www.phy.latech.edu/greenw/micro.html

LIGO-G000108-00-D

LSC mtg
LLO mtg 03/00

Analysis of Seismic Data Taken at LLO

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Conclusions

- Tentative qualitative agreement with Rohay results
- SAC good analysis tool

To Do:

- Repeat RMS analysis on complete data set
- determine velocity profiles of all configuration
- check out S AZ region

Four Sensor in 3 Configs:
Huddle, Gravity Gradient, Micro-Seismic

July : Huddle + Microseis. I

Aug : gravity grad.

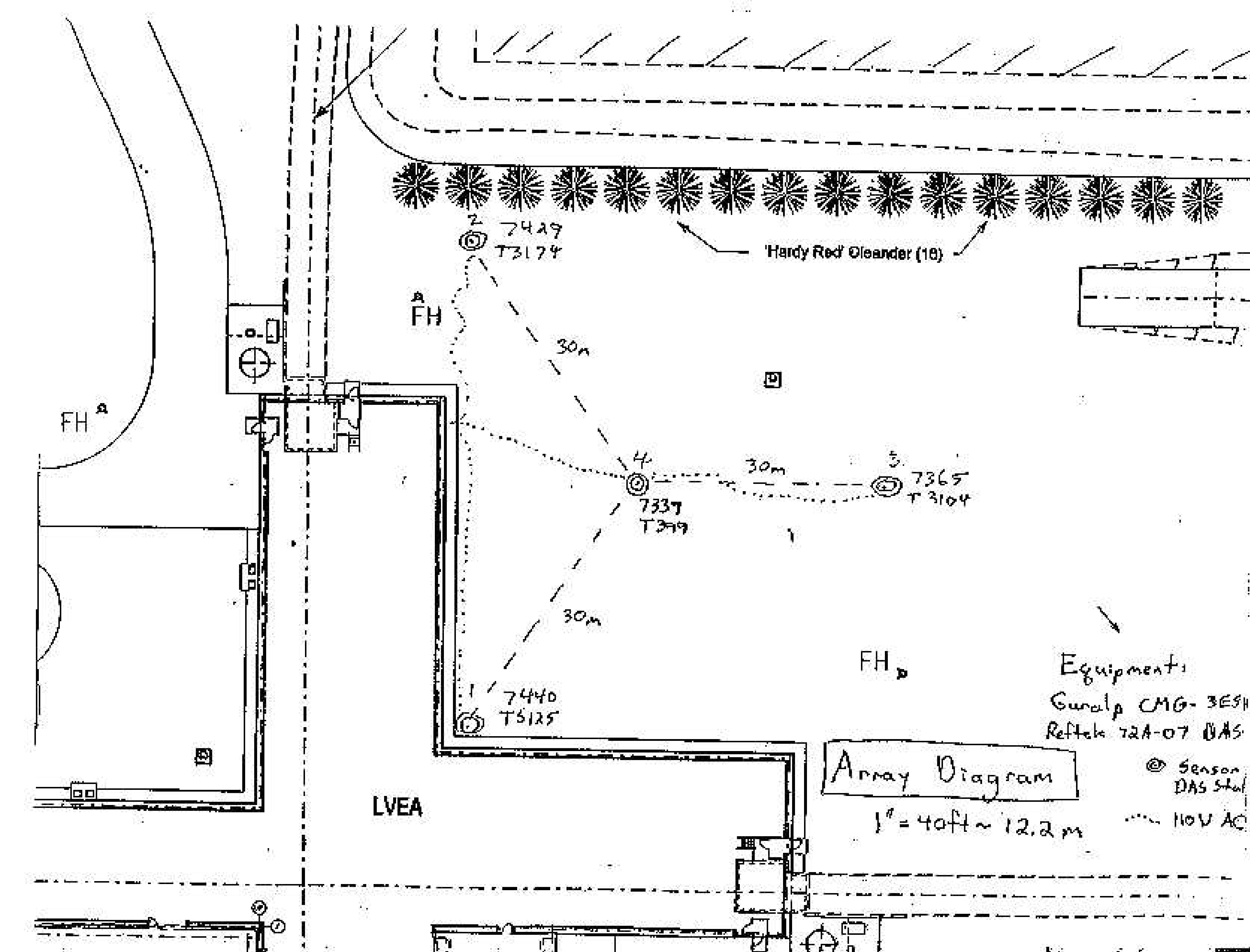
Sep : Microseis. II

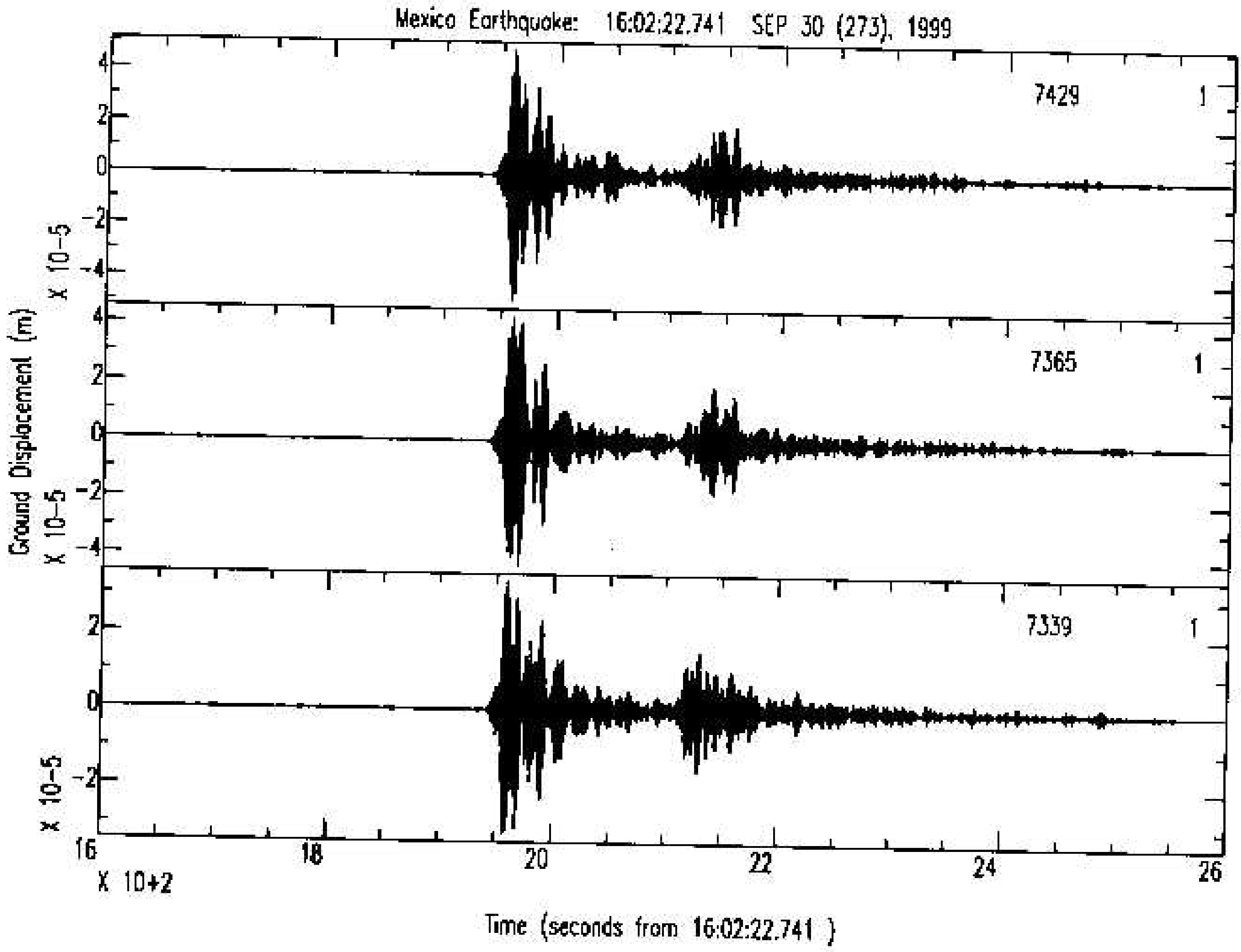
- Sensors: GURALP CMG-3ESP (sensitivity 2000 V/m/s)
- DAS: REFTEK 72A-07 (standalone)
- on loan from PASSCAL

