A RECONNAISSANCE OF EARTH FISSURES NEAR STANFIELD, MARICOPA, AND CASA GRANDE, WESTERN PINAL COUNTY, ARIZONA

by

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INTRODUCTION

Earth fissures are tension cracks that are common in Arizona's alluvial basins. In Arizona, these fissure are generally a result of land subsidence caused by groundwater withdrawal, which has lowered water tables as much as several hundred feet. Subsidence can cause flooding of lowered areas, and can change drainage directions, thereby disabling storm drains, sewers, and water conveyance systems such as aqueducts. Earth fissures can cause significant damage to structures such as buildings, roads and irrigation canals. Land subsidence and earth fissures are serious geologic hazards and their impact will increase as Arizona's population grows.

Western Pinal County is extensively cultivated and residential development is rapidly increasing. Significant pumping of groundwater for agriculture has lowered the water table hundreds of feet and active subsidence is occurring. Several areas are known to have earth fissures.

PURPOSE

Several areas of central and southern Arizona were surveyed for earth fissures by helicopter in 1986. The air survey was primarily a reconnaissance of areas with known fissures to determine if existing fissures had lengthened or new fissures had developed since the areas were last field-checked in 1977. Fissures seen from the air were plotted on maps, but were not confirmed by field checking. This project was initiated to test the accuracy and efficiency of searching for fissures by aircraft versus using aerial-photo interpretation. The Casa Grande-Maricopa-Stanfield area of western Pinal County was chosen for this study based on indications of numerous earth fissures in and near residential and agricultural areas, and extreme lowering of groundwater levels in the Maricopa-Stanfield groundwater basin. The location of the area covered by this study is shown in Figure 1.

GEOGRAPHIC SETTING AND HYDROGEOLOGY

The area of this study is a large valley bounded on the southeast by the Casa Grande Mountains, on the south by the Tat Mololi Mountains, to the west by the Palo Verde and Table Top Mountains, and on the north by the Sacaton Mountains. For purposes of groundwater investigations, the area is referred to as the lower Santa Cruz area by the U.S. Geological Survey and as the Maricopa-Stanfield sub-basin of the Pinal Active Management Area by the Arizona Department of Water Resources.

Formed by the late-Miocene Basin and Range disturbance, a deep structural basin is centered between the towns of Stanfield and Maricopa. A thick sequence of unconsolidated alluvial and fluvial clay, silt, sand, and gravel fills the basin. Gravity modelling (Oppenheimer, 1980) indicates that the structural basin may be up to 8000 feet deep. Casa Grande lies on shallow bedrock ridge that connects the Casa Grande and Sacaton Mountains.

Groundwater extraction in excess of natural recharge has lowered the water table up to

