Hungarian Geothermal System (OGRe)

Users' Manual

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Content

1. OGRe in brief

The Hungarian Geothermal System (OGRe) aims to provide up-to-date and reliable geological, hydrogeological and geophysical data and information about Hungary's geothermal energy resources via a user-friendly and publicly accessible site via

https://map.mbfsz.gov.hu/ogre_en

We hope that this platform will help the preparatory work of national and international consortia aiming to invest into new geothermal projects in Hungary, as well as the every-day work of policy makers. Furthermore it aims to assist higher level education and also provide useful information to the public interested in geothermal energy.

The web-map system is comprised of a set of *maps* edited for the territory of the entire country (e.g. geological horizons bounding the most important geothermal aquifers, isotherm maps characterizing the subsurface temperature conditions, maps showing the 3D spatial distribution of the most important geothermal reservoirs, etc.); *point features* (e.g. thermal water wells, boreholes, locations of geothermal projects, etc.) and *polygons* (e.g. thermal groundwater bodies, concessional areas, etc.). These are arranged into various thematic groups, which can be visualized up to request and can be combined with each other.

Maps presented on the portal are based on regional geoscientific models, therefore they provide a large-scale overview about the geothermal conditions of a certain territory; however they **do not replace** detailed exploration and pre-feasibility study necessary for a concrete project **at local scale**.

With a detailed map series of geophysical coverage, as well as maps showing the location of boreholes deeper than 500 m, and hydrocarbon exploration wells, OGRe provides a unique opportunity to search for data for a certain territory for a detailed prospection. For further information and data, please visit the State Geological, Geophysical and Mining Data Store and the Hydrogeological Data Store.

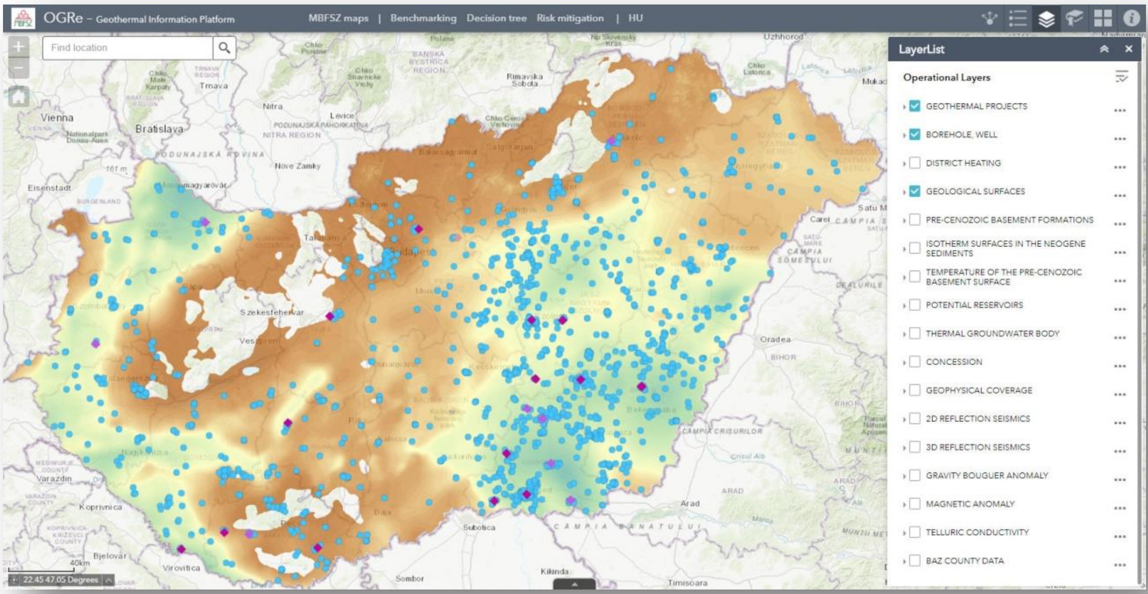
The different thematic groups and their specific layers generally show metadata. An exception is the group of *thermal water wells*, where the system provides detailed data of 1695 wells (e.g. depth of screened intervals, aquifer lithology, groundwater level, yield, temperature, hydrogeochemical character, utilization type, etc.). The other exception is the pilot area of the Borsod-Abaúj-Zemplén county, where the simplified lithostratigraphy of the boreholes and the images of the various geophysical measurements (e.g. 2D seismic lines, well-logs) are also available.

In addition OGRe also comprises 3 thematic modules (benchmarking, decision tree, risk mitigation) based on the results of the DARLINGe project, and which provides assistance during the different stages of geothermal project development.

We appreciate any remark related to the content of the portal to be sent to:
info@mbfsz.gov.hu!

