Figure 1. A theodolite (left) was used to define grids for high-resolution magnetic survey. James Kelly and Ron Wilson was setting up the theodolite. A portable cesium gradiometer G858 (right) was used to measure the total component of the geomagnetic field. Ron Wilson was performing the magnetic survey.

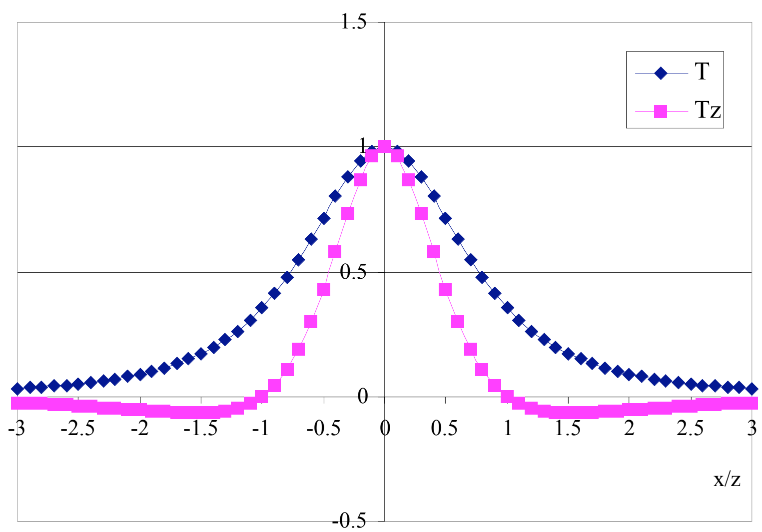


Figure 2. The half width of the total field component of magnetic anomaly (T) of the monopole with the vertical magnetization is ± 0.77 x/z. It is ± 0.45 x/z for the vertical gradient (Tz). The horizontal resolution is theoretically increased with the vertical gradient data by 70% (0.77/0.45 = 1.71)

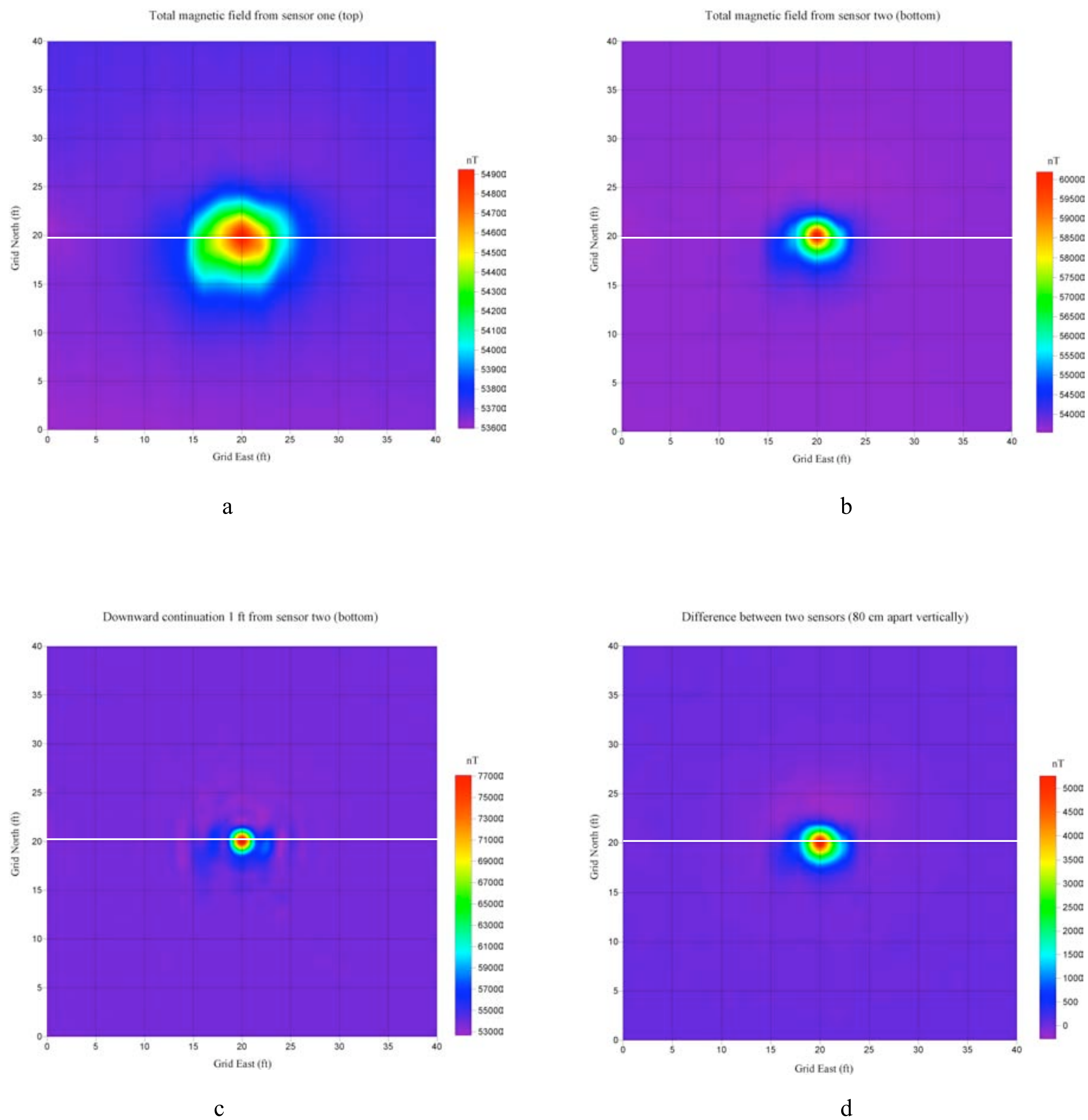


Figure 3. Magnetic anomaly of Well KGS. (a) Total field component of magnetic anomaly of the top sensor (44 inches above the ground). (b) Total field component of magnetic anomaly of the bottom sensor (14 inches above the ground). (c) Total field component of magnetic anomaly “2 inches above the ground.” (d) Pseudo-vertical gradient (bottom – top). Improvement in the horizontal resolution is obvious when comparing magnetic field (a) with the pseudo-vertical gradient data (d). The downward continuation results (c) also possess higher horizontal resolution. Central profiles indicated by white lines are shown in (e).

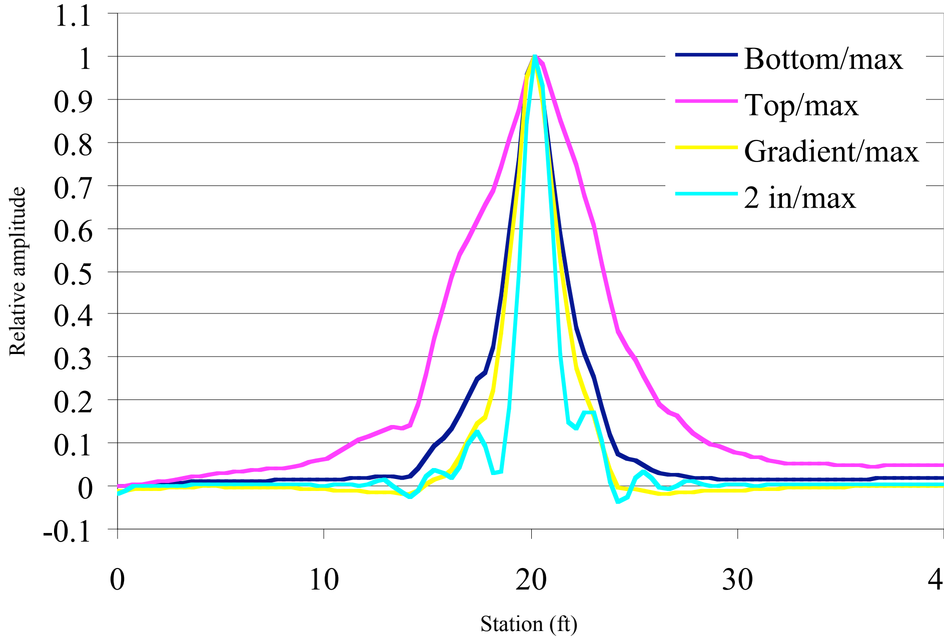
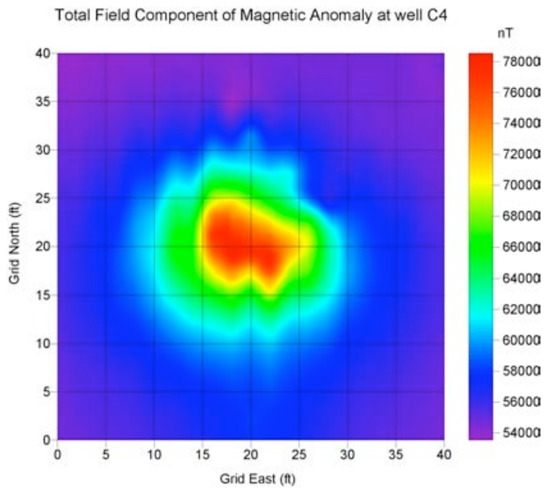
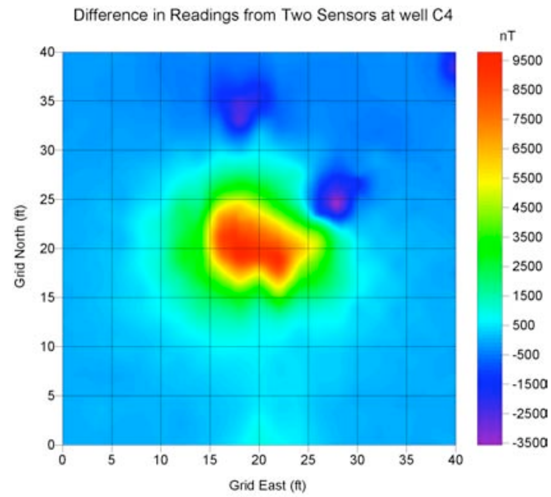


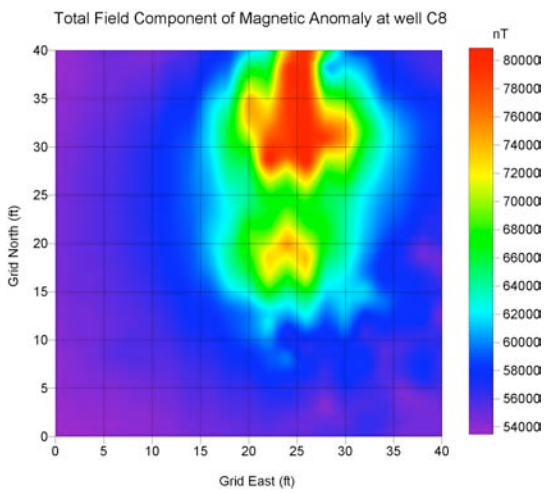
Figure 3e. The central profiles of magnetic data shown in Figure 3a-3d. The narrower anomaly peaks are, the higher the horizontal resolution.



