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# CRUCIBLES IN THE PETRIE COLLECTION AND HIEROGLYPHIC IDEOGRAMS FOR METAL

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THE Petrie Collection at the University of London contains a number of crucibles which have been published only briefly.[1] The growing interest in early metallurgy makes a more complete publication of these vessels worth while. The author is most grateful to Dr G. T. Martin, Curator of the Petrie Museum, for permission to undertake this republication and to Miss Rosalind Hall for the assistance given while studying the objects. Dr N. J. Seely of the Institute of Archaeology, London, is to be thanked for providing X-ray fluorescence analysis of fragments of slag from some of the crucibles. Comments by Mr Ian Edwards of the Victoria State College and Dr Colin Hope of the University of Melbourne have also been appreciated.

There are six crucibles in the collection, four of which are small and unprovenanced and two of which are larger and from known locations. There is no information about the date of the smaller crucibles, and, although some general indications may be obtained from analysis, it is probable that each one represents a long-standing tradition. Variations in crucible size and shape occur as a result of specific function and operating environment, but chronological variations and development will not be evident until a greater number of crucibles are known. The typological system which is quoted in some instances is that derived by Tylecote.[2]

1. *UC* 8993 (see fig. 1, no. 1 and pl. XIII, no. 1). Size: 110 mm dia., 80mm high.
Type: F, bag-shaped or globular. Provenance: Unknown.

The shape of the crucible is spherical, and it is of medium size. The reddish tint of the interior indicates that the crucible was probably made from Nile clay. Its exterior is almost completely vitrified and variously coloured green, red, black, and brown. It may, therefore, be deduced that the crucible was subjected to repeated and extended periods of high temperature about its outer surface.

Since there is no slag on the inside, there is no indication of what metals were melted in it. If the crucible was used for copper melting, some copper would most likely remain on the interior surface. It is also unusual for copper-melting crucibles of this size to have the furnace placed under them as indicated by the external vitrification, rather than over the top. It is, therefore, likely that the crucible was used for

1. Museum No. UC 18146 in G. Brunton, *Qau and Badari I* (London, 1927), 36, 67, pl. xli, no. 25; UC 8901 in W. M. F. Petrie, *Researches in Sinai* (London, 1906), 162, fig. 161; and Museum Nos. UC 8993, 8994, 8995, and 8996 are Nos. 247, 248, 245, and 246 respectively, in Petrie, *Tools and Weapons* (The British School of Archaeology in Egypt) (London, 1917), 61, pl. lxxvii.
2. R. F. Tylecote, *A History of Metallurgy* (London, 1976), 19.