Data Analysis Software

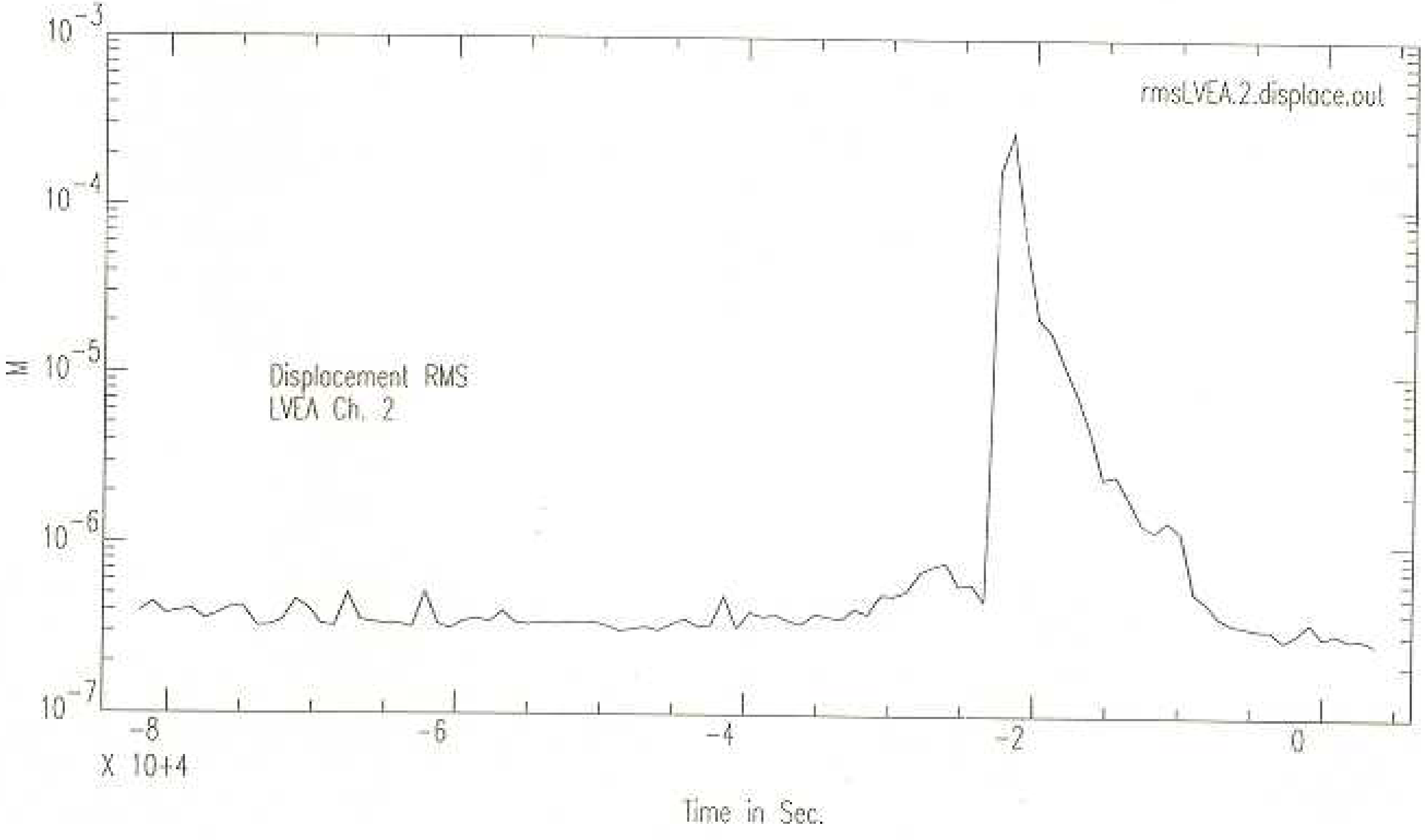
Seismic Analysis Code (SAC)

- by geophysicists at LLNL
- macros or subroutines in C or Fortran (Similar to PAW)
- interface to MATLAB


2
7429
T3174
'Hardy Red' Oleander (16)
FH
FH
30m
4
7337
T399
30m
3
7365
T3104
30m
FH
1
7440
T5125
LVEA
Equipment:
Guralp CMG-3ES
Reftek 72A-07 DAS
Array Diagram
1" = 40ft ~ 12.2 m
Sensor
110V AC


Mexico Earthquake: 16:02:22.741 SEP 30 (273), 1999
7429
1
7365
1
7339
1
Ground Displacement (m)
X 10−5
4
2
0
-2
-4
16
18
20
22
24
26
X 10+2
Time (seconds from 16:02:22.741)