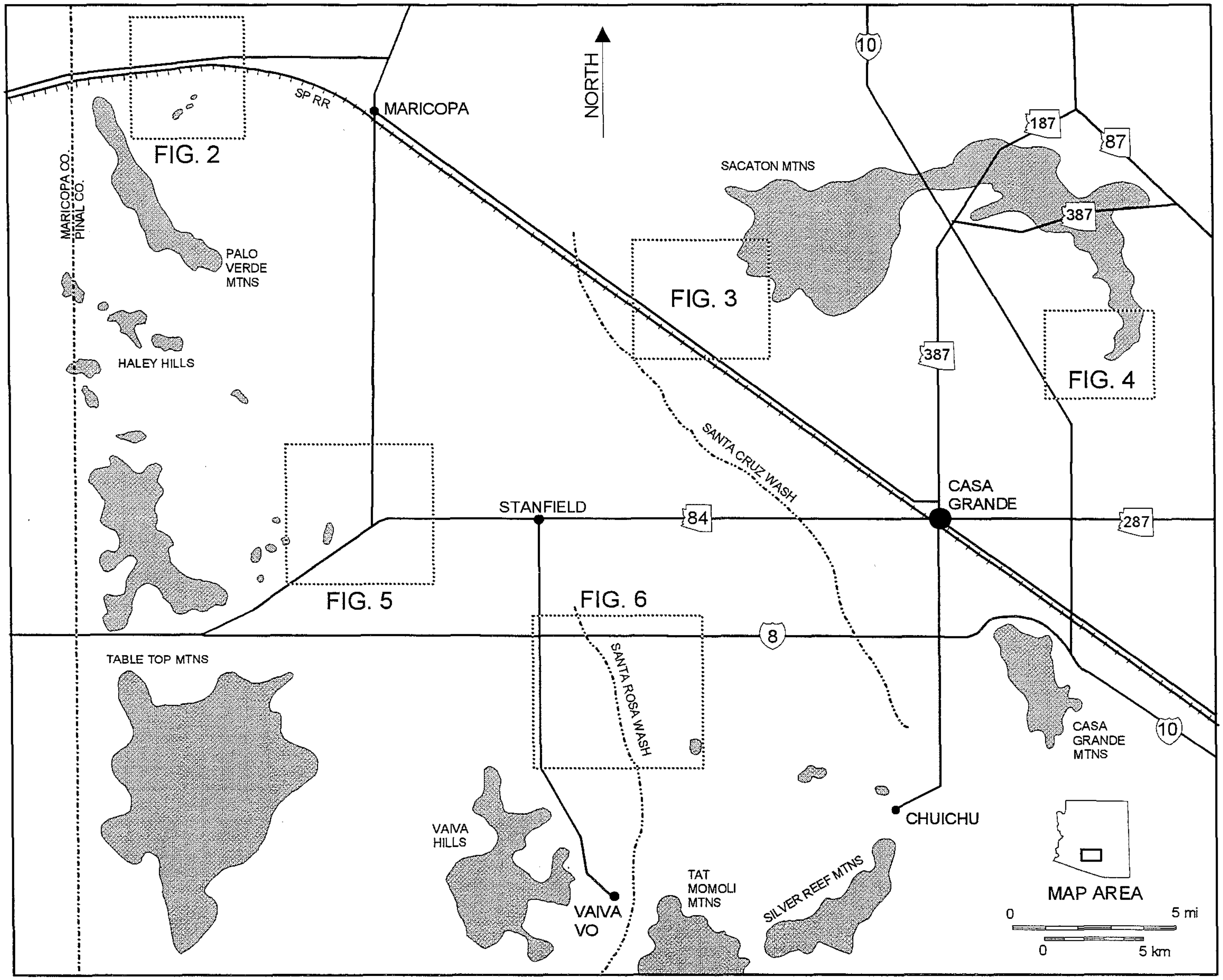

Figure 1. Location of earth fissure study

500 feet near Stanfield and Maricopa since the 1930s (Schumann and Genualdi, 1986b; Schumann et al., 1986). About 100 feet of decline has taken place between 1977 and 1989 (Hammett, 1992). This pumping has caused the land to subside by as much as 12 feet near Stanfield (Laney et al., 1978; Pierce, 1979).

PREVIOUS STUDIES

Land subsidence and earth fissures have been intensely studied in Arizona. Data on water-level declines and land subsidence, as well as locations of earth fissures in the area covered in this investigation are presented in Schumann (1974), Laney (1976), Laney and others (1978), Konziecki and English (1979), Schumann and Genualdi (1986a; 1986b), Schumann et al. (1986), ABGMT (1987), and Hammett (1992). The most comprehensive summary of subsidence and earth fissures in Arizona is that of Slaff (1993).

METHODS

The first step in this investigation was to compile the locations of earth fissures based on unpublished helicopter survey maps and detailed aerial photos taken in 1987. Possible fissures indicated on the maps and photos were visited in the field during April through June, 1995. Where possible, intervening areas were also explored to determine if fissures were present that were not recognized during the helicopter survey or were not discernible on the photos. Fissures on Indian Reservation land and in residential areas were considered inaccessible and were plotted based on aerial-photo interpretation.

RESULTS

Field work confirmed that the features identified by the helicopter reconnaissance were, in fact, earth fissures. In the years since the air survey was performed, several of the fissures have grown and many new fissures have developed. Locations of fissures checked in this study are shown on Figures 2 through 6 (PLATE 1).

