Arizona Geological Survey

Earth Fissure Mapping Program

2007 Progress Report

Open-file Report 08-02
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Arizona Geological Survey

Earth fissure reactivated in Queen Creek, July 2007 following heavy rains. A horse died after being trapped in the mud in the fissure. Photo by Mimi Diaz.

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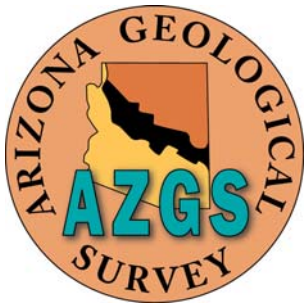


EXECUTIVE SUMMARY

The Arizona Geological Survey (AZGS) is tasked by statute to undertake comprehensive mapping of earth fissures and deliver earth fissure map data to the State's Internet Map Server (IMS) for online public distribution (Appendix A).

Earth fissures have formed in and around the margins of many basins in Arizona where the land has subsided more than a few feet. The potential for risk to people and damage to property from earth fissures is increasing due to urban encroachment on fissure-prone areas, and to continued basin subsidence which results in earth fissures propagating.

In June 2007, AZGS released planning maps of known and reported earth fissures for Maricopa, Pinal, Pima, and Cochise counties,. Since then more than 44,000 copies of these planning maps have been downloaded from the AZGS website. Twenty-two areas of earth fissures were delineated as "study areas" and prioritized for detailed mapping.

Once AZGS completes detailed mapping in a study area, the map data are provided to the State's IMS for public access. The IMS server provides the data

in GIS format supported by other data layers at an anticipated scale of 1:12,000. Mapping in the Chandler Heights study area was completed in 2007 and was transferred to the State Land Department in early 2008 for public release. Currently, AZGS geologists are mapping earth fissures in the Apache Junction, Luke and Pichacho study areas. In addition, AZGS staff continues to respond to reports of newly discovered or growing fissures.

As part of our mapping protocols, we now recognize three categories of earth fissures on the basis of certainty of their location and their surface expression.

The Arizona Land Subsidence Group (ALSG) serves as a technical advisory resource to the AZGS earth fissure mapping program and discussion forum for the geotechnical community on issues related to identifying, characterizing, and researching earth fissures. ALSG completed and released a report on research needs for monitoring, predicting, and mitigating earth fissures and subsidence; PDF copies of the report are available to download for free at ALSG (www.azlsg.org) or AZGS (www.azgs.az.gov) websites.

The AZGS Earth Fissure Advisory Group guided the program to establish a set of formal standards and procedures on identifying, mapping, and characterizing earth fissures, including defining the accuracy of field measurements. Release of a report documenting mapping protocols and standards is scheduled in conjunction with release of the Chandler Heights earth fissure map in early 2008.

To alert the larger community, AZGS staff briefed local governments, professional organizations, and trade groups on mapping plans and products (8 formal public talks, 18 briefings, 4 field trips, and 20 news interviews). AZGS staff offered a number of training seminars to professionals (planning, real estate, development, etc) about what fissures are, how to use our new maps, and guidance on mitigating fissure impacts.

INTRODUCTION

Statutory authority

The Arizona Geological Survey (AZGS) is tasked by statute to undertake comprehensive mapping of earth fissures and deliver fissure map data to the State Land Department (SLD) starting in 2007 and every five years subsequently (Appendix A).

Companion legislation (A.R.S. 33-422) requiring disclosure of earth fissures within non-incorporated areas, was amended in the state legislature in 2007 to clarify the legislative intent. The original legislature mistakenly specified particular types of soils as being associated with earth fissure development, which is inconsistent with geological understanding of fissure development. The language that associated earth fissures with particular soils was removed.

Nature & origins of earth fissures

Earth Fissures are cracks in the ground up to many thousands of feet in length and possibly hundreds of feet in depth that develop in areas of ground subsidence from rapid depletion of aquifers and down-dropping of the water table. It has long been thought that earth fissures propagate upward from compacted aquifer sediments at or near a falling water table and are associated with a change in the mechanical or physical properties of those sediments. The absence of any surface expression of earth fissures does not preclude their existence below ground. However, recent discussions are raising the possibility that the fissures initiate near the surface and propagate downward as well as longitudinally.

Earth fissures range from incipient, where they are characterized by discontinuous, pock-marked ground and hairline fractures, to mature features miles in length, with corresponding erosive gullies more than 10 ft wide, and several tens of ft deep. It is generally believed that fissures extend downward hundreds of feet, but determining their true depth is hampered by collapse of unconsolidated sediments adjacent to the fissure and our inability thus far to probe more than a few tens of feet below the surface. Because of their proclivity for channeling surface waters, fissures commonly host dense vegetation along their trace.

Also, because earth fissures are related to basin subsidence, they tend to form parallel to basin margins and thus perpendicular to the natural drainage. As a result, channels and washes preferentially drain water into fissures, causing extensive erosion and gully formation by carrying soils and surface sediments down and along the relatively narrow earth fissure crack.

