

# The Location of Archaic Greek Sybaris\*

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There are at least seventy ancient Greek and Roman writers who refer to the city of Sybaris on the Gulf of Taranto in Southern Italy. In general these sources agree that the city was founded about 720 B.C. and destroyed by the neighboring Greek city of Croton about 510 B.C. Also, there is agreement that the city lay between two rivers, the Crathis and the Sybaris (now the Crati and Coscile). Diodorus Siculus (11.90.4) writing in the first century B.C., recounts that fifty-eight years after its destruction by the Crotoniates, the remaining Sybarites reestablished their city for a few years of prosperity and were then again driven out. He goes on to say (12.10.3-7) that after this second defeat the Sybarites encouraged the Athenians to establish a new city called Thurii "not far" from the site of Sybaris. The Lucanians defeated Thurii in 390 B.C. and the Romans established a garrison there in 282. The city was finally abandoned in the ninth century A.D.

Although the ancient site of most of the Greek colonies in Italy, such as Locri, Metapontum, Paestum, etc., have long since been located and at least partially excavated, that of Sybaris has remained an enigma. Perhaps because Sybaris became a symbol of wealth, luxury, and decadence, and because it was thought to be the largest and richest of all Greek cities in the sixth century B.C., the search for its ruins has continued for almost a century. Recently the University Museum in Philadelphia and the Leric Foundation in Rome published an account, *The Search for Sybaris, 1960-*

1965,<sup>1</sup> of five years of investigations on and around the plain of the Crati river, which relates the long and complicated attempt to locate precisely the site of the original archaic city. Since 1965 the University Museum has continued that search in collaboration with Dr. Giuseppe Foti, the Superintendent of Antiquities in Reggio-Calabria.

Summarizing the 1960-65 investigations, I wrote: "The concentration of archaic pottery in the Parco del Cavallo area on what appear to be ancient and buried sand dunes along the old shore line undoubtedly mark the port of Sybaris but we have yet to find temples or major public buildings such as those at Metapontum, Locri, and Paestum which would conclusively prove that this is the site of the city as well as the port."<sup>2</sup> Now, as a result of these last three seasons, I feel confident that our 1968 map (frontispiece) does in fact locate beyond any reasonable doubt, the site of the archaic city itself. Without extensive excavations, which for reasons given infra are practically impossible, this conclusion requires explanation which is necessarily complex largely because we have been utilizing unconventional tools and methods.

Our attention was directed to the problem of Sybaris primarily because both the Leric Foundation and the University Museum were interested in adapting underground search equipment to the needs of archaeology; but it was Anna and Enrico Mueller of Cassano-Ionio who first proposed that we search for it. Like all other branches of scientific research, archaeology has been influenced

\*During eight years of campaign on the Crati plain there have been so many organizations and individuals involved in "The Search" that it is now cumbersome and difficult to acknowledge all of the assistance and the ideas which they have contributed. This was, indeed, the team approach which is characteristic of contemporary research. Most significant was the successful cooperation of two distinct disciplines—science and the humanities—and this success was made possible by a banker, Mr. Orville Bullitt of Philadelphia, who not only financed the major part of the research, but provided the essential drive and enthusiasm to achieve results. But there are many others who played decisive roles—Carlo M. Leric of the Leric Foundation in Rome, Enrico and Anna Mueller of Cassano-Ionio, Elizabeth Ralph of the University Museum who did most of the instrument surveys, Franco Brancaleoni of the Leric Foundation who did the larger part of the drilling; archaeologists Ellen Kohler, Paola Zancani Montuoro, Lucia Cavagnaro Vanoni, Marjolein de Vos Leopold, Francesca Serra, Piet Stoop,

Donald Brown, David Ridgway, Orio Miggiano, Santo Tiné, and Giuseppe Pellegrino; the hydrologist, Robert L. Raikes; the geologist, Howard Meyerhoff; the geophysicists, Sheldon Breiner, Frank Morrison and Douglas O'Brien of Varian Associates; and, in various other capacities, Oliver Colburn, James Delmege, John Dimick, Dino Adamesteanu, Theresa Carter, Bruno Frascino, Bernardo Benito, as well as many others.

All of the work has been in collaboration with the Superintendent of Antiquities in Reggio-Calabria, at first Alfonso de Francis and later Giuseppe Foti, who supervised the research for most of the eight-year period. We are also deeply indebted to the U.S. Air Force, the Italian Air Force, the Photoaeroteca in Rome, Varian Associates in Palo Alto, and the U.S. Embassy in Rome, particularly to Ambassador G. Frederick Reinhardt who followed all of our work with a keen personal interest.

<sup>1</sup>Rome: Editore Leric (1967). Hereinafter cited as *The Search*.

<sup>2</sup>Rainey, F., *The Search*, 308.

dramatically by a new order of scientific research tools developed since the last World War. One application of this new order of technology is the use of magnetometers for the detection of deeply buried ruins. The search for the ruins of a famous Greek city in an area of about 125 km. offered not only a test of the existing magnetometers but a proving ground for the development of more sensitive and efficient instruments. Moreover, the very recent development in remote-sensing devices for aerial reconnaissance has led us, during the past three years, into experiments with infrared aerial film and infrared scanning equipment. Hence as we shall go on to explain in some detail, our interest in the location of Sybaris has to do not only with the historical-archaeological objective of fixing the site of a Greek city, but also in testing the reliability of new methods of archaeological reconnaissance.

In 1930 Eduardo Galli discovered a piece of a stone column still visible above ground in what is now known as the Parco del Cavallo area of the plain north of the present bed of the Crati River and west of the Bruscate Road. Excavations in that area made by Senator Zanotti-Bianco in 1932<sup>3</sup> uncovered a large Roman building (Excavation I on map) which he believed to be part of Thurii-Copiae, a Roman colony sent in 194 B.C. to repopulate the fields of Greek Thurii. About thirty years later these excavations were expanded by the Superintendent of Antiquities in Reggio-Calabria. In the meantime Donald Brown,<sup>4</sup> working under the auspices of the American Academy in Rome, in the period from 1949 to 1953, made a series of deep borings in the Parco del Cavallo area which proved that there were three levels of occupation in that section of the plain: Roman, Classico-Hellenistic, and archaic Greek.

