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Study of Correlation between Magnetic Reconnaissance and Excavation in the Dolores Archaeological Program

by

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INTRODUCTION

In September of 1978, a magnetic reconnaissance program was initiated within the Bureau of Reclamation Dolores Project area of Colorado for the DAP (Dolores Archaeological Program). The magnetic program was continued throughout the 1979 field season, by which time 26 grids, at 25 selected prehistoric sites, had been magnetically surveyed. The raw data obtained by these surveys was sent to NEBCAR (Nebraska Center for Archaeophysical Research) to be analyzed by Rob Huggins under the direction of Dr. John Weymouth.

The magnetic reconnaissance program was established to aid in archaeological investigations of the DAP. Magnetic surveying is an aid to locating subsurface features, and is, therefore, capable of indicating the presence of specific, buried archaeological features such as subterranean domiciles and hearths. The magnetic survey may also indicate site boundaries and outline the overall occupation pattern of a site, enabling a more accurate archaeological sampling procedure to be used.

Detecting the location of the subsurface archaeological features involved using a proton magnetometer to measure the earth's magnetic field over a grid of points on the surface of the site. Marked variations or "anomalies" in the earth's field, caused by differences in the concentration, composition, and orientation of iron oxides in the soil were plotted using a variety of graphical displays, primarily magnetic contour maps (SYMAP [Dougenik and Sheehan 1975]) and line contour maps. Because some cultural processes such as intense burning alter the iron oxides in the soil, an assessment could be made concerning the possible cultural origin of these anomalies and the location of a test area which was most likely

to locate the archaeological source of the anomaly. Where possible, additional comments concerning the geometry of features were also noted (see Huggins and Weymouth 1978, 1981). Since anomalies in the earth's magnetic field can also be caused by geologic contributions or by recent and historic disturbances, and adjacent cultural features may produce ambiguous responses to the observer, a degree of uncertainty occurred in the assessment of each anomaly and in some cases no cultural features were located.

This study will determine the success of the present magnetic reconnaissance program and explore techniques capable of increasing the amount of information available from the magnetic record. The information revealed by this study will assess the usefulness of magnetic surveying to archaeological research, particularly in organization of fieldwork and the direct collection of archaeological data.

This report will contain three major sections in addition to the overall introduction and summary. The first section is an assessment of the existing program and provides quantitative estimates of the success and failure of the program by comparing the results of the 1978-1979 magnetic data analysis (Huggins and Weymouth 1978, 1981) with 1978-1979 excavation results provided by the DAP. The second section will examine the practicality of utilizing computer assisted filtering to improve the detection of cultural features. The data base consists of cultural features located during archaeological excavations (information provided by DAP) and image enhancement of the original magnetic data gathered by NEBCAR. The third section will attempt to determine what additional information is available about the interiors of pitstructures from their associated anomalies. Profiles of the magnetic anomalies of features drawn from the original magnetic information, assisted by computer

simulated models of how an idealized pitstructure might appear, will be compared with associated cultural features identified by archaeological operations. The data base will be composed of cultural feature information provided by DAP, the original magnetic data provided by NEBCAR, and, specifically for the modelling studies, magnetic susceptibility data taken from Pitstructure 2 of Site 5MT2193.

ASSESSMENT OF THE EXISTING MAGNETIC PROGRAM

Introduction

After the magnetic data had been received, processed, and interpreted by NEBCAR, anomalies believed to have archaeological affiliations were recommended for excavation. Test squares were selected by NEBCAR to locate the source of these anomalies and were given priority numbers in accordance with a presumed likelihood of encountering cultural sources. The test squares were set out over the anomalies and numbered (with "1" indicating the area with the highest probability of locating an archaeological feature). Frequently there existed a number a magnetic anomalies appearing to have either similar archaeological sources or having an equal chance to yield a cultural source. In these instances, test squares were further identified by having a letter follow the priority number, i.e., 1a, 1b, etc.

This section examines the accuracy of NEBCAR's existing magnetic reconnaissance program concentrating on (1) the accuracy in locating archaeological features, (2) the accuracy in describing the source, and (3) the utility or practicality of the priority system. This evaluation is based on comparison of magnetic data with the results of excavations conducted during the 1978 and 1979 field seasons. This comparison is done site by site, with each site evaluation consisting of general comments about the magnetic data for that site from the NEBCAR reports, including the number of suggested test squares. Features correctly and incorrectly located will be discussed, as will the accuracy of the descriptions of those correctly located. The site discussions also indicate whether the site data was subjected to computer filtering (see "Computer Methods to

Improve Detection" for the results of filtering). Following the site presentations will be a comprehensive summary of the accuracy of the priority system as revealed by the site assessments.

In the following assessments, the terms "block" and "half block" are used. A block is a square area which measures 20 by 20 m and a half block is a rectangular area which measures 10 by 20 m. These are standard field units and can be located with reference to the grids used for control of excavations.

Individual Site Assessments

Site 5MT23, Grid 1

Grid 1 was an area of four full blocks and two half blocks. Several difficulties arose on this site due to numerous large holes, vegetation, and metal objects (Huggins and Weymouth 1978). Excavation operations at this grid were limited to Blocks C, D, and E. Of these blocks, only magnetic test Priority 1b fell into a tested area. The remaining ten were not tested (see table 1).

Summary of Site 5MT23, Grid 1. Excavation of Priority 1b test square revealed burned rock and adobe. The anticipated source had been a buried, burned feature, possibly more complex than a simple hearth (see table 1).

Two features were further identified during excavation. They were a subterranean domicile (pithouse) at 38-41N, 53-55E and a portion of a surface structure complex, Surface Structures 14 and 16, at 22-23N, 3-5E. The surface structures have no related anomalies visible on the unfiltered map, but the domicile may be related to a negative magnetic region although it is possibly distorted by a nearby dipole. These areas have been filtered in an attempt to identify the two features.

Table 1. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT23, Grid 1

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	37N, 6E	Burned feature, possibly more complex than a simple hearth	Not tested
1b	35N, 8E	Same as 1a	Burned rock & adobe
1c	33N, 10E	Same as 1a	Not tested
2	33N, 38E	No suggested source	Not tested
3	30N, 31E	Burned feature	Not tested
4	14N, 33E	Circular feature with soft fill	Not tested
5	13N, 6E	Burned region	Not tested
6	1N, 15E	Burned feature	Not tested
7a	13N, 22E	No suggested source	Not tested
7b	15N, 24.5E	No suggested source	Not tested
7c	15.5N, 27E	No suggested source	Not tested

Site 5MT23, Grid 2

Grid 2 was composed of five blocks. Igneous river cobbles having a typically high magnetic contrast were found in abundance on the surface and caused strong localized dipole and monopole anomalies. In spite of difficulties caused by these cobbles, metal, and irregular topography, individual anomalies of potential archaeological interest were more distinct than Grid 1 (Huggins and Weymouth 1978). Unfortunately, none of the 26 suggested magnetic test areas have been examined to date (refer to table 2).

Summary of Site 5MT23, Grid 2. Block C contained a feature of archaeological interest; a portion of a subterranean domicile. The domicile, located at 38N, 4E, has no apparent associated anomaly. The data of

Table 2. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT23, Grid 2

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	38N, 40E	Pitstructure or burned material	Not tested
1b	29.5N, 36E	Pitstructure	Not tested
1c	24N, 32.5E	Pitstructure or metal	Not tested
1d	36.5N, 53.5E	Pitstructure with associated hearths	Not tested
2a	38.5N, 34.5E	Activity area with burned material	Not tested
2b	41.5N, 36E	Same as 2a	Not tested
2c	35.5N, 28.5E	Burned region	Not tested
2d	30N, 51E	Burned feature, possibly architectural	Not tested
2e	40N, 51E	Burned or compacted region	Not tested
2f	33N, 52E	Hearth	Not tested
2g	34N, 42E	Hearth	Not tested
2h	35N, 44E	Hearth	Not tested
2i	37.5N, 47.5E	Hearth	Not tested
2j	39N, 46E	Hearth	Not tested
3a	15.5N, 32E	Possibly a pitstructure	Not tested
3b	24N, 51E	Pitstructure, or well-burned feature	Not tested
3c	30N, 13E	Pitstructure	Not tested
3d	29N, 22.5E	Possibly a pitstructure	Not tested
4a	14N, 36E	Hearth	Not tested
4b	17N, 38E	Hearth	Not tested
4c	18N, 53E	Hearth	Not tested
4d	14N, 54E	No source suggested	Not tested
5a	33N, 2.5E	No source suggested	Not tested
5b	24.5N, 8E	No source suggested	Not tested
5c	23.5N, 19.5E	No source suggested	Not tested
5d	22N, 22E	No source suggested	Not tested

the area has been filtered in an attempt to isolate any magnetic contribution by the subterranean domicile.

Site 5MT2162

The magnetometer survey was conducted over a two-block area in 1979. The presence of metal debris somewhat confused the magnetic field, and many of the smaller responses were undoubtedly masked. The survey did reveal seven anomalies of possible archaeological interest and seven magnetic test areas were located accordingly (Huggins and Weymouth 1981). Three of the areas were not tested, one area had a cultural source, and the three remaining areas had noncultural sources (see table 3).

Table 3. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2161

Priority	Location of anomaly center	Anticipated source	Excavated source
1	17N, 4E	Pitstructure	Pitstructure
4a	26N, 17E	Hearth	No cultural source
4b	39N, 13E	Hearth	Not tested
4c	33N, 17E	Hearth	Not tested
4d	27N, 17E	Hearth	No cultural source
4e	40N, 9E	Burned or activity area	Not tested
5	25n, 7E	Burned region	No cultural source

Summary of Site 5MT2162. The Priority 1 test square located a pitstructure consisting of a main chamber and an antechamber. It was suggested by NEBCAR to be a pitstructure or two closely related pitstructures, with the southern structure either smaller or more intensely burned (Huggins and Weymouth 1981).

No additional features were located during the blading operations.

Site 5MT2192

Magnetometer survey at Site 5MT2192 consisted of five blocks that were initially examined in 1978. Several linear trends, indicating long, linear sources of a geologic nature, were apparent on the magnetic map; but numerous other anomalies were thought to indicate archaeological features (Huggins and Weymouth 1978). Twenty-one magnetic test excavation areas were indicated by NEBCAR for these anomalies, but seven of these areas were not examined during excavation. Of the remaining 14 areas, 4 revealed cultural sources while 10 did not (see table 4).

Summary of Site 5MT2192. The four correctly located sources consisted of an unburned pithouse, a borrow pit, roomblocks, and a warming pit together with two unspecified pits. The descriptions of the suggested sources were fairly accurate for this site (refer to table 4). The pithouse was located at an area suggested to be a pitstructure. A southern lobe of the anomaly was thought to indicate a southern antechamber or ventilator, some burned material, or an activity area. Excavation revealed a southern ventilator shaft. A borrow pit containing two hearths was found in a magnetic test area that was suggested to contain either a pitstructure or, more probably, a burned area. The roomblock was found in an area believed to be slightly burned and/or compacted, possibly associated with the pitstructure. A large area was indicated as the source because of the anomaly size and the region of high variance to the south of this anomaly (Huggins and Weymouth 1978). The fourth cultural source located by magnetics was a warming pit containing sandstone and charcoal flecks and two nearby, unspecified, unburned pits. These were excavated in an area which was thought to contain an architectural feature with compacted or slightly burned fill.

Table 4. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2192

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	32N, 40E	Pitstructure with southern antechamber	Subterranean domicile with southern vent
1b	25N, 13E	Pitstructure	Sandstone outcropping
1c	35N, 48E	Pitstructure or burned area	Borrow pit with two hearths (Features 7 and 8)
2a	40N, 39E	Burned and/or compacted	Roomblock
2b	25N, 9E	Hearth	Sandstone outcropping
2c	19N, 9E	Hearth	Not tested
2d	19N, 16E	Hearth	Not tested
2e	20N, 20E	Hearth	Not tested
2f	36N, 43.5E	No suggested source	No cultural source
2g	40N, 47E	Architectural feature with compacted or burned fill	Warming pit (Feature 2) and two unspecified pits (Features 28 and 29)
2h	30.5N, 48E	No suggested source	No cultural source
3a	39N, 20E	Activity area	Not tested
3b,c	31N, 29E	Burned area with two locations of more extreme firing	No cultural source
4a	32N, 20E	Intensely burned area	No cultural source
4b	33.5N, 23E	Burned feature	No cultural source
4c	38N, 27E	Small hearth	No cultural source
4d	40N, 25E	Small hearth	Not tested
5a	23N, 25E	Long linear feature	Not tested
5b	24N, 47E	Hearth	No cultural source
6	18N, 32E	Small hearth	Not tested

Five additional features were identified by excavation in this five-block area. There were two unspecified pits (Feature 1 and 27), an unspecified pit with charcoal fill (Feature 5), a basin-shaped pit or cist (Feature 3), and a large roasting or cooking pit (Feature 26). Feature 5 appears to be possibly associated with the lobe of a nearby region of decreased magnetic intensity on the magnetic map. Any magnetic contribution by Feature 26 is obliterated by a nearby dipole caused by surface iron. Features 1, 3, and 27 have no apparent associated magnetic anomalies. The magnetic data for this site has been filtered in an attempt to recognize subtle anomalies caused by excavated features which did not have magnetic signatures in the original data used for the 1978 and 1979 NEBCAR reports.

Site 5MT2193

A one-block area, plus six additional 6- by 20-m areas at the east side of the grid (added later because archaeological features were suspected), was examined in 1978. The survey area contained no small-scale topographic features which would cause disturbances except for five archaeological test squares located around the periphery of the grid which caused disturbances close to those points (Huggins and Weymouth 1978). Seven test squares were then suggested by NEBCAR, but none of the test excavations over these anomalies revealed a cultural source (see table 5).

Summary of Site 5MT2193. Prior to formal evaluation, two suggested anomalies were excavated. This excavation revealed two pithouses. One additional feature was identified during archaeological explorations, a basin-shaped pit with a dark, organic fill (Feature 118). This feature had no apparent magnetic association.

Table 5. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2193

Priority	Location of anomaly center	Anticipated source	Excavated source
-	10N, 9E and 18N, 8E	No suggested source	Two subterranean domiciles
1	7N, 35.5E	Oval, burned feature	No cultural source
2	15N, 34E	No source suggested	No cultural source
3	2N, 27E	No source suggested	No cultural source
4	19N, 29E	Small burned feature i.e., cooking hearth	No cultural source
5	15N, 30E	Small burned feature i.e., cooking hearth	No cultural source
6	19N, 35E	Feature with loose fill	No cultural source
7	10N, 30E	Small burned feature i.e., cooking hearth	No cultural source

The area of this feature has not been filtered because it appears to lack characteristics which can be revealed by filtering. The feature is small (40 by 40 by 12 cm), oxidation is slight, and the original magnetic maps contain no indication of the feature.

Site 5MT2194

Two blocks at Site 5MT2194 were magnetically surveyed in 1979. The ground was free of topographic variations which may have caused disturbances in the magnetic field. The site contained six anomalies of possible archaeological interest, and seven magnetic test excavation areas were established in these regions (Huggins and Weymouth 1978). Six of the areas were noncultural while one was cultural (see table 6).

Summary of Site 5MT2194. Priority 1 square revealed an unburned pithouse with the floor approximately 1 m below surface level. The suggested

source was a burned area such as a large hearth or pitstructure with a depth of 1 m (refer to table 6).

Table 6. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2194

Priority	Location of anomaly center	Anticipated source	Excavated source
1	12N, 10E	Burned area, either	Unburned subterranean domicile
2	38N, 5E	Hearth	No cultural source
3	29N, 20E	Activity or ash area	No cultural source
4	31N, 10E	Possibly an iron source	No cultural source
5	33N, 13E	Burned or activity area	No cultural source
6	20N, 11E	Compacted feature or pathway	No cultural source
7	26N, 12E	Burned feature	No cultural source

Excavation operations revealed 10 additional features in the two block area which were not apparent in the original magnetic data: two (Features 1 and 3) were hearths containing a charcoal and ash fill; three (Features 2, 30, and 35) were probable hearths; and four (Features 4, 5, 6, and 9) were unburned, unspecified pits. Also unidentified was a surface structure (Surface Structure 1). Convolution filtering has been applied to try to refine the magnetic data and identify these features.

Site 5MT2199

This site was magnetically surveyed in 1979 and the survey activities covered a two-block area. It was considered unlikely that the general trend of the south sloping ground surface would affect the magnetic field, but two drainages running north to south are magnetically detectable. Although no large-scale features were magnetically located, five smaller anomalies were selected for examination (Huggins and Weymouth 1978). Two

of these were not tested, while the remaining three contained no cultural sources (see table 7).

Table 7. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2199

Priority	Location of anomaly center	Anticipated source	Excavated source
1	40N, 11E	Large burned area or metal	Not tested
2	5N, 5E	Hearth	No cultural source
3	18N, 15E	Geological feature	No cultural source
4	6N, 16E	No suggested source	No cultural source
5	29N, 5E	Hearth	Not tested

Summary of Site 5MT2199. Only one feature was identified during excavation of the two-block area. The feature (Feature 2) was a pit with burned sandstone but little charcoal, possibly a boiling or warming pit. It is not identified with an associated anomaly on the magnetic map and is considered unlikely to have contributed significantly to the magnetic record; therefore, the area has not been convolution filtered.

Site 5MT2202

Two blocks were magnetically surveyed for this site in 1979. According to the magnetic information the site was not promising for archaeological features. Additionally, a large trench dug before the magnetic work was done adversely affected 20 percent of the region. Four magnetic test areas were indicated by NEBCAR but were suggested to have dubious cultural affiliation (Huggins and Weymouth 1981). None of the four areas revealed cultural sources after excavation (see table 8).

Summary of Site 5MT2202. One cultural feature was located just within the magnetometer grid. This was a stone-lined hearth (Feature 1) containing a soft, dark, charcoal-filled soil. It has no apparent

associated anomaly on the magnetic map. The magnetic data has not been subjected to convolution filtering.

Table 8. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2202

Priority	Location of anomaly center	Anticipated source	Excavated source
1	10.5N, 30E	Burned region	No cultural source
2	5N, 35E	Burned feature	No cultural source
3	5N, 30E	Peripheral burned or decayed feature	No cultural source
4	13N, 8.5E	Burned area	No cultural source

Site 5MT2203

Site 5MT2203 was a topographically flat area at which two magnetic blocks were established. The site was magnetically surveyed in October 1978. Seven anomalies were noted magnetically and 13 magnetic test squares were then indicated (Huggins and Weymouth 1978). Ten of these areas were not tested, and two failed to contain cultural sources. One magnetic test square contained a cultural source (see table 9).

Summary of Site 5MT2203. Priority 1 located an activity area containing a hearth and ash pit at a depth of approximately 30 cm below the surface. The source was suggested to be a burned region with a maximum depth of 1.5 m (refer to table 9).

Seven additional features were identified during the excavation operations. Two were slab-lined hearths (Features 1 and 2), one was a cist (Feature 4) filled with hearth debris, and the remaining four were hearths that lacked slab linings (Features 3, 5, 8, and 9). Two of the hearths contained a charcoal fill (Features 3 and 9) and two have ash fills (Feature 5 and 8). All but one feature (Feature 9) have possible magnetic anomaly associations. Features 2, 3, and 5 are possibly related

to areas of increased magnetic intensity, and Features 1, 4, and 8 are possibly associated with areas lobing outward from the region of increased magnetic susceptibility designated as Priority 1 magnetic test area. The magnetic data has been filtered in an attempt to identify subtle magnetic contributions of the features.

Table 9. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2203

Priority	Location of anomaly center	Anticipated source	Excavated source
1	20N, 16E	Burned region	Activity Area 2, with ash pit (Feature 4) and hearth (Feature 1)
2a	6N, 21E	Burned region or geological source	Not tested
2b	13N, 23E	Burned region or geological source	Not tested
3a	7N, 32E	No source suggested	Not tested
3b	2N, 33E	No source suggested	Not tested
3c	1N, 37E	No source suggested	Not tested
4	15N, 31E	No source suggested	Not tested
5a	17N, 37E	Small hearth	Not tested
5b	15N, 40E	Small hearth	Not tested
5c	12N, 37E	Small hearth	No cultural source
6	18N, 22E	No source suggested	Not tested
7a	4N, 1E	No source suggested	Not tested
7b	17N, 1E	No source suggested	Not tested

Site 5MT2236

At Site 5MT2236 six magnetic blocks were surveyed in October of 1978. A variety of anomalies appeared, some obviously geologic in nature. Ten regions were selected as possibly having cultural sources.

Fifteen test areas were selected by NEBCAR (Huggins and Weymouth 1978) and all were tested. Fourteen test areas had noncultural sources, but the source of the remaining area was archaeological in nature (see table 10).

Table 10. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2236

Priority	Location of anomaly center	Anticipated source	Excavated source
1	21N, 31E	Pitstructure	Burned subterranean domicile
2a	18N, 40E	Hearth	No cultural source
2b	14N, 30E	No source suggested	No cultural source
3a	15N, 50E	No source suggested	No cultural source
3b	12N, 54E	No source suggested	No cultural source
3c	5N, 55E	No source suggested	No cultural source
4	16N, 60E	No source suggested	No cultural source
5	41N, 46E	No source suggested	No cultural source
6a	6N, 40E	No source suggested	No cultural source
6b	3N, 40E	No source suggested	No cultural source
7a	16N, 16E	No source suggested	No cultural source
8	14N, 23E	No source suggested	No cultural source
9a	2N, 68E	No source suggested	No cultural source
9b	3N, 75E	No source suggested	No cultural source
10	40N, 37E	No source suggested	No cultural source

Summary of Site 5MT2236. Priority 1 was anticipated to be a pitstructure and subsequent excavation revealed a burned pithouse (refer to table 10).

Excavation revealed 14 additional features. Four of these features were rooms (Rooms 1, 2, 3, and 4), two were surface structures (Surface Structures 1 and 2), and two were burials (Burials 1 and 2). Four

features were slab-lined hearths (Hearths 1, 2, 3, and 4), one was a firepit, and one feature was an artifact concentration. Seven of the features (Hearths 1 through 3, firepit, Burials 1 and 2, and the artifact concentration) have no association with anomalies on the original magnetic SYMAPS. Rooms 1 through 4 are each possibly related to regions of increased magnetic intensity as are Hearth 1 and Surface Structures 1 and 2. Convolution filtering has been applied to the magnetic data to try to isolate any subtle magnetic contributions from these features.

Site 5MT2242

This site was composed of three blocks. Except for suspected geologic anomalies, the site appeared to contain anomalies of only small scale cultural features such as fire hearths. Eight magnetic test excavation areas were selected by NEBCAR (Huggins and Weymouth 1981). Three areas were not tested and five magnetic test areas failed to reveal cultural sources (see table 11).

Table 11. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2242

Priority	Location of anomaly center	Anticipated source	Excavated source
3a	8N, 11E	Architectural feature/ surface structure	No cultural source
3b	34N, 15E	Architectural feature/ surface structure	No cultural source
4a	11N, 8E	Hearth	Not tested
4b	5N, 29E	Hearth	Not tested
4c	10N, 30E	Hearth	Not tested
4d	17N, 23E	Hearth	No cultural source
5a	15N, 35E	Architectural feature	No cultural source
5b	32N, 3E	Architectural feature	No cultural source

Summary of Site 5MT2242. Two additional features were located by excavation but were not evidenced by magnetic anomalies. Feature 1 was a collection of artifacts in close association and Feature 2 was a hearth with burned soil and sandstone. Feature 1 has no associated anomaly and is unlikely to have created any substantial magnetic field alteration. Feature 2 is possibly related to a region of increased magnetic intensity. The magnetic data for this site has been convolution filtered in an attempt to isolate any subtle magnetic anomalies related to these features.

Site 5MT2844

Two blocks were magnetically surveyed at this site, and seven anomalies of interest were designated as test excavation areas (Huggins and Weymouth 1978). All areas were tested, but only one identified a cultural area (see table 12).

Table 12. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2844

Priority	Location of anomaly center	Anticipated source	Excavated source
1	33N, 5E	Pitstructure	Surface structure
2a	3N, 7E	No source suggested	No cultural source
2b	3N, 9E	No source suggested	No cultural source
3	23N, 5E	Burned region	No cultural source
4	18N, 6E	Shallow, elongated source	No cultural source
5	26N, 18E	Iron object	No cultural source
6	South of Anomaly 5	No source suggested	No cultural source

Summary of Site 5MT2844. The Priority 1 magnetic test area was located above a surface structure. The suggested source from the magnetic information was a pitstructure (refer to table 12).

No other cultural features were identified during the excavation operations of the two-block area.

Site 5MT2848

The manetic survey area at Site 5MT2848 consisted of a four-block magnetic grid set out in a plowed field. Metal objects were present, but no topographic features were apparent which would disturb the magnetic field. Five anomalies of interest were noted by NEBCAR, and six magnetic test excavation areas were indicated (Huggins and Weymouth 1978). All six areas were tested and two test areas contained cultural sources. The remaining four were noncultural (see table 13).

Table 13. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2848

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	20N, 17E	Pitstructure with southern antechamber	Subterranean domicile with southern vent
1b	18N, 13E	Hearth	Possible hearth
2	10N, 11E	Area of soft fill such as borrow area or pitstructure	No cultural source
3	18N, 9E	Burned or ash area	No cultural source
4	13N, 15E	Small hearth	No cultural source
5	15N, 29E	Activity area	No cultural source

Summary of Site 5MT2848. Priority 1a magnetic test area was suggested to be a pitstructure with a southern antechamber. Excavation revealed a pithouse with a southern ventilator shaft. The second identified

cultural source was at Priority 1b, a suggested hearth. During testing, a charred and oxidized area assumed to be a hearth was identified.

Ten additional features were located by excavation within the four-block area. Two surface structures were identified (Surface Structures 1 and 2), and one pithouse (Pitstructure 2) was located at the edge of the magnetometer grid. Five features were hearths, three of which contained dense charcoal (Features 5, 6, and 7), and one of which showed only limited oxidation (Feature 4). The final feature was a fireplace (Feature 2). A charred and oxidized area was also located southwest of Pitstructure 1.

Only two excavated features show possible associations with magnetic anomalies on the original magnetic SYMAP. Surface Structure 2 may be related to areas of increased magnetic intensity and Pitstructure 2 may be associated with an anomaly that extends off the area magnetically surveyed as suggested in the magnetometer report. The magnetic data of this site have been convolution filtered in an attempt to isolate any subtle magnetic contributions for these features.

Site 5MT2853

Two blocks set in a uniform plowed field were surveyed on this site. Several anomalies caused by iron objects were present, but seven anomalies of potential archaeological interest were isolated by NEBCAR (Huggins and Weymouth 1978). All seven areas were tested, but six had no cultural sources (see table 14).

Summary of Site 5MT2853. The Priority 1 magnetic test area proved to be of a cultural nature, revealing two superimposed pithouses. The source had been suggested to be either a burned region or a pitstructure (refer to table 14).

Table 14. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2853

Priority	Location of anomaly center	Anticipated source	Excavated source
1	7N, 17E	Burned region, possible pithouse	Subterranean domicile complex
2a	10N, 9E	No source suggested	No cultural source
2b	10N, 6E	Burned region	No cultural source
3	5N, 9E	No source suggested	No cultural source
4	25N, 16E	Burned region	No cultural source
5	33N, 18E	No source suggested	No cultural source
6	12N, 13E	Architectural feature filled with less compact soil	No cultural source

Excavation operations identified two additional features not related to any identifiable anomalies on the original SYMAP. One feature was an oxidized firepit (Feature 1) while the second feature was a surface structure (Surface Structure 1). The magnetic data for this site has been filtered in an attempt to isolate any subtle magnetic anomalies caused by these features.

Site 5MT2854

There were 3.75 blocks magnetically surveyed at this site. Of the 12 magnetic test areas identified by NEBCAR (Huggins and Weymouth 1981), 4 areas were not tested. Four of the remaining areas were bladed but revealed no cultural sources, and two more were tested but had no identifiable cultural sources. Two of the test areas were associated with cultural sources (see table 15).

Summary of Site 5MT2854. Priority 1a and 1c magnetic test areas located pithouses. Their anticipated sources were pitstructures (refer to table 15).

Table 15. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2854

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	13N, 20E	Pitstructure	Subterranean domicile
1b	15N, 35E	Pitstructure	No cultural source
1c	22N, 19E	Pitstructure	Subterranean domicile
2a	26N, 15E	Burned area, or roomblocks	No cultural source
2b	8N, 25E	Hearth	No cultural source
2c	13N, 39E	Hearth	No cultural source
2d	8N, 18E	Burned extension of 1a	No cultural source
2e	25N, 11E	Burned/activity area	Not tested
2f	13N, 26E	Burned area or hearth	Not tested
3a	8N, 39E	Hearth or geologic effects	No cultural source
3c	15N, 30E	Possible borrow pit	Not tested
4a	7N, 34E	Midden or activity area	Not tested

Seven features were identified during excavation in areas not designated as magnetic tests. One was a feature which was identified on the basis of discolored soil, but was not excavated (Feature 7), three were hearths (Features 2, 5, and 8), two features were unspecified pits (Features 1 and 6), and one feature was a burned region (Feature 3). Four of these features (Features 1, 2, 5, and 7) have no associated anomalies visible on the original SYMAP. Features 3, 6, and 8 are each possibly associated with areas of increased magnetic susceptibility. Convolution

filtering has been applied to the magnetic data in an attempt to isolate any subtle magnetic variations caused by these eight features.

Site 5MT2857

There were 2.5 blocks examined at this site, and 7 magnetic test areas were suggested by NEBCAR (Huggins and Weymouth 1981). No cultural features were located within the seven test areas, and no cultural features were located elsewhere within the 2.5 magnetic block area (see table 16).

