



**Implementation of hydrocarbon project
evaluation techniques for geothermal
project assessment:
Case study in the vicinity of Vienna**

October 2023

Agenda

1 Introduction

2 Hydrocarbon G&G Project Evaluation

3 Play/Lead/Prospect Evaluation

4 Risk Elements definition

5 Conclusion

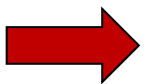
Introduction & Specification

Vienna City Council has set the goal for the city to become ‚climate-neutral‘ by 2040.

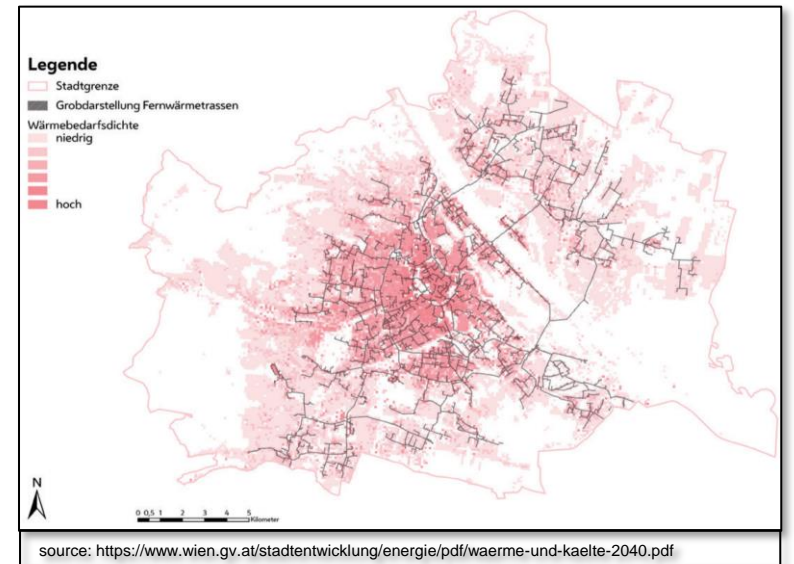
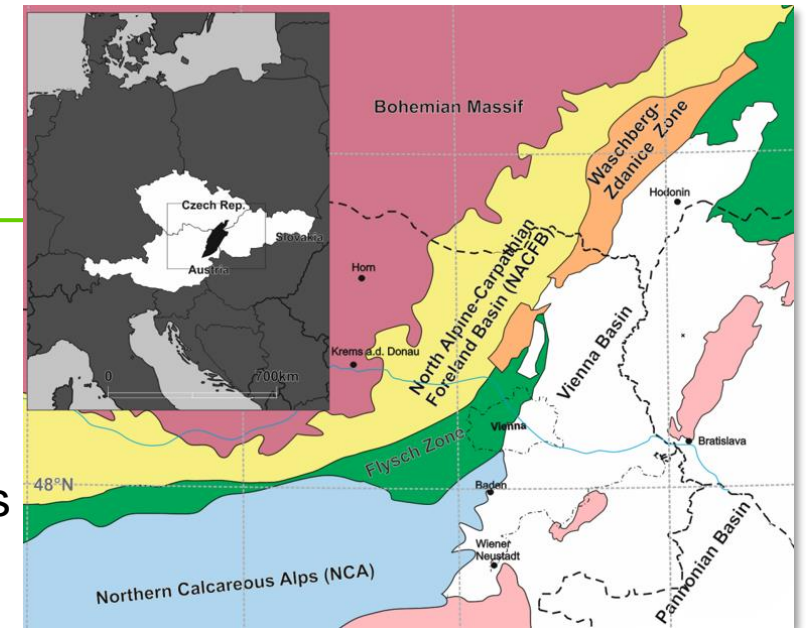
- ▶ Heat production 2019 of about 6.4 TWh/a
- ▶ Heat distribution network: 1300+ km
- ▶ 400,000+ households are connected to the heat distribution network
- ▶ Geothermal heat (GT) and heat pumps should replace/reduce fossil fuels from CHPs.

Project Specification:

- ▶ Identify water bearing reservoirs close to Vienna to feed into the heat distribution network
- ▶ Min. reservoir temperature of 90°C
- ▶ Min. name plate capacity per doublet of 15 to 20 MWth
- ▶ Geothermal project life cycle of minimum 40 years



Find appropriate evaluation techniques to identify and assess geothermal projects in the AOI



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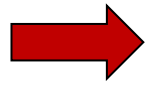
Setup of GT project evaluation system

- ▶ International standards for GT project evaluation are not existent or still in preparation
- ▶ International standards (**Technical Assurance & Governance**) for Hydrocarbon (HC) project evaluation are existent