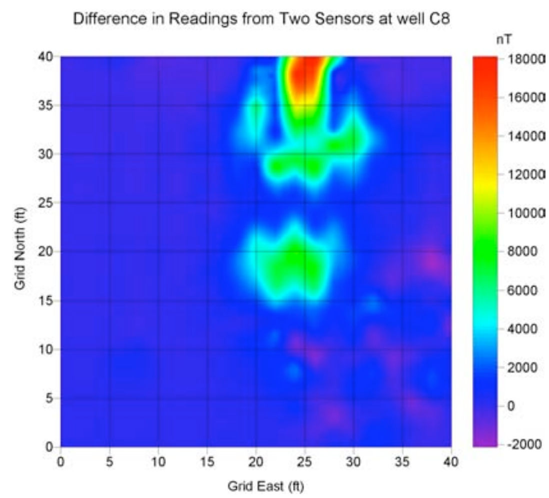
a



b



c



d

Figure 4. Magnetic signatures at known well sites. The pseudo-vertical gradient data at both sites (b) and (d) possess higher horizontal resolution than their total field component of magnetic anomalies (a) and (c).

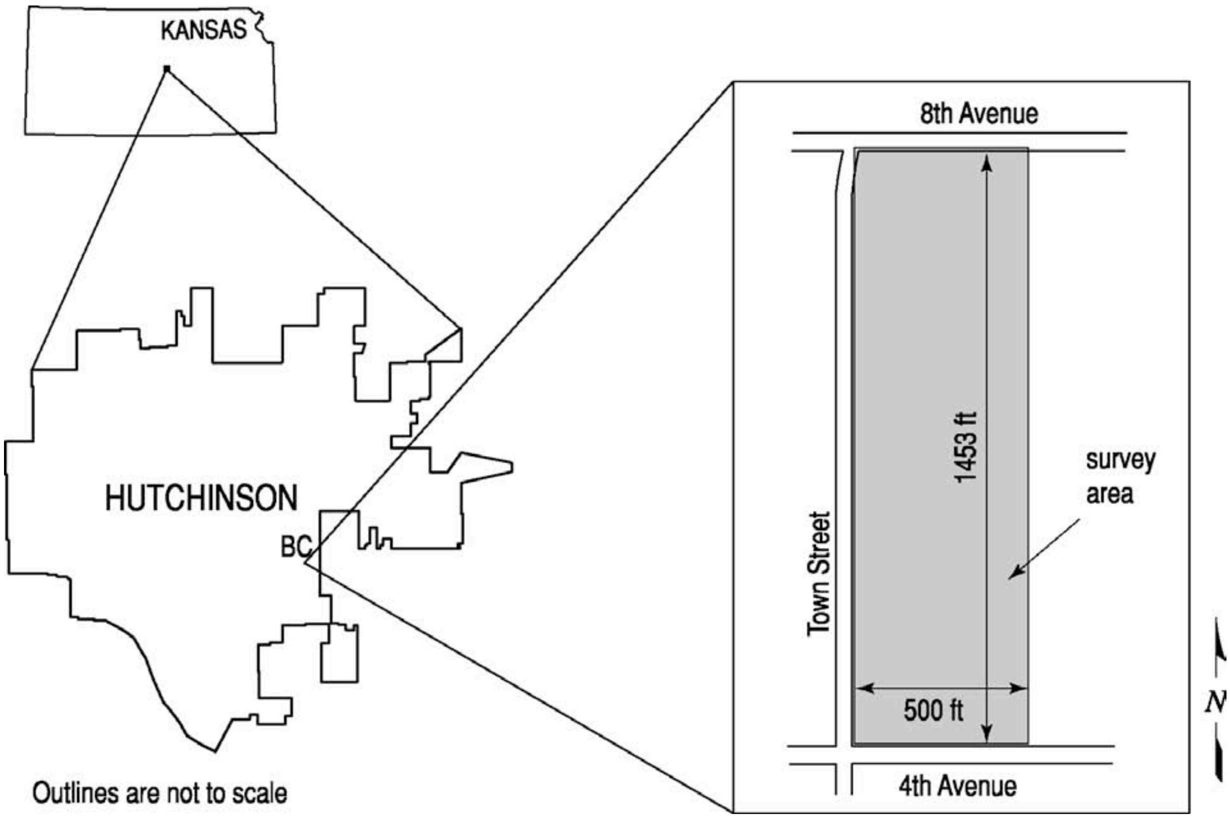


Figure 5a. A site map showing the location of the high-resolution magnetic surveys conducted in the Big Chief Mobile Home Park in the City of Hutchinson in 2003.

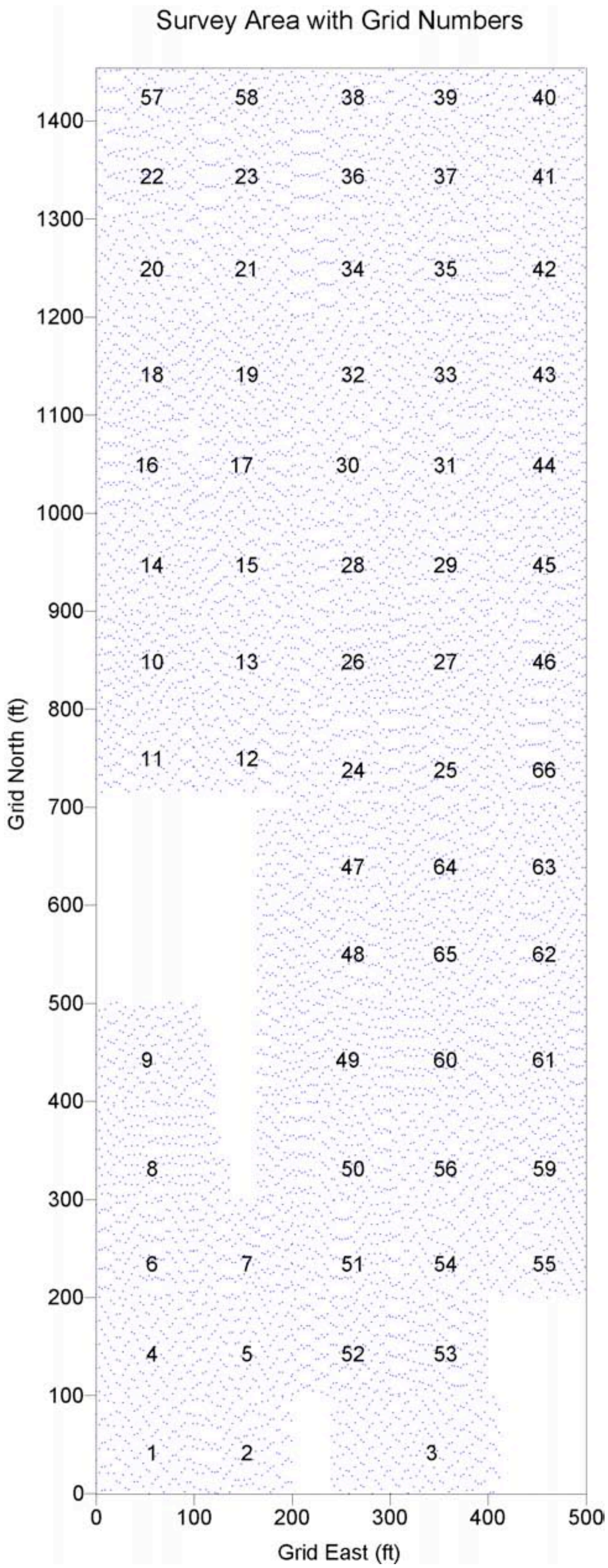


Figure 5b. The survey area with grid numbers.

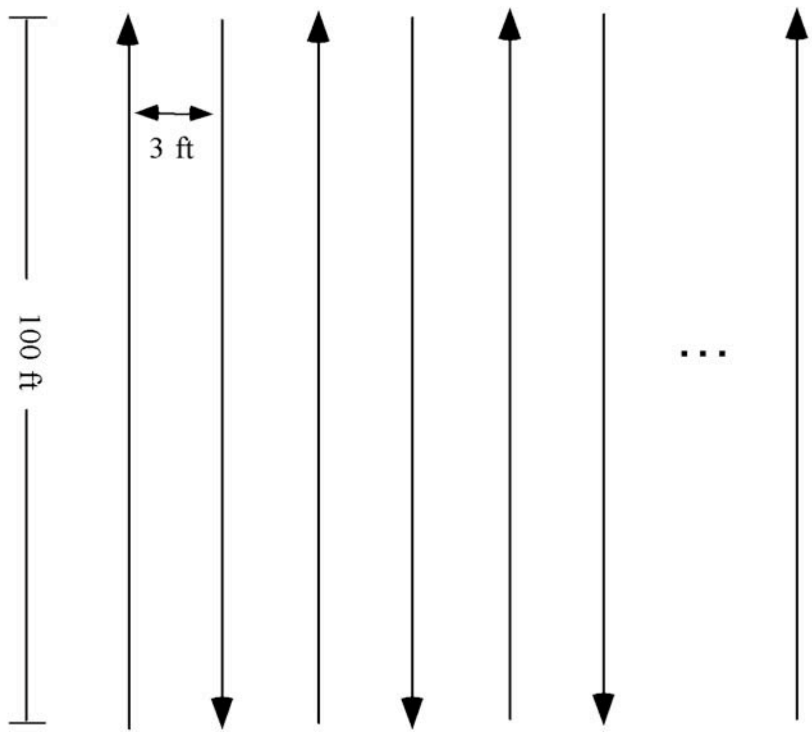


Figure 6. Survey lines within a grid. Arrows indicate the walking direction.

