COMPARISON OF MORPHOMETRIC ASPECTS OF DOLINES BETWEEN TWO ZONES IN BERICI HILLS (VICENZA, ITALY)

PRIMERJAVA MORFOLOGIJE VRTAČ IZ DVEH DELOV GRIČEVJA BERICI (VICENZA, ITALIJA)

BENEDETTA CASTIGLIONI

Izvleček UDK 551.435.83(450.343)

Benedetta Castiglioni: Primerjava morfologije vrtač iz dveh delov gričevja Berici (Vicenza, Italija)

Gričevje Berici so skupina planotastih gričev nad benečijsko ravnino; na planoti so vrtače, zaradi katerih ima pokrajina svojstven značaj. Opisana sta dva različna dela gričevja in narejena je medsebojna primerjava morfologije vrtač. Avtorica nekatere razlike posebej poudarja in podaja hipotezo o vzrokih teh razlik.

Ključne besede: morfometrija vrtač, nastanek vrtač, kraška planota, kraško površje, Italija, gričevje Berici

Abstract UDC 551.435.83(450.343)

Benedetta Castiglioni: Comparison of morphometric aspects of dolines between two zones in Berici Hills (Vicenza, Italy)

The Berici Hills are a limestone hilly group rising with plateau features above the Venetian plane; on the top of the plateau many dolines have developed, giving peculiar characters to the landscape.
Two different parts of the Berici Hills have been considered, to describe and compare morphometric aspects of their dolines. Some differences between the two zones have been identified and some hypotheses about their cause are given.

Key words: morphometry of dolines, evolution of dolines, karst plateau, karst landscape, Italy, Berici Hills

Address - Naslov
Benedetta Castiglioni
Dipartimento di Geografia dell'Università di Padova
Via del Santo 26
I - 35123 Padova
Italy

INTRODUCTION

The Berici Hills are situated in the Venetian plain, south of the town of Vicenza, in the north-east of Italy. This group is mostly formed by Eocene and Oligocene limestones (marly limestone in the west, pure and sometime massive limestone in the east); it appears like a table-land, unitary in some parts, cut into by large valleys in others. It has very steep slopes on the eastern side, while on the western it degrades more gently to the plain.

Karst morphogenesis is active on the plateau surface, and the most frequent karst form we meet is the doline. Therefore dolines represent a very important element to determine the typical characters of Berici Hills landscape; dolines are an expression both of natural environmental aspects and also of changes of human land use and impact.

Since the doline bottom is always filled by sediments (terra rossa), perhaps several tens of metres deep, it is the best place of the plateau for farming. So in the landscape we can note many scattered farmhouses, each in front of one doline; in the bottom there is cultivation or meadow, while the slopes are covered by wood. The north slope, that is exposed to the south and has better microclimatic conditions, is often used for cultivation too, with terraces supported by dry stone walls.

DATA COLLECTION

The aim of this research is to compare the features of dolines in two different parts of Berici Hills with the help of statistical analysis.

So I considered two zones of the plateau: the first (Fig. 1) is a lengthened and narrow ridge in the northern part (I called it "north zone"), while the second (Fig. 2) is a piece of the south-western table-land (I called it "south zone"). I observed all the dolines included in the two zones (34 in the north zone, 63 in the south zone), and I collected morphometric data with the help of the topographic map on the scale 1:5000.

I considered on one hand the real doline by the isohypse that passes through the lowest rim, and on the other hand the catchment-basin pertaining to the doline. Therefore I studied in particular the following variables:

- position: UTM coordinates of the lowest point of the doline, bottom altitude

- doline dimensions: longest axis length, perpendicular axis length, area, lowest depth (the difference between the rim altitude and the bottom altitude)
- basin dimensions: longest axis length, area, highest depth (the difference between the altitude of the highest point of the basin and the bottom altitude)
- distance from the nearest doline (between the lowest points).

I compiled two tables, one for each zone, with all the data collected (tab. 1 and tab. 2).

DATA PROCESSING

The first observation is about the distribution of dolines: while in the south zone dolines' catchment-basins cover completely the plateau, in the north zone they take up only the 33% of the surface. The remaining 67% of the north zone belongs to catchment-basins connected with the hydrographic network of the slopes; some suspended dry valleys are present too.

Moreover, most of dolines of the north zone are situated at an altitude between 200m and 300m, while the south zone is at a lower altitude, between 100m and 160m.

Looking at the frequency distribution histograms it is possible to make some remarks. First of all it is possible to note that dolines are generally medium-small, but they are smaller in the north zone (Fig. 3); the average values for the variable "longest axis length" are 75m in the north, 104m in the south.

It can be also noted that there are some wider dolines (perhaps uvalas), expecially in the south (Fig. 4).

Regarding (Fig. 5) the depth of the doline (lowest depth), there are no big differences between south and north zone; in both zones dolines are not very deep, with values that go from 0,3m to 12,5m in the northern sample, and from 0,4m to 14,9m in the southern one.

On the other side, catchment-basins are quite wide, and their dimensions are similar in the two zones; rather, there are bigger values for "highest depth" in the north zone (Fig. 6 and Fig. 7)

At the end, looking at the variable "distance", we note that in the south zone dolines are closer each other than in the north one; the average values are 102m south, 158m north.

The second part of the statistical anlysis consists of the correlation of the variables (with the principal components analysis), and the comparison of the results of the two zones.

It can be noted that in both zones there is a strong link between the variables "doline longest axis length" and "doline area" (correlation coeffi-

cient: 0,95 north; 0,94 south) (Fig. 8) and quite a good correlation also with "perpendicular axis length". It means that the doline shape is quite regular, nearly round, and that there are not many dolines with lengthened or different shapes.

On the contrary, doline depth is not strongly correlated with doline dimensions, especially in the south zone: wide dolines are not really correspondingly deep (Fig. 9).

There is good correlation between doline dimensions and basin dimensions in the south zone, in particular between "doline area" and "basin area"; correlation is worse in the north zone (Fig. 10): it means that it is not always true here that a large basin pertains to a large doline and vice versa.

Also the variable "distance" is differently correlated in the two zones (Fig. 11). South there is quite good correlation with doline dimensions and less good with basin dimensions; therefore smaller dolines are nearer each other. On the contrary, north there is no correlation between the distance among dolines and dimensions, and it is principally because the area is not completely covered by dolines.

CONCLUSIONS

We have seen that there are some differences in doline shape and development between north and south zone. It is possible to try to understand on what these differences can depend.

Probably we have to research the cause principally in the different lithology of the two zones: marly limestone south, back-reef limestone north. Moreover the different kind of relief landforms (plateau or ridge) can contribute to the doline characters in the two zones too.

Actually, the results of measurements allow us to say that probably doline development is more difficult in the north zone, because on a ridge more dolines are situated on the plateau edge, opened toward the plateau escarpment. So there are smaller dolines with bigger, highest depth, on this ridge, where we found higher relief energy than in the south zone. It could be possible to study in depth the reciprocal interactions between slope and doline development, between karst and, broadly speaking, fluvial morphogenesis.

Many other conditions that are involved in karst evolution are very similar in the two zones (for instance altitude, climate conditions, length of time of karst morphogenesis), so they cannot be determining factors for the identified differences.

REFERENCES

ALBERTINI R. (1952) - Cenni geomorfologici sui Colli Berici. Rivista Geografica Italiana, 59, pp. 93-116, Firenze.

LORENZONI G.G. (1988) - La natura. In AA.VV."I Colli Berici - natura e civiltà", Signum Edizioni.

MIETTO P. (1988) - Aspetti geologici dei Monti Berici. In AA.VV. "I Colli Berici - natura e civiltà", Signum Edizioni.

MIETTO P. (1988) - Carsismo e speleologia nei Monti Berici. In AA.VV. "I Colli Berici - natura e civiltà", Signum Edizioni.

MIETTO P., SAURO U. - Grotte del Veneto. Regione Veneto, La Grafica Editrice.

