

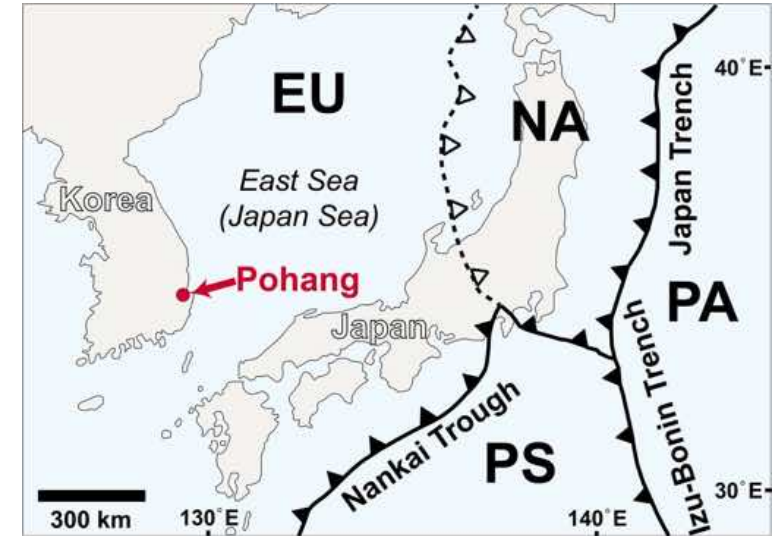
The Nov. 2017 Pohang (South Korea) earthquake of magnitude 5.5: An anthropogenic event with implications for Switzerland?

Prof. Dr. Stefan Wiemer

With major contributions from many others

The Pohang Project

- The project started in 2011, investment of \$38 million, \$16 million provided from government funding and \$22 million from private investors.
- Planned capacity of 1.2 MW, expected to provide electricity for 1,000 households.
- If the start of the plant is successful, further funding of \$70 million will be sought to expand the facility to a total power generation capacity of 6.2 MW by 2019.
- EGS system. Project to reach depth of 4.5 kilometers.
- Partner in EU DESTRESS project.



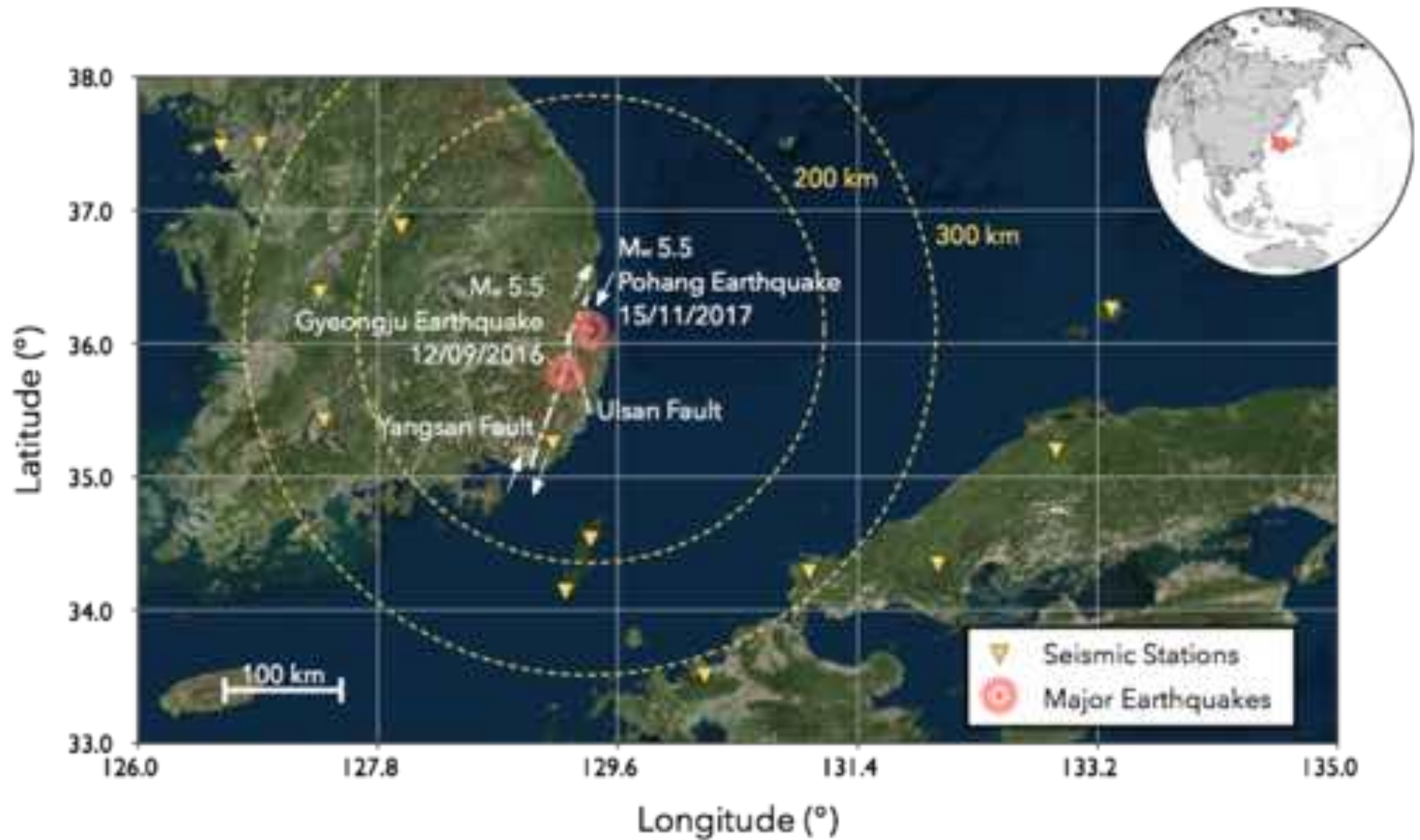
Drilling rig on project site in Pohang/ South Korea (source: DESTRESS Project)

The Mw 5.5 2017 South Korea Earthquake: Nov. 11 2017



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Grigoli et al. (2018, Science)

The Mw 5.5 2017 South Korea Earthquake: Damages



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Due to its shallow focus (about 4.5 km depth) the earthquake caused extensive damage in and around the city of Pohang.



Major news in Korea ...

