

43rd Association of Surveyors PNG Congress
Lae International Hotel, Lae
12th - 15th August 2009

Lae, a City caught between two plates

15 Years of Deformation measurements with GPS

Richard Stanaway *QUICKCLOSE*

Laura Wallace, GNS, NZ

Zebedee Sombo,

Johnson Peter, Trevor Palusi,

Ben Safomea and John Nathan

Department of Surveying and Land Studies

Papua New Guinea

University of Technology

University of California (Santa Cruz)

Colleen Stevens, Laura Wallace, Eli Silver
and other staff/students

Research School of Earth Sciences The Australian National University

Paul Tregoning, Richard Stanaway

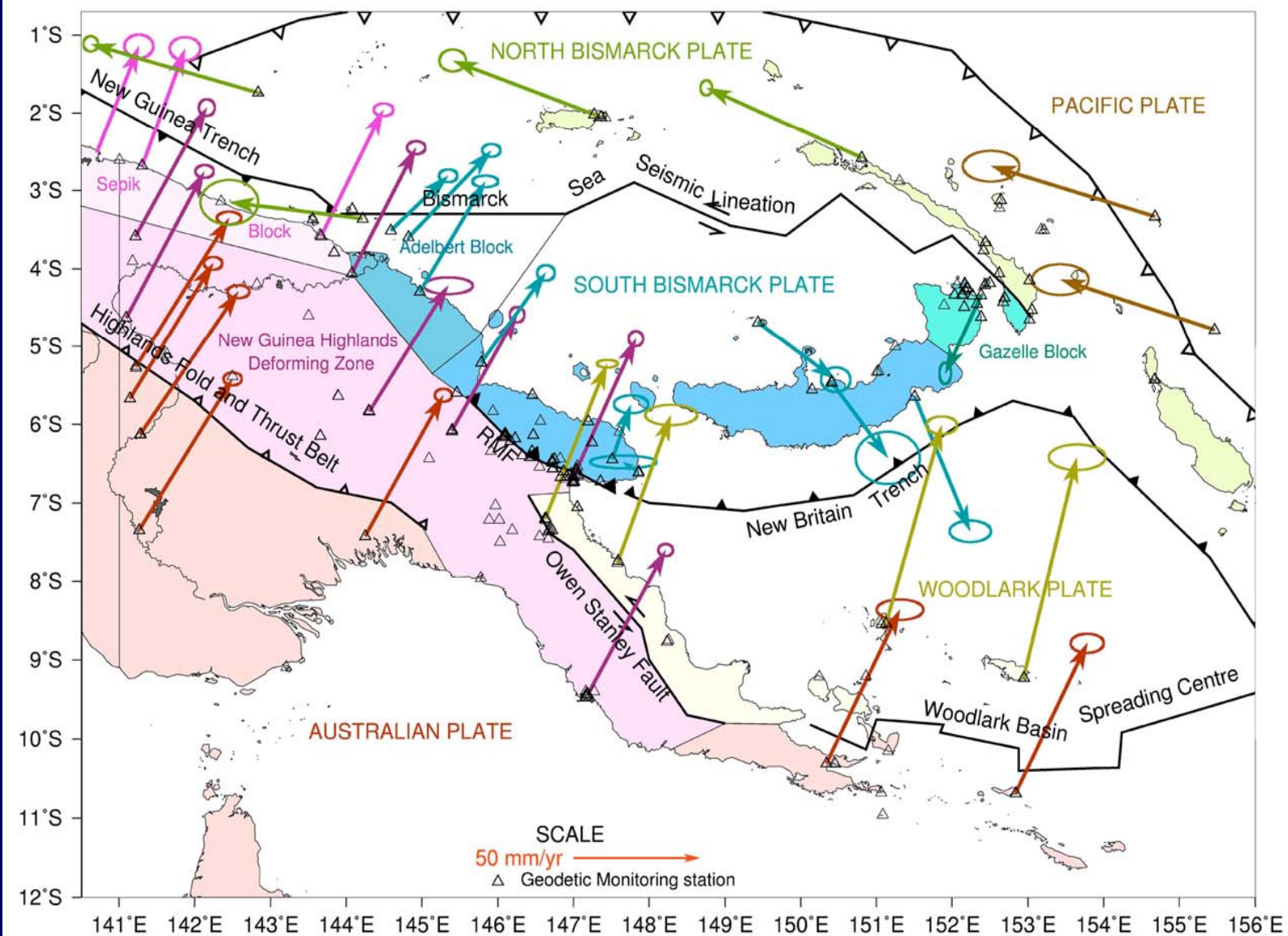
Department of Surveying & LS, Unitech

Russell Jackson, Bob Curley, Rod Little, Suvenia
Hasiata, Sylvester Tiki, the late Jones Taugaloidi,
other staff and numerous students

