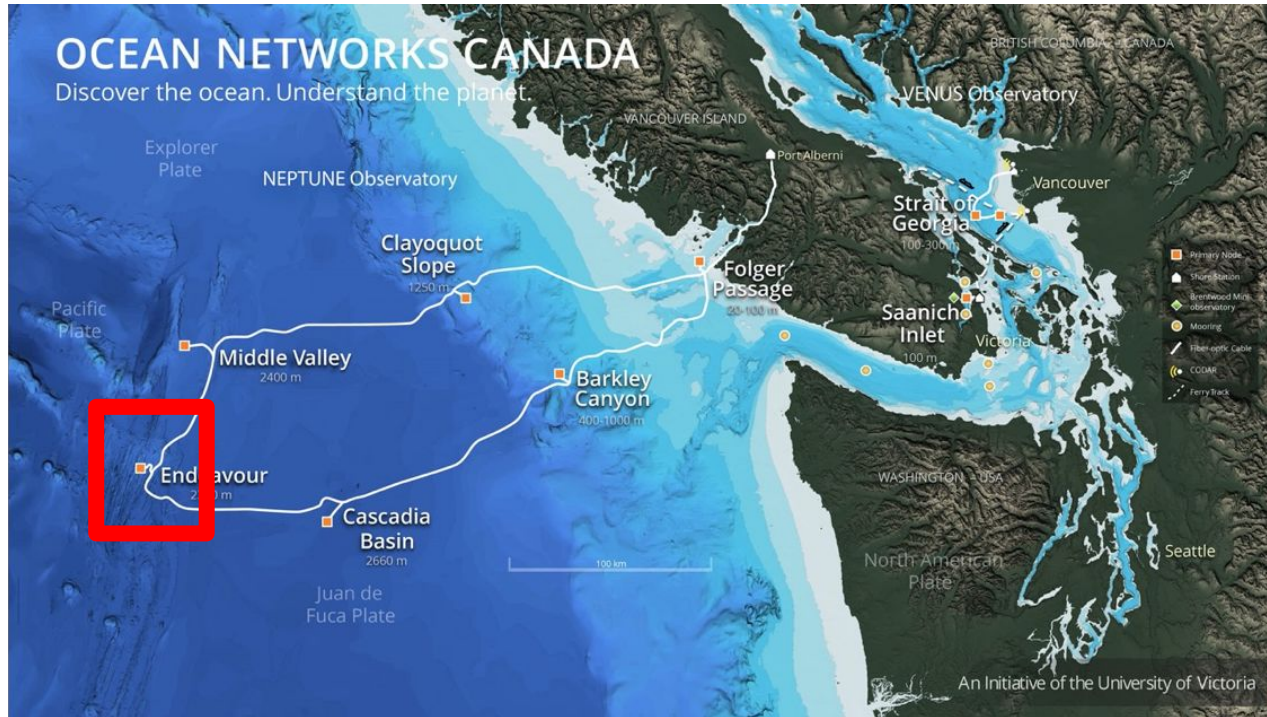


## Recent seismicity at the Endeavour segment

Zoe Krauss, William Wilcock  
University of Washington



Endeavour segment: ~90 km portion of the Juan de Fuca ridge.

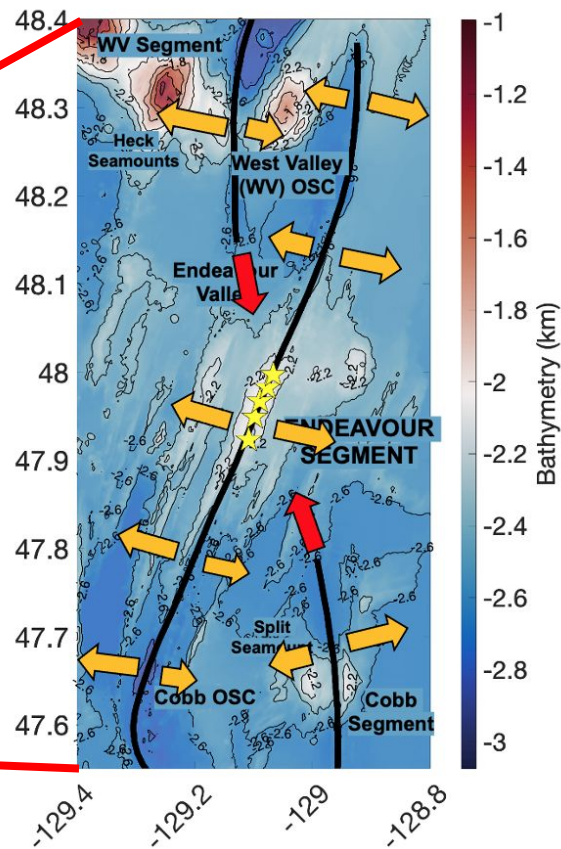
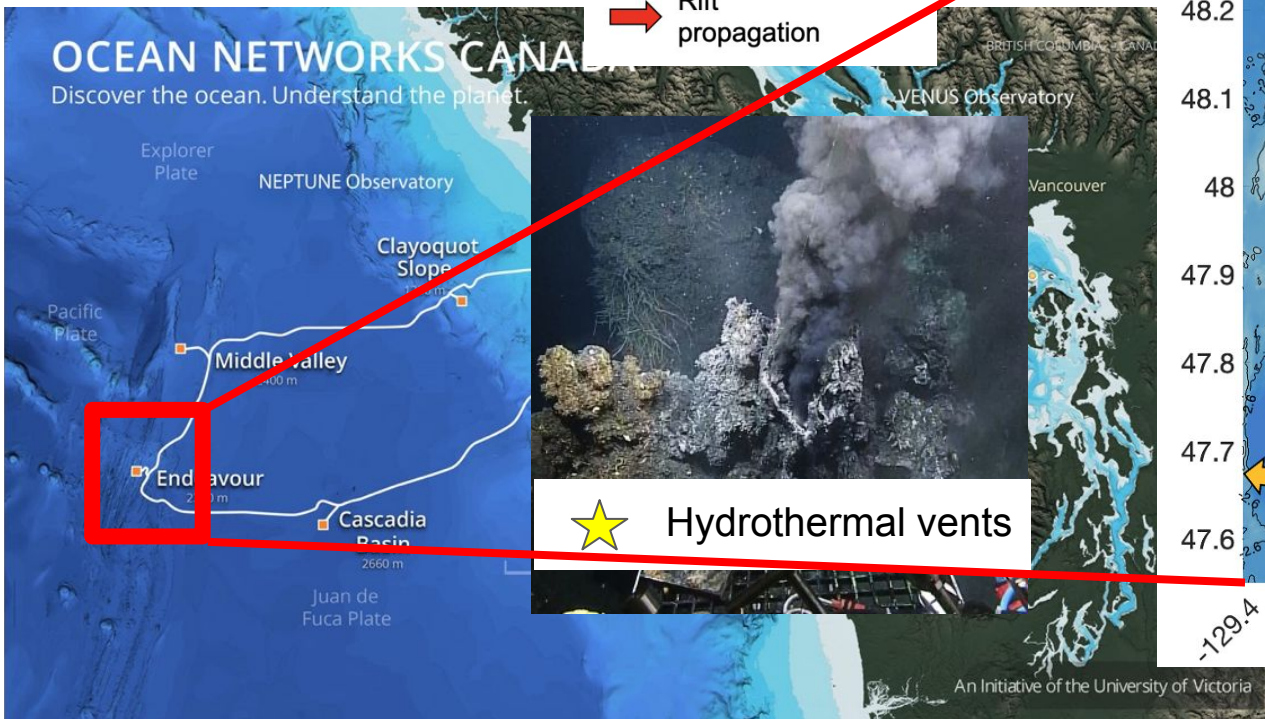


