
Development of a short-span strainmeter for observation of deformation associated with deep low-frequency tremors

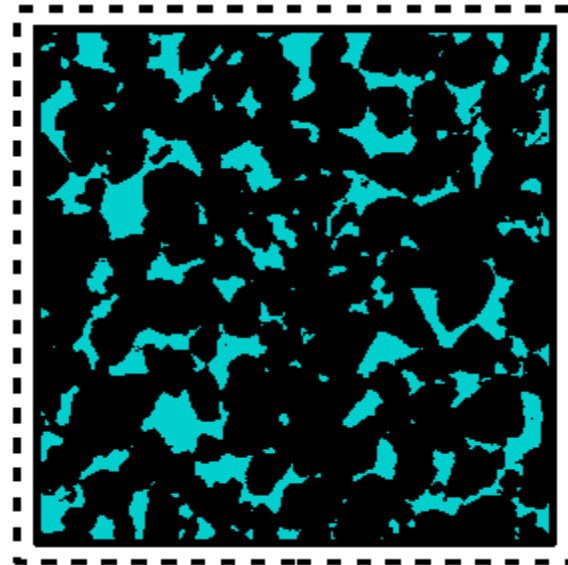
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Strain measurement for long period deformation

“Poroelastic” medium

Pore pressure (-- water level)

Stress



Proxy
Long period -??

Strain

Development of
new style sensor

Water content

Short span strainmeter

- Extensometer with a length standard of 1-3 m
- Small space
- Low cost
- Easy to install

No large tunnels, no boreholes!!

- Settlement to rock is important
- Array observation with multiple stations
 - Obtain coherent signal
- Target: short-term slow slip event

Diformation observed in Kishuu observatory

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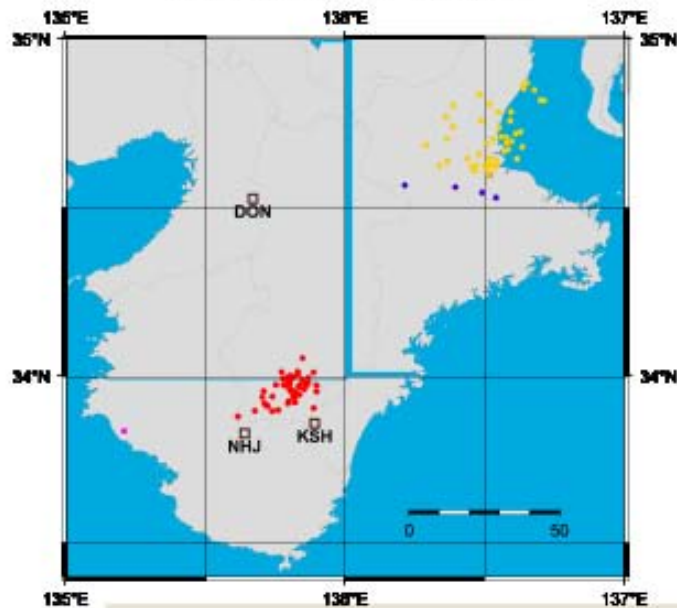


Fig.3f. Locations of event occurred on period for 10th Nov. to 20th Nov..

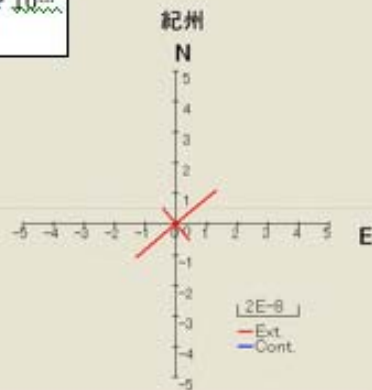


Fig.3h. Direction of principal strain.