- <https://www.youtube.com/watch?v=AQ9qcb9ITuQ>



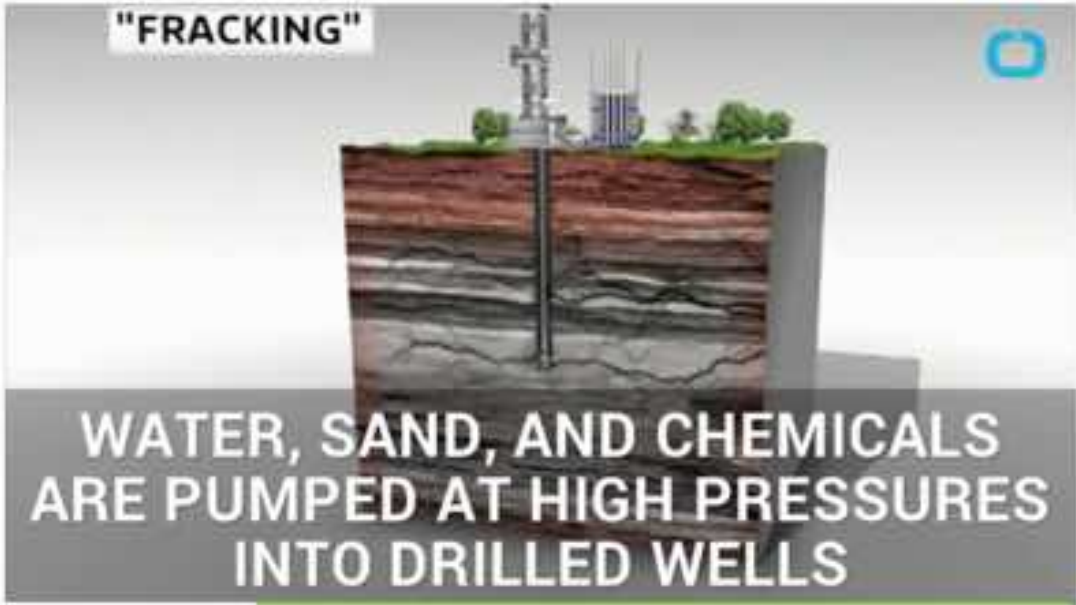
... and around the world (with the usual terminology confusion)

Newsweek

TECH & SCIENCE








FRACKING MIGHT HAVE LED TO 5.5 MAGNITUDE EARTHQUAKE THAT INJURED NEARLY 100 PEOPLE: STUDY

BY KATHERINE HIGNETT ON 4/26/18 AT 3:26 PM



"FRACKING"

WATER, SAND, AND CHEMICALS ARE PUMPED AT HIGH PRESSURES INTO DRILLED WELLS

SHARE       

SED informed early and actively (for good reasons)



The screenshot shows the ETH Zürich website with a dark blue header. The main navigation bar includes links for 'News & Veranstaltungen', 'Die ETH Zürich', 'Studium', 'Doktorat', 'Forschung', 'Wirtschaft & Gesellschaft', and 'Campus'. On the right side of the header, there are links for 'Studierendenportal' and 'Alumni-Vereinigung'. The left sidebar contains a list of links: 'ETH-News', 'Archiv', 'Redaktion', 'Newsletter und Abo', 'Mobile Apps', 'Weitere Meldungen', 'Zukunftsblog', 'Magazin «Globe»', 'Soziale Medien', 'Veranstaltungen', and 'Medieninformationen'. The main content area features a news article titled 'Menschgemacht oder nicht?' dated 26.04.2018, written by the 'Redaktion'. The article text discusses a study published in 'Science' regarding a connection between an earthquake in South Korea and a nearby geothermal project. A photograph of a geothermal wellhead is visible on the left side of the article text.

ETH zürich Studierendendenportal Alumni-Vereinigung

News & Veranstaltungen Die ETH Zürich Studium Doktorat Forschung Wirtschaft & Gesellschaft Campus

ETH-News
Archiv
Redaktion
Newsletter und Abo
Mobile Apps
Weitere Meldungen
Zukunftsblog
Magazin «Globe»
Soziale Medien
Veranstaltungen
Medieninformationen

Menschgemacht oder nicht?

