Project 5: Thermal injection

Background
In the operation of a geothermal field, reinjection of exhaust water from the power plant is often used to increase the size of the reservoir and create new pathways of flow. However, these activities are often associated with induced seismic activity. Seismic activity with magnitude 4 (M4) is usually not felt and considered safe as an outcome of thermal injection.

Problem
An approved trial run of water injection was carried out by a geothermal company for 35 days and the resulting pressure was measured. At day 10 they recorded seismic activity of around magnitude 1 (M1) and at day 20 they recorded seismic activity of M2. They then restarted injection at day 25 and on day 35 measured seismic activity of M3, where they ceased the trial. They want to increase injection rates but nearby stakeholders have raised concerns. The geothermal reservoir is recharged from surrounding sources and has slow leakage.

Stakeholders
The local geothermal company have proposed increased injection rates of 250t/hr as they feel this is still safe. Local farmers who have cattle in the area oppose any further increases as seismic activity scares their animal stock. Local iwi are concerned for the environment but also are shareholders and wish to see improved economic return, they support increases but only if seismic activity does not exceed current magnitude levels of M3. The local council wish to maintain economic activity but are concerned by the effects on the environment, culture, and local farmers. They want a measured injection rate that will respect local stakeholders. The consent will not be granted if the seismic activity exceeds M4.5.

Project
You have been retained by the local council to conduct a modelling study and provide a recommendation that accounts for all stakeholders concerned. This will be used as part of the resource consent hearing. To assist you with your project you have been provided with:

- Average water injection rates to the geothermal reservoir over 35 days.
- Measurements of average pressure in the geothermal reservoir over the same 35 days.
- Note: You should review the relationship between pressure and earthquake magnitude (M).

You should undertake a computer modelling study that will assist decision-making during the resource consent hearing, in particular addressing the noted concerns of ALL stakeholders. The model you develop should be defensible, reflective of reality, and take appropriate account of uncertainty. You will be required to communicate the model findings in both oral and written formats.