

16TH INTERNATIONAL CONFERENCE

UNDERGROUND CONSTRUCTION PRAGUE 2026

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Implementation of geological models and geoscientific data into BIM projects

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Motivation

- ✓ Complex treatment and reduction of uncertainties
 - ✓ Optimization of exploration phases and related costs
 - ✓ Design optimization due to building location and foundation
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- Risk reduction during construction and operation
 - Contract Terms and Conditions, Geotechnical Baseline Report



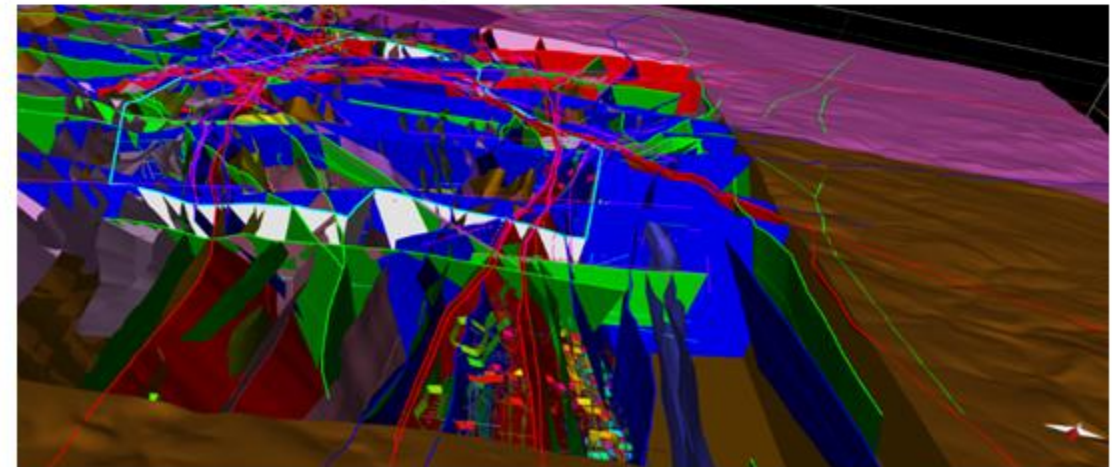
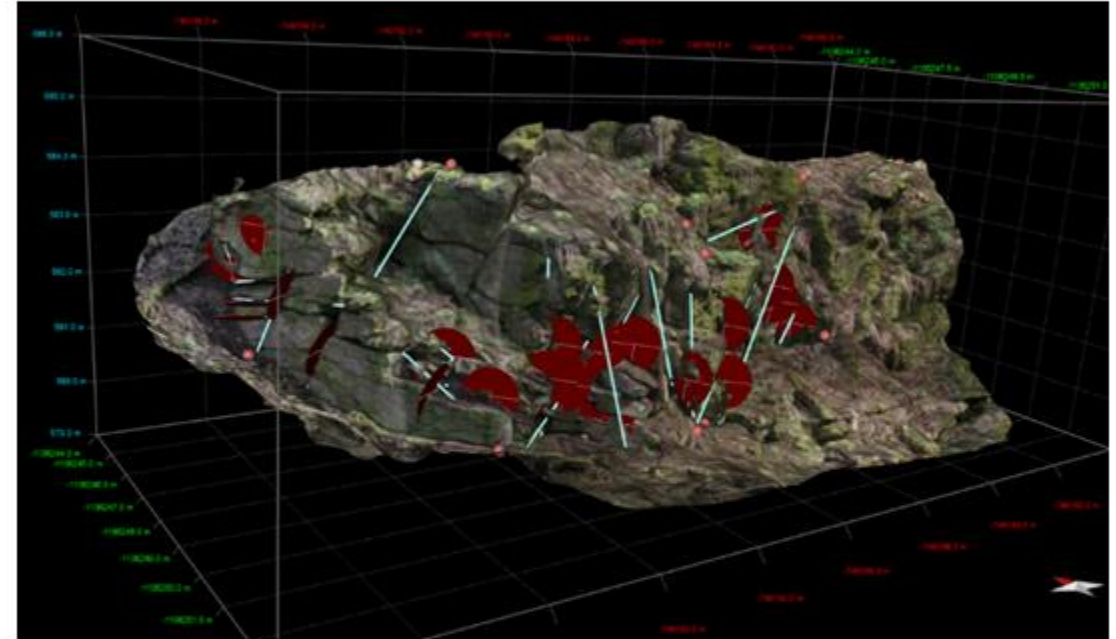
SÚRAO

CGS - 3D models at various scales

- **100 m²** – Experiment design, DFN
- **1 km²** – Economic geology, mineral deposits
- **10-100 km²** – Radioactive waste or CO₂ disposal
- **> 1000 km²** – Tunnels, geothermal evaluation, models of sedimentary basins for HG

Modelling SW – now dominantly **MOVE SW**:

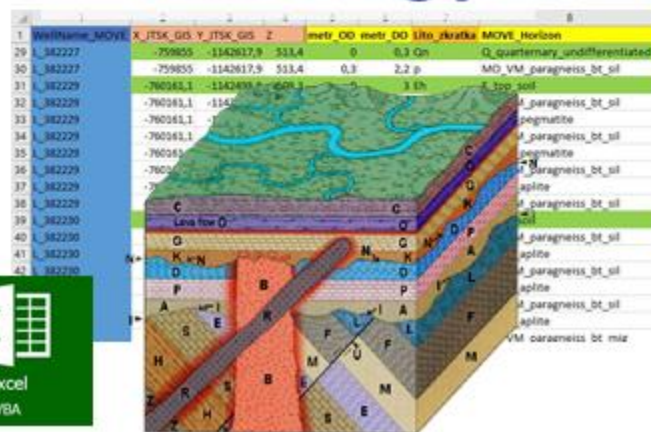
- Mainly Explicit modelling
- Suitable for complex, mainly crystalline geology of the Bohemian massif



