The Late Pleistocene Human Occupation of Mexico

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Abstract

There has been much discussion and controversy as to the age of the earliest occupation and human skeletal remains in Mexico. It has been argued by several researchers that there is evidence for occupation as early as 30-40 Ka at sites such as El Cedral (San Luis Potosi), Babisuri rock shelter (Baja California Sur) and Valsequillo (Puebla). The evidence for such early occupation will be reviewed and evaluated, such as lithic assemblages, modified bone and footprints, and their dating using stratigraphy, tephrochronology, C^{14}, OSL, Uranium Series and ESR. From this review and evaluation it is considered that there is good evidence from Mexico for human occupation at least as early as 40 Ka.

Other sites important in the discussion on migration and dispersal of humans across Mexico during the younger Late Pleistocene are evaluated, such as Tlapacoya, Tepexpan, Tocuila, Chimalhuacan, El Peñon and El Metro (in the Basin of Mexico) and the Yucatan caves. Here there is skeletal material which has been unequivocally dated using ^{14}C at least to around 10.5 Ka and is some of the earliest directly dated human material in the Americas.

This latest work on the geoarchaeology of sites in Mexico enables reconstructions of early human environments and the controls on their habitats by climate change, volcanic processes and sea level oscillations. There is also the importance of historical native populations to take into account, such as the Pericue Indian group (Las Palmas culture), a population that became extinct in the 18th century. They display distinctive cranial morphologies (long and narrow skulls) which have been linked in the past to an early primary migration along the Pacific coast and suggested as evidence for a relict population. However our recent DNA results indicate that the group had just the normal haplogroups found in the modern Native American Indians suggesting the possibility of processes of ***in situ*** differentiation for this extinct group.

North American archaeologists generally have rejected any claims that the colonisation of the American continent occurred prior to a pre-11.5 BP date (Meltzer, 1993; Fiedel 2006). Whilst many much older sites have been claimed, the sceptics ask difficult questions, there is usually fierce debate and generally a rejection of the site's proposed antiquity. There are often questions about the reliability of the C^{14} dates, whether the artefacts were humanly produced, or natural rock fragments and whether the suggested hearths and associated carbon deposits are anthropogenic in origin. Similarly there has been much discussion as to the age of the earliest occupation and human skeletal remains in Mexico. It has been argued by several researchers that there is evidence for occupation as early as 30-40 ka at sites such as El Cedral (San Luis Potosí) and the Babisuri rock shelter (Baja California Sur). This has been the case too at Valsequillo in Central Mexico where controversy originated in the 1960s, continued through the 1980s after the deposits were originally dated and the debate has resurfaced after further claims for the site's antiquity (Renne et al, 2005; Gonzalez et al, 2006; Largent, 2006; Adler, 2006). In this paper there is a review and evaluation of this ongoing current debate for the age of such early occupation in Mexico using archaeological, stratigraphical and dating evidence. From this review and evaluation it is considered that there is good evidence from Mexico for human occupation at least as early as 40 K BP but that controversy inevitably still exists. There is less controversy related to sites between 20-30 K BP and human occupation in the Basin of Mexico and other locations was common in the period 10.5-13 K BP.

Evaluation of Mexican Pleistocene Human Occupation Sites

a) El Cedral: The site Rancho La Amapola is located close to the village of El Cedral and is an artesian spring site, with evidence of megafauna, lithics and worked bone (Fig. 2) associated with a sequence of lake sediments, lacustrine marsh peats and evaporites (Lorenzo and Mirambell, 1986). The worked horse tibia has been dated to > 15 K BP whilst there is a date on a convincing discoidal scraper at 33,300 ± 2700 BP and a potential hearth surrounded by mammoth patellas at 31, 840 ± 1600 BP.

b) Tlapacoya: Work on this site in the Basin of Mexico by Mirambell (1978) and Lorenzo and Mirambell (1986) suggested human occupation as old as 24 K BP based on dated charcoal on hearths and lithic assemblages. This however has remained a controversial site with consistent doubts as to the evidence put forward and some of the conclusions with regard to the age of the archaeological evidence and indeed for the archaeological evidence itself (for example, Haynes, 1967; Waters,1985). Some new excavations were completed to try and resolve some of the questions posed from this site. The new stratigraphy is shown in Fig. 5 where a complex succession of clays, silts, volcanic ashes and reworked ashes, organic-rich sediments and secondary lahars was exposed. From this new work some summary conclusions suggest that:

- There is no new evidence to support the presence of human activity at 24 K BP and the original C^{14} dates (Garcia Barcena, 1986) have large standard deviations which could make them as young as 16 K BP.
- There was no evidence for a lithic assemblage and it is considered that the 2,500 andesite flakes from the original excavations must be derived from the local bedrock which fractures into naturally sharp flakes.
- The small number of obsidian flakes from the original excavations are considered to have been introduced by rodent burrowing from above and the two “worked” bone fragments are considered just to be broken bone (Alan Turner, pers.comm.).
- The lake beach gravels and hearths from the original excavations are thought to be local angular pebble gravel, scree and burnt vegetation respectively. Waters (1985) had suggested that the circular hearth-like areas may have been created by trees “rooting” in the sediment and this may be an alternative. The length of fetch in the shallow lake would not be capable of forming lake beach gravels of the size indicated and the suggestion by Mirambell (1978) that many of the andesite flakes had rounded edges is unsubstantiated by shape analyses in her publications and by our work.
- There was evidence of reworking of the Pumice-with-Andesite tephra at several locations from the slopes above, which emphasises the importance of slope processes in the nearshore area at Tlapacoya.
- The Upper Toluca Pumice tephra, dated to 10.5 K BP (Arce et al. 2003) had the “stratified”, embedded cranium found in 1971. This layer had been dated to 9,920 ± 250 BP (Garcia Barcena, 1986) which agrees well with the AMS C^{14} date for the unstratified cranium at 10,200 ± 65 (Gonzalez et al. 2003).

Based on this new fieldwork there is firm evidence that humans were present at Tlapacoya at around 10.5 K BP and not earlier.

c) Santa Isabel Iztapan I and II: These sites on the margins of Lake Texcoco were excavated in 1952 and 1954 (Aveleyra Arroyo de Anda and Koerdell, 1953, Aveleyra Arroyo de Anda 1955, Gonzalez et al, 2006). In association with seven articulated mammoths were found flakes some embedded in the skeletons which suggested mammoth kill locations. They included flint projectile points, a scraper, a knife and a prismatic blade in obsidian and an end scraper and retouched blade composed of flint. Some of the bones had deep cut marks. There have been no recent direct dates on these mammoths because of lack of collagen preservation in the bone, although one early date of 9,000 ± 250 years BP represents the minimum age, although there must be doubt as to its accuracy. However, tephra work by the authors at Santa Isabel Iztapan II (Fig.3) suggests that the mammoths embedded in the lacustrine green clay (jaboncillo) at depths between 1.75 to 2.25 m are younger than 14.5 K BP as they were above the pockets of Pumice-with-Andesite ash. The Upper Toluca Pumice layer is not present as a recognisable ash fall layer (as at Tepexpan) and unlike Tocuila where there is a considerable thickness of this ash. This emphasises the lateral variability and the importance of fluvial reworking in a shallow, marginal lakeshore environment. The points were of Lerma typology not Clovis points and in fact no typical Clovis, or later Folsom points have been found in the Basin of Mexico.

d) Tepexpan: This site was discovered in 1947 by Helmut de Terra (1947, 1949) on the former shores of Lake Texcoco. Since the discovery there has been much discussion related to the excavation methods and the real age of the skeleton (Black, 1949, Krieger, 1950, Lorenzo, 1989). For many years it was considered to be the oldest Mexican Late Pleistocene human until the skeleton was dated in the 1980s using C^{14} dating to be around 2000 years old. New work by the authors (Lamb et al in prep) indicate that the skeleton was contaminated by preservatives after excavation that results in an erroneous young date of 2,200 years old. U Series dating indicates that the skeleton is between 4,700 and 7,400 years old and this new dating agrees well with the C^{14} date of Solleiro-Rebolledo et al (2006) who dated the humus at the top of their lowest palaeosol to 5,600 ± 40 years BP. They consider that the position of Tepexpan man corresponds approximately to this date. We consider a date in the period 5700-5900 BP as likely, especially as the skull morphology is mesocephalic.

e) Babisuri Cave, Baja California Sur: This rock shelter on the Isla Espiritu Santo (fig.4) to the south-east of La Paz has been excavated by Fujita et al (2006) and provided sixteen AMS dates on molluscs in association with stone tools for the lower layer of between 36, 818 ± 461 BP and > 47, 500 BP. In this layer there is apparently selection of large shell sizes, with only one size present (unlike natural deposits) and there are none with the two valves attached, or in life position. It was suggested however by Fiedel (2006) that much younger human populations could have collected older shells and that there was no real evidence for human presence in this cave older than 9 K BP. This had already been suggested by Fujita et al (2006) but indicating that at lower sea levels between 21-10 K BP was the only time that humans could have collected shells of this age of around 40 K BP. There is also an unexplained time gap in the depositional sequence in the stratigraphic sequence. Thus there does remain doubt as to the age of the human populations at this location but it does emphasise the use of marine resources for the inhabitents of Baja California Sur since the Late Pleistocene.

