Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Federal Office of Topography swisstopo
Swiss Geological Survey

wissen wohin
savoir où
sapere dove
knowing where

swisstopo

Building a National 3D Geological Model of Switzerland:

Integrating Diverse Geological Settings and Data Constraints

12.10.2026

Eva Kurmann
Ferdinando Musso Piantelli, Lance Reynolds, Salomè Signer, Anina Ursprung, Philip Wehrens, Herwig Müller

GSEU GEOLOGICAL SERVICE FOR EUROPE

Why a National Geological Model?

Federal mandate: Digitisation of the geological subsurface by 2032

National Geological Model (NGM)

Standardised collection and **digitisation** of geological data

Accelerated production of **nationwide 2D & 3D geodata**

Central, public access to geodata

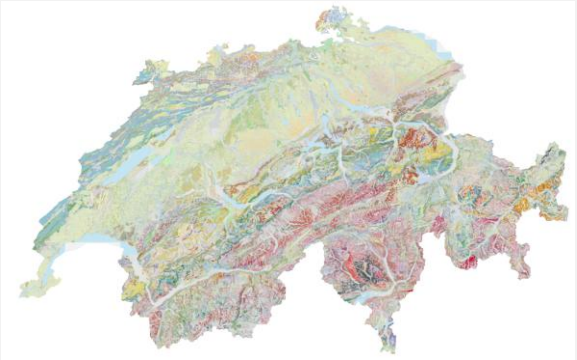
swiss geol assets

swiss geol viewer

swiss geol boreholes

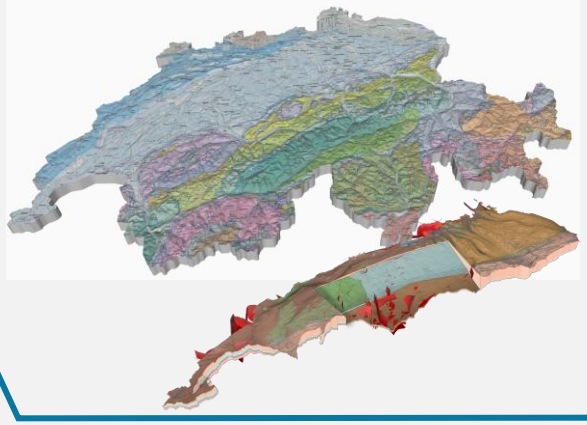
swiss geol lexic

2D geological data



Harmonisation of the geological 2D vector data (1:25000)

3D geological models



Nationwide 3D geological model

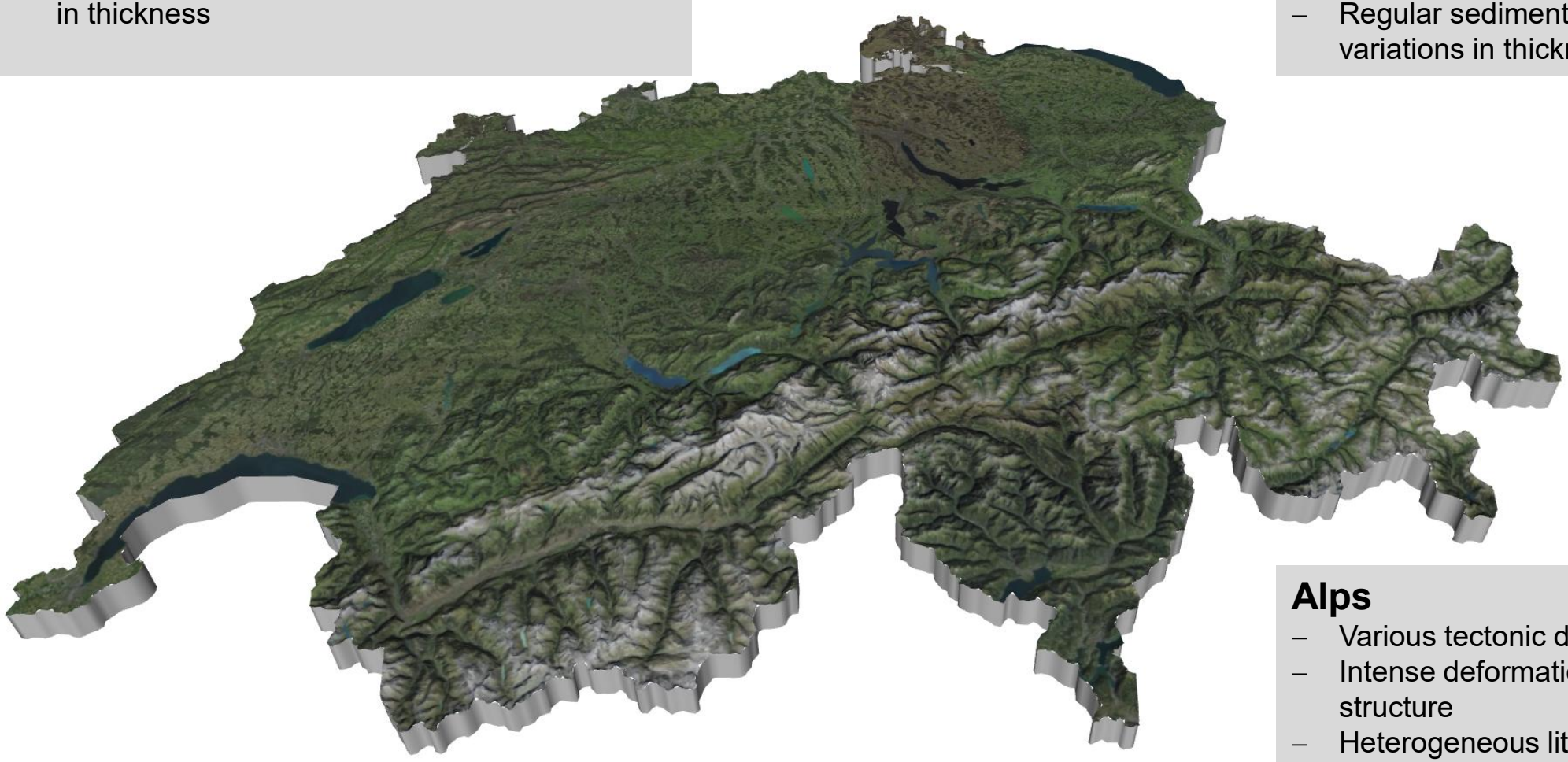
A national model – different geological regions

Jura mountains

- Classic fold and thrust belt
- Regular sequence of folds and thrusts
- Regular stratigraphy with continuous variations in thickness

