Clay is found abundantly in nature: its remarkable qualities of plasticity when wet and hardness when dry; its imperviousness to heat; its readiness to be worked without the need of any tool but the hand, make it an ideal raw material. One would therefore assume that clay played an important role early in the story of man; but this is not so. Cultural man who appeared on earth at least 2.5 million years ago, turned his interest first to hard and sharp materials such as flint, bone and wood: cutting and piercing tools are the first needed by a primitive culture.

To estimate when clay was adopted is not easy: body paint and as medicine, two of its most common uses among primitive people, do not leave any trace; unfired clay used for shelters of wattle and daub or modelled into some artifact is subject to weathering and rapidly disintegrates. This may be why none of the paleolithic sites excavated in either the Iraqi or Iranian side of the Zagros (Shandar, Barda-Balka, Bisfitun, Charr-i-Khar, Hazar Merd, Paleagawra, Warwasi, Zarzi and Hotu) yield any evidence of the use of clay. However, an even more likely explanation for this conspicuous absence is that clay, because of its heaviness and fragility, is of little or no use to unsettled hunters and gatherers. It is noticeable that the rare European paleolithic sites which yield clay, such as Dolni Vestonice and several French caves, were all sites which had acquired a definite permanence of occupation. It would then appear that, as long as man lived as a nomadic hunter, the spectrum of the raw material he used was very limited: in the beginning of the ninth millennium B.C. at Zawi Chemi (where a single unshaped lump of clay was recovered), it must have been restricted to stone, bone, antler, skin, shell and vegetable matter.

At last in the middle of the ninth millennium B.C., coinciding with first evidences of early sedentarization, clay begins its career in the Zagros, and altogether Karim Shahir, Tepe Aslub and Ganj Dareh produced quite a number of clay objects. Thereafter, paralleling the progress of sedentarization, the evidences of the use of clay steadily multiply, so much so that the vast quantity utilized in the settlements throughout the centuries accumulates to shape the artificial hills known as mounds, tells or tepes. My purpose is to review the evolution of the beginnings of the use of clay in the Zagros. This I have divided into three stages:

I. 8500-7500 B.C., the use of clay limited to small objects.
II. 7500-6300 B.C., clay used as a building and refractory material and for the storage of goods.
III. 6300-5800 B.C., general proliferation of pottery containers.

STAGE I

The time encompassed by Stage I roughly spans the thousand years between the middle of the ninth and eighth millennia B.C. The sites: Karim Shahir, Tepe Aslub and Ganj Dareh Tepe (level E) are still probably temporary encampments showing, however, new trends toward an economy based on more intensive food collection or an incipient cultivation of cereals. Also, the domestication of sheep may well be achieved. It is in this setting that clay makes its appearance. At Aslub a sizeable quantity of small, hard clay rubble suggests that the oval "pit-house" may have been covered with a roofing of wattle and daub. Otherwise, the use of clay at this stage is limited to figurines and small geometric objects such as cones, spheres, discs and cylinders.

Human figurines are rare: two at Karim Shahir and, counting all fragments, at most half a dozen at Aslub; they are of minute size (2 to 4 cm.), sexless and extremely schematized. No stereotyping is yet noticeable, and each figure is unique: one example from Karim Shahir stands on two little feet pointing out of the mass, its faceless head projecting backwards; from Aslub a featureless figure has outstretched arms, a second has legs and arms looking like stumps, and a third is a plaque-like face with a pinched nose and a scatter of circular reed incisions. The prototype of the fat Venus is not yet created. The meaning of these figurines is a mystery; they have been in turn interpreted as toys or deities (sic transit
Clay is a product of the disintegration of feldspar, a main constituent of igneous rocks. When moist, its thin crystals, seldom over 2000 μm in diameter and 0.0005 mm thick, slide over one another just like pieces of glass with water in between, conveying at the same time plasticity and resistance; when dry, the crystals interlock and become rigid. The alumina and silica found in its basic formula (Al₂Si₂O₅·2H₂O) provide refractory qualities. Clay is usually not found at its place of formation but in beds where it has been redeposited by water; in the conveying process the clays pick up various mineral, metallic and organic impurities which greatly influence their texture, color and oxidizing or vitrifying temperature. For this reason clay is a highly variable material.

