Flotation at Sīrāf

PLATES XXXVI-VII

One of the aims of the 1972–73 season at Sīrāf in southern Iran was to complete the collection of data for a study of the subsistence economy of the medieval city. In previous seasons all bones, shells and plant remains large enough to be retrieved by the excavators were collected; the excavators now sought a method of collecting small bones, objects and, above all, seeds and other botanical remains. Flotation of bulk samples was the method chosen and an efficient flotation unit was built on the spot by Mr David Williams, of the Institute of Archaeology, University of London, who here describes his methods.

Although flotation was developed mainly to recover botanical remains, the technique is also used to increase the efficiency of recovering all classes of material (French, 1971, 59). The system used at Sīrāf is cheap and easy to construct, simple to operate and efficient.

We considered two existing systems before building the Sīrāf unit: those developed at Cambridge and at Ankara. The Cambridge system uses froth flotation (Jarman, Legge and Charles, 1972). A different unit with continuously flowing water has been developed at the British Institute of Archaeology at Ankara (French, 1971). The Cambridge 'flotation cell' involves expensive equipment not readily available in remote areas. On the other hand, although the Ankara machine was expensive to build, we thought it could be adapted to the materials available at Sīrāf, which is 240 km. from the nearest town, Bushehr, and (given an appropriate source of water), built and run more cheaply. This, and the virtual impossibility of building a 'Cambridge' unit on the spot, led us to opt for a modification of the Ankara system.

THE ANKARA SYSTEM

The Ankara unit has a through-flow of water, with recovery points along this for heavier (non-flotable) and lighter (flotable) materials (French, 1971). Water passes through a 'main box', is channelled over a weir, through the 'flot box', and thence to waste. Supports in the main box carry a removable piece of 1·5 mm.^{2} nylon mesh, the 'residue net'. The lighter fraction (flot) is carried over the weir and caught in a 1·5 mm.^{2} nylon sieve held in the flot box.

Soil is fed into the main box where mechanical agitation and the water flow release and carry off the flot. Heavy particles $<$1·5 mm.^{2} pass through the residue net ('sludge'); those $>$1·5 mm.^{2} are caught ('residue'). From time to time the sludge is released from the base of the main box and thrown away. The residue is washed, dried, and sorted manually.

THE SĪRĀF MACHINE

We built two units at Sīrāf and supplied them from a single source of water. The system, of course, may be used in single or multiple units. The details are as follows. The water is carried to the main box(es) by 1¼-in. (31·75-mm.) flexible plastic pipe (FIG. 1 and PLS. XVI-VII). At Sīrāf the junctions were 1¼-in. iron pieces, and joints were sealed either with paint and goat hair or jubilee clips, as appropriate. An additional pipe with a tap provides water for cleaning.

The main boxes are 50-gallon (227·4-litre) drums with the tops removed. The inlets are 1¼-in. steel pipes, with cowls cut from metal cans to control the inflow of water. A tap at the main box regulates the flow. The nylon mesh for the residue is supported by a 2-cm. grid of stout wire which rests on three parallel cross-struts of 6-mm. iron rod, slung from the rim of the main box. The residue net is held at the rim by clothes pegs.

At Sīrāf, the weir, again cut from a metal can, was bolted to the rim of the main box 5 cm. below the rim (7 cm. would have been preferable). The joint was sealed by a strip of reinforced rubber; any rubber of 2-4 mm. thickness, *e.g.* a large inner tube, will serve. There was slight leakage but this did not affect the operation. However, a more efficient weir could be made by cutting to an appropriate shape the lid of the 50-gallon drum and welding it to the main box.

An outlet—a short piece of internally threaded 2-in. (50·8-mm.) pipe—was welded to the base of each drum; it was plugged with the original screw-in plug of the drum.

The flot box is a polythene bowl supported on orange boxes. The bowl is fixed at an angle to provide an automatic weir, the 1·5 mm.^{2}-sieve is supported horizontally inside this, in such a way that the flot is kept immersed in water to prevent damage by too-rapid drying.

An extra 50-gallon drum is used for washing the residue by dipping the nylon mesh in which it has been trapped.

THE COST OF THE MACHINE

All the components were bought in Bushehr. All the small tools needed to build the unit (except perhaps tin snips) should be available on any excavation. The welding was done without difficulty in a neighbouring village.

