ISC-EHB: Reconstructing the EHB Earthquake Database

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2. University of Colorado, Boulder, USA

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Outline

- EHB
- New criteria and procedures for ISC-EHB
- ISC-EHB: 2000-2003
- Comparisons with other catalogues
- Plans for rebuilding and extending ISC-EHB

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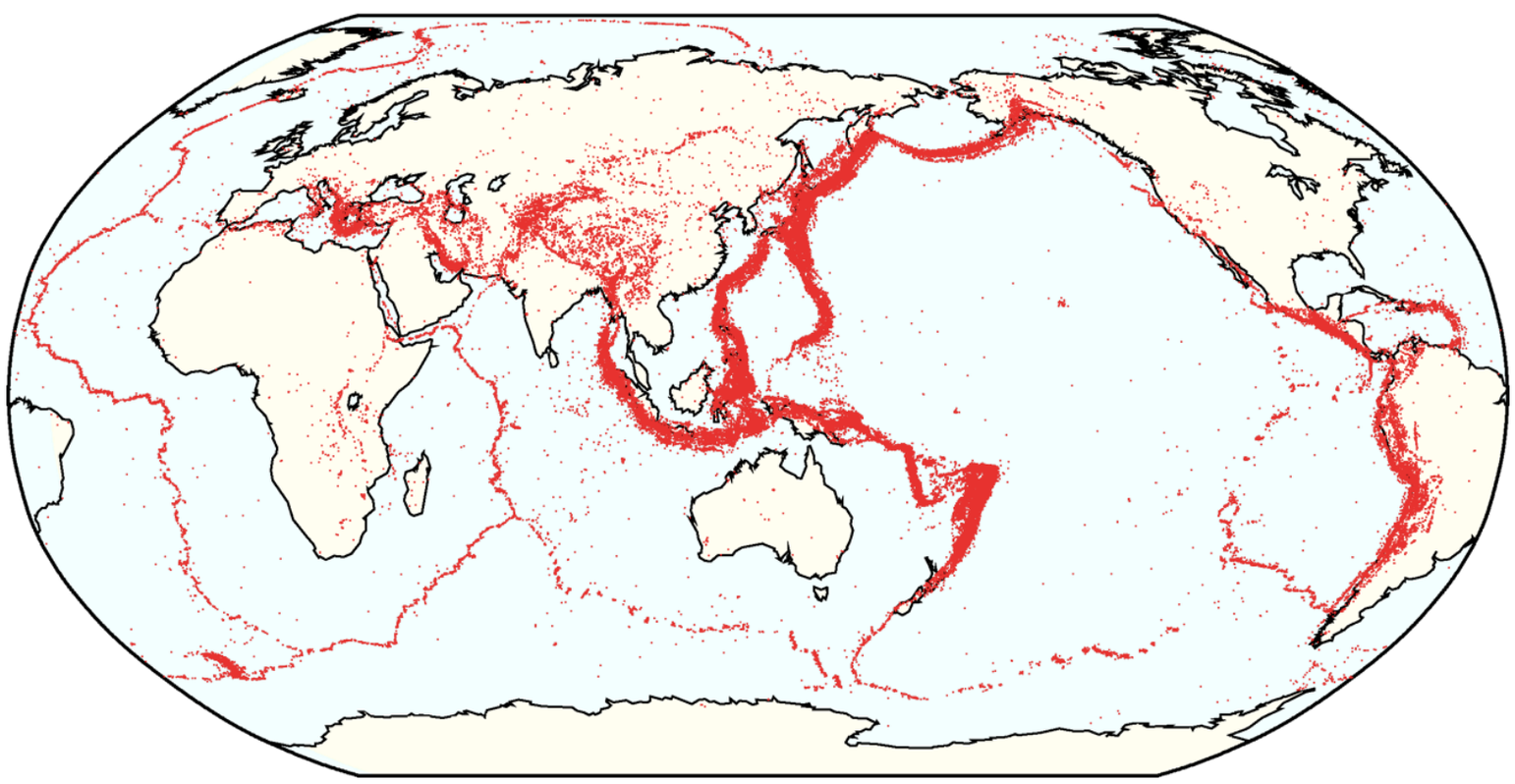
Engdahl, van der Hilst, Buland (EHB)

- A database of teleseismically well constrained events selected from ISC Bulletin and relocated using algorithm (Engdahl et al., 1998).



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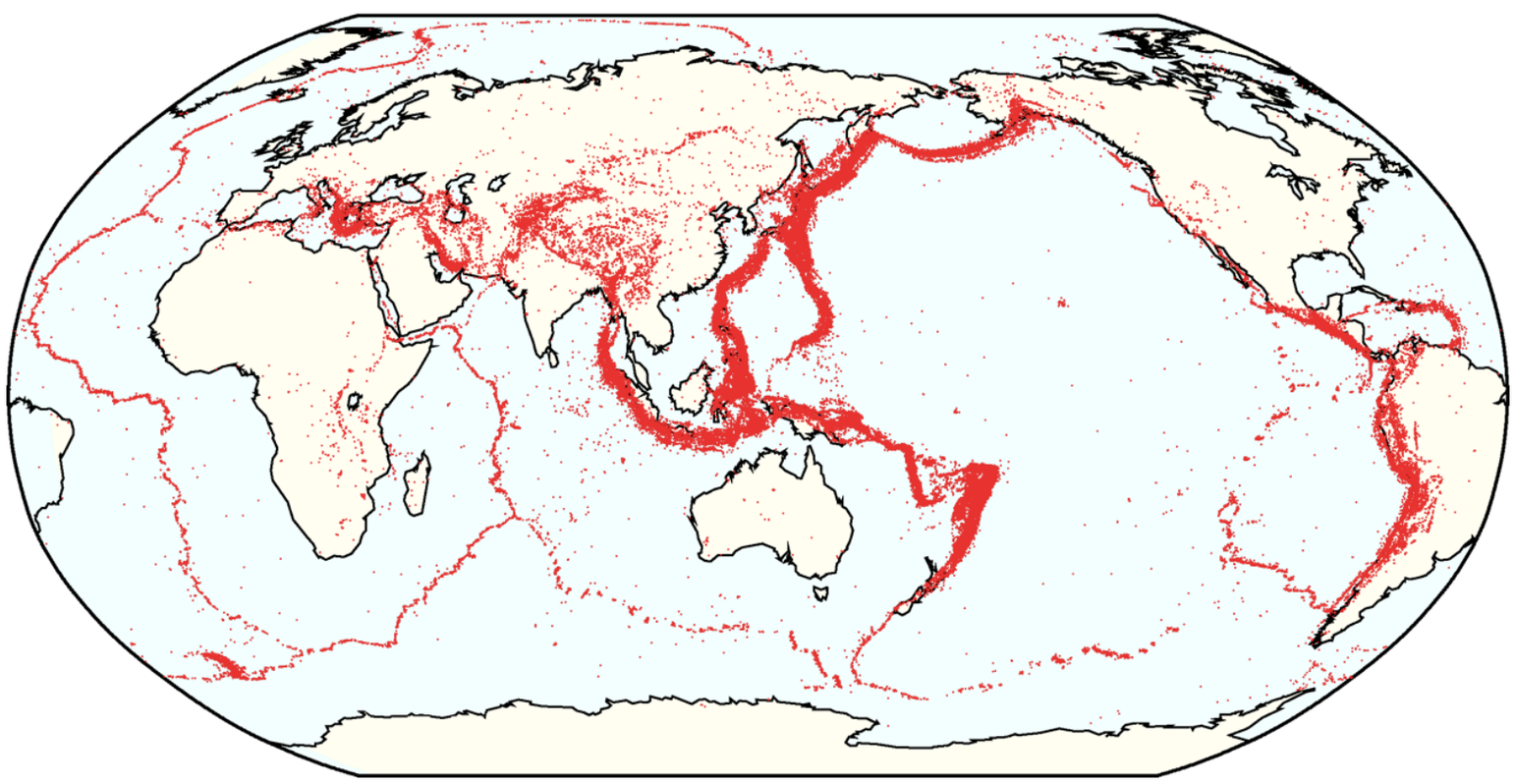

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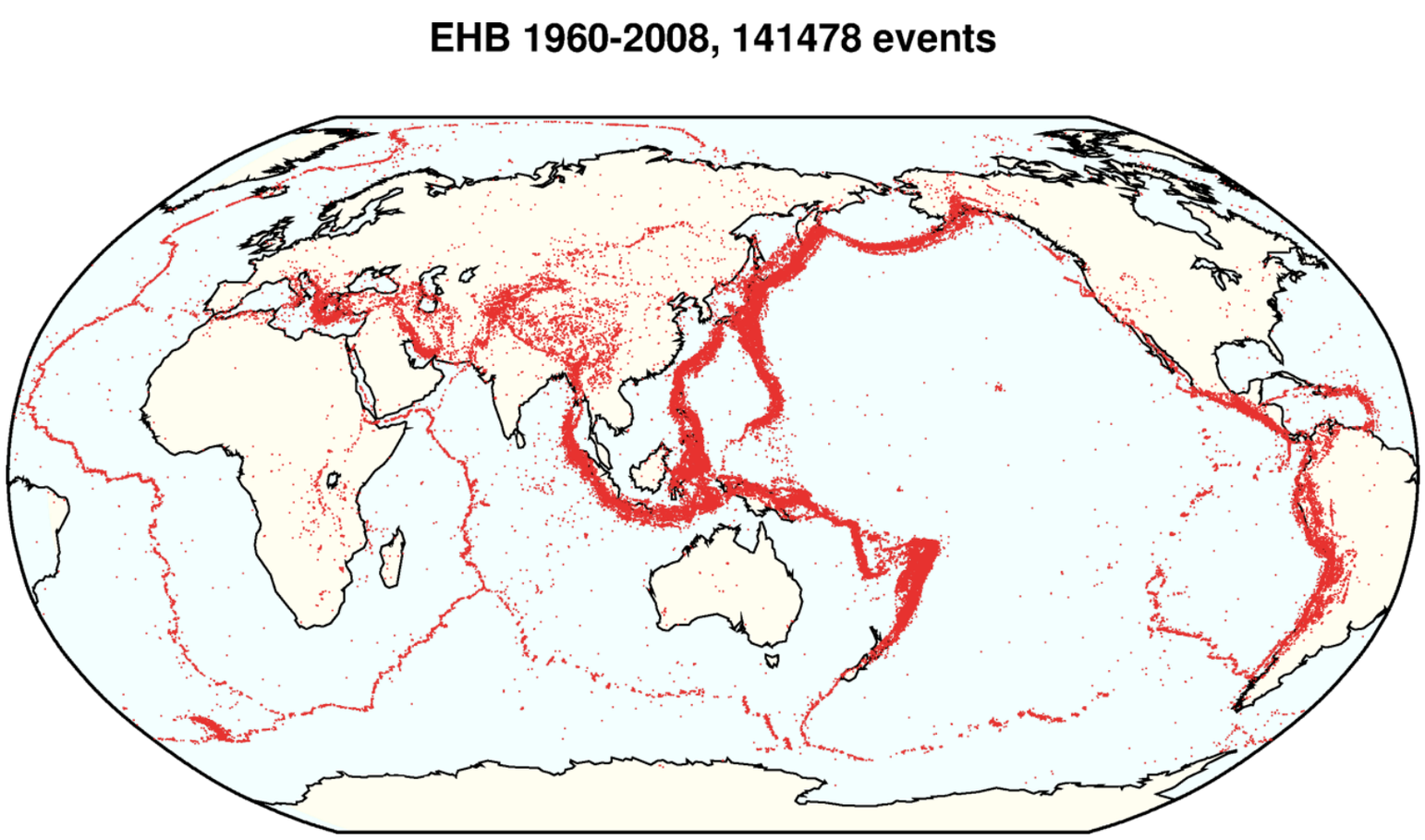
- 141,478 events between 1964 and 2008.