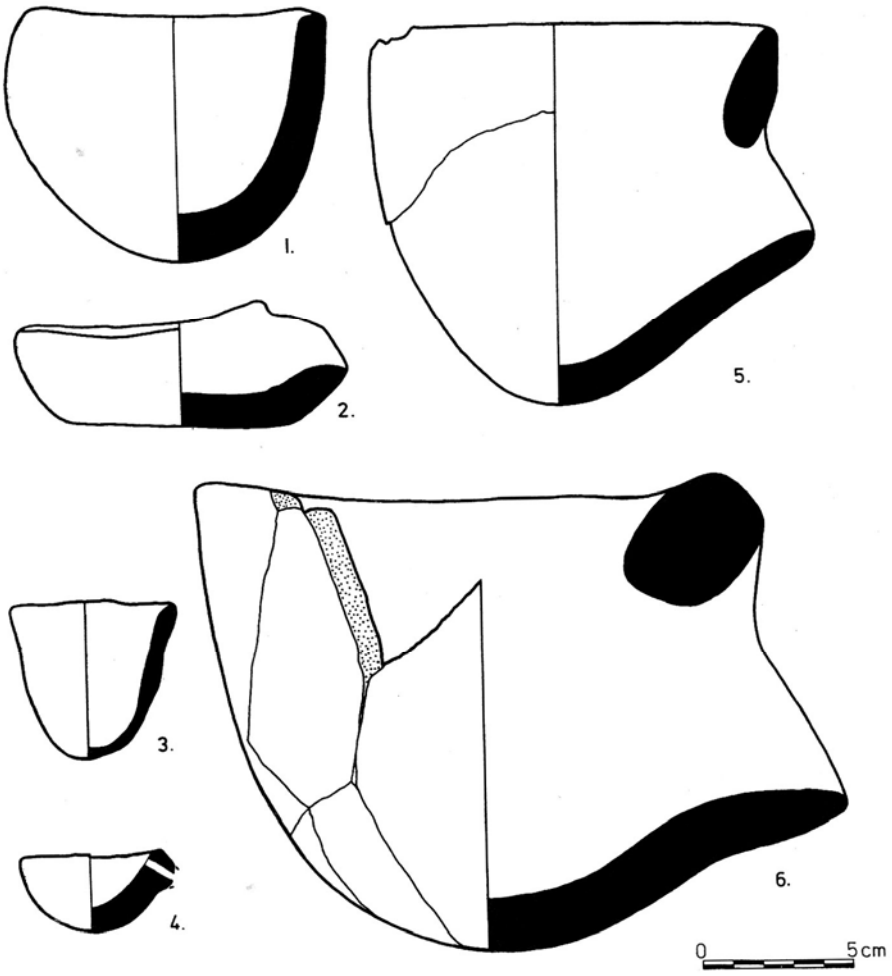



FIG. 1. The crucibles in the Petrie Collection

melting and refining a precious metal such as gold and that the dross which was skimmed from the surface of the melt was wiped on to the sides of the crucible, a process resulting in the variety of colours. The fact that crucibles used for refining gold in modern times have high sides and after use have coloured slag on their exterior gives some validity to this suggestion.

2. *UC 8994* (see fig. 1, no. 2, and pl. XIII, no. 2). Size: 110 mm dia., 40 mm high. Type: J2, oval or boat-shaped, flat bottomed. Provenance: Unknown. Analysis: Slag from the interior contained copper, tin, zinc, and traces of iron, lead, and cobalt.

This crucible has a low-sided open shape and a flat bottom. The vessel is handmade from fine Nile clay in which there was a little organic material. The crucible fabric was, therefore, a moderately good insulator.

Crucible slag covers the internal surface while the exterior is relatively clean. The furnace was clearly placed over the crucible in this instance and the forced ventilation was directed straight at the charcoal over the metal in the crucible. It is unlikely that this crucible was carried to make the pour as it would be difficult to hold, and so most probably it was simply tilted forward to pour the charge directly into a mould placed in front of it. The slag analysis reveals that the crucible was used for melting tin bronze and so a second-millennium date would seem likely.[3]

3. *UC 8995* (see fig. 1, no. 3, and pl. XIII, no. 3). Size: 55 mm dia., 55 mm high. Type: F, bag-shaped or globular. Provenance: Unknown. Analysis: Slag from the interior contained copper, arsenic, tin, and traces of iron.

The crucible is small with a deep shape and thin sides. It is made from a grey-coloured clay which has many small holes indicating that it originally contained organic material such as chaff. The organic material has been consumed during firing leaving a good refractory fabric. However, the thinness of the crucible sides would reduce the insulation properties of the vessel and allow easy transference of heat. It is, therefore, possible that this crucible was immersed in the hearth for heating.

There was a little slag on the inside of the crucible, and this revealed that the metal melted was bronze. The exterior of the crucible has no crucible slag on it and shows no signs of heating. The grey colour of the fabric seems to indicate that it was made from Qena- or Ballas-type clay which, like other Nile clays, contains fluxing agents in the form of iron compounds.[4] The absence of slag on the exterior is, therefore, hard to explain. The vessel could contain only about 20 g bronze which would have melted with a relatively short application of heat, and this may not have been sufficient time for the fabric of the crucible to vitrify. It is also possible that the crucible has had comparatively little use.

