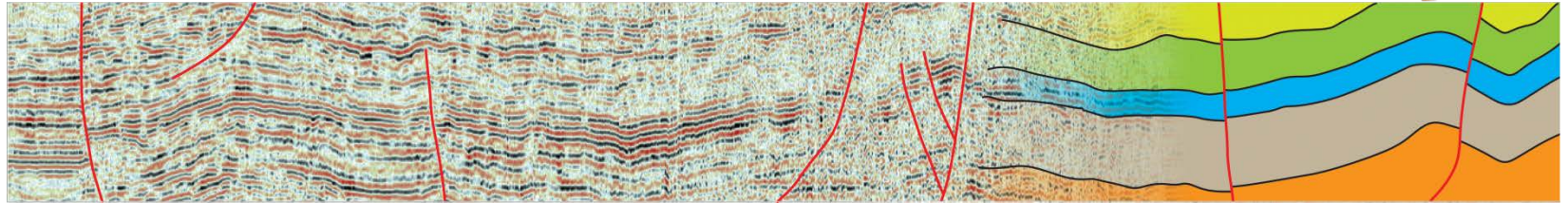




Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra



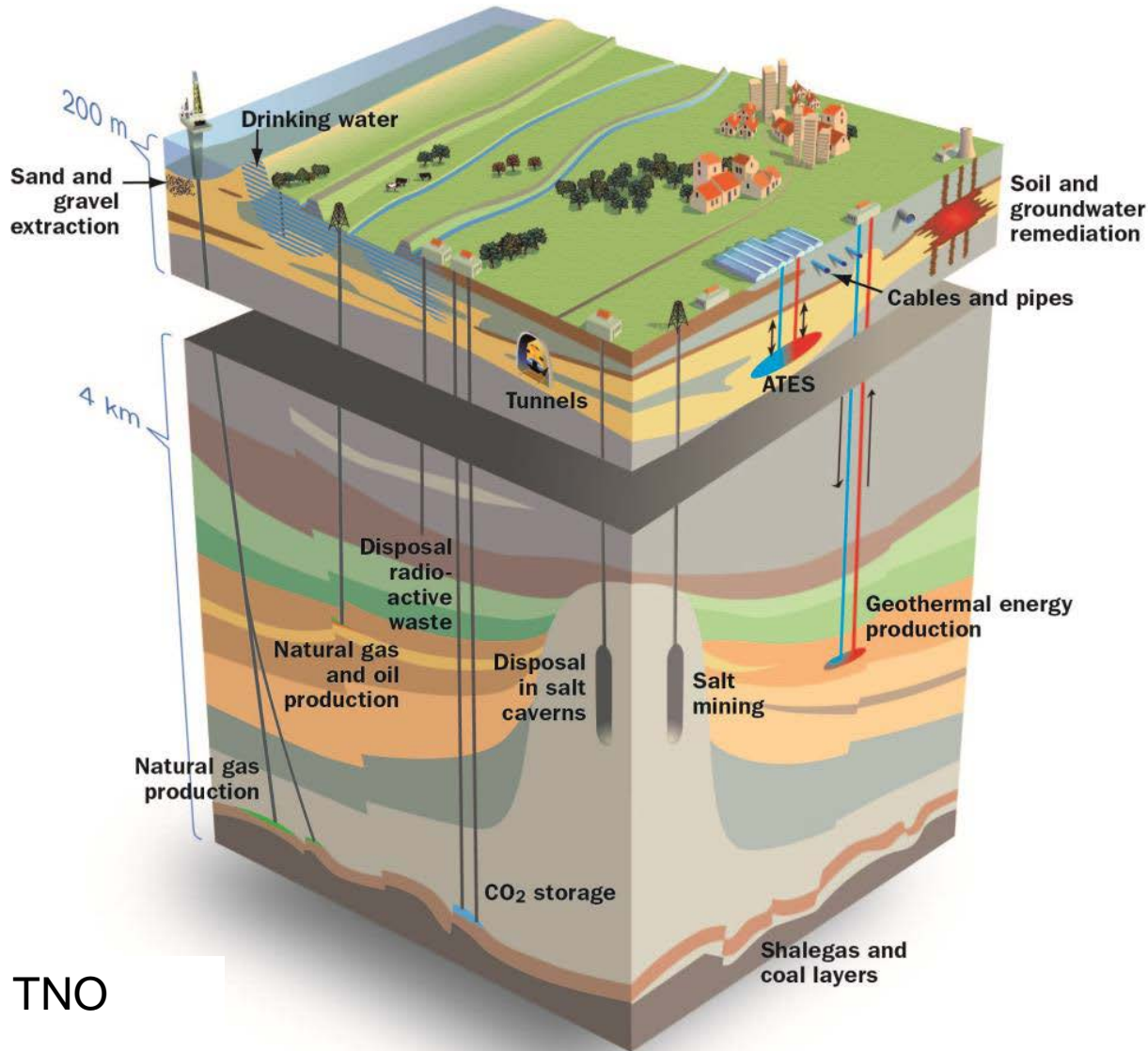
Exploration and Visualization of the Swiss Underground

Project CH-GeoMol as a Case Study

Olivier Lateltin – Swiss Geological Survey – Neuchâtel 10.09.2015



Exploration of the Underground



Source TNO



Main Contributors of Subsurface Data

SEAG

Aktiengesellschaft für schweizerisches Erdöl

- founded 1956 with the goal of acquiring own expl. leases
- by 1994 only SEAG remained as a HC E&P player
- SEAG collected & saved subsurface data acquired in extensive campaigns carried out between 1958-1966 as well as later campaigns



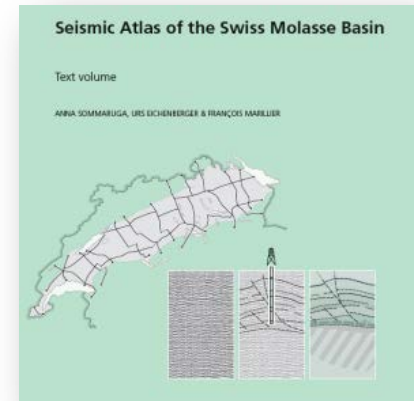
main contributions to GeoMol are seismics and well data



- National Cooperative for the Disposal of Radioactive Waste
- founded 1972
- research on storage of HC & nuclear waste
- own geol. research programs of the Swiss subsurface
- own expl. campaigns
- most subsurface data from SEAG and HC E&P



main contributions to GeoMol are seismic, interpretations, well data and know-how



- first detailed academic and basin-wide study of the subsurface of the SMB



main contributions to GeoMol are interpretations



GeoMol EU & GeoMol CH

2 Projects in parallel

GeoMol EU (low-res) 1:200'000

- in cooperation with neighboring countries
- Swiss part based on SASMB interpretations
- LG 3D fault modelling
- available to the public (**web-based viewer**)

- ends Q2 2015 -

GeoMol CH (high-res) 1:50'000

- modeling split up amongst 6 partners
- additional interpretations of 2D seismic & wells
- new interval velocities
- additional surface and near surface data
- restricted availability

GeoMol CH - Goals

- basis for federal planning
- basis for exploration campaigns (HC & T)
- basis for future geol. models
- 3D model to be completed Q4 2015

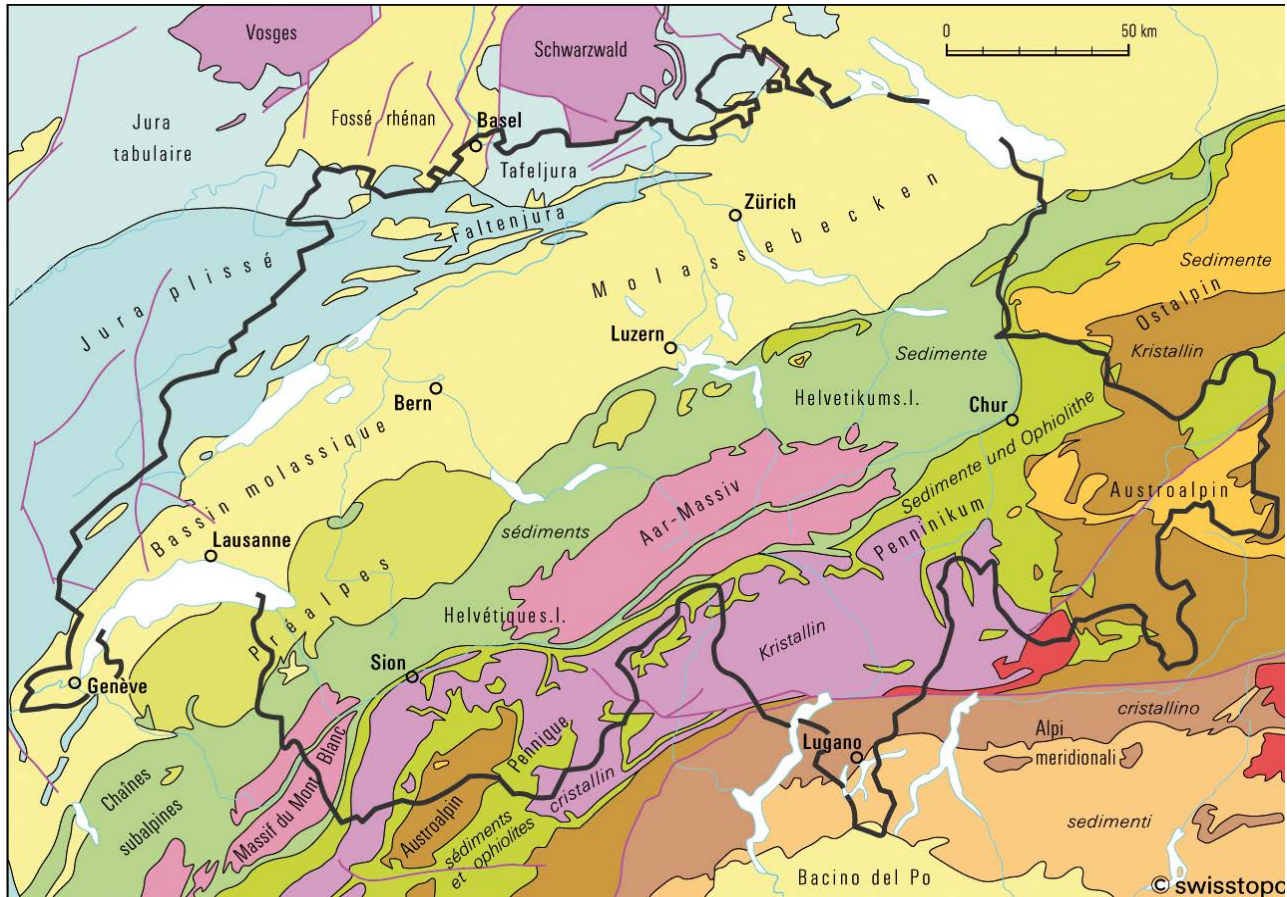
- ends Q3 2016 -

GeoMol CH – Continuation & Updates

- improved tZ conversion
- populate model with petrophys. data
- populate model with temperature data
- Base Mesozoic mapping
- Paleozoic trough mapping



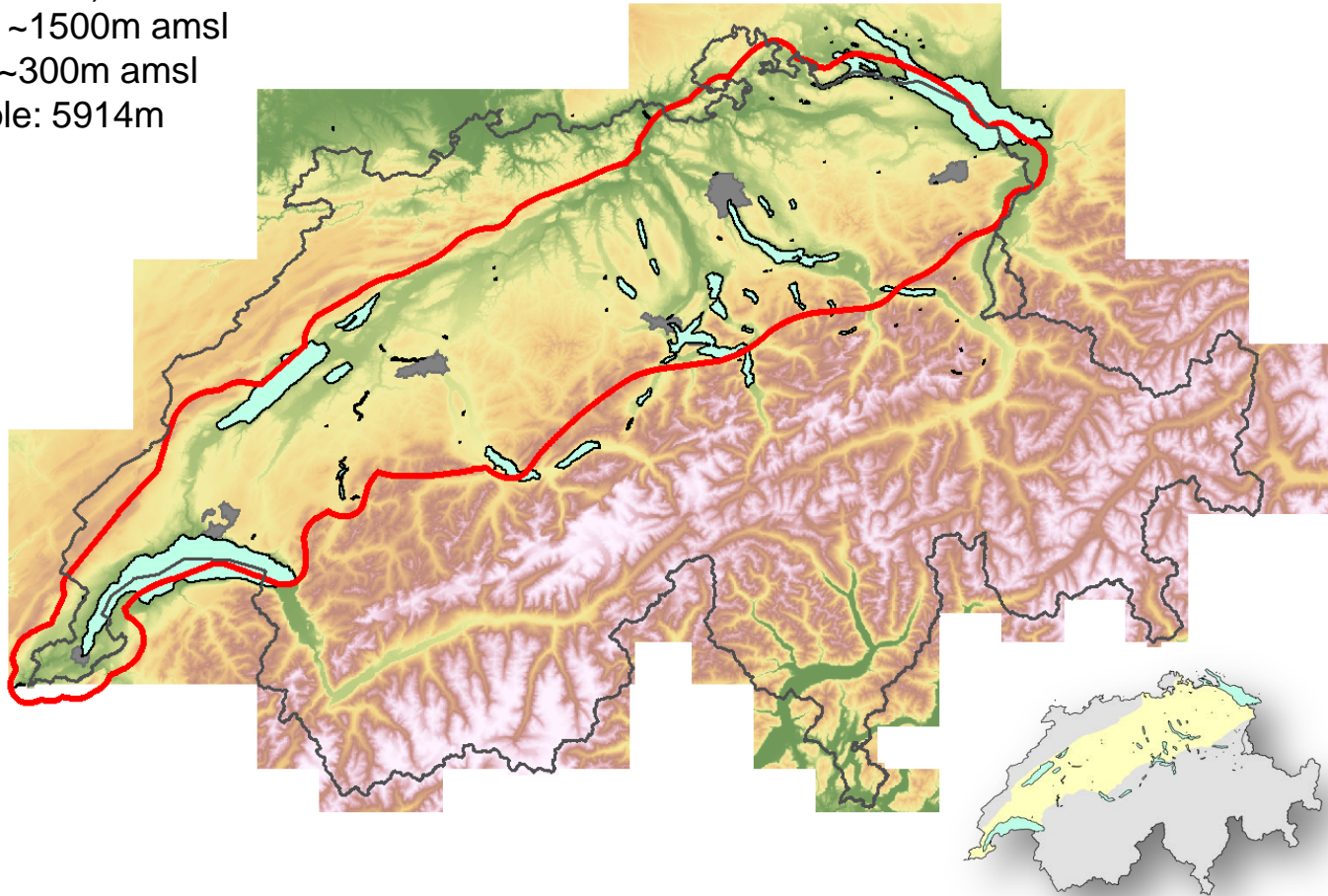
Geology of Switzerland





Area of Interest - Dimensions

~315km (NE-SW axis)
~80km (NW-SE axis)
max elevation: ~1500m amsl
min elevation: ~300m amsl
longest borehole: 5914m





