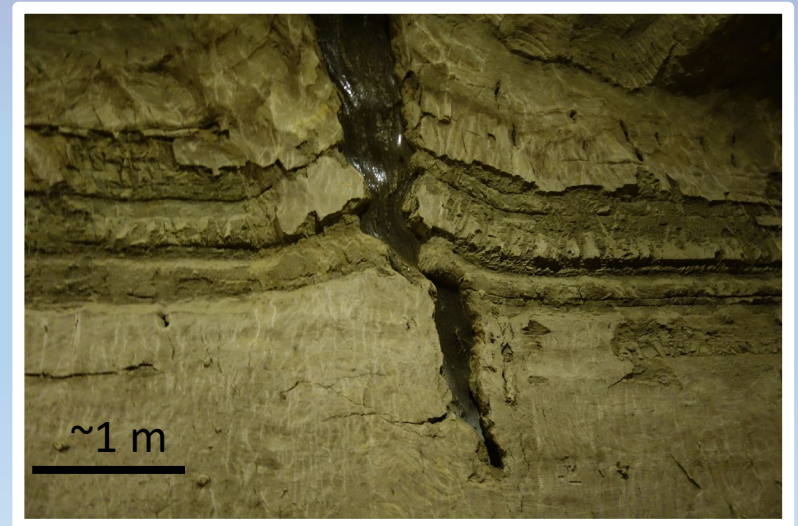
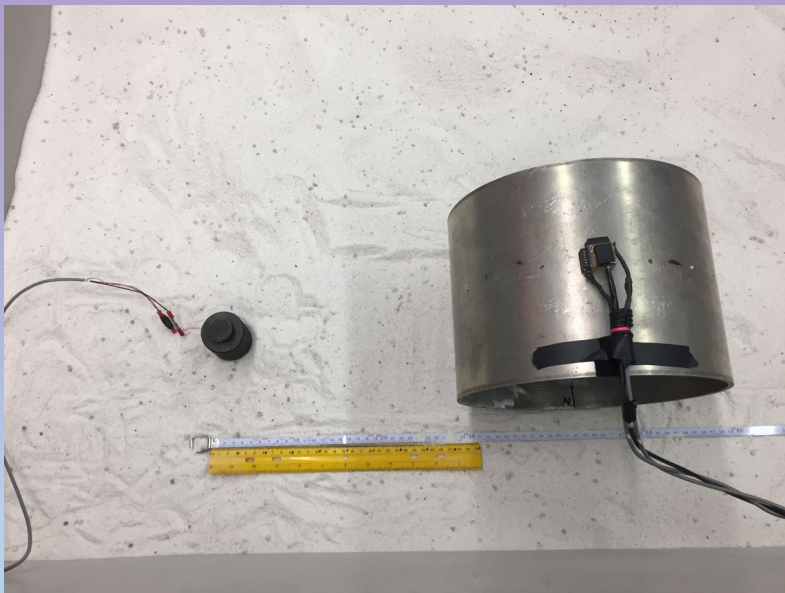


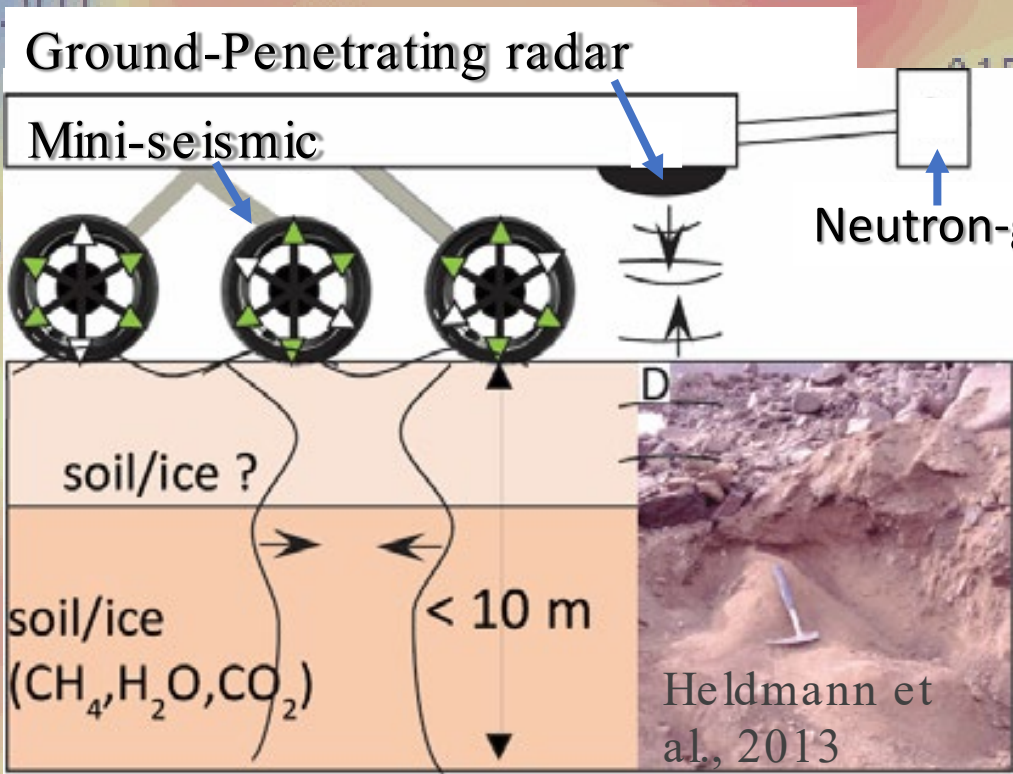
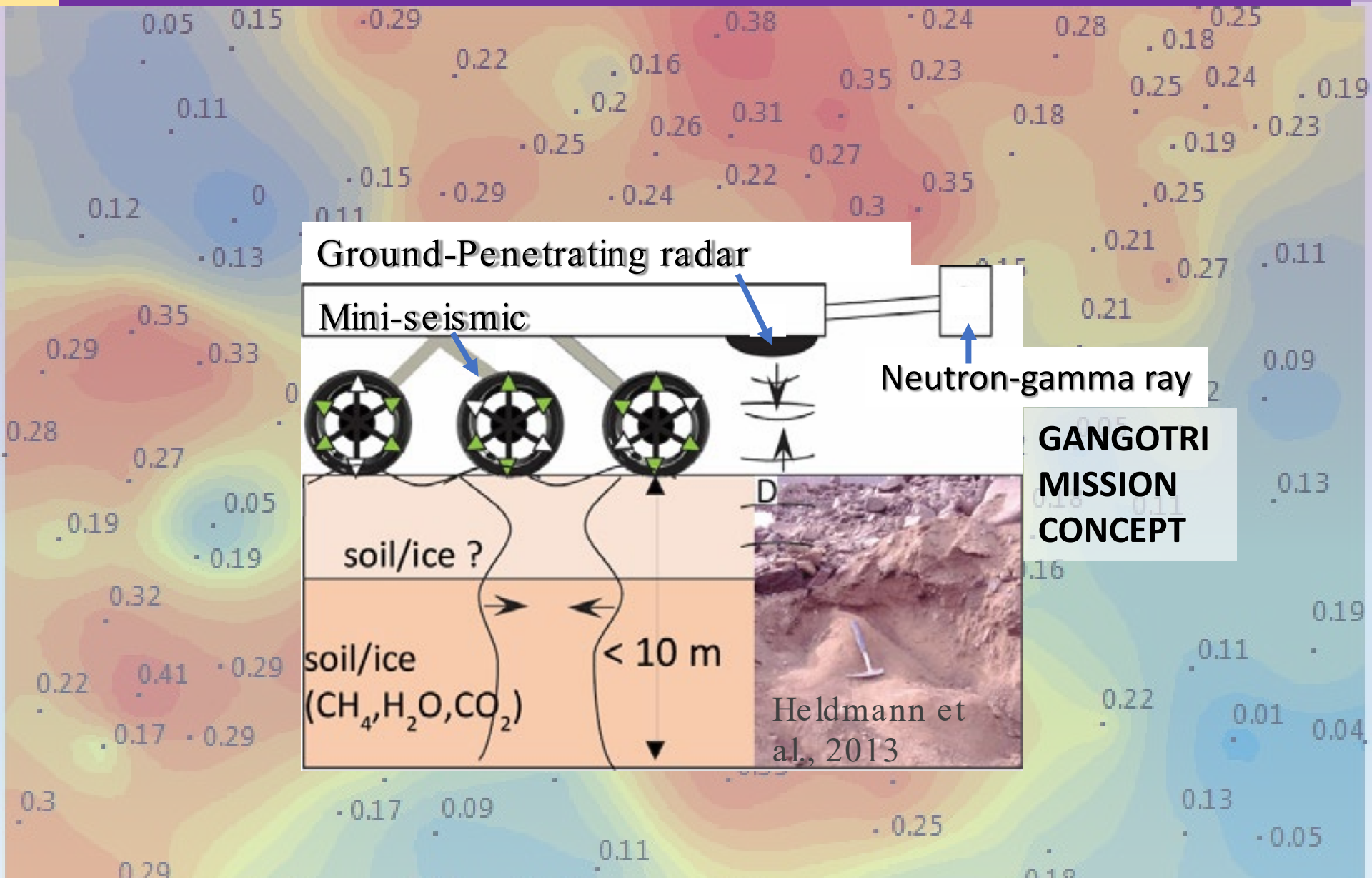
Seismic Wheel for Shallow Characterization (0- 1 m) of Soils on Mars (and the Moon too)

