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Petroarchaeometry of epigravettian and mesolithic flints in the Val Cismòn-Lagorai area (NE Italy). The flint supply question

ABSTRACT

BENEDETTI R., CAMPANA R., D'AMICO C. & NANNETTI M.C., 1993 - Petroarchaeometry of epigravettian and mesolithic flints in the Val Cismòn-Lagorai area (NE Italy). The flint supply question. [Petroarcheometria delle selci epigravettiane e mesolitiche nell'area Val Cismòn-Lagorai (NE Italia). Il problema dell'approvvigionamento delle selci]. *Preistoria Alpina,* 28: 33-49.

A number of flints from the archaeological sites Colbricon (*CB*, Mesolithic), Pian dei Laghetti (*PL*, Latest Epigravettian), Riparo Villabruna (*RV*, Epigravettian) in the area Val Cismòn- Lagorai (Trentino-Bellunese) have been studied in comparison with geological flints sampled along Val Cismòn and close zones. Gray flint artefacts strongly predominate over red ones.
By petrographic and geochemical methods, the following conclusions have been achieved.
- The gray flints from the sites *CB, PL* and *RV* are all strictly similar to the geological flints from a single zone near Malga Dotessa. No other geological sample is consistent with the archaeological flints, save only two (of seven) *RV* artefacts. The Malga Dotessa zone is suggested, therefore, to have been a relevant lithic source, exploited from Epigravettian to Mesolithic, whereas other sources were occasional.
- The *RV* red flints, save one, do not correspond to any geological flint. Their source is still unknown. The other red artefacts are consistent with several geological flints studied, but a precise source cannot be located.
- High-mountain *CB* and *PL* flints probably had common sources. A possible path of transport of the red flints to the *CB* and *PL* sites may have been about the same as the gray flints.

Parole chiave: selci, Epigravettiano, Mesolitico, selci alpine, petroarcheometria.
Key words: flint, Epigravettian, Mesolithic, alpine flint, petroarchaeometry.

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1. Introduction

1.1 Petroarchaeometric introduction

Flint petroarchaeometry consists of the petrographic, geochemical and mineralogical study of prehistoric flint artefacts, jointly carried out with the study of geological flint samples, selected for comparison, and assumed potentially to be the exploitation sources of the lithic supply to the sites where artefacts were found.

Three archaeological deposits are considered in this paper. Two of them are high-mountain sites, that is Colbricon - *CB* - at 1900 m a.s.l., mesolithic (BAGOLINI and DALMERI, 1987) and Pian dei Laghetti - *PL* - at 1400 m, final epigravettian (BAGOLINI *et al.,* 1984), the third one is the Riparo Villabruna - *RV* - (BROGLIO and VILLABRUNA, 1991) in the Cismòn valley, at 500 m a.s.l.

The lithic material of the three deposits is schematically scheduled according to its colour in table 1, on the basis of the data from Dalmeri and Peresani, which also provided us with the archaeological samples (table 2).

Table 1.

	Colbricon (M) CB (x)	**Pian dei Laghetti (M-E)** PL (x)	**Riparo Villabruna (E)** RV (xx)
Gray	72,8%	87,1%	80,6%
Red	23,6%	10,9%	17,6%
Miscellaneous	3,6%	2,0%	1,8%

M = Mesolithic E = Epigravettian x = data from Dalmeri xx = data from Peresani
Gray = light to dark, including sporadic black specimens

Red = red shading to yellowish and brownish
Miscellaneous = yellow, brown, beige, green

In many to most cases, widespread presence of spot, maculae, points, gradual shading, speckling.

Table 2 - Selected material for study (no. of samples).

	CB	PL	RV	GEOLOGICAL
Gray	5	3	7	14
Red	4	2	7	19
Miscellaneous	2	-	1	5
Total	11	5	15	38

Legend as in Table 1.