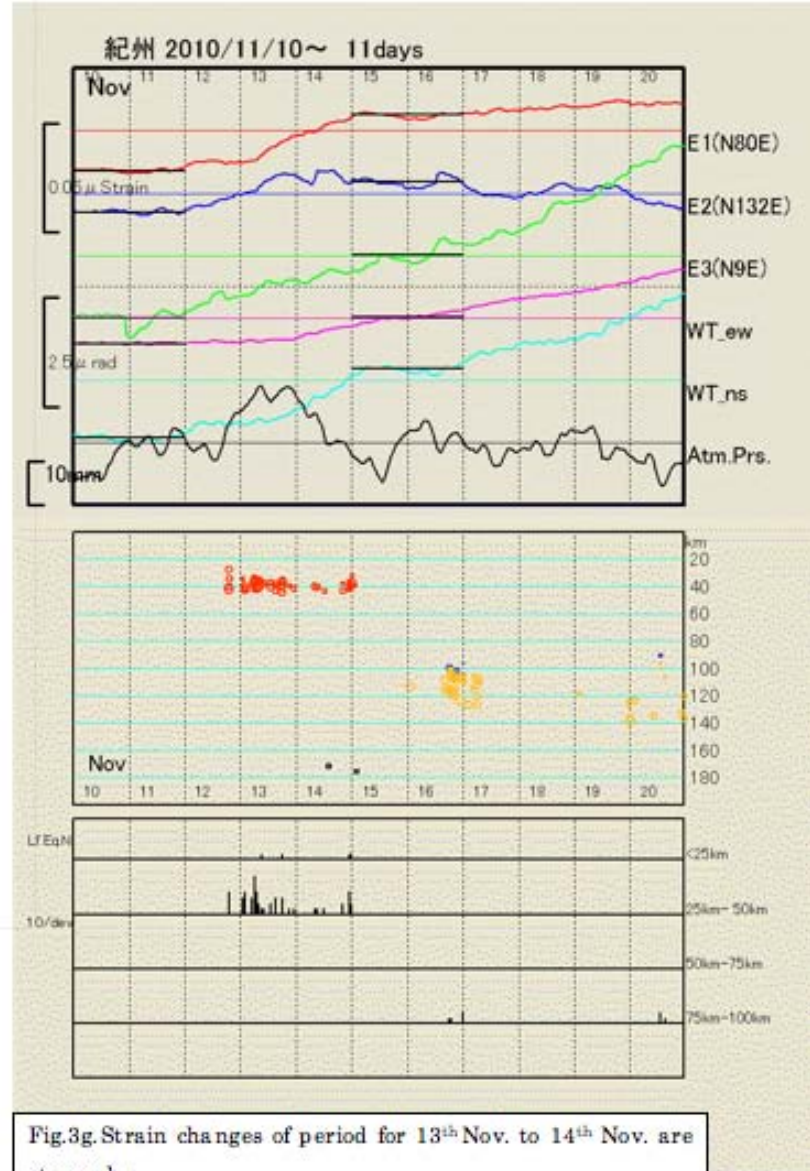


Fig.3g. Strain changes of period for 13th Nov. to 14th Nov. are stressed..

Diformation observed in Kishuu observatory

~ 20 nano strain

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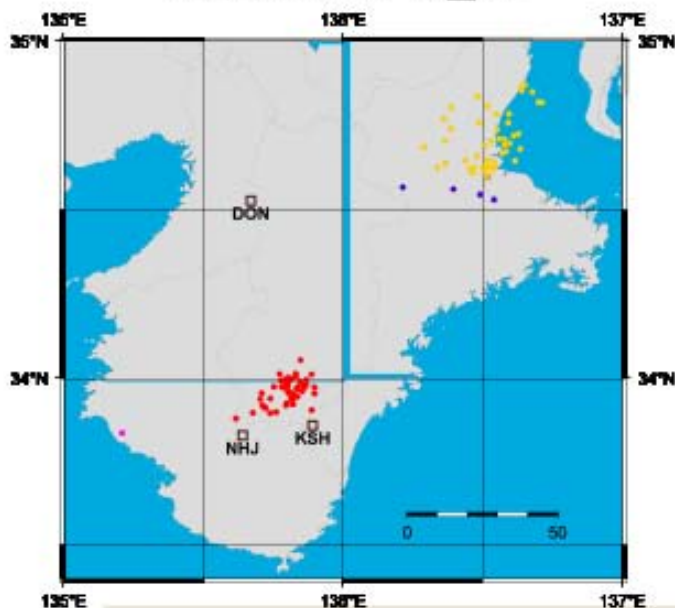


Fig.3f. Locations of event occurred on period for 10th Nov. to 20th Nov..

