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**Present Use and Production of Metates and Molcajetes in Turícuaro (Michoacán, Mexico):
Deciphering the Evolution of Food Preparation Practices.**

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ABSTRACT

In Central America, maize processing for the production of tortillas bears a strong cultural connotation of the preservation of cultural traditions. The METATE project aims to explore the long-term history, from Prehispanic times until today, of the production and use of grinding stone tools (metates and molcajetes) on the slopes of the El Metate volcano (Michoacán, Central Mexico). It has been approached through a multidisciplinary program including volcanology, archaeology, and anthropology. The village of Turícuaro has been recognized for centuries as a major center of metate production for the entire Purépecha region in Michoacán. According to the few remaining craftsmen who make metates (*metateros*) in the village of Turícuaro, the quality of the rock selected and the organization of metate production have undergone significant changes during recent decades. We discuss how the introduction of new mechanical and electronic devices has generated important social consequences at the domestic, village, and regional scales.

KEYWORDS

Food practices; grinding tools; volcanic region; andesite lava; craftsmen; quarries; production

Introduction

Grinding tools are among the oldest and most widespread technologies in the world. They have been known since the Paleolithic and their development has been closely linked to agricultural communities on all continents for millennia, whether for the processing of millet and rice in China, wheat and barley in the Middle East and Europe, millet and sorghum in Africa, or maize and manioc in the Americas. Today, these systems are largely industrially developed, but the grinding tools are still used on a domestic scale for the daily processing of grains in some regions of the world. The context of their production and use is of great interest to archaeologists in search of key elements to better understand these technologies and the social context of their production and use. As a result, a number of investigations have been carried out since the 1980s to document the remaining custodians of the know-how associated with these technologies (Alonso 2019; David 1998; Hamon and le Gall 2013; Nixon-Darcus and D'Andrea 2023; Roux 1985).

In Central America, the use of metates and molcajetes for food production has a long history, deeply rooted in the cultural identity and culinary habits of many populations (Biskowski 2000; Nelken-Terner 1968; Rodríguez-Yc 2013). Written and pictorial records from the sixteenth century show that these two objects were closely associated with the feminine sphere and food preparation. A painted image in the Codex Mendoza (Figure 1a) shows a young Aztec woman making maize paste on a tripod metate. She is facing two traditional Mesoamerican cooking implements: the comal (a terracotta disk used to cook tortillas) placed on three hearthstones, and the molcajete (here often made in terracotta) with its stone pestle. Metates have a flat or slightly concave grinding surface and are used to prepare maize for tortillas and other ingredients that have been the staple diet of Mesoamerican populations for almost three millennia. Molcajetes have a bowl-shaped grinding surface and are used as mortars to prepare the hot sauces that are served with many traditional meals. Fundamental work on the manufacturing process and current use of tripod metates has been carried out, particularly in southern Mexico and Guatemala (Biskowski and Watson 2013; Cook 1982; Hayden 1987; Katz 2003; Searcy 2011). A symbol of Mesoamerican culinary traditions, the metate constitutes a remarkable case in the history of technology as it is one of the few artisanal products that have survived over centuries. In Michoacán and adjacent areas, for the Prehispanic period, archaeological evidence shows that metates and molcajetes were used since at least the Early- to Middle Formative period (1500-1600 BC). The earliest examples were made from stone and have been discovered in funerary sites such as El Opeño, Michoacán (Oliveros 1974), Capacha, Colima (Kelly 1980), and Mascota, Jalisco (Mountjoy 2012). It should be noted that these millstones can be tripodal or apodal. The latter form predominated in the Classic and Epiclassic periods, and it was not until the Postclassic period that tripod metates, the direct antecedents of today's examples, became widespread. Stone tripod molcajetes remain rare, ceramic mortars being frequently used from the Classic period onwards. Often regarded as domestic objects whose production did not involve significant investment, these implements have been little studied. We do know, however, that in certain regions where soft rocks predominate (Maya lowlands, Gulf of Mexico coast) metates could be traded over relatively long distances (Abramiuk and Meurer 2006). The *Relación de Michoacán*, a manuscript written in 1541 and the main written source on the Tarascan empire, also indicates that metates were among the objects of exchange that were transported through the region by caravans of porters (Alcalá 2000 [1541], 665). Figure 1(b) shows one of these porters carrying a tripod metate with the aid of a tumpline; the morphology of

the metate is strongly reminiscent of present-day examples. Beyond its role as a domestic utensil, the metate has strong cultural, symbolic, and social dimensions for the communities that use it. Paradoxically, few studies have explored the evolution of their context of production and use over time.

This craft has been a major activity over almost seven centuries in the volcanic region of the Meseta Purépecha in Michoacán (Western Mexico), an area with great volcanological, archaeological, and ethnohistorical potential. Mainly practicing agriculture or fishing (Williams 2009), Purépecha villages all specialized in different crafts, considered to be expressions of their cultural identity, such as the production of wooden objects (Sevina, Tzintzuntzan), copper vessels (Santa Clara del Cobre), musical instruments (Paracho), and basketry (Pátzcuaro). Recently, geologists at the National Autonomous University of Mexico reported that a particular volcano located in the Michoacán-Guanajuato volcanic field and named “El Metate” (called “Kanakuarani” in Purépecha) was still quarried for the production of molcajetes and metates (Chevrel et al. 2016). El Metate represents a substantial source of raw materials, whose abundance and quality are among the most prized for the regional production of grinding stones, in both present-day and archaeological contexts (Figure 2). Hence, the village of Turícuaro, located to the north-east of the Hoya Urutzen and El Metate volcanoes, has for centuries specialized in the production of stone food-preparation tools made out of andesite lava blocks (León 1906; West 1948, map 20). The recent discovery of quarries and associated production waste at the Tzintzicátaro archaeological site, located near the present-day village, suggests that this activity was probably carried out as early as the post-classical period (A.D. 1000–1522) and during the first decades of the colonial era during sixteenth century (Figure 3).

