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Mountain of sustenance, mountain of destruction: The prehispanic experience with Popocatépetl Volcano

P. Plunket *, G. Uruñuela [1]

Departamento de Antropología, Universidad de las Américas-Puebla, Sta. Catarina Mártir, 72820 Cholula, Puebla, México

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Abstract

Twelve seasons of work have documented two temporally distinct sets of prehispanic houses and agricultural fields buried by pumiceous airfall deposits at Tetimpa on the northeastern flank of Volcán Popocatépetl in the state of Puebla, Mexico. Archaeological survey and excavation, in addition to stratigraphic, volcanologic, and geomorphic field methods and radiocarbon dating have been used to gather information on two major volcanic eruptions that devastated prehispanic settlements and rendered this region uninhabitable for generations, first about 2000 years BP and then again between AD 700 and 900. Impacts of these eruptions were probably responsible for many of the population shifts evident in the archaeological record during these centuries. Available geological data are interwoven with the historical and archaeological records to summarize and explain the most significant findings of this research.

Keywords: Popocatépetl; eruption; Tetimpa; Cholula; natural disaster; abandonment

1. Introduction

Initial archaeological discoveries of prehispanic houses and agricultural fields buried under volcanic ash on the northeastern flank of Popocatépetl Volcano date to the 1960s when local communities began to excavate the tephra to make cinder block in small cottage industries (Tschohl and Nickel, 1972; Seele, 1973). In the early 1990s, miners introduced large front-end loaders to extract the pumice, greatly accelerating the destruction of the buried ancient settlements. After the onset of Popocatépetl's current eruption in 1994, evacuation routes were paved, providing yet easier access to the pumice quarries and making the documentation of the archaeological remains even more urgent.

In November 1993, archaeologists from the Universidad de las Américas in Cholula, Puebla, began a long-term research project designed to study the impact of Popocatépetl's volcanic activity on the prehispanic settlements of the western Puebla-Tlaxcala Valley in central Mexico. Twelve field seasons (1993–2005) have focused on the Tetimpa region, a 20 km^2 area located between the towns of San Nicolás de los Ranchos and San Buenaventura Nealtican on the northeastern flank of the mountain in the state of Puebla (Fig. 1). Archaeological survey and excavation – in addition to stratigraphic, volcanologic, and geomorphic field methods and radiocarbon dating – have been used to gather information on two major volcanic eruptions that devastated prehispanic settlements and rendered this region uninhabitable for generations. These eruptions were probably responsible for many of the population shifts evident in the archaeological record during the first and eighth centuries AD (Sanders et al., 1979; Siebe et al., 2004; Uruñuela and Plunket, 2005).

Research has focused on the following aspects: (1) determination of the extent and timing of human occupation in the area; (2) reconstruction of the social, political, and ritual patterning in village organization; (3) identification of subsistence strategies and exchange networks; (4) accurate dating of the volcanic eruptions visible in local stratigraphy; (5) establishment of the lateral impact of the volcanic events; and (6) understanding of abandonment processes and the sociopolitical aftermath of major

* Corresponding author. Tel./fax: +52 222 229 2048.
E-mail addresses: patricia.plunket@udlap.mx (P. Plunket), gabriela.urunuela@udlap.mx (G. Uruñuela).
[1] Fax: +52 222 229 2048.

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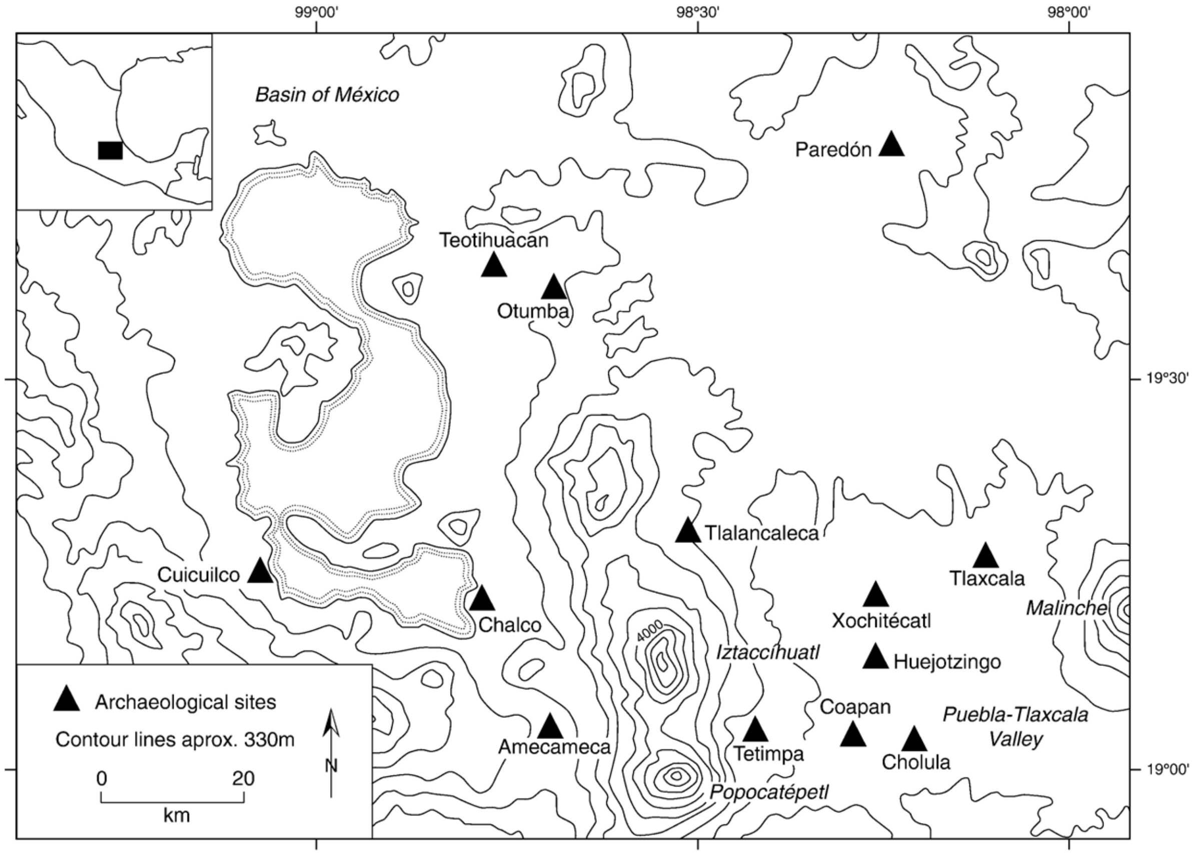