Mud is clay naturally mixed with a high percent of nonplastic materials such as recent products of rock disintegration, sand and decomposed organic material.

gloria Del: God who once created man out of clay—in his—or her—turned made of clay by man).

The number of animal figures is equally small, and can be identified as follows: such as Aslab. Only one is intact; it represents the head of an unidentified little animal: fashions and seen with a pinched nose and ears. (At Gani) Dareh, half a dozen sheep and goats modeled in the most unskillful fashion, but perhaps the prototype of the animal figures of the next millennia.

Geometric objects were found by the dozen at Aslab and Gani Dareh. They are shaped according to well defined and standardized forms, mostly cones, tetrahedrons, spheres, discs and cylinders. The cones and tetrahedrons range from 0.5 to 2 cm in the base; the spheres are represented in two sizes: the larger is 5 cm in diameter, the smaller is 2.5 cm in diameter; the discs are either flattened pellets 1 cm in diameter (present at Aslab only) or flat or plano-convex discs 2 cm 5 cm. In diameter and 1 cm thick, sometimes thinly perforated in the center; the cylinders are thin cylinders rolled between the palms of the hand (present at Aslab only), 1 cm or 4 cm long and 2 mm thick, Aslab adds to this repertoire a long list of less popular forms: square prisms, stilts, tiles, a few speci- men, among them a crescent, a square, a triangle and angle also composite and complicated shapes. All these objects have puzzled many archaeologists, and the fact that they seem to be omnipresent in space and time makes them even more intriguing. The top chart on page 15 summarizes their distribution from the Caspian and from the ninth to the third millennium B.C. when at last they appear in a meaningful context, which may provide the key to their understanding.

At Susa in 3300 B.C. the cones, tetrahedrons, discs, cylinders are found tightly enclosed and duly sealed in toad-like bulb-like. The bulb-like are archieves of transactions; each geometrical object within is a calculus standing for a specific item, while the number express the quantity of the exchange. Later in the fourth millennium when writing was invented, the cones and spheres were translated into two-dimensional pictograms and were drawn with a stylus on clay tablets. Even later, in the sophisticated Mesopotamian arithmetic system of 2500 B.C. the understanding for the numeral 1 is a small cone, while a small sphere is 10, a larger cone is 60, a large cone with an engraved circle is 600, a large sphere is 3600, a large sphere with an engraved circle is 36,000, and so forth. It may well be presumptive to assume that the geometric objects were used as calculi from the ninth to the third millennium B.C.; however, the representation of a fundamental concept such as the number one (a kind of a kind) would probably involve permanency and universality and would provide an explanation for the widespread distribution and simplicity of their appearance. For what purpose would these early calculi have been used? To count the animals of the flock? To keep record of stored goods? For barter? For games and gambling? To keep track of time? The clay selected for the manufacture of these small objects was fine-grained mortmorillonite. It seems that it was used without any preparation and the few inclusions in the composition, such as sand and possibly bits of grass, were accidental. The hardness of the objects and their color varying from buff to reddish but with a great quality to black specimens made me suspect that they had been fired in an open campfire of wood which would produce zones of spheres: oxidizing at the periphery and reduc- ing in the middle. A series of tests have been performed to try to verify this observation. This was made possible thanks to the kindness of B. B. Hove who generously provided four samples from Aslab and four from Sarab (6000 B. C., Stage III) and thanks to W. Kinberg, Head of the Division of Ceramics at M.I.T., who kindly gave his interest and time to direct a series of tests on the samples.