The exceptional longevity of metate production and use can be considered in terms of the stability of a process and the suitability of technical choices for the function of these tools, for both current and past production. Our goal in this article is to present a long-term history of the close link between raw material choices, production techniques, and the evolution of food processing from a long-term perspective, from Prehispanic times until today, with a focus on the production of metates and molcajetes. We examine the factors of stability versus diversification in the production and use of metates for culinary preparation in Mesoamerica from a diachronic perspective. The very principle of the metate is based on a complex balance between the selection of a rock with optimal mechanical qualities, in terms of manufacturing, efficiency and functional durability, and a method of action aimed at crushing grains and then kneading the maize paste using a single instrument. The aim is to determine how the high degree of interdependence between the different skills involved (selection of the rock, mastery of manufacture, use for a given finished product) may have contributed to limiting the emergence of technical innovations in this field until today. Do the characteristics of the traditional metates (raw materials, morphologies, techniques of use) reveal a particularly appropriate technological adaptation to the complete process of preparing maize for consumption, specific to this cultural area? Processing the maize into flour involves grinding and kneading after nixtamalization—that is, soaking and cooking in an alkaline solution, which not only softens the grains, but more importantly, greatly enhances the digestive extraction of key nutrients by the human metabolism. What criteria are used to select a given stone, in relation to the expected quality of the finished product (especially maize flour)? And finally, how has the recent introduction of mechanical devices—with its technical, economic, and social consequences—impacted

the production of traditional devices? Through these different questions, we try to reconstruct the evolution of this milling stone activity at different spatial scales (from quarries to kitchens) and temporal scales (from the thirteenth century to the present day).

Methodology

A multidisciplinary team was involved in the survey combining volcanological, archaeological, and anthropological techniques to obtain a systematic overview of the activity.

First, in order to reconstruct the eruption dynamics of the El Metate volcano (Chevrel et al. 2016; Chevrel, Guilbaud, and Siebe 2016), volcanologists reviewed their data in the light of these new anthropological questions. To improve the characterization of the mechanical qualities of the rocks and their effectiveness in terms of grinding techniques, the mineralogy and vesicularity (porosity) of rock samples were described thus allowing us to compare the different lava flows and areas exploited for metate production (Figure 4).

Our survey was conducted between 2018 and 2023, over a total of 14 weeks with the invaluable help and knowledge of one of the few remaining metatero families in charge of metate and molcajete production, the Vidales, who are based in the village of Turícuaro. Most of the knowledge regarding this volcanic area and the techniques of metate and molcajete production was related to us by the men of the family: Don Pedro Vidales, his son Nicolás Vidales and, on particular aspects, his grandsons, especially Héctor and Cristián Vidales (Figure 5). A series of interviews was conducted following a detailed list of questions, in order to cross-check the sources of information, and clarify, when necessary, contradictory data or viewpoints. Another part of the survey was aimed at collecting oral information on the last decades of the activity through the personal history and memories of the Vidales family. Precise dates of each exploitation area were difficult to obtain, but their oral accounts of the timeline and succession of exploitation and activities were consistent, from generation to generation. Weeks of observations were necessary to record the production processes, both in the quarries at the summit of the volcano and in the domestic workshops, with the various craftsmen from the family and for different productions (types, size, decoration). To complete this survey, two additional families were visited and surveys were carried out in the shops and markets in neighboring villages where metates and molcajetes are sold. Information regarding the use of metates and the organization of food preparation was mainly provided by Doña Livia Vidales, wife of Don Pedro, as the use of metates and molcajetes remains exclusively women's work. The manufacture of metates and molcajetes is men's work.

To explore the territory of metate and molcajete raw material exploitation around the village of Turícuaro, an extensive field survey was conducted on the slopes of both Hoya Urutzen and El Metate volcanoes, to identify areas of exploitation for production. Large areas were explored on foot following (1) indications provided by the Vidales family on ancient quarries in the vicinity, (2) ancient pathways, (3) and anomalies in the landscape that were verified, when necessary, by clearing the dense vegetation. An integrated geomatic approach, including the use of geographic information systems (GIS), was designed to enable cartographic modeling in space and time of the different quarry zones and pathways identified (GPS differential). Photogrammetry, aided by a drone, provided the topographic and 3D-records needed to study the spatial organization of the quarries and workshops.

By following methods currently used in anthropology, a detailed analysis of the tools involved in each stage of metate and molcajete production was carried out, along with documentation of the products. Using photogrammetry and macrophotography, a systematic record was made of the products and macro-traces obtained at each stage of the sequence in order to establish technological references.

Finally, exploratory investigations, based on a prior survey, were carried out in order to track the diffusion and selling of metates and molcajetes within the Purépecha area, as well as the changes in food practices and daily use of metates and molcajetes.

Results: The Exploitation of Volcanic Resources for Metate and Molcajete Production Around the Village of Turícuaro

Our surveys allow us to reconstruct the evolution of the exploitation of volcanic resources for metate and molcajete production since Prehispanic times around the village of Turícuaro, including the territory of El Metate and Hoya Urutzen volcanoes. Though most of the quarries remain difficult to date precisely, the memory of living metateros, as well as historical and stratigraphic evidence, was an invaluable source of information for identifying the general trend in the evolution of the exploitation of raw materials from geological sources. This evolution can be linked to three major historical events documented by archaeology in the region: (1) the emergence of this activity in connection with the rise of the Tarascan civilization during the thirteenth through sixteenth centuries, (2) its development after Spanish colonization, and (3) its gradual decline from the mid-twentieth century to the present day, following the accelerated mechanization of food processing.

It is interesting to note that the manufacture of metates required a rock with particular mechanical properties. In fact, some ancient sources suggest that Mesoamerican populations made a clear distinction between these properties. For example, the Nahuatl vocabulary in the Florentine Codex mentions a specific category of rock called metlatetl (literally metate stone) defined by Sahagún as follows: "It is black, dark, hard; it is hard, very hard; it is solid, round, wide; asperous, scabrous, unpleasing, blemished. It is which can be fashioned well, worked, pecked, smoothed, abraded, sculpted." (Sahagún [1577] 1950).

