Data Repository Item 2010050

Laser-scanning method and LDEM data from 83 topographic profiles

To accompany High-resolution spatial rupture pattern of a multiphase flower structure, Rex Hills, Nevada: New insights on scarp evolution in complex topography based on 3-D laser scanning

Ramona Baran[*] [†]
Bernard Guest[*] [‡]
Anke M. Friedrich[*] [††]
[*] *Department of Earth and Environmental Sciences, Ludwig-Maximilians-University Munich, Luisenstr. 37, 80333 Munich, Germany*
[†] *e-mail : ramona.baran@iaag.geo.uni-muenchen.de*
[††] *e-mail: friedrich@lmu.de*
[‡] *now at: Department of Geoscience, University of Calgary, 2500 University Drive Northwest, Calgary, Alberta, T2N 1N4, Canada, e-mail: bguest@ucalgary.ca*

LASER-SCANNING METHOD

The field work with the scanner (Riegl 3-D laser scanner *LMS-Z420i®*) follows a relatively simple principle. The scanner was set up on a tripod at the first scan position at an appropriate distance (~ 100 m) from the object of interest (Fig. DR1). The scanner power was taken from a car battery. The scanning procedure was easily controlled with a laptop (Riegl software *RiSCAN PRO®*). Both a wireless and a default wire-lead data transmission between scanner and laptop were possible. A digital camera was mounted on top of the scanner which allows the later combination of scans and photographs (Fig. DR1a). During each scan, the scanner rotated 360° around a vertical axis. While the scanner was set up at its position, several tripod-mounted reflectors were distributed as marker points in the region of interest (eight reflectors in this example, Fig. DR1b) to avoid distortions during subsequent DEM generation. Following a calibration process for the camera and scanner (scan resolution of 0.066° etc.), the first scan was performed at position P1 (Fig. DR1b) while the camera took pictures of the scanned area. The scanner was then moved to the next position (P2) together with some of the reflectors (open circles in Fig. DR1b). At least three reflectors remained at their original (P1) positions (black circles in Fig. DR1b) and should also be located in the overlapping region of scans P1 and P2 (white area in Fig. DR1b). Using the scanner software, it was possible to search for these overlapping marker points within individual scans and thereby link these scans to form a merged data set covering a larger area. This procedure was repeated until the area of interest was completely covered. In the case presented here, eleven scan positions were required to scan the southern Rex Hills flank.

The result of the laser-scanner measurements was a large point cloud. We removed 35 % of the points from the cloud by defining this threshold in the filter options of the scanner software. The reduced point cloud represents the basis for the DEM. The DEM was generated by triangulation, where the DEM surface is defined by a triangular network, in which the points represent the triangle corners. Finally, we created a very detailed DEM (Fig. 5) and a set of cross sections with a cm-scale resolution (accuracy of around ± 5 cm). For the purpose of this study to examine the surface expression of the Rex Hills structure, geo-referencing of this DEM was not necessary. Therefore, all coordinates shown in Figures 5, 7, 8, and DR2 are relative. The high-resolution cross sections allow the very detailed analysis of different of fault scarps.

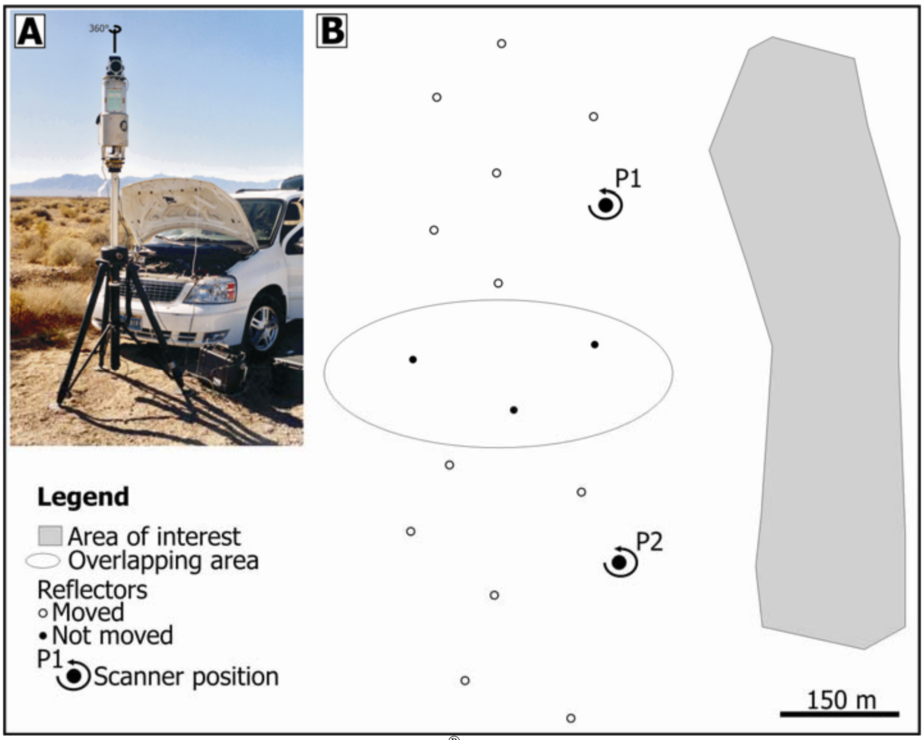
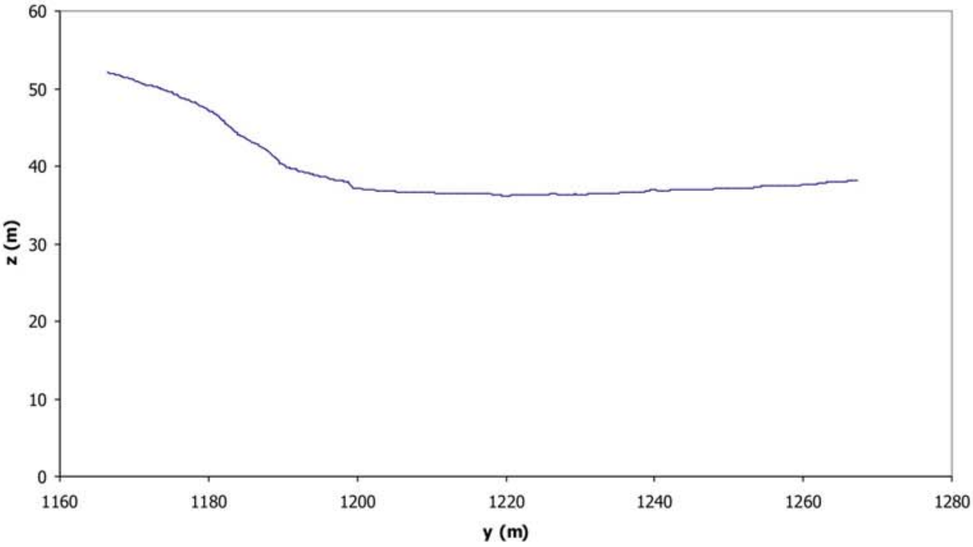
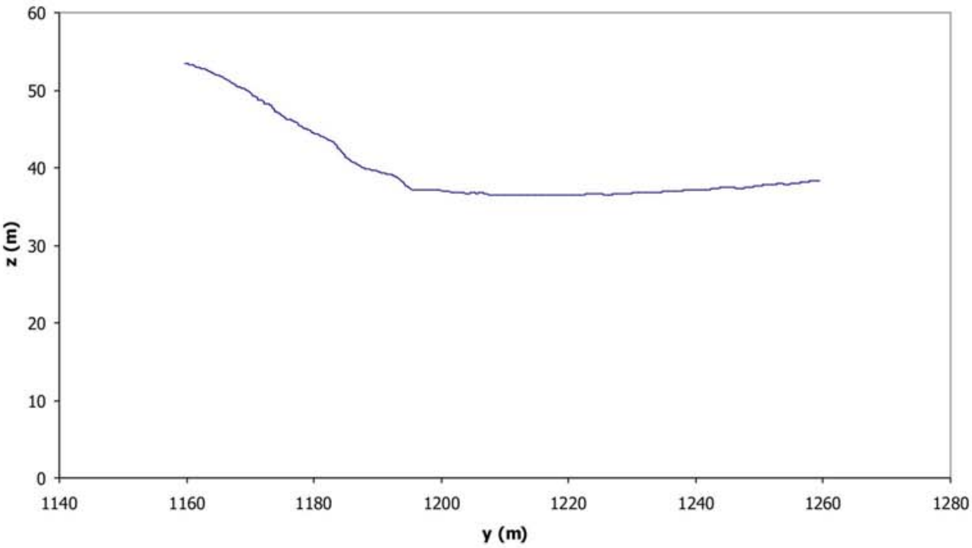


Fig. DR1 (A) Picture of the laser scanner *LMS-Z420i*® set-up for field work. The vertical rotation axis of the scanner is additionally shown. (B) The sketch emphasizes the scanning procedure. The scanner is shifted from position P1 to P2 after the first scan. The second scan is performed at P2. An overlap (white area) exists between both positions where reflectors (black circles) are used to link the individual scans.

