Data Management and Visualisation of 3D-Objects in the Geothermal Information System GeotIS

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Funding & Partners

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Web Site:

http://www.geotis.de

Current Partners:

IIAG
Leibniz Institute for Applied Geophysics

KIT
Karlsruher Institut für Technologie

Mecklenburg Vorpommern
Landesamt für Umwelt, Naturschutz und Geologie
GeotIS – Web-Based Geothermal Information System

- Location of geothermal facilities
- Operating parameters
- Geothermal energy statistics
- Areas of hydrothermal resources
- Well data
- Location of seismic surveys
- Stratigraphic models (3D)
- Subsurface temperature (3D)
- Hydraulic properties of formations
- Major fault network + fault literature

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GeotIS Web Interface

Geothermal Information System for Germany

Waldkraiburg
State: Operating
Primary use: District heating
Secondary use: not specified
Temperature: 199 °C
Flow rate: 80 l/s
Depth: 2718 m
Total capacity: 16.4 MW\textsubscript{e}
Geoth. capacity: 15 MW\textsubscript{e}
Direct heat production: 19.73 GWh/a
Electr. capacity: 0 MW\textsubscript{e}
Electricity production: 0 GWh/a
GeotIS Energy Statistics

Installed capacity [MW\(_e\)], Annual production [GWh/a]
Grid Data

Undergroundmodel
defined area
stratigraphic units

Stratigraphic Unit
grids
color schemes

RasterGridUnit
GRID2D Base & Top
(Z, T)

SGridUnit
SGRID
(various parameters)

GridCoverage
data tiles (2D, 3D)
faults

SGridCoverage
data tiles (3D)

3D Temperature
Viualisation of Faults in GeotIS
Visualisation of Faults and Interactive Cross Sections
Visualisation of Faults in GeotIS
2¹⁄₂D Raster (GRID2D)

**TIN:**
Triangular Irregular Network
Node spacing: 50 - 5000 m (variable)

**GRID2D:**
regular, orthogonal
Node spacing: 100 m (fixed)
Import as CPS3 file

\[ z = f(x, y) \]
Advantages:

• Very fast grid operations
• Cross sections and top views are simple to create
• Simple generalization (scale adaption)
• Little memory usage
• Export option in Gocad/Skua

Disadvantages:

• Fault geometry not part of grid
• Geometrical restrictions: no thrust faults or overturned formations
• Realization of normal faults are very laborious
Stratigraphic Grids (SGRID)

- **Hexahedron** network / volume grid (cells)
- Each node has its coordinate triplet (uvw ⇔ xyz)
- Properties are node or cell centred
- Cells follow horizons, fault planes or lines
- Faults are realised by splitting with up to 7 split nodes for one regular node
- Neighbour cells, dead cells, borders and faults are stored as binary flags
- Import as native Gocad/Skua file
- Easy transformation to tetrahedrons
Cross Sections Based on GRID2D & SGRID
Visualisation of Parameters on Cross Sections
Top View Comparison GRID2D & SGRID
SGRID Files (Gocad/Skua)

Java Programme geotisCore

- reading SGrids
  - Filename.sg ✓
  - FilenameObjectname__ascii@@ ✓
  - FilenameObjectname__flags@@ ✓
  - FilenameObjectname__region_flags@@ X

- Validating Hexahedrons,
  - killing flat cells ✓

- Generating cross section ✓
- Generating top view ✓
Characterization of Fault Systems

Attributes of fault lineaments:

- Code number
- Category, horizon
- Name of fault zone
- Reference
- Length, strike
- Map sheet (GÜK200)
Characterization of Fault Systems

Literature Review:

- Approx. 1000 references in the records
- Linking lineaments with map sheets
Fault Geometric Setting

(A) Major Normal Fault Segment
(B) Fault Bend
(C) Horsetail Fault Termination
(D) Breached Step-Over or Relay Ramp

(E) Fault Intersection
(F) Accommodation Zone Between Fault Dip Domains
(G) Displacement Transfer Zone Along a Strike-Slip Fault Zone
(H) Transtensional Pull-Apart

Faulds & Hinz (2015)
Geothermal Classification of Deep Faults in Germany

Fault categories according to hydraulic conductivity

- **proven**
  - hot springs
  - drilling fluid loss, kick
  - hydraulic test
  - tracer experiment
  - favorable lithology (e.g. Carbonate)

- **increased likelihood**
  - recorded seismicity, high stress field
  - favorable fault geometry, optimal orientation to current stress field

- **unknown**
  - adverse fault geometry, unfavorable orientation in current stress field
  - adverse lithology

- **decreased likelihood**
  - no seismicity
  - inaccessible (e.g. very deep faults underneath salt domes)

- **useless**
  - geringe Durchlässigkeit nachgewiesen
Summary

- Web-GIS with complex client-server architecture
- Data storage in files and in a relational database (> 100 tables)
- Clear separation between working data and presentation data
- Sophisticated workflows for updating database
  - wells
  - geothermal output statistics
  - geologic models
  - temperature model
  - fault literature
- GeotIS improved data import interface
- New algorithms for SGRIDs visualization

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