In collaboration with

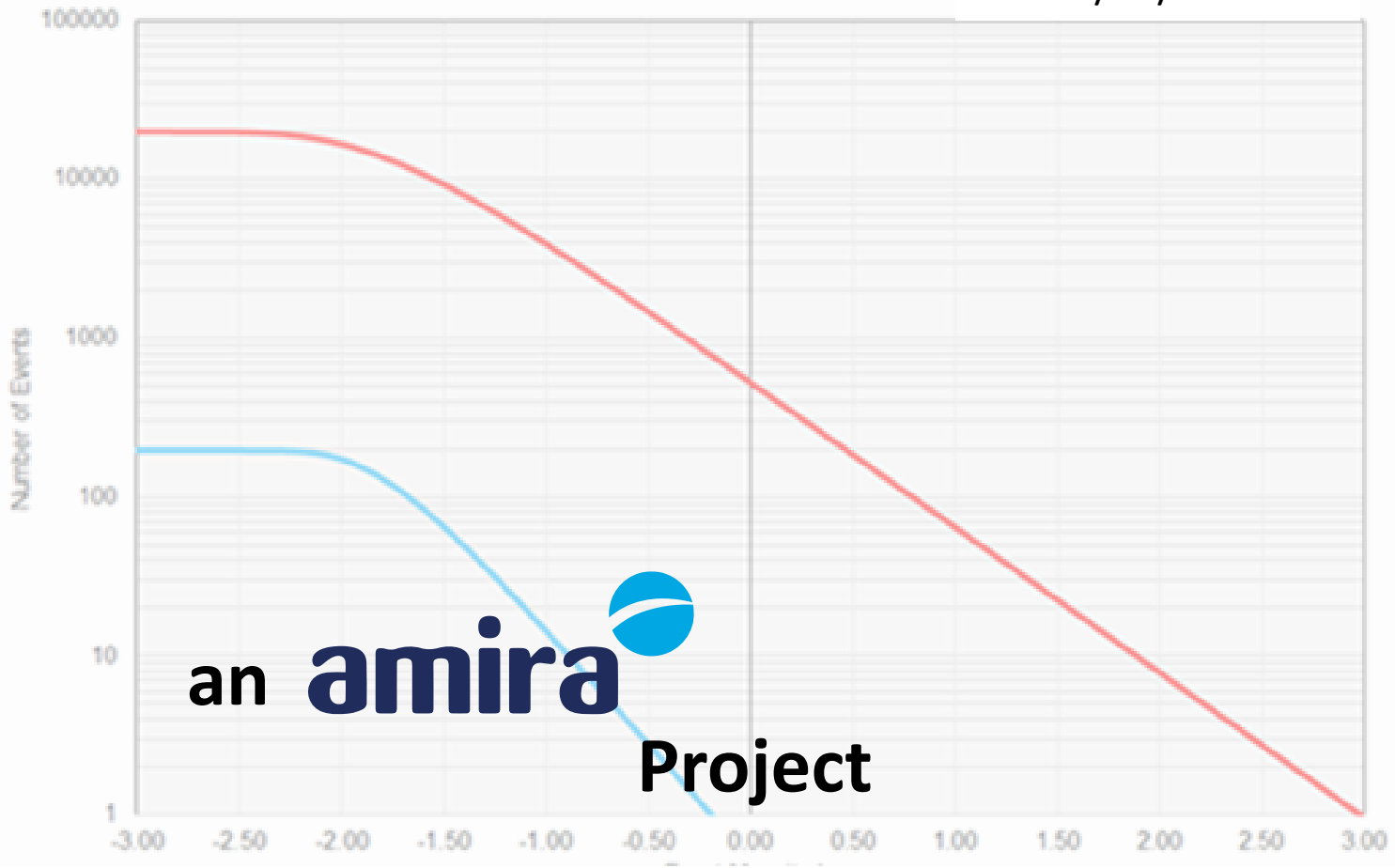
Cavroc

amira

mining one Consultants

Amira's P1262 Mine Seismicity Research Project

15/02/2024



an amira Project

Our Proposed Framework

- A clear, simple and transparent guideline.
- Apply software that is accepted for rock mechanics applications.
- Apply software that are easy enough to learn by all geotechs.
- Include detailed and transparent validations.
- Is able to forecast seismicity for a specific mining scenario in terms of potential hazard and locations where seismicity is expected.

