Overview of active tectonics in the New Guinea-Solomon Islands-Vanuatu region

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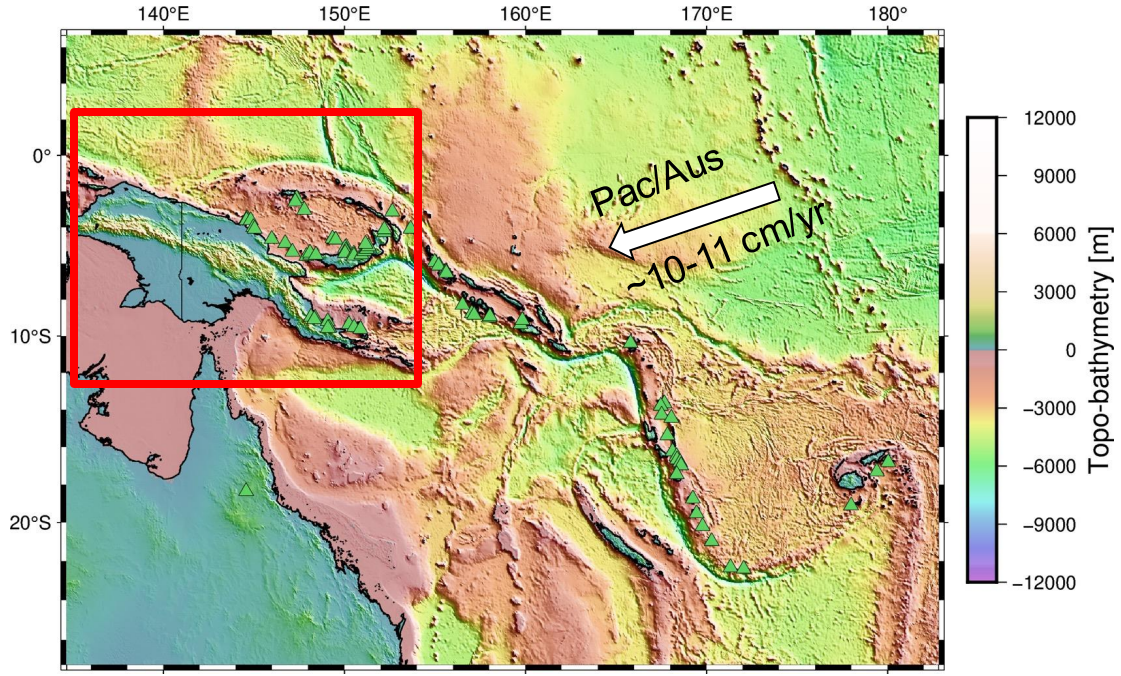
Southwest Pacific Tectonic setting



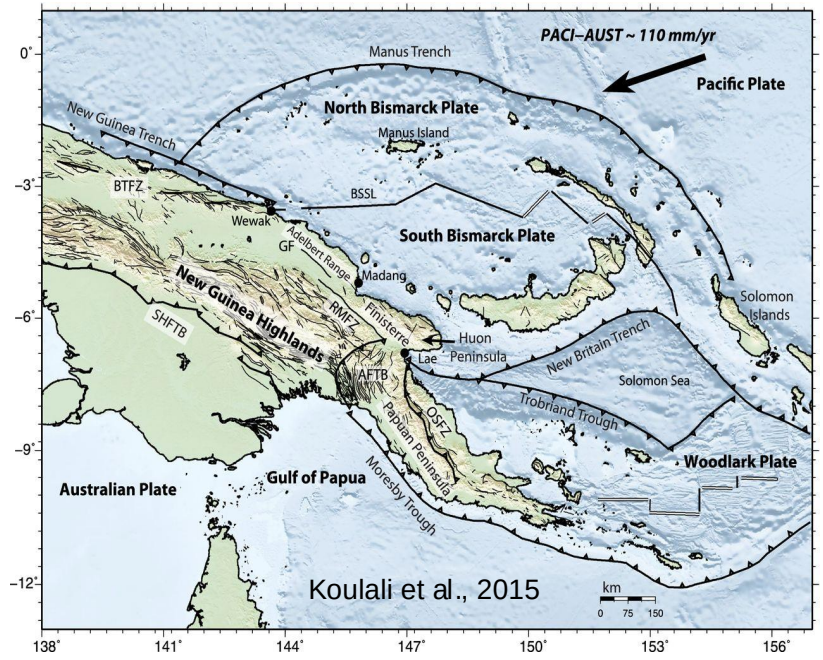
Complexly deforming boundary zone between the Pacific and Australian plates

Australia-Pacific Plate motion is ~10-11 cm/yr through the region

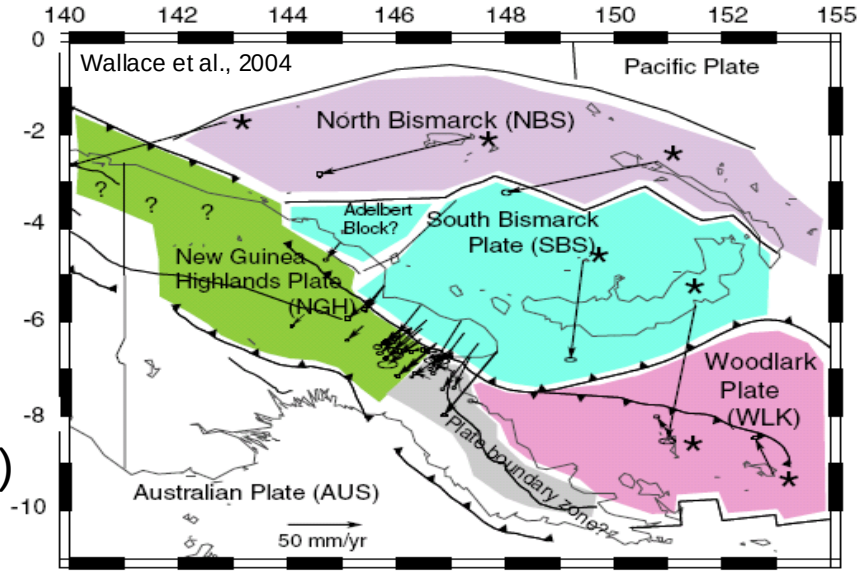
The plate boundary zone is fragmented into rapidly rotating microplates, which have a major impact on the rates and sense of motion on subduction zones and other faults in the region

Arc volcanism and rift-related volcanism

New Guinea Tectonics is characterized by complex active deformation strongly influenced by rapid microplate rotations

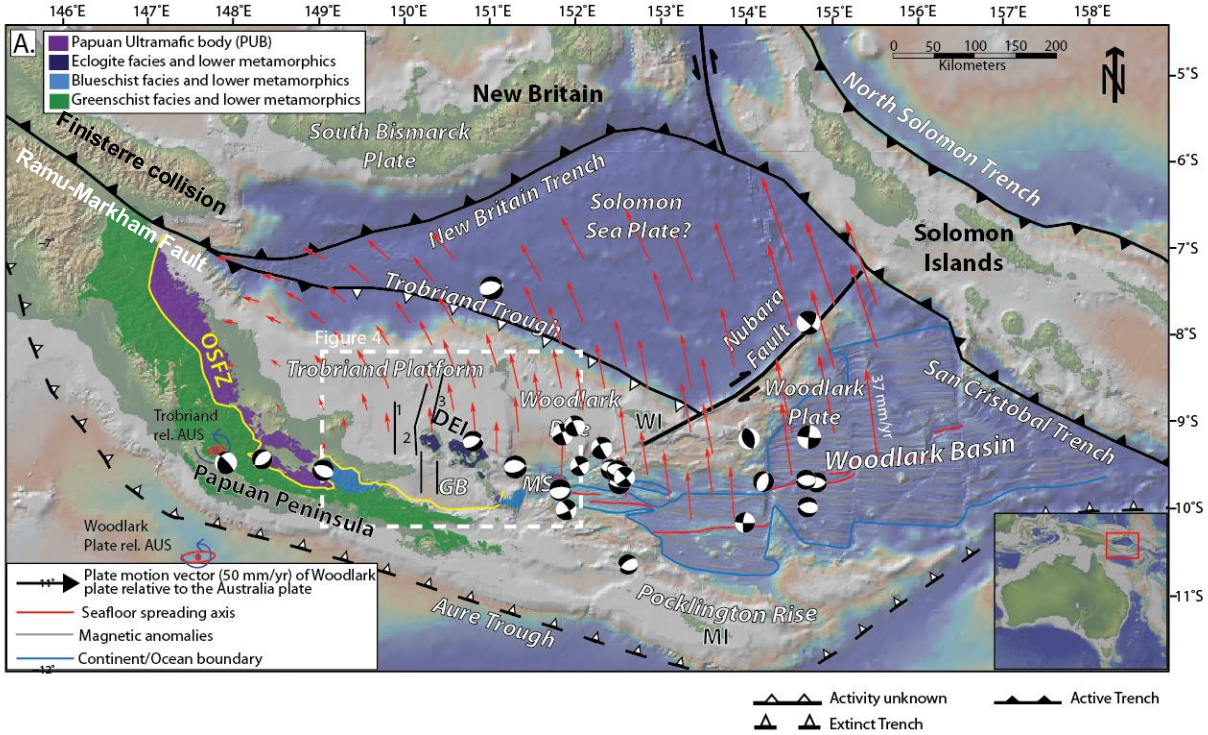


Virtually every type of plate boundary co-exists here: Subduction, collision, continental rifting, seafloor spreading, and transform faulting