In 1961 and 1962 we began exploration of the plain of the Crati, and the surrounding hills, with a proton magnetometer developed for archaeological prospecting at Oxford. We also used power-driven drills and test pits for testing anomalies recorded with the magnetometer. It was soon apparent that we could pick up buried ruins on the plain down to 2-3 m., but also that the magnetometer would

not function on the uplands where there were many pockets of volcanic and, consequently, magnetic soils which for us produced "false anomalies," i.e. not archaeological remains. On the plain, which is wholly an alluvial deposit, buried walls and other structures are detected as magnetic contrasts in relation to the surrounding soils, that is, the magnetometers record slight changes in magnetic intensity when passed over archaeological remains.

With electrical resistance apparatus and the proton magnetometer, during the early years of the present campaign we discovered and traced for some 1300 m. a stone retaining wall which ran generally parallel to the Crati River (later this was found to extend southward 800 m. more, crossing under the present bed of the Crati. See map).<sup>5</sup> Test excavations at two points (II and III on map) along this wall exposed a construction which was originally fourth century Greek and then later rebuilt and heightened by the Romans. It functioned both in Greek and Roman times as a retaining wall to protect the settlement from inundation by the flooding river and rising sea level, or from silting.<sup>6</sup> Many other building foundations in stone, presumably Roman, were also detected with the instruments and the drills in a limited area between the long retaining wall and the present bed of the Crati.

However, six test cuts made during the 1962 to 1966 seasons down to 6-7 m. in this Parco del Cavallo area south of the Stombi road exposed no archaic Greek constructions below the fourth century structures of the Greek city known as Thurii. In three cuts constructions of the age of Thurii were bedded on or just above the basic marine sands. Below them in the sands were many archaic Greek sherds of the period of Sybaris, but in no case could we distinguish an actual habitation level with architectural remains of this period. Hundreds of drill holes were made in the area, generally confirming this puzzling situation of archaic sherds in coarse sands below Roman and fifth century to Hellenistic levels. Some of the archaic sherds were water-worn as if transported, but the majority were not. There was, however, in 1962, one clue to an undisturbed occupation level

<sup>3</sup> Zanotti-Bianco, U. and Zancani Montuoro, P., "La Campagna archeologica del 1932 nella Piana del Crati," *AttiMGrecia* N.S. 3-4 (1960-61) 7-20; Foti, G., "Le campagne di scavo (1960-1962) al 'Parco del Cavallo' alla ricerca del sito di Sibari," *Klearchos* 29-32 (1966) 89-103.

<sup>4</sup> *AJA* 58 (1954) 144 and *Expedition* (Bulletin of the Uni-

versity Museum) 5:2 (Winter 1963) 40-47.

<sup>5</sup> Ralph, Elizabeth K., "Instrument Surveys," *The Search*, 59-64.

<sup>6</sup> Kohler, Ellen, "Archaeological Observations during the 1962 Campaign," *The Search*, 270-285.

of the archaic period. North and west of the long wall, along the Stombi road, our drills struck a level at about 5 m. containing archaic sherds, bones, charcoal and other evidence of an actual habitation level in archaic times. At that time I reported<sup>7</sup> that the concentration of archaic sherds below classical structures in the Parco del Cavallo probably indicated the port of Sybaris. The ruins of the city itself I thought at that time should be sought some distance inland.

In the following three seasons the reconnaissance of the plain was carried inland as far as the acropolis of Torre Mordillo 17 km. from the seashore, south to the Torrente San Mauro, and north of the present Sybaris station. The plain was searched with the proton magnetometer and two different types of power-driven drills. On the low-lying foothills around the plain, where instruments would not function, we made a normal search for sherds and other archaeological remains and excavated a number of test pits. Several Roman and Hellenistic sites were recorded but no site of the period of Sybaris was found. During these years Paola Zancani Montuoro and Piet Stoop had begun excavations at sites on the foothills north of the plain near Francavilla where Greek pottery and bronzes had been found by collectors for many years. These sites now turn out to be part of a large necropolis, with Iron Age tombs of native Italic people who gradually became Hellenized in the eighth to the sixth centuries, plus a small acropolis with sanctuaries which were occupied by Sybarites or fully Hellenized people. Hence the only certain sites of archaic age so far discovered on or about the Crati plain were in the region of the Parco del Cavallo on the plain, and on the foothills of Francavilla to the northwest.

Our failure to discover any other archaic sites in the foothills tended to return our attention to the great flat plain of the Crati where we then knew that any archaic remains must necessarily lie some 4-6 m. below the present surface. By that time, more than 1500 holes drilled on the plain gave us a fairly clear picture of its structure. Essentially the plain is composed of basic marine or river sands and gravels, a superimposed layer of sterile gray-blue clay, and a surface layer of cultivated soils or at least soils containing humus from the decomposition of growing plants. Robert Raikes

observed<sup>8</sup> that the gray-blue clays are so fine-grained that they could be deposited only in still water and therefore at some time there must have been a broad lagoon, covering most of what is now the plain, into which numerous rivers and streams from the surrounding mountains deposited their burden of silt. As the lagoon filled with clay and a marshy plain emerged above the surface, vegetation began to grow again even though it was quite certainly submerged each spring with flood waters from the mountains. We know that cultivation was resumed in Roman times because we have found the ruins of Roman villas on the flood plain now buried 2-3 m. under cultivated soils.

The many drill borings and the test excavations on the plain in the Parco del Cavallo region clearly show that archaic and classical remains invariably lie at the surface of the basic sands or in the lowest levels of the clay deposit. Roman remains are generally in the upper levels of clay or in the surface deposit of cultivated soils. Six test cuts (map) in the southern section of the site have confirmed this basic stratification. The seventh (see map) uncovered only archaic remains on the basic sands. It is apparent, then, that the deep layer of gray-blue clay was deposited after the destruction of Sybaris and in part, at least, during the period of the later city, Thurii. The lower section of the long wall was built in the Thurii period, presumably to protect the city from flood waters when clays were being deposited.