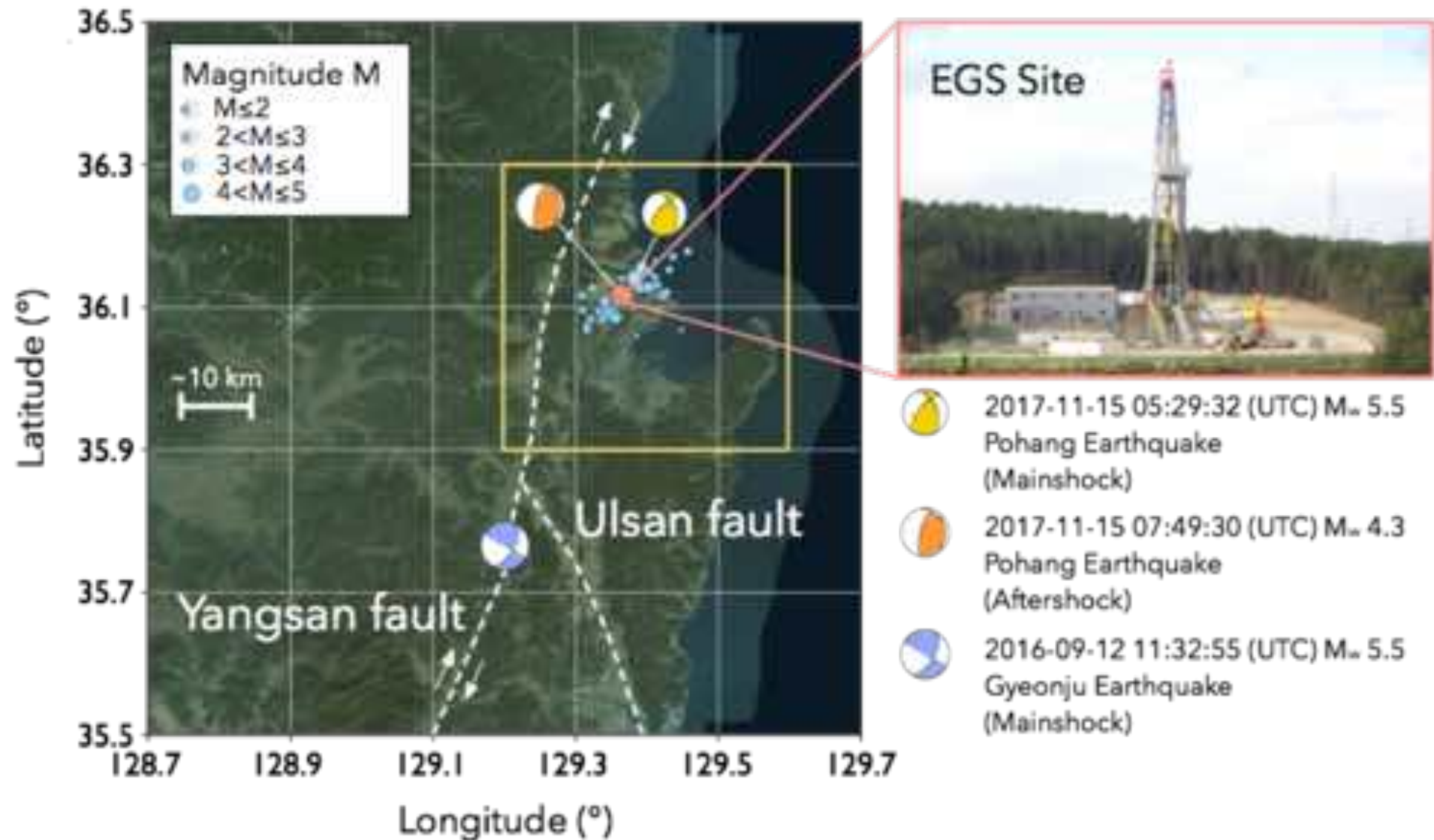
26.04.2018 | News
Von: Redaktion

Eine soeben in der Fachzeitschrift «Science» veröffentlichte Studie untersucht, ob eine Verbindung zwischen einem Erdbeben der Magnitude 5.5 in Südkorea und einem nahegelegenen Geothermieprojekt besteht.

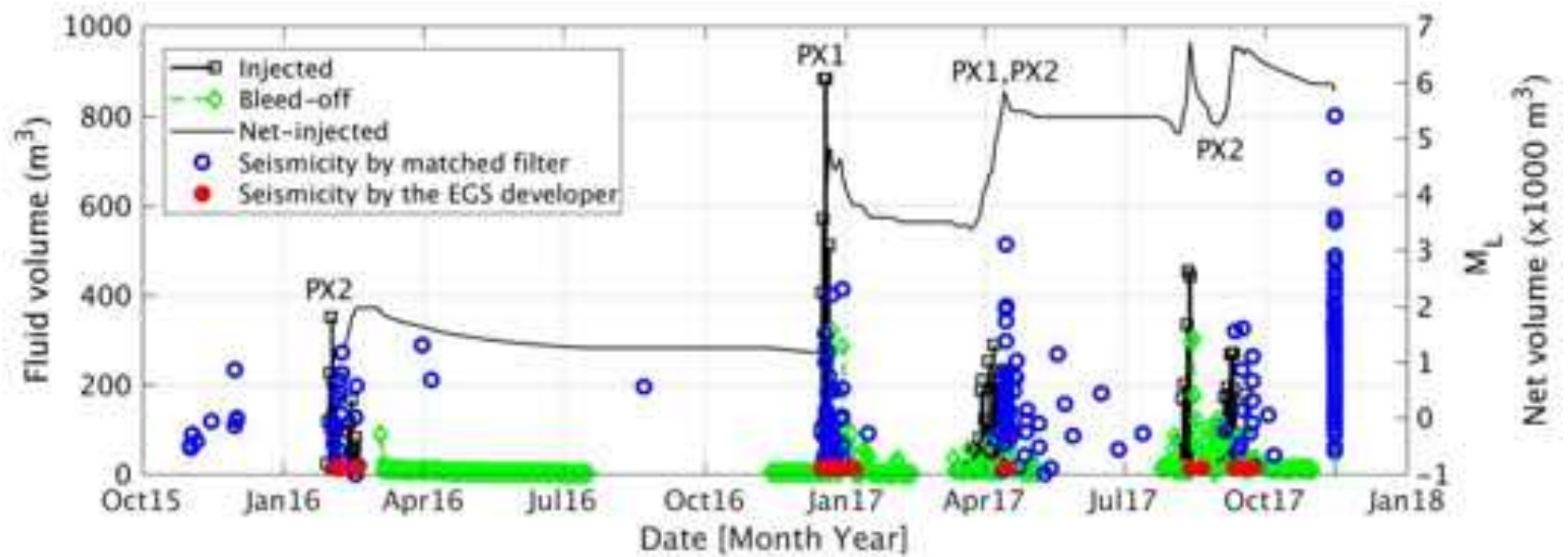


Verfasst wurde der Beitrag von einem Team des Schweizerischen Erdbebendienstes an der ETH Zürich unter Mitwirkung der Gruppe Ingenieurgeologie der ETH, des GFZ Potsdam und der Universität Glasgow. Bei dem Erdbeben, das sich am 15. November 2017 ereignete, wurden etwa 80 Menschen verletzt und zahlreiche Gebäude in der Stadt Pohang beschädigt. Sollte sich herausstellen, dass es sich dabei um ein menschengemachtes Be-

