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PROCEEDINGS

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Edited by: Alberto Antoniazzi, Aldo Antoniazzi, Juan Luis Arsuaga Ferreres, José Maria Bermúdez de Castro, Eudald Carbonell i Roura, Elena Cavallini, Savino di Lernia, Federica Fontana, Carmen Gutierrez Saez, Laura Longo, Giorgio Manzi, Sarah Milliken, Luiz Oosterbeek, Viera Pavukova, Marco Peresani, Vittorio Pesce Delfino, K. Pizchelauri, Luciana Prati, Robert Sala i Ramos, Carlo Peretto

ABACO

Scientific direction: Carlo Peretto
Editorial direction: Carlo Giunchi

Editing coordination: Marinella Fabro, Andrea Laghi
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WORKSHOP 13

Ca' Belvedere di Monte Poggiolo: i primi abitanti in Emilia-Romagna
Ca' Belvedere di Monte Poggiolo: les prèmiers habitants en Emilia-Romagna
Ca' Belvedere di Monte Poggiolo: the first inhabitants in Emilia-Romagna

Coordinatori / Coordinateurs / Coordinators:
Alberto ANTONIAZZI, Aldo ANTONIAZZI, Elena CAVALLINI, Federica FONTANA, Sarah MILLIKEN, Carlo PERETTO

NEW OBSERVATIONS ON THE GRAVELS OF THE SEDIMENT CONTAINING A PALAEOLITHIC INDUSTRY AT CA' BELVEDERE DI MONTE POGGIOLO AND OF THOSE OF OTHER LOCAL QUATERNARY DEPOSITS

Alberto Antoniazzi, Aldo Antoniazzi*, Franco Bisi,** Stefania Greggi***, Piero Mazzavillani*****

**Via Tumedei 90, 47100 Forlì, Italy.*
*** Centro di Telematica, Università di Ferrara. Via Macchiavelli 34, 44100 Ferrara, Italy.*
****Via Rio Sasso 28, 47018 S.Sofia (FO), Italy.*
*****Via Cella 107, 48100 Madonna dell'Albero (RA), Italy.*

As part of the research carried out on the geological context of the Palaeolithic site of Ca' Belvedere di Monte Poggiolo, a lithological and morphometric analysis was made of the gravels of the local Quaternary deposits (Fig. 1), and the methodology used and some preliminary results have already been published (Antoniazzi *et al.* 1992). The data, which were analysed at the Computing Centre of the Institute of Mathematics of the University of Ferrara, were derived from samples taken from the following contexts:

1) Lower Pleistocene coastal deposits at Monte Poggiolo: fluvial sandy gravely sediments and palaeosoil with lithic industry from the section of the excavation, gravely beach deposits at Ca' del Monte, fluvial sediments from rio Petrignone and Casetto Fontana (Amore *et al.* 1996a, 1996b; Antoniazzi *et al.* 1984, 1988, 1992, 1993, 1996b, 1996c; Antoniazzi & Piani 1992; Antoniazzi 1996; Gagnepain 1996; Monegatti *et al.* 1992; Peretto 1989a, 1989b, 1992b);
2) Lower Pleistocene *Sabbie Gialle* at Sabbioni;
3) Middle Pleistocene terrace (the section between Pennita and Palazzo);
4) the bed of the river Montone at Castrocaro.

The granulometry of the samples studied is presented in Table 1. In the non-pedogenised sediment at Ca' Belvedere gravels predominate in the upper part, while sands are prevalent in the lower part. Only the top of the deposit is composed of silty sand with gravels, as a result of a particular enrichment with carbonates of illuvial origin.

The palaeosoil at Ca' Belvedere, which was derived from the pedogenetic alteration of the sediment containing the lithic industry, is a silty sand with gravel and has a pedogenetic enrichment of clay. In the lower part (C horizon) the granulometry is analogous to that of the original non-pedogenised deposit.

The beach sediments at Ca' del Monte and those of the rio Petrignone and Casetta Fontana are generally sandy gravels.

The samples of the *Sabbie Gialle* taken at Sabbioni come from lenticular levels within the dominant sediment and their granulometry is in one case mainly gravely and in the other mainly sandy.

The more recent alluvial deposits are decidedly gravely.

Table 2 shows the granulometric fraction of the gravels. The fraction between 6 and 20 mm dominates in almost all of the deposits studied. The only exceptions are sample 2 from Ca' del Monte, which has markedly smaller dimensions, and sample 1 from Sabbioni, in which this fraction is present in analogous quantities to those of the two lateral classes (less than 6 mm and greater than 20 mm). In the sediments examined, gravels with medium and fine gravels dominate and granules are subordinate. There is a minimal presence of coarse gravels, of which the pebbles are almost always less than 80 mm. The fine pebbles and granules are markedly predominant only in sample 2 from Ca' del Monte.