Differential thermal analysis was tried. This is based on the fact that exothermic and endothermic effects are produced by physical and chemical transformation of material (dehydration, oxidation, fusion, vaporization, crystal transitions, etc.). Powdered samples from each site were placed individ- ual in a source of heat at constant rate (10°/m.) and their reactions were measured in comparison to an adjacent sample of inert material (aluminum oxide). The graphs exhibited a substantial endothermal peak at a temperature of about 200° C corresponding to elimination of water (thus oxide but not fired material—but however, tests performed by W. D. Kinberg on Sialk sherds showed some reaction, different from that, after a period of several millennia in the ground, the material, though fired, had been completely dehydrated—thus making inco- nclusive the interpretation of this reaction). The graph showed a second peak in the region between 800 and 900° C. Which is character- istic of the crystallization process of montmorillonite; this revealed that crystallization temperature had never been reached previ- ously. In conclusion, differential thermal anal- ysis gave only the negative result that, if firing had been involved, it had not exceeded a temperature of 800° C.

Examination through a scanning electron microscope gave more positive results. Magnification between 20 and 100,000 times could be achieved and the crystal structures appeared distinctively on the screen could be photographed. Professor Kinberg's analysis of the photographs showed that there is in fact that the background exhibited an aggregate with noticeable continuity; the ordinarily hexagonal crystals of montmorillonite had lost their sharp edges to become rounded. This modification of the particles would suggest that the clay had been subjected to the clay temperature above 500° C. Results from both tests thus set a range of temperature with a mini- mum of 500 and a maximum of 600° C:

500° C up to 600° C is the temperature range of an unglazed clay.

Further tests of refring are now underway in the way of determining with more accuracy the temperature at which various facts were fired. Because the geometric objects show little evolution in the course of the next stages, they will not be further discussed in this exposition. Therefore, it should be noted here that examination of the Sarab samples (from pottery levels) showed that the montmorillonite and felspar crystals presented sharp edges, suggesting that, if firing took place, it would not have exceeded 300° C—a tempera- ture considered by the author to be excessive.

Three general points can be made about the use of clay in Stage 1:

1. Clay is used in small quantities and expresses abstract concepts such as divinities (7) or numbers, thus pre- saging the choice of clay as the sub- stance of the cosmetic.
clay at Jarmo a layer of reeds underlay the clay. The rooms were small: 2x2.50 m. at Ali Kosh and often smaller at Ganj Dareh. (The length of the poles used for the roofs may be responsible for this.) The spaces in the roofing were then also sealed with clay as evidenced by chunks of clay with characteristic impressions found at Ganj Dareh.

These houses where clay was the raw material for the floor, the substructure, the mortar, the plaster and perhaps for the roofing, fulfilled all the requirements of the early settlers: they were able to resist the elements, were permeable, could be summerly heated in winter; they offered protection against marauding animals.

Around the houses clay was commonly used as a refractory material. At Ali Kosh, a depression in the clay floor provided a hearth 50 cm. in diameter and 10 cm. deep. At Jarmo, oval "baked in place pottery basin" 60 cm. long and 15 cm. deep with sides projecting slightly over the surface ground, were dug in the courtyard and lined with clay: they may have been hearths. More elaborate was a roasting pit situated in a courtyard at Ali Kosh: it consisted of a depression 23 cm. in diameter and 1 meter in diameter, surrounded by a curb of two courses of mud bricks; the pit was lined with mud showing signs of burning.

Clay ovens represented a further development in the mastery of fire; they confined the heat to a closed chamber, thus preventing any loss by radiation; draft could be controlled, thus allowing better oxidation and higher and more uniform temperatures. One of the best preserved examples was found at Jarmo (II, B). It was a domed, circular structure built of tan; the fire was fed from the courtyard through a scoop-shaped opening. The chamber was 25 cm. higher; its furnishing had been plastered several times with coarse clay heavily mixed with globules of firing. A semi-circular chimney was incorporated in the tan wall. At Ali Kosh and Ganj Dareh, similar structures were built with mud bricks; these were 3 m. in diameter, 1 to 2 m. in diameter. Cereal grains were found in the open hearth of Ali Kosh, carbonized bones in the rooms of Ganj Dareh and grains have been identified which could indicate a particular use for the ovens at this stage.