Historical background

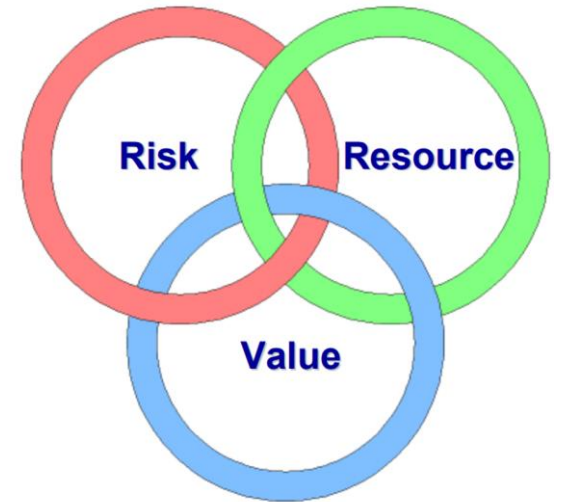
- Exploration for new giant fields in the 1980's and 1990's destroyed value rather than creating it
- Exploration lost credibility, needed to become more efficient and profitable
- Exploration capital had to be optimized
- Concepts of portfolio management, standardized risk analysis methods were established in the 1990's
- Exploration performance increased significantly
- Project assessments were standardized to challenge different HC projects based on portfolio management

Setup of GT project evaluation system



Find appropriate evaluation techniques to identify and assess geothermal projects in the AOI

- ▶ Ability to turn geological and geophysical (G&G) information into drillable prospects
 - Methodology to estimate resource volumes
 - Develop reliable risk analysis system
 - Generate project economics based on risk and resource assessment



Main Focus in this presentation...

- ▶ Technical assessment using Play/Lead/Prospect evaluation techniques (Resource)
- ▶ Define Risk elements as input for Risk assessment (Risk)

