THE BAQ^{c}AH VALLEY, JORDAN: A CESIUM MAGNETOMETER SURVEY

P. McGOVERN

MASCA The University Museum University of Pennsylvania Philadelphia, Pa. 19104

Introduction

In June 1977, I co-directed a salvage excavation of a partially robbed-out Late Bronze Age burial cave in the Umm ad-Danānīr region of the northwestern Baq^{c}ah Valley, approximately twenty kilometers northwest of Amman, Jordan (McGovern 1979).* In contrast to earlier surveys which had found no evidence for the Late Bronze Age in the valley (Glueck 1939; de Vaux 1938), a very extensive and representative repertoire of LB IA-IIA local and imported pottery (including Mycenaean IIIB, Cypriote Base-Ring II, Chocolate-on-Cream, and bichrome wares), along with accompanying grave goods (scarabs, cylinder seals, bone inlay, a bull figurine, earrings, bracelets, toggle-pins, many types of glass and faience beads, etc.), were recovered from an anciently disturbed stratum above the floor of the cave. The high quality and quantity of the pottery and small artifacts (52 whole vessels, 290 small finds, and *ca*. 10,000 sherds were registered), coming from a sounding limited to less than a quarter of the cave, strongly suggested that LB settlement(s) and other burial caves existed nearby. With this prospect in view and as a first step towards developing future excavation strategy, a thorough archaeological survey, employing geophysical prospecting instruments, was carried out during October and November 1978. **

Preliminary studies

Assuming the excavated cave to be representative, it appeared likely that other burial caves in the region would be silted up and their mouths covered over by soil eroded away and washed down from the hill above. Obviously, surface exploration would then be of little use. Even where a cave entrance might be partially visible, there would be a high probability of modern disturbance. Completely filled-in caves, on the other hand, could be expected to have intact burials, and might produce a much-needed stratigraphic sequence of Transjordanian LB pottery and artifacts.

Earlier MASCA cesium magnetometer surveys had been successful in detecting graves (Ralph 1969). In order to test the magnetometer's usefulness for the Umm ad-Danānīr region, the magnetic susceptibilities of stone and soil samples from the 1977 cave excavation were measured using a single sensor, with frequent checks on the background field intensity. The difference in average magnetic susceptibility between the cave fill (0.005 nT m^3/kg) and the sandstone and

Plate 1:
Cylinder seal (impression), almost certainly from northern Mesopotamia, from excavated Cave A2 on Jebel al-Hawāyah.

