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► **To cite this version:**

Valentine Roux, Catherine Lara. Por qué los alfareros no han adoptado el horno: comparación de discursos etnográficos en la India y en el Ecuador: Por qué los alfareros no han adoptado el horno: comparación de discursos etnográficos en la India y en el Ecuador. *Americae. European Journal of Americanist Archaeology*, 2016, 1, pp.21-35. hal-02045668

HAL Id: hal-02045668

<https://hal.science/hal-02045668>

Submitted on 25 Feb 2019

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Americae, 1, 2016 | Altepetl, p. 21-35

mis en ligne le 15 novembre 2016

ISSN : 2497-1510

Pour citer la version en ligne :

ROUX Valentine et LARA Catherine, « Why potters have not borrowed the kiln? Comparing narratives of Indian and Ecuadorian potters », *Americae* [en ligne] | 1, 2016, mis en ligne le 15 novembre 2016. URL : <http://www.mae.u-paris10.fr/articles-articulos/why-potters-have-not-borrowed-the-kiln-comparing-narratives-of-indian-and-ecuadorian-potters/>

Pour citer la version PDF :

ROUX Valentine et LARA Catherine, « Why potters have not borrowed the kiln? Comparing narratives of Indian and Ecuadorian potters », *Americae* [en ligne] | 1, 2016, mis en ligne le 15 novembre 2016, p. 21-35 (<http://www.mae.u-paris10.fr/articles-articulos/why-potters-have-not-borrowed-the-kiln-comparing-narratives-of-indian-and-ecuadorian-potters/>).

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Why Potters have not Borrowed the Kiln?

Comparing Narratives of Indian and Ecuadorian potters

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In a recent study (Roux et al. forthcoming), it has been possible to demonstrate that in a context where different techniques are used for different types of objects by actors living in close geographical proximity, there is a cognitive bias which fosters technological polarization, creating clusters of technological standards and thereby technological boundaries. In this paper, we relate narratives of Indian and Ecuadorian potters who have not borrowed the kiln. The objective is to illustrate how cognitive limitations universally shape the mental representations of the properties of the techniques and how these representations are strong factors of technological polarization and non-borrowing. In conclusion, we propose that the issue of the non-adoption of the kiln, glaze and the potter's wheel in Mesoamerica and South America should be reexamined in light of these results.

Keywords: kiln, pottery, non-diffusion, technology, ethnoarchaeology, India, Ecuador.

Por qué los alfareros no han adoptado el horno: comparación de discursos etnográficos en la India y en el Ecuador

En un estudio reciente (Roux et al., forthcoming), fue posible demostrar que en un contexto en donde actores que viven geográficamente cerca utilizan diferentes técnicas para diferentes tipos de objetos, existe un sesgo cognitivo que favorece la polarización tecnológica y por ende, el mantenimiento de las fronteras tecnológicas. En este artículo, reportamos los relatos de alfareros de la India y del Ecuador que no han adoptado el horno. El objetivo es ilustrar cómo las limitaciones cognitivas moldean—de forma universal—las representaciones mentales de las propiedades de las técnicas, y cómo estas representaciones son factores fuertes de polarización tecnológica y de no-adopción. En conclusión, evocamos los puntos de la no-adopción del horno, del vidriado y del torno de alfarero en Meso y Sur América, así como de la necesidad de su replanteamiento a la luz de estos resultados.

Palabras claves: horno, cerámica, no difusión, tecnología, etnoarqueología, India, Ecuador.

Pourquoi des Potiers n'ont pas emprunté le four ? Comparaison de récits de potiers indiens et équatoriens

Dans une étude récente (Roux et al. à paraître), il a été possible de démontrer que dans un contexte où différentes techniques sont utilisées pour différents types d'objets par des acteurs vivant à proximité géographique, il existe un biais cognitif qui favorise une polarisation technologique et par là-même des frontières technologiques. Dans cet article, nous relatons les récits des potiers indiens et équatoriens qui n'ont pas emprunté le four. L'objectif est d'illustrer comment des limitations cognitives façonnent, de manière universelle, les représentations mentales des propriétés des techniques et comment ces représentations sont des facteurs forts de polarisation technologique et de non emprunt. En conclusion, nous évoquons la question de la non-adoption du four, de la glaçure et du tour de potier en Mésoamérique et Amérique du Sud et, de son réexamen à la lumière de ces résultats.

Mots-clés : four, poterie, non-diffusion, technologie, ethnoarchéologie, Inde, Équateur.

NOWADAYS, in Mesoamerica, firing technologies include both updraft kilns and open firings (Arnold 1991; Balkansky et al. 1997; Foster 1955; Shepard 1963). They have co-existed since pre-Hispanic times as attested by pre-Hispanic circular updraft kilns unearthed in Mexico [in central Mexico at Tula and Tlaxcala, (Hernández Sánchez 2011: 64-67); in Vera Cruz at Los Tuxtlas, (Pool 1997)]. The adoption of the kiln has been explained in light of the performance characteristics of the kiln and open firing (Pool 2000). It is supposed that

the kiln was adopted in order to fire fine clay paste vessels with even surface colors for the sake of its control of temperature fluctuations, rate of temperature increase and firing atmosphere (*ibid.*). The past coexistence of different firing technologies could thus correspond to different functions: the kiln for the fine serving orange wares, the open firing for the coarse utilitarian wares. In modern situations, the kiln presents the advantage of making better use of space; this would explain its adoption by densely settled communities making utilitarian wares (Arnold 1991).

