
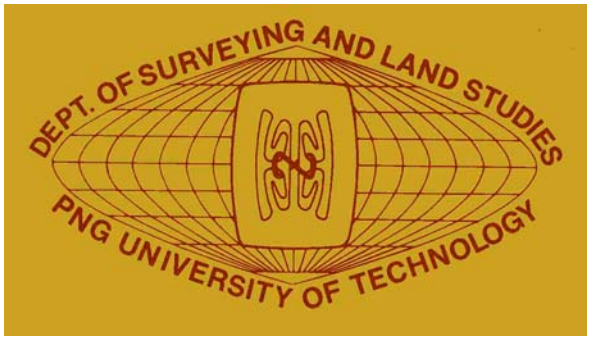


# Lae

# A deforming city

## Geophysical Insights

**Richard Stanaway**

*Geodesist*

*Research School of Earth Sciences*

*The Australian National University*

# Geodetic monitoring – land does move!
# But how fast?

- Global Positioning System (GPS) can measure horizontal land movements at cm level at global scales, mm at local level
- Land moves as result of the physical forces acting on it
  - plate tectonics ( including earthquakes)
  - land slides
  - expansion due to changes in water table
  - earth and ocean tides
  - loading of ice, snow and the atmosphere
- Geodetic monitoring can be used to assist in forecasting, and to some extent, prediction of volcanic eruptions, earthquakes and

# landslides


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## Which groups are doing geodetic monitoring in PNG?

- **Australian National University**
  - **Research School of Earth Sciences**
- **PNG University of Technology (UNITECH)**
  - **Department of Surveying and Land Studies**
- **PNG National Mapping Bureau (NMB)**
- **PNG Department of Minerals and Energy**
  - **Rabaul Volcanological Observatory**
  - **Geological Survey of PNG**
- **Institute of Geological and Nuclear Sciences (NZ)**

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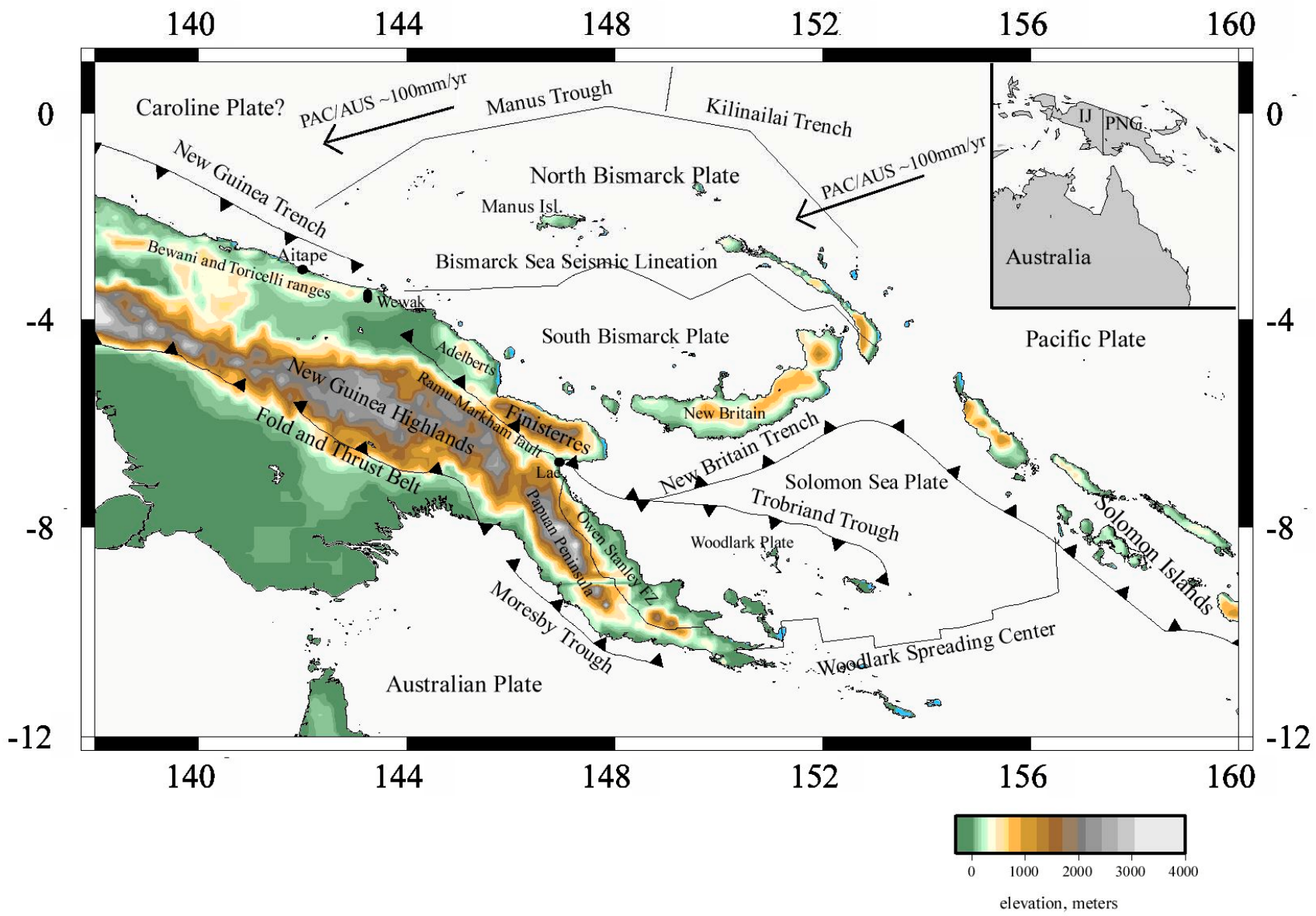
# What are the applications of Geodetic Monitoring?

- Tectonic modelling
- Geophysical hazard monitoring and forecasting
  - Earthquakes (and resulting tsunamis)
  - Landslides
  - Volcanic activity
- Sea level and climate change
- Geodetic Datum development
  - Mapping
  - Digital Cadastral Database (DCDB)
  - Navigation
  - Location Based Services




**Present day tectonic setting of PNG (from Wallace, 2002)**

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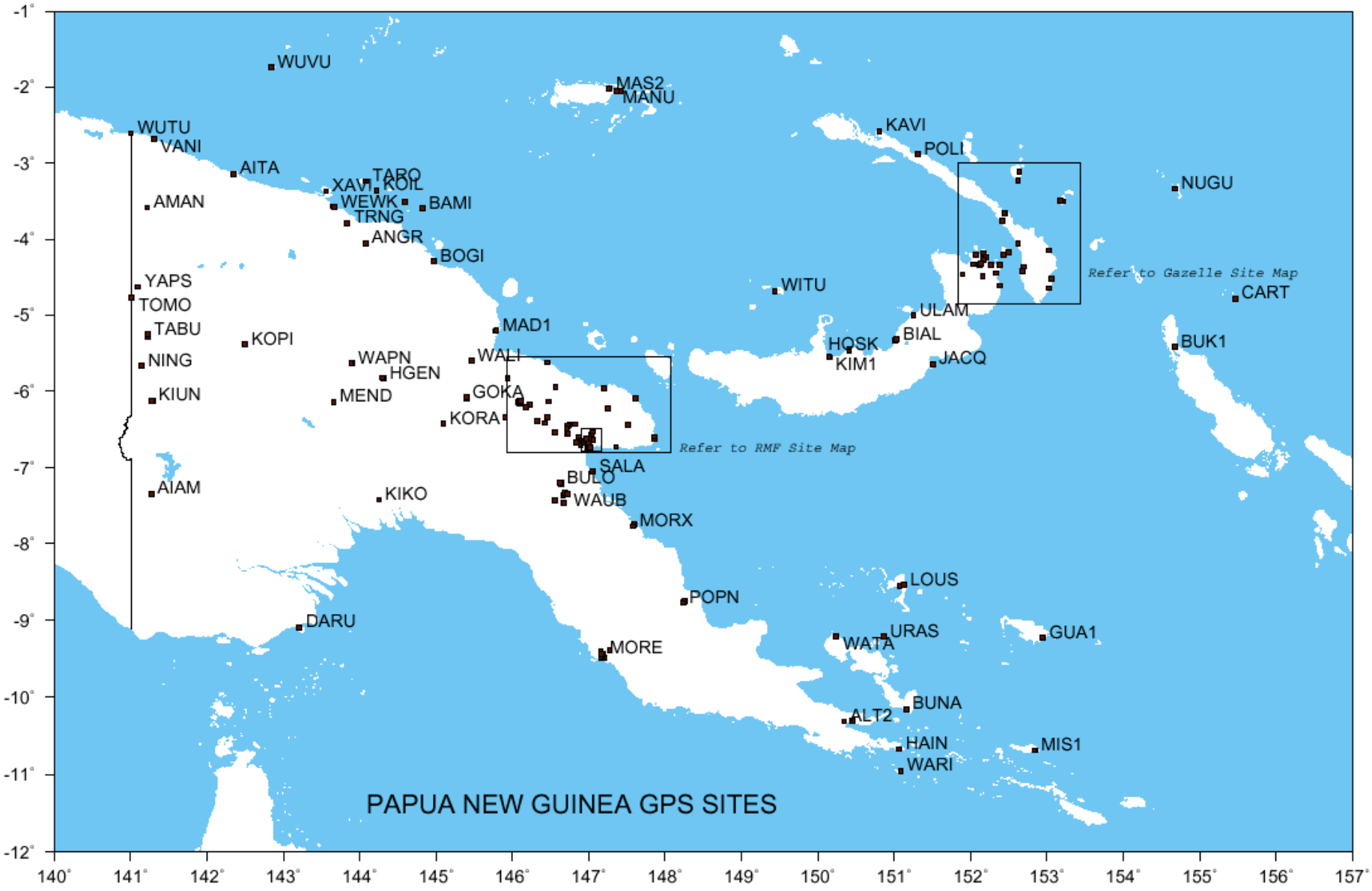


