



Revisiting Seismic Magnitudes of Soviet UNEs to Investigate the m_b - M_s Discriminant.

MTV Workshop, 2021

30 March 2021

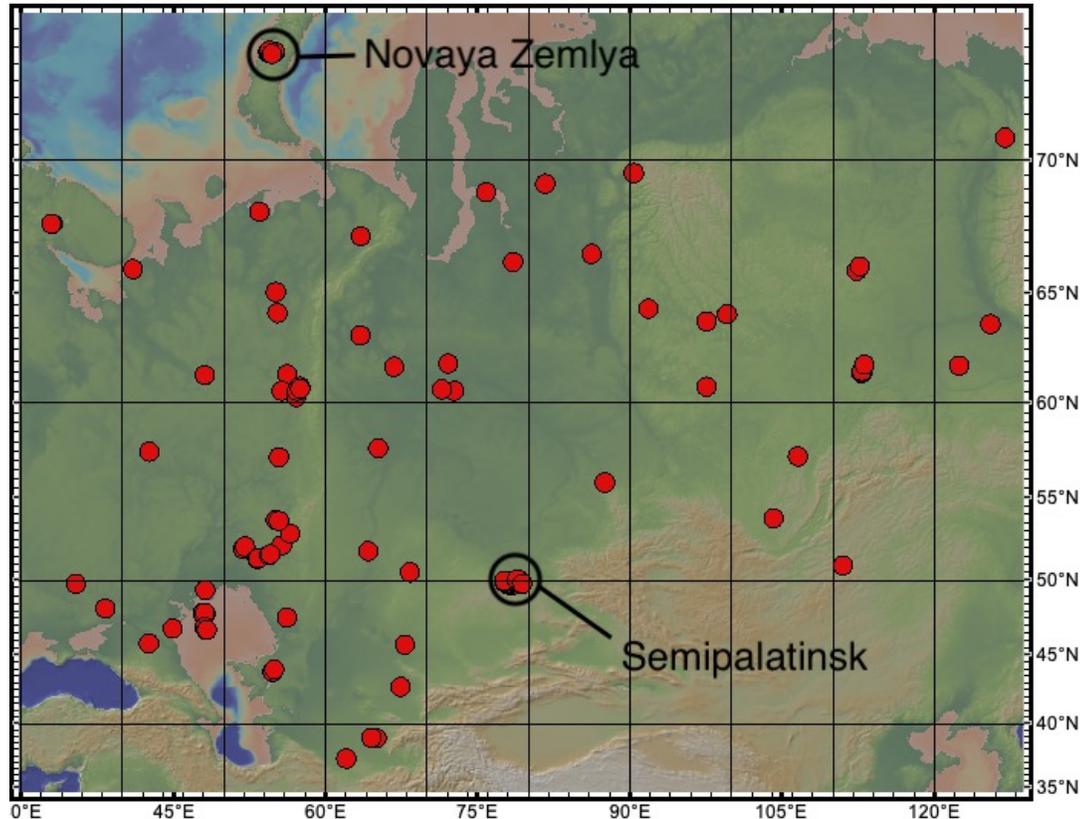
Jocely Lopez Luna, Columbia University