Table 16. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2857

Priority	Location of anomaly center	Anticipated source	Excavated source
3a	15N, 14E	Structure	No cultural source
3b	36N, 16E	Structure	No cultural source
4a	32N, 3E	Soft fill feature	No cultural source
5a	15N, 20E	Activity area with burning	No cultural source
5b	29N, 12E	Activity area	No cultural source
5c	14N, 40E	Burned region	No cultural source
5d	35N, 9E	Structure	No cultural source

The unlikelihood of encountering features was reflected by the low numbers in the priority scheme.

Site 5MT2858

Site 5MT2858 contained two magnetically surveyed blocks and had several anomalies of possible archaeological interest. Four magnetic test excavation areas were indicated for these anomalies by NEBCAR (Huggins and Weymouth 1981). Three areas proved to be the result of cultural features while the fourth was noncultural in origin (see table 17).

Table 17. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT2858

Priority	Location of anomaly center	Anticipated source	Excavated source
1	30N, 15.5E	Burned region with soft fill or metal	Subterranean domicile
2	25N, 12E	Burned region with soft fill or metal	Subterranean domicile
3	11.5N, 12E	Soft fill feature	No cultural source
4	33.5N, 11E	Burned region with soft fill or metal	Subterranean domicile

Summary of Site 5MT2858. The test areas designated with Priorities 1, 2, and 4 were pithouses, and all had been previously suggested to be burned regions with soft fill (refer to table 17).

One additional feature was located during excavation operations: Feature 1, a hearth. The feature has no obviously related anomaly on the magnetic map. This site has not been subjected to convolution filtering because the feature appeared to be insufficient in size (60 by 58 by 33 cm) and in nature due to rodent disturbance and lack of oxidation.

Site 5MT4512

Two blocks were examined at this site. An arroyo bordering the south side of the grid, an area of stone rubble, and a circular depression may cause minor variations in the field. Several anomalies of interest occurred, and seven magnetic test excavation areas were set out by NEBCAR (Huggins and Weymouth 1978). Four areas were not tested, and two areas were noncultural. Only one test area had a cultural source (see table 18).

Summary for Site 5MT4512. The Priority 1 area led to excavation of an unburned subterranean domicile with a southern antechamber 4 m below

the surface level. The source had been suggested to be a large-scale architectural feature or burned area with a depth of 1.3 m (refer to table 18).

Table 18. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4512

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	17N, 6E	Burned region	Unburned subterranean domicile with southern antechamber
1b	8.5N, 28E	Activity area	Not tested
2a	20N, 24E	No source suggested	Not tested
2b	13N, 25.5E	Possibly iron	Not tested
2c	15N, 27E	No source suggested	Not tested
3a	6N, 18E	Burned area	No cultural source
3b	6N, 15E	No source suggested	No cultural source

Excavation revealed 20 additional archaeological features within the two-block area. Seven of the features were hearths (Features 6, 11, 13, 18, 21, 26, and 27), one feature was a sandstone-lined hearth (Feature 31), two were charcoal-stained pits (Features 36 and 22), and these were pits with some burning and sandstone (Features 41, 42, and 43). Feature 37 was a large slab-lined pit surrounded by an irregular, shallow pit (Feature 35). There are two large depressions (Features 9 and 23), a subterranean pitroom (Pitstructure 2), a hearth with burned sandstone (Features 32), and a large hearth with sandstone and charcoal (Feature 20).

Thirteen of these features have no anomalies associated with them according to the original SYMAP's presentation of the magnetic field (Features 6, 9, 11, 13, 18, 20, 21, 22, 23, 26, 31, 32, and

Pitstructure 2). Seven other features appear to be associated with areas of increased magnetic intensity (Features 27, 35, 36, 37, 41, 42, and 43). Feature 20 is located near a dipole caused by an iron object and may be affected by this. The magnetic data for this site has been convolution filtered in an attempt to identify subtle magnetic contributions of these features.

Site 5MT4513

The surveyed area at Site 5MT4513 consisted of a one-block area having no distinct features. The site was described by NEBCAR as being very unpromising for archaeological features greater than 1 m in dimensions. Three magnetic test areas were selected by NEBCAR for anomalies of small-scale archaeological features (Huggins and Weymouth 1981). Upon excavation none of the areas was found to have a cultural source (see table 19). No cultural features were found within the magnetically surveyed area.

Table 19. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4513

Priority	Location of anomaly center	Anticipated source	Excavated source
4a	8N, 18E	Hearth	No cultural source
5a	19N, 2E	Hearth	No cultural source
5b	14N, 5E	Hearth	No cultural source

Site 5MT4545

The four-block surveyed area at this site had a variety of anomalies assumed to be caused by geological and archaeological sources. Ten anomalies were selected by NEBCAR as having archaeological sources (Huggins and Weymouth 1978). Five anomalies were discovered to have no cultural sources (see table 20).

Table 20. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4545

Priority	Location of anomaly center	Anticipated source	Excavated source
1a,b	30N, 22E	Burned region	Subterranean Domiciles 1 and 2
2a,b	33N, 14E	No source suggested	Room 1 is located between the two areas
3a,b	26N, 39E	Burned region	No cultural source
4	31N, 37E	Area of soft fill, possibly a borrow pit	No cultural source
5	37N, 5E	Burned region	No cultural source
6	8N, 7E	Geologic source	No cultural source
7	14N, 17E	No source suggested	No cultural source
8	SE portion of magnetic grid	No source suggested	Overlaps midden

Summary of Site 5MT4545. The test areas indicated by Priorities 1a and 1b were the result of two burned pithouses. Their suggested source was a burned region. Priorities 2a and 2b had no suggested sources but were related to a burned surface structure and possibly to a hearth. Priority 8 had no suggested source and overlaps a midden area (refer to table 20).

Excavation revealed 35 features outside of the test areas but within the four-block area. Twelve were rooms (Rooms 1-10, 12, and 14), two were slab-lined hearths (Features 27 and 68), one was an oxidized hearth (Feature 5), and another excavated feature was a large unspecified pit (Feature 90). Features 1 and 92 were trash-filled borrow pits. The remaining 17 features are generally small hearths and pits.

Rooms 2, 3, and 5-10 all appear to be associated with areas of increased magnetic susceptibility, or lobes of such regions on the unfil-

tered SYMAPS. Rooms 2 and 12 have no associated anomalies. Feature 68 appears to be related to a region of increased magnetic susceptibility, while Feature 5 is possibly associated with a lobe of a region of increased magnetic intensity. Features 72, 73, 75, 76, and 80 are all located within a midden area and have no distinctly related magnetic anomalies. The site data has been filtered in an attempt to further isolate these anomalies.

Site 5MT4614

Four blocks were initially magnetically surveyed at this site, and three additional blocks were later added. No field disturbances were expected from the topography and no iron materials were visible on the surface (Huggins and Weymouth 1978). Eighteen magnetic test areas were indicatd by NEBCAR (Huggins and Weymouth 1978, 1981), but four were not tested and seven revealed no cultural sources (see table 21).

Summary of Site 5MT4614. Seven magnetic test areas contained cultural materials (refer to table 21). Priority test areas 1a and 1b were anticipated to be pitstructures. Excavation revealed two pithouses with southern ventilator shafts. Priority test area 1c was also thought to be due to a pitstructure, but was in fact a surface structure. Anomaly Priorities 2a, 2c, 2e, and 2f were suggested to be activity areas, either burned or compacted. Priority 2c was two surface structures, and Priority 2e was also a surface structure. Priority 2f was discovered to be an unspecified, burned pit.

Excavation proceedings identified 14 additional features within the magnetically surveyed grid, but outside of the magnetic priority test areas. These features were a slab-lined hearth (Feature 54), two firepits (Features 7 and 61), four unspecified pits (Features 62, 73, 74, and 83),

Table 21. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4614

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	35.5N, 54E	Pitstructure	Subterranean domicile with southern vent shaft
1b	26.5N, 49.5E	Pitstructure	Subterranean domicile with southern vent shaft
1c	22.5N, 44E	Pitstructure	Surface structure
2a	39.5N, 48.5E	Activity area, possibly burned or compacted	Surface structure and storage bins
2b	36N, 45E	Activity area, possibly burned or compacted	No cultural source
2c	30N, 45E	Activity area, possibly burned or compacted	Two surface structures
2d	25.5N, 55E	Activity area, possibly burned or compacted	No cultural source
2e	41N, 53E	Activity area, possibly burned or compacted	Surface structures
2f	31N, 49E	Activity area, possibly burned or compacted	Unspecified, burned pit
3a	30.5N, 57E	Burned area	No cultural source
3b	27N, 60E	Burned area	No cultural source
3c	13N, 44E	Burned region	Not tested
3d	19N, 37E	Burned region	Not tested
3e	29.5N, 60E	Burned region	No cultural source
3f	33.5N, 38E	Burned region	Not tested
3g	31N, 39E	Burned region	Not tested
4a	35N, 48.5E	Soft fill or geologic	No cultural source
4b	29.5N, 54E	No suggested source	No cultural source

three unspecified pits with burning (Features 6, 63, and 82), and four storage bins (Features 57, 58, 59, and 60). Features 6, 7, 82, and 83 may be related to a region of increased magnetic intensity. The magnetic data for this site have been subjected to convolution filtering in an attempt to identify subtle magnetic contributions of these features.

Site 5MT4640

This two-block area showed little in the way of archaeological features. Five magnetic test areas were selected for anomalies of possible cultural interest (Huggins and Weymouth 1981), but two had noncultural sources (see table 22).

Table 22. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4640

Priority	Location of anomaly center	Anticipated source	Excavated source
1	14.5N, 12E	Activity area	Pit with charcoal
2	8N, 14.5E	Activity area	Surface structure
3	21N, 5E	Possibly hearths or kilns	No cultural source
4	24N, 17E	Small hearth	No cultural source
5	16.5N, 2E	Small hearth	Possibly a surface structure

Summary of Site 5MT4640. The Priority 1 test area was described as possibly an activity area with regions of burned and/or compacted soil. Excavation operations identified a pit with moderate amounts of charcoal throughout the fill. The pit appears to be related to an anomaly with a maximum intensity of 26 quarter gammas at 16N, 13E. Priority 2 was also suggested to be an activity area and was found to be a surface structure. Priority 5, suggested to be a small hearth, was either a truncated surface structure or a large pit (refer to table 22).

No other cultural features were located within the magnetometer blocks.

Site 5MT4644

Six blocks were magnetically surveyed at this site. Twenty magnetic test excavation areas were identified by NEBCAR (Huggins and Weymouth 1981). Five of these areas were not investigated, and nine areas had noncultural sources. Six areas were found to have cultural sources (see table 23).

Summary of Site 5MT4644. Priority 1a and 1b magnetic test areas revealed pithouses with southern ventilator shafts. Both areas had previously been described as areas containing possible pitstructures with southern antechambers. Priority 4d, suggested to have a hearth as a source, was located in a midden area, as were 4e, a suggested burned region, and 4f, suggested as either a hearth or a burned region. No distinct features were located in any of the test areas; however, Priority 5d, suggested to possibly be a structure, was found to be a pitlike feature (refer to table 23).

Eleven features were found within the magnetometer blocks, but outside of the indicated test areas. Six cultural features were identified after blading, but were not excavated (UCU [unexcavated cultural unit] 1-3, 10, 12, and 13). Five features were excavated. These included a slab-lined hearth (Feature 4), a hearth with charcoal fill (Feature 67), and an unspecified pit with dark, organic fill (Feature 5). Feature 18 is a large pit containing a concentration of carbonized maize cobs (Feature 15). A dark stain near 41N, 51E is possibly another pitstructure.

Nine of the features (UCU 1-3, 10, 13, 16, and Features 4, 15, and 18) have no apparent magnetic anomalies associated with them. Feature UCU

Table 23. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4644

Priority	Location of anomaly center	Anticipated source	Excavated source
1a	43N, 25E	Pitstructure with southern antechamber	Subterranean domicile with southern vent
1b	45N, 39E	Pitstructure with southern antechamber	Subterranean domicile with southern vent
2a	48N, 17E	Burned region	No cultural source
2b	44N, 14E	Burned region	No cultural source
2c	38N, 19E	Burned region	No cultural source
2d	34N, 23E	Burned region	No cultural source
2e	45N, 33E	Burned activity area	Not tested
3a	54N, 6E	Pitstructure or surface structure	Not tested
3b	17N, 10E	Surface structure	Not tested
4a	50N, 10E	Hearth	No cultural source
4b	50N, 5E	Hearth	No cultural source
4c	57N, 9E	Hearth	No cultural source
4d	13N, 14E	Hearth	Nothing distinct but located in midden area
4e	10N, 17E	Burned region	Nothing distinct but located in midden area
4f	18N, 20E	Burned region or hearth	Nothing distinct but located in midden area
4g	20N, 3E	Hearth	No cultural source
5a	24N, 37E	Burned region	No cultural source
5b	24N, 29E	Activity area	Not tested
5c	31N, 8E	Activity area	Not tested
5d	56N, 27E	Possible structure	Pitlike feature (Feature 13)

12 may be related to an extension of a nearby area of decreased magnetic intensity. Features 67 and 5 appear to be related to an area of increased magnetic intensity. The magnetic data from this site have been convolution filtered in an attempt to isolate any subtle magnetic contributions from the features.

Site 5MT4649

This site had a total surveyed area of two blocks. After processing the data, it was felt that the site contained few areas of archaeological interest, and three low priority test areas were selected by NEBCAR (Huggins and Weymouth 1981). None of these revealed a cultural source (see table 24).

Table 24. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4649

Priority	Location of anomaly center	Anticipated source	Excavated source
4	37.5N, 2E	Burned area	No cultural source
5a	36N, 6E	Burned area	No cultural source
5b	15N, 16E	Hearth	No cultural source

Summary of Site 5MT4649. Only one cultural feature was identified after blading. This was Feature 1, a concentration of sandstone, thought perhaps to be the lining of a shallow pit.

This site has not been filtered because of its lack of features. It is unlikely that the sandstone would provide an anomaly of sufficient magnitude to be magnetically detected, and also the feature would be almost fully obscured by a strong magnetic field from a piece of surface iron.

Site 5MT4681

One block was magnetically surveyed at this site. It was felt that the area contained little of archaeological interest, with only four

anomalies of potential interest. Four low priority test areas were accordingly set out by NEBCAR (Huggins and Weymouth 1981), but three failed to reveal cultural sources (see table 25).

Table 25. Priority, location, and comparison of descriptions derived from magnetic information to the excavated source for Site 5MT4681

Priority	Location of anomaly center	Anticipated source	Excavated source
3a	17N, 9E	Surface structure	Surface structure
5a	18N, 13.5E	Small feature	No cultural source
5b	13N, 6E	Small feature or hearth	No cultural source
5c	6N, 6E	Small feature	No cultural source

Summary of Site 5MT4681. Magnetic Priority 3a did have a cultural source, a surface structure as anticipated (refer to table 25). Excavation operations identified two features in addition to the surface structure. Feature 2 was a pit with a small amount of charcoal, and Feature 1 was a small hearth. Neither feature creates a visible magnetic anomaly on the original magnetic map.

Convolution filtering has been used on the magnetic data in an attempt to determine whether such a feature may be visible magnetically.

Site 5MT4763

On this site two and one-half blocks were magnetically surveyed in June 1979. It was originally considered to be a part of Site 5MT451? but was later separated and designated as a separate site. The designation Site 5MT4512 now applies only to the area directly south of Site 5MT4763. The site contained no apparent metal surface debris to disturb the magnetic field. No distinct architectural features were visible, although there are smaller anomalies which are suggestive of archaeological

features (Huggins and Weymouth 1981). Five magnetic test areas were set over anomalies of potential archaeological interest. None of the test areas fell within the excavated or bladed areas so no correlative table is included.

Summary of Site 5MT4763. Two features were identified within the magnetically surveyed areas but outside of the suggested test areas during the excavation operations. These features were a surface structure and a hearth (Feature 2) with a dark charcoal fill. Neither feature appears to have a related magnetic anomaly visible on the original magnetic SYMAP.

Convolution filtering has been utilized on the magnetic data for this site in an attempt to isolate any magnetic contributions from the features.

Assessment of the Priority System

The frequency of cultural features located in magnetic test square areas of the same priority is presented in table 26. With the anomalies numbered according to the possibility of locating a cultural source, it would be expected that correct location of anomalies would decrease as the priority numbers proceed toward 10. This is precisely what occurs (refer to table 27 and fig. 1). Priority 1 correctly located 23 cultural sources out of 27 tested anomalies. There is a sharp decrease in correct location of cultural sources for priority 2, and an even greater decrease below that priority. Magnetic priorities 6, 7, 9, and 10 failed to correctly identify any anomalies having cultural sources, while priority 8 correctly located one cultural source in two anomalies.

The priority scheme functions well as an indicator of the likelihood of encountering archaeological features, and reflects the initial experimental ideology of the magnetic reconnaissance. Anomalies with lower

Table 26. Frequency of cultural and noncultural sources located within magnetic priority test areas according to site and priority ranking

Site	1	2	3	4	5	6	7	8	9	10
5MT0023, G-1	1/0, 2 NT	1 NT	1 NT	1 NT	1 NT	1 NT	3 NT			
5MT0023, G-2	4 NT	10 NT	4 NT	4 NT						
5MT2192	2/1	2/3, 3 NT	0/2, 1 NT	0/3, 1 NT	0/1, 1 NT	1 NT				
5MT2193	0/1	0/1	0/1	0/1	0/1	0/1	0/1			
5MT2194	1/0	0/1	0/1	0/1	0/1	0/1	0/1			
5MT2199	1 NT	0/1	0/1	0/1	1 NT					
5MT2162	1/0			0/2, 3 NT	0/1					
5MT2202	0/1	0/1	0/1	0/1						
5MT2203	1/0	2 NT	0/1, 2 NT	1 NT	0/1, 2 NT	1 NT	2 NT			
5MT2236	1/0	0/2	0/3	0/1	0/1	0/2	0/1	0/1	0/2	0/1
5MT2242			0/2	0/1, 3 NT	0/2					
5MT2844	1/0	0/2	0/1	0/1	0/1	0/1				
5MT2848	2/0	0/1	0/1	0/1	0/1					
5MT2853	1/0	0/2	0/1	0/1	0/1	0/1				
5MT2854	2/1	0/4, 2 NT	0/1, 1 NT	1 NT						
5MT2857			0/2	0/1	0/4					
5MT2858	1/0		0/1	1/0						
5MT4512	1/0, 1 NT		0/2							
5MT4513				0/1	0/2					
5MT4545	2/0		0/2	0/1	0/1	0/1	0/1	0/1		
5MT4614	3/0		0/3, 4 NT	0/2						
5MT4640	1/0		0/1	0/1	1/0					
5MT4644	2/0		2 NT	3/4	1/1, 2 NT					
5MT4649				0/1	0/2					
5MT4681			1/0		0/3					
5MT4763			2 NT	2 NT	1 NT					
Total	23/4, 8 NT	9/25, 22 NT	1/27, 17 NT	4/25, 16 NT	2/24, 18 NT	0/7, 3 NT	0/4, 5 NT	1/1	0/2	0/1

NOTE: Cultural/noncultural.
NT - Not tested.
G - Grid.

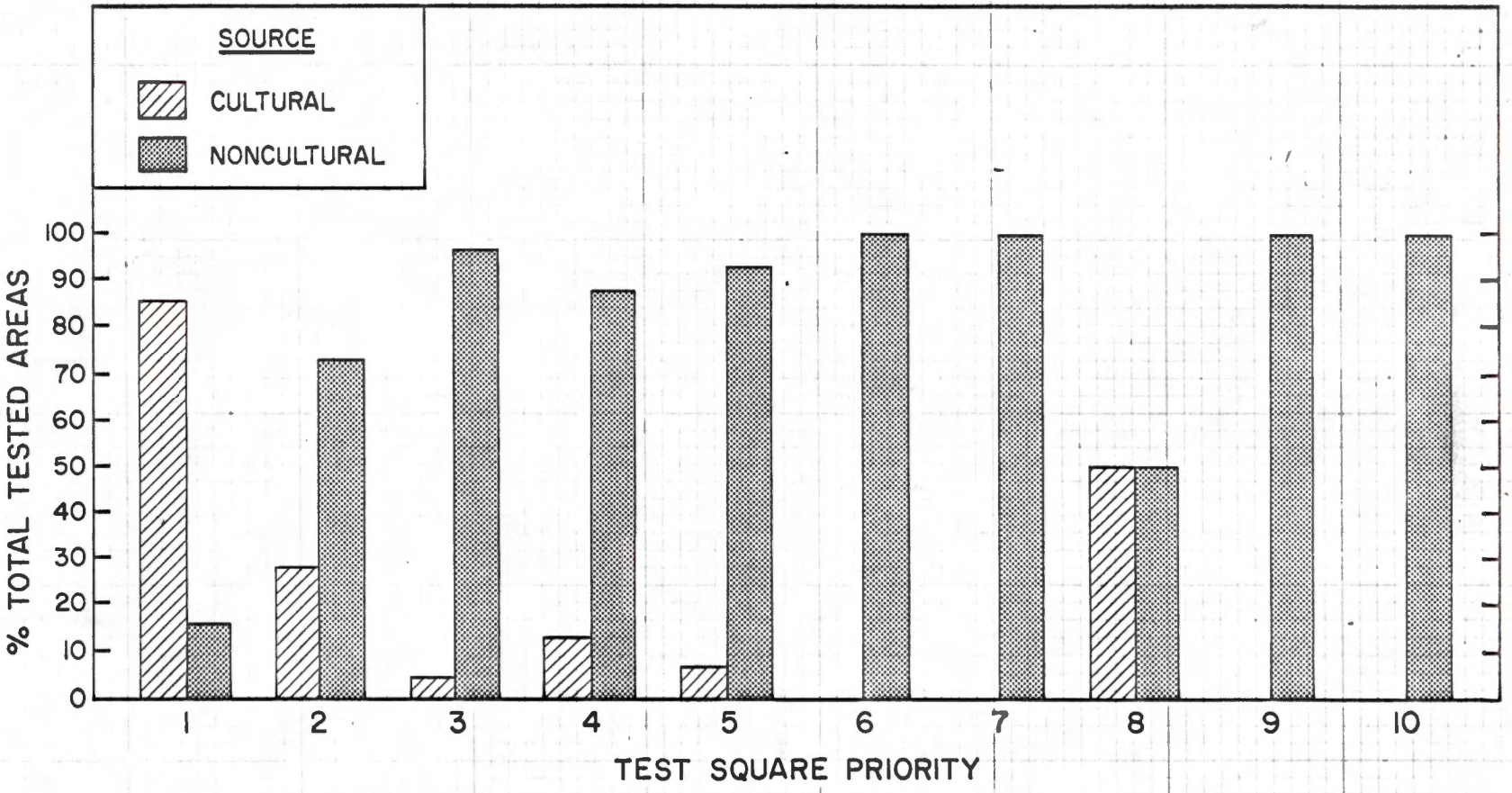


Figure 1. Comparison of percentage cultural versus noncultural features excavated for each test square priority.

priorities are basically caused by unknown or indistinct sources and are likely to be due to geologic contributions to the field. Since areas having geological anomaly sources have now been tested, the likelihood of selecting these anomalies as archaeologically interesting is substantially reduced, leaving room for a generally increased success rate in all priorities.

Table 27. Comparison of magnetic test areas containing cultural sources to those with noncultural sources or areas not tested

	Test square priority										
	1	2	3	4	5	6	7	8	9	10	Total
Total with cultural sources	23	9	1	4	2			1			40
Total with noncultural sources	4	25	27	25	24	7	4	1	2	1	120
Total not tested	8	22	17	16	8	3	5				79
Total	35	56	45	45	34	0	9	2	2	1	239

Description Accuracy

In addition to the practice of assigning priority numbers to anomalies of interest, descriptions of the anticipated cultural sources were also included. Such descriptions ranged from simple (e.g., "burned region") to elaborate (e.g., "pitstructures, burned, with a southern antechamber and a maximum depth of 1.3 m"). The accuracy of these descriptions has been examined according to anticipated source and actual, excavated source. Descriptive accuracy is presented in table 28 and compared by priority number on table 29.

Table 28. Comparison of the characteristics of excavated features with the anticipated characteristics derived from the magnetic field interpretation

Site	Anomaly priority	Anticipated source description	Excavated source description
5MT2192	1a	Pitstructure with a southern antechamber	Subterranean domicile with a southern ventilator shaft
	1c	Burned area or pit-structure	Borrow pit containing two hearths
	2a	Burned and/or compacted area, possibly associated with the pit-structure	Roomblock
	2g	Architectural feature with compacted or slightly burned fill	Warming pit with charcoal flecks and sandstone, and two unburned unspecified pits
5MT2194	1	Burned area, such as a large hearth or pit-structure, with a depth of 1 m	Unburned subterranean domicile with a floor depth of approximately 1 m
5MT2162	1	Pitstructure, or two closely related pit-structures with the southern structure smaller or more intensely burned	Two subterranean domiciles, with the southern structure smaller than the northern one
5MT2203	1	Burned region with a maximum depth of 1.5 m	Activity area containing a hearth and ash pit, about 30 cm below ground surface
5MT2236	1	Pitstructure	Subterranean domicile, burned
5MT2844	1	Pitstructure	Surface structure
5MT2848	1a	Pitstructure with a southern antechamber	Burned subterranean domicile with a southern ventilator shaft
	1b	Hearth	Charred, oxidized area, thought to be remains of a hearth
5MT2853	1	Burned region or pithouse	Subterreanean domicile complex, unburned

Table 28. Comparison of the characteristics of excavated features with the anticipated characteristics derived from the magnetic field interpretation--Continued

Site	Anomaly priority	Anticipated source description	Excavated source description
5MT2854	1a	Pitstructure	Subterranean domicile
	1c	Pitstructure	Subterranean domicile
5MT2858	1	Burned region with soft fill	Subterranean domicile
	2	Burned region with soft fill	Subterranean domicile
	4	Burned region with soft fill	Subterranean domicile
5MT4512	1	Large scale architectural or burned feature at a depth of 1.3 m	Subterranean domicile, unburned, 1 m below the surface
5MT4545	1i,ii	Burned region	Two subterranean domiciles, burned
	2i	No suggested source	Burned surface structure, and a possible hearth
	8	No suggested source	Overlaps midden area
5MT4614	1a	Pitstructure	Subterranean domicile
	1b	Pitstructure	Subterranean domicile
	1c	Pitstructure	Surface structure
	2a	Activity area, either burned or compacted	Surface structure
	2c	Activity area, possibly burned or compacted	Two surface structures
	2e	Activity area, possibly burned or compacted	Surface structure
	2f	Activity area, possibly burned or compacted	Unspecified, burned pit
5MT4640	1	Activity area with regions of burned or compacted soil	Pit, with charcoal fill

Table 28. Comparison of the characteristics of excavated features with the anticipated characteristics derived from the magnetic field interpretation--Continued

Site	Anomaly priority	Anticipated source description	Excavated source description
5MT4640 (cont.)	2	Activity area	Surface structure
	5	Hearth	Truncated surface structure or large pit
5MT4644	1a	Pitstructure with southern antechamber	Subterranean domicile with a southern ventilator shaft
	1b	Pitstructure with southern antechamber	Subterranean domicle with a southern ventilator shaft
	4b	Hearth	Midden area
	4e	Burned region	Midden area
	4f	Hearth or burned region	Midden area
	5d	Possible structure	Pit-like feature
5MT4681	3a	Surface structure	Surface structure
5MT0023, G-1	1b	Burned feature, possibly more complex than a simple hearth	Burned rock and adobe

Table 29. Comparison of magnetic priority areas to accuracy of feature description

	Accurate source description						Inaccurate source description						Partially accurate source description						No source identified						Total
Priority number	1	2	3	4	5	6-8	1	2	3	4	5	6-8	1	2	3	4	5	6-8	1	2	3	4	5	6-8	
NEBCAR suggested source																									
Pitstructure	11						4						2						2		1				20
Burned region with soft fill													1	1	1										3
Burned region	2									2				1					1	7	10	6	7	1	37
Hearths										1	1									6	2	10	6	1	28
Activity areas							1	1						4						2	1		2	2	13
Surface structures			1																						1
Architectural features																				1	2		2	1	6
Burned features													1						1	1	1	1	1	1	7
Structures											1										2		1		4
No source suggested								2				1								7	7	3	1	3	24
Other																				1	1	5	3	3	13
Total	14	-	1	-	-	-	4	3	-	3	2	1	4	6	-	1	-	-	4	25	27	25	23	12	

Pitstructures

Of the 20 sources anticipated to be pitstructures, 55 percent (11) were accurately described, 10 percent (2) were partially accurate, 20 percent (4) were inaccurately described, and 15 percent (3) failed to reveal a cultural source. All of the anticipated pitstructure sources were suggested for priority 1 except one. That one source was assigned a priority 3 and proved to have no cultural source. The partially accurate descriptions occurred for Site 5MT2194 and Site 5MT2853, where the sources were respectively suggested to be (1) a burned area possibly a pitstructure, and (2) a burned region possibly a hearth or pitstructure. The inaccurate predictions occurred at Sites 5MT2192, 5MT2844, and 5MT4614. At Site 5MT2192 two priority 1 test areas were suggested to be pitstructures but during excavation were found to be a sandstone outcropping and a borrow pit containing two hearths. The anomalies thought to represent pitstructures at Site 5MT2844 and Site 5MT4614 were actually surface structures.

Five pitstructures that were identified during excavation were inaccurately described magnetically. Two anomalies suggested to represent burned regions (Sites 5MT4512 and Site 5MT45450) actually represented pitstructures, one of which was unburned. Three other pitstructures excavated at Site 5MT2858 were associated with anomalies whose sources had been suggested to be burned regions with soft fill or metal. These last three suggest a magnetic environment typical of subterranean domiciles. The magnetic anomalies at these sites would now be recognized as related to pitstructures.

