Reports

Archeological Investigation of Cuicuilco, Valley of Mexico, 1957

Between 28 May and 8 July 1957, a National Geographic Society–University of California expedition conducted explorations in the archeological zone of Cuicuilco, D.F., Mexico. The party included, in addition to us, A. B. Elsasser, René Millon, and R. J. Squier of the University of California and Eduardo Contreras of the Instituto Nacional de Antropología e Historia (*1*). Recently instituted commercial quarrying of the lava flow (pedregal) which overlies the archeological deposits disclosed several earth mounds. These were recognized as of archeological significance by Eric Wolf and Angel Palerm in 1956 (*2*).

By January 1957, the sloping sides of four small earth mounds had been partially exposed by clearing off the superjacent basalt in quarrying operations. In each case the lava flow had not completely covered the top of the mounds, which anciently formed obstructions to the flow. One edge and the center of each mound was available for excavation, and testing of three of the mounds was carried out. Each mound proved to contain a structure, either of clay or earth, with a basalt boulder facing, as well as graves, an abundance of potsherds, and minor artifacts. The mounds thus far located in the quarry area lying on the west side of Insurgentes Boulevard have been grouped by us as a separate subzone of Cuicuilco, and will be referred to as Cuicuilco-B in order to distinguish it from the Cuicuilco Pyramid itself (lying about 0.3 mile to the east) which was the scene of Cummings' investigation.

That Cuicuilco-B is contemporaneous with and associated with the round, terraced, boulder-faced Cuicuilco Pyramid is established beyond question. It thus appears that the pyramid and Cuicuilco-B complex as a unit may represent the beginnings of urbanism, which would be the earliest such development now known for the Central Mexican Highland. The extent of the site complex is clearly greater than now known, and only with additional quarrying can the full extent and arrangement of the various components be determined.

Mound 1 contains a clay platform mound, probably oval in outline, rising 7 meters above the base in a series of narrow curved terraces which are smoothly surfaced. The size of this structure was not determined, but its minimum length is over 100 feet. The history of the structure is complicated since the original low structure which rested on tepetate subsoil was rebuilt three times by adding to its lateral and vertical dimensions. It is believed that this clay platform mound is earlier than the stone-faced structures in mounds 2 and 4 (see below) and that, in all probability, the innermost structure in the Cuicuilco Pyramid may be a clay construction of this sort.

Mound 2 yielded a square platform measuring 48 feet on a side with sloping sides which were faced with basalt cobbles. The hearting of the structure consisted of a fill of midden deposit probably secured in the immediate vicinity. The original platform was enlarged once, and at this time a row of well-dressed rectangular granite blocks was laid down as a decorative feature.

Mound 4 is less completely known since only a single trench was excavated. This excavation disclosed a basalt boulder facing about 3 feet thick covering the outside of the conical earth mound. An inner structure consisting of what seems to be a rectangular pit whose sides are lined with basalt boulders contained a circular clay basin, numerous thin sand and ash layers, much charcoal, and an abundance of sherds. Two burials in this stone-lined pit were associated with large numbers of the distinctive cruciform objects recorded earlier by Kroeber (*3*). These are hand-modeled flat four- or six-pointed objects made of white wood ash.

The clay and stone-faced structures in mounds 1, 2, and 4 were apparently abandoned and suffered erosion of their crowns for some period. Terminal use of the Cuicuilco-B area is marked by occupation debris lying on top of the eroded structures and immediately beneath the pedregal. A similar sequence of events apparently occurred at the pyramid, according to Cummings (*4*). Constructions employing unfired adobe bricks which occur in the pyramid were not noted in mounds 1, 2, and 4.

An abundance of potsherds and a few complete vessels were recovered from the three excavated mounds. Small collections were obtained from the midden sheet lying beneath the lava between the mounds and from the bottom of the 21-foot-deep shaft previously excavated by Cummings near the pyramid. This material has not yet been fully analyzed, but the following tentative observations can be made.

The crown of each mound, which remained uncovered by lava, yielded Aztec sherds mixed with earlier Preclassic refuse. Sherds recovered from the capping deposit between the platform constructions and the lava which covered the mound slopes appear to date from the very end of the Preclassic period and suggest the contemporaneity of the Ticoman III and Teotihuacan I periods. Deeper deposits, especially near the base of the clay platform (mound 1), produced only Ticoman III sherds; it is possible that earlier phases may be revealed when the analysis is completed.