<u>3 subduction zones:</u> New Britain Trench, New Guinea Trench, Manus Trench (very slow)

New Britain Trench and Ramu-Markham Fault

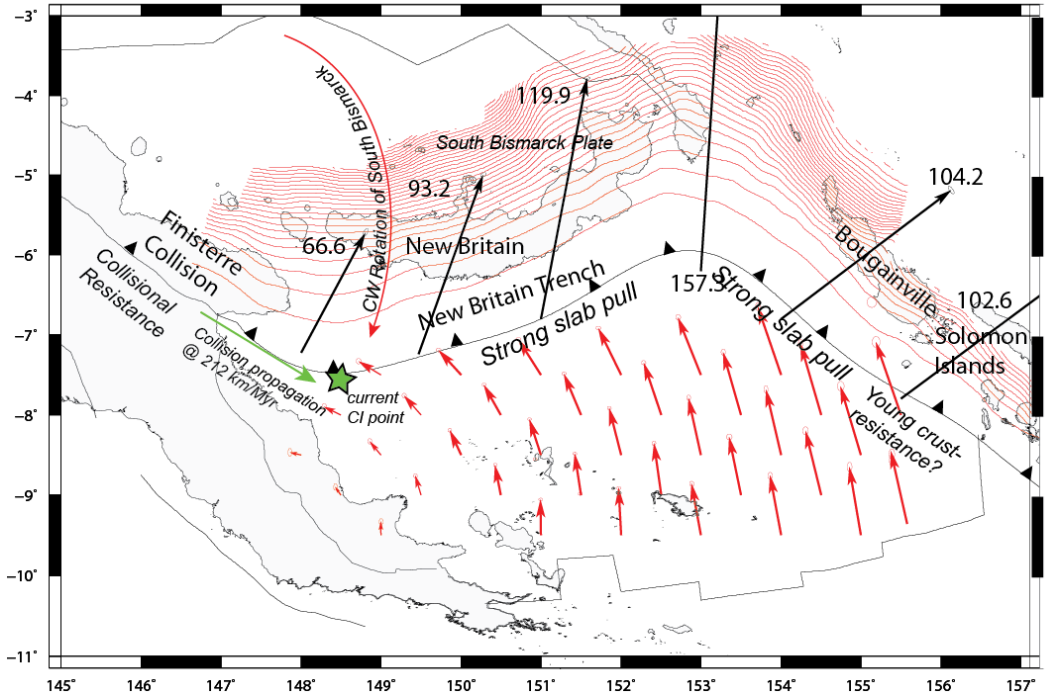


Subduction of the Solomon Sea/Woodlark Plate at the Britain Trench

Transitions westward to active arc continent collision (since 3-4 Ma) between New Guinea margin and Finisterre terrane

New Britain Trench continues eastward and becomes the San Cristobal Trench offshore the Solomon Islands

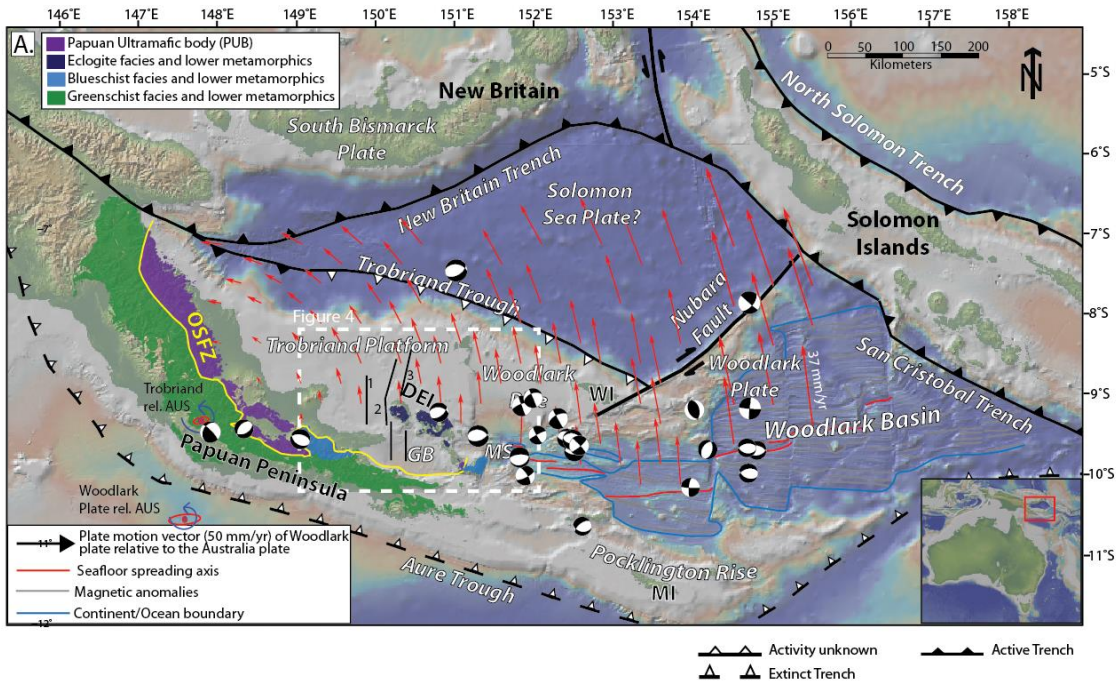
Rapid clockwise rotation of the South Bismarck Plate and rapid anti-clockwise rotation of the Woodlark Plate dominate kinematics



Wallace et al., 2014

- Convergence along Ramu-Markham Fault (onshore) ~2-5 cm/yr (arc-continent collision)
- New Britain Trench convergence rates increase from ~5 cm/yr near coast to ~15 cm/yr offshore east New Britain
- Eastward increase in extension/spreading rates in Woodlark Basin
- Rapid strike-slip and extension on northern boundary of South Bismarck Plate (BSSL)
- Rapid microplate rotations observed in geodetic, paleomagnetic, and seafloor spreading data

Extension and seafloor spreading in SE PNG in Woodlark Basin



Active extension since ~5 Ma

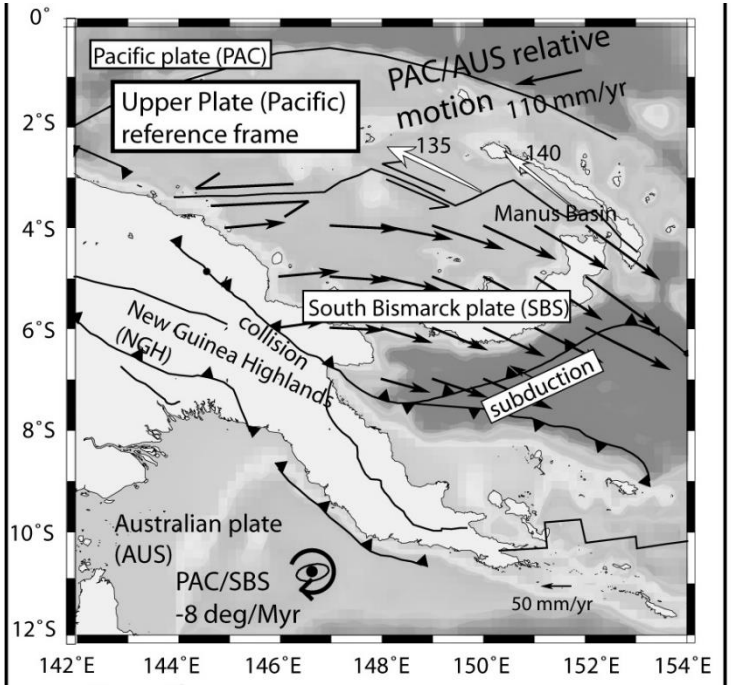
Extension a consequence of clockwise rotation of Woodlark Plate away from Australian Plate

