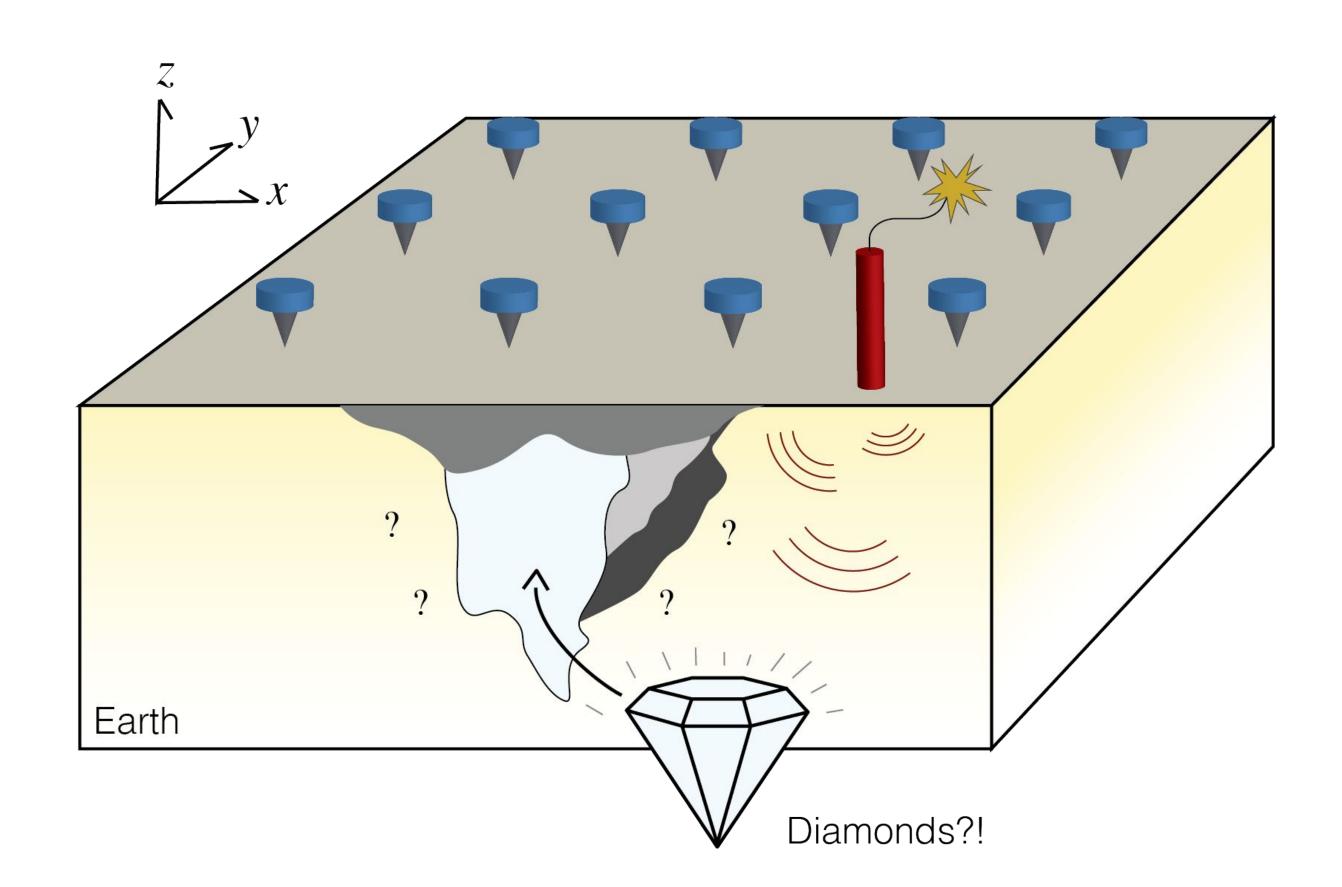# Where are the diamonds? - *using explosions*

