Intergovernmental Oceanographic Commission

Workshop Report No. 315

Expert Meeting on Tsunami sources, hazards, risk and uncertainties associated with the Vanuatu, Solomon and New Britain Subduction Zones

Port Vila, Vanuatu
14–17 May 2024

UNESCO

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We would like to express our gratitude to Vanuatu Meteorology and Geohazards Department (VMGD) for hosting this workshop. Special thanks go to Ken Gledhill (New Zealand) and Christopher Moore (USA) for their tireless efforts in finalization of this report and all experts who have not only participated but also contributed to the drafting of this report.

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Executive Summary

A group of experts met in Port Vila, Vanuatu from 14 to 17 May 2024 to consider potential tsunami sources in a broad region including the New Britain, Solomon and Vanuatu trenches and related tectonic features (the Study Region). The meeting was held under the auspices of the Intergovernmental Oceanographic Commission (IOC) of UNESCO and was a continuation of a series of similar workshops considering the tsunami source regions in the Pacific Ocean, including Central and South America, the Tonga - Kermadec system and the South China Sea. It was a joint meeting with the Science Monitoring And Reliable Telecommunications (SMART) Tam-Tam project, because some of the attendees were involved in both undertakings. A number of tectonic, tsunami, seismological and geodetic experts with knowledge of the Study Region were involved. The overall tectonics of the Study Region were considered, including the arrangement and relative rates of the tectonic plates (including microplates) and likely segmentation of the subduction zones. Non-subduction regions were identified and discussed as well as possible non-seismic tsunami sources.

The outcomes of the meeting included an endorsement with some updates of the earthquake sources identified by the 2012 Global Earthquake Model (GEM) Faulted Earth study of subduction zones worldwide (Berryman et al., 2015). The major differences included updating the lower limits of the maximum credible earthquakes (M_{max}(min)) for various parts of the subduction systems with more recent earthquake data, and a re-evaluation of the upper limits of maximum credible earthquakes (M_{max}(max)) for the various identified subduction zone segments. The general assessment of the meeting was that the use of whole subduction zone segment dimensions only to estimate M_{max}(max) was likely to overestimate the maximum credible earthquakes in the region. The consensus was that ideally a probabilistic approach should be taken. However, as this would take more time than was available it was decided by the group to use 90% of the appropriate values from the Australian Probabilistic Tsunami Hazard Model in the interim. In fact, this did not make a major difference to M_{max}(max) for most segments in the region, but it does reduce the values for whole margin ruptures (Table 2).

Some non-subduction zone regions with the potential to produce tsunami generating earthquakes were identified and characterised using a similar approach to the GEM methodology. The meeting discussed whether to include the source zones to the north of Papua New Guinea in the study, and it was decided to include them but with revised parameters compared to GEM.

Non-earthquake sources of tsunamis were also considered. For example, a list of volcanic sources capable of causing tsunamis in the region was built from published work, but not characterised in detail. Similarly, an attempt was made to identify potential landslide sources.

An important outcome of the meeting was a list of potential tsunami source scenarios with parameters that can be employed for tsunami modelling informing preparedness and evacuation planning by Member States.

The meeting produced a number of recommendations for further scientific work to improve the knowledge of tsunami threats in the region. These include the need for a full probabilistic treatment of all potential tsunami sources and impacts in the region, more geodetic observations to constrain relative plate rates and slip deficit accumulation, and more paleotsunami studies to assess past tsunami occurrences. There is also a need to improve the sustainability and the spatial coverage of the instrument networks in the region and to encourage full and open sharing of data and scientific results.

The organisers also suggest that similar meetings in the future include greater lead time to allow more experts to attend, and that remote attendance only be considered if very good internet connectivity is available at the venue.

1. BACKGROUND AND OBJECTIVES

1.1 PURPOSE

The Intergovernmental Oceanographic Commission (IOC) of UNESCO supported the Member States of the Pacific Tsunami Warning and Mitigation System (PTWS) to better understand the uncertainties associated with several Pacific subduction zones by sponsoring an experts' workshop in Port Vila, Vanuatu. This was in response to a recommendation of the Task Team on Seismic Data Sharing in the Southwest Pacific at the 8th session of the Regional Working Group of the PTWS on Tsunami Warning and Mitigation for the Pacific Islands Countries and Territories (PICTs). The experts' meeting concentrated on the subduction systems from the western end of the New Britain Trench through the Solomon (San Cristobal) Trench to the southern section of the Vanuatu (New Hebrides) Trench, including the Matthew Hunter section, a total length of around 4000 km (Figure 1). This will be referred to as the Study Region. These combined subduction systems are slightly longer than the Tonga - Kermadec system located to the east. Several similar workshops have been held successfully covering tsunami sources in South America (UNESCO/IOC, In prep), Central America (UNESCO/IOC, 2021*)*, the South China Sea (UNESCO/IOC, 2018), and in the Tonga - Kermadec region of the Southwest Pacific (UNESCO/IOC, 2020). The purpose of these experts' meetings is to quantify earthquake and tsunami sources and resulting hazards and risks to support holistic risk management (readiness, response, reduction and recovery) and target suitable reduction projects.

Very large tsunamis associated with the Study Region subduction zones have the potential to cause widespread loss of life, and damage and disruption to multiple regions simultaneously. Many Southwest Pacific countries are exposed and vulnerable to destructive tsunamis with significant consequences. The meeting aimed to focus on the uncertainties of tsunami hazard associated with these subduction zones and to provide scenarios which can be used to help readiness activities including modelling for evacuation planning.

1.2 OBJECTIVES

The experts' meeting aimed to deliver a number of outcomes which are summarised in this IOC Technical Report. Members of the experts' meeting endorse and support the report. The objectives are as follows:

- Use paleoseismology, past event data, seismic observations, geodetic observations, and tsunami modelling in the Study Region to develop a better understanding of the tsunami hazards across the region. The range of estimates of maximum potential earthquake (M_{Max}) for the subduction zones and broader regions are to be considered and discussed.
- Discuss the uncertainties of the tsunami sources along the subduction systems of interest. This will include bounds on the maximum credible earthquake magnitude and rates of tsunamigenic events, to understand the most extreme consequences and risk management challenges, and those of more likely, lower magnitude scenarios. Use real events from other regions to better define consequences for events that have not yet been observed.
- Investigate possible non-seismic tsunami sources in the regions of interest.
- Use this understanding of hazard, risk and uncertainty to define a number of Pacific and global community needs and actions. For example, identifying scientific research needs, evaluation of risk management programmes, informing priorities and investments to support risk management for at-risk Southwest Pacific countries and the broader Pacific.

- Identify and record gaps in knowledge or understanding of the regional subduction zones, and propose means for addressing or managing these gaps.
- Consider the possible occurrence of slow subduction zone earthquakes (tsunami earthquakes) and their influence on tsunami generation.
- Meet the agreed key objectives of ICG-PTWS.

1.3 KEY SCIENTIFIC QUESTIONS

- Are there any non-subduction zone earthquake sources in the greater region?
- What, if any, is the segmentation of the subduction zones?
- What are credible M_{Max} values on the subduction zone segments?
- Are there any non-earthquake sources of note (volcanic, landslides, atmospheric driven, etc.)?

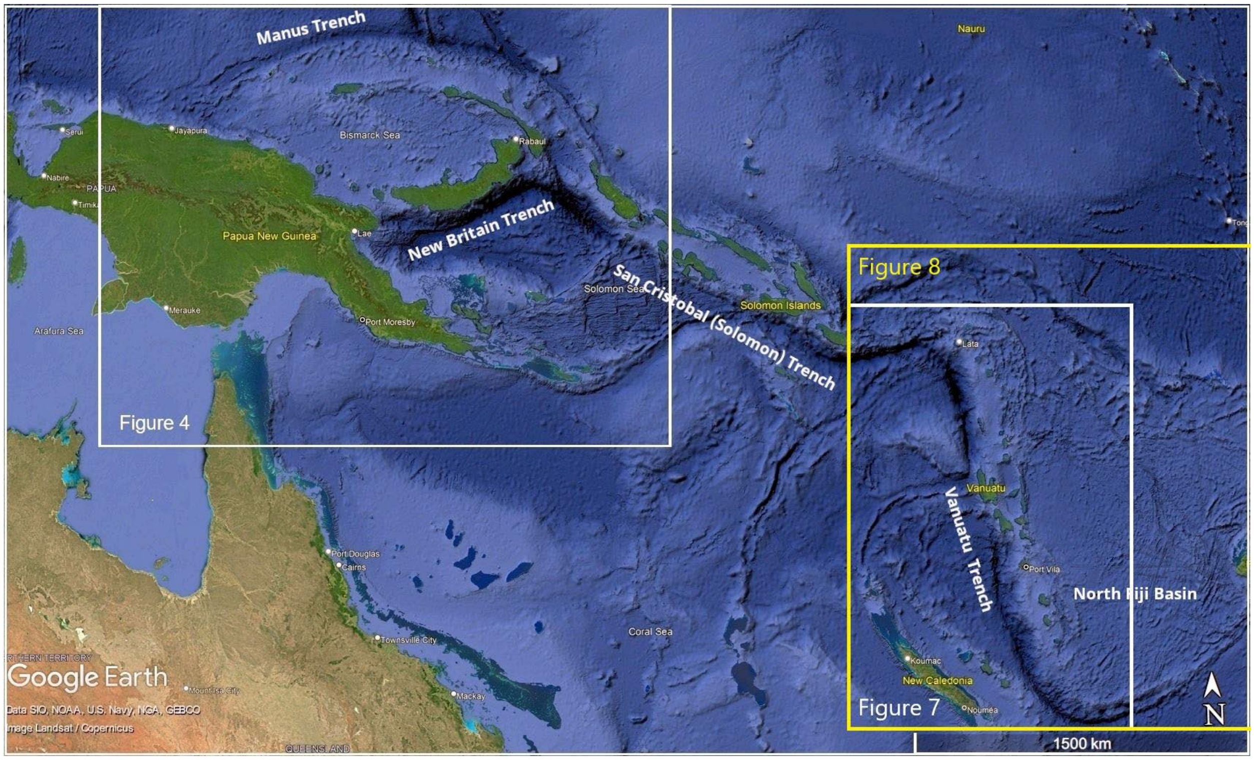


Figure 1. *Map indicating the subduction systems of interest for the workshop, principally (from northwest to southeast) the New Britain Trench, San Cristobal (Solomon) Trench, and the northern and southern sections of the Vanuatu (New Hebrides) Trench. Note that originally the Manus region was not included, but the workshop experts requested the addition. This will be referred to as the Study Region for the workshop. The approximate coverage of the maps showing more tectonic detail (Figures 4, 7 and 8) are shown. The other maps in this document have similar extents to this map, or cover smaller sub-regions.*

1.4 MEETING OVERVIEW

Because the workshop was joint with the Science Monitoring And Reliable Telecommunications (SMART) TAM TAM project, the first half day was spent introducing the experts attending the workshop and outlining the intended outcomes. Included in this was a general overview of the tectonic setting of the Study Region and some related introductory talks. The second full day was devoted to talks expanding on the tectonics of the Study Region and looking in more detail at the plate tectonics, seismicity, geodesy, paleoseismology and paleotsunami evidence to inform the likely tsunami potential of the trench systems. The clear message from the talks was that all parts of the Study Region are complex, including the existence of several microplates and high rates of plate convergence. This results in very high rates of earthquakes (~20% of the World seismicity according to USGS earthquakes catalogue for earthquakes Mw >= 6.0 over the last 50 years) and volcanic activity (~70 known active volcanoes corresponding to ~6% of active subduction zone volcanoes according to the Global Volcanism Program, 2024) and therefore high potential for tsunamis to be generated. These talks are summarised in the next section.

The second full day of the workshop was devoted to reaching consensus on the potential of the various trench systems and other active regions to produce tsunamis, and quantifying potential sources as much as possible, as well as identifying the bounds on maximum credible earthquakes for each sub-region. This included detailed discussions on the most likely segmentation of the trench systems, including what the meeting experts considered was the most reasonable maximum credible earthquake for each trench system and segment.

On the final day of the workshop the meeting outcomes were reviewed and agreed following the presentation of the tsunami modelling of selected scenarios performed overnight.

Although the Study Region for the workshop was the plate boundary from the western end of the New Britain Trench, through the San Cristobal Trench to the northern and southern sections of the Vanuatu Trench, the meeting agreed to include the Manus and New Guinea trenches for completeness, although less time was spent discussing these systems.

2. REGIONAL TECTONIC OVERVIEW

The plate margin in the Study Region is complex with high convergence rates and several microplates accommodating the overall plate motion between the Pacific and Australian plates. The major structures include the New Britain subduction trench, a pronounced convergence feature between the Bismarck Sea and the Solomon Sea, the San Cristobal Trench southwest of the Solomon Islands, and the Vanuatu subduction system located between Vanuatu and New Caledonia. Basically, the Study Region consists of these trenches and subduction systems (Figure 2) taking up the motion between the Pacific and Australian plates along this major section of the Pacific Ring of Fire. The plate motion rates vary from around 5 cm/yr in the southern section of the Vanuatu Trench (Matthew and Hunter zone) to over 10 cm/yr on the northern San Cristobal (Solomon Islands) section of the plate boundary and the New Britain Trench.

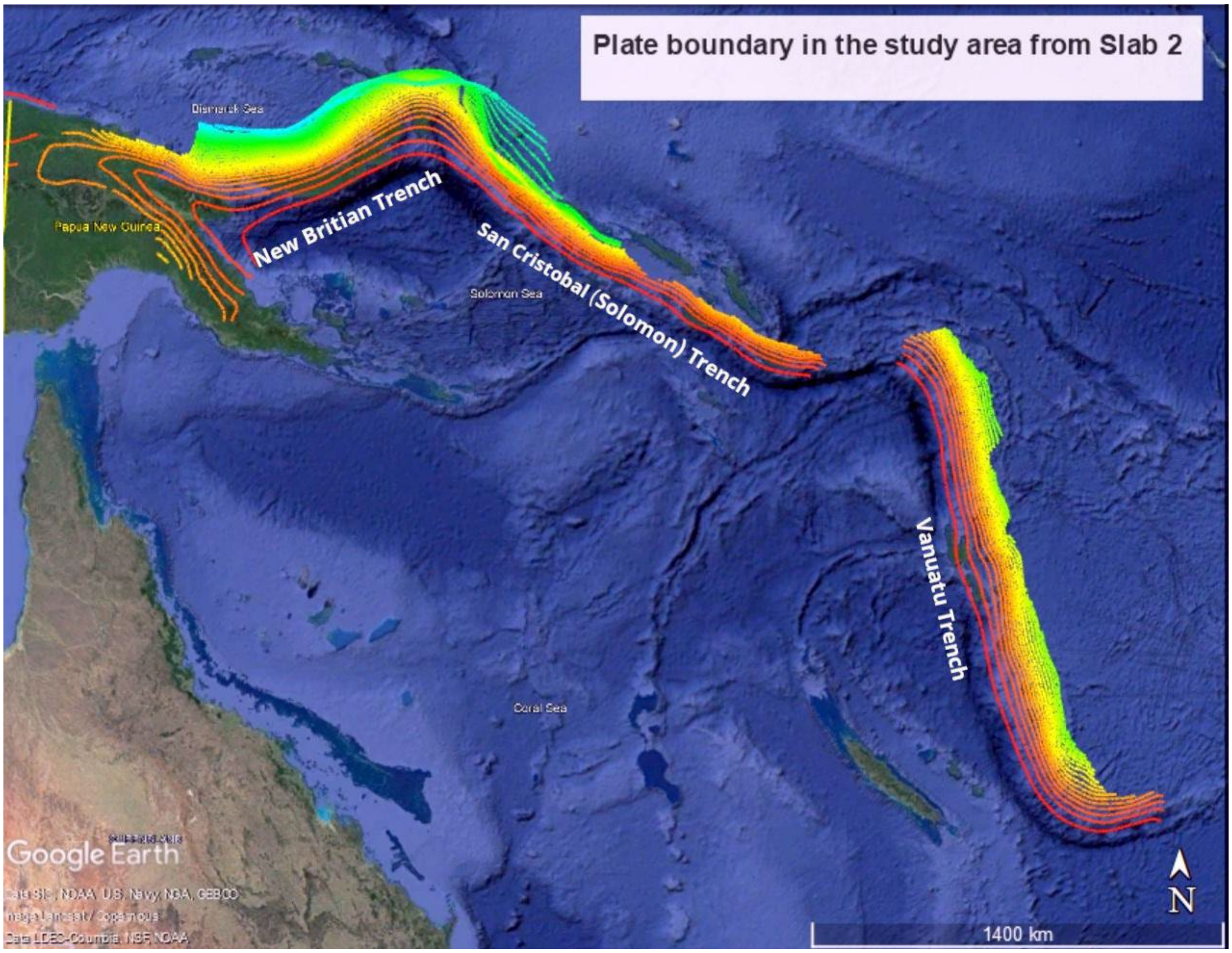


Figure 2. *The plate boundary in the Study Region from Slab 2 (Hayes, 2018) showing coloured contours on the plate interface with depth (reds, yellows, greens, to blues with increasing depth). The region of interest is from the west of the New Britain Trench, through the Solomon (San Cristobal) Trench southwest of the Solomon Islands to the Northern and Southern sections of the Vanuatu (New Hebrides) Trench extending southward between New Caledonia and Vanuatu.*

The Papua New Guinea-Solomon Islands-Vanuatu region is located within a complexly deforming zone between the Pacific and Australian Plates, which converge through this region at rates of 1-15 cm/yr. Portions of the region (Papua New Guinea and Vanuatu) are also fragmented into independent microplates that rotate rapidly, relative to the Australian and Pacific Plates. This produces large changes in plate convergence rates and sense of motion along the boundaries of these microplates, influencing the style and rate of subduction throughout the region. Due to fragmentation of the region into microplates, numerous other active boundaries have also developed, such as the Bismarck Sea Seismic Lineation, Woodlark Rift, North Fiji Basin, and various back-arc extensional and reverse structures east of the Vanuatu Arc. These areas also host substantial rates of activity, accommodating up to 14 centimetres of plate motion per year. Other subduction zones also exist in the region, including the Manus Trench and the New Guinea trench, which also impact on tsunami hazard. For example, the 9 September 2002 Mw 7.6 earthquake on the New Guinea Trench produced a tsunami known as the Wewak tsunami (Borrero et al., 2003), not far from the source of the destructive tsunami of 17 July 1998 which followed a Mw 7.0 earthquake (a.k.a. The Sissano tsunami; Tappin et al., 2001). Also, on 23

December 1930, a magnitude 6.5 earthquake occurring on the Manus Trench was followed by a 12 m high tsunami (NGDC/WDS, 2024).

The current regime of northward subduction of the Australian Plate in the Study Region has only been established in the last several million years, following Miocene collision of the Ontong Java Plateau (a Cretaceous Large Igneous Province) with the North Solomon Trench (Mann and Taira, 2004). Prior to Ontong Java collision, southward subduction of the Pacific Plate occurred at the North Solomon and Manus Trenches and along the formerly active Vitiaz subduction zone. The Ontong Java collision caused a reversal in subduction polarity and establishment of current northward-directed subduction of the Australian Plate in Papua New Guinea, the Solomon Islands, and Vanuatu. Sections 2.1 to 2.4 below describe the key tectonic features in more detail in each of the main regions: Papua New Guinea, Solomon Islands, and Vanuatu.

The earthquake activity is high on all parts of the plate boundary in the Study Region, with over 230 earthquakes of Mw 7 or above recorded since 1900 (Figure 3) in the National Earthquake Information Centre catalogue (NEIC, USGS, https://earthquake.usgs.gov/earthquakes/search/). Five of these earthquakes have been Mw 8 or over, including the 2007 Gizo and 2013 Lata (Solomon Islands) earthquakes in the San Cristobal region. In the 1900s Mw 8+ earthquakes occurred in the New Britain region (the 1906 earthquake near Lae, Papua New Guinea and the 8.1 Mw 1971 event near Panguna, Papua New Guinea and Mw 8.0 1971 event along Bougainville, Solomon Islands (Lay et al., 2017).

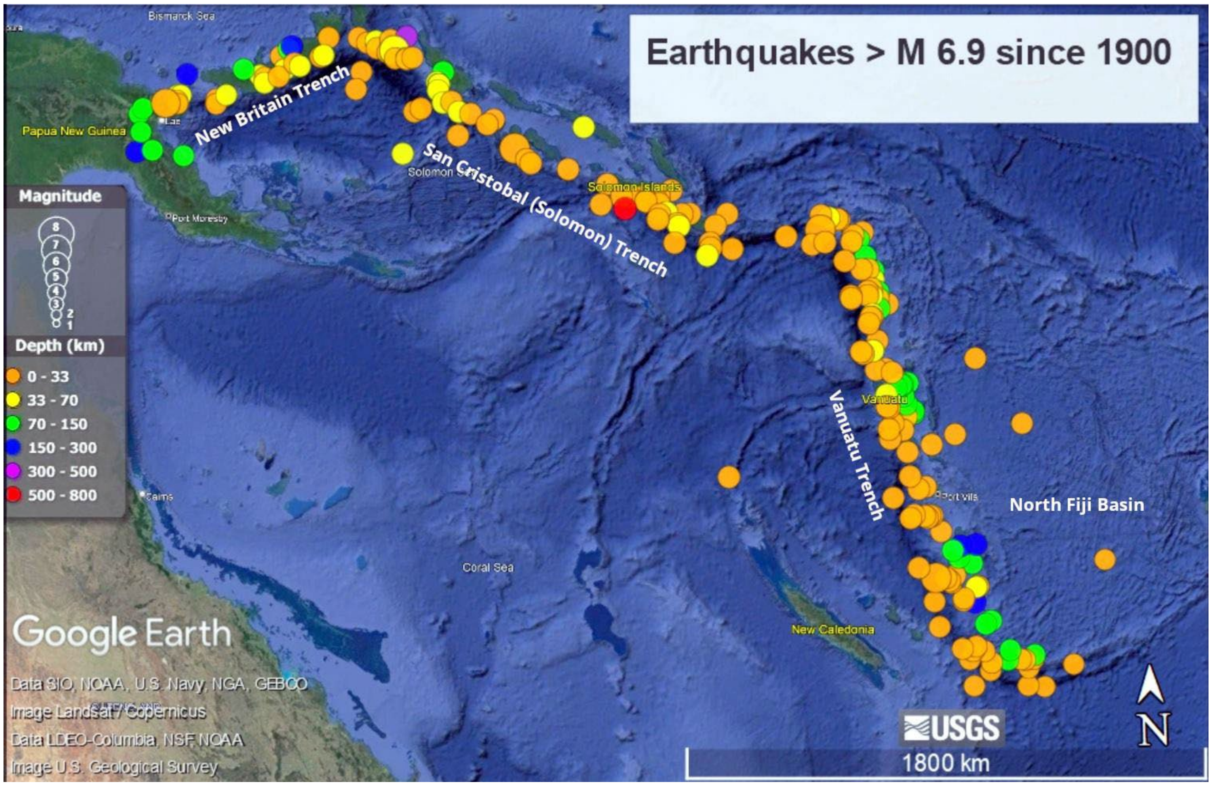


Figure 3. *Earthquakes in the Study Region of Mw 7 or greater since 1900, colour-coded by source depth with the symbol size based on magnitude (USGS NEIC Earthquake catalogue, Accessed 1 October, 2024).*

2.1 THE PAPUA NEW GUINEA - NEW BRITAIN REGION

The current plate configuration has evolved over time during the collision of the Australian and Pacific Plates. Micro-plates evolved to accommodate the relative motions of the major plates along the irregular plate boundary - including the Solomon Sea Plate, and the North and South Bismarck Plates. After the arrival of the Ontong-Java Plateau, the Australian Plate began to subduct under the microplates affiliated with the Pacific Plate at the New Britain Trench and in the San Cristobal Trench.

2.1.1 Tectonics and Geodesy

The South Bismarck microplate (Figure 4) occupies much of Northeastern Papua New Guinea, including the northeastern corner of the Papua New Guinea mainland, and New Britain. It rotates rapidly (~8 degrees/Myr) clockwise relative to the Australian and Pacific Plates, in response to the Pliocene collision of the Finisterre Arc with the Papua New Guinea mainland (Wallace et al., 2004). This rapid rotation produces large changes in convergence rates along the New Britain Trench (from ~5 cm/yr near Lae, to ~15 cm/yr offshore east New Britain). The Solomon Sea subducts northward at the New Britain Trench beneath the south coast of New Britain, and transitions westward to the Ramu-Markham Fault south of the Huon Peninsula (Figure 4), which accommodates active arc continent collision between the Papua New Guinea mainland and the Finisterre Arc Terrane. The Bismarck Sea Seismic Lineation constitutes the northern boundary of the South Bismarck Plate and accommodates rapid strike-slip motion (up to 14 cm/yr) and extension. The Woodlark Plate encompasses much of southeastern Papua New Guinea; anti-clockwise rotation of the Woodlark Plate away from the Australian Plate results in continental extension within the Papuan Peninsula, transitioning eastward to seafloor spreading in the Woodlark Basin at rates of several cm/yr (Wallace et al., 2014). The Woodlark plate may be composed of at least three microplates. Some have proposed the existence of a separate Solomon Sea Plate and have suggested that the Trobriand Trough is an active subduction zone. However, this is under debate (e.g., Wallace et al., 2014).

