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Early neolithic pots and cooking

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The specific quality of ceramic-ware as compared with other types of receptacle materials, is its possible use over flame.[1] Of the first ceramics produced in the Near East, some were indeed suitable for this purpose, but these were by far and large the exceptions. It seems that after tentative trials with early techniques, the adaptation of the ceramic product to a clearly-defined use constituted a major step forward. Judging by references to the terms "cooking pot" and "cooking ware" in the studies made on Near-Eastern prehistoric ceramics, this stage would not have been reached much before the end of the 6th millenium B. C. It must also be added that the question of ceramic use for cooking has not, until now, been studied systematically for the ancient Near East. Information recently provided by Mid-Euphrates ceramics dating from the 6th millenium B. C. has led us to begin indepth research. Before presenting this new information, we shall discuss a few notions concerning ceramic technology.

When pots are used for cooking and not simply as containers as most of them are, they require some very special properties: notably, they have to be able to resist strong tensile stresses. As with any solid material submitted to a heat source, ceramic expands, with the result that during cooking, temperatures are uneven through the different parts of the pot. Expansion of the outside part of the pot in contact with the flames is considerably greater than expansion of the inner part in contact with the food. Uneven expansion leads to tensile stresses within the wall of the pot which may be strong enough to cause the pot to break. Therefore, one may talk about thermal shock as one talks about mechanical shock.

To make pots resistant to thermal stress, the ideal solution would be to use a raw material incorporating a low thermal expansion coefficient.[2] There are indeed some clays which offer this quality. Generally speaking, most clays produce ceramics with a rather high, or even very high thermal expansion coefficient, making them practically unusable for cooking. As an element of comparison, Pyrex glass has a very low thermal expansion coefficient of 32.10^{-7} and therefore resists thermal shock extremely well. Some ceramic products do, in fact, have coefficients neighbouring this value. Most of them, however, are higher and can even be as high as 100.10^{-7} which is the expansion coefficient of normal glass - hardly suitable for cooking, unless great care is taken to heat the receptacle very slowly.

Most of the clays used to make pottery have a middle high or high thermal expansion coefficient. To prevent the risk of breaking when using the pots for cooking, two solutions can be (and have been) tried by potters.

The first is to give the pottery as loose a texture as possible so that the different constituent elements intermingle and absorb, by very tiny distortions, tensile stresses occurring when the pot is used for cooking. This loose texture can be obtained through low-temperature firing and by adding mineral temper. The drawback to this solution is that it makes the pottery more brittle with poor resistance to mechanical shock. For this reason, potters often make very thick pots for cooking. This added thickness exacerbates expansion stress and results in lower resistance to thermal shocks. *In short, a vicious circle.*

The second solution, which is more difficult to implement, consists of making pottery thinner to reduce the tensile stresses incurred by thermal expansion, and then to fire it at a higher temperature to make it mechanically resistant. In most cases, however, a higher firing temperature yields a higher expansion coefficient and results in less resistance to thermal shock. *The vicious circle yet again.*

There are three main parameters with which the potter can work to obtain an even balance between thermal shock resistance and mechanical shock resistance. These are temper, firing temperature and thickness. There is of course a fourth parameter, the type of clay used. If the potter uses a clay which produces pottery with a lower expansion coefficient, then the drawbacks of both solutions will be less significant.

From the point of view of suitability for cooking, we shall now consider pottery from Bouqras, a Neolithic site located in the Euphrates valley (Fig. 1).[3] This pottery dates roughly from the first half of the 6th millenium B. C.

Chemical analyses of about 130 sherds and about 50 samples of mudbricks and clays from surroundings of the site have been processed. The composition dendrogram of these samples (Fig. 2) shows that even if most of the