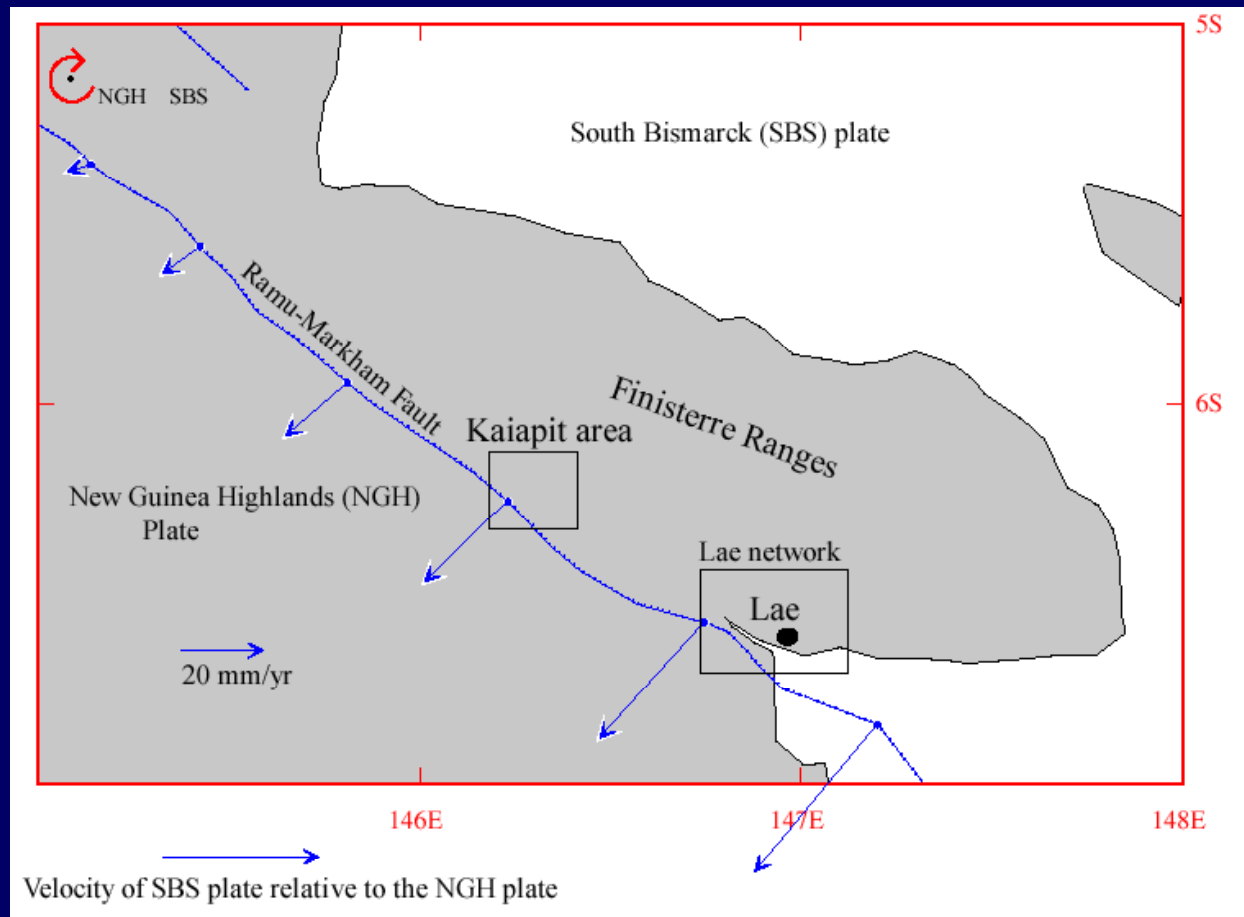
PNG National Mapping Bureau

Robert Rosa, John Kwasi, Wesley Loratung,
Peter Pako and other NMB Surveyors

Melchior Karesa - chainman



Tectonic Plates in PNG



Relative motion of South Bismarck Plate



4 million years before present



now

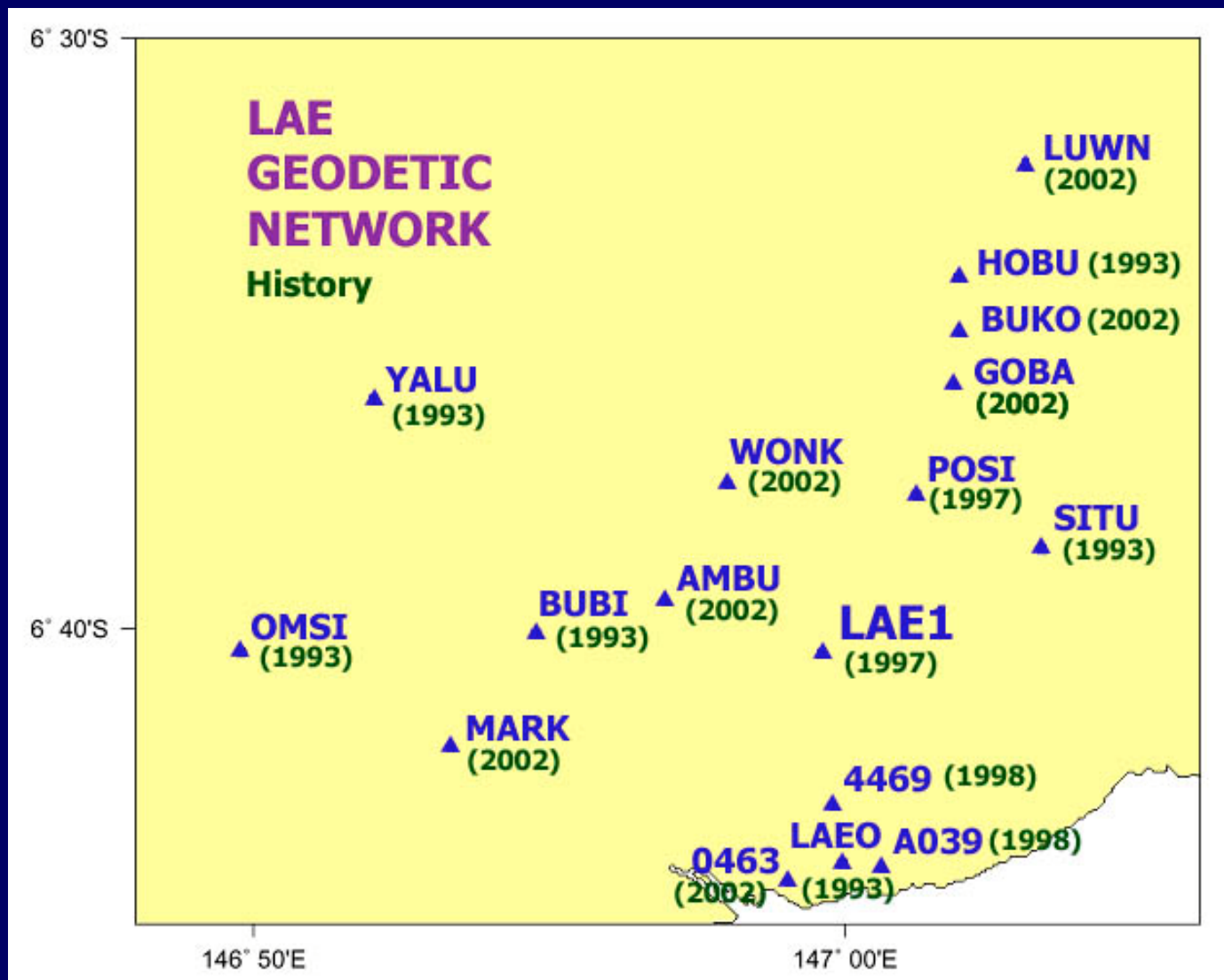


4 million years in the future?

