Ben Postlethwaite
Masters Committee Meeting I
Supervisor: Michael Bostock
July 10th 2012

Thesis/Research Overview

First, a little about me.

Foulridge, Lancashire. 1979

Mission, BC. 1981 - 1998

Vancouver, BC. 2000 - Present

UBC. 2007 - Present.

and a tiny bit more.

http://benpostlethwaite.ca

Research - Grant

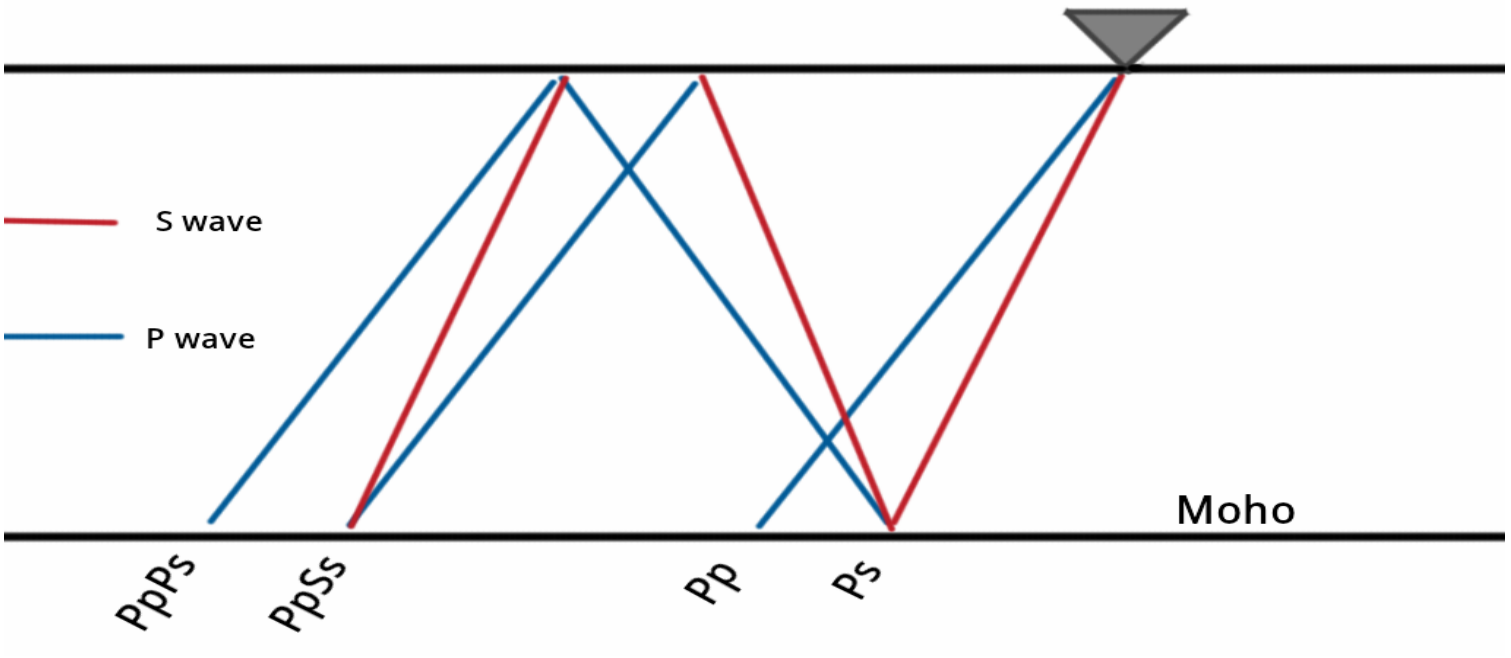
- Funding comes from NSERC grants established for the project “An Improved Model of the Canadian Lithosphere” which was initiated by Michael and A.W. Frederikson of the University of Manitoba.
- UBC portion of grant is for research related to receiver function analysis and production of crustal depth and seismic property map (R = Vp/Vs) from all available Canadian seismic data.