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1 Introduction

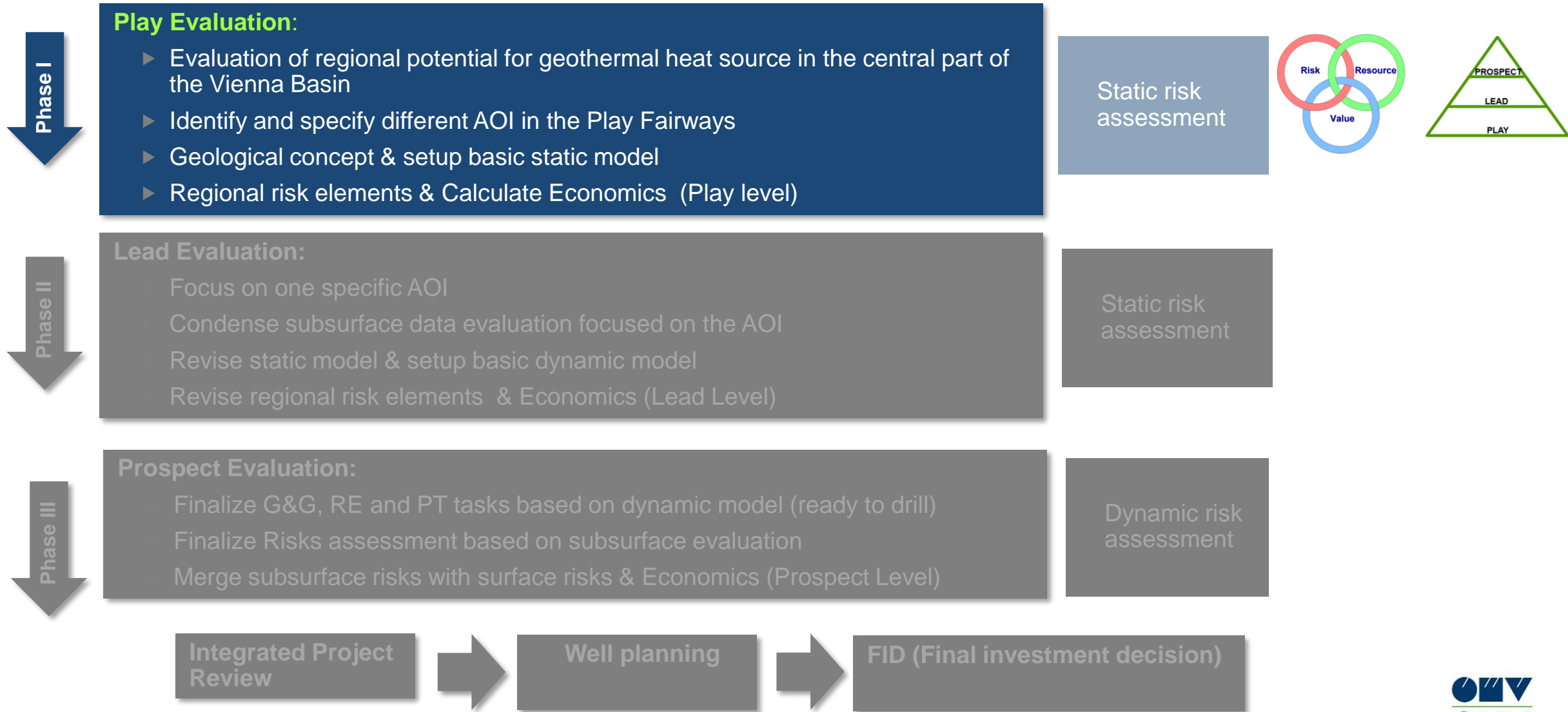
2 Hydrocarbon G&G Project Evaluation

3 **Play/Lead/Prospect Evaluation**

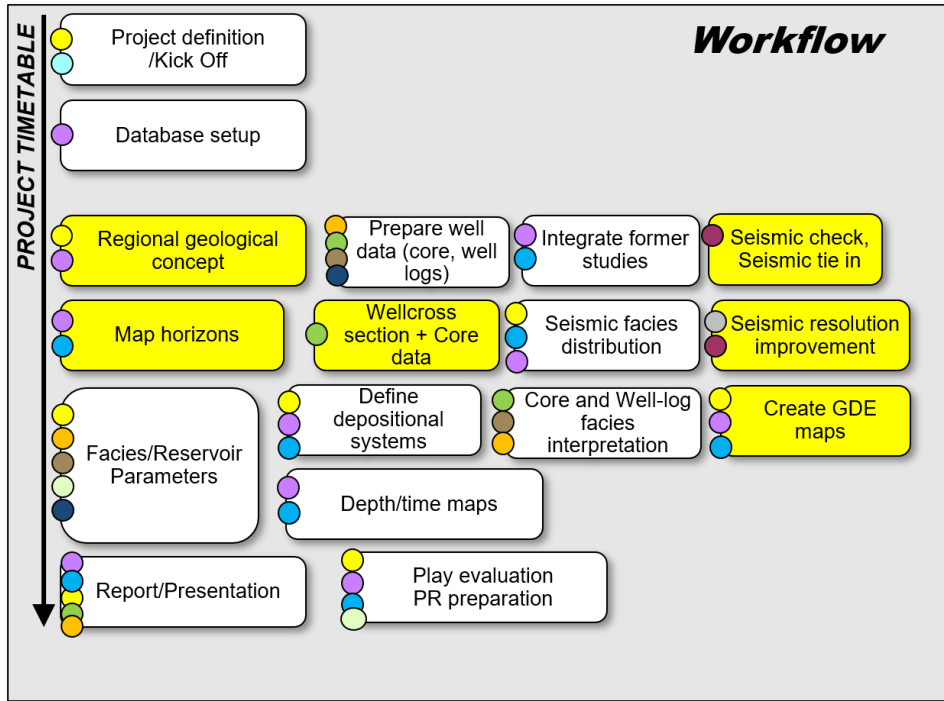
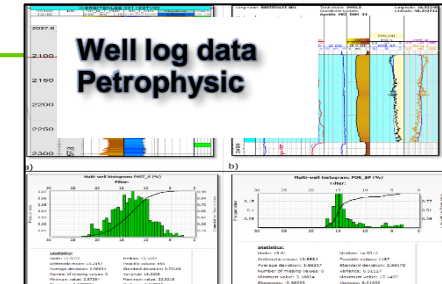
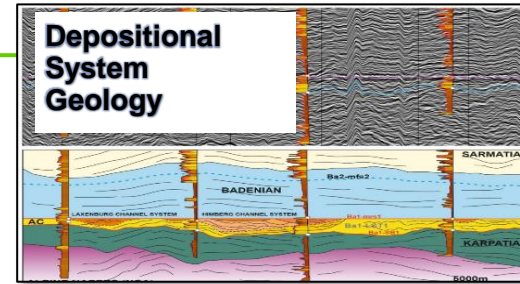
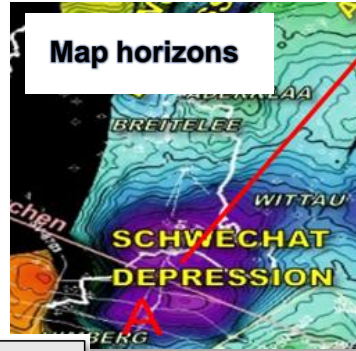
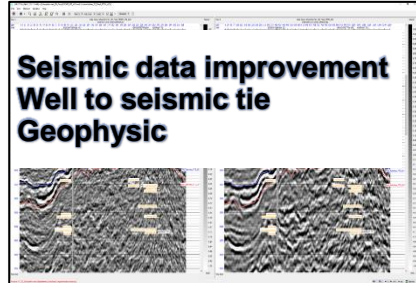
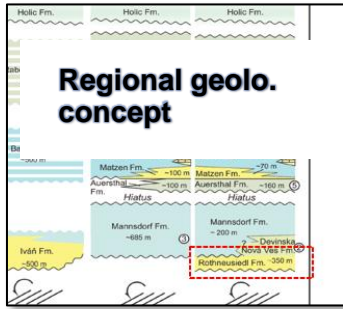
4 Risk Elements definition