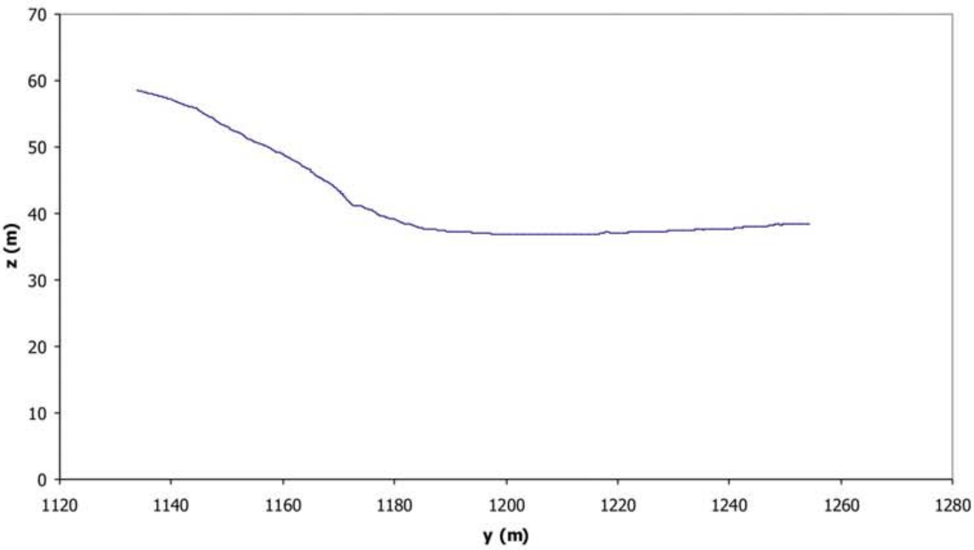
Profile 1



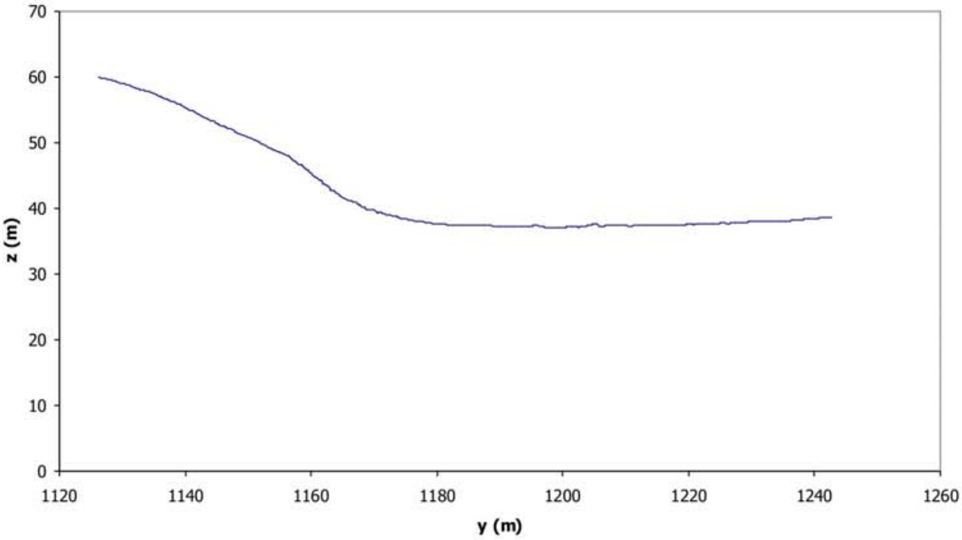
Profile 2



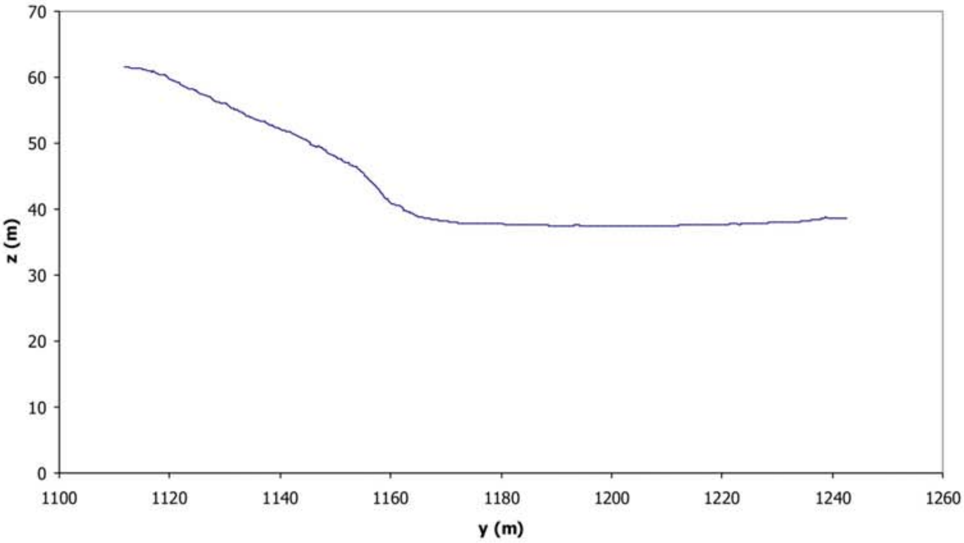
Profile 3



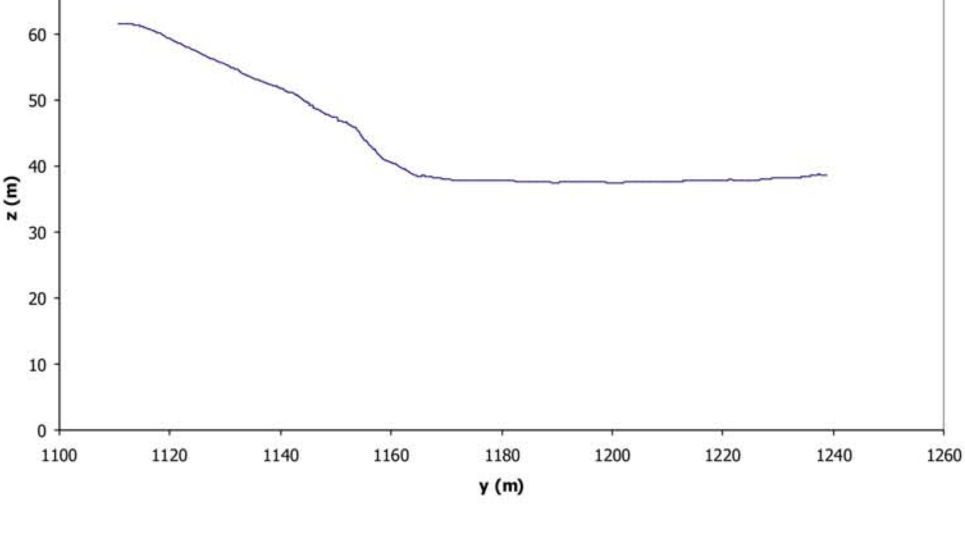
Profile 4



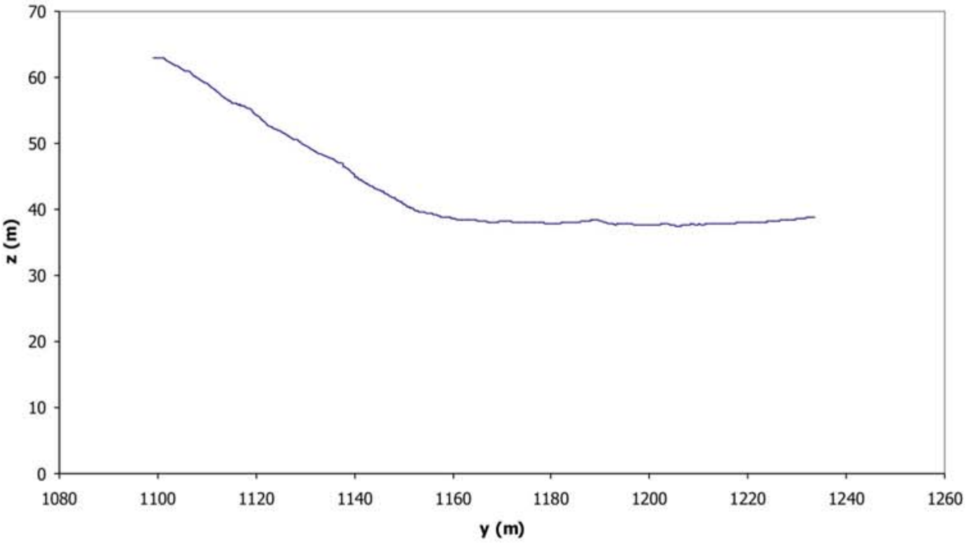
Profile 5



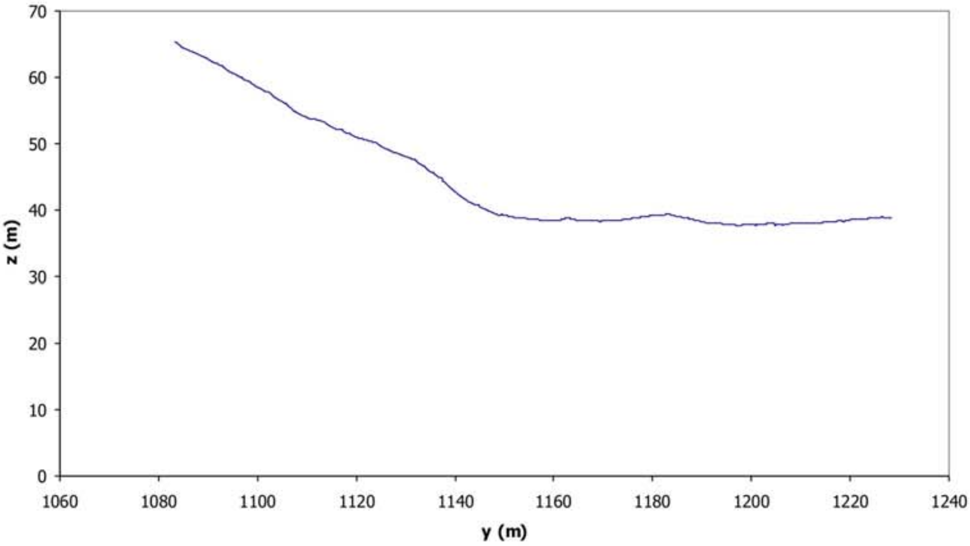
Profile 6



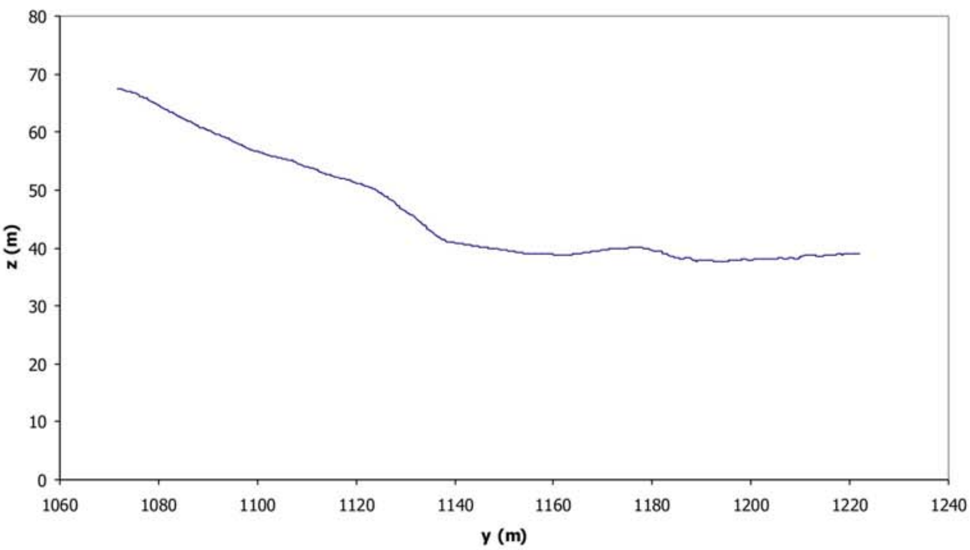
Profile 7



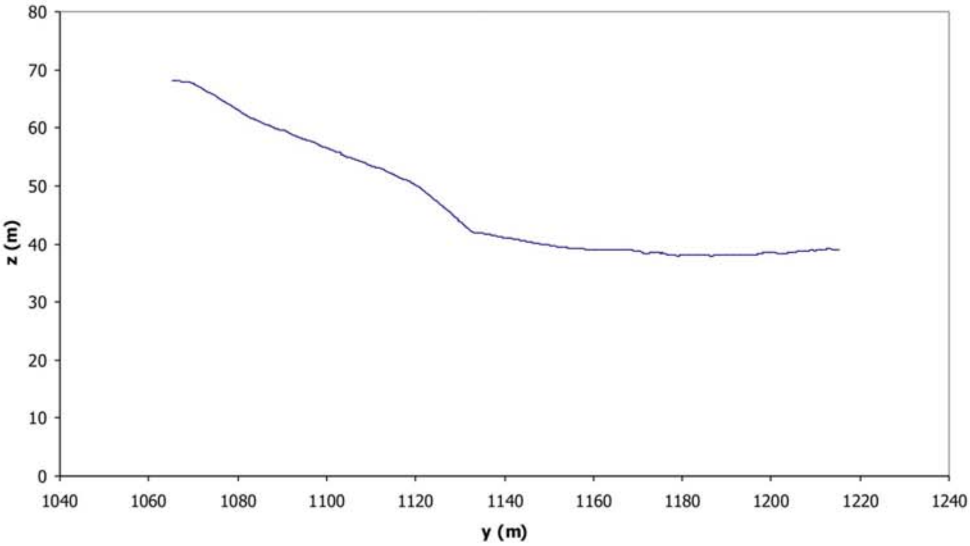
Profile 8



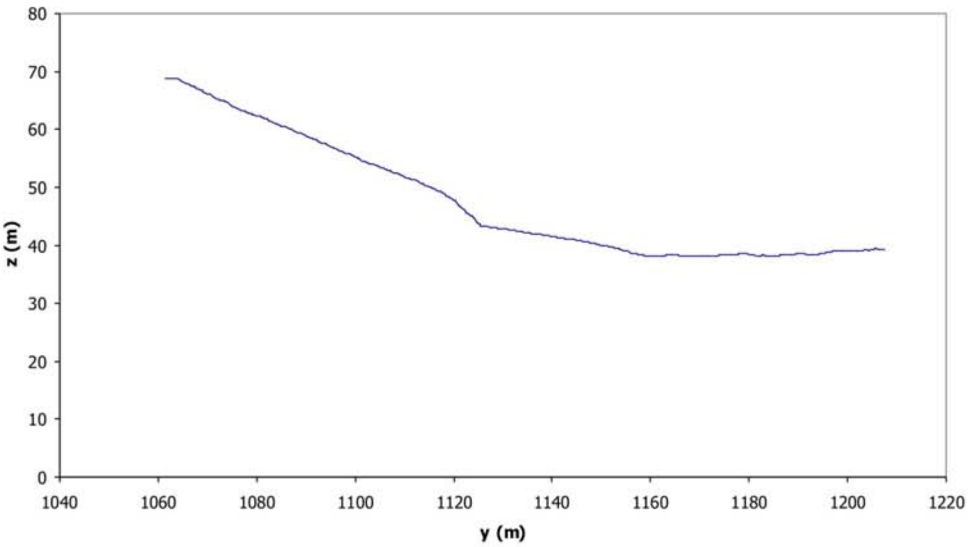
Profile 9



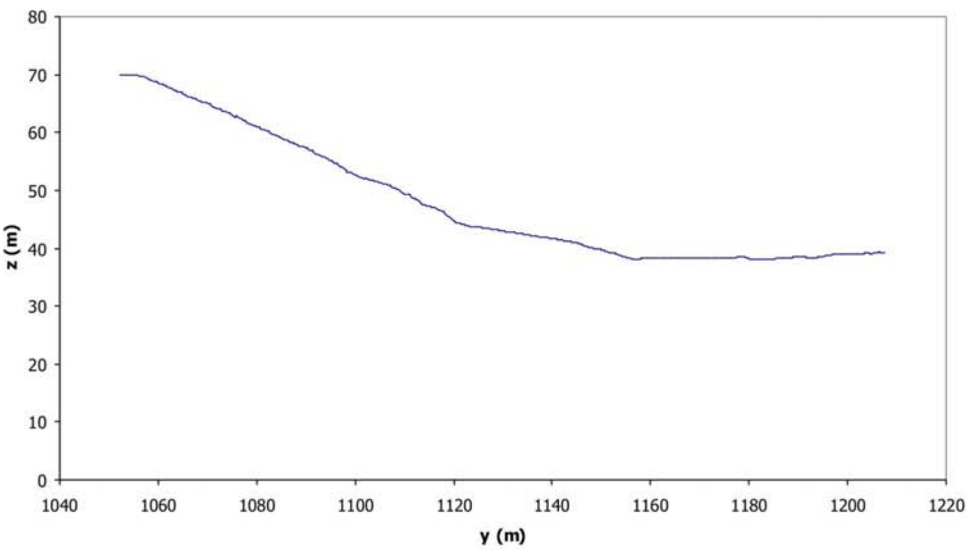
Profile 10



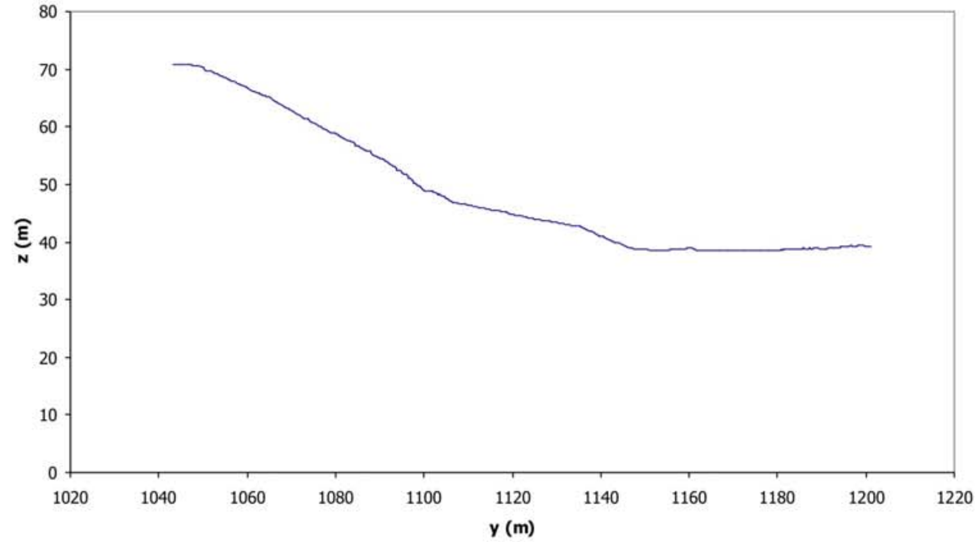
Profile 11



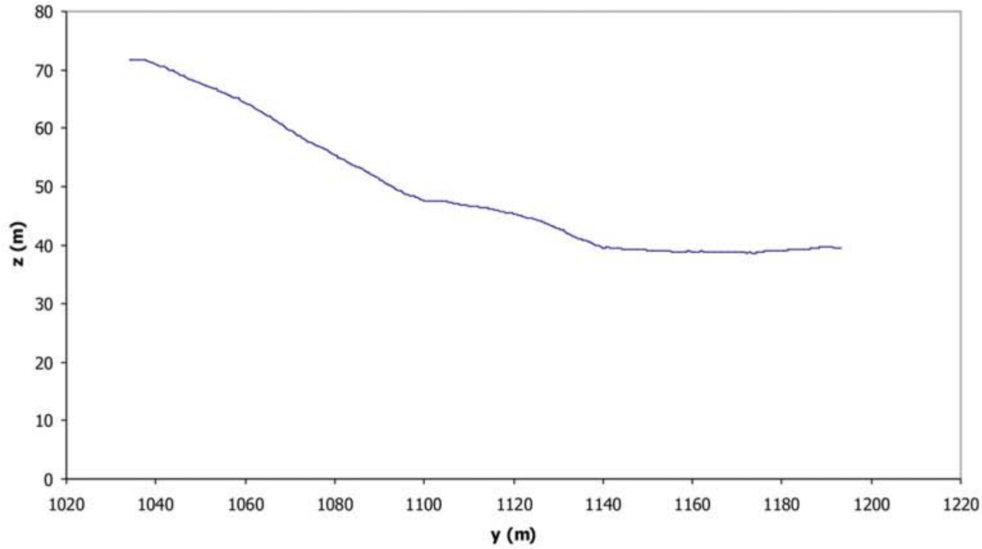
Profile 12



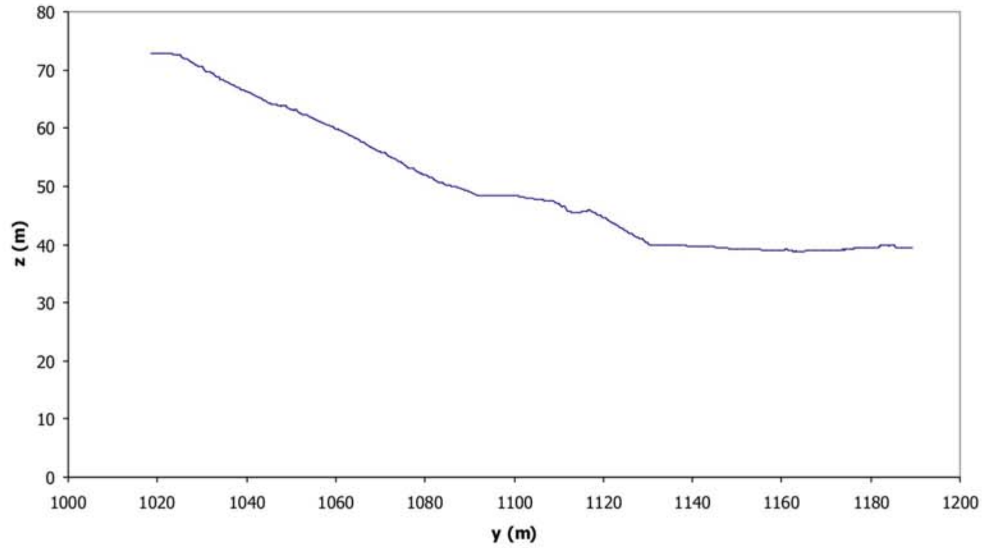
Profile 13



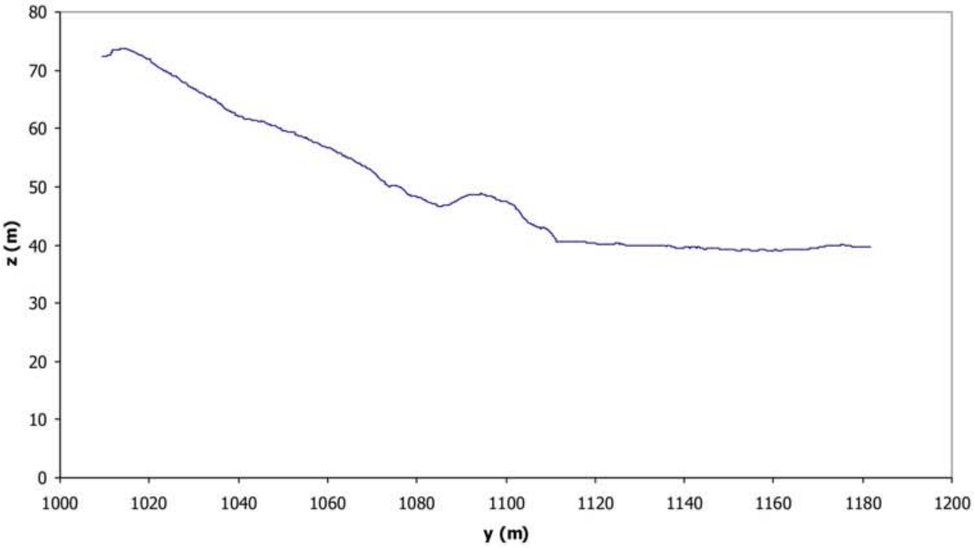
Profile 14



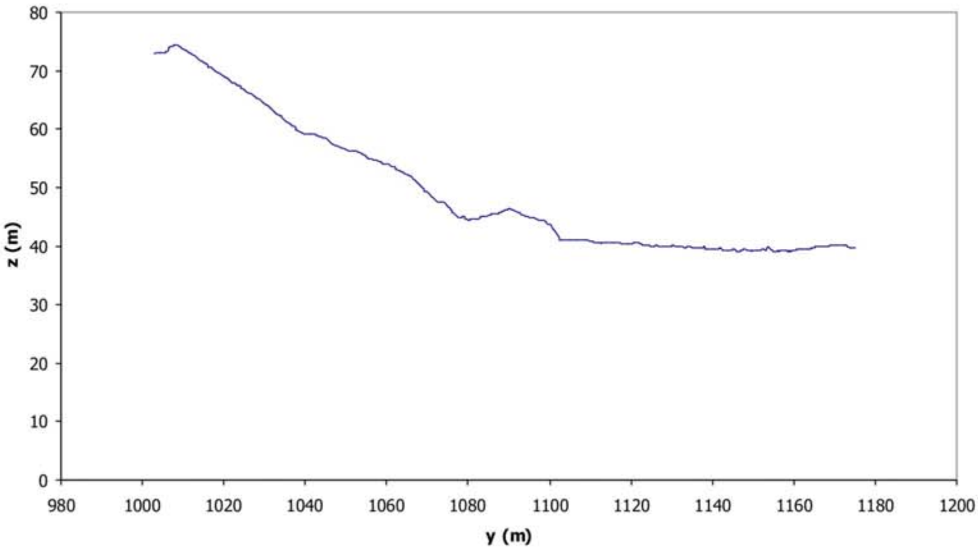
Profile 15