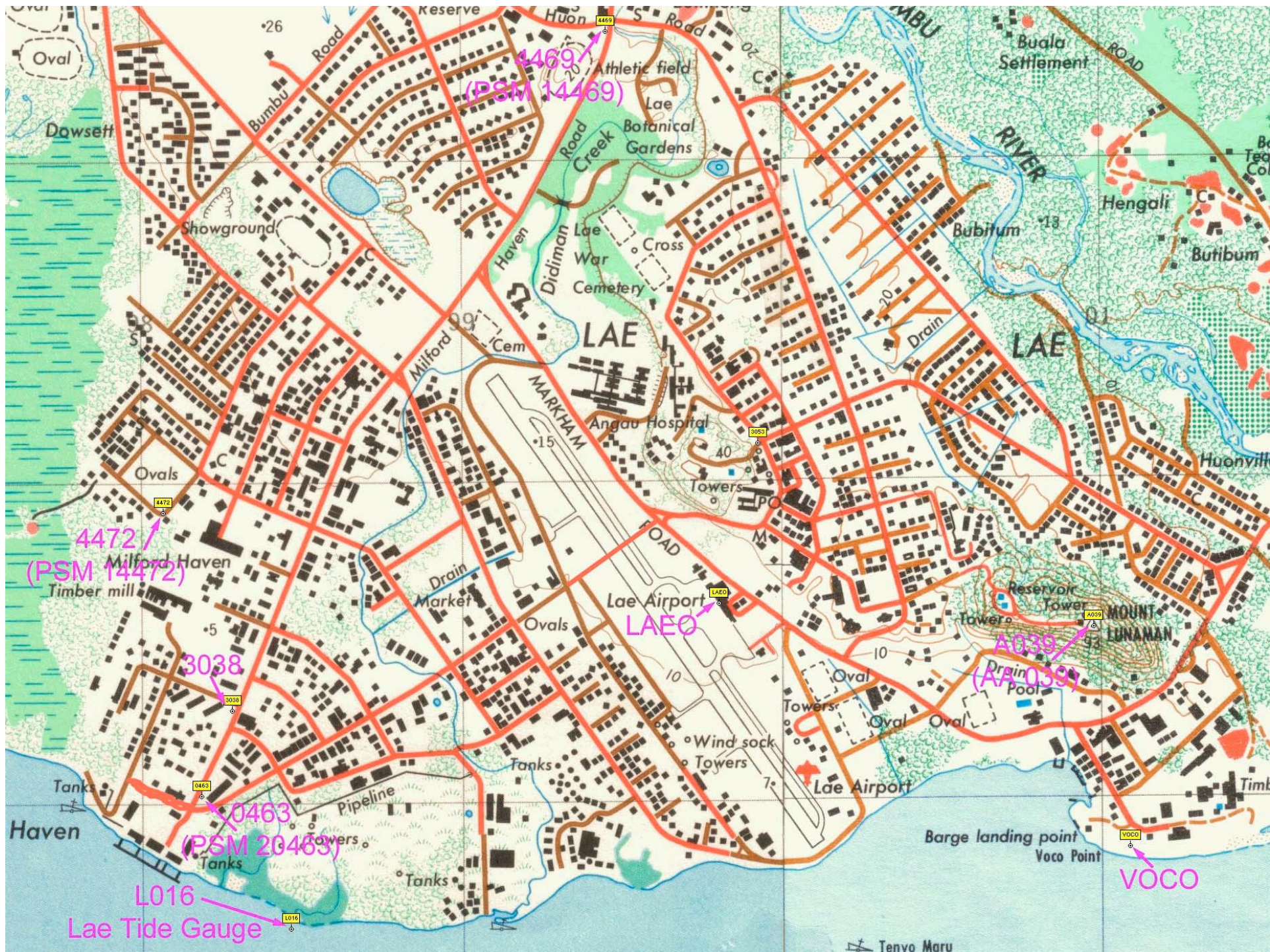


Sialum coral terraces - Photo: Sandy Tudhope

Rapid uplift (2 - 7 mm/yr)



Lae City Geodetic Network





Lae North - Hobu (Kwapsanek) Network

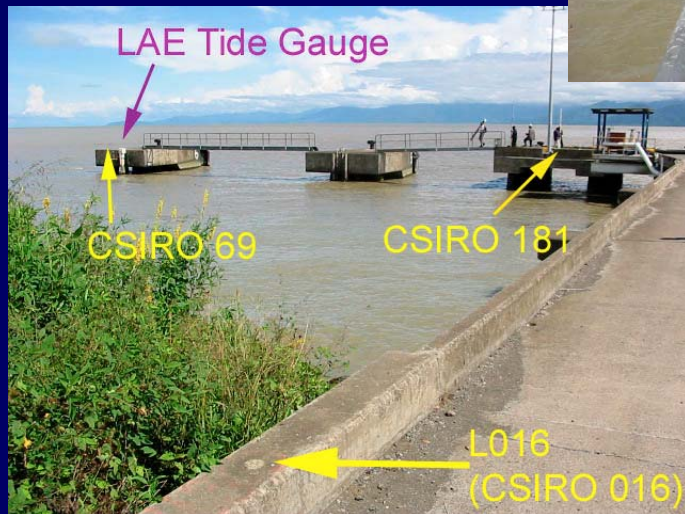




Absolute height change



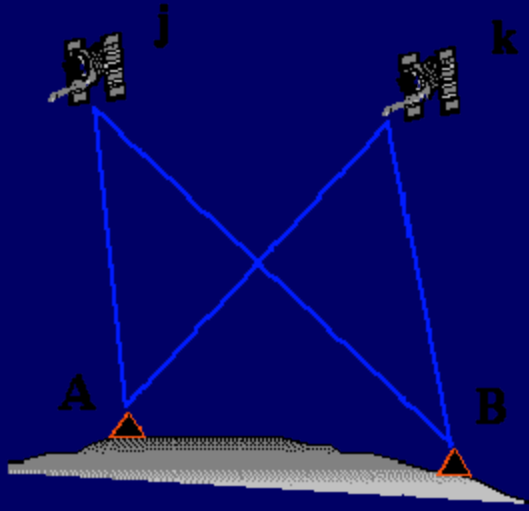
**Precise levelling
(UniTech
students 2002)**