Burnished utility ware, including ollas and several large bowl forms, comprises the great majority of sherds. The color ranges from buff through reddish brown to brownish black, while the rim forms show the complete range found in the Ticoman III period (*5*). Loop handles are common but neck handles are quite rare. A variety of smaller bowl forms with burnished interior and exterior surfaces display a similar color range and an emphasis on composite silhouette shapes.

The predominant decorated ware is Ticoman III red on yellow, but Ticoman incised red on yellow is relatively rare. Dull white ware is common in contrast to a much rarer polished white ware. Polychrome painting is poorly represented. Other Ticoman III decorated wares include red, red on brown, red on white, black on white, white on red, black, several yellow-to-orange wares, and a variety of types which feature incised, cuneiform, fabric-impressed, channeled, or notched-ridge decoration. A wide range of tripod supports were found, including globular (most common), double globular and true mammiform (very rare), globular with cusp, conical, claw, and naturalistic leg forms comparable to those of Ticoman (*6*) and Gualupita (*7*).

The latest sublava deposits yielded a sizable sample of sherds which suggest

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either a transition from the ceramic tradition of Ticoman to that of Teotihuacan or the influence at Cuicuilco of developing Teotihuacan from some other part of the Valley of Mexico. The most distinctive and abundant ware bears negative painting (black on yellow or black and red on yellow) with more complex, less curvilinear designs than are typical of Teotihuacan I negative. One type of vessel support has a Teotihuacan I form (*8*) but the surface lacks the characteristic high polish. Several other wares, including red, red on yellow, white on red, and blackish brown, display decorative designs, forms, or high polish which are related in some manner as yet incompletely understood to standard Teotihuacan I types.

Definite Teotihuacan I sherds are rare and occur in the uppermost levels. These include a scattered assortment of red, negative, polychrome, and fine-line incised types.

A small sample of very thin polished red and polished black sherds from the base of Cummings' shaft near the pyramid and from the deepest levels of mounds 2 and 4 may represent an earlier ceramic period. These are possibly related to El Arbolillo, but no firm conclusion on this is possible until the material has been analyzed further.

A variety of clay figurines support the conclusion on a terminal Preclassic date. Three radiocarbon dates are available for Cuicuilco. De Terra collected a subpedregal carbon sample (No. C-200) from the vicinity of the pyramid which yielded a date of 2422 ± 250 years. In January 1957, two wood charcoal samples (Nos. M-663 and M-664) from below the pedregal were collected from occupation deposits near mound 2 at Cuicuilco-B, and these have been dated by the University of Michigan Laboratory as 2040 ± 200 and 1430 ± 200 years old, respectively. Since samples M-663 and M-664 should be the same age, it seems probable that a laboratory error was made in treating one or both samples. Of the two, the oldest (M-663) is more likely to be closer to the actual age. Piña Chán's date for the termination of the Preclassic (Formative) in the Valley of Mexico is 200 B.C. (*9*). Since the Cuicuilco-B material seems to be primarily Late Preclassic but is associated with ceramics which are related to Teotihuacan I as known from the sites of El Tepelcate (*8*), the inner hearting of the Pyramid of the Sun at Teotihuacan (*10*), and to the newly discovered Teotihuacan I complex at Teotihuacan (*11*), the date of sample M-663 seems to be more nearly correct than that of M-664.

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References and Notes

1. The assistance of Eusebio Davalos, Ignacio Bernal, and Roman Piña Chán of the Instituto and Carmen Leonard of the Centro de Investigaciones Antropologicas de México is gratefully acknowledged.
2. The National Geographic Society provided funds to support the recent investigations. Their recent interest may be considered a continuation of their earlier interest in the site, which dates from 1922–25, when Byron Cummings investigated the Cuicuilco Pyramid under the society's auspices. The University of California, through the Committee on Research and Associates in Tropical Biogeography, provided further assistance.
3. A. L. Kroeber, *Univ. Calif. Publs. Am. Archaeol. and Ethnol.* 17, 401 (1925).
4. B. Cummings, *Natl. Geographic Mag.* 44, 212, 220 (1923); *Univ. Arizona Soc. Sci. Bull.* 4, 50 (1933).
5. G. Vaillant, *Am. Museum Nat. Hist. Anthropol. Papers* 32, plate LXIX (1931).
6. G. Vaillant, *ibid.* 32, plate LXXV (1931).
7. G. Vaillant, *ibid.* 35, Fig. 26 (1934).
8. E. Noguera, *Am. Antiquity* 9, Fig. 2, Nos. 12, 13 (1943).
9. R. P. Chán, *Las Culturas Preclasicas de la Cuenca de Mexico* (Fondo de Cultura Economica, Mexico City, 1955).
10. E. Noguera, *El Mexico Antiguo* 3 (1935).
11. R. Millon, *Boletin del Centro de Investigaciones Antropologicas de Mexico*, No. 4 (1957); *Am. Antiquity* 23, No. 2 (1957).