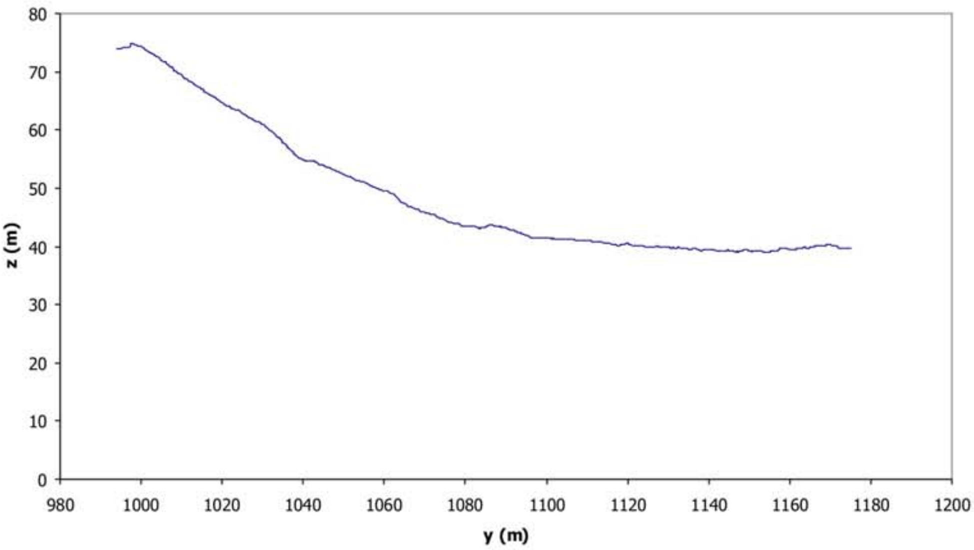
Profile 16



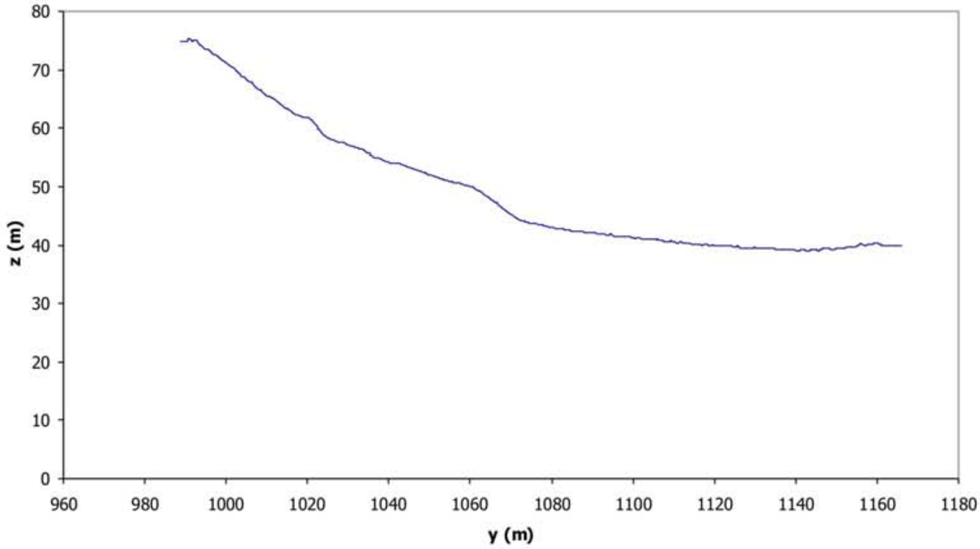
Profile 17



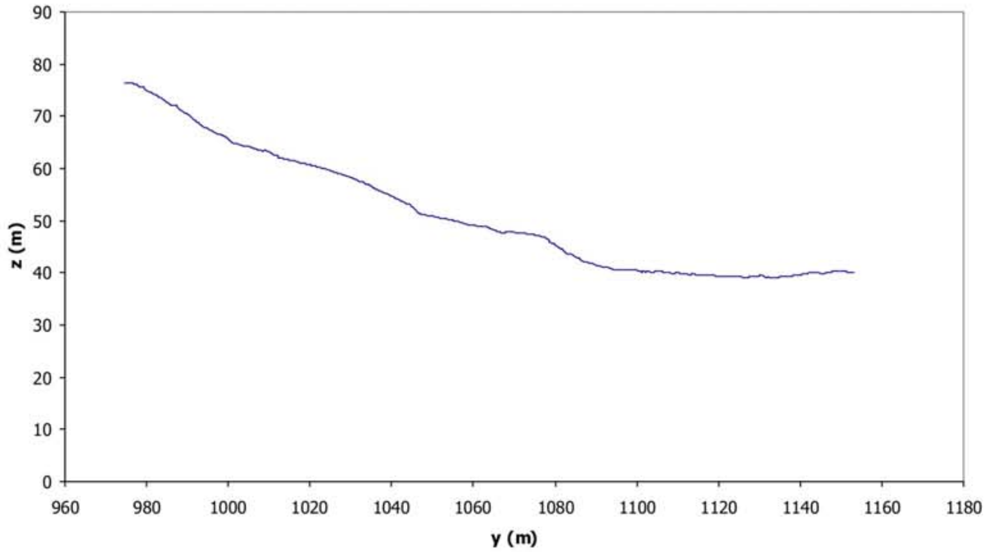
Profile 18



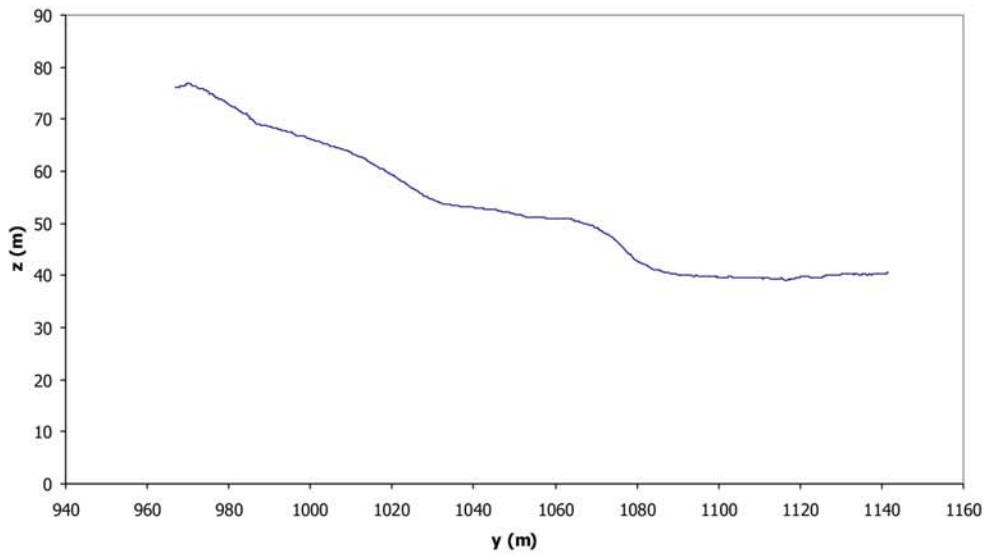
Profile 19



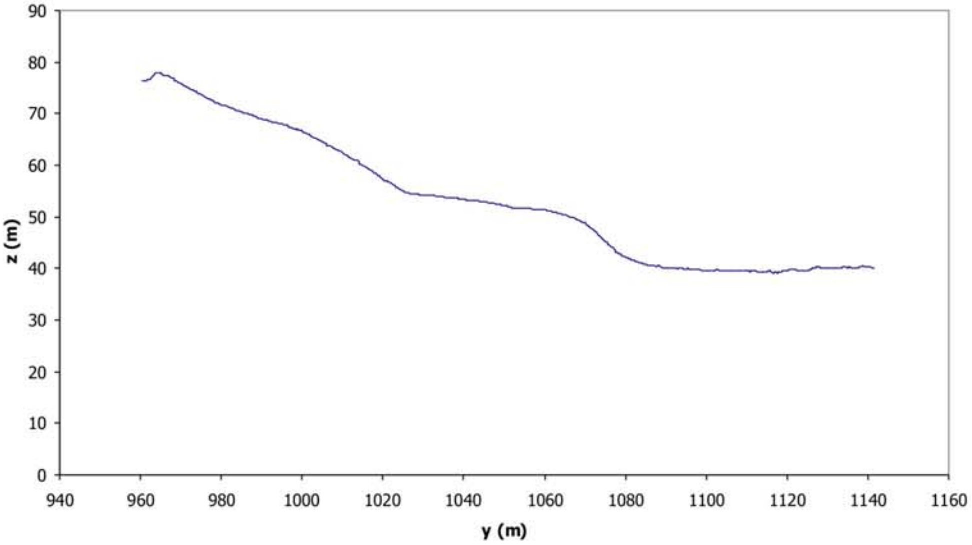
Profile 20



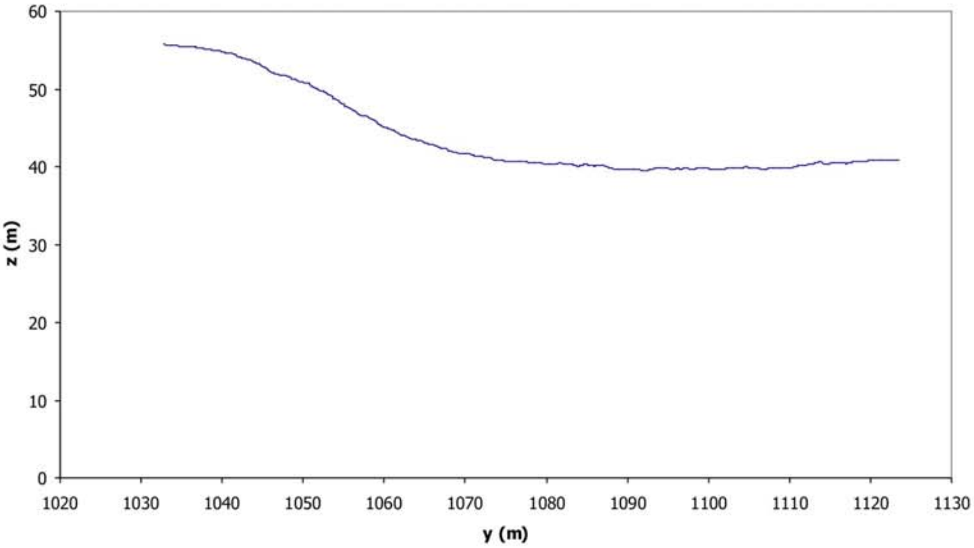
Profile 21



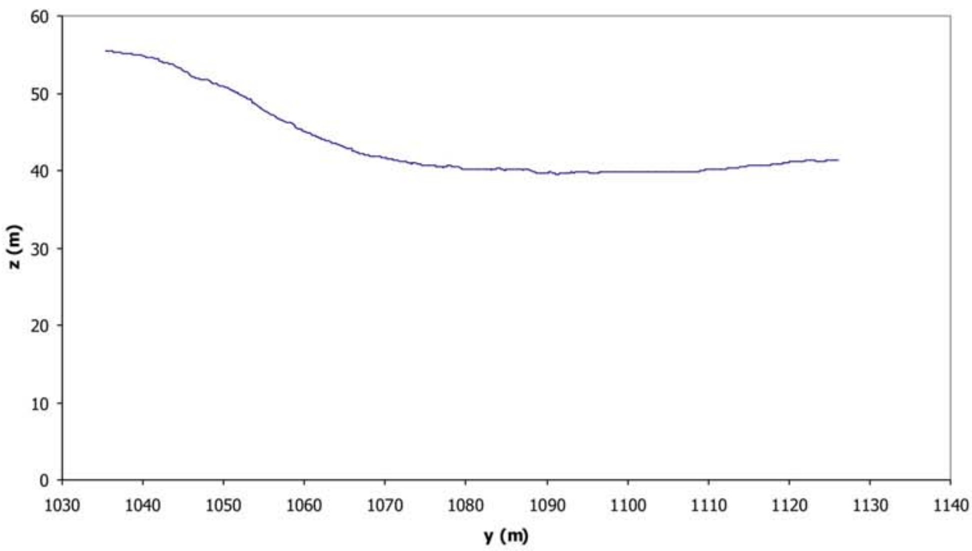
Profile 22



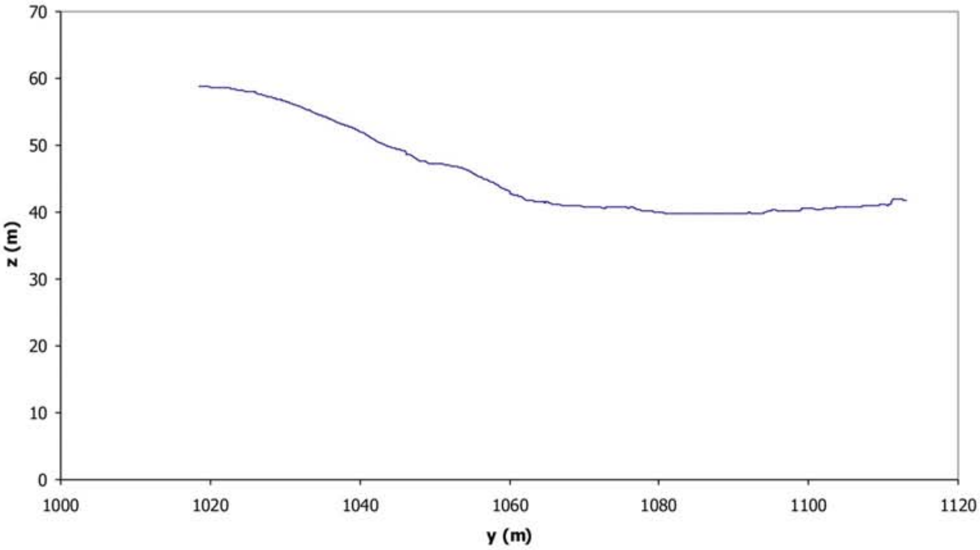
Profile 23



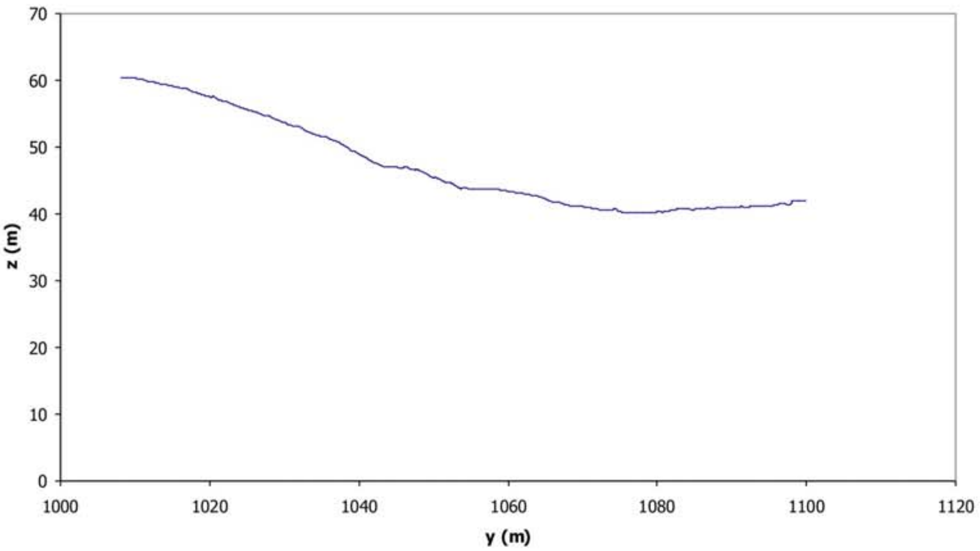
Profile 24



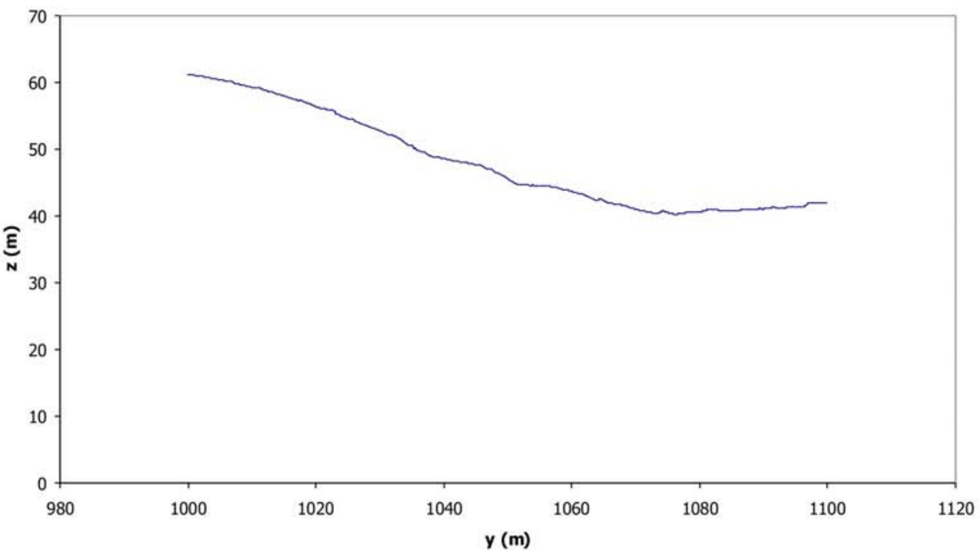
Profile 25



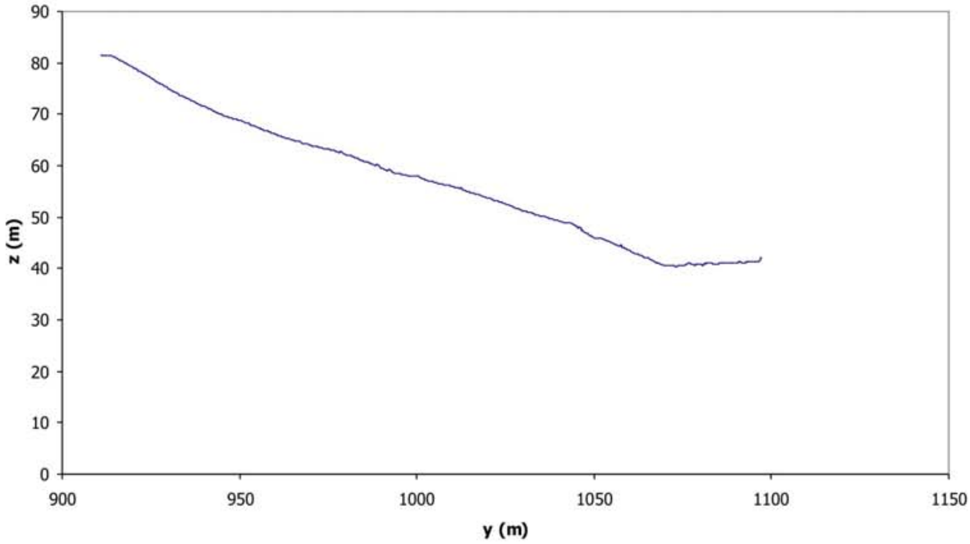
Profile 26



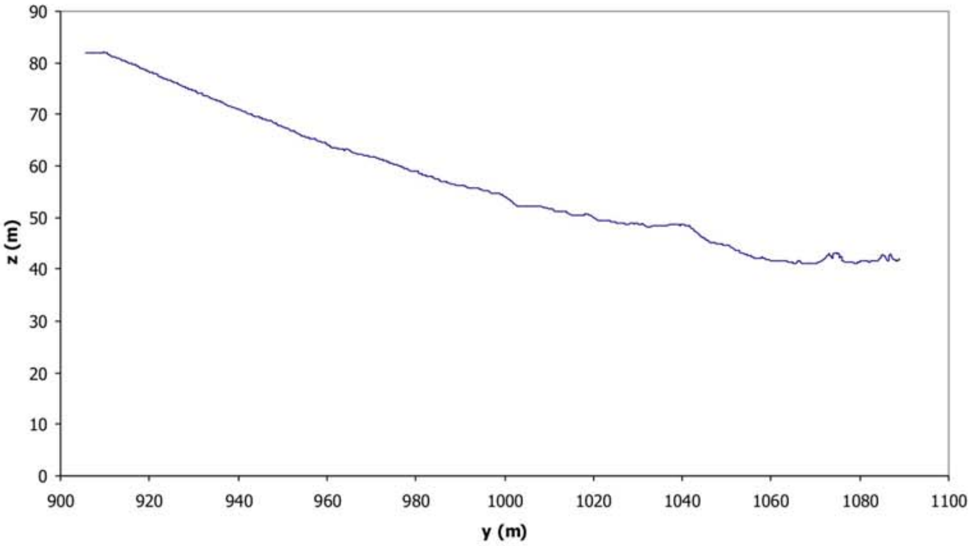
Profile 27



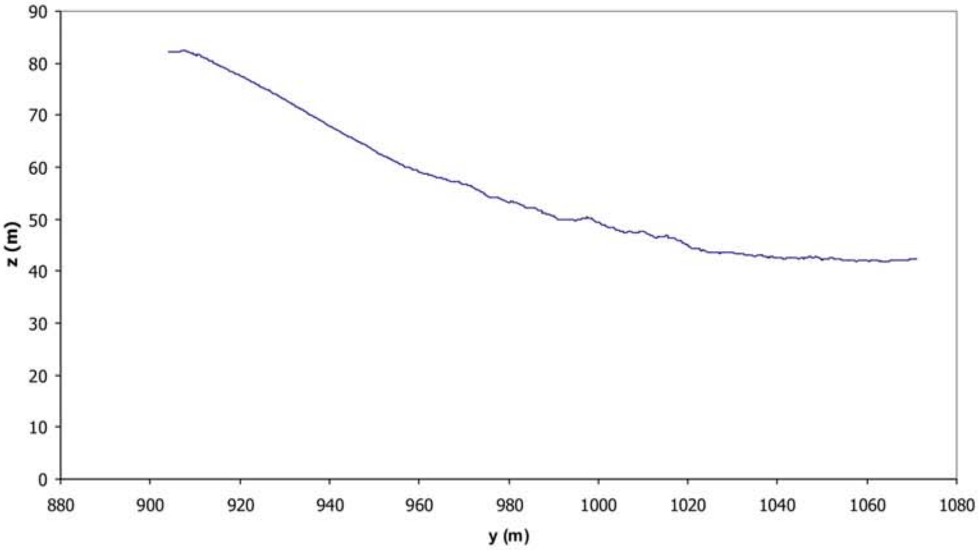
Profile 28



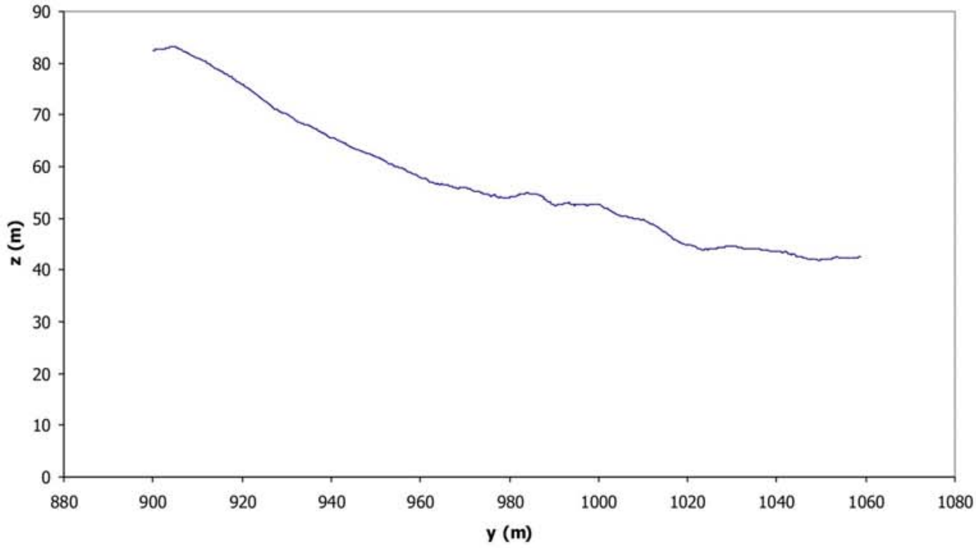
Profile 29



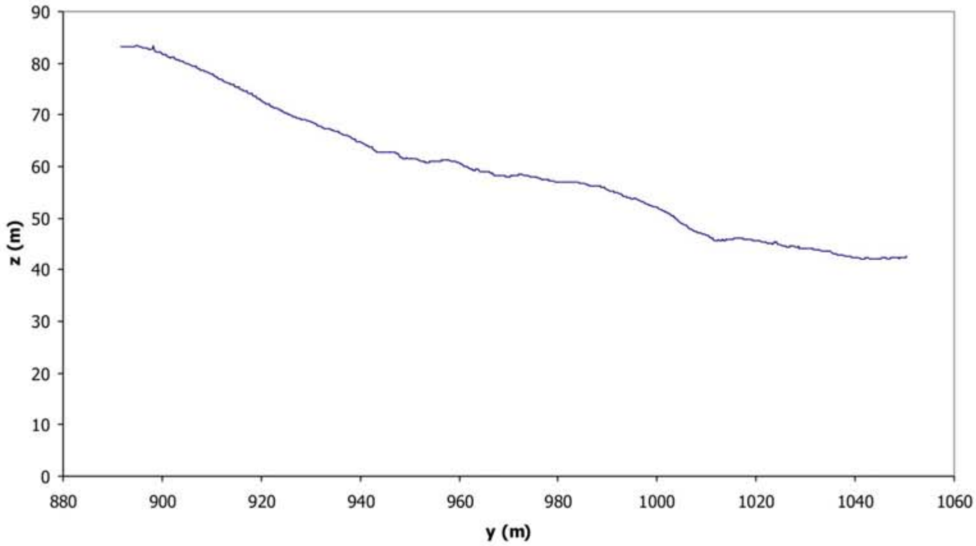
Profile 30



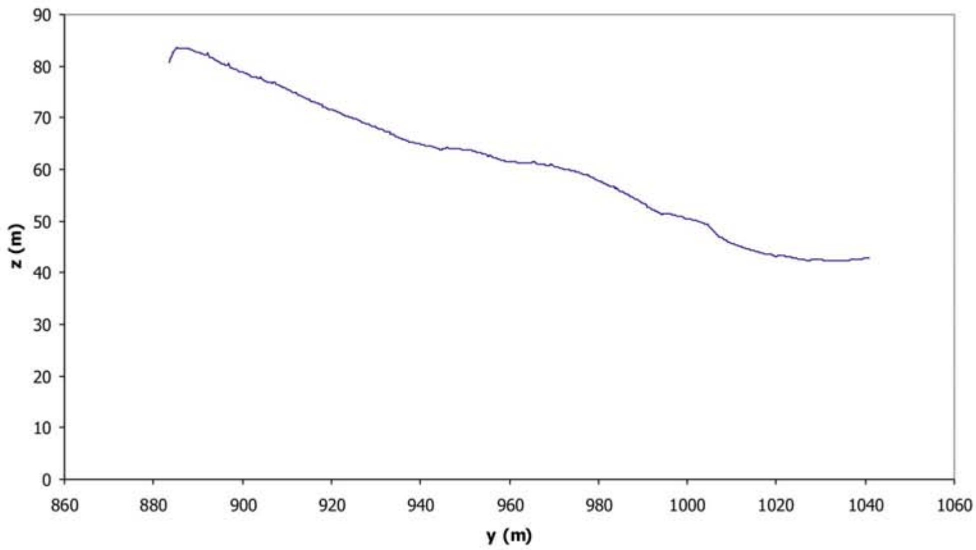