In his study of the drill records Robert Raikes<sup>8</sup> has concluded that there was, at the time of Sybaris, a line of shore dunes parallel to the shore line and that the archaic settlement was built upon this line of dunes. Then in the sixth century B.C. as a result of an earthquake or other tectonic phenomenon, the shoreward part of the plain subsided as much as 3 m. with a pronounced tip to landward. This caused an inland rush of sea water which broke through the line of dunes to form a lagoon over a large part of the plain. Moreover, he believes there must have been a second subsidence because the later structures of Thurii times are also buried in the fine clay and now lie below sea level.

Since much of this reconstruction of what happened on the plain at the time of Sybaris, and the later Thurii, is based upon the records of

<sup>7</sup> *ILN*, December 8, 1962, 928ff.

<sup>8</sup> Raikes, Robert L., "Geomorphological and Hydrological Considerations," *The Search*, 257-261.

several hundred drill holes in the Parco del Cavallo area, some account of our drilling procedure is necessary. We have utilized three types of power driven drills, one of which uses a flow of water down the drill stem to force drill cuttings up to the surface around the stem, and two which are auger or screw drills used without water. It will be apparent that, without taking cores, very accurate studies of soil stratification cannot be made. The hydraulic drill is equipped to take cores, but in the very dense clays on the plain coring is an impossibly slow process. However, we soon learned from drill holes and excavated soundings, that only three levels (humus, clay and sand) were significant and, of these, the most significant was the surface of the basic sands—where archaic remains were concentrated. This level (4:6 m.) can be determined with fair accuracy not only by the drill cuttings, but because in passing from very dense clays to almost liquid sands the drill stem ceases to bind and runs free. Sherds and other occupation debris are washed to the surface with the hydraulic drill and are caught in the flanges of the auger drills. With experience and a knowledge of the basic stratification, drill operators can soon learn to fix the level of such debris with reasonable accuracy.

Finally, during the last three years, the drills have been utilized primarily to confirm the location of stone structures and roof tiles recorded by the magnetometer, or to search out such remains. The drills which we have used can be forced through large fragments of roof tiles but are stopped dead by stone structures of any kind. When building remains are struck by the drills, their depths can then be determined with absolute accuracy.

In 1964 it was obvious to all of us that the proton magnetometer could detect Roman remains in the upper humus level (2-3 m. in depth) anywhere on the sedimentary plain. But it was also clear that any archaic remains would lie beneath the clays 4-6 m. in depth. A more sensitive instrument was required. Experiments with a sonic device were unsuccessful but Sheldon Breiner of Varian Associates joined us at that time with an experimental rubidium magnetometer, which had the capability of 100-fold greater sensitivity, but was not yet portable by hand. Results of the experiment were

promising. Varian then designed a magnetometer, specifically for archaeological purposes, utilizing the element cesium in the sensing device and a new digital readout which made it possible to operate the instrument with much greater speed. By 1965 we could explore and record up to 10 acres in one day. Experiments with the new magnetometer were concentrated in the Parco del Cavallo area where we knew the location of buried structures of the Roman and Greek periods, but they were also extended to many parts of the plain in search of remains which could not have been detected with the proton magnetometer. One large structure (VI on map) in the Parco del Cavallo area located with the cesium magnetometer at 5-6 m. in depth was examined with a test-cut, since the depth suggested it would be classical or archaic in age. Actually it turned out to be Roman in spite of the surprising depth. Below it at the surface of the basic sands were the usual archaic sherds.

In 1964, a systematic drilling program carried on north of the Parco del Cavallo area and north of the Stombi road resulted in the discovery of stone structures at a depth of just over 4 m. At first I assumed that at that depth such structures must be Roman. But an examination of the sherds washed out by the drill in all of that zone north of the Stombi indicated that they were all of archaic age and lay on or just above the basic sands. Therefore we selected one of four clusters of buried stone remains to be reexamined with an excavation. This was begun in the fall of 1964 and completed in the spring of 1965. We found the wall-foundations of houses constructed of uncut river stones, and masses of archaic roof tiles scattered above the foundations. Although it was extremely difficult to examine these remains with care because of the uprush of water from the sands upon which they rested, it was clear from the potsherds and the roof tiles that we had found the first archaic Greek structures *in situ* so far known on the Crati plain.<sup>9</sup> Also there was evidence that they had been burned, presumably at the time of the destruction of Sybaris in 510 B.C. With these foundation walls there was one block of well-cut limestone which was displaced and seemed to be no part of a construction.

It is necessary to explain at this point why systematic, large-scale excavations are practically im-

<sup>9</sup> Ridgway, David, "Test Excavations of Anomalies, 1964," *The Search*, 293-297 300 n. 9.

possible on the Crati plain. When the clay layer is penetrated, water rushes up from the sands in powerful *sorgenti* which rapidly fill any excavation to within one meter of the present ground surface. Even a drill penetrating this clay allows the water to rise in the drill hole to the one-meter level. All seven of the test excavations on the plain have been made under the greatest difficulty, utilizing a whole battery of electric and gasoline pumps, a well-point system, drag-line shovels, and caissoned sumps to clear the mud and water from the occupation level at the base of the clay. But even with this equipment, test cuts of up to 50 m. square are reduced to 5 or 10 m. at the 6-meter level because the upper water-laden clay and humus will not stand at an acute angle or in terraces. In not one of the excavations have we succeeded in clearing all of the water submerging the archaic level. It is now clear, after the excavation in 1966, that a well-point system is not sufficient to remove the water pressure below the clays and I am convinced that the use of steel caissons enclosing a test-excavation and driven to a depth of 7-8 m. (assuming this were feasible) would still not make it possible to eliminate water at the archaic level.

After the completion of the work in 1965, later reported in *The Search* (1967), we continued to search for the remains of buildings of the archaic period on the Crati plain, with the highly sensitive cesium magnetometer and a drill to test anomalies recorded by the instrument. Also at this time the U.S. Air Force included the Crati plain with other areas in Italy in an experiment with a new multi-band aerial camera and an infrared scanning device. The multi-band camera, operated at 12,500 feet, recorded nine different images covering the spectral range from ultraviolet to infrared. Study of these aerial photographs convinced us that the best hope for detecting archaeological remains at such depths in the plain was with infrared film in the 7000 Angstrom range and that the photographs should be taken from an altitude not greater than 5000 feet.