The high sides enabled the crucible to be lifted from the hearth by gripping it on the sides with two insulating pads possibly made from a refractory ceramic. The small amounts of bronze melted would have been insufficient for Most tools and weapons and so this vessel was most probably the property of a jeweller or maker of ornaments.

4. *UC 8996* (see fig. 1, no. 4, and pl. XIII, no. 4). Size: 50 mm dia., 25 mm high. Provenance: Unknown. Analysis: Slag from the interior contained copper and arsenic and traces of iron.

The shape of the crucible is that of an open dish, and it does not coincide with any of Tylecotes's types. It is small and made from a fine clay which has been well fired. The resulting ceramic is strong, but neither its shape nor its fabric provides any insulation.

3. A. Lucas (ed. J. R. Harris), *Ancient Egyptian Materials and Industries,* 4th edn. (London, 1962), 220.

4. *Ibid.* 368, 381.

This crucible was also used to melt small amounts of copper when placed in a hearth. It is unlikely that the hole in the side of the crucible was a spout[5] because the melt would have quickly solidified when being poured, thus choking the hole. The most probable purpose for the hole would have been to assist in manipulating the vessel. The side of the crucible is reinforced around the hole by an increased thickness so that it was strong enough for a thin dowel to have been inserted into it from above and the crucible lifted from the hearth. Dowel holes were not normally used as a means of handling crucibles because the body of the vessels was made to provide insulation, not strength. Some Aegean crucibles were designed so that a spike could be used to manipulate them[6] but there is no suggestion of any traditional links with this crucible. In this case the dowel inserted in a hole was the obvious way to achieve the precise control of the crucible by someone such as a jeweller who required only small amounts of metal at a time.

*5. UC 181.46* (see fig. 1, no. 5, and pl. XIV, no. 1). Size: 135 mm dia., 125 mm high. Type: L, side-pouring hole. Provenance: Qau. Analysis: Slag from the interior contained copper and arsenic with traces of iron.

The crucible is large and shaped like a deep bowl with a hole in the side. It was found in a tomb No. 4964 of the Seventh or Eighth Dynasty with the remains of an adult male.[7] There were two large grey stones in the crucible when it was found. The First Intermediate Period date agrees with the absence of tin in the crucible slag; however, most parallels for this crucible shape come from later periods. The crucible found by Petrie in Sinai[8] may be of New Kingdom date and the crucible found at Keos[9] is also probably Late Bronze Age. A slightly smaller crucible of this shape from Byblos may be earlier than both of these but probably still within the second millennium BC.[10] Together these vessels seem to testify to a long tradition which employed this shape of crucible.

With the exception of some plaster the crucible now consists of crucible slag which formed on its internal surface. The exterior surface has disintegrated leaving an impression of its texture on the remaining slag. It was fine clay mixed with straw which, when fired, would have produced a good insulating material. The heat was applied to the inside of the crucible by forcing the draught through the hole in the side of the crucible. The crucible would have been filled with charcoal, and there would have been charcoal in front of the side hole. In this way sufficient heat would have been applied to the metal with the expenditure of a minimum amount of charcoal and human energy. As Tylecote suggests in relation to the Keos crucible,[11]

5. Petrie, *Tools and Weapons,* 61, believed that the hole was a spout.
6. See, e.g., W. Lamb, *Excavations at Thermi in Lesbos* (1936), 157, and C. Tsounlos, *Ai Proistoraikai Akropoleis Dimeniou kai Sesklou* (1908), fig. 288.
7. Brunton, *op. cit.* 36, 67.
8. See crucible No. 6.
9. J. L. Caskey, 'Excavations in Keos', *Hesperia* 31 (1962), 277, pl. 98(f), and Tylecote, *op. cit.* 18, 20.
10. M. Dunand, *Fondles de Byblos,* II 2 (Paris, 1958), fig. 962, no. 16653.
11. *Op. cit.* 18.

it is probable that a mould was placed in front of it so that it could be rocked forward to discharge the molten copper.

