

Figure 28. Cross Section. Electrical Resistivity data collected over Indian Well Cave.

There are five other areas of high resistivity at the Indian Well Cave site. Anomalies IW-1, IW-2, IW-3, and IW-4 all have peak resistivities of 28,000 ohm-m, 17,500 ohm-m, 32,600 ohm-m, and 72,100 ohm-m, respectively. These four anomalies appear as half circles along the bottom edge of the cross-section. To identify the true characteristics of these anomalies, it would be advantageous to survey to greater depths. One additional anomaly, IW-5, located at 24.4 m (80.1 ft) from the southeast and located very close to the surface, has a maximum resistivity of 18,800 ohm-m. The width of the small anomaly appears to be approximately 2.4 m (7.9 ft). The larger anomalies, namely IW-1, IW-3 and IW-4, may represent unknown caves. While the smaller anomalies could represent very small caves, they could also represent normal resistivity variations within the basalt.

Seismic Reflection

Figure 29 displays the approximate location of the HRSW survey line as it passed over Indian Well Cave ⁽⁶⁾ and table 8 gives the location of every tenth geophone along the line. Interpreted and uninterpreted sections are provided on figure 30 and in appendix D, respectively. Zero time is at an elevation of 1435 m (4708.0 ft). Reverberations are minimal on this line, indicating that the basalt in this area has minimal velocity changes with depth.

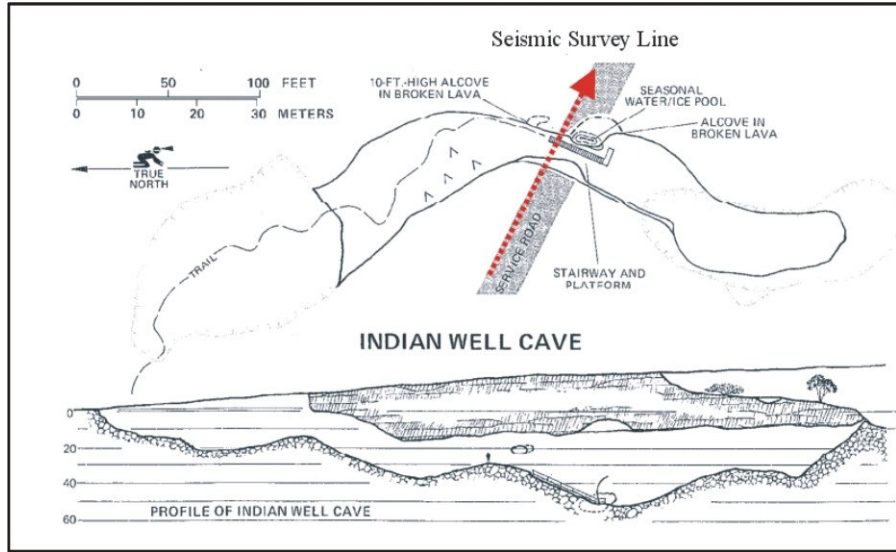


Figure 29. Map. HRSW survey line over Indian Well Cave. ⁽⁶⁾

Table 8. Geophone coordinate locations over Indian Well Cave.

ID	Easting (m)	Northing (m)	Elevation (m)
Geophone 101	624183.36	4619014.2	1428.40
Geophone 111	624188.69	4619011.36	1428.51
Geophone 121	624194.07	4619008.55	1428.63
Geophone 131	624199.42	4619005.77	1428.69
Geophone 141	624204.77	4619002.99	1428.75
Geophone 151	624210.11	4619000.2	1428.83
Geophone 161	624215.45	4618997.43	1428.89
Geophone 171	624220.81	4618994.76	1428.94
Geophone 181	624226.22	4618992.17	1428.97
Geophone 191	624231.64	4618989.56	1429.04
Geophone 196	624234.34	4618988.25	1429.08

All coordinates are listed in NAD 83/UTM Zone 10.

