from the U.S. Geological Survey public access World Wide Web site on the Internet.

Time_Period_of_Content:
  Time_Period_Information:
    Single_Date/Time:
      Calendar_Date: 2002
  Currentness_Reference:
    Publication supercedes Harald Drewes, William N. Kelley
    and Steven R. Munts, (2001).
Status:
  Progress: Complete
  Maintenance_and_Update_Frequency: As Needed
Spatial_Domain:
  Bounding_Coordinates:
    West_Bounding_Coordinate: -111.32
    East_Bounding_Coordinate: -109.00
    North_Bounding_Coordinate: 32.26
    South_Bounding_Coordinate: 31.32

Keywords:
  Theme:
    Theme_Keyword_Thesaurus: none
    Theme_Keyword: geology
    Theme_Keyword: geologic map
  Place:
    Place_Keyword_Thesaurus: none
        Place_Keyword: Cochise County
        Place_Keyword: Pima County
        Place_Keyword: Santa Cruz County
    Place_Keyword: Arizona
    Place_Keyword: USA

Access_Constraints: none

Use_Constraints:
  This digital database should not be used or displayed at any scale larger than 1:125,000 (for example, 1:100,000 or 1:24,000).

  Any hardcopies utilizing these datasets shall clearly indicate their source. If users modify the data in any way they are obligated to describe on the hardcopy map the types of modifications they have performed. Users specifically agree not to misrepresent these datasets, nor to imply that changes they made were approved by the U.S. Geological Survey.

Point_of_Contact:
  Contact_Information:
    Contact_Person_Primary:
      Contact_Person: Floyd Gray
      Contact_Organization: U.S. Geological Survey
    Contact_Position: Geologist
    Contact_Address:
      Address_Type: mailing and physical address
      Address:
        USGS Geologic Division
        Dennis DeConcini Environmental & Natural Resources Bldg.
        520 North Park Ave., Room 357
      City: Tucson
      State_or_Province: Arizona
      Postal_Code: 85719-5035
      Country: USA
    Contact_Voice_Telephone: 520-670-5582
    Contact_Facsimile_Telephone: 520-670-5571
    Contact_Electronic_Mail_Address: fgray@usgs.gov

Data_Set_Credit:
  The geologic map database was initially prepared from folded paper geologic maps (Drewes, 1980) by the staff at Optronics Specialty Co., Inc. Optronics scanned the geologic map and prepared minimally attributed ArcInfo exchange-format files. William N. Kelley and Steven R. Munts (contractors) georeferenced and transformed the data for Sheets 1 and 2 and completed the editing, data model preparation and attributing of arcs and polygons for the west sheet (Sheet 2). Robert A. Fields, Douglas M. Hirschberg (contractor) and Karen S. Bolm reviewed and edited the files for both sheets and developed additional spatial and attribute data. The manuscript and digital data were reviewed by Helen Kayser (contractor) and Pamela Derkey at the USGS Spokane office.

Native_Data_Set_Environment:
  SunOS, 5.6, sun4u UNIX
  ARC/INFO version 7.2.1

Cross_Reference:
  Citation_Information:
    Originator: Drewes, Harald
    Publication_Date: 1980
    Title: Tectonic Map of Southeast Arizona
    Geospatial_Data_Presentation_Form: map
    Series_Information:
      Series_Name: Miscellaneous Investigation Series Map
      Issue_Identification: Map I-1109
    Publication_Information:
      Publication_Place: Denver, CO

Publisher: U.S. Geological Survey
Online_Linkage: http://geopubs.wr.usgs.gov/i-map/i1109/

Data_Quality_Information:
Attribute_Accuracy:
Attribute_Accuracy_Report:
Accuracy was verified by manual comparison of the source with hardcopy plots and printouts. Some interpretation of the original data was necessary when map areas covered a very small areal extent, had no labels and were represented with similar color hues. In some cases the decorations for faults on the original map made it difficult to determine where a particular type of fault started and stopped. Numerical values for strike should be considered approximate because they were digitized from the source map and not taken from field notes. The item "strike" also represents lineation bearing and plunge direction to simplify the database. Strike symbols were digitized using the right-hand rule and the strike direction was calculated mathematically. Dip values in the database represent the dip value annotated on the original map.
Logical_Consistency_Report:
Polygon and chain-node topology is present. Polygons intersecting the neatline are closed along the border. Segments making up the outer and inner boundaries of a polygon tie end-to-end to completely enclose the area. Polygon slivers and line dangles were removed. Line segments are a set of sequentially numbered coordinate pairs. No duplicate features or duplicate points exist in a data string. Intersecting lines are separated into individual line segments at the point of intersection. Point data are represented by two sets of coordinate pairs, each with the same coordinate values. All nodes are represented by a single coordinate pair indicating the beginning or end of a line segment. The neatline was generated by mathematically generating the four sides of the quadrangle, densifying the lines of latitude and projecting the file to Transverse projection (shown as UTM 12).
Completeness_Report:
All geologic units were captured from Drewes (1980) at a scale of 1:125,000. Four concealed contact lines in the "Qg" alluvium map unit in the northwest part of the map were excluded from the database. The original map also had two points with a "Qg?" map unit label and no corresponding contact representing the extent of the map unit. These labels were excluded from the database.