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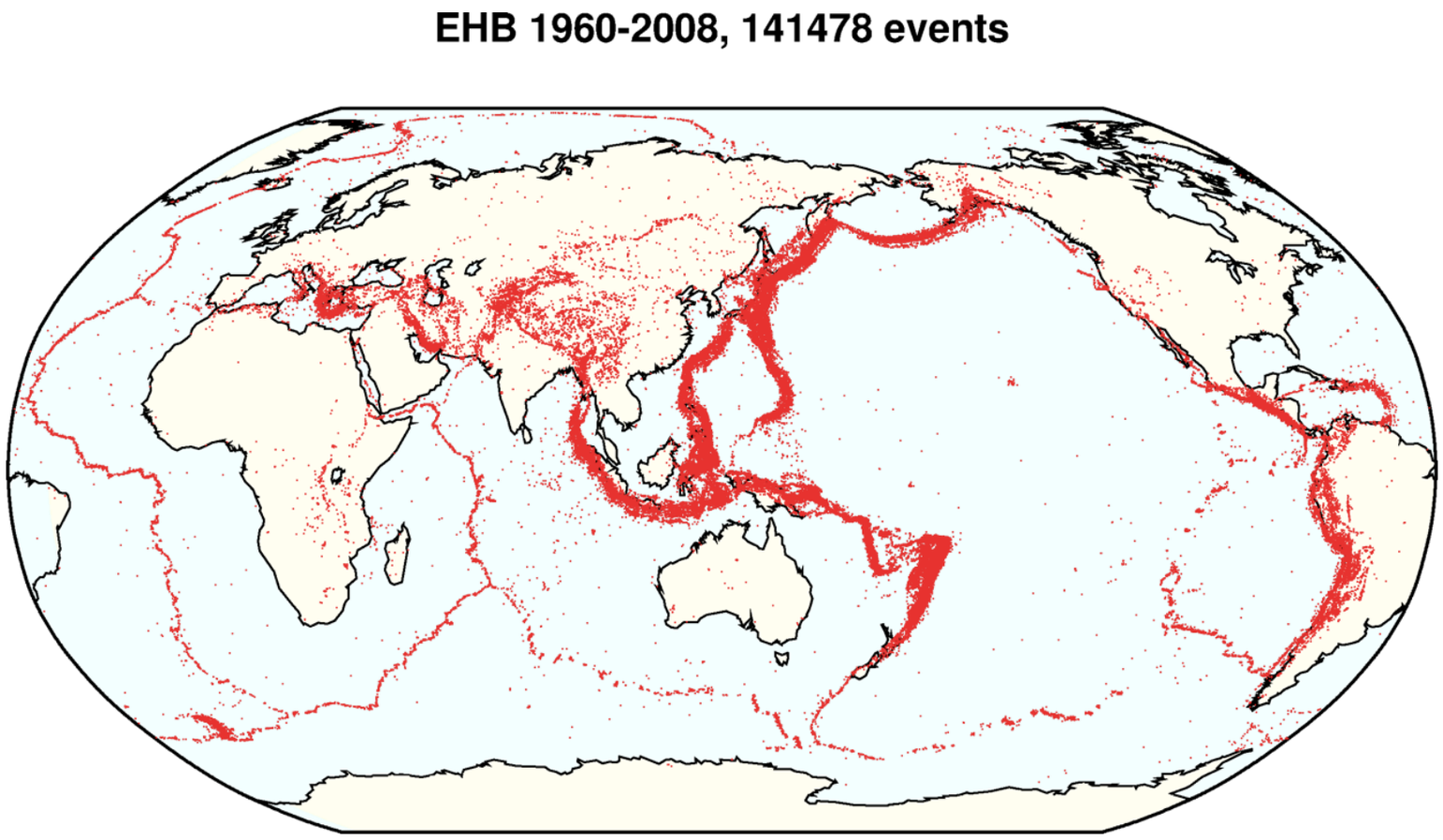

Why extend it?

It is a valuable dataset for tomography and seismicity studies on regional and global scales.

Why reinvent it?

Since 2008 the data quality and volume has increased so changes are needed to produce a cleaner and more robust dataset, the ISC-EHB.

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ISC-EHB: Event selection criteria

Events are selected from the ISC Bulletin if they meet both these criteria:

1) There are > 15 teleseismic (>28^0) time-defining stations with a secondary teleseismic azimuth gap < 180^0.

AND

2) The defining prime magnitude > 3.75 (Di Giacomo & Storchak, 2016).

ISC-EHB: Processing

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Bulletin of the Seismological Society of America, Vol. 88, No. 3, pp. 722–743, June 1998

Global Teleseismic Earthquake Relocation with Improved Travel Times and Procedures for Depth Determination

by E. Robert Engdahl, Rob van der Hilst, and Raymond Buland

Abstract We relocate nearly 100,000 events that occurred during the period 1964 to 1995 and are well-constrained teleseismically by arrival-time data reported to the International Seismological Centre (ISC) and to the U.S. Geological Survey's National Earthquake Information Center (NEIC). Hypocenter determination is significantly improved by using, in addition to regional and teleseismic *P* and *S* phases, the arrival times of *PKiKP, PKPdf,* and the teleseismic depth phases *pP, pwP,* and *sP* in the relocation procedure. A global probability model developed for later-arriving phases is used to independently identify the depth phases. The relocations are compared to hypocenters reported in the ISC and NEIC catalogs and by other sources. Differences in our epicenters with respect to ISC and NEIC estimates are generally small and regionally systematic due to the combined effects of the observing station network and plate geometry regionally, differences in upper mantle travel times between the reference earth models used, and the use of later-arriving phases. Focal depths are improved substantially over most other independent estimates, demonstrating (for example) how regional structures such as downgoing slabs can severely bias depth estimation when only regional and teleseismic *P* arrivals are used to determine the hypocenter. The new data base, which is complete to about *Mw* 5.2 and includes all events for which moment-tensor solutions are available, has immediate application to high-resolution definition of Wadati–Benioff Zones (WBZs) worldwide, regional and global tomographic imaging, and other studies of earth structure.

