Estimation of Cavity

Limestone is a soluble rock and limestone hills contain a variable amount of cavities in a form of caves, above ground as well as underground. Estimation of cavity percentage is prone to error. This problem is aggravated in the present estimation as the hills are covered with vegetation. The best estimates are thus made by plotting the known cavities on the plan and the amount estimated by "counting squares".

2.5.1b ***Estimation of Limestone Tonnage***

Total mass or tonnage of the limestone is obtained simply by multiplying the total volume of the limestone available by the Specific Gravity of the limestone:

Specific Gravity (SG) =

$$\frac{\text{Weight of limestone in air}}{\text{Weight of limestone in air — Weight of limestone in water}}$$

A few SG determinations were made on samples taken from representative drill cores from the various hills. Core samples, about three to four kilograms each, were used and weighed using a spring balance in air and in water. The results obtained are given in Table 4 below.

2.5.1c ***Estimation of Magnesium Tonnage***

Magnesium (Mg) reserve in the limestone of the area is obtained by multiplying the total amount of limestone in tonne (tonnage) by the grade (in weight percentage) of Mg in the limestone. Surface samples will be used to determine the percentage of Mg and to estimate the above-surface tonnage of Mg. Borehole samples will be used in estimating the underground tonnage of Mg.

2.5.2 Underground Reserve

The derivation of volume and tonnage for both limestone and Mg is exactly the same as for the above-ground deposit. However, the average chemical composition of limestone (from borehole samples) as well as the average percentage of cavities for both hills are needed (refer to Section 5 and 6).

Fig. 19: Measuring height for estimating the reserve using laser binocular.