EARTH FISSURE MAPPING PROGRAM

AZGS Earth Fissure Planning Maps (OFR-07-01)

The AZGS earth fissure mapping program compiled planning maps of known and reported fissures for Maricopa, Pinal, Pima, and Cochise counties, where virtually all earth fissures in Arizona occur. The planning maps were publicly released in June 2007 at a scale of 1:250,000. This is the most comprehensive state-wide assessment of the extent and location of the earth fissure problem ever undertaken.

AZGS geologists are using these planning maps to guide our detailed mapping efforts, establish staffing assignments, and as a rough estimate of the time required for field mapping. Once detailed mapping of an area is complete, the AZGS provides the mapped data the State's IMS for online public distribution as interactive maps from the Arizona Department of Real Estate's website.

Through the end of 2007, more than 44,000 copies of planning maps or the accompanying program report were downloaded from the AZGS website,

azgs.az.gov. Details are shown in Tables 1 & 2. In addition, a few hundred copies of printed planning maps were sold to the public or provided to local government planning agencies. The Arizona Land Subsidence Group report (AZGS CR-07-C) was released in December 2007.

Table 1. September through December Downloads of Earth Fissure Maps & Reports

Product (PDF)	Monthly Downloads			
	Sept.	Oct.	Nov.	Dec.
AZGS CR-07-C (ALSG report)	---	---	---	*1319*
Maricopa County	3118	905	662	680
Pinal County	1361	912	510	634
Cochise County	289	117	123	237
Pima County	300	152	138	196
Earth Fissure Report OFR-07-01	1676	1019	998	[1]800
Total EF PDF Downloads	6561	3105	2477	2547

[1] This is a conservative estimate of OFR-07-01 downloads for December 2007.

Table 2. Earth Fissure Planning Maps/Report Downloads: 4 June to 31 December 2007

Product (PDF)	Downloads
Maricopa County	15929
Pinal County	10995
Cochise County	2576
Pima County	2875
Press Release (6.04.2007)	1447
Earth Fissure Report OFR-07-01	10543
Total PDF Downloads	44365

Mapping methods and protocols

Earth fissure mapping involves four phases for map production;

1. preliminary investigation,
2. collection of data in the field,
3. post-processing of the GPS data, and
4. map production

Preliminary investigation involves researching previously reported earth fissures and aerial photo investigation. Collection of the field data involves investigating every suspected earth fissure based on previous reports and reviewing air photos for unreported or unknown earth fissures. Earth fissures are precisely located using Global Positioning Satellite (GPS) receivers at numerous points along their surface expression. Once these data are collected we post-processed the GPS location data using differential correction to deal with effects of atmospheric interference on the coordinate data. Once the data are corrected

and filtered for accuracy, they are produced as a shape file and loaded into the AZGS Earth Fissure database. Using a Geographic Information System (GIS) program we create lines that represent the confirmed locations of earth fissures. We also depict earth fissures that were reported previously but we were unable to unconfirm in our field investigations,

Accuracy and display of data

Mapped earth fissure lines will be displayed online at 1:12,000 scale. At this scale, the line widths used to portray fissures would be approximately 13 ft wide on the ground. We have three types of classification for lines on the earth fissure map; continuous, discontinuous, and reported/unconfirmed. "Continuous" and "discontinuous" depict two different surface expressions of earth fissures. "Reported/unconfirmed" lines are the approximate locations of earth fissures whose existence has been previously reported, but which cannot be re-located on the ground, so that we were not able to confirm their existence. Three situations could result in our inability to confirm a reported earth fissure; (1) the fissure has been disturbed (by such activities as grading or plowing) or built over, precluding investigation; (2) we have been denied access to the site by the landowner; or (3) the reported feature was not actually an earth fissure.

Dissemination of fissure disclosure maps and data

Following completion of detailed, GPS-based mapping of a designated earth fissure study area by AZGS geologists, the fissure map data are transmitted to the SLD in digital format compatible with their GIS standards. By statute, SLD has ninety days to prepare the final earth fissure map layer and incorporate it with the other map layers they maintain in an online web service format. Earth fissure maps will be served at a scale of 1:12,000 or smaller, which is compatible with other data layers they maintain. The lines on the GIS maps are programmed so that they show the accuracy as the scale of the display is changed. Thus, if the GIS layer is expanded tenfold, the line characterizing the earth fissure will be ten times wider. This will prevent misunderstanding about the accuracy of the field mapping of the fissures.

Maps and data on the AZGS website

AZGS currently serves the four earth fissure planning maps online (http://www.azgs.az.gov/efc) that show the locations of fissures mapping during reconnaissance-scale fissure studies over the past few decades, as well as areas of fissures that have not been mapped at all (Figures 5 through 9). The scale of the maps, 1:250,000, precludes precise determination of earth fissure locations.

These previously published fissure maps and reports are for sale as printed reports from AZGS.