It is unclear whether all of the "new" fissures have developed since 1987 or if some of them were simply not recognized as fissures by previous workers. During the course of field-checking the aerial-survey maps and photos, several fissures were discovered literally by accident. Some of these fissures are so similar in appearance to natural drainages on air photos that if field work had been limited only to confirming fissures indicated by the helicopter survey or conspicuous fissure-looking features on photos, these fissures would not have been discovered during this investigation. Other accidently-discovered fissures are not discernable on the photos and probably have formed since 1987.

A few fissures reported by previous workers and visible on the 1987 photos have been partially obscured or completely obliterated by residential or agricultural development. These fissures are plotted based on previously published maps (Schumann, 1974; Laney et al., 1978), helicopter survey maps, and 1987 aerial photos.

CONCLUSIONS

As groundwater levels in Arizona's deep alluvial basins continue to decline, land subsidence and development of earth fissures will also continue. Monitoring of earth fissure activity is important for land use planning and reduction of geologic hazards. Helicopter surveys are a rapid way to track the growth and spread of fissures, but cost is a limiting factor in their use. Conventional aerial photo interpretation is less expensive, but detailed photo coverage may be difficult to find and is not available for most parts of the state. Many features, such as old roads, canals, berms, fences, and cattle trails, can interfere with the recognition of fissures on photos. Fissures that are very young may not be obvious from a fly-over or on a photo. Still, aerial photography is an invaluable aid in the study of earth fissures. Helicopter surveys and aerial-photo interpretation must be confirmed by field-checking.

REFERENCES

ABGMT, 1987, Subsidence areas and earth-fissure zones: Arizona Bureau of Geology and Mineral Technology Fieldnotes, vol.17, no.1, p. 6-9.

Hammett, B.A., 1992, Maps showing groundwater conditions in the Eloy and Maricopa-Stanfield sub-basins of the Pinal Active Management Area, Pinal, Pima, and Maricopa Counties, Arizona - 1989: Arizona Department of Water Resources Hydrologic Map Series Report Number 23, 3 sheets.

Konieczki, A.D., and English, C.S., 1979, Maps showing ground-water conditions in the lower Santa Cruz area, Pinal, Pima, and Maricopa Counties, Arizona - 1977: U.S. Geological Survey Water Resources Investigation Open-File Report 79-56, 4 sheets.

Laney, R.L., 1976, Water-level declines, land subsidence and earth fissuring in south-central Arizona, in Arizona Watershed Symposium, 20th annual, Phoenix, September 15,1976, Proceedings: Arizona Water Commission Report No. 8, p. 30-39.

Laney, R.L., Raymond, R.H., and Winikka, C.C., 1978, Maps showing water-level declines, land subsidence, and earth fissures in south-central Arizona: U.S. Geological Survey Water Resources Investigations Open-File Report 78-83, 2 sheets, scale 1:125,000.

Oppenheimer, J.M., 1980, Gravity modelling of the alluvial basins, southern Arizona: Tucson, University of Arizona, unpublished M.S. thesis, 81p.

Peirce, H.W., 1979, Subsidence-fissures and faults in Arizona: Arizona Bureau of Geology and Mineral Technology Fieldnotes, v. 9, no.2, p.1-2, 6.

Schumann, H.H., 1974, Land subsidence and earth fissures in alluvial deposits in the Phoenix area, Arizona: U.S. Geological Survey Miscellaneous Investigations Series Map I-845-H, 1 sheet, scale 1:250,000.

Schumann, H.H., Laney, R.L., and Cripe, L.S., 1986, Land subsidence and earth fissures caused by ground-water depletion in southern Arizona, in Anderson, T.W., and Johnson, A.I., eds., Regional aquifer systems of the United States - Southwest alluvial basins of Arizona: American Water Resources Association Monograph Series No. 7, p. 81-91.

Schumann, H.H., and Genualdi, R.B., 1986a, Land subsidence, earth fissures, and water level change in southern Arizona: Arizona Bureau of Geology and Mineral Technology Open-File Report 86-14, 1 sheet, scale 1:500,000.

Schumann, H.H., and Genualdi, R.B., 1986b, Land subsidence, earth fissures and water-level change in southern Arizona: Arizona Bureau of Geology and Mineral Technology Map 23, scale 1:1,000,000.

Slaff, S., 1993, Land subsidence and earth fissures: Arizona Geological Survey Down-to-Earth Series 3, 24 p.