

First data on the exploitation of hyaline quartz crystals in the upper Romanche (Isère and Hautes Alpes, France)

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SUMMARY - *First data on the exploitation of hyaline quartz crystals in the upper Romanche (Isère and Hautes Alpes, France)* - The upper Romanche Valley, on the north backside of the Pelvoux massif and inside the Grande Rousses massif, was the location of intensive work for the extraction of hyaline quartz crystal with a general characterisation which concerned the mountainous massifs up to a high altitude beyond glacial slides. These are starts of shorts galleries and pits, but also sometimes real mining works with most of the time an extension limited to druses of quartz veins in general vertical enclosed in the crystalline basement. These extraction sites, to be found in great number and testifying of intensives researches, include traces of the technologies used for the digging: powder with manual boring of crowbars holes, but also fire setting in the massives quartz veins, or with chisels in the spits of gneiss, which testify the polyphased character of the exploitation of many sites. They come together with crystal sorting areas, where the raw material was cleared of the clay product and where the crystal were separated from their matrix, these craps being able of forming on the spot accumulation of up to several tens of cubic meters. No definite chronological element was available yet on that question, but the discovery of stone mauls and ceramic from the most important exploitation sites could testify of a generalized exploitation of crystal as soon as the Neolithic age. The whole of these elements testify therefore of a structured extractive activity, with a systematic character which extended through the ages in the alpine massifs and which appears as a real factor for mountain occupation.

RIASSUNTO - *Primi dati sullo sfruttamento dei cristalli di quarzo ialino nell'Alta Romanche (Isère e Hautes Alpes, Francia)* - L'Alta Valle della Romanche, sul versante settentrionale del massiccio del Pelvoux e all'interno del massiccio delle Grande Rousses, è stata oggetto di lavori intensivi di estrazione dei cristalli di quarzo ialino, fino ad altitudini elevate e talora al di sopra delle lingue glaciali. Si rinvennero imbocchi di brevi gallerie e fosse, ma talvolta anche di veri e propri cantieri di abbattimento aventi per lo più un'estensione limitata alle geodi dei filoni di quarzo, che si presentano generalmente subverticali e incassati nello zoccolo cristallino. L'elevato numero di siti estrattivi identificati è indice di ricerche intensive e rivela tracce delle varie tecniche impiegate per lo scavo: a polvere pirica, con perforazione manuale dei fori da mina, ma anche a fuoco, nel quarzo filoniano massiccio, o a punteruolo, nei filoni di gneiss. Tale varietà tecnologica dimostra che parecchi siti hanno avuto più fasi di sfruttamento. Le escavazioni si accompagnano sovente ad aree di cernita dei cristalli, dove il minerale grezzo veniva ripulito dai materiali argillosi e dove i cristalli venivano separati dalla matrice; i residui di queste operazioni possono avere dato luogo ad accumuli di diversi metri cubi. Non è per il momento disponibile nessun elemento cronologico preciso, ma il rinvenimento di strumenti litici e di pezzi di ceramiche nei siti estrattivi più importanti potrebbe attestare che lo sfruttamento dei cristalli risale al Neolitico. L'insieme delle evidenze testimonia quindi un'attività mineraria specifica e strutturata, portata sistematicamente avanti in certi massicci alpini nel corso delle epoche, la quale appare un vero e proprio fattore di occupazione della montagna.

Key words: Haute Romanche, Neolithic, quartz crystal, prehistoric mining, fire setting

Parole chiave: Alta Romanche, Neolitico, cristallo di rocca, miniere preistoriche, abbattimento al fuoco

1. INTRODUCTION

Hyaline crystals artefacts are known in numerous archeological sites generally of the mesolithic or neolithic age of the alpine massif and of its periphery and are also to be found in manufactured products of antique age or of more recent date.

This crystal hewing industry has lasted so over time and seems to have been flourishing till the artificial crystal invention at the beginning of the 19th century which brought about its quick decline.