As can be seen in Table 3 and Figure 2, the gravel is constituted by: flint, metamorphic quartz, limestone, calcarenite, sandstone, marly limestone, organogenic limestone and other lithologies. In the deposit at Ca' Belvedere with the lithic industry in primary context the lithology of the pebbles is dominated by limestone (average 46.4%) and flint (average 40.5%). Sandstone is markedly subordinate (average 11.0%). There are also traces of metamorphic quartz, jasper and granitoid rocks etc. Among the siliceous rocks, nummulitic and red flint have been distinguished. Occasionally large and more or less rounded concretions of carbonates and iron manganese are also found, which were probably inherited from pre-existing eroded soils in the same areas as those from which the other pebbles came. An analogous origin can be attributed to the sporadic arenaceous pedorelicts, which are very altered and have a brown colour, and which contrast markedly with the freshness of the other gravels.

While in the deposit at Ca' Belvedere the flint content exceeds 50% only in the sample from level 120, which lies immediately on top of the base of the sediment, in the palaeosoil this value is much higher, since a marked and prolonged pedogenesis has destroyed a large part of the pebbles composed of other lithologies. At the base of the soil, where the pedogenetic process was less marked, the composition of the pebbles is analogous to that of the original sediment.

The lithological composition of the gravels at Ca' del Monte and the section of rio Petrignone is also analogous to that of the sediment at Ca' Belvedere and there is the same variability. In the gravels of the *Sabbie Gialle* on the other hand there is a marked predominance of flint, which is greater where the gravels are finer, and a minimal presence of sandstone.

The pebbles from the bed of the river Montone and the section between Pennita and Palazzo are, on the other hand, almost exclusively arenaceous (more than 70%) and, subordinately, calcareous. Flint is present only in traces. This composition clearly depends on the rocks which are currently eroding in the montane basins.

The different lithologies of the Lower Pleistocene sediments also indicate that the formations outcropping today were once covered by other rocks. This was probably a ligurid layer which has now been destroyed by erosion, characterised by lithological formations similar to those present in the ligurid complexes which are still dominant in vast sectors of the Apennines in Emilia-Romagna, and which are the source of very characteristic pebbles (Selli 1942) similar to those examined here.

The presence of red flint pebbles in the Lower Pleistocene deposits, resulting from the alteration of the *Scaglia cretaceo-eocenica marchigiana* (Veggiani 1965), is attributed to the solid transport by the coastal currents.

The form of the clasts was classified following the criteria of Zingg and the Cailleux flatness index and the Krumbein and Folk spericity indices were also calculated (Ricci Lucchi 1980; Bosellini *et al.* 1989). The results of the classification of the forms according to Zingg (discoidal, spherical, laminar and elongated) are shown in Figure 3. Discoidal forms dominate and spherical forms are subordinate in the gravels of the sediment at Ca' Belvedere, Ca' del Monte, rio Petrignone and in those below the palaeosoil. In the palaeosoil, on the other hand,

there is a decrease in the discoidal forms and an increase in elongated forms; this phenomenon can probably be attributed to the selective action of pedogenesis. In the gravels of the *Sabbie Gialle* there is a marked predominance of spherical forms, while discoidal and elongated forms are subordinate and present in roughly equal quantities. In those of the more recent sediments discoidal forms are dominant.

Figure 4 shows the values of the Cailleux flatness index. In pebbles from the site of Ca' Belvedere, Ca' del Monte, the rio Petrignone and at the base of the palaeosoil the two classes <2.1 e >2.1 are practically equal. In the *Sabbie Gialle*, on the other hand, there is a marked predominance of the class with an index of <2.1, while in the sediments of the terrace between Pennita and Palazzo and in the bed of the river Montone the index is >2.1. Finally, in the palaeosoil there is a predominance of pebbles with an index of <2.1. This shows that the Cailleux flatness index is not particularly significant in this case since it is not possible to distinguish between beach and river pebbles, although it did reveal once again the substantial difference between the Lower Pleistocene gravels and the more recent ones, which probably results from the different modes of degradation of the different rocks. The variations in the index towards the <2.1 class which were noted in the gravels from Sabbioni and in the palaeosoil seem to be related essentially to the lithological type of the clasts, destroyed by erosion at Sabbioni and by pedogenesis in the palaeosoil.

The Krumbein and Folk sphericity indices of the pebbles in the sediments were calculated in order to evaluate them in relation to a theoretical spherical reference form. As regards the Krumbein sphericity index (Table 4 and Figure 5), one can see that the gravels from Ca' Belvedere, Ca' del Monte, rio Petrignone and the base of the palaeosoil are very similar, with a maximum in class 7 and the greatest significant frequency extended to classes 6 and 8. In the gravels of the *Sabbie Gialle* there is a predominance of class 8, although class 7 is also important, and therefore there is a certain asymmetry in favour of the higher values. An analogous, but more symmetrical, situation is found in the gravels of the palaeosoil at Ca' Belvedere. In the more recent deposits (the terrace between Pennita and Palazzo and the bed of the river Montone) the maximum varies between classes 6 and 7. This index also highlights the differences between the deposits noted previously.