Fig. 1. Map of central Mexico locating Tetimpa and archaeological sites discussed in the text.

natural disasters in the surrounding area. We present herein the major contributions of this research and discuss their significance.

2. Mountain of sustenance

In ancient Mexico, mountains were thought to contain subterranean waters that filled the space under the firmament. In the central highlands, this was Tlalocan, the realm of the rain god, and from here emanated the waters of rivers, lakes and ultimately the sea. Mountains themselves were propitiated in rituals to petition for rain, and in this sense they played an essential role in the generation of agricultural produce, the staff of life (Broda, 2001, pp. 296–297). Bernardino de Sahagún (1981), the Franciscan friar who documented native customs and beliefs during the decades immediately following the Conquest, commented that the mountains of the Sierra Nevada, in particular Popocatépetl and its northern neighbor Iztaccíhuatl, were considered sacred since this was where the rain clouds converged. He tells that, even towards the end of the sixteenth century, pilgrimages were still made to their summits to offer sacrifices to the water deities. Fray Diego Durán (1971, p. 255), another early observer of native beliefs, recounts that:

> In olden times this mountain [Popocatépetl] was hallowed by the natives as the most important among the mountains, especially by those who lived in its vicinity or on its slopes. In both climate and other desirable things it is the best part of the land. Even though its slopes are rough with cliffs and hills and the land most rugged, the hills and cliffs are thickly populated and always were so, owing to the splendid waters which come from this volcano and to the great abundance of maize and European produce which are harvested around it. The closer they are [to the volcano], the earlier [the fruit and grain] ripen and the tastier they are. I should not forget the beautiful and abundant wheat which ripens on its heights and its slopes. For these reasons the people revered [the mountain] and held it in high esteem. They offered it the usual and continued sacrifices and presents, aside from the special feast offered yearly.

Today, the farmers who live on the flanks of Popocatépetl envisage the volcano in human terms. To them he is Gregorio, a masculine being with long wavy hair, thought by some to be analogous to the “smoke” tendrils that unfurl from the 5400 m-high crater. Tradition requires that he be venerated with offerings placed in a sacred cave high on the slopes of the mountain (Plunket and Uruñuela, 1998a) in order to secure his favor and benevolence.

3. Mountain of destruction

After the Conquest, Popocatzin, or Smoking Mountain, was known to both Spaniards and natives as the volcano that gave forth smoke and flames several times a day (Durán, 1971, p. 253).

Since the fourteenth century, it has erupted over 30 times (Sigurdsson, 2000, p. 1379), but none of those events had major destructive consequences. Ancient Aztec legend, however, credits natural forces like wind, floods, and volcanic eruptions with the destruction of previous worlds in an ongoing cycle of creation and destruction, and affirms that the third creation, or sun, was annihilated by a massive eruption, a rain of fire, which caused the rocks to boil and turn red (Bierhorst, 1992; Sullivan and Knab, 1994, p. 66).

Two major eruptions that occurred during prehispanic times may have provided the basis for Aztec legends (Seele, 1973; Panfil, 1996; Siebe et al., 1996; Plunket and Uruñuela, 1998b). The earliest of these was a VEI-6 plinian event that took place during the first century AD; this explosive eruption produced a tephra column between 20 and 30 km high and deposited >3.2 km^3 of yellow andesitic pumice over an area extending at least 25 km east of the crater (Panfil, 1996, p. 16; Siebe, 2000, p. 61). It buried at least one large village with lapilli, causing the abandonment of the settlement (Plunket and Uruñuela, 2003; Uruñuela and Plunket, 2003). Following the plinian phase, thick (30–100 m) olivine andesitic lava flows – now known as the Pedregal de Nealtican – covered about 50 km^2 of the eastern piedmont of the volcano and in places dammed and diverted drainages, altering the surface hydrology of the western Puebla Valley (Panfil, 1996, pp., 16–20). Tetimpa, which in the native Nahuatl language means “place filled up with rock” (Karttunen, 1983, p. 234), is the local name for the area impacted by the plinian phase of this eruption.