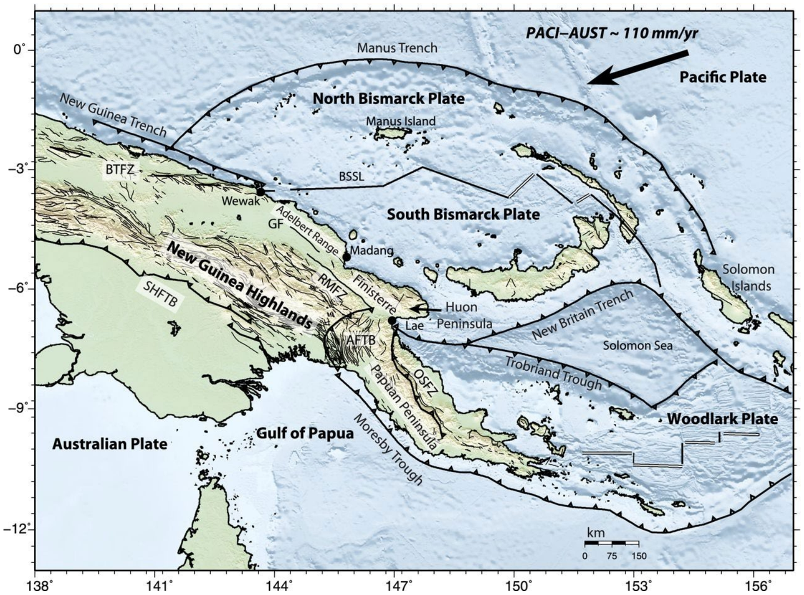


__Figure 4.__ An example of the complexity of the plate boundary region around Papua New Guinea, indicating the micro-plates and main tectonic features (from Koulali et al., 2015). BSSL = Bismarck Sea Seismic Lineation; RMFZ = Ramu.markham fault zone.

The North Bismarck microplate is located north of the South Bismarck Plate, and geodetic observations suggests that although the North Bismarck Plate is largely moving with the Pacific Plate motion, it does have some slow northward motion relative to the Pacific (Tregoning, 2002). The Manus Trench was one of the major subduction zones in the Miocene and earlier period (prior to subduction polarity reversal). However, based on geodetic measurements, it is thought to currently accommodate slow southward subduction of the Pacific Plate beneath the North Bismarck Plate (north of New Ireland and Manus Island in Papua New Guinea) at on the order of 1-2 cm/yr. A well-established subduction zone exists in the western part of Papua New Guinea (west of the South Bismarck Plate), where the Pacific Plate subducts south-westward beneath the New Guinea mainland at rates of 8-9 cm/yr (Koulali et al., 2015). This feature continues westward offshore the north coast of west Papua in Indonesia.

2.1.2 Seismicity

The New Britain Trench region frequently experiences large earthquakes being one of the most seismically active regions of the world (Figure 5). Deep earthquakes (depth greater than 300 km) are reasonably common as well, with several Mw 6.5+ earthquakes occurring over the past 40 years, including a Mw 6.8 event in June 1995. Because of their great depths, none are known to have caused damage. In some locations the underthrust slab in the region is seismically active to depths greater than 400 km.

The primary loci of earthquake activity along the New Britain and northwest Solomon Islands trenches concentrate along subduction zones involving the Solomon Sea Plate underthrusting the South Bismarck plate toward the northwest and the Pacific plate to the northeast (Figures 5, 6a). Lower levels of seismicity exist along the offshore boundary between the Woodlark Plate and the Solomon Sea Plate, and along the southeastern margin of Papua New Guinea and the Woodlark Plate. This region is thus dominated by microplate interactions, although the seismicity distribution and available focal mechanisms are limited for characterizing long-term earthquake behaviour on the boundaries outside the subduction zones. This is particularly evident when seismicity plots emphasize the larger events.

The subduction zone seismicity is intense (Figure 5), with high earthquake productivity and relatively short recurrence intervals between repeated ruptures in major events (e.g., Lay and Kanamori, 1980). The nearly orthogonal trends of the New Britain and Solomon subduction zones suggest the possibility of persistent segmentation between the two zones. However, the seismicity distribution is continuous around the large-angle bend in the subduction zone with the underthrust Solomon Sea plate appearing to drape continuously around the bend without pronounced tearing. Strong stress transfer across the bend is suggested by the occurrence of large events in the two subduction zones with a large difference in fault strike having close temporal and spatial proximity (Lay and Kanamori, 1980). The seismicity defines subducted lithosphere to at least 600 km depth along both zones, with abundant activity at depths from 70 to 250 km. The high convergence rates, ranging from 10-15 cm/yr appear to be responsible for the high seismicity levels. Gutenberg-Richter relations can be established for each subduction zone segment given the abundant seismicity.

Seismicity rates decrease southeastward from Bougainville, and are very low from ~8°S to ~9°S, where the Woodlark ridge intersects the Solomon Trench (Figures 5, 6a). This ridge bounds a Woodlark micro-plate adjacent to the Solomon Sea Plate, with right lateral strike slip faulting on the micro-plate boundary.

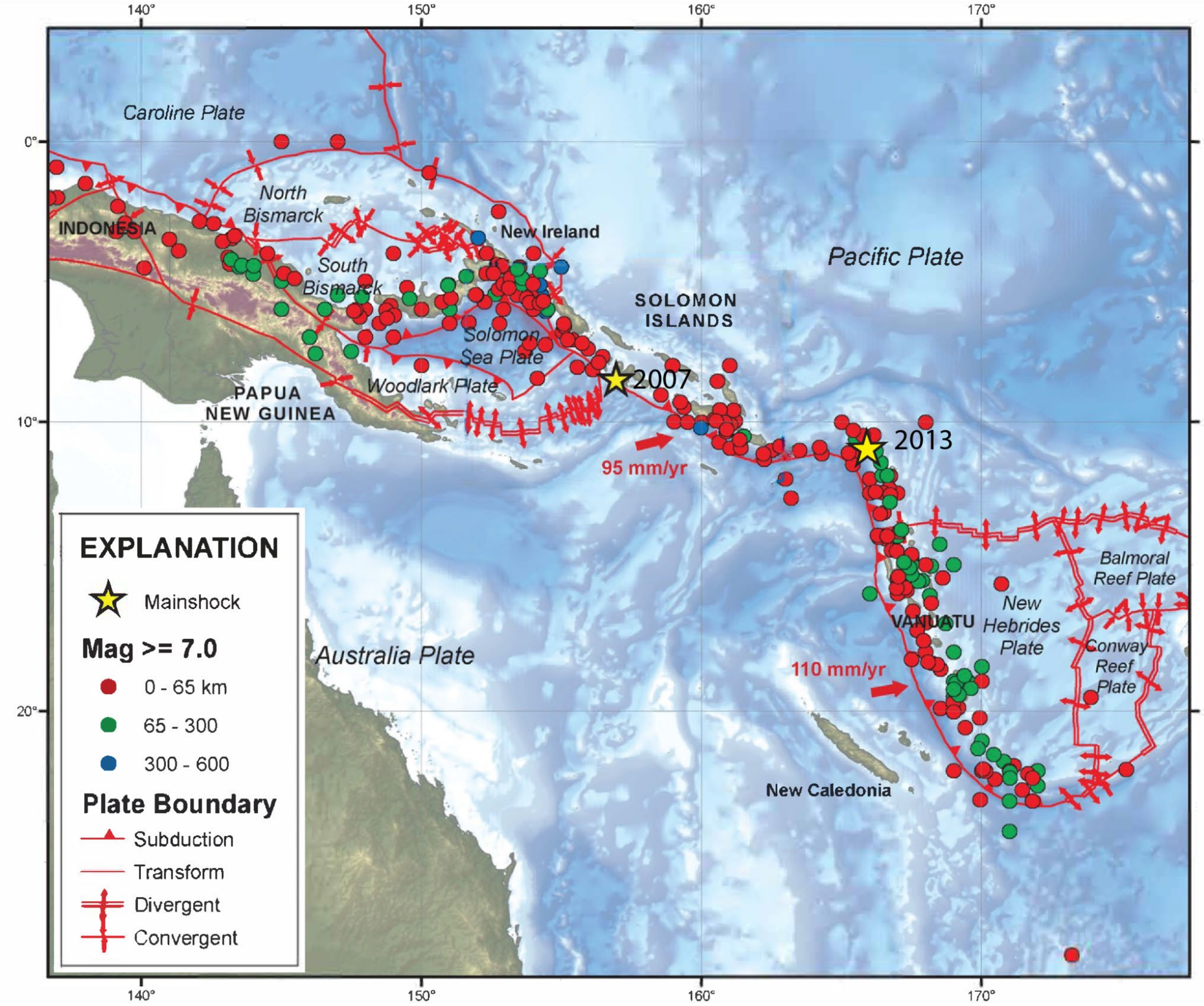


Figure 5. *The earthquakes of Mw >= 7 in the Solomon Islands and Vanuatu regions since 1900, with yellow stars showing the location of the 1 April 2007 Mw 8 event in the Solomon Islands (e.g., Furlong et al., 2007; Taylor et al., 2008) and the 6 February 2013 Mw 8 event in the Santa Cruz Islands (Solomon Islands); e.g., Lay et al, 2013) (modified from USGS poster; Hayes, et al., 2017).*

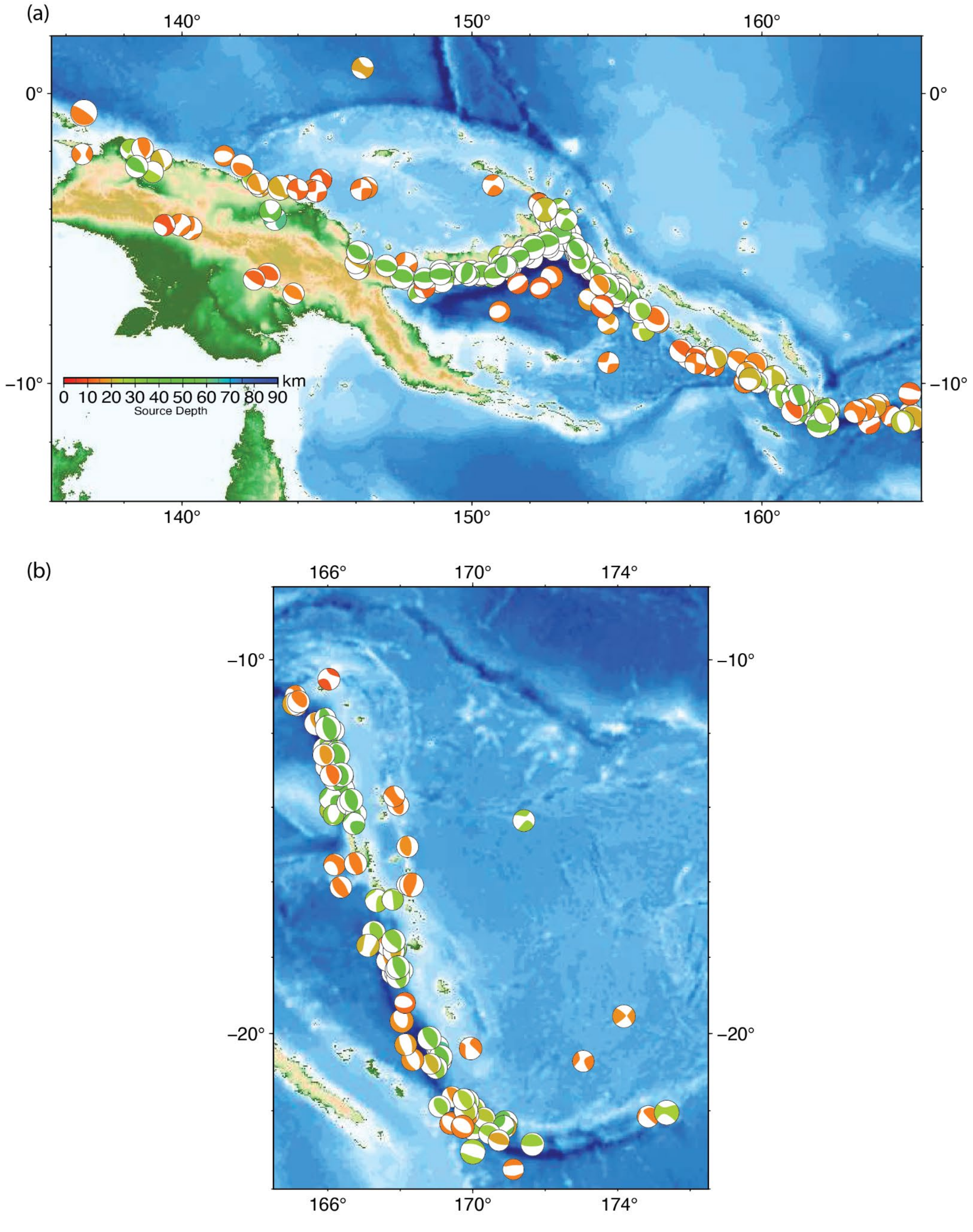


Figure 6. *Source moment tensors from the Global Centroid Moment Tensor (GCMt) catalogue for Mw ≥ 6.5 events at depths up to 70 km from 1976 to 2024, plotted at the GCMT centroid locations. Radius of the source representations scales with Mw (largest events are 8.1, smallest are 6.5), with colour indicating depth. (a) New Guinea, New Britain, and Solomon Islands regions. (b) Vanuatu and Matthew-Hunter regions.*

2.2 THE SOLOMON ISLANDS REGION

The Solomon (San Cristobal) Trench is a subduction zone that transitions to a transform boundary along the Solomon Islands, between the New Britain and Vanuatu Trench systems. It is a segment of a convergent plate boundary formed by subduction of the Solomon Sea plate and the Australian plate north-eastward beneath the Pacific plate. The trench reaches a depth of over 8000m. The region has produced many large earthquakes, including Mw 8 events in 2007 and 2013 (located on Figure 5) causing tsunamis (e.g., Taylor et al., 2008; Lay et al., 2013), and a couple of earthquakes just below Mw 8 in 2016 (Lay et al., 2017; Thomas et al., in prep; see more details in Section 3.2).

2.2.1 Tectonic and Geodesy

The New Britain Trench continues eastward to become the Solomon (San Cristobal) Trench offshore the west coast of Bougainville and the Solomon Islands. The plate subducting at the New Britain and San Cristobal Trenches changes character along-strike, from the 20-45 Ma crust of the Solomon Sea Plate offshore New Britain and Bougainville, to subduction of <5 Ma crust of the Woodlark Basin offshore the Western Solomon Islands (New Georgia Group), to subduction of the Eocene Australian margin in the Southern Solomon Islands. Convergence rates at the San Cristobal Trench are orthogonal to the trench (at ~10 cm/yr), as derived from relative motion between the Woodlark Plate and the Solomon Islands (north of the Woodlark Spreading centre) (Wallace et al., 2014). The sense of motion at the subduction zone changes east of 156.5 E (representing the Woodlark/Australia Plate boundary), where the Australian and Pacific Plates converge at an oblique angle to the trench at ~9 cm/yr. At approximately 161 E, the San Cristobal Trench becomes oriented more ENE, which is parallel to Pacific-Australian Plate relative motion. Subduction likely ceases on this portion of the plate boundary between 161E and Santa Cruz Islands, and strike-slip becomes dominant. Subduction then resumes on the northern portion of the Vanuatu Trench.

Although the vast majority of Pacific-Australia relative plate motion is accommodated along the San Cristobal Trench, some slow motion of the Solomon Islands relative to the Pacific Plate (e.g., Tregoning et al. 1999) may be accommodated in the North Solomon Islands, in the region of the North Solomon Trench (the former site of southward subduction) and/or along structures related to the Kia-Kaipito-Korigole Fault Zone (Mann and Taira, 2004).

2.2.2 Seismicity

The high stressing rates and abundant seismicity are accompanied by unusually efficient seismic triggering and occurrence of large earthquake doublets that in some cases have spanned the strong bend in the Solomon Sea Plate near the junction of the New Britain and Solomon Trenches. Pairs of underthrusting events with magnitudes in the range Mw 7.7 to 8.1 straddling the ~90° bend have occurred in 1919/1920, 1945/1946, 1971, as noted by Lay and Kanamori (1980). Two major event doublets also occurred in 1974 and 1975 offshore Bougainville. The interaction susceptibility extends to interactions between large earthquakes on other faults and megathrust failures. The 2000 Mw 8.0 New Ireland strike slip earthquake on the boundary between the North and South Bismarck plates triggered a pair of Mw 7.8 tsunamigenic thrust ruptures on the New Britain segment (Geist and Parsons, 2005), and the December 17, 2016 Mw 7.9 earthquake appears to have initiated as a 90 km deep intraslab rupture that triggered the megathrust in the Northwest Solomon Islands segment with a rupture that overlapped prior large event rupture zones in 1971 and 1995 (e.g., Lay et al., 2017). The latter type of triggering interaction presents significant challenges to earthquake and tsunami warning efforts, as initial seismological detection and location would indicate a non-threatening intermediate depth rupture, whereas the unexpectedly shallow triggered earthquake faulting was tsunamigenic. Again, these strong interactions reflect high stressing rates and triggering susceptibility that makes the region distinctive.

The Woodlark ridge has active spreading with normal faulting segments offset by right lateral fracture zones and this system impinges obliquely on the Solomon Trench, producing a triple junction with the Woodlark/Solomon Sea subplates to the northwest, the Australian plate to the southeast, and the Pacific plate to the northeast. There is about 20° difference in convergence angle across the triple junction and a slab window must exist down-dip to the northeast. The very low seismicity rates and absence of any large historical earthquake (but note the very short written history in the region related to the relatively recent European settlers arrival) prompted suggestions that the subduction of very young, warm near-ridge oceanic lithosphere prevented significant earthquake occurrence. However, this was proved wrong when the Mw 8.1 April 1, 2007 Solomon Islands underthrusting event occurred. That event, which appears to have involved a synchronous doublet with two shallow patches of slip on either side of the triple junction with slip vectors respecting the change in convergence directions between the two underthrusting plates (Furlong et al., 2009) will be discussed in 3.1. This was the most tsunamigenic event on record in the Solomon Islands, with a 12 m tsunami run-up on islands near the trench (e.g., NGDC/WDS tsunami catalogue, 2024; Wei et al., 2015). While it has proved seismogenic, it is plausible that the very narrow coupled zone on the megathrust (probably extending down-dip only 10-15 km) provides a reasonable barrier that would prevent almost all through-going ruptures, so this could reasonably be treated as a segment boundary (despite the bilateral rupture having traversed it) in terms of being a major obstacle to ruptures extending along the entire arc.

Further to the southeast, the seismicity levels increase, although the activity is not as intense overall as in the northwestern trench. There have also been strong faulting interactions, including a triplet of major events in 1977, so susceptibility to earthquake interactions remains high. Approaching the southeast corner of the arc, intraplate activity increases with large events in both the slab and on the megathrust. It is reasonable to define this as a southeast segment along the Solomon Subduction zone prior to the transition to strike-slip motion.

Rounding the bend, the plate boundary between the Pacific and Australian plates has little convergence and strike-slip activity dominates from 162.5-165°E (Figure 6a). This portion of the boundary is reasonable to treat as a separate segment given the low probability of thrusting continuously transforming to strike-slip motion around a strong curve in a single event (although discrete earthquake triggering on each fault could occur, as in the case of the 1980 sequence discussed above). The largest documented event with strike-slip mechanism along this portion of the plate boundary is an Mw 7.6 event in 2014, and only 3 other events with Mw > 7 are listed in the USGS-NEIC and GCMT catalogues. The tsunamigenic potential should be low for the strike-slip faulting, in contrast to the megathrust activity in the southeast Solomon Islands or in the Santa Cruz Islands region at the eastern end.

2.3 THE VANUATU REGION

The Vanuatu subduction system is the major tectonic feature in the plate boundary zone located between the Tonga–Fiji region and the Solomon Islands (Figure 5), and is accompanied by a complex series of rifts and transform faults in the North Fiji Basin (e.g., Louat and Pelletier, 1989; Tanahashi et al., 1991; Power, et al., 2012). In this region the Australian Plate subducts northeastward beneath the Vanuatu Arc and transforms to a complex series of rifts in the North Fiji Basin (Figure 7). GPS velocities indicate that rapid clockwise rotation of the Vanuatu Arc is the primary tectonic control on the kinematics of back-arc deformation in the North Fiji Basin, particularly in areas of active rifting in the Erromango and Futuna Troughs (Pelletier et al., 1998; Calmant et al., 2003).

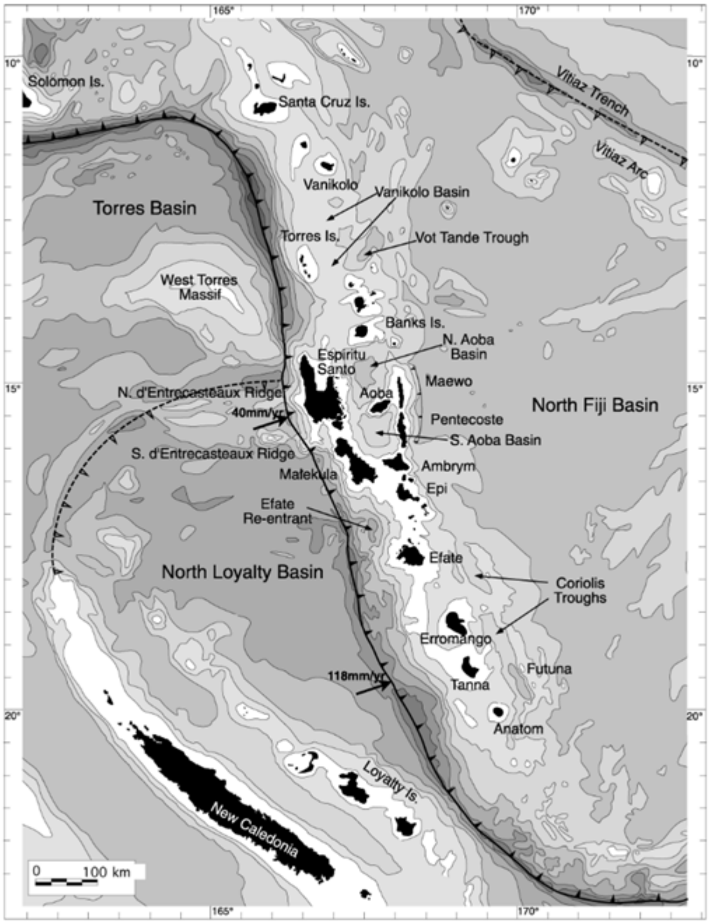


Figure 7. *The major tectonic features of the Vanuatu region (from Meffre and Crawford, 2001).*

2.3.1 Tectonics and Geodesy

Similar to Papua New Guinea, the kinematics of subduction and other active tectonic features in the Vanuatu region is strongly influenced by rapid (6-8 deg/Myr) clockwise rotation of much of Vanuatu relative to the subducting Australian Plate (Wallace et al., 2005). This leads to large along-strike changes in convergence rates along the Vanuatu Trench, from ~9 cm/yr in the northern portion of the Trench, locally disrupted to ~3-5 cm/yr in the central portion offshore Santo Island, and then increasing rapidly to ~15 cm/yr of convergence at the southern Vanuatu Trench offshore New Caledonia (Calmant et al., 2003; Power et al., 2012). The subduction zone takes on a more easterly strike south of the Matthew and Hunter Islands towards Fiji, where GNSS data suggest that 4-5 cm/yr of northward subduction of the Australian Plate occurs with strong partitioning of strike-slip motion on a sliver fault north of the subduction zone (Calmant et al., 2003).

Collisions of the D'Entrecasteaux Ridge and West Torres Plateau (Figure 7 & 8) with the trench produce the locally slower convergence rates on the central Vanuatu Trench. This collision causes around half of the plate motion budget to be transferred into a back-arc shortening region east of Santo (e.g., Taylor et al. 1995; Calmant et al., 2003). The zone of back-arc reverse faulting east of Santo has produced large, tsunamigenic earthquakes (Regnier et al., 2003; Roger and Pelletier, 2024), and is thus an important source of tsunami hazard in its own right. Shear zones transect the Vanuatu Arc on either side of the D'Entrecasteaux Ridge subduction point (Calmant et al., 2003). Elastic block models fitting GNSS velocities in Vanuatu suggest that the plate interface in the Santo region is undergoing contemporary interseismic coupling, building stress and slip deficit that will eventually be relieved in future megathrust earthquakes there (Power et al., 2012).

Where the southern subduction zone bends around to the Matthew-Hunter segment, much of the plate motion is transferred onto a strike-slip fault system within the upper plate north of the Matthew and Hunter Islands (Pelletier et al., 1998). North of this region a complex system of rifts accommodates the opening of the north Fiji Basin, one of the most complex back-arc rift systems on earth. Northeast of the Matthew and Hunter region, the subduction zone transitions into a more slowly deforming (< 2 cm/yr) strike slip zone that continues northeast towards Fiji (Power et al., 2012). Note that recent studies argue that the Matthew-Hunter segment is more an independent subduction zone initiated recently than a continuous feature of the subduction zone north of the collision region between the Loyalty Ridge and the Vanuatu Arc (e.g., Patriat et al., 2015, 2019).

