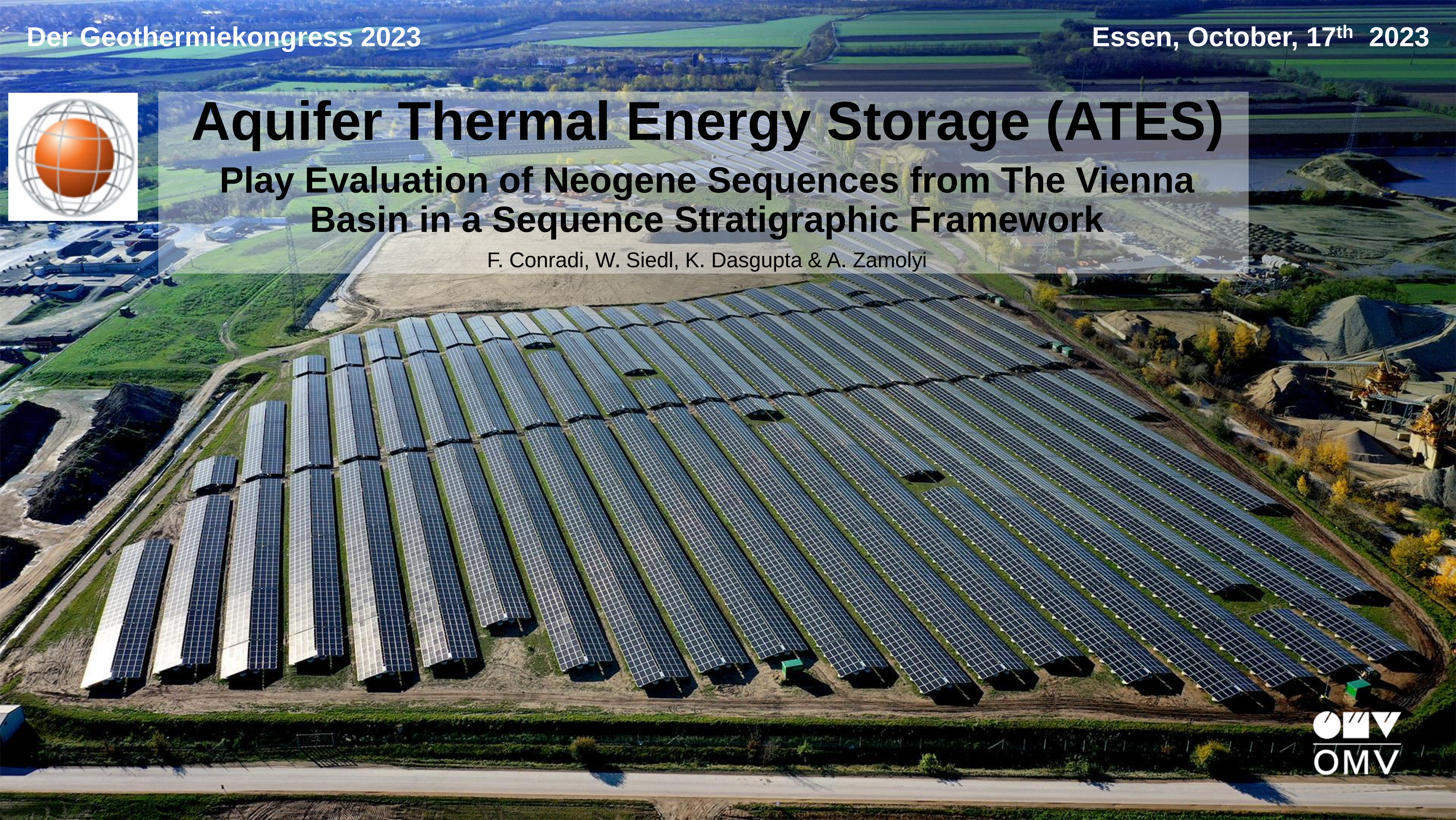
Der Geothermiekongress 2023

Essen, October, 17th 2023

Aquifer Thermal Energy Storage (ATES)

Play Evaluation of Neogene Sequences from The Vienna Basin in a Sequence Stratigraphic Framework

F. Conradi, W. Siedl, K. Dasgupta & A. Zamolyi



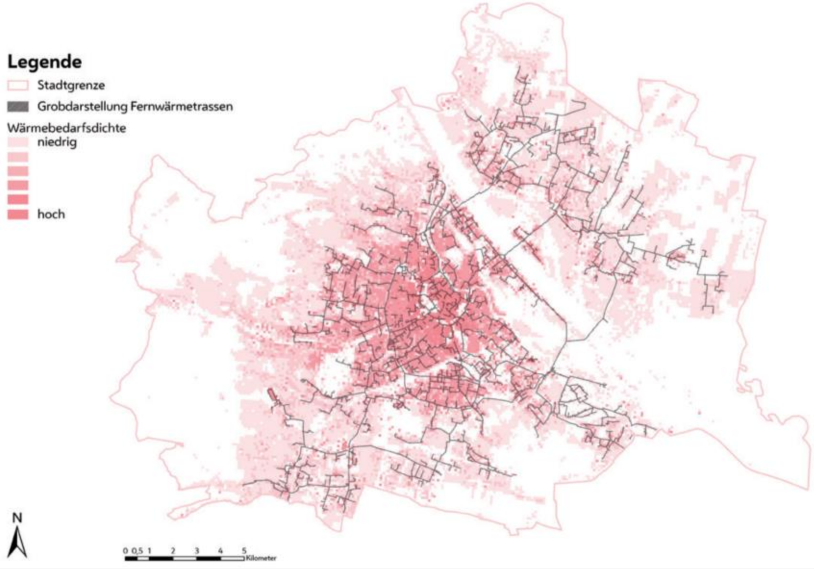
OMV

Introduction

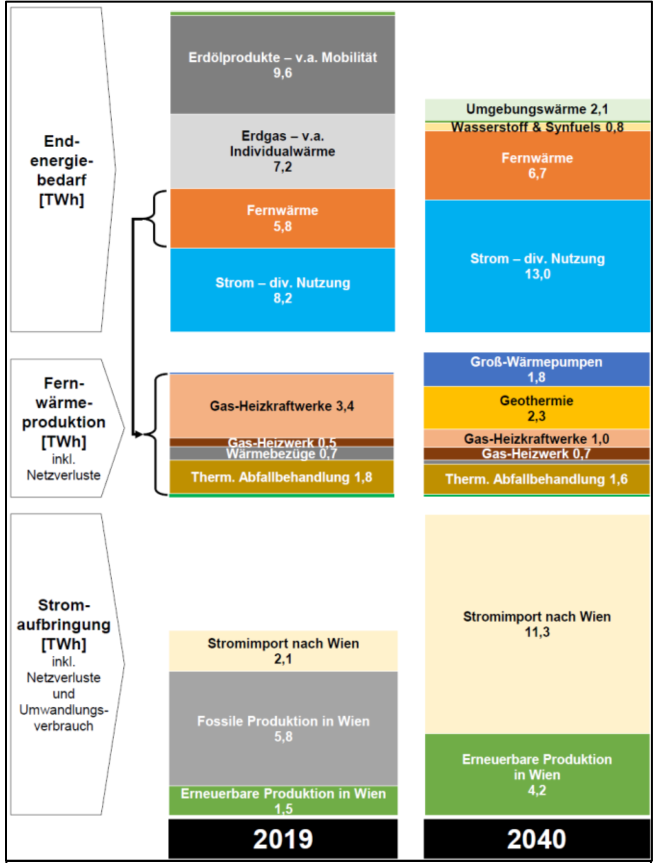
Context & Framework

- In 2020 Vienna City Council has set the goal for the city to become ‚*climate-neutral*' by 2040.
- DHC:
  - Energy production 2019 = 6.4 TWh
  - District heating network: 1300+ km
  - 400,000+ households connected
  - 50% of energy demand in heating sector
- Geothermal and Heat Pumps should replace/reduce fossil fuels in the heating sector

> ***„ATES is deemed as an important building block in the decarbonization process, as it can make use of excess energy that otherwise would be wasted"***



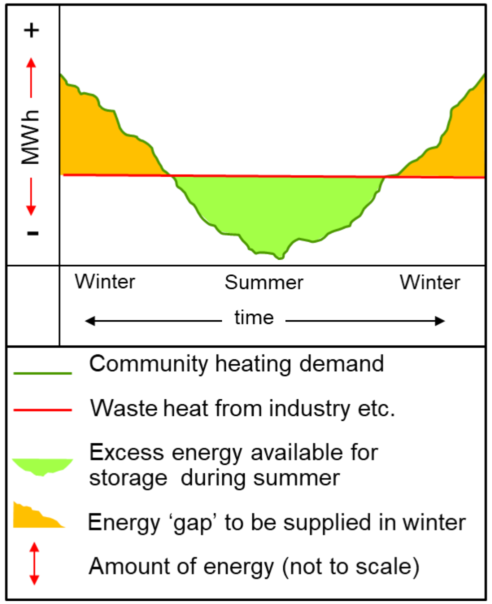
source: https://www.wien.gv.at/stadtentwicklung/energie/pdf/waerme-und-kaelte-2040.pdf



