

Space Archeology Overview at Gordion: 2010 to 2012

In fiscal years 2010, 2011, and 2012, Compton Tucker was the principal investigator of a NASA Space Archaeology project that worked at Gordion, in Central Turkey. Tucker was assisted by an excellent team of co-workers including Joseph Nigro and Daniel Slayback of Science Systems Applications Incorporated, Jenny Strum of the University of New Mexico, and Karina Yager, a post doctoral fellow at NASA/GSFC. This report summaries their research activities at Gordion for the field seasons of 2010, 2011, and 2012. Because of the possible use of our findings at Gordion for tomb robbing there and/or the encouragement of potential tomb robbers using our geophysical survey methods to locate areas to loot, we have not published any of our survey results in the open literature nor placed any of these results on any web sites. These 2010-2012 survey results remain in the confidential archives of the University of Pennsylvania's University Museum of Archaeology and Anthropology, the group that leads the Gordion Excavation and Research Project. Excavations are planned for 2013 at Gordion, including several that will be based upon the research results in this report.

The site of Gordion in central Turkey, famous as the home of King Midas, whose father's intricately tied knot gave the site its name, also served as the center of the Phrygian kingdom that ruled much of Central Anatolia in Asia Minor during the early first millennium B.C. Gordion has been a University of Pennsylvania Museum of Archaeology and Anthropology excavation project since 1950, yet the site is incompletely published despite six decades of research. The primary obstacles related to the site and its preservation were two problems that NASA technology could address: (1) critical survey errors in the hundreds of maps and plans produced by the earlier excavators, most of which used mutually incompatible geospatial referencing systems, that prevented any systematic understanding of the site; and (2) agricultural encroachment upon the site that was compromising its archaeological integrity. Our NASA Space Archaeology proposal was written to address both of these problems. When we started working at Gordion in 2010, we added a third objective, (3) ground penetrating radar and magnetic geophysical surveys of threatened areas.

The first objective our NASA Space Archaeology Project was to provide the University of Pennsylvania's Museum of Archaeology and Anthropology a system to rectify and incorporate all existing survey data from Gordion, including previous aerial photographs of the site, detailed site surveys, maps, and excavation plans, into a common mapping system. This was accomplished with a Geographic Information System (GIS) based upon a 60 cm Quickbird satellite image ortho-rectified using Shuttle Radar Topographic Mission (SRTM) 30 m digital elevation data and tied to a known datum at Gordion. This enabled the first accurate, multi-layer plan of this complex site, occupied almost continuously from the Bronze Age to the 1st millennium CE, and made possible Gordion's three-

dimensional development for the first time. This can be found at:
<http://sites.museum.upenn.edu/gordion/>

The second objective of our research plan was to incorporate ortho-rectified Landsat data from the 1980s, 1990, 2000, 2005, and 2010 to determine agricultural encroachment upon archaeologically-sensitive areas at greater Gordion. We started this work but the archaeologists at Gordion impressed upon us the need for non-destructive geophysical surveys there and we modified our research plan, adding ground penetrating radar and magnetic surveys to our research plans as a third objective. The third objective came to dominate our research activities at Gordion from 2010-2012.

Background:

Before we discuss our field campaigns of 2010, 2011, and 2012, we need to describe the archaeological site of Gordion. Located in modern central Turkey, Gordion was an important historical center in the ancient Near East (Kealhofer 2005). It has been remembered as the city visited by Alexander the Great, who allegedly “untied” the Gordian Knot by cutting it with his sword and thus became the prophesied ruler of Asia. It is also associated with Midas, king of Phrygia, who in Greek legend was cursed with asses’ ears and the “Golden Touch”. Even though the place has been long remembered in history and legend, it was rediscovered in the late nineteenth century and the imposing monuments of the citadel began to emerge only after the University of Pennsylvania began excavations there in 1950.



Figure 1.1. Location of Gordion in Asia Minor



Figure 1.2a. Excavating the Citadel Gate Building in the 1950's. Figure 1.2b Gordion Citadel (1989)

Balloon photograph.

Gordion's historical significance derives from its very long and complex sequence of occupation—spanning over 4,500 years—and from its role as a major center of power in the early first millennium B.C. Nearly 60 years of field work and excavations have been performed at Gordion. Alfred and Gustav Körte conducted excavations there in 1900, first identifying the site as Gordion, but the most extensive operations were the 1950–1973 campaigns directed by Rodney Young of the University of Pennsylvania Museum (Young 1981; Kohler 1995). The main foci of Young's work were the Citadel Mound and thirty of the tumuli or burial mounds, but important excavations also occurred in the inner and outer town. After Young's death in 1974, excavations ceased until 1988.

Over 30 seasons, 270 trenches have been opened and over 50,000 artifacts have been recovered, dating from the Early Bronze Age (3,000 B.C.) to the Medieval Period (1200 to 1450 A.D.). The majority of the structural remains and deposits no longer physically exist, which is the inevitable result of archaeological excavation—to dig down to earlier, lower levels you must dig through and destroy the later, overlying levels. They still exist in graphic form, however, in the excavation's documentary records—written reports, drawings, maps, and photographs—that were created as the digging and the post-excitation analysis proceeded.

Quickbird image of Gordion



Figure 1.4. Quickbird image of Gordion, showing the citadel and Midas Mound.

References:

Kealhofer, L. (Ed.). 2005. *The Archaeology of Midas and the Phrygians. Recent Work at Gordion*. ed. L. Kealhofer, Philadelphia, pp. 10–21.

Kohler, E. L. 1995. *The Gordion Excavations (1950-1973) Final Reports, Volume II. The Lesser Phrygian Tumuli, Part 1: The Inhumations*, Philadelphia.