The Folk sphericity index (Table 5 and Figure 6) shows that in the pebbles from Ca' Belvedere, Ca' del Monte and rio Petrignone the maximum corresponds with class 7, there is a slight reduction in the adjacent classes 6 and 8, and a marked decrease in classes 4 and 9, and therefore the trend is asymmetrical. In the palaeosoil the index falls within class 7, with an increase in values towards high classes. In the *Sabbie Gialle* the maximum is concentrated in class 8. In the gravels of the terrace between Pennita and Palazzo and in the bed of the river Montone, on the other hand, the maximum varies between classes 5 and 6 and the decrease in values is quite regular towards the high classes while it is sharper towards the low ones.

The Folk index also highlights the significant difference between the Lower Pleistocene deposits and the more recent ones. In the case of the *Sabbie Gialle* the pebbles are more rounded, which is clearly related to prolonged transport in a marine environment.

The lithological and morphometric study of the gravels from the Palaeolithic site of Ca' Belvedere di Monte Poggiolo and the other gravely sediments in the area demonstrated the existence of two distinct sedimentary phases in the local Quaternary, which were probably dependent on the different characteristics of the lithological outcrops in the respective provenance basins of the clasts.

Since the transition between the old and the new type of sedimentation probably took place during the Middle Pleistocene, the deposit at Ca' Belvedere fits well in the sedimentary cycle of the Lower Pleistocene.

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Sample	Gravel %	Sand %	Silt %	Clay %
Ca' Belvedere (level 101 B)	26,2	51,3	21,3	1,2
Ca' Belvedere (level 102 A)	11,1	57,1	29,0	2,8
Ca' Belvedere (level 103 B)	50,2	38,4	11,4	0,0
Ca' Belvedere (level 104 A)	54,3	37,6	8,1	0,0
Ca' Belvedere (level 105 B)	63,2	31,2	5,6	0,0
Ca' Belvedere (level 106 B)	60,3	34,7	5,0	0,0
Ca' Belvedere (level 107 A)	54,6	36,6	8,8	0,0
Ca' Belvedere (level 108 B)	27,0	64,8	8,2	0,0
Ca' Belvedere (level 109 B)	34,8	58,8	6,4	0,0
Ca' Belvedere (level 110 A)	48,8	48,4	2,8	0,0
Ca' Belvedere (level 111 A)	42,6	55,7	1,7	0,0
Ca' Belvedere (level 113)	37,2	60,5	2,3	0,0
Ca' Belvedere (level 118)	31,2	68,2	0,6	0,0
Ca' Belvedere (level 120)	37,2	62,4	0,4	0,0
Ca' Belvedere (55-56) palaeosoil	26,1	45,9	28,0	0,0
Ca' Belvedere (58-67) palaeosoil	24,1	41,2	21,6	13,1
Ca' Belvedere (71-75) palaeosoil	66,5	18,2	15,3	0,0
Ca' del Monte 1	57,8	40	2,2	0,0
Ca' del Monte 2	61,6	37,1	1,3	0,0
Ca' del Monte 3	54,0	36,6	9,4	0,0
Rio Petrignone	73,3	18,2	4,2	4,3
Sabbioni 1	52,2	42,7	5,1	0,0
Sabbioni 2	34,3	64,2	1,5	0,0
Pennita terrace	85,0	14,5	0,5	0,0
Bed of the river Montone	86,1	11,1	2,8	0,0

Tab. 1. Granulometry of the samples.

Sample	Fraction in mm 2.0-5.9 %	6.0-19.9 %	20.0-39.9 %	40.0-79.9 %	> 80.0 %
Ca' Belvedere (level 101B)	37,7	46,6	14,6	1,2	0,0
Ca' Belvedere (level 102A)	31,3	47,7	18,4	2,6	0,0
Ca' Belvedere (level 103B)	14,4	53,9	29,9	1,8	0,0
Ca' Belvedere (level 104A)	19,8	55,6	19,6	5,0	0,0
Ca' Belvedere (level 105B)	16,2	64,0	15,2	4,4	0,2
Ca' Belvedere (level 106B)	28,9	26,7	35,1	9,3	0,0
Ca' Belvedere (level 107A)	19,4	59,8	19,0	1,7	0,0
Ca' Belvedere (level 108B)	27,3	51,5	16,2	4,5	0,6
Ca' Belvedere (level 109B)	25,7	53,2	18,6	2,3	0,3
Ca' Belvedere (level 110A)	22,2	57,1	16,4	3,8	0,4
Ca' Belvedere (level 111A)	28,5	49,7	19,6	1,9	0,3
Ca' Belvedere (level 113)	11,6	74,1	14,3	0,0	0,0
Ca' Belvedere (level 118)	33,4	34,5	23,0	9,1	0,0
Ca' Belvedere (level 120)	22,3	61,9	15,3	0,5	0,0
Ca' Belvedere (55-56) palaeosoil	36,8	53,7	8,8	0,7	0,0
Ca' Belvedere (58-67) palaeosoil	36,5	57,0	5,9	0,6	0,0
Ca' Belvedere (71-75) palaeosoil	31,2	47,4	20,2	1,2	0,0
Ca' del Monte 1	28,1	52,8	18,3	0,9	0,0
Ca' del Monte 2	78,8	12,1	6,1	3,0	0,0
Ca' del Monte 3	53,8	40,3	5,4	0,0	0,5
Rio Petrignone	28,5	43,2	20,4	6,6	1,2
Sabbioni 1	32,4	31,4	28,8	5,5	1,9
Sabbioni 2	48,5	48,5	2,9	0,0	0,0
Pennita terrace	29,6	41,9	22,2	5,7	0,6
Bed of the river Montone	18,0	58,4	18,8	4,1	0,7

Tab. 2. Granulometric fraction in the gravels.