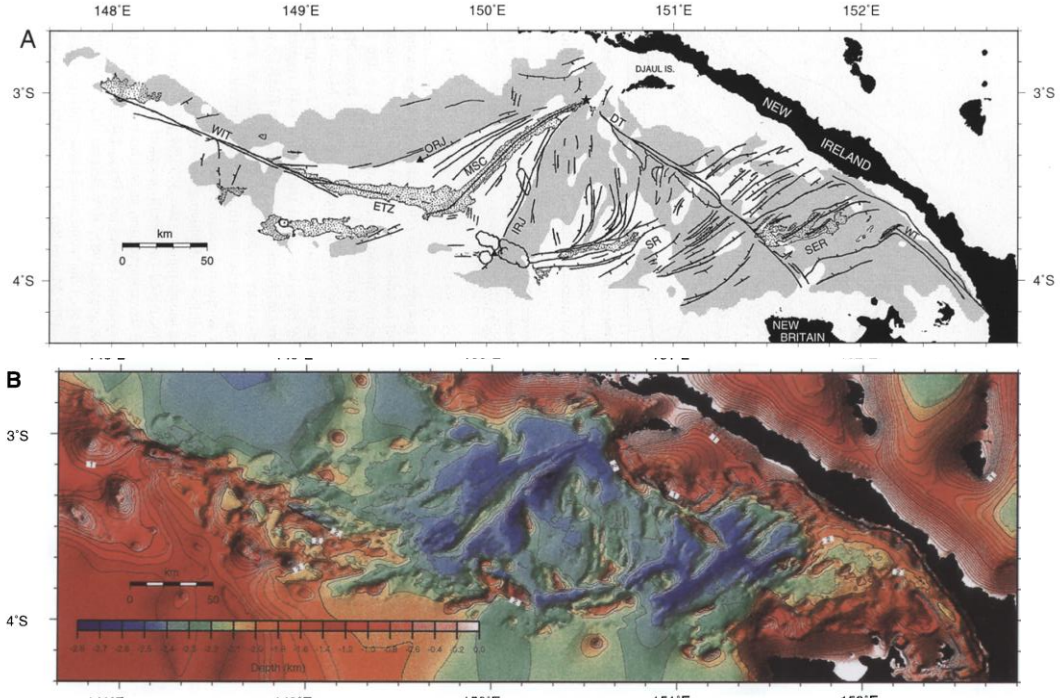
Continental extension in the west, seafloor spreading in the east

Nubara Fault—major right-lateral fault

Is the Trobriand Trough still active?

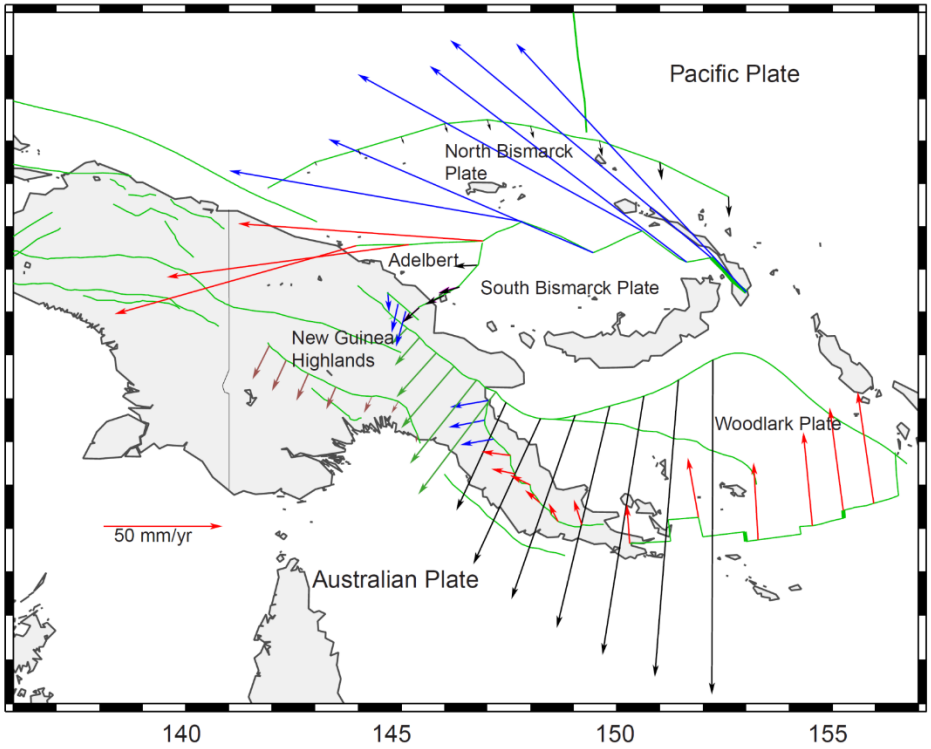
Bismarck Sea Seismic Lineation: northern boundary of South Bismarck Plate RAPID strike-slip and extension (seafloor spreading in Manus Basin)

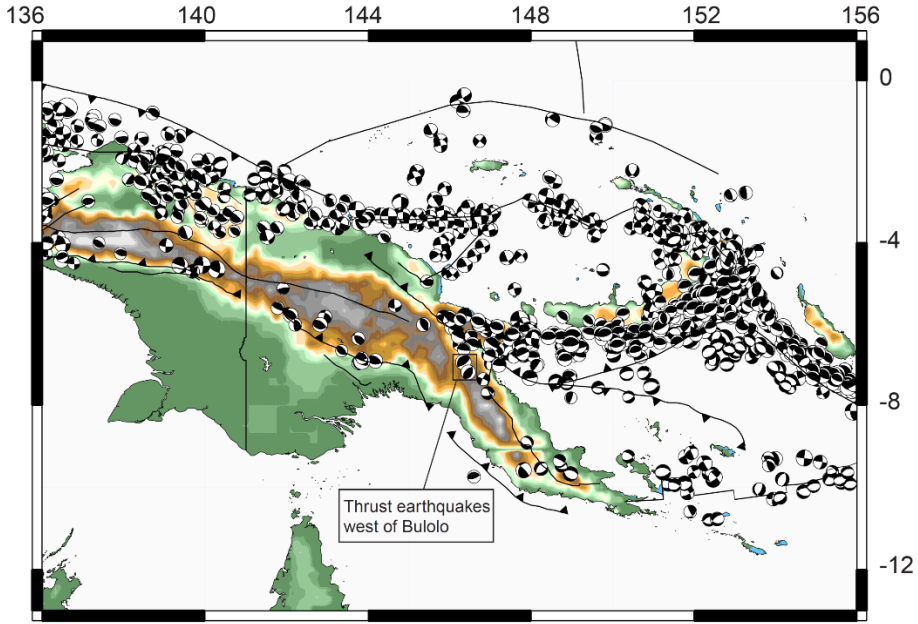




Martinez and Taylor, 1995

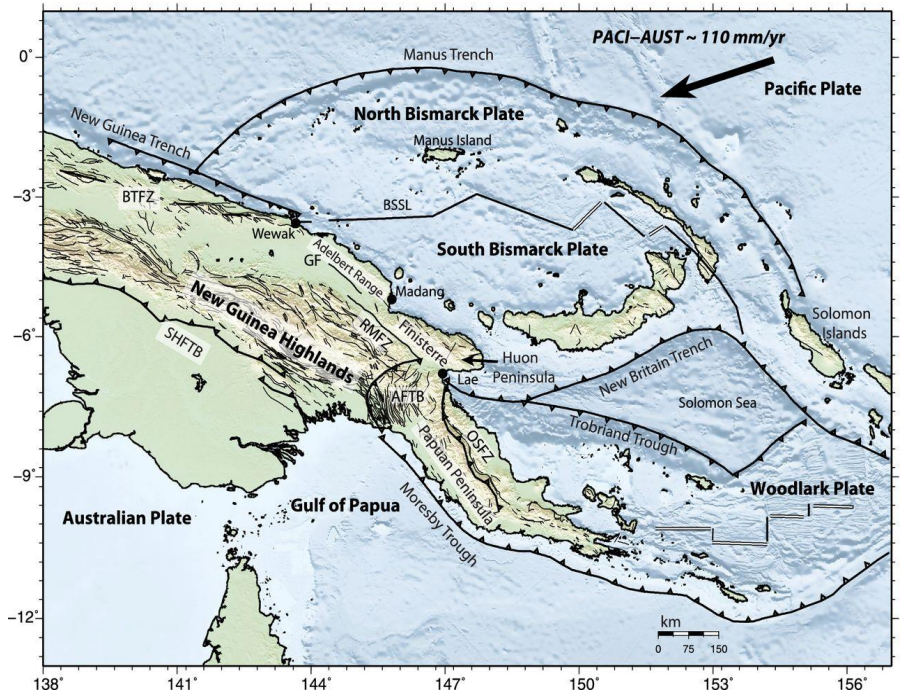
PNG: Highly complex kinematics, rapidly changing rates and sense of motion





