CHAPTER XII

MINERAL TECHNOLOGY

Lime Roasting

Maize may be the staple crop of indigenous Middle America but lime (or wood ash) is an equally essential ingredient in the preparation of food, since soaking in a mildly caustic solution is necessary to release the pericarp from the rest of each maize kernel. In Alta Verapaz, where limestone is the bedrock nearly everywhere, lime is the obvious choice. In volcanic and other limeless areas, wood ashes are used where lime is not imported.[1] The usefulness of limestone for lime-making varies, but by coincidence *Aldea* Koxila was so endowed as to be a center of supply for all of Chamelco's needs and an exporter to Cobán and especially Carchá. For details in the Q?eqči? terminology for limestones see Table 6, Chapter III.

Equipment

From a linguistic standpoint it appears that a large part of the technology of lime-roasting may be Spanish. The oven is termed *o:rn* (<Sp. *horno*); ashes are removed from it with a long-handled hoe or *asaron* (<Sp. *azadón*); rocks are freighted to the oven in a wooden box or *kašon* (<Sp. *cajón*) though they and other goods more often go in a *kakašt* (<Sp. *cacaxte*, from Aztec?). Details and dimensions of

[1] Usages in the Western Highlands are detailed in McBryde, 1947: 183-184.

each of these devices appear in Figure 24.[2]

An oven can be excavated into any convenient slope where bedrock is not too close to the surface, but the subsoil clay should be as red as possible. Unfortunately, we did not have time to make our own in order to establish the amount of labor invested in an oven, but it is on the order of three to five man-days. The weak link is the 'bridge' (*š-q?a*), which is reinforced with cross-logs, themselves held in place by vertical posts. An oven is good until its bridge collapses and that event may happen anywhere from one to five or more years after construction. The oven interior is coated with red clay like that used in one type of pottery; the stoking and draft orifice is shaped with special care and requires periodic repair as heat and accidental blows cause chips to spall off. The only operating tool associated with an oven is a long-handled hoe for clearing ash from the firepit. Standard picks and sledgehammers serve for quarrying the raw rock. The dimensions of two ovens were taken and found to correspond to within 10% or less in every measurement, suggesting either rote imitation or else close optimization of the traditional design – or both.

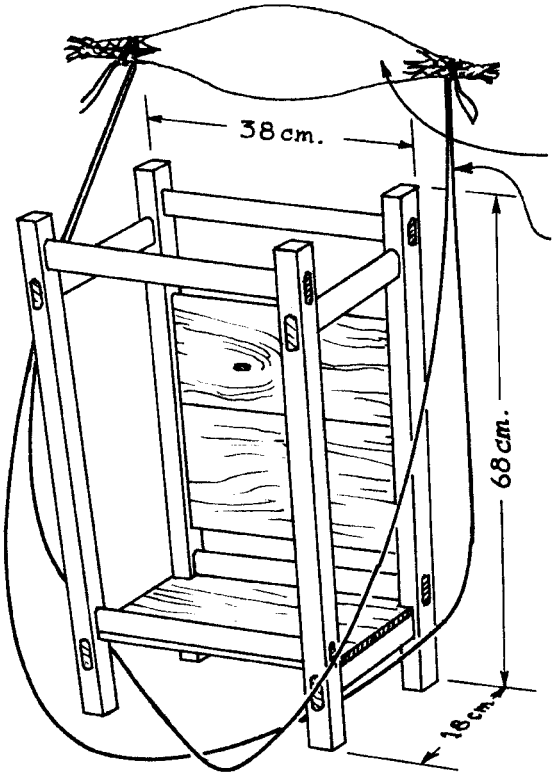
Raw Materials

The preferred stone for lime-making is black-gray, soft, fine-grained, and has a strong odor of sulfur when freshly exposed that suggests a trace of petroleum. Persons (such as my informant) who

[2] Cf. Chortí methods in Wisdom, 1940: 177.