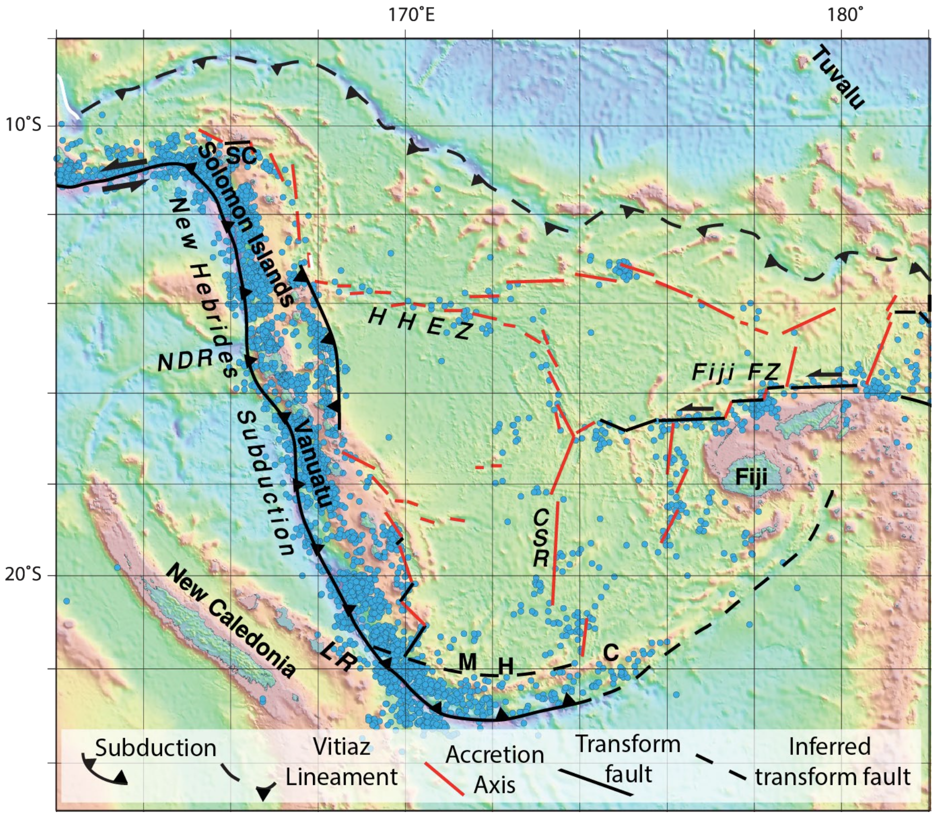


Figure 8. *Tectonic settings of the North Fiji Basin, showing the major tectonic features discussed in the Vanuatu region (modified from Patriat et al., 2015). CSR = Central Spreading ridge; HHEZ = Hazel Holme Extensional Zone; SC = Santa Cruz; NDR = North D'Entrecasteaux Ridge; LR = Loyalty ridge; M = Matthew; H = Hunter.*

2.3.2 Seismicity

After the 90° change in strike of the boundary near 165°E (Figure 5), subduction between the Australian plate and the Pacific Plate/North Fiji Basin involves ENE Australian plate motion rates of 8-9 cm/yr extending from 10.5°S to 23°S, but convergence rates vary along the arc due to the collision with ridge structures on the incoming Australian plate. Seismicity is spread along the entire arc and includes intermediate depth activity extending to 200 or 350 km depth with spatial clustering and deeply extending fingers of seismicity. The northernmost 300 km of the subduction zone has experienced the most recorded large megathrust events (Figure 6b), notably the 6 Feb. 2013 Mw 8.0 event west of Nendo Island, which generated a 11-12 m run-up (Lay et al., 2013; Roger and Pelletier, 2024). This event is discussed further in Section 3.1.. About 150 km to the south, where the West Torres Plateaux impinges on the arc, a large doublet event struck in 1980 (Mw 7.7, 7.5) and a partially overlapping triplet occurred in 2009 (Mw 7.8, 7.6, 7.4), suggesting ~30-year recurrence (Cleveland et al., 2014). Finite-source models are inadequate to establish whether persistent asperities ruptured in the sequential ruptures. The 21 April 1997 (Mw 7.7) earthquake near the southern end of this sequence ruptured within the underthrust slab but was large enough to excite a 3 m tsunami (Cleveland et al., 2014). This is the largest documented intraslab rupture in the region. Cumulative radiated seismic energy is highest in the northern 250 km of the subduction zone but continues to be significant for the southern 350 km before tapering off.

South of the convergence with the d'Entrecasteaux fracture zone from about 15°S to 18°S there is a zone of lower seismicity, which some characterize as a seismic gap (e.g., Cleveland et al., 2014). There is no seismological record of a large earthquake in this region extending back to 1900. Prior efforts such as GEM have segmented the arc to separate the region to the north from the seismic gap zone, which has large slip deficit (Power et al., 2012) and low convergence rate. The major contrast in the subduction zone environment is the structure of the subducting plate. From 18°S to 23°S the seismicity picks up and has been relatively uniformly distributed for Mw 7.5-7.7 earthquakes on the megathrust and in the outer rise (normal faulting). The 16 May 1995 Mw 7.7 outer rise normal-faulting event at the southern end is the most tsunamigenic and produced a 8 m runup on Aneityum island to the north (Roger and Pelletier, 2024). Around 171°E near 23°S the subduction zone bends eastward, and due to slip partitioning involving microplate rotation in the upper plate, plate convergence includes arc-perpendicular interplate thrusting at about 5 cm/yr (Calmant et al., 2003) with a rapidly rotating strike. This extends eastward to a tsunamigenic Mw 7.7 megathrust rupture in 2021 with northward thrust motion (Ye et al., 2021; Gusman et al., 2022a; Roger et al., 2023; Robert et al., in review, 2024) and tsunamigenic outer rise normal-faulting up to Mw 7.7, as in 2023 (Faugère et al., 2024; Robert et al., in review, 2024). The 2021 and 2023 events produced tsunamis that spread through the North and South Fiji Basins, everywhere in the southwest Pacific Ocean, but with little impact, especially on neighbouring New Caledonia and Vanuatu (Roger et al, 2023; Robert et al., in review, 2024). The Matthew - Hunter Fracture Zone (MHFZ) becomes dominated by strike-slip deformation further east (Power, et al. 2012), with the largest event that has been recorded being about Mw 7.6 (1990). Note that Patriat et al. (2015, 2019) have proposed that the southernmost part of the Vanuatu subduction zone is a neo- volcanically active subduction system (~2 Ma) oriented S-N and separated at the collision zone with the Loyalty Ridge from the ~SW-NE subduction of the rest of the arc. Interplate and outer rise sequences in the Loyalty Islands region tend to be very productive in terms of aftershock sequences (Roger et al., 2021; Ye et al., 2021).

2.4 OTHER REGIONS OF INTEREST

The complex microplate tectonics and high rates of plate motion mean that there are numerous other potential tsunami sources in the PNG-Solomons-Vanuatu region, in addition to the subduction sources discussed in the preceding sections. Reverse faulting in the backarc of northern Vanuatu constitutes some of the most important crustal faulting tsunami sources, and has produced large earthquakes (Mw 7.5) and catastrophic tsunami (Regnier et al., 2003; Roger and Peletier, 2024). The 1999 Mw 7.5 Ambrym earthquake and tsunami on this system is discussed later in this report. In the Vanuatu Arc region, the various fracture zones and microplate boundaries are described above. Earthquakes on the many structures in the North Fiji Basin (NFB)have not historically been tsunamigenic. The NFB is a region of newly created crust dominated by rifting and strike-slip faulting, and seismogenic depths are likely to be small (<10 km), thus limiting potential earthquake magnitudes. Moreover, faulting appears to be somewhat distributed, which will also limit fault lengths. We thus consider crustal faults in the north Fiji Basin to be of limited tsunami hazard.

The distribution and rates of activity on crustal faults in the Solomon Islands region is largely unknown. However, it is possible that a small component of Pacific-Australia Plate motion (<10-20%) may still be accommodated to the northeast of the Solomon Islands, on existing reverse faulting structures imaged there (Mann and Taira, 2004). We cannot rule-out the potential for tsunamigenic reverse-faulting events (perhaps similar to the Mw 7.5 Ambrym event) could occur in the region northeast of the Solomon Islands. Future onshore and offshore geodetic and geophysical imaging investigations would help to clarify this.

Normal faults in the Solomon Sea of southeastern PNG (accommodating continental extension) may also pose a local tsunami source. Paleoseismic investigations of emerging coral reefs along the Papuan Peninsula coastline reveal coseismic uplift events of 0.5 to 1.8 m, in Mw > 7.0 earthquakes (Biemiller et al., 2020) North of PNG, rapid extension and strike-slip occurs on the Bismarck Sea seismic lineation, along the northern margin of the South Bismarck Plate (BSSL; Fig.4), Great (Mw 8.0) strike-slip faulting earthquakes have occurred on the BSSL, including the 2000 Mw 8.1 earthquake on the Weitin Fault near New Ireland (Chen et al., 2019). These events have not been significantly tsunamigenic, likely due to their nearly pure strike-slip mechanisms, although we cannot rule-out potential for tsunamigenic events on faults in the BSSL region in future.

In addition to these events, some outer rise faults produced tsunamigenic earthquakes showing strong normal faulting component in the region, especially in the neighbourhood of the south segment of the Vanuatu subduction zone, between the Loyalty Islands and the southernmost islands of the Vanuatu Arc as shown by the GCMT focal mechanisms on Figures 9 and 10. To date, the largest known events are the 15 May 1995 Mw 7.7 Walpole earthquake, the 5 December 2018 Mw 7.5 Maré earthquake, and the 19 May 2023 Mw 7.7 earthquake having occurred close to the epicentre of the 1995 one. All three were tsunamigenic and close in time with thrust-type ruptures on the subduction interface (e.g., Roger et al., 2021). Normal faulting outer rise events happen in other locations in the Study Region, for example on the south of the San Cristobal Trench (Solomon Islands), as highlighted by Neely and Furlong (2018), however none of them is known to have been tsunamigenic.

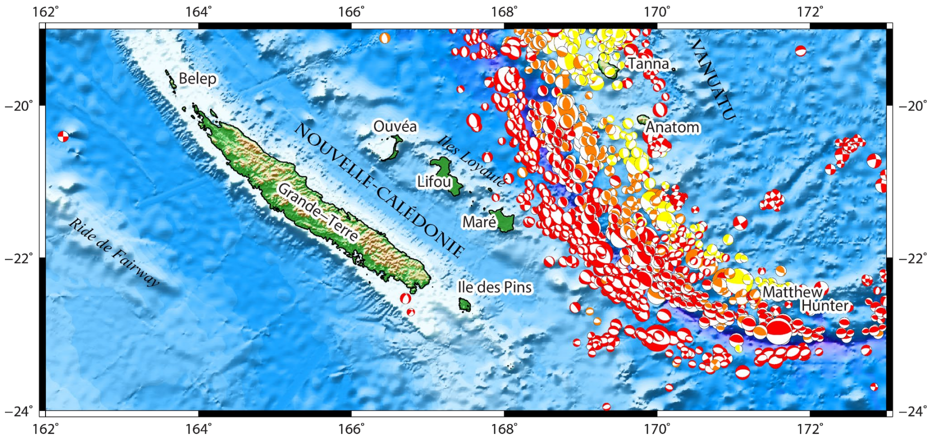


Figure 9. *The GCMT focal mechanisms for earthquakes of magnitude Mw <= 6.9 from 1973 to 2021 (Dziewonski et al, 1981; Ekström et al., 2012). Colour depends on the depth, red: 0-30 km, orange: 30-100 km; yellow: more than 100 km. From Pelletier et al. (2021).*

Overall, the PNG-Solomons-Vanuatu region is characterised by immense tectonic complexity. More detailed, future studies are needed in this region to clarify the distribution of major offshore active faults, and their potential for tsunamigenesis.

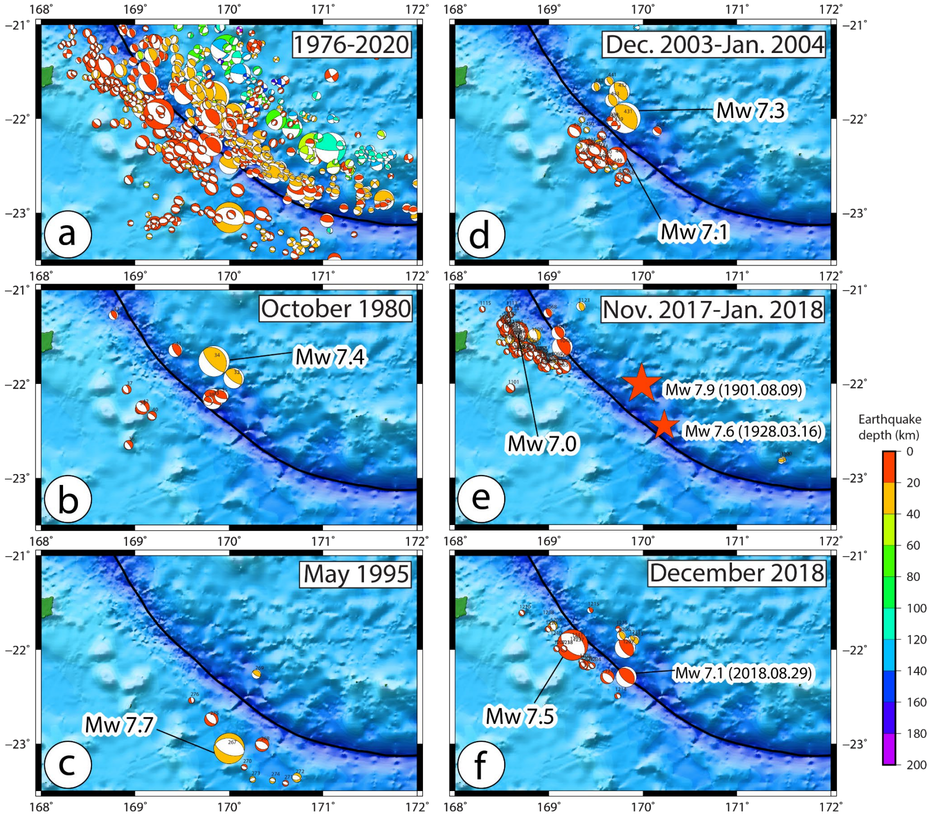


Figure 10. *Focal mechanism solutions from the GCMT project plotted for the period 1976–2020 with focus on five different seismic sequences having occurred in the southern section of the Vanuatu subduction zone showing nine large shallow earthquakes at the Loyalty Ridge–Vanuatu Arc subduction zone and a relationship between outer rise normal faulting events and thrust events on the subduction interface. From Roger et al. (2021).*

3. EARTHQUAKE, TSUNAMI AND PALEOTSUNAMI CONSTRAINTS

3.1 EARTHQUAKE CONSTRAINTS

Previous large earthquakes provide information on the likely size and impact of future events. The two largest, well-recorded tsunamigenic megathrust ruptures in the region are the 1 April 2007 Mw 8.1 Solomon Islands event and the 6 February 2013 Mw 8.0 Nendo (Santa Cruz Islands) event (Figure 5).

The 2007 earthquake occurred within the low seismicity region seaward of Choiseul Island where the Woodlark microplate is underthrusting the Pacific plate and the Australian plate is underthrusting the Pacific plate. Thus, this earthquake rupture straddled a triple junction where the Woodlark spreading system is impinging on the subduction zone. The absence of historical seismicity in this region indicates distinct seismogenic properties relative to the northwestern and southeastern regions of the Solomon subduction zone. Anomalous properties are expected due to the very young age of the underthrusting lithosphere adjacent to the Woodlark ridge, which converges obliquely at the trench. Conventional thinking about the influence of subducting ridges suggested that large rupture should not occur in this region and that the plate boundary contact along the underthrust spreading centre would likely be too weak to accumulate significant strain, so a large earthquake would not be expected here. The reality proved otherwise, and the Mw 8.1 earthquake nucleated near the intersection of one of the spreading system transform faults and the trench, and spread predominantly unilaterally northwestward across the two plate interfaces; first along the Australia plate/Pacific plate interface and then northwestward along the Woodlark microplate/Pacific plate interface. There is about a 20° change in the relative motion of the underthrusting plates due to the Woodlark Ridge spreading motions.

Finite-fault slip inversions based on seismic body waves and surface waves were produced by Furlong et al. (2009), revealing two distinct large slip patches, one on each plate boundary, with some poorly resolved down-dip extension of lower slip. Rake varied on the fault model and ended up closely matching the predicted changes in rake given the relative plate motions for the Woodlark and Australian plates relative to the Pacific. Slip extended to near the trench. Peak slip was 3-4 m in the two patches in this seismic model. Aftershocks tended to fringe the large-slip patches, with stronger activity in the northwestern plate boundary overlapping background activity and extending along Bougainville Island across the depth range of the seismogenic fault. Aftershocks to the southeast tended to be shallow, up-dip of where a slabless window is expected to locate below 20 km depth. Background activity also concentrates near the trench in this region.

The 6 February 2013 Mw 8.0 rupture struck in a long-term seismic gap in the northernmost Vanuatu trench. The shallow dipping thrust event triggered large outer rise extensional faulting seaward of the slip zone, upper plate strike slip faulting landward of the slip zone, and strike-slip faulting along the transform boundary to the northwest. Finite-fault inversion using seismic waves and tsunami modelling indicate a two large-slip patches distribution with one slip patch near the trench (Lay et al., 2013). This event produced 11 m run-up on West Nendo and 0.89 m amplitude at the Lata tide gauge (Roger and Pelletier, 2024). Positive sea level perturbations reached Nendo after about 3 m, following initial sea level downdraw. The event was well recorded at six DART systems and 3 tide gauge stations in Hawaii, with good fits to the simulated signals predicted for the finite-source model, although absolute timing adjustments had to be made suggesting that absolute placement of the faulting model has some uncertainty.

Both the 2007 and 2013 ruptures have somewhat depleted high frequency spectra for teleseismic P waves, and moment-scaled radiated energy for both events is at the lower end of the values for typical megathrust ruptures but above the values for identified tsunami earthquakes (tsunami earthquakes are shallow megathrust events that have low rupture velocity, low moment-scaled radiated energy, long source duration, depleted short-period seismic wave energy and large tsunami excitation due to large slip in low rigidity environment). So, despite having slip distributions that extend to the trench, neither event is classified as a tsunami earthquake.

3.2 TSUNAMI CONSTRAINTS

Past tsunamis were discussed, some of them being quite recent. These events give an insight into possible future tsunamis and the possible impacts. This is a list of the most significant events (the catalogue of Roger & Pelletier, 2024 describes a total of 100 events having been recorded and/or reported in the Vanuatu Arc):

- 1875: 28 March is the only deadly tsunami recorded in New Caledonia (25 deaths in Lifou), although there is no confirmed knowledge of the seismic source parameters (Ioualalen et al., 2017)
- 1920: This event is in the tsunami/earthquake catalogues, but there is no valuable information about any tsunami waves. Also, Ioualalen et al. (2017) discussed its magnitude through the use of numerical simulations of the tsunami.
- 1999: 26 November Mw 7.5 earthquake (on the back-arc faults) triggered a destructive and deadly tsunami in Ambrym and Pentecost islands (Vanuatu) with a run-up of up to 8 m (Ioualalen et al., 2006). It has a reverse faulting mechanism and is the largest known earthquake in the back-arc of this region. There are measurements of vertical motion (uplift up to 1.5 m) and subsidence in Ambrym eastern shore and surrounding islands. The tsunami generation mechanism(s) is still discussed (earthquake alone, additional submarine landslide source, etc).
- 2007: 1 April Mw 8.1 Solomon Islands event (see detailed description in Section 3.1).
- 2013: 6 February Mw 8.0 Nendo (Santa Cruz Islands) event (see detailed description in Section 3.1).
- 2016: 8 December Mw 7.8 interface earthquake on the Solomon Islands subduction zone. This event caused destruction and casualties. It was well recorded by stations of the SW Pacific and a few DARTs (Thomas et al., in prep).
- 2018: 5 December Mw 7.5 earthquake with normal mechanism at the collision between the Loyalty Ridge and the Vanuatu Arc. This event produced many observations and sea level gauge records (Roger et al., 2021).
- 2021: 10 February Mw 7.7 earthquake with reverse mechanism at the southeasternmost part of the subduction zone (toward Fiji). This event produced many observations, sea level gauge and DART records (Gusman et al., 2022a; Roger et al., 2023; Robert et al., in review, 2024).
- 2023: 19 May Mw 7.7/7.1 doublet earthquakes with complex normal mechanism (close to the location of the 1995 Mw 7.7, which was about 250 km East of Vio, East New Caledonia). These events have many observations, sea level gauges and DART records (Faugere et al., 2024; Robert et al., in review, 2024; Roger & Gusman, in prep., O'Kane et al., in prep).

Note that a 9 August 1901 Mw 7.8 earthquake and tsunami are mentioned in catalogues but there is strong doubt on the date and location of this event (it was removed in a recent update from USGS).

3.3 PALEOTSUNAMI CONSTRAINTS

Paleotsunami (and paleoseismic) evidence in countries straddling the San Cristobal (Solomon) and New Britain subduction zones is sparse, primarily due to the limited number of studies in these regions on land in New Caledonia (including Loyalty Islands), the Vanuatu Islands, the Solomon Islands, and Papua New Guinea. The available paleotsunami evidence is summarised in Table 1. For New Caledonia, Paris et al. (2023) identified up to six potential events in the geological/depositional record of Grande Terre and the Loyalty Islands over the last 3,000 years based on analysis of potential tsunami deposits. Three of these events are suggested to have occurred in the last 1,000 years based on geochronological time-markers, with two of them suggested to be linked to a Vanuatu subduction source.

In the Vanuatu region, five events were identified in the geological record of Efate island based on geological/sedimentological evidence (Goff et al., 2008), while in the Solomon Islands, a potential paleotsunami in AD 1400’s has been identified based on a re-interpretation of archaeological evidence on Taumako Island in the Duff Islands group (Cain et al., 2019). The source for this event is hypothesised by Cain et al. (2019) to be associated with a potential 15th Century Tonga Trench Mw 9+ earthquake suggested in the literature by Goff et al. (2011; 2022). This event could alternatively be associated with the eruption of the Kuwae Volcano in the Vanuatu Arc in AD 1452–1453 (Witter and Self, 2007; Ballard et al., 2023) which may have triggered a large destructive tsunami (Roger and Pelletier, 2024).

In Papua New Guinea, paleotsunami investigations are confined to the Sandaun Province in the north (Goff et al., 2017; Davies et al., 2019), with the identified events representative of likely sources at the New Guinea Trench. No paleotsunami investigations have been undertaken in other areas especially in southern/eastern provinces that may indicate potential sources at the New Britain, San Cristobal or Vanuatu subduction sources.

In summary, the current dearth of paleotsunami evidence for New Caledonia, Vanuatu, Solomon Islands and Papua New Guinea is reflective of the lack of paleotsunami investigative studies undertaken in these regions. As a result, the absence of definitive evidence for significant tsunamigenic events associated with potential sources along the Vanuatu, San Cristobal and New Britain Subduction Zones does not imply that such events are not possible. Ongoing research to expand the geographic coverage of paleotsunami evidence as well as testing of likely source scenarios in this region through forward modelling can provide insights on the potential scale, magnitude and potential frequency of such events, for use in EWS and Tsunami Ready planning and operational designs. Note for example that a field survey was led in 2023 by French research institutions in collaboration with the Vanuatu Geohazards Department (VMGD) to identify potential tsunami deposits at specific locations in the islands of Aneityum and Tanna. The data obtained during this survey are still being processed at the time of the redaction of the present report.

Country	Paleotsunami	Evidence	Interpreted Event Source	Subduction Zone	Reference
New Caledonia	~1850–1900 CE	Grande Terre (Womi), Loyalty Islands (Maré) and in Grande Terre (Pouébo, and perhaps Womi and Koulnoue)	March 28, 1875 earthquake (Mw ≥ 8.3)	NW Vanuatu Trench segment	Paris et al. (2023)
	~1700 CE	Maré (Patho), Grande Terre (Koulnoue, Womi, and possibly Bwa), and Ile-des-Pins (Baie des Crabes)	1729 ± 3 CE earthquake [1] (Unknown Mw)	NW Vanuatu Trench segment	Paris et al. (2023)
	~1450 CE	Grande Terre (Womi)	~1450 CE earthquake [2] (Mw 9.4) *or AD 1452–1453 volcanic eruption*	Tonga-Kermadec Trench *or Kuwae volcano (Vanuatu)*	Paris et al. (2023) *Roger et al. (2024)*
	~900 CE	Grande Terre (Womi) and the Loyalty Islands (W)	Unknown	Unknown	Paris et al. (2023)
	~100–800 CE	Grande Terre (Womi) and the Loyalty Islands (Wé on Lifou Island)	Unknown	Unknown	Paris et al. (2023)
	~2950–3000 BP	Grande Terre (Womi)	Unknown	Unknown	Paris et al. (2023)
Vanuatu	1452/1453 CE	Tonga	1452/1453 CE Kuwae eruption ~1450 CE earthquake [3] (Mw 9.4)	Kuwae volcano Tonga-Kermadec Trench	Goff et al. (2008) Goff et al. (2022)
	~1200 BP	Efate (Tankanus)	Unknown	Unknown	Goff et al. (2008)
	~2800 BP	Efate (Devils Point and Mangaasi)	Unknown	Unknown	Goff et al. (2008)
	~3750 BP	Efate (Devils Point)	~3800 BP earthquake (Mw 9.5)	Chile (Arica-Atacama)	Goff et al. (2008; 2022)
	~4200 BP	Efate (Baufatu)	Unknown	Unknown	Goff et al. (2008)
Vanuatu	Unknown	Makura Island (Shepherd Islands)	*“Deposits* [...] *identified, including some just above the Aknau cultural layer”*	Unknown	Ballard et al. (2023)
Solomon Islands	1400–1500’s CE	Namu (Taumako Island) Ontong Java/Ulawa Island	~1450 CE earthquake (Mw 9.4) ~1275–1655 CE earthquake (Unknown Mw) [4]	Tonga-Kermadec Trench San Christobel / Solomon Trench	Goff et al. (2022) Cain et al. (2019)
Papua New Guinea [5]	1440–1600 CE	Sissano Lagoon	Unknown	New Guinea Trench	Davies et al. (2019)
	1150–1240 CE	Sissano Lagoon	Unknown	New Guinea Trench	Davies et al. (2019)
	~6000 BP	Paniri Creek	Unknown	New Guinea Trench	Goff et al. (2017)

Table 1. *A summary of paleotsunami studies in the Study Region.*

[1] This event was inferred by Louat and Baldassari (1989) from ^{230}Th ages on emerged coral heads, which were originally interpreted by Edwards et al. (1988) to have been exposed during coseismic uplift in Malekula, Vanuatu. Ongoing paleotsunami investigations in Vanuatu (Roger 2024, personal communication) provide a means to potentially corroborate these observations if contemporaneous paleotsunami deposits in Vanuatu are identified.