The written sources also mention rock crystal search at the roman time (De Saint-Denis 1972), as well as in the 17th and 18th centuries (Caire Morand 1826). Big

crystals raw from any hewing were found in the excavations of the roman site of the Park Hotel at Muralto in Ticino.

If the origin of these crystals could be attributed without doubt to the alpine massif and sometimes more accurately to some areas of this massif by examining the shape and the habit of these crystals, and if many crystal extraction sites are known there for the recent times, these sites were never before treated with an archaeological approach.

However already in 1966 in the Ossola valley, C. Albertini had met in an alpine fissure with quartz crystal a fragment of a broken dagger attributed to the Middle Bronze age (Albertini & De Giuli 1975).

If the artefacts in hyaline crystals have been in recent years the object of numerous research works, and particularly about their typology or their mineralogical characterization (Cousseran 2001; Brisotto 1999, Baroni 2003), and although an alpine origin *sensu lato* is approved unanimously, no definite identification process of the sources deposits and of their modes of exploitation had been undertaken so far.

The search for sources deposits of archeological quartz was conducted in the area of the Upper Romanche valley, located to the East of Grenoble, in an area located between the Lautaret pass and the town of Bourg d'Oisans at the north backside of the Pelvoux massif, known as being particularly rich in quartz veins (Fig. 1); these in effect were known, having been the location of an intense activity of crystal

search in the 18th century, particularly to feed the cutting works of A. Caire Morand in Briançon, together with the cutting works in Grenoble (Bernard 1997). However, areas located more to the north, particularly in the Tarentaise and the Maurienne valleys and the Beaufortain area could have equally been the object of these prospections due to their richness in quartz deposits and to numerous written evidences of their exploitation.

2. THE HYALINE QUARTZ CRYSTAL SOURCE DEPOSITS IN THE UPPER ROMANCHE

The searches lead with prospections of a systematic character have so brought to the fore a set of crystal quartz exploitation works of an extent unsuspected so far made most of the time of simples pits and trenches on the veins, but also sometimes, actual vertical chambers and exploitation caves. The counted sites necessarily most incomplete owing to the uneven nature of the area exceeds currently one hundred, spread out between the bottom of the valley and the periphery of glacier strips up to 2700 m high.

The question of the age was raised, for these exploitations the nature of wich is certainly multi-phase, in fact, if the written sources (Guettard 1782) and particularly the Cassini map (Rossi & Gattiglia 1993) state a small local industry in the 17th and 18th centuries of an evidently inveterate nature as testified by the con-