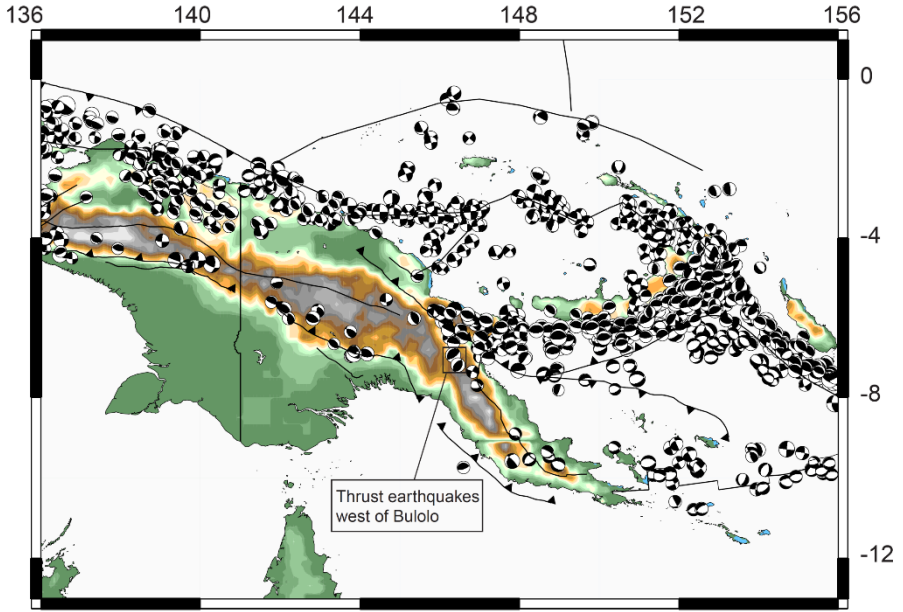
Wallace et al., 2004

The Manus Trench

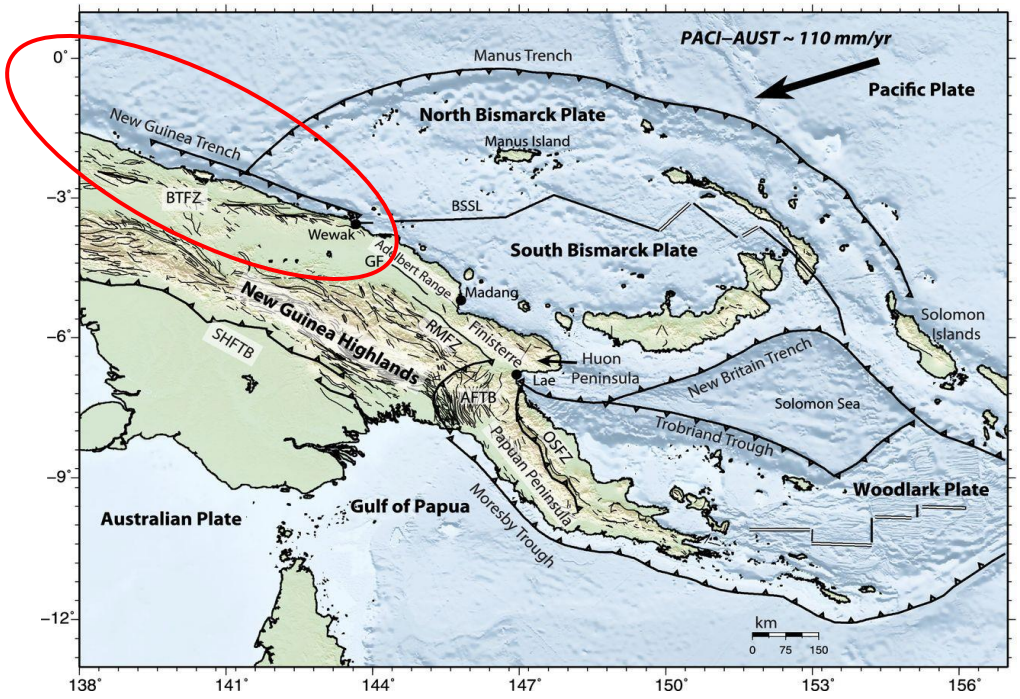


A few possible moderate thrust earthquakes, but no significant seismicity. Most motion between Pacific and South Bismarck Plates is along BSSL

Was a major subduction zone but after subduction initiated at the New Britain Trench ~6-7 Myr ago, it has mostly shut-down. North Bismarck Plate now mostly moving with Pacific Plate, but Manus Trench may still accommodate up to 1 cm/yr convergence