Research - Thesis

- Broadly speaking the research follows the requirements in the NSERC proposal with the added focus on a new method developed by Michael to unpack additional information from receiver function analysis.
- Scope is still Canada wide but we hope the extra information will allow further constraints on the broad geologic picture.

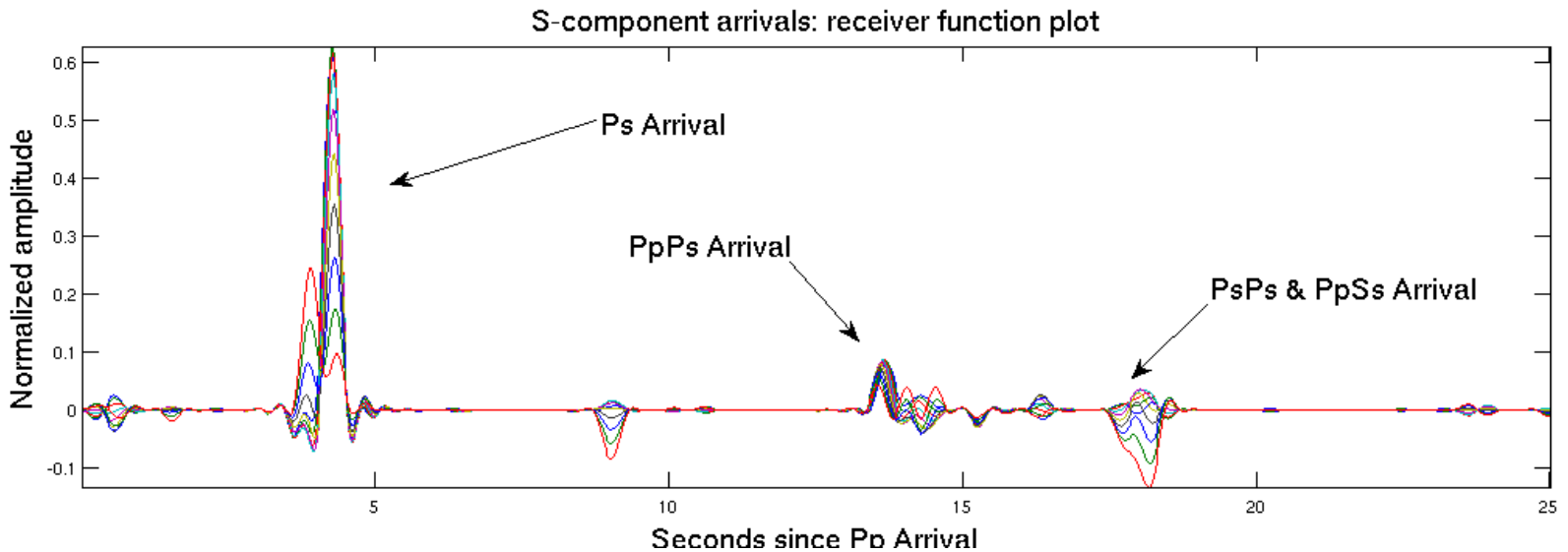
Research - Background

- Kanamori (2000) put together machinery in use today.
- Focused on reflected S-wave phases.