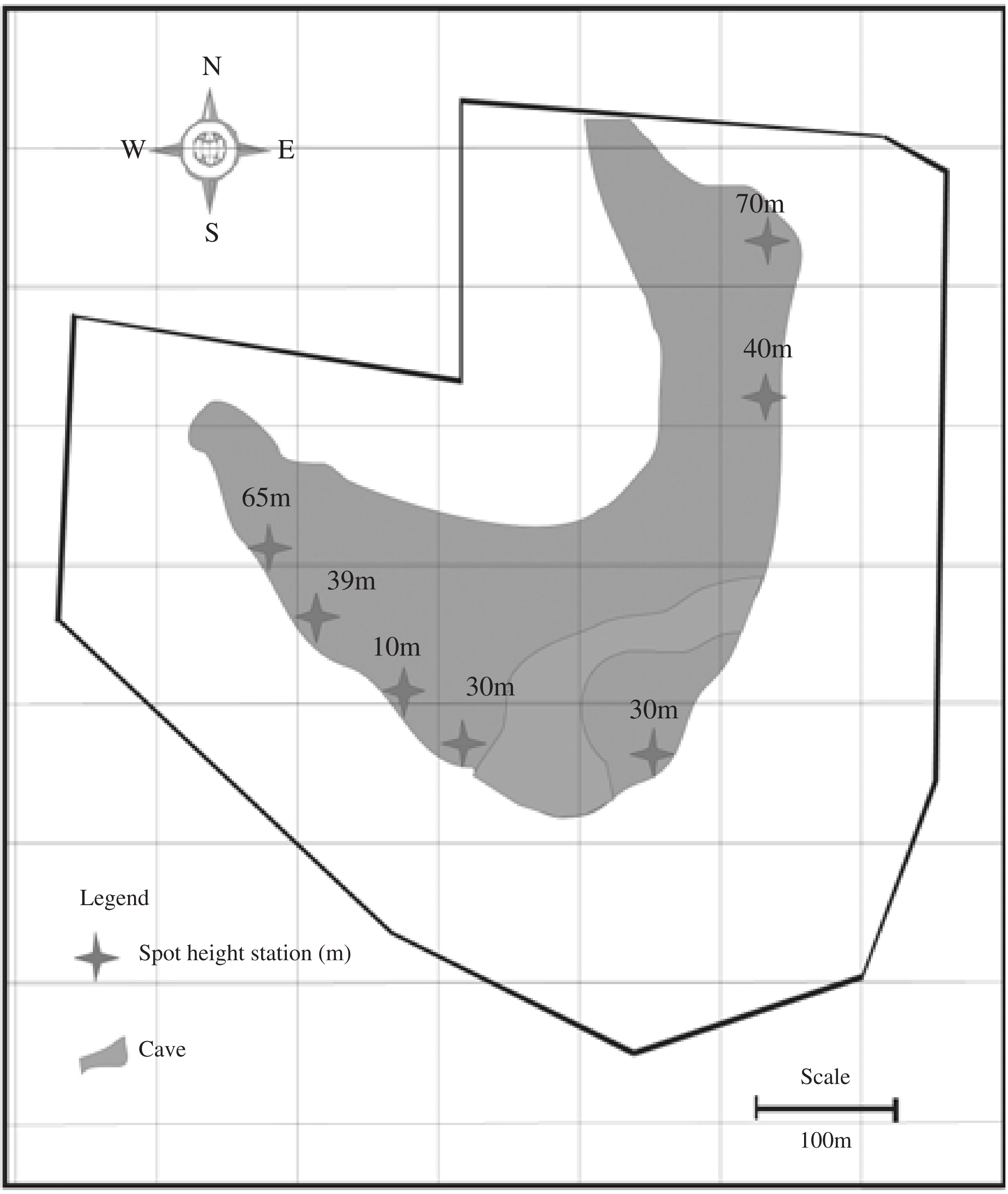

Fig. 20: Estimation of plan area for the South Hill.