# Endeavour segment: ~90 km portion of the Juan de Fuca ridge.

— Tectonic boundaries

→ Extension/spreading

→ Rift propagation



Mid-ocean ridges undergo periodic “rupture” events.

### SPREADING CYCLE:

Extension builds up

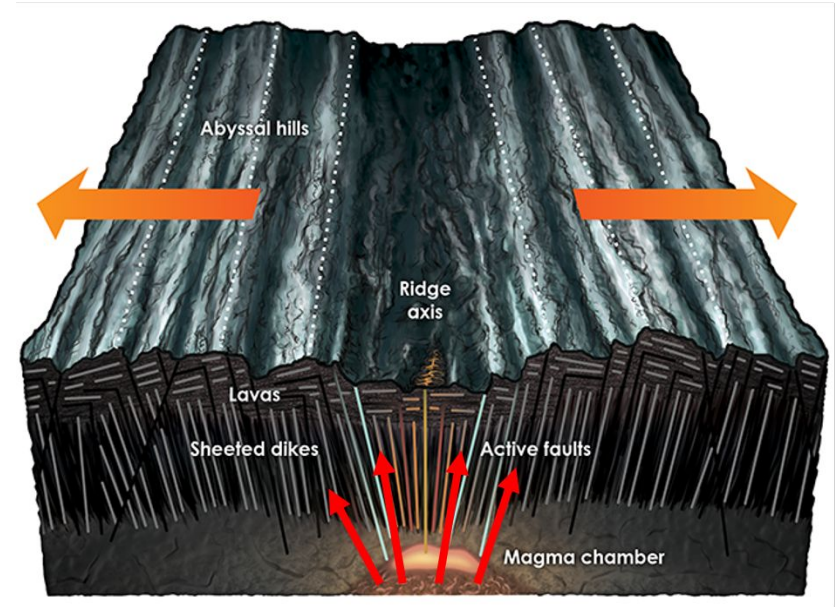


**RUPTURE EVENT:**  
Extension cemented in place by  
magma injection

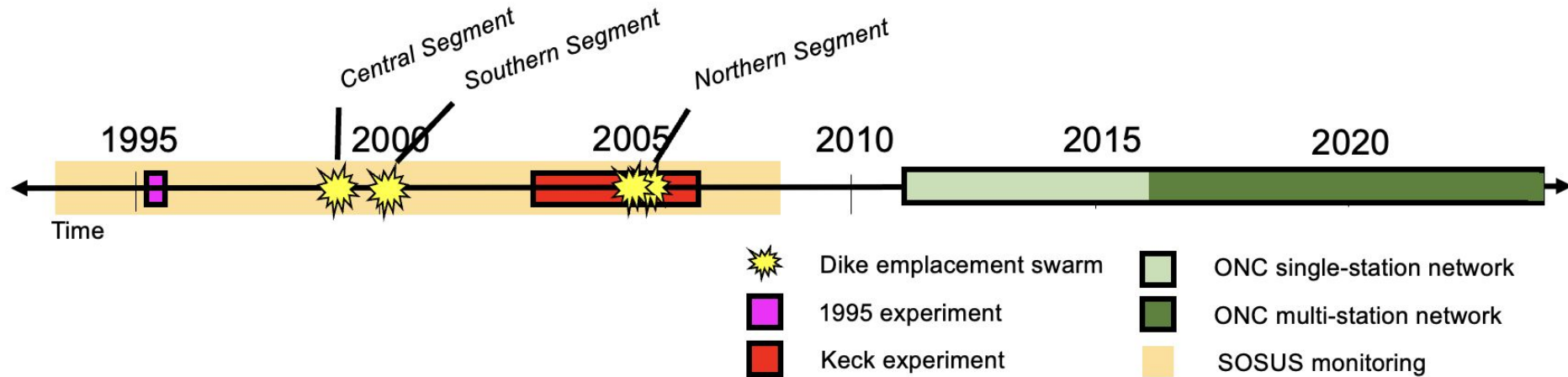


Extension builds up

*With a 1 m dike width and 52 mm yr<sup>-1</sup> spreading rate, **this should repeat at the Endeavour every ~20 years.***