Stratigraphy

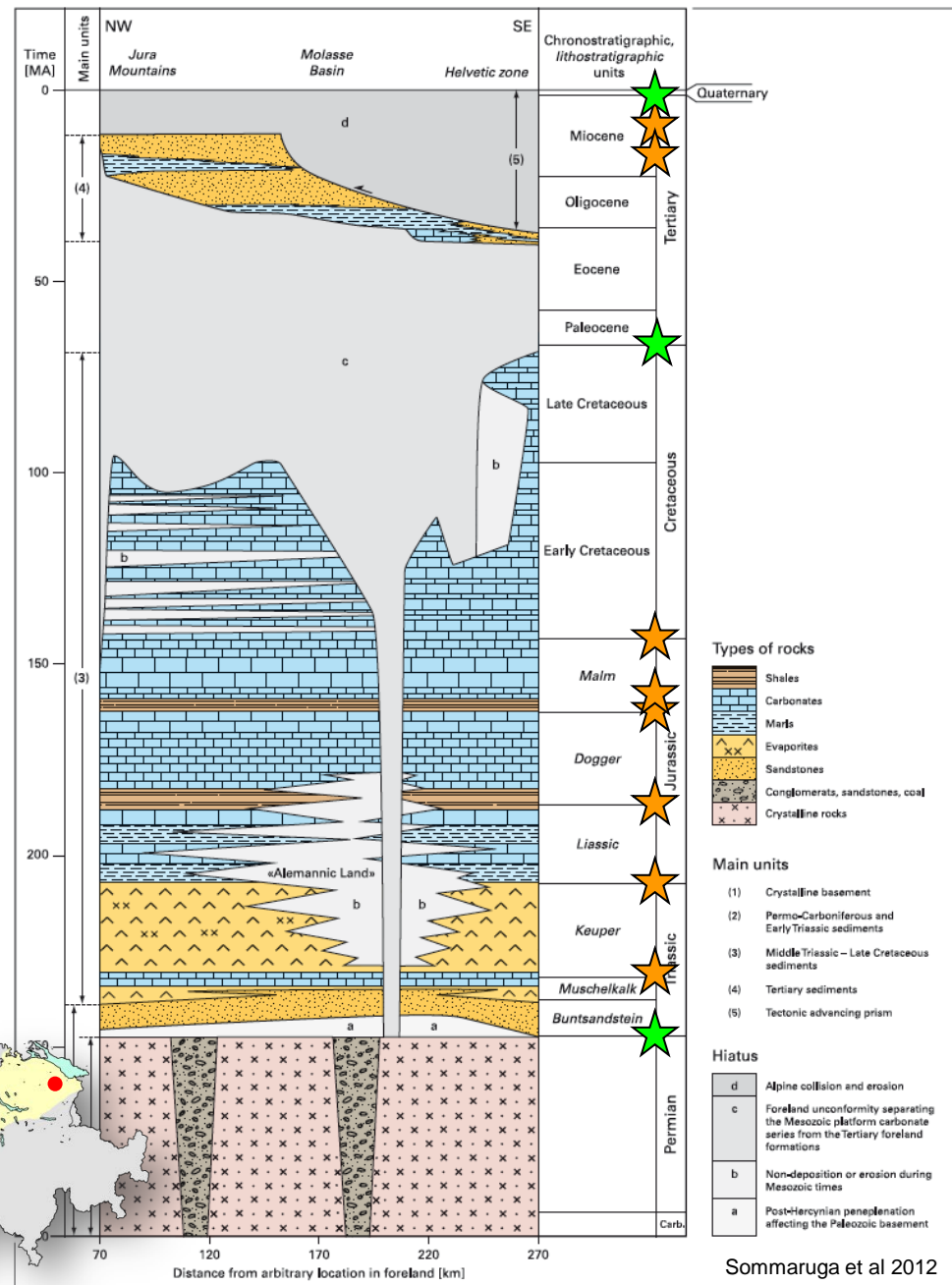
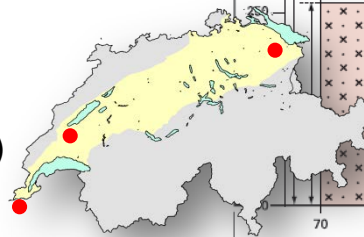
Cenozoic: siliciclastics (& carbonates)
sandstones, conglomerates, shales
3805m in SGSW-1

Cretaceous: carbonates
380m in Humilly-1

Jurassic: carbonates & shales
1050m in Humilly-1

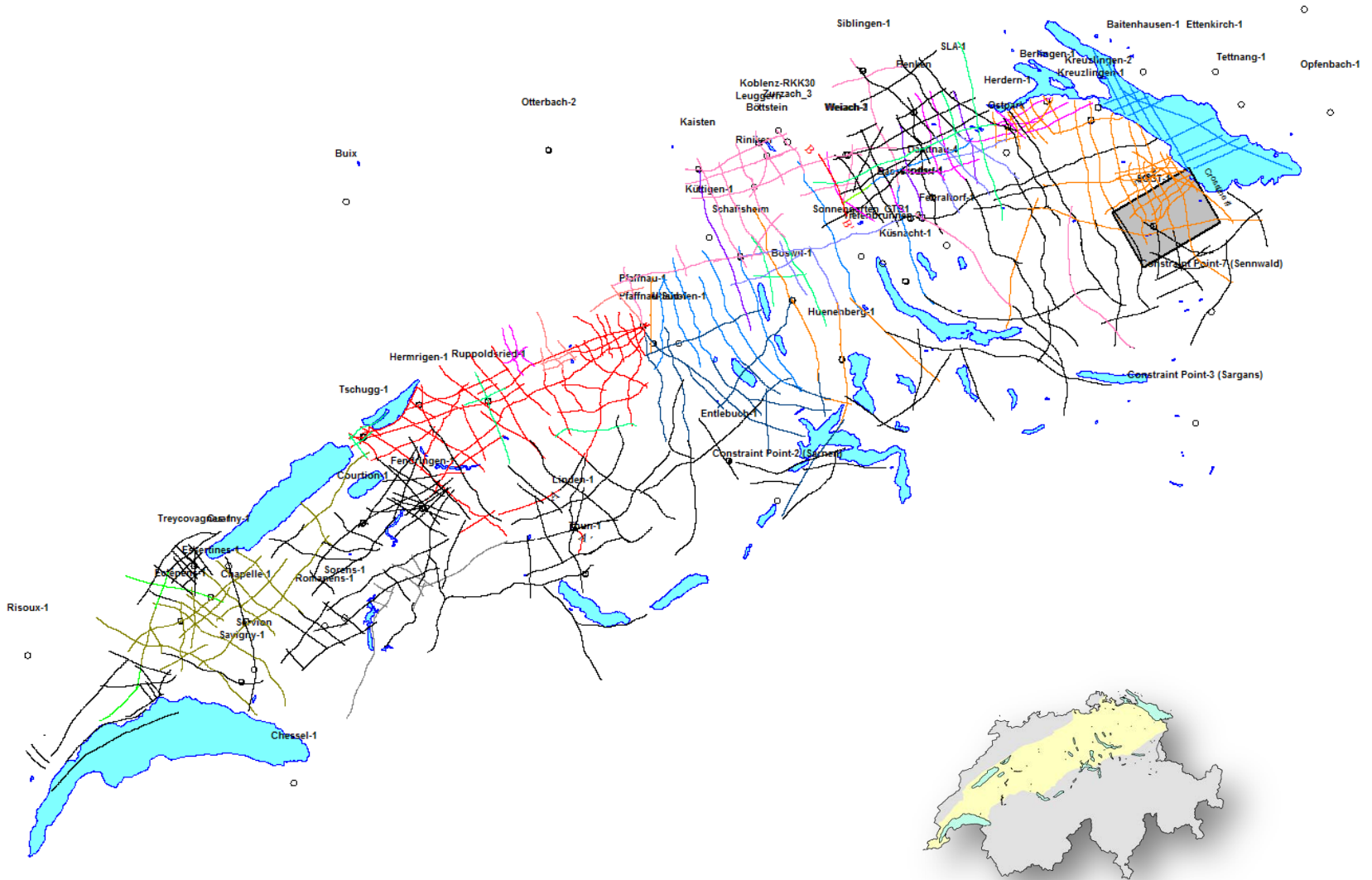
Triassic: evaporites, carbonates
siliciclastics
>634m in Essertines-1

- ★ Modelled horizon (formation top)
- ★ Modelled horizon (formation base)





2D Seismic





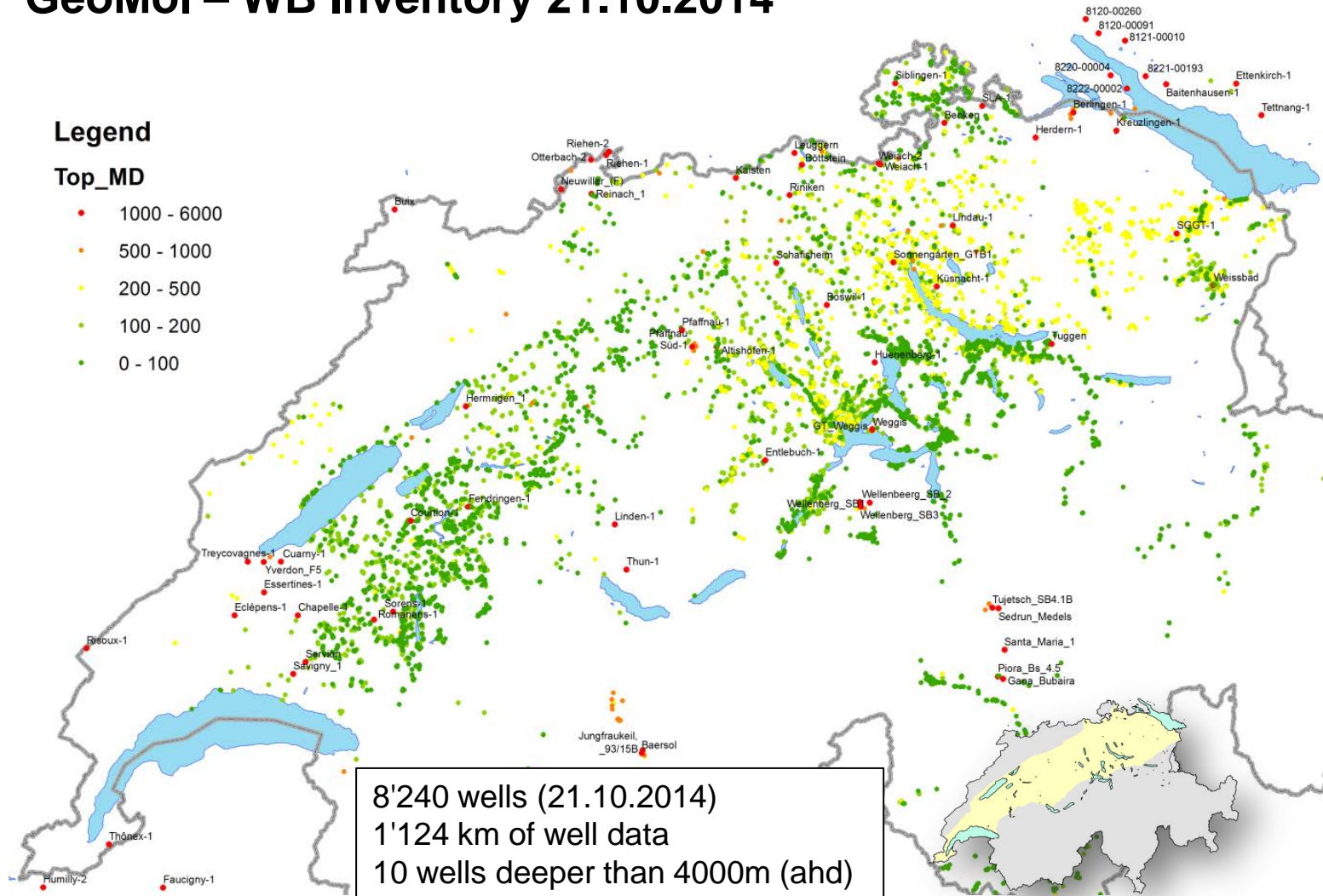
Wells – Measured Depth [m]