Benefits to Sponsors

Sponsor Benefits	Minor Sponsor rights	Major Sponsor rights	Additional test site(s) (full benefits)	Additional test site(s) (limited benefits)
Ability to confidently model and forecast the mining risk profiles, it becomes possible for mining companies to optimise and iterate on their designs and schedules to obtain the best outcome for the operation in terms of safety, efficiency and economics. **This research project is fundamentally focused on improving operational safety with respect to mine seismicity.**	✓	✓	✓	✓
In depth seismic data review and analysis (different from reports provided by seismologist i.e. IMS, ESG, etc.) including detailed geotechnical analysis and interpretation of rockmass behaviour in different stages of mining	✓	✓	✓	✓
Quantification and selection of a mine schedule that reduces seismic risks for an operation	✓	✓	✓	✓
Ability to determine how to best position infrastructure to reduce the seismic risk	✓	✓	✓	✓
Consideration of the timing for development placement to reduce seismic risks	✓	✓	✓	✓
Update standoff procedures or exclusion zones based on a case-by-case basis	✓	✓	✓	✓
Optimise ground support designs to withstand probable seismic events and distances	✓	✓	✓	✓
Improved scheduling estimates for machine use, ground support dependencies and task timing	✓	✓	✓	✓
Completing all the above in-house without ongoing reliance on external consultants	✓	✓	✓	✓
The research providers will assign perpetual, non-revocable royalty- and license-free non-exclusive global rights to all Project Technology (new IP generated in the Project), along with that part of the background IP necessary to be able to utilise the Project Technology, to the Sponsors of the Project to use in their own operations in the Field (see Appendix Item 1 of the proposal). For the avoidance of doubt, Project Technology does not include any source codes, algorithms that are considered as commercial secrets. They remain private property of Mining One/Cavroc. Sponsors may require specific licence to operate or view, which are considered separate to the Project Technology and must be obtained separately through a lease arrangement with Mining One/Cavroc.	✓	✓	✓	✓
Priority access to the research team after project completion and 5% discount for related consulting studies (on terms to be agreed)	✓	✓	✓	
Quarterly progress reports	✓	✓	✓	
Biannual Sponsor review meeting (SRM) participation	✓	✓	✓	✓
Voting rights: if unanimity is not reached on any change to the research program and/or the inclusion of case studies, publications, and other material matters will be decided by a vote. A simple majority will suffice to achieve a result. If the result is a tie, then Amira Global will have the deciding vote (having consulted extensively with sponsors).	1 vote	2 votes		
Access to the password protected Amira Global project website	✓	✓	✓	✓

Key Deliverables

Item	Key deliverables	Minor Sponsor	Major Sponsor	Additional test site(s) (full benefits)	Additional test site(s) (limited benefits)
1	Number of included test sites (up to max of 10)	None	One site	Any	Any
2	Raw and detailed processed data from the test sites. Note: Major sponsors are not required to share potentially sensitive information such as raw data or site location(s) with other sponsors.	No	Yes Sanitised reports only as approved by individual data owners.	Yes Sanitised reports only as approved by individual data owners.	Yes Sanitised reports only as approved by individual data owners.
3	Summary test site reports (general findings) conforming to the restrictions mentioned in Item 2 of this table	No	Yes	Yes	Yes
4	Detailed geotechnical data review	No	Yes	Yes	Yes
5	Seismic data review and analysis	No	Yes	Yes	Yes
6	Statistical modelling and Multiscale seismic profile	No	Yes	Yes	Yes
7	Seismic Back Analysis	No	Yes	Yes	Yes
8	Ongoing Seismic back analysis Validation (Production during research duration) New models will be run and analysed to better understand the discrepancies between the model and the actual responses as well as the sensitivity of energy outputs to various parameters.	No	Yes	Yes	Yes
9	Seismic Forecasting	No	Yes	Yes	No
10	12 months free software lease and free training, for sponsor companies for each year of sponsorship. StopeX Licence	No	Single License	Single License	No
11	Free StopeX Training (up to 4 persons)	No	Yes	Yes	No
12	Site Specific StopeX add-ons (Perpetual version free)	No	Yes	Yes	No
13	Perpetual access to StopeX add-ons developed during this project	No	Yes	Yes	No
14	12-Month free FLAC3D License	No	Single License	Single License	No
15	Access to Guidelines Monograph before public access	Yes	Yes	Yes	Yes
16	Access to Final Project Report	Yes	Yes	Yes	Yes

