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Stairs of similar size have been found in a monumental staircase in Jerusalem: rock-cut steps, averaging 0.25 m. in height, uncovered in the southern moat of the Citadel may have been connected with Herod's palace in the Upper City.[37] Paved steps belonging to a gateway approach to the same palace in the western city fortifications are 0.32 m. in height,[38] each being essentially one foot, or *pous*, of the standard that has been suggested for Herod's Temple, with three feet being equal to two cubits.[39]

37 R. Sivan and G. Solar: Discoveries in the Jerusalem Citadel, 1980–84, *Qadmoniot* 4 (68) (1984), p. 116.

38 M. Broshi and S. Gibson: Excavations Along the Western and Southern Walls of the Old City of Jerusalem, in H. Geva (ed.): *Ancient Jerusalem Revealed*, Jerusalem, 1994, pp. 147–155.

39 This step height is close to the foot of 0.31 m. deduced by R. Grafman (Herod's Foot and Robinson's Arch, *IEJ* 20 [1970], pp. 60–66) from measurements of Robinson's Arch. Further, see Jacobson (above, n. 3), p. 47.

Excavations at Sepphoris: The Location and Identification of Shikhin Part II

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THIS paper is the second and final part of an essay that reports the results of an archaeological survey conducted by the University of South Florida Excavations at Sepphoris in the summer of 1988. The essay presents the data to support our identification of an otherwise unnamed hill north of Sepphoris as the most probable location for ancient Shikhin (Fig. 1).[1] In Part II we provide detailed information about the survey, the pottery and the results of the neutron activation analysis; these data, together with the materials previously presented, enable us to identify the site of ancient Shikhin with confidence.

The Survey of Shikhin, 1988

The northernmost two of the three small hills north-north-west of Sepphoris (Ṣippori) show clear evidence of occupation in antiquity. These two hills were surveyed between 9–17 June 1988.[2] The area of occupation extends over some 11 hectares (Fig. 2). We identify it as the site of ancient Shikhin (Asochis).

The surface survey of the site revealed modest remains of ancient structures. There are architectural fragments scattered about the site, several of which are now in re-use in the many modern terrace walls on the hill; others have tumbled down the slopes (especially on the east) and lie at the base of the hill close to fields presently under cultivation. Still others lie in the numerous piles of stones which have been gathered to adapt the area for agricultural use. Occasionally, large pieces of ancient plaster were observed on the surface. Cuttings in bedrock, noted throughout the site, show that the hill was extensively quarried for building stones. These outcroppings are

1 *IEJ* 44 (1994), pp. 216–227.

2 The survey was conducted under the direction of T.R.W. Longstaff, Associate Director of the Excavations at Sepphoris, who was also the survey photographer. S.B. Womble, Jr. was surveyor; R.C. Levy and D.R. Edwards assisted him.

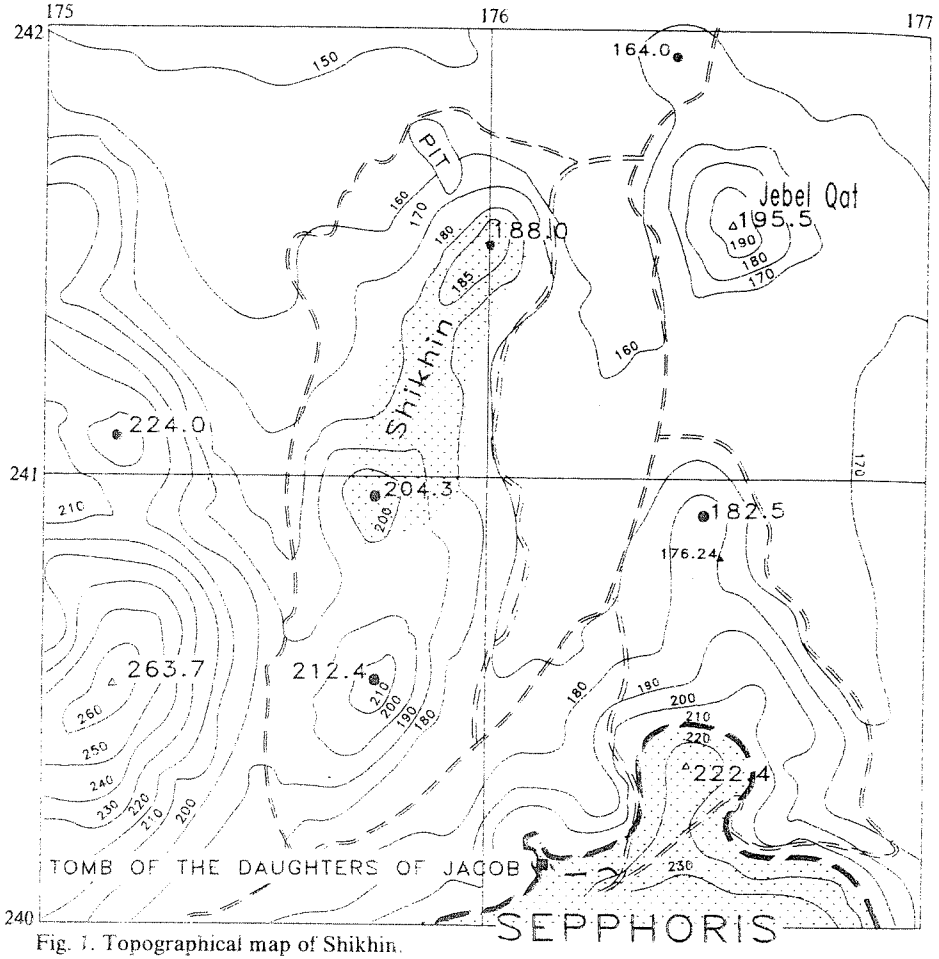

Fig. 1. Topographical map of Shikhin.

also frequently incorporated into buildings and other structures, a situation similar to that at nearby Sepphoris. This entire area is nowadays the location of a flourishing olive orchard.

Indicator sherds were gathered from the surface by a team of volunteers organized to systematically explore the entire area in strips from north to south. A count of the sherds collected is provided in Table 1.

The pottery distribution indicates a long history of activity, ranging from the late Iron Age to the Byzantine period. Indeed, the heavy concentration of Roman pottery (109 of 141 sherds collected) suggests that the site flourished from the first to the fourth century. Six wasters were found in the north-west portion of the site, not far from the pit that appears on the 1924 maps; as mentioned in Part I,

Table 1. Count of sherds by period from the Shikhin survey.