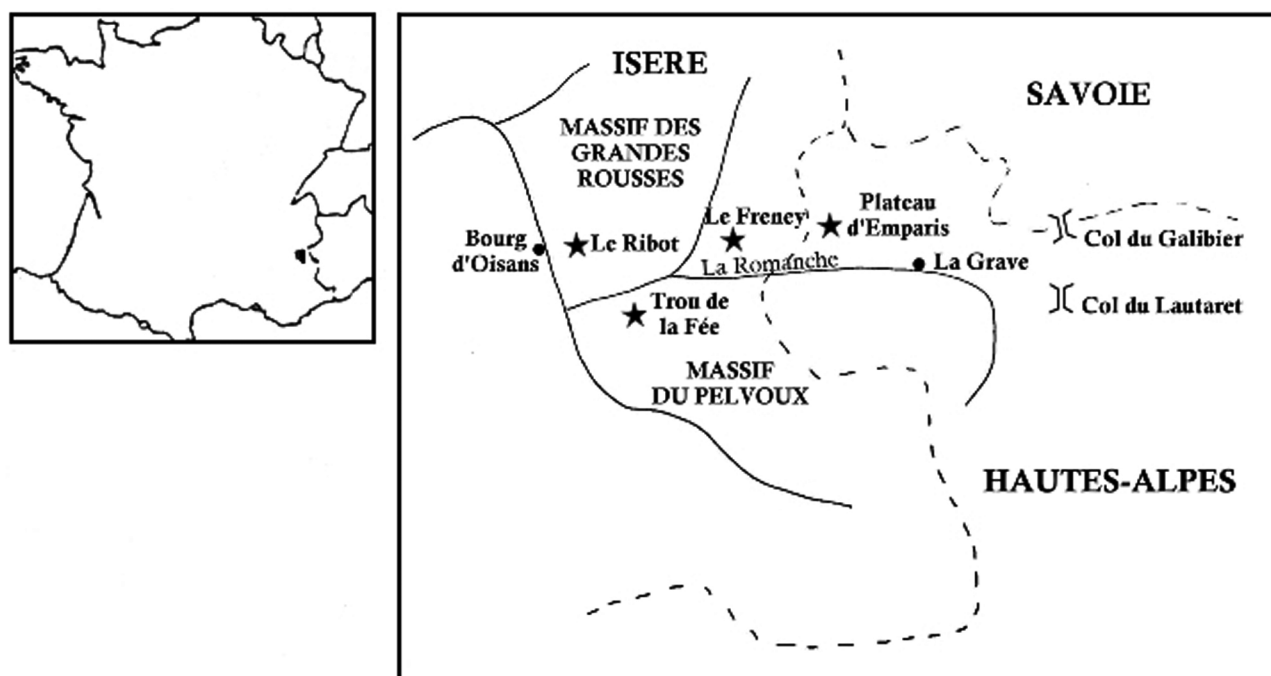


Fig. 1 - Situation map.

Fig. 1 - Carta dell'area di ricerca.

flicts it generated, particularly between the exploiting local populations and the companies created to exploit the crystals or with the state and the king. The elements strictly related to the local extraction of the crystals are very scarce and the most ancient is to be found with no doubt in the trading licences of Louis XIII where is mentioned in 1409 a place named "La Cristallière" in the district of Vizille (Francois 1998).

There are very few datation elements of the extraction sites of hyaline quartz crystals and the analysis of the digging modes has enabled a first approach of this aspect.

3. GEOLOGICAL CONTEXT OF THE CRYSTALS DEPOSITS OF THE UPPER ROMANCHE

The veins of milky quartz, often powerful (from 10 cm to one or to two meters) and of most varying extension, are enshrined in the crystalline platform of the external alpine massifs of the Pelvoux and the Grandes Rousses with generally a localization next to the contact between the metamorphic or magmatic rocks and the sedimentary triassic cover representing a precious guide for prospecting.

These veins perpendicular to this contact with the cover (and so more often near vertical) are all the more present in its neighbourhood; they are rooted more or less quickly in depth and a few big structures can expand in depth beyond 200 m.

They are particularly numerous in the northern part of the Pelvoux crystalline massif where they gather sometimes in sizeable veins fields or are found there isolated. These vein deposits on the other hand are absent from the southern part of the massif where only quartz veins are found more or less metalliferous but without crystals (Rostan 2005).

Such veins rich in crystals are not found either in the crystalline massifs of Argentera Mercantour more to the South of which hyaline quartz crystals resources are very limited.

The crystals are found in these veins within geodic cavities more or less expanded but able to reach large volumes (up to several cubic meters); these cavities are spread in strings in the veins and seems to originate from late dissolutions within the vein, probably of alpine age by and large, and within which the crystals expanded. The geodic cavities follow one another and are split by zones where only small cavities more or less filled with quartz subsist.

Cavities of fissure shape developed deep in the narrow veins are equally found, but the real alpine fissu-

res, generally of smaller extension are little developed there, contrary to the areas located more to the North (Maurienne, Tarentaise, etc.); however this type of deposit, well known on the mineralogical level, can only provide a necessarily limited crystal volume and could only be subject to works of small extent.

4. CRYSTAL EXPLOITATION WORKS

These works show the characteristic of being approximately limited to geodic cavities and of practically not entailing any digging to search in the massive quartz nor any cross-cut gallery to gain access to the veins.

In this way the principles of these works differ significantly from the classic mining works conducted for the metallic ores and show systematically an archaic nature.