[2] The hypothetical 15th Century Tonga Trench earthquake and far-field tsunami proposed by Goff et al. (2011; 2022) was suggested by Paris et al (2023) as a potential source for the ~1400 CE paleotsunami in New Caledonia. However, potential sources along the Vanuatu arc cannot be ruled out, including the Kuwae volcano eruption (1452–1453 AD).

[3] Goff et al. (2022) provided an alternative source scenario associated with the 1450's CE paleotsunami deposits in Tonga, modifying initial interpretations by Goff et al. (2008) which favoured an eruption source mechanism at Kuwae volcano.

[4] Complex faulting along the San Cristobal Trench cannot be ruled out as a potential source for the 15th Century paleotsunami event suggested by Cain et al. (2019) on Taumako Island.

[5] Potential paleo tsunamis in Northern Papua New Guinea suggested by Goff et al. (2022) and Davies et al. (2019), are inferred to be associated with seismogenic / co-seismic sources along the New Guinea Trench, based on the 1998 Aitape earthquake and tsunami analogy.

4. DETERMINISTIC vs PROBABILISTIC TSUNAMI MODELLING: UNDERSTANDING UNCERTAINTIES

Approaches to seismic tsunami hazard assessment range from deterministic to probabilistic. Deterministic approaches typically involve modelling a single scenario, or a small set of scenarios, without quantitative estimates of the scenario likelihoods; it is also called scenario-based approach, often considering one or a handful of maximum credible scenarios. This has the advantage of simplicity, both in implementation, and in the communication of the results. But with deterministic approaches it may be difficult to communicate or estimate the scientific uncertainties in the likelihood or plausibility of different scenarios.

Probabilistic approaches attempt to address this by including some information on scenario frequencies (or equivalently, the chance of a scenario occurring in a given timeframe) and the uncertainties in these frequencies (Geist and Parsons, 2006). For seismic tsunamis, these uncertainties typically stem from our limited knowledge of the frequency and plausibility of large earthquakes. For seismic tsunamis on major earthquake source-zones, often the simplest way to do this is to refer to an existing offshore Probabilistic Tsunami Hazard Assessment, such as the 2018 Australian PTHA ("PTHA18"; Davies and Griffin, 2018) or the latest New Zealand PTHA (Power, et al., 2022). These PTHAs include a large set of hypothetical tsunami scenarios and models of their uncertain occurrence rates.

The Australian PTHA18 includes models of the Vanuatu and Solomon trenches, and other sources in the region. It is commonly found that historically observed tsunami waveforms show reasonable agreement with some random scenarios from PTHA18 that have similar earthquake location and magnitude, although the degree of agreement varies. PTHA18 includes models of earthquake frequencies and uncertainties in these frequencies, derived from a Bayesian approach that leverages earthquake catalogues and plate convergence rates. The coupling, maximum magnitude, and Gutenberg-Richter *b* values are treated as uncertain parameters. Maximum magnitudes range from slightly above the largest historical earthquake, up to the magnitude of a "relatively compact" earthquake that fills the source-zone. A minimum coupling of 10% is enforced, and while this is sensibly conservative for most earthquake source-zones in PTHA18, there are a few very large source zones which could plausibly have lower coupling (e.g. the New Guinea Trench) for which the uncertainty could be better represented. Segmented models are given 50% weight on some major source zones, with the segment boundaries following GEM (Berryman et al., 2015). Unsegmented models are also used.

While acknowledging that this meeting was taking a deterministic, expert based approach, the group agreed it would be desirable to conduct a full PTHA for the Study Region, but such an undertaking was outside the scope of the workshop. However, the published work for both the Australian (Davies and Griffin, 2018) and New Zealand (Power, et al., 2022) PTHAs would be a good starting point for such a study because they have identified and characterised most of the probable earthquake sources in the region. Further, the group resolved to include such a study in the final recommendations. It is noted here that New Caledonia developed a database made of thousands tsunami scenarios (Duphil et al., 2021) which could be used to initiate a regional PTHA.

5. WORKSHOP OUTCOMES

The outcomes of the meeting are presented in this section. The meeting concentrated on earthquake subduction zones sources, but non-subduction zone earthquakes and non-earthquake sources were also discussed. The length of the meeting, internet connection and travel issues limited what could be achieved, but it is considered this report contains a reasonable summary of the state of knowledge of the tsunami sources in the Study Region.

5.1 EARTHQUAKE SOURCES

Most of the time at the workshop was devoted to discussing and agreeing on the major earthquake tsunami sources in the region. Earthquake sources were considered the most likely to cause widespread damaging tsunamis, but these sources included the classic megathrust events as well as backarc and outer rise earthquakes.

5.1.1 Subduction Zone Sources

Subduction zone earthquakes include those on the subduction interface as well as outer rise events, although in most cases it is the subduction thrust events which are the most significant earthquake sources. Following GEM (Berryman et al., 2015), the meeting agreed that for any region the minimum Mw(max) would be based on the largest historical event (or recent) earthquake in the region, but there was considerable debate on what the maximum Mw(max) should be. There was general agreement that using the tectonics, geometry and full dimensions of a region was likely to overestimate the maximum possible earthquake size. After much discussion it was decided to base M_{max}(Max) on the results of PTHA18 (Davies and Griffin, 2018). During the discussion, paleotsunami, seismic and geodetic constraints were considered, although it was agreed that in most cases there was insufficient paleotsunami information. Although geodesy provides some constraint via plate and microplate rates, more data are required, especially for assessing slip deficit distributions. In many cases it was also agreed that the earthquake catalogue for the Study Region was too short to provide high levels of confidence that the largest possible earthquake had already occurred. In fact this is unlikely to be the case.

5.1.1.1 Tsunami Earthquakes

One of the objectives of the workshop was to identify any tsunami earthquakes. Tsunami earthquakes are shallow megathrust events that have low rupture velocity, low moment-scaled radiated energy, long source duration, depleted short-period seismic wave energy and large tsunami excitation due to large slip in low rigidity environment. Only one earthquake was identified as a potential tsunami earthquake, an event just to the southeast of the 2007 Solomon Islands earthquake. This earthquake occurred on 3 January 2010 and was of M_w 7.1 and ruptured almost to the trench, producing a 7 m tsunami, which is much higher than expected for the earthquake magnitude (Newman et al., 2011). As stated earlier in this document, although the 2007 and 2013 earthquakes had somewhat depleted high frequency spectra, and moment-scaled radiated energy for both events is at the lower end of the values for typical megathrust ruptures, the values are still above those for tsunami earthquakes, and the events are therefore not classified as such. Therefore, apart from that one possible example, there are no well documented major tsunami earthquakes elsewhere in the Study Region.

5.1.1.2 Subduction Zone Segmentation

During the workshop detailed discussions on possible segmentation of the subduction zones in the Study Region were held. Much of the discussion related to modifications to the GEM model for the region (Berryman, et al., 2015). Alternative models were discussed, but were in general agreement with the GEM model, although it was pointed out that the segments in the GEM model represented changes in structure and properties of the subduction systems, rather than an interpretation of possible rupture segments. The outcome was the suggestion that some "hard" segment boundaries exist, but there was no good argument that ruptures could not propagate through other segment boundaries which were referred to as "soft" boundaries. The meeting agreed by consensus on the segments presented in Figure 11, which are very similar to those in the GEM model. This includes the New Britain subduction system as a segment with hard boundaries, with further "hard" boundaries resulting from the strike-slip region in the south-east of the Solomons system and as a south-eastern boundary of the Vanuatu Trench system where there is a transition to strike-slip at the eastern end of the Matthew-Hunter Trench. Again, these are similar to those adopted by GEM. It was also agreed that best practice would be to run several models with a range of appropriate earthquake sizes along the subduction systems, rather than restricting ruptures to given segments, particularly to allow for possible rupture through soft boundaries.

There was a general consensus that the M_{max}(max) values in the GEM report were on the high side. A suggestion for addressing this was to use 90% of the posterior M_{max} distribution from the Australian PTHA on the geometry. This does not have a big impact for most segments but does reduce the maximum values for whole-zone ruptures (Table 2). The meeting also revised the values for M_{max}(min) based on earthquakes which have occurred since the GEM model was published (see Table 2).

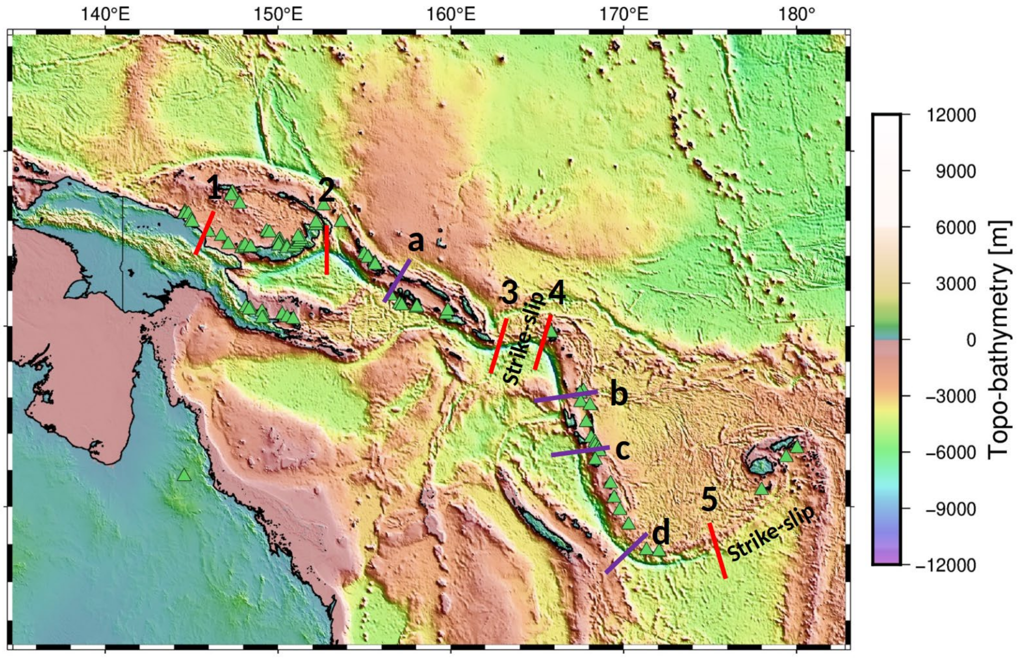


Figure 11. *Segmentation of the subduction systems in the Study Region as agreed by the workshop experts. Red lines mark the “hard” boundaries and Purple lines represent the “soft” boundaries. Whereas it was considered that ruptures were very unlikely to breach the “hard” boundaries, rupture through the “soft” boundaries was considered possible. The green triangles show locations of active volcanoes (Global Volcanism Catalogue, 2024).*

SUBDUCTION ZONE	SEGMENT	M_{max}(min) GEM	M_{max}(min) WORKSHOP	M_{max}(max) GEM	M_{max}(max) WORKSHOP
Solomons	**Whole margin**	8.10	8.1+/-0.15 (2007)	9.306	9.2
Solomon	Northwest	8.10	8.1+/-0.15 (2007)	8.620	8.8
Solomon	Southeast	8.10	8.1+/-0.15 (2007)	9.094	9.1
Vanuatu	**Whole margin**	8.30	8.1+/-0.3 (1875/1920)	9.366	9.1
Vanuatu	North	7.60	8.0+/-0.15 (2013)	8.444	8.7
Vanuatu	Central	8.30	7.5+/-0.15 (1973)	8.696	8.9
Vanuatu	South	7.60	8.1+/-0.3 (1875/1920)	8.639	8.8
Vanuatu	Matthew-Hunter	8.00	7.7+/-0.15 (2021)	8.387	8.6
New Britain		8.00	8.0+/-0.15(1971)	8.818	9.1
New Guinea Trench	**Whole margin**	8.20	8.2+/-0.15(1996)	9.369	-
New Guinea Trench	East	7.60	7.6+/-0.15 (2002)	8.900	-
New Guinea Trench	West	8.20	8.2+/-0.15(1996)	9.029	-
Manus Trench	**Whole margin**	7.50	7.3+/-0.3 (1944)	9.501	-
Manus Trench	East	7.50	7.3+/-0.3 (1944)	9.067	8.3
Manus Trench	West	7.50	6.3+/-0.15(2017)	9.129	8.3

Table 2. *Workshop Outcome Versus GEM. This table shows the values of* M_{max}*(min) and* M_{max}*(max) from the GEM study and this workshop. The major differences are the* M_{max}*(min) from the workshop have been*

updated using the largest known earthquake on the segments and the M_{max}(max) values are from the Australian PTHA study as explained in the text (where available). The years in brackets identify the earthquakes used for M_{max}(min). A fuller list of source parameters is contained in Annex I. The stated error bars for M_{max}(min) relate to the assumed error in the magnitude determination, with older data having larger uncertainty.

For the New Guinea and Manus trench regions the meeting agreed on revisions of M_{max}(min) but there was general consensus that the M_{max}(max) values based on geometry were too high. However, there was no consensus on how to reduce these in any logical way. It was noted that the plate rates at the Manus trench are low but the GEM M_{max}(max) values are over M9, which by the consensus of the meeting was considered much too high.

5.1.2 Non-Subduction Earthquake Sources

The potential of the region surrounding the Mw 7.5 26 November 1999 Ambrym earthquake (Figure 12), a back-arc intraplate thrust event (Regnier et al., 2003) located east of Ambrym, Pentecost and Maewo Islands, central Vanuatu, in the so-called back-arc thrust belt (BATB) was discussed at the workshop.

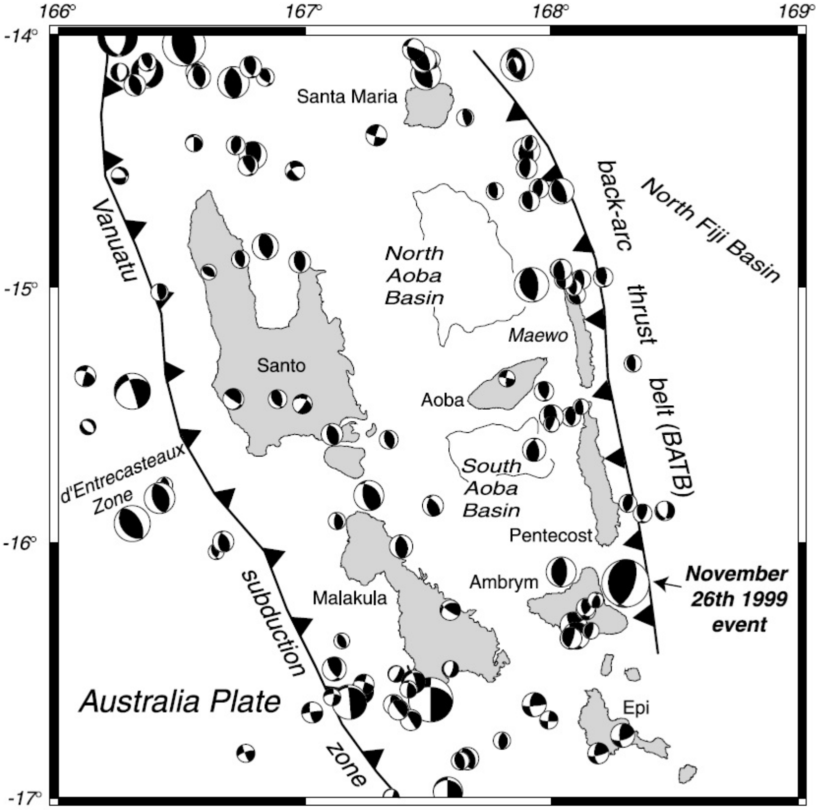


Figure 12. *Location of the M 7.5 1999 Ambrym earthquake (from Lagabrielle et al. 2003). This was a thrust faulting back-arc event occurring on the BATB which caused a tsunami with a run-up as high as 8 m on Ambrym. The meeting considered that the BATB region may be capable of an even larger earthquake.*

The meeting agreed that an estimate of the maximum credible earthquake in that region be made, with the possible dimensions being 200 km by 20 km dipping at 25 deg. Taking the 1999 earthquake (Mw 7.5) as the M_{max}(max) value, the potential maximum rupture suggests a maximum credible earthquake M_{max}(max) of around Mw 8, depending on the scaling relationship employed, following the GEM terminology.

Only limited discussion of strike-slip regions on the margins of some of the microplates and along the eastern portion of the Solomon Islands (Figure 6a) and east of the Matthew-Hunter trench (Figure 6b) was conducted. Search of the USGS/NEIC and Global Centroid Moment Tensor (GCMT) catalogues was performed for the two primary plate boundary regions. For the region from 162° E to 165°E and 13°S to 9°S (from South Solomon Islands to Santa Cruz Islands), 3 events with Mw ≥ 7.0 are listed by NEIC since 1900 (Mw 7.3 in 1914, Mw 7.1 in 1993, Mw 7.6 in 2014). The 1993 and 2014 events have strike-slip focal mechanisms (non-vertical plane in 1993). The GCMT catalogue back to 1976 adds 1 Mw 7.0 event in 2015 with strike-slip. So, the largest observed strike-slip event in this segment is 7.6 (2014), and there is no documentation of tsunami generation. For the region from 173°E to 179°E and 24°S to 19°S (spanning the region of the Matthew-Hunter zone east of the 2021 thrust event, since 1900 there are 2 Mw ≥ 7.0 events since 19900 (Mw 7.6 in 1990 and Mw 7.2 in 2016, both with strike-slip mechanisms. The GCMT catalogue back to 1976 adds 1 Mw 7.1 event in 2000 with strike-slip mechanism. Again, there is no documentation of the tsunami for these events. The panel infers that strike-slip events as large as Mw 7.6 that occur in these regions are not of great concern for tsunami relative to the megathrust and outer rise events of similar size that occur in the subduction zone segments.

5.2 NON-SEISMIC SOURCES

Three types of non-earthquake tsunami sources were discussed at the workshop - those caused by volcanoes, landslides and meteotsunamis. There is an interrelationship between the first two causes because many of the potential landslide sources in the Study Region may involve landslides related to volcanoes. The third source type is being studied around the world, but is still not studied in the Study Region.

5.2.1 Potential Volcanic Sources

The meeting discussed possible volcanic tsunami sources in the region. Following recent events in Indonesia (in Palu, 2018) and Tonga (Hunga Tonga-Hunga Ha'apai -HTHH- volcano, 2022), the community is placing more focus on these rare but damaging events (e.g., Schindelé et al., 2024). Several recent studies have attempted to quantify the hazard and start to decide how such events can be detected and responded to by tsunami warning centres. The IOC TOWS WG formed a task team, which recently published a report (UNESCO/IOC, 2024) and a resulting paper (Schindelé et al., 2024). Although the meeting did not discuss volcano sources in great detail, it was decided to include a list of possible and potential volcano sources taken from the recently published IOC report (UNESCO/IOC, 2024), but there may be additional volcano sources not listed in the report, especially underwater volcanoes which can be easily missed if (1) there is a lack of bathymetric data, (2) not erupting often, (3) located far from the coasts (and from potential observers) . The meeting heard about research going on in New Zealand to devise methods of quickly detecting and characterising volcano generated tsunamis (Gusman & Wang, 2024). Following the 2022 HTHH eruption and tsunami a group of PTWS experts devised a means and operational procedures using the signals on the New Zealand tsunameter (DART) network (Power et al., 2018) to identify and warn for similar events in the future (UNESCO/IOC, 2022).

Tsunamis triggered by or associated with a handful of volcanic eruptions have been reported in the Study Region. Last example to date, in January 2023, the Epi Volcano eruption was followed by a small tsunami recorded on Port Vila and Luganville coastal gauges (Roger et al., 2023). According to the authors, although the maximum tsunami amplitude recorded on these gauges was very small (~5 cm) at these two distant locations (~125 and ~175 km), numerical simulations producing results close to reality indicate that the waves may have been much larger locally (1m and above close to the source). Other eruptions could have triggered tsunamis, but without much certainty: the Kuwae eruption around 1450 AD discussed in Ballard et al. (2023) may have been able to also trigger a tsunami with the same characteristics of the HTHH one (possibly more powerful).

In Savo Island, Solomon, the Toghavitu eruption is associated with tsunamis and earthquakes according to Petterson et al. (2003) but without providing more details. Finally, a few events are listed in Paris et al. (2014) concerning the Bismarck Sea in Papua New Guinea, including: in 1937 and 1994 with pyroclastic flows/explosions in Rabaul and a tsunami showing several meters run-up; and in 1660 (+- 20 years), pyroclastic flows (?) in Long Island (Papua) followed by a tsunami killing people.

As listed in Table 3, the possible sources in the Study Region are either subaerial or submarine landslides, or pyroclastic flows. This demonstrates the close linkage between landslide and volcano tsunami sources.

NAME	**COUNTRY**	**REGION**	**TYPE**	**DISTANCE TO COAST (km)**	**LAST ERUPTION**
Dakataua	PAPUA - NEW GUINEA	NEW BRITAIN	B	5.5	1895
Rabaul	PAPUA - NEW GUINEA	NEW BRITAIN	B	0.6	2014
Tuluman	PAPUA - NEW GUINEA	NEW BRITAIN	C	0	1957
Ulawun	PAPUA - NEW GUINEA	NEW BRITAIN	A	10.5	2022
Tinakula	SOLOMON ISLANDS	EAST SOLOMON	A	1.1	2020
Kavachi	SOLOMON ISLANDS	WEST SOLOMON	C	0	2021
Savo	SOLOMON ISLANDS	WEST SOLOMON	A	2.3	1847?
East Epi	VANUATU	VANUATU	C	0	2023
Eastern Gemin	VANUATU	VANUATU	C	0	1996
Kuwae	VANUATU	VANUATU	C	0	1974
Lopevi	VANUATU	VANUATU	A	2.2	2007
Yasur	VANUATU	VANUATU	B	2.2	2020

Table 3. *A list of volcanoes in the Study Region with the potential to cause tsunamis from Schindelé, et al., (2024). Type A are subaerial landslides; Type B are submarine landslides; Type C are pyroclastic flows.*

5.2.2 Potential Landslide Sources

The possibility of landslide induced tsunamis was discussed and it was agreed that this needs a paragraph of potential landslide sources and their ability to trigger tsunamis.

The 1888 Ritter Island Volcano flank collapse is known to have triggered a devastating tsunami ten of metres high on neighbouring coasts (Ward and Day, 2003). This event, located on Figure

13 provides the only documented tsunami associated with a landslide in the whole region of the study. According to the authors, 5 km^3 of material have been mobilised to produce a tsunami observed in several locations in the region, which was reported in coeval documents, bringing information about wave periods, amplitude, and run-up distance and altitude. In Matupi and Rabaul, flow depth of ~12-15 m has been reported, circa 500 km NE of the source (Figure 13).

It has been suggested that the Mw 7.5 1999 Ambrym earthquake in the backarc region of the Vanuatu subduction system could have involved landslide activity, but a study by Ioualalen et al. (2006) was inconclusive and the observed tsunami may be explained by the earthquake source.

The Papua New Guinea tsunami of 17 July 1998 near 3°S, 142°E (close to where the Manus trench intersects the New Guinea trench, see Figure 4) claimed over 2200 lives and has been interpreted as being generated by offshore faulting in an Mw ~ 7.1 earthquake (e.g., Kikuchi et al., 1999; Tanioka, 1999; Geist, 2000), but also has been associated with contribution from a triggered submarine mass failure (e.g., Geist, 2000; Tappin et al., 2008). The event involved a 10-15 m high tsunami that devastated the coast around Sissano Lagoon. The event does not have seismic characteristics of a tsunami earthquake (slow rupture or low moment-scaled radiated energy). Five offshore surveys detected an ~40-km-long fault scarp and collapse features within a ~10-km wide bathymetric amphitheatre slump features that are a likely source of the largest waves in the local tsunami (Tappin et al., 1999; 2001; 2008). This is best-documented recent submarine mass failure associated with a known tsunami in the Study Region.