A refinement for the achievement of sedentarization was the storage of a portion of the crops for the lean season. Here again clay was the solution. At Ali Kosh storage cubicles 1x1.50 m. were used in the living area. At Ganj Dareh similar cubicles were clustered according to an intricate plan; access to some of them was possible through a round opening in the side at a man's height and varying from 30 cm. in diameter to a square hardly larger than a hand through the extended legs and occasionally crudely shaped breasts. The squatting posture of the single figurine from Ali Kosh could suggest giving birth.

Animal figurines were found by the hundreds in the cubicles of Ganj Dareh. Mammals only are represented and mostly domesticated species, particularly cattle: small or adult pigs from Ganj Dareh and Ali Kosh little stocky animals have a pinched spine, sometimes pointed ears and a short tail; a characteristic type at Jarmo is a pig-like animal with a massive forepart tapering down to a narrower hindpart. Tests performed by Anna O. Shepard and Vivian L. Bromlan at Boulder, Colorado, on fragments of Jarmo figurines showed that they were fired or baked to a temperature of 400 or 450 °C, thus representing the second tangible proof of firing.

During this stage clay advanced to become one of man's most common raw materials. Constant experimentation in handling rapidly led to major improvements such as tempering and burnishing. The area of extensification of use of clay has extended south to Tepe Guran and Ali Kosh and west to Jarmo; however, further west, Mefaket produced only some rubble and two dozen fragmentary, identifiable clay artifacts; to the east, Belt Cave, inhabited by a group of hunters and possibly incipient herders, yields only five cones and a few chunks of clay, apparently part of a nest of wattle and daub built to divide the cave into compartments or pens. Thus, a peripheral zone with negligible archaeologically speaking clay is juxtaposed to the center of intensive use of clay located from Kermanshah to Kiriuk.

STAGE III

In the course of the few centuries which separate Stage II (3500 - 3000 B.C.) from Stage III (3000 - 2500 B.C.), clay containers—this time unequivocally fired—spread to all sites of the Zagros: Tepe Guran, Tepe Sarah, Ali Kosh, Belt Cave, Hatj-i Zard and Jarmo. At first they appear in modest number but swiftly multiply and become the matrices of the refined wares of the predynastic household; in Jarmo, for instance, the 1950-51 season reported 204 sherds from levels 5-4, against 161 from levels 2-1.

The great majority of the vessels are conspicuously medium-sized bowls ranging from 15 to 30 cm. in diameter and 10 to 15 cm. deep; vessels with straight walls are common; vessels with highly decorated sides; straight, everted or inverted rims; flat or round bottoms. The tremendous success of this particular shape, which was borrowed from stone prototypes, may reveal that, once again, clay was a fulfilling a specific need. The variety of which pottery appears may indicate what this could have been. Pottery containers appear at Tepe Guran at the same moment that a settled agricultural community replaces its encampment. At Belt Cave their appearance coincides with the full achievement of domestication and the pottery decor which would be attributed to it.

An innovation to be ascribed to this stage has been milked. The bowls, as well as other less popular shapes, such as mugs, small jars and small cups with very short necks, seem to be the result of the preparation of some new dairy product, although to us they would not seem appropriate for such use because of their smallness and porosity. These defects are the result of insufficient firing; Matson estimated that the pottery from Belt Cave had been baked for 4 to 6 hours at a temperature of 450 °C. Oxidation did not usually penetrate deep in the paste, and the core was left gray; the color of the red-brown slip, found on most sites, attests a reducing atmosphere during the final stage of the kiln firing or cooling.