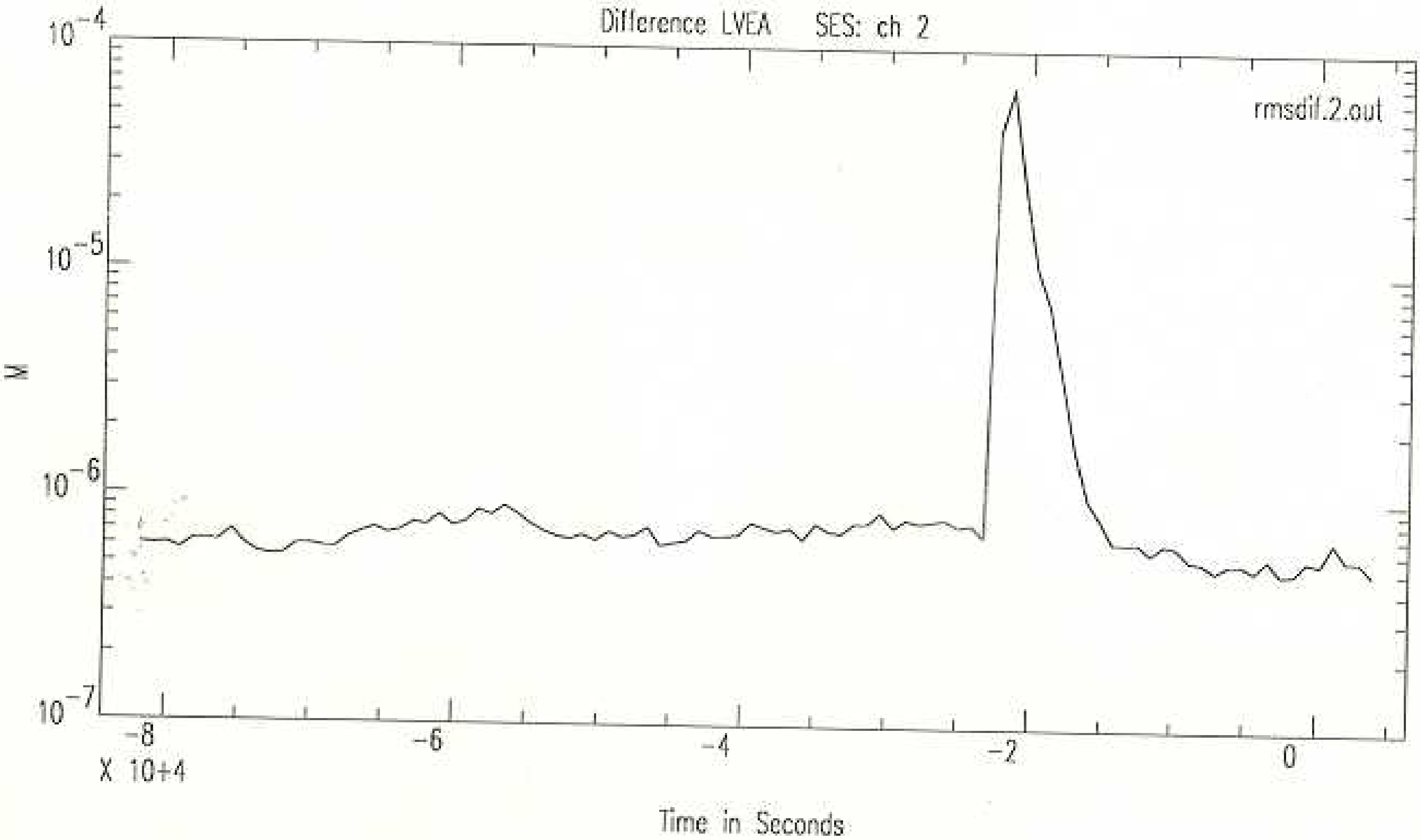
decimate to 10 samples/sec
BP @ .01 Hz .2 Hz Butterworth
RMS over 5 min. intervals



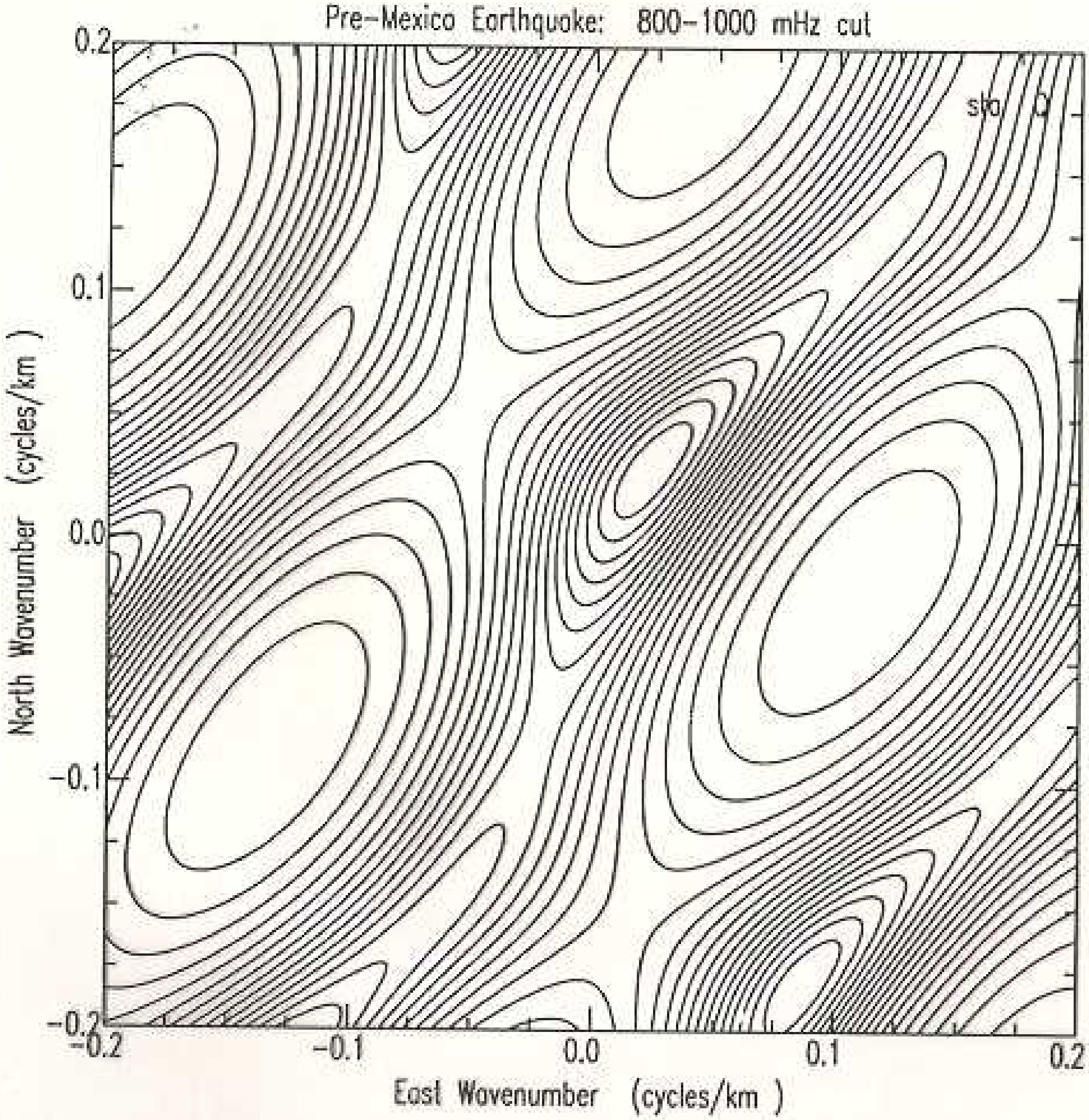
At LLO

Find: microseismic noise "difference" greater than "individual".

