

# The Lae Seismic Zone GNSS Survey 2023 - results and interpretation

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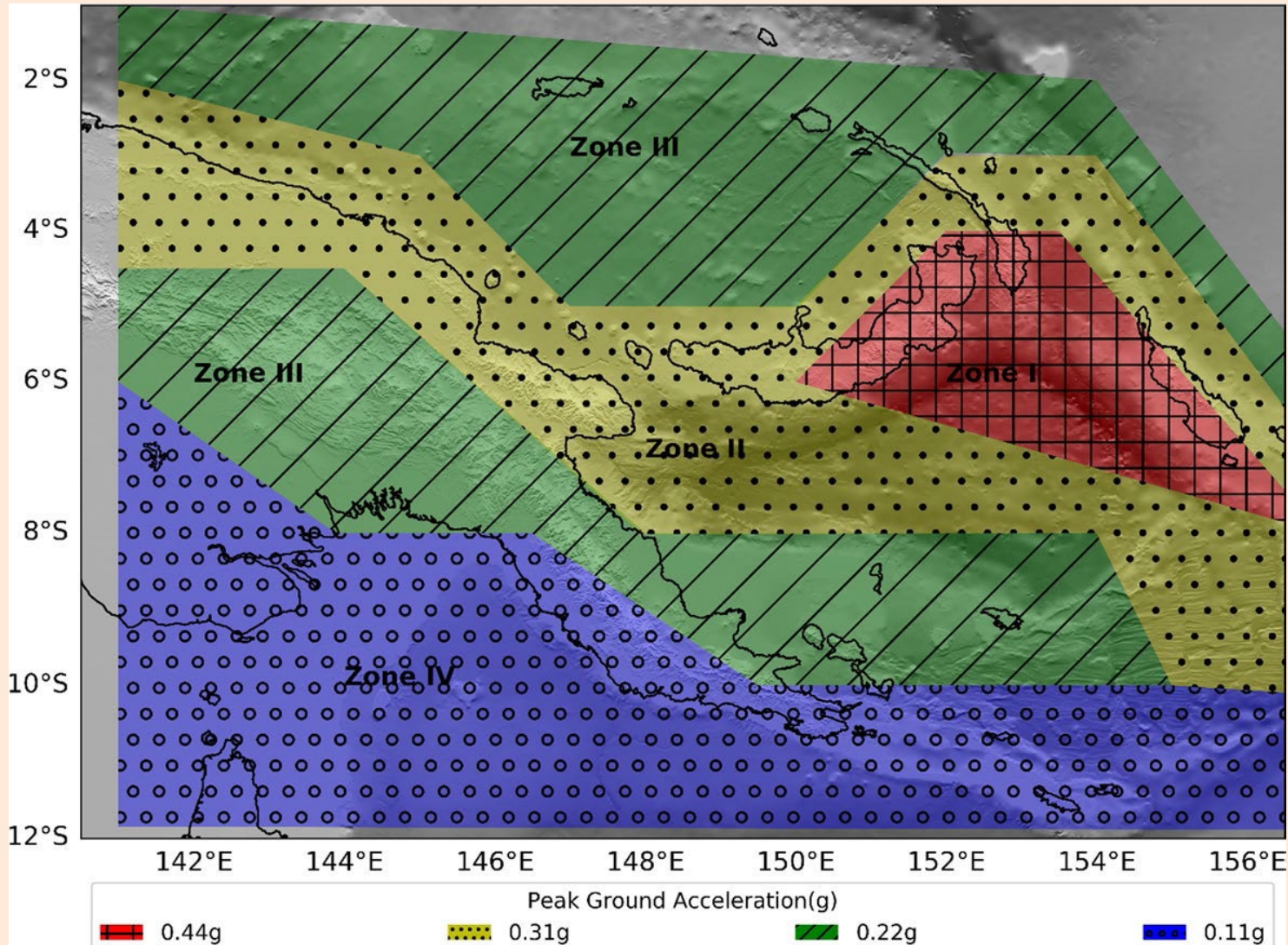
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# Seismic hazard map – 1982!



The seismic zoning map of the national building code of PNG (Jury et al. 1982)