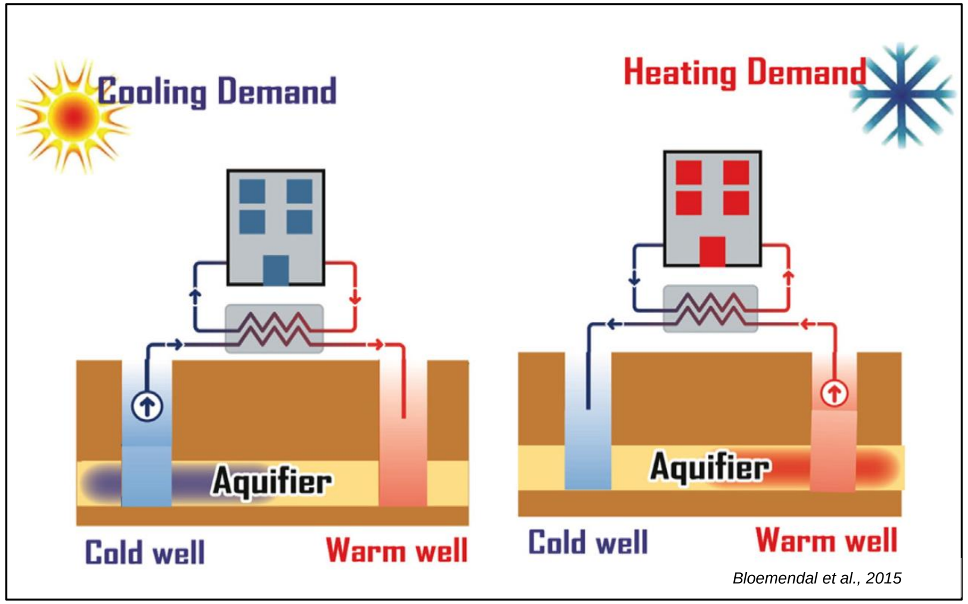
source: Aue & Burger, DECARB Endbericht, 2021

General Consideration

Rationale



Principle



Possible Scale

ATES Example			
	charge	discharge	*unit*
charge/discharge	4000	5000	*m3/d*
	46	58	*l/s*
period	7	5	*months*
	5110	3650	*h*
T_input / output	100	90	*degC*
T_output / input	50	50	*degC*
Delta T	50	40	*degC*

Power / Leistung	**10**		**MW**
Energy Output per period/per year	50	**35**	***GWh/period***
Total Efficiency per cycle (charge/discharge)	**0,7**		

This study

- Play Evaluation:
  - Subsurface focus
  - Regional reservoir presence
  - Reservoir properties

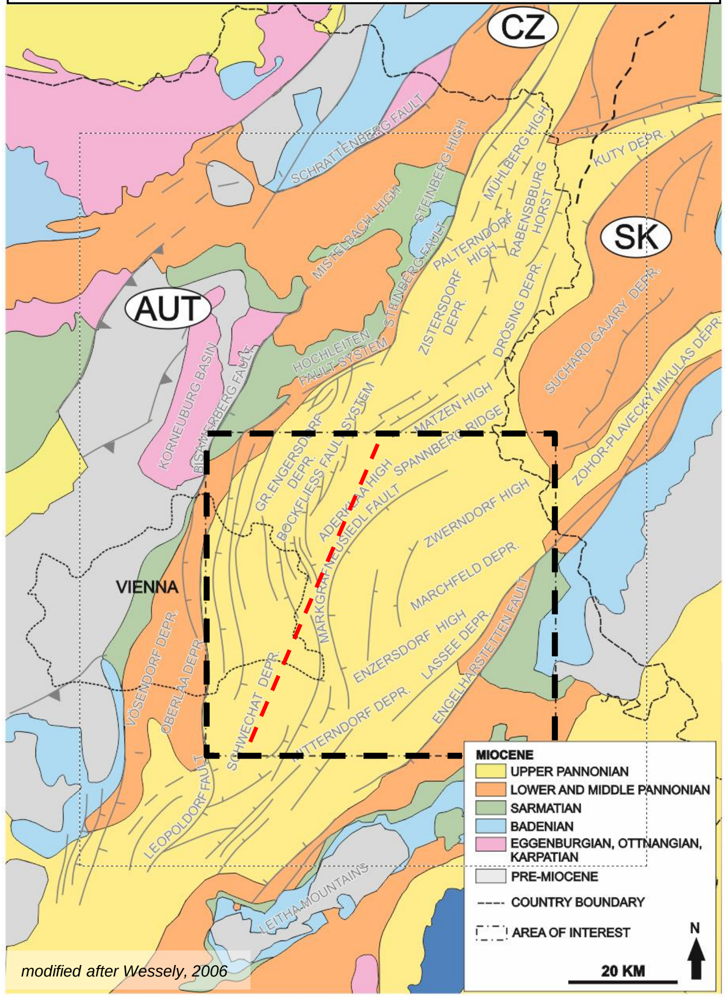
Beyond this study

- Lead Evaluation:
  - Evaluation of one (or more) specific lead(s)
- Prospect Evaluation:
  - Planning of ATES drilling project

Introduction

Study Area, Project Outline & Reservoir Overview

Study Area



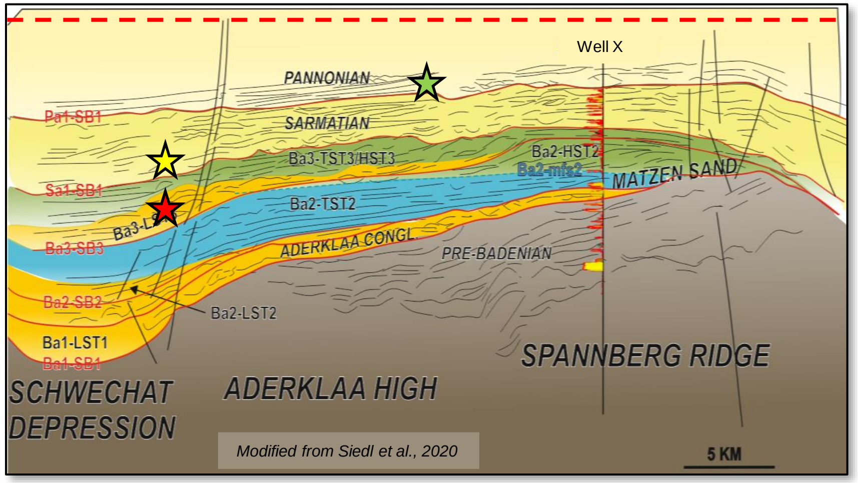
modified after Wessely, 2006

Project Objective:

- To evaluate potential aquifers (reservoirs) of the Badenian, Sarmatian & Pannonian for ‚***A****quifer* ***T****hermal* ***E****nergy* ***S****torage*' (**ATES**) on a Play level

Project Objectives:

- Identify and characterize reservoirs
- Visualize reservoirs as GDE map



Modified from Siedl et al., 2020

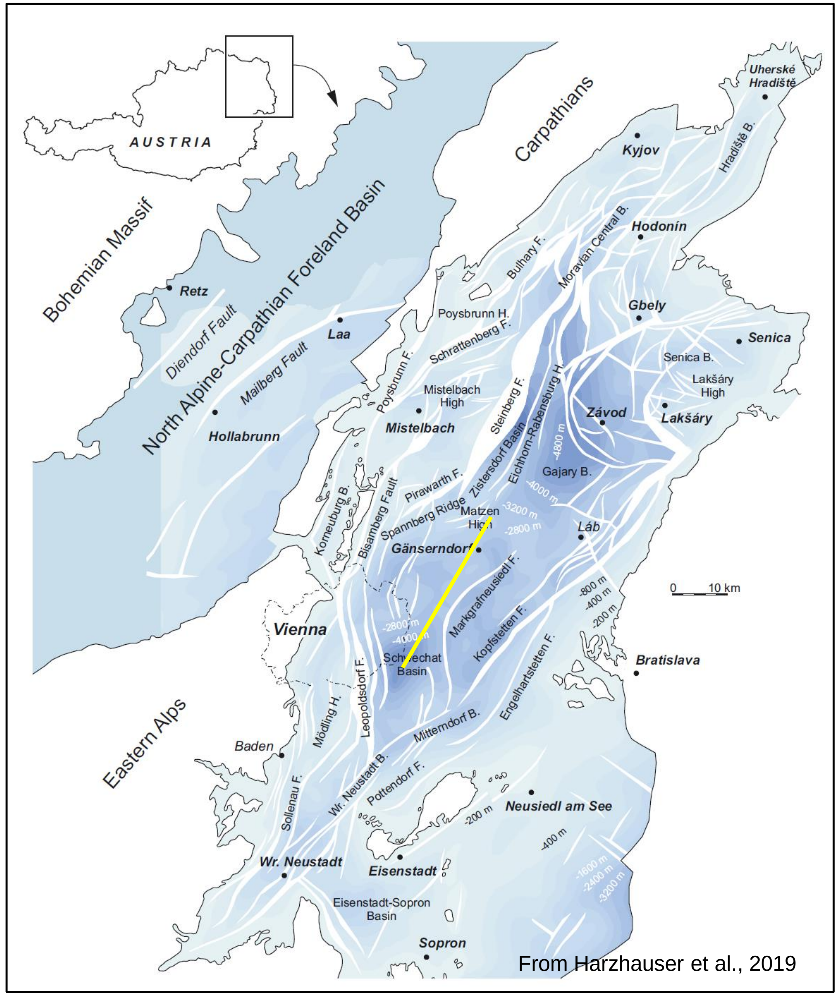
Reservoirs:

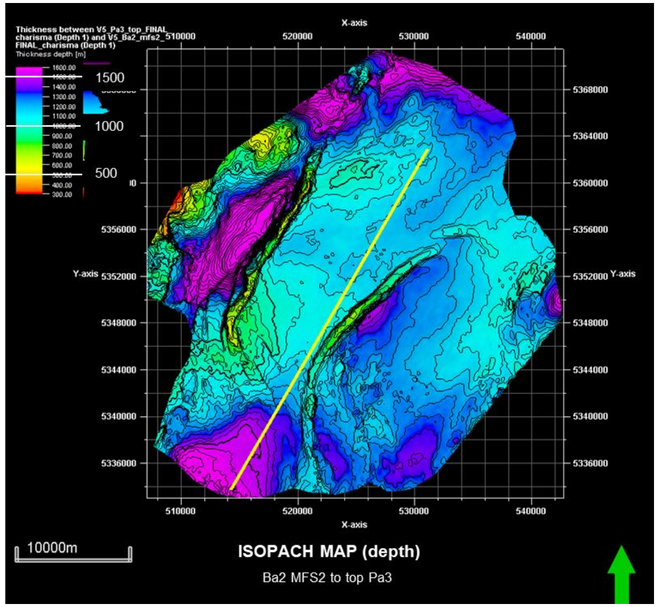
- Badenian: clastic, marine fan-system ★ (red)
- Sarmatian: clastic, marine fan-system ★ (yellow)
- Pannonian: lacustrine delta system ★ (green)

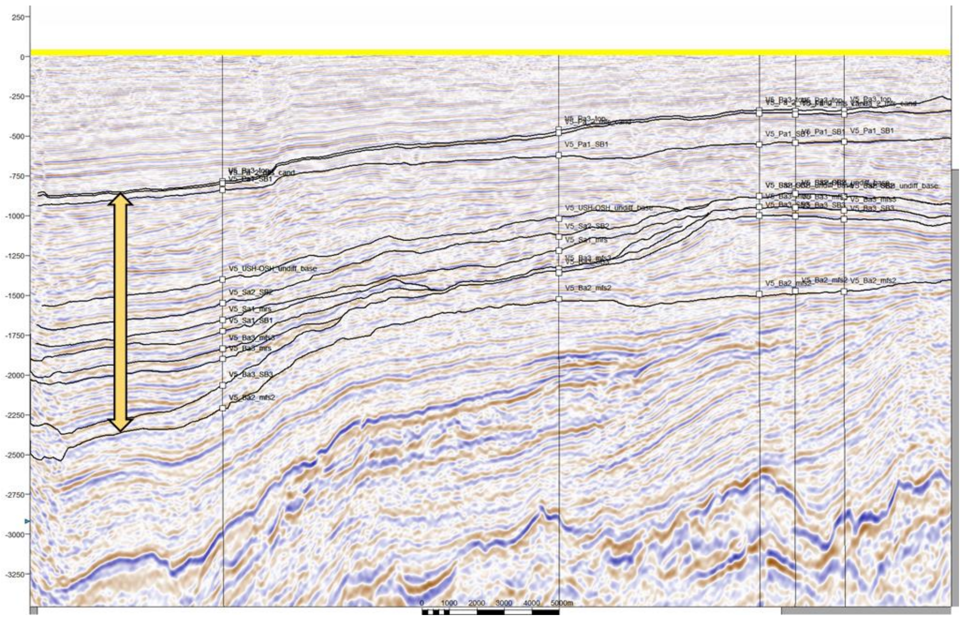
Methods:

- Well data preparation (Well logs, Cores, Cuttings, Well tops data, Check shots)
- Well-to-seismic tie-in
- Well cross sections of reference wells
- Seismic resolution improvement
- Seismic interpretation
- Depositional system interpretation
- Core and well log facies interpretation
- Assessment of reservoir properties using core and well log data
- GDE maps of all plays
- Sensitivity Study

Basin Morphology



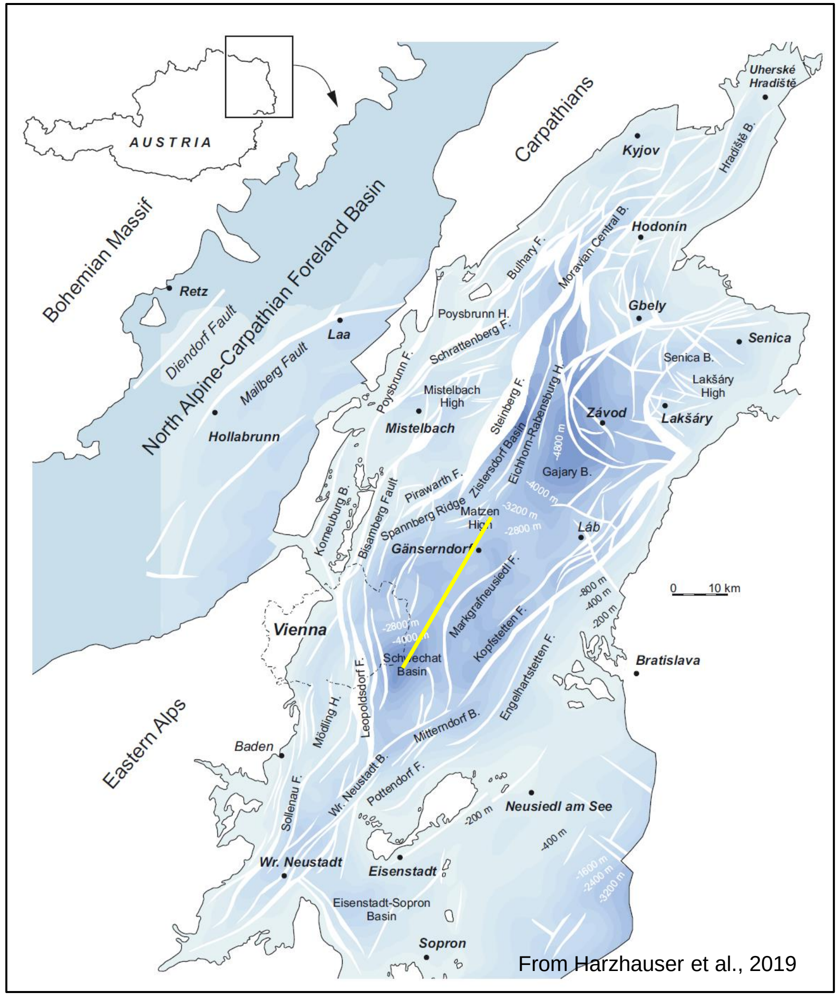


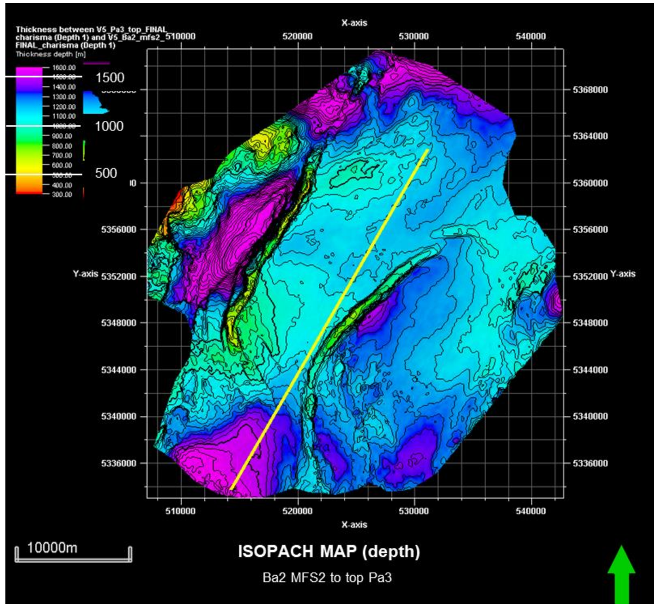


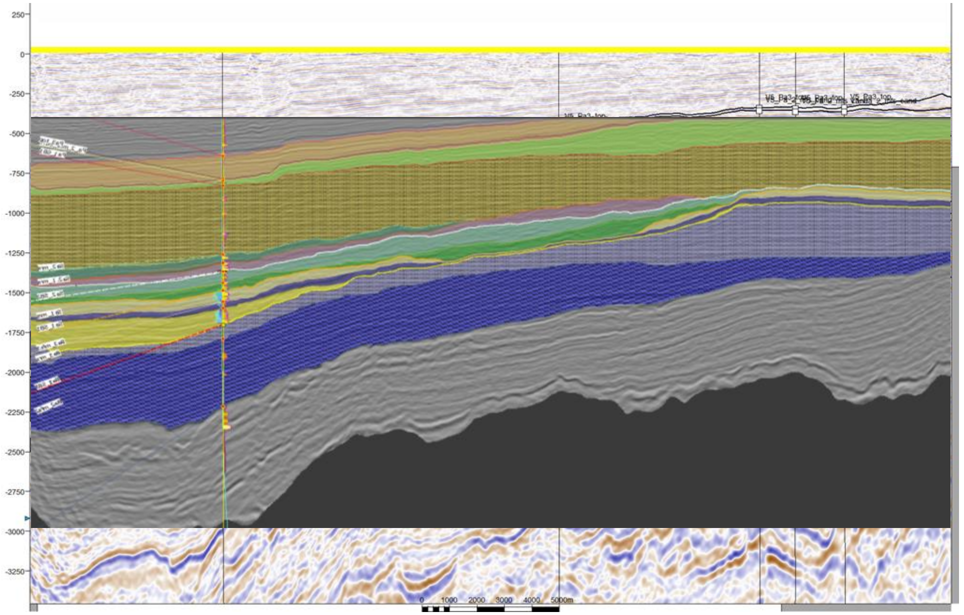
- *“Pull-apart / piggy-back basin developed on top of the northward moving allochthonous Alpine-Carpathian units”*
- Up to ca. 5 km Neogene sediment infill since Early Miocene
- Development of several distinct ‘mini-basins’

Regional Geological Setting

Basin Morphology



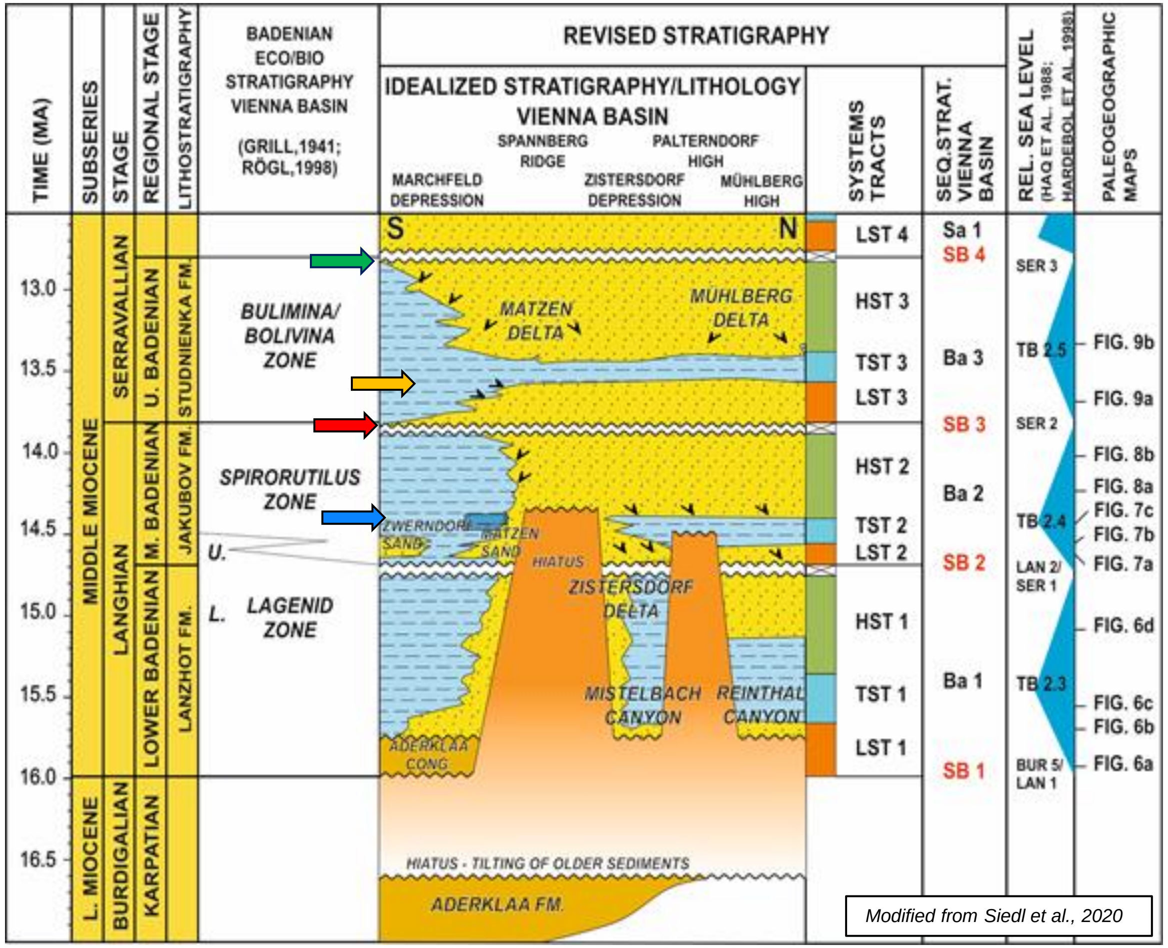


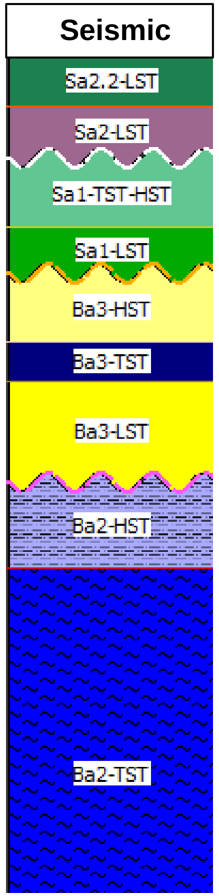


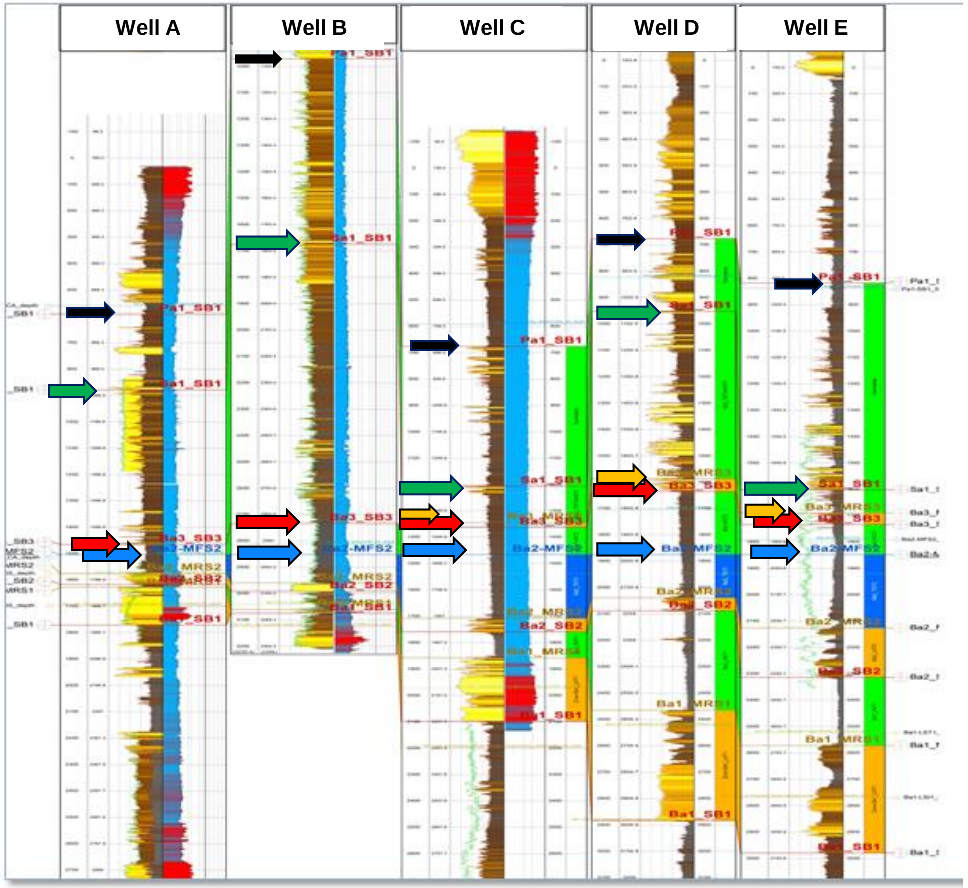
- *"Pull-apart / piggy-back basin developed on top of the northward moving allochthonous Alpine-Carpathian units"*
- Up to ca. 5 km Neogene sediment infill since Early Miocene
- Development of several distinct 'mini-basins'

Methodology

Workflow – Badenian Example



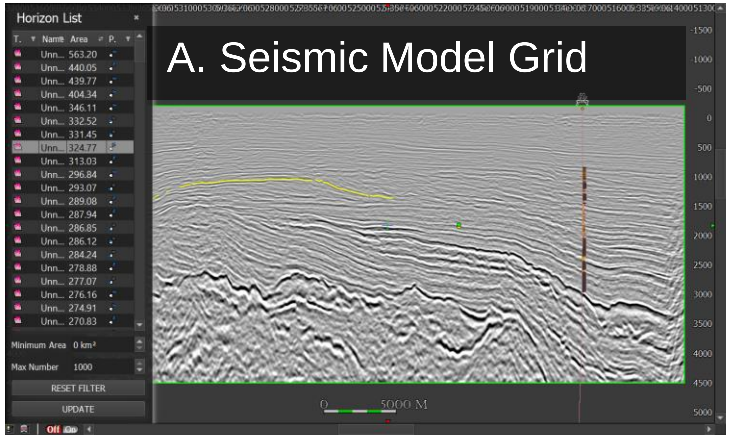


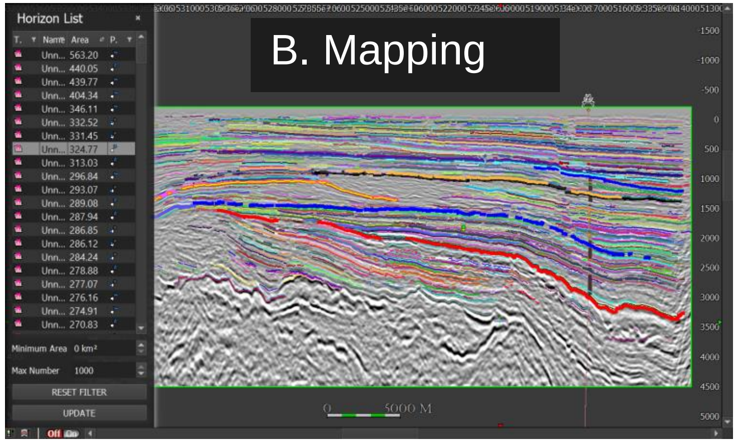


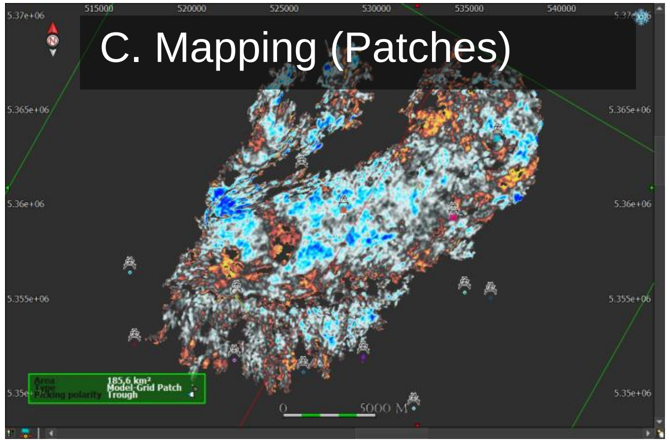
Key seismic Horizon: Ba2 mfs2 | Ba3 SB3 | Ba3 mrs3 | Sa1 SB1 | Pa1 SB1

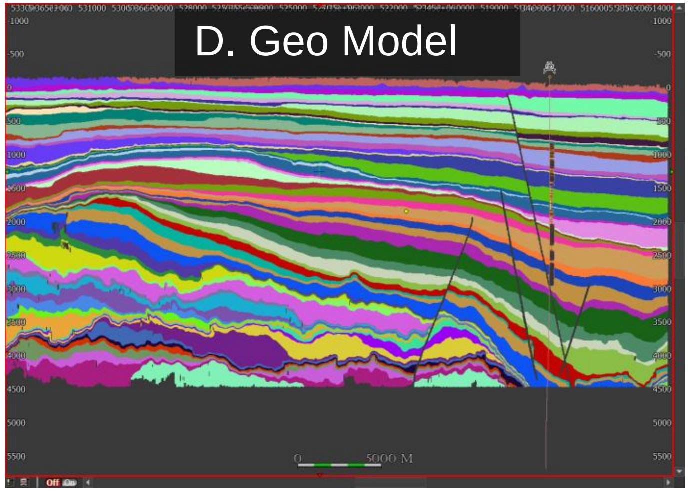
Methodology

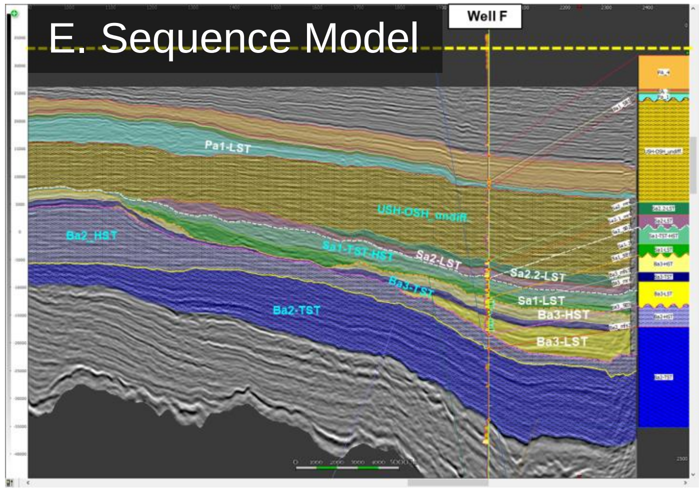
Seismic Workflow: Model-Grid → Sequence - Model











A. Seismic 'Model-Grid' with polarity-consistent patches for whole 3D volume

B. Mapping on Model-Grid by using automatically tracked patches in a geological meaningful way

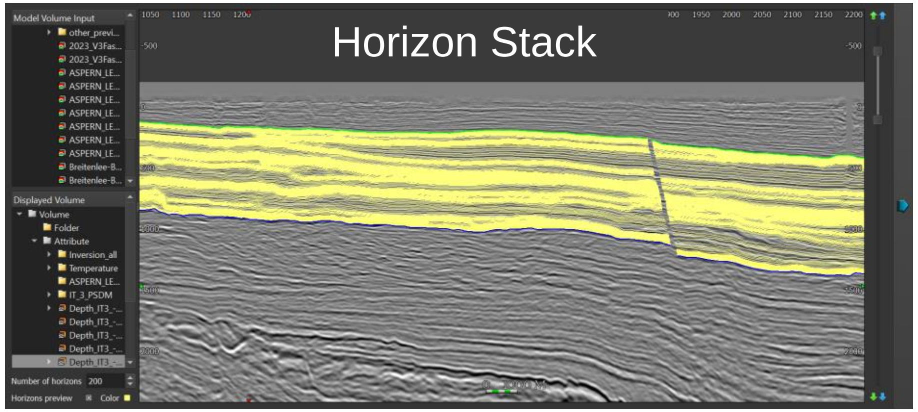
C. Data mapping with attributes (e.g. Rel AI, RMS) can support correlations/interpretations

D. First-pass Geo-Model provides geological time-consistent units in 3D

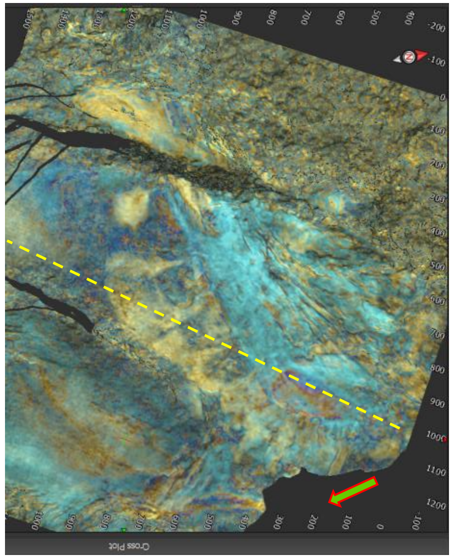
E. Adoption of 'Sequence Model' allows for truncation of strata (i.e. unconformities, pinch-outs, erosional features…), thus definition of seismic sequence stratigraphic untis.

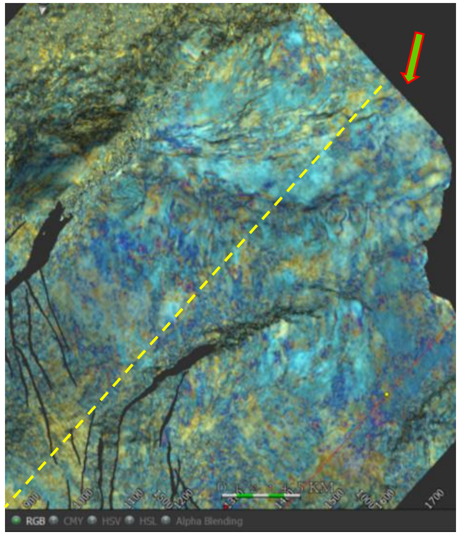
Methodology

Seismic Geomorphology – Examples

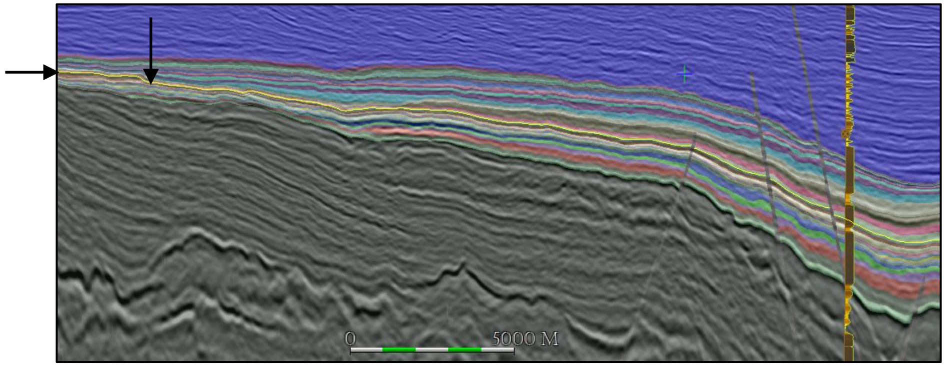


- Horizon stack consists of a series of geological time-equivalent horizons, according to geo-model.
- Spectral decomposition data (and other seismic attributes) mapped on horizon slices used to illustrate seismic features that are interpreted as architectural elements from the depositional system of each sequence

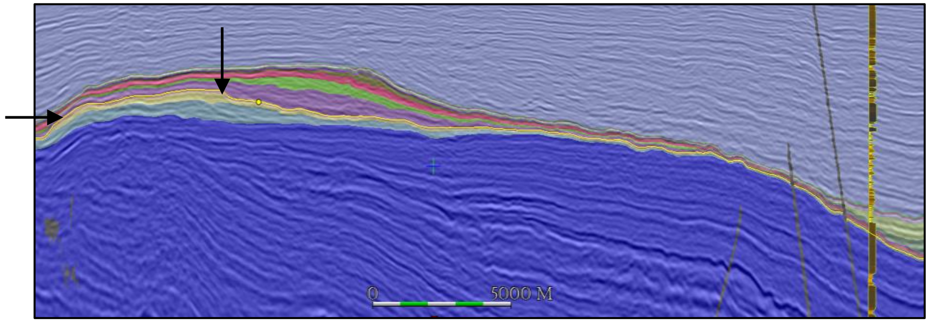




= *Depositional dip*



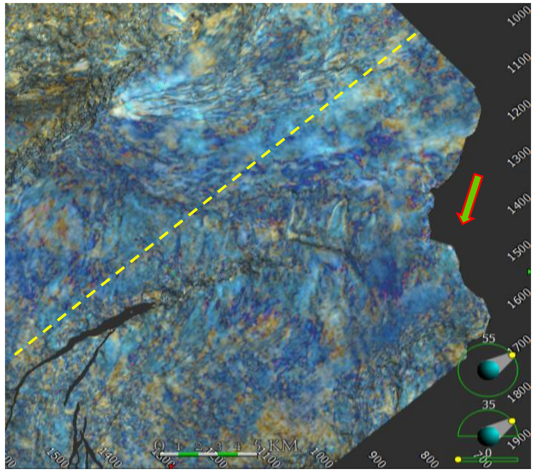
Aggradational, continuous reflector pattern with a clear 'line of marine onlaps'. Small-scale gravity-displaced frontal splays' with no or very short 'feeder channels' present. ***Transgressive System Tract (TST).***

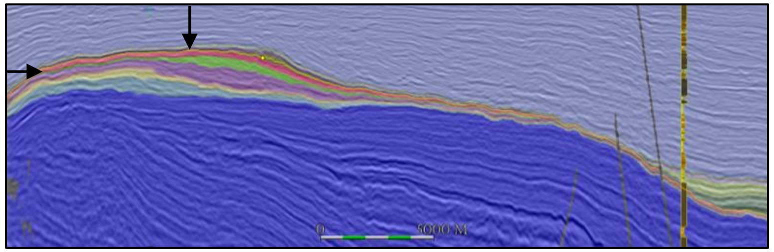


Aggradational to progradational, semi-continuous reflectors showing clinoforms. Shelf margin evolves. Numerous small, rel. short, mostly straight channels feeding into cone-like feature 4-9 km distal from margin.
Late TST - Early Highstand System Tract.

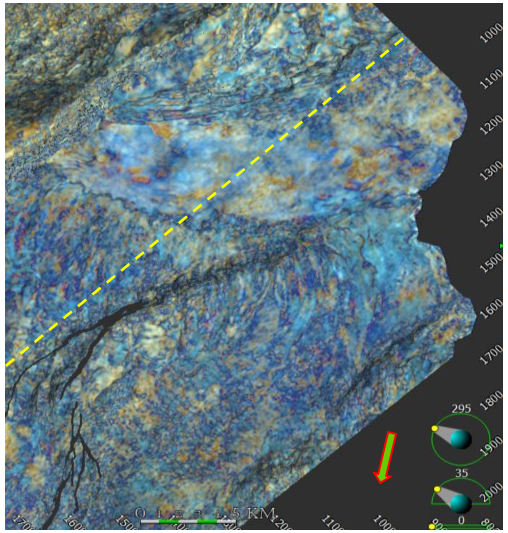
Methodology

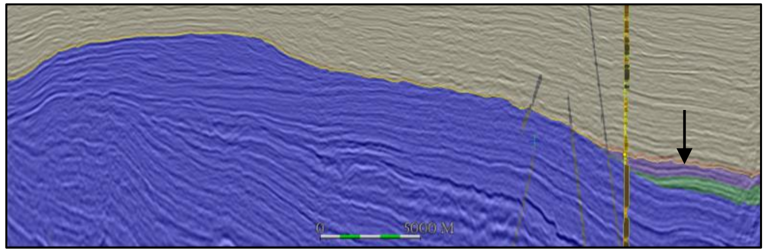
Seismic Geomorphology – Examples



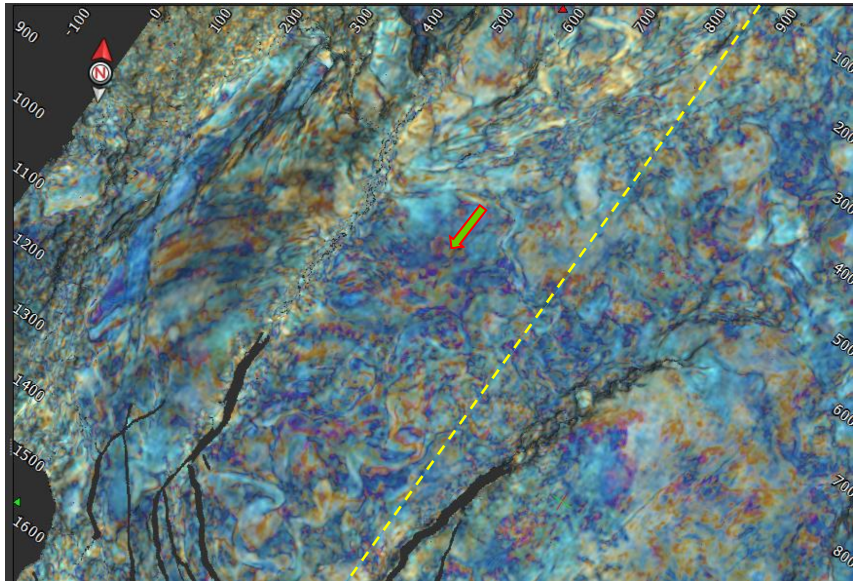


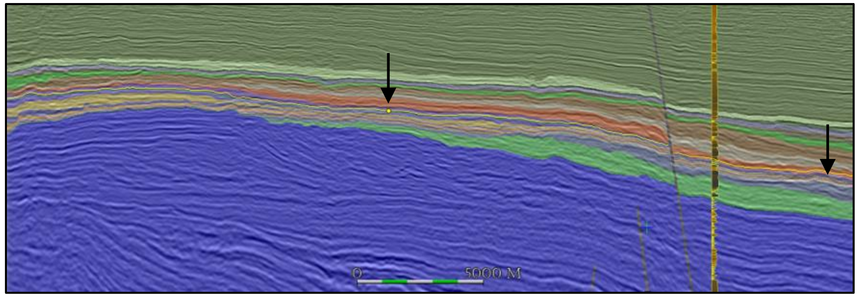
Progradational & aggradational, semi-continuous reflector pattern. Straight to slightly sinuous, mid-sized 'slope channel' present. No significant fan development in distal areas.
Late Highstand System Tract.





Shelf edge marked by slump scars. Sinuous, non-meandering erosional, tributary slope channels present. At point of transition to distributary channel arrangement marine fan-systems develop.
Lowstand System Tract



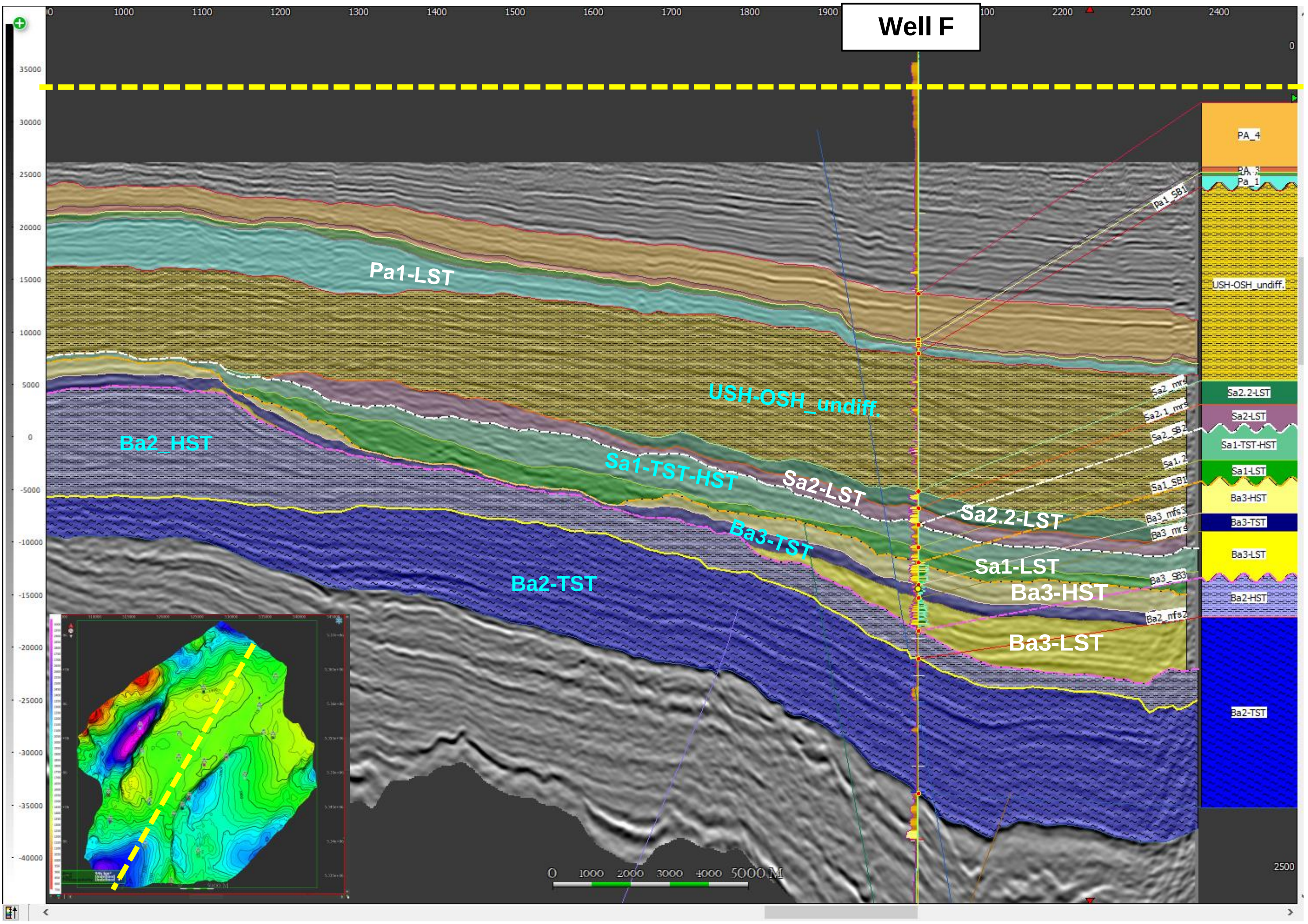


Aggradational, discontinuous to semi-continuous reflector pattern, strongly meandering channels of marginal-marine origin. Presumably tide-dominated delta environment.
Lowstand conditions of higher order during overall transgression.

= Depositional dip

Results

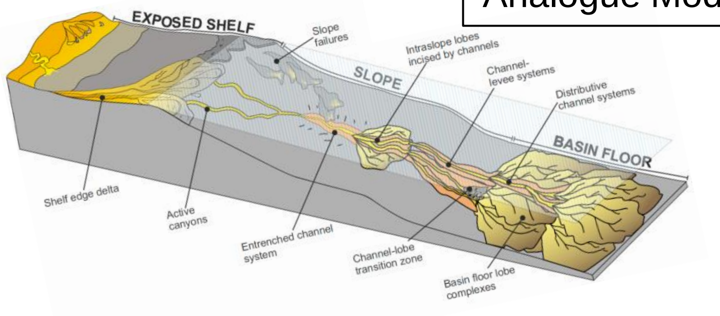
Seismo-Stratigraphic Model



Construction of GDE map

- Overlay of nearby time equivalent horizons within single sequence illustrate change / evolution of depositional features
- Spectral Decomposition slices from Horizon Stacks 'tool of choice'
- Depositional system analogue chosen needs to be consistent with all interpretations (seismic, core & logs)
- Drawing or seismic extraction of depositional features → abstraction
- Grouping of features, 1st pass interpretation of Gross Depositional Environments
- QC of intermediate product with well data (cross sections, well logs, core)

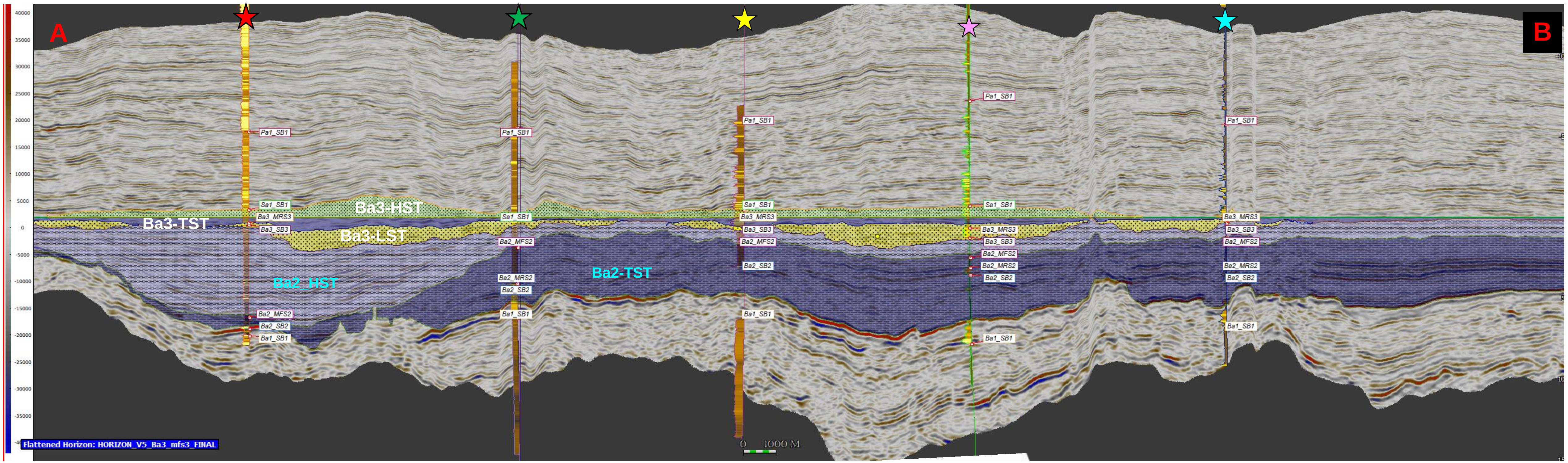
Analogue Model

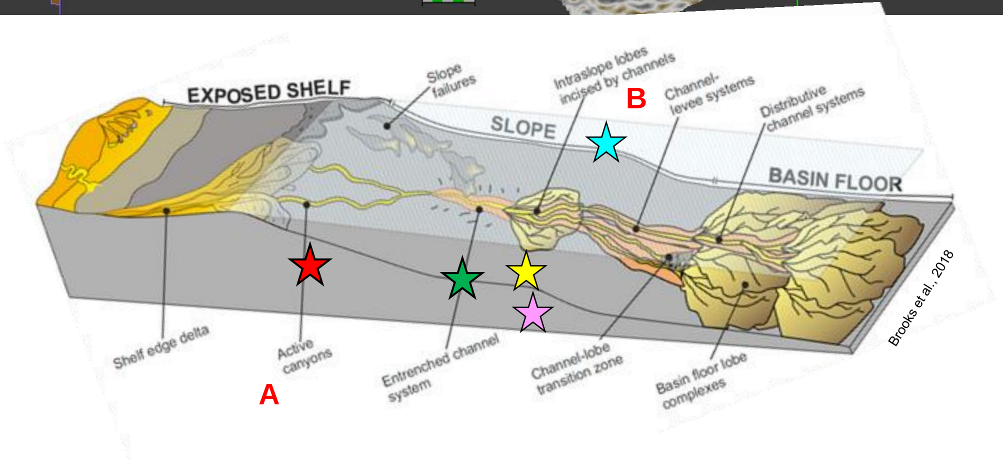


Brooks et al., 2018

Results

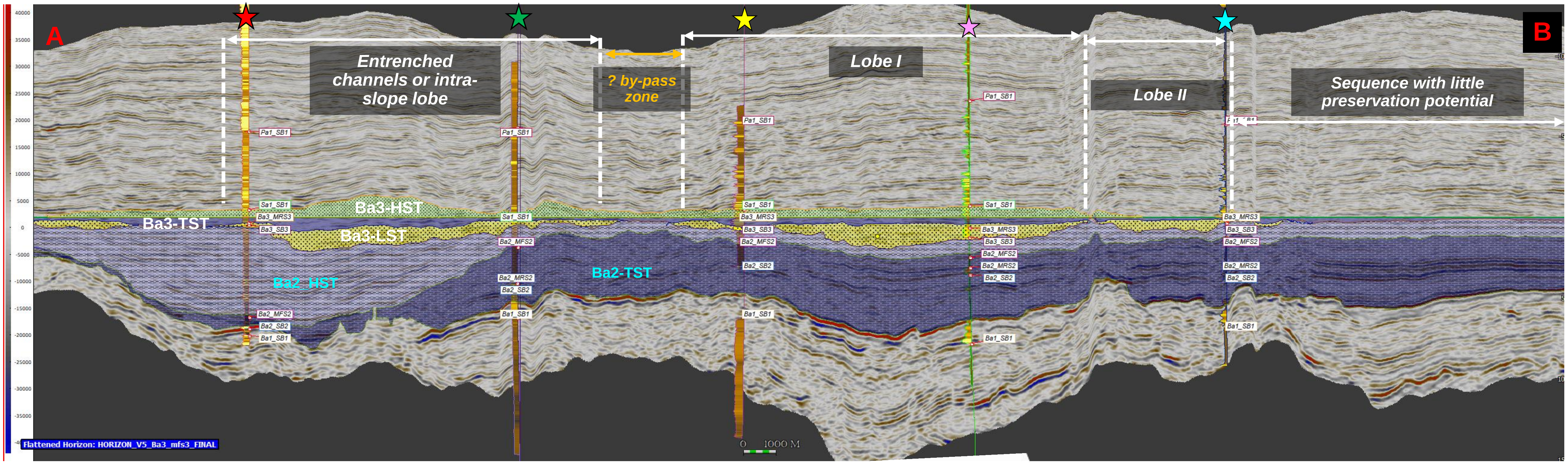
Badenian Seismic Cross Section

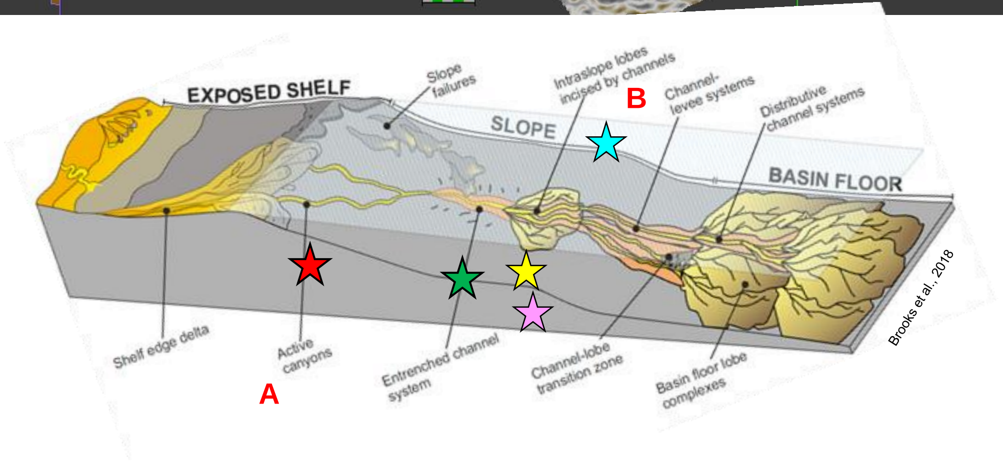




Results

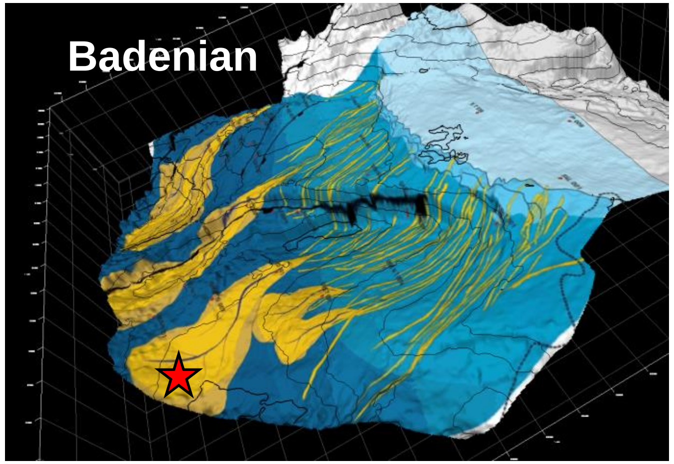
Badnian Seismic Cross Section

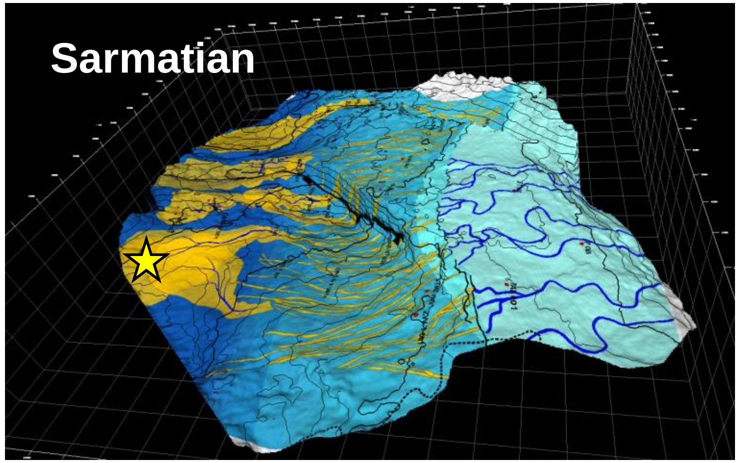


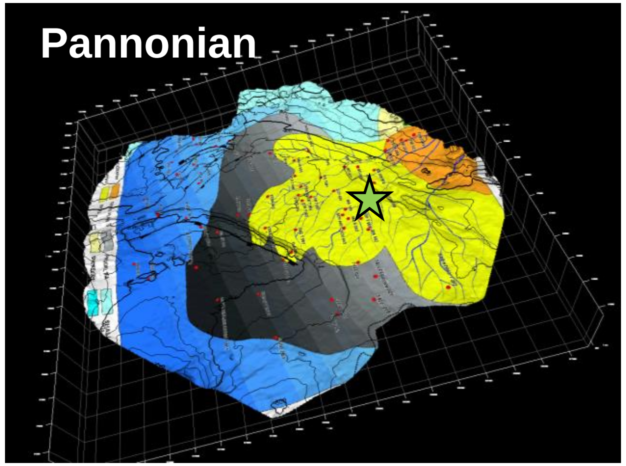


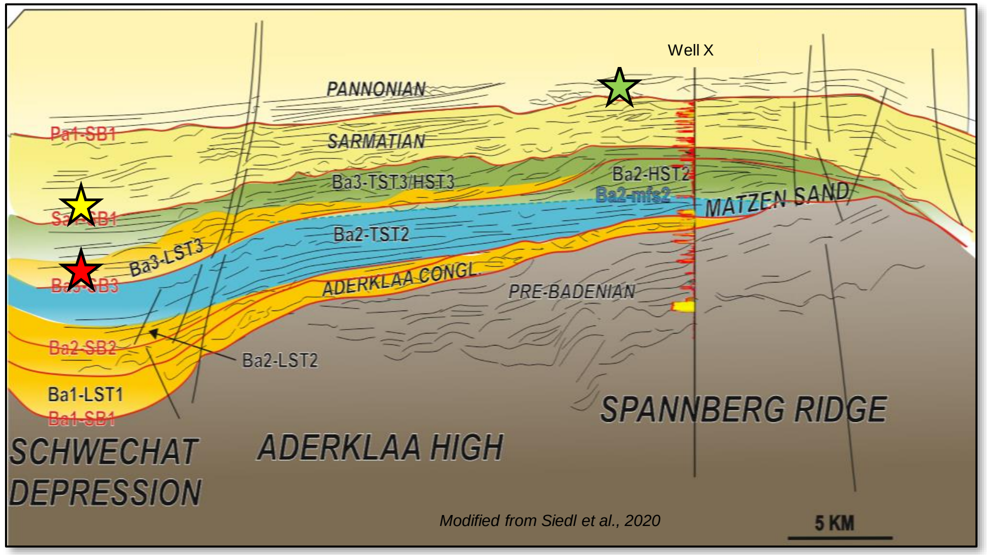
Results

Gross Depositional Environment Maps









Modified from Siedl et al., 2020

Key Reservoir Parameter

Sequence / Interval	Badenian	Sarmatian	Pannonian
Area cummulative (km)	ca. 150	ca. 130	ca. 850
Schwechat lobe / fan area / GrossEngersdorf lobe (km)	68	60	65
Thickness Gross (m)	92-301	206-467	100-264
Max. net thickness drilled (m)	199	224	186
AVG_PHIE_eff_after cut-off	21	28	25
Nr. of wells	9	5	23
Temperature range (deg C)	50-80	40-70	30-50

Summary & Future Outlook

Play Evaluation Summary:

- Definition of several plays of pre-defined chronostratigraphic Neogene intervals in AOI in vicinity of the City of Vienna.
- Sensitivity Analysis performed to provide framing parameter for ATES application in Neogene of the Central Vienna Basin
- Reservoir parameters of selected intervals match pre-requisites from ‘Sensitivity Study’
- Depositional model & GDE map for each play provided
  - Various methodologies based on seismic, well log & core analysis in-line with proposed geological depositional models

Lead Definition (next phase):

- Selection of Leads from Play area – according to customer requirement
- Risk Management for each Lead
  - Subsurface including hydrogeochemistry
  - Surface
  - Economics
- Maturation of Lead to Drilling Project

THANK YOU !

Selected References

Integrated stratigraphy of the Sarmatian (Upper Middle Miocene) in the western Central Paratethys

Mathias Harzhauser[1] and Werner E. Piller[2]
[1]*Museum of Natural History Vienna, Geological-Paleontological Department, Burgring 7, A-1014 Vienna, Austria*
e-mail: mathias.harzhauser@nhm-wien.ac.at
[2]*Institute for Earth Sciences (Geology and Paleontology), University of Graz, Heinrichstrasse 26, A-8010 Graz, Austria*

Width and Thickness of Fluvial Channel Bodies and Valley Fills in the Geological Record: A Literature Compilation and Classification

Article *in* Journal of Sedimentary Research · June 2006
DOI: 10.2110/jsr.2006.060

Austrian Journal of Earth Sciences | Vienna | 2020 | Volume 113/1 | 87 - 110 | DOI: 10.17738/ajes.2020.0006

Revised Badenian (middle Miocene) depositional systems of the Austrian Vienna Basin based on a new sequence stratigraphic framework

Wolfgang SIEDL[1]*, Philipp STRAUSS[1], Reinhard F. SACHSENHOFER[2], Mathias HARZHAUSER[3], Thomas KUFFNER[1] & Matthias KRANNER[3]

Disconnected submarine lobes as a record of stepped slope evolution over multiple sea-level cycles

Hannah L. Brooks[1], David M. Hodgson[1], Rufus L. Brunt[2], Jeff Peakall[1], Miquel Poyatos-Moré[2,3], and Stephen S. Flint[2]
[1]Stratigraphy Group, School of Earth and Environment, University of Leeds, Leeds LS2 9JT, UK
[2]Stratigraphy Group, School of Earth and Environmental Sciences, University of Manchester, Manchester, M13 9PL, UK
[3]Department of Geosciences, University of Oslo, 0371 Oslo, Norway

Combining climatic and geo-hydrological preconditions as a method to determine world potential for aquifer thermal energy storage

Martin Bloemendal [a,b,*], Theo Olsthoorn [a,c], Frans van de Ven [a,d]

From Wessely, G. & Liebl, W. (eds), 1996, *Oil and Gas in Alpidic Thrustbelts and Basins of Central and Eastern Europe*, EAGE Special Publication No. 5, pp. 355–363.

Legal Disclaimer

This presentation is prepared in order to outline our expression of interest. Nothing in this presentation shall be construed to create any legally binding obligations on any of the parties. Neither party shall be obligated to execute any agreement or otherwise enter into, complete or affect any transaction in relation to this presentation.

All figures and information in this presentation are strictly confidential, they are by no means binding and thus indicative only.

OMV

Contact

OMV Energy
Trabrennstrasse 6-8
1020 Vienna

Corporate Communications
insertemailadress@omv.com
www.omv.com
www.omv.com/socialmedia