The costs, in pounds sterling, were as follows:

Water supply—plastic pipe, junction pieces, jubilee clips, etc.	10·50
Main boxes (2)—drums, inlet and outlet pipes, taps, welding etc.	9·40
Miscellaneous—nylon mesh, flot sieves, polythene bowls, pegs etc., polythene sheet for drying residue.	6·30
total:	£26·20

THE UNIT IN ACTION

At Sīrāf we decided to carry the samples to the source of water, rather than the water to the site. We carried the samples in '*tanikes*' (18-litre paraffin cans) by Landrover to the flotation unit, a distance of 2–3 km. Our sample size was sixteen *tanikes* (= 0·4 m.^{3} of undug earth).

Our water supply was a pump-filled irrigation reservoir from the base of which the main boxes were filled. The reservoir was sufficiently deep to provide enough pressure for a steady flow, 2–3 mm. deep, over the weir. The operator (one boy per machine) introduces the soil, half a *tanike* at a time, and agitates it manually. Once immersed all immediately flotable material is borne over the weir, and agitation continues until all the flot has been carried off and all particles <1·5 mm.^{2} have passed through the residue net. Another half *tanike* of sample is introduced and the process repeated.

Depending on the nature of the deposit between one and three *tanikes* of earth were put through the machine before the residue net needed emptying. The residue in the net was washed in a drum of water and spread on polythene sheeting to dry. Boys then sorted the dry residue at a table. The numerous finds (bones, shell, small sherds, etc.) were 'processed'—treated, inventoried and packed—by the finds assistants.

The flot was shade-dried in the sieves and stored in polythene bags when fully dry; it will be studied off the site.

When a sample was completed the sludge was released from the main box, which was cleaned out before refilling. Because the box can hold all the sludge from one sample, it is emptied only once in every four hours, and this infrequency of emptying is a major factor in the speed of the operation. Altogether, we processed twenty-five samples of 0·4 m.^{3}, taking four hours each on average; sorting the residue from each averaged thirty-one man hours. We also processed ten smaller samples.

The cost of each large sample was £2·42 (water, bought by the day, 75p, boys' wages at 40p per 8-hr day, flotation operator, 19p and sorters, £1·48).

WIDER IMPLICATIONS OF THE UNIT

The efficiency of a machine in recovering botanical remains is difficult to estimate. Gordon Hillman, an archaeobotanist who has studied 'flot' from both Cambridge and Ankara machines believes that, while it is not impossible that the Cambridge machine offers higher percentage recovery per unit volume of soil for specific categories of seed,* the lower

* E.g. damaged *Lithospermum* fruitlets. These are hollow with silicified walls that are denser than water, so that when damaged, they are likely to sink in the absence of a frothing device.

total quantity of soil that it can process apparently more than offsets this advantage (pers. comm.). The need to design experiments to test and improve efficiency is one of the problems facing flotation.

However, flotation has a wider application than just the botanical. Payne (1972) argues the case for water separation as a means of providing quantitative sampling for *all* archaeological materials, especially the fauna. His experiments demonstrate the widespread failure of conventional archaeological techniques to recover archaeological materials without bias. Thus at Sīrāf, a coastal city in a harsh environment, we needed to use flotation not merely to recover plant remains but also to collect quantitative evidence for the use of fish as a source of protein, for fish bones are often too small to be collected in the trench. Furthermore, we wished to estimate the efficiency of our recovery rate in the excavation as a whole, and to investigate particular problems involving small artifacts, and so on.

Indeed, several small finds were collected from the residue and we encountered an instructive example of the problems of recovery. As expected, we found more small beads than we would have collected in the trench; the proportion of shell beads increased markedly. However, we noticed a *fall* in the number of larger glass beads of >3 mm. diameter, attributable to their destruction by the agitation in the main box. Elsewhere such destruction may be less frequent, for at Sīrāf much of the glass is devitrified and very fragile, but some destruction is liable to occur.

The residue sorting speed is difficult to predict. It varies greatly from sample to sample, from site to site. From my Aşvan experiences I had thought the Sīrāf residue slow to sort: a sample of the fill below the floor of the Great Mosque took eleven man-hours to sort; because of the quantity of small bone, a sample of domestic waste from an alley took fifty. The table below compares residue sorting speeds from Sīrāf with those from two Greek prehistoric sites. The data show, in fact, that Sīrāf residue was not difficult to sort, and emphasizes both inter- and intra-site variability.

Details		Sīrāf	Sitagroi	Franchthi Cave
Sorting speed (man-hours per m.^{3})	min.	28	80	140
	max.	125	120	460
Recovery standard		*c.* 2–3 mm.	3 mm.	5 mm.