Aerial film of this type was then purchased from Eastman Kodak and turned over to the Aerial Photo Service in Rome to be used by the Italian Air Force in a second aerial reconnaissance of the whole plain and the surrounding foothills. The

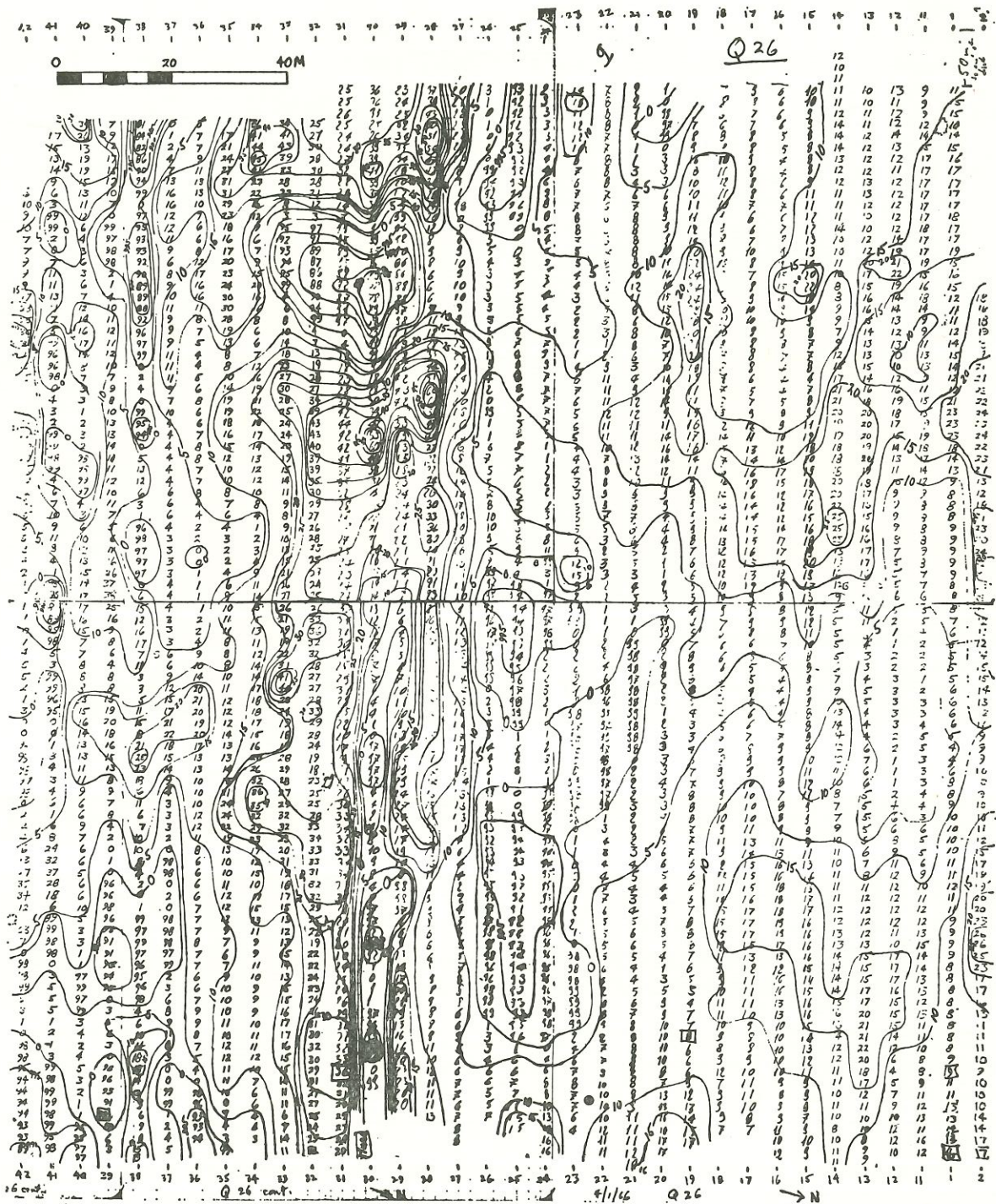
flight was completed in 1968 and the several hundred infrared photos resulting are presently under study. There are, of course, many complex and difficult problems in the interpretation of such films, particularly when we are seeking evidence of remains buried several meters deep in an area which has undergone many basic physical changes and many centuries of cultivation. The fundamental question is whether it is possible at all to detect archaeological remains at such depth and under the water table with remote sensing methods. In this case we have a combination of evidence to test the possibility: i.e., maps of specific zones on the plain, where we have located stone foundations with the magnetometer and the drills, which can be compared with the air photos. There is still the problem of determining the exact shape or form of such structures in order to correlate them with very faint and indistinct images on the film.

Magnetometer surveys in the zone north of the Stombi canal, backed up by drill borings and excavation No. VII (see map), show that the archaic remains there are not overlain by later Greek and Roman ruins<sup>10</sup> and these surveys record many constructions, particularly in a limited section north of the Stombi and west of the Bruscate road. But their exact form and extent can be determined only by very extensive drilling. That was not possible with the drill available to us in 1966 and 1967, which was slow and difficult to operate in the dense clays. In 1968 we found a new Mobile drill which could be tractor-mounted and operated with a hydraulic lift. The Mobile drill, operating at many times the speed of the older McCulloch drill, made it possible during the summer and fall of 1968 to trace out with at least some degree of accuracy the actual form of stone foundations in this area north of the Stombi. Moreover, with this type of auger drill we could lift sherds and other remains from the occupation level (in this zone no more than 4.5 m. in depth) and trace the maximum area of occupation north of the Stombi. Magnetometer surveys were done by Elizabeth Ralph and the drilling in 1968 by Theresa Carter and Bruno Frascino.

It is essentially the combination of drilling records and magnetometer grids made with the new cesium magnetometer in this area which have en-

<sup>10</sup> On the periphery of this area we did find Roman constructions overlying archaic structures at three points. These were encountered by the drill at depths of 2-3 m., or approxi-

mately 2 m. above the normal archaic level. They could be identified as Roman not only by the depth, but because the drill cuttings showed that mortar was used in construction.