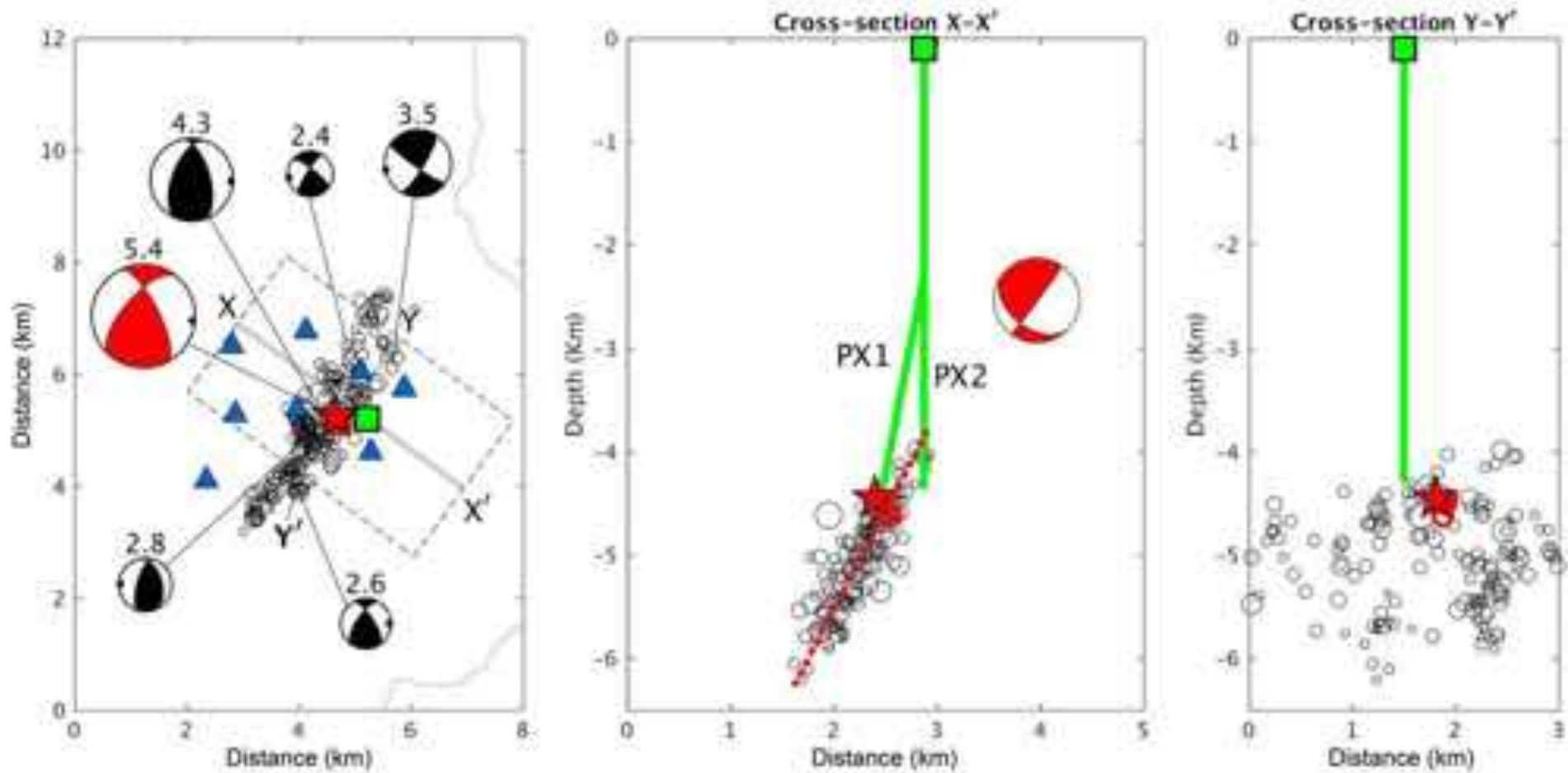
And published a paper in Science on the mainshock in April 2018



Project Timeline: Activities in two wells.



The mainshock – very close to the wells. By coincidence?



We had an instrument near the site



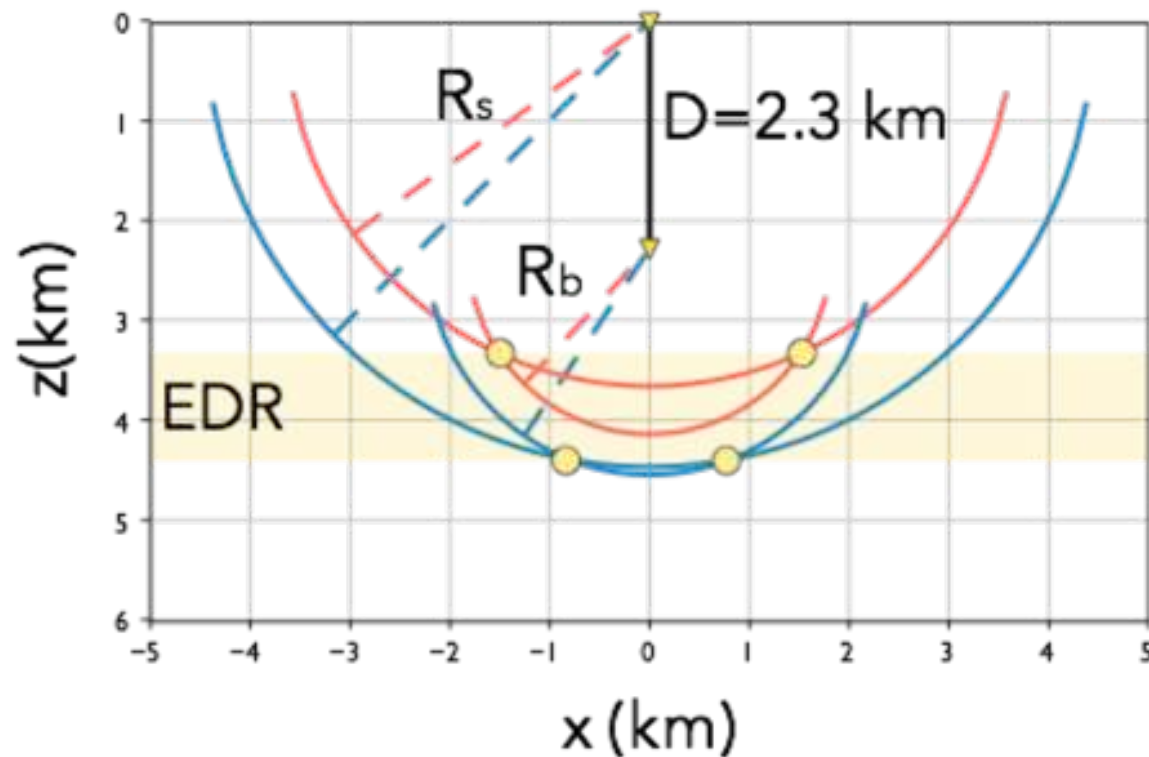
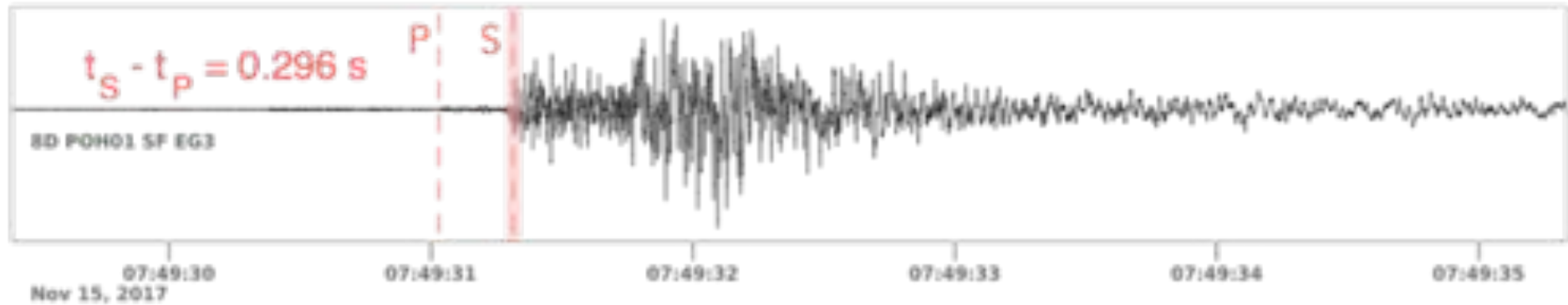
The Mw 5.5 2017 South Korea Earthquake: depth of the large events