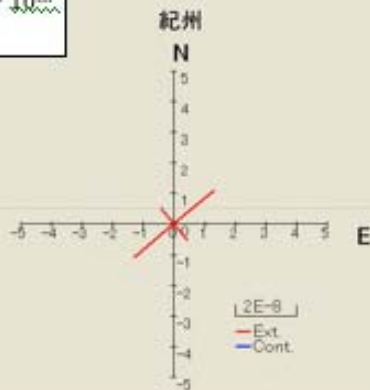


Fig.3h. Direction of principal strain.

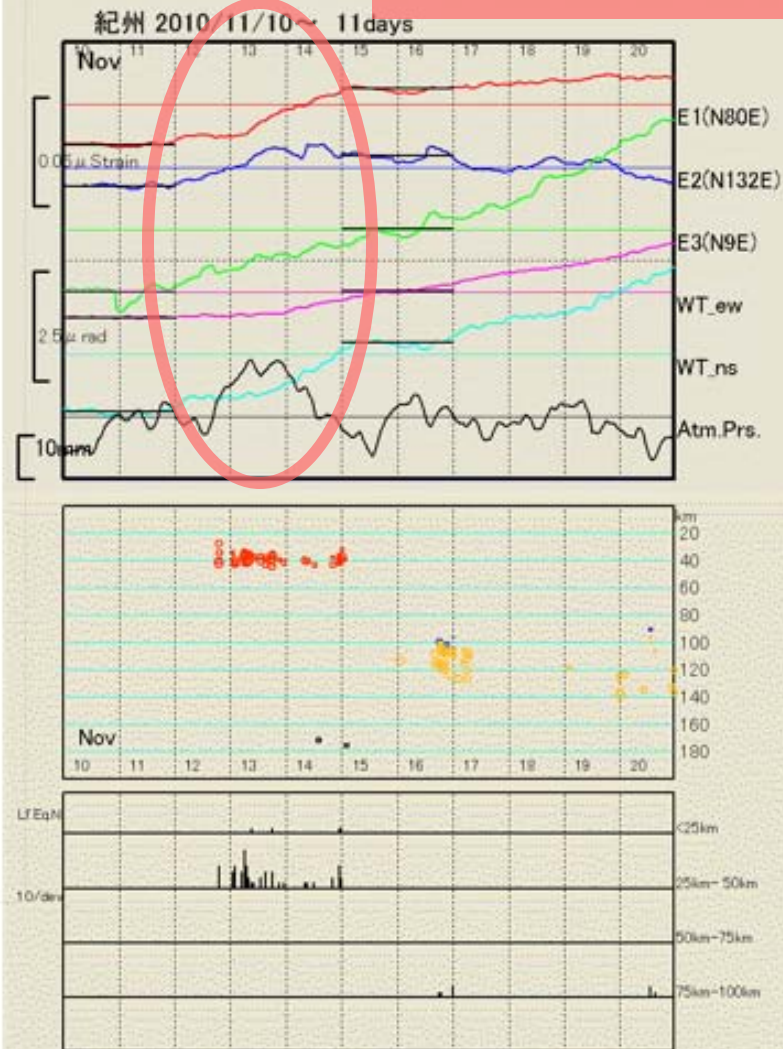


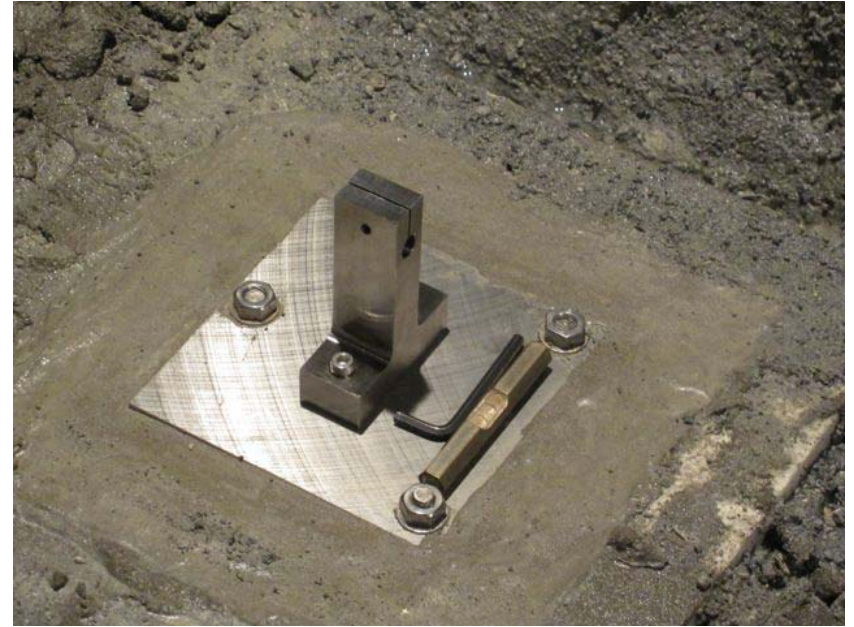
Fig.3g. Strain changes of period for 13th Nov. to 14th Nov. are stressed..

Key concept: The piers, fixed and free end



Short, small
3-component in small tunnel

Key concept: Components of the extensometer



Tightly fixed to to rock

Accomplished technique
for sensor part imported
from tunnel observation

Installation