ILL. 1. Cesium magnetometer grid no. 26. Pronounced anomaly, partly positive and partly negative, runs length of grid. This was caused by the long wall (just w of Bruscate Road), and is typical of these massive structures, partly made of bricks, at the Roman level

abled us to revise our 1965 conclusions about the actual site of Sybaris. Also, it is this combination of records which may make it possible to determine the feasibility of infrared aerial photography for the location of remains at such depth.

To explain such a combination of evidence, some description of the method of magnetometer survey is necessary at this point.<sup>11</sup> Grids, varying in size from 50 x 100 to 180 x 400 m., were laid out in each field with parallel base lines marked by fence lines or rows of stakes. The parallel base lines at each end of the grid were then divided into 5 m. intervals marked by flags, so that a man carrying the magnetometer sensing device could walk along a line between the markers. Magnetometer readings were taken at 2 m. intervals along these lines. The sensor man was followed by a second carrying the readout device and a third carrying a notebook pad. With the cesium magnetometer now available, it is not necessary to pause for a reading. The operators walk steadily along the line while the man carrying the readout calls out a number (magnetic intensity reading) at every two paces (2 m.), which is written by the third man in a notebook oriented in the same direction as the grid laid out on the ground.

Since the magnetic anomalies indicating buried remains at that depth are small (less than 20 gammas) the cesium magnetometer was operated in the differential mode. That is, a second sensor was fixed at the center of the grid and attached to the other instruments with a long cable. This served to cancel out diurnal and other extraneous magnetic disturbances so that only archaeological remains were detected. It is, however, necessary to emphasize that we cannot in practice cover all of a given area like this with a series of grids. On the plain there are now scattered buildings, wire fences, reinforced concrete irrigation and drainage ditches, roads, bridges, powerlines, etc. Any appreciable amount of iron will disturb magnetic readings of this sensitivity and thus all modern surface constructions must be avoided. Moreover, there were always some fields under cultivation with crops which would be injured by the trampling of magnetometer crews. For this reason by no means all of the Parco del Cavallo area nor that zone north

of the Stombi road could be examined, and thus our maps recording anomalies are not complete.

When one grid survey was completed on the ground, the pages of the notebook were pasted together to form a grid map composed of magnetic readings. The next step was to draw in contours of equal magnetic intensity, just as one would draw in a survey of land elevations, but in this case the "hills" represent archaeological features such as massed roof tiles or stone foundation walls (see ill. 1).

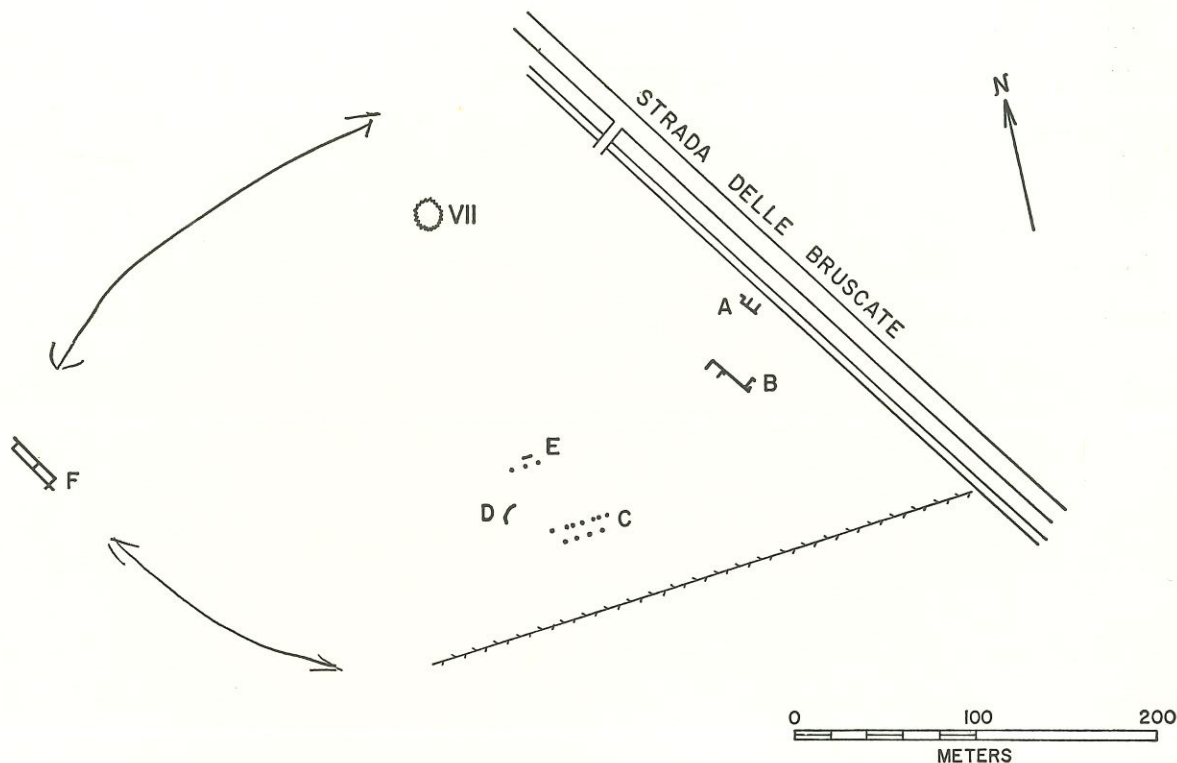
When we now place all of these magnetometer grids upon a normal surface map of this region of the Crati plain, we can observe one very significant fact. Grids in the area which we have marked as the occupied zone show many steep magnetic contours (see ills. 1 and 2). Those made outside the zone show none (ill. 3). That is, the normal sedimentary plain is magnetically "quiet" while that section (where we have archaeological remains proved by the drills and the test excavations) is not. Since we demonstrated in test-cut No. VI that the cesium magnetometer will detect features down to 5-6 m. and the surface of the basic sands (earliest occupation level) are rarely any deeper than that, we can then predict that magnetically "quiet" areas anywhere on the plain contain no archaeological structures. By no means all of the 125 sq. km. of the plain have been surveyed in this manner but sections in all the major zones have been covered. Except for a few Roman remains in the upper levels of humus, we have found no areas of occupation on the plain other than that charted on the map.