f) Dates on Preceramic Skulls in the Basin of Mexico: This area is particularly rich in Late Pleistocene lacustrine and fluvial sediments and volcanic deposits, together with an included fauna that includes mammoths, sabre-toothed cats, bison, camel, glyptodont and horse, at times in association with human artefacts, or showing possible cut marks. A programme of radiocarbon dating using Accelerator Mass Spectrometer (AMS) on human skeletons that were considered to be of Preceramic age produced the first directly dated Late Pleistocene humans from Mexico, whilst relative dating was derived from a tephrochronological framework on volcanic ashes (Gonzalez et al, 2003). The direct dates include Peñon Woman III and Tlapacoya Man, whilst Chimalhuacan Man and Metro Man were found in volcanic ash (the Upper Toluca Pumice) from the Nevado de Toluca Volcano. Suggested human artefacts in mammoth bone (Arroyo-Cabrales et al, 2001, Gonzalez et al, 2006, Gonzalez and Huddart, in press) have been located from the Tocuila mammoth site, embedded in lahar derived from the Upper Toluca Pumice (Gonzalez and Huddart in press). In Table 1 the skeletal dates are included, together with some direct radiocarbon dating on some megafaunal remains found in Central Mexico. The evidence suggests that there were humans present in the basin around 11 K BP but that the Upper Toluca Pumice eruption may well have played an important role in the extinction of the megafauna and affected this human population by death and/or migration (Huddart and Gonzalez, 2006; Gonzalez and Huddart in press).

g) Yucatan Caves: At the cave sites of El Toro and El Tunel in Loltún (Konieczna, 1981) the context of the Paleoamerican assemblage is poor and exact dating of flakes, cores and other artefacts is difficult, although there are strata with extinct Pleistocene species and pollen (Fig. 6). Lopez (1980) suggests that the artefacts from zones dating between 21-11 K BP. Recent work on the east coast of Quintana Roo had produced almost 3 complete human skeletons from flooded caves (Gonzalez, A., et al. 2006), in association with extinct Pleistocene fauna, hearths and lithic tools. The oldest has been dated at 11, 670 ± 60 BP, whilst the other two are around 8 K BP.

h) New Geoarchaeological work at Valsequillo, Puebla: Valsequillo is about 100 km south-east of Mexico City, south of the city of Puebla where a modern reservoir constructed in the 1940s mirrors the position of a Pleistocene lake in the area. Around its shores and in quarries there is a sequence of fluvial, lacustrine and volcanic deposits in which mammalian bones and human skulls, engraved bone fragments, modified bones and flint points and scrapers have been found (Fig.7), although most of these crucial finds are now missing and there has been doubt expressed as to the authenticity of the carvings and some of the evidence put forward for "kill sites" (Armenta Camacho, 1959, 1978; Irwin-Williams 1967, 1969, 1978; Güenther, 1968; Güenther et al 1973; Szabo et al 1969; Gonzalez et al 2006). Most finds are on, or near, the Tetela peninsula in the Valsequillo Gravels especially at Hueyatlaco and associated sites (Irwin-Williams, 1978: 9) (Fig. 8). However, reservoir, high water conditions have plagued the archaeological excavations, both during the 1960s at for example, the El Mirador site (Irwin-Williams, 1978: 14) and more recently at the Hueyatlaco site (Ochoa-Castillo et al, 2003: 62). There have also been extremely contentious dates provided for the Hueyatlaco archaeological site of between 250, 000 to 275, 000 years, and even older, by radiometric dates on fossil butchered bone associated with bifacial stone tools and on overlying, stratigraphically younger, tephra layers (Szabo et al 1969; Steen-McIntyre et al 1981). These very old dates have been rejected by the majority of archaeologists and the sites have largely been ignored. Early U Series dates (Fig.12) have been shown to be unreliable and potentially likely to give dates which can be grossly in error (Pike et al 2002). Even the original excavator suggested that the dates were inconsistent with the tool typology (Irwin-Williams 1981). However, diatoms from some of the sediments contained taxa that became extinct before the end of the Sangamon interglacial (VanLandingham 2004) but the bones, although reworked, were thought to be Wisconsin in age (Graham, 1978), although Güenther (1968) and Güenther et al. (1973) noted species extinct by the end of Illinoian and Sangamon time. Another major problem is that most of these sediment sequences show evidence of reworking (Gonzalez et al 2006) throughout the undoubted Late Pleistocene, Valsequillo Gravels.

Human Footprints in the Valsequillo Basin and their age

The "Toluquilla footprint layer" contains human and animal footprint traces preserved on the upper bedding planes of the ash, which was deposited in the shallow Pleistocene lake (Lake Valsequillo) (Fig. 9). The Xalnene Ash was deposited from a subaqueous, monogenetic volcano (Cerro Tolquilla) that erupted within Lake Valsequillo some time around 40 Ka (Gonzalez et al., 2006a). The footprints were made and preserved during the latest stages of deposition of the ash and are present in several layers in the top 20 cm of the ash succession, where they are interbedded with lake sediments (Gonzalez et al., 2006a). The Xalnene Ash was exposed on lake shorelines during low stands in the water level, associated with either water-displacement during the volcanic eruption, or due to climatically-driven fluctuations in the water balance. The traces are associated with desiccation cracks formed during exposure of the lake floor. Humans and animals traversing the lake shore and exposed lake floor left short trails and individual prints in the coarse ash (Fig.10). Lake marginal transgressions preserved the traces through burial by lake sediment and subsequent pulses of volcanic ash. The volcanic ash is cut by a number of irregular, silt-filled hydrofractures formed by the loading of underlying saturated lake silts by the ash during deposition. This indicates that the ash has not undergone immediate post-depositional re-working and the footprints are also cross-cut by these hydrofractures and desiccation cracks and were formed syn-depositionally with the ash.

The stratigraphic context and geochronological control for the Xalnene Ash is shown in Figs.11 and 12 and discussed in detail in Gonzalez et al. (2006a). The Toluquilla Footprint Layer has been dated to 38 ±8.57 Ka (sample number: TW04-10) using Optically Stimulated Luminescence dating of baked, silty xenoliths within the ash which were interpreted as being baked at the time of the eruption, which reset the time signal. The ash layer is older than the stratigraphically younger, fluvial sediments from the Valsequillo Gravels exposed in the Barranca Caulapan (Fig.12) where there are radiocarbon dates between 9.15 ±0.5 Ka (W1896) from the top of the sequence to 38.9 ±0.8 Ka (Oxa-14355) on a mollusc shell at its base, as well as an Electron Spin Resonance date on a mammoth molar and U-Series dates on bones. All of the dates obtained with different methods are in agreement. There are no weathering horizons, or soils, in these gravels, or above the Xalnene Ash at the footprint quarry. It is on this stratigraphic basis that the human footprints of the Toluquilla Footprint Layer are believed to provide evidence of early human occupation of the Americas, due to their potential age of more than 40,000 years ago.

Current controversy related to the age of the Xalnene Ash

However Renne et al (2005) also dated the Xalnene Ash but with startlingly different results. This unit is the one in which we have interpreted a potential suite of human and animal footprints. Renne et al (2005) document that this ash is much older at 1.3 Ma years based on single grain Ar-Ar dating and they suggest that the footprints cannot be human, because of the age but are the result of quarrying operation. However, Gonzalez et al. (2006a,b) and Huddart et al. (in press) recognise also the presence of a much younger set of anthropogenic traces superimposed and cross-cutting the older traces, which have been interpreted as potential fossil footprints. In both papers a set of well-established criteria have been used to establish that the older traces on the ash are human. Other footprints have also been found within the Valsequillo Basin on naturally-exposed Xalnene Ash bedding planes where no quarrying has occurred.

There are further important dating issues. The ash was produced by explosive subaqueous eruptions from Cerro Toluquilla, incorporating fragments of the country rock, giving as a result an extremely heterogeneous ash, not homogeneous as suggested by Renne et al (2005). They admit that if the lapilli they dated were derived by erosion of pre-existing tephra, their age could substantially pre-date deposition. We consider this likely. Our attempts to date the ash by Ar-Ar dating had no success (Gonzalez et al., 2006a). Non-atmospheric argon in the lapilli was detected yielding apparent ages in the range 2.2-4.6 Ma. The ages gave a "saddle" shape, commonly associated with extraneous argon which might be dissolved in the glass, or present as older mineral fragments on the outsides of the lapilli. A total fusion age for the overlying summit lava did not release sufficient radiogenic argon to determine an age, with insufficient potassium concentrations. Additional OSL dating on the palaeolake sediment sequence ***below*** the ash suggests age estimates ranging between 35 and 200 ka, in clear disagreement with the 1.3 Ma date.

