



**NTNU – Trondheim**  
Norwegian University of  
Science and Technology

## **Role of illumination in the context of Seismic While Drilling - a synthetic study**

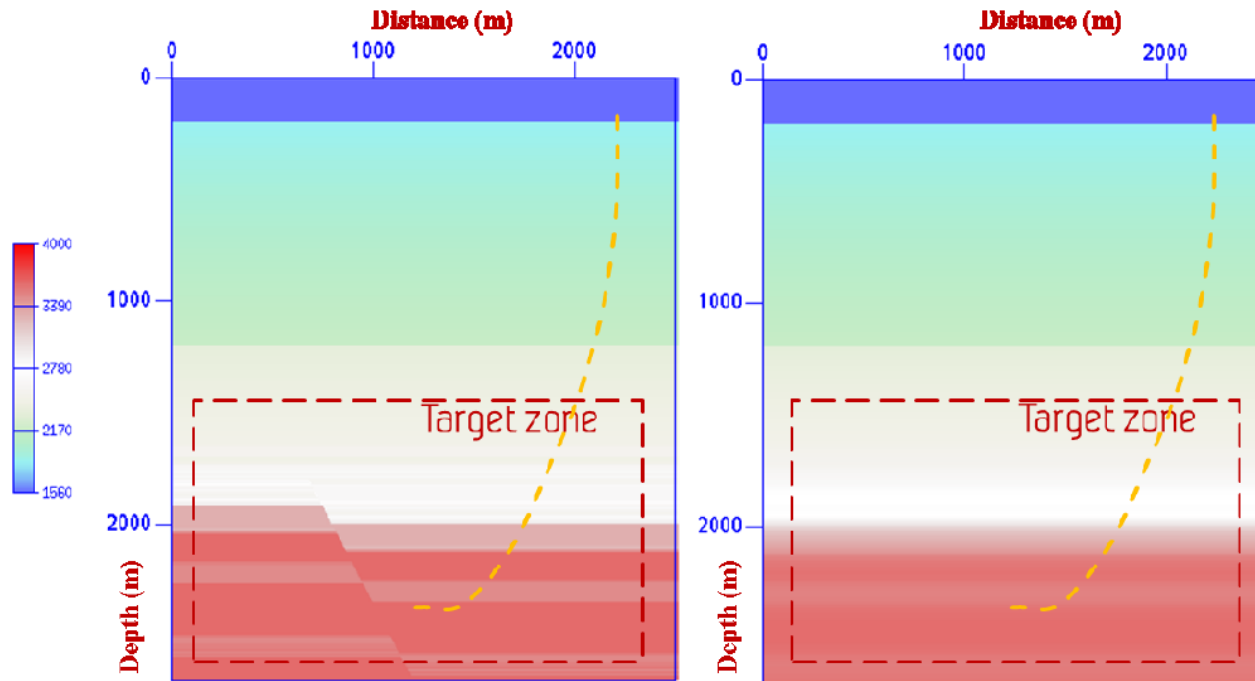
Yi Liu, Anouar Romdhane and Børge Arntsen