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```
 1733408
FEQ x  iter = 2    0  3  7   h =  1  4 59.55   lat = 31.996  lon =  50.904   depth = 15.0   0.0  smdel =  0.000
 1733412
FEQMd  iter = 2    0  3  7   h =  4 32 17.99   lat = 19.139  lon =-104.172   depth = 10.0   0.0  smdel =  0.000
0 3 7 COLM   0.46  18.85    264.84    100.08     84.68     Pg      iP    iP     4 32 25.36  -1.74                      0.0  0.4
      COLM   0.46                               84.68     Sg      iS    iS     4 32 31.46  -1.55                      0.0  0.1
0 3 7 CJM    0.90  19.04    113.40     95.86    293.69  +  Pg      iP    iP     4 32 34.94  -0.34                      0.0  0.4
      CJM    0.90                              293.69     Sg      iS    iS     4 32 48.16   1.18                      0.0  0.1
0 3 7 ZIIG   2.99  13.75    301.07     45.92    120.23  +  Pn      eP    eP     4 33  4.28  -1.18                      0.0  0.4
      ANMO  15.88                              353.12     PcP     eS    eS     4 40 39.38 -21.50*                     0.4  0.0
      NVAR  22.81                              330.36     PcP           PcP    4 41 13.60  -1.44*                -1.4  2.1  0.0
      PDAR  23.99                              350.21     PcP           PcP    4 41 14.90  -1.91*                -1.9  1.5  0.0
      ULM   31.74                               10.14     PcP     PcP   PcP    4 41 31.98  -1.10*                -1.1 -0.4  0.0