- Test site: Donzurubo observatory tunnel
Tuff (20-15 Ma)

- 1. Remove pavement of the floor
- 2. Make a hole with 30 cm x 30 cm x 30 cm
- 3. Fix three of 30-cm-long bolts as anchor
- 4. Cure cement
- 5. stainless piers to bolts
- 6. Put a Super-Invar standard
- 7. Put a displacement sensor (LVDT, 25mV/ μ m)

Donzurubo tunnel -- natural monument



天然記念物 どんづる峯

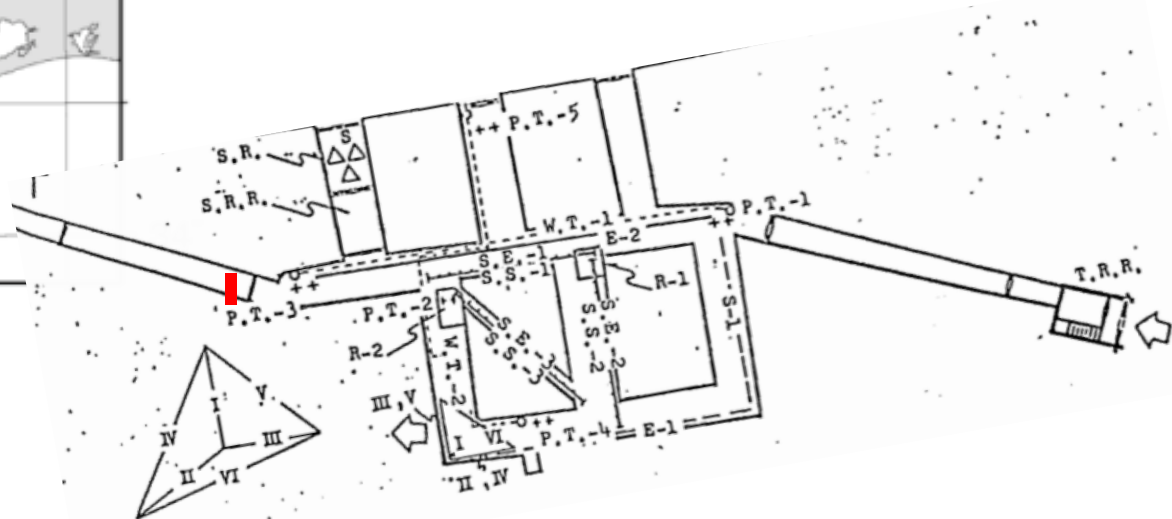
昭和二十六年十一月一日指定

どんづる峯は二上山火山群の雄峯で、瀝青岩の噴出をもつてはじまった二上山の火山岩屑が水底に沈積して凝灰岩層となり、その隆起と風化水蝕により奇岩・奇勝となったものである。