Tide Gauge network - Lae

Sea Level/Tectonic monitoring

Global Positioning System

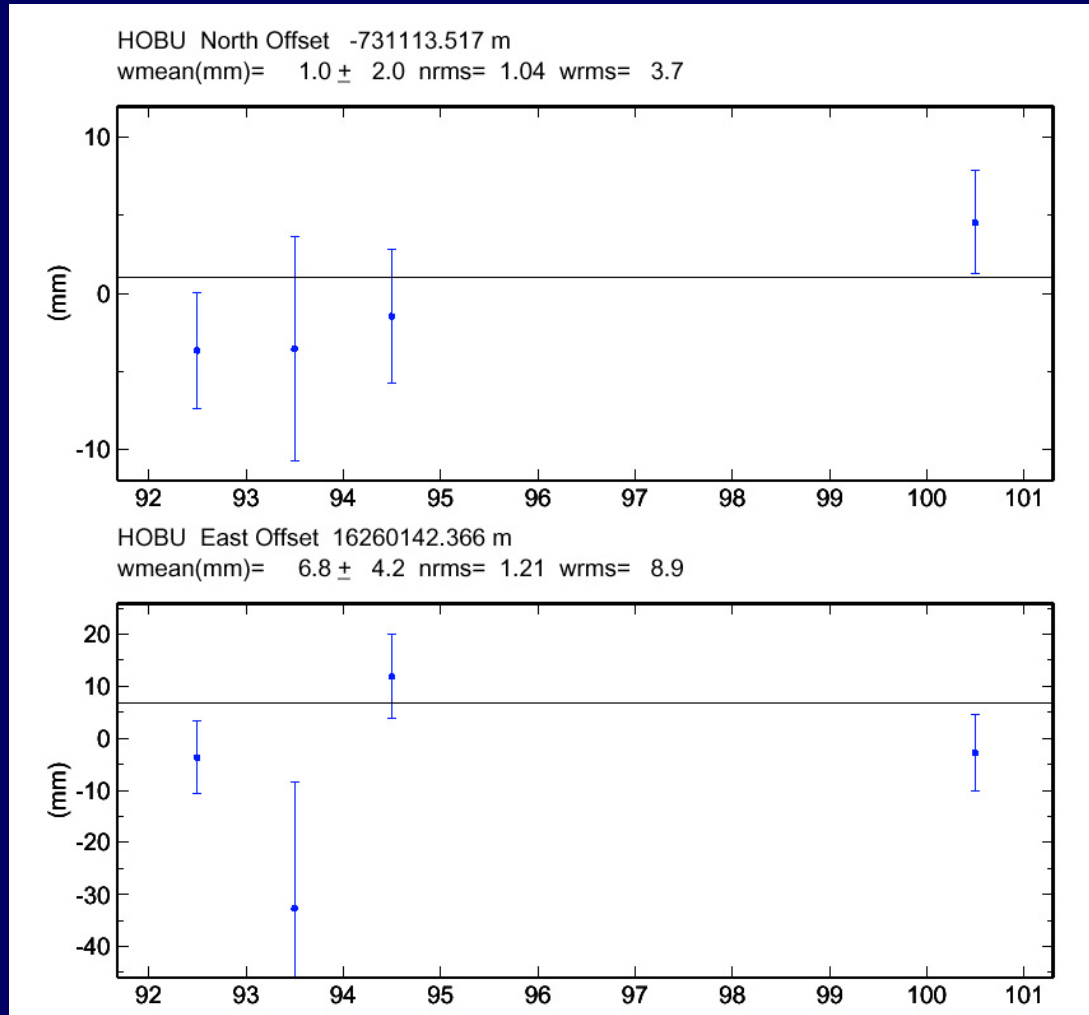


differentiated
Carrier-phase
using precise
(post-processed)
orbits

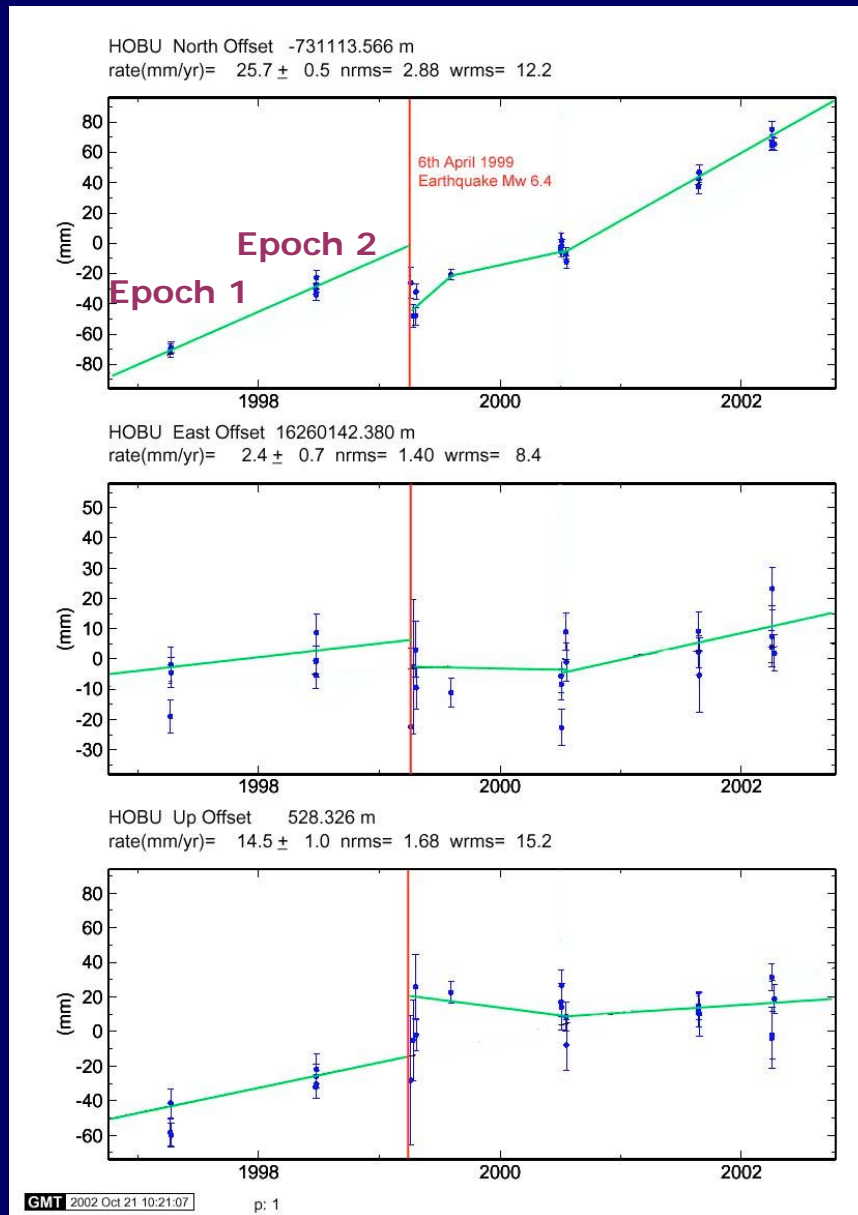
Precision: 0.001 ppm
(1 mm / 1000 km)

Ideal measurement tool for global
measurement of tectonic motion

1-5 days GPS measurements



e.g. HOBU near Lae, plot showing site
repeatability and uncertainty for each day



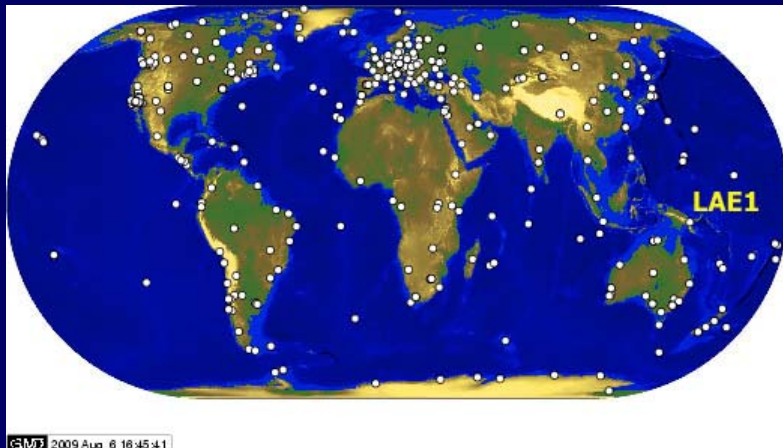
e.g. Hobu, plot showing timeseries
for different measurement campaigns
& 1999 earthquake coseismic deformation