FIGURE 24

LIME-MAKING DEVICES



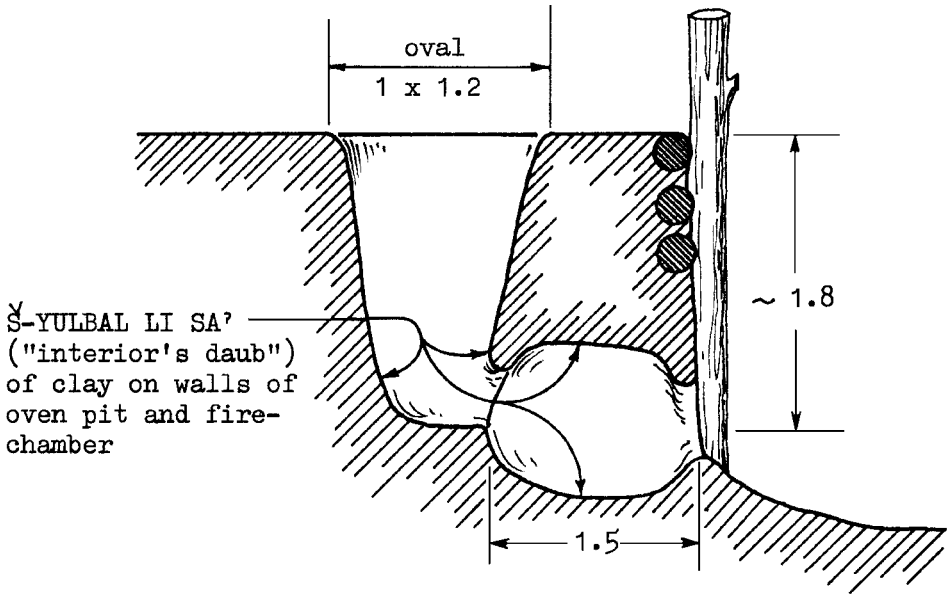
(1) KAKA:ŠT (< Sp. cacaste < Aztec word for similar frame?)

TA:B (in this case, of leather)

7 mm. diameter rope

(note: 5 mm. diameter rope wrapped in spiral around whole frame and laced once, vertically, at mid-line of open spaces)

(2) ʾO:RN (< Sp. horno) oven



Note: all dimensions in meters unless otherwise specified

have outcrops of this rock on their property can expect a steady income of 25¢ per oven-full of rock quarried by their lime-making neighbors. Partly weathered rock at the outcrop surface is easiest to break up; fractures are followed as they reveal themselves in the release of unexpected chunks. Blows are directed at the largest flat surface perpendicular to the fracture. One man-day is more than enough to quarry nearly 600 kg. of rock into usable pieces from ¼ to 2 kg. in weight. However, back-packing these from quarry to oven over steep trails is a job that requires about two man-days.

The wood used for fuel, at least in Koxila ovens, is pine. Twisted and otherwise worthless trees can be had for 50¢ cutting rights while the preferred fuel wood, oak, would cost 20¢ for every 50 kg. load. A tree takes roughly two man-days to fell, cord, split and carry; one tree will usually suffice for one firing of the oven plus 80 kg. of surplus wood.

Procedure

An oven can be loaded with rock by one man in less than an hour. Large rocks are loaded first, in a pile which gradually closes in on the firepit orifice until this can be bridged with one large stone which has been set aside for the purpose. Old half-fired clinkers and potsherds cover the top of the load (*š-č?apbal š-be:n li čun*, closure over the lime) since this layer will not reach the proper temperature in any case.

Firing begins at first light (0500 to 0530) and continues for about fifteen hours (to 2000). Dry wood and pitch pine (*q?ol čax*) are needed to start the fire, but from then on fresh wood is pre-

dried in stacked layers over the ‘flue’ before being stoked into the fire. Seven to ten minutes elapse between stokings of roughly six pieces of wood out of the bottom third of the stack, which is re-built every 45 minutes to release this dry fuel. Accidental ignition of the drying pile is put out by throwing in yet more wood, thereby increasing the smoke output and presumably cutting off available oxygen in the flue gases. Coals are cleared from the firepit about once an hour.

Weighing of sixteen wet and seven dry pieces of wood showed a weight loss of almost exactly ½. Weighing of the finished lime showed a loss equally close to ½ (see Table 36).

Not every firing of an ovenfull of rock results in a salable product. When failure is not obviously a result of trying to make do with inferior rock, it is blamed on the polluting proximity of a person who is ritually ‘hot’ (*tiq ru*) and especially one whose heat is fueled by alcohol (*lax go:m*). The ruination is instantly signaled by a change from the normal black smoke of a well-stoked oven to light gray.

Cost and Value

The accounting summary in Table 36 shows that lime-making pays about as well as the best going rate for field labor, 50¢ per day, yet with location and schedule at the worker’s rather than an employer’s convenience. Thus it is no wonder that almost every able-bodied man in Koxila makes lime while able-bodied women carry it by fifty-pound basketloads to retail in the markets of Chamelco, Chamíl, and Carchá.