There are further geological problems with a 1.3 Ma ash date. If correct, there must be a basin regional unconformity where a million years of the Pleistocene would be unaccounted for. However, in the regional geological mapping of the Valsequillo basin there has been noted a conformable sequence from lower lake sediments, through Xalnene Ash and upper lake sediments with incorporated lahar units at the Cerro Tepalcayo quarry, north-east of San Francisco Totimehuacan. Furthermore Sangamonian (80-220,000 yr BP) diatoms in sediments in the Valsequillo Basin have been reported by VanLandingham (2004), which we consider to be derived from sediments underlying the Xalnene Ash. Our view of the Late Pleistocene basin development is that there is no regional unconformity. This is a conclusion reached after our detailed geological mapping of the Quaternary lake, fluvial and volcanic sequences which was initiated by the pioneering work of Malde (1968).

The ash's reverse magnetisation, suggesting a date older than 0.79 Ma (Renne et al., 2005), needs careful evaluation. There are other possible explanations such as self-reversal of the magnetisation common in subaqueous basalts, which contain inhomogeneous titanomagnetite grains as remanence carriers, or the presence of the Laschamp Geomagnetic Excursion, dated to around 40 ka. Hence, it is possible that the reversal noted by Renne et al (2005) is not the Brunhes/Matuyama reversal but one much younger. No properly orientated samples were reported by these authors and detailed palaeomagnetic and magnetic mineralogy studies are required to assess the true status of the reverse magnetization in the ash. Attempts to date the Hueyatlaco site using palaeomagnetism were unsuccessful (Liddicoat et al. 1981).

Thus there are some misgivings about the dates, the palaeomagnetism and discussion presented by Renne et al (2005) but there is obviously the need for further discussion of the geology, dates, archaeology and footprints in this basin. This is long overdue given its importance in the understanding of when humans entered the Americas.

A Suggested Dating Framework for the Valsequillo Sequence

The following tentative revised dating framework for the Valsequillo archaeological deposits is suggested (Table 2). It is considered that the older U-Series and fission track dates from the Tetela peninsula should be discounted and that the chronology should be based on the AMS and conventional radiocarbon dates, ESR and U-Series dates from the Barranca Caulapan and the OSL dates from the Toluquilla quarry area. It is suggested that the radiometric dates on the volcanic sequence from the western slopes of La Malinche can be used to relatively date some of the volcanic deposits on the Tetela peninsula and to the south-east of Puebla. Our ongoing tephrochronological and other geological work will in the future help confirm, or revise this chronology.

Evidence from Historical Native Populations: an example the Pericue Las Palmas Culture

There is a also the importance of historical native populations to take into account, such as the Pericue Indian group (Las Palmas Culture), a population that became extinct in the 18th century, who lived in southern Baja California and their Holocene predecessors (Rosales-Lüpez and Fujita, 2000). They display distinctive cranial morphologies (long and narrow skulls) and are important because they have been linked to an early migration along the Pacific coast and suggested as evidence for a relict population in this peninsula directly linked to a primary migration (Gonzalez-José et al, 2003). However our recent DNA results indicate that the group had just the normal haplogroups found in the modern Native American Indians suggesting the possibility of processes of ***in situ*** differentiation for this extinct group.

Conclusions:

There is definitive evidence for human occupation in the Basin of Mexico by directly dated and relatively dated skeletal material to the period around 11 K BP, or even slightly earlier and in coastal Yucatan. This phase includes mammoth kill and scavenging sites as at Santa Isabel Iztapan I and II and Tocuila. However, the evidence from Tlapacoya for older occupation is discounted, although Dixon (1999) suggests that it is difficult to attribute the uncanny aggregations of bones, lithics and charcoal entirely to non-cultural agents. The evidence from El Cedral seems good, indicating human occupation around 30 K years ago but the evidence from Babisuri rock shelter with human presence around 40 K is difficult to interpret based on the evidence published so far.

The Valsequillo Basin is an important region, with dates of at least 22,000 years BP and we suggest dates of around 40 K. These dates should be considered in the models of early peopling of the continent and the human footprints discussed here are an important addition to the story of the colonization of the Americas.

Inevitably, the initial colonization of this continent remains a contentious issue, with different theories as to when it happened and by whom (e.g., Dixon, 1999; Chatters, 2000; Fiedel, 2000). Some researchers believe the settlement was 30 K or older (Bonnichsen and Turnmire, 1999); but the most accepted dates of occupation are in the latest Pleistocene, related to the 'Clovis First' model, whilst the oldest directly radiocarbon dated-human remains found so far are around 11.5 K (Dillehay, 2000; Gonzalez et al., 2003). This hypothesis of human settlement is complicated, however, since the earliest accepted human occupation date (12.5 K) comes from the Monte Verde site in southern Chile (Dillehay, 1989, 1997), where lithic technologies are very different from the Clovis sites in the south west of the USA. The human footprints and their dating (Gonzalez S. et al., 2006a) at Valsequillo help to resolve the controversy related to the age of the archaeological (lithics and worked animal bone) and associated megafaunal remains that were reported in the Valsequillo Gravels in the 1960s and 1970s. The latter must be younger than the footprint level in the revised chronological framework (See Table 2).

Our work suggests that other sites in Mexico with the same type of fossiliferous gravels associated with lithics, which have been claimed to be of great antiquity in the past, should be re-evaluated; e.g., Tequixquiac in the north of the Basin of Mexico (Barcena, 1882), where a workman digging a canal found a carved animal head from a camel's sacrum (Aveleyra Arroyo de Anda, 1964). Other megafaunal bones and stone tools have been found in this area. In Oaxaca it is suggested by Lettow and Otto (2004-5) that human footprints on an ash boulder are as old as between 25,000-30,000 years and there are also undoubted human footprints in Cuatrociénegas in Coahila which may be Late Pleistocene in age.

These potential 'early' Mexican sites need to be carefully re-evaluated in a wider continental scale approach, rather than as isolated sites. Evidence from South America from Pedra Furada (Guidon and Delibrias, 1986; Pessis, 1996; Parenti, 2001; Santos et al., 2003) with dates up to 50,000 years BP and Monte Verde 1 with dates around 33,000 years BP (Dillehay and Collins, 1988; Dillehay, 1989, 1997, 2000) have also suggested that there may have been earlier occupation of the Americas than currently accepted. Despite dating controversy in the locations discussed, from the evidence presented, the 'Clovis First' model of human occupation can no longer be accepted as the initial evidence of human presence in the Americas. A new timing for the initial migrations, as well as new routes of migration need to be considered.

Mexico Paper Figures:

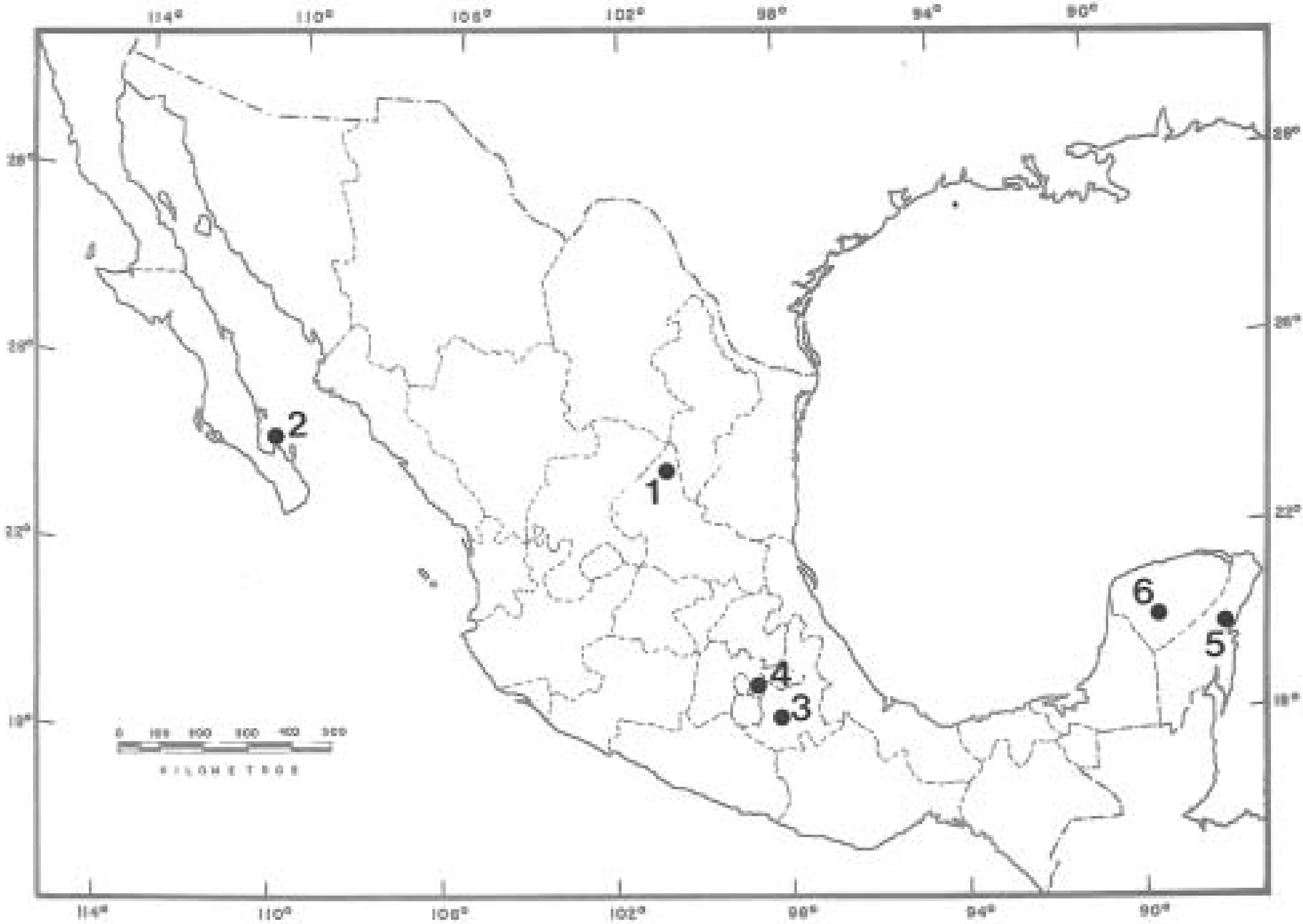
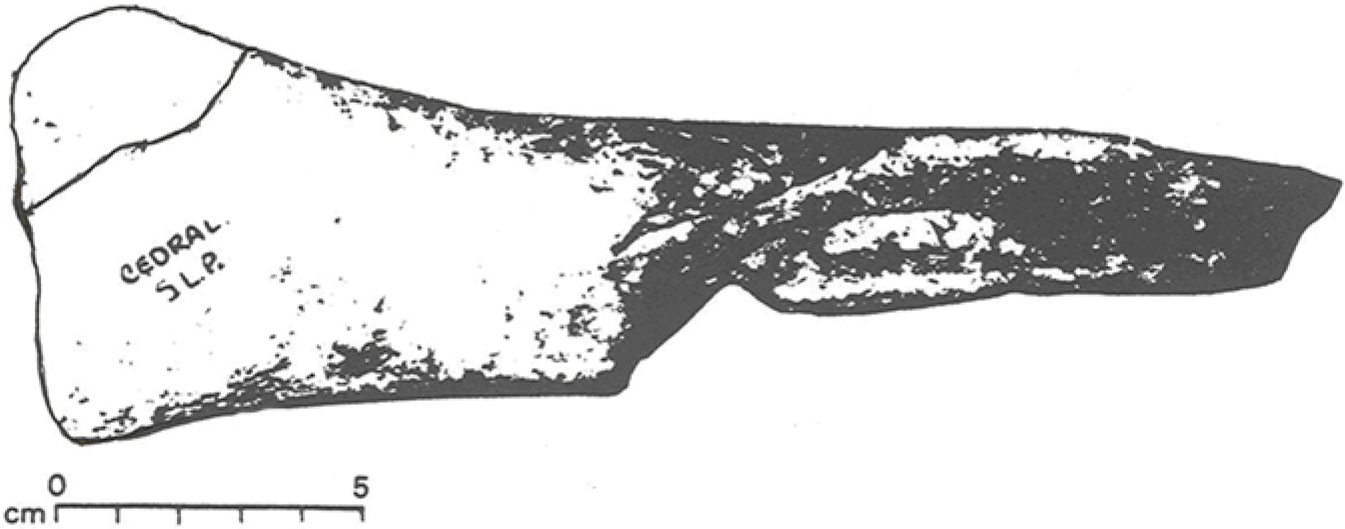
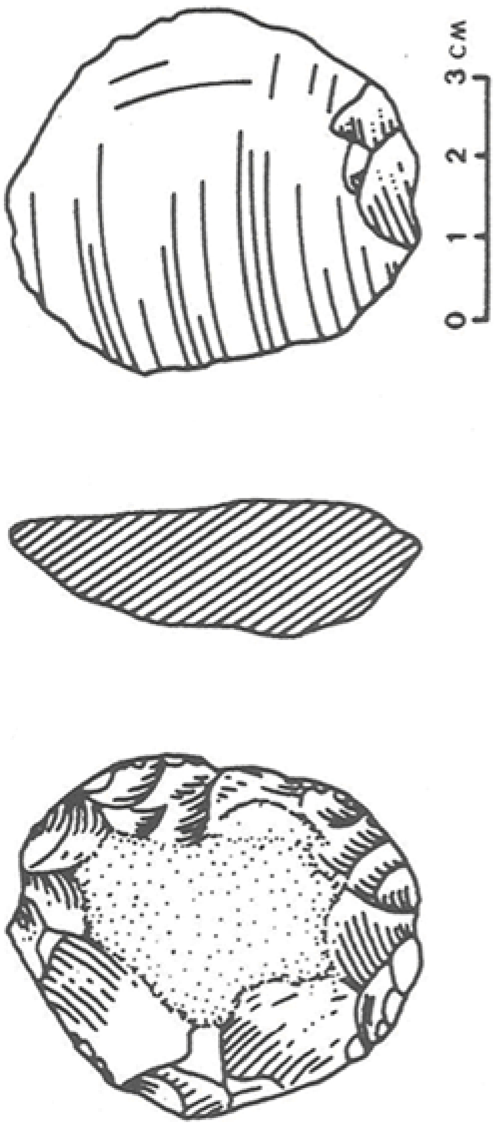


Figure 1: Location of Late Pleistocene sites in Mexico: 1) El Cedral, San Luis Potosi. 2) Babisuri Rockshelter, Baja California Sur. 3) Valsequillo Basin, Puebla. 4) Basin of Mexico.
5) Quintana Roo Caves. 6) Loltun Cave, Yucatan.



Utilized horse tibia.



Discoidal scraper.

Limestone nucleus used as a hammerstone.

Figure 2: El Cedral Site, San Luis Potosi, Examples of associated artefacts after Lorenzo and Mirambell 1986b.