Profile 31



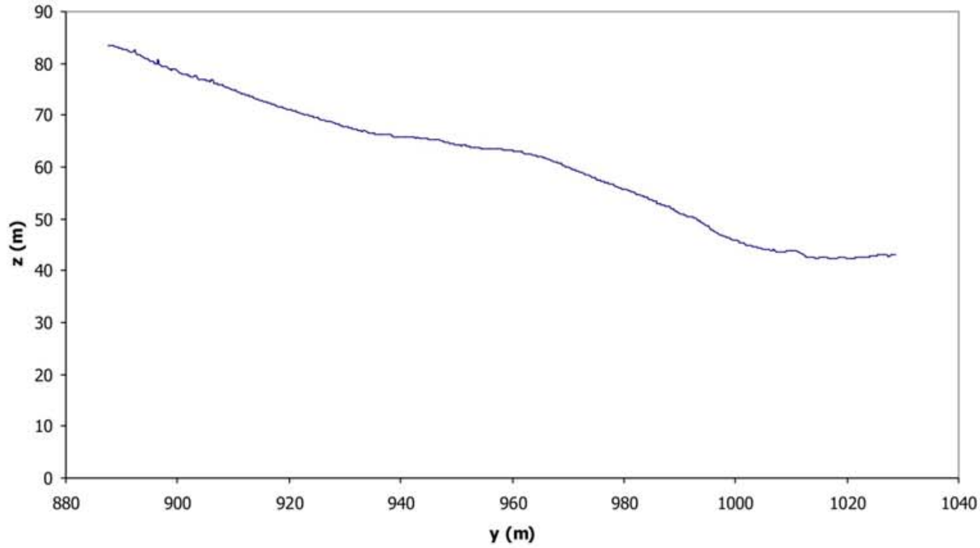
Profile 32



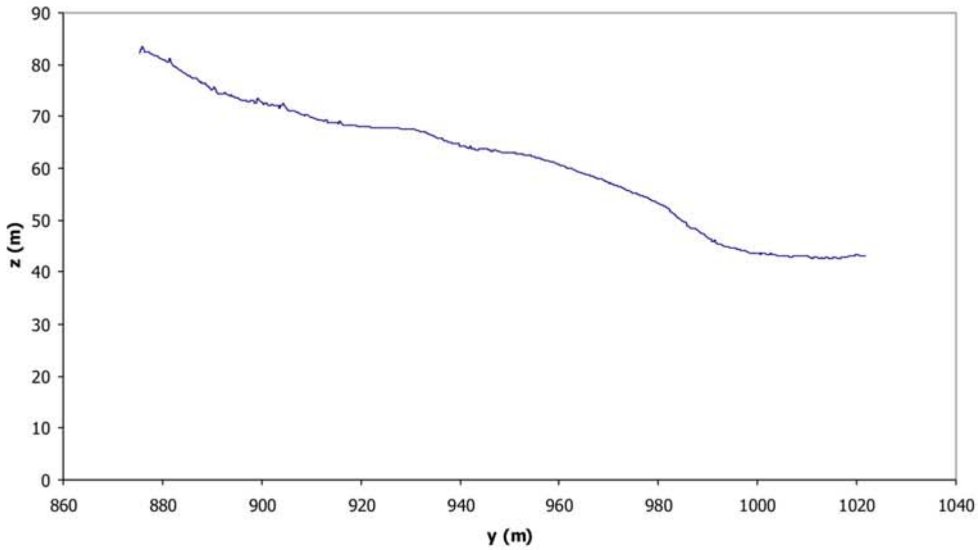
Profile 33



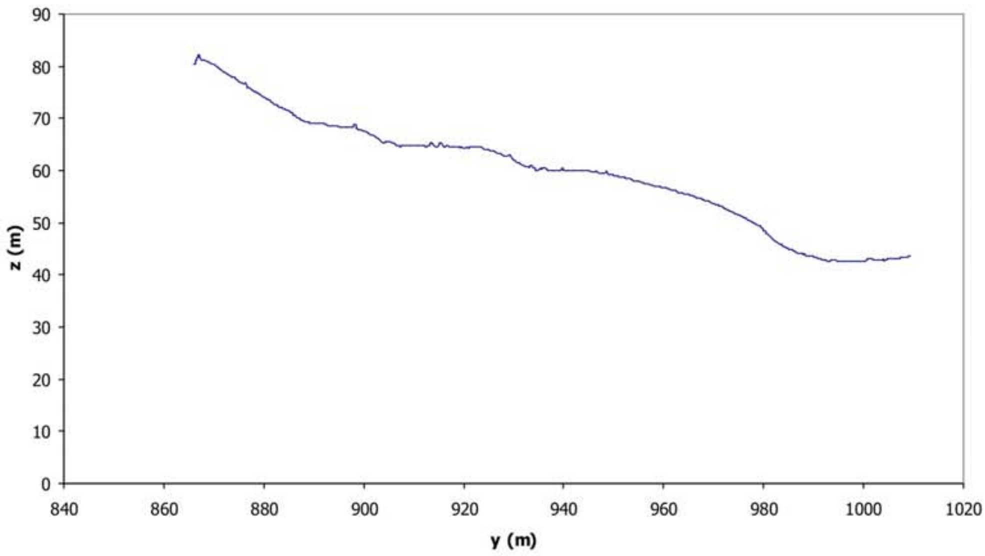
Profile 34



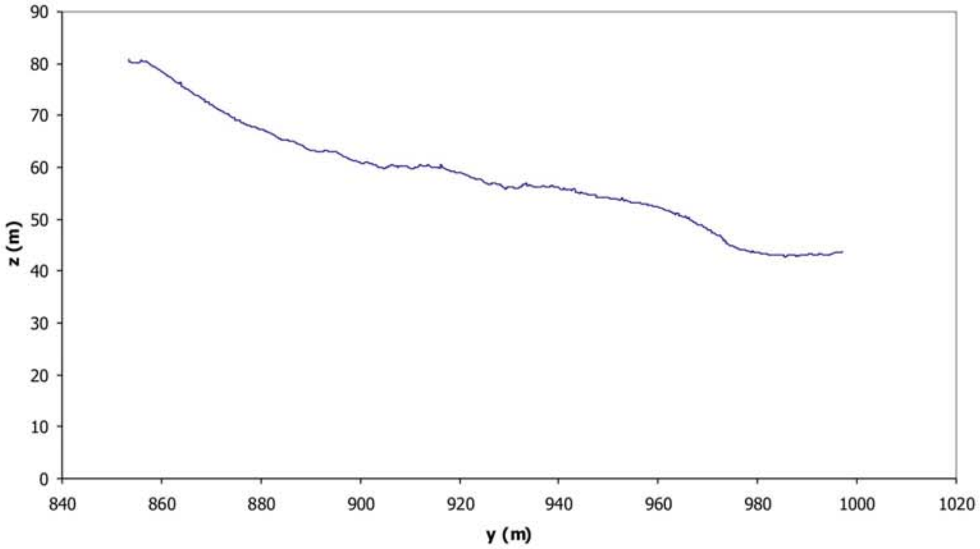
Profile 35



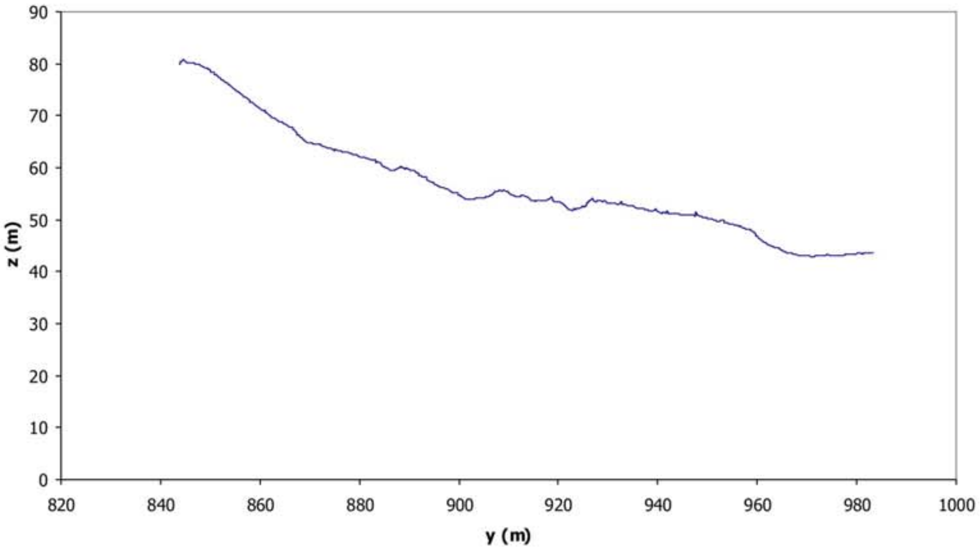
Profile 36



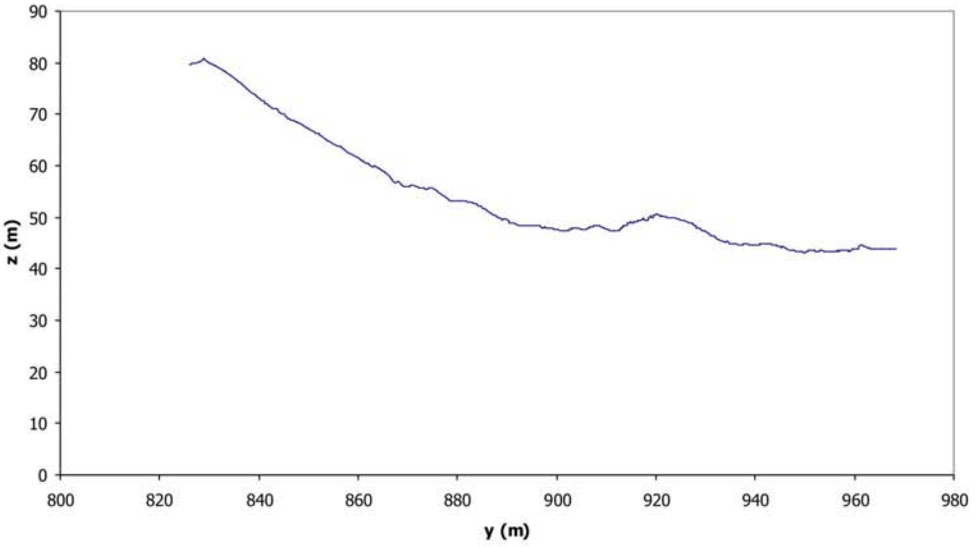
Profile 37



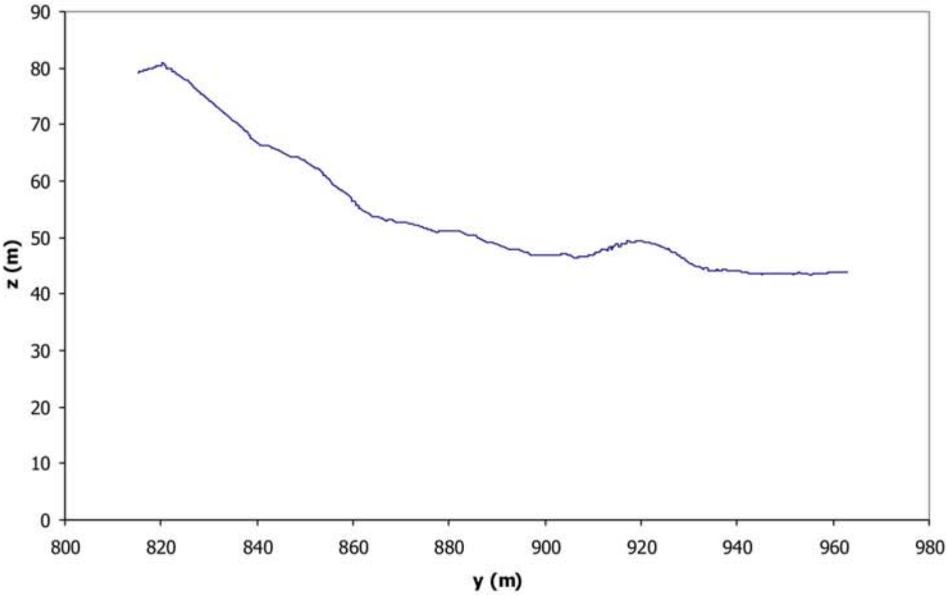
Profile 38



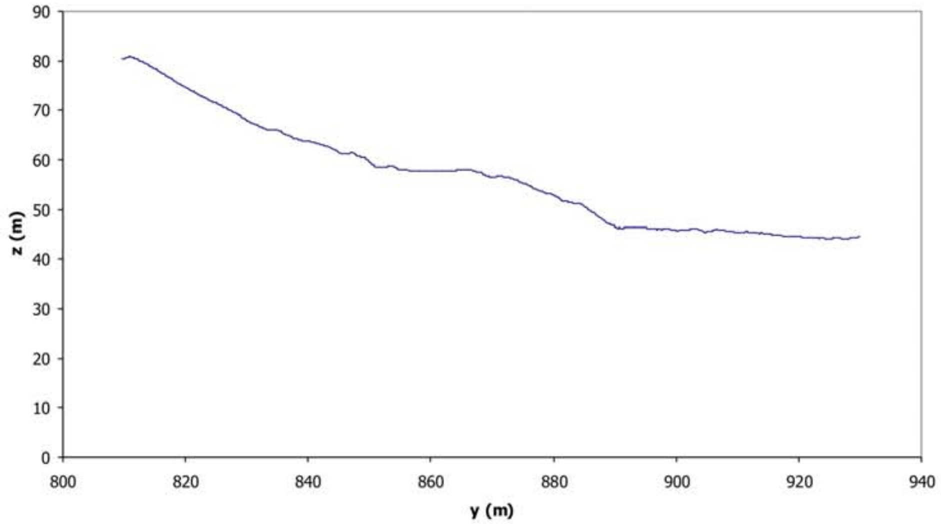
Profile 39



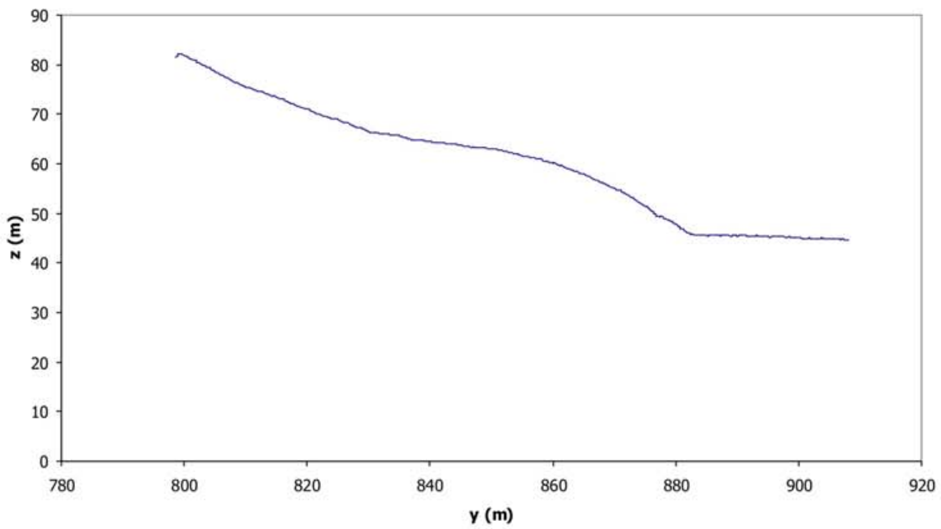
Profile 40

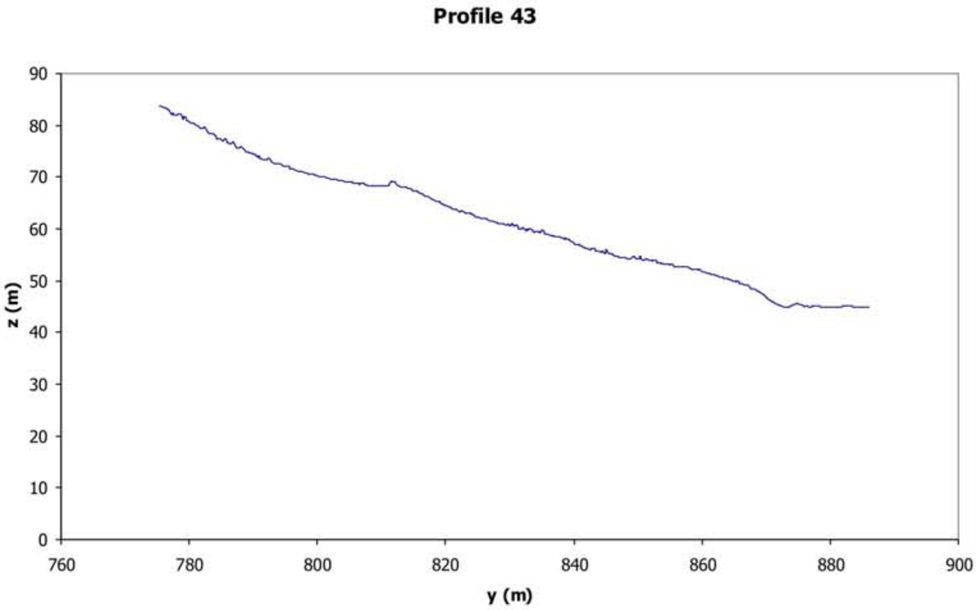


Profile 41

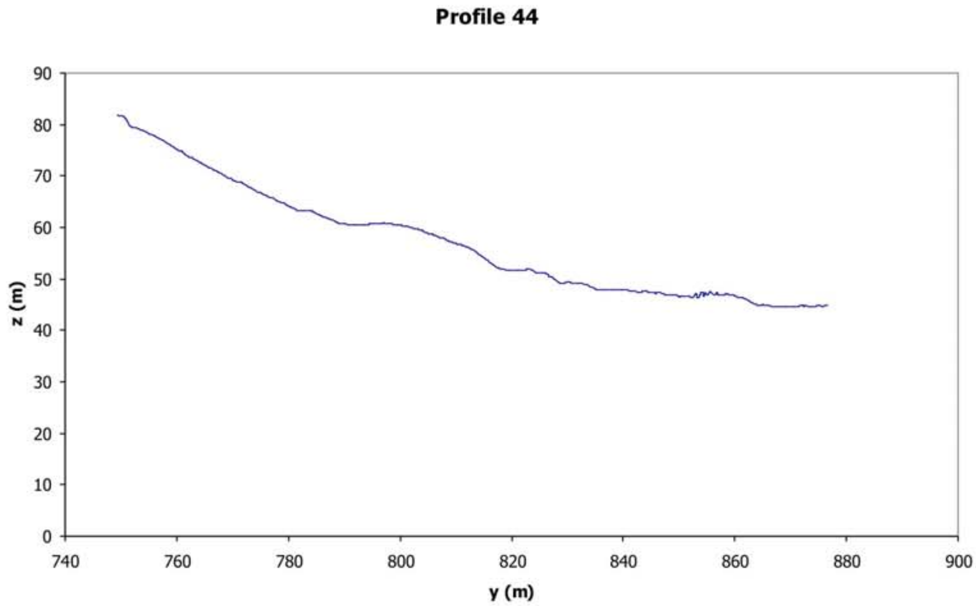


Profile 42

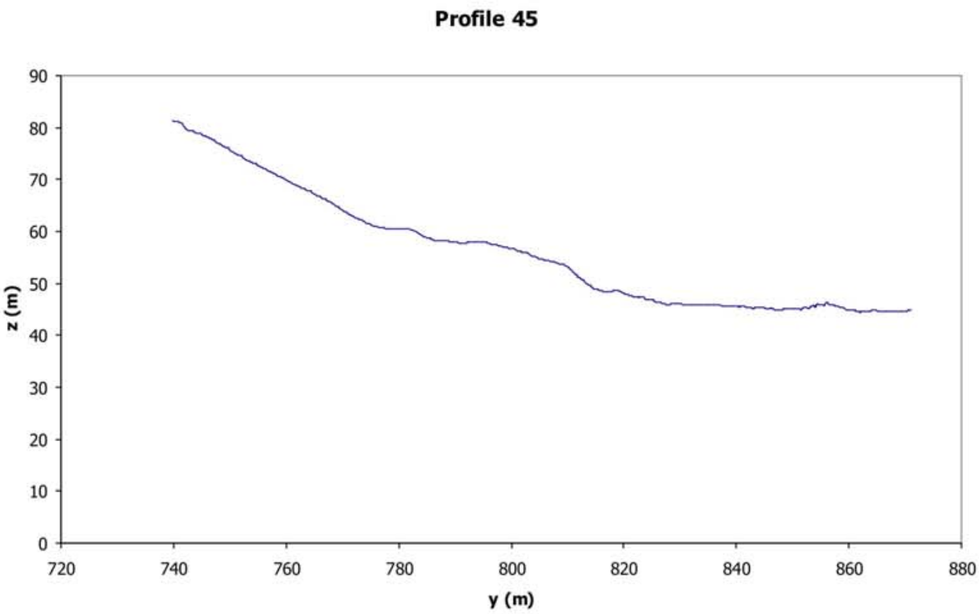




Profile 43
z (m)
y (m)

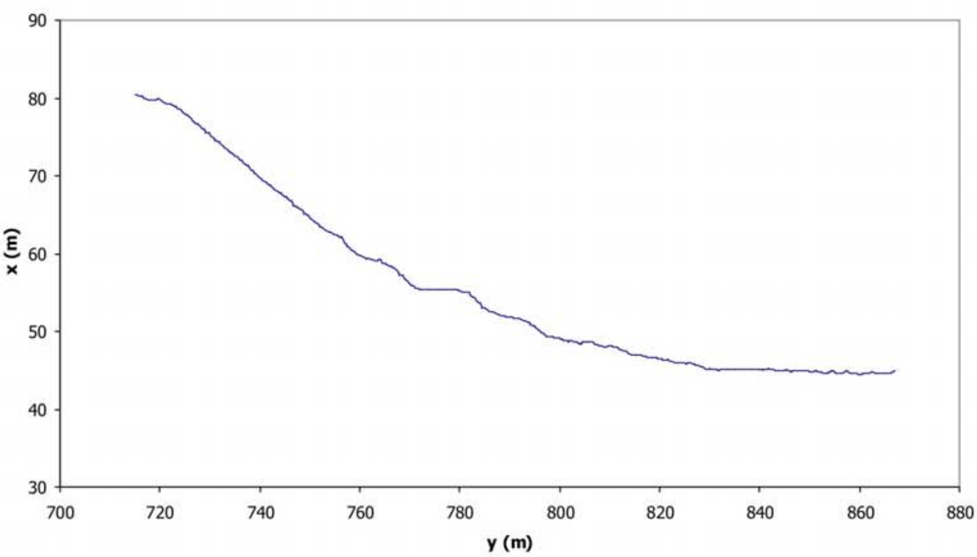


Profile 44
z (m)
y (m)

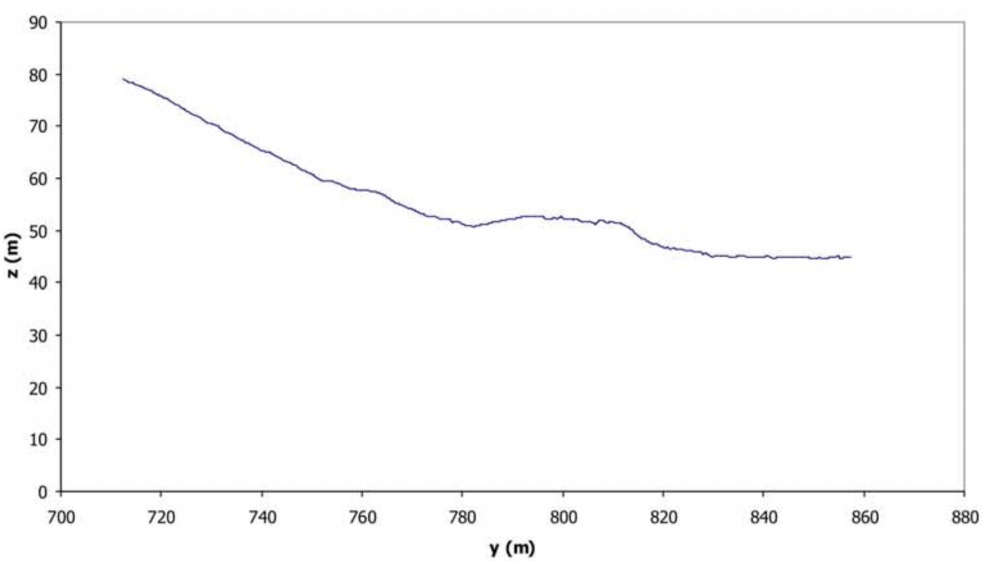


Profile 45
z (m)
y (m)