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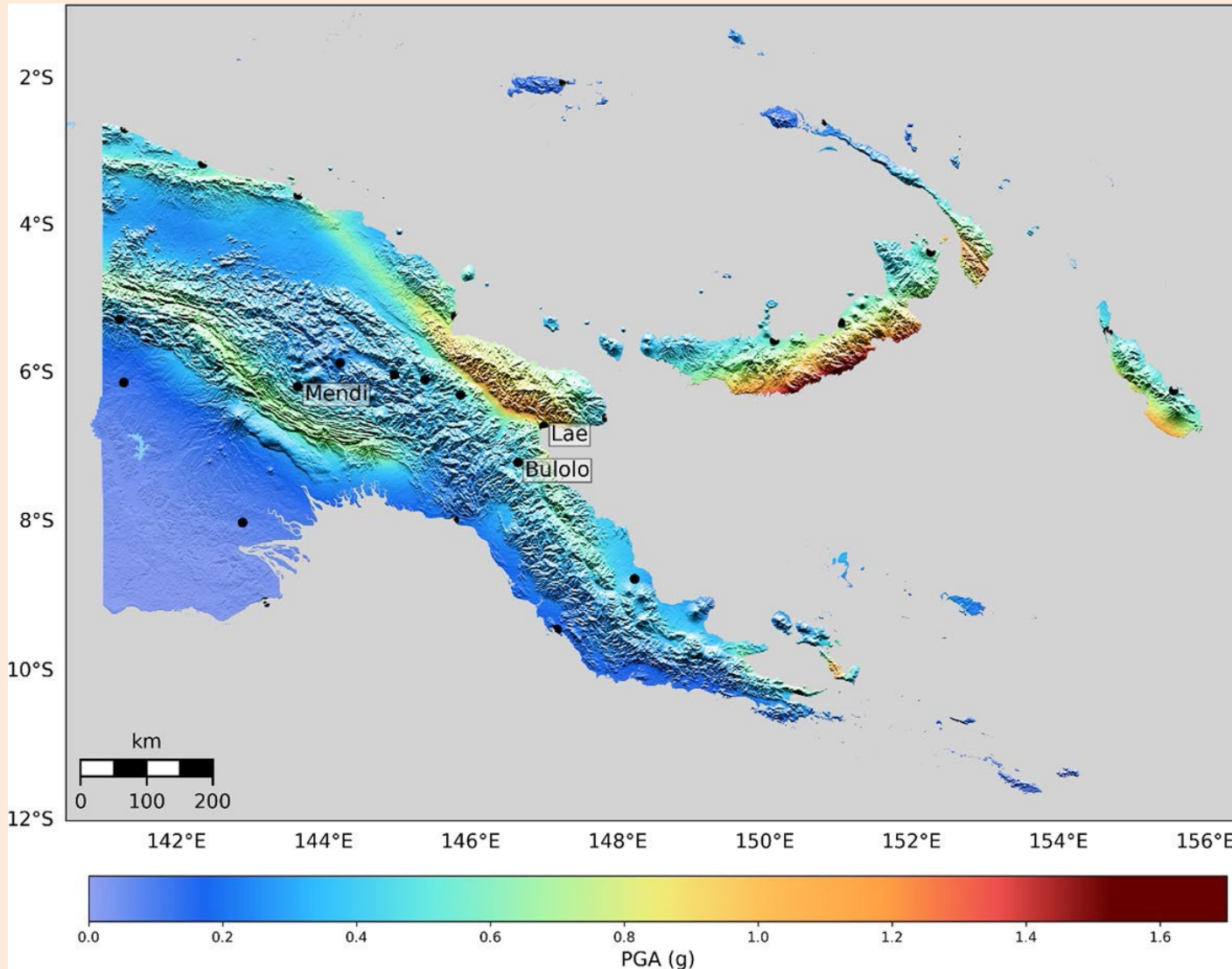
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# Seismic hazard map – 2020 update



Ghasemi et al.,  
2020  
Seismotectonic  
model and  
probabilistic  
seismic hazard  
assessment for  
Papua New  
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# Tectonics – time slice – 4 million years bp



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# Tectonics – time slice – 2023 - now



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# Tectonics – time slice – 4 million years future



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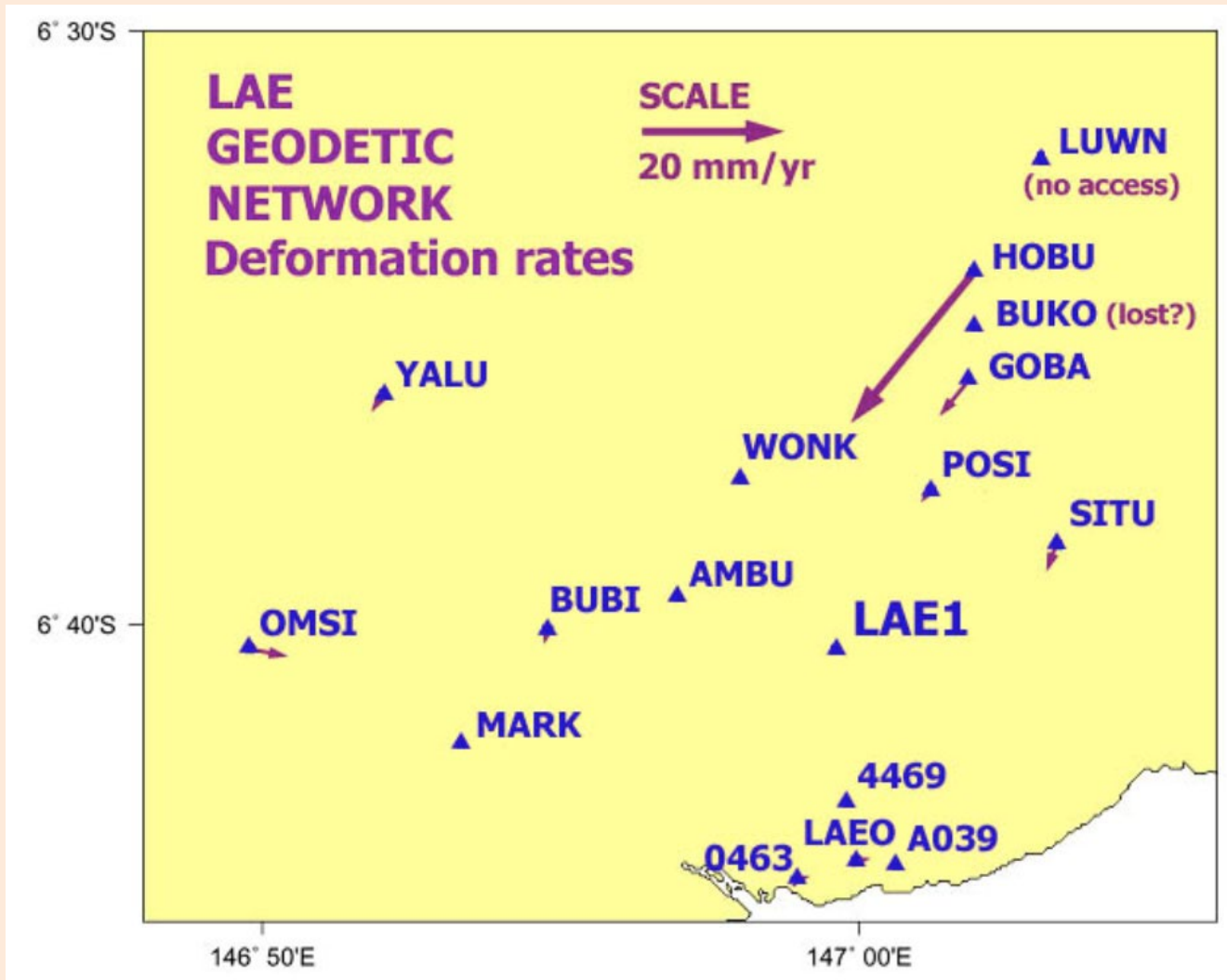
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# Lae deformation – DSLS Unitech study 2009