**GPS Site locations in Papua New Guinea**

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# Permanent Geodetic tracking sites in PNG

*Global Positioning System (GPS)*

- **Unitech, Lae (LAE1)**
- **NMB Tower, Port Moresby (MORE)**
- **RVO, Rabaul (RVO_)**
  - **Sulphur Point (SPT_)**
  - **Vulcan Island (VIS_)**
  - **SDA, Matupit Island (SDA_)**
- **Manus tide gauge, Lombrum (PNGM)**

*DORIS*

- **NMB, Port Moresby (MORB)**

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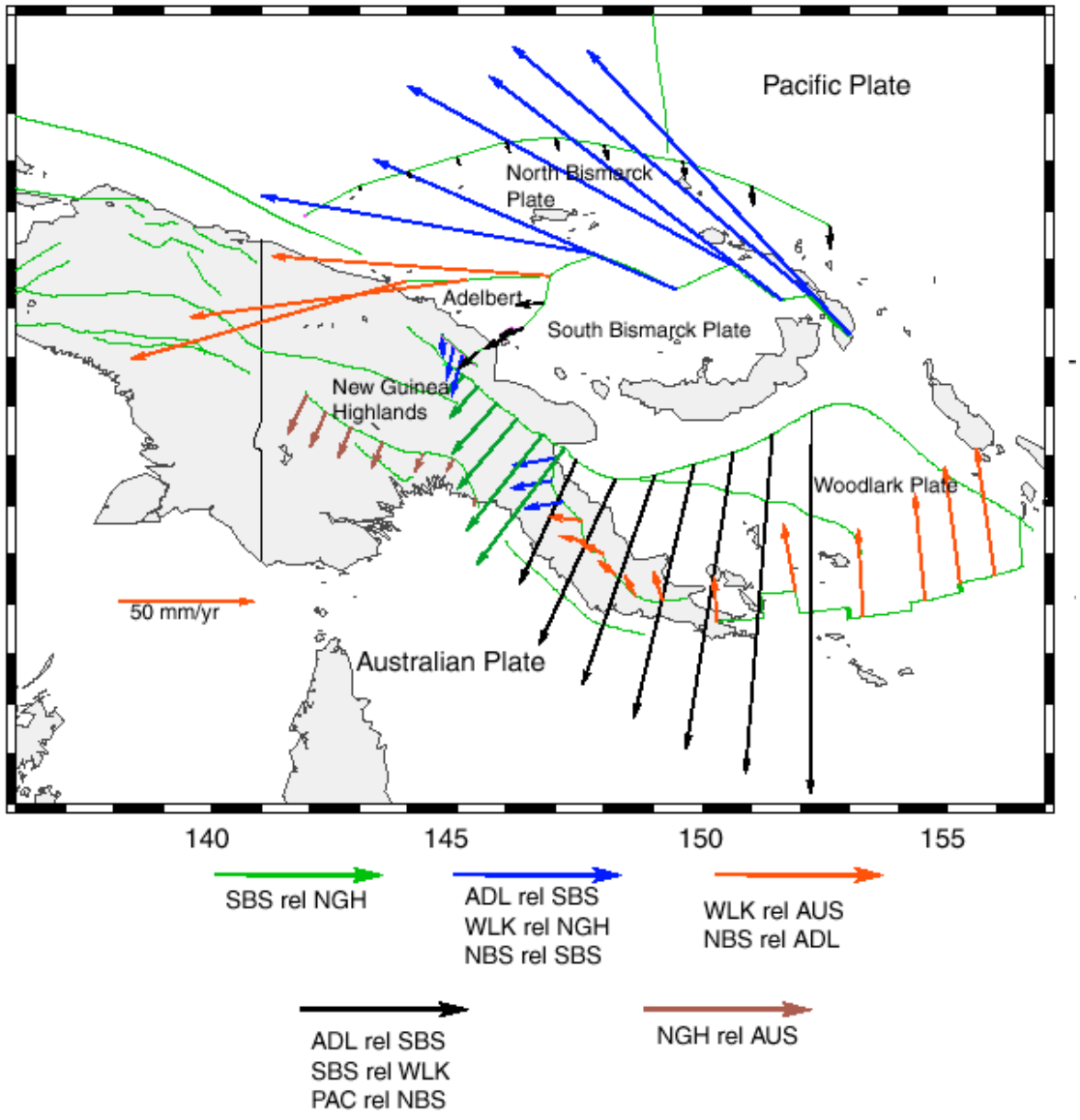


