# Electromagnetic Geophysics Techniques for Location of Abandoned Underground Mines

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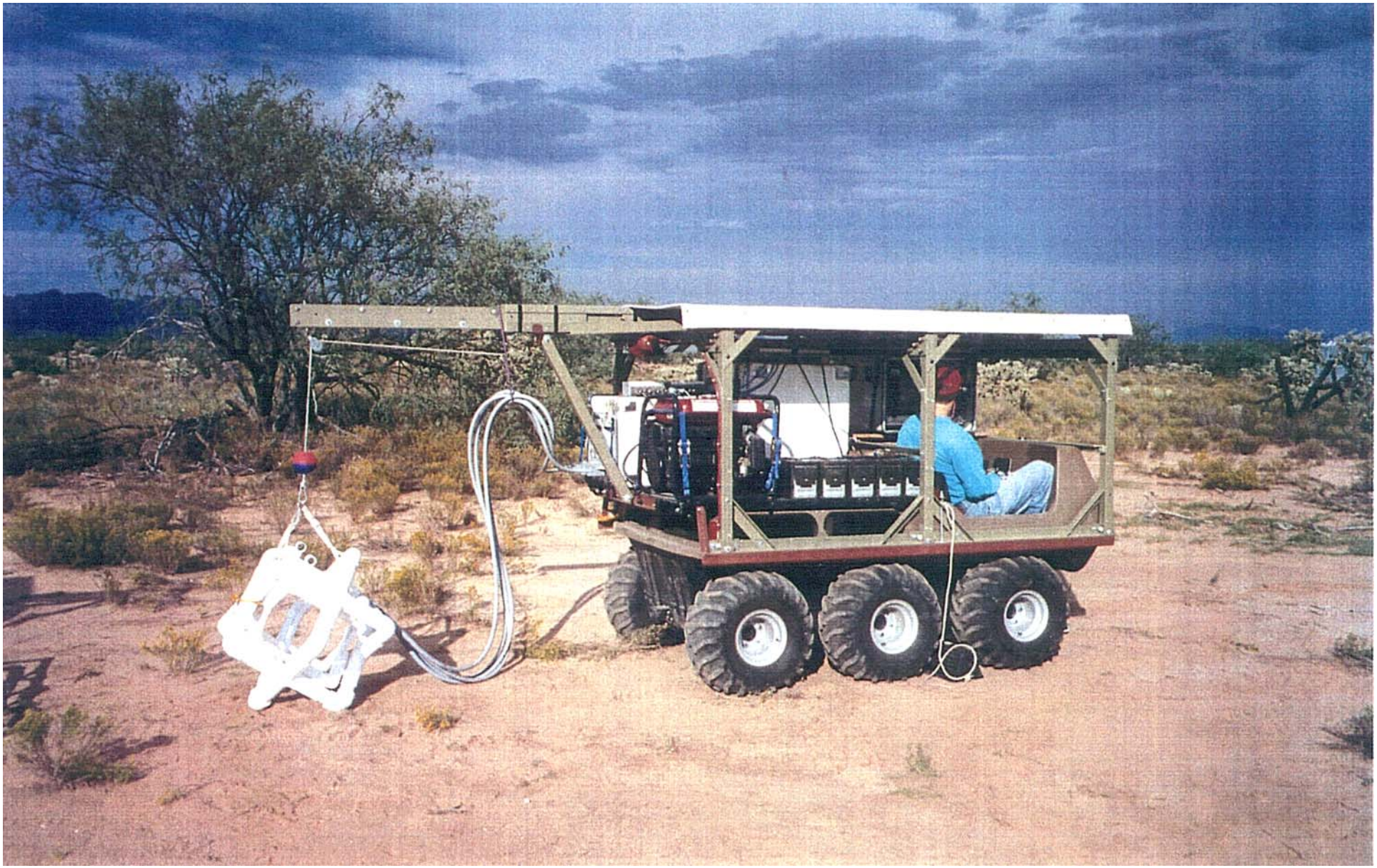
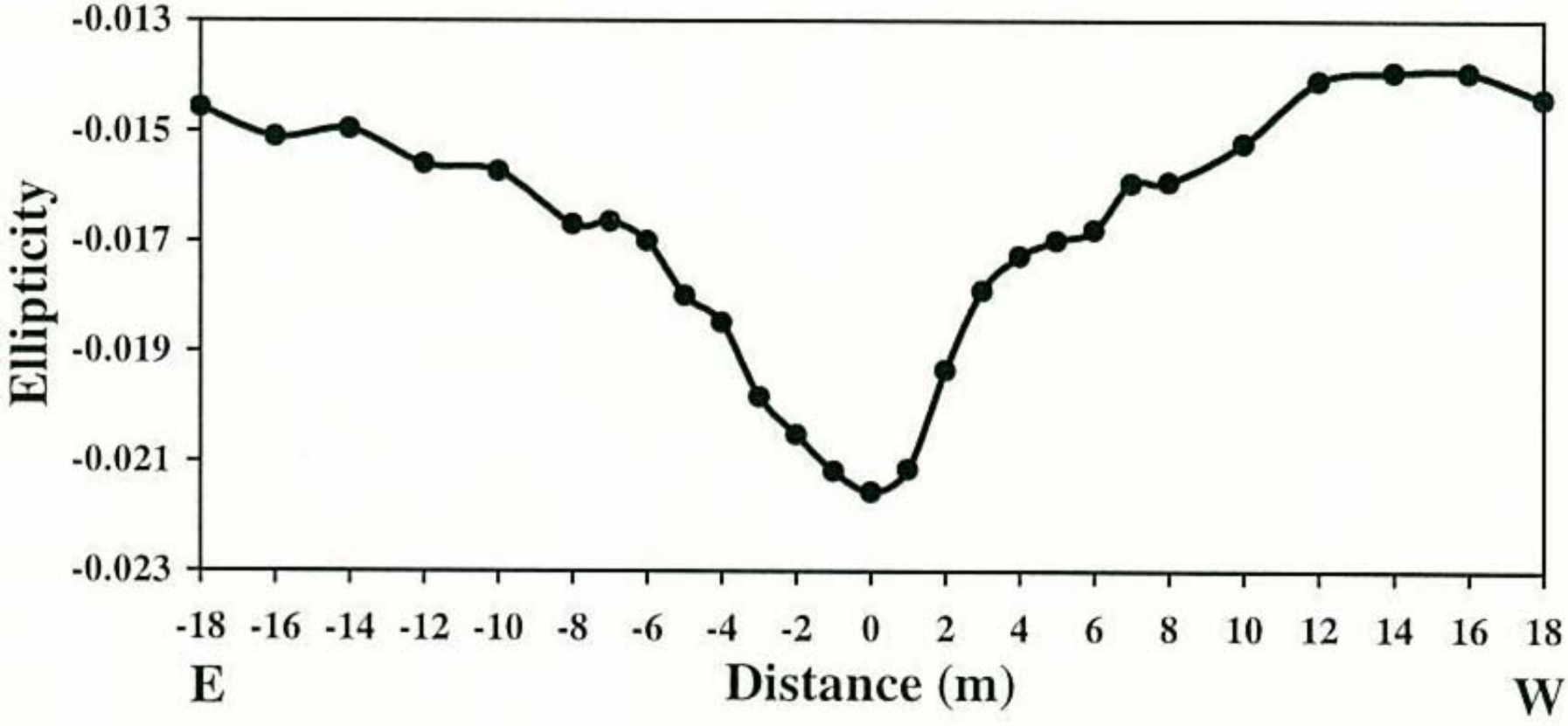
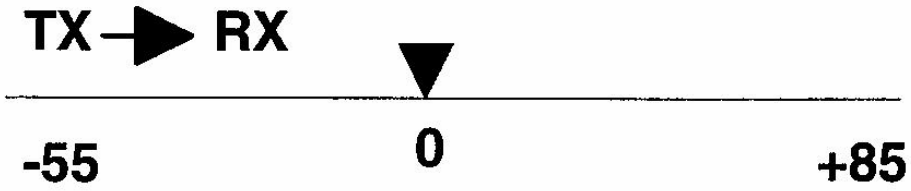
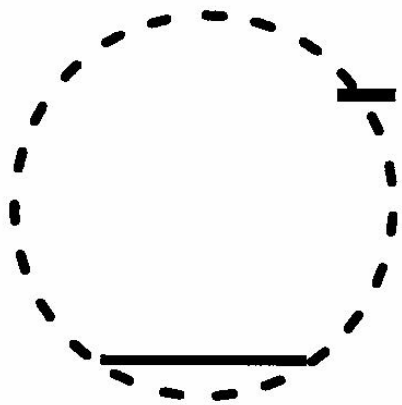