Project Investment Model (three-year project)

Sponsorship category	Sponsorship Year 1, AUD***** (incl Amira fee)	Sponsorship Year 2, AUD***** (incl Amira fee)	Sponsorship Year 3, AUD***** (incl Amira fee)	Total Sponsorship over three years, AUD***** (incl Amira fee)
Major Sponsor* (with one test site)	90,000	90,000	90,000	270,000
Minor Sponsor (no test site)**	30,000	30,000	30,000	90,000
Additional test site(s) (cost per site; full benefits)***	60,000	60,000	62,500	182,500
Additional test site(s) (cost per site; limited benefits)******	40,000	40,000	33,500	113,500

Notes:

* Major Sponsors are companies who are mineral producers and/or exploration companies and who will provide test site(s)/data to the project

** Minor sponsors are mineral producers and/or exploration companies who will not be providing test site(s) to the project

*** Major Sponsor can nominate more than one test site at an additional cost per site; with all benefits similar to Major sponsor and the proposal, see Section 6; please note additional site(s) can only be chosen in addition to Major Sponsorship

**** Major Sponsor can nominate more than one test site at an additional cost per site; with limited benefits; for more details see Section 6; please note additional site(s) can only be chosen in addition to Major Sponsorship

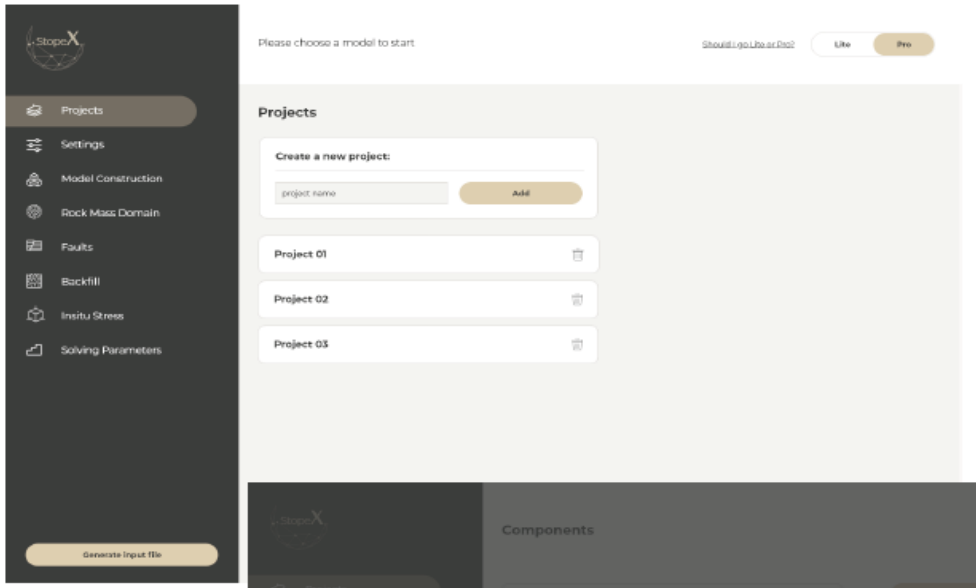
*****Plus Australian GST if applicable – generally applicable to companies that have operations in Australia – companies are requested to seek specialist advice on this matter. The first sponsorship payment will be due upon project start-up and the subsequent and final instalments will be due on the anniversary of the first payment. Sponsors have the option to pay the Total Sponsorship amount upfront. They can also choose to pay a portion of the Total Sponsorship upfront as long as the amount is greater than the sponsorship due in year 1. If a sponsor chooses to pay an amount greater than the year 1 sponsorship the balance will be split in proportion to the amounts payable in the subsequent years.