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Voigt, M. M., and R. C. Henrickson. 2000. "Formation of the Phrygian State: The Early Iron Age at Gordion," *Anatolian Studies* 50, pp. 37–54.

Young, R. S. 1981. *The Gordion Excavations (1950-1973) Final Reports, Volume I. Three Great Early Tumuli*, Philadelphia.

Chapter 2 Description of NASA's Gordion Radar and dGPS Surveys 2010

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Overview

Tucker, Nigro, and Sturm, henceforth referred to as the "NASA Team", collected a series of dGPS points and performed ten ground penetrating radar surveys between July 20th and July 29th, 2010 on site at Gordion. Joseph Nigro collected data from 8 dGPS locations (figure 2.1) to complement dGPS points already collected by University of Penn. Museum (UPM) personnel. These locations, all corresponding to Turkish cadastral survey locations, will be used to provide improved location control for the ortho-rectification of high-resolution satellite data obtained by NASA and UPM.

In addition, between July 21st and July 29th, 2010 ten areas were imaged using 400 MHz (1 area) and 200 MHz (9 areas) ground-penetrating radar (GPR) antennas in the Gordion study area (see figure 2.2, table 2.1, and Appendix 2A). People taking part in the GPR surveys were Joseph Nigro, Jennie Sturm, and Compton Tucker.



Figure 2.1. Locations of the 8 dGPS areas collected in 2010 by Joseph Nigro.

While the GPR data are being processed at this time for the final report, the most promising find seems to be from the area to the

west of Tumulus KY (figure 2), an area similar in general appearance to Tumulus KY as described in Kohler (1995).



Figure 2.2. Grids three, four, and five surveyed by the NASA Team. Grid 4 seems to be the most promising area surveyed based upon our preliminary assessment coupled with a coincident magnetic survey by GHH.

As noted by Richard Liebhart, the surface of grid 4 was composed of different soil than the surrounding area and is similar to tumulus KY, only 50 m away, where a tomb with a horse burial was excavated in 1955 (figure 2.3). This was further apparent from the stark difference in vegetation growing there that has persisted over many years (Liebhart 2010, personal communication, based upon walking past this area for 12 field seasons).



Figure 2.3. Tumulus KY excavation photograph from 1955 showing the placement of two bridled horses in close proximity to the deceased. Tumulus KY was also a low tumulus as was the area we measured in figures 2.4 & 2.5.

The GRP survey of grid 4 indicates a circular structure to this grid with two areas of strong radar reflection (figure 2.4), indicating the presence of metal. A surface feature, a plowed series of furrows, runs down the center of this area, and was the result of an attempt at a fire break when a ground fire is reported to have occurred earlier in the year. Furthermore, the ground penetrating radar return from grid 4 indicates the top 2 m of this general area is undisturbed and thus probably has not been looted. The penetration depth of our ground penetrating radar with the 400 MHz antennae is thought to be 2.0 to 2.5 m.

Our colleagues from GHH collected magnetometer data from this area after our radar survey had been completed. Their data indicate 2 areas of magnetic anomalies coincident with our radar survey (figure 2.5).

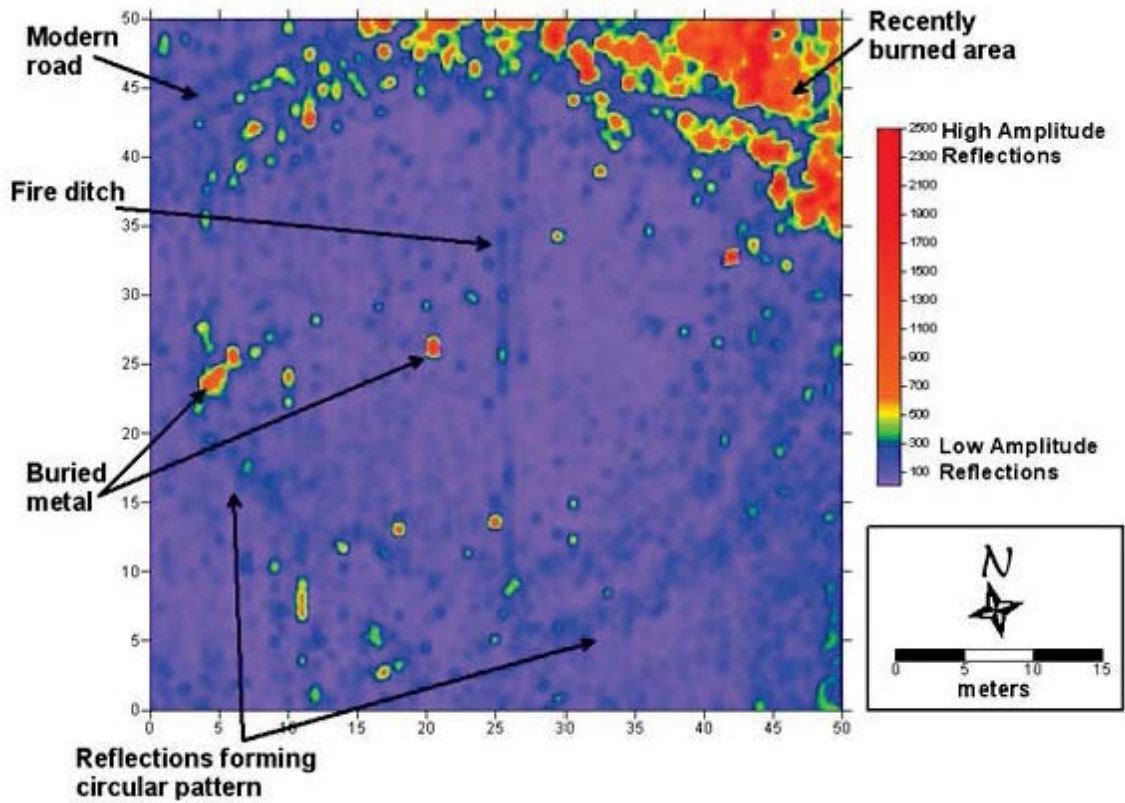


Figure 2.4. 400 MHz ground penetrating radar imagery from Grid 4, the area opposite Tumulus KY (figure 2.3). Our survey identifies two areas of buried metal and a generally circular area surrounding the area. See also figure 2.5 for coincident magnetic survey data.