-0.013
-0.015
-0.017
-0.019
-0.021
-0.023
Ellipticity
-18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18
E
Distance (m)
W

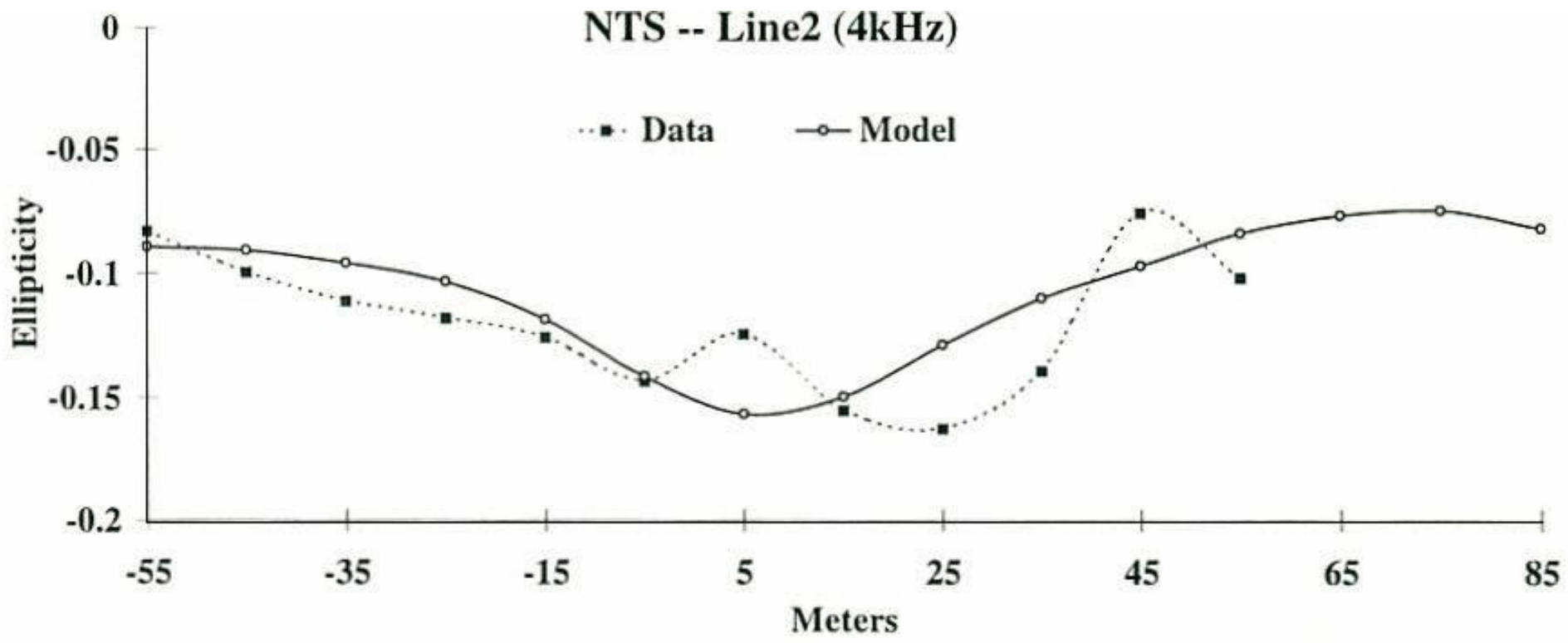


