Geology 5660/6660: Applied Geophysics
Lab 01

- *How to pick a seismic phase arrival time*

- *Introduction to the Burger et al. Programs,* **Reflect** *&* **Refract**

Due Next Tue, Feb 4th at 3:00 pm

Submit lab write-ups to Rob for grading: rgmcdermott@aggiemail.usu.edu

Lab write-ups should:

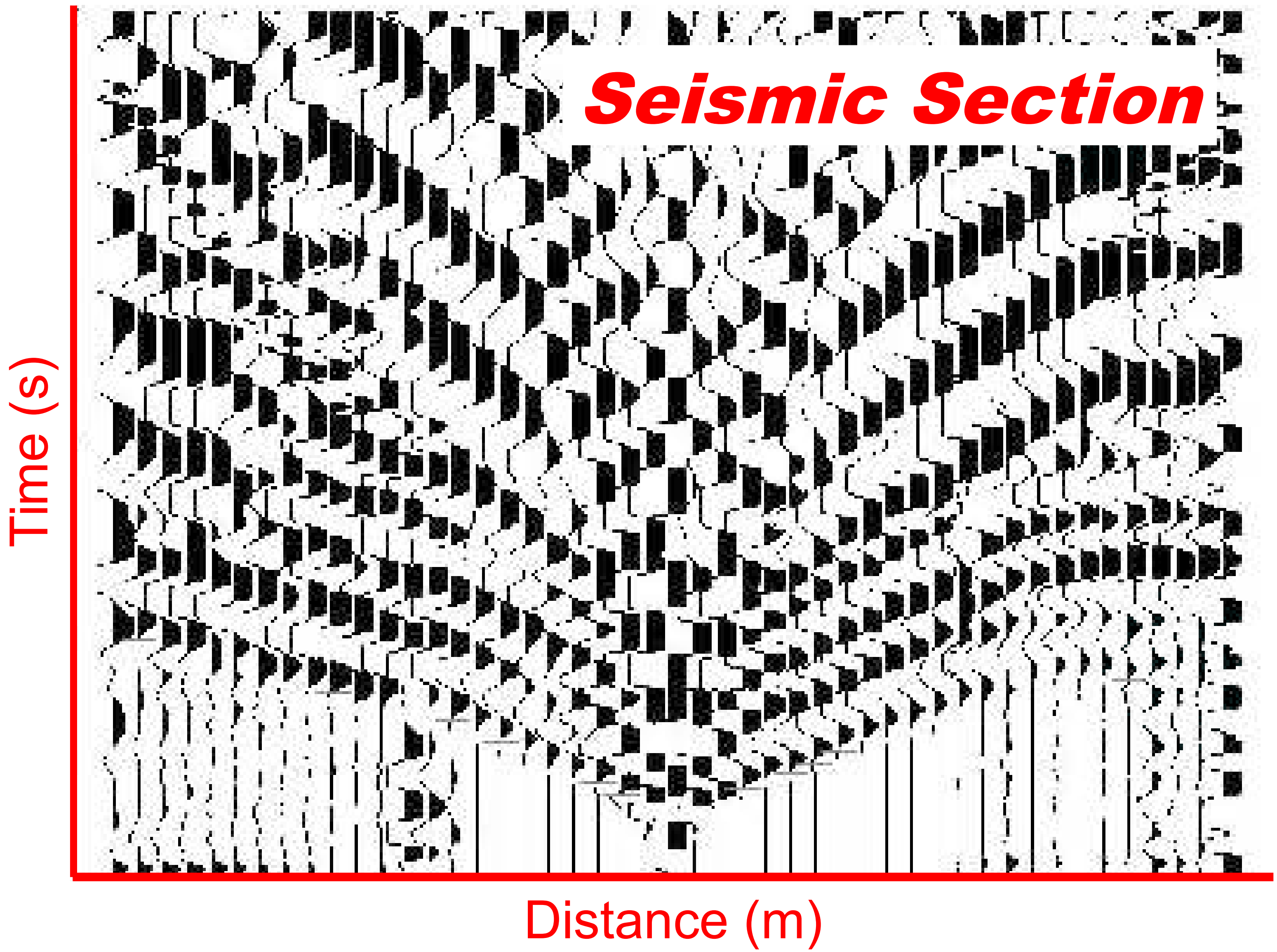
(a) Be a single document (DOCX, PDF, ODT – NOT SPREAD-SHEETS!)

(b) Include plots, numerical data if relevant, and explanatory background where appropriate

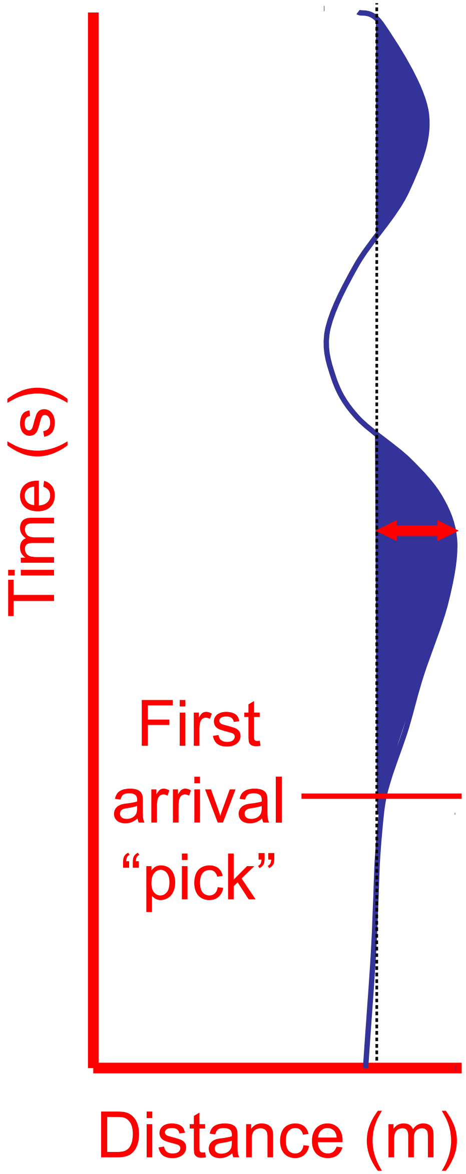
(c) Show your work – equations, calculations, …

If you have a wrong answer without showing work, you get ***0 credit***.