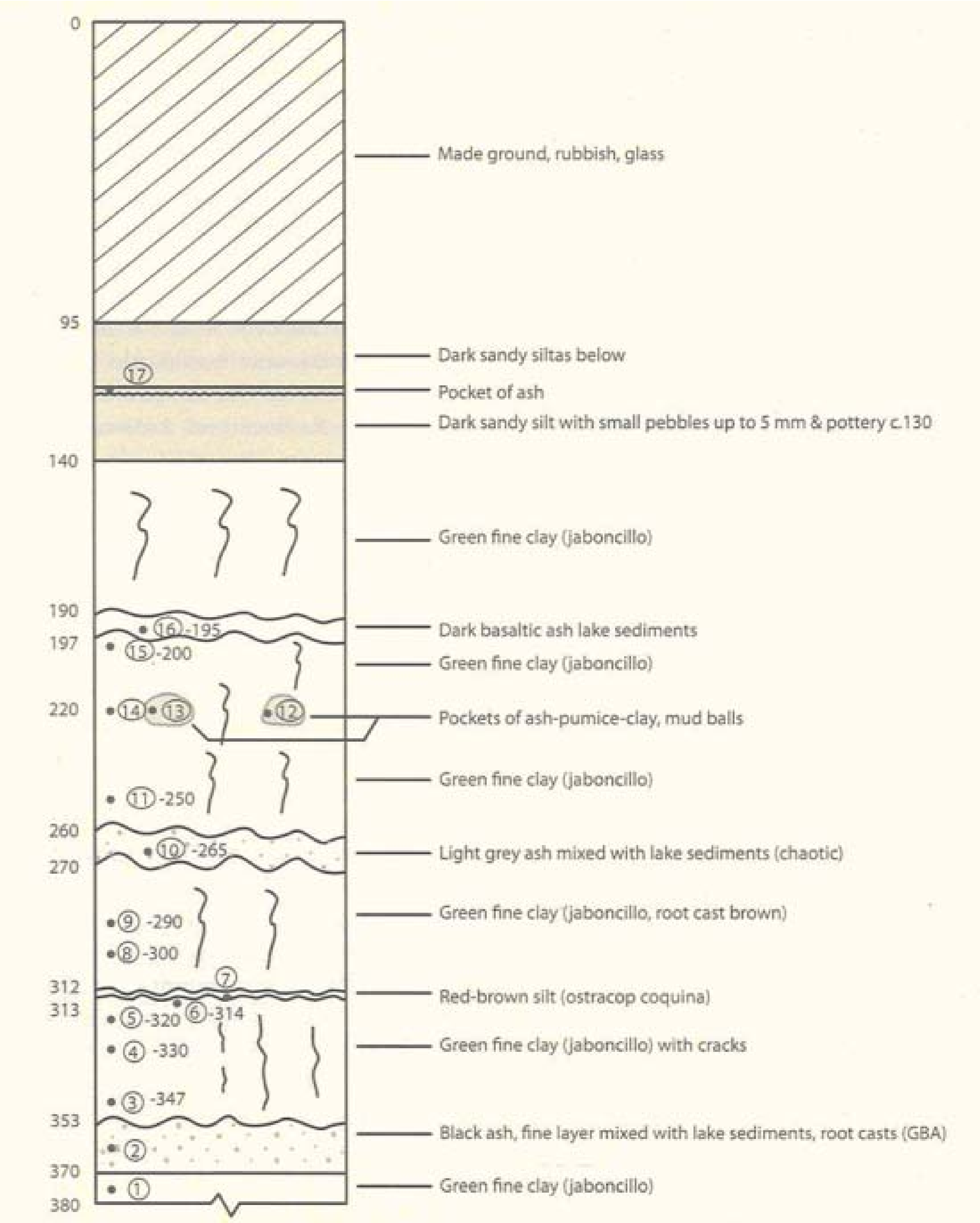
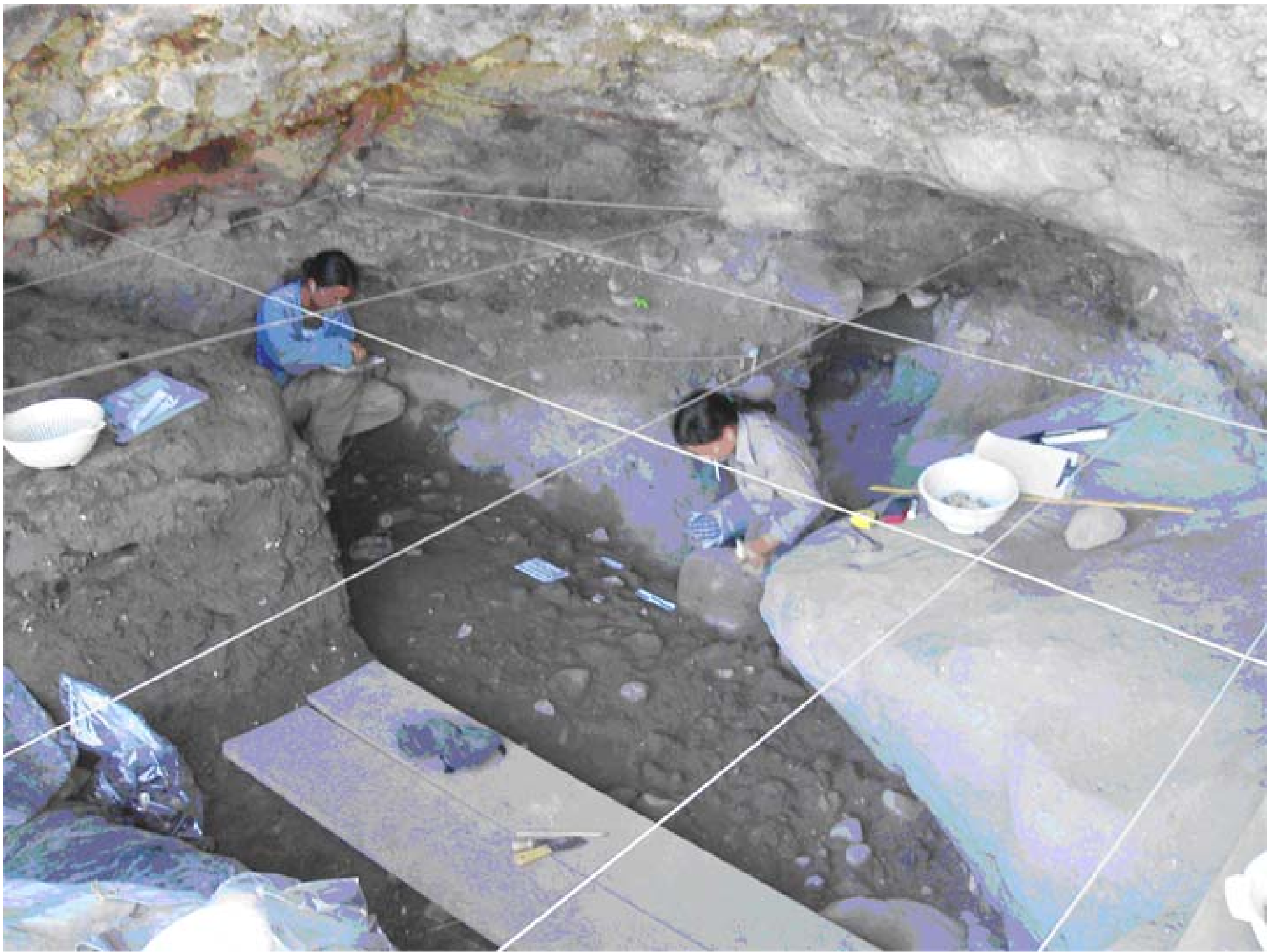


Figure 3: Stratigraphy at the Santa Isabel Iztapan II Mammoth Site after Gonzalez S. et al 2006c. This mammoth was found with associated tools.

a) Location in the Baja California Peninsula, Mexico.

Figure 4. Babisuri Rockshelter at Espiritu Santo Island.

b) Detail of 2006 excavation directed by Harumi Fujita, photo by Nicholas Beer.



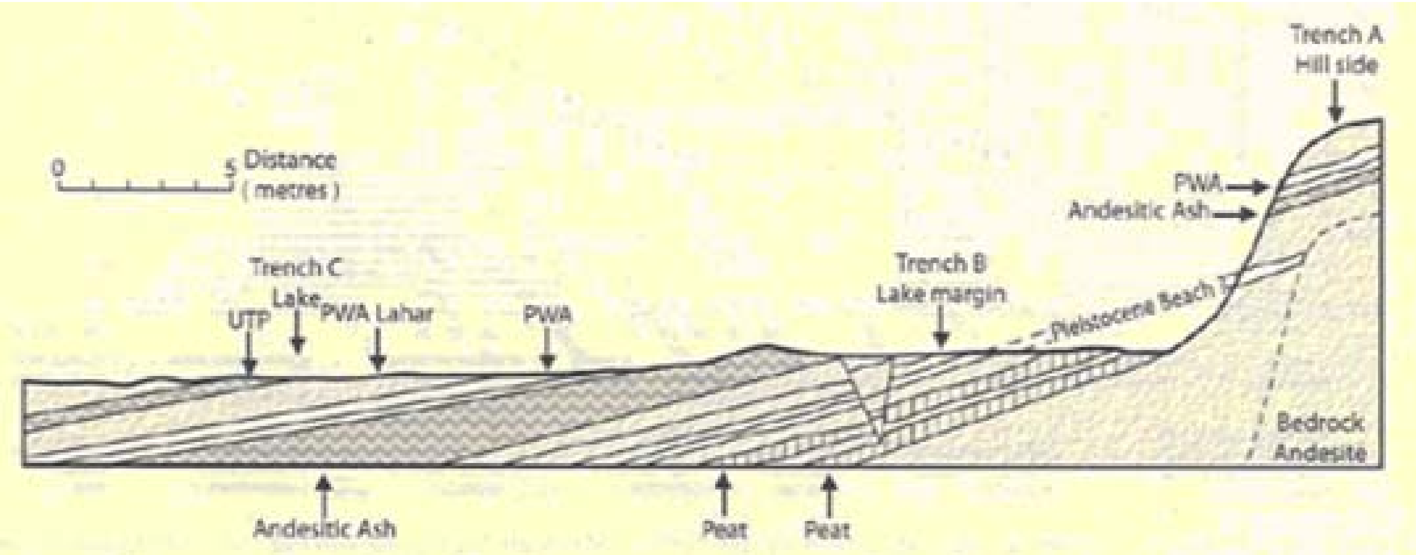
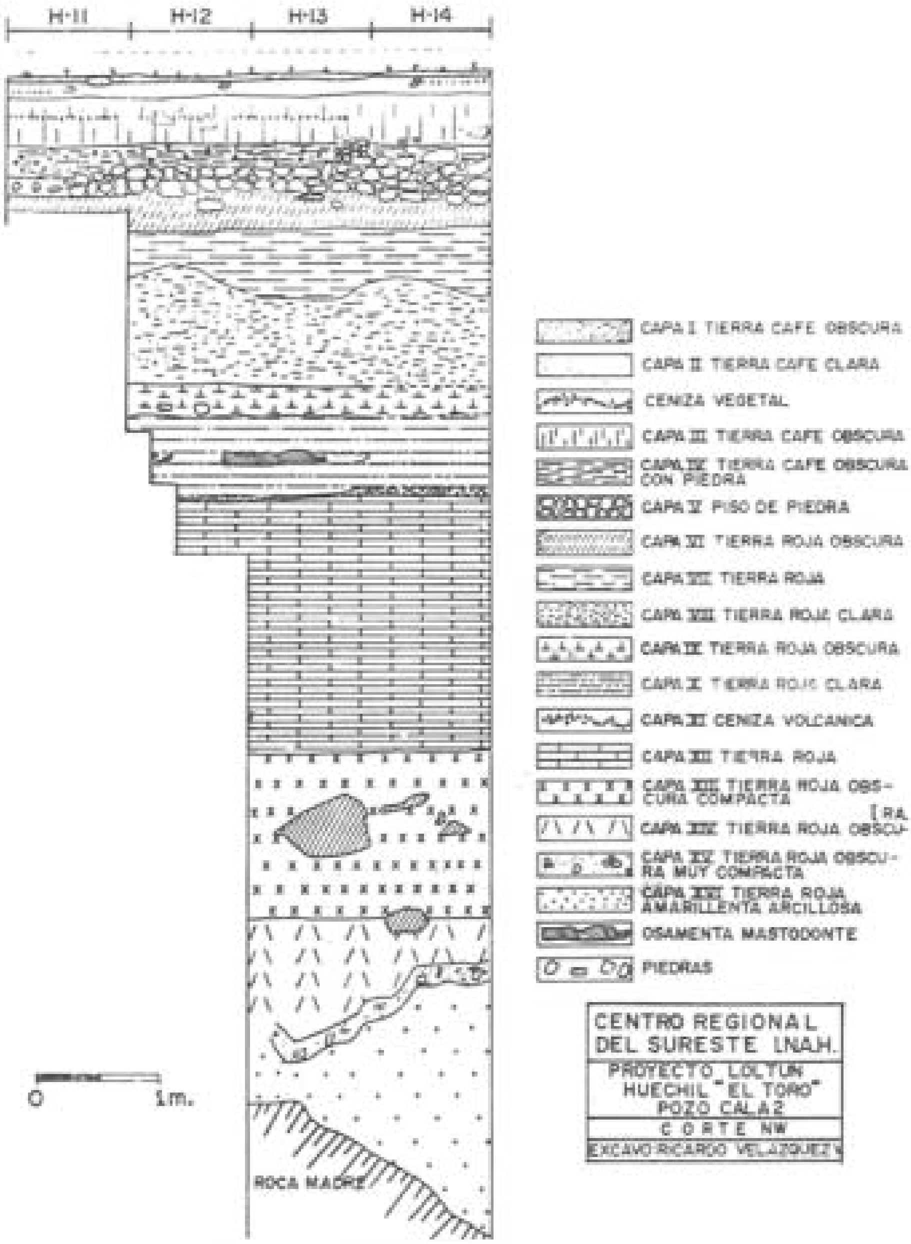