Molasse basin

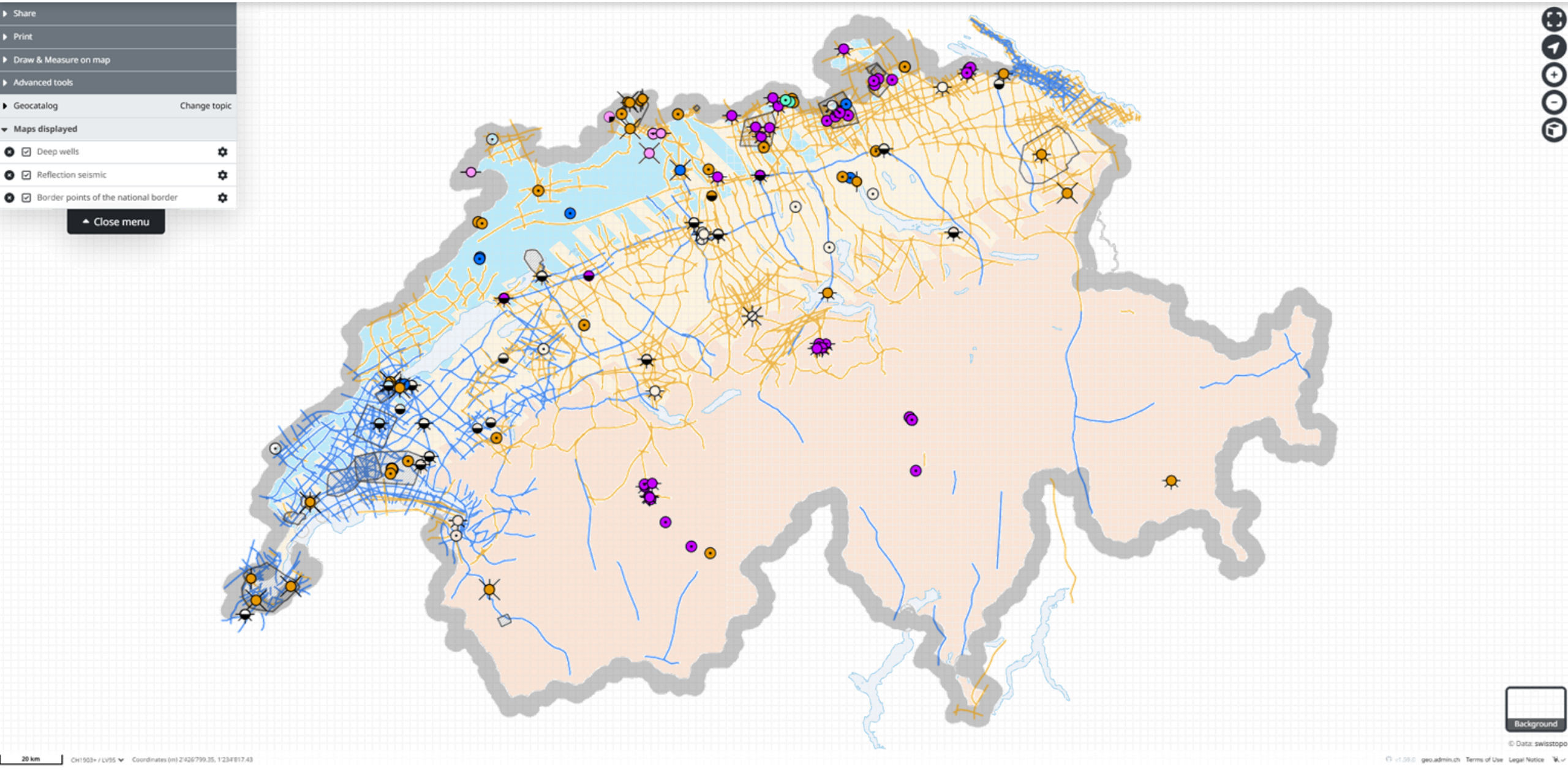
- Asymmetrical Alpine foreland basin
- Large-scale, continuous, weakly deformed stratigraphic geometry
- Regular sedimentary sequence with regional variations in thickness



Alps

- Various tectonic domains
- Intense deformation and complex nappe structure
- Heterogeneous lithostratigraphic sequences

A national model – varying data sets

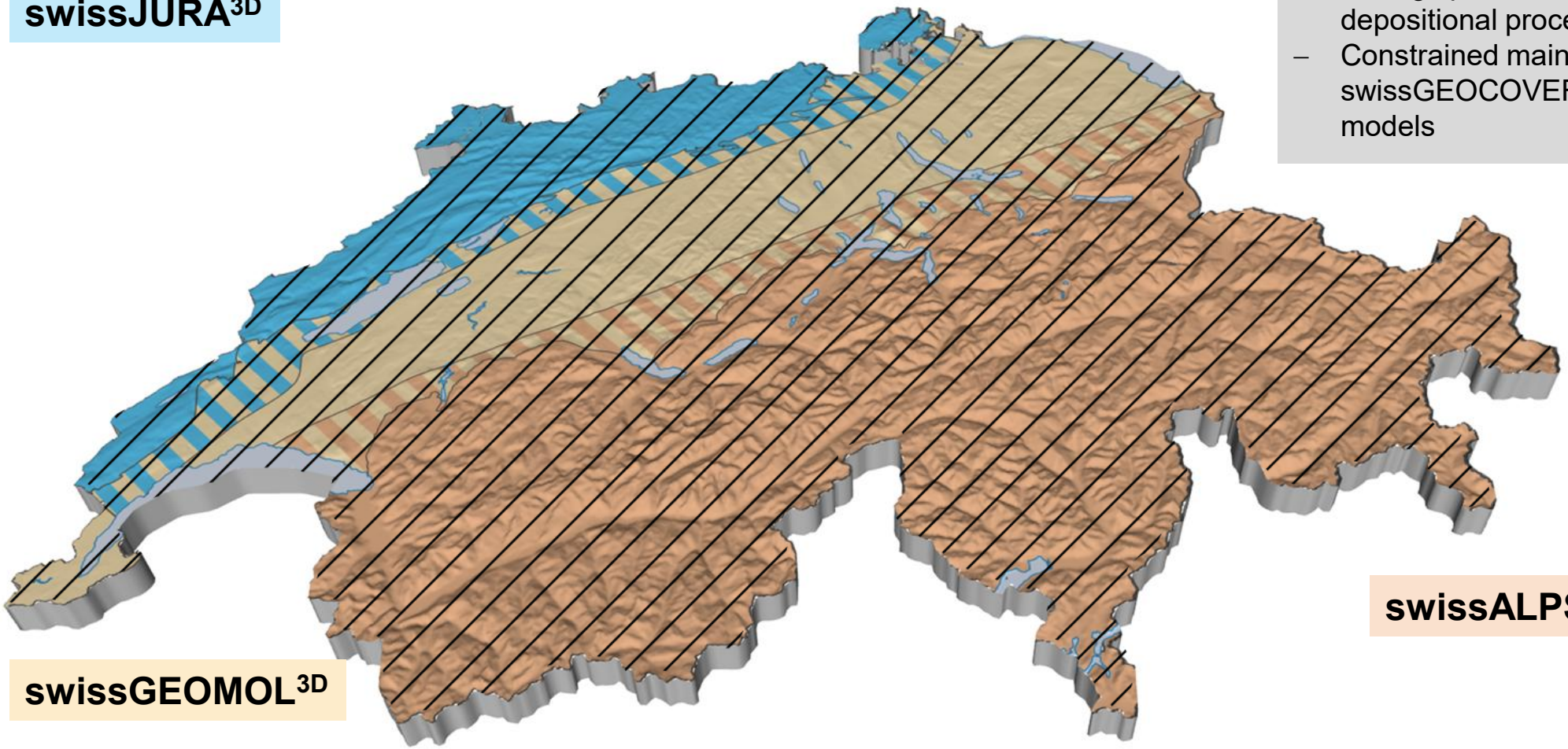


Four national 3D geological models

swissBEDROCK^{3D}

- Boundary between unconsolidated deposits and bedrock
- Strong spatial variability shaped by erosional and depositional processes
- Constrained mainly by boreholes, swissGEOCOVER^{2D} and existing regional models