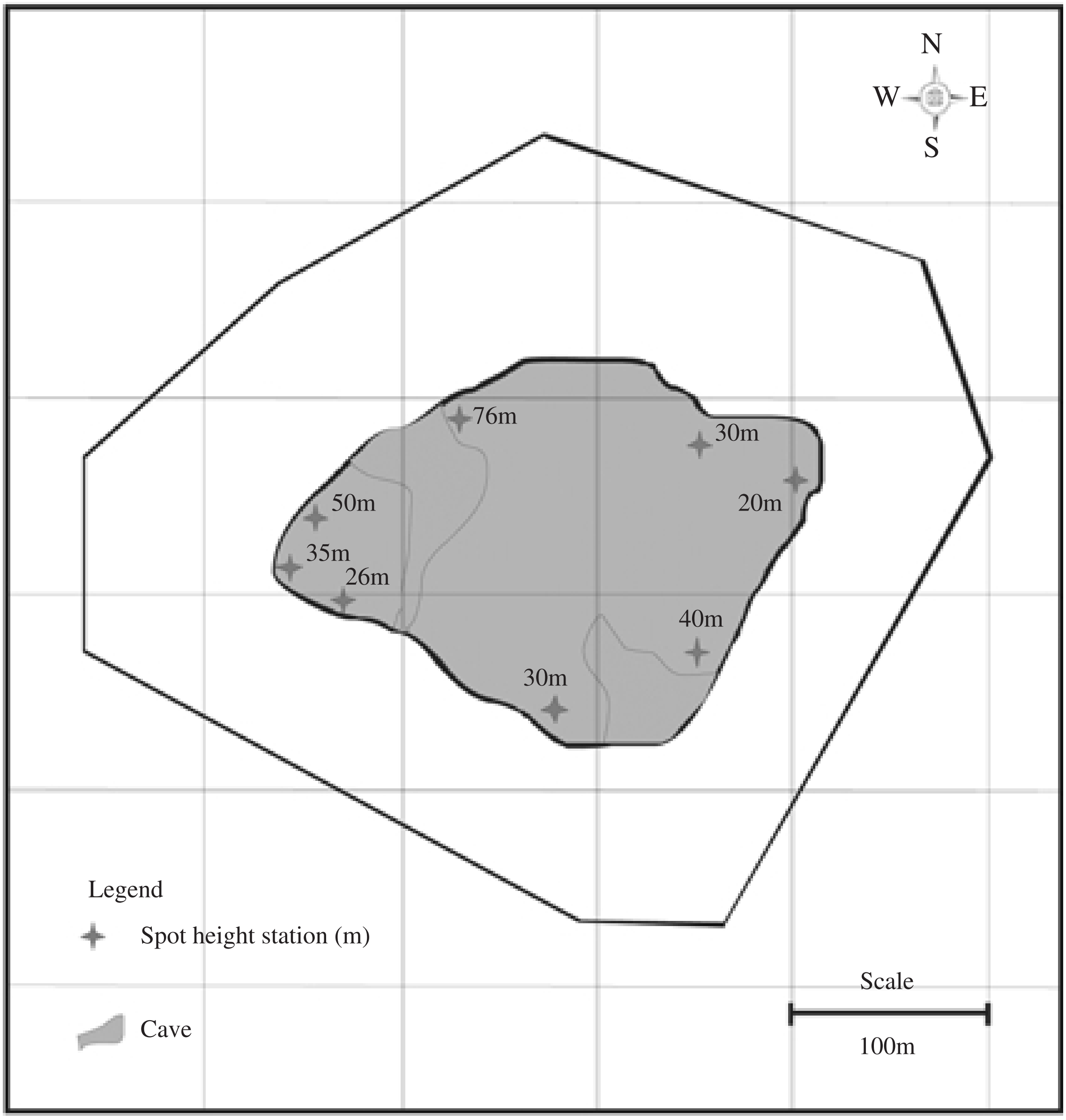

Fig. 21: Estimation of plan area for the North Hill.

Table 4: The determination of SG by laboratory experiment

Location	Sample No.	SG
South Hill	59B	2.85
	61B	2.86
	77A	2.87
	77C	2.86
	80	2.85
	Average	**2.86**
North Hill	81B	2.87
	83A	2.89
	83B	2.88
	89A	2.89
	91	2.88
	Average	**2.88**

3 THE RESULTS OF DRILLING

3.1 THE SOUTH HILL

The summary of borehole data for BH-1, BH-2 and BH-3 is shown in Table 5.

Table 5: Particulars for Boreholes No. BH-1, BH-2 and BH-3 for the South Hill

Borehole No.	Total Depth (m)	Soil/Rock Properties	Total Thickness of Cavity (m)	Total Percentage of Cavity
BH-1	30.5	Highly fractured, light grey to grey weathered limestone for the top 10m. Below this level the rock are slightly fractured and weathered with varying colour from light grey, grey, pinkish grey.	0	0
BH-2	34.0	Greyish, brown sandy silt with some quartz gravels for the top 4 m. The deeper portions are occupied by grey to dark grey, highly fractured weathered limestone.	0	0
BH-3	40.0	The first 10 m are occupied by non-calcareous rock, i.e. brown sandy silt and grey silty sand with some quartz pebbles. The deeper portions are made of slightly fractured, weathered limestone — pale grey, grey to pinkish light grey in colour.	6.0 (at four depths)	15.0

3.2 THE NORTH HILL

The summary of borehole data for BH-4, BH-5 and BH-6 is shown in Table 6.

Table 6: Particulars for Boreholes No. BH-4, BH-5 and BH-6 for the North Hill

Borehole No.	Total Depth (m)	Soil/Rock Properties	Total Thickness of Cavity (m)	Total Percentage of Cavity
BH-4	37.5	The overburden is dark brown sandy silt (up to 7.50m depth), overlying grey, highly fractured weathered limestone (7.50m — 16.50m). The lithology changes to grey, slightly fractured weathered limestone to the end of the borehole at 37.50m. However, the sequence was interrupted by two cavities, at 18.50m — 21.50m and at 22.50m — 25.00m.	5.5 (at two depths)	14.7
BH-5	32.0	The overburden is 2.0m thick brown sandy silt. The sequence is dominated by grey, slightly fractured weathered limestone (2.0m — 27.0m), which became dark grey, highly fractured limestone (29.0m — 32.0m). Cavities occur at three depths: 14.0m — 15.0m, 19.5m — 22.5m, and 27.0m — 29.0m.	6.0 (at three depths)	18.8
BH-6	32.5	The overburden occupies the top 2.5m, comprised of brownish, light yellow sandy silt with some quartz gravels. The lithology varies to pinkish grey, slightly fractured weathered limestone (2.5m — 10.5m); grey, slightly fractured weathered limestone (10.5m — 13.5m); dark grey, highly fractured weathered limestone (13.5m — 32.5m). Cavity occurs at the depth of 9.0m — 10.5m.	1.5 (at one depth)	4.6