On the plain of Sybaris there are two types of anomalies detected by the magnetometer. Concentrations of fired clay, such as bricks or roof tiles, register on the readout as more magnetic than the surrounding soils, while stone constructions register as less magnetic. We refer to these two types as positive and negative anomalies. In the southern sector of the site we detect many massive Roman constructions of stone as negative anomalies and Roman brick constructions as positive. In the northern sector, however, all of our magnetometer anomalies are positive. Excavation No. VII (see detail map in ill. 4) and drill borings in that sector show that these positive anomalies are heavy con-

<sup>11</sup> Ralph, E. K., "Comparison of a Proton and a Rubidium Magnetometer for Archaeological Prospecting," *Archaeometry* 7 (1965) 20-27; Ralph, E. K., Morrison, F., O'Brien, D. P.,

"Archaeological Surveying Utilizing a High-Sensitivity Difference Magnetometer," *Geoexploration* 6 (1968) 109-122.





ILL. 4. Area N of the Stombi where the forms of archaic structures have been determined by drilling in 1968. Excavation no. VII also shown

centrations of large roof tiles which, as in Excavation No. VII, lie above stone foundations. The drill meets resistance by such roof tiles so that they can be detected by the driller and also fragments of the tiles are caught in the drill bit and flanges, but the drill can be forced through. In many cases stone foundations are found directly below. Since we know that the basic sands, or the thin layer of humus on these sands (the archaic habitation level) lies generally about 4.5 m. deep in this sector we can tell from the drill borings that stone foundations, so far located, normally do not stand more than 25-50 cm. high (see structure B in ill. 5).<sup>12</sup>

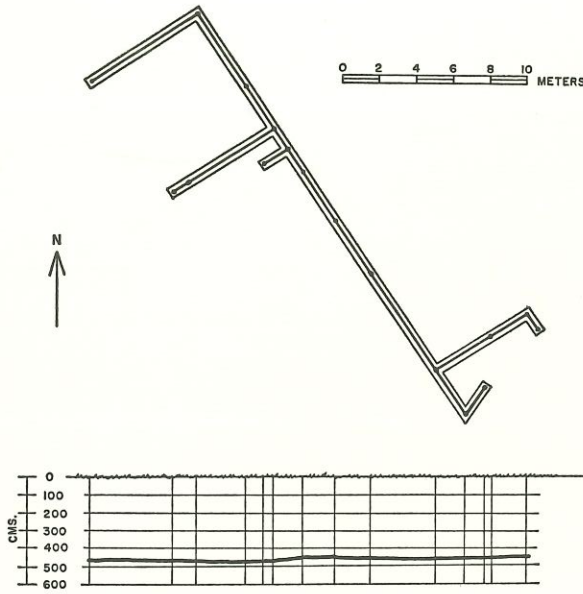
Under these circumstances the drilling done in 1968 was in search of low-lying stone foundations which could be traced with a series of drill holes delineating the shape and size of archaic buildings in this sector. Positive magnetometer anomalies caused by masses of roof tiles apparently disguise any negative anomalies which would be caused by shallow stone foundations lying below them. The

<sup>12</sup> Here we have one of the three examples on the periphery of the northern sector of Roman structures lying above archaic Greek. Above the NE corner of the archaic structure the drill

intensive drilling was largely limited to one field (ill. 5) where several archaic structures were located, and in this limited area we have succeeded in determining the shape and form of the structures, utilizing the drill as a probe—a slow process requiring hundreds of drill holes. All of the structures in this field certainly have not been found. Drilling continues and other stone foundations are still being located, but there are now a sufficient number to demonstrate that there were major buildings of the Sybaris period in the archaeological zone recorded on our map.

The long rectangular foundation of Structure F (ill. 6) are similar in form and size to those archaic structures excavated by Piet Stoop at Francavilla. Others, such as the parallel lines of stone blocks of structure C (ill. 4) are difficult to interpret from this kind of probing. Each block of stone is about 2 m. in diameter and they all lie at the same level. Roof tiles lying just above them are recorded by the drilling. It is possible that they are

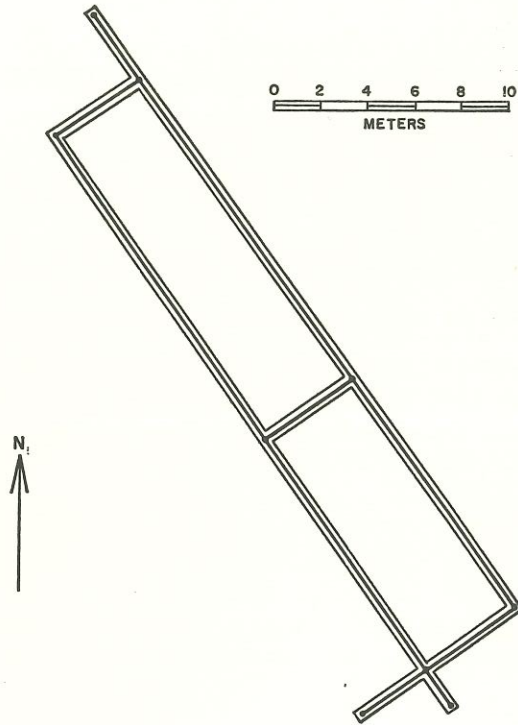
struck what is probably a Roman pavement at 2-3 m. beneath the surface. Building mortar was lifted in the flanges of the drill from this construction.



ILL. 5. Detail of structure B in ill. 4

the separate bases of a colonnaded structure. Several structures in this field which were detected by the magnetometer (positive anomalies—i.e. roof tiles) were drilled and stone was struck below the tiles, but only those marked on ill. 4 as A-F have been traced out in detail.