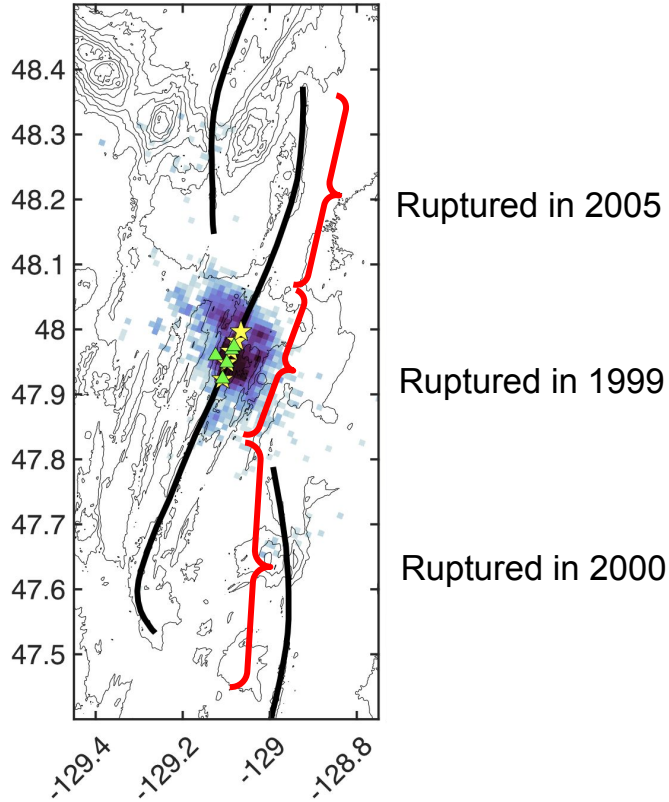
We've been monitoring earthquakes at the Endeavour segment for multiple decades, which allows us to track the spreading cycle.



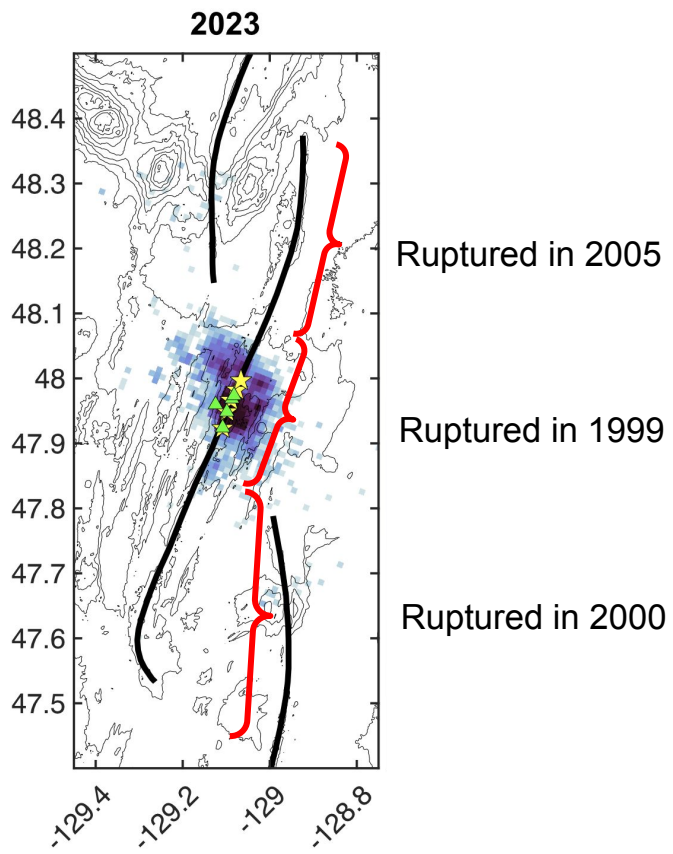
- Last “rupture” in 1999-2005, sequential dike emplacements
- Ocean bottom seismometer recordings before, during, and after that event
- Hydroacoustic monitoring for other events

Nearly 20 years since the last rupture, we can begin to anticipate a subsequent event. What should we be looking for?