Göran Ekström, Columbia University

Paul G. Richards, Columbia University



Introduction and Motivation

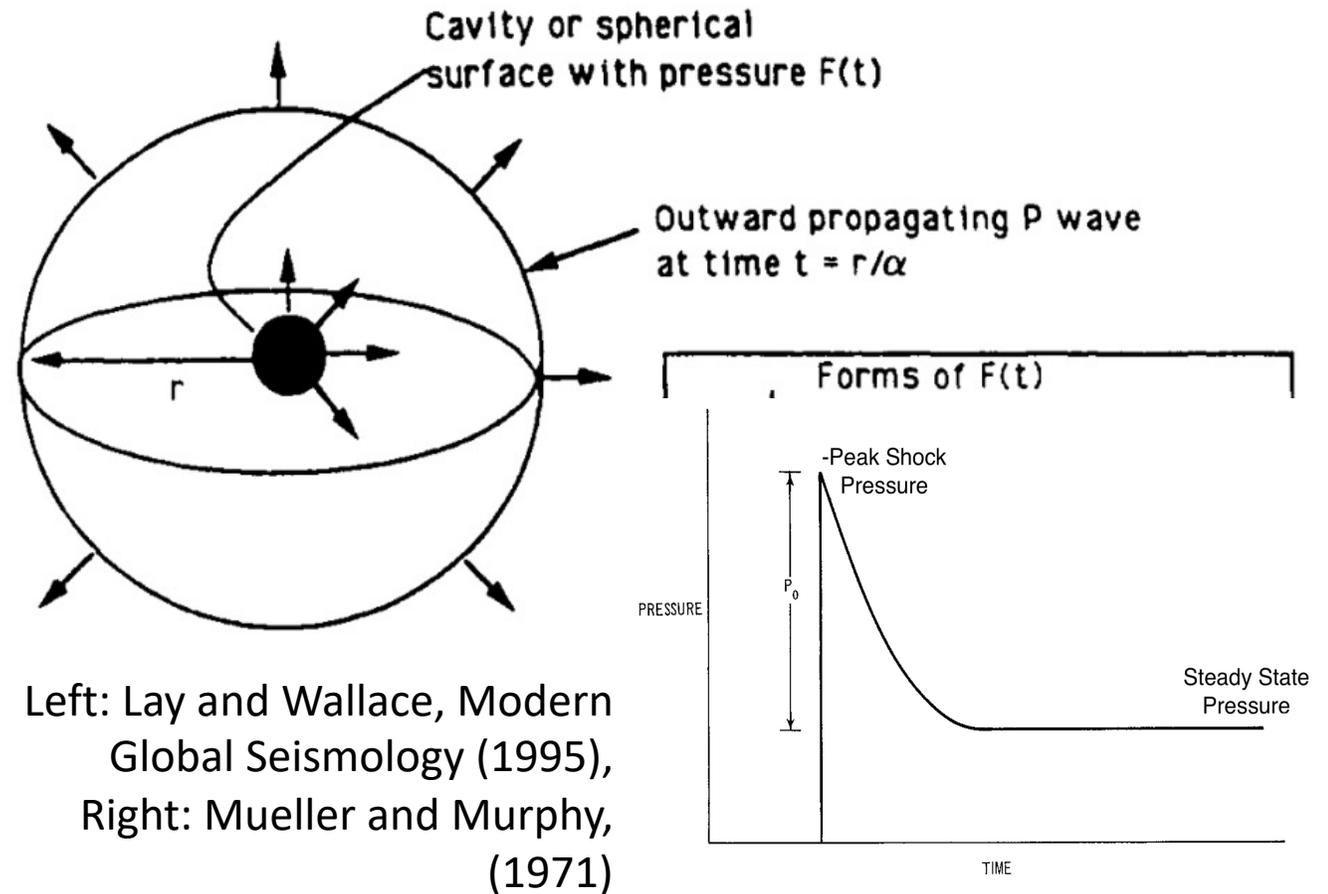


Created with GeoMapApp.