Sample	F %	Q %	L %	C %	S %	ML %	OL %	O %
Ca' Belvedere (level 101 B)	33,2	4,0	47,0	2,0	11,3	1,6	0,8	0,0
Ca' Belvedere (level 102 A)	34,2	0,0	45,8	1,6	17,1	1,3	0,0	0,0
Ca' Belvedere (level 103 B)	38,8	0,5	41,1	4,0	15,0	0,0	0,5	0,3
Ca' Belvedere (level 104 A)	42,9	0,2	42,3	2,2	11,1	0,0	0,4	0,8
Ca' Belvedere (level 105 B)	41,0	0,5	36,9	4,6	16,6	0,0	0,2	0,3
Ca' Belvedere (level 106 B)	39,4	0,0	35,1	4,0	16,8	1,2	2,5	0,9
Ca' Belvedere (level 107 A)	47,4	1,2	24,7	10,9	12,0	1,6	1,4	1,0
Ca' Belvedere (level 108 B)	47,9	1,9	24,8	11,1	9,7	0,0	3,1	1,4
Ca' Belvedere (level 109 B)	36,1	1,3	34,4	11,7	8,9	0,8	2,8	4,1
Ca' Belvedere (level 110 A)	36,6	0,2	36,4	8,3	10,1	0,0	6,1	2,2
Ca' Belvedere (level 111 A)	40,1	1,1	35,6	9,1	9,1	0,0	3,6	1,4
Ca' Belvedere (level 113)	41,7	1,7	33,5	8,4	6,3	0,2	6,7	1,5
Ca' Belvedere (level 118)	34,8	0,7	39,4	8,0	4,5	0,0	10,8	1,7
Ca' Belvedere (level 120)	52,6	1,4	21,0	10,4	5,0	1,6	6,8	1,4
Ca' Belvedere (55-56) palaeosoil	68,4	1,5	16,2	2,6	6,3	0,0	0,0	5,1
Ca' Belvedere (58-67) palaeosoil	67,8	2,8	13,3	2,5	12,7	0,0	0,0	0,9
Ca' Belvedere (71-75) palaeosoil	37,7	1,6	49,2	3,7	2,2	2,8	0,9	1,9
Ca' del Monte 1	32,2	0,3	42,6	0,6	20,3	3,5	0,3	0,3
Ca' del Monte 2	40,9	0,0	39,4	9,1	6,1	3,0	1,5	0,0
Ca' del Monte 3	52,2	0,5	27,4	2,7	15,1	1,6	0,5	0,0
Rio Petrignone	43,8	0,3	38,1	4,2	8,4	4,2	0,9	0,0
Sabbioni 1	51,5	0,3	28,8	10,4	4,2	0,0	4,2	0,6
Sabbioni 2	87,9	1,5	2,4	1,0	4,4	0,0	0,0	2,9
Pennita terrace	0,3	0,0	12,3	7,2	75,1	0,3	0,0	4,8
Bed of the river Montone	1,1	0,2	7,7	12,0	73,8	0,0	0,0	5,2

Key: F=Flint; Q=Quartz; L= Limestone; C=Calcarenite; S=Sandstone; ML=Marly limestone; OL=Organogenic limestone; O=Other

Tab. 3. Lithological composition of the pebbles.

Sample	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10 %
Ca' Belvedere: average			0,0	0,4	6,0	21,6	33,1	26,7	9,7	2,5
Ca' Belvedere (55-67) palaeosoil				0,6	5,9	14,9	31,5	31,1	13,4	2,6
Ca' Belvedere (71-75) palaeosoil				0,6	7,2	19,6	30,8	28,3	11,2	2,2
Ca' del Monte				0,6	4,7	27,0	37,4	24,0	4,2	2,1
Rio Petrignone				0,3	6,9	22,5	33,6	28,2	7,5	0,9
Sabbioni 1				0,3	3,6	14,6	23,6	34,6	19,4	3,9
Sabbioni 2				0,5	1,9	13,1	30,1	30,6	16,0	7,8
Pennita terrace			0,3	0,9	18,6	34,7	32,6	11,1	1,2	0,6
Bed of the river Montone				0,6	9,2	32,8	35,7	16,4	4,2	1,1

Tab. 4. Krumbein sphericity index.