Earth fissure mapping staff

The Earth Fissure Mapping Program is tasked to the AZGS Environmental Geology Section. Geologic staff who worked in the program during 2007 are:

Dr. Phil Pearthree, Chief, Environmental Geology
Dr. Todd Shipman, Manager, Earth Fissure Program
Mimi Diaz, Phoenix Branch Chief and Project Geologist
Mike Mahan, Project Geologist
Bryan MacFarlane, Project Geologist
David Haddad, Project Geologist

TECHNICAL ADVISORY GR0UP

For the past two years, AZGS participated in the Arizona Land Subsidence Group (ALSG) meetings. ALSG is an informal network of industry and government geologists and engineers that meets monthly to discuss technical and programmatic issues about subsidence, including earth fissures. ALSG serves as a technical advisory resource to the AZGS on issues related to identifying, characterizing, and mapping earth fissures. ALSG members reviewed the draft Chander Heights disclosure map and provided advice on: 1) the number and nature of earth fissure categories which resulted in defining three discrete mapping categories; 2) formalizing mapping guidelines and protocols; and 3) visual presentation and interpretation scales.

Additionally, ALSG spent considerable time and effort examining research needs on subsidence and earth fissures beyond the AZGS mapping effort. They formalized this in a white paper, *Land Subsidence and Earth Fissures in Arizona: Research and Informational Needs for Effective Risk Management*, published by AZGS as CR-07-C. Highlighting the ALSG report were recommendations for constructing an integrated research, monitoring, mitigation, and data dissemination program to manage risk from subsidence and earth fissures.

EARTH FISSURE ADVISORY GROUP

Under the authority of A.R.S. 27-151C3, the State Geologist, Lee Allison, appointed an earth fissure advisory group (EFAG) in late 2006 with representatives from state and local government, technical and trade associations and other organizations with concerns about earth fissures. The EFAG reviewed the AZGS fissure mapping standards, procedures, and characterizations and offered advice on documenting them and addressing legal issues prior to final release of the first disclosure map.

A list of members and their affiliation is attached (Appendix B).

The group met twice during 2007 in Phoenix. The Group's discussions are done largely by email.

PROGRAM PLANS

Online availability of earth fissure map data

New fissure data collected by AZGS go into digital maps that SLD will serve online at a scale of up to 1:12,000. AZGS, however, is collecting GPS data with an estimated horizontal uncertainty of less than 6 feet (about 2 meters) and in many areas less than 3 feet (about 1 meter). These GPS waypoints are compiled into data files that will be made publicly available, in the format of ArcGIS shape files. Users could then download the GPS waypoints and construct their own maps at larger scales than that available via the SLD map service. The GPS data will be in a database format and will not be presented on a map.

Training seminars

AZGS began giving seminars and briefings to potential users of the earth fissure maps, including real estate agents, developers/builders, and county and city officials. The seminars are aimed at non-technical audiences and cover the nature, history, and causes of fissures, where to find maps and other resources, how to read and interpret the fissure maps, and how other jurisdictions have dealt with them. These seminars are 2-3 hours in length. We typically hold these in cooperation with professional organizations who would advertise them to their members. The hosting professional groups may offer continuing education credits to their members for attendance.

Educational Materials

AZGS is developing educational materials describing earth fissures in lay terms to use at training seminars, and as stand-alone flyers and brochures for non-technical readers. These materials will be placed online at the AZGS Earth Fissure Center web page (azgs.az.gov/efc) for viewing and downloading. The U. S. Federal Emergency Management Agency (FEMA) provided a grant to AZGS starting in 2007 to design and distribute these materials. AZGS staff geologists Dr. Michael Conway and Mimi Diaz are carrying out this project. The funds are coming through the Arizona Div. of Emergency Management.

REFERENCE MATERIALS

SYMPOSIA AND PUBLIC TALKS

AZGS has given talks at numerous conferences, symposia, professional organizations and to the public. Talks given in 2007 include:

Wings Over Willcox Festival, January 20, 2007, Willcox, AZ, “Mega-cracks in the Willcox Region,” by Ray Harris

Structural Engineers Association of Arizona 2007 Convention, June 22, 2007, Phoenix, AZ, “Earth Fissures,” by Todd Shipman

Association of Engineering and Environmental Geologists, May 31, 2007, Tempe, AZ, “Earth Fissures and the AZGS Role in Geologic Hazards,” by M. Lee Allison

County Supervisors Association (Arizona), Mid-year meeting, June 6, 2007, Tucson AZ, “Earth Fissures in Arizona,” by M. Lee Allison

So. Arizona Chapter International Code Council (SAICC), dinner meeting, July 10, 2007, Catalina, AZ, “Earth Fissures,” by M. Lee Allison

Arizona Chapter, American Public Works Association, August 15, 2007, Tempe, AZ, “Earth Fissures,” by M. Lee Allison

Arizona Land Subsidence Group, September 6, 2007, Phoenix, AZ, “Earth Fissure Mapping Guidelines,” by Todd Shipman

Tucson Realtors Association, October 25, 2007, Tucson, AZ, “Earth Fissures,” by Todd Shipman