The kiln presents objective advantages when considered in terms of thermal performance characteristics—maximum temperature achieved, temperature variation within the kiln load and control of the rate of temperature increase—and in terms of control of firing atmosphere—protecting the load from gusts of wind and reducing the incidence of fire clouds in oxidized pottery kilns (Arnold 1991; Gosselain 1992; Pool 2000; Rice 1984). These performance characteristics make that the kiln's adoption is usually analyzed in terms of cost-benefit with the conclusion that the adoption of the kiln is inevitable in light of its advantages. Now, there are ethnographic cases where the kiln has not been adopted, even though the potters are well aware of these advantages. These cases raise the puzzling question of the non-diffusion of supposedly advantageous techniques. Studies have underlined the importance of the social boundaries in such a phenomenon. Depending on the theory it has been explained in terms of cultural choices, group identity (Degoy 2008; Dobres 2000; Gosselain 2000, 2008, 2011; Hegmon 1998; Hodder 1985; Lemonnier 1993; Stark 1998), degrees of interactions (Lave and Wenger 1991), or adaptive advantages (Henrich and Boyd 1998; McElreath et al. 2003; Richerson and Boyd 2005; Shennan 2002).

In a recent study (Roux et al. forthcoming), it has been possible to demonstrate that in a context where different techniques are used for different types of objects by actors living in close geographical proximity, there is a cognitive bias which fosters technological polarization, creating clusters of technological standards and thereby technological boundaries. Polarization is defined as the division of the population “into a small number of factions with high internal consensus and sharp disagreement between them” (Flache and Macy 2011). Technological standards are defined as specific ways of making specific ranges of vessels and whose transmission over several generations makes them traditions.

In this paper, we propose to relate in detail the narratives of Indian and Ecuadorian potters who have not borrowed the kiln, still firing their vessels in open structures. The objective is to illustrate how cognitive bias universally shapes mental representations of the properties of the techniques and how these representations are strong factors of technological polarization and non-borrowing.

METHODOLOGY AND DATA

In order to study how cognitive limitations shape mental representations of technological properties, independently of the cultural specifics of potters' communities, two geographical areas have been considered: India and Ecuador. In both areas, open firings co-exist with kilns. In India, the ceramic production is distributed between two social groups, the Muslims and the

Hindus. In Ecuador, it is distributed between households belonging to the same social community.

Analysis of the non-borrowing of the kiln will take into account on the one hand the geographical, social and economic context of ceramic production and on the other, the reasons given by the potters for not adopting or adopting late the kiln. The late adopters of the kiln correspond to potters who long held out against the kiln while most of the potters around them had adopted it. The reasons for the potters' reluctance to adopt the kiln were collected during interviews about their practice, their knowledge of the different firing structures, and their perception of the advantages and disadvantages of each structure. These reasons are the verbal expression of the potters' representations of their craft and their ways of making an object.

Interviews of Indian potters were conducted in the Jodhpur district (Rajasthan) with 37 potters distributed among 17 villages (table 1) and in the Bulandshar district (Uttar Pradesh) with 36 potters distributed among 17 villages (Figure 1, Table 1). Each village comprises between 1 to 60 potters' households. In both regions, the surveyed villages represent around 60% of the potters' villages.

Interviews of Ecuadorian potters were conducted in the canton of San Miguel de Porotos (south of the Cañar province) with 12 potters distributed among three hamlets, and in the canton of Sigsig (Azuay province) with 4 potters distributed between two hamlets (Figure 2, Table 2, next pages). In total, San Miguel de Porotos has 10 potter households, and Sigsig, 5.

CONTEXT OF CERAMIC PRODUCTION

INDIA

In India the two places investigated, the Jodhpur district (Rajasthan) and the Bulandshar district (Uttar Pradesh), are inhabited by Hindu and Muslim potters. The Hindu potters belong to the endogamous caste called “Prajapat.” The Muslim potters from Rajasthan are called “Moila.” Their historical myth suggests that they were Hindus who converted to Islam a few centuries ago. The Muslim potters from Uttar Pradesh are called “Multani.” They came from the Indus valley along with successive waves of migration between the fifteenth and the nineteenth centuries (Sarawati and Behura 1964; Sodhi 2006). In both regions Muslim potters are strictly endogamous and entertain tight family relationships through matrimonial alliances. Hindu and Muslim potters used to produce different ranges of morpho-functional vessels sold through different economic channels, the Muslim potters selling mostly through the cash economy, and the Hindu potters through the *jajmani* system: they would provide Hindu families with pottery in exchange for cereals (*jajmani* system); their revenues were complemented by other