El Metate volcano (N 19°32'19", W 101°59'34", 2910 m.a.s.l.) is classified as an andesitic monogenetic shield, covering an area of 103 km², and is the result of flow from a single eruption that occurred over a period of at least ~30 years around A.D. 1250 (Chevreil et al. 2016). Its eruption was mainly effusive and formed large voluminous lava flows. It produced 13 distinct lava flow units ranging from 3 to 15 km in length and from a few meters up to 200 m in thickness, with blocks measuring from a few decimeters to several meters in size. The scale of the eruption over a relatively short period of time must have had consequences for the ecology and human occupation of this landscape. Despite its great size (volume of 9.2 km³), only a few areas and specific lava flows were exploited for the production of metates and molcajetes (lava flows F7 and F12, Figure 4) due to their specific and combined characteristics of hardness and porosity.

The various lava flows at El Metate display several differences, including their mineralogical and chemical element compositions (Chevreil, Guilbaud, and Siebe 2016). SiO₂ contents in the different lava flows do not vary much and range between 58 and 61 percent by weight. A correlation between SiO₂ content and hardness of the lava flows could not be established, although different blocks display marked

differences in their propensity for being cut and shaped. Considering the location of the exploitation areas, the most obvious criterion for the suitability of a block seems to be its porosity (percent of void spaces per volume) and the associated geometric organization, size, and morphology of vesicles (void spaces). In the case of El Metate, vesicles occupy approximately 9 percent by volume in most lavas, except in rocks from the dome summit and from late-stage proximal lavas (F11 to F13) that contain 11–29 percent by volume of vesicles (Chevrel, Guilbaud, and Siebe 2016). For example, the F4 lava flow at the base of the volcano displays a porosity of 0.6–8 percent, while the F7 lava flow displays smaller vesicles that occupy 9 percent of the rock. In stark contrast, andesite samples from F12 near the summit of the volcano show 29 percent vesicles with irregular shapes and measuring up to a few millimeters in size (Figure 6). This peculiarity seems important for the production of metates and the choice of exploitation areas. Lava flows in general do not offer homogeneous characteristics, especially at their surfaces and basal zones, and it appears that El Metate andesites display different porosities, ranging from low (0%) to more porous rock (29%). However, the textural arrangement, size, and morphology of the pores render the interstices and vesicles barely visible to the naked eye. No detailed petrographic analyses have been conducted on Hoya Urutzen lava flow samples, but it is clear from our survey that at least some of the lava flows feature large vesicles, measuring up to several centimeters in some cases, which lends the rock surfaces a high degree of roughness (Figure 7).

Exploitation of the Hoya Urutzen Volcano Areas and the Archaeological Site of Tzintzincátaró

At least three main areas of andesite exploitation have been identified on the Hoya Urutzen lava flows.

Area 1. On the archaeological site of Tzintzincátaró, metate roughouts have been found in large quantities (Figure 8). The site is located 1.5 km south of the modern village of Turícuaro and may have been the original location of the community. The settlement pattern and the ceramic artefacts visible on the surface suggest a Postclassic to Early Colonial period occupation. Though no investigations have been conducted to identify the precise origin of the raw material used, it appears very likely that these stone objects were produced in the direct vicinity of the archaeological site. To the east of the site of Tzintzincátaró, quarrying areas for coarse vesicular andesites have been documented. Several levels of exploitation are visible on the steep slopes of the lava flows, and these attest to the exploitation of very large quantities of volcanic rock at an undetermined moment in time. Coarse vesicular andesite was particularly suitable for grinding activities as indicated by the production material at the archaeological site.

Area 2. Observations from the present pathway to the top of the El Metate volcano have revealed exploitations on the western slopes of Hoya Urutzen, a 30-minute walk from the village of Turícuaro,. There is no living memory of these exploitations among the Vidales, meaning that they at least predate the twentieth century. Along the modern pathway, the vertical face of a quarry for extraction of coarse vesicular andesites has been identified; at its base, it displays an area that had been cleared and leveled, apparently by quarrymen prior to work, with waste material piled behind. On other areas of the slopes, the extraction of blocks has created deepened circular areas, around which tested blocks, fragments of blocks, large and small flakes and metate roughouts have been found. Some elements (fragmented blocks, roughouts) were gathered and re-exploited in more recent times, and at least one recent workshop was

identified (indicated by sparse vegetation).

Area 3. To the south of Hoya Urutzen, after a 30-minute walk up the creek in the direction of Las Cruces volcano, we identified a large area of exploitation of coarse vesicular andesites. It is characterized by a widely scattered distribution of small quantities of waste and roughouts. Given that Nicolás Vidales used to come to this site with his grandparents to gather wood rather than metates, we deduce that the workshops predate the twentieth century.

Twentieth Century Quarries on El Metate: Taleminuchi

According to Don Pedro Vidales, quarrying operations were conducted in Taleminuchi since at least the middle of the twentieth century. At that time, up to 200 metateros were active in the village of Turícuaro. The quarries of this area were exploited by his grandfathers (canteras de los abuelos), uncles, and then by his elder brothers, from whom he learned how to produce metates as a child, following a patrilineal transmission of know-how. Located at the base of the El Metate volcano, the quarrying area of Taleminuchi is easily accessible by an hour walk from Turícuaro, with only a short steep pathway toward the end to climb up the front of lava flow F7. In this area, a “blue stone, not so hard” was exploited for the production of metates. Though the extent of the exploitation area has been difficult to map due to the dense vegetation, quarrying areas are organized as follows: peripheral blocks delimit a central circular zone, either flattened or deepened, where piles of material and abandoned metate and molcajete roughouts can be found. The exploitation of blocks is attested by the presence of shaped blocks and large flakes. This quarry was gradually abandoned during the twentieth century in favor of the El Cerro quarries. According to Don Pedro, the abandonment of the quarry was not motivated by the quality of the andesite itself, which is very similar to the andesite exploited today near the summit of El Metate. The porosity of this lava flow (approximately 9%), and its microporous structure, means that metateros considered it a good raw material, in contrast to the more accessible lava flow F4 for example, which was considered too hard to cut. The reason for the abandonment of the Taleminuchi quarry area was motivated instead by the smaller size of blocks and their frequent internal fractures in comparison to those near the top of the volcano. In addition, only low quantities of small blocks were still available for exploitation. Products share the same characteristics as today’s metates and molcajetes, attesting to direct continuity in the transmission of know-how from the quarrymen of Taleminuchi to those working today near the summit of El Metate.

