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# AGE ESTIMATES FOR THE PETROGLYPH SEQUENCE OF INCA HUASI, MIZQUE, BOLIVIA

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## Introduction

Reliable information about the antiquity of pre-historic Bolivian rock art has remained elusive until now, as is the case in the rest of South America. We are better informed about recent rock art corpora of Bolivia, *i.e.*, of the Colonial and Republican Periods (Querejazu L. 1992). However, for the time before the Spanish conquest, beginning in 1532, clues for the age of all Bolivian rock art have until now been limited to archaeological speculation. In 1987, I examined the then-newly discovered site Cabracancha (Department of Santa Cruz) and attempted an approximate age estimate of its petroglyphs, using geomorphological criteria (Bednarik 1988). This led to an age estimate of 500-1000 years BP. The petroglyphs at this small site are dominated by a distinctive 'trident' design which is also prominent on ceramic remains in Bolivia. Such remains were subsequently excavated in a stratified context at Comacho Tunal Mayu, where they occurred together with charcoal providing a radiocarbon age of 560 ± 70 years BP in 1996 (Roy Querejazu Lewis, personal communication, April 1997). This seems to confirm the estimate derived from 'direct' indices, increasing confidence in the validity of such analytical approaches.

The last ten years have seen the development of the microerosion dating methods for petroglyphs (Bednarik 1992, 1993a). These methods have been subjected to a series of blind tests, involving petroglyphs on several continents. With the exception of the controversial Côa sites in Portugal, all these blind tests produced results that are fully compatible with archaeological predictions or other estimates, but even at the Côa sites they match the results of other direct dating evidence (Bednarik 1995a, 1995b; Watchman 1995). Microerosion data are believed to provide results of great reliability, but lack precision, particularly where local calibration curves are not established, or where only one mineral component is calibrated. However, because the results appear to be consistently reliable, and because numerical precision is not a high priority in the initial establishment of a chronological framework for the rock art of a region lacking such a system entirely, I consider the use of microerosion analysis appropriate in the establishment of a chronology of Bolivian petroglyphs. During March and April of 1997 I examined a series of petroglyph sites in the Mizque Valley, and near Cochabamba, with the specific purpose of securing data suitable for initiating a reliable chronological framework for prehispanic Bolivian rock art. In the course of this work I succeeded in acquiring such data from five sites: Inca Huasi, Toro Muerto, Kalatrancani 1 and 3, and Lakatambo 2. Of particular importance in creating such a chronology is the first-mentioned site which is briefly described here.

## The site

Inca Huasi is located 3 km from the town of Mizque, immediately above the Uyuchama River (Figure 1). It occupies the lowest end of a prominent quartzite dyke, caused by contact metamorphism, that extends in a wide sweep to the top of the mountain at whose foot the site is situated. The dyke has resisted the erosive impact of the river, and has preserved, on its side away from the river, a slope of softer sandstone averaging 23° towards NNE. Petroglyphs occur both on this slope and on the part of the dyke immediately above it, over an area of c. 30 m by 20 m. All those on the quartzite dyke are cupules, while those on the sandstone comprise cupules, circles with central pit, a wave line, and linear grooves. The cupules on the sandstone slope are usually arranged to form linear sets, while those on the dyke above it are apparently distributed randomly, often covering small panels completely.

At an elevation higher than the uppermost petroglyphs, just above a recently constructed concrete irrigation channel, is an area of sloping sandstone pavement covered by numerous horizontal polished grinding dishes, each around 50 or 60 cm long. These are better preserved than the petroglyphs on the same type of rock, and are spatially separate from them. In the same area numerous artifacts occurring on the surface of a sediment have either been deposited there, or have been washed out of the soil by rain water. Stone tools and ceramic fragments are found here, but are absent below the petroglyph panels. Most of the lithics observed are coarse-grained flakes, some with concave retouch, but the majority are crude, non-diagnostic implements.