J. M. Lorenzo¹, T. A. Douglas², H. Haviland⁴, M. Zanetti⁴, R. C. Weber⁴, C. Fassett⁴, D. A. Patterson¹, C. Sun¹, A. Bates¹, S. Karunatillake¹



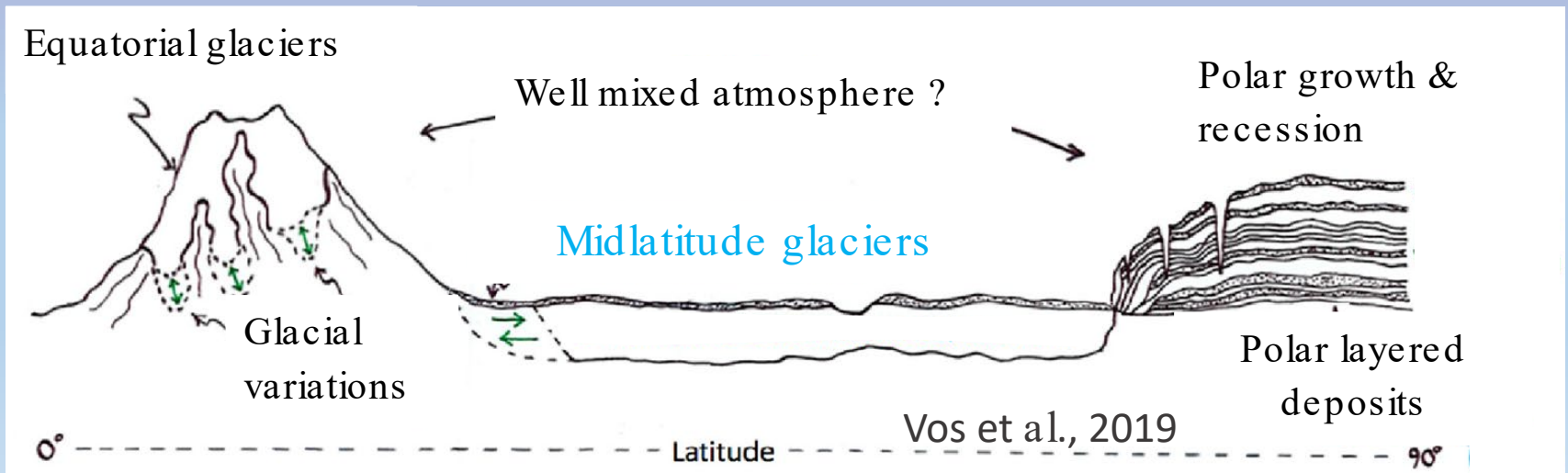
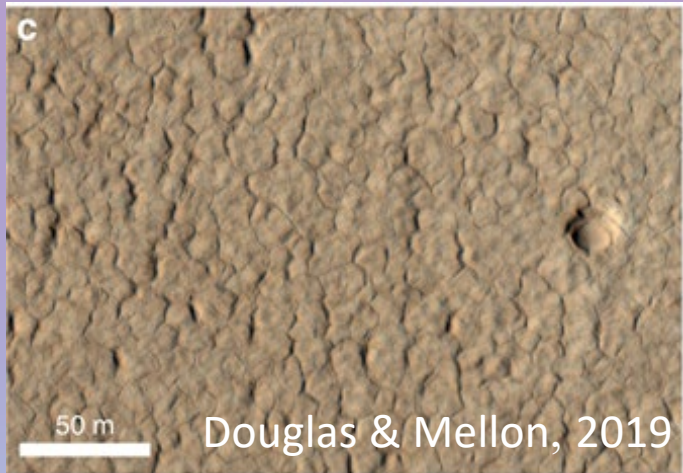
Fairbanks, Alaska