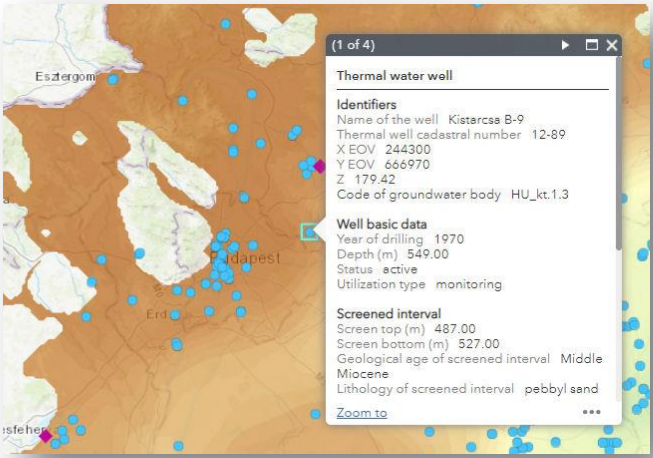
2. General overview of the web-map system

The interactive map is found in the main window of the application, which layers can be browsed in the drop-down menus of the upper right icons. Data of the different maps can be visualized in a table format as well: the table can be evoked or hidden with an arrow found at the bottom of the map. Navigation is assisted by several functions: zoom in and out and the search by location (settlement) are found at the upper left corner. Scale bar and coordinates are found at the bottom left corner, while an overview map is put at the bottom right corner. In the header, there is a link to the MBFSZ web-map services, to the 3 thematic modules and to the Hungarian version of the application.



2.1. Map

By clicking on a point, line, or surface of the map, the relevant information pops up in a window. In case the clicking at a given point is related to more information, one can scroll among them by clicking on the little arrow in the upper right part of the header of the pop-up window.

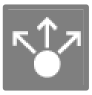


One can also zoom to a selected object. If you click on the...at the bottom right corner of the pop-up window, several further functions become available:

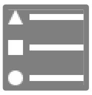
- Moving: moves the selected object into the centre of the map.
- Add marker: adds a marker, to which one can zoom later, or can be deleted.
- View in attribute table: data of the pop-up window are visualized in an attribute table (see more in chapter 2.3.)

2.2. Right side menu

In the right part of the upper header the following functions can be activated by clicking on them:



Share: The map can be shared in an email, or social media, or can be incorporated into a website.



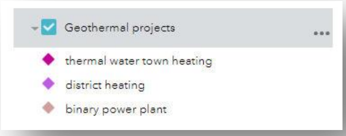
Legend: The legend is dynamic, always shows only the elements related to the actually visualized layers of the map.

Layer list: The layers of the different maps were arranged into thematic groups, they are available by clicking on the little arrow in front of the name of the layer group. Those layers will appear on the map, whose little box is ticked in.

By clicking on the 3 dots after the layer's name, further functions become available. In case of layer groups one can get the detailed list of layers within the group, change the layer's transparency, can move further up or down the group in the layers' list, and hence on the map itself, and we can also get the a description of the given layer in a pop-up window.

The different layers lap on each other according to their order given in the right side menu, therefore they cover each other. This can be eliminated if the point-related layers (e.g. boreholes) are positioned at the top in the default extent. Although the transparency of the full layers can be modified, if too many layers are switched on simultaneously, the clearness of the map becomes limited.

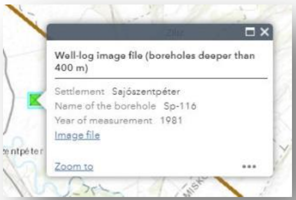
Data of the layers are also available in a table format (see also chapter 2.3.) and description of a layer can be also available in a pop-up window.



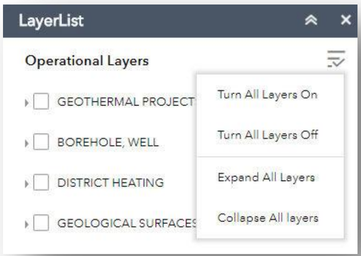
Legend of a given layer can be seen (or hidden) by clicking on the little arrow in front of the layer's name.

In the layer's group of the Borsod–Abaúj–Zemplén county pilot area (*BAZ county data)* data of the different layers can be downloaded as well.

In layers *Borehole deeper than 500 m with lithological sequence* and *Borehole deeper than 500 m penetrating the pre-Cenozoic basement*, the list of boreholes can be downloaded with their basic stratigraphical data. In the layer *SEGY available (actual SEGY section line)* the preview of the SEGY can be downloaded. In the layer *2D seismic sections from publications* the published sections (figure) can be downloaded with the reference to the publication. In the layer *Well-log image file (boreholes deeper than 400 m)* the image of the log itself, while in the layer *Magnetotelluric section (MT)* the image of the processed section can be downloaded.

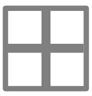


To access data, click on the relevant element of the map, than on the link shown in the pop-up window.



By clicking on the icon next to the layers, the appearance of the layers group can be adjusted. By switching on „Turn All Layers On" one can visualize, or switch off all layer groups. By expanding all layers, the individual layers within a layer group can be opened or hidden.

Bookmark: One can create an own bookmark, to spot the actual map in order to have an easy access in the future.

