

---

# Kansas Geological Survey

---

## Report on the 2000 Ashland and the 1999 Plains sinkholes

By

Gregory C. Ohlmacher

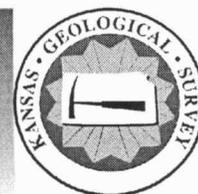


**Open File Report 2000-39**

**GEOLOGIC INVESTIGATIONS**

*Geologic mapping, economic minerals, industrial minerals, geologic hazards*

The University of Kansas, Lawrence, KS 66047



July, 2000

# **KANSAS GEOLOGICAL SURVEY OPEN-FILE REPORT 2000**

Report on the 2000 Ashland and the 1999 Plains Sinkholes

by

Gregory C. Ohlmacher

### *Disclaimer*

The Kansas Geological Survey does not guarantee this document to be free from errors or inaccuracies and disclaims any responsibility or liability for interpretations based on data used in the production of this document or decisions based thereon. This report is intended to make results of research available at the earliest possible date, but is not intended to constitute final or formal publications.

Kansas Geological Survey  
1930 Constant Avenue  
University of Kansas  
Lawrence, KS 66047-3726

## Introduction

In the summer of 2000, the Kansas Geological Survey was asked by the tenant farmers to examine recent sinkholes in Clark and Meade counties. The first location was a series of three sinkholes that opened in the spring of 2000 southwest of Ashland. One sinkhole at this location had a central collapsed area that was about 31 m (102 ft) in diameter with vertical sides. The rancher was concerned that the walls of this sinkhole were unstable. The other two sinkholes at this location were gradual with no central collapsed area.

The second location was an isolated sinkhole that opened in 1999 south of Plains. This sinkhole consisted of an oval-shaped collapse area that was 5.8 m (19 ft) in length. The farmer had filled the sinkhole; however, subsidence is continuing and new cracks have opened around the fringe of the earlier sinkhole.

It is recommended that the collapsed area and perimeter of the sinkhole near Ashland be fenced off and that the other two sinkholes near Ashland and the sinkhole near Plains be monitored. If sinkholes at Ashland and Plains continue to enlarge, then these sinkholes should also be fenced off. If additional remedial measures are considered for any of these sinkholes, a detailed site investigation by a qualified geologist and geotechnical engineer is recommended.

## Sinkhole near Ashland

Date of Failure: Late April or early May 2000  
Date Visited: June 27, 2000  
Type of Geologic Hazard: Land Subsidence (3 sinkholes)  
Topographic Quadrangle: Ashland 7½'  
General Location: 3.5 kilometers southwest of Ashland (Clark Co.)  
Latitude and Longitude: N 37° 10.289' W 99° 48.072' (NAD 27)  
UTM Coordinates: 4,113,992 N 428,871 E Collapse sinkhole #1  
4,113,993 N 428,917 E Gradual sinkhole #2  
Public Land Survey: SW NE Sec. 15, T. 33 S., R. 23 W.  
Access: Private land, contact owner or owner's representative



### Description

Three sinkholes were observed at this location. The first sinkhole is a catastrophic failure. It is teardrop shaped in map view with nearly vertical sides. The dimensions are approximately 33.5 m (110 ft) by 30.5 m (100 ft), and the depth is estimated to be 15 m (50 ft). Water had collected in the bottom of the sinkhole at the time of my visit. The ranch operator reported that there had been water in the sinkhole immediately after the failure, but it dried out until recent rains. The walls exposed red to orange sandstone, siltstone, and shale of the Permian Whitehorse Formation. The geologic map (Fairer and Green, 1994) shows the area as Quaternary Dune Sand; however, no dune sand was observed. Bedrock in the walls of the sinkhole is highly fractured. The dip of bedrock is horizontal except at the west end where it dips gently west. These dipping strata may indicate the presence of an earlier, healed sinkhole west of the current failure. Numerous perimeter fractures around the outside of the sinkhole extend for a distance of about 30 m (100 ft) beyond the rim. Perimeter fractures are curved cracks in the ground surface

that are approximately parallel with the rim of the sinkhole. The ground surface increases in elevation for about 30 m (100 ft) beyond the rim in all directions until it reaches the pre-failure elevation. It was reported that the area was flat prior to the failure.