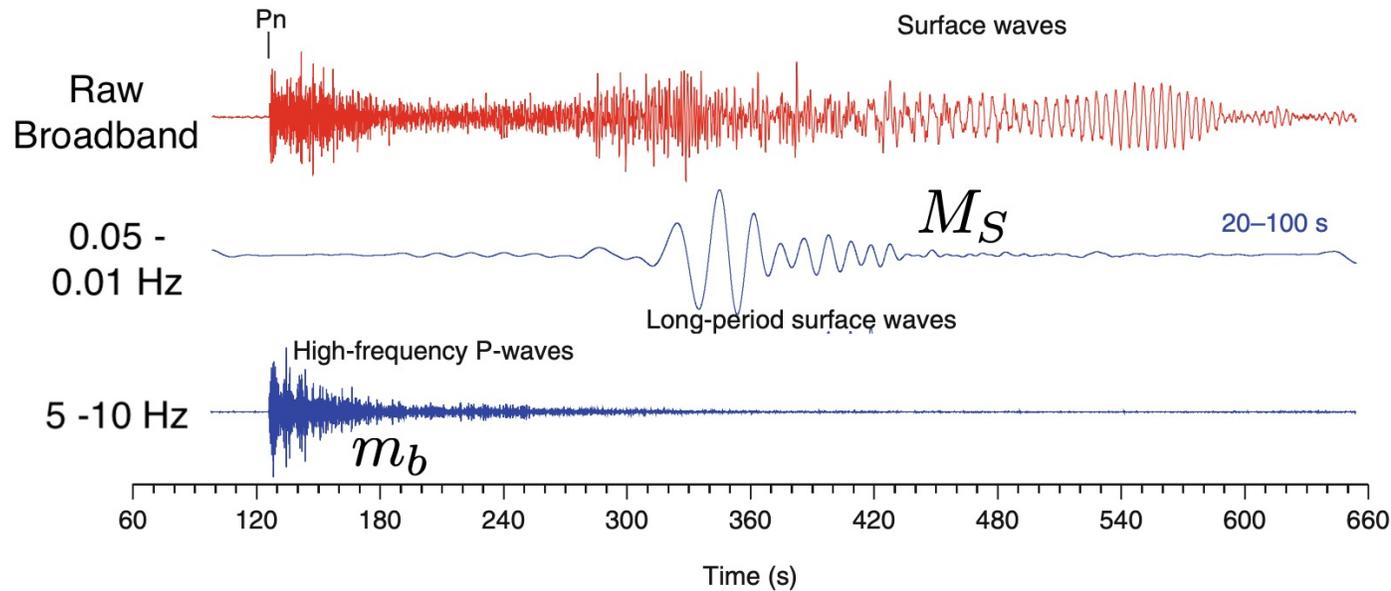
- Former Soviet Union (FSU) has generated a wealth of underground nuclear explosion (UNE) data.
- 2 test sites, 5+ test subsites.
- Hundreds of explosions
 - 437 blasts have at least one point of data associated with it.
 - Large proportion of UNEs are Peaceful Nuclear Explosions (PNEs)

Introduction and Motivation

- UNE shockwaves become linear seismic waves at the elastic radius.
- Seismic waves are distorted by path effects, dispersion, scattering, etc.
 - Recorded as ground motion at a seismic station.



