NAtural Seismicity as a Prospecting and MONitoring tool for geothermal energy extraction

Kick off meeting

Josef Horálek

Prague+Reykjavík 2021

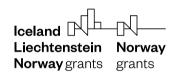## Outline

1. Project summary

2. Team

3. Work Packages

4. Timeline

5. Results

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Basic data

- project title: NAtural Seismicity as a Prospecting and MONitoring tool for geothermal energy extraction
- acronym: NASPMON
- KAPPA programme : Financed by the EEA and Norway Grants (85%) & the State budget of the Czech Republic (15%)
- Support provider: TAČR (Technology Agency of the Czech Republic)
- identification code: TO01000198
- duration: 01/2021 – 04/2024

Iceland
Liechtenstein
Norway grants

Norway
grants

T A
Č R

Objectives

- reveal the physical processes that cause earthquakes with special emphasis on the role of fluids, geothermal operations and tectonic plate movements
- apply the results to develop guidelines for underground operations in seismically active areas
- test and develop seismic methods as a prospecting tool in geothermal exploration

The target area in Iceland has intensive seismicity due to variety of geodynamic processes and human activities, such as plate movements in rift segments, volcanoes, active hydrothermal areas with production/reinjection. The results are expected to be transformable to other areas with potential geothermal sources and micro-earthquake activity.

The main tasks

- analyze seismicity recorded by REYKJANET
- test and develop automatic seismic data processing procedures
- characterize of source mechanisms and stress field
- derive 1D and 3D velocity models of the Earth's crust
- make an integrated analyses of geophysical and geological data to detect fluid paths and their accumulation
- the use of local seismicity as a prospecting tool in geothermal exploration for energy production

The project will enhance understanding of subsurface structures and processes related to geothermal reservoirs. Such results are of high importance for geothermal development and are applicable to other seismic regions where the fluid balance is affected by human activities or natural processes.

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Institutions

- Institute of Geophysics (IG), CAS - main applicant, project promoter
- Iceland Geosurvey (ÍSOR) - project partner
- Institute of Rock Structure and Mechanics (IRSM), CAS - project partner
- Faculty of Science, CU - project partner

Institutions- Commitments

	2021	2022	2023	2024
IG	3.9	4.05	4.05	1.4
ISOR	1.15	1.1	0.95	0.4
IRSM	0.9	0.9	0.9	0.3
CU	0.6	0.6	0.6	0.2

People - IG

KEY PERSONS:

- Josef (Pepa) Horálek (Principal investigator)
- Jana Doubravová
- Jakub Klicpera
- Bohuslav (Slávek) Růžek
- Petra Adamová
- Pavla Hrubcová
- Jan (Honza) Šílený
- Hana (Hanka) Jakoubková (currently on maternity leave)

OTHERS:

- Diana Konrádová (Ph.D. Student)
- Veronika Turjaková (Ph.D. Student)
- Petr Jedlička (technician)
- Alena Boušková (seismogram processing)

People - ÍSOR

KEY PERSONS:

- Gylfi Páll Hersir
- Þorbjörg (Tobba) Ágústsdóttir
- Egill Árni Guðnason
- Sigríður (Sisa) Kristjánsdóttir
- Ólafur G. Flóvenz

OTHERS:

- Friðgeir Pétursson
- Asdís Benediktsdóttir
- Rögnvaldur Magnússon

People - IRSM and CU

KEY PERSONS:

- Jiří (Jirka) Málek (IRSM)
- Tomáš Fischer (CU)

OTHERS:

- Lucia Fojtíková (IRSM)
- Josef (Pepa) Vlček (CU)

Steering committee

Members:

- Josef (Pepa) Horálek
- Jana Doubravová
- Gylfi Páll Hersir
- Þorbjörg (Tobba) Ágústsdóttir
- Jiří Málek
- Tomáš Fischer

Decisions on:

- Preparation and organisation of meetings
- Content, finances and intellectual property rights
- Personal matters
- Evolution of the Partnership

Outline

WP's and teams I. - institutions involved and leaders

- WP1: Project management (IG) - Josef
- WP2: Data acquisition and data archiving (ÍSOR, IG) - Egill
- WP3: Automatic data processing: detection and location of earthquakes (ÍSOR, IG, CU) - Tobba
- WP4: Seismic activity: Time and space analysis (IG, ÍSOR, CU) - Jana

WP's and teams II. - institutions involved and leaders

- WP5: Earthquake source mechanisms and stress analysis (IG, ÍSOR) - Josef
- WP6: Upper crustal seismic models (IG, IRSM, ÍSOR) - Slávek
- WP7: Ground motion model: Input for hazard assessment (IRSM, ÍSOR) - Jiří
- WP8: Multi disciplinary interpretation (ÍSOR, IG, IRSM, CU) - Gylfi

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2021

Years		2021											
Months		1	2	3	4	5	6	7	8	9	10	11	12
WP1	**Project management**				M1								
WP2	**Data acquisition and data archiving**		M1		M2								
WP3	**Automatic data processing**		M1	M2	M3			M4		M5		D1	
WP4	**Seismic activity: Time and space analysis**												
WP5	**Earthquake Source Mechanisms and stress analysis**												
WP6	**Upper crusal seismic models**												D1
WP7	**Ground Motion Model**												
WP8	**Multi-disciplinary interpretation**												

