*Workshop on Probabilistic Fault Displacement: Critical issues, Data needs and Interface plans October 1st, 2019, Pomona, California*

# SURE Database

## A compilation of field-based datasets for PFDHA and further development

**A Worldwide and Unified Database of Surface Ruptures (SURE) for Fault Displacement Hazard Analyses**

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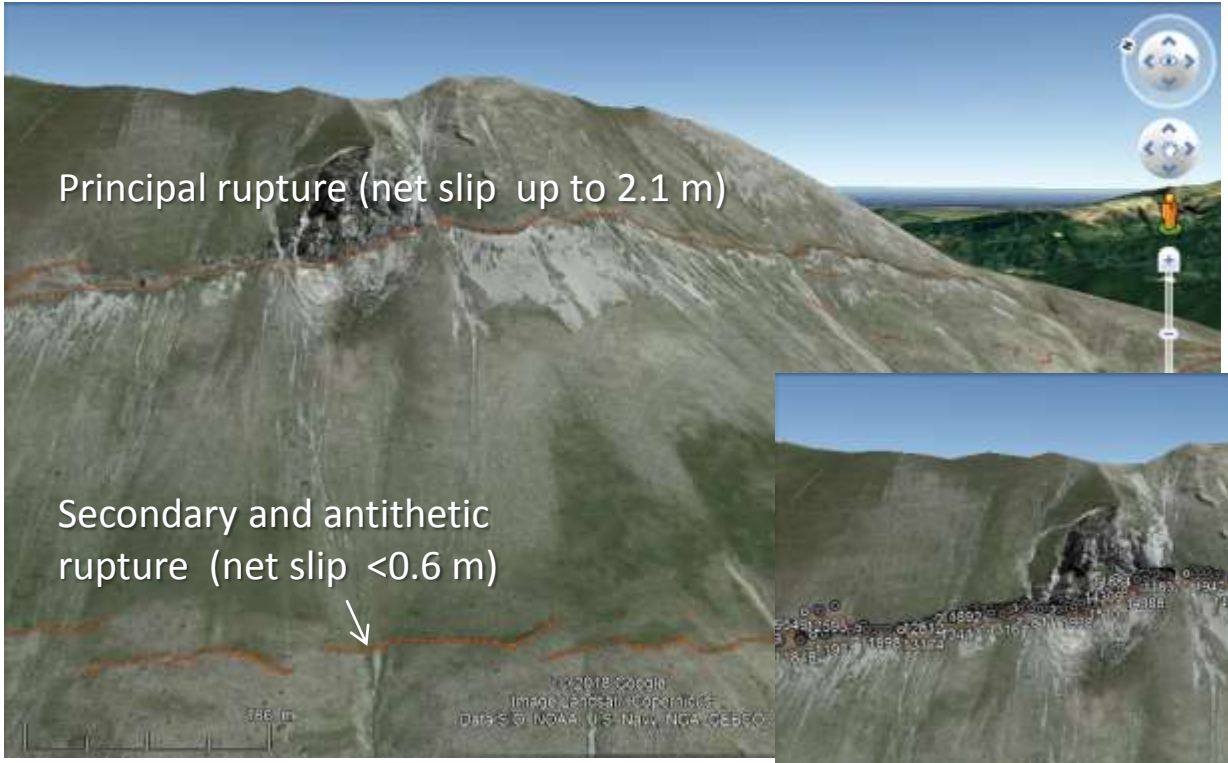
# Key points

- User-friendly format
  - Shapefiles and tables can be easily implemented by worldwide geologists with their own datasets
- Open access
  - SRL Data mine paper
  - ESC Fault2SHA website
- Long-living
  - European Seismological Commission (ESC) guarantee
  - IRSN –french public institution- will take over
- Content
  - 45 earthquakes from magnitude 5–7.9
  - More than 15,000 coseismic surface deformation observations & and 56,000 of segments
  - 22 earthquake cases are from Japan, 15 from United States, 2from Mexico, Italy, and New Zealand, 1 from Kyrgystan, Ecuador, Turkey, and Argentina.
  - 24 earthquakes are strike-slip faulting events, 11 are normal, and 10 are reverse faulting