Iron II C	Persian (Iron III)	Hellenistic I	Hellenistic II	Roman I (ER)	Roman II (ER)
2	3	2	5	53	35
Roman III (LR)	**Byzantine I**	**Byzantine II**	**Arab**	**Unknown**	**Wasters**
21	6	0	0	8	6

it is likely that clay was excavated from this pit for the manufacture of pottery. The presence of wasters and a clay source is evidence for a kiln in the immediate vicinity.

A total of 58 features of archaeological interest were mapped in relation to known survey points using a TOPCON GTS-3B Total Station. This sophisticated electronic surveying instrument provided a high degree of accuracy (an error factor of less than 1 in 10,000) in the location of these features. The features included 32 cisterns in various stages of deterioration, 12 solution cavities apparently used in antiquity (for water storage, dry storage, or as lime kilns), seven features in cut bedrock (foundations for walls, thresholds, doorposts, or water channels), three stone fragments (one threshold or doorpost and two basalt grinders in re-use in modern terrace walls), one small fragment of an olive press in re-use to close a cistern, one large screw-type olive press, one ancient wall visible on the surface, and one small aqueduct with several capping stones in place.

A detailed list of these features follows (see Fig. 2):

88001 Survey point from earlier surveying activity, consisting of a round-headed spike driven into quarried bedrock near the pit at the north-west of the site. This was used as a primary point for the location of some of the features described in this survey.

88002 Bell-shaped cistern with a capstone having an opening *c.* 0.3 sq.m. The depth is estimated to be greater than 4 m.

88003 Fragment of a doorpost or threshold in re-use in a later terrace wall. The fragment is *c.* 0.5 × 0.4 × 0.2 m.

88004 Cistern without a capstone, presently blocked with a large boulder. The cistern's mouth is *c.* 0.6 m. in diameter.

88005 Large solution cavity in bedrock, open from the north-west and south-west. The opening is *c.* 2.3 m. wide and *c.* 0.7 m. high. This chamber was plastered in antiquity; fragments of the plaster survive.

88006 Possible building foundation on quarried bedrock. The thickness of the walls ranges from *c.* 0.8 to 1 m. The preserved length is *c.* 2 m. from north to south and 10 m. from east to west.

88007 Cistern blocked with a large boulder. The mouth of the cistern is eroded to a diameter of *c.* 1 m. A fragment of a capstone is wedged into the opening to support the boulder.

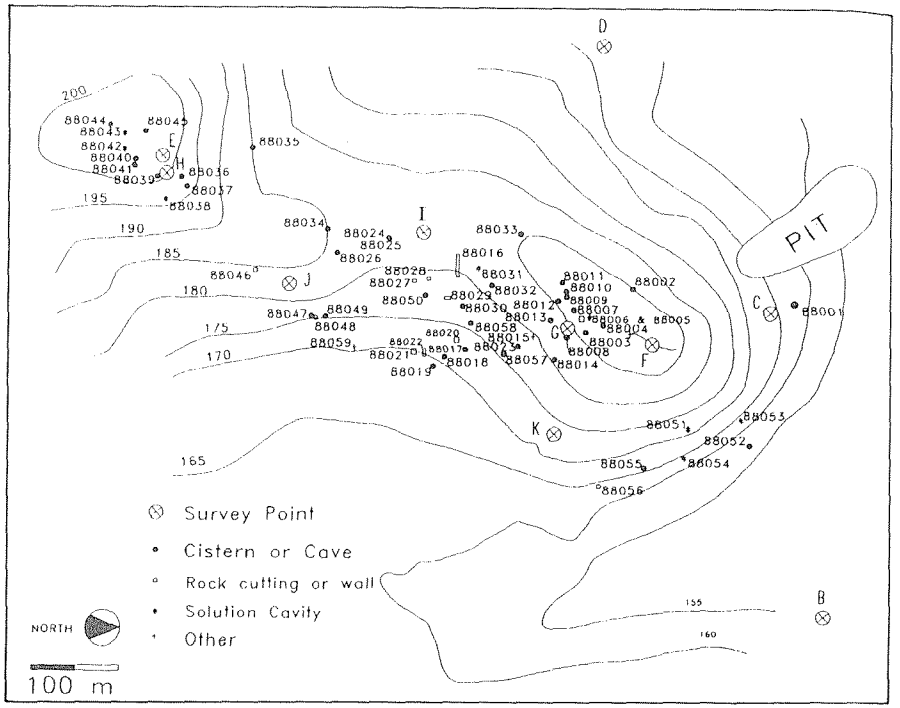

Fig. 2. The survey of Shikhin.

88008 Fragment of an olive press, *c.* 1.5 × 0.7 × 0.35 m. The stone is now in use to block the opening to a cistern with an eroded mouth, *c.* 0.7 m. in diameter.

88009 Cistern. The bedrock seems to have been cut to receive a capstone. Present diameter of the mouth is *c.* 0.7 m. This cistern is filled with stone and debris.

88010 Large bell-shaped cistern with a mouth *c.* 1 m. in diameter. The depth of the shaft to the bell is *c.* 0.8 m. The cistern is filled with debris to *c.* 1.8 m. from the surface.

88011 Bell-shaped cistern with an opening *c.* 1 sq.m., now badly eroded. The cistern is filled with debris to *c.* 2 m. from the surface.

88012 Large cistern with a badly eroded mouth greater than 1 m. in diameter. A tree grows from one side of the cistern, whose depth is estimated to be greater than 6 m.

88013 Cistern carved into a bedrock shelf created by quarrying. The cistern is now filled to the surface with debris. The mouth's diameter appears to be *c.* 0.5 m.

88014 Large bell-shaped cistern partially closed with a boulder. The mouth's diameter is *c.* 0.3 m., widening rapidly into the bell. The present depth to debris on the bottom is *c.* 7 m.

88015 Possible grinder or cistern capstone fallen away from secondary use in a modern terrace wall, which appears to incorporate *c.* 4 m. of an earlier wall. The stone is a cube of *c.* 0.4 cu.m. The centre hole is *c.* 0.3 m., narrowing to 0.15 m.

88016 *Wall* — possibly Byzantine, judging from the construction technique — two rows wide with a rubble core. The width is *c.* 1.1m., and the preserved length *c.* 25 m. An angle iron point from some earlier survey was observed at the eastern end of the wall.

88017 Large cistern with a badly eroded mouth greater than 2.5 m. in diameter. A tree growing from cistern makes access difficult. Depth appears to be over 6 m.

88018 Bell-shaped cistern cut into bedrock. The circular shaft, *c.* 1 m. in diameter, is *c.* 0.9 m. in depth to the bell. The overall depth appears to be *c.* 6 m.

88019 Cistern with a square opening now partially eroded. The cistern is filled with debris to *c.* 1 m. from the surface.