If we can identify where you went wrong, it may get you partial credit.



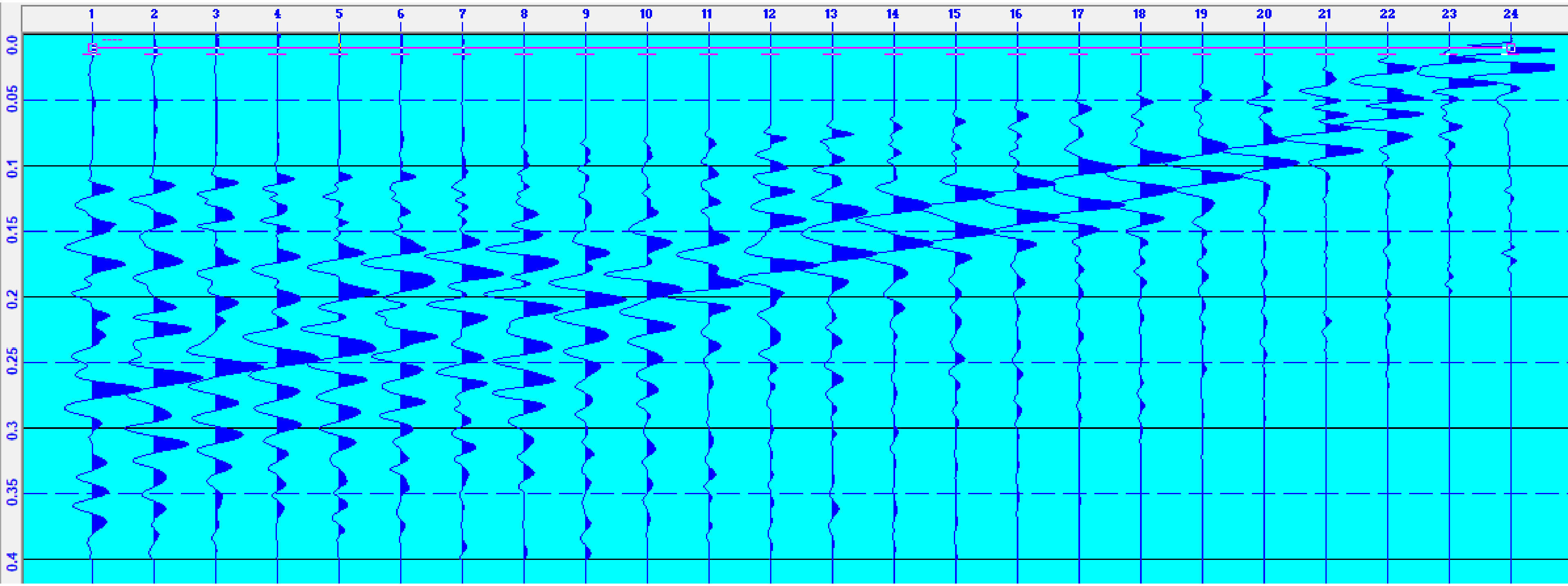
In *seismic refraction* studies, we *pick* the *time of first arrival* of seismic energy!



Some useful info about seismic sections:

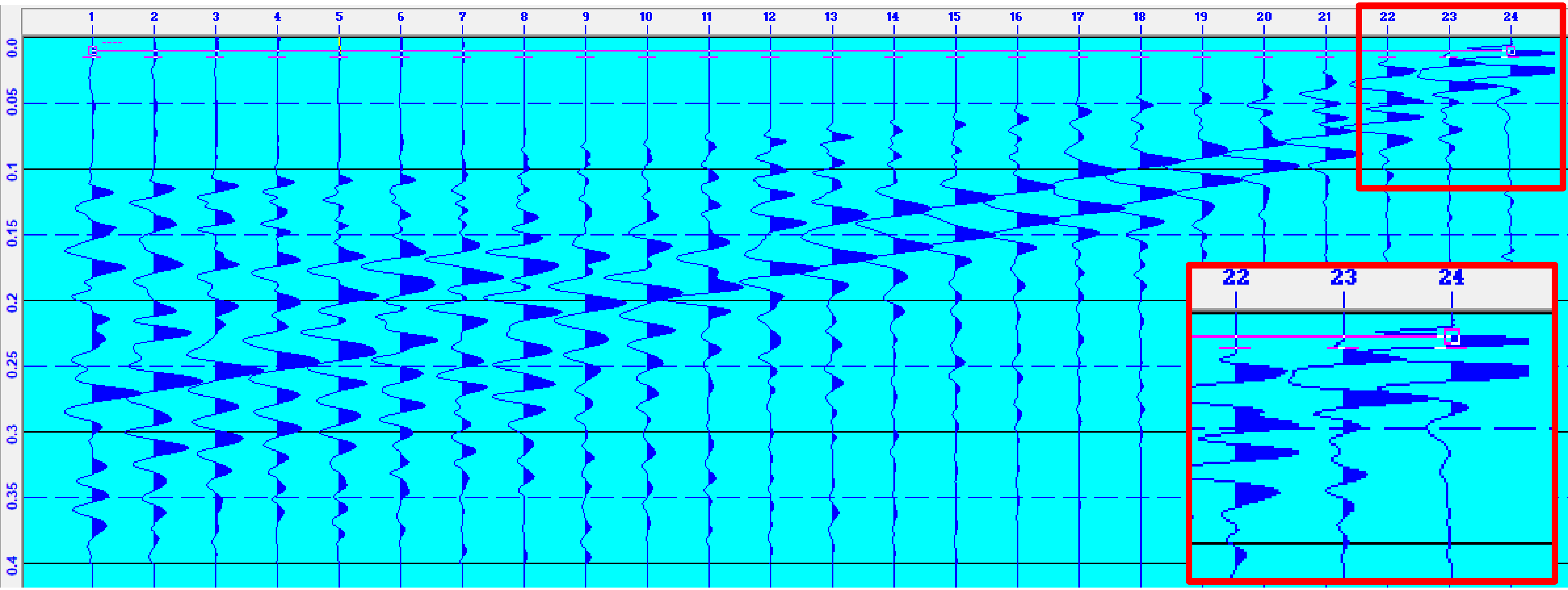
- Seismic *traces* ⇒ ground acceleration at the observing seismometer/geophone
- *Noise* will be present (we reduce by *stacking* or using a large source)
- *Amplitudes* (i.e., deflections) are often made more visible by amplification ⇒ “*gain*”
- Positive-valued deflections on the trace are often “filled” to help visually correlate arrivals at neighboring traces
- For a vertical geophone, *if polarity is correct*, **positive = up**
- Refracted wave first motion will always be upward! WHY?

