

Short Report on 3rd Induced Seismicity Workshop (Davos, Switzerland 5-8 March 2019)

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More than 100 years after the German writer of Nobel Prize fame, Thomas Mann, enjoyed the Schatzalp of Davos, some 175 experts from all parts of the world working on induced seismicity convened there from 5 to 8 March 2019 on the invitation of the Swiss Seismological Service to participate in the 3rd Induced Seismicity Workshop after 2015 and 2017.

First, the audience joined the Grand Tour of observations of induced seismicity: the Permian basin, a current “hot-spot” of unconventional hydrocarbon development, underpinning the US’ position as No. 1 producer of oil and gas; geothermal induced seismicity in Iceland and in South Korea; and mining-induced versus that of fracking-related seismicity in England. The audience then took an introspective look and hotly debated social aspects of induced seismicity and the at times contentious role of “experts”, the communicative strategies of the industry and scientists in connection with induced seismicity and shifting perceptions of “informed” citizen groups. Maybe the audience realized that scientists are subject of undue expectations as “purveyors of The Truth”.

Next and from a liability and legalistic standpoint a crucial question: can science help distinguish between induced, triggered and natural earthquakes? Statistics and mechanics offer insights that may lead to a scientific consensus on this question: today though, we are far from a clear-cut and systematic answer in how to analyze and unequivocally attribute earthquakes of possibly anthropogenic origin to the three classes. Statements will continue to be qualified with words such as “possibly, probably or likely”.

Induced seismicity in the Groningen natural gas field was a major topic of the workshop: the field will cease production in 2030, and has long fueled the Dutch and European economies having generated €10s, if not 100s of billions of economic value since the early 1960s. The operator, the Dutch regulator and legions of scientists are developing a sound understanding of the causes of the observed induced seismicity. Vulnerable building stock in the North of the Netherlands and the highly compartmentalized and following 60 years of production a compacting reservoir, stress bounding faults that slip and generate damaging earthquakes. Remedial actions are besides shutting in production, strengthening the building stock.

Another “hot-spot” of scientific investigation is the 2017 Pohang earthquake sequence with magnitudes up to 5.5, in connection with enhanced geothermal system development. The earthquake injured 135 residents, had people move into emergency housing, and caused more than US\$75 million in direct damage and over US\$300 million of total economic impact (estimated by the Bank of Korea). This was the most damaging earthquake to strike the Korean Peninsula for centuries. At Schatzalp, scientists and engineers from Korea, the US, Switzerland and Germany showed a suite of initial studies that suggest a causal relation, with plenty of “lessons” to be “learnt”!

Importantly, the Schatzalp workshop demonstrated an intensifying dialogue between seismologists who have dominated the discourse, and the rock mechanics community who provide modern and much better theory of what actually happens when faults slip. The large disconnect between the fields of geophysics and geomechanics was on display – bridging this gap will be a key point in understanding the trifecta regarding induced, triggered or natural. The dialogue is essential for the ultimate goal to provide not only scientific insights but also develop engineering solutions to minimizing induced seismicity. Modelers reported on a number of case studies to investigate conceptual interpretations of “what actually happened”. Also, models demonstrate numerical approaches to test a wide range of hypotheses, which guide science and engineering towards minimizing induced seismicity risks.

What became clear is that underground laboratories are the essential bridge between laboratory and the large-scale field observations. Accessible field laboratories at the scale of 10s to 100s of meters in size at depths up to 1-2 km are a critical research infrastructure for finding answers to scientific questions and developing engineering solutions – France, the USA (FORGE in Utah), Germany (Reiche Zeche in Saxonia) and the Swiss infrastructures at Mont Terri, Grimsel and the newly built Bedretto.

Perspectives for the Induced Seismicity Working Group (is-WG)

One of the prospective goals of the IPGT working will be to carry out its Charter in the most efficient way possible. In lieu of the recent developments in Pohang and the publicized platform it achieved – Science AAAS (see [Grigoli et al, 2018](#); [Kim et al., 2018](#)) – the landscape and resources required to carry out this Charter will have changed from country to country. We have already seen public backlash in Switzerland with the immediate disruption of the Haute-Sorne EGS project in early 2018. Also, a joint South Korean and European research and innovation project ([DESTRESS](#)) funded by the European Commission within the Horizon 2020 framework *recently published* its decision to cease research activities at this particular site while at others activities continue.

This news item is being written days after the release of an [oversight report](#) that investigates the EGS Pohang project operated by NexGeo Inc. The coming months and years will be spent on scientific analysis and interpretation of the events at Pohang and extracting learnings. The geothermal research and industry community will likely need to anticipate and play catchup with the court of public opinion to attain the Charter of IPGT over the next years.

Learning lessons from the Schatzalp workshop, specifically from the session on Societal Aspects of Induced Seismicity, we believe that we can address the publics concerns using the tools that social scientists have detailed. In that session, the workshop discussed *alternative science* which appears to pray on top-level science by cherry-picking words and data that to promote the rhetoric and alternative agendas. Their rhetoric is usually the same, for us it will involve special interest groups concerned about certain practices surrounding EGS, most specifically fracking and induced seismicity. These groups tend to employ the concept of *environmental melodrama* ([Schwarze, 2006](#)) that cater to the publics “David and Goliath” fairytale mentality. In these scenarios, EGS companies are vilified under the guise of science, where interest groups provide definite answers with high certainty to sway public opinion. As we know, high-certainty and definitive answers are just not currently possible with our level of understanding of the complexities in subsurface geothermal systems. Moreover, it appears the need to teach the public about *uncertainty*, according to the social scientist, will be a step in the right direction.

Public education and teaching appeared to be the only offered solution. This is not a bad start for the Induced Seismicity -WG considering the active but independent work by partnered nations over the last few years. ETH Zurich (Switzerland) has been dynamically thinking about communication and has published the “*Good Practice*” *Guide for Managing Induced Seismicity in Deep Geothermal Energy Projects in Switzerland* ([Wiemer et al., 2017](#)) – a how-to guide targeted at permitting and regulatory oversight authorities. This manual has addresses the four critical areas described in the current version of the [Induced Seismicity-WG white paper \(2014\)](#), at least in the Swiss landscape.

The Working Group needs to continue focusing on induced seismicity in the following categories: A1. Safety and operations, A2. Understanding of processes during stimulation and operation, A3. Components, hardware and software development and A4. Social dimension. The white paper is currently unreleased to the public. We believe that providing an updated version to EGS operators, which allows them to operate under the scope of “good practice”, should be a primary goal of is-WG leading up to and during the summer meeting in Lausanne 2019.