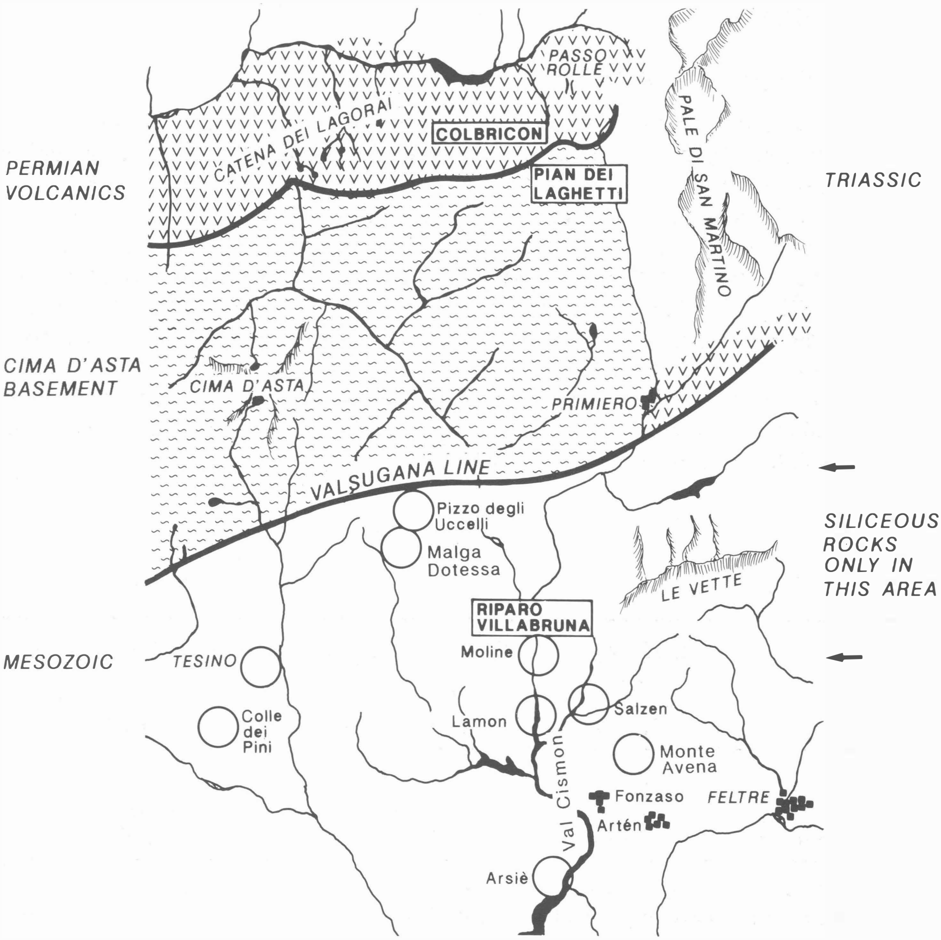


Fig. 1 - Schematic map of the area of interest. The location of the three archaeological sites is contoured. Sampled areas (cfr. table 3) are indicated as small circles. The northern half of the map, made of basement rocks, permian volcanics and triassic sequences (in the east), is devoid of flints. In the southern half, mesozoic sequences do bear flinty intercalations within limestones, mostly Cretaceous. The two domains are tectonically separated by the Valsugana line.

Fig. 1 shows the region of interest, laying in eastern Trentino, and the contiguous Belluno province, in the eastern Southern Alps. The two sites *CB* and *PL* are situated in a zone where metamorphic basement rocks and Permian Volcanics crop out. This zone is devoid of flints. The *CB* and *PL* flints were therefore, necessarily imported from some sources distant some twenty or more Kilometers in the south. The epigravettian *RV* site, on the contrary, lies in a zone where flint-bearing Formations occur. Their flint sources could be, although not necessarily, local or near.

In order to explore the possible lithic sources of the flint artefacts of the *CB, PL* and *RV* deposits, a geological sampling was carried out in the flint-bearing Formations to the south (Fig. 1), according to colours of the flint artefacts and using a random criterion of sampling (table 2).

Table 3 - Geochemistry of flints. Geological samples.

Sample	Colour		Al	Fe	Mg	K	Na	Li	P	Ca	Cu	Zn	Cr	Mn	Ba	Ti	ALK
1	red	UC	2079	1000	148	1110	665	15	0	1179	4	15	4	3	122	124	1775
4	red	UC	2789	1561	362	1251	622	17	25	1837	5	8	6	7	235	166	1873
5	red	UC	2411	1134	295	962	571	17	34	1127	7	12	3	3	219	81	1533
6	red	UC	2863	1580	362	1180	596	16	69	1122	6	16	4	7	170	167	1776
19	red	UJ	1597	1307	366	595	558	8	52	30621	7	16	2	48	32	157	1153
21	red	UC	2597	1233	222	1747	763	13	86	6297	7	12	9	28	61	194	2510
23	red	UC	2741	1699	310	1106	809	12	128	11559	12	14	6	13	111	141	1915
26	red	UC	2031	1041	142	865	813	13	33	5374	9	17	5	128	140	179	1678
42	red	MC	2289	1842	162	1084	494	13	24	2239	8	16	6	4	62	181	1578
2	black	MC	2059	300	113	626	497	10	30	2761	9	12	5	4	113	89	1123
7a	gray	MC	2392	1573	217	1194	561	10	18	920	14	6	12	3	105	161	1755
14	gray	LC	2211	673	241	992	465	14	0	2862	98	8	9	6	222	164	1457
22	black	MC	2453	651	192	1123	937	14	76	4138		18	7	13	191	157	2060
25	gray	LC	1886	879	237	679	715	10	17	7257	3	17	4	9	17	151	1394
37	gray	LC	2183	383	133	902	554	14	27	1193	8	7	3	7	130	170	1456
40	gray	LC	2502	792	406	1041	599	14	74	2545	6	8	6	7	88	226	1640
41	gray	MC	2904	1382	638	1161	689	16	39	14638	8	22	8	35	67	253	1850
49	gray	LC	1041	243	130	611	378	17	14	1468	3	6	2	2	70	81	989
50	gray	LC	1248	432	84	532	362	12	38	1236	3	8	2	3	29	49	894
51	gray	LC	1677	526	149	678	504	18	0	2030	4	12	3	3	37	115	1182
7b	yellow	MC	2770	7754	277	1229	563	11	30	2012	19	11	8	4	126	174	1792
29	yellow	MC	3211	4266	442	1676	906	15	33	11554	6	22	10	8	71	321	2582
30	beige	UJ	1611	371	226	669	382	14	55	1902	6	9	1	25	21	85	1051
33	beige	UJ	1691	467	203	663	382	12	50	11626	7	10	1	150	16	81	1045
35	brown	UJ	4703	1937	715	1917	700	13	44	1686	7	9	3	47	24	315	2617

UC - Upper Cretaceous; MC - Middle Cretaceous; LC - Low Cretaceous; UJ - Upper Jurasic

Table 3 (follow) - Geochemistry of flints. Archaeological samples.