The presence of charcoal in the crucible during heating would have produced reducing conditions so that any iron oxide in the crucible ceramic would have acted as a flux, thus facilitating vitrification of the internal surface. If the crucible was filled to its lip, it would have contained an estimated 1.3 kg of copper. The extent of vitrification of the crucible indicates that it has been used on numerous occasions. As a burial object it may, therefore, testify that the person with which it was buried was a coppersmith of considerable experience.

*6. UC 8901* (see fig. 1, no. 6, and pl. XIV no. 2). Size: 190 mm dia. 150 mm high. Type: L, side-pouring hole. Provenance: Serābīt el-Khādīm, Sinai. Analysis: Slag from the interior contained copper, tin, arsenic, and traces of iron.

Petrie published the crucible with the following comments:

A crucible was found at Serābīt which was almost complete. The form of the crucible shown in hieroglyphs has been a puzzle hitherto, as it rose up so high above the spout. Here \t *e* see that in order to get a sufficiently refractory material the Egyptians had to use a very weak paste for the body, which easily crumbles away. It was, therefore, not practicable to lift the crucible with a heavy charge of melted metal in it. The only way to empty it was to roll the crucible forward on its round bottom. Thus the form required was a hemisphere, prolonged upward to allow for accidental tilting in the fire and to give a better hold in moving it, yet with a spout for the ready delivery of the metal. Thus they arrived at the form which we see here in reality, and which is used as the emblem of copper in the hieroglyphs.[12]

Petrie's observation that the crucible was made from a material with high insulating properties and that strength was sacrificed has proved to be a general principle in ancient crucible manufacture. It may be true that this crucible was not lifted with the charge in it as he suggests. However, the two best-known metallurgical scenes from the Old Kingdom tomb of Mereruka[13] and the New Kingdom tomb of Rekhmirē[14] both show crucibles being carried, fully charged, with the aid of ceramic pads in the first instance and withies in the second, so the possibility cannot be entirely dismissed. The high-sided shape of the crucible gives it structural strength which may have enabled it to be carried in operation without collapsing.

The crucible was found in the vicinity of a New Kingdom temple and so a similar date for the crucible is possible. This date may ultimately be confirmed by the results of recent excavations.[15] The crucibles depicted in the tomb of Rekhmirē are quite different in shape, a fact which may seem to mitigate against a New Kingdom date for this crucible. However, it has already been suggested that crucibles with high sides and a spout in the side give economy of furnace fuel, and this would have been important in Sinai where fuel would have been scarce. It is, therefore, probable that

12. Petrie, *Researches in Sinai,* 162.
13. P. Duell, *The Mastaba of Mereruka* (Chicago, 1938), pls. 30, 32-3.
14. N. de G. Davies, *The Tomb of Rekh-mi-re at Thebes* (New York, 1943), pl. 17.
15. I. Beit-Arieh, 'New Discoveries at Serâbît El-Khâdîm', *Biblical Archaeologist* 44, 1 (1981), 13-18.

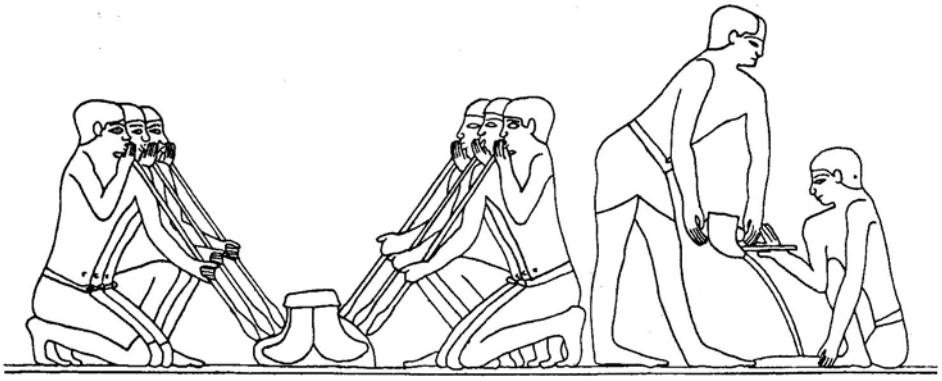


FIG. 2. Metal-workers depicted in the tomb of Mereruka at Saqqara (after Duell)

this shape of crucible was used in Sinai due to the environmental conditions. The presence of tin in the slag confirms a second millennium BC date.