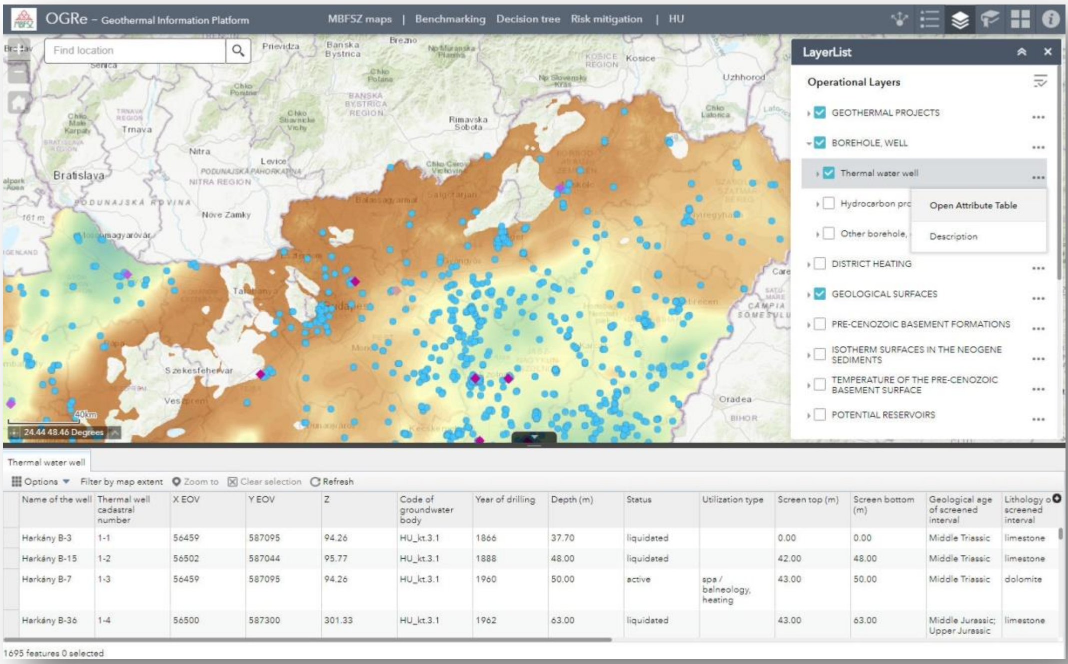


Basemap gallery: One can choose between the satellite or topographic basemap.

Info about the application: Access to the Users' Manual.

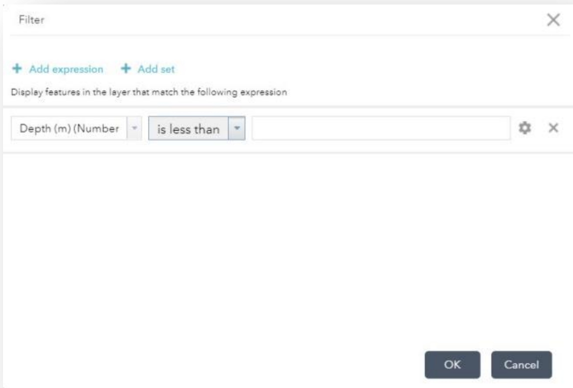
2.3. Attribute table

A table listing the elements / data of a given map (attribute table) can be visualized /hidden with an arrow found at the bottom of the map. If one would like to look at the data of a certain layer in a table, click on the 3 dots after the layer's name in the layer's list and choose: *open attribute table*.



Data belonging to different layers appear on separate sheets, which can be turned off.

In the drop-down menu of *Options* one can visualize the marked records, using the *Filter* function, and adjust the visibility of the table's columns. The *Filter* function always operates within the actual sheet. Data can be filtered according to simple, or multiple criteria.



Elements can be filtered for a selected part of a map. If one wants to get the full list of data again, click once more on the button *Filter by map extent*. In the table we can mark one or more elements, and can zoom on the selected elements.

2.4. Header, thematic modules

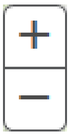
MBFSZ maps: Link to the web-map services of the Mining and Geological Survey of Hungary.

Links to the thematic modules: Benchmarking, Decision tree, Risk mitigation.

HU: Link to the Hungarian version of OGRe.

2.5. Navigation

One can modify the enlargement of the map and the position with the icons found at the upper left corner.



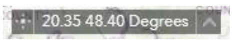
Zoom-in (+) and Zoom-out (–).

Default extent. Enlarges the map to the initial scale.

Search. One can search based on a settlement name or address, and than can zoom to it.

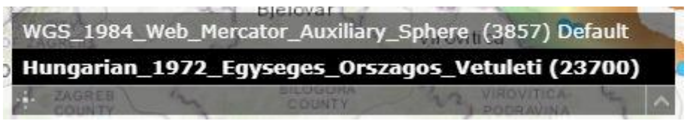
Scale bar and coordinates are found at the bottom left corner.

Scale bar.



Coordinates. Shows the actual coordinates of the point, where the cursor is on the map in a Web Mercator projection system. Coordinates automatically change by moving the cursor.

It is also possible to select a point on the map and define its coordinates in a Web Mercator or EOV projection. For this first click on the right side arrow and select the requested projection system,



than click on the left side cross-hairs, finally click on the requested point on the map.

The overview map is found at the bottom right corner.

Overview map. The overview map pops up by clicking on the arrow. This map shows the position of the actual map extent. By moving the map extent on the overview map, one can modify the map extent itself. The overview map can be closed with a little arrow found at its bottom right corner.