88020 Quarried bedrock, possibly used as the foundation of a building, but no distinct plan was evident.

88021 Storage room *c.* 3 sq.m., with an arched doorway cut into bedrock. The chamber is filled with debris to *c.* 1 m. from the ceiling. Modern bottles lie on top of earlier debris.

88022 Cut bedrock, apparently for the construction of a doorway. The opening is *c.* 1.4 m. wide. The preserved height is *c.* 0.4 m. and the preserved length of quarried bedrock exposed *c.* 8.5 m.

88023 Cistern now blocked with a boulder. The mouth appears to be *c.* 0.6 m. in diameter; the depth is greater than 3 m.

88024 Cistern filled to the top with debris. The mouth, now badly eroded, appears to be *c.* 1.1 m. in diameter.

88025 Collapsed cistern or lime kiln (although no liming is now evident). The opening is now *c.* 3 m. in diameter.

88026 Cistern with a nicely cut shaft, now filled to the top with debris. The neck opening is *c.* 0.55 m. in diameter.

88027 Quarried bedrock, possibly for the foundation of a building. The bedrock forms a 'wall' *c.* 0.5 m. wide and preserved to a length of *c.* 6.2 m.

88028 Possible structure or entrance to an underground chamber. Collapsed earth beneath a modern terrace wall reveals a possible lintel or portion of a structure.

88029 Probable aqueduct carved into bedrock and running approximately north to south. The channel is U-shaped in section, and has a preserved depth of *c.* 0.2 m. and a uniform width of 0.4 m. The preserved length now showing at the surface is 5.4 m.

88030 Deep cistern exposed by recent harrowing around an olive tree. The cistern is bell-shaped, with a neck opening of *c.* 0.3 m. The depth to the bell is *c.* 1 m., and the overall depth appears to be greater than 4 m.

88031 Cave or solution cavity in bedrock.

88032 Bell-shaped cistern partially blocked with stones. The neck is *c.* 0.6 m. in diameter; the depth to the bell *c.* 0.5 m. Overall depth to debris is estimated to be greater than 3 m. One blocking stone might be a fragment of a threshold.

88033 Large circular collapse, perhaps from a cistern or lime kiln. The diameter is *c.* 3.2 m.; the depth *c.* 1.5 m.

88034 Oval collapse, perhaps from a cistern or lime kiln. The diameter is *c.* 1 × 1.5 m.; the depth *c.* 1 m.

88035[3] Bell-shaped cistern with a badly eroded mouth. A tree growing from this cistern has caused considerable erosion. The mouth's diameter is *c.* 1.5 m.; the depth to the bell *c.* 0.5 m. The overall depth could not be determined.

88036 Very large cistern with a fig tree growing from its mouth. The present diameter of

3 Features 88035 to 88045, inclusive, were located on the hill immediately to the south of the first hill surveyed. Not all of the features on this southern hill were identified and plotted.

the mouth is greater than 4 m., as is the depth. A shaft high on the east-north-east wall may connect this cistern to 88037.

88037 Very large bell-shaped cistern *c.* 6 m. in diameter, widening to the south. The northern wall has collapsed. An opening greater than 3 m. in diameter appears to be collapsed, and not the original neck. A shaft high up on the west-north-west wall may connect this cistern to 88036.

88038 Ramp-like depression, *c.* 5 m. wide and 5 m. long, leads to a solution cavity, the opening of which is *c.* 5 m. wide.

88039 Cistern blocked with stones. The neck is eroded to a diameter of *c.* 1.6 m.; the depth is estimated at *c.* 5 m.

88040 Cistern with an opening originally *c.* 0.8 m. in diameter, but now badly eroded at the west. This cistern is nicely carved from bedrock and is now filled to *c.* 1.1 m. from the surface with debris.

88041 Cistern with an opening *c.* 0.8 m. in diameter. The mouth is blocked with stones, and the cistern is filled with debris to *c.* 2.3 m. from the surface.

88042 Large solution cavity with an opening, *c.* 10 m. wide, to the east and two openings to the west.

88043 Cuttings in bedrock above a solution cavity: a circular depression, 0.7 m. in diameter and 0.15 m. deep, and a cup-like conical depression adjacent to the south-south-west, *c.* 0.3 m. in diameter and 0.18 m. in depth. A modern Israeli survey point is located adjacent to these features and was plotted on our map.

88044 Solution cavity, *c.* 4 m. wide, with a very shallow chamber.

88045 Large cistern greater than 2 m. in diameter and greater than 8 m. in depth.

88046 Screw-type olive press carved from bedrock. The press would be *c.* 1.7 m. wide, with post holes on each side. This press is broken and not preserved on the east side.

88047 Possible cistern with an opening eroded to a diameter of *c.* 1.3 m. This chamber is filled with debris to *c.* 0.4 m. from the surface.

88048 Possible foundation for a building cut from bedrock. There appears to be a collapse of cut stone from upper courses into the interior space, defined by walls *c.* 0.55 m. wide and preserved to a length of 1.7 m. from east to west and 2.7 m. from north to south.

88049 Possible collapsed cistern open at ground level. An eroded or collapsed opening, *c.* 0.65 m., exposes a 'pit', *c.* 1. m. deep, which may open into a cistern.

88050 Possible cistern or pit, filled to *c.* 0.2. m. from the surface with earth and stones.

88051 Solution cavity in bedrock.

88052 Very large bell-shaped cistern with a broken capstone. The mouth of the cistern beneath the capstone is greater than 1.5 m.; the depth of the cistern, to debris fill, is greater than 5 m.

88053 Possible solution cavity with a very small opening, *c.* 0.2 m.

88054 Solution cavity with an opening *c.* 0.75 m.

88055 Circular depression, which appears to be a collapsed cistern with an eroded mouth, *c.* 1.3 m. in diameter, and filled with stone and debris to *c.* 0.75 m. from the surface.

88056 Possible drain or aqueduct of irregular width, with a preserved length of *c.* 1 m.

88057 Bell-shaped cistern adjacent to a pile of stones. The neck has a diameter of *c.* 0.6 m.; it was not possible to estimate the depth.

88058 Circular depression over an underground cavity, perhaps a cistern. The diameter is 0.4 m.; the depth greater than 2.5 m.

88059 Small basalt grinder, *c.* 0.3 m. in diameter, in re-use in a modern terrace wall.

As suggested above, a kiln site may be tentatively identified on the north-western slope of the north hill included in this survey. As can be seen in Fig. 2, the features and cisterns tend to be concentrated along the summit and eastern slope of the north hill. Evidence of ancient occupation (primarily cisterns and solution cavities used in antiquity) diminishes, but for the northern slopes of the second, south, hill. The discovery of a kiln in this region of Lower Galilee is of great importance, and we propose to excavate this site in the near future.