swissJURA^{3D}



swissALPS^{3D}

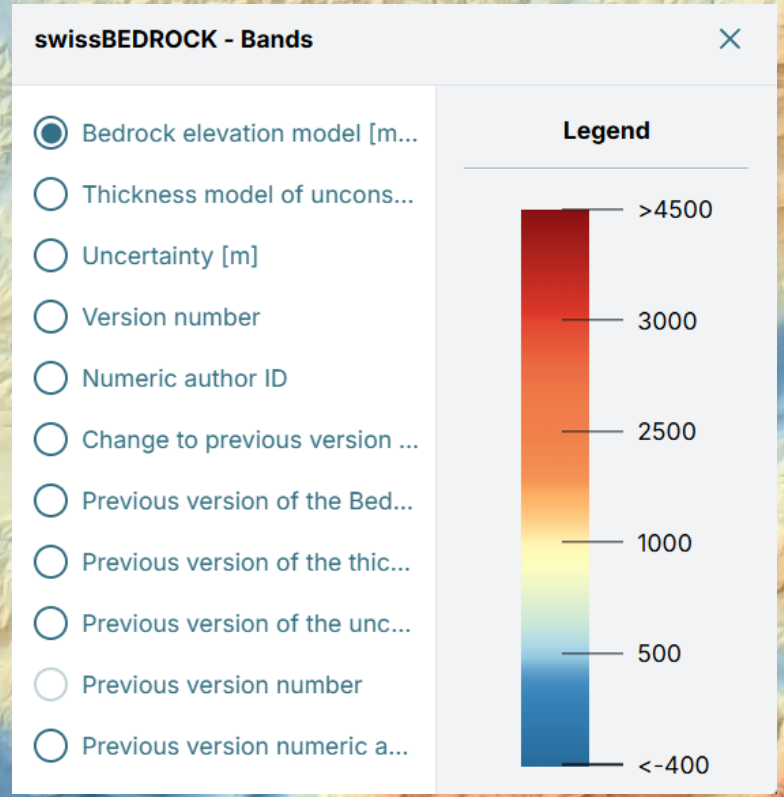
swissGEOMOL^{3D}

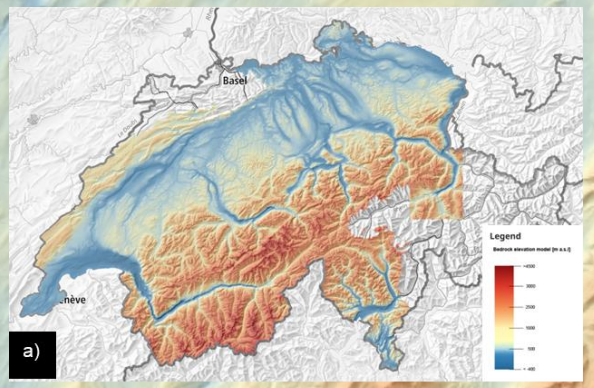
swissBEDROCK^{3D}

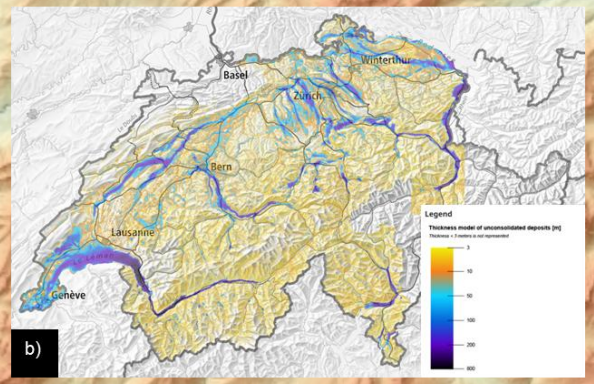
Technical specifications

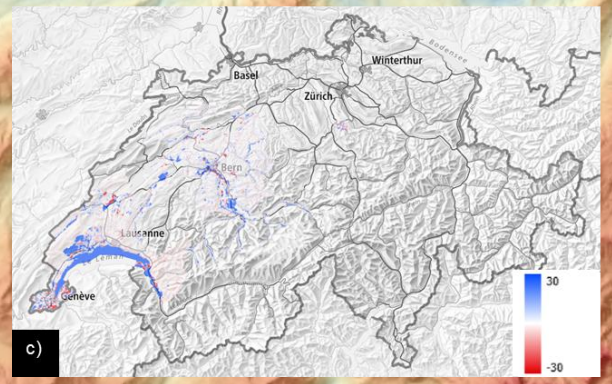
- Cell dimensions: 10m x 10m
- **Automated workflow :**
  - Regional replacement with a model created by third parties (e.g. cantons)
  - Regional update: based on boreholes (boreholes.swissgeol.ch) and extracts from swissGEOCOVER^{2D}
- Multidimensional raster with 11 data bands
- Regular updates
- Download and technical documentation available