Sample	1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	9 %	10%
Ca' Belvedere: general average		0,0	0,6	6,7	14,8	21,1	24,5	20,1	9,4	2,7
Ca' Belvedere (55-67) palaeosoil			0,4	3,8	5,8	15,9	31,0	25,3	13,8	4,2
Ca' Belvedere (71-75) palaeosoil			0,6	6,6	11,2	2,9	27,5	16,9	12,2	3,1
Ca' del Monte			0,3	9,1	18,9	21,8	28,9	14,2	6,2	0,5
Rio Petrignone			0,6	5,7	13,5	25,8	26,4	18,6	7,2	2,1
Sabbioni 1			1,0	1,6	4,9	13,9	22,3	30,7	19,1	6,5
Sabbioni 2				0,5	2,4	12,6	23,3	24,8	24,3	12,1
Pennita terrace			2,4	21,0	25,1	23,4	18,0	6,6	3,0	0,6
Bed of the river Montone		0,2	0,7	12,7	22,3	28,5	18,2	11,8	4,6	0,9

Tab. 5. Folk sphericity index.

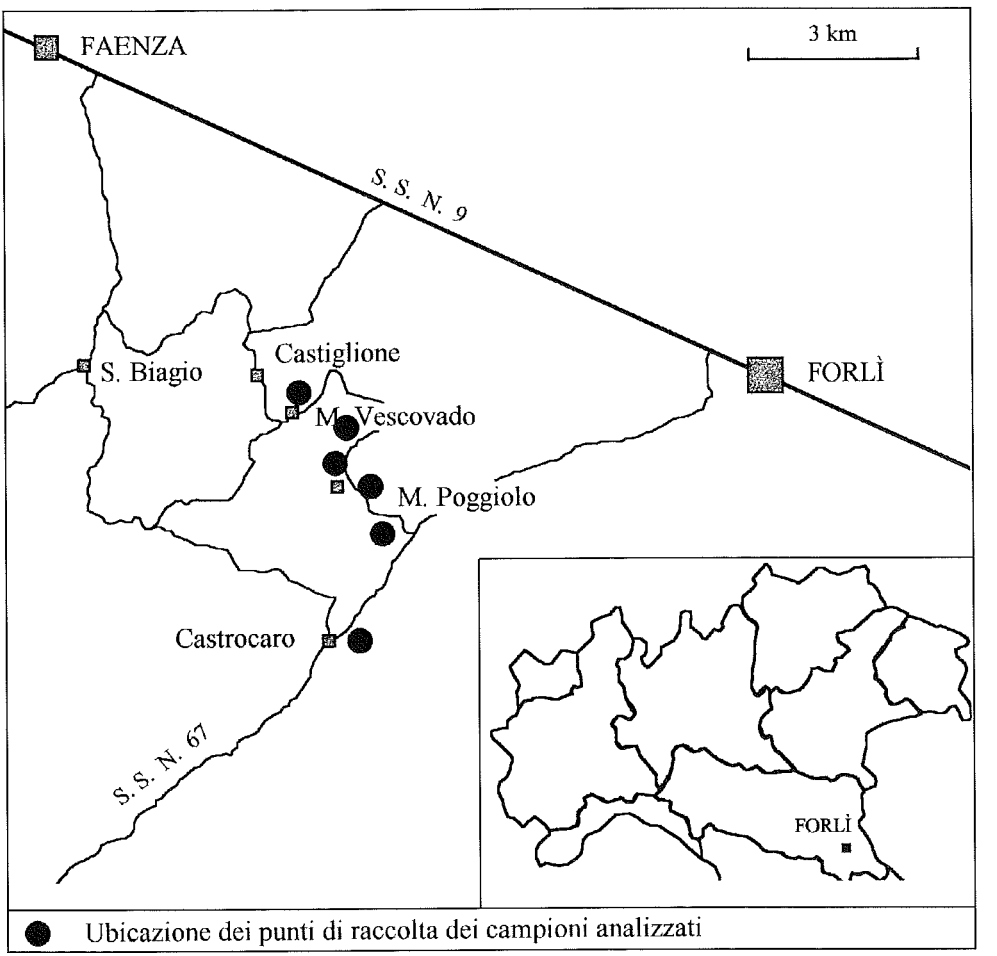

Fig. 1. Geographic location.