Selected Pottery from the Survey Site (Figs. 3, 4)

The pottery repertoire from the survey is limited to sherds picked up from the area between the two hills, not from the north side of the north hill. Although hundreds of sherds were visible on the north, they were not sampled as they had undergone severe disturbance by modern plowing. The forms found in a survey in no way reflect the full range to be found at any site by excavation. On the other hand, it is significant that there were no unexpected finds in the pottery of the Roman period.

Fig. 3:7. Rim of a jar with thickened and inverted rim, but with a small eversion on the exterior lip. It is red (2.5YR 5/7) on the interior and exterior with a 100% grey core. It resembles an Early Roman jar rim from Meiron.[4]

Fig. 3:36. Base of a small juglet, finely tooled, with a groove in the ring base. In general form and fabric it is Early Roman, very lightly ribbed on the outside.

Fig. 3:14. String-cut base of a juglet, reddish-brown on the exterior and interior with a 100% grey core. In form it resembles Herodian juglets, especially Lapp's form 31.2 (the globular juglet with a flat base), but its faint ribbing and generally rougher fabric might place it in the second century.[5]

Fig. 3:34. Ribbed body and less of the red ware colour characteristic of a Late Roman juglet. The base was formed by turning the pot over and closing it by hand.

Fig. 3:35. Juglet base, string-cut like Fig. 3:14, but with rather more pronounced ribbing. It appears to be Early Roman.

Fig. 3:30. Rim and partial collar of a Roman jar. It is red (2.5YR 6/8) on the interior and exterior with a 99% grey core.

Fig. 3:8. Rim of a Late Roman jar, with a slight groove near the exterior lip. It is the same colour throughout (5YR 5/1 or grey). It resembles a type of Late Roman jar found at Meiron.[6]

Fig. 3:18. Rim of a large cooking pot with an external diameter of *c.* 31 cm. It has a pronounced rolled rim with a ridge that forms a groove just below. The ware

4 E.M. Meyers, J.F. Strange and C.L. Meyers: *Excavations at Ancient Meiron, Upper Galilee, Israel, 1971–72, 1974–75, 1977* (*Meiron Excavation Project* III), Cambridge, 1981, Pl. 8.15:9, although the Meiron example has light ribbing on the neck.

5 P.W. Lapp: *Palestinian Ceramic Chronology, 200 B.C.–A.D. 70*, New Haven, 1961, p. 163.

6 Meyers *et al.* (above, n. 4), Pl. 8.10:15.

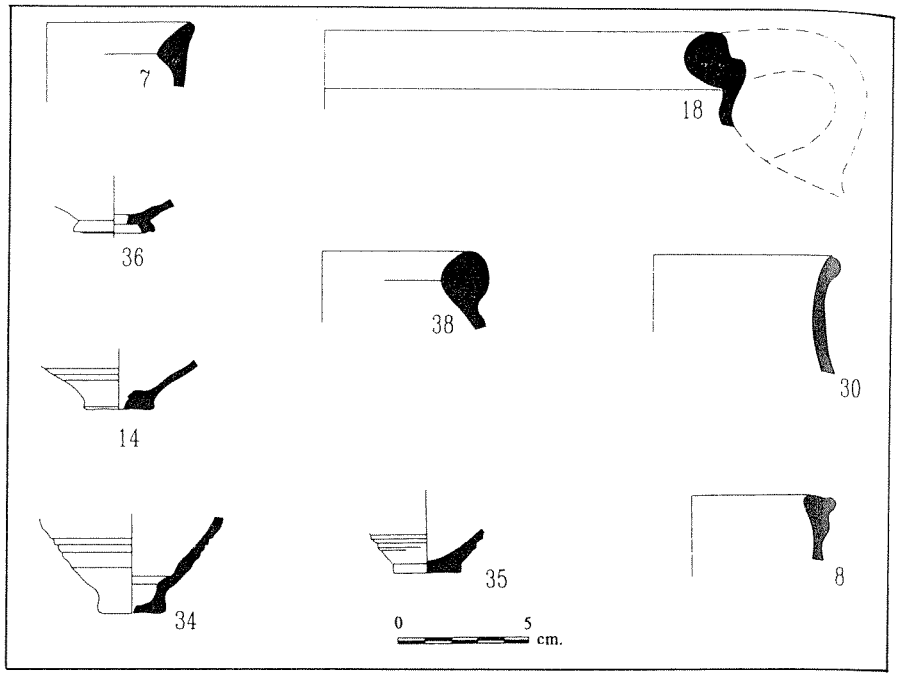

Fig. 3. Selected Shikhin survey pottery: Iron II and Roman.

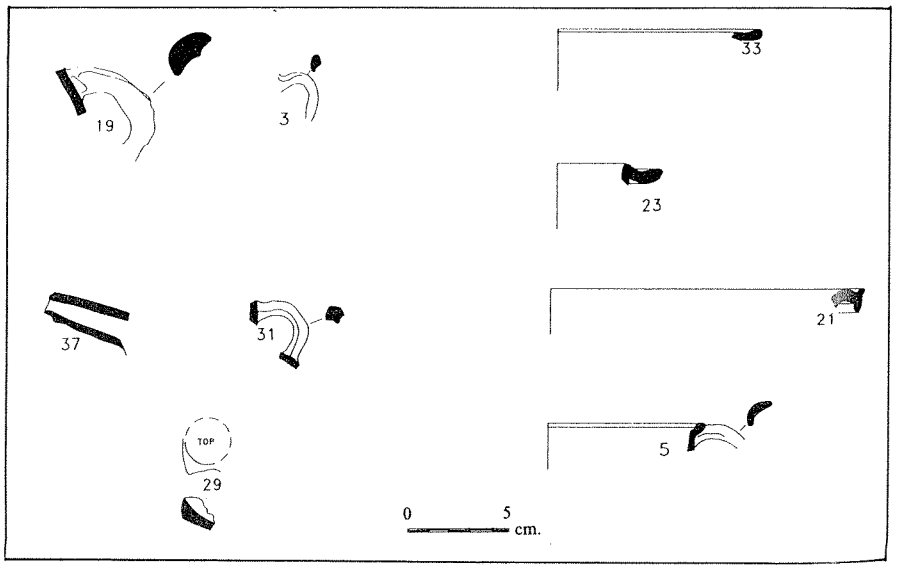

Fig. 4. Selected Shikhin survey pottery: Roman.

is fired red throughout, with many sparkling inclusions. It has no core. In general form and fabric this sherd resembles eighth-century Iron IIC cooking pots.[7] It is also similar to the seventh-century cooking pots from Ta'anach.[8]

Fig. 3:38. Rim of a jar with an external diameter of *c.* 11.4 cm., of grey ware with a 100% core. Inclusions are few, large and black. In general, this sherd resembles Iron Age ware, such as the large jars from Ta'anach, periods IB (twelfth century B.C.E.) and IIB (tenth century B.C.E.), although the Ta'anach jars measure *c.* 20–23 cm. in diameter at the rim.[9]

Fig. 4:5. Cooking pot with rounded body, thin strap handles, short neck and a single groove inside the rounded rim. This Early Roman cooking pot type is well known throughout most of the Galilee. It is called form A4 at Capernaum, for example, where it is well represented in the Early Roman stratification.[10] Adan-Bayewitz calls it form 4A in the Kefar Ḥananya repertoire.