Current Status

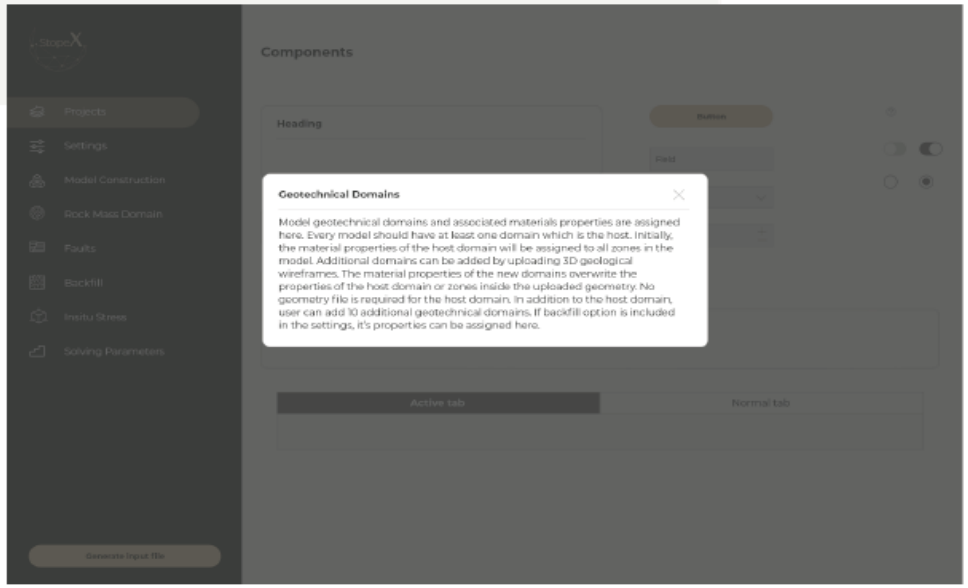
- Project is progressing very well and currently in the Q3 with Evolution and Vale as major sponsors with 4 sites and Bluestone resources as a minor sponsor.
- The next slides are the output of the current stage.

Sample Project Outputs at Completion of Q3

- Numerical modelling on-demand web-based platform beta version will be live in a few weeks. This platform allows three options:
  - Solve models in house (using FLAC3D or Abaqus)
  - Submit to the cloud using standard run speed
  - Submit to the cloud using maximum run speed (144CPUs)