Brendan Smithyman and the SimPEG Team

Seismic imaging & inversion

- **Why?** Wave velocities, density & layer boundary information can identify rock types and structures
- **How?** Inject vibrations with vibrating trucks or explosives, and measure at many locations
- **Response.** Waves propagate through the earth differently in response to physical properties
- **Data.** Particle velocity or pressure at each sensor
- **Goal.** Use seismic imaging and inversion to see rock layer boundaries and inform interpretation
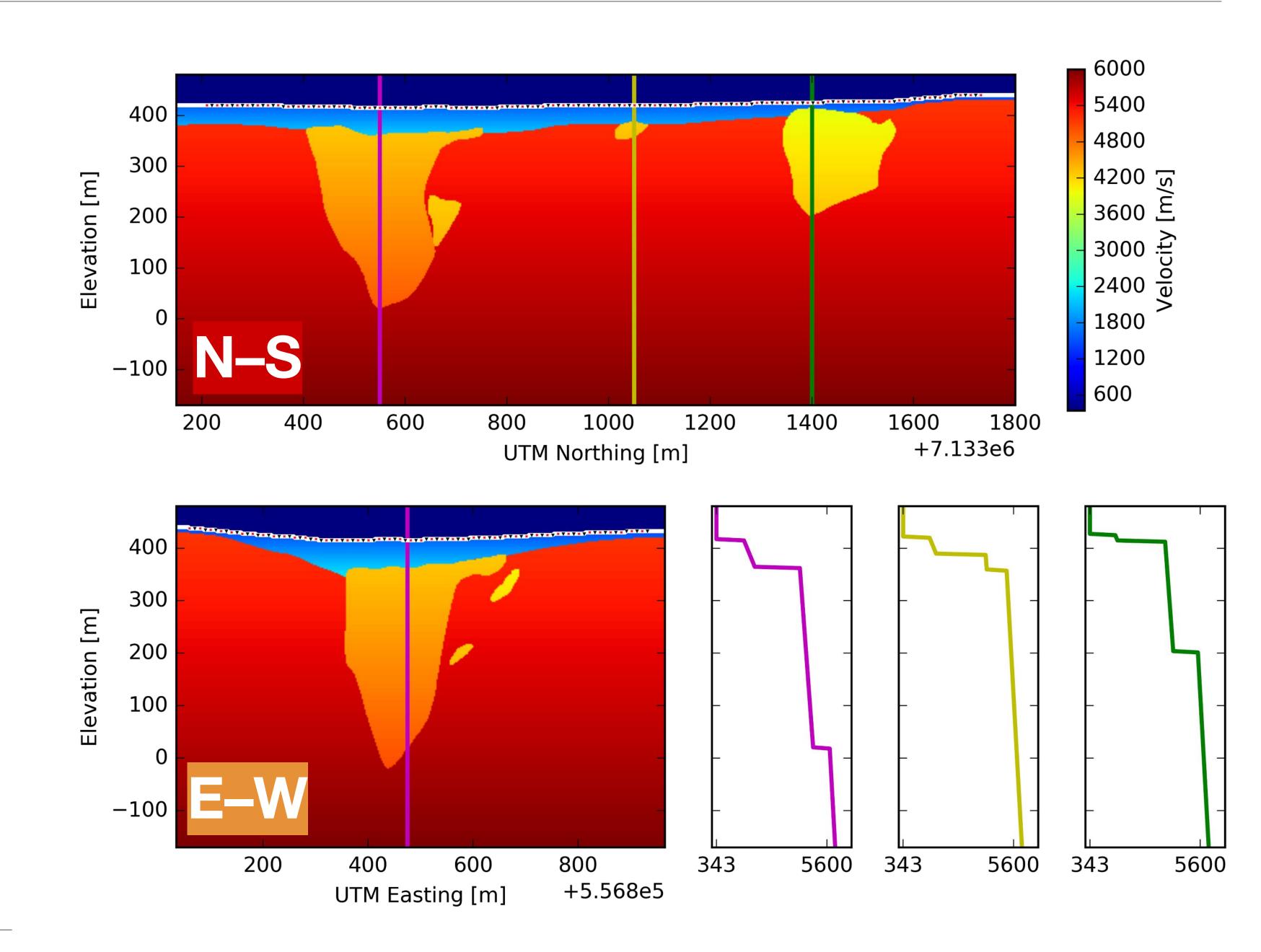
Physics