At least 400 years passed before the Tetimpa region was reoccupied. Organic accumulations and a sandy matrix define a weak A soil horizon in the upper 15–40 cm of the pumice (Panfil, 1996, p. 21), and this appears to have been sufficient to allow cultivation and the establishment of isolated farmsteads, although the density of these new settlements was greatly diminished from what it had been in the first century AD. The ceramics associated with these new houses indicate an occupation dating to the sixth and seventh centuries AD. This eruptive hiatus also has been documented in the San Nicolás lacustrine sequence (Panfil, 1996, pp. 20–21), a set of stratified sediments deposited on top of the lava from the initial eruptive sequence that dammed the Alseseca and Nexac streams, which drain water from the northeast flank of Popocatépetl and the southwest slope of Iztaccíhuatl, and channel pyroclastic flows and lahars. Twenty to 30 m of interbedded clays, silts, and sands – with no evidence of tephra layers – can be divided into a lower section of finely laminated silts and clays deposited in a low-energy lacustrine environment, and an upper section of core sand and gravel that might reflect a shallower lake and erosion from storm events.

Panfil (1996, pp. 23–25) has established that this hiatus ends with the deposition of massive purplish-gray lahars – up to 6.5 m thick – that are not associated with tephra layers and may not be volcanic in origin. These lahars flowed down the Alseseca stream valley and into the Barranca Nexac, reaching as far as San Jerónimo Tecuanipan, about 10 km southwest of Cholula. Overlying these laharic deposits is airfall tephra from plinian events and pyroclastic surges that occurred in two distinct phases, separated by as much as 150 years. This eruptive sequence initiated with a pyroclastic surge in the seventh century AD, and ended about 200 years later with pyroclastic surges and airfall tephra eruptions that blanketed the northeastern and eastern slopes of the volcano. The modern topsoil, composed of sand, silt and organic materials, covers this last pumitic deposit, and presents no further evidence of major

Fig. 2. Remains of a first century AD house compound at Tetimpa with profile of Popocatépetl in the background.

volcanic events on the northeastern flank of the volcano (Siebe et al., 1996; Panfil et al., 1999).

4. Radiocarbon dating

The primary contexts afforded by Tetimpa's domestic structures, activity areas, and agricultural fields provide reliable dating for both of the eruptive sequences considered here since they were in use when the disasters occurred (Figs. 2 and 3). They include burned roofing materials, charcoal from hearths, food left in storage bins, and charred remains of cultivated plants that have permitted us to reliably constrain the natural events by radiocarbon dating.

The most reliable date for the first eruption is an AMS (Accelerator Mass Spectrometer) determination on a carbonized corn cob found sealed inside a jar, which yielded a reading of 2010±40 BP (2 Sigma range of cal 100 BC–AD 70 [Beta-146572]). This, 13 additional radiocarbon dates, and the cultural artifacts recovered from the houses buried by the tephra, indicate that the initial eruption probably took place during the first half of the first century AD.

Although the second eruption was equally destructive as the first, it is less well dated. The small settlements on the northeastern flank of the volcano were widely dispersed, leaving few archaeological remains in the primary contexts that are so useful in providing tight temporal constraints. Archaeological excavations were conducted at one Classic-period house (Hirth, 1996) and agricultural fields associated with the occupation during the latter part of the eruptive hiatus (Hirth and Andrews, 1997). Two radiocarbon samples from the Classic-period house allow us to frame the occupation between the sixth and eight centuries AD (Hirth, written communication, 2004). The first, 1580±40 BP (AMS Beta-178626), comes from a trash pit in the patio of the house; its 2 Sigma range of cal AD 400–570, provides confirmation for the timing of Tetimpa's reoccupation at about 400–500 years after the initial eruption. A second date was obtained from charred roofing (or a burned tree) and provided a date of 1200±60 BP (2 Sigma range of cal AD 680–980). Three radiocarbon dates were secured from the remains of plants charred by the pyroclastic surges that initiated the second eruptive sequence. These are AMS dates that range between 1170±40 BP and 1220±40 BP (2 Sigma ranges between cal AD 700 and 980 [Beta 178628, 178629, and 178630]) (Hirth, written communication, 2004).

Panfil's (1996) work also provides an important basis for dating of the second eruptive sequence. Two charcoal samples – apparently produced by a pyroclastic surge – were taken from the surface of the paleosol that developed on the pumice from the first eruption. These samples yielded dates of 1380±80 BP (2 Sigma range of cal AD 550–800 [I-17625]) (Plunket and Uruñuela, 1998b, Table 1) and 1340±70 BP (2 Sigma range of cal AD 605–865 [Beta-86483]) (Panfil, 1996, Table 2). These dates are slightly earlier than those obtained from the scorched fields excavated by Hirth and Andrews (Hirth, written communication, 2004), but they consistently place the beginning of a renewed period of volcanic activity at about AD 700.