Main platform

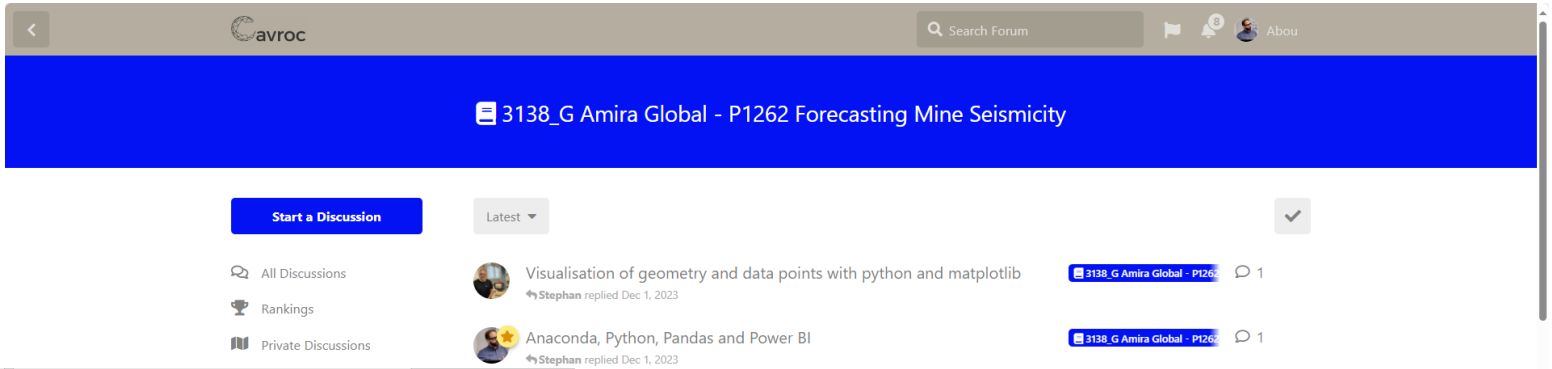


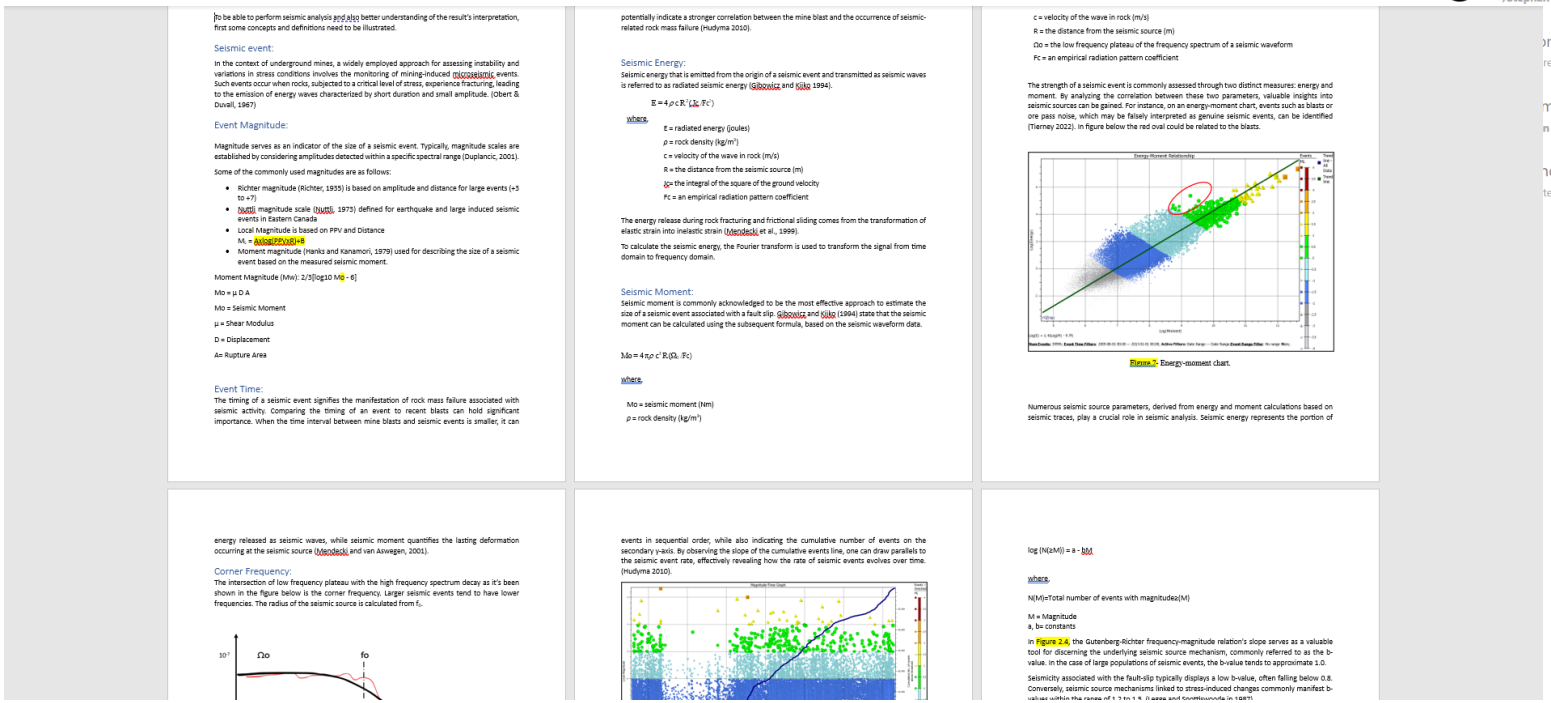
Realtime help