BONDESAN A., MENEGHEL M., SAURO U. (1992) - Morphometric analysis of dolines. International Journal of Speleology, vol. 21 (1-4) pp. 1-55, Trieste.

	long.	lat.	bottom alt.	rim alt.	high. p. alt.	dol.axis	basin axis	dol.area	bas.area	low.depth	high.depth	perp.axis	distance
1	9787	3609	319,70	320,00	358,50	45	280	1119,78	12800,00	,30	38,80	35	165
2	9795	3623	312,50	317,50	344,40	100	180	4956,88	20690,69	5,00	31,90	65	145
3	9786	3635	311,40	317,50	327,70	75	220	3032,40	12628,96	6,10	16,30	57	145
4	9815	3642	291,50	302,50	330,00	215	305	13086,91	40497,20	11,00	38,50	85	267
5	9803	3666	281,20	282,00	324,50	40	330	1131,06	44706,15	,80	43,30	33	232
6	9781	3669	272,80	285,30	325,00	175	455	15289,06	90237,55	12,50	52,20	125	203
7	9776	3689	280,00	284,00	317,50	90	240	3428,45	31145,95	4,00	37,50	55	195
8	9773	3708	283,50	284,00	317,50	65	250	1397,57	40744,30	,50	34,00	30	130
9	9782	3717	267,60	272,00	315,20	62	245	2171,45	22636,50	4,40	47,60	50	130
10	9793	3729	254,50	257,50	315,20	50	265	1637,84	28747,40	3,00	60,70	40	95
11	9799	3736	246,30	247,50	270,00	50	190	1379,84	15431,25	1,20	23,70	37	95
12	9787	3737	262,00	263,00	285,00	65	180	2215,81	15218,69	1,00	23,00	42	100
13	9750	3731	284,50	287,00	315,20	80	280	4095,01	31105,60	2,50	30,70	70	150
14	9753	3747	290,60	292,50	306,07	40	100	706,57	4713,90	1,90	15,47	25	120
15	9775	3745	269,20	271,50	310,00	85	320	2501,40	37418,20	2,30	40,80	37	135
16	9761	3755	280,50	281,00	302,00	50	125	1796,60	9207,07	,50	21,50	40	83
17	9754	3759	277,20	287,50	301,00	57	130	2080,07	6586,90	10,30	23,80	45	83
18	9783	3755	253,40	257,50	280,00	50	190	1852,93	14983,66	4,10	26,60	43	95
19	9788	3764	238,20	242,50	266,00	80	190	3378,91	16199,09	4,30	27,80	55	95
20	9731	3762	265,00	277,50	300,00	115	240	5549,36	18736,76	12,50	35,00	60	165
21	9751	3769	269,60	272,50	290,00	50	125	1641,69	9969,50	2,90	20,40	43	107
22	9744	3778	253,50	257,50	285,00	75	165	2686,15	11758,12	4,00	31,50	50	90
23	9735	3778	246,20	252,50	306,70	120	465	6457,18	55738,77	6,30	60,50	65	90
24	9758	3787	249,80	252,00	285,00	85	220	3818,15	21351,93	2,20	35,20	55	170
25	9744	3798	238,80	241,50	280,00	65	265	3035,54	22837,84	2,70	41,20	55	180
26	9698	3803	219,90	221,50	263,10	60	285	2266,51	18674,15	1,60	43,20	50	110
27	9710	3802	224,00	227,50	263,10	75	265	3504,63	17231,68	3,50	39,10	65	80
28	9716	3808	218,50	221,10	250,00	75	210	3368,83	9088,12	2,60	31,50	65	80
29	9763	3814	222,80	224,00	266,20	42	315	1267,56	48110,02	1,20	43,40	35	90
30	9766	3823	213,50	217,50	254,00	70	300	2279,95	26986,30	4,00	40,50	40	90
31	9752	3833	202,00	207,00	225,50	65	150	2443,35	12432,82	5,00	23,50	40	170
32	9758	3876	156,00	159,00	207,60	57	375	1709,48	46386,20	3,00	51,60	40	435
33	9828	3899	144,20	144,50	164,20	80	185	3314,88	16700,07	,30	20,00	50	435
34	9816	3941	106,90	106,50	111,60	40	115	996,84	6452,57	,60	5,70	30	435

Tab. 1 - Collected data for north zone

	long.	lat.	bottom alt.	rim alt.	high.p.alt.	dol.axis	basin axis	dol.area	bas.area	low.depth	high.depth	perp.axis	distance
1	9129	2710	129,8	136,5	164,1	93	270	4967	17986	6,7	34,3	70	92
2	9133	2713	137,0	139,0	148,8	60	160	2069	10274	2,0	11,8	47	85
3	9141	2714	136,2	143,0	164,1	95	275	5869	20409	6,8	27,9	80	85
4	9150	2704	147,3	147,9	164,1	50	225	1251	14877	,6	16,8	33	95
5	9159	2703	146,5	146,9	164,1	55	300	1286	15704	,4	17,6	30	70
6	9160	2696	142,3	146,9	164,1	90	350	4946	36936	4,6	21,8	75	70
7	9180	2664	125,8	132,5	172,0	135	530	9890	78744	6,7	46,2	105	140
8	9109	2800	140,5	146,5	166,0	170	410	12390	39578	6,0	25,5	100	100
9	9100	2798	144,0	146,5	159,4	72	350	3119	14706	2,5	15,4	55	100
10	9083	2798	137,7	142,0	159,4	95	260	5976	24780	4,3	21,7	80	120
11	9075	2792	134,6	138,0	152,1	85	280	4252	14591	3,4	17,5	65	85
12	9067	2791	134,1	138,0	151,0	70	200	3640	11186	3,9	16,9	65	85
13	9067	2776	125,4	132,5	141,0	92	205	6128	18838	7,1	15,6	85	65
14	9056	2775	130,0	132,5	136,7	60	130	1997	7160	2,5	6,7	45	65
15	9077	2782	132,0	133,0	141,0	50	225	1452	9779	1,0	9,0	40	90
16	9183	2776	153,2	162,0	170,0	160	260	12800	28172	8,8	16,8	100	90
17	9196	2762	157,0	164,0	172,0	85	200	5359	17203	7,0	15,0	80	115
18	9204	2752	162,8	168,0	175,9	67	135	3145	10023	5,2	13,1	62	65
19	9192	2750	151,6	162,5	170,0	125	165	9111	14023	10,9	18,4	95	95
20	9177	2754	151,0	158,5	170,0	165	240	12460	28751	7,5	19,0	110	152
21	9175	2769	156,9	159,5	170,0	90	200	3106	9621	2,6	13,1	40	85
22	9170	2776	160,7	162,5	171,0	70	150	2699	12072	1,8	10,3	50	85
23	9160	2762	147,0	155,1	174,2	150	420	10980	46168	8,1	27,2	115	162
24	9146	2755	139,0	143,0	174,2	240	430	9062	64571	4,0	35,2	57	162
25	9132	2764	140,4	143,0	174,2	140	380	7398	45475	2,6	33,8	68	105
26	9124	2782	146,4	151,0	171,3	175	300	12950	45233	4,6	24,9	110	115
27	9121	2766	143,5	147,0	155,5	60	140	2011	7648	3,5	12,0	45	105
28	9104	2755	127,8	138,0	155,5	160	350	12810	45421	10,2	27,7	110	130
29	9093	2763	124,4	135,3	150,0	125	270	11190	28633	10,9	25,6	115	130
30	9091	2780	128,7	129,5	157,1	110	280	4421	42114	,8	28,4	50	62
31	9085	2784	124,7	129,5	152,0	80	270	4404	25029	4,8	27,3	70	62
32	9075	2765	124,5	128,0	142,5	55	250	1960	19554	3,5	18,0	40	90
33	9067	2767	124,5	128,0	140,0	50	160	1804	8308	3,5	15,5	45	90
34	9064	2759	122,3	127,4	140,0	240	340	18350	46939	5,1	17,7	95	92
35	9045	2756	116,6	119,0	136,7	80	250	3669	26036	2,4	20,1	62	58
36	9039	2755	117,0	119,0	126,5	60	210	1942	13517	2,0	9,5	43	58
37	9041	2769	122,8	128,0	136,7	65	180	3086	14877	5,2	13,9	60	112
38	9035	2764	116,1	122,5	135,6	105	230	7297	17343	6,4	19,5	92	100
39	9036	2776	129,3	132,0	136,0	60	120	2143	6800	2,7	6,7	50	73
40	9028	2776	124,9	127,0	145,8	75	285	3436	20640	2,1	20,9	60	73
41	9024	2762	116,9	117,8	145,8	50	370	1075	18797	,9	28,9	30	95
42	9020	2753	111,1	114,5	124,3	70	225	2676	13733	3,4	13,2	55	100
43	9012	2759	109,7	111,5	145,8	80	470	3412	33091	1,8	36,1	63	100
44	9001	2760	105,4	106,5	137,0	48	300	704	16982	1,1	31,6	20	80
45	9072	2740	124,6	133,5	140,0	110	240	8662	19887	8,9	15,4	110	155
46	*9090*	*2736*	*117,0*	*131,9*	*144,7*	*190*	*290*	*19216*	*43446*	*14,9*	*27,7*	*130*	*170*
47	9113	2742	134,0	141,0	146,0	115	190	8173	14962	7,0	12,0	95	155
48	9130	2745	132,1	140,8	158,6	220	330	20366	58508	8,7	26,5	120	170
49	9086	2740	156,6	163,9	173,9	140	260	7028	24169	7,3	17,3	70	105
50	9201	2747	157,9	163,0	183,2	90	310	2742	17182	5,1	25,3	45	65
51	9196	2731	162,2	164,5	181,1	65	170	2497	13711	2,3	18,9	55	70
52	9200	2726	164,0	166,5	183,2	65	200	2942	15231	2,5	19,2	57	70
53	9193	2711	157,0	164,8	173,9	85	200	4189	17618	7,8	16,9	67	145
54	9177	2714	150,6	155,5	173,9	100	275	5833	33311	4,9	23,3	85	97
55	9176	2705	156,3	160,5	173,4	70	150	3637	13531	4,2	17,1	65	97
56	9166	2717	141,1	144,5	170,0	65	270	2868	17862	3,4	28,9	60	65
57	9161	2722	139,2	144,5	160,0	80	200	4259	17455	5,3	20,8	65	65
58	9165	2730	144,3	148,0	171,0	95	230	3947	24817	3,7	26,7	55	95
59	9154	2736	145,3	148,0	159,8	60	160	1635	13189	2,7	14,5	35	125
60	9139	2727	135,2	140,8	159,8	160	320	9035	35635	5,6	24,6	80	102
61	9111	2721	119,8	131,9	164,1	340	650	27540	104375	12,1	44,3	130	195
62	9092	2717	123,5	132,5	141,2	90	170	5076	17357	9,0	17,7	75	140
63	9072	2723	116,5	127,0	138,2	140	260	11720	27429	10,5	21,7	105	140