In *seismic refraction* studies, we *pick* the *time of first arrival* of seismic energy!



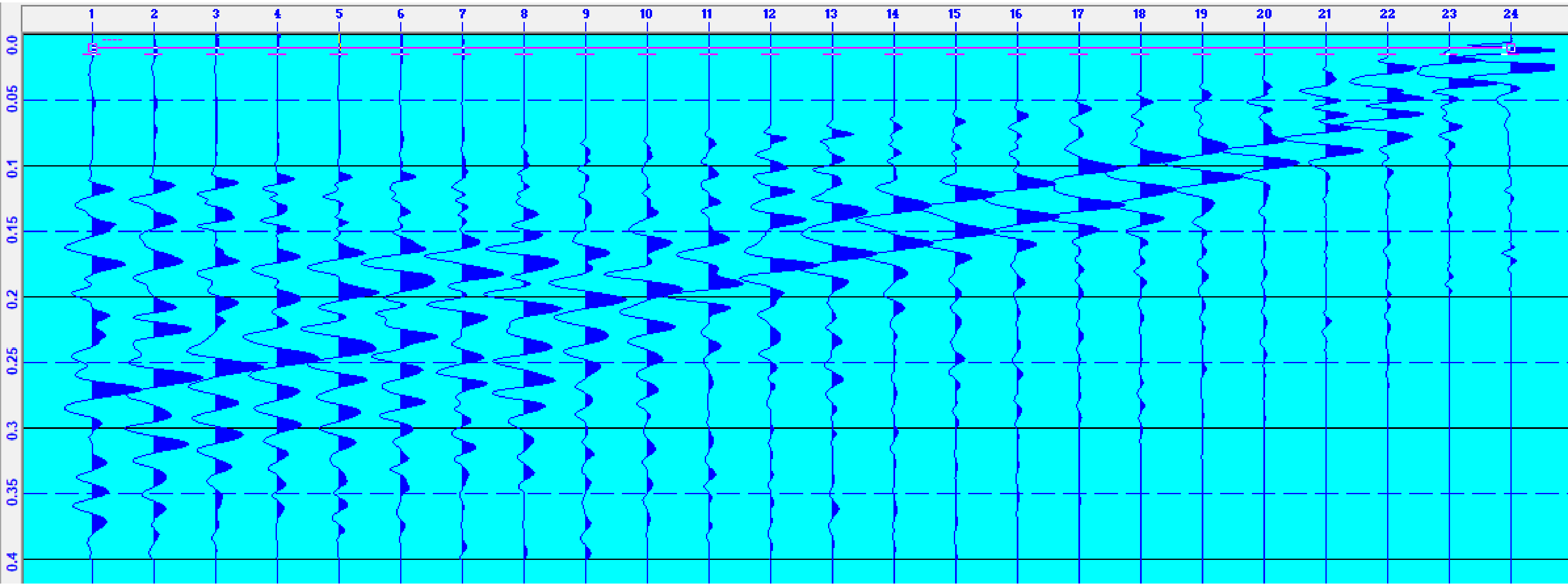
So when is the first arrival occurring on each of these traces?

By convention, *polarity* is defined so that upward first motions are plotted as positive (i.e., filled) on the *seismic section*.



In this plot, the first motions are negative!

Does that make sense?