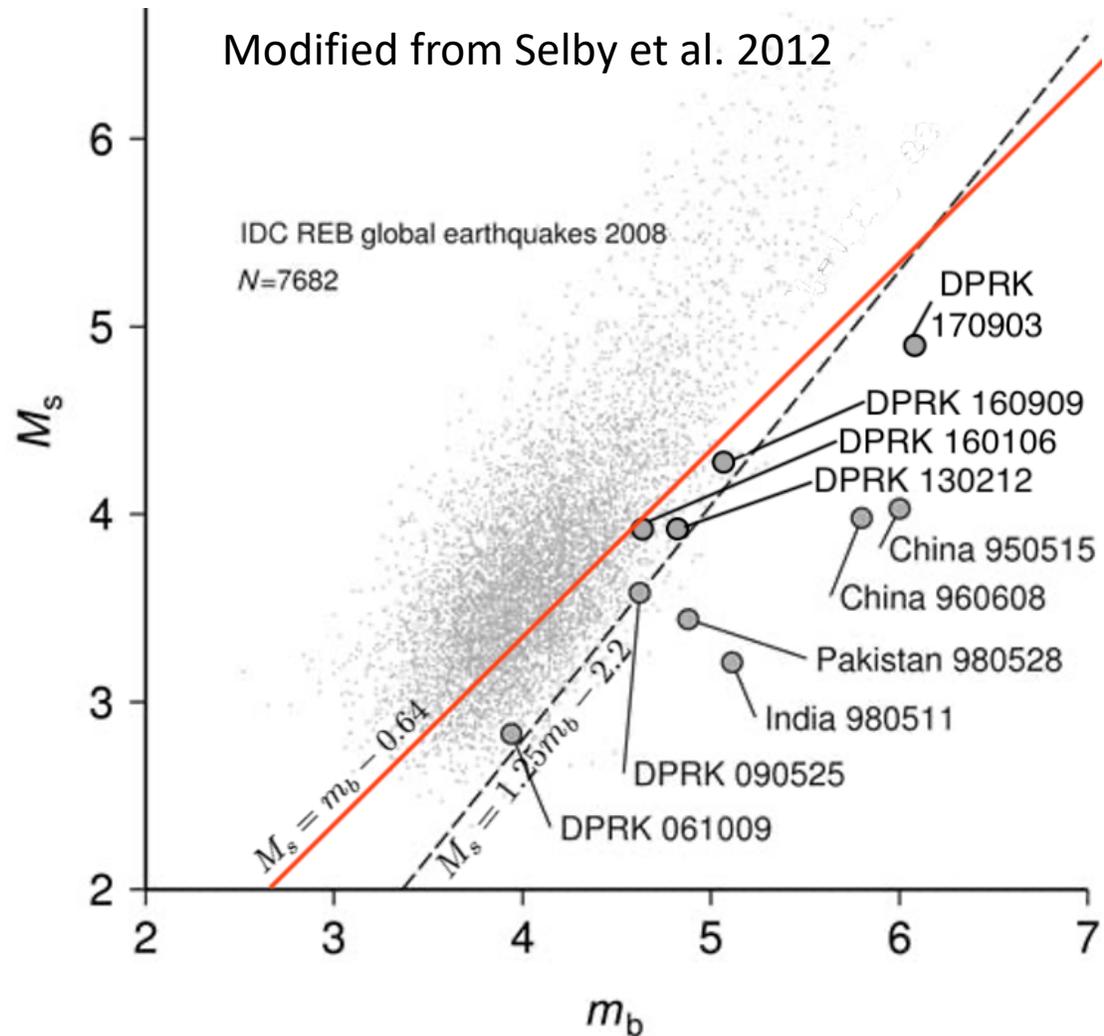
Introduction and Motivation



Richards et al. (2019) "Seismic Monitoring of Nuclear Explosions."

- $m_b - M_S$ discriminant is traditionally used for monitoring underground nuclear explosions.
- Expect isotropic sources to show $m_b > M_S$
- Discriminant is not yet fully understood and is not without flaws.

Mission Relevance



- Instance of $m_b - M_s$ shortcoming: Tests by the Democratic People's Republic of Korea.
- $m_b - M_s$ is central to the monitoring branch of the Comprehensive Test Ban Treaty (CTBT).
- Better understanding of $m_b - M_s$ supports monitoring and non-proliferation.

