Analysis and Management of Seismic Risks Associated With Engineered Geothermal System Operations in South Australia

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ABSTRACT

In 2005, the Petroleum and Geothermal Group (PG) of the Division of Minerals and Energy Resources, Department of Primary Industries and Resources SA funded a report into evaluation of the seismic hazard generated at Geodynamics' engineered geothermal system (EGS) site in the Cooper Basin (Hunt & Morelli 2006). This report was well received internationally, and in 2007, after the induced seismic events at Basel, Switzerland, a second report was funded (by PG for the land access protocols technical interest group (TIG 1) of the Australian Geothermal Energy Group (AGEG)) to develop protocols for the analysis and management of seismic risks associated with EGS operations in SA (Morelli & Malavazos in progress). This presentation summarises the findings of that report, which outlines the:

- Risk analysis and management processes;
- Risks associated with both natural, and induced seismicity and the monitoring of such events;
- Infrastructure and population within SA's geothermal exploration licences (GEL);
- Geotechnical data that is required for comprehensive risk analysis; and
- Recommendations for the analysis and management of seismic risks associated with EGS operations in SA.

RISK ANALYSIS & MANAGEMENT

Risk analysis is recognised as the core element of the risk management process and along with communication and consultation and monitoring and review, is one of the most important components of the risk management process, as outlined in Figure 1.

Risk Analysis

The EGS seismic risk analysis process used in this study (Figure 2) was developed from the risk analysis process used by Dhu and Jones (2002) (for the analysis of earthquake risk in Newcastle and Lake Macquarie), and that proposed by Hunt and Morelli (2006) (for the analysis of induced seismic risk associated with EGS operations).

Communication & Consultation

Effective communication and consultation is important as it provides a means for all stakeholders, from the organisation in control of the EGS project, to the relevant government and private organisations, through to the general public, to be aware of what may occur. If implemented

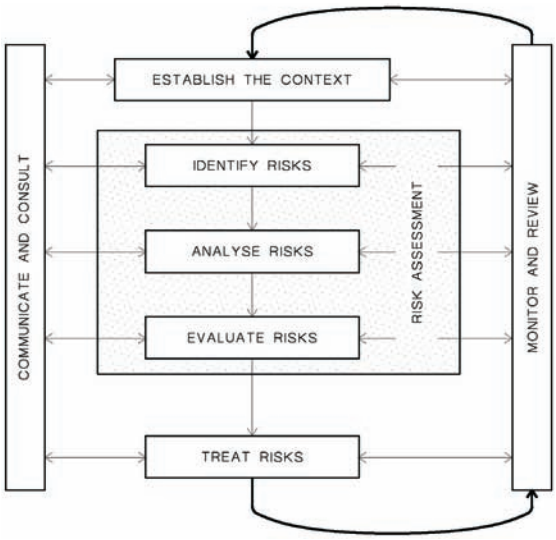

Figure 1. Risk management process (Standards Australia & Standards New Zealand 2004).