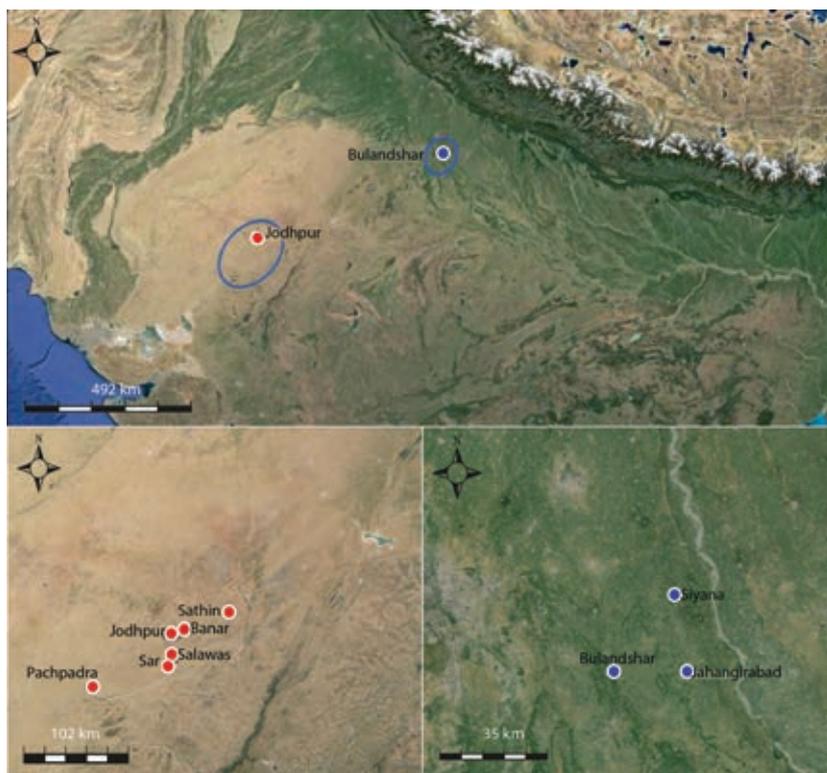


Figure 1. Top: location of the surveyed regions in North India. Below (left): villages of the Jodhpur region mentioned in the text. Below (right): villages of the Bulandshar district mentioned in the text.

Potter's communities	Villages surveyed in Rajasthan	Villages surveyed in Uttar Pradesh
Muslim potters	Banjara, Boranada, Dava, Ramasni, Rohat, Rudakali, Salawas, Sar, Sangasni, Tanawra	Dasna, Asaura, Mirzapur,
Hindu potters	Bisalpur, Hungaon, Jodhpur, Sathin	Bulandshar, Asampur, Utravali, Mursana, Nagada, Siyana
Muslim and Hindu potters	Banar, Palasni, Pachpadra	Aurangabad, Daulri, Gulaothi, Gesupur, Jahangirabad, Jewar, Dibai, Shikarpur

Table 1. Villages surveyed in Jodhpur and Bulandshar districts.

professional occupations (often agricultural labor). In the seventies, the *jajmani* system started to decline with the arrival of plastic and aluminum vessels. As a result, most of the Hindu potters started to quit the profession massively and to turn to other jobs. Nowadays, Muslims and Hindus sell indifferently to Muslims and Hindus. They live side by side, sometimes in the same villages. In most cases, they are in close contact, often visiting each other. In a few cases they have the same network of clients. In the case of the Jodhpur region, Muslim and Hindu potters manufacture the same type of vessels (water jars made out of salty clay tempered with granite). In the Bulandshar district, Muslim potters manufacture glazed pottery and Hindu potters non-glazed vessels. In both regions, the annual production rate is on average between 2,000 and 6,000 containers.

ECUADOR

In Ecuador the two cases investigated, the canton of San Miguel de Porotos (south of the Cañar province) and the canton of Sigsig (Azuay province), are inhabited by potters who are of indigenous origin (cañari) and speak

Spanish, but whose parents or grandparents used to speak Quichua (language of pre-Hispanic origin related to the Quechua of Peru). Pottery is a specialized activity conducted on a domestic scale (Sjöman 1992).

The twelve potters of the San Miguel de Porotos canton are distributed between three hamlets: Pacchapamba (4 potters), Chico Ingapirca (5 potters) and San Juan Bosco (3 potters). Only a few hundred meters (10 to 20 minutes' walking distance) separate these three hamlets. Household distribution is not determined by kinship in the sense that within each hamlet the households do not share any kinship link. The members of one family live in two distinct hamlets (San Juan Bosco and Chico Ingapirca). One potter from Chico Ingapirca is the godfather of a potter's child from Pacchapamba (Francisco). However, even though the potters from the canton of San Miguel de Porotos are in close contact with each other, can be family related, and know each other's work well, the three hamlets of San Miguel do not think of themselves as a community as shown by their refusal to make an association which required a minimum of ten potters. Regarding ceramic production, the potters from Pacchapamba and San Juan Bosco are specialized in the



Figure 2.
Location of the surveyed villages in Ecuador.

Hamlet	Family	Household
Pacchapamba	Pérez Zimbaña	María Pérez
		María Zimbaña (María's daughter)
	Fernández	Margarita Fernández
		María Fernández (Margarita's sister)
Chico Ingapirca	Suquinagua	Edelina Suquinagua
	Morocho	Rosa Morocho
		Juana Morocho
	Inga	Francisco Inga (Godfather of Margarita's son)
		Cecilia Inga (Francisco's daughter)
		Mariana Inga (Francisco's sister)
San Juan Bosco	Tenenpohuay González	Teolinda Tenenpohuay
		Remigio González (Teolinda's son-in-law)

Table 2. Families interviewed in the three hamlets of the canton of San Miguel de Porotos.

manufacture of big utilitarian wares (cooking pots, jars, tortilla dishes), whereas the potters from Chico Ingapirca are specialized in small ornamental or specialized wares (birthday pots, plates for flower pots). The annual production is slightly lower in Pacchapamba (550 items a year against 750 in San Juan Bosco and Chico Ingapirca).

The five potter's households in the canton of Sigsig are distributed between two hamlets, Cashapugro (four households) and La Esmeralda (one household) 5 kilometers away. The potters from Cashapugro belong to the same family. The potter from La Esmeralda has no relationship with Cashapugro. They hardly know each other. The potters from Sigsig combine pottery with agricultural activities. They manufacture mainly

utilitarian wares that they sell either in markets (at Sigsig and Cuenca), or directly to customers. On average they produce 200 pots a year.