Modern Quarries Near the Summit of El Metate

Most of the quarries identified in the area are located near the summit of El Metate volcano, where the andesite from lava flow F12 is still being exploited (Figure 4). These quarries are accessible after a 3-hour walk on foot or donkey from the village of Turícuaro. This area belongs to the municipality and is regulated by the ejido; there is no family ownership of the quarries. As described in recent studies (Chevrel et al. 2016; Chevrel, Guilbaud, and Siebe 2016), the early and late lavas of El Metate are morphologically distinct, with late flows having thicker fronts and blocky surfaces, particularly suitable for andesite exploitation.

Though Don Pedro specified that this area started to be exploited by his family in the mid-twentieth century, our survey identified a group of quarries to the south of today’s

exploitation area, that seems older judging by a different and unknown type of metate produced there (with short feet and no rim around the edge of the grinding surface). Since the middle of the twentieth century, the metateros of Turícuaro have exploited microporous andesite blocks on a large area of lava flow F12. This andesite displays a high degree of porosity (up to 29%) and a particular structure (microporous, angular). According to Don Pedro, the quality of the rock varies from one block to another, but a considerable number of them are of large size and also have good cohesion. “Red” andesite (with higher oxidation and alteration) appears to be too soft to produce metates of good quality, while “blue” andesite (less altered and cohesive) is generally preferred. Its hardness facilitates the cutting of the blocks and the shaping of the objects with metal picks, and ensures better resistance to smoothing during use (Figure 9). Associated manos and pestles, used during grinding, are made from small fragments selected among the wastes produced during metate or molcajete shaping. Near the summit of El Metate, a standardized type of tripod metate is produced, together with different kinds of molcajetes. Various exploitation strategies have been recognized, depending on the aspect of the blocks, their size, and their location (surface or underground). Most of the abandoned areas of exploitation are organized as small units, with all stages of roughout production represented (Figure 10). On the periphery, broken blocks testify to the exploitation of previously larger blocks. On the opposite side, quantities of waste and flakes have been pushed away from the working area in the center. These cleared work areas only feature a few abandoned roughouts which broke during shaping (Figure 11). They are generally connected to other areas of exploitation by narrow pathways that occasionally cut through previous waste mounds. This organization corresponds to the one implemented by the Vidales metateros.

This overview of the quarrying area around the village of Turícuaro suggests an evolution, spanning centuries, in the criteria governing the selection of rocks to produce metates. After the abandonment of coarse vesicular andesites from Hoya Urutzen volcano at an undetermined date, metateros have favored microporous harder andesites from different lava flows of the neighboring El Metate volcano, first from its base (lava flow F7 Taleminuchi), and then near its summit (lava flow F12). This major shift in the qualities of rock selected is all the more puzzling as the closest sources to the village were abandoned for an area that is difficult to access and requires more complicated exploitation logistics. In order to understand this major technical shift, we must also consider economic and social factors.

The Long-term Evolution of the Activity in Turícuaro

During the last decades, technological improvements such as the introduction of mechanical and electrical devices have deeply impacted the organization of artisanal lithic manufacturing, with consequences for the demand for and quality of the metate and molcajete production, the distribution networks, and finally on the future existence of these activities.

The production of metates has traditionally been the main craft activity in the village of Turícuaro in the Purépecha area, but since the middle of the twentieth century the village has slowly been turning to the exploitation of wood. While almost 200 metateros lived and worked in the village at the beginning of the twentieth century, according to Don Pedro, and there was one metatero in each family in 1912 (West 1948, 71), only 12 remained in 1945 (West 1948, 71). Today, only three extended families and approximately 10 metateros still make a living from this activity, which is

experiencing a marked and rapid decline. With the introduction of manual and mechanical mills (Katz 2003), the masa (maize dough for tortilla preparation) can be obtained directly from stores without the long and strenuous stage of manual maize grinding (Figure 12). Consequently, today metates are rarely used for the grinding of maize grains but more generally for the mixing of the masa (Figure 13). While maize grinding requires a high degree of surface irregularity to break and open the hard grains (even after nixtamalization), flat regular grinding surfaces are more suited for mixing masa. Similar considerations apply to molcajetes. With the introduction of electric licuadoras (blenders), molcajetes are still sold in markets and found in kitchens, but their use has deviated from their initial function of pounding. Today, these tripod bowls are used to mix spices for salsas (sauces) rather than for grinding them, and often they are simply used to present dishes.

In parallel to these technical evolutions, we observe a long-term and progressive shift in the properties sought for raw materials for the production of metates and molcajetes in Turícuaro. Considering Mesoamerican examples, materials that are too compact have always been excluded from the outset because they are too hard to cut and unsuitable for grinding operations due to their excessive hardness. By contrast, vesicular materials (especially basalts) have long been favored because of their roughness, which is better suited for the processing of maize and other foodstuffs. In addition, a vesicular material self-renews its surface roughness by abrasion and pitting during use. If the rock is also hard, the contamination of the finished product is low, as already noted in other Mesoamerican contexts (Hayden 1987, 14). This was particularly true for the rocks exploited at Hoya Urutzen volcano, which display high porosity, with large vesicles. But since the beginning of the twentieth century, andesite from the summit lava flows of El Metate volcano has been preferred by quarrymen in Turícuaro. These lava flows present several advantages: (1) availability of large-sized blocks with a low degree of internal breakage; (2) high porosity implying greater surface roughness, which increases the grinding efficiency (around 29% porosity); and (3) a microporous structure (small-sized vesicles) which facilitates the cleaning of the metate surface and limits the loss of maize within the interstices of the rock. This somewhat rare and distinctive microporous structure ensures a combination of optimal hardness for easy shaping, optimal roughness for grinding maize, and optimal compactness (density) for mixing tortilla dough, which also makes the surface easier to clean. Hence, according to the users, rocks of lower porosity appear to be more compatible with modern sanitary expectations than vesicular ones. The identification of these qualitative physical criteria should enable us in the future to search more easily for lava flows that were likely exploited in Prehispanic times and to pinpoint areas for further archaeological prospection.