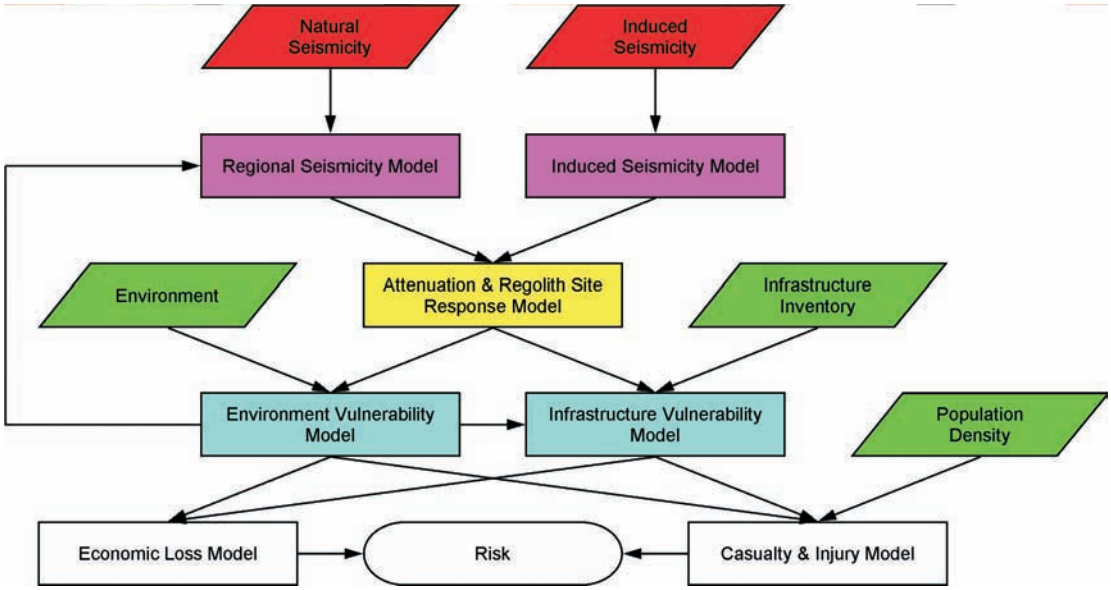

Figure 2. EGS seismic risk analysis process.

effectively, any induced seismicity generated will not come as a complete surprise to most and delays due to public perception of induced seismic events, as have been experienced in Basel due to an extensive, yet ineffective, public notification campaign (Häring, MO 2008, *pers. comm.*, 7 February), can be avoided.

Monitoring & Review

The ongoing monitoring and review of any risk management process is very important from an organisational sense, and essential to making the process as dynamic as possible. Incorporating changes in context, risk, and the effectiveness of risk treatment, as new data and information come to hand, ensures that the management plan remains relevant.

RECOMMENDATIONS

The main recommendation to come from this report is that for the geothermal industry in SA to keep advancing as it has in recent times, and avoid any postponements due to seismicity, there needs to be close interaction between government and industry regarding seismicity associated with EGS operations. This will 'share the load' with regards to research into seismicity from an EGS point of view, and the seismic profile of the state in general.

Protocol

Protocol recommendations were developed from the risk analysis and management processes, while taking into consideration a previously developed protocol (IEA-GIA Annex 1-Subtask D Working Group 2008), and risk evaluation 'traffic light' concepts, as have already been implemented at Basel (Geothermal Explorers Ltd 2007) and Berlín (Bommer et al. 2006). Protocol recommendations are as follows:

- AS/NZS 4360:2004 (Standards Australia & Standards New Zealand 2004) is to be the basis of all EGS seismic risk analysis and management processes;
- EGS seismic risk management is to be a regulatory requirement of any work program once a suitable site is selected for development;
- Once a site is selected for development, the deployment of an appropriate seismic monitoring network for the site, to gather both natural and induced seismicity data that complement existing SA Government and Australian Government networks (i.e. able to detect seismic events less than M 3), should be a priority and remain active throughout the life of the project;
- Seismic risk analysis should be completed before deep exploration drilling commences, to obtain a general indication of the level of risk and reveal any major risk issues for consideration later in the development;
- At least one deep (as is practical and below regolith if possible) seismic monitoring station to be deployed prior to hydraulic stimulation or large scale injections;
- Strong motion accelerometers to be deployed with the seismic monitoring stations, downhole and near surface, to record events that 'clip' the seismometer, and determine regolith amplification;
- Seismic risk analysis to be completed prior to hydraulic stimulation or large scale injection to assess the potential monetary or human consequences of induced seismicity;
- The proponent or licensee must demonstrate to the regulatory authority (PG) that it has adequately assessed and can effectively manage any seismic risk before commencing any hydraulic stimulation or large scale injection. The process should not be static and changes should be made as more information/data become available; and
- There should not be a 'one size fits all' 'traffic light' system employed state-wide as there is far too much diversity within SA's GELs, in terms of population, infrastructure and environment. Seismic risk should be assessed on a case by case basis.

Other

Another recommendation that has come about as a result of this study is:

Old seismic monitoring stations should be updated and new stations deployed as part of the SA Government and Australian Government seismic monitoring networks, so that seismic events greater than M 3 can be located accurately and relevant data obtained for attenuation and regolith site response models at EGS locations.

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