Returning then to the critical evidence for the actual location of archaic Sybaris, I see the most convincing proof in the limited area north of the Stombi road (see map). Here there is essentially one level of occupation at 4.2 to 4.5 m., at the base of the clay and on the surface of the underlying sands, which is archaic Greek, and judging from the pottery, terminates the late sixth century B.C. Here the foundations of major buildings have also been traced by systematic drilling. South of the Stombi there is an unclear zone, which may be an old river bed, where so far we have found only limited archaeological remains. (Most of this area has not been surveyed with the magnetometer but drill borings record pottery and other cultural remains). Still further south, but north of the long wall, we begin to detect the usual three distinct periods of occupation with many traces of buried features. This situation continues to about 600 m. south of the present bed of the Crati. There is, then, archaic occupation, as determined by the presence of potsherds only, over the entire shaded area of the map (approximately  $2\frac{1}{4}$  sq. km.) with archaic building remains *in situ* found only in the north-



ILL. 6. Detail of structure F in ill. 4

ern zone. Six test cuts in the southern zone disclose only Roman and classical building remains, with archaic sherds in the basic sands below. Archaic foundations, of course, may lie below other Roman and Greek structures which have been located with the instruments and drills in this zone, but we have no way of detecting them except with test cuts, and the six cuts in the area, necessarily reduced to no more than small pits at the 6 m. level, are certainly no proof that they do not exist.

On our map we have indicated the probable course of the Crati and the Sybaris rivers at the time of Sybaris. The position of the ancient Crati bed is indicated both by magnetometer survey (magnetic contours in broadly spaced parallel lines) and by drill borings. In the summer of 1968 I confirmed this, at least to my own satisfaction, by drilling a line of holes southward from the present bed of the Crati. For approximately 600

m. the series of borings raised pottery and other finds of the familiar three periods of occupation and then quite suddenly ran out of them at a point where the normal dense clay deposit essentially disappeared, leaving only a level of semi-liquid sands below the recent humus layer. This could, of course, be a river course at any period but the abrupt termination of occupation refuse at this point indicates that it was the Crathis bed during Graeco-Roman times. The river must have found its present bed sometime after Roman occupation of the site since it now flows over a Roman retaining wall. The location of the Sybaris bed in archaic times is more tenuous because a magnetometer grid in that section does not show the same striations. However, the drills show a sharp decrease in the thickness of the clay layer and a limit of occupation at that point; the absence of distinct magnetic phenomena may be explained by Meyerhoff's<sup>13</sup> observation that the gradient of the Sybaris bed has always been less than that of the Crati and, therefore, the two river bed deposits would probably be quite different.

By and large Robert Raikes' conclusion<sup>14</sup> that the Graeco-Roman cities were built on a line of dunes along the shore has been confirmed by the recent (1968) drilling in the northern zone. On the landward side (west of the archaeological remains) the deposit of sterile and fine-grained clay increases sharply in depth, as one would expect with the formation of a lagoon on the landward side of the dunes. The changing structure of the plain shown by lines of drill holes running east and west are, for me, convincing evidence that the line of dunes did exist at the time of Sybaris and that the sea did inundate the dunes and the city when the plain subsided to its present level. Today the level of archaic remains in the northern sector is approximately 2 m. higher than in the southern sector. It is probable that the original constructions were built on higher dunes in ancient times and that this may account for less disturbance by in-rushing sea water. Raikes' conclusion that there was a second subsidence of the plain in the period of Thurii also has some confirmation in the observation made by Ellen Kohler after the long wall had been exposed in test-cut no. II. Large cut stone blocks in

the fourth-century wall below that constructed by Romans were found forced out of position as if by the force of the in-rushing sea.<sup>15</sup>

Convincing evidence for the precise location of Greek Sybaris as indicated on our map may be summarized as follows: 1) this is the one area on the plain of Sybaris where the magnetometer records a large zone of magnetic disturbance caused by archaeological remains; 2) drilling confirms the distribution of archaic pottery over an area of 2¼ sq. km.; 3) the magnetometer and the drill borings locate and outline major constructions of archaic age, *in situ*, in the northern sector; 4) test cuts have exposed constructions of the time of Thurii and Thurii-Copiae in the southern sector and one limited building complex in the archaic level in the northern sector; 5) ancient river beds are quite certainly identified to the north and south of the occupation area which tend to confirm the written accounts of Sybaris as lying between two rivers;<sup>16</sup> 6) there is clear physical evidence of a land subsidence which now places these archaeological remains several meters below sea level and 4-6 m. below the present land surface—a situation which explains why the ruins of Sybaris, unlike those of its neighboring cities, had not been found in nearly a century of searching.

There are still some puzzling inconsistencies between the archaeological evidence and the Graeco-Roman written references to the city. If Sybaris sank beneath the sea (as did its mother city of Helice on the Gulf of Corinth)<sup>17</sup> how does it happen that Herodotus makes no comment about this? He must have lived on or near the site of the city about a century after its destruction. He speaks (5.45) only of a Sybarite temple on the dry bed of the Crati. (One of the ancient beds of this river can be seen clearly on the infrared scanner image of the plain taken from 12,500 feet.) All the archaeological evidence points to the conclusion that Thurii was built over the southern section of the city of Sybaris, which does not accord with the statement of Diodorus Siculus (12.10) that the Athenians founded the new city of Thurii "not far" from Sybaris by a spring called Thuria. Athenaeus (*Deip.* 12.520) mentions that the city "lay in a hollow" of the surrounding mountains. This

<sup>13</sup> Meyerhoff, Howard, "Geologic Factors Affecting the Search for Sybaris," *The Search*, 252.

<sup>14</sup> *The Search*, 260.

<sup>15</sup> *The Search*, 276.

<sup>16</sup> Diodorus Siculus, 11.90.3-4.

<sup>17</sup> Marinatos, S. N., "A Submerged Town of Classical Greece," *Archaeology* 13 (1960) 186-193.

does not agree with the evidence of a city built upon a line of dunes, unless he refers to the whole plain facing the sea as lying "in a hollow." Also there is the famous story first recorded by Strabo (6.1.13), describing how the Crotoniates, after they defeated the Sybarites, conducted the river over the city and submerged it. So far as we can see this would be an impossible task since the city lay on dunes above a flat plain. But perhaps this is a romanticized version of the destruction by the sea, written about 500 years after the event.

There are other references which are more in accord with the physical evidence. Strabo (5.4.13) says that the city is "rendered unhealthy by a river that spreads out into marshes in the neighborhood." Certainly this is a clue to explain the long retaining walls of Thurii and Roman times and the location of all the ruins buried under silts. Athenaeus (*Deip.* 12.519) speaks of the Greeks as carrying part of their wine production "over to the city in boats." This was written in the late second or early third century A.D., and may well refer to the lagoon, formed after the subsidence of the plain, which must have separated the later Greek city of Thurii from higher ground to the west.