Interseismic velocities relative to a stable Australian Plate

Stanaway et al., 2009



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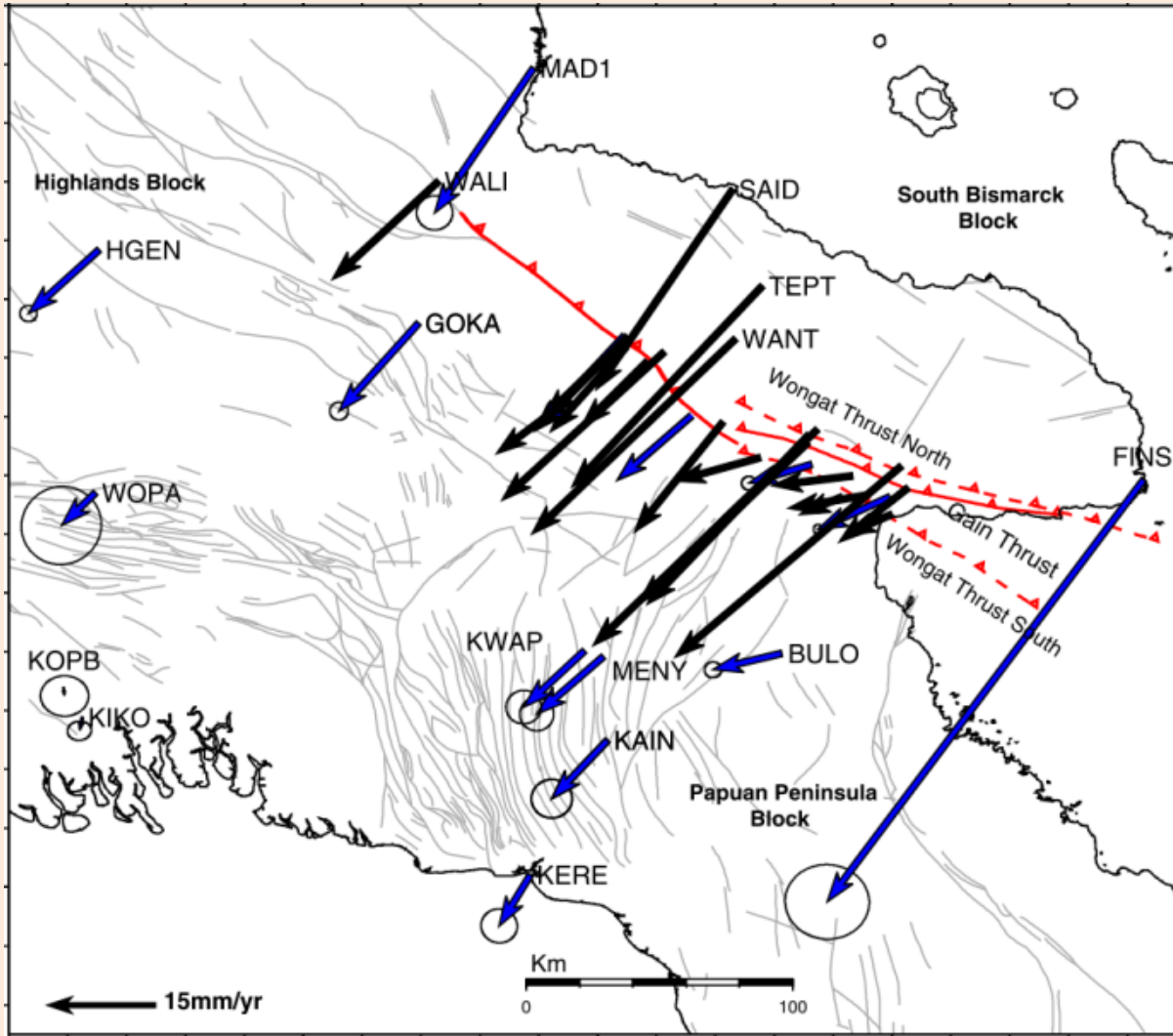
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# Tectonic site velocities – 2014 study