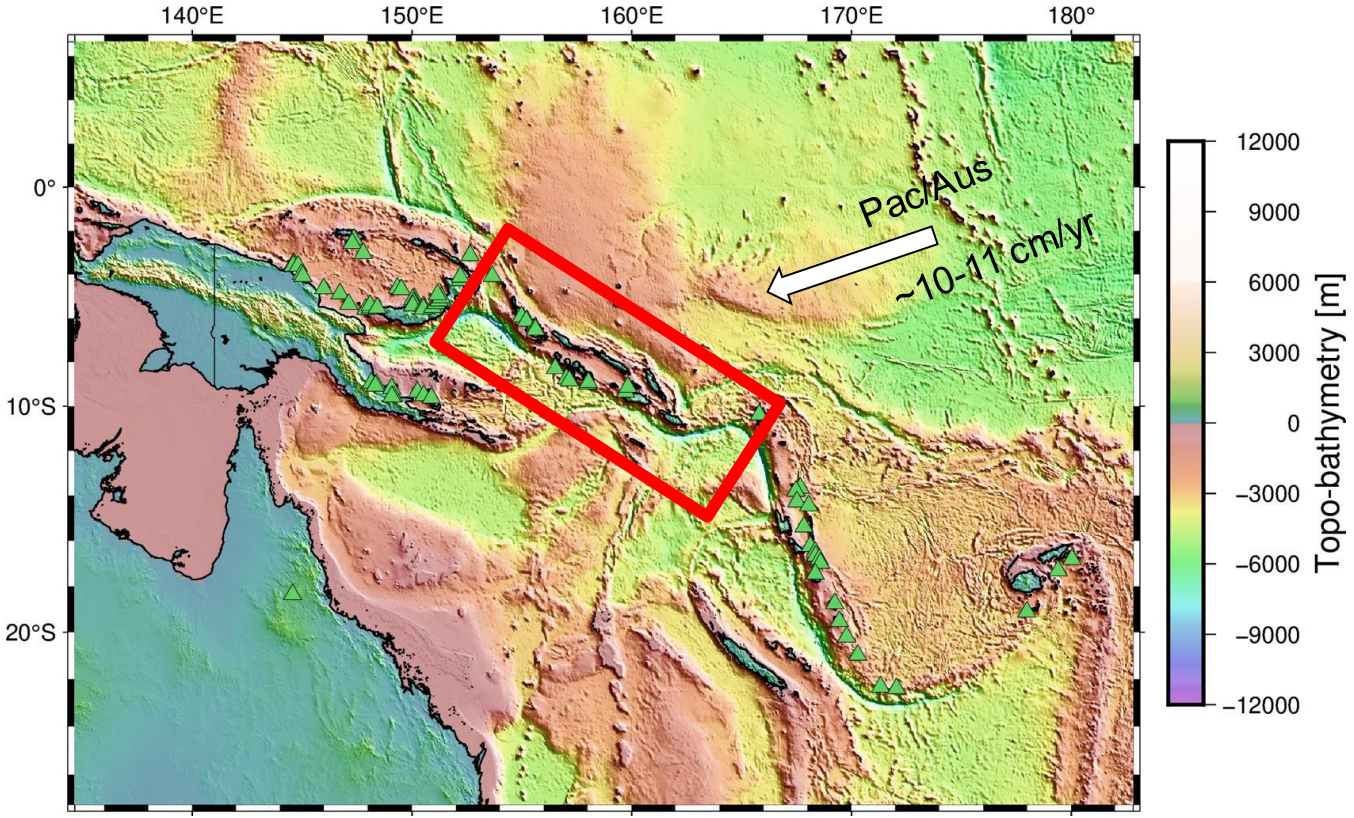


The New Guinea Trench

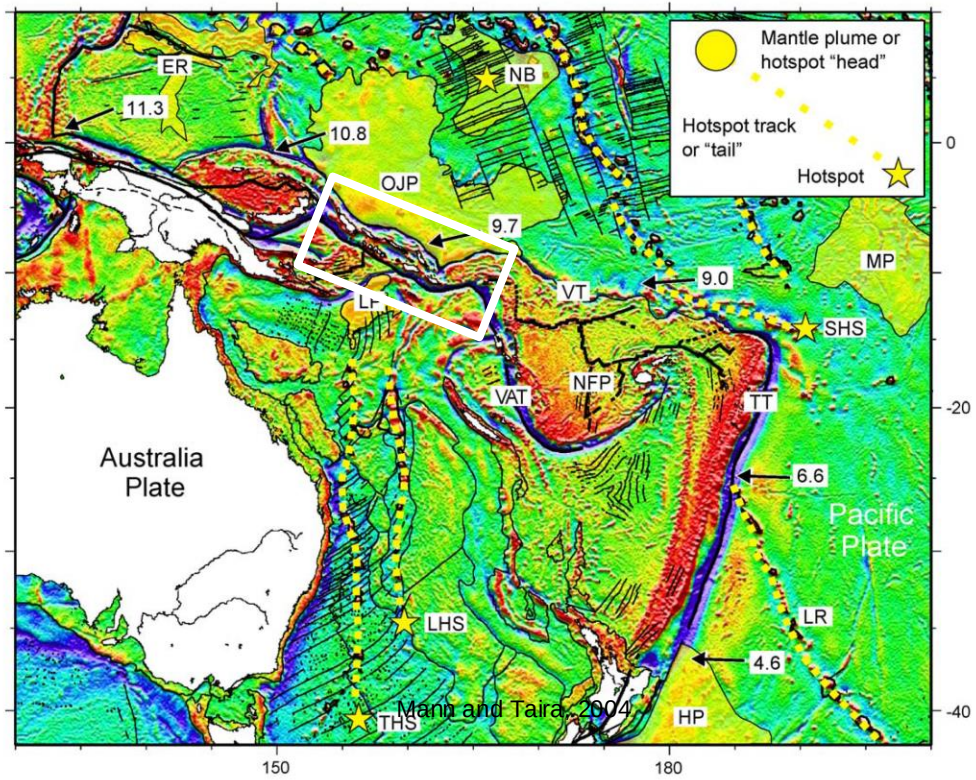


- New Guinea Trench accommodates southward subduction of the Pacific Plate beneath the New Guinea mainland
- It has been the site of significant tsunami earthquakes (Aitape, 1999)
- This feature accommodates most of the Pacific/Australia relative motion in western part of PNG and across border into west Papua

Solomon Islands



Subduction Tectonics in the Solomon Islands

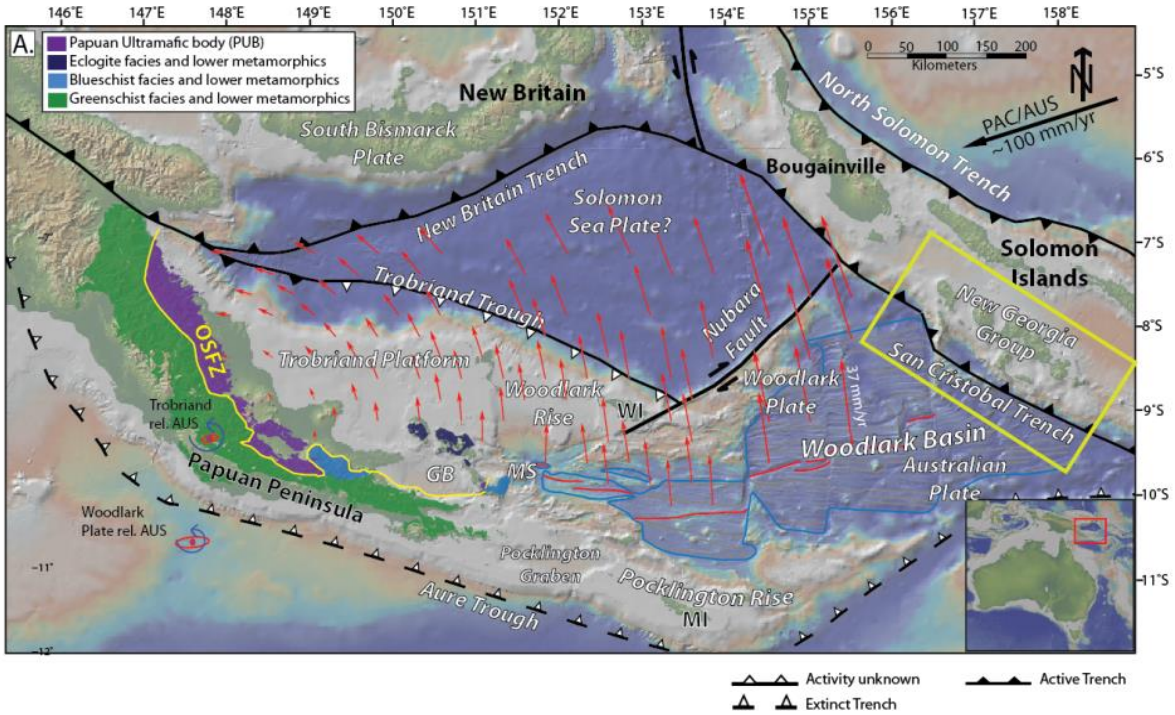


Eocene-Miocene: subduction of Pacific Plate at north Solomons Trench.

Ontong Java Plateau collision with North Solomon Trench (~late Miocene?) caused subduction polarity reversal to current setting where Australian Plate and Woodlark Plate subduct beneath the Solomons at San Cristobal Trench

Ontong Java collision with the subduction system likely also shut down subduction at the Manus Trench

San Cristobal Trench

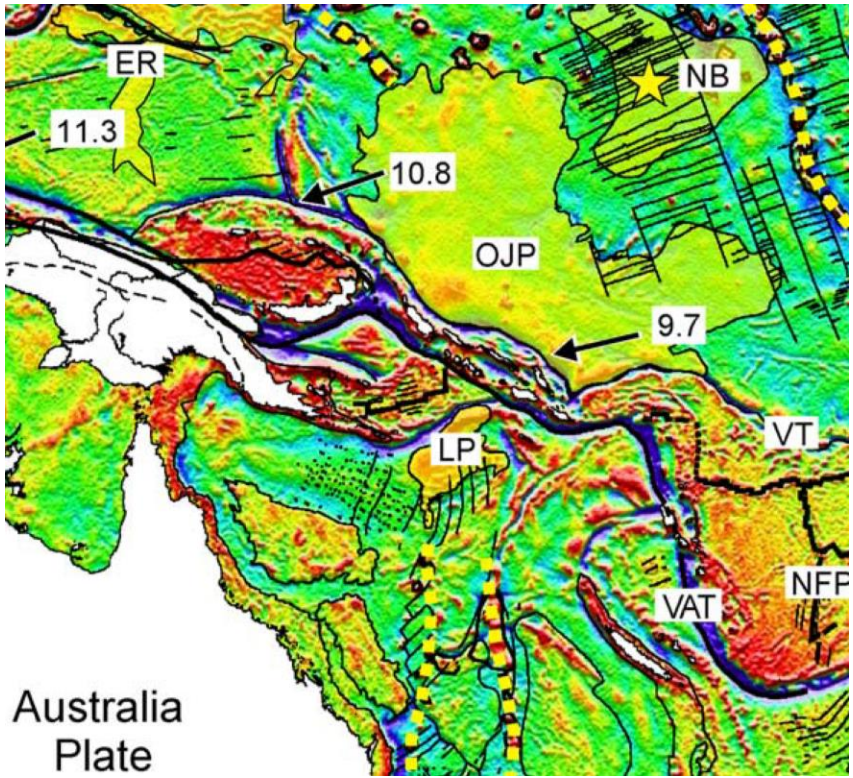


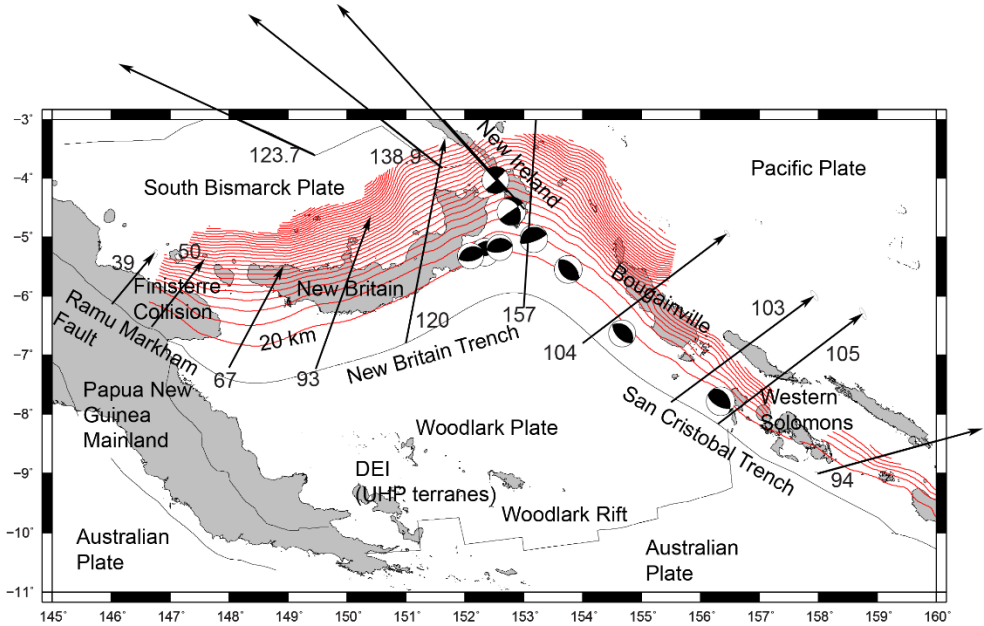
San Cristobal Trench accommodating most of the PAC/AUS plate motion

North Solomons trench largely inactive (due to OJP collision)

Large changes in age of subducting plate

Woodlark spreading center subducting beneath western Solomon Islands





Convergence in west and north Solomons reflect Woodlark and Australian plate motion relative to Pacific

In eastern Solomons subduction is more oblique (parallel to Pacific-Australia motion)

Vanuatu region: It is ALSO complicated!!