BRIEFINGS

AZGS staff gave briefings to numerous state, local, and professional groups during 2007:
Palo Verde Nuclear Generating Station, April 26 [Shipman & Diaz]
Pima Assoc. of Govts, Watershed Planning Subcommittee, May 24 [Allison]
Pinal County, May 30 [Allison]
City of Apache Junction, May 30 [Allison]
Arizona Land Subsidence Group, Phoenix, May 30 [Allison]
City of Mesa, May 31 [Allison]
Maricopa County, May 31 [Allison]
City of Queen Creek, May 31 [Allison]
City of Eloy, May 31 [Allison]
City of Marana, June 12 [Shipman]
City of Mesa, June18 [Diaz]
City of Casa Grande, July 11 [Allison]
AZ Department of Real Estate, Phoenix, July 11 [Diaz]
Pinal County, July 13 [Diaz]
City of Mesa, August 2 [Diaz]
City of Phoenix, August 6 [Diaz]
AZ State Land Department, Phoenix, August 20 [Diaz]
AZ Department of Environmental Quality, Phoenix [Diaz]

FIELD TRIPS TO FISSURES

AZGS led numerous trips to visit earth fissures and giant desiccation cracks during the past year. These trips included:

University of Arizona class to Marana earth fissures, May 30 [Shipman]
Maricopa Flood Control District staff, UA graduate students, and retired USGS staff, "Rodgers Earth Fissures," Harquahala, September 28 [Shipman]
Georgia Tech researchers, Chandler Heights, October 18 [Shipman, Diaz]
Chander-Gilbert Community College to Apache Junction earth fissures, November 2 [Shipman]
Prescott College class to Chandler Heights earth fissures, 20 Oct. 2007 (Shipman)

NEWS MEDIA INTERVIEW AND BRIEFINGS

AZGS staff spoke with reporters dozens of times as part of at least xx stories broadcast on or printed in local and statewide news media. Staff also provided extensive materials to KAET-TV for a documentary aired in Spring, 2007, and did on-camera presentations.

Interviews include (date, reporter, outlet, location, - topic, [interviewee]):

2-27-07 & 3-5-07 "Under Arizona" one-hour documentary, AZ Public Television, Phoenix [Allison]
5-15-07 "Arizona Illustrated" KUAT, Tucson - Picacho Peak fissures - [Shipman]
5-15-07 KUAT television and radio, Tucson [Pearthree]
5-29-07 KAET, Tempe - Chandler Heights fissures – [Shipman]
5-30-07 Steve Goldstein, "Horizon," Ch 8 KAET, Tempe, 10 minute on-air interview [Allison]
6-4-07 Tony Davis, AZ Daily Star,Tucson [Allison]
6-5-07 Pam White, KUAT, NPR-Tucson [Allison]
6-5-07.1 Lynn, AZ Republic, Phoenix [Allison]
6-5-07.2 Channel 13 Phoenix – Chandler Heights fissures [Diaz]
6-6-07 Channel 12, Phoenix – Apache Junction fissures [Diaz]
6-6-07.1 Rick, Ch 12 NBC, Phoenix [Allison]
6-6-07.1 Sam Stoker, Tucson Weekly, Tucson [Allison]
6-15-07 Sam Stoker, Tucson Weekly, Tucson [Allison]
6-25-07 Mike Walberg, AZ Republic, Phoenix [Allison]
7-24-07 Channel 12, Phoenix – Chandler Heights horse dies in fissure [Diaz]
8-27-07 Sam Stoker, Tucson Weekly, (follow up) [Allison]
9-6-07 Channel 5, Phoenix – Chandler Heights fissures and the monsoon [Diaz & Shipman]
10-3-07 Sara Bogan, East Valley Tribune, fissures and new construction in Queen Creek [Shipman]
11-4-07 "Government Connections" Access Tucson, - "Arizona Geological Survey" [Allison]

NEW PUBLICATIONS

During 2007 AZGS geologists published articles about subsidence and earth fissures:

Allison, M. Lee and Todd Shipman, 2007, *Earth Fissure Mapping Program: 2006 Progress Report, Geological Hazards and Limitations of Earth Fissures by Counties*, Arizona Geological Survey Open-file Report 07-01, 25p, scale 1:250,000, 4 sheets

Allison, M. Lee and Todd Shipman, 2007, *The Role of the AZGS in Mapping Earth Fissures*, Arizona Geology, Arizona Geological Survey, Vol 36, #4 Winter/Vol 37, #1 Spring, p1-4.

