This slide presentation was presented at the May 3, 2004 Coyote Creek Shear velocity Comparison Workshop at the USGS, Menlo Park, CA.

This is an extract from Asten, M.W., and Boore, D.M., eds., Blind comparisons of shear-wave velocities at closely spaced sites in San Jose, California: U.S. Geological Survey Open-File Report 2005-1169. [available on the World Wide Web at http://pubs.usgs.gov/of/2005/1169/].

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U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Frequency-Wavenumber Analysis of Active and Passive Surface Waves

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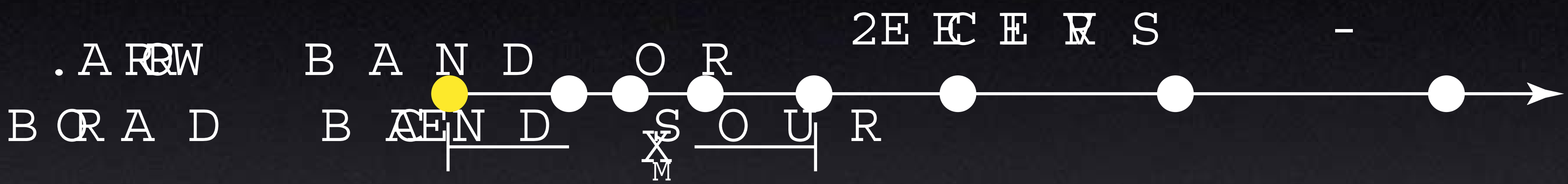
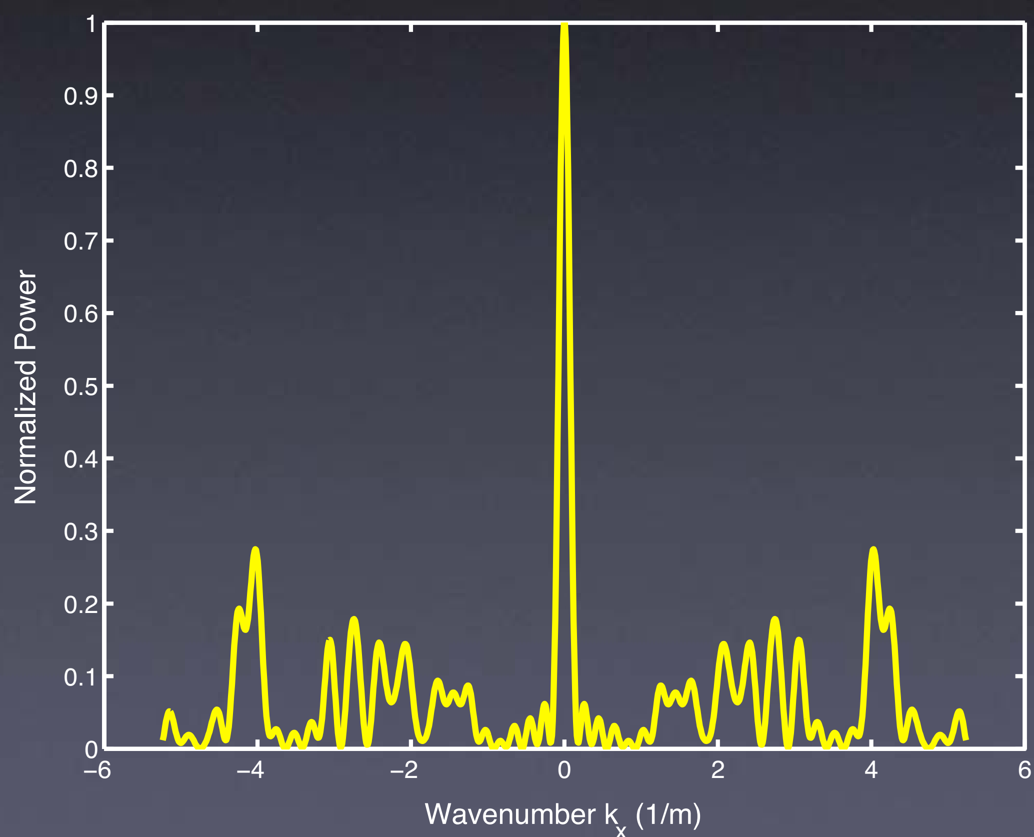
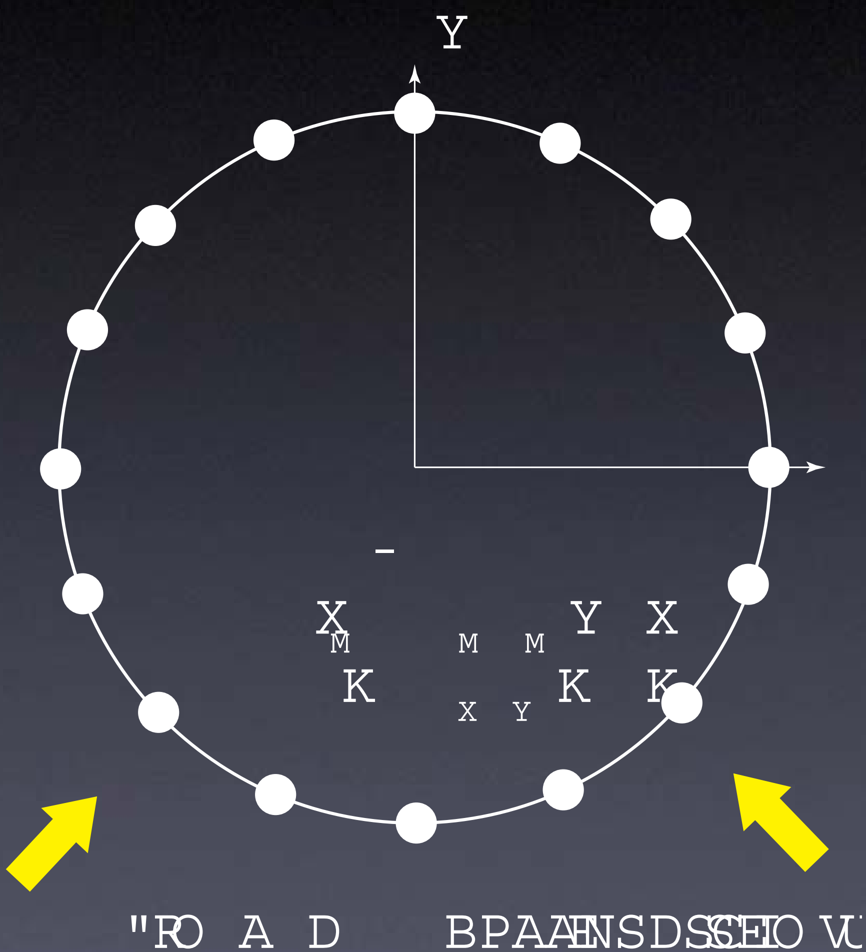
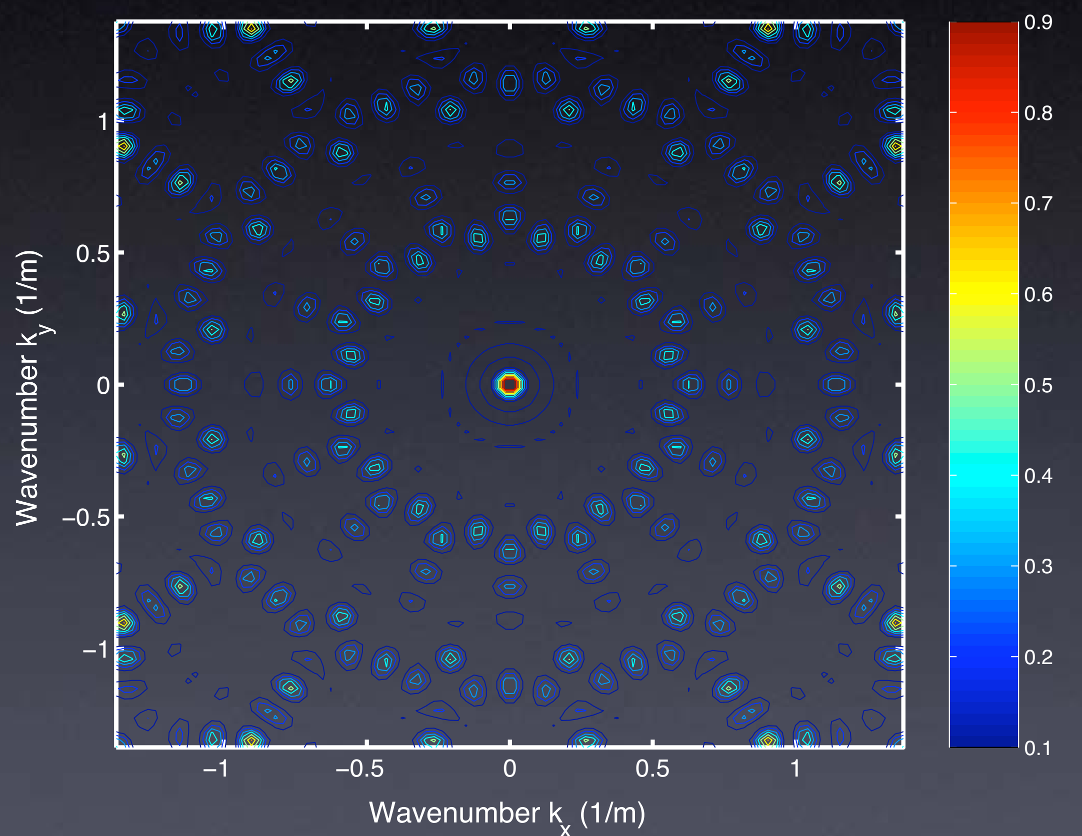
Active Test Configuration