Tab. 2 - Collected data for south zone

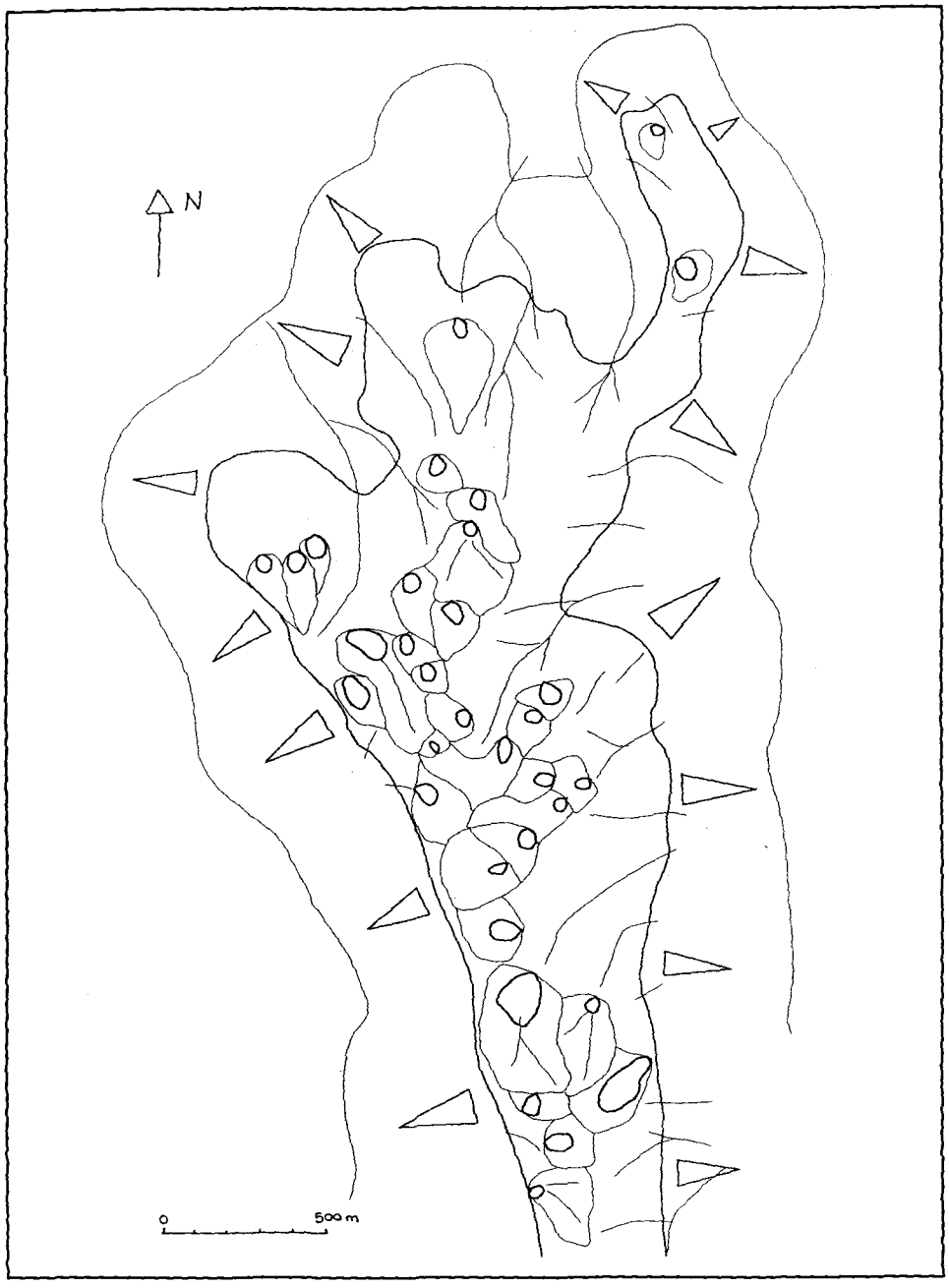

Fig. 1: North zone: dolines, catchment-basins, plateau escarpment, suspended dry valleys and hydrographic network are shown