      SADO  32.97                               33.62     PcP     PcP   PcP    4 41 36.76   0.18*                 0.2 -0.4  0.0
      YKA   43.92                              353.04     PcP     PP    PcP    4 42  9.96  -0.24*                -0.2 -0.4  0.0
      SCHQ  45.52                               29.46     PcP     PcP   PcP    4 42 17.90   1.92*                 1.9 -0.3  0.0
      ILAR  53.69                              338.85     PcP     PcP   PcP    4 42 45.80   0.06*                 0.1 -0.2  0.0
 1733414
FEQMx  iter = 2    0  3  7   h =  5 48 20.50   lat =-49.190  lon = 164.658   depth = 10.0   0.0  smdel =  0.000
      ARMA  21.20                              327.41     PcP     eS    eS     5 57 12.90  -0.67*                -0.7  2.0  0.0
      ASAR  35.10                              305.37     PcP     PcP   PcP    5 57 44.70   0.65*                 0.6 -1.5  0.0
 1733416
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      WMQ   49.16                              308.43     PcP     PcP   PcP    6 38 18.50   0.23*                 0.2  0.4  0.0
0 3 7 YKA    75.22   5.81    292.02    154.15     27.93     pP      epP   eP     6 40 25.70  -0.48* -0.5 -6.4           -0.2  0.0
 1753014
FEQ x  iter = 2    0  3  7   h = 12 39 29.10   lat =-20.273  lon = 168.793   depth = 30.0   0.0  smdel =  0.000
0 3 7 BKM    2.64  13.75    168.72     53.87    348.54  -  Pn      iPn   iP    12 40  9.50  -0.23                      0.0  0.4