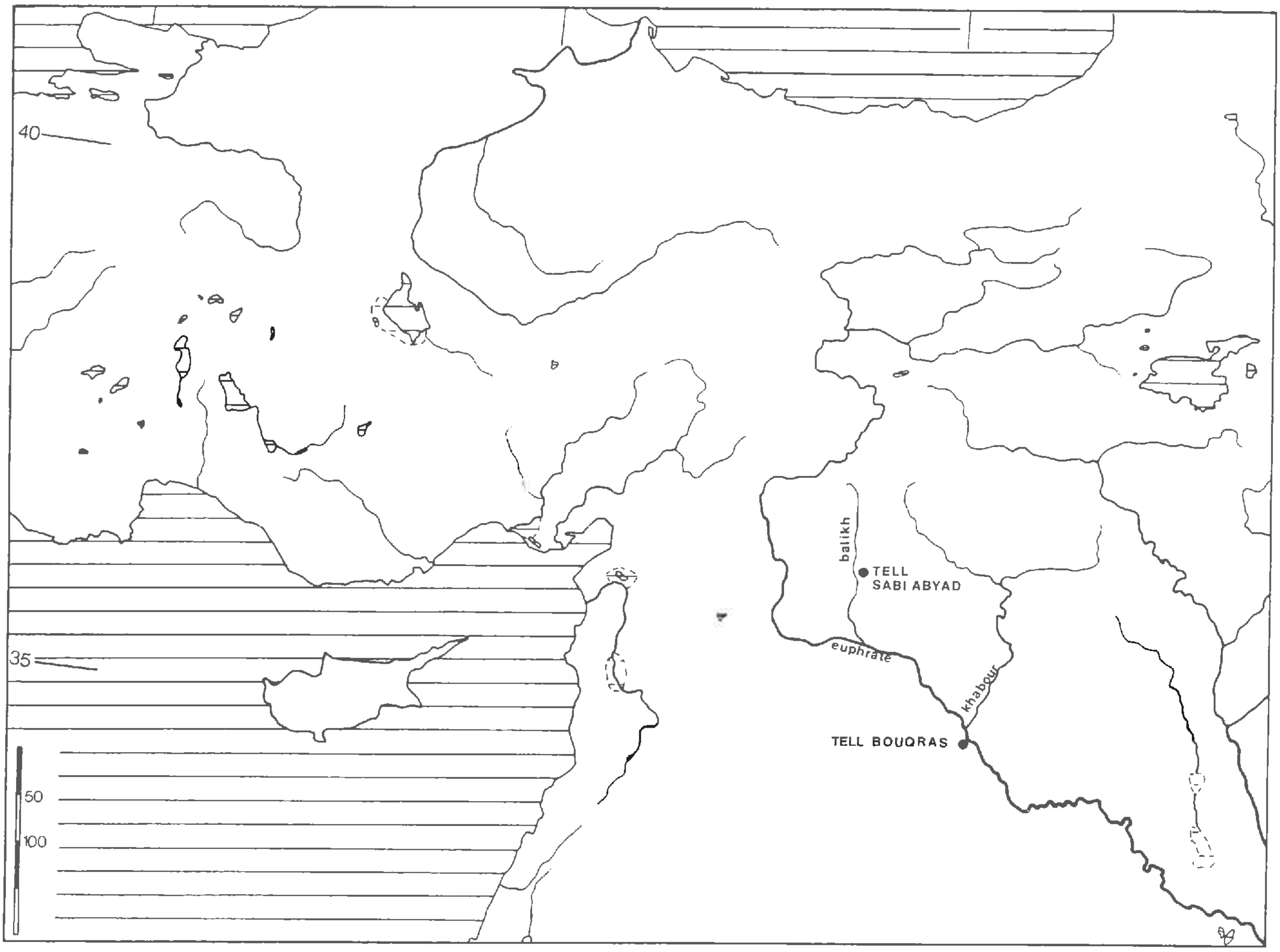

Fig. 1 Mid-Euphrates and localization of Tell Bouqras and Tell Sabi Abyad/Balikh valley

pottery was locally produced, a certain quantity had been brought to the site.[4]

The local production consisted of mainly coarse ware with vegetal temper and without mineral temper. It is a calcareous ceramic (containing 10 to 25 % of calcium oxide). Calcareous clays are very poor materials for making cooking pots unless they are fired at a low temperature. Regarding Bouqras, this pottery has been fired at a somewhat high temperature for such an early production: primary and secondary calcite percentages are often very close to 0 and the results from dilatometric measurements also demonstrate that temperatures above 800 °C are not uncommon. But there are rather large variations between the samples: firing temperatures of the local Bouqras production range from 700 °C to 900 °C. The third characteristic, besides calcareous clay and high firing temperatures which makes this pottery unsuitable for cooking, is the high thermal expansion coefficient ranging from 70 to 80.10^{-7}. This figure is closer to the coefficient of glass than that of Pyrex. Thus, it is not surprising to find only a few traces of cooking on this local pottery.

On the other hand, one of the imported wares (Fig. 2) shows a large number of black traces on the outside and inside surfaces as compared with the bulk of the material. In addition, this particular ware presents several unusual characteristics. It contains larger mineral inclusions, is thicker, its shapes are more closed and ledge-handles are frequent. The combination of these characteristics suggests a specific purpose. Moreover, chemical analysis, measurement of firing temperatures and the thermal expansion coefficient have clearly proved that this group was much more suitable for cooking than the local Bouqras production. On the diagram illustrating the thermal expansion coefficient versus calcium oxide percentage (Fig. 3), the white dots represent the local production from Bouqras and the black dots the samples of the specific group. The latter is clearly distinguished from the Bouqras production by its calcium oxide percentage, lower than 10 %, and its expansion coefficient extending from 40 to 70.10^{-7}. Firing temperatures are also much lower since they range from 600 °C to 750 °C. Therefore, this pottery presents a somewhat looser texture than the local production. The loose texture, together with the lower expansion coefficient and abundant mineral temper, point to the use of this pottery for cooking. It is also worth considering that it may, by sheer fluke, include just the right combination of characteristics. Furthermore, the fact that this pottery was imported should also be taken into account. On the composition diagram (Fig. 2), it is clearly identified in the foreign group (group 5). At first, it was puzzling that such coarse ware was imported since all importations were of fine ware. This was not only the case for the Bouqras site. Nevertheless, if we consider the particularly frequent traces of cooking (to omit) in this group, we may suppose that Neolithic users recognized its qualities for cooking and that possibly, they imported it for that specific purpose. But this is only guess-work. As this group represents less than 5% of the overall bulk, some local pottery may well have been used for cooking, regardless of the risks of breaking.

