Refraction Microtremor Technique

Based on tow ideas:

-Standard refraction equipment:

e.g. microtremor.

thy used for:

**4.5 to 14 Hz (or higher) vertical geophones.*

-Slowness-frequency transformation of the recorded microtremor:

Separate *Rayleigh waves from other seismic arrivals.*

Comparative Study of the Refraction Microtremor (ReMi) Method: Using Seismic noise and standard P-wave refraction equipment for deriving 1-D S-wave profiles

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Advantages of using SeisOpt ReMi:

-Data acquisition and analysis takes few hours.

-No physical restrictions.

-No specialized recording equipment required

-No artificial seismic source.

-Can be used offshore as effectively as on-shore.

Why SeisOpt® ReMi™

Disadvantages of commonly used method:

Drilling and logging S-wave velocities: -

expensive and take along time. -

Permitting required -

Physical restrictions -

Surface methods: -

expensive and take along time. -

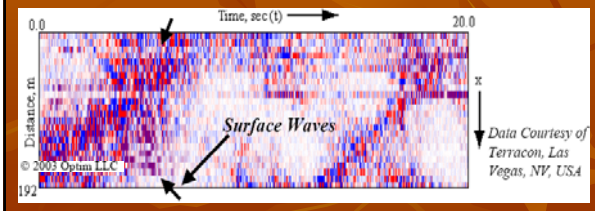
Specialized recording equipment required -

Artificial seismic source required -

Steps of ReMi™ Method:

- Step 1:the Slant Stack operation of the vertical particle velocity.

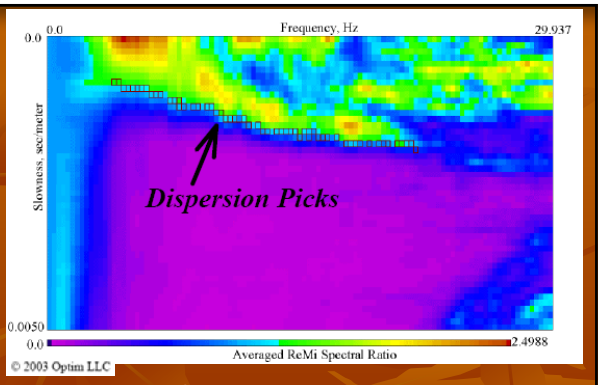
$$A(p=p0+ldp, \tau=kdt) = \Sigma A(x=jdx, t=idt = \tau+px)$$



SeisOpt® ReMi™ Method:

•Acquire 15-20 seconds microtremor along a linear array.

• Array length depends on depth of investigation.



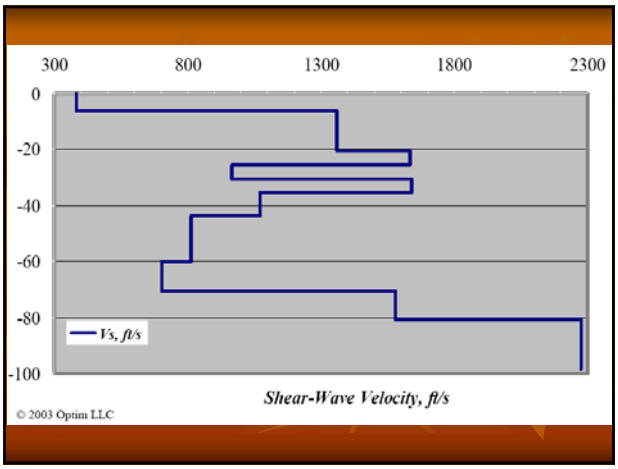
Lower limit of the apparent phase velocities can be recognized as the true phase velocities

Step 2: Fourier transformation: p-τ to p-f domain ■

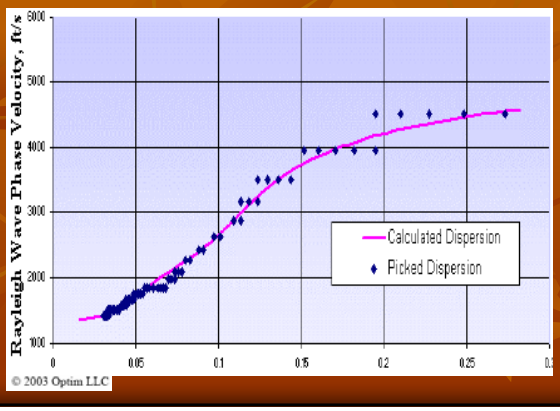
$$F\,A(p,f = mdf) = \Sigma\, A(p,\tau=kdt)ei2\pi\, m\, df\, kdt$$