Interseismic velocities relative to a stable Australian Plate

Koulali et al., 2014



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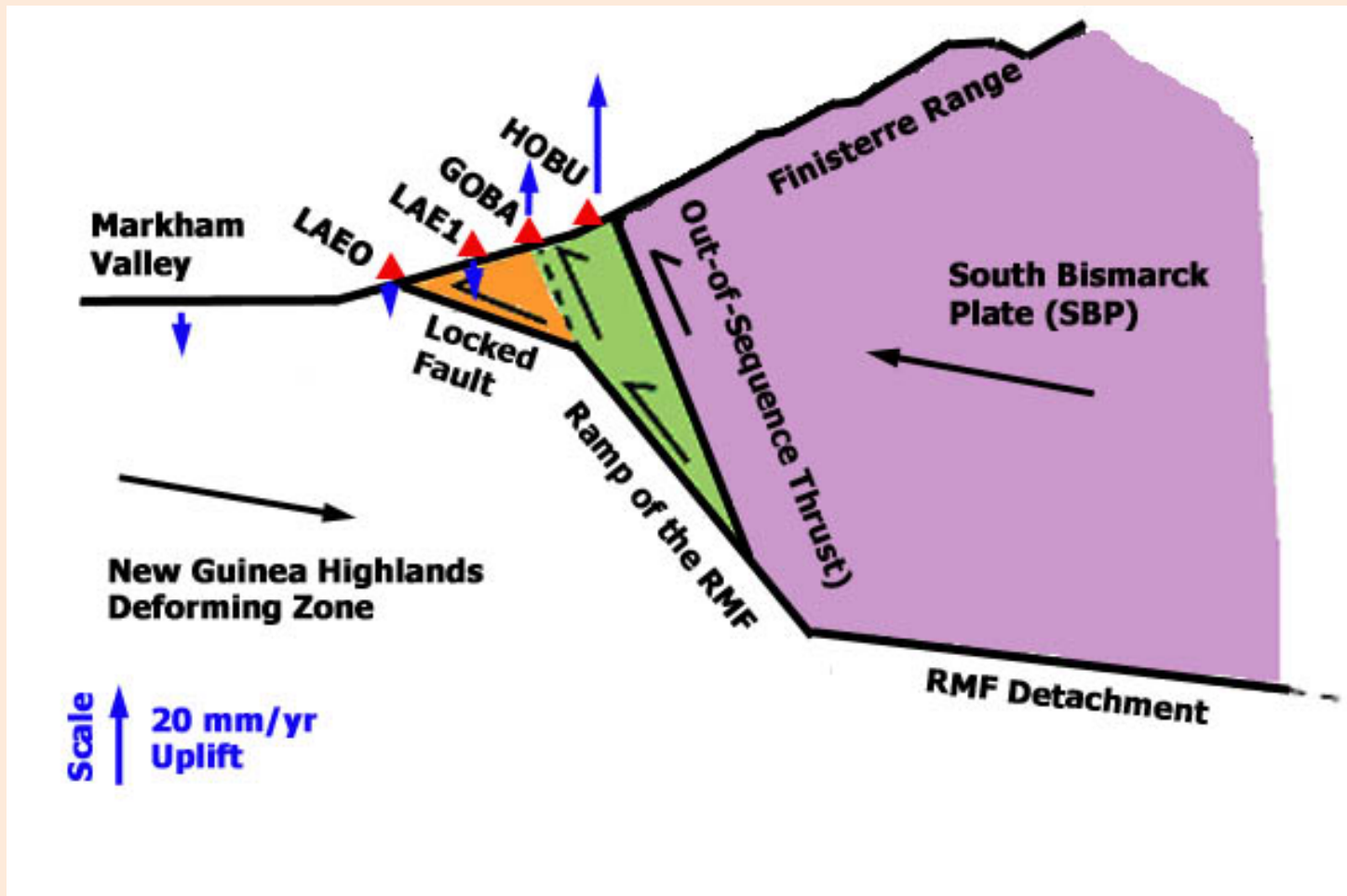


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# Lae city N-S cross-section of active deformation



Wallace et al, 2004 and Stanaway et al., 2009



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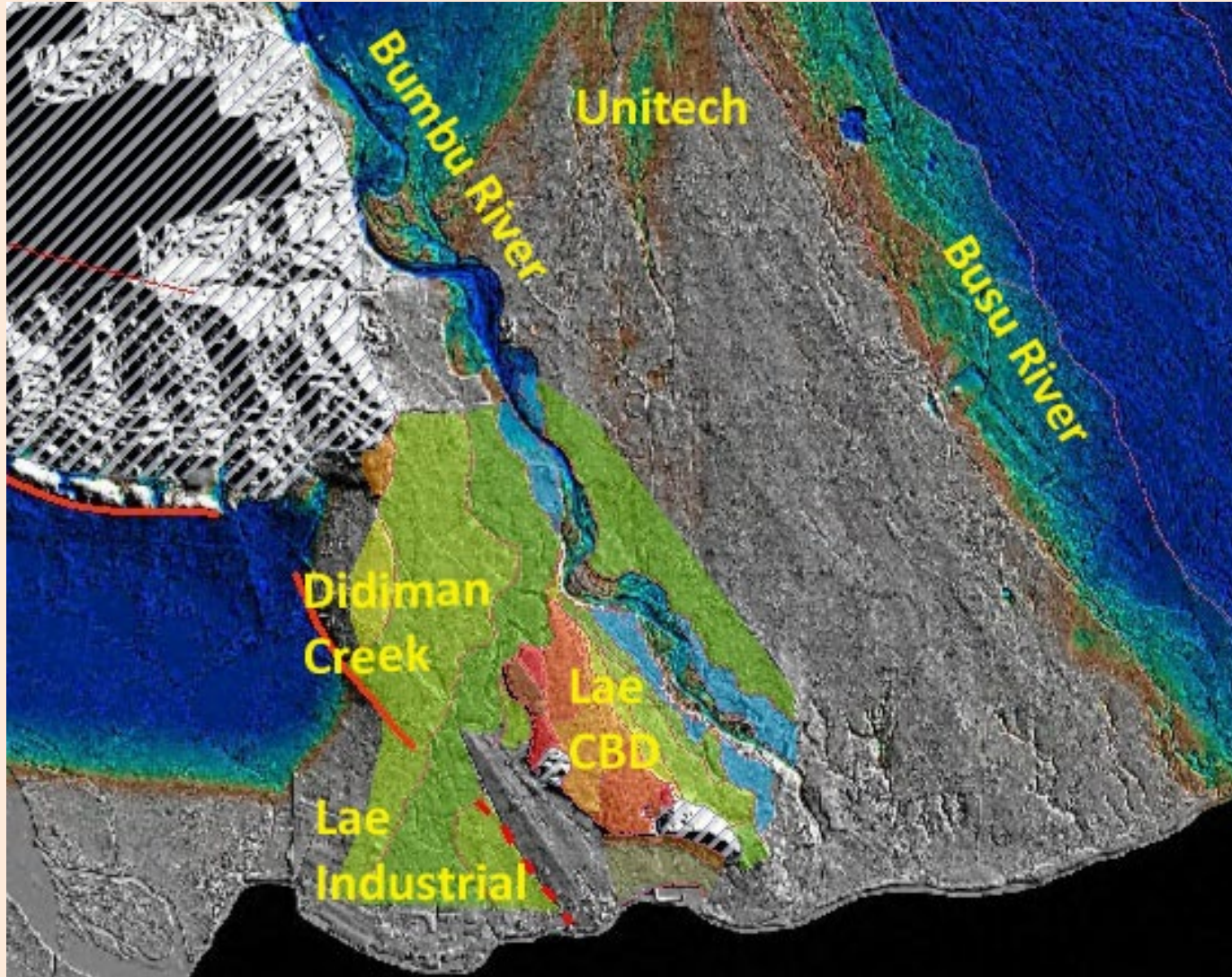
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# Lae geomorphology



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# Motivation for 2023 GNSS Survey

The PNG Government (DMPGM) requested assistance from the Australian Government (Geoscience Australia/DFAT) to improve hazard assessment in the Lae area.