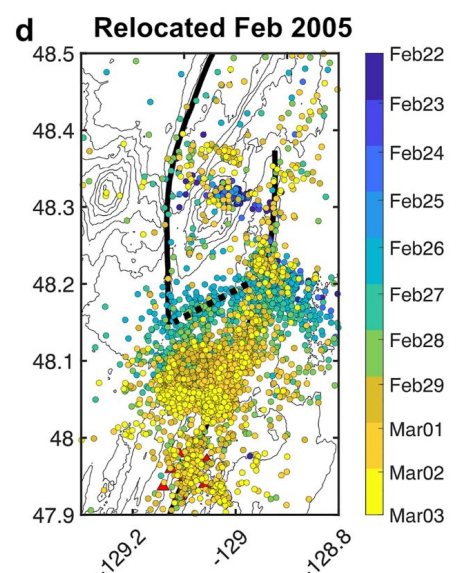
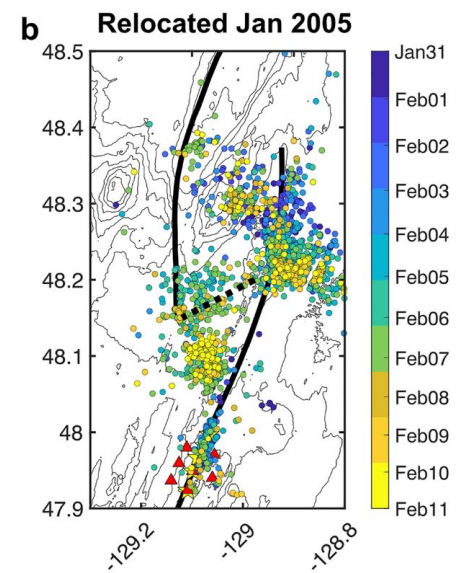
2023



Nearly 20 years since the last rupture, we can begin to anticipate a subsequent event. What should we be looking for?



*North segment rupture Jan-March 2005:  
1000s of earthquakes migrating 10s of kilometers*

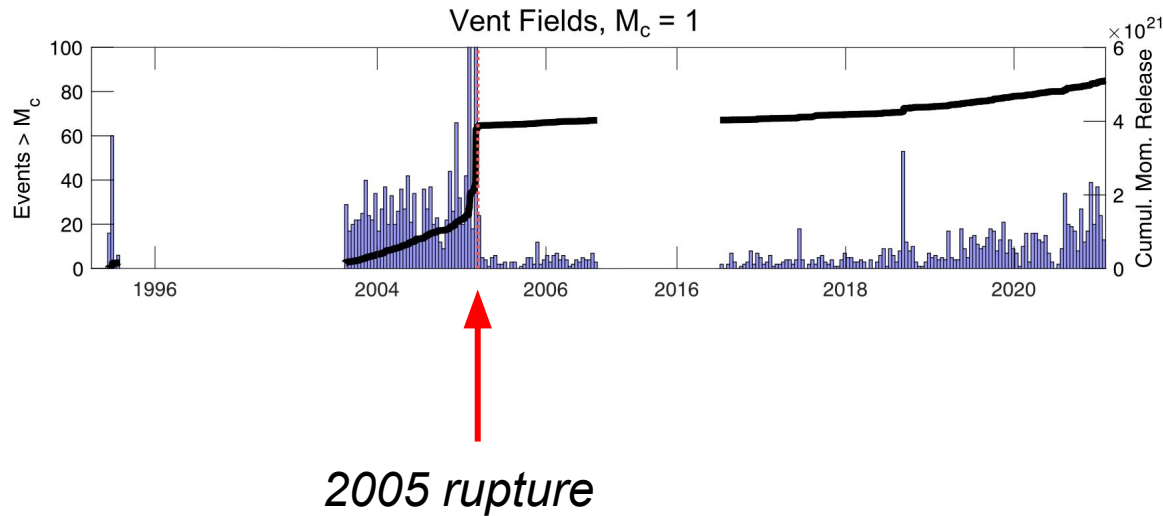


\*non-extrusive magmatism!

*Krauss et al., 2023, JGR*

Nearly 20 years since the last rupture, we can begin to anticipate a subsequent event. What should we be looking for?

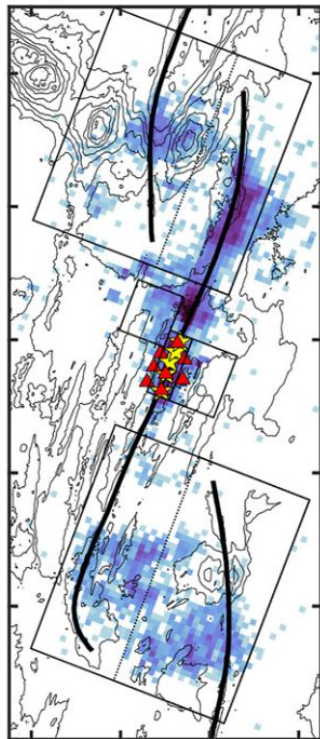
- Signs of impending rupture:
- Exponentially increasing seismicity rates





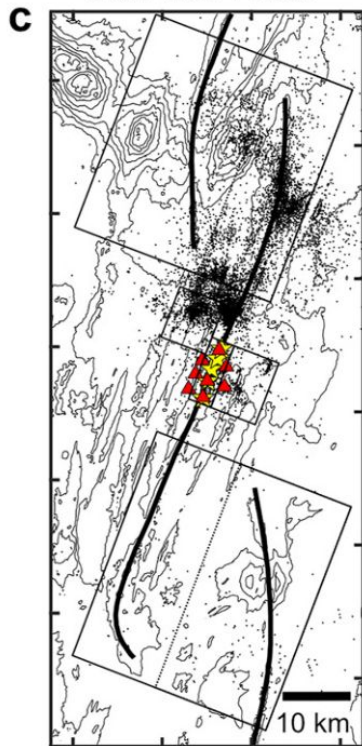
Nearly 20 years since the last rupture, we can begin to anticipate a subsequent event. What should we be looking for?