→ PhD thesis of Fiia Nurminen: new historical cases, especially reverse faults (~10), will be soon implemented

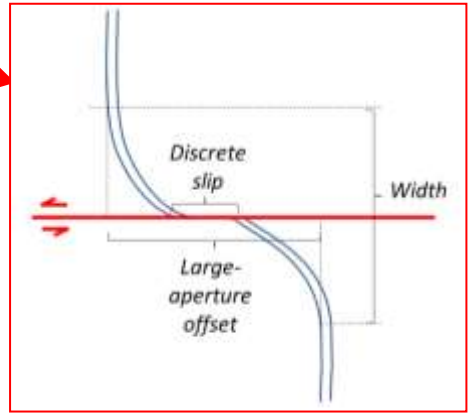
*M6.5 Norcia earthquake (Italy)*




**Shapefile of rupture segments with related table**

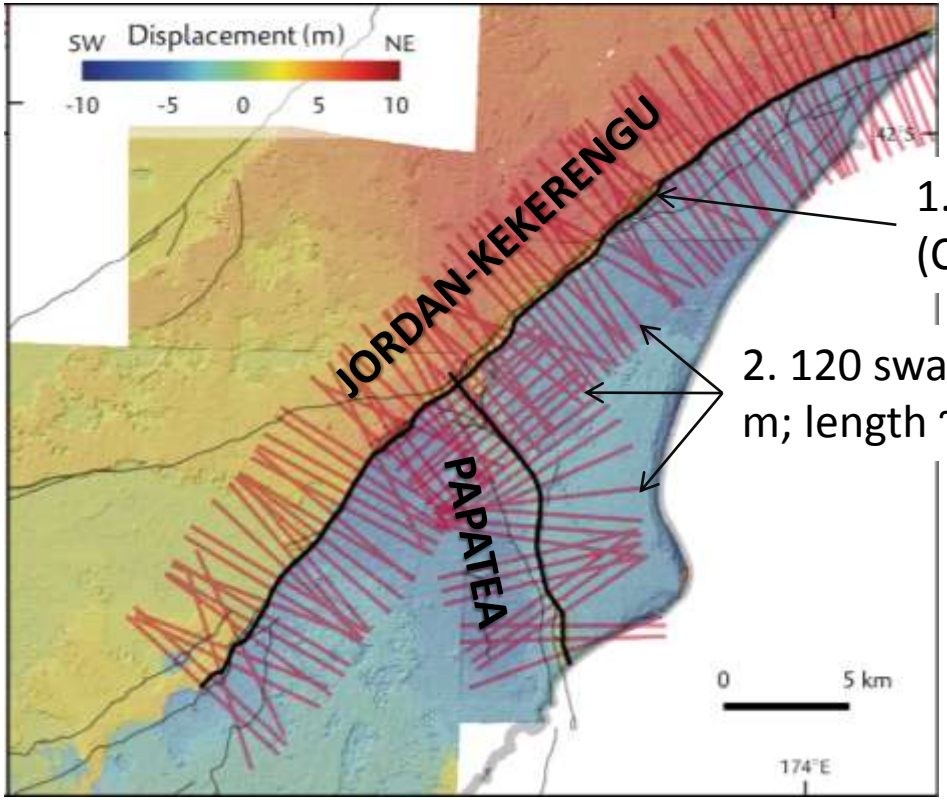

**Shapefile of slip measurements with related table**

| | | |
|---|---|---|
| Basic information | Id1 | Concatenation of earthquake date numbers YYYYMMDD |
| | Id5 | Segment ID |
| | IdO | Observation of rupture ID |
| | Date | Date of observation |
| | Initial Reference | Source of data |
| | Observer | Name |
| | Id-Observer | ID provided by observer |
| | Longitude | In decimal degrees (WGS84) |
| | Latitude | In decimal degrees (WGS84) |
| | Elevation | In meters |
| Horizontal component of fault displacement | Strike slip (SS) | Horizontal component of discrete slip along fault plane. In meters. |
| | Sense of slip (SS) | LL : Left-Lateral; RL = Right-Lateral |
| | Uncertainty horizontal (+/-) (SS) | In meters. |
| | Max and min values (SS) | In meters |
| | Large-aperture offset (SS) and uncertainty | In meters.<br>Corresponds to the total strike component of fault displacement, including that on the discrete fault plane and off-fault flexure, if any |
| | Aperture Width (SS) | In meters.<br>Width of the band where large-aperture offset is accommodated |