0 3 7 DZM    2.83  13.75     51.21     53.86    230.37  +  Pn      ePn   eP    12 40 10.36  -2.02                      0.0  0.4
0 3 7 NOUC   2.95  13.75     52.40     53.86    231.50     Pn      ePn   eP    12 40 12.59  -1.36                      0.0  0.4
      STKA  26.95                              239.10     PcP     PcP   PcP    12 48 30.60   1.12*                1.1 -0.1  0.0
      ASAR  32.48                              257.56     PcP     PcP   PcP    12 48 44.18   1.62*                1.6 -1.5  0.0
      ASPA  32.49                              257.56     pwP     esP   epP    12 46 10.30  -1.46*  6.7 -1.5  3.5      -0.6  0.0
```

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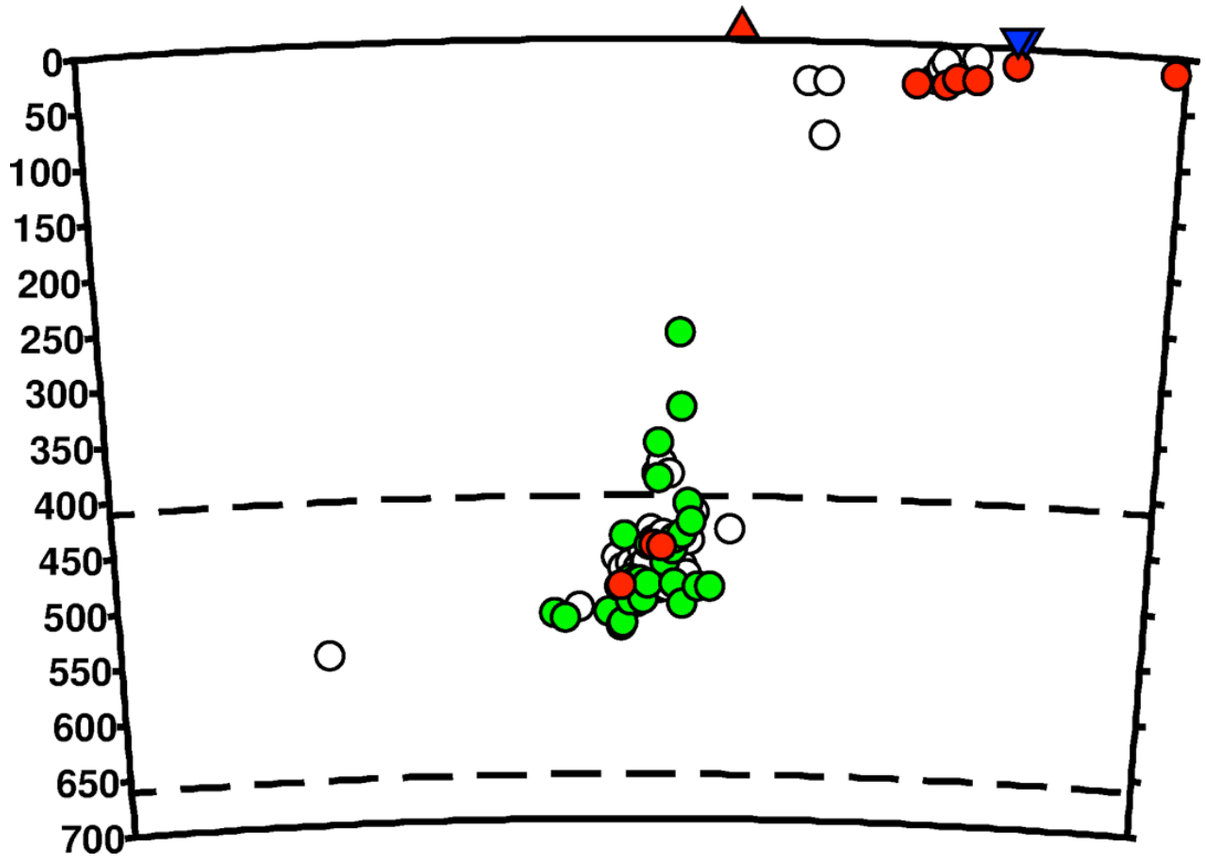
4. Relocated events are plotted in subduction zone cross sections along with events from ISC-GEM catalogue (Storchak et al., 2015).



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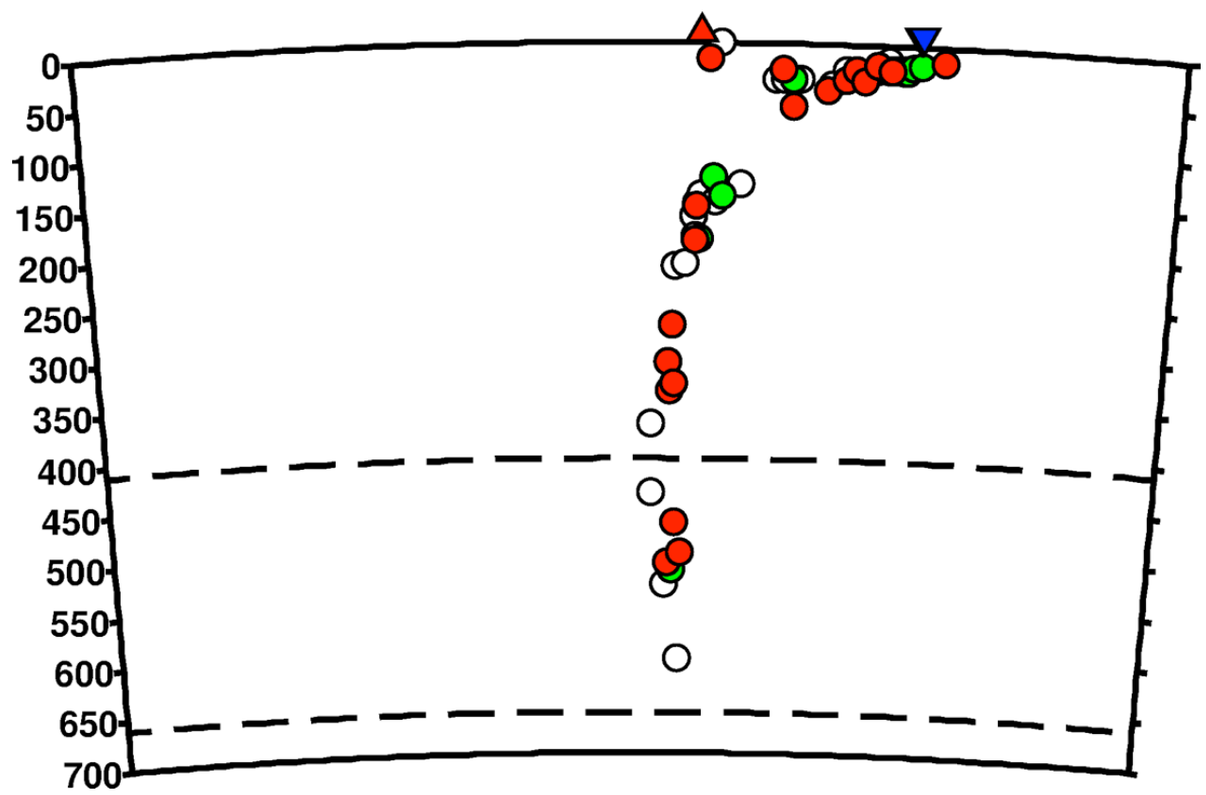
5. These plots are used to confirm or modify poorly constrained depths.



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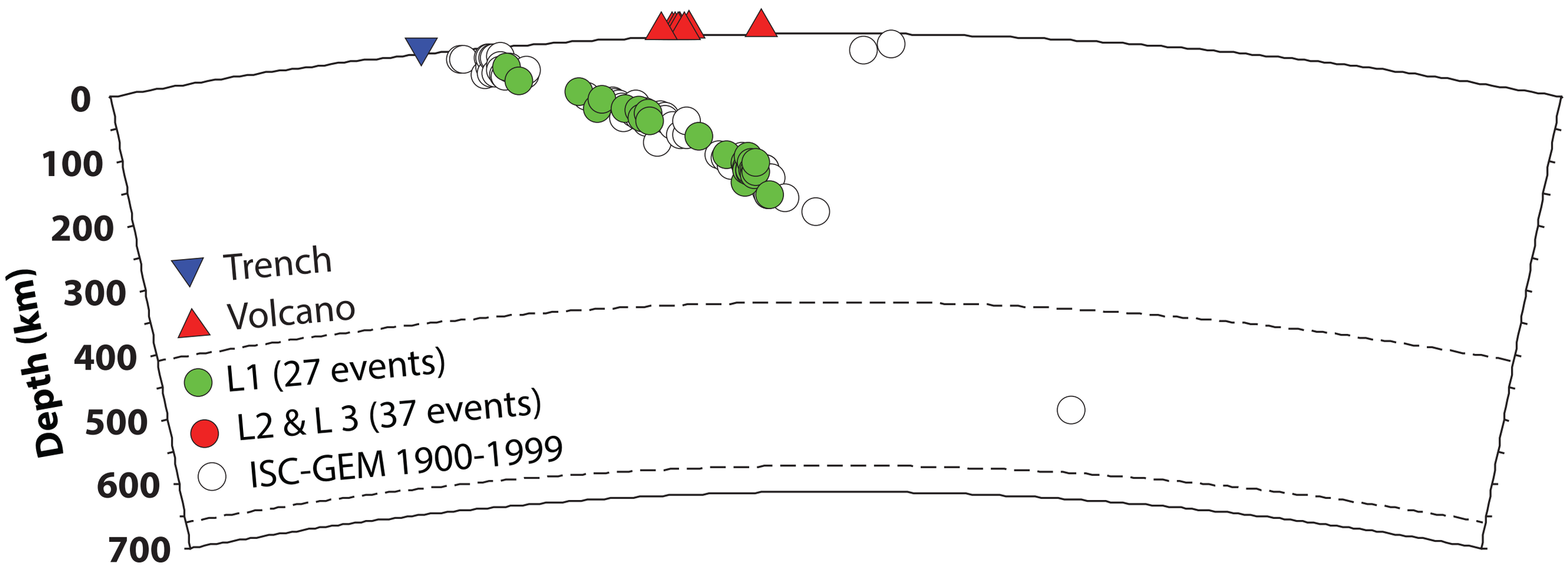
ISC-EHB: Depth Categories

Level (L1) - Free depth with standard depth error < 5 km, or fixed depth well constrained by depth phases.



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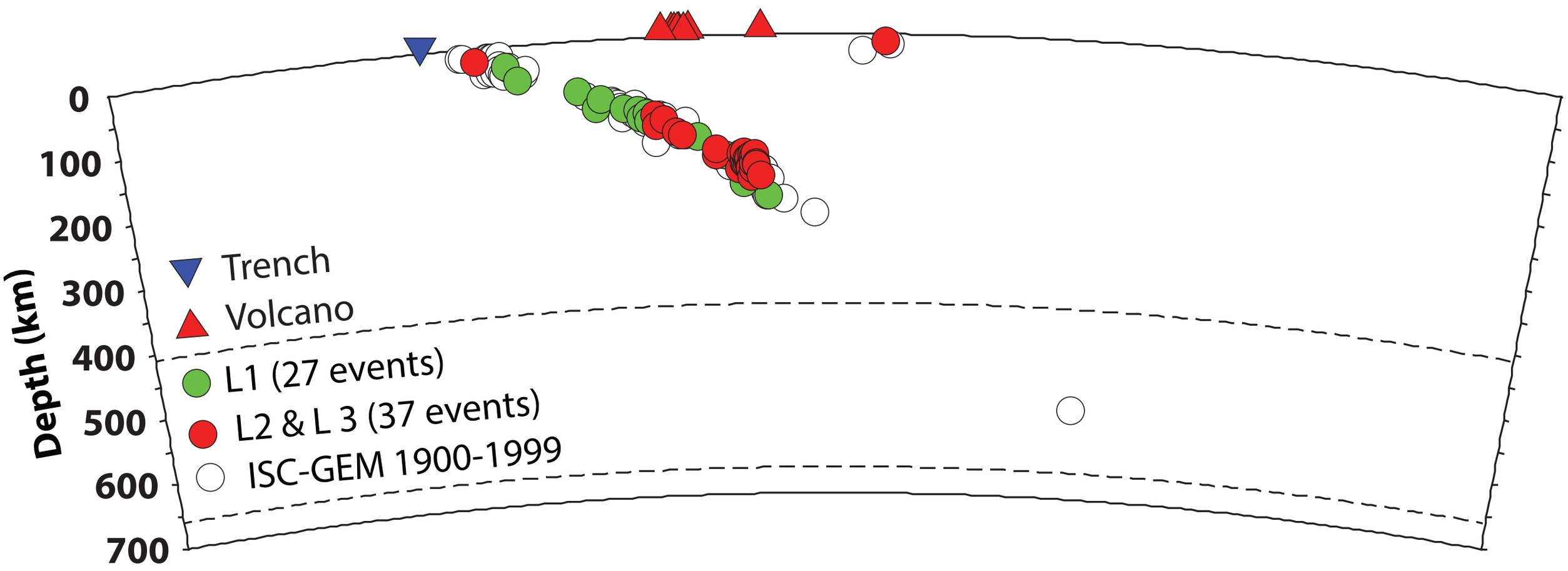
Level (L1) - Free depth with standard depth error < 5 km, or fixed depth well constrained by depth phases.