FIRING STRUCTURES

THE INDIAN KILNS

In the Bulandshar region the kiln is a vertical updraft kiln made of bricks covered with clay whose type originates from Multan (Pakistan). The one made by the Muslim potters has a square foundation into which the two circular superimposed chambers are separated by a



Figure 3. Multani kiln (left) and Prajapati kiln (right) in the Bulandshar district, 2011 (© V. Roux).

clay-perforated sole as described by Rye and Evans (Rye and Evans 1976) (Figure 3, left). The one made by the Hindu potters does not present a square foundation but is built according to the same principles (Figure 3, right). Kilns have different capacities depending on their size.

The kiln adopted in the Jodhpur district is also a circular vertical updraft kiln made in bricks coated with

clay. In contrast, the floor separating the two chambers is made of metallic blades resting both against the wall and a central rectangular pillar leaning against the circular wall (Figure 4, top). The combustion chamber is partly buried in the soil with a square mouth. This type of kiln originates from Gujarat. The capacity of the Gujarati kiln is small: 50 jars of 30 liters.



Figure 4. Kilns found in the Jodhpur district (top) and in the Barmer district (Pachpadra, below), 2014 (© V. Roux).



Figure 5. Kiln in Chico Ingapirca (© C. Lara).

Another type of kiln is also found in the Jodhpur region. It originates from Jaipur and is used at Pachapdra only (Figure 1). Unlike the Gujarati kiln, the metallic blades of the floor separating the two chambers rest on a large central circular pillar (Figure 4, below). The result is a larger heating chamber containing up to 120 jars and a floor with small peripheral holes. The advantage is that the vessels are less in contact with the fire than in the Gujarati kiln.

Nowadays, whatever the kiln, the main combustible is sawdust—more rarely wood (in Jodhpur, acacias mostly). The firing time (the time during which combustible is added) depends on both the size of the kiln, the type of floor separating the two chambers and the combustible (variety of wood and sawdust). It varies between 2 to 5 h. The cooling takes from 12 to 24 h. Temperatures reach 850°-900° C. The lifetime of these kilns is around 10 years.

THE ECUADORIAN KILN

In the canton of San Miguel de Porotos, in Chico Ingapirca, the kiln is a square vertical updraft kiln made up of adobe bricks (Figure 5). A perforated floor separates the firing and the heating chambers. The firing chamber has a frontal square opening through which the wood is inserted. The vessels are piled up on the floor. The lowest row lies on a layer of shards. When beginning the firing, the heating chamber is covered with branches. The capacity of the kiln is 100 vessels. The firing lasts around 1h30. The type of fuel used consists of straw and wood (kindling, usually from eucalyptus).

THE INDIAN OPEN FIRINGS

In the Bulandshar region the potters traditionally fire their vessels in open firings with a shallow circular



Figure 6. Open firing in the Bulandshar district, 2011 (© V. Roux).



Figure 7. Open firing in Jodhpur city, 2014 (© V. Roux).

depression and a central hearth (Figure 6). Cow dung and wood chips form the fuel bed on which the vessels are arranged. The first vessels are disposed in the center so as to form a chimney. Then all of the vessels are arranged concentrically around this central chimney. They are covered with cow dung. The firing is started through the central chimney with a piece of burning cow dung. Lastly, the whole load—which can be up to 800 vessels—is covered successively with straw and wet clay for containing the heat. The firing lasts around 12 h followed by 12 h cooling.

In the Jodhpur region open firings operated by Hindu potters also take place in a shallow depression. However, there is no central chimney but multiple peripheral hearths whose number depends on the width of the firing structure. Nowadays in Jodhpur city the combustible is straw and bark (for the lower bed) and wood and bark (for the upper bed covering the vessels). The final cover for the purpose of containing the heat is made up of broken shards (Figure 7). The duration of the firing depends on the size of the structure.

THE ECUADORIAN OPEN FIRINGS

In the canton of San Miguel de Porotos two open firing structures coexist: open firing in Pacchapamba and walled firing in San Juan Bosco.

In the open firing, the pots in the first row layer lie on a bed of shards. They are aligned against each other in a square arrangement. They are topped with a layer of wood and a second row of smaller pots, which in turn is topped with wood and ever smaller pots (Figure 8). The final load is covered with straw and eucalyptus leaves. Hundred to several hundred of vessels are fired in these open firings. The firing lasts around 1h30.

In the walled firing, the enclosure consists of a wall in the shape of a horseshoe (or three walls forming an open square) (Figure 9, next page). This 1 m high wall is made up of stone blocks. The arrangement of the vessels and the wood is the same as for open firing (including the layer of shards underneath the first row of vessels). The final load is covered with straw. Two hundred vessels are fired at a time in walled firing. The firing lasts around 2 h.



Figure 8. Open firing in Pacchapamba, 2011 (© M. Brazzera).



Figure 9. Walled firing in San Juan Bosco, 2014 (© C. Lara).

500 pots(10 liters)	Fuel	Working hours to prepare the firing	Rate of breakage	Cost of the kiln (Rs*)
Kiln	1-1,5t**	2	5-10%	7000
Open firing	2t	6-72***	10%	–

Table 3. Comparative costs between kiln and open firing in the Jodhpur region for firing 500 pots.

* 1 €=82 Rupees (abbreviated Rs).

** The quantity of fuel (mostly sawdust) depends on the type of wood and its calorific properties.

***The working hours to prepare the fire include the time to collect wood. Depending on the conditions for collecting wood, this time spans from very little (when the wood is bought ready cut) to 72 h. In the latter case, one day is devoted to collect wood (acacias), one day to dry it, and one day to cut it.