The various modification traces on the rock surfaces of this site can readily be divided into three groups on the basis of different morphologies and ages. The polished dishes appear more recent than the petroglyphs on the soft sandstone, and these in turn are clearly younger than the cupules on the significantly more weathering-resistant quartzite of the dyke formation. There are several other features on the rock surfaces that help us to create a relative time frame of various processes and events that have contributed to the present geomorphic exposures. For instance, there is a distinctive difference in the weathering of the lowermost meter or so of the sandstone slope, the zone just above the present sediment level below the site's main panel. This zone shows relatively little surface deterioration in comparison to the rest of the slope. Almost certainly this indicates a previous higher sediment level during a long period of the past, and that the lower part of the slope was only exposed to weathering relatively recently. This is readily confirmed by the absence of petroglyphs at this lower level, and their commencement immediately above the conspicuous blank zone. Also, there are several areas of heat-induced exfoliation, usually also exhibiting distinctive reddening of thin edges and prominent aspects of the rock surface topography. This discoloration, also found further up on the sandstone slope, is no doubt the result of dehydration of goethite contained in the sandstone to the more stable hematite, which accounts for the distinctive change in color from brown to red. These examples of surface heat spalling and reddening of the rock indicate almost certainly the former presence of hearths.

Of particular importance to reconstructing the geological history of the Inca Huasi petroglyph site are distinctive erosion phenomena on the SSW side of the dyke, *i.e.*, on the near-vertical cliff facing the river, which has been pounded by fluvial erosive forces in the past. At present, the top of this cliff reaches a height of 12 to 15 m above the river in the area where the petroglyphs are distributed (Figure 2). Ancient damage can be found, especially at the top of the rock formation, where it relates to a time when the river was at a significantly higher level. All vertical edges of the cliff facing the direction of water flow have been extensively battered at all levels, whereas similar edges on the 'off-side', *i.e.*, those not exposed to the kinetic impact of the river cobbles, show no corresponding damage.

Individual impact marks are often easily recognizable, and there are even cases where the point of percussion and radial lines remain discernible (Figure 3). This raises the possibility that some of these flake scars may actually be the result of some anthropic action, of quarrying the rock as a source of stone tool material. This is, however, unlikely, because:

a - the rock, while partially metamorphosed to quartzite, is not of sufficient quality to serve for the production of good lithic tools;

b - the flakes removed indicate no well-directed blows, and are usually too small for stone implements;

c - the kinetic damage occurs evenly down the cliff and the direction of percussion is always the same, horizontally;

d -the relative weathering of the impact scars indicates a progressive lowering of the river level; and

e -the edges most easily accessible for quarrying, *e.g.*, on the uppermost surfaces, have not been affected in this way, only vertical edges.

The details so far described are only some of those observed, but they should suffice to provide some basic information concerning the recent geomorphological history of the site. The petroglyphs can be chronologically slotted into this relative framework, through various means. In describing this rock art I begin with the oldest tradition present at Inca Huasi.

## The early cupule tradition

The most conspicuous characteristic of this tradition is that it is entirely restricted to the hard quartzite surfaces of the dyke formation, *i.e.*, there are no similar random panels of very early cupules on the softer sandstone slope. In considering this curious distribution pattern we need to appreciate that to produce a cupule on the quartzite was vastly more difficult than to produce a cupule of equal dimensions on the much softer sandstone. The taphonomic explanation to account for the extant distribution pattern, the most logical one can offer, would be that the cupules were most probably produced on both types of surfaces, but have survived only on the one that is far more resistant to weathering processes. While it is possible that the harder quartzite was sought out specifically, this alternative explanation is not convincing.

Nevertheless, I am unable to offer the taphonomic version as a falsifiable proposition, hence I shall abstain from basing any further deductions on it. I am on more solid ground when I consider the characteristics of the early cupule tradition and its support surface. Although the quartzite is incompletely metamorphosed, grains and 'cement' form a reasonably homogenous whole. The cupules lack peck marks, being rather smooth and well shaped. Under the binocular microscope the deep retreat of the cement is, however, amply evident, and has resulted in a deeply eroded microtopography that is entirely indistinguishable from that of any adjacent, unworked surface. This applies equally to horizontal and vertical panels. Microerosion analysis (Bednarik 1993a) is not possible because no originally fractured edges are detectable, and also because some of the cupules are covered by eroding mineral accretions. A series of pH readings taken from rainwater collected in several cupules and other recesses on top of the quartzite dyke ranges from pH 5.6 to 6.1 (mean pH 6.0).

Of particular significance is the observation that the amount of weathering evident in the lichen-free early cupules on vertical surfaces is practically indistinguishable from the most recent of the edge-battering scars in their close proximity, when both are examined microscopically. We must therefore assume that the production of the early cupules commenced relatively soon after the river had exposed the dyke essentially as it is today. While this provides solid relative dating information for these petroglyphs, it does not solve the question of the real age of this tradition: we do not as yet know at what time the river was 10-12 m above its present level. However, nearby archaeological finds would suggest that this could have been the case during the early part of the Holocene at the latest.