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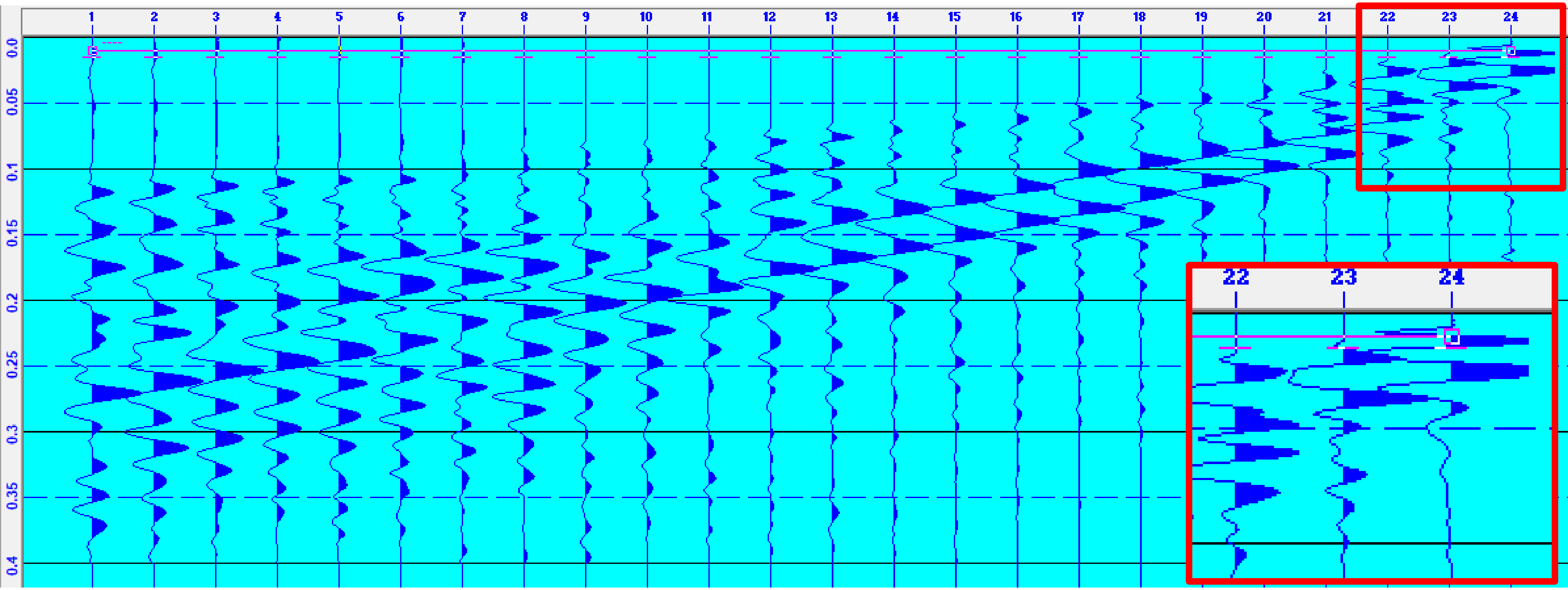
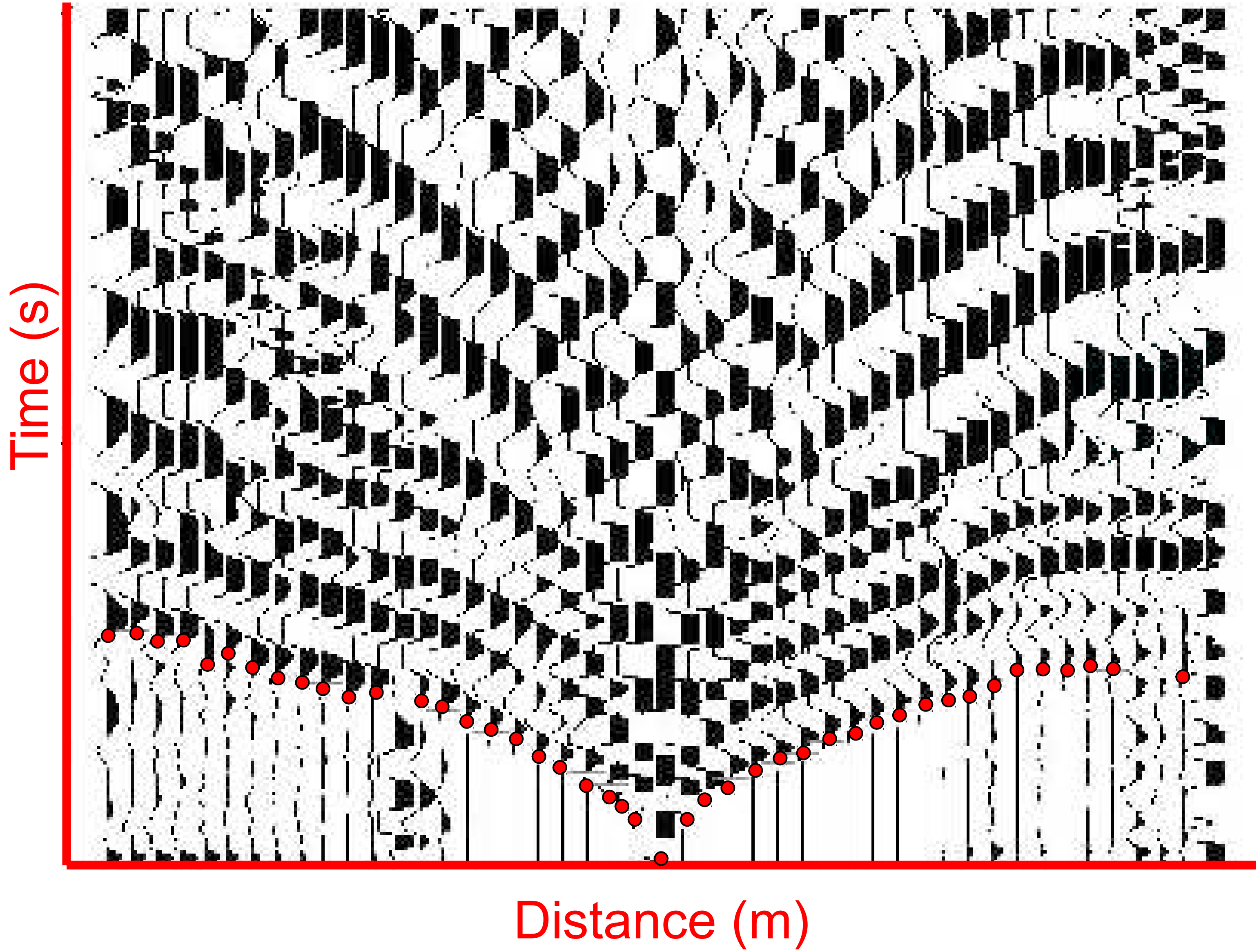


In this plot, the first motions are negative! This can result from mis-wiring of electronics, attaching geophone leads to the cable backwards, or a plotting error...

It’s important to look carefully for this reason!