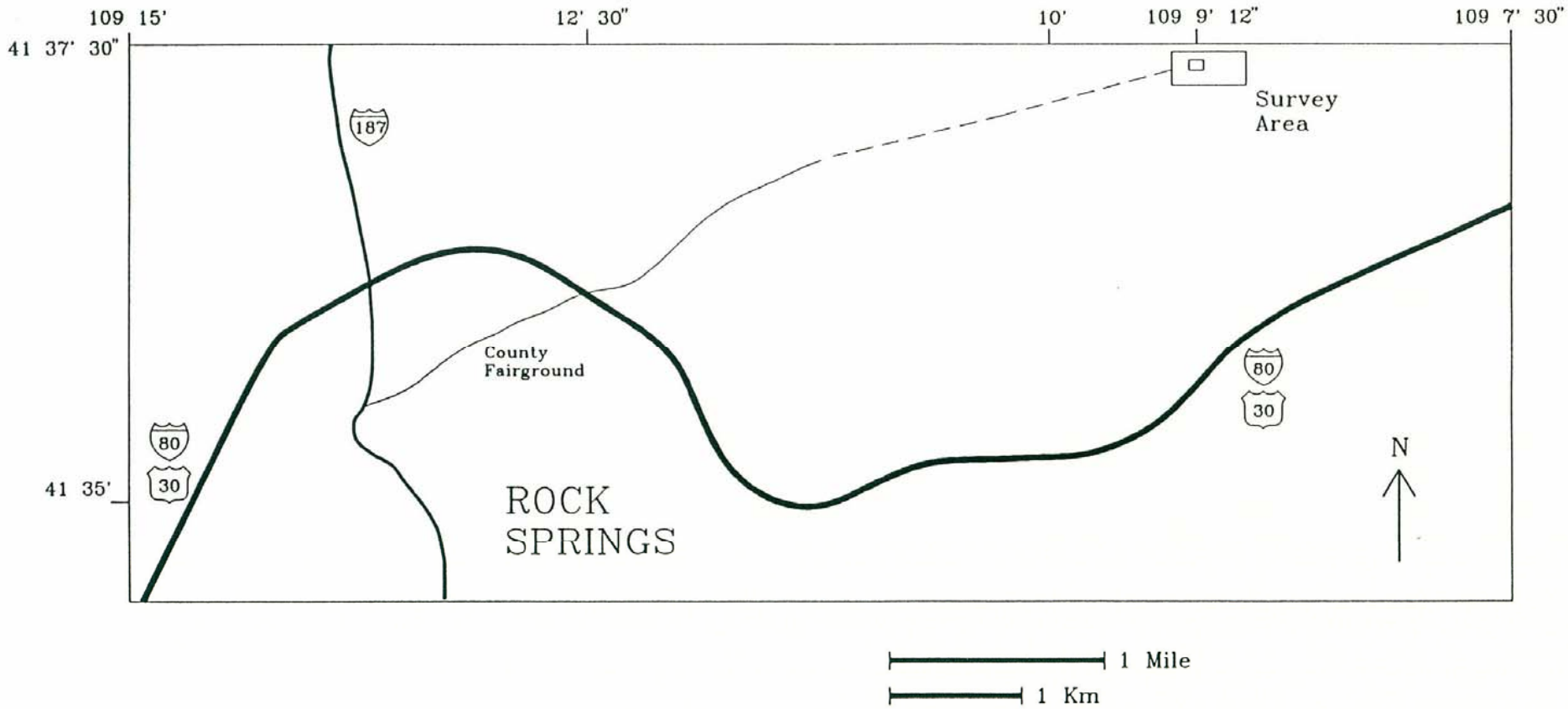

TX-RX Separation=90m
Background=600ohm*m



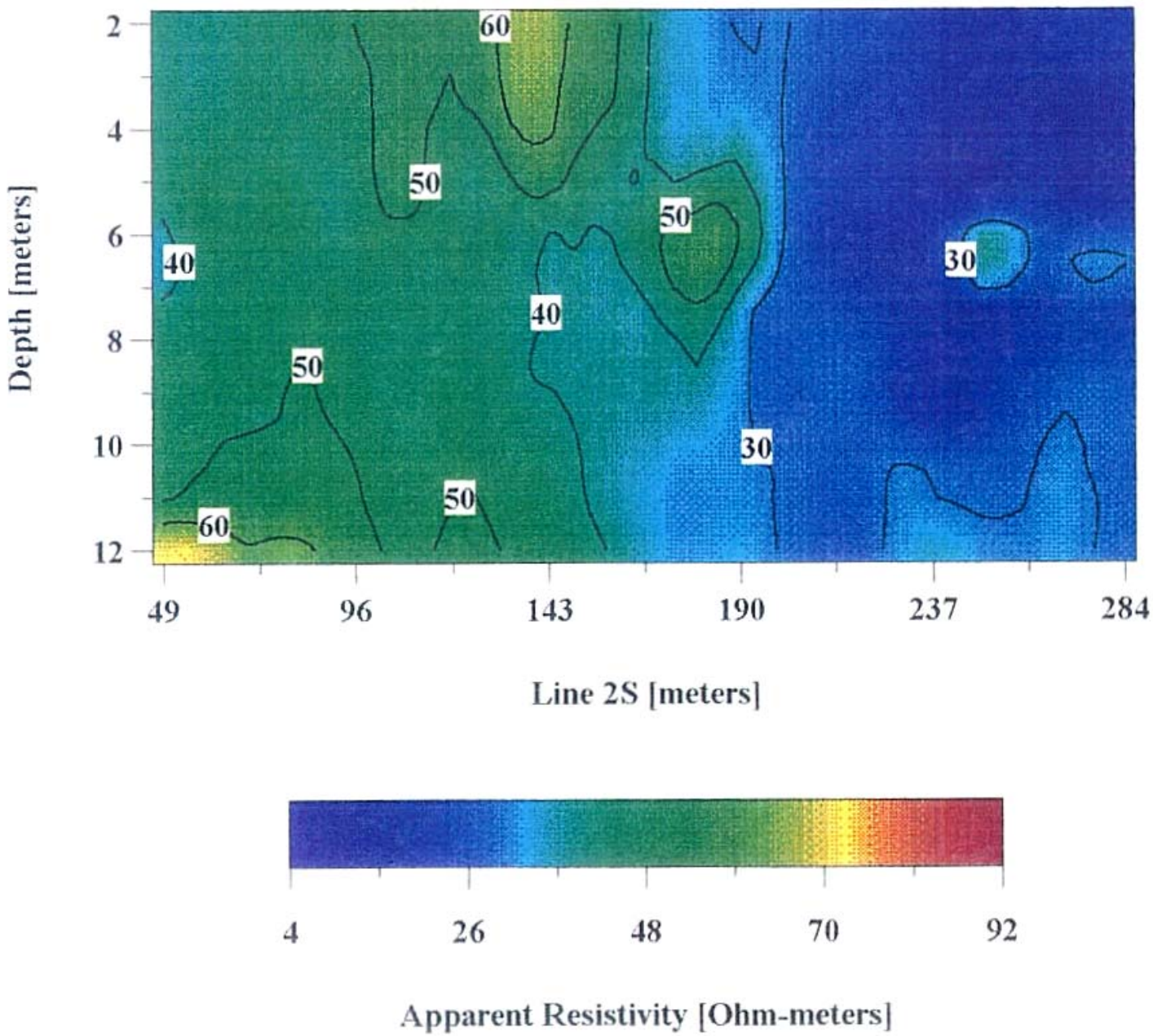
**Top Sheet**
Depth=20m
Center X=49m
Length=200m
Width=1m
Conductance=3S