Integrated Tools for Resource Mapping

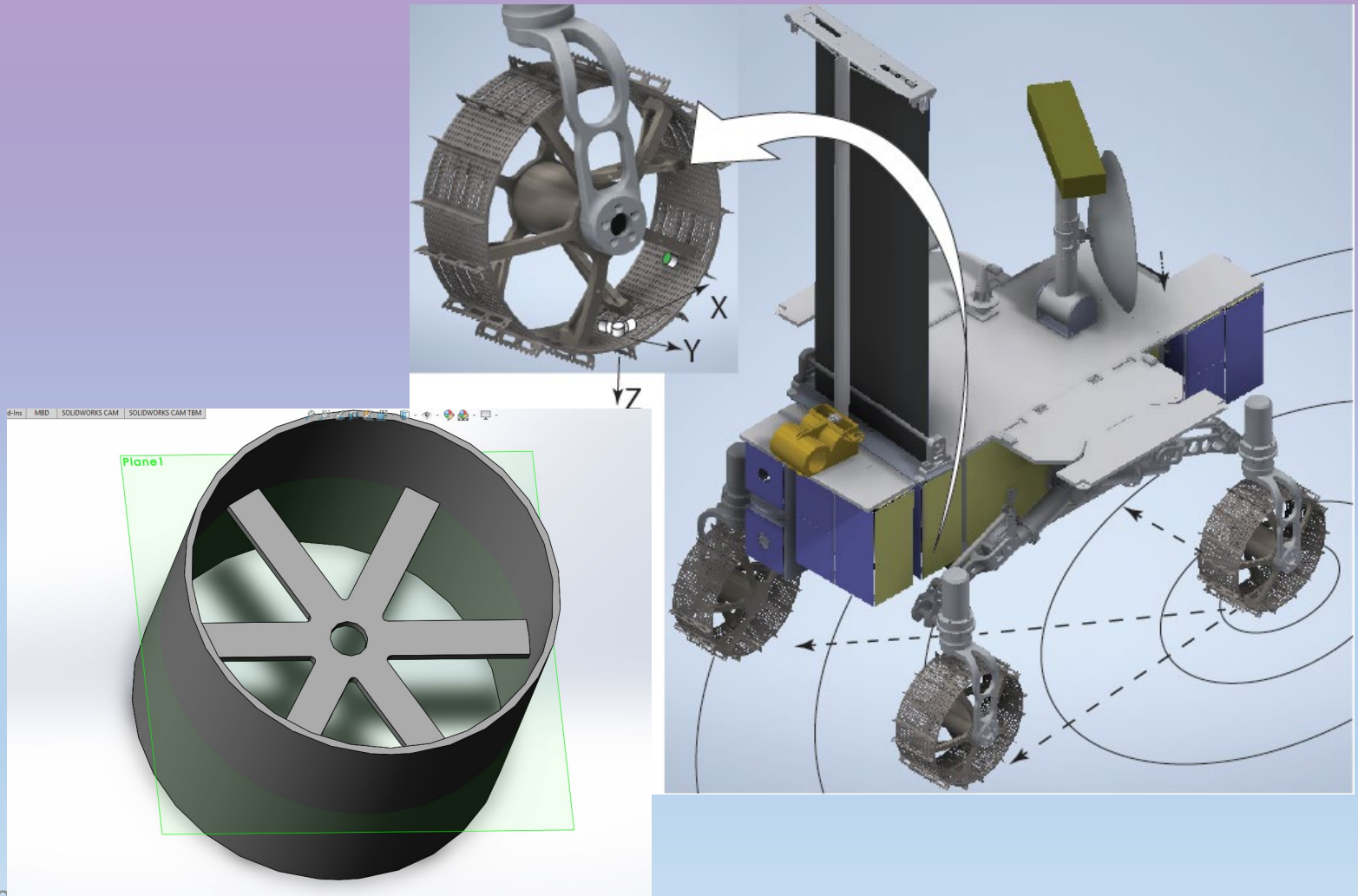


**GANGOTRI
MISSION
CONCEPT**

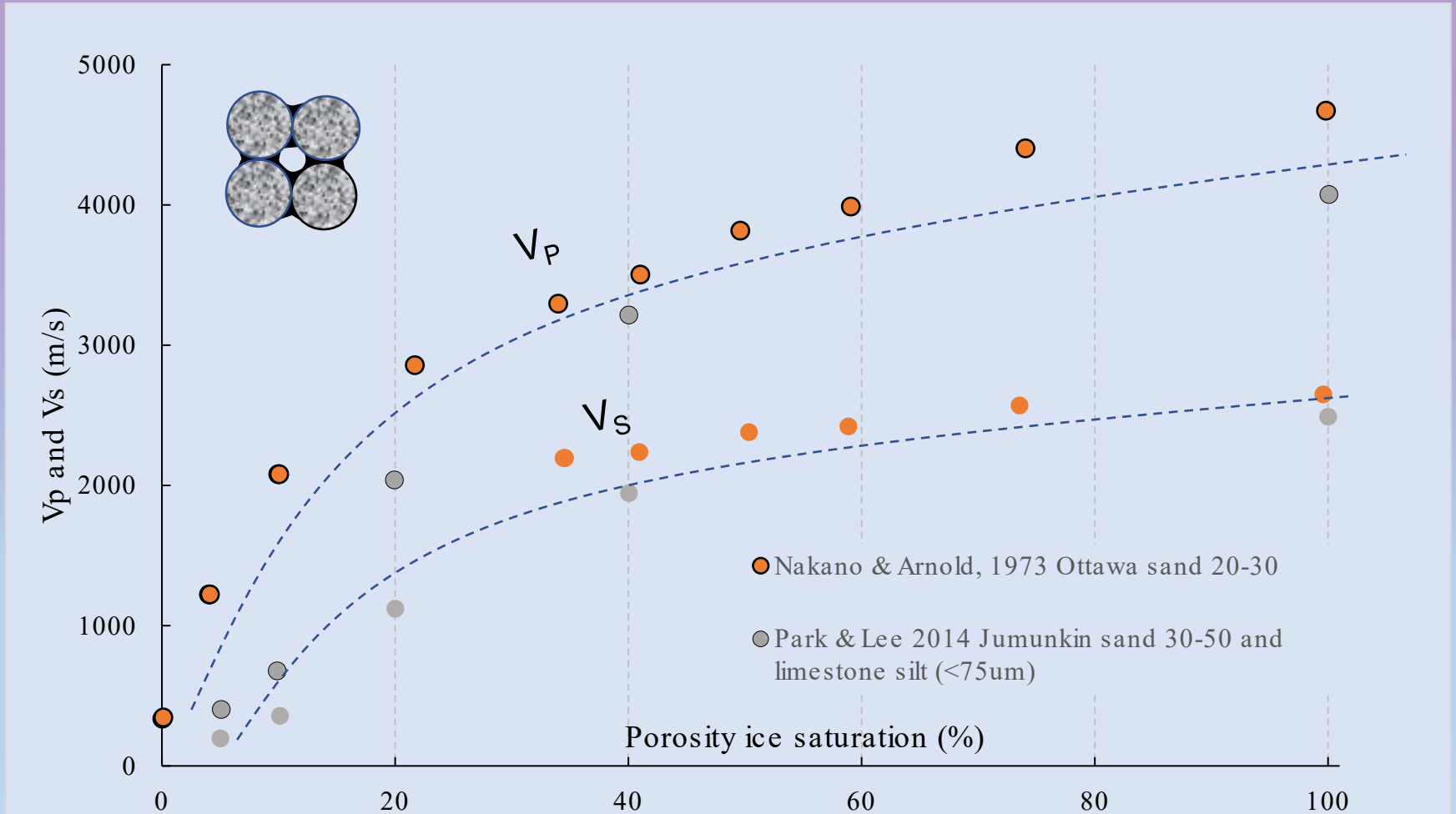
Mid-latitude Glaciers and Permafrost



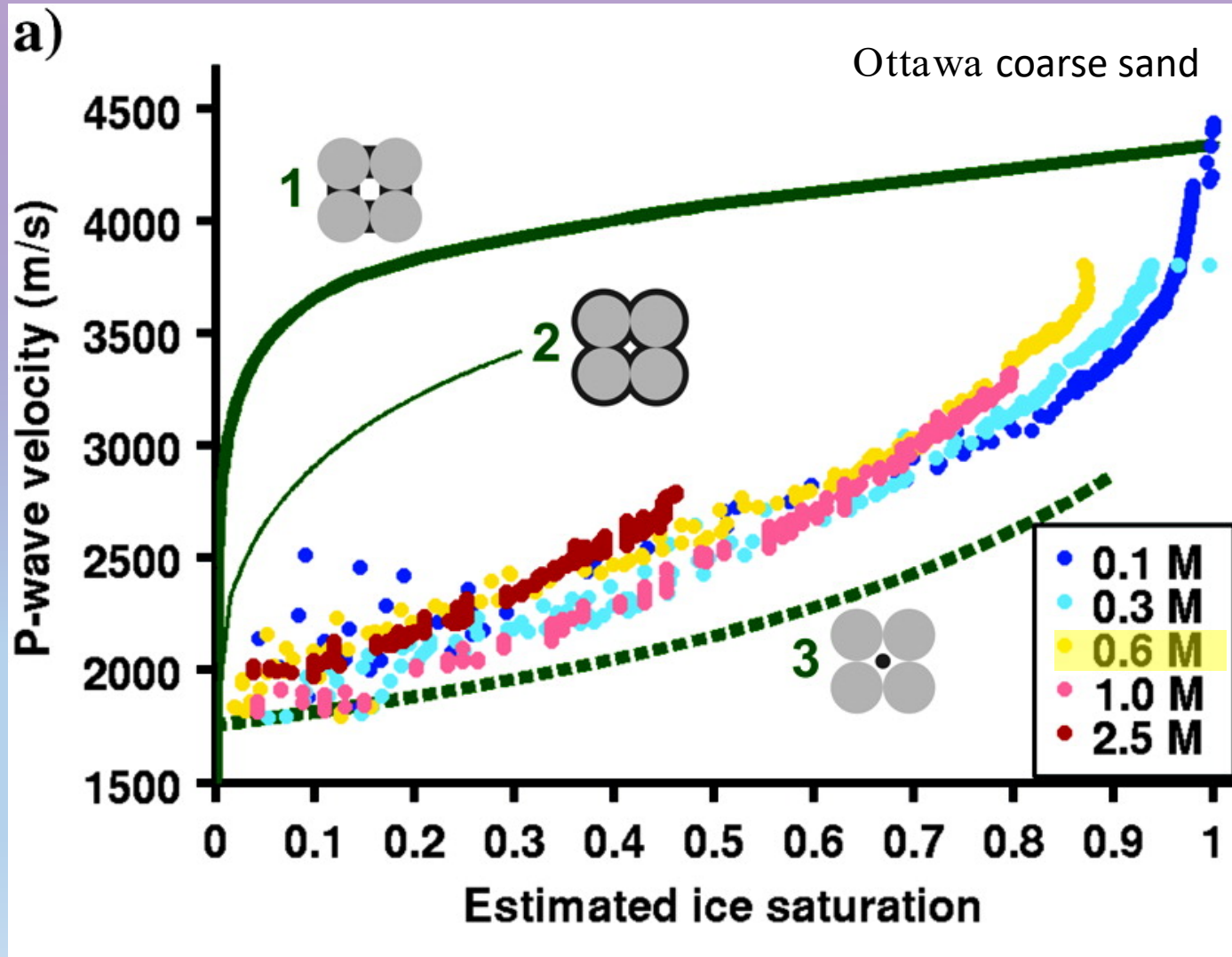
Piezo-ceramic Sensors and Pulsers on a Wheel



Seismic Velocity Sensitivity to Ice Saturation



P-wave Velocity Sensitivity to Brine Salinity



Shallow Seismic Reflection Imaging

Peter Clift (Co-PI)

