Missouri S&T

Center for Transportation Infrastructure and Safety

Mapping Subsurface in Proximity to Newly-Developed Sinkhole Along Roadway

by

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A National University Transportation Center

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Technical Report Documentation Page

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16. Abstract MS&T acquired electrical resistivity tomography profiles in immediate proximity to a newly-developed sinkhole in Nixa Missouri The sinkhole has closed a well-traveled municipal roadway and threatens proximal infrastructure. The intent of this investigation was to characterize the subsurface expression of the sinkhole so that appropriate mitigation efforts can be designed and implemented			
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Nixa Electrical Resistivity Tomography Investigation

Figure 1: Locations of ERT profiles 1-10 (Figures 2-11).

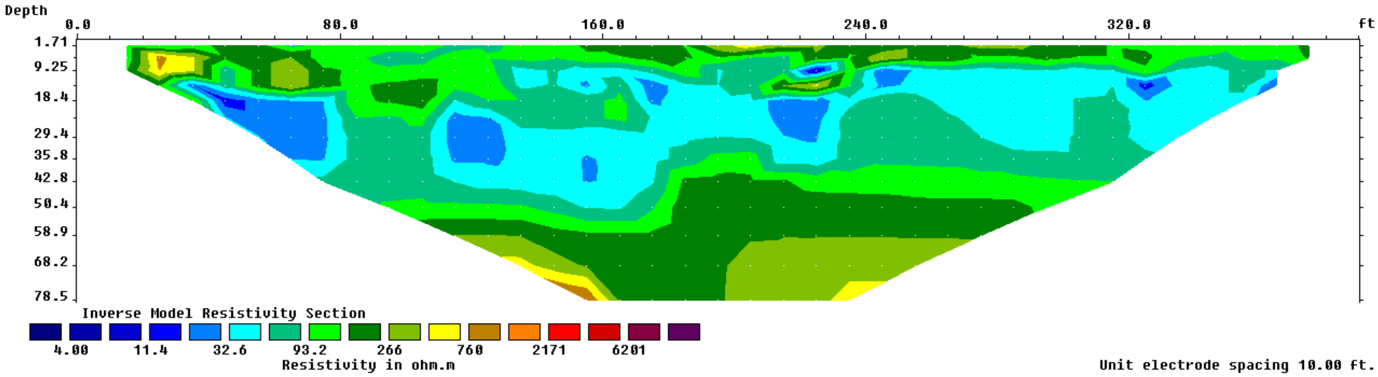


Figure 2: ERT Profile 1. Oriented south-north.

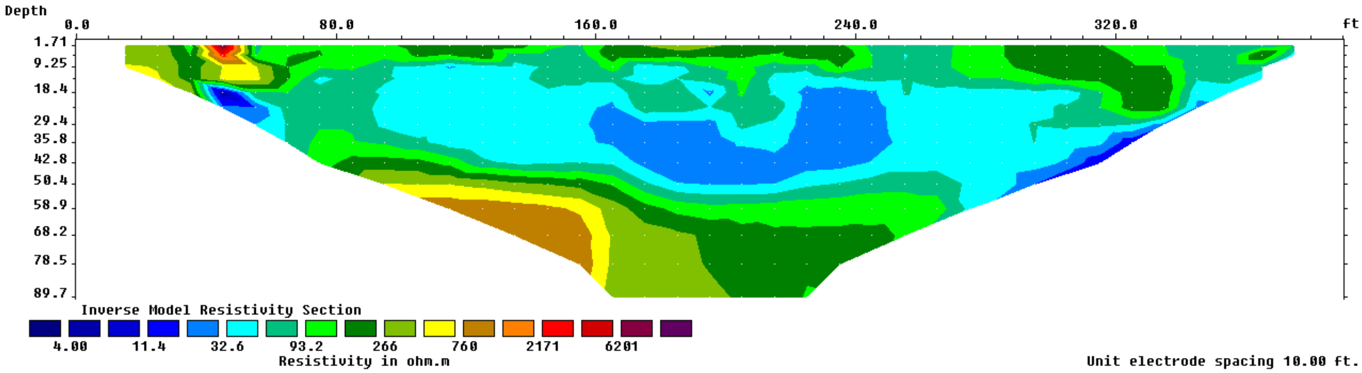


Figure 3: ERT Profile 2. Oriented south-north.