4 THE RESULT OF GEOPHYSICAL SURVEY

4.1 THE SOUTH HILL

The location of the geoelectrical survey lines for the South Hill is shown in Fig. 22. Also shown are the geoelectrical resistivity cross sections for line 3 (200 m, eastern side of the hill, trending NNE-SSW), line 5 (100 m, northern side of the hill, trending NNW-SSE) and line 6 (100 m, trending almost NW-SE). The larger scale geoelectrical resistivity cross sections for the lines are shown in Fig. 23 (line 3), Fig. 24 (line 5) and Fig. 25 (line 6).

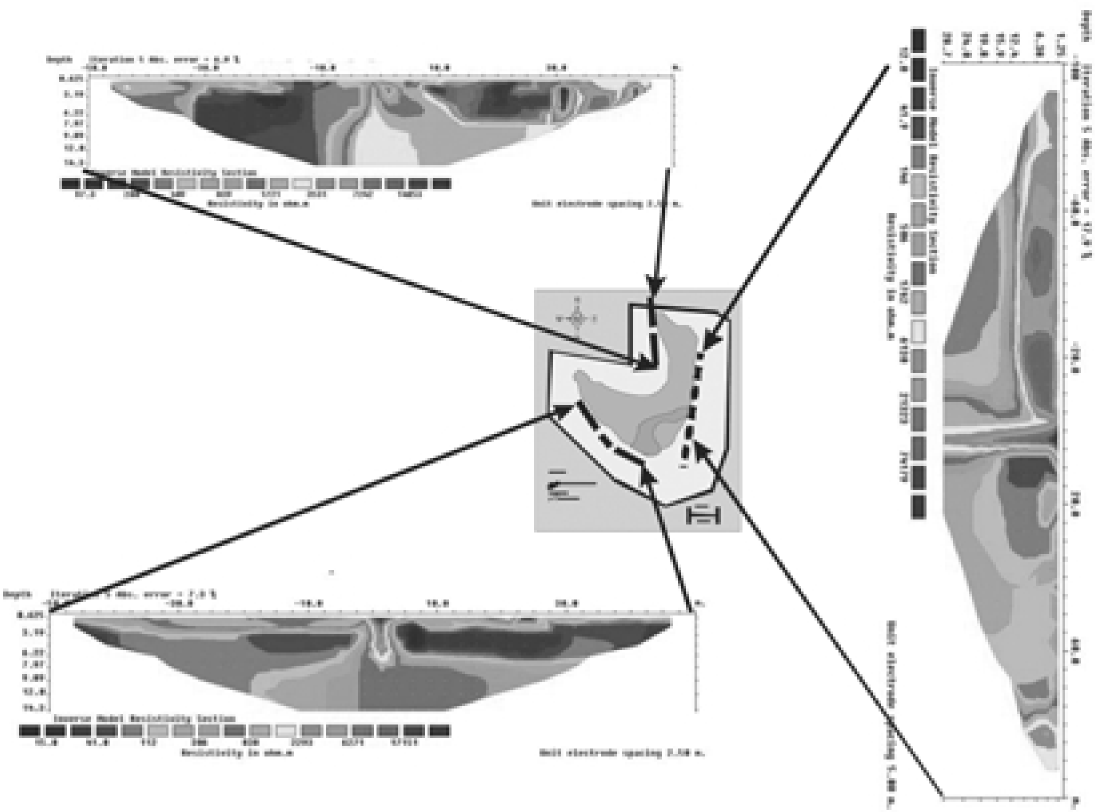

Fig. 22: The geoelectrical survey lines for the South Hill.