**First-order tectonic model of Papua New Guinea (from Wallace *et al.*, 2003)**

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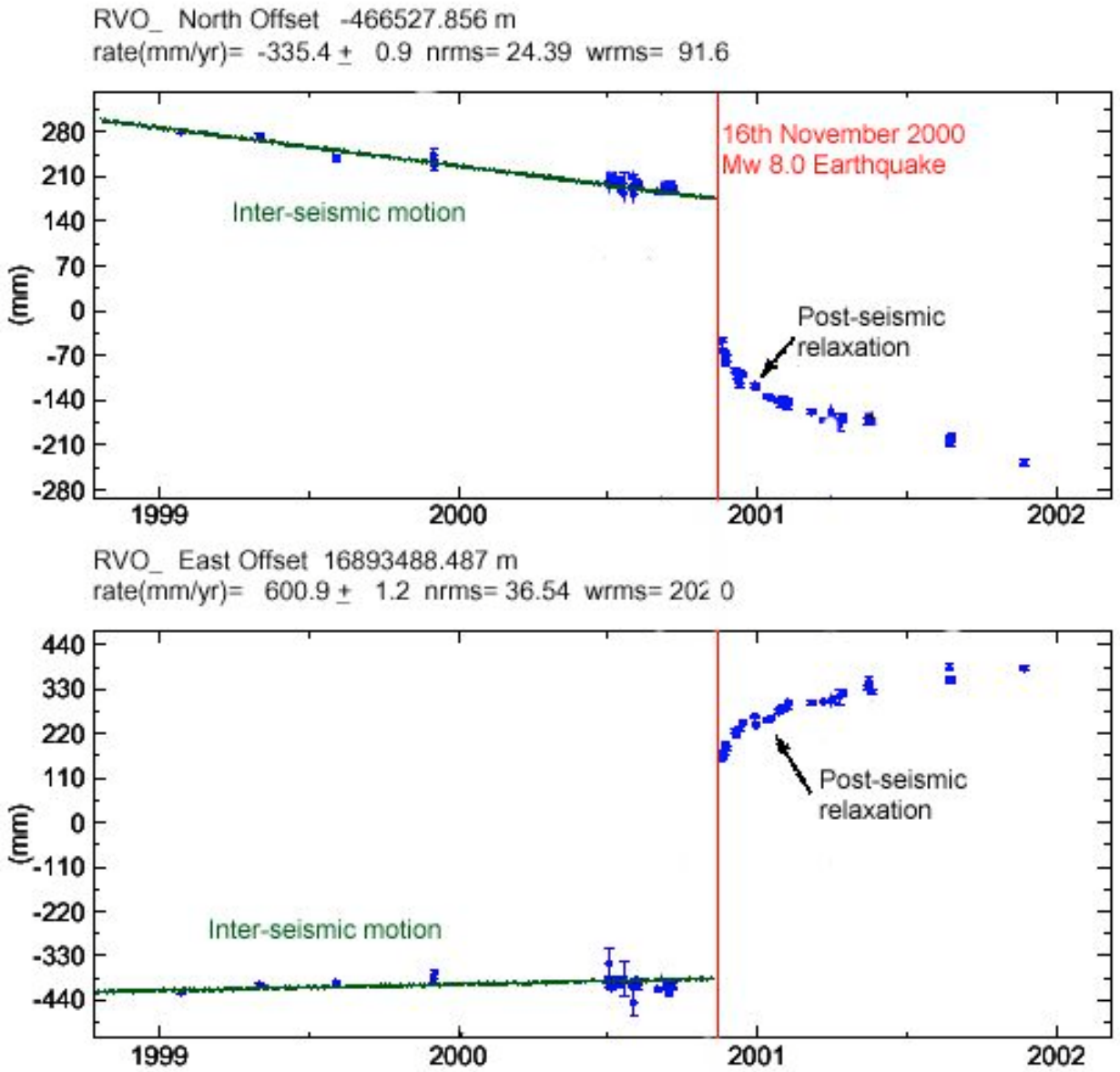


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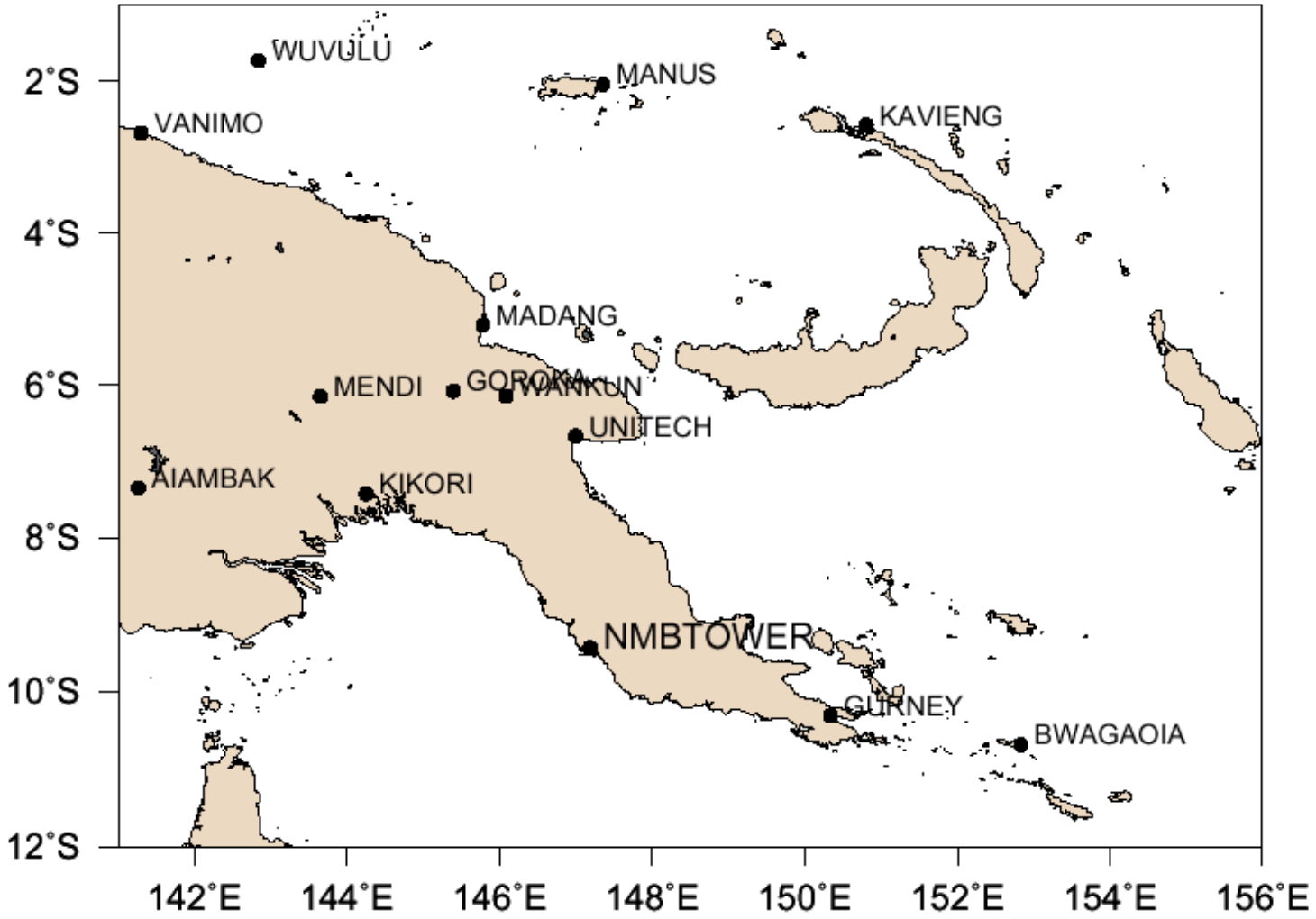


**PNG94 geodetic datum fiducial network**

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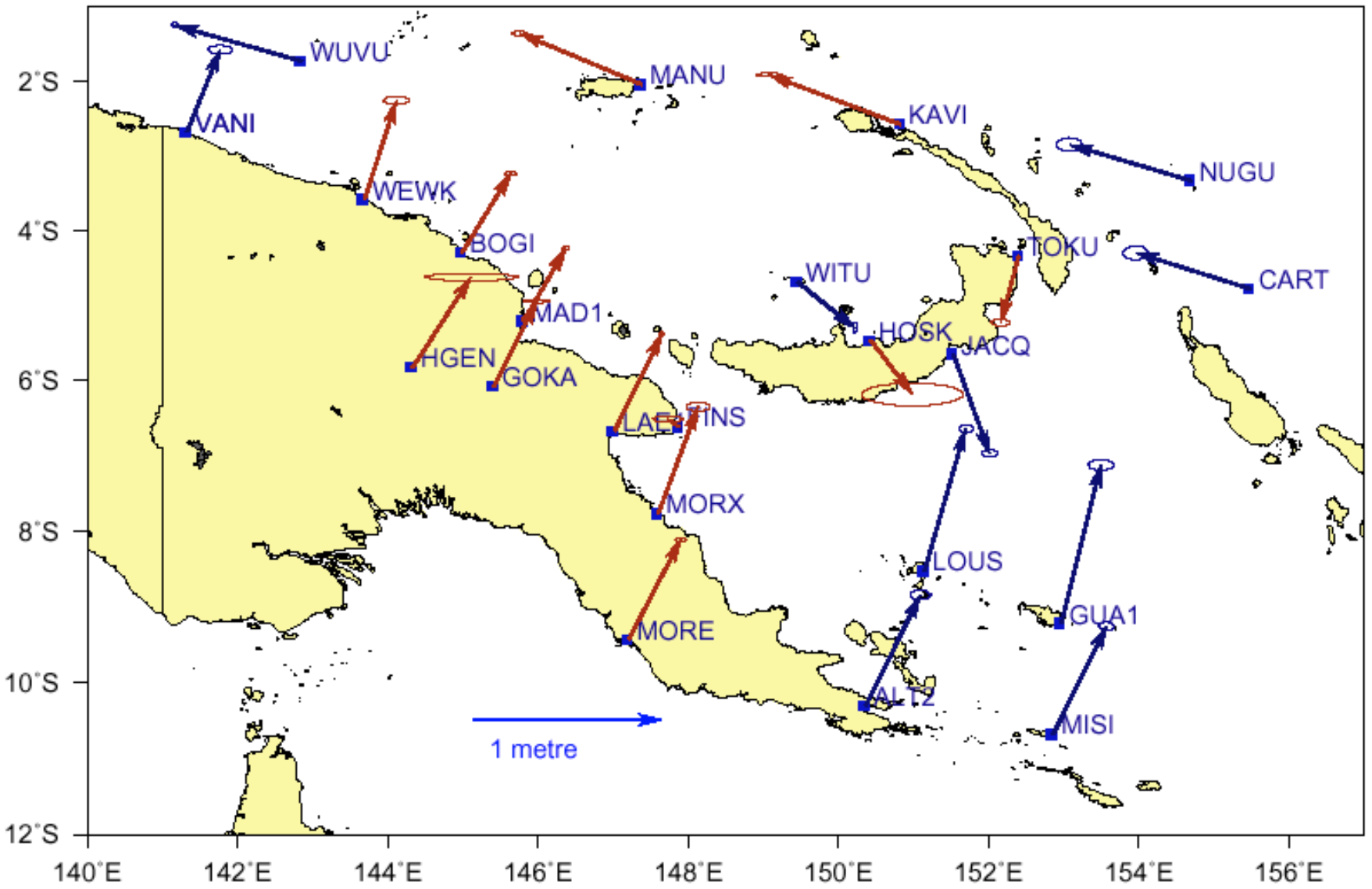