TABLE 36

ACCOUNTING SUMMARY FOR LIME ROASTING

labor (man-days)

quarry rock	1
carry rock	2
cut and carry wood	2
load oven	-(1 hour)
superintend firing	1½
unload oven	-(1 hour)
	6½

cash outlay

quarrying rights	Q0.25
woodcutting rights	0.50
	0.75

total materials (Kg)	raw	finished
stone (case study)	635 (567)	317.5 (274.5)
wood (case study)	816 (340?)	408 (170?)
salable lime		(244.0)
waste rock		(30.5)

cash income

wholesale: 14 baskets at 25¢	Q3.50
(11 baskets at 25¢	2.75)
wholesale: 7 sacks at 75¢	5.25
(Q1.00 at Carchá)	

net return/ man-day: Q 0.41 to 0.68 (latter incl. gains from additional labor of 10 Km porterage)

Pottery

Containers and cooking utensils used by the highland Q?eqči? are made from three types of clay and two sorts of temper.[3] However, local materials will not yield the most durable and appreciated cooking ware, which is brought in by pedlars from the Salamá Valley and is tempered with bas (see Chapter III, Table 5.

Men with massive tumpline-loads of *comales* (*k?il*) and pots (*emel*) can be seen nearly any day of the year trudging the steep grades on the 15 km. of road from Salamá to Hacienda Santa Rosa.

Still, the main volume of pottery used by the Q?eqči? is made by them: men are responsible for digging, hauling and mixing the raw materials, while forming the vessels and managing the firing is strictly women's work. Potters tend to be localized where superior materials are found, yet this localization is equally an artifact of instruction by apprenticeship. One type of clay mix is labelled *š-kuk ax* čičen (jug of persons from *Aldea* Čičen) while the other is *š-kuk ax San Pe:dr* (from San Pedro Carchá). A girl or woman who desires to take up the ceramic handicraft will observe and imitate a working potter at the relatively steep tuition (for those outside the immediate family) of 25¢ a day, and she probably will not be able to master the craft in less than seven days. However, materials to supply the novice are as hard-won as those for the professional – a fact which may help justify the fee.

---

[3] 0n other peoples' pottery see: Gillin, 1951: 46-47; McBryde, 1947: 167-174; Wisdom, 1940: 167-170.

Materials

Čičen-style pottery is made with a mix of equal parts of *q?eqi* č*?o*č*?* and *saqi* č*?o*č*?*, black and white clays, respectively, with constituent minerals detailed in Chapter III. The white clay comes from aldea Čiqanox, several km.east of Čičen proper; black clay may be dug there or at Čičun, about 1 km from Chamelco on the road to Cobán. A temper of *poq* (fine volcanic ash) is added at a rate of 1:3 to the above mix; it is almost ubiquitously available. For cooking ware, in contrast to storage jugs and censers, *samahib* (sand) temper is dug from the bed of a stream, e.g. Mestelha?. Incidentally, sands and gravels are precious resources in Alta Verapaz: the main mineral base is either limestone or clay with few particles of intermediate size.

San Pedro-style pottery uses only one clay, red-brown *seb*, with the same kind and quantity of temper as above. My informant for this part of the study happened to live in Bárrio San Marcos of Chamelco, but said that her husband dug clay at Mariho:c, which is more than halfway to San Pedro. For him to dig and pack home one load of 34 kg. (75 lbs.) required a full day's work. *Poq* temper (and *poq* for other uses) continues to be dug at several sites just west of Chamelco, to the great annoyance of the Ladinos who now 'own' the lands in question. The temper must dry for a day or so until it can be seived easily to rid it of pebbles and roots. Mixing of clay and temper is heavy work, a man's job: *poq* is dusted over the dirt floor, the clay is wetted and beaten with a club to soften it, then

clay and *poq* are mixed by tramping the mass out with bare feet and folding it over on itself every time it thins out. As many pebbles and concretions as possible are picked out at this stage, which requires about two hours for 45 kg. (100 lbs.) of mix.

Both styles of pottery are slipped with a wash made from bright red *kaqi* *č?oč?* otherwise termed *š-bonol kuk* (jug's paint). This is found in small pockets here and there in trail-bank cuts, with no obvious relationship to adjacent materials. Fortunately, very little suffices for very many pots.

The final and essential material is wood for firing, as many as four man-loads being needed for a batch of twelve pieces. The labor cost of these will vary according to the minimum distance to the cheapest usable fuel, which may be pine bark if sawyers are working nearby, or *c?a?ax*, or *oqob*, or any other good firewood (see Chapter IX).

Procedure

Weather which is dry enough to bring the raw pots to a moisture con-tent suitable for firing can be expected only from February through May, so that potting is a markedly seasonal occupation. During the four-month working period some two dozen large articles may be produced per week.