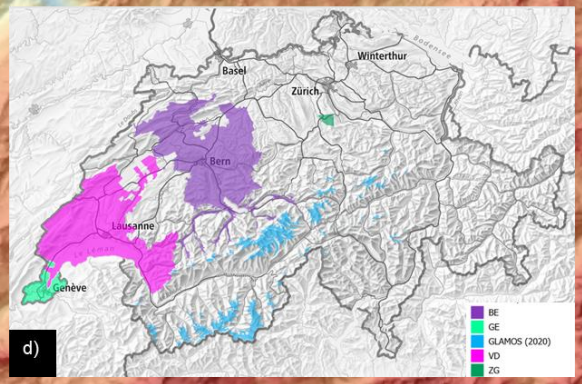
viewer.swissgeol.ch





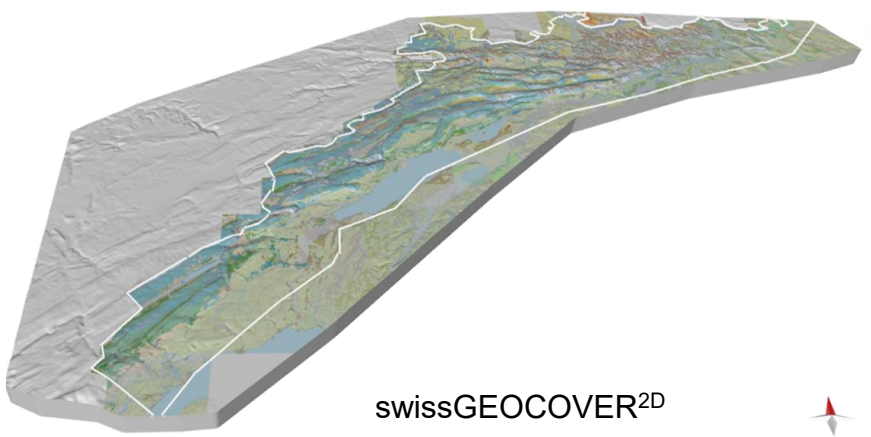




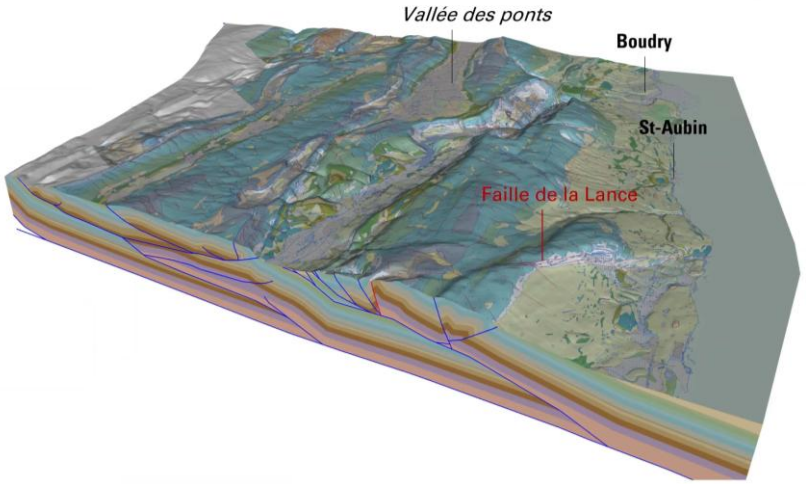


swissJURA^{3D} – Different modelling strategies

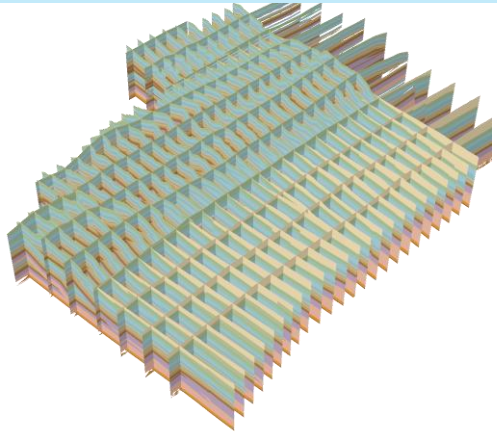
swissJURA^{3D}



swissGEOCOVER^{2D}



Fence model

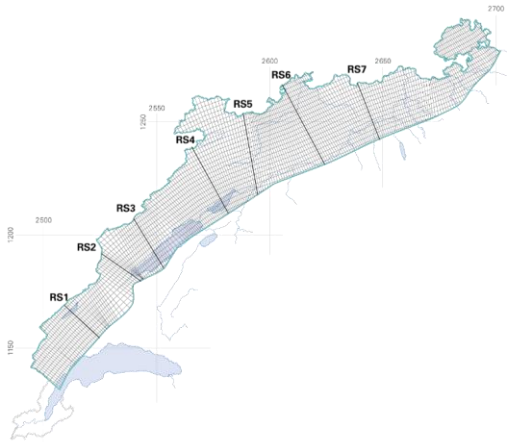


dense network of modelled, ideally balanced cross-sections

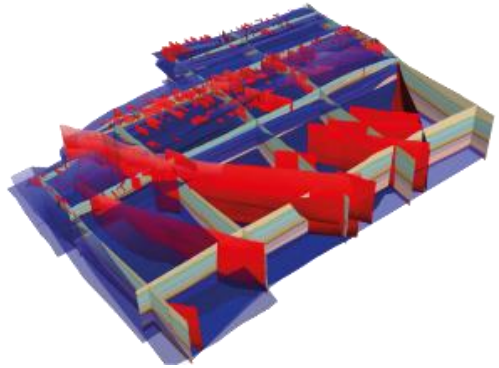
regular cross-sections

provides better control of the model

basic framework of the subsurface



Structural model

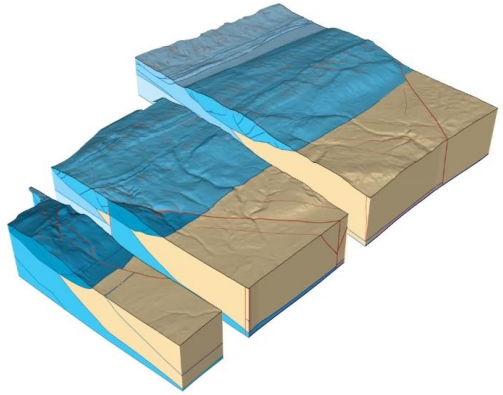


on the basis of phase 1

modelling the fault surfaces between the fence diagram

matching with GC3 on the surface

connecting element in the fence diagram



Horizon model

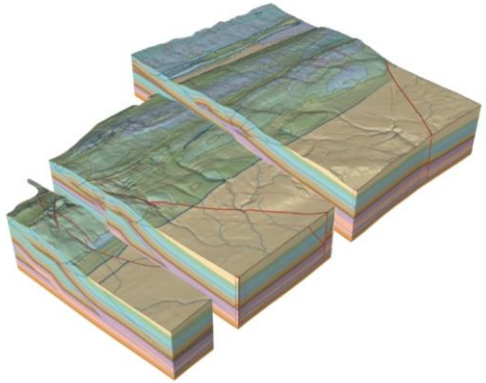


on the basis of phase 1 and 2

modelling of a lithostratigraphic interface (Top Ifenthal)

matching with GC3 on the surface

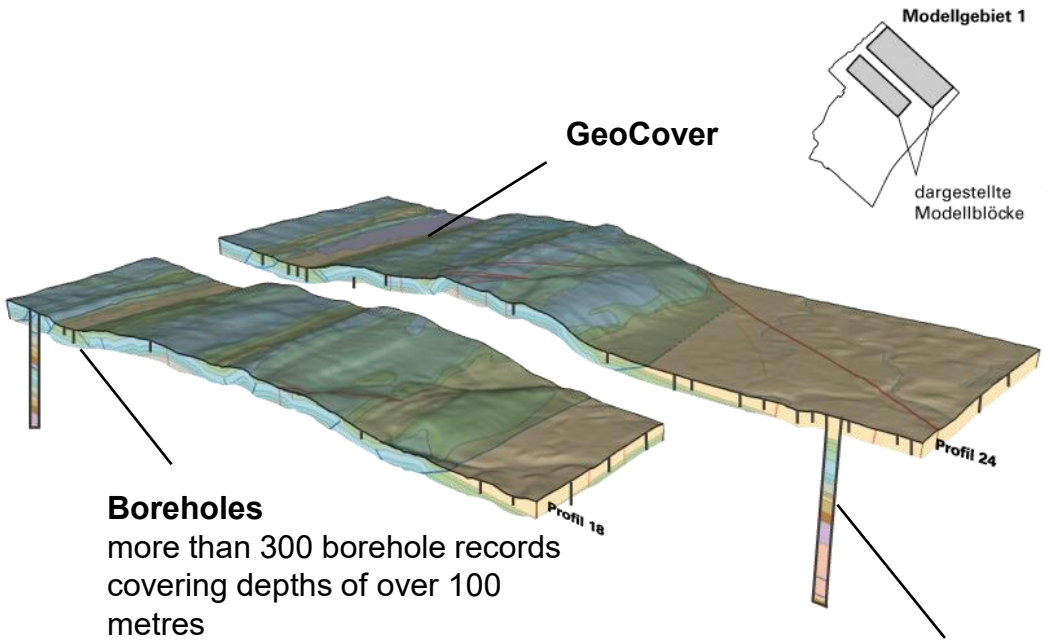
connecting element in the fence diagram



Challenge: limited data, significant geological constraints

The state of the input data

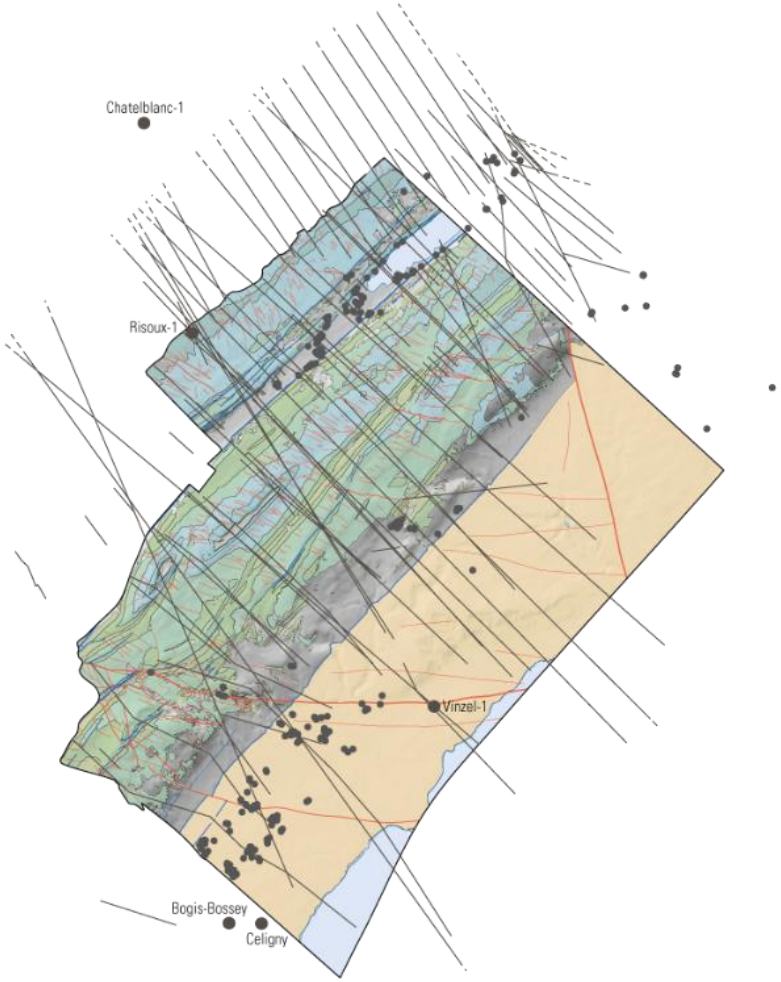
- High-quality surface geological database
- Large amount of shallow borehole data
- Few deep boreholes and little seismic data
- Heterogeneous geological profiles and 3D models



Boreholes
more than 300 borehole records covering depths of over 100 metres

Deep wells
Very few

Schematic representation of the geological data relating to the subsurface.



Data coverage map
Model area 1 St-Cergue – Le Sentier

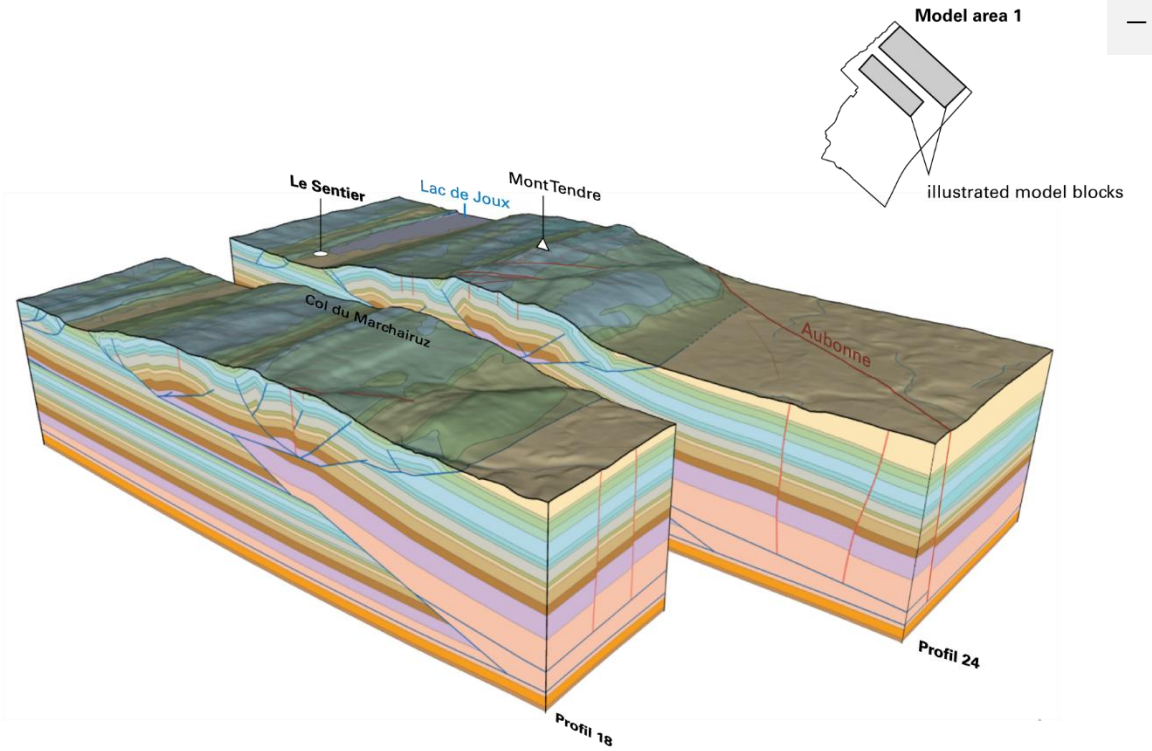
Challenge: limited data, significant geological constraints