N. Benton

A. Gostic

M. Morrison

B. Odom

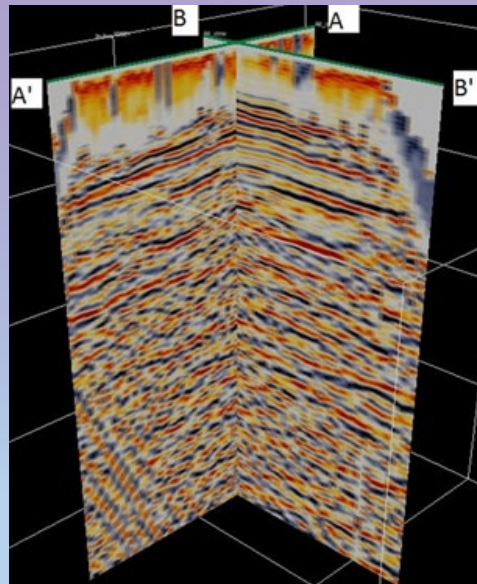
A. Lechnowskyj

E. Olson

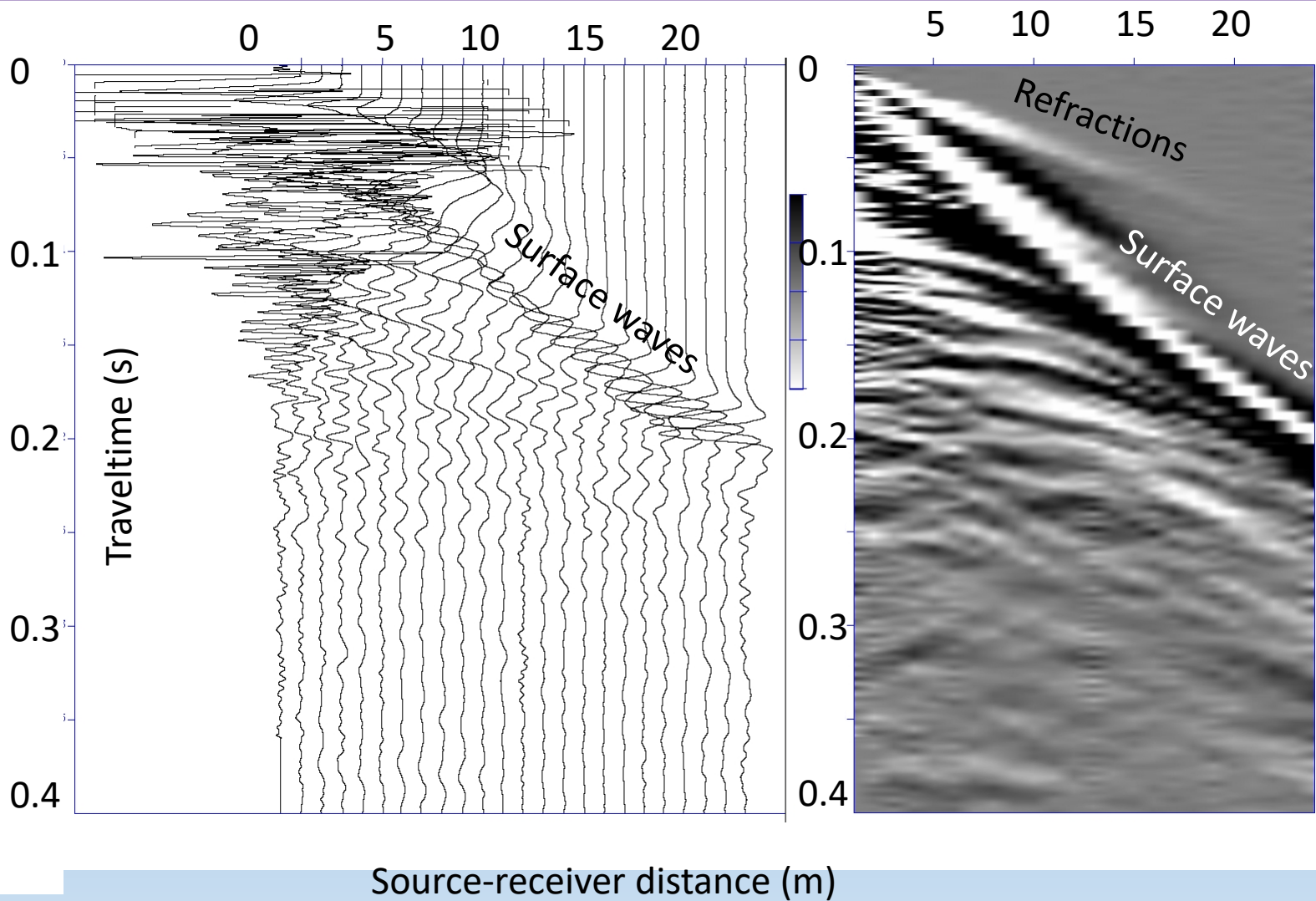
M. Moran

A. Barbato

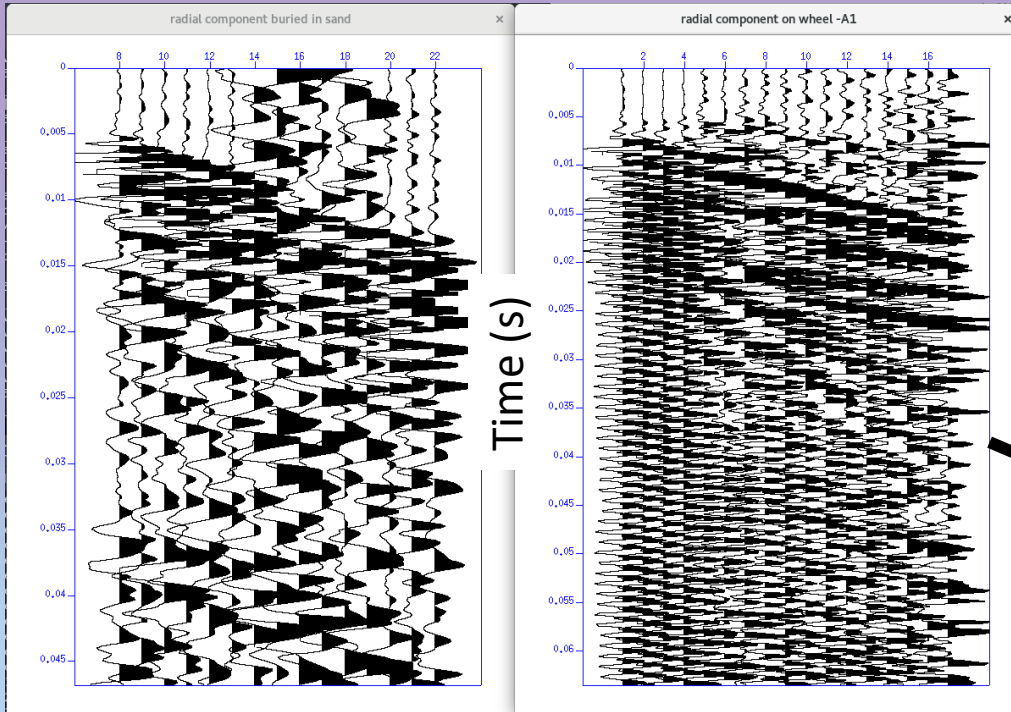
Holocene Point Bars



Surface waves

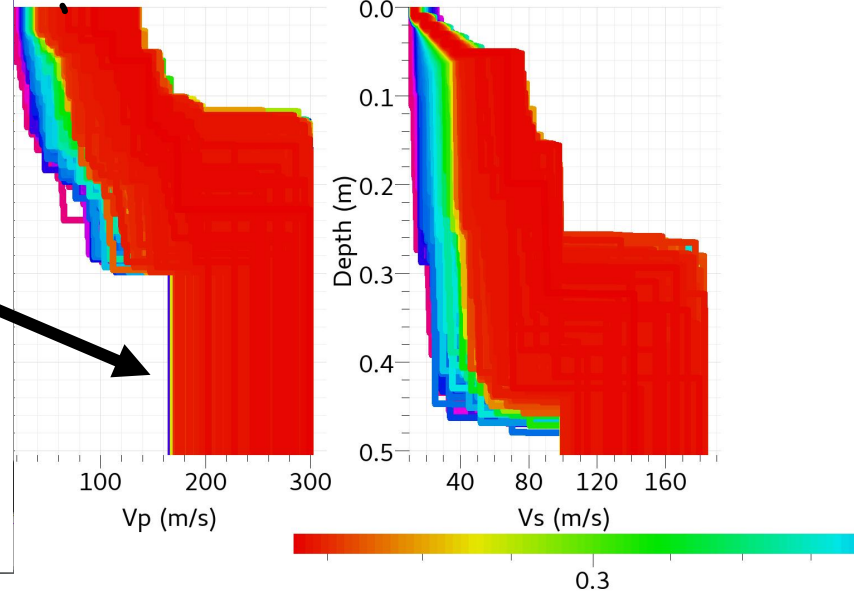


Post-acquisition Analysis of Surface Waves

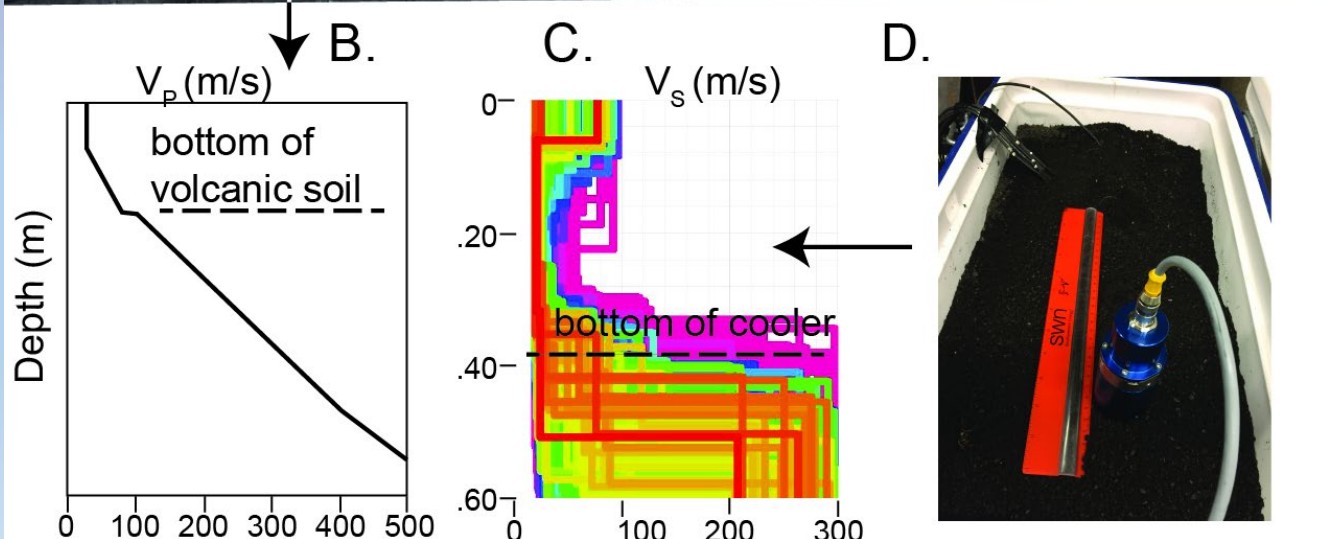


Source-sensor offset
(0.1-0.8 m)