Many consequences derive from the introduction of new devices and from the associated requirements in terms of stone supply. First of all, the demand for stone devices has considerably decreased, in parallel with the number of craftsmen who have had to quit progressively given the absence of prospective consumers and the low profitability of this difficult and dangerous activity. As blocks weigh several tons and are generally unstable, severe injuries may happen during their breakage. The families of craftsmen who have decided to maintain their activity have had to adapt in a number of ways. The three generations of men from the Vidales family that produce metates illustrate these ongoing changes. Don Pedro, patriarch of the metateros, has dedicated his life to this activity. He started working as a 5-year-old child in the quarries with his uncle; today, at the age of 72, he helps his son and grandsons in their activities, but remains the custodian of the memory of metate stone exploitation

in the vicinity of the volcano. The choice of softer stones – of lower quality, and with a shorter lifetime - has been observed among the youngest generations who started their apprenticeship when they quit school around the age of 16. Softer rocks are harder to shape with metal picks, but easier to cut and sculpt with the steel disks of the mechanical saws (*cortadoras*) used mainly by the younger generation. Such mechanical innovations greatly reduce the time for creating metates and thus increase “productivity”, especially for newcomers in the field (Figure 14). This general reduction in the quality of products is accompanied by a rapid loss of know-how, which is not correctly or fully transmitted to the younger generations. Don Pedro’s son, Nicolás, who as a child learned from his father, had to quit the activity at the age of about 35 in order to earn a better salary elsewhere to support his family. This mirrors the situation of other metateros in the region, like Gustavo Valencia in Cuanajo, who had to quit the production of metates on El Frijol Volcano at the age of 60 for health reasons, and with no interested person to whom he could transmit his knowledge. Both cases illustrate in the clearest manner a rapid and definitive break in the intergenerational transmission of centuries-old knowledge regarding metate production. The decline of the activity in Turícuaro also has been accelerated by another collateral effect. As the demand is no longer focused on high-quality products, but rather on cheap ones, the metates and molcajetes of Turícuaro face direct competition from other areas of production outside the region. Turícuaro’s products are still famous in the Purépecha area, and commissions are still accepted on individual order. However, the *tiendas* (stores) and markets in nearby villages sell mostly molcajetes from other more distant areas where they are produced in large numbers with the aid of machinery. The scale of production in these areas is much higher, and the enterprise is more important economically, as hundreds of pieces are stored before shipment. This ensures a quick profit despite the high cost of machinery (Figure 15).

Surveys carried out in Nahuatzen, Cherán, and Capácuaro allowed us to identify a possible center of rival producers in the La Piedad area (Vargas Dias 2010), 120 km north of Turícuaro (Figure 16). Today, the techniques and scales of metate and molcajete production in this area differ greatly from those practiced in Turícuaro. In the quarries of El Tlacuache, explosives are used to break the andesite blocks and to facilitate their extraction. Then, the blocks are transported by truck to the village where metates and molcajetes are shaped in family workshops using machinery and metal picks, following more or less the same sequence of production as in Turícuaro (Figure 17). In Japacurio (Numarán municipality), for the past couple of years molcajetes are being mechanically mass-produced from soft andesite slabs that are extracted using machinery (Figure 18). The products are supplied in large quantities to various markets along main roads such as the north–south federal road from La Piedad to Uruapan that passes through the village of Capácuaro, close to Turícuaro. This impact on production, particularly its restructuring in terms of scale and space, is reminiscent of the increasing segmentation of the labor of Maya potters who are subject to pressure to meet growing tourist demand. Arnold (2015) highlighted in particular the separation between the people who exploit clay sources, those who make pots, and those who sell them to markets and shops.

Contrary to Katz’s conclusion in 2003 (49), the decline of the traditional production and use of metates has accelerated considerably, and probably inexorably, in the two last decades. Given the inevitability of the rapid disappearance of the centuries-old Turícuaro industry, the last remaining metateros of the village are now more inclined to produce decorative metates and molcajetes than functional ones. In particular this trend is expressed by the growing production of zoomorphic molcajetes, representing pigs or

donkeys, which demonstrate masterful stone carving techniques (Figure 19). Some young craftsmen even transform metates and molcajetes into veritable works of art. Stone tools are thus produced to become decorative objects or souvenirs, in a context of increasing tourism, but also to be exported to Mexicans living abroad. For example, for several years now, Turicuario-based Héctor Vidales, the grandson of Don Pedro Vidales, has been producing large molcajetes decorated with floral and zoomorphic motifs, which are considered masterpieces of their type. These pieces require several weeks of work and are specially designed for local (in the villages) and regional (Casa de los Artesanos, Morelia) contests within the Indigenous community, where Héctor competes to win prizes but also to gain greater visibility for his work (Figure 20). This development of activity mirrors certain observations made in Mesoamerica in regard to other craft productions. As Arnold (2008) has already noted for Maya production, the increase in tourism has led to profound change in ceramics, especially their forms and decorations, to better meet the new demand.

Beyond the technical aspects, these changes have consequences for the organization of daily activities, the sharing of tasks within the family, and especially the social life of women. With less time invested in the grinding of maize and the preparation of tortillas, family women and girls can now spend time in other activities and need to spend more time out of their homes. Moving away from the model of household self-sufficiency, from work in the fields to food preparation, this shift also contributes to the greater importance of milling shops and tortillerías as places of sociability within the village and symbolizes the passage to a “modern” way of life which is contrary to “tradition” (understood here as “archaism”). Metates are still a traditional part of the wedding dowry, together with petates (bedrolls generally woven from palm leaves) and today also the refrigerator. In fact, metates remain strong cultural identifiers in the more traditional Purépecha villages, as well as in other regions of Central America (Cook 1982; Katz 2003). This apparent contradiction is reminiscent of the trajectory of other domestic and altogether highly symbolic objects in different parts of the world (e.g. Gosselain, Decroly, and Decroly 2009).