Figure 5: New stratigraphy at the Tlapacoya site, Basin of Mexico after Huddart and Gonzalez, 2006.



Loltun, stratigraphy at El Toro trench.

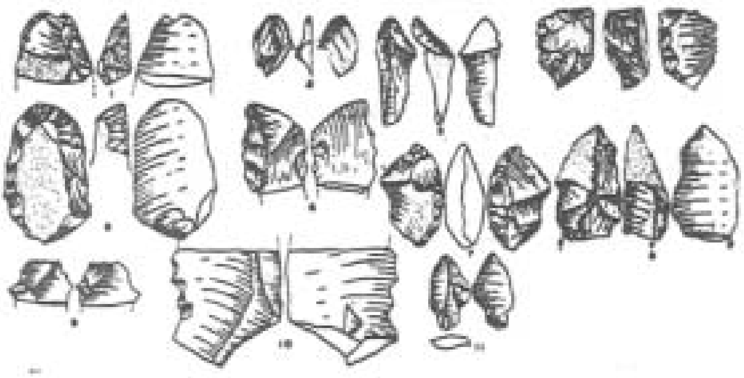


Figure 6: Stratigraphy and associated preceramic artefacts at Loltun Cave, Yucatan

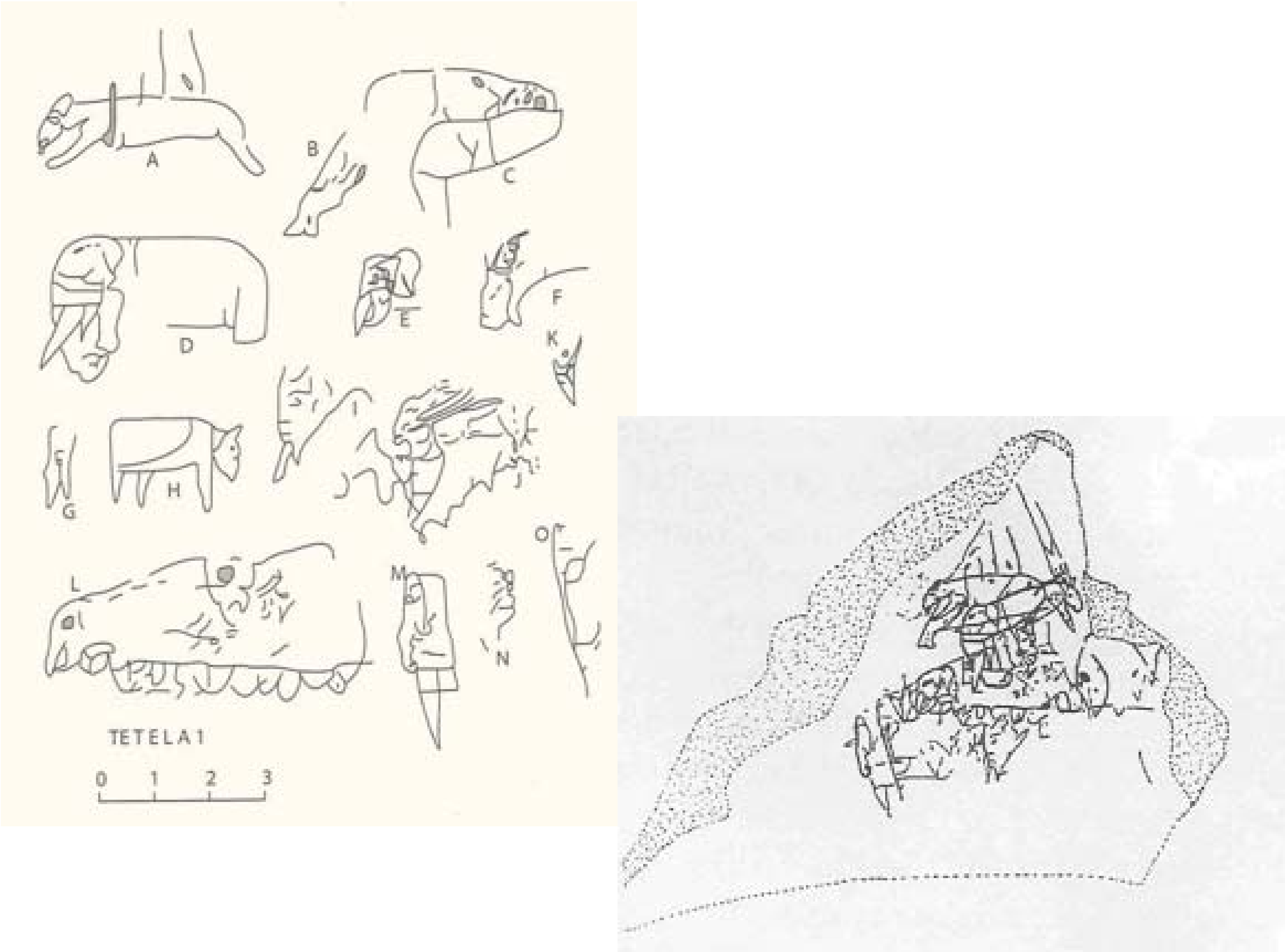
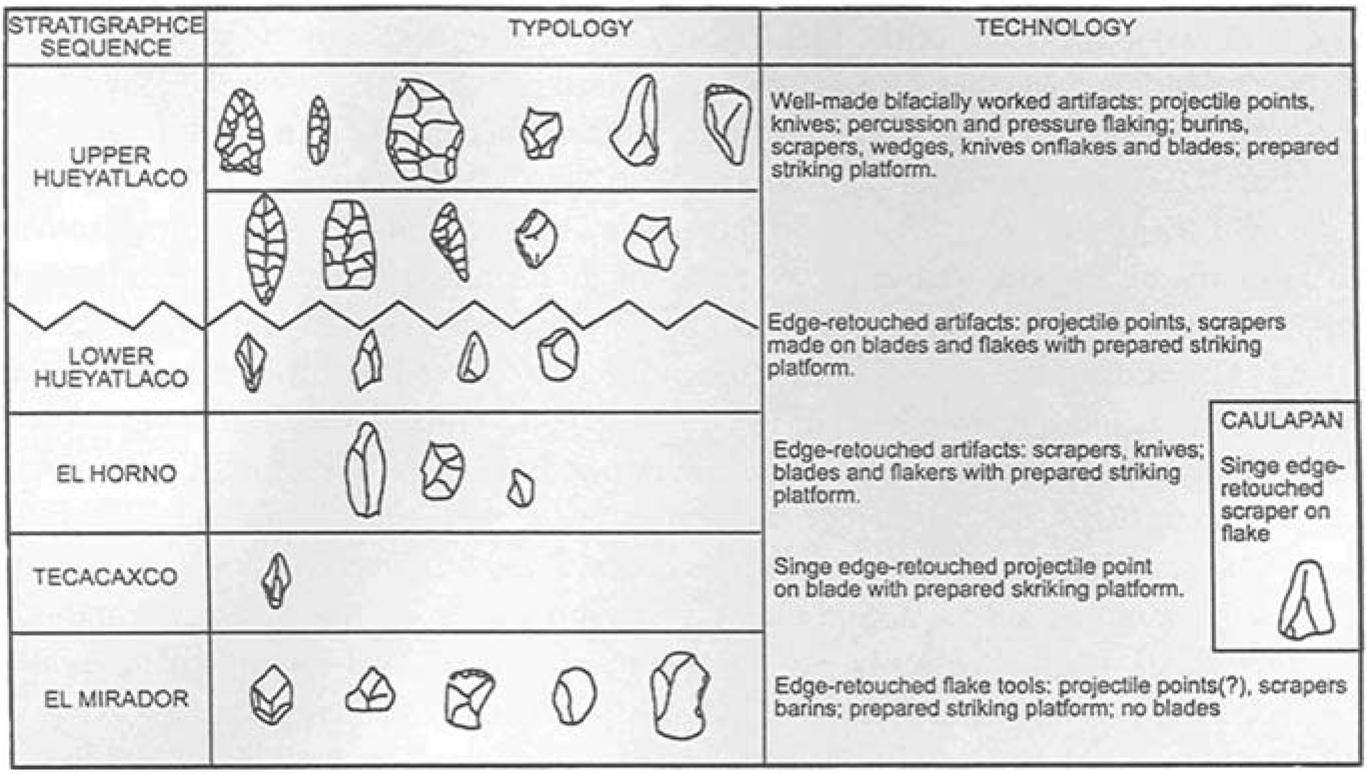