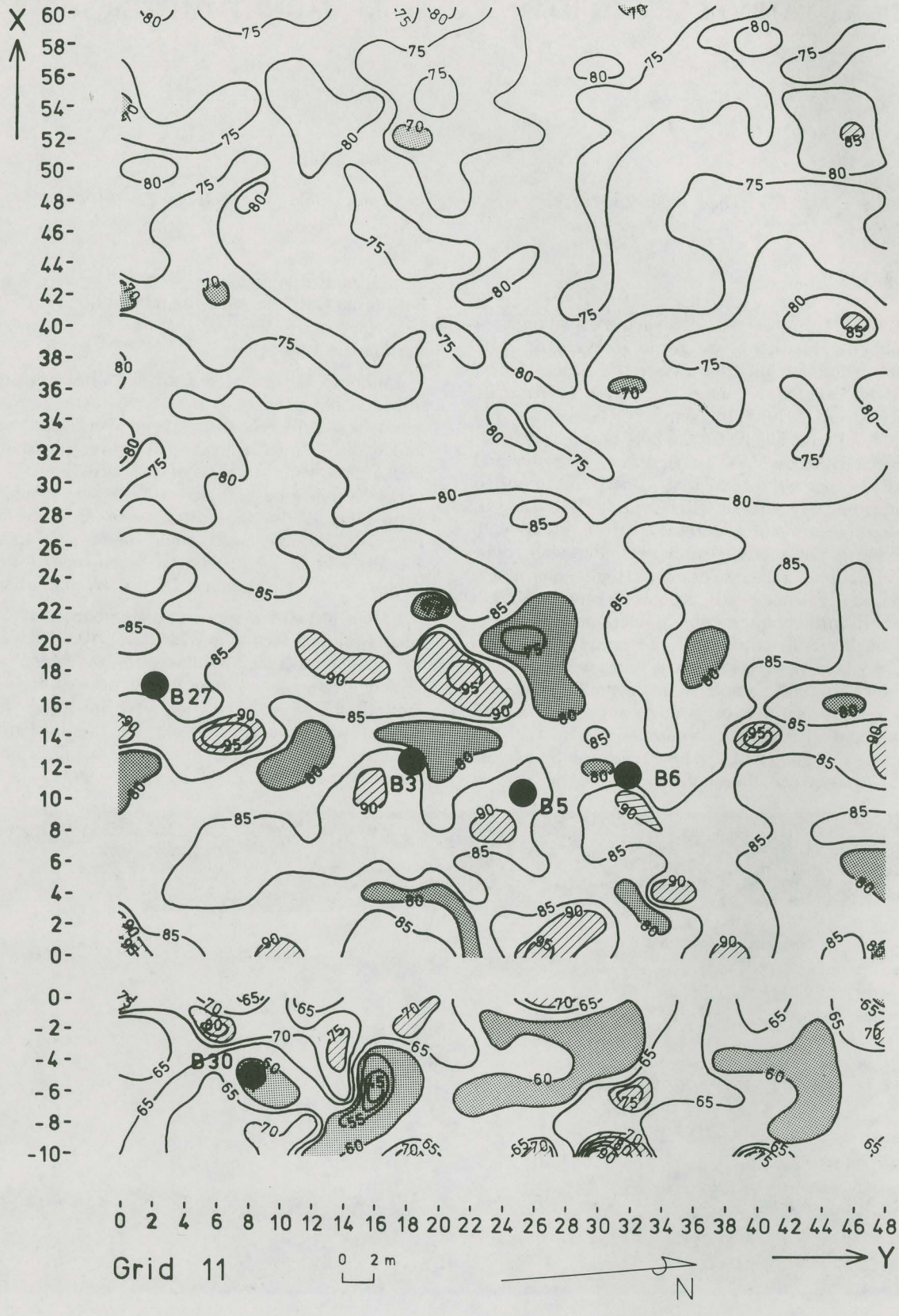
X
60-
58-
56-
54-
52-
50-
48-
46-
44-
42-
40-
38-
36-
34-
32-
30-
28-
26-
24-
22-
20-
18-
16-
14-
12-
10-
8-
6-
4-
2-
0-
0-
-2-
-4-
-6-
-8-
-10-
B27
B3
B5
B6
B30
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48
Grid 11
0 2 m
N
Y

Fig. 1:
Magnetic Contour Map of Grid 11
Contour interval of 5 nT is based on magnetometer readings every 2 m, and only the last two numbers of the magnetic intensity are recorded (*i.e.*, 85 should be read as 43,885 nT). A slow diurnal decrease in the background field intensity should be noted: traverses X0 to X -10 were done in the early afternoon after completing traverses X0 to X60 in the morning.
Robbed-out burial caves are indicated by black dots, letter and number; magnetic highs by diagonal hatching; lows by stippling.
Line drawing prepared by H. Schenck, MASCA.

limestone bedrock, which showed a slight susceptibility, was statistically significant. Assuming an 8 - 50 cubic meter volume range for the filled-in caves (the excavated cave had about 30 cubic meters of soil fill), magnetic anomalies between 10 and 50 nT could be expected. The cesium magnetometer (with its 0.1 nT sensitivity) would detect the complete range of projected anomalies.

