considerable depth, within the grounds of Guy's Hospital, near the River Thames in London, where it is intended to build a Cancer Care Centre (Watson, 2012). The remains proved to be waterlogged and in a sound condition. English Heritage subsequently decided that excavation of this legally protected boat (the only vessel in England subject to a scheduling order—22 June, 1983) should not be undertaken. Instead, they arranged that the new hospital building would be designed so that all load would be transferred away from the boat and that, should it prove necessary, the boat could be recovered from underneath the new Centre. Furthermore, it is intended that the ground water around the boat will be increased by diverting rainfall from the roof of the new building. English Heritage considers that these arrangements should ensure that the New Guy's House boat cannot be damaged by the building operation and will remain waterlogged.

It seems clear that, for some considerable time, none of these four vessels will be available for further research. Future work on Romano-Celtic seagoing vessels probably depends on some fortuitous discovery of another example of this tradition.

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References

McGrail, S., 1995, Romano-Celtic boats and ships: characteristic features. *IJNA* 24: 134–45.
McGrail, S., 1997, Early frame-first methods of building wooden boats and ships. *Mariner's Mirror* 83.4: 76–80.
Marsden, P., 1965, A boat of the Roman period discovered on the site of New Guy's House, Berrnondsey 1958. *Trans. London Middlesex Archaeol. Soc.* 21.2: 118–31.
Marsden, P., 1966, *A ship from the Roman period from Blaokfriars in the city of London*. Guildhall Museum.
Marsden, P., 1967, *A Roman ship from Blackfriars*. London.
Marsden, P., 1994, *Ships of the Port of London.* Vol. 1. London: English Heritage.
Nayling, N. and McGrail, S., 2004, *Barland's Farm Romano-Celtic Boat.* York: CBA Research Report 138.
Pomey, P., Kahanov. Y. and Rieth, E., 2012, Transition from Shell to Skeleton in Ancient Mediterranean Ship-Construction: analysis, problems and future research. *IJNA* 41.2: 235–314.
Watson, B., 2012, Guy's Hospital boat fifty years on. *London Archaeologist* (2012): 119–25.

A Submerged Monumental Structure in the Sea of Galilee, Israel

We report the discovery of a conical stone pile built of large, natural, unhewn basalt cobbles and boulders measuring *c.*70 m in diameter at a depth of -218.5–-219.5 m.

Geophysical survey

The south-western part of the Sea of Galilee was surveyed in the summer of 2003, when the lake level was 210.7 m bmsl (Reshef *et al.*, 2007) (Figs 1a and b). Detailed mapping of the bottom morphology and bathymetry was obtained with Marimatech E-Sea Scan 800 sidescan sonar (325 kHz) and ODOM Echotrack dual frequency (24 kHz and 200 kHz) echo sounder. For processing and assembling a mosaic image of the sidescan sonar data we used the CARIS software.

The shallow sub-bottom structure (up to 13 m deep) was mapped with acoustic single-channel data acquired by a Datasonics dual-frequency (2–7 kHz and 10–20 kHz) sub-bottom CAP 6600 Chirp II profiler. The seismic data totalled approximately 60 km with a source interval of about 2.5 m. To enhance the quality of the seismic images, we applied signal processing that included filtering, noise reduction and scaling to the data.

The submerged structure

In the seismic-reflection profiles in the south-western part of the Sea of Galilee we note a submerged, slightly asymmetric cone-shaped pile of stones, rising above the gently sloping (<2°) sandy bottom of the lake. Sonar images show that the pile is circular in plan, and the Chirp-reflection profiles show that the western face is somewhat steeper than the eastern part (Fig. 2a). Sub-bottom reflectors that dip away from the exposed part show that a portion of the base of the cone is buried producing readings of about 3–4 milliseconds, which correspond to about 2–3 m of sand (Fig. 2b).