EARTH FISSURE STUDY AREAS

The earth fissure planning or study areas are currently scheduled to be mapped in the following order, based largely on likelihood of development in the shortest time frame:

1) Chandler Heights, including the Queen Creek area (Pinal & Maricopa)
2) Apache Junction (Pinal)
3) Luke (Maricopa)
4) Toltec Buttes (Pinal)
5) Picacho (Pinal)
6) Maricopa (Pinal)
7) White Horse Pass (Pinal)
8) Signal Peak (Pinal)
9) Tator Hills (Pinal)
10) Greene Wash (Pinal)
11) Sacaton Butte (Pinal)
12) Scottsdale/NE Phoenix (Maricopa)
13) Pete's Corner (Pinal)
14) Santa Rosa Wash (Pinal)
15) Sulphur Springs North (Cochise)
16) Three Sisters Buttes (Cochise)
17) Bowie-San Simon (Cochise)
18) Dragoon Road (Cochise)
19) Wintersburg (Maricopa)
20) Marana (Pima)
21) Harquahala Plain (Maricopa)
22) Mesa (Maricopa)

EARTH FISSURE PUBLICATIONS FROM THE AZGS

Down-to-Earth Series

DTE-3-Land Subsidence and Earth Fissures in Arizona, by S. Slaff, 1993, 24 p**.** $4.50

DTE-13-A Home Buyer's Guide to Geologic Hazards in Arizona, by Raymond C. Harris and Philip A. Pearthree, 1993, 24 p. $8.95

Maps

M-23-Land Subsidence, Earth Fissures, and Water-Level Change in Southern Arizona, by H.H. Schumann and R.B. Genualdi, 1986, scale 1:1,000,000. $4.00

Special Papers

SP-5-Geologic Diversity of Arizona and Its Margins; Excursions to Choice Areas, edited by G.H. Davis and E.M. VandenDolder, 1987, 422 p.[Field-Trip Guidebook for the 100th Annual Meeting of The Geological Society of America, Phoenix, Ariz., 1987]. $20.00

SP-2-Guidebook to the Geology of Central Arizona, by D.M. Burt and T.L. Péwé, 1978, 176 p. [Field-Trip Guidebook for the 74th Regional Meeting of the Cordilleran Section, The Geological Society of America, Tucson, Ariz., 1978]. $15.00

Open-File Reports

OFR-04-01-Giant Desiccation Cracks in Arizona, by R.C. Harris, 2004, 93 p. $22.00

OFR-03-07-Additional Giant Desiccation Cracks near Wintersburg, Maricopa County, Arizona, by R.C. Harris, 2003, 17 p. $5.50

OFR-01-10-A New Earth Fissure Near Wintersburg, Maricopa County, Arizona, by R. C. Harris, 2001, 22 p.$6.50

OFR-99-26-Field Guide to Earth Fissures and Other Land-Subsidence Features in Picacho Basin, Pinal County Arizona, by R.C. Harris, 1999, 55 p. $10.00

OFR-99-18-Geologic Map of the Picacho Mountains and Picacho Peak, Pinal County, Southern Arizona, by S.M. Richard, J.E. Spencer, C.A. Ferguson, and P.A. Pearthree 1999, 43 p., 2 sheets, scale 1:24,000. Text and sheets $10.00

OFR-98-23-Geology and Geologic Hazards of the Casa Grande Area, Pinal County, Arizona, by J.E. Klawon, P.A. Pearthree, S.J. Skotnicki, and C.A. Ferguson, 1998, 26 p., scale 1:24,000, 6 sheets, [1-Stanfield; 2-Casa Grande West; 3-Casa Grande East; 4-Coolidge; 5-Double Peak; 6-Chuichu]. Complete set. $15.00

OFR-97-19-Earth Fissures in the Bowie-San Simon Area, Cochise County, Arizona, by R.C. Harris, 1997, 10 p., scale 1:24,000. Text and sheet $7.00

OFR-96-23-Geologic Map of the Mesa 30' x 60' Quadrangle, East-Central Arizona, by J.E. Spencer, S.M. Richard, and P.A. Pearthree, 1996, scale 1:100,000. $3.00

OFR-95-11-Bibliography on Subsidence and Earth Fissures in the Metropolitan Phoenix Area, by R.A. Trapp and R. Frisch-Gleason, 1995, 6 p. $2.00

OFR-95-8-Bibliography of Subsidence and Earth Fissures Within Arizona, by R. Frisch- Gleason, Steven Slaff, and R.A. Trapp, 1995, 21 p. $4.50

OFR-95-6-A Reconnaissance of Earth Fissures Near Stanfield, Maricopa, and Casa Grande, Western Pinal County, Arizona, by R.C. Harris, 1995, 6 p., scale 1:24,000. Text and sheet $5.00

OFR-94-11-A Reconnaissance of Earth Fissures Near Apache Junction, Chandler Heights, and Southwestern Picacho Basin, by R.C. Harris, 1994, 5 p., scales 1:24,000 and 1:27,000, 2 sheets. Text and sheets $4.00

OFR-94-7-Surficial Geology of the Santan Mountains Piedmont Area, Northern Pinal and Eastern Maricopa County Area, Arizona, by Gary Huckleberry, 1994, 32 p., scale 1:24,000, 2 sheets. Text and sheets $8.00

OFR-93-11-Earth Fissures and Related Subsidence Features Adjacent to the Tucson Aqueduct, Central Arizona Project, Pinal and Pima Counties, Arizona, by S. Slaff, 1993, 18 p., scale 1:24,000, 6 sheets. Text and sheets $15.00

OFR-93-1b-Gravity and Magnetic Surveys at Brady Earth Fissure, Picacho Basin, Pinal County, Arizona: Raw Data, by Steven Slaff, 1993, 15 p. $2.50