Burned Areas

Forty magnetic test areas were described as the result of burned regions. Thirty-two (80 percent) of the test areas had no cultural

sources, but two (5 percent) of the areas were accurately described, four (10 percent) were partially accurate, and two (5 percent) were inaccurate descriptions of the anomaly source. The partially accurate and accurate source descriptions involve a variety of sources related to burning. The accurately described burned region sources include an activity area with an ash pit and hearth (Site 5MT2203) and a burned subterranean domicile at Site 5MT4545. The partially accurate descriptions include a roomblock at Site 5MT2192 and three pitstructures at Site 5MT2858. The roomblock creates an anomaly which was described as a burned or compact area, and while the rooms may not have been burned, their floors were compacted. The inaccurately described burned regions were actually an unburned pitstructure (Site 5MT4512) and a portion of a midden. Of the anomaly areas described as burned regions which had cultural features as sources (eight), half are pitstructures and could now be recognized and magnetically described as such.

Hearths

Of the 28 features suggested to have hearths as their sources, three (10.7 percent) did have cultural sources. Only one of the cultural sources was accurately described as a hearth, the other two representing areas within a midden. The areas within the midden could not be defined as specific, localized features. It appears that greater care should be exercised in assigning priority areas to such anomalies, and then the priority number should be low.

Activity Areas

Thirteen priority areas were described as activity areas. None were considered a totally accurate description, but four descriptions were partially accurate and two were inaccurate. The four partially accurate

descriptions were at Site 5MT4614 and Site 5MT4640. Three areas at Site 5MT4614 were described as representing activity areas, either burned or compacted, and were found to be surface structures bearing these characteristics. A similar area at Site 5MT4640 was described as an activity area and also was found to be a surface structure. The inaccurately described sources also occurred at Site 5MT4614 and Site 5MT4640. Both sources at these sites were described as activity areas with burned or compacted soil. The actual sources were revealed to be an unspecified pit, and a pit with charcoal fill, respectively.

Miscellaneous Descriptions

Sources which were also described included architectural features (six), burned features (seven), structures (four), and a surface structure (one). Of these, the surface structure was the only feature accurately described, while a burned feature description was partially accurate. Structures and architectural features described only one excavated feature, a structure. Other anomalies (13) and anomalies for which no cultural source was suggested (24) identified only 2 features, a burned surface structure with a possible hearth and a midden at Site 5MT4545.

Summary

Location and descriptive accuracy indicates that large-scale features such as pitstructures are most easily located. Intensely burned and/or compacted areas may also be detected and lead to the identification of surface structures, roomblocks, and hearth areas. Anomalies described as activity areas are also accurate in locating cultural sources, primarily surface structure.

The more nebulous magnetic areas described as possible hearths, architectural features, and areas having no suggested sources seldom located cultural features (in suggested areas). Many noncultural sources produced small anomalies similar to those expected by hearths or other small, high susceptibility cultural features. More care should be taken in assigning test area status to most of the smaller or nebulous anomalies. Several techniques and graphic display methods are available and may enhance the visibility of these nebulous anomalies. One technique, convolution filtering, will be applied to the magnetic data of some of the 26 sites to determine its utility to the Dolores magnetic program.

COMPUTER METHODS TO IMPROVE DETECTION

Introduction

After determining the success rates of the magnetic priority scheme, the magnetic data were reexamined to see if the archaeological features found through excavation but not clearly visible in the magnetic record were detectable by utilizing computer filtering techniques. Emphasis was placed on the features that had been found outside of the magnetic priority test areas but within the magnetically surveyed grid.

The original magnetic data, as presented in the 1978 and 1979 NEBCAR reports, were first reexamined for indications of anomalies missed or ignored by these reports but that were actually caused by cultural features. Frequently there existed extremely vague magnetic anomalies such as a slight lobe on one side of a region of increased or decreased magnetic intensity. Occasionally a relatively apparent anomaly of an archaeological feature was not recognized as such. This was due primarily to an unfamiliarity with the region and usually occurred during the early period of the DAP's magnetic program.

After this examination of the original data, methods were sought to improve the detection of cultural features whose responses were weak or confused by other anomalies. Convolution filtering was chosen to assist in isolating the more subtle trends (rather than other pattern enhancement techniques such as residual trend analysis) because it was felt that this technique offers the best resolution of subtle anomalies of a specific size. In illustration, the majority of the features that were not isolated in the 1978 and 1979 NEBCAR reports were smaller than 1.5 m in diameter, suggesting small subtle responses obscured by background.

Convolution filtering is capable of removing most of the larger anomalies to leave the smaller responses which are suspected to be caused by the smaller features.

Line contour maps were chosen to graphically display the filtered result. Of the variety of the graphical display techniques available, such as SYMAP, dot density, isometric plotting, or profiles, line contours afford a more discerning presentation of the anomalies which are of specific interest in this portion of the study.

Convolution filtering involves the mathematic operation of a function on a matrix of magnetometer data. The numerical value of the magnetometer data at a point is replaced by a weighted average of the surrounding values out to a certain radius from the replaced point. This operation is then repeated for each value of the original data creating a new "filtered" matrix. Depending on the values of the weighting function, anomalies of a specific size can be removed leaving those anomalies of interest behind. For the sake of completeness a brief appendix is included with a technical description of the weighting function.

These methods were applied to Sites 5MT23 Grid 1 and Grid 2, 5MT2192, 5MT2194, 5MT2203, 5MT2236, 5MT2242, 5MT2848, 5MT2853, 5MT2854, 5MT4512, 5MT4545, 5MT4614, 5MT4644, 5MT4681, and 5MT4763. With a previous knowledge of the location of excavated features, a search was conducted for indications of anomalies related to the excavated cultural features but not mentioned in the magnetometer reports. Line contour maps of the original data were first examined for indications of these anomalies, then the corresponding locations on the convolution filtered line contour maps were examined. The results of these methods are presented site by site on the following pages.

Filtering on Individual Sites

Site 5MT0023, Grid 1

Two features were identified during archaeological testing outside of the magnetic test square areas, but within the magnetically surveyed grid. Archaeological test squares, 2 by 2 m in size, situated as randomly sampled probability areas, located portions of the features, but outlines were not further established. The features identified were a surface structure complex (Surface Structures 14 and 16) and a pithouse.

Reexamination of original data. The surface structure had no visibly related anomaly on the original line contour map. The pithouse appears to be related to a negative anomaly, but this is distorted by a nearby dipole. The relationship is unlikely to be real, since pitstructures are commonly related to regions of increased magnetic intensity.

Convolution filtering. The regions of the two features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. It became evident that any anomaly related to the pithouse would be highly confused by a nearby, strong dipole which is probably caused by an iron source. As a result, it is impossible in this case to resolve the anomaly caused by the pitstructure. The surface structures also show no related magnetic anomaly. The feature apparently lacks a significant magnetic contrast with the surrounding area.

Summary. Neither the surface structure nor the pithouse caused anomalies detectable by filtering. As previously indicated, this may be due to the magnetic field from a strong dipole source near the pithouse and an insignificant magnetic susceptibility contrast of the surface structure.

Site 5MT0023, Grid 2

Block C of Grid 2 contained one feature of archaeological interest which was outside of the suggested magnetic test areas, but within the magnetically surveyed grid. A 2- by 2-m test excavation square located a pithouse, but the outline of the pithouse was not established. The pithouse is located at 38N/4E and may extend northward off of the magnetically surveyed grid.

Reexamination of original data. The original line contour map was reexamined, but the pitstructure had no anomaly which could be identified.

Convolution filtering. The region of the feature was filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. No anomaly related to the pithouse was in evidence. This may be due to the feature extending off of the magnetically surveyed area.

Summary. The pithouse had no visibly associated magnetic anomaly on either the original or the filtered data. This may be due to the pithouse extending northward off of the magnetic grid.

Site 5MT2192

Five features were excavated outside of the magnetic test areas but within the magnetically surveyed area. These features were two unspecified pits (Features 1 and 27), a basin-shaped cist (Feature 3), an unspecified pit with charcoal fill (Feature 5), and a large roasting/cooking pit (Feature 26).

Reexamination of original data. Of the five features, four (Features 1, 3, 26, and 27) had no apparent magnetic anomaly associations on the original line contour maps. The unspecified pit with charcoal fill

(Feature 5) appeared to be possibly related to a nearby lobe extending from a region of decreased magnetic intensity shown on the magnetic map.

Convolution filtering. The regions of the features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined and it was apparent that only Feature 1 caused an obviously visible anomaly. This was an area of decreased magnetic intensity of -3 quarter gammas. An anomaly of Feature 26 could be masked by a nearby, strong dipole. Features 3, 5, and 27 were not visible after filtering. There is apparently no association between Feature 5 and the lobe of the low-intensity region visible on the original line contour map. The lack of identifiable magnetic anomalies associated with the three features is probably due to the nature of the features, small soft-fill pits, and their locations. All three features were situated in areas of great variation and steep magnetic gradients.

Summary. At this site, convolution filtering was able to isolate a magnetic anomaly caused by one feature of the five. The small anomaly (Feature 1) was identified in an area of little magnetic variation, unlike similar features (Features 3, 5, and 27) which were probably masked by the surrounding high variation.

Site 5MT2194

Ten features were identified outside of the selected magnetic test areas but within the magnetically surveyed area. These features were a surface structure (Surface Structure 1), two hearths with charcoal and ash fill (Features 1 and 3), three other hearths (Features 2, 30, and 35), and four pits with soft fill (Features 4, 5, 6, and 9).

Reexamination of original data. Reexamination of the original line contour map failed to reveal anomalies which could be related to the features.

Convolution filtering. The regions of the ten features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined. After filtering, most features are still magnetically unresolved.

Features 1, 2, and 3 are not visible which may be due to their locations in areas of steep magnetic gradients. None of the four soft fill features (Features 4, 5, 6, and 9) are visible. The possibly small anomalies caused by such features may be masked by other magnetic variations. Feature 5 is undoubtedly masked by a dipole situated next to its location, and Feature 35 is also not visible. The surface structure has a related anomaly, but this is not clear enough that it would be selected as caused by a cultural feature. Feature 30, a probable hearth, appears to be contributing to a dipole area, but this also is not clear because the dipole is affected by a piece of iron.

Summary. Most of the features had no related anomalies made visible after filtering. Of the two features (Feature 30 and Surface Structure 1) which had related anomalies, neither anomaly was sufficient to be isolated as the result of a cultural feature. This was due to other factors contributing to and distorting the magnetic anomalies.

Site 5MT2203

Seven features were found during excavation to be within the magnetically surveyed area but outside of the selected magnetic test areas. These features were four unlined hearths (Features 3, 5, 8, and 9), two slab-lined hearths (Features 1 and 2), and a cist filled with hearth debris (Feature 4).

Reexamination of original data. After reexamining the original line contour map, six of the features (Features 1-5, and 8) appeared to be

related to areas of increased magnetic intensity. The remaining feature had no visible associated magnetic anomaly.

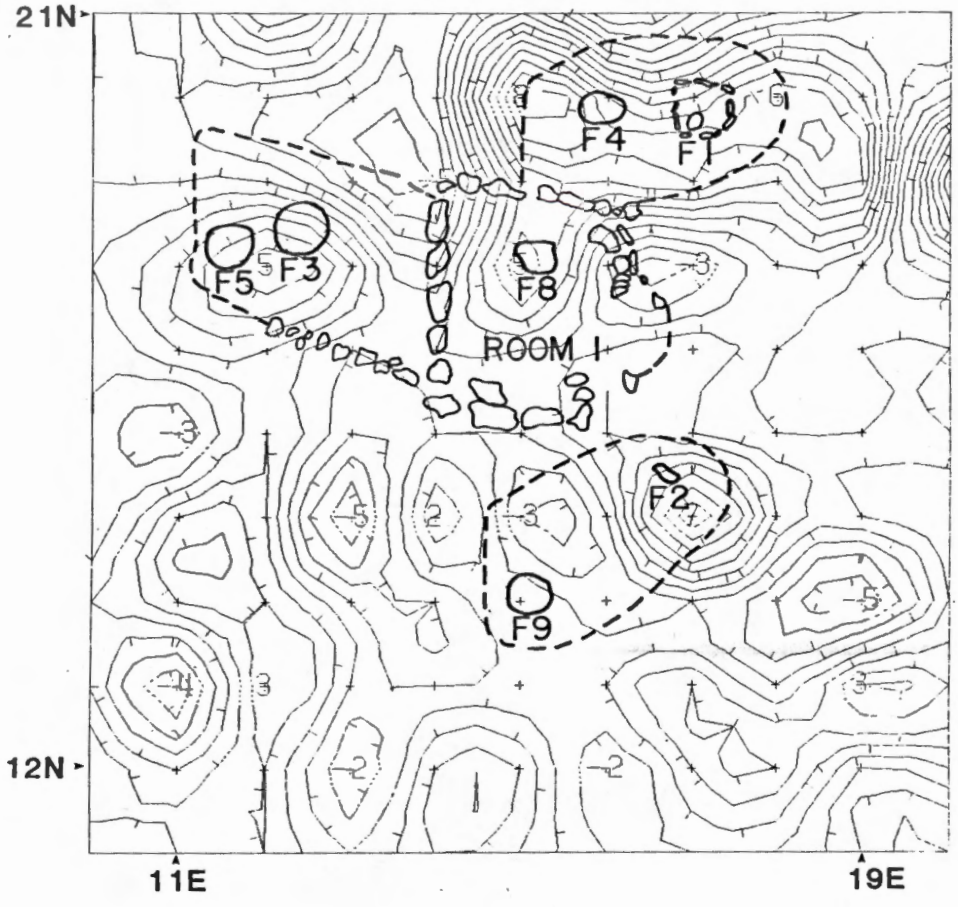
Convolution filtering. The regions of the features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined (refer to fig. 2). Only one feature (Feature 9) is not visible magnetically after filtering, probably due to an insignificant susceptibility contrast with the surrounding soil. The remaining six features show enhanced anomalies. Feature 2 is seen to be a source of a region of increased magnetic intensity and the filtering emphasized the relationship of an anomaly of increased magnetic intensity to Features 3 and 5. The two features are definitely causing the anomaly. Feature 8 is located within Room 1 and filtering identified an anomaly of increased magnetic intensity to be related to this feature. While Features 1 and 4 cannot be specifically isolated, both definitely contribute to a high magnetic area.

Summary. Convolution filtering succeeded in enhancing the anomalies of six of the seven features identified through excavation. These same six features appeared to have slight anomalies associated with them on the original line contour map.

Site 5MT2236

Fourteen features were found outside of the selected magnetic test square areas but within the magnetically surveyed grid. The features identified were two burials (Burial 1 and 2), four rooms (Rooms 1-4), four hearths (Hearths 1-4), two surface structures (Surface Structures 1 and 2), a firepit, and an artifact concentration.

Reexamination of original data. Seven of the features (Rooms 1-4, Surface Structures 1 and 2, and Hearth 1) appear to be related to areas of



C.I. = 1 1/4γ

KEY

SCALE 0 1 1.5m

SANDSTONE SLABS

ACTIVITY AREA BOUNDARIES

MN

FIGURE 2 CONVOLUTION FILTERED MAP OF SITE 5M2203 WITH SUPERIMPOSED ARCHAEOLOGICALLY EXCAVATED FEATURES.

NEBCAR 1981

increased magnetic intensity. The remaining seven features (Hearths 2-4, Burials 1 and 2, firepit, and artifact concentration) have no associated magnetic anomalies on the unfiltered map.

Convolution filtering. The region containing the fourteen features was filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined (refer to figs. 3 and 4). Rooms 1 and 2 are definitely related to anomalies with increased magnetic intensity. It is also evident that the association of Rooms 3 and 4 to the anomalies suspected on the original maps is unlikely, and that the rooms have no visible magnetic anomalies. The artifact concentration is located on a dipole, but it is doubtful that there is any relationship. The artifacts are primarily of sandstone which has little magnetic susceptibility. The slab-lined hearths and firepit are not magnetically visible after filtering. This is probably due to a combination of factors such as small size, nonintensive burning, or nearby dipoles which could mask effects of the features. Although the surface structures (Surface Structures 1 and 2) are more defined after filtering, the anomalies are not distinctive from other surrounding noncultural anomalies. The burials are not evident even after filtering.

Summary. After filtering, it became evident that three of the features (Rooms 3 and 4, Hearth 1) thought to be related to magnetic anomalies on the original maps had no association. Two features (Rooms 1 and 2) were found to correspond to anomalies, while two other features (Surface Structures 1 and 2) contributed to anomalies but were not distinctive.

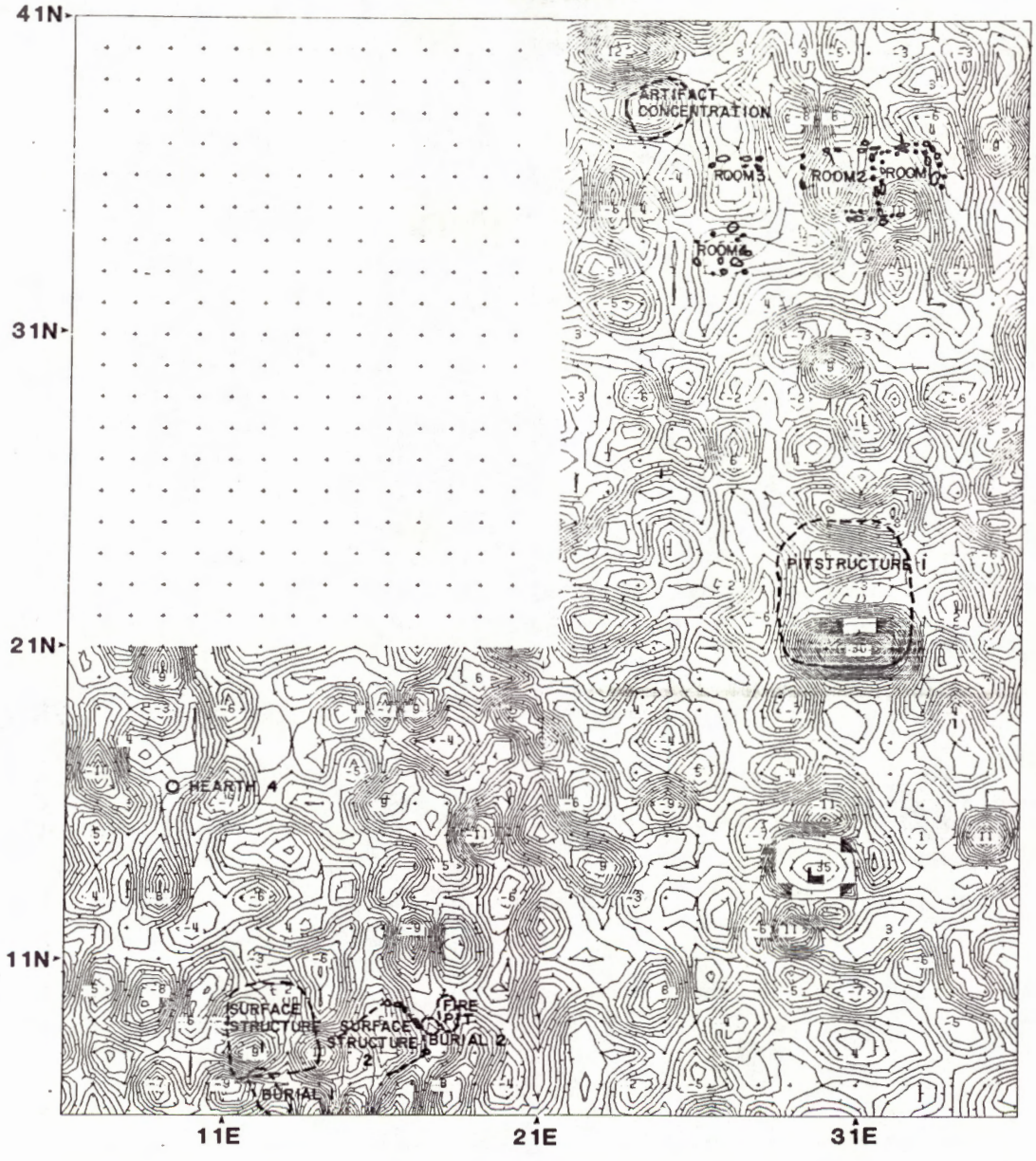
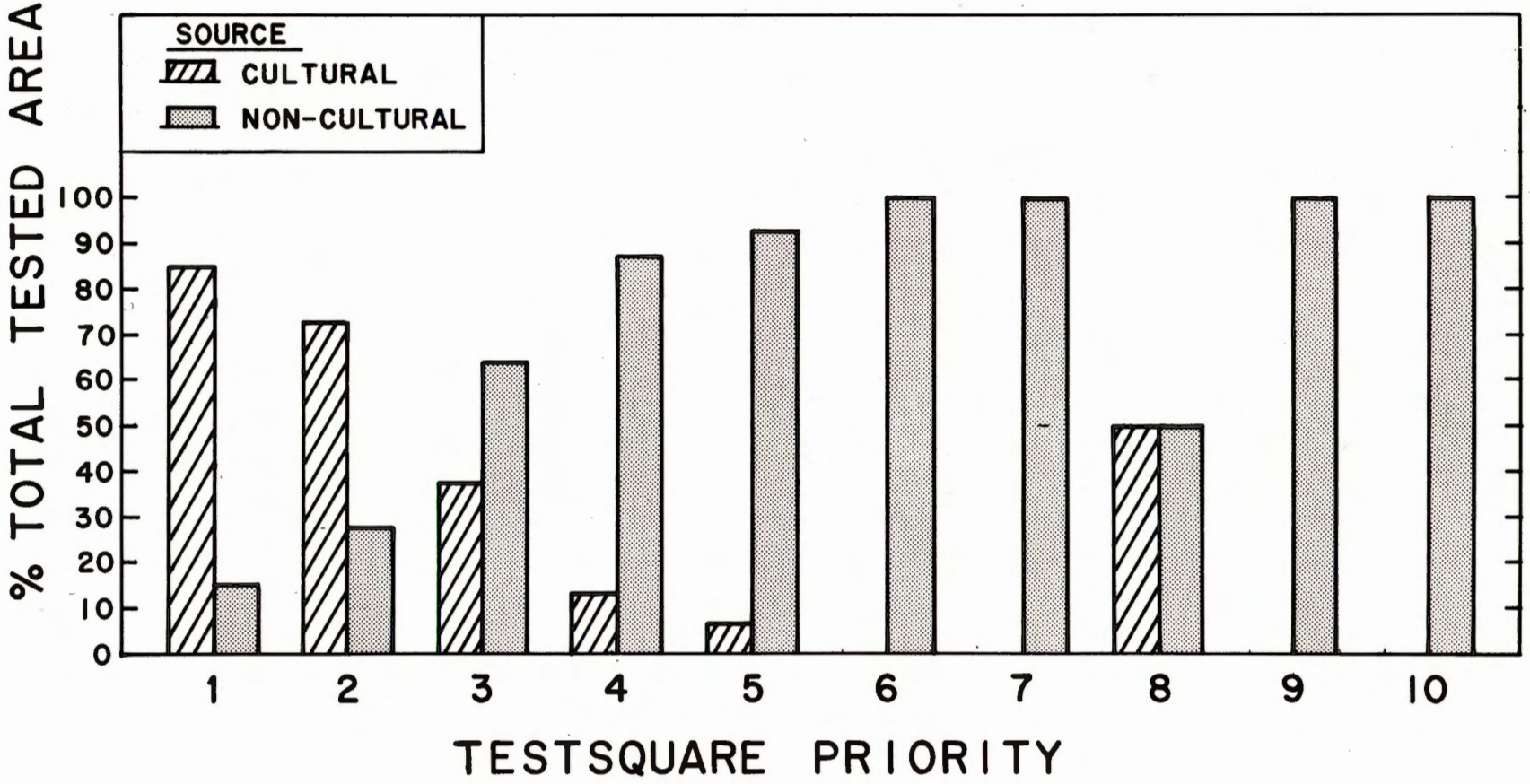


FIGURE 3 CONVOLUTION FILTERED MAP OF SITE 5MT2236 WITH SUPERIMPOSED ARCHAEOLOGICALLY EXCAVATED FEATURES. NEBCAR 1981

Histograph 1. COMPARISON OF PERCENTAGE CULTURAL V.S. NONCULTURAL FEATURES EXCAVATED FOR EACH TEST SQUARE PRIORITY.



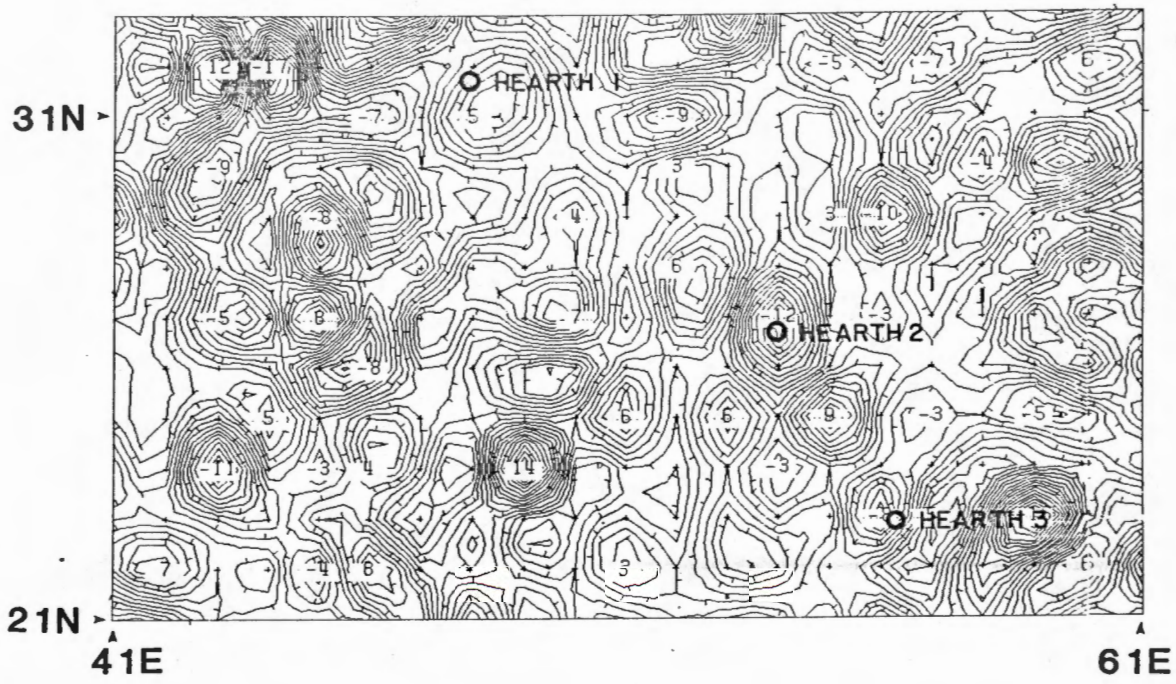


FIGURE 4 CONVOLUTION FILTERED MAP OF SITE 5MT2236 WITH SUPERIMPOSED ARCHAEOLOGICALLY EXCAVATED FEATURES.

NEBCAR 1981

Site 5MT2242

Two features were identified at this site outside of the designated magnetic test square areas but within the magnetically surveyed area. The features were a hearth (Feature 2) and an area containing associated sandstone artifacts (Feature 1). Feature 1 was not considered likely to produce a visible magnetic anomaly since sandstone generally has little magnetic susceptibility. This area was not subjected to convolution filtering.

Reexamination of original data. Reexamination of the original line contour map indicated that Feature 2 could be causing an increase in the magnetic field, visible as a high monopole anomaly.

Convolution filtering. The region of Feature 2 was filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined. The hearth, which contained burned soil and sandstone, is visible as an area of increased magnetic intensity. The anomaly, however, probably would not be selected as an area of interest because it is located in a region that is difficult to interpret. There are effects from surface iron and a complexity of neighboring fields.

Summary. Of the two features located by excavation, one (Feature 1) was considered unlikely to create a substantial anomaly for detection. The hearth had an anomaly visible on the original map, which was enhanced by filtering. The nature of the anomaly was unfortunately such that it would probably not be selected as an area of potential archaeological interest.

Site 5MT2848

Ten features were identified by excavation outside of the magnetic test square areas, but within the magnetically surveyed area. The

Site 5MT2242

Two features were identified at this site outside of the designated magnetic test square areas but within the magnetically surveyed area. The features were a hearth (Feature 2) and an area containing associated sandstone artifacts (Feature 1). Feature 1 was not considered likely to produce a visible magnetic anomaly since sandstone generally has little magnetic susceptibility. This area was not subjected to convolution filtering.

Reexamination of original data. Reexamination of the original line contour map indicated that Feature 2 could be causing an increase in the magnetic field, visible as a high monopole anomaly.

Convolution filtering. The region of Feature 2 was filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined. The hearth, which contained burned soil and sandstone, is visible as an area of increased magnetic intensity. The anomaly, however, probably would not be selected as an area of interest because it is located in a region that is difficult to interpret. There are effects from surface iron and a complexity of neighboring fields.

Summary. Of the two features located by excavation, one (Feature 1) was considered unlikely to create a substantial anomaly for detection. The hearth had an anomaly visible on the original map, which was enhanced by filtering. The nature of the anomaly was unfortunately such that it would probably not be selected as an area of potential archaeological interest.

Site 5MT2848

Ten features were identified by excavation outside of the magnetic test square areas, but within the magnetically surveyed area. The

features identified were a pithouse (Pitstructure 2), two surface structures (Surface Structures 1 and 2), a fireplace (Feature 2), five firepits (Features 3-7), and a charred, oxidized area situated southwest of Pitstructure 1.