| | Fault-normal component (heave) (FNS) and sense of relative displacement | In meters.<br>Shortening (S) or lengthening (L) |
| | Opening | In meters.<br>Aperture of the rupture measured perpendicular to the walls |
| Vertical component of fault displacement | Vertical throw (VT) (m) | In meters.<br>Separation between hanging wall and footwall measured vertically |
| | Upside | Gives the cardinal direction of the upthrown block surrounding the fault. |
| | Uncertainty vertical (+/-) (VT) | In meters. |
| | Max and min vertical (VT) | In meters. |
| | Large-aperture Offset (VT) (m) and uncertainty | In meters.<br>Corresponds to the total vertical component of faultsurface displacement (throw), including that on the discrete fault plane and off-fault flexure, if any |
| | Aperture Width (VT) | In meters.<br>Width of the band where large-aperture offset is accommodated |
| | Vertical slip (VS) (m) and uncertainties | In meters. Free-face fault slip.<br>Actual vertical component of slip, accounting for the fault dip |




+ many other variables (local geology, structural complexity,…)

# Contribution of Optical Correlation data to SURE
# Analysis of off-fault deformation in the triple junction area of 2016 M7.8 Kaikoura earthquake rupture




1. Definition of a single Main Fault trace (Cosi-Corr, ROI)

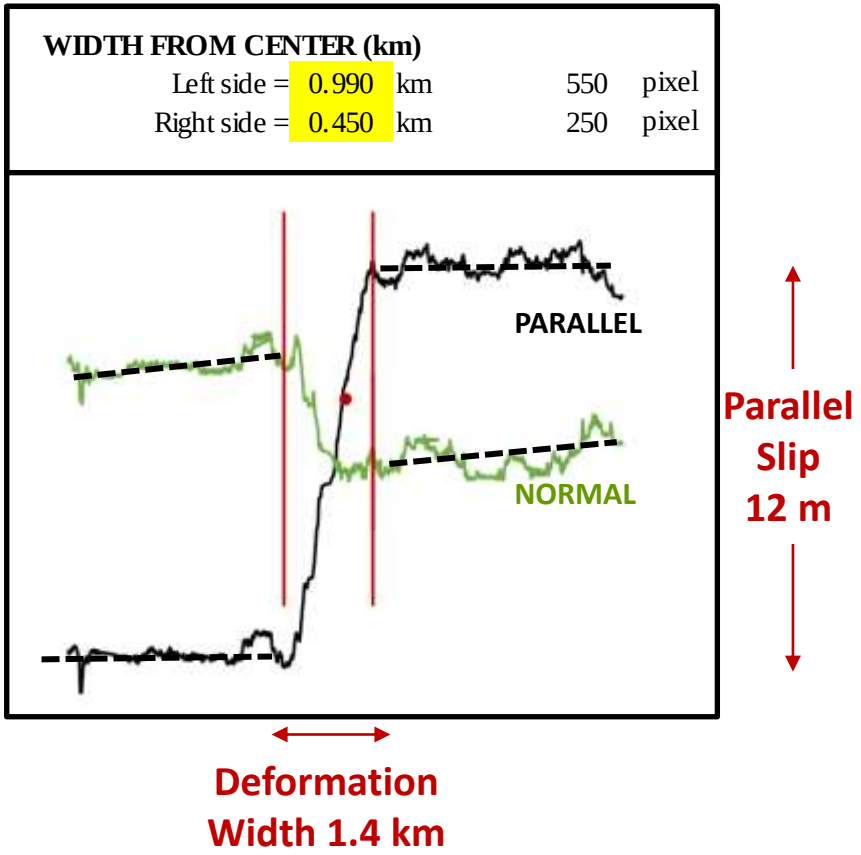
2. 120 swath profiles, 90 m wide, defined each 500 m; length ~ 9 km