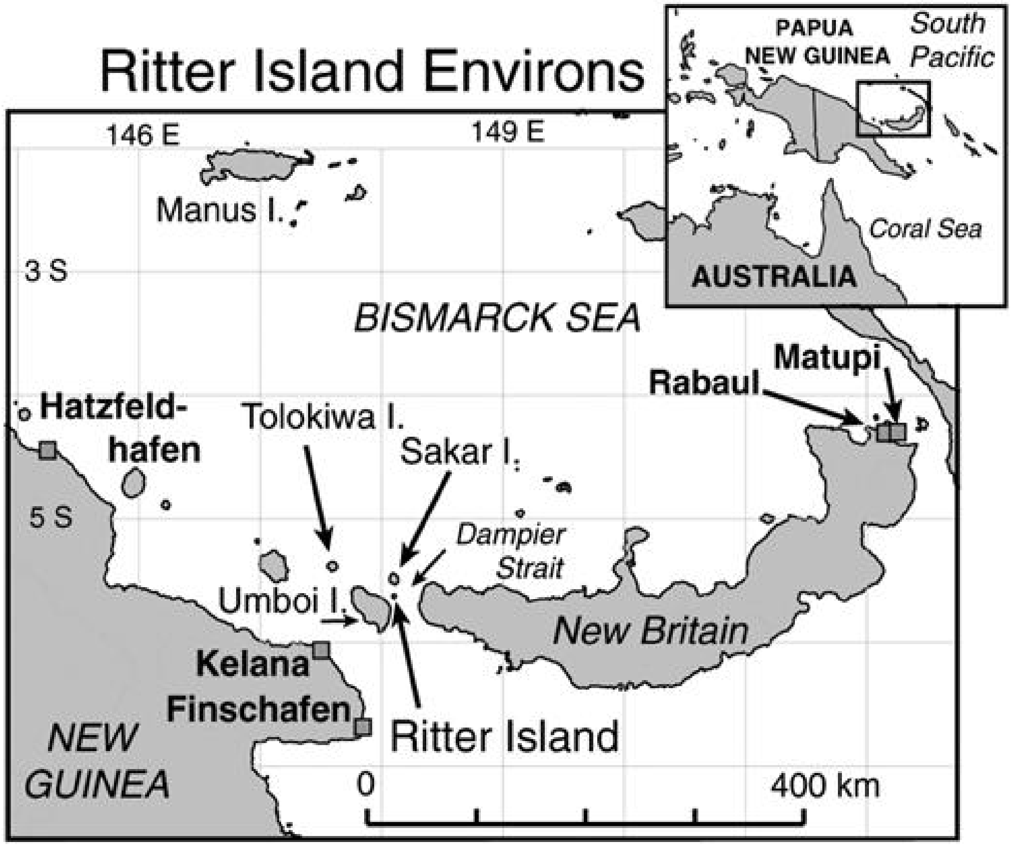


Figure 13. Location of the Ritter Island Volcano collapse on the southern edge of the Bismarck Sea on 13 March 1888 (Ward and Day, 2003).

In addition to these ones, submarine scars of landslides have also been identified in a few places and may have been able to generate devastating tsunamis when they occur. They include notably the numerous landslide scars and mass-transport deposits (MTDs) mapped in the Bismarck Sea by Silver et al. (2009) and for which the authors have built some scenarios which could be used for simulating tsunami propagation and inundation. Alternatively, they tentatively proposed some tsunami run-up values at some key locations using a relationship law between the landslide main parameters and the tsunami amplitude. Another case is the Lansdowne Bank (West of New Caledonia) scars and related MTDs from Etienne et al. (2021) who proposed preliminary simulations of tsunamis and their impact on New Caledonia. Another study was led off the east coast of Tanna in 2018 showing a large tilted, block underwater (Clare et al., 2018). However, no evidence of tsunami was linked to this landslide.

5.2.3 Other Potential Sources

Meteotsunamis were briefly discussed. Unlike tsunamis triggered by seismic activity or some other methods of directly displacing water (volcanic eruptions and landslides), meteotsunamis are driven by air-pressure disturbances often associated with fast-moving weather events (IOC, 2023). The report of the IOC/UNESCO TOWS-WG Ad-hoc Team on Meteotsunami (IOC, 2023) did not contain any mention of sources in the Study Region. To date, the only event which has been compared to a meteotsunami and recorded in the region is the atmospheric-driven disturbance triggered by the HTHH volcano eruption in 2022 which was recorded by local coastal gauges (e.g., Gusman et al., 2022b). Note that this region hosts several underwater volcanoes and probably unknown ones to discover. These volcanoes may have the potential to trigger HTHH-like eruption and associated meteotsunami.

5.3 ANALYSIS OF TSUNAMIGENIC EARTHQUAKE SOURCES

5.3.1 Tsunamigenic Earthquake Sources

While the workshop participants agreed on the possibility of large tsunamigenic earthquakes along any of the considered subduction zones (with the exception of Manus), there was no consensus on just how large a future event might be for any particular region. It was agreed that for the minimum values of M_{max} put forth in the GEM that have been exceeded by an actual (more recent) event, this event magnitude would be used for M_{max} minimum, and that for the maximum value of M_{max} the frequency/magnitude model from Davies and Griffin, 2018 would be used unless it exceeded the previous recommended value. There was much discussion on the possibility that some segment boundaries suggested by the GEM may have been too restrictive, and the idea of a “soft” segment boundary was adopted in which a rupture may in some cases cross the boundary. Scenarios in this section are posed as plausible examples of possible events though the experts had diverse opinions as to how large future earthquakes might be, and whether future earthquakes would follow rupture length-magnitude relationships based on past studies.

Segment	M	Strasser, et al		Wells & Coppersmith		Suggested	
		Length	Width [km]	Length	Width [km]	Length	Width [km]
Solomon Northwest	8.8	468.8	161.0	483.1	99.5	400	100
Solomon Southeast	9.1	702.3	205.2	721.1	132.1	700	100
Vanuatu North	8.7	409.7	148.5	422.7	90.6	400	100
Vanuatu Central	8.9	536.4	175.5	552.1	109.4	500	100
Vanuatu South	8.8	468.8	161.0	483.1	99.5	500	100
Vanuatu Matthew-Hunter	8.6	358.1	137.0	369.8	82.4	300	100
New Britain	9.1	702.3	205.2	721.1	132.1	600	100
Manus Trench East	8.3	239.1	107.5	247.7	62.1	200	100
Manus Trench West	8.3	239.1	107.5	247.7	62.1	200	100

Table 4. *Rupture length and width estimates based on maximum Mmax magnitudes based on scaling relationships from Strasser, et al (2010) and Wells and Coppersmith (1994)*

While ad-hoc upper bounds have been set on Mmax in previous regional studies of tsunami sources, one participant pointed out that in the case of the regions which produced the two largest events of our generation, Sumatra (Indonesia) and Tohoku (Japan), the events of the last 10 years were far larger than those represented by regional events of the previous 100 years, illustrating the problem with setting a limit on the maximum M_{max} value based solely on the historical record. Though there was no broad consensus on maximum M_{max}, it was agreed that we would take guidance from the 90th percentile value from the Davies and Griffin (2018) PTHA posterior M_{max} distribution for a given segment. In general, these values are not larger than those provided by Berryman et al., (2015). In Table 4, we use the M_{max} value from this study and compare length and width values using two different scaling studies (Strasser et al 2010, Wells & Coppersmith 1994). While the PTHA models that cover this region have ruptures that are distributed across segment boundaries, and the experts agree on several segment boundaries that may be crossed, the suggested tsunami sources in this report do not cross the most pronounced boundaries in the region: New Britain-to-Solomons and Solomons-to-Vanuatu. Given the 2007 Solomon Islands underthrust event, we recommend taking the sources recommended here as a minimum and invite users to include sources that cross the segment boundaries.

There is some suggestion that uniform-slip tsunami sources can underestimate tsunami wave heights (Geist 2002, Davies and Griffin 2018). The sources suggested in this report take fault parameters other than slip and area from the NOAA Pacific Marine Environmental Lab (PMEL) database of tsunami unit sources (Gica et al, 2008) with the limitation that fault sizes are limited by the 100x50 km database faults. As a way to mitigate the possible underestimate of wave heights with uniform-slip sources, the suggested rupture lengths and widths are rounded down from Strasser, et al (2010) to form a compact source, and slip is derived from the magnitude assuming a rigidity of 40 GPa. For the nine segments, six multi-fault scenarios are identified for the New Britain, Solomon Northwest, Solomon Southeast and Vanuatu segments, one multi-fault source and one single-fault source are identified along the Vanuatu Matthew-Hunter, and four single-fault sources are identified along each of the Manus segments (Figure 14).

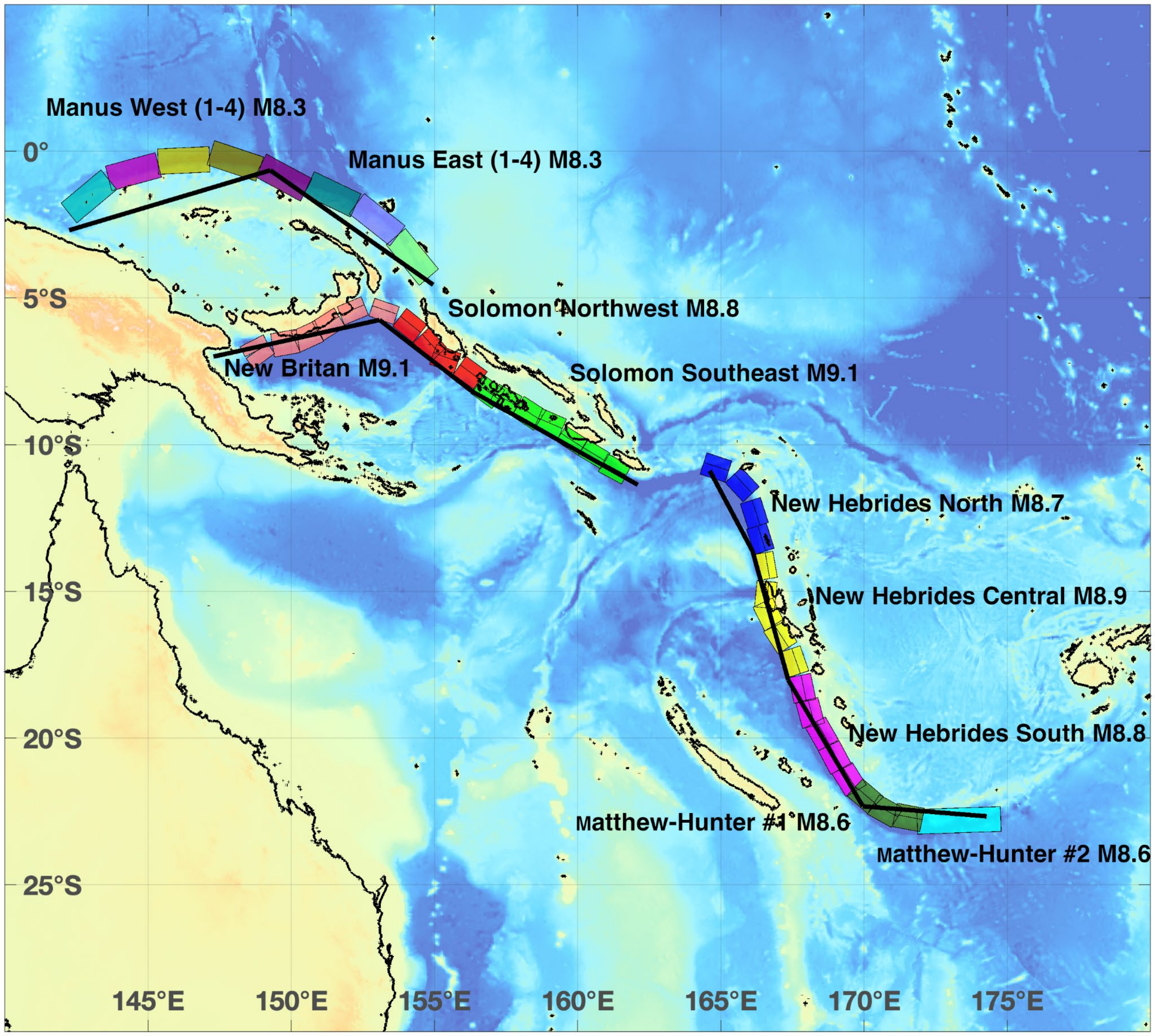


Figure 14. *Tsunami source scenarios based on maximum M_{max} estimates for each segment. Note that the Manus East and Manus West suggestions move the 200-km fault along the segment, with four possible positions shown. Black lines are segment boundaries as identified in the GEM.*

Based on suggested rupture lengths and magnitudes, the estimated slip amount for each segment was calculated by use of the following formulas:

$$M_w = \frac{2}{3} log_{10}(M_O) - 10.7$$

with

$$M_O = \mu \underline{u} S$$

Where μ is the estimated shear modulus of the Earth's crust (4.0 x 10^{10} N/m^2), $\underline{u}$ is the homogeneous slip amount (in *m*) and S is the surface area of the rupture in m^2. The remaining fault parameters dip, strike, rake and depth were taken from the PMEL propagation database. The complete fault plane parameters for all tsunami sources are described in the Annex I.

5.3.2 Tsunami Simulation Model

We simulate the tsunami examples in the next section, just to give the user a reader impact of the local and regional impact using possible sources inferred from the guidance in this report. The sources used, outlined in detail in Annex I, are modelled using the MOST model (Titov 2009; Titov et al. 2016): an established tsunami model that has been widely tested and evaluated and is in use operationally for forecasting at the NOAA Tsunami Warning Centers, and benchmarked and compared to other tsunami models in use by the National Tsunami Hazard Mitigation Program (NTHMP, 2012). The model uses the source parameters listed in Annex I, and is run for 24 hours of simulation time with a 10-second time-step on a 4-arcminute pacific basin bathymetry grid based on the GEBCO dataset.

5.3.3 Tsunami Examples

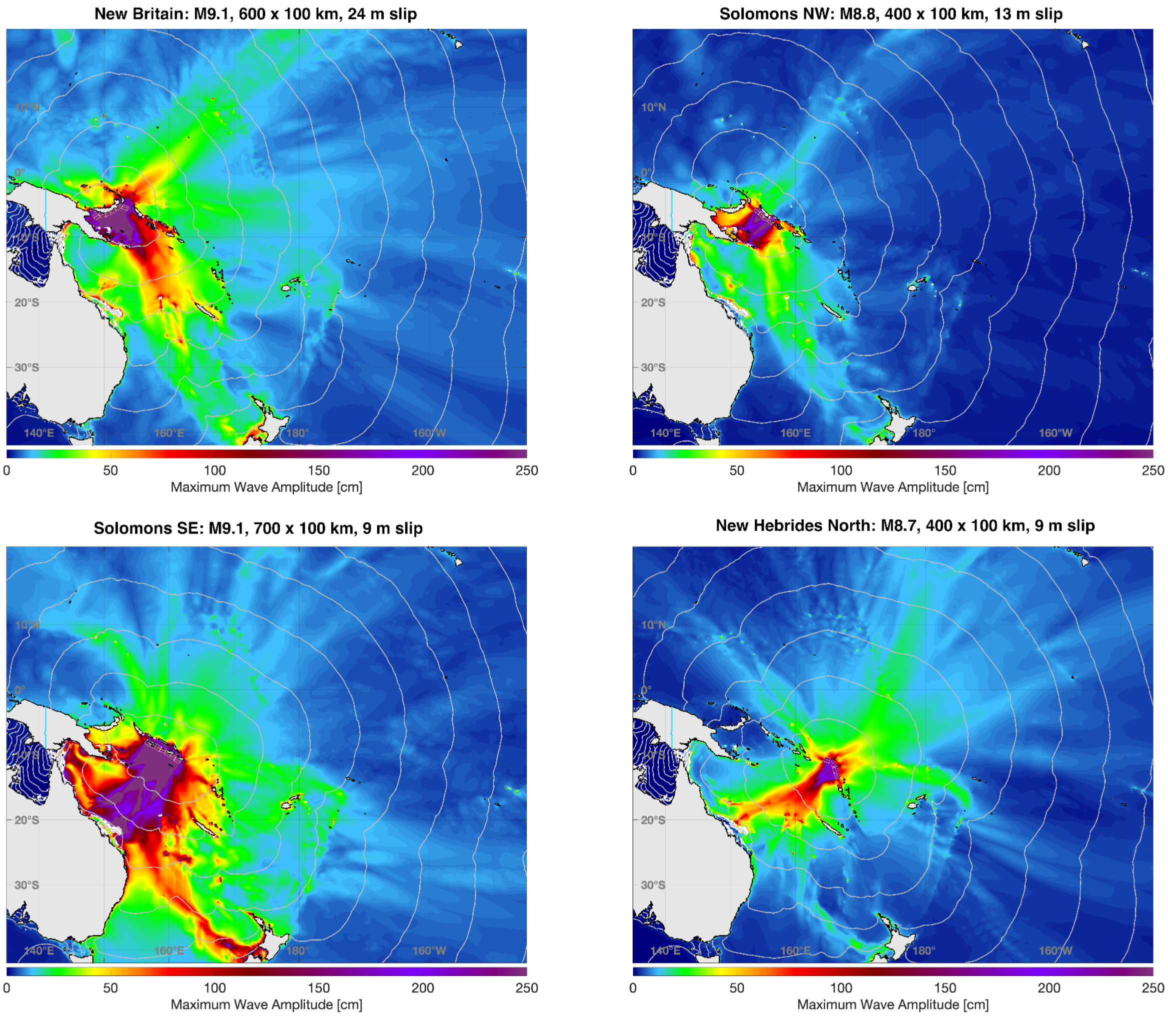
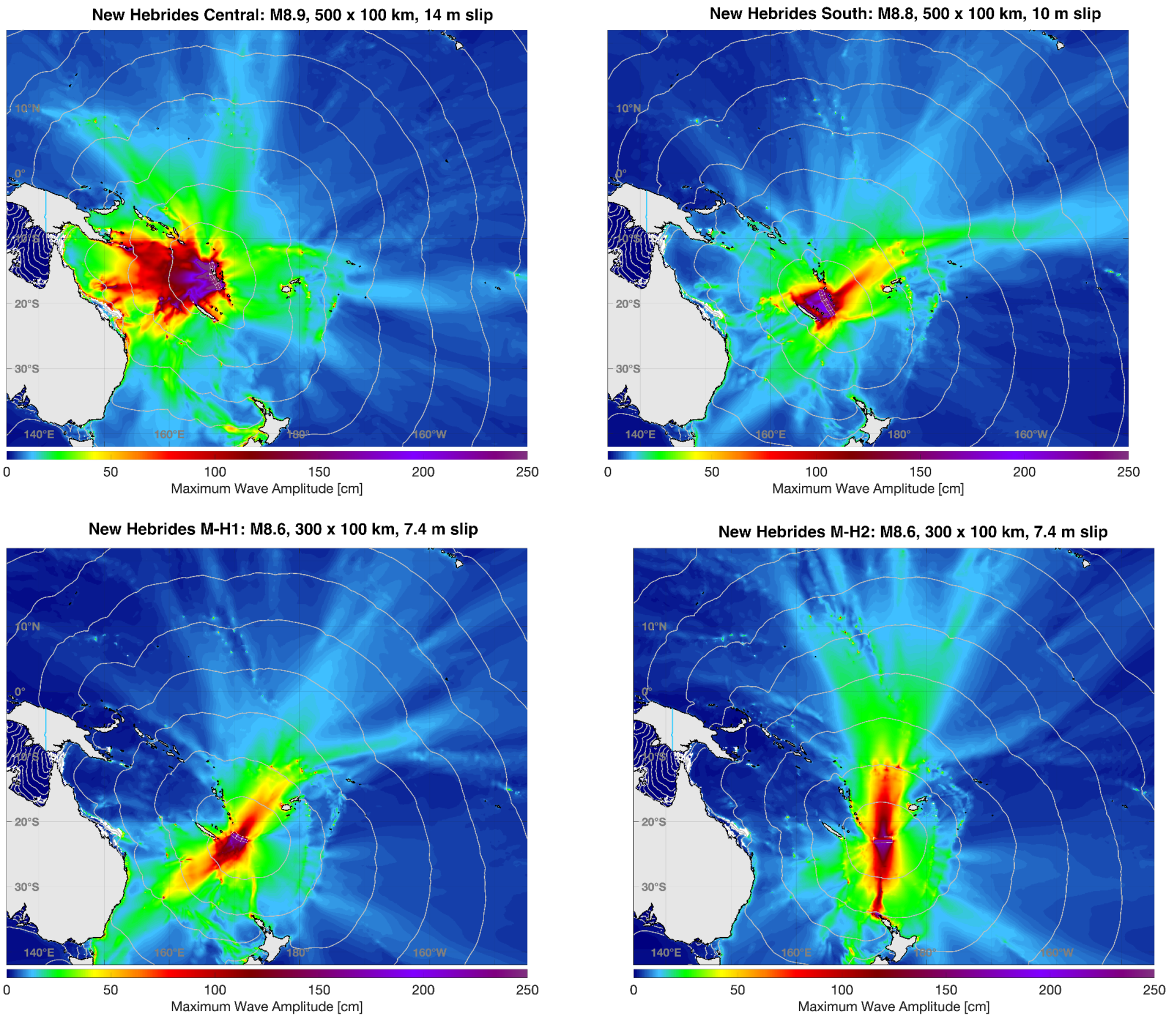


Figure 15. *Maximum tsunami wave amplitude and hourly arrival time contours generated by the New Britain M9.1 segment (upper left), the Solomon Islands Northwest M8.8 segment (upper right), the Solomon Islands Southeast M9.1 segment (lower left), and the Vanuatu North M8.7 segment (lower right).*

Figures 15, 16, 17 and 18 show the different impact of maximum tsunami wave height offshore for the different source scenarios. The tsunami energy is directed perpendicular to the dominant strike direction as expected, but the New Britain and Solomon Islands Northwest segments (Figure 15) tend to have much of the energy contained regionally as the position of the islands opposite the segment tends to trap waves, while the Solomon Islands Southeast event impacts NE Australia and reflects to send large amplitude waves as far away as New Zealand.