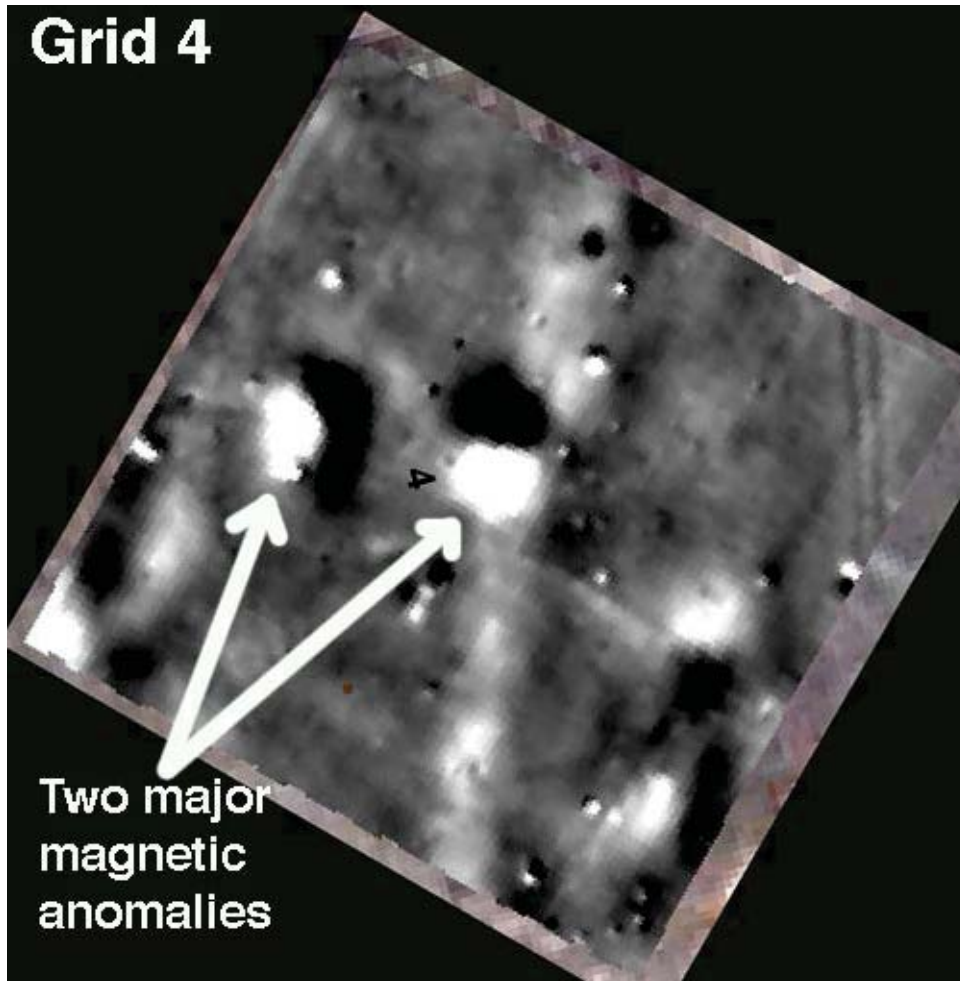


Figure 2.5. Magnetic survey of Grid 4 showing 2 major anomalies in the same locations as the radar anomalies in figure 2.4.

After conducting radar measurements, the location of every area imaged was determined using a differential global positioning system (dGPS).

Unlike last year, it was not necessary to clear all the areas measured this year with a “weed whacker”. Only 2 areas required herbaceous vegetation clearing. Mr. Zekei Utku’s brother, Umer Utku, performed the vegetation clearance. A new weed whacker of Italian manufacture was acquired through NASA and a NASA sticker affixed to it.

We first surveyed the ramp area on the citadel, thought to perhaps be a location of a gate (figure 2.2). We used the GHH 200 MHz

antennae for this survey. All nine other radar surveys we performed used Jenny Sturm’s 400 MHz antennae.

Fifteen of the areas were 25 x 25 m, one area was 25 x 20 m, and another area was 20 x 15 m. Preliminary examples of the data collected are presented from area 16 as figure 2.2 and from area 2.6 as figure 3. The total area in the common cemetery surveyed was slightly more than 1 ha.

Appendix 2A.

Table 2A.1: Collection parameters for the ten GPR grids collected at the Gordion site during the July 2010 field season.