GeoMol – WB Inventory 21.10.2014

Legend

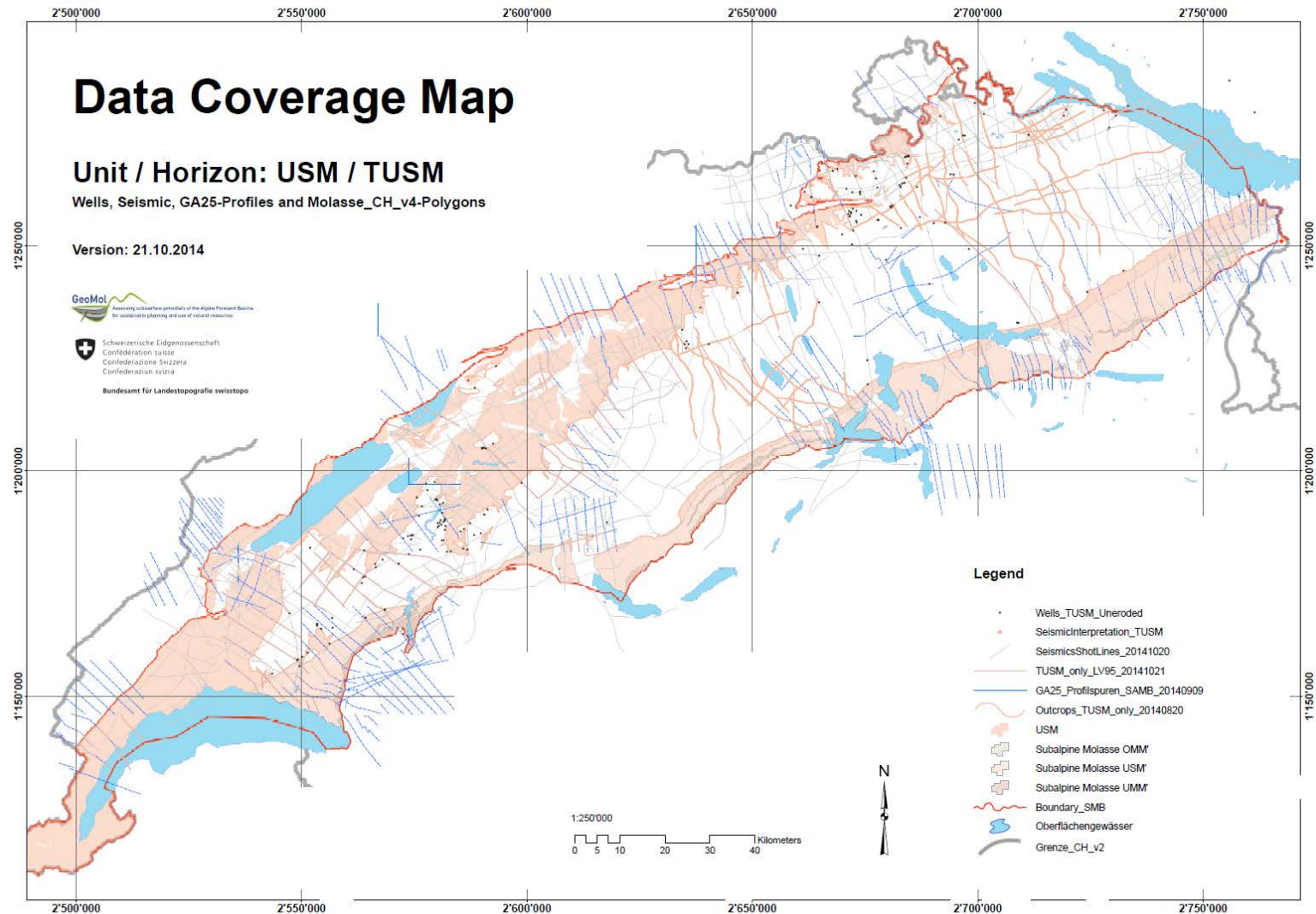
Top_MD

- 1000 - 6000
- 500 - 1000
- 200 - 500
- 100 - 200
- 0 - 100





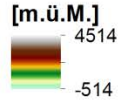
Data Coverage Map USM



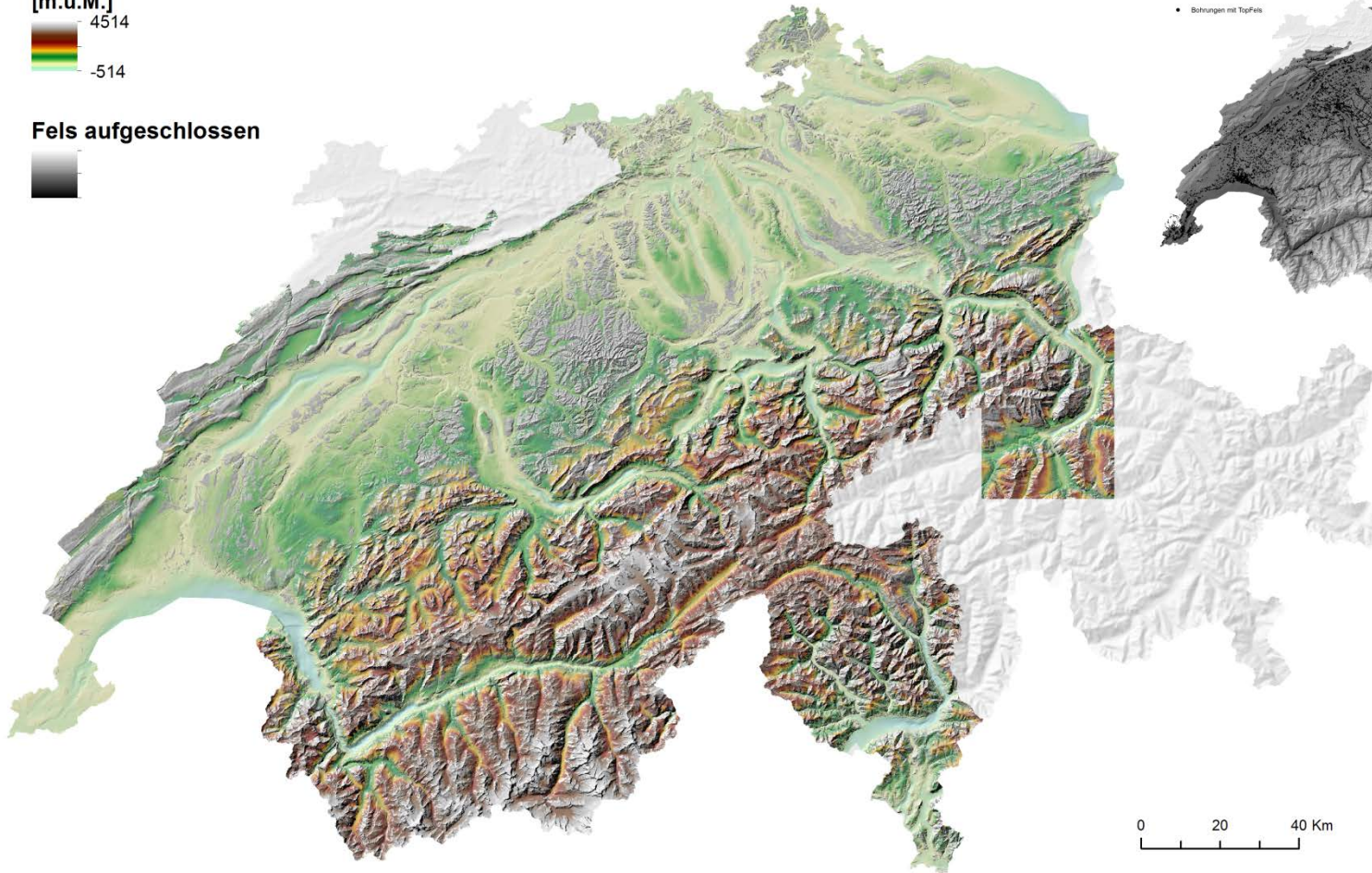


Top Bedrock

Felsoberfläche



Fels aufgeschlossen



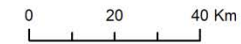
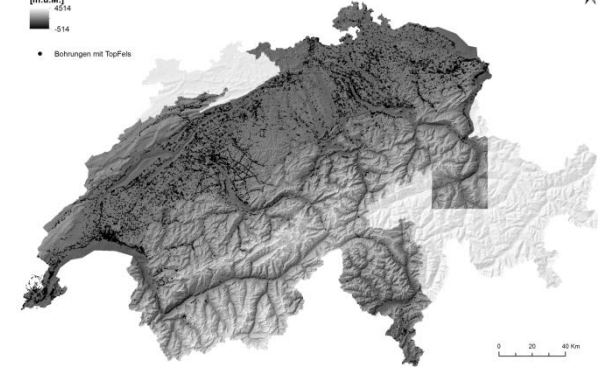
Felsoberfläche

[m.ü.M.]