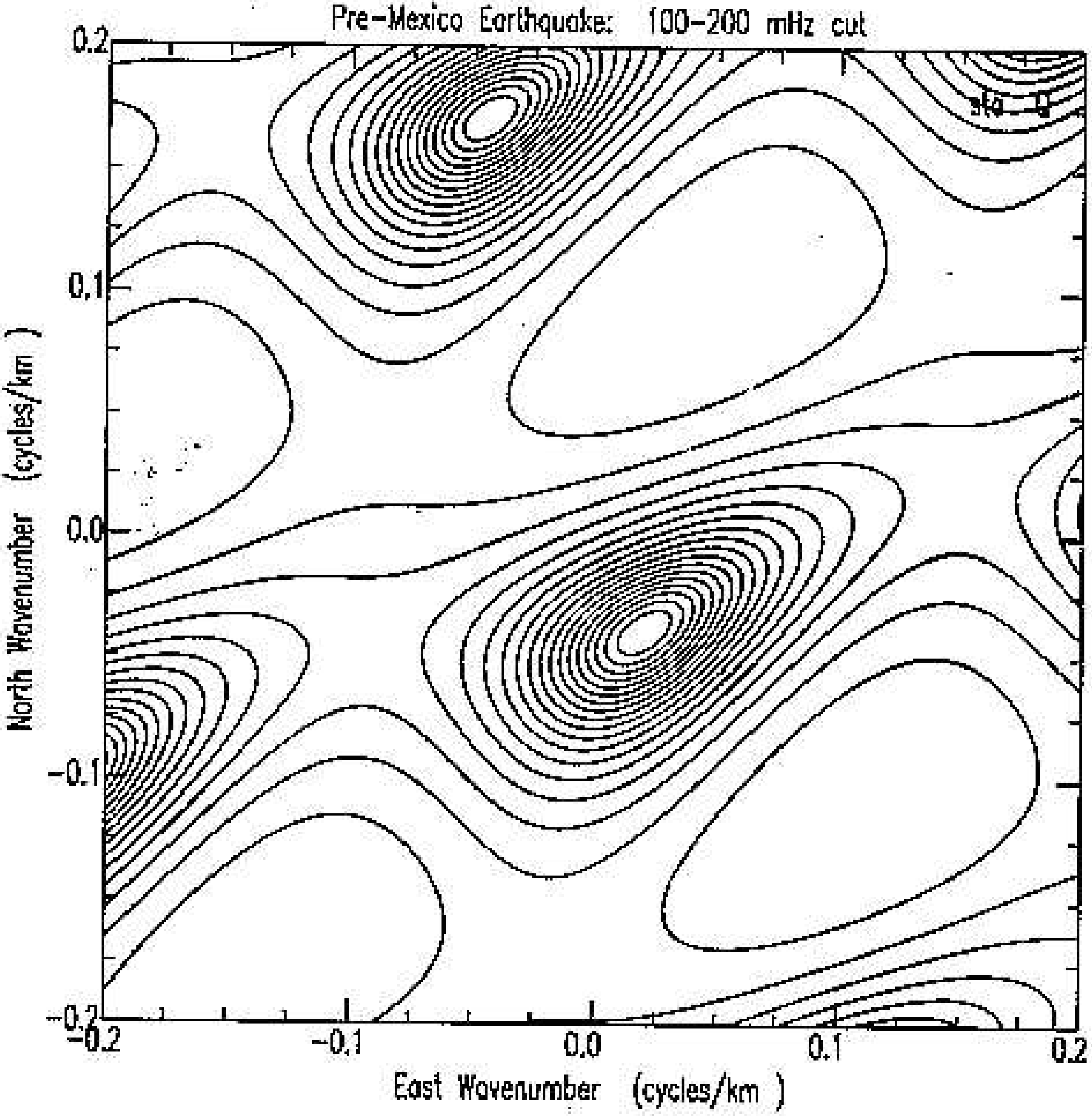
Agrees with Rohay result ⇒ slower vel. at LLO than LHO.



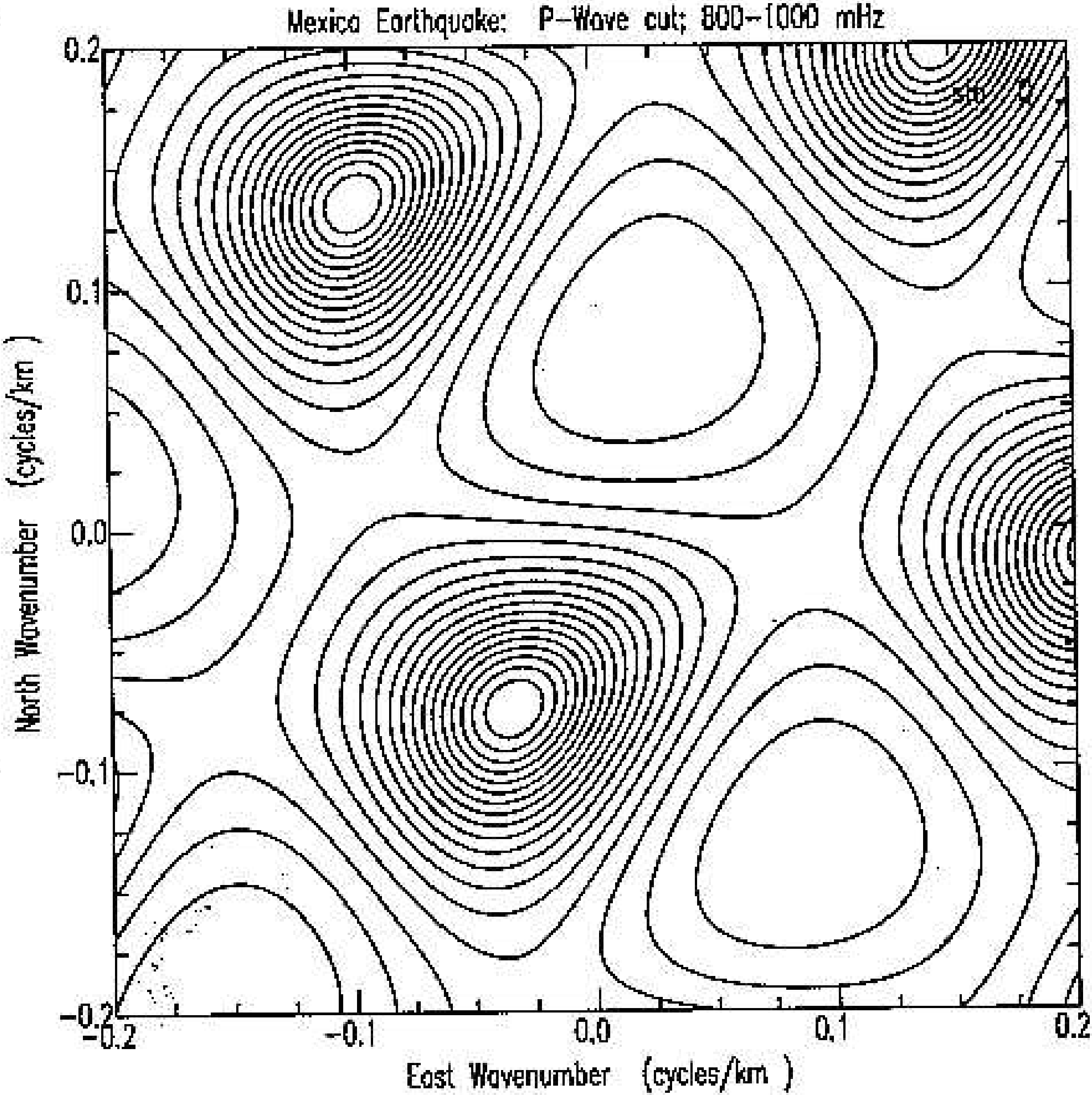
SAC wavenumber routine BBFK



combined powers of 3 signals contoured as fcn of horiz. wavenumbers



Pre-Mexico Earthquake: 100-200 mHz cut
0.2
0.1
0.0
-0.1
-0.2
North Wavenumber (cycles/km)
-0.2
-0.1
0.0
0.1
0.2
East Wavenumber (cycles/km)



Mexico Earthquake: P-Wave cut; 800-1000 mHz
North Wavenumber (cycles/km)
East Wavenumber (cycles/km)
0.2
0.1
0.0
-0.1
-0.2
-0.2
-0.1
0.0
0.1
0.2