Three concealed map unit areas labeled "Klq?" on the original west sheet were printed with a color representing the "QTgu" map unit. This database shows these three areas with the green "Klq" color assigned to this map unit. Three lines located in the Yw and Yc map unit in the northern part of the west sheet were undefined in the map explanation and were excluded from this database. Hachured lines representing beach ridges in the Qp map unit along the margins of the Wilcox Playa were not included in the database. Well location, map units penetrated and corresponding thickness data also were not included in this database. Cartographic base map data such as rivers, roads, etc. and map inserts and corresponding explanations, cross sections, references, and other data which were not included in the geospatial database can be viewed in the i1109_e.jpg and i1109_w.jpg raster image files.
Positional_Accuracy:
Horizontal_Positional_Accuracy:

Horizontal_Positional_Accuracy_Report:
Arcs and points are probably no more accurate than ± 187 meters based upon the RMS error encountered when transforming the dataset based upon mathematically defined tics.
Lineage:
Source_Information:
Source_Citation:
Citation_Information:
Originator: Drewes, Harald
Publication_Date: 1980
Title: Tectonic Map of Southeast Arizona
Geospatial_Data_Presentation_Form: map
Series_Information:
Series_Name: Miscellaneous Investigation Series Map
Issue_Identification: Map I-1109
Publication_Information:
Publication_Place: Denver, CO
Publisher: U.S. Geological Survey
Source_Scale_Denominator: 125000
Type_of_Source_Media: folded paper
Source_Time_Period_of_Content:
Time_Period_Information:
Single_Date/Time:
Calendar_Date: 1980
Source_Currentness_Reference: publication date
Source_Citation_Abbreviation: Drewes, 1980
Source_Contribution: This is the original source for the 2002 dataset.
Source_Contribution: Harald Drewes, William N. Kelley and Steven R. Munts, (2001).

Process_Step:
Process_Description:
The geologic maps (Drewes, 1980) were optically scanned by Optronics Specialty Co., Inc. and given minimal attribution. Version 1.0 for the west part of the area was edited and attributed by W. N. Kelley and S. R. Munts (contractors). Version 2.0 for the whole map area was developed by Robert A. Fields (USGS), Douglas M. Hirschberg (contractor) and Karen S. Bolm (USGS).
Process_Date: 2001

Spatial_Data_Organization_Information:
Direct_Spatial_Reference_Method: Vector
Point_and_Vector_Object_Information:
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: Point
Point_and_Vector_Object_Count: 8787
SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: String
Point_and_Vector_Object_Count: 24743

SDTS_Terms_Description:
SDTS_Point_and_Vector_Object_Type: GT-polygon composed of chains
Point_and_Vector_Object_Count: 8788

Spatial_Reference_Information:
Horizontal_Coordinate_System_Definition:
Planar:
Grid_Coordinate_System:
Grid_Coordinate_System_Name: Universal Transverse Mercator
Universal_Transverse_Mercator:
UTM_Zone_Number: 12
Transverse_Mercator:
Scale_Factor_at_Central_Meridian: 0.999600
Longitude_of_Central_Meridian: -111.000000
Latitude_of_Projection_Origin: 0.0
False_Easting: 500000.000000
False_Northing: 0.000000
Planar_Coordinate_Information:
Planar_Coordinate_Encoding_Method: coordinate pair
Coordinate_Representation:
Abscissa_Resolution: 0.01
Ordinate_Resolution: 0.01
Planar_Distance_Units: Meters
Geodetic_Model:
Horizontal_Datum_Name: North American Datum of 1927
Ellipsoid_Name: Clarke 1866
Semi-major_Axis: 6378206.4
Denominator_of_Flattening_Ratio: 294.98

Entity_and_Attribute_Information:
Overview_Description:
Entity_and_Attribute_Overview:
The 'Spatial Digital Database for the Tectonic Map of Southeast Arizona' report, i1109.pdf, contains a detailed description of each attribute code and a reference to the associated map symbols on the map source materials. The digital tectonic map of southeast Arizona includes a geologic (linear feature) arc attribute table, i1109.aat, which relates to the i1109.con, i1109.st2, i1109.lgu and i1109.ref files. A rock unit polygon attribute table, i1109.pat, relates to the i1109.ru and i1109.ref files. Point features representing structural attitudes of bedding, fault planes, foliation and lineation are located in the point attribute table, i1109sdp.pat, which relates to the i1109sdp.ref file. Geomorphic features such as paleoplayas, exotic breccia zones and maar craters are located in i1109gm.pat and its related i1109gm.ref file. Points representing cinder cones are located in i1109cin.pat and its related i1109cin.ref file. Points representing rock sample sites and radiometric age dates are contained in i1109sam.pat and its related i1109sam.ref file. Information on ArcInfo interchange files is listed in the i1109.pdf text report.

Entity_and_Attribute_Detail_Citation: See the report text, i1109.pdf, for a detailed description of the items in the spatial database available on the WorldWideWeb at http://geopubs.wr.usgs.gov/I-map/i1109.

Distribution_Information:
Distributor:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: U.S. Geological Survey
Contact_Electronic_Mail_Address: http://geopubs.wr.usgs.gov/i-map/i1109/

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Metadata_Reference_Information:
Metadata_Date: 20020102
Metadata_Review_Date: 20020208
Metadata_Contact:
Contact_Information:
Contact_Organization_Primary:
Contact_Organization: U.S. Geological Survey Information Services
Contact_Person: Robert A. Fields
Contact_Position: Geologist
Contact_Address:
Address_Type: mailing and physical address
Address:
USGS Geologic Division
Dennis DeConcini Environmental & Natural Resources Bldg.
520 North Park Ave., Room 357
City: Tucson

State_or_Province: Arizona
Postal_Code: 85719-5035
Country: USA
Contact_Voice_Telephone: 520-670-5589
Contact_Facsimile_Telephone: 520-670-5571
Contact_Electronic_Mail_Address: rafields@usgs.gov
Metadata_Standard_Name: FGDC Content Standards for Digital Geospatial Metadata
Metadata_Standard_Version: FGDC-STD-001-1998
Metadata_Access_Constraints: none
Metadata_Use_Constraints: none