Passive Test Configuration





f-k Calculations

$$Z(k, f_0) = \sum_{m=1}^{M} w_m S_m(f_0) e^{ik \cdot x_m} = e^H W S$$

$$e(k) = [\exp(-ik \cdot x_1), \ldots, \exp(-ik \cdot x_M)]^T$$

$$W = \mathrm{diag}[w_1, \ldots, w_M]$$

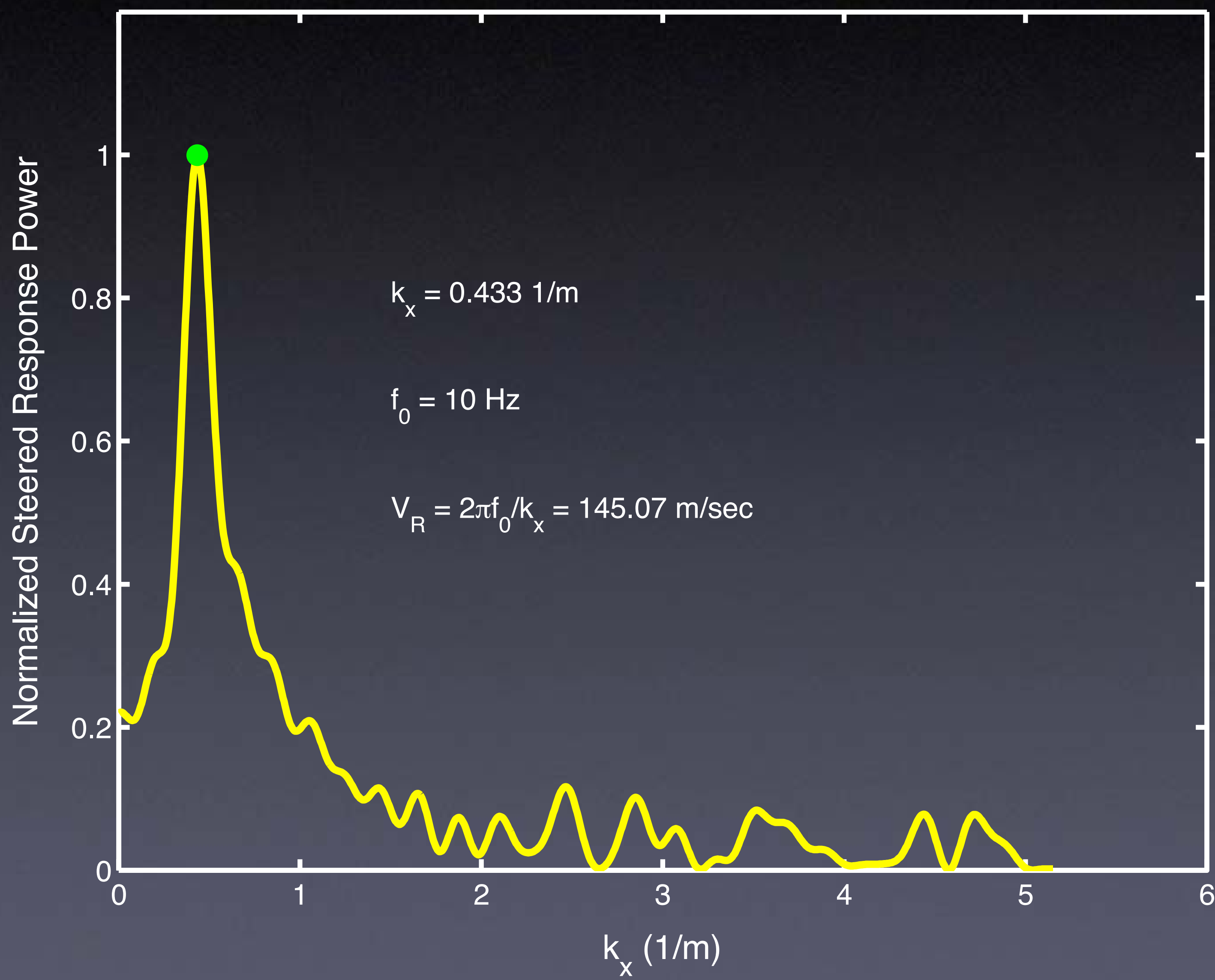
$$S(f) = [S_1(f), \ldots, S_M(f)]^T$$

f-k Calculations

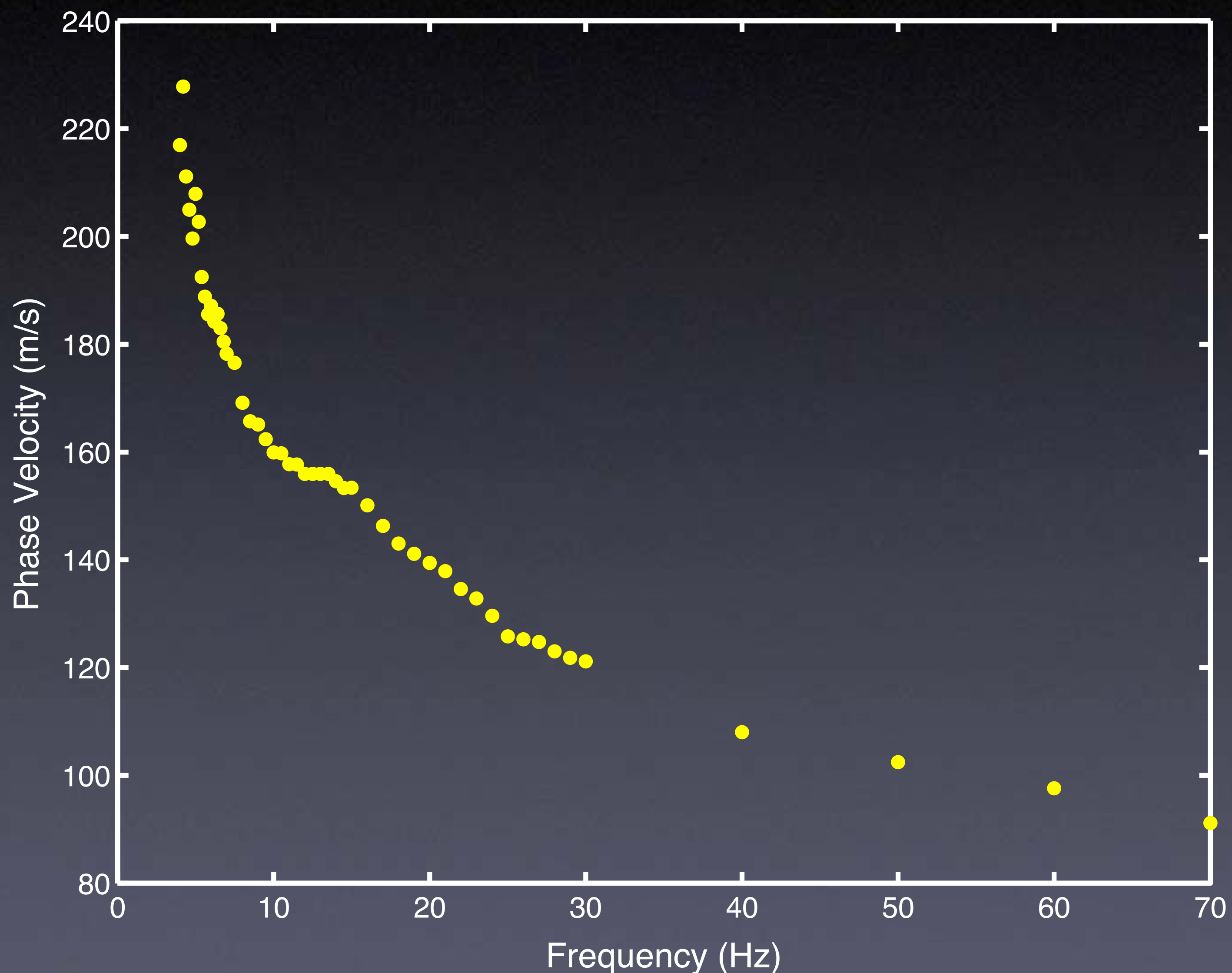
$$P(k,f) = ZZ^H = e^H W SS^H W^H e = e^H W R W^H e$$