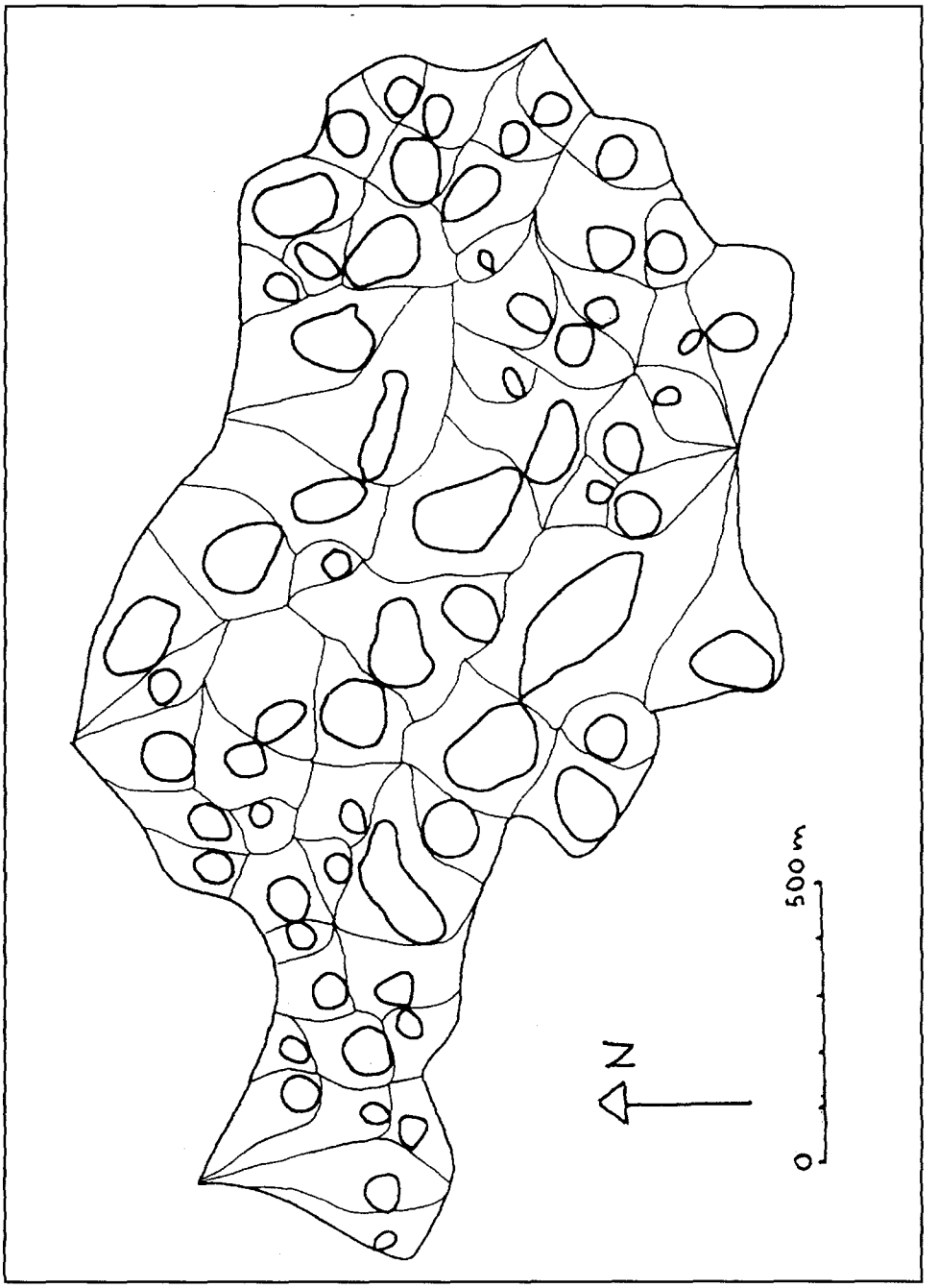

Fig. 2: South zone: dolines and catchment-basins are shown

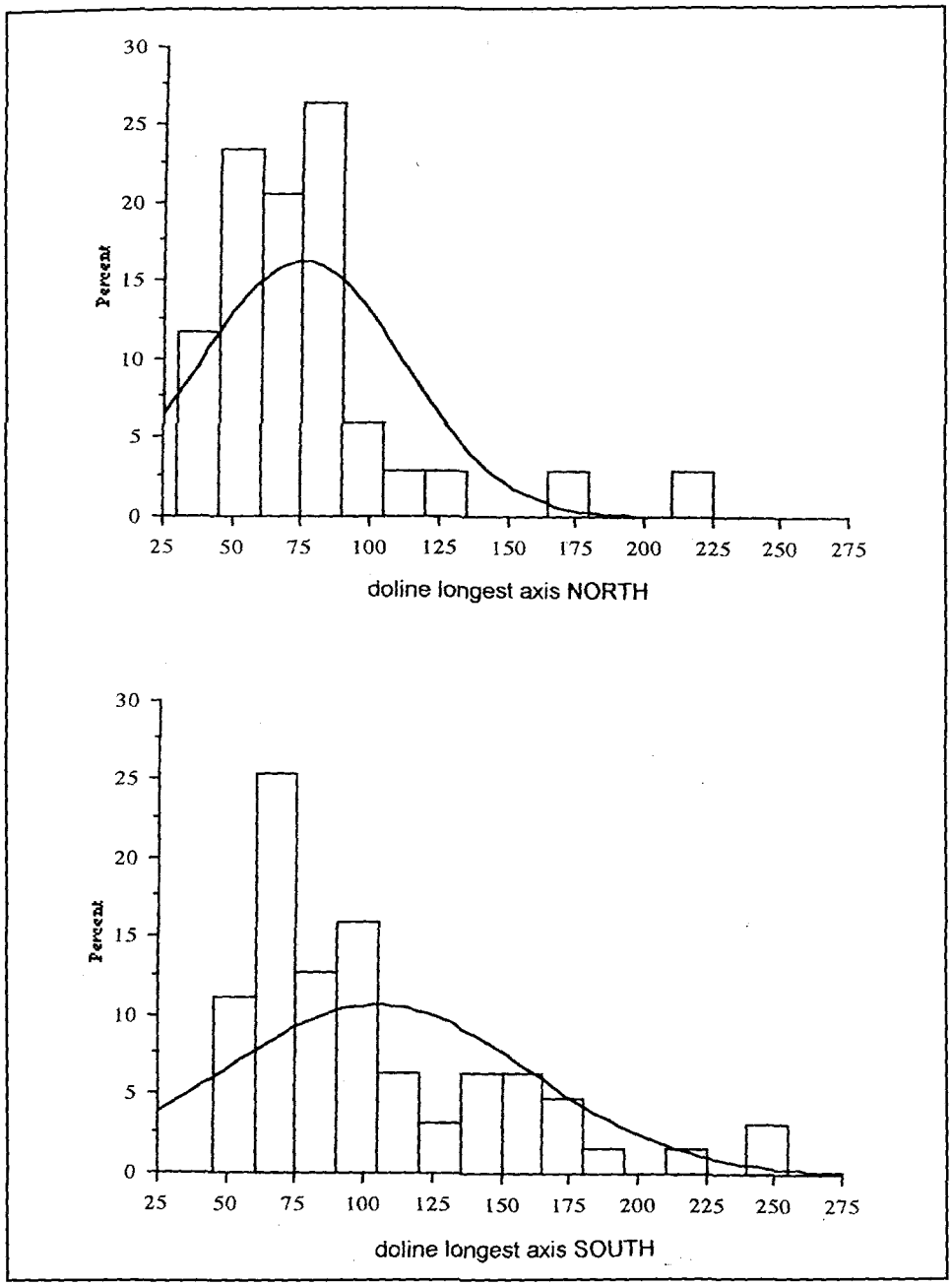

Fig. 3: Comparison between the two zones of the frequency distribution histograms for the variable "doline longest axis length"