Survey results

Our expectations appear to have been completely justified. Another 32 partially or fully robbed-out burial caves were located on the eastern lower slopes of the two hills which lie north and south of the Wadi Umm ad-Danāmīr (Jebel al-Hawāyah and Jebel al-Qeṣīr, respectively). Of those caves whose robbers' dumps could be surface-sherded, nineteen were Late Bronze Age in date (five MB IIC/LB IA, three LB IA, three LB II, seven LB, and one LB II/Iron IA). In between these robbed-out caves, no less than 18 significant anomalies in the 10 - 50 nT range were located and mapped. Since these anomalies are near the robbed-out caves and in the same soft limestone/sandstone strata, some of them undoubtedly represent filled-in LB burial caves.

The average intensity of the Earth's magnetic field for the Umm ad-Danāmīr region was about 43,850 nT, which normally decreased slightly during the morning hours. Since the variation was always quite slow and did not show any large changes due to solar storms or other magnetic disturbances, a single sensor in its absolute mode was used for the survey. This speeded up the operation over difficult terrain, even though two sensors in the differential mode would have eliminated all variations, including the diurnal one.

Grid 11 (Fig. 1) on Jebel al-Qeṣīr provides a good example of the type of data we obtained. As is readily apparent, there is a great deal more magnetic activity in the immediate vicinity of the robbed-out caves on the lower part of the hill in contrast to further up the hill where there is virtually no activity. Each of the robbed-out caves had an associated robbers' dump downhill from the cave entrance, and predictably these show up as magnetic highs (X14, Y0; X10, Y16; X8, Y24; X9, Y32; X -9, Y10). The robbed-out caves themselves show up either as lows (B3 and B30) or blend in with the background intensity (B27, B5, and B6), depending upon the amount of magnetic soil fill which has been removed and the size of the air cavity (with no magnetic susceptibility) thus created. When the air void is large enough, it is possible to have a low anomaly relative to the slightly magnetic bedrock.

A number of magnetic highs on the grid, which are not due to robbers' dumps, are very likely filled-in burial caves. Anomalies of 15 nT (X14, Y7) and 10 nT (X14, Y40), both 2 m x 4 m in area, are equivalent in size and located on the same line as robbed-out caves B27, B3, B5, and B6, so that they are probably best explained as burial caves, missed by the robbers.

A 15 nT high (X17, Y22), 4 m x 6 m in area, with a 10 nT reverse anomaly to the north, may represent an extension of cave B3, since this cave appears to have been only partially robbed-out. Other highs occur further downhill along another line of robbed-out burial caves, which includes cave B30, *e.g.*, a 15 nT anomaly at X1, Y27, and a 10 nT one at X -6, Y32.

Magnetic lows are also of potential importance, since they could in fact turn out to be caves or parts of caves that have large air voids, which would naturally be much easier to excavate than filled-in caves. For example, a 10 nT anomaly at X22, Y20, 2 m x 2 m in area, could be a further extension of cave B3. The 20 nT low at X -5, Y16 may be a large unfilled cave with only its mouth covered over, although the high gradient dipole, which showed up even more clearly in a high resolution grid with a 1 m spacing of measurements, suggests surface iron.

The same pattern of magnetic highs and lows near robbed-out burial caves repeats itself in the other grids, covering a total area of 3.4 hectares, on the lower slopes of the two hills. However, only future excavation of various types of magnetic anomalies can enable one to interpret the results more exactly.

*Chief sponsors of the project were the Jordanian Department of Antiquities and the American Center of Oriental Research in Amman (ACOR), with additional support provided by the Kyle-Kelso Archaeological Fund.

**The survey, jointly funded by the Jordanian Department of Antiquities, the National Geographic Society, and MASCA, was headed by two MASCA personnel, Patrick McGovern (principal investigator) and Bruce Bevan.

References

Glueck, N., 1939: *Explorations in Eastern Palestine, III.* Annual of American Schools of Oriental Research 18-19, 191 (Edit., Burrows and Speiser, American Schools of Oriental Research, New Haven).

McGovern, P.E., 1979: *American Schools of Oriental Research Archeological Newsletter 4*, 9.

Ralph, E.K., 1969: *Expedition 11*, 14.

de Vaux, R., 1938: *Revue biblique 47*, 398.