Reexamination of original data. A reexamination of the original line contour map detected what may be anomalies caused by the pithouse and Surface Structure 2. Unfortunately most of the pitstructure and its anomaly extend off of the southern end of the magnetic grid at 25-31E, making it difficult to delineate a definite association. Surface Structure 2 may be related to an area of increased magnetic intensity.

Convolution filtering. The regions of the features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined. Only the pithouse and the charred, oxidized area are creating clearly visible magnetic anomalies. The Pitstructure 2 anomaly is only tenable because the majority of it would extend off of the magnetic grid. The charred, oxidized area located southwest of Pitstructure 1 is clearly identified by an area of increased magnetic intensity, emphasizing the area as potentially of archaeological interest. Surface Structures 1 and 2 are not identifiable. Surface Structure 1 lies between two areas of numerous, strong dipoles which may be masking any possible effects of the structure. Surface Structure 2 appears to have some relationship to an anomaly of increased magnetic intensity which is especially strong in the western half of the structure, but would not be selected because of its similarity to other noncultural anomalies. Features 5 and 6 contribute to regions of increased magnetic intensity, but would not be distinguished from other similar anomalies.

The remaining burned features are either located on steep magnetic gradients (Features 2, 3, and 4) or are distorted by dipoles (Feature 7).

Summary. Of the ten features located by excavation, only two have magnetic anomalies which are detectable after convolution filtering. The two features were a pithouse (Pitstructure 2) and a charred, oxidized region. While the charred and oxidized region was clearly visible as an area of increased magnetic intensity, the pitstructure anomaly was only tenable because the majority of the structure was situated outside of the magnetically surveyed area. Three additional features (Surface Structure 2, Features 5 and 6) contributed to areas of increased magnetic intensity, but were not distinctive enough to be selected from the magnetic field as archaeologically interesting. The remaining five features were not visible because of dipoles, magnetic gradients, or insufficient magnetic contrast with the surrounding soil.

Site 5MT2853

Excavation operations identified two features outside of the magnetic test square areas but within the magnetically surveyed area. Feature 1 was an oxidized firepit and the other feature was a surface structure (Surface Structure 1).

Reexamination of original data. After reexamining line contour maps of the original data, it is apparent that neither feature contributed to the magnetic record in an obvious manner.

Convolution filtering. The region of the two features was filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. Unfortunately, filtering was unable to draw out either feature. Feature 1 is directly on the southeast gradient of a strong dipole, probably caused by surface iron, so that any

magnetic contribution is masked. The surface structure is also invisible, at least partially due to multiple dipoles northwest and southeast of the structure.

Summary. Convolution filtering was not helpful at this site. Any anomalies of the two features identified during excavation were distorted or masked by strong dipoles.

Site 5MT2854

Seven features were identified during excavation outside of the magnetic test square areas, but within the magnetically surveyed grid. The features were two unspecified pits (Features 1 and 6); three fire hearths (Features 2, 5, and 8), one of which contained some charcoal (Feature 8); a burned region (Feature 3); and one unexcavated feature (Feature 7).

Reexamination of original data. A reexamination of line contour maps of the original data reveals anomalies possibly related to three of the features. Features 3, 6, and 8 appear to be related to regions of increased magnetic intensity.

Convolution filtering. The regions of the features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. Four features (Features 2, 5, 6, and 7) make no obvious contributions to the magnetic record. All of these features are located on steep, magnetic gradients which could affect magnetic contributions of the features. Feature 1 becomes visible as a region of increased magnetic intensity, but it is still of a very small magnitude. Feature 3 is possibly visible but still quite small although the filtering has enhanced the anomaly. Feature 8 is also magnetically

visible, although of such a small magnitude that it is unlikely to be singled out as archaeologically interesting.

Summary. Three features (Features 1, 3, and 8) of the seven identified by excavation at this site caused anomalies which could be isolated by filtering. All three anomalies were quite small, however, and unlikely to be singled out as caused by cultural features.

Site 5MT4512

Twenty features were identified during archaeological testing outside of the magnetic test square areas but within the magnetically surveyed grid. These features include nine hearths (Features 6, 11, 13, 18, 20, 21, 26, 27, and 32), a sandstone-lined hearth (Feature 31), two charcoal-stained pits (Features 36 and 22), and three pits with evidence of burning (Features 41, 42, and 43). There were also two large depressions (Features 9 and 23), a large slab-lined pit (Feature 37) surrounded by an irregular, shallow pit (Feature 35), and a pitstructure (Pitstructure 2).

Reexamination of original data. Of the 20 cultural features, 13 (Features 6, 9, 11, 13, 18, 20, 21, 22, 23, 26, 31, and 32, and Pitstructure 2) have no anomalies associated with them according to the original magnetic line contour maps. Seven other features (Features 27, 35, 36, 37, 41, 42, and 43) appear to be associated with areas of increased magnetic intensity.

Convolution filtering. The regions of the features were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered information were then examined. After filtering, only Features 26 and 37 create obviously visible magnetic anomalies. Both features are related to regions of increased magnetic intensities of about 9 quarter gammas. Feature 13, located within Feature 9, and Feature 41 are

seen to be related to areas of increased magnetic intensity, but are too similar to other noncultural anomalies to be selected as archaeologically interesting. The remaining features are not visible due to insufficient magnetic contributions (Features 6, 18, 21, 22, 23, 26, 31, 35, 42, and 43, and Pitstructure 2) or are masked by dipoles (Features 11, 20, and 27) or a region of a strongly decreased magnetic intensity (Feature 32).

Summary. At this site, convolution filtering was able to isolate magnetic anomalies caused by 2 of the 20 cultural features. Feature 36, a charcoal-stained pit, and Feature 37, a large slab-lined pit, created anomalies of increased magnetic intensity. A hearth (Feature 13) and a large pit with evidence of burning (Feature 42) created anomalies, but would not be selected from among similar noncultural anomalies. The remaining 16 features were either masked or made insignificant contributions to the magnetic field.

Site 5MT4545

Thirty-five features were identified during excavation operations outside of the magnetic test square areas but within the magnetically surveyed grid. The features were 12 rooms (Rooms 1-10, 12, and 14), two trash-filled borrow pits (Features 1 and 92), a large unspecified pit (Feature 90), two slab-lined hearths (Features 27 and 68), and an oxidized hearth (Feature 5). The remaining 17 features were primarily small hearths and pits.

Reexamination of original data. A reexamination of the original line contour map of this site revealed several magnetic anomalies possibly caused by cultural features. Rooms 2, 3, and 5-10 are visibly related to regions of increased magnetic intensity, but were not recognized as cultural features during NEBCAR's selection of test areas. Features 5 and 68

also appear to have related anomalies of increased magnetic intensity. The remaining 25 features have no associated anomalies.

Convolution filtering. The magnetic data from this site were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined (refer to fig. 5). After filtering, Rooms 2, 3, 8, and 9 can be identified due to better resolution of their anomalies of increased magnetic intensity. Rooms 1 and 5 are not distinguishable, probably due to a strong, nearby dipole attributed to an iron source. Rooms 6 and 4 are also affected by this dipole, but they are somewhat visible as regions of increased magnetic intensity. Room 7 shows a classic magnetic anomaly of increased intensity. Room 12 has a definite anomaly, but the surrounding magnetic field reflects contributions from other, unidentified sources. Room 14, containing Feature 27, a hearth built into a partially filled, slab-lined floor and having partially slab-bed walls, is seen to be responsible for a magnetically high region. Room 10 is partially off of the magnetic grid area, and thus cannot be easily examined or interpreted. Feature 1, a large midden-filled borrow pit, has an anomaly which appears to be related to a localized component in the south-central portion of the feature. Feature 92 and Feature 90 both are related to anomalies of increased magnetic intensity, but probably would not be selected as areas of archaeological interest on this basis. The anomaly of Feature 90 is affected by a magnetic high to the south, and the anomaly of Feature 92 is greatly affected by nearby dipole confusion. Of the smaller features, only Features 5 and 68 have associated anomalies. Both features are related to areas of increased magnetic intensity, with Feature 68 having a greater magnitude. The remaining small features of the site may exist in the magnetic record, but are indistinguishable from surrounding areas.

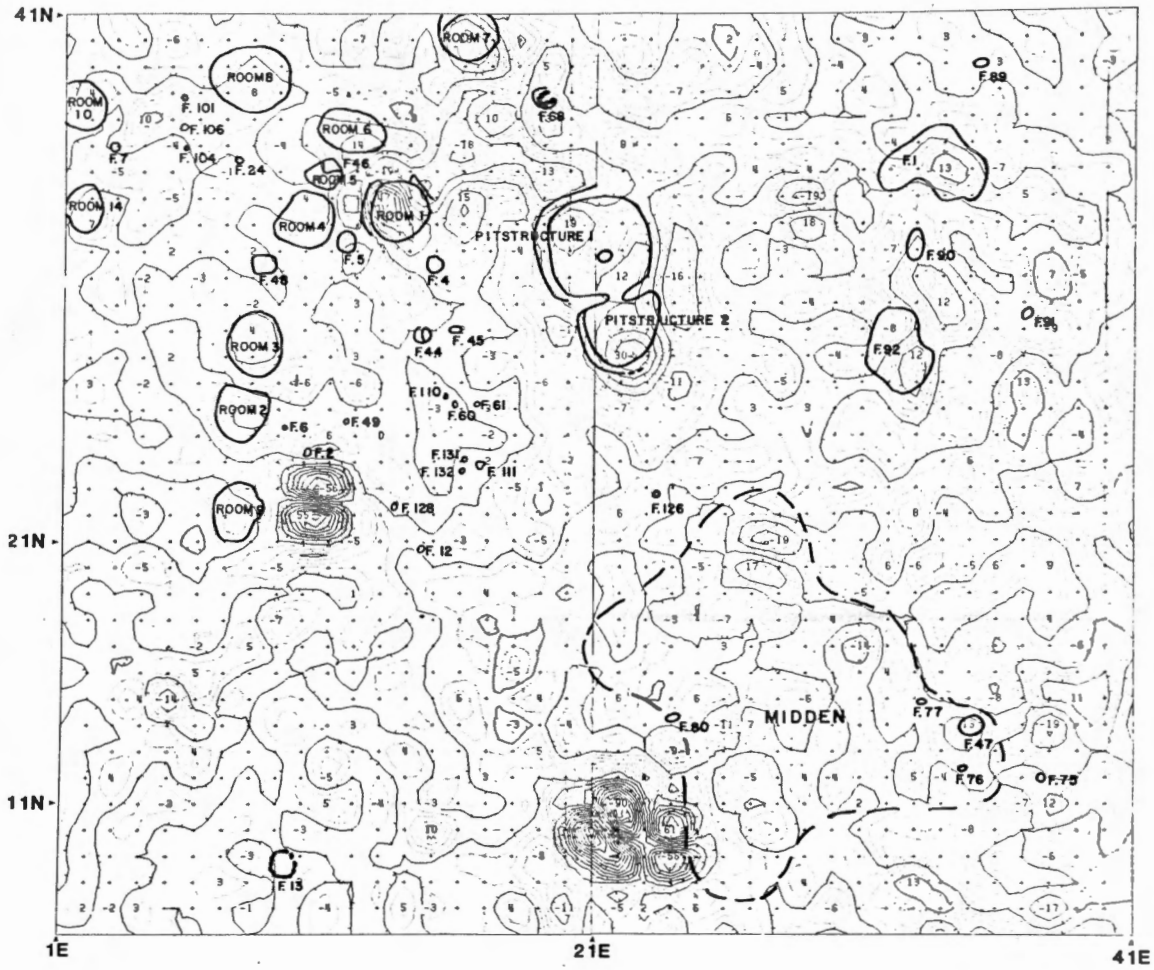


FIGURE 5 CONVOLUTION FILTERED MAP OF SITE 5MT4545 WITH SUPERIMPOSED ARCHAEOLOGICALLY EXCAVATED FEATURES.

NEBCAR 1981

Summary. Fourteen features (Rooms 2, 3, 4, 6, 7, 8, 9, 12, and 14, Features 1, 5, 68, 90, and 92) of the 35 identified through excavation caused anomalies that could be detected after convolution filtering. The remaining small features were indistinguishable from their surrounding background.

Site 5MT4614

Fourteen features were identified during excavation outside of the magnetic test square areas but within the magnetically surveyed grid. The features were a slab-lined hearth (Feature 54), two firepits (Features 7 and 61), four unspecified pits (Features 62, 73, 74, and 83), three unspecified pits with burning (Features 6, 63, and 82), and four storage bins (Features 57, 58, 59, and 60).

Reexamination of original data. After reexamining the original magnetic line contour map, it appears that Features 6, 7, 82, and 83 could be related to regions of increased magnetic intensity. The remaining features are not visible in the original magnetic record.

Convolution filtering. The magnetic data of the site were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. Feature 7 and associated Feature 6 are visible, appearing as a region of increased magnetic intensity of 14 quarter gammas. The anomaly is probably caused primarily by the firepit (Feature 7). The magnetic field surrounding the anomaly contains many other small anomalies of a similar nature, making it unlikely that any would be singled out as having a cultural source. A storage bin (Feature 57) is also visible as an anomaly of increased magnetic intensity. The remaining features (Features 54, 58, 59, 60, 61, 62, 63, 74, 73, 82, and 83) are not visible, primarily because of the extensive magnetic variance at this site.

Summary. Of the 14 features identified only by excavation operations, only three additional features appeared to be visible in the magnetic record after convolution filtering. Features 6 and 7 shared an anomaly and Feature 57 also caused an anomaly. Because of their similarity to surrounding anomalies neither anomaly would be selected as an area of archaeological interest.

Site 5MT4644

Eleven features were identified during the excavation proceedings outside of the magnetic test square areas but within the magnetically surveyed area. The features were six identified but unexcavated cultural units (UCU 1-3, 10, 12, and 13), a slab-lined hearth (Feature 4), a hearth with charcoal fill (Feature 67), an unspecified pit with dark organic fill (Feature 5), and carbonized maize cobs (Feature 15) in a large pit (Feature 18).

Reexamination of original data. Upon reexamination of the original line contour map of the site, three features appear to be related to magnetic anomalies. UCU 12 may be related to a lobe of a nearby region of low magnetic intensity and Features 5 and 67 appear to be associated with regions of increased magnetic intensity.

Convolution filtering. The magnetic data from this site were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. After filtering, UCU 2, 3, 10, and 12 remain undetected. UCU 2, 10, and 12 are within areas confused with variations of increased and decreased magnetic intensity areas. UCU 3 apparently is of insufficient magnitude to be identified within the magnetic field. UCU 13 is definitely visible as an area of an increased magnetic intensity of five quarter gammas surrounded by lower regions.

UCU 1, a possible surface structure, has an improved response after filtering. It is insufficient, however, to be obvious as an anomaly with cultural affiliations. Feature 67 has a visible, but weak anomaly of increased magnetic intensity. The area probably would not be selected as an area of archaeological interest. Excavated Features 4, 5, 15, and 18 are not visible on the filtered map. Feature 4 probably is masked by the strong anomaly caused by Pitstructure 1. Feature 5 is situated near dipoles which may mask an anomaly, but it is more likely that an anomaly would not be of sufficient magnitude to be detected. Feature 15 located within Feature 18, is also situated between dipoles and hence not visible.

Summary. Three features (UCU 1 and 13, Feature 67) of the 11 detected at this site were visible after filtering. Two of the features (UCU 1 and Feature 67) created weak anomalies which probably would not be isolated as culturally derived from among other anomalies at the site.

Site 5MT4681

Two features were identified during excavation outside of the magnetic test square areas but within the magneticaly surveyed grid. The features were a small fire hearth (Feature 1) and a small pit with charcoal but no apparent oxidation (Feature 2).

Reexamination of original data. Neither feature has a visible magnetic anomaly on the original line contour map.

Convolution filtering. The magnetic data of the site were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. Feature 1 is associated with a region of increased magnetic intensity. This anomaly, however, is not distinctive. It is similar to many other small anomalies in the region. Feature 2 is not visible in the magnetic record. This is probably due to

a low magnetic susceptibility because of small size and a lack of oxidation.

Summary. Convolution filtering was able to identify an anomaly caused by Feature 1. The anomaly was not distinctive from surrounding, similar anomalies however. Feature 2 was also indistinguishable.

Site 5MT4763

Two features were identified through excavation of areas outside of the magnetic test square areas but within the magnetically surveyed grid. These features were a surface structure and a hearth (Feature 2).

Reexamination of original data. Following a reexamination of the original line contour maps, it is obvious that neither feature has a visible, related magnetic anomaly.

Convolution filtering. The magnetic data from this site were filtered with Gaussian parameters of S1 = 0.05 and S2 = 1.0. Line contour maps of the filtered data were then examined. The surface structure appears to be related to a region of decreased magnetic intensity. While it is possible that an unburned structure could produce such an anomaly, it is unlikely to be occurring here. Other similar low regions also occur nearby, further suggesting that no relationship exists. The only way to verify the relationship between the surface structure and the anomaly would be an examination of susceptibility from bulk soils samples. The hearth makes no visible contribution to the magnetic field after filtering. This is probably due to the nature of the feature, a small, unmodified hearth with apparently no oxidation.

Summary. Two features, a hearth and a surface structure, were located during excavation operations. Neither feature appeared to be associated with a visible anomaly following convolution filtering. This

was due to an insufficient magnetic contrast with the surrounding soil.

Summary

Convolution filtering was used on a number of sites to determine if cultural features located during excavation but not originally chosen as magnetic priority test areas could be separated from background variations. The parameters chosen for filtering were such that magnetic contributions of the larger features were reduced so the anomalies from smaller features would be emphasized.

Of the 144 features revealed through excavation, but not identified by NEBCAR (Huggins and Weymouth 1978, 1981), 49 cultural features were isolated in the magnetic record following the convolution filtering. The variety of these features magnetically detected included unspecified pits (9), a burned region, hearths (19), rooms (11), surface structures (5), a pitstructure, trash-filled borrow pits (2), and an unexcavated cultural unit. Of the 49 anomalies visible after filtering, only 25 were clearly distinguishable above the background magnetic field. The remaining 24 anomalies which consisted of 10 hearths, 2 rooms, 6 surface structures, 3 unspecified pits, 2 trash-filled borrow pits, and 1 burned region, were noticeable only because the location of the source which caused them was previously known from the excavations.

For various reasons, 95 of the features could not be isolated even after filtering. The majority of these were hearths or firepits (42) and small pit features (28). Other cultural features included rooms (5), surface structures (4), burials (2), large depressions (1), pitstructures (3), and unexcavated cultural units (5). While many of the hearths and small pit features are located near dipoles (12) or on steep magnetic

gradients (13) which may mask magnetic contributions from the feature, it is more probable that the nature of the feature and the standard 1-m sampling rate are responsible for not detecting anomalies from these features. The features are generally small with slight oxidation, which may necessitate a smaller sampling rate (such as every 50 cm) to isolate them. Of the other features, the burials and depressions seem to make insignificant magnetic contributions. Four of the seven surface structures and rooms are distorted by dipoles. Also, a lightly compacted or unburned structure could create an insignificant contribution to the magnetic field. Of the three pitstructures not detected, one quite probably extends off of the magnetically surveyed areas so the entire anomaly was not visible, and another was distorted by dipoles created by surface iron. The third may have created an insignificant magnetic contrast with the surrounding soil.

The utilization of convolution filtering for the DAP magnetic program appears to be a worthwhile endeavor in many cases. The filtering refines magnetic anomalies and can enable detection of magnetic contributions from cultural features not readily evident otherwise. Approximately 34 percent of the cultural features revealed solely through excavation created magnetic anomalies which were clearly visible after convolution filtering. Of the remaining 95 magnetically undefined features, over 43 percent (41) were masked or distorted by dipoles or situated on steep magnetic gradients. Another cultural feature (a subterranean domicile) extended only slightly onto the magnetically surveyed grid, and so its magnetic anomaly could not be detected.

A comparison of the archaeological information to the magnetic data indicated that the magnetic sampling rate was too great to isolate the

smaller cultural features such as hearths or pits. Alteration of field techniques during the magnetic survey can lead to improved anomaly resolution for the small features. The sampling interval may be reduced to 50 cm. This will improve resolution of anomalies and will enable location of cultural features of less than 1 m diameter. The greater time required for magnetic surveys at 50-cm intervals is a limiting factor, and it is suggested that it be employed only at sites of particular interest. This interval could be useful in situations where a site map is to be drawn based only on archaeological and magnetic survey information or where more magnetic information is required for a specific cultural feature or site.

The sensor bottle height may also be dropped, allowing for detection of the more subtle magnetic anomalies which may be masked by irregular magnetic fluctuations, although complications could arise with the lowering of the sensor height. The lowering of the sensor bottle will necessitate a reduced survey interval, and so require a greater time expenditure. Random variations due to surface irregularities and surface iron are also relatively greater. However, since the gradient tolerance of the instrument is able to handle most anomalies from surface iron variations, it is recommended that the sensor height be lowered in instances where detection of the more subtle magnetic anomalies is required and where the surface irregularities are slight. Care should be taken to account for the increase in contributions from unwanted sources such as iron and surface irregularities. This can be accomplished by carefully noting any topographic change and by inspecting the surface for metal before the survey.

STRUCTRAL INFORMATION AVAILABLE FROM THE INDIVIDUAL MAGNETIC ANOMALIES CREATED BY PITSTRUCTURES

Introduction

The previous sections of this study were concerned with improving the ability of magnetometer surveying to locate features. It is also possible to use the data to determine the internal structure of some features. This section examines the individual anomalies to determine if information can be derived about the composition and structure of the causative features. The anomalies from pitstructures, the most common large-scale features of the Dolores project area, will be examined in detail to ascertain whether information concerning the boundaries and orientation of the main structure can be identified. Information about hearths, ventilator shafts/antechambers, intrusive elements, and other general structural features (i.e., cists, activity areas, etc.) will also be sought. Hopefully, use of the information obtained will lead to more distinct structural interpretations of the magnetic data in order to provide archaeologists with explicit knowledge of pitstructures before excavation begins. The correlation between the physical characteristics of a computer model (i.e., depth, width, etc.) and its corresponding magnetic anomaly can be easily determined. This information can then be applied to the anomalies from the actual pitstructures and similar geometric predictions made.

In order to compare the excavated pitstructures to their corresponding magnetic anomalies, line profiles running N-S and W-E were drawn by computer at 1-m intervals through magnetic anomalies on Sites 5MT2162, 5MT2192, 5MT2193, 5MT2194, 5MT2236, 5MT2848, 5MT2854, 5MT2858,

5MT4512, 5MT4545, 5MT4614, and 5MT4644. Selected examples of these profiles are included as figures in this report. Excavation information and pitstructure descriptions have been provided by DAP. A computer model was created by R. Huggins and J. Weymouth at NEBCAR. The model has been based on the structural characteristics of Pitstructure 2 at Site 5MT2193 as revealed through excavation. Susceptibility measurements from soil samples provided other necessary parameters for the modeling. Two model dwellings have been created and are designated as Models 2193 and 2193a. The only difference between the two models is that Model 2193 has a ventilator shaft and opening, and that Model 2193a does not.

It is hoped that through comparison, it will be possible to disclose the general boundaries and central hearth of the actual subterranean domicile, identify the ventilator shaft, and detect the intrusion of the ventilator shaft of Pitstructure 2 at Site 5MT2193 into the main chamber of Pitstructure 1. Through an understanding of the profile variations created by these characteristics, it will be possible to generalize and examine the profiles of other sites for similar information.

Detection of Interior Features

Pitstructures

The general boundaries of a pitstructure's main chamber can be found through examination of magnetic anomaly profiles. A method which is useful in discerning the boundaries of the chamber utilizes the inflection points of the anomaly profile. These points occur where the curve of the anomaly profile changes the direction of its concavity from upward to downward, or vice versa. Usually the inflection point is readily observable, but in cases where it is questionable, the points on the anomaly

which occur at one-half the maximum value give a reasonable approximation to the position of the inflection points. It is less accurate than determining inflection points but is adequate in most instances.

The boundaries of the main chamber, then, are indicated by the inflection points of the anomaly profile. Where possible, the inflection points on the following profiles are identified through visual inspection. To illustrate the use of inflection points and their relationship to actual boundaries of pitstructure main chambers, refer first to the profile of Model 2193 (fig. 6). On this south-north profile, the inflection points are at approximately 8.3N and 14.2N and suggest that the main chamber will extend for approximately 5.9 m. For the west-east profile (refer to fig. 7), the inflection points are situated approximately at 21.3E and 24.3E, suggesting that the main chamber will extend for 3.0 m. The actual dimensions of the main chamber of Model 2193 extend from approximately 9.3N to 14.8N for a length of 5.5 m and from approximately 20.6E to 25.0E for a width of 4.4 m. The south-north dimension by this method is 7 percent too long, and the west-east dimensions is 32 percent too narrow. The shift to the south of the anomaly relative to the source is due to the inclination of the earth's magnetic field.

For pitstructures which include antechambers, the inflection points will indicate the length of the main chamber plus the antechamber. The width of the main chamber, however, may be separately defined from the width of the antechamber since on the lines of east-west profiles the two structures create separate anomaly contributions. The magnetic profiles of Site 5MT4545, Pitstructure 1 illustrate the use of inflection points to establish the pitstructure boundaries. The length of the structure is

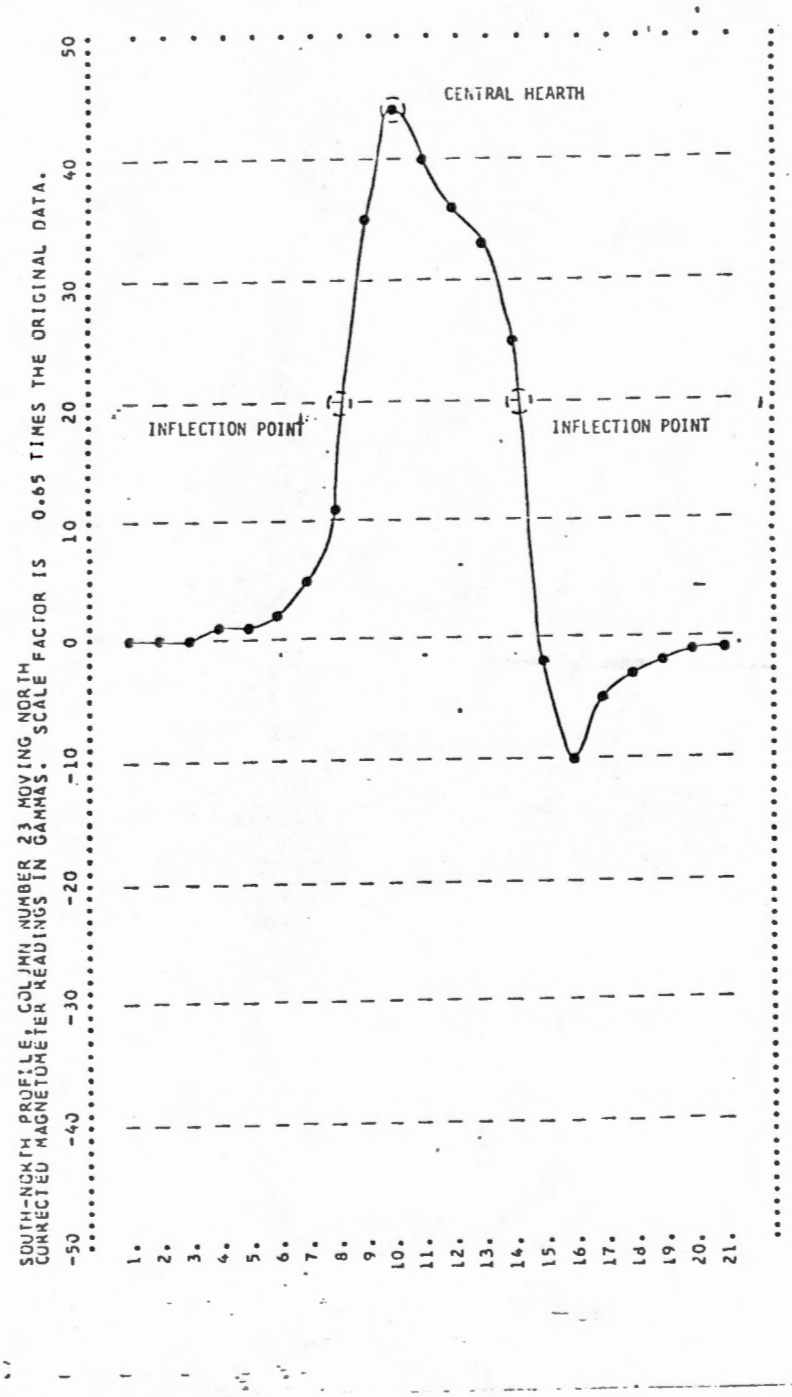


Figure 6. Model 2193 illustrating the inflection points and central hearth on the north-south profile (line 32E).