**Plot of the distortion of the PNG Geodetic Datum 1994 (PNG94) with respect to ITRF2000 between epochs 1994.0 and 2004.0 (Stanaway, 2003)**

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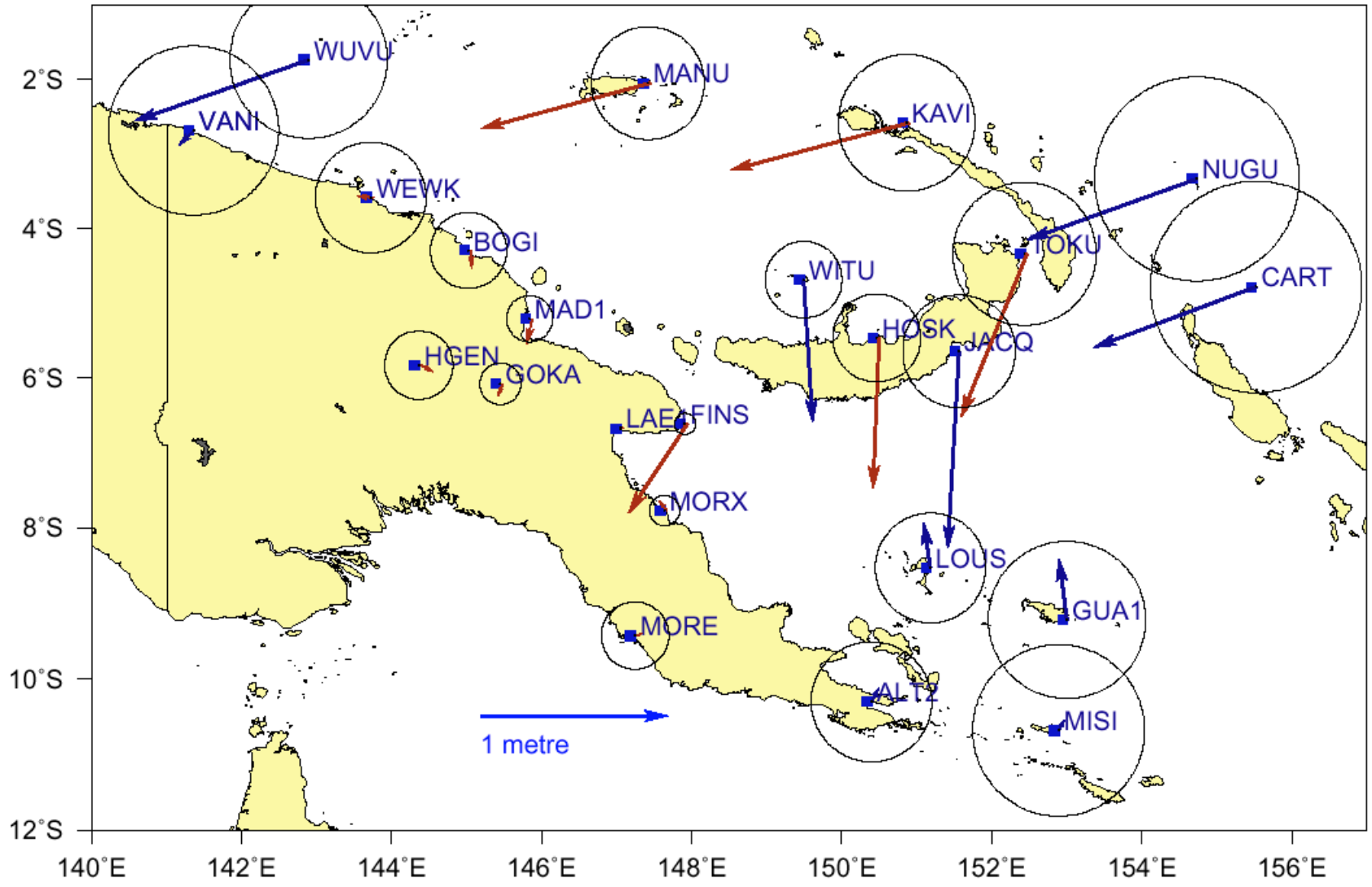


**Distortion of datum over 10 year period relative to LAE1 and error circles.**
**(from Stanaway, 2003)**

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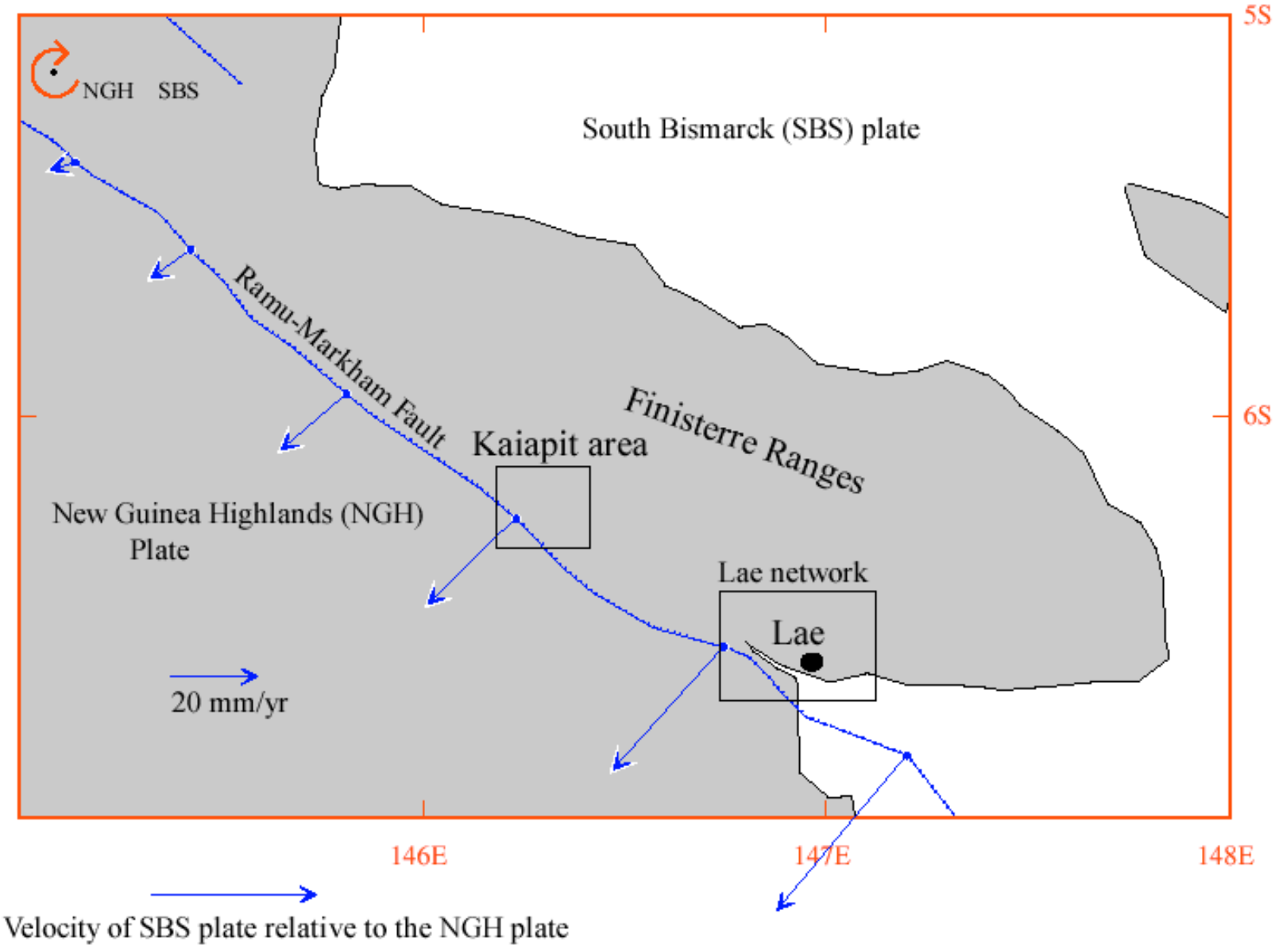


