International Lithosphere Program

Activity Report 2023 – Task Forces / Coordination Committees

Project Title: *Global Lithospheric Stress - The World Stress Map in 3D*
Project No.: 2021-TF3
PI(s): Mojtaba Rajabi, Sebastian von Specht, Oliver Heidbach

1. Highlights of recent ILP Task Force work/results

Since 2022, the team has started to work on mine-scale stress mappings, in order to investigate stress pattern at small scales (< 100 m). The results of this initiative, which supported by Australian mining industry, has presented in conferences. For example, Fig. 1 illustrates the stress map of northern Bowen Basin in Australia with over 890 quality rank stress orientations derived from approximately 128 km image log analysis from 680 boreholes, which makes the Bowen Basin as a basin with the highest data density in the world in terms of quality-ranked stress information.

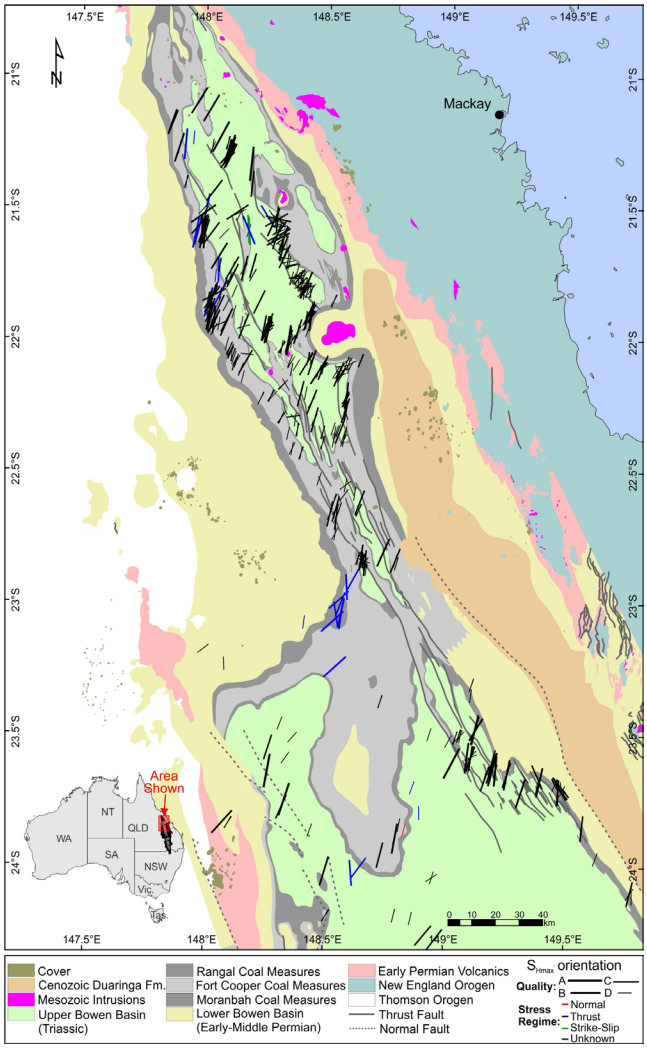

Figure 1: Stress map of northern Bowen Basin using 890 quality-ranked orientation of maximum horizontal stresses S_{Hmax}.

Surprisingly the mean S_{Hmax} orientation in the northern Bowen Basin is 20 ± 19° with a strong spatial and depth consistency. Moreover, the agreement between the observed mean S_{Hmax} orientation in this study and the predicted S_{Hmax} orientation using a plate-scale geomechanical model emphasizes the significant influence of plate boundary forces on the stress pattern in the northern Bowen Basin. This pattern stands in contrast to most of the eastern Australian basins which display considerable stress variabilities at different scales. A detailed borehole image log analysis in this study uncovered very small-scale stress rotations (occurring between 1 to 10 meters) in some boreholes which are attributed to stiffness contrasts caused by changes in lithology and the presence of geological structures. A paper of this study is submitted and we expect that it will be published next year.

2. Presence at international meetings/workshops (this year)

- Research visit from Germany to Australia in March 2023, which resulted in great stress analysis in Australian basins, and improvement of geomechanical numerical workflow for model calibration in the absence of stress magnitude data.
- We organised a successful session in EGU 2023 entitled "*The crustal stress state and strength: Conceptions, modelling, and uncertainties*".
- Presentation of the first version of the New Zealand's stress map at Geoscience Society of New Zealand Annual Conference 2023, Wellington, New Zealand.
- Presentation of new geomechanical workflow at the GeoBerlin 2023.
- Two presentations on the Australian stress mapping at 4th Australasian Exploration Geoscience Conference (AEGC 2023), Brisbane, Australia.
- Two presentations on geomechanical modelling and mine-scale stress mapping at 2nd EAGE Workshop on Fluid Flow in Faults and fractures, Canberra, Australia.
- Presentation on the mine-scale stress mapping at the 26th World Mining Congress (WMC 2023), Brisbane, Australia

3. Important publications of ILP Task Force members (max. five)

Ziegler, M.O., Heidbach, O. & Rajabi, M. 2023. No data instead of big data – a novel approach to stress modelling. Saf. Nucl. Waste Disposal, 2, 79-80.

Ziegler, M. O., & Heidbach, O. 2023. Bayesian quantification and reduction of uncertainties in 3D geomechanical-numerical models. JGR-Solid Earth, 128, e2022JB024855.

Reiter, K., Heidbach, O., and Ziegler, M.: Impact of faults on the remote stress state, EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-1829, 2023.

4. New contacts (this year)

- Parisa Tavoosiiraj, University of Queensland, Australia.
- Dr. Renate Sliwa, Integrated Geoscience Pty Ltd, Queensland, Australia.
- Dr. Michal Kruszewski, RWTH Aachen University, Germany
- Dr. Joan Esterle, University of Queensland, Australia.

5. Usage of ILP funding (this year)

Travel support of Carlos Pena to participate the EGU 2023 Gen. Ass. in Vienna and a research visit from Germany to Australia of Moritz Ziegler, two WSM workshops in Germany to prepare the new 3D WSM database structure and pore pressure data quality ranking.

6. Activities planned for 2024

- EGU session on *Stability of the crust – strength and stress make it*, EGU 2024, Vienna.
- PI Rajabi aims to conduct a research visit to GFZ-Potsdam to work on the new release of the WSM project.
- Announcement of the new 3D WSM database structure.
- Conduct a research visit to Australia in order to train and share knowledge on geomechanical modelling with the Australian partner (PI Rajabi).