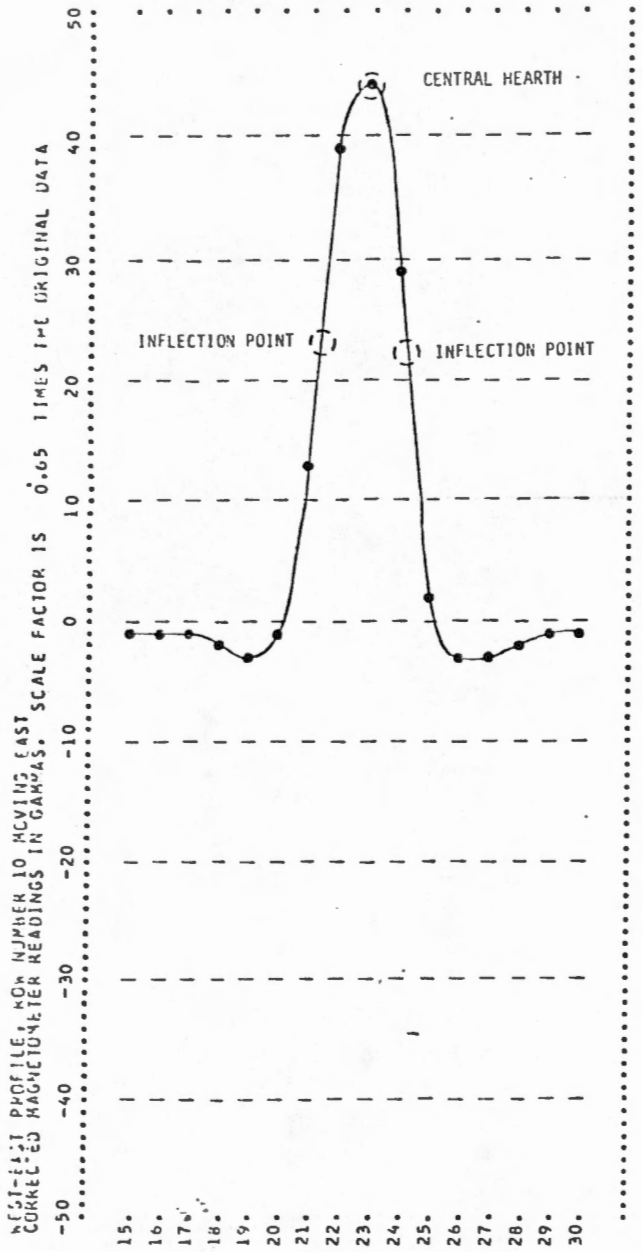


Figure 7. Model 2193 illustrating the inflection points and central hearth on the east-west profile (line 10N).

Table 30. Comparison of the points of inflection of the north and east profile through the pitstructure anomaly to the approximate excavated boundaries

Site	Pitstructures?	Points of inflection	Approximate excavated boundaries
5MT2162*	1,2	14.5 - 20.5N	13.0 - 21.0N
	1	3.5 - 6.5E	3.0 - 6.0E
	2	2.5 - 6.75E	2.0 - 6.75E
5MT2192	1	30.5 - 32.5N	29.0 - 31.5N
		38.5 - 40.5E	39.0 - 42.0E
5MT2194	1	10.5 - 13.6N	10.5 - 14.0N
		8.5 - 11.75E	8.25E- 12.25E
5MT2236*	1	19.5 - 22.25N	21.0 - 25.5N
		29.5 - 32.5E	28.5 - 32.5E
5MT2848*	1	18.5 - 22.5N	20.0 - 26.0N
		15.25 - 19.5E	15.0 - 20.0E
5MT2853*	1,2	5.5 - 9.5N	unknown
		14.75 - 19.5E	15.0 - 20.0E
5MT2858	1	27.5 - 31.5N	28.0 - 33.5N
		12.75 - 17.5E	11.5 - 18.0E
5MT4512	1	6.25 - 9.5N	7.5 - 9.75N
		5.5 - 8.5E	6.0 - 8.5E
5MT4545	1,2	27.5 - 33.75N	27.6 - 34.0N
	1	19.5 - 22.75E	19.5 - 23.2E
	2	20.5 - 23.5E	21.0 - 23.75E
5MT4614	1	24.5 - 28.5N	25.8 - 28.2N
		48.25 - 49.75E	48.2 - 50.6N
	2	30.5 - 34.6N	32.0 - 36.0N
		51.5 - 54.5E	51.4 - 55.2E
5MT4644	1	43.5 - 46.5N	43.8 - 48.5N
		35.5 - 40.5E	36.5 - 41.4E
	2	40.25 - 46.5N	42.0 - 47.4N
		22.5 - 27.5E	22.0 - 27.5E

* Indicates sites which were augered.

measured on a south-north orientation and indicates that Pitstructure 1 extends from 27.5 to 33.75N (fig. 8). The width of the main chamber

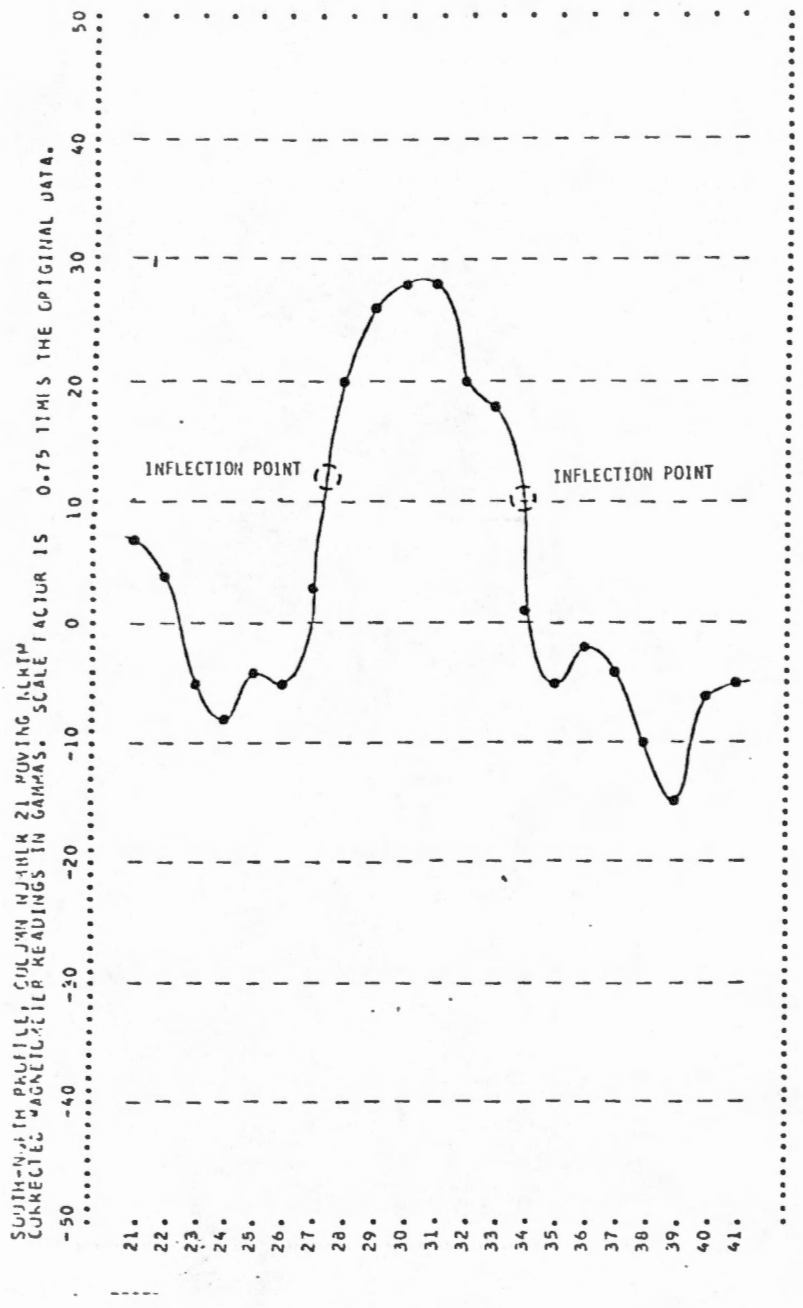


Figure 8. Site 5MT4545 showing the inflection points on the north-south profile (line 21E).

appears to be 19.5-22.75E (fig. 9) and the antechamber width appears to be 20.5-23.5E (fig. 10). The actual extents revealed by excavation are approximately 27.6-34N for length, a main chamber width from 19.5 to 23.2E, and an antechamber width from 21.0 to 23.8E. Again the estimated boundaries approximate the excavated boundaries with an average of 8 percent error. A comparison of the inflection points and excavated pitstructure boundaries is summarized on table 30 and in figures 11 and 12. It is apparent that inflection points provide a fair estimate of both the location of the boundaires and the dimension of the pitstructure. The results of a comparison between the dimensions estimated through use of inflection

Table 31. Comparison of the dimensions of the pitstructure estimated by inflection points to the excavated pitstructure dimensions

Site	Pitstructures	Estimated dimensions	Excavated dimensions	Difference between the dimensions
5MT2162*	1,2	6.0 m (N-S)	8.0 m (N-S)	2.0 m
	1	3.0 m (E-W)	3.0 m (E-W)	0.0 m
	2	4.25 m (E-W)	4.75 m (E-W)	0.5 m
5MT2192	1	2.0 m x 2.0 m	2.5 m x 3.0 m	0.5 m x 1.0 m
5MT2194	1	3.1 m x 3.25 m	3.5 m x 4.0 m	0.4 m x 0.75 m
5MT2236*	1	2.75 m x 3.0 m	4.5 m x 4.0 m	1.75 m x 1.0 m
5MT2848	1	4.0 m x 4.25 m	6.0 m x 5.0 m	2.0 m x 0.75 m
5MT2858	1	4.0 m x 4.75 m	5.5 m x 6.5 m	1.5 m x 1.5 m
5MT4512	1	3.25 m x 3.0 m	3.25 m x 2.5 m	0.0 m x 0.5 m
5MT4545	1,2	6.25 m (N-S)	6.4 m (N-S)	0.15 m
	1	3.25 m (E-W)	3.7 m (E-W)	0.5 m
	2	3.0 m (E-W)	2.75 m (E-W)	0.25 m
5MT4614	1	4.0 x 1.5 M	2.4 m x 2.4 m	1.6 m x 0.9 m
	2	4.1 m x 3.0 m	4.0 m x 3.8 m	0.1 m x 0.8 m
5MT4644	1	3.0 m x 5.0 m	4.7 m x 4.9 m	1.7 m x 0.1 m
	2	6.25 m x 5.0 m	5.4 m x 5.5 m	0.85 m x 0.5 m

* Indicates sites which were augered.

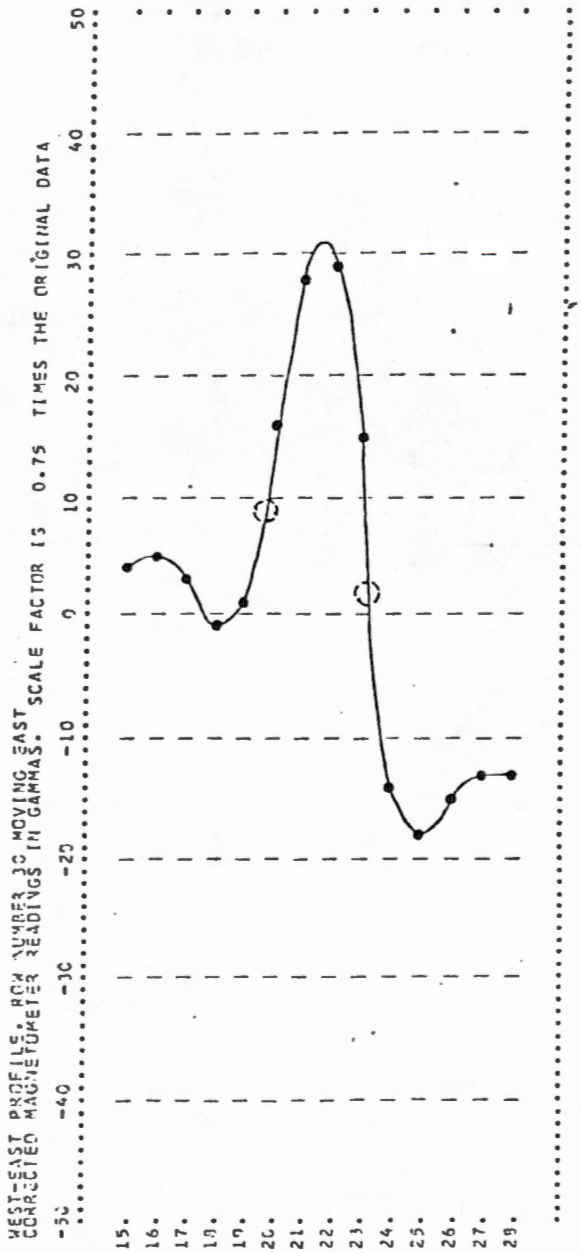


Figure 9. Site 5MT4545 showing the inflection points on the east-west profile (line 30N).

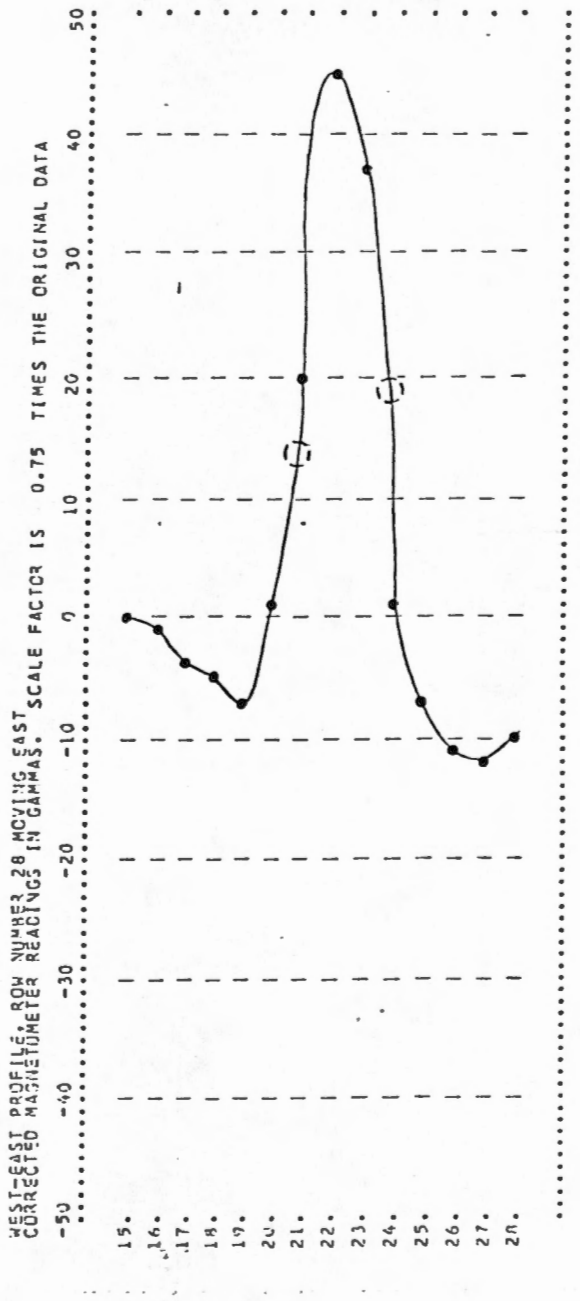


Figure 10. Site 5MT4545 showing the inflection points on the east-west profile (line 28N) of the antechamber.

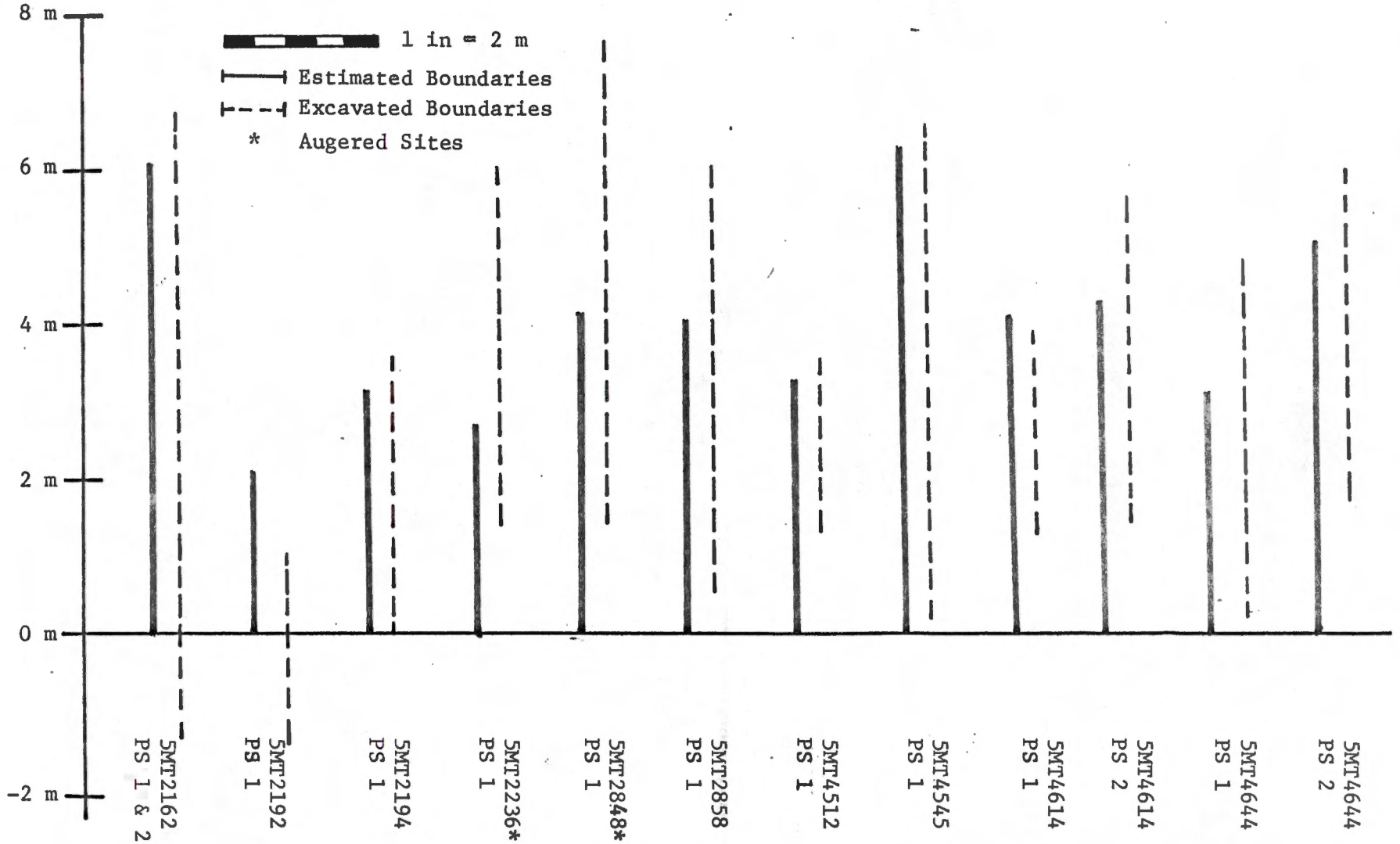


Figure 11. Comparison of north-south pitstructure dimensions from magnetometer survey with dimensions revealed by excavation.

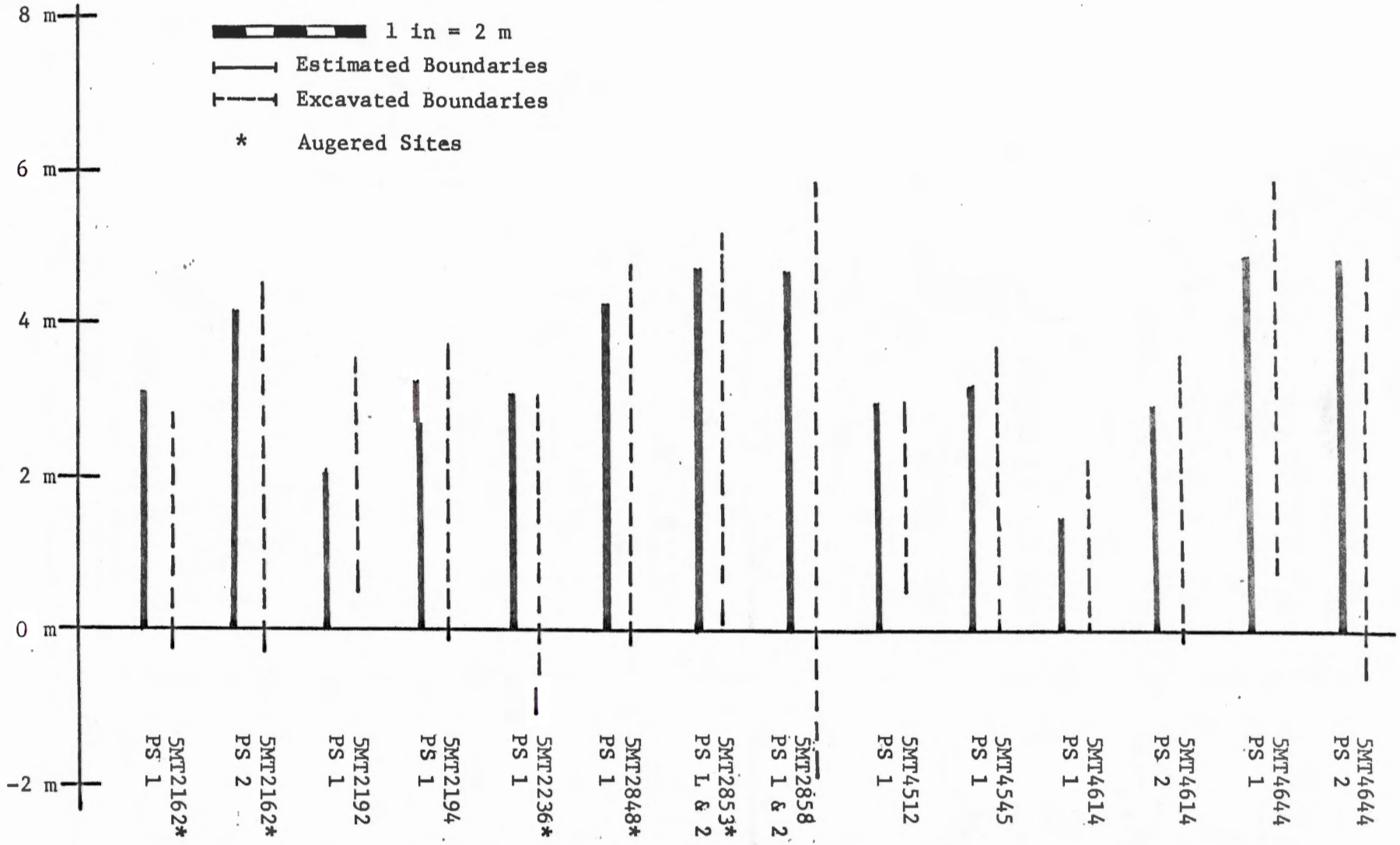


Figure 12. Comparison of east-west pitstructure dimensions from magnetometer survey with dimensions revealed by excavation.

points and the excavated dimensions are shown in table 31. In general, it appears that the average of the dimensions of the pitstructures can be estimated to within 20 percent, which agrees well with theory.

In reviewing both table 30 and table 31, it is very apparent that the west-east boundary extents and dimensions are more accurate than the south-north estimates. Both the east-west and south-north estimates will vary because of pitstructure orientation. Typical Anasazi dwellings of the Dolores area are oriented at angles from the north lines, usually at a northwest to southeast line. The 1-m sampling rate will also cause a larger scatter in the estimates of both east-west and south-north boundaries and dimensions; a 50-cm sampling rate would allow better definition of the structure.

Location of southern and northern boundaries are affected by other factors also, such as anomalies being located to the south of their sources, and ambiguities in the location of the southernmost inflection point introduced by the magnetic field from the ventilator shaft. While the amount of the southern shift of the anomaly depends on the feature depth and, therefore, may cause some problems in locating the feature edge, the ventilator shaft probably causes the greater variation.

Central Hearths

The central hearth of a pitstructure's main chamber is perhaps the most easily identifiable internal feature of the structure. It is usually the most severely burned feature, creating a readily visible peak in the anomaly which is caused by the pitstructure as a whole. The great increase in magnetic intensity which is attributed to the hearth may even tend to obscure contributions from other internal pitstructure features. The central fire hearth is readily visible on both south-north and west-east profiles.

In idealized Model 2193, the estimated east-west coordinate of the location of the central hearth corresponds with the location of the center of the anomaly maximum at approximately 23.0E (refer to fig. 7). The central hearth of Model 2193 is actually centered at 23.0E. The northern coordinate of the anomaly maximum is typically found about one-third of the distance between the sensor and the feature to the south of the anomaly, a phenomonen related to the inclination of the earth's field. To illustrate the means of calculating the northern coordinate of the central hearth, the northern profile of Model 2193 (refer to fig. 6) will be used. The anomaly maximum occurs at approximately 10.0N. The southern shift of the anomaly center is

$$\cos(I) \times d$$

where I is the inclination and d is the depth. The depth used in this calculation (3.25 m) is known from the depth used to simulate Model 2193. The inclination is approximately 65°, giving a shift of 1.4 m. Knowing the estimated location of the anomaly maximum (10.0N), the center of the central hearth can be estimated to be at approximately 11.4N. In actuality, the central hearth of Model 2193 was centered on the point (11.5N, 23E).

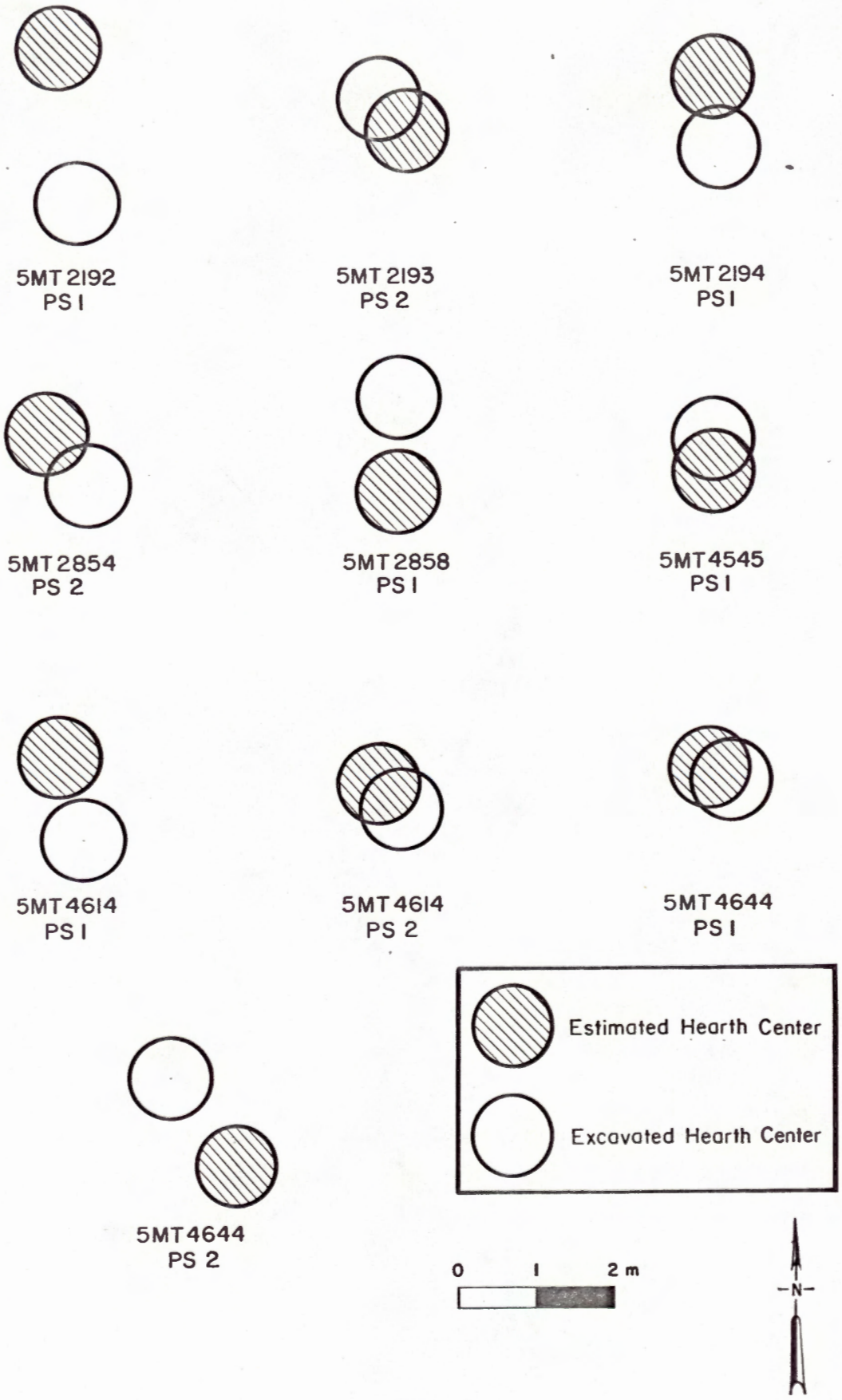
The method continues to work well on actual sites (table 32 and fig. 13). Because it is not always possible to estimate the depth of an extended feature, the southern shift of the anomaly center must be estimated by some other means. For the pitstructures at the sites used in this section, the average depth is 1.5 m and so the anomaly shift will be roughly estimated to be one-third (1.5 m) or 0.5 m for these central hearths. Pitstructure 1 of Site 5M4545 will serve as an example to locate the central hearth. At this pitstructure, the estimated eastern

coordinate of the center of the central hearth is at 21.5E. The estimated northern coordinate of the center of the central hearth, as suggested by the profile through the magnetic anomaly, is at 30.7N. Correcting for the southern displacement of approximately 0.5 m, a northern coordinate estimate for the central hearth's center is 31.2N. The estimated coordinates,

Table 32. Comparison of the center point locations of central hearths of pitstructures from estimates provided by magnetic profiles to locations revealed through excavation

Site	Pitstructures	Estimated location	Approximate location as revealed through excavation
5MT2162	1	16.0N, 5.0E	Augered
	2	19.0N, 4.5E	Augered
5MT2192	1	32.0N, 39.5E	29.9N, 39.75E
5MT2193	1	17.75N, 21.5E	No clear information
	2	10.5N, 23.25E	11.5N, 23E
5MT2194	1	12.5N, 10.0E	11.5N, 10.0E
5MT2236	1	21.5N, 31.0E	Augered
5MT2848	1	20.5N, 17.5E	Augered
5MT2853	1	12.0N, 17.0E	Augered
	2	7.75N, 19.0E	Augered
5MT2854	1	interference	
	2	23.25N, 19.5E	22.75N, 20.0E
5MT2858	1	29.75N, 15.0E	31.0N, 15.0E
5MT4512	1	8.5N, 7.5E	8.75N, 7.25E
5MT4545	1	31.0N, 21.5E	31.5N, 21.5E
5MT4614	1	27.5N, 49.5E	26.5N, 49.75E
	2	33.5N, 53.5E	33.3N, 53.75E
5MT4644	1	45.5N, 38.75E	45.25N, 29.0E
	2	42.75N, 25.5E	44.0N, 24.75E
Model 2193	2	11.5N, 23.0E	11.5N, 23.0E

Figure 13. Graphic representation of the magnetically estimated center to the excavated hearth center.



