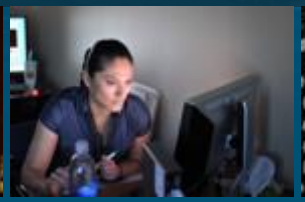
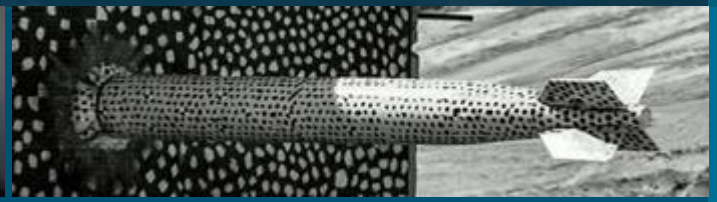
Importance of Legacy Data to National Security

–Securing Legacy Seismic Data to Enable Future Discoveries–





PRESENTED BY

Brian Young // Geophysics (Org 8861)

September 18, 2019

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Legacy Data at the National Labs

>800 US UGTs
- 75% UGTs in the analog era
- 100% atmospheric tests

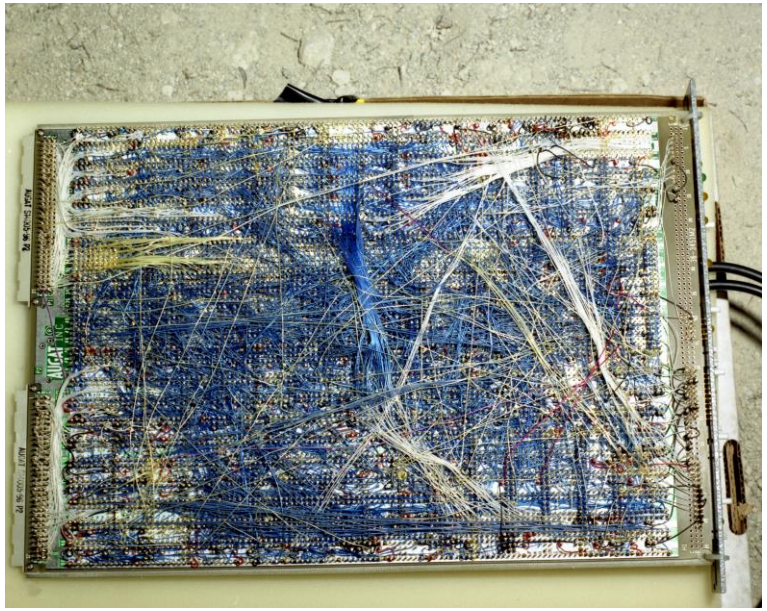
Opportunity cost—action vs inaction
- Missed opportunity; loss of a benefit that could have been gained

Data sits on physical tapes (analog), floppy disks, burnt CDs in boxes, cabinets, and bunkers
- Slowly decaying
- Decaying faster than paper records, in fact (wherever paper even exists!)

Discovery is a significant effort
- Orphaned data, reports
- Geologic samples

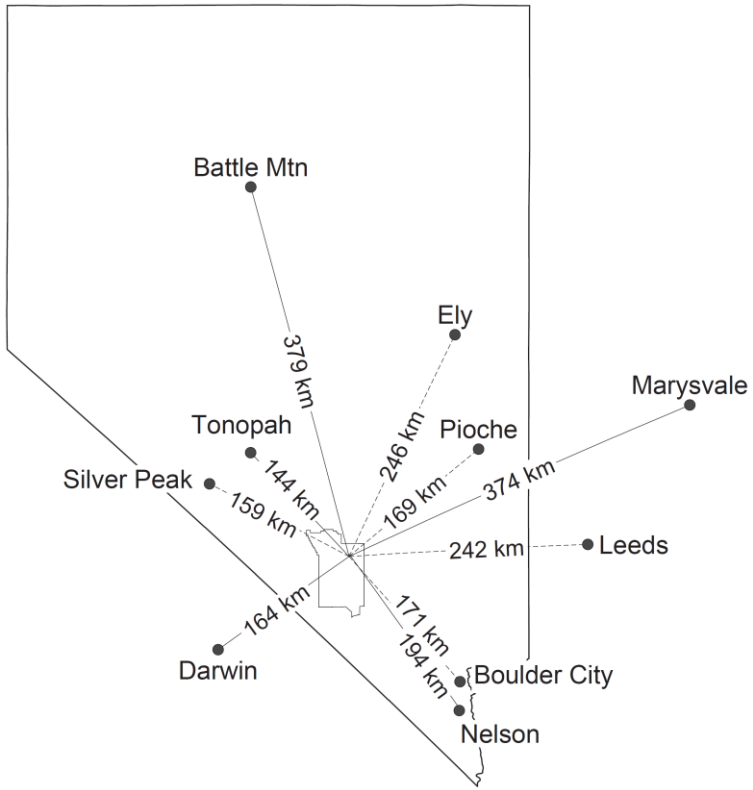
Lawrence Livermore National Laboratories (2017). Weapon physicist declassifies rescued nuclear test films. YouTube video, url: https://www.youtube.com/watch?v=pWpqGKUG5yY