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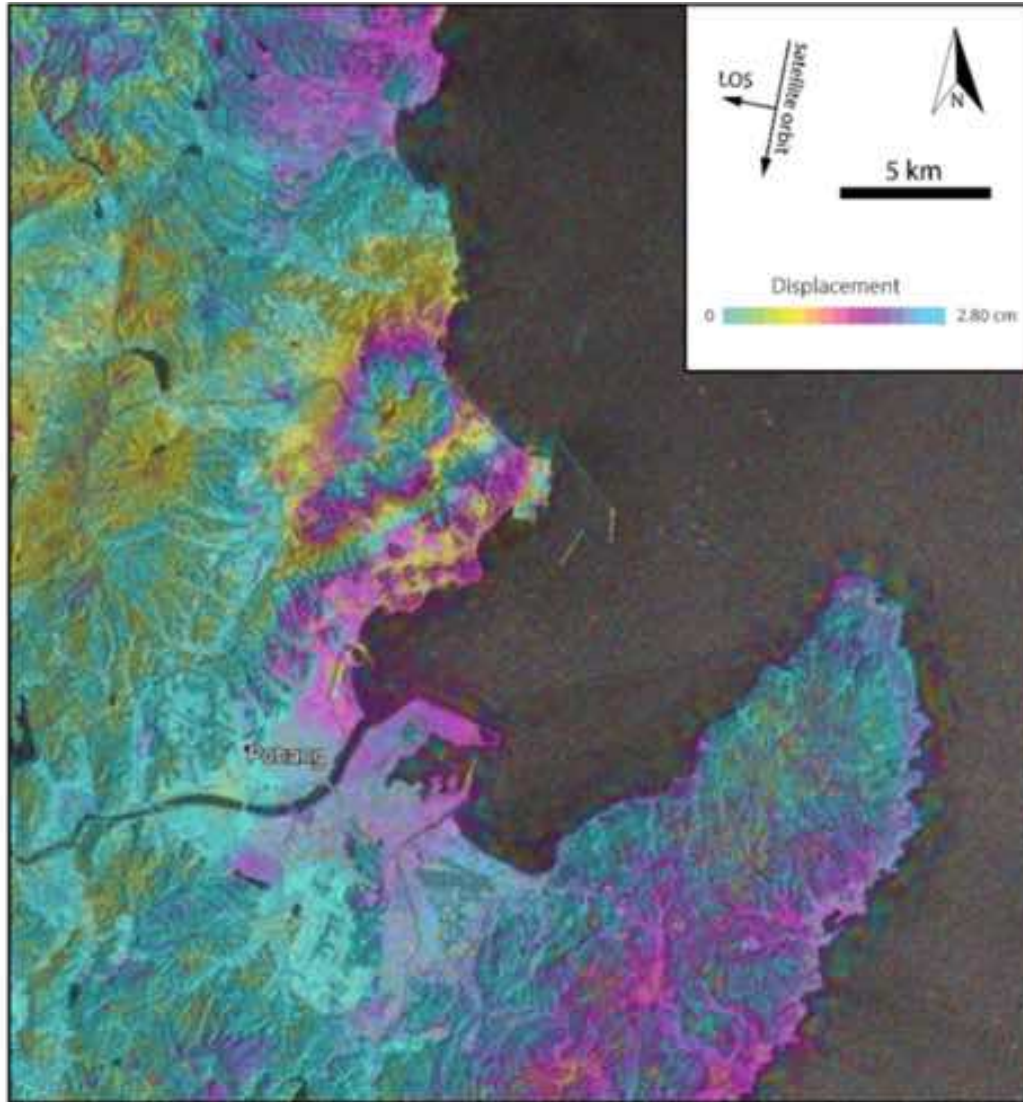
The largest aftershock recorded by the borehole accelerometer



By using the surface and borehole accelerometers it is possible to constrain the depth of the largest aftershock.

For the MS the borehole sensor was clipped.

The Mw 5.5 2017 South Korea Earthquake: geodetic analysis



Differential interferogram obtained by processing two Sentinel-1 SAR images acquired over the area of Pohang on November 04, 2017 and November 16, 2017, respectively.

Each color cycle is associated with a change of ~ 2.8 cm in line-of-sight (LOS) distance between the satellite and the ground.

In the interferogram about two complete cycles are visible in the epicentral area (about 5 cm of LOS deformation).

