

# Towards a European Fault Database

## TOWARDS A EUROPEAN FAULT DATABASE

Johan ten Veen, Serge van Gessel, Harry Middelburg, Maryke den Dulk

TNO – Geological Survey of the Netherlands

## HISTORY

TNO pilot database (started in 2010)

Cross-border harmonisation

The widely available fault information (GSO's etc.)

Importance: Resources, hazards and impacts

Credits: ideas presented here benefited from invaluable discussions with experts from European GSO's (LFU, RNSB, LBEG, BGR, ISPRA, BRGM, ...) either in the context of GeoERA or beyond

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## APPLICATION OF FAULTS

- › Occurrence and thickness of resource-bearing layers
- › Formation and destruction of seals and traps
- › Migration of fluids
- › Hazards/impacts (natural/induced)
- › Framework for geomodels

A database should support multiple applications

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## FAULT DATA TYPES

↑ Paper

A database should support different fault types & input formats

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**FAULT DATA SCALES** **TNO** innovation for life

European tectonic regions with major faults (From Reimann et al, 2014)

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**FAULT DATA SCALES** **TNO** innovation for life

Towards regional-scale structural elements with major boundary faults and intra-element faults (regional mapping scale)

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**FAULT DATA SCALES** **TNO** innovation for life

Towards local structural domains, reservoir faults and reservoir segments

A database should contain faults at various scales that link back to regional scale tectonic features

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**FAULT DATA PARAMETERS** **TNO** innovation for life

- › Geometric properties (from 2D / 3D fault geometries)
- › Modelled properties (lateral variation along fault plane)
- › Relation between layer and fault model (juxtaposition, gaps)
- › Fault offset (amount, timing, stratigraphy involved)
- › Static properties, permeability, temperature, fluids, Geological/mechanical states, stress, pressures, etc.
- › Dynamic (seismicity, fluid flow, etc.)
- › Production/engineering data

Parameters are spatially variable and scale dependent

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**GEO-ERA** **TNO** innovation for life

**GeoERA**  
GEO-ENERGY

7 projects

HIKE – hazard and impacts knowledge Europe

The GeoERA programme is put forward by 45 national and regional Geological Survey Organisations (GSO) in Europe. Its overall goal is to integrate the GSO's information and knowledge on subsurface energy, water and raw material resources, to support sustainable use of the subsurface in addressing Europe's grand challenges.

**GEOERA-HIKE OBJECTIVES** **TNO** innovation for life

- › Compilation 2D and 3D faults and -parameters in a spatial database
- › Define requirements of FDB architecture
- › Development of integration and parameterization methods
- › Coordination with EGDI (implementation, hosting, access of DB)
- › Demonstrate applicability through research on hazards & resources

2D Fault maps      3D Fault included surface      3D faults with offset parameters

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GeoERA - GEO-ENERGY Preliminary Draft 11

**WP.2 Fault Dbase - WP tasks, deliverables, dependencies**

2018	2019	2020	2021
D1a: Fault Characterization & Use Case Catalogue	D2: Fault data Country reports	T3: Fault Analytics	D3: Fault analytics report
T1: Desk study FDB Specifications	T2: Collecting and processing GSO Fault data, upload, QC and testing	T4 (a, b, ...): Case Studies	D4: Bundled case study reports
D1b: FDB Specifications		T5: Link Client Applications	D5: Application/User Manual
IP Interface	GE2 Hotline GE4 3D GEO-NEU GE6 GeoConnect3D	IP Interface	IP Interface
IP Project: Development of FDB architecture Development of GSO harvesting functionality			
FDB in EGDI: Deployment Dissemination			

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 731166

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**WP.2 Fault Dbase - WP tasks, deliverables, dependencies**

2018      2019      2020      2021

T1: Desk study FDB Specifications

T2: Collecting and processing GSO Fault data, upload, QC and testing

T3: Fault Analytics

T4 (a, b, ...): Case Studies

T5: Link Client Applications

D1a: Fault Characterization & Use Case Catalogue

D2: Fault data Country reports

D3: Fault analytics report

D4: Bundled case study reports

D5: Application/User Manual

IP Interface

IP Project: Development of FDB architecture  
Development of GSO harvesting functionality

FDB in EGDI: Deployment Dissemination

Maintain beyond GeoERA lifecycle

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## DATABASE DESIGN

**TNO** innovation for life

A Dutch pilot fault database since ~2010:

- Oracle spatial database
- Upload procedure fault sticks
- Query tool

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- Upload procedure for fault sticks (time & depth)
- Reads (Kingdom Charisma) Faults Sticks
- Creates planes from stick (triangulation)
- Relates geometries in distance and time units
- Calculates geometric characteristics
- Average strike / dip orientation
- Average dip angle
- Length
- Vertical depth / Average top- and bottom depth
- Strike / dip Variation