Sandia National Laboratories (1976). INTERIOR TRAILER 001, PROJECT X. National Archives ID: 75455977

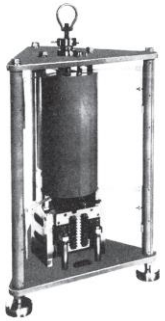


Sandia National Laboratories (1976). DISTANT ZENITH-STARS SYSTEM, NEVADA TEST SITE. National Archives ID: 75491015

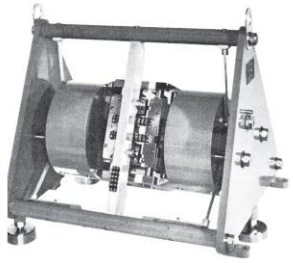
Leo Brady Seismic Network



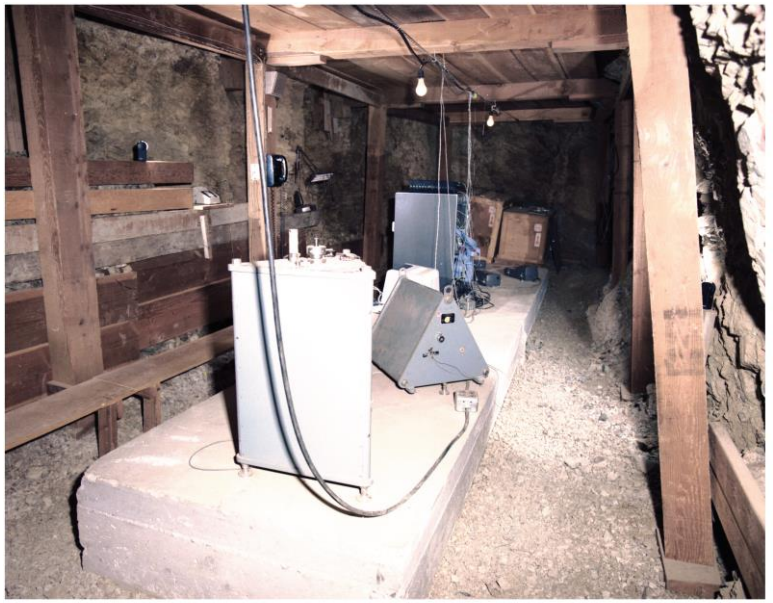
Benioff 1051



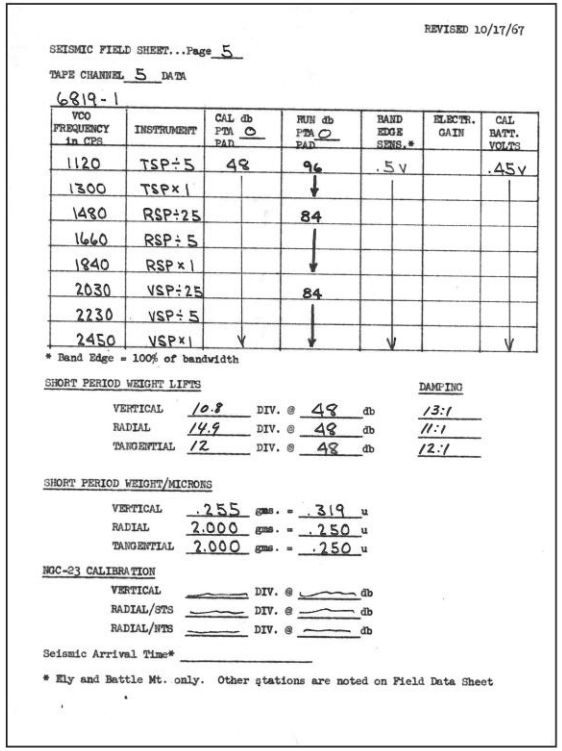
Benioff 1101



Crown CX822



Benioff seismometers at Nelson's Landing (June 1985)