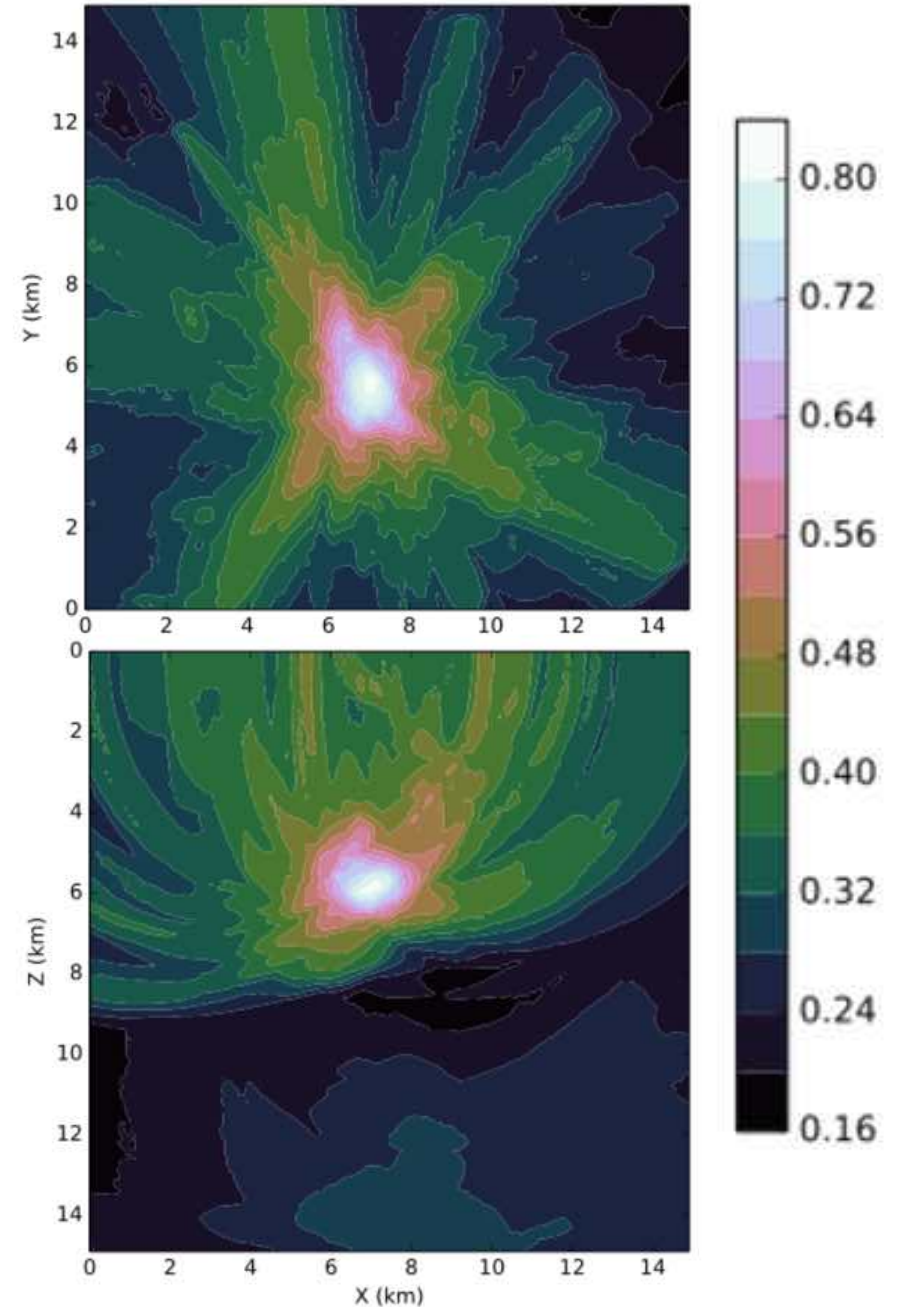
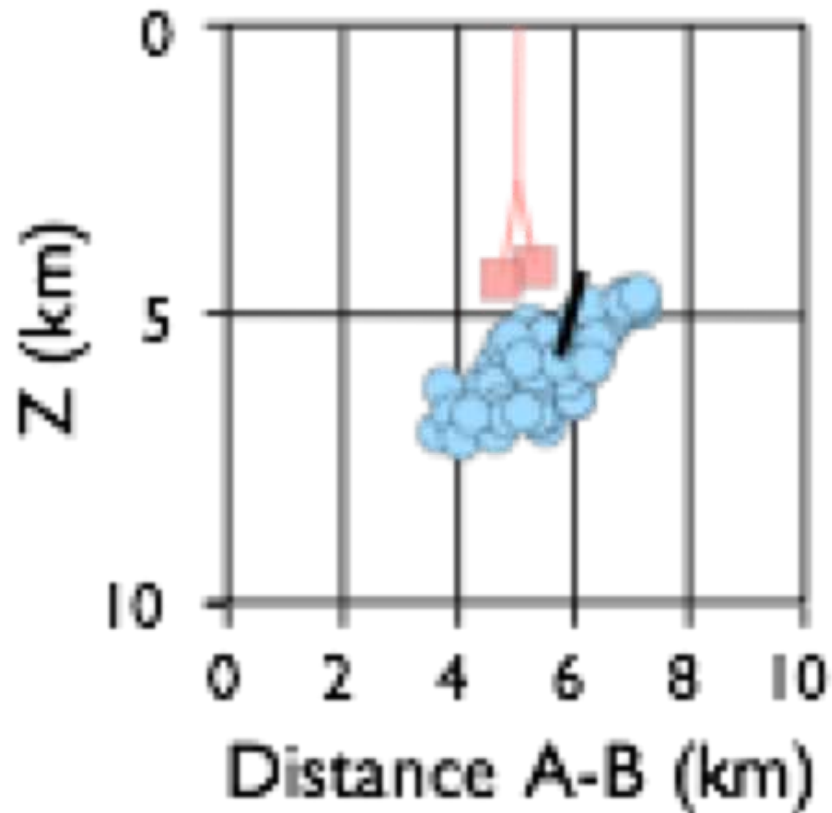
The Mw 5.5 2017 South Korea Earthquake: Advanced analysis