Forming of the principal product, a water jug or *kuk*, begins with a well-kneaded ball of tempered clay about 20 cm. in diameter; this is patted into a gross 'tortilla' and placed on a shallow plate (termed *anam*) which serves to shape the base and protect it as the

work is turned back and forth while resting on the ground.[4] The edges of the ‘tortilla’ are pulled and thinned upward and inward a bit at a time until a bowl of 15 to 20 cm. depth is formed; at that point another ball of roughly equal size is rolled out to a gross coil twice as long as the base is deep. This is then press-joined to the basal bowl and the walls worked upward to the point where the external curve will change from convex to concave, at about 30 to 35 cm. depth. In all of this hand-shaping no guide to dimensions, symmetry or wall thickness is used excepting a calibrated eyeball.

On completion the base is set aside to dry and harden, having first been picked clean of grits, burnished with a scrap of tree gourd (*xo:m*), and given a central dent in the bottom by pounding with a half-*xo:m*. Drying will take only 10 to 20 minutes on a sunny day; meanwhile, another base can be completed. This half of the finished article is termed *ben š-tel li kuk*, “over the arm of the jug”. The second phase begins with another fat coil which is joined to the base and formed into a truncated cone about 20 cm. tall, then worked inward to the proper concave shape by use of a wetted, clean *xo:m*. The lip of the orifice is then squared off between thumb and fin-gers, flared out with *xo:m*, and fingers, and finally rounded with thumb and fingers.

The standard Q?eqčiʔ water jug has the shape of a squat amphora, and perhaps owes as much to Spanish (and ultimately Greek) influence as to archaeological Maya ceramics. To complete the form, two hand-

[4] Cf. procedures documented in Foster, 1967: 106-112.

les or ‘ears’ (*š-šik li kuk*) are attached at the break in curvature. Two opposite spots are scraped flat with the edge of a *xo:m* and washed with watery clay paste, then a flattened cylinder of clay some 10 cm. long is pasted on, shaped down to a ‘U’, then pasted in below. A small roll of clay inserted into the lower inside joint is smoothed into a fillet which leaves the ‘ear’ circular inside, and completes it. About one fistful of clay suffices for an ‘ear’. Handles with this general shape and location may be seen on any number of drawings of archaeological vases, but at or above the maximum girth of a spheroidal body upon which a cylindrical or flared neck is superposed.[5]

The completed pot is set aside to dry for an hour before it is taken up again to be smoothed with the edge of a scrap of *xo:m*, an operation termed *pak?luč?*. Scraping begins with the basal dimple and works up to the rim, bypassing the handles. Nicks, scratches and holes left by included grits are filled in with clay scrapings and smoothed with wetted fingers. A wet hand is first passed over a section about to be scraped, then the edge of the *xo:m* tool is used, and finally a light burnishing is given with the tool’s smooth surface. Manipulating a raw jug during this work without crushing it is a triumph of gentle dexterity requiring simultaneous use of thighs, forearms and hands. Usually the basal half alone is meticulously scraped, yet at that the job takes 20 minutes per *kuk*.

One day after completion each jug is slipped with dilute *kaqi*

---

[5] Cf. Navarrete, 1962.

č?oč? (red earth) over all exterior surfaces and burnished, either with a pebble from a river or an archaeological celt (termed *š-ma:l ka:q*, lightning's axe).[6] Slipping begins with the base half, after which the *kuk* is set aside to dry, mouth down. After taking time to slip another base, the first is burnished, re-slipped, again set aside to dry, and finally burnished again. This two-stage procedure then repeats for the upper half of the *kuk*, excepting the 'ears' which are slipped but not burnished and the interior which is slipped only a few cm. inside the rim. Slipping is done with a scrap of cloth; along with the burnishing it takes roughly half an hour per *kuk*. If slipped while still wet (*raš*, green), pottery will come out of the fire pink rather than the desired brick red.

After another four or five days for thorough air-drying, firing may take place. However, if for any reason an article cannot be completed within one day's work it cannot be carried forward the next day but must be reduced to clay again – for practical reasons of mismatching shrinkage. Production may run as high as six *kuk* per day, with firings in two-day batches of ten or twelve, but the demands of other tasks during the dry season do not allow either men or women to sustain this maximum except in families with many adult members and without a wealth of land.