Work by A.M. Tobon-Lopez (IPGP Master student 2019), S. Baize, Y. Klinger, A. Vallage, J. Champenois

*-Pléiades (post) v SPOT (pre)*
*-MicMac software*
*-Spatial resolution 1.8 m*

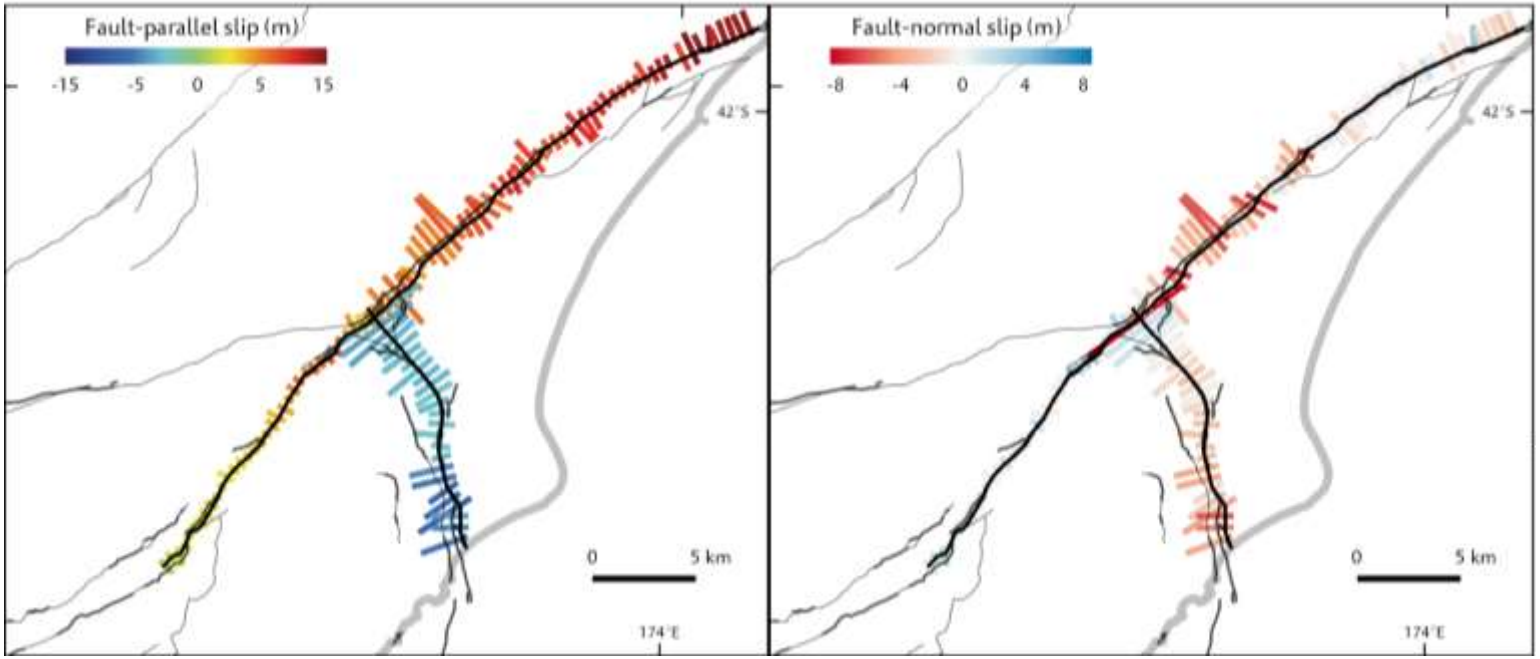
# Profile analysis

- ENVI-CosiCorr ‘Stacking profiles’ tool
  - Horizontal components of slip only
- Export profiles data to Excel
  - Adjust the far-field fit on each side of defined fault (ROI)
  - Analyze simultaneously both components
  - Estimate uncertainties