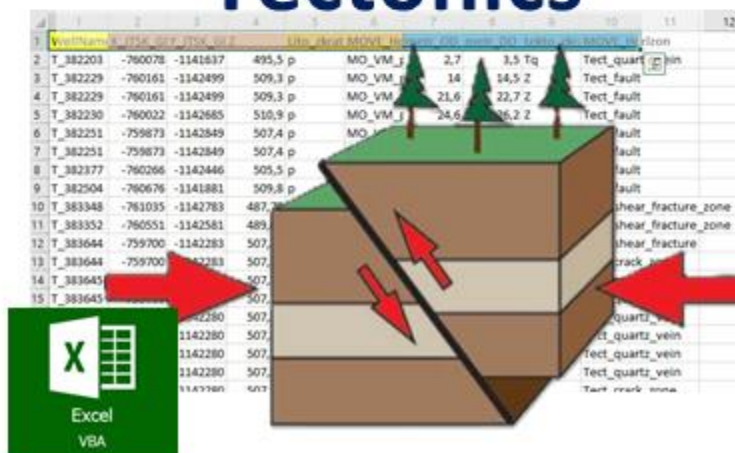
Example of data processing - Boreholes



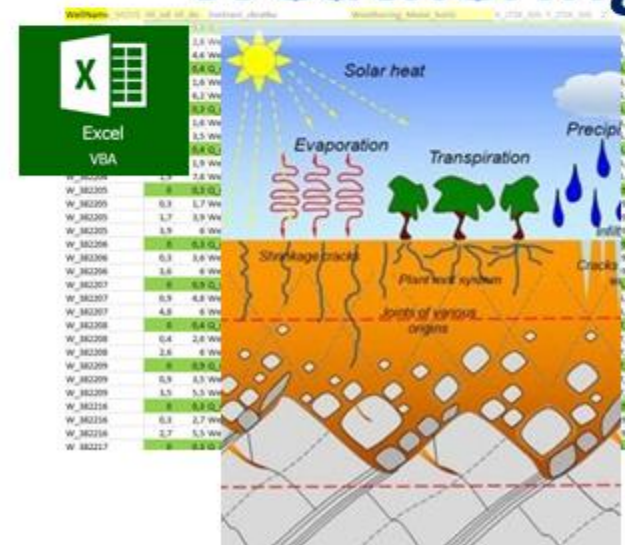
Lithology



Tectonics



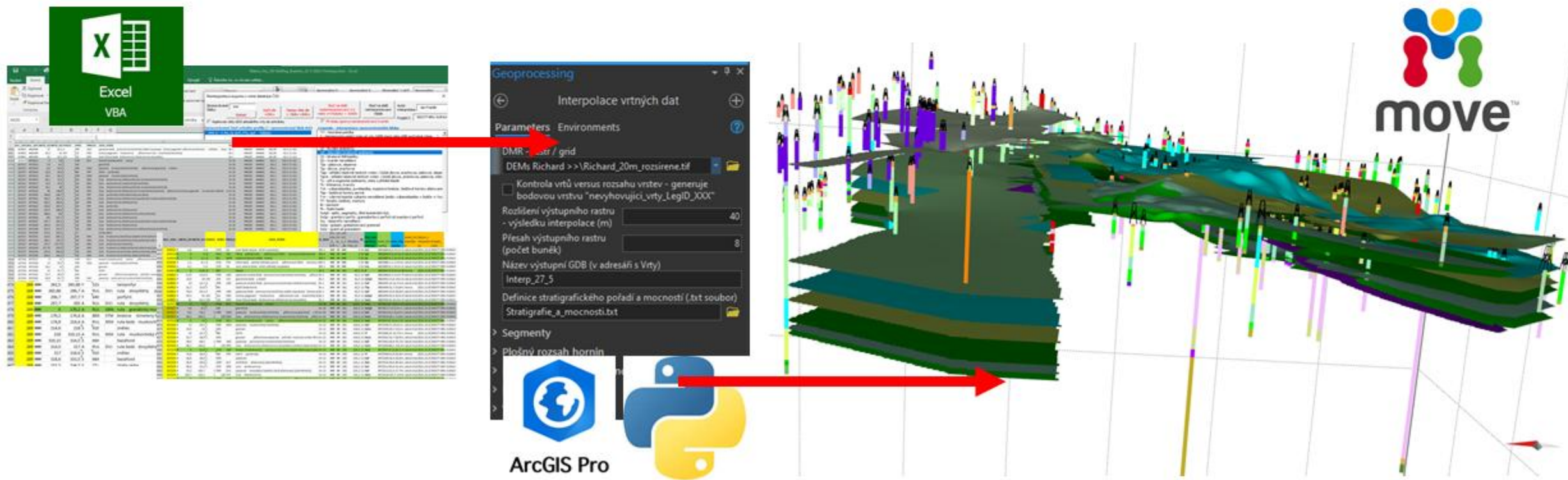
Weathering



Example of data processing - Boreholes

1. **MS Excel** – based VBA „application“ for semi-automatic reinterpretation of original core geological descriptions

2. Python interpolation tool for **ArcGIS Pro**, designed for use of **large borehole datasets** that are internally inconsistent, interpretations of **geophysical data** and **surface geology**.

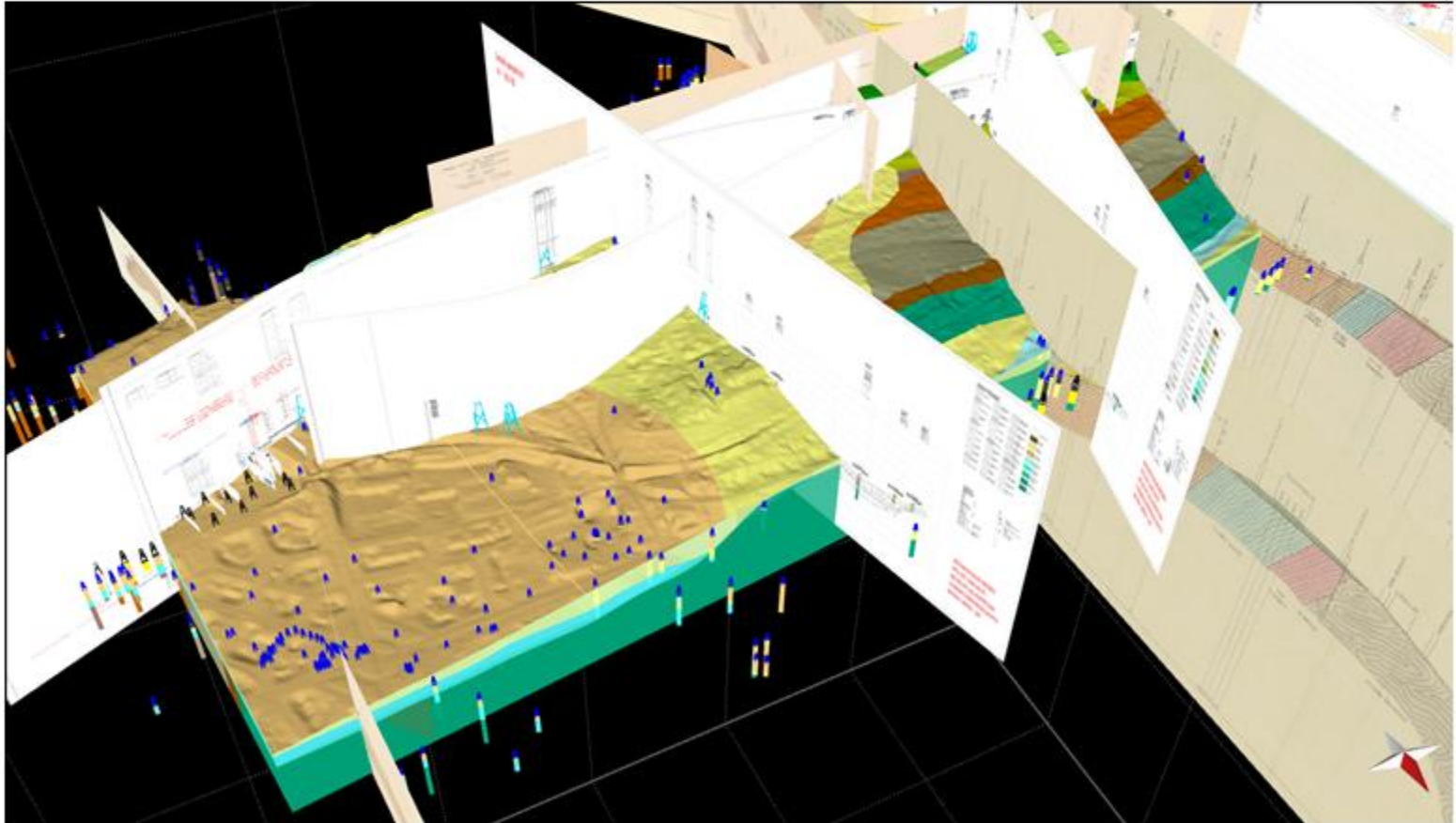


Final geological model in native sw.

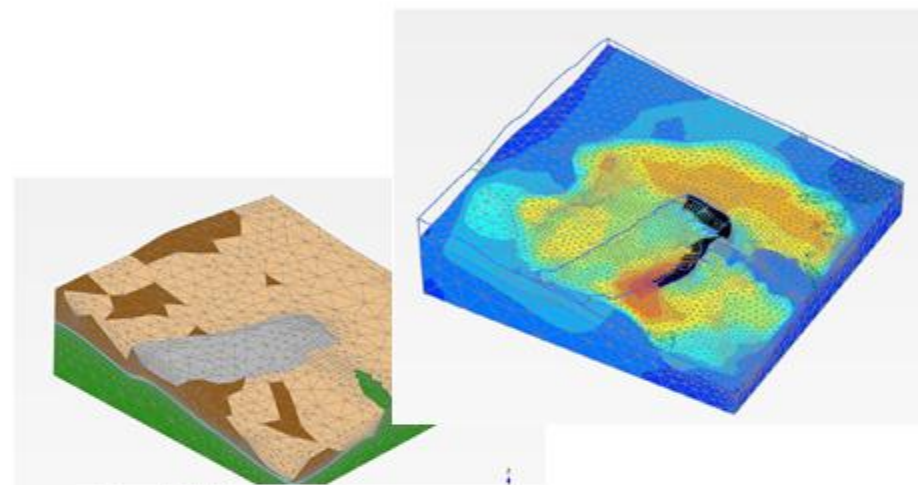
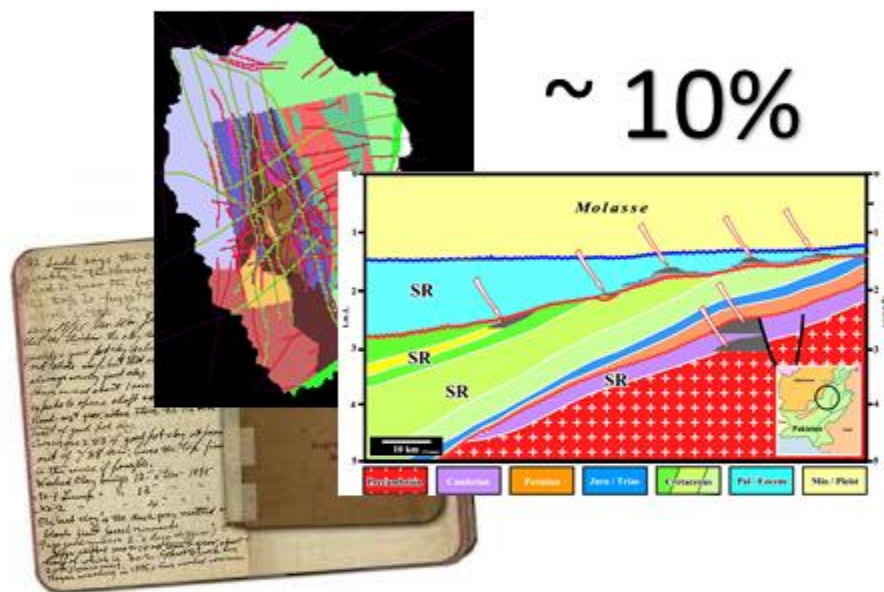
The resulting carefully manually created geological model respects:

- various geoscientific input data
- geological studies and reports
- regional scientific interpretations
- general geological rules.