REVISED 10/17/67

SEISMIC FIELD SHEET...Page 5

TAPE CHANNEL 5 DATA

6819-1

VCO FREQUENCY in CPS	INSTRUMENT	CAL db PTA 0 PAD	RUN db PTA 0 PAD	BAND EDGE SENS.*	ELECTR. GAIN	CAL BATT. VOLTS
1120	TSP÷5	48	96	.5 V		.45V
1300	TSP×1		↓	↓		↓
1480	RSP÷25		84			
1660	RSP÷5		↓			
1840	RSP×1					
2030	VSP÷25		84			
2230	VSP÷5		↓			
2450	VSP×1	↓	↓	↓		↓

* Band Edge = 100% of bandwidth

SHORT PERIOD WEIGHT LIFTS — DAMPING

VERTICAL 10.8 DIV. @ 48 db 13:1
RADIAL 14.9 DIV. @ 48 db 11:1
TANGENTIAL 12 DIV. @ 48 db 12:1

SHORT PERIOD WEIGHT/MICRONS

VERTICAL .255 gms. = .319 u
RADIAL 2.000 gms. = .250 u
TANGENTIAL 2.000 gms. = .250 u

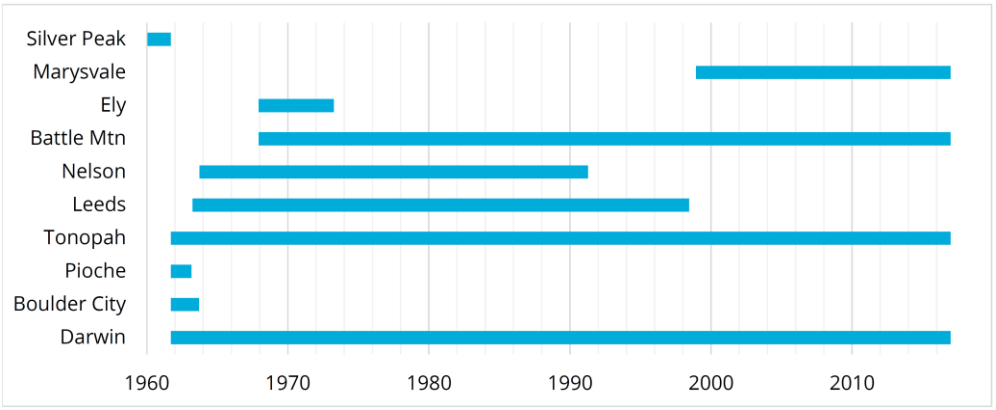
NGC-23 CALIBRATION

VERTICAL ____ DIV. @ ____ db
RADIAL/STS ____ DIV. @ ____ db
RADIAL/WTS ____ DIV. @ ____ db

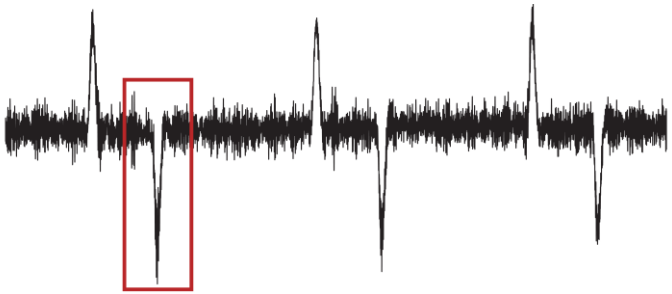
Seismic Arrival Time* _____

* Ely and Battle Mt. only. Other stations are noted on Field Data Sheet