# Fault slip and deformation width

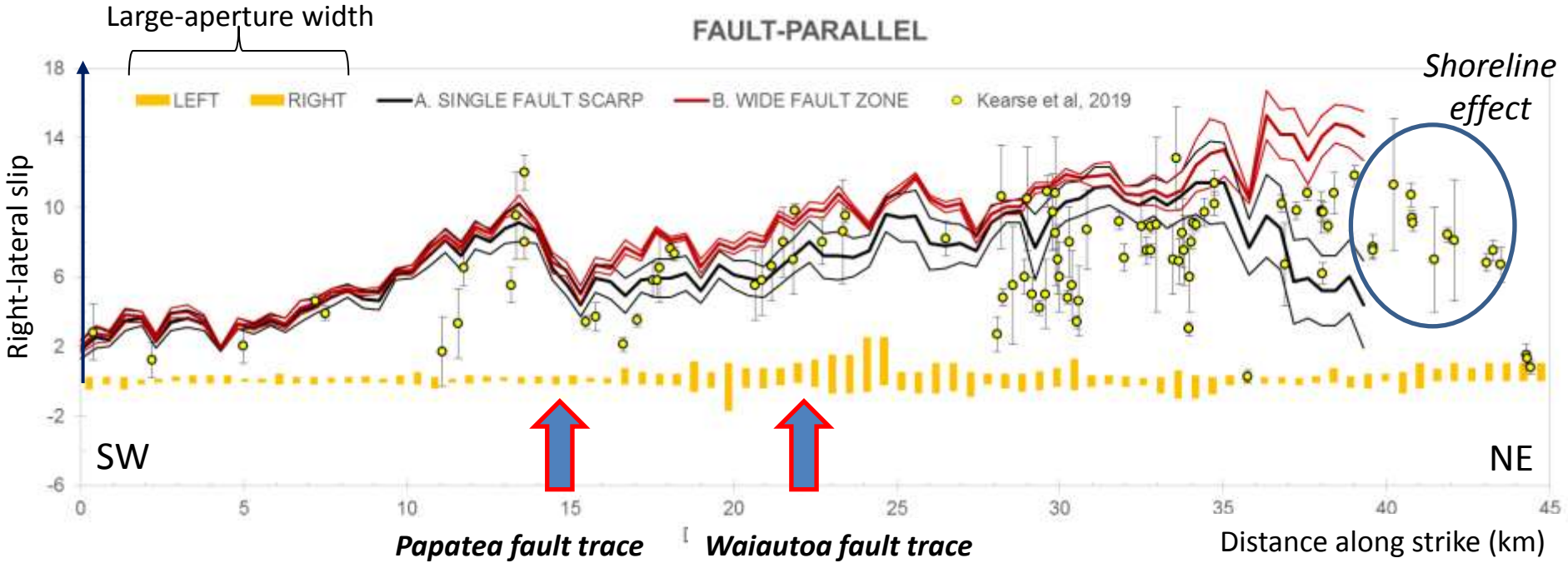
- In places, total deformation is accommodated over large widths (1-3 km) according to geodesy




- Dextral motion on Kekerengu-Jordan
- Sinistral motion on Papatea

- Contraction around Kekerengu and Papatea
- Lengthening around Jordan & triple junction

- Slip distribution Jordan-Kekerengu
  - Total deformation (red curve) from geodesy exceeds field-measured values
  - Deformation zone widens north of the Papatea / Jordan intersection



# SURE and its future

- Improvement
  - Complete the existing database with local geology & structural complexity information
  - New cases with field-based data
- Optical Correlation data
  - In which form?
    - Latitude, Longitude of intersection point between fault and profile
    - ‘Large aperture width’ and ‘Large aperture offset’
  - Pros
    - Complete the field measurements with a dense set of values spanning the whole rupture
    - Heave is accessible (often difficult to measure in the field)
  - Cons
    - No access to vertical component for most of the captured earthquakes
    - Depending on images’ resolution, direct access to the balance between discrete slip and warping may not be accessible without field measurement
    - Existing tool (Cosi-Corr) could be adapted for fault displacement analysis
- Collaboration
  - International community (SURE) <-> U.S. PFDHI community
    - Exchange of data and concepts
    - Common publications