OFR-93-1a-Gravity and Magnetic Surveys at Brady Earth Fissure, Picacho Basin, Pinal County, Arizona, by Steven Slaff, 1993, 29 p., scale 1:24,000. Text and sheets $7.00

OFR-92-13-DRASTIC Analysis of the Potential for Groundwater Pollution in Pinal County, Arizona, by D.L. Moulton, with a fissures study by Steven Slaff, 1992, 67 p., scale 1:250,000, 11 sheets. Text and sheets $25.00

OFR-91-1-Earth-Fissure Activity Near Brady and Picacho Pumping Plants, Tucson Aqueduct, Central Arizona Project, Pinal County, Arizona, by Steven Slaff, 1991, 43 p., scale 1:24,000, 2 sheets. Text and sheets $10.50

OFR-90-7-Bibliography on Arizona Earth Fissures and Related Subsidence, With Selected References for Other Areas, by Steven Slaff, 1990, 28 p. $4.75

OFR-90-2-Surficial Geologic Maps of the Picacho Basin, by Garrett Jackson, 1990, 9 p., scale 1:24,000, 5 sheets [1-Picacho Reservoir; 2-Newman Peak; 3-Casa Grande Mts.; 4-Eloy North; 5-Eloy South]. Complete set. $11.50

OFR-89-10-Development of Earth Fissures in Picacho Basin, Pinal County, Arizona From 1959 to 1989, by Steven Slaff, G.W. Jackson, and P.A. Pearthree, 1989, 38 p., scale 1:24,000, 6 sheets [1-Red Rock NW (Newman Peak); 2-Picacho Reservoir; 3- Casa Grande Mts.; 4-Eloy NE (Eloy South); 5-Eloy North; 6-Valley Farms]. Text and sheets $18.25

OFR-88-20-Potential Land Surface Subsidence at the Arizona Superconducting Super Collider (SSC) Site; Considering Past, Current and Possible Future Ground-Water Withdrawal, by S.J. Brooks, 1988, 28 p. $4.50

OFR-86-14-Land Subsidence, Earth Fissures, and Water-Level Change in Southern Arizona, by H.H. Schumann and R.B. Genualdi, 1986, scale 1:500,000 [also printed at 1:1,000,000 scale as Map 23]. $5.00

Appendix A

Statutory requirements

Arizona Revised Statutes:

27-152.01. Duties of Arizona geological survey

The Arizona geological survey shall:

3. Beginning on or before January 1, 2007 and every five years thereafter, submit to the state land department copies of all data files of known areas of earth fissures for the purposes of section 37-173, paragraph 11. On receipt of the earth fissure maps from the state land department that are based on data files submitted, the Arizona geological survey shall provide any map to any member of the public in printed or electronic format on request. The following notice shall be displayed below each map:

Notice

The state of Arizona has made a reasonable effort to ensure the accuracy of this map when it was produced, but errors may be present and the state of Arizona does not guarantee its accuracy. The map supplements, and is not a substitute for, a professional inspection of property for defects and conditions.

37-173. Duties [of the Department of State Land]

11. Within ninety days after receiving data files of known areas of earth fissures from the Arizona geological survey pursuant to section 27-152.01, paragraph 3, produce maps of those areas with overlays showing affected counties, cities, towns, highways and streets. The division shall transmit the maps in printed and electronic format to the Arizona geological survey and the state real estate department for purposes of providing public access to the earth fissure maps pursuant to sections 27-152.01 and 32-2117.

32-2117. Earth fissure maps; posting; immunity [Department of Real Estate]

A. On receipt of maps from the state land department, the department of real estate shall provide any earth fissure map to any member of the public in printed or electronic format on request and provide access on its web site to the earth fissure maps prepared by the state land department pursuant to section 37-173, paragraph 11. The following notice shall be displayed below each map:

Notice

The state of Arizona has made a reasonable effort to ensure the accuracy of this map when it was produced, but errors may be present and the state of Arizona does not guarantee its accuracy. The map supplements, and is not a substitute for, a professional inspection of property for defects and conditions.

B. Nothing in this section shall be construed as denying a person rights guaranteed by the Arizona Constitution, and notwithstanding any other law, a subdivider, owner or licensee is not liable to any person or governmental entity for any act or failure to act in connection with:

1. The disclosure of real estate subject to earth fissures if the subdivider, owner or licensee provides a written disclosure or includes notice in a public report, issued pursuant to section 32-2183 or 32-2195.03, with respect to real estate subject to earth fissures, of the map and web site described in subsection A of this section. The written disclosure or notice in a public report, issued pursuant to section 32-2183 or 32-2195.03, of the map and web site does not create an independent cause of action.