Department of  
Surveying & Land Studies



Australian Government  
Geoscience Australia



PNGAus Partnership

Analysis by  
Richard Stanaway

Identified geodetic monitoring network

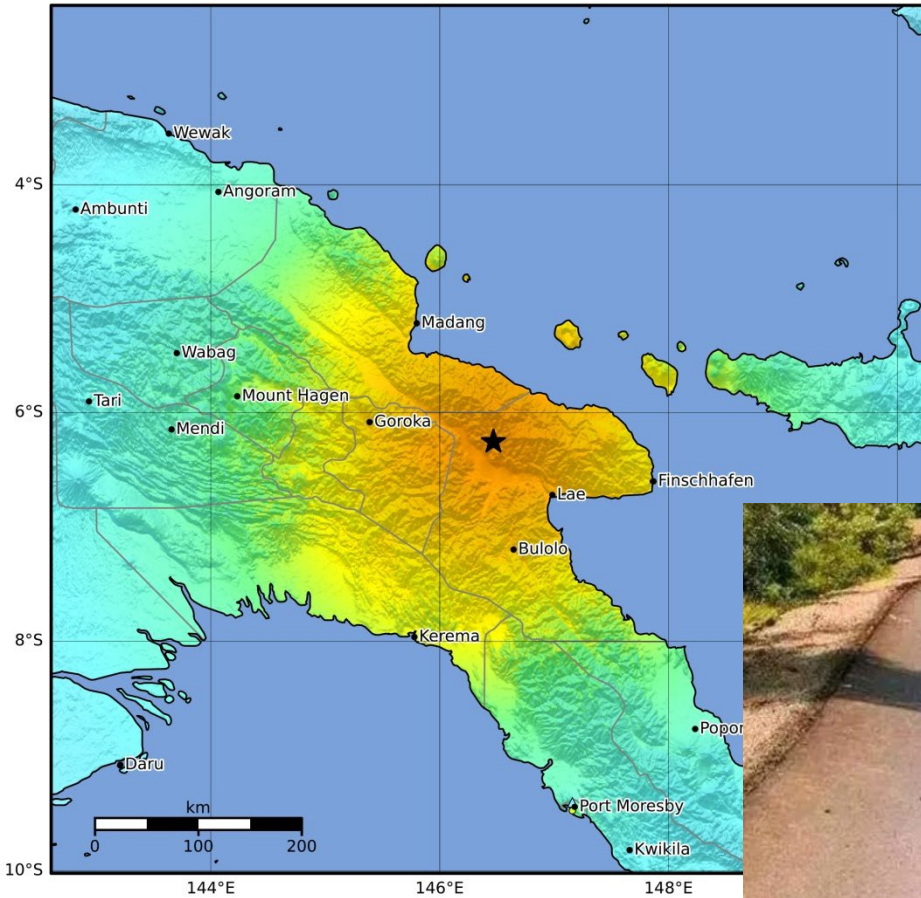


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Macroseismic Intensity Map USGS  
 ShakeMap: 66 km E of Kainantu, Eastern Highlands, PG  
 Sep 10, 2022 23:46:57 UTC M7.6 S6.26 E146.47 Depth: 90.0km ID:us6000iitd



# Mw 7.6 Wantoat earthquake 11 September 2022



| SHAKING   | Not felt | Weak   | Light | Moderate   | Strong | Very strong | Severe         |
|-----------|----------|--------|-------|------------|--------|-------------|----------------|
| DAMAGE    | None     | None   | None  | Very light | Light  | Moderate    | Moderate/heavy |
| PGA(%g)   | <0.0464  | 0.297  | 2.76  | 6.2        | 11.5   | 21.5        | 40.1           |
| PGV(cm/s) | <0.0215  | 0.135  | 1.41  | 4.65       | 9.64   | 20          | 41.4           |
| INTENSITY | I        | II-III | IV    | V          | VI     | VII         | VIII           |

Scale based on Worden et al. (2012) Version 5: Processed  
 △ Seismic Instrument ○ Reported Intensity ★ Epicenter



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# LAE2 – new CORS at Unitech



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# **GNSS and Geodynamics Workshop – DSLS, Unitech and at OSG, DLPP, Waigani November 2022 - (supported by Geoscience Australia)**



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# GNSS fieldwork - DSLS Unitech



Phase 1  
January 2023

Phase 2  
March 2023

Pepekene



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# GNSS fieldwork – DSLS – Boat team – Morobe/Huon Peninsula



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# GNSS fieldwork - battery charging – village hospitality



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# GNSS fieldwork – DSLS – Markham Valley



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# Long hours – Lae CBD



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# Lae seismic GNSS some sites used



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# Locating old PSMs using – PPP on temporary reference marks (TRM)



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# Many PSMs – removed for road upgrades



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# Geodetic analysis

Raw GNSS data (Topcon tps format) converted to Rinex 2.11 30 second epoch  
Rinex file headers edited for antenna ARP height, antenna model and site ID  
After 2-3 weeks (IGS Final orbits) – submission to NRCan-PPP and AusPOS  
ITRF2020 coordinates at epoch of measurement and uncertainty 95% CI  
Historical (1994-2023) GPS measurements for network – mostly recovered  
Historical log sheets to correct Rinex headers (antenna type and ARP height)  
This is a VERY LABORIOUS and time consuming task  
Processing historical data with NRCan-PPP and AusPOS  
Transformation of earlier data ITRF to ITRF2020 using IERS parameters  
Time-series stacking of coordinates at each epoch of measurement  
Visual filtering and inspection of time series  
Isolation of coseismic offsets and spurious setups  
Local PP of local network observations (rapid static) ITRF epoch of measurement  
ITRF2020 velocity estimation (least squares) and coseismic offsets  
Velocities in stable Australian plate reference frame