3. Content of the layers

3.1. GEOTHERMAL UTILIZATION

The map shows the location and main data of geothermal district heating, thermal water town-heating and geothermal power production projects.

3.1.1. Geothermal projects

The map shows the location and main data of geothermal district heating, thermal water town-heating and geothermal power production projects.

3.1.2. Thermal water utilization

The map shows the main types of thermal water utilization (balneology / spa, district heating, thermal water town heating, agriculture heating, agriculture, industry, public use/drinking water, monitoring, reinjection).

3.2. BOREHOLE, WELL

Shows the thermal water wells (outflow temperature is higher than 30°C) and their detailed data, as well as the basic data of the hydrocarbon prospecting wells and boreholes deeper than 500 m.

3.2.1. Thermal water well

Shows the thermal water wells (outflow temperature is higher than 30°C) and their detailed data in Hungary.

3.2.2. Status of thermal water wells

Shows the actual status of wells (active, inactive, liquidated).

3.2.3. Geothermal gradient of thermal water wells

It is calculated form the bottom-hole temperature measurement (if available) from the wells. High values indicate active convections and promising geothermal potentials.

3.2.4. Hydrocarbon prospecting wells

Shows the basic data of hydrocarbon prospecting wells in Hungary.

3.2.5. Other boreholes deeper than 500m

Shows the basic data of boreholes deeper than 500m in Hungary.

3.3. DISTRICT HEATING

The map shows the cities with district heating infrastructures with information on district heating suppliers and producers, and highlights those locations, where district heating is already (partly or totally) geothermal-based.

3.3.1. Geothermal district heating

The map shows locations, where district heating is already (partly or totally) geothermal-based.

3.3.2. District heating

The map shows the cities with district heating infrastructures with information on district heating suppliers and producers.

3.4. GEOLOGICAL HORIZONS

The maps show the bounding horizons of the most important geothermal aquifers, as well as the top of the pre-Cenozoic basement expressed in m below the surface.

Mapscale: 1: 500,000.

3.4.1. Base of Quaternary

The map shows the base of the Quaternary sedimentary successions expressed in m below the surface.

3.4.2. Base of Upper Pannonian

The map shows the base of the Upper Pannonian sedimentary successions expressed in m below the surface.

3.4.3. Base of Panamanian

The map shows the base of the Pannonian sedimentary successions expressed in m below the surface.

3.4.4. Top of the pre-Cenozoic basement

The map shows the top of the pre-Cenozoic basement expressed in m below the surface.

3.5. Pre-Cenozoic geological map

The map shows the geological formations of the pre-Cenozoic basement at a 1:500,000 scale.

References:

HAAS JÁNOS, BUDAI TAMÁS, CSONTOS LÁSZLÓ, FODOR LÁSZLÓ, KONRÁD GYULA 2010: Magyarország pre-kainozoos földtani térképe 1: 500 000 (Pre-Cenozoic geological map of Hungary, 1:500,000). A Magyar Állami Földtani Intézet kiadványa. 2010

HAAS JÁNOS, BUDAI TAMÁS (SZERK.); HAAS JÁNOS, BUDAI TAMÁS, CSONTOS LÁSZLÓ, FODOR LÁSZLÓ, KONRÁD GYULA, KOROKNAI BALÁZS (2014): Magyarország prekainozoos medencealjzatának földtana. Magyarázó „Magyarország pre–kainozoos földtani térképéhez" (1: 500 000). Budapest, 71 p.

3.6. ISOTHERM MAPS IN THE PANNONIAN SEDIMENTARY SUCCESSION (BASED ON A CONDUCTIVE MODEL)

The maps show the depth of the various isotherms in the porous basin fill sedimentary succession of the Pannonian Basin, expressed in m below the surface. The calculated temperatures derive from a simplified conductive model (ZILAHI-SEBESS L. 2012). In case of significant groundwater flow (convection), the actual measured temperatures may considerably differ from the modelled values. The white patches on the map show areas, where Pannonian sediments are not known, therefore the conductive model is not applicable.

Mapscale: 1: 500,000.

Reference:

ZILAHI-SEBESS LÁSZLÓ, MERÉNYI LÁSZLÓ, GULYÁS ÁGNES, PASZERA GYÖRGY, TÓTH GYÖRGY, BODA ERIKA, BUDAI TAMÁS 2012: R5. A hazai energiahordozó vagyon hasznosítása: Készletgazdálkodási és hasznosítási cselekvési terv. Magyarország geotermikus potenciálja. Zárójelentés. 2012. MBFH–MFGI

3.6.1. Depth of the 30°C isotherm

The map shows the depth of the 30°C isotherm in the Pannonian porous basin fill sedimentary succession expressed in m below the surface. The calculated temperatures derive from a simplified conductive model.

3.6.2. Depth of the 50°C isotherm

The map shows the depth of the 50°C isotherm in the Pannonian porous basin fill sedimentary successions expressed in m below the surface. The calculated temperatures derive from a simplified conductive model.

3.6.3. Depth of the 75°C isotherm

The map shows the depth of the 75°C isotherm in the Pannonian porous basin fill sedimentary successions expressed in m below the surface. The calculated temperatures derive from a simplified conductive model.