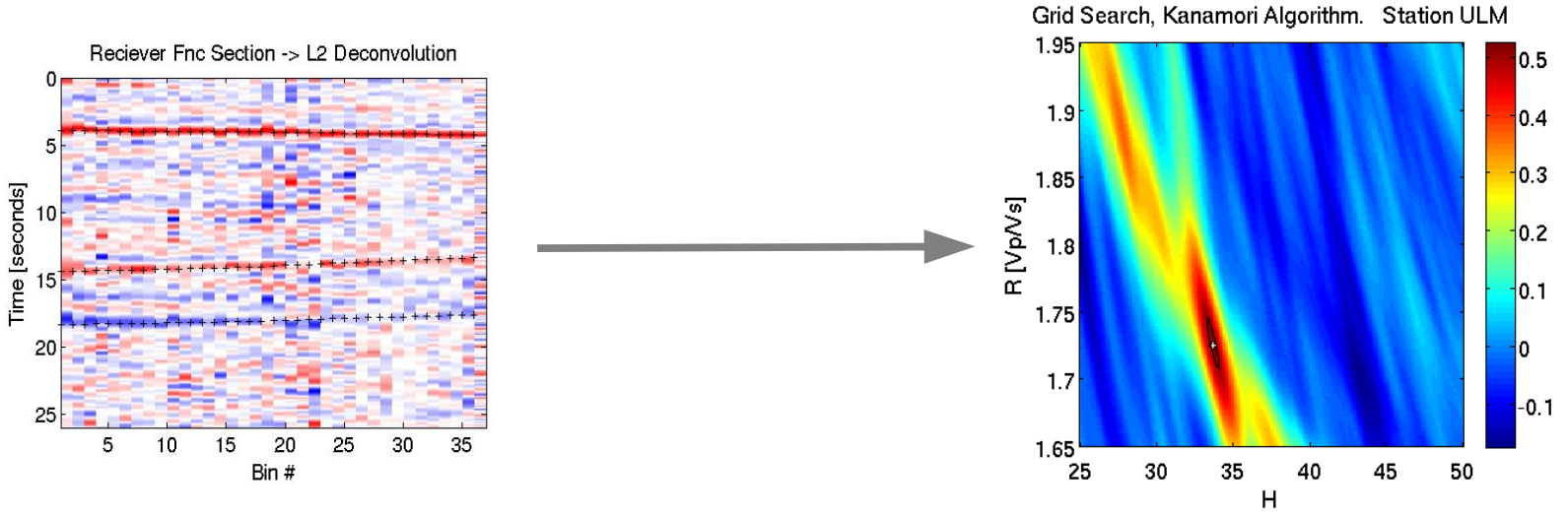
Research - Background

- Rotate seismograms into S-component and P-component space.
- Three events of interest contained in S-component seismogram.
- P-component seismogram used as approximation to source function



Research - Background

- Perform deconvolution on all S-wave seismograms from particular angle -> produce 1 receiver function.
- Do this for different angles, stack receiver function side by side.
- These receiver functions become the data used to test models using different Vp/Vs and H values in a grid search.
- Grid search is the process of solving the equations in the model for a range of Vp/Vs values.
- The values that best predict the data = best estimates for the values of the material properties.



Research - Background

- In 2010 in a paper “Bias in seismic estimates of crustal properties” by Michael Bostock and M. Ravi Kumar outlined a method to extract Vp, Vs and H from a receiver function grid search.
- This is accomplished by breaking it down into two steps:

$$t_{Ps}(p_i) = H\left[\sqrt{R^2 - p_i^2 V_p^2} - \sqrt{1 - p_i^2 V_P^2}\right] \quad (1)$$

$$t_{Pps}(p_i) = H\left[\sqrt{R^2 - p_i^2 V_p^2} + \sqrt{1 - p_i^2 V_P^2}\right] \quad (2)$$

$$t_{Pss}(p_i) = 2H\sqrt{R^2 - p_i^2 V_p^2} \quad (3)$$

$$t_{Pss}(p_i) = \frac{\sqrt{R^2 - p_i^2 V_p^2} + \sqrt{1 - p_i^2 V_P^2}}{\sqrt{R^2 - p_i^2 V_p^2} - \sqrt{1 - p_i^2 V_P^2}}\, t_{Ps}(p_i) \quad (4)$$

$$t_{Pss}(p_i) = \frac{2\sqrt{R^2 - p_i^2 V_p^2}}{\sqrt{R^2 - p_i^2 V_p^2} - \sqrt{1 - p_i^2 V_P^2}}\, t_{Ps}(p_i) \quad (5)$$