**(from Wallace, 2002)**

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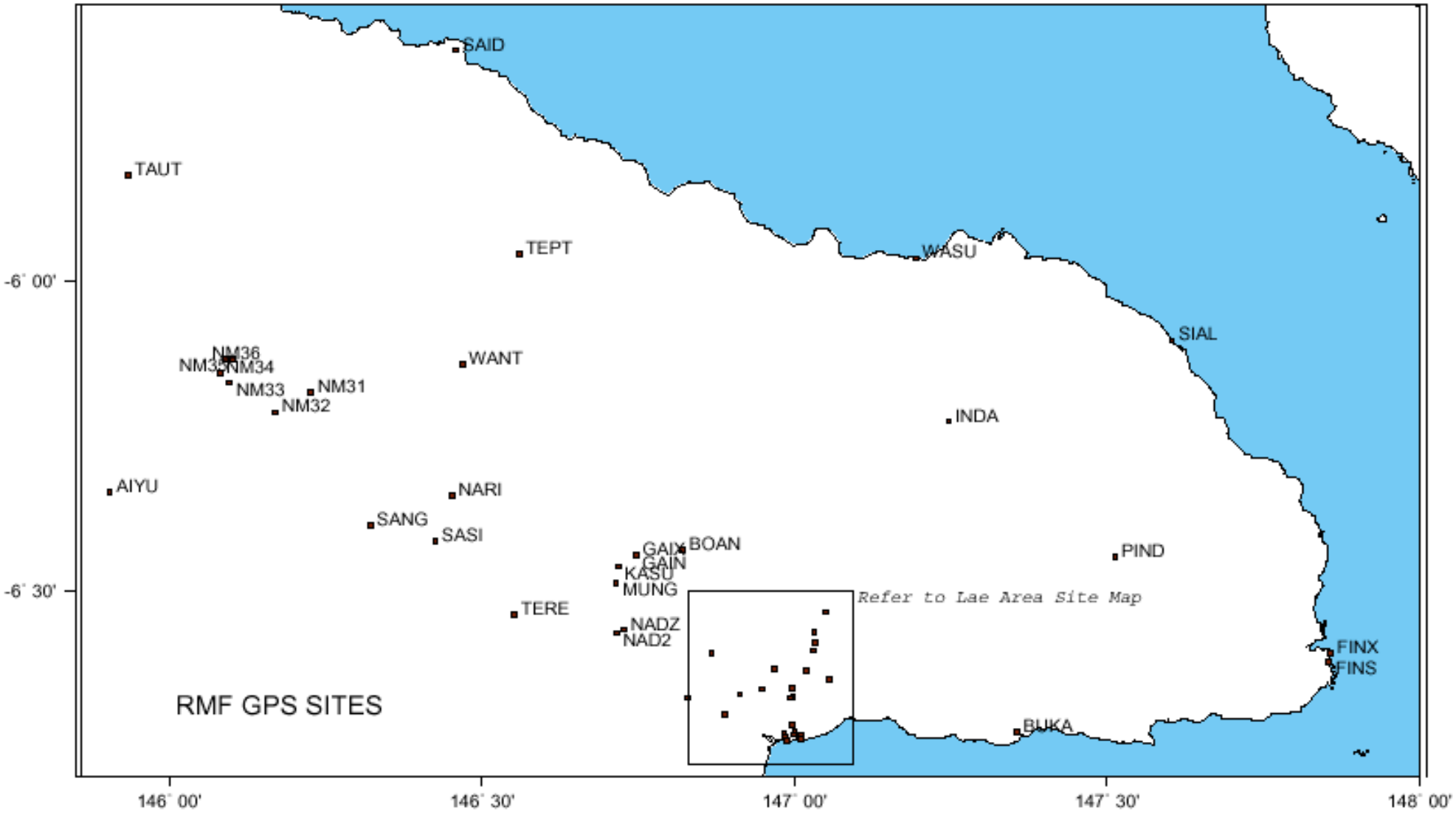


**GPS Sites along the Ramu-Markham Fault and the Huon Peninsula**

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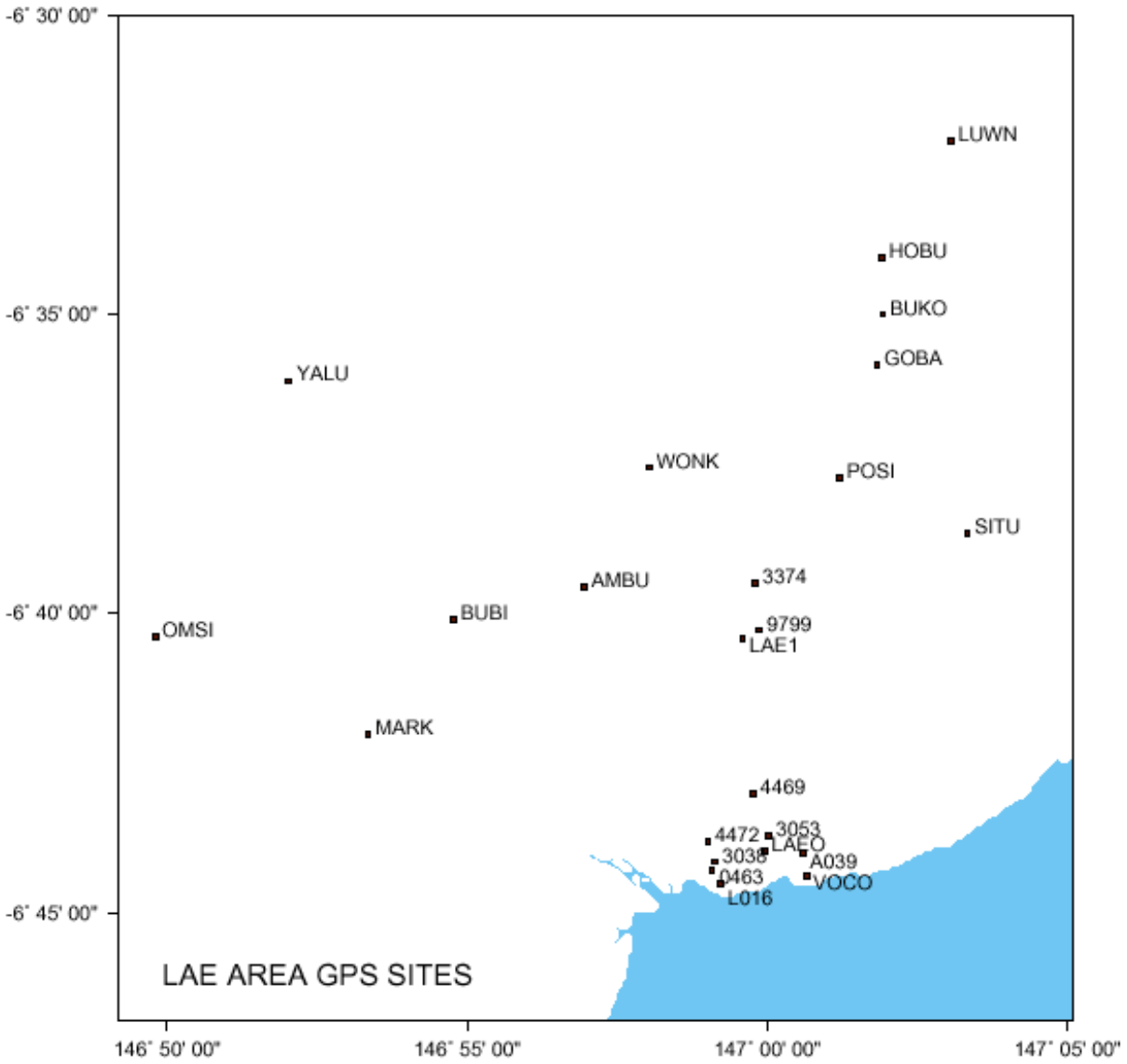


