Summer Intern Program, 2021

David Fuentes

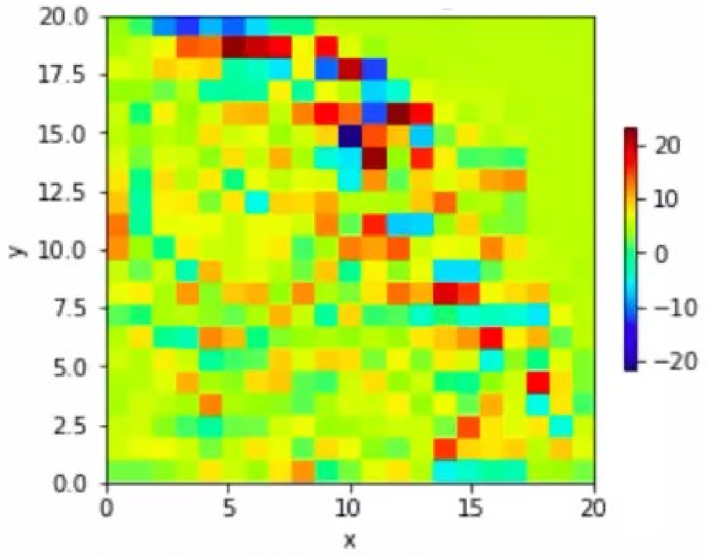
Bill Menke

Charlotte Rhoads

Does Supplementing Travel Time Data with Amplitude Data improve Geo-tomographic Determinations of Earth Structure?

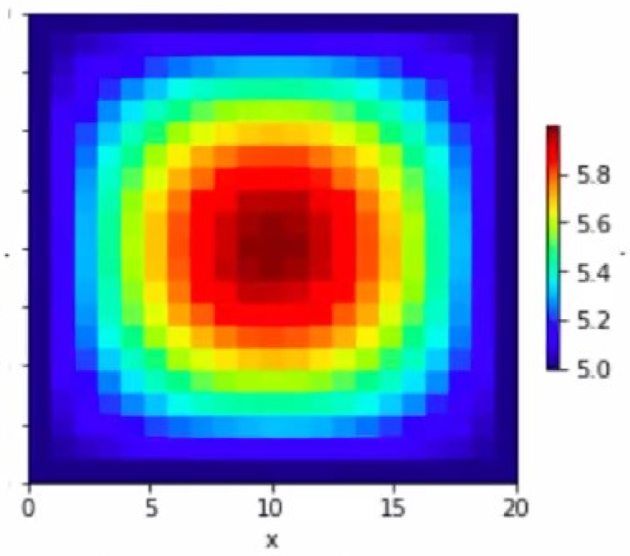
Charlotte Rhoads[1], Dr. William Menke[2]
[1]Vassar College, [2]Lamont-Doherty Earth Observatory of Columbia University