In his description of the crucible from Serābīt el-Khādīm, Petrie relates the shape of the vessel to the hieroglyphic sign for copper. Gardiner lists the shape N34,  , as the New Kingdom ideogram for copper and describes it as an 'ingot of metal'.[16] Although this sign is no doubt the shape to which Petrie is referring as that of a crucible, Petrie's crucible does not have quite the same shape and proportions as the sign. This may be considered to put his suggestion in doubt although precision of ideogram shape cannot be expected. In fact, the crucible depicted in the tomb of Mereruka from which copper is being poured has a shape similar to that of the New Kingdom ideograms.[17] This might previously have been dismissed because of the chronological difference; however, crucibles of the 'Mereruka shape' were recently excavated at Tell edh-Dhiba'i, an Old Babylonian site now in modern Baghdad.[18] This reduces the time difference although it does not say anything about the continued use of such crucibles in Egypt. The tomb of Rekhmirē shows open crucibles being used in the casting of a bronze door, and this may indicate the form of crucible used in large casting works. It still remains possible that, for smaller casting work, the 'Mereruka shape' of crucible continued to be used along with the type found at Qau and in Sinai because of their furnace fuel efficiency.

Bruyere has already noticed the connection between the Mereruka crucibles and the hieroglyphic sign.[19] However, he believed that they were similar to the vessels that he found at Deir el-Medina which he suggests were used for sharpening copper implements. The furnace in the relief in the tomb of Mereruka is identified by Bruyere as the bipod version of the Deir el-Medîna vessels. A more obvious