Sample	Colour	Al	Fe	Mg	K	Na	Li	P	Ca	Cu	Zn	Cr	Mn	Ba	Ti	ALK
5CB	red	2443	1937	231	1316	622	10	21	331	4	15	6	5	55	169	1938
6CB	red	1937	1374	93	656	674	17	25	361	4	4	3	3	42	139	1330
20CB1	red	1695	1627	152	890	509	9	32	394	4	8	3	5	10	141	1399
22CB1	red	2535	1203	94	967	659	15	44	244	3	22	4	2	66	201	1626
11PL	red	2441	1682	161	1076	702	16	50	353	3	11	9	5	60	153	1778
13PL	red	2138	1438	128	964	681	17	41	311	5	13	9	1	152	152	1645
RVA1	red	2201	1362	232	908	661	11	0	1413	8	16	13	5	75	125	1569
RVA2	red	3130	1235	184	1180	748	8	0	2899	7	8	5	4	518	179	1928
RVA3	red	3155	1506	200	1117	776	16	0	851	16	8	13	2	147	163	1893
RVA5	red	3864	1852	341	1593	813	15	0	1934	5	8	10	5	107	202	2406
RVA9	red	3162	1480	234	1203	471	12	0	2258	10	8	18	7	106	135	1674
RVA16	red	2996	1368	185	1018	572	25	0	1291	7	7	10	3	129	136	1590
RVA17	red	2695	1321	495	963	499	13	0	10390	23	9	6	8	649	123	1462
2CB	gray	1091	419	81	616	613	14	19	357	3	11	5	3	29	107	1229
3CB	gray	956	338	94	450	548	14	0	387	3	10	7	3	16	78	998
4CB	gray	822	174	67	459	413	9	0	368	3	11	2	3	63	90	872
15CB1	black	1656	502	101	781	587	9	5	721	8	14	7	2	50	101	1368
17CB1	gray	1142	539	71	773	496	8	9	260	3	10	4	2	55	75	1269
8PL	gray	1001	510	163	480	441	11	46	945	9	7	3	7	41	46	921
9PL	gray	1414	511	181	742	535	15	5	496	4	13	2	9	21	84	1277
10PL	gray	847	227	82	653	513	17	8	440	2	9	3	3	21	112	1166
RVA7	gray	1545	395	203	717	358	14	0	4226	7	8	3	4	67	61	1075
RVA8	gray	1326	368	136	479	530	13	0	3858	3	5	2	3	55	26	1009
RVA10	gray	1553	470	99	578	427	17	0	3981	4	6	3	5	67	49	1005
RVA10	gray	1537	474	200	540	527	13	0	3880	6	8	3	5	130	58	1067
RVA11	gray	2047	505	197	1205	749	12	0	3197	4	10	4	4	93	86	1954
RVA11	black	2578	553	156	1000	568	10	0	459	6	6	16	1	112	105	1568
RVA15	gray	1319	429	122	504	379	13	0	4048	6	7	3	1	59	62	883
16CB	beige	2225	704	104	1112	779	18	15	747	5	9	8	46	31	172	1891
24CB	brown	7124	7849	943	3215	851	20	88	408	4	12	8	13	45	223	4066
RVA12	green	4519	3397	508	1992	949	18	0	2686	8	9	24	8	159	633	2941

CB1 = Colbricon 1; CB = Colbricon 77; PL = Pian dei Laghetti; RVA = Riparo Villabruna A

The flint-bearing Formations in the zone are as follows:

A - Uppermost Jurassic or lowest Cretaceous «Rosso Ammonitico» limestones, very poorly outcropping. Flints (cherts) are beige, brown, red.

B - Lower to Middle Cretaceous «Biancone» limestones, widely present in the region - Flints are, for the most part, light to dark gray, rarely black. In the transition to the overlying Formation, black flints are slightly more abundant, and some beige, brown and yellow flints also occur.

C - Upper Cretaceous «Scaglia rossa» marly limestones, widespreadly outcropping. Flints are mostly red (yellowish to brownish), rarely brown, yellow, and black.

The «Gray» archaeological flints of the three sites of table 1 and fig. 1 clearly seem to have been exploited from the «Biancone» and transition zone flints, whereas the «Red» flints mostly derive from the «Scaglia Rossa» Formation. The few «Miscellaneous» flints could originate from all Formations, being, however, of low significance from a statistical and, therefore, archaeometric point of view (table 1).

The geological sampling (table 2) was obviously oriented by these observations. Some geological samples from the near Monte Avena (D'Amico *et al.* 1990) were also used for comparison.

The term flint was used in the sense of Hauptmann (1980), Schmid (1986) Bates and Jackson (1987), that is pure siliceous rocks, moderately to appreciably translucent, with conchoidal fractures, present as nodules, lenses, discontinuous layers within mesozoic limestones. A few samples could also be named «radiolarites» (sections 2.1 and 3.1), according to Thurston (1978), Greensmith (1981) and Tomkeieff (1983), but these are macroscopically indistinguishable from the other flints. Only the «Rosso Ammonico» rocks, being of matte appearance, could be better described as jaspers, according to Pettjohn (1975) and Bates and Jackson (1987). However, nomenclature is surely a minor aspect, save for the aim of unambiguous understanding. For example, radiolarite is probably an unnecessary term, because this rock is usually macroscopically not distinguishable from flint or other cherts. Anyway, the overwhelming nomenclature of the cherty rocks, should be rationally simplified (e.g. Pettijohn, 1975; Bosellini *et al.*, 1989) also for petroarchaeometric purposes.

1.2 Methodology

From each archaeological and geological piece a thin section for petrographic investigation was made, and a proper fragment (about 1 g) was used for chemical analysis. Chemical attack was made on this fragment without grinding, in order to avoid contamination from the mill. Chemical solutions obtained were measured twice in AA spectrometry, determining Al, Fe, Mg, Ca, K, Na, Ti, P, Ba, Mn, Cu, Zn, Cr, Li. CO2 was measured through thermic analysis. XR diffraction was achieved for control and definition of the crystallinity grade (Murata and Norman, 1976). Analytical methods have been more extensively discussed in D'Amico *et al.* (1990).

Measurement error do not exceed 3%. A moderately high sampling error should be considered, due to the small pieces analyzed. This choice is essentially due to an archaeological constriction, that is the small size of many fragments, as well as to the methodological option of directly attacking unground pieces, which must unavoidably be very small.

Two control analyses of 20 and 10 fragments, randomly taken from two geological samples (Benedetti, 1993) made it possible to evaluate the total error (measurement plus sampling error), which is between 7% and 24% (mostly 15%) for the elements considered in the statistical diagrams (Figs. 2-6).

1.3 General Geochemistry of the examined flints

Al, Fe, Mg, Ca, Na, K, P, Ca, Cu, Zn, Cr, Li, Mn and Ba were measured in AA spectrometry (table 3).

These elements were selected on the basis of previous experiences (e.g. DE G. SIEVEKING G. *et al.,* 1972, 1986; D'AMICO *et al.,* 1990). A number of elements were also analyzed to definitely check their reliability and availability as chemical parameters for petroarchaeometric comparisons.