M1	Kick-off meeting in Prague during the 1st quater of 2021
M1	Seismic data archive and structure complete by March 2021
M2	REYKJANET data stations streaming in real time by April 2021.
M1	Set up QuakeMigrate test and tune by February 2021
M2	Set up Seiscomp for REYKJANET by March 2021

2021

Years		2021											
Months		1	2	3	4	5	6	7	8	9	10	11	12
WP1	Project management				M1								
WP2	Data acquisition and data archiving		M1		M2								
WP3	Automatic data processing		M1	M2	M3			M4		M5		D1	
WP4	Seismic activity: Time and space analysis												
WP5	Earthquake Source Mechanisms and stress analysis												
WP6	Upper crusal seismic models												D1
WP7	Ground Motion Model												
WP8	Multi-disciplinary interpretation												

M3	Tune Seiscomp for REYKJANET by April 2021
M4	Tunning of detection algorithms (Seiscomp, SLRNN, QuakeMigrate, comparison of their performance by July 2021
M5	Implementation of the formula for routine local-magnitude estimation of by September 2021
D1	Deliver phase picks from all earthquakes in WP2 of ML > 1.25 by October 2021
D1	Deliver 1D velocity model for Reykjanes Peninsula

2022

Years		2022										
Months		13	14	15	16	17	18	19	20	21	22	23	24
WP1	Project management										M2	
WP2	Data acquisition and data archiving											
WP3	Automatic data processing	D2					M6					
WP4	Seismic activity: Time and space analysis				D1								D2
WP5	Earthquake Source Mechanisms and stress analysis				D1								D2
WP6	Upper crusal seismic models				D2								D3
WP7	Ground Motion Model											
WP8	Multi-disciplinary interpretation											

M2	Project work shop in Prague
D2	Deliver earthquake locations from QM and Seicomp, NLLC and hypoDD and their comparison with earthquake locations
	based on manul arrival-time readings by November 2021
M6	Implementation of method for correct association of P- and S- phases in series of overlapping events by June 2022

2022

Years		2022										
Months		13	14	15	16	17	18	19	20	21	22	23	24
WP1	**Project management**										M2		
WP2	**Data acquisition and data archiving**												
WP3	**Automatic data processing**	D2					M6						
WP4	**Seismic activity: Time and space analysis**				D1								D2
WP5	**Earthquake Source Mechanisms and stress analysis**				D1								D2
WP6	**Upper crusal seismic models**				D2								D3
WP7	**Ground Motion Model**												
WP8	**Multi-disciplinary interpretation**												

D1	Presentations poster/oral at EGU
D2	Deliver primary map of the britle-ductile boundary

D1	Presentations poster/oral at EGU
D2	Deliverprimary catalog of source mechanisms

D2	Deliver 3D velocity model for Reykjanes Peninsula
D3	Presentations poster/oral at EGU

2023

Years		2023										
Months		25	26	27	28	29	30	31	32	33	34	35	36
WP1	Project management												
WP2	Data acquisition and data archiving												
WP3	Automatic data processing						D3						
WP4	Seismic activity: Time and space analysis				D3							D4	
WP5	Earthquake Source Mechanisms and stress analysis				D3							D4	
WP6	Upper crusal seismic models				D4							D5	
WP7	Ground Motion Model												D1
WP8	Multi-disciplinary interpretation												

D3	Test current version of SEISMON_WB by March 2023

D3	Presentations poster/oral at EGU
D4	Submit paper

D3	Presentations poster/oral at EGU
D4	Submit paper

2023

Years		2023										
Months		25	26	27	28	29	30	31	32	33	34	35	36
WP1	**Project management**												
WP2	**Data acquisition and data archiving**												
WP3	**Automatic data processing**						D3						
WP4	**Seismic activity: Time and space analysis**				D3							D4	
WP5	**Earthquake Source Mechanisms and stress analysis**				D3							D4	
WP6	**Upper crusal seismic models**				D4							D5	
WP7	**Ground Motion Model**												D1
WP8	**Multi-disciplinary interpretation**												

D4	Presentations poster/oral at EGU
D5	Submit paper

D1	Deliver GMM, peak ground acceleration and velocity for the target area

2024

Years		2024			
Months		37	38	39	40
WP1	Project management		M3		M4
WP2	Data acquisition and data archiving				
WP3	Automatic data processing				D4
WP4	Seismic activity: Time and space analysis				
WP5	Earthquake Source Mechanisms and stress analysis				
WP6	Upper crusal seismic models				
WP7	Ground Motion Model				
WP8	Multi-disciplinary interpretation				D1

M3	Final meeting in Prague during the 1st quarter of 2024
M4	Stackholder meetings in Reykjavík and Prague

D4	Fully automatic detection and location of earthquakes using SEISMON_WB and Seiscomp

D1	Submit paper draft using multi-disciplinary data

Outline

Data

- Maps of earthquake hypocentres on the Reykjanes Peninsula (4/24)
- Maps of the seismic velocities (6/23)
- Open access database of earthquake parameters (4/24)

Software

- Updated ground motion model for Reykjanes Peninsula (11/23)
- Automatic data processing (4/24)

Technical upgrade

- Improvement of routine seismic monitoring (11/22)
- Upgrade of the REYKJANET network to on-line, real time data transfer (9/21)

Scientific papers

- Time and space distribution of hypocentres, imaging of faults (6/22)
- Source mechanisms and local stress analyses (6/23)
- Interpretation of seismic and other geophysical data (4/24)

Project website

https://www.ig.cas.cz/en/naspmon-project-website/

I firmly believe that the project will be successful !