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An Industry Perspective on Induced Seismicity

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Summary

This poster details the questions and responses from a survey on induced seismicity that is designed for energy professionals. It covers demographics, awareness & risk perception, policy & decision-making, economic impacts, and mitigation techniques. It also has a special section on induced seismicity in the Duvernay Play.

Introduction

The University of Calgary is seeking insights from the energy industry on induced seismicity (earthquakes caused by industrial activities). Induced seismicity is a major issue for the public, government, and energy industry. There are several potential causes of induced seismicity, including fluid injection or withdrawal, enhanced geothermal systems, hydraulic fracturing, reservoir impoundment, mining, etc. (Hitzman 2012). The rationale for our study and its accompanying survey is that a collection of professional opinions from the energy industry can help guide our research for the mitigation and risk evaluation of induced seismicity and dispel assumptions that we are making regarding the needs and preferences of industry. We want to collect and publish the anonymous thoughts of energy professionals regarding induced seismicity risk, hazard evaluation, and mitigation. Furthermore, we want to compare these opinions with the industry experience in the Duvernay Formation, an active target of our current research. Our survey is currently being conducted up to the end of Geoconvention 2018.

Theory and/or Method

The study is currently being carried out through an online survey using Google Forms (link to be published after abstract acceptance). This results in a multi-platform compatible survey that is easy to fill out and distribute through professional networks. The survey has five sections - demographics, awareness & risk perception, policy & decision-making, economic impacts, and mitigation techniques. There are also additional questions specific to unconventional operators working in the Duvernay. The questions rely on energy professional's expertise and familiarity with the issues being discussed; however, there is always a "not sure" or default category to avoid eliciting inaccurate responses if participants face a lack of understanding or knowledge regarding the questions. These questions are summarized below.

Questions and Hypotheses

Demographic Information

We want to differentiate participants anonymously, and that the responses will vary based on the sector the professionals work in, their technical specialty, their type of employer, their geographical area of specialty, and their amount of industrial experience. To that end, we are asking the following questions:

- What area of the energy sector do you work in the most?
- What is your primary technical discipline?

- What kind of company do you work for?
- Where do you do the majority of your work?
- How many years of industry experience do you have?

Awareness & Risk Perception

We want to understand professional's awareness of induced seismicity and the risks surrounding it. Risk being defined as the probability of a significant induced earthquake multiplied by the consequences of that event. We are concerned that energy professionals by and large may suffer from a lack of familiarity and experience with induced seismicity. Additionally, they may not feel like they understand the causes of IS adequately as a group. This may limit their and their organization's mitigation efforts. We are testing this hypothesis through the following questions:

- What is your familiarity and experience with induced seismicity?
- I understand what causes induced seismicity.

We believe that professionals consider induced seismicity as an environmental, health and safety, and economic risk, but to varying degrees based on their demographics. We also think that there are other risks that professionals consider when making decisions that we aren't considering in our research and we are seeking feedback to identify them using the following questions:

- Induced seismicity poses an environmental risk.
- Induced seismicity poses a risk to public health and safety.
- Induced seismicity poses an economic risk to operators.
- Please list other risks that should be considered.

Humans are generally poor evaluators of probability and we hypothesize that the perceived risk of induced seismicity from all causes is lower than the actual likelihood of these events occurring. Additionally, we hypothesize that professionals experience cognitive dissonance and a narrative fallacy when evaluating risks and that they will rate the probability from hydraulic fracturing higher than the probability from all causes.

Policy

We hypothesize that the industry believes that induced seismicity policies from EGS (Majer et al. 2007) and carbon capture (Shapiro 2015) aren't applicable to hydraulic fracturing. We also think that the current industry perception is that traffic lights are ineffective at reducing large seismic events, even though the traffic light policies have significantly altered the completions strategies employed by industry. Despite this change in completions strategy, we think that IS has a negligible or low influence on the IRR of a typical project. We are testing this with the following questions:

- Regulatory policies developed for enhanced geothermal systems and carbon capture are applicable to hydraulic fracturing.
- Traffic light policies are effective at reducing large seismic events.
- Traffic light policies have made a significant difference on drilling, completion, and operation strategies.
- How much do the current induced seismicity risks and policies reduce a typical project's internal rate of return?

Evaluation & Mitigation

When it comes to evaluation, we think that a large portion of the industry believes that it isn't possible to evaluate the risk or and/or mitigate induced seismicity. This is despite the industry considering many factors to evaluate induced seismicity and having a significant (albeit sparse) amount of information at its disposal. This disparity may stem from an underutilization of the tools available to industry (evidenced by the low number of tools selected in our survey). Yet, it may turn out that the combination of factors and

processes aren't currently sufficient to evaluate the risk of induced seismicity and that more research is required. To that end we asked the following questions:

- It is technically possible to evaluate the risk of and/or mitigate induced seismicity.
- The key factor(s) used to evaluate induced seismicity include:
- The key process(es) used to evaluate induced seismicity include:
- The factors and processes available to industry are sufficient to evaluate the risk of induced seismicity.
- Could you elaborate on the above question, why or why not? What tools would you recommend for further research / commercialization?

Our information indicates that the majority of industry is only using broadband seismometers and microseismic to avoid induced seismicity (Maxwell 2009), but it appears that there might be some surprising technologies on the horizon. We think that most operators would recommend seismic monitoring assuming the price is reasonable (even though significant in absolute terms). Yet, the overall amount operators are willing to invest in monitoring is likely quite low in relative terms (% of project capital expenditures) due to the uncertainty surrounding induced seismicity. This may mean that microseismicity is simply a by-product of operational workflows and not primarily driven for induced seismicity mitigation. We are testing this through three questions:

- The key tool(s) used to mitigate induced seismicity include:
- What probability would it take for you recommend broadband seismic or microseismic monitoring, assuming it added 2% to a project's capital expenditure?
- What percentage of project capital expenditure would you be willing to commit to mitigation techniques for induced seismicity?

The Duvernay Play

In addition to a general questionnaire about induced seismicity, we are also asking specific questions about the Duvernay Play. This is driven both by the emergence of the East Duvernay play, the proliferation of the Deep Basin, and the large induced events observed near Fox Creek. We limit the survey to professionals in the Duvernay Play, or in analogues where they feel they have experience and that were applicable. Our hypothesis is that most professionals feel that the risk to surface infrastructure in the Fox Creek area is manageable and therefore acceptable. Looking at the adjustment of well azimuth (a subject of ongoing research), we believe that most professionals feel like the azimuth of the wells is adjusted mainly for operational / completion purposes and has no effect on induced seismicity. We think that this off-lease border drilling aversely affects a project's rate of return due to more difficult drilling, lost reserves, and more complex surveys. In assessing this problem, we are likely missing some of the cost and operational factors that contribute to this effect wanted professionals to comment directly and guide our future studies. The following questions are posed for that purpose:

- Induced seismicity poses an unacceptable risk to surface infrastructure in the Fox Creek area.
- Adjusting the azimuth of wells perpendicular to the maximum horizontal stress helps mitigate induced seismicity.
- How much does drilling diagonally reduce a typical project's internal rate of return?
- Could you elaborate on the above question? What are the key factors affecting the economics and operations when drilling diagonally?
- What are the key causal mechanisms for large earthquakes in the Duvernay?
- Most professionals will link large earthquakes to critically oriented faults.

Conclusions

The responses from the survey up to May 5th will be presented at the conference. In addition, several question that will form a public perception survey will be presented for discussion. A public open report will be generated with statistics and responses from the questions.

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