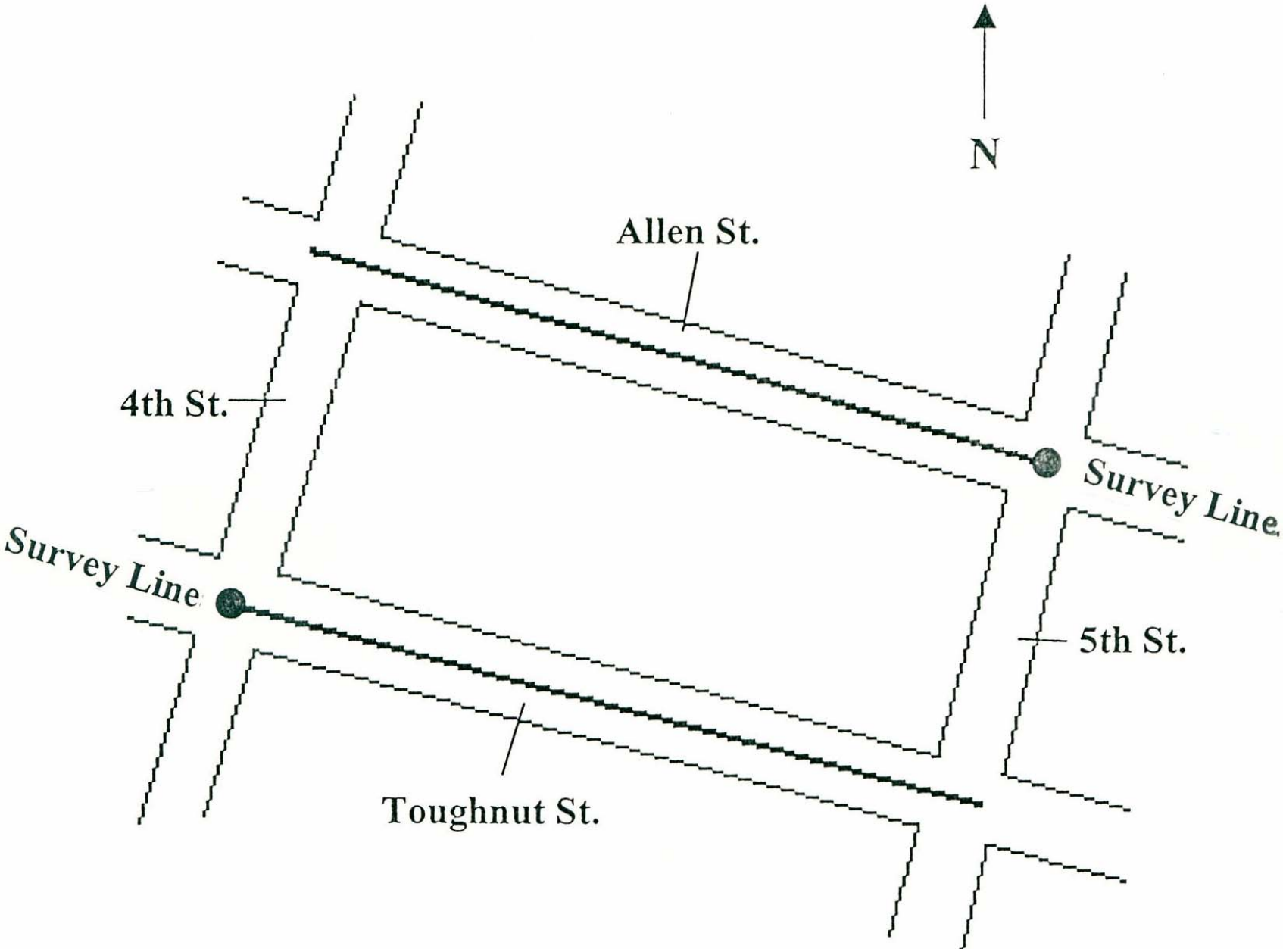
**Bottom Sheet**
Depth=25m, center X=45m
Length=200m, width=4m
Conductance=3S


NTS -- Line2 (4kHz)
Data
Model
Ellipticity
0
-0.05
-0.1
-0.15
-0.2
-55
-35
-15
5
25
45
65
85
Meters