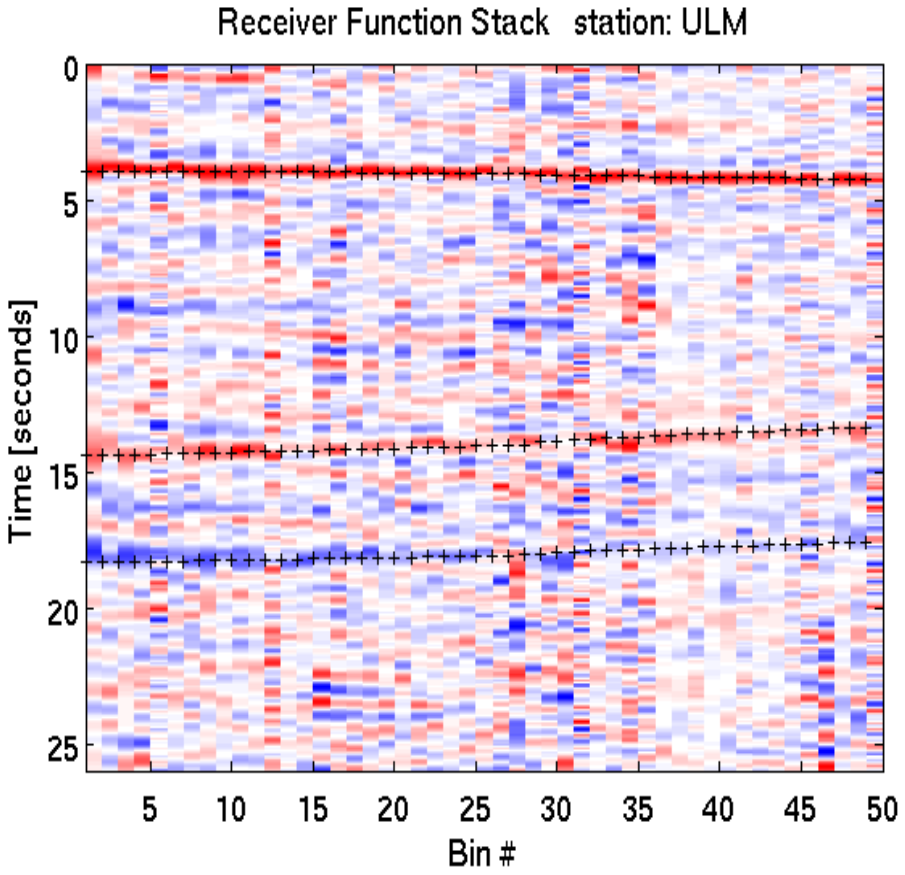
2) Then plug Vp_best and R_best into original Tps equation and do line search for H

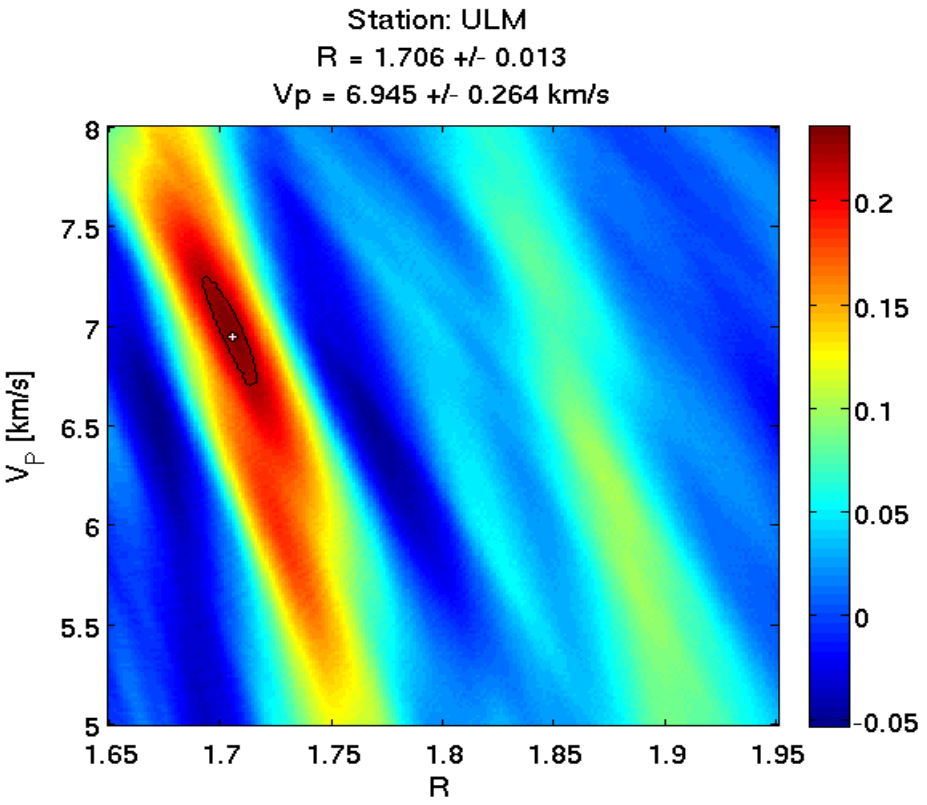
1) Solve the divided equations for tpss and tpps to get best estimates for Vp_best and R_best

