Drift and attenuation on the NCS: A new look at an old approach

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Outline

- Introduction
- About our study
- Method: Example wells
- Assumptions
- Results and interpretation
- Next steps

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Why map seismic attenuation?

- Bandwidth reduction and phase distortion vs. depth
    - Due to absorption and other effects
- Reduced image interpretability and resolution

Potential:

- Better correction of images and AVO
- Better understanding => attenuation prediction
- Sensitivities – find anomalies (?)

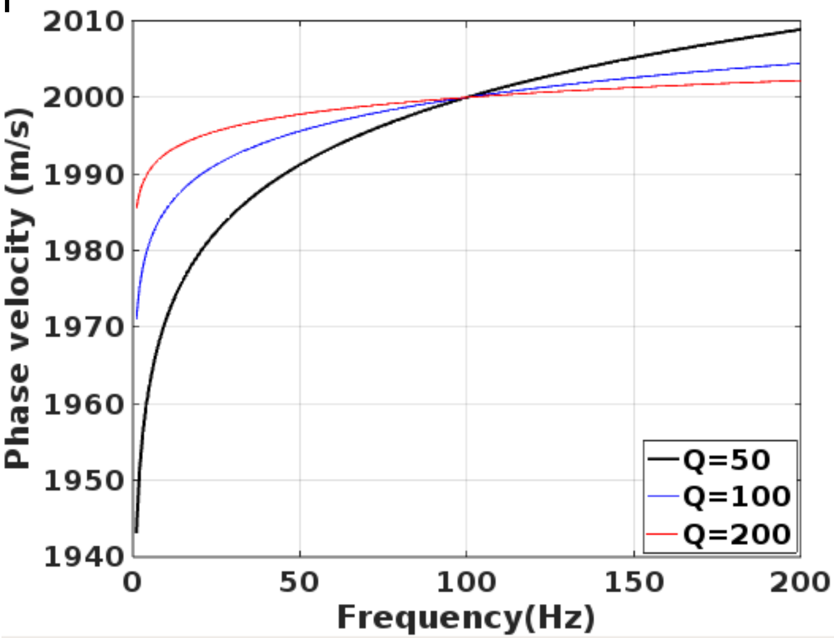
Seismic attenuation and dispersion

$$Q^{-1} \approx \frac{1}{2\pi}\frac{\Delta E}{E}$$

For causal linear wave propagation absorption requires frequency-dependent velocity, e.g.:

$$\frac{c_{f_1}}{c_{f_2}} \approx 1 + \frac{1}{\pi Q}\ln\left(\frac{f_1}{f_2}\right)$$

Kolsky-Futterman (NCQ) attenuation model (Kolsky(1953); Futterman(1962))



