Heterogeneity of tectonic stress field and its spatial pattern inferred from focal mechanisms clustering in Sulawesi, Indonesia

*Muhammad Taufiq Rafie[1], Haidir Jibran[2], Lujia Feng[3], Muh. Altin Massinai[1]

1. Solid Geophyics Laboratory, Department of Geophysics, Hasanuddin University, 2. Program Study of Geophysics, Hasanuddin University, 3. Earth Observatory of Singapore, Nanyang Technological University

Sulawesi is situated in one of the most tectonically active regions in the world. The island is located at the convergence of several major tectonic plates, including the Sunda, Indo-Australian, and Philippine Sea Plates. This complex tectonic setting results from deformation driven by collisional and rotational interactions between the Philippine-Pacific and Indo-Australian regions with the Sundaland. To investigate the present-day tectonic regimes and deformation patterns in Sulawesi, we retrieve the stress field and its spatial variations using stress inversion of focal mechanisms data. A total of 1390 focal mechanisms were used to estimate principal stress orientations into six different regions. These regions were clustered using the machine learning algorithm called Density-Based Spatial Clustering of Applications with Noise (DBSCAN). The inversion results reveal the kinematics of major fault system in Sulawesi and highlight the spatial heterogeneity of the stress field. In northern Sulawesi, two dominant orientations of maximum horizontal stress (SHmax) are observed, with varying tectonic regimes: compression in the north, strike-slip in the center, and extension near Tomini Gulf. The SHmax direction is predominantly N-S in the northern arm of Sulawesi, while in central Sulawesi, it is primarily WNW-ESE. In southern Sulawesi, the Matano Fault Zone exhibits a strike-slip regime with a dominant WSW-ENE SHmax orientation. In the northern Molucca Sea, a compressive tectonic regime is observed, with SHmax trending WNW in the north and gradually rotating to WSW in the south. The northern Sula region also exhibits a compressive regime with SHmax trending NNE, while the western Sangihe region displays a W-E trending compressive stress field. In the eastern part of the Flores Back-Arc Thrust, SHmax is oriented NNW-SSE, indicating a compressive regime. The orientation of SHmax relative to the triple-junction convergence direction reflects the accommodation of the Philippine, Sunda, and Indo-Australian plates' motion.

Keywords: Tectonic regime, stress inversion, focal mechanisms, Sulawesi Island