Report of Transnational Access Projects

Project ID: C3-TA2-541-11_2

Principal investigator: Neha, National Taiwan University (NTU), Taiwan

Website: *https://scholar.google.com/citations?user=JhEChooAAAAJ&hl=en*

Linkedin: *https://www.linkedin.com/in/neha-choudhary-80a621231/*

ORCID: https://orcid.org/0000-0002-7721-4985

Project team (if applicable): Prof. Ray Y. Chuang, Department of Geography, National Taiwan University, Taiwan

Project title: Physics-based Dynamic Rupture Modeling for Taiwan

Project acronym: phyDRMT

Hosting installation: MP-PSHA-Towards Physics-based Probabilistic Seismic Hazard Analysis (TA2-541-11), LMU

HPC support: Leonardo - Computational Resources on GPU Supercomputer (TA2-55-1), CINECA

Hosting team: Mathilde Marchandon (LMU), Iris Christadler (LMU), Vikas Kurapati (TUM)

Date of visit: Feb. 11 - March 2, 2026, access to Leonardo continues

Report of activities:

The Transnational Access project "Physics-based Dynamic Rupture Modeling for Taiwan" was designed to investigate the rupture dynamics of the 2022 Taitung earthquake sequence in eastern Taiwan using physics-based numerical simulations. The project focused on developing a computational framework for dynamic rupture modeling of the Mw 6.6 foreshock and Mw 6.9 mainshock events that occurred within the Longitudinal Valley Fault system. The work was carried out at Ludwig Maximilian University (LMU) Munich in close collaboration with Iris Christadler and Dr. Mathilde Marchandon.

During the access period, a significant portion of the work focused on acquiring the theoretical and computational background required for dynamic rupture modeling using SeisSol. This included studying the physical principles governing spontaneous earthquake rupture, fault friction laws, stress initialization procedures, and seismic wave propagation in heterogeneous elastic media. Relevant scientific literature,

Geo-INQUIRE is funded by the European Commission under project number 101058518 within the HORIZON-INFRA-2021-SERV-01 call

software documentation, and previous SeisSol applications were reviewed to establish a comprehensive understanding of the modeling framework.

A major activity of the visit involved learning and implementing the complete SeisSol workflow on high-performance computing (HPC) systems. This included understanding simulation setup procedures, computational requirements, parameter files, model execution strategies, and post-processing tools. Particular attention was given to the analysis of input parameters controlling rupture behavior, including fault friction properties, material parameters, stress conditions, and rupture nucleation approaches.

The available seismological, geodetic, and geological information for the 2022 Taitung earthquake sequence was reviewed and evaluated. Published earthquake source models, focal mechanisms, hypocentral locations, and fault interpretations were analyzed to identify suitable fault geometries for dynamic rupture simulations. Since the earthquake sequence consisted of both a foreshock and a mainshock, special emphasis was placed on understanding the geometric relationships between the candidate fault structures and their potential influence on rupture propagation and stress transfer.

Another important component of the project involved training in mesh generation and model construction. Computational meshes suitable for dynamic rupture simulations were developed, and different meshing strategies were explored to ensure adequate representation of the fault system while maintaining computational efficiency. This process included fault representation, domain discretization, mesh quality assessment, and preparation of simulation-ready geometries compatible with SeisSol.

Based on the available fault models and geological constraints, preliminary simulation setups were prepared and a series of test simulations were performed. These simulations were designed to verify the computational workflow, evaluate numerical stability, assess the influence of fault geometry on rupture behavior, and test different foreshock and mainshock configurations. The focus of these simulations was on workflow validation and model development rather than the generation of final scientific results. While the project has not yet reached the stage of producing fully validated rupture models, the activities completed during the visit have established the essential foundation for subsequent large-scale simulations and scientific analyses. The project is currently under active development, with additional numerical experiments, model refinements, and validation studies planned for the next phase of the work.

Project outcomes:

The primary outcome of the access period was the successful establishment of a complete workflow for physics-based dynamic rupture modeling of Taiwan earthquakes using SeisSol. The project resulted in improved expertise in dynamic rupture theory, HPC-based earthquake simulations, mesh generation, fault geometry construction, and parameter selection for dynamic rupture studies.

Simulation-ready fault geometries and computational meshes were successfully developed for the 2022 Taitung earthquake sequence. Preliminary test simulations demonstrated the feasibility of the modeling framework and provided initial insights into the influence of fault geometry and model parameters on rupture behavior. These simulations also helped identify key parameters that will require further refinement in subsequent stages of the project.

At the current stage, the project remains in the model development and testing phase. Additional simulations will be required to optimize model parameters, refine fault geometries, and explore a broader range of physically plausible rupture scenarios. Future numerical experiments will focus on obtaining robust dynamic

Geo-INQUIRE is funded by the European Commission under project number 101058518 within the HORIZON-INFRA-2021-SERV-01 call

rupture models capable of reproducing the observed characteristics of the 2022 Taitung earthquake sequence. The future simulation results will be compared with published seismological, geodetic, and geological observations, including earthquake source models, GNSS measurements, InSAR-derived deformation fields, and geological fault constraints. These comparisons will be used to validate the numerical models and improve understanding of rupture dynamics, fault interactions, and deformation processes within the Longitudinal Valley Fault system.

The outcomes of this work are expected to contribute to peer-reviewed journal publications and presentations at international scientific conferences. Furthermore, in accordance with the objectives of the Geo-INQUIRE programme, the developed workflows, simulation setups, associated datasets, and future modeling results will be shared through Geo-INQUIRE infrastructures following FAIR (Findable, Accessible, Interoperable, and Reusable) data principles, supporting future collaborative research and reproducible scientific investigations.

Geo-INQUIRE is funded by the European Commission under project number 101058518 within the HORIZON-INFRA-2021-SERV-01 call