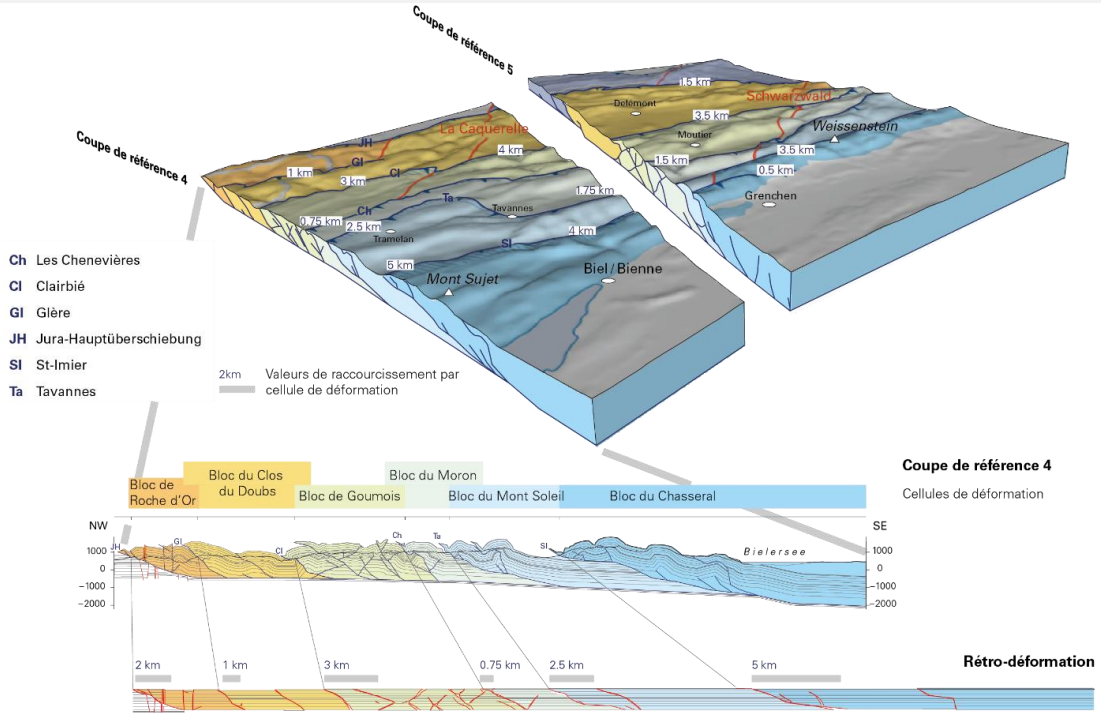
The state of the input data

- High-quality surface geological database
- Large amount of shallow borehole data
- Few deep boreholes and little seismic data
- Heterogeneous geological profiles and 3D models

Model framework conditions

- Consistency with geological map at the topography (swissGEOCOVER^{2D})
- Uniformly varying thicknesses
- Kinematic and structural framework
  - Large-scale structures and shortening amount
  - Kinematic consistency
- Basal detachment in the model
- Influence of crystalline basement structures





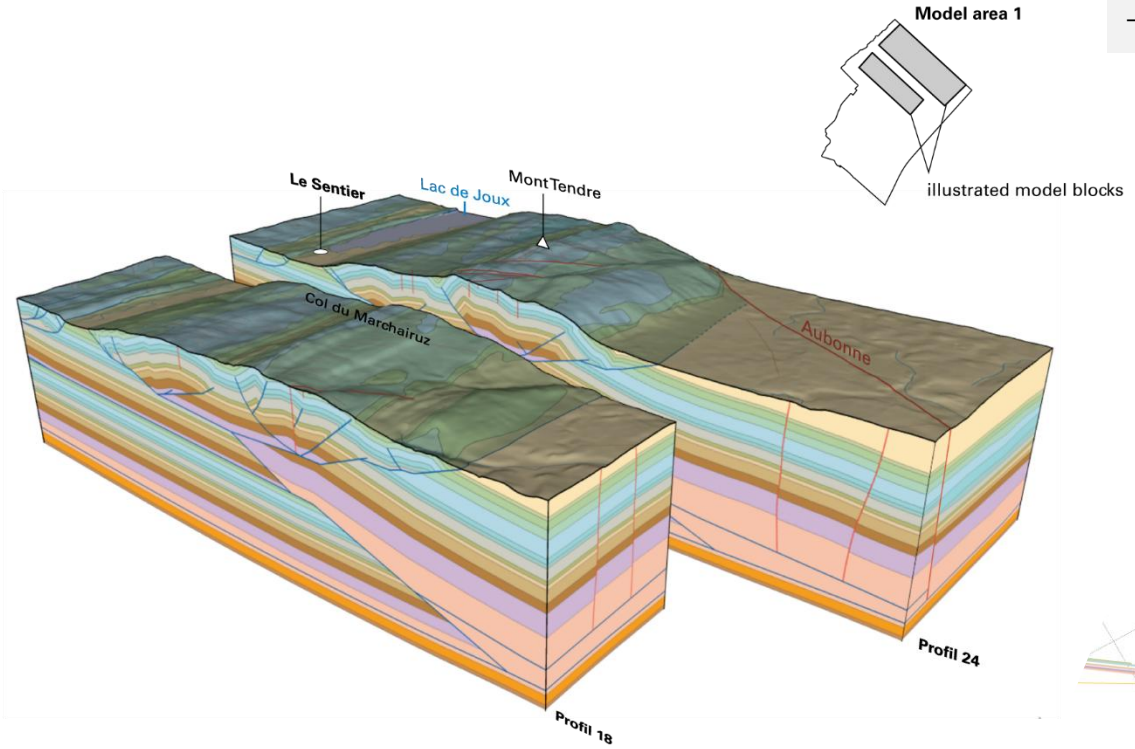
Challenge: limited data, significant geological constraints