But it's just a half way towards the final output for further model use.



Transfer of information to stakeholders



Mapová přehledka 3D modelů

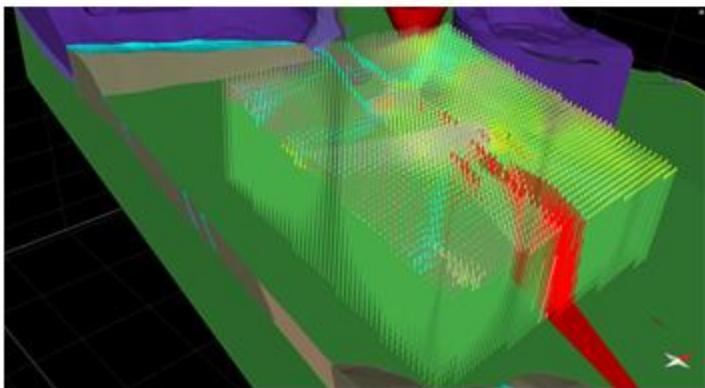
ČGS vytváří modely tří typů – strukturněgeologické modely horninového podloží středního až velkého rozsahu, fotogrammetrické modely terénních měřítek relativně menších rozměrů a fotogrammetrické modely sbírkových vzorků. Interaktivní mapa níže ukazuje, ve kterých oblastech ČR byly strukturněgeologické nebo terénní fotogrammetrické modely již vytvořeny – kliknutím na příslušnou oblast se uživatel zobrazí základ (metadatum) a náhled modelu (pokud není jeho veřejná prezentace o přehledka je přibližně aktualizována).

Pro jednotný metadatový popis 3D geologických modelů byl definován 3DGM, který je plně kompatibilní a požadavky směrnice INSPIRE z standardem ISO 19115.



~ 50%

~ 30%



Transfer of information to stakeholders

**How to transfer
more?**

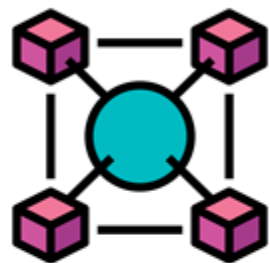


Transfer of information to stakeholders

- **BIM IFC exports** – to combine geol. models with construction planning of tunnels or large buildings and to deliver the rock environment comfortably to engineers and architects, possibly populated with geotechnical parameters



IFC use context



§

- Data model, ISO 16739 standard, **vendor neutral**
- Widely used in the construction industry to transfer project information
- A **BIM IFC model will be mandatory** for all public contracts in the Czech Republic that exceed the value threshold since **1.1.2027**
(see Act on the Management of Information on Construction and the Built Environment and on Amendments to Certain Other Acts)

- Capable to replace „2D“ classical project documentation, see:



- **Strahov Dormitories, Block 12**, Czech Republic, 2022-2025
- Randselva Bridge, Norway, 2019-2022
- New Stavanger University Hospital, Norway, 2018-2024;
- Smisto Hydropower Project, Norway, 2015-2023;
- Aarau Cantonal Hospital 'Dreiklang', Switzerland, 2022-2024
- ...and many more

BIM – interdisciplinary tool

Geological native 3D model



Integration of geological bodies, surfaces and primary data into the designer's software in accordance with ISO and other conventions respected by non-geologists

Universally understandable 3D construction site model in open data format



BIM – interdisciplinary tool



Which IFC version to use?

- **4.0** – no support of geological / geotechnical objects, but widely implemented in BIM sw
- **4.3** – support of basic geological / geotechnical objects and parameters, but implementation in BIM sw is still limited
- **5.0** – Future development, different approach and file structure, involvement of e.g. time-series data