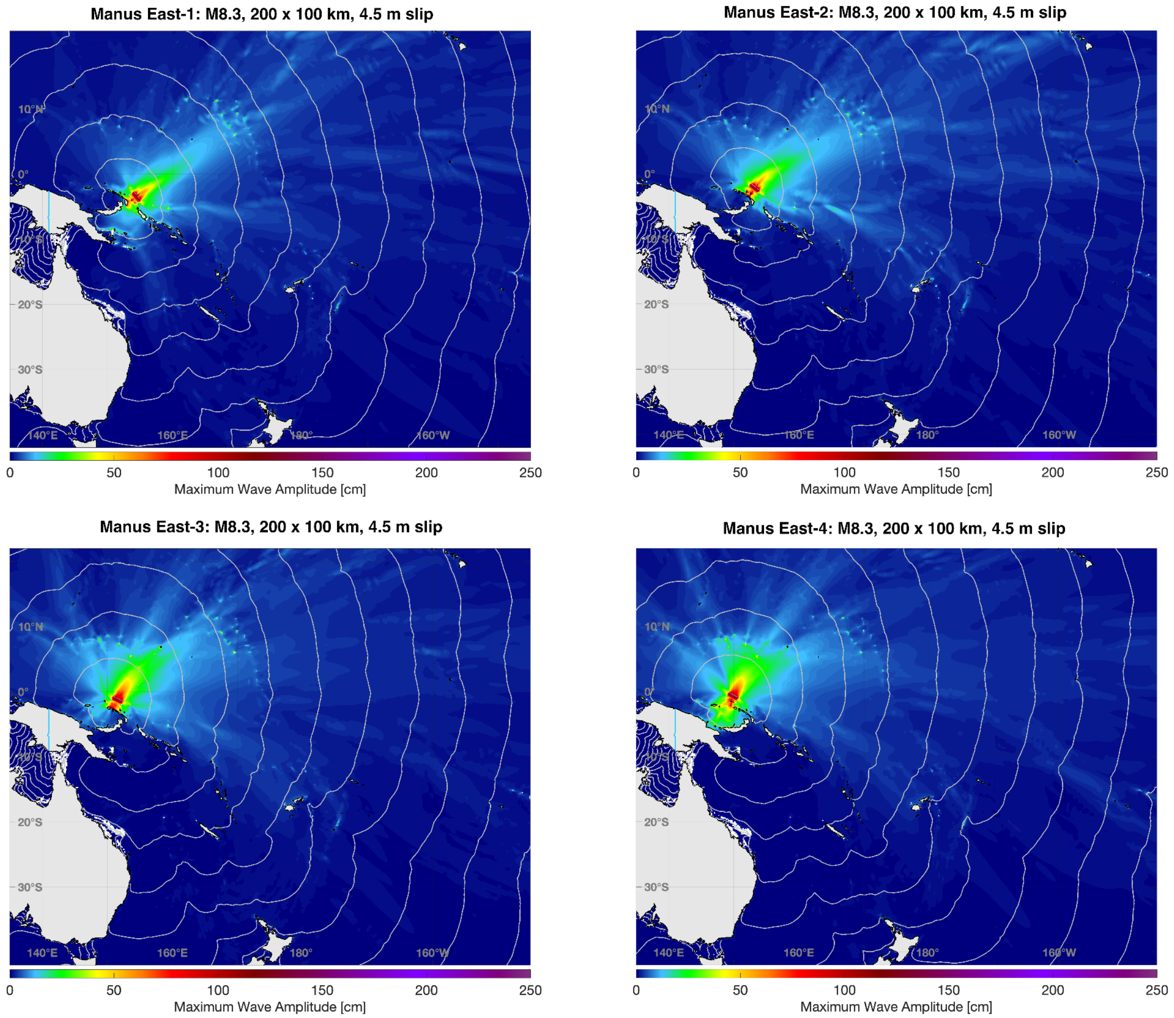
New Hebrides Central: M8.9, 500 x 100 km, 14 m slip

New Hebrides South: M8.8, 500 x 100 km, 10 m slip

New Hebrides M-H1: M8.6, 300 x 100 km, 7.4 m slip

New Hebrides M-H2: M8.6, 300 x 100 km, 7.4 m slip

Figure 16. *Maximum tsunami wave amplitude and hourly arrival time contours generated by the Vanuatu Central M8.9 segment (upper left), the Vanuatu South M8.8 segment (upper right), the Vanuatu Matthew-Hunter1 M8.6 (lower left), and the Vanuatu Matthew-Hunter2 M8.6 segment (lower right).*



Manus East-1: M8.3, 200 x 100 km, 4.5 m slip

Manus East-2: M8.3, 200 x 100 km, 4.5 m slip

Manus East-3: M8.3, 200 x 100 km, 4.5 m slip

Manus East-4: M8.3, 200 x 100 km, 4.5 m slip

Figure 17. *Maximum tsunami wave amplitude and hourly arrival time contours generated by the Manus East-1 M8.3 segment (upper left), the Manus East-2 M8.3 segment (upper right), the Manus East-3 M8.3 segment (lower left), and the Manus East-4 M8.3 segment (lower right).*

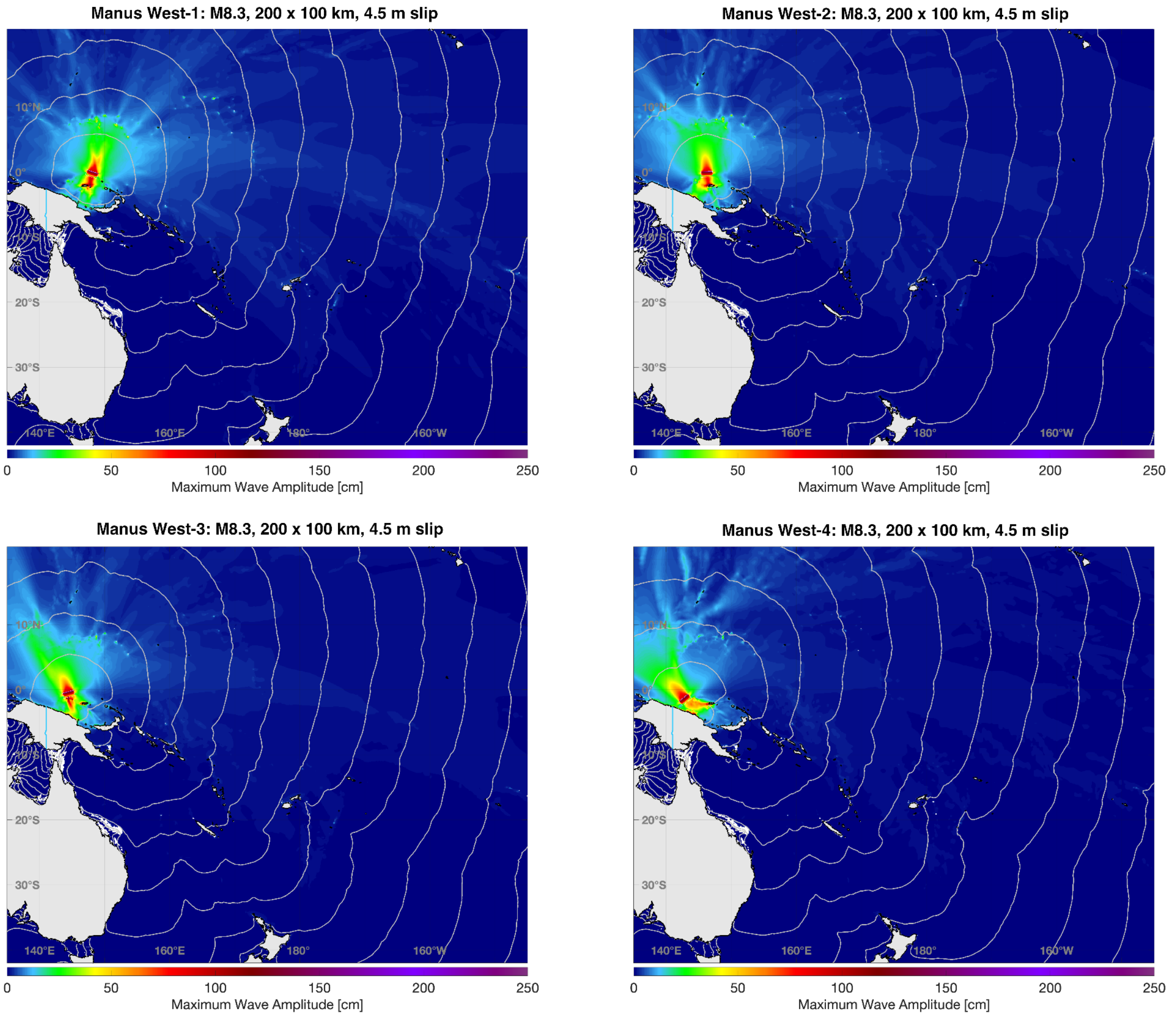


Figure 18. *Maximum tsunami wave amplitude and hourly arrival time contours generated by the Manus West-1 M8.3 segment (upper left), the Manus West-2 M8.3 segment (upper right), the Manus West-3 M8.3 segment (lower left), and the Manus West-4 M8.3 segment (lower right).*

The Vanuatu Matthew-Hunter source 1 uses the PMEL 100-km unit source segments to model the sharp bend, and source 2 uses a single segment with magnitude M8.6 and strike estimated from the Davies, et al (2018) PTHA study, but, as discussed in section 6.2, relatively little is known about the subduction zone in this region. The maximum wave amplitudes plot shown in Figure 16 shows the result of the suggested source, with a large impact basin wide due to the lack of islands or continents nearby allowing tsunami energy to propagate large distances unimpeded.

The Manus segments (Figures 17 and 18) are each quite small as compared to the other segments suggested, and the impact of any of the four fault planes would be largely local, affecting largely the islands of Papua New Guinea. The segments are meant to be moved along the subduction zone when conducting deterministic or scenario-based tsunami hazard assessment studies for a particular location, allowing for maximum impact for any given location.

6. OTHER TOPICS DISCUSSED

During the meeting several other topics were discussed, and these are summarised in this section. These were mainly related to current or planned instrument deployments which have the potential to improve our understanding of the tsunami hazard in the Study Region.

6.1 THE TAM-TAM SMART CABLE PROJECT

An initiative (known as TAM-TAM), mainly funded by the French Government, is planning to install a SMART cable (more details in Howe et al., 2022) between Vanuatu and New Caledonia. The cable will include four nodes, each equipped with a temperature and pressure sensor, a seismometer and an accelerometer. In parallel, two optic fibres will be deployed, fully dedicated to science (see Figure 19 for a provisional path). They will allow access to distributed measures on the seafloor. It is planned that the cable will be operational in 2027. This cable will cross the Vanuatu subduction trench, providing an unprecedented data set that can be used to improve the earthquake and tsunami monitoring and alert systems, by adding instruments on the seafloor close to the subduction. It will also provide valuable data to better understand the regional dynamics of the area, giving more inputs for hazard assessment. Finally, the cable data can be used in a variety of other scientific topics, from seismology to physical oceanography and marine biology.

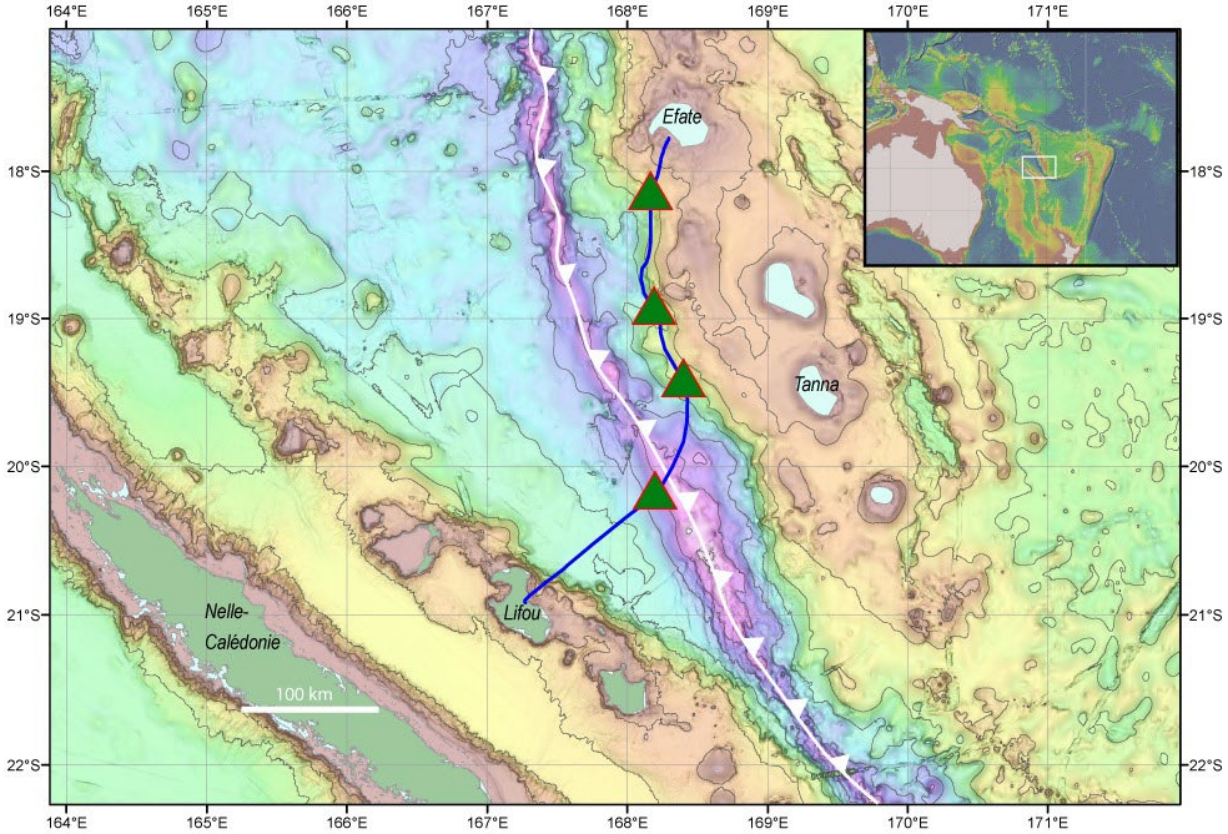


Figure 19. *The preliminary provisional path of the TAM-TAM cable showing the SMART repeater locations (personal communication, M.Patriat).*

6.2 THE MATTHEW-HUNTER GEOPHYSICAL STUDY

As discussed above, the Matthew-Hunter Subduction Zone (MHSZ) is one of the most remote and least studied subduction zones worldwide, resulting in a poor understanding of its earthquake and tsunami hazards. It thus offers a unique opportunity to study a young subduction zone in the process of formation, but also sufficiently advanced to create magmatic products. An ocean bottom seismograph (OBS) and marine geophysics project has been funded by the US National Science Foundation and is tentatively scheduled for deployment in late 2025 or early/mid 2026. This project will deploy an array of 20 passive OBSs for 15 months, as well as carrying out a marine geophysical survey to map bathymetry, gravity, and magnetics. The goals of the survey are to define the slab geometry, seismicity, structure, and mantle flow patterns associated with this developing subduction zone. The seismographs will be deployed in an array designed to image the structure of the forearc, the volcanic Hunter Ridge, and the extensional Monzier Rift. Seismic data will be analysed using Rayleigh wave tomography from ambient noise and earthquakes, body wave tomography, and shear wave splitting. In addition, an extensive multibeam bathymetric, acoustic backscatter imagery, gravity and magnetic survey will be carried out to identify tectonic structures, regions of recent seafloor volcanism, and magnetic isochrons. Geophysical track spacing will be sufficiently dense to fully map the forearc area and carry out three-dimensional geophysical inversions over the same regions as the main seismograph deployment. Marine geophysical surveys conducted during transits between Suva, Fiji and Port Vila, Vanuatu will provide data for previously unsurveyed portions of the trench, and allow study of the transition from subduction in the MHSZ to strike-slip motion along the Hunter fracture zone to the east. Seafloor seismic data collection by the OBS array during 2026-2027 should coincide with initial data collection by the TAM-TAM smart cable, complementing the seafloor instrumentation and DAS data collection along the cable, and allowing assembly of a large regional seismic dataset.

6.3 THE NEW ZEALAND TSUNAMETER NETWORK

Starting in 2019 New Zealand deployed a 12 station tsunameter network aimed at providing tsunami detection and characterization for New Zealand and countries in the South-West Pacific region (Figure 20).

The network was designed to provide data within 20 minutes for New Zealand and 30 minutes for South-West Pacific countries following tsunami initiation (Power, et al., 2023). The stations are fourth generation DARTs designed to be deployed close to trenches, and the network is focused on the Hikurangi, Kermadec, Tonga and Vanuatu subduction systems. Note that two of the sites are within the Study Region. The network has proved very useful for recent earthquake events such as the 2021 Raoul Island Mw 8.1 earthquake (e.g., Romano et al., 2021), the 2021 Matthew Island Mw 7.7 earthquake (Gusman et al., 2022a; Roger et al., 2023; Robert et al., in review 2024), the 2023 Loyalty Islands Mw 7.7 earthquake (Work in progress: Robert et al., in review 2024; Faugere et al., in prep.; Roger et al., in prep.) and for characterising the Hunga Tonga-Hunga Ha’apai volcano induced tsunami of January 2022 (Gusman, et al., 2022b). Other DARTs near the Study Region are operated by Australia (in the Coral Sea) and the US north of the Solomons region.

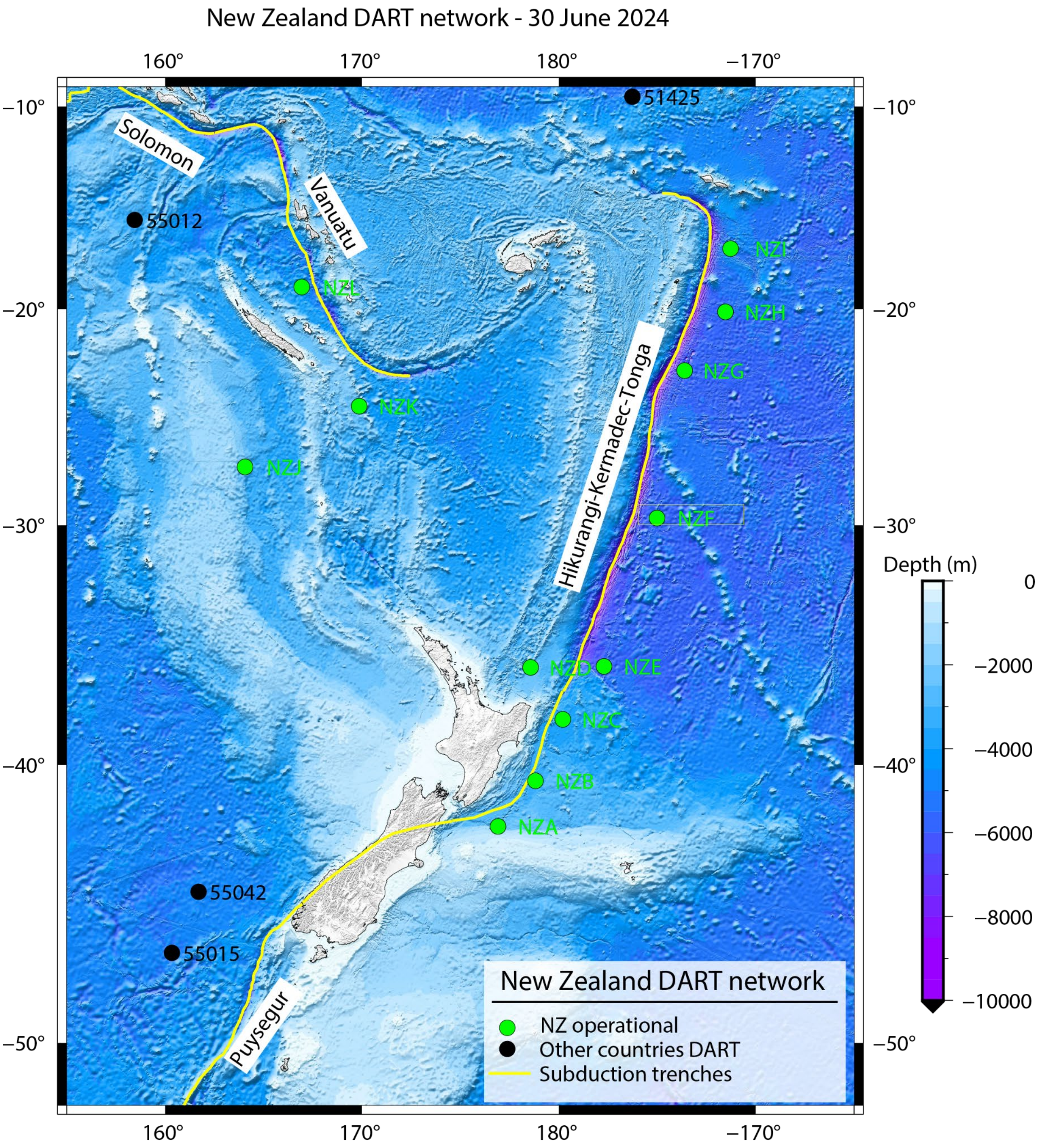


Figure 20. *Map of the locations of the New Zealand DART network stations. The green circles indicate the installed locations of the New Zealand network, with black circles indicating other countries' DARTs. Note the three New Zealand DARTs close to the Study Region.*

6.4 ORSNET

The Oceana Regional Seismic Network (ORSNET) is a shared network of more than 50 seismic stations owned by South Pacific countries (Figure 21). The genesis for ORSNET grew out of regional PTWS WG meetings starting in 2006 and a Task Team on "Seismic Data Sharing in the

South-West Pacific" in 2009 in Vanuatu. The idea of ORSNET as a federation of individual country seismic networks was developed, with data sharing amongst Pacific seismic stations to better understand regional seismic activity and hazard. A collaboration between IRD (Noumea) and the Vanuatu Geohazards Observatory (Vanuatu) since 2010 provided the core ORSNET capability, and many other countries in the region now contribute. The big challenge is to keep the stations running in the harsh tropical environment with frequent cyclones damaging sites. At the time of writing, a number of stations were not reporting data to the ORSNET hub in Noumea. Of the approximately 50 ORSNET stations which makeup ORSNET network, around 20 were functioning well but around 30 have provided no data for a week or more, with some stations being off the air for more than a year.

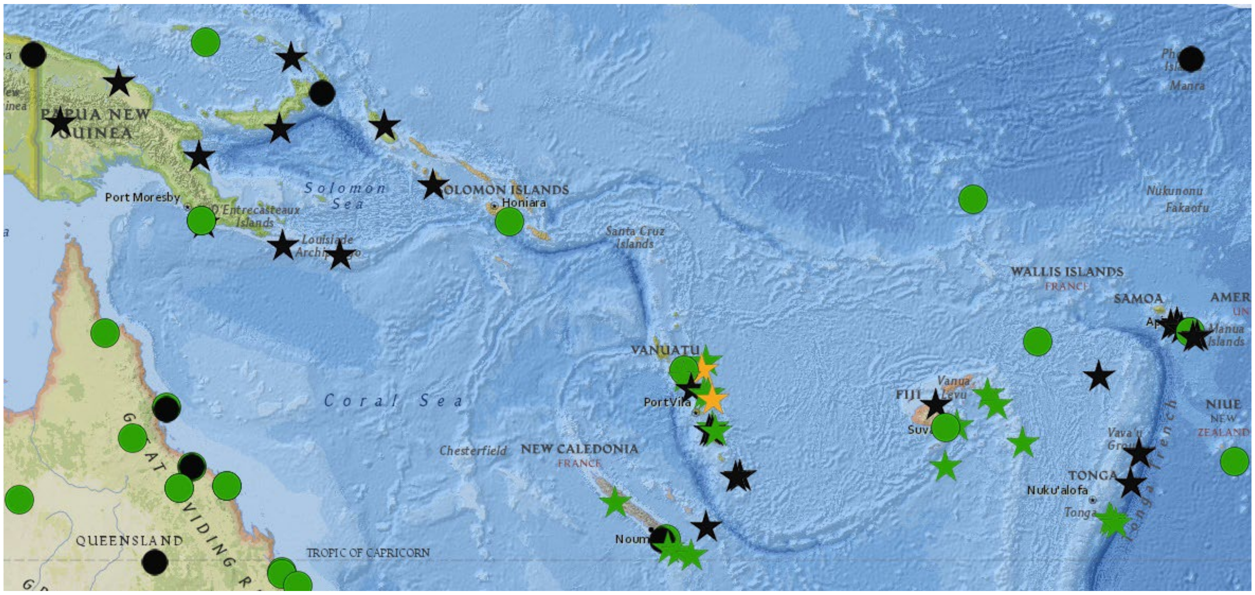


__Figure 21.__ The ORSNET stations (stars) and supporting stations (circles). Green indicates the station is currently operational, black indicates it is not. From the ORSNET website (https://www.orsnet.org/), accessed 11 September 2024..

6.5 OTHER RECENT INITIATIVES

In 2023 the USGS installed a new station (FNUL) on Vanua Levu, the large northern island of Fiji (see http://ds.iris.edu/mda/OI/FNUL/). There are also plans to install one on Tongatapu, Tonga.

6.6 INSTRUMENTATION AND DATA NEEDS

There were some clear messages coming from the workshop on data and instrumentation needs. First, there is a lack of real-time geodetic data for the region. There are a number of campaign geodetic sites, but few have seen repeat observations recently. In a region of rapid plate convergence showing numerous microplates this is a concern. Secondly, paleotsunami data is very sparse in the Study Region, as summarised in Table 1. Finally, there are issues with the sustainability of even the existing seismograph stations in the Study Region, and it is one of the most undersampled areas on the planet, particularly given how tectonically active it is. There is a need for more sea level and seismograph stations, but the sustainability of these new stations and the existing ones need to be urgently addressed.

7. CONCLUSIONS AND RECOMMENDATIONS

The workshop experts presented a comprehensive overview of the complex nature of the plate boundary and related systems in the Study Region, which are summarised in Section 2. The meeting confirmed that the whole Study Region is one of the most active and tectonically complex areas on the planet, with the occurrence of megathrust earthquakes capable of producing very damaging tsunamis. In addition to subduction megathrust sources, there are other faulting, volcanic, and landsliding sources that are also capable of producing at least locally significant tsunamis. The plate margin has high convergence rates almost everywhere. There are several microplates which contribute to the complexity, and the whole area accommodates the overall plate motion (10-11 cm/yr) between the Pacific and Australian plates. The major structures include the New Britain subduction trench, a pronounced feature between the Bismarck Sea and the Solomon Sea, the San Cristobal Trench southwest of the Solomon Islands, and the Vanuatu subduction system between Vanuatu and New Caledonia.

The outcomes of the meeting included an endorsement with some updates of the earthquake sources identified by the 2012 GEM Faulted Earth study of subduction zones worldwide (Berryman et al., 2015). The major differences included updating the lower limit of the maximum credible earthquakes (M_{max}(min)) on various parts of the subduction systems based on more recent earthquakes, and a re-evaluation of the upper limit of maximum credible earthquakes (M_{max}(max)) on the various identified subduction zone segments. The general assessment of the meeting was that the use of full subduction zone segment dimensions only to estimate M_{max}(max) was likely to overestimate the maximum credible earthquakes in the region and ideally a probabilistic approach needs to be taken. As doing a full PTHA was out of the scope for the workshop it was decided to use 90th percentiles of the appropriate values from the Australian PTHA model, where available in the interim, until a more detailed study can be done. In fact, this did not make a major difference to M_{max}(min) for most segments in the region, but it does reduce the values for whole margin ruptures (Table 2).

Some non-subduction zone regions with the potential to produce tsunamis generating earthquakes were identified and characterised using a similar approach to the GEM methodology. The meeting discussed whether to include the source zones to the north of Papua New Guinea in the study, and it was decided to include them but with revised parameters compared to GEM based on known earthquakes. Non-earthquake sources of tsunamis were also considered including a list of volcanic sources capable of causing tsunamis in the region. These were identified from published work, but not characterised in detail. Similarly, an attempt was made to identify potential landslide sources. A significant outcome of the meeting was the production of a list of potential tsunami source scenarios with parameters that can be used for tsunami modelling for preparedness and evacuation planning by Member States.

The meeting endorsed a number of recommendations, most of which related to the need for more data and additional studies to improve the understanding of tsunami hazard in the Study Region:

- There is a need for many more GNSS stations in the longer term (preferably continuous GNSS), and re-measurement of existing campaign geodetic sites in the shorter term. There is a lack of up-to-date geodetic constraints in much of the Study Region.
- There is a need for more paleotsunami investigations and data for the region, and IOC should encourage science organisations to undertake such studies.
- A full probabilistic tsunami hazard study is needed for the Study Region, similar to those produced by Australia and New Zealand.