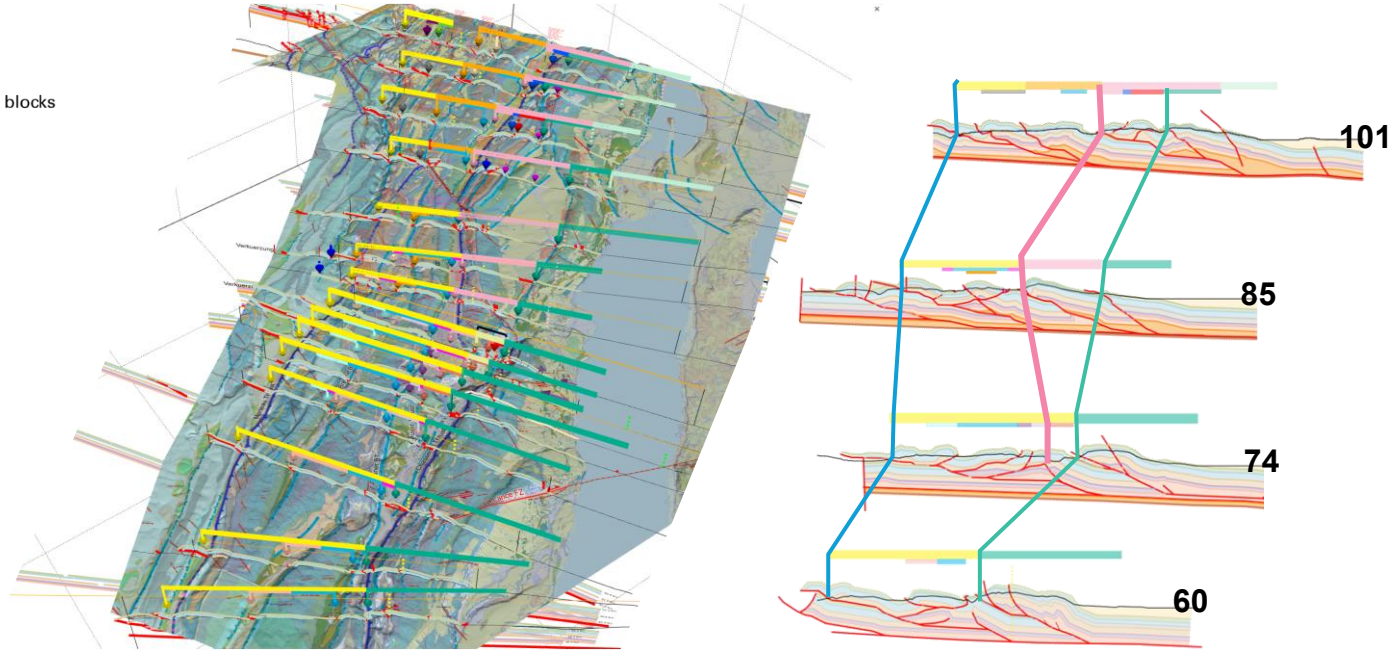
The state of the input data

- High-quality surface geological database
- Large amount of shallow borehole data
- Few deep boreholes and little seismic data
- Heterogeneous geological profiles and 3D models

Model framework conditions

- Consistency with geological map at the topography(swissGEOCOVER$^{2D)}$
- Uniformly varying thicknesses
- Kinematic and structural framework
  - Large-scale structures and shortening amount
  - Kinematic consistency
- Basal detachment in the model
- Influence of crystalline basement structures





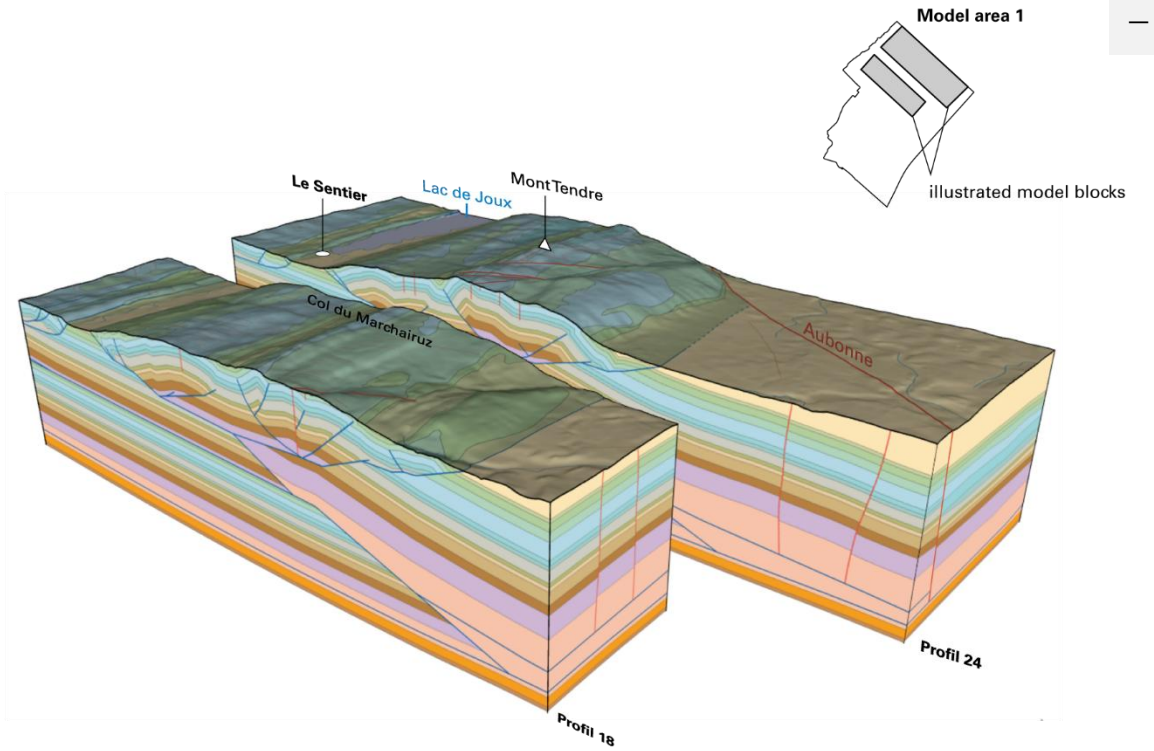
Challenge: limited data, significant geological constraints

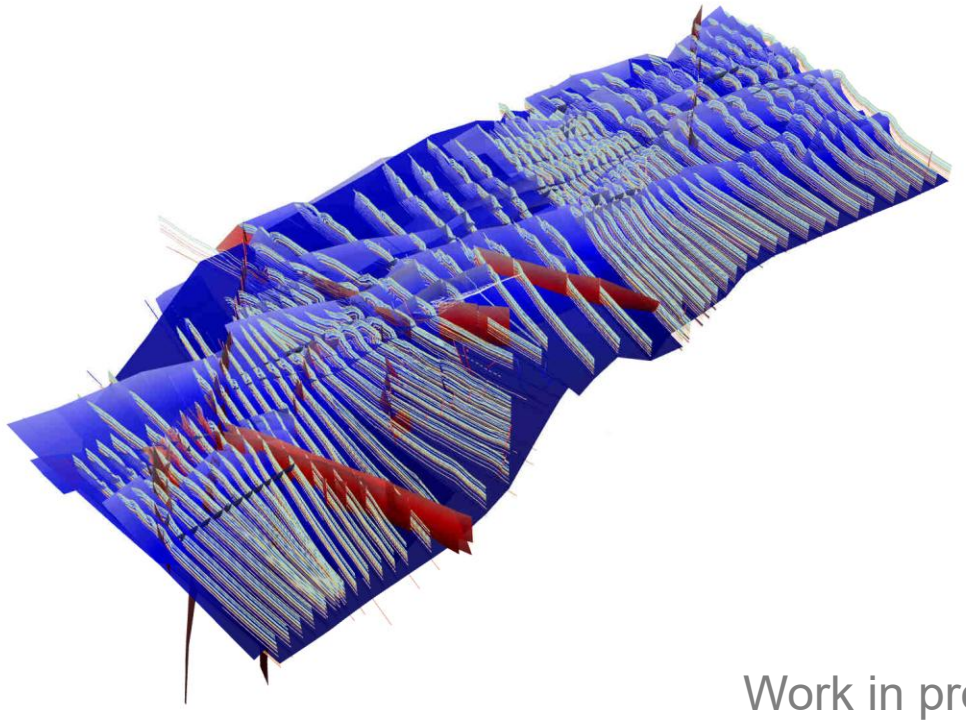
The state of the input data

- High-quality surface geological database
- Large amount of shallow borehole data
- Few deep boreholes and little seismic data
- Heterogeneous geological profiles and 3D models