The early cupules on top of the ridge are generally of average diameter for cupules world-wide, and 3-21 mm deep, but there are also a few exceptionally large examples, including three of the four present on top of a free-standing rock tower that marks the western end of the site. The smallest are generally in the order of 3 cm, the largest in the order of 15 cm in diameter.

**The later petroglyph tradition**

In contrast to the unstructured arrangements of the early cupules at Inca Huasi, the more recent petroglyph tradition is quite structured, and appears to relate to an entirely different behavior pattern. Cupules are aligned in linear sets in most cases, and the peck marks remain distinctly recognizable despite the much softer nature of the rock. These petroglyphs are restricted to an area of 20 × 8 m on the sandstone slope that survived the river's erosion because of the protection offered by the quartzite dyke. This sandstone is subjected to granular exfoliation, and under magnification, the surface of the peck marks is quite eroded and exhibits a deep retreat of the silica cement. A widespread black deposit on these petroglyphs resembles an accretionary patina visually, but consists in fact of lichen growth comprising two distinctive species of lichen. The various linear groove petroglyphs in the same area offer a similar pattern of erosion and are very likely to be from the same period.

Because this tradition is executed on a much less weathering-resistant rock type than the early cupules, it is very difficult to estimate the relative age relationship. The absence of peck marks in the old cupules tends to emphasize the age difference greatly, but caution is advisable here. It is quite possible that the relative hardness of the quartzite led to much less distinctive peck marks. Nevertheless, on the basis of the microscopic study I am confident in proposing that the early cupules are at the very least twice as old as the later petroglyph tradition, but are likely to be several times as old.

**The polished dishes**

To the NNW of the 'late petroglyphs', *i.e.*, slightly higher up the mountain slope, but on the same sandstone facies, occurs a concentration of polished dish-shaped depressions, covering much of an area measuring about 5 m across. Microscopic study of these perhaps utilitarian surfaces offers considerable insight into their production and weathering. The grains of this facies are mostly 70-240 μm maximum size, and there is little retreat evident in the amorphous silica cement, relative to the abrasion-truncated grains. At the surface, all grains are truncated horizontally (Figure 4), through abrasion with a stone of a similar hardness to that of the bedrock. This is evident from the way the individual quartz grains are worn: primarily by micro-chipping from the perimeter of each grain. Striations across the ground surface of each grain are rarely observed, and where they do occur they are very faint. They are oriented in both principal directions, indicating that the pestle was moved horizontally as well as in the direction of the hill's slope. Locally, erosion pock marks are evident, measuring up to 1 mm across, but they are neither dense nor deep, and again there is little retreat evident in the cement within them. This retreat amounts to about 30% of that found in the recent petroglyph tradition at the site. The truncated grains are generally of frosted appearance.

The excellent preservation of these polished surfaces renders reliable microerosion analysis possible, particularly as the truncation surface usually forms an angle of close to 90° with the emerging side surfaces of each grain (Figure 4). Care needs to be taken only to distinguish reliably between micro-chipping and actual micro-wanes. One of the polished dishes was selected randomly for metrical analysis, and an area measuring less than 20 $mm^2$ was scanned systematically at 80×. A total of 35 micro-wane width measurements (Bednarik 1992, 1993a) was secured from this small area. They are summarised in a histogram (Figure 5) showing a range of 8-15 μm (mean 10.97 μm). This represents a fairly reliable microerosion value, and if a quartz calibration curve were available for the Mizque Valley region, it could be readily translated into a numerical age estimate for the polishing action.

In the absence of such a calibration curve I resort to using the Grosio (Italy) curve, which also falls within the Lake Onega (Russia) calibration range. Accordingly, and in full appreciation of the qualifications that apply to such substitution, the polished surface analysed at Inca Huasi would be E1028 ± 300 years old if the Grosio calibration values are accepted as relevant.[1] This procedure deserves full confidence, because recently I obtained a very reliable calibration curve from safely dated surfaces in northern Portugal, taken from a Roman granite bridge in Vila Real and from two Roman inscriptions at the famous site of Panóias. The climatic conditions are reasonably similar to those of the Mizque valley, and the Portuguese curve is very similar to the Grosio calibration. Therefore the results reported here are probably more reliable than I am willing to accept.