Fig. 4:23 and 33. These sherds represent the 'bowl with everted lip' from Khirbet Shema' and Meiron, or Adan-Bayewitz' form 3A in the Kefar Ḥananya repertoire. At Capernaum this is form A17, 'Tegami a labbro sporgente.'[11] Loffreda dates this type at Capernaum to between 63 B.C.E. and 135 C.E.

Fig. 4:3. Handle, less than 3 cm. long, of a small juglet. The attachment at the top has a sufficiently tight curvature to suggest that it was attached to a narrow-mouthed juglet. This juglet may be Capernaum form A10a, usually less than 10 cm. high, and with a collar at the top. This form dates from 63 B.C.E. to 135 C.E. at Capernaum.[12]

Fig. 4:31. Handle similar to Fig. 4:3, but larger and in a redder ware. The curvature of the sherd at the top suggests a neck less than 1 cm. in internal diameter; the sherd is, therefore, of a juglet. This juglet may also be Capernaum form A10a (63 B.C.E. to 135 C.E.).[13]

Fig. 4:19. Jar or amphora handle. In form it is quite similar to Capernaum jars of class A, or likely the Shikhin jar.[14] The wall thickness at the handle attachment is only 4–5 mm. A second handle from the survey, No. 25 (not illustrated), is redder and wider by 3 mm.; the thickness of the wall at the attachment is 3–4 mm. These two sherds give some hint of the possible variability of this jar type at Shikhin.

7 R. Amiran: *Ancient Pottery of the Holy Land*, Ramat Gan, 1969, Pl. 75:18, a cooking pot from Megiddo IV–I.

8 W.E. Rast: *Taanach* I, *Studies in the Iron Age Pottery*, Cambridge, 1978, Fig. 76:6, a cooking pot of red ware and external diameter of 26 cm. at the rim.

9 Rast (above, n. 8), Figs. 10:2, 35:1.

10 S. Loffreda: *Cafarnao* II, *La Ceramica*, Jerusalem, 1974, p. 29, Fig. 2, Photo 2.

11 *Ibid.*, Fig. 6, Nos. 8–14.

12 *Ibid.*, p. 34, Fig. 4, Photo 5.

13 *Ibid.*

14 *Ibid.*, p. 26, Fig. 1.

The pottery from Shikhin collected in the survey reveals a small occupation in the eighth and perhaps the seventh centuries B.C.E., a small presence in the Persian period, and a possibly greater presence in Hellenistic periods I and II. It is during the Early Roman period that the number and types of sherds suddenly increase dramatically (see Table 1). Although this is a small sample, its importance cannot be gainsaid. The sudden rise in counts is similar in contour to that of the pottery counts for the entire site of Sepphoris, as illustrated by Fig. 5, although without the additional peak in the Byzantine I period.

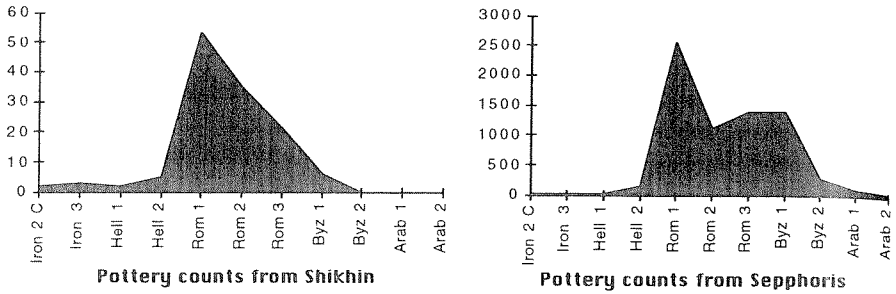

Fig. 5. Pottery profiles of Shikhin and Sepphoris.

It seems, therefore, reasonable to hypothesize that the survey site may have been occupied in generally the same periods as Sepphoris, with the exception, perhaps, of the Arab period, from which no sherds have been found to date. Only excavation will tell, but at this venture it would be well to sink a probe at the survey site, surely ancient Shikhin, and test the hypothesis that its occupation parallels that of Sepphoris.

The Evidence from Neutron Activation Analysis[15]

by David Adan-Bayewitz, Frank Asaro, Isadore Perlman and Helen V. Michel[16]

The role of Shikhin in pottery manufacture has not been dealt with in the past in discussions of the site's identification. Only two Galilean settlements are mentioned in rabbinic literature as centres of pottery manufacture in the Roman period.[17] This information is significant because much of this literature was formulated in Roman Galilee. The first of these centres, at Kefar Ḥananya, has been the subject of an earlier study, which showed that this settlement was the principal supplier of common cooking ware to the Galilee and that it also marketed its ware to the Golan from the latter part of the first century B.C.E. to the early fifth century C.E.[18] That study involved the analysis by neutron activation (NAA)[19] of a large number of common pottery vessels from 17 sites in the Galilee and Golan. The data also showed that the common storage jars used in the Galilee during the Roman period were not made at Kefar Ḥananya. Employing this evidence and subsequent data from analyses at the Hebrew University of Jerusalem and the Lawrence Berkeley Laboratory of the University of California,[20] we sought to locate the place of manufacture of these common storage jars.

As will be described below, this provenance problem involved several different kinds of evidence, including pottery reference material and information from rabbinic literature. Ultimately, however, it was the present survey that provided the samples of ceramic waste described in this paper, the analysis of which enabled us to locate the site of manufacture of these common Galilean storage jars. Our analytical work, in turn, supports the identification of the survey site as ancient Shikhin.