Ongoing work at
GES/SED/Stanford: Better
absolute and relative
locations

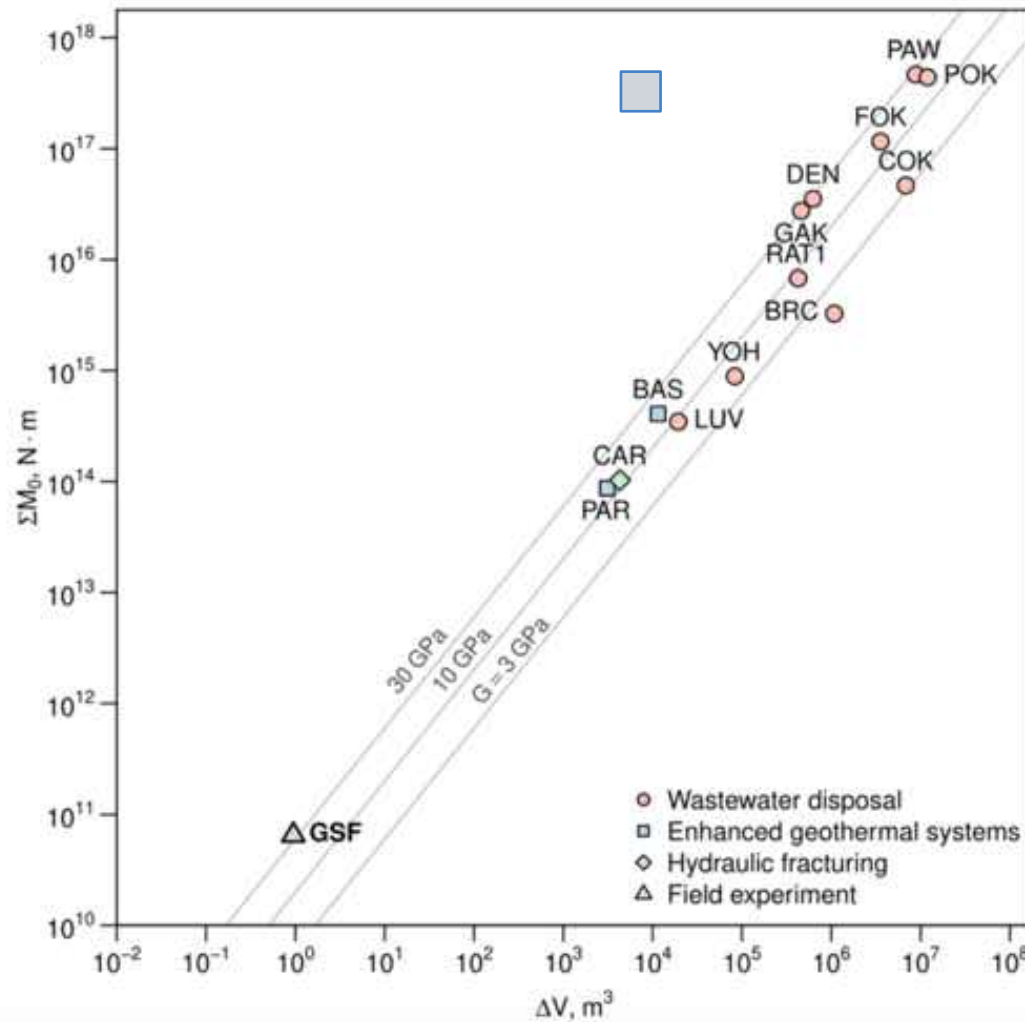


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The Mw 5.5 2017 South Korea Earthquake and the McGarr relation



■ Pohang Mw=5.5

Much bigger than one might have expected from fluid volumes ...
Implications for risk studies?

Ongoing activities

- Official investigation report by a government-appointed international committee (incl. Domenico, Bill Ellsworth ...). Report in November?
 - Various Korean and international research group working on the analysis. Major challenges: Data access and data quality.
 - DESTRESS EC consortium, lead by GFZ, is analyzing the data.
 - Kanton Jura requested GeoEnergie Suisse AG to consider the implication and if necessary update the risk study. GES is analyzing Pohang data and studying implications.
- Pohang will be analyzed for many more years to come.



Implications

- The seismic monitoring and analysis workflow in Pohang was clearly insufficient. High-quality data needs to be processed in near-real time.
- Public acceptance may drop even further.
- Will we ever know for sure what was the exact reason for the problem, why then, why there? Not so clear ...
- Classical traffic lights have once again shown to be of limited values, we need adaptive traffic lights that analyze data in near-real time.
- Do current seismic risk studies consider the chance of 'triggering' adequately?
- Keeping in mind that other technologies have considerable risks also...



LA GÉOTHERMIE PROFONDE
A PROVOQUÉ LE SÉISME DE 2017 EN CORÉE



VIERKÖPFIGE FAMILIE IN ESSLINGEN GESTORBEN

Hohe Dunkelziffer bei Kohlenmonoxid-Vergiftungen

Experte: »Geschätzt vergiften sich jährlich 3000 Menschen



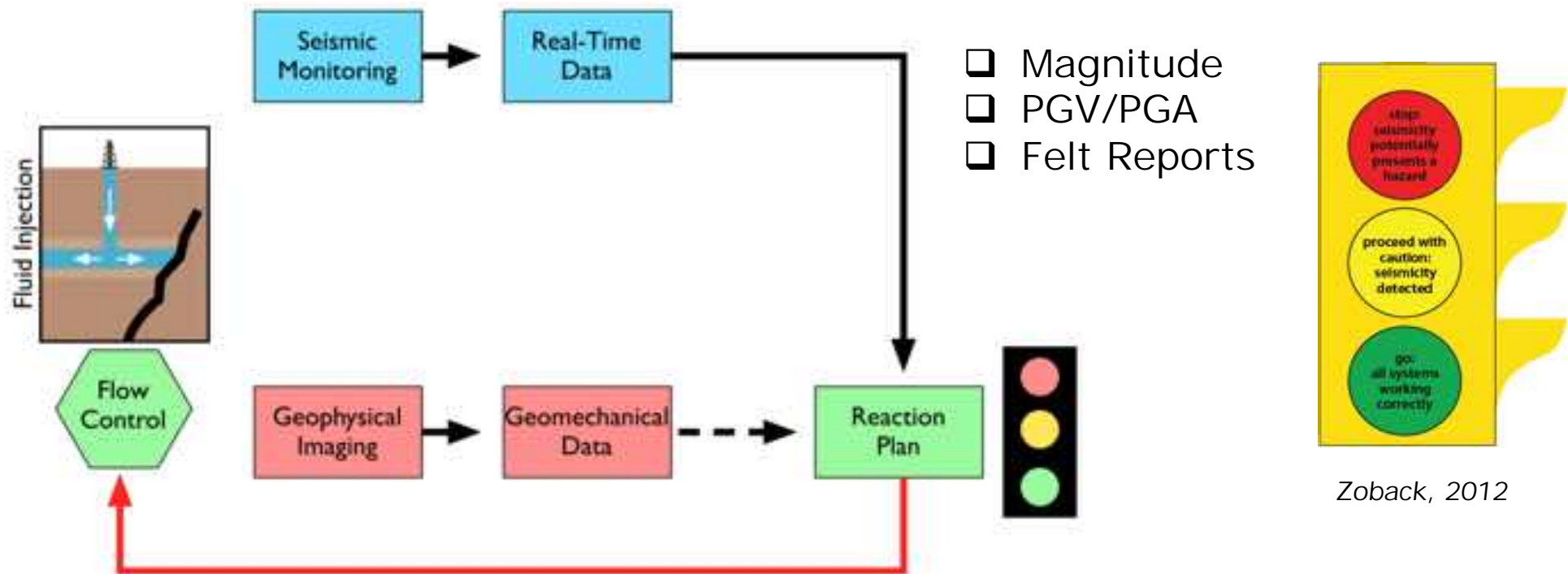
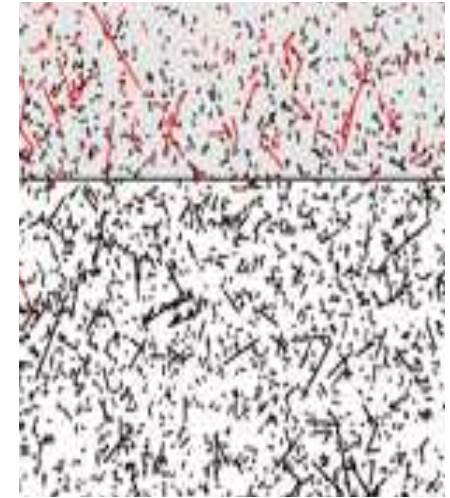
06.02.2018 - 12:02 Uhr