Figure 7: Engraved bone and stone tools stratigraphy, Valsequillo Basin, Puebla, Figures (a) and (b) after Armenta, 1978; Figure (c) after Szabo et al 1969.



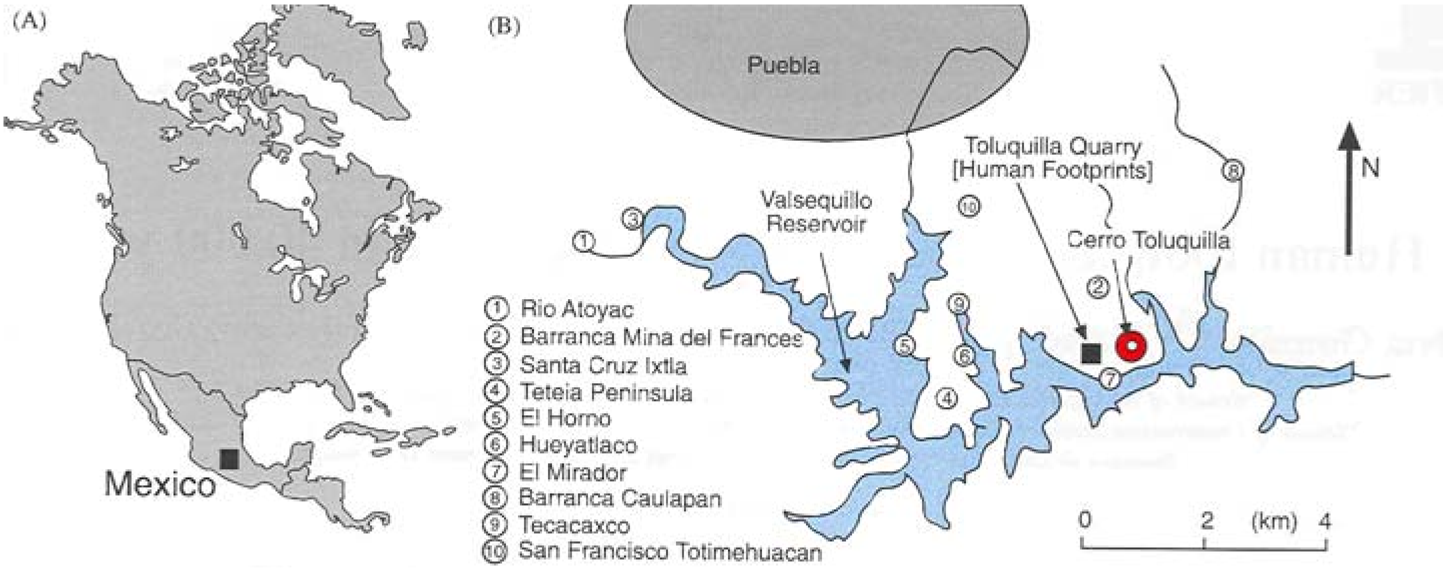


Figure 8: Location of sites in the Valsequillo Basin, Puebla.

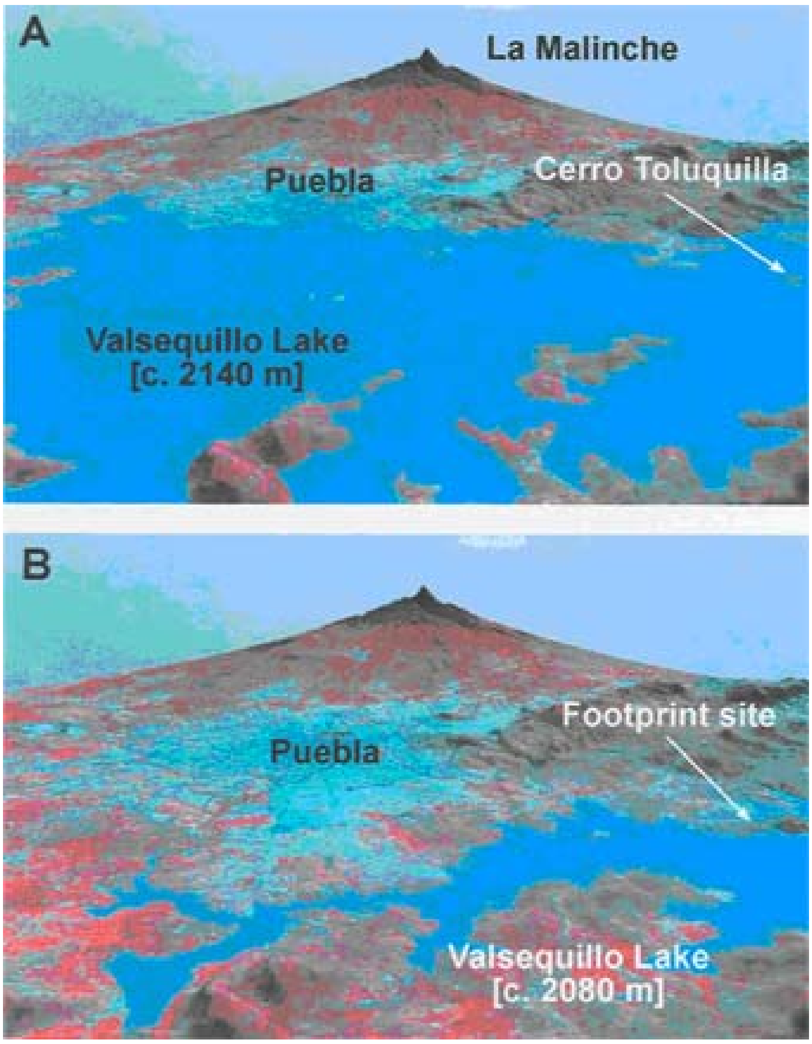


Figure 9: A) Reconstruction using GIS of the maximum level of the shallow Late Pleistocene lake at the Valsequillo Basin, Puebla, also shown are La Malinche Volcano and Cerro Toluquilla Volcano. B) Reconstruction using GIS of the level of the Late Pleistocene lake when the human footprints were made (After Gonzalez S. et al 2006a).

Figure 10: Examples of human footprints preserved in the Xalnene Ash.