Al, Fe, K, Mg, Na, and only in part Ti and Ba proved to be the most useful elements for comparison and definition of chemical groups having a statistical sense. Other elements were either monotonously distributed (e.g. Li, Cu, Zn, Cr), or too scattered (e.g. Mn), or irregurarly distributed (e.g. P), or clearly linked to the casual presence of calcareous portions (Ca). In all cases they were unsuited for separating groups having a statistical meaning.

As a geochemical introduction to the data, used in the following chapters for the archaeometric interpretation, the elemental distribution in the two groups «Gray» and «Red» (tables 1 and 2) is shown in fig. 2.

It is evident that the two colour-based groups are composite, being divisible in subgroups, for which some bivariate or multivariate analyses are necessary (e.g. Figs. 3-6). However, statistically significant differences between the two groups are evident from fig. 2, when Fe, Al, K, and Ti are considered.

All these elements are more abundant in the «Red» than in the «Gray» population whereas Na, and Mg are unsuitable to show the same tendency with some confidence.

Distribution in fig. 2 is clearly not casual, thus indicating some real and substantial geochemical differences betweeen the two colour-based groups. This observation indicates that geochemical data are confidently reliable and available for distinguishing and comparing different groups of flint samples, at least as a statistical approach. A confirmation of such reliability is given by the composition of some yellow and brown flints in table 3, where diversity in colour is strikingly correspondent with chemical differences.

Of course, no geological or statistical analysis is necessary for separating and distinguishing «Gray» from «Red» samples. We should instead, investigate whether geochemical data are able to separate different subgroups within the «Gray» and «Red» groups respectively, in order to go further into the group discrimination. This will be discussed in the following chapters.

2. Gray Flint

2.1 Grouping on a petrographic basis

The «Gray» flints (table 1) widely occur as nodules or thin discontinuous layers within the limestones of the Lower-Cretaceous «Biancone» Formation.

The colours of the flints range from light to mid-dark gray. Spots and points, lighter than the matrix, as well as shadings and specklings may be present. Black flints

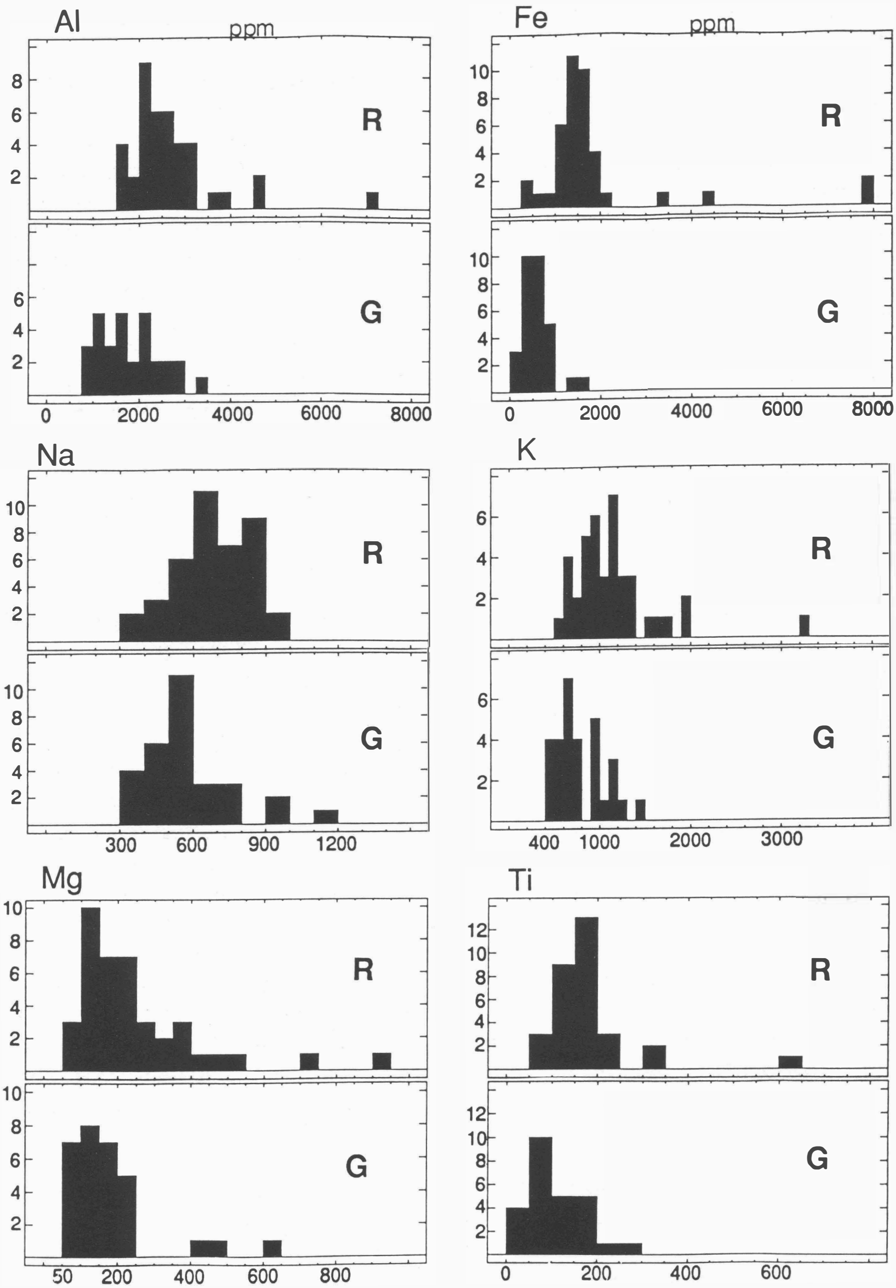


Fig. 2 - Elemental geochemistry of «Gray» and «Red» + «Miscellaneous» samples (cfr. table 1), including both geological and archaeological flints.
The two groups «Gray» - G - and «Red» - R - are statistically different. This is shown in particular by Fe, K, Al and Ti distribution. Both groups are clearly composite and can be divided into sub-groups, by using bivariate and multivariate analyses (as made in chpt. 2 and 3).

are rather uncommon, save in the transition layers between the «Biancone» and the overlying «Scaglia Rossa» Formation (cfr. sect. 3.1).