Close inspection by scuba diving revealed that the structure is made of basalt boulders up to 1 m long with

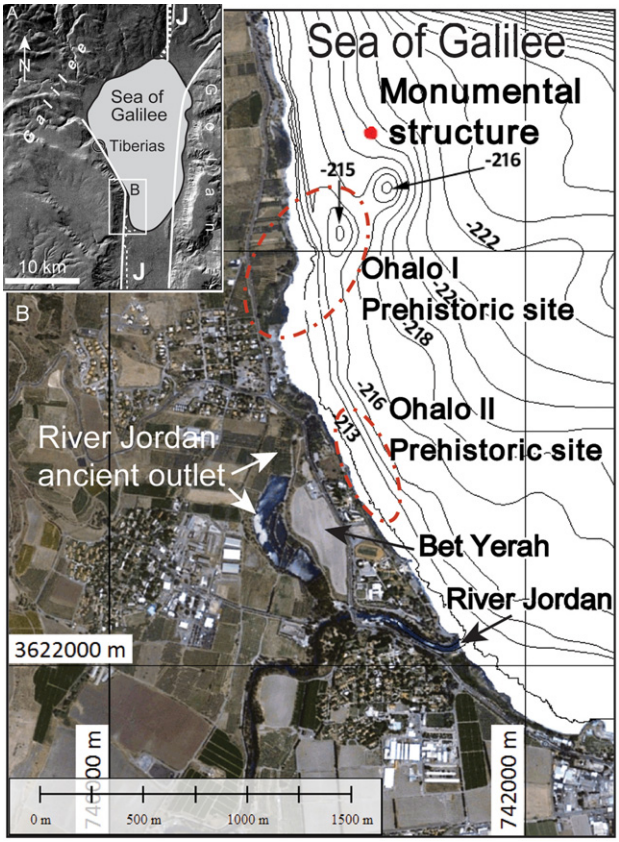

Figure 1. Location maps: *a)* The Sea of Galilee is a fault-bounded basin (faults shown with solid white lines). The River Jordan (J, dotted line), the main water supplier to the lake, enters at the north and exits southward. Shaded topography from Hall (1994). (Shmuel Marco); *b)* The lake bathymetric map based on multi beam survey (after Sade *et al*., 2008) with the location of the monumental structure (red). (Shmuel Marco)

no apparent construction pattern (Fig. 3). The boulders have natural faces with no signs of cutting or chiselling. Similarly, we did not find any sign of arrangement or walls that delineate this structure. The boulders are bare without any overgrowth. In contrast with the sandy terrain surrounding it, *Tilapia* fish teem around the structure and between its blocks, probably taking advantage of the hiding places and shelter that it offers.

Archaeological context

The structure is found 500 m from the Ohalo I prehistoric site and about 1.2 km north of the archaeological mound of Bet Yerah and the Ohalo II prehistoric site (Fig. 1b). Within the confines of Ohalo I, there are various built stone structures. The highest is a circular stone pile, *c.*7 m in diameter and 2 m high. It is located at the saddle connecting the topographic 'peninsula' to the beach. Its base has an elevation of *c.*-212 m. The second, a rectangular, elongated stone structure measuring about 20x10 m, lies in an axis parallel to the beach and almost 100 m to the east of the round structure. It has a base elevation of *c.*-214 m and stands about 0.6–0.8 m in height. To the south of these there was a disturbed semi-circle of large basalt stones at *c.*-213 m, which may be the remains of a small quay. None of these have been excavated, thus it can only tentatively be suggested that they were constructed during the Hellenistic/Roman/Byzantine period, through similarities with other remains found around the lake (Nun, 1977: Chapter 4; Nadel *et al*., 2006: 40–45).

Interpretation

Physical considerations

The shape and composition of the submerged structure (Fig. 4) does not resemble any natural feature. We therefore conclude that it is man-made and might be