2. Any disclosure that occurred before the date the map described in subsection A of this section is posted on the web site if the subdivider, owner or licensee had no actual knowledge that the land was subject to earth fissures before the map was posted.
33-422. Land divisions; recording; disclosure affidavit
F. The affidavit of disclosure shall meet the requirements of section 11-480 and follow substantially the following form:
When recorded mail to:
_____
_____
_____
_____
Affidavit of Disclosure
Pursuant to A.R.S. §33-422
I, _____ (seller(s))
being duly sworn, hereby make this affidavit of disclosure relating to the real property situated in the unincorporated area of:
_____, County, State of Arizona, located at:
_____
___
and legally described as:
(Legal description attached hereto as exhibit "A")
(property).
7. The property (is (is not subject to (fissures or (expansive soils. (unknown
Explain: _____
_____
_____
_____

Appendix B

Arizona Geological Survey
Earth Fissure Advisory Group membership

Association of Engineering and Environmental Geologists
Ken Fergason
AMEC Earth & Environmental, Inc.
1405 West Auto Drive
Tempe, Arizona 85284-1016
480-940-2320
ken.fergason@amec.com

Arizona Association of Realtors
Tom Farley
VP Government Affairs
255 E. Osborn Rd. #200
Phoenix, AZ, 85012
602.248.7787 or 1.800.426.7274
TomFarley@AARonline.com

State Land Department
Gary Irish, GIS Section Chief
Eugene Trobia, State Cartographer (alternate)
1616 W. Adams St.
Phoenix, AZ 85007
602.542.2605 girish@land.az.gov
602.542.3190 gtrobia@land.az.gov

Arizona Department of Real Estate
Cindy Ferrin, Deputy Director of Subdivisions & Land Development
Ron Passarelli, Deputy Commissioner (alternate)
2910 N. 44th St.
Phoenix, AZ 85018
602.468.1414, x440 cferrin@azre.gov
602.468.1414, x115, rpassarelli@azre.gov

Arizona Land Subsidence Group
Raymond Sadowski
Sr. Environmental Engineer
Freeport-McMoRan
One North Central Avenue– 17th Floor
Phoenix, AZ 85004
602.366.8592
Raymond_Sadowski@fmi.com

Central Arizona Association of Governments
Robert Wilson
271 Main St.
Superior, AZ 85273
1.800.782.1445 (x25) or 520.689.5004 (x25)
rwilson@caagcentral.org

Office of the Attorney General
Laurie Woodall, Assistant Attorney General*
1275 W. Washington St.
Phoenix, AZ 85007
602.542.7798
Laurie.woodall@azag.gov

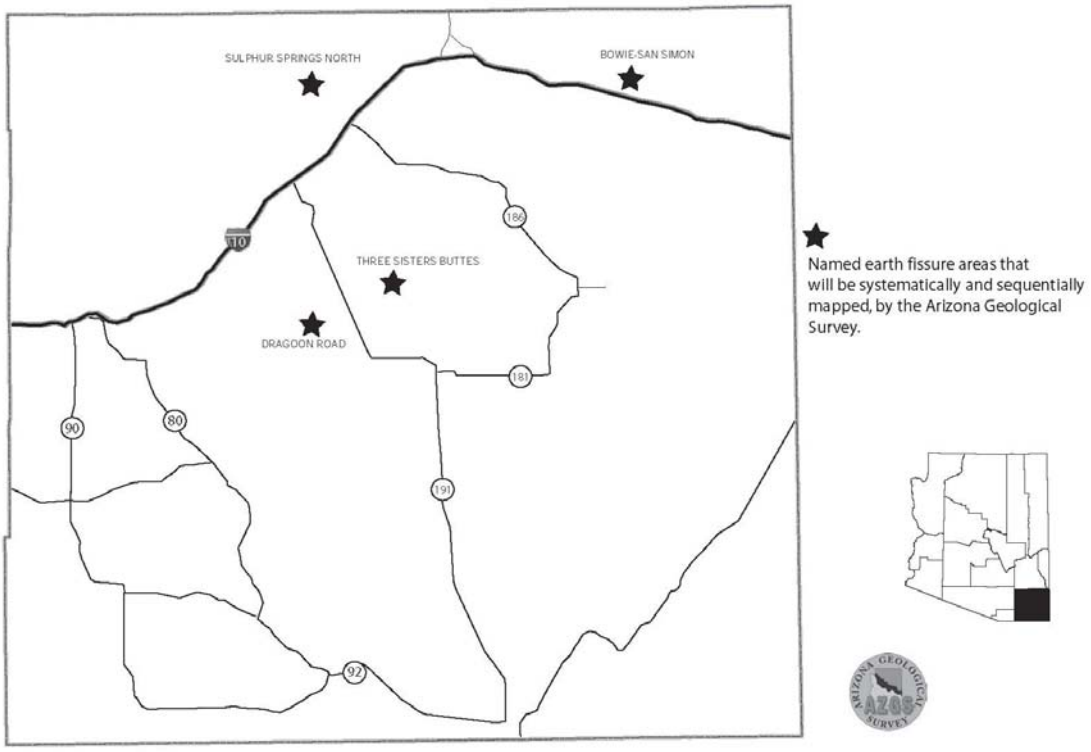
County Supervisors Association of Arizona
Craig Sullivan, Executive Director
1905 W. Washington St. Suite 100
Phoenix, Arizona 85009
602.452.4500
craigs@countysupervisors.org