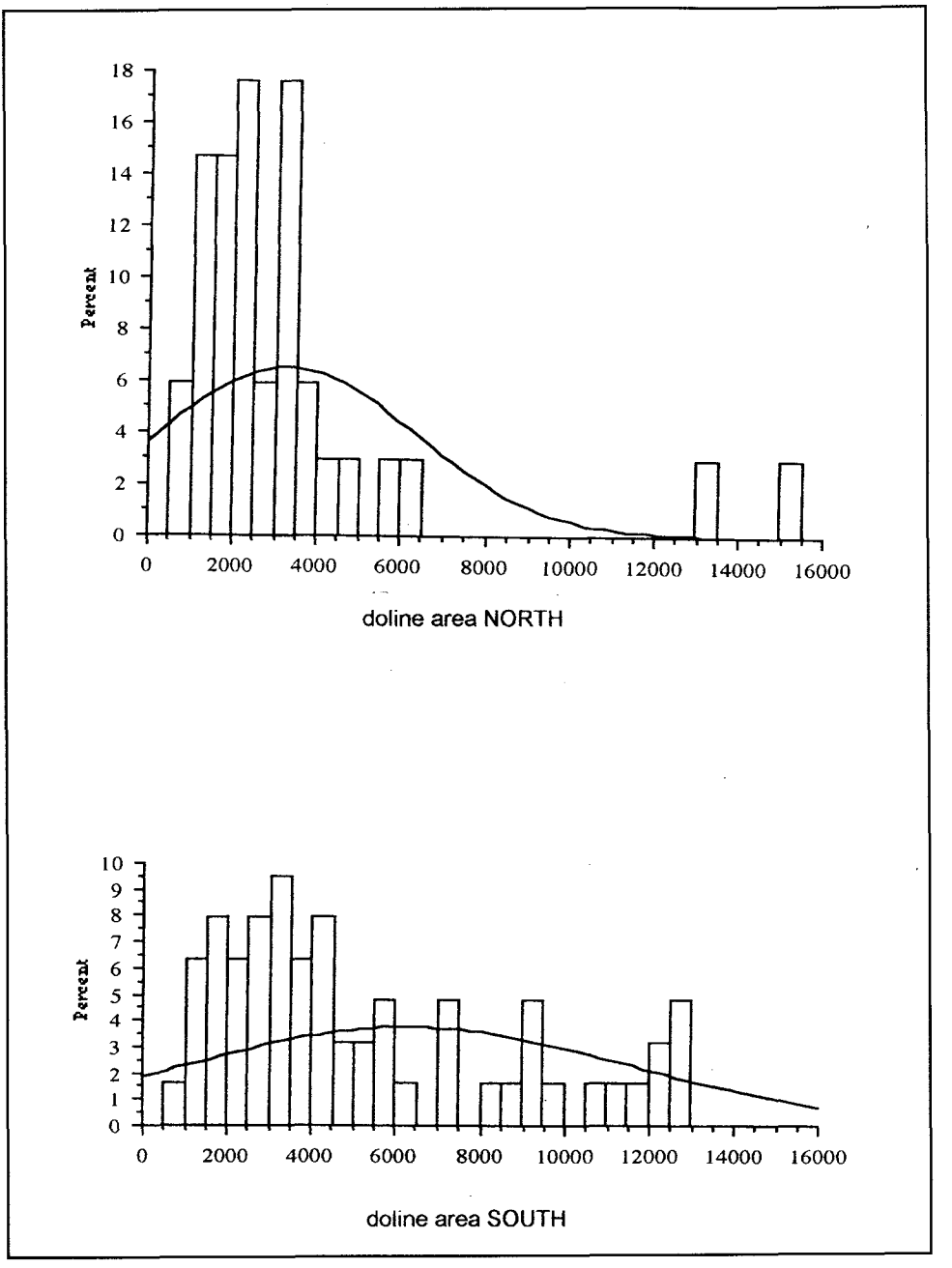

Fig. 4: Comparison between the two zones of the frequency distribution histograms for the variable "doline area"

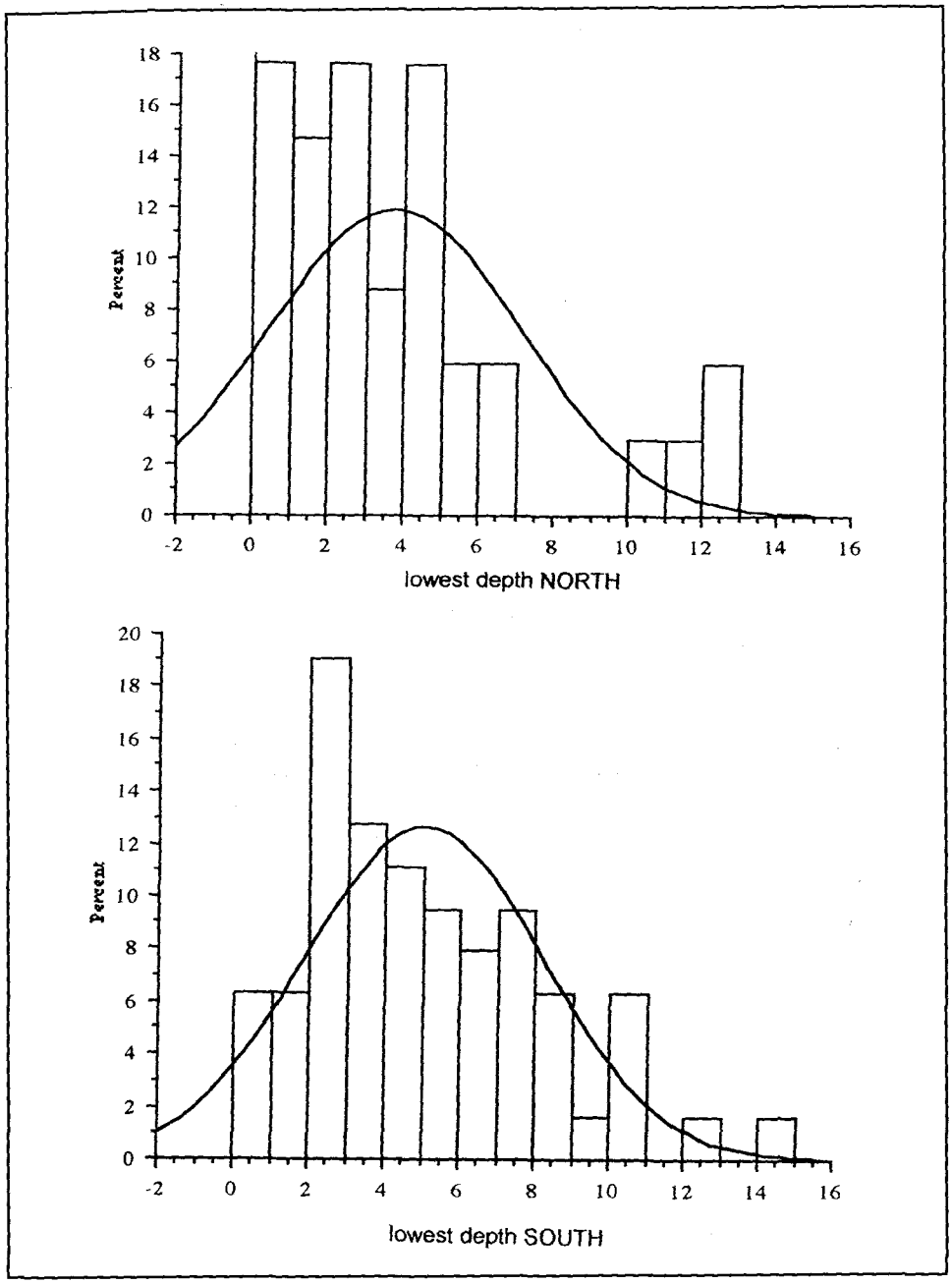

Fig. 5: Comparison between the two zones of the frequency distribution histograms for the variable "lowest depth"