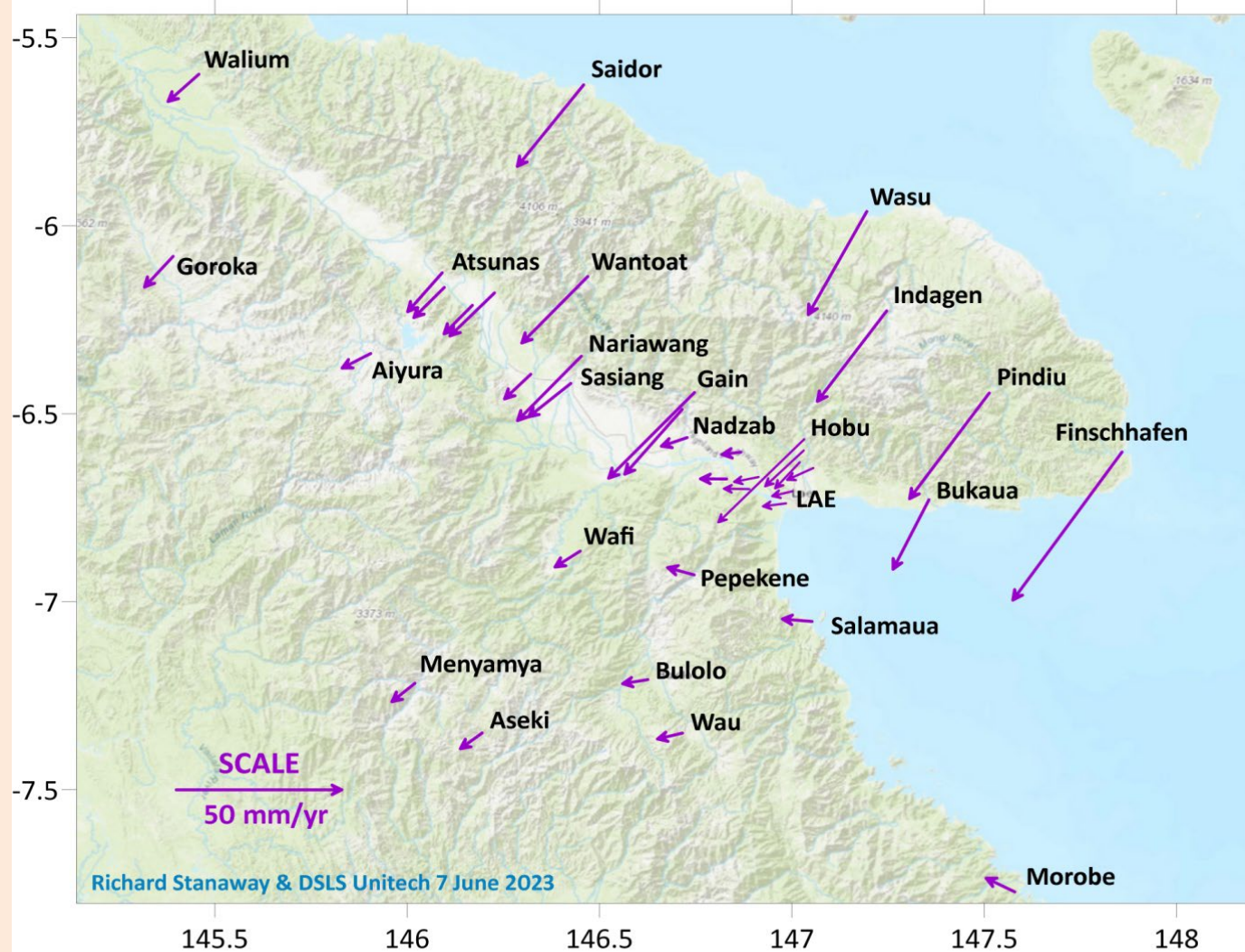


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# Initial results – velocities in Australian Plate frame



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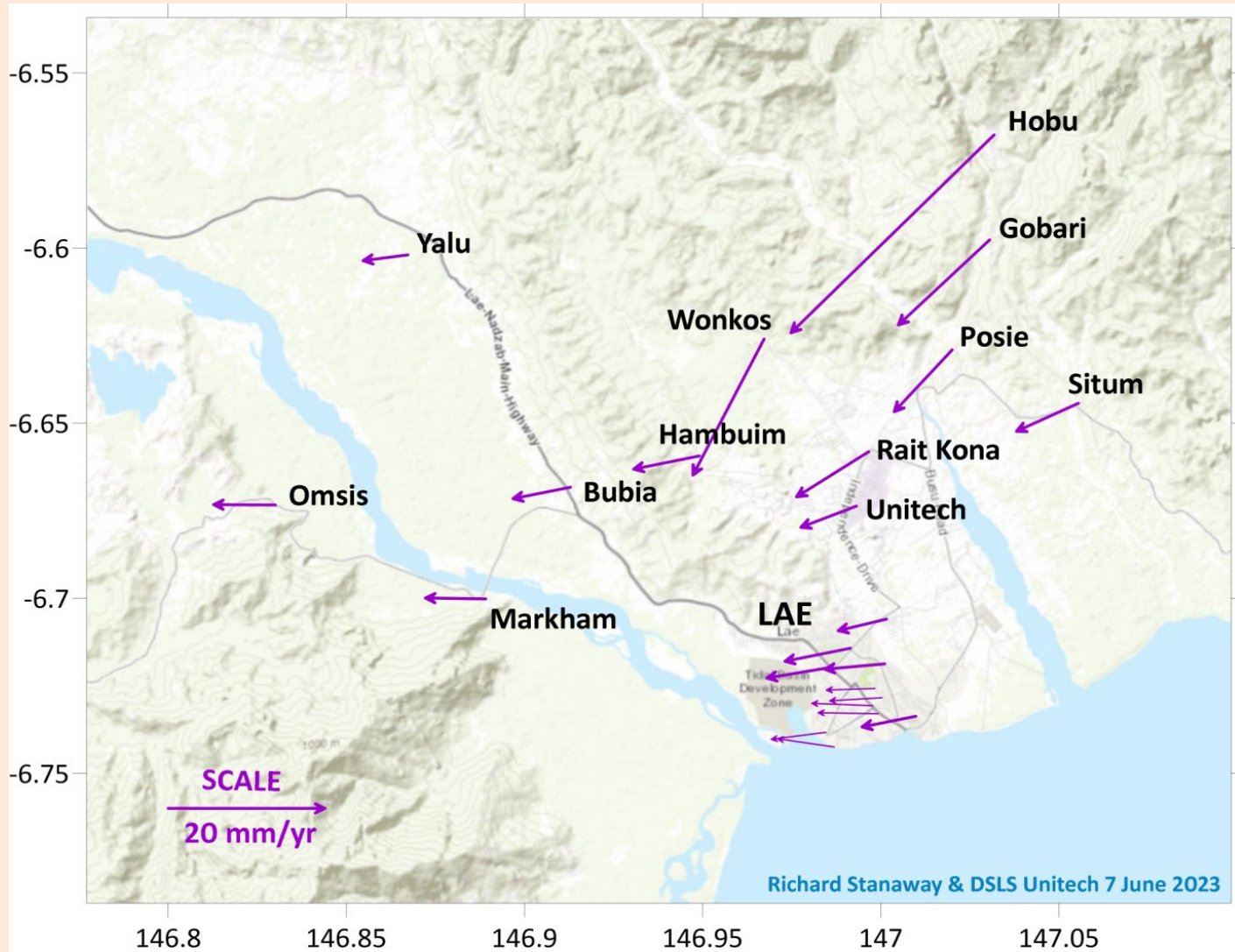