The archaeological «Gray» flint artefacts are perfectly similar to the geological ones and can confidently be attributed to some Lower-Cretaceous source.

Two groups can be approximately distinguished, on a petrographic basis, in the geological and archaeological flints examined. One group has a homogeneously structureless matrix made of microcrystalline quartz and containing few (usually <10%, rarely up to 20%) tiny spherules of trasparent chalcedony and minor hydrous chalcedony (brownish, with low refraction, cfr. Folk and Weaver, 1952), both interpreted as diagenized radiolares. Some spots of cryptocrystalline quartz, corresponding to the lighter spots visible with the naked eye, are commonly present, as well as shadings and specklings in the matrix.

This type of flint seems not so common geologically, having been sampled only in the Malga Dotessa zone (Fig. 1; three samples), but prevails in the archaeological samples, being represented by all *CB* and *PL* artefacts (5+3) and five of seven *RV* pieces (cfr. table 2).

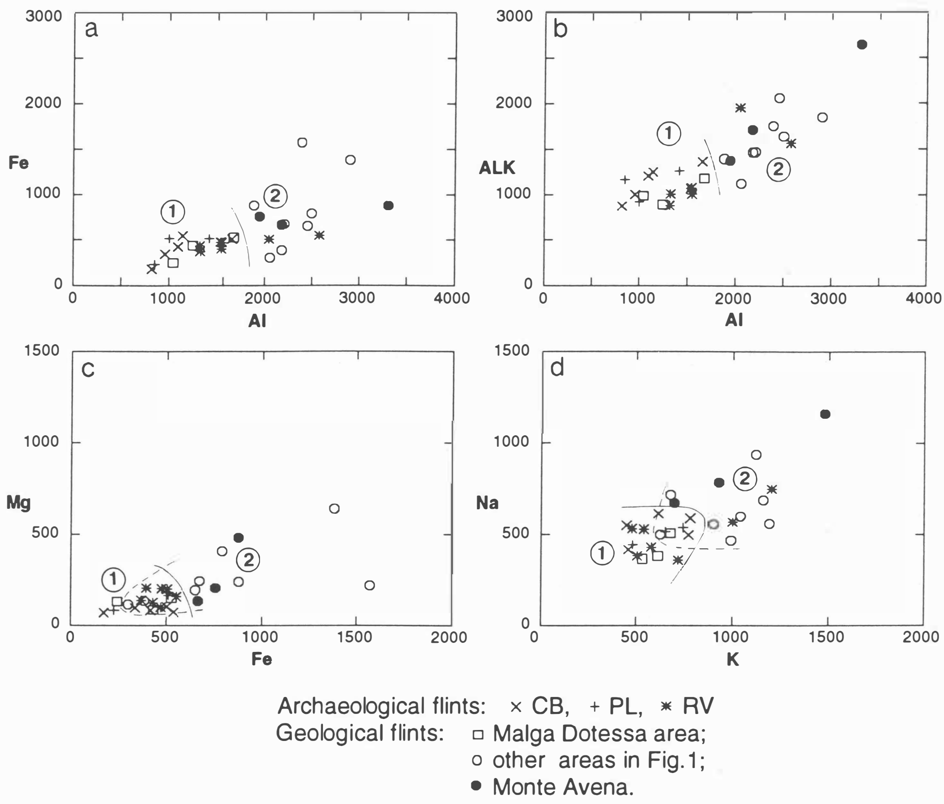


Fig. 3 - «Gray» flints, selected bivariate diagrams.
The two groups distinguished by petrography can also be clearly separated if the distribution of Al and other elements is considered. *CB*, *PL* and five of seven *RV* archaeological flints belong to the sub-group (1), with only three geological flints, sampled in the Malga Dotessa area. This can be suggested as the probable lithic source of «Gray» flints to the archaeological sites. Only two of seven *RV* flints can have a provenance from other sampled geological areas of the sub-group (2).

The second group is probably a composite one. It is heterogeneous, richer in chalcedony spherules (radiolaritic flints), often accompanied by bicameral and lensoid diagenized microfossils, which are completely lacking in the first group of flints. The matrix consists of micro-quartz with spots and shadings of crypto-quartz and is variously structured. This group is given by only two of seven *RV* flints and all the geological samples, save the Malga Dotessa ones.

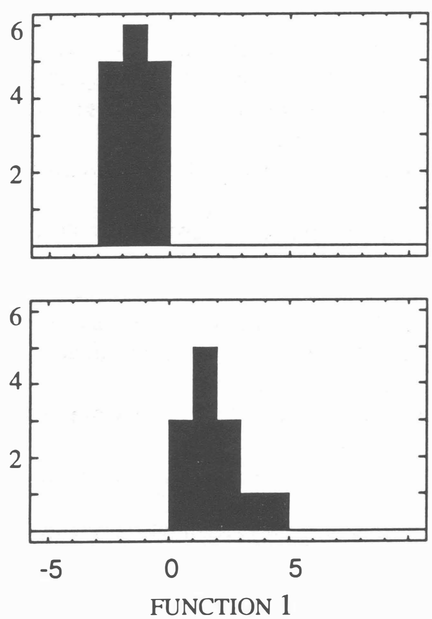
Mineralogy (microscopy and XRD) gives no difference between the two groups. Quartz (plus chalcedony) of low-crystallinity index (MURATA and NORMAN, 1976; range 0.66-1.80, but two cases with values 3.01 and 4.10) is the only detectable mineral phase, except a little calcite in some samples. No opal, opal-CT and clay minerals seem to be present.

2.2 Grouping on a geochemical basis

Geochemical data (table 3) indicate that the first group defined by petrography in the previous section, is, on the whole, purer than the second one. This difference is being examined by means of distribution analyses. The diagrams of fig. 3 show some bivariate distributions of the principal elements from table 3. From a geochemical point of view, good correlations Al/Alk an Na/K and poor correlations Fe/Al and Mg/Fe should be pointed out.