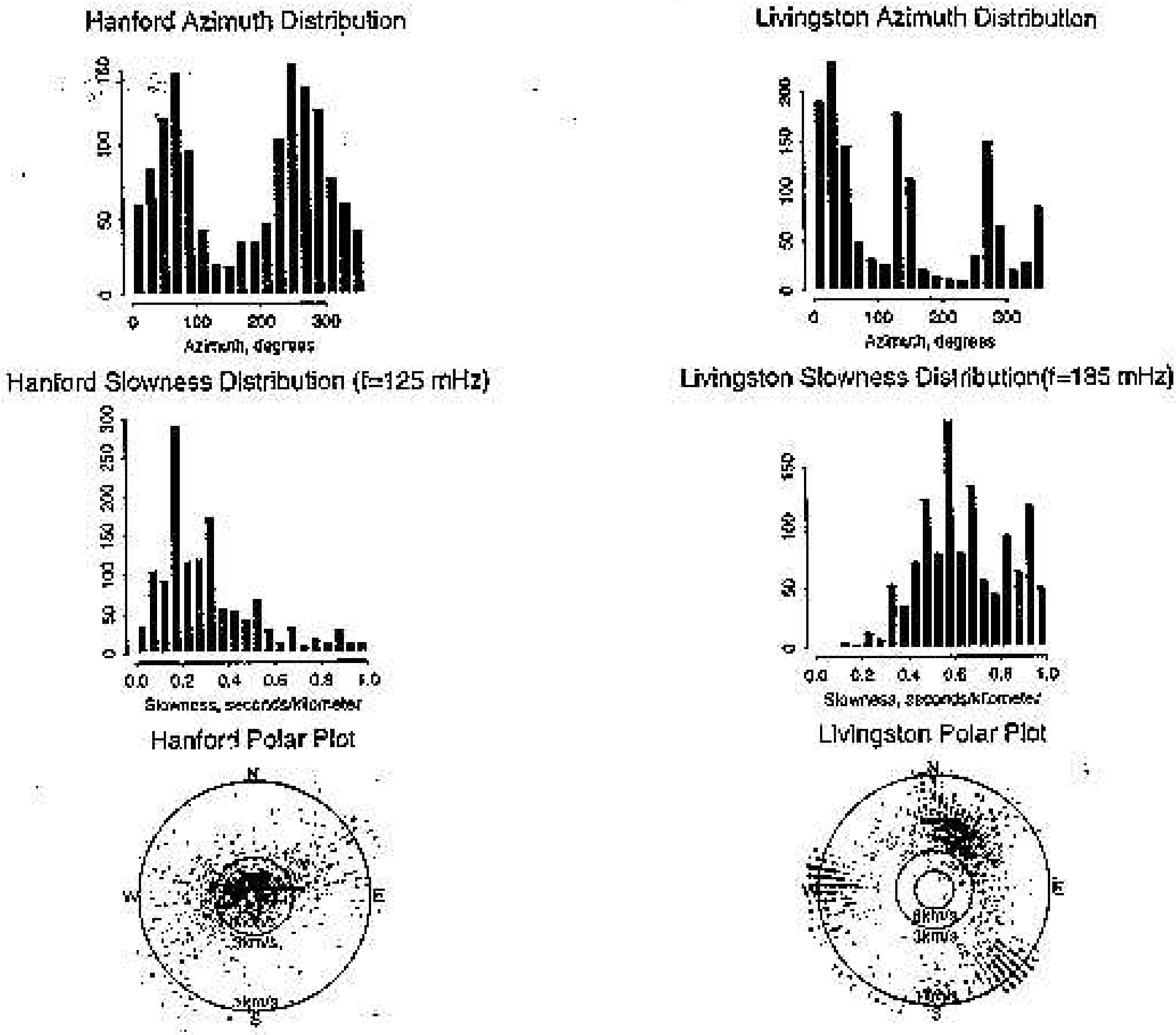
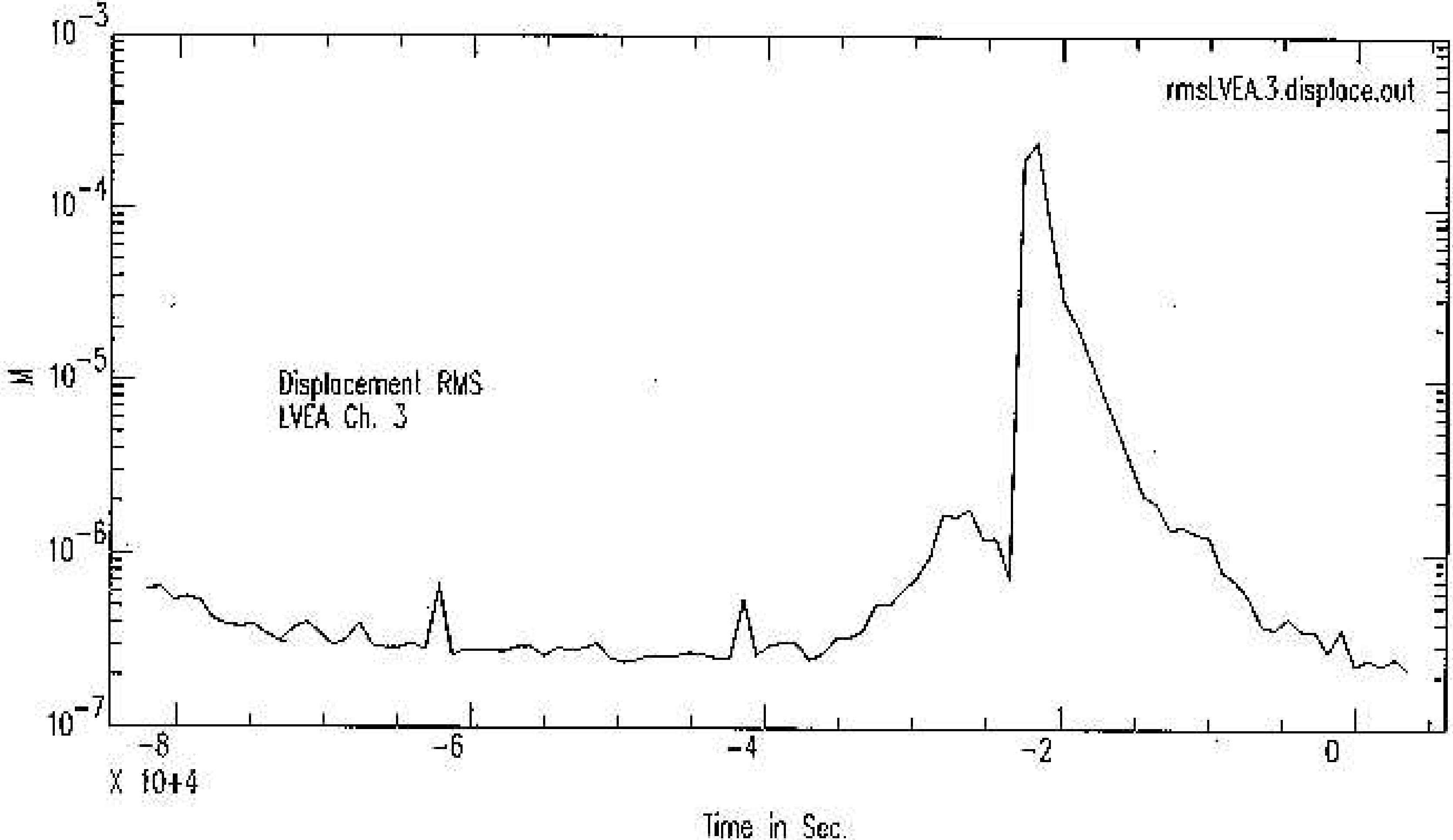