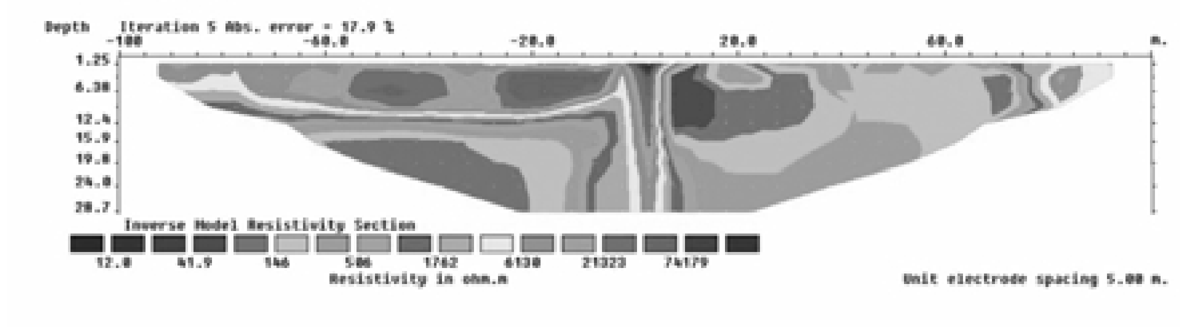

Fig. 23: The geoelectrical resistivity cross section of line 3 of the South Hill.

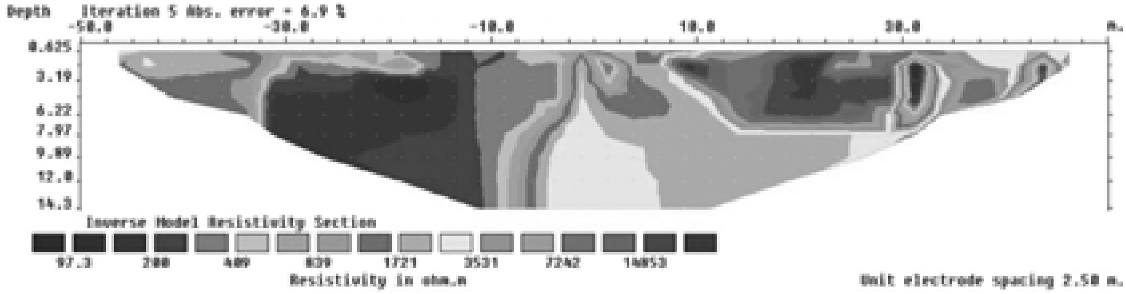

Fig. 24: The geoelectrical resistivity cross section of line 5 of the South Hill.

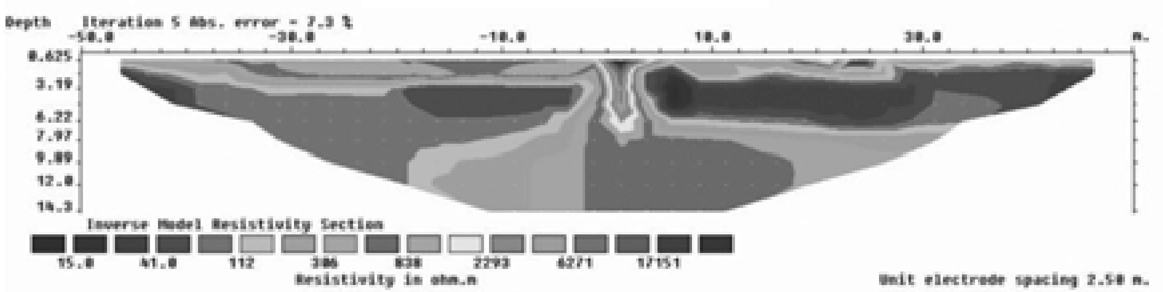

Fig. 25: The geoelectrical resistivity cross section of line 6 of the South Hill.