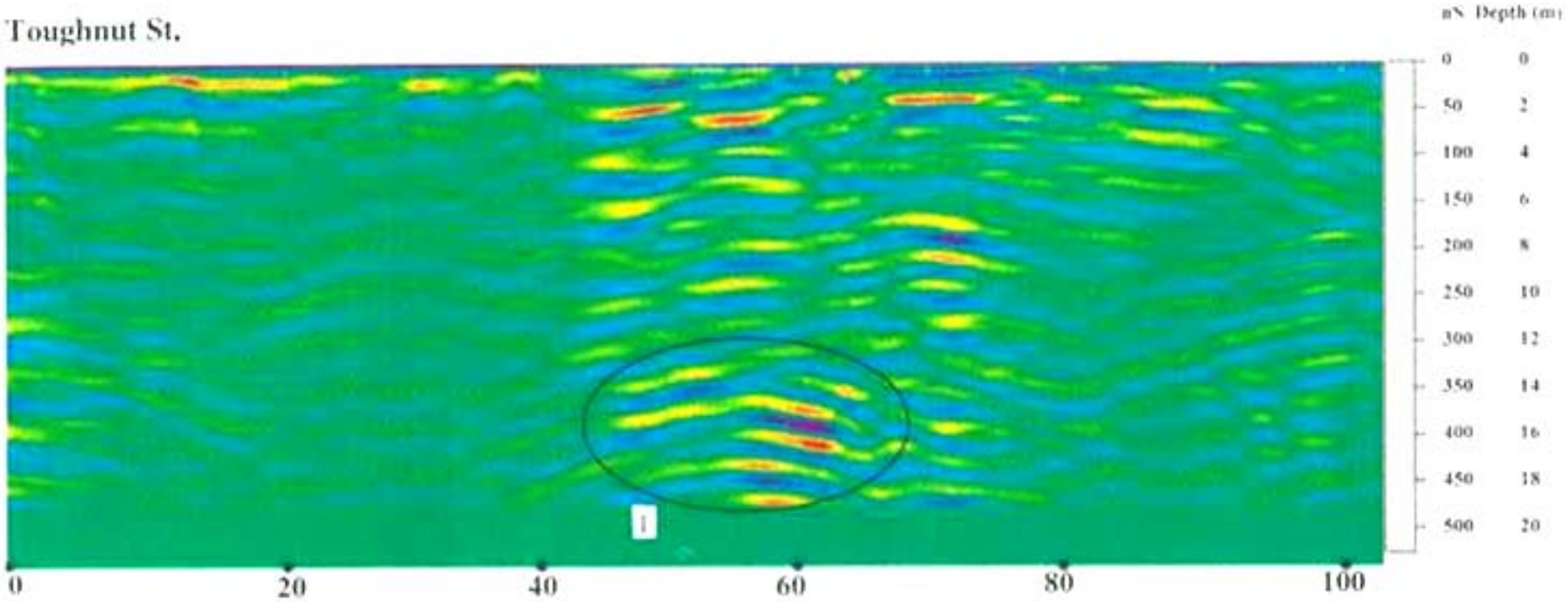

109 15'
12' 30"
10'
109 9' 12"
109 7' 30"
41 37' 30"
41 35'
Survey
Area
187
County
Fairground
80
30
80
30
ROCK
SPRINGS
N
1 Mile
1 Km

Apparent Resistivity Section for Line 2S from Inversion



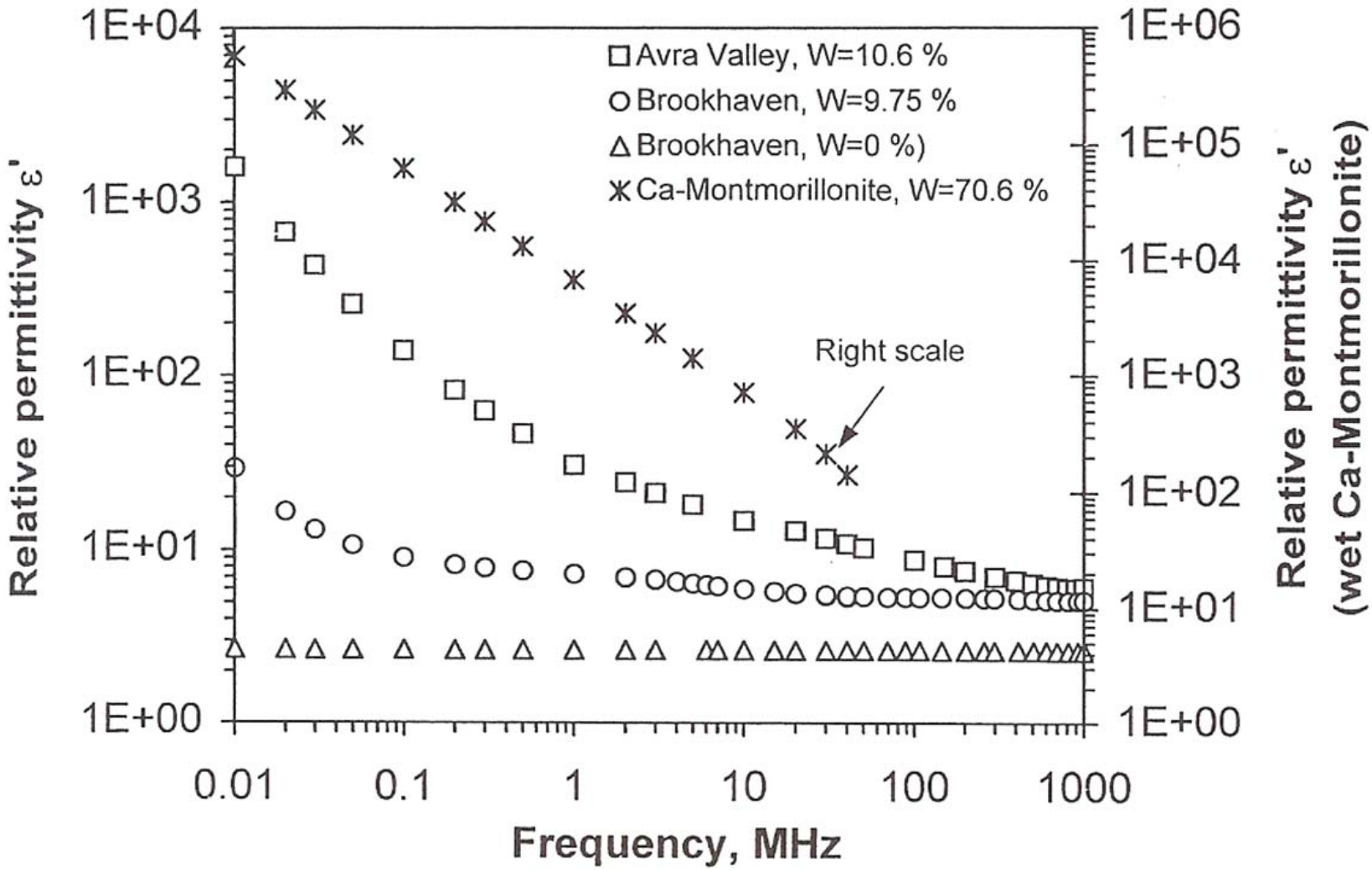

N
Allen St.
4th St.
Survey Line
Survey Line
5th St.
Toughnut St.