Aug 2003-Dec 2004



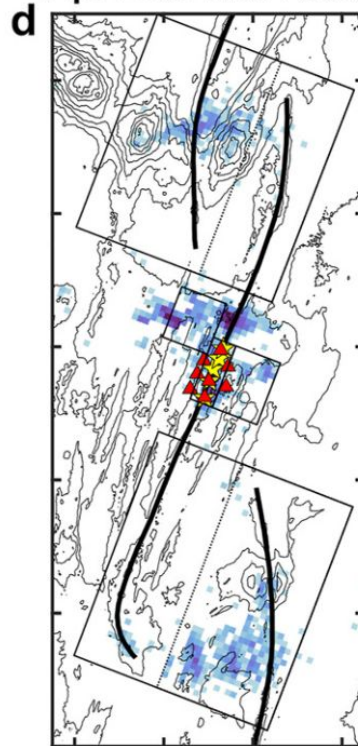
BEFORE

Jan-Mar 2005



DURING

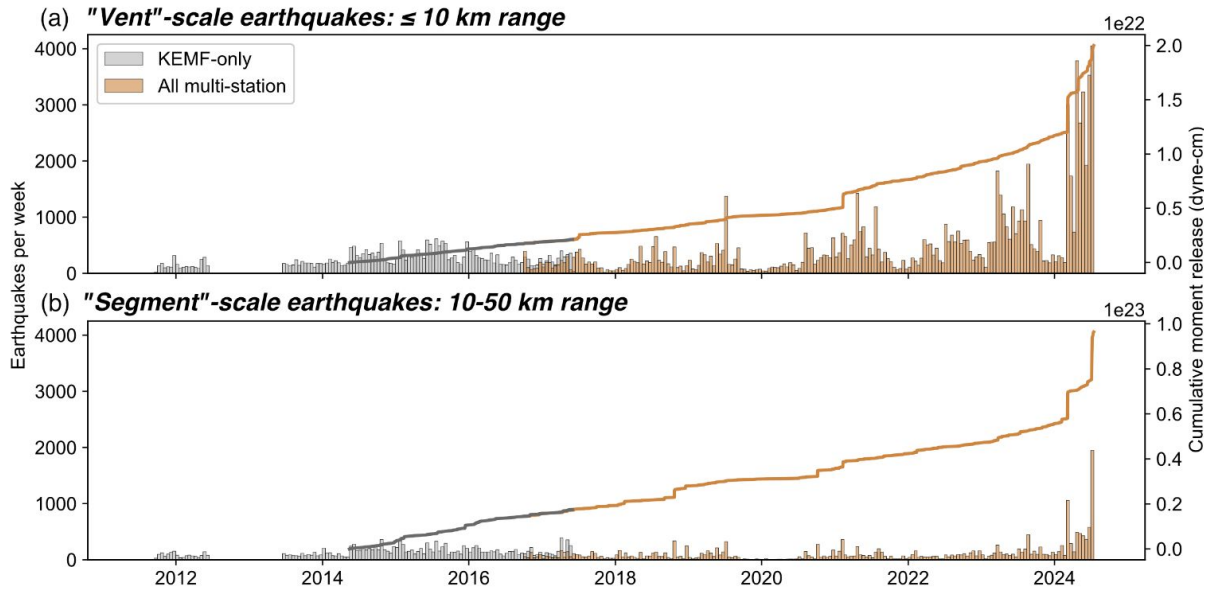
Apr 2005-Mar 2006



AFTER

- Signs of impending rupture:
- Exponentially increasing seismicity rates
  - More on-axis seismicity outside of the central segment

Indeed, we are starting to see many signs of impending rupture.



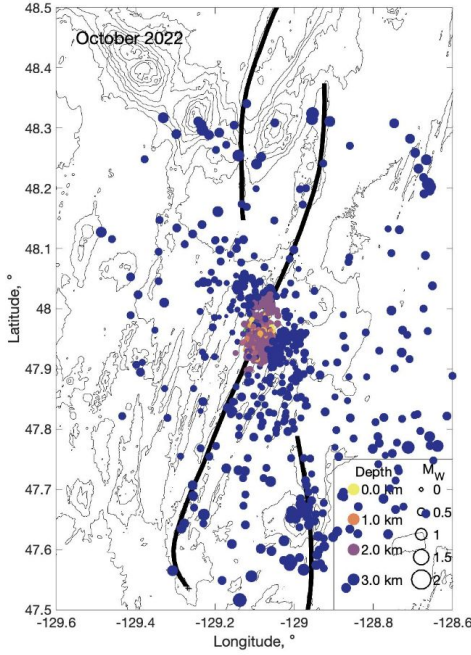
Signs of impending rupture:

- Exponentially increasing seismicity rates
- More on-axis seismicity outside of the central segment

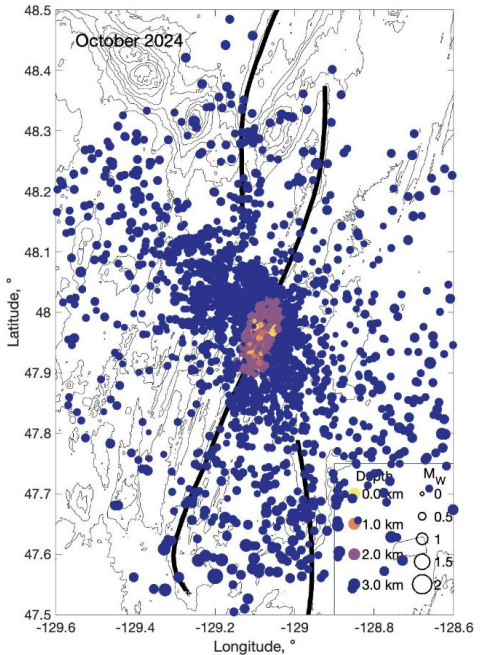
*Krauss et al., 2023, JGR*  
*Krauss et al., in review*

Indeed, we are starting to see many signs of impending rupture.