100 pots	Fuel	Working hours to prepare the firing	Cost of the kiln (US dollar)
Kiln	Wood: 1 bundle Straw: 6 loads of mules	2	410\$
Open firing	Wood: 7 loads of mules Straw/eucalyptus leaves: 20 loads of mules	4	–
Walled firing	Wood: 5 loads of mules Straw: 3 loads of mules	4	6\$

Table 4. Comparative costs between kiln, open firing and walled firing in Ecuador.

COMPARATIVE COSTS

Comparative costs involved in kilns and open firings are given in tables 3 and 4. In India and Ecuador, the rate of breakage is similar in kilns and open firings. The difference in fuel is also comparable. In both cases, fuel is around half or less than a half when firing in kiln. In the Jodhpur region, the cost of the fuel depends on the location of the village. Up to 1975 the state had barren land where most of the potters could collect the wood for

free; from 1975 onwards the state started to give out these lands (to industries, temples, etc.). Consequently, some villages lost access to this land and had to pay to collect wood. At first prices were very low; they increased generally a few years after the potters had adopted the kiln. In a village like Banar wood is still free.

In the Jodhpur region, the building of a kiln costs 7,000 Rupees¹ (4,000 for the iron bars, 1,800 for 600 bricks, 1000 for worker), which corresponds to the

¹ 85 Euros in 2014 (1 Euro = 82 Rs).

sale of 140 water jars (5 working days). In Ecuador, a kiln costs approximately 410 US dollars² (360 dollars for 200 bricks, 50 dollars for workers and other supplies), which corresponds to around 3 months' sales.

HISTORICAL NARRATIVES AND INDIGENOUS DISCOURSES

THE BULANDSHAR REGION (INDIA)

The Bulandshar region presents two cases in point: a case where the non-borrowing of the kiln is observed between the two social communities involved; and a case where the non-borrowing of the kiln is observed within a same social community.

The first case is the most common with the Muslim potters using the kiln and the Hindu potters using open firings. The latter know about the kiln very well: they have seen it and know how it works. When asked, they can even draw it. The main reasons given by the Hindu potters for not borrowing the kiln are technical, organizational and economical, three emic categories of reasons.

Technical reason

- “We manufacture small and thin vessels; they would break under the effect of the high temperatures. The Multani potters use kilns because they make thick big pottery whose firing requires high temperatures.” This reason has been recorded in towns inhabited by both Hindu and Muslim potters. Interestingly, the relationship is made between the thickness of the pots and firing structure and not between the use of glaze and firing structure. The differences in thicknesses of the vessels correspond to the fact that Hindu potters paddle the whole body of their wheel-thrown vessels while the Muslims pound only the bottom.

Organizational reason

- “The kiln is not interesting because you have to sit five hours by the kiln to put the combustible in, whereas the open firing fires by itself.”

Economic reason

- “We know how the open firing works. Why then change and adopt the kiln? Also, we would have to pay for sawdust whereas the cow dung used for the open firing is free. Moreover, firing losses are the same in both firing structures; so the kiln does not present any specific advantages.” These reasons have been given by rural potters still making a wide range of utilitarian vessels.

The second case takes place in two towns, Jahangirabad and Siyana (Figure 1), where a few Hindu potters use the kiln, but not all of them. The latter explain the non-adoption of the kiln mainly with technical arguments.

In Jahangirabad, one Hindu potter borrowed the kiln around 30 years ago. He asked a Multani potter who was a very close friend to explain to him how it worked. He wanted to have a kiln because he thought it was more efficient than the open firing and thus more economical in the context of a market economy, which was then starting to prevail to the detriment of the *jajmani* system. He built the kiln himself after the oral instructions of his Multani friend. The result is a kiln which is smaller and simpler than the Multani one. It does not have any square foundation and is lower in height. It contains 500 vessels only (against 1000 in the Multani kiln). The copying is thus not a perfect replica (Figure 3, right). Nowadays, there are eight families who use the updraft kiln. They correspond to the potter's eight sons. What is to be underlined here is that these potters use the kiln for big vessels only. Small vessels are still fired in open firings beside the kiln. As a consequence, the other Hindu families of Jahangirabad who make only small vessels are not interested in the kiln because they say that small vessels cannot be fired in a kiln. They also say that the kiln takes up too much space. Kilns are built in courtyards depriving potters of working space as opposed to the open firings, which are temporary and can be carried out outside the potter's compound. This has been recorded in both towns and rural areas.

In Siyana, there are five families using the kiln. They are relatives of the first adopter. The kiln is smaller than the one in Jahangirabad and is used for firing small vessels only. Indeed, unlike Jahangirabad the big vessels are fired in open firings. As a consequence the other Hindu potters living in Siyana who make big and small vessels use open firings only, explaining either that they make big vessels which cannot be fired in kilns or that they do not have enough space to build a kiln.

THE JODHPUR REGION (INDIA)

Up to 25 years ago both communities in the Jodhpur region, Hindus and Muslims, used to fire their vessels in open firings: circular and multiple hearths for the Hindus (Figure 5), oblong and single hearth for the Muslim. However, the existence of the kiln had been known in the region since the seventies. It was used in Jodhpur city by two Hindu seasonal potters from the state of Haryana (a northern state next to New Delhi). They were brothers who rented a compound for several months each year. They had built a circular updraft kiln in the courtyard (Kramer 1997: 209). The kiln was in bricks with a clay perforated floor fixed at the mid-height of the cylinder. At that time only one Jodhpuri potter (Hindu), their neighbor, copied the kiln with their help. No trace of this type of kiln is to be seen nowadays in Jodhpur city.

2. 310 Euros in 2014 (1 Euro = 1.31 US dollar).

