43rd NATIONAL CONFERENCE

GRUPPO NAZIONALE DI GEOFISICA DELLA TERRA SOLIDA
NATIONAL GROUP FOR SOLID EARTH GEOPHYSICS

11 -14 FEBRUARY, BOLOGNA

BELMELORO CAMPUS, VIA ANDREATTA 8

TOPIC 1 - SEISMICITY, VOLCANOES, DATA AND MODELS

Session 1.1: Earthquakes, Active Faults and Seismogenic Processes: from Field Surveys to Laboratory Experiments

Convenors of the session:

Paolo Galli (DPC) - Angela Saraò (OGS) - Stefano Solarino (INGV) - Simone Bello (UniCH)

Session 1.2: The role of geofluids in earthquakes, volcanoes and geothermal fields

Convenors of the session:

Mimmo Palano (UniPa) - Francesca Forni (UniMI) - Luigi Passarelli (INGV-BO)

Session 1.3: Physical models for the Solid Earth and integration between modeling and data of different nature

Convenors of the session:

Anna Maria Marotta (UniMI) - Carla Braitenberg (UniTS) - Massimo Nespoli (UniBO) - Barbara Orecchio (UniME)

TOPIC 2 - DISASTER RISK ANALYSIS AND REDUCTION

Session 2.1: Earthquake and tsunami hazard: different return periods, different conceptual schemes and models in a continuum spectrum of time

Convenors of the session:

Daniela Di Bucci (DPC) - Dario Albarello (UniSI) - Bruno Pace (UniCH)

Session 2.2: Science and technology to support earthquake prevention and preparedness

Convenors of the session:

Mauro Dolce (UniNA) - Sara Sgobba (INGV) - Maria Polese (UniNA)

Session 2.3: Risk Communication

Convenors of the session:

Serena Tagliacozzo (IRPPS, CNR) - Valentina Rizzoli (CORIS, Sapienza University of Rome)

TOPIC 3 - APPLIED GEOPHYSICS FOR ENERGY, ENVIRONMENT AND NEW TECHNOLOGIES

Session 3.1: Energy Transition and Resources

Convenors of the session:

Vincenzo Lipari (OGS) - Paolo Mazzuchelli (ARESYS) - Erika Barison (OGS)

Session 3.2: Near Surface Geophysics

Convenors of the session:

Chiara Colombero (Polito) - Emanuele Forte (UniTS) - Michele Cercato (Uniroma)

Session 3.3: Theoretical and Methodological Development in Applied Geophysics

Convenors of the session:

Andrea Tognarelli (UniPI) - Luca Masnaghetti (SLB) - Gianluca Fiandaca (UniMI)

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OGS Istituto Nazionale di Oceanografia e di Geofisica Sperimentale

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Fault Model of the 2024 M_W 7.4 Hualien (eastern Taiwan) Earthquake Sequence from GNSS and InSAR Data

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On 2 April 2024, the M_W 7.4 Hualien earthquake struck eastern Taiwan, representing the largest seismic event in the region since 1951. Located in the northern sector of the Longitudinal Valley, an area of high geodetic strain (>1 μstrain/yr), the earthquake initiated at a hypocentral depth of 40 km (USGS) and was followed by a M_W 6.5 aftershock 13 minutes later. The event was associated with reverse faulting consistent with crustal contraction rates of ~30 mm/yr along the eastern Taiwan coast. The seismotectonic complexity of the region, influenced by the interplay of the Ryukyu Trench, collision, and subduction, involves two major fault systems: the east-dipping Longitudinal Valley Fault (LVF) and the west-dipping Central Range Fault (CRF).

Using GNSS and InSAR data, we investigated the ground displacement field and performed elastic dislocation modeling to constrain the source parameters of the mainshock. Two simplified fault scenarios—steep E-dipping and gentle W-dipping faults—were tested, alongside a composite model incorporating both fault systems. The composite model, which best fits the geodetic data, includes contributions from: (i) a low-angle, W-dipping CRF-related rupture, (ii) a steeply E-dipping LVF segment, and (iii) minor contributions from the high-angle Milun and Lingding faults. This complexity reflects the dynamic interaction of asperities on distinct fault surfaces and helps explain discrepancies in hypocentral locations reported by USGS and CWA (up to 20 km horizontally and vertically).

Our findings suggest that seismic release was partitioned among interconnected fault systems. While the W-dipping CRF dominated surface deformation, the northern LVF segment and minor faults also contributed to the rupture. This partitioning indicates that the 2024 Hualien earthquake was not a simple linear morphogenic event but rather a manifestation of the region's evolving tectonic structures. The reactivated faults, inherited from earlier tectonic phases, continue to evolve rapidly in this active geodynamic setting.