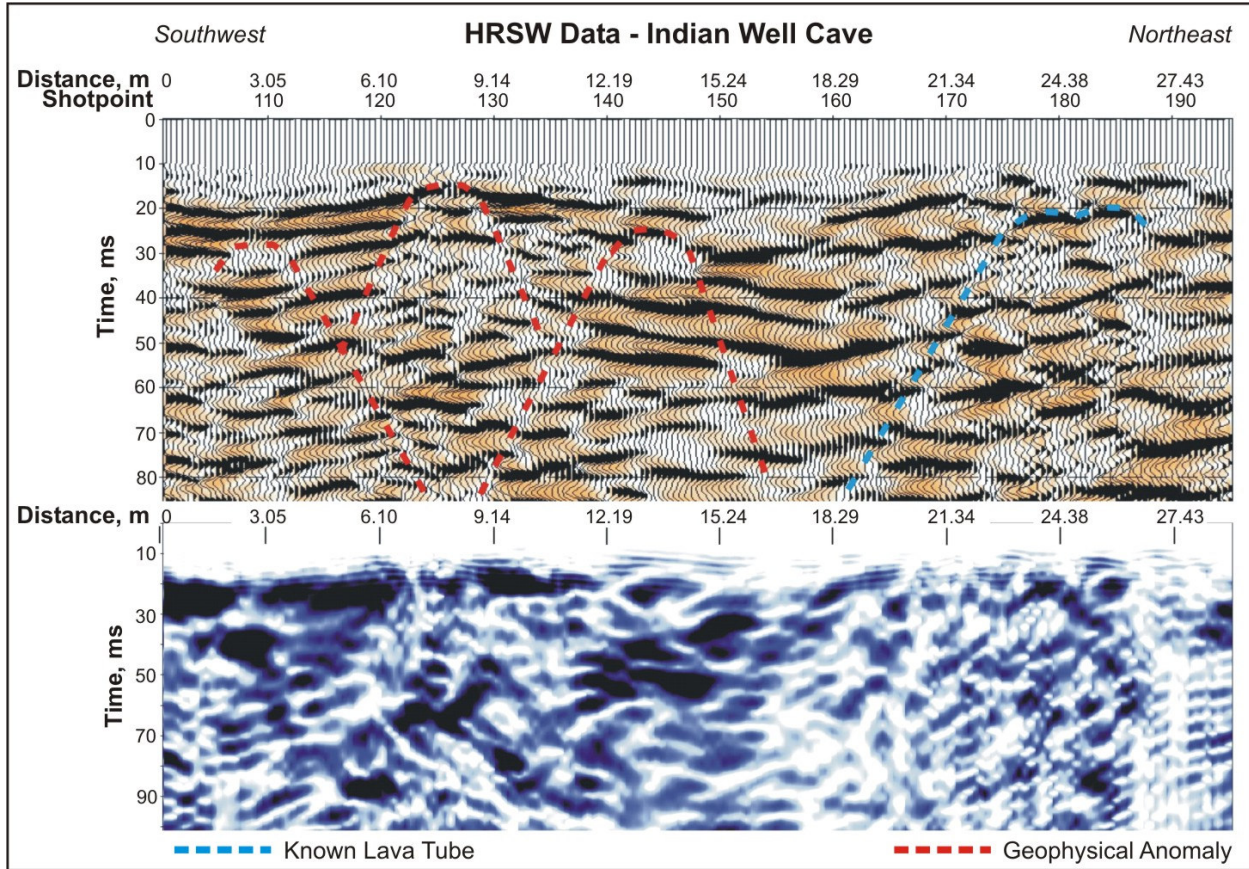


Figure 30. Cross Section. HRSW data collected over Indian Well Cave.

The known cave beneath this profile is centered at shot point 180 and extends about 4.0 m (13.1 ft) on either side of this point. The stacking velocity in the vicinity of the known cave is approximately 1,356 m/sec (4449 ft/sec), and the expected overburden is approximately 8.8 m (28.9 ft) thick. The reflection from the top of this lava tube should then occur 13 ms below the start of the data (the ground surface is at 10 ms on this line). A reflection event is evident at this level, with a zone of incoherent seismic reflectors underneath it. The lava tube is evident from a destructive interference diffraction pattern that extends down to the left from the west (left) edge of the cave resulting in a linear region where the seismic reflectors are disjointed and have lower amplitudes. This zone is outlined in blue.

A suspected lava tube occurs at shot point 126, and appears to be approximately 3.7 m (12.1 ft) across. This anomaly originates about 4.0 m (13.1 ft) below the ground surface, and is evidenced by an arcuate reflection event overlying a zone of low amplitudes bounded on either side by diffractions. The diffractions on either side are located at shot points 109 and 144.

4.3.3 Comparisons

Figure 31 displays the anomalous zones at the Indian Well Cave site. Indian Well Cave was detected in the HRSW reflection, magnetic, and electrical resistivity data sets. All interpreted

locations correspond well with each other. Additional anomalies were selected along the entire length of the road with each of the methods, although the locations and size interpretations varied widely. Of the methods used, the electrical resistivity and magnetic methods provided the most spatially consistent locations. The GPR method did not, in this case, show anomalies over the known cave site.