Grid #	Dimensions (meters)	Antenna Freq. (MHz)	Transect spacing (meters)	Depth (ns)	Date Collected (2010)	Description of Area
1	22 x 50	200	2	90	July 21	“Ramp”
2	15 x 25	400	0.5	50	July 22	“Radial Walls” Tumulus
3	20 x 22	400	0.5	45	July 23	Common Cemetery
4	50 x 50	400	0.5	50	July 23 & 24	tumulus, across from KY
5	10 x 40	350	0.5	50	July 26	east of compound
6	30 x 40	400	1	40	July 27	Ken’s tumulus in field
7	10 x 10	400	1	40	July 27	Ken’s “test tumulus” in field
8	38 x 44	400	1	50	July 28	“Outer City” tumulus
9	9 x 13	400	0.5	45	July 29	Wall cut, south side
10	6 x 10	400	0.5	45	July 29	Wall cut, north side

Chapter 3
Description of NASA's Gordion Magnetometry and dGPS Surveys 2011

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Tucker, Slayback, Nigro, and Sturm, henceforth referred to as the “NASA Team”, performed magnetic surveys on 3.8 ha between July 12th and July 24th, 2011 on site at Gordion (figure 3.1). Associated with the magnetometer surveys were differential global positioning system (dGPS) measurements of all the areas surveyed. Daniel Slayback led the magnetometry effort and Joseph Nigro led the dGPS data collection efforts and a tabular summary of the NASA team’s efforts day-by-day appears as Appendix 3A.

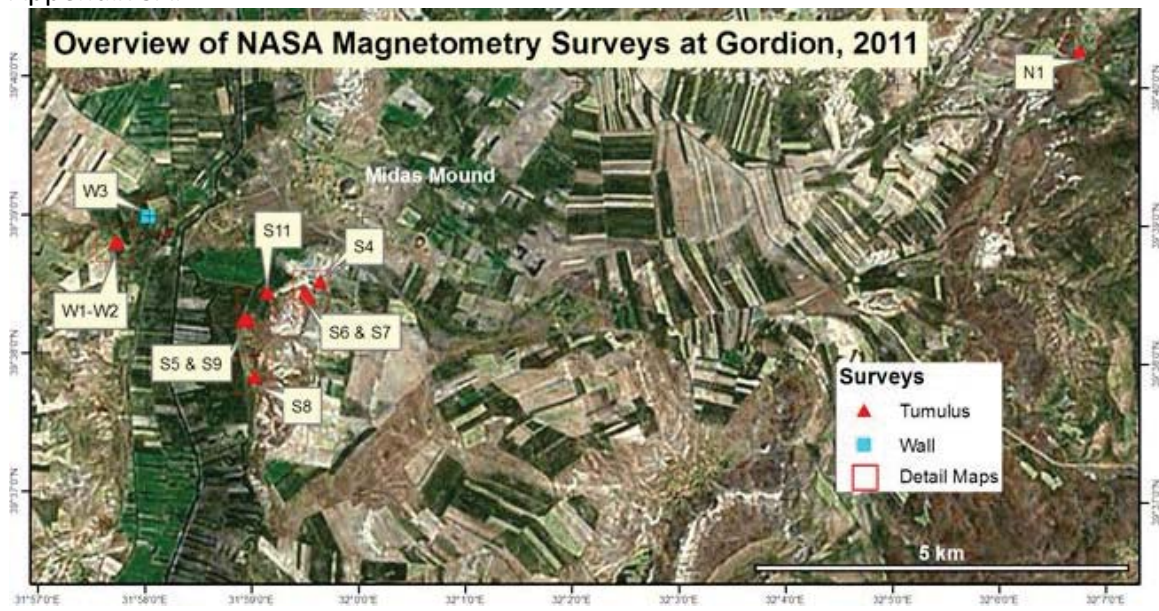


Figure 3.1. Location of the magnetometer surveys and associated dGPS data collected in 2011 by the NASA team.

The NASA team focused on magnetic surveys of tumuli this year, extending the work of the GGH team at Gordion in 2008 and 2009. In addition, opportunistic magnetometer surveys were made in the area beyond the regular train tracks to the west of the citadel mound where a middle Phrygian wall section has been exposed for ~3 m. Specific information on the areas surveyed appears as Table 3.1. The system used in these surveys was the Geometrics 858 configured to collect as a magnetometer (appendix figure 3A1) with a second Geometrics 858 configured to run as a base station during data collection. While the magnetometer data are being processed at this time for the final report, several promising areas were identified and are described in this preliminary field report.

The large tumulus ~5 km to the East North-East of Gordion adjacent to a well-preserved section of the Roman Road was surveyed in 4 sections totaling 0.67 ha (referred to in this report as tumulus “N-1”). A section of the Roman Road was also magnetically surveyed at the same location (figure 3.2).

Table 3.1. Summary of the areas identified in figure 3.1 where the NASA team collected magnetometer and dGPS data at Gordion from July 12 to 24, 2011.

Item	Description	Survey Date	Grid	X size (m)	Y size (m)	Area (ha)
N1	North Tumulus 1 (by roman road fragment)	18-July	1	50	50	0.25
N1		19-July	2	40	24	0.10
N1		19-July	3	50	24	0.12
N1		24-July	4	40	50	0.20
S5	South Ridge Tumulus 5	16-July	1	44	50	0.22
S6	South Ridge Tumulus 6	15-July	3	70	36	0.25
S6		20-July	5	70	50	0.35
S6		23-July	6	30	44	0.13
S7	South Ridge Tumulus 7	13-14 July	1	24	22	0.05
S8	South Ridge Tumulus 8	15-July	1	50	50	0.25
S9	South Ridge Tumulus 9	16-July	1	24	40	0.10
S11	South Ridge Tumulus 11	16-July	1	18	22	0.04
W1-W2	West of railroad, tumuli 1 & 2	17-July	1	24	54	0.13
W3	West of railroad, Phrygian Wall remnant	17-July	1	30	30	0.09
W3		20-July	2	34	50	0.17
W3		22-July	3	100	50	0.50
W3		22-July	4	50	50	0.25
W3		23-July	5	90	50	0.45
W3		23-July	6	32	50	0.16
					Total:	3.8

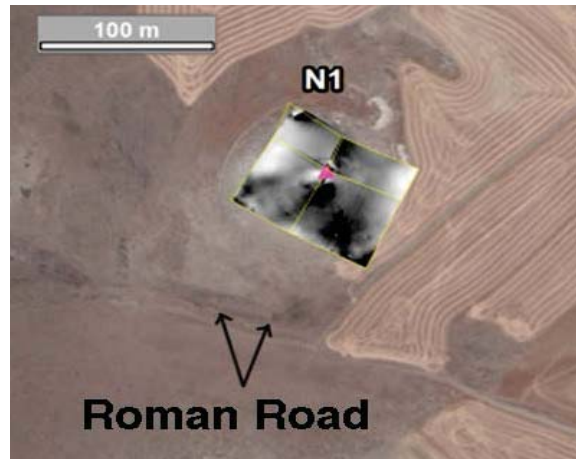


Figure 3.2. Magnetic data from the large tumulus adjacent to the Roman Road ~ 5 km from Gordion to the East North East. A small section of the Roman Road was also surveyed.