Checkshot drift and seismic attenuation

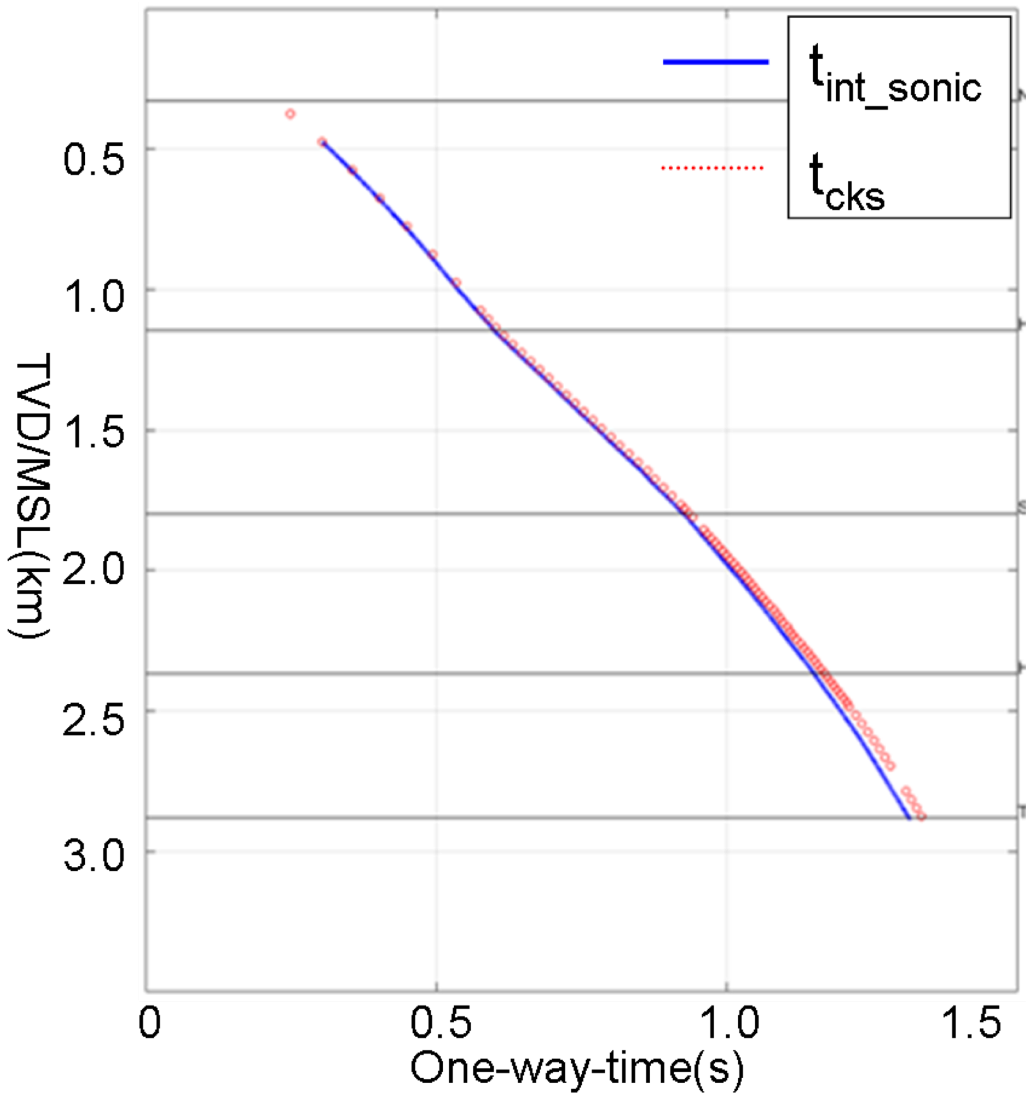
$$\Delta \text{drift} \approx \frac{d \ln\left(\frac{f_2}{f_1}\right)}{\pi V_{f_2}} Q^{-1}$$

Stewart et al. (1984)

For example values:

Q = 100;
d = 500 m;
f_2 = 15 kHz,
f_1 = 50 Hz; and
V_{f2} = 2000 m/s
Δdrift ≈ 4.5ms