$$R(f) = SS^H = \begin{matrix} G_{11}(f) & G_{12}(f) & \cdots & G_{1M}(f) \\ G_{21}(f) & G_{22}(f) & \cdots & G_{2M}(f) \\ \vdots & \vdots & \ddots & \vdots \\ G_{M1}(f) & G_{M2}(f) & \cdots & G_{MM}(f) \end{matrix}$$

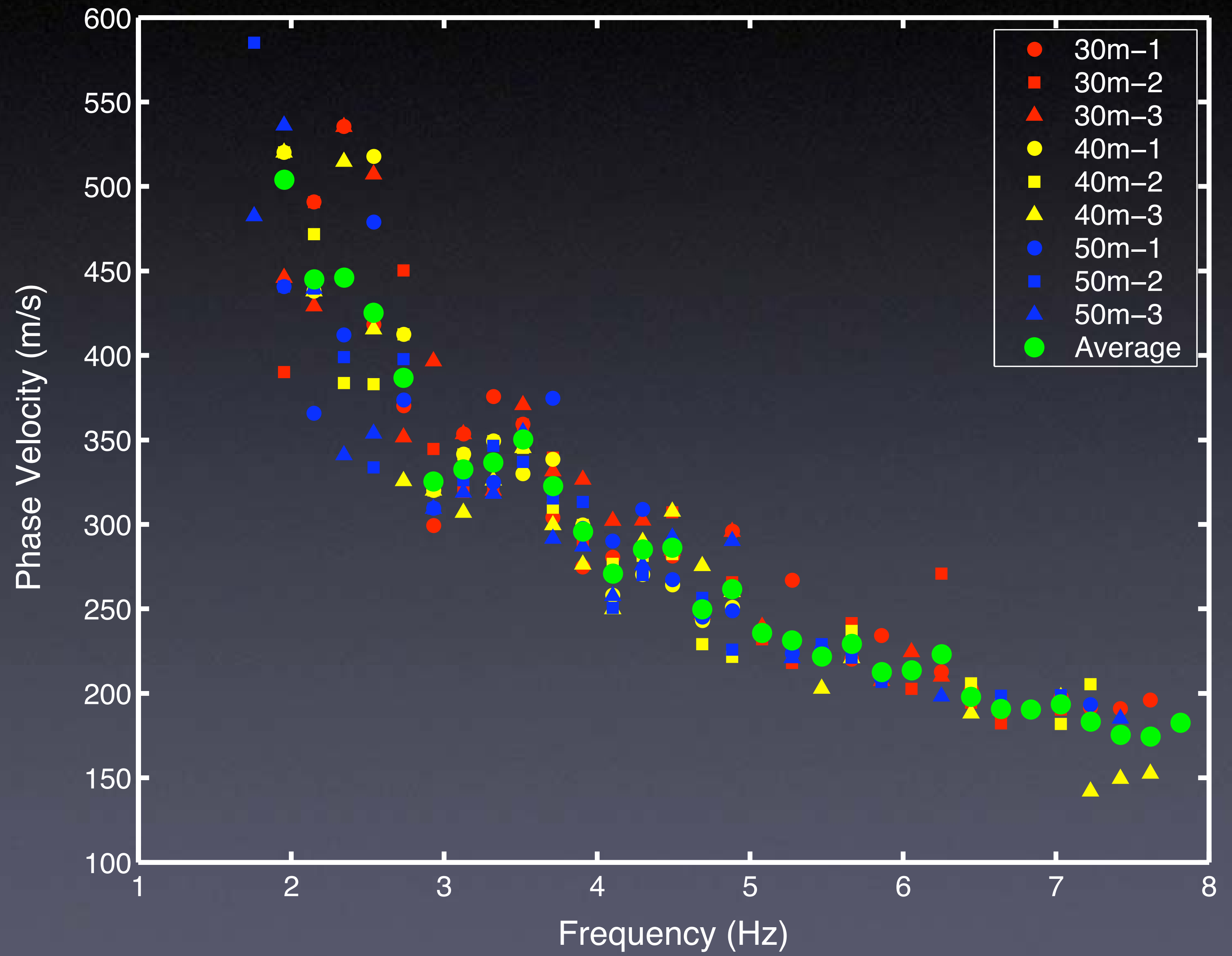
Steered Response Power Spectrum