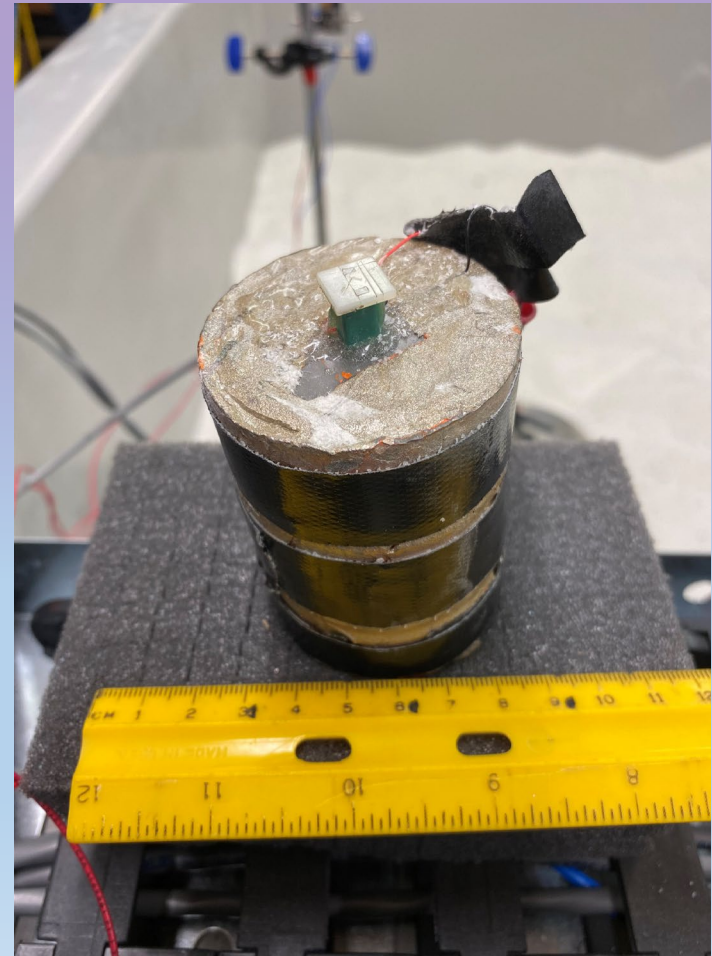
Source-sensor offset
(0.2 – 1 m)



MSFC summer 2019 Regolith Experiment



Post-acquisition Analysis of Surface Waves



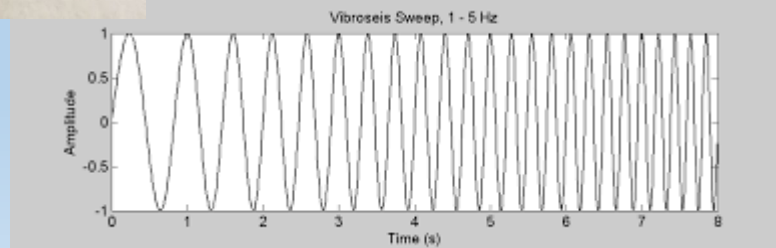
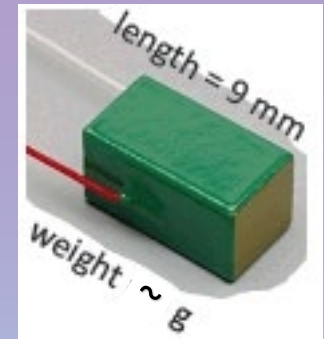
Piezo-ceramic sources and sensors