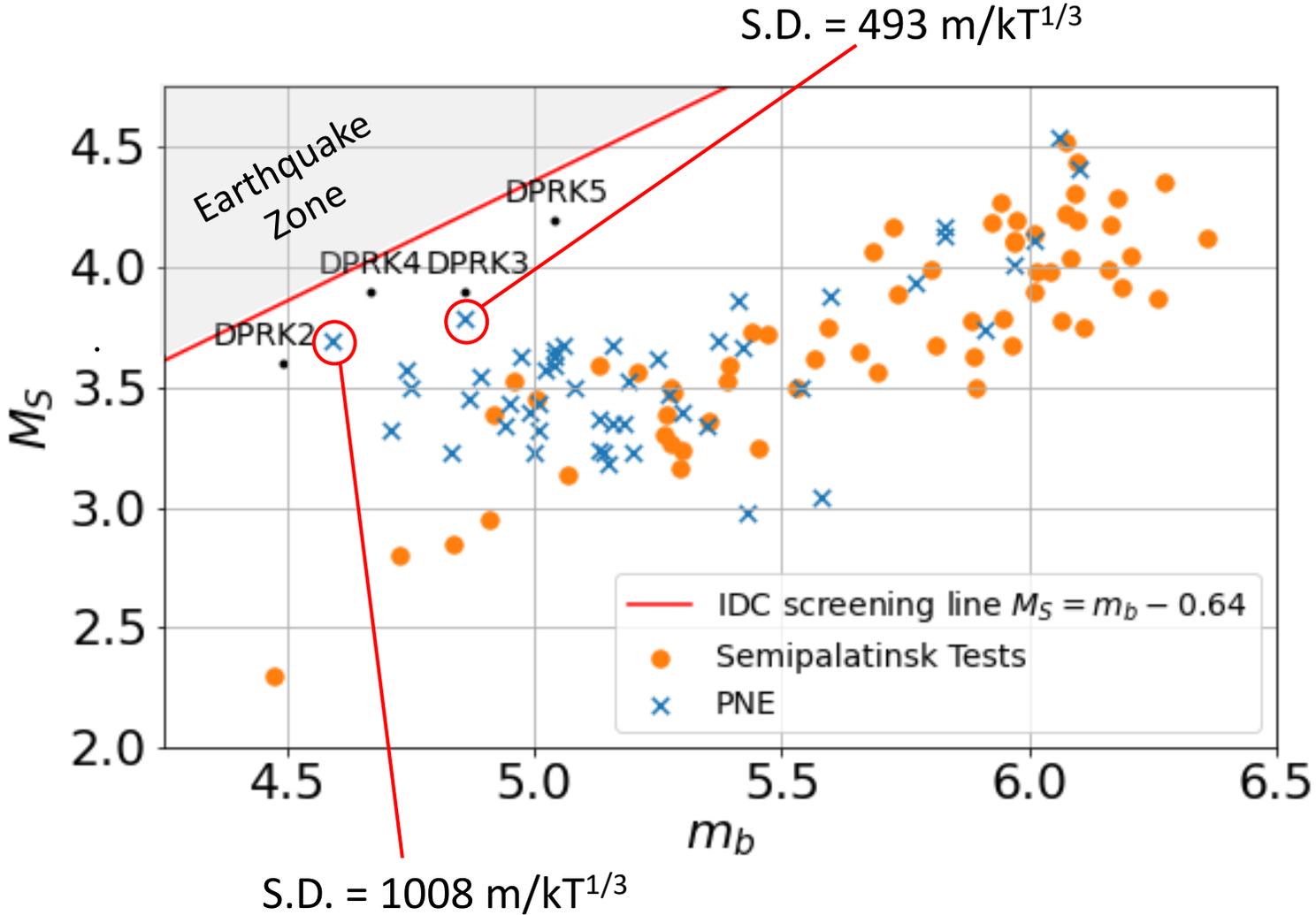
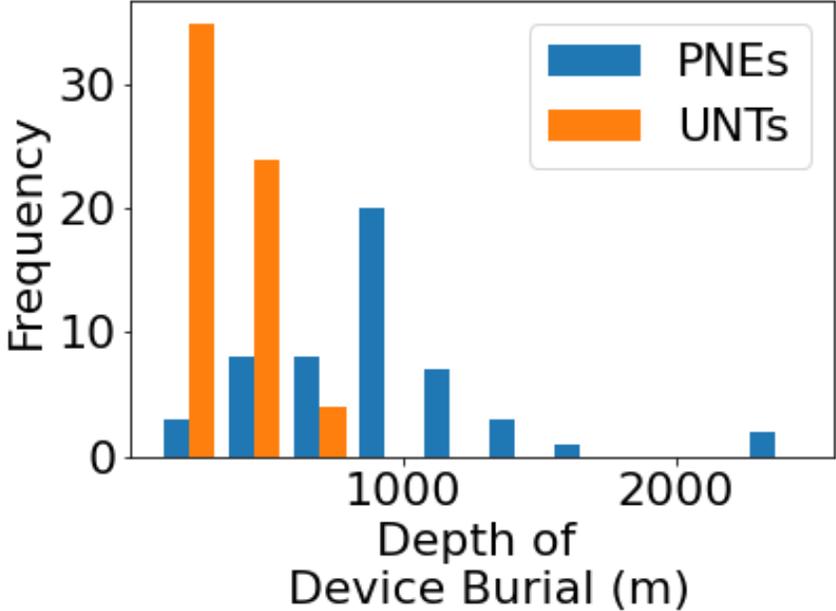
Technical Approach