- Stress/strain relations
- Elastic wave equation (approximated by 2D viscoacoustic numerical modelling)
- Simulate using parallel frequency-domain finite difference Helmholtz solver package *Zephyr*   https://github.com/uwoseis/zephyr

$$\left(\nabla \cdot \frac{1}{\rho}\nabla + \frac{\omega^2}{c^2\rho}\right)\mathbf{u} = -\mathbf{s}$$
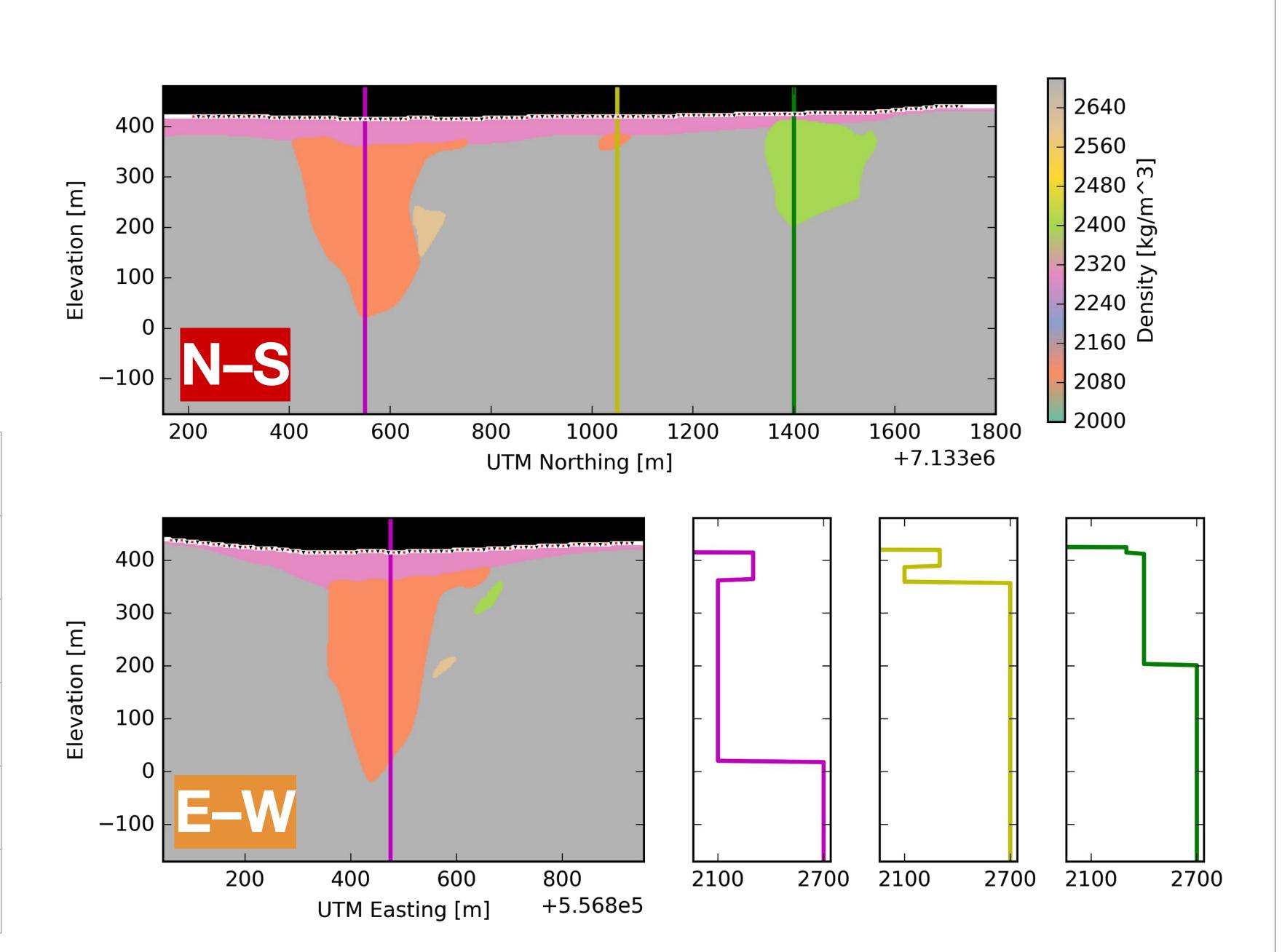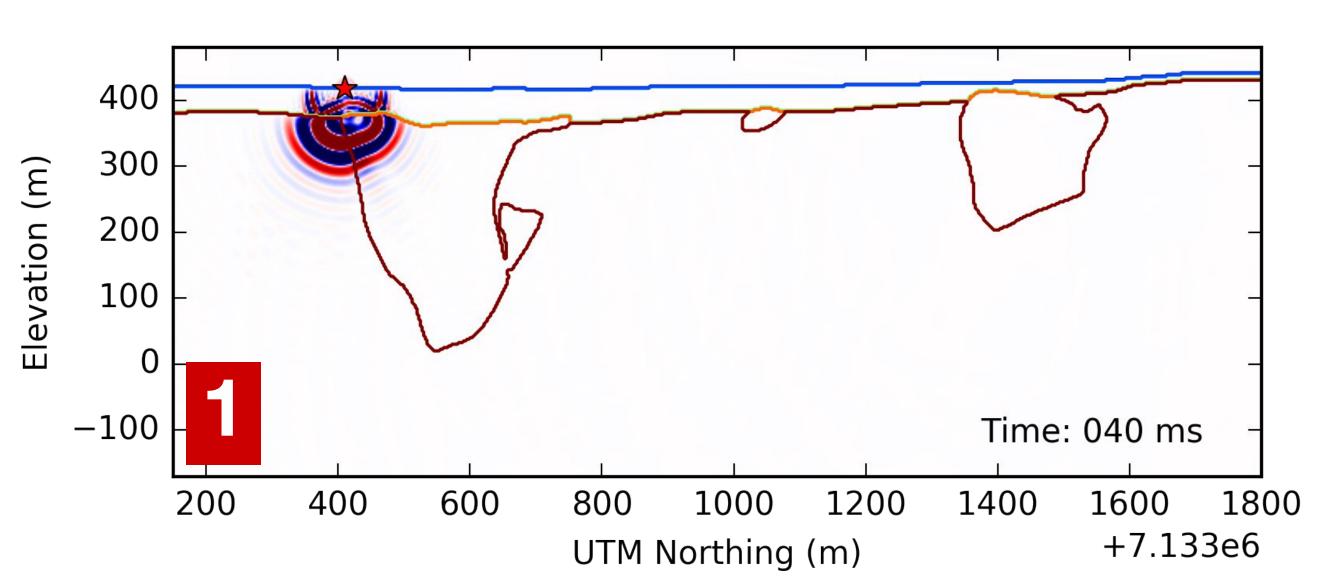
Model