The presence of a seasonal Hindu potter from Haryana in the seventies is also reported in the village of Banar, a village inhabited by Moila potters and located 20 km from Jodhpur. This potter used a kiln too. He was specialized in the manufacture of pitchers. However, none of the Moila potters copied him because they said they were not sure that their pots could be fired in kilns. In 1985, the government launched a regional program to finance potter's kilns and cement wheels. However, none of the potters understood the functioning of the kiln and none of them even tried to build one.

The adoption of the kiln in the Jodhpur region has two stories. The first one starts in 1987 in the Jodhpur district with a Moila potter from Sar who went, as a seasonal potter, to Ahmedabad, a city located 462 km from Jodhpur (8 h by road). There, he discovered the use of the kiln (by Hindu potters). When he came back, he decided to build one because he says it was more rapid (4 h against 12h) and less effort than the open firings which entailed collecting wood, cutting it (2 days work), and gathering *gobar* (cow dung). Moreover at that time the saw dust used as fuel was free. He was rapidly followed by potters from Salawas, a village 10 km from Sar. Once the kiln was adopted in Sar and Salawas, the other Moila villages from the Jodhpur district followed according to different rhythms and stories, most of them after discussions or meetings with the potters from these two villages. The adoption of the kiln occurred at a time when the ceramic production shifted from a diversified production (kitchen ware for the Moila potters and storage jars for the Hindu potters) to a uniform production (white water jars tempered with granite, [Roux 2015]).

The second story starts in 1999 in Pachpadra (Barmer district), a well-known Hindu rural center for making vessels. Over there the kiln was introduced by two Hindu potters who went to Jaipur in February 1998 invited by the Jawahar Kala Kendra (craft center) to see how to manufacture glazed toys and small clay objects (Pachpadra was renown as a pottery production center and this invitation was motivated by future orders being given to Pachpadra potters). One year later another workshop was organized in Khurja by Rajsiko (Directorate of small scale industries, Rajasthan) in March 1999. There they saw different kinds of kilns and glazing processes. When they came back, they started to build one kiln, but dedicated to small items only. These items did not sell well and the kiln was not used often. A few years later, one potter started to make a bigger kiln and from 2009 onwards the kiln began in part to spread.

In the Jodhpur region, two situations are encountered: a situation where the kiln's non-borrowing occurs (occurred) between the two communities involved; and a situation where the kiln's non borrowing takes (took) place within the same social community.

The first situation concerns the Hindu potters who used open firings a long time after the Moila had adopted the kiln. The reasons given are technical and social.

Technical reason

- Hindu potters (from the village Sathin): "The kiln was used by the Moila for making a type of water jar different from the one we usually make. As we do not make these jars we had no reason to borrow the kiln." When these Hindu potters started to make the same type of water jar as the Moila potters they kept firing them in open firing, but were unsuccessful. So they went to the place where these jars originated, 70 km away, to watch how the kilns were made. They never asked their Moila neighbors.

Social reason

- Hindu potters: "In the village, I was alone in my community. I was reluctant to adopt it because nobody could show me how to make it and use it." One Hindu potter never adopted it. His was the sole potter's household of the village. He is now 70 years old and produces very sporadically. Another one adopted it lately with the help of a Moila neighbor who had become a close friend.

The second situation concerns Moila and Hindu potters who did not adopt the kiln even though potters from their own community had adopted it. The reasons are of four sorts: technical, organizational, economic and social.

Technical reasons

- Moila potters: "As long as we made kitchen ware we were not interested in taking the kiln because our vessels would have broken. They were not thick enough to resist the temperatures reached in the kiln." These potters still consider that the quality of the firing is better in the open firing than in the kiln because vessels are fired longer and therefore harder. Potters do not mind that the water jars fired in kilns are not well fired because they are meant to be used for one year only (consumers change water jars each spring). Thus a potter from Sar told us that his maternal uncle uses both the kiln and the open firing. The kiln is for firing water jars and the open firing for the kitchen ware. He says: "the kitchen ware is better fired because it takes a long time for the fire to spread across the vessels. As a result there is a sort of preheating before the fire engulfs the whole load. If the kitchen ware were fired in the kiln it would last only a year. Kitchenware fired in the open firing is like glass."
- Hindu and Moila potters: "The advantages of the kiln are not obvious. In the open firing, there is less firing loss than in the kiln because there is no excess of temperatures. In terms of quality of firing, in both firing structures, the best fired vessels are in the center, and the less fired are on the sides."

Organizational reasons

- Moila and Hindu potters: “The small capacity of the kilns requires too frequent firings.” A Hindu potter from Pachpadra who used to have a kiln returned to the open firing explaining that he prefers to do one open firing per month (with 500 vessels), rather than ten kilns per month. At the end, as he says, the number of fired vessels in a month is the same, whether fired in kiln or in open firing.
- Hindu potter (Pachpadra): “With the open firing, the whole family is involved in the loading, while with the kiln, the man is stuck in the kiln and cannot help bringing the pots.” The potter who gave this explanation used to have a kiln, gave it up and returned to the open firing.
- Hindu and Muslim potters: “In the kiln one can put only 50 jars. In joint families we need to fire several hundred jars at a time which is possible with open firing only.” The Moila potters specified that they took the kiln when brothers separated from the father’s house because only then the production was low enough for the kiln to be appropriate.
- Hindu and Muslim potters: “The kiln is tiring: one has to keep sitting for 2 h in the heat and smoke to feed the fire with saw dust.”

Economic reasons

- Hindu and Muslim potters: “Kiln was too expensive.” The building of a kiln has a cost (7000 Rs) and has been considered prohibitive by a few potters for a long time.