30 September 1957

Electrolytically Controlled Device for Dispensing Liquids

Commercially available equipment for dispensing small volumes of liquids continuously for 24 to 72 hours was considered inadequate, or too expensive or cumbersome for certain applications. An instrument was therefore designed to utilize the production of gas by electrolysis of water for dispensing solutions aseptically and at any desired rate, by regulation of the electric current (*1*).

The unit, shown in Fig. 1, has two chambers, a generator (*A*) holding the platinum electrodes and a reservoir (*B*). The two chambers are separated by a rubber balloon (*C*). Gases generated by electrolytic decomposition of water in the generator apply pressure within the balloon which in turn forces the liquid through the delivery tube (*D*). The 9-mm inner tubing (*E*) eliminates the chance of explosion by separating the oxygen and hydrogen generated by electrolysis. Tube *E* also acts as an automatic cut-off switch by interrupting the circuit when sufficient gas accumulates in tube *E* to fill it below the tip of the movable electrode (*F*).

The electrode section (*A*), including tube *E*, is filled with an electrolyte. After chamber *A* is completely filled, suction is applied at *G* to collapse the rubber balloon (*C*), after which the stopcock is closed. The liquid to be dispensed is placed in chamber *B*, and the air is displaced by allowing balloon *C* to expand into the lower chamber. As soon as all of the air is displaced, *A* and *B* are tightly fitted together, the stopcock is closed again, and the delivery tube (*D*) is opened.

The delivery rate was found to be equal to that calculated by using the electrochemical equivalents of hydrogen and oxygen, with appropriate corrections for temperature and pressure of the gas phase. A current of 1 ma produced 0.0104 ml of gas per minute at 760 mm-Hg and 0°C. A small transformer and selenium rectifier with a potentiometer and milliammeter have been used, but the transformer and rectifier can be replaced by a 6-v battery.

This device has been used for delivering liquids for continuous-flow paper electrophoresis, and for compensation in a Tiselius type electrophoresis apparatus. A modified apparatus, in which the generator was connected to a reservoir by Tygon tubing, was used for controlling flow rates in ion-exchange or chromatographic separations. Either device can be used for continuous adjustment of *p*H or for addition of nutrient solutions to bacterial cultures during growth, as in a chemostat.

Electrolytic production of gas from water to dispense liquids has the following advantages. (i) The rate of flow is almost infinitely variable. (ii) The flow rate can be adjusted easily at any time without disturbing the apparatus assembly. (iii) The liquid is dispensed uniformly. (iv) The cost per unit is much less than the cost of equipment in which a syringe is used to perform analogous operations. (v) Controls may be remote from the actual device, and power requirements are minimal. (vi) The appa-

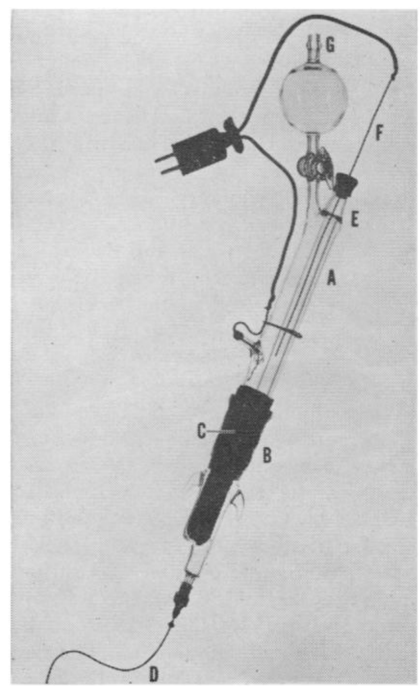

Fig. 1. Electrolytically controlled device for dispensing small volumes of liquid.