In further case studies we have used IFC 4.0

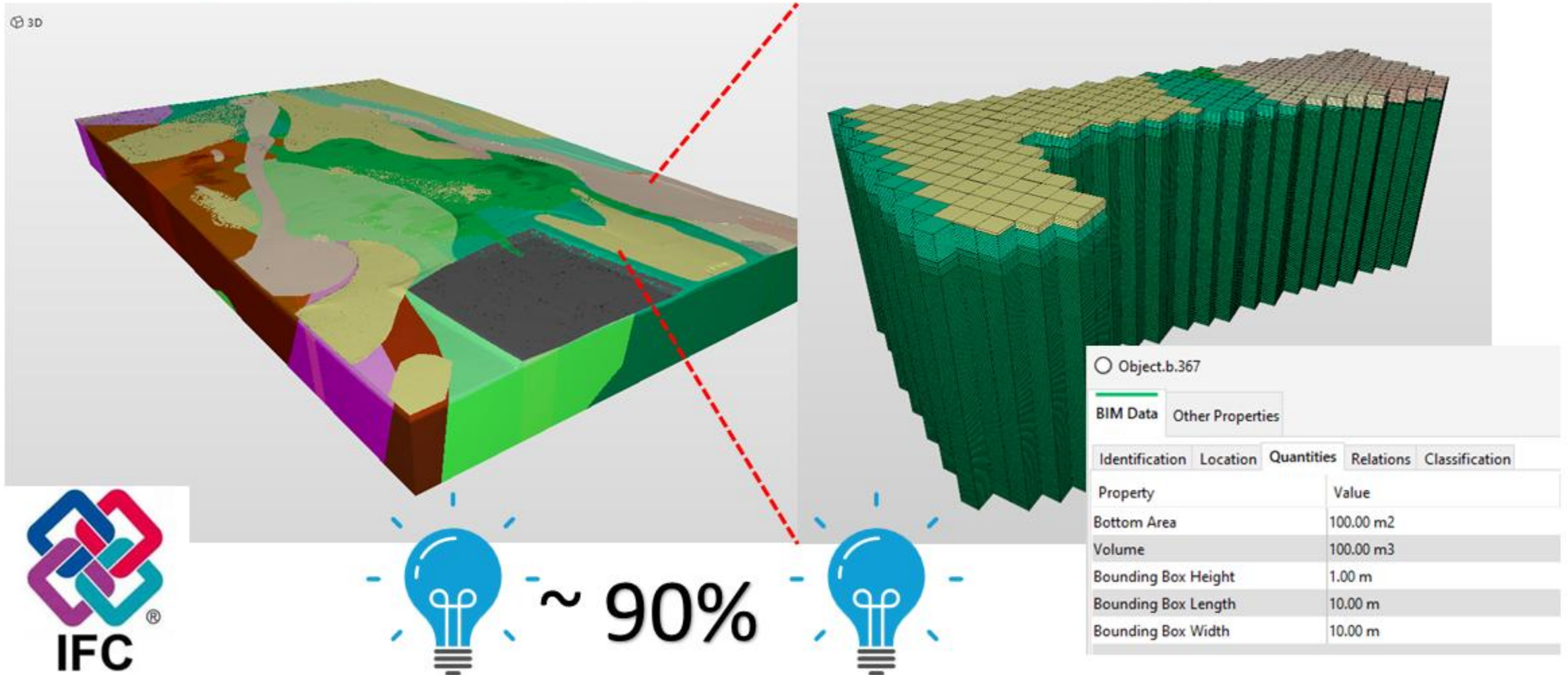
Use Case 1 - Dukovany NPP



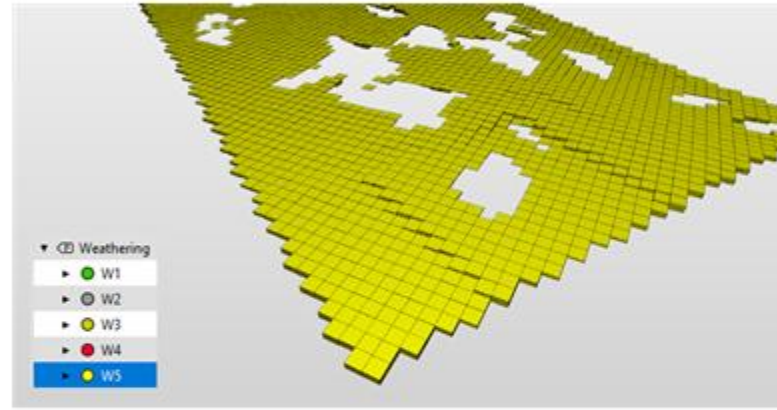
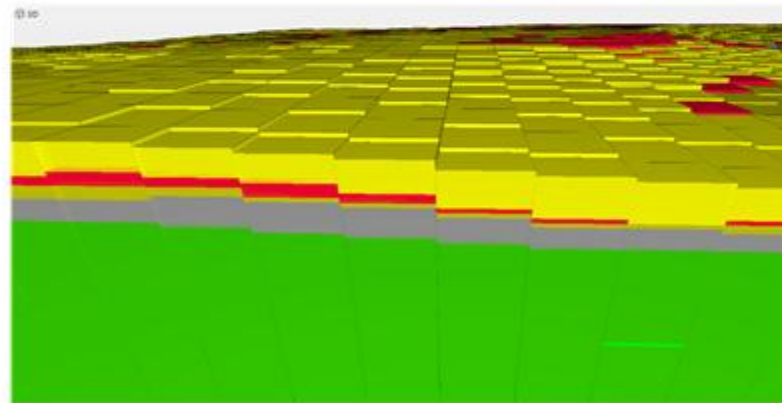
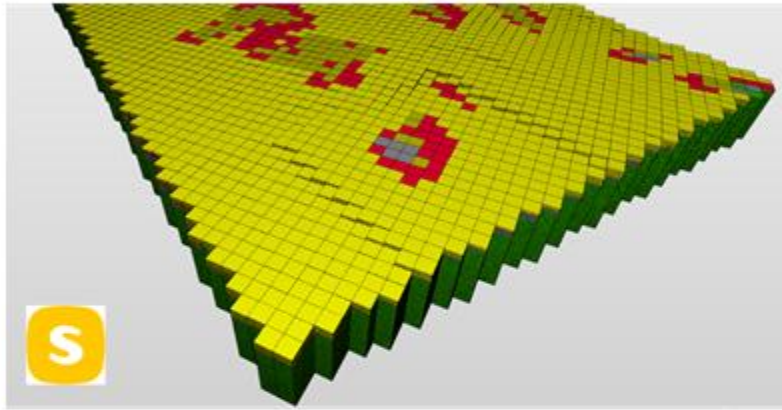
BIM models – 2 interpretations types

X0 quasihomogeneous units (objects)

> 2 mil. voxels (objects)



Working with GEO - BIM model



- W5** neogen sediments
- W4** completely weathered rocks
- W3** highly weathered rocks
- W2** moderately weathered rocks
- W1** slightly weathered and fresh rocks



data inputs



processing

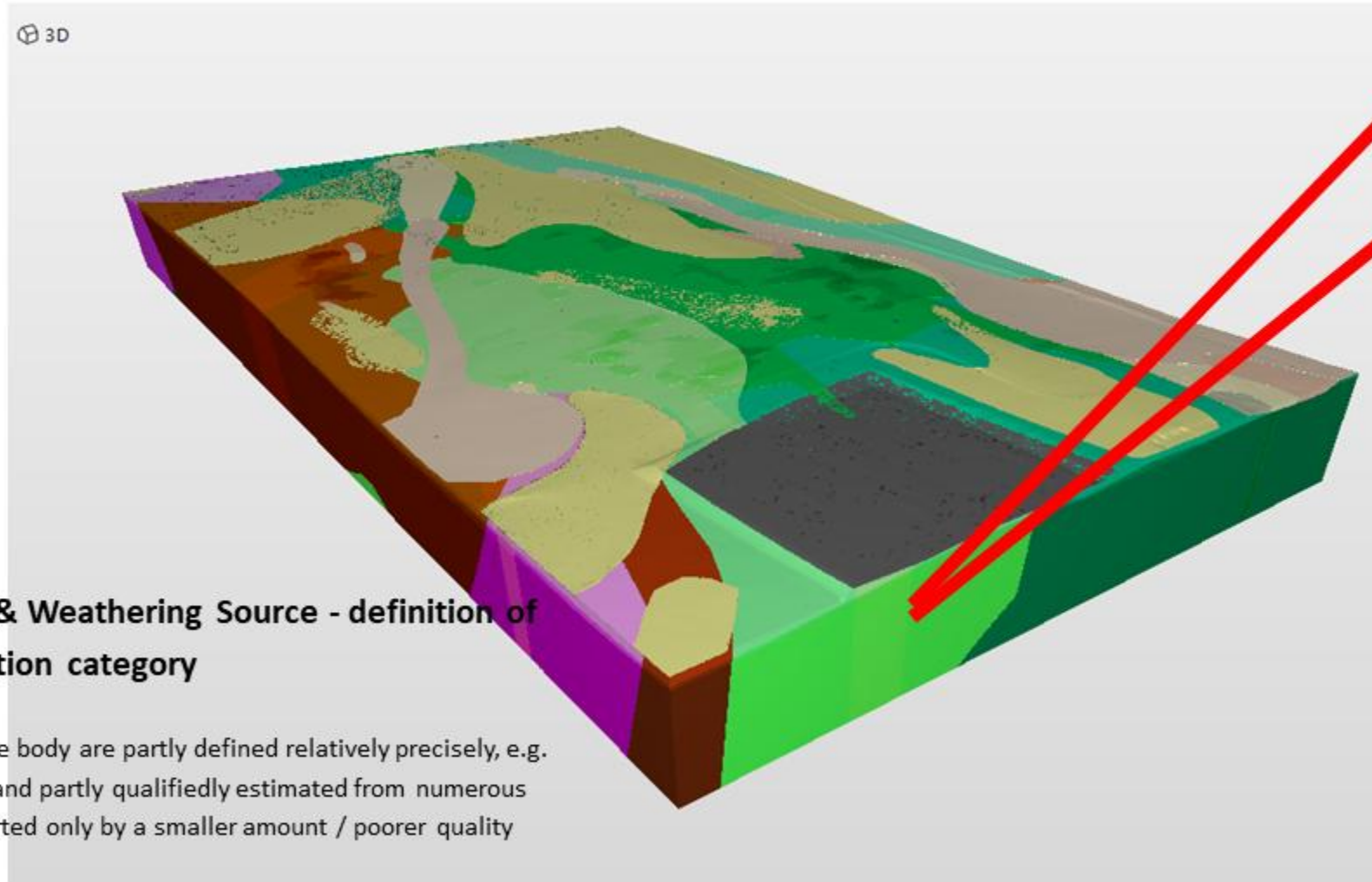


proprietary model



open IFC model

Model credibility 1 - Classified expert estimate for quasihomogeneous volumes



CGS_Geology	^
Lithology	☆
MO_VM_paragneiss_bt_sil	
Lithology Source	☆
C	
Weathering	☆
2	
Weathering Source	☆
C	

Ifc Building Element Proxy Type	^
Name	☆
QUASI-HOMOGENOUS BODY	
Element Type	☆
QUASI-HOMOGENOUS BODY	
Predefined Type	☆
USERDEFINED	

Ifc Classification Reference	^
Identification	☆
Weathering_2	
Relating Classification.Name	☆
Weathering	