## Interpretation

A discussion of possible relationships between the three phases of site use observed at Inca Huasi and the various other petroglyph sites in central Bolivia would be very useful (consider, for instance, the very similar cupule rows at Toro Muerto and Lakatambo), but it may be premature at this stage. Even though extensive direct dating evidence is now available to us for several other petroglyph sites in this region, such correlations are not developed on this occasion because they will be discussed elsewhere. I should point out, nevertheless, that a tentative first chronological model of the region's principal petroglyph traditions is imminent, and will be based on a variety of analytical techniques.

The present paper, however, is guided by a less ambitious rationale. The information from Inca Huasi is presented on its own, without seeking support in other data. In this way, confirmationist argument is avoided, which, I believe, is the correct way to develop a sound regional chronology for central Bolivian rock art.

In presenting the data from Inca Huasi I emphasize that they must not be interpreted without due regard for the various qualifications that apply to them. Direct dating results are scientific, not because they are thought to be precise, true or factual, but because they are presented as falsifiable propositions (Bednarik 1996). They are testable without necessarily resorting to induction, the application of alternative methods, or other modes of reasoning, *i.e.*, confirmation or uniformitarianism. Interpreting scientific data in a simplistic fashion leads to their misuse and distortion, as has already happened frequently in direct rock art dating (Bednarik 1994, 1996). This can be avoided in the Bolivian research program by referring readers to the extensive literature on this topic, and by stating the most obvious qualifications.

In the present paper I offer a numerical value as the possible age of one of the many polished surfaces at Inca Huasi. This does not mean that the remaining similar dished surfaces at this site necessarily have to be of a similar age, although that does appear be the case. As already mentioned, the 'date' given for one anthropic rock surface is not a date in the conventional archaeological sense, it must be read in the context of certain logical reservations: there is the lack of a valid calibration curve; the lack of opportunity to use a second component mineral as required under the basic methodology of microerosion analysis (this is not possible in siliceous sandstone or quartzite); and the lack of petroglyph-producing stone tools from Inca Huasi. (None

[1] The conventional way of stating microerosional age estimates is to place a capital "E" in front of the number to indicate that the date is erosion-derived.

were found. These can be and have been dated independently of the petroglyphs in some cases, including in Bolivia.) Finally, there is a series of minor qualifications, such as those concerning the type(s) of crystalline quartz present at the site, which was not determined. It would be too complex to elaborate on the potential effects of each of these qualifications, but in considering them realistically I arrive at the conclusion that there is a very high probability that the true age of the polished surface in question, *i.e.*, the time it was last treated, lies between E730 and E1330 years BP. If a calibration curve for the region were determined, the error margin would be quantified, and it would be very significantly reduced if two mineral components could be calibrated and analyzed.

This may seem a rather large tolerance factor but this result is, nevertheless, invaluable as a first building block in constructing a sound chronology for central Bolivian petroglyph traditions. The recent petroglyphs at Inca Huasi show a cement retreat of more than three times that in the polished surfaces, which suggests that they may be in the order of two to three times as old (the solution of the cement is thought to increase with progressing recession). Therefore we can estimate the linear petroglyphs and arranged cupules on the sandstone slope to be roughly between 1500 and 4000 years old.

Unfortunately we cannot extrapolate in a similar fashion to the age of the random cupules on the quartzite dyke of Inca Huasi, because of the significantly different lithology and the absence of any quantitative microerosion data for this tradition. However, that tradition seems almost as old as the time when the dyke was initially exposed by fluvial action. While this provides no numerical value of age, the dyke may have been first exposed during the final Pleistocene or early Holocene. The main problem with estimating the antiquity of the early cupules is that we cannot be sure whether their spatial restriction to the resistant quartzite is a taphonomic phenomenon, although this is suggested to be the case. If it were thus attributable to selective survival, *i.e.*,if similar cupules on the soft sandstone have entirely eroded, then this tradition is very likely to be of the final Pleistocene. If this assumption is incorrect, the early cupules of Inca Huasi would most probably be of the early Holocene.

For the time being this matter cannot be resolved but we note the recent discovery of very archaic petroglyphs in Cueva Epullán Grande, Argentina, which appear to be of the late Pleistocene (Crivelli M. and Fernández 1996). It is to be expected that further such archaic petroglyphs, which often include cupules, will be identified in the Americas, and I predict that they will be found either in well-sheltered locations (*e.g.*, caves) or on extremely weathering-resistant rock (primarily quartzite). It is to be noted that taphonomically determined attribute profiles of extremely old petroglyph traditions in other continents consistently comply with this logical prediction. The oldest known petroglyphs in the world occur on fully metamorphosed quartzite in deep caves (Bednarik 1993b; Kumar 1996), in the form of cupules.