In conclusion, we can say that the main technical problems early potters encountered were problems of choice of clay and firing. Usually, when early pottery is discussed, it seems logical to assume it was low fired and that progress would have been to obtain higher firing temperatures. But in the case of Near-Eastern Neolithic, ways of obtaining high firing temperatures were already known - even before pottery techniques started - as lime was first made from limestone during the 8th millenium B. C. Within such a context, real progress as far as cooking pots were concerned, was to fire pottery at low temperatures. Regarding the choice of clay, the identification of clays suitable for making cooking pots and able to withstand high firing without decreasing thermal resistance was not discovered until long afterwards, probably around the Iron Age. Progress in this matter during prehistoric times would have been to adapt available clays to cooking purposes by adding abundant and well-calibrated temper. This may be what we observe in Sabi Abyad, a site in the Balikh valley (Fig. 1),[5] where such pottery appears in the Pre-Halaf levels around the middle of the 6th millenium B. C.: this ware may have been used for cooking. The study of this material, still being processed, constitutes the next stage of research into cooking wares.

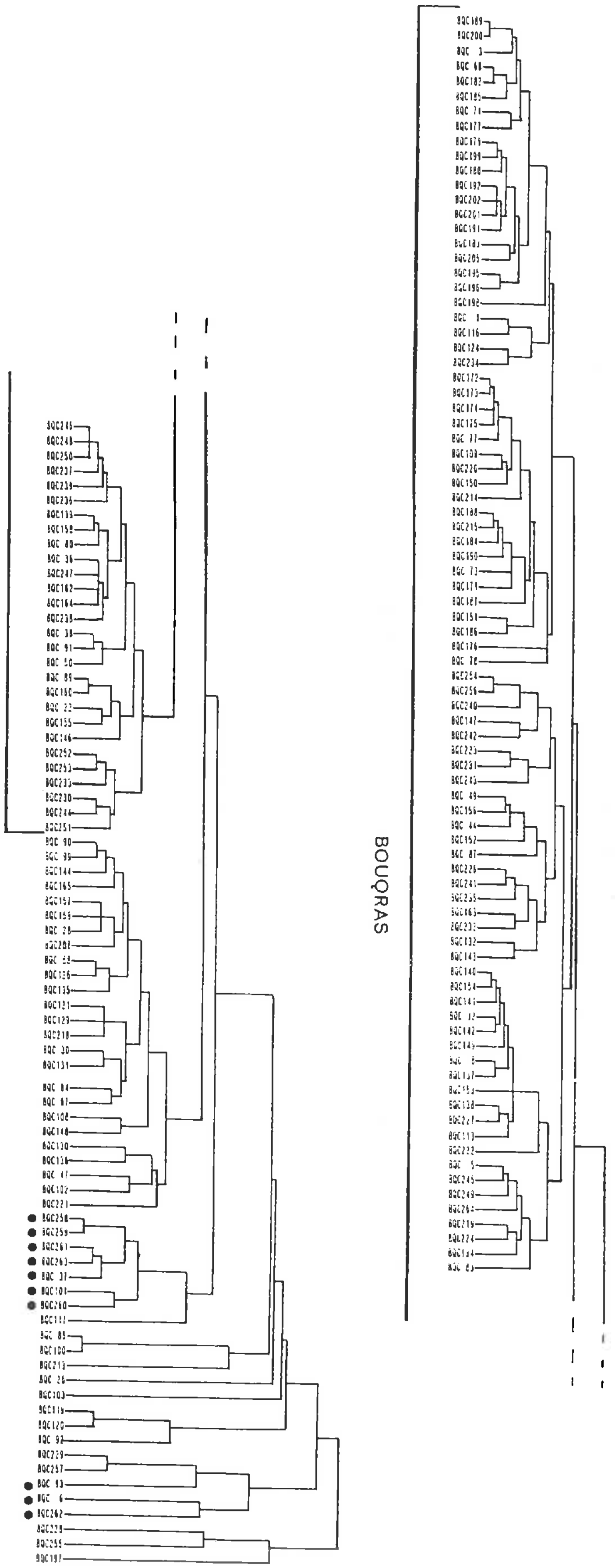

Fig. 2 Cluster analysis dendrogram of pottery samples found in Bouqras. Samples within the square bracket: Bouqras production; black dots: possibly "cooking" ware.