$$\Delta \text{drift} \equiv \Delta t_{cks} - \Delta t_{int\_sonic}$$



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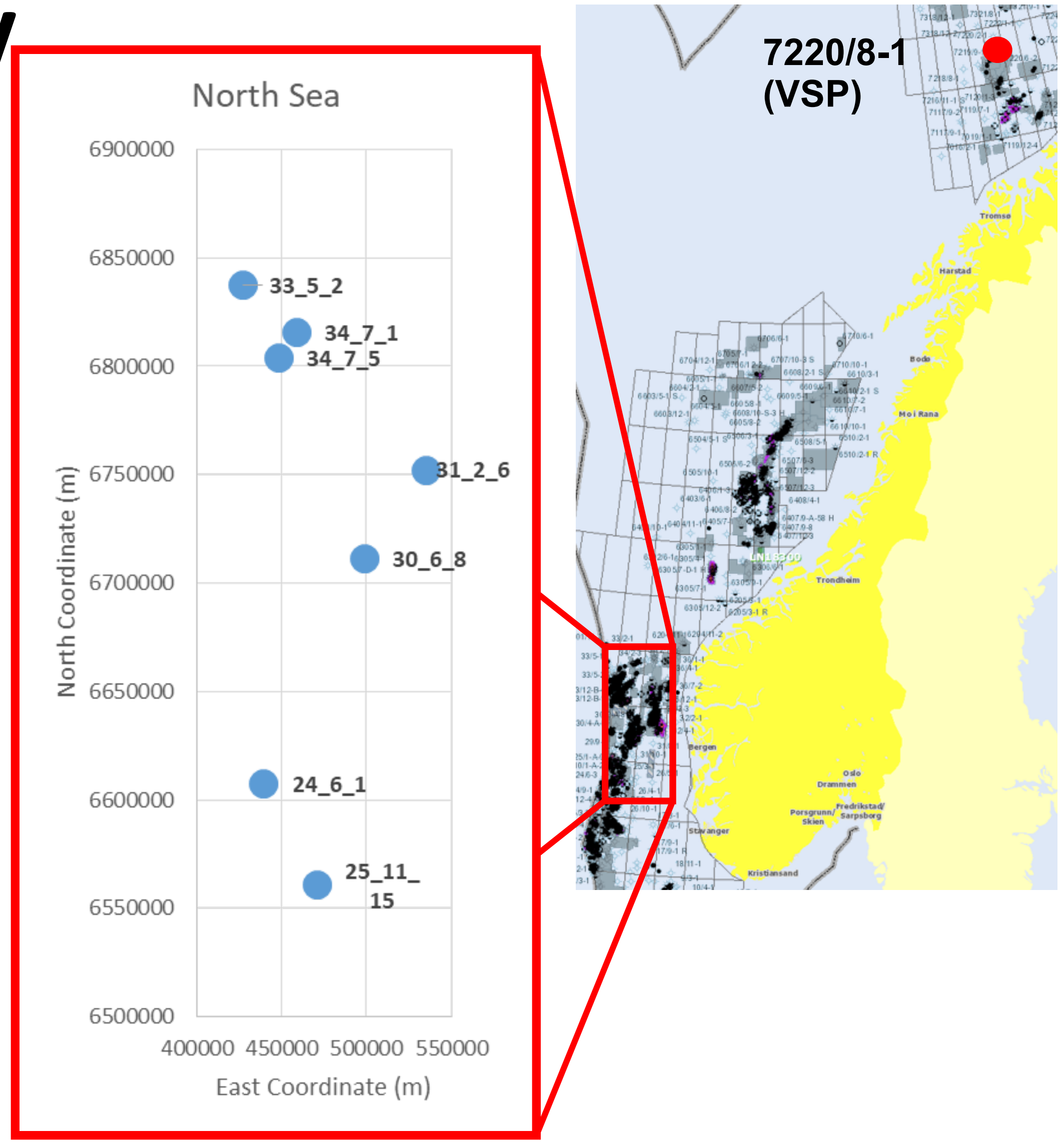
About our study

- Data from 8 wells.
- Comparing drift gradients (and Q^{-1}) to geology.
- Well data released by NPD.