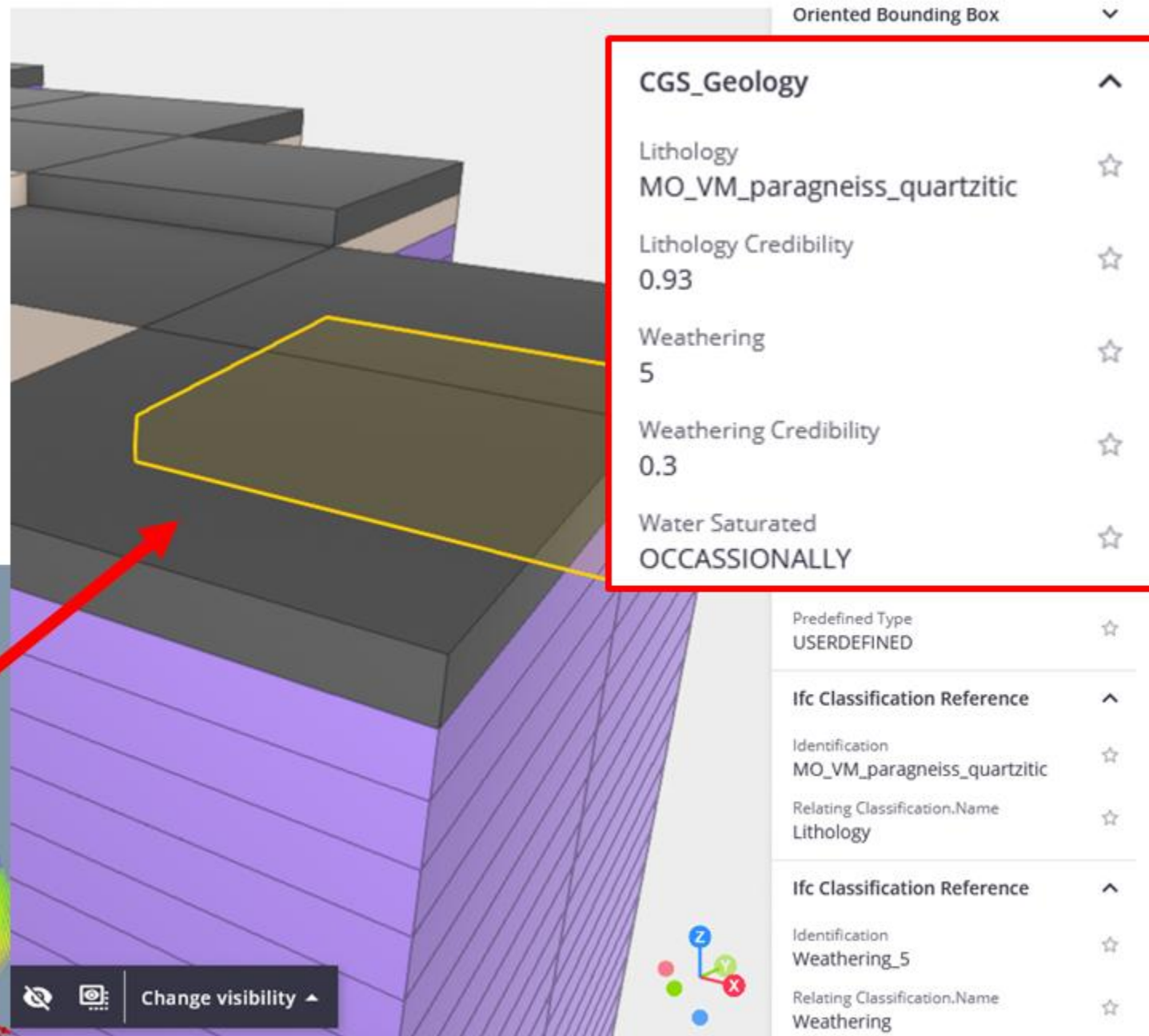
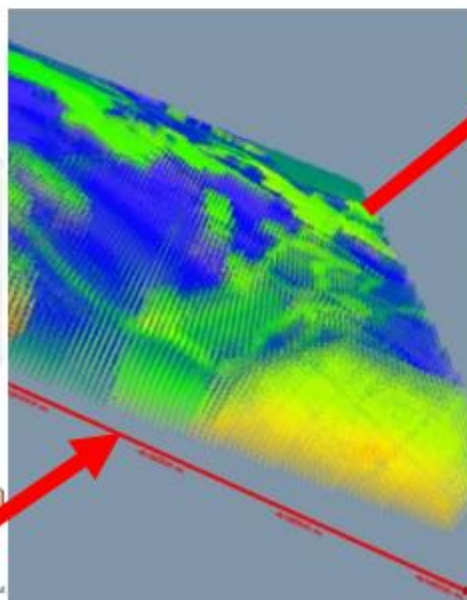
Ifc Classification Reference	^
Identification	☆
MO_VM_paragneiss_bt_sil	
Relating Classification.Name	☆
Lithology	

Model credibility 2 - Uncertainty calculated according to Staněk et al. (2025)

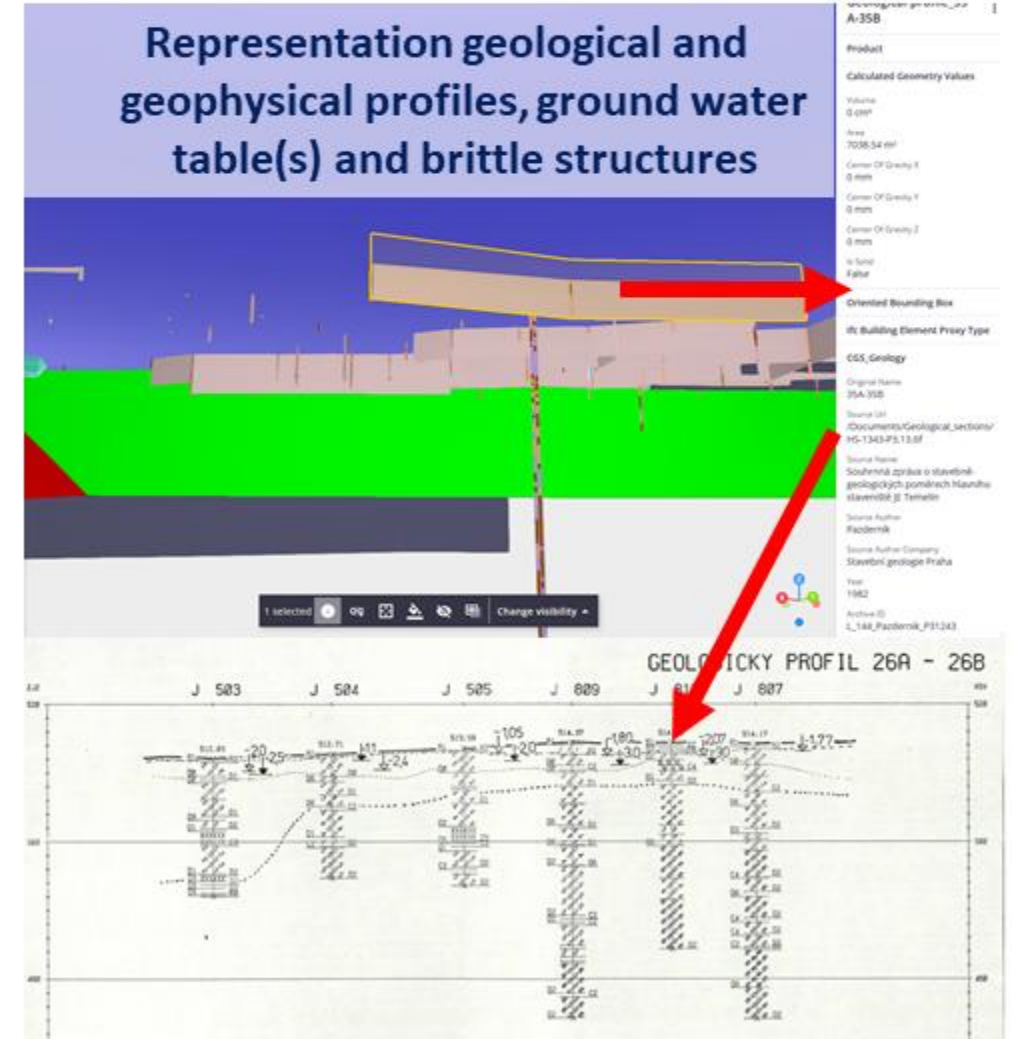
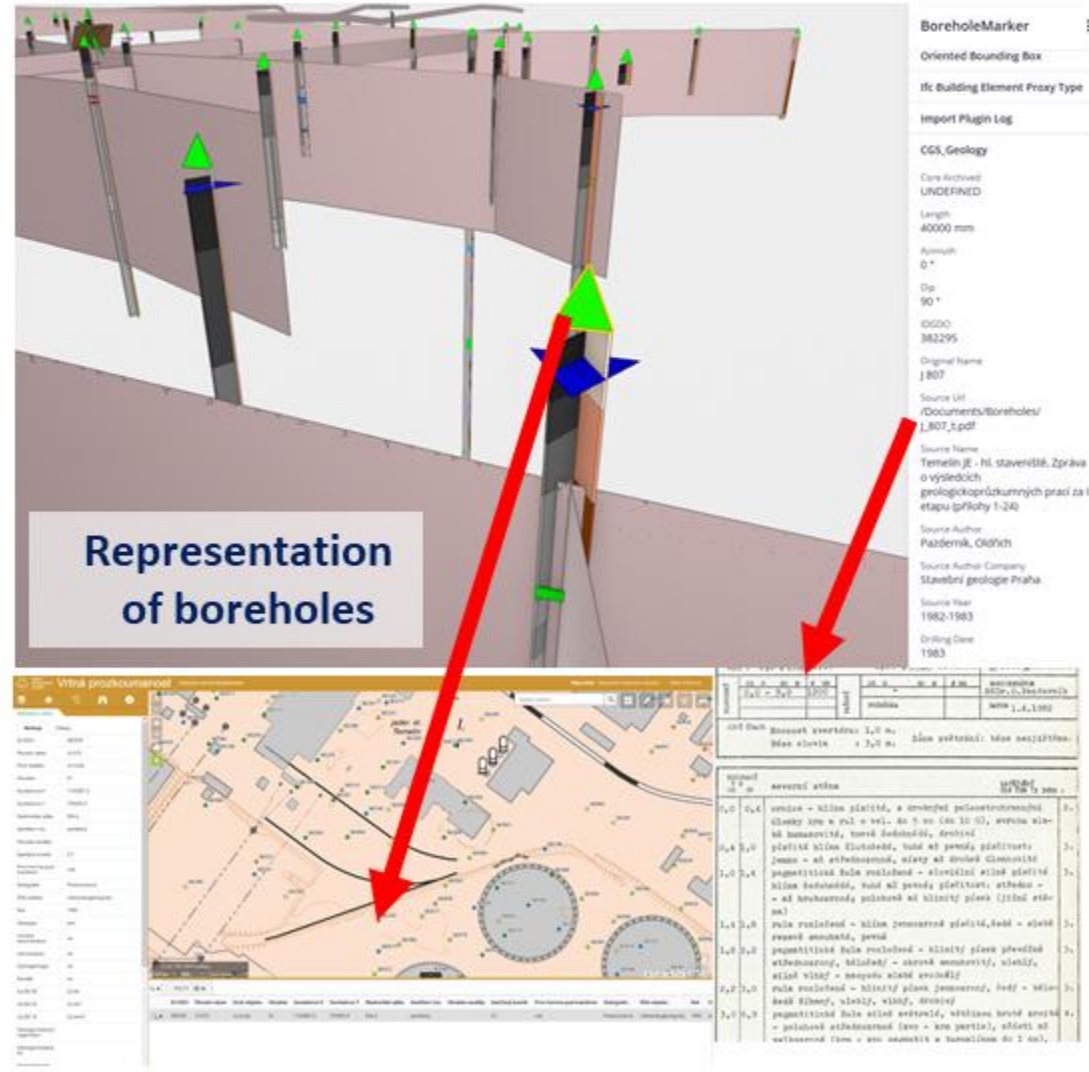
Staněk, F., Franěk, J., Jelínek, J., Žáček, V. (2025): **Estimating relative uncertainty of geological 3D models with low density of input data in geologically complex regions.** Earth Science Informatics. ISSN 1865-0473. <http://doi.org/10.1007/s12145-025-01778-0>