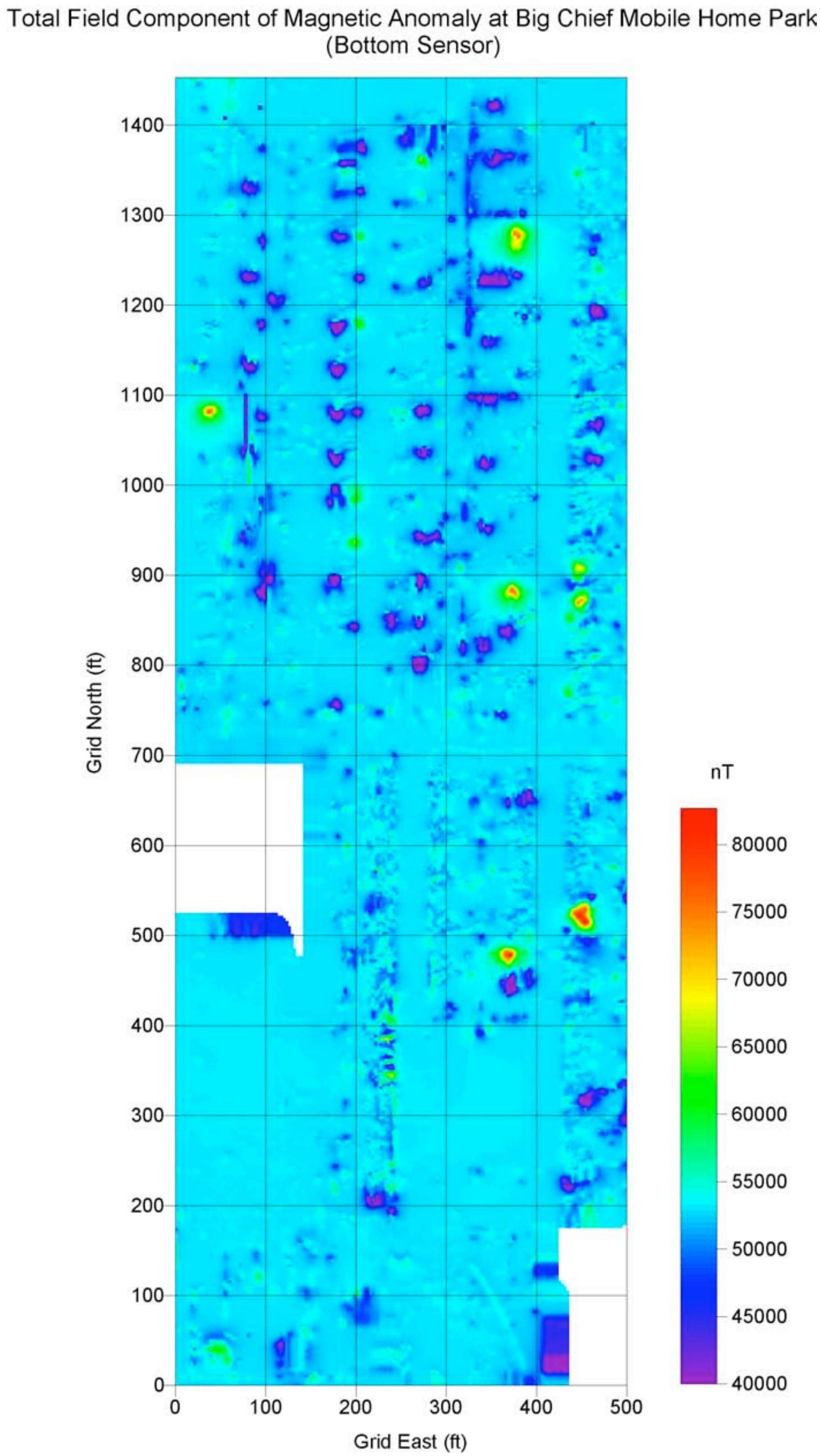


Figure 7. The total field component of magnetic anomaly from the bottom sensor at the Big Chief Mobile Home Park, Hutchinson, Kansas.

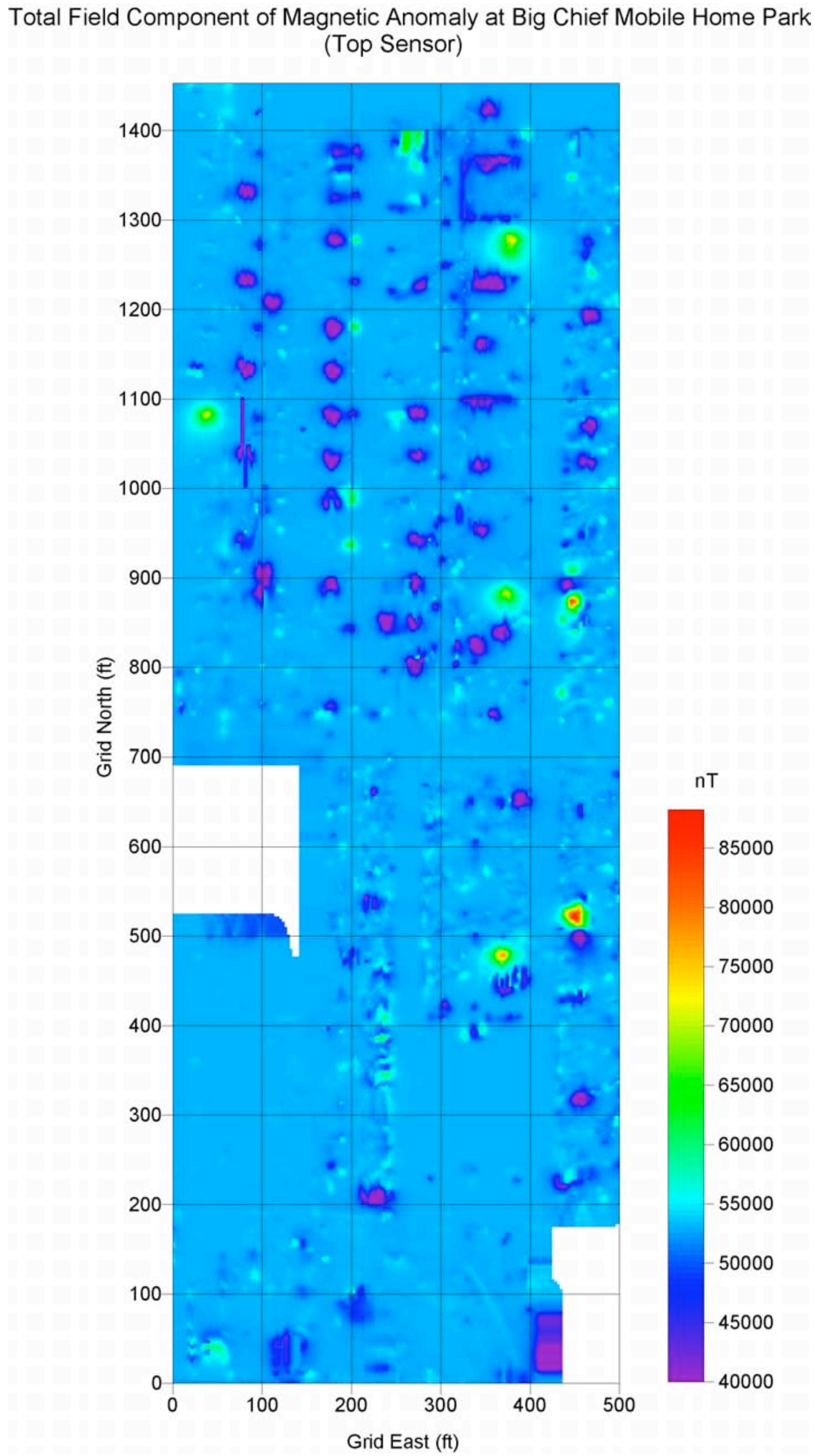


Figure 8. The total field component of magnetic anomaly from the top sensor at the Big Chief Mobile Home Park, Hutchinson, Kansas.