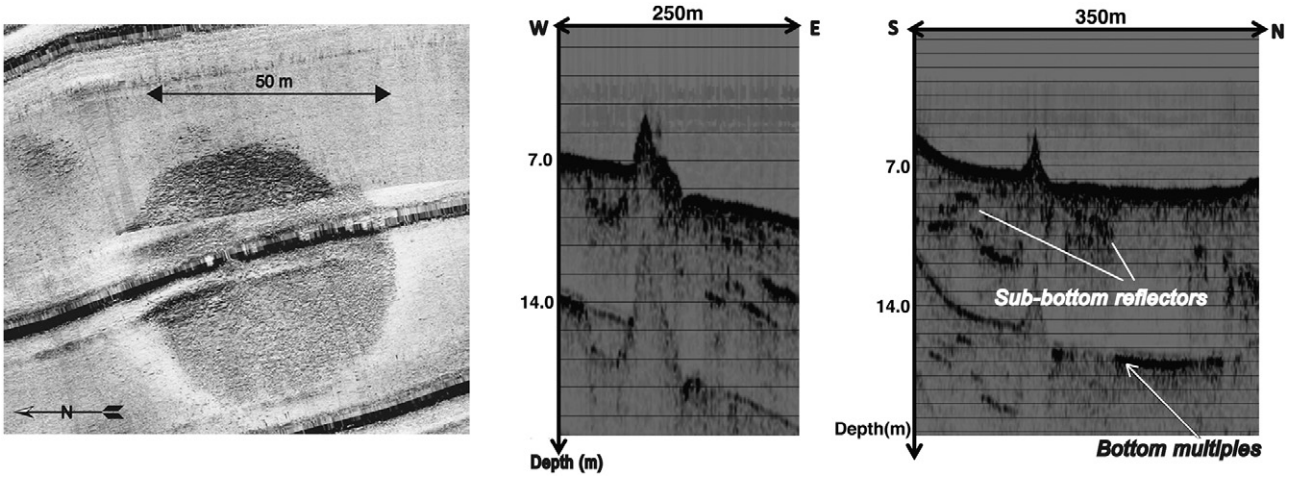

Figure 2 a) Mosaic of sonar swathes images reveals the structure as a circular heap of stones; *b)* Two chirp profiles of the structure. Note large vertical exaggeration. (Shmuel Marco)

termed a cairn. The boulders had to be transported at least a few hundred metres from the nearest basalt outcrop.

We assume that 2–3 m of sand that covers the base of the cairn accumulated naturally after its construction. The sediment accumulation rates in lakes vary in space and time. The location of the structure is not associated with any stream which could supply sediment. Therefore, long-shore currents and suspended particulate matter are the plausible sources. An interesting observation from the Ohalo II site is the deposition of *c.* 20 cm of sand within a single winter on top of plastic sheets that were placed to cover the excavations. We believe that this event does not represent the long-term deposition rate. Assuming an accumulation rate of 1–4 mm/yr (Koren and Klein, 2000), construction may have taken place between two and 12 millennia ago.

Archaeological considerations

Several questions arise about the structure: When was it built? What was its purpose and use? Was it built as an underwater installation or on land during low lake levels and later submerged?

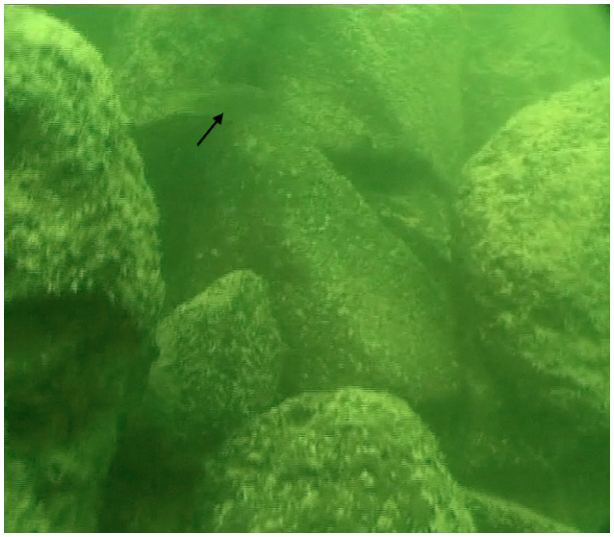

Figure 3. An underwater photo shows that the monumental structure is made of basalt boulders. Fish (marked with arrow) is about 10 cm. (Shmuel Marco)

The purpose and usage of the structure may be connected to how it was built. A possible interpretation for the structure is related to the fact that it attracts fish and thus may be interpreted as a part of a marine-based economy. If so, the structure must have been built as an underwater structure. Stone-built installations that are thought to be ancient fish nurseries are well known in the Sea of Galilee. They are found near the shores at regular intervals. They were generally made of basalt pebbles and cobbles up to 0.3 m long, piled to form circular installations. Their date is not clear. However, they are significantly smaller than the structure we discuss here, with diameters between 1.5 m and 4 m and heights up to 0.6 m (Galili and Sharvit, 2002: 18). Their interpretation as fish nurseries may be plausible, though not confirmed by archaeological finds. Detailed surveys along the Sea of Galilee shores by Nadel (1993, 2002) and Galili and Sharvit (2002) detected many submerged remains but none of them was as deep or as massive as the structure discussed here.