5 Conclusion

Evaluation Phases - Project Setup



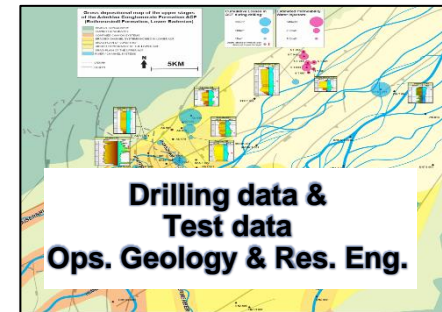
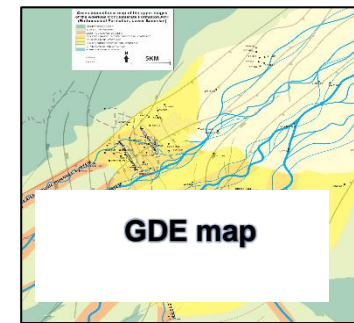
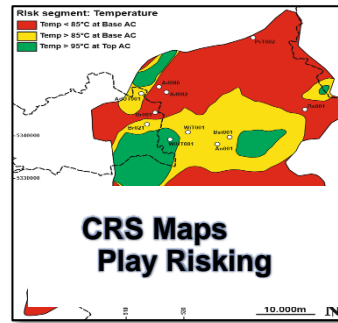
Play Phase - Feasibility Phase



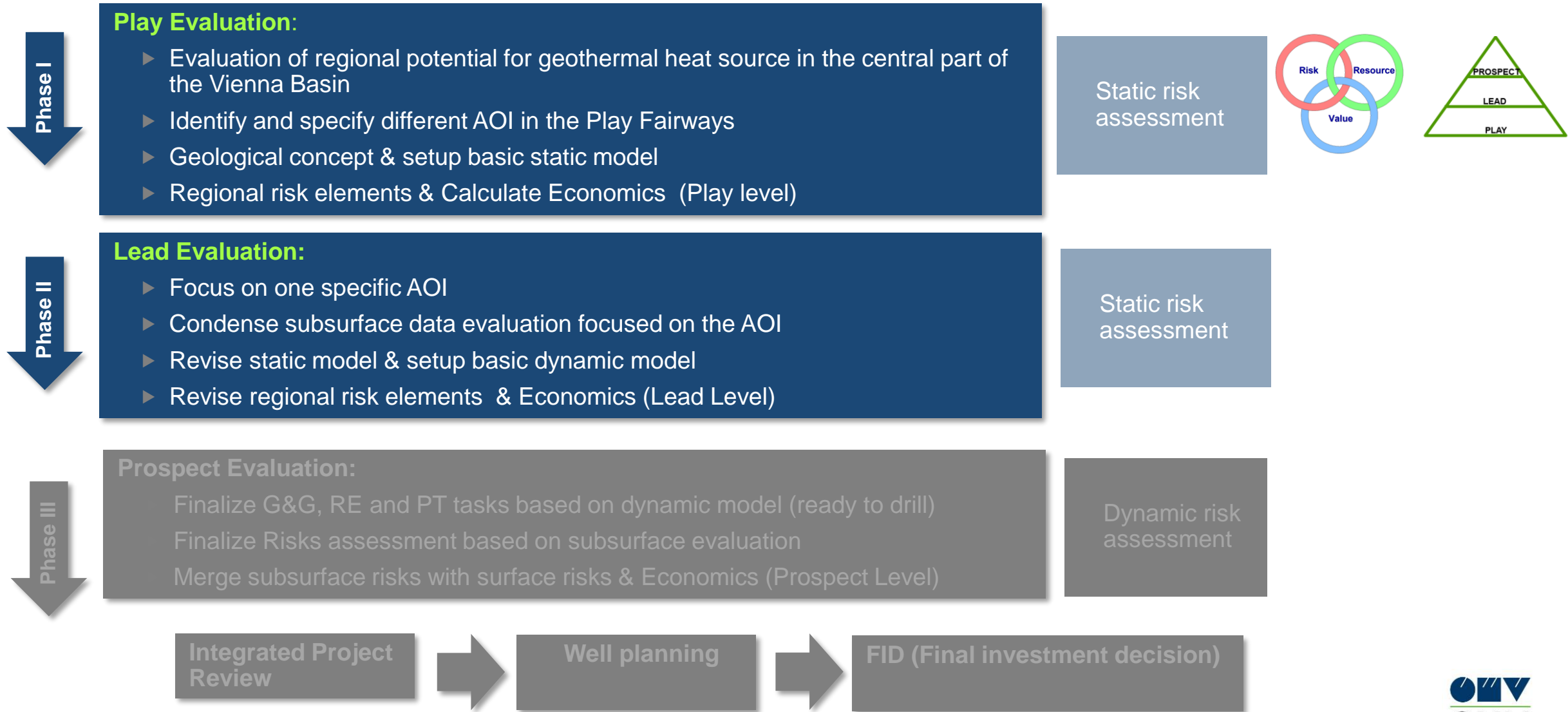
- Project Manager
- Teamleader; Senior Expl.
- Senior Expl. Geo. FH
- Junior Expl. Geol.
- Senior Prod. Geol.
- Staff Expl. Geol.
- Senior Exp. Geophysic
- Senior Sediment. Lab
- Senior Petrophysic
- Senior Res. Eng.
- Reservoir Eng.
- Res-Geophysic
- Res-Geophysic
- Senior Opr. Geol.