Repeat
observations
made every
1-2 years

time series

ITRF
site velocity
computed

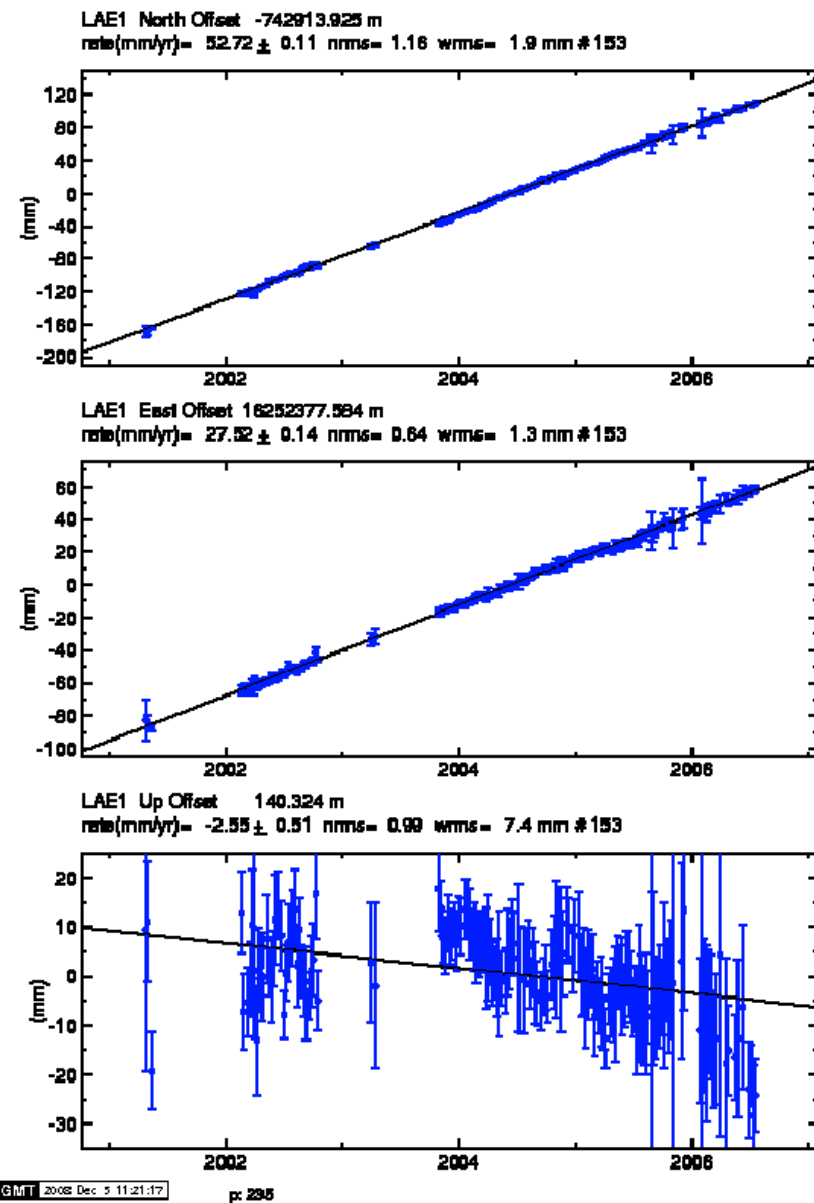
Rigid plate
models &
fault locking
estimated



IGS - Tracking Network

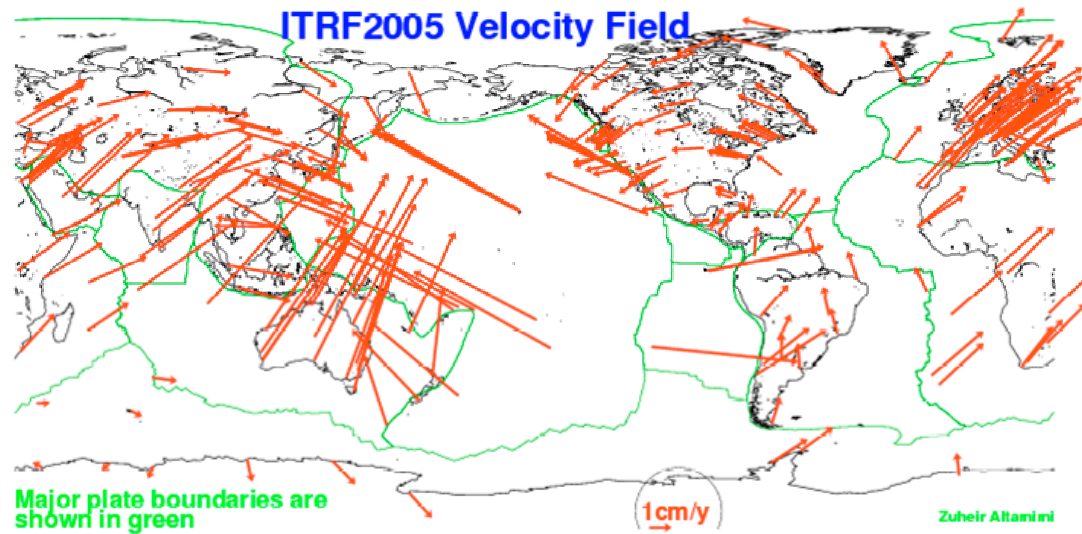


LAE1

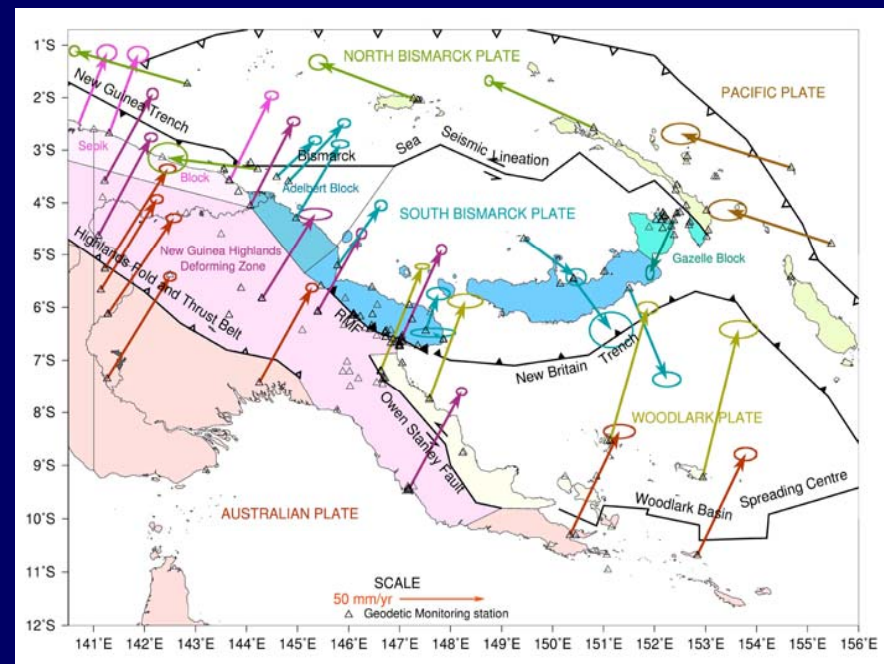


ITRF2005 Timeseries (MIT)