Firing is possible with Čičen-style pots even when these are damp; the other style will spall and crack if fired in this state,

---

[6] The same folk belief is given for the Chorti in Wisdom, 1940: 382 (fn. 24).

yet is more durable than the first sort when properly processed. Before the main firing a batch of pottery is always pre-heated and dried around an open fire, each piece being rotated periodically to expose every surface. A leaf is used for a ‘hot-pad’ once the pottery is thoroughly heated. The ashes of this first fire are spread out and a base course of firewood laid on them, then jugs are laid in courses, mouths facing out, each course at 90° to the one below so that the upper nests in the lower and the whole adds up to a rough pyramid. Twigs are fitted in among the jugs and around the bottom of the stack, then an outer pyramid of sticks or split firewood is built to complete the open-air ‘kiln’.

For the observed firing of a batch of only six *kuk*, the initial fire was maintained for a little under three hours while the main firing burned out in only half an hour. For a full-scale firing the pre-heating fire would be allowed 11.3 kg. (25 lbs.) of wood in addition to the 90.7 kg. (200 lbs.) for the main firing and the process would last correspondingly longer.

Freshly-fired pottery is dull reddish brown and almost glowing hot, hence it must be gingerly fished out of the ashes by its ‘ears’, using a long pole. After 15 to 25 minutes of cooling the slip returns to its bright red color (roughly Munsell 10R 4/8).

Our trial batch of articles was produced out of season, with *poq* that had too high a content of *saqlum* (betrayed by its off-white color when dry). As a result a large chip spalled from an *emel* during heating and it was discarded, while three of the six *kuk*

suffered spalling, cracking, or both. The normal rate of defects is claimed to be one flaw in twelve or more pieces. However, even imperfect articles are still saleable at a 15% to 50% discount depending on original value and degree of damage (see Table 37). Ordinarily, women bring their own works to market in headloads; however, one man was observed carrying four *kuk* on a tumpline (yet without a wooden pack frame) by using the lashing shown in Figure 25.

The Geography of Pots

Concern with the activities of present-day potters in traditional cultures – whether or not these offer valid clues to their ancestors' activities – has been late to flourish. Among the few such studies which could be cited for North and Middle America are Arrot (1967 a, b), Borhegyi (1952), Fontana *et al.* (1962), Foster (1955), Thompson (1958) and Stanislawski (1969). A unique synthesis of the sequence of pottery forms in time and place is contained in Ford (1969).

From the details of materials and techniques above, or from any combination of the studies just cited, one can eventually extract the information out of which to make a broad geographic study of something rather like "implement geography" as proposed by Sonnenfeld.[7] Yet even in itself this sort of minute depiction of a simple technology based on knowledge and use of an areally variable earth resource is no less "geographic" than, for example, description of past or current procedures in the making of iron and steel.

---

[7] Sonnenfeld, 1960.

TABLE 37

ACCOUNTING SUMMARY FOR POTTERY

TEST BATCH				INFORMANT DESCRIPTION		
	materials					
	Kg	lb.		Kg	lb.	
seb	29.0	(64)	40.8 (90)	34.1	(75)	45.4 (100)
poq	11.8	(26)		11.3	(25)	
wood	45.4	(100)		102.0	(225)	
	articles (* = damaged)					
kuk	Kg	lb.	mkt. val.	"as is"	*kuk*	
1*	1.47	(3:04)	.12	.12	12 at .15 = Q1.80	
2*	1.47	(3:04)	.12	.10		
3*	1.82	(4:00)	.15	.10		
4	1.90	4:03	.15	.15		
5	1.82	4:00	.15	.15		
6	1.70	3:12)	.15	.15		
sansa:r					*sansa:r*	
1*	0.29	(0:10.2)	.04	.02	? at .04	
2	0.31	(0:10.8)	.04	.04		
emel					*emel*	
1*	0.23	(0:08)	.02	.00	? at .04 & up (by size)	
	9.51	(21:00)	Q0.94	Q0.83	TOTALS	

TIME FOR ONE *KUK*

job	hours	days	worker*	sub-totals (m-d)
collect clay		1	M	
collect temper		½	M	
mix materials	2:00		M	1¾
form base half	0:15		F	
dry	0:15		-	
form top half	0:20		F	
dry	0:20		-	
add handles	0:10		F	
dry	1:00		-	
scrape & burnish	0:20		F	
dry	1(or 2)		-	
slip & burnish	0:30		F	1½ to 2¾
dry		4 or 5	-	(1:35 working time)
collect firewood		½	M	
pre-heat	4:00		F	
stack & fire	1:00		F	
cool	0:25		-	

*M: male F: female

FIGURE 25

METHOD FOR CARRYING KUK WITH TUMPLINE AND LASHING ONLY