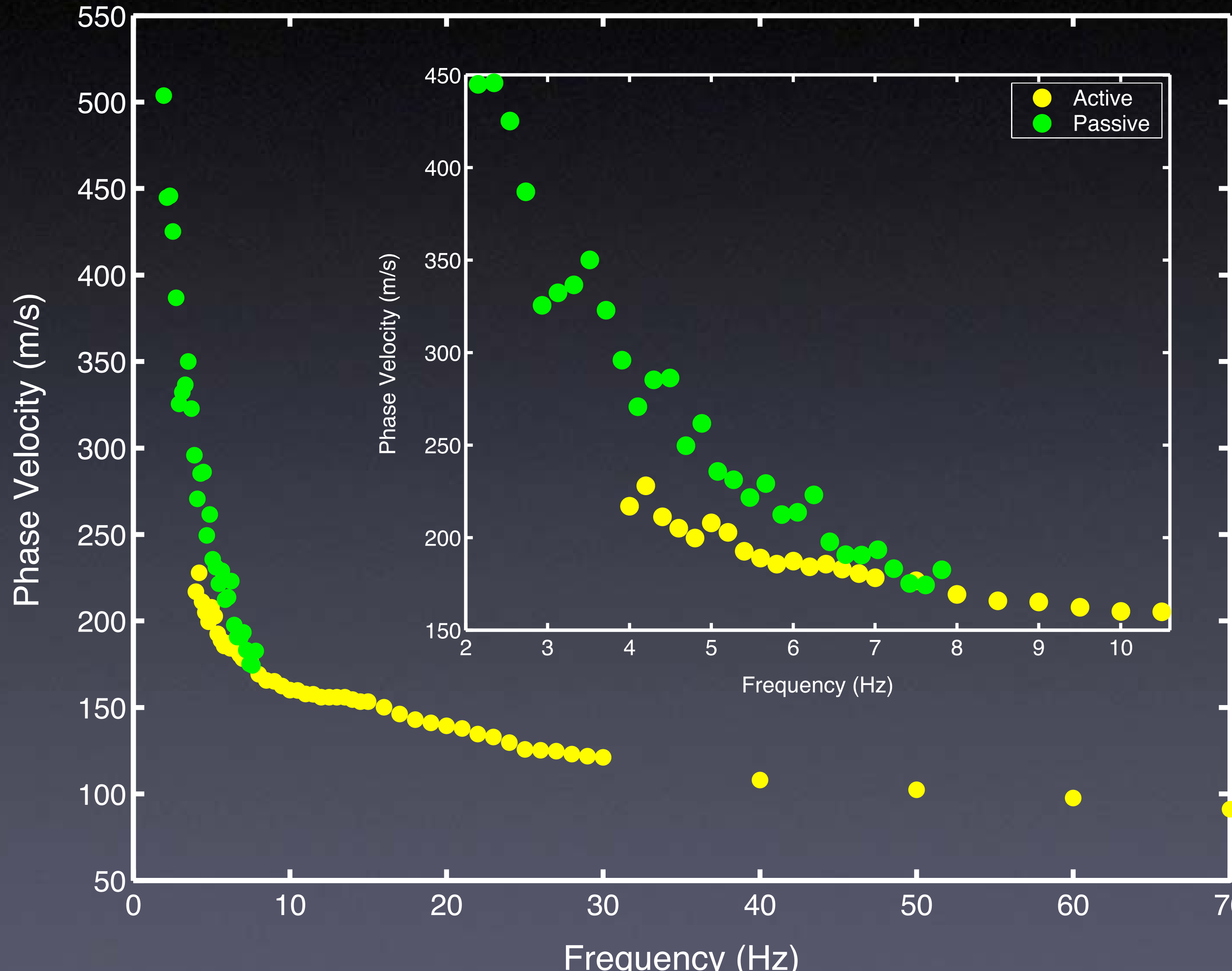
Active Dispersion Curve



Passive Dispersion Curve



Active-Passive Dispersion Curve



Inversion

The V_s profile should "depart from the simplest case only far as is necessary to fit the data." (Constable et al., 1987)