I believe that the above information concerning the apparent antiquities of the three use phases of Inca Huasi, however limited and vague, provides reliable first glimpses of the ages of petroglyph traditions in the central Bolivian mountains — provided that these data are used with the appropriate restraint, and are not archaeologically misinterpreted.

**Acknowledgments**

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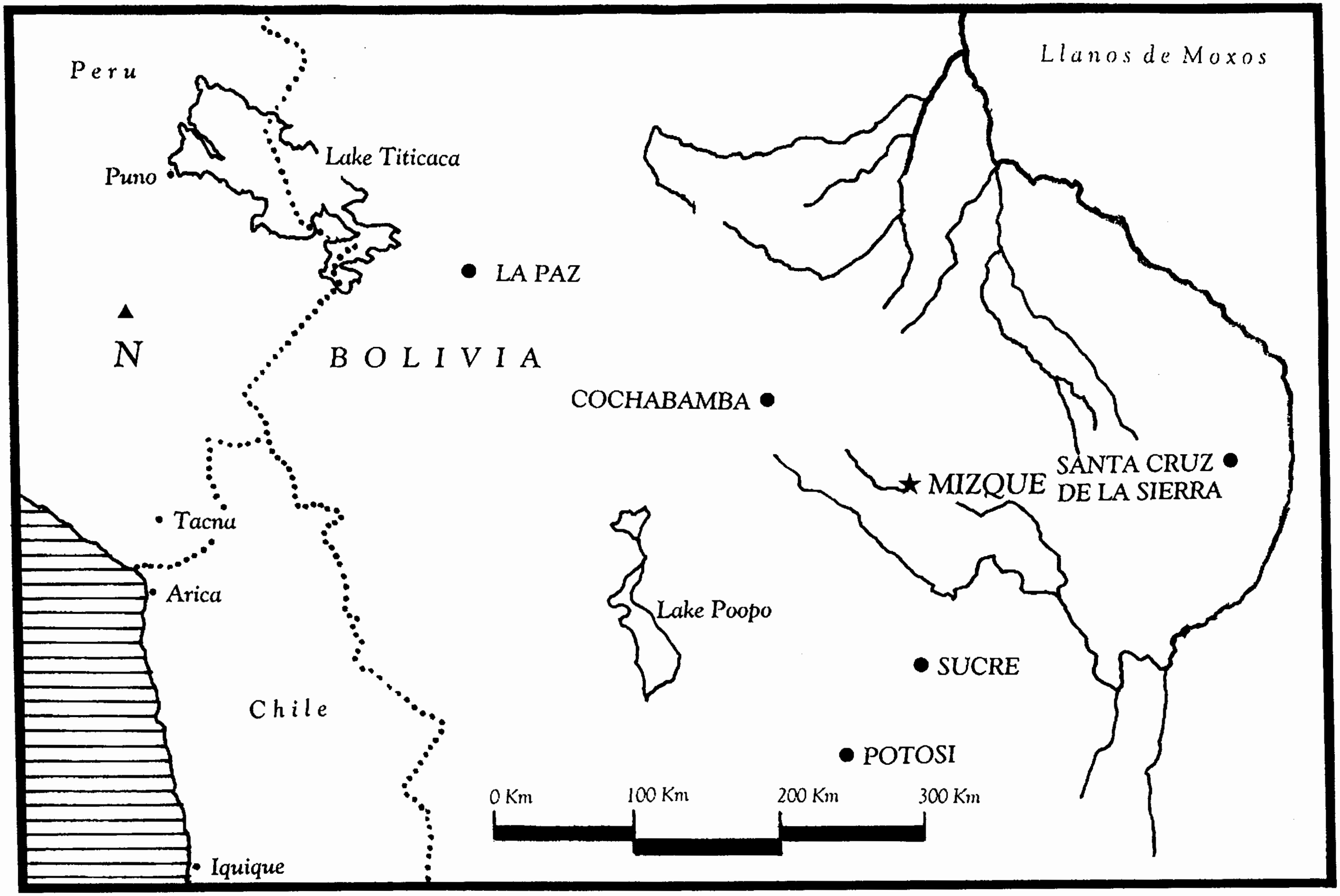


Figure 1. Map of southern Bolivia to show location of Mizque. Inca Huasi is 3 km from Mizque.