Sample Project Outputs at Completion of Q3

- Guidelines Monograph – Seismic Data Analysis

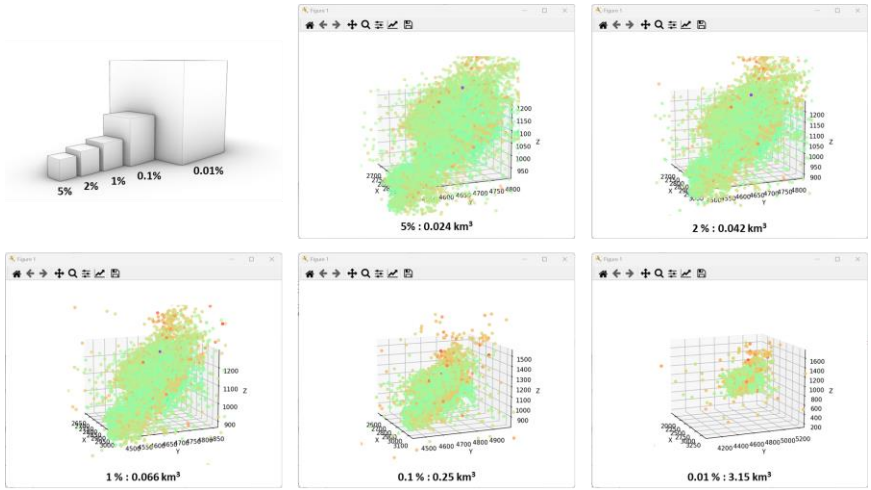
(50% completed)

