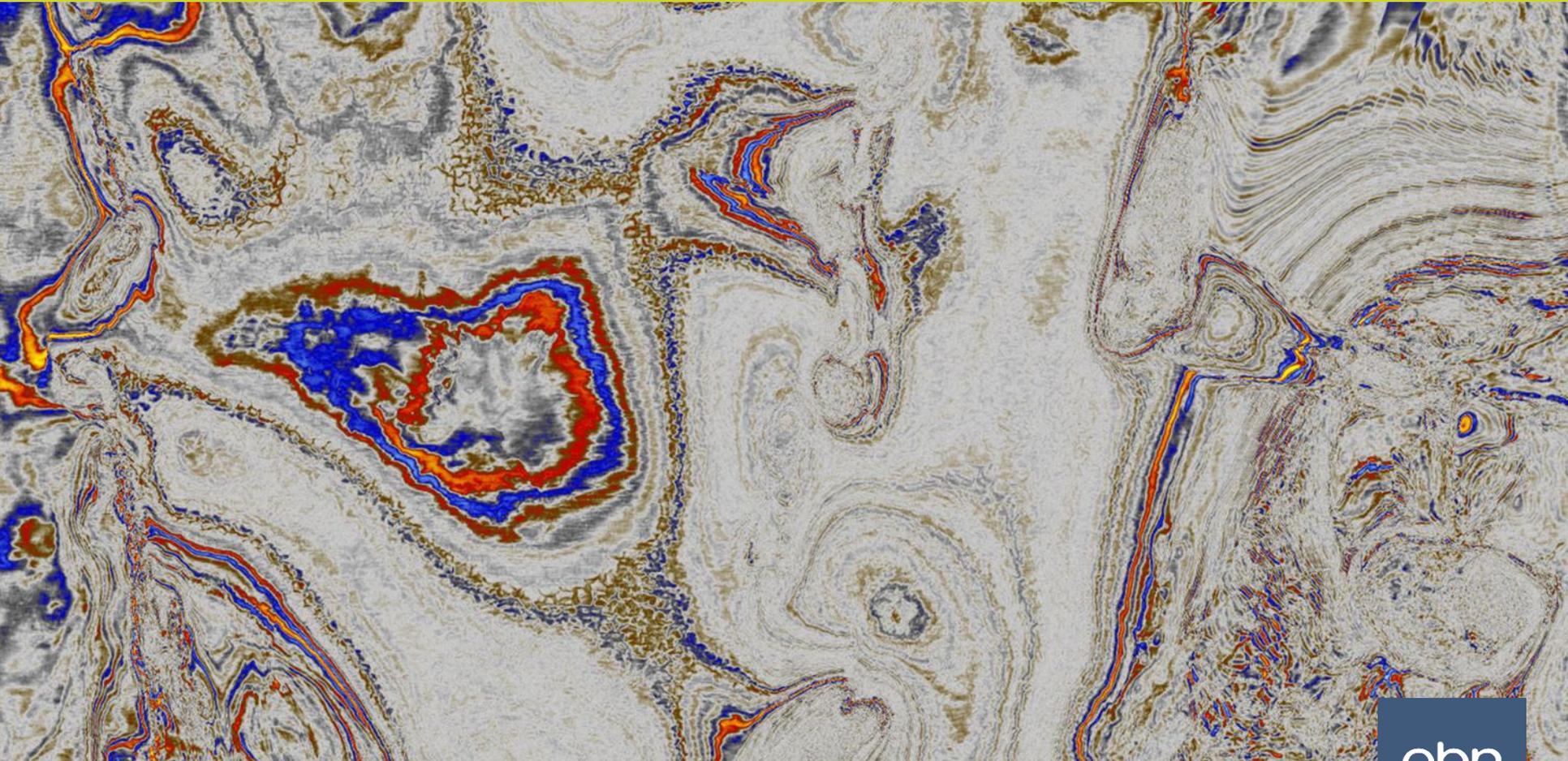


# How well do we predict depth?



**Guido Hoetz**  
**Chief Geoscientist EBN B.V.**

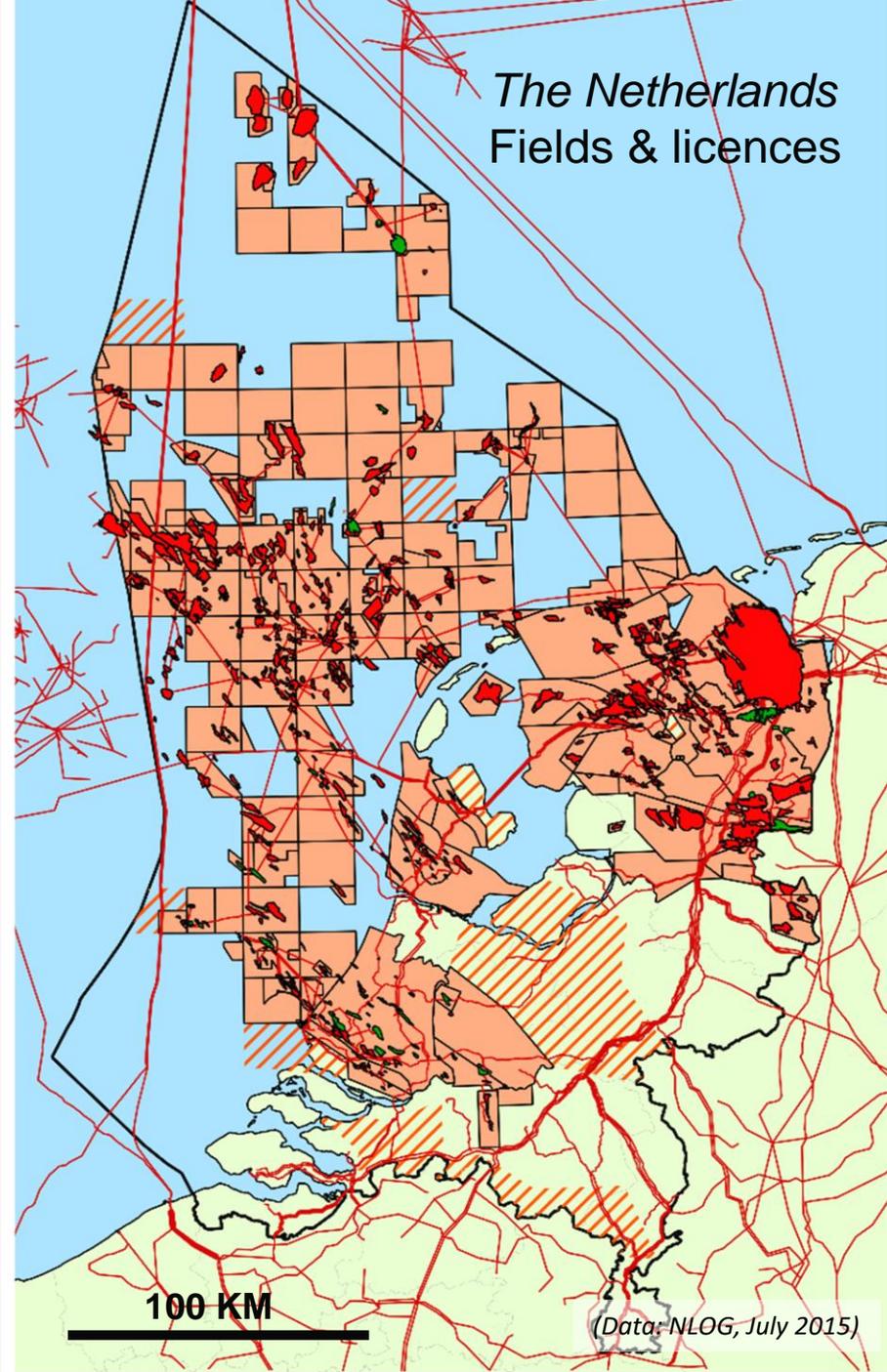
ebn

# contents

- Background
- Depthing matters
- Typical depth conversion workflow
- Depth errors & bias
- Explaining the bias
- Conclusions