4.4 MONUMENT ROAD CAVE

4.4.1 Site Description

LBNM officials suggested that this cave might be appropriate for geophysical testing. The shadowed area shown at the bottom of figure 32 is one of the entrances to Monument Road Cave. It has two large openings that are located on either side of the road. The cave is 76.8 m (252.0 ft) in length and is oriented northeast to southwest ⁽¹⁷⁾. The depth from the road surface to the roof of the cave is 5.5 m (18.0 ft). The cave has a width of 12.2 m (40.0 ft) and a height of 5.5 m (18.0 ft) underneath the road. The entire floor of the cave is covered with debris ranging in size from pebbles to boulders. Some areas in the cave contain coralloid on the walls, a type of mineral deposit left by evaporation of mineral rich groundwater ⁽¹⁷⁾. This site was selected because it is a large cave beneath thin overburden.

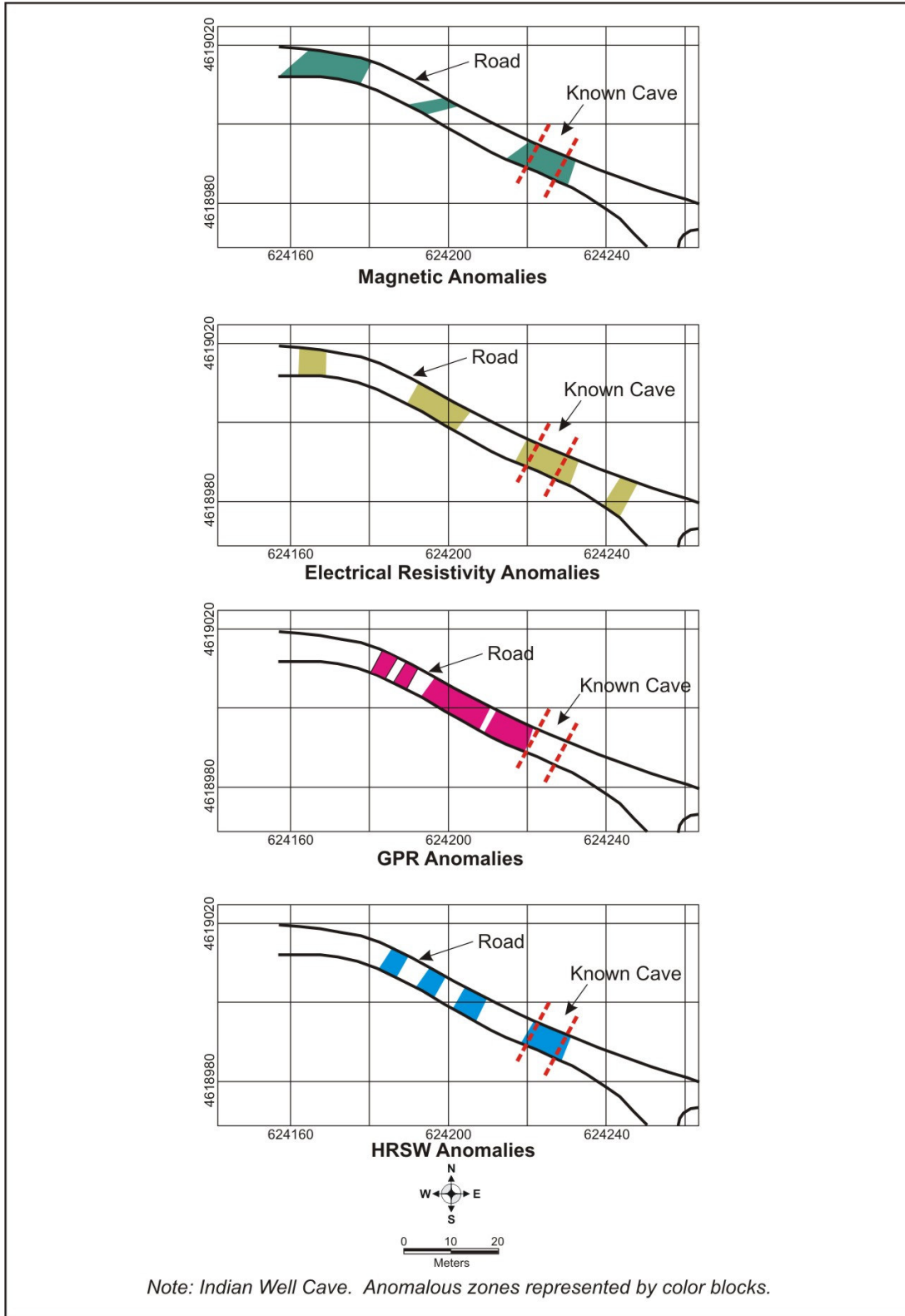


Figure 31. Map. Comparison of anomalous zones at Indian Well Cave.