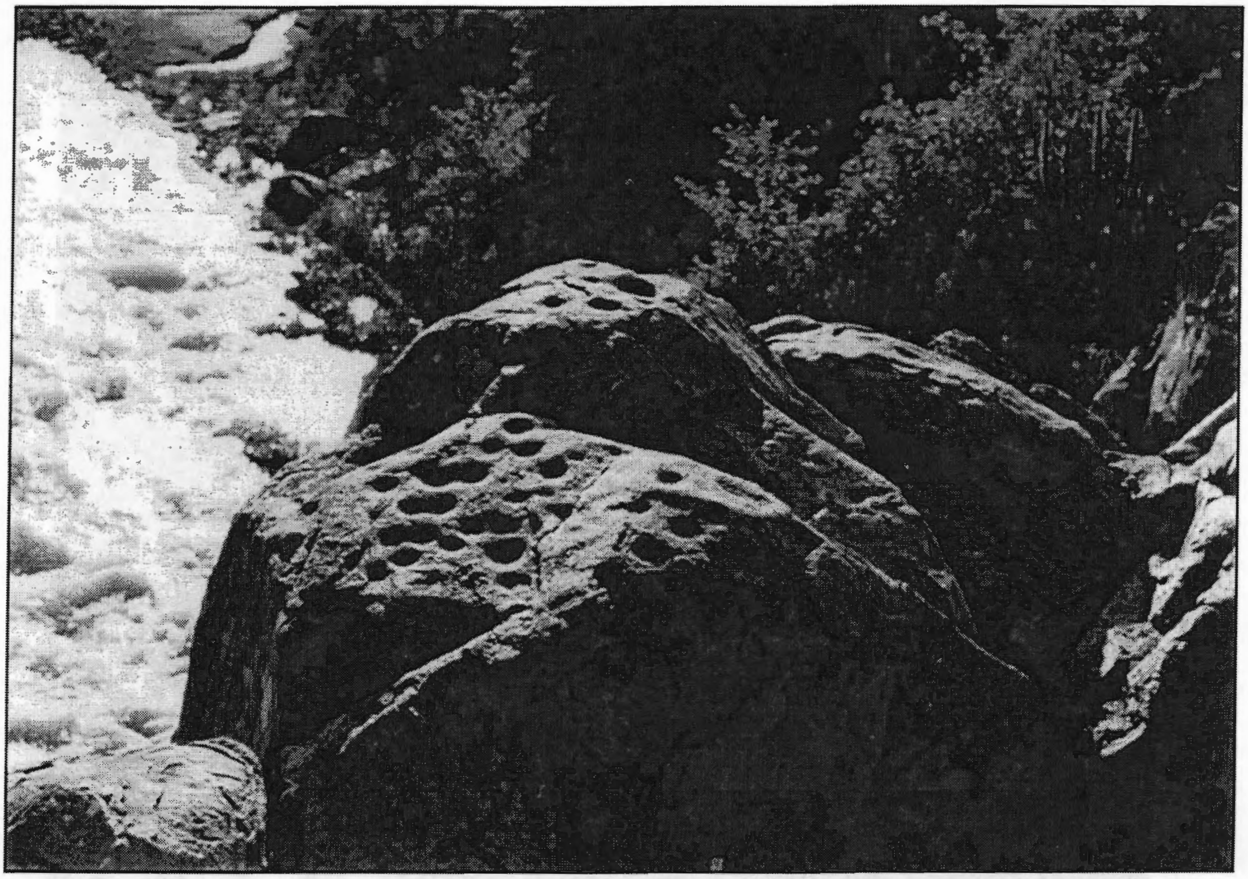

Figure 2. Cupules on the top of the quartzite dyke, with the Uyuchama River visible below. Inca Huasi petroglyph site, central Bolivia.


Figure 3. Impact mark on vertical edge of the quartzite dyke, with radial lines clearly visible. The impact is due to fluvial action. Inca Huasi.