The second eruptive sequence took place in two phases (Panfil, 1996, p. 33). The first of these began with the pyroclastic surge discussed above and ended with a thin airfall layer of pink pumice. A second sedimentary deposit – the Lake San Pedro sequence – contains 1.3 m of laminated clay, silt, and sand above the pink pumice. A carbon sample from the surface of this deposit was dated to 1210±60 BP (2 Sigma range of cal AD 680–980 [94-L4-cs6 (16802)]) (Panfil, 1996, Table 2), suggesting another short hiatus of about 150 years. Overlying the Lake San Pedro sequence are a series of two airfall pumice deposits and two pyroclastic surges; carbon stratigraphically above the most recent pumice provided a date of 1190±70 BP (2 Sigma range of cal AD 680–1000 [Beta-83780]) (Panfil, 1996, Table 2).

The termination of major volcanic activity also has been documented in stratigraphic excavations on the north side of the main square of Cholula, Puebla (López et al., 2002b). At the base of the sequence, a series of laminated dark clays, which contain ceramics of the Late Classic period (AD 700–900), was deposited directly on the culturally sterile *tepetate*. These were sealed by 20–30 cm of volcanic ash. Early Postclassic ceramics, usually dated to between AD 900 and 1100, occur for the first time in water-lain sediments deposited directly on top of this ash. Two radiocarbon determinations from these layers yielded dates of 970±50 BP (intercept cal AD 1030, 2 Sigma range cal

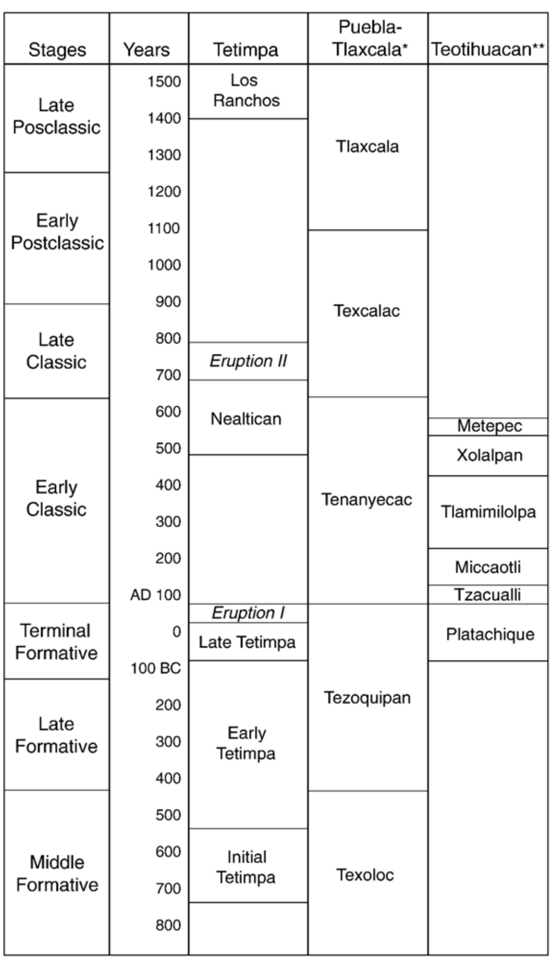

Fig. 3. Comparative chronological chart (*García Cook, 1981; **Sugiyama, 2004).

AD 990–1185 [Beta-188340]) and 1040±130 BP (intercept cal AD 1005, 2 Sigma range cal AD 690–1260 [Beta-188341]), confirming Panfil's finding that Popocatépetl's second eruptive sequence had ended prior to AD 1000 (Plunket and Uruñuela, 2005a).

5. The first occupation

Tetimpa was initially settled between 800 and 700 BC as part of a gradual agricultural expansion into the forested piedmont of the Sierra Nevada. By the beginning of the first century AD, it had grown into a large dispersed village with over 600 wattle-and-daub houses – perhaps 3000 to 4000 people – and a number of non-residential structures that spread over 4 km^2. The houses were built according to a standardized module consisting of a large central room used for family ritual flanked by two smaller lateral structures for sleeping and cooking (Plunket and Uruñuela, 1998a). Together they frame a courtyard with an ancestral shrine, wattle-and-daub storage bins, and remains of household subsistence activities (Uruñuela and Plunket, 1998, 2003).

Small effigy volcanoes are a common, although not exclusive, theme for the domestic patio shrines (Fig. 4). These mountain replicas, modeled from clay, rocks and sherds and crowned with crudely carved stones, encase one or two chimneys that produced smoke in imitation of the ash and vapor plumes expelled from the volcano's crater. The miniature "smoking mountains", probably built to appease the volcano, provide direct evidence that the inhabitants of the lower flanks of Popocatépetl witnessed many such emanations during their lifetimes, and that the volcano was a significant figure in village ritual prior to its massive eruption (Plunket and Uruñuela, 1998a, 2002a).

The three-room houses are arranged in clusters in which junior residences congregate around a senior house and a ritual structure (Plunket and Uruñuela, 2005b), in a pattern suggesting population growth with segmentation at the nuclear family level (Flannery, 2002, p. 431) that was typical of Formative villages in ancient Mexico. Senior houses engaged in a variety of reciprocal trading partnerships (Plunket et al., 2005). Neutron activation analyses of ceramics from Tetimpa indicate that villagers traded locally for most of their serving vessels, but a number of items were imported from the northeastern Basin of Mexico, the area between Huejotzingo and Tlaxcala, and the Tepexi region of southern Puebla, distances of up to 80 km from Tetimpa. All houses forged alliances to the north to procure obsidian from the Otumba and Paredón mines.