3.6.4. Depth of the 100°C isotherm

The map shows the depth of the 100°C isotherm in the Pannonian porous basin fill sedimentary successions expressed in m below the surface. The calculated temperatures derive from a simplified conductive model.

3.6.5. Depth of the 125°C isotherm

The map shows the depth of the 125°C isotherm in the Pannonian porous basin fill sedimentary successions expressed in m below the surface. The calculated temperatures derive from a simplified conductive model.

3.7. TEMPERATURE OF THE PRE-CENOZOIC BASEMENT (BASED ON A CONDUCTIVE MODEL)

The map shows the temperature of the pre-Cenozoic basement expressed in °C. The calculated temperatures derive from a simplified conductive model. In case of significant groundwater flow (convection), the actual measured temperatures may considerably differ from the modelled values. These anomalies can be substantial in strongly karstified formations and along fault zones.

Mapscale: 1: 500,000.

3.8. POTENTIAL RESERVOIRS

As a result of the geology of Hungary, the potential geothermal reservoirs can be grouped into two large lithological types: (1) porous basin fill sediments (mainly composed of Quaternary and Upper Pannonian sands), and (2) karstic and fractured carbonates, magmatic and metamorphic rocks of the pre-Cenozoic basement. Mapscale: 1:500,000

3.8.1. Porous reservoirs

The spatial distribution, as well as the top- and bottom bounding surfaces of the porous reservoirs were edited by combing the relevant geological horizons and isotherm maps based on a conductive model. The delineated reservoirs are 3D bodies.

Mapscale: 1:500,000

Quaternary 30-50°C top

The map shows the spatial distribution and depth of the horizon, below which thermal water of 30-50°C is likely to occur within the Quaternary sedimentary succession.

Quaternary 30-50°C bottom

The map shows the bottom of the Quaternary sedimentary succession, wherein thermal water of 30-50°C is likely to occur.

Upper Pannonian 30-50°C top

The map shows the spatial distribution and depth of the horizon, below which thermal water of 30-50°C is likely to occur within the Upper Pannonian sedimentary succession.

Upper Pannonian 30-50°C bottom

The map shows the bottom of the Upper Pannonian sedimentary succession, wherein thermal water of 30-50°C is likely to occur.

Upper Pannonian 50-75°C top

The map shows the spatial distribution and depth of the horizon, below which thermal water of 50-75°C is likely to occur within the Upper Pannonian sedimentary succession.

Upper Pannonian 50-75°C bottom

The map shows the bottom of the Upper Pannonian sedimentary succession, wherein thermal water of 50-75°C is likely to occur.

Upper Pannonian 75-100°C top

The map shows the spatial distribution and depth of the horizon, below which thermal water of 75-100°C is likely to occur within the Upper Pannonian sedimentary succession.

Upper Pannonian 75-100°C bottom

The map shows the bottom of the Upper Pannonian sedimentary succession, wherein thermal water of 75-100°C is likely to occur.

Upper Pannonian 100-125°C top

The map shows the spatial distribution and depth of the horizon, below which thermal water of 100-125°C is likely to occur within the Upper Pannonian sedimentary succession.

Upper Pannonian 100-125°C bottom

The map shows the bottom of the Upper Pannonian sedimentary succession, wherein thermal water of 100-125°C is likely to occur.

Upper Pannonian 125°C < top

The map shows the spatial distribution and depth of the horizon, below which thermal water above 125°C is likely to occur within the Upper Pannonian sedimentary succession.

Upper Pannonian 125°C < bottom

The map shows the bottom of the Upper Pannonian sedimentary succession, wherein thermal water above 125°C is likely to occur.

3.8.2. Karstified, fractured reservoirs below 2500 m

The map of the karstic-fractured reservoirs shows the areal distribution of the carbonate, magmatic and metamorphic rocks of the pre-Cenozoic basement surface below 2500 m after HAAS et al. (2010). However, these rocks form potential geothermal reservoirs with increased permeability only if they karstified, weathered during their geological development, or could fracture along significant fault zones. As the carbonate, magmatic and metamorphic rocks can also occur at bigger depth in the basement overlain by other formations, at least 2500 m deep boreholes intersecting them are also displayed on the map, as well as the modelled 120°C and 150°C isotherms of the basement surface. The map also shows the areas with unknown geology of the pre-Cenozoic basement surface below 2500 m, as potential area for further investigations.

Mapscale: 1: 500,000.

Within the layer group the following layers are displayed:

Drilled pre-Cenozoic limestone-dolomite below 2500m

Drilled pre-Cenozoic limestone-dolomite below 2500m with the location of the borehole and its basic data.

Drilled pre-Cenozoic formations below 2500m

Drilled pre-Cenozoic formations below 2500m with the location of the borehole and its basic data.

Borehole deeper than 2500 m

Borehole deeper than 2500 m with the location of the borehole and its basic data.

The estimated temperature of the pre-Cenozoic basement is 120°C

The estimated temperature of the pre-Cenozoic basement is 120°C based on a conductive model.

The estimated temperature of the pre-Cenozoic basement is 150°C

The estimated temperature of the pre-Cenozoic basement is 150°C based on a conductive model.