ITRF2005 Velocity Field

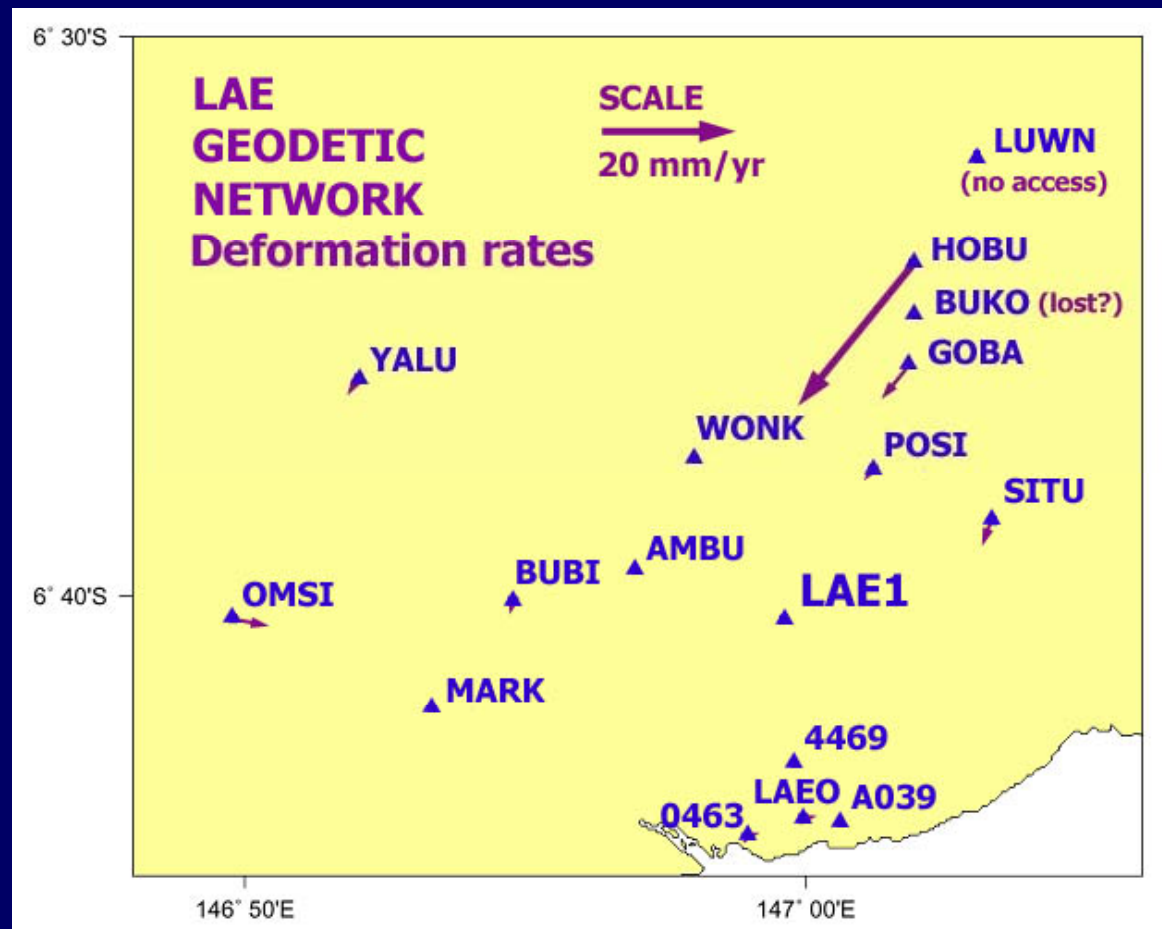


ITRF Site motions

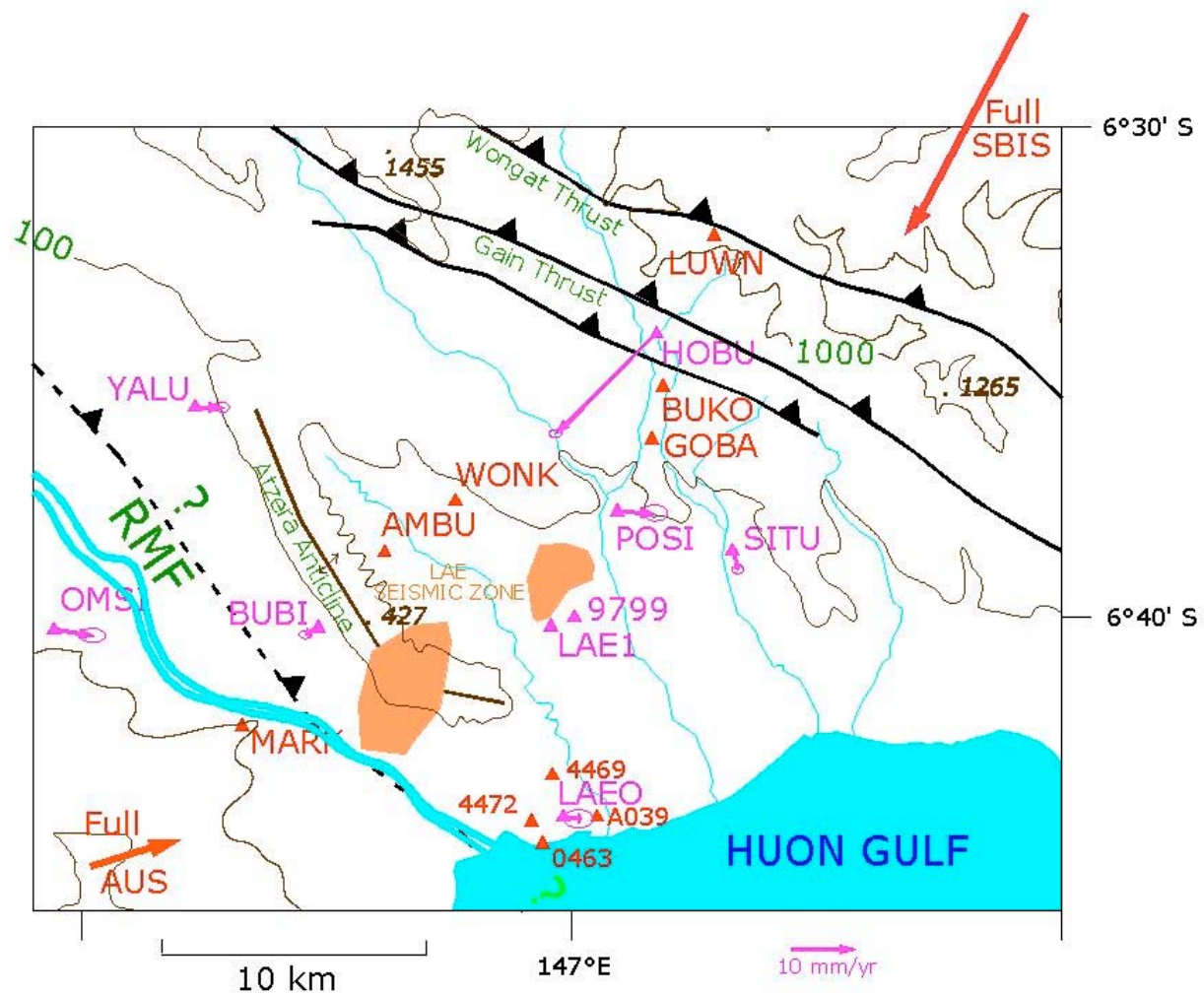


		PNGMG94 (PNG94) Zone 55 (updated)				Positional Uncertainty (1 σ)		
Site ID	Location	No	E	N	Ell. Ht.	E	N	ht
0463	Lae Wharf	PSM 20463	498296.713	9255179.742	76.120	0.014	0.007	0.024
9799	Unitech	PSM 9799	499765.887	9262578.623	130.332	0.004	0.004	0.010
BUBI	Bubia	ST 31021	490374.510	9262915.834	106.932	0.008	0.006	0.015
GOBA	Gobari	n/a	503379.197	9270724.151	370.403	0.014	0.009	0.018
HOBUE	Hobu	ST 31028	503520.544	9274039.099	528.021	0.008	0.004	0.018
LAE1	Unitech	PSM 31107	499246.770	9262320.802	140.340	0.006	0.003	0.012
LAE0	Old Airport	ST 31022	499918.240	9255768.942	84.372	0.014	0.007	0.024
OMSI	Omsis	ST 31025	481219.098	9262352.515	97.525	0.014	0.004	0.017
POSI	Posie	n/a	502219.091	9267253.886	242.971	0.017	0.009	0.019
SITU	Situm	ST 31029	506134.357	9265567.214	169.843	0.004	0.006	0.012
			Velocity relative to LAE1			Uncertainty (1σ)		
Site ID	Location	No	E m/yr	N m/yr	U m/yr	E	N	ht
0463	Lae Wharf	PSM 20463	0.001	-0.002	0.006	0.001	0.001	0.004
9799	Unitech	PSM 9799	0.000	0.000	0.000	0.001	0.001	0.003
BUBI	Bubia	ST 31021	0.003	0.000	-0.008	0.002	0.001	0.004
GOBA	Gobari	n/a	-0.004	-0.004	0.008	0.002	0.002	0.003
HOBUE	Hobu	ST 31028	-0.022	-0.019	0.028	0.002	0.001	0.003
LAE1	Unitech	PSM 31107	0.000	0.000	0.000	0.000	0.000	0.000
LAE0	Old Airport	ST 31022	0.001	0.000	0.004	0.001	0.001	0.004
OMSI	Omsis	ST 31025	0.006	0.001	-0.003	0.002	0.001	0.004
POSI	Posie	n/a	-0.001	0.001	0.003	0.002	0.001	0.003
SITU	Situm	ST 31029	-0.001	0.003	0.003	0.001	0.001	0.002