Play Evaluation:

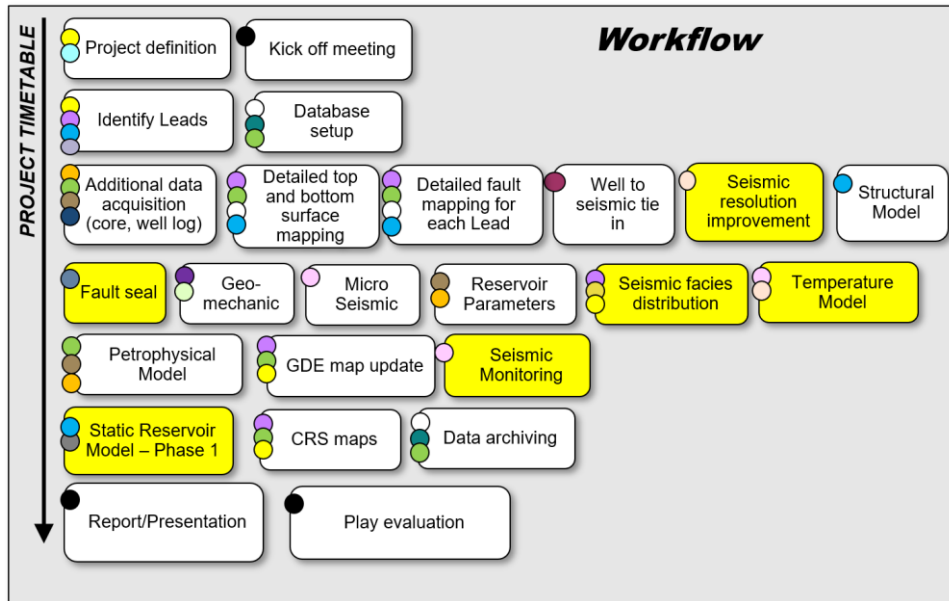
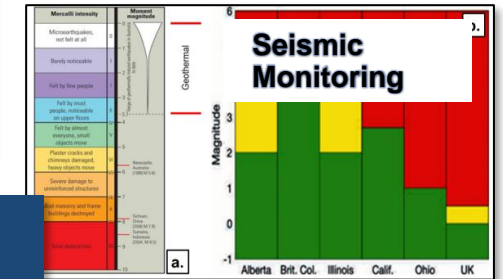
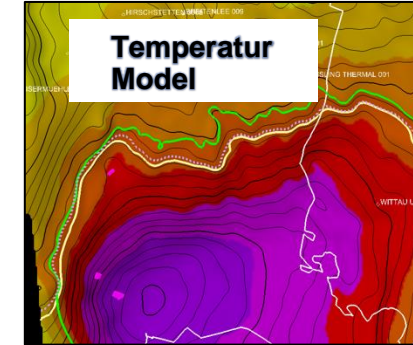
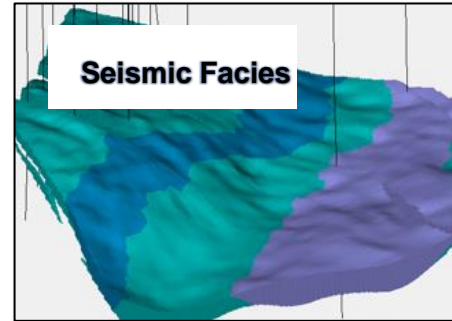
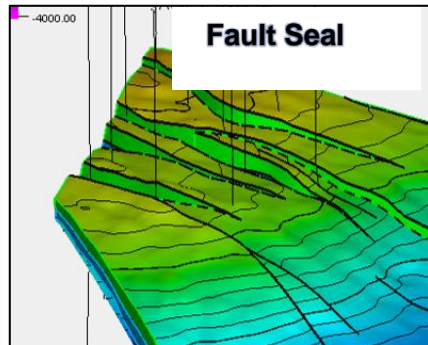
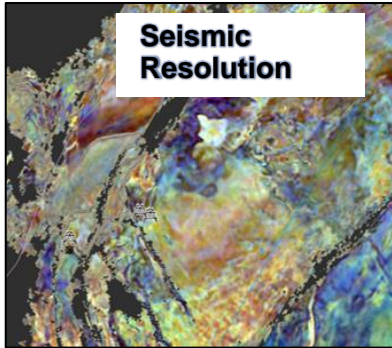
- Evaluation of regional potential for geothermal use in the central part of the Vienna Basin
- Identify and specify different AOI in the Play Fairways
- Geological concept