31.2N/21.5E, compare favorably with the excavated coordinates 31.5N/21.5E, at the center of the central hearth (refer to table 32).

It is apparent that the magnetic profiles are well suited for identifying the coordinates of the center of a pitstructure's central hearth. The maximum point of the magnetic anomaly of a pitstructure defines the hearth location.

Ventilator Shafts

The geometry of the ventilator shaft of a pitstructure is usually very difficult to define in the magnetic field. The ventilator shaft opening is usually small, generally about 1.5 m or slightly larger in diameter, and close to the pitstructure's main chamber. In spite of these difficulties, the ventilator shaft may make a very subtle but detectable contribution to the pitstructure's magnetic anomaly. This contribution is obvious when comparing the profile of Model 2193, which has a ventilator shaft, to the simulated model which was created having no ventilator shaft, Model 2193a. The visible contribution of the ventilator shaft opening, shown as an increase in the magnetic intensity at the south side of the profile (fig. 14) suggests that the ventilator opening lies between 7-8N and 24E. The center of the ventilator opening on Model 2193 actually occurs at 7.75N/24.25E. The ventilator shaft opening is made much more apparent upon comparison with the model profile, which has no ventilator shaft and opening (fig. 15). On this profile, a steep, uninterrupted rise constitutes the southern slope of the line.

Of all the pitstructures examined in this study, eight have ventilator shafts and openings identifiable from excavation. The excavated and estimated locations of the ventilator shaft openings are presented in table 33 and figure 16.

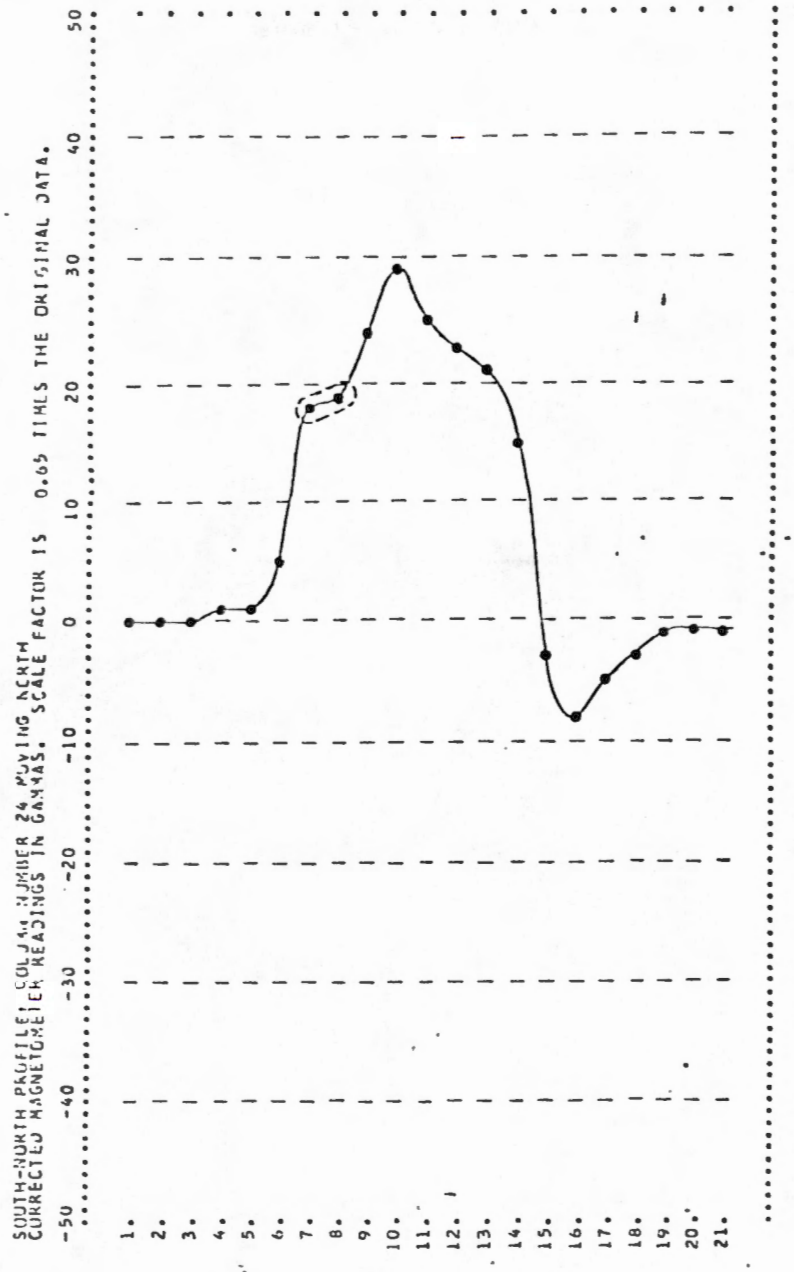


Figure 14. Model 2193 illustrating the ventilator shaft contribution on the north-south profile (line 24E).

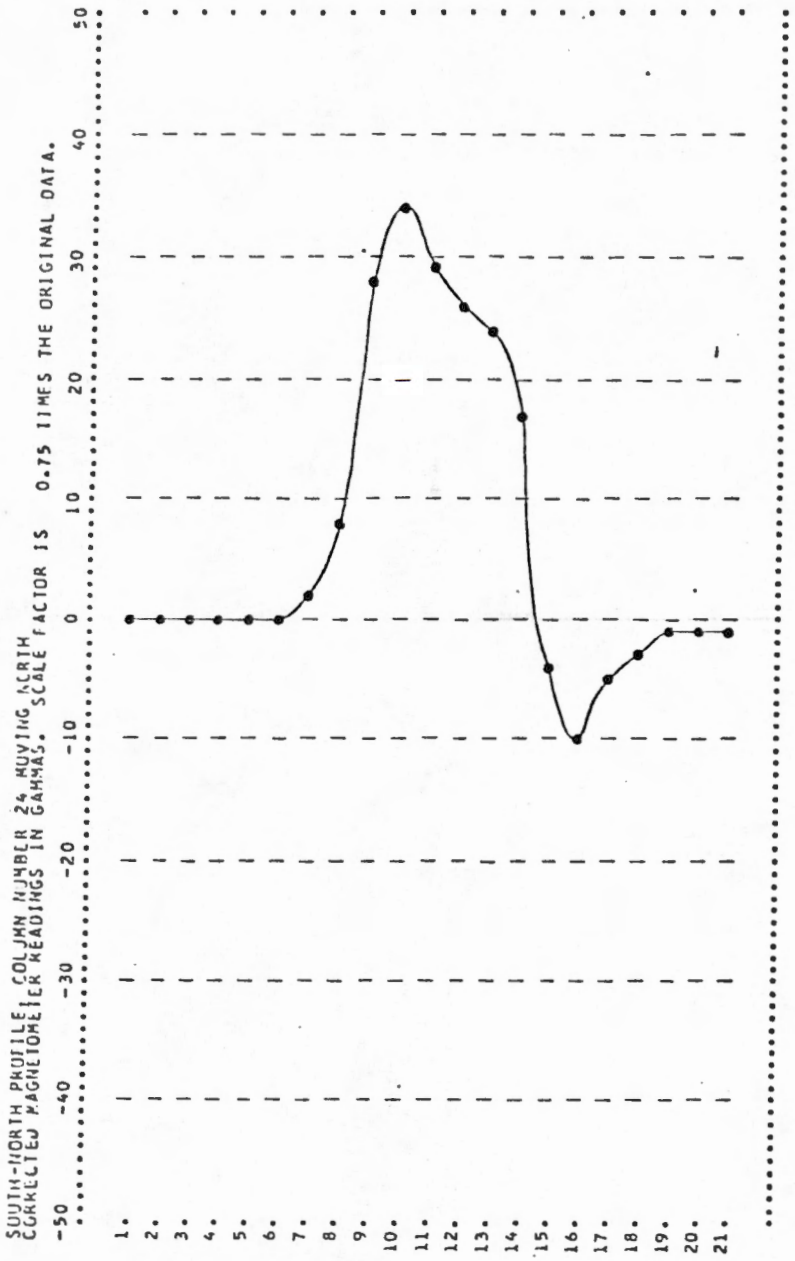


Figure 15. Model 2193a illustrating the lack of a ventilator shaft contribution on the north-south profile (line 24E).

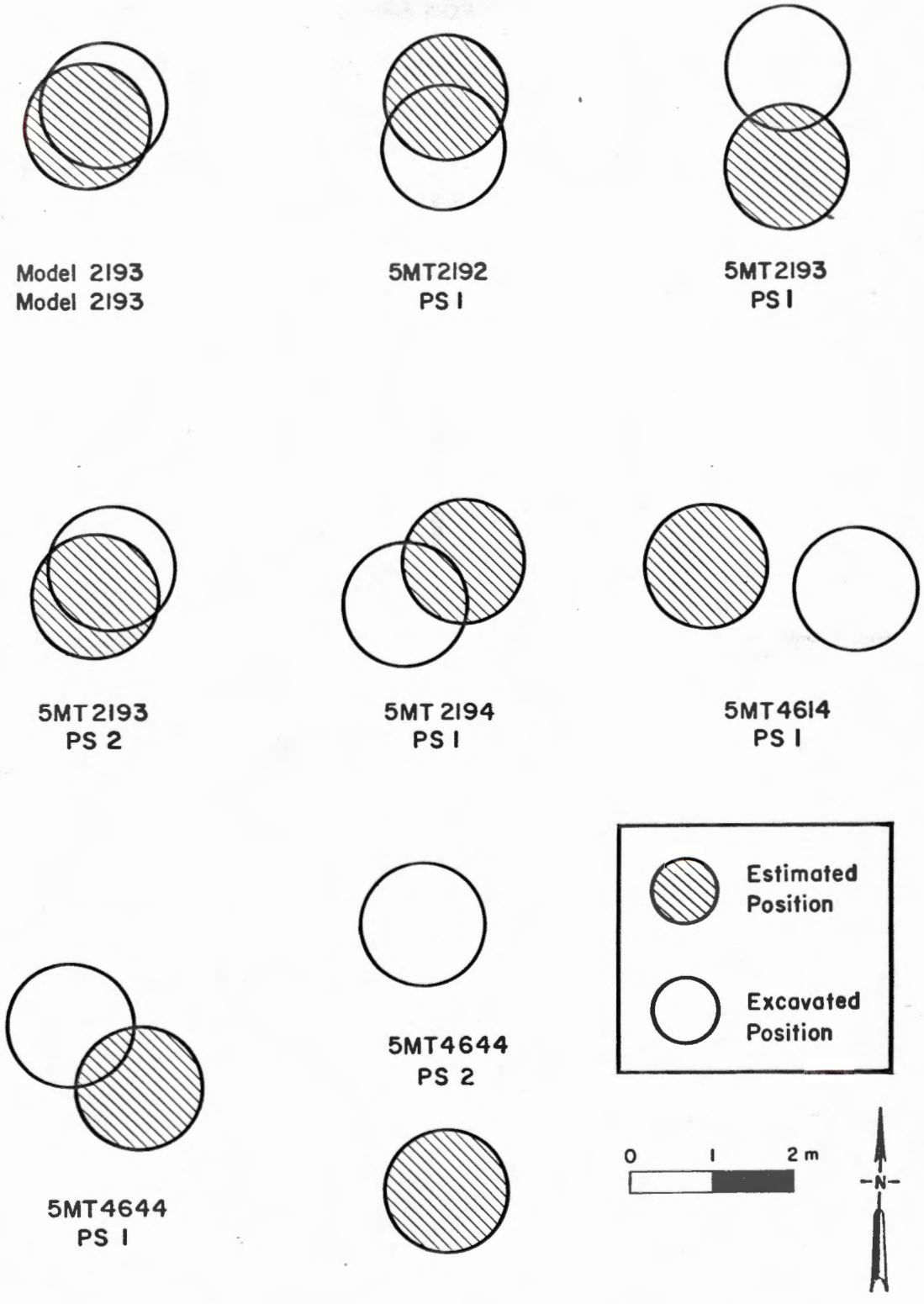


Figure 16. Graphic representation of the estimated center of the ventilator shaft to the excavated position.

Table 33. Comparison of the estimated position of the center of the ventilator shaft opening to the excavated position

Site	Pitstructure	Estimated position	Excavated position
Model 2193		7.5N - 24.0E	7.75N, 24.3E
5MT2192	1	28.5N - 41.0E	28.0N, 41.0E
5MT2193	1	13.5N - 22.5E	14.8N, 22.5E
	2	7.5N - 24.0E	7.8N, 24.25E
5MT2194	1	10.0N - 11.0E	9.5N, 10.5E
5MT4614	1	24.5N - 49.0E	24.3N, 50.8E
	2	31.0N - 51.0E	31.8N, 54.5E
5MT4644	1	41.5N - 37.0E	42.3N, 37.8E
	2	38.5N - 26.0E	41.8N, 25.5E

Of the eight pitstructures having ventilator shafts, three (Site 5MT4614, Pitstructures 1 and 2; Site 5MT4644, Pitstructure 2) show large discrepancies. Site 5MT4614, Pitstructure 2 was not graphed because of the large deviation (table 33) in estimated and actual positions. The ventilator opening was shown by excavation to be very close (0.25 m) to the main pitstructure chamber. It is possible that the proximity of the ventilator shaft opening to the main pitstructure chamber and the orientation of the structure, which is such that the ventilator shaft lies hidden by the main chamber anomaly on north and east lines, obscures any of Site 5MT4644, Pitstructure 2, also shows a large discrepancy between estimated and actual position (fig. 16). This difference is probably due entirely to the ventilator shaft lying almost directly south of the pitstructure's main chamber. In such a position, the greater main chamber anomaly will mask the smaller ventilator contribution. It is unlikely that ventilators located directly south of the pitstructure will be detectable. The estimated position of the ventilator shaft opening of Pitstructure 1 at Site 5MT4614 is approximately 1.75 m east of its actual location. There is no

obvious reason for this difference. The feature is a good distance to the southeast of the main structure, and the magnetic profile shows an increase that corresponds well with the northern coordinate of the ventilator shaft. There is no apparent reason why the anomaly would shift east about 1.75 m.

The remaining five domicile ventilator shaft openings were all fairly close to their estimated coordinates, suggesting that it is possible to identify the position of the ventilator opening if certain conditions are met. The ventilator shaft opening must be located more than 50 cm from the main chamber, and best results are obtained when it is situated off center of the magnetic north line which bisects the main chamber.

Antechambers

Unlike the magnetic contributions made by ventilator shafts, antechambers alter the entire south slope of a pitstructure's magnetic profile. The sharp rise of the southern slope of the south-north profiles that is characteristic of the anomalies of pitstructures with ventilator shafts becomes a broader, curved rise for pitstructures with antechambers (fig. 17). It is on the south-north profiles that antechambers may be most easily detected.

On the west-east profiles, an antechamber may also be visible. The antechamber anomaly appears as an area which adopts the usual pitstructure anomaly form, but which begins somewhat south of the main pitstructure anomaly. The antechamber anomaly is typically of a smaller magnitude than the main chamber anomaly and may be contiguous with the anomaly of the main chamber. The resulting profile is similar to that which would be expected from two slightly overlapping pitstructures that lack ventilator shafts (figs. 18-21).

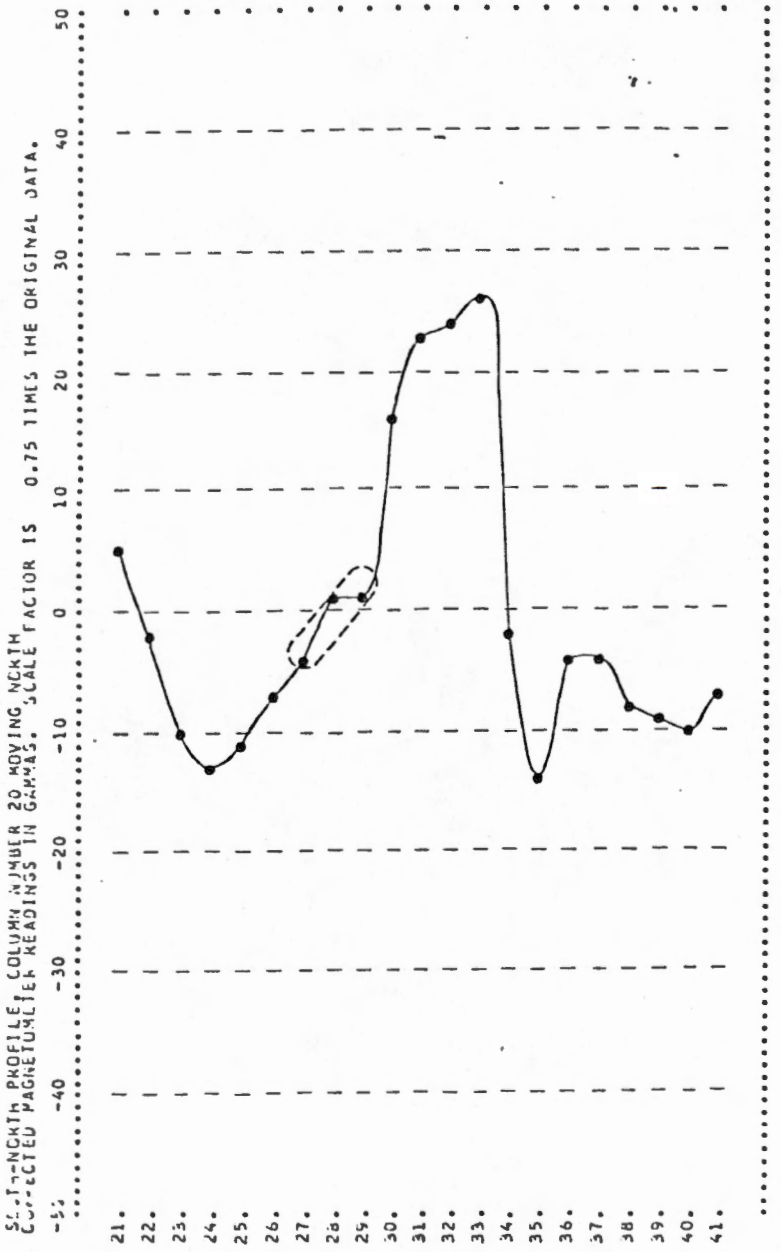


Figure 17. Site 5MT4545 illustrating the antechamber contribution on the north-south profile (line 20E).

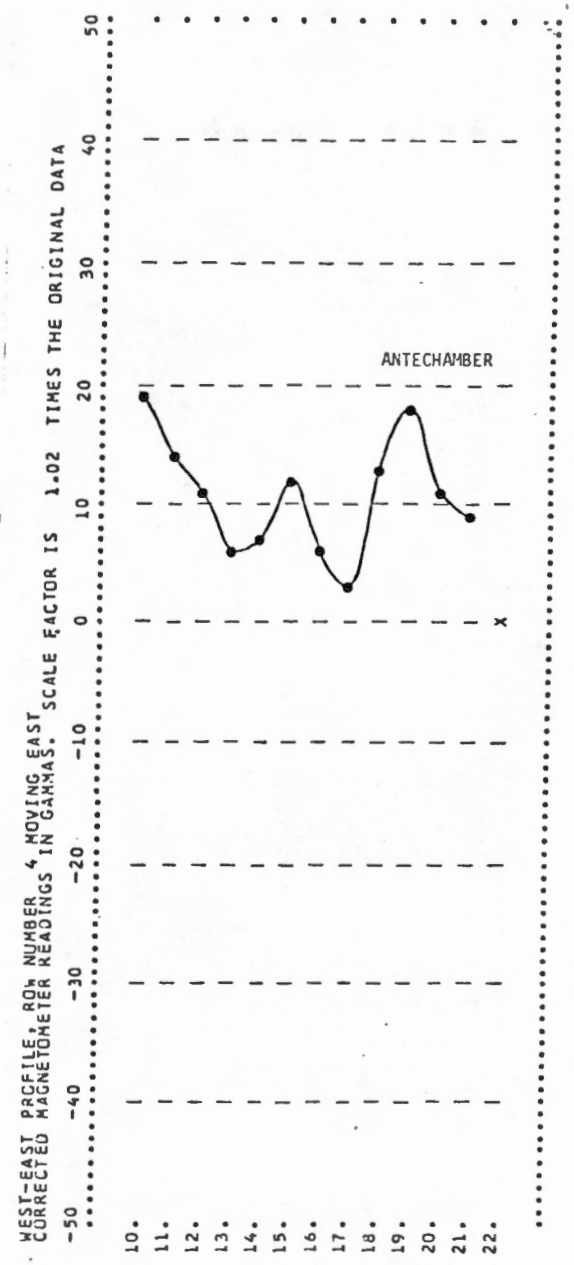


Figure 18. Site 5MT2853 illustrating the antechamber contribution on the east-west profile (line 4N).

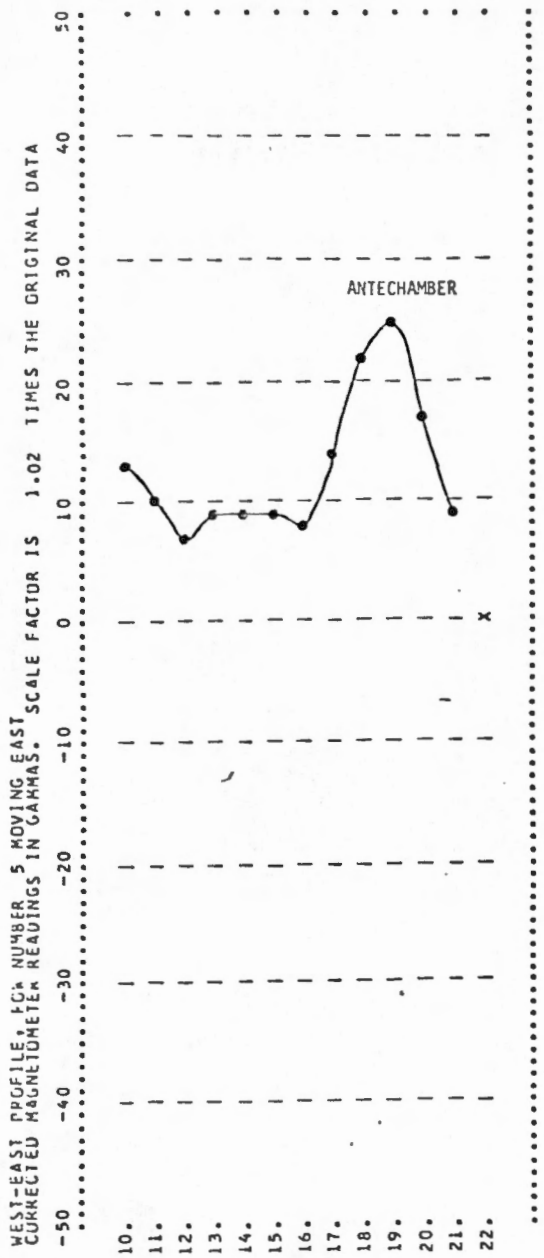


Figure 19. Site 5MT2853 illustrating the antechamber contribution on the east-west profile (line 5N).

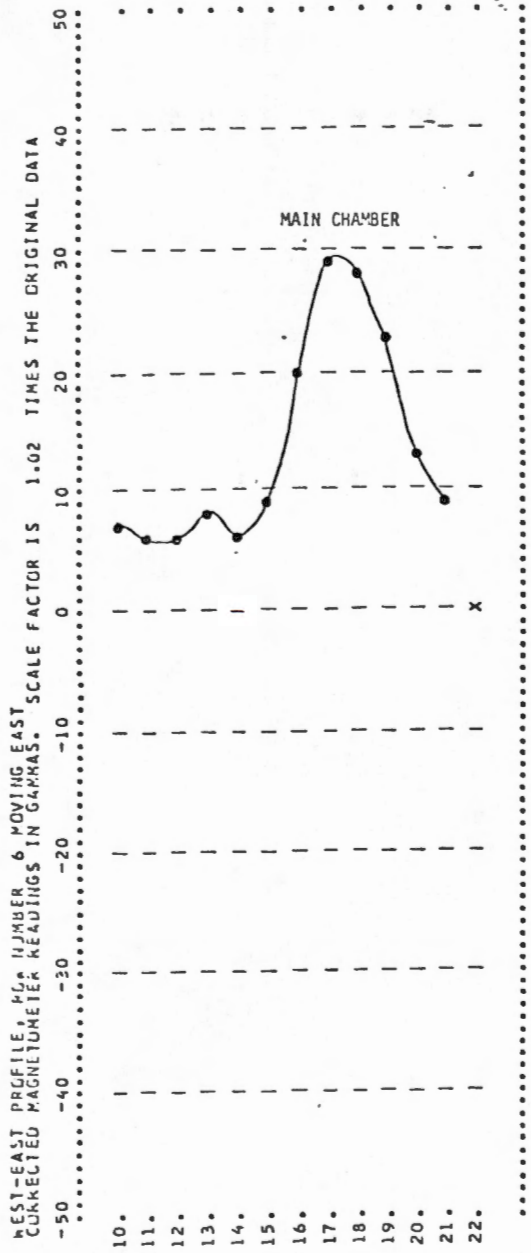


Figure 20. Site 5MT2853 illustrating the antechamber contribution on the east-west profile (line 6N).

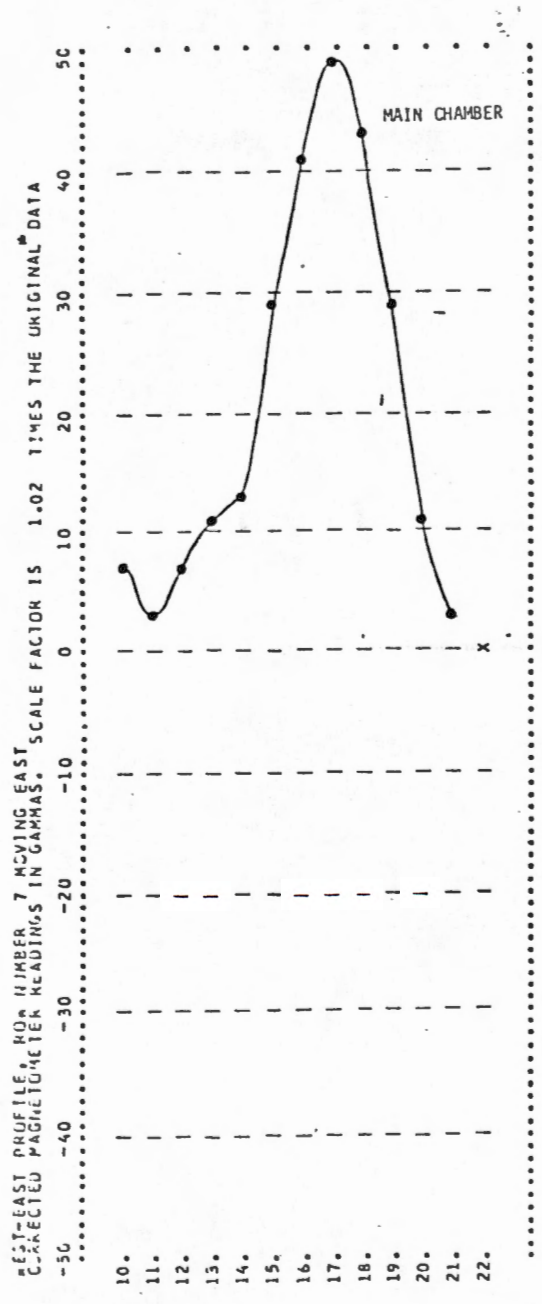


Figure 21. Site 5MT2853 illustrating the antechamber contribution on the east-west profile (line 7N).

Once an anomaly is believed to be related to an antechamber, an estimate of the potential boundaries may be possible. The boundaries may be found in the same manner as main chamber boundaries, by using the inflection points of the antechamber anomaly (refer to table 34 and fig. 22). Because the antechamber anomaly frequently merges with the main chamber anomaly, the northern extent of the antechamber may not be detectable.

Table 34. Comparison of estimated to excavated boundaries for antechambers

Site	Pitstructure	Estimated boundaries	Excavated boundaries
5MT2162	1	13.5 - unknown	13.0 - 15.8N (augered)
		3.5 - 6.5E	3.0 - 6.2E
5MT2853		3.5 - unknown	4.0 - 6.0N (augered)
		17.5 - 20.5E	18.0 - 20.0E
5MT2858		23.75 - 26.25N	25.0 - 27.0N
		13.5 - 16.5E	13.0 - 16.0E
5MT4512	1	6.0 - 7.5N	6.5 - 7.5N
		6.0 - 8.0E	6.25 - 7.75E
5MT4545	2	27.5 - 29.0N	27.75 - 30.0N
		20.5 - 23.5E	21.0 - 23.75E

The pitstructure at Site 5MT4545 provides an excellent example of a pitstructure with antechamber. The antechamber is visible on both the north-south and west-east profiles. On Line 20E (fig. 17), moving north from 21N, the antechamber contribution becomes obvious between 27 and 29N. On Line 21E (fig. 8), the antechamber contribution has increased in magnitude to create a broad, gentle curve on the southern slope of the main chamber's magnetic anomaly. At Line 22E (refer to fig. 23), the antechamber anomaly reaches its maximum magnitude at 28N, and on further east lines decreases.