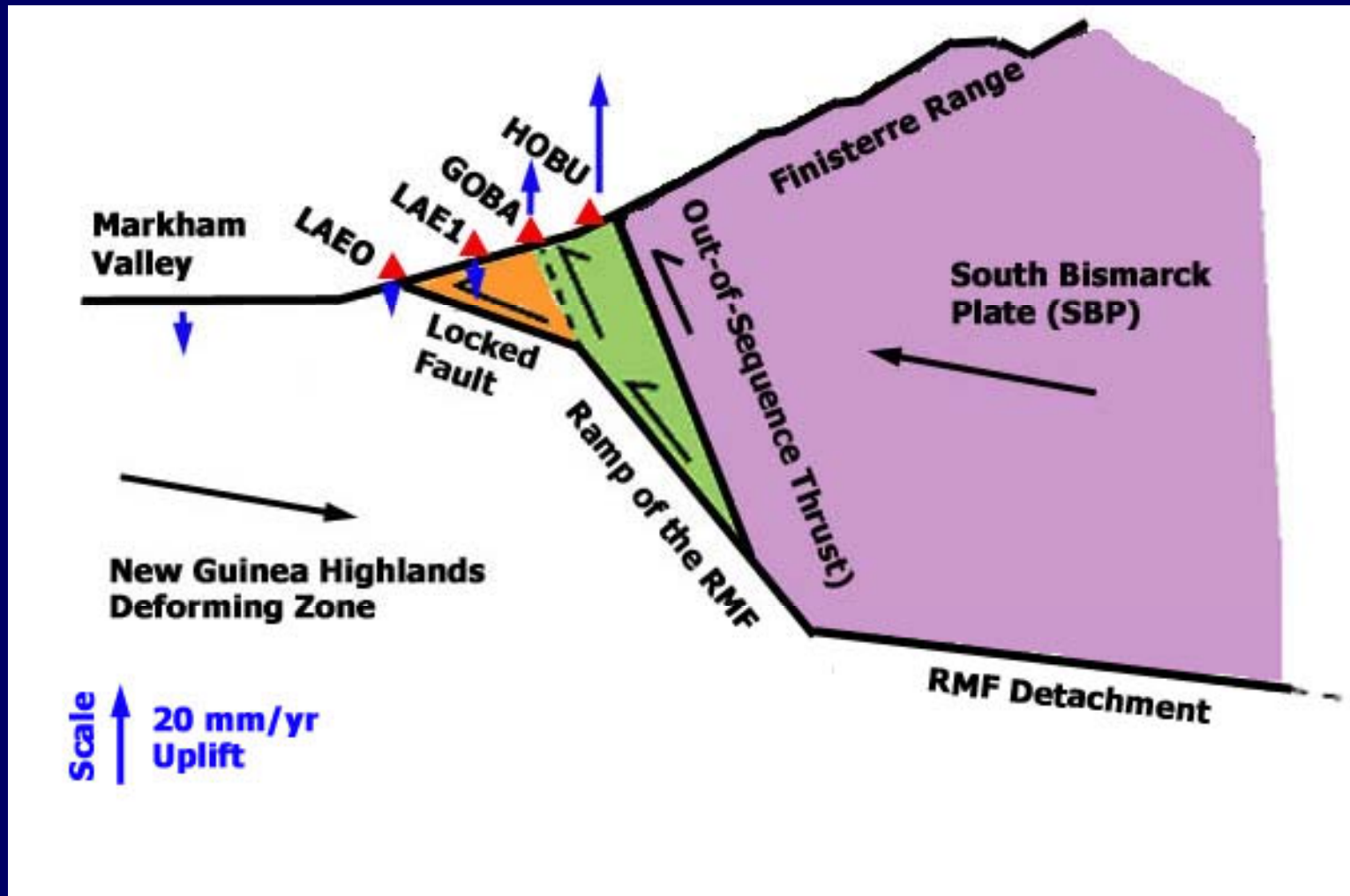
Lae Network - GNSS results 1993-2009



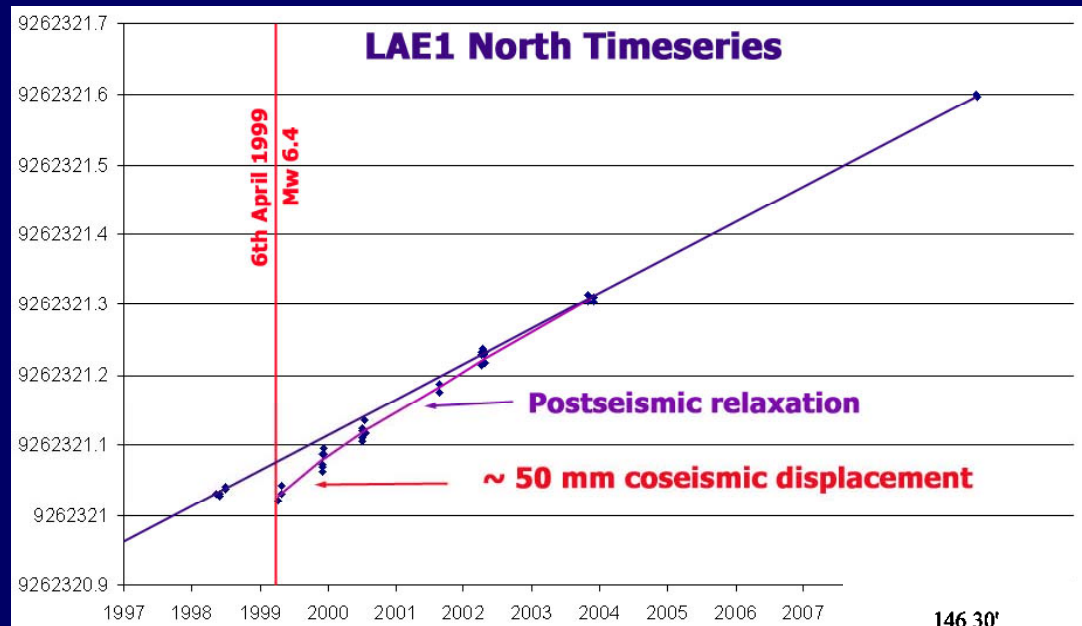
Lae Network - Internal Deformation Rates



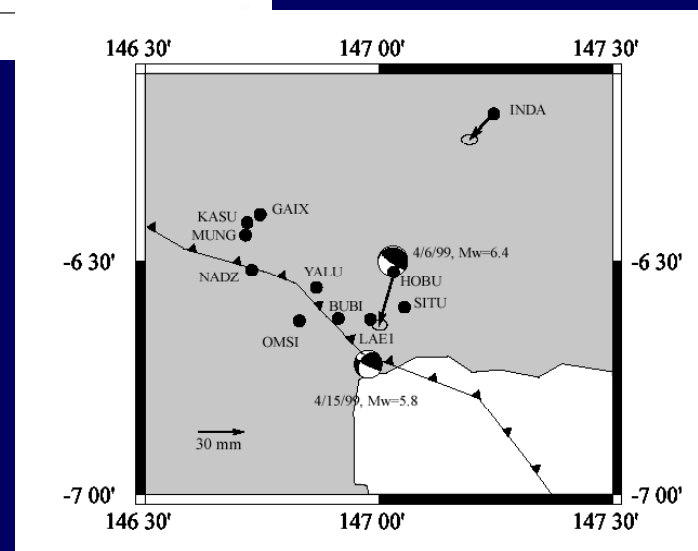
Lae Sesimic Zone



Lae Faults (N-S Cross Section)



**Displacement
6th April 1999 -
Hobu Earthquake**





Mike Sandiford - Landform Atlas

SRTM Image - Markham Valley / Lae

**Earth scientists can forecast seismic hazards
but cannot predict exactly where or when
earthquakes will occur**

**Surveying underpins tectonic
hazard assessment and monitoring**

Seismic Hazard is high in Lae area

**Mw 7.0 Earthquake in Lae area
every 100-110 years on average**

**Building Code &
Hazard management Plan**

On a human time scale