Travel Time Data Only



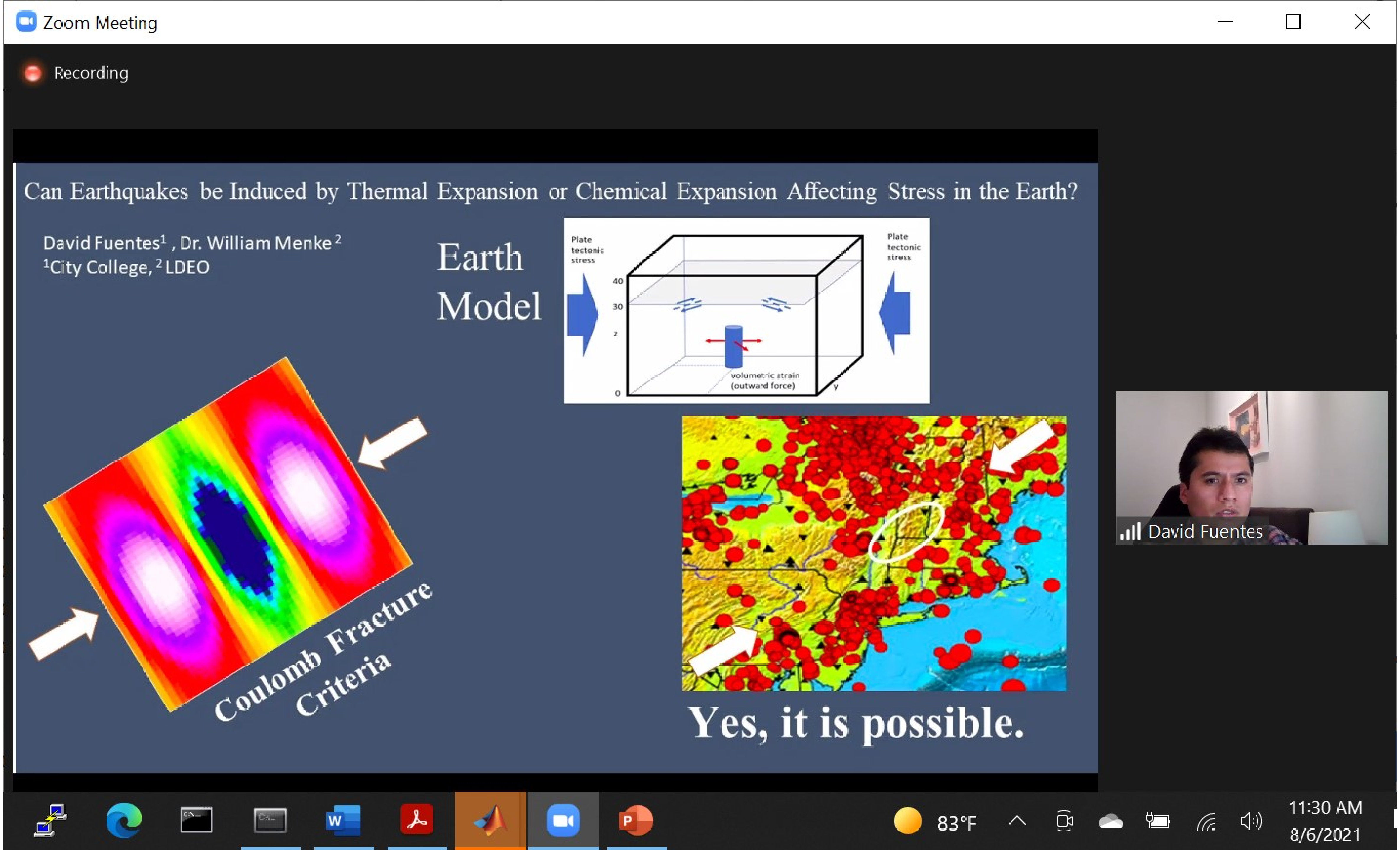
Data from 20 Earthquakes

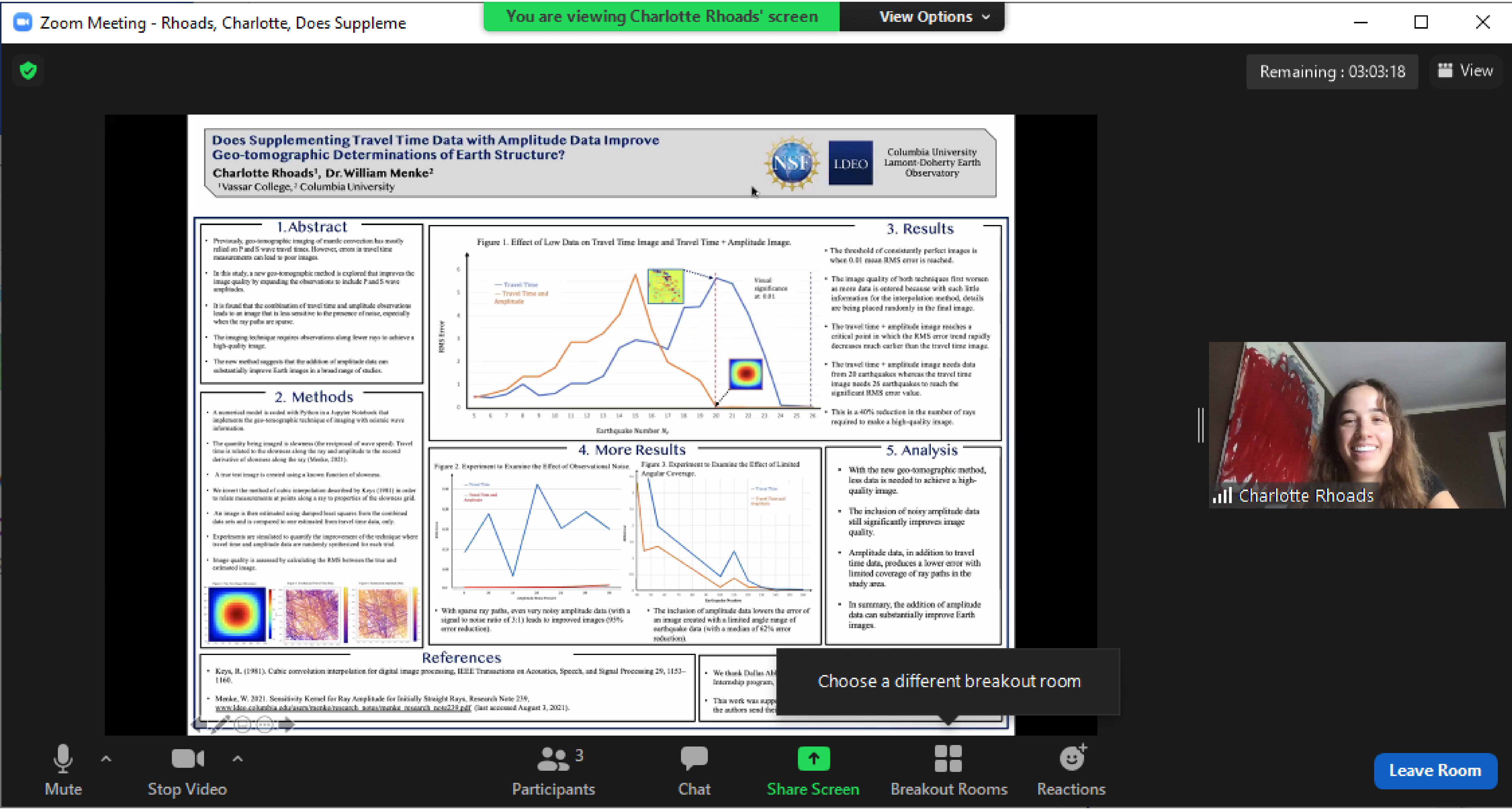
Travel Time + Amplitude Data



Data from 20 Earthquakes

Yes, the addition of amplitude data can substantially improve Earth images in a broad range of studies.


Zoom Meeting
Recording
Can Earthquakes be Induced by Thermal Expansion or Chemical Expansion Affecting Stress in the Earth?
David Fuentes[1], Dr. William Menke[2]
[1]City College, [2]LDEO
Earth Model
Plate tectonic stress
Plate tectonic stress
40
30
z
0
y
volumetric strain (outward force)
Coulomb Fracture Criteria
Yes, it is possible.
David Fuentes
83°F
11:30 AM
8/6/2021


Zoom Meeting - Rhoads, Charlotte, Does Suppleme
You are viewing Charlotte Rhoads' screen
View Options
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Does Supplementing Travel Time Data with Amplitude Data Improve Geo-tomographic Determinations of Earth Structure?
Charlotte Rhoads[1], Dr. William Menke[2]
[1]Vassar College, [2] Columbia University
NSF
LDEO
Columbia University Lamont-Doherty Earth Observatory
1. Abstract
2. Methods
3. Results
Figure 1. Effect of Low Data on Travel Time Image and Travel Time + Amplitude Image.
4. More Results
5. Analysis
With the new geo-tomographic method, less data is needed to achieve a high-quality image.
The inclusion of noisy amplitude data still significantly improves image quality.
Amplitude data, in addition to travel time data, produces a lower error with limited coverage of ray paths in the study area.
In summary, the addition of amplitude data can substantially improve Earth images.
References
Choose a different breakout room
Charlotte Rhoads
Mute
Stop Video
Participants
Chat
Share Screen
Breakout Rooms
Reactions
Leave Room

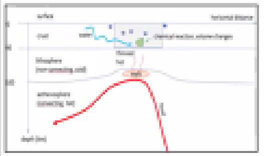
Can earthquakes be induced by thermal expansion or chemical expansion affecting stress in the earth?