Figure 3. Summary of wavenumber analysis. The determination of apparent velocity and direction of the peak microseismic noise is described in Appendix B. At Hanford, the propagation velocity is most frequently determined to be faster than 3 km/s. At Livingston, the propagation velocity is most frequently determined to be slower than 3 km/s. The lower propagation velocity at Livingston creates artificial concentrations at velocities near 1 km/s at western and southeastern azimuths (due to the beam-pattern effect). The larger symbols in the polar plots (bottom) correspond to the largest coherent noise amplitudes (upper 25th percentile) measured.



rmsLVEA.3.displace.out
Displacement RMS
LVEA Ch. 3
M
10^-3
10^-4
10^-5
10^-6
10^-7
-8
-6
-4
-2
0
X 10+4
Time in Sec.

trial ←

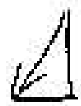
$\Delta LAT = 30.55200 - 16.059 = 14.493°$ S

$\Delta LON = -96.931 + 90.773 = -6.158$ W

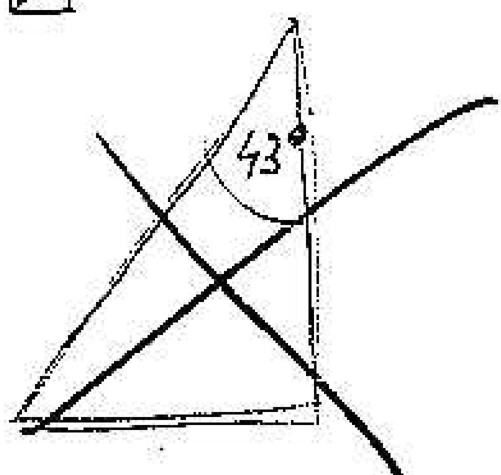
mid latitud $= \frac{1}{2}(30.552 + 16.059) = 23.3055°$

$p = \Delta L_o$

$\frac{D L_o}{\sec 23.3055} = p = \frac{14.493° \text{ S}}{}$ $= 5.73°$S



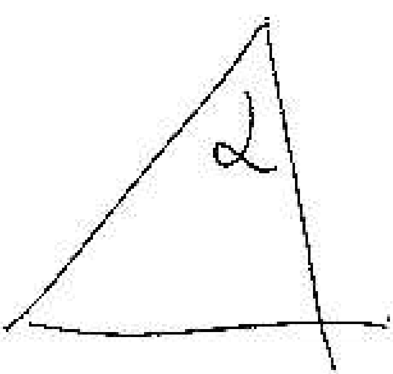
$\tan C = \frac{5.73° \text{ S}}{6.158 \text{ W}}$



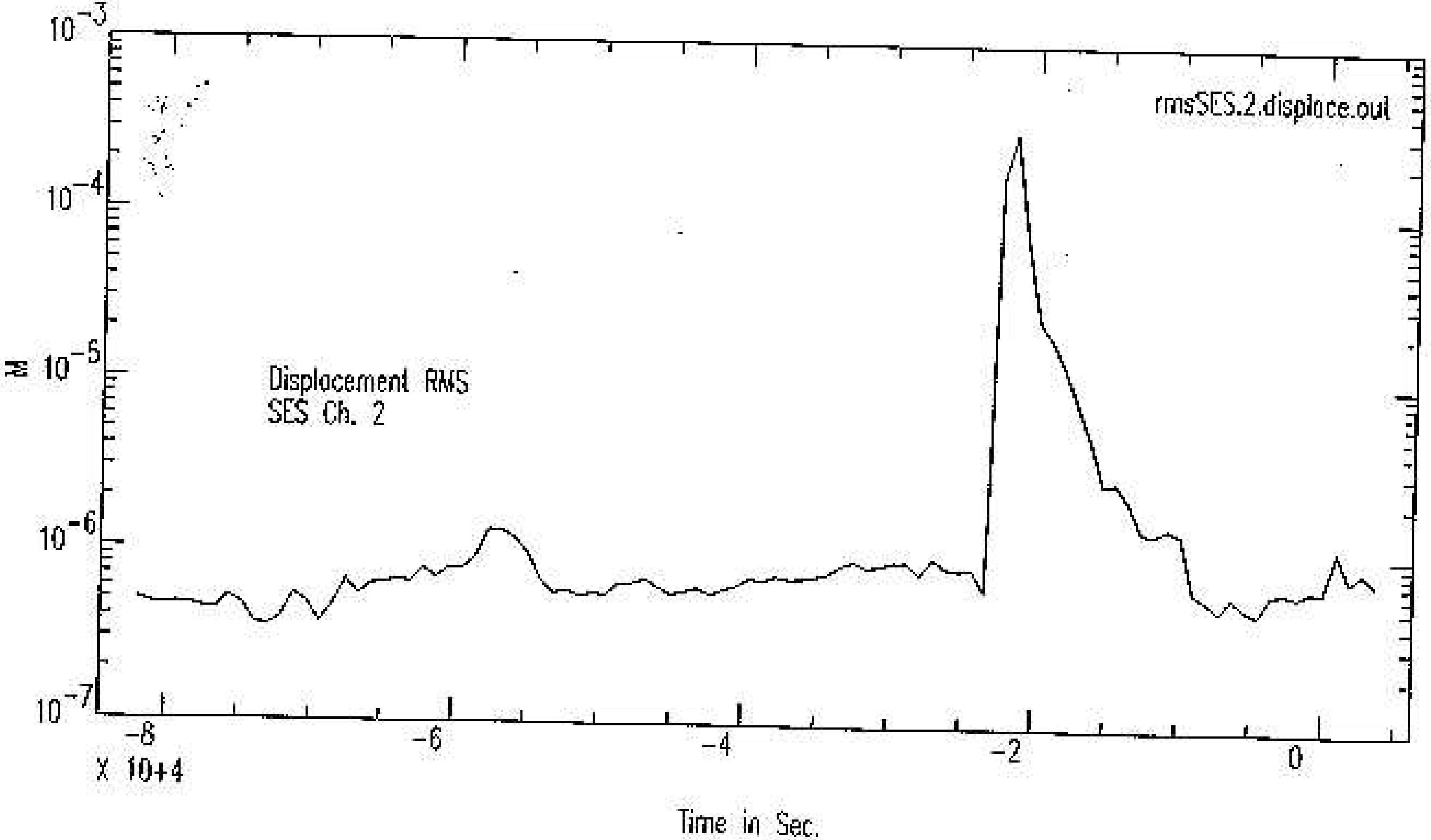
$p = D L_o \cdot \cos 23.3055 = 6.158 \text{ W} \cdot \cos$