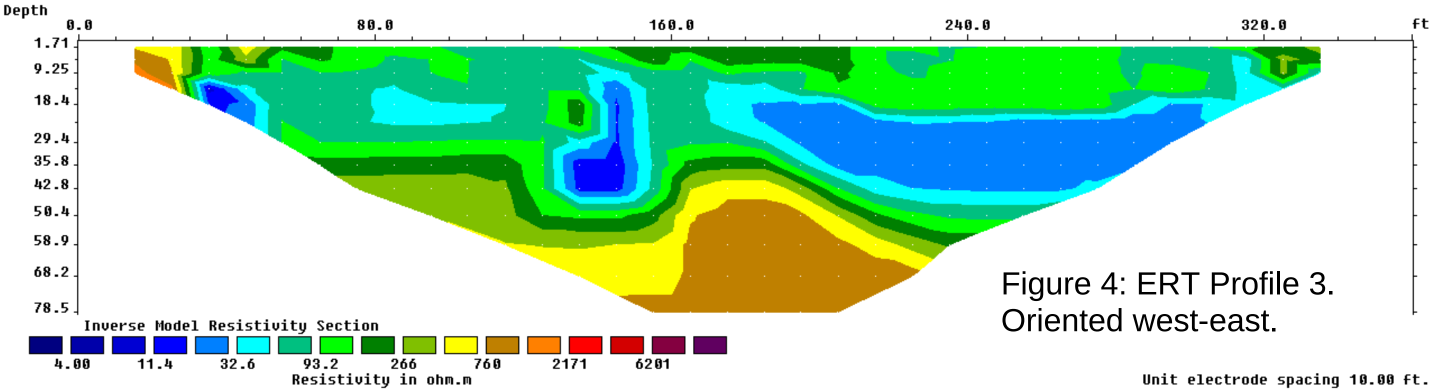


Figure 4: ERT Profile 3. Oriented west-east.

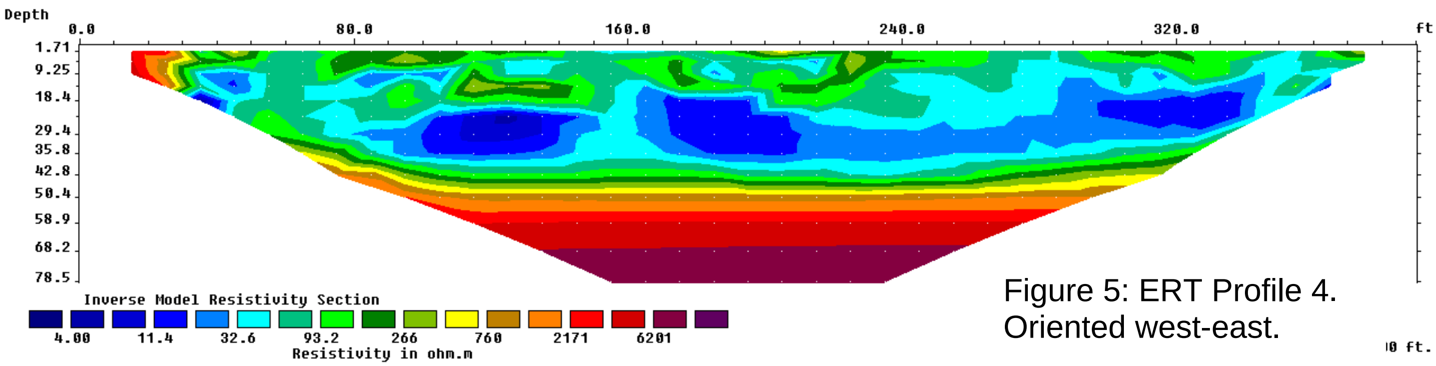


Figure 5: ERT Profile 4. Oriented west-east.

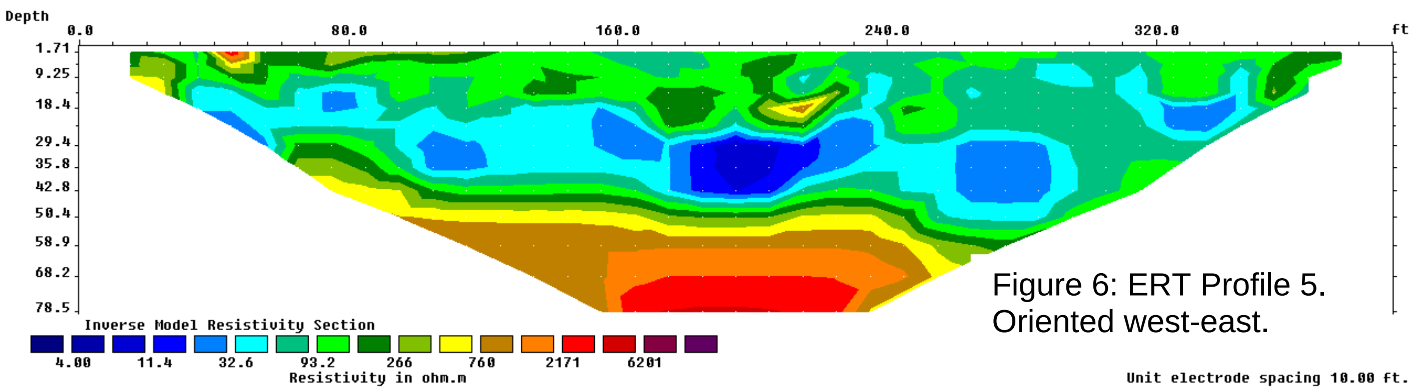


Figure 6: ERT Profile 5. Oriented west-east.