4514

-514

• Bohrungen mit TopFels

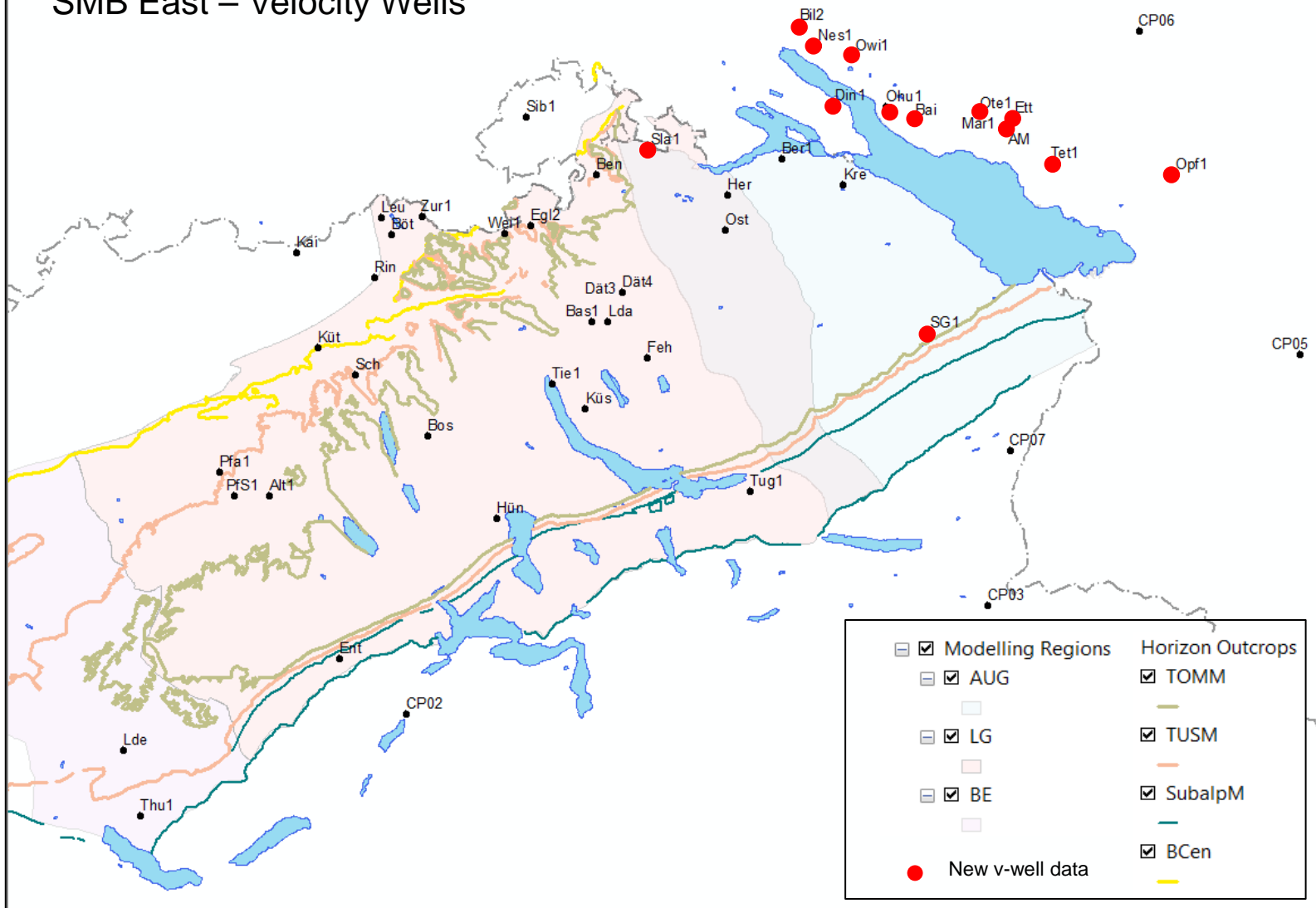


cell size: 25m x25m



Available Velocity Data

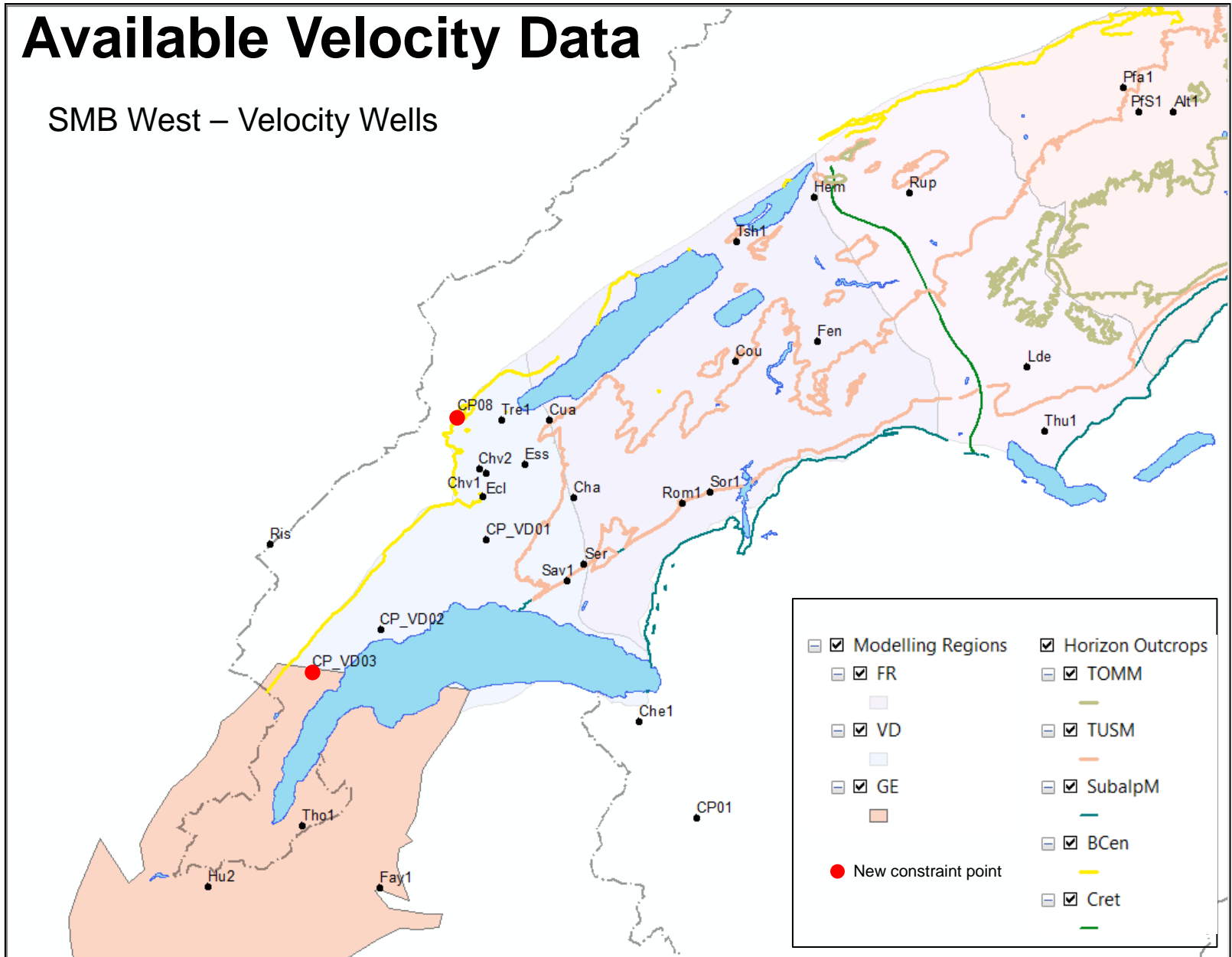
SMB East – Velocity Wells





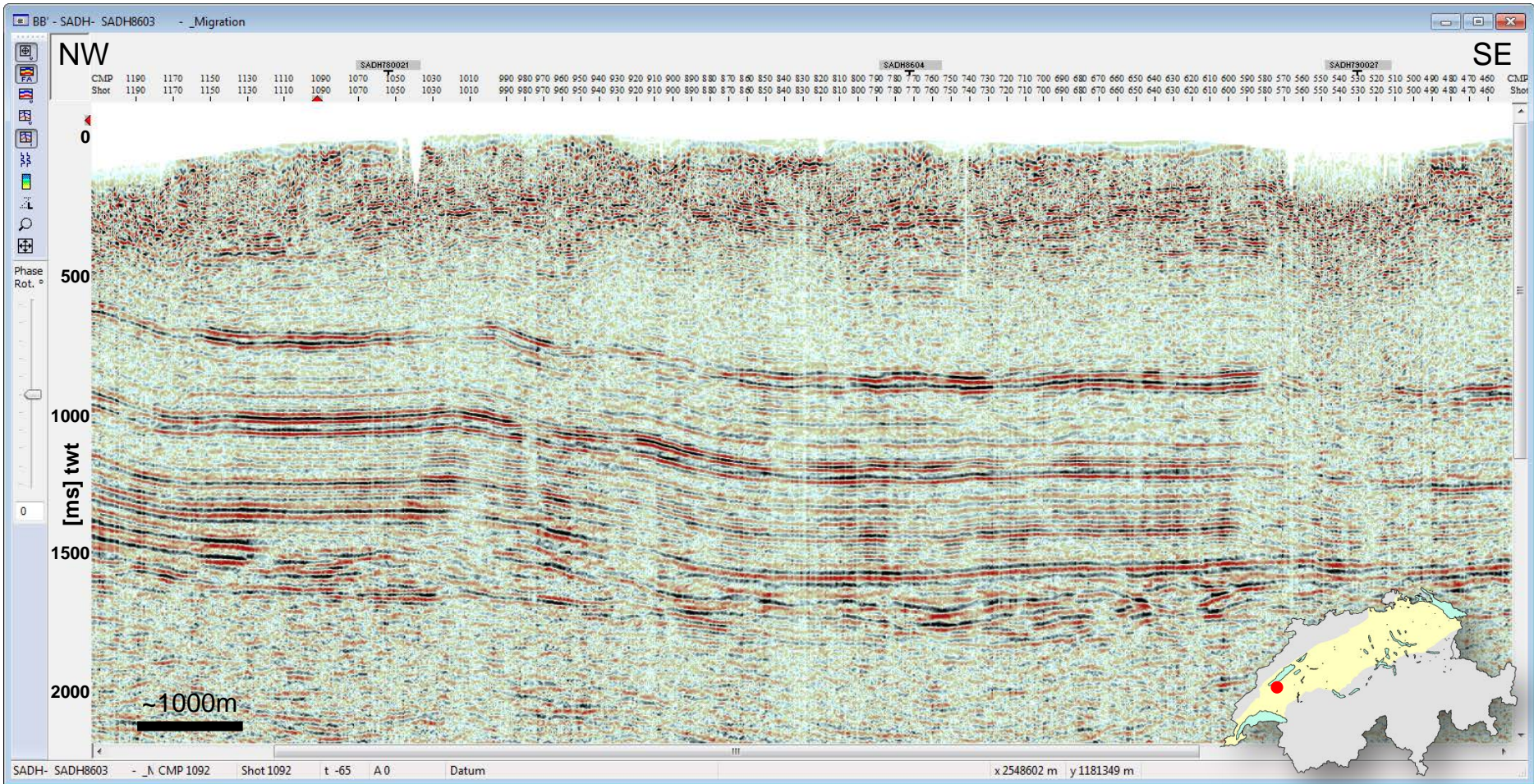
Available Velocity Data

SMB West – Velocity Wells





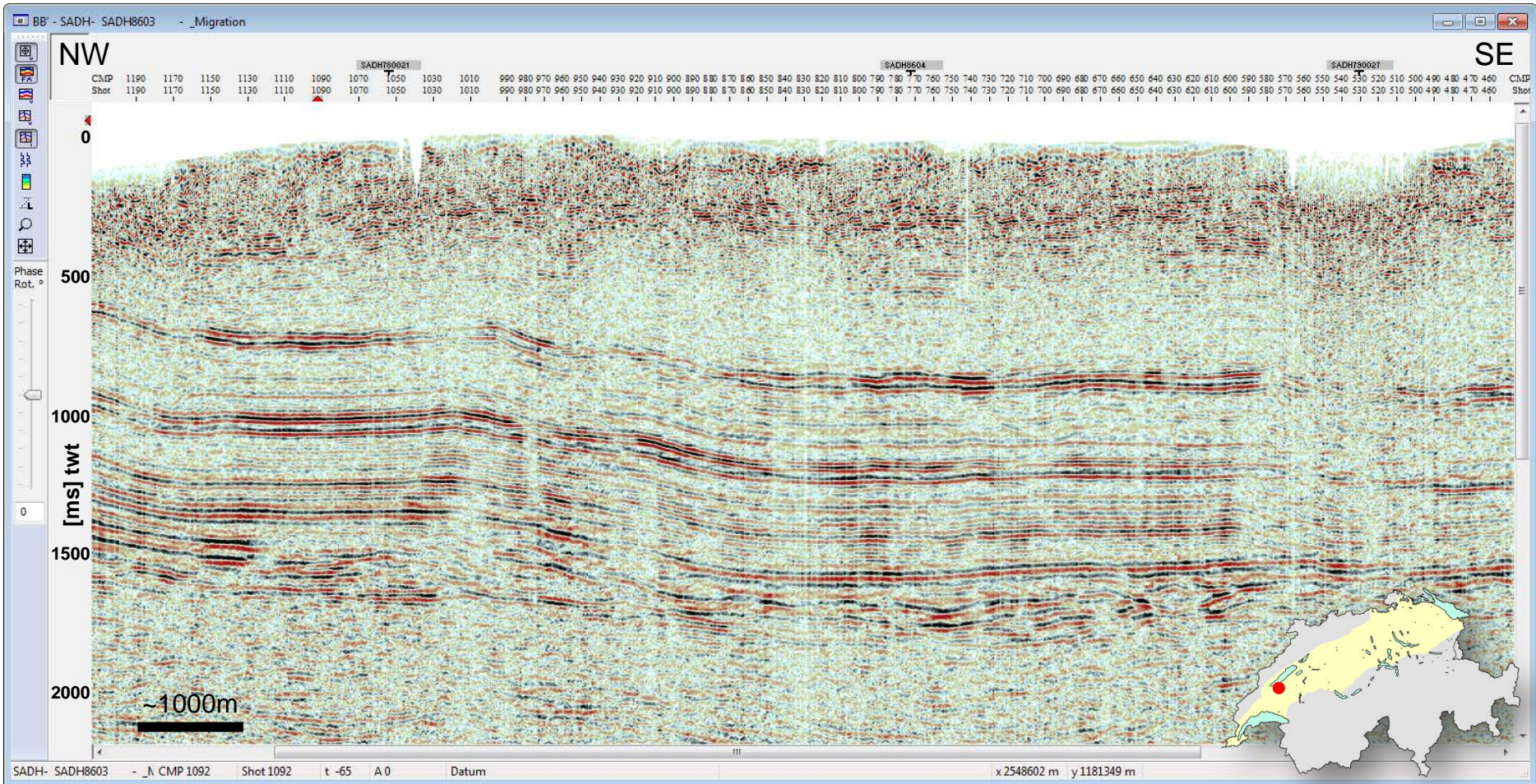
2D Seismic



seismic line property of Swiss Federation



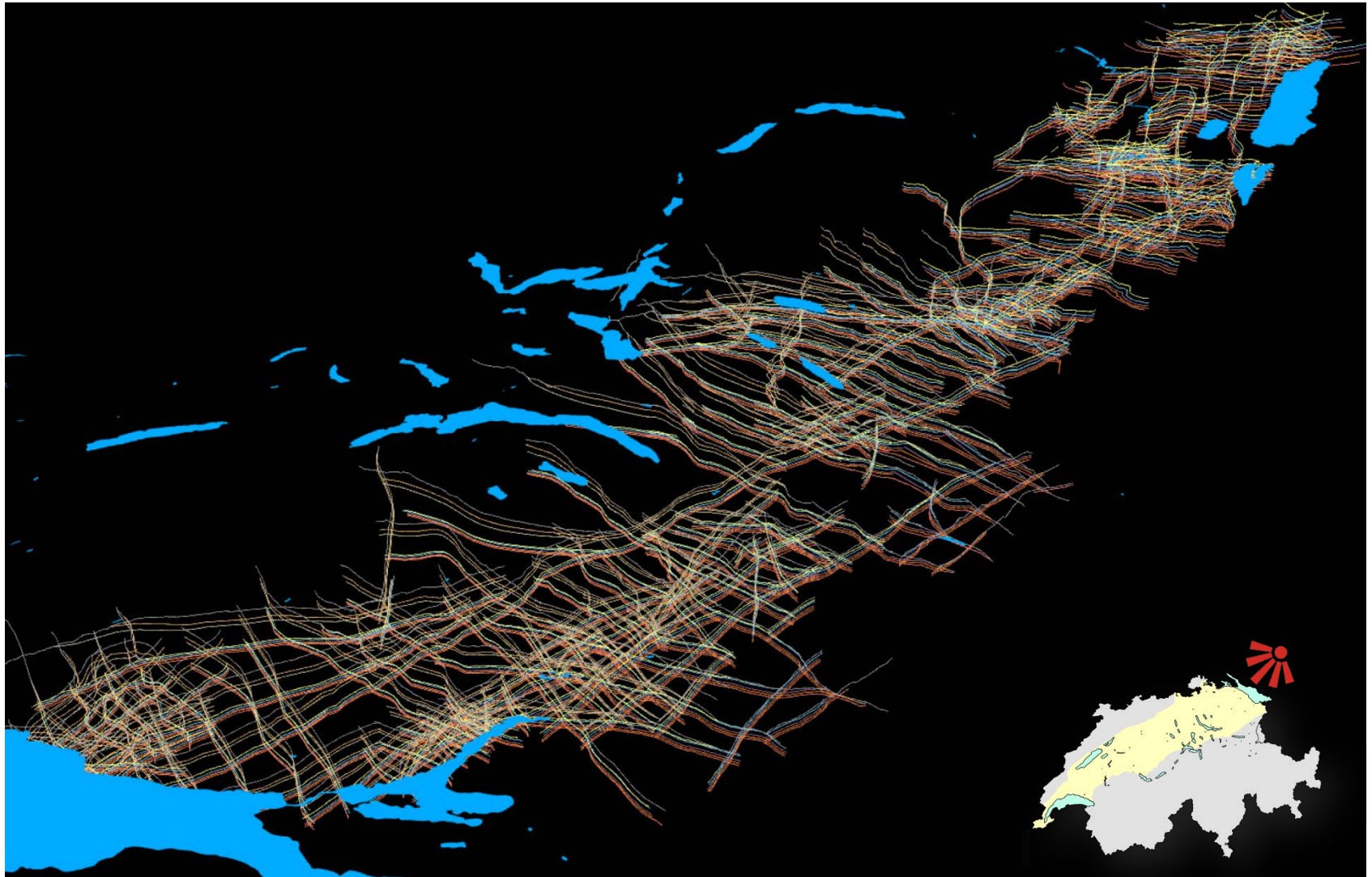
2D Seismic Interpretation



seismic line property of Swiss Federation



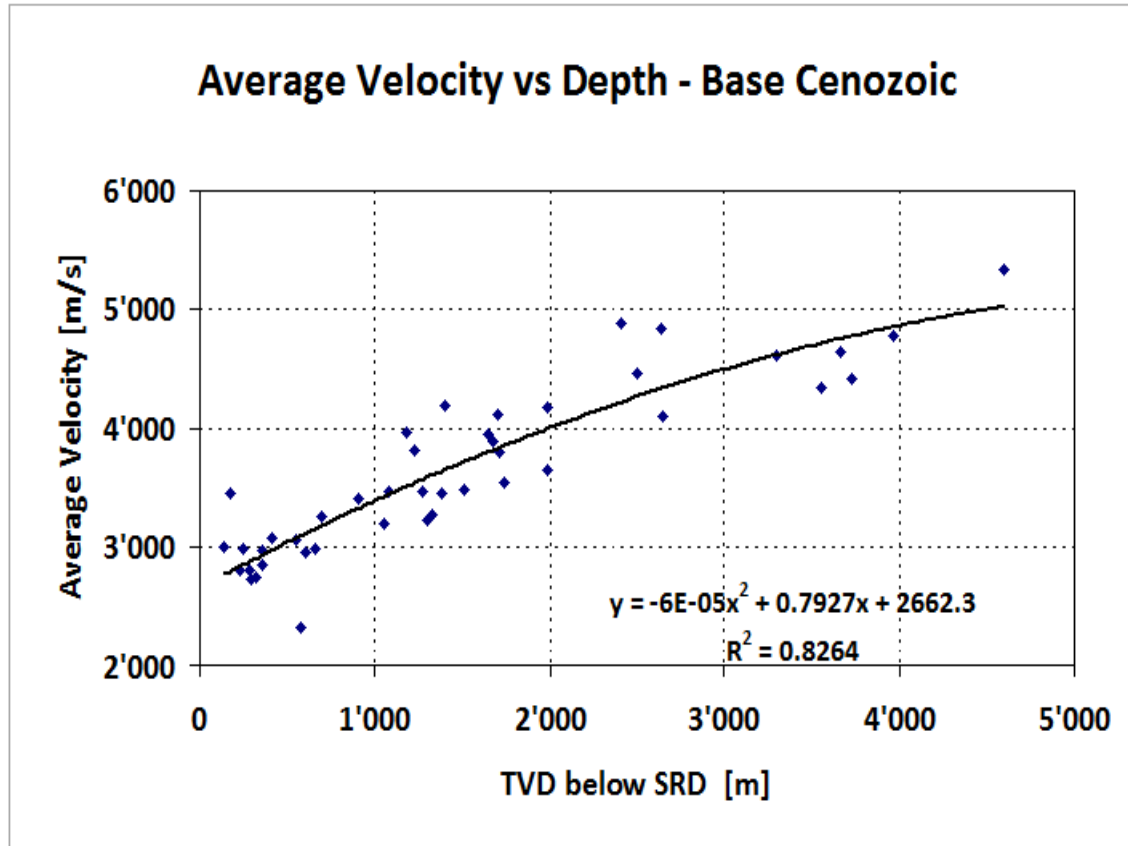
Nagra 2D Interpretation Dataset





Time-depth conversion

Data Analysis

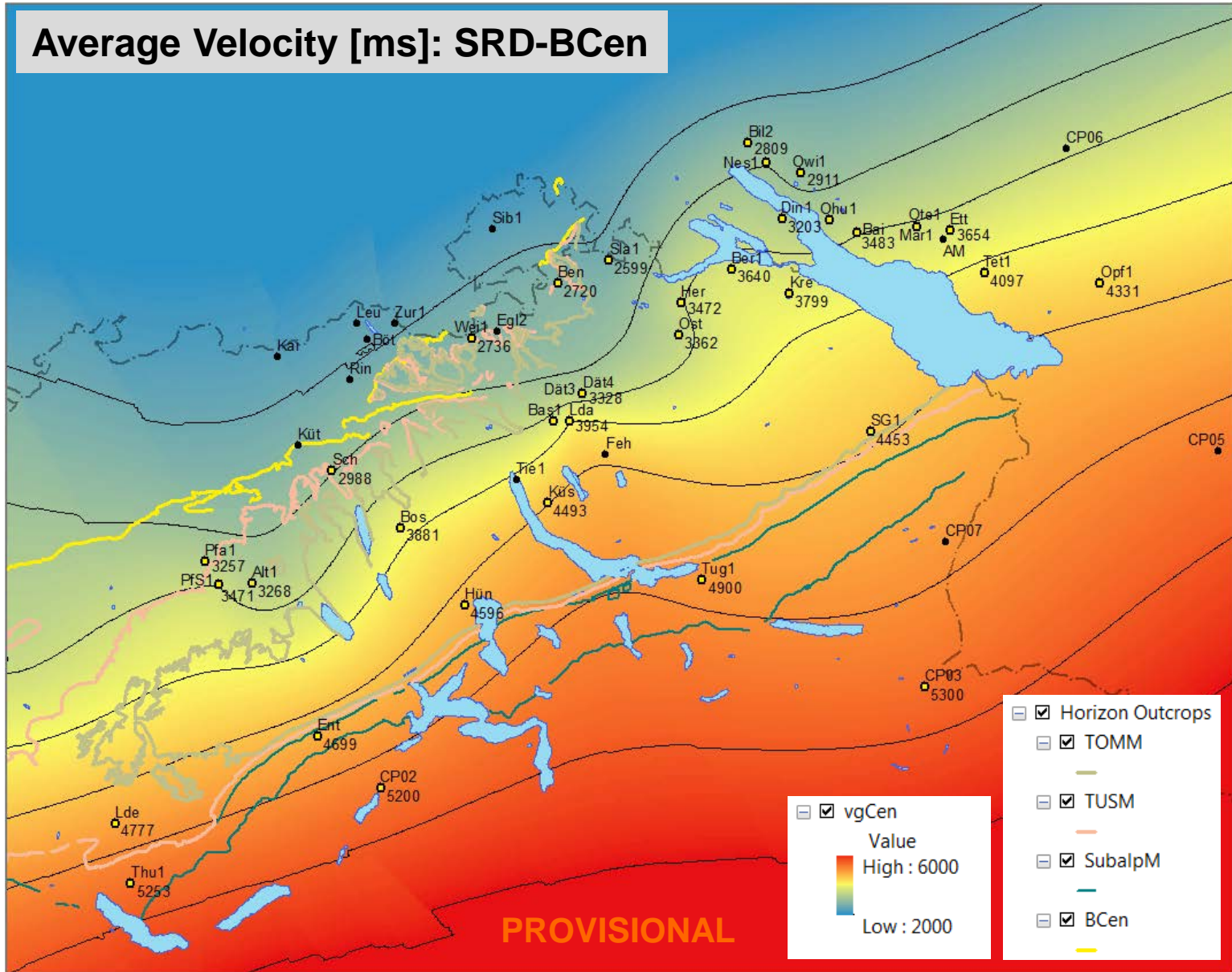


Well_Name	Cen_TVD	Cen_Vel
Riniken	140	2998
Essertines_1	176	3452
Chavornay-2	233	2812
Chavornay-1	247	2994
Billafingen-2	288	2809
Benken	295	2731
Weiach-1	317	2745
Hermrigen_1	353	2851
Nesselwangen-1	361	2979
Cuarney-1	416	3071
Tschugg-1	547	3067
SLA-1	574	2335
Owingen-1	607	2953
Schafisheim	655	2988
Pfaffnau_1	691	3260
Ruppoldsried	907	3412
Dingelsdorf-1	1049	3203
Pfaffnau Süd-1	1082	3471
Chapelle-1	1176	3957
Courtion-1	1228	3814
Herdern-1	1268	3468
Oberuhldingen-1	1301	3233
Altishofen-1	1322	3268
Berlingen-1	1379	3457
Thônex-1	1402	4182
Baitenhausen-1	1507	3483
Lindau-1	1650	3954
Boswil-1	1675	3881
Fendringen-1	1702	4107
Kreuzlingen_1	1710	3799
Markdorf-1	1734	3550
Savigny_1	1980	4168
Ettenkirch-1	1984	3654
Romanens-1	2410	4879
Küsnacht-1	2508	4453
Sorens-1	2637	4839
Tett nang-1	2649	4097
Huenenberg-1	3298	4612
Opfenbach-1	3555	4339
Entlebuch-1	3661	4642
SGGT-1	3730	4419
Linden-1	3964	4768
Thun-1	4598	5321