$= 5.655$

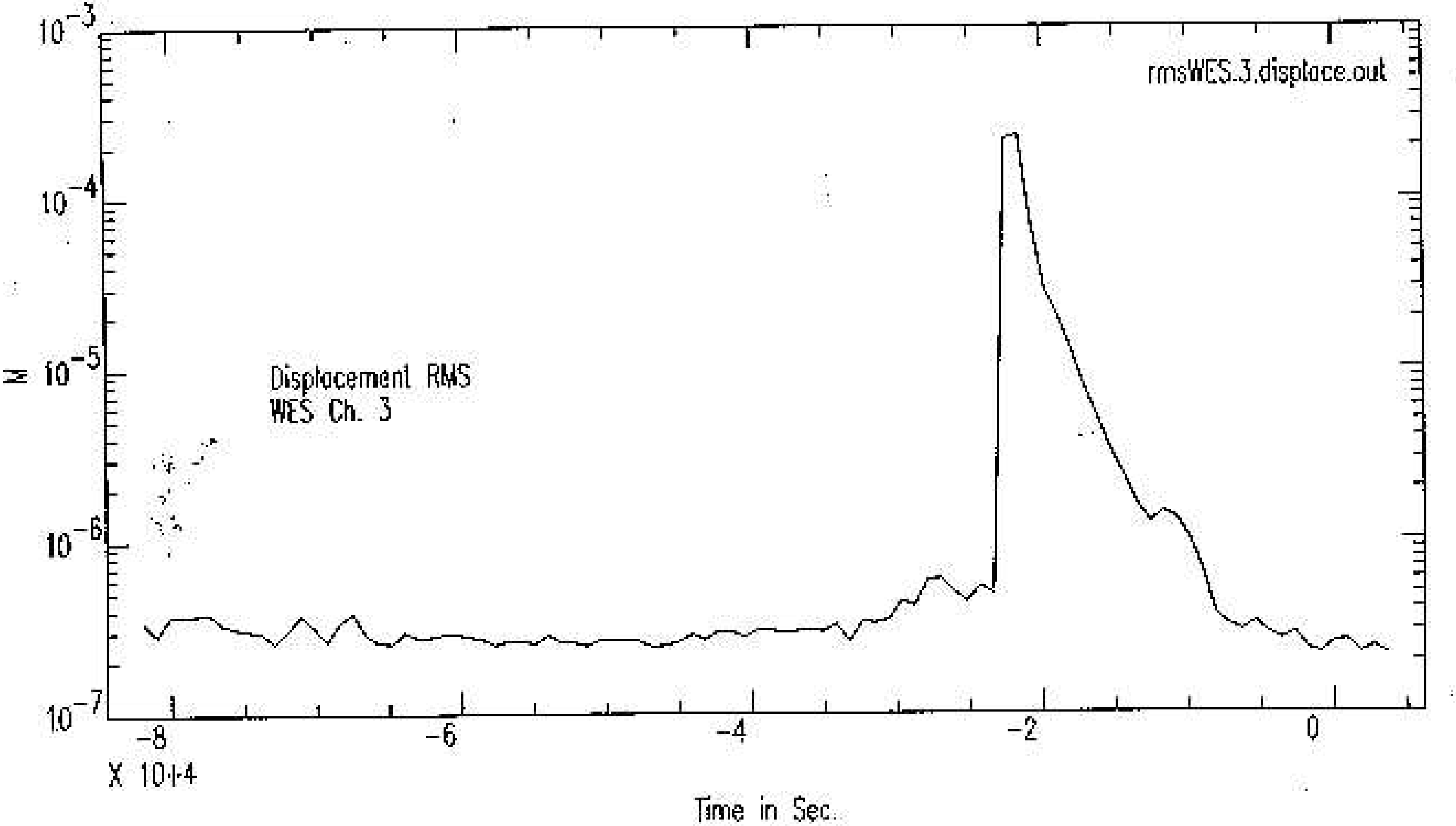
$\tan C = \frac{5.655 \text{ W}}{14.453 \text{ S}} = 0.3901$



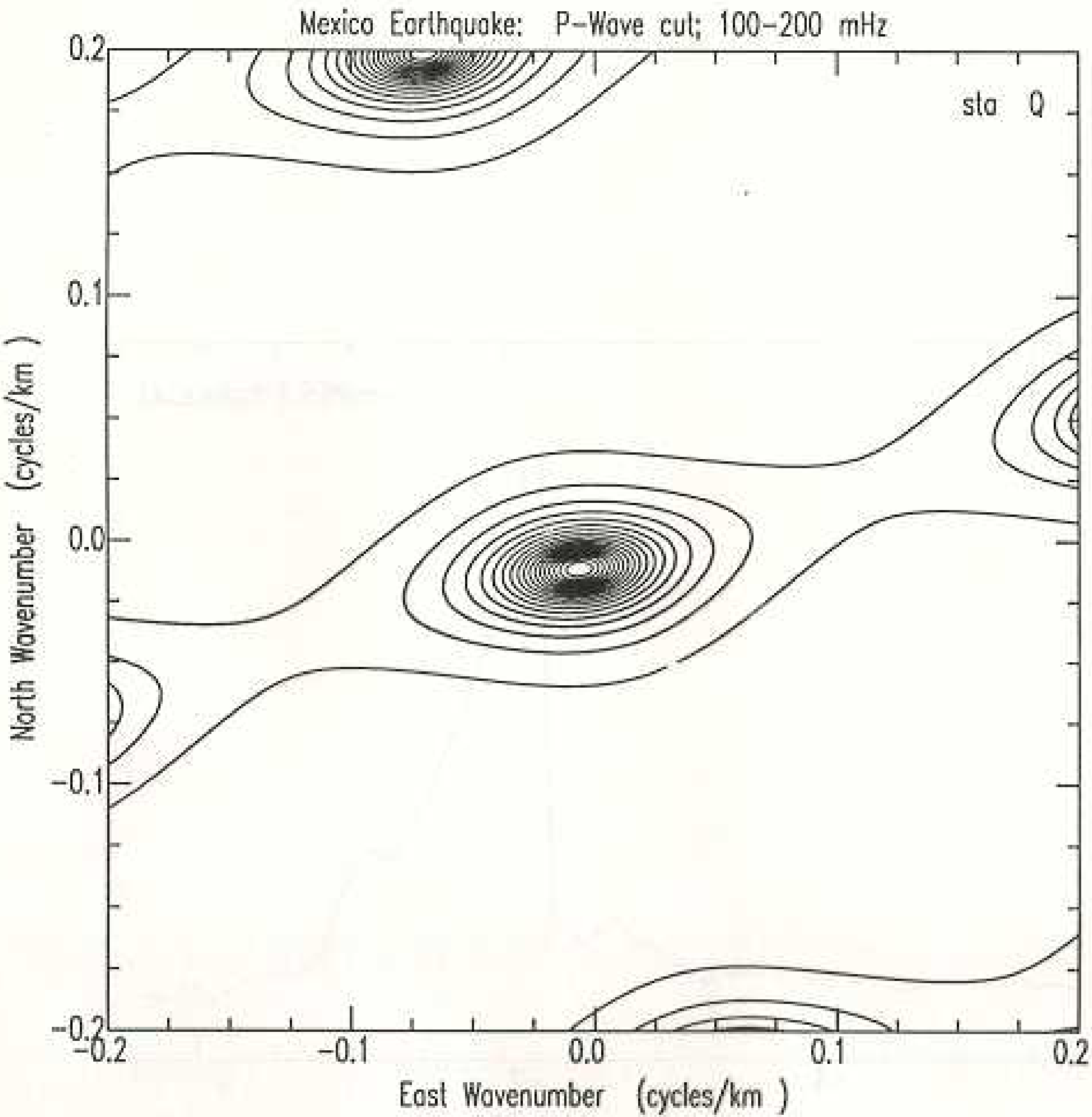
$\alpha = 21.3°$ W of S



rmsSES.2.displace.out
Displacement RMS
SES Ch. 2
M
10−3
10−4
10−5
10−6
10−7
−8
−6
−4
−2
0
X 10+4
Time in Sec.