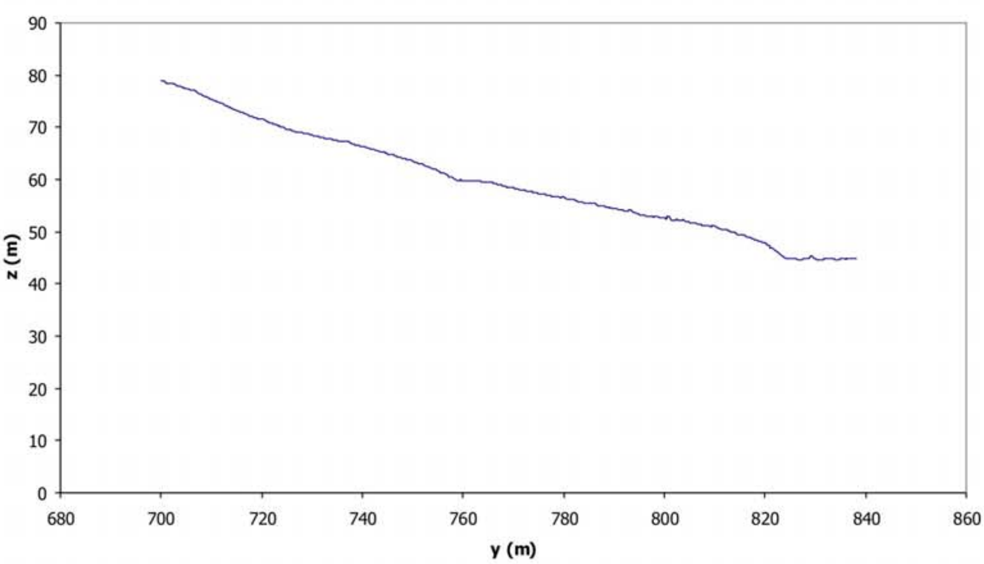
Profile 46



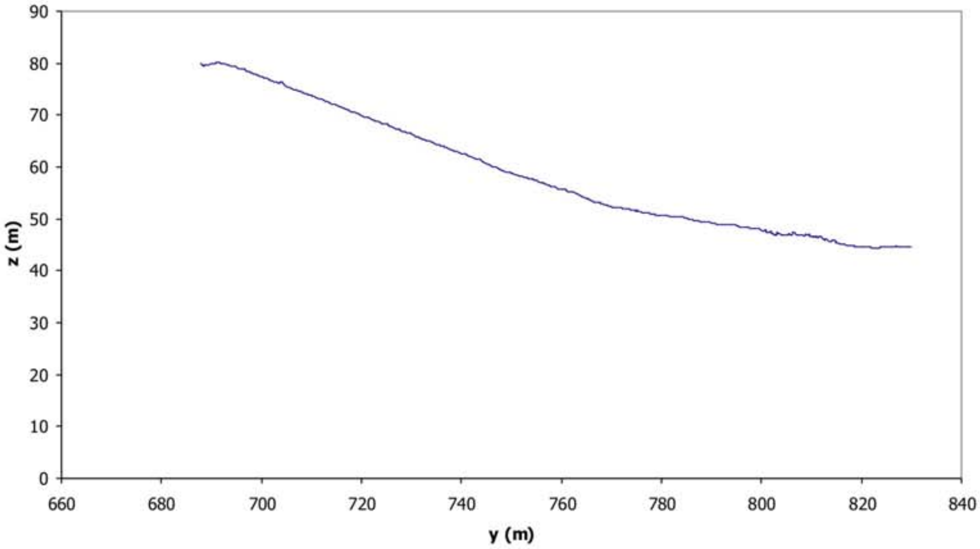
Profile 47



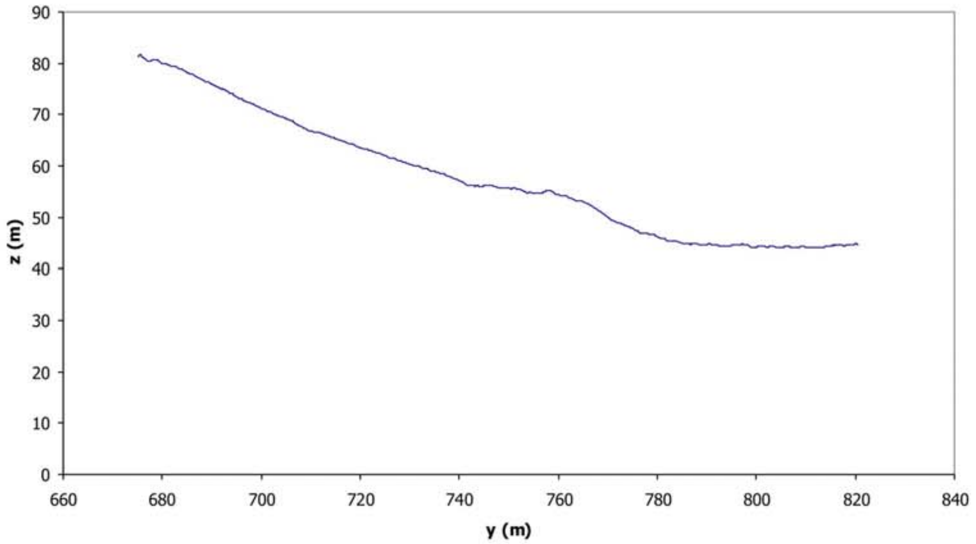
Profile 48



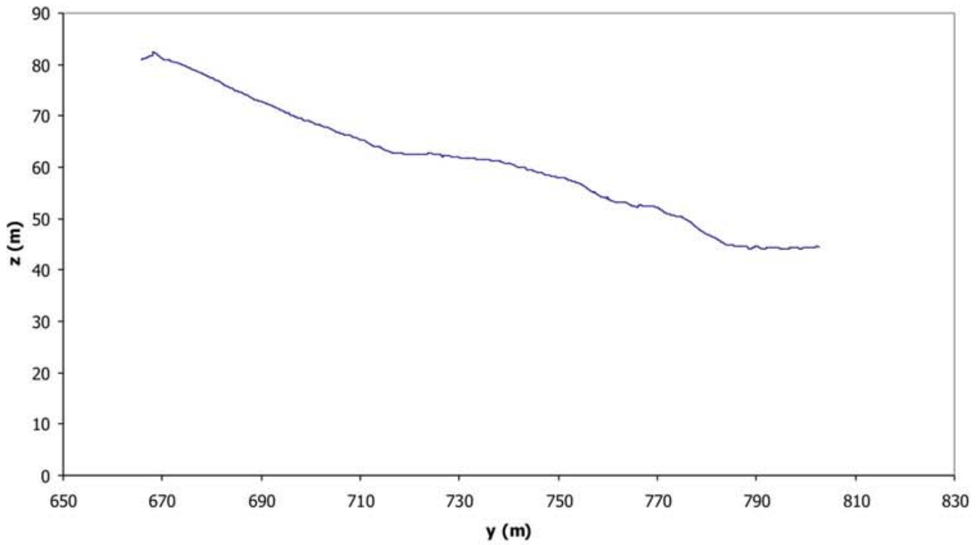
Profile 49

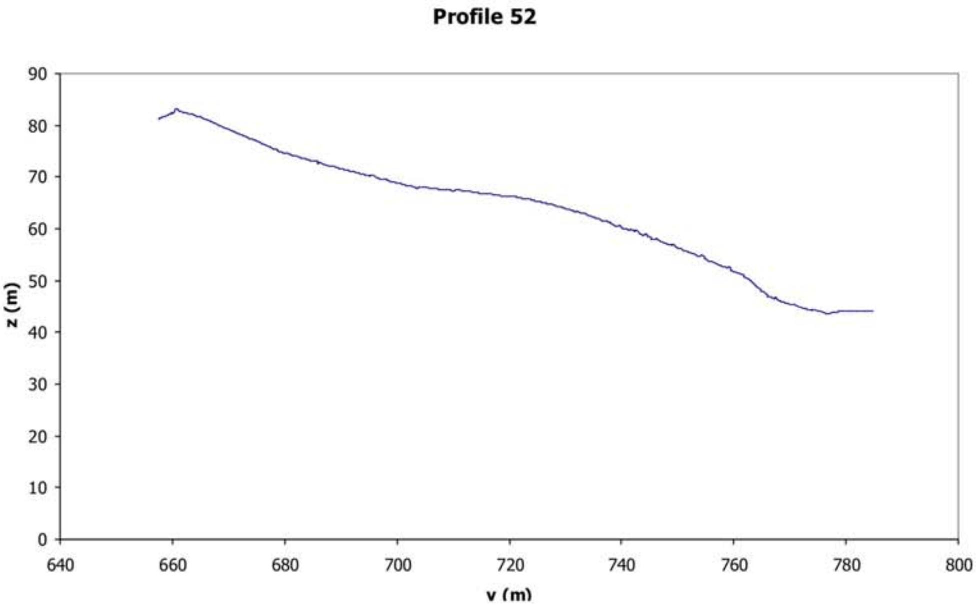


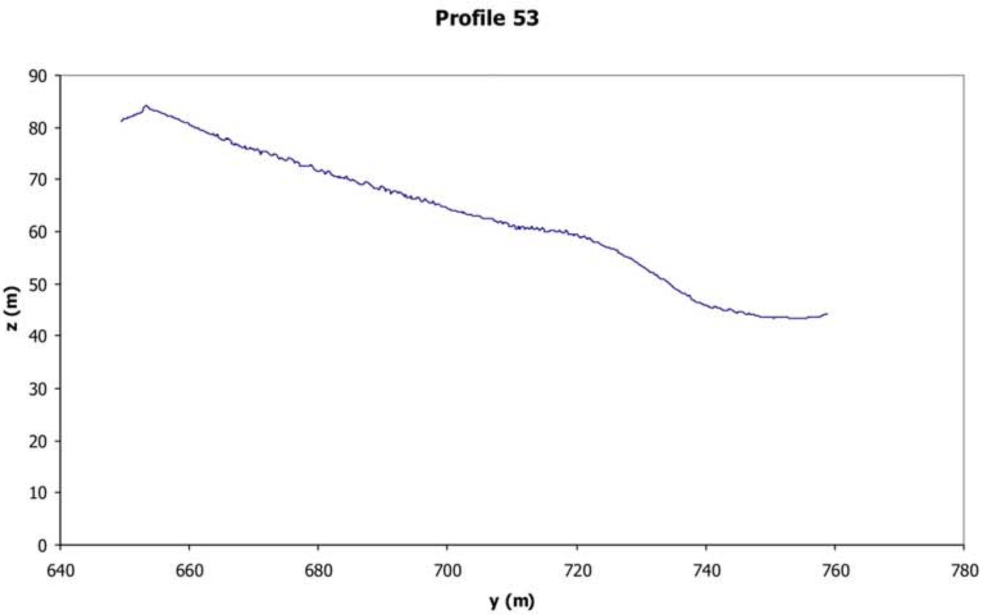
Profile 50

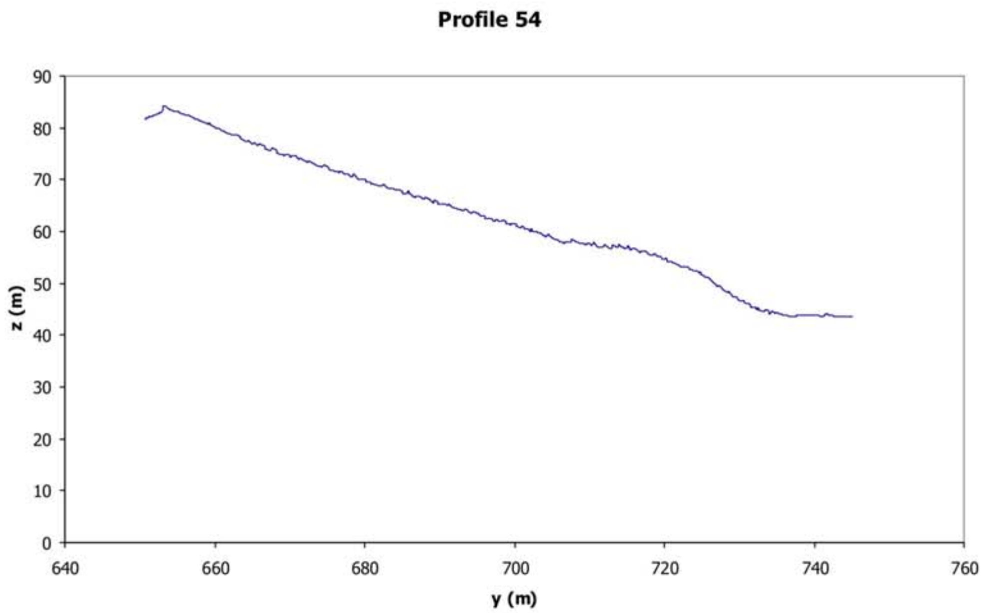


Profile 51

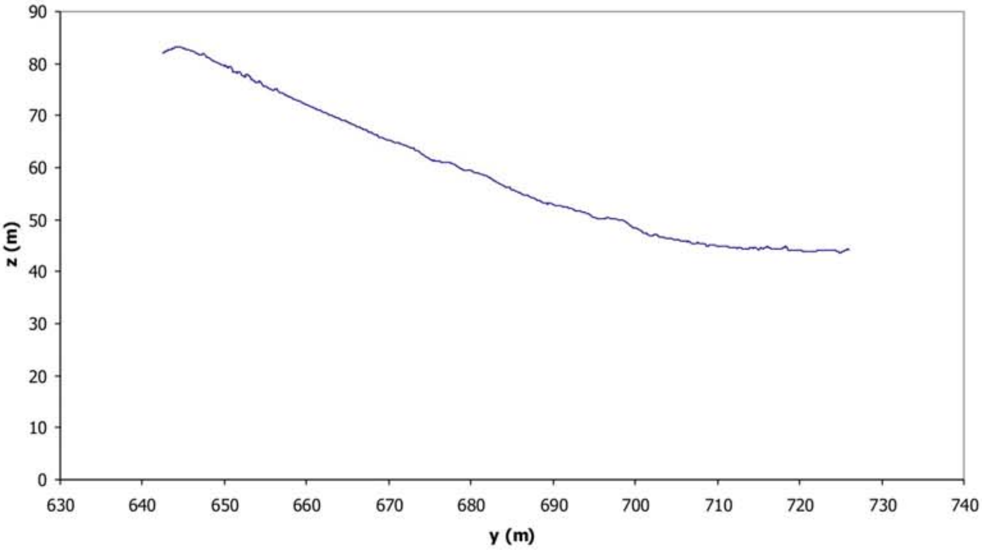



Profile 52
z (m)
y (m)
0
10
20
30
40
50
60
70
80
90
640
660
680
700
720
740
760
780
800

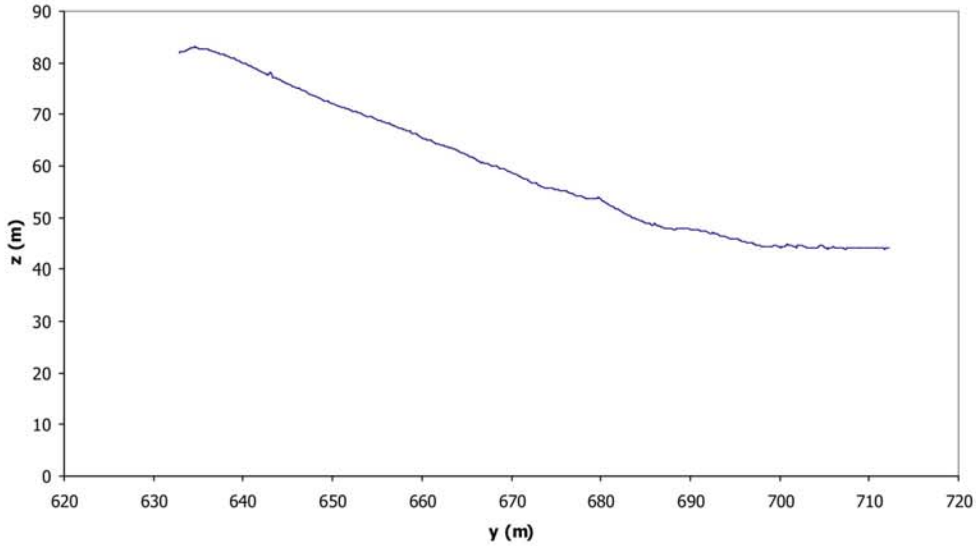

Profile 53
z (m)
y (m)
0
10
20
30
40
50
60
70
80
90
640
660
680
700
720
740
760
780