- 2D cross-sectional models (3D is common in industry, but requires large resources
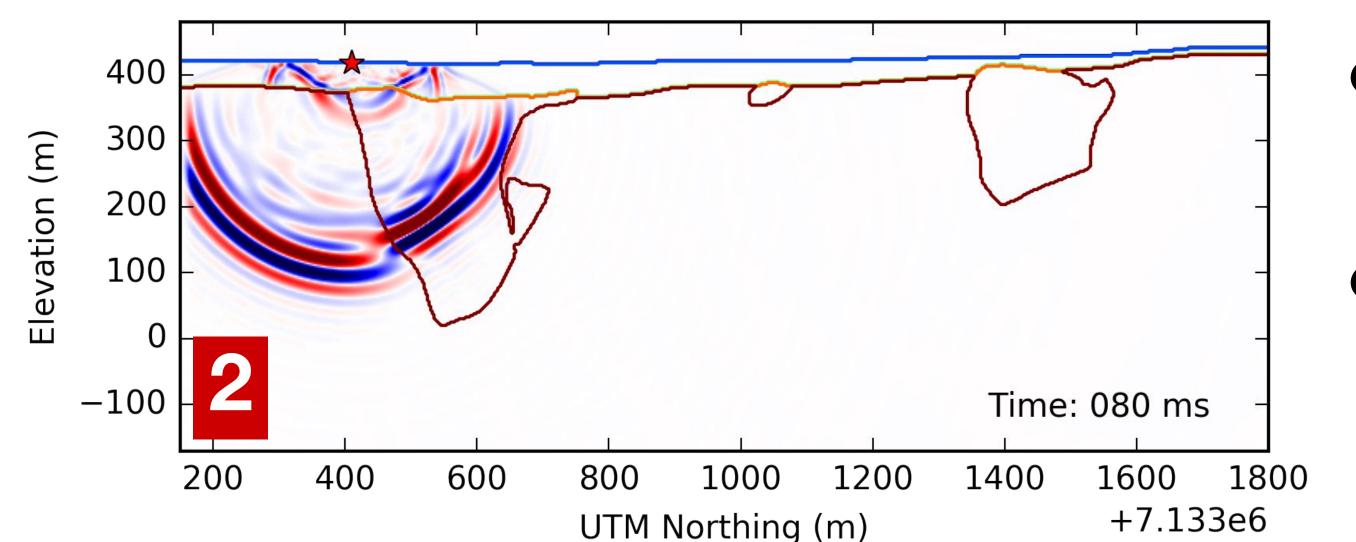- Velocity, density and attenuation control wavepaths, reflection & transmission

