ICDP project Drilling the Eger Rift – present status and further plans

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EGU General Assembly Tuesday, May 5, 2020
ICDP Eger in NW Bohemia/Vogtland: A unique field lab

- intra-continental rift
- Small, shallow basin at intersection with major faults (resources/hazard)
- Several quaternary volcanoes and Maars
Diffuse CO$_2$ degassing – evidence for magmatic processes


$\delta^{13}$C and CO$_2$ flux; max flux at Bublak is $\approx 28.00$ l/h

$\text{(}^{3}\text{He}/^{4}\text{He} = 1 \text{ Ra)}$

1 Ra: atmosphere

8±2 Ra: mid-ocean ridge basalt

$\approx 5$ Ra: ocean island (hot spot)

$\approx 6$ Ra: West Bohemia

$\rightarrow$ CO$_2$ originates from mantle-type magmas, source reservoirs $> 30$ km depth
ICDP Eger – objectives

- Substantially increase the number of detected weak earthquakes with precise relative location and focal mechanisms in the wider region of the Cheb Basin:
- Correlate CO2 flux and chemical fluid composition with variations of stress in the crust.
- Analyzing microbial activities at CO2 mofettes and maar structures in context to changes of habitats
- Collecting unaltered volcanic breckzie from maar structures and paleo tracers of CO2 flux
- Understanding the triggering mechanism of fluid-induced earthquake sequences
ICDP Eger – drilling objectives

- 4 drill sites for seismic monitoring
  - 1 collocated with Maar drilling
- 1 drill site (3 wells) for fluid monitoring
  - 2 of which used for micro-biology
- Implement 3D high frequency arrays
- Continuous hydrophysical/chemical fluid monitoring at depth
ICDP EGER: Project status

S1 Rohrbach
(400m in crystalline): drilled in 2019

S2 Tisová
(490 m in phyllites): drilled in 2017 – donated by ore-prospection company

S3 Studenec
(400 m in phyllites): finished (October 2018)
site of STC station

S4 Mýtina
(300-400m in maar): preparation, drilling planned for 2020

Hartoušov (basin, CO₂)
F1 (30m), F2 (108m): finished (inkind contrib.)
F3 (300-400m): preparation – drilled in 2019
Planned / existing drillings and 3D-3C arrays

**S1 Landwüst**
- 3D-3C array
- fibre-optic cable

**S2 Tisová-Kraslice**
- borehole array / sensor

**S3 Studenec**
- borehole array / sensor

**S4 tbdf**
- borehole sensor

**F1-3 Hartoušov**
- fluid monitoring
- borehole sensor
S1 drill site Landwüst - Germany

Drilling to 400 m May – August 2019

≈17 m

≈2.5°

Fibre optic cable behind casing
S1 core scanning at BGR Spandau

Cores / samples available after formal applications

unexpected fault zone
Seismological monitoring wells in Czechia

**S2 (Tisova/Kraslice) Nov 2017**
- 450 m
- 6.4°

**S3 (Studenec) December 2018**
- 408 m
- 9°
Fluid monitoring & seismology boreholes in the Hartoušov CO$_2$ mofette

**F2:** 2016 & August 2019  $\approx 70$ m

- $\Delta P_f \approx 6$–36 MPa
- toxic - CO$_2$
- natural reserve
- geo-bio studies

**F3** Aug–Sep 2019  $\approx 239$ m
Hartoušov continuous multi-well fluid/gas monitoring

- gas multiplexer to sample 3 wells (F1-F3)
- suite of new sensors
- chemistry & isotopes
EGER: Seismological monitoring using shallow boreholes and 3D arrays

(b) S1-S3: Seismological monitoring

- Surface array: 15 x 15Hz SP
- 200m - 400m chain of 12 x 3C 15Hz SP
- Bottom hole 3C 2Hz SP

A shallow drilling only, but a big step in resolution
Seismic 3D-3C array: expected rate of digital data

Normal operation: 75 channels @ 400 Hz → 75 x 400 x 86400 x 2.5 = **6.5 Gbyte / day**

During swarms: 75 channels @ 1000 Hz → **16.2 Gbyte / day**

Virtual network “ICDPEGER”:

- 3D-3C array data (e.g. Landwüst)
- BB sensors (bottom and top of well)
- Environmental data (P₀, T, …)
- Fluid-parameter (at F-wells):
  - P at different depth levels / rate
  - comp. (CO₂, He, CH₄, Ar, N₂, H₂, …)
  - isotopes (e.g. ¹³C, ¹⁸O, CO₂)
- Stations from permanent networks?
- Fibre optic cable (DAS) at S1?
Eger: Geophysical Data Availability

Process of defining MoU on (continuous) data availability and distribution is starting now

✔ All ICDP data be associated to virtual network (ICDPEGER) on IDA node standard
  - seismic ++
  - fluid parameter ($\Delta P$, $q$, $CO_2$, He, $CH_4$, Ar, $N_2$, H$_2$, ...)
  - environmental
✔ Continuous data from permanent network be associated to virtual network
✔ Most (all) continuous data be available though GEOFON
✔ Data (parts of data) may be restricted for limited time period (embargo)

→ if some groups have need to receive parts of data in real time, now right time!
Geomicrobiological Analysis

- Daniel Lipus and Jens Kallmeyer (GFZ Potsdam)
- 30 core samples processed for DNA extraction
  - DNA extracted from 25 samples (biological duplicates need to be completed)
  - DNA could not yet be extracted from 5 samples
  - DNA recovery: 0.01 – 0.7 ng/μl
- Microbial abundance data for 20 samples
  - Range: $10^3 – 10^7$ 16S rRNA gene copies per gram
  - Matches 2016 data in upper core segment
- 16S rRNA amplicon libraries for 15 samples
  - Allows taxonomic classification
  - Expected to be completed by April for all samples
- Metagenome libraries for 2 samples (Goal: 5 by April)
  - Needed for functional annotation
EGER: Quaternary volcanism more active than thought

Komorni Hurka (Kammerbühl)
Zelezna Hurka (Eisenbühl)

One of these maars is the target of the S4 borehole

Aims:
- paleoclimatic record
- sampling volcanic breccia
- sampling the interface between the bedded breccia and country rock
- installing downhole seismometer

Liba Maar

Mytina Maar, Neualbenreuth Maar
Summary

• Western Eger Rift: persistent occurrence of earthquake swarms and CO$_2$ discharge, quaternary volcanism
  => unique natural laboratory for studying the interactions between deep CO$_2$, tectonics and deep microbial life

• Surface observations approached their edge
  => observatory in depth

• Network of five ~400 m boreholes with seismographs and fluid sensors to increase the sensitivity and suppress the atmospheric influence

• Three seismic boreholes S1-S3 and fluid borehole F3, drilling of the paleoclimatic+volcanologic+seismic borehole S4 planned for 2020