PROVISIONAL

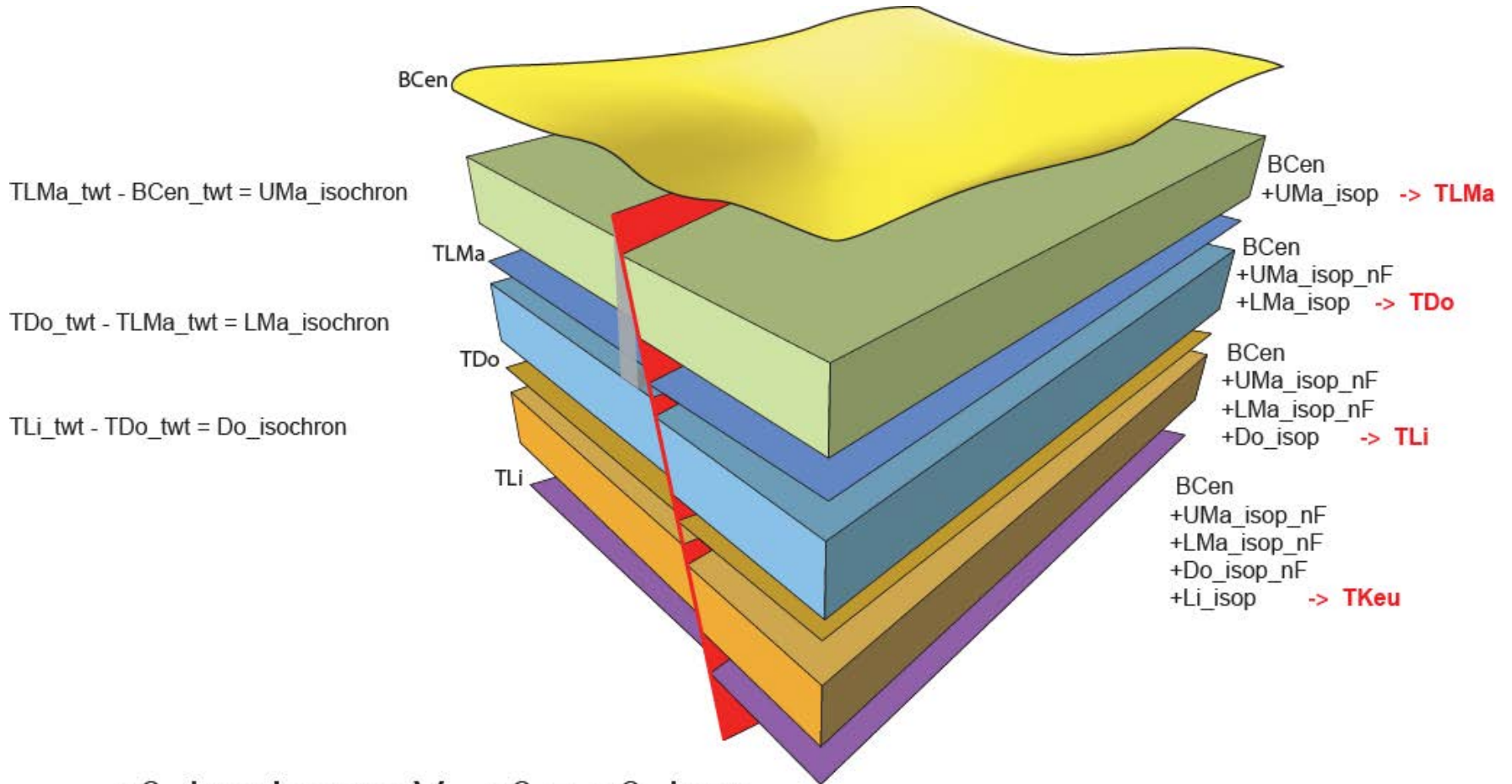


Average Velocity [ms]: SRD-BCen





Isopach Stacking



$$\alpha\beta_{isochron} \times V_{int} \alpha\beta = \alpha\beta_{isop}$$

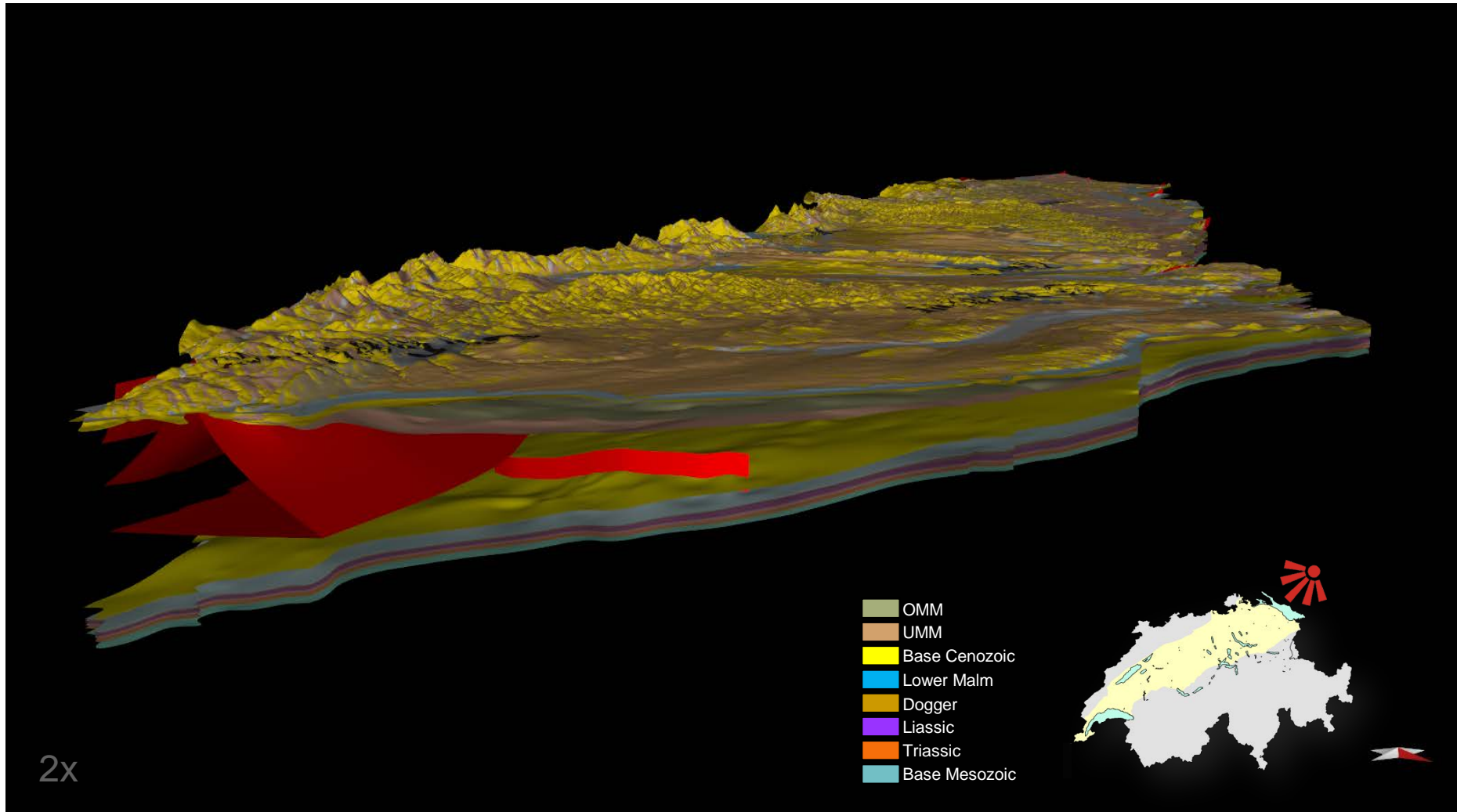
Use twt grids *without* fault polygons to calculate isochrons ($\alpha\beta_{isop_nF}$).
 That way fault shadows can be avoided.

Use faults of isopach baselayer to calculate top of strat older layer.

PROVISIONAL

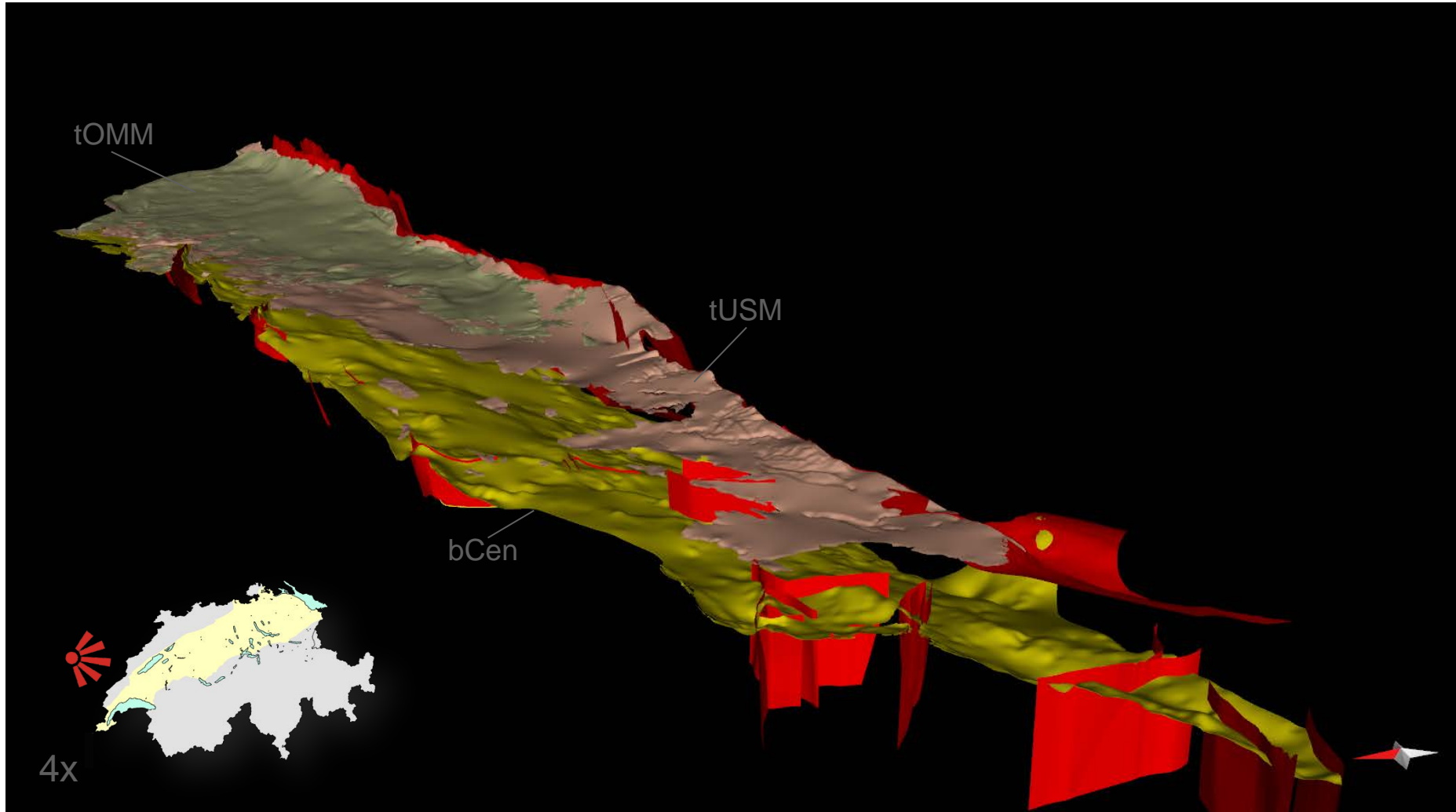


Complete Framework Modell



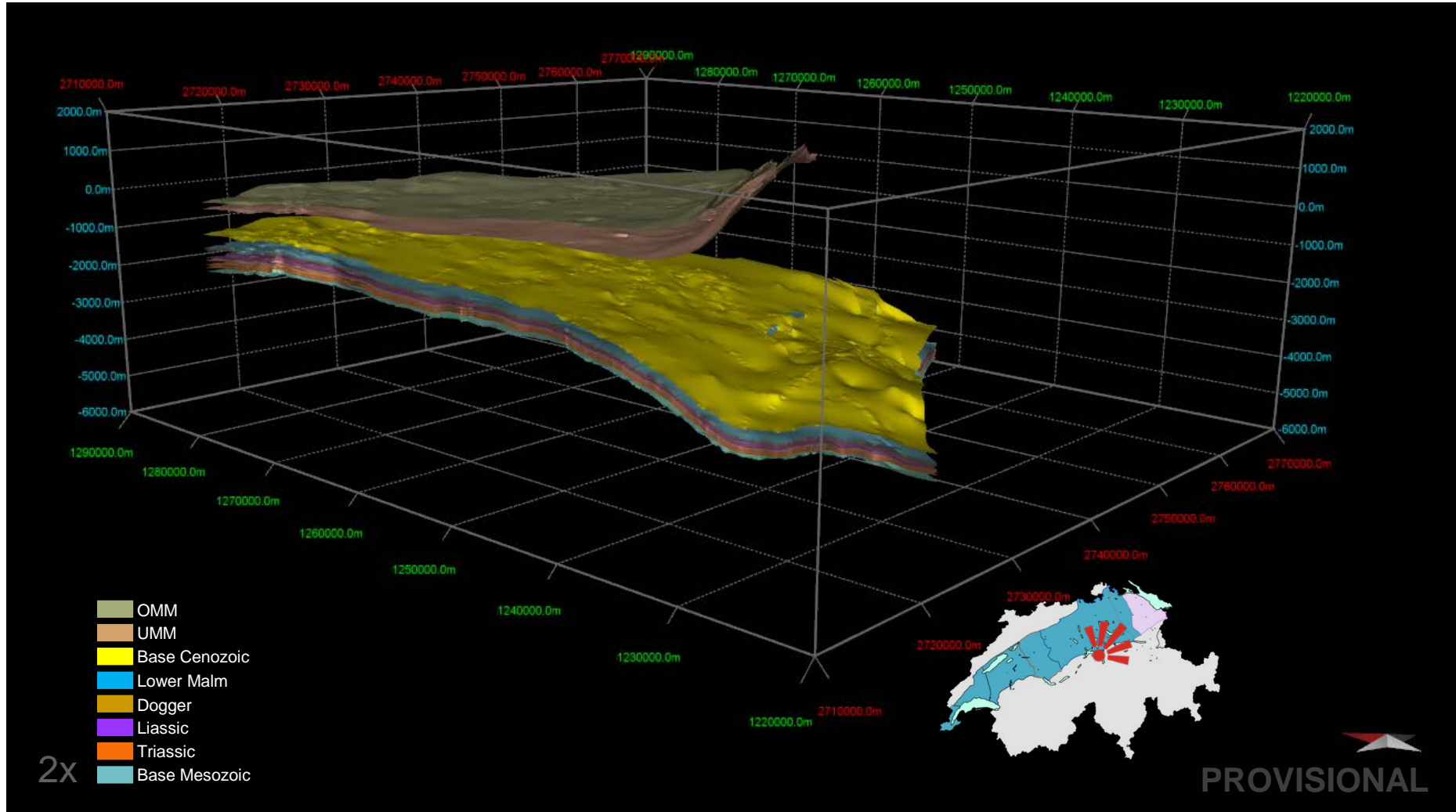


Cenozoic in 3D (Framework Modell)

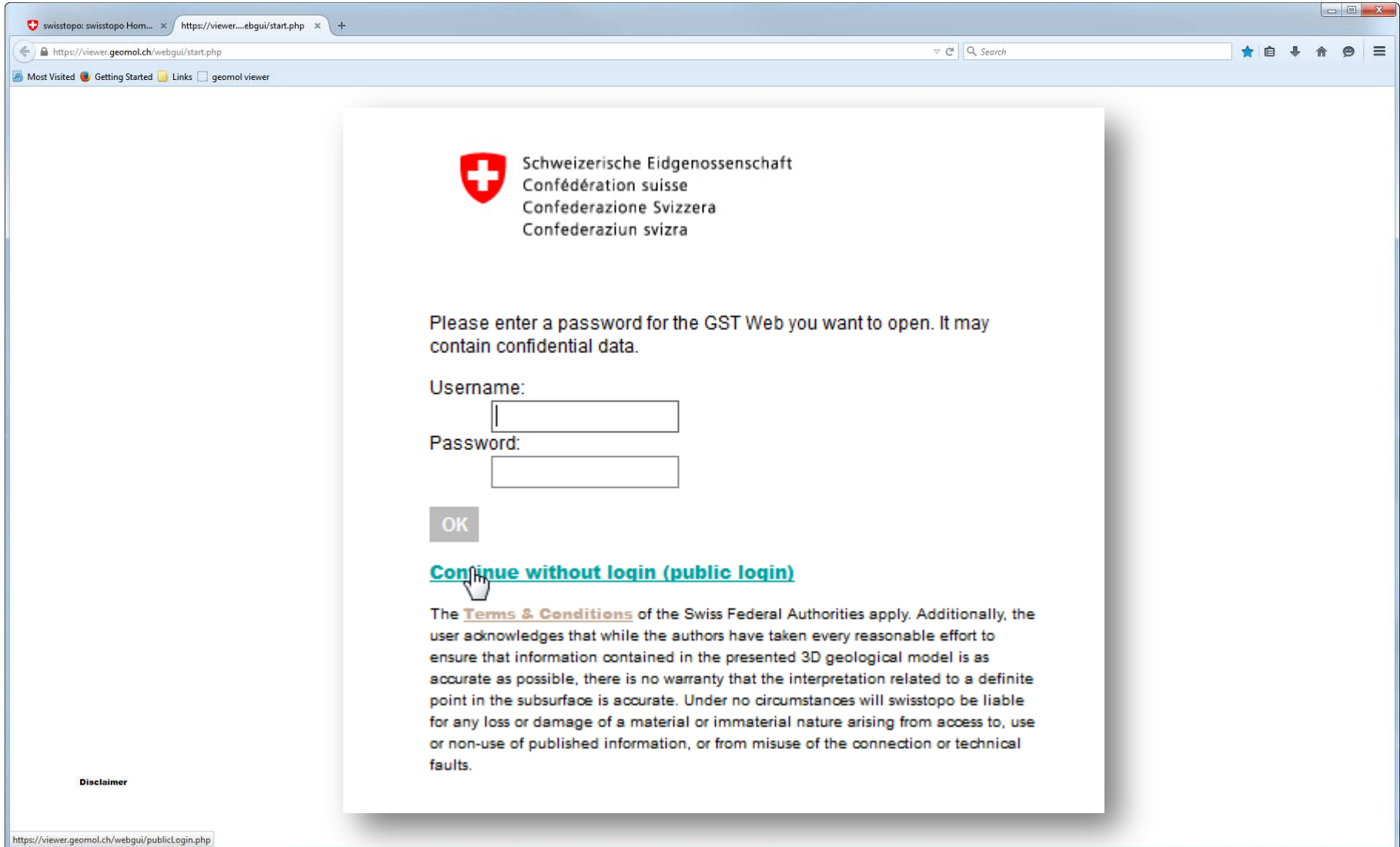




Lake Constance Area Pilot Region in 3D




2x



swisstopo: swisstopo Hom... x https://viewer...ebgui/start.php x +

https://viewer.geomol.ch/webgui/start.php

Most Visited Getting Started Links geomol viewer

 Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Please enter a password for the GST Web you want to open. It may contain confidential data.