An important component of our work on local trade in common pottery in the Galilee and Golan is the quantification of pottery collections from a number of excavated sites in these regions, which provides an estimate of the relative quantities of each of the vessel forms.[21] One of the quantified collections was from Sepphoris. All of the pottery (excluding lamps) recovered by the University of South Florida Excavations at Sepphoris from two areas adjacent to the present fortress (Field I, Areas 3 and 6) was counted.[22] These areas were selected because they contained

15 The work described in this contribution was supported by the Director, Office of Energy Research, Office of Basic Energy Sciences, Chemical Sciences Division of the U.S. Department of Energy under Contract No. DE-AC03-76F00098. Costs were covered by a research grant to D. Adan-Bayewitz by the Hebrew History Federation. Incidental expenses were funded by the Bar-Ilan University Dr. Irving and Cherna Moskowitz Chair in Land of Israel Studies.

16 D. Adan-Bayewitz is affiliated with Bar-Ilan University. F. Asaro and H.V. Michel are affiliated with Lawrence Berkeley Laboratory. Prof. I. Perlman (The Hebrew University of Jerusalem and Lawrence Berkeley Laboratory), who participated in the early stages of this study, died on 3 August 1991.

17 D. Adan-Bayewitz: *Common Pottery in Roman Galilee, A Study of Local Trade*, Ramat Gan, 1993, pp. 23–26.

18 Adan-Bayewitz (above, n. 17); see also *idem, Manufacture and Local Trade in the Galilee of Roman–Byzantine Palestine, A Case Study* (diss., The Hebrew University of Jerusalem), Jerusalem, 1985; D. Adan-Bayewitz and I. Perlman: Local Pottery Provenience Studies, A Role for Clay Analysis, *Archaeometry* 27 (1985), pp. 203–217.

19 The method is presented in I. Perlman and F. Asaro: Pottery Analysis by Neutron Activation, *Archaeometry* 11 (1969), pp. 21–52, with revisions in *idem*, Pottery Analysis by Neutron Activation, in R.H. Brill (ed.): *Science in Archaeology*, Cambridge, MA, 1971, pp. 182–195.

20 On the compatibility of the analytical data from these two facilities, see J. Yellin *et al.*: Comparison of Neutron Activation Analysis from the Lawrence Berkeley Laboratory and the Hebrew University, *Archaeometry* 20 (1978), pp. 95–100.

21 Adan-Bayewitz (above, n. 17), pp. 201–223.

22 D. Adan-Bayewitz and I. Perlman: The Local Trade of Sepphoris in the Roman Period, *IEJ* 40 (1990), pp. 153–172.

remains of residential structures and subterranean cavities dating from the Early to Late Roman periods.[23] These quantitative data showed that kraters and bell-shaped bowls of distinctive forms[24] were unusually abundant at the site. Counts of collections from other sites showed that vessels of these two types are relatively uncommon outside the central hill area of Lower Galilee. The best explanation for the large quantity of these vessels at Sepphoris appeared to be the hypothesis that they were made in or near that city. This supposition was tested by NAA of six examples from Sepphoris, three of each vessel type. The analysis showed that all six matched one another in chemical composition, supporting our initial hypothesis (see further below).[25]

Other analysed vessel types share the same composition as these kraters and bell-shaped bowls. Among these other vessels were 23 storage-jar pieces of a single class[26] excavated at Sepphoris, Ḥammath Tiberias, Tabgha, Capernaum, Ḥorvat Ḥazon and Rama in the Lower Galilee, at Meiron, Nabratein and Sa'sa' in the Upper Galilee and at Susita, Gamla, 'En Nashut and Dabiya in the Golan (Fig. 6). All but one of the analysed storage jars of this class matched one another in chemical composition. Since the composition of the exceptional storage jar was quite similar, it was probably also made in the same vicinity.[27] The storage jars of this class, characterised by an inset neck and everted rim, are the most common storage jars at Galilean sites in contexts dating from the late first century B.C.E. until approximately the mid-third century C.E.; they also occur at Gamla and other sites in the Golan.

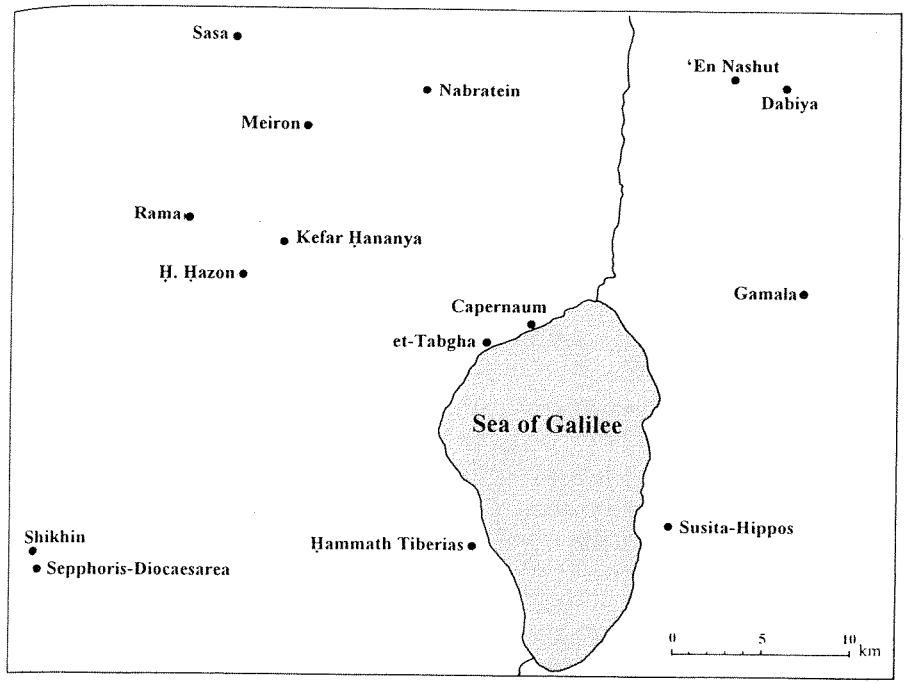

Fig. 6. Map of Galilee and Golan, showing Kefar Ḥananya and sites from which common storage jars, with inset neck and everted rim, were selected for NAA.