Fig. 4 Diagram of the workflow of the determination of the uncertainty of 3D geological models, including the related algorithms. Legend: orange - input data, blue - algorithm, brown - final output



Model credibility 3 - Integration of primary geoscientific data into IFC



Use Case 1

Dukovany NPP

OZI Building



BIM model as integrated database

Identification	Location	Issues	Quantities	Material
Property	Value			
Site	EDUII site			
Building	D09.ZWA01			
Floor	1NP			
Federated Floor	(ASR) 1NP			

Location

UJV-IFC-U_System-Subsystem	
Property	Value
IdElementInstanceSystemC...	2
IdElementSystemCode	001acw.1.2
IdElementTypeSystemCode	001acw.1
IdSubsystemCode	1-02t-XX-XX
IdSystemCode	SY23.1-003hhwx
IdSystemElementSubsyste...	SY23.1-003hhwx-001acw.1....
User01aSystemName	Vytápění : Vytápění teplovo...
User01bSystemCode	SY23.1

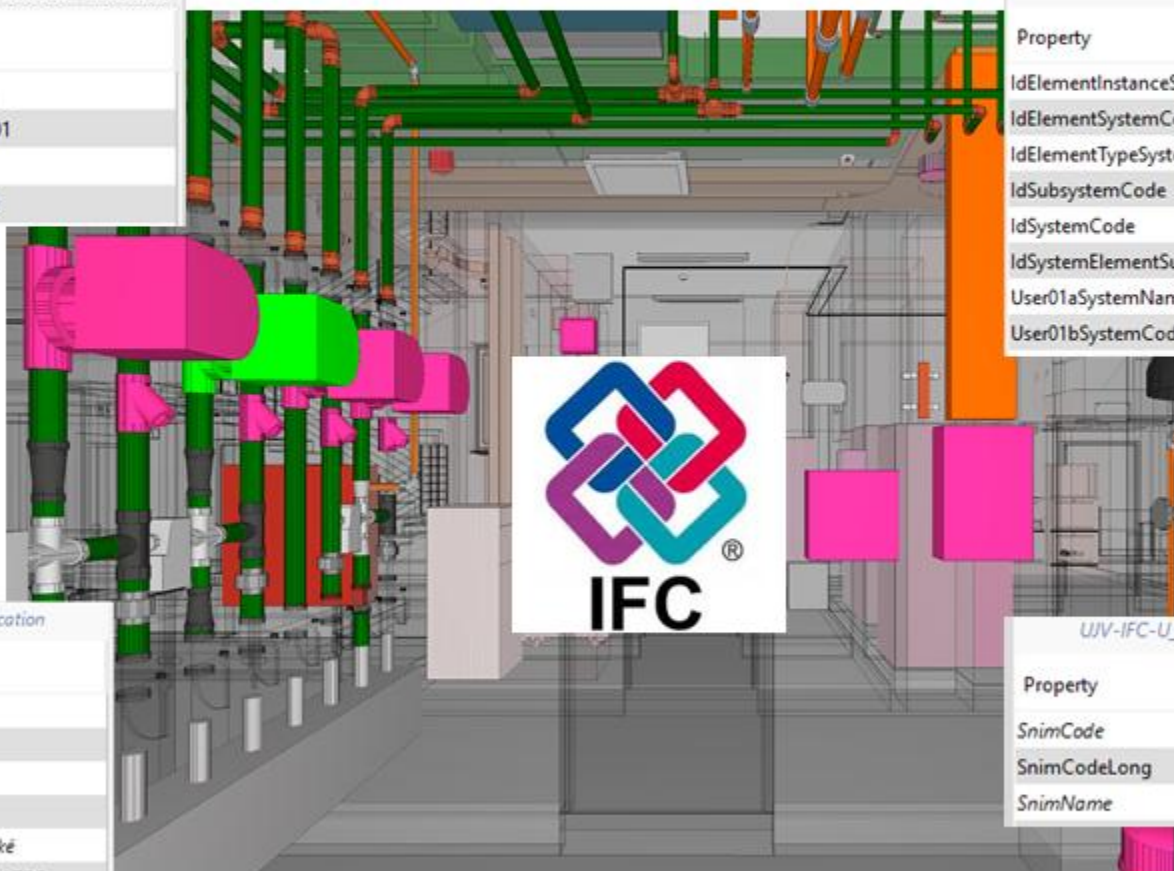
System

UJV-056-Pump-IFC-U_TechnicalSpecification	
Property	Value
CS_SCHEDULEID	1,028,800
CS_SCHEDULETYPEID	1,028,738
Typ média (i)	Topná voda
Typ napojení	závit
Typ ovládání	ruční/automatické
UJV_FilterIfcCategory	IfcPump.CIRCULATOR