Conclusion

Our survey on the history and territory of production of metates and molcajetes around El Metate volcano highlights a dynamic evolution in relation to food habits, technical innovations, and social organization. Far from a frozen perception of an immutable “traditional” craft, it underscores how the technical choices and the transmission of know-how have evolved together with the historical context. The choice of a “good” raw material and a “good” block for producing a “good” metate is a subtle balance between shapeability, efficiency of use, durability over time, and the aesthetics of cultural heritage, as already highlighted in other Mesoamerican contexts (Hayden 1987, 111). But the definition of all these parameters has varied through time and space. Over centuries the metateros of Turicuario were motivated to adapt themselves to the constraints of andesite availability and quality, as well as to economic disruption, at least since the Spanish colonization. In this sense, the evolution of metate craft over nearly seven centuries is inextricably linked to the volcanic but also cultural contexts of the region. The changes in food practices, from grinding to mixing, illustrated by our survey would have been difficult to identify and highlight from an archaeological perspective alone, and must be considered within a historical process.

Geolocation Information

El Metate volcano (N 19°32'19", W 101°59'34", 2910 ma.s.l.).

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References

- Abramiuk, Marc A., and William P. Meurer. 2006. "A Preliminary Geoarchaeological Investigation of Ground Stone Tools in and around the Maya Mountains, Toledo District, Belize." *Latin American Antiquity* 17 (3): 335-354.
- Alcalá, Jerónimo de. 2000 [1541]. "Relación de las Ceremonias y Ritos y Población y Gobernación de los Indios de la Provincia de Mechuacán." In *Relación de Michoacán*, edited by M. Franco Mendoza, 313-691. Gobierno del Estado de Michoacán, Zamora: Colegio de Michoacán.
- Alonso, Natalia. 2019. "First Approach to Women, Tools and Operational Sequences in Traditional Manual Cereal Grinding." *Archaeological Anthropological Science* 11: 4307–4324.
- Arnold, Dean E. 2008. "Social Change and Evolution of Ceramic Production and Distribution in a Maya Community." Boulder: University Press of Colorado.
- Arnold, Dean E. 2015. "The Evolution of Ceramic Production Organization in a Maya Community." Boulder: University Press of Colorado.
- Biskowski, Martin. 2000. "Maize Preparation and the Aztec Subsistence Economy." *Ancient Mesoamerica* 11: 293-306.
- Biskowski, Martin, and Karen D. Watson. 2013. "Changing Approaches to Maize Preparation at Cerro Portezuelo." *Ancient Mesoamerica* 24 (1): 213-223.
- Chevrel, Magdalena Oryaëlle, Marie-Noëlle Guilbaud, and Claus Siebe, 2016. "The ~AD 1250 Effusive Eruption of El Metate Shield Volcano (Michoacán, Mexico): Magma Source, Crustal Storage, Eruptive Dynamics, and Lava Rheology." *Bulletin of Volcanology* 78, 32. <https://doi.org/10.1007/s00445-016-1020-9>
- Chevrel, Magdalena Oryaëlle, Claus Siebe, Marie-Noëlle Guilbaud, and Sergio Salinas. 2016. "The AD 1250 El Metate Shield Volcano (Michoacán): Mexico's Most Voluminous Holocene Eruption and Its Significance for Archaeology and Hazards." *The Holocene* 26 (3): 471-488. doi: 10.1177/0959683615609757

Cook, Scott, 1982. *Zapotec Stone Workers. The Dynamics of Rural Simple Commodity Production in Modern Mexican Capitalism*. Lanham, MD: University Press of America.

David, Nicolas, 1998. "The Ethnoarcheology of Grinding at Sukur, Adamawa State, Nigeria." *African Review* 15 (1): 13-63.

Gosselain, Olivier, Renaud Zeebroek Decroly, and Jean-Michel Decroly. 2009. "Les Tribulations d'une Casserole Chinoise au Niger." *Techniques & Culture* 51: 18-89.

Hamon Caroline, and Valerie Le Gall. 2013. "Millet and Sauce: The Uses and Functions of Querns among the Minyanka (Mali)." *Journal of Anthropological Archaeology* 32: 109-121.

Hayden, Brian. 1987. "Traditional Metate Manufacturing in Guatemala Using Chipped Stone Tools." In: *Lithic Studies among Contemporary Highland Maya*, edited by Brian Hayden, 8-119. Tucson: University of Arizona Press.

Katz, Esther. 2003. "Le Metate, Meule Dormante du Mexique." In *Meules à Grains. Actes du Colloque International de la Ferté-sous-Jouarre (16-19 mai 2002)*, edited by Mouette Barboff, François Sigaut, Cozette Griffin-Kremer, and Robert Kremer, Paris, 32-50. Paris: Ibis Press, Maison des Sciences de l'Homme.

Kelly, Isabel. 1980. *Ceramic Sequence in Colima: Capacha, an Early Phase*. Anthropological Papers of the University of Arizona, No. 37. Tucson: University of Arizona Press.

León, Nicolas. 1906. Los Tarascos. "Notas Históricas, Étnicas y Antropológicas. Tercera parte. Etnografía Pos-Cortesiana y Actual." *Anales del Instituto Nacional de Antropología e Historia* 2 (3) : 298-479.

Mountjoy, Joseph B. 2012. *El Pantano y Otros Sitios del Formativo Medio en el Valle de Mascota, Jalisco*. Estado de Jalisco, México: Secretaria de Cultura.

Nelken-Terner, Antoinette. 1968. *Los Implementos de la Molienda Pre-hispánica. Ensayo Metodológico*. Tesis de Maestría. Escuela Nacional de Antropología e Historia, México.

Oliveros, José Arturo. 1974. "Nuevas Exploraciones en El Opeño, Michoacán." In *The Archaeology of West Mexico*, edited by Betty Bell, 182-201. Ajijic: Sociedad de Estudios Avanzados del Occidente de México.

Rodríguez-Yc, José Ruperto. 2013. *La Molienda en Mesoamérica, Formas, Funciones, Usos y Manufactura de los Instrumentos. Un Estudio Etnoarqueológico en México*. Barcelona: Tesis de Doctorado en Historia, Universitat de Barcelona.

Roux, Valentine. 1985. *Le Matériel de Broyage. Etude Ethnoarchéologique à Tichitt, Mauritanie*, Mémoire No. 58. Paris: Éditions Recherches sur les Civilisations.