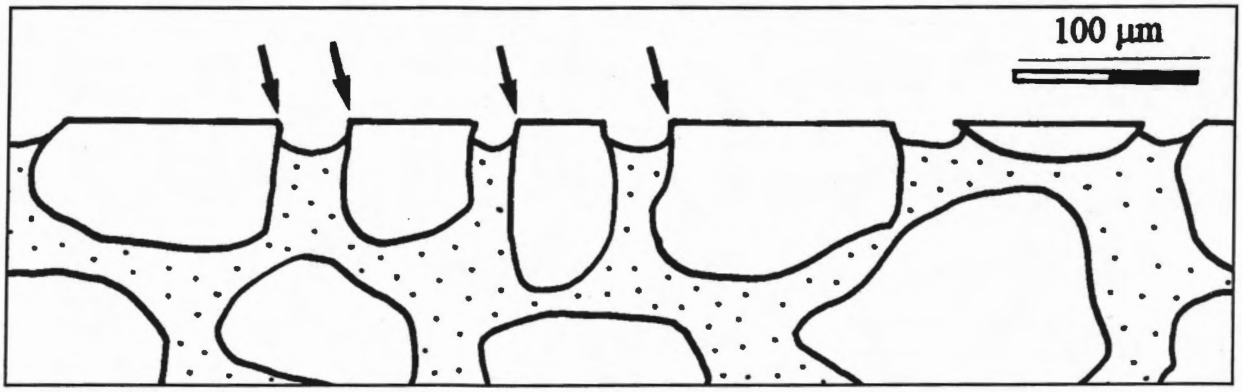


Figure 4. Schematic section through polished dish surface at Inca Huasi, showing the abrasion-truncated quartz grains, the retreating amorphous silica cement, and the locations (arrows) of micro-wanes measured for analysis.

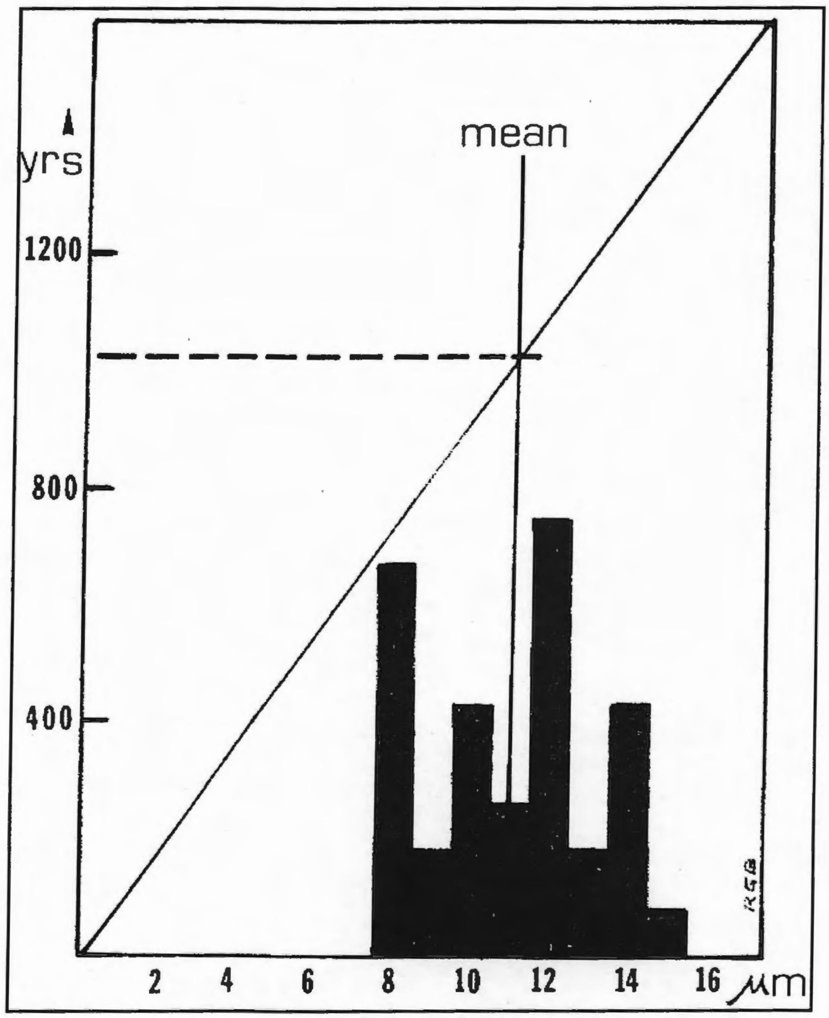


Figure 5. Histogram of 35 micro-wane widths from the polished surface analyzed at Inca Huasi, projected onto the Grosio calibration curve for crystalline quartz.