Arizona Department of Environmental Quality
Victor Gass
1110 W Washington St.
Phoenix, Arizona 85007
602-771-4517
gass.victor@azdeq.gov

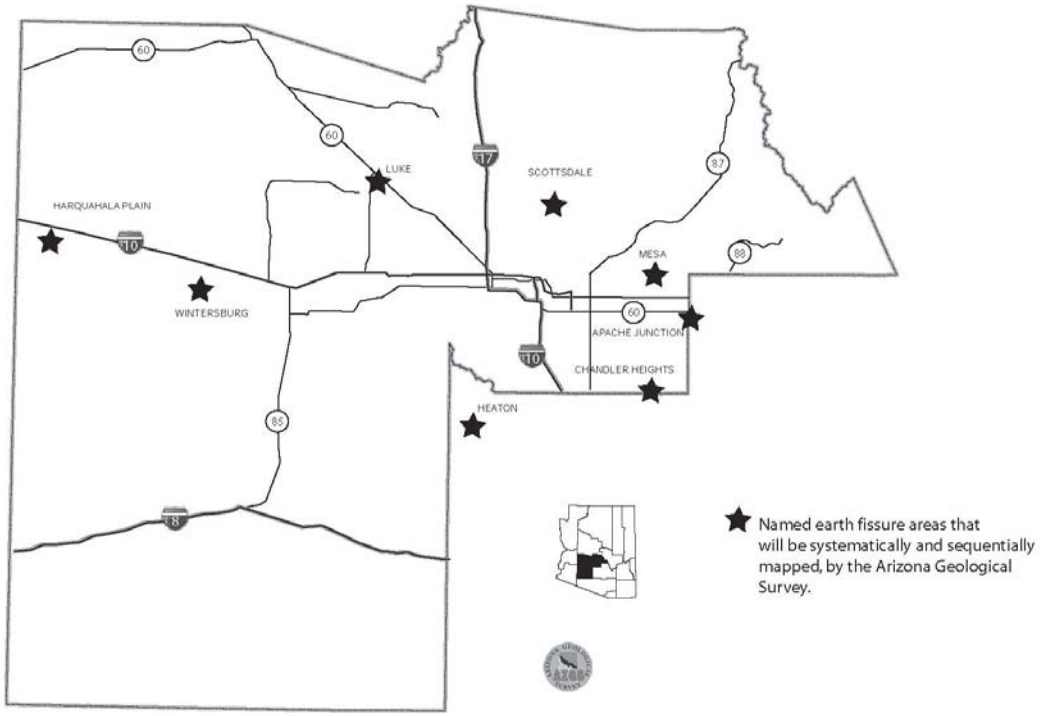
Arizona Geological Survey, Earth Fissure Program Staff
416 W. Congress, #100
Tucson, Arizona 85701
520-770-3500
Todd Shipman, todd.shipman@azgs.az.gov
Phil Pearthree, phil.pearthree@azgs.az.gov

* effective January 2, 2008, Laurie Woodall is with K.R. Saline and Associates, in Mesa, Arizona

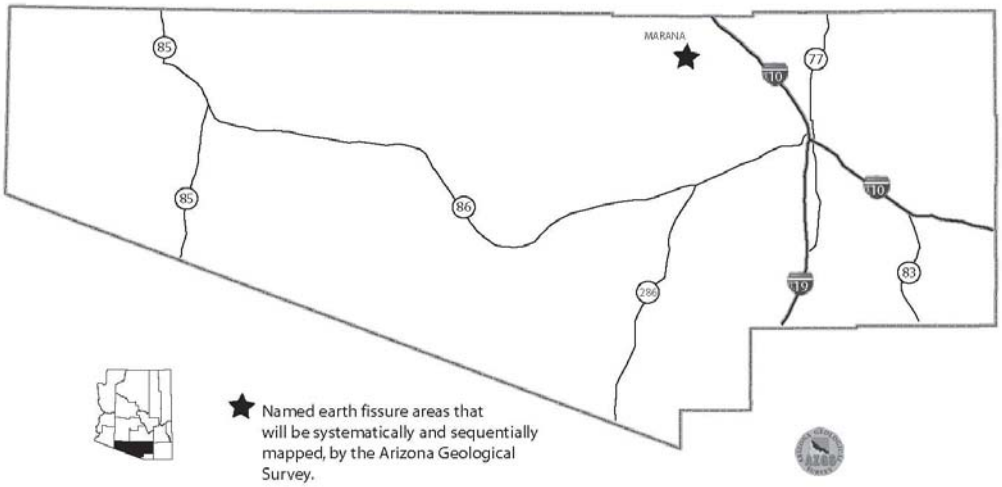
COCHISE COUNTY EARTH FISSURE PLANNING MAP



MARICOPA COUNTY EARTH FISSURE PLANNING MAP



PIMA COUNTY EARTH FISSURE PLANNING MAP



PINAL COUNTY EARTH FISSURE PLANNING MAP