The second sinkhole is located east of the first. The center of the second sinkhole is approximately 46 m (151 ft) east of the center of the first. It was a gradual failure with gently sloping sides. The amount of subsidence was less than 3 m (10 ft). No water had collected in this sinkhole. Several small ridges, less than 15 cm (0.5 ft), had formed in the center of this sinkhole. These ridges probably formed due to compression in the center of the subsiding area. Tangential tension cracks were observed away from the central region.

The third sinkhole is located northeast of the second sinkhole. It is a gradual failure with gently sloping sides. No data was collected on the third sinkhole.

No structures were damaged by the collapse; however, the operator reported the loss of one cow.

### **Geologic Setting**

Sinkholes are the surface manifestation of the collapse of voids in the soil and rock. These voids can be natural (caves and caverns) or human-induced (underground mines). No evidence exists at this site for underground mining or for oil wells. Thus, it is highly unlikely that human processes are responsible for these sinkholes.

Clark County is in an area of active karst. Kansas Geological Survey geologist Jim McCauley (personal communication, 2000) visited two recently active sinkholes in Clark County. Both are located northeast of Ashland. Additionally, Big and Little Basins located northwest of Ashland are considered to be sinkholes. Numerous sinkholes have been mapped and reported in Meade County, which is west of Clark County, including the Meade Salt Sink of 1879 (Frye, 1942; Izett and Honey, 1995).

No caves are reported near the location of the current sinkhole; however, the Blaine Formation is located below the Whitehorse and Dog Creek Formations. The Blaine Formation is composed of 50 feet of gypsum and shale (Swineford, 1955, Green and Fairer, 1995). Surface exposures of the Blaine Formation occur in southeastern Clark County. At the location of the sinkhole, the Blaine Formation is at or just below the level of the streams.

Gypsum is subject to dissolution and cave formation. Ground water flowing in the fractures of the gypsum beds dissolves the gypsum and forms a cave. Caves normally form at or immediately below the water table where the fresh water from precipitation reaches soluble rock. Gypsum is 100 times more soluble than limestone (Young and Beard, 1993). Comanche County, east of Clark County, has 235 caves in gypsum (Young and Beard, 1993), and some of these caves are in the Blaine Formation (Jim McCauley, personal communication, 2000).

No field data exists that confirms a cave in the Blaine Formation at the Ashland site. Other gypsum formations and some layers of rock salt exist below the Blaine Formation. Any of these gypsum or salt layers could potentially be the layer with the cave that collapsed. Because the Blaine Formation is the closest gypsum layer to the elevation of the valley bottom, it is about the

assumed elevation of water table where caves tend to form. This makes the Blaine Formation the most likely rock unit for the cave.

### **Recommendations**

The Kansas Geological Survey was requested by the ranch operator to examine the collapse sinkhole and comment of the stability of the walls. The operator wanted to know if he could collapse one side and build a ramp that would provide an exit for any cattle entering the sinkhole. Based on the highly fractured nature of the bedrock in the walls and the perimeter fractures, I told the operator that the sides were unstable. The walls of the sinkhole will recede (the sinkhole will increase in diameter) over the next several years even if nothing is done. I recommended placing a fence around the sinkhole. If the owner or the operator wish to do more, I recommend they hire a geotechnical engineering consultant and a geologist to advise and design any remedial measures.

## Sinkhole near Plains

Date of Failure: 1999  
Date Visited: July 20, 2000  
Type of Geologic Hazard: Land Subsidence (sinkhole)  
Topographic Quadrangle: Kismet NE 7½'  
General Location: 9.6 kilometers south of Plains (Meade, Co.)  
Latitude and Longitude: Not measured  
UTM Coordinates: Not measured  
Public Land Survey: SE Sec. 17, T. 33 S., R. 30 W.  
Access: Private land, contact owner or owner's representative



Photograph by Earl Shinogle

### Description

The farmer reported that a sinkhole opened in his wheat field in 1999. The sinkhole was oval shaped in map view, and the dimensions were 5.8 m (19 ft) by 3.2 m (10.5 ft) by approximately 1.1 m (3.5 ft) deep. The farmer filled the sinkhole with soil. This year the region has continued to subside and a perimeter fracture has formed at the location of the rim of the sinkhole.

I observed the perimeter fracture at the former rim of the sinkhole. The fracture is nearly vertical and has opened about 15 cm (6 in.) in two locations. I lowered a steel tape measure about 13.4 m (44 ft) down the fracture and didn't appear to hit bottom. However, I was unsure whether the

tape was collecting in a larger void. No additional fractures were observed. The sinkhole has subsided an additional 15 cm (6 in.) since the sinkhole was filled.