Sensors: (a)
PCBP/Endevco*
cryo-2271A 27 g



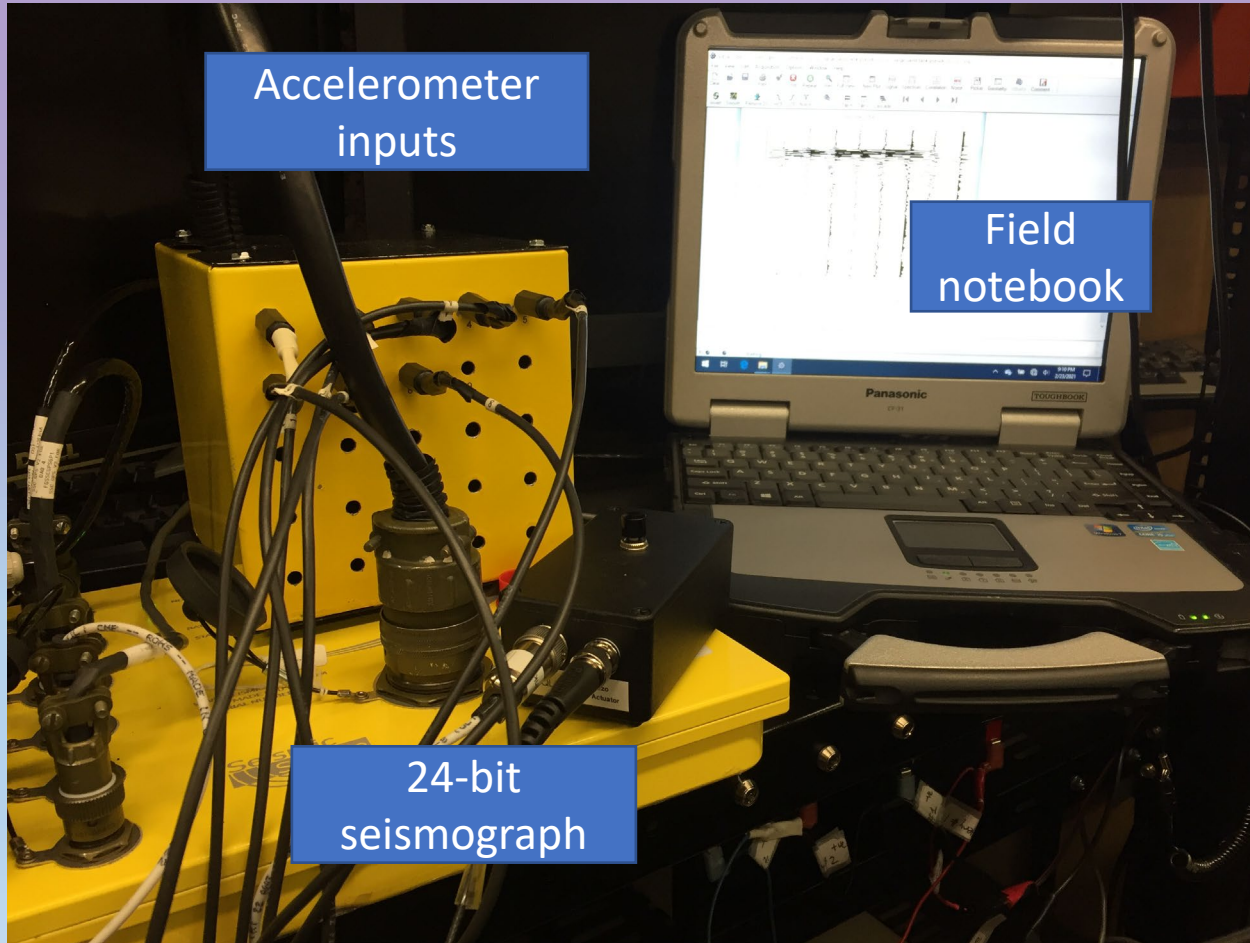
Source:
TOKIN AE0707D08DF



Pulse or, Swept-source

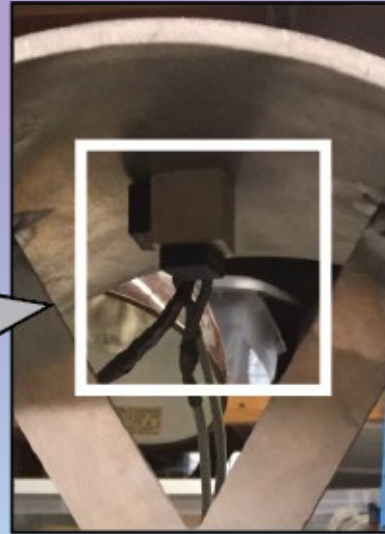
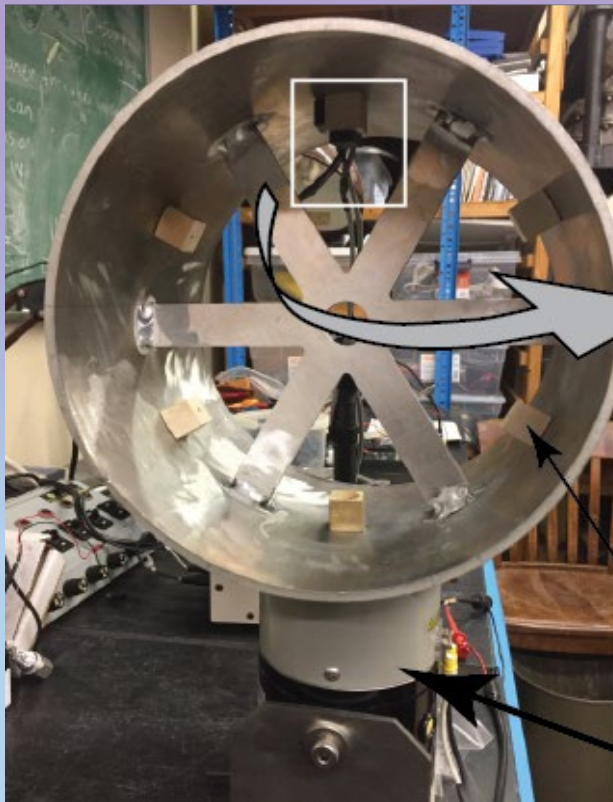
(also, 356A71: 3-
component)

Field-portable Acquisition System



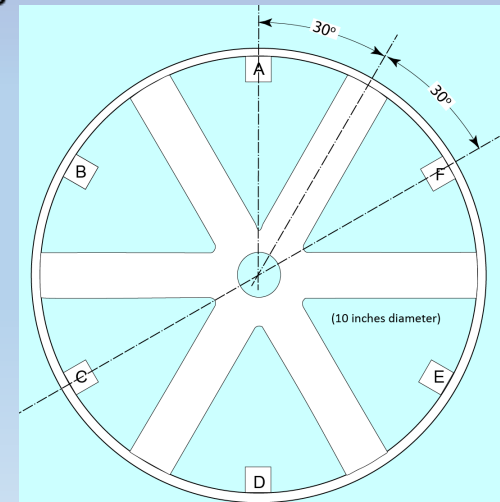
Field-ready
Digital
Acquisition
-40 to + 40
deg C.

Characterization of Resonance

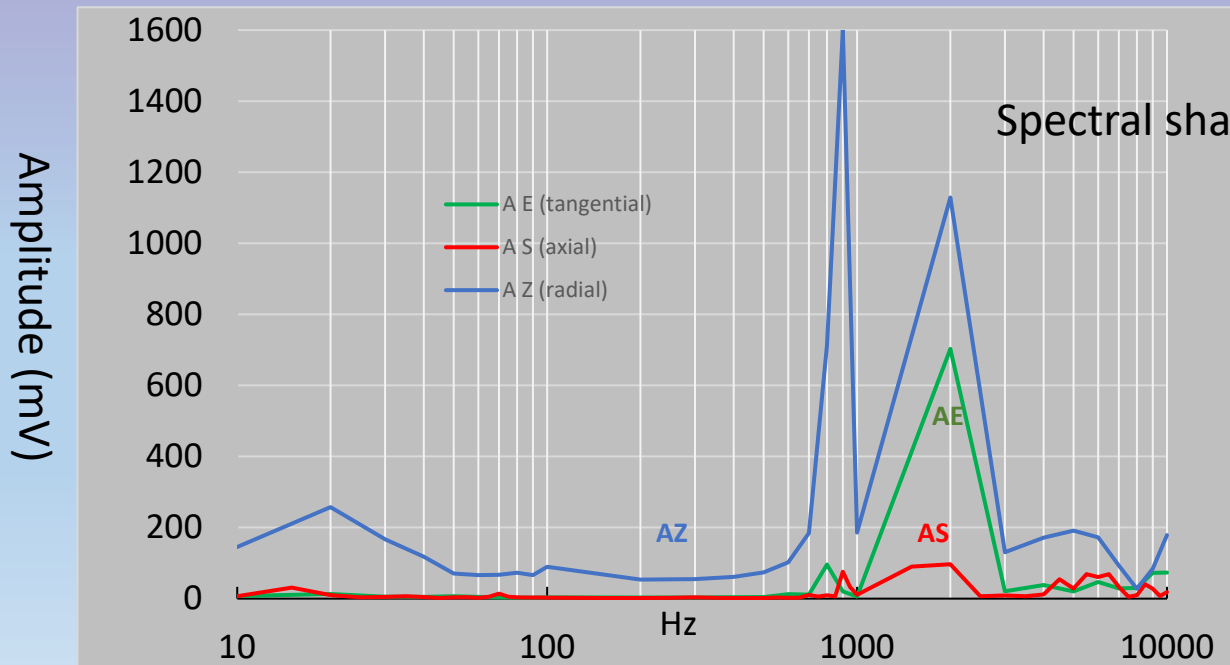
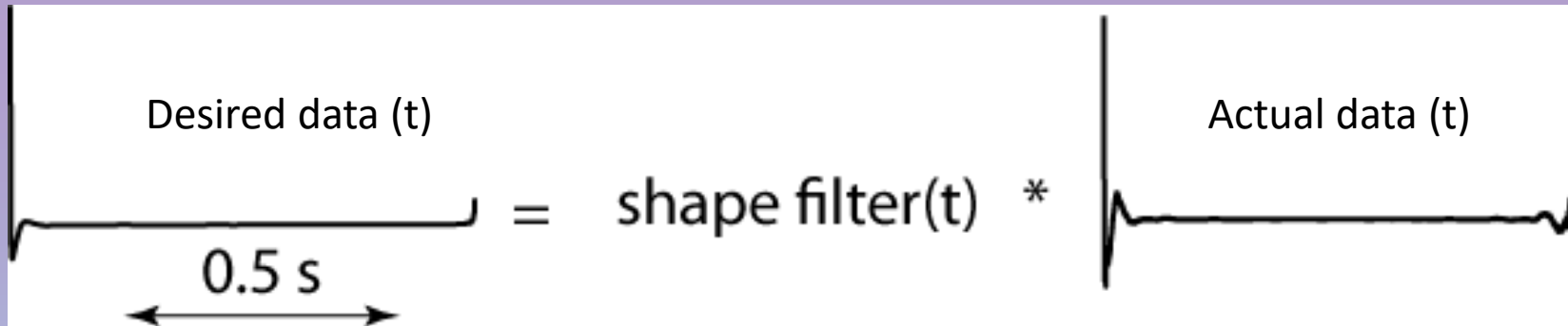


Three mounted accelerometers aligned into radial, axial, and tangential orientations