Step 3: Velocity Spectral Analysis : Power spectrum

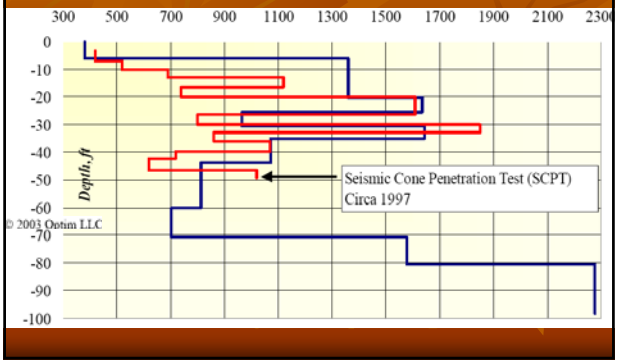
$$SA(|p|,f) = [SA(p,f)]p>=0 + [SA(-p,f)]p<0 :$$
$$Stotal(|p|,f) = \Sigma\, SAn(p,f)]$$

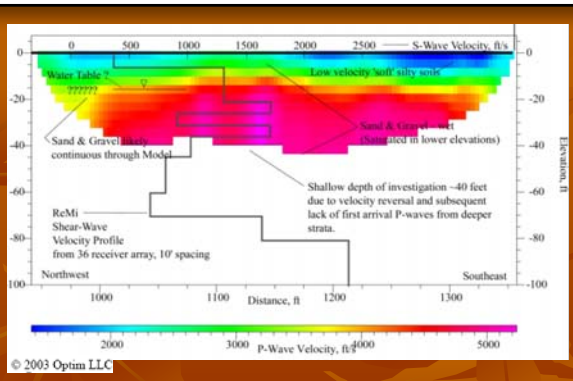


Step 4: Interactive Forward Velocity Modeling



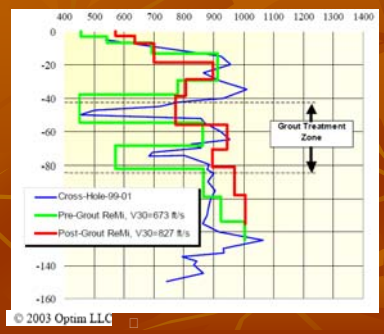
•Comparison of SeisOpt ReMi with SCPT



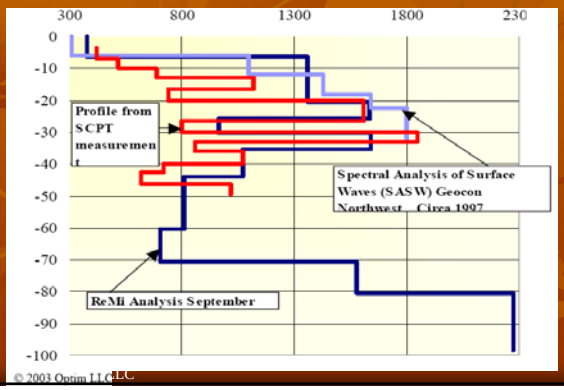


•Shear-wave profile from ReMi overlain on refraction velocity model from SeisOpt @2D

•Comparison of Cross-hole and SeisOpt ReMi at Wickiup



•Comparison of SASW with SCPT



• ReMi Vs profiles can be used for:

-Earthquake site response.

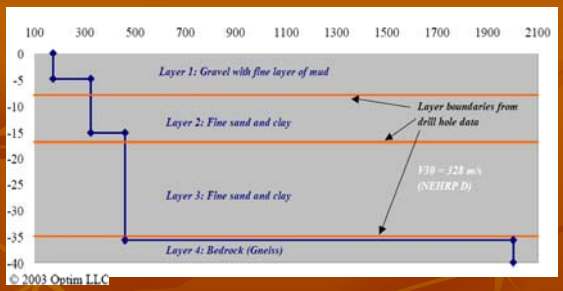
-Liquefaction analysis.

-Mapping the subsurface and estimating the strength of subsurface material.

-Complementing seismic refraction analysis in areas characterized by near-surface velocity reversals.

-Finding buried cultural features, such as dumps and fill material in submerged structures.

-Determining soil classification for offshore projects.



The resulting ReMi S-wave velocity profile revealed boundaries that correlated well with logged cores from drill holes, and also provided the same soil classification standard as the drill holes.

Conclusion:

SeisOpt® ReMi™

-Compares well with previously used 1-D shear wave measurement techniques: Economic, accurate and reliable.

-Determine shear strength of subsurface material

-Save money in performing seismic site characterization studies