They are in effect for the most part visually conducted in the geodic cavities with pits on the veins or simple emptying of cavities and the works consist of either widening cavities after extraction of the crystals or after a digging meant to follow small cavities which are generally able to open further in the vein on more important cavities. So examining the rock faces of the extraction sites does not generally show practically any more crystal traces and the works were stopped on the massive quartz without crystal nor cavities.

The most important works consist of digging on the big fissure cavities up to a hundred meters long on some sites of the district of Le Freney d'Oisans or in caves opened onto a succession of sizeable cavities; the smallest consist of a simple emptying of cavities of a few litres volume.

The techniques used to carry out the digging consist of black powder, fire setting, and the manual digging with metallic tools or stone tools.

5. DISTRIBUTION OF CRYSTAL EXPLOITATION

The high altitude deposits, often uncovered recently by the withdrawal of glaciers strips and some areas difficult of access have not been the seat of works more or less ancient for hyaline quartz crystals exploitation, at least with regard to the bigger crystal cavities and remained untouched till recent times.

The analysis of the modes of digging in relation to the geographical distribution of sites is particularly rich in learnings. The only deposits dug exclusively with powder without traces of previous works are all located in high altitude in areas of a lengthy and difficult

access. Moreover, it is understood from the written work of the 18th century that the deposits are all located in high altitude; if this feature does not correspond to any logical reality and many crystal sites are found downstream in the valleys, it indicates *a priori* a relative exhaustion of the crystal resources at low altitude from before that time. On top of that, if some areas of a high altitude (above 2000 m) and rich in exploited veins do not show any trace of powder digging, it is systematically in geographical areas of easy reach (Le Plateau d'Emparis à La Grave, le Trou de La Fée at Les Deux Alpes).

Actually, all other sites and in particular the big sites of average altitude show all at different degrees digging techniques more archaic with essentially fire setting; some sites reached phases of work extended enough with these techniques so that no attempt of notable rework was done later on (Le Ribot, Lacs Cristallins, Le Trou de La Fée...).

So it is likely that powder digging allowed a rich start of crystal extraction activity with the overcoming on numerous sites of technological barrier which prevented the development of works in massive quartz.

6. DIGGING TECHNIQUES

The quartz veins are a particularly compact and strong material when they are massive and they prevent from a classic manual mechanical digging in full block using metal or stone equipment; however the geodic cavities appear in the veins with heterogeneous cracks, which announce the neighbourhood of the cavity.

Most of the time, the rock face of the sizeable cavities show plates more or less thick spiked with crystals and that are already detached, allowing for a quick extraction of the content of the cavity and not needing any more special techniques.

The digging in massive and compact quartz was realized generally by thermic extraction sometimes of a very high volume (more than 1000 m³ at Le Ribot in the district of La Garde) and for a small part by powder digging; actually those works using powder often only concern local rework of sites exploited with other methodologies or else sites of very high altitude that were thus remained free of any work till the generalization of the use of powder in the underground works in 17th century.

A close examination of fire setting modes brings to the fore a technique specific to cavities of oblong section, shaped as a willow leaf non typical for this digging mode, showing here technical forms distinct

from those, now classic, known in metallic mines of various times.

We attribute this type of fire setting to a widening of the geodic cavities after taking the crystals, the fires were set in a narrow vacuum obtained by mechanical digging or by simply removing the crystals that are found most often already naturally detached within the cavities; cavities of classic round section dug with fire are found on the other hand systematically at the end of the excavation, testifying of a thermic extracting done this time in massive and homogeneous rocky materials with the purpose of searching for new cavities (Fig. 2).

In this case the examination of rock faces in the crystal sites in general does not show any more the least trace of crystals because the digging was continued as long as there remained small cavities capable of indicating the existence of other more important geodic cavities beyond.

Besides such fire setting with sections in «willow leaf» shape have been described in the copper deposits of Roua in the Alpes Maritimes (Rostan & Mari 2005).

The process of thermic extraction for extracting quartz crystals can be understood in the following way (Fig. 3): after a first phase of easy extraction of the crystals located in an untouched cavity, fires are lit in this cavity to widen the rock faces and give access to the following geode, the process was repeated as many times as necessary; at the end of the geodic cavity, the thermic extraction will involve massive quartz with a cutting front of a hemispheric shape till the opening of another cavity, directly adjoining or till the end of the works for lack of a new cavity.