Model framework conditions

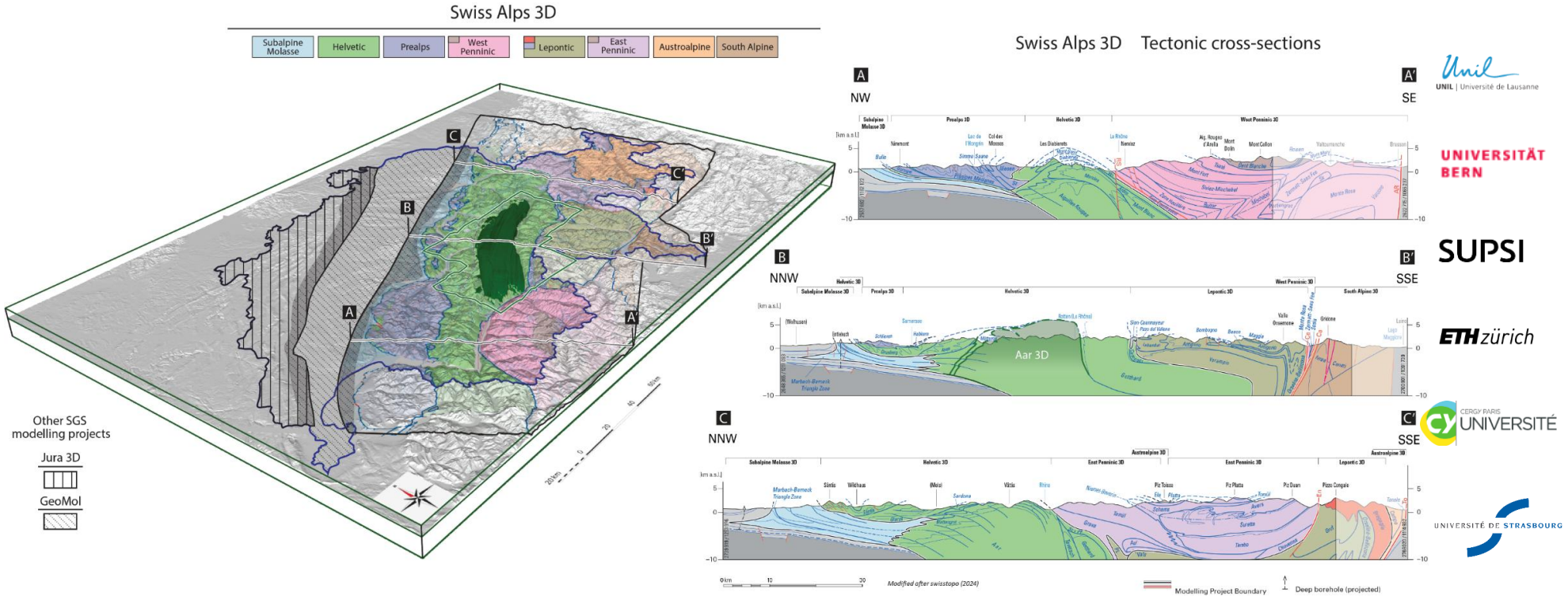
- Consistency with geological map at the topography(swissGEOCOVER$^{2D)}$
- Uniformly varying thicknesses
- Kinematic and structural framework
  - Large-scale structures and shortening amount
  - Kinematic consistency
- Basal detachment in the model
- Influence of crystalline basement structures





Work in progress

swissALPS^{3D} – Different modelling strategies



UNIL | Université de Lausanne

UNIVERSITÄT BERN

SUPSI

ETH zürich

CERGY PARIS UNIVERSITÉ

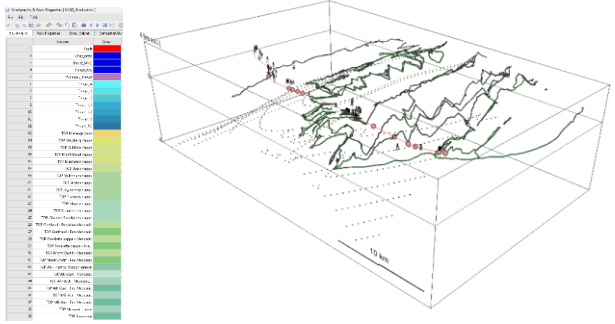
UNIVERSITÉ DE STRASBOURG

Key results

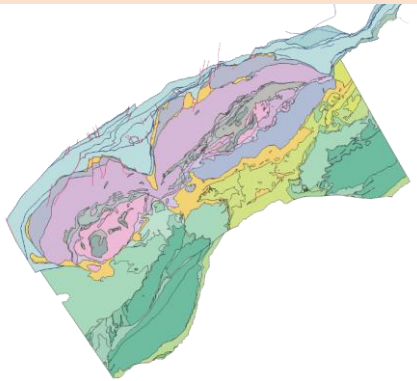
Development of:

- A consistent large-scale 3D geological model of the Swiss Alpine nappe stack subsurface.
- Key knowledge and digital visualization of the main lithostratigraphic and structural systems of the Alpine subsurface.
- A diverse community of experts in 3D modelling of deformed Alpine regions.

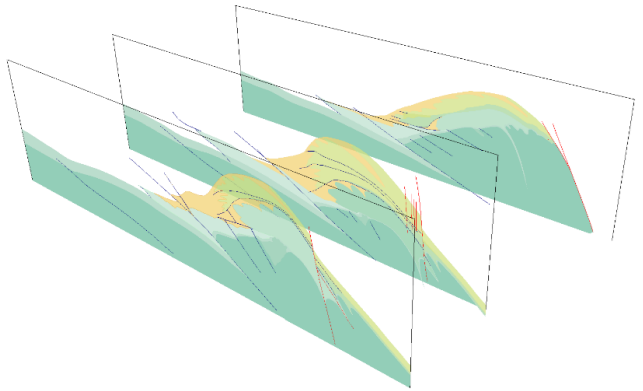
1 Input Data



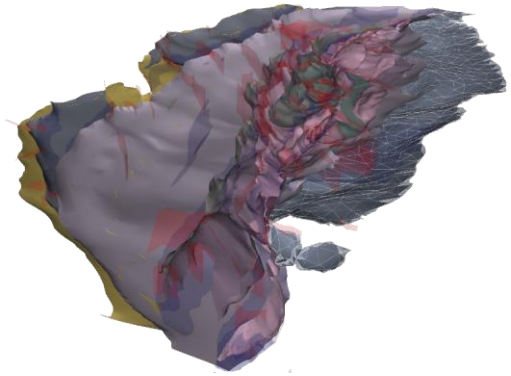
2 Map of the modelled structures



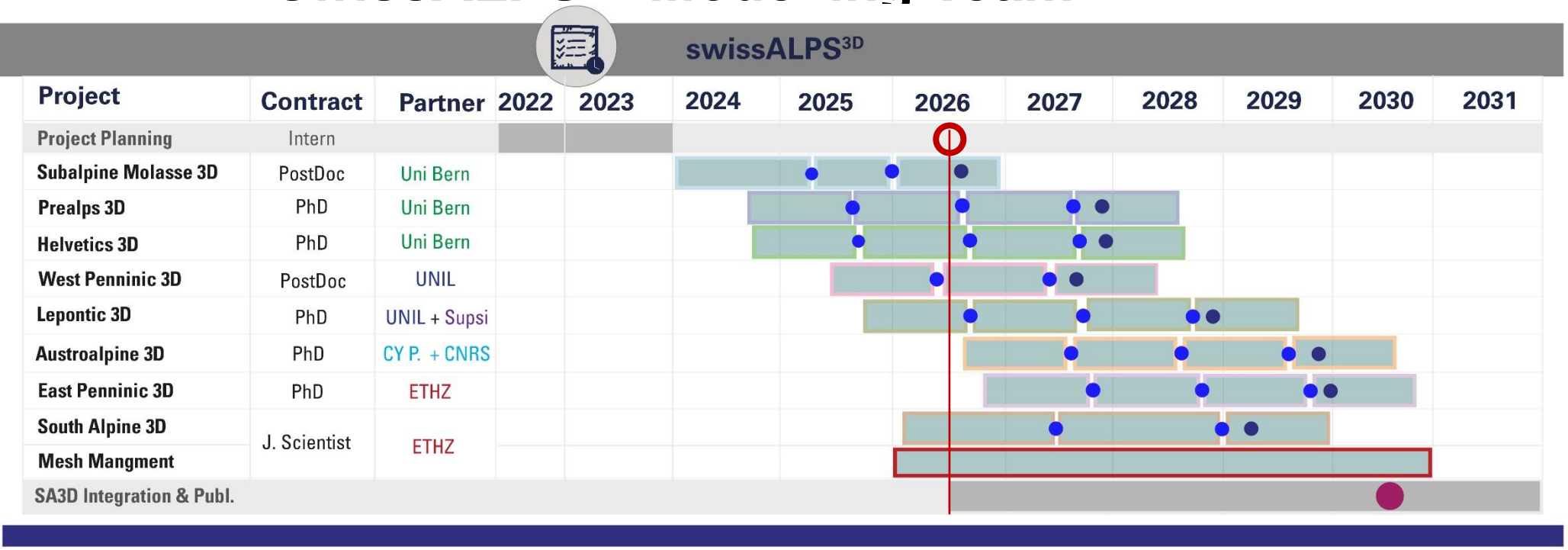
3 Reference sections



4 3D-surfaces (Meshes)