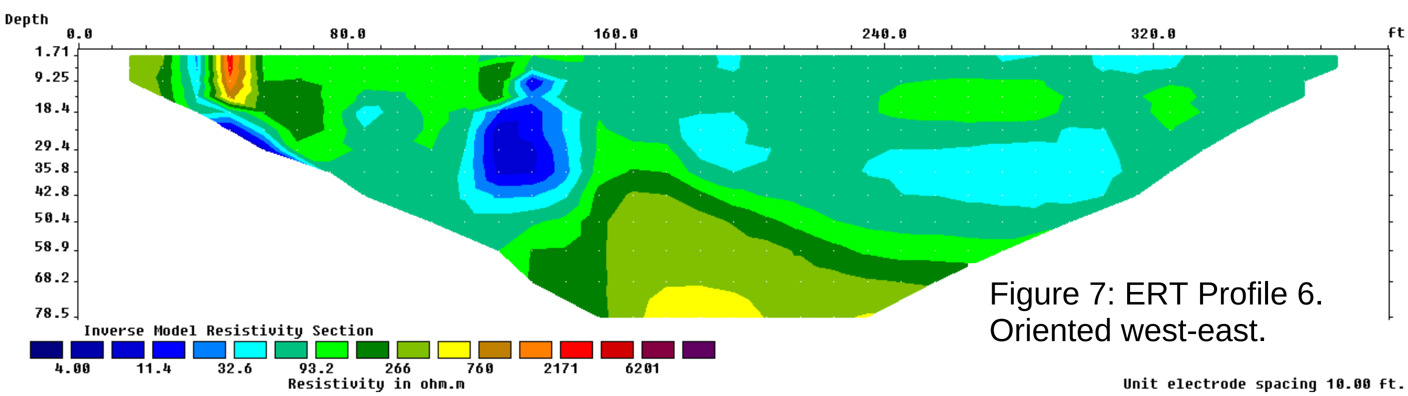


Figure 7: ERT Profile 6. Oriented west-east.

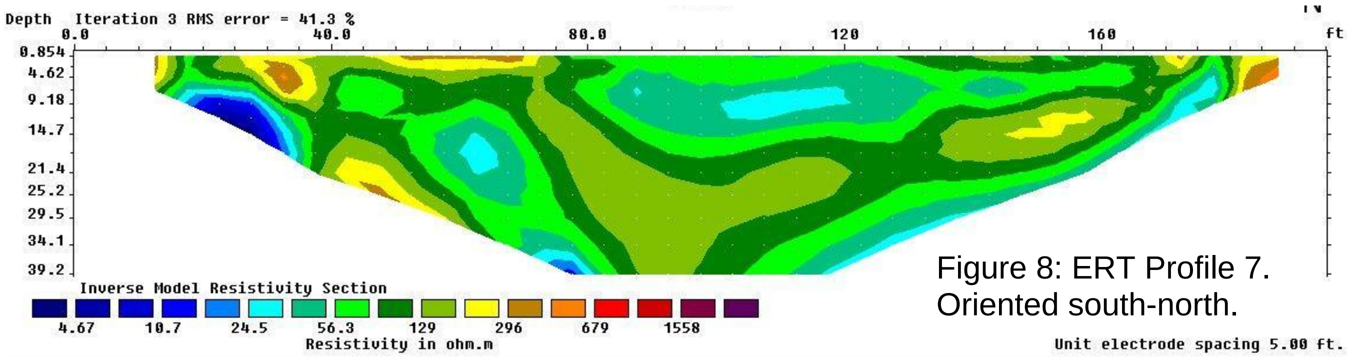


Figure 8: ERT Profile 7. Oriented south-north.

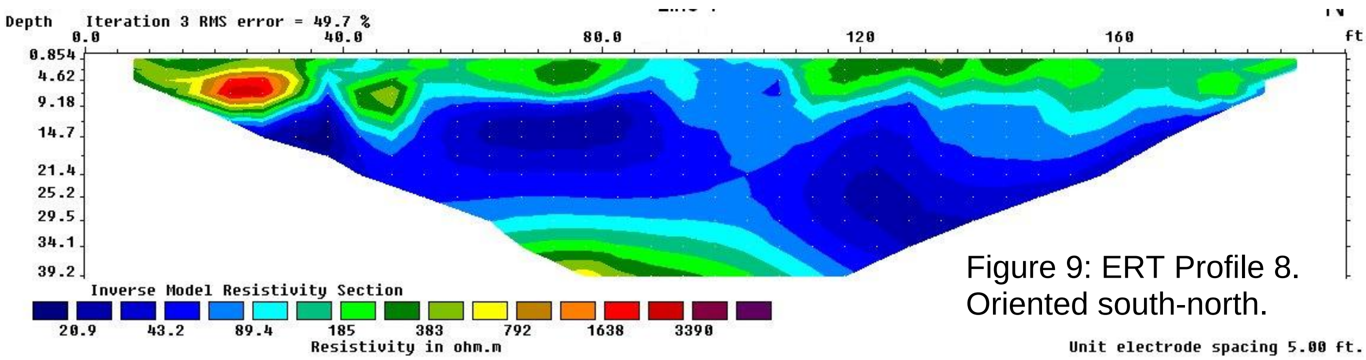


Figure 9: ERT Profile 8. Oriented south-north.