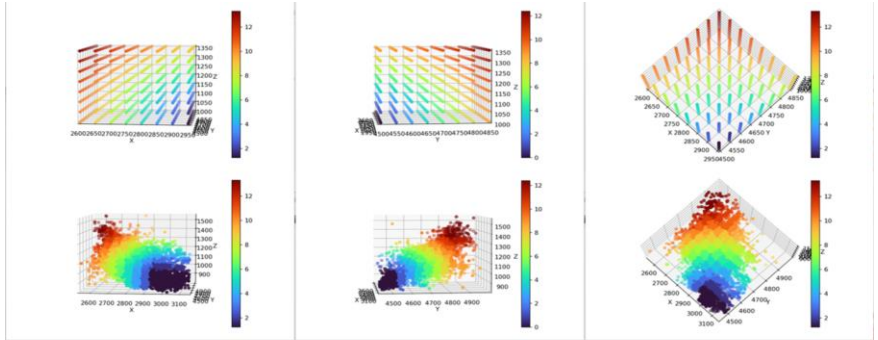


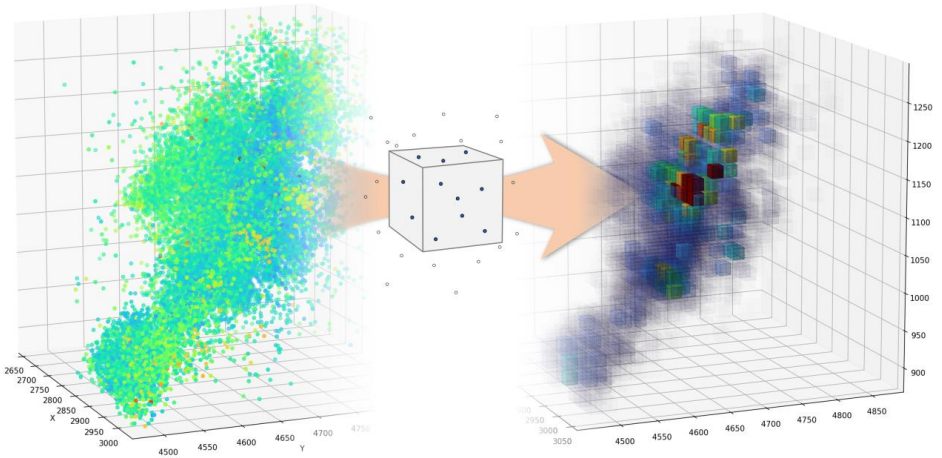


Sample Project Outputs at Completion of Q3

- Developed a regular cell generation algorithm for spatial and clustering analysis of seismic data and numerical model outputs. This has been developed using Python language and with several libraries developed that can be accessed via Git Hub. This enables access to the platform with or without a Cavroc software license. Considering the open-source type format of the libraries it enables a continuous improvement and new features to be added. Some examples current functionalities are:
  - Generate a regular or irregular grid (with efficiency to handle data files more than 5M rows) from use inputs such as
    1. Cell size (edge length)
    2. Grid extents with options of
       1. User defined x,y and z extent
       2. Geometry based with an offset
       3. Bound by available seismic data
  - Functionalities for accessing and looping through the grid data to:
    1. Assign attributes to each cell
    2. Conduct numerical analysis such as statistical analysis using various distribution etc.
    3. Find seismic events and model zones/elements within each cell and assign values such as PPV, event magnitude etc. to each cell