Die Kohlenmonoxid-Tragödie in Esslingen: Familienvater Turgay Ö. (29), seine Frau Filiz (29), Sohn Mert (4) und Tochter Minel (3) starben in ihrem Reihenhaus. Ersten Erkenntnissen nach hatte sich ein Abgasschlauch von der Heiztherme gelöst, das tödliche Gas strömte offenbar seit Tagen unbemerkt aus.

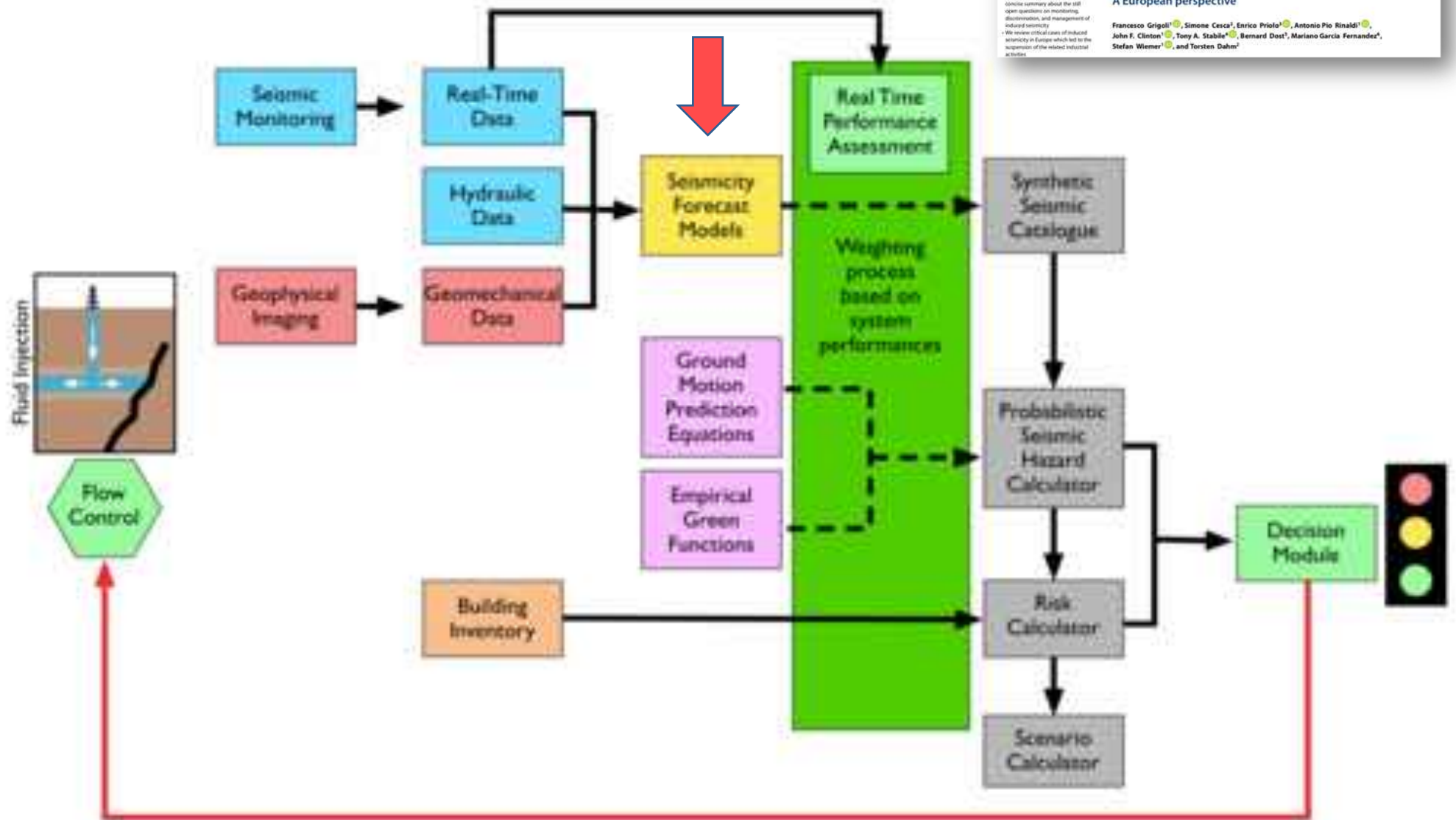
Leider kein Einzelfall – im Gegenteil: In Deutschland starben 648 Menschen nach jüngsten Daten des Statistischen Bundesamts [☞](#) aus dem Jahr 2015 an einer Kohlenmonoxidvergiftung   – so viele wie seit 1998 nicht mehr. Damals starben 477 Menschen durch das leise Gift.

Planned Activities







- How do we image faults in the vicinity? And what does it take to activate them This will become an even stronger focus of the Bedretto activities.
- ATLS are needed. We are going to validate them under real-world conditions in Iceland (Geothermica Project COSEISMOQ)



Adaptive Traffic Light System (ATLS)



COSEISMIQ: Validating ATLS

<p>Project Coordinator</p>  <p>Prof. Stefan Wiemer</p>	<p>Project Partner</p>  <p>Dr. Edda Sif Aradóttir</p>
<p>Project Partner</p>  <p>Prof. Chris Bean</p>	<p>Project Partner</p>  <p>Dr. Peter Meier</p>
<p>Project Partner</p>  <p>Dr. Kristján Ágústsson</p>	<p>Cooperation Partner (*)</p>  <p>Prof. Torsten Dahm</p>



Thank you!

3rd Schatzalp Induced
Seismicity Workshop –
co-sponsored by the
SCCER-SoE and BFE.

5.- 8.3.2019