At this point acute problems of fires organization and of mastering the draughts are set particularly for the creation of narrow galleries or of deep pits dug *per descensum*.

A few baked clay fragments of slag like shape including small fragments of flat quartz from the thermic extraction could testify from a device to protect crystals yet to be extracted during the process of thermic extraction with a filling of the cutting front by clay usually existing on the spot directly in the cavities of the vein.

Very few sites show traces of manual digging with a metallic set of tools, in this case the chisels, and this situation is the result of several factors.

In effect, on one hand this digging mode is not possible in massive quartz which is a too compact a material and on the other hand most of the crystalline rocks enclosing the veins are rocks also very compact in which it is not possible to use this method.

In this way, only the zones including micaceous

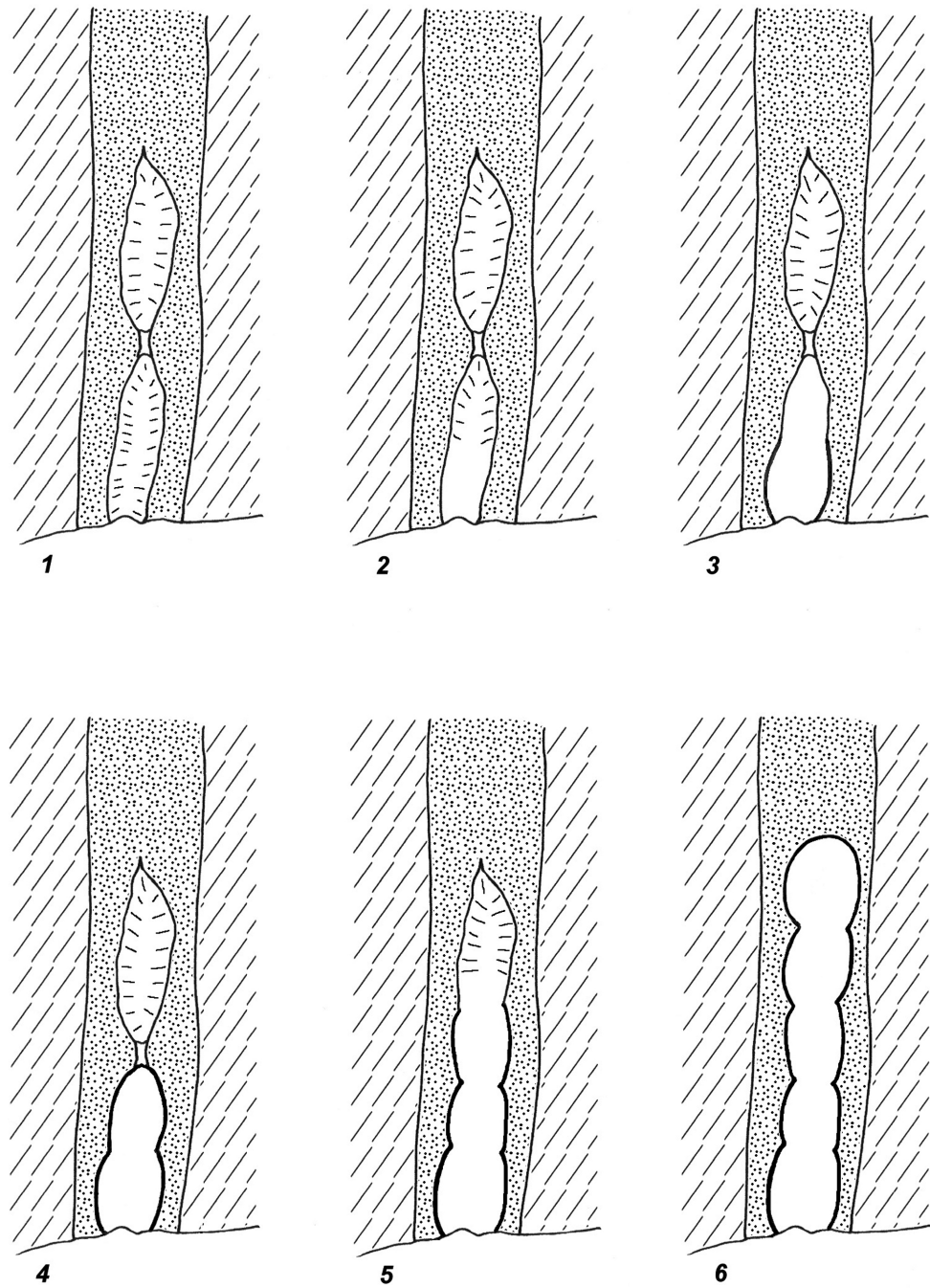


Fig. 2 - Successive steps of the quartz crystal extraction by fire setting. 1. First state. 2. First crystal extraction. 3. Widening by fire setting and new extraction of the crystal. 4. New widening by fire setting. 5. Fire setting in massive quartz to find a new cavity. 6. New fire setting in massive quartz after the emptying of the cavity.

Fig. 2 - Fasi dell'estrazione dei cristalli con abbattimento al fuoco. 1. Stato iniziale. 2. Prima estrazione del cristallo. 3. Allargamento con abbattimento al fuoco e nuova estrazione del cristallo. 4. Nuovo allargamento con abbattimento al fuoco. 5. Abbattimento al fuoco nel quarzo massivo per cercare una nuova cavità. 6. Nuovo abbattimento al fuoco in quarzo massivo dopo lo svuotamento della cavità.

gneiss and chloritoschists show this type of digging, which is located for the Upper Romanche in the district of la Grave in a limited way, and in the area of Le Freney d'Oisans.

Digging with stone mauls is recognized nowadays on the most important sites of crystal extraction alone or together with the fire setting; the stone mauls in strong rocks essentially quartzites and leptynites of neighbouring origin, have been found in the tip heap or inside the crystal sites on the locations of Le Ribot at La Garde, of Freney 3 at Le Freney d'Oisans and of Lacs Cristallins at La Grave (Fig. 4).

On top of that, ceramic fragments still under examination allow to estimate the Neolithic age as the average for this type of works.

7. ORGANIZATION OF THE EXPLOITATION SITES

The extractions sites, at least with respect to those that have used black powder works are generally more or less structured present depending on their importance with, next to the extraction site, specific areas