Those of us who have worked on the vast flood plain of the Crati and Coscile rivers (ancient Crathis and Sybaris) during the past eight years have been reminded, constantly, of the great physical changes which have taken place there during the past 2500 years. Today it is almost impossible to visualize the shore, the plain, and the encircling mountains as seen by the original colonizing

Greeks. Then the mountains and foothills must have been heavily forested, the character of the two rivers consequently quite different, and the shore line, with its line of dunes, at least 2 km. inland from the present shore. We know that the plain was to a large extent a malarial swamp in the period from the ninth to the twentieth century. Today it is again a rich agricultural area, drained and irrigated, and it is soon to be an industrial region with a new harbor, an oil refinery, and associated industries.

At present Elizabeth Ralph is demonstrating at the town of Elis in Greece that the plan of an entire buried city ruin can be recovered with a cesium magnetometer survey. However, as we have explained, the situation at Sybaris is much more complicated due to the fact that over most of the region there are three levels of occupation and that all, with the possible exception of the Roman, have been greatly disturbed by physical changes on the plain and by successive man-made relocations. Therefore, even though a good part of the archaeological zone has been surveyed with the cesium magnetometer, one does not see clearly defined patterns of structures except for the massive long wall. A comparison of the magnetometer grids at Elis and at Sybaris illustrates as well as anything why Sybaris had not been found previously and why even after eight years of intensive searching with geophysical instruments, only a small fraction of the structures from the time of archaic Sybaris has been located.

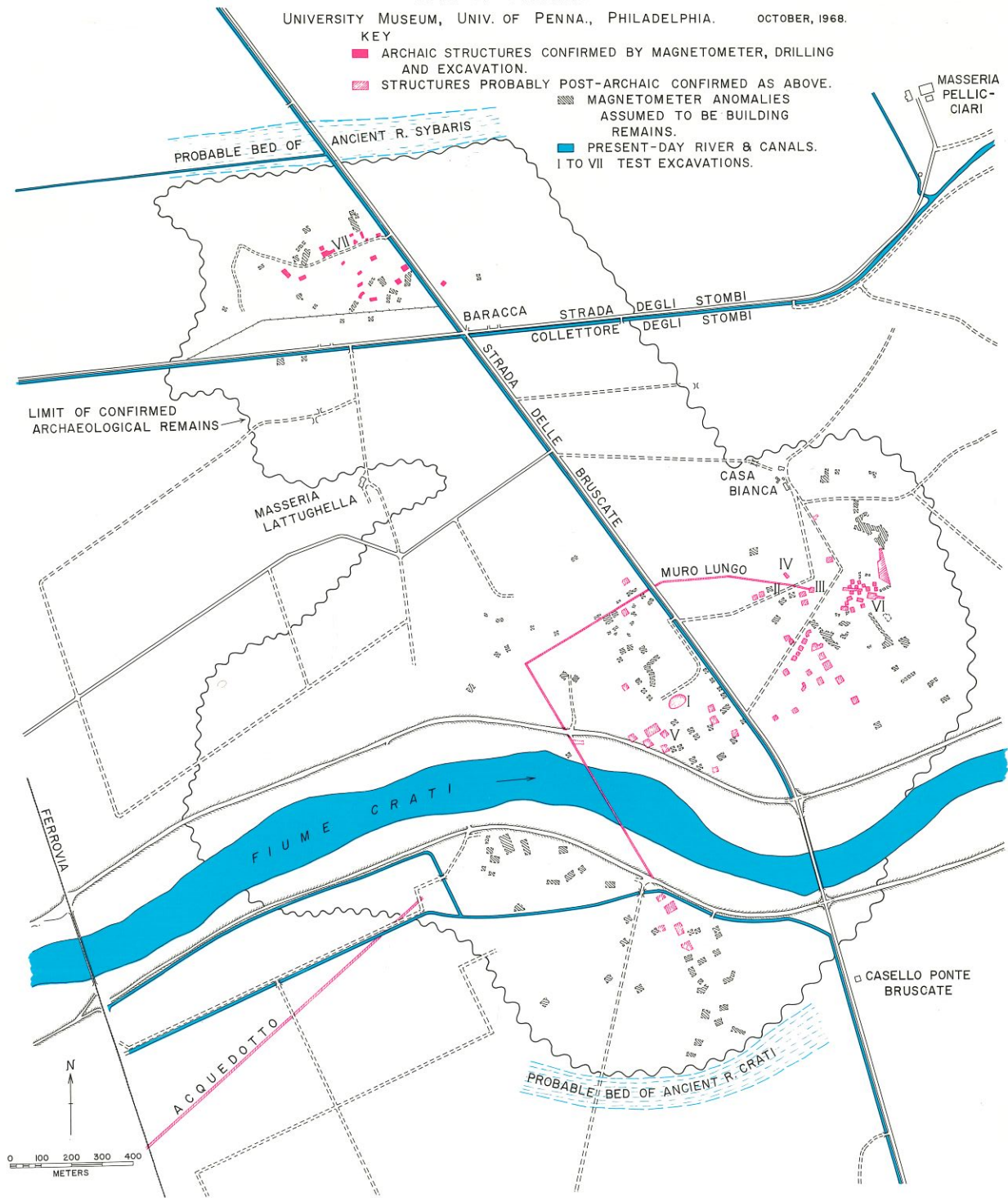
UNIVERSITY MUSEUM, PHILADELPHIA

SITE OF SYBARIS

UNIVERSITY MUSEUM, UNIV. OF PENNA., PHILADELPHIA. OCTOBER, 1968.

KEY

- ARCHAIC STRUCTURES CONFIRMED BY MAGNETOMETER, DRILLING AND EXCAVATION.
- ▨ STRUCTURES PROBABLY POST-ARCHAIC CONFIRMED AS ABOVE.
- ▩ MAGNETOMETER ANOMALIES ASSUMED TO BE BUILDING REMAINS.
- PRESENT-DAY RIVER & CANALS.
- I TO VII TEST EXCAVATIONS.



Site of Sybaris. Area between long wall ("Muro Lungo") and zone of archaic structures appears blank because only one small magnetometer grid was made here. Drilling, however, produces sherds at the archaic level throughout the area