From the archaeometric point of view, separability of geochemical data groups is as important as the correlate distributions, in order to check the effective separation of the distinguished groups. This distiction appears clear from fig. 3. Samples of the first group give rise to a complete discrimination in diagrams 3a and 3b, and a clear statistical separation also in diagrams 3c and 3d.

Multivariate discriminant analysis of the two groups, using SPSS, results in the distribution of Fig. 4. The two groups of flints are 100% significatively separated, without any overlay.



Two groups, one function
F1=100% of variance.

Variable employed:
Al, Fe, Mg, K, Na
More significant: Al, K

Fig. 4 - «Gray» flint discriminant analysis. The two «Gray» sub-groups are completely separated by the multivariate analysis.

2.3 Discussion and conclusion on «Gray» flints

From the analyses of sect. 2.2, the conclusion can be drawn that the distinction of the two groups is effectively based on confident data, and merits some archaeometric application. The two groups are defined as follows. a) A group texturally and chemically homogeneous, consisting of 3 geological Lower Cretaceous flints, all sampled in the Malga Dotessa area (fig. 1), and 13 archaeological flints: all *CB* and *PL*, and the most part (5 of 7) of *RV* artefacts. b) A composite group, texturally and chemically heterogeneous, chemically less pure than the first one, consisting of 11 geological Lower-to-Middle Cretaceous flint from all occurrences mapped in fig. 1, save the Malga Dotessa area, and only 2 *RV* archaeological flints.

The following archaeometric conclusion can thus be drawn. 1) The major lithic supply probably had its source in the Malga Dotessa zone, whereas the other sampling areas of fig. 1 can only represent sporadic sources. 2) In particular, the Malga Dotessa area must be the source of the Colbricon (*CB*) and Pian dei Laghetti (*PL*) gray flints which all belong to the first group. The same is valid for the most part of the Riparo Villabruna (*RV*) flints. 3) This conclusion being true, the Malga Dotessa area should be considered as a long-duration flint source in the region, because the flint exploitation should have lasted from the Epigravettian to the Mesolithic. This conclusion deserves a careful examination from the archaeological point of view. Other sources (e.g. two of seven *RV* artefacts) appear only occasional and sporadic. Some caution must be taken with the present conclusion since the statistical sample studied is rather small. However, the data are so coherent that the present conclusions can be confidently assumed as most probable.

3. Red flints

3.1 Petrographic and Geochemical grouping

The «Red» flints (yellowish to brownish red, with spots, specklings and shadings) occur, as usual, as nodules and discontinuous layers within limestones, mainly in the Upper Cretaceous «Scaglia rossa» Formation. Quite minor red flints occur also in Upper Jurassic levels, where, however, beige and brown flints dominate.

A clear division in subgroups can hardly be made on the basis of the petrographic characters.

Microquartz usually dominates in the matrix, accompanied by spots, maculae, or shading to portions of cryptoquartz; this sometimes appears opaque. Cristallinity index is low, ranging from 0.86 to 1.80, as usual in flints. Diagenized microfossils, filled with trasparent and/or coloured hydrous chalcedony, mostly as spherules (in some cases up to about 50%: radiolaritic flints), but also policameral (globigerinidae, gasteropodae) or lensoid forms are variously present.

Diagenesis is also variously developed, so that microfossils stand clearly out in the matrix, as often as they shade gradually into it.

Geochemical data of red and miscellaneous flints are tabulated in table 3. Some bivariate diagrams are shown in fig. 5.

The geological red flints form a rather scattered, composite group. The *CB* and *PL* red artefacts clearly belong to the same group and were probably supplied from one or more source areas listed in Fig. 5 and Fig. 1.

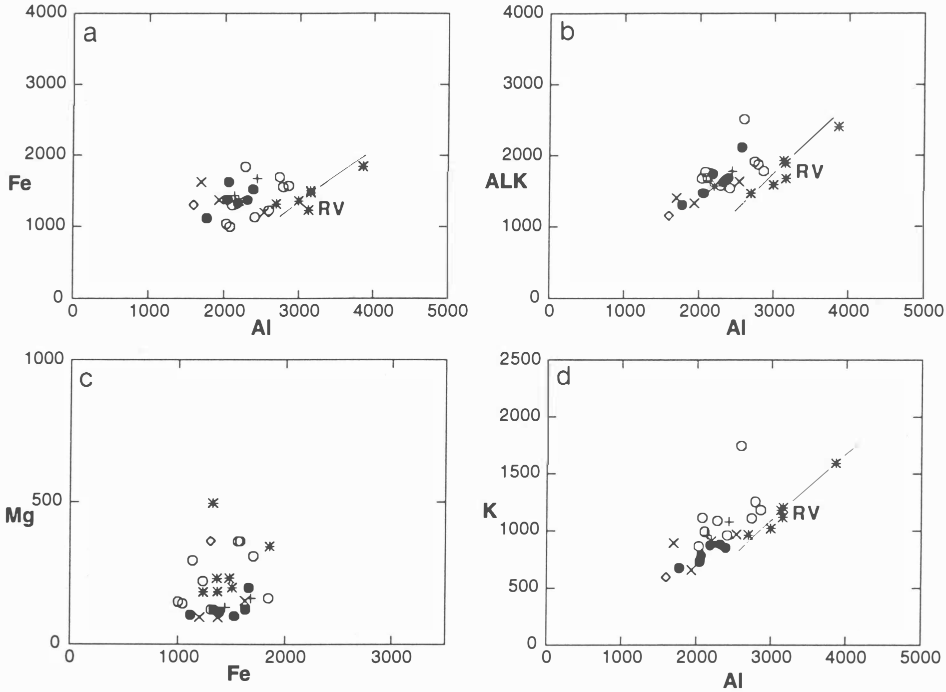


Fig. 5 - «Red» flints, selected bivariate diagrams. A single rather scattered group embraces both archaeological and geological flints. Only the *RV* red flints (save one) form a separate group, having a good inner correlation, mainly defined by a higher Al content with respect to the other flints.