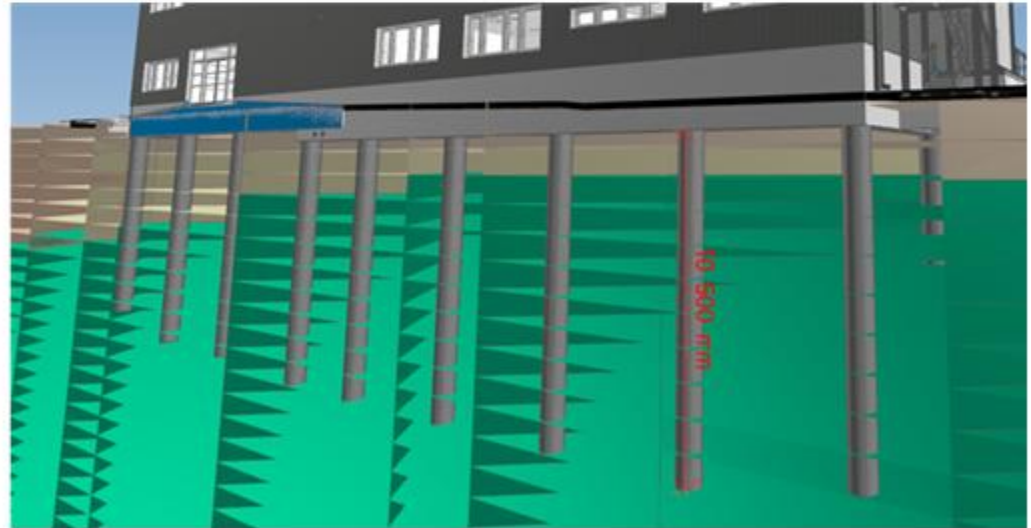
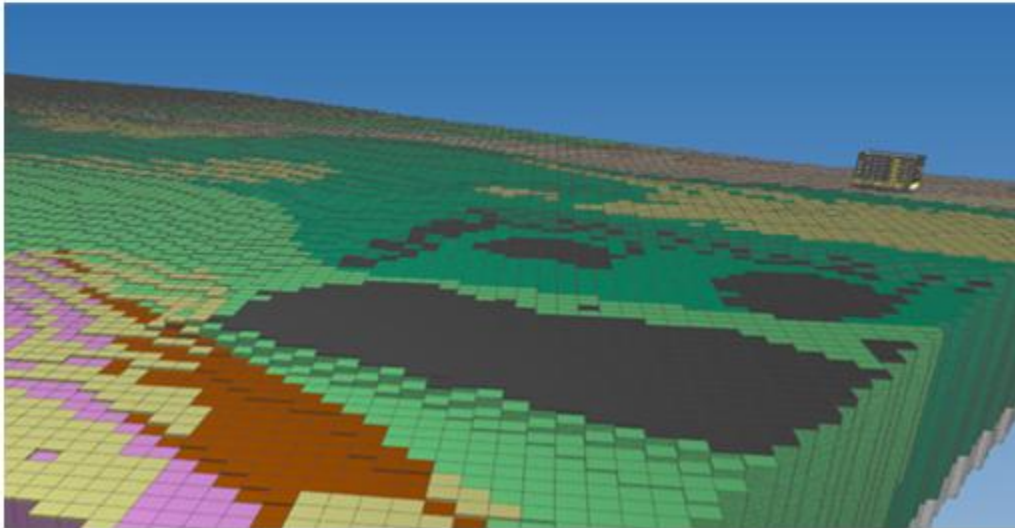
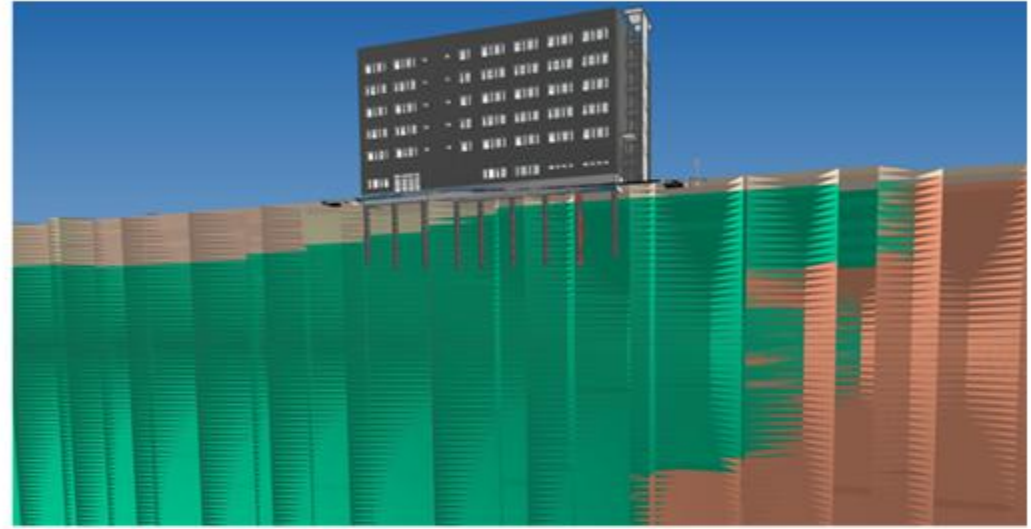
Specification

UJV-IFC-U_SNIM-Classification-Identification	
Property	Value
SnimCode	COa00
SnimCodeLong	COa00.0001.2
SnimName	Čerpadlo : čerpadlo cirkulač...