rigid cube base to mount piezo-polymer accelerometers
electromagnetic shaker



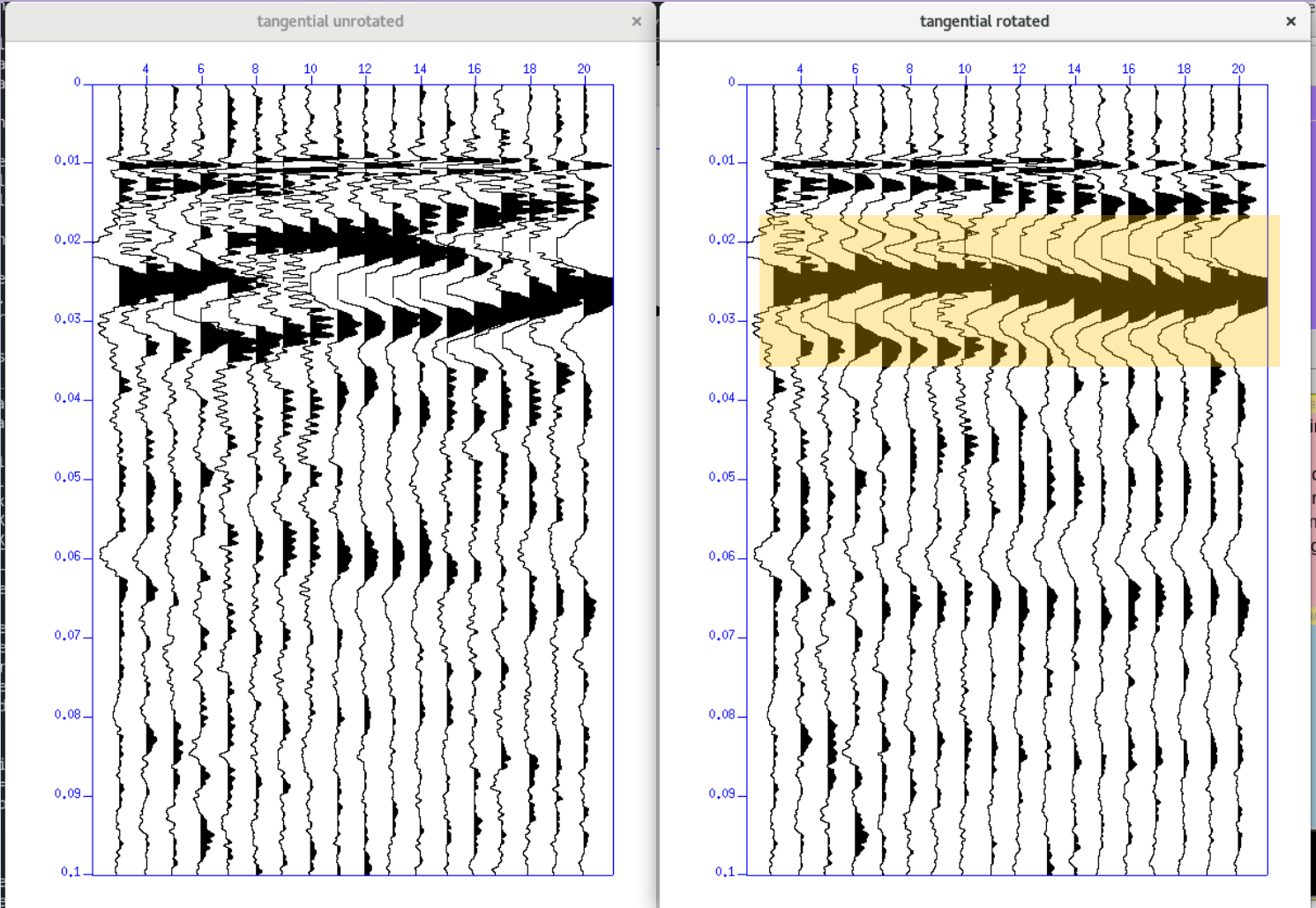
Resonance



Spectral shaping (frequency, phase)

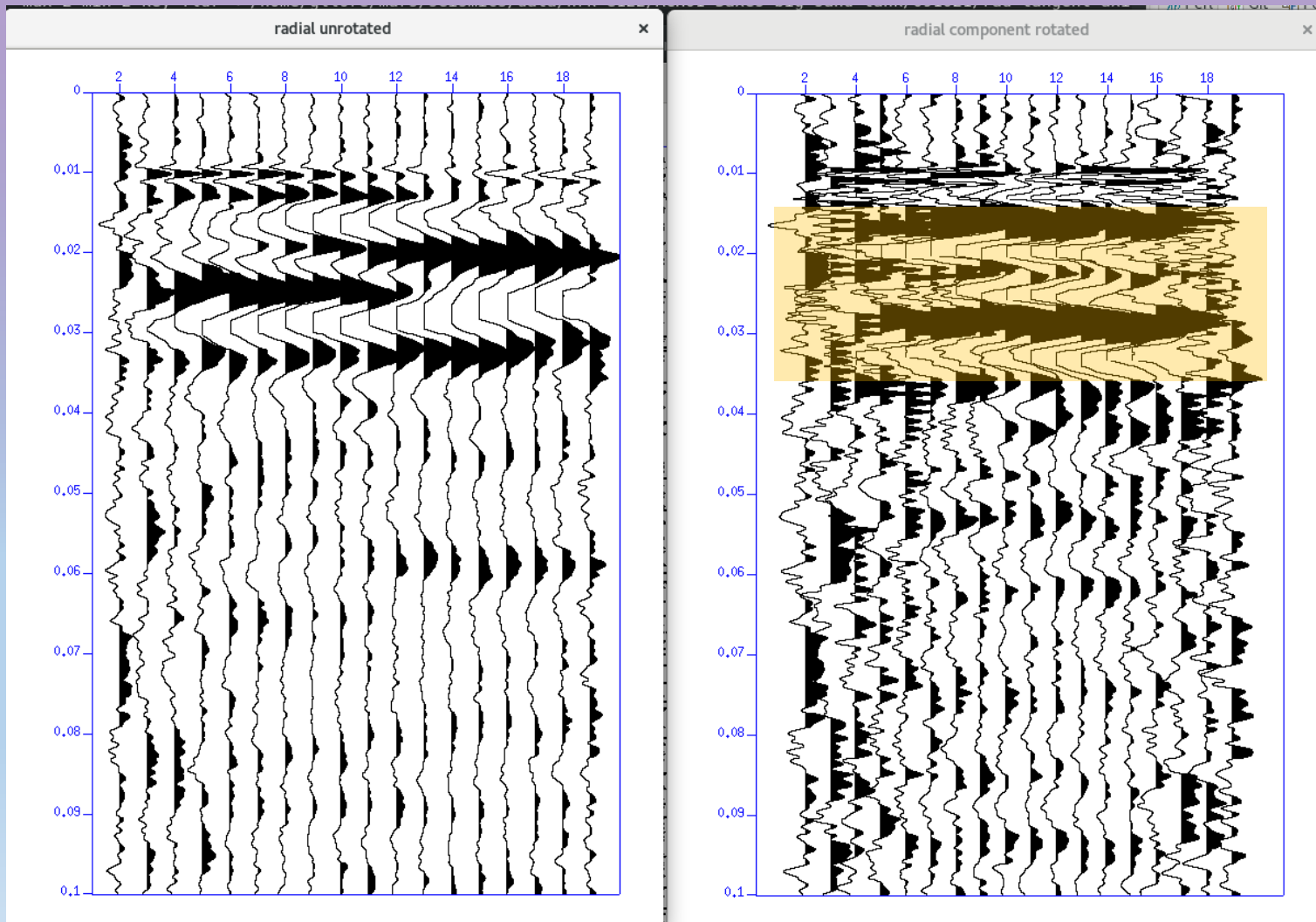


Post-acquisition Analysis of Surface Waves



Offset=0.4 m

Post-acquisition Analysis of Surface Waves



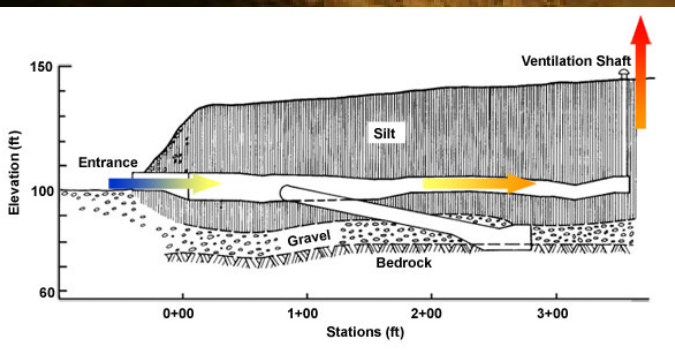
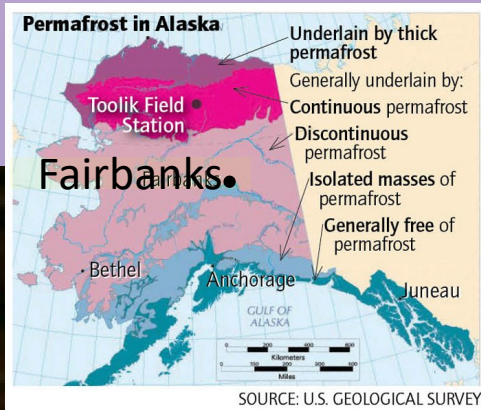
Offset=0.4 m

Environmental Chamber



Permafrost Tunnel Research Facility*

*A Cold Regions Research & Engineering Laboratory (CRREL)