A strong magnetic anomaly was evident in figure 3.2 indicating a possible tomb chamber but detailed subsequent processing will be needed to determine if the tumulus has been previously robbed. Four or five years ago a mechanical digger had removed a large (~4 x 4 x 2 m) volume of the tumulus on its north aspect. There were no indications of current robbing activities on this tumulus.

The NASA team collected detailed magnetometer data on tumuli S6 and S7 (figure 3.3).

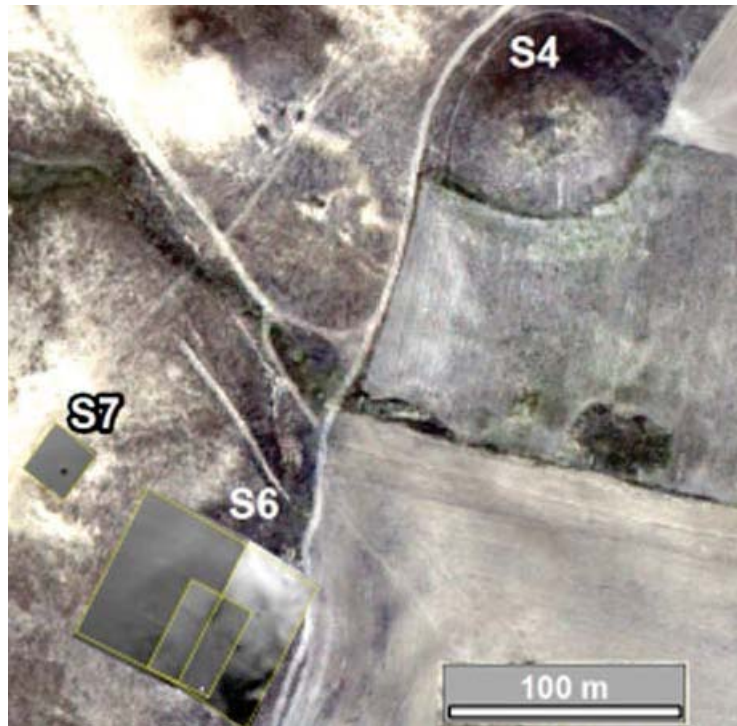


Figure 3.3. Preliminary magnetic survey results from tumuli S6 and S7.

The preliminary analysis of the magnetic data from tumulus S6 indicates an undisturbed tumulus because the magnetic properties of this tumulus are very homogenous. This indicates as unlikely previous occurrence of plundering. No tomb chamber was evident but this may emerge in the subsequent detailed processing of the magnetic data collected.

Tumulus S7, a small mound adjacent to the road, was also surveyed. Dr. Slayback was walking from tumulus S6 with the magnetometer on back (see figure 3A1) to the truck we rented and noticed a strong magnetic anomaly. We then laid out a grid and surveyed this area that became tumulus S7. The strong anomaly in tumulus S7 is evident as the dark spot in the area surveyed for this tumulus.

Dr. Slayback also informally surveyed several of the possible tumuli along the ridgeline to the west of tumuli S4, S5, and S7. This was done by using the magnetometer in “search” mode, which can help identify possible anomalies that can be systematically surveyed at a later date. He concluded many of the possible tumuli along the

ridgeline in this area were natural and there were no indications of magnetic anomalies indicating the presence of tumuli.

We surveyed three tumuli to the south of figure 3.3, including tumulus S11 in a corner of an onion field (figure 3.4). Another tumulus ~80 m to the west from tumulus S11 was inaccessible because it was in the middle of the onion field.



Figure 3.4. Tumuli S5, S9, and S11 along the East Ridge overlooking Gordion.

Strong magnetic anomalies were observed in tumulus S5 and single anomalies were observed in tumuli S9 and S11, all indicating possible burial chambers (figure 3.4).

We also surveyed in two different areas on the west side of Gordion and within 100-200 m of the Ankara to Eskisehir railroad line (figure 3.1). The first area we surveyed was where several

Hellenistic tumuli exist (figure 3.5). We found several magnetic anomalies in tumuli W1 and W2 and also indications of robbing, evident by heterogeneous magnetic properties in the areas surveyed.

The second area west of the Ankara to Eskisehir railroad line was also immediately adjacent to an area where a ~3 m section of a middle Phrygian wall has been exposed (figure 3.6). This area of ~1.6 ha showed the presence of several linear features that could be architectural although they could be associated with previous irrigation activities in the agricultural fields in this area. This area will also be studied in detail in the NASA Team's subsequent analyses. This concludes the preliminary analyses of the magnetic data collected by the NASA Team.



Figure 3.5. Magnetic surveys of tumuli W1 and W2 to the west of the Ankara to Eskisehir railroad line. Several magnetic anomalies were evident and robbing pits on both tumuli were also noted.