On the west-east profiles of Lines 27-33N (figs. 24-28), profiles of two distinct anomalies are visible. The first, or southern anomaly,

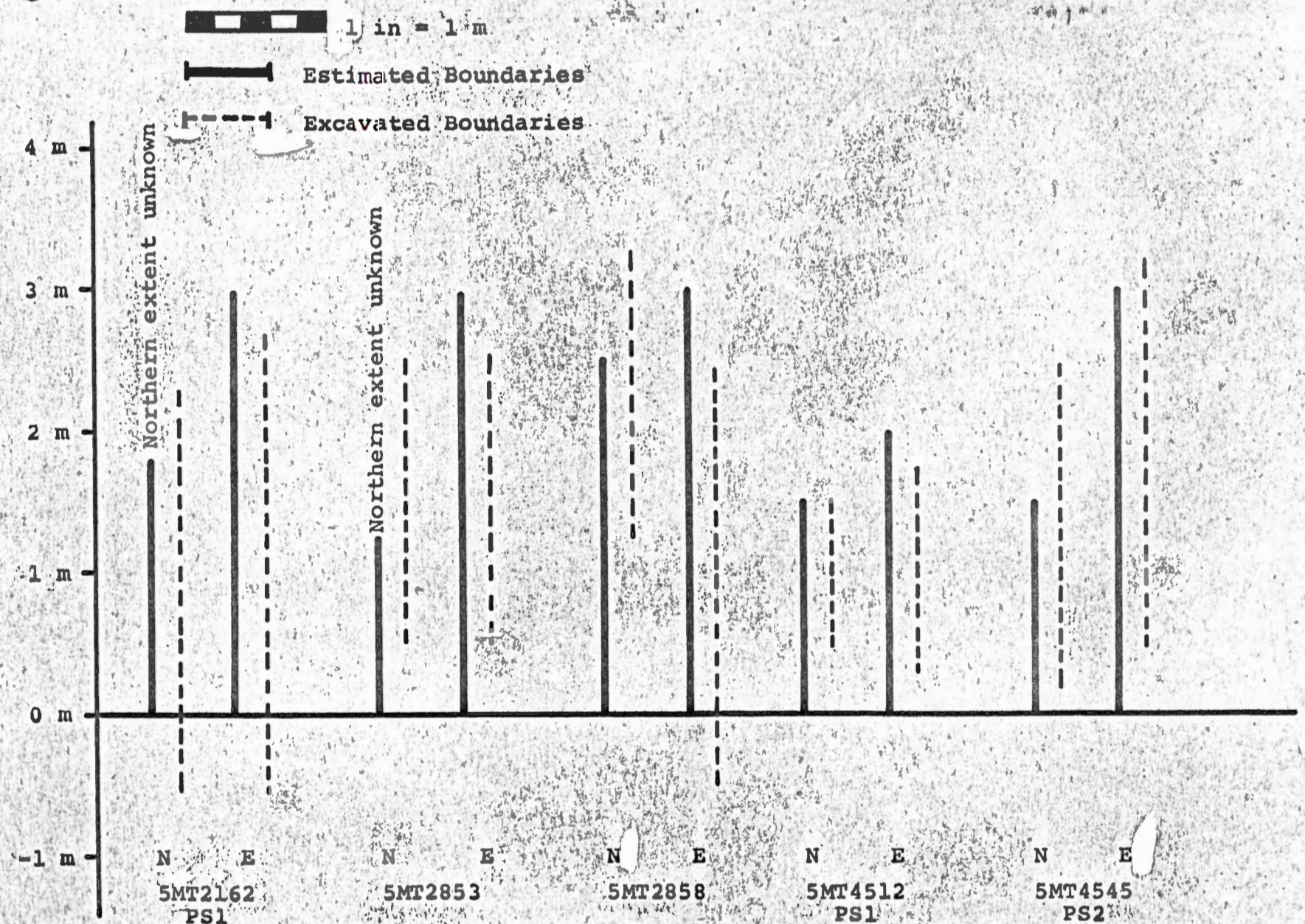


Figure 22. Graphic Comparison of the estimated south-north and west-east boundaries to excavated boundaries of Antechambers.

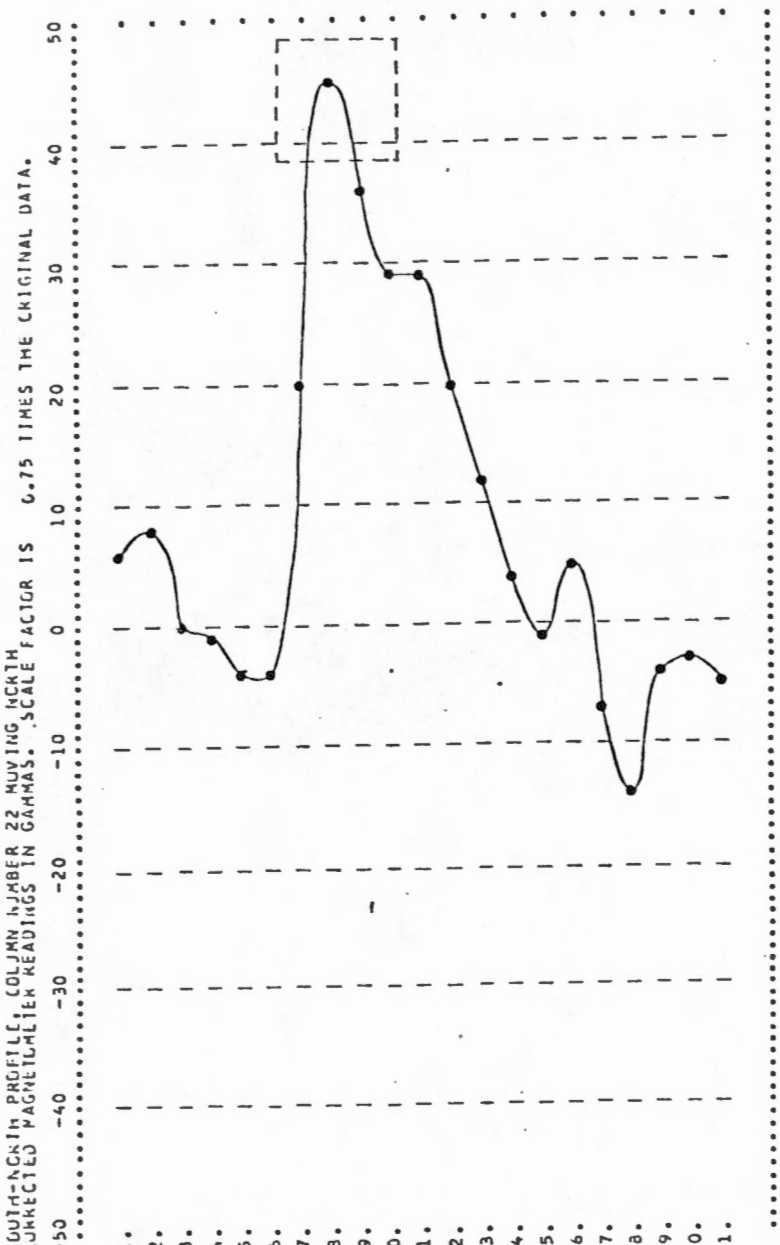


Figure 23. Site 5MT4545 illustrating the antechamber contribution on the south-north profile (line 22E).

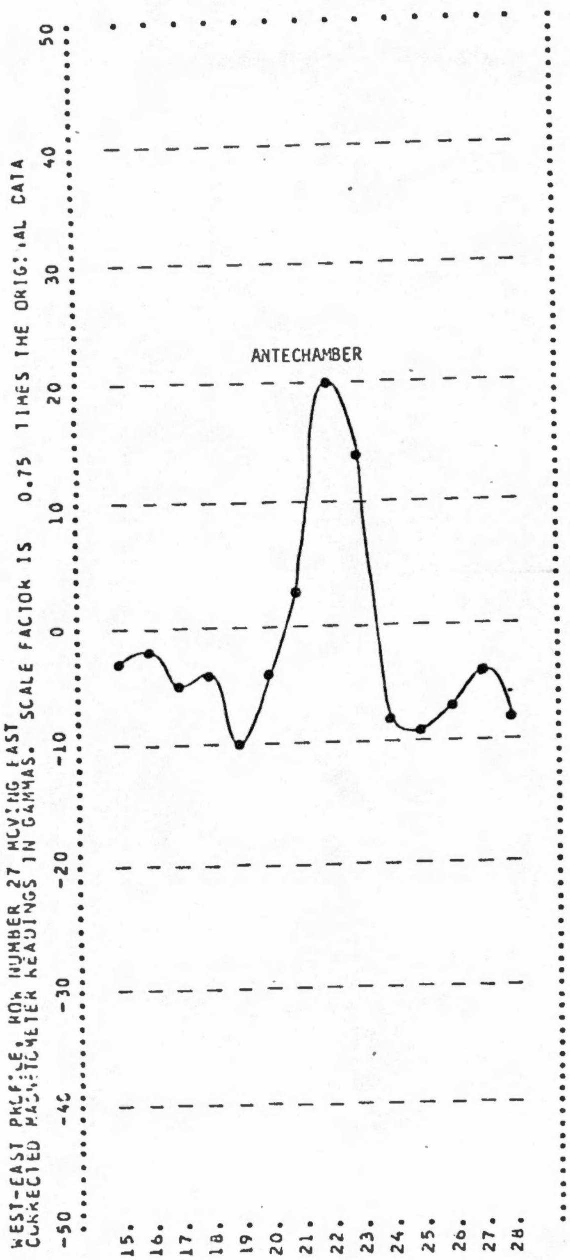


Figure 24. Site 5MT4545 showing the antechamber sequence on the east-west profile (line 27N).

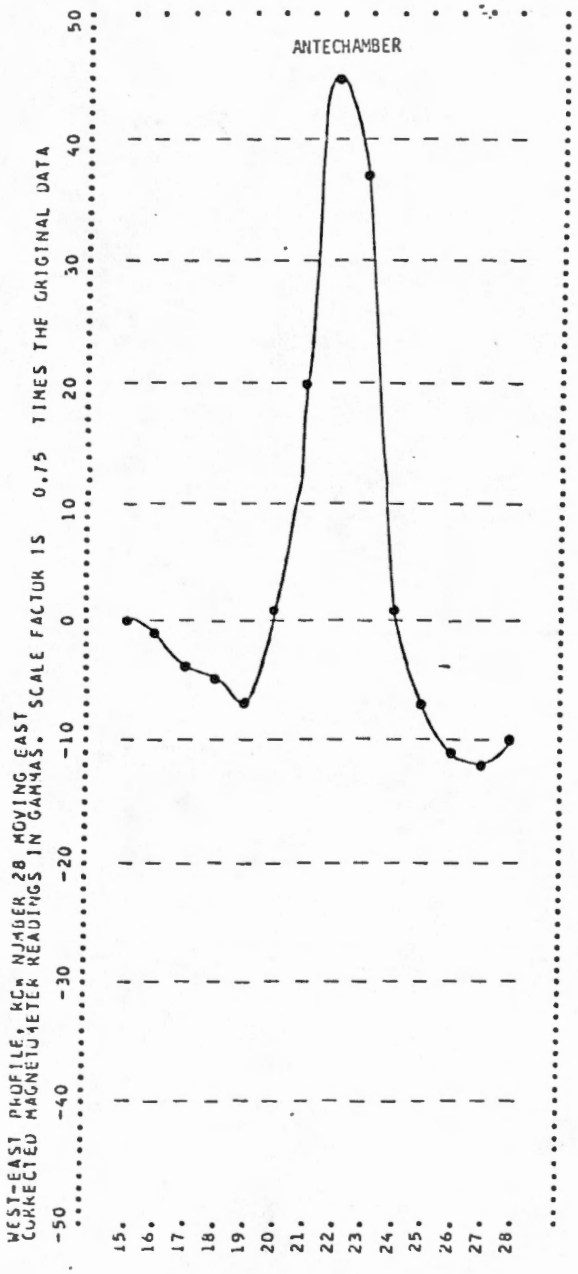


Figure 25. Site 5MT4545 showing the antechamber sequence on the west-east profile (line 28N).

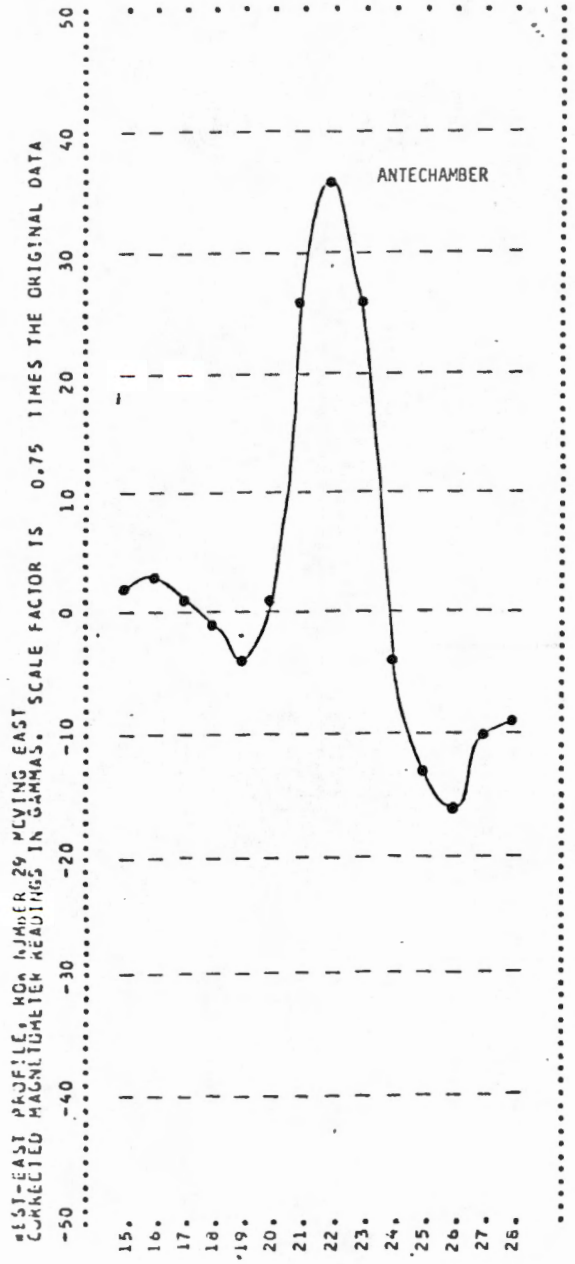


Figure 26. Site 5MT4545 showing the antechamber sequence on the east-west profile (line 29N).

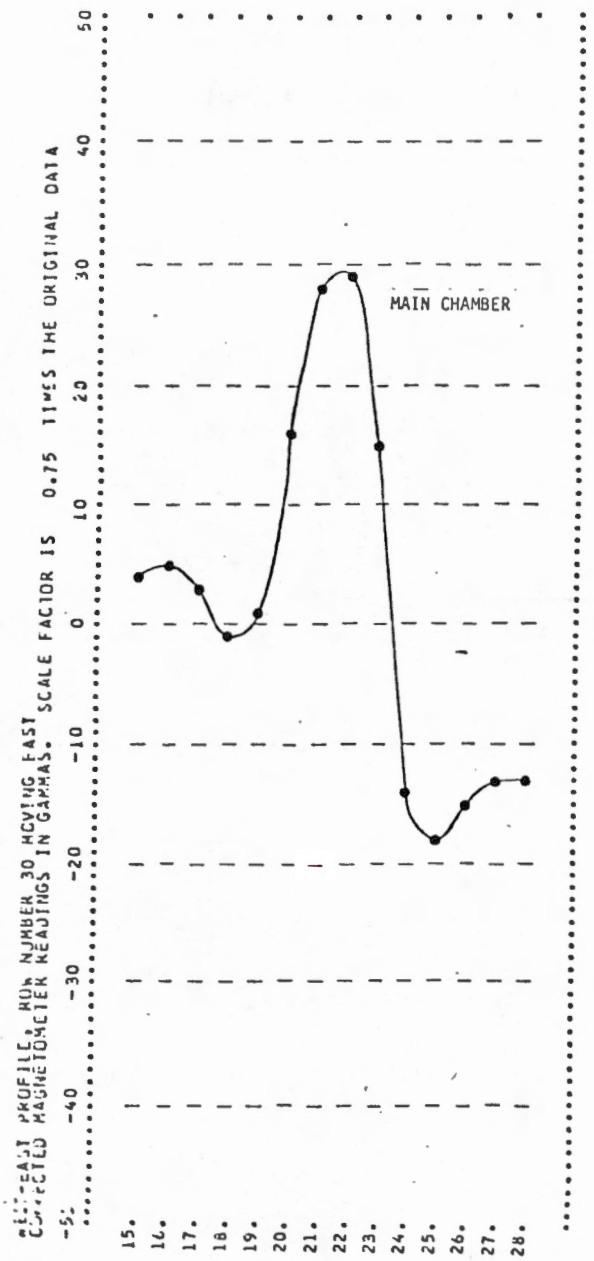


Figure 27. Site 5MT4545 showing the antechamber sequence on the east-west profile (line 30N).

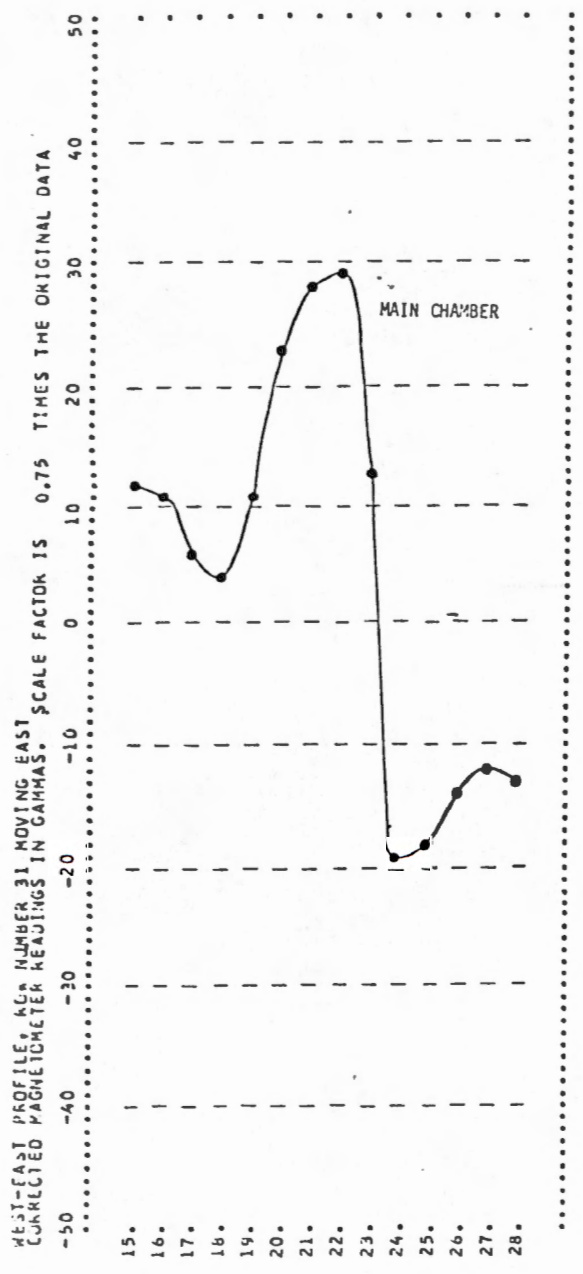


Figure 28. Site 5MT4545 showing the antechamber sequence on the east-west profile (line 31N).

becomes apparent on Line 27N between 19 and 24E. The profile reaches its maximum on Line 28N at 22E, and declines on Lines 29 and 30N. Beginning on Line 31N, a typical pitstructure profile is formed. On Line 31N the slope of the profile west of 21E changes so that the points have a greater magnitude compared to the preceding profiles, and on Lines 32 and 33N (profiles not included) points east of 20E decrease to form the characteristic rise to a maximum and decrease of a magnetic anomaly. The east-west profiles indicate that an antechamber may exist between the points 27-30N.

Having determined that an antechamber does exist, it is possible to estimate the boundaries of the antechamber by using inflection points on the east-west profiles of the anomaly. This can be illustrated by using the Line 28N profile (fig. 25) where the inflection points are located at approximately 20.5 and 23.5E. The excavated boundaries are at 21.0 and 23.75E.

Unfortunately the magnetic contribution of the antechamber on the south-north profiles is not totally separate from the main chamber's anomaly, so that the location of the northern extent of the antechamber is only an approximation. The best estimate of the northern extent is probably between 29 and 30N. The southern extent, detected by inflection point, is estimated to be at 27.5N. The excavated south-north boundaries of the antechamber were at 27.8-30.0N.

Site 5MT4545 illustrates the form an antechamber's magnetic anomaly creates on a magnetic profile and the means for establishing dimensions and boundaries. The magnitude of the antechamber's magnetic anomaly with respect to the main chamber's magnetic anomaly is not usual. The magnitude of an antechamber anomaly is generally smaller than for the corresponding main chamber. At Site 5MT4545, however, the antechamber was more

severely burned than the main chamber, thus causing a greater magnetic intensity for the antechamber.

Antechambers are easier to detect on magnetic profiles than ventilator shafts, due to their larger size and their creation of individual anomalies visible on the east-west profiles. It is also possible to estimate the boundaries of antechambers from the magnetic data using the inflection point method.

Burning within the Pitstructure

The anomaly related to a pitstructure is caused by factors such as compaction, organic fermentation, and burning. Burning within the structure appears to make the greatest contribution to the magnetic anomaly, and the intensity of the burning remarkably alters the magnitude of the entire anomaly. In table 35, the range of magnetic magnitude is compared with the intensity of the burning of the entire pitstructure. The moderately to heavily burned pitstructures appear to create magnetic intensities of greater than approximately 60 quarter gammas, while pitstructures with light to no burning generally create magnetic intensities of less than 45 quarter gammas. Knowing this, it is possible to predict the degree of burning of a pitstructure from the magnetic data.

Besides the large-scale burning described previously, small isolated burning within the pitstructure may also visibly alter the magnetic field and hence the magnetic profiles. Such an instance occurs at Site 5MT4545.

At Site 5MT4545, the magnetic intensity of the moderately burned antechamber distorts the anomaly of the lightly burned pitstructure. The burned soil and debris of the antechamber creates an abnormal, increased intensity on the southern slope of the south-north profile (fig. 23) dwarfing the magnetic contribution of the main chamber's central hearth.

The source of the increase in intensity was found to be a lens of burned debris located near 28N/22E. The debris is concentated along the western wall of the antechamber, creating a very pronounced peak throughout the antechamber anomaly and continuing into the anomaly of the main chamber.

Table 35. Comparison of the burn intensities of Anasazi pitstructures to magnetic magnitude of anomalies

Site	Pitstructure	Burn intensity	Magnitude (quarter gammas)
5MT2162	1	Augered	53
	2	Augered	61
5MT2192	1	No burning	24
5MT2193	1	Heavy	77
	2	Moderate	69
5MT2194	1	None	33
5MT2236	1		74
5MT2848	1	Heavy	117
5MT2853	1	Augered	-
	2	Augered	48
	3	Augered	24
5MT2854	1	None	36
	2	None	44
5MT2858	1	None	
5MT4512	1	None	25
5MT4545	1	Light	41
	2	Moderate	62
5MT4614	1	None	
	2	None	
5MT4644	1	Heavy	108
	2	Heavy	112

Aside from the instance of burning at Site 5MT4545, no indications of isolated burning were magnetically detectable in any other pitstructures

selected for examination. This is probably because the majority of burned features within a pitstructure would create small magnetic contributions which would not be detected above the central hearth's contribution.

Burning within a pitstructure is either localized within the structure or involves the entire structure. Intense localized burning may be of a sufficient magnitude to be detected on the magnetic profiles but localized areas of moderate burning do not appear detectable. Intensity of the burning of the pitstructure may also be determined from the magnitude of the magnetic anomaly.

Intrusive Elements and Pitstructure Complexes

On occasion foreign elements may intrude into a pitstructure. Among the sites examined in this section, second pitstructures constitute the intrusive elements at two sites, Site 5MT2193 and Site 5MT2853.

At Site 5MT2193, the ventilator shaft and opening of Pitstructure 1 intrudes approximately 50 cm into the main chamber of Pitstructure 2. On the original magnetic map of the site, two magnetic monopole highs are situated such as to suggest two closely associated pitstructures. On the north-south magnetic profiles it later becomes apparent that the two structures may be slightly superimposed. Two closely associated pitstructure anomalies occur, beginning at Line 20E. Situated between the two primary anomalies is a small anomaly contributing to a minor increase in magnetic intensity. On Line 21E (fig. 29), the small anomaly begins to merge with the anomaly of the southern pitstructure (Pitstructure 2), causing a secondary peak to occur on what would be the northern slope of the Pitstructure 2 profile. Contributions from the intrusive element are especially noticeable on Lines 22 and 23E (figs. 30 and 31). The sharp increase in magnetic intensity implies a feature of high magnetic

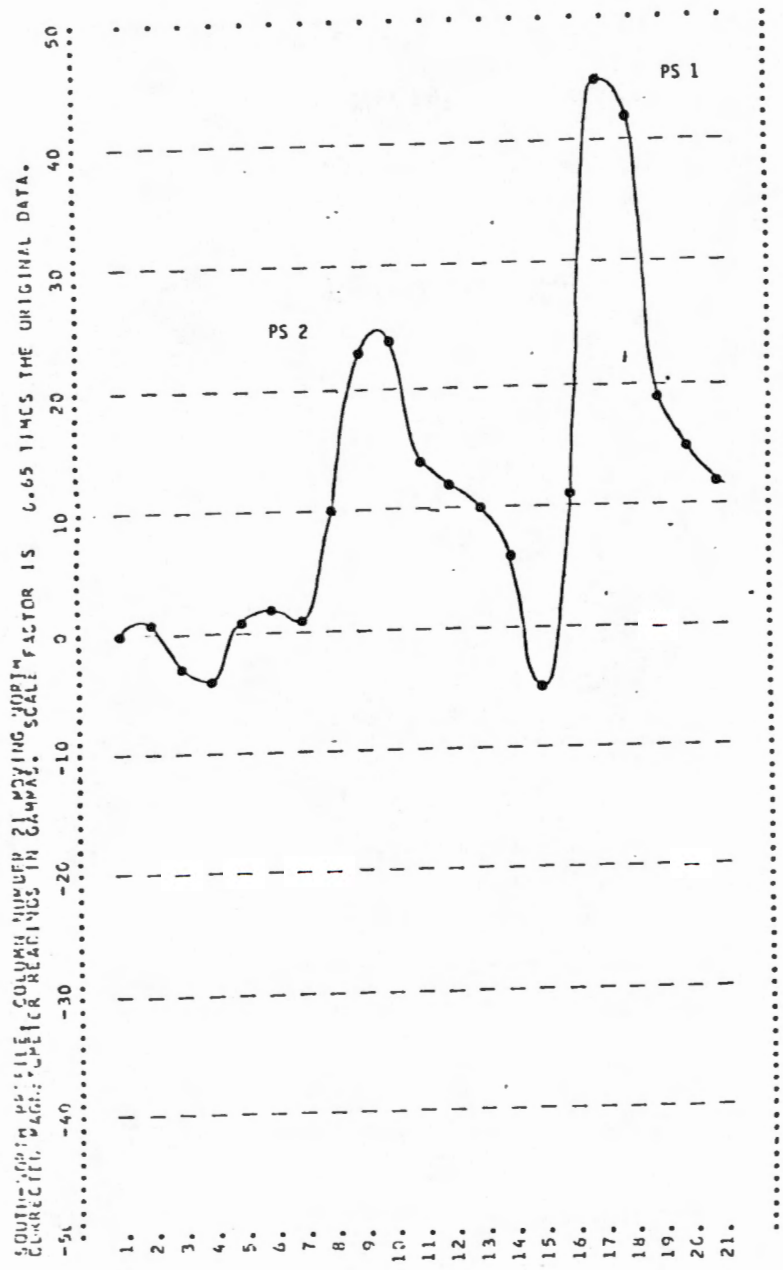


Figure 29. Site 5MT2193 sequence showing the intrusive ventilator shaft of Pitstructure 1 into Pitstructure 2 on the north-south profile (line 21E).