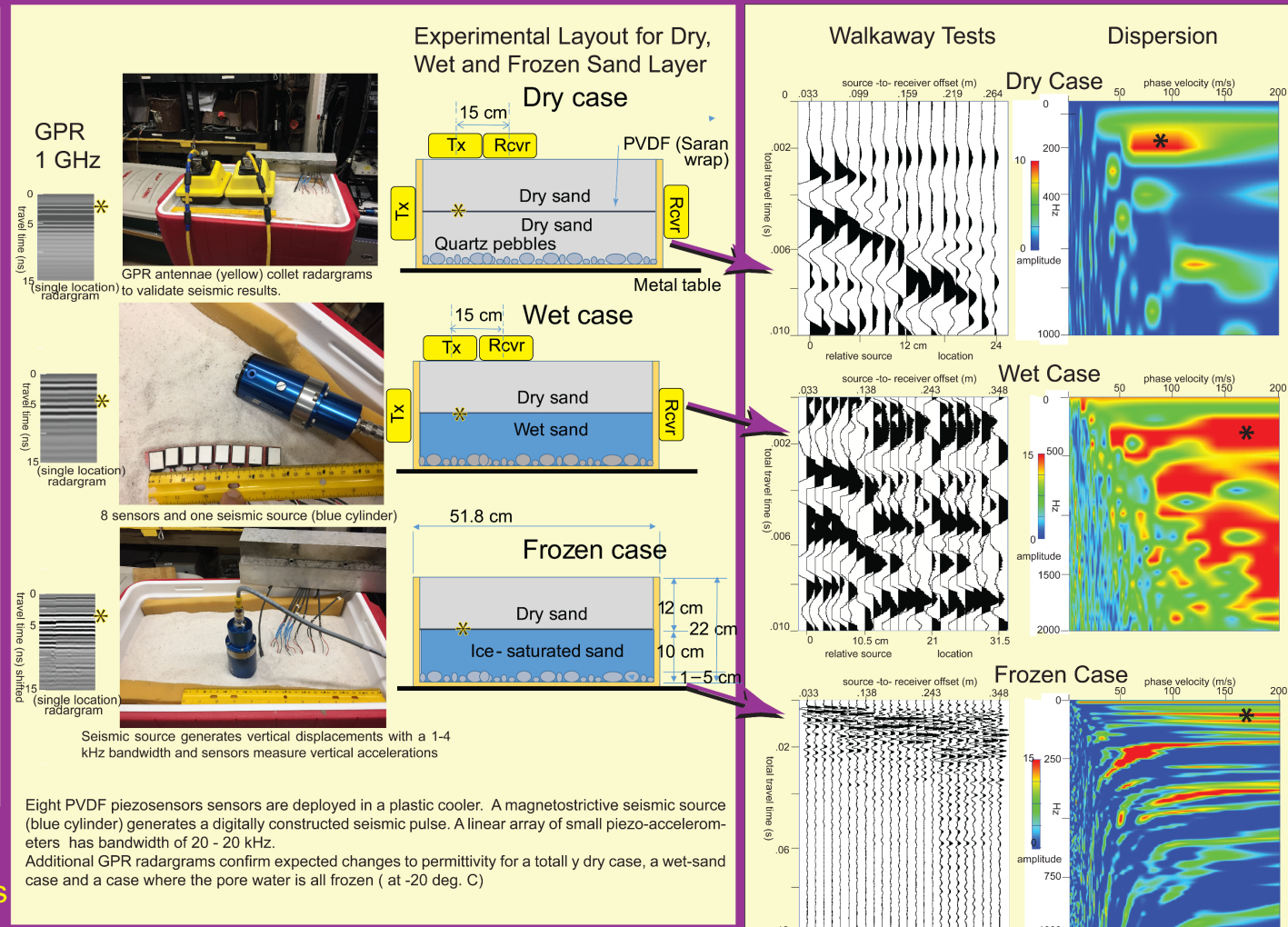


Since 1969, ~250 m tunnels; 500 m new, since 2019.

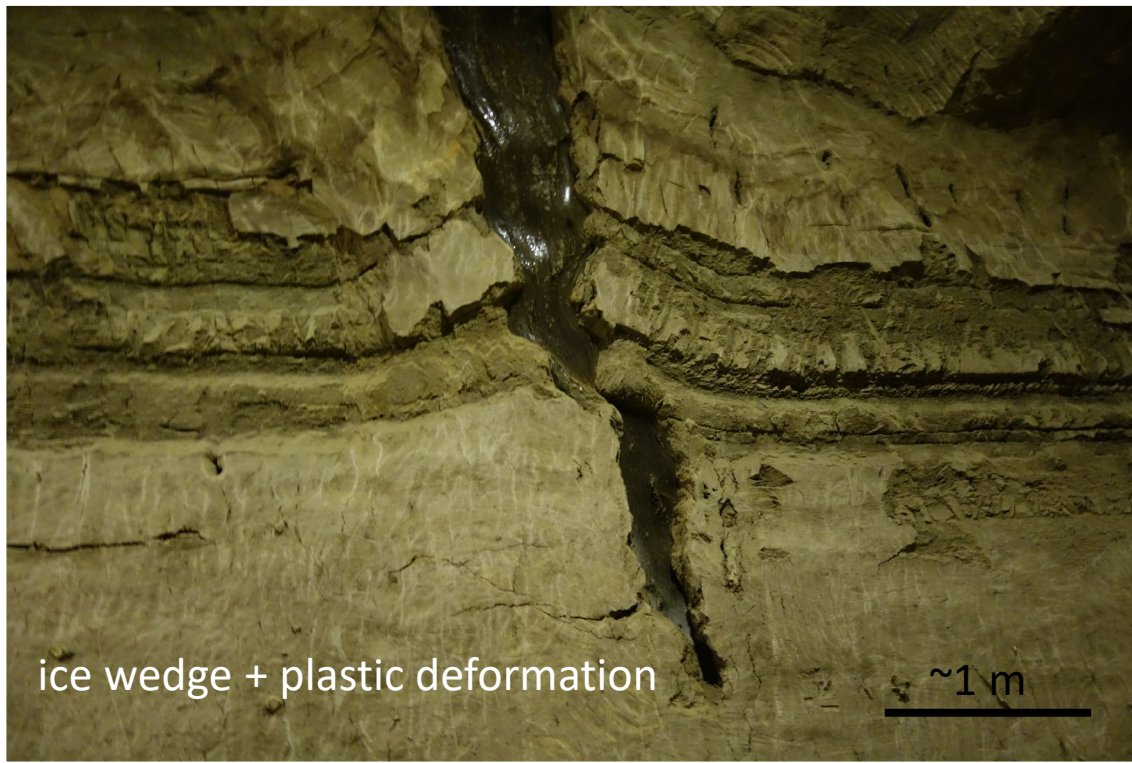
Calibrations against GPR

Physical Seismic Models

Seismic Wave Data

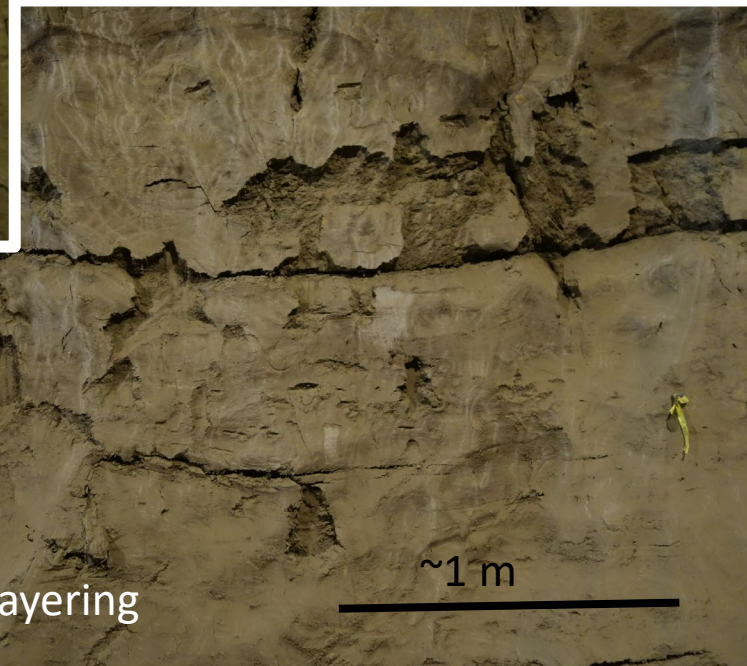


USACE-Permafrost Tunnel Research Facility



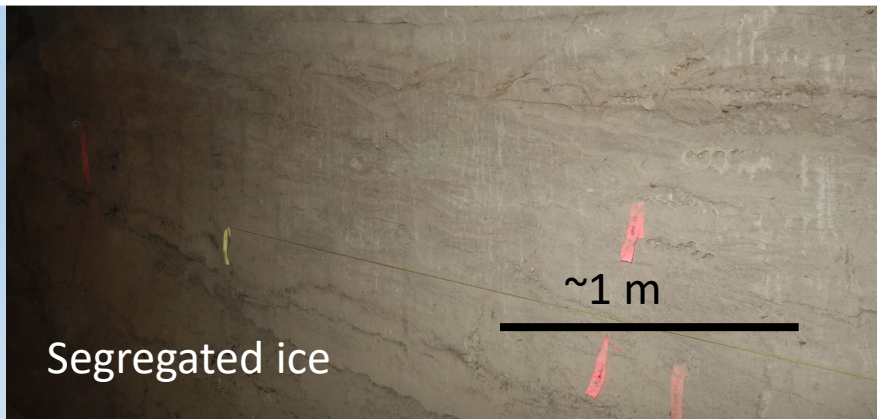
ice wedge + plastic deformation

~1 m



Silt-layering

~1 m



Segregated ice

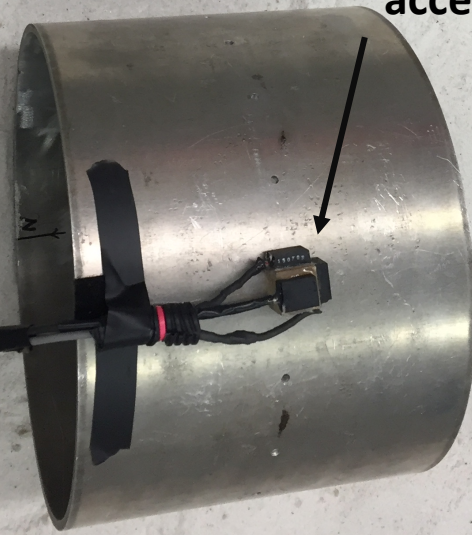
~1 m

**Buried
source**



*** External mounting
is for convenience**

*** 3-component
accelerometers**



USACE-Permafrost Tunnel Research Facility