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## DATABASE EXAMPLE

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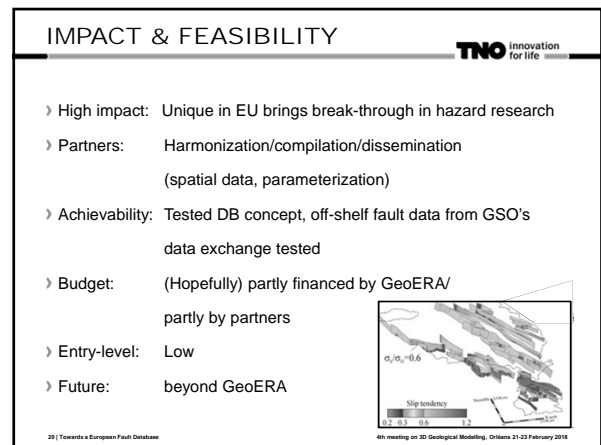
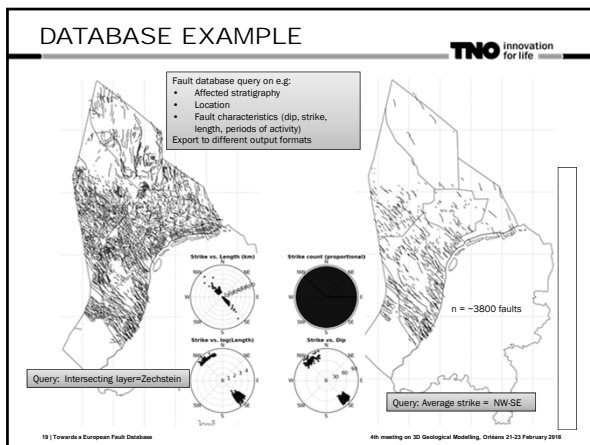
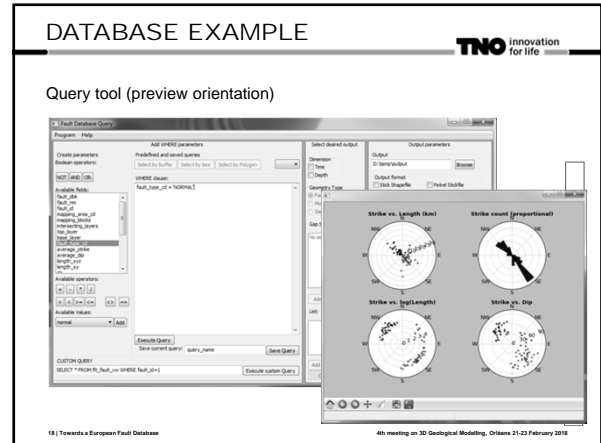
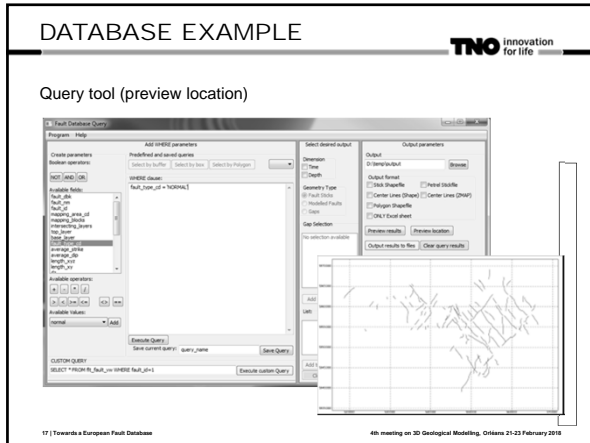
Query tool (preview tabular results)

Fault ID	Fault Name	Fault ID	Mapping	Intersecting Top	Intersecting Bottom
1	NORP_F1000_1	NORP	PS1-001	AT_AJBSA12L_1	5
2	NORP_F1000_2	NORP	PS1-001	AT_AJBSA12L_1	5
3	NORP_F1000_3	NORP	PS1-001	AT_AJBSA12L_1	5
4	NORP_F1000_4	NORP	PS1-001	AT_AJBSA12L_1	5
5	NORP_F1000_5	NORP	PS1-001	AT_AJBSA12L_1	5
6	NORP_F1000_6	NORP	PS1-001	AT_AJBSA12L_1	5
7	NORP_F1000_7	NORP	PS1-001	AT_AJBSA12L_1	5
8	NORP_F1000_8	NORP	PS1-001	AT_AJBSA12L_1	5
9	NORP_F1000_9	NORP	PS1-001	AT_AJBSA12L_1	5
10	NORP_F1000_10	NORP	PS1-001	AT_AJBSA12L_1	5

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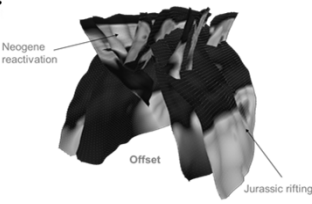
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### CHALLENGES

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- › I/O between partners (formats) needs further testing
- › Understanding each other's modeling workflows
- › Collate paper, 2D and 3D modeling results
- › Metadata - developing common vocabulary
- › How to add metadata to faults
- › How to parametrize faults
- › Fit for purposes
- › Scalability
- › Queries
- › ..
- › .



Neogene reactivation

Offset

Jurassic rifting

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THANK YOU FOR YOUR ATTENTION

..and please feel free to think along

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