Agricultural fields are usually not preserved in the archaeological record, their imprint having been erased long ago by more recent activity. The furrowed fields of the Tetimpa region, however, have provided new insights into prehispanic agricultural systems (López, 2000). The early fields occupy the vacant area between houses, and they were oriented to arrest the

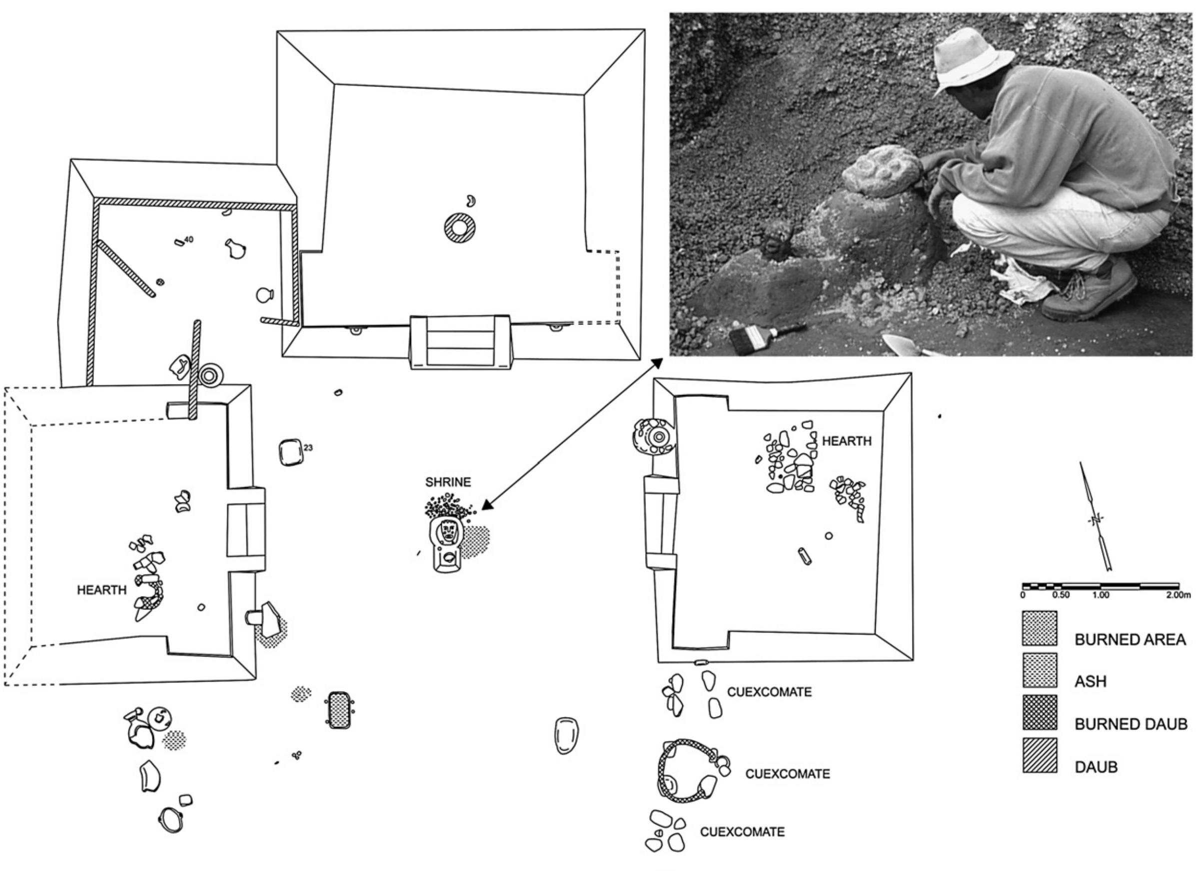

Fig. 4. Domestic shrine in the patio of at a first century AD Tetimpa house.

erosion of the sandy piedmont soil, and perhaps increased water absorption. Furrows are spaced regularly at intervals of 1–1.3 m apart and macrobotanical remains indicate that they probably represent *milpa* agriculture (Aguirre, 2000). More compact furrow systems with only 0.45–0.85 m between furrows are vestiges of orchards and gardens (López, 2000).

The abruptness of the event that sealed Tetimpa's fate suggests that quotidian activities were "frozen in time", and that the archaeological remains reflect a typical day in the life of the prehispanic villagers (Plunket and Uruñuela, 2000a,b). However, this is a deceptively simple scenario, and further analysis shows that this was a dramatic episode in the village's history, a time of crisis and intense anxiety, during which individual decision-making created distinct archaeological patterns (Plunket and Uruñuela, 2003). The things people leave behind as they abandon their homes, document both the circumstances that led to the exodus and also their ideas of returning (Tomka, 1996). For example, the positioning of the ceramic bowls and *metates* – face up or face down – indicates that some families were in residence when the explosion occurred, while others were away and had stored these items to keep them clean (Fig. 5). For some, the abandonment was an abrupt evacuation, but for others it was a more gradual process as wary people stayed away from their homes, returning only to tend their fields and gardens. Families were able to remove most of the more portable items from their homes, including nearly all of the food. With few exceptions, storage bins are empty and only a few large or heavy artifacts were left in the rooms or along the edges of the patios. The gradual nature of the evacuation might also explain why we have found no casualties associated with such a massive natural disaster.