Level (L2) - Free depth with depth error 6 - 15 km, or a fixed depth based on the GCMT solution.

Level (L3) - Free depth with depth error > 15 km, or a fixed depth based on review of local/nearby seismicity, or tectonic regions.



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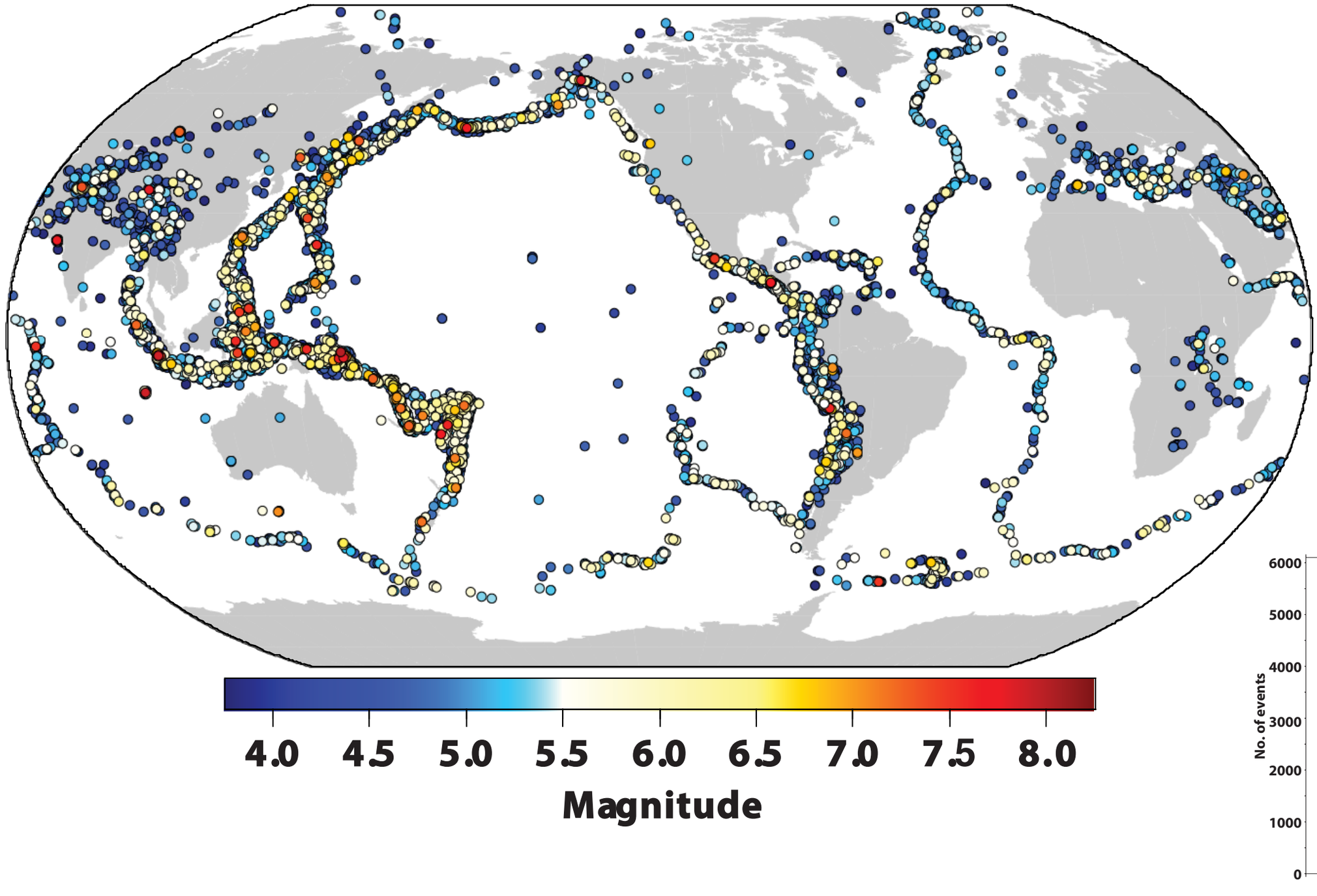
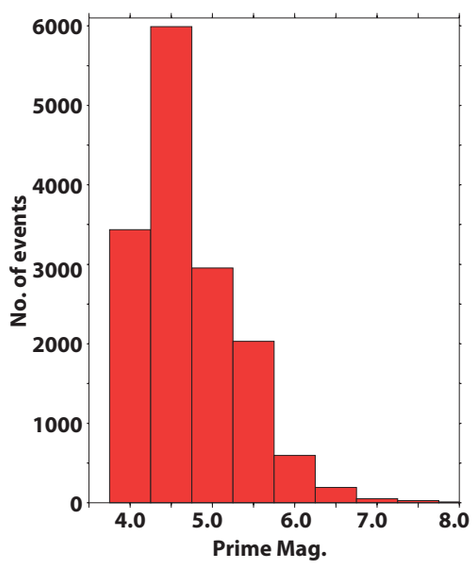
ISC-EHB 2003: Location and Magnitude

15,133 events between 2000-2003





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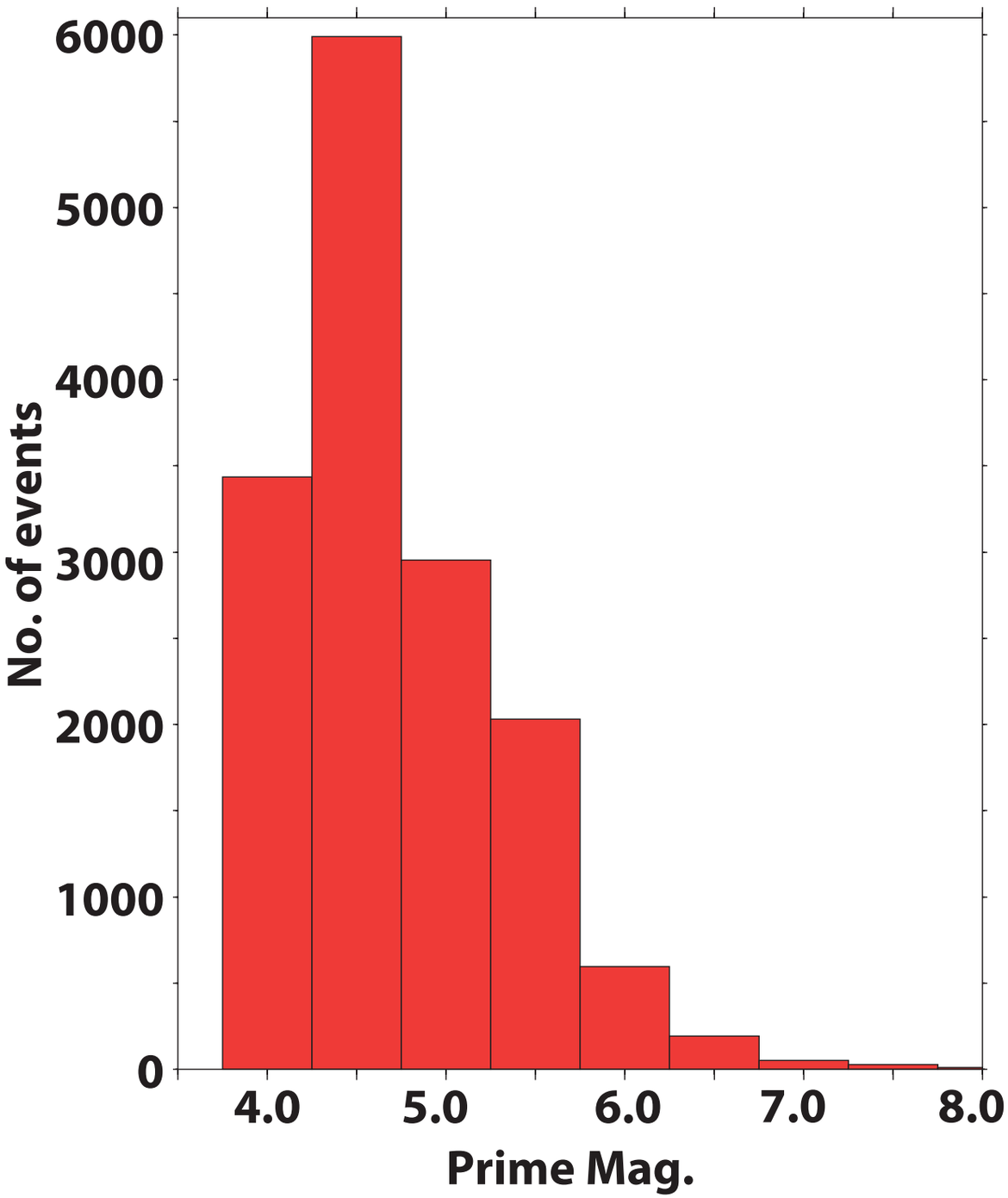
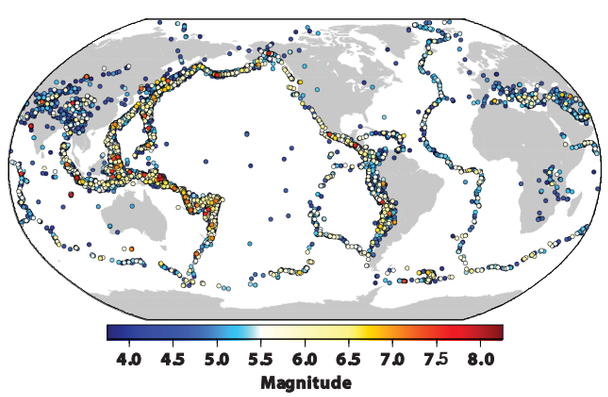
Magnitude range 3.7 - 8.3





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Depth Category	No. events	Median (km)
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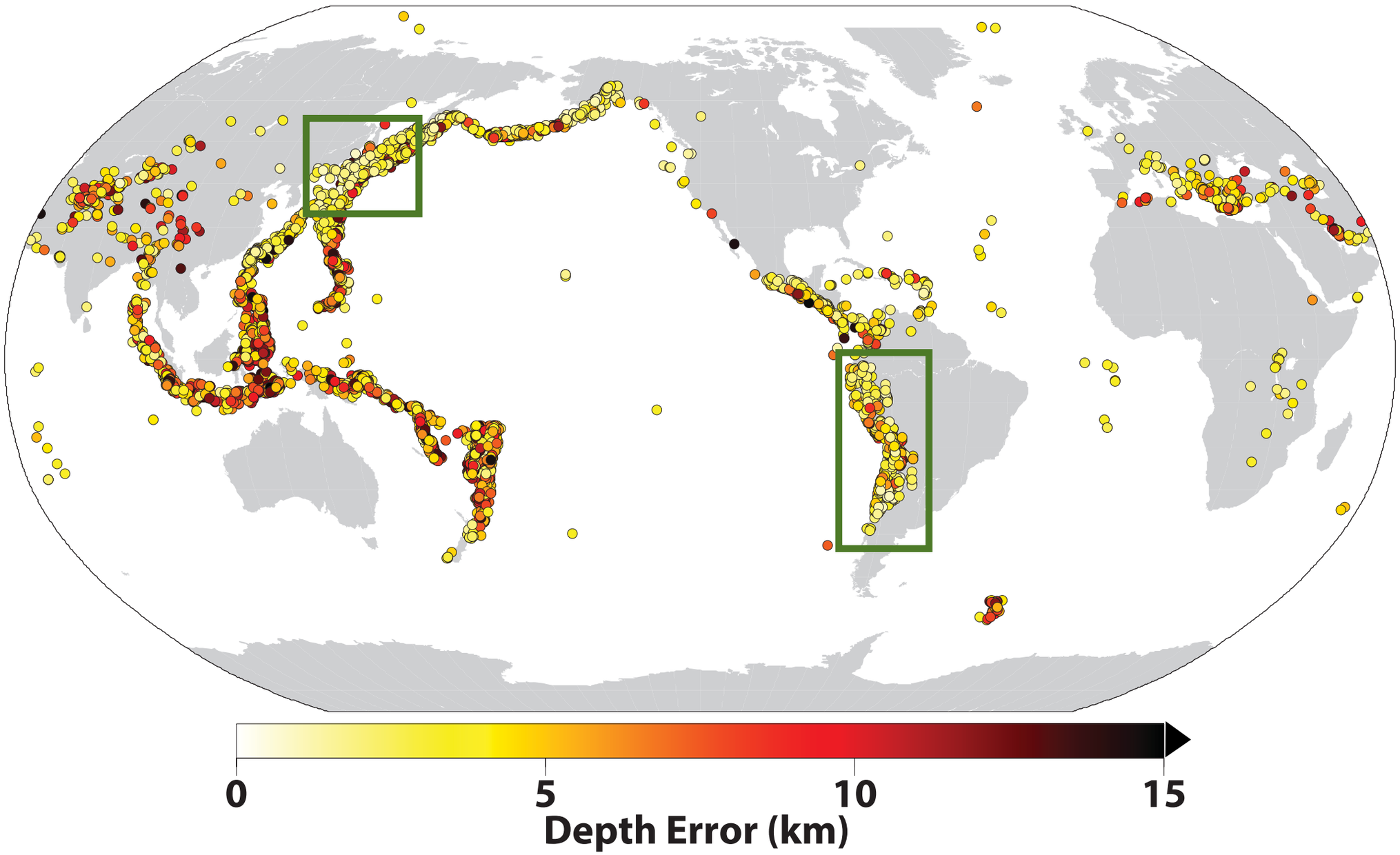
L3	6658	n/a



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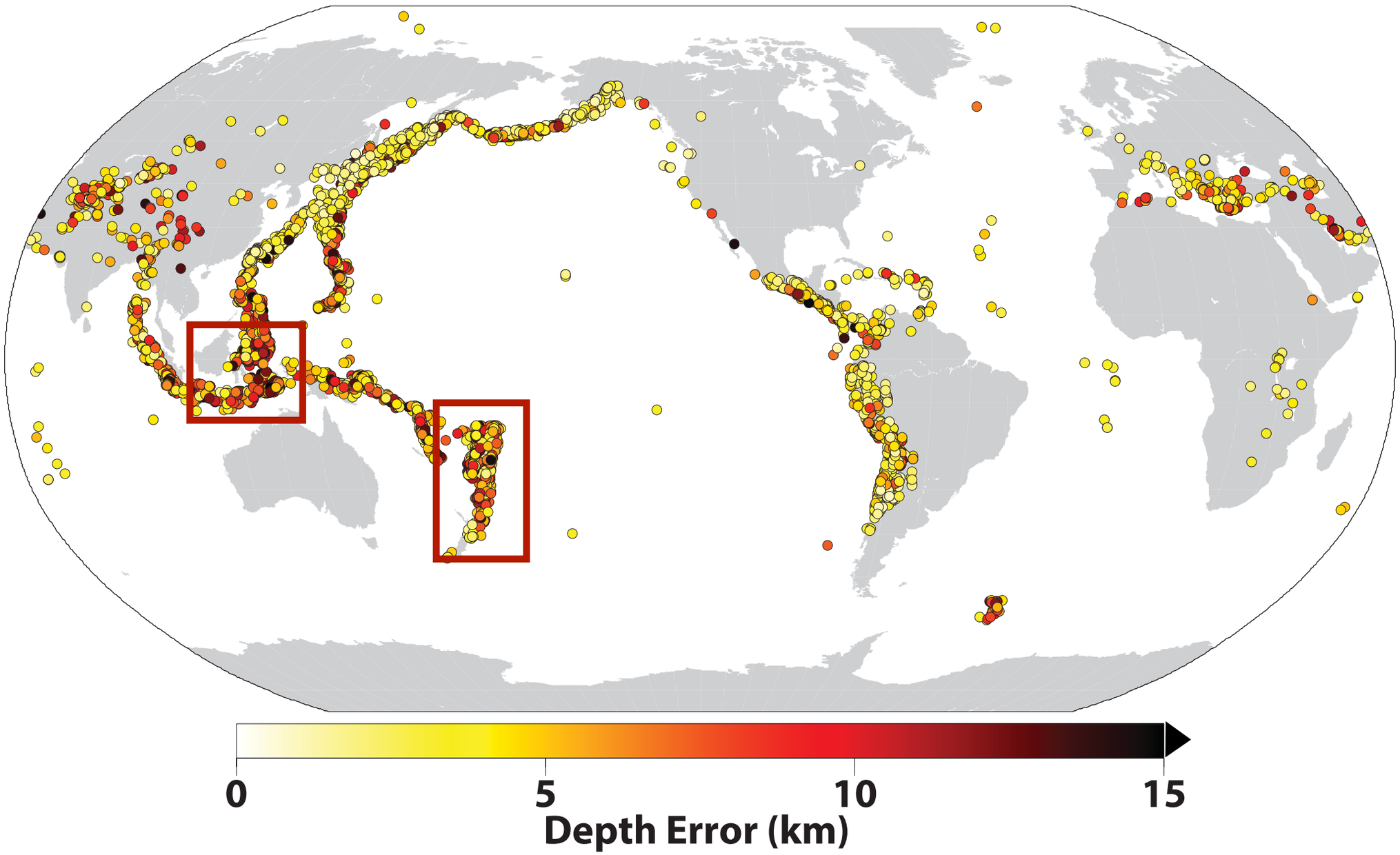

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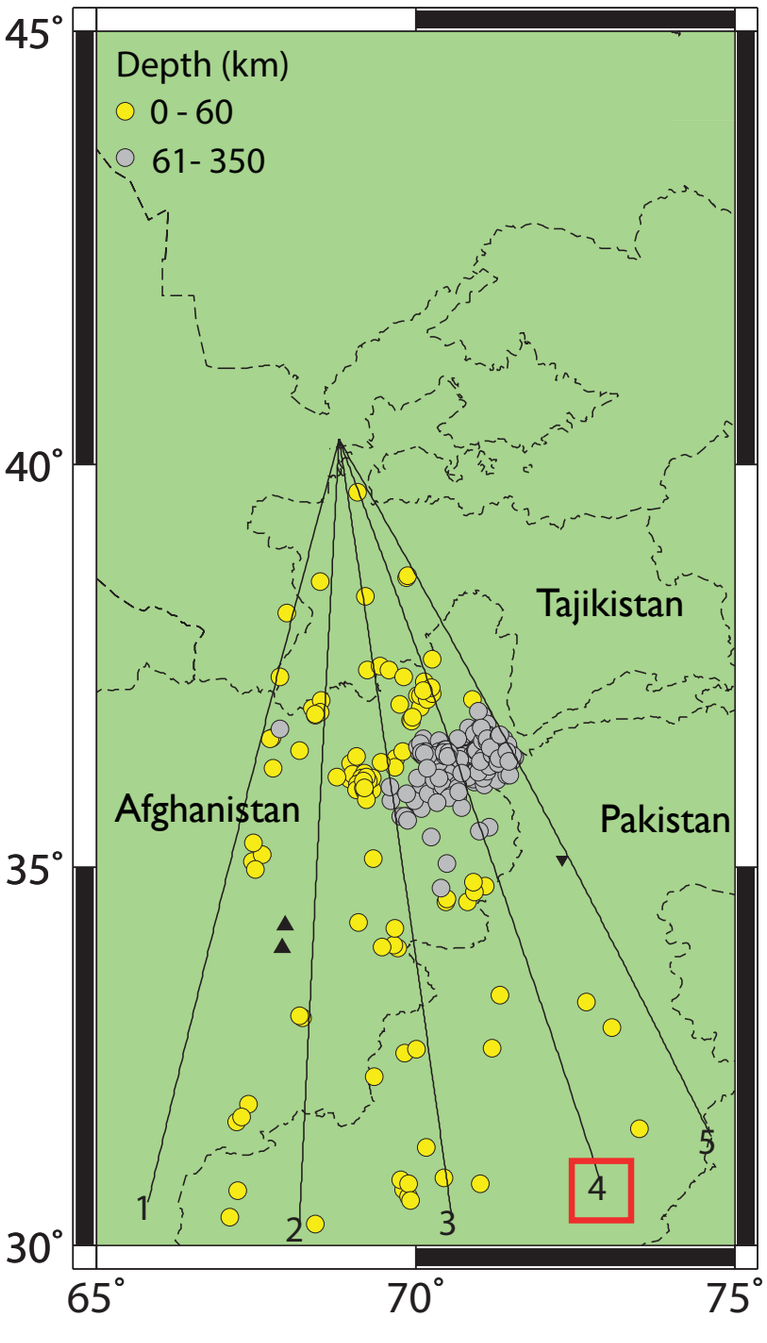
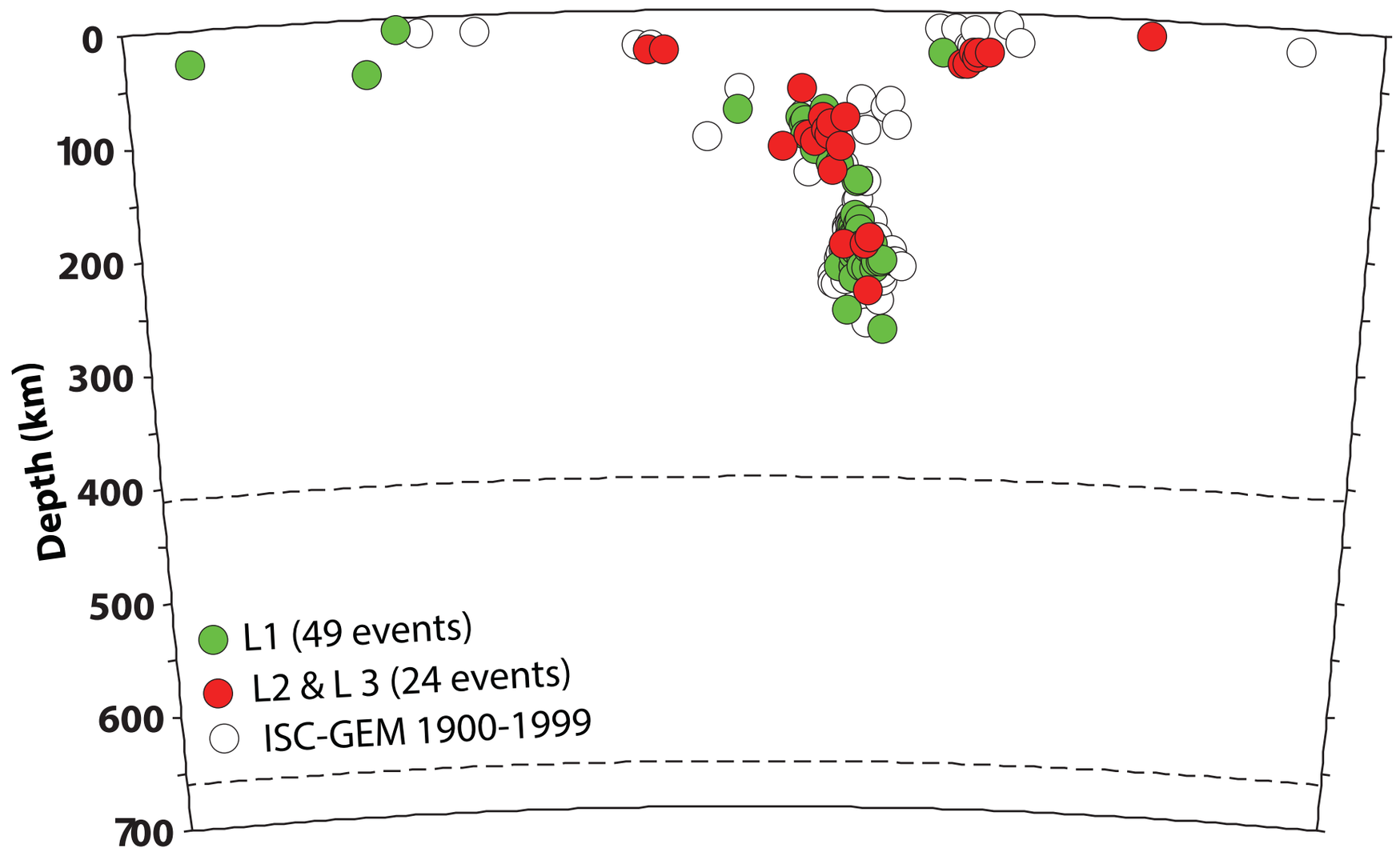
Intermediate depth - Hindu Kush



Cluster at intermediate depth, similar shape to that reported in other studies Sipl et al. (2013)



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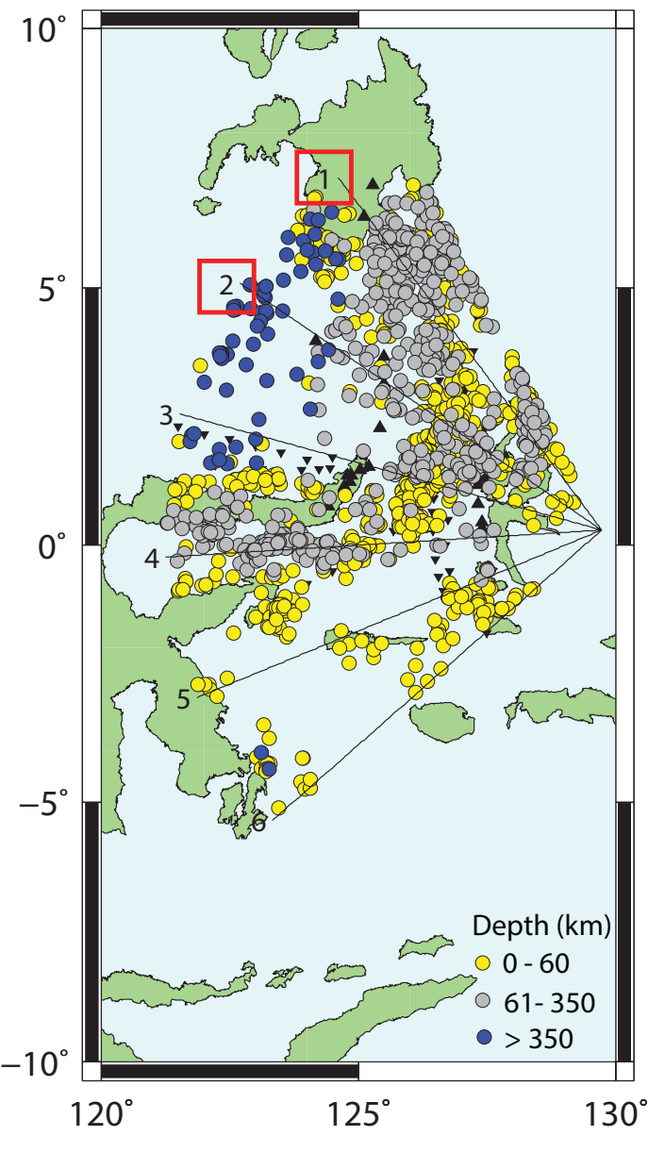
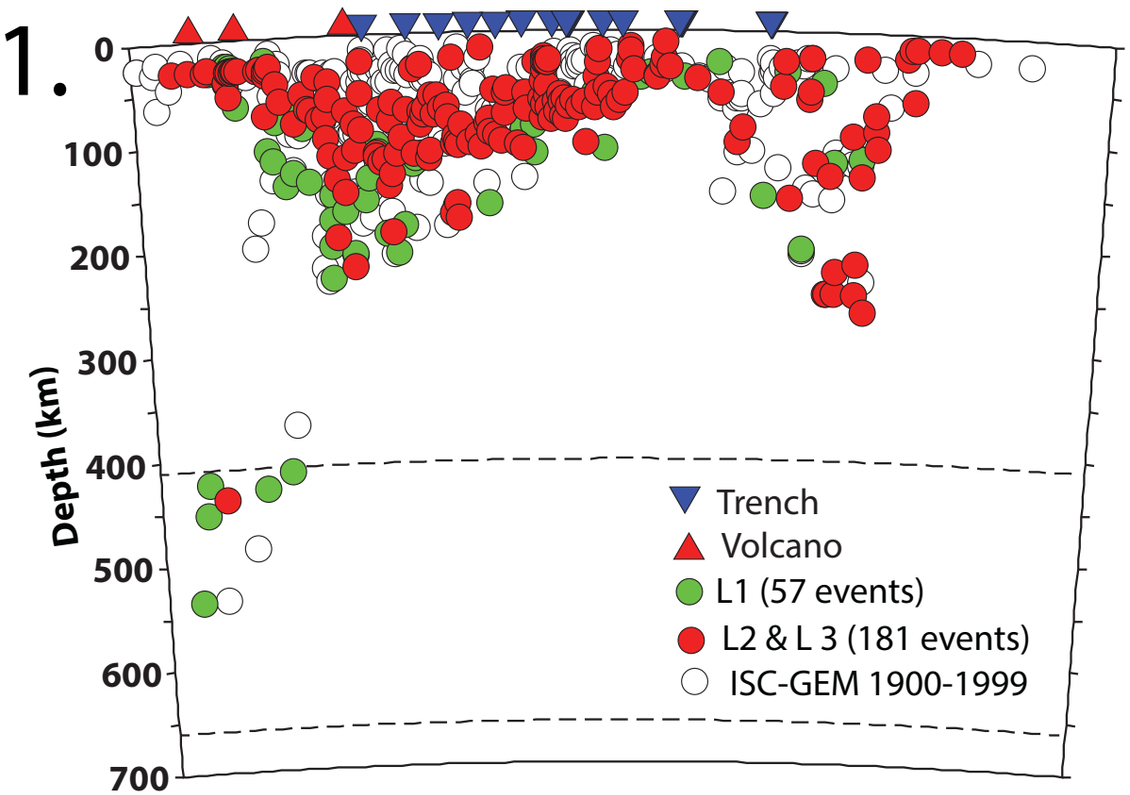
Complicated regions - Halmahera

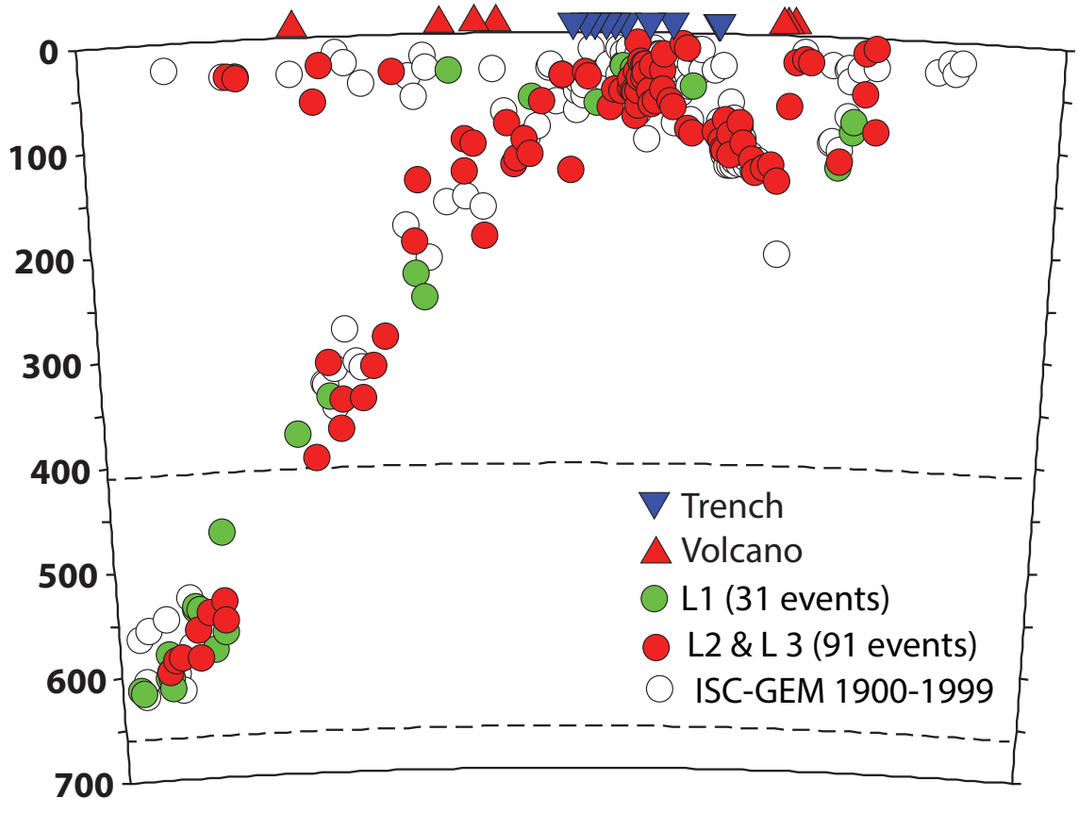


1.



In some regions it is easier to identify a structure and outliers.

2.