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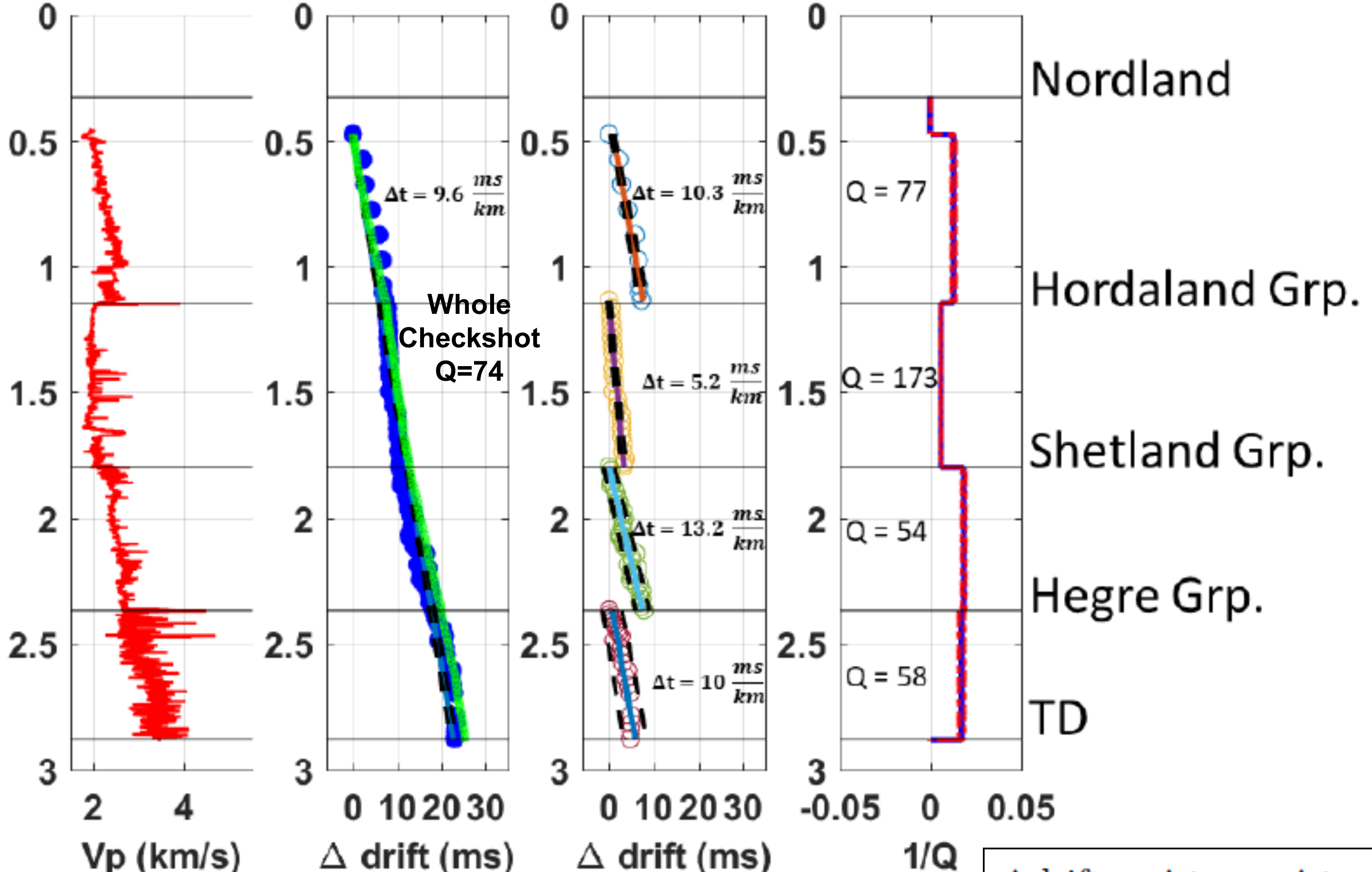
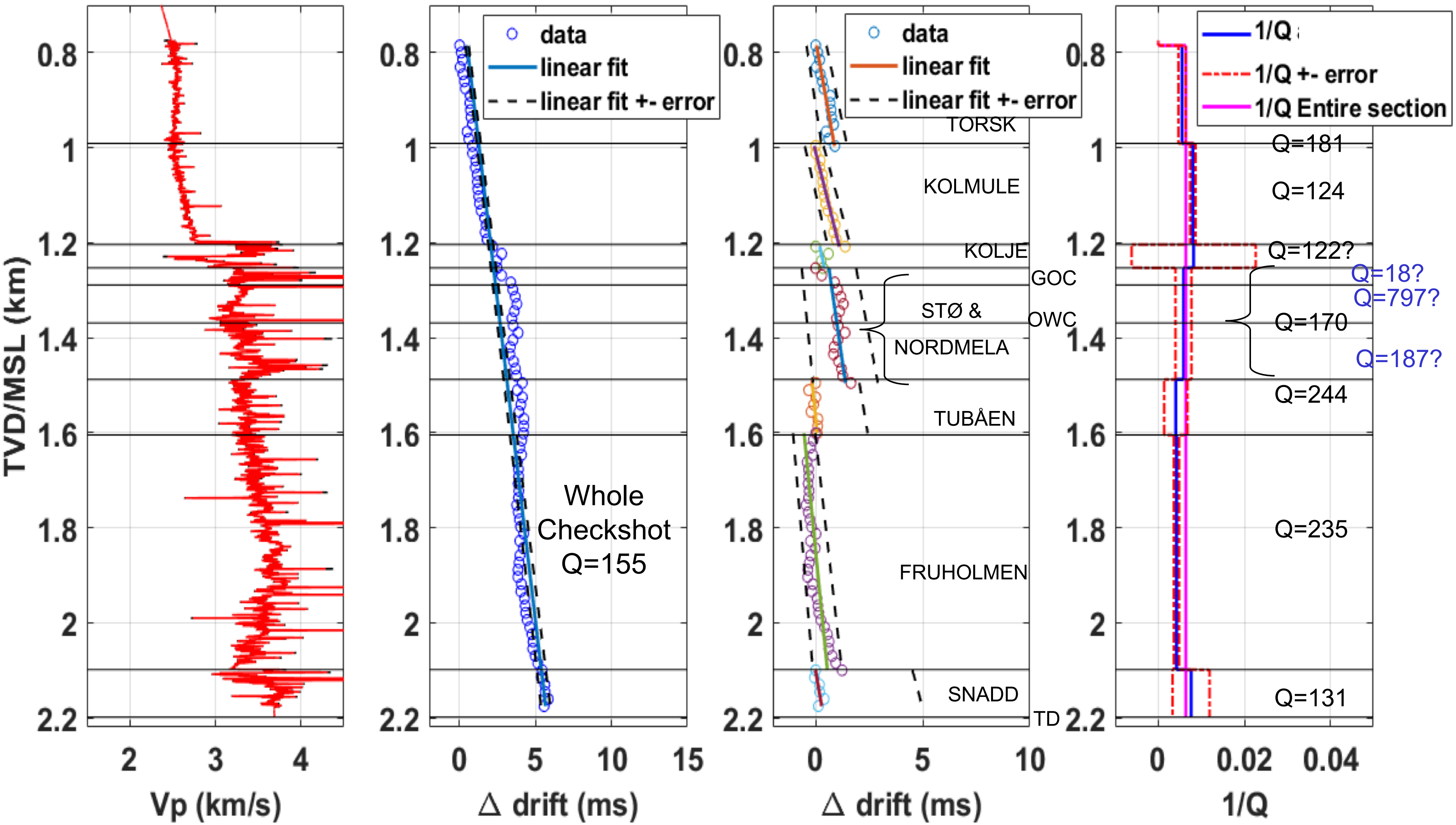
Example drift analysis from well 34/7-1 (Snorre)