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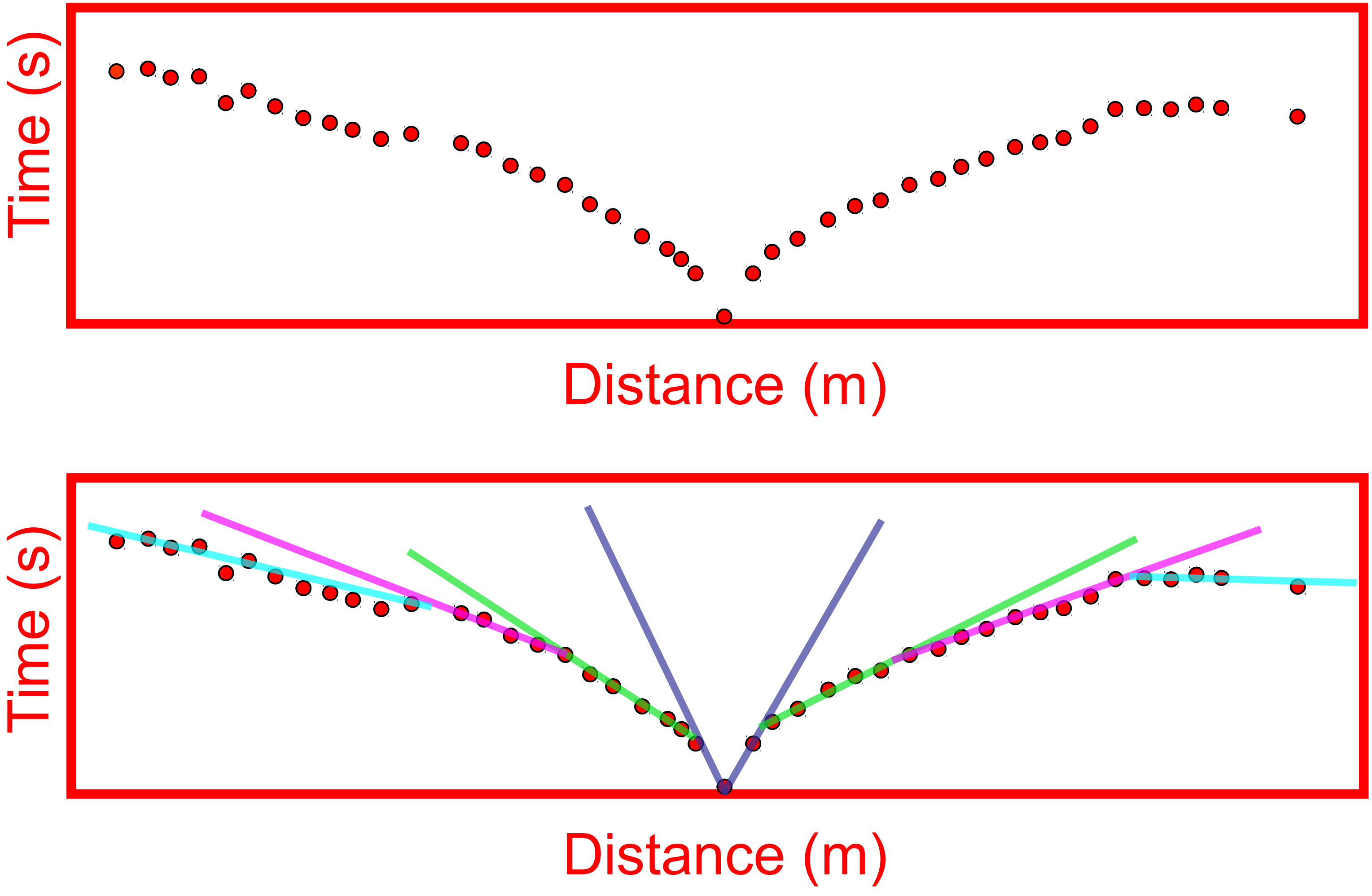