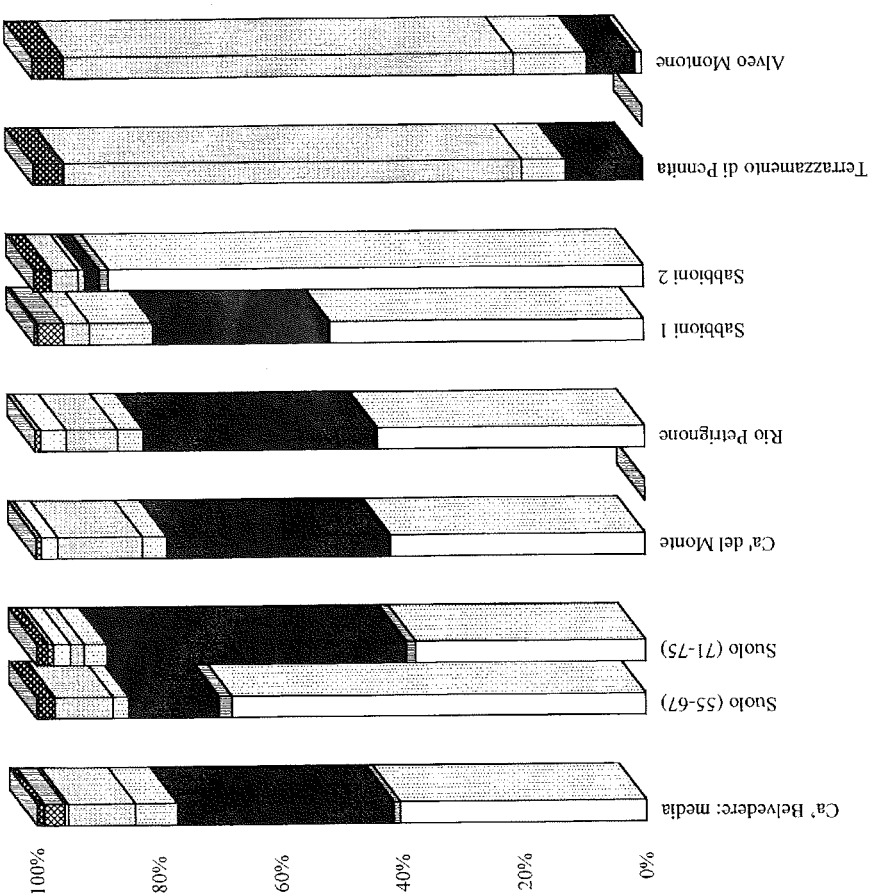

Fig. 2. Lithological composition of the pebbles.

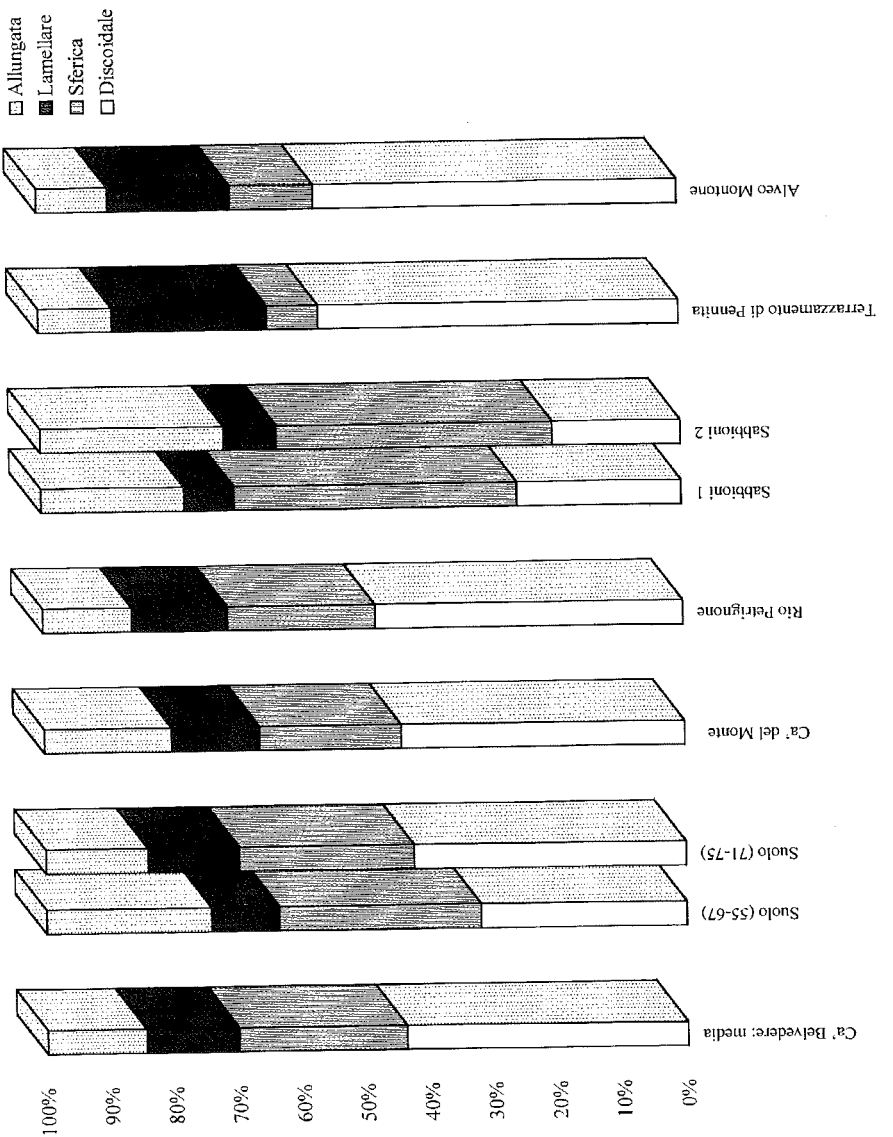

Fig. 3. Form of the pebbles according to Zingg.