An alternative scenario is that the structure was built onshore, when the water level was lower than today. The submergence could have occurred either because of tectonic movement or because of rising water levels. Earthquake-related sudden submergence of the lake margins was inferred from the Ohalo II, 23,000-year-old Upper Palaeolithic site (Nadel *et al.*, 1995; Nadel *et al.*, 2001), where *in situ* brush-hut floors, a grave, hearths and other installations were covered with lake sediments. Given the proximity to the marginal faults of the basin, we consider tectonic submergence of the structure plausible, but as this monumental structure is very robust it could also withstand slow, gradual, climatically induced submergence.

The bathymetric map of the Kinneret shows that the southern section of the lake is significantly shallower than its central and northern parts (Ben-Avraham *et al.*, 1990). A low stand after the dry winter of 2002–2003 exposed an island at the southern tip of the lake (*c.* 3 km south-east of the submerged feature), on which circular stone structures with diameters of up to 3 m were discovered, and a few more were discovered on the bottom of the lake north of this island by scuba diving conducted by Y. Paz (data not published). Reshef *et al.* (2007) have reconstructed the ancient outlet of the Jordan River to the Sea of Galilee (through the channel

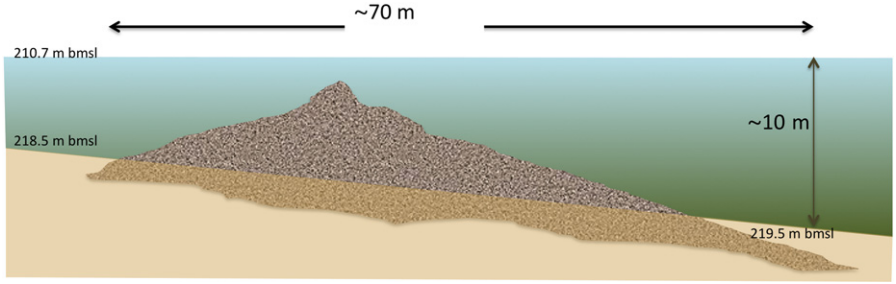

Figure 4. A schematic section with approximate proportions of the structure. (Shmuel Marco)

of the present Yavniel creek) north of Bet Yerah. This reconstruction is based on a Chirp survey and sediment analyses that show that the old alluvial fan of Yavniel Creek occupies the south-western part of the lake. It extends north-eastward from the fossil Yavniel Creek entrance to the lake. We consider these observations evidence for relatively low water levels in antiquity, at least below -219.5 m, which could have enabled the construction of the structure on shore.

We estimate the volume of the structure at *c.*25,000 m^3, and its weight about 60,000 tons. Thus, the effort invested in such an enterprise is indicative of a complex, well-organized society, with planning skills and economic ability.

The possible relation of the submerged stone structure to the ancient settlements along the shores of the Sea of Galilee is of great importance. Flourishing settlement systems existed along the shores in the Bronze and Iron Ages, between the 4th and the 1st millennia BCE. Urban centres such as Bet Yerah, Tel Hadar and Bethsaida were the prominent settlements in Biblical periods (see Kochavi, 1996; Arav, 2001; Greenberg *et al*., 2006).

The only period in this region for which megalithic structures can be connected to settlement sites is the Early Bronze Age, between the late 4th and the late 3rd millennia BCE. The monumental site of Khirbet Beteiha, located some 30 km north-east of the submerged stone structure, comprises three concentric stone circles, the largest of which is 56 m in diameter. It is dated to the EBA (Epstein 1976). The unique megalithic site of Rogem Hiri, 17 km east of Khirbet Beteiha, includes four stone rings with an inner passage grave and has a diameter of 156 m. It is assumed to date to the EBA (see Mizrachi, 1992; Aveni and Mizrachi, 1998). Many megalithic structures, including stone circles, menhirs, and dolmens are found along the Jordan Valley (Worschech, 2002; Scheltema, 2008) and their relation to the EBA urbanization is discussed elsewhere (Paz, 2005).