Rabbinic sources provide significant information for locating the site of manufacture of these common Early and Middle Roman Galilean storage jars. As mentioned, only two Galilean settlements are referred to as centres for pottery manufacture, Kefar Ḥananya and Shikhin. Whereas Kefar Ḥananya is specifically noted as a centre for the manufacture of several types of utilitarian vessels, Shikhin is noted only for its manufacture of storage jars. The Shikhin storage jar was so well known by the mid-second century that the measure of its volume could be proposed as a standard for halakhic purposes (tos. Terumot 7,14; PT Terumot 8,6 45d).[28]

23 J.F. Strange and T.R.W. Longstaff: Sepphoris (Ṣippori), 1983, *IEJ* 34 (1984), pp. 51–52; *idem*, Sepphoris (Ṣippori), 1985 (II), *IEJ* 35 (1985), pp. 297–299. For earlier excavations nearby, see L. Waterman: *Preliminary Report of the University of Michigan Excavations at Sepphoris, Palestine, in 1931*, Ann Arbor, 1937. A large part of this residential area, on the western side of the summit, has since been exposed, both by the University of South Florida Excavations at Sepphoris and by the Joint Expedition to Sepphoris, the latter directed by E.M. Meyers, E. Netzer and C.L. Meyers. See J.F. Strange and T.R.W. Longstaff: Sepphoris (Ṣippori), 1986 (II), *IEJ* 37 (1987), pp. 278–280; and J.F. Strange, D.E. Groh and T.R.W. Longstaff: Sepphoris (Ṣippori), 1987, *IEJ* 38 (1988), pp. 188–190; *idem*, Sepphoris (Ṣippori), 1988, *IEJ* 39 (1989), pp. 104–106; and E.M. Meyers *et al.*: Sepphoris (Ṣippori), 1985 (I), *IEJ* 35 (1985), pp. 295–297; *idem*, Sepphoris, 'Ornament of All Galilee', *BA* 49 (1986), pp. 4–19; *idem*, Sepphoris (Ṣippori), 1986 (I) — Joint Sepphoris Project, *IEJ* 37 (1987), pp. 275–278; *idem*, Sepphoris (Ṣippori), 1987 and 1988, *IEJ* 40 (1990), pp. 219–222; *idem*, *Sepphoris*, Winona Lake, IN, 1992, pp. 19–29.

24 D. Adan-Bayewitz and M. Wieder: Ceramics from Roman Galilee: A Comparison of Several Techniques for Fabric Characterization, *Journal of Field Archaeology* 19 (1992), Fig. 5:1, 2. Note that the scale in Adan-Bayewitz and Perlman (above, n. 22), Fig. 3 is inaccurate.

25 Adan-Bayewitz and Perlman (above, n. 22).

26 Adan-Bayewitz and Wieder (above, n. 24), Fig. 5:5.

27 Adan-Bayewitz and Perlman (above, n. 22).

28 For a discussion of those texts, see Adan-Bayewitz (above, n. 17), pp. 32–38; and *idem*, 'Talmudic Archaeology': An Archaeological–Archaeometric Approach, *Proceedings of the Tenth World Congress of Jewish Studies*, B, 1, *The History of the Jewish People* (1990), pp. 37–43 (Hebrew). The standard is proposed by R. Neḥemiah; cf. tos Kelim, Bava Kama 2.2 and Sifra Šemini 7.3, where R. Neḥemiah is concerned with the measure of broken vessels susceptible to ritual impurity. The measures of other storage jars of known manufacture are cited as halakhic standards in a tannaitic text of slightly earlier date, see m Kelim 2.2.

The frequency throughout the Galilee of one class of storage jar is the distribution pattern we would expect for jars attested in the literary sources as being so familiar.

Most of the sampled jars of this class are securely dated by their archaeological contexts to the first and second centuries. This is consistent with the literary references to Shikhin as a well known centre for the manufacture of storage jars by the mid-second century. It is thus likely that the storage jars of this class are those of Shikhin.

Several pottery wasters were recovered from the site during the 1988 survey, two within a radius of several metres. Since wasters were not marketed, their recovery is one of the best indicators of pottery manufacture at a site. One of the wasters seems to be an example of the kraters mentioned earlier. In Fig. 7 this waster is shown beside a large fragment of one of these kraters. Although the waster is misshapen and fused to globs of fired clay, both pieces have a deep groove of similar diameter and a higher adjacent rim. The lower and inner sides of the waster are vitrified. The second waster is a deformed storage-jar handle (Fig. 8). This piece has a warped body; pronounced bloating and vitrification of the handle are evident.[29] Both of these wasters were analysed by neutron activation.[30]

It has been shown that varying amounts of calcareous material were added as temper to the clay used to make the pottery group that includes the kraters, bell-shaped bowls and common storage jars discussed above;[31] for reasons that will be presently seen, this pottery group will henceforth be called the Shikhin pottery group. This added calcareous material, which is essentially sterile in the chemical elements usually measured by NAA, acted as a variable diluent of the pottery composition. Depending on the extent of dilution, the Shikhin pottery group could be divided into three subgroups, called Shikhin 1, 2 and 3, all of which have the same *clay* composition and share the same provenance.

The mean chemical abundances for 18 elements of one of these groups, Shikhin 1, with 38 pottery pieces, are shown in Table 2, Column 1.[32] This group includes

29 For descriptions of pottery wasters and firing faults, see O.S. Rye: *Pottery Technology, Principles and Reconstruction*, Washington, D.C., 1981, pp. 110–114.

30 A third waster, of nondescript form, that was folded over, trapping extraneous earth, was also analysed. This piece is vitrified on the exterior, but much of the surface was broken in antiquity, exposing an extensively bloated, sponge-like interior (pores of 2–5 mm. commonly occur). This waster differed somewhat in composition from the other two analysed wasters, and it was thought that the waster itself might not be uniform in composition due to contamination, possibly from extraneous earth. This was confirmed when another sample was prepared from the same piece, and its composition was found to differ significantly (8–11% for several elements) from that of the initial sample.

31 Adan-Bayewitz and Weider (above, n. 24).

32 Data for a number of pottery pieces were obtained at the Lawrence Berkeley Laboratory with a different reactor than previously used, and it was not possible to achieve the precision of measurement previously obtained. The best precision obtainable was 2.5%. This fact, however, does not affect the provenance determinations. Ca and Ti have not been measured with the present procedures.

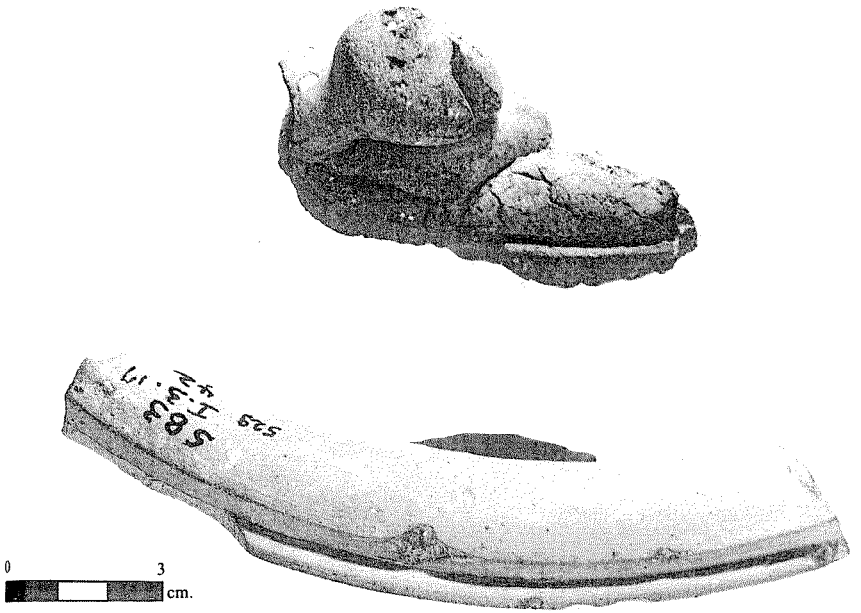

Fig. 7. Waster from Shikhin survey, shown with a krater fragment with which it shares similar features.