Evaluation Phases - Project Setup



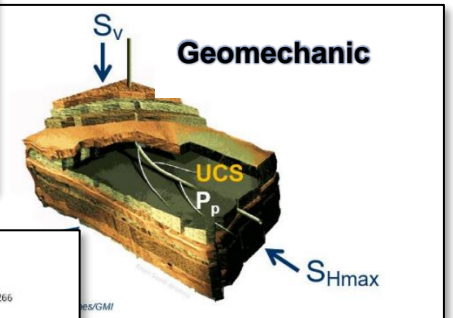
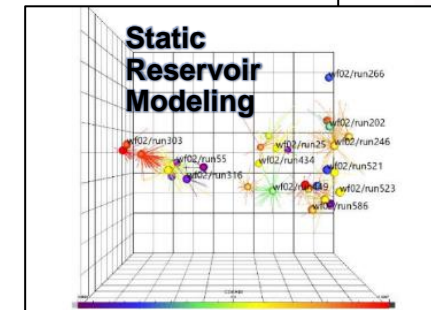
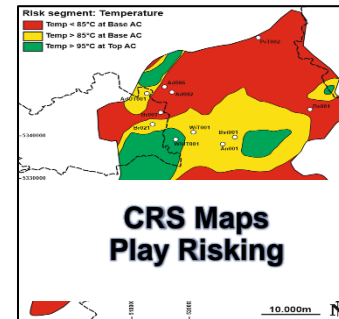
Lead Phase- Implementation Phase



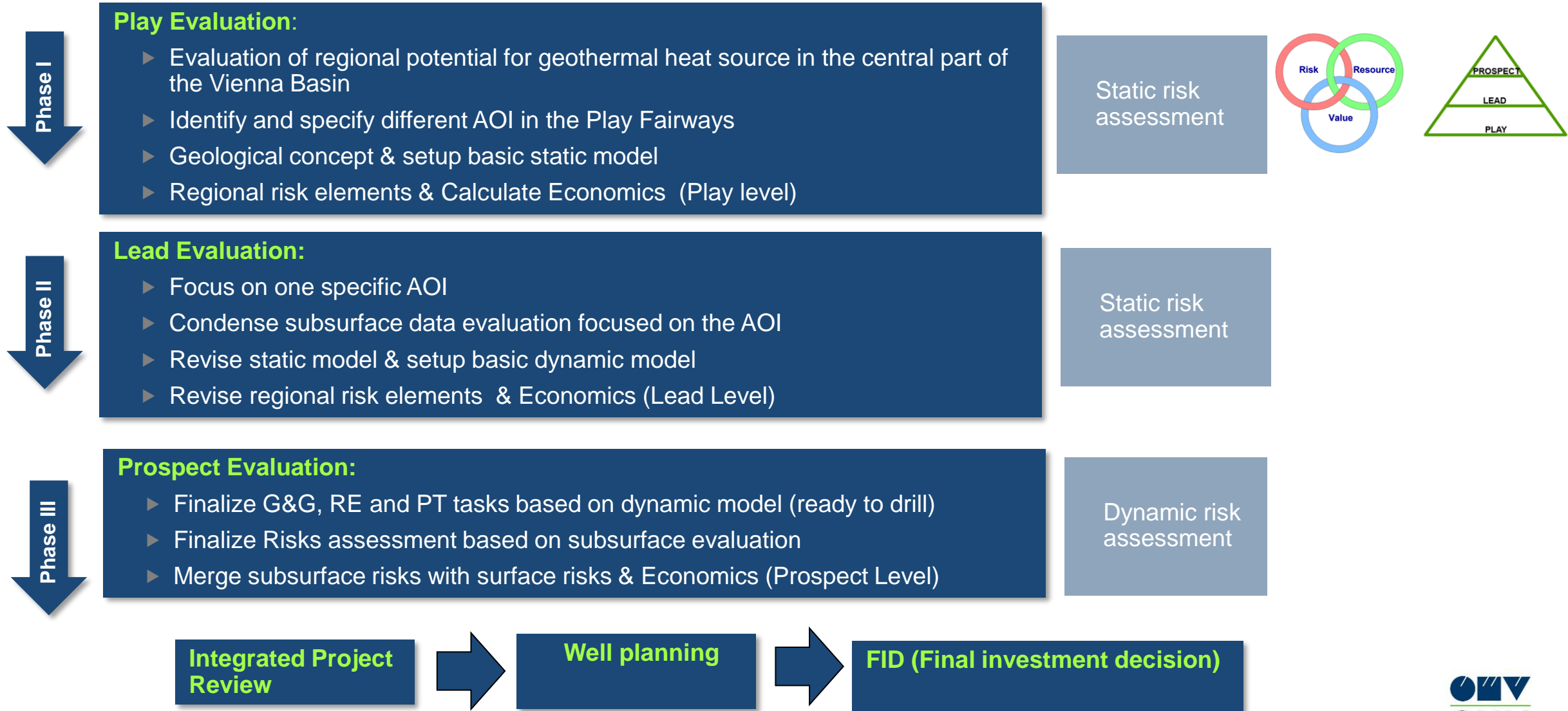
- Project Manager
- Teamleader, Exp-Geol.
- Exp-Geol.
- Prod-Geol.
- Exp-Geol.
- Opr-Geol.
- Exp-Geophysic
- Laboratory
- Fault seal
- Geophysic
- Geomechanic
- Petrophysic
- Reservoir Eng.
- Reservoir Eng.
- Reservoir Eng.
- Res-Geophysic
- Advisor Geol.
- Datamanag.
- All