$$\Delta \mathrm{drift} \equiv \Delta t_{cks} - \Delta t_{int\_sonic}$$

Second example well 7220/8-1 (Johan Castberg)



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Key assumptions

- Dispersion from absorption is main cause of drift
- Consistent picking of time-depth
- Impact of scattering and scale is small
- Kolsky-Futterman (NCQ) dispersion/attenuation applies

N. B. Our Q^{-1} is measured vertically

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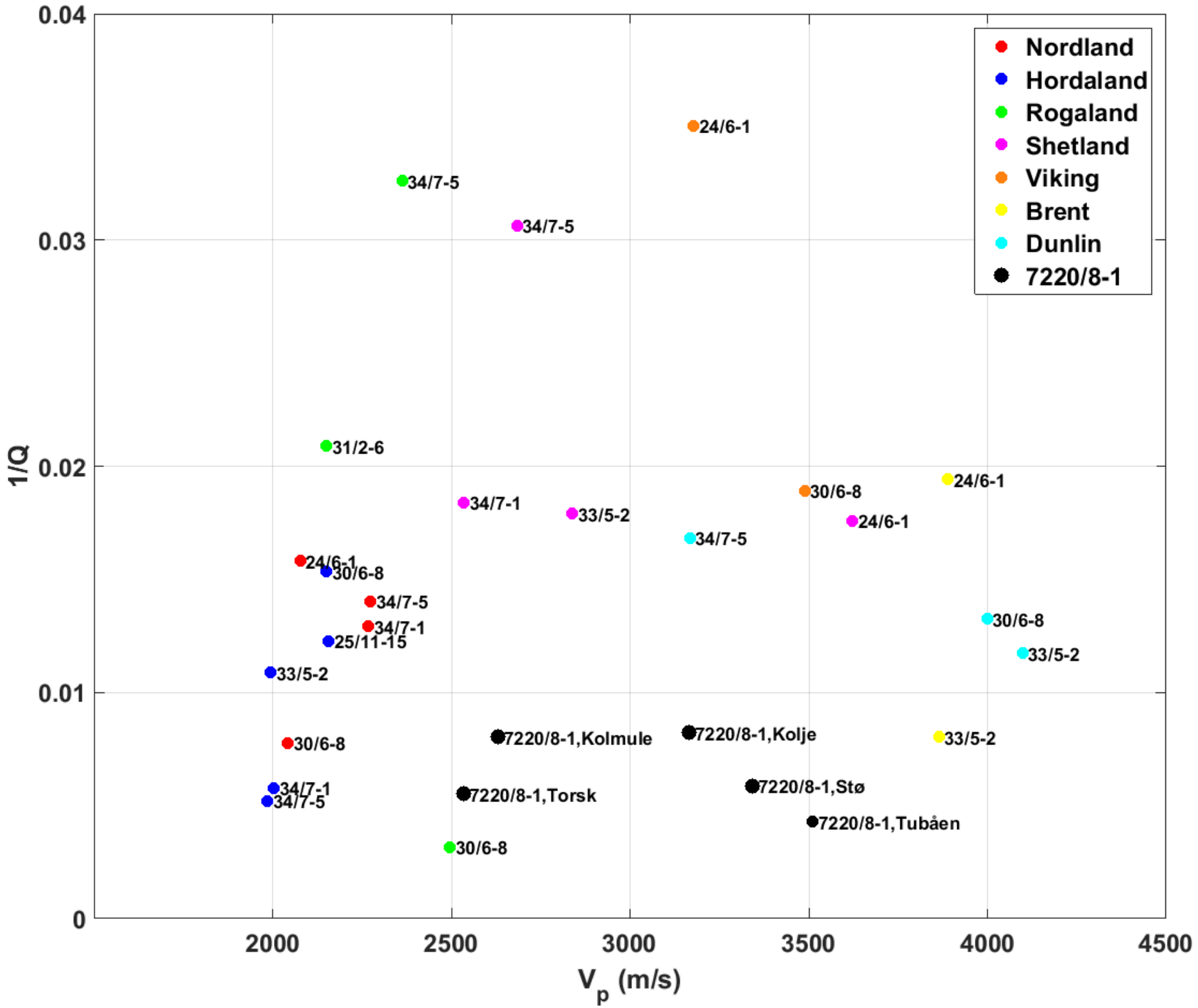
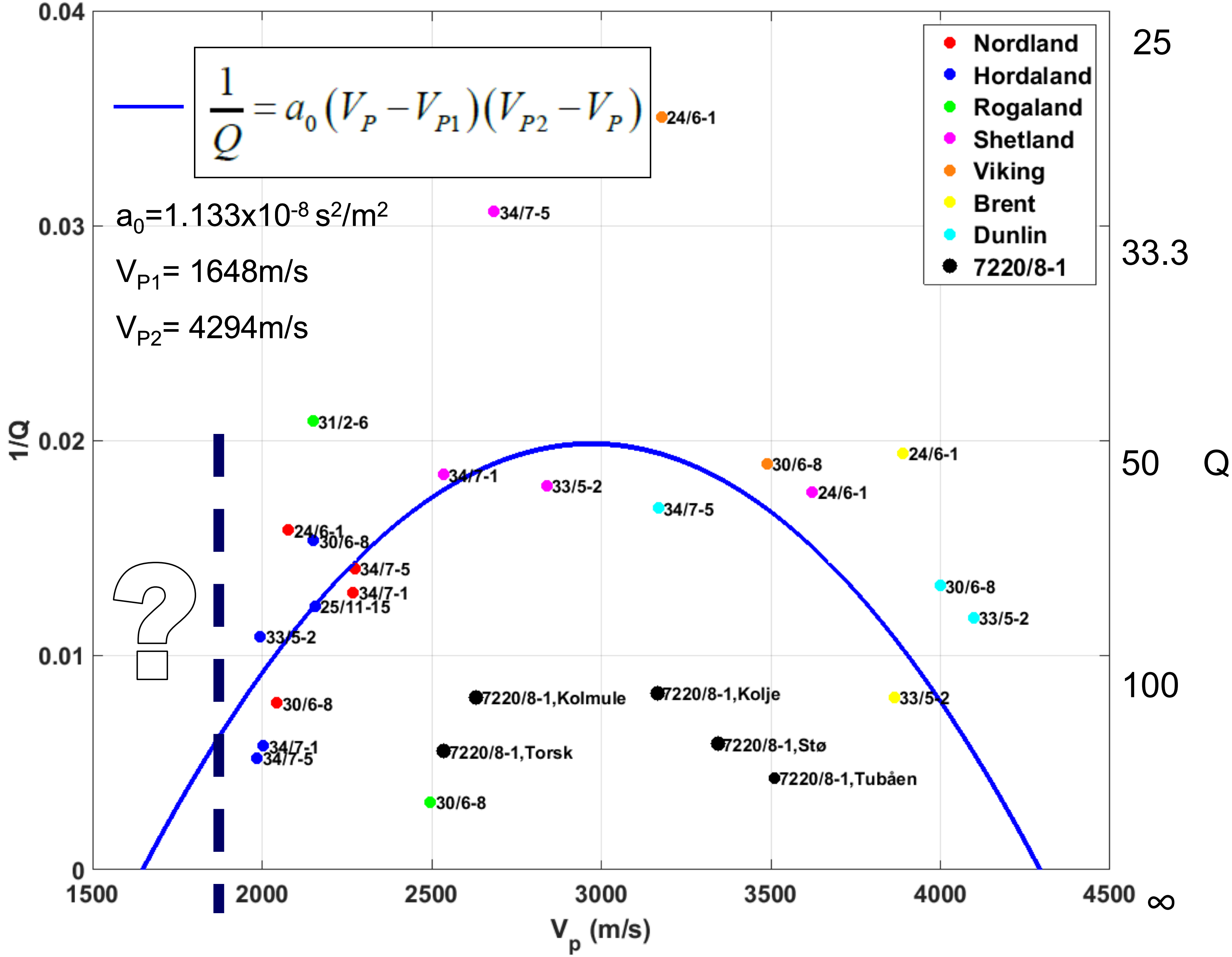