Fig. 8. Storage jar waster from Shikhin survey.

Table 2. Element abundances of the Shikhin 1 pottery provenance group and pottery wasters.*

	Shikhin 1 group abundances 38 samples	Storage jar waster ADAN-547 1 sample	Krater waster ADAN-546 1 sample	Krater waster ADAN-546 × 1.06
Ca%	8.0 ± 2.0	—	—	—
Ce	107.1 ± 7.1	99.5 ± 1.0	99.1 ±1.0	105.0 ±1.1
Co	29.6 ± 4.5	27.0 ± .3	26.9 ± .3	28.5 ± .3
Cr	188.6 ± 11.8	172.0 ± 1.7	168.0 ±1.7	178.1 ±1.8
Cs	2.67 ± .28	2.85 ± .06	2.80 ± .05	2.97 ± .05
Eu	2.07 ± .08	2.03 ± .03	1.95 ± .04	2.07 ± .04
Fe%	5.70 ± .21	5.60 ± .06	5.45 ± .05	5.78 ± .05
Hf	11.37 ± .87	11.07 ± .15	10.37 ± .14	10.99 ± .15
La	45.0 ± 1.9	44.6 ± .5	42.1 ± .5	44.6 ± .5
Lu	0.63 ± .03	0.62 ± .02	0.59 ± .02	0.63 ± .02
Na%	0.32 ± .07	0.288 ± .006	0.272 ± .005	0.288 ± .005
Sc	18.78 ± .63	18.38 ± .18	17.58 ± .18	18.63 ± .19
Sm	8.35 ± .32	8.12 ± .08	7.84 ± .08	8.31 ± .08
Ta	1.75 ± .09	1.70 ± .04	1.71 ± .04	1.81 ± .04
Th	10.90 ± .41	10.84 ± .11	10.27 ± .10	10.89 ± .11
Ti%	0.82 ± .05	—	—	—
U	3.91 ± .57	3.47 ± .05	3.84 ± .05	4.07 ± .05
Yb	4.59 ± .26	4.33 ± .12	4.25 ± .12	4.51 ± .13

* All elements are in units of parts-per-million unless indicated by the % sign. Entries after ± signs are measurement errors (one sigma value) for 1 sample or standard deviations for multiple samples. Column 1 contains selected pottery pieces from 15 sites in the Galilee and the Golan. Columns 2 and 3 are pottery wasters recovered at the survey site. On the missing values in Columns 2–4, see n. 32.

The chromium abundance in Standard Pottery (Perlman and Asaro, above, n. 19) has been revised downward by 11.4% (W. Alvarez *et al.*: Iridium Anomaly Approximately Synchronous with Terminal Eocene Extinctions, *Science* 216 [1982], pp. 886–888), while the ytterbium abundance has been revised upward by 5.7% (F. Asaro *et al.*: Equadorian Obsidian Sources Used for Artifact Production and Methods for Provenience Assignments, *Latin American Antiquity* 5 [1944], Cr and Yb abundances obtained at the Hebrew University and the Lawrence Berkeley Laboratory before the corrections have been modified accordingly.

examples of the kraters and bell-shaped bowls, 17 of the common Galilean storage jars,[33] and other vessel types.[34] A comparison of the chemical composition of the deformed storage-jar handle waster (Table 2, Column 2) with the Shikhin 1 pottery group shows that only two elements differ from the abundances of that group by more than one standard deviation.[35] Virtually all the values of the apparent krater waster (Column 3), however, are seen to be systematically lower than those of the Shikhin 1 group and, indeed, this waster matches the Shikhin 3 group, which is characterised by systematically lower chemical abundances than Shikhin 1. By means of a simple dilution correction, however, multiplying each of the abundances of this waster by 1.06 (Column 4), all the values, except one, are seen to lie within one standard deviation of the Shikhin 1 group abundances.[36] The compositions of these two wasters from the survey site, therefore, match extremely well with the Shikhin pottery group.

This close match is substantive evidence for the provenance of the pottery group at this manufacturing centre. Additional vessels recovered during the survey, including a krater, a bell-shaped bowl and one of the common Galilean storage jars, were also analysed. The compositions of these vessels also matched that of the Shikhin pottery provenance group, and the data for the krater and jar have been included in the Shikhin 1 group (Table 2, Column 1).[37]

It should be noted that the composition of the Shikhin pottery group (Shikhin 1, 2 and 3) differs markedly from that of the Kefar Ḥananya group, the other important Galilean pottery provenance group of the Roman period.[38]

From the above analytical evidence, it seems well established that the common storage jars of Roman Galilee and other pottery vessels were made at the surveyed site identified as Shikhin. Thus, the location of the surveyed site (discussed above), its role as a pottery manufacturing centre, its principal product and the period of its production are all consistent with the information about Shikhin from the literary sources.[39]

33 Six other common Galilean storage jars belong to Shikhin pottery groups 2 and 3.

34 See, e.g., Adan-Bayewitz and Wieder (above, n. 24), Fig. 5.

35 The worst agreeing elements, Ce and Cr, differ by only 1.1 and 1.4 standard deviations, respectively.

36 The worst agreeing element, Cs, differs by only 1.1 standard deviations.

37 The bowl belongs to the Shikhin 2 pottery group.

38 Comparison of the abundances of the Shikhin pottery group (Table 2, Column 1) with those of a Kefar Ḥananya group of 183 pieces, given in Adan-Bayewitz and Perlman (above, n. 22), p. 157, Table 1, Column 1, shows that the elements Ca, Hf, Sm, Ta and Th cover a range in Shikhin 1 that does not overlap with the range of these elements in the Kefar Ḥananya group.

39 The pottery produced at Shikhin will be the subject of a separate monograph that will include the chemical abundances and drawings of the individual pieces in the Shikhin provenance group and a statistical treatment of the analytical data, as well as a typological and chronological discussion of the Shikhin pottery and data on its geographic and quantitative distribution.