Villages on the flanks of the volcano were entirely abandoned, as were several major towns situated at its base, and many thousands of refugees must have sought shelter in communities on the valley floor farther east, out of harm's way, creating a complex problem for sociopolitical systems that lacked formal mechanisms for managing massive resettlement. Many of Tetimpa's wattle-and-daub houses had ignited as the hot lapilli rained down, and the fragile walls collapsed on top of coals left behind in the hearths. When it was all over, the villages lay buried beneath 1–2 m of lapilli, and the once-fertile landscape lay barren and sterile.

On the other side of the volcano, in the neighboring Basin of Mexico, archaeological survey has documented an enormous population decline – on the order of about 30% – accompanied by a major shift in the settlement pattern between 100 BC and AD 100 (Sanders et al., 1979, p. 183). During the previous five centuries, the southern Basin, with its rich soils and abundant rainfall, had witnessed a sustained increase in human occupation; but suddenly the shores of the freshwater lakes and the lower slopes of the Sierra Nevada were almost entirely abandoned. Simultaneously, the emerging city of Teotihuacan and its hinterland in the northern part of the Basin experienced an abrupt population explosion. Traditionally, archaeologists have argued that this phenomenon was a product of Teotihuacan's bid for political control of the countryside as the city's government somehow forced the northward displacement of 50,000 people (e.g., Sanders et al., 1979, p.107; Millon, 1981, p. 217). However, the dating of a major eruption of Popocatépetl to the first century AD, when most of the urban center's growth took place, indicates that instead the developing state was confronted with an ecological disaster of unprecedented proportions. It was an event that accelerated social and ideological processes already underway, including population nucleation in and around the city and modifications of prevailing belief systems to facilitate the incorporation of a heterogeneous assemblage of refugees (Plunket and Uruñuela, 2005b, 2006). Additionally, two other volcanoes along the southern rim of the Basin of Mexico – Chichinautzin and Xitle – were active during this time period, reinforcing the undesirable nature of the southern Basin for human occupation (González et al., 2000; Siebe et al., 2004). Prior to 100 BC, most of the Basin's population lived in towns and villages along the lakeshore between Cuicuilco and Chalco, but after AD 100 almost all of these settlements disappear (Sanders et al., 1979).

Fig. 5. First century AD house compound with objects "face up", indicating that it was in use at the time of the disaster.

6. The second occupation

About AD 500, human populations resettled the Tetimpa region, farming the thin soil that was slowly developing on the pumiceous ash. It is much more difficult to document the Classic occupation, because it is situated in between tephra deposits and is usually entirely destroyed when these are extracted by the front-end loaders. The one excavated house (Hirth, 1996) covered well over 130 m^2 (it had been partially destroyed by mining) and consisted of five rooms and three patios; its spatial layout is quite distinct from the residences of the earlier occupation, signaling important changes in social organization brought about by the development of more urban lifestyles during the eruptive hiatus.

The isolated farmsteads established during this time of calm are associated with areas of greater soil accumulation. The Classic period agricultural furrows are limited in extent, due mainly to the meager and uneven soil development, but they provide singular evidence of the strategies employed to salvage and replant fields after the renewal of volcanic activity in the eighth century AD. Hirth and Andrews (1997) found that, after the furrows were buried under the 10–15 cm layer of ash and pink pumice, the farmers excavated them so that they could be replanted, thus reworking the pumice into the paleosol. Detailed stratigraphic excavations document how this process was repeated at least one more time before farmers were forced to abandon the area when a 15–30 cm layer of tephra blanketed the northeastern slope of Popocatépetl.

Siebe et al. (1996) have suggested that the second eruptive sequence resulted in massive lahars that swept into the western Puebla Valley and destroyed the city of Cholula. Their reconstruction is based on examination of the deposits – which they identify as lahars of volcanic origin – that overlie the Classic period architecture on the southern side of Cholula's Great Pyramid. Certainly the eruptions would have had significant social, political, and environmental consequences for the ancient settlement and its hinterland, but it remains to be established that the city itself was buried under massive mudflows. Excavations in the low-lying fields of the Rancho de la Virgen at the northeastern corner of Cholula's Great Pyramid (Fig. 6), and at the Colegio Taylor and the Convento de San Gabriel in the area between the main prehispanic structure and the Municipal Palace located further west (i.e., between the Pyramid and the volcano) – a zone that should show the presence of these deposits if indeed they reached the Pyramid – to date have failed to find stratigraphic evidence of these lahars (López et al., 2002a,b; Plunket and Uruñuela, 2002b, 2005a,b). Excavations on the campus of the Universidad de las Américas to the east of the Great Pyramid have demonstrated that, in areas where stratigraphy is intact, lahar deposits are also absent although a sterile layer of sandy volcanic ash consistently seals the black clay deposits of the Classic period; cultural materials overlying this layer belong to the Early Postclassic (Plunket and Uruñuela, 2005b, p.103). Additionally, the 1985 INAH rescue project of a 4 km-long drainage system to the south of the Great Pyramid documented no evidence of the massive lahars overlying Classic remains; indeed, as part of that work, Plunket explored one Classic-period platform two blocks south of the Pyramid covered with a Postclassic platform. The emplacement of adobe walls directly over the Classic architecture demonstrates the absence of lahars in this area.