**GPS Sites in the Lae Urban area**

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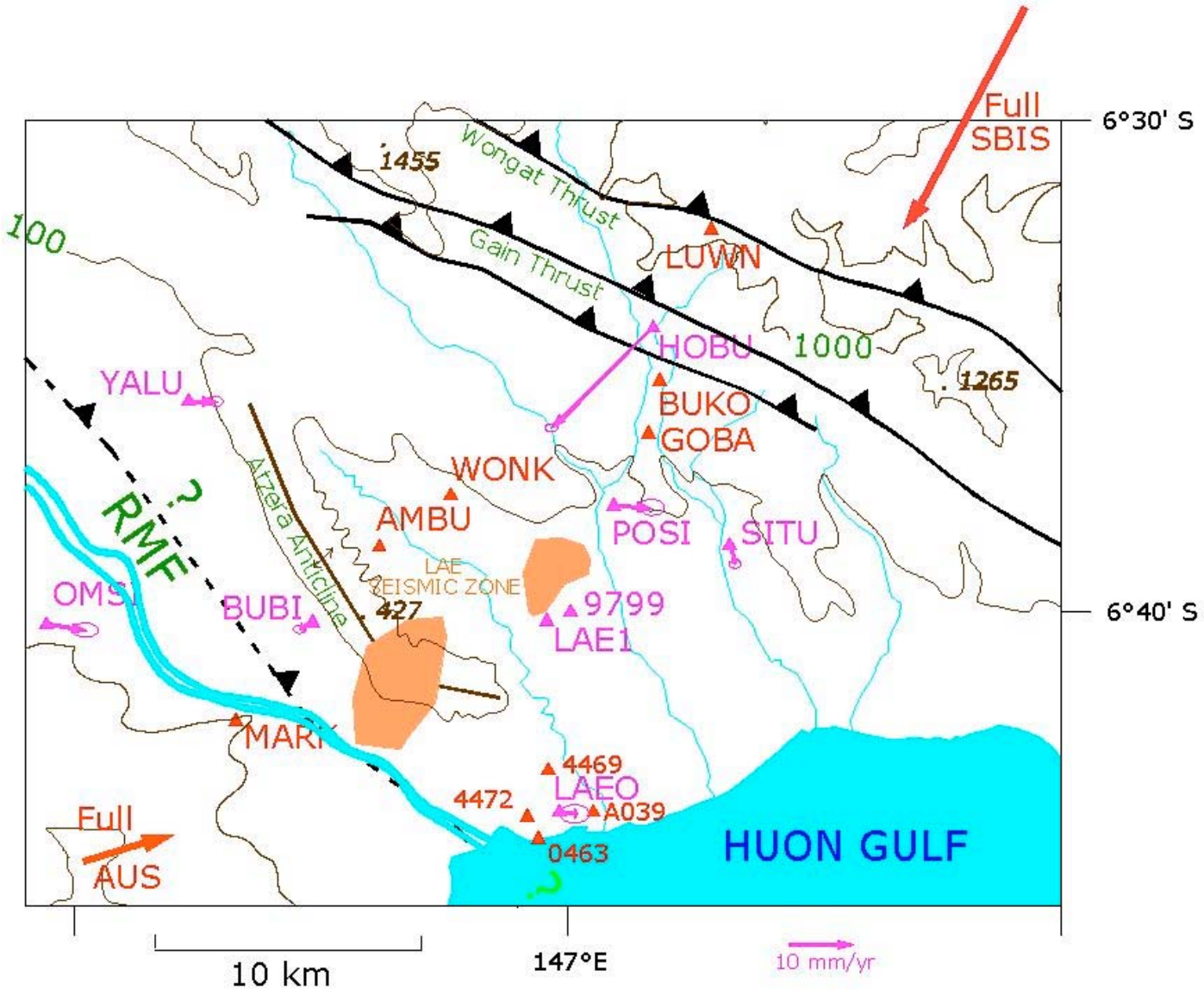