Information: Sīrāf and Franchthi Cave: my own records; Sitagroi: from a water-sieving experiment conducted by Sebastian Payne

COMPARATIVE SPEED OF OPERATIONS

Regarding the speed of the actual flotation, the Sīrāf unit compared well with both the Ankara and the Cambridge systems (see table below). The figures quoted here are based on personal experience of all three systems, as published figures for the Cambridge machine are higher than those I obtained at Tell Abu Hreyra in Syria. The speed of the Ankara

Details	Sīrāf	Ankara: e.g. Aşvan, Turkey	Cambridge: Tell Abu Hreyra, Syria
Number of machines	2	2	1
Total *tanikes* (= 0·025 m.^{3}) processed per hour	8	20	6
Tanikes processed per machine-hour	4	10	6
Number of staff	2	4	3–4
Tanikes processed per man-hour	4	5	1·5–2

Working: each operation involved one member of the excavation staff as supervisor and used local labour

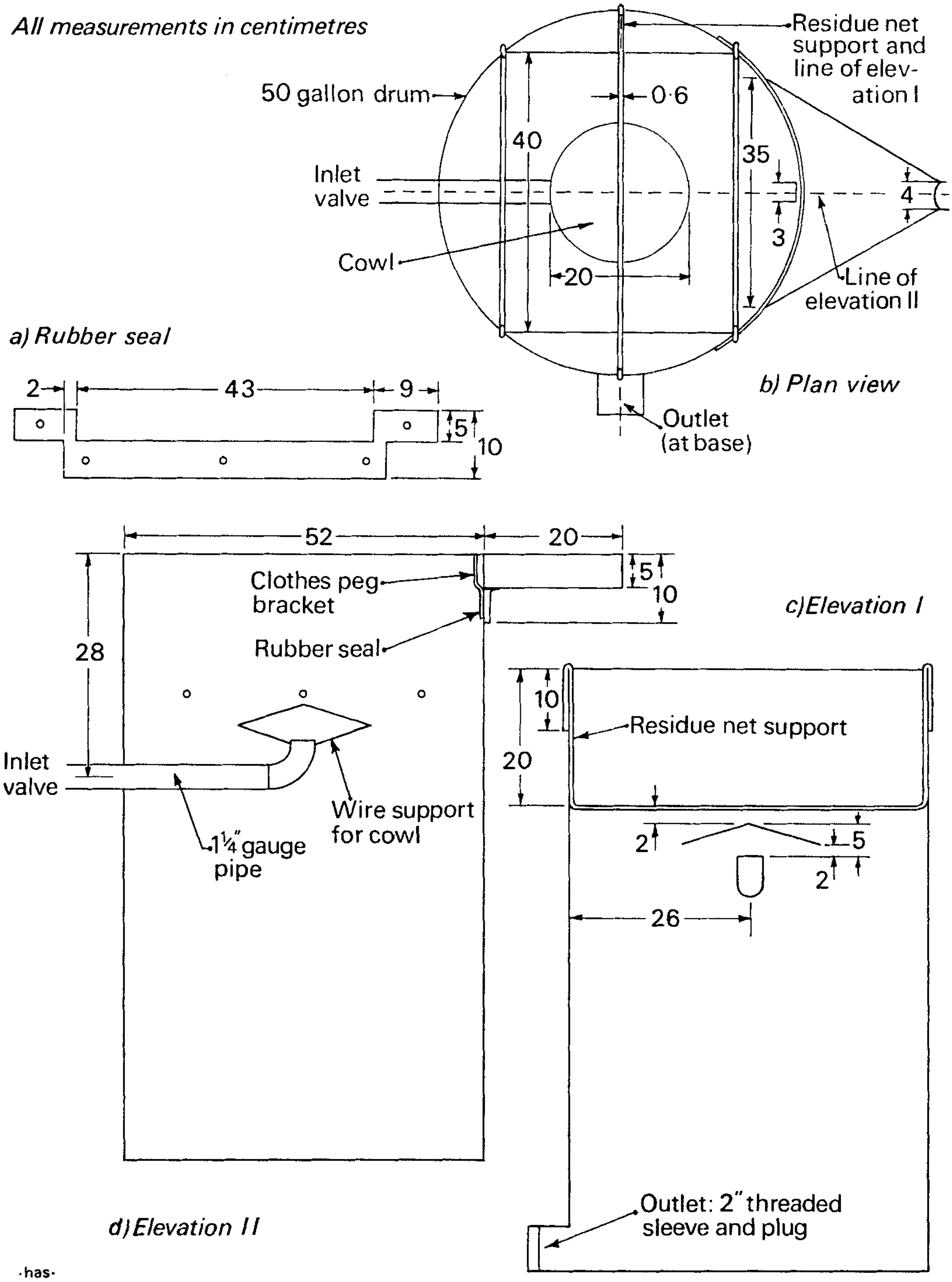

Fig. 1. Blueprint of the Sīrāf flotation unit

https://doi.org/10.1017/S0003598X00039132 Published online by Cambridge University Press