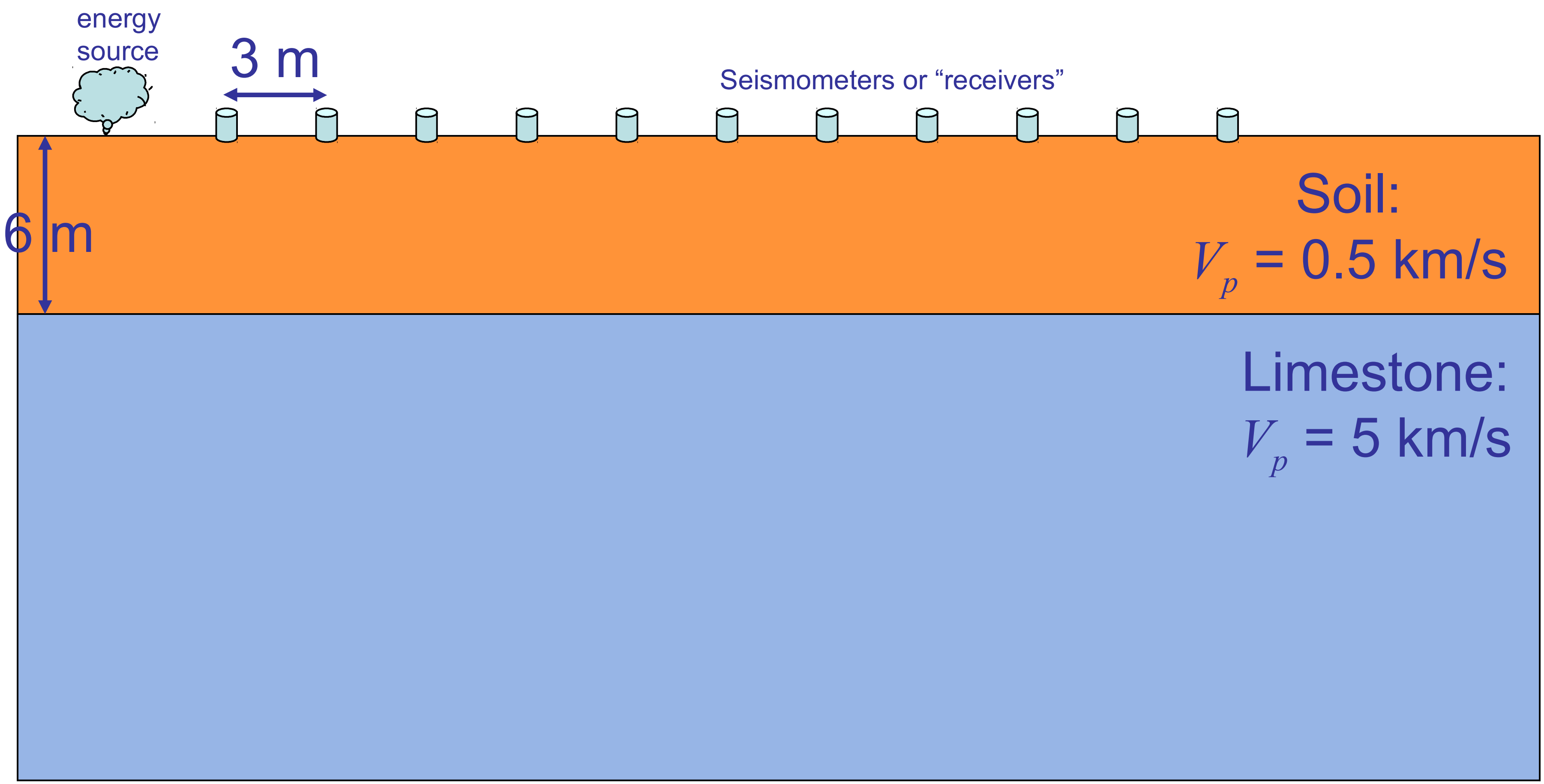
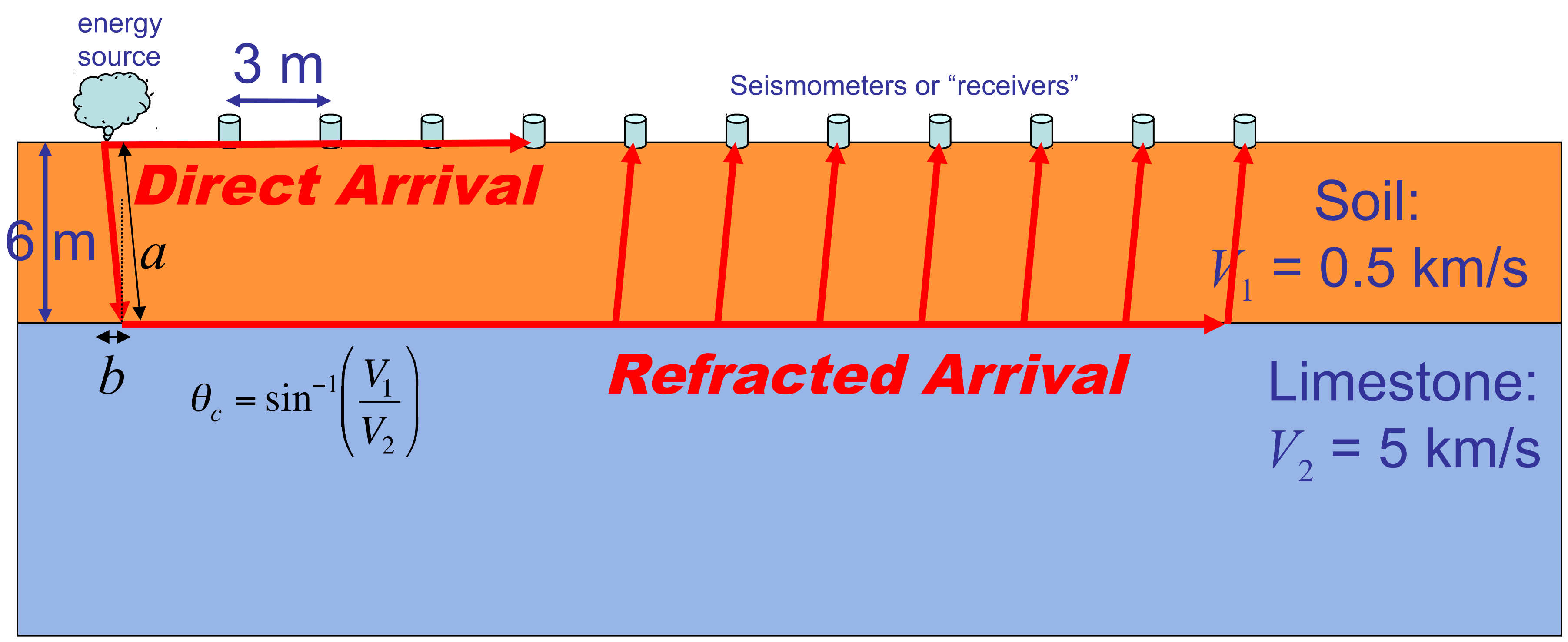