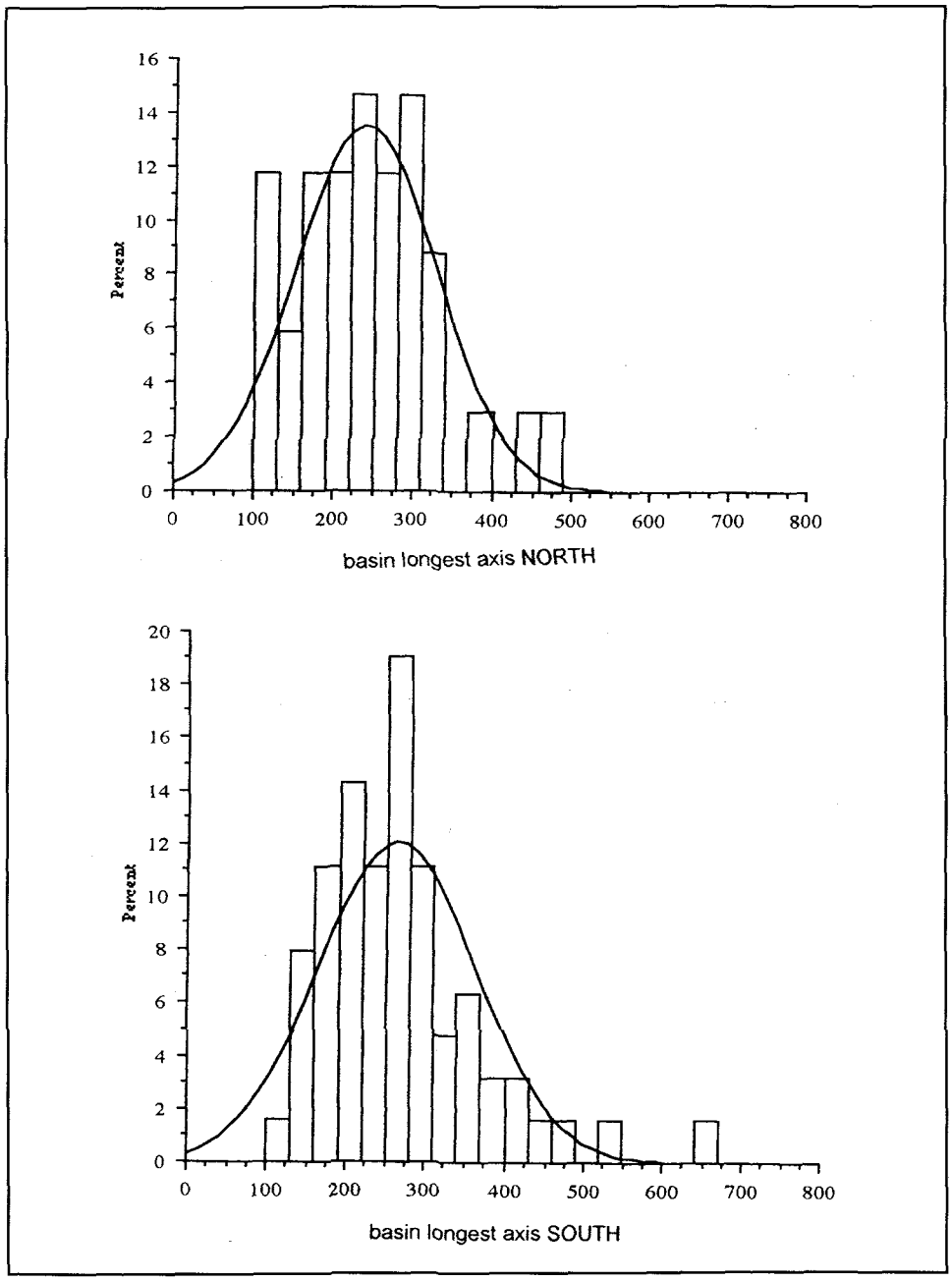

Fig. 6: Comparison between the two zones of the frequency distribution histograms for the variable "basin longest axis length"

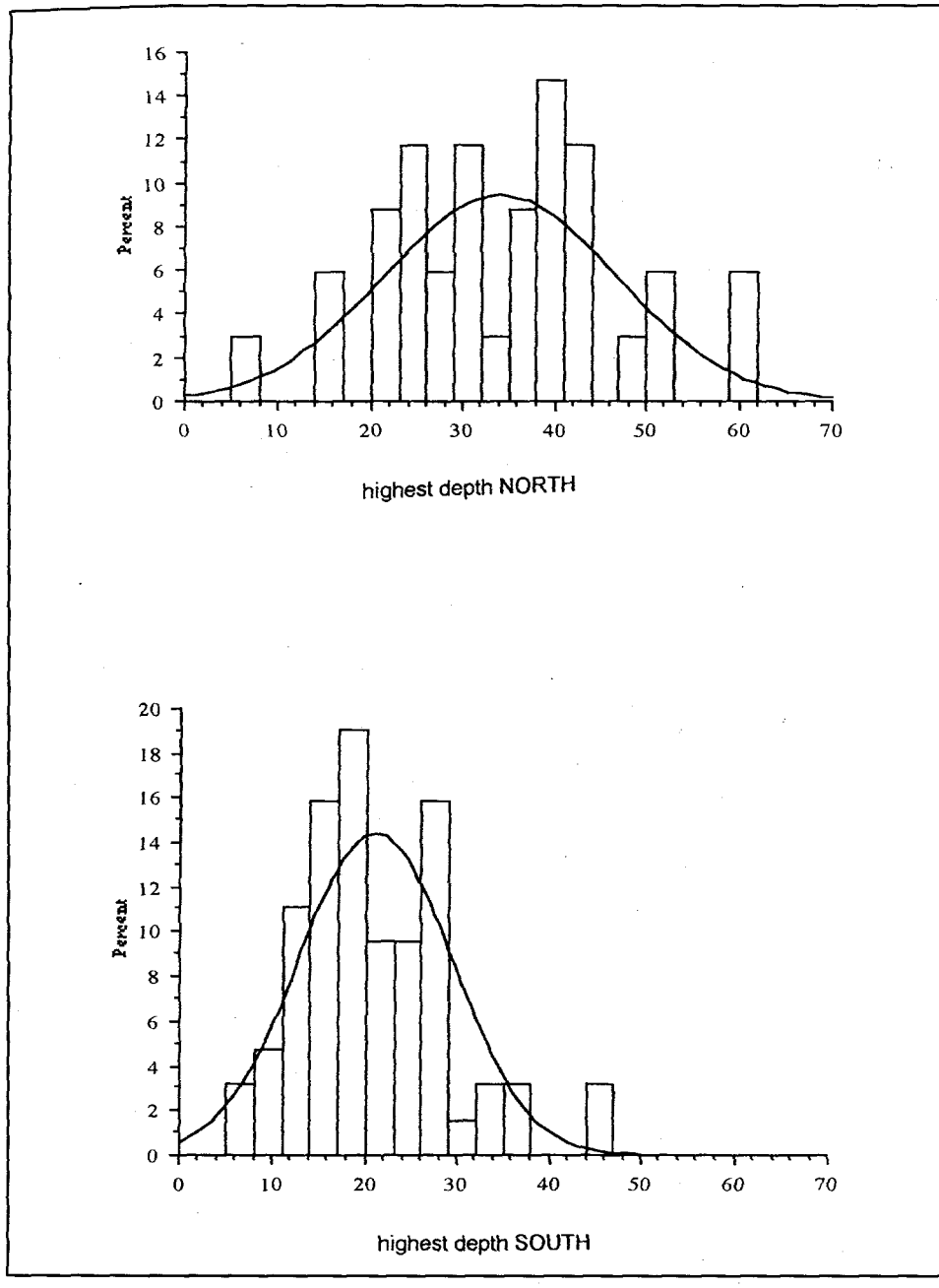

Fig. 7: Comparison between the two zones of the frequency distribution histograms for the variable "highest depth"