The variety of stone-built structures at this part of the lake is unique for the discussed elevations. Maybe all of them should be associated with the previous outlet, where remains interpreted as quays and a variety of fishing facilities were constructed at -212, -213, -214 and -222 m. Due to local conditions, this may have been a profitable location regardless of water levels. The continuous use of the place with water-level differences of *c.*10 m has not been documented elsewhere around the lake.

To date no archaeological excavation has been carried out at the site of the submerged stone structure. Underwater research is needed to explore its foundations, search for indicative artefacts, and provide firm dating evidence.

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References

Arav, R. 2001, Bethsaida 2000. *Israel Exploration Journal* 51, 239–46.
Aveni, A. and Mizrachi, Y., 1998, The Geometry and Astronomy of Rujm el-Hiri, a Megalithic Site at the Southern Levant. *Journal of Field Archaeology* 25, 475–96.
Ben-Avraham, Z., Amit, G., Golan, A. and Begin, Z. B., 1990, The bathymetry of Lake Kinneret and its structural significance. *Israel Journal of Earth Sciences* 39, 77–84.
Epstein, C., 1976, Khirbet Bteiha. *Hadashot Arkheologiyot* 8 (Hebrew), 59–60.
Galili, E. and Sharvit, J., 2002, The Sea of Galilee, Coastal and Underwater Surveys. *Hadashot Arkheologiyot* 114, 17–18.
Greenberg, R., Eisenberg, E., Paz, S. and Paz, Y. 2006, (eds). *Tel Bet Yerah, Vol. 1: Excavation Reports*. (IAA Reports no. 30). Jerusalem.
Hall, J. K., 1994, Digital shaded-relief map of Israel and environs 1:500,000. Israel Geological Survey.
Kochavi, M., 1996, The Land of Geshur: History of a Region in the Biblical Period. *Eretz Israel* 25, 184–201.
Koren, N. and Klein, M., 2000, Rate of sedimentation in Lake Kinneret, Israel: spatial and temporal variations: Earth Surf. Process. *Landforms* 25, no. 8, 895–904.
Mizrachi, Y., 1992, Rujm el-Hiri—Toward an Understanding of a Bronze Age Monument in the Levant. (unpublished PhD Thesis). Cambridge.
Nadel, D., 1993, Submerged Archaeological Sites on the Shores of Lake Kinneret. *Atiqot* 22, 1–9.
Nadel, D., 2002, Surveys of the Beaches along the Southern Sea of Galilee. *Hadashot Arkheologiyot* 114, 19.
Nadel, D., Carmi, I. and Segal, D., 1995, Radiocarbon dating of Ohalo II: archaeological and methodological implications. *Journal of Archaeological Science* 22.6, 811–22.
Nadel, D., Belitzky, S., Boaretto, E., Carmi, I., Heinemeier, J., Werker, E. and Marco, S., 2001, New dates from submerged Late Pleistocene sediments in the southern Sea of Galilee, Israel. *Radiocarbon* 43.2, 1167–78.
Nadel, D., Nadler, M., Werker, E. and Boaretto, E., 2006, Ohalo I—Shaldag Beach: A Final Report on an Epipalaeolithic—Neolithic Workshop Site in the Sea of Galilee. *Mitekufat Haeven—Journal of the Israel Prehistoric Society* 36, 39–97.

Nun, M., 1977, *Sea of Kinneret, a Monograph*. Tel Aviv: Ha-Kibbutz Ha-Meuhad.
Paz, Y., 2005, The Megalithic manifestation of the Urban process at the Golan during the Early Bronze Age. *Mediterranean Archaeology and Archaeometry* 5.1, 4–14.
Reshef, M., Ben-Avraham, Z., Tibor, G. and Marco, S., 2007, The use of acoustic imaging to reveal fossil fluvial systems—a case study from the southwestern Sea of Galilee: *Geomorphology*, 83, no. 1–2, 58–66.
Sade, A. R., Tibor, G., Hall, J. K., Diamant, M., Sade, H., Hartman, G., Amit, G., Schulze, B., Zohary, T. and Markel, D., 2008, Multibeam bathymetry of the Sea of Galilee (Lake Kinneret): Geological Survey of Israel and Institute of Oceanographic and Limnologic Research.
Scheltema, G., 2008, *Megalithic Jordan*. Amman: American Center of Oriental Research publications 6.
Worschech, U., 2002, *Cromlechs, Dolmen und Menhire*. Frankfurt am Main: Freidensau.