Depth of the pre-Cenozoic basement surface is 2500m

Depth of the pre-Cenozoic basement surface is 2500m

Carbonate basement formation below 2500m

Carbonate, or partly carbonate formation of the pre-Cenozoic basement surface below 2500m (HAAS et al. 2010).

Magmatic, metamorphic basement formation below 2500m

Magmatic, metamorphic formation of the pre-Cenozoic basement surface below 2500m (HAAS et al. 2010).

Unknown geology below 2500m

Unknown geology of the pre-Cenozoic basement surface below 2500m (HAAS et al. 2010).

Reference:

HAAS JÁNOS, BUDAI TAMÁS, CSONTOS LÁSZLÓ, FODOR LÁSZLÓ, KONRÁD GYULA 2010: Magyarország pre-kainozoos földtani térképe 1: 500 000 (Pre-Cenozoic geological map of Hungary, 1:500000). A Magyar Állami Földtani Intézet kiadványa. 2010

HAAS JÁNOS, BUDAI TAMÁS (SZERK.); HAAS JÁNOS, BUDAI TAMÁS, CSONTOS LÁSZLÓ, FODOR LÁSZLÓ, KONRÁD GYULA, KOROKNAI BALÁZS (2014): Magyarország prekainozoos medencealjzatának földtana. Magyarázó „Magyarország pre–kainozoos földtani térképéhez" (1: 500 000). Budapest, 71 p.

3.9. THERMAL GROUNDWATER BODY

Groundwater bodies are the basic elements of the River Basin Management Plans (RBMP) to be performed each 6 years according to the Water Framework Directive (2000/60/EC). The delineation of the groundwater bodies was done considering geological settings (basin, karst, mountain), temperature (cold < 30°C, thermal > 30°C), hydrogeological conditions (flow directions). Based on the combination of these criteria, 15 thermal karstic groundwater bodies and 8 porous groundwater bodies were delineated. The quality and quantity status of these groundwater bodies is regularly assessed during the RBMP-s. For further details please visit http://vizeink.hu/

3.9.1. Thermal groundwater body

The map shows the areal distribution of the porous and karstic thermal groundwater bodies.

3.10. CONCESSION

The modification of the XLVIII. Act on Mining (1993) in 2010 designated the entire area of Hungary as a closed area below a depth of 2500 m for the exploration and exploitation of geothermal energy, which can thus happen only in the frame of a concessional procedure. For more details about concession please visit: https://mbfsz.gov.hu/en/concession-procedure.

3.10.1. Mining plots

The map shows the areas for which geothermal concession right was received as Oct. 2020 (concession, exploration, geothermal protection zones).

3.10.2. CVIA areas

The map shows those areas for which a complex vulnerability and impact assessment (CVIA) was done prior to concession according to the Governmental Decree 103/2011 (VI.29.). The full text of these studies can be downloaded by clicking on the relevant area.

3.11. GEOPHYSICAL COVERAGE

The different geophysical measurements done at the surface with various devices provide much denser data about the subsurface compared to deep boreholes. In terms of deep geothermal, the most important are potential field measurements (gravity [results in. Ch. 3.14. GRAVITY BOUGER ANOMALY], magnetic [results in Ch. 3.15. MAGNETIC ANOMALY] and magnetotelluric), 2D and 3D seismics and various well-logs in deep boreholes.

Surface geophysical data provide information about the subsurface geology via different physical parameters of the formations from a much wider 3D space (both horizontally and vertically) than boreholes. Well-logs deliver qualitative data about the geology of the surroundings of the boreholes.

3.11.1. Magnetotellurics (MT)

Due to solar activity electric and magnetic anomaly fields are induced in the Earth’s crust, which depend on the electric conductivity of the rocks. In magnetotelluric measurements both the electric and the magnetic components are recorded.

The specific electric resistivity of compact rocks is big, while that of the looser rocks is lower. The fluid content – depending on its composition – and the temperature can significantly modify the specific electric resistivity. Maps and sections showing the spatial distribution of electric resistivity hold information on structural patterns and fluid content.

This layer shows all the known MT measurement points.

3.11.2. Magnetotellurics (MT, data file available)

This layer shows only those MT points, from where the data files themselves (edi) necessary for further processing are available in the Mining and Geological Survey of Hungary (MBFSZ).

3.11.3. VSP

Seismic data measured from the surface can be converted to depth (to rock formations in certain depth known from boreholes) by seismic logging, checkshots or Vertical Seismic profiling (VSP) measurements.

The VSP provides data for the refinement of the geological model interpreted on the basis of the surface seismics (for the seismic identification of the lithological interfaces crossed by the drilling, for the depth transformation of the seismic profiles).

This layer shows all known VSP measurements.

3.11.4. VSP (digital information available)

This layer shows only those VSP measurements, from which any sort of digital information (even a report in pdf format) is available in the Mining and Geological Survey of Hungary (MBFSZ).

3.11.5. Checkshots

Seismic data measured from the surface can be converted to depth (to rock formations in certain depth known from boreholes) by seismic logging and VSP measurements. In chechshots only the first arrival of the seismic wave is measured, thus resulting a time-depth diagram specific for the given borehole.