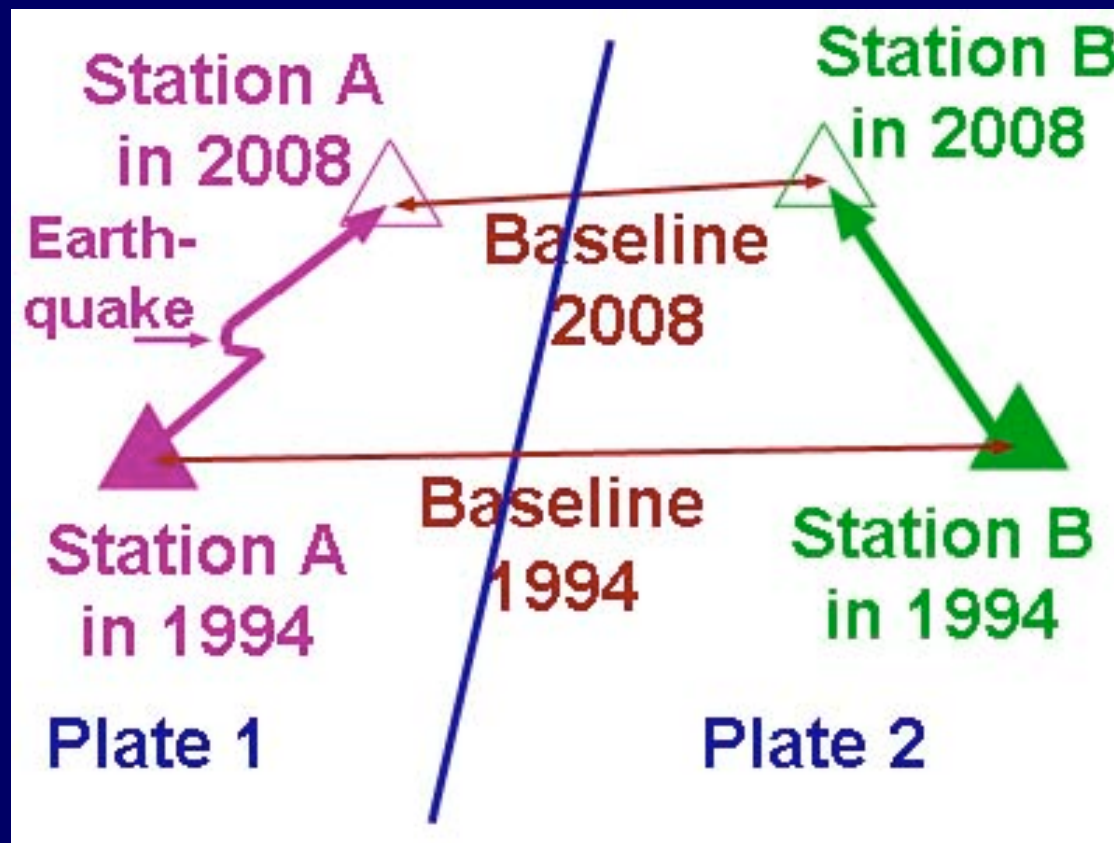
**First human settlement in PNG
c. 50,000 years ago**

Markham Valley 2-3 km wider than now

**The Australian Plate has rammed
1 km further into the PNG Highlands
and lifted them up by 100 metres**

Coral formations at 3000m elevation

Effect of tectonic deformation on survey baselines & datums



A topographic map showing a large lake in the lower-left quadrant, surrounded by a green shoreline. The surrounding land is depicted with brown and tan colors, indicating elevation. Several mountain peaks are visible, with the most prominent one in the upper-left quadrant. The map uses contour lines and shading to represent the terrain's relief.

**Thank
you**

Friday: Heighting with GNSS