$$^{2} = \tilde{W} V_R^{exp} - \tilde{W} V_R^{theo} \; ^{2}$$

$$R_1 = V_s \; ^{2}$$

$$\tilde{W} = \mathrm{diag}(1/ \; _1, 1/ \; _2, \ldots, 1/ \; _{nf})$$

$$S = R_1 + \mu^{-1} \; ^{2} - \; ^{2}$$

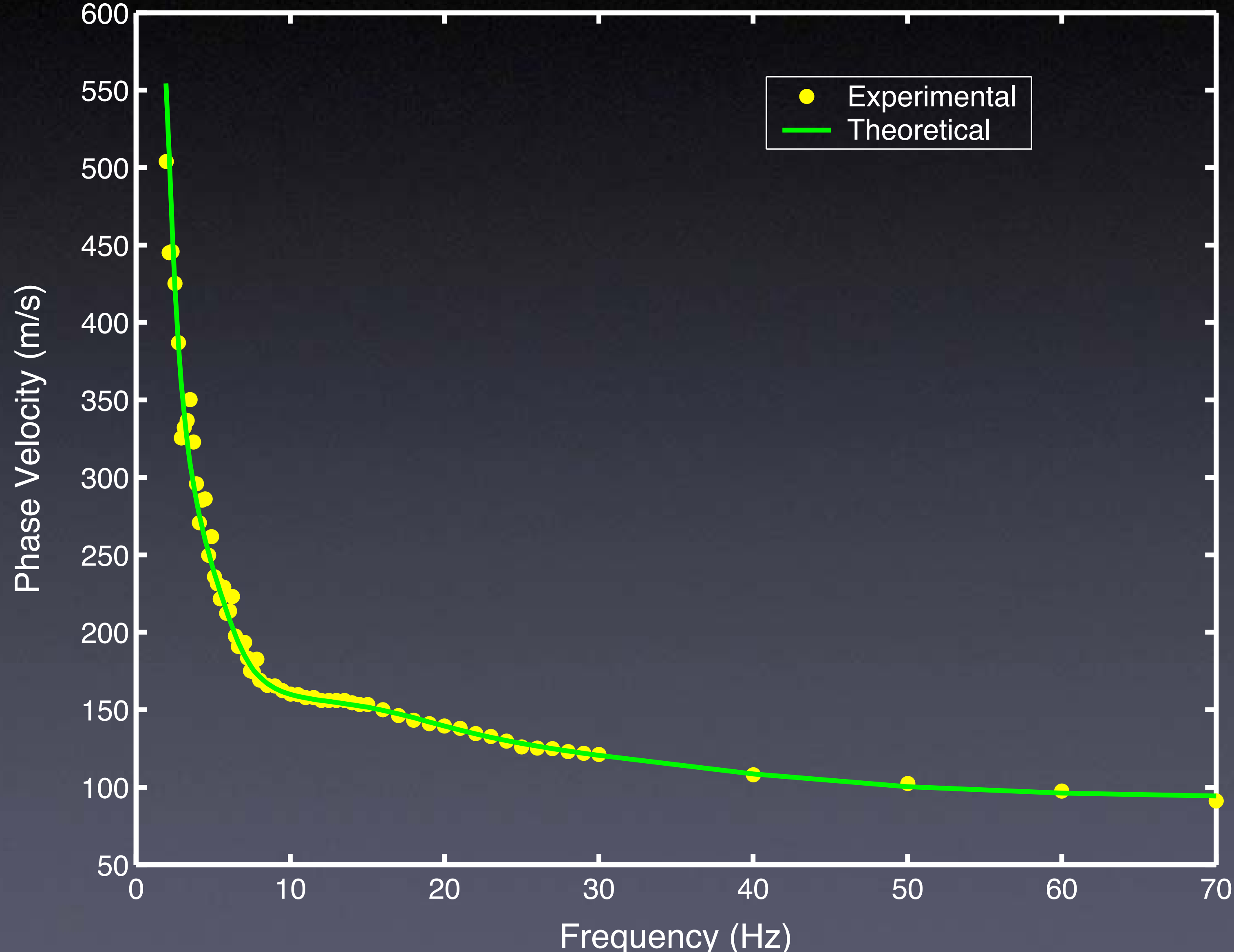
Inversion

$$V_{s(i+1)}(\mu) = \mu^{T} + \tilde{W} J_i^{T} \tilde{W} J_i^{-1} \tilde{W} J_i^{T} \tilde{W} d_i$$