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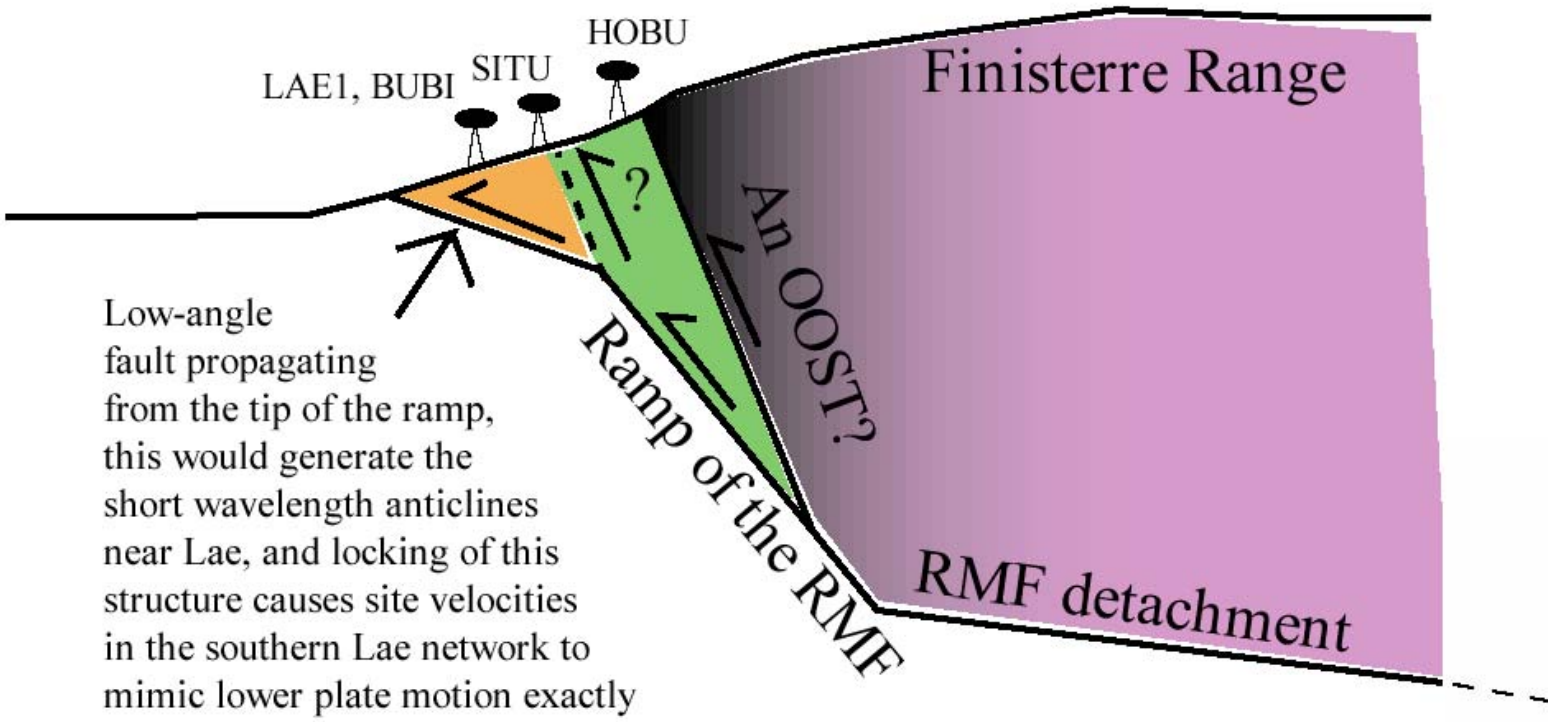
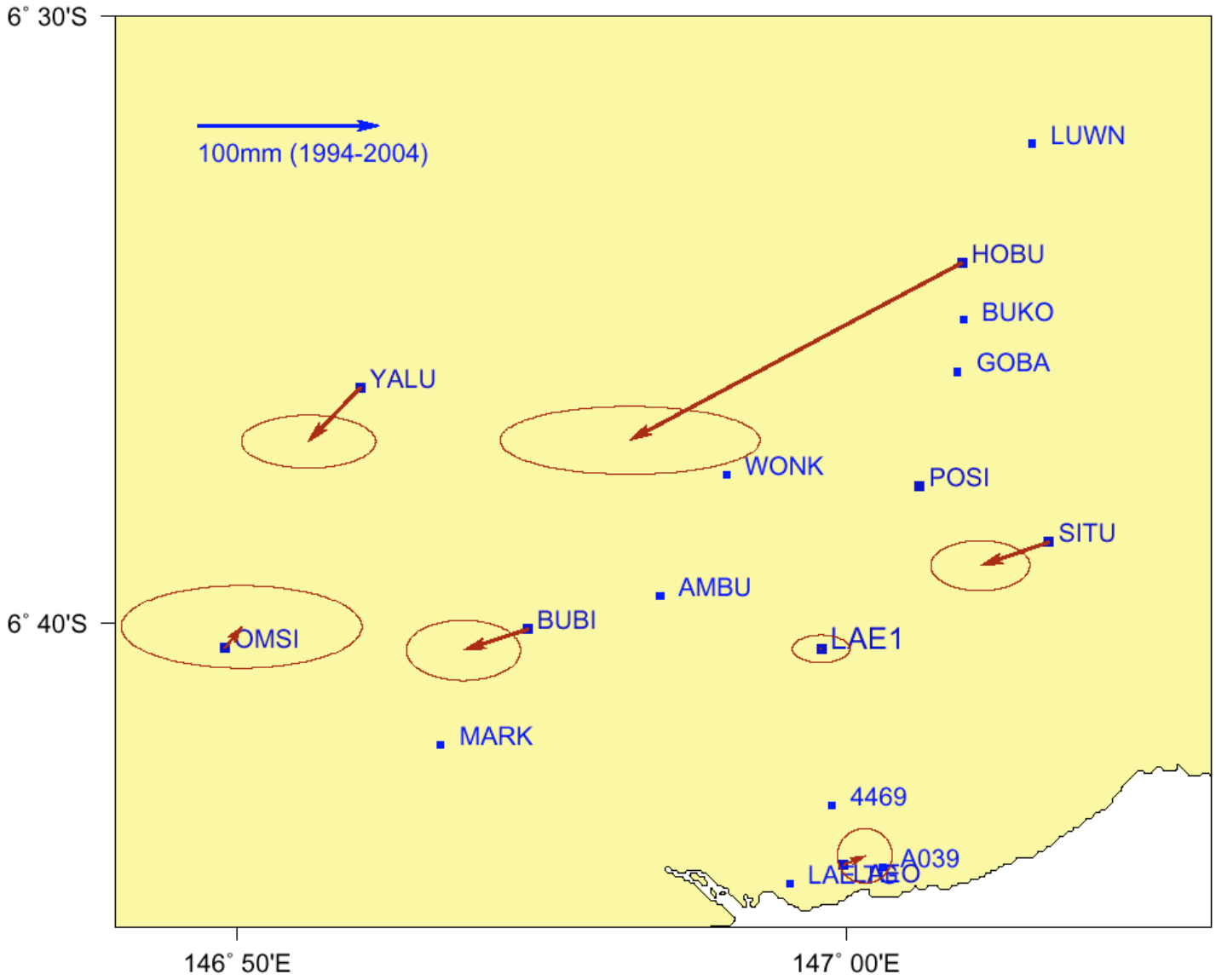



**Ramp detachment geometry across the RMFZ near Lae (from, Wallace, 2002);**




**Estimated displacement of sites from 1994.0 to 2004.0 in the vicinity of Lae, with respect to LAE1 (from Stanaway, 2003)**

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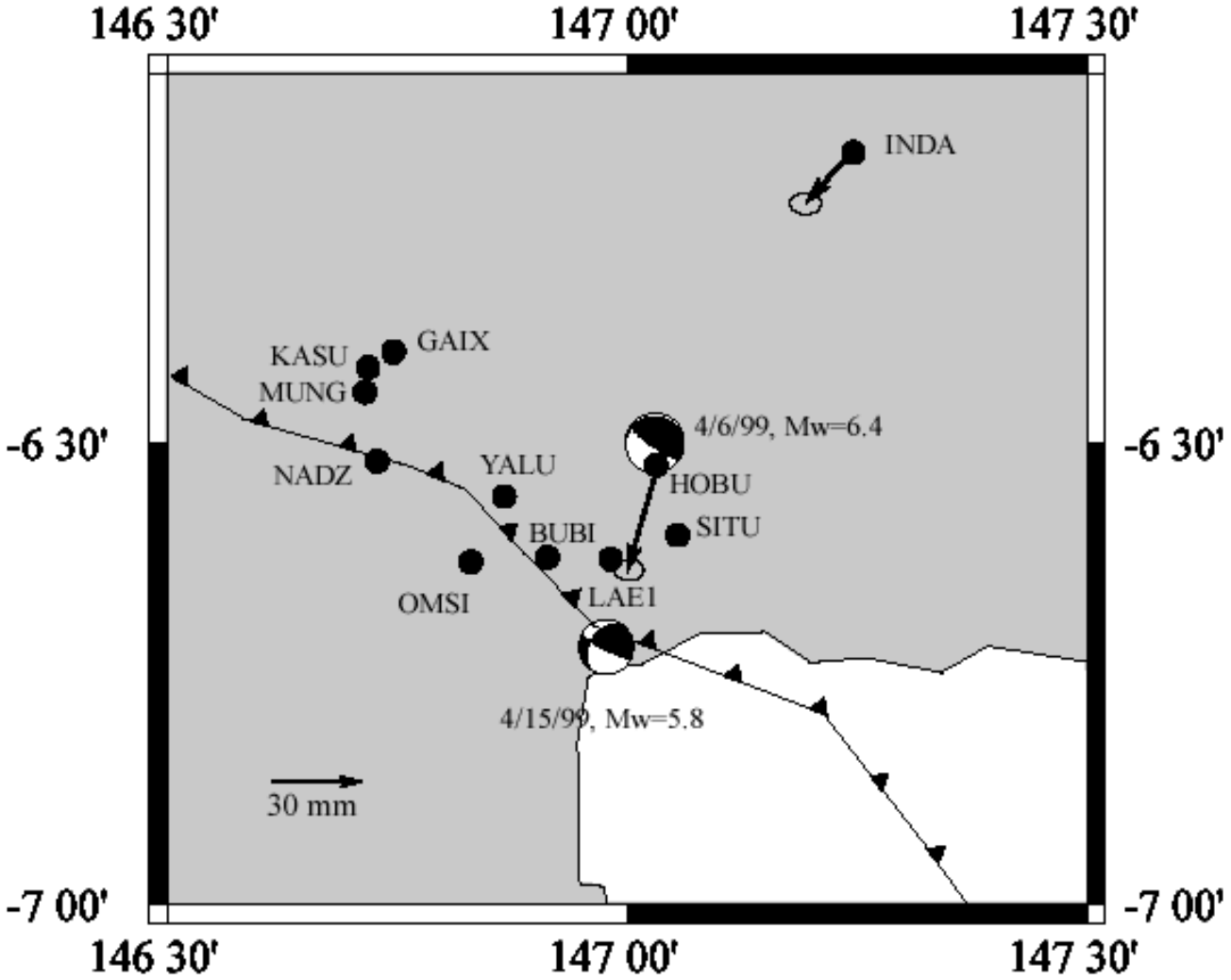