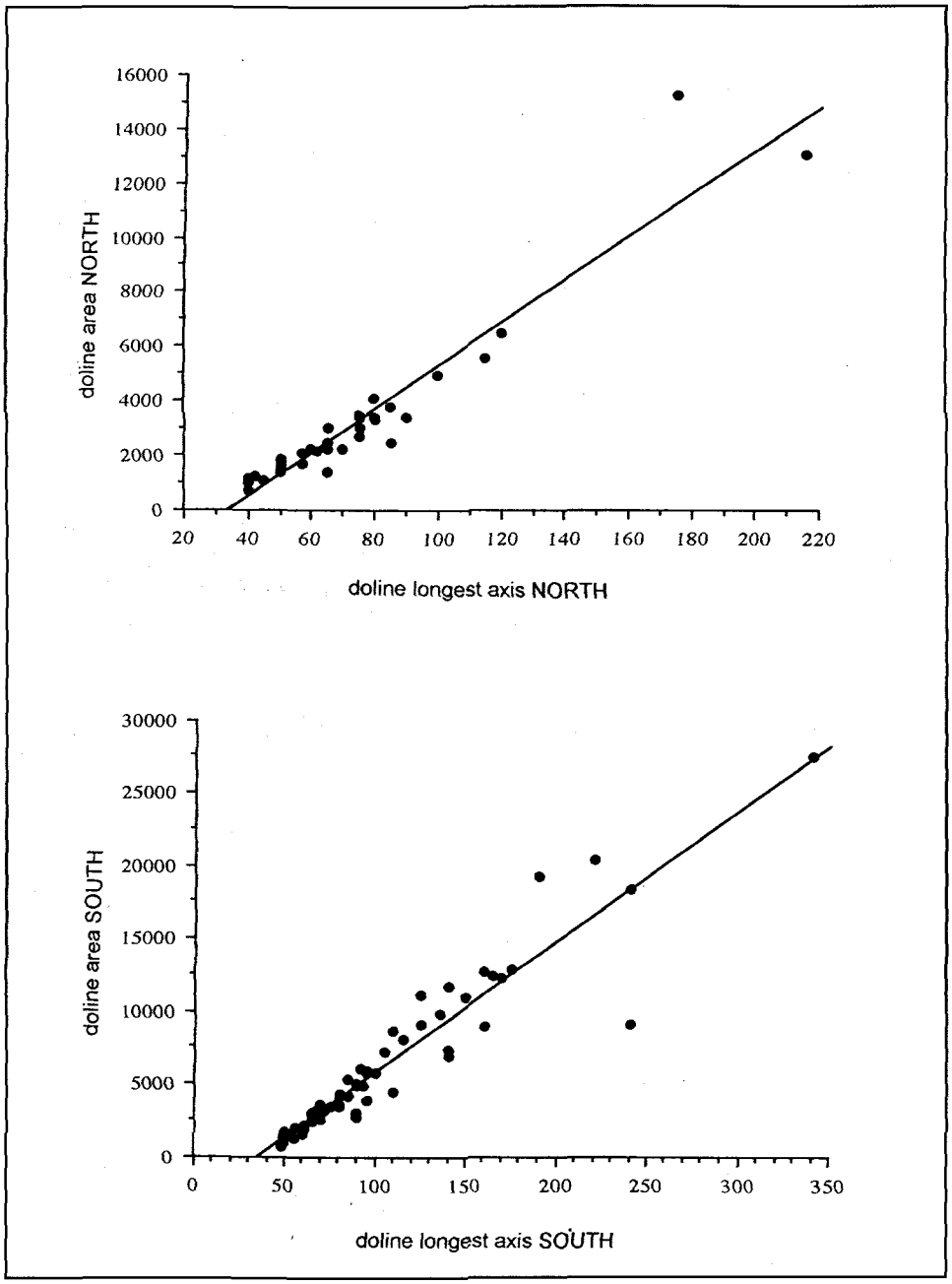

Fig. 8: Comparison between the two zones of the scattergrams concerning the variables "doline longest axis length" and "doline area"

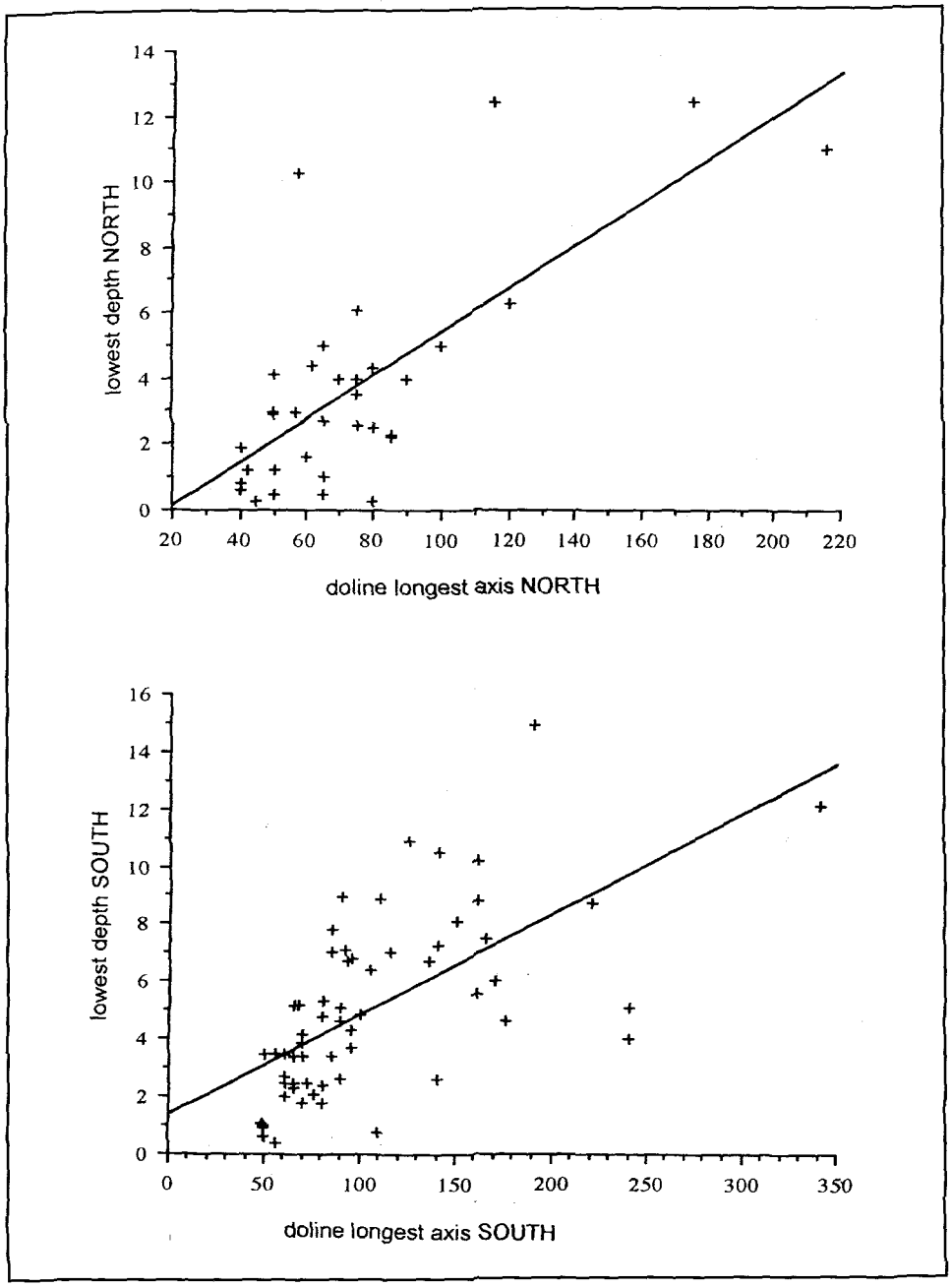

Fig. 9: Comparison between the two zones of the scattergrams concerning the variables "doline longest axis length" and "lowest depth"