swissALPS^{3D} Modelling Team



swisstopo SA3D Core Team


Herwig R. Müller
NGM Program Lead


Dr. Ferdinando Musso Piantelli
SA3D Project Lead


Dr. Eva Kurmann
SA3D Deputy

Scientific Supervisors


Prof. Dr. Anindita Samsu


Prof. Dr. Marco Herwegh


Prof. Dr. Filippo Schenker


Dr. Stefan Heuberger


Prof. Dr. Whitney M. Behr


Dr. Geoffroy Mohn


Prof. Dr. Alfons Berger


Prof. Dr. Fritz Schlunegger


Prof. Dr. Stefan Schmalholz


Prof. Dr. Jean-Luc Epard


Dr. Lukas Nibourel


Prof. Dr. Gianreto Manatschal

Modelling Team


Subalpine Molasse 3D
Dr. Philippos Garefalakis
PostDoc
Start: January 2024

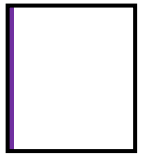

Helvetic 3D
Matteo Furlan
PhD
Start: September 2024


Prealps 3D
Sebastian Drvorderic
PhD
Start: August 2024


West Penninic 3D
Dr. Sofia Brisson
Postdoc
Start: May 2025

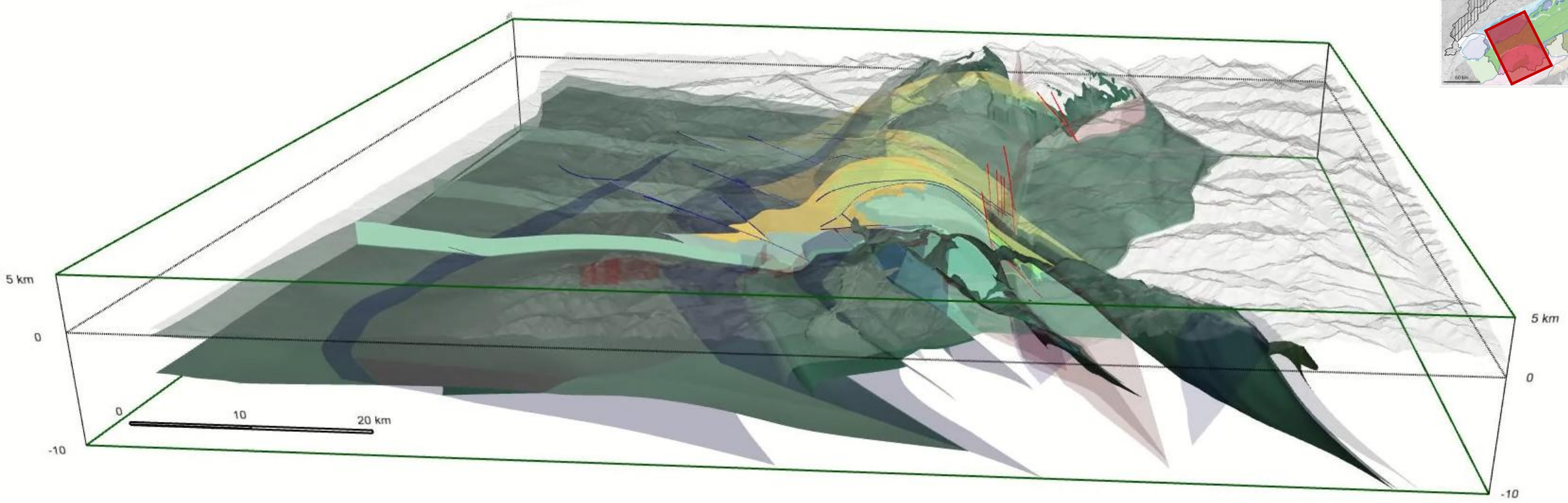

Lepontic 3D
Matteo De Guglielmi
PhD
Start: September 2025

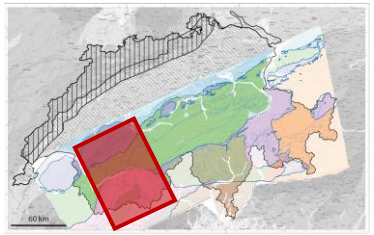

Austroalpine 3D
Jules Paulin
PhD
Start: September 2026


East Penninic 3D
Tba
PhD
Start: September 2026


South Alpine 3D
SA3D Mesh Management
Martina Cervelli

swissALPS^{3D} first results







Helvetic

Prealps

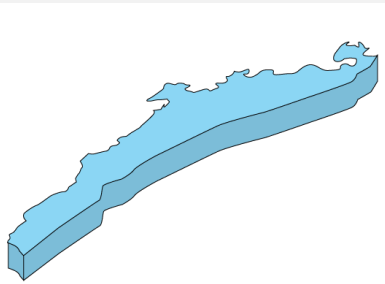
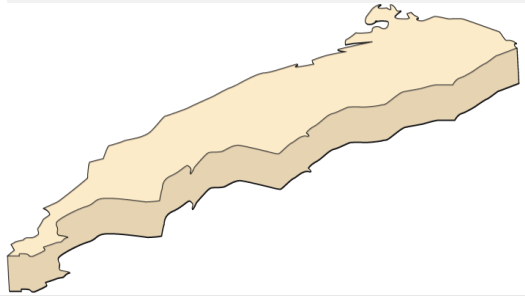
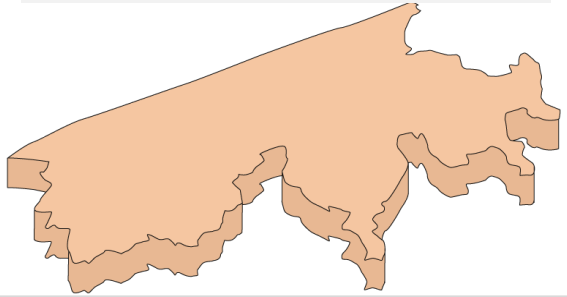
Subalpine Molasse


Matteo Furlan


Sebastian Drvorderic

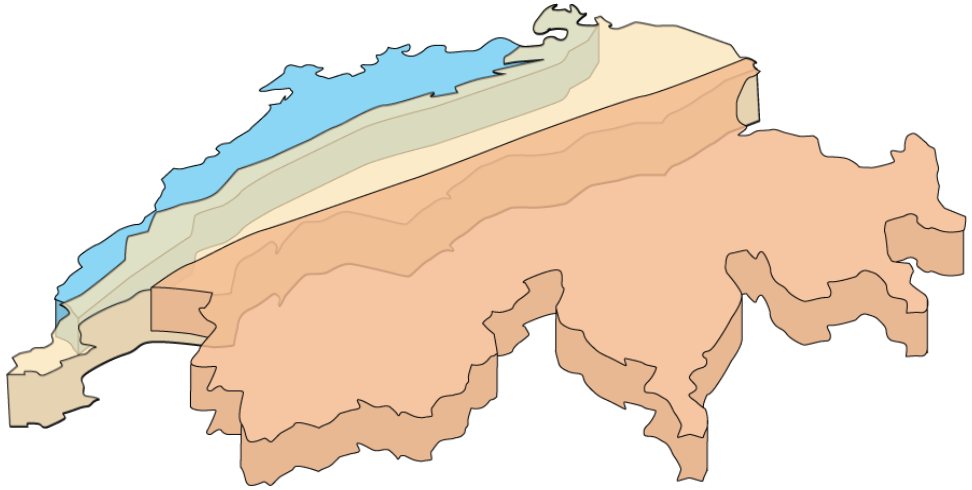

Dr. Philippos Garefalakis

Three models – different constraints

	swissJURA^{3D}	swissGEOMOL^{3D}	swissALPS^{3D}
			
Data density	surface depth	surface depth	surface depth
Geological compexity	complexity predictability	complexity predictability	complexity predictability
Level of detail	surface depth *at surface: swissGEOCOVER^{2D}* *at depth: schematic, more conceptional*	surface depth *at depth: seismic data*	surface depth *detailed position of major tectonic structures (Tectonic map)*

Towards an Integrated National 3D Geological Model

Adapted modelling strategies
Allow us to represent the geology in 3D as appropriately as possible within the available ressources.



A common geological foundation
Harmonised geological maps (swissGEOCOVER^{2D}), as well as classifications (Lexic) and transition zones, provide the basis for model integration.

Transparent communication
Differences in data basis, level of detail, uncertainty and limitations are clearly communicated to users.

Long-term maintenance
Experience from maintaining existing models helps us develop long-term update strategies for the entire national 3D framework.

Thank you for your attention!



Contact: eva.kurmann@swisstopo.ch