The results highlight the persistent seismic hazard in the region, particularly at the sequence's northern and southern terminations, where Coulomb stress increases. As aftershock activity

diminishes, systematic re-location of seismic events will be critical to confirming the rupture complexity inferred here.

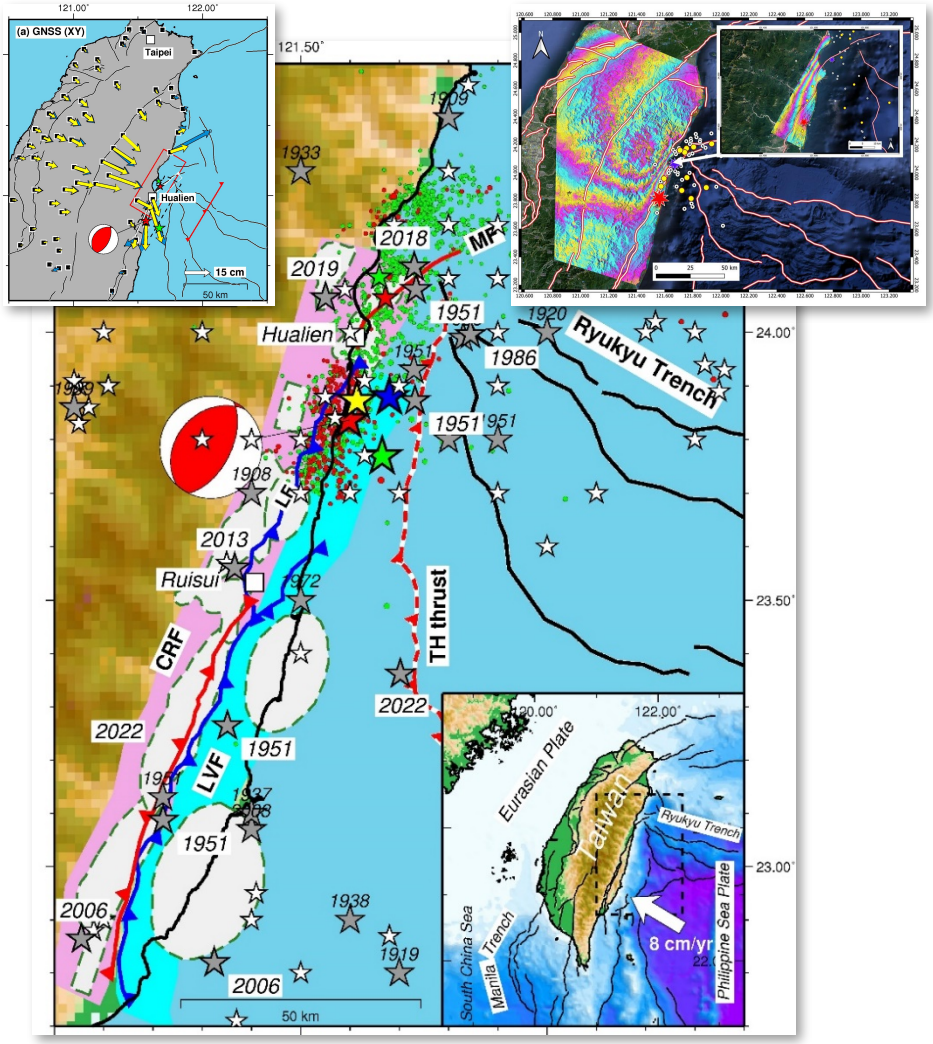

Fig. 1 – Seismotectonic settings of the study area. Major faults are represented by solid lines (adapted from Huang & Wang, 2022, and Zelenin et al., 2022). Seismic activity is shown with dots indicating aftershocks that occurred between April 2 and 28 (CWA catalog, accessible at https://scweb.cwa.gov.tw/en-us/earthquake/data/); colored stars mark the locations of the Mw 7.4 mainshock and the Mw 6.5 aftershock, while gray and white stars represent historical earthquakes (6.0 ≤ M < 6.5 and M ≥ 6.5, respectively) (Tang et al., 2023). Light gray areas highlight rupture zones from recent large earthquakes along the LVF (light blue) and CRF (pink) (adapted from Tang et al., 2023). The inset provides a tectonic map of Taiwan, with the dashed box indicating the region shown in the main figure. Abbreviations: CRF = Central Range Fault; LVF = Longitudinal Valley Fault; MF = Milun Fault; LF = Lingding Fault; TH = Takangkou-High. The upper inset on the left shows the horizontal GNSS coseismic offsets (blue and yellow arrows are observed and synthetic displacements), while the inset on the right shows the ascending ALOS-2 wrapped interferogram. On the left inset, the red box represents our best-fit W-dipping solution (F1), while the dashed box is the deeper segment of the LVF (F4), and the white boxes are the Lingding (F2) and Milun (F3) faults, respectively.

References

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