Sample seismic field notes



- ~75% UGTs in analog era
- 592 UGTs digitized



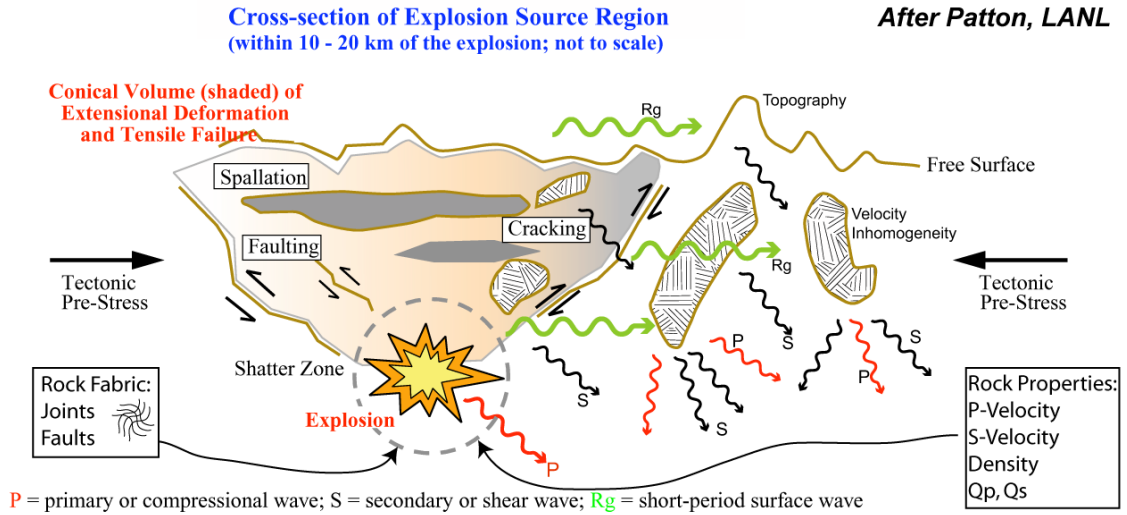
What can we do with more data?

Each event is ground truth

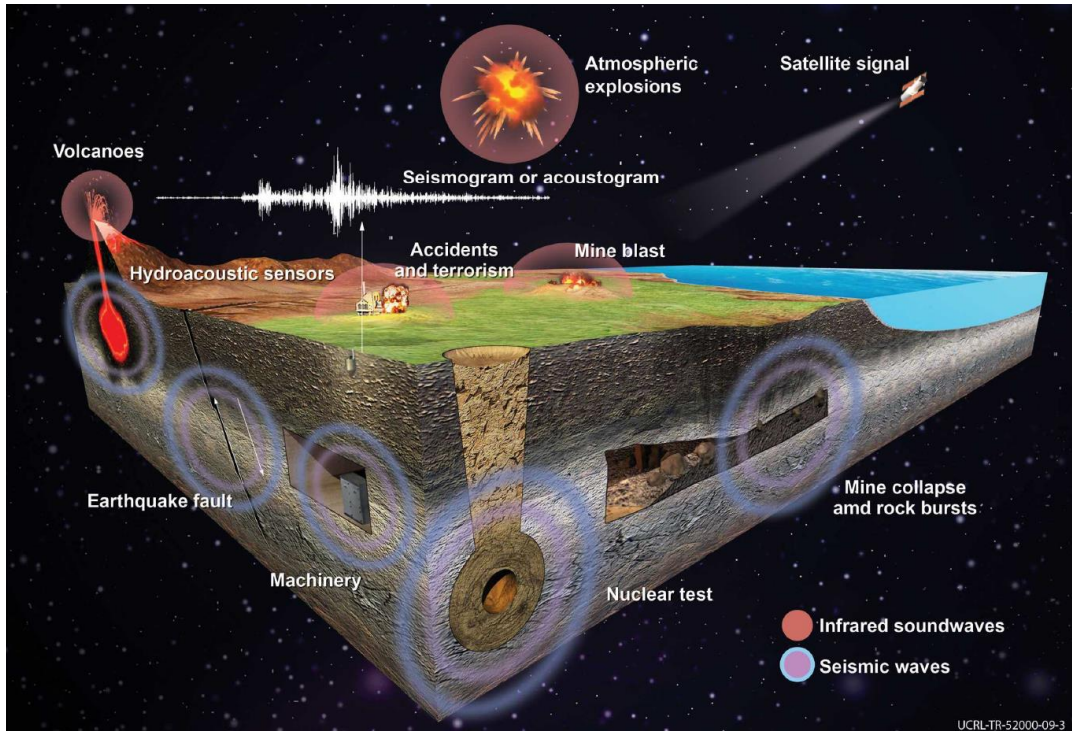
- Earthquake location, time are uncertain
- Explosions are known almost exactly
- Improve seismic models

But also, more data =

- More opportunities to have a "hmm, that's odd…" moment
- Machine learning
- Bayesian approach: statistics
  - Instead of analyzing UGTs one-at-a-time, wiggle-by-wiggle, what could we learn if we had tons of waveforms?
  - Uncertainty quantification[1]
  - Monte Carlo[2]
    - Essentially invented at LANL (Ulam, von Neumann, Metropolis)



Mellors, R., C. Snelson, A. Pitarka, T. Chen, E. Matzel, W. Walter, and the SPE team (2016). A Large N Array at the Nevada National Security Site. IRIS: USArray Short Course, Presentation. LLNL-PRES-694105.