Figure 3.6. A large survey was conducted in the area adjacent to an exposed middle Phrygian stonewall ~3 m in length and 1-2 m high (noted in the red color next to the label “W3”).

Appendix 3A.

Table 3A.2: Information for the magnetometer surveys collected at Gordion from July 12 to 24, 2011. We conform to the existing naming convention for tumuli where they have been named previously. See figure 3.1 for an overview of the areas described below.

Fri 08-July	Arrival at Excavation House of Slayback & Tucker
Sat 09-July	Begin instrument setup, purchase of supplies
Sun 10-July	Finished instrument setup and modifications; complete test run. Arrival of Nigro & Sturm
Mon 11-July	Looked for and found truck to carry equipment
Tue 12-July	Began setting up corner points for survey grids S8, S4, S5, S6. Surveyed tumulus S6, grid 1 (see figure 1 for locations).
Wed 13-July	Continued survey of S6, grids 1-2. Surveyed S7 and performed a quick survey of S4 to verify ability to locate anomalies. Travel to Ankara to submit research permit application.
Thu 14-July	Returned from Ankara. 4 additional surveys of S7 were made to test

	different sensor and survey grid configurations.
Fri 15-July	Finished survey of S6 with grids 3-4. Surveyed S8.
Sat 16-July	Surveyed S5, S9, and S11. Setup grid for S10, but a survey here would require clearing of vegetation. S10 was not surveyed.
Sun 17-July	Surveyed W1-W2 (one grid), W3 (by Phrygian wall remnant), and W4.
Mon 18-July	Surveyed N1 (large tumulus by roman road fragment, north of Gordion), grid 1.
Tues 19-July	Continued survey of N1 with grids 2-3. Also surveyed portion of Roman road segment.
Wed 20-July	Resurveyed S6, grid 5, and extended survey of W3 with grid 2.
Thu 21-July	[Day off]--collected GPS data in the afternoon
Fri 22-July	Extended survey of Phrygian wall area (W3) with grids 3-4.
Sat 23-July	Finished extension of Phrygian wall survey (W3) with grids 5-6. Added additional grid on top of S6 to look for clearer anomaly signature.
Sun 24-July	Completed survey of N1 with grid 4. Brakes on truck failed on descent from area of tumulus N1 ending our work for the Gordion 2011 field season.



Figure 3A1. The NASA Team's 2-probe Geometrics model 858 magnetometer carried by Dr. Slayback on a Gordion tumulus. Dr. Slayback executed almost all of the magnetometer data collections and also processed the magnetometer data presented in this report.



Figure 3A2. Team Geophysics Gordion 2011.

Chapter 4:
Description of NASA's Gordion Magnetometry Surveys 2012

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Tucker, Slayback, Nigro, and Yager, henceforth referred to as the “NASA Team”, performed magnetic surveys on 3.5 ha of area between July 17th and July 27th, 2012 on site at Gordion (figure 4.1). Associated with the magnetometer surveys were differential global positioning system (dGPS) measurements of all the areas surveyed. Daniel Slayback led the magnetometry effort and Joseph Nigro led the dGPS data collection effort. A tabular summary of the NASA team’s efforts day-by-day appears as Appendix Table 4.1.



Figure 4.1. Location of the magnetometer surveys collected in 2012 by the NASA team. See also Appendix Figures 4.1a, 4.1b, and 4.1c.

The NASA team focused on magnetic surveys of tumuli, extending our survey work of 2011. In addition to magnetic surveys of 20 tumuli, a magnetometer survey was made on a Bronze Age Settlement close to the Yassihoyuk road junction with the Ayas-Polatli Road. Detailed information on the areas surveyed appears as Appendix figures 4.1a-c.

The measurement hardware used in our surveys were two Geometrics 858 model magnetometers. The magnetometer data

collected are being processed at this time for the final report. However, we described some of our preliminary findings in this report. In addition to our survey activities, we come upon a looting activity of a tumulus 11 km from Gordion. Tucker and Yager were laying out survey areas in the Gordian region, near the road junction between the roads to Ayas , Polatli, and Yassilhoyuk in the afternoon of July 24, 2012 around 17:00, when they decided to take a break and revisit Tumulus N1 and the adjacent Roman Road (see figure 4.1). Tucker and Yager approached Tumulus N1 and went to the north side of the tumulus, where a back hoe had been used in 2002 to remove a modest amount of the tumulus for an abortive robbing attempt.

They approached the north side of Tumulus N1 and immediately noticed a new hidden robbing entrance, approximately 1 m wide and 1.5 m high, evident by the support of two wooden pallets that formed the roof of the robbing tunnel several bushes around the entrance. Subsequent inspection of the robbing entrance revealed a metal light shaft, approximately 40 cm in diameter, and a robbing tunnel that was straight for 3-4 m, then turned to the southeast and descended ~15-20 degrees, over a total distance of 36 m. We searched the rubble pile from the robbing tunnels, found two pieces of pottery but no wood nor worked stone, and returned to the Gordion Kazi Evi and reported the robbing to Prof. Rose, Prof. Sams, and the Turkish Kultur Bakanligi Temsilcisi, Mr. Memet Akalin.

On July 26 and again on July 27, 2012, we resurveyed tumulus N1 and have superimposed the looters tunnel upon our magnetic survey (figure 4.2). A photograph of the robbing entrance is also included in this report (figure 4.3).

Table 4.1. Summary of the areas identified in figure 4.1 where the NASA team collected magnetometer and dGPS data at Gordion from July 17 to 27, 2011.