Lead Evaluation:

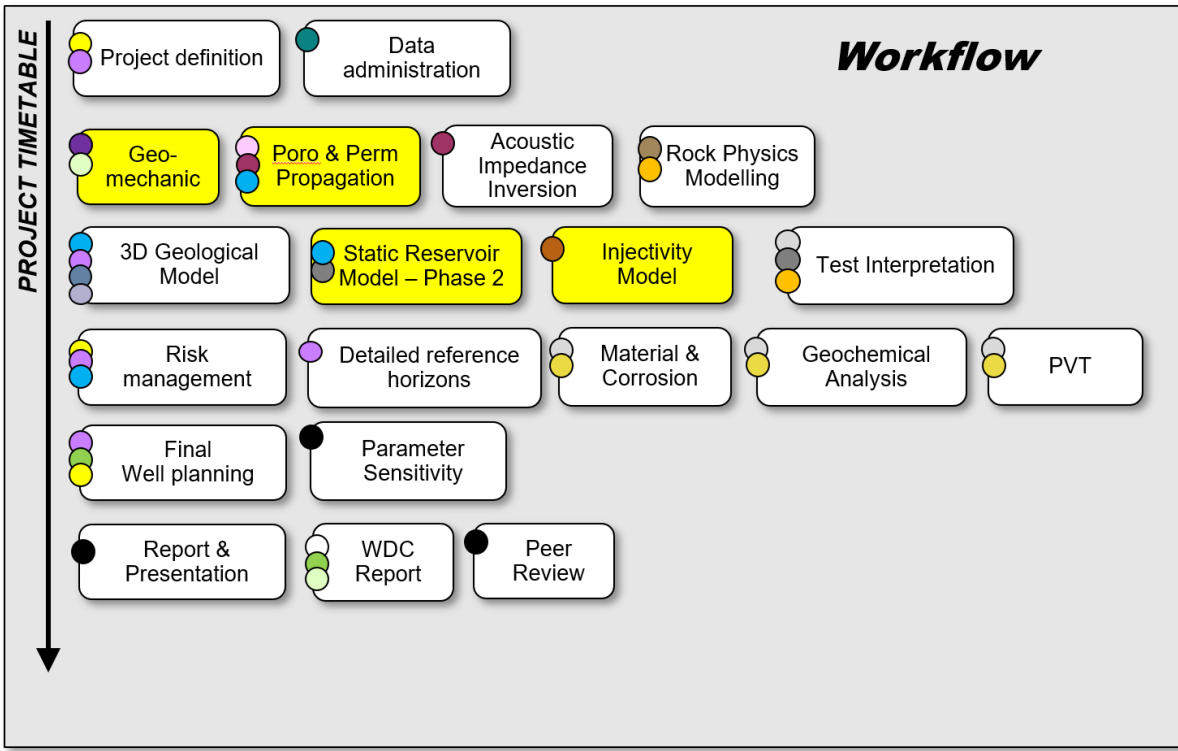
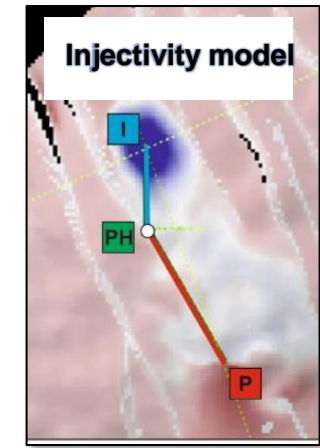
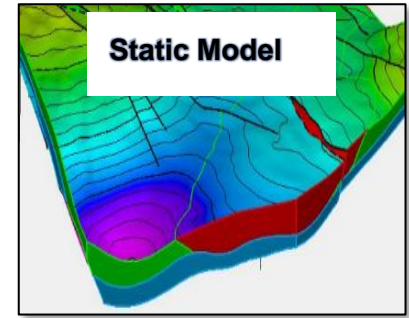
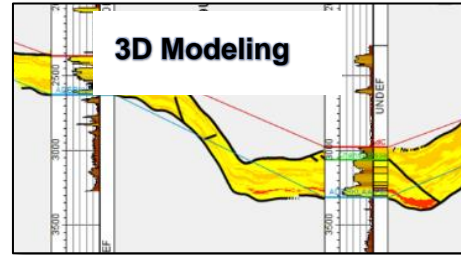
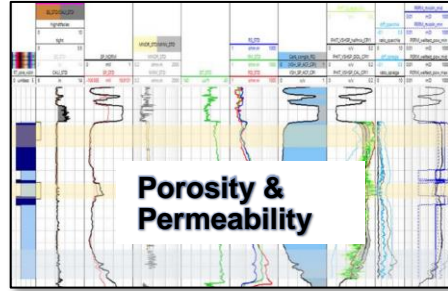
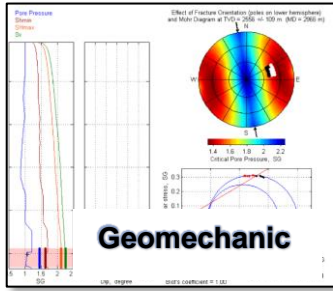
- Focus on one specific AOI
- Condense subsurface data evaluation focused on the AOI
- Revise static model & setup basic dynamic model