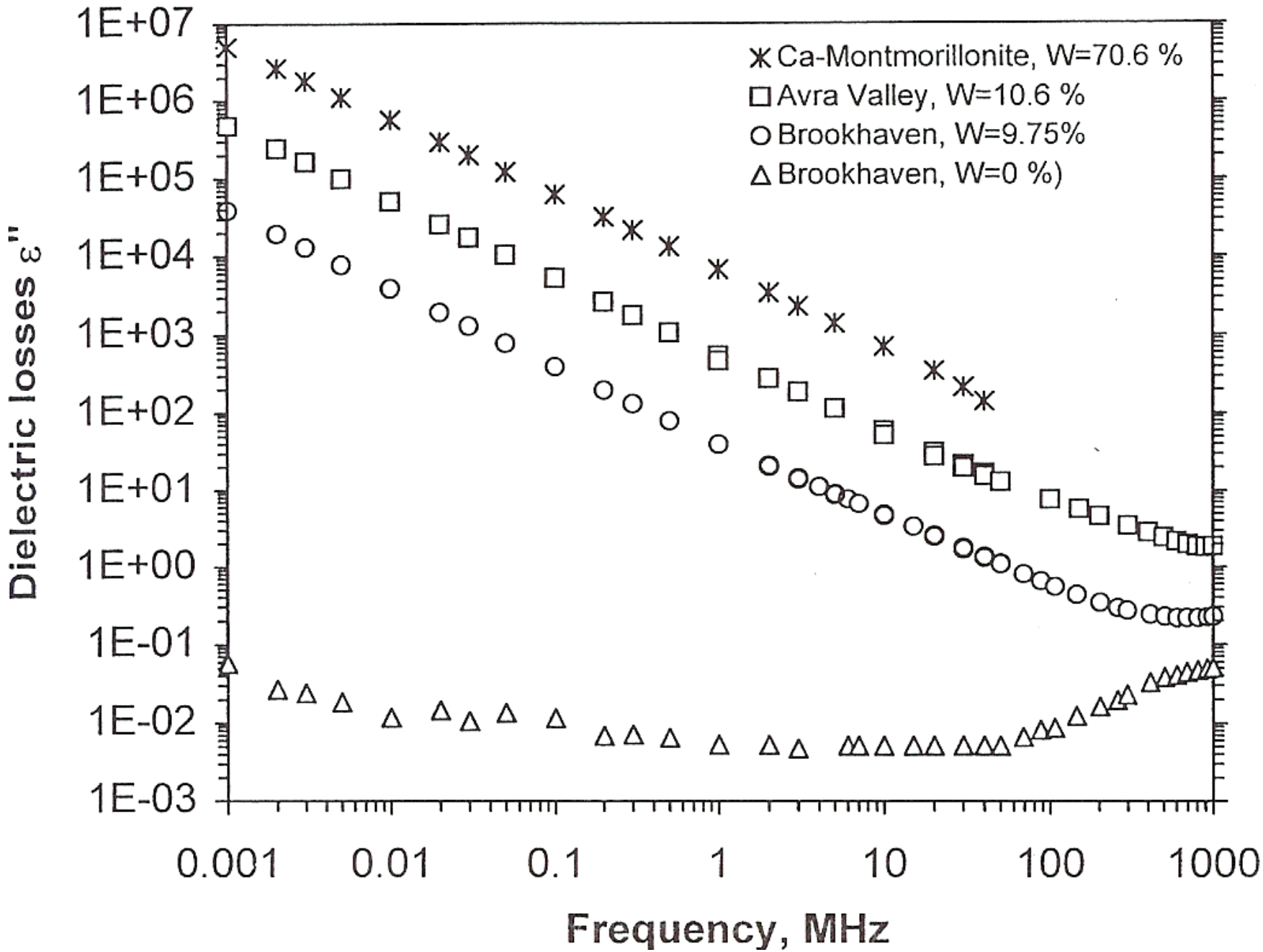
Toughnut St.