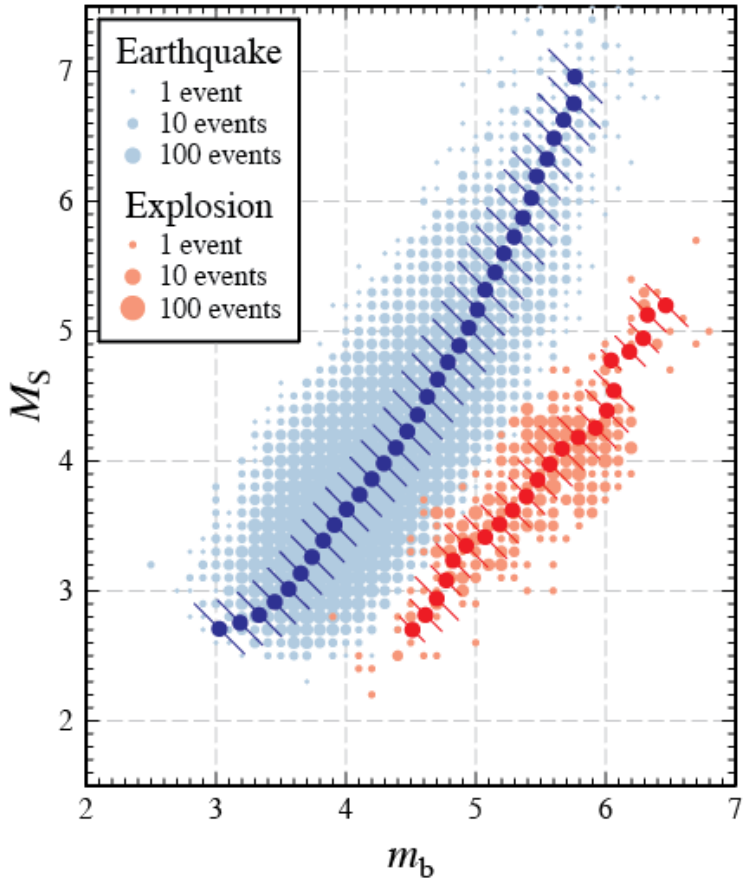
Symons, Neill (2016). US NDC Modernization & IDC Re-engineering. Presentation for the Capital Hill Monitoring Event, Washington D.C. SAND2016-8584C, OSTI ID: 1380175

[1] Bahcall, J. N., A. M. Serenelli, and S. Basu (2006). 10,000 Standard Solar Models: A Monte Carlo Simulation. *Astrophys. J.*, **165**, pp. 400–431. doi: 10.1086/504043

[2] Metropolis, N. (1987). The Beginning of the Monte Carlo Method. *Los Alamos Science*, Special Issue.