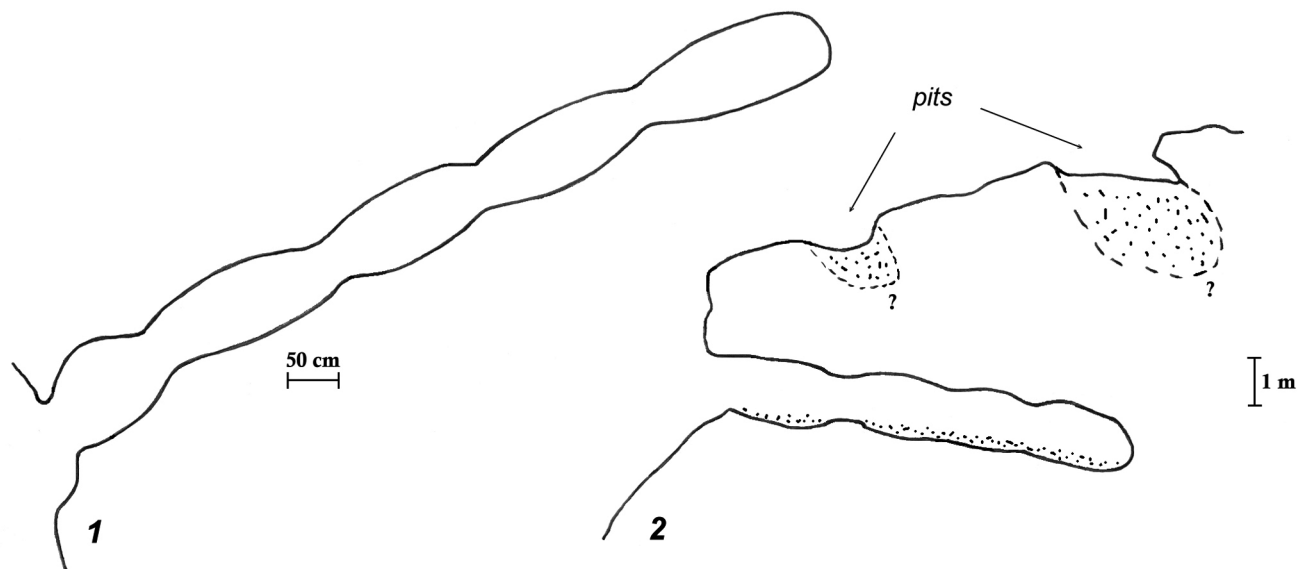


Fig. 3 - Crystal mine of Le Trou de la Fée at Les Deux Alpes. Morphology of the cavity dug by fire setting. 1. Map view; 2. Vertical view.

Fig. 3 - Miniera di cristalli del Trou de La Fée a Les Deux Alpes. Morfologia della galleria ottenuta con abbattimento al fuoco. 1. Veduta in piano. 2. Veduta verticale.