2022



2024

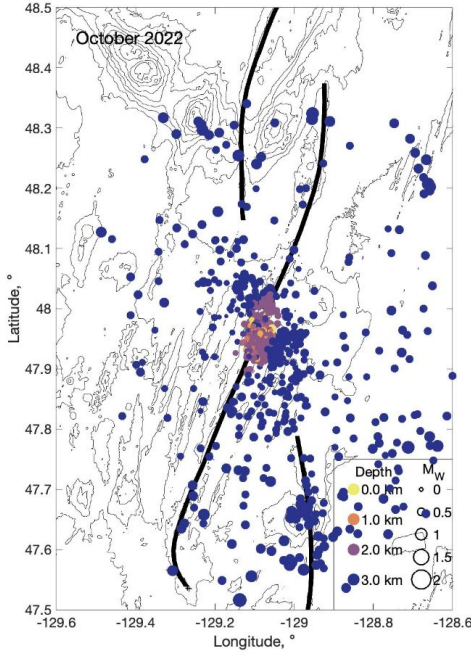


Signs of impending rupture:

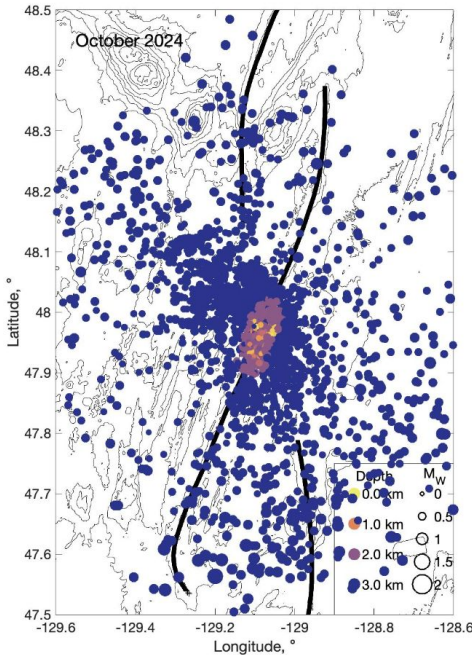
- Exponentially increasing seismicity rates
- More on-axis seismicity outside of the central segment

Indeed, we are starting to see many signs of impending rupture.

2022



2024



Signs of impending rupture:

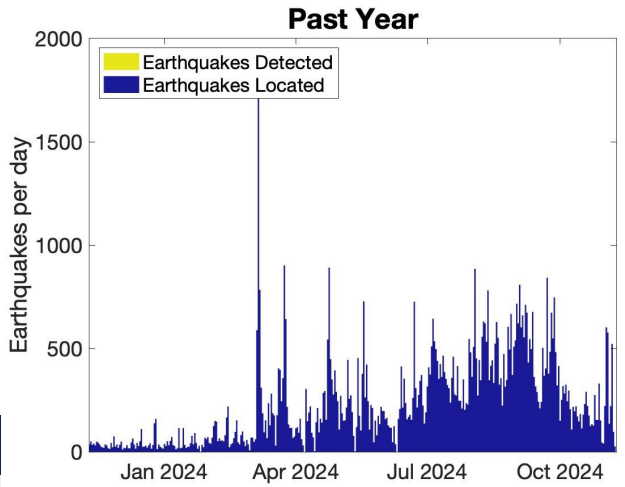
- Exponentially increasing seismicity rates
- More on-axis seismicity outside of the central segment

Which portion will rupture first?

Central/Southern?

- Probably! But anything could happen.

Larger swarms and larger earthquakes are getting more common.



**Earthquake Hazards Program**  
In cooperation with: [US](#)

- Latest Earthquakes
- Overview**
- Interactive Map
- Regional Information
- Impact
- Felt Report - Tell Us!
- Did You Feel It?
- Technical
- Origin
- Moment Tensor
- Waveforms
- Download Event KML

## M 4.9 - 259 km WSW of Tofino, Canada

2024-03-06 08:41:27 (UTC) | 48.039°N 129.006°W | 10.0 km depth

[Interactive Map](#)

Contributed by [US](#)<sup>1</sup>

[Regional Information](#)

Contributed by [US](#)<sup>1</sup>

[Felt Report - Tell Us!](#)

0 0 0 0 0 3

Responses

Contribute to citizen science. Please [tell us](#) about your experience.

Citizen Scientist Contributions

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British Columbia Video

- [How small of a parking space is too small?](#) 2:42  
Vancouver homeowner dismayed by parking stall sizes in new development
- [Family celebrates B.C. great-grandmother's 107th birthday](#) 0:55
- [Firefighters respond to smoke at Science World](#) 0:38
- [Woman survives after being buried by avalanche](#) 1:44

### Deepsea eruption expected off B.C. coast after flurry of earthquakes – but only scientists will notice

Scientists with Ocean Networks Canada predict an underwater rupture in the Earth's crust could happen 260 kilometres west of Vancouver Island, after they detected up to 200 small earthquakes per hour in the area last week.