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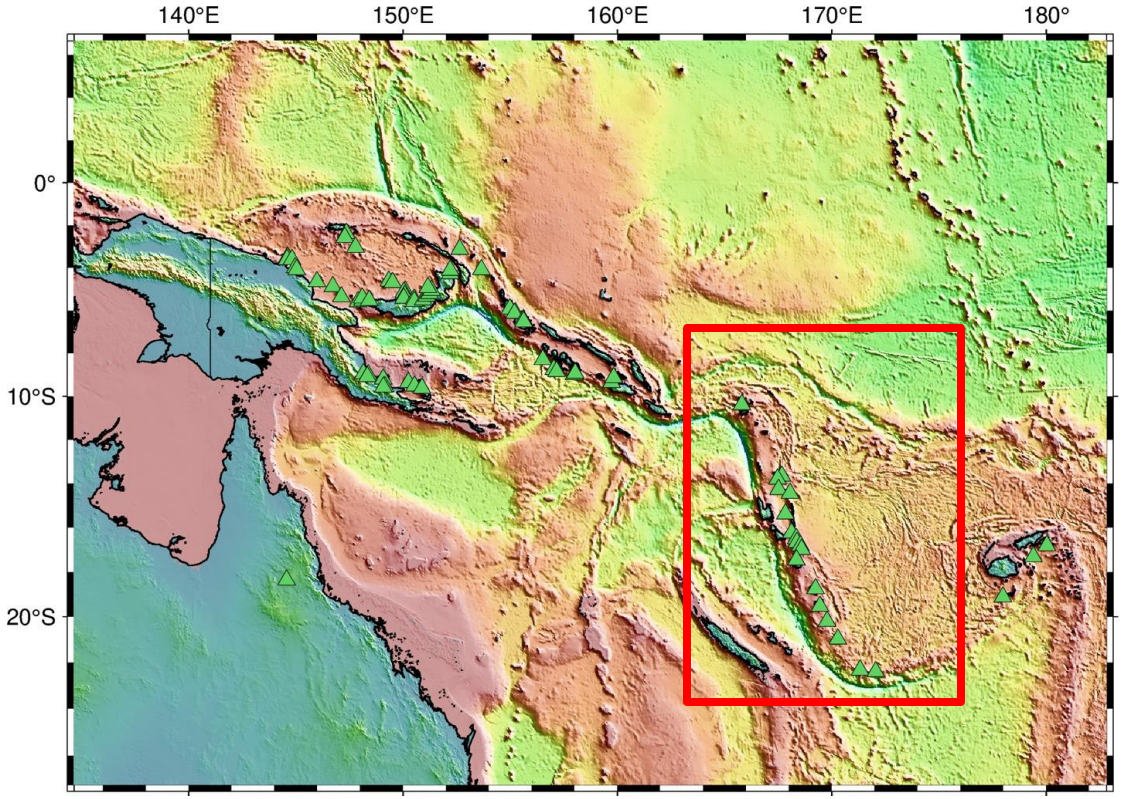
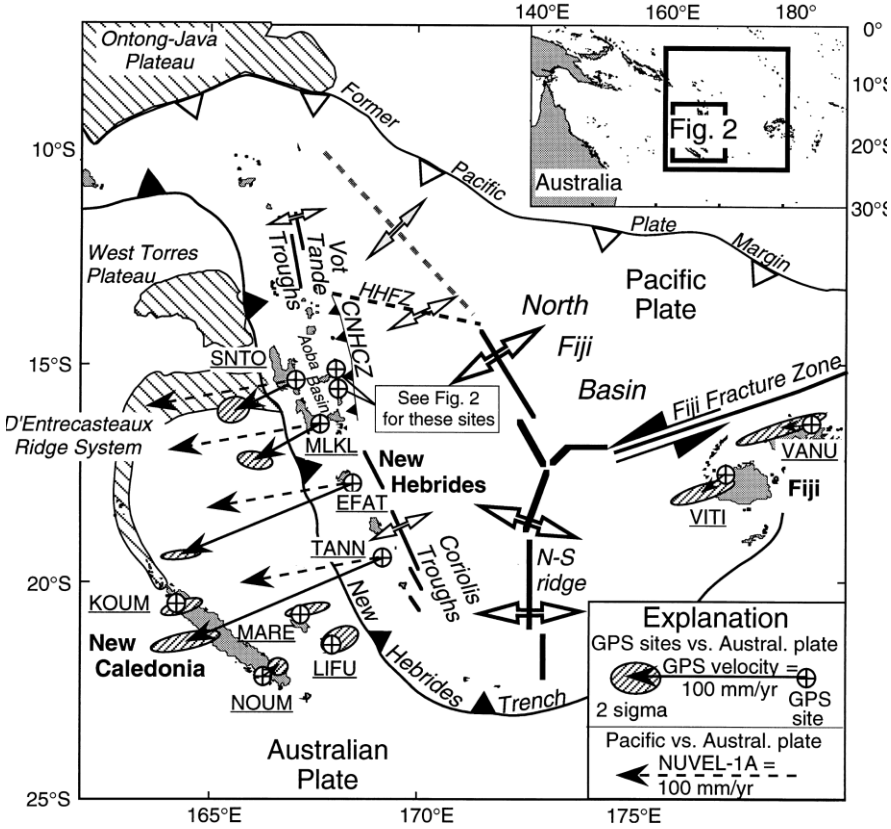


Major Tectonic Features of the Vanuatu region



Taylor et al., 1995

- Subduction of the Australian Plate at the New Hebrides Trench
- Back-arc extension in the Coriolis Trough and Vot Tande Trough
- Shortening in the backarc east of Espiritu Santo
- Distributed rifting in the North Fiji Basin
- Rapid rotation of Vanuatu and ridge collisions are responsible for this complexity

Ridge and plateau subduction impacts convergence rates and upper plate faulting at New Hebrides Trench

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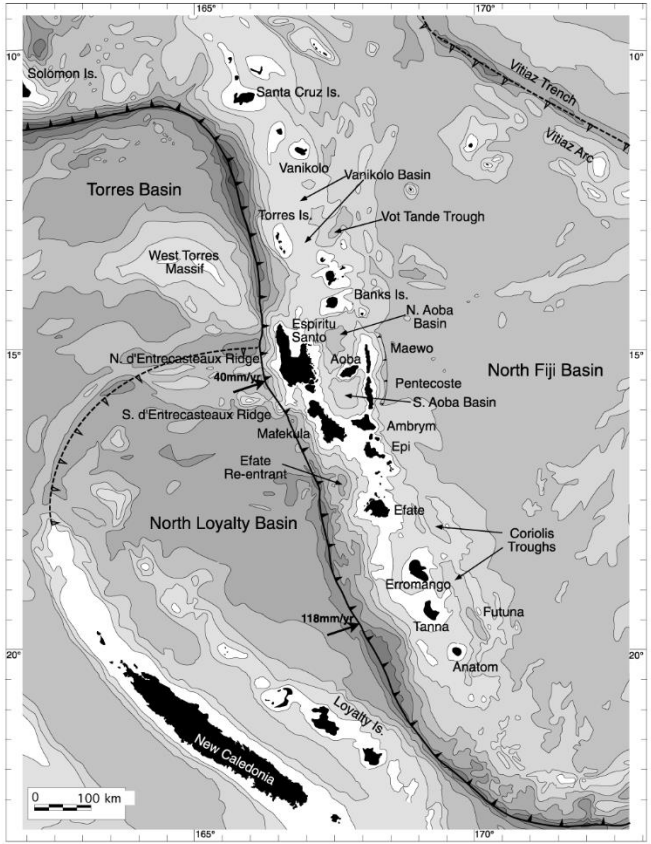