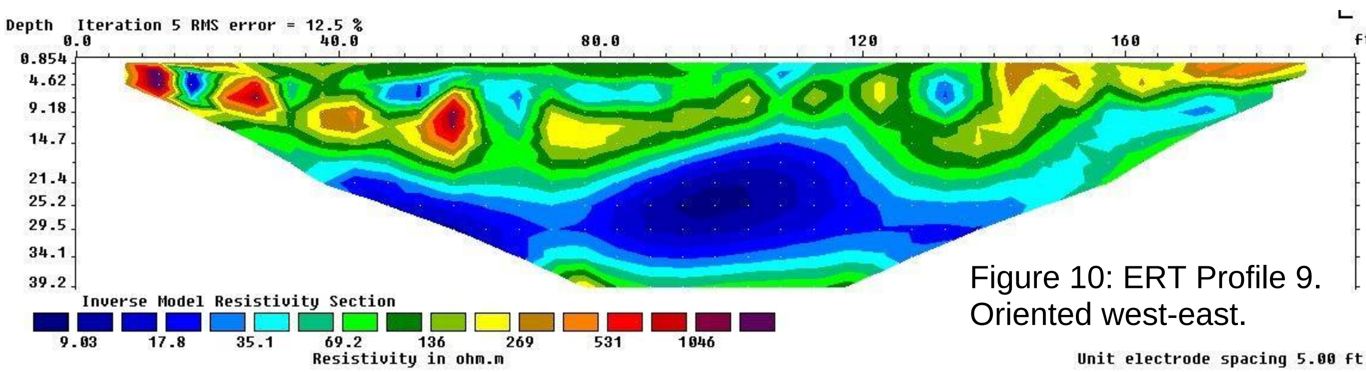


Figure 10: ERT Profile 9. Oriented west-east.

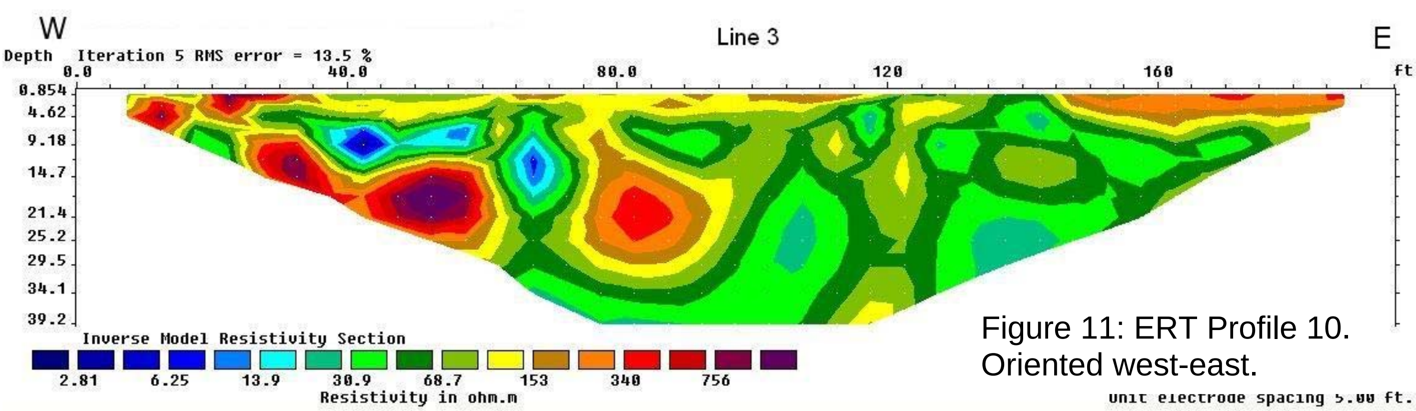


Figure 11: ERT Profile 10. Oriented west-east.