system at Aşvan compares well with the published figures for Can Hasan (French, 1971, 62). It should be noted that although one Sīrāf machine processes less than one Cambridge flotation cell, considerably less labour is needed. Speed of operations could be increased, particularly in clay soils, by the addition of dispersants, *e.g.* 'Calgon', and this is used in schemes operating in the USA (Schneider and Noakes, 1970, 85). Dispersants could be of special importance for flotation in Britain where clay soils are encountered more often than in Western Asia, where most of my data were obtained. Another problem was highlighted recently at Southwark, London, where it was the hardness of the London water which greatly hindered the operation of the bubbler in the Cambridge flotation cell being used.

SUMMARY

A flotation unit was built easily and cheaply at Sīrāf, and a programme of sampling simply and successfully carried out. Because it can be done at such a low cost (£26·60 at Sīrāf), expense alone is no longer a valid excuse for failing to use flotation on many more sites, for without it the excavator stands to lose a significant—perhaps critical—proportion of the data he has undertaken to collect.

Acknowledgements: I am grateful to the Director of the Sīrāf Expedition, Dr David Whitehouse, for inviting me to build a flotation unit on the site and to the Council of the British Institute of Persian Studies for awarding me a bursary which enabled me to join the excavation. I am indebted to Dr David French, for my experiences with the Ankara system led directly to the design of the Sīrāf unit. I would like to thank Dr Whitehouse, Dr French, Dr T. W. Jacobsen (Franchthi Cave), and Andrew Moore (Tell Abu Hreyra) for permission to quote figures from the flotation carried out on their respective sites, and Sebastian Payne and Gordon Hillman for helpful suggestions on the writing of this account.

FRENCH, D. H. 1971. An experiment in water-sieving, *Anatolian Studies*, XXI, 59–64.

JARMAN, H. N., A. J. LEGGE and J. A. CHARLES. 1972. Retrieval of plant remains from archaeological sites by froth flotation, in (ed.) E. S. Higgs, *Problems in economic prehistory* (Cambridge), 39–48.

PAYNE, S. 1972. Partial recovery and sample bias: the results of some sieving experiments, in (ed.) E. S. Higgs, *Problems in economic prehistory* (Cambridge), 49–63.

SCHNEIDER, K. A. and J. E. NOAKES. 1970. Site analysis with a mobile archaeological laboratory: microsample extraction and radiocarbon dating, *Southeast Archaeological Conference, Bulletin* 13 (Morgantown, West Virginia), 82–7.

A saint in a stone circle

PLATE XXXV

The Editor of ANTIQUITY has recently brought together an anthology of megalithic monuments with sometimes improbable historical associations (Daniel, 1972), and another curious example may be added. In the church of St-Merri in Paris is a sixteenth-century panel painting of the Fontainebleau School, depicting Ste-Geneviève, patron saint of Paris, as a shepherdess guarding her flock within a realistically depicted circle of about 37 small standing stones set in a landscape with figures, buildings and towns in the background (PL. XXXV). Attention was drawn to this, in the context of Breton megalithic monuments, by Denis Roche (1969), who reproduced an eighteenth-century engraving of the picture and commented that Cambry (1805) had referred to a '"parc" de Sainte-Geneviève' apparently in terms of a stone enclosure. No such reference can be traced in the *Monumens Celtiques* however, and we are left with the picture itself.

Miss Susan Waterston, who has guided me through the iconographical problems involved, points out that Réau regards the depiction of the original fifth-century saint as a shepherdess with her flock as a late medieval invention, perhaps arising from confusion with Ste-Marguerite and influenced by the taste for pastoral romances from the sixteenth century onwards. The St-Merri picture is the earliest example of this convention cited (Réau, 1958, 563, 566). Normally the attributes are a distaff (not shown in this instance) and the shepherd's crook with a spatulate end for casting stones at errant sheep, a distinctive object which Miss Waterston has noted in other contemporary contexts, such as the Hieronymus Bosch