凝灰岩層の傾斜は、その下部では走向ほぼ北東を示し、北西に五〇度の傾斜をなしている。なお、どんづる峯層は更に北東へ広く、また南西へも延長し、その凝灰岩の層理が非常に正しく、あたかも大壘を斜めに数限りなく重ねたような景観が更に風化水蝕により峡谷が刻まれ、また直立した谷壁の地肌には地層の切口が小波のような美しい縞を現わし、学術上貴重な資料であるばかりでなく、周囲は樹木に覆われた山々に囲まれて特異な別天地を感じさせ、奇勝の名にふさわしいところである。

奈良県教育委員会

平成元年三月



A hole to settle the pier



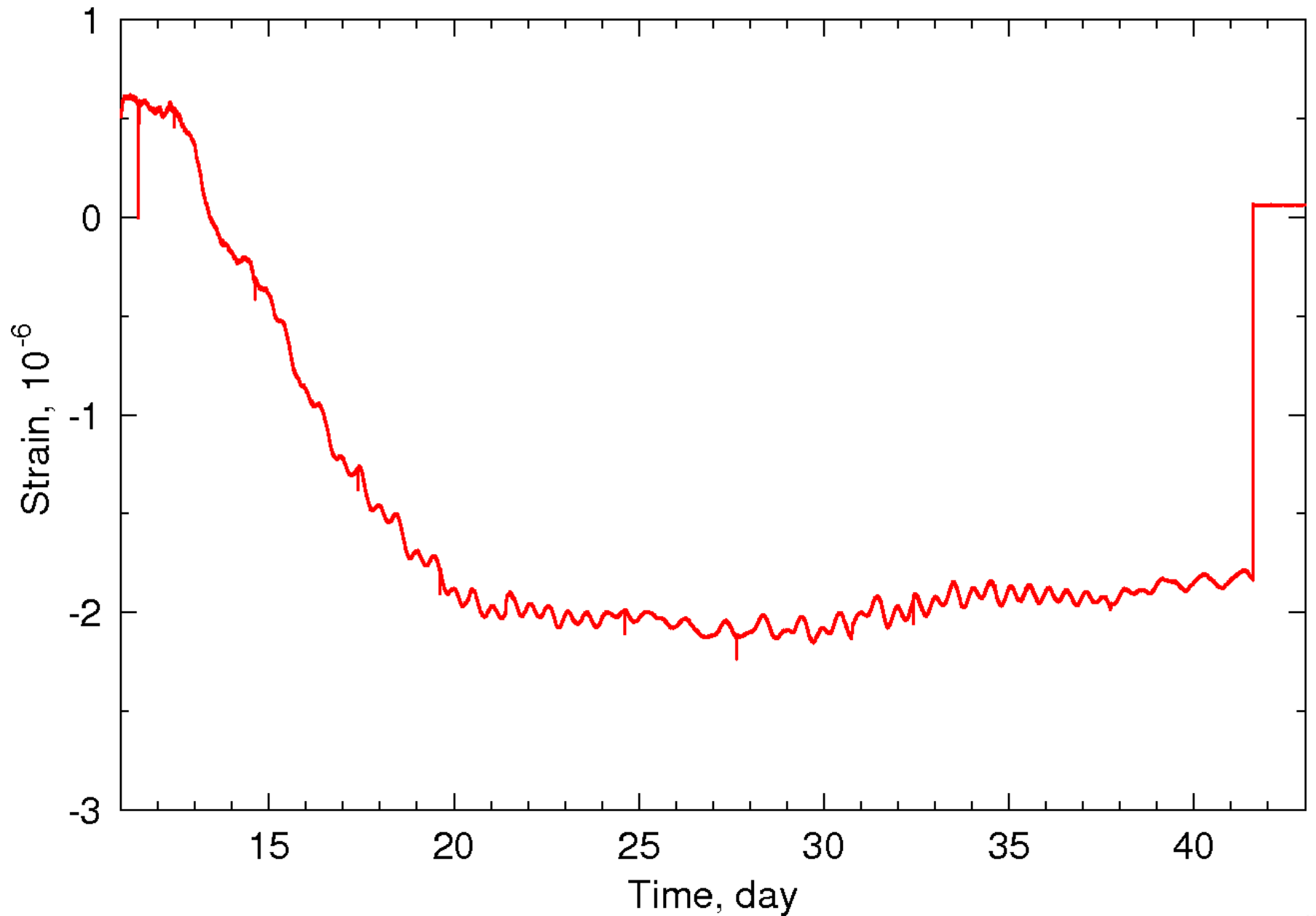
Anchor bolts



Cementing



Data for first 1 month



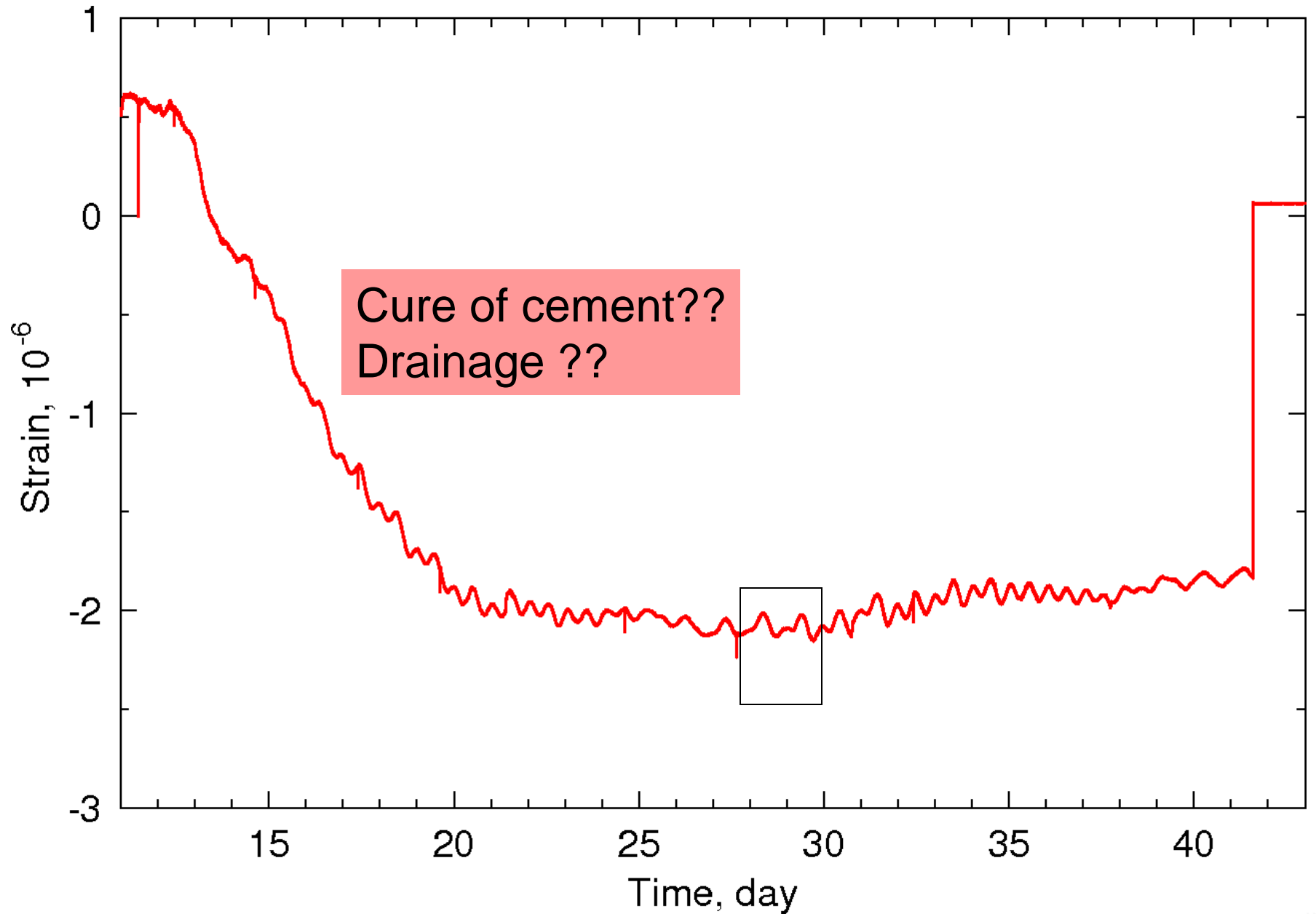
Submergence of the pier....