Profile 54
z (m)
y (m)
0
10
20
30
40
50
60
70
80
90
640
660
680
700
720
740
760

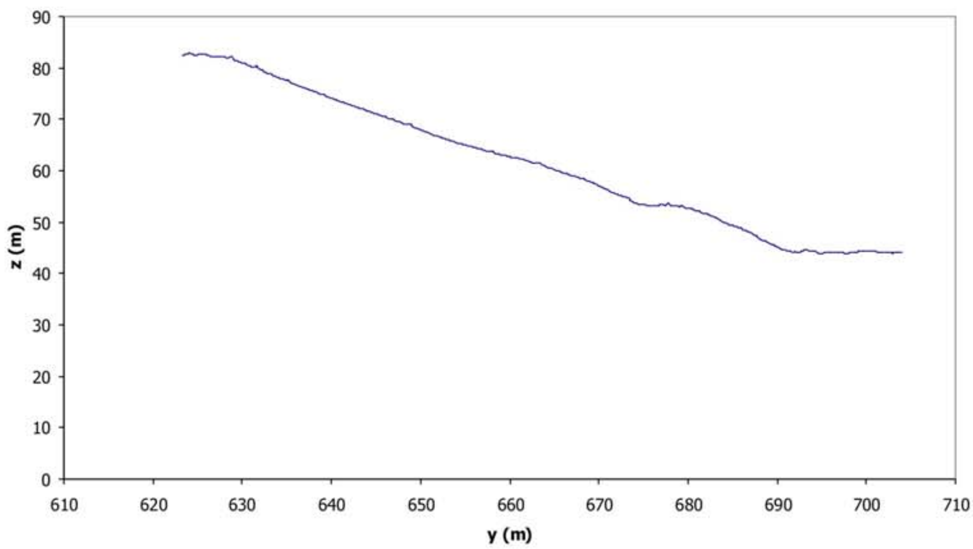
Profile 55



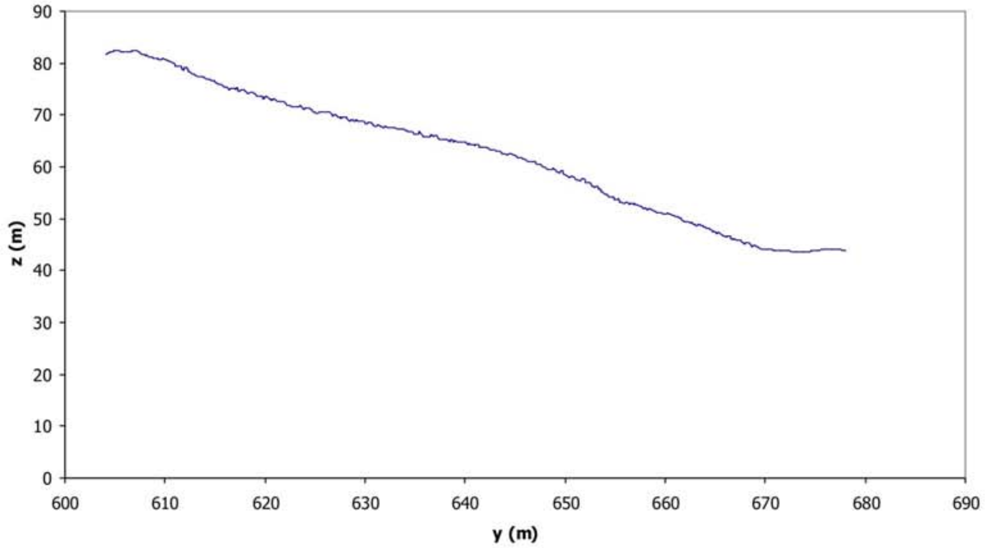
Profile 56



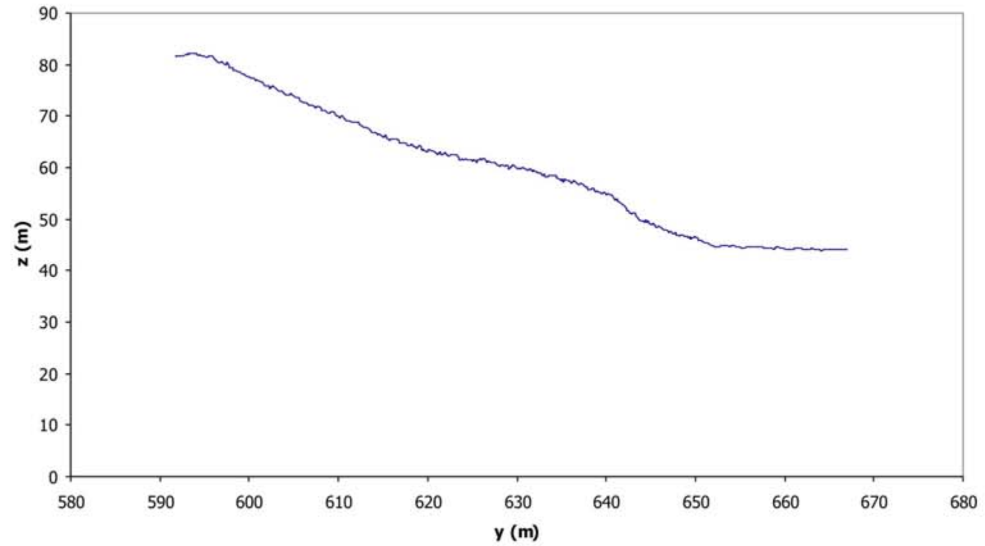
Profile 57



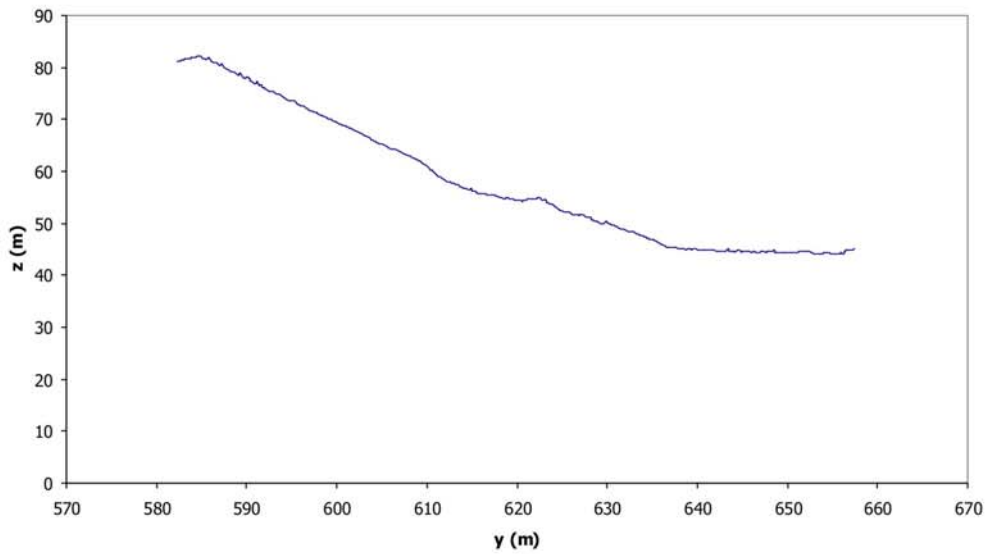
Profile 58

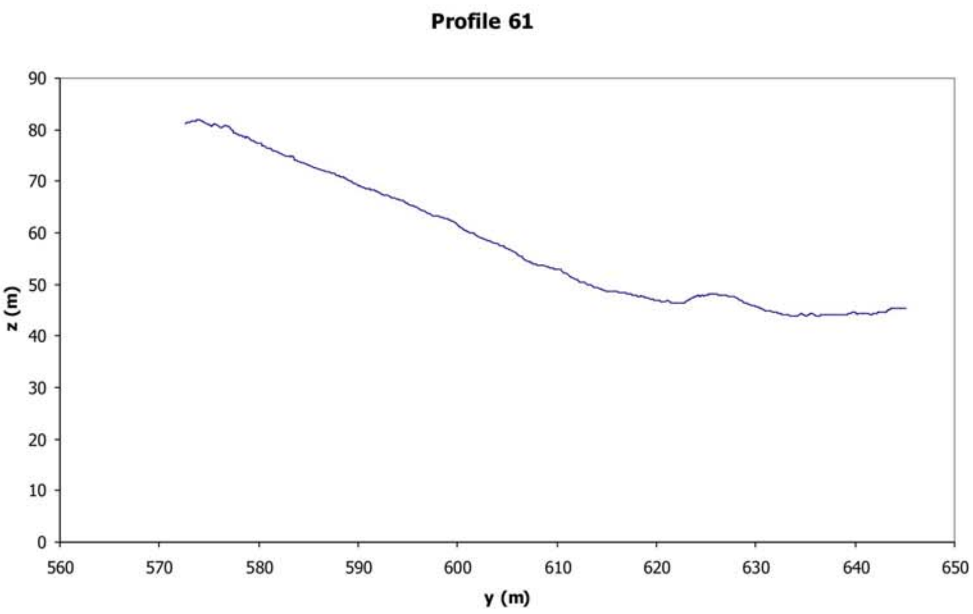


Profile 59

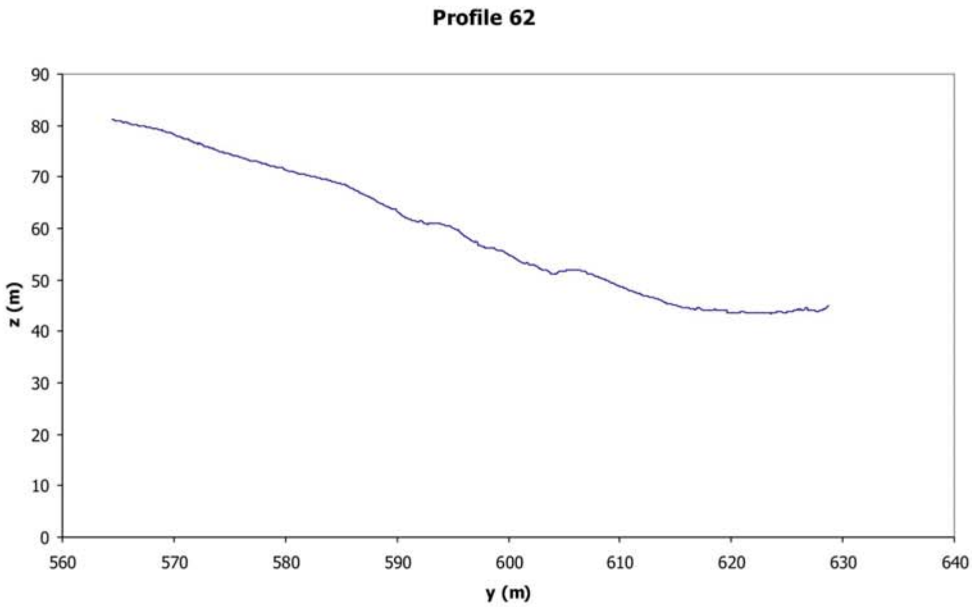


Profile 60

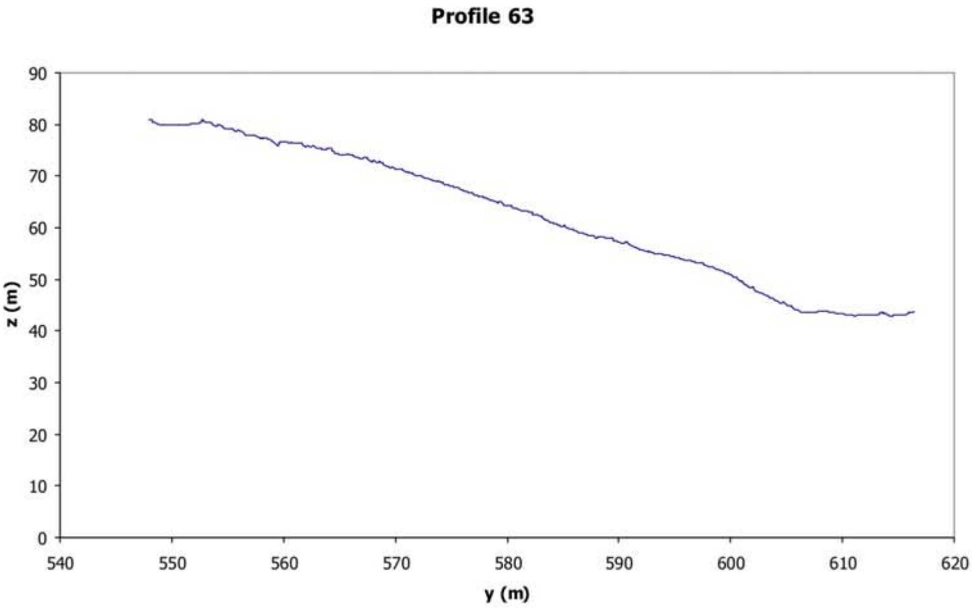




Profile 61
90
80
70
60
50
40
30
20
10
0
z (m)
560
570
580
590
600
610
620
630
640
650
y (m)

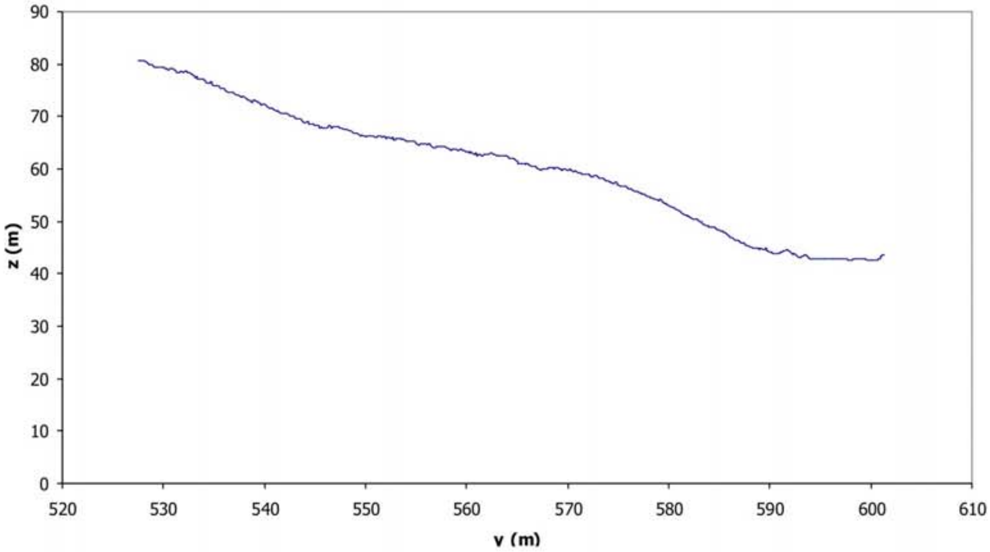


Profile 62
90
80
70
60
50
40
30
20
10
0
z (m)
560
570
580
590
600
610
620
630
640
y (m)

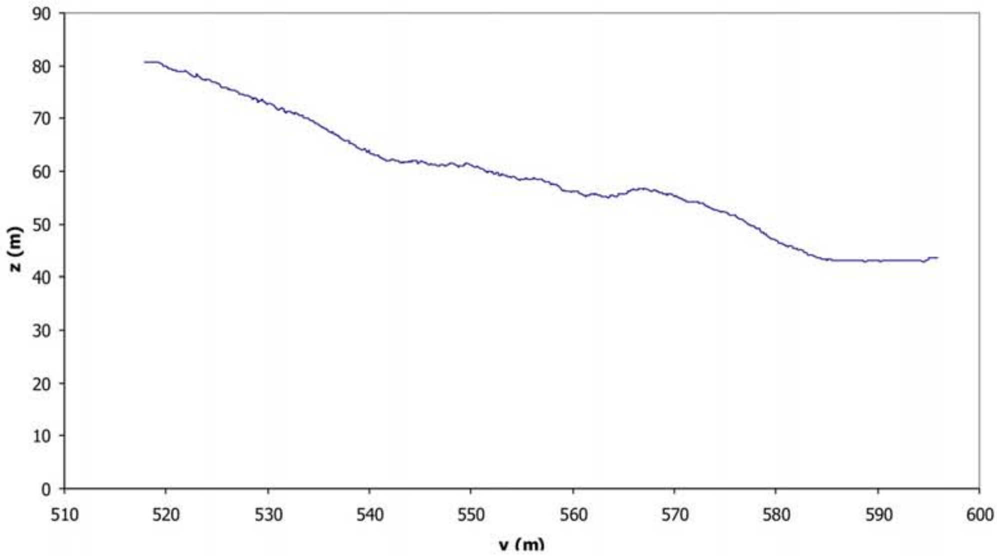


Profile 63
90
80
70
60
50
40
30
20
10
0
z (m)
540
550
560
570
580
590
600
610
620
y (m)

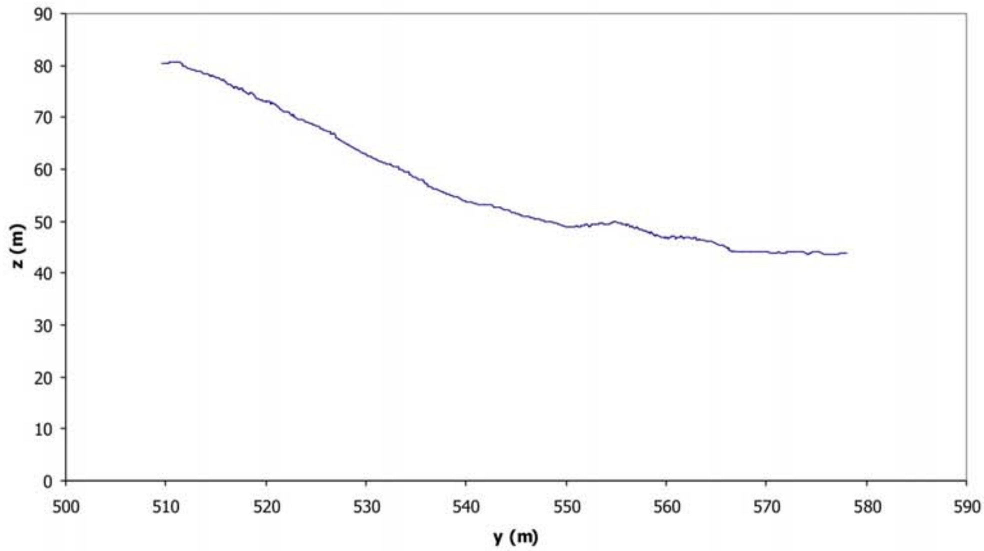
Profile 64

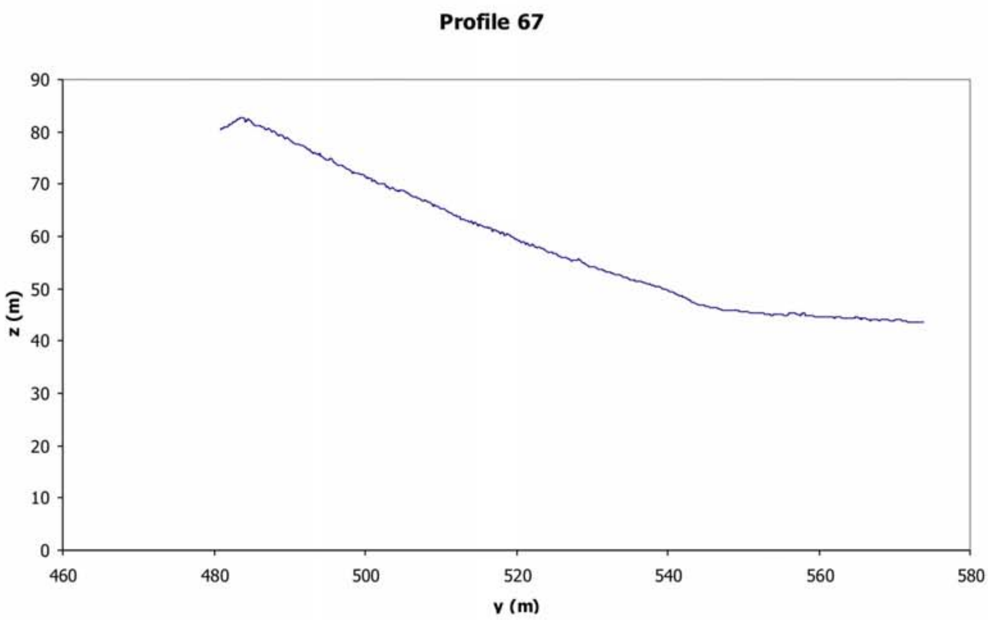


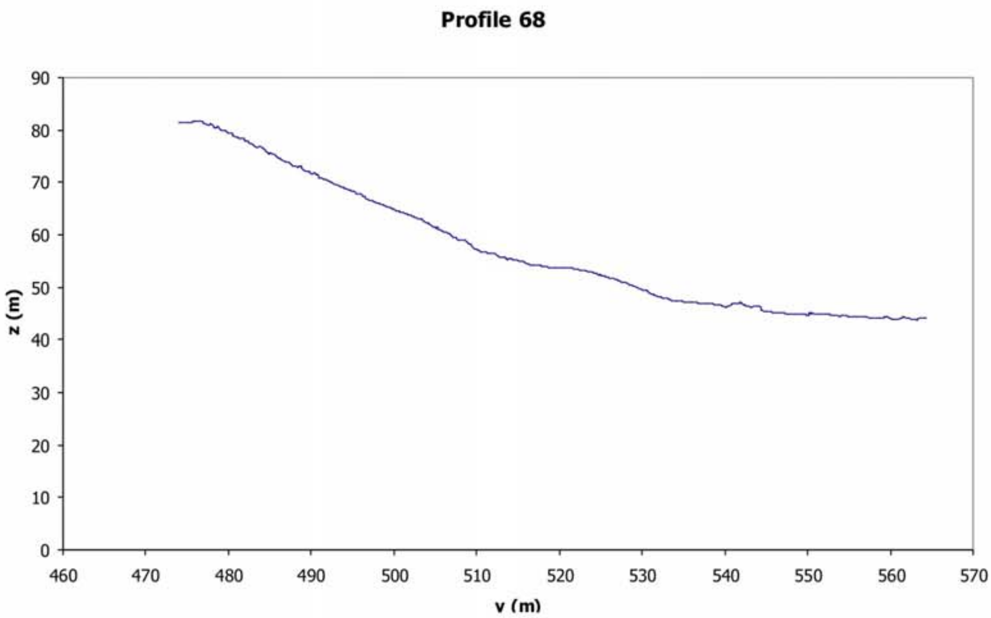
Profile 65

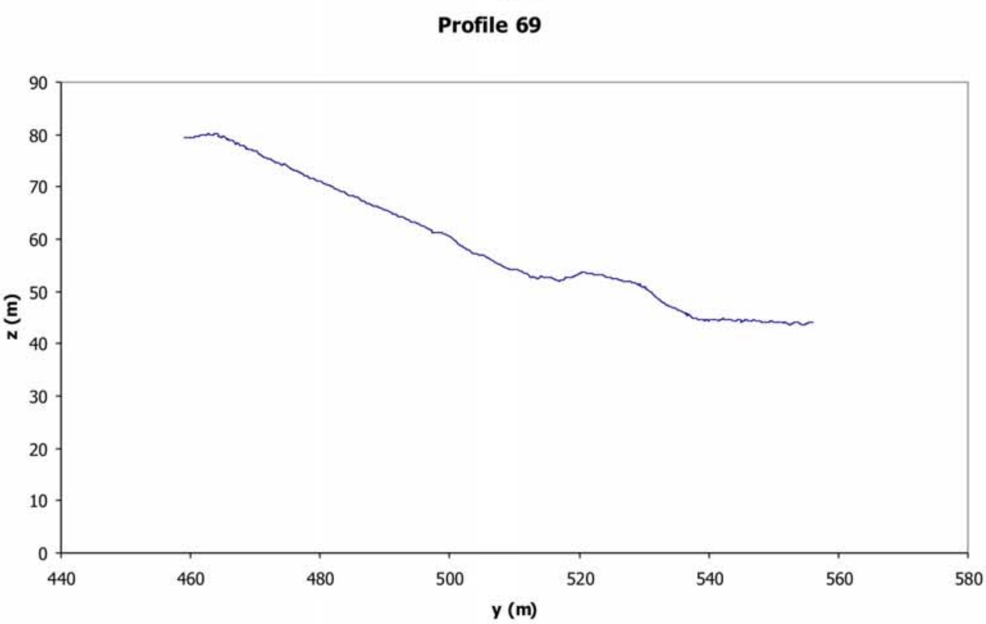


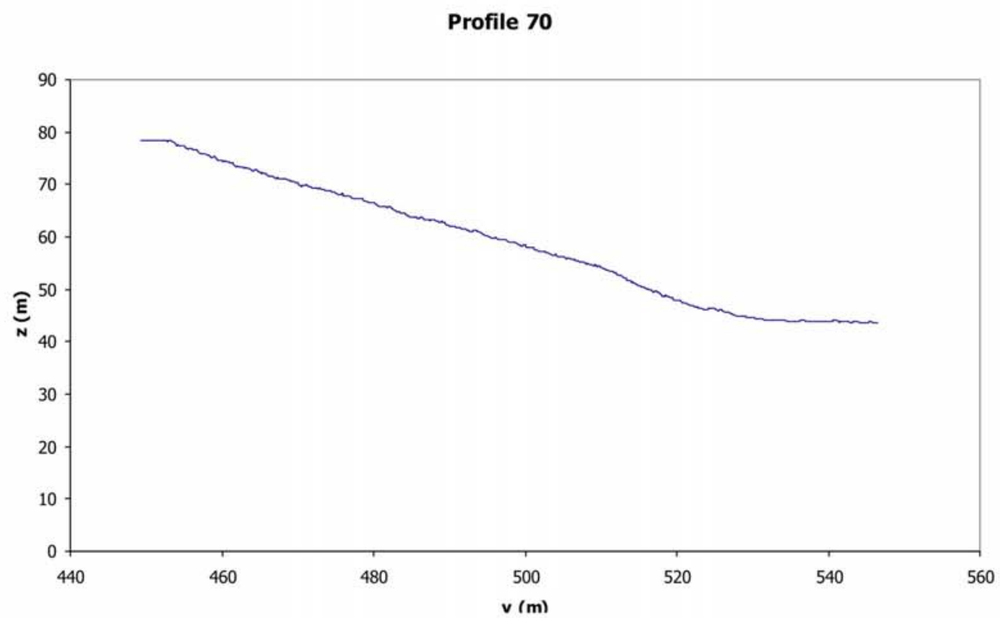
Profile 66

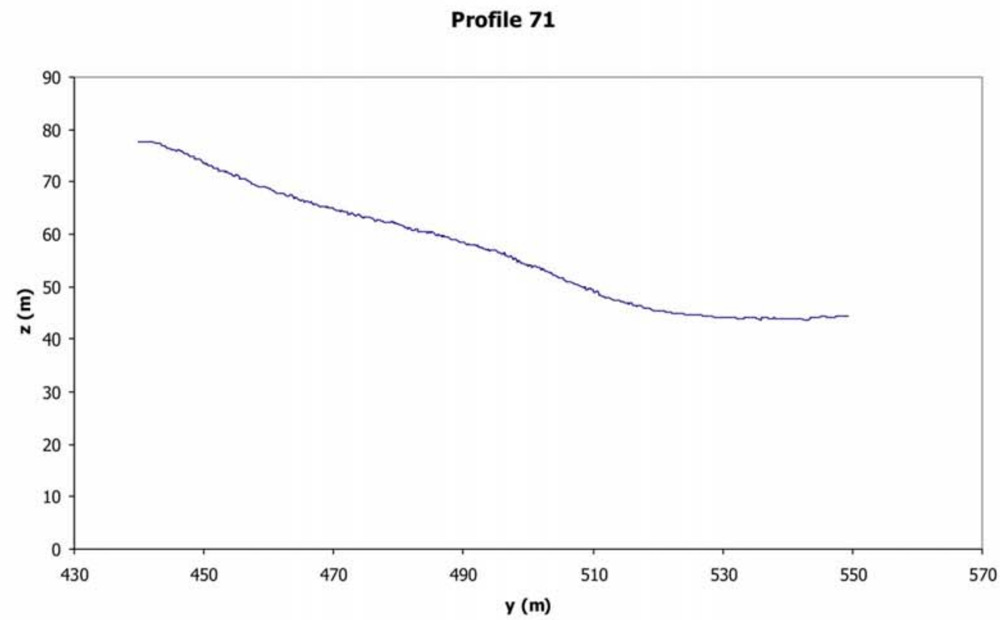


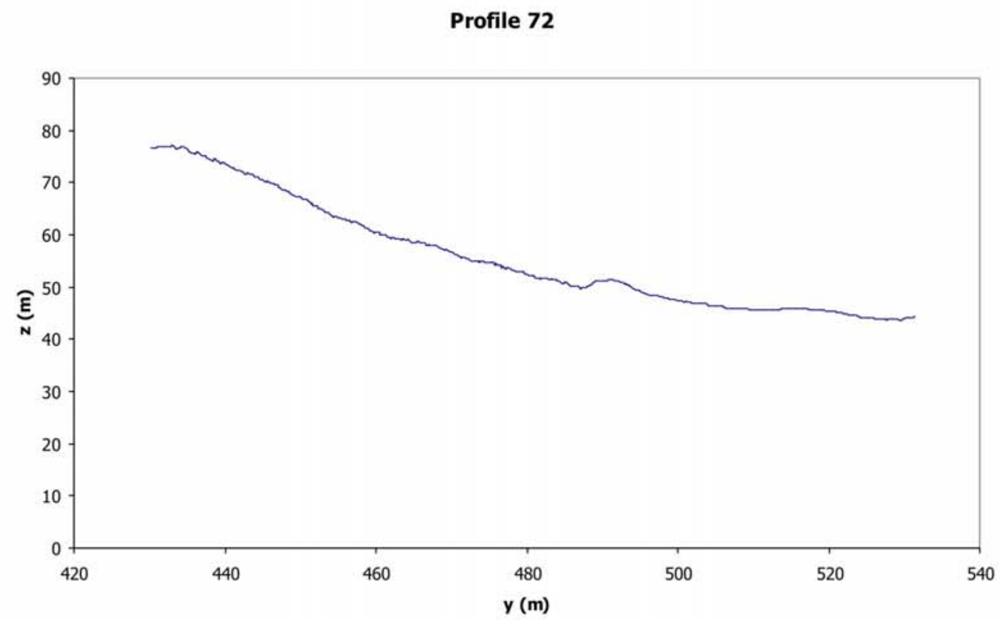

Profile 67
z (m)
0
10
20
30
40
50
60
70
80
90
460
480
500
520
540
560
580
y (m)