3.11.6. Well-logs

Well-logging represent a wide range of different geophysical measurements performed in boreholes. The in-situ geophysical measurements provide information on various physical parameters from a larger rock volume in the borehole and from their surroundings under real pressure and temperature conditions, compared to limited information available from rock samples.

There are several methods, where the nearby surrounding (10 cm – 1–2 m) of the borehole is studied in high resolution (n×cm – n×10 cm) from the following aspects:

- lithology (natural potential, natural gamma, spectral gamma (K, Th, U, etc.) logs
- porosity (gamma-gamma, neutron-methods, sonic (acoustic) logs)
- fluid saturation (water-oil-gas phases and their ratio) (different resistivity logs)
- sidewall imaging of the borehole (electric or acoustic imaging, borehole TV)
- status of the borehole (e.g. borehole diameter, inclination, stratal dip, acoustic cement-column logging, etc.)
- production rate (e.g. yield-depth measurements, flow measurements)

During formation tests, the productivity and pressure of various layers is studied within a section plugged by packers (DST tests: in situ pressure and temperature measurements, fluid sampling).

From a geothermal point of view the continuous and differentiated temperature measurements and fluid flow measurements are extremely important.

This layer shows all known well-logging locations.

3.11.7. Well-logs (data file available)

This layer shows only those boreholes, from where the well-log data files themselves are available in the Mining and Geological Survey of Hungary (MBFSZ).

3.12. 2D REFLECTION SEISMICS

The transit velocity of seismic waves also let us conclude on the subsurface geology, different structures. Transit velocity largely depends on the linkage of rock-forming minerals, as well as fluid content. The transit velocity of seismic waves is larger in consolidated (compact) rocks, compared to loose sediments, or fractured rocks.

2D seismic lines allow the high resolution identification, location and lithological characterization of potential geothermal reservoirs (rock assemblages) in the depth.

3.12.1. Total 2D lines

This layer shows the metadata of all known 2D reflection seismic lines.

3.12.2. Detailed search

This layer allows the detailed search of 2D seismic lines from various aspects. It contains:

SEGY available (Detailed)

Those lines, where seismic **data files (SEGY) are available** in the Mining and Geological Survey of Hungary (MBFSZ) (SEGY file available).

Within the layer, we can further search for SEGY files based on their own section lines and basic metadata (in case of a detailed view of *1:150 000* scale or above).

SEGY available (Overview)

Those lines, where seismic **data files (SEGY) are available** in the Mining and Geological Survey of Hungary (MBFSZ) (SEGY file available).

2D line – Confidential (2020. Jun)

those 2D lines which are confidential (2020 June) according to the provisions of the 1993. XLVII Act on Mining 25. § (3).

2D line – Public (2020. Jun)

those 2D lines which are **public** (2020 June) according to the provisions of the 1993. XLVII Act on Mining 25. § (3).

3.13. 3D REFLECTION SEISMICS

The transit velocities of seismic waves also let us conclude on the subsurface geology, different structures. Transit velocity largely depends on the linkage of rock-forming minerals, as well as fluid content. The transit velocity of seismic waves is larger in consolidated (compact) rocks, compared to loose sediments, or fractured rocks.

3D seismic blocks allow the high resolution identification, location and lithological characterization of potential geothermal reservoirs (rock assemblages) in the depth.

3.13.1. Processed 3D block – public data

This layer shows only the processed 3D blocks, which are public (2020 June) according to the provisions of the 1993. XLVII Act on Mining 25. § (3)

3.13.2. Processed 3D block – confidential

This layer shows only the processed 3D blocks, which are confidential (2020 June) according to the provisions of the 1993. XLVII Act on Mining 25. § (3)

3.13.3. Field 3D block – public data

This layer shows only the field 3D blocks, which are public (2020 June) according to the provisions of the 1993. XLVII Act on Mining 25. § (3)

3.13.4. Field 3D block – confidential

This layer shows only the field 3D blocks, which are confidential (2020 June) according to the provisions of the 1993. XLVII Act on Mining 25. § (3).

3.14. GRAVITY BOUGER ANOMALY

The gravity (Bouguer anomaly) map holds information about the density distribution of the lithosphere / rocks. The rock density is depending on many factors, such as lithological composition, structural position, compactness, etc. The brown-coloured areas of the Bouguer anomaly map are places with higher-density formations closer to the surface, while greenish areas are characterised by thick, low-density near surface formations.

Old metamorphic and magmatic (compact) rocks have high density, while loose young sediments and volcanic clastic rocks have low density. Due to structural movements (faulting, shearing in tectonic zones) rocks become more fractured, which causes an increase in porosity, thus a decrease in density – these anomalies are also displayed on the Bouguer anomaly map. Gravity data are useful to identify structural elements, fault zones, horsts, grabens, large-scale basins, deep-rooted fractures, etc.

The map is based on the data of the Hungarian Gravity Database (>380,000 points measured by ELGI, OKGT, MOL), reflecting the density conditions of the lithosphere, It presents the so-called Bouguer anomaly map at a scale of 1: 500,000. [It is prepared by Potsdam base gravity level, Adriatic altitude, Cassinis (1950) latitude, Faye (Free-air) altitude, Bouguer plate and topographic correction, reduction correction: 2000 kg/m^3].