Sahagún, Fray Bernardino de. [1577] 1950. *General History of the Things of New Spain: Florentine Codex, Book IV*. Translated and annotated by Arthur J. O. Anderson and Charles E. Dibble. Monographs of the School of American Research. Santa Fe, N.M.: School of American Research.

Searcy, Michael T. 2011. *The Life-Giving Stone: Ethnoarchaeology of Maya Metates*. Tucson: University of Arizona Press.

Vargas Dias, Juan Pablo. 2010. *Etnoarqueología de la Producción de Artefactos Líticos de Molienda dos Estudios de Caso: Gunajuato y Michoacán*. Tesis de Maestría en Arqueología, Centro de Estudios Arqueológicos, Michoacán.

West, Robert C. 1948. *Cultural Geography of the Modern Tarascan Area*, *Institute of Social Anthropology Publication No. 7*. Washington, D.C.: Smithsonian Institution Press.

Williams, Eduardo. 2009. "The Exploitation of Aquatic Resources at Lake Cuitzeo, Michoacán, Mexico: An Ethnoarchaeological Study." *Latin American Antiquity* 20: 600–620.

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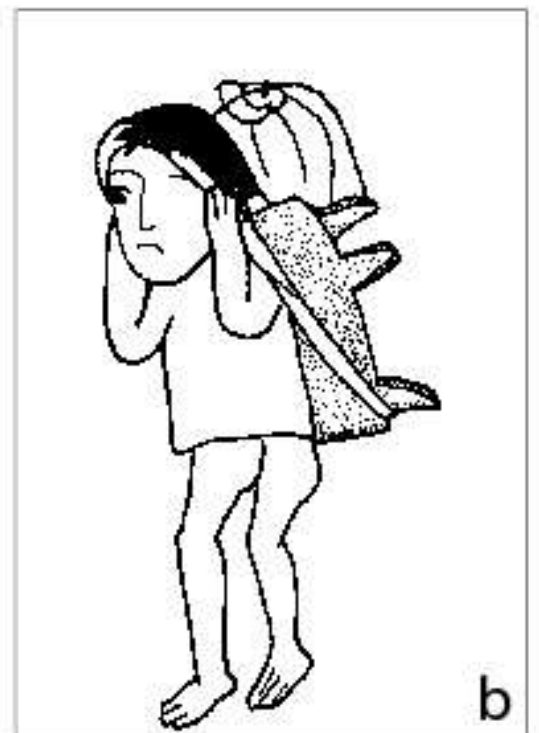
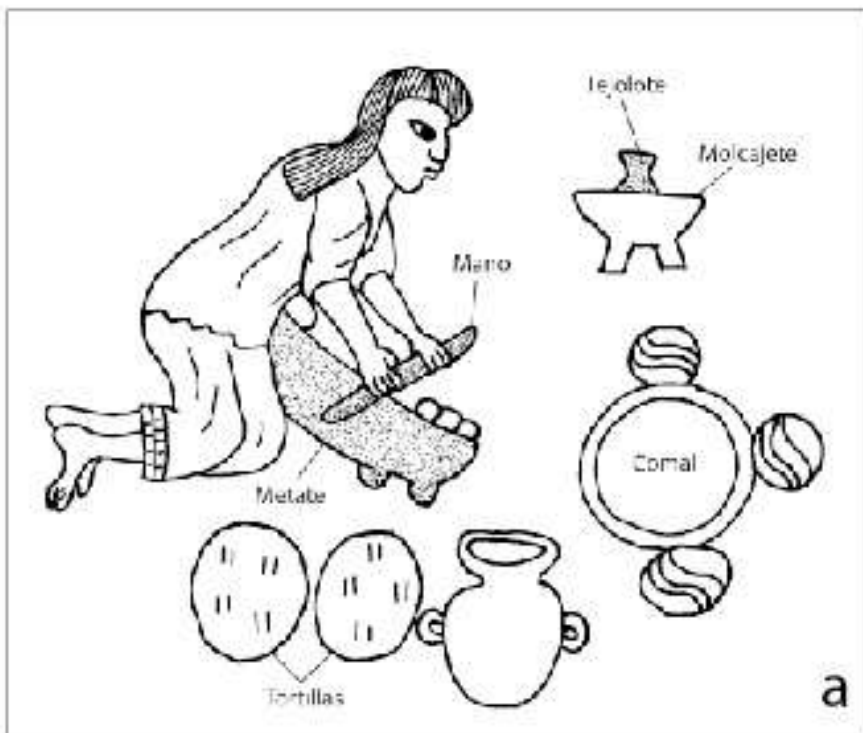
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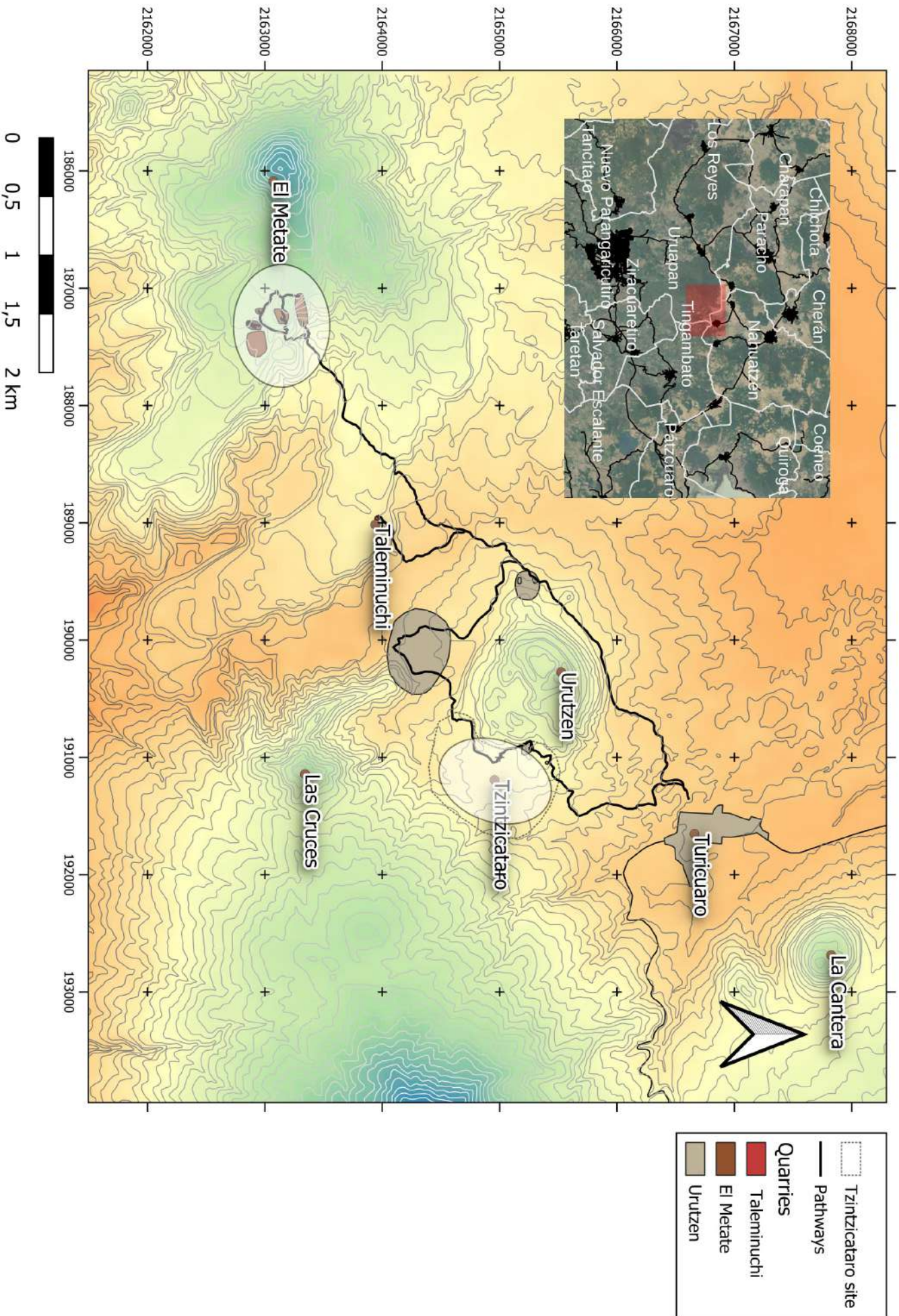