	Velocity	Density	Attenuation
PK	Mod	Low	Mod
HK	L. Mod	High	Mod
VK	L. Mod	Mod	Mod
Till	V. Low	Mod	V. High
Host	High	High	Low

↑ **P-wave Velocity**   ↓ **Bulk Density**
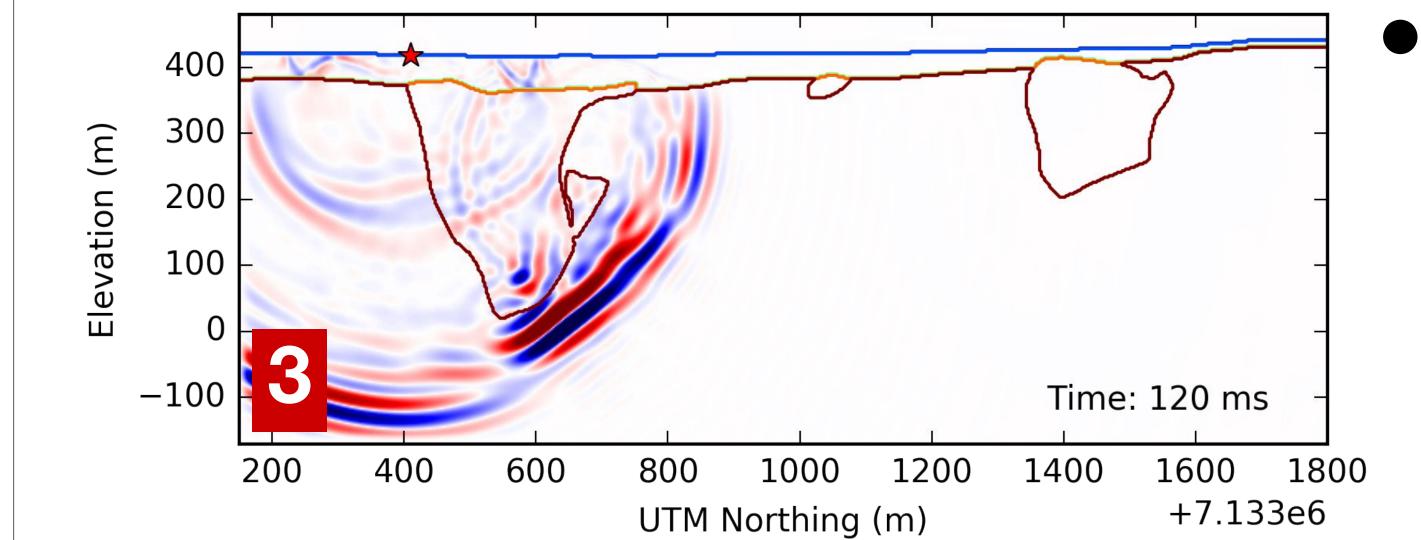
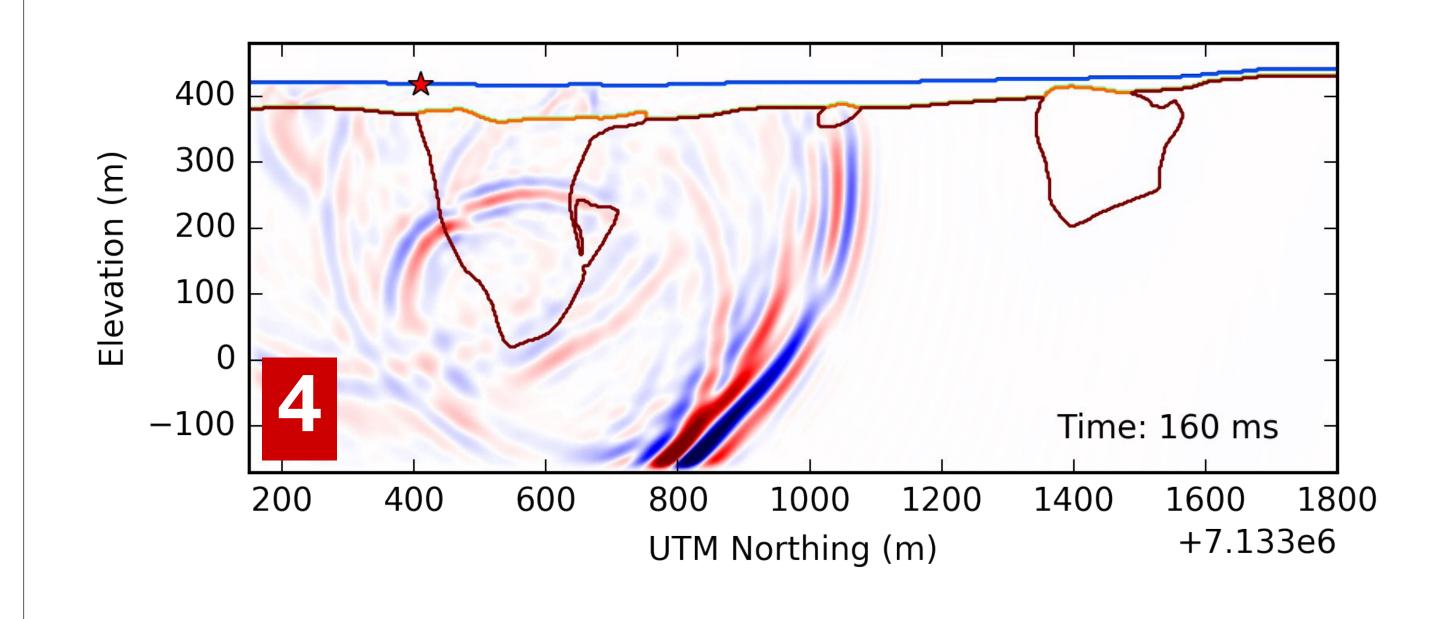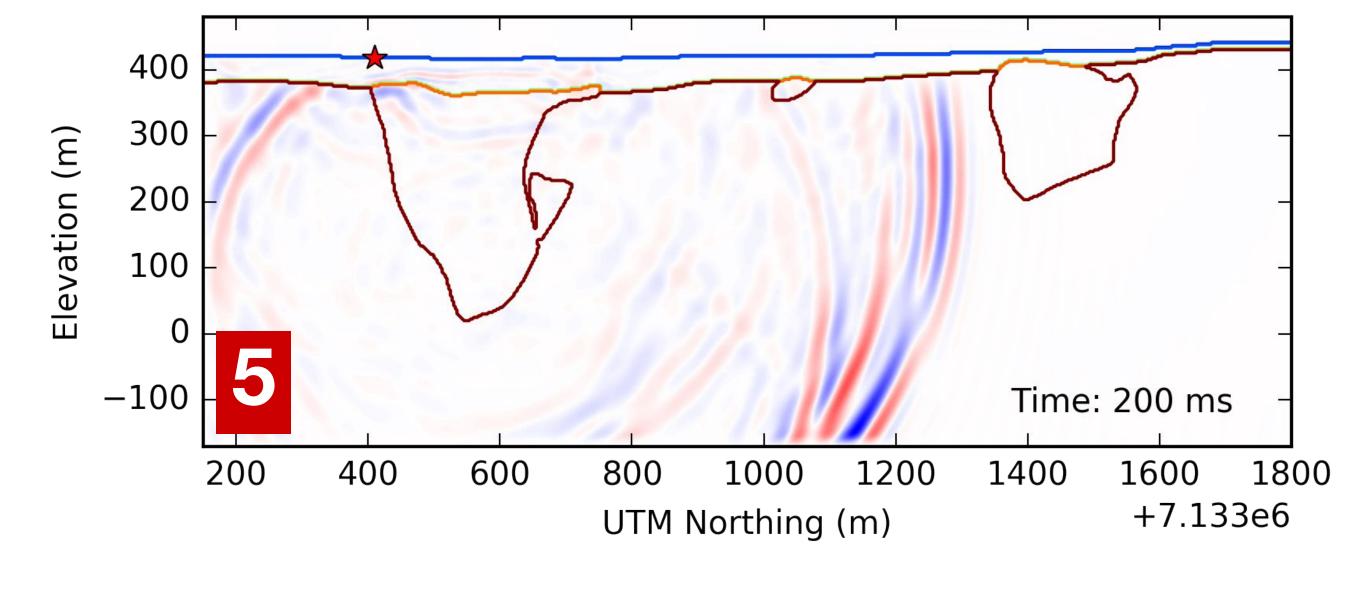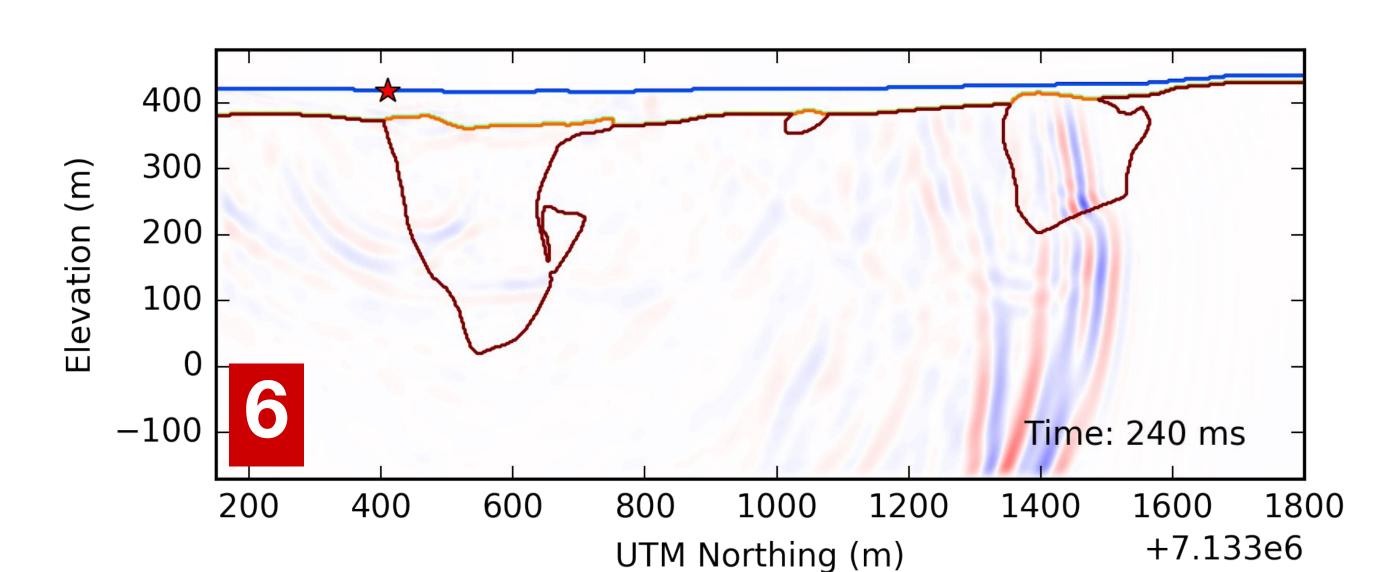## Wave propagation examples

- Seismic waves move slowly through sediments and quickly through hard rock
- Changes in stiffness & density result in waves reflecting off of rock unit boundaries
- Each wave that arrives at the surface results in vibrations that can be recorded on *geophones*
- Using these recordings, we can inform the model through *seismic imaging* and *seismic inversion*

- Diagnostic physical properties in seismic
  - *Velocity*: rate at which pressure waves propagate
  - *Bulk density*: kg/m^3, relates to amplitude
  - *Seismic impedance*: contrasts give rise to reflections (velocity times density)

← **N–S Animation**

E–W Animation →

https://goo.gl/bgxHnK

https://goo.gl/H1sRQ3