Evaluation Phases - Project Setup



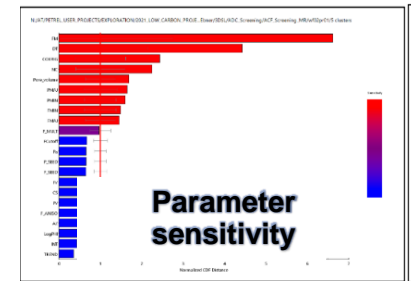
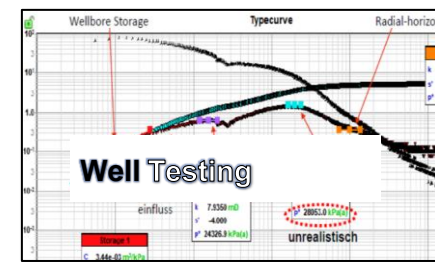
Prospect Phase – Pilot Phase



- Project Manager
- Teamleader, Exp-Geol.
- Exp-Geol.
- Prod-Geol.
- Opr-Team leader
- Opr-Geol.
- Exp-Geophysic
- Laboratory
- Prod-Geol.
- Induced seismicity
- Geomechanic
- Petrophysics
- Project manager
- Reservoir Eng.
- Reservoir Eng.
- ext. Sedimentology
- Laboratory
- Opr-Geol.
- Advisor Geol.
- Data manag.
- All

Prospect Evaluation:

▶ Finalize G&G, RE and PT tasks based on dynamic model (ready to drill)



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Risk elements

- ▶ Static Risks
- ▶ Dynamic Risks



STATIC RISK ASSESSMENT SCHEME FOR GEOTHERMAL PROJECTS	<p>Play Phase</p> <p>Risk Parameters: - Temperature - Flow Rate (Injection/Production Rate) - Water Chemistry</p> <p>Definition of minimum requirements for project success</p>
	<p>Lead Phase</p> <p>Risk Parameters: - Temperature - Flow Rate (Injection/Production Rate) - Water Chemistry</p> <p>Probability for project success, minimum requirements</p>
	<p>Prospect Phase</p> <p>Risk Parameters: - Temperature - Flow Rate (Injection/Production Rate) - Water Chemistry</p> <p>Probability for project success, minimum requirements</p>

$$P_{GSR} = P_{TEMP} \times P_{FR} \times P_{WC}$$

DYNAMIC RISK ASSESSMENT

Prospect Phase

- Risk Parameters:**
- Thermal breakthrough
 - Flowrate change
 - Reservoir pressure change
 - Induced seismicity

Conclusions

- ▶ HC Technical Assurance & Governance and Risk assessments are properly standardized
- ▶ No international standards for GT project evaluation are available
- ▶ HC technical assurance and governance is not entirely viable for GT projects, thus has to be revised and made fit for purpose
- ▶ Risk elements have to be optimized for GT purposes
- ▶ Play/Lead/Prospect assessment approach can be taken over from HC business, but need to be adjusted