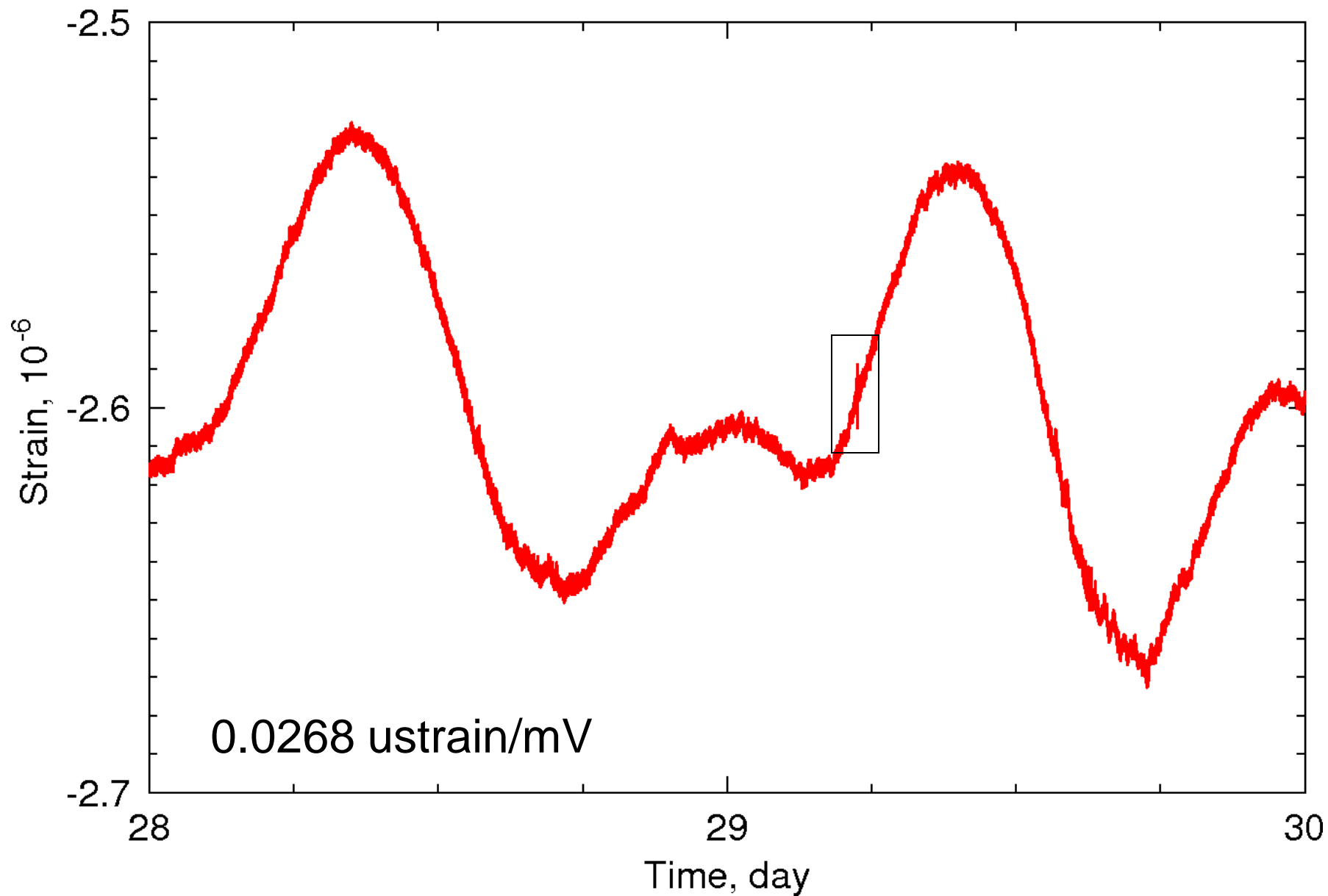
Submergence of the tunnel



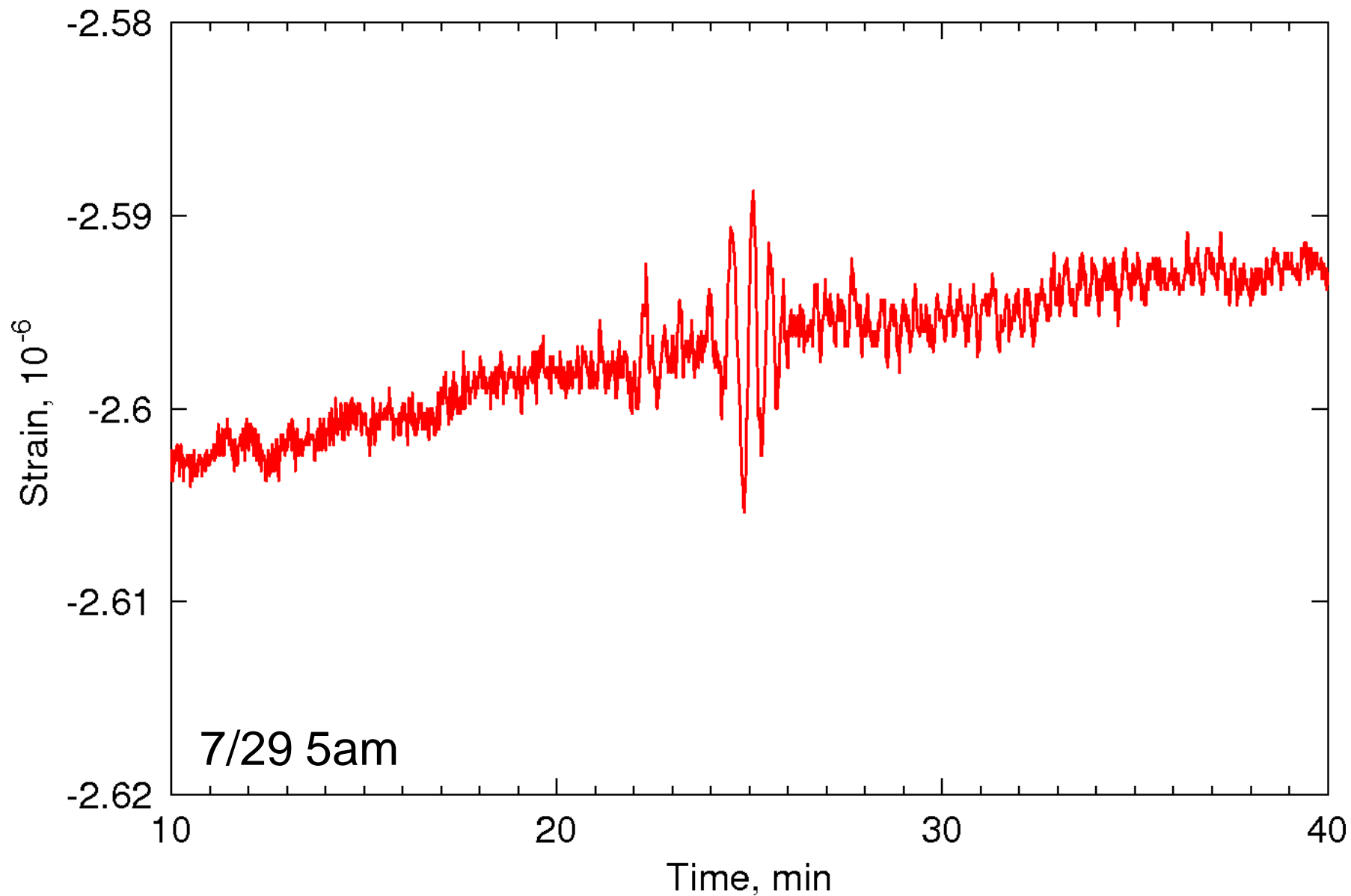
Data for first 1 month



Data for 2 days



M 6.5 - NEW IRELAND REGION, PAPUA NEW GUINEA



Summary

Short-span strainmeter can beautifully observe strain change such as earth tides

To 10 nano strain

Building an array at Kii peninsula

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