- There continues to be a need for more sustainable sea-level and seismograph stations in the region. For example, if most of the current ORSNET stations were operational, the coverage would be much enhanced, but currently over half of the instruments in the network are awaiting service. There are also currently not enough coastal gauges able to record localised but large tsunamis triggered by eruptions or landslides.
- There is a continued need for more accurate bathymetry and land topography data in the Study Region to improve tsunami inundation modelling for evacuation zone planning. This would enhance the outcomes of this workshop in terms of better use of the identified tsunami sources. Better bathymetry data (and offshore seismic reflection imaging) would also help to identify and characterise potential tsunami sources.
- The meeting endorsed and encouraged the sharing of data from all geophysical instruments in the Study Region as well as research outcomes from planned studies as they become available to enhance our knowledge of tsunami hazard.
- Finally, the organisers suggest that similar meetings in the future include greater lead time to allow more experts to attend, and that remote attendance only be considered if very good internet connectivity is available at the venue.

8. REFERENCES

Benz, H.M., Herman, Matthew, Tarr, A.C., Furlong, K.P., Hayes, G.P., Villaseñor, Antonio, Dart, R.L., and Rhea, Susan, 2011. Seismicity of the Earth 1900–2010 eastern margin of the Australia plate: U.S. Geological Survey Open-File Report 2010–1083-I, scale 1:8,000,000.

Baillard, C., W. C. Crawford, V. Ballu, M. Régnier, B. Pelletier, and E. Garaebiti, 2015. Seismicity and shallow slab geometry in the central Vanuatu subduction zone, J. Geophys. Res. Solid Earth, 120, 5606–5623, https://doi.org/10.1002/2014JB011853.

Ballard, C., Bedford, S., Cronin, S.J. and Stern, S., 2023. Evidence at source for the mid-fifteenth century eruption of Kuwae, Vanuatu. Journal of Applied Volcanology, 12(1), p.12.

Bergeot, N., M. N. Bouin, M. Diament, B. Pelletier, M. Re´gnier, S. Calmant, and V. Ballu, 2009. Horizontal and vertical interseismic velocity fields in the Vanuatu subduction zone from GPS measurements: Evidence for a central Vanuatu locked zone, J. Geophys. Res., 114, B06405, https://doi.org/10.1029/2007JB005249.

Berryman K., Wallace L., Hayes G., Bird P., Wang K., Basili R., Lay T., Pagani M., Stein R., Sagiya T., Rubin C., Barreintos S., Kreemer C., Litchfield N., Stirling M., Gledhill K., Haller K., Costa C., 2015. The GEM Faulted Earth Subduction Interface Characterisation Project, Version 2.0, April 2015, GEM Faulted Earth Project], available from http://www.nexus.globalquakemodel.org/gem-faulted-earth/posts.

Biemiller, J., Taylor, F., Lavier, L., Yu, T.-L., Wallace, L., & Shen, C.-C., 2020. Emerged coral reefs record Holocene low-angle normal fault earthquakes. Geophysical Research Letters, 47, e2020GL089301. https://doi.org/ 10.1029/2020GL089301.

Biemiller, J., Boulton, C., Wallace, L., Ellis, S., Little, T., Mizera, M., et al., 2020. Mechanical implications of creep and partial coupling on the world's fastest slipping low-angle normal fault in southeastern Papua New Guinea. Journal of Geophysical Research: Solid Earth, 125, e2020JB020117. https://doi.org/10.1029/2020JB020117.

Borrero, J.C., Bu, J., Saiang, C., Uslu, B., Freckman, J., Gomer, B., Okal, E.A. and Synolakis, C.E., 2003. Field survey and preliminary modeling of the Wewak, Papua New Guinea earthquake and tsunami of 9 September 2002. Seismological Research Letters, 74(4), pp.393-405. https://doi.org/10.1785/gssrl.74.4.393 .

Cain, G., Goff, J., McFadgen, B., 2019. Prehistoric Coastal Mass Burials: Did Death Come in Waves? J Archaeol Method Theory 26, 714–754. https://doi.org/10.1007/s10816-018-9386-y.

Calmant, S., B. Pelletier, R. Pillet, M. Regnier, P. Lebellegard, D. Maillard, F. Taylor, M. Bevis, and J. Recy, 1997. Interseismic and coseismic motions in GPS series related to the Ms 7.3 July, 13, 1994, Malekula earthquake, Central New Hebrides Subduction Zone, Geophys. Res. Lett., 24, 3077– 3080, https://doi.org/10.1029/97GL02962.

Calmant, S., P. Lebellegard, F. Taylor, M. Bevis, D. Maillard, J. Recy, and J. Bonneau, 1995. Geodetic measurements of convergence across the New Hebrides subduction zone, Geophys. Res. Lett. 22, 2573– 2576, https://doi.org/10.1029/95GL01780.

Calmant, S., Pelletier, B., Lebellegard, P., Bevis, M., Taylor, F.W., Phillips, D.A., 2000. New insights on the tectonics along the New Hebrides subduction zone based on GPS results: J. Geophys. Res., v. 108(18), https://doi.org/10.1029/2001J1200644.

Calmant, S., Pelletier, B., Lebellegard, P., Bevis, M., Taylor, F.W., Phillips, D.A., 2003. New insights on the tectonics along the New Hebrides subduction zone based on GPS results. Journal of Geophysical Research: Solid Earth 108. https://doi.org/10.1029/2001JB000644.

Chen, K., Milliner, C. and Avouac, J.P., 2019. The Weitin Fault, Papua New Guinea, ruptured twice by mw 8.0 and mw 7.7 earthquakes in 2000 and 2019. Geophysical Research Letters, 46(22), pp.12833-12840.

Clare, M.A., Le Bas, T., Price, D.M., Hunt, J.E., Sear, D., Cartigny, M.J., Vellinga, A., Symons, W., Firth, C. and Cronin, S., 2018. Complex and cascading triggering of submarine landslides and turbidity currents at volcanic islands revealed from integration of high-resolution onshore and offshore surveys. Frontiers in Earth Science, 6, p.223.

Cleveland, K. M., Ammon, C. J., and Lay, T., 2014. Large earthquake processes in the northern Vanuatu subduction zone, J. Geophys Res Solid Earth, 119, 8866-8883, https://doi.org/101002/2014JB011289.

Davies, G., Griffin, J., 2018. The 2018 Australian Probabilistic Tsunami Hazard Assessment. Record 2018/41. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2018.041.

Davies, H.L., Simeon, O.B., Hope, G., Petchey, F., Davies, J.M., 2019. Past major tsunamis and the level of tsunami risk on the Aitape coast of Papua New Guinea. Nat Hazards 96, 1019–1040. https://doi.org/10.1007/s11069-019-03585-5.

Duphil, M., Aucan, J., Lefèvre, J., Pelletier, B., Roger, J., Thomas, B., 2021. Tsunami Hazard Assessment for New Caledonia. https://doi.org/10.13140/RG.2.2.21282.56000.

Dziewonski, A. M., T.-A. Chou and J. H. Woodhouse,1981. Determination of earthquake source parameters from waveform data for studies of global and regional seismicity, J. Geophys. Res., 86, 2825-2852, 1981. https://doi.org/10.1029/JB086iB04p02825.

Edwards, R.L., Taylor, F.W., Wasserburg, G.J., 1988. Dating earthquakes with high precision thorium-230 ages of very young corals. Earth Planet. Sci. Lett. 90, 371–381. https://doi.org/10.1016/0012-821X(88)90136-7.

Ekström, G., M. Nettles, and A. M. Dziewonski, 2012. The global CMT project 2004-2010: Centroid-moment tensors for 13,017 earthquakes, Phys. Earth Planet. Inter., 200-201, 1-9, 2012. https://doi.org/10.1016/j.pepi.2012.04.002.

Etienne, S., Le Roy, P., Tournadour, E., Roest, W.R., Jorry, S., Collot, J., Patriat, M., Largeau, M.A., Roger, J., Clerc, C. and Dechnick, B., 2021. Large-scale margin collapses along a partly drowned, isolated carbonate platform (Lansdowne Bank, SW Pacific Ocean). Marine Geology, 436, p.106477.

Fakhruddin, B., Karunakar Kintada, K., and Tilley, L., 2021. Probabilistic tsunami hazard and exposure assessment for the pacific islands- Fiji. International Journal of Disaster Risk Reduction 64 (2021) 102458. Doi: https://doi.org/10.1016/j.ijdrr.2021.102458.

Faugère, Y., Roger, J., Delepoulle, A., Dibarboure, G. and Hebert, H., 2024. The 19 May 2023 tsunami near the Loyalty Islands captured by the new SWOT satellite (No. EGU24-15140). Copernicus Meetings. https://doi.org/10.5194/egusphere-egu24-15140.

Fisher, M., Geist, E., Sliter, R., Wong, F., Reiss, C., and Mann, D., 2007. Preliminary analysis of the earthquake (Mw 8.1) and tsunami of april 1, 2007, in the Solomon Islands, Southwestern Pacific Ocean, The International Journal of The Tsunami, 26, 3-69.

Furlong, K. P., Lay, T., and Ammon, C. J., 2009. A great earthquake rupture across a rapidly evolving three-plate boundary, Science, 324, 226-229. https://doi.org/10.1126/science.1167476.

Geist, E. L., 2000. Origin of the 17 July 1998 Papua New Guinea tsunami: Earthquake or landslide? Seismological Research Letters, 17(3), 344-351.

Geist, E. L., and Parsons, T., 2005. Triggering of tsunamigenic aftershocks from large strike-slip earthquakes: Analysis of the November 2000 New Ireland earthquake sequence, Geochem. Geophys., Geosyst., 6(10). https://doi.org/10.1029/2005GC000935.

Geist, E.L. and Parsons, T., 2006. Probabilistic analysis of tsunami hazards. Natural Hazards, 37, pp.277-314.

Gica, E. et al. 2008. Development of the forecast propagation database for NOAA's Short-term Inundation Forecast for Tsunamis (SIFT). NOAA Tech. Memo. OAR PMEL-139, 89 pp.

Global Volcanism Program, 2024. [Database] Volcanoes of the World (v. 5.2.4; 21 Oct 2024). Distributed by Smithsonian Institution, compiled by Venzke, E. https://doi.org/10.5479/si.GVP.VOTW5-2024.5.2

Goff, J., Borrero, J., Easton, G., 2022. In search of Holocene trans-Pacific palaeotsunamis. Earth-Sci. Rev. 233, 104194 https://doi.org/10.1016/j.earscirev.2022.104194.

Goff, J., Chagué-Goff, C., Dominey-Howes, D., McAdoo, B., Cronin, S., Bonté-Grapetin, M., Nichol, S., Horrocks, M., Cisternas, M., Lamarche, G., Pelletier, B., Jaffe, B., Dudley, W., 2011. Palaeotsunamis in the Pacific Islands. Earth-Science Reviews, The 2009 South Pacific tsunami 107, 141–146. https://doi.org/10.1016/j.earscirev.2010.10.005.

Goff, J., Charley, D., Haruel, C., Bonté-Grapentin, M., 2008. Preliminary Findings of the Geological Evidence and Oral History of Tsunamis in Vanuatu. SOPAC Technical Report No.416, Suva.

Goff, J., Golitko, M., Cochrane, E., Curnoe, D., Terrell, J., 2017. Reassessing the environmental context of the Aitape Skull - Skull - the oldest tsunami victim in the world? PLOS ONE 12 (10), e0185248, https://doi.org/10.1371/journal.pone.0185248.

Goff, J., Witter, R., Terry, J., Spiske, M., 2020. Palaeotsunamis in the Sino-Pacific region. Earth-Sci. Rev. 210, 103352, https://doi.org/10.1016/j.earscirev.2020.103352.

Govers, R. and M.J.R. Wortel, 2005. Lithosphere tearing at STEP faults: Response to edges of subduction zones. Earth and Planetary Science Letters 236 (2005) 505– 523.

Gusman, A.R.; Roger, J.H.M.; Power, W.L.; Fry, B.; Kaneko, Y., 2022a. The 2021 Loyalty Islands earthquake (Mw 7.7) : tsunami waveform inversion and implications for tsunami forecasting for New Zealand. Journal of Geophysical Research. Solid Earth, 9(11): e2022EA002346; https://doi.org/ 10.1029/2022EA002346.

Gusman, A.R., Roger, J., Noble, C., Wang, X., Power, W., Burbidge, D., 2022b. The 2022 Hunga Tonga-Hunga Ha'apai Volcano Air-Wave Generated Tsunami. Pure Appl. Geophys. 179, 3511–3525. https://doi.org/10.1007/s00024-022-03154-1.

Gusman, A., Wang, X., 2024. Volcanic tsunami threat level database: pilot phase. GNS Science. https://doi.org/10.21420/GD64-6S52.

Hayes, G.P., Ginevra L. Moore, G.L., Portner, D.E., Hearne, M, Flamme, H., Furtney, M. and Smoczyk, G.M., 2018. Slab2, a comprehensive subduction zone geometry model. Science 362, 58–61, https://doi.org/10.1126/science.aat4723.

Hayes, G.P., Myers, E.K., Dewey, J.W., Briggs, R.W., Earle, P.S., Benz, H.M., Smoczyk, G.M., Flamme, H.E., Barnhart, W.D., Gold, R.D., and Furlong, K.P., 2017. Tectonic summaries of magnitude 7 and greater earthquakes from 2000 to 2015: U.S. Geological Survey Open-File Report 2016–1192, 148 p., https://doi.org/10.3133/ofr20161192.

Heidarzadeh, M., A. R. Gusman, T. Harada, and K. Satake, 2015. Tsunamis from the 29 March and 5 May 2015 Papua New Guinea earthquake doublet (Mw 7.5) and tsunamigenic potential of the New Britain trench, Geophys. Res. Lett., 42, 5958–5965, https://doi.org/10.1002/2015GL064770.

Holm, R.J., Richards, S.W., 2013. A re-evaluation of arc–continent collision and along-arc variation in the Bismarck Sea region, Papua New Guinea. Australian Journal of Earth Sciences 60, 605–619, http://dx.doi.org/10.1080/08120099.2013.824505.

Holm, R.J., Spandler, C., Richards, S.W., 2013. Melanesian arc far-field response to collision of the Ontong Java Plateau: geochronology and pertrogenesis of the Simuku Igneous Complex, New Britain, Papua New Guinea. Tectonophysics 603, 189–212, https://doi.org/10.1016/j.tecto.2013.05.029.

Holm, R.J., Spandler, C., Richards, S.W., 2015. Continental collision, orogenesis and arc magmatism of the Miocene Maramuni arc, Papua New Guinea. Gondwana Research 28 (2015) 1117–1136. dx.doi.org/10.1016/j.gr.2014.09.011.

Howe, B. M., Angove, M., Aucan, J., Barnes, C. R., Barros, J. S., Bayliff, N., Becker, N. C., Carrilho, F., Fouch, M. J., Fry, B., and Jamelot, A.: SMART subsea cables for observing the earth and ocean, mitigating environmental hazards, and supporting the blue economy, Front. Earth Sci., 9, 775544, https://doi.org/10.3389/feart.2021.775544, 2022.

Ioualalen, M., Pelletier, B., Watts, P., Regnier, M., 2006. Numerical modelling of the 26 November 1999 Vanuatu tsunami. Journal of Geophysical Research: Oceans 111. https://doi.org/10.1029/2005JC003249.

Ioualalen, M., Pelletier, B., Watts, P., Regnier, M., 2006. Numerical modeling of the 26 November 1999 Vanuatu tsunami. Journal of Geophysical Research: Oceans 111. https://doi.org/10.1029/2005JC003249.

Ioualalen, M., Pelletier, B., Solis Gordillo, G., 2017. Investigating the March 28th 1875 and the September 20th 1920 earthquakes/tsunamis of the Southern Vanuatu arc, offshore Loyalty Islands, New Caledonia. Tectonophysics 709, 20–38. https://doi.org/10.1016/j.tecto.2017.05.006.

Ioualalen, M., Pelletier, B., Watts, P., Regnier, M., 2006. Numerical modeling of the 26 November 1999 Vanuatu tsunami. Journal of Geophysical Research: Oceans 111. https://doi.org/10.1029/2005JC003249.

Ioualalen, M., Pelletier, B., Solis Gordillo, G., 2017. Investigating the March 28th 1875 and the September 20th 1920 earthquakes/tsunamis of the Southern Vanuatu arc, offshore Loyalty Islands, New Caledonia. Tectonophysics 709, 20–38. https://doi.org/10.1016/j.tecto.2017.05.006.

Johnson, K.L., Pagani, M. and R.H. Styron, 2021. PSHA of the southern Pacific Islands, Geophys. J. Int. 224, 2149–2172. https://doi.org/10.1093/gji/ggaa530.

Kikuchi, M., Yamanaka, Y., Abe, K., Morita, Y., 1999. Source rupture process of the Papua New Guinea earthquake of 17 July 1998 inferred from teleseismic body waves. Earth Planets Space, 51, 1319-1324.

Koulali, A., Tregoning, P., McClusky, S., Stanaway, R., Wallace, L., Lister, G., 2015. New Insights into the present-day kinematics of the central and western Papua New Guinea from GPS. Geophysical Journal International 202, 993–1004. https://doi.org/10.1093/gji/ggv200.

Kuo, Y.-T., C.-S. Ku, Y.-G. Chen, Y. Wang, Y.-N. N. Lin, R. Y. Chuang, Y.-J. Hsu, F. W. Taylor, B.-S. Huang, and H. Tung (2016). Characteristics on fault coupling along the Solomon megathrust based on GPS observations from 2011 to 2014, Geophys. Res. Lett., 43, 8519–8526, https://doi.org/10.1002/2016GL070188.

Lagabrielle, Y., Pelletier, B., Cabioch, G., Régnier, M., Calmant, S., 2003. Coseismic and long-term vertical displacement due to back arc shortening, central Vanuatu: Offshore and onshore data following the M 7.5, 26 November 1999 Ambrym earthquake. Journal of Geophysical Research: Solid Earth 108. https://doi.org/10.1029/2002JB002083.

Lay, T., and Kanamori, H., 1980. Earthquake doublets in the Solomon Islands, Physics of the Earth and Planetary Interiors, 21, 283-304, https://doi.org/10.1016/0031-9201(80)90134-X

Lay, T., Ye, L., Kanamori, H., Yamazaki, Y., Cheung, F. F., and Ammon, C. J., 2013. The February 6, 2013 Mw 8.0 Santa Cruz Islands earthquake, Tectonophysics, 608, 1109-1121. https://doi.org/10.1016/j.tecto.2013.07.001.

Lay, T., Ye, L, , Ammon, C. J., and Kanamori, H., 2017. Intraslab rupture triggering megathrust rupture co-seismically in the December 17, 2016 Solomon Islands Mw 7.9 earthquake, Geophys. Res. Lett., 44, 1286-1291. https://doi.org/10.1002/2017GL072539.

Louat, R., Baldassari, C., 1989. Chronologie des s´eismes et des tsunamis ressentis dans lar´egion Vanuatu Nouvelle Cal´edonie (1729-1989) = Chronology of felt earthquakes and tsunamis in the region Vanuatu New Caledonia (1729-1989) 49.

Mann, P., and Taira, A., 2004. Global tectonic significance of the Solomon Islands and Ontong Java Plateau convergent zone. Tectonophysics 389 (2004) 137 – 190. https://doi.org/10.1016/j.tecto.2003.10.024.

Meffre, S., Crawford, A.J., 2001. Collision tectonics in the New Hebrides arc (Vanuatu). Island Arc 10, 33–50. https://doi.org/10.1046/j.1440-1738.2001.00292.x.

Monzier, M., P. Maillet, J. Foyo Herrera, R. Louat, F. Missegue, and B. Pontoise, 1984. The termination of the southern New Hebrides subduction zone (southwestern Pacific), Tectonophysics, 101, 177–184, https://doi.org/10.1016/0040-1951(84)90050-7.

Neely, J.S. and Furlong, K.P., 2018. Evidence of displacement-driven maturation along the San Cristobal Trough transform plate boundary. Earth and Planetary Science Letters, 485, pp.88-98. https://doi.org/10.1016/j.epsl.2017.12.044.

Newman, A.V., Feng, L., Fritz, H.M., Lifton, Z.M., Kalligeris, N., Wei, Y., 2011. The energetic 2010 MW 7.1 Solomon Islands tsunami earthquake. Geophysical Journal International 186, 775–781. https://doi.org/10.1111/j.1365-246X.2011.05057.x.

NTHMP, National Tsunami Hazard Mitigation Program, 2012. Proceedings and Results of the 2011 NTHMP Model Benchmarking Workshop. Boulder: U.S. Department of Commerce/NOAA/NTHMP, (NOAA Special Report), 436.

National Geophysical Data Center / World Data Service (NGDC/WDS): NCEI/WDS Global Historical Tsunami Database. NOAA National Centers for Environmental Information. https://doi.org/10.7289/V5PN93H7 [last accessed on 29/10/2024]

Paris, R., Switzer, A.D., Belousova, M. et al. Volcanic tsunami: a review of source mechanisms, past events and hazards in Southeast Asia (Indonesia, Philippines, Papua New Guinea). Nat Hazards 70, 447–470 (2014). https://doi.org/10.1007/s11069-013-0822-8.

Paris, R.; Pelletier, B.; Roger, J.H.M.; Wassmer, P.; Sabatier, P., 2023. Sedimentary evidence of tsunamis in New Caledonia, southwest Pacific. Marine Geology, 463: 19p, https://doi.org/10.1016/j.margeo.2023.107116.

Patriat, M., J. Collot, L. Danyushevsky, M. Fabre, S. Meffre, T. Falloon, P. Rouillard, B. Pelletier, M. Roach, and M. Fournier, 2015. Propagation of back-arc extension into the arc lithosphere in the southern New Hebrides volcanic arc, Geochem. Geophys. Geosyst., 16, 3142–3159, https://doi.org/10.1002/2015GC005717.

Patriat, M., Falloon, T., Danyushevsky, L., Collot, J., Jean, M.M., Hoernle, K., Hauff, F., Maas, R., Woodhead, J.D., Feig, S.T., 2019. Subduction initiation terranes exposed at the front of a 2 Ma volcanically-active subduction zone. Earth and Planetary Science Letters 508, 30–40. https://doi.org/10.1016/j.epsl.2018.12.011.

Pelletier, B., Lebellegard, P., Roger, J., 2021. Sismicité et tsunamis en Nouvelle-Calédonie, aléa et risque. Géologues, Géosciences et société, 209, 106-111.

Pelletier, B. and Louat, R., 1989. Seismotectonics and present day relative plate motions in the Tonga-Lau and Kermadec- Havre region, Tectonophysics, 165, 237-250, https://doi.org/10.1016/0040-1951(89)90049-8.

Pelletier, B., Calmant, S. and Pillet, R., 1998. Current tectonics of the Tonga-New Hebrides region: Earth and Planetary Sci. Letters, 164, p. 263-276, https://doi.org/10.1016/S0012-821X(98)00212-X.

Power, W.L., Fry, B., Gusman, A.R., Burbidge, D.R., Brewer, M., Wang, X., 2018. Preliminary DART buoy network design. https://doi.org/10.21420/0G31-AT33.

Power, W. L. (compiler), 2013. Review of Tsunami Hazard in New Zealand (2013 Update), GNS Science Consultancy Report 2013/131. 222 p.

Power, W., Wallace, L., Wang, X., & Reyners, M., 2012. Tsunami hazard posed to New Zealand by the Kermadec and southern New Hebrides subduction margins: an assessment based on plate boundary kinematics, interseismic coupling, and historical seismicity. Pure and Applied Geophysics, 169(1-2), 1-36, https://doi.org/10.1007/s00024-011-0299-x.

Power WL, Burbidge DR, Gusman AR., 2022. The 2021 update to New Zealand's National Tsunami Hazard Model. Lower Hutt (NZ): GNS Science. 63 p. (GNS Science report; 2022/06). https://doi.org/10.21420/X2XQ-HT52.

Regnier, M., Calmant, S., Pelletier, B., Lagabrielle, Y., Cabioch, G., 2003. The Mw 7.5 1999 Ambrym earthquake, Vanuatu: A back arc intraplate thrust event. Tectonics 22, 2002TC001422. https://doi.org/10.1029/2002TC001422.

Robert, W. H., Yamazaki, Y., Cheung, K. F., & Lay, T., 2024. Tsunami variability for the Loyalty Islands 2021 megathrust and 2023 outer rise MW 7.7 earthquakes, Journal of Geophysical Research: Oceans, in review.

Roger, J.H.M.; Pelletier, B.; Aucan, J., 2019. Update of the tsunami catalogue of New Caledonia using a decision table based on seismic data and marigraphic records. Natural Hazards and Earth System Sciences, 19(7): 1471-1483; https://doi: 10.5194/nhess-19-1471-2019.

Roger, J.H.M.; Pelletier, B.; Duphil, M.; Lefèvre, J.; Aucan, J.; Lebellegard, P.; Thomas, B.; Bachelier, C.; Varillon, D., 2021 The Mw7.5 Tadine (Maré, Loyalty Islands) earthquake and related tsunami of 5 December 2018 : seismotectonic context and numerical modelling. Natural Hazards and Earth System Sciences, 21(11): 3489-3508; https://doi:10.5194/nhess-21-3489-2021.