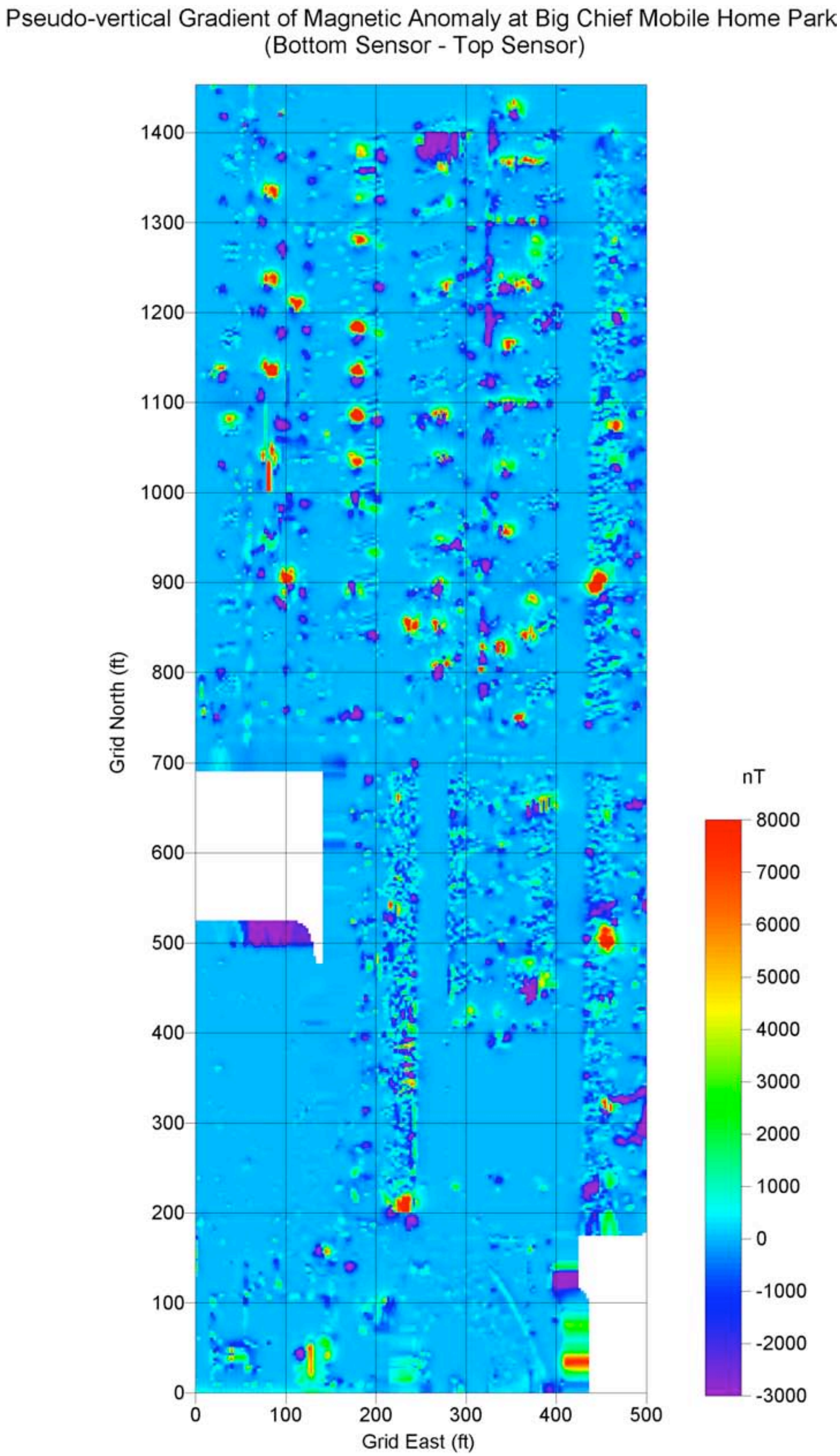


Figure 9. Pseudo-vertical gradient data at the Big Chief Mobile Home Park, Hutchinson, Kansas.

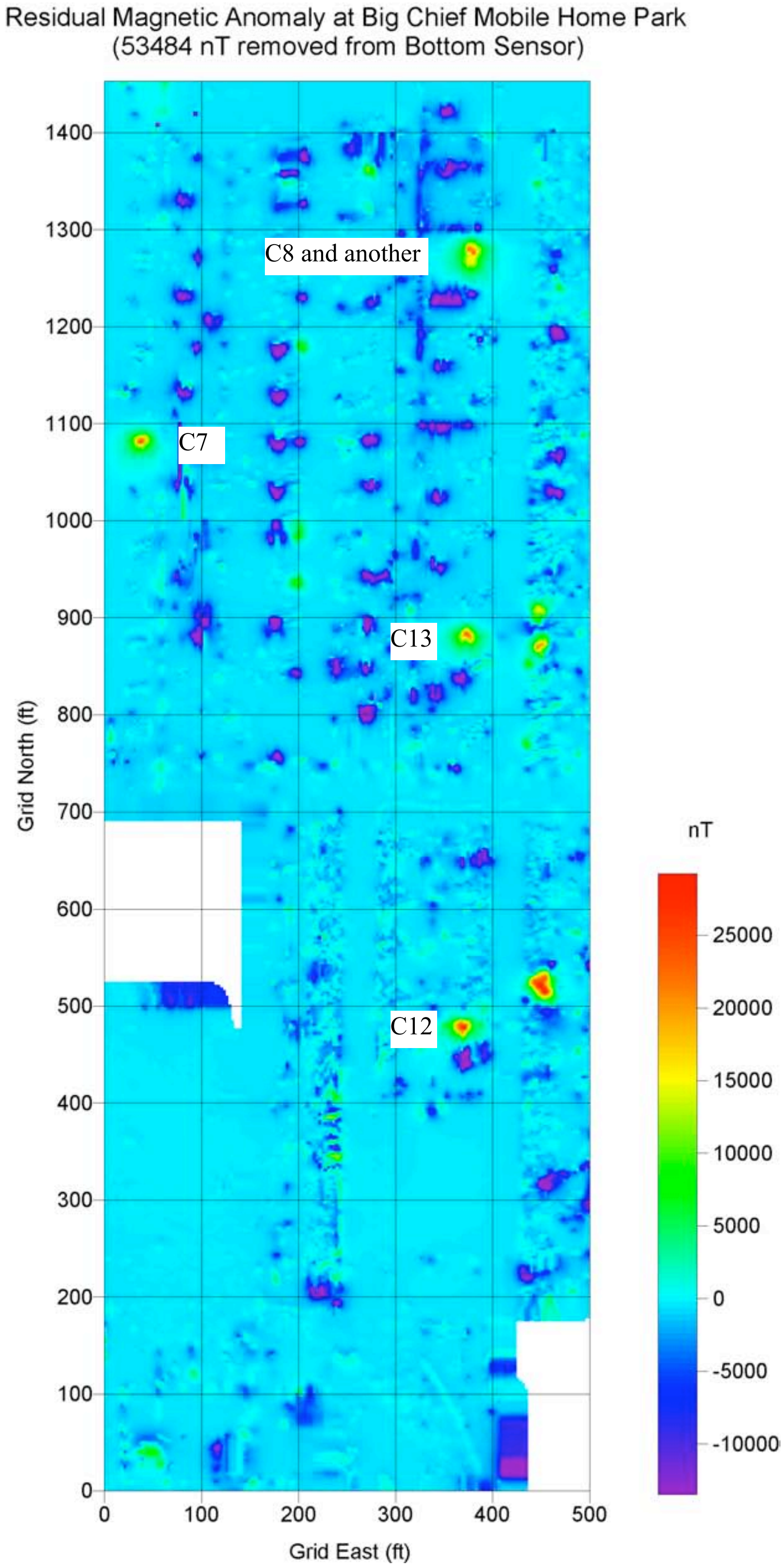
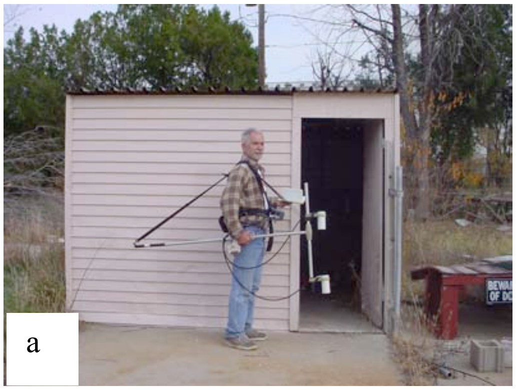
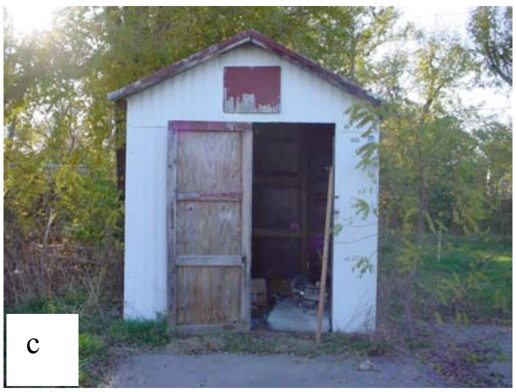


Figure 10. A residual magnetic map at the Big Chief Mobile Home Park, Hutchinson, Kansas.





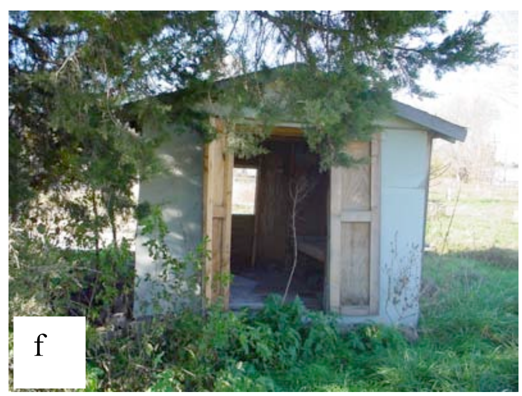


Figure 11. Sheds made of seven different materials in the Big Chief Mobile Home Park, Hutchinson, Kansas. a. Type-I metal sheets. b. Type-II metal sheets. c. Type-III metal sheets. d. Concrete. e. Bricks. f. Wood. g. A shed with metal door and metal beams. Ron Wilson and Jianghai Xia were acting as a scale in the photos.

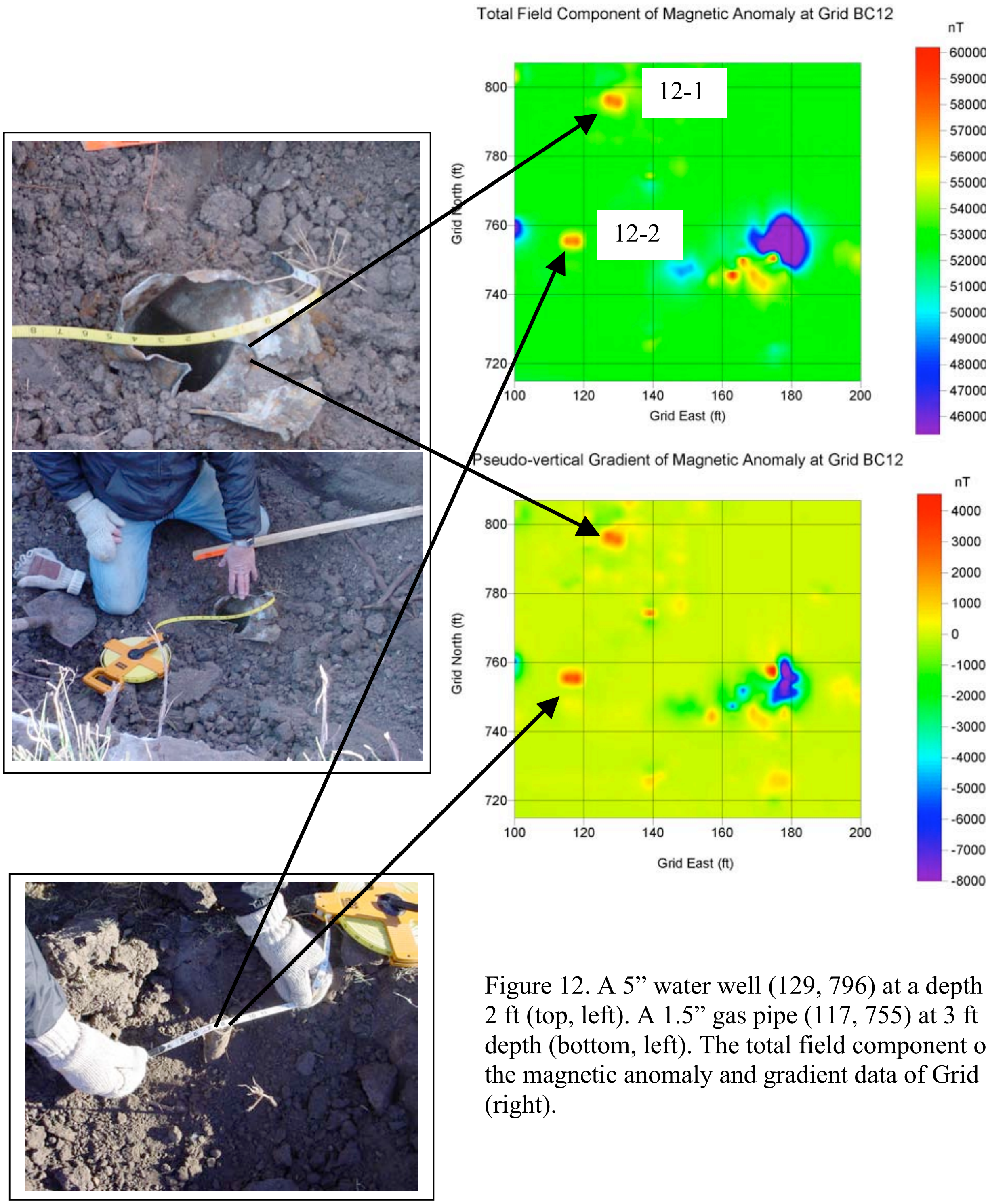


Figure 12. A 5" water well (129, 796) at a depth of 2 ft (top, left). A 1.5" gas pipe (117, 755) at 3 ft depth (bottom, left). The total field component of the magnetic anomaly and gradient data of Grid 12 (right).

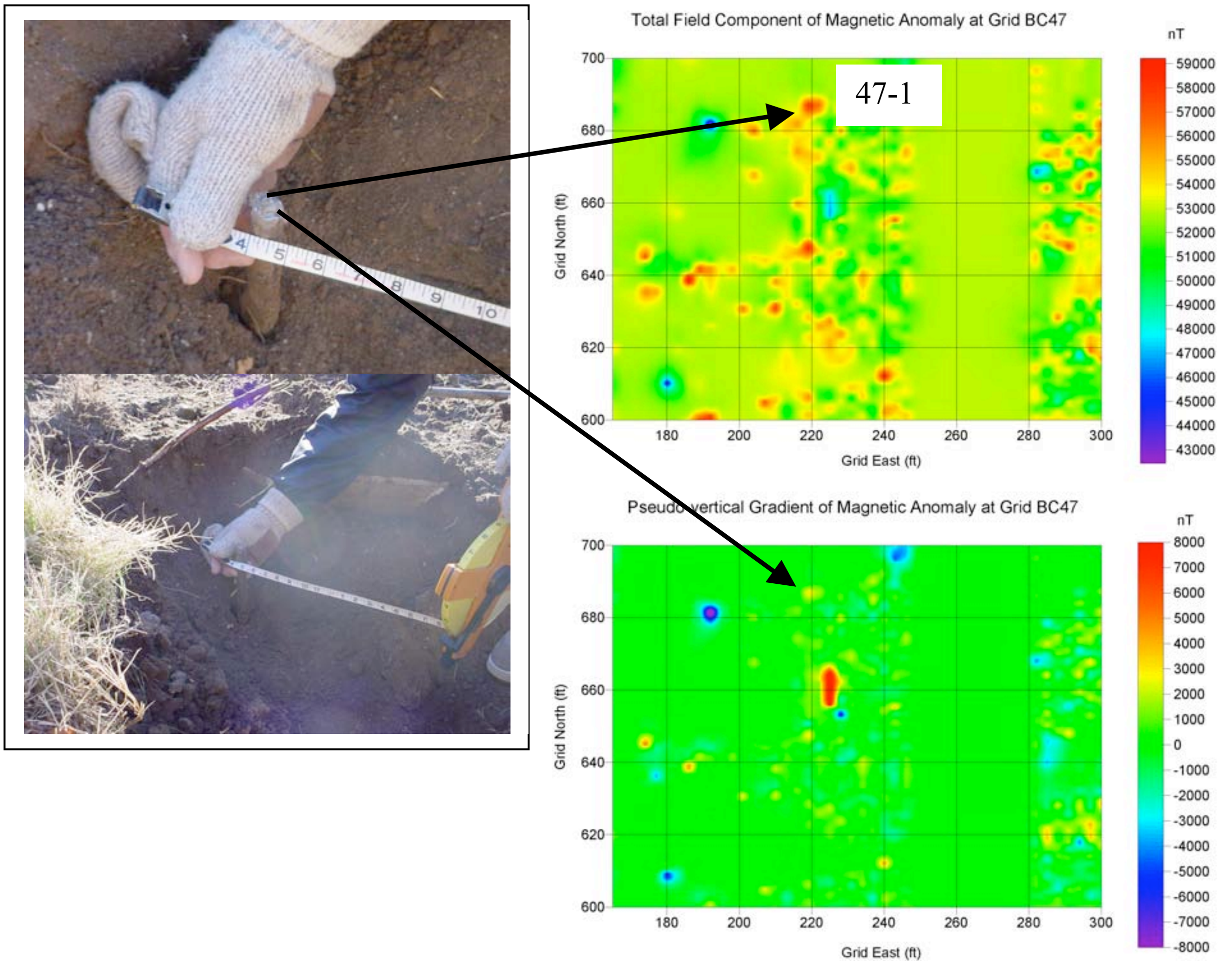


Figure 13. A 1" rebar (219, 687) at a depth of 3 ft (left). The total field component of the magnetic anomaly and gradient data of Grid 47 (right).

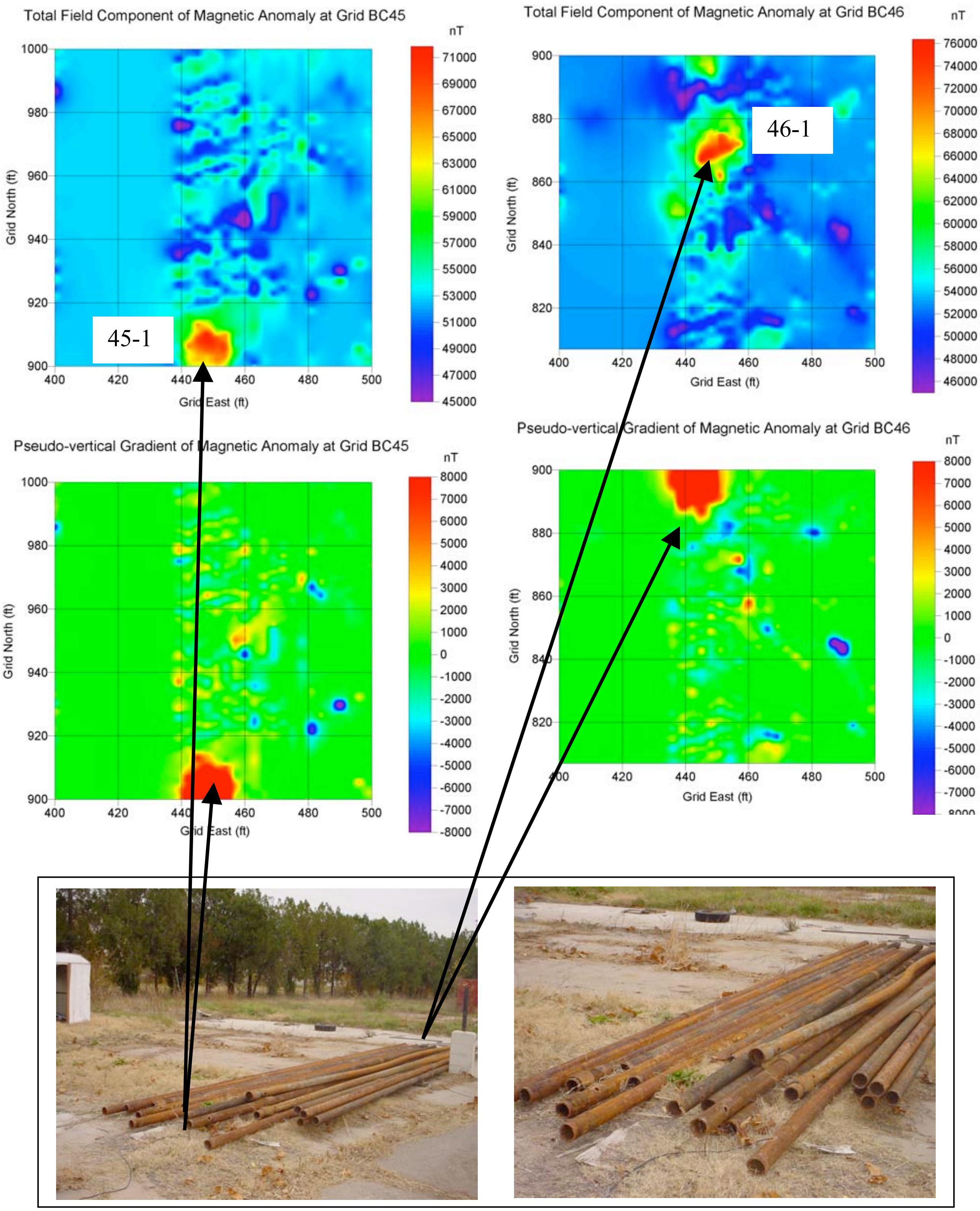


Figure 14. A pile of well cases (448, 908) in Grid 45 and (454, 871) in Grid 46 (bottom) produced anomalies with amplitude of over 18,000 nT (top). The anomalies were disappeared after the pile of well cases was removed.

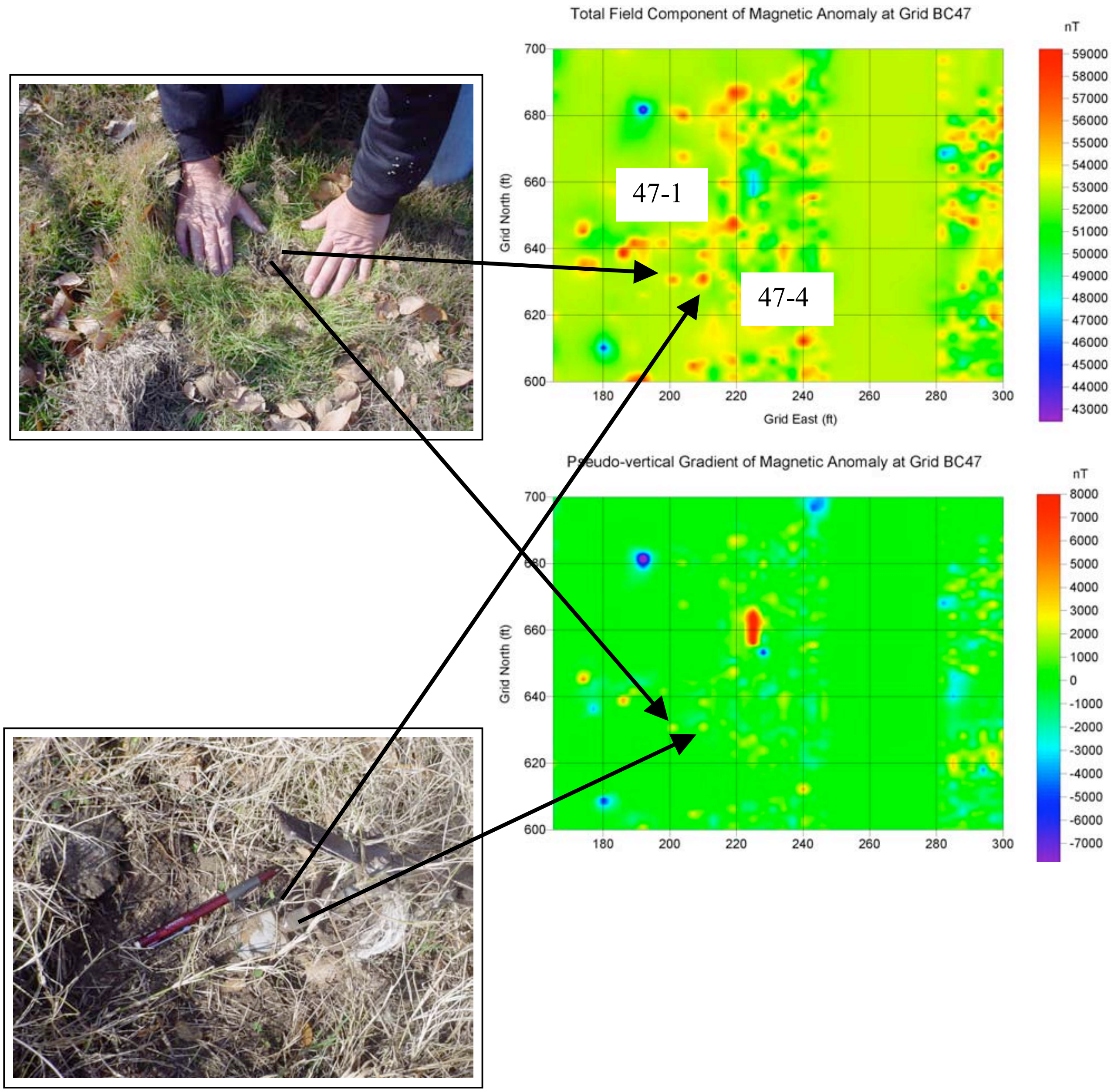


Figure 15a. Two tie-downs for a trailer at (201, 631) and (210, 631) in Grid 47 produced anomalies with amplitude of around 3,000 nT with the half-width of 2 ft or less (right). Similar anomalies can also be seen at (176, 646) and (186, 639), and (240, 612), etc.

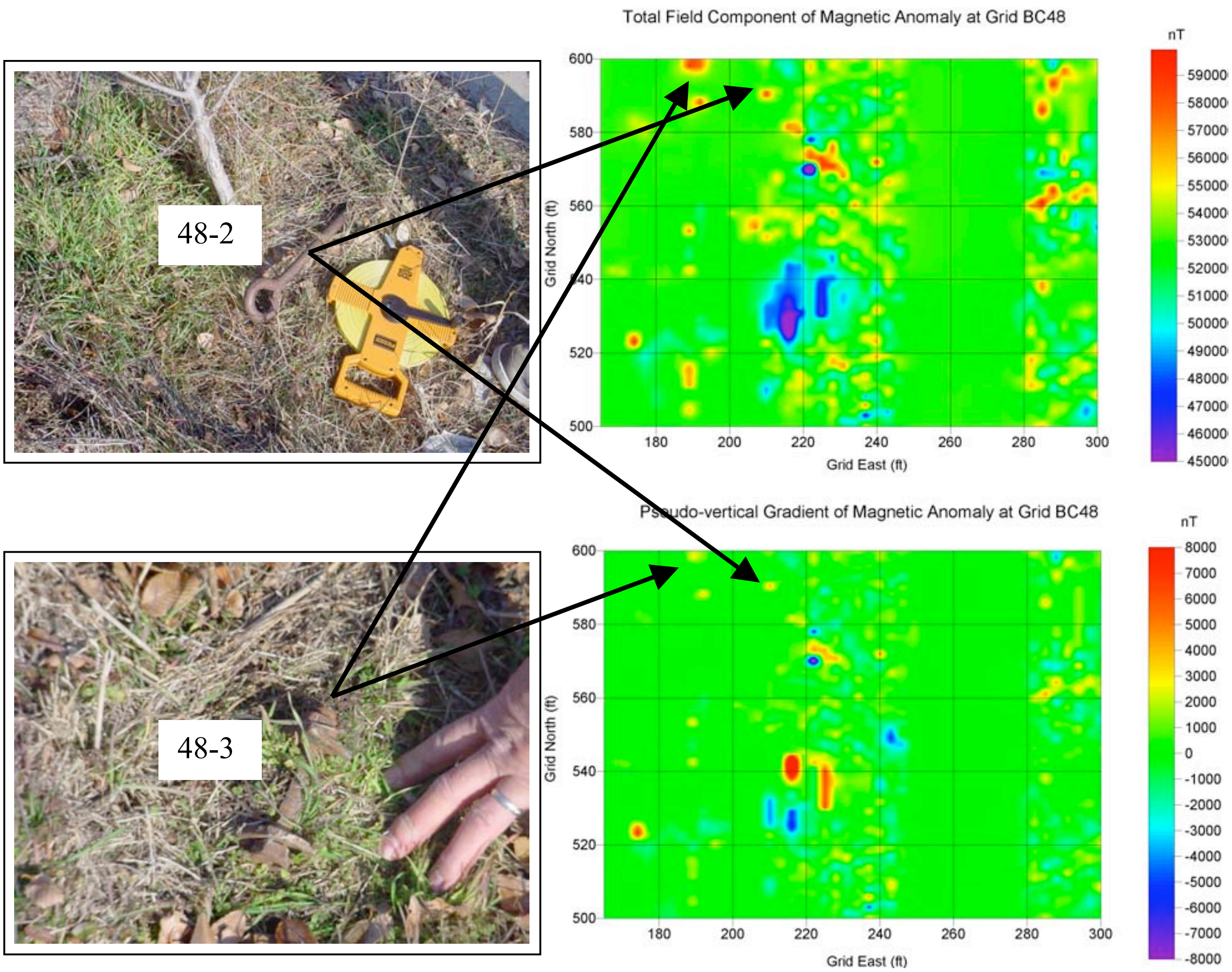


Figure 15b. Two tie-downs for a trailer at (210, 590) and (190, 598) in Grid 48 produced anomalies with amplitude of around 4,000 nT with the half-width of 3 ft or less (right). Similar anomalies can also be seen at (176, 522), etc.

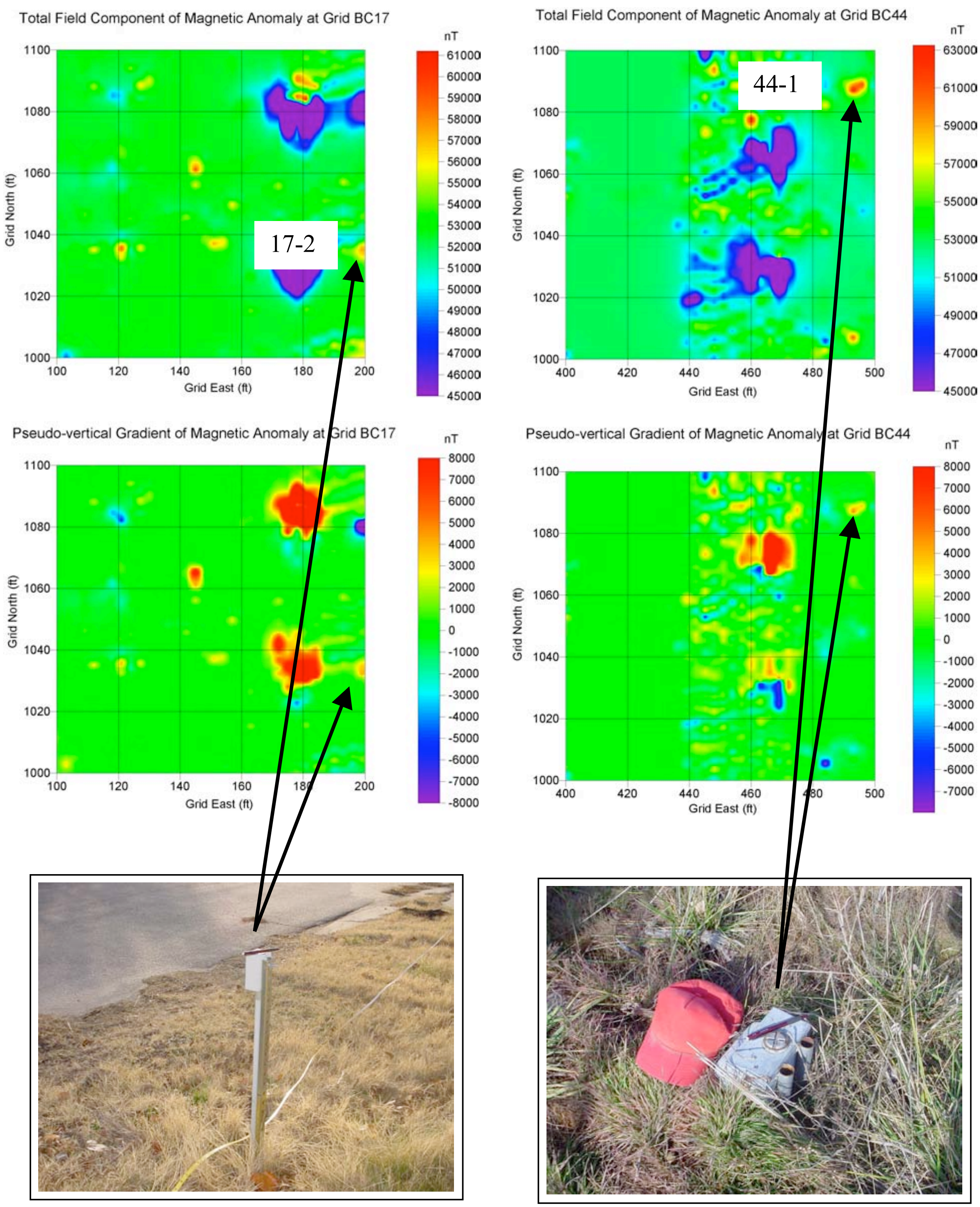


Figure 16. Two power outlets at (200, 1034) in Grid 17 and (494, 1088) in Grid 44 produced anomalies with amplitude of around 3,000 nT and 8,000 nT, respectively. Their half-widths were 3 ft or less.

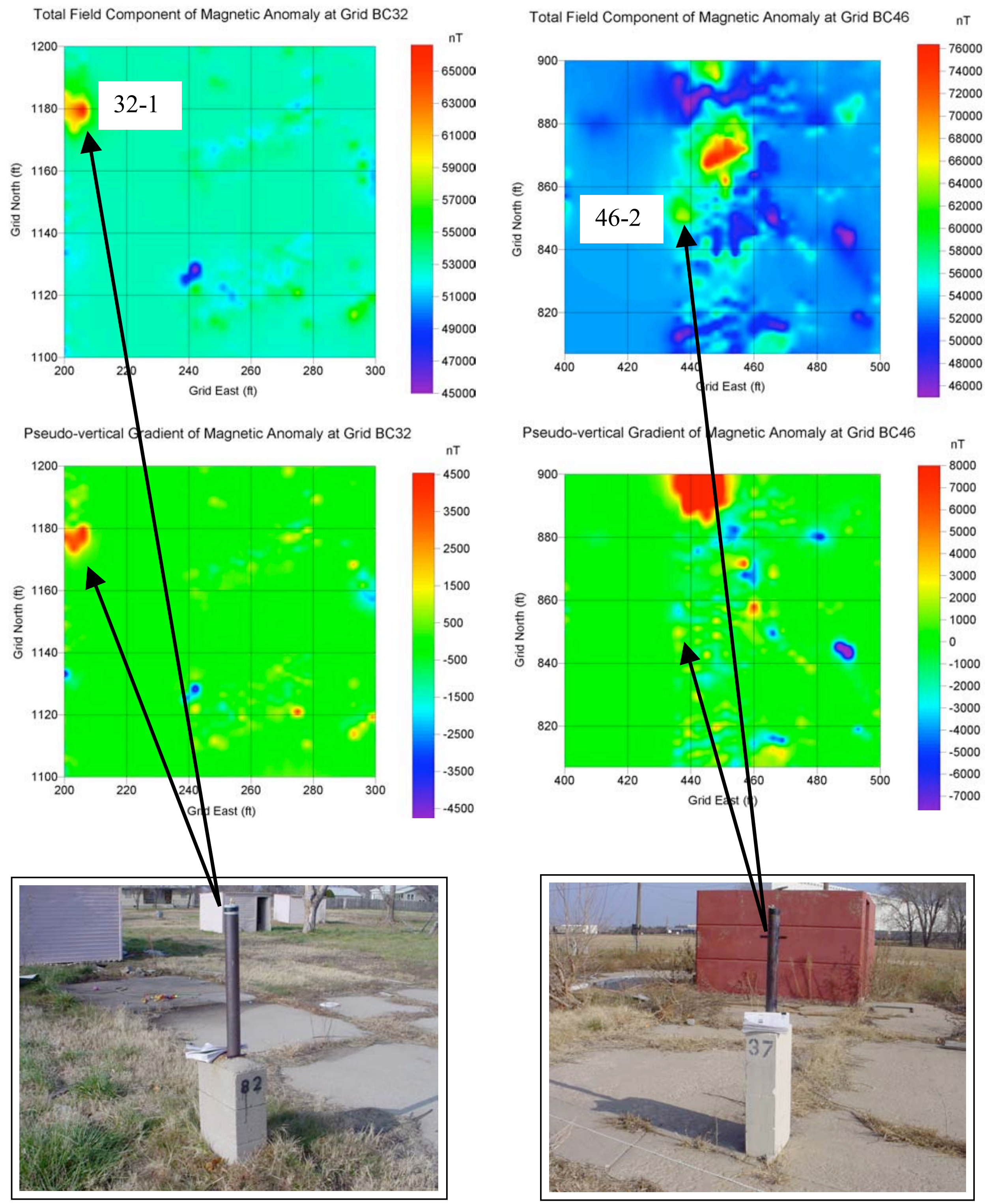


Figure 17. Two light poles at (206, 1179) in Grid 32 and (436, 850) in Grid 46 produced anomalies with amplitude of over 11,000 nT. Their half-width were over 3 ft. The magnetic reading was back to normal (53,500 nT) after the light pole 37 (BC46-2) was removed.

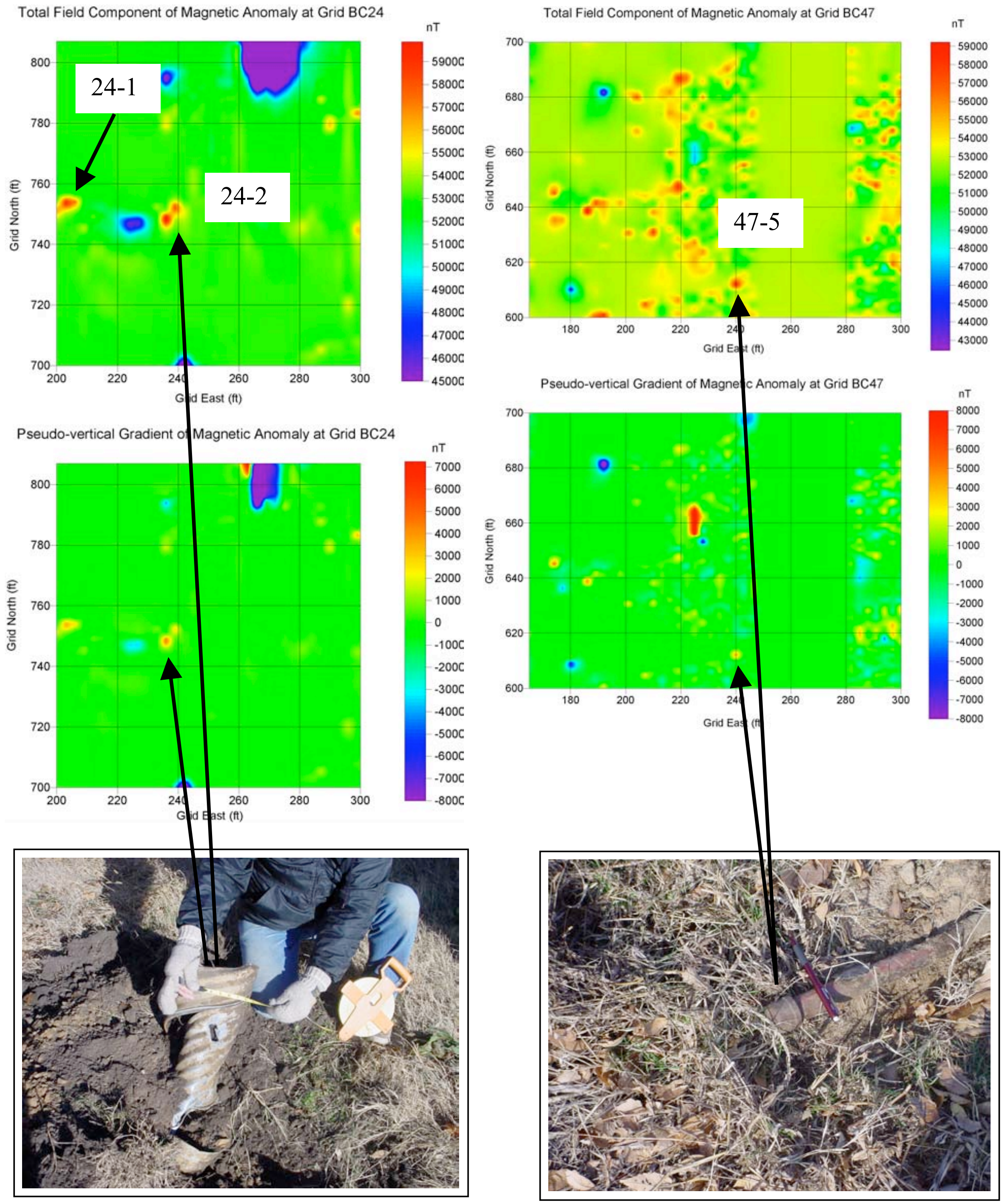


Figure 18. A 6" horizontal corrugated drainage pipe (236, 748) in Grid 24 at a depth of 1 ft. The total field component of the magnetic anomaly and gradient data. The anomaly was on the one side of a street. The almost same anomaly (BC24-1) at the other side of the street (203, 752) and was interpreted as the other end of the drainage pipe. The other anomaly due to the end of horizontal pipe was located at (240, 612) in Grid 47.

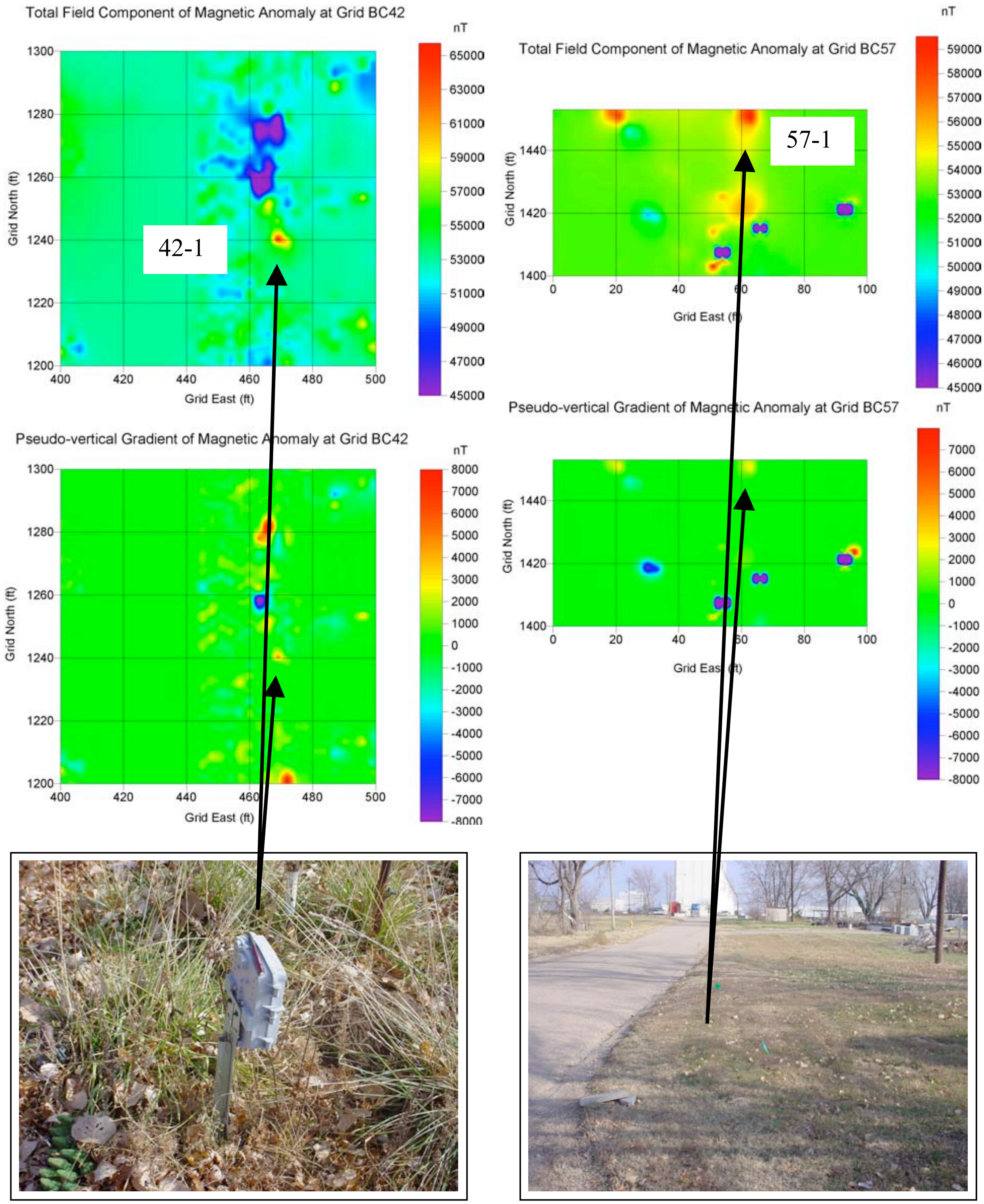


Figure 19. A telephone box produced a magnetic anomaly with amplitude of 12,000 nT and gradient of 300 nT/in at (469, 1240) in Grid 42. An anomaly at (63, 1451) in Grid 63 was interpreted to be due to a sewer line. The other anomaly at (20, 1452) in Grid 63 was also interpreted to be due to the same sewer line.

Table 1. Readings at the center of sheds (inside).

Type-I metal sheets			
Name of shed	Relationship	Reading (nT)	Notes
BC13-1	x1 > x2	37,000	in Grid 13, made of type-I metal sheets
BC13-2		44,000	xi, yi are the coordinates of shed i in the grid
BC15-1	y1 < y2	40,000	If not metioned, sheds were made of type-I metal
BC15-2	x3 > x2 or x1	39,000	sheets. See photo 1999, 2015
BC15-3		42,000	
BC16-1		40,000	
BC17-1	y1 < y2	40,000	
BC17-2		39,000	
BC18-1		43,000	
BC19-1	y1 < y2	39,000	
BC19-2		38,000	After shed removed, reading was 53,000
BC20-1		36,000	A dryer inside
BC21-1	x1 > x2	38,000	
BC21-2		40,000	
BC22-1		35,000	
BC23-1	y1 < y2	42,000	After shed removed, reading was 52,500
BC23-2		39,000	
BC24-1		41,000	
BC26-1	x1 < x2	37,000	
BC26-2		41,000	
BC26-3	y3 > y2 or y1	37,000	
BC27-1	x1 < x2	35,000	
BC27-2		38,000	
BC28-1	y1 < y2	37,000	Another shed in Grid 28 BC28-2
BC29-1		36,000	
BC30-1	y1 > y2	39,000	
BC30-2		38,000	
BC31-1	y1 > y2	39,000	
BC31-2		38,000	
BC33-1		38,000	
BC34-1		41,000	
BC35-2		33,000	Other two sheds in Grid 35 BC35-1, BC35-3
BC37-1		37,000	
BC39-1		35,000	
BC43-1		40,000	
BC44-1	y1 > y2	41,000	
BC44-2		39,000	
BC59-1		38,000	Type-I metal sheets. photo 1999, 2015

Table 1. (continue)

Type-II metal sheets			
BC45-1	x1 < x2	48,000	Type-II metal sheets. photo 2008, 2016
BC55-1		43,000	Type-II metal sheets. photo 2008
BC60-1		45,000	Type-II metal sheets. photo 2008
BC64-1		44,000	Type-II metal sheets. photo 2008
Type-III metal sheets			
BC49-1	y1 > y2	52,000	Type-III metal sheets. photo 2013
BC49-2		52,000	Type-III metal sheets. photo 2013
Concrete			
BC42-1		42,000	Concrete. photo 2010
BC46-1		53,000	Concrete. photo 2010
BC47-1		49,000	Concrete. photo 2010
BC48-1		47,000	Concrete. photo 2010
BC61-1		48,000	Concrete. photo 2010
BC63-1		48,000	Concrete. photo 2010
Bricks			
BC28-2		52,000	Shed is made of bricks. photo 1997
BC36-1		53,000	Bricks. photo 1997
Wood			
BC35-1	x1 < x2 < x3	49,000	Wood walls and a metal roof.
BC45-2		52,000	Wood. photo 2009
BC35-3		25,000	Metal beam and metal door. photo 1989

Table 2. Anomaly List.

Grid #	Anomaly #	X	Y	Amplitude (nT)	Half-width (ft)	Gradent (nT/in)	Source	Photo #
A. Vertical pipes/rebar								
1	1	57	26	62,740	3	230	a 1.5" gas pipe (vertical)	2046
1	2	81	7	57,050	2	150	a 1.25" pipe (vertical)	2047
12	1	129	796	57,360	3	120	a 5" water well, 2' deep	2079-2080
12	2	117	755	57,330	2	150	a 1.5" gas pipe (vertical), 3" deep	2077-2078
32	2	293	1114	58,160	2	100	a 1" gas pipe (vertical)	2055
47	1	219	687	58,290	2	160	a rebar, 3" deep (vertical)	2082-2083
66	2	478	744	60,960	2	120	a 1" gas pipe (vertical)	2042
66	4	487	801	57,290	1.5	140	a 1" elec. pipe (vertical)	2044-2045
B. Well cases								
45	1	448	908	71,480	7	480	well cases, removed reading back to 52,000	2025-2026
46	1	454	871	73,850	5	120	well cases, removed reading back to 52,000	2025-2026
C. Trailer ties								
44	2	445	1073	58,200	1.5	180	a tie-down for a trailer	2061
47	3	201	631	56,230	2	130	a tie-down for a trailer	2066
47	4	210	631	57,840	2	130	a tie-down for a trailer	2067
48	2	210	590	58,230	2	190	a trailer tie	2070
48	3	190	598	58,070	3	100	a trailer tie	2071
D. Power outlets								
17	2	200	1034	57,050	2	180	an electric outlet	2049
44	1	494	1088	61,000	3	170	an electric outlet	2060
46	3	490	882	59,700	2	90	an electric outlet	2064
47	2	174	645	57,450	2	280	an electric panel	2065
55	1	482	206	58,690	3	150	an electric panel	2075
61	1	487	492	61,240	2.5	280	a power outlet	2073
61	2	488	452	60,670	2.5	180	an electric outlet	2072
66	3	487	758	60,470	2	50	an electric outlet	2043

Table 2. (continue)

E. Light poles								
28	1	200	988	63,297	5.5	140	a light pole	2052
28	2	200	940	64,870	4.5	210	a light pole	2051
32	1	206	1179	66,230	3.5	220	a light pole	2054
34	1	203	1276	64,920	3.5	100	a light pole	2056
41	1	445	1346	64,780	3	120	a light pole	2058
46	2	436	850	64,880	4	130	a light pole, reading 53,500 after the pole removed	2063, 2084-2085
66	1	433	770	64,160	3	110	a light pole	2041
F. Horizontal pipes								
24	1	204	754	58,120	2	150	the other end of 6" corrugated drainage pipe (no digging)	
24	2	236	748	59,860	2	210	a horizontal 6" corrugated drainage pipe, 1 ft deep	2081
47	5	240	612	59,160	2	230	a 1" (an end of horizontal) pipe	2068
G. Other sources								
13	1	115	839	58,480	1.5	170	a 2' sawer cover	2048
17	1	145	1061	59,750	2	210	2 T-shape posts (steel), 3' apart	2050
29	1	315	908	59,630	3	130	a small shed (corrugated metal sheet)	2053
36	1	272	1364	64,960	5.5	300	a pile of junk metal sheets	2057
42	1	469	1240	65,730	3	250	a telephone box	2059
44	3	460	1077	62,480	2	380	a corner of a shed	2062
48	1	192	588	58,350	2	180	steel cables	2069
55	2	460	200	58,860	2	200	a water meter	2074
57	1	63	1451	59,510	2.5	140	a sewer line (Green flags)	2076