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Comparison with other catalogues

Original EHB

- Original EHB 20,632 events between 2000-2003.
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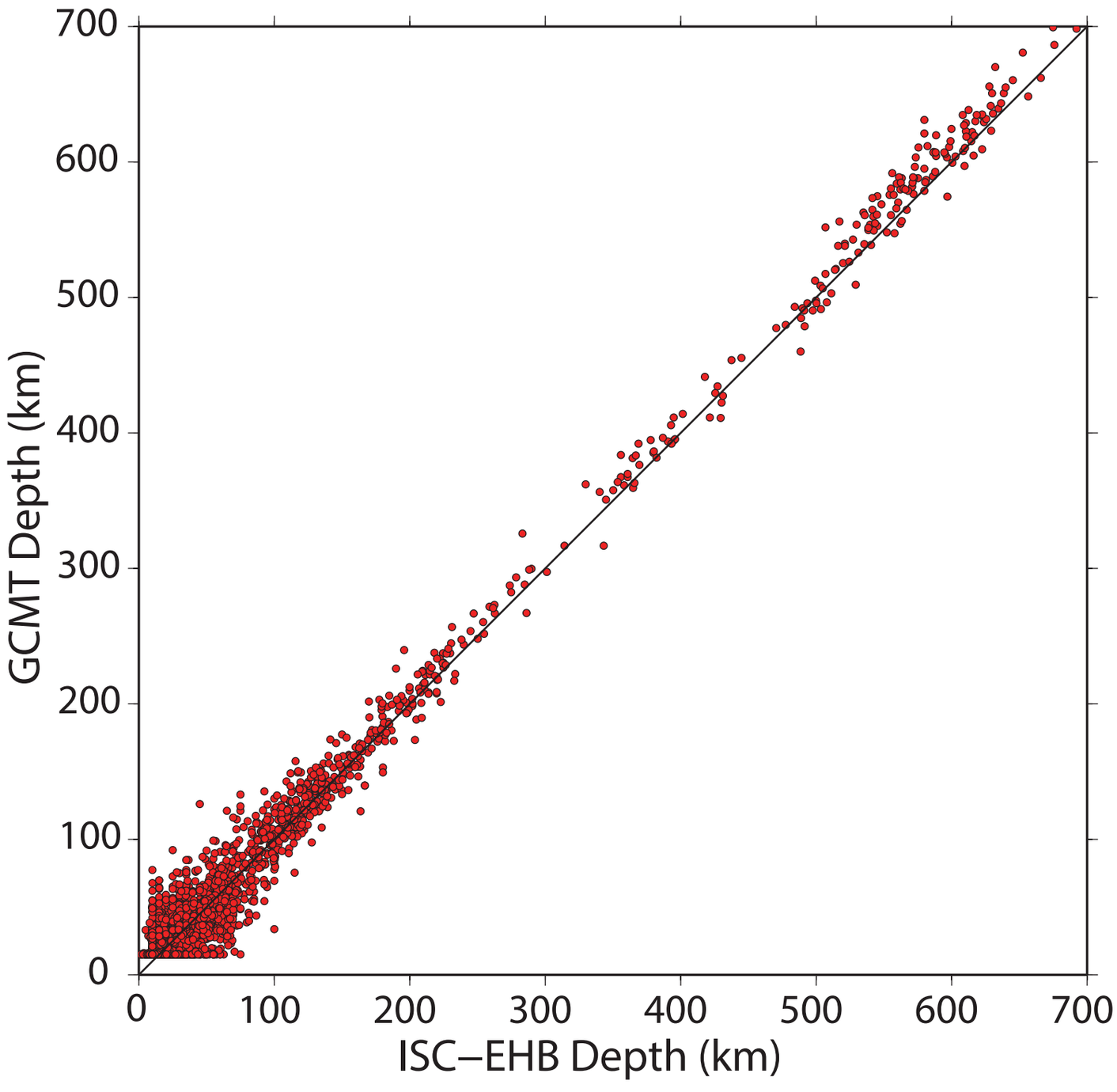
GCMT

- General good agreement between ISC-EHB and GCMT.
- Greater bias at large depths.
- Large scatter at shallow depths.



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•Cleaner and more robust dataset.

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What data are available now and where?

The ISC-EHB Bulletin contains 136,024 seismic events from 1964-2008, where the period 2000-2003 has been rebuilt.

www.isc.ac.uk/isc-ehb

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Future Plans

- Subduction zone cross sections for 2000-2003 will be available soon.
- Currently processing 2004-2013, which will hopefully be released later in 2017.
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Download ISC-EHB at: www.isc.ac.uk/isc-ehb
Any questions about ISC-EHB, email me at jen@isc.ac.uk

Acknowledgements

64 Institutions in **48** countries, including the Royal Society, BGS and Blacknest in UK, make the annual **membership** subscriptions to the ISC.

14 international, public or commercial entities sponsor individual ISC **projects**:

CTBTO PREPARATORY COMMISSION

CTBTO Link to ISC database

REF TEK A DIVISION OF TRIMBLE

GeoSIG swiss made to measure

SEISMOLOGY RESEARCH CENTRE

güralp

International Station Registry

NSF