$$J_i = \frac{V_{Rj}}{V_{sk}}$$

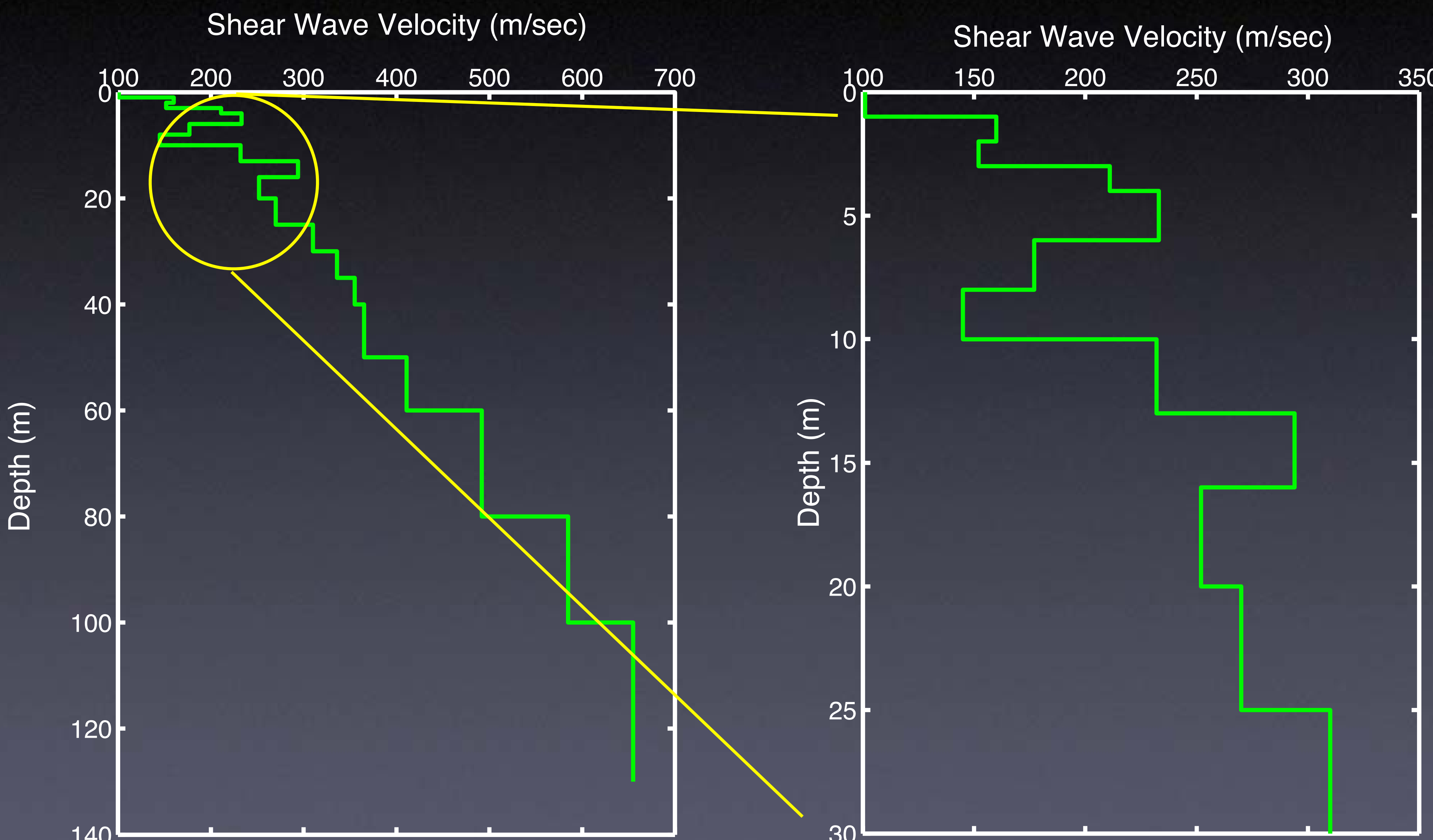
$$d_i = J_i V_{si} + V_{R}^{exp} - V_{Ri}^{theo}$$

Inversion



Experimental
Theoretical
Phase Velocity (m/s)
Frequency (Hz)
600
550
500
450
400
350
300
250
200
150
100
50
0
10
20
30
40
50
60
70

V_S Profile



Shear Wave Velocity (m/sec)
100
200
300
400
500
600
700
Depth (m)
0
20
40
60
80
100
120
140
Shear Wave Velocity (m/sec)
100
150
200
250
300
350
Depth (m)
0
5
10
15
20
25
30