# Outline

- Introduction
- Model building
- Illumination maps and ray paths
- Conclusion



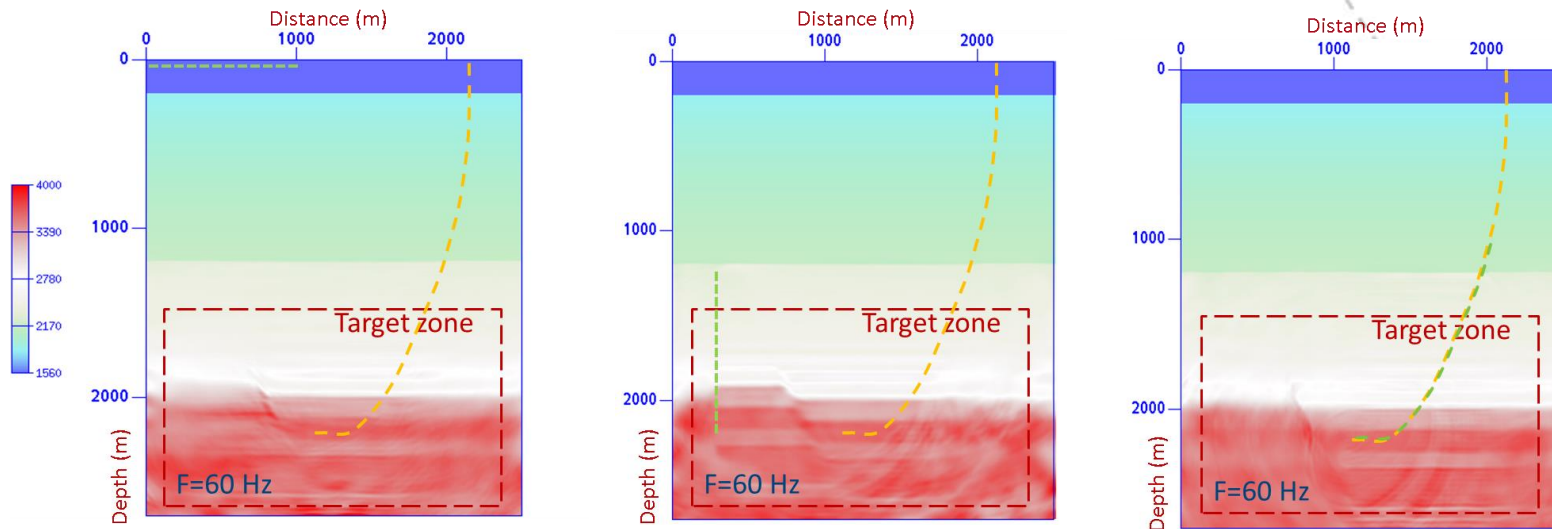
# Introduction



Romdhane et al. (2012)

- Norne field, 2500 x 2700m
- 1500 - 4000m/s
- f-x domain, 10 – 60 Hz

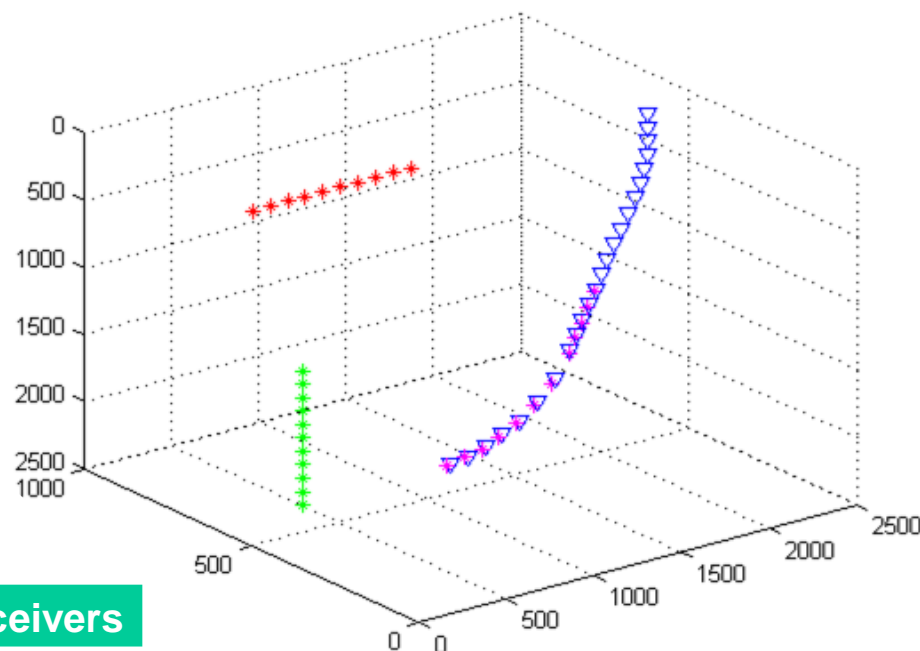
# Introduction



- Different acquisition geometry --> Different results from FWI / imaging
- How to optimize the survey for better illumination ahead of the drill bit?

# Model building

- 2D to 2.5D
- 5 acquisition geometries:

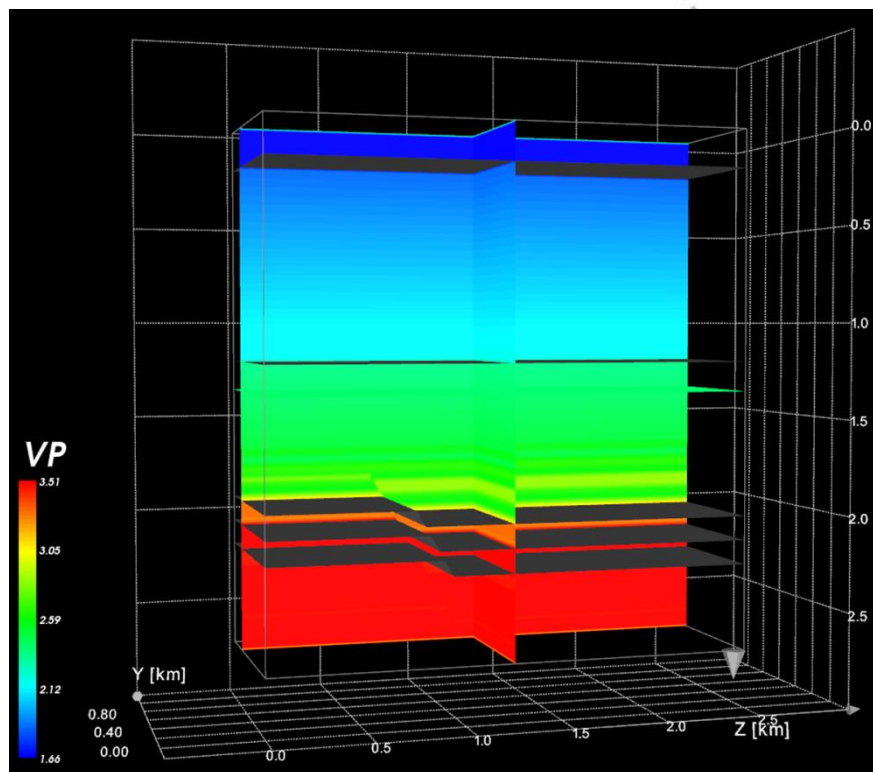
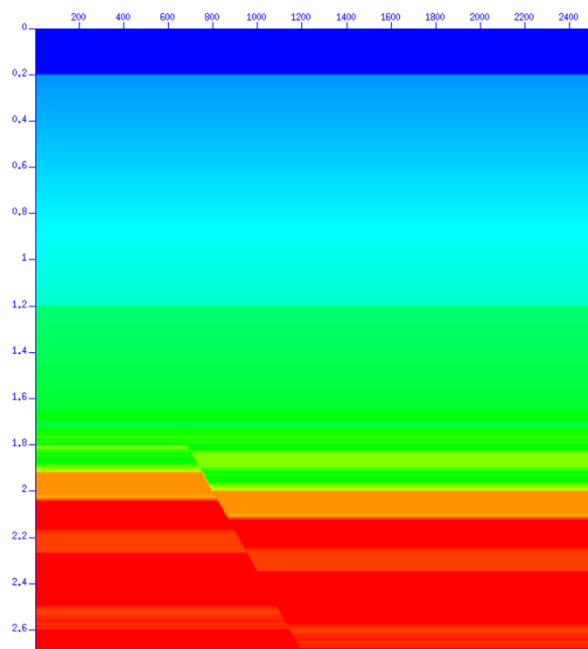


Geometry	Shots	Receivers
Multi-offset VSP	101	238
Crosswell	101	238
In-wellbore	116	238
Reverse VSP	116	101
Multi-offset VSP No.2	101	238

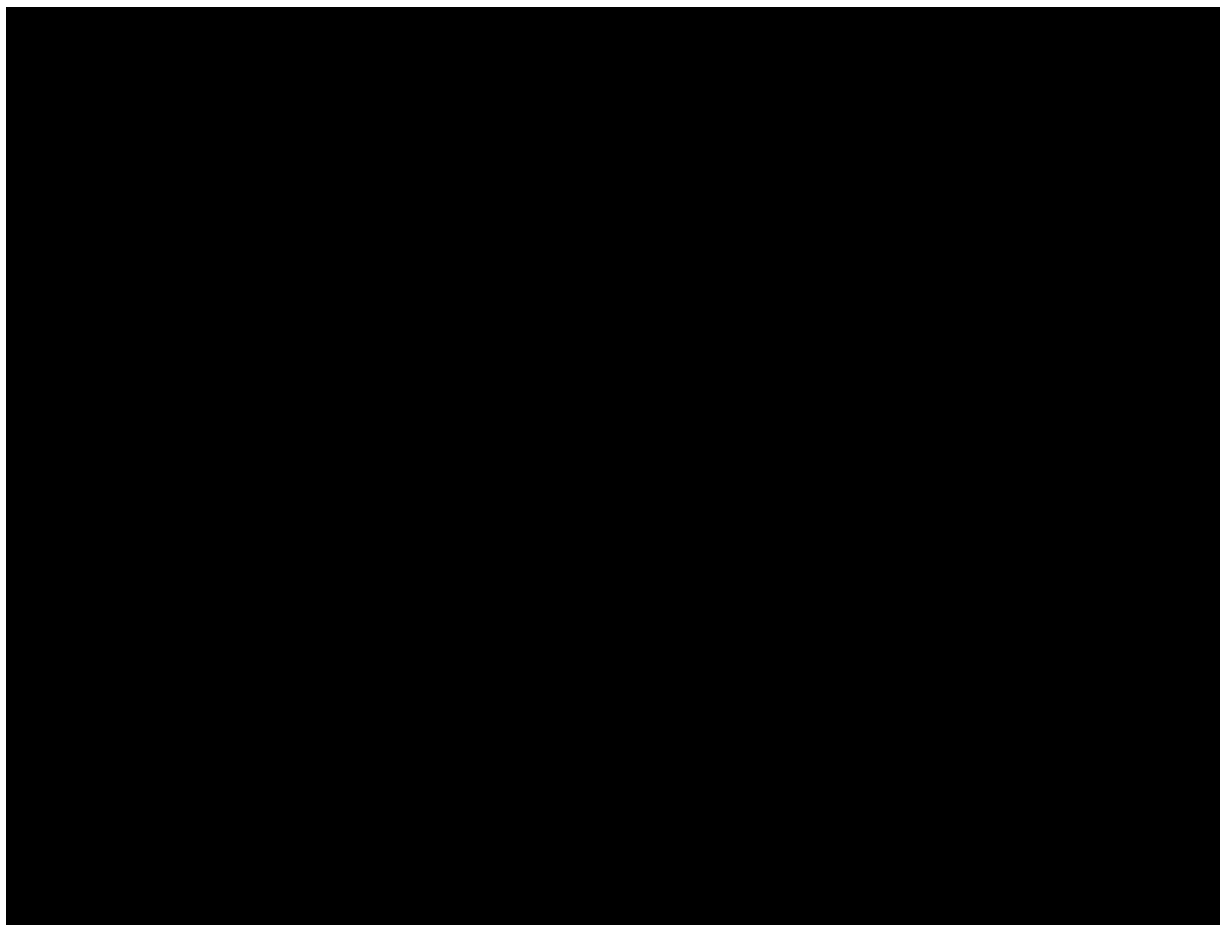
# Model building

## - Velocity model and Interfaces

- Select interfaces --> ascii xyz
- Smooth the model --> segy

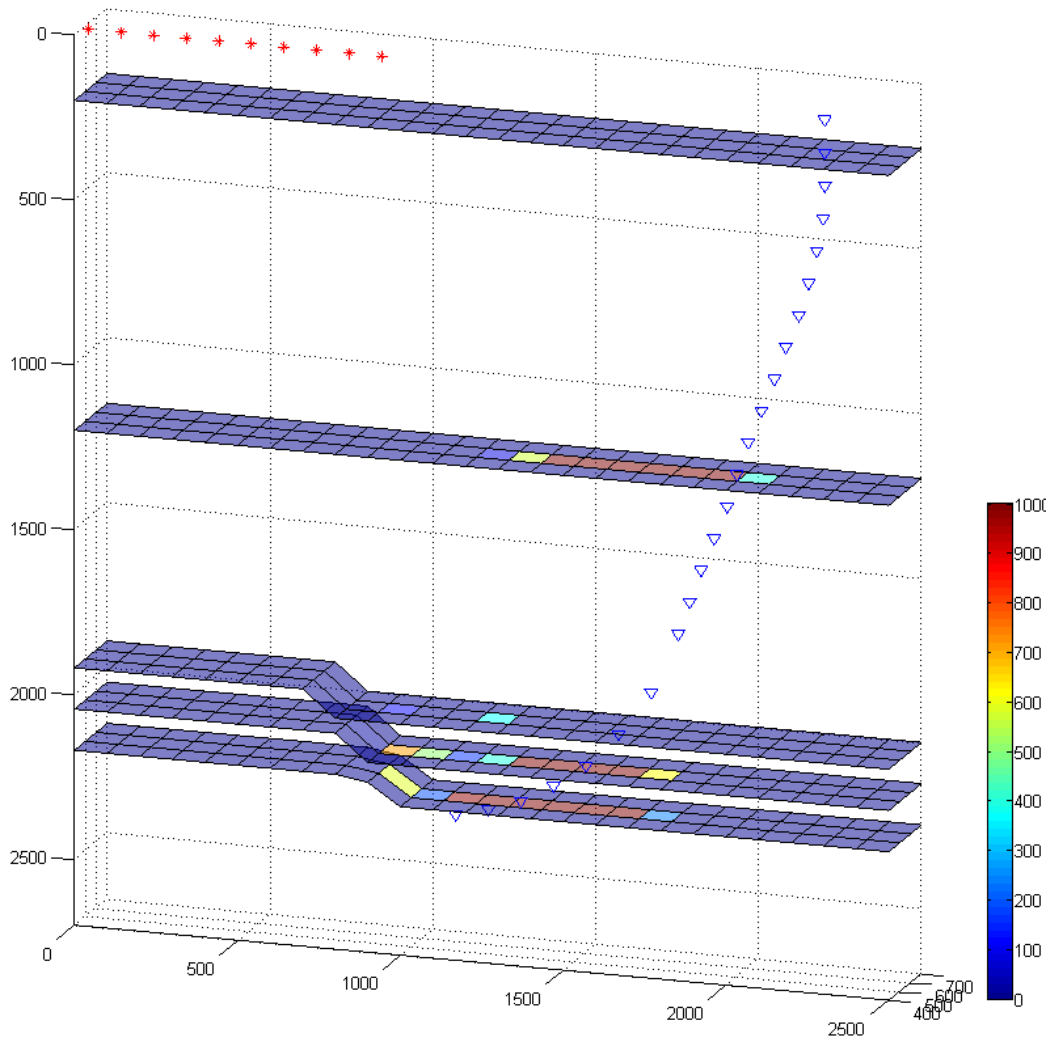


# Illumination maps & ray paths

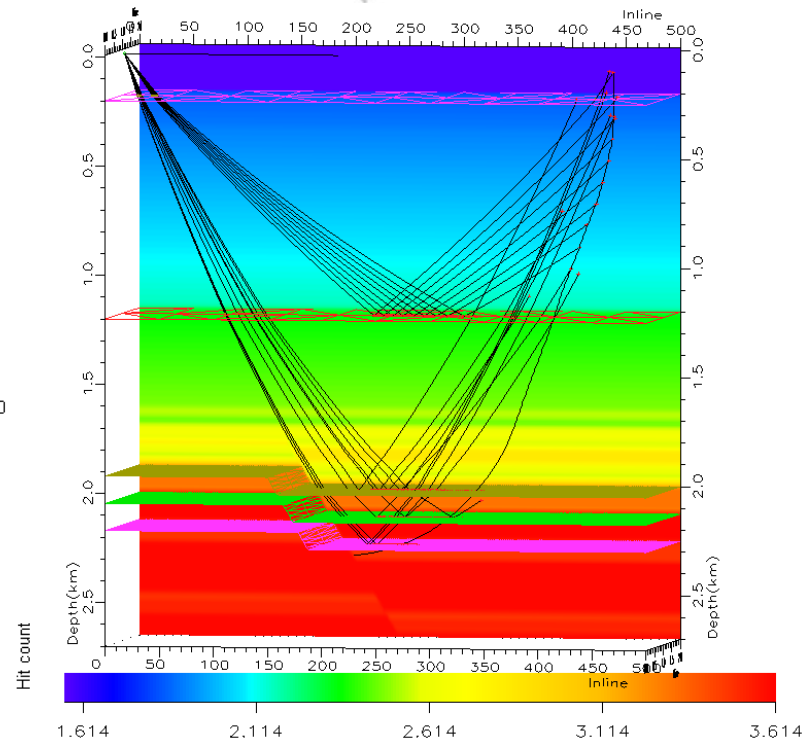


# Illumination maps & ray paths

Hit Map for VSP