Six *RV* artefacts are Al-richer than all other samples. Because of their consistent inner correlation (Figs. 5a, b, d), they behave as a geochemical separate group, not resembling any other red flint studied here. Accordingly, the source of most *RV* red artefacts is still unknown. Only one of the *RV* flints plots within the above composite group, similarly to the *CB* and *PL* artefacts.

3.2 Multivariate analysis and conclusion on «Red» flints

In order to further investigate the «Red» composite group, a multivariate discriminant analysis (SPSS) was carried out. The results are shown in Fig. 6.

The *RV* archaeological sub-group is clearly separated from the other flints, except for one case, and it is not confrontable with any of the geological flints examined.

The other flints can be broadly separated into two sub-groups, one consisting of only geological flints, collected along Val Cismòn (1 in Fig. 6), and the second made both of geological and archaeological flints (2 in Fig. 6).

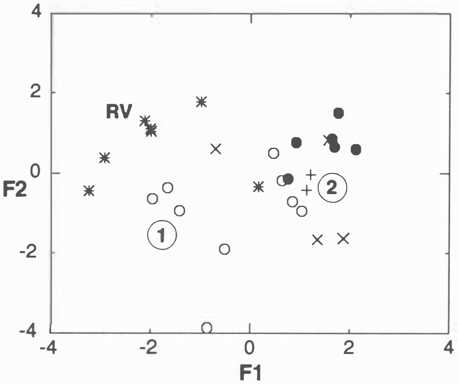


Fig. 6 - «Red» flints discriminant analysis. Symbols as in Fig. 5.
The archaeological *RV* sub-group is fully distinguished, both as plotting position and inner correlation, compared to the other flints. The archaeological flints, *CB*, *PL* and one *RV*, belong, on the whole, to the sub-group (2), where geological samples from Monte Avena, Arsiè, Salzen, Tesino, Pizzo Uccelli are represented. Sub-group (1) is given by only geological samples from some places in Val Cismòn.

On a geochemical basis, these archaeological flints (*CB, PL* and one *RV*) could be considered as exploited from a common source area, which cannot be defined in detail, because the comparable geological flints of group 2 in Fig. 6 were sampled in various areas (Monte Avena, Arsiè, Salzen, Tesino, Pizzo Uccelli, cfr. Fig. 1).

In conclusion, geochemical data are suitable and reliable for discriminating some sub-groups within the «Red» sample and allow the following points to be outlined.

1) Two sub-groups of archaeological flints can clearly be distinguished: *RV* and *CB+PL* (+ one *RV*) flints. The two groups must have been supplied from different sources.
2) The source of most of the *RV* flints is unknown, because no examined geological flint is comparable with them.
3) *CB* and *PL* flints (plus one *RV*) are fairly similar, and can be considered as an actual sub-group, although its distribution is rather scattered in Fig. 6 and the statistical sample is small. Further sampling would be suitable for a control.
4) The archaeological sub-group *CB+PL* and one *RV* can have a common provenance, but this cannot be specified, because the geological flints from several areas (Monte Avena, Arsiè, Salzen, Tesino, Pizzo Uccelli) have a comparable geochemical composition. Only a provenance from some points along Val Cismòn (sub-group 1 in Fig. 6) can be ruled out.

4. Summary and conclusion

4.1 Summary

The petrographic and geochemical study of 31 archaeological and 38 geological flints was carried out in order to define the lithic exploitation and supply to three prehistoric sites in the Val Cismòn - Lagorai region (Trentino and Belluno province), that is Colbricon (*CB*), a mesolithic deposit at about 1900 m a.s.l., Pian dei Laghetti (*PL*), a latest epigravettian site at about 1400 m, and Riparo Villabruna (*RV*), an epigravettian deposit at about 500 m a.s.l.

In the three archaeological sites the gray flints predominate over the red and coloured ones (Table 1). Sampling of geological and archaeological flints (Table 2, Fig. 1) includes all cases.

The gray flints occur in the Lower Cretaceous «Biancone» Formation, whereas the red and miscellaneous flints mostly occur in the Upper Cretaceous «Scaglia rossa» Formation, in both cases as nodules or discontinuous layers within limestones. Minor red and miscellaneous flints occur also in Upper Jurassic limestones.

General geochemistry of the flints examined (sect. 1.3, Table 3, Fig. 2) reveals significant elemental differences between gray and red flints. This concordance composition/colour indicates that the methods used (sect.1.2) are reliable for comparison work and consequent interpretation. Measurement and sampling errors are also briefly discussed.

The petrographic and geochemical data of the gray flint group (chpt. 2), makes it possible to clearly distinguish two sub-groups. The first one is quite homogeneous and includes three geological specimens, sampled in a single area (Malga Dotessa), as well as all the *CB* and *PL* archaeological fragments and the most part of the *RV* artefacts (Figs. 3 and 4). The second sub-group is a composite one, including all other geological samples and a minor part of the *RV* pieces.

The red flints (chpt. 3) form a composite group, not easily divisible into sub-groups on a petrographic basis. Geochemical data (Figs. 5 and 6) make it possible to separate the *RV* red flints, save one, as a distinct sub-group, not comparable with any, either geological or archaeological, flint studied. *CB* and *PL* flints are, on the contrary, fairly similar to each other and comparable with geological flints from various places, excluding the bottom of the valley.

4.2 Archaeometric conclusion and interpretation

Some conclusions can be drawn and some inputs to interpretation given, based on the petroarchaeometric data obtained.

1 - The Colbricon and Pian dei Laghetti high-mountain sites bear fully comparable, similar flints both gray and red. As a consequence common sources can be postulated for the two sites, as if the same human groups had occupied them, or as if long-duration supplying sources had been exploited by the latest - epigravettian and mesolithic local populations.

2 - Riparo Villabruna indicates a more complex strategy of lithic supply. For the most part, the *RV* gray flints are similar to the *CB* and *PL* gray flints and a common source for them seems probable. Only a minor part of the *RV* gray flints must have had a different provenance, being compositionally different.
The *RV* red flints show substantial differences from the *CB* and *PL* sub-groups. For their most part, they reveal common characters in the sub-group, distinct from any other geological or archaeological flints here examined. Only one *RV* sample shows similar composition as *CB* and *PL* flints.