Profile 68
z (m)
0
10
20
30
40
50
60
70
80
90
460
470
480
490
500
510
520
530
540
550
560
570
y (m)

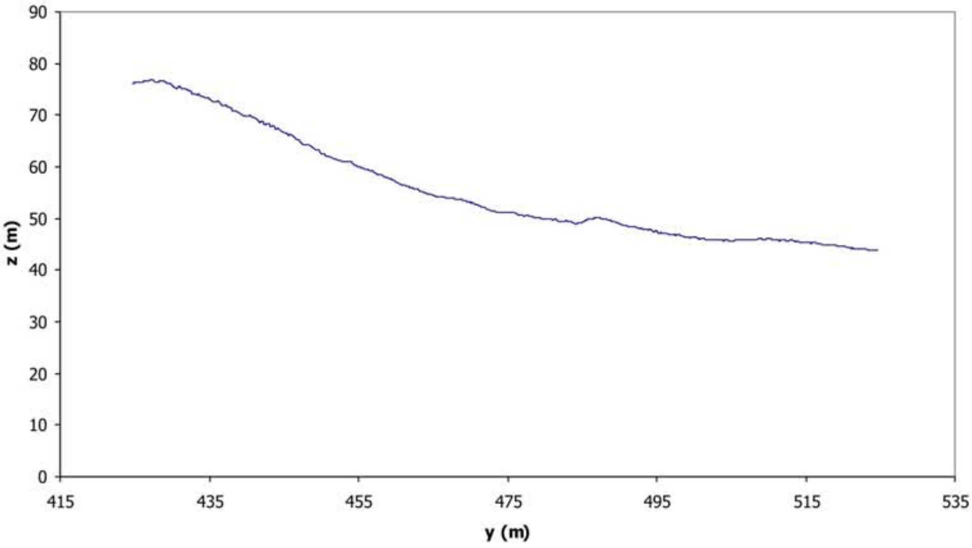

Profile 69
z (m)
0
10
20
30
40
50
60
70
80
90
440
460
480
500
520
540
560
580
y (m)


Profile 70
z (m)
y (m)

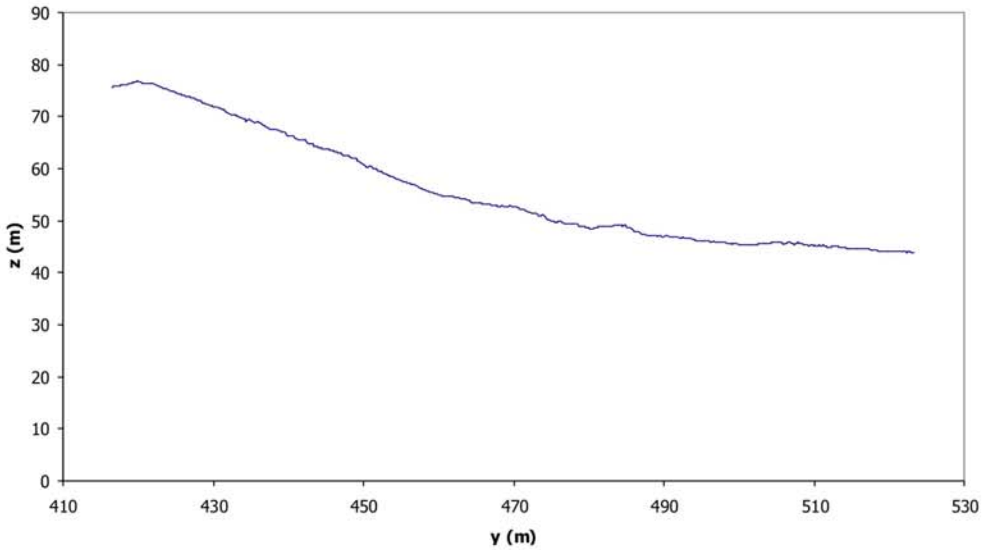

Profile 71
z (m)
y (m)


Profile 72
z (m)
y (m)

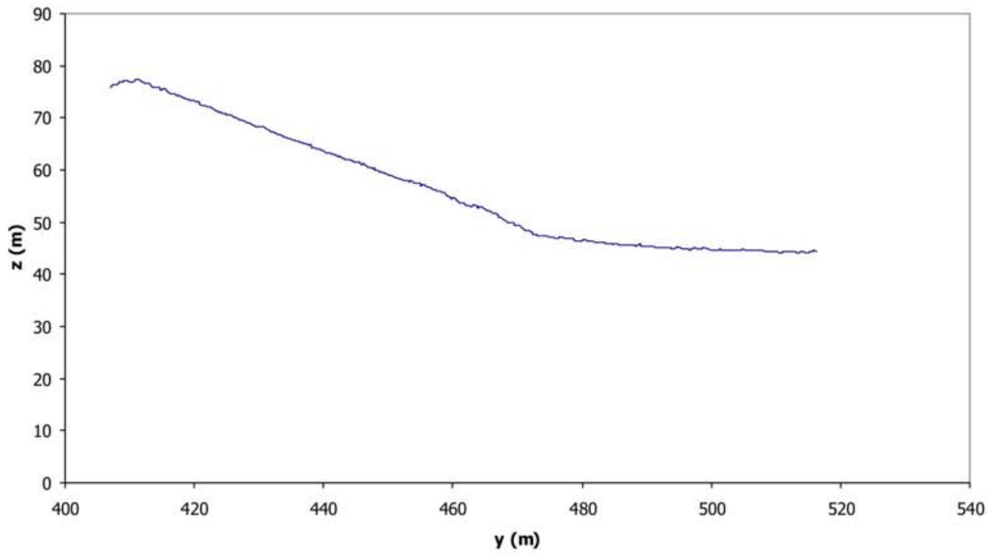
Profile 73



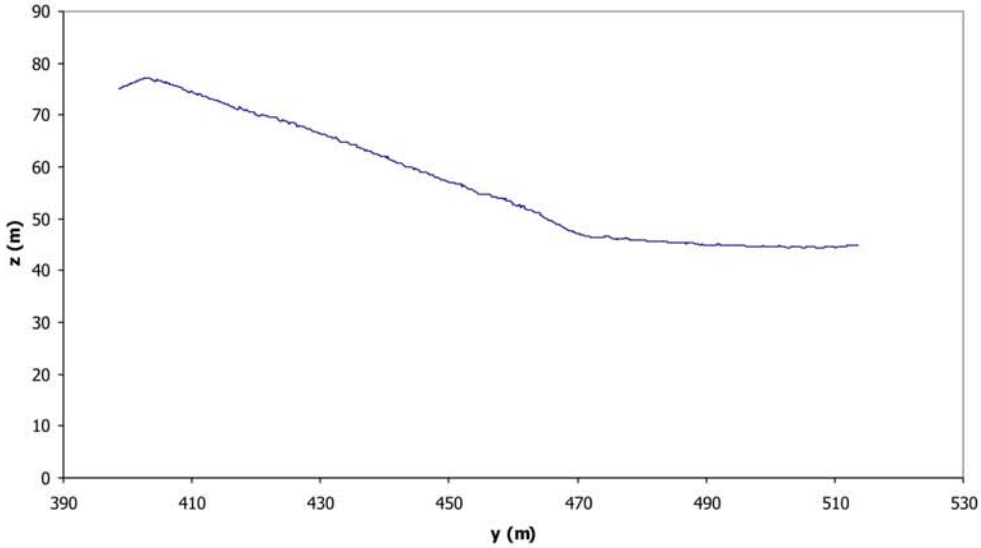
Profile 74



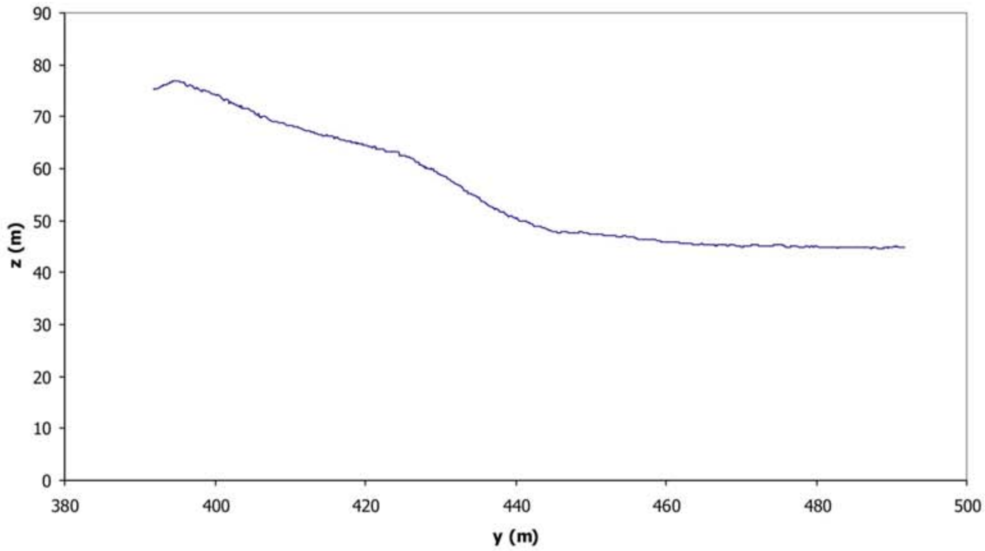
Profile 75



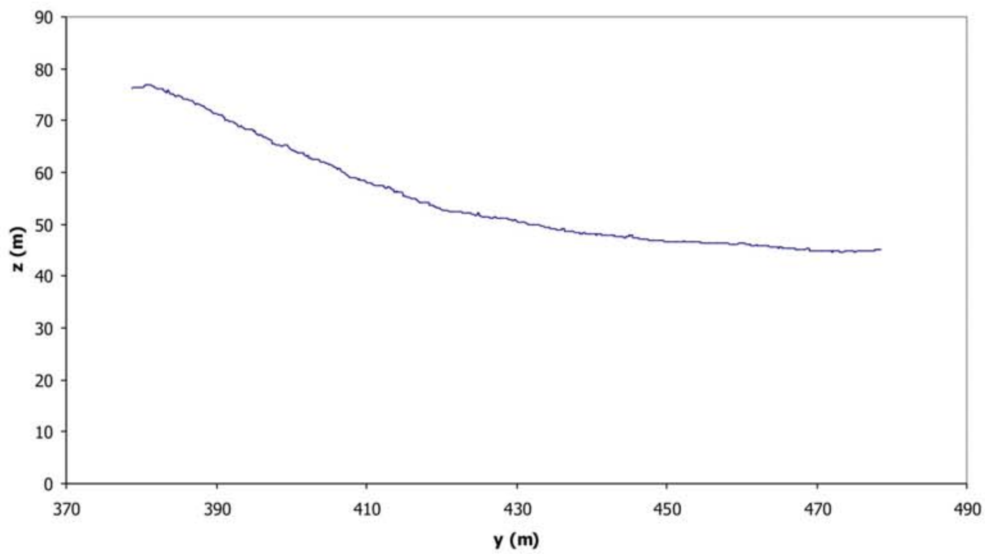
Profile 76



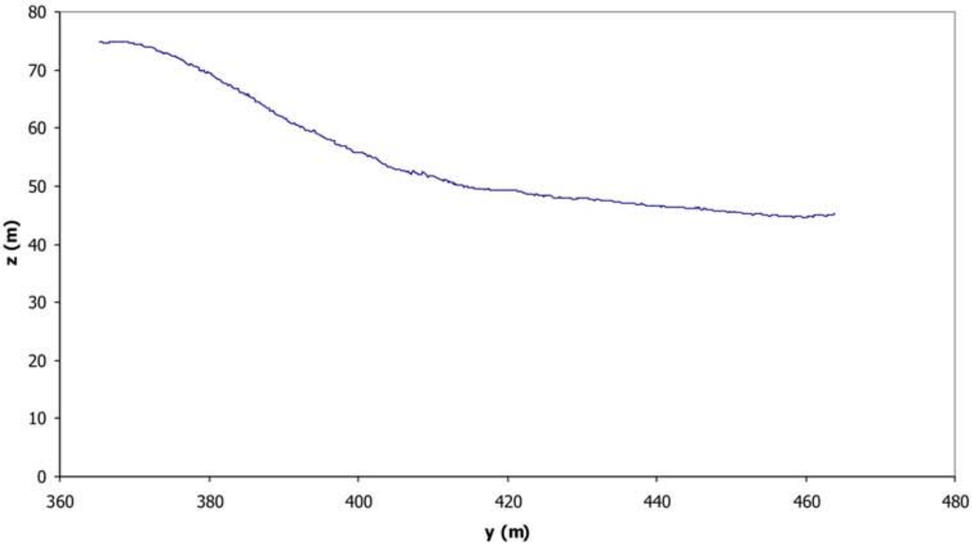
Profile 77



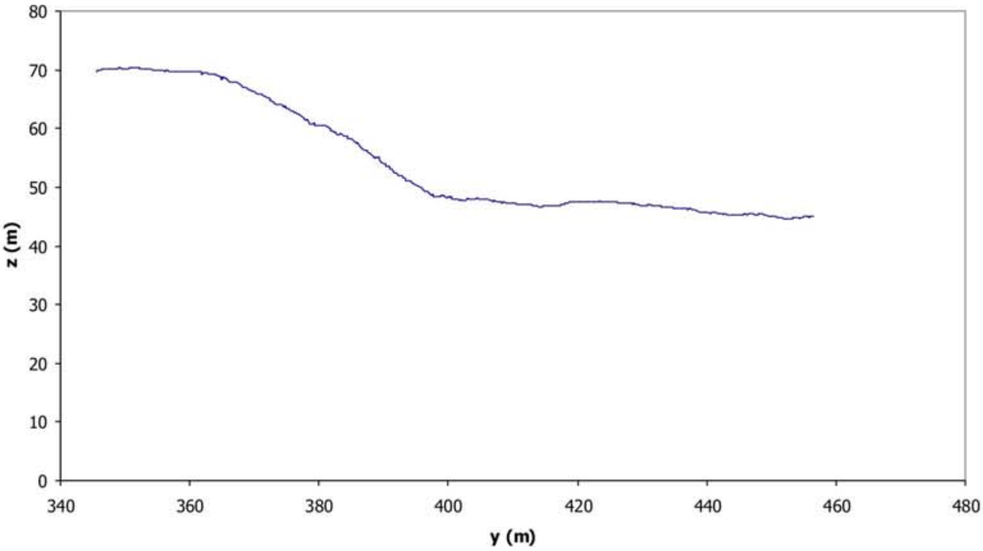
Profile 78



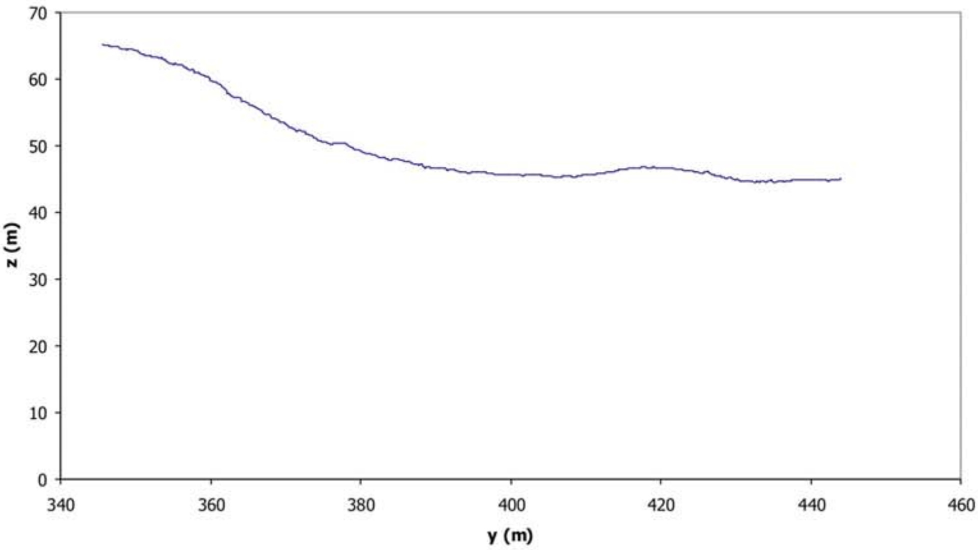
Profile 79

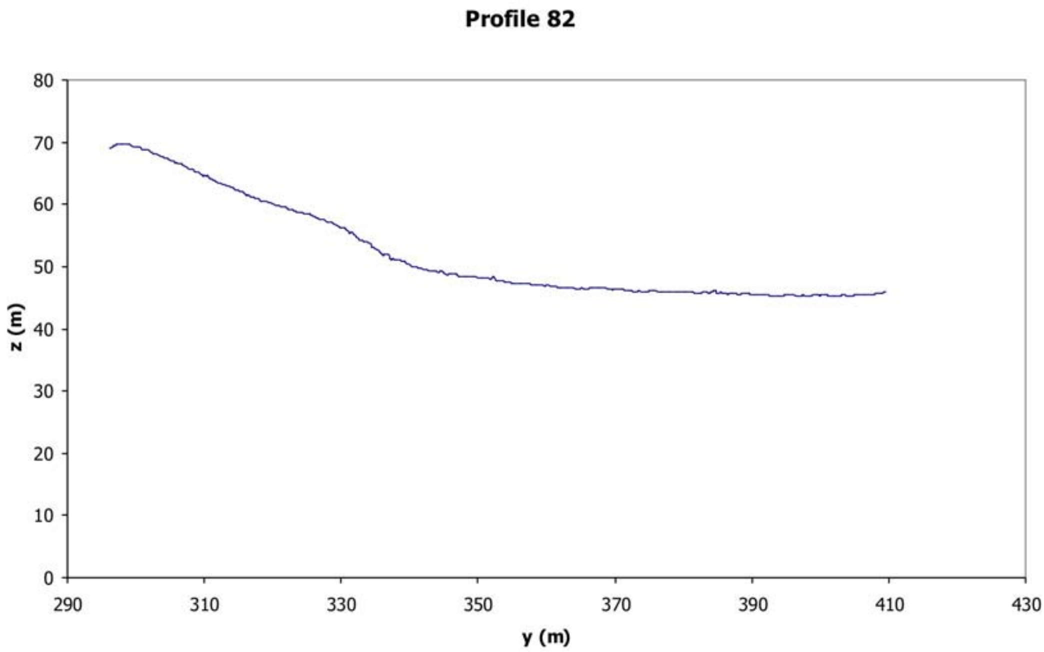


Profile 80



Profile 81





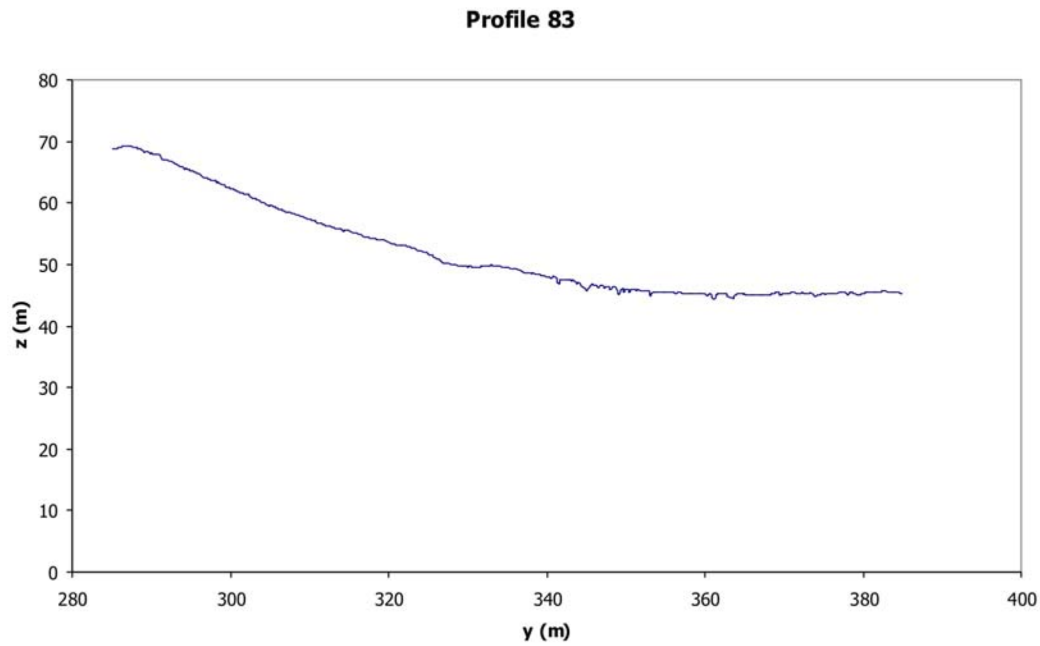


Fig. DR2 Topographic profiles extracted from the LDEM are shown. The location of the profiles is already shown on Figure 5a respectively at the bottom of Figure 8.