The walls of the perimeter fracture expose tan sands and silts. The material exposed in the upper part of the fracture may be the fill placed by the farmer. According to the geologic map of Meade County, the surface geology at the site is Quaternary dune sand as is the rest of the southern portion of section 17. The northern portion of section 17 is mapped as Quaternary Kingsdown Silt. The Kingsdown Silt includes loess and alluvial deposits and underlies the dune sand.

The farmer reported oil wells southwest and east of the site. Kansas Geological Survey well records confirmed these locations. An irrigation well is located north of the sinkhole. No wells are reported at the sinkhole.

### **Geologic Setting**

The location of this sinkhole is unusual. Although, active karst exists in Meade County east of Crooked Creek (Mudge, 1879; Frye, 1940; Frye, 1942; Izett and Honey, 1995), this sinkhole is in western Meade County where karst features are less common. Numerous shallow broad depressions called buffalo wallows are observed around the sinkhole, but the sinkhole is not within one of these depressions. Because no oil wells exist in the sinkhole, subsidence caused by salt or gypsum dissolution around the well casing is unlikely.

In eastern part of the county, the dissolution appears to be occurring in Permian gypsum and salt beds. At the site of the sinkhole, the top of the Permian rocks is 152 m (500 ft) to 174 m (570 ft) below the ground surface (Frye, 1942). A gypsum or salt bed that could potentially be dissolving to form a cave might be tens of meters below the top of the Permian. The material between the surface and the Permian rocks is alluvium consisting of sand, gravel, silt, and clay of the Meade and Ogallala Formations and some Cretaceous sandstone and shale. Caliche is reported in the Kingsdown Silt, but I'm not sure if dissolution of caliche will produce a sinkhole.

Without further investigations, the cause of this sinkhole will remain unknown. The list of potential causes includes dissolution of gypsum or salt beds in the Permian rocks, piping of the silty beds in the units above the Permian, hydrocompaction of silt and sand layers, dissolution of caliche, and settlement caused by ground-water extraction. Settlement by ground-water extraction is highly unlikely since the nearest well is about 610 m (2,000 ft) from the sinkhole. Hydrocompaction occurs in arid areas when water is introduced into loose, dry sand and silt, causing the soil to densify. Wind- and water-deposited sediments have low initial densities and can be subject to hydrocompaction. Piping is the removal of silt by ground-water flow.

### **Recommendations**

My minimum recommendation is to monitor the sinkhole. Since the cause of the subsidence is unknown, the extent of the void is uncertain. Thus the risk is unknown. The farmer should watch for signs that the sinkhole is enlarging, including material sloughing into the perimeter fracture, new perimeter fractures opening beyond the current sinkhole, and increases in the rate of subsidence. If evidence of enlargement occurs, the area should be fenced off. In its current state, potential exists for personal injury or damage to personal property. If this is a concern to

the owner or the farmer, the area should be fenced off. If the owner or the farmer wish to do more, I recommend hiring a geotechnical engineering consultant and a geologist to advise and design any remedial measures.

## References

- Fairer, G. M., and Green, M. W., 1994, Preliminary geologic map of the Ashland Quadrangle and part of the Ashland SE Quadrangle, Clark County, Kansas: U. S. geological Survey Open File Report 94-657, 1 map.
- Frye, J. C., 1940, A preliminary report on the water supply of the Meade Artesian basin, Meade County, Kansas: Kansas Geological Survey Bulletin 35, 39 p.
- Frye, J. C., 1942, Geology and ground-water resources of Meade County, Kansas: Kansas Geological Survey Bulletin 45, 152 p.
- Green, M. W., and Fairer, G. M., 1995, Geologic overview of Clark County, Kansas: U. S. Geological Survey Open File Report 95-256, 18 p.
- Izett, G. A., and Honey, J. G., 1995, Geologic map of the Irish Flats NE Quadrangle, Meade County, Kansas: U. S. Geological Survey Miscellaneous Investigations Series Map I-2498, 1 map.
- Mudge, B. F., 1879, The new sink-hole in Meade Co., Kansas: Kansas City Review of Science, v. 3, p. 152-153.
- Swineford, A., 1955, Petrography of upper Permian rocks in south-central Kansas: Kansas Geological Survey Bulletin 111, 179 p.
- Young, J., and Beard, J., 1993, Caves of Kansas: Kansas Geological Survey Educational Series 9, 48 p.