Meffre and Crawford, 2001

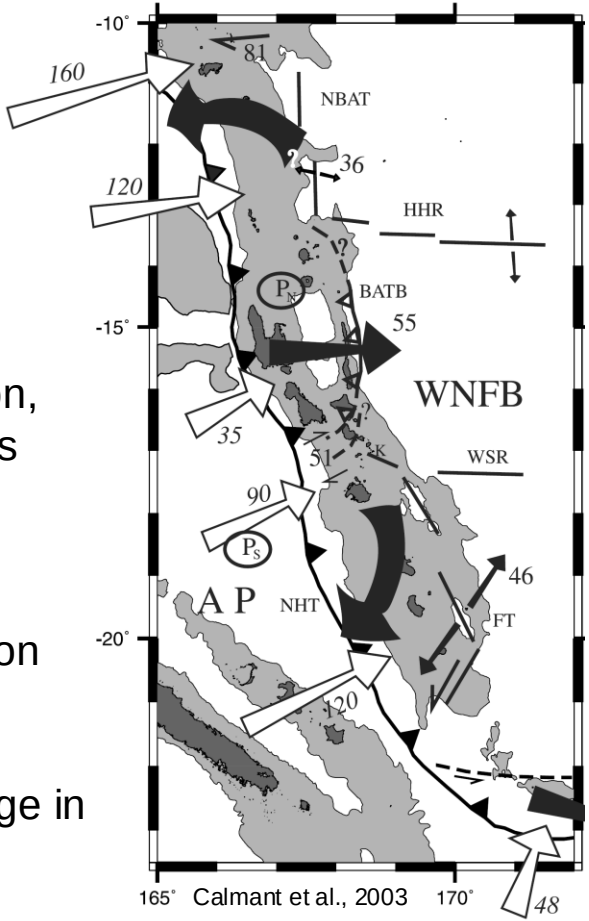
D'Entrecasteaux ridge (DER) collision slows subduction and produces rotation

Adjacent to collision, shortening transferred into back-arc region

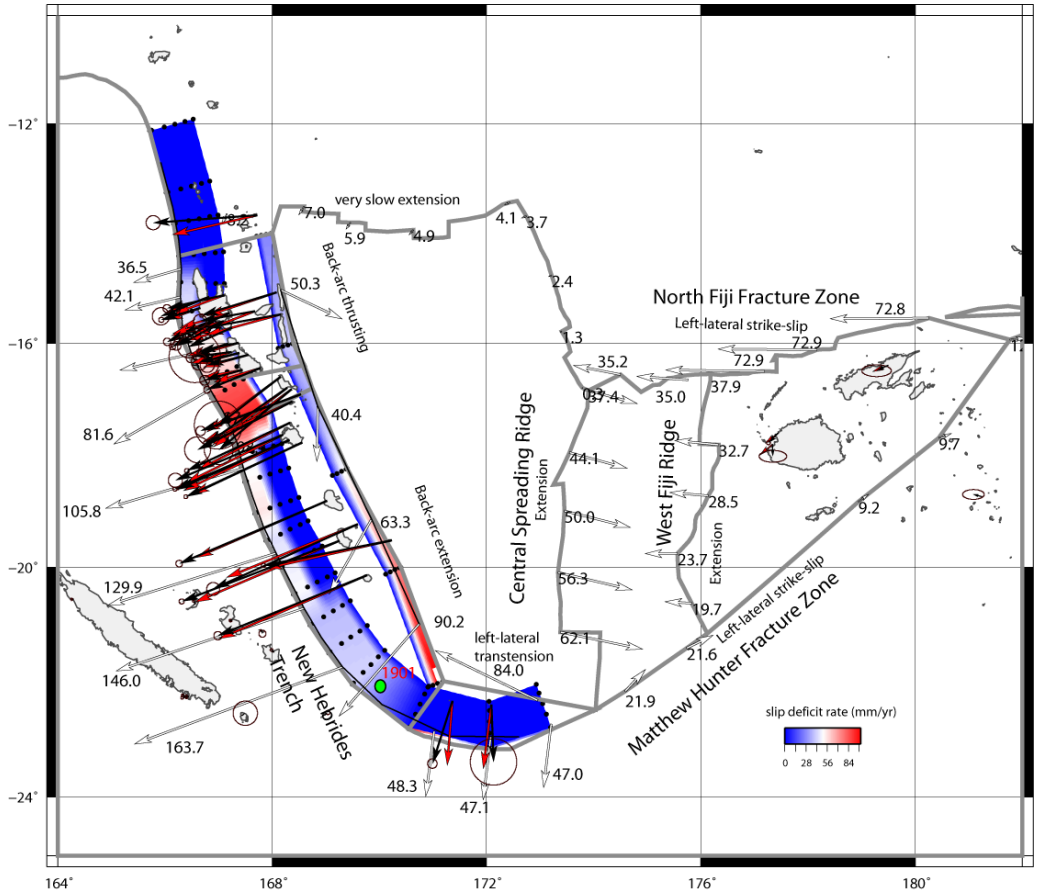
North and South of DER collision, back-arc rifting occurs in Coriolis and Vot Tande Troughs

Shear across upper plate accommodates differential motion where DER collides

Incipient collision of Loyalty Ridge in south



Calmant et al., 2003



Power, Wallace et al., 2009

Large along-strike changes in convergence rates on New Hebrides Trench

Matthew Hunter segment of subduction accommodating north-south convergence

Transitions to strike-slip dominated regime towards Fiji

The planned Tamtam cable crosses the New Hebrides Trench

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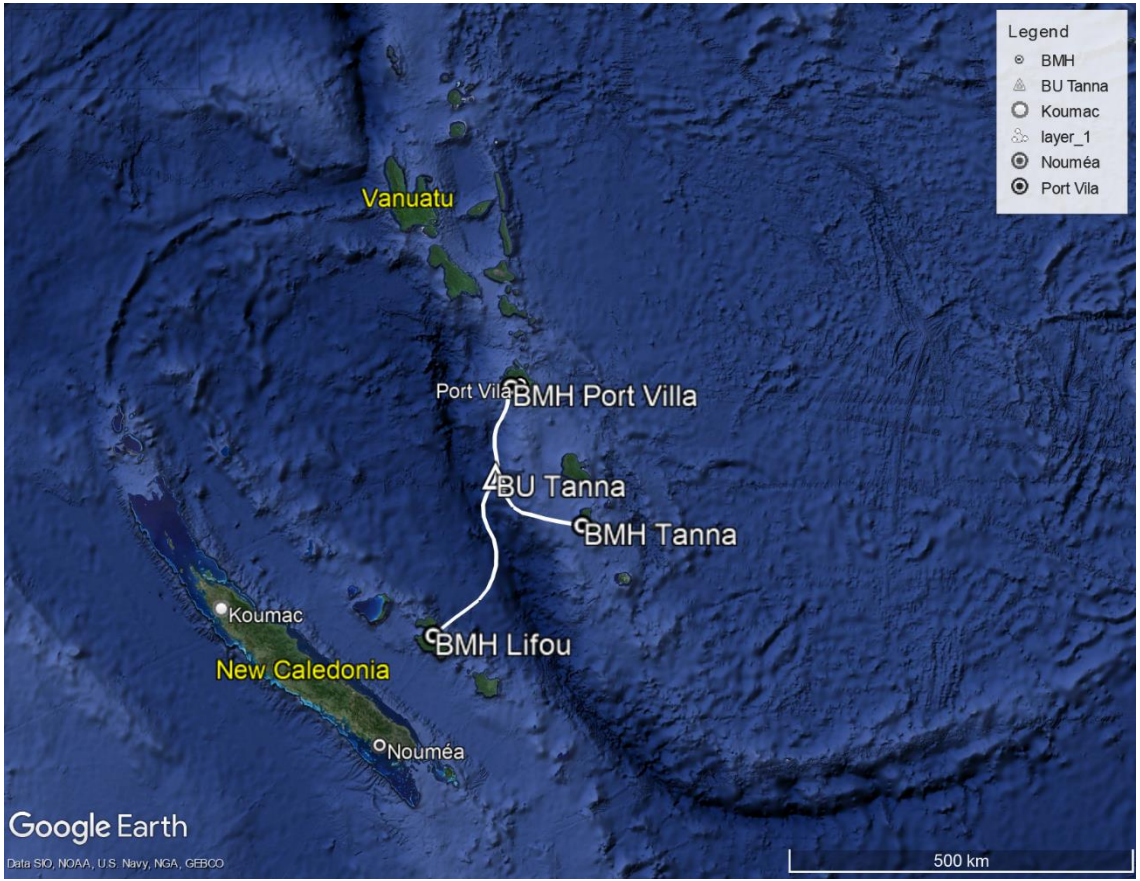