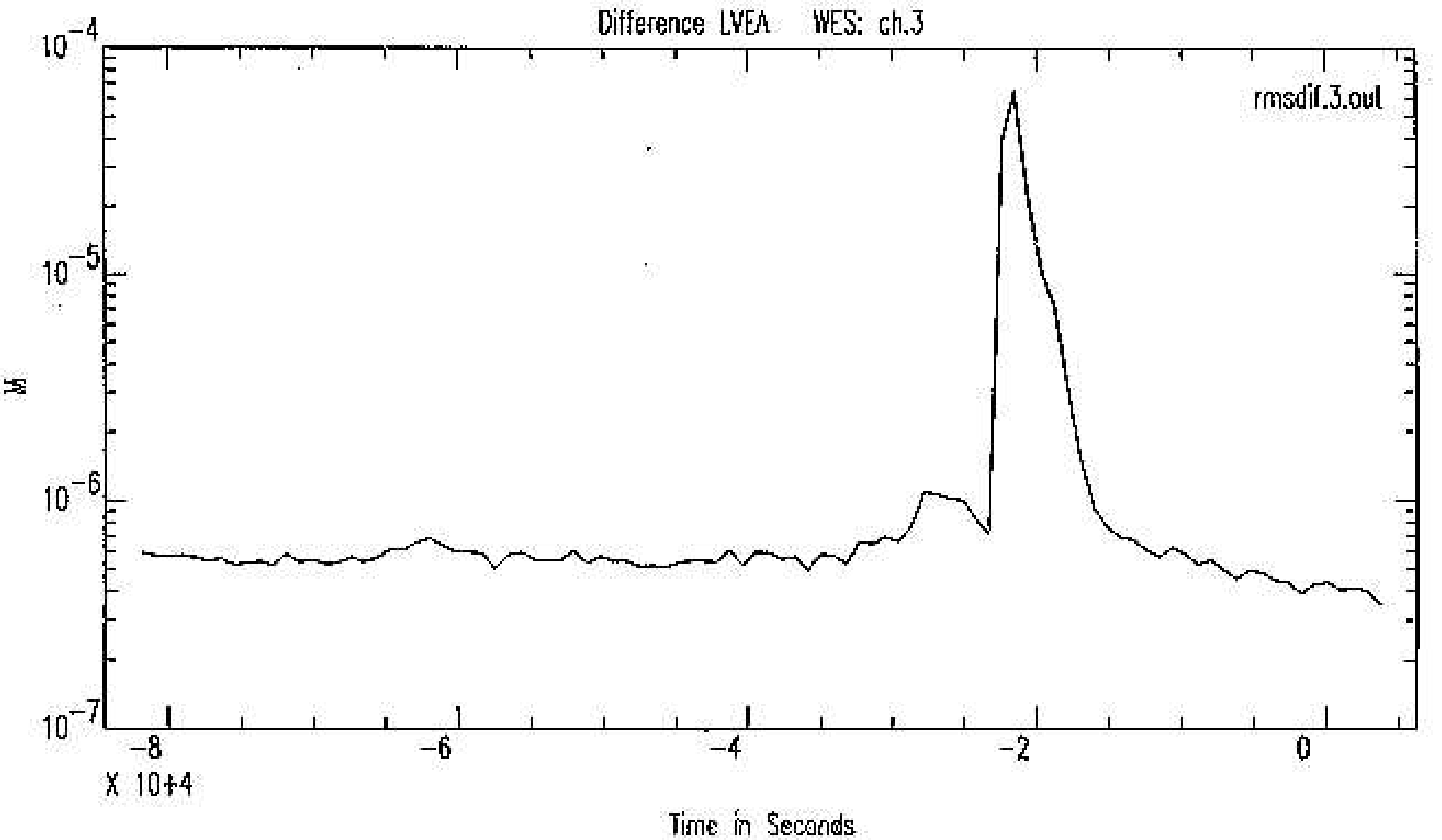
rmsWES.3.displace.out
Displacement RMS
WES Ch. 3
M
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
−8
−6
−4
−2
0
X 10↑4
Time in Sec.



$v = \frac{f}{k} \approx 10 \frac{km}{s}$

from ~25° W of S

Actual source dir: 21.3° W of S (Oaxaca, Mexico LAT 16.059 LON -96.931)



Difference LVEA WES: ch.3
rmsdif.3.out
M
10^{-4}
10^{-5}
10^{-6}
10^{-7}
-8
-6
-4
-2
0
X 10+4
Time in Seconds

final

$\Delta LAT = 30.55200 - 16.059 = 14.493^\circ$ S

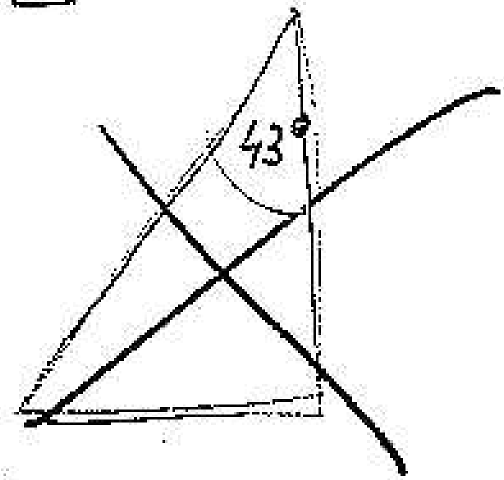
$\Delta LON = -96.931 + 90.773 = 6.158$ W

mid latitude $= \frac{1}{2}(30.552 + 16.059) = 23.3055^\circ$

$p = \Delta L_o$

$\frac{DL_o}{\sec 23.3055} = p = \frac{14.493^\circ \text{ S}}{\ } = 5.73^\circ$ S

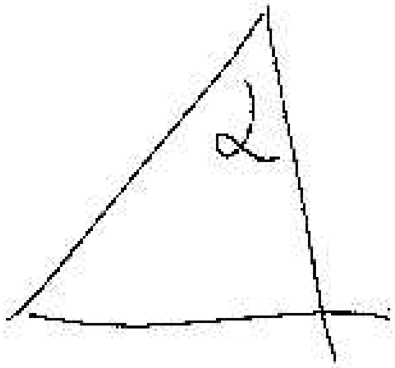
$\tan C = \frac{5.73^\circ \text{ S}}{6.158 \text{ W}}$



$P = DL_o \cdot \cos 23.3055 = 6.158 \text{ W} \cdot \cos$

$= 5.655$

$\tan C = \frac{5.655 \text{ W}}{14.453 \text{ S}} = 6.3902$



$\alpha = 21.3^\circ$ W of S

Note 1, Linda Turner, 05/09/00 11:45:23 AM
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