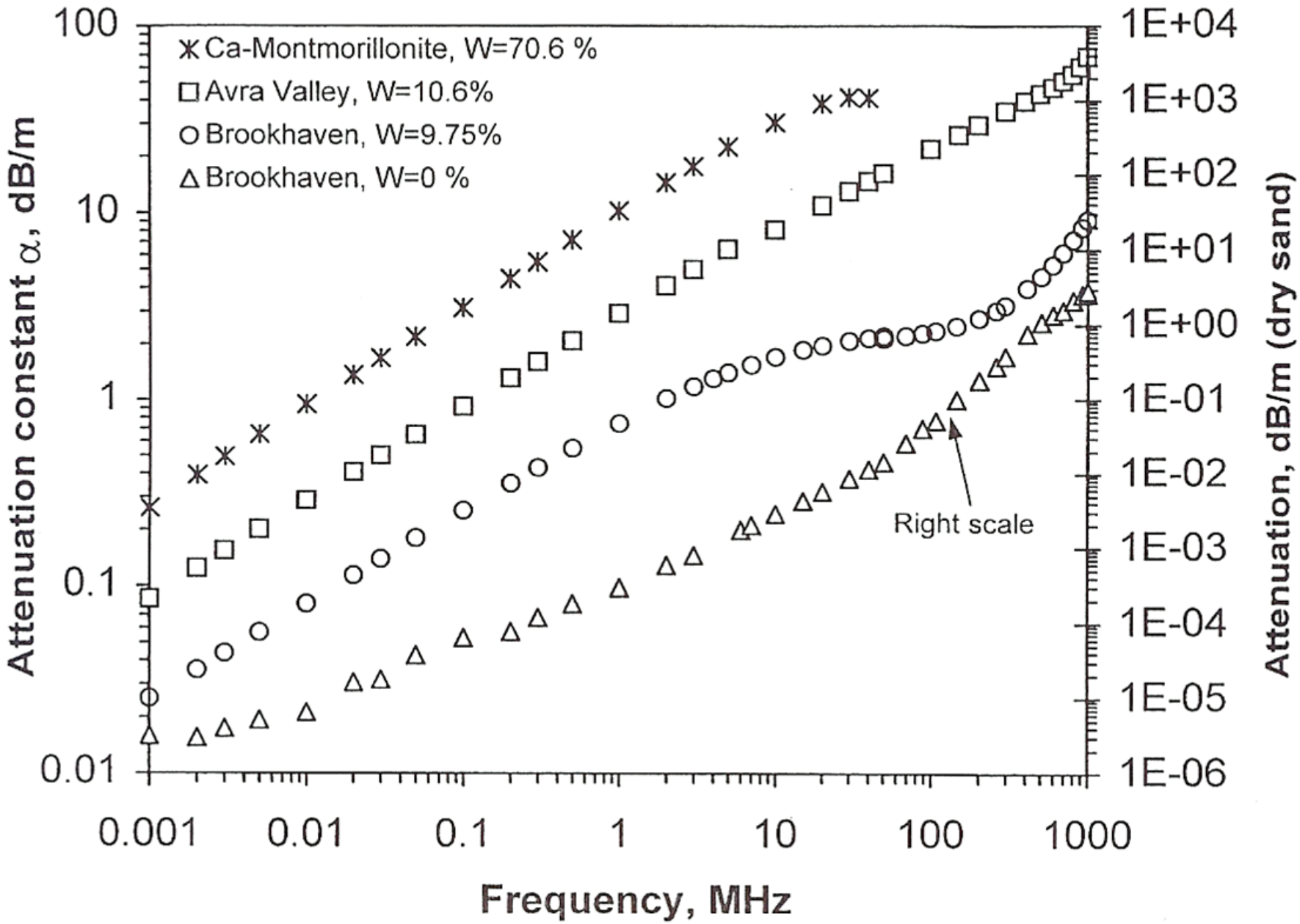


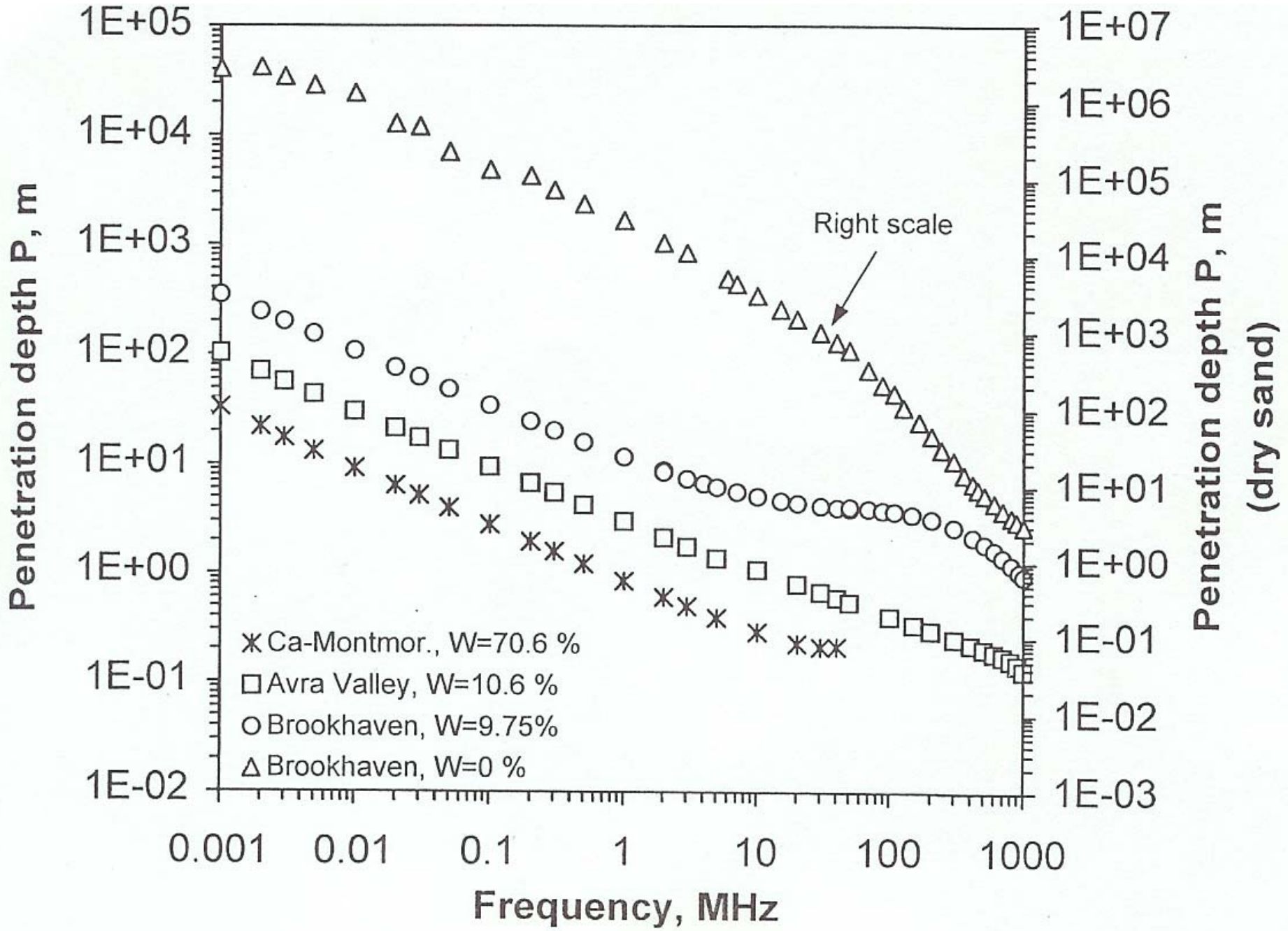

Distances in meters.

Allen St.

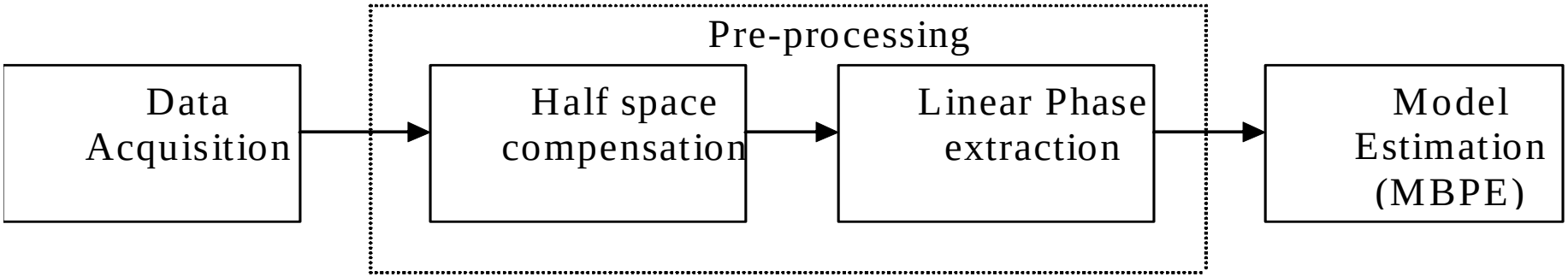

Avra Valley, W=10.6 %
Brookhaven, W=9.75 %
Brookhaven, W=0 %)
Ca-Montmorillonite, W=70.6 %
Right scale
Relative permittivity ε'
Relative permittivity ε'
(wet Ca-Montmorillonite)
Frequency, MHz
1E+04
1E+03
1E+02
1E+01
1E+00
1E+06
1E+05
1E+04
1E+03
1E+02
1E+01
1E+00
0.01
0.1
1
10
100
1000