As a first approximation, we can draw straight lines through the travel-time picks to model the velocity structure assuming multiple layers with planar boundaries (because the math is easy).



energy source
3 m
Seismometers or “receivers”
6 m
Soil:
V_p = 0.5 km/s
Limestone:
V_p = 5 km/s

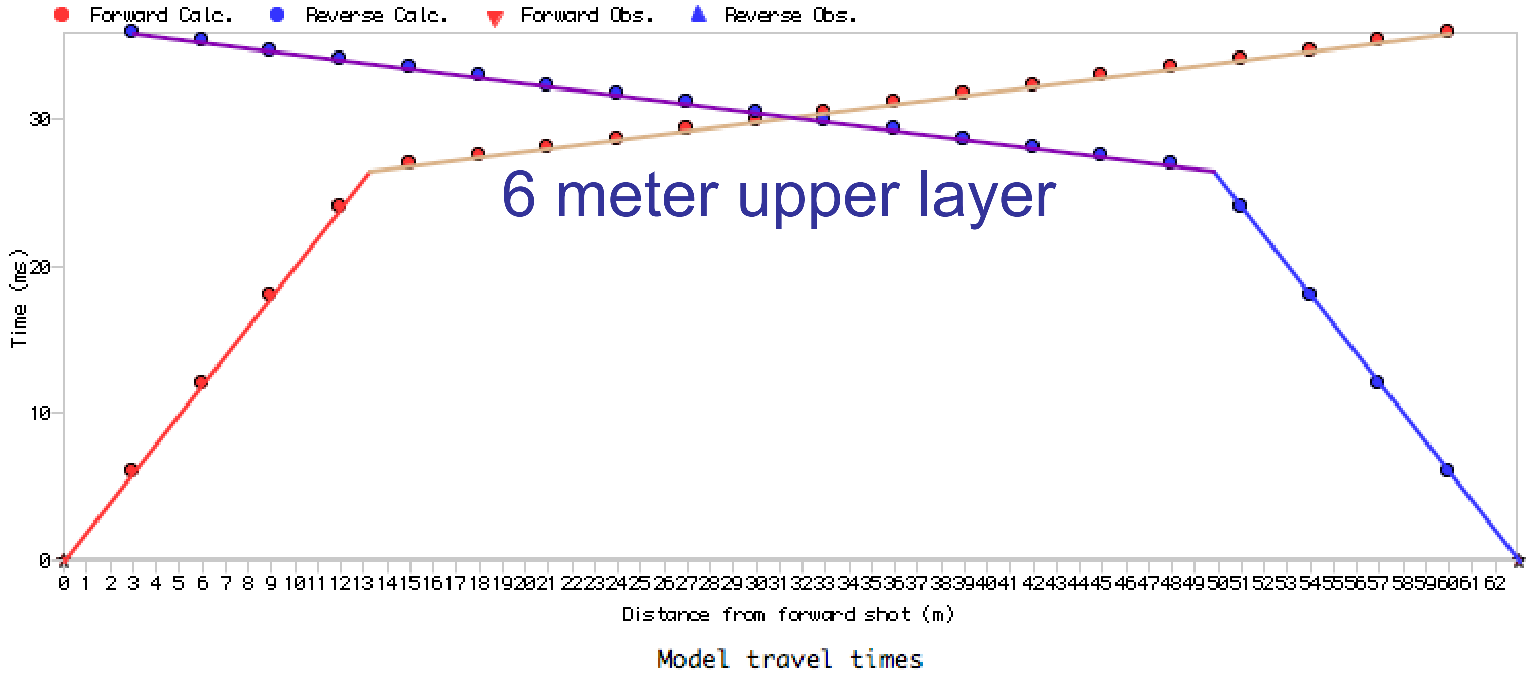


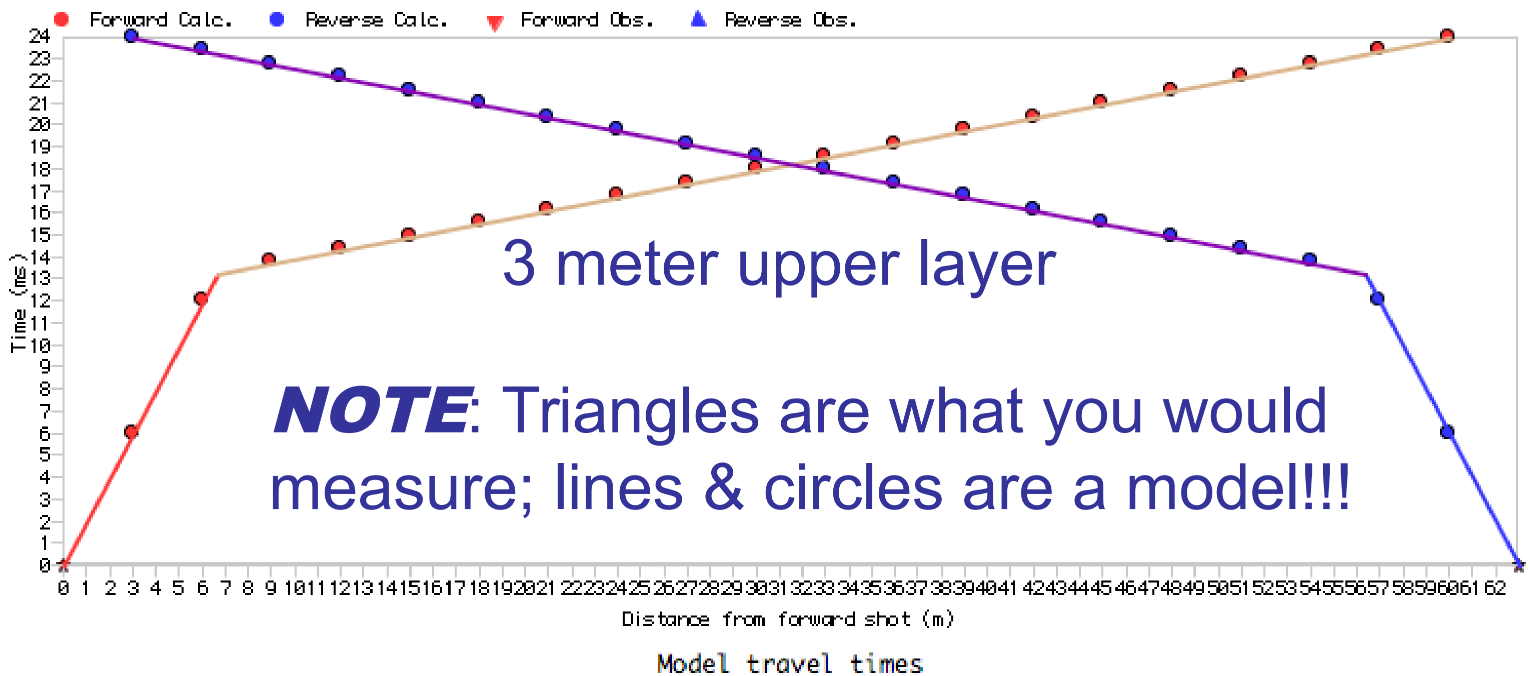
In this example, a plot of first-arriving travel time will yield the following lines:

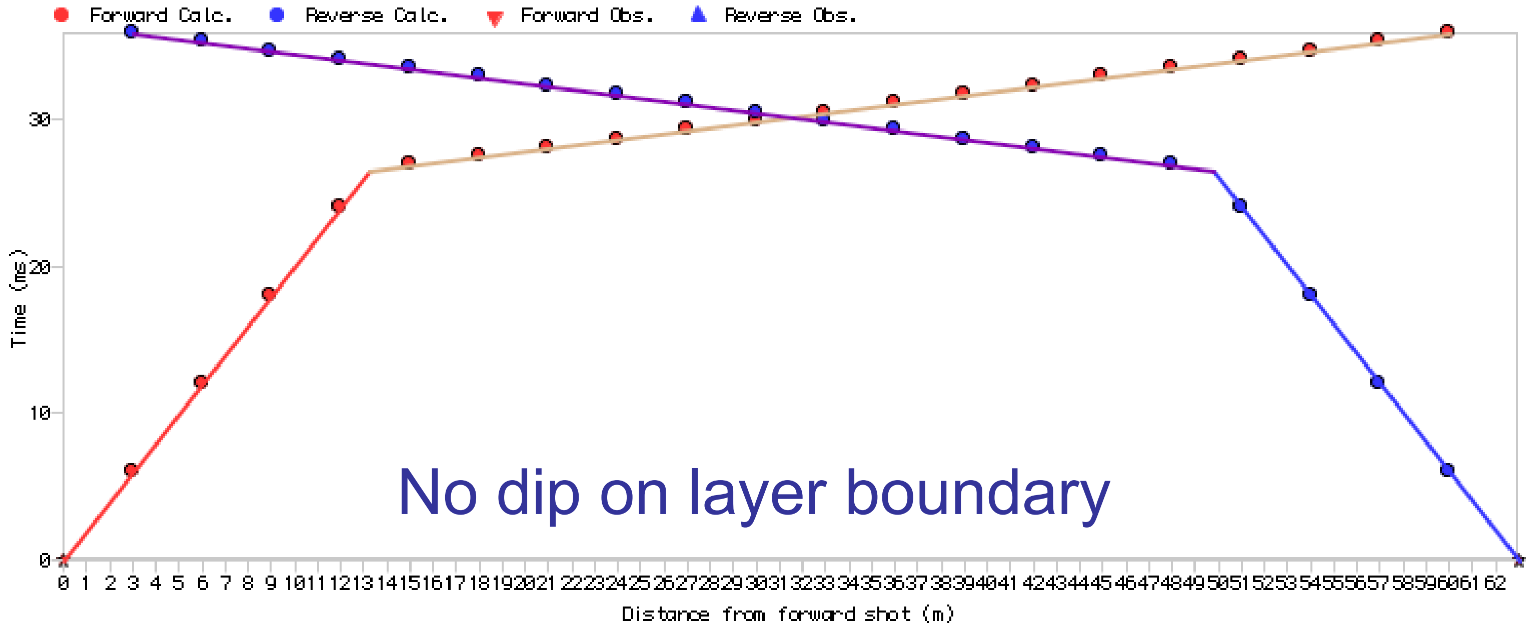
(a) Direct arrival, with slope $1/V_1$, having a zero intercept (WHY?)

(b) Refracted arrival, with slope $1/V_2$, with an intercept that depends on layer thickness, h, and V_1, V_2:

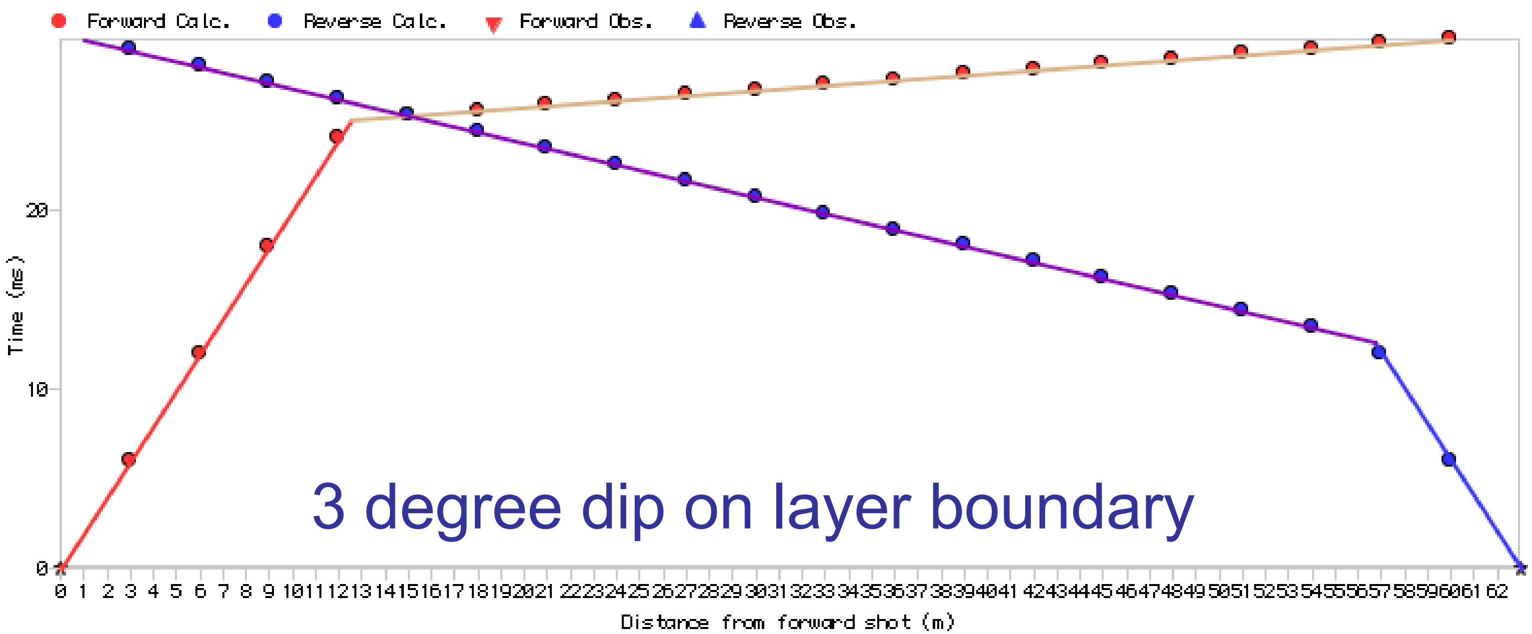
$$t_{refr} = \frac{x}{V_2} + \frac{2a}{V_1} - \frac{2b}{V_2} = \frac{x}{V_2} + \frac{2h\sqrt{V_2^2 - V_1^2}}{V_1 V_2}$$


Forward Calc.
Reverse Calc.
Forward Obs.
Reverse Obs.
Time (ms)
Distance from forward shot (m)
Model travel times
6 meter upper layer


Forward Calc.
Reverse Calc.
Forward Obs.
Reverse Obs.
Time (ms)
Distance from forward shot (m)
Model travel times
3 meter upper layer
NOTE: Triangles are what you would measure; lines & circles are a model!!!



Model travel times



Model travel times

How about this?