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# Lae area velocities in stable Australian Plate frame



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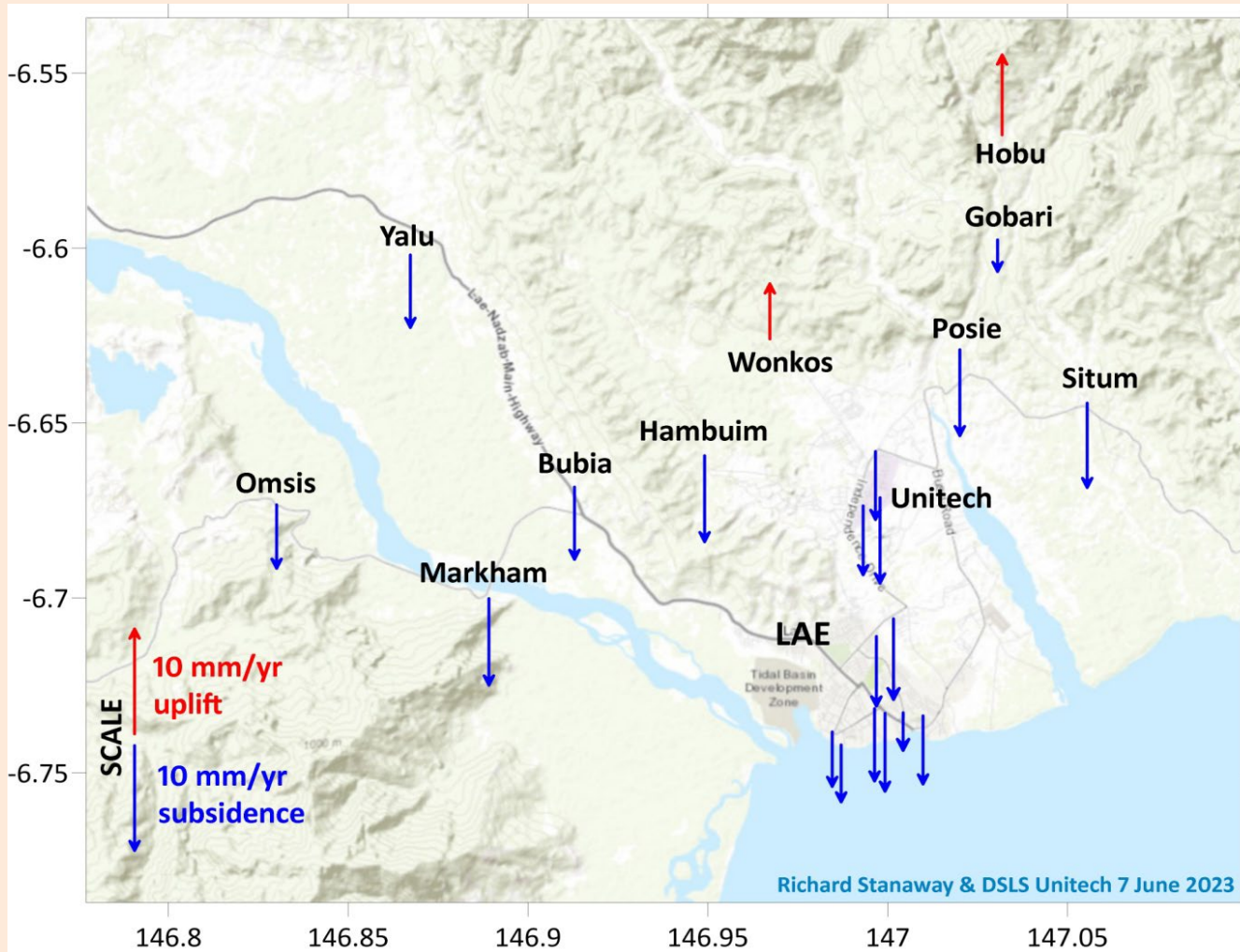
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# Vertical rates in Lae area