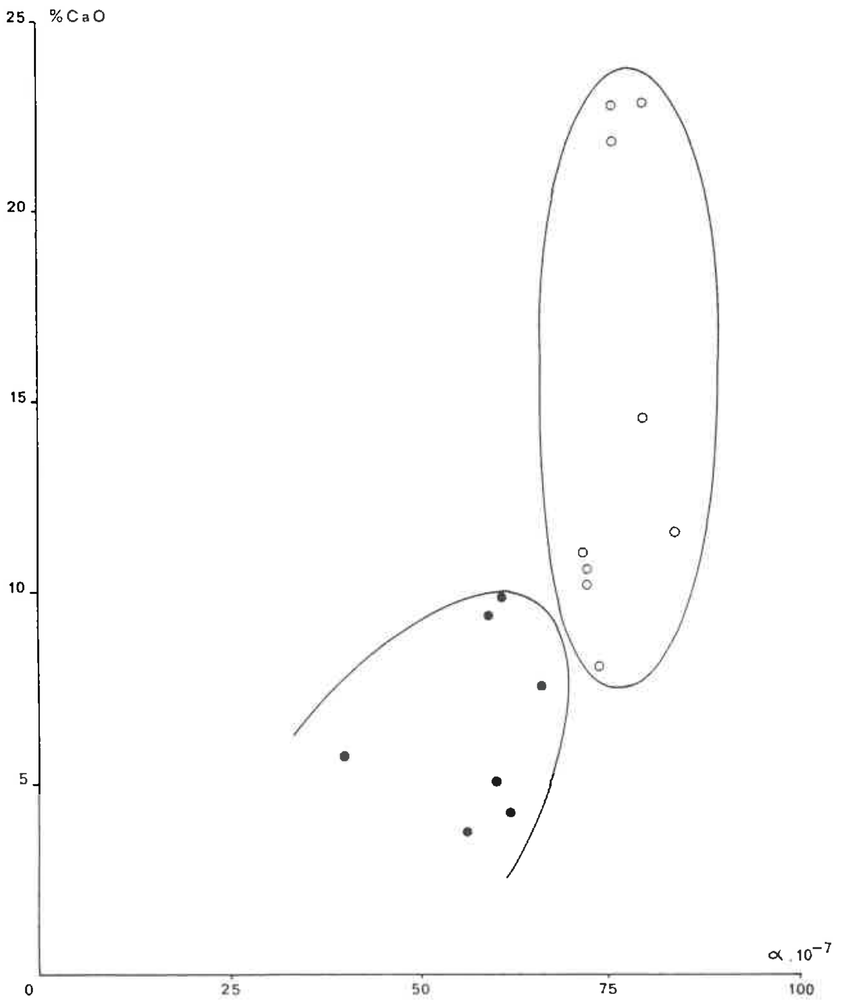

Fig. 3 Thermal expansion coefficient versus calcium oxide percentage. White dots: Bouqras production; black dots: possibly "cooking" ware.

Anmerkungen

1. To avoid confusion, the word "firing" will be used for the production of pottery and the word "cooking" for the use of it.
2. This "coefficient of thermal expansion is a measure of the increase that accompanies the heating of the material" (P. M. Rice, Pottery Analysis. A Source Book, Chicago-London 1987, S. 364). It is definite by the relation $l=lo(1+\alpha)$ in which l is the length at T°C of a sample, the length of which is lo at a temperature of 0°C.
3. The site of Bouqras has been dug by a Dutch expedition from Amsterdam and Groningen Universities (P. A. Akkermans et alii, Bouqras revisited: A preliminary report on a project in Eastern Syria, in: Proceedings of the Prehistoric Society 49, London 1983, p. 335ff.; M. Le Mière, Les premières céramiques du Moyen-Euphrate, Lyon 1986 [Thèse de Doctorat]).
4. M. Le Mière, M. Picon, Production locale et circulation des céramiques au VI[e] millénaire au Proche-orient, in: Paléorient 13,2, Paris 1987, p. 133ff.
5. P. M. M. G. Akkermans (Ed.), Excavations at Tell Sabi Abyad - Prehistoric Investigations in the Balikh Valley, Northern Syria, Oxford 1989 (B.A.R. International Series 468); P. M. M. G. Akkermans, M. Le Mière, The 1988 excavations at Tell Sabi Abyad, a later Neolithic village in Northern Syria, in: American Journal of Archaeology 96, New York 1992, p. 1ff.