A stage III bowl from Belt Cave (Fig. 1) is the application of a slip or wash on the out-
side surface, as attested to the potteries of Tepe Guran and Ali Kosh; burinishing formerly used in the preparation of even floors is also commonly applied to the vessels; both methods not only enhanced the appearance of the pots but also diminished their porosity. Furthermore, motifs were painted with red ochre on a number of bowls. The most ancient patterns recorded so far in the Zagros area are from Tepe Guran and seem to imitate basket or net work; somewhat later a close pattern of diagonal banded lines is usual at Tepe Guran, Jarmo, and Sarah, as well as geometric motifs such as zig-zags, chevrons, and open triangles at Tepe Guran, Ali Kosh, Tepe Sarah and Hajji Firuz.

This concern for improving the naturally dull appearance of clay is also found in architecture. At Tepe Guran the inside walls of the houses were colored with a thin layer of white or red-colored gypsum—the first evidence of the use of calcium sulfate in the Zagros; the floors were built in a terrazzo technique with small pieces of white faience imbedded in red-colored clay, creating a decorative effect. A further improvement within the house is the addition of built-in furniture—a bench and table are moulded in clay and tucked into the recessed wall of a house at Tepe Guran.

Clay at this stage is even employed as a body ornament, and at Jarmo and Tepe Guran buttons, beads and pendants are not rare. They were perforated with a step while moist and fashioned into multiple shapes: spherical, discoidal, biconical, cylindrical, etc. At Ali Kosh bell-shaped pendants seem to have been part of a belt.

New trends now appear in the iconography of the figurines. One type of figure is made of several parts held together with sticks. The famous Venus of Sarah belongs to this group and is made of six different parts: two thick, cigar-shaped legs with grooved markings to indicate the musculature; a fat stomach which overlaps the legs; appended breasts; a back which is decorated with a belt of finger impressions incised at the height of the buttocks; and a long neck which ends without a head. Many fragments belonging to such figurines were found at Sarah. The composite figurines from Jarmo are more naturalistic; in some the emphasis may be placed not on femininity alone but on pregnancy: they are represented seated, the arms are bent at the elbow, and the hands meet over the round stomach or casually rest on the thigh. The head is topped with a coiled headress and the face is depicted with incised features or pellet eyes.

An opposite trend is an extreme stylization: at Sarah female figurines are reduced to a mere pyramid with a slight depression at the base to indicate the thighs; they are also sometimes provided with hanging breasts. The "lady stalks" of Jarmo have a slender, cylindrical body with fused legs and a small head with pinched face. The "T-shaped figurines" of Ali Kosh consist of a small stalk centered on an elongated base; sometimes they are topped by a patchy pelvis. The "double-winged base objects" of Jarmo are essentially the same; however, some of them exhibit a roughly pinched face with incised features and an occasional long chin or beard which has led to their interpretation as male figurines. At Tepe Sarah, the stalk is sometimes surrounded by a small lump of clay bearing incised decorations.

A great variety of species, wild or domesticated, are represented among the animal figurines; the 1100 specimens from Jarmo could be divided into at least fifteen different types such as dogs, pigs, sheep, goats, etc. At Sarah the animals are accurately observed and represented in characteristic positions: the dog is relaxing with extended legs, the raggled coat of a bear is suggested by checked lines.

Stage III is marked by the tremendous success of pottery containers, resulting in its current designation as "Pottery Neolithic" or "Ceramic Neolithic," as opposed to the preceding "Aurignacian Neolithic" (Stages I and II). In the light of this paper, Stage III appears, however, only as a further step in the conquest of clay, a process set in motion in the Zagros in the preceding stage and perfected by the addition of temper in the eighth. Perhaps the most significant achievement of this period is the penetration of the use of clay in all parts of the Zagros.

CONCLUSION

In this paper I have tried to demonstrate that the use of clay coincides with the earliest attempt at settlement. Even more, clay contributed greatly to the process of sedentarization, providing the settlers with crucial necessities: durable shelter, ovens for domestic and industrial use, storage containers, etc. The conquest of clay had multiple repercussions through the following millennia: it led to advances in pottery technology which ushered in the age of metal; it led to such architectural accomplishments as the palaces, temples and ziggurats which characterized the age of cities; on clay was impressed the first writing which marked the beginning of history.

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