Research - Current

- To date I have built out the program/tool-chain to preprocess, deconvolve and perform the grid search and have begun downloading 12 years of data from all the Canadian seismic stations.
- I have all Eastern Canadian stations downloaded, pre-processed and picked.
- Additionally I have some data from Dave Snyder of NRCAN that has come from Polaris which I am working on now. (re-pre-processing)

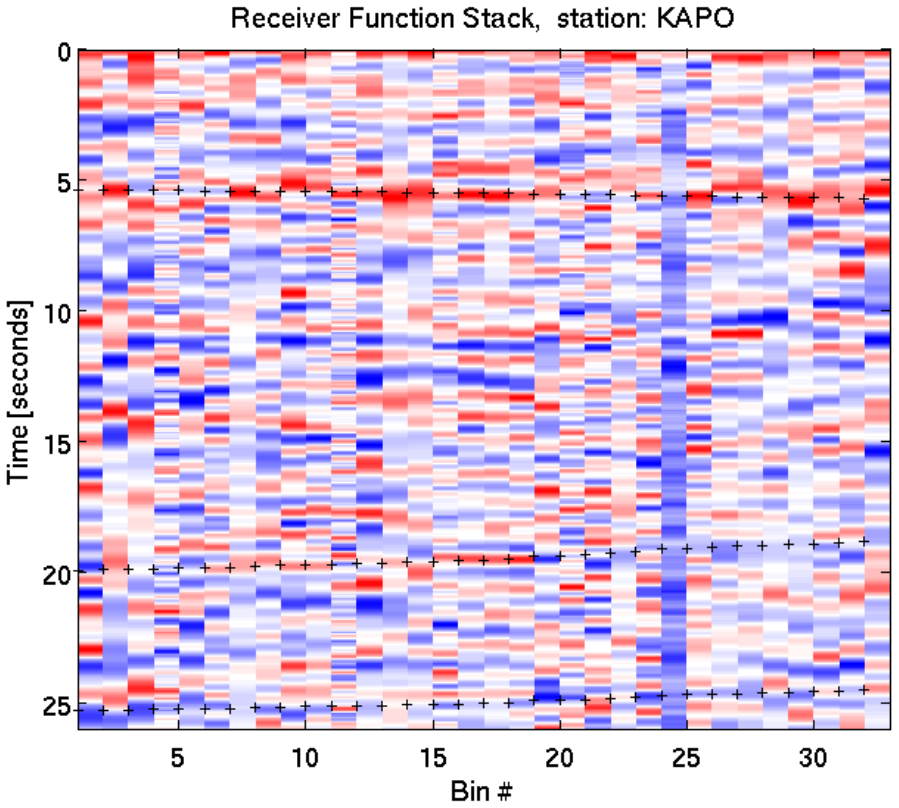
Research - Data - The Good

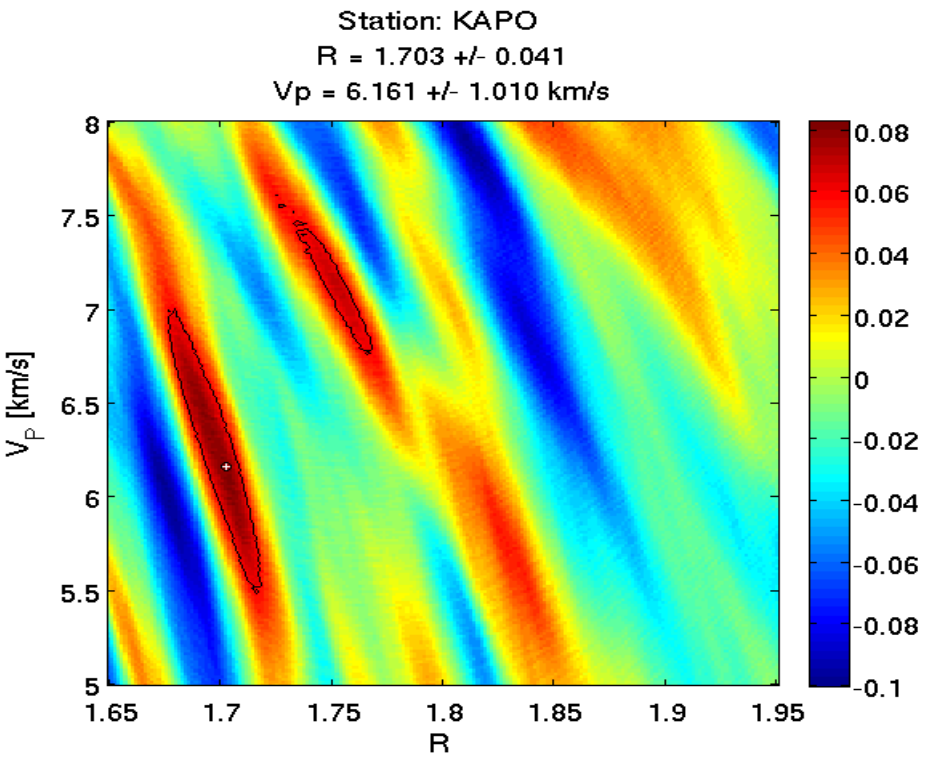