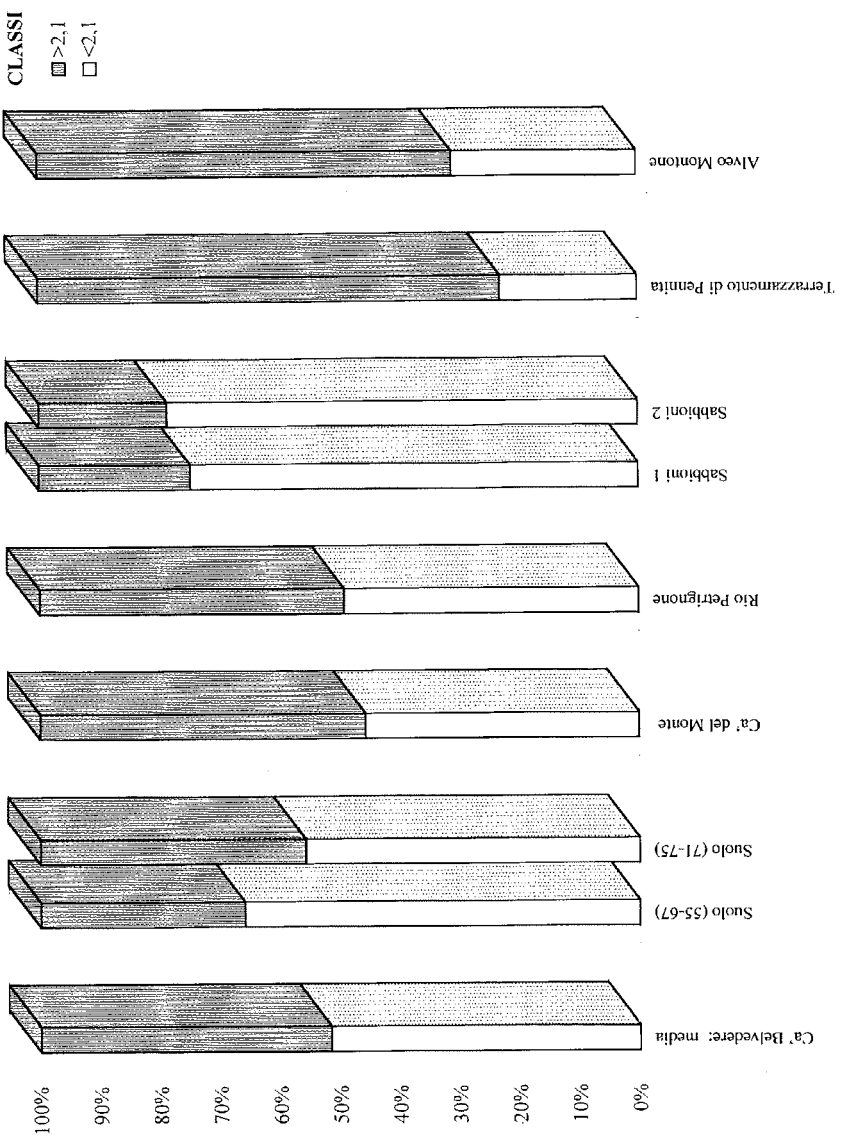

Fig. 4. Cailleux flatness index.