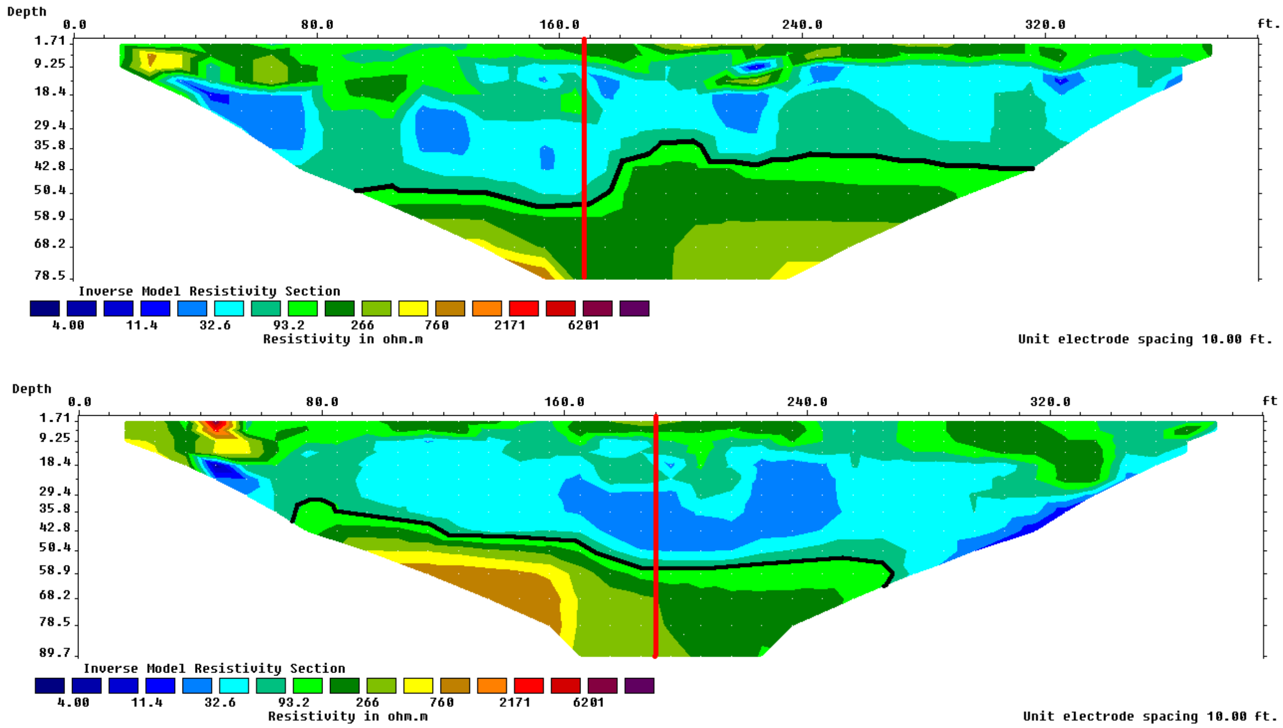


Figure 12: ERT Profiles1 and 2. Interpreted top of rock has been superposed. Interpreted solution-widened fractures have been identified. Oriented south-north.

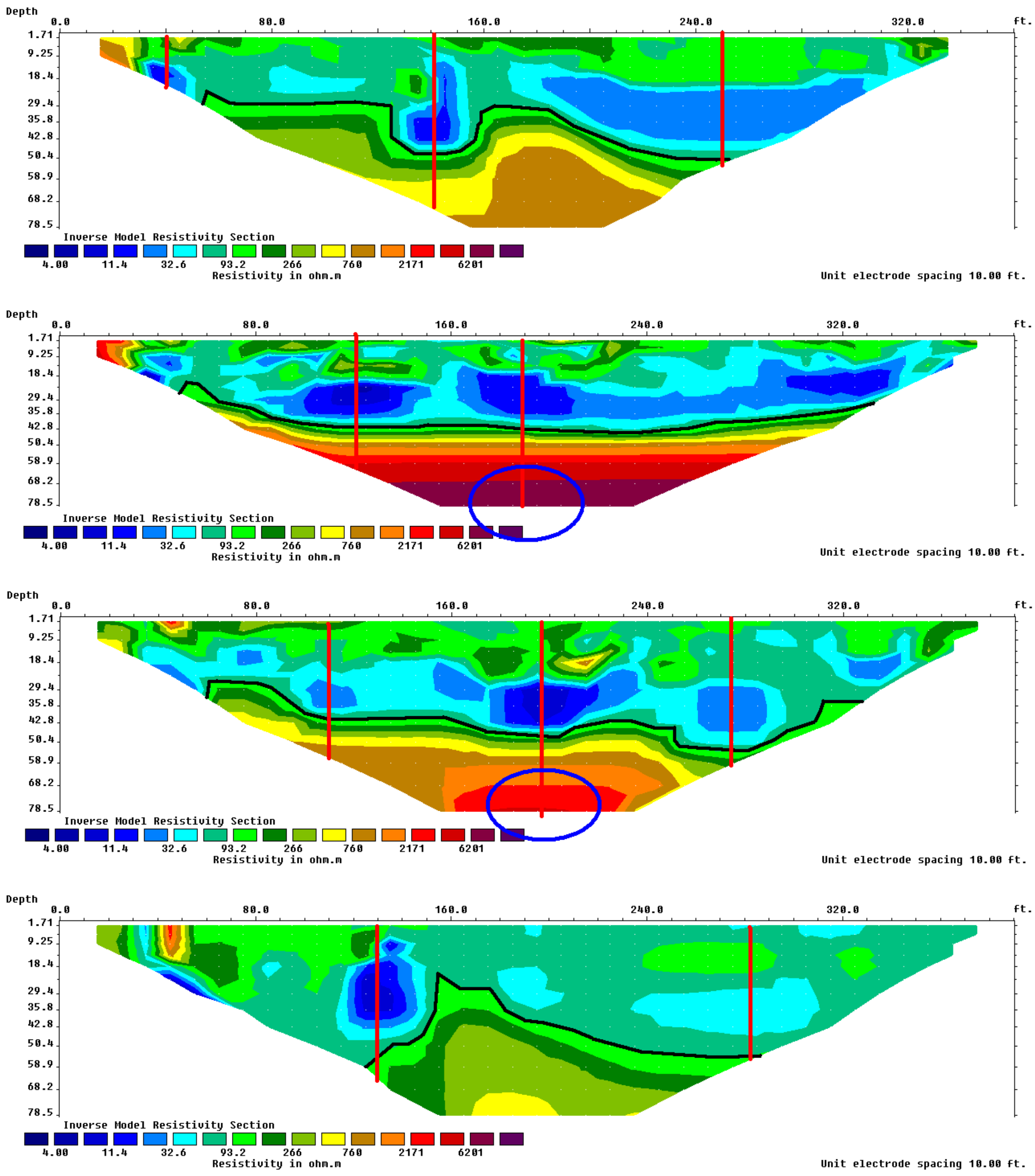


Figure 13: ERT Profiles 3, 4, 5 and 6. Interpreted top of rock has been superposed. Interpreted solution-widened fractures have been identified. Oriented west-east. Areas of potential concern (anomalously high resistivity) have been highlighted.