Receiver Function Stack ----------> Grid Search for Vp & Vs

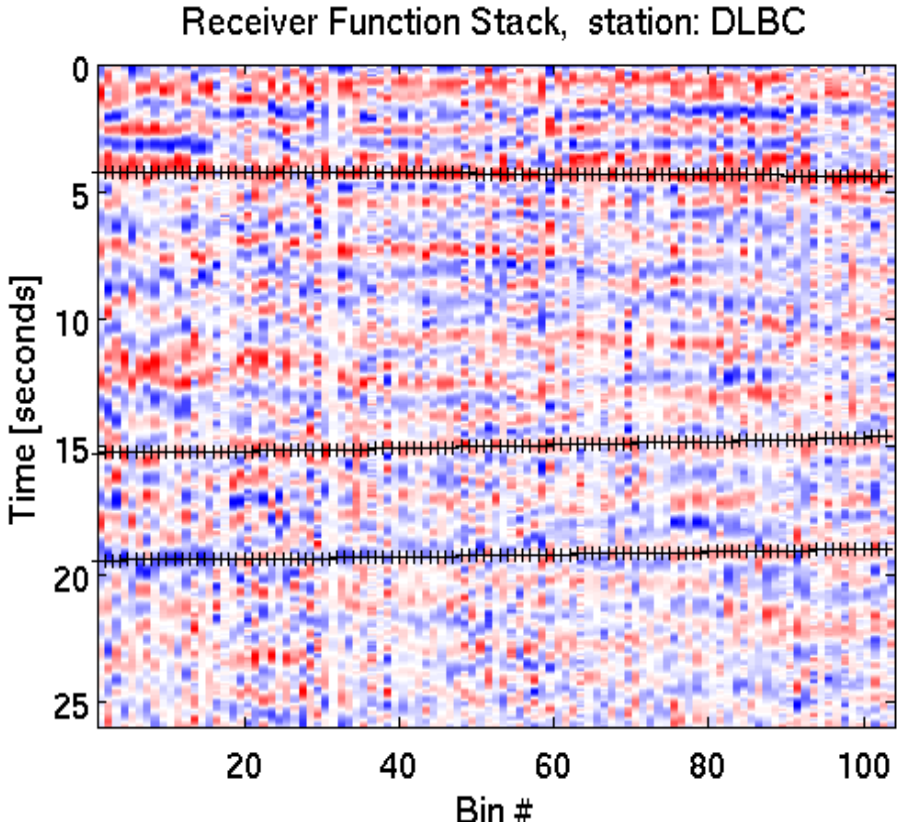
Research - Data - The Bad

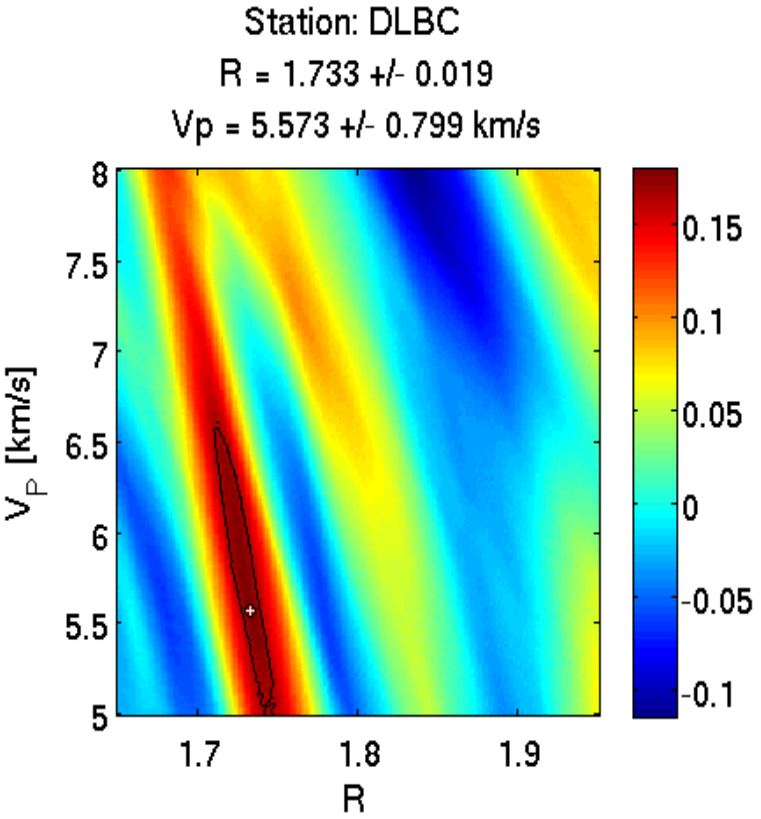




Receiver Function Stack ----------> Grid Search for Vp & Vs

Research - Data - The Ugly





Receiver Function Stack ----------> Grid Search for Vp & Vs

Research - Future

- Finish preprocessing Snyder's data.
- Download and preprocess rest of Canadian data.
- Try L1 minimization, Extended-Time Multitaper Frequency Domain Cross-Correlation methods. (including hybrid step approaches.)
- Begin 2nd stage of project and get ready for AGU.

Research - Future

- 2nd stage involves pairing the database of bulk seismic properties at each Canadian station with Nik Christensen's data on mineral & rock seismic properties.
- Going to require ternary or quaternary diagrams with well chosen end members.
- David Snyder seemed to doubt the existence of a searchable geologic database at his institution at least. Follow-up required.