HELMHOLTZ

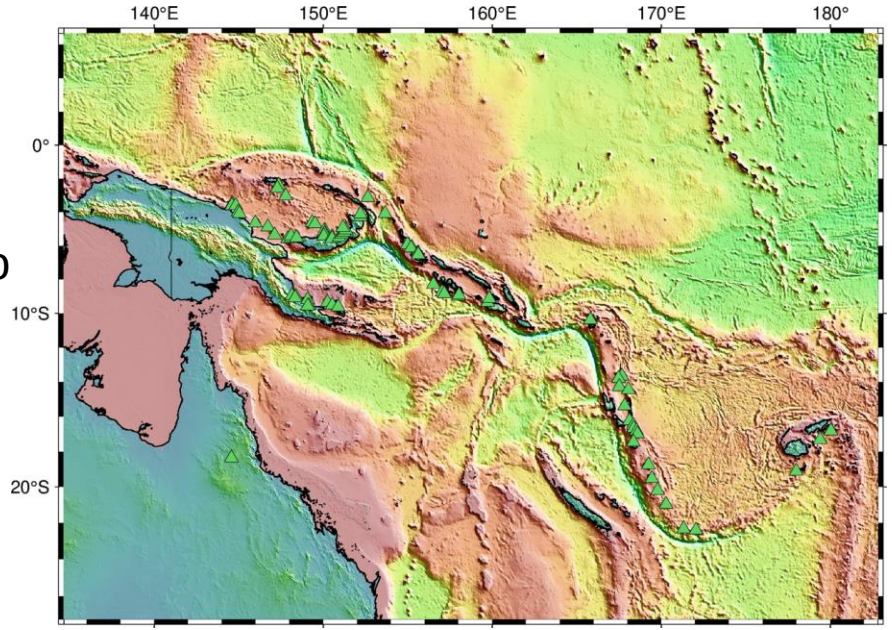
Conclusions

- PNG-Solomons-Vanuatu region is an extremely active and complex tectonic setting with multiple subduction zones and other tsunami sources

- The current subduction system was established in the late Miocene, in response to the Ontong Java Plateau collision

- Rapid microplate rotations cause large changes in convergence rates and sense of motion over short distances

- Planned Tamtam cable spans the New Hebrides Trench offering important monitoring and research opportunities



Subduction to collision transitions influence the complex microplate rotations and kinematics in PNG and Vanuatu

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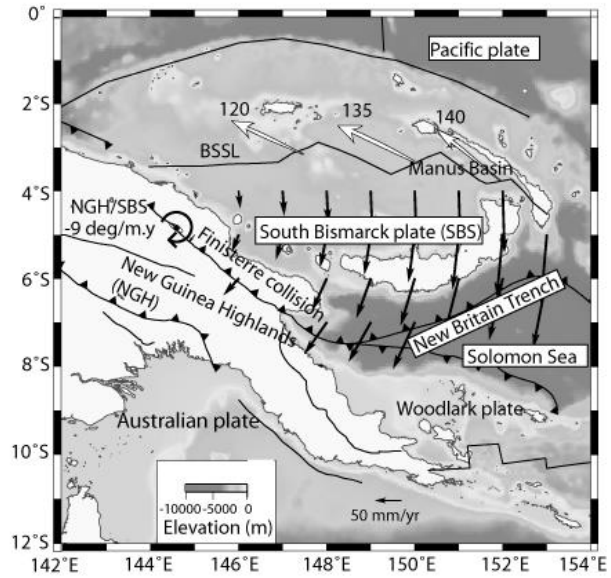
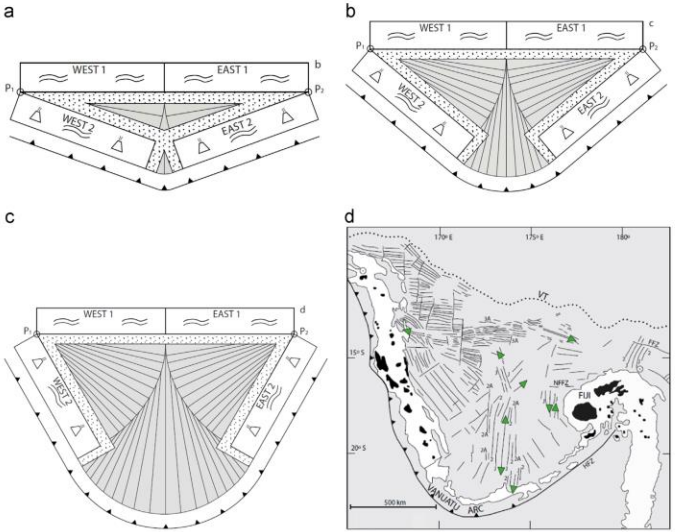
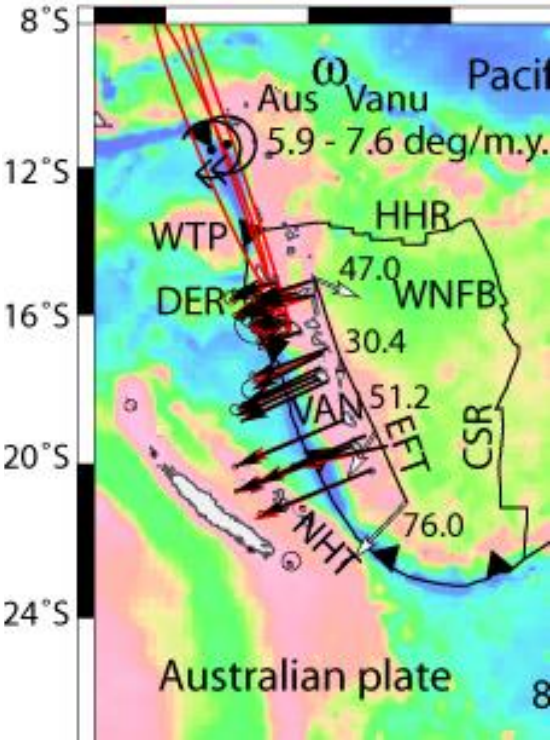


Wallace et al., 2005

Rapid microplate rotation about collision points is common in western Pacific



Martin, 2013



Wallace et al., 2005

Significant coseismic uplift from emerged coral reefs occurred during the 2007 Mw 8.1 subduction earthquake in western Solomons

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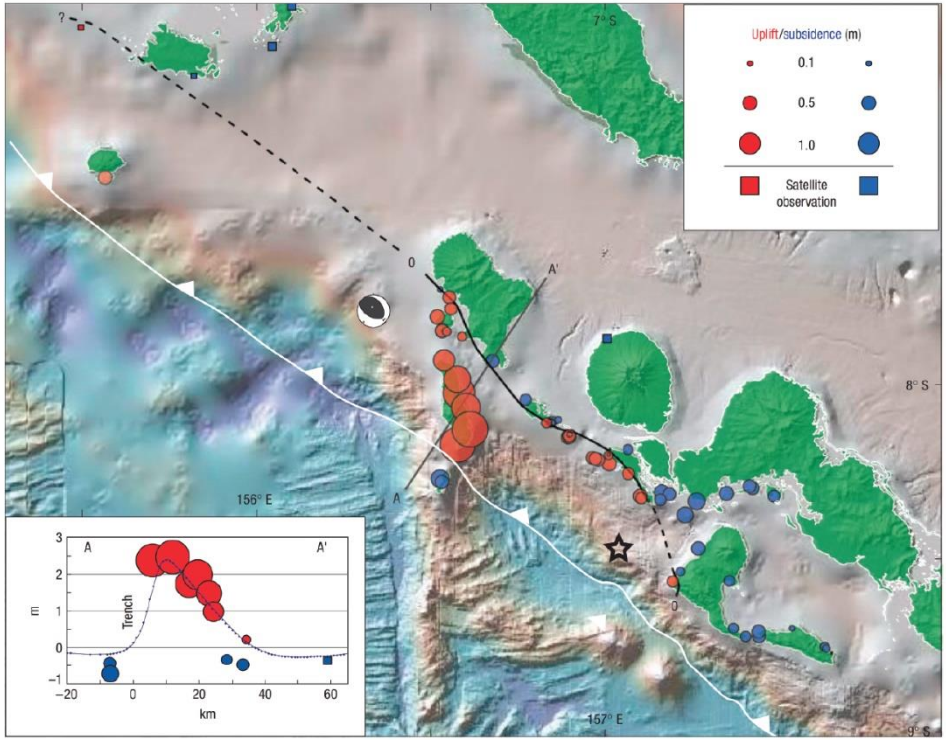

Taylor et al., Nature Geoscience, 2008

Coral micro atolls in western Solomons record long, precise record of vertical tectonics

The New Georgia Group in the western Solomons is one of the only places on Earth where land exists on both sides of the trench, within km of the trench