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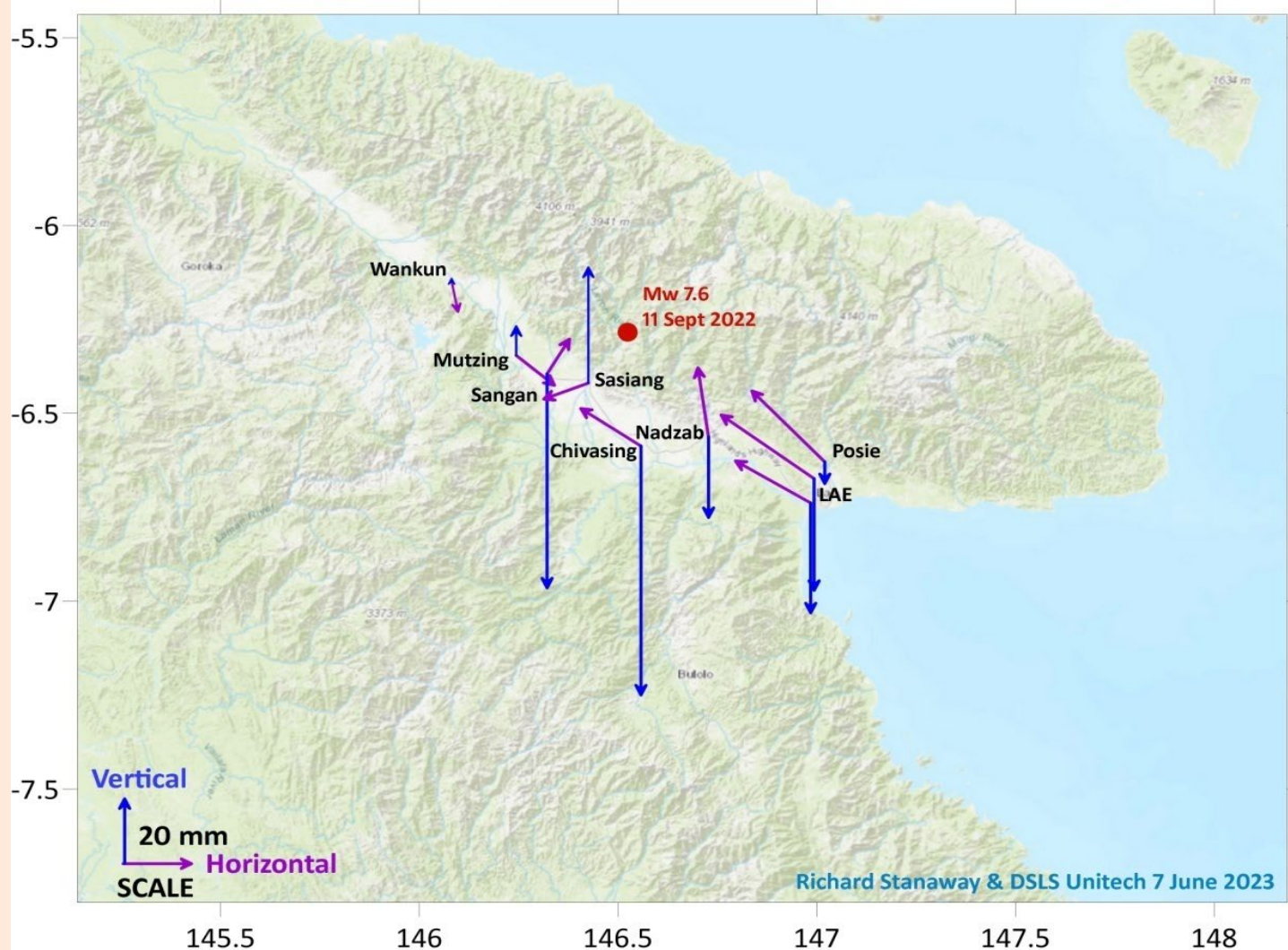
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# Coseismic displacement from 11 September 2022 eq.



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# Initial conclusions

Very high resolution of strain field in Lae city

40 mm/yr convergence between Hobu and Lae City  
(Gain and Wongat thrusts)

5 mm/yr convergence between Unitech and Lae City area  
7-9 mm/yr subsidence S of the active thrusts – suggests  
locking of RMFZ

Potential for significant uplift in a future earthquake in  
the Lae city area (evidenced by geological studies and  
sedimentary profiles/dating in Lae area)



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# Seismic GNSS survey is also a very large contribution to PNG2020 development – comprehensive survey of Lae and Morobe Province

Table A1. ITRF2020 coordinates at epoch 2020.0 (proposed PNG2020) of observed sites (decimal ellipsoidal coordinates and heights)

| Site ID | Station name | Location                   | ITRF2020 epoch 2020.0 (proposed PNG2020) |              |                      |
|---------|--------------|----------------------------|------------------------------------------|--------------|----------------------|
|         |              |                            | Latitude                                 | Longitude    | Ellipsoid height (m) |
| 0463    | PSM 20463    | LAE Wharf Gate             | -6.73829911                              | 146.98459396 | 76.098               |
| 2028    | PSM 32028    | LAE Earhart Memorial       | -6.73068099                              | 146.99774538 | 87.149               |
| 2029    | PSM 32029    | LAE Old Airstrip           | -6.73164628                              | 146.99636607 | 86.219               |
| 2030    | PSM 32030    | LAE Market                 | -6.73349563                              | 146.99357223 | 82.100               |
| 3012    | PSM 3012     | LAE Bugandi School         | -6.71399237                              | 146.98082227 | 84.128               |
| 3023    | PSM 3023     | LAE Kamkumung Geso Gedec   | -6.70596748                              | 147.00164394 | 99.598               |
| 3027    | PSM 3027     | LAE Top Town 1st Street    | -6.73281382                              | 147.00429985 | 104.722              |
| 3053    | PSM 3053     | LAE Top Town Coronation St | -6.72841780                              | 147.00035864 | 100.662              |
| 3374    | PSM 3374     | LAE Rait Kona              | -6.65816452                              | 146.99662723 | 140.940              |
| 9799    | PSM 9799     | LAE Unitech Rugby          | -6.67136816                              | 146.99788855 | 130.172              |
| A039    | AA 039       | LAE Mt Lunaman             | -6.73370532                              | 147.00984619 | 169.605              |
| AVU1    | PSM 15257    | AVUWA GI Airstrip          | -6.22884082                              | 145.99501887 | 1707.006             |



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# Thank you!



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