Canada - British Columbia | 1 Hour Ago



**VIDEO**  
West Vancouver exercise program tackles more than just fitness  
March 11

**Parents demand solution to serious, long-standing staffing shortfall at Vancouver elementary school**  
Canada - British Columbia | March 11

**VIDEO**  
B.C. government announces Surrey hospital expansion

HOME / ENDEAVOUR SITE RECORDS THE HIGHEST LEVEL OF EARTHQUAKE ACTIVITY IN 20 YEARS

## Endeavour site records the highest level of earthquake activity in 20 years

Early indications of new seafloor forming in the Northeast Pacific Ocean

News & Stories

MARCH 8, 2024

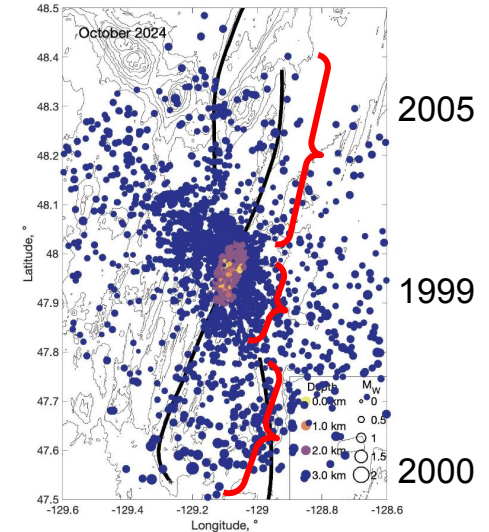
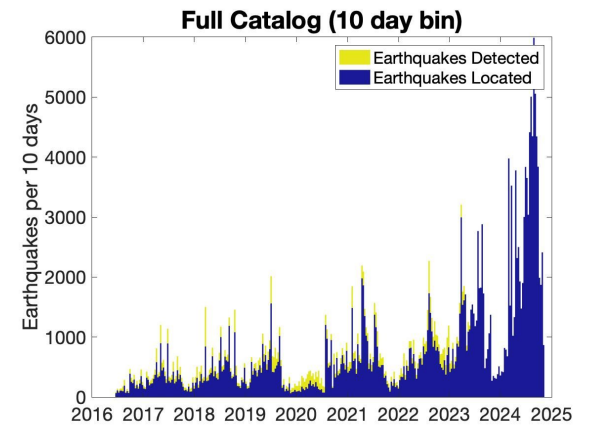
A peak of more than 200 earthquakes per hour were detected this week at a deep sea site within Ocean Network Canada's northeast Pacific seafloor observatory, the highest rate of earthquakes observed in this region since 2006.



# Looking forward...

What changes can we continue to monitor?

- Extended distribution of on-axis seismicity
- Continually increasing seismicity rates



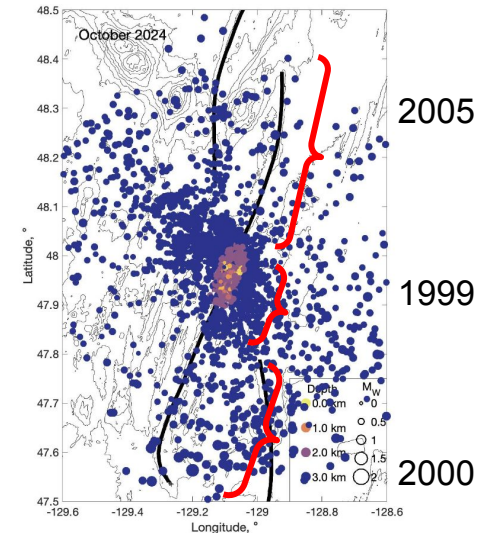
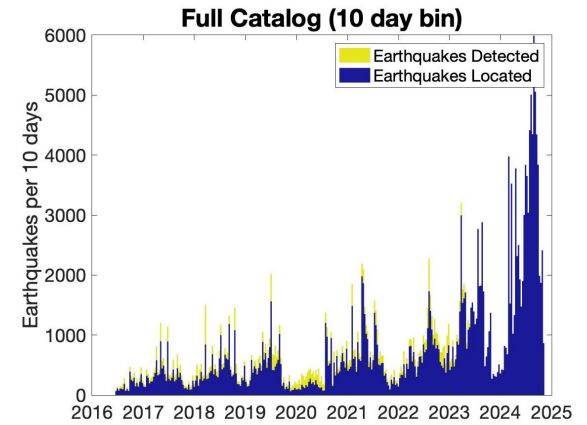
# Looking forward...

What changes can we continue to monitor?

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How will we know that actual rupture is happening?

- Migrating seismicity
- Thousands of earthquakes



## Looking forward...

What changes can we continue to monitor?

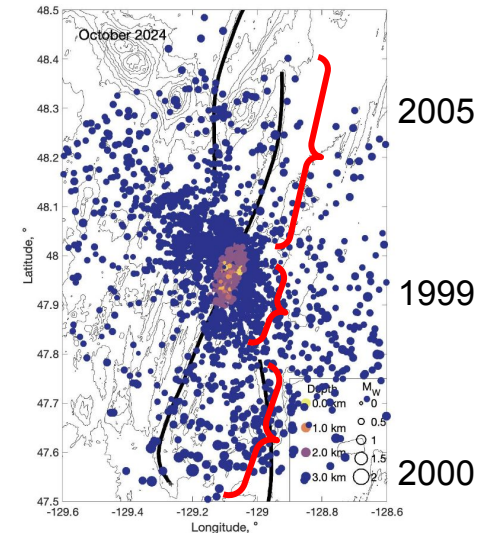
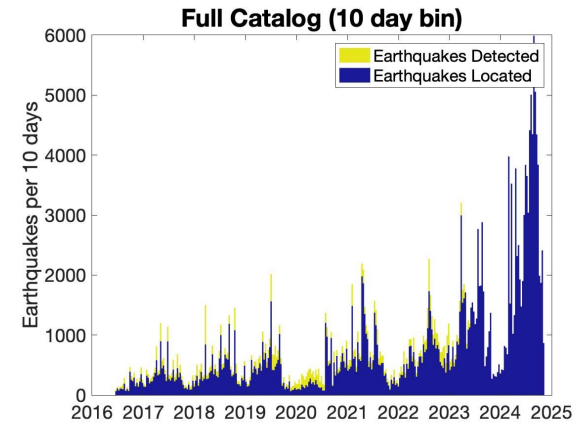
- Extended distribution of on-axis seismicity
- Continually increasing seismicity rates