Social reasons

- Hindu potters: “The smoke of the kiln is a nuisance. So we prefer to fire in open firing.” In Pachpadra, the local newspapers reported on complaints by non

potters. On the other hand, in Jodhpur city, a few Hindu potters living in densely settled areas have kilns and say that the neighbors do not complain.

SAN MIGUEL DE POROTOS (ECUADOR)

The presence of the kiln in San Miguel de Porotos has been attested at Chico Ingapirca for a long time. There is no memory of its introduction. On the basis of oral narratives the kiln was already used in the sixties by the three houses of potters who were then in activity.

The potters of Pacchapamba and San Juan Bosco consider that the open or the walled firing is their method, that it works well and therefore that they have no interest in changing it. More precisely, the reasons for not adopting the kiln are of three sorts: technical, organizational and economic.

Technical reasons

- San Juan Bosco: “The kiln is used by Francisco (Mariana’s brother) whose production is famous and different from ours; we do not make the same items and therefore we do not need the kiln.”
- Pacchapamba: “Kilns are for potters who make special items like the ‘decorated figurines’ made by Francisco or the ‘birthday vessels’ made by Edelina.”
- San Juan Bosco: “Our pots are well fired, with a nice color and sell well.” In this regard, their way of firing is as good as the kiln.

Organizational reasons

- San Juan Bosco “Firing in open firing takes less time than firing in kilns (according to what they heard, 2 h against 6 h).”
- Pacchapamba: “In open firing pots can be withdrawn rapidly after the end of firing, whereas in kiln one has to wait a whole day.”



Figure 10. Open firing in Sigsig, 2014 (© C. Lara).

Economic reasons

- San Juan Bosco: “We are aware that the kiln uses less wood. However there is no problem for finding wood. So why take the kiln?”

SIGSIG (ECUADOR)

In the canton of Sigsig there is no kiln. All the vessels are fired in open firing whose combustible includes pine cones, branches and straw (Figure 10). However, the potters are well aware of the kilns used in the neighboring towns of Chordeleg and Cuenca (around 30 km from Sigsig).

Over there potters make wheel-thrown glazed vessels which are sold on the markets of Sigsig and Cuenca. It is on these markets that the potters from Sigsig have heard of the potter’s wheel and kiln, which, however, they have never seen. They have been advised by customers of the advantages of the kiln, which would allow them to produce more and to have less firing losses. However, they never got interested. The reasons given are technical and economic.

Technical reasons

- “Kilns are for glazed pots which are in fact artificial and dangerous for health; we are making natural pots and therefore we do not need kiln.”
- “Even if the kiln lets pots be fired during the rainy season, the point is that the rain never bothered us. If it rains, too bad! We just have to wait until it stops to continue working”;

Economic reasons

- “Our firing losses are very minor and do not justify an investment as big as building a kiln”;
- “We would not know how to use a kiln which, moreover, might be very costly”;
- “Our customers are happy with our pots; if we were to change our manufacturing techniques, would they still be happy?”

DISCUSSION

Our case studies report on potters who did not borrow the kiln, either definitely or temporarily. All these potters know or knew about it and the use of open firing appears to be an informed and deliberate choice.

The first point to be underlined is that the reasons given by Indian and Ecuadorian potters for not adopting the kiln are very similar; in this regard, they are not proper to specific cultural or economic contexts, knowing that in India the ceramic production is much higher than in Ecuador. These reasons can be grouped

into three main etic categories: social, cost/benefit and functional reasons.

Social reasons express the role of the social organization in potter’s choices. In our case studies they correspond to situations where nobody could help the potter in making a kiln: either there was only one potter household in the village, or that the potter did not have contact with any of the neighboring households using the kiln. These situations are rare. However, they explain well how isolated potters may be aware of a new technique but do not adopt it because not surrounded socially.

Cost/benefit reasons show that the concept of “technical advantage” is very relative. Indeed the main advantages of the kiln are not considered as such by all the potters. Thus, when the wood is freely available, the gain of fuel is not considered as important and therefore as a decisive argument for the adoption of the kiln. In the same way, the gain of space offered by the kiln is not perceived as relevant when needing the space for multipurpose activities either in densely or weakly settled area; or else in a context of low production, rain is not viewed as a problem, having time to wait for a better weather. Lastly, the quality of the finished products and the rate of breakage are perceived as very much comparable whatever the firing structure. In fact, there are numerous disadvantages associated expressly with the kiln: it is considered to present major constraints when it comes to frequency of firings (firing every two days in a kiln against once a month in open firing; firing low number of vessels in kilns against high number in open firings while the latter is required when living in joint families), loading work or unloading timing, the hardness of the work (sitting by the kiln against not sitting by the open fire). The cost of the kiln may also be mentioned even though in our case study it is not really prohibitive.

Now, all these cost/benefit reasons have always been given alongside a main functional reason which associates firing structure and finished products: when the products fired in open firings and kilns are different, potters consider that the products fired in open firing cannot be fired in kiln (not proper to fire thin or on the contrary thick vessels, not proper to fire big or on the contrary small vessels, not proper for firing utilitarian vessels, not proper for firing “our” types of vessel). Such a functional reason has been given in all the studied situations and by most of the potters, either in India or in Ecuador, either in low or high production, either in the case of one or two social communities in charge of the ceramic production.