0.04
0.03
0.02
0.01
0
1/Q
2000
2500
3000
3500
4000
4500
V_p (m/s)
Nordland
Hordaland
Rogaland
Shetland
Viking
Brent
Dunlin
7220/8-1
24/6-1
34/7-5
34/7-5
31/2-6
34/7-1
33/5-2
30/6-8
24/6-1
24/6-1
34/7-5
24/6-1
30/6-8
34/7-5
34/7-1
25/11-15
33/5-2
30/6-8
33/5-2
30/6-8
34/7-1
34/7-5
30/6-8
7220/8-1,Kolmule
7220/8-1,Kolje
33/5-2
7220/8-1,Torsk
7220/8-1,Stø
7220/8-1,Tubåen



$$\frac{1}{Q} = a_0 (V_P - V_{P1})(V_{P2} - V_P)$$
a_0=1.133x10^{-8} s^2/m^2
V_{P1}= 1648m/s
V_{P2}= 4294m/s
Nordland
Hordaland
Rogaland
Shetland
Viking
Brent
Dunlin
7220/8-1
1/Q
V_p (m/s)
Q
25
33.3
50
100
∞
0.04
0.03
0.02
0.01
0
1500
2000
2500
3000
3500
4000
4500
24/6-1
34/7-5
31/2-6
34/7-1
33/5-2
30/6-8
24/6-1
34/7-5
24/6-1
30/6-8
34/7-5
34/7-1
25/11-15
33/5-2
30/6-8
33/5-2
7220/8-1,Kolmule
7220/8-1,Kolje
33/5-2
30/6-8
34/7-1
34/7-5
7220/8-1,Torsk
7220/8-1,Stø
7220/8-1,Tubåen
30/6-8
?

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Next steps

- Evaluate results i.e. Q/dispersion model assumed:
  - e.g. via comparison with other Q estimates from VSP.*
- Test application of the Q model predictions:
  - e.g. in processing via well-tie.*
- Improve model and understanding:
  - Analyse more wells;
  - Use more complete datasets*;
  - Link to research in rock physics and mechanisms.

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- Veronica Torres Caceres' presentation at EAGE
is at 1645 on Thursday 14th June in Room B

- We are interested in collaboration with groups with access to data and funding.