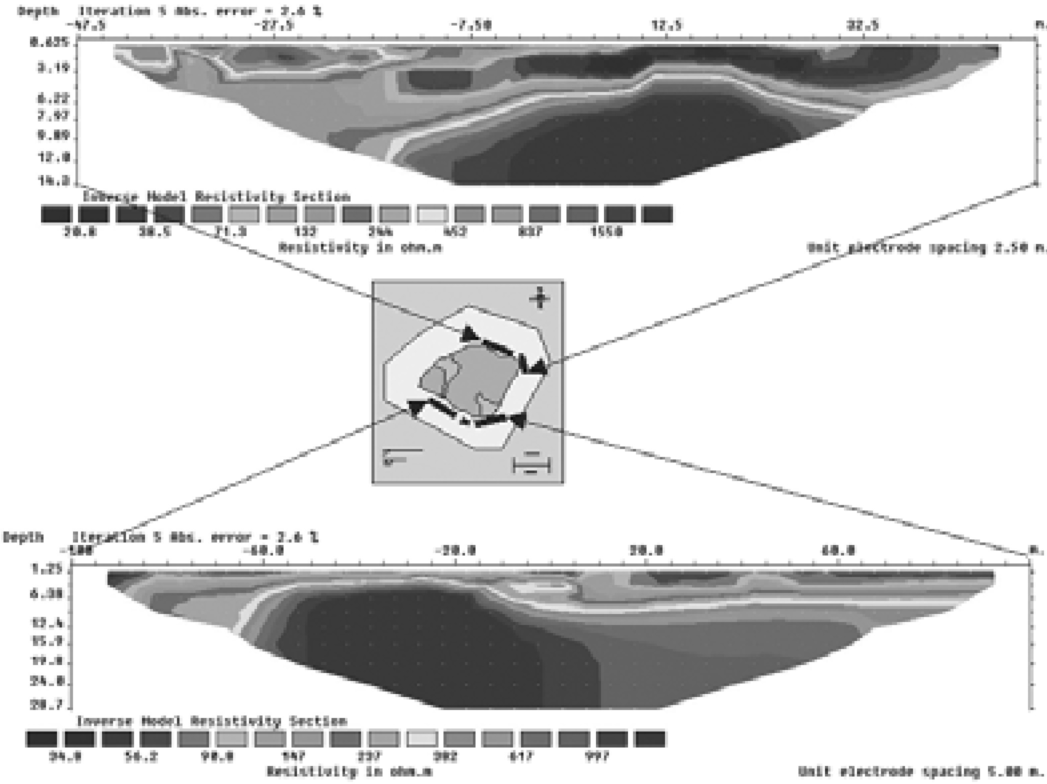

Fig. 26: The geoelectrical survey line for the North Hill.

Line 3 is adjacent to BH-2, with BH-3 to its south. For the northern part of this line, the upper layers are characterised by low resistivity values from 50 Ωm to 200 Ωm. This can be correlated with the sandy silt layer with quartz pebbles recorded in BH-2, which probably also has high water content. The low resistivity layer at a depth of 16 m to 28 m is indicative of a subsurface cavity within the limestone. This can be correlated to BH-3 in which cavities were encountered at four different depths. From this geoelectrical imaging result, approximately 40% of this line 3 which exhibits low resistivity values is indicative of cavities within the limestone.

Line 5 is located some distance away from the borehole BH-2. Therefore the correlation established as outline above is employed in its interpretation. The southern part of this line is characterised by moderately low to moderate geoelectrical resistivity values (100 — 200 Ωm). This low resistivity zone is approximately 35% (± 5%) of the mapped subsurface area, and probably represents a cavity zone within the limestone. By comparison, the northern part of this line is relatively fresh limestone as shown by the very high resistivity values (7000 — 15000 Ωm).

Line 6 is located along the southern edge of the South Hill. For this line the penetration depth achieved is up to 15.0 m. The low resistivity values for the top 6.0 m is most likely due to the non-calcareous rock, i.e. sandy silt and silty sand with quartz pebbles. For the southern part of this line, the low resistivity layers continue downwards to a depth of up to 15.0 m. This is interpreted as a zone of highly fractured limestone, most probably with cavities. This zone represents 40% (± 5%) of the mapped subsurface.