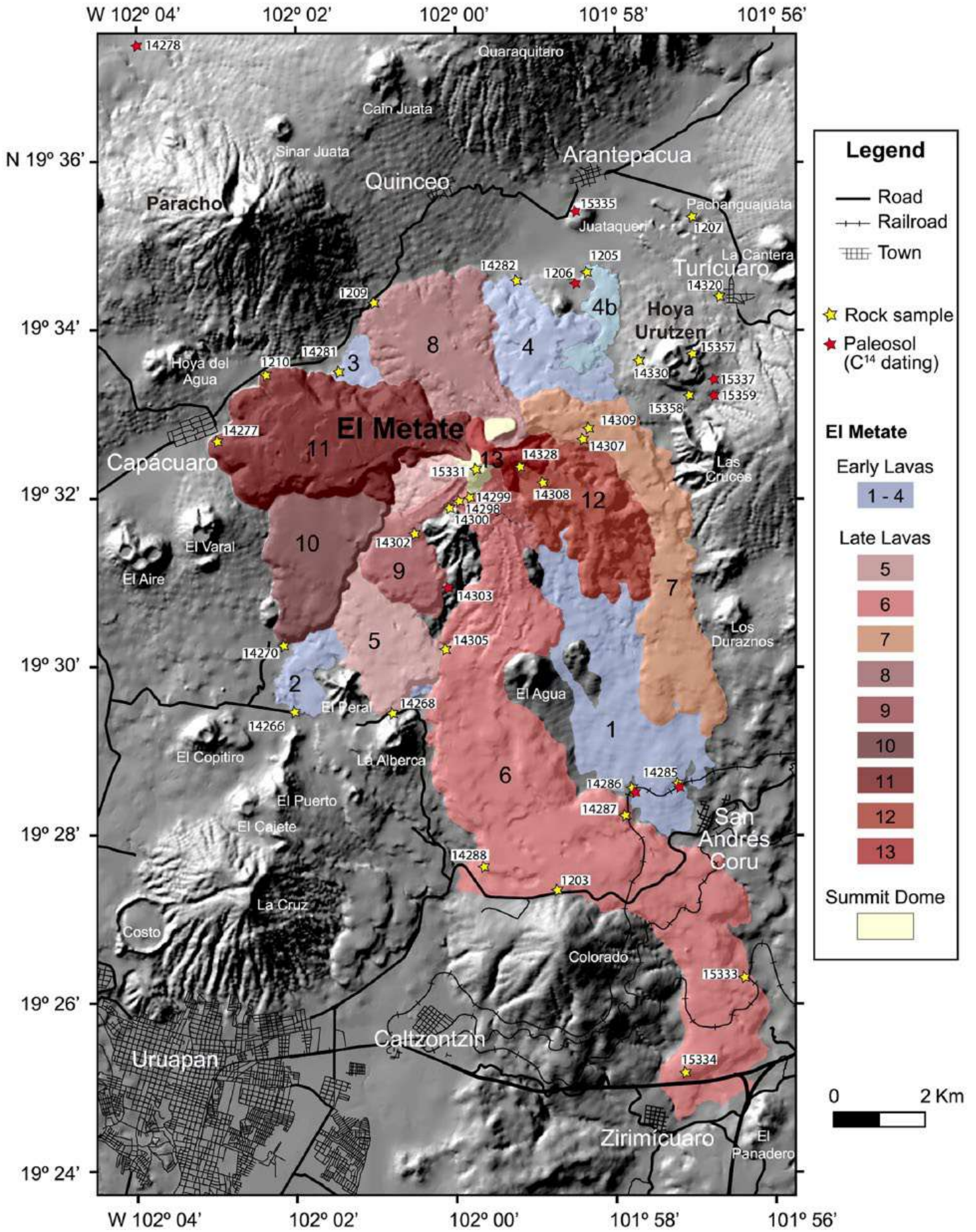
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