Username:

Password:

OK

[Continue without login \(public login\)](#)

The **Terms & Conditions** of the Swiss Federal Authorities apply. Additionally, the user acknowledges that while the authors have taken every reasonable effort to ensure that information contained in the presented 3D geological model is as accurate as possible, there is no warranty that the interpretation related to a definite point in the subsurface is accurate. Under no circumstances will swisstopo be liable for any loss or damage of a material or immaterial nature arising from access to, use or non-use of published information, or from misuse of the connection or technical faults.

Disclaimer

https://viewer.geomol.ch/webgui/publicLogin.php



Disclaimer – Federal Terms & Conditions

Federal Administration

The Federal Authorities

Contact

DE

FR

IT

RM

EN

ES



Schweizerische Eidgenossenschaft

Confédération suisse

Confederazione Svizzera

Confederaziun svizra

The Federal Authorities

Terms and conditions

Limitation of liability

Although every care has been taken by the Federal Authorities to ensure the accuracy of the information published, no warranty can be given in respect of the accuracy, reliability, up-to-dateness or completeness of this information.

The Federal Authorities reserve the right to alter or remove the content, in full or in part, without prior notice.

In no event will the Federal Authorities be liable for any loss or damage of a material or immaterial nature arising from access to, use or non-use of published information, or from misuse of the connection or technical faults.



GST Viewer – Disclaimer & Acknowledgements

Disclaimer



Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

The 3D geological model of the Swiss Molasse Basin presented on this website represents a **simplification of the real geological settings**. The 3D model is based on **interpretations of different kinds of data** (seismics, boreholes, cross sections, maps, etc.), of varying vintages, quality, details and acquisition purposes. Additionally, type and vintage of input data also reflect different interpretations and geological knowledge and reflect uncertainties related to exact spatial location of these data sets. Furthermore, the final model as presented here is based on many different data sets, which initially are not coordinated and therefore implies a further simplification. Last but not least, the geological knowledge and background of different staff members influenced the model development.

The **Terms & Conditions** of the Swiss Federal Authorities apply. Additionally, the user acknowledges that while the authors have taken every reasonable effort to ensure that information contained in the presented 3D geological model is as accurate as possible, there is no warranty that the interpretation related to a definite point in the subsurface is accurate. Under no circumstances will swisstopo be liable for any loss or damage of a material or immaterial nature arising from access to, use or non-use of published information, or from misuse of the connection or technical faults.

Geo data used for the development of the GeoMol 3D geological model are **provided with compliments by SEAG (AG für Schweizerisches Erdöl), Nagra (Nationalen Genossenschaft für die Lagerung radioaktiver Abfälle), St.Galler Stadtwerke, Swissgas AG, Konsortium Untertagespeicher KUT, the Swiss Federal Railways and FREAG (Fribourg Erdöl AG).**

The Swiss Federal Offices of Topography swisstopo, of the Environment OFEN, of Energy FOEN and Spatial Planning ARE support the project financially.

The cantons of AG, AI, AR, BE, FR, GE, GL, GR, LU, NE, NW, OW, SO, SG, SH, SZ, TG, TI, UR, VD, VS, ZH and ZG support the GeoMol project either financially or in kind by supplying data.

This web application is using the WebGL technology. Please use a web browser that is capable of displaying WebGL content. We recommend that you use Firefox, Chrome, Opera* or Safari*. (*Please verify that WebGL is enabled.)

Please visit <http://www.x3dom.org/check/> in order to test if your system is capable of displaying WebGL. For more information on WebGL and making your PC capable of displaying WebGL natively, please visit <http://get.webgl.org/>.

[Continue](#)



GST Viewer – virtual vertical borehole

swisstopo: swisstopo Hom... x GST Web x +

https://viewer.geomol.ch/webgui/gui2.php

Most Visited Getting Started Links geomol viewer

GeoMol Switzerland

3D Geology 2D Geology

Borehole

Location where the borehole should be placed. For an inclined borehole you will be asked for the elevation in m a.s.l. in order to define where the borehole should begin. If no value will be defined by the user the highest value from the bounding box will be used. You can also supply a title which will be printed on the section result.

Orientation

Vertical Borehole Inclined Borehole

Startpoint

2592033.9151584003 Easting
1197858.6250714145 Northing

Settings

(optional) Title
-1 Scale
all Elements Momakay

Create Select new Borehole

- OSM forest
- Tektonische Karte 500
- Eiszeitliches Maximum 500
- Tranchenwerk
- Geologische Karte 500
- Geotechnik und Gesteine
- Landeskarte 1:1 Mio. | LK 1000
- Model areas

Disclaimer Logout

Quellen: OpenStreetMap contributors, CC-BY-SA, data © OpenStreetMap contributors, ODbL



GST Viewer – virtual geological cross-section

swisstopo: swisstopo Home... x GST Web x +

https://viewer.geomol.ch/webgui/gui2.php

Most Visited Getting Started Links geomol viewer

GeoMol Switzerland

3D Geology 2D Geology

Sections

Draw a line with one segment, by clicking on the map to set the first point. Click twice to set the second point. For a horizontal section you need to define the elevation in m a.s.l. where the section should be processed. You can also supply a title which will be printed on the section result.

Orientation

Vertical Section Horizontal Section

Startpoint

2597938.5363562144 Easting
1186113.6672577483 Northing

Endpoint

2621836.0141328825 Easting
1191634.3955594 Northing

Settings

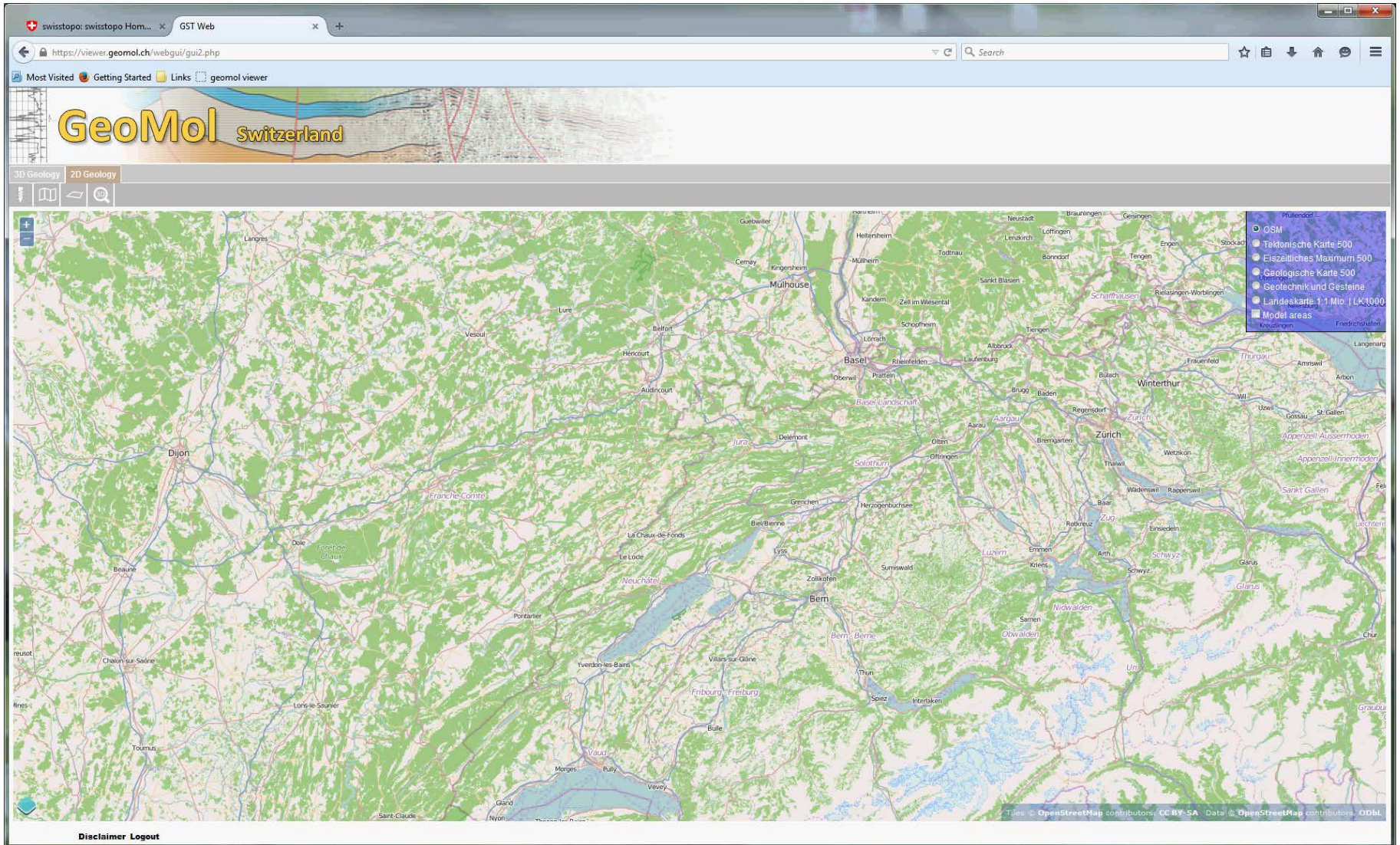
Create Select new Section

- OSM
- Tektionische Karte 500
- Eiszeitliches Maximum 500
- Geologische Karte 500
- Geotechnik und Gesteine
- Landeskarte 1:1 Mio. | LK1000
- Model areas

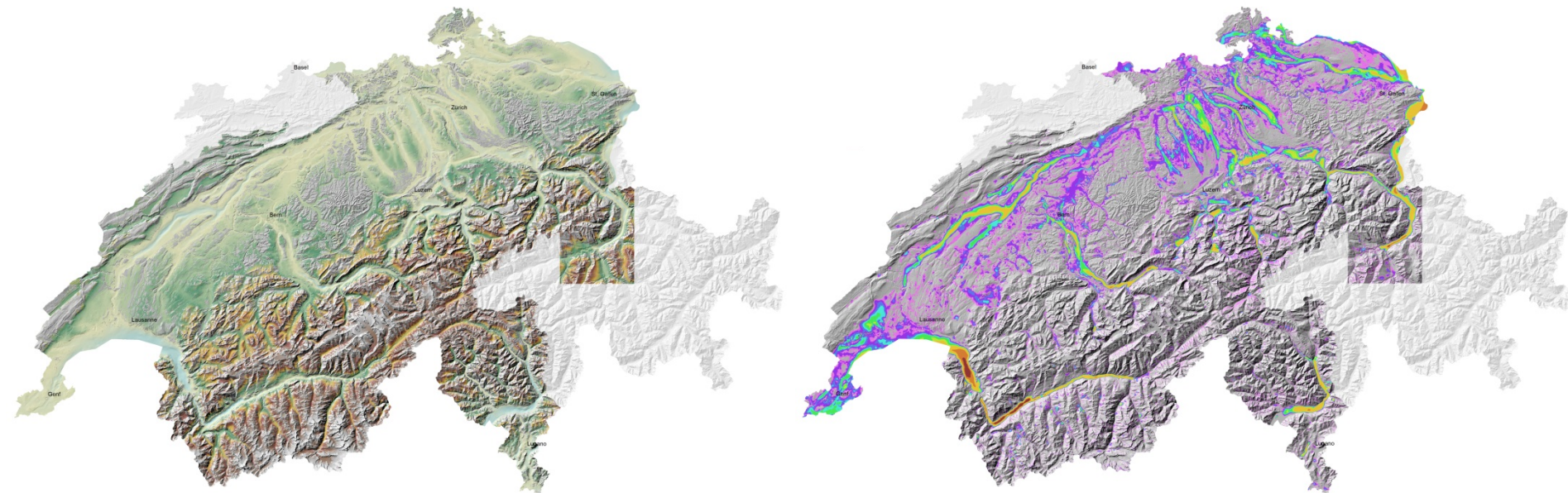
Disclaimer Logout

© 2012 OpenStreetMap contributors, CC-BY-SA, Data © OpenStreetMap contributors, ODbL

GST Viewer – virtual horizontal map

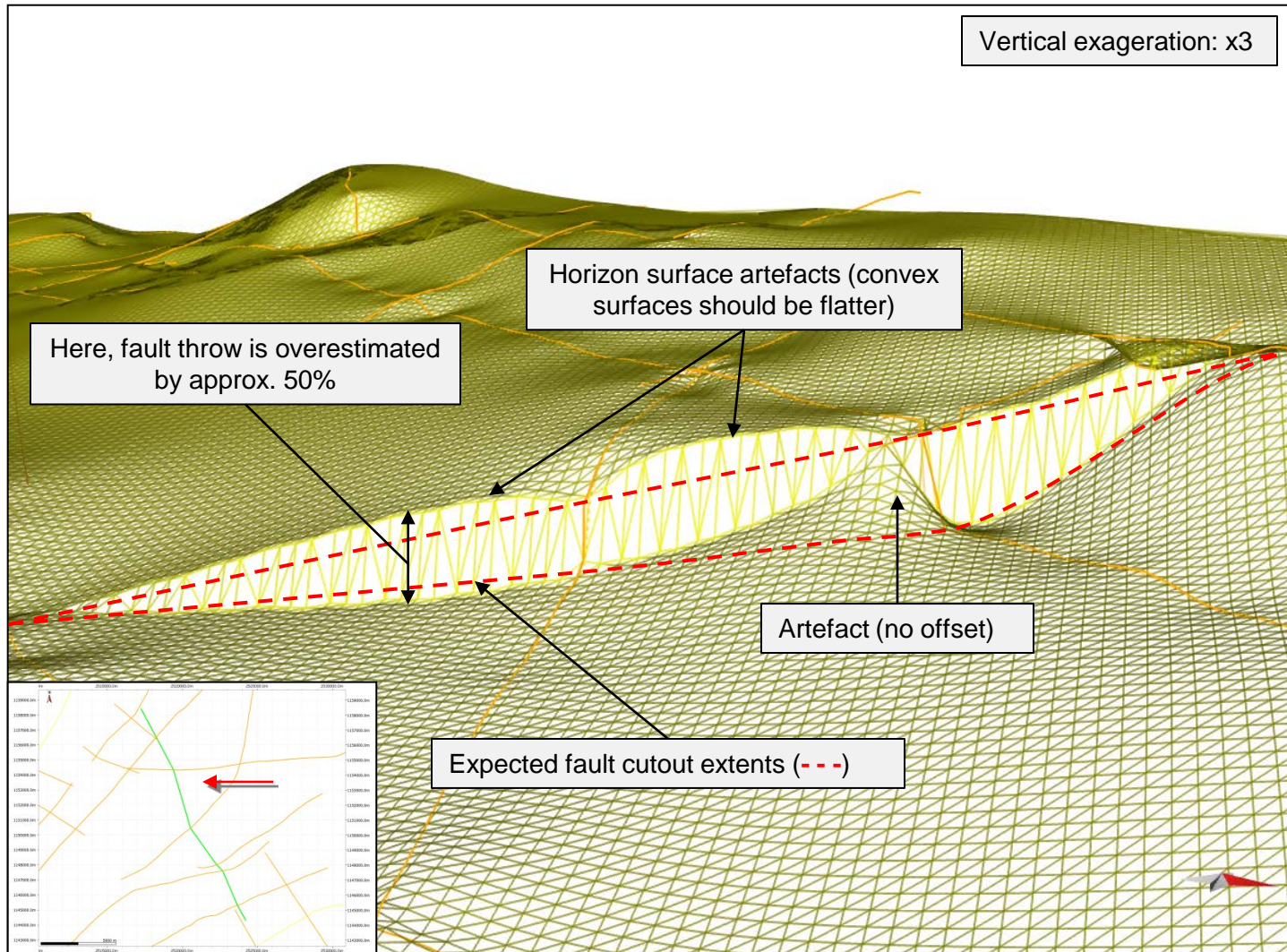


TopBedrock / Quaternary Thickness





Spline With Barriers (ArcMap) - Issues





**GeoMol –
Assessing subsurface potentials
of the Alpine Foreland Basins
for sustainable planning
and use of natural resources**

Project Report



GeoMol Framework-Model 1: 200'000

Die erstellten geologischen 3D-Modelle, die entsprechenden Karten und die dazugehörigen Metadaten können unter folgenden Internetadressen abgerufen werden:

3D-Model:

<http://www.geomol.eu/3dexplorer>

Mapviewer:

<http://www.geomol.eu/mapviewer>

Metadata:

<http://meta.geomol.eu/geonetwork/srv/en/main.home>

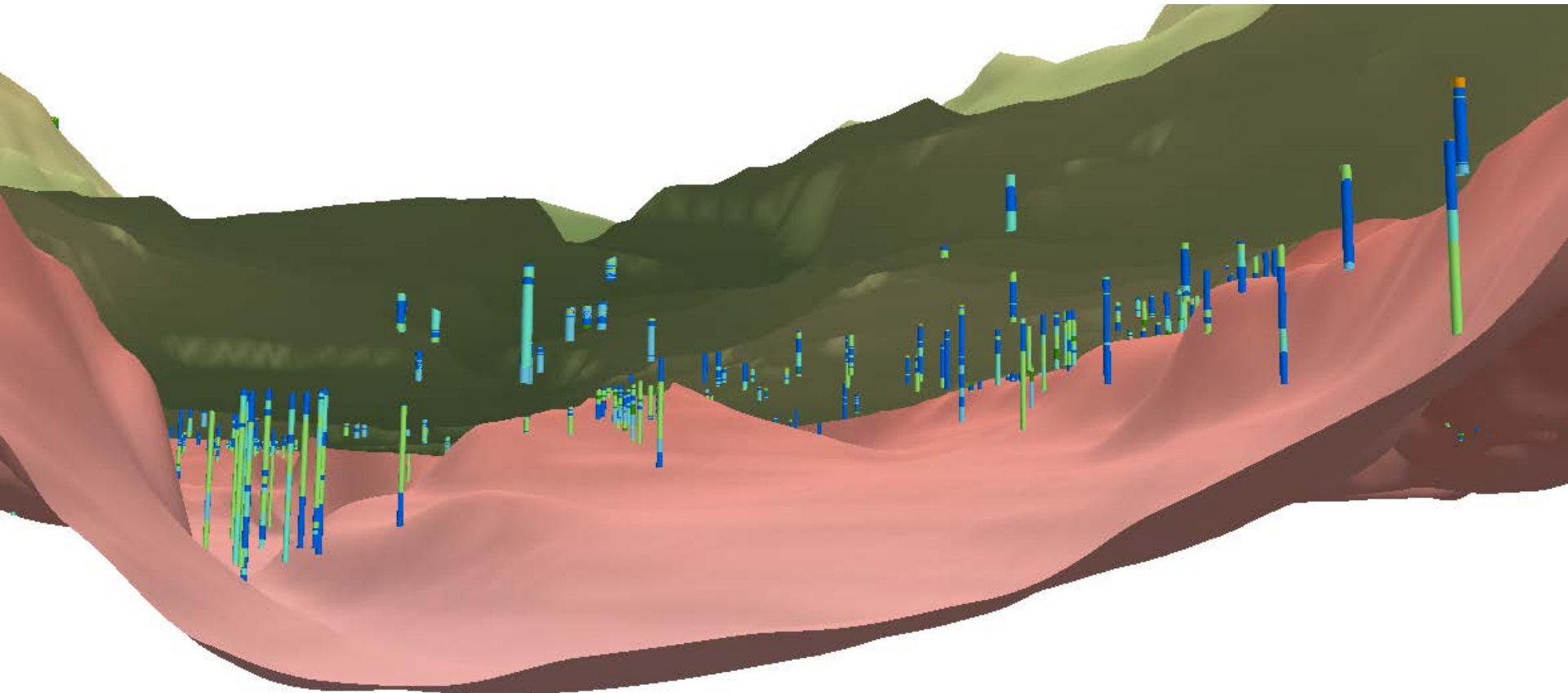
Report:

http://www.geomol.eu/report/GeoMol_Report_web_reduced.pdf



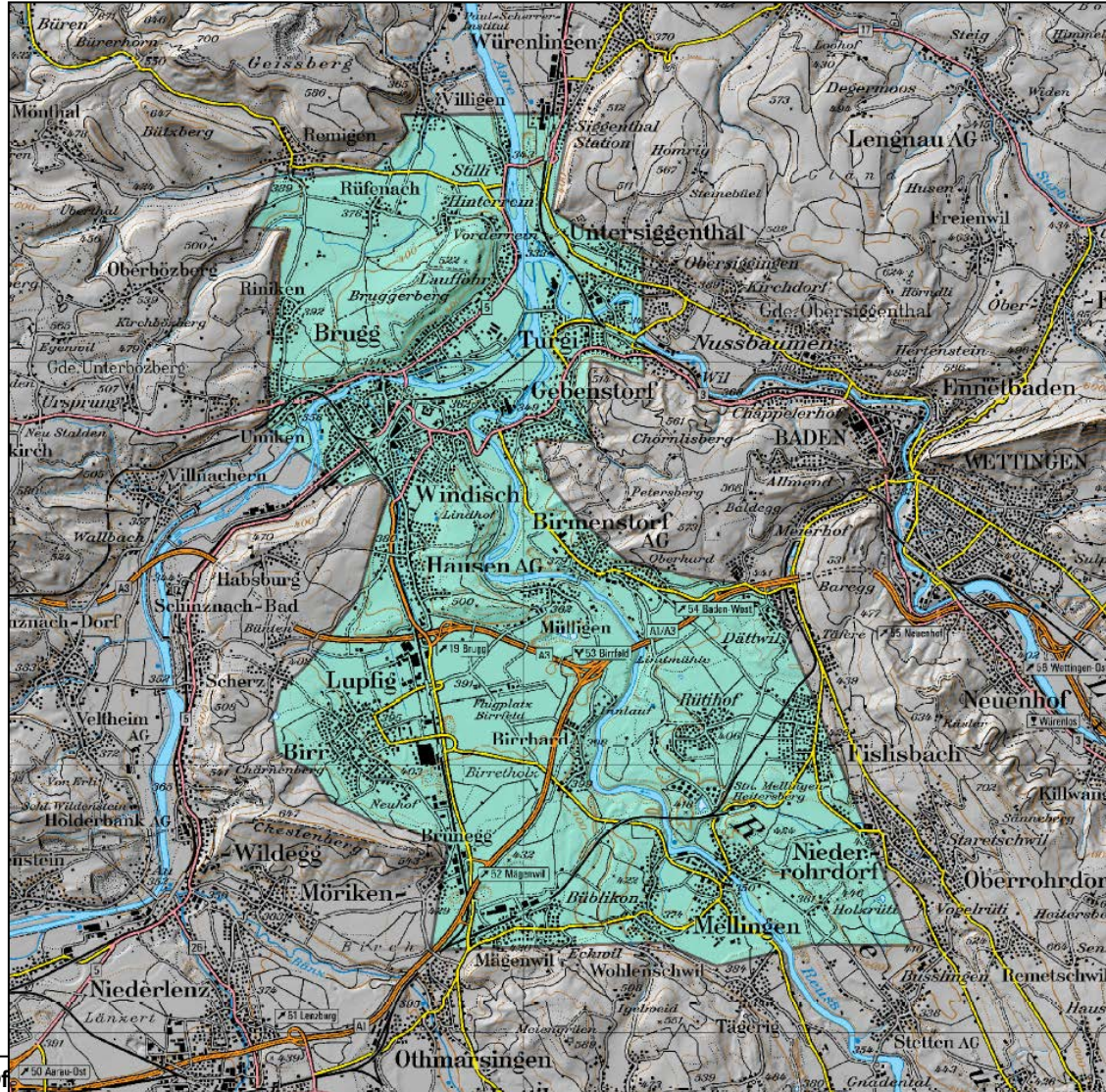
Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

GeoQuat: Informationssystem der quartären Lockergesteine in der Schweiz



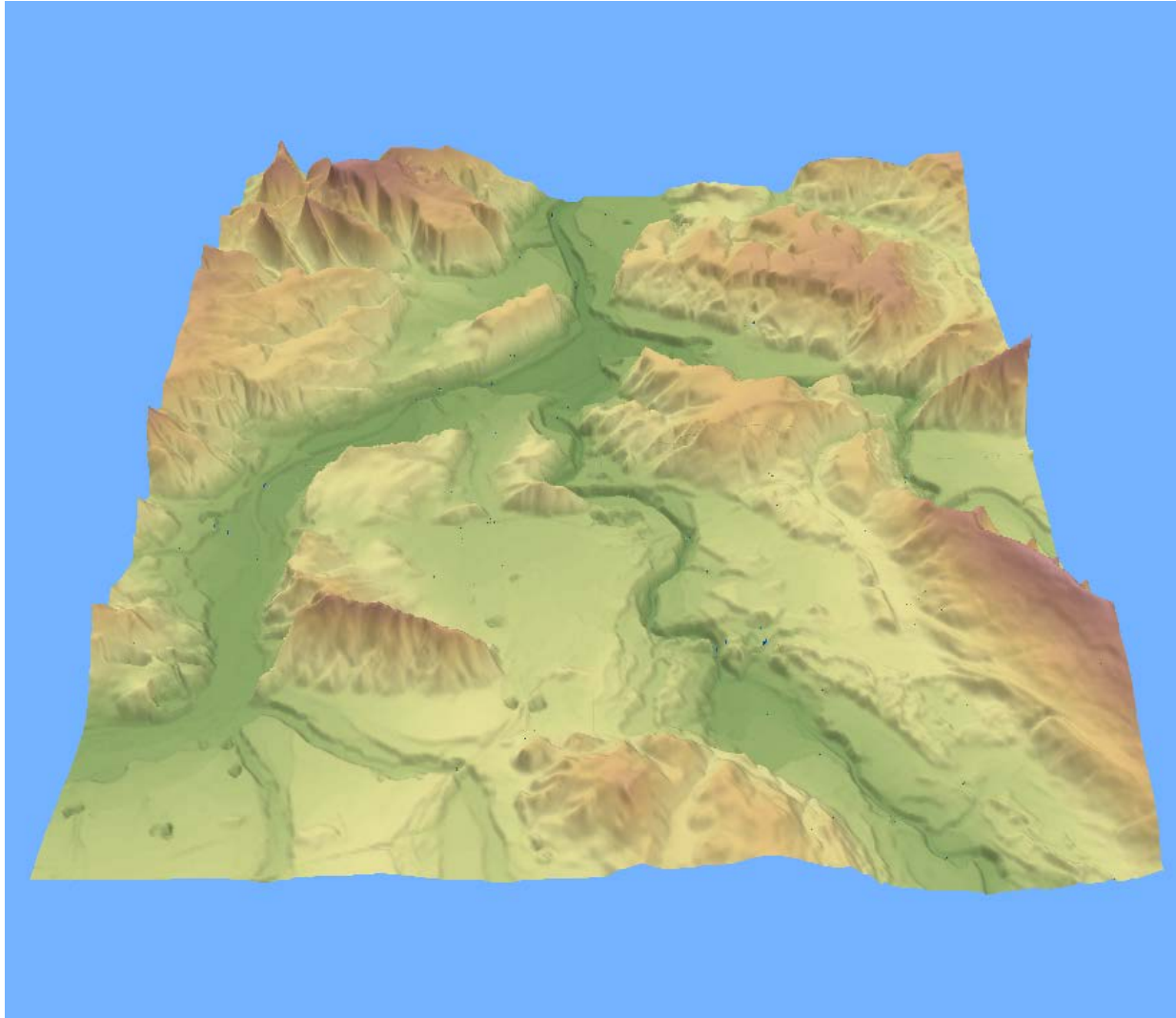


Case-study: Birrfeld





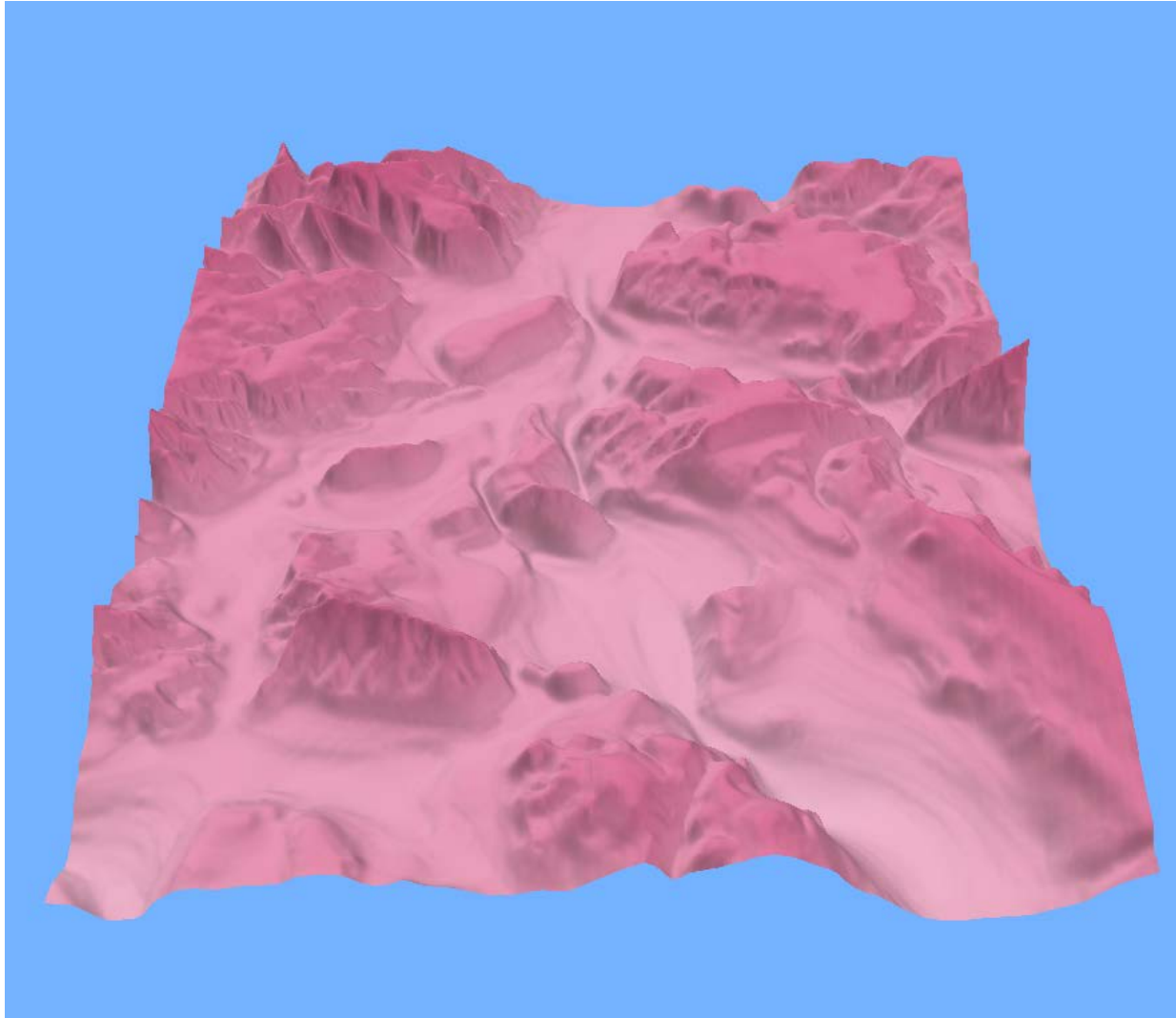
Case-study: Birrfeld



Digital elevation model



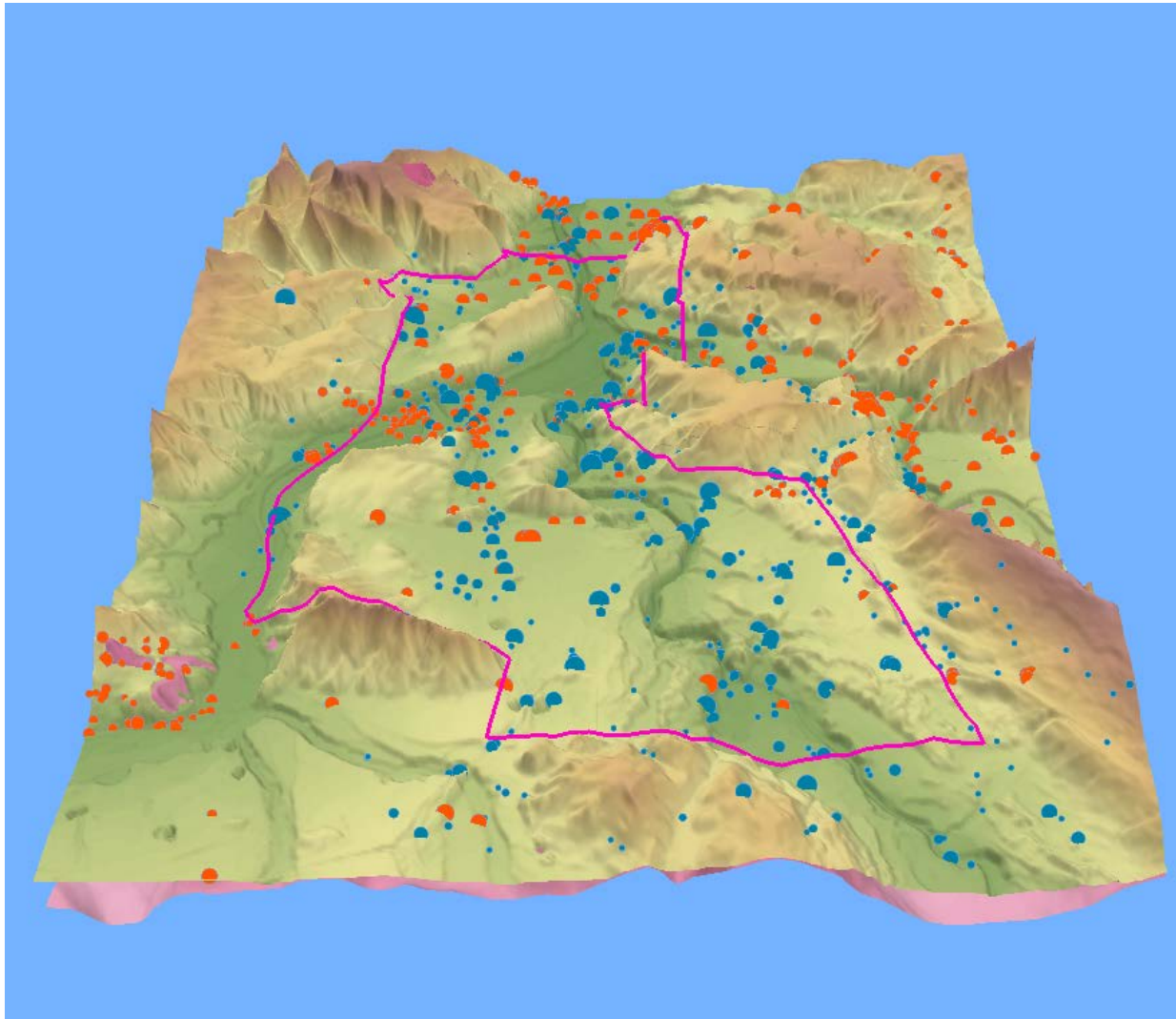
Case-study: Birrfeld



**Toprock Model
(GeoMol)**



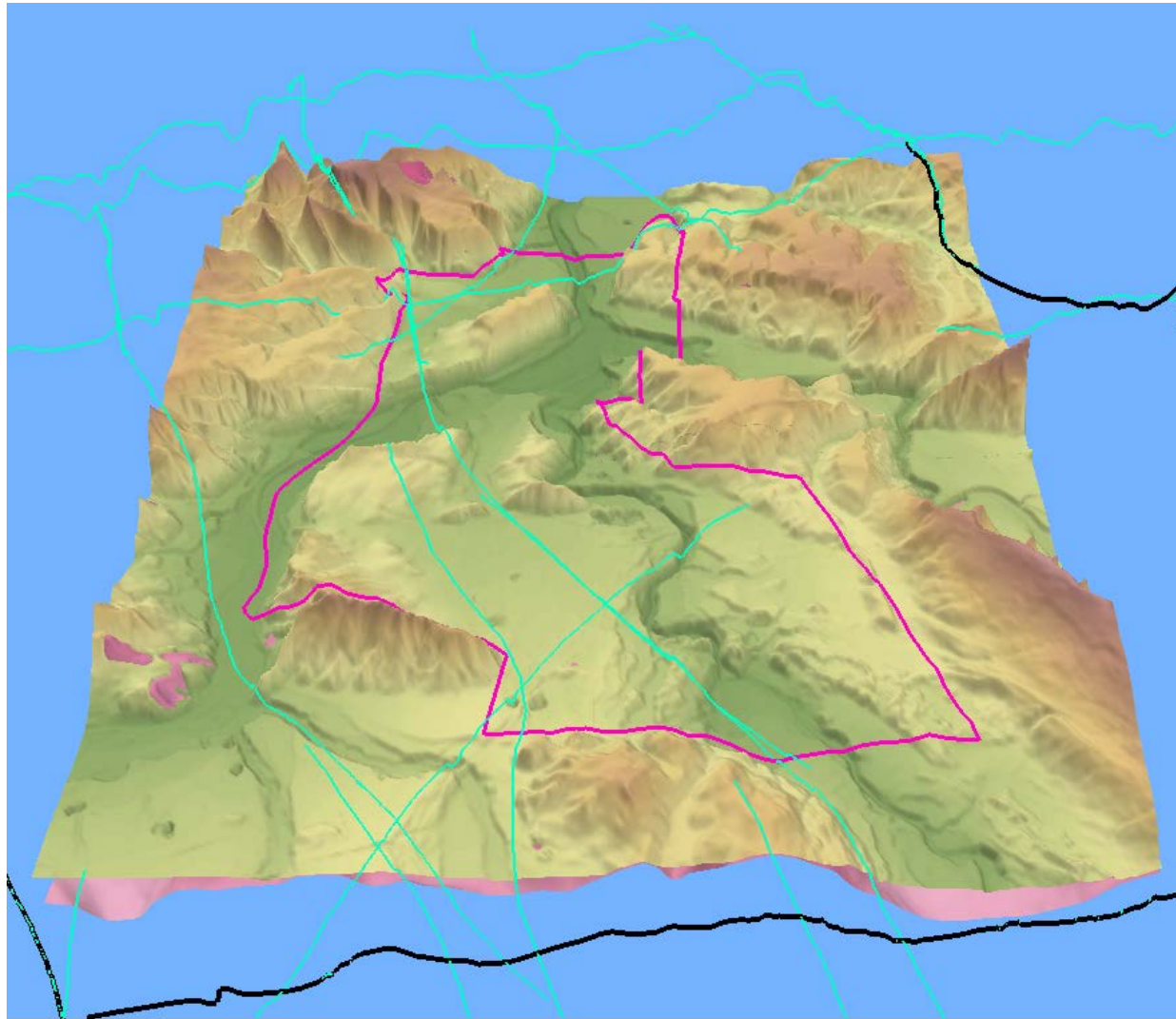
Case-study: Birrfeld



1400 Boreholes



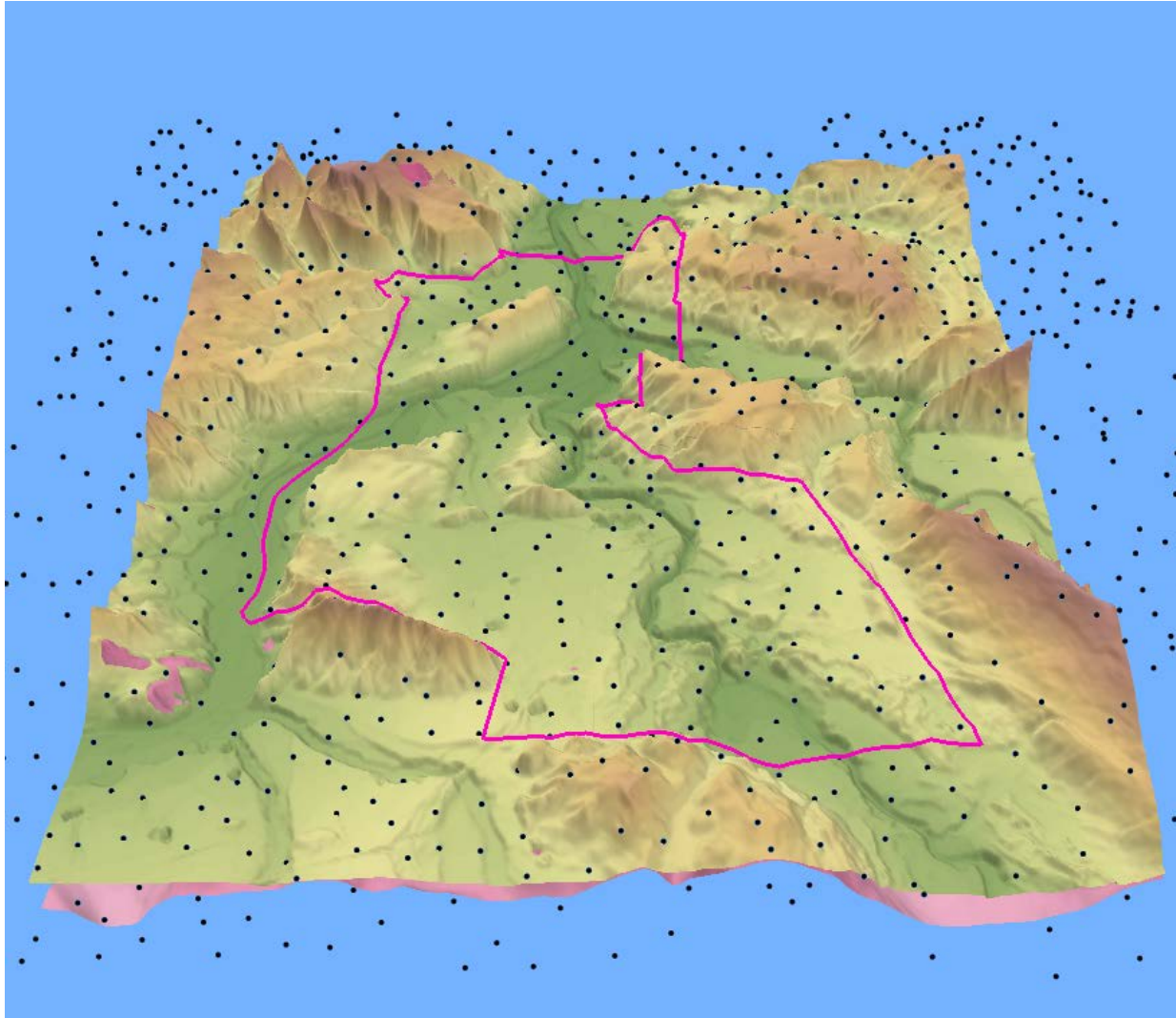
Case-study: Birrfeld



Sismic Lines



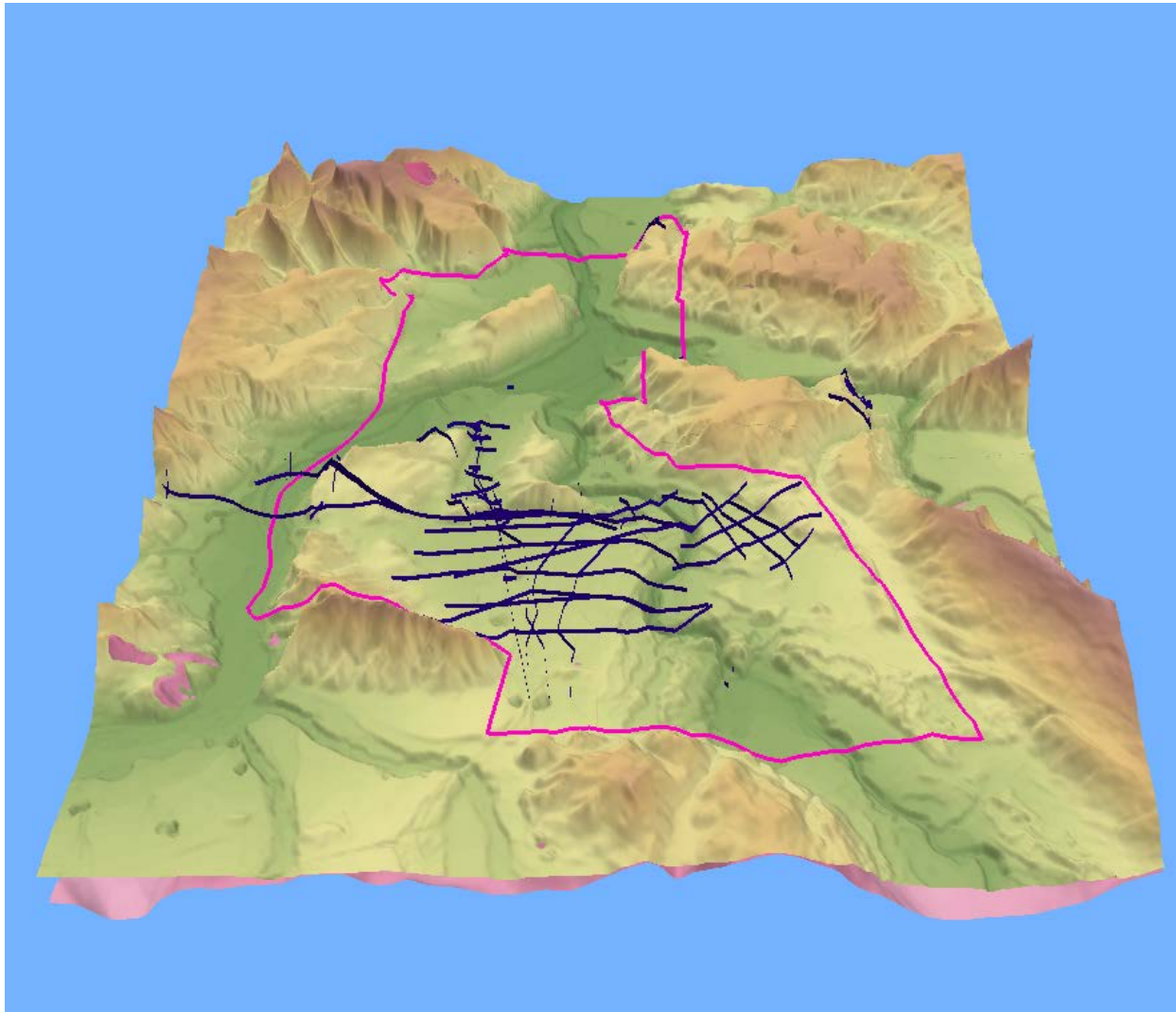
Case-study: Birrfeld



Gravimetry



Case-study: Birrfeld



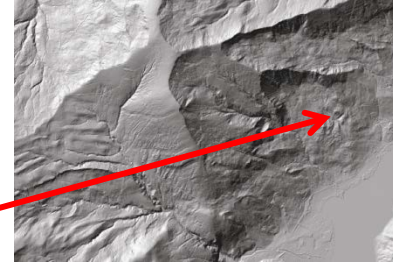
Geological cross-section



Uncertainty estimates with depth

- At the surface: Digital Elevation Model

0 m: vertical accuracy in mm



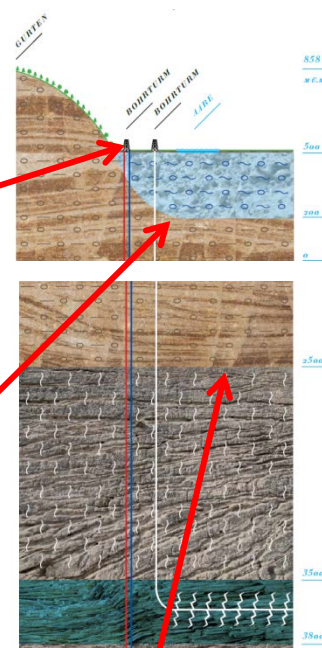
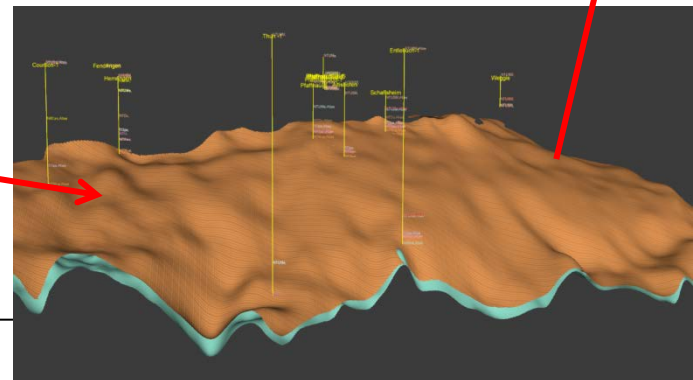
- At the top of the bedrock :

- 200 m: +/- 5 bis 10 m



- At the deep underground:

- 2000 m: +/- 100 m





Thank you for your attention!