ISC Event Bibliography

USGS science for a changing world

FM Global

OYO oyo corporation

THE LIGHTHILL RISK NETWORK

Aon Benfield, Lloyd's, Guy Carpenter, Catlin.

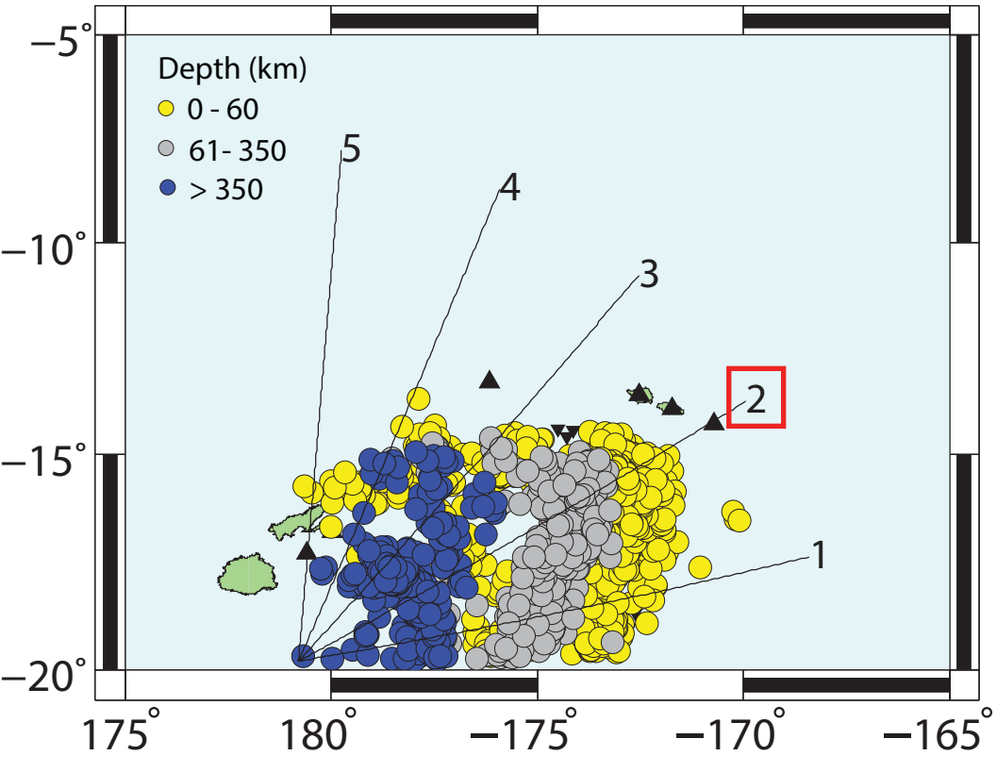
ASPEN

NSF

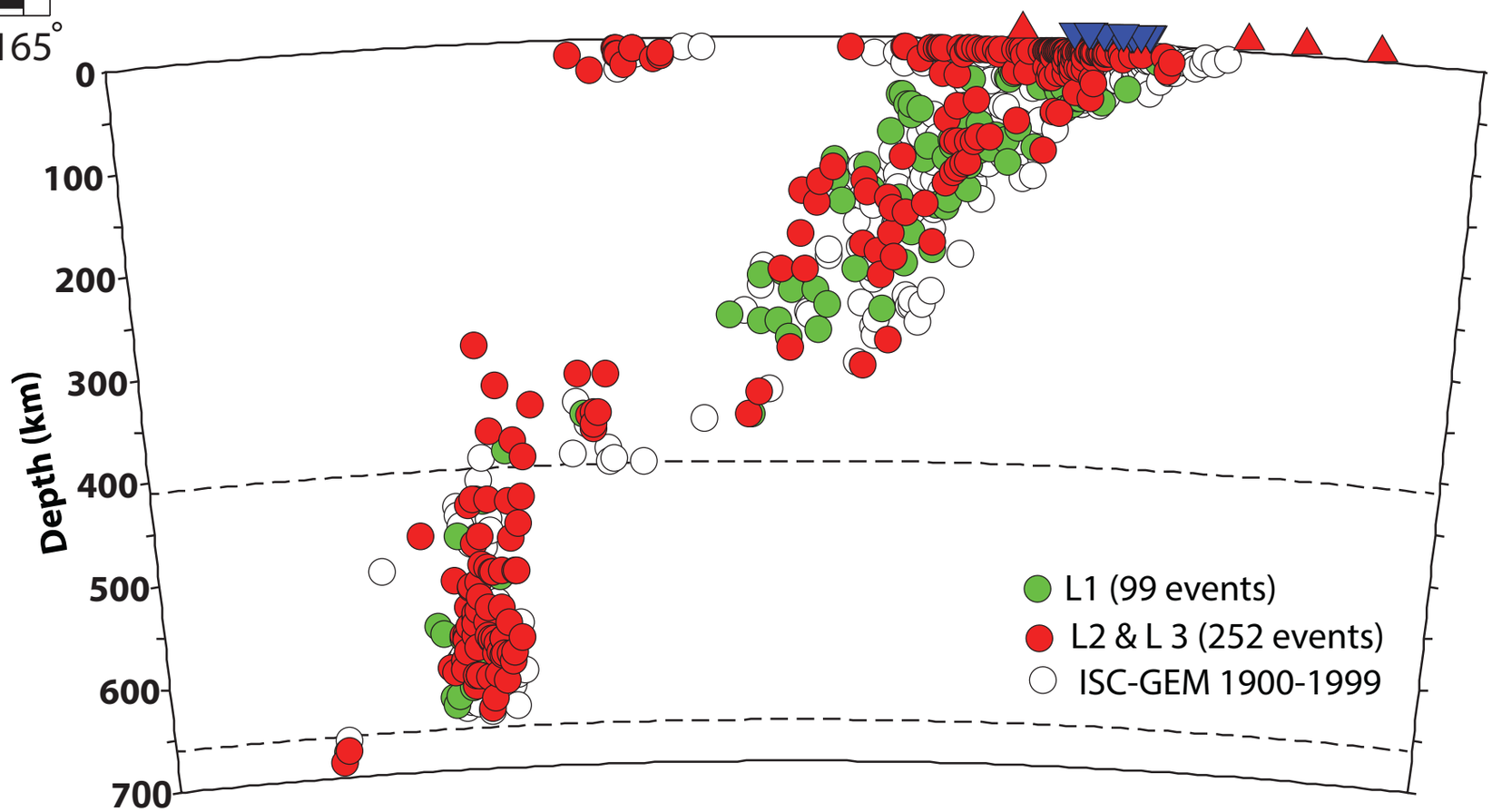
ISC-GEM Catalogue

International Seismological Centre

Subduction zone structure - Tonga



- Subduction zones feature heavily in the dataset.
- In regions of good azimuthal coverage some structures can be seen clearly.
- A potential detached slab structure is observed in Tonga.



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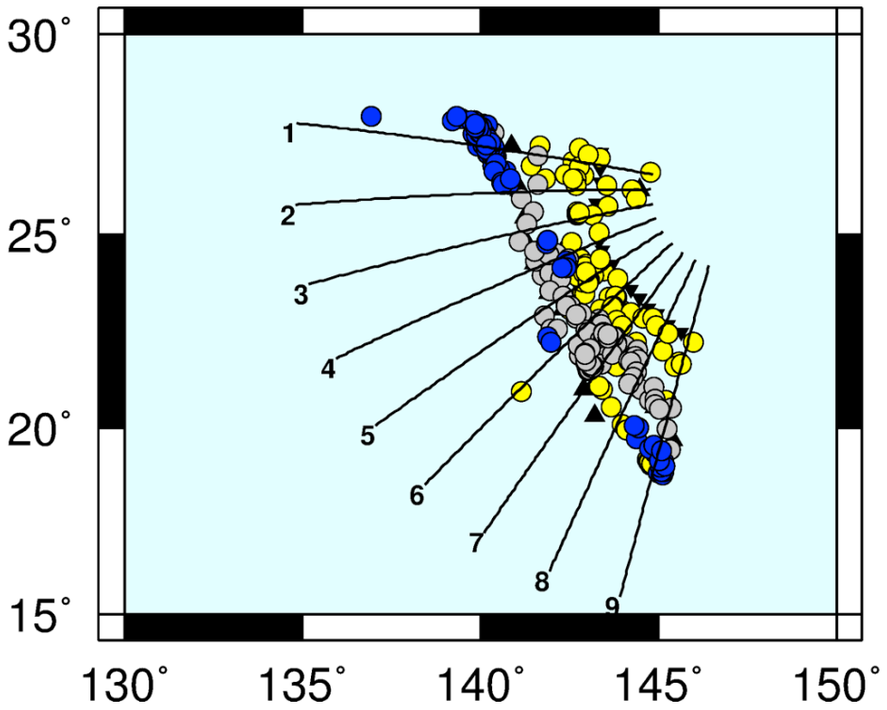
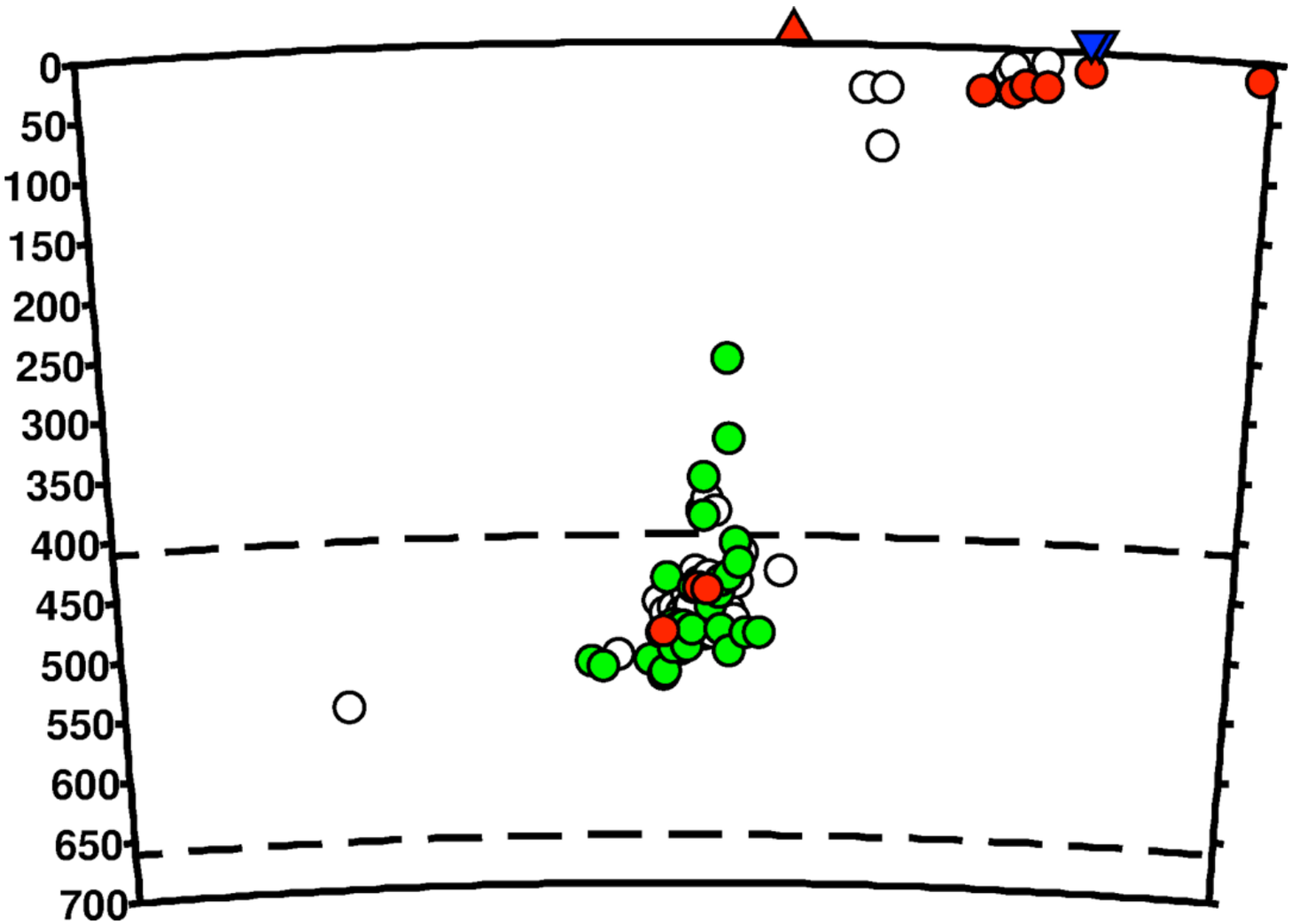
Bonin - Cross Section 1



L1 - 13 events
L2 & L3 - 20 events



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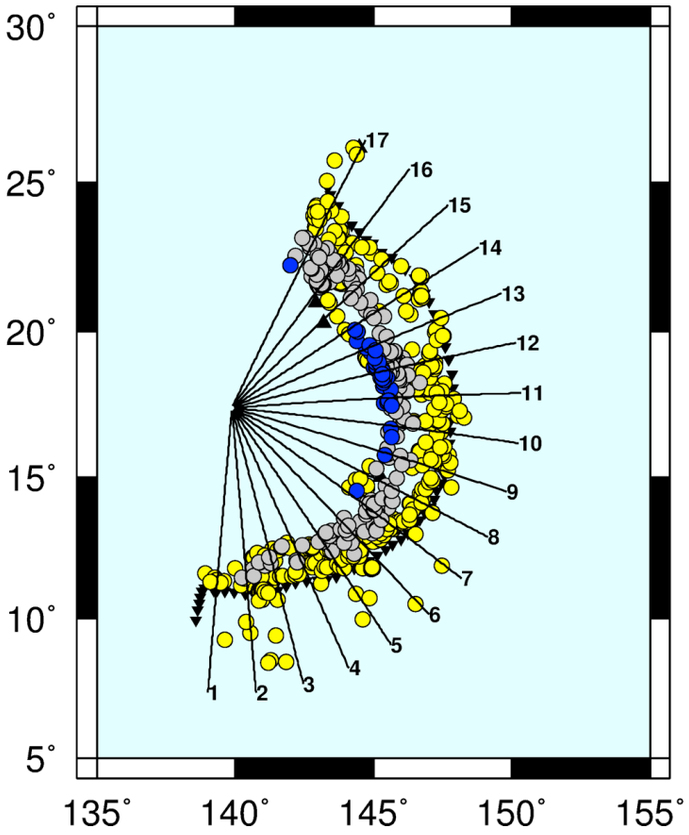
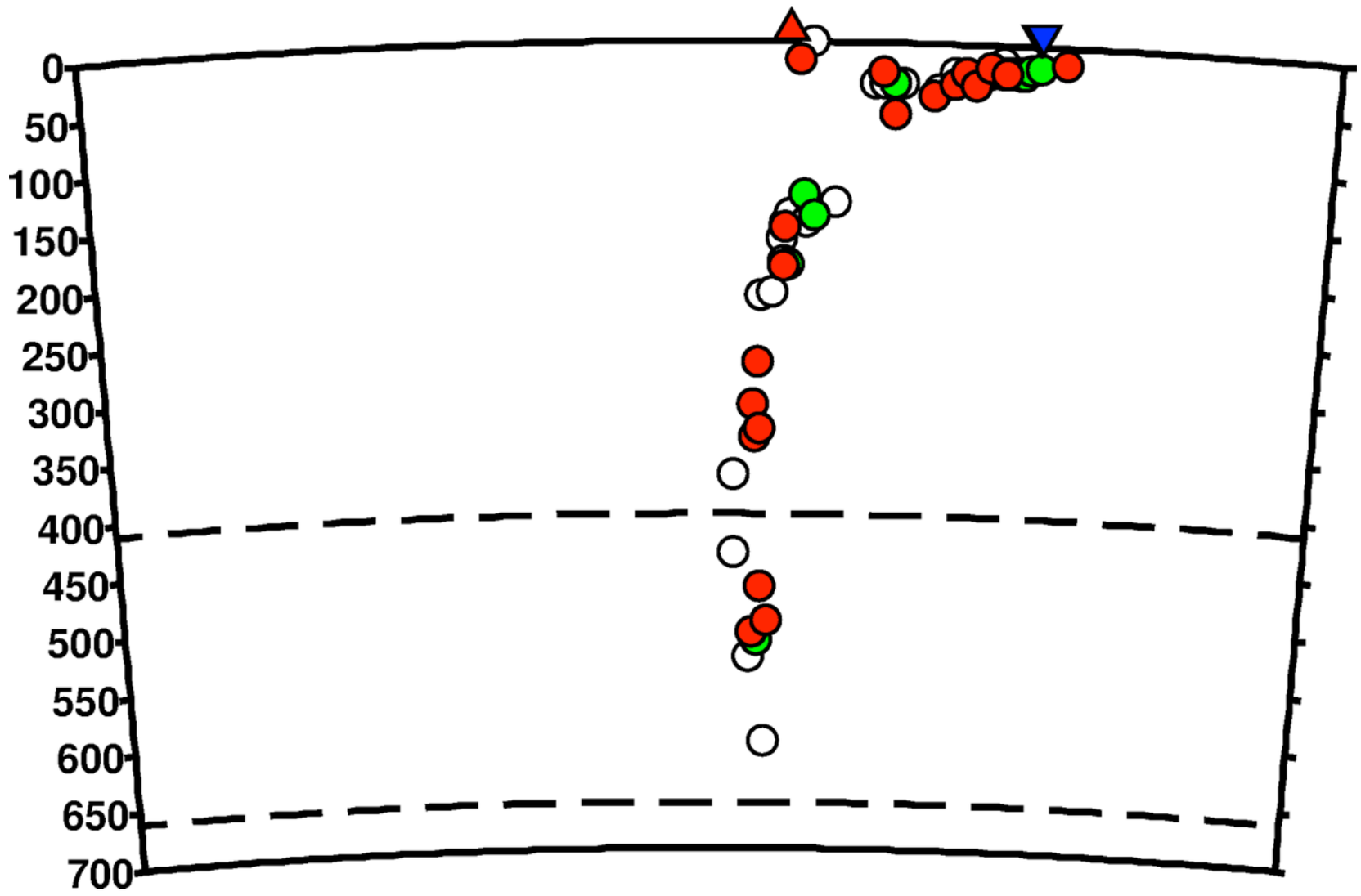
Marianas - Cross Section 11



L1 - 30 events
L2 & L3 - 9 events



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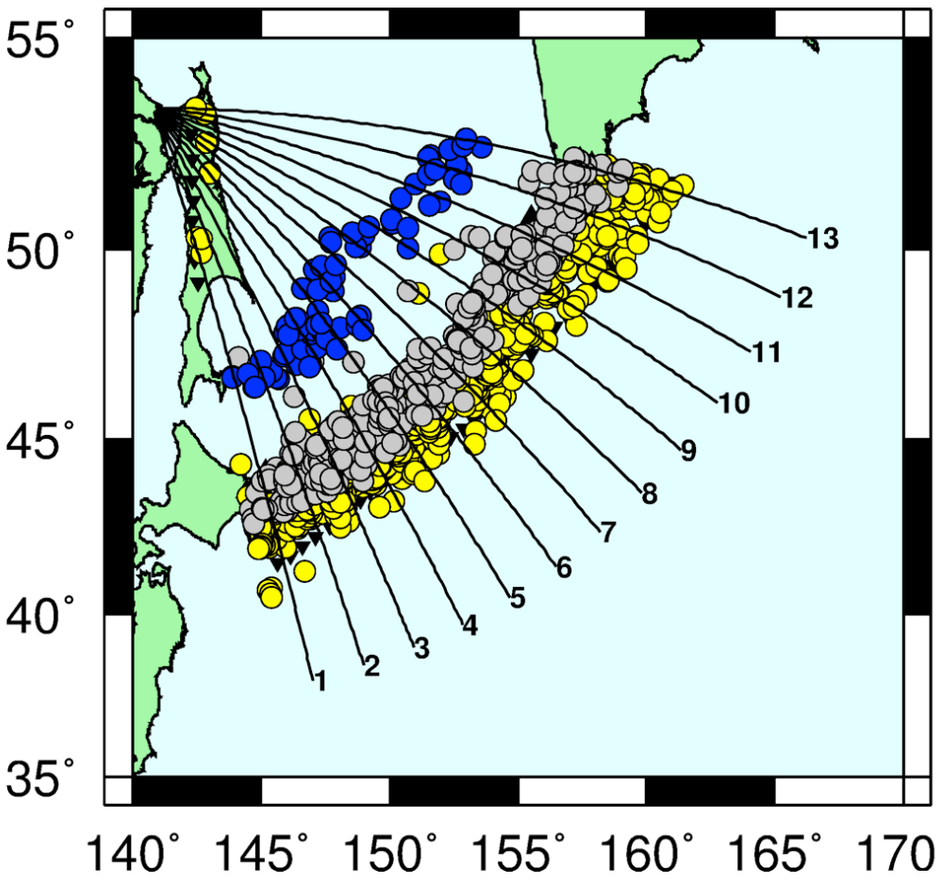
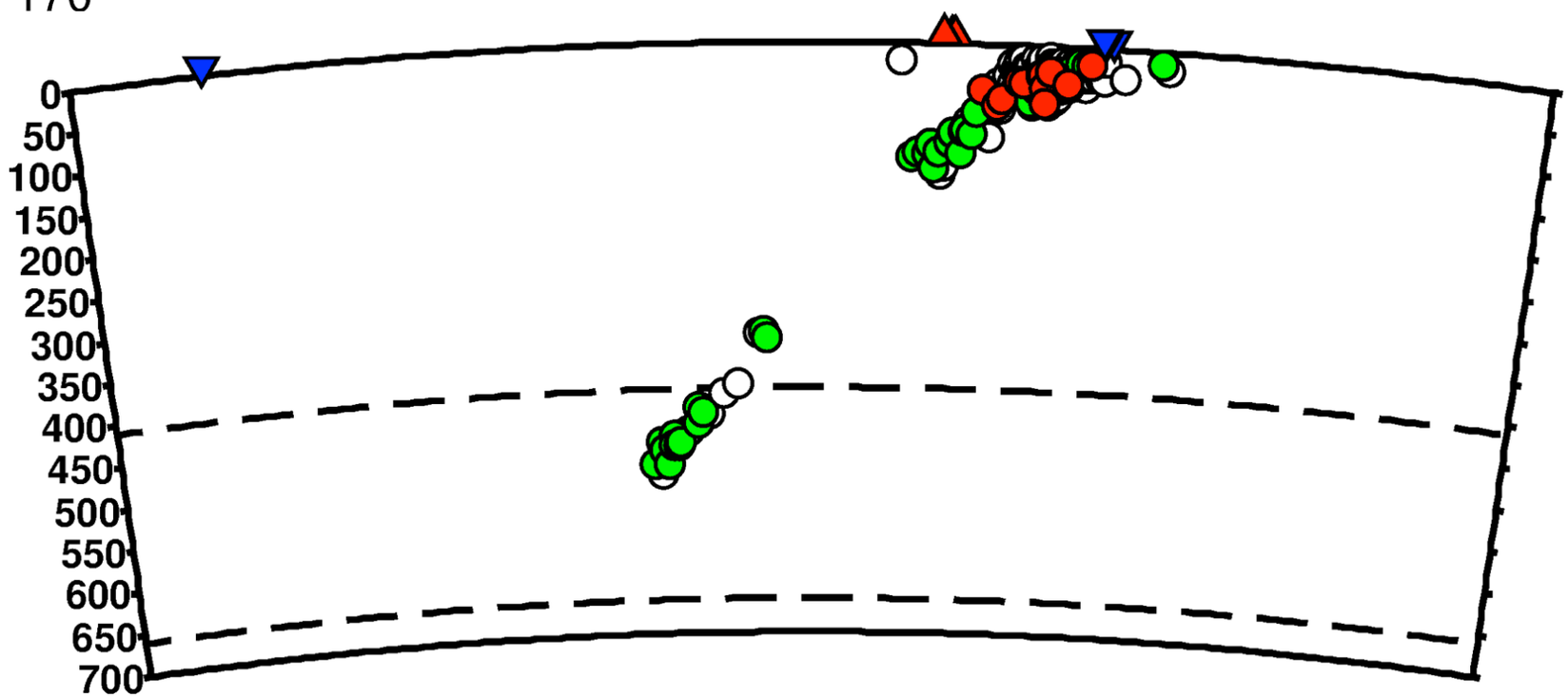
Kurile - Cross Section 4

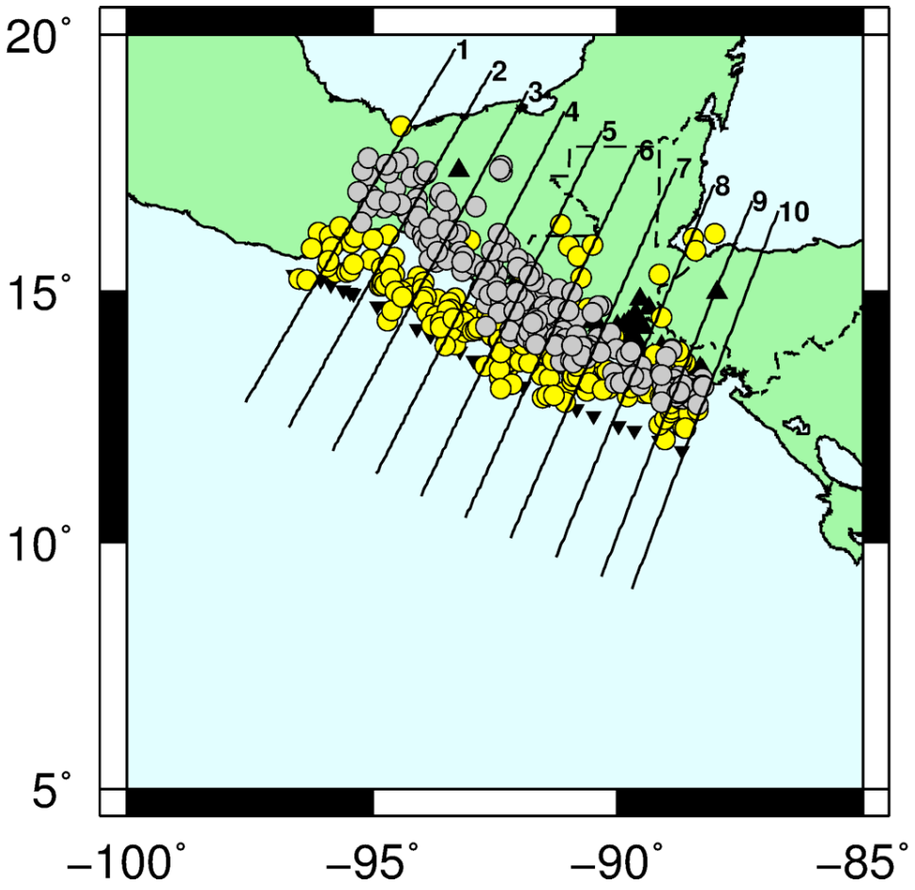


L1 - 42 events
L2 & L3 - 32 events

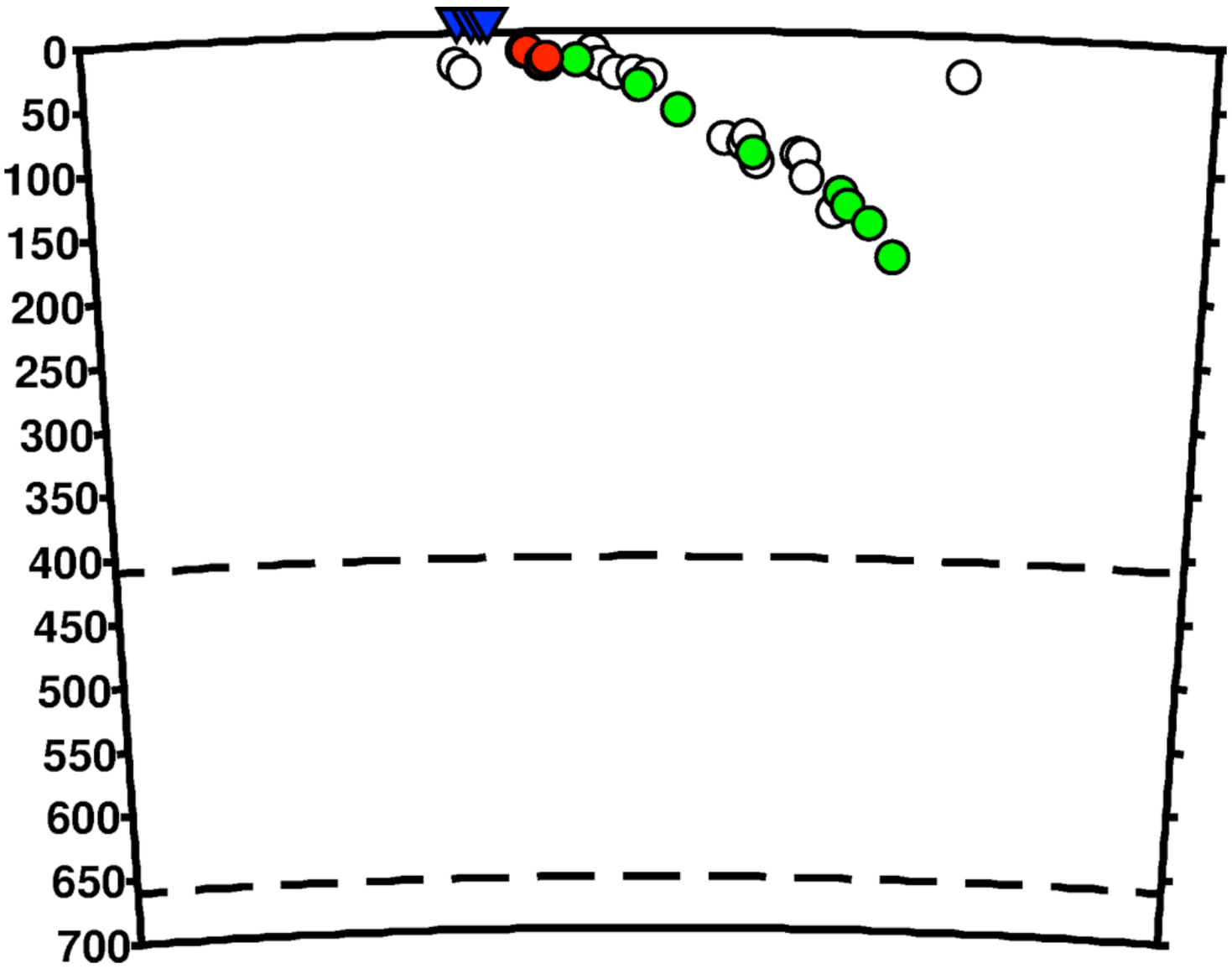


International Seismological Centre

Central America - Cross Section 1

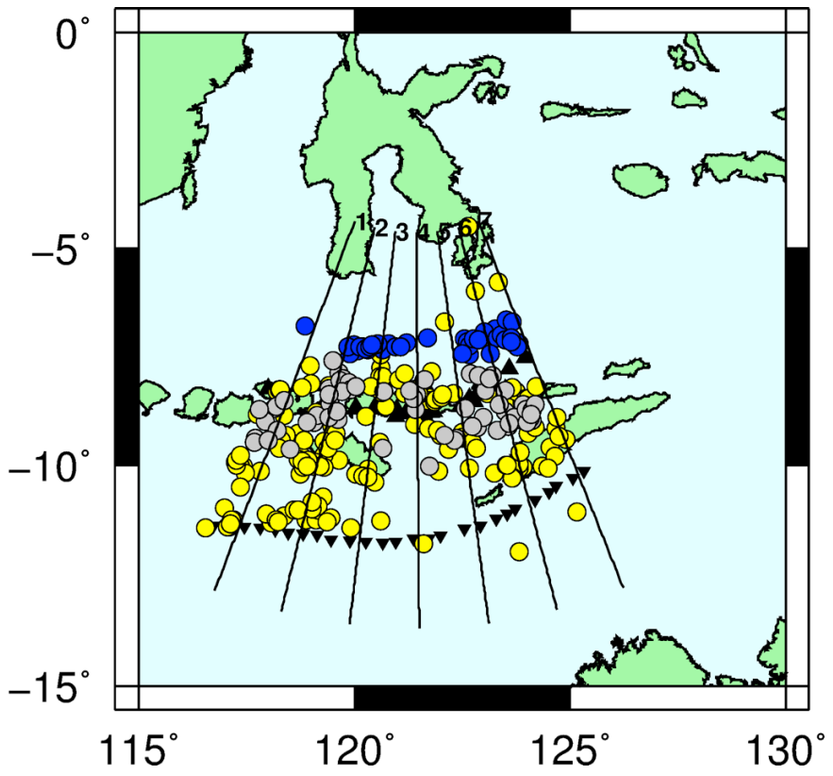


L1 - 9 events
L2 & L3 - 3 events



International Seismological Centre

Sunda - Cross Section 2



L1 - 5 events
L2 & L3 - 16 events