What’s under the Reelfoot rift?

How can earthquakes happen there?

Why do earthquakes happen there?
During rifting, granite rocks stretched & faulted, leaving deep Mississippi Embayment wider than rift itself

Over millions of years, Embayment filled with thousands of feet of sediment deposited by Mississippi river and its ancestors

Simplification of complex reality: “All models are wrong. Some models are useful.”
Activity 7.1
What’s in the mystery box?
What did you do to try to find out?
Seismic reflection shows when waves that bounced off interfaces arrive

Deep reflector is “basement” - top of rocks pulled apart to form rift. Faults offsetting it probably formed during rifting and may be where earthquakes occur today

Shallower reflectors are sedimentary rocks that filled the rift over time. Fault offsets on these reflectors are less than at depth, so faults moved less since sediments deposited

Implications: old faults don’t heal, and so move occasionally when forces within continent are strong enough

Gravity and magnetic data show denser igneous bodies below basement
What causes the earthquakes?

Plate interior contains many fossil faults: somehow forces within the plate (which we don’t understand) are causing small motions on them.

Like chunk of floating ice with cracks inside it.
Activity 7.2: Why New Madrid?

Plate interior contains many fossil faults developed at different times with different orientations - like the MCR - so why do only a few appear active today?

Options:

1) Something special is making faults in the New Madrid area active

2) Different fault systems have been active at different times, and New Madrid is just the most active today

How could we try to tell the difference?
Problem: most possible forces are large-scale forces that affect most of central and eastern North America. They may contribute to causing New Madrid earthquakes, but don’t explain why in the past few hundred years earthquakes seem to happen more at New Madrid than other places.

Plate motion driving forces
Another large scale force: GIA - glacial isostatic adjustment

Vertical Velocities

IGb00
1 5 mm/yr
+ve

-ve

Sella et al., 2007

GPS shows nothing unusual at New Madrid
Possible local stress source for seismicity: postglacial erosion in Mississippi Embayment

Flexure caused by unloading from river incision 16 - 10 ka reduces normal stresses sufficiently to unclamp pre-existing faults.

Fits timing of recent seismicity.

Doesn’t require weak zone.

Fault segments that ruptured unlikely to fail again.

Calais, Freed, Van Arsdale & Stein, 2010
NMSZ no hotter - and thus not thermally weaker - than rest of central US

No obvious strength reason for platewide stresses to concentrate in NMSZ rather than other faults
Option 2: Earthquakes move around, and New Madrid is the presently active area.