**6th April & 15th April 1999 earthquakes locations and coseismic displacement (from Wallace, 2002).**

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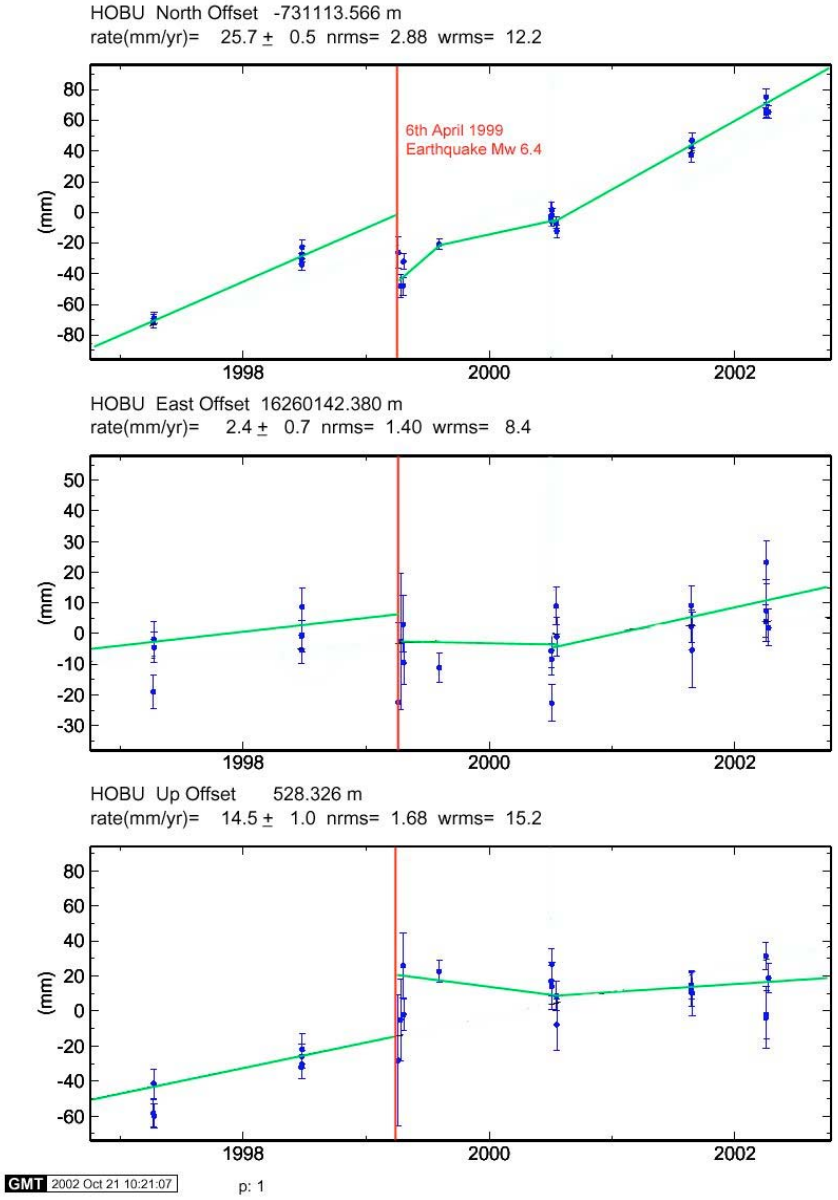


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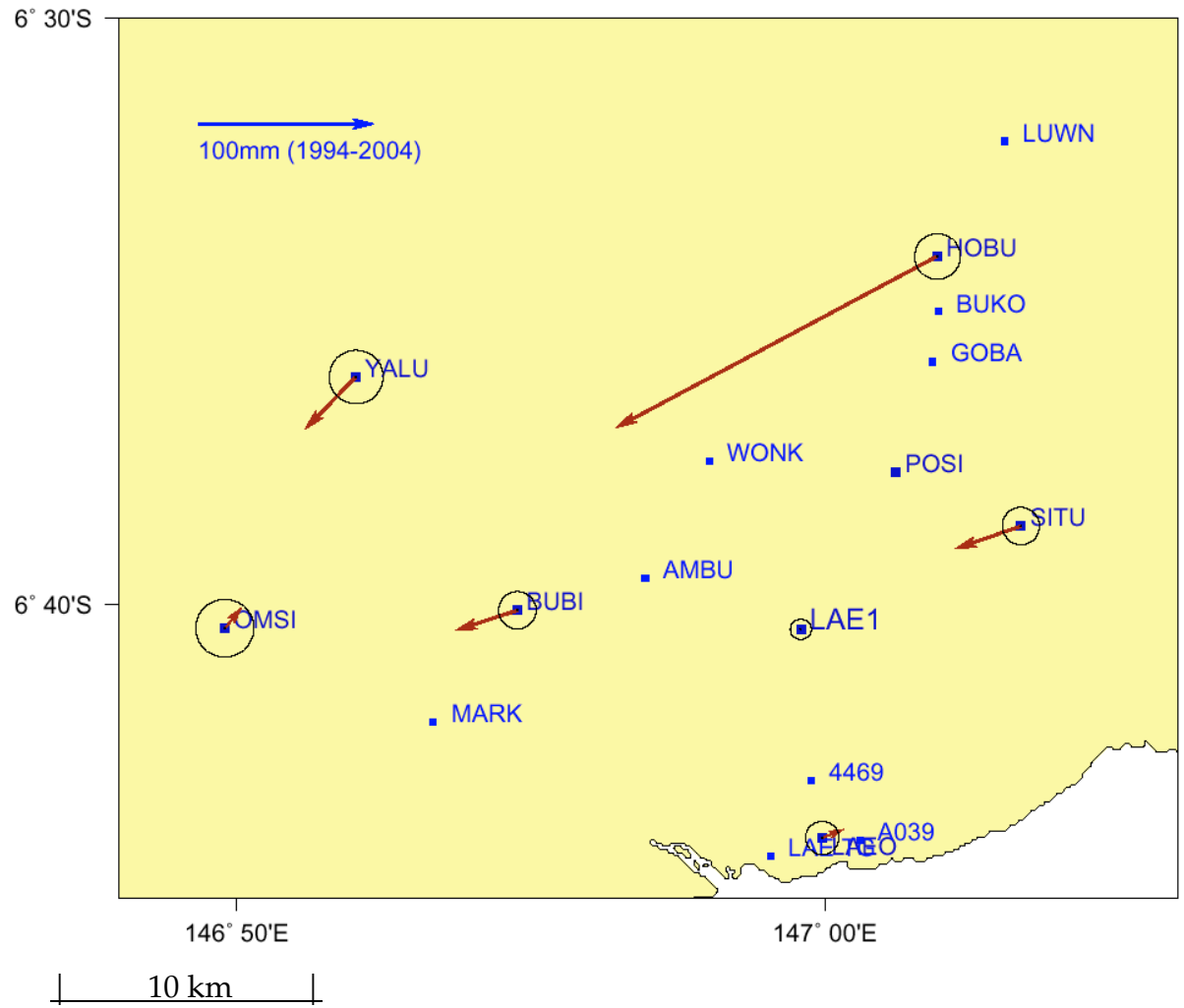


**Lae city geodetic datum distortion is measurable by surveyors over 10 years (from Stanaway, 2003)**

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## Ongoing joint projects between ANU and Unitech

- **Annual GPS observations and analysis of the Lae network**
  **(student projects – GPS control surveys)**
- **Annual precise levelling/GPS tie between Lae tide gauge and the LAE1 permanent GPS base station**
  **(major student project for 3 students)**
- **Rapid response GPS surveys to capture displacement resulting from major earthquakes in PNG**
- **Participation in PNG crustal motion surveys**
  **(staff, student and logistic support)**

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# Considerations for Lae hazards

- Earthquake hazard is moderate in the Lae area
- Hazard should be considered in building code
- Wharf subsidence risk is high after major earthquake
- Landslide risk in surrounding hills is high
- Controls required on spread of settlements and ground clearance to mitigate landslide risk and sediment discharge into waterways!!

- Prediction is not yet possible!