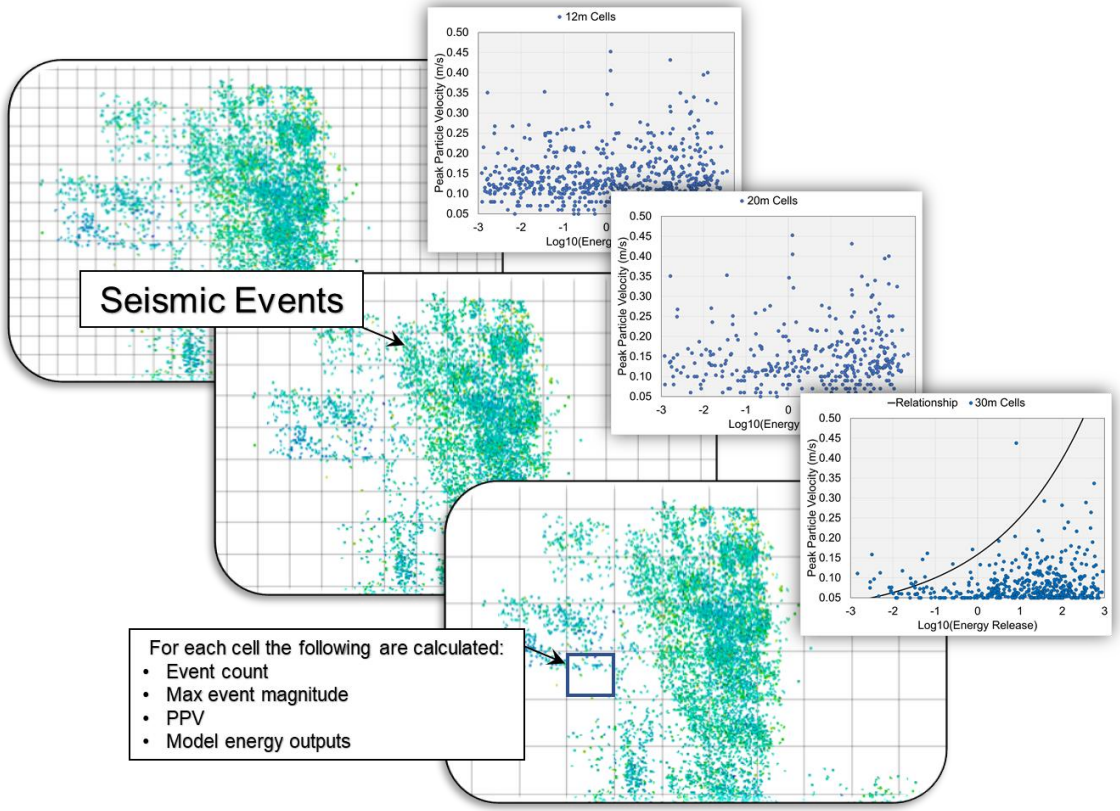




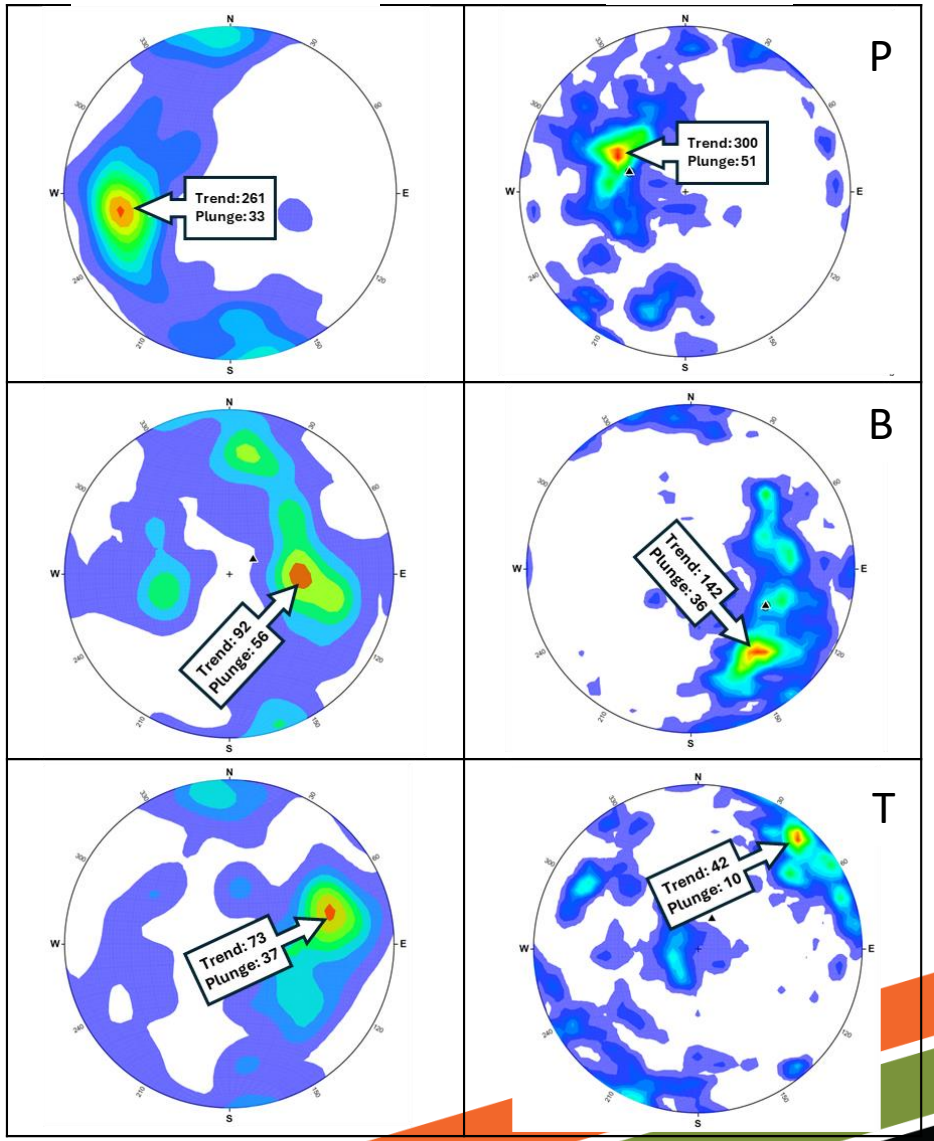


Sample Project Outputs at Completion of Q3

- Quantitative Model Calibration and Validation again Seismic Data.
- Using SMTI and stress inversion analysis for model calibration and confirmation of the stress field and quantify model calibration.



SMTI Analysis | Model



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