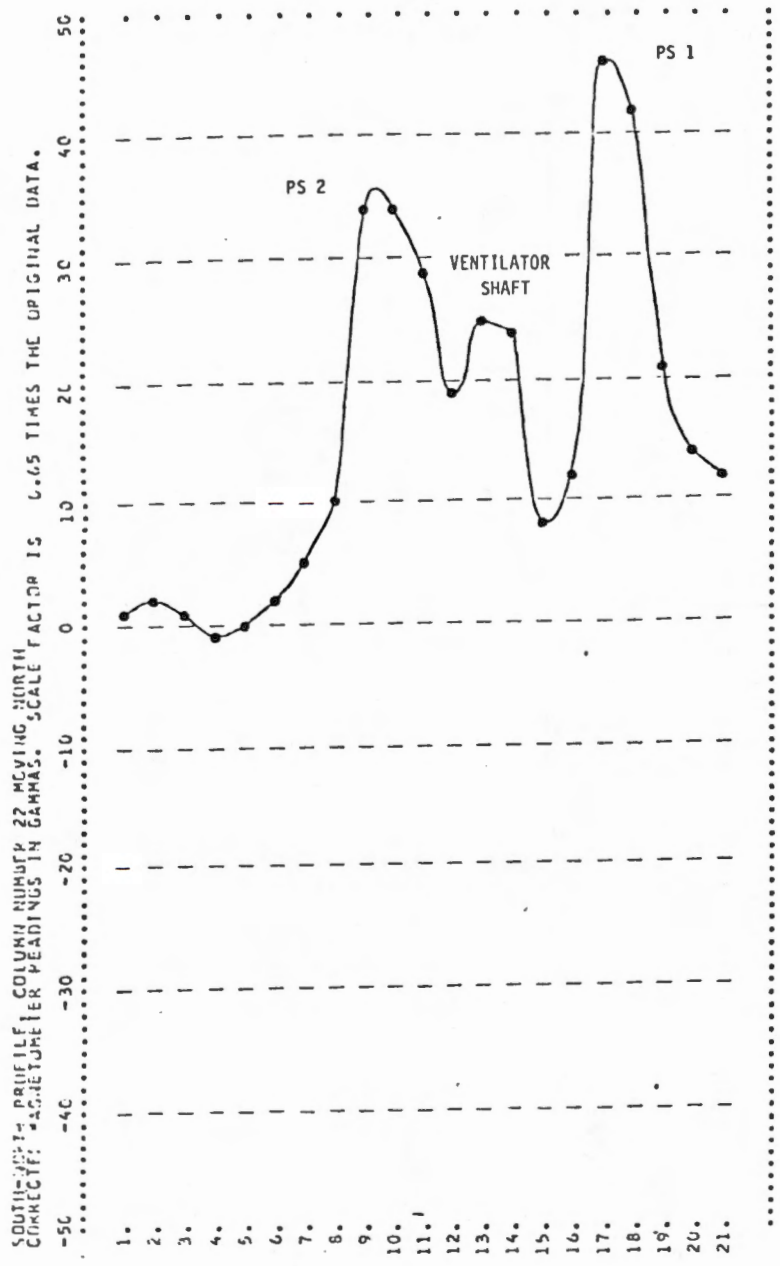


Figure 30. Site 5MT2193 sequence showing the intrusive ventilator shaft of Pitstructure 1 into Pitstructure 2 on the north-south profile (line 22E).

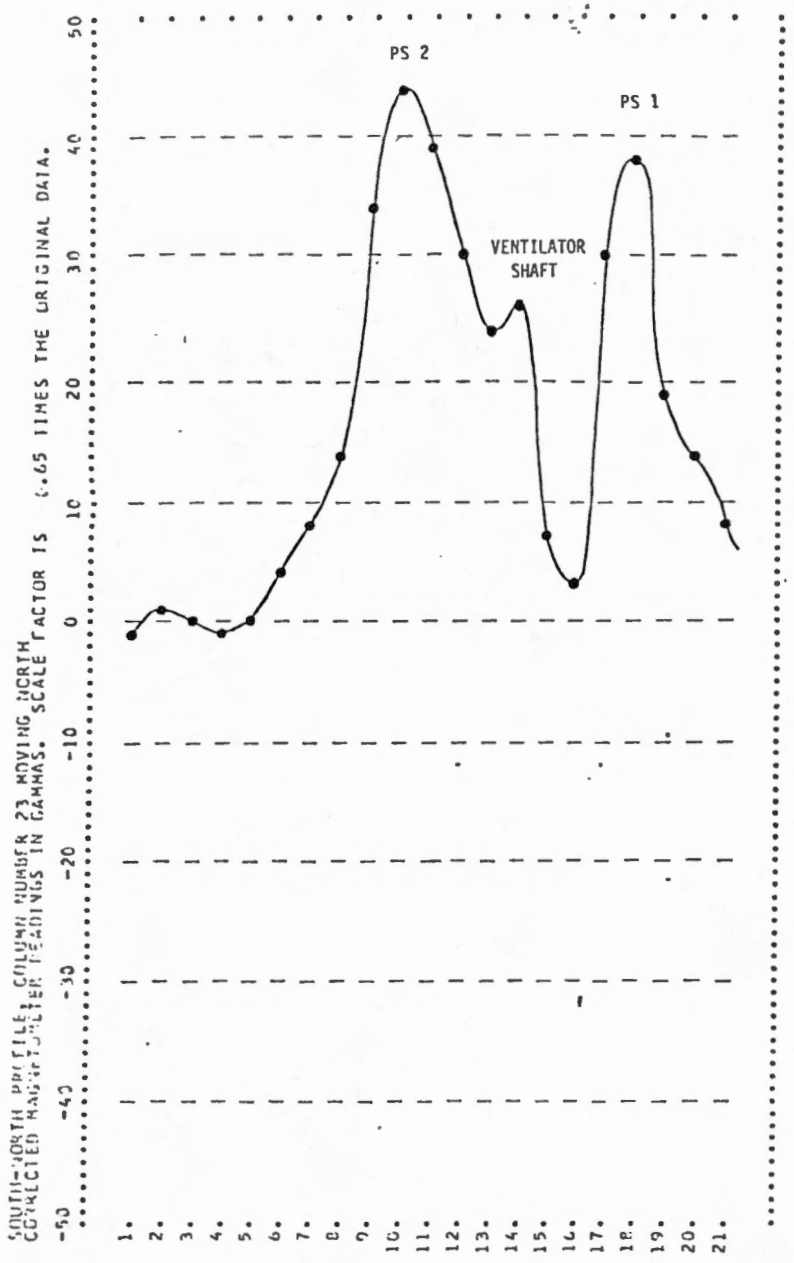


Figure 31. Site 5MT2193 sequence showing the intrusive ventilator shaft of Pitstructure 1 into Pitstructure 2 on the north-south profile (line 23E).

intensity within Pitstructure 2. The evident proximity of a second pitstructure (Pitstructure 1) to the north of Pitstructure 2 suggests that the feature intruding into Pitstructure 2 could also be related to Pitstructure 1. Combining the thought with an understanding of the typical Anasazi pitstructure, it may be suggested that the intrusive element could be a ventilator shaft or a small antechamber.

A similar instance occurs at Site 5MT2853. The original magnetic map of the site contains an anomaly which is designated as a pitstructure anomaly by NEBCAR. The magnetic profiles also indicate a pitstructure, but of great complexity, having contributions from at least two sources.

At Line 13E (profiles not included), moving north along the profile, a pitstructure anomaly is beginning to become visible at about 6-10N. A slight increase at 4-6N may be associated with the pitstructure also. Over the next two lines, Lines 14 and 15, the anomaly continues in a fairly typical form. The small increase at 4-6N remains, increasing only slightly. By Line 16E, the small anomaly decreased, and by 17E it has disappeared from the magnetic profile. At the main pitstructure anomaly on Line 16E, a slight abnormality has occurred on the northern slope of the anomaly profile. The abnormality is an increase in magnetic intensity such as would be created by a burned feature or an intruding feature of magnetic intensity. At 17E, the pitstructure anomaly reaches its maximum. The abnormal increase on the northern slope has continued to increase slightly. On Line 19E (fig. 32), the pitstructure anomaly has dissolved into three adjoining anomalies. The anomaly at 6-9N was previously identified as due to a pitstructure, and there is no reason to suggest that this is not true at this time. The second anomaly (6-9N) may still be considered as a pitstructure anomaly.

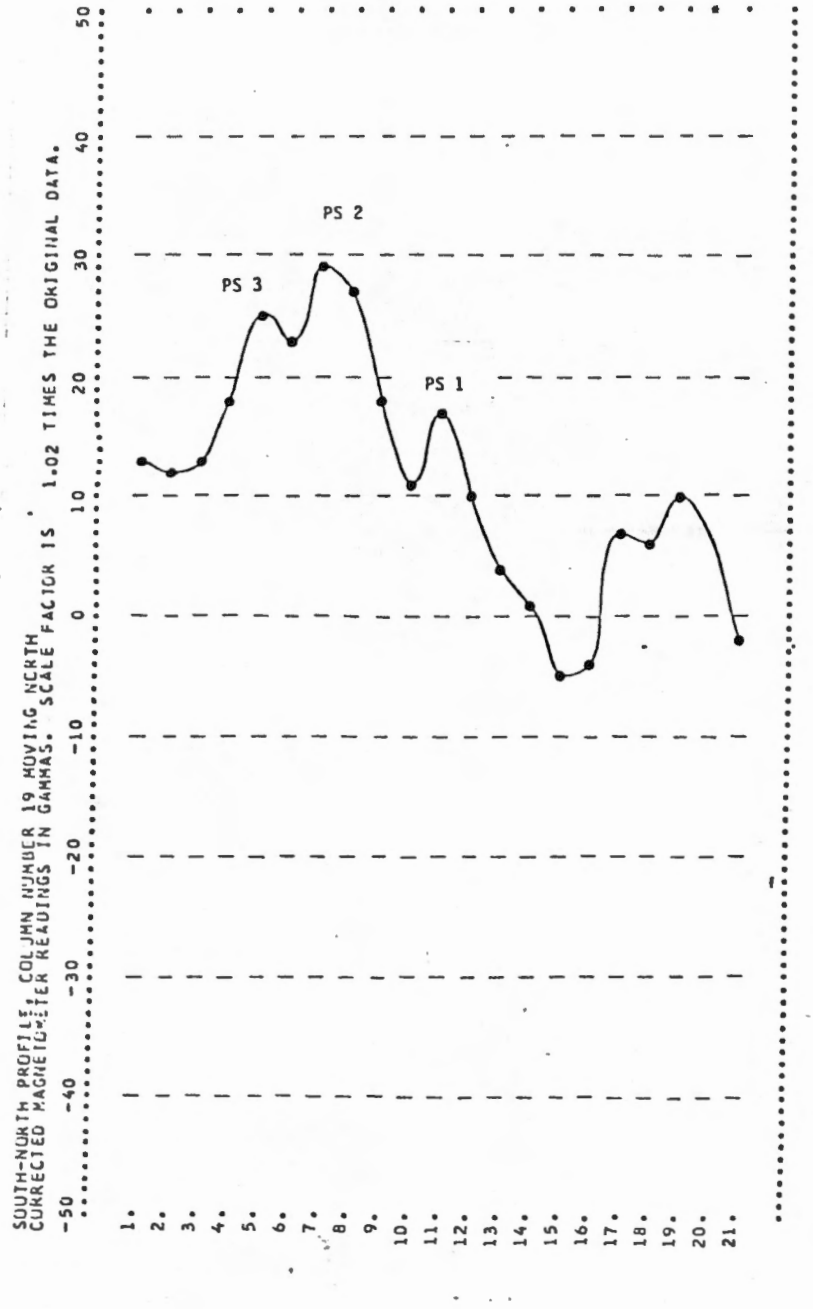


Figure 32. Site 5MT2853 showing a three-pitstructure complex on the north-south profile (line 19E).

The first anomaly, approximately 3-6N, indicates a feature of increased magnetic intensity within or at a close proximity to the pit-structure. The magnitude is not great, suggesting that the area is not intensely burned. The first anomaly (3-6N) appears to follow the form of a ventilator shaft, or more probably an antechamber. A slight increase occurs on the southern slope of the pitstructure anomaly at Line 18E, and becomes an individual anomaly at Line 19E. This implies the possibility of an antechamber rather than a ventilator shaft.

The third anomaly, located at approximately 10-15N, indicates another feature of increased magnetic intensity either within or intruding into the pitstructure. This anomaly to the north of the pitstructure anomaly becomes visible at Line 16E continuing on to Line 20E. It has its maximum magnetic intensity on Line 19E at 11N where it creates an individual anomaly. The magnitude of the third anomaly is much smaller than those of the first or second anomaly. The third anomaly does not appear to indicate a small feature within the pitstructure. The anomaly does not drop sharply at the northern slope, but flows out to develop a broad anomaly more typical of an anomaly created by a larger cultural feature. Based on this information, the third anomaly at 10-15N appears most likely to be caused by a large feature intruding into the pitstructure which creates the second anomaly.

The west-east profiles for the complex anomaly at Site 5MT2853 are presented in the profile 9 sequence. These profiles indicate a long, south-north feature creating a strong anomaly from 3 to 10N and a weaker anomaly from 10 to 16N. It appears to extend west-east from about 12 to 19E (profiles not included). The stronger, southern anomalies (3-10N) appear to be similar to anomalies of pitstructures with southern

antechambers. The northern anomaly is long (south-north) but wider (east-west) than the southern anomaly. The increased width of the southern anomaly (3-10N), which becomes readily visible on Line 9N/12-14E (profile not included), appears to be related to the northern anomaly (10-16N), again suggesting an intrusion into the pitstructure creating the southern anomaly.

From the magnetic profiles of Site 5MT2853, it appears that the large anomaly at this site contains a complex situation. Three individual, but related, anomalies occur. Two of the anomalies may represent a pitstructure with a southern antechamber, while the third anomaly may represent the partial intrusion of a large cultural feature of slight magnetic intensity.

The situation that actually occurs at this site was revealed by trenching the feature complex. The trench revealed two partially overlapping pitstructures. The earlier of the two structures had both a main chamber and an antechamber. The later pitstructure appears to have intruded on a small portion of the main chamber of the earlier structure. The pitstructure and antechamber correspond well with the second and first anomalies respectively and the later pitstructure corresponds with the third magnetic anomaly.

The two cases presented here demonstrated the kinds of information that may be gained about intrusive features and complex magnetic anomalies thorugh examination of the anomaly profiles. Such examinations may provide information that is useful to the archaeologist in planning excavation procedures. Examination of the magnetic profiles would also be profitable when magnetic survey is used for mapping purposes rather than excavation purposes.

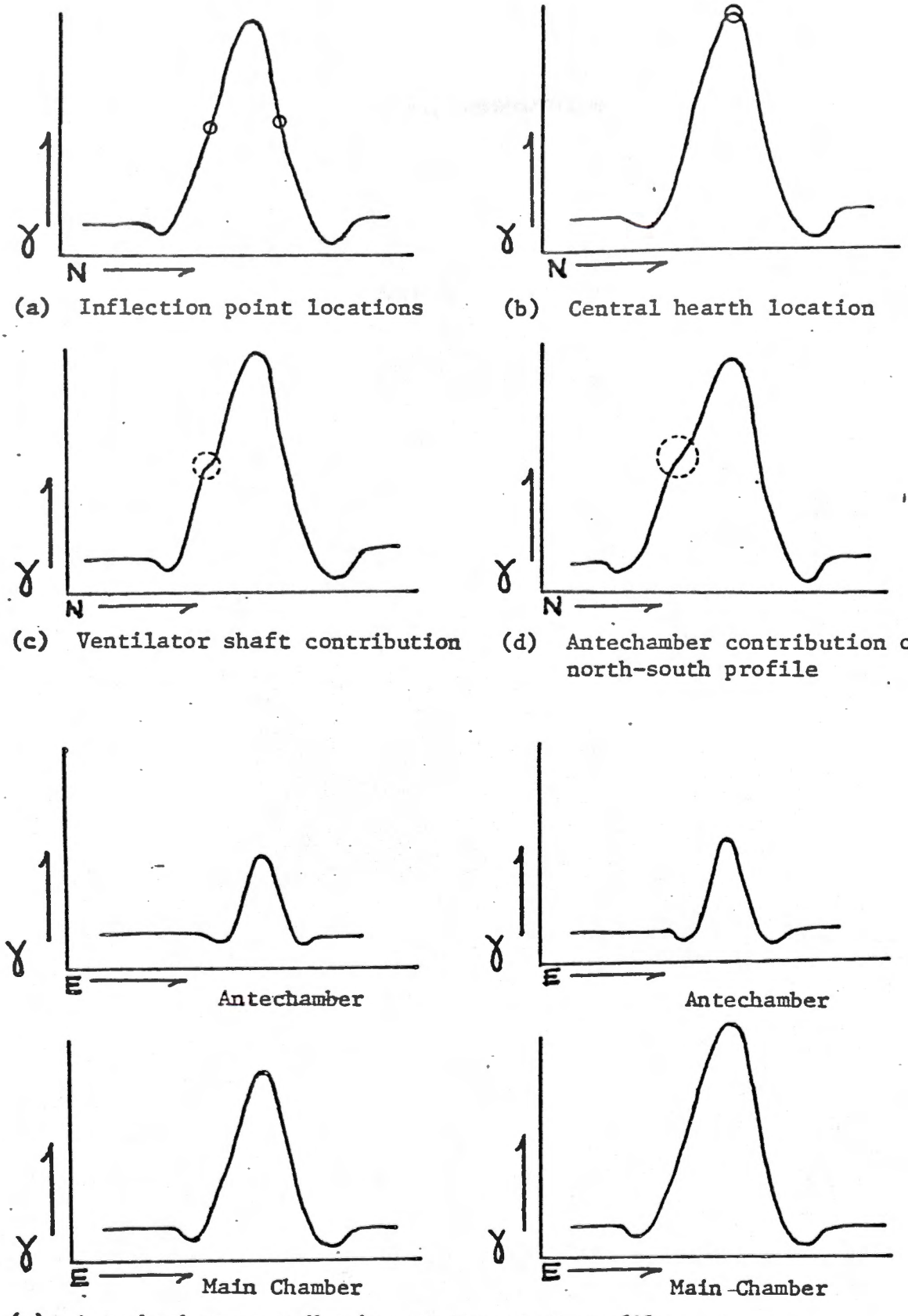
Summary

This section has given a comparison of magnetic profiles for excavated features in order to derive knowledge about individual anomalies that may be useful to archaeologists in planning site excavation. The inspection of the anomaly profiles of pitstructures can be used to establish the boundaries and dimensions of the structure, provide location information about the central hearths and ventilator shafts, identify antechambers and their boundaries, and to disect complex anomalies for clearer feature representations.

The boundaries and dimensions of the pitstructure and its antechamber may be estimated from the profiles by locating the inflection points where the curve of the slope changes direction (refer to fig. 33a). The method has been demonstrated to be accurate within 20 percent of the excavated dimensions (refer to tables 30 and 31).

The central hearth is often the most readily visible feature of a pitstructure anomaly, frequently dwarfing any other internal contributions. The central hearth is generally the maximum point on the magnetic profile of a typical pitstructure anomaly (refer to fig. 33b), corrected for the southern shift of the anomaly. The method has proven to be a good estimate of the hearth's center (refer to table 32).

The ventilator shaft and opening may be difficult to identify at times because of the relatively small magnetic contribution to the pitstructure anomaly. Frequently it is visible as a slightly increased magnetic measurement on the southern slope of the anomaly profile (refer to fig. 33c). The antechambers are easier to detect than the ventilator shafts and openings. On south-north profiles, antechambers may create either a variance similar to that of a ventilator shaft, but which



(a) Inflection point locations

(b) Central hearth location

(c) Ventilator shaft contribution

(d) Antechamber contribution on north-south profile

(e) Antechamber contribution on east-west profile

Figure 33. Summary of the structural information of pitstructures which may be isolated in the magnetic record.

broadens the entire southern slope of a pitstructure anomaly (refer to profile 33d), or it may create a separate anomaly similar to that of a pitstructure's main chamber. On an east-west profile, the antechamber adopts a standard pitstructure anomaly form and is located slightly south of the main pitstructure anomaly (refer to profile 33e).

Intrusive features and complex anomalies may be profitably examined through the use of magnetic profiles. The profiles will suggest characteristics that could cause the varied anomalies, and an understanding of the archaeology of the area may identify the complexes of cultural features.

Burning within an entire pitstructure is also evident in the magnetic data. The intensity of the burning is indicated by the magnitude of the anomaly created. An anomaly of greater than 60 quarter gammas may indicate that the structure is moderately to heavily burned while an anomaly of less than 45 quarter gammas suggests light to no burning.

It is more difficult to isolate localized burning within the pitstructure. The strong anomaly of the central hearth will mask any indications of localized burning, unless the magnetic contribution of the burned feature is greater than that of the central hearth.

Unfortunately it was impossible to identify specific features within the pitstructure other than the central hearth position because the hearth is the dominant feature in most pitstructure anomalies and tends to dominate the magnetic profiles. In order to isolate other cultural features within the pitstructures, it will be necessary to subtract or reduce the magnetic contribution of the central hearth. This may be possible either by using convolution filtering to reduce the hearth's contribution or by modeling a hearth using previous susceptibility informa-

tion and subtracting the idealized hearth anomaly from the real data. The resulting data might indicate other pitstructure features.

A great aid to detecting smaller features of a subterranean domicile and refining information already available from pitstructure profiles would be to reduce the magnetic survey interval from the standard 1 m to 50 cm. This would allow clearer definition of the features. However, until the overriding influence of the central hearth can be reduced or eliminated, many of the interior features of the pitstructures will remain undetectable.

SUMMARY

This section will briefly review the results and comment on possible alterations of the existing magnetic program to better identify cultural features of interest to the archaeologist. Also, it will include a presentation of the features that may be located using the magnetic data obtained by the DAP, the ways in which the method may be altered to possibly detect the more subtle feature contributions, and the architectural information that may be obtained through the use of magnetic profiles. This section will also evaluate the magnetometer survey program in terms of the goals that were specifically set by DAP for this program.

Assessment of the Existing System

In the section "Assessment of the Existing Magnetic Program" it was determined that the priority system of NEBCAR functions well as an indicator of the likelihood of encountering archaeological features and reflects the initial experimental ideology of the magnetic reconnaissance. The location and descriptive accuracy indicates that large-scale features such as pitstructures are most easily located. Intensely burned and/or compacted areas are also detectable and lead to the identification of surface structures, roomblocks, and hearth areas. The smaller, unoxidized, or shallow features such as hearths and small pit features are infrequently identified, and it is suggested that more care should be taken in assigning test area status to most of these smaller features. Several techniques and graphic display methods are available which may enhance the smaller features.

Convolution Filtering

Convolution filtering was used on a number of sites to determine if the cultural features identified during excavation, but not originally chosen as magnetic priority test areas by NEBCAR, could be separated from background variations. The parameters chosen for filtering were such that magnetic contributions of the larger features were reduced so that the anomalies from smaller features would be emphasized.

Convolution filtering was found to be helpful in many cases. The filtering was able to refine magnetic anomalies and to enable detection of magnetic contributions from cultural features not readily evident otherwise. The majority of the features that remained undetected even after convolution filtering were hearths or firepits and small pit features. Of these magnetically undefined features, nearly half were masked or distorted by dipoles or situated on steep magnetic gradients.

It is suggested that in cases where the archaeologist needs to locate the smaller hearths and pit features, some alterations in the field survey may be helpful in addition to convolution filtering or other data enhancement techniques. These alterations might include a closer sampling rate along with a reduced sensor height. The implications of such actions have been discussed in previous summaries of sections along with the limiting factors. The primary limiting factor is the greater time required for the magnetic surveys, and it is suggested that the alterations be employed only at sites of particular interest.

Structural Information Available from Magnetic Profiles

Following the comparison of magnetic anomaly profiles to excavated pitstructures, it is found that it is possible to gain much information

about unexcavated pitstructures from the magnetic data. It becomes possible to establish the boundaries and orientation of the structure, provide specific location information about central hearths and ventilator shafts, and to identify antechambers and their boundaries. It is also possible to examine complex anomalies for clearer feature representations before excavation and to determine the intensity of burning of the entire structure.

Information provided by magnetic data can greatly aid explorations of pitstructures by helping to plan excavation. Knowing where to excavate, and the size of the structure, may allow less damage to be done to nearby associated features. Where trenching of the structure is desired, previous knowledge of feature locations may help to orient the test trenches along the pitstructures north-south and east-west lines. This knowledge will allow less damage to the pitstructure features. Excavation strategies may also be affected by the presence or absence of an antechamber or ventilator system. The presence of an antechamber as opposed to a ventilator system may frequently be determined from the magnetic anomaly, allowing the excavation strategy to be defined accordingly before excavation. Perhaps one of the most useful applications of the exploration of individual magnetic anomalies will be in clarifying complex pitstructure situations such as Sites 5MT2193 and 5MT2853.

Unfortunately it was impossible to identify specific features within the pitstructure because of the dominating magnetic contribution of the central hearth. In order to isolate other cultural features within the pitstructure, it will be necessary to subtract or reduce the overwhelming magnetic contribution of the central hearth. This may be possible through convolution filtering or modeling.

A tremendous aid in refining the information already available from pitstructure profiles might be to reduce the magnetic survey interval over the pitstructure from the standard 1 m to 50 cm. This would allow clearer definition of already detectable features and could possibly aid in detecting other features within the pitstructure.

Objectives of the DAP Magnetometer Program

Specific objectives were established by DAP for the magnetometer program, with the immediate objective being a determination of the effectiveness of the magnetometer as a tool in detecting subsurface archaeological features in the Dolores area. Ultimate objectives were also set forth as follows: (1) to survey all suitable sites selected for intensive investigations in order to aid in site managements, (2) to survey selected sites as part of the preliminary operations in order to provide additional criteria for selection of an excavation sample, (3) to survey sites on secondary impact zones of the project and sites rejected for excavation in order to map features, and (4) to better articulate types of magnetic anomalies and archaeological features.

According to the assessment of sites presented in this study, it appears that the immediate objective has been accomplished. Magnetometer surveying can be an effective tool in detecting and identifying subsurface archaeological features in the Dolores area. The features most readily visible are pitstructures, large or intensely burned hearths, and, if they are burned or compacted, surface rooms. It is generally not possible to identify the smaller features such as pit features or small, unoxidized hearths. The section "Computer Methods to Improve Detection" demonstrated that the data may be utilized to provide more than general locational

information by examining the structure of a pithouse to the magnetic profiles. Magnetometer surveys are indeed capable of providing a good deal of information useful to the DAP.

With the immediate objective of the magnetic program accomplished, the ultimate objectives may be addressed. Objectives 1 and 2 deal with the utility of magnetic survey in planning excavation and in site selection. Because the magnetic survey can identify subfeatures, the potential and boundaries of the site may tenatively be determined. Within the site, features may be identified, and thus locations specified. Architectural information about the pitstructures may also be established. Through magnetic surveying, the archaeologist will obtain a clearer preliminary understanding of the site, which will aid in site management and selection. It may aid in site management by indicating whether a site contains the necessary requirements to answer the problems to be addressed.

Magnetic surveying may also be used to aid in guiding the excavation of a site. An understanding of the extent and layout of the site will help to define the area of excavation and to indicate the most fruitful areas for excavation. Knowing some of the features that exist at the site may help to stratify a sampling procedure. For example, magnetic results may help divide the site into areas of rooms, pitstructures, and potential activity areas; and the archaeological sample may be stratified accordingly. An understanding of an archaeologial site's contents before excavation may greatly aid in planning site excavation and contribute to site management.

Objective 3 of the magnetic program is to use magnetic surveying to map features at sites which are not selected for excavation. Magnetic

surveying can be utilized to establish the kinds of features a site contains, and where they are located. However, it must be acknowledged that magnetic results may not be used as an exclusion technique. Since only the features creating magnetic contributions that contrast substantially with the surroundng magnetic field make visible magnetic anomalies, many of the smaller, and less magnetically intense features will not appear in the magnetic data.

Currently, the magnetic data from the Dolores area appear to firmly establish only the existence and location of pitstructures, large and oxidized hearths, and surface rooms. The pit features such as cists and small hearths will not be evident. The omission of these features will give a biased understanding of the site, unless it is recognized that these features may exist but are not now visible in the magnetic record. If the mapping of the site is done with the realization that it will not form a complete picture, magnetometer surveys may indeed be useful in mapping unexcavated sites.

Objective 4 of the magnetometer program of the Dolores project is to better articulate types of magnetic anomalies and archaeological features. This study has added to the growing knowledge of the relationships of the cultural features to magnetic anomalies. The "Assessment of the Existing Magnetic Program" has indicated that it is possible to successfully identify many large-scale or magnetically intense features, and "Computer Methods to Improve Detection" has indicated that through the use of convolution filtering, it is possible to better identify smaller, magnetically intense features such as hearths. It has become apparent that the unoxidized, smaller, or shallow features are not easily identified in the Dolores region and that more care should be taken in assigning

magnetic anomalies to such features. "Structural Information Available from the Individual Magnetic Anomalies created by Pitstructures" has directly added to the better articulation of the magnetic anomaly and cultural feature by identifying some of the types of information which may be elicited from individual magnetic anomalies. Comparisons of individual anomalies to cultural sources, such as with pitstructures, leads to a greater understanding of the anomaly and its form.

Conclusions

The examinations of the magnetic anomaly-cultural feature relationships presented in this report affirm that magnetometer surveying may successfully satisfy the immediate and ultimate objectives set for the remote sensing program by DAP. Magnetic surveying may aid in site selection and management and may be used as an aid in mapping unexcavated sites. Through continued use and study of magnetic data, made possible by such long-term, large-scale projects as DAP, it will be possible to further articulate magnetic anomalies and archaeological features and to explore the many potential applications of magnetometer surveying to archaeology.

APPENDIX A

The primary purpose of most filtering techniques is to treat the data so that features in the data in certain specified size ranges are emphasized while other sized features are deemphasized or suppressed. In the case of convolution filtering each grid value is replaced by a weighted average of neighboring points. Specifically in this report, each grid value was replaced by the sum of products of the neighboring values, out to four grid units in all directions, and a weighting function consisting of a positive Gaussian function with a standard deviation S1 minus a second Gaussian with a standard deviation S2. If S1 is small and S2 is large, then the first Gaussian just smooths the values a bit while the second Gaussian smooths the values considerably. Since the second Gaussian is negative, this larger, smoothed region is removed; that is, the local trend is subtracted leaving the residual. The net result is to enhance features in the size range S1 to S2 and to remove larger features.

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