David Fuentes[1], Dr. William Menke[2]
[1] City College, [2] Columbia University

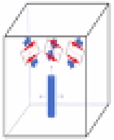
LDEO Columbia University Lamont-Doherty Earth Observatory

1. Abstract

- The CFC is used to assess whether or not earthquakes occurring in the shallow crust of New England might have a relationship to the Northern Appalachian Anomaly (NAA).
- We hypothesize that lower crustal volume changes are produced by chemical alteration.
- A suite of different shapes are simulated using a 3D finite difference method finding that the strongest effect is predicted for a chimney-shaped altered region.
- The overall effect of the chemical alteration is to lead to pattern of seismicity that is spatially very heterogeneous and that shares some similarity with the actual pattern of seismicity observed in New England.



Simplified model of the area under investigation.

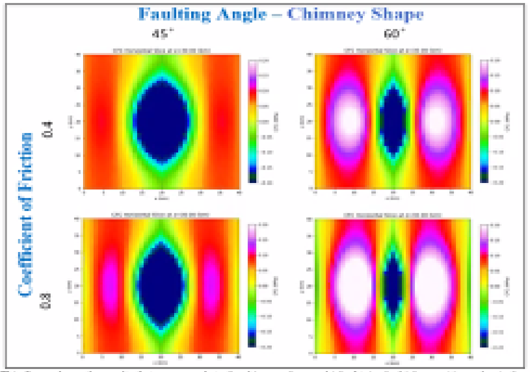


Model of studied area showing region of volumetric strain (Blue) and reverse faults (Red).

2. Methods

- Worked with the finite difference method.
- Simulated stress in the Earth and predicted if earthquakes were favored.
- The model used was a 40*40*40 km cube.
- The source of stress was a region of 1% of volumetric expansion, simulating a chemical reaction.
- The Coulomb Fraction Criteria (CFC) was used to determined whether stress changes favored or suppressed earthquakes.

3. Results



This figure shows the results that corresponds to the chimney shape, which obtained a higher positive value in the Coulomb Fraction Criteria (CFC) compared to the spherical and pancake shape.

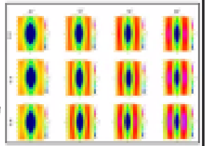
- Three different volumetric strain shapes were simulated: spherical, pancake and chimney.
- Depending on the angle and coefficient of friction, it was determined whether reverse failure was favored.
- The combinations and angles and coefficient of friction that occurred in the chimney shape were the most positive CFC favoring the reverse fault.
- It was also found that a zone located right above the volumetric stress resulted in no reverse faults and therefore earthquakes did not occur.

Plane of Observation (Green)

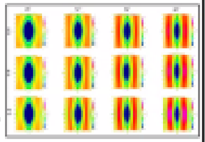
4. Effects of other Shapes

- In the other two shapes that were simulated, it was observed that the spherical shape favored reverse failure more than the pancake shape, but less than the chimney shape.
- At the highest angle degree (60°) and highest coefficient of friction (0.8), both the spherical and pancake shape had the minimal reverse faulting in comparisons to the chimney shape. (as seen in the lower right-hand corner of both images)

Spherical Shape



Pancake Shape



5. Summary of Results

- The chemical reaction causes the earthquakes to not occur right above the reaction, regardless of the coefficient of friction and the fault angle.
- Combinations of angle of faulting and coefficient of friction enhance earthquakes at edges (CFC = 0.3 Mpa).
- The chimney shape is the volumetric strain that is most likely to favor the faulting and cause an earthquake.
- It is possible, but not proven that the NAA is caused by chemical alteration above its upwelling.

References

Levin, V., Long, M.D., Skryzalin, P., Li, Y. and López, I., 2018. Seismic evidence for a recently formed mantle upwelling beneath New England, Geology 46, 87–90. doi: 10.1130/G39641.1.

Menke, W., Skryzalin, P., Levin, V., Harper, T., Darbyshire, F. and Dong, T., 2018. The Northern Appalachian Anomaly: A modern asthenospheric upwelling, Geophysical Research Letters 45, 10,173–10,179, doi:10.1002/2016GL070918.

Acknowledgments

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