Perhaps the most important archaeological evidence regarding the lahar hypothesis comes from excavations at the Great Pyramid itself (Marquina, 1970b). Initial archaeological work in 1931 faced major problems due to the tremendous destruction resulting from the extraction of dirt from the Pyramid to make

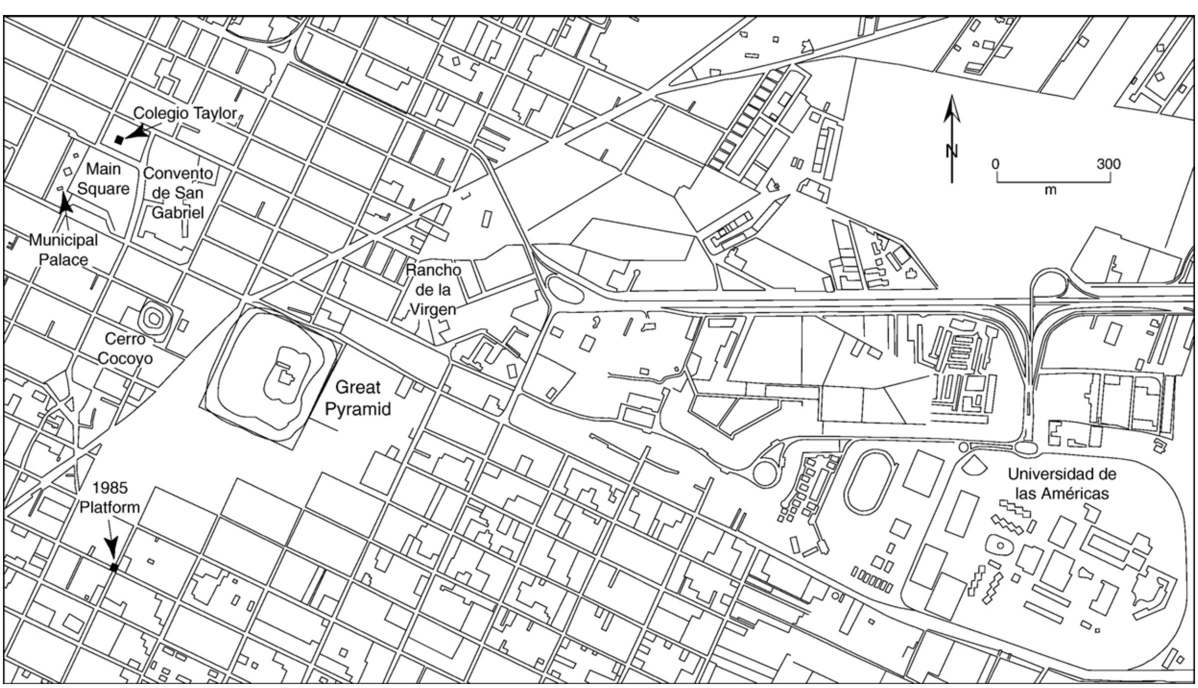

Fig. 6. Map of Cholula showing the location of the Great Pyramid and other locations discussed in the text.

adobes, the continuous plowing of the surface, and the roads and ramps used to read the church on top (Marquina, 1970a, p. 33). All of these activities led to extensive erosion, which left deep deposits covering the flanks of the building.

On the west side of the monument, a 12 by 24 m excavation reached a depth of 5.6 m, terminating at a stucco floor laid directly on sterile subsoil. The stratigraphy of the deposits over the floor (Acosta, 1970, Fig. 20) shows 0.4 m of eroded Late Classic materials covering the last construction phase on this side of the Pyramid; these, in turn, are sealed by 1.6 m of Early Postclassic remains. No structures or burials were found in these 2 m – a fact that might indicate that these are indeed lahars – however, the ceramics in the Early Postclassic stratum (Acosta, 1970, p. 128) suggest a date between AD 950 and 1150 (Sanders et al., 1979, p. 463), well after the date proposed by Siebe and his colleagues. The archaeologists did note volcanic strata at the Pyramid, one within the Early Postclassic and another in the Late Postclassic (Müller, 1970), but both of these were airfall deposits.

Finally, it is important to consider that, during the latter half of the Classic, the Great Pyramid fronted on a large plaza bounded by a low platform on the south and another substantial mound to the west (Cerro Cocoyo [Fig. 6], now severely mutilated). These structures would not only have protected the Great Pyramid from the lahars, but they also would have contributed erosion materials to the deposits excavated in the plaza. We conclude that the evidence for the destruction of Cholula by massive lahars from Popocatépetl during the Late Classic is problematic and needs to be reevaluated, by both geologists and archaeologists.