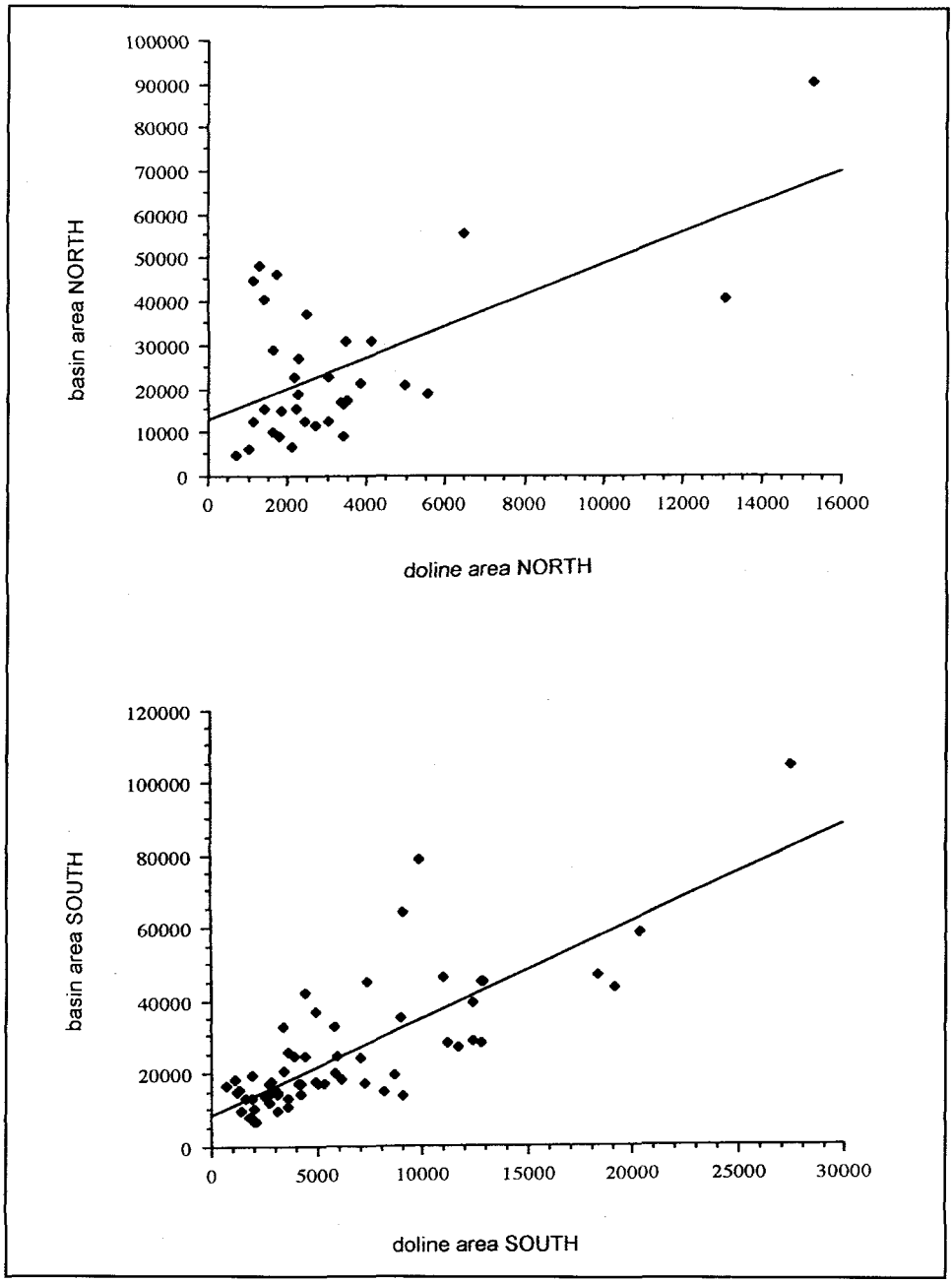

Fig. 10: Comparison between the two zones of the scattergrams concerning the variables "doline area" and "basin area"

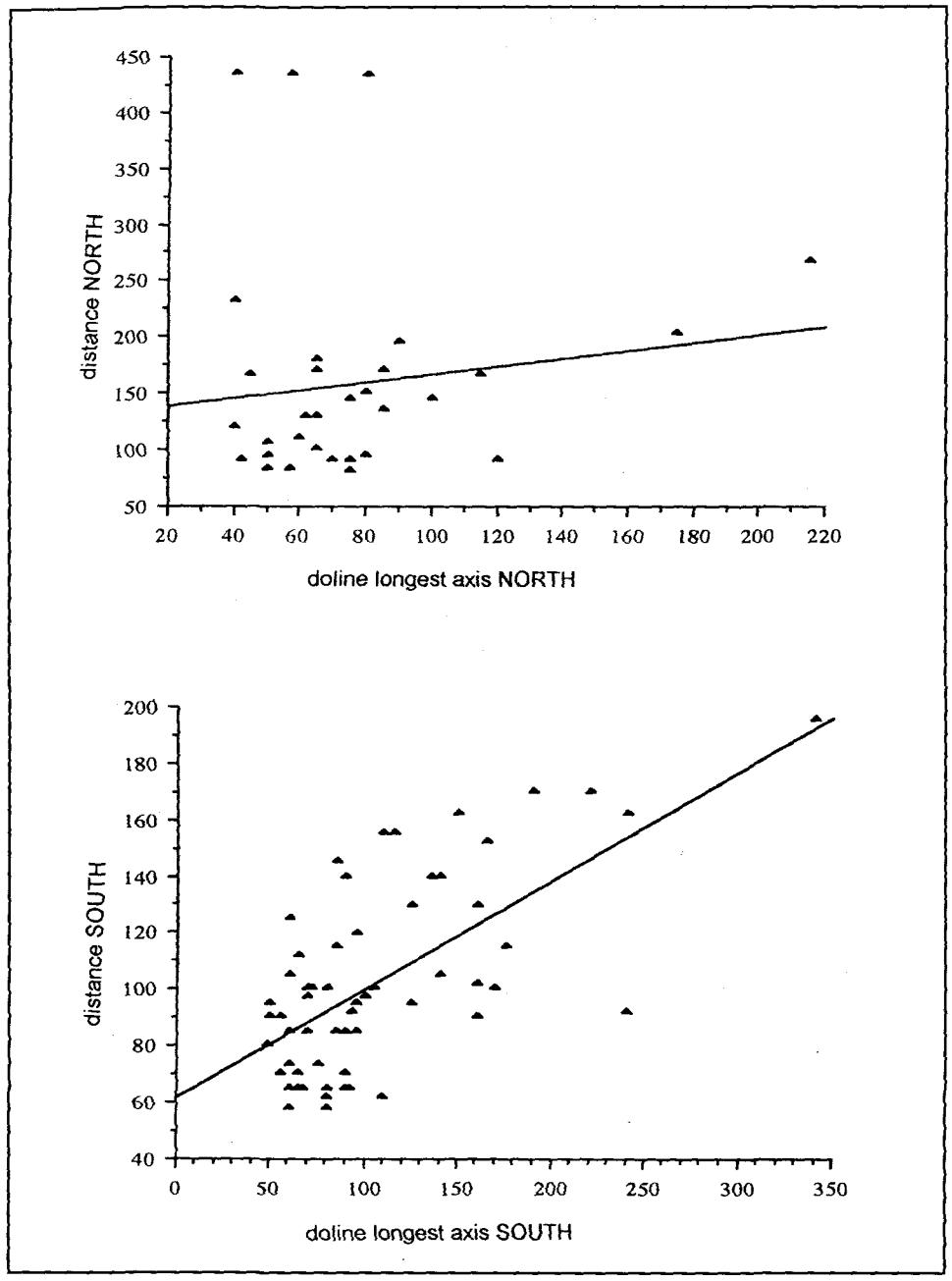

Fig. 11: Comparison between the two zones of the scattergrams concerning the variables "doline longest axis length" and "distance"

PRIMERJAVA MORFOLOGIJE VRTAČ IZ DVEH DELOV GRIČEVJA BERICI (VICENZA, ITALIJA)

Povzetek

Oblika vrtač kaže določene razlike med severnim in južnim delom gričevja Berici. Glavni vzrok je najbrž v različni litološki sestavi: lapornati apnenci na jugu, grebenski apnenci na severu. Razen tega so tudi različne reliefne oblike (planota ali sleme) tiste, ki so prispevale k različnemu značaju vrtač.

Rezultati meritev opravičujejo domnevo, da je severna cona bolj neugodna za nastanek vrtač, saj je na območju slemena več vrtač na robu planote odprtih proti pobočjem. Na slemenu je tako več manjših, a globokih vrtač, saj je tod večja reliefna energija, kot v južni coni. Dobro bi bilo poglobljeno preučiti medsebojni vpliv med razvojem pobočij in razvojem vrtač, med kraško in rečno morfogenezo v širšem smislu.

Več drugih okoliščin, pomembnih za razvoj krasa, je v obeh conah zelo podobnih (nadmorska višina, klimatske razmere, trajanje kraške morfogeneze), tako da ne morejo biti odločilni dejavniki za navedene razlike.