Reference:

KISS JÁNOS, GULYÁS Ágnes 2005: Magyarország gravitációs Bouguer-anomália térképe / Bouguer Anomaly Map of Hungary. M=1:500 000, Published by ELGI

3.15. MAGNETIC ANOMALY

Some rocks – especially basic and intermedier magmatic rocks, as well as some metamorphic rocks – contain ferromagnetic minerals, which cause magnetic anomalies. The magnetic anomaly map – similarly to the gravity (Bouger-anomaly) map – holds mainly geological-structural information.

The map is based on the data of the Hungarian Magnetic Database (>75 000 points measured by ELGI and OKGT) and it presents the magnetic anomaly map reflecting the magnetization and magnetizability of the crust in a scale of 1: 500,000. [It is prepared by Barta's (1950) ΔZ normal field and with an additional baselevel correction of +20 nT].

Reference:

KISS JÁNOS, GULYÁS ÁGNES 2006: Magyarország mágneses ΔZ anomália térképe. / Magnetic ΔZ Anomaly Map of Hungary. M=1:500 000-es nyomtatott térkép. ELGI kiadvány.

3.16. TELLURIC CONDUCTIVITY

Due to solar activity electric and magnetic anomaly fields are induced in the Earth's crust, which depend on the electric conductivity of the rocks. In telluric measurements only the electric components are measured.

The specific electric resistivity of compact rocks is big, while that of the looser rocks is lower. The fluid content – depending on its composition – and the temperature can significantly modify the specific electric resistivity. Maps and sections showing the spatial distribution of electric resistivity hold information on structural patterns and fluid content.

The map is based on the data of the Hungarian Telluric Database (>16 000 measured by ELGI, OKGT, MTA-GGKI, ME) and it presents the conductivity anomaly map reflecting the electrical conductivity of the upper part of the crust at a scale of 1: 500,000 [for a period of 25 s (f=0,04 Hz)] calculated using apparent conductivity values.

References:

MADARASI ANDRÁS, NEMESI LÁSZLÓ, VARGA GÉZA 2006: Telluric map of East Hungary. Geophysical Transactions, 45/2. 65–98.

NEMESI LÁSZLÓ (ed.) 2000: Telluric map of West Hungary. Geophysical Transactions, 43/3–4. 111–298.

3.17. BORSOD–ABAÚJ–ZEMPLÉN COUNTY

The pilot area of the Borsod-Abaúj-Zemplén county the simplified lithostratigraphy of the boreholes and the images of the various geophysical measurements (e.g. 2D seismic lines, well-logs) are available.

3.17.1. Lithostratigraphy of boreholes deeper than 500m

Location of boreholes deeper than 500m with their basic data and simplified stratigraphy.

3.17.2. Boreholes deeper than 500m penetrating the pre-Cenozoic basement

Location of boreholes deeper than 500m penetrating the pre-Cenozoic basement with their basic data and simplified stratigraphy.

3.17.3. Seismic data (SEGY section line)

Section line of those 2D reflection seismic lines, which processed data file (SEGY file) is available at the Mining and Geological Survey of Hungary (MBFSZ). The visualized section line is the actual SEGY section line. The attached picture of the SEGY file provides a pre-view suitable for a quality check only.

3.17.4. 2D seismic sections from publications

2D seismic lines and attached pictures from publications.

3.17.5. Well-log image file (boreholes deeper than 400m)

Location of well-log and the attached image file (boreholes deeper than 400m).

3.17.6. Magnetotelluric section (MT)

Magnetotelluric section (MT) with processed image linked to the section line.

3.11.7. Borsod-Abaúj-Zemplén county

Contour of Borsod-Abaúj-Zemplén county.

4. Thematic modules

OGRe also comprises 3 thematic modules (benchmarking, decision tree, risk mitigation) based on the results of the DARLINGe project, and which provides assistance during the different stages of geothermal project development.

4.1. Benchmarking

This tool comprises 12 independent indicators to evaluate strengths and weaknesses of current thermal water management and utilization practice, regarding management (licensing and monitoring), technology and energy (operational and efficiency issues), environment (reinjection and over-exploitation), as well as social aspects.

There is a calculation formula for each indicator and the results are grouped into one of five categories, pointing out how much efforts have to be taken to improve the current exploitation practice.

4.2. Decision tree

This tool aims to educate the readers what kind of various decision gates might occur during the development of a geothermal project. The tool consists of series of questions grouped into fields of (1) geothermal resources, (2) market, (3) licencing, and (4) funding. The answer of questions is a simple yes or no, and starts from the beginning of an ideal project and guides throughout all major project development phases, with decisions at major milestones.

4.3. Risk mitigation

This tool aims to define those geological risk mitigation measures, by which highly probable damages can be avoided in a given project. First the tool is collecting information about the project along 4 subsequent questionnaires (general information, available data, reservoir properties, fluid properties). Than the given project phase should be selected, and the tool will list the suggested the relevant risk mitigation measures.

5. Reference

OGRe – Geothermals Information System. MBFSZ 2020. https://map.mbfsz.gov.hu/ogre/