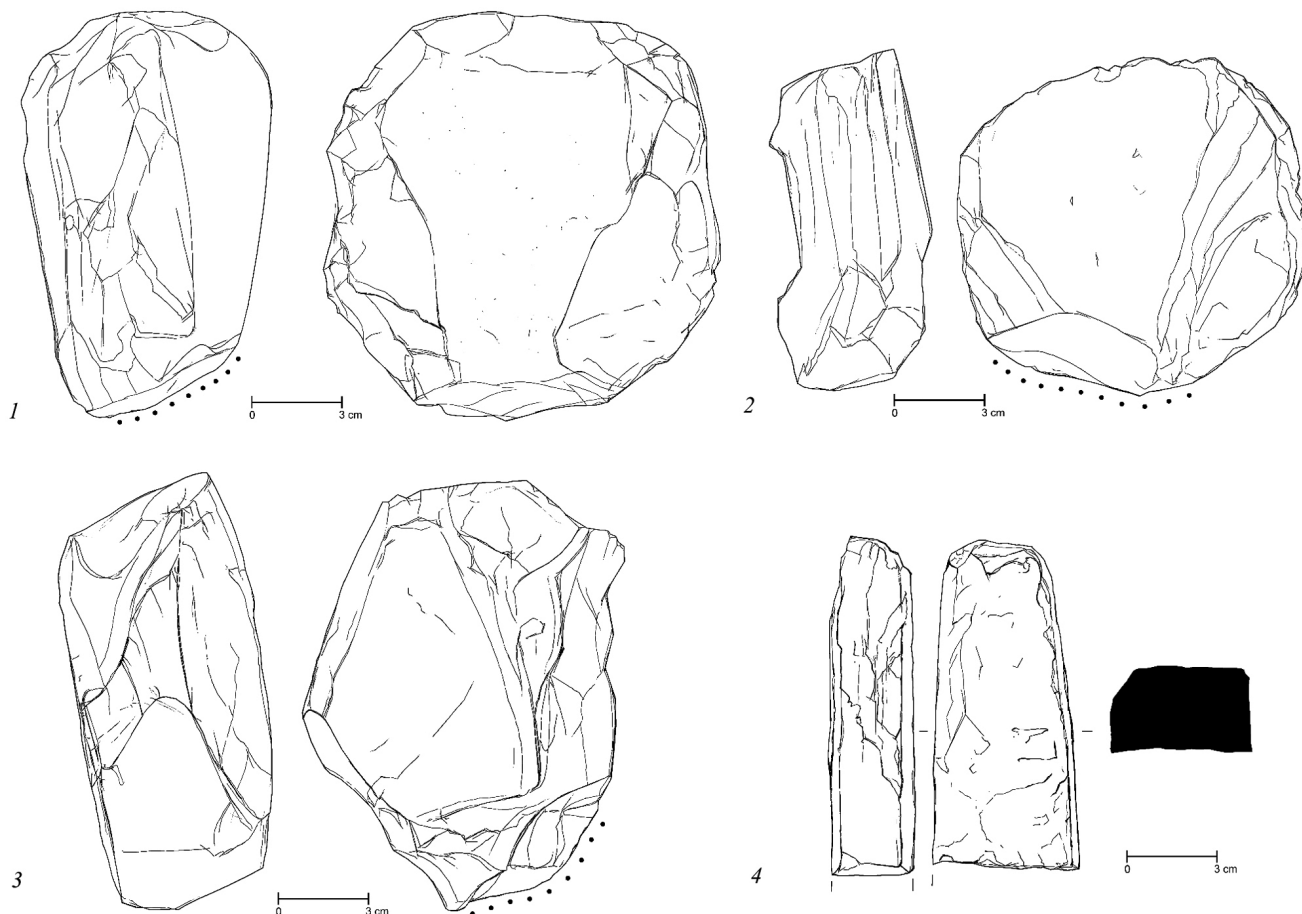


Fig. 4 - Stone mauls from crystal mines (drawings by A. Gattiglia). 1. Plateau d'Emparis: Quartzite maul. 2. Le Freney d'Oisans: Chloritoschist maul. 3. Le Ribot: Leptynite maul. 4. Le Ribot: Amphibolite maul.

Fig. 4 - Mazze dalle miniere di cristalli (disegni di A. Gattiglia). 1. Plateau d'Emparis: mazza in quarzite. 2. Le Freney d'Oisans: mazza in cloritoscisto. 3. Le Ribot: mazza in leptinite. 4. Le Ribot: mazza in anfibolite.

devoted to sorting the extracted products; these zones are identified by the presence of more or less important heaps of broken crystals or of small size which cannot be from their position and their nature, attributed to tip heaps.

In effect, these scrap accumulations made of broken, cracked or of small size crystals with massive quartz, prism base still attached to their matrix, a few rock debris and yellowish clays products usually found within the geodics cavities and left from the clearing of the crystals.

The examination of these crystal fragments does not show for the time being splinters attributable to any cutting up but seem rather to stem, for the considered sites, either from the extraction or more often from the actions taken to separate the prisms from their milky massive quartz matrix not usable for the cutting activity.

Those sites in the current state of research do not seem to include crystal hewing workshops *in situ* but rather to have been specialized in the activity of extraction and preparation of the product before its export from the site; this aspect, recognized in particular for the modern time where the products from the crystal sites were exported to Swiss or Italian hewers workshops then, later on, to hewing establishments of Grenoble or Briançon seems also to be verified for more ancient times, as it has not yet been found on the sites crystal fragments attributable to cutting up.

8. CONCLUSIONS

It so appears that the hyaline quartz crystals deposits were the seat of very developed works at least from the Neolithic age, and therefore it is likely, at least at the present stage of research, that most of the hyaline quartz crystals extraction sites were exploited from the prehistoric age as they show strong analogies with the shape of the works and extractive process of sites for which an age can currently be assigned, and are in their neighbourhood.

So, quartz crystal production does not seem to have been the result of an uncertain collection on the part of actors brought to mountain by pastoral, cynegetic or other preoccupations but rather as the result of an organized and specialized activity, particularly at the prehistoric times with certainly an extractive industry devoted to export for hewing beyond the production sites.

Therefore it is possible to discard without any doubt a crystal collection from the glacial moraines, because crystals are only exceptionally found in the

Romanche moraines in high altitude and very close to the veins.

Production has probably been of the magnitude of several millions crystals for the sole area of the Upper Romanche; this is a very sizeable figure which depicts the importance of quartz crystal hewing industry in the Alps.

This activity shows therefore once here a traditional feature, evidently without mining know how for the times earlier than the 17th century and represents an occupation factor of mountain in itself.

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