Classification

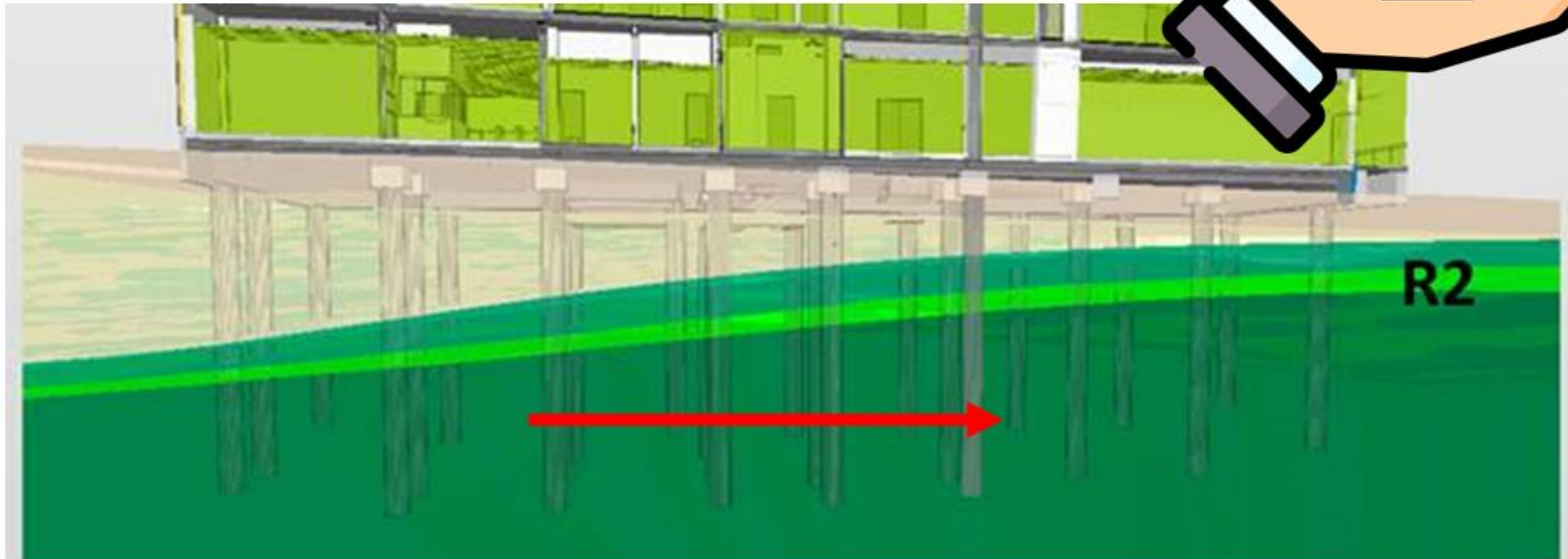


Federated BIM – geology + buildings incl. foundations

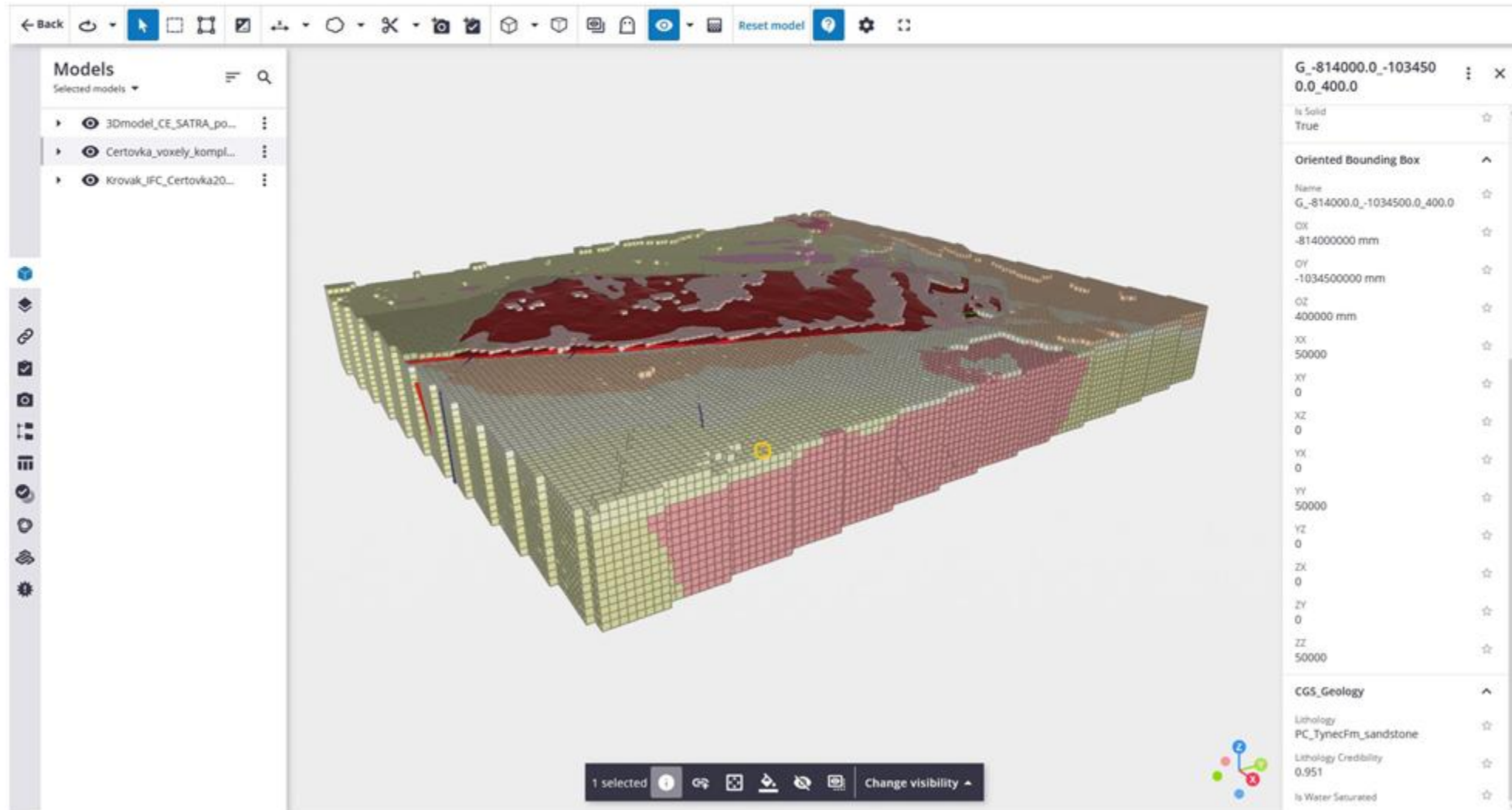


Money saving

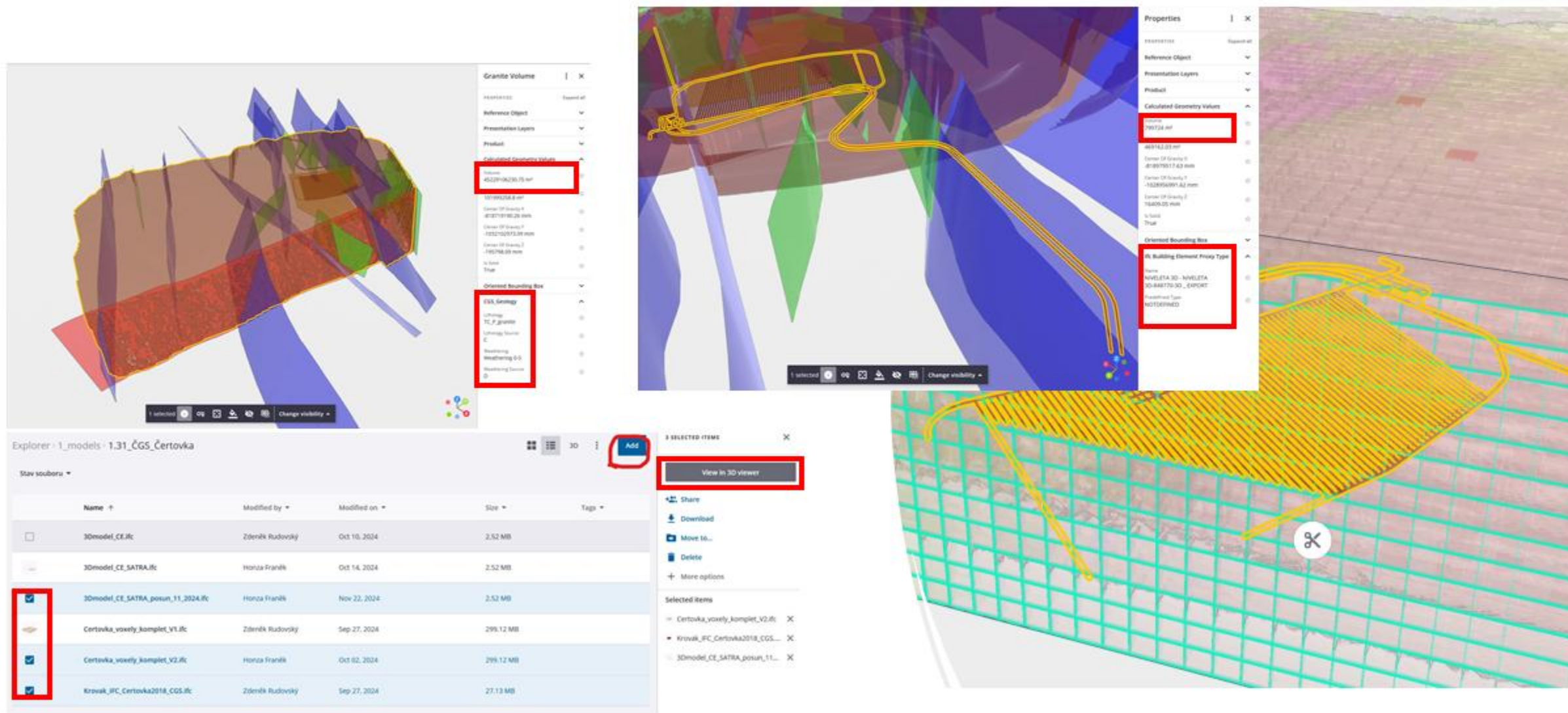
According to Czech standard ČSN 73 6133 (starting with R2 class, i.e. bedrock strength 50-150 MPa) = shift of the building location + shorter piles = cca. **1,3 mil. Kč** (52.000,- EUR) expected money saving



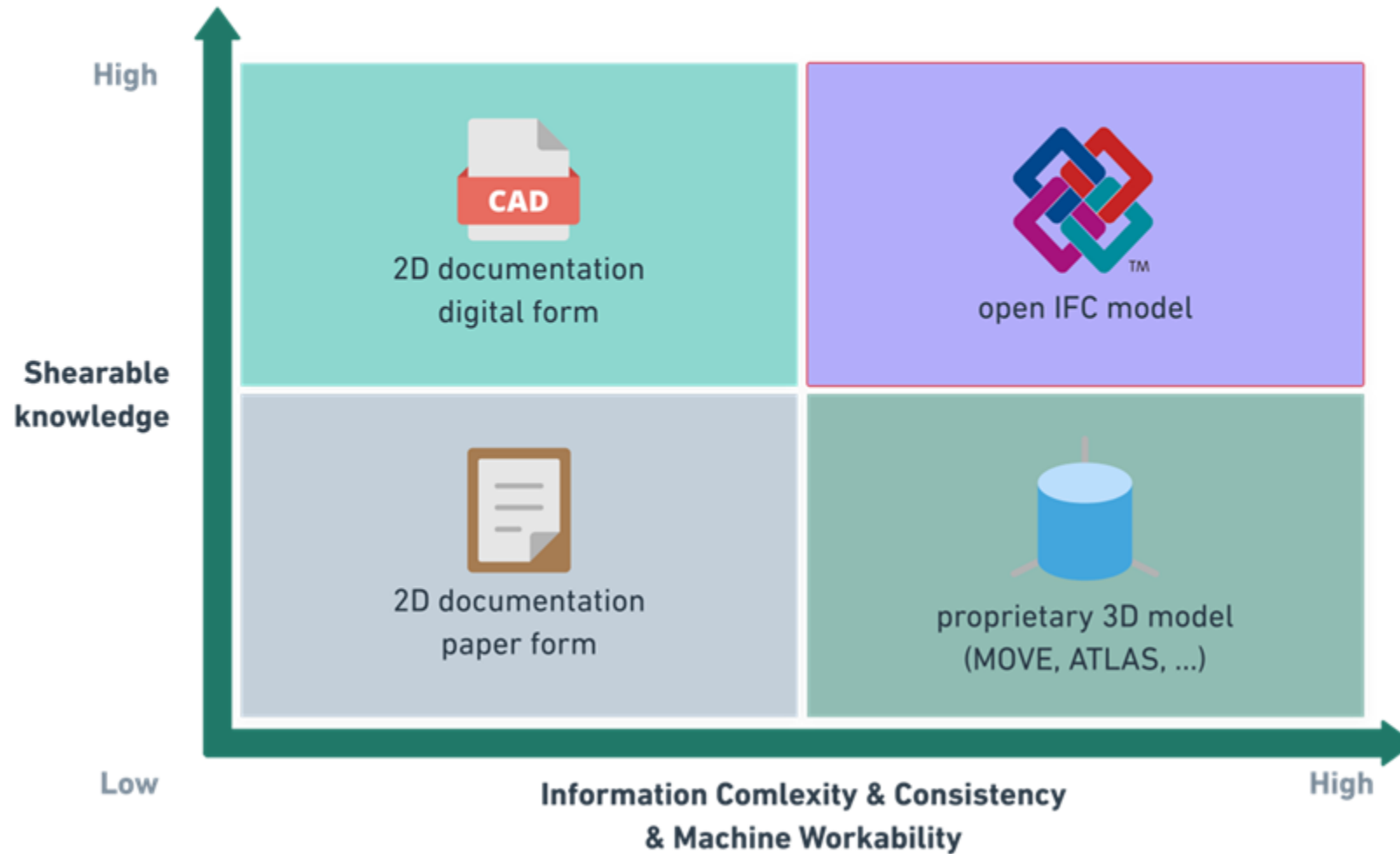
Use Case 2 – HLW Deep geological repository



Use Case 2 – HLW Deep geological repository



Benefits maximization



Thank You for your attention