Thus, in the Jodhpur region, the Muslim and the Hindu potters considered that the kiln was not appropriate for their vessels as long as the kiln was used by seasonal outsiders making “foreign” types of vessels. Later when the Moila adopted the kiln for making white water jars, the neighboring Hindu potters making red clay jars declared the kiln not appropriate for their vessels. In the Bulandhsar district Hindu potters still consider the

kiln inappropriate for firing their vessels, knowing that the Hindu and Multani potters (using the kiln) manufacture different ranges of vessels according to different technical processes.

This verbally expressed association between the technical system and the finished products is not peculiar to situations where two social groups are in charge of the ceramic production. It is also found among potters belonging to the same social group. Thus, in India at Siyana, one Hindu family borrowed the kiln and associated it with the firing of small bowls. It followed that the other Hindu families involved in the manufacture of a large range of vessels kept firing their vessels in open firings, associating the kiln with the exclusive firing of small vessels. *A contrario*, at Jahangirabad, 36 km from Siyana, the sole Hindu family who borrowed the kiln from the Multani potters associated it with the firing of big vessels, using open firings for small vessels. This perception of the firing technologies prevails among Hindu potters in the whole town even though Multani potters from this very town fire big and small vessels in their kilns. Another example is found in the Muslim community of the Jodhpur region. As long as potters were making vessels different from the ones fired in kilns (kitchen ware *versus* water jar), they did not adopt the kiln. The association between the type of vessel and the firing technology comes from a similar story: the kiln was introduced alongside a new type of vessel and therefore was considered appropriate for firing this production and only this production. The same story is reported in Ecuador. The potters in Sigsig who make utilitarian wares associate the kiln with glazed vessels. As a result, they perceive the kiln as inappropriate for their vessels. The potters from Pacchapamba and San Juan Bosco who make utilitarian wares associate the kiln with the ornamental and specialized wares made in Chico Ingapirca. The cases of Margarita Fernández (Pacchapamba) and the Morocho sisters (Chico Ingapirca) are a case in point. Margarita was born in Pacchapamba, where she learned to make big vessels and fire them in open firings. She then married a man from Chico Ingapirca, where she moved to and adopted the kiln along the manufacture of small decorative items. When her husband died, she returned to Pacchapamba, made again big utilitarian pots and went back to the open firing, which she preferred because considered as more appropriate for firing big pots. The same way, the Morocho sisters were born in San Juan Bosco, where they learned to fire pots in walled firing. They married men from Chico Ingapirca, where they moved to and then adopted the kiln along the manufacture of small decorative items, leaving behind the manufacture of big vessels.

* * *

To sum up, our ethnographic data show that there is a tendency not to borrow the kiln when different firing

structures are perceived to be associated with specific finished products. The main reason given is functional. The cost/benefit reasons come next and vary depending on the individual.

This functional reason expresses a universal cognitive bias according to which individuals use a “covariation principle” to assess causality. The “covariation principle” states that “if event A accompanies outcome B, and if event A is absent when outcome B is absent, then people tend to attribute A as the cause of B” (Carley 2001; Kelley 1967, 1973). According to this principle, if technique A accompanies product B, and if technique A is absent when product B is absent, then people tend to attribute technique A as the cause of product B, or product B as the cause of technique A. This cognition issue has major repercussions, among which the non-borrowing of the kiln by people making products other than the ones fired in kiln, and consequently the emergence of technological polarization and boundaries even within homogeneous social groups.

* * *

This result has strong methodological implications for studying past situations. It implies analyzing the context of introduction of the new technique in order to characterize the new technological standard which may have developed. It implies next assessing whether different technological standards were maintained, thus whether different finished products were used with different firing structures. One will then be in a position to understand technological phenomena such as the non-adoption of the kiln.

CONCLUSION

Following the Spanish conquest, the indigenous and the Spanish ceramic traditions were apparently produced in different workshops (Hernández Sánchez 2011: 104). The Spanish-style ceramics involved the introduction of the potter’s wheel, the lead and tin-based glaze and new vessel shapes by Spanish potters being brought to Mexico city (Hernández Sánchez 2011: 105, 141). The indigenous pottery was supposedly still fired in both kiln and open firing, while the Spanish-style ceramics was fired in kilns.

In the light of this study, we propose that the issue of the non-adoption of the kiln, the glaze and the wheel in Mesoamerica and South America should be reexamined and/or studied further. Indeed, we saw that the use of different technological standards favors technological polarization and the non-borrowing of techniques. We must add that polarization increases along with social affiliation and differentiation when technological standards are used by economically complementary social groups, thereby favoring negative influence and persistent

technological boundaries (Roux et al. forthcoming). In Mesomaerica and South America, distinct technological standards were used by the Spanish and the indigenous potters. All the conditions were thus present for a strong polarization and the non-borrowing of techniques between the two communities.

Acknowledgments. The ethnographic investigations in Rajasthan (India) and in Ecuador have been funded by the ANR (Agence nationale de la recherche) within the framework of the program CULT (Metamorphosis of societies—“Emergences and evolution of cultures and cultural phenomena”), project DIFFCERAM (Dynamics of spreading of ceramic techniques and style: actualist comparative data and agent-based modeling) (n° ANR-12-CULT-0001-01). In Rajasthan, the support of the Rupayan Sansthan was invaluable. We thank here Kuldeep Kothari for his help as well as Meet Kaur Gulati and Lakshman Diwakar for their assistance in the field. In Ecuador, we thank Tamara Landívar, curator of the ethnographic department of the ethnographic museum of Pumapungo in Cuenca, Ministry of Culture, for her help and her interest in the project. In Bulandshar district (India), the data were collected with the financial support of the UMR 7055, CNRS. At last, we would like to thank all the potters in India and in Ecuador for their availability and their unfailing kindness.

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