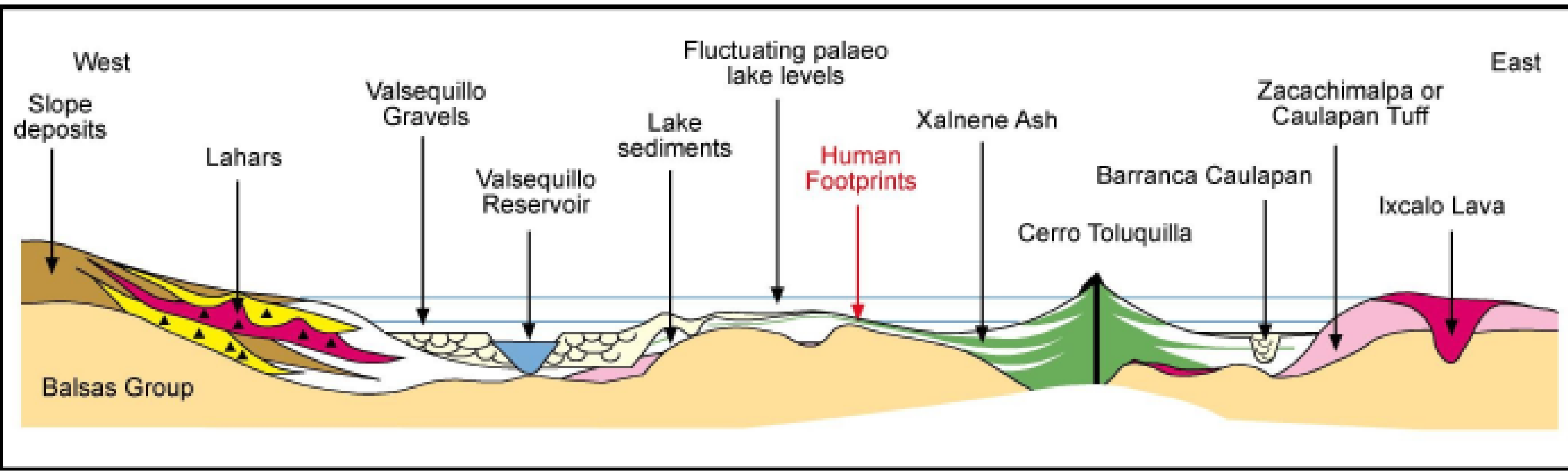


Figure 11: Cross section showing the main geological units in the Valsequillo Basin, and the location of the human footprints site, after Gonzalez S. et al 2006a

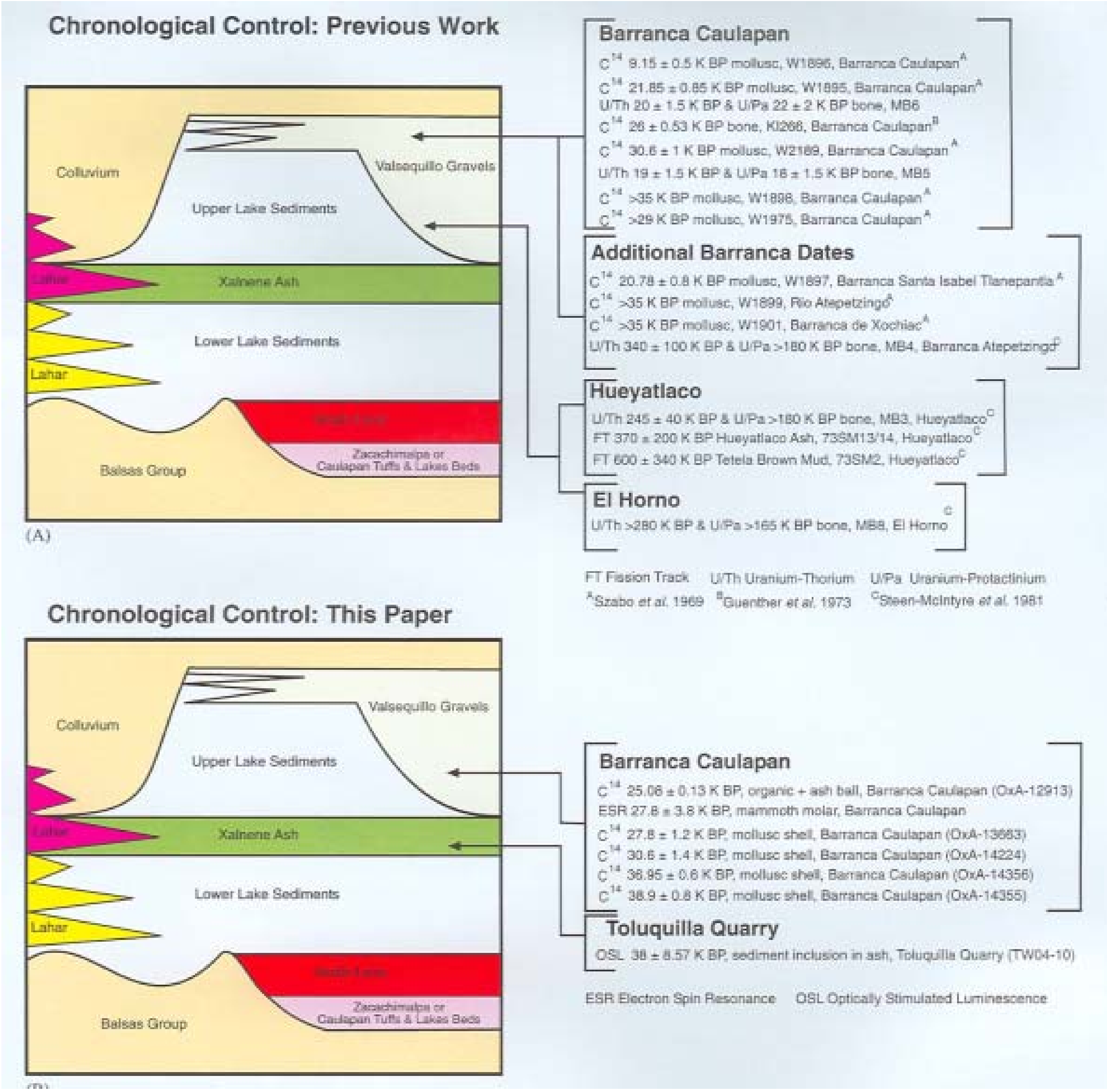


Figure 12: Chronological controls for the Valsequillo Basin deposits, after Gonzalez S. et al 2006a.

Table 1. Dates of some Human Skulls and Megafauna from Central Mexico

Locality	Lab. No.	Specimen Number	Species	δ^{13} C	AMS years BP.
Peñon III	OxA-10112	6-07-1959/DAF/INAH	Homo sapiens sapiens, left humerus	-11.6	10,755 ± 75
Tlapacoya I	OxA-7557	10-1961-62/DAF/INAH	Homo sapiens sapiens, skull	-16.0	10,200 ± 65
Texcal Cave, Valsequillo	OxA-10113	9-12-1964/DAF/INAH	Homo sapiens sapiens, skull	-14.4	7,480 ± 55
San Vicente Chicoloapan	OxA-10111	5-05-1955/DAF/INAH	Homo sapiens sapiens, skull	-14.6	4,410 ± 50
Tepexpan Man	P89 919		Homo sapiens sapiens , skull	-19.8	2,290 but with C:N = 15, contaminated
Tocuila	OxA-7746	Toc-793, mammoth 5	Mammuthus columbi, skull	-12.6	11,100 ± 80
La Villa	0xA-7752	DP-SN4	Mammuthus columbi, mandible	-14.1	11,300 ± 120
Los Reyes-La Paz	OxA-7747	DP-1940	Mammuthus columbi, tibia	-12.0	18,280 ± 160
Tequexquinahuac	Beta-153819	Chapingo collection	Mammuthus columbi, tusk		13, 450 ± 40
Tocuila	OxA-10307		Mammuthus columbi, rib		11,255 ± 75
San Josecito , Cave, San Luis Potosi	OxA-7556	SJC-5351	Nothrotheripos shastsensis (groundsloth), rib	-16.4	13,450 ± 40

Table 2. Suggested Dating Framework for the Valsequillo Basin:

Stratigraphic Unit and Artifacts	Dates
9. Tetela Brown Mud (lahar); Buena Vista lapilli	c.8k
8. Valsequillo Fluvial Gravels, Lahars, and white Ash sequence (Wisconsin)	c.9k-c39k
7. Lahars in the Atoyac and Atepizingo valleys and in the Periferico Ecologico (from La Malinche Volcano)	c.23k
6. Scraper found in the Valsequillo Gravels at Barranca Caulapan site.	c.23k
5. Hueyatlaco White Ash, in the Atepinzingo valley and the convoluted rhyolitic ash in the Periferico Ecologico	c.25k
4. Hueyatlaco artifacts associated with megafaunal bones (mammoth, horse and camel)	c.25-39k
3. Upper lake sediments succession	c.25-39k
2. Xalnene Basaltic Ash with human footprints	c. 40k
1. Lower lake sediments succession (Sangamonian)	40-200k

Note: The animal bones and artifacts found in the Valseqilllo fluvial gravels sequence are all reworked and not *in situ*.
The AMS radiocarbon dates are in situ from a freshwater molluscan fauna from finer grained, overbank sands/silts found in the sediment sequence.

Footnotes

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