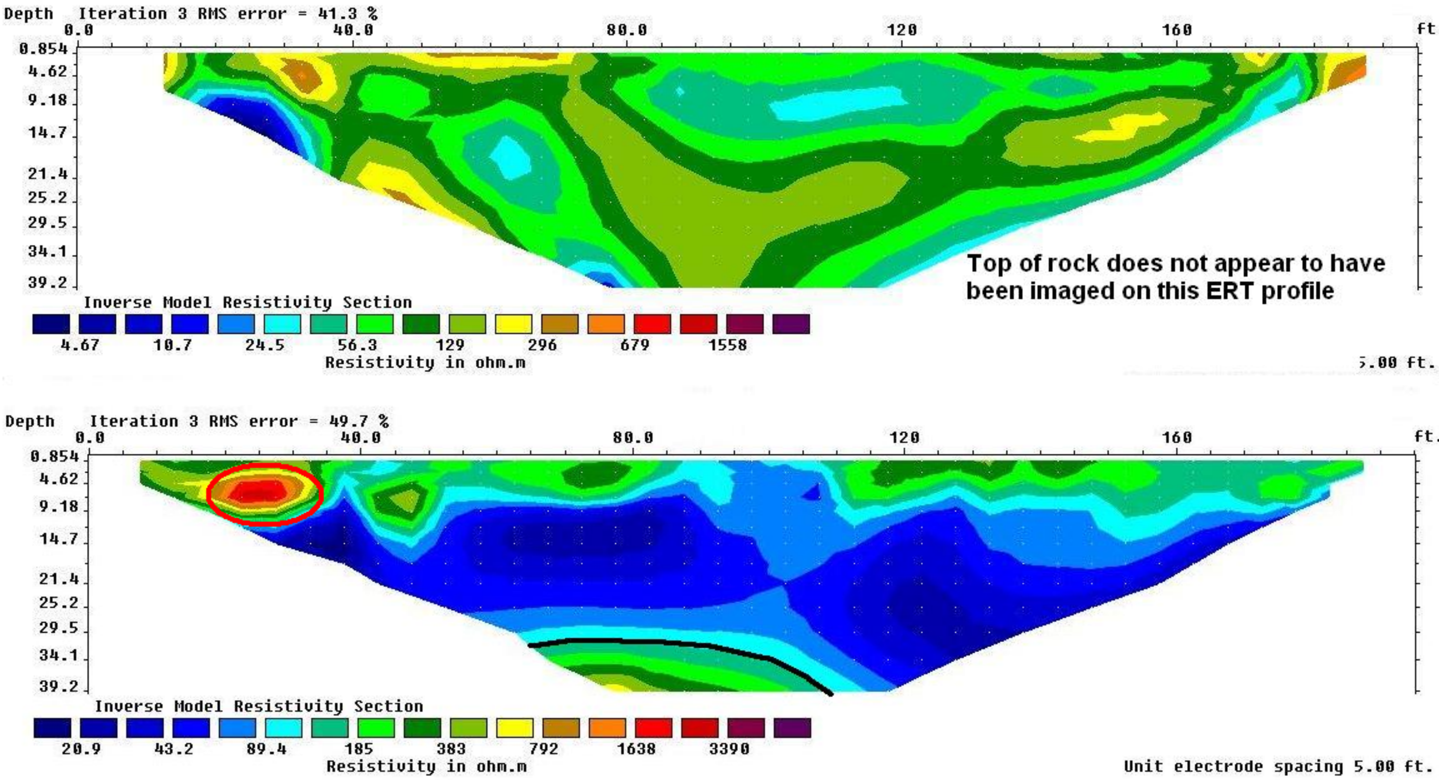


Figure 14: ERT Profiles 7 and 8. Interpreted top of rock has been superposed. Areas of potential concern (anomalously high resistivity) have been highlighted. Oriented south-north.

Shallow

Shallow electrical resistivity tomography (ERT) profiles (extending to depths of 40 ft) were acquired along four 200 ft traverses (traverses 7-10, Figure 2). Non-interpreted and interpreted versions of these ERT profiles (referred to as profiles 7-10) are presented appendices B and C, respectively.

ERT profile 7 (see appendices B and C) is oriented south-north and was acquired about 20 ft to the west of the outer edge of the excavated sinkhole. Profile 7 is also less than 20 ft to the west of borings #1, #2 and #3. In two key respects, ERT profile 7 differs from all of the other nine ERT profiles (except profile 10). First, the deeper soils (15 ft to 30 ft) in immediate proximity to the sinkhole on profile 7 are characterized by anomalously high resistivities (between 40 and 200 ohm-m, as opposed to between 10 and 100 ohm-m). The most logical explanation is that the soil in immediate proximity to the excavated sinkhole is drained and therefore very dry. Second, the top of bedrock (correlates reasonably well with the 100 ohm-m contour on other ERT profiles) could not be confidently identified and/or mapped in the central segment of ERT profile 7, despite the fact that bedrock was encountered at a depth of 34 ft in boring #1. The most logical explanation is that there is not significant resistivity contrast between dry soil and underlying rock in immediate proximity to the sinkhole. Hence the soil/rock contact in proximity to borehole #1 cannot be imaged on this ERT profile with confidence.