Earthquakes vs. explosions

P–S wave partition one of the major earthquake–explosion discriminants



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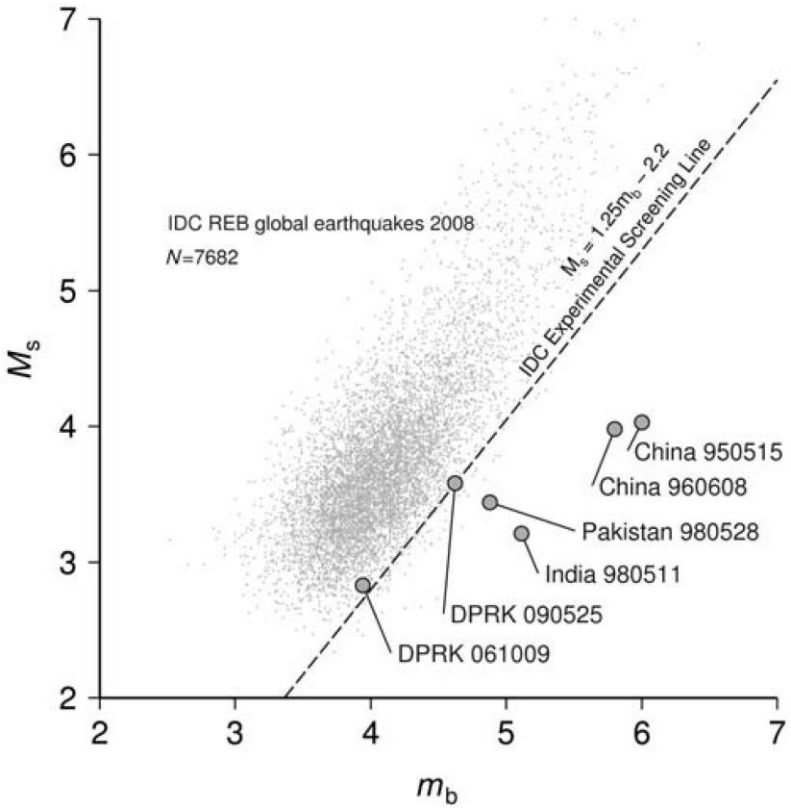
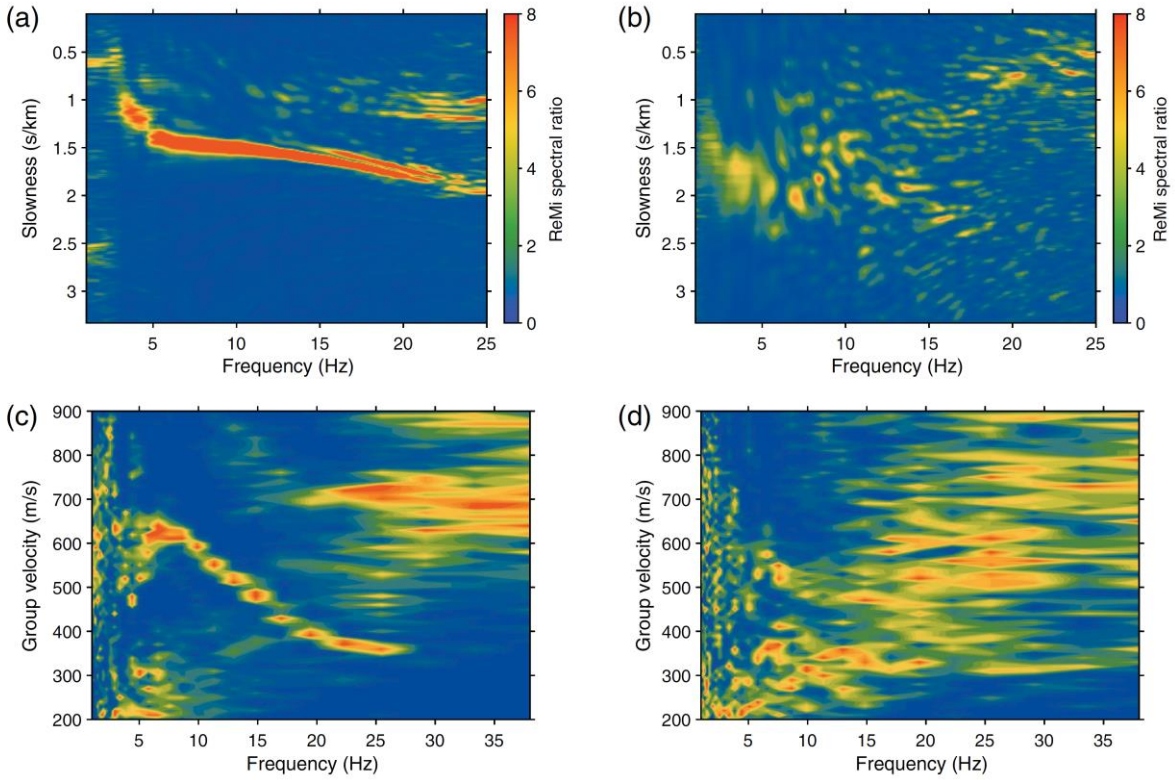


Selby, N. D., P. D. Marshall, and D. Bowers (2012). m_b:M_S Event Screening Revisited. *Bull. Seismol. Soc. Am.*, **102**(1). pp. 88–97.

Yucca Flat: Before and After?



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Calibration

Pre-1992 method:
0.1472 cm/s

(assumes constant nominal deflection, natural period)

New method:
0.1637 cm/s

(Recalculate instrument constants from recorded calibration pulses)

Murphy & Lahoud (BSSA, 1969):
0.1620 cm/s

(empirical)