Roger, J., & Pelletier, B., 2024. A brief history of tsunamis in the Vanuatu Arc. Natural Hazards and Earth System Sciences 24(10), 3461-3478, https://doi.org/10.5194/nhess-24-3461-2024.

Roger, J., Pelletier, B., Gusman, A., Power, W., Wang, X., Burbidge, D., Duphil, M., 2023. Potential tsunami hazard of the southern Vanuatu Subduction Zone: tectonics, case study of the Matthew Island tsunami of 10 February 2021 and implication in regional hazard assessment. Natural Hazards and Earth System Sciences, In Press, https://doi.org/10.5194/nhess-2022-157.

Roger, J., Ashraf, S., Pelletier, B., Krippner, J., Bani, P., Gusman, A.R., Thomas, B., Kali, J.-C., 2023. The East Epi Volcano submarine eruption and associated tsunami of 31 January 2023: a powerful event in the shadow of the HTHH eruption. AGU Fall Meeting 2023, NH51D-0505, https://www.google.com/url?q=https://ui.adsabs.harvard.edu/abs/2023AGUFMNH51D0505R/abstract&sa=D&source=docs&ust=1725682344691642&usg=AOvVaw0WkCkFTf2xgLn3cJYAltQc.

Roger, J.H.M., Bull, S., Watson, S.J., Mueller, C., Hillman, J.I.T., Wolter, A., Lamarche, G., Power, W., Lane, E., Woelz, S., Davidson, S., 2024. A review of approaches for submarine landslide-tsunami hazard identification and assessment. Marine and Petroleum Geology 162, 106729. https://doi.org/10.1016/j.marpetgeo.2024.106729.

Sahal, A., Pelletier, B., Chatelier, J., Lavigne, F. and Schindelé, F., 2010: A catalog of tsunamis in New Caledonia from 28 March 1875 to 30 September 2009, Comptes Rendus Geoscience, 342, 434-447, https://doi.org/10.1016/j.crte.2010.01.013.

Schindelé, F., Kong, L., Lane, E.M., Paris, R., Ripepe, M., Titov, V., Bailey, R., 2024. A Review of Tsunamis Generated by Volcanoes (TGV) Source Mechanism, Modelling, Monitoring and Warning Systems. Pure Appl. Geophys. https://doi.org/10.1007/s00024-024-03515-y.

Silver, E., Day, S., Ward, S., Hoffmann, G., Llanes, P., Driscoll, N., Appelgate, B. and Saunders, S., 2009. Volcano collapse and tsunami generation in the Bismarck volcanic arc, Papua New Guinea. Journal of Volcanology and Geothermal Research, 186(3-4), pp.210-222. https://doi.org/10.1016/j.jvolgeores.2009.06.013.

Tanahashi, M., Kisimoto, K., Joshima, M., Lafoy, Y., Honza, E., Auzende, J.M., 1991. Geological structure of the central spreading system, North Fiji Basin. Marine Geology, The geology, geophysics and mineral resources of the South Pacific 98, 187–200. https://doi.org/10.1016/0025-3227(91)90103-B.

Tanioka, Y., 1999. Analysis of the far-field tsunamis generated by the 1998 Papua New Guinea earthquake. Geophysical Research Letters, 26, 3393-3396.

Tappin, D. R., Matsumoto, T., Watts, P., Satake, K., et al., 1999. Sediment slump likely caused 1998 Papua New Guinea tsunami, EOS, Transactions of the American Geophysical Union, 80, 329,334,340.

Tappin, D. R., Watts, P., McMurtry, G. M., Lafoy, Y., Matsumoto, T., 2001. The Sissano, Papua New Guinea tsunami of July 1998 – Offshore evidence on the source mechanism. Marine Geology, 175, 1-23.

Tappin, D. R., Watts, P., Grilli, S. T., 2008. The Papua New Guinea tsunami of 17 July 1998: anatomy of a catastrophic event. Natural Hazards Earth System Science, 8, 243-266.

Taylor, B., Goodliffe, A., Martinez, F., Hey, R., 1995. Continental rifting and initial sea-floor spreading in the Woodlark basin. Nature 374, 534–537. https://doi.org/10.1038/374534a0.

Taylor, B., Goodliffe, A.M., Martinez, F., 1999. How continents break up: Insights from Papua New Guinea. Journal of Geophysical Research: Solid Earth 104, 7497–7512. https://doi.org/10.1029/1998JB900115.

Taylor, B., A. Goodliffe, and F. Martinez, 2008. Initiation of transform faults at rifted continental margins, C. R. Geosci., 341, 428–438, https://doi:10.1016/j.crte.2008.08.010.

Taylor, F. W., Briggs, R. W., Frohlich, C., Brown, A., Hornbach, M., Papabatu, A. K., et al., 2008. Rupture across arc segment and plate boundaries in the 1 April 2007 Solomons earthquake. Nature Geoscience, 1(4), 253–257. https://doi.org/10.1038/ngeo159.

Thomas et al., in prep. 8 December 2016 Mw 7.8 Solomon Islands earthquake.

Titov, V. V., 2009. Tsunami forecasting. In A. N. Bernard & A. R. Robinson (Eds.), The Sea. Tsunamis, Chap. 12 (Vol. 15, pp. 371–400). Cambridge, MA: Harvard University Press.

Titov, V. V., Kânoğlu, U., & Synolakis, C., 2016. Development of MOST for real-time tsunami forecasting. Journal of Waterway, Port, Coastal, and Ocean Engineering, 142(6), 03116004. https://doi.org/10.1061/(asce)ww.1943-5460.0000357.

Tregoning, P., Jackson, R.J., McQueen, H., Lambeck, K., Stevens, C., Little, R.P., Curley, R., Rosa, R., 1999. Motion of the South Bismarck Plate, Papua New Guinea. Geophysical Research Letters 26, 3517–3520. https://doi.org/10.1029/1999GL010840.

Tregoning, P., 2002. Plate kinematics in the western Pacific derived from geodetic observations. Journal of Geophysical Research: Solid Earth 107, ECV 7-1-ECV 7-8. https://doi.org/10.1029/2001JB000406.

UNESCO/IOC, 2018. Scientific Meeting of Experts for Coordinated Scenario Analysis of Future Tsunami Events and Hazard Mitigation Schemes for the South China Sea Region Xiamen, China 16–18 November 2015. IOC Workshop Report No. 275, https://unesdoc.unesco.org/ark:/48223/pf0000366304 (accessed 10.10.24).

UNESCO/IOC, 2020. Expert Meeting on Tsunami Sources, Hazards, Risk and Uncertainties associated with the Tonga-Kermadec Subduction Zone, Wellington, New Zealand, 29 October–3 November 2018. IOC Workshop Report No. 289, https://unesdoc.unesco.org/ark:/48223/pf0000374009 (accessed 5.17.24).

UNESCO/IOC, 2021. Expert Meeting on Tsunami Sources, Hazards, Risk and Uncertainties Associated with the Colombia-Ecuador Subduction Zone, Guayaquil, Ecuador, 27–29 January 2020. IOC Workshop Report No. 295, https://unesdoc.unesco.org/ark:/48223/pf0000376784 (accessed 10.10.24).

UNESCO/IOC, 2022. Interim Procedures and PTWS products for Tsunamis developed after the Hunga Tonga Hunga Ha'apai Volcano event (User's Guide and informational webinar on 6 September 2022), 17 August 2022, IOC CL 2902, https://oceanexpert.org/document/30759.

UNESCO/IOC, 2023. Report by IOC/UNESCO TOWS-WG Ad-hoc Team on Meteotsunami, Chair: Mike Angove Co-Chair: Dr. Ivica Vilibic, https://oceanexpert.org/downloadFile/52941.

UNESCO/IOC, 2024. Monitoring and Warning for Tsunamis Generated by Volcanoes, Paris, UNESCO. (IOC Technical Series No. 183), https://www.unesco.org/en/articles/monitoring-and-warning-tsunamis-generated-volcanoes (accessed 9.2.24).

UNESCO/IOC, In prep. Meeting of Experts on tsunami sources and hazard in Southern Peru and Northern Chile, 20-24 August, 2023, In Prep.

U.S. Geological Survey National Earthquake Information Center Comprehensive Earthquake Catalog, accessed 1 October, 2024, http://earthquake.usgs.gov/earthquakes/search/.

Wallace, L.M., Stevens, C., Silver, E., McCaffrey, R., Loratung, W., Hasiata, S., Stanaway, R., Curley, R., Rosa, R., Taugaloidi, J., 2004. GPS and seismological constraints on active tectonics and arc-continent collision in Papua New Guinea: Implications for mechanics of microplate rotations in a plate boundary zone. Journal of Geophysical Research: Solid Earth 109. https://doi.org/10.1029/2003JB002481.

Wallace, L.M., McCaffrey, R., Beavan, J., Ellis, S., 2005. Rapid microplate rotations and backarc rifting at the transition between collision and subduction. Geology 33, 857–860. https://doi.org/10.1130/G21834.1.

Wallace, L. M., S. Ellis, T. Little, P. Tregoning, N. Palmer, R. Rosa, R. Stanaway, J. Oa, E. Nidkombu, and J. Kwazi, 2014. Continental breakup and UHP rock exhumation in action: GPS results from the Woodlark Rift, Papua New Guinea, Geochem. Geophys. Geosyst., 15, 4267–4290, HTTPS://doi:10.1002/2014GC005458.

Ward, SN., and Day, S., 2003. Ritter Island Volcano—lateral collapse and the tsunami of 1888. Geophys. J. Int. 154, 891–902, https://doi.org/10.1046/j.1365-246X.2003.02016.x.

Wei, Z., Dalrymple, R.A., Hérault, A., Bilotta, G., Rustico, E., Yeh, H., 2015. SPH modeling of dynamic impact of tsunami bore on bridge piers. Coastal Engineering 104, 26–42. https://doi.org/10.1016/j.coastaleng.2015.06.008.

Wells, D. L., and Coppersmith, K. J., 1994. New empirical relationships among magnitude, rupture length, rupture width, rupture area, and surface displacement. Bull. Seismol. Soc. Am. 84, 974–1002.

Witter, J.B., Self, S. The Kuwae (Vanuatu) eruption of AD 1452: potential magnitude and volatile release. Bull Volcanol **69**, 301–318 (2007). https://doi.org/10.1007/s00445-006-0075-4.

Woodhead, J., and Brauns, 2004. Current limitations to the understanding of Re^Os behaviour in subduction systems, with an example from New Britain. Earth and Planetary Science Letters 221, 309-323, https://doi.org/10.1016/S0012-821X(04)00091-3.

Ye, L., Gong, W., Lay, T., Kanamori, H., & Chen, X., 2021. Shallow megathrust rupture during the 10 February 2021 MW 7.7 Southeast Loyalty Islands Earthquake Sequence. The Seismic Record, 1(3), 154–163. https://doi.org/10.1785/0320210035.

Yoneshima, S., Mochizuki, K., Araki, E., Hino, R., Shinohara, M., and Suyehiro, K., 2005. Subduction of the Woodlark Basin at New Britain Trench, Solomon Islands region.

ANNEX I

SUGGESTED SOURCES AND MODELLING PARAMETERS

Segment	Lon	Lat	Strike	Dip	Rake	Depth	Length	Width	Slip
Solomon Northwest: nv7a	154.3814	-5.6308	308.3	39.7	90	19.2	100	50	13
nv7b	154.1658	-5.9017	308.3	16.5	90	5	100	50	13
nv8a	155.1097	-6.3511	317.2	45.3	90	22.9	100	50	13
nv8b	154.8764	-6.5656	317.2	21	90	5	100	50	13
nv9a	155.5027	-6.743	290.5	48.8	90	22.9	100	50	13
nv9b	155.3981	-7.0204	290.5	21	90	5	100	50	13
nv10a	156.4742	-7.2515	305.9	36.9	90	27.6	100	50	13
nv10b	156.2619	-7.5427	305.9	26.9	90	5	100	50	13
Solomon Southeast nv11a	157.083	-7.883	305.4	33	90	29.7	100	50	20
nv11b	156.8627	-8.1903	305.4	29.6	90	5	100	50	20
nv12a	157.6537	-8.1483	297.9	37.5	90	28.6	100	50	20
nv12b	157.485	-8.463	297.9	28.1	90	5	100	50	20
nv13a	158.5089	-8.5953	302.7	33.6	90	23	100	50	20
nv13b	158.3042	-8.9099	302.7	21.1	90	5	100	50	20
nv14a	159.1872	-8.9516	293.3	38.4	90	34.1	100	50	20
nv14b	159.0461	-9.2747	293.3	35.5	90	5	100	50	20
nv15a	159.9736	-9.5993	302.8	46.7	90	41.4	100	50	20
nv15b	159.8044	-9.8584	302.8	46.7	90	5	100	50	20
nv16a	160.7343	-10.0574	301	46	90	41	100	50	20
nv16b	160.5712	-10.3246	301	46	90	5	100	50	20
nv17a	161.4562	-10.5241	298.4	40.1	90	37.2	100	50	20
nv17b	161.29	-10.8263	298.4	40.1	90	5	100	50	20
New Hebrides N: nv21a	164.9445	-10.4183	287.9	40.3	90	23.3	100	50	9
nv21b	164.8374	-10.7442	287.9	21.5	90	5	100	50	9
nv22a	166.0261	-11.1069	317.1	42.4	90	20.8	100	50	9
nv22b	165.7783	-11.3328	317.1	18.4	90	5	100	50	9
nv23a	166.5179	-12.226	342.4	48	90	22.4	100	50	9
nv23b	166.2244	-12.3171	342.4	20.4	90	5	100	50	9
nv24a	166.7236	-13.1065	342.6	47.1	90	28.5	100	50	9
nv24b	166.4241	-13.1979	342.6	28.1	90	5	100	50	9
New Hebrides C: nv25a	166.8914	-14.0785	350.3	54.1	90	31.2	100	50	14
nv25b	166.6237	-14.123	350.3	31.6	90	5	100	50	14
nv26a	166.92	-15.145	365.6	50.5	90	29.1	100	50	14

Segment	Lon	Lat	Strike	Dip	Rake	Depth	Length	Width	Slip
nv26b	166.6252	-15.117	365.6	28.8	90	5	100	50	14
nv27a	167.0053	-15.6308	334.2	44.7	90	25.5	100	50	14
nv27b	166.7068	-15.7695	334.2	24.1	90	5	100	50	14
nv28a	167.4074	-16.3455	327.5	41.5	90	22.4	100	50	14
nv28b	167.1117	-16.5264	327.5	20.4	90	5	100	50	14
nv29a	167.9145	-17.2807	341.2	49.1	90	24.1	100	50	14
nv29b	167.6229	-17.3757	341.2	22.5	90	5	100	50	14
New Hebrides S: nv30a	168.222	-18.2353	348.6	44.2	90	24	100	50	10
nv30b	167.8895	-18.2991	348.6	22.3	90	5	100	50	10
nv31a	168.5022	-19.051	345.6	42.2	90	22.3	100	50	10
nv31b	168.1611	-19.1338	345.6	20.2	90	5	100	50	10
nv32a	168.8775	-19.6724	331.1	42	90	21.7	100	50	10
nv32b	168.5671	-19.8338	331.1	19.5	90	5	100	50	10
nv33a	169.3422	-20.4892	332.9	40.2	90	22.4	100	50	10
nv33b	169.0161	-20.6453	332.9	20.4	90	5	100	50	10
nv34a	169.8304	-21.2121	329.1	39	90	22.7	100	50	10
nv34b	169.5086	-21.3911	329.1	20.8	90	5	100	50	10
New Hebrides MH1: nv35a	170.3119	-21.6945	311.9	39	90	22.1	100	50	7.4
nv35b	170.0606	-21.9543	311.9	20	90	5	100	50	7.4
nv36a	170.9487	-22.1585	300.4	39.4	90	23.5	100	50	7.4
nv36b	170.7585	-22.4577	300.4	20	90	5	100	50	7.4
nv37a	171.6335	-22.3087	281.3	30	90	22.1	100	50	7.4
nv37b	171.5512	-22.6902	281.3	20	90	5	100	50	7.4
New Hebrides MH2	173.2949	-22.3839	268	20	90	5	300	100	7.4
New Britain: nv1a	148.6217	-6.4616	243.2	32.3	90	15.7	100	50	24
nv1b	148.7943	-6.8002	234.2	12.3	90	5	100	50	24
nv2a	149.7218	-6.1459	260.1	35.1	90	16.4	100	50	24
nv2b	149.7856	-6.5079	260.1	13.1	90	5	100	50	24
nv3a	150.4075	-5.9659	245.7	42.4	90	18.6	100	50	24
nv3b	150.545	-6.2684	245.7	15.8	90	5	100	50	24
nv4a	151.1095	-5.582	238.2	42.4	90	23.6	100	50	24
nv4b	151.2851	-5.8639	238.2	21.9	90	5	100	50	24
nv5a	152.0205	-5.1305	247.7	49.2	90	32.4	100	50	24
nv5b	152.1322	-5.402	247.7	33.2	90	5	100	50	24
nv6a	153.345	-5.1558	288.6	53.5	90	33.6	100	50	24
nv6b	153.2595	-5.4089	288.6	34.9	90	5	100	50	24
ManusTrenchEast_1	153.8931	-3.88	140.2	15	90	3	200	100	4.5
ManusTrenchEast_2	152.7321	-2.6806	127.7	15	90	4.4	200	100	4.5

Segment	Lon	Lat	Strike	Dip	Rake	Depth	Length	Width	Slip
ManusTrenchEast_3	151.2513	-1.8618	115	15	90	4.7	200	100	4.5
ManusTrenchEast_4	149.5251	-1.2829	117.8	15	90	4.9	200	100	4.5
ManusTrenchWest_1	147.9102	-0.7434	108	15	90	4.8	200	100	4.5
ManusTrenchWest_2	146.2667	-0.7486	87.5	15	90	4.3	200	100	4.5
ManusTrenchWest_3	144.6035	-1.1154	75.1	15	90	4.3	200	100	4.5
ManusTrenchWest_4	143.2106	-1.8756	50.8	15	90	2.9	200	100	4.5

ANNEX II

LIST OF ACRONYMS

BPR	Bottom Pressure Recorder
CTBTO	Comprehensive Nuclear-Test-Ban Treaty Organization
DART	Deep-ocean Assessment and Reporting of Tsunamis
GLOSS	Global Sea Level Observing System
ICG/PTWS	Intergovernmental Coordination Group for the Pacific Tsunami Warning and Mitigation System (IOC)
IOC	Intergovernmental Oceanographic Commission (UNESCO)
Mw	Moment magnitude of an earthquake
M_{max}	The maximum credible earthquake expected for a subduction zone or segment
M_{max}(min)	The minimum value of M_{max} - usually based on largest known earthquake
M_{max}(max)	The maximum value of M_{max} - usually based on geometry of the zone
NCEI	National Centers for Environmental Information (NOAA)
NEIC	The National Earthquake Information Center, USGS.
NOAA	US National Oceanic and Atmospheric Administration
OBS	Ocean Bottom Seismometers
ORSNET	Oceania Regional Seismic NETwork (South-West Pacific islands)
PMEL	Pacific Marine Environmental Laboratory (NOAA)
PTHA	Probabilistic Tsunami Hazard Assessment
PTWC	Pacific Tsunami Warning Centre (US)
PTWS	Pacific Tsunami Warning System (IOC)
SMART	Science Monitoring And Reliable Telecommunications (cables)
SOP	Standard Operating Procedure
TAMTAM	A project to establish a SMART telecommunications cable between Vanuatu and New Caledonia with four sensor sites.
UNESCO	United Nations Educational, Scientific and Cultural Organization
USGS	United States Geological Survey
WG	Working Group

ANNEX III

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ANNEX IV

AGENDA

Day 1- Tuesday 14 May 2024: Introductions and Overviews (Joint with SMART)			
	Agenda Item	Time	Session Facilitator
1.1	Welcome and introductions/role of IOC, ICG-PTWS, and SMART	13:00 – 13:15	Chair
1.2	Overview of meeting aims/objectives/IOC requirements and expectations of experts meeting	13:15 – 13:30	Chair
1.3	Introductions (experts introduce themselves and background).	13:30 – 14:00	Chair
1.4	Regional tectonic overview	14:00 – 14:25	Laura Wallace
1.5.1	Introduce the SATREPS project	14:25 – 14:40	Fukashi Maeno
1.5.2	JICA's Van-REDI project	14:40 – 14:55	Osamu Kamigaichi
1.5.3	Vanuatu trench historical earthquakes and catalogues	14:55 – 15:15	Jean Roger
1.6	Tsunami modelling and the 2021 and 2023 Loyalty Islands earthquakes and tsunamis	15:15 – 15:35	Fai Cheung
	Afternoon Tea		
1.7	Introduction of French initiatives on the Tamtam SMART cable project	15:55 – 16:20	Virginie Durand
1.8	Synergies between the project Geophysical Study of Ongoing Subduction Initiation Along the Matthew-Hunter Trench and Tamtam SMART Cables	16:20 – 16:45	Douglas Wiens
1.9	Vanuatu perspective on experts workshop and Tamtam SMART Cable in the region (to be confirmed)	16:45 – 17:10	VMGD
1.10	TAMTAM catalyzing student involvement and education	17:10 – 17:35	Pascal Michon, NUV
1.11	Summary of day 1, Discussion, revise agenda if required	17:35 – 18:00	Chair
	Day 1 Close		

Day 2 - Wednesday 15 May 2024: Background: Tectonics, Seismic and Tsunami Sources			
	Agenda Item	Time	Session Facilitator
2.1	Introduction to Day 2	09:00 – 09:15	Chair
2.2 2.2.1 2.2.2 2.2.3	Current state overviews Global practice and global analogues (Slab 2 and GEM, etc.) Overview of trench systems	 09:15 – 09:30 09:45 – 10:30	Chair, Laura Kong Ken Gledhill Laura Wallace, Thorne Lay, Doug Weins
	Morning Tea		
2.3	Current state scientific updates continued		Chair, Ken Gledhill
2.3.1	Volcano sources	11:00 – 11:20	Aditya Gusman
2.3.2	Deterministic seismic assessment options	11:20 – 11:40	Bill Fry
2.3.3	Seismology	11:40 – 12:00	Thorne Lay
2.3.4	Paleotsunami	12:00 – 12:20	Shaun Williams
2.3.5	GNSS/Geodesy	12:20 – 12:40	Laura Wallace
	Lunch		

2.3 2.3.5	Current state scientific updates continued Are there any non-earthquake sources of note (volcanic, landslides, etc), or non-subduction earthquakes? Discussion	13:00 – 13:30	Chair
2.4	Analysis Options: Probabilistic seismic assessment options Deterministic vs. probabilistic approaches - discussion	13:30 – 14:30	Chair, Ken Gledhill Gareth Davies
2.5	Constraints: Discussion	14:30 – 15:30	Chair
Afternoon Tea			
2.6	Discussion on elicitation process on seismic source models to support tsunami discussions (potential models that can be tested)	15:45 – 16:30	Chair
2.8	Summary of day 2 - Discussion	16:30 – 17:00	Chair
Day 2 Close			

Day 3 - Thursday 16 May 2024: Putting It All Together - Maximum credible scenarios and implications			
	Agenda Item	Time	Session Facilitator
3.1	Re-confirm and test meeting outcomes and following Day 2 (what can/we need to achieve and priorities)	09:00 – 09:15	Chair
3.2.1	Agree on scenarios for each trench system (including credibility ranking) Part 1	09:15 – 10:00	Chair, Ken Gledhill
Morning Tea			
3.2.2	Agree on scenarios for each trench system (including credibility ranking) Part 2	10:30 – 12:30	Chair
Lunch			
3.2.3	Agree on scenarios for each trench system (including credibility ranking) Part 3	13:30 – 14::00	Chair, Doug Weins
Afternoon Tea			
3.3	Implications for tsunami hazards and warning – do our findings change accepted state?	15:30 – 16:00	Laura Kong
3.4	How can we test the impact of the scenarios?	16:00 – 16:30	Chris Moore
3.6	Summary of day 3	16:30 – 17:00	Chair
Day 3 Close			
Day 4 - Friday 17 May 2024: Workshop Summary and TAMTAM Talks			
	Agenda Item	Time	Session Facilitator
4.1	Re-confirm and test meeting outcomes and following Day 2 (what can/we need to achieve and priorities)	09:00 – 09:15	Chair
4.2	Review of scenarios (hopefully following some modelling)	09:15 – 10:00	Chris Moore
Morning Tea			
4.3	Anything we have missed? Recommended further work	10:30 – 11:30	Ken Gledhill

4.4	Summary	11:30 – 12:00	Chair
Lunch			
4.5	Review the Tamtam project.	13:00 – 13:15	Bruce Howe
4.6	Discussion - Question and answer with Ministers and delegates	13:15 – 14:15	Bruce Howe
4.7	Review of experts meeting result in relation to the Tamtam Cable.	14:15 – 15:00	Ken Gledhill
Afternoon Tea			
4.8	Prima and Tamtam Cable	15:00 – 15:15	Simon Fletcher
4.9	Pacific Peering and Tamtam Cable	15:15 – 15:30	Benoit Maritan
4.10	Data Management Tamtam Cable	15:30 – 15:45	Matt Fouch
4.11	Closing	15:45 -16:00	Bruce Howe, Chris Moore, Ken Gledhill
Day 4 Close - End of Workshop			