TABLE DR1. LIST OF 83 TOPOGRAPHIC PROFILES EXTRACTED FROM THE LDEM AND RELATED FAULT SCARPS WITH VALUES FOR FAULT-SCARP HEIGHT, SLOPE ANGLE, AND VERTICAL SEPARATION.

Profile no.	z-coordinate (m) base of scarp	z-coordinate (m) top of scarp	Scarp height (m) = difference between base and top	Max. slope angle θ (°)	Vertical separation (m)
1	37.1	37.6	0.5	24.6	0.3
	39.7	41.7	2	45	1.7
	44.2	46.3	2.1	40.4	1.6
2	37.1	38.7	1.6	26.4	1.1
	40	43	3	41	2.1
3	41.1	44.3	3.2	37	1.7
4	41.4	47.6	6.2	35.2	2.8
5	40.6	46	5.4	39.1	3.2
6	38.5	45.5	7	41.1	4.1
7	37.7	38	0.3	8.6	0.2
	39.5	46.2	6.7	22.5	3.5

	52.3	54.7	2.4	31	1.9
8	38	39.1	1.1	8	0.9
	40.6	47.2	6.6	28.1	3.2
9	38.2	40	1.8	12.5	1.5
	41.1	50	8.9	32	4.8
10	42	50.1	8.1	30.9	4.3
11	43.3	48.6	5.3	36.5	2.7
12	38.3	40.7	2.4	13.1	1.4
	44.3	46.8	2.5	29.5	2
	52.8	55.1	2.3	26.8	1.8
13	38.7	42	3.3	16.7	2.1
	46.9	51	4.1	30.6	2
14	39.6	43.5	3.9	18	2.7
15	40	46.8	6.8	23.4	5.6
16	40.5	46.5	6	37.8	4
	48.4	52.2	3.8	29.5	2.5
	61.7	64.7	3	25.1	1.6
17	41.1	43.6	2.5	41.2	2
	44.8	51.2	6.4	28.1	4
	57.1	58.7	1.6	20.1	0.9
18	41.4	42.9	1.5	12.2	1.1
	46.6	48.8	2.2	25.5	1
	55	60.9	5.9	31.7	2.7
19	44.1	49.9	5.8	24.9	3.2
	54.7	56	1.3	19.7	0.7
	58.3	61.3	3	36.9	1.5
20	41.3	46.5	5.2	26.2	4.1
	47.7	48.7	1	15.2	0.8
	51.1	52.3	1.2	24.6	0.8
	61.9	62.9	1	18.6	0.6
	64.8	65.8	1	27.5	0.5
21	40.8	50.5	9.7	37.1	7.7
	53.9	62.3	8.4	24.3	4.7
	69	73.5	4.5	28.4	2.4
22	41.1	49.9	8.8	33.9	7.2
	54.5	66.5	12	23.7	7.5
23	45.1	46.2	1.1	33.2	0.9
	52	54.3	2.3	25.2	1.8
24	52	54.2	2.2	26.8	1.9
25	40.1	40.5	0.4	12.2	0.3
	42.1	46.7	4.6	26.4	3.4
	47.6	48.8	1.2	28.4	1
26	41.2	42.3	1.1	19.1	0.8
	43.9	46.6	2.7	23.7	1.9
	47.1	50.9	3.8	29.1	1.8
27	42.4	43.8	1.4	15.6	1.1
	44.8	47.2	2.4	22.6	1.7
	48.9	51.6	2.7	27.5	1.6
28	40.7	48.2	7.5	22.6	3.5
	58.5	62.1	3.6	14.2	1.8
29	42	48	6	28.3	4.5
	52.1	54.2	2.1	26	1.4
30	44.3	47.2	2.9	11.5	2.6
	47.8	49.6	1.8	19.1	1.6
	49.8	51.9	2.1	21.3	1.6
31	42	43	1	11.4	0.8
	43.9	52	8.1	21.9	5.9
32	45.7	54.3	8.6	23.9	7.3
	58.3	60.6	2.3	22.1	1.7
	62.7	65.5	2.8	26	1.9
33	46.1	49.5	3.4	35	2.4
	51.3	60.3	9	24.6	6.6
	61.7	63.8	2.1	15.3	1.6
34	42.5	43.4	0.9	25	0.8
35	45.1	52.1	7	36.5	3.3
	63.7	67	3.3	17.5	2.8
36	45	50.9	5.9	39.5	3.4
	60.5	64.1	3.6	20.6	3.1
	64.7	67.7	3	24.4	2.3
37	44.1	51.6	7.5	28.3	4.7
	56.2	59.6	3.4	15	3.1
38	43.5	48.1	4.6	38.1	2.8
	53.9	59.6	5.7	26.1	3.3
	64.8	67.5	2.7	39.5	1.4
39	44.8	49.7	4.9	26.2	3.3
	49.5	52.3	2.8	29.2	2.1
	53.2	55.2	2	28.9	1.4

	56.8	59.2	2.4	38.1	1.2
40	44.3	48.8	4.5	22.3	3.7
	54.8	61.5	6.7	37.7	4.5
	66.3	69.8	3.5	31.2	0.9
41	46.3	50.4	4.1	32.3	3.2
	52.6	55.9	3.3	26.2	2.7
	58.4	60.7	2.3	36.8	1.7
	66.2	69	2.8	38.3	1.2
42	45.7	58.9	13.2	33.3	7.5
43	44.9	48.2	3.3	37.2	2.1
	56.3	57.7	1.4	30.5	0.6
44	45.1	46.5	1.4	24.2	1
	49.2	51.3	2.1	25.1	1.9
	52.2	55.8	3.6	37.3	1.9
	60.7	62.7	2	20.5	1.8
45	44.6	46	1.4	16	1
	48.6	53.2	4.6	35.1	2.9
	58.2	60.3	2.1	23.8	1.4
46	49.3	50.8	1.5	21.2	1.1
	52.5	54.4	1.9	26.2	1.5
	55.4	57.4	2	24.9	1.8
	59.8	61.5	1.7	31.1	1.3
47	46.7	50.9	4.2	31.1	2.6
	57.7	58.9	1.2	18.7	0.9
48	44.8	49.8	5	30.8	3.6
	59.8	63.3	3.5	20.3	2.2
49	44.6	46.1	1.5	11.7	0.6
	52.4	54.7	2.3	19.4	2.1
50	46.6	52.8	6.2	30.8	4.3
	56.2	57.3	1.1	23.3	0.9
	66.6	68.2	1.6	24.3	1
51	44.8	51.4	6.6	26.3	6.2
	53.6	56.6	3	27.6	2.1
	62.8	65.9	3.1	20.5	1.3
52	46.1	51.1	5	38.2	2.1
	68.3	69.8	1.5	15.3	0.8
53	45.5	57.6	12.1	35.4	8.8
54	44.6	55.1	10.5	40.6	6.2
55	47	49.1	2.1	37.9	2
	50.2	51.1	0.9	40.3	0.8
	59.5	60.4	0.9	31.5	0.7
	61.3	63.9	2.6	43.1	1.1
56	44.4	47.4	3	25	2.6
	48.6	53	4.4	37.5	3
	55.8	59.4	3.6	36.8	2.9
57	44.4	52.2	7.8	37	6.8
	53.5	54.1	0.6	39.8	0.3
58	54.1	57.3	3.2	51.7	1.8
59	44.6	45.8	1.2	31.2	1
	49.5	54.5	5	55.3	3.2
60	45.5	53.9	8.4	36.7	5.6
	57	60.4	3.4	52.3	1.9
61	44	47	3	37.7	2.2
	49.6	52.1	2.5	42.8	1.9
	54	56.2	2.2	48.9	2
	59.3	62.2	2.9	52.2	1.6
62	45.6	51.2	5.6	41.8	4.9
	51.4	55.3	3.9	39.9	3
	56.3	59.8	3.5	50.4	3.2
	61.9	68.3	6.4	49.8	3.7
63	43.6	51.4	7.8	46.4	3.9
	60.4	62.9	2.5	45.3	1.2
64	44.1	56	11.9	41.1	9.8
	60.4	62.4	2	34	1.1
65	43.3	51.2	7.9	48.1	4.9
	62.1	70	7.9	44	3.7
66	44.3	49.7	5.4	31.5	4.7
	56.4	59.9	3.5	49.4	1.6
67	47	50.9	3.9	29.4	2
68	48.1	53	4.9	29.8	3.8
	56.7	62.8	6.1	38.8	3.8
69	44.6	50.5	5.9	42.6	4
	54.3	56.5	2.2	30.7	2.1
	57.3	60.7	3.4	37.8	1.5
70	44.9	52.9	8	32.3	3
71	47.9	55.9	8	27.7	4.2
72	48.5	50.8	2.3	30.1	1.9

	55	57.9	2.9	27.6	2.2
	59.4	62.2	2.8	33.9	1.6
73	48.4	49.7	1.3	19.8	1.1
	51.1	53.5	2.4	26.1	1.9
	62.3	65.2	2.9	36.6	1.9
74	47.2	49	1.8	30.7	1.5
	50	52.3	2.3	30.1	2.2
	59.8	61.3	1.5	33.7	0.9
75	47.4	52.3	4.9	30.7	2.7
76	46.3	50.3	4	33.5	2.7
77	47.9	61.9	14	39.8	8.3
78	59	60.9	1.9	36.8	1.2
79	52.2	55.4	3.2	33.8	1.5
80	48.4	58.7	10.3	36.8	4.5
81	50.4	52	1.6	21.1	0.7
	56.7	61	4.3	34.1	2.9
82	49.9	56.3	6.4	30.5	4.8
83	47	49.6	2.6	16	1.9
	50.1	52.9	2.8	27.5	1.3

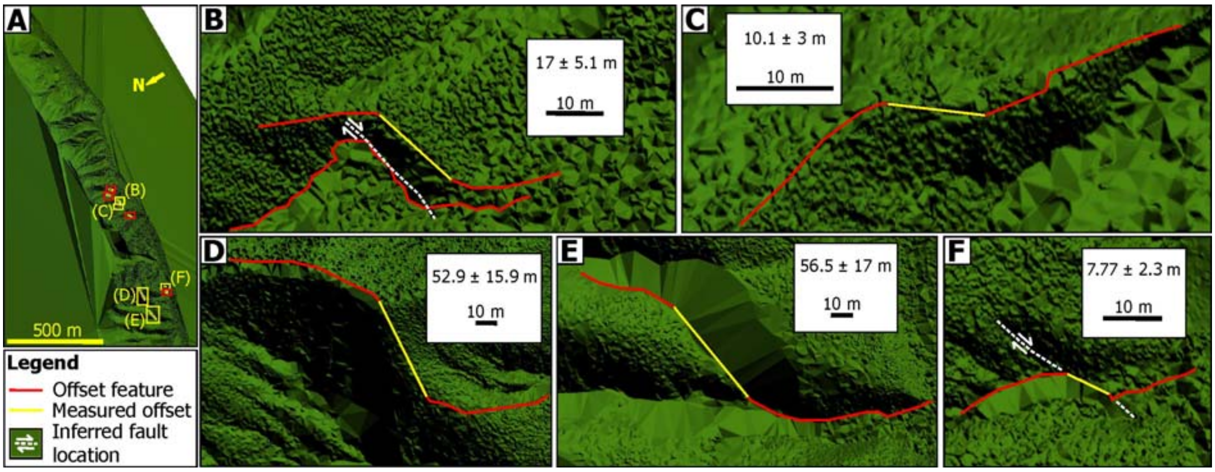


Fig. DR3 (A) The location of nine measured dextral offsets is shown in the LDEM (also Table DR2). The offsets marked in yellow are shown in detail in Figures b to f. In contrast, no detail is shown for offsets marked in red as those are shown in Figure 9b to e. The legend is valid for the offsets shown in Figures b to f. (B) Details of offset no. 3 (ridge crest). (C) Details of offset no. 4 (ridge crest). (D) Details of offset no. 6 (ridge crest). (E) Details of offset no. 7 (gully). (F) Details of offset no. 8 (gully).

TABLE DR2. LIST OF NINE DEXTRAL OFFSETS MEASURED IN THE LDEM.

Offset no.	Measured offset (m)	Uncertainty 30% bound (m)
1	18.9	±5.7
2	17.4	±5.2
3	17	±5.1
4	10.1	±3
5	14.3	±4.3
6	52.9	±15.9
7	56.5	±17
8	7.77	±2.3
9	8.6	±2.6

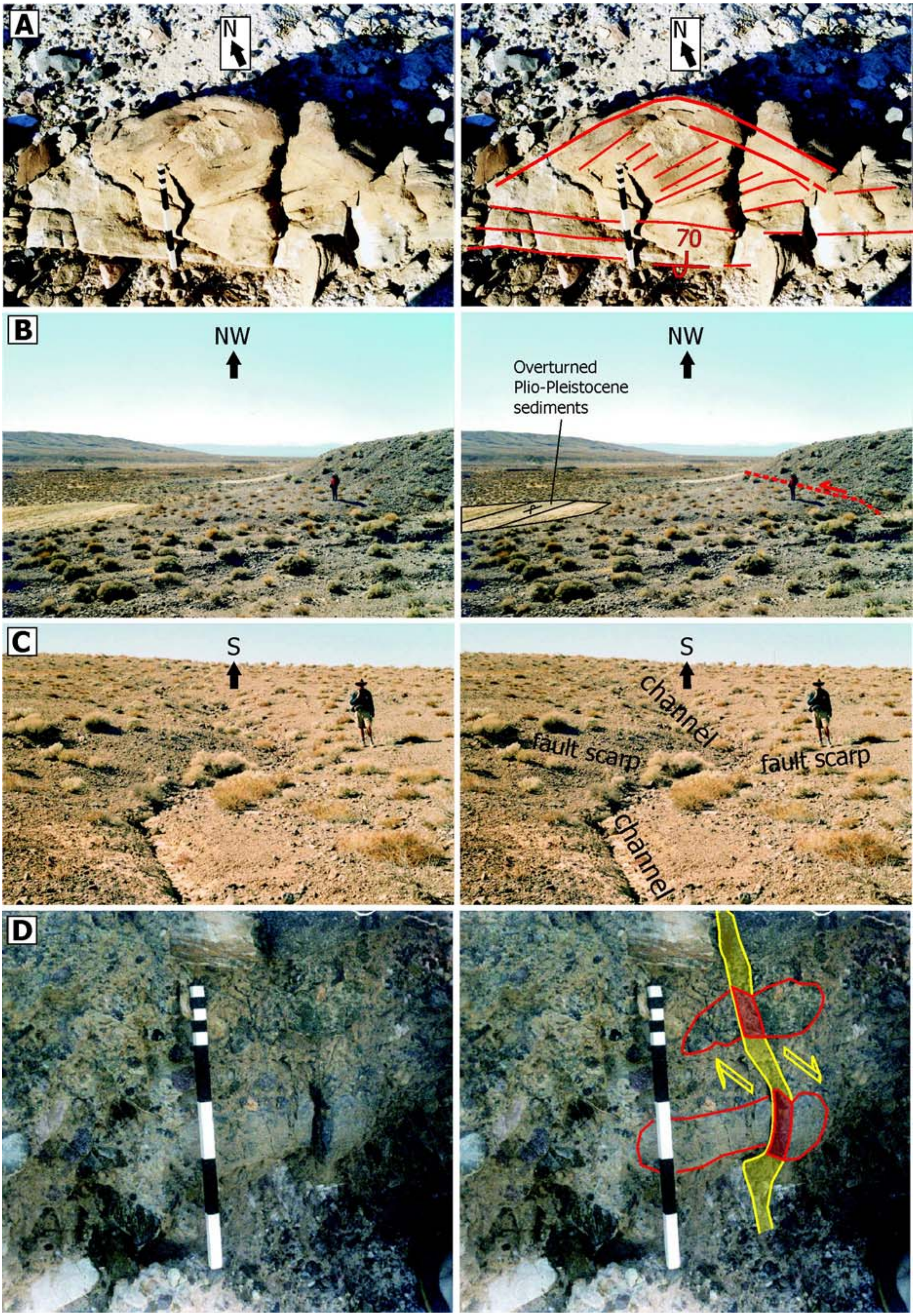


Fig. DR4 Colored version of Figure 4.

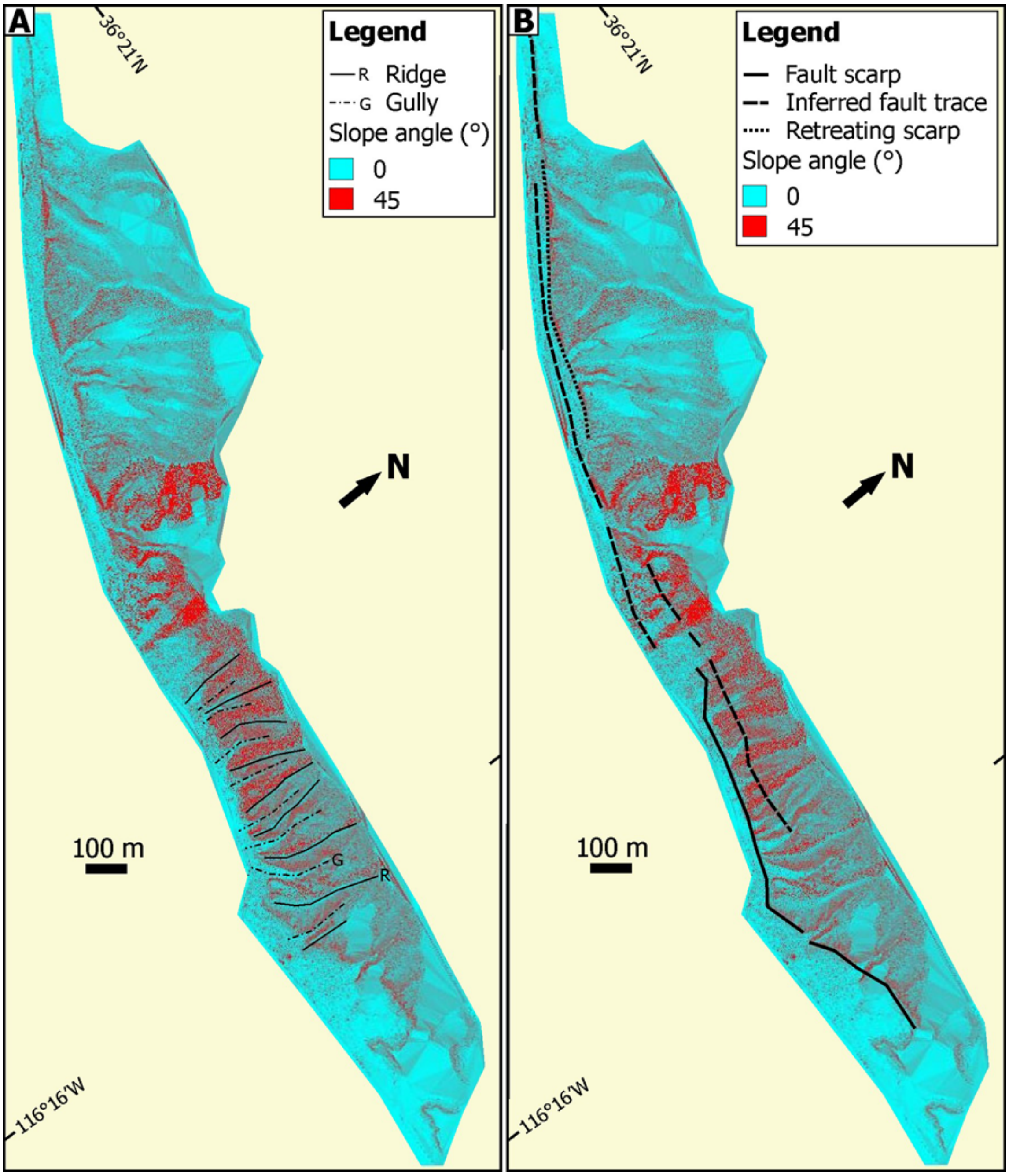


Fig. DR5 Colored version of Figure 6.