- Collect existing FSU explosion data.
- m_b and M_S
 - Network averaged m_b and M_S measurements.
- Yield (W)
 1. Yield estimated using $m_b = 4.55 + 0.75 \log (W)$
 2. Reported by FSU.
- Depth / Scaled Depth
 - Device depth of burial measurements from former Soviet union reports.
 - Scaled depth of burial derived from yield and depth of burial.
- Investigate trends in data.



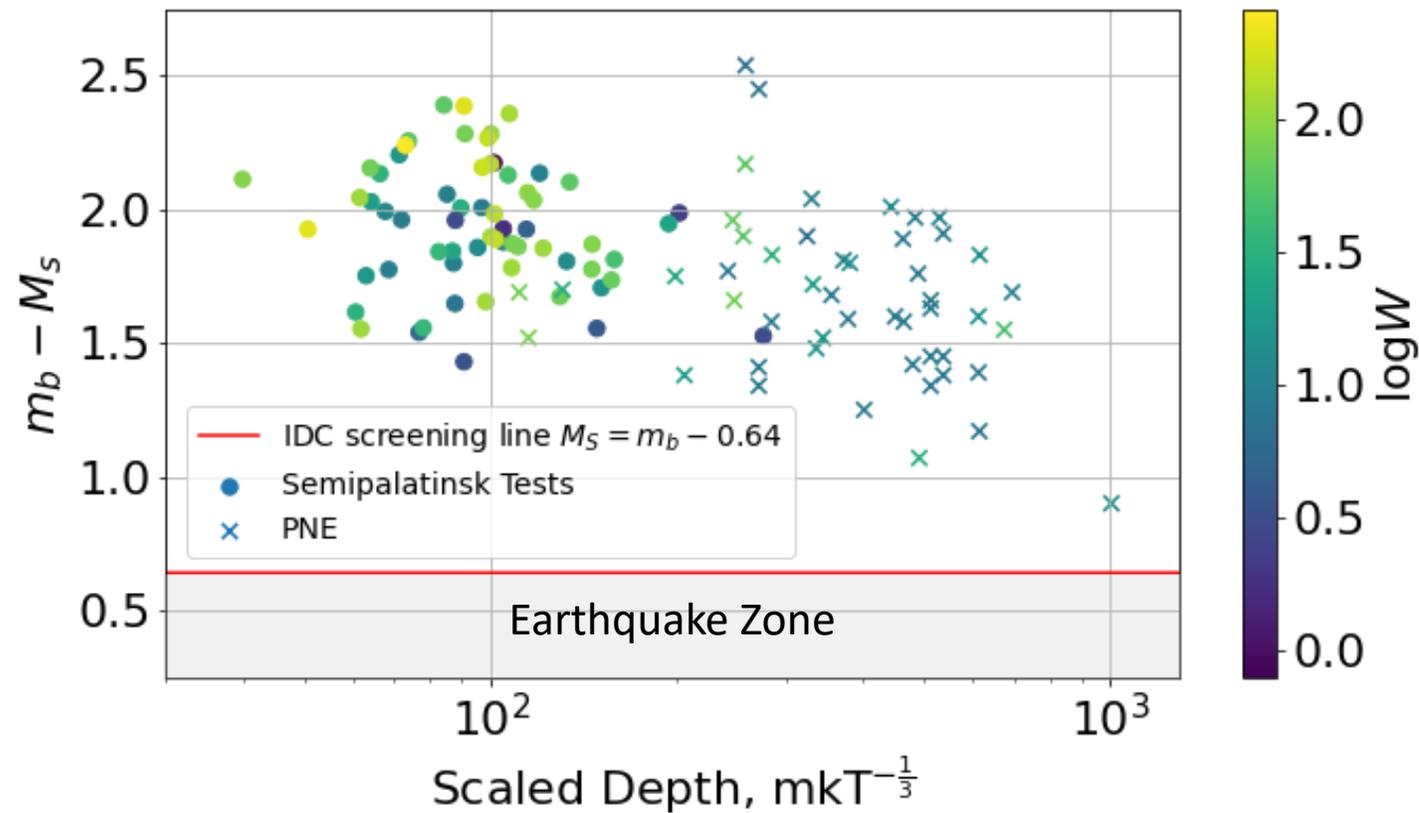
Results

- 115 explosions with m_b , M_S , and DOB data available.



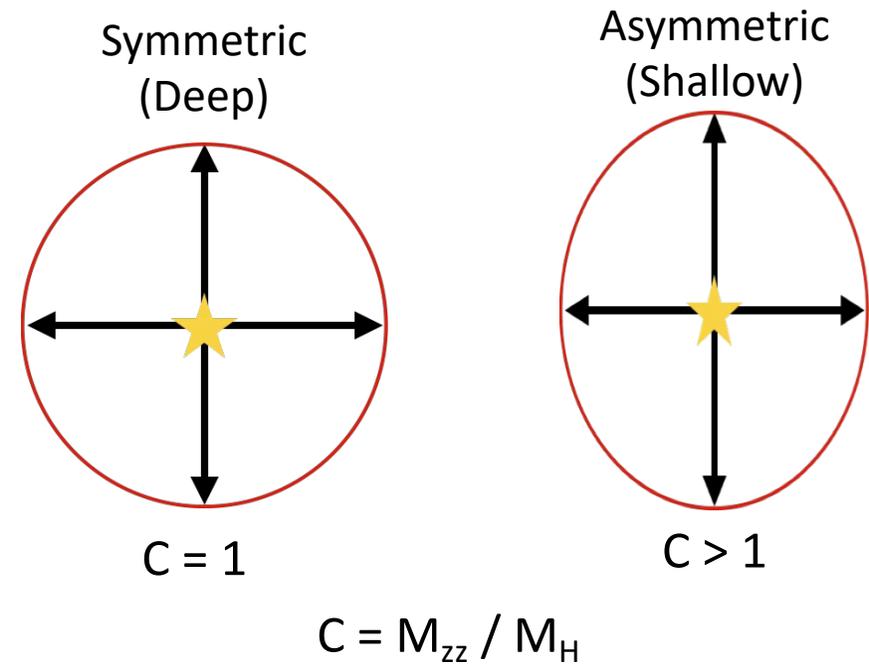
Results

- Weak ($r = -0.48$), negative, linear association.



Expected Impact

- Observed trends in the magnitude data:
 - $m_b - M_S$ is small for overburied explosions.
- An extended source model may provide a better physical understanding of the $m_b - M_S$ discriminant.



Howe et al. 2020

Conclusion and Next Steps

- Magnitudes, depths, and yields of Soviet UNEs provide constraints on explosion source models, and may lead to a better understanding of the $m_b - M_S$ discrimination tool.
- Trends in the data appear to be consistent with the asymmetric elastic source model proposed by Howe et al. (2020)
- Other effects on magnitudes need to be investigated.
- Quantitative investigation of the broadband seismic signals in digitized analog records of unusually shallow and deep UNEs at Semipalatinsk will test the relevance of our proposed asymmetric source model.



Acknowledgements



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