Area	Type	Survey Date	length (m)	Width (m)	Area (ha)
E1	tumulus	17-Jul-12	28	32	0.09
E2	tumulus	17-Jul-12	28	48	0.13
E4	tumulus	18-Jul-12	48	50	0.24
E5	tumulus	18-Jul-12	32	40	0.13
E6	tumulus	18-Jul-12	36	44	0.16
E7	tumulus	20-Jul-12	36	48	0.17
E8	tumulus	20-Jul-12	38	44	0.17
E9	tumulus	20-Jul-12	42	44	0.18
E10	tumulus	21-Jul-12	40	46	0.18
E11	tumulus	21-Jul-12	34	32	0.11
E12	tumulus	21-Jul-12	20	30	0.06
E13	tumulus	22-Jul-12	14	32	0.04
E14	tumulus	22-Jul-12	28	50	0.14
E15	tumulus	22-Jul-12	40	40	0.16
E16	tumulus	22-Jul-12	22	40	0.09

E17	tumulus	23-Jul-12	18	28	0.05
E18	tumulus	23-Jul-12	30	36	0.11
E19	tumulus	24-Jul-12	32	70	0.22
E20	tumulus	25-Jul-12	48	90	0.43
E21	Settlement	25-Jul-12	20	50	0.10
N1	tumulus	26-Jul-12	54	48	0.26
N1	tumulus	27-Jul-12	48	40	0.13

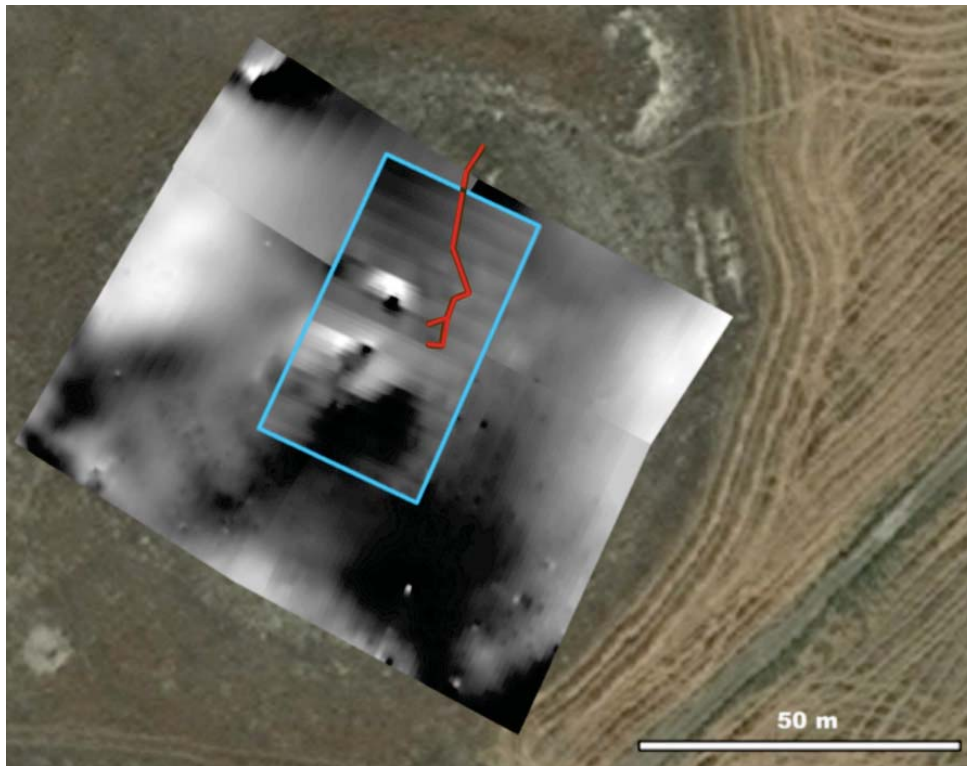


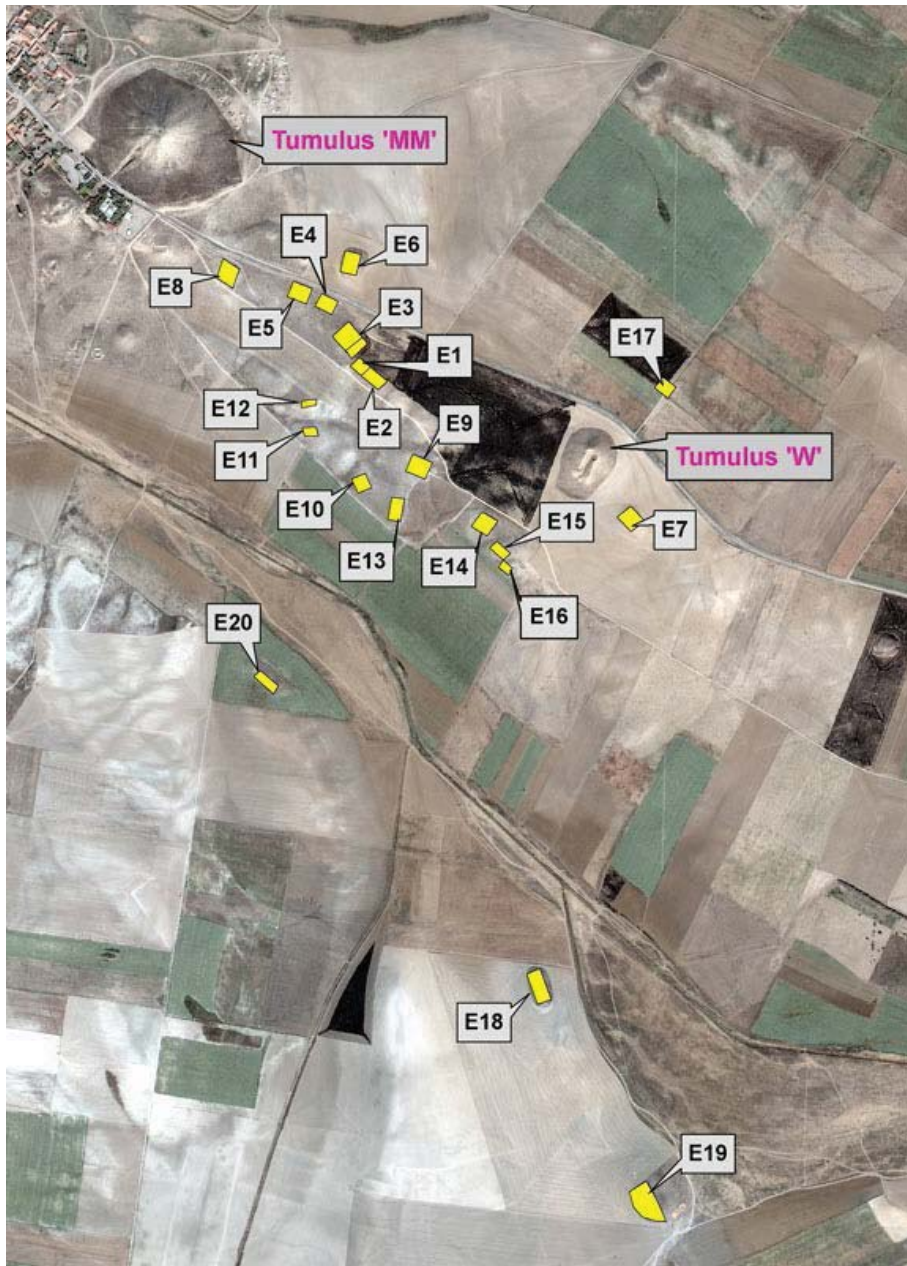
Figure 4.2. Magnetic data from the large tumulus adjacent to the Roman Road ~ 5 km from Gordion to the East North East. The area survey in 2012 is within the blue rectangle and the robbing tunnels are in red. A photograph of the robbing tunnel entrance follows as figure 4.3.