ERT profile 8 is oriented south-north and was acquired about 50 ft to the east of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (15 to 30 ft) varies from 20 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 8, indicates that soil thicknesses in the central segment of profile vary from 30 ft to in excess of 40 ft. These soil thicknesses are consistent with boring control. The most potentially significant feature on the profile is the encircled zone of high resistivity centered at the 25 ft mark. This feature could be caused by a bridged void. Alternatively, it could be caused by anomalously resistive soil.

ERT profile 9 is oriented west-east and was acquired about 60 ft to the north of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (typically 15 to 30 ft) varies from 20 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 9, indicates that soil thicknesses in the central segment of profile vary from 35 ft to in excess of 40 ft. These soil thicknesses are consistent with boring #2 (bedrock at 34 ft). The most potentially significant features on the profile are the encircled zones of high resistivity. These features could be caused by bridged voids. Alternatively, they could be caused by anomalously resistive soils.

ERT profile 10 oriented west-east and was acquired about 40 ft to the south of the outer edge of the excavated sinkhole. Profile 10 ties boring #3. In two key respects, ERT profile 10 differs from all of the other nine ERT profiles (except profile 7). First, the deeper soils (15 ft to 30 ft) in immediate proximity to the sinkhole on profile 10 are characterized, in places, by anomalously high resistivities (up to 1000 ohm-m, as opposed to between 10 and 100 ohm-m). The most logical explanation is that the soil is drained and therefore very dry. Second, the top of bedrock could not be confidently identified and/or mapped in the central segment of ERT profile 10. Neither observation is surprising, because bedrock in boring #3 is at a depth of more than 75 ft. The most potentially significant features on the profile are the encircled zones of high resistivity. These features could be caused by bridged voids. Alternatively, they could be caused by well-drained highly resistive soils.

Deeper

Shallow electrical resistivity tomography (ERT) profiles (extending to depths of 80 ft) were acquired along eight 400 ft traverses (traverses 1-6, Figure 2). Non-interpreted and interpreted versions of these ERT profiles (referred to as profiles 1-6) are presented appendices D and E, respectively.

ERT profile 1 is oriented south-north and was acquired about 80 ft to the west of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (15 to 30 ft) varies from 20 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 1, indicates that soil thicknesses in the central segment of profile vary from 35 ft to 50 ft. These soil thicknesses are consistent with boring control. The center of an interpreted solution-widened fracture (characterized by lower resistivity/lower elevation rock) has been highlighted. This feature is aligned with the sinkhole and a comparable feature on ERT profile 2 suggesting the sinkhole developed on an east-northeast trending lineament (near-orthogonal to the dominant north-northwest trending lineaments).

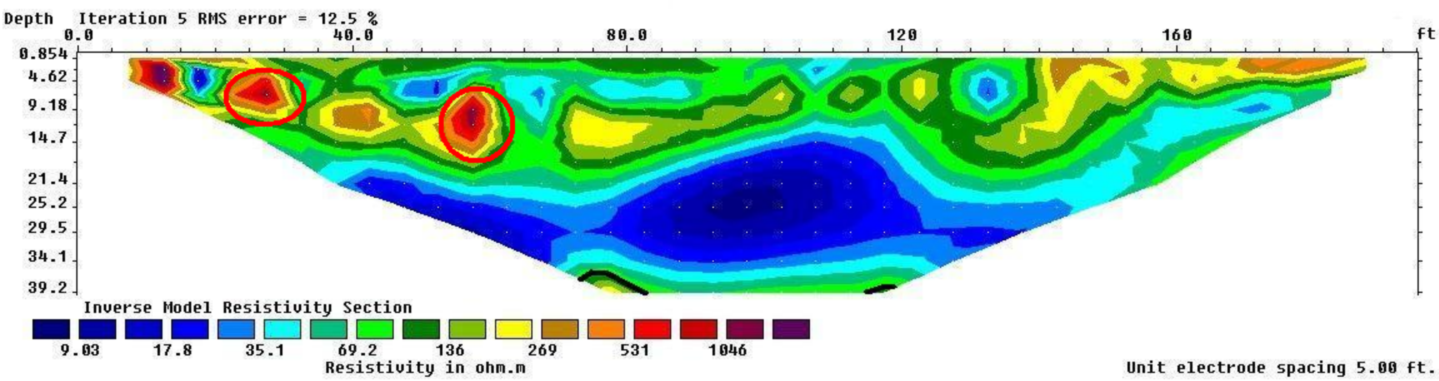
ERT profile 2 is oriented south-north and was acquired about 50 ft to the east of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (15 to 30 ft) varies from 20 to 100 ohm-m (soils characterized by resistivities of less than 20 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 2, indicates that soil thicknesses in the central segment of profile vary from 30 ft to 55 ft. These soil thicknesses are consistent with boring control. The center of an interpreted solution-widened fracture (characterized by lower resistivity/lower elevation rock) has been highlighted. This feature is aligned with the sinkhole and a comparable feature on ERT profile 1 suggesting the sinkhole developed on an east-northeast trending lineament (near-orthogonal to the dominant northwest trending lineaments). The most potentially significant feature on the profile is the encircled zone of high resistivity centered at the 45 ft mark. This feature corresponds to the similar anomaly observed on ERT profile 8 and could be caused by a bridged void. Alternatively, it could be caused by anomalously resistive soil.