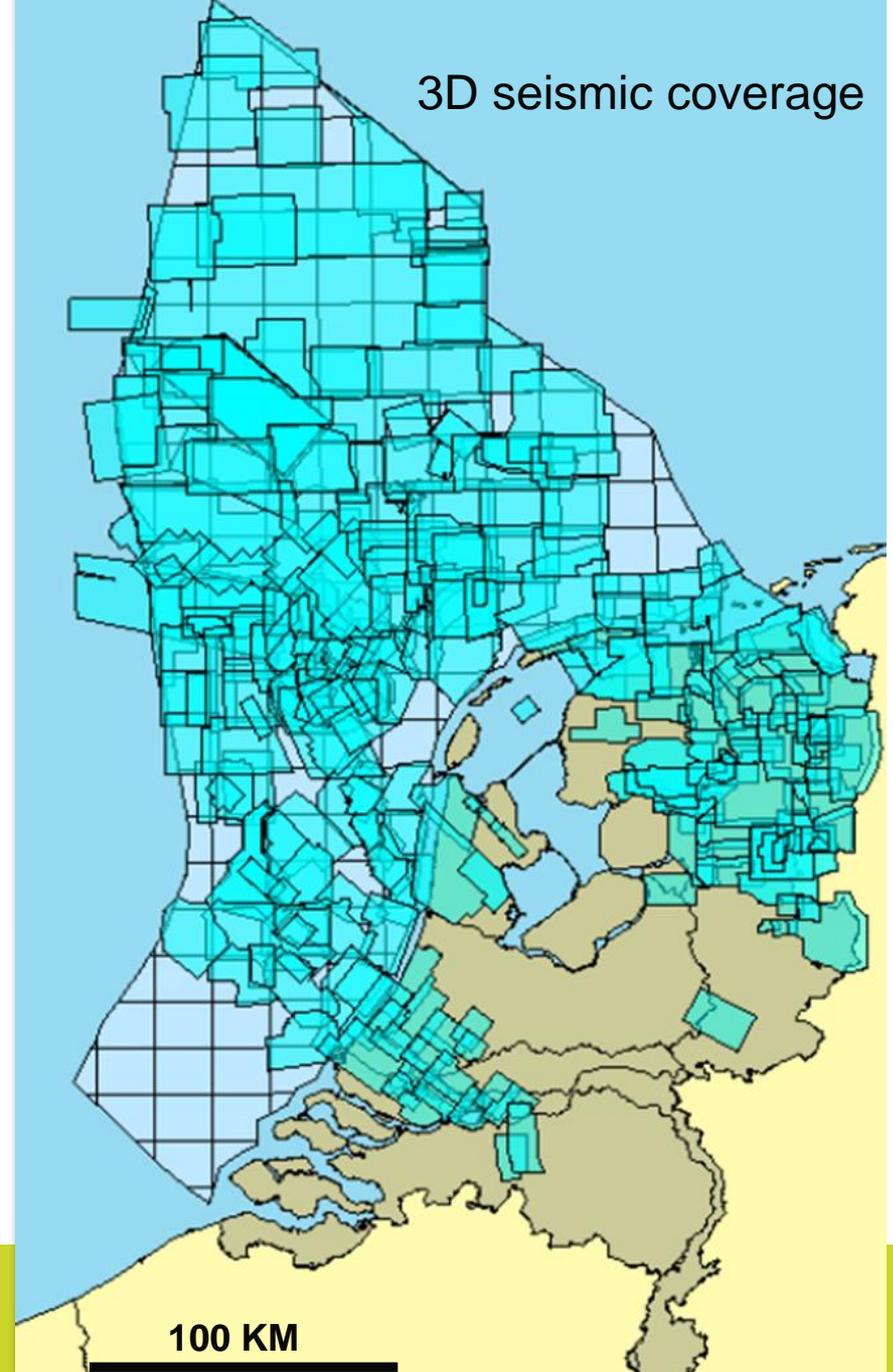
# About EBN

- EBN invests in exploration and production of natural gas and oil on behalf of the Dutch State
- Number of employees: 81 (2016)
- Participates in nearly all dutch upstream (~40% share)
- Production: ~500k boe/d (2014)
- All profits of EBN are transferred to Dutch government: € 4.9 bln (2014)
- Access to most data



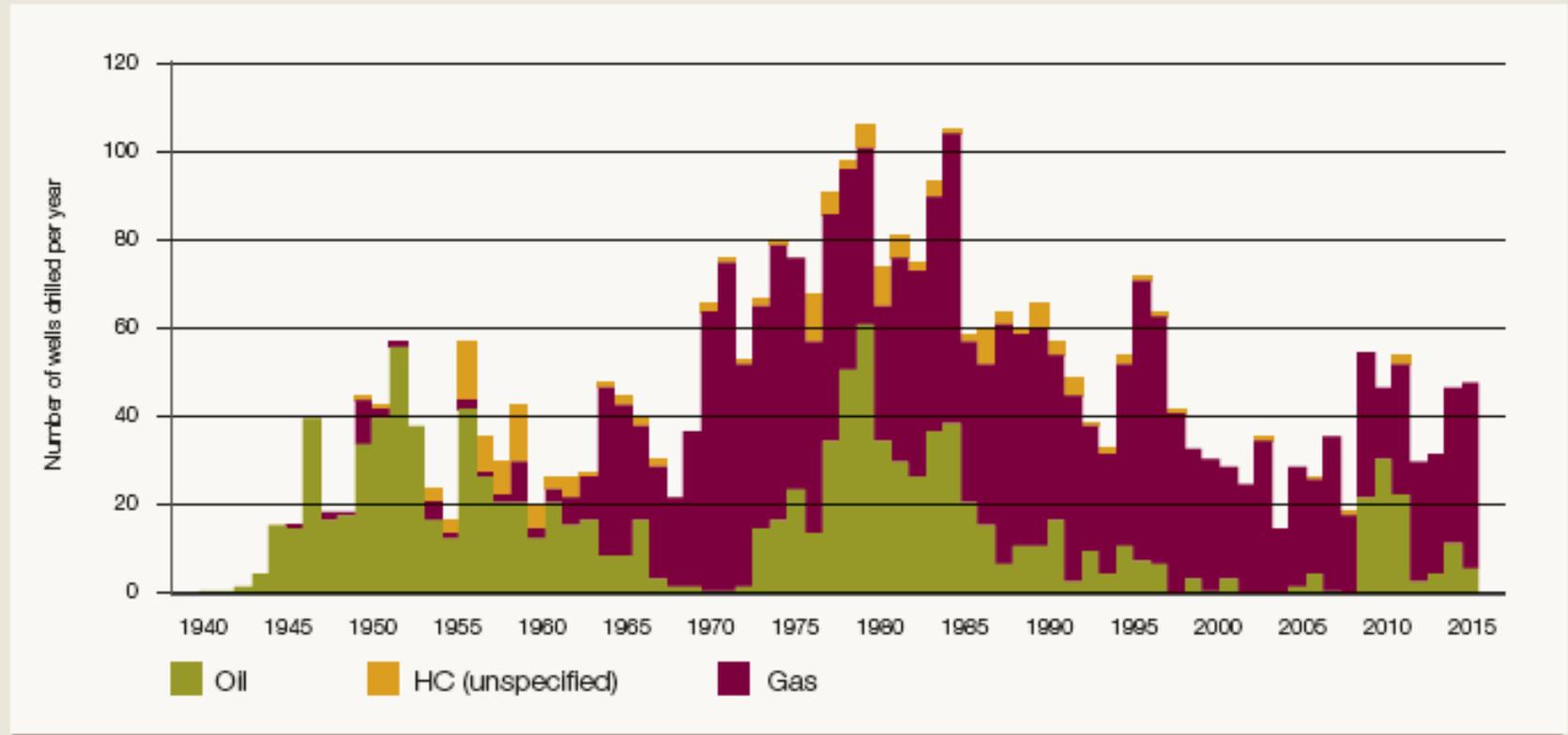
# About EBN

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- **Access to most data**
  
- **140,000 km<sup>2</sup> 3D seismic**
- **> 5,000 wells**



# ~40 new wells annually do test seismic technology in NL

## Drilling activity in the Netherlands

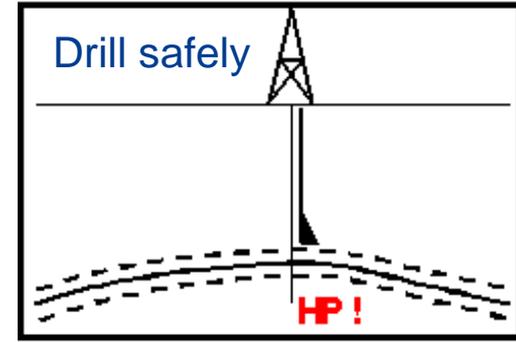
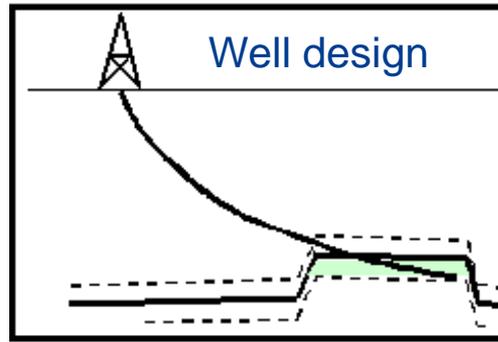
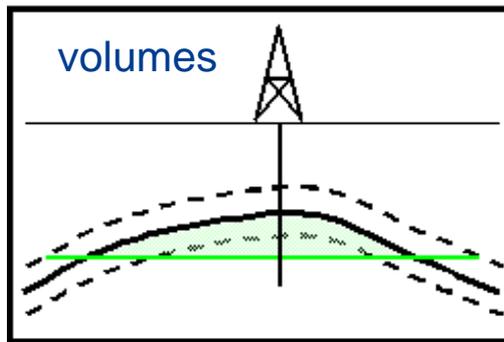


EBN 2014

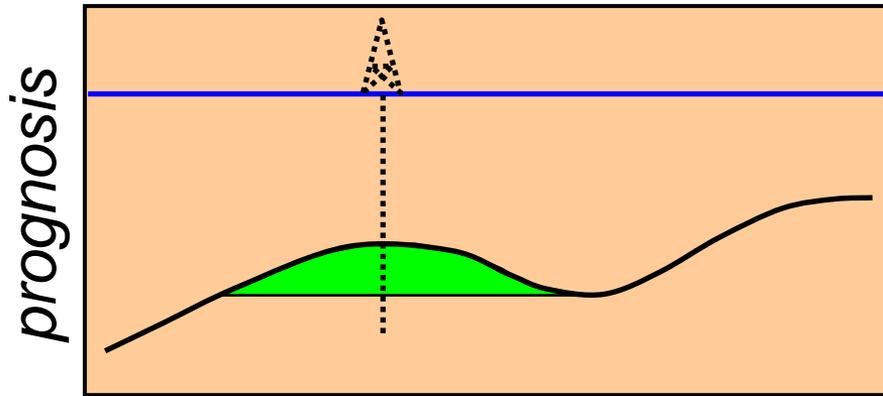
# Depthing matters...

More accurate description of subsurface allows better project risking/ ranking and execution (*including better & safer wells!*)

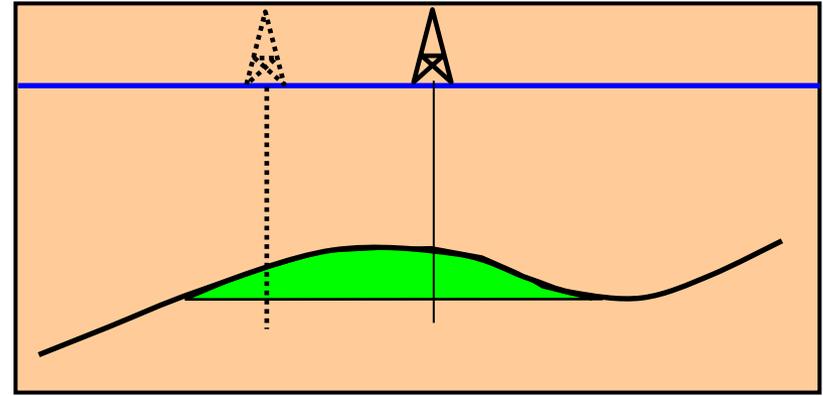
Depth prognosis is a key parameter



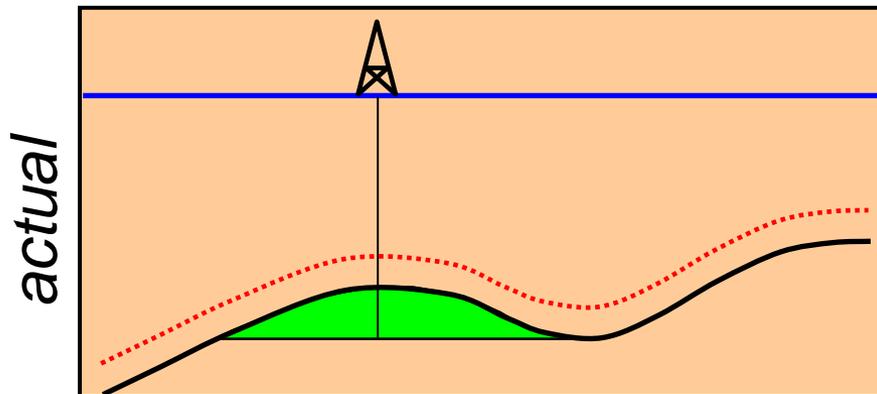
# Impact depth conversion: situation dependent



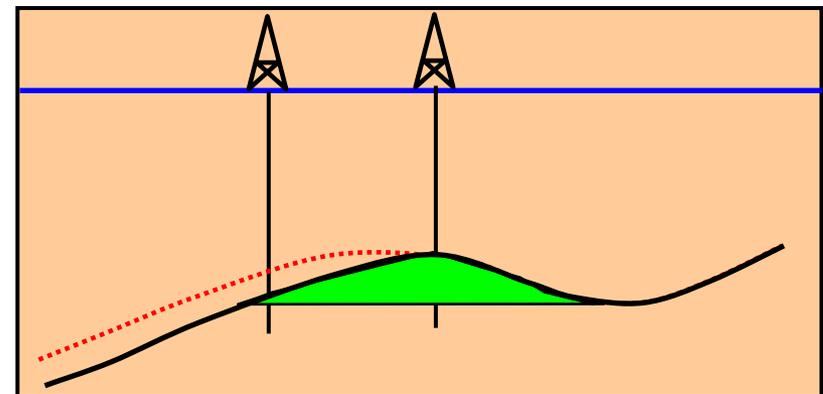
Typical exploration case



Typical development case



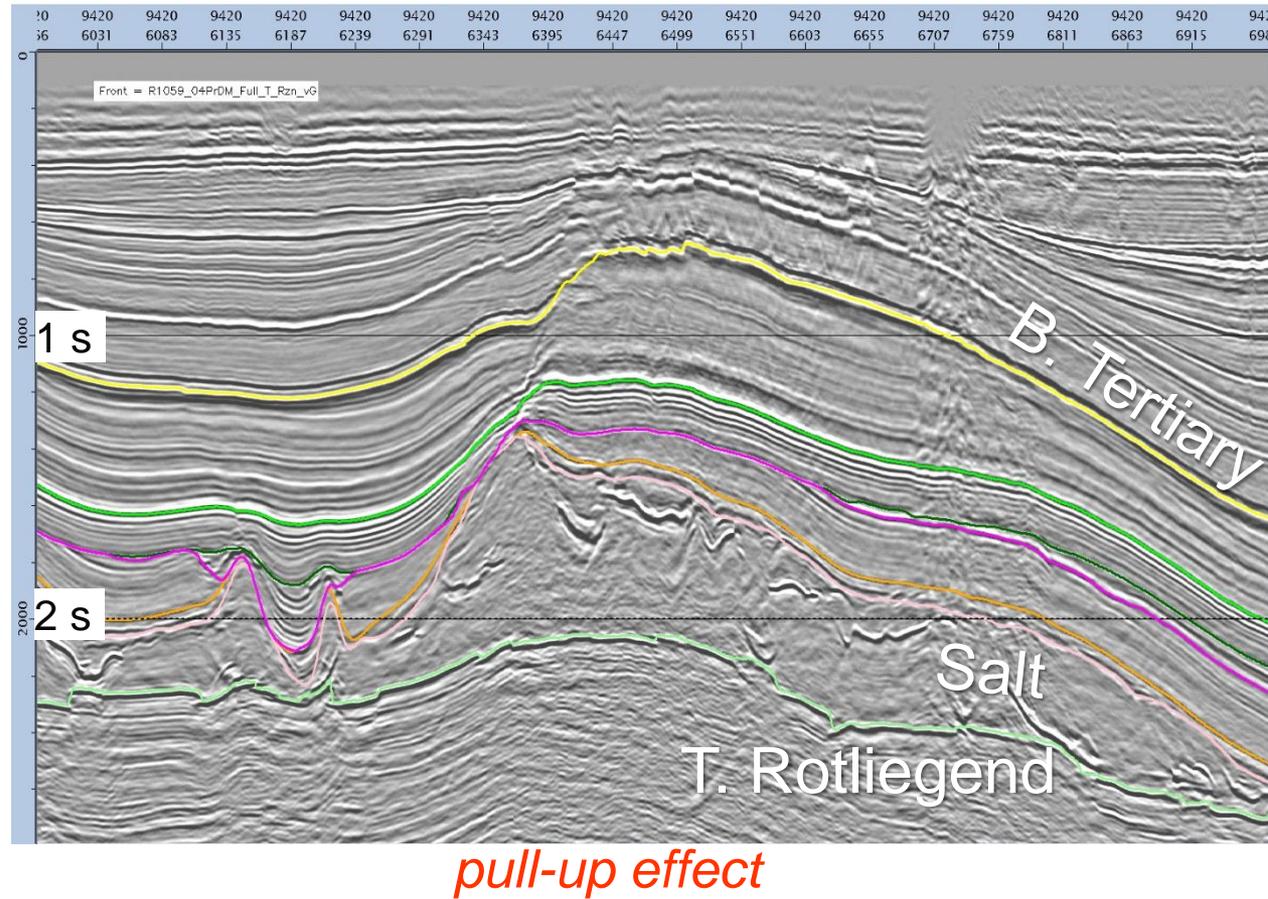
If entire structure deep to prognosis:  
closure unaffected & well still successful



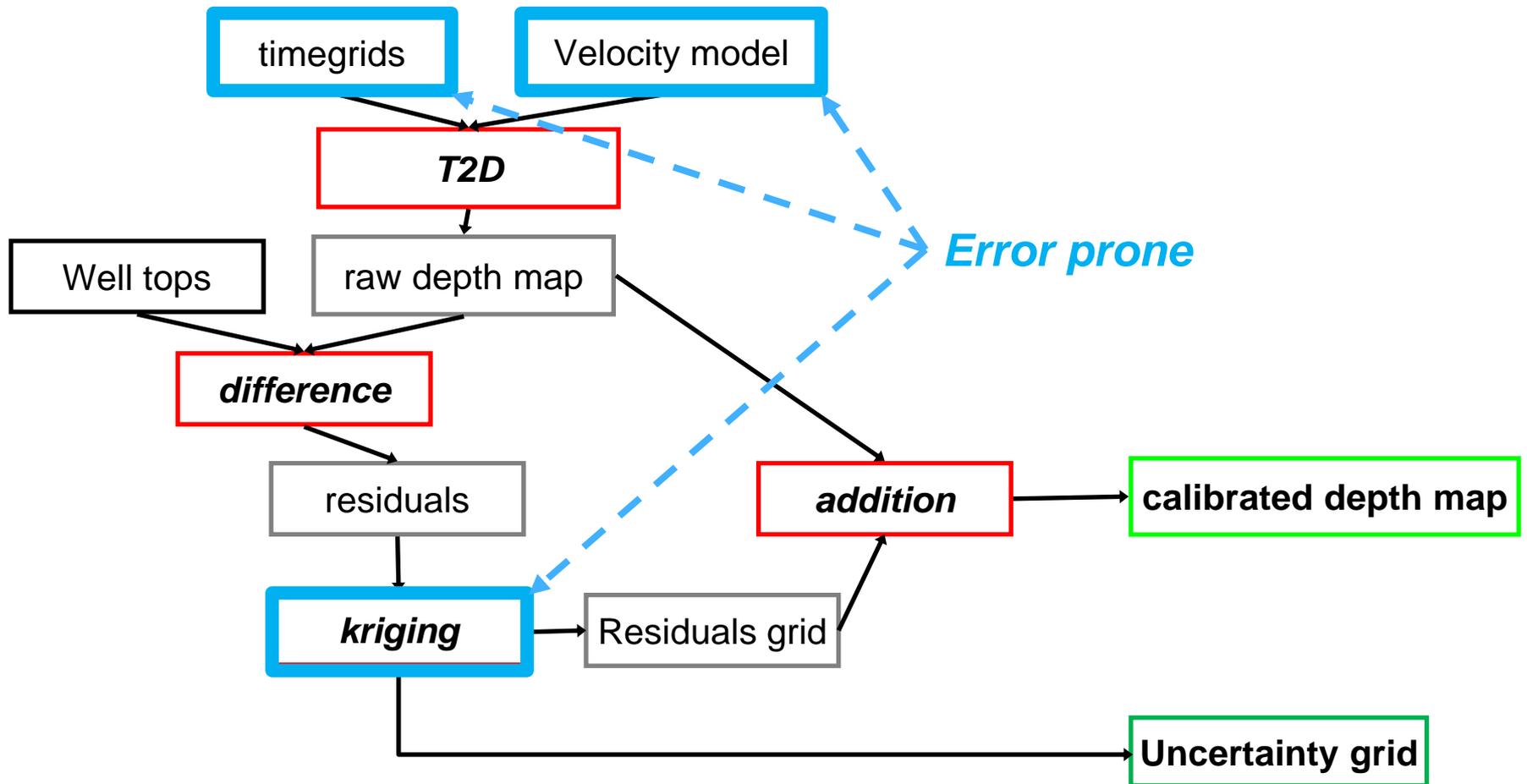
If structure locally deep to prognosis and  
contact fixed: HC column in well reduced

# Typical Time-Depth conversion workflow (1)

- 3D PreSDM data
- Interpretation on timedata
- Layercake approach
- Velocity model based on well data and pro-velocities
- Frequent use of  $V_0, K$  velocity parametrisation (per layer)



# Typical Time-Depth conversion workflow (2)

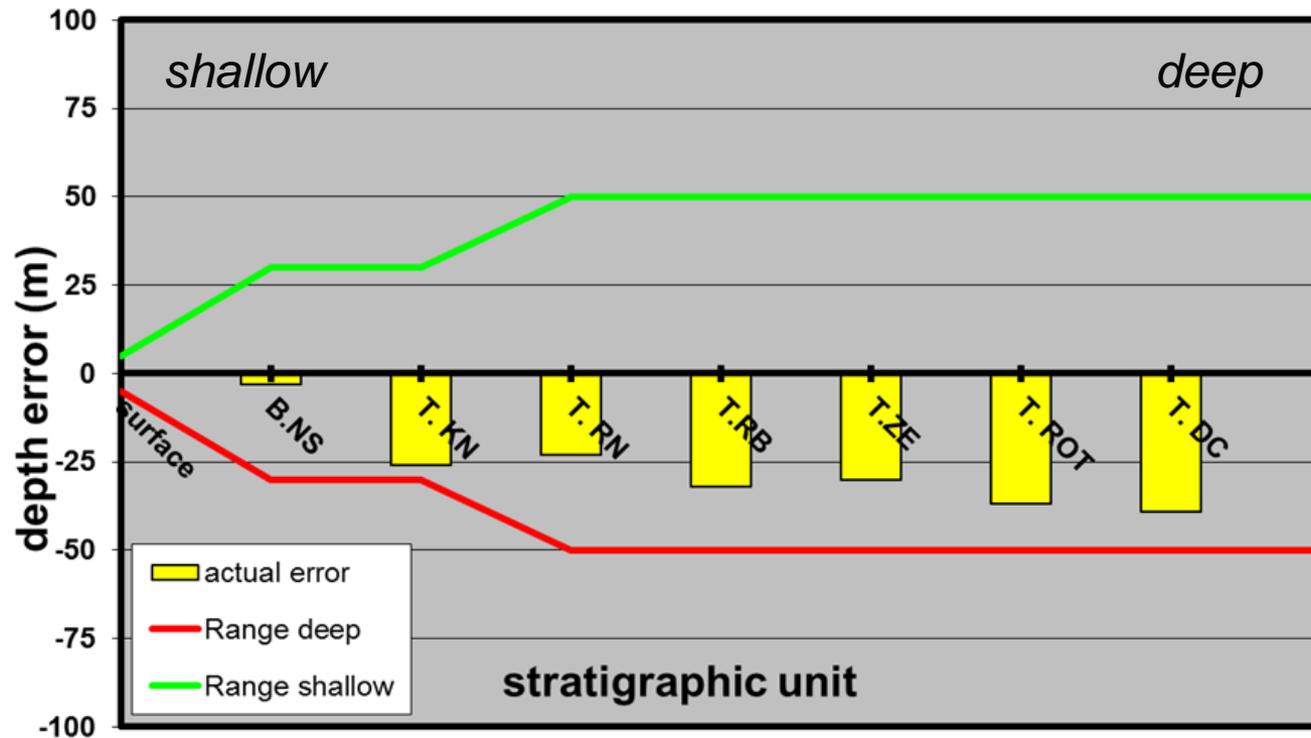


# Depth prediction review

- 253 recent wells (all operators)
- Comparing **prognosed** depth vs **actual** depth:  
at target level and overburden levels
- Analyse depth errors

# Depth errors: example A

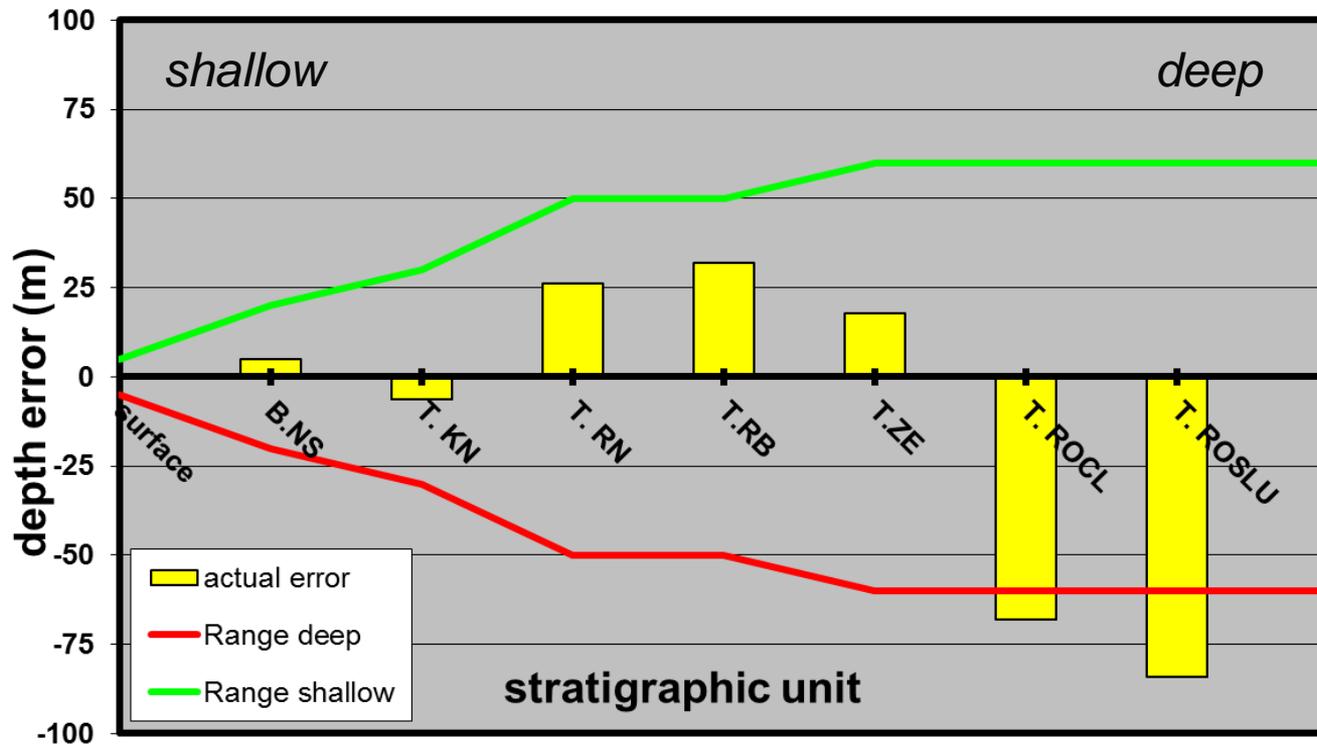
## depth prognosis vs. actual



Conclusion: velocity layer 2 underestimated:  
error propagates down, but within range

# Depth errors: example B

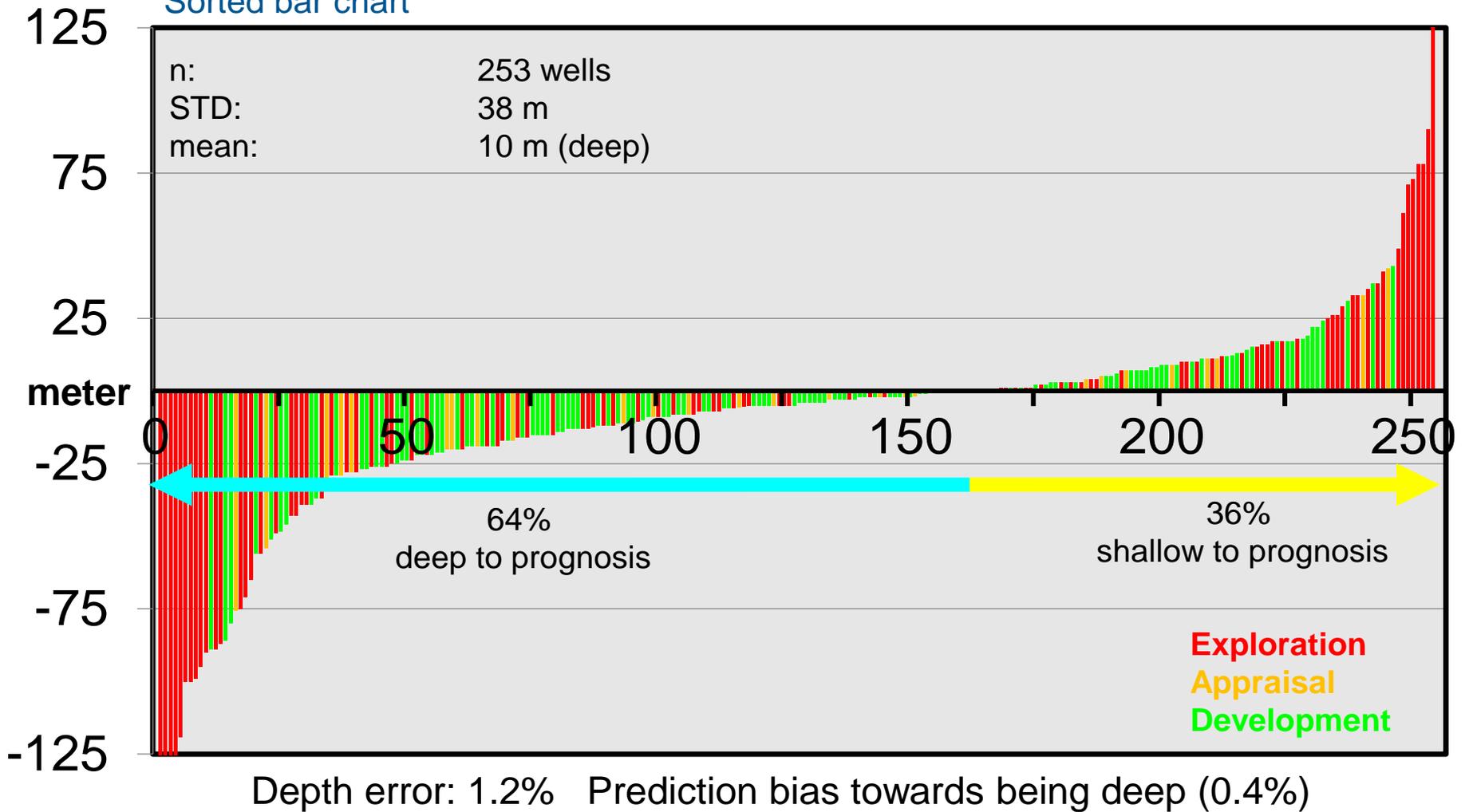
## depth prognosis vs. actual



Conclusion: velocity layer 6 (*evaporites*) underestimated:  
outside range!

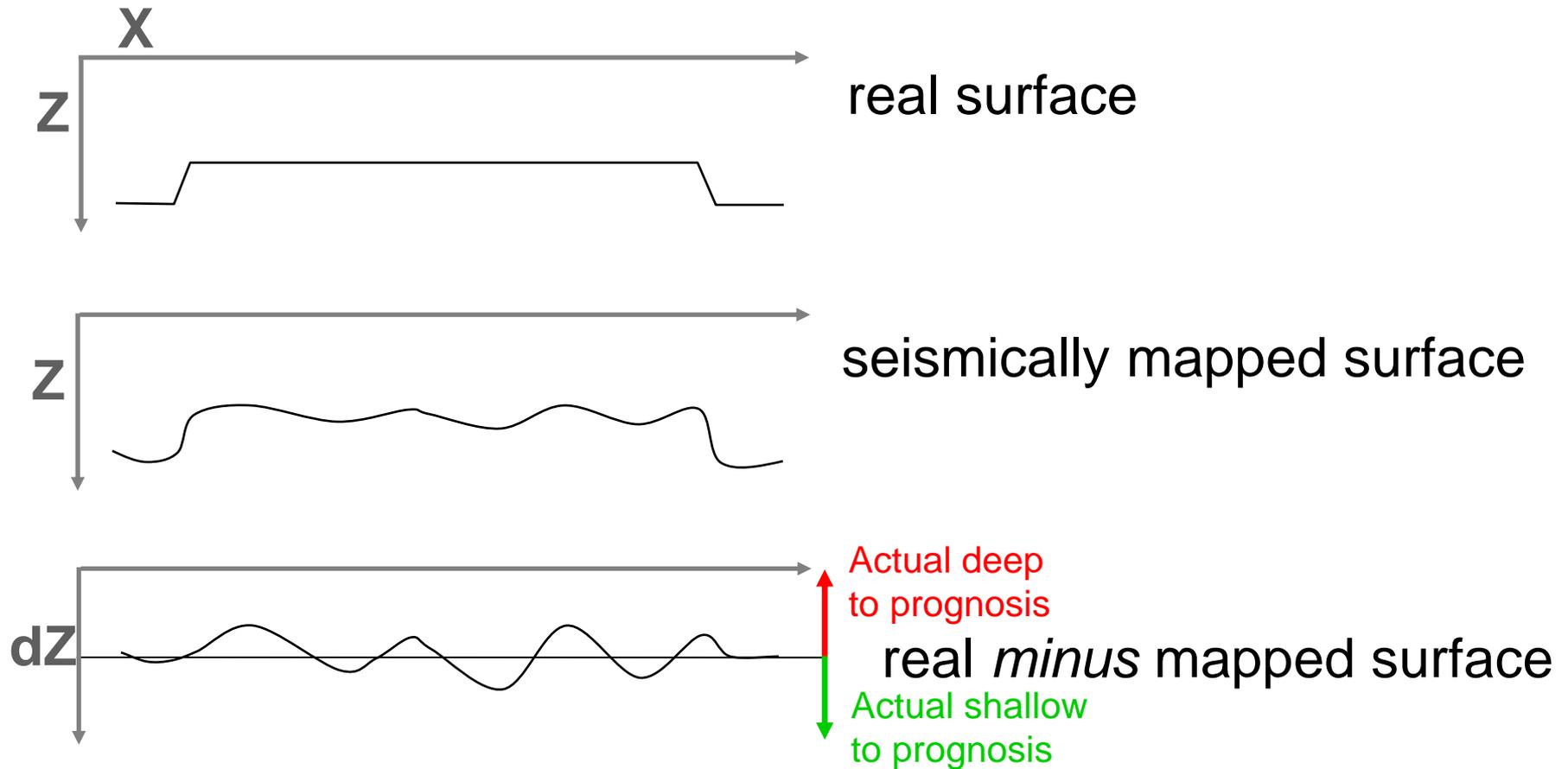
# Depth errors (target level)

Sorted bar chart



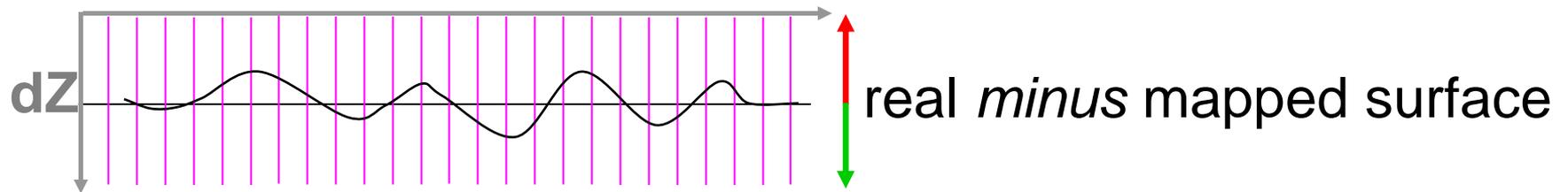
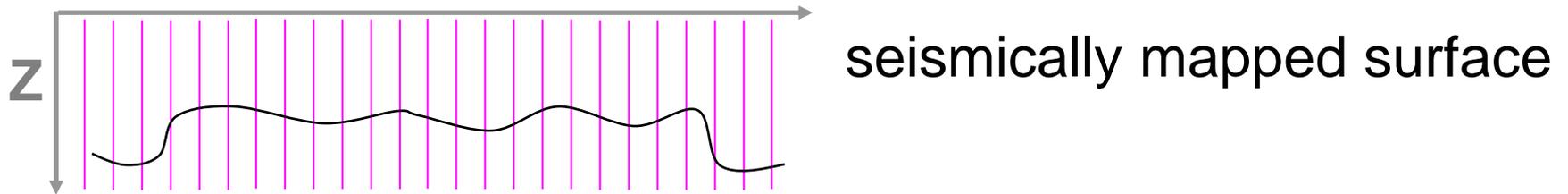
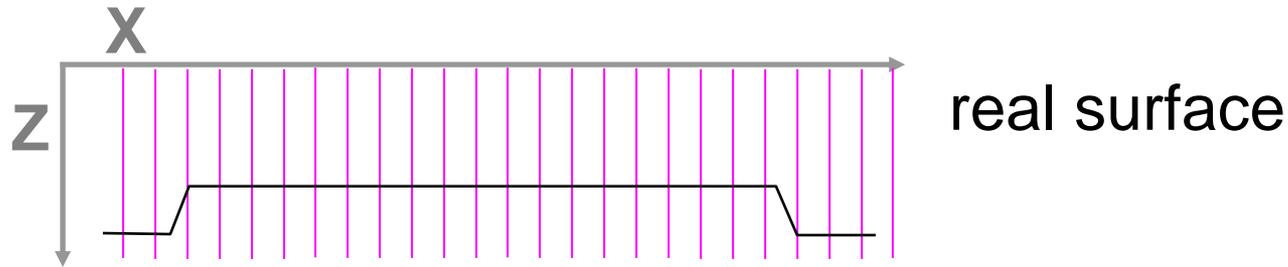
# Why biased estimates?

## *Seismic maps contain noise*



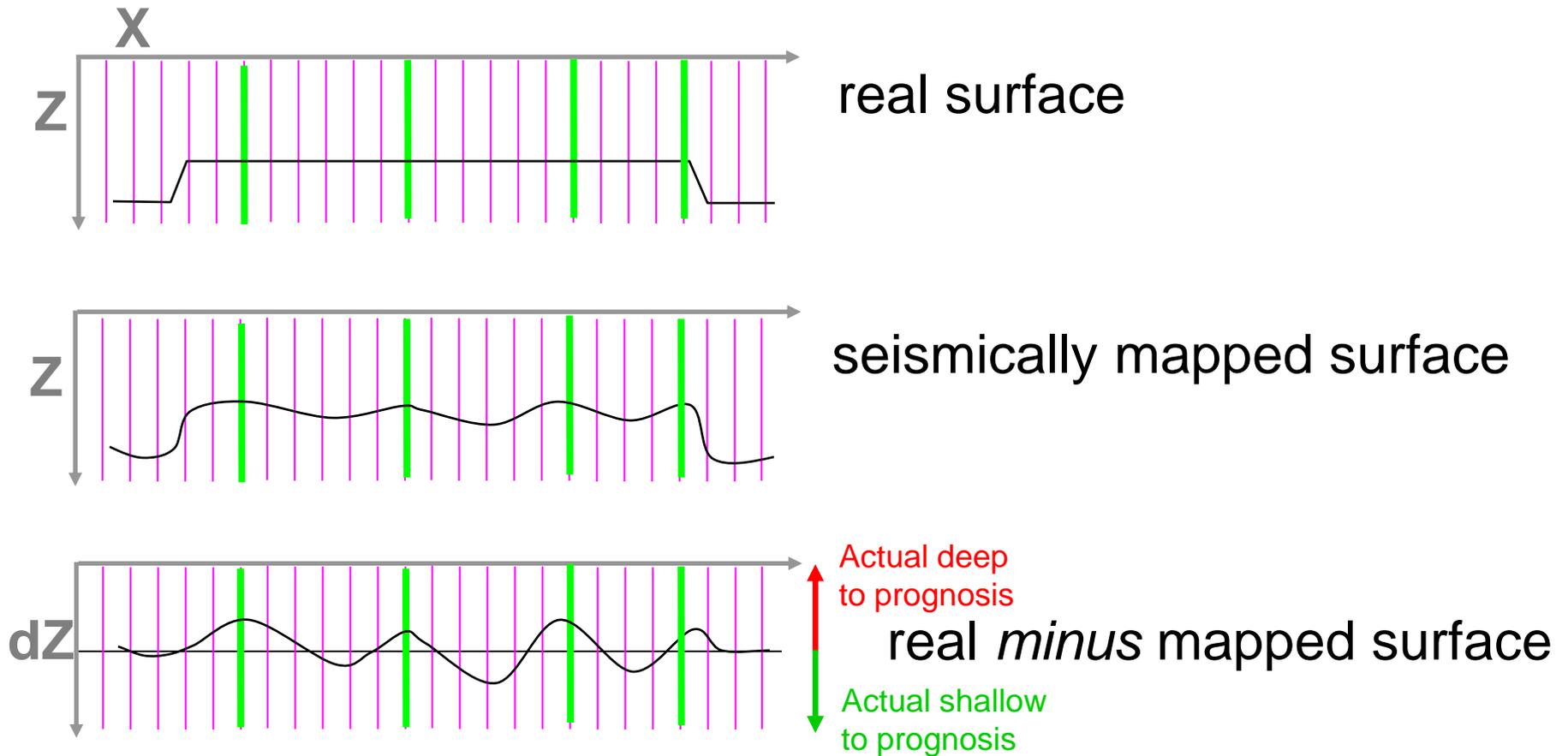
# Why biased estimates?

## *Random sampling: no bias*

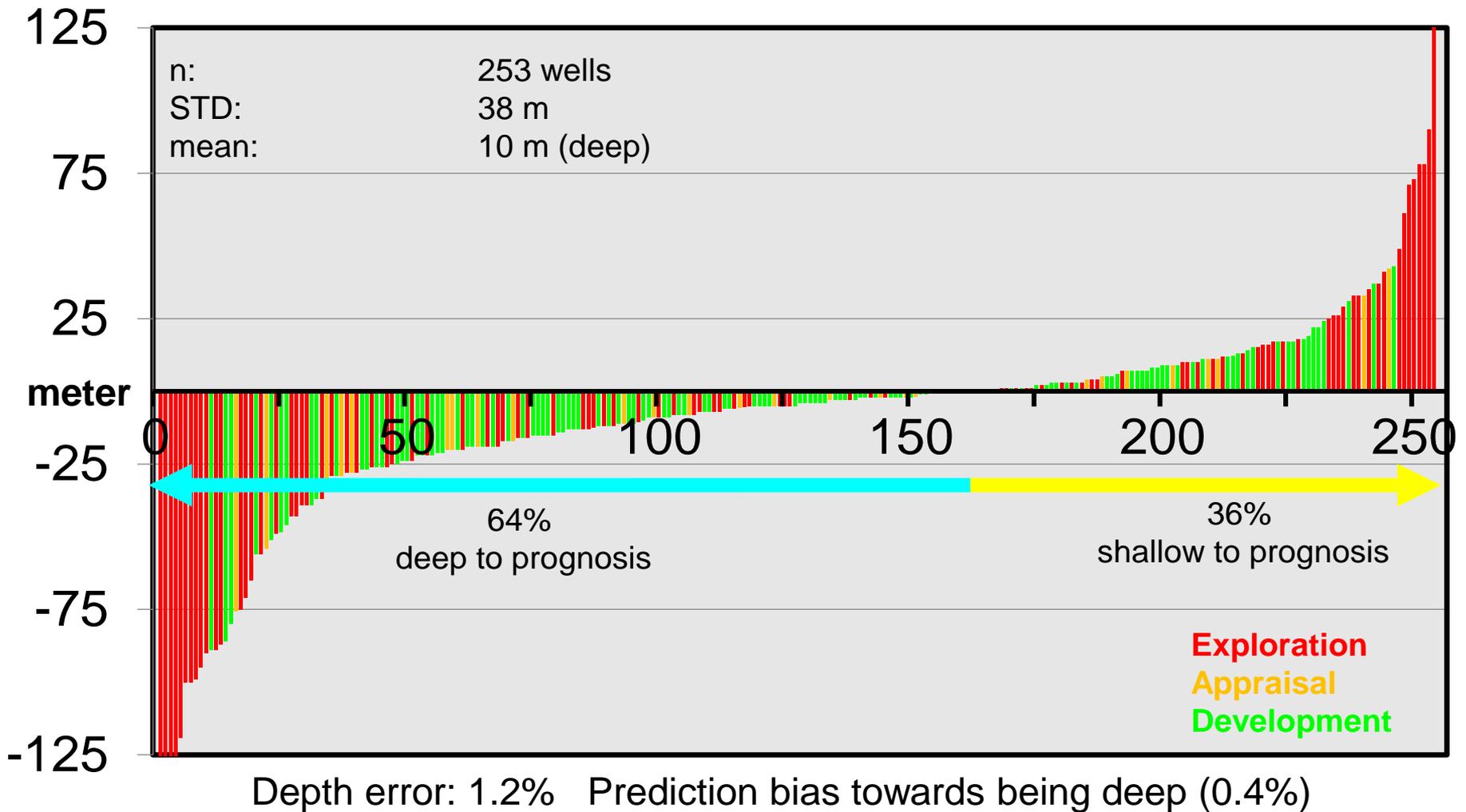


# Why biased estimates?

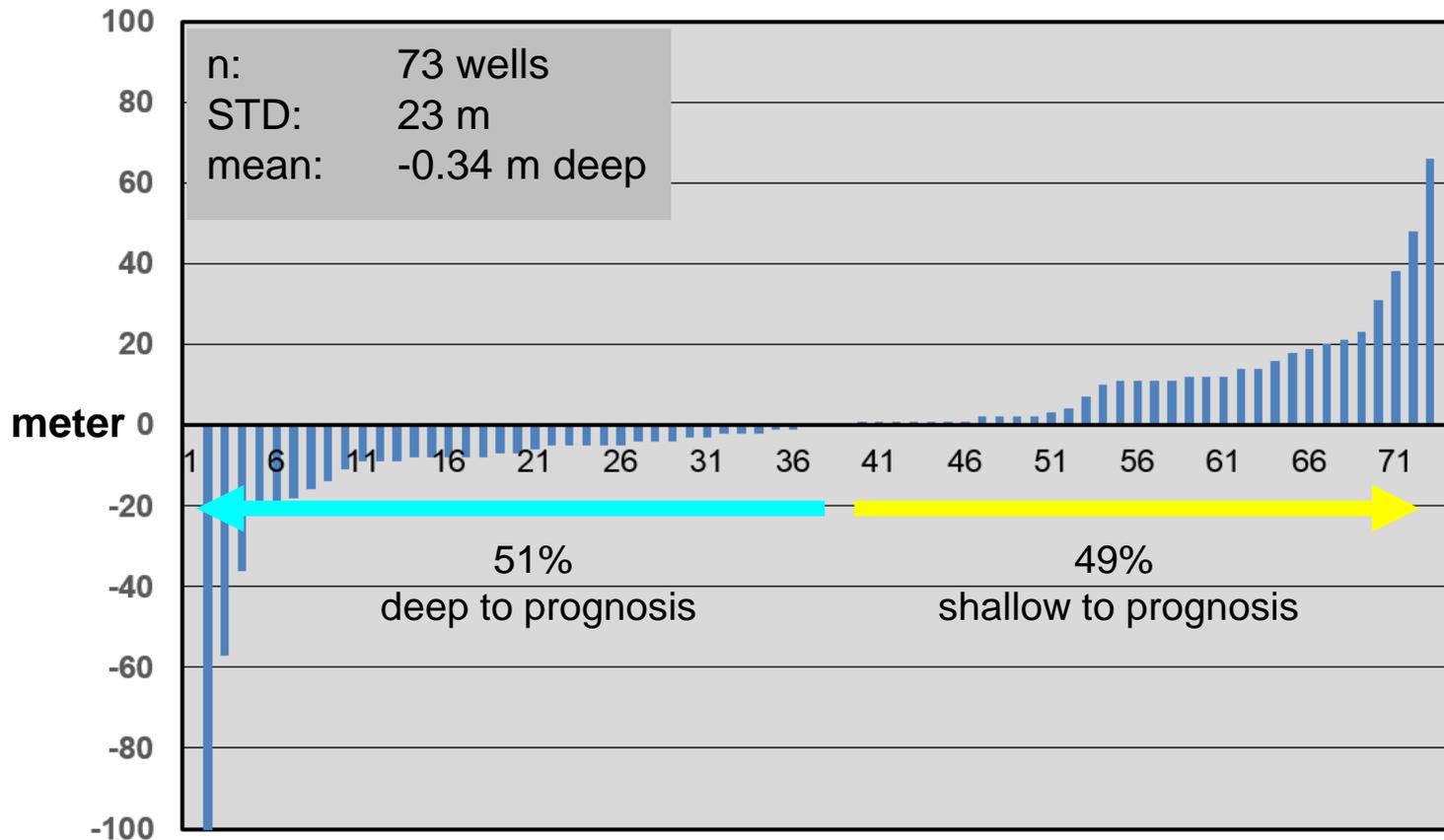
## *Selective sampling: bias*



# Depth errors (target level)

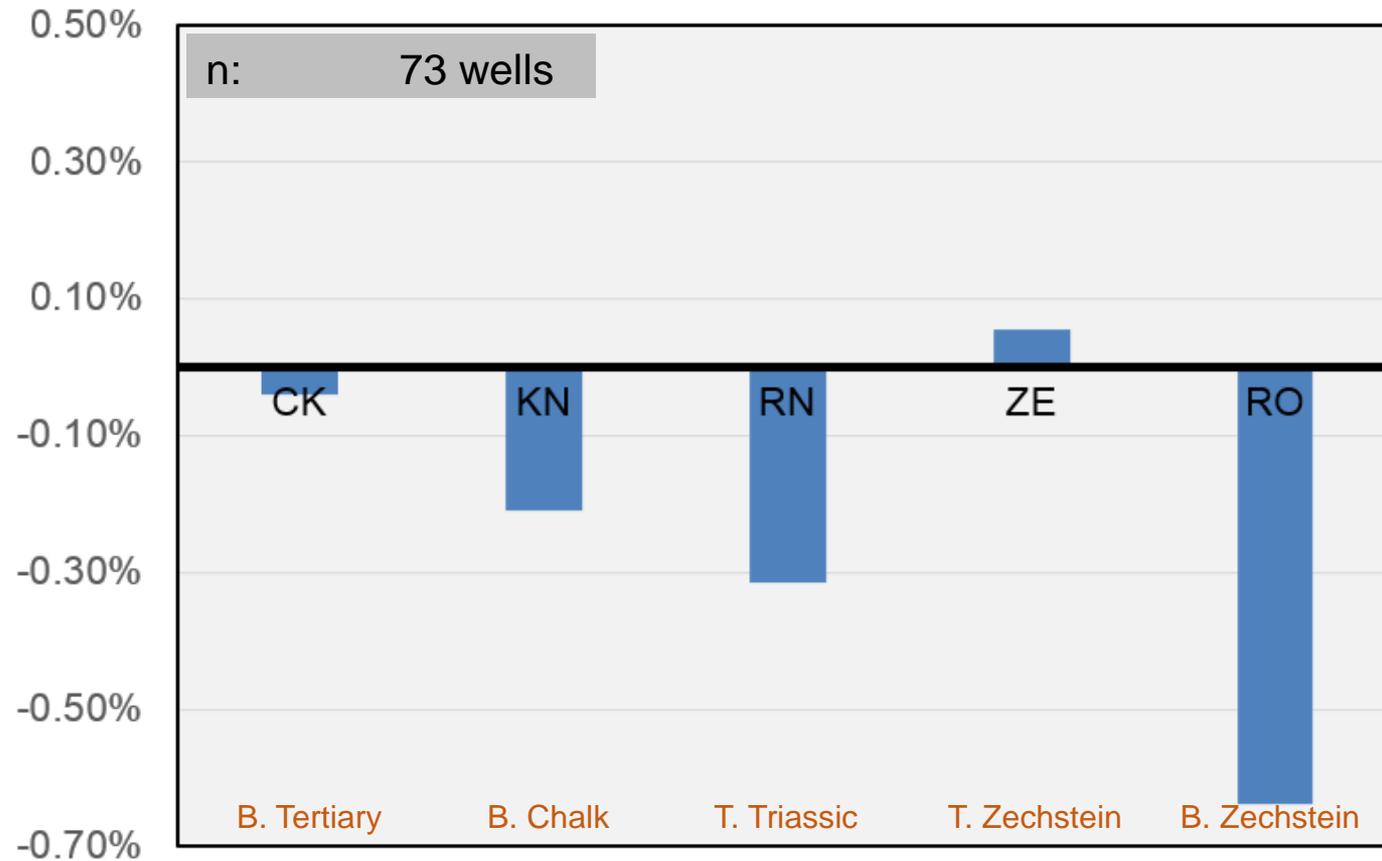


# Depth errors at Base Tertiary (overburden marker)



Depth error: 2.5% Prediction bias small (0.04%)

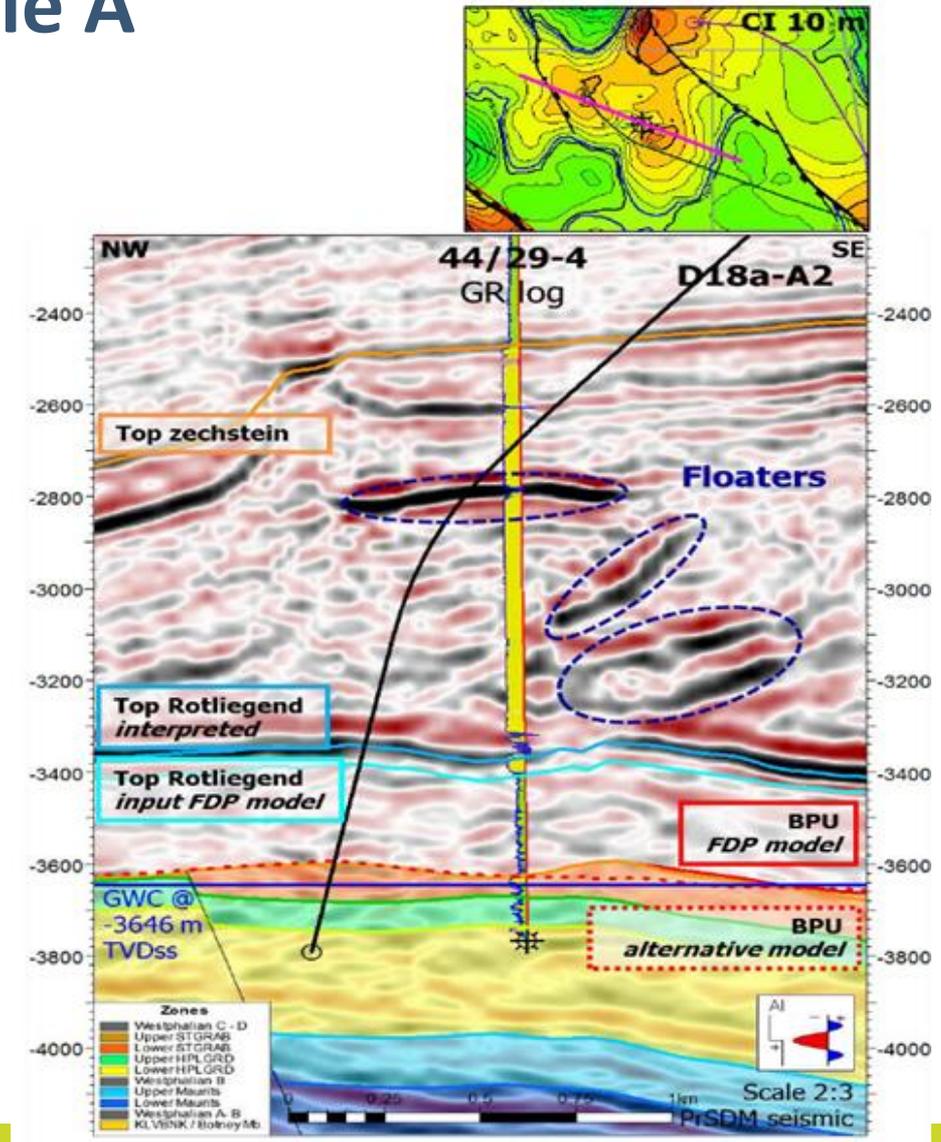
# Depth bias for key overburden reflectors



Depth bias increases from 0.04% (B. Tertiary) to 0.6% (at Rotliegend target)

# Phantom highs: example A

*Phantom highs on depth maps can be caused (amongst others) by imperfect TD-conversion*

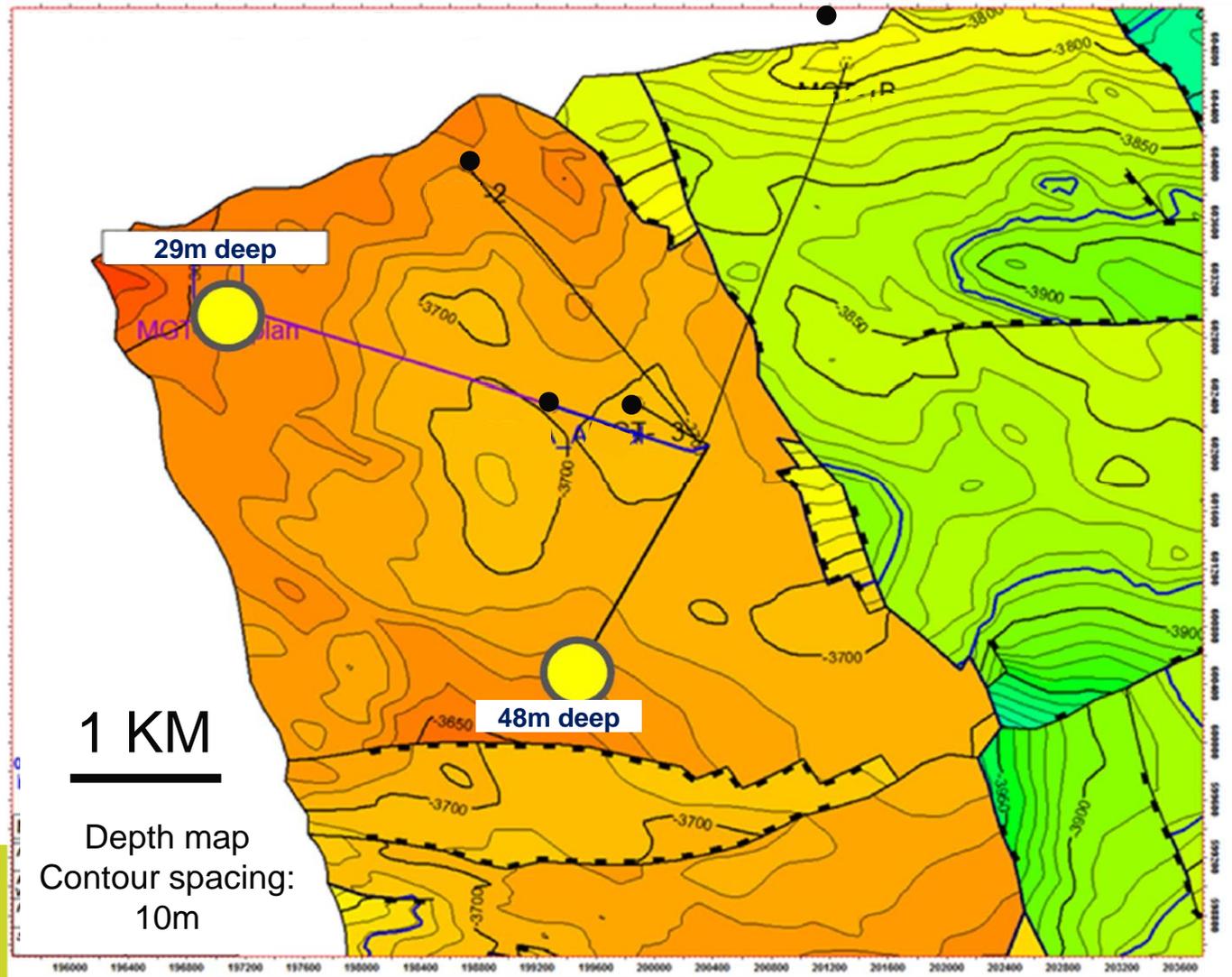


# Phantom highs: example B (2 infill wells)

*Chasing for  
the highs...*

*but,*

*how real are  
the mini-highs?*



# conclusions

- Average depth error: 38 m (1std) i.e.1.2%
- Most depth errors due to TD conversion (rather than picking wrong loop)
- Bias (10m too *deep*) causes overestimate in volumes
- Bias might be explained by *Selection Bias*
- Proper depth conversion remains a challenge