The transition between the Classic and Postclassic (AD 700–900) in the Puebla-Tlaxcala region represents an extremely complex problem (García Cook and Merino, 1991; Plunket and Uruñuela, 2005b; Uruñuela and Plunket, 2005). Archaeological excavations in Cholula (Dumond and Müller, 1972), in addition to work at nearby Cerro Zapotecas (Mountjoy, 1987), Cacaxtla-Xochitécatl (Serra, 1998), and the various surveys of the Puebla-Tlaxcala Valley, suggest another period of important changes during the seventh and eighth centuries AD, including a cessation of monumental construction in Cholula, the establishment of a new politico-religious ideology linked to the Olmeca-Xicalanca of Cacaxtla (Ringle et al., 1998), the political collapse of Teotihuacan, and the transformation of regional settlement patterns. While some of this turbulence may have been caused by the second eruptive sequence of Popocatépetl (Siebe et al., 1996), much of it derived from the evolution of urban life and the establishment of a class society during the Classic period (AD 100–700) that created new social and political tensions. The second eruptive sequence took place in a very different world than the first, a world of cities with a much greater organizational capacity; interestingly, one of these great cities – Teotihuacan – survived only as a relic of past glory, while another – Cholula – went on to become the most important religious center of all ancient Mexico (Rojas, 1985).

7. Discussion

Volcanic disasters have long been invoked by archaeologists and geologists alike as prime movers throughout history. They have been blamed for the destruction of cities, famine, mass migrations, demographic collapse, and even the demise of civilizations (Hoffman, 1999; Scarth, 1999; Harris, 2000; Siebe, 2000; Sigurdsson, 2000; Dull et al., 2001). Disasters, however, most often are perceived in terms of their immediate impact and not so much as key pieces in the initiation of social, political, and economic transformations (however, see Sheets, 1979; Dull et al., 2001). Archaeological research at Tetimpa, Cholula, and other areas of the western Puebla-Tlaxcala Valley can be used to interweave the archaeological and historical records with the geological evidence, to better understand both the proximate and ultimate causes of culture change through time in this part of highland Mexico.

Anthropological studies of disaster have established that these events tend to accelerate changes that are already underway (Nolan, 1979; Driessen and McDonald, 2000). If they are of a sufficiently catastrophic scale, they can motivate social action, provide contexts for innovative agendas, promote new power relations, and allow the emergence of new leadership (Oliver-Smith, 1996, p. 310; Hoffman, 1999, p. 311). Both the Terminal Formative (100 BC–AD 100) and Late Classic (AD 700–900) were times of rapid social transformation in central Mexico; in this context, a major volcanic eruption would have served as a catalyst to accelerate those changes even more and highlight the inability of local authorities to deal not only with the forces of nature, but also with unforeseen social and political consequences derived from decision-making during the recovery process. Cities would have arisen during the Classic period without the massive eruption of the first century AD, but the pace of that emergence and the nature of the cities that evolved on either side of Popocatépetl were highly contingent upon the volcanic event.

The Terminal Formative population of the Puebla-Tlaxcala Valley has been estimated at over 100,000 (Dumond, 1972, p.119), and many of these people lived at one of several large, complex chiefdoms that developed in the fertile well-watered shadow of the volcano. Some of them were quite close to the Sierra Nevada – e.g., Coapan, Xochitécatl, and Tlalancaleca – and they appear to have been abandoned when Popocatépetl erupted, leading to a major restructuring of prehispanic society during the first century AD. Undoubtedly many social, political, and economic factors were in play, but a VEI-6 eruption probably prompted major population movements and political reorganization that had a lasting impact on the culture history of this region.

During the Classic, much of the population became concentrated at Cholula and a few other sites, as refugees relocated after their lands were blanketed with volcanic deposits that prevented reclamation (Plunket and Uruñuela, 2000a,b). The total population of the Puebla Valley appears to shrink (Dumond, 1972, p. 115), perhaps by as much as 30% (García Cook, 1981, p. 263), just as it did in the Basin of Mexico at this same time. Of the almost 200,000 people who perished from the effects of volcanic eruptions worldwide between AD 1600 and 1899, the majority of those deaths were not due to ashfalls, lahars, or pyroclastic flows, but rather resulted from starvation and diseases (Fisher et al., 1997, Table 15.3). These data demonstrate that while eruptions are terrifying events, their ecological and social consequences are more significant in terms of human life. Forest fires, the destruction of piedmont hunting and gathering areas, drought and an increased risk of frost resulting from the explosive events, would have contributed to economic chaos and the creation of a socially charged environment in which many individuals may not have survived.

The two major cities of the Classic period in highland Mexico, Cholula and Teotihuacan, initiated major monumental religious construction towards the beginning of the second century AD (Millon et al., 1965; Marquina, 1970a; Kabata et al., 2001; Sugiyama, 2004; Plunket and Uruñuela, 2005a). How much of this construction was designed to appease unruly supernaturals? Scholars have observed that fear of divine vengeance motivates social action and that religious responses to catastrophe can be highly adaptive (e.g., Nolan, 1979, p. 331; Chester et al., 1985; Fisher et al., 1997, pp. 179–198). The huge population influxes experienced by both emerging cities must have accelerated social processes already underway before the disaster, but the enormous and sudden increase in labor resources might have been intelligently channeled into huge communal building projects designed to placate an angry deity.

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