3 - The common source for supplying the three sites with gray flints, as suggested by archaeometric data, can be probably located within a precise area, near Malga Dotessa (cfr. Figs. 1 and 7), the only area where similar geological flints have been sampled. This being true, a question of long-lasting flint exploitation arises, which probably needs an appropriate archaeological study. Other gray flint sources appear only sporadic and of minor importance.

4 - The source areas for providing the *CB*, *PL,* and only partly the *RV* sites, with red flints cannot be precisely located, because several sampled areas in Fig. 1 and 7 are consistent with this possibility. Only the bottom areas of Val Cismòn should be excluded.
5 - The source of most *RV* red flints is different from those of the *CB* and *PL* red flints, and still unknown (cfr. Fig. 7), all geological red samples being different from the *RV* flints.
6 - Possible procurement paths to the sites are put forward in Fig. 7. The most probable and important one is the way from Malga Dotessa to *CB*, *PL* and *RV* sites for gray flint supply. The same way to *CB* and *PL* for providing red flints is consistent with geological comparison data, but different providing paths cannot be excluded.

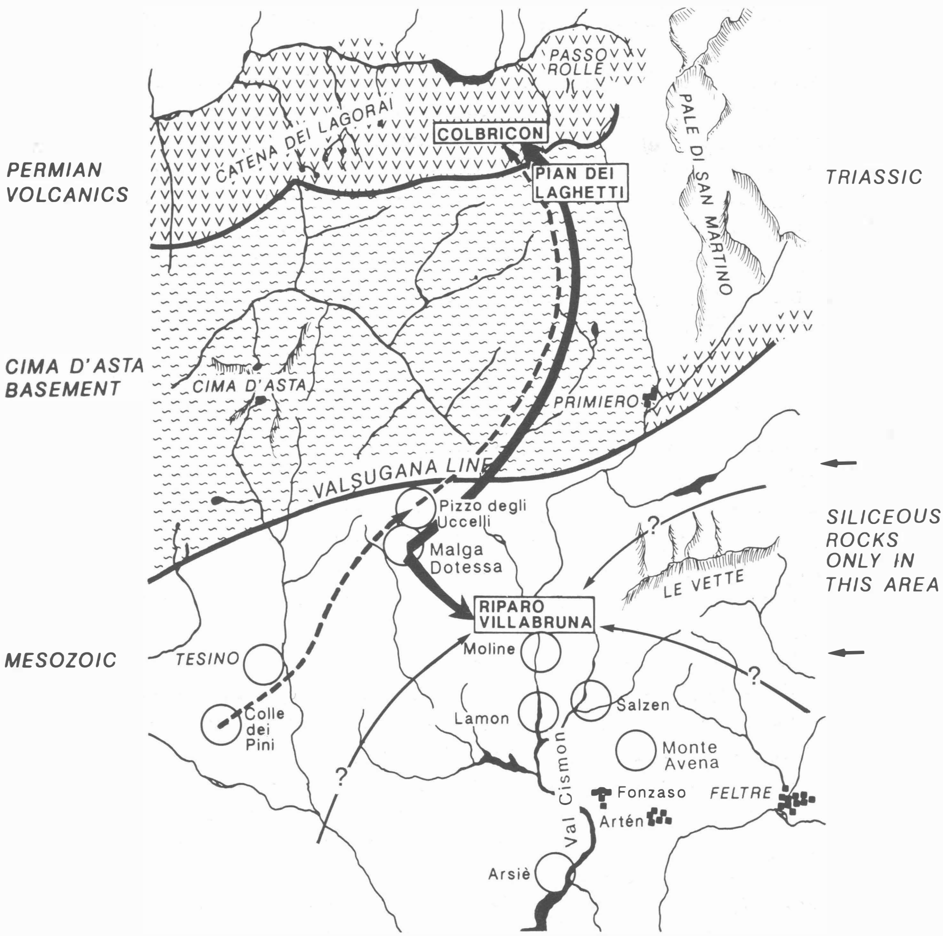


Fig. 7 - The same map as Fig. 1. The probable or possible paths of flint procurement, according to this paper, are marked. In full evidence the probable path of the Gray flint supply to the three sites. A possible way of trasport of the Red flints to the two high mountain sites *CB* and *PL* is represented by a dotted line. The thin lines accompanied by question-mark symbolically indicate an unknown Red flint provenance, different from the sampled areas, to Riparo Villabruna.

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RIASSUNTO

Sono state studiate alcune selci provenienti dai siti archeologici di Colbricon (CB, Mesolitico), Pian dei Laghetti (PL, Tardo Epigravettiano) e Riparo Villabruna (RV, Epigravettiano recente), situati nel territorio compreso tra Val Cismon e Lagorai (Trentino-Bellunese), e sono state comparate con le selci geologiche provenienti da campionature effettuate in Val Cismòn e zone limitrofe. I manufatti di selce grigia prevalgono decisamente su quelli rossi. Con l'ausilio di metodologie petrografiche e geochimiche si è giunti alle seguenti conclusioni:

- le selci grigie provenienti dai siti CB, PL, RV hanno tutte una forte somiglianza con le selci geologiche provenienti da un'unica zona situata vicino a Malga Dotessa. Nessun altro campione geologico concorda con le selci archeologiche, a parte due (su sette) manufatti RV. Si ipotizza, quindi, che la zona di Malga Dotessa abbia rappresentato una fonte litica importante, sfruttata dall'Epigravettiano al Mesolitico, laddove invece altre fonti erano di tipo occasionale;
- tutte le selci rosse RV, eccetto una, non corrispondono ad alcuna selce geologica; la loro fonte è tutt'ora ignota. Gli altri manufatti rossi concordano con varie selci geologiche studiate, anche se non si riesce a localizzarne con precisione la fonte. Le selci d'alta quota CB e PL avevano probabilmente delle fonti comuni. Una delle possibili vie di trasporto delle selci rosse verso i siti CB e PL potrebbe essere stata più o meno la stessa di quella usata per il trasporto delle selci grigie.

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