ERT profile 3 is oriented west-east and was acquired about 90 ft to the north of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (typically 15 to 30 ft) varies from 10 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 3, indicates that soil thicknesses in the central segment of profile vary from 25 ft to 50 ft. These soil thicknesses are consistent with boring control. Several interpreted solution-widened fractures have been highlighted. The central feature is aligned with the sinkhole and a comparable feature on ERT profiles 4, 5 and 6 suggesting the sinkhole developed on a northwest trending lineament where it intersects an east-northeast trending lineament (see descriptions of profiles 1 and 2).

ERT profile 4 is oriented west-east and was acquired about 60 ft to the north of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (typically 15 to 30 ft) varies from 5 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 4, indicates that soil thicknesses in the central segment of profile vary from 30 ft to 40 ft. These soil thicknesses are consistent with boring control. Several interpreted solution-widened fractures have been highlighted. The central feature is aligned with the sinkhole and a comparable feature on ERT profiles 3, 5 and 6 suggesting the sinkhole developed on a northwest trending lineament where it intersects an east-northeast trending lineament (see descriptions of profiles 1 and 2). The most potentially significant feature on profile 4 is the encircled laterally-extensive zone of high resistivity at depths greater than about 45 ft. This feature could be caused by the presence of an air-filled horizontal fracture.

ERT profile 5 is oriented west-east and was acquired about 60 ft to the south of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (typically 15 to 30 ft) varies from 5 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 5, indicates that soil thicknesses in the central segment of profile vary from 25 ft to 50 ft. These soil thicknesses are consistent with boring control. Several interpreted solution-widened fractures have been highlighted. The central feature is aligned with the sinkhole and a comparable feature on ERT profiles 3, 4 and 6 suggesting the sinkhole developed on a northwest trending lineament where it intersects an east-northeast trending lineament (see descriptions of profiles 1 and 2). The most potentially significant features on profile 5 is the encircled laterally-extensive zone of high resistivity at depths greater than about 50 ft. This feature could be caused by the presence of an air-filled horizontal fracture.

ERT profile 6 is oriented west-east and was acquired about 120 ft to the south of the outer edge of the excavated sinkhole. The resistivity of the deeper soils (typically 15 to 30 ft) varies from 10 to 100 ohm-m (soils characterized by resistivities of less than 30 ohm-m are interpreted as “clayey” and very possibly deposited in shallow ponds of karstic origin). The top of bedrock (100 ohm-m contour interval), as identified on profile 6, indicates that soil thicknesses in the central segment of profile vary from 25 ft to 55 ft. These soil thicknesses are consistent with boring control. Two interpreted solution-widened fractures have been highlighted. The eastern-most feature is aligned with the sinkhole and a comparable feature on ERT profiles 3, 4 and 5 suggesting the sinkhole developed on a northwest trending lineament where it intersects an east-northeast trending lineament (see descriptions of profiles 1 and 2).



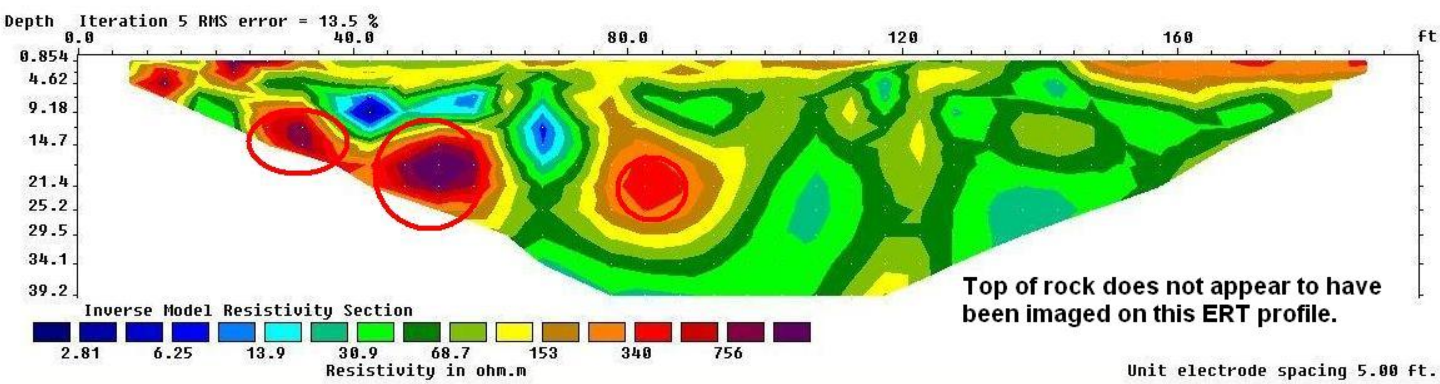


Figure 15: ERT Profiles 9 and 10. Interpreted top of rock has been superposed. Areas of potential concern (anomalously high resistivity) have been highlighted. Oriented west-east.