How will we know that actual rupture is happening?

- Migrating seismicity
- Thousands of earthquakes

How can/should we respond to this event?

- We will have more than one shot, probably will have multiple stages
- Associated phenomena will be widespread and varied

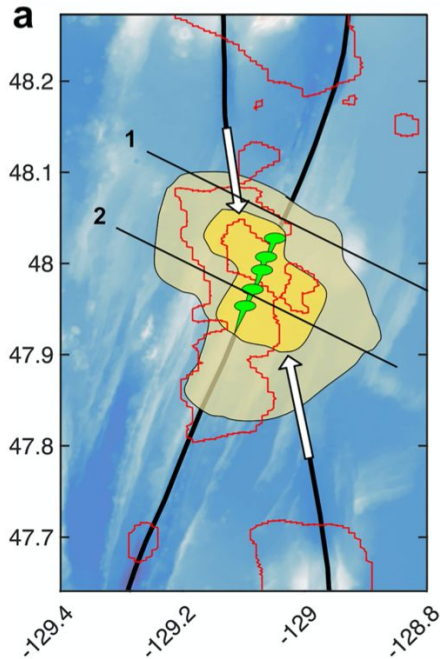






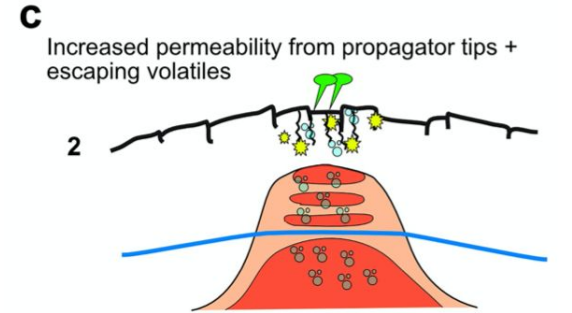
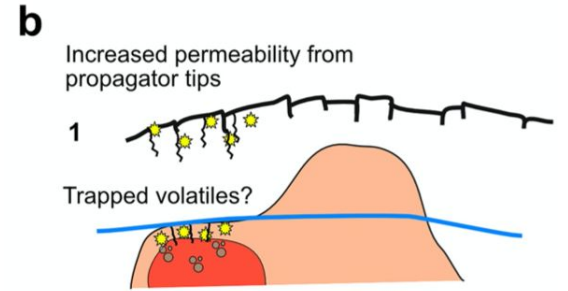


# We think the propagating rifts may also be partly responsible for preventing extrusion at the Endeavour segment.



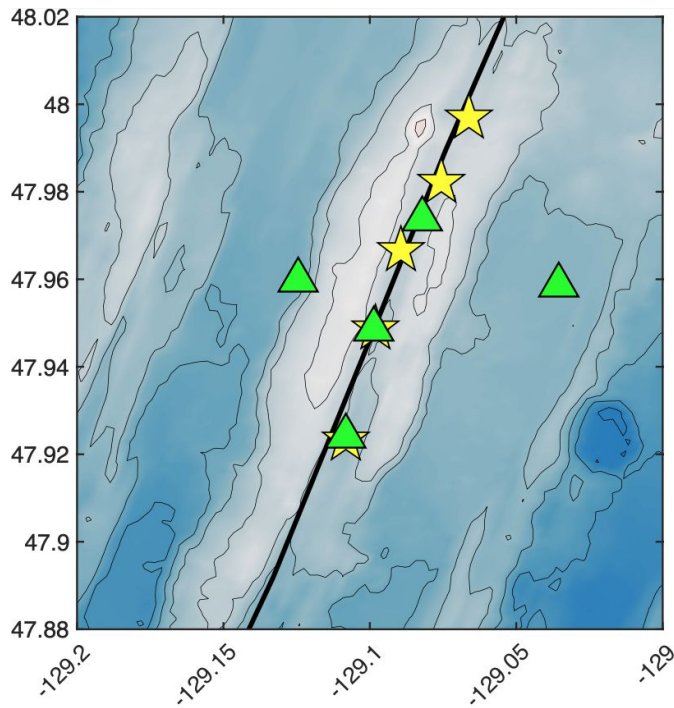
- Seismicity
- Enhanced seismicity
- Spreading axes (bathymetry)
- Propagating ridge extent, proposed
- 1% mantle melt
- Venting

- The extra fracturing allows “volatiles”, or the gases within magma that lower its density and make it less likely to erupt, to escape
- This hypothesis fits well with estimated volatile content and measured heat output of the segment



- Mush
- Increased partial melt
- Enhanced volatile content
- Earthquakes
- Enhanced permeability from fracturing
- Moho

## Current cabled network:



## Cabled + autonomous network:

