Cake & Discuss The Property Model

Organization Committee

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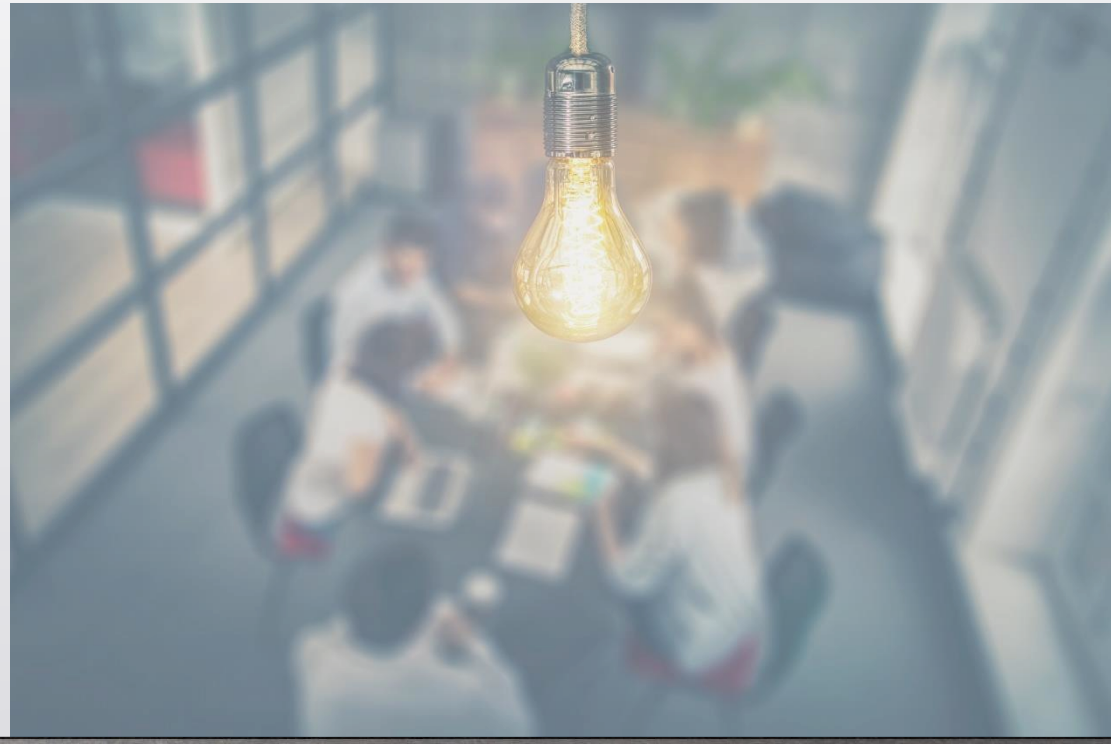
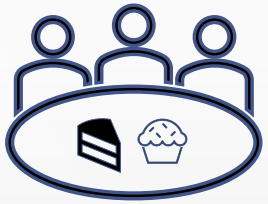




Welcome to "Cake & Discuss"

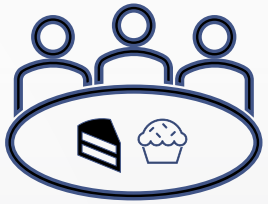
- *13 April: The Structural Framework*
- *22 August: The Grid*
- **7 November: The Property Model**

Session 4
The Property Model

Session 5
The Uncertainty Study

Welcome to "Cake & Discuss"

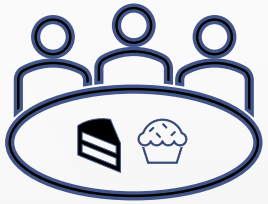
- Fundamental spirit of FORCE
  - Cooperative forum
  - Facilitate cooperation within the industry
- Group discussions
  - Discussion based on impulse talk
  - Small group: Mix of experience and expertise
  - Summary session
- This is not a place where we can solve all the issues but discuss and share experiences
  - If you want to bring up a topic suggest an impulse talk



How this works

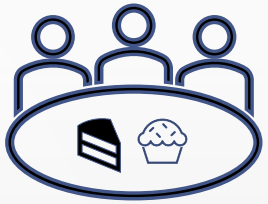
- Welcome and introduction
- Divide audience into groups
- Each group chooses a discussion keeper
- "Impulse" talks round today's topic
- Discussion time after talk
  - Have you seen this?/What's your best practice? ….
- Round the room: each group present findings
- In total 3 impulse talks and follow-up discussion in groups and presentation to other groups
- Closeout and feedback
- Mingle, talk & enjoy food and drinks throughout the afternoon

Time	Duration	Activity
12:30-12:50	20 min	Intro to concept Presentations “who is here today” Sort groups
12:50-13:00	10 min	1. “Impulse” talk
13:00-13:30	30 min	Group discussion
13:30-13:35	5 min	Break (deliver talking points)
13:35-13:50	15 min	Presentations and overall discussion
13:50-14:00	10 min	2. “Impulse” talk
14:00-14:50	50 min (30+5+15)	Group discussion Break (deliver talking points) Presentations and overall discussion
14:50-15:00	10 min	3. “Impulse” talk
15:00-15:50	50 min (30+5+15)	Group discussion Break (deliver talking points) Presentations and overall discussion
15:50-16:00	10 min	Closeout / feedback



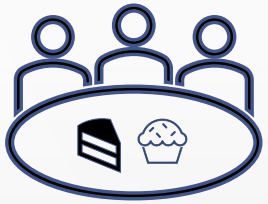
Choose a discussion keeper

- Role:
  - Make sure everybody in the group gets talking time
  - Time keeping
  - Make sure the key ideas are on the flip chart
  - Find a presenter to other groups- 1 presenter per impulse talk
  - When problems are raised
    - -> probe for solutions
    - -> keep the discussion going
  - TAKE A PICTURE OF YOUR FLIP CHART / SHARE YOUR PPT
    - Send it to marine.seignole@akerbp.com



Impulse talk topics

- Upscaling/Blocking of well logs
- Usage of outcrops in subsurface modeling
- Poro perm relationship: Thomas - Stieber

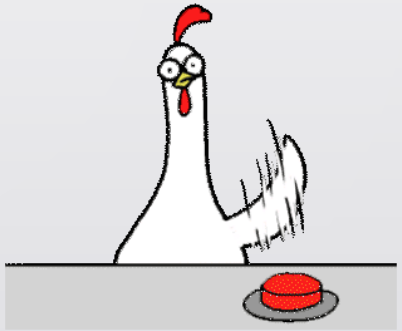


Impulse talk 1

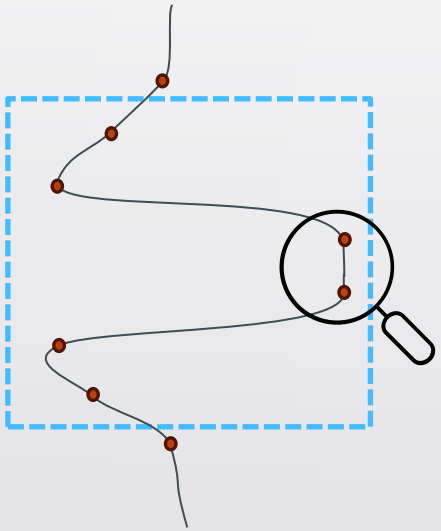
Upscaling/Blocking of Well Logs

Grid cell should be representative for the average property in the whole cell volume:

Let's click the button –
The software will do the job!



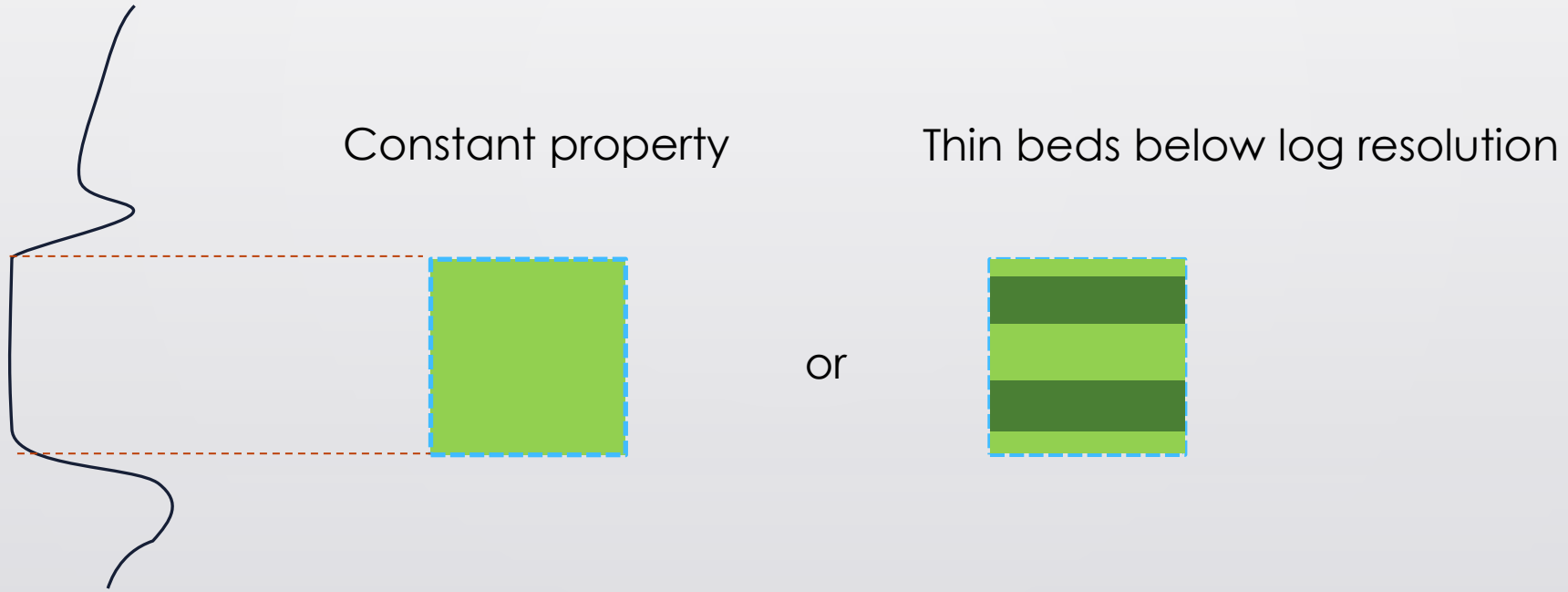
Are all the log values ok?



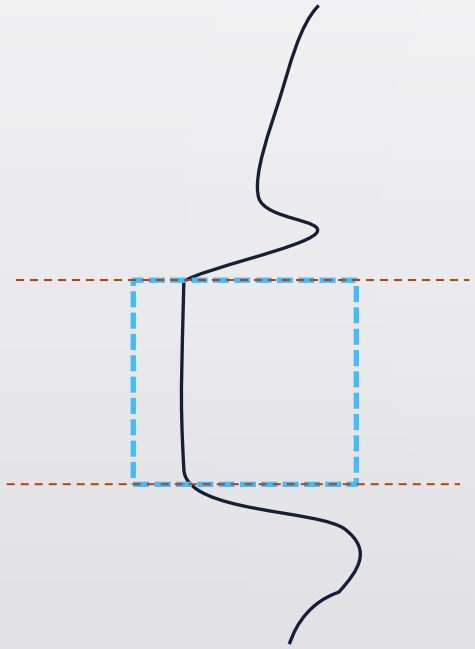
No 0, +- 999, other unrealistic values in the data set that should be undefined?

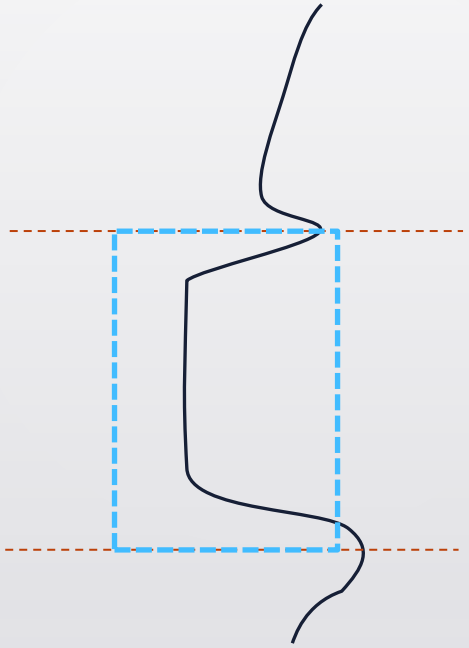
Or one well in fractions, the others in percentage

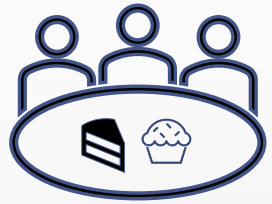
Typically, we upscale logs assuming they are representative of the properties we want to model – but are they truly representative?
(we will have separate impulse talk on this topic)



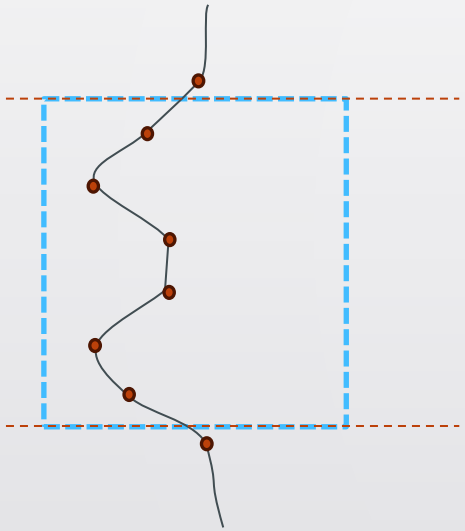
How we picked the tops influences the average value



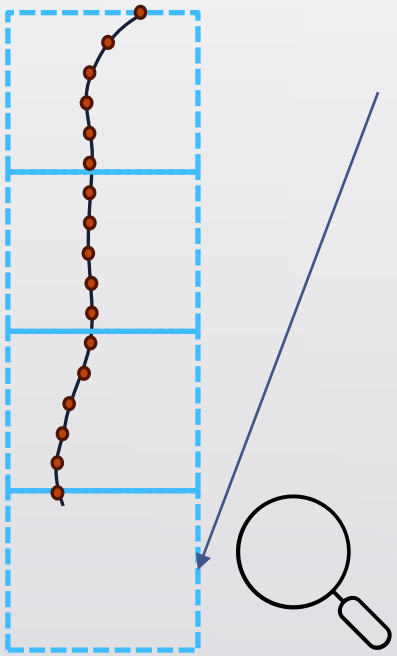




What if top picking and sampling interval are not “matching”?
Do we get the average we want?

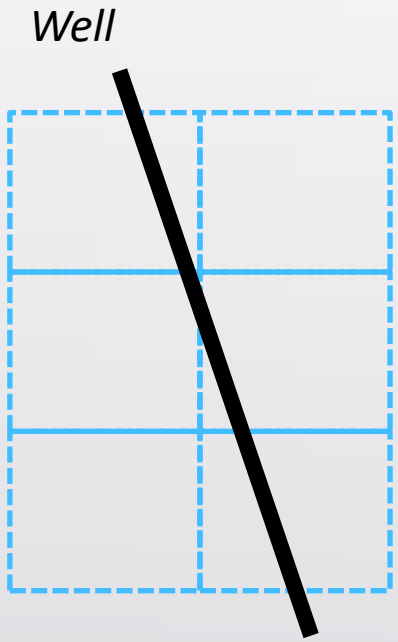


Do you consciously use treat as lines/points?



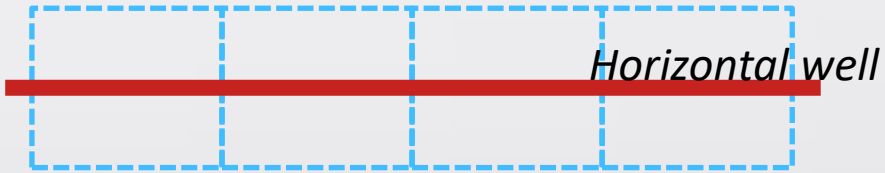
Will this give a representative value in the cell?

Or should a minimum number of points be included?



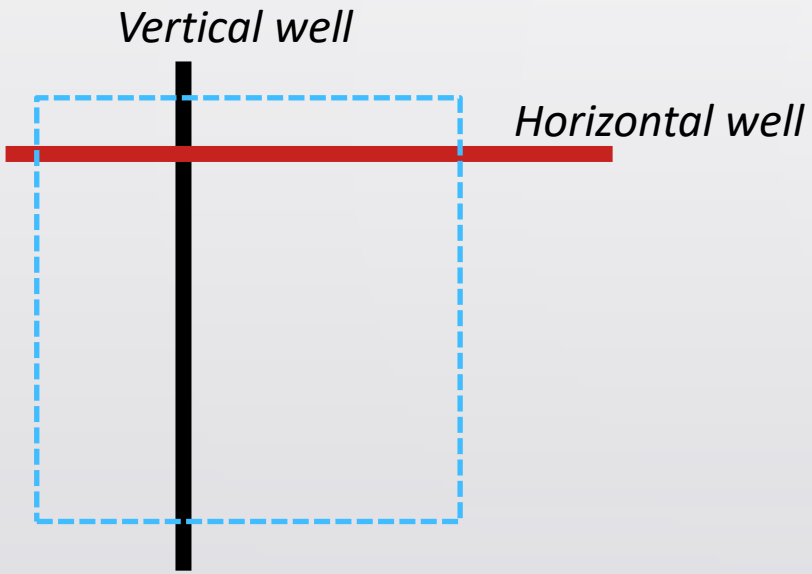
Will this give a representative value in the cell?

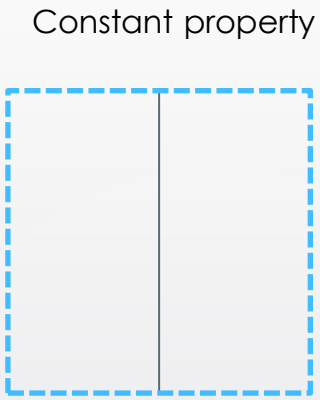
Or should neighboring cells be considered?

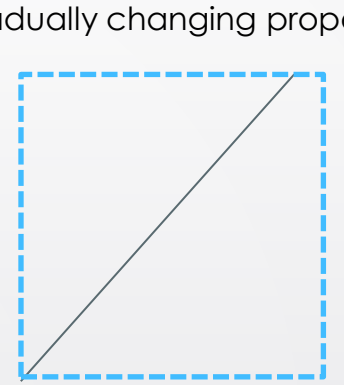


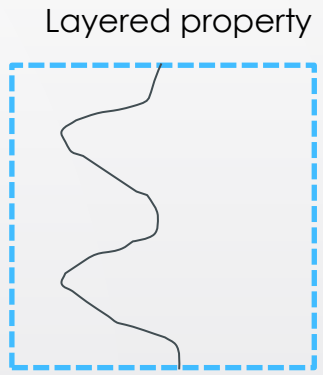
Is this a good setting for horizontal wells?

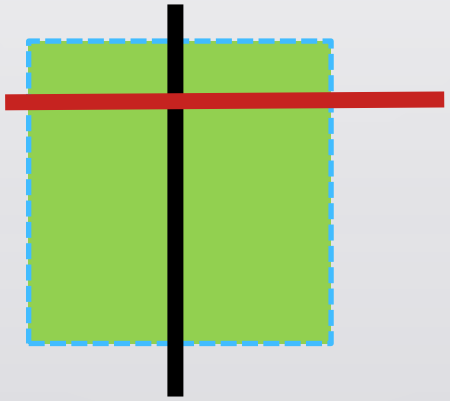
It can make a difference if I have information about the property from a vertical or horizontal well depending on the formation characteristics and grid resolution

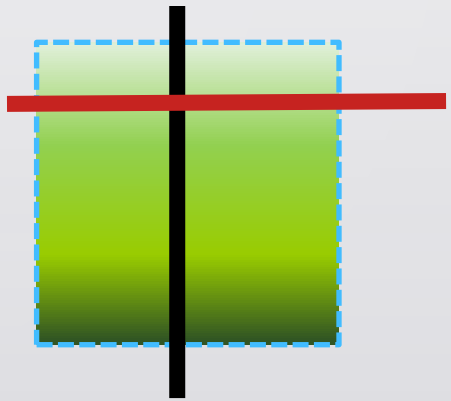


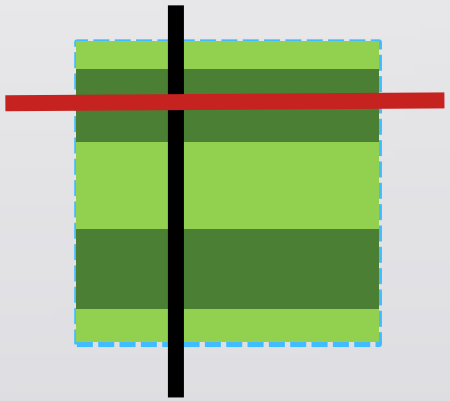










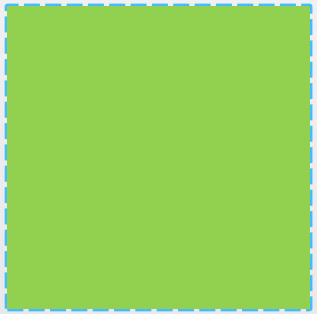


What kind of “averaging” do we use?

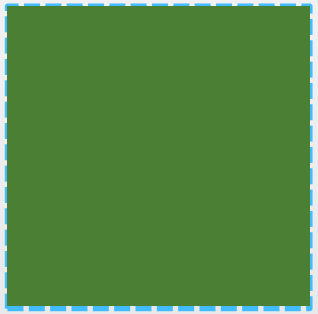
For a discrete property it the upscaled cell will only get one value

Input log

Upscaled value

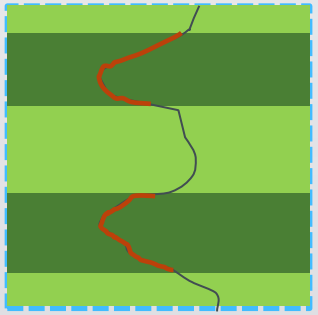


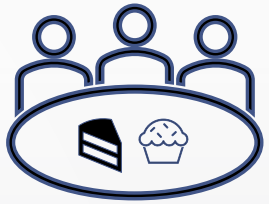
or



Most of
Mid point
Random pick
Min
Max
….

Can be used as bias
For continues properties

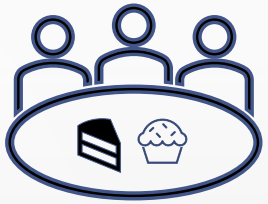




What kind of “averaging” do we use?

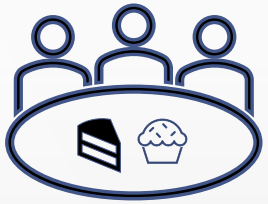
If this is e.g. porosity compared to permeability?

Arithmetic
Geometric
Harmonic
Min
Max
….



Talking points

- Have you encountered pitfalls or does the “default” usually work?
- What are your best practices?
- What are your methods of QC?



Group - Notes

- TAKE A PICTURE OF YOUR FLIP CHART
  - Send it to marine.seignole@akerbp.com

Upscaling of well logs

- Continuous parameters:
- Normally default works ok with vertical wells
  - But cont. logs should be used with a bias to a discrete log (zone/facies)
- Before upscaling you need to spend time on layering concept/design because that impacts upscaling.
  - You don't need high resolution in solid shale, in most cases
  - For the reservoir zones – think through what you want to capture
- Thin bed – upscaling not representing reservoir due to too much averaging. Need to use bias or if very thin beds/lamina - Thomas Steiber can be a good approach
- Facies upscaling: Small calcite concrete in your reservoir – you need to account for this:
  - You can put in a multiplier for calcite in the upscaling process – to capture it as a facies
  - You can multiply with a N/G factor to account for missing calcite in the upscaling process

QC

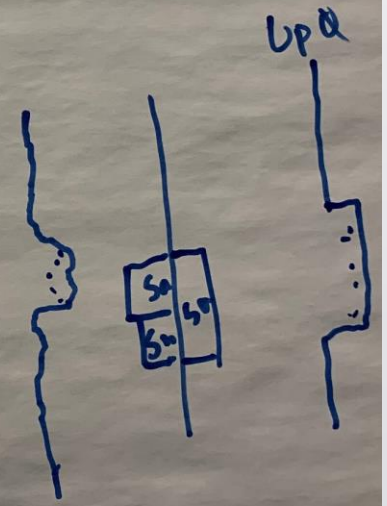
- plot your upscaled log together with raw logs and core measurements– visual QC

- histograms/statistics

- Include core measurements when you do statistics

Upscaling

- Tool readings/sampling
  - Shale/sand beds affecting bed above/below
- Only pick the good stuff?
  - underestimate thickness of bed?
- Only use vert./dev. wells
  - use hz. wells for QC only?
  - use parts of hz. wells?
  - two upscaled sets → vert. → hz. wells.
- Default settings ok?
  - generally, yes.
- QC?
  - well by well?
  - it off, why? Is there a perfectly good reason
    - hz. well scraping up/down.



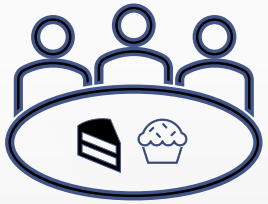
Pitfalls of "default"

- defalt dosn't allways work
- caution using neighbouring cells

- very important getting vertical resolution correct
  - vertical variogram for each zone 1/2 of the range possible best practice
- midpoint vs. ~~avg~~ most of for calcite
  - statistics best fit midpoint but when doing dynamic modelling better match using most of.

QC:

- well section window
- histogram statistics
- core data vs. log data
  - by upscaling core data
  - vs upscaled log data



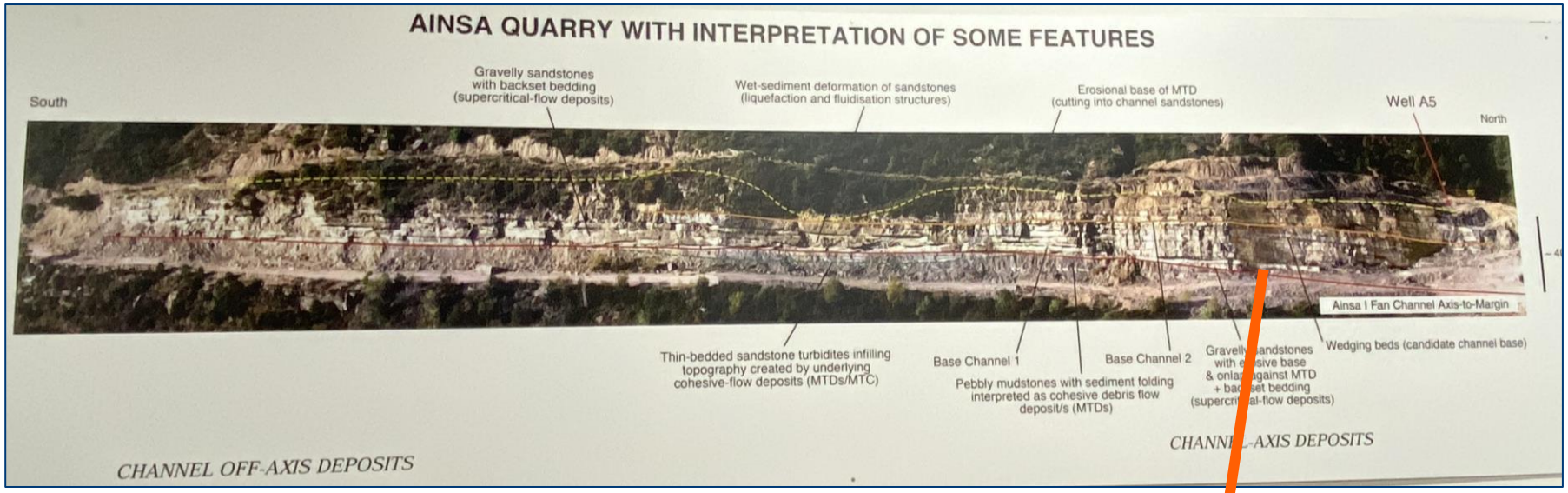
Impulse talk 2

Usage of outcrops in subsurface modeling

- 3D spatial distribution from field
- Outcrop scale vs core and seismic scale
- Vertical and lateral continuity
- Depositional environment (can we learn from outcrop)
- Faults and baffles

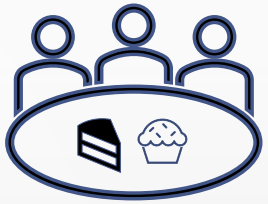
PGNiG | UPSTREAM NORWAY
ORLEN GROUP

Heterogeneity & Scalability



- How to translate heterogeneity and scales into the model?
- How important are the different features for the model/Significance of detail to reservoir modelling?
- Which observations/measurements to do in the field (outcrop)?
- Risk to have too much trust in analogues?

Well A5



Group - Notes

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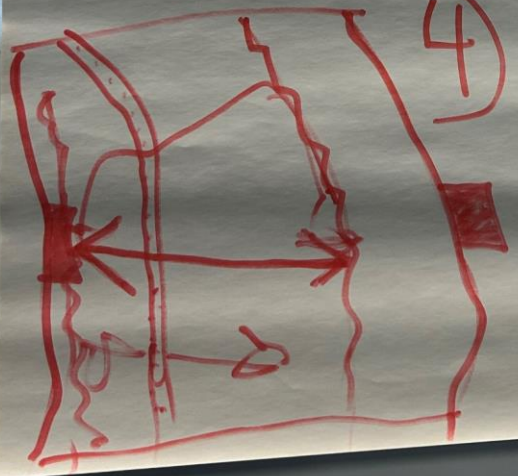
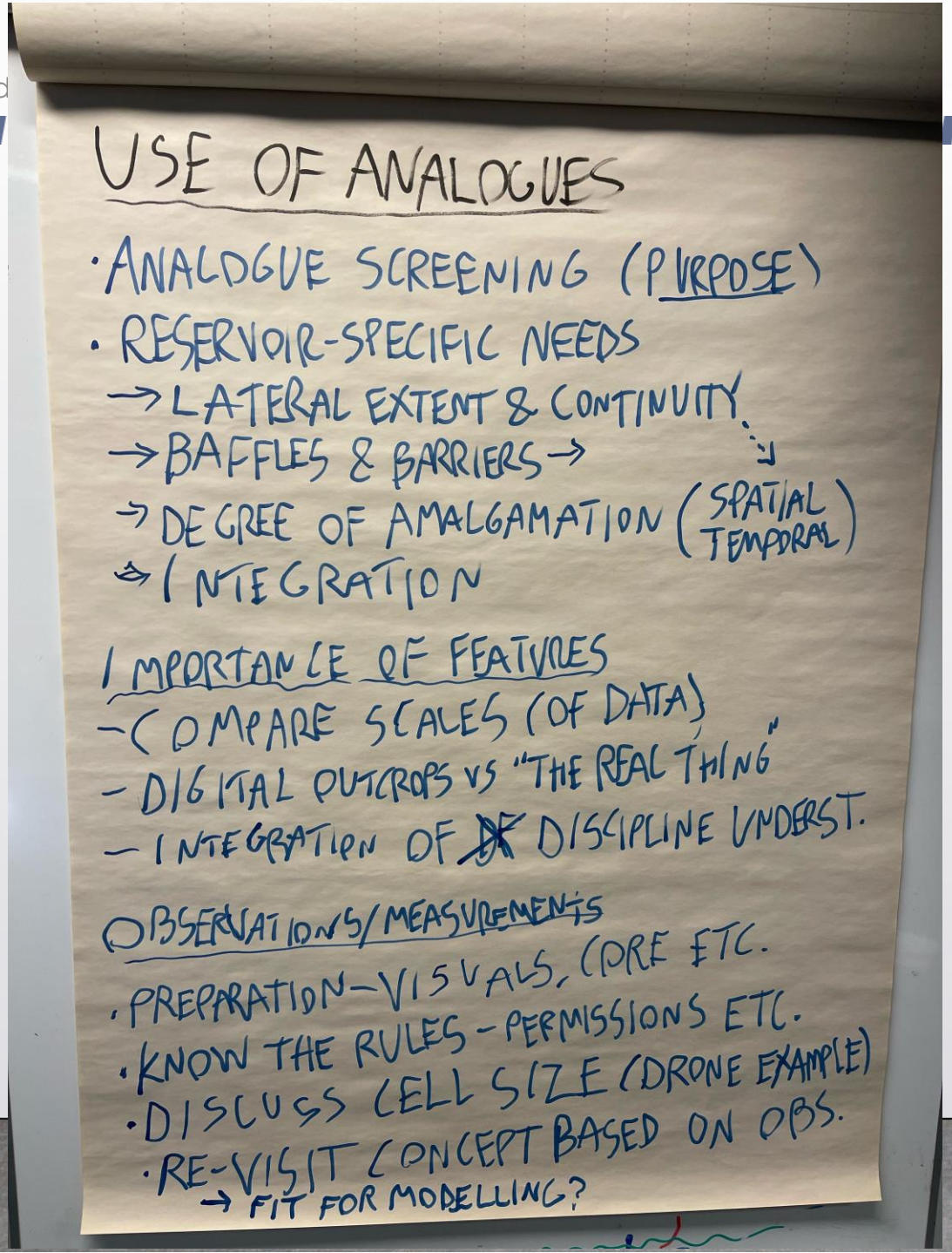
1) Purpose (↳ Fluid + L) and reservoir characteristics

2) Data input to lateral distribution of elements analogues, seismic ++

3) Measurements from field/analogues
↳ dimensions
↳ definition



4) Outcrops as input to zonation


USE OF ANALOGUES
· ANALOGUE SCREENING (PURPOSE)
· RESERVOIR-SPECIFIC NEEDS
→ LATERAL EXTENT & CONTINUITY
→ BAFFLES & BARRIERS →
→ DEGREE OF AMALGAMATION (SPATIAL TEMPORAL)
→ INTEGRATION
IMPORTANCE OF FEATURES
- COMPARE SCALES (OF DATA)
- DIGITAL OUTCROPS VS "THE REAL THING"
- INTEGRATION OF ~~DF~~ DISCIPLINE UNDERST.
OBSERVATIONS/MEASUREMENTS
· PREPARATION - VISUALS, CORE ETC.
· KNOW THE RULES - PERMISSIONS ETC.
· DISCUSS CELL SIZE (DRONE EXAMPLE)
· RE-VISIT CONCEPT BASED ON OBS.
→ FIT FOR MODELLING?

Oppgave 2

No 1

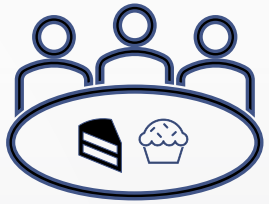
- When in the field think about your grid – see what is included in only one grid cell (100x100 or 50 x50) ☺
  - Ask the question – how do I upscale and which grid size design is needed
  - If faults look at the geometry, fault smear zone, damage zone etc that you cannot see in the well logs. How does it impact the heterogeneity and flow in the reservoir
  - RE, gP and GL should ideally be in the field together looking at analogues to discuss the view on scales, i.e. vertically, horizontally, and also might have different view of what is important, i.e flow
- No 2: Important factors:
  - Factors affecting flow/connectivity. I.e extensive thin shale barriers that can not be captured on seismic
  - Important to see the depositional geometries laterally which cannot be seen by well data (most often)
  - Bugs?

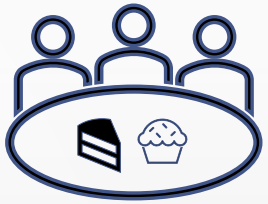
No 3

- Draw a grid cell with a rope to see the grid cell scale in real life
- Notice how rapid facies can change in the field – it's the same in your reservoir probably ☺
- Try to do some early correlations of the main events

No 4

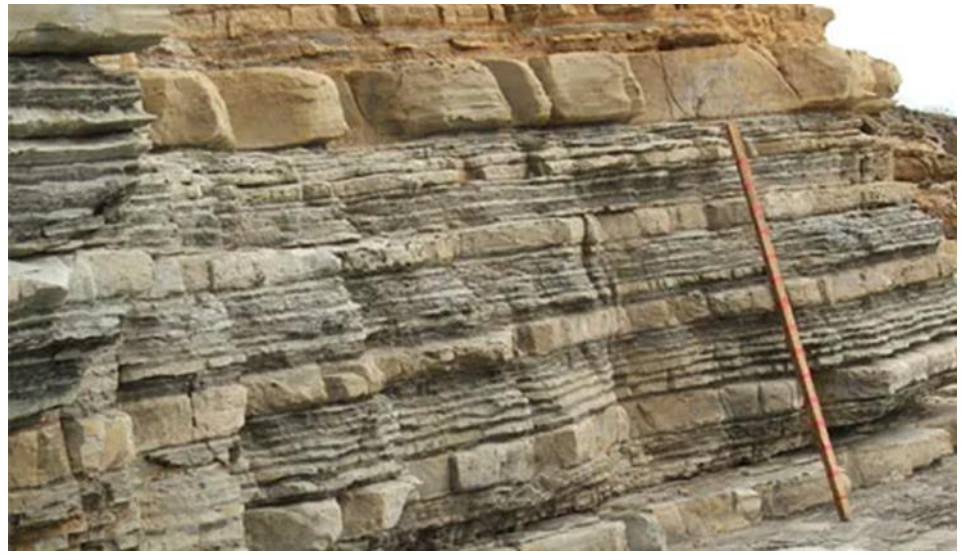
- Yes, be openminded and think about other possible concepts for your model. Consider building different depositional scenarios. We are usually biased to one concept
- The same facies can be found in iffeent environmental settings





Impulse talk 3

Thomas Stieber



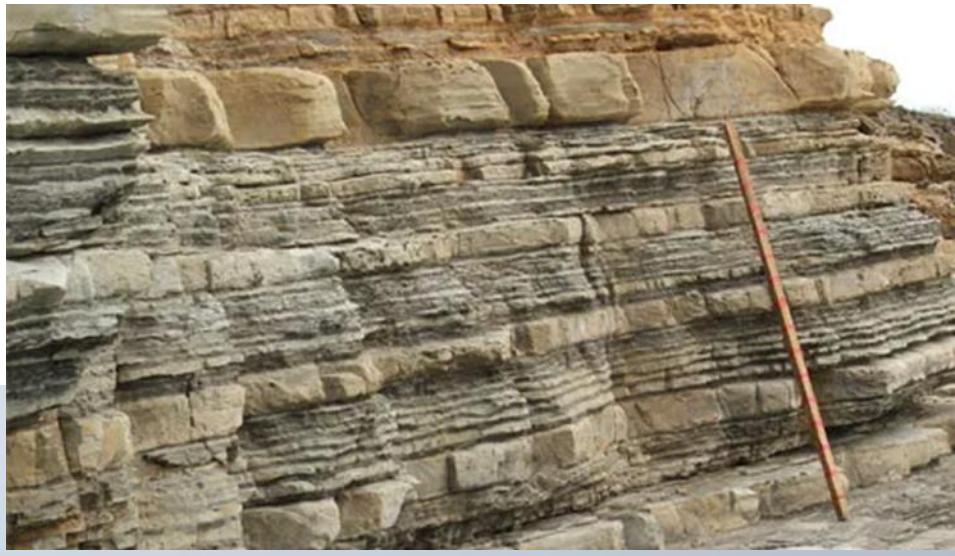
What is ?

- Methodology introduced by T&S in 1976 to describe “sub-log” net rock.
- Assumes known sand and shale porosity & calculates Fntg fractional NTG from PHIT
  - Vsh=(1-fntg)+DispSh
  - PHIT_Model = PHIT_Sand*fntg (= Arithmetic Upscaling)
  - KH_Model = Kh_Sand*fntg (Note: Kh_Sand is unknown – so Kh_Sand~Klogh)
- Using TS will often (always??) increase both storage and flow capacity

ONE FIELDS RESERVOIR IS ANOTHER FIELDS BAFFLE

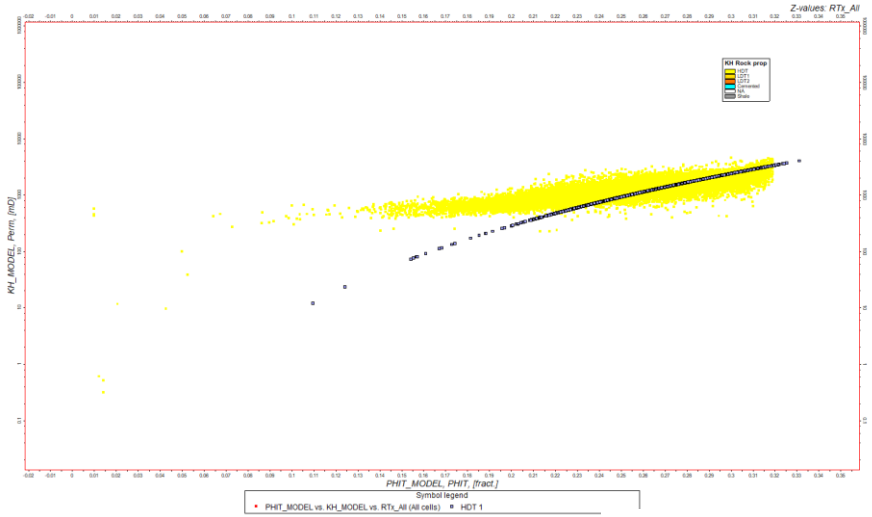
TBT’s (Heterolithics) in two settings

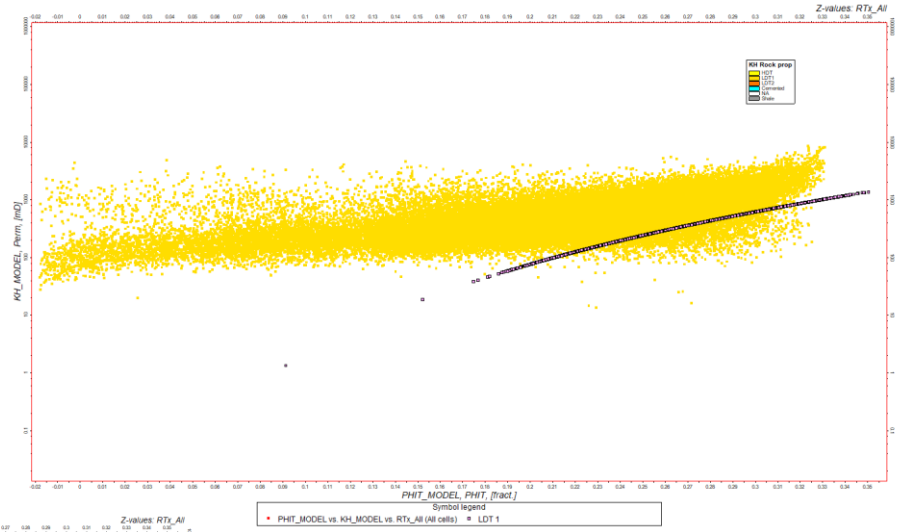
What is important to flow?

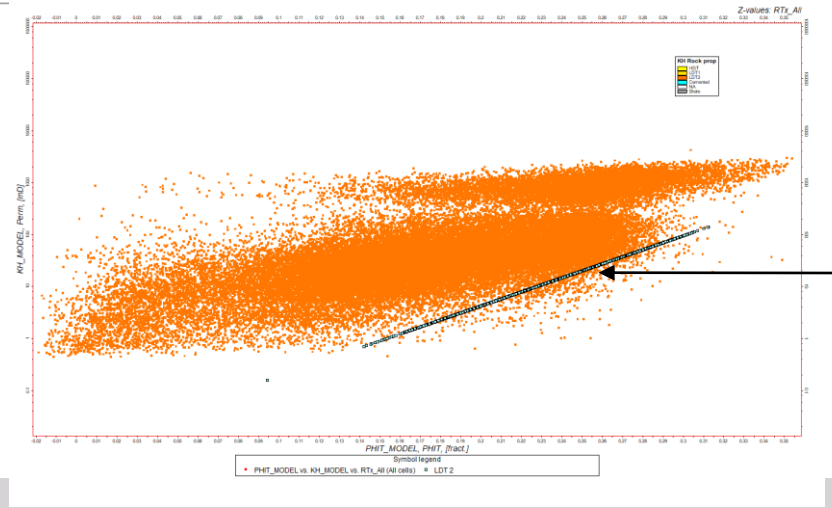


Are we happy with this KH_Model realization?

Modeled PHIT-model vs KH_model compared with PHIT vs Klogh per facies







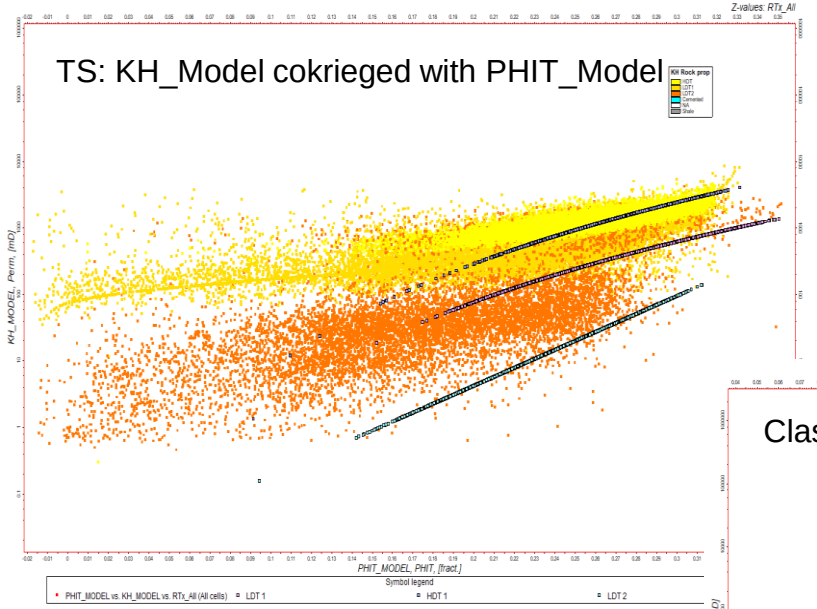
This facies (TBT's) is what TS was designed for.

This is the result of arithmetically upscaling perm twice. The resulting increased permeabiliy yields easier flow and higher oil saturations - > increased STOOIP and EUR.

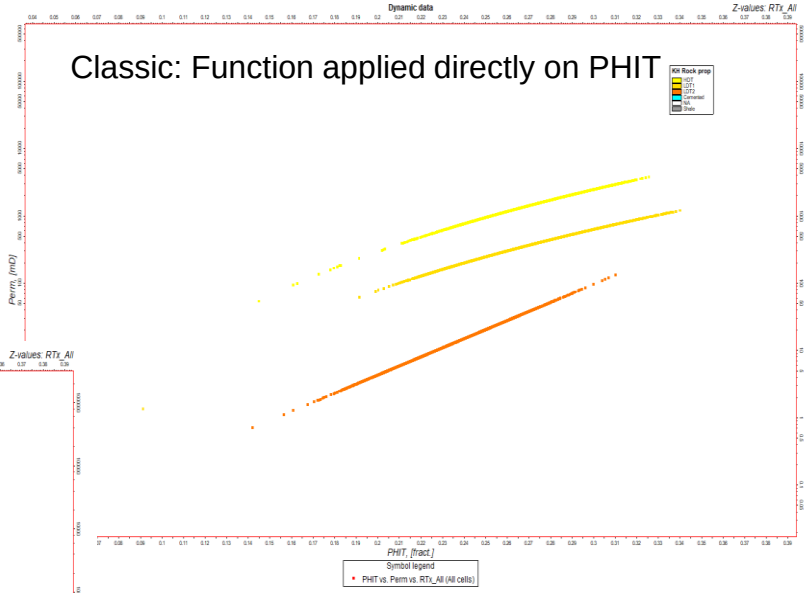
Three perm modeling options

KH_Model[U] vs Klogh[U] vs Function

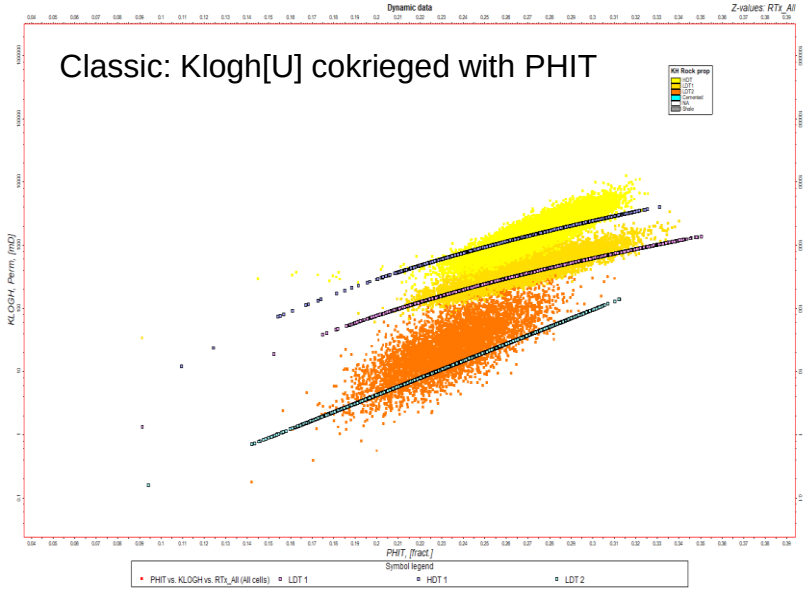
TS: KH_Model cokrieged with PHIT_Model



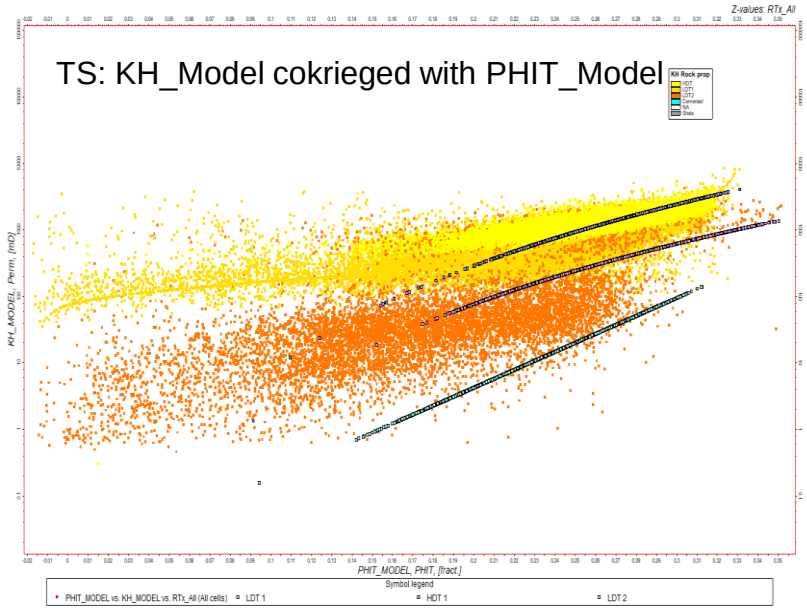
Classic: Function applied directly on PHIT



Classic: Klogh[U] cokrieged with PHIT



TS option



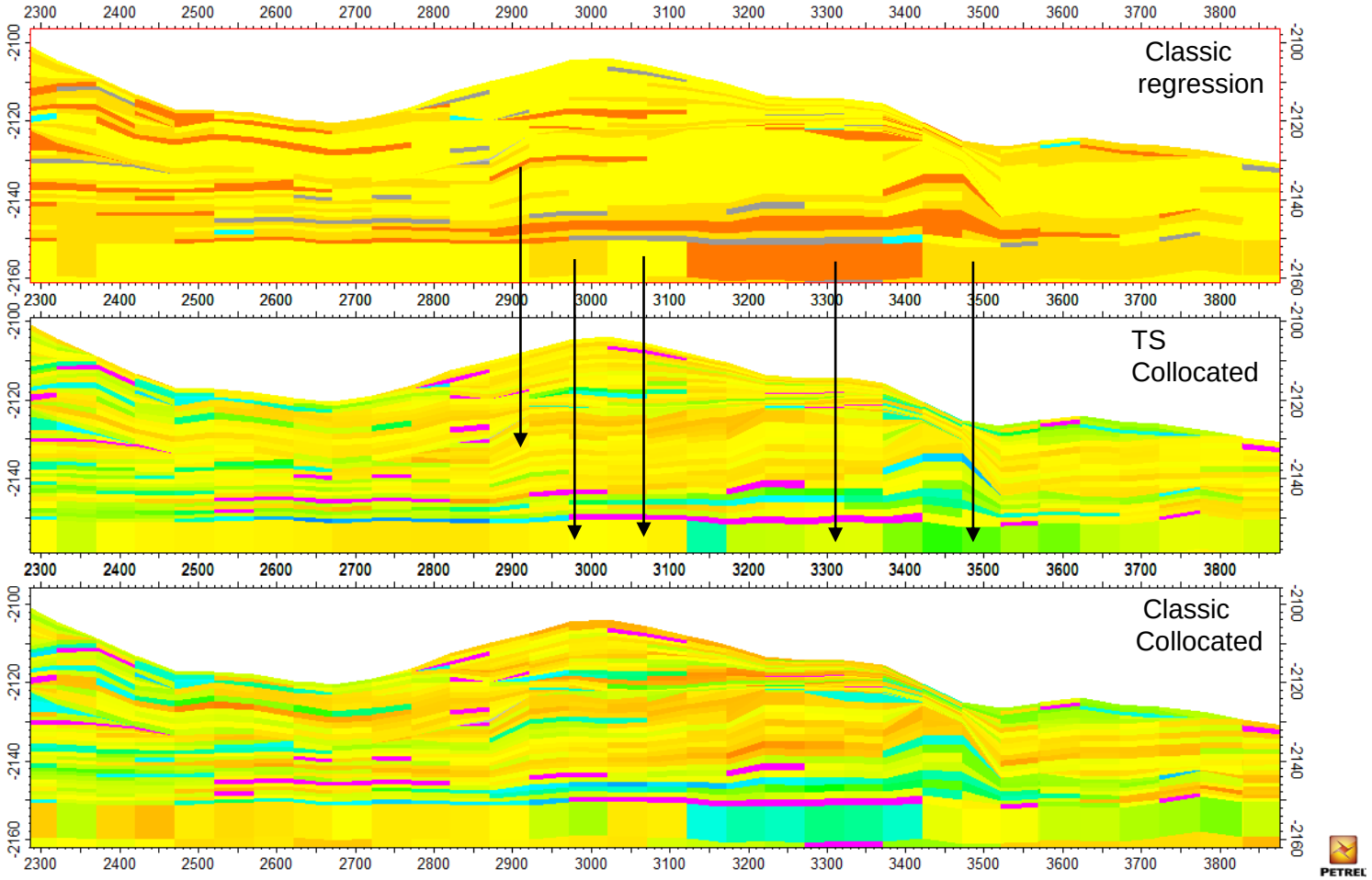
- fntg (fractional NTG at logs resolution) cannot be model
  - =>PHIT_Model has to be modeled
  - =>lost of the poro/ perm relationship
- PHIT_Model is an **arithmetic** upscaling at log resolution.
- KH_ Model needs to be uscalled
  - => Low end perms cannot be captured

- Overlap between facies
  - => decrease the impact of Facies model

- Scatter in result > scatter in core data

Wich perm model is from wich modeling option?

Don’t be fooled by the non net – these are quite different



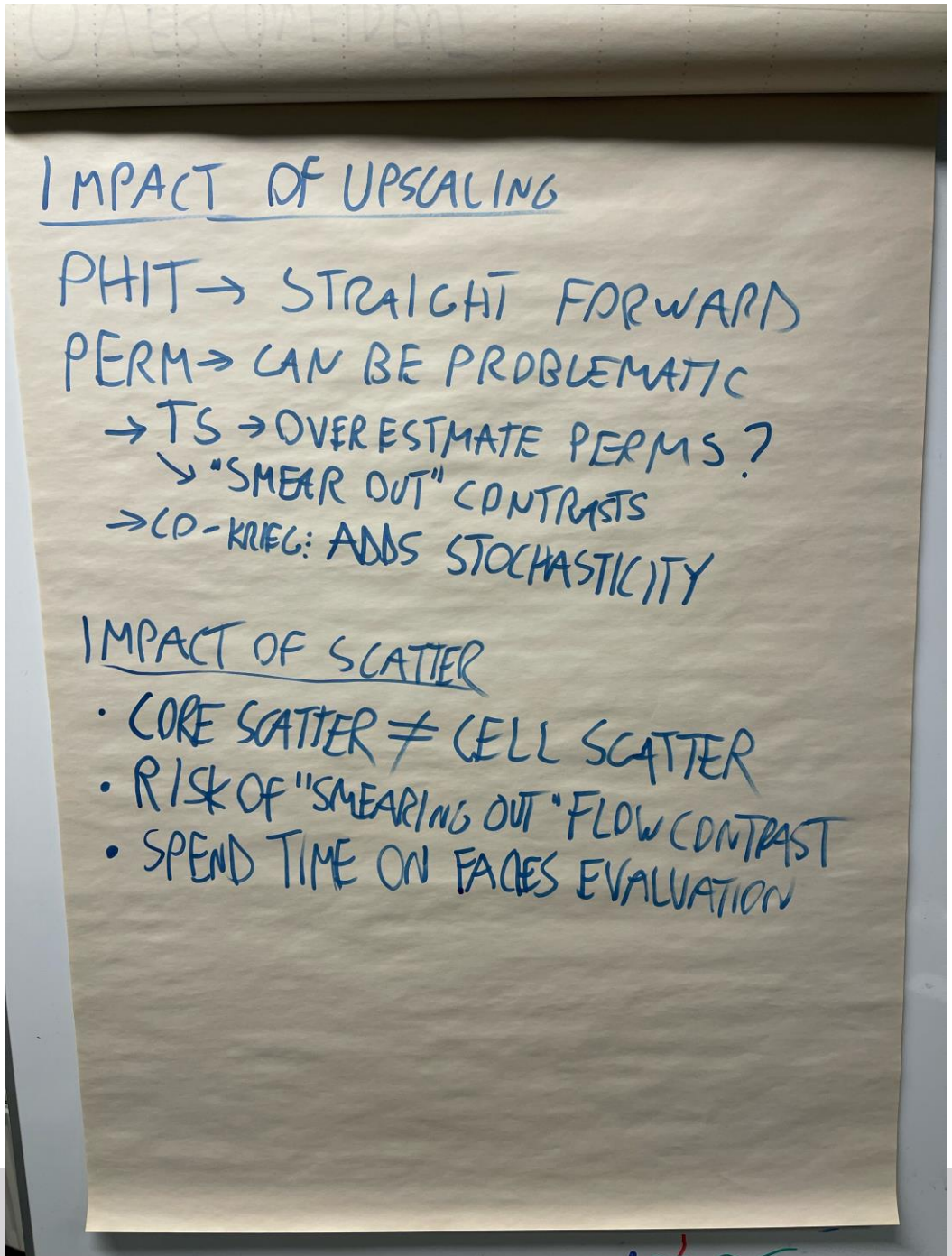
Using the function will still yield intra-facies heterogenity – because Porosity is already stochastically distributed

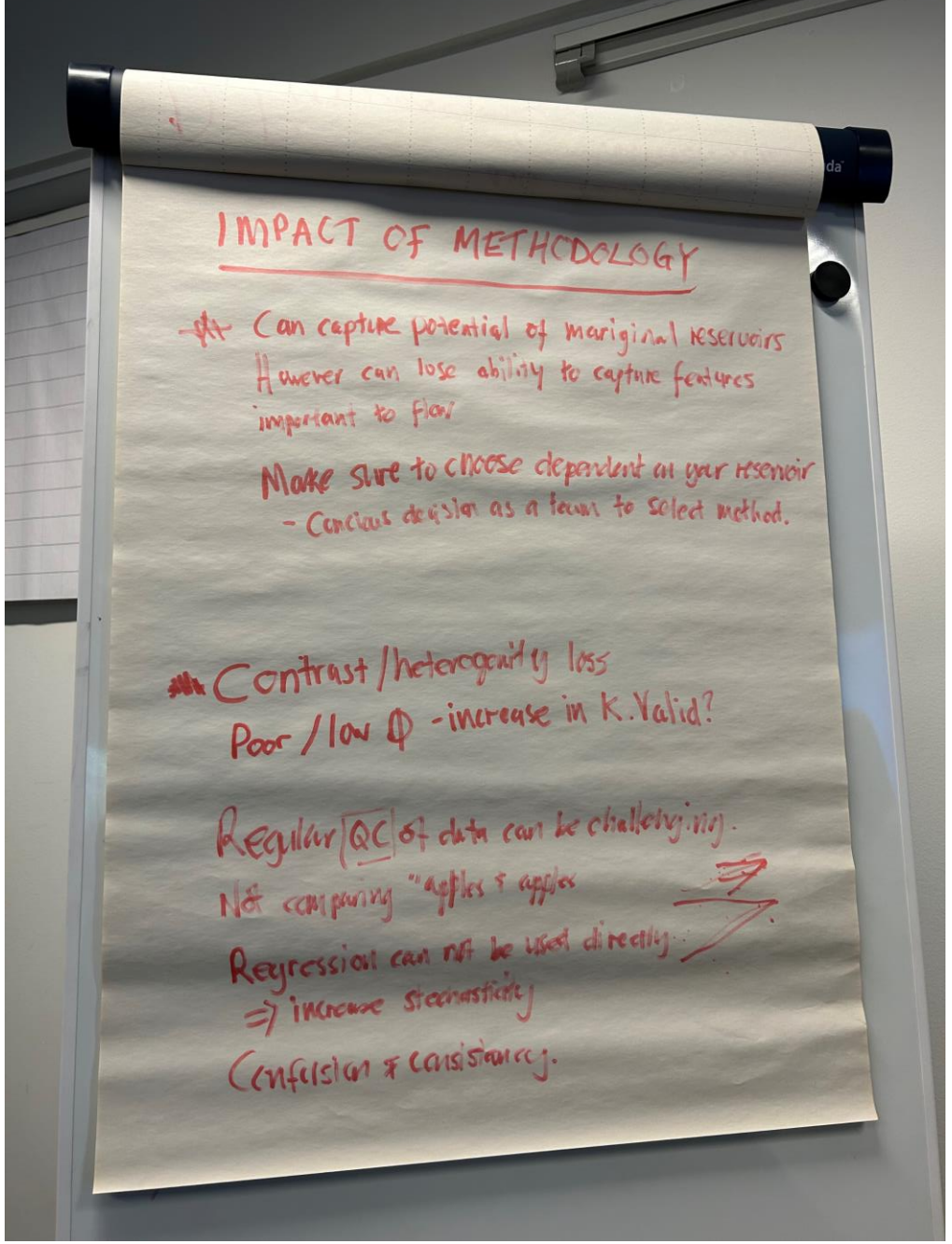
Using PHIT_Model colocated with PHIT_Model smears out my facies contrasts. I can no longer count on facies to control flow. HM to be done on multipliers rather than facies editing

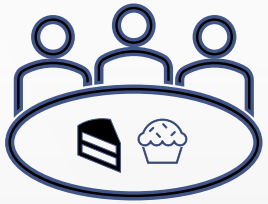
Using Klogh colocated with PHIT adds «randomness» on top of the porosity «randomness». Variable perm per porosity within facies.

Discussion points Permeability modelling

- What to use and when?
  - Co-krigging
  - Direct regression
  - TS
  - …
- Impact of the upscaling
- Impact of the scatter
- What is the impact of the selected methodology?
- Tomas Stieber
  - Company experience?
  - Team data handling


IMPACT OF UPSCALING
PHIT → STRAIGHT FORWARD
PERM → CAN BE PROBLEMATIC
→ TS → OVERESTMATE PERMS?
↘ "SMEAR OUT" CONTRASTS
→ CO-KRIEG: ADDS STOCHASTICITY
IMPACT OF SCATTER
• CORE SCATTER ≠ CELL SCATTER
• RISK OF "SMEARING OUT" FLOW CONTRAST
• SPEND TIME ON FACIES EVALUATION


IMPACT OF METHODOLOGY
Can capture potential of marginal reservoirs
However can lose ability to capture features important to flow
Make sure to choose dependent on your reservoir
- Concious decision as a team to select method.
Contrast / heterogeneity loss
Poor / low Φ - increase in K. Valid?
Regular QC of data can be challenging.
Not comparing "apples & apples"
Regression can not be used directly
⇒ increase stochasticity
Confusion & consistency.



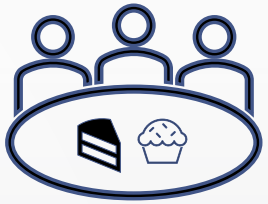
Group - Notes

- TAKE A PICTURE OF YOUR FLIP CHART
  - Send it to marine.seignole@akerbp.com

Feedback

- 13 participants- 9 feedback forms received

- Format: good format to promote discussions between participants, the relaxed atmosphere and networking possibility seems to be appreciated- 1 comment on not enough discussion time
- Session length- ½ day seems to fit all
- Satellite location- working well with the Oslo set up as it is
- Session topics- well received topics and interest on more company presentations
- Other feedback
  - Several topic suggested: data analysis, algorithms, variograms, object modelling, facies vs rocktype, hierarchical modeling



Next dates

- Cake&Discuss
  - March 2024 (to be confirmed)
- FORCE IRM group
  - 6/7 Feb 2024: In-person @ the NPD: Making good decisions under subsurface uncertainty: How difficult can it be?

Session 4
The Property Model

Session 5
The Uncertainty Study