A Pascual 1 Roman Amphora from Catalonia from the sea at Saint Alban's Head Ledge, Dorset, England

On the 19 July 1994 the upper portion of an amphora was recovered by the Alderney fishing boat *Royal Escape* whilst long-lining off St Alban's Head, Dorset (Fig. 1). It was recovered among a considerable amount of modern rubbish that her lines had picked up from the sea-bed; this was being discarded overboard by the crew when the amphora was noticed by her skipper, Ray Gaudion, who rescued it from a crewman who was about to throw it over the side. Mr Gaudion retains possession of the amphora.

The amphora

The vessel consists of the upper two thirds of an amphora which had the rim broken off some time ago (Fig. 2). A clean break at its lower edge was presumably caused when the long line broke it free of the sea-bed. The upper part of the amphora is covered in marine life, mainly barnacles, with the lower part being clean of growth. The inside of the vessel is coated with a black organic lining with marine growth present in the lower horizontal half, stopping in a distinct line above which the lining is thicker and clean of any growth.

The amphora contained wine and was made in Catalonia, north-east Spain. The vessel is in Williams Fabric 1 (Williams, 1981; Peacock and Williams, 1986: 93–5). The black lining on the interior is likely to be the remains of the resin or pitch with which wine (and other) amphoras were lined.

The absence of the rim makes it impossible to decide with certainty whether the amphora is a Pascual 1 manufactured between the 40s BC and AD 20 (and possibly later), which contained *c.*25 litres of wine, or a Dressel 2–4 (Fig. 3). The Dressel 2–4 superseded the Pascual 1 but their manufacture overlapped, perhaps into the earlier first century AD, and the Dressel 2–4 continued to be made to *c.*AD 80. Dressel 2–4 contained a little more wine; *c.*26 litres. As Dressel 2–4 made in Catalonia usually have a pronounced

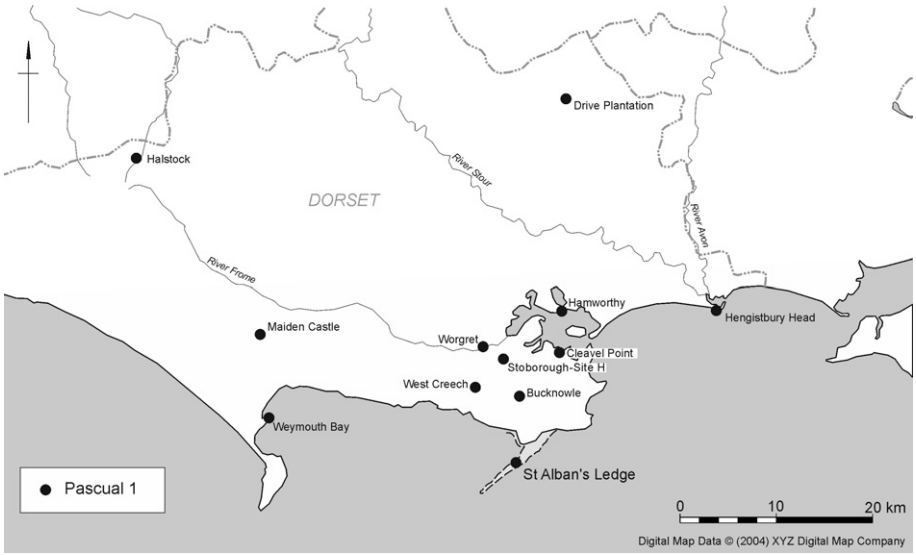

Figure 1. St Alban's Ledge and the distribution of Pascual 1 amphoras in Dorset and the Isle of Wight identified on typological or contextual grounds as dating to the British Iron Age (pre-AD 43). (Drawing: Liz James, Wessex Archaeology)