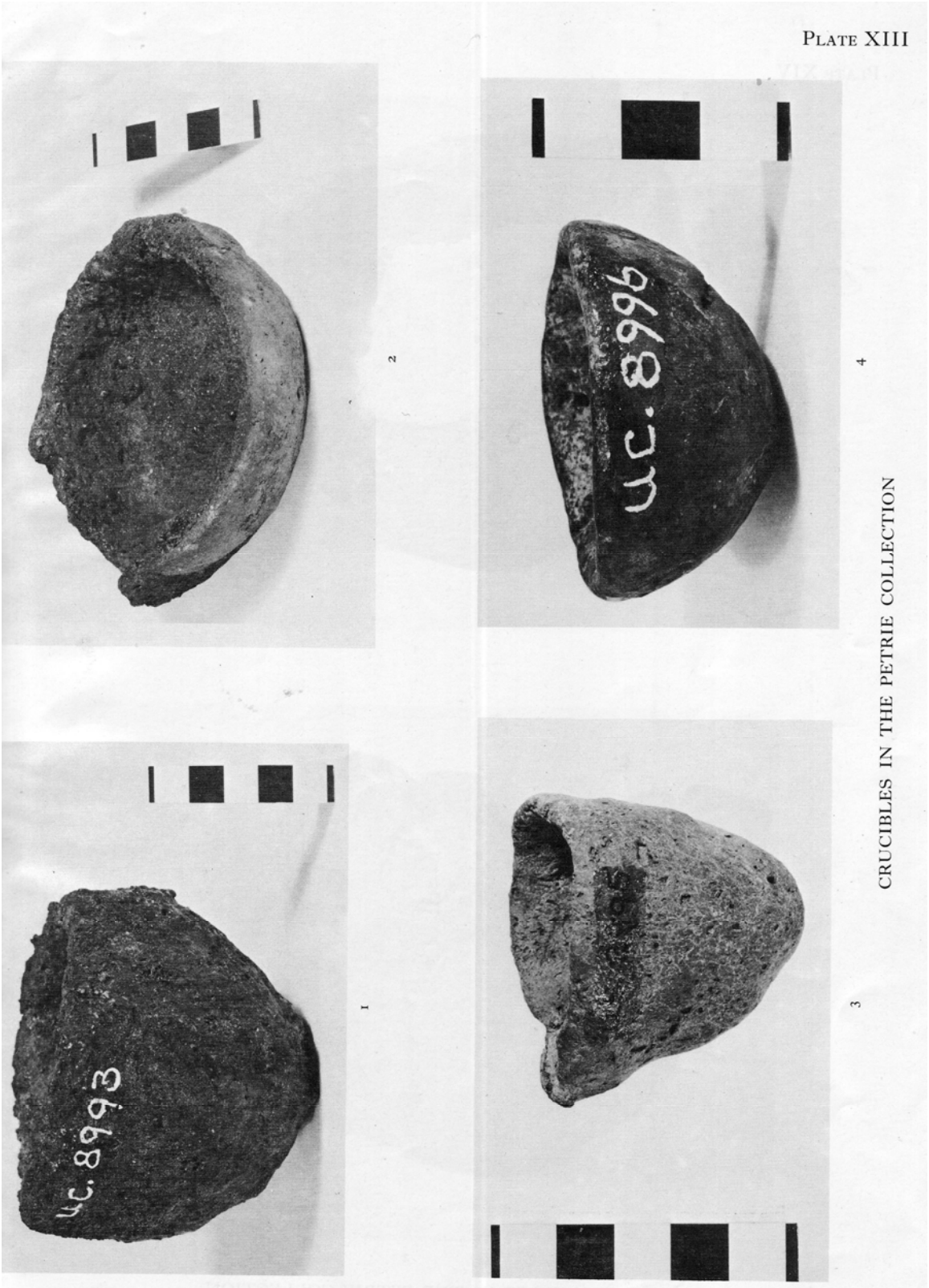
16. A. Gardiner, *Egyptian Grammar,* 3rd edn. (Oxford, 1957), 490.
17. Duell, *op. cit.*, pl. 30.
18. L. al-Gailani, 'Tell edh Dhiba'i', *Sumer* 21 (1965), 33-40, and C. J. Davey, 'The Metalworker's Tools from Tell edh Dhiba'i', *Bulletin of the Institute of Archaeology,* 20 (1983), 169-85.
19. B. Bruyère, *Fouilles de Deir el Médineh (1934-1935)* (Cairo, 1939), 218.

explanation is that the furnace in the Mereruka reliefs consists of two crucibles placed back to back, so that they would not topple over.

In his sign list Gardiner notes that in the Middle Kingdom, W 13,  , is the earlier equivalent of  . He indicates that the sign is a 'red pot' and that the Old Kingdom equivalent is round at the bottom. The Old Kingdom ideogram appears in tomb reliefs which depict metal-working scenes where it either indicates the use of copper or identifies the person as a metal-worker.[20] At Giza the latter appears to be the case while in the tomb of Mereruka the former seems more likely. The origin of the hieroglyph sign appears to be the furnace which in the Old Kingdom consisted of two crucibles of the shape shown in the tomb of Mereruka and recently found at Tell edh-Dhiba'i placed back to back and heated simultaneously by charcoal ventilated by means of blowpipes. The crucibles would naturally have appeared as a 'red pot'. It is possible that at a later date the crucibles were not used as pairs but singly and so the hieroglyph sign was modified.

20. S. Hassan, *Excavations at Giza 1930-1931* (Cairo, 1936), 192-3, fig. 219; Duell, *op. cit.*, pl. 30.

PLATE XIII




CRUCIBLES IN THE PETRIE COLLECTION

PLATE XIV

1

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CRUCIBLES IN THE PETRIE COLLECTION