Figure 4.3. Robbers' entrance to their tunnels in Tumulus N1, discovered by Compton Tucker and Karina Yager on July 24, 2012.

This concludes the preliminary report by the NASA Team at Gordion in 2012.

Appendix Figures and Tables



Appendix Figure 4.1a. This figure is a larger portion of figure 4.1. Most of the NASA Team's magnetometer data were collected on the tumuli identified in this figure.



Appendix Figure 4.1b. This figure identifies the area along the Yassihoyuk to Polatli Road where magnetic data were collected from a Bronze Age settlement. See also figure 4.1 in the main section.



Appendix Figure 4.1c. The location of magnetic data collection from Tumulus N1, the tumulus that was under robbing attack. See also figures 4.1, 4.2, and 4.3 in the main section.



Appendix Figure 4.2. The NASA Team's 4-probe Geometrics model 858 magnetometers carried by Dr. Slayback on a Gordion tumulus. Dr. Slayback executed almost all of the magnetometer data collections and also processed the magnetometer data presented in this report.



Appendix Figure 4.3. NASA Team Geophysics Gordion 2012. From left to right: Nigro, Yager, Tucker, and Slayback.

Appendix Table 4.1. NASA Team's activities July 17th to 27th, 2012.

Tues 10-July	Depart IAD Airport with magnetometer equipment for Istanbul via Munich
Wed 011-July	Tucker & Nigro arrive Istanbul early afternoon, clear equipment, and go to hotel
Thu 12-July	Investigate and arrange transport of people and equipment to Gordion. Slayback & Yager arrive
Fri 13-July	Arrival at Excavation House of NASA Team 17:00 hours local time
Sat 014-July	Begin instrument setup, purchase of robe & gloves
Sun 15-July	Finished instrument setup and modifications; complete test run with 2 probes. Dogukan joins NASA team
Mon 16-July	Truck arrives, test equipment in 2-probe configuration, lay out plots for next day, set up dGPS
Tue 17-July	Measure magnetically three tumuli in two grids (E1 & E2) close to Tumulus "W"

Wed 18-July	Move to 4-probe configuration, measure magnetically three tumuli (E4, E5, & E6) close to Tumulus "W"
Thu 19-July	Went to Ankara to renew work permits, set up plots for tomorrow in afternoon
Fri 20-July	Measure magnetically three tumuli (E7, E8, & E9) close to Tumulus "W"
Sat 21-July	Measure magnetically three tumuli (E10, E11, & E12) close to Tumulus "W"
Sun 22-July	Measure magnetically four tumuli (E13, E14, E15, & E16) close to Tumulus "W"
Mon 23-July	Measured magnetically two "linear" tumuli (E18 & E19) ~3 km to the SE of the Dig House
Tues 24-July	In the morning, we re-measured the linear tumulus with the marble stones (E18), extending the grid to 80 m by 40 m. We also measured a "two-hump" tumulus E20 on our way back to the Kazi Evi.
Wed 25-July	Visited Robbing Site with Turkish Representative and then measured magnetically the Bronze Age site on Yassihoyuk-Polatli Road in morning. In the afternoon, we returned to the robbed tumulus and attempted to re-measure this magnetically in the afternoon. GPS problems prevented this from being achieved. We also measured the Bronze Age settlement site along the road to Polatli. Karina Yager leaves in the evening.
Thu 26-July	Day off, but we measured Tumulus N1 again and explored robbing tunnel
Fri 27-July	Re-measured Tumulus N1, broke down equipment, and started writing Gordion 2012 Field Report
Sat 28-July	Continued work on field report, Dan Slayback departs for Rhodes. Kepche destroys robbers' tunnels in Tumulus N1.
Sun 29-July	Tucker & Nigro depart for Kayseri.