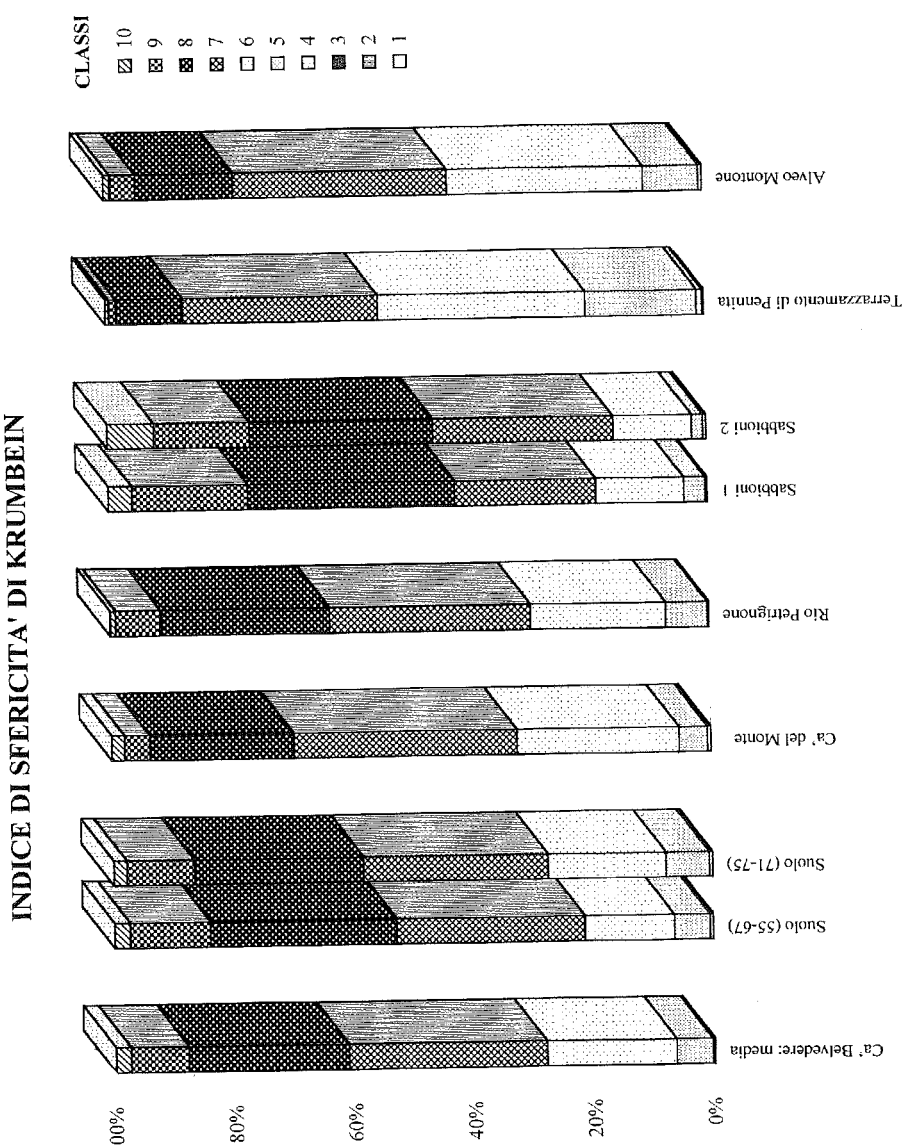

Fig. 5. Krumbein sphericity inde.

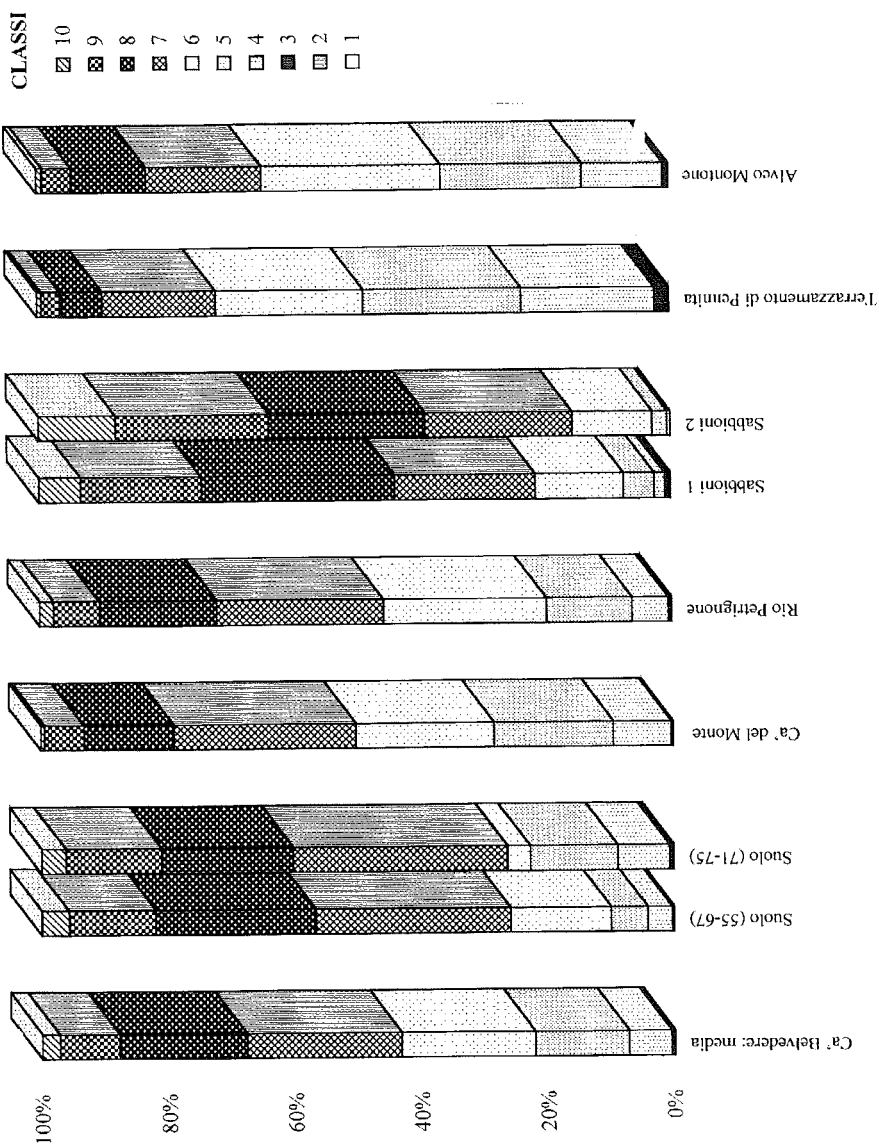

Fig. 6. Folk sphericity index.