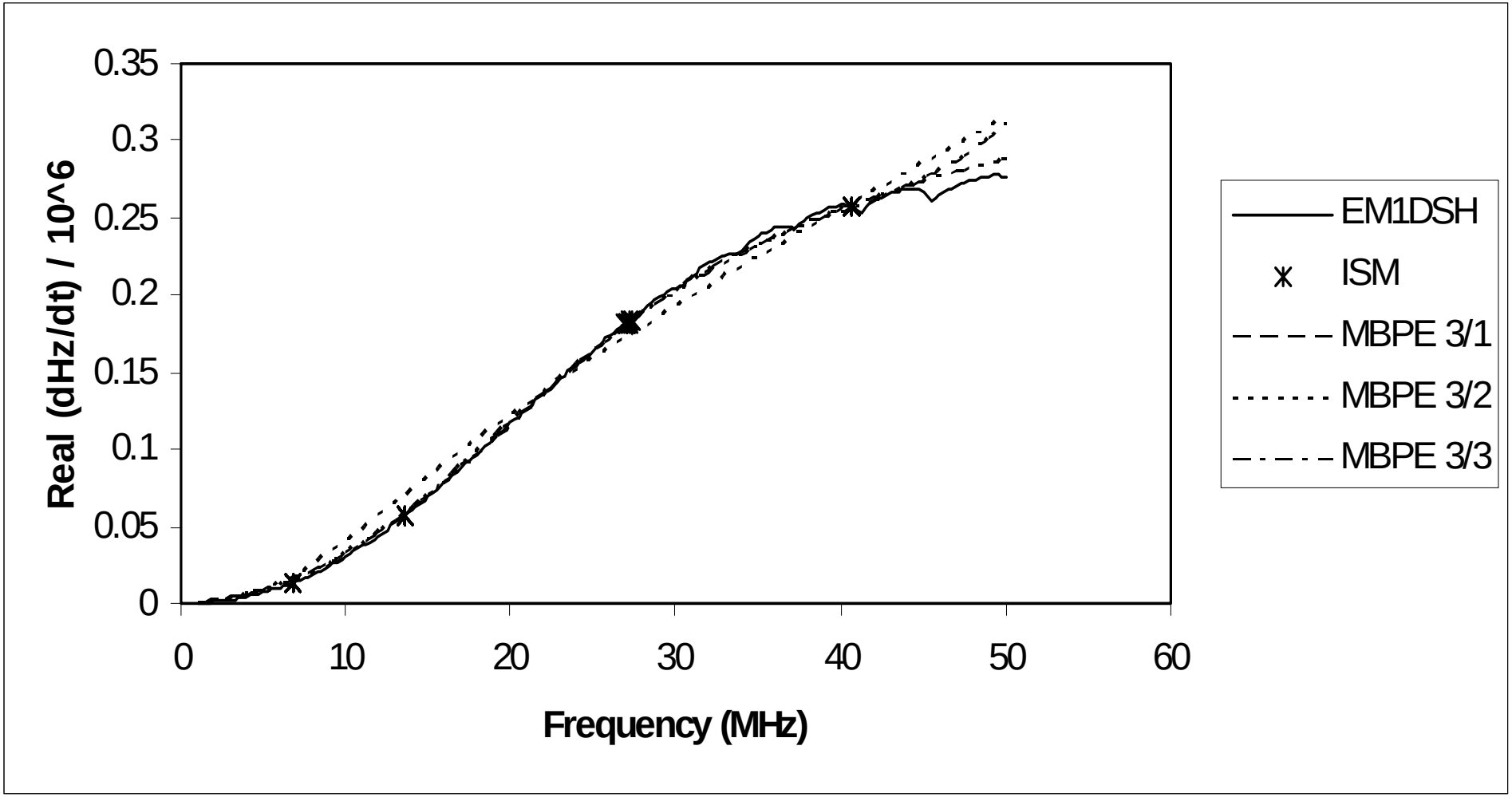

Ca-Montmorillonite, W=70.6 %
Avra Valley, W=10.6 %
Brookhaven, W=9.75%
Brookhaven, W=0 %)
Dielectric losses ε''
1E+07
1E+06
1E+05
1E+04
1E+03
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
0.001
0.01
0.1
1
10
100
1000
Frequency, MHz


Ca-Montmorillonite, W=70.6 %
Avra Valley, W=10.6%
Brookhaven, W=9.75%
Brookhaven, W=0 %
Right scale
Attenuation constant α, dB/m
Attenuation, dB/m (dry sand)
Frequency, MHz
100
10
1
0.1
0.01
1E+04
1E+03
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
1E-04
1E-05
1E-06
0.001
0.01
0.1
1
10
100
1000


1E+05
1E+04
1E+03
1E+02
1E+01
1E+00
1E-01
1E-02
Penetration depth P, m
1E+07
1E+06
1E+05
1E+04
1E+03
1E+02
1E+01
1E+00
1E-01
1E-02
1E-03
Penetration depth P, m
(dry sand)
Right scale
Ca-Montmor., W=70.6 %
Avra Valley, W=10.6 %
Brookhaven, W=9.75%
Brookhaven, W=0 %
0.001
0.01
0.1
1
10
100
1000
Frequency, MHz

| Center frequency (MHz) | Bandwidth (kHz) | Bandwidth (%) |
|---|---|---|
| 6.78 | +/- 15 | 0.44 |
| 13.56 | +/- 7 | 0.10 |
| 27.12 | +/- 163 | 1.20 |
| 40.68 | +/- 20 | 0.10 |


Pre-processing
Data Acquisition
Half space compensation
Linear Phase extraction
Model Estimation (MBPE)


0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
Real (dHz/dt) / 10^6
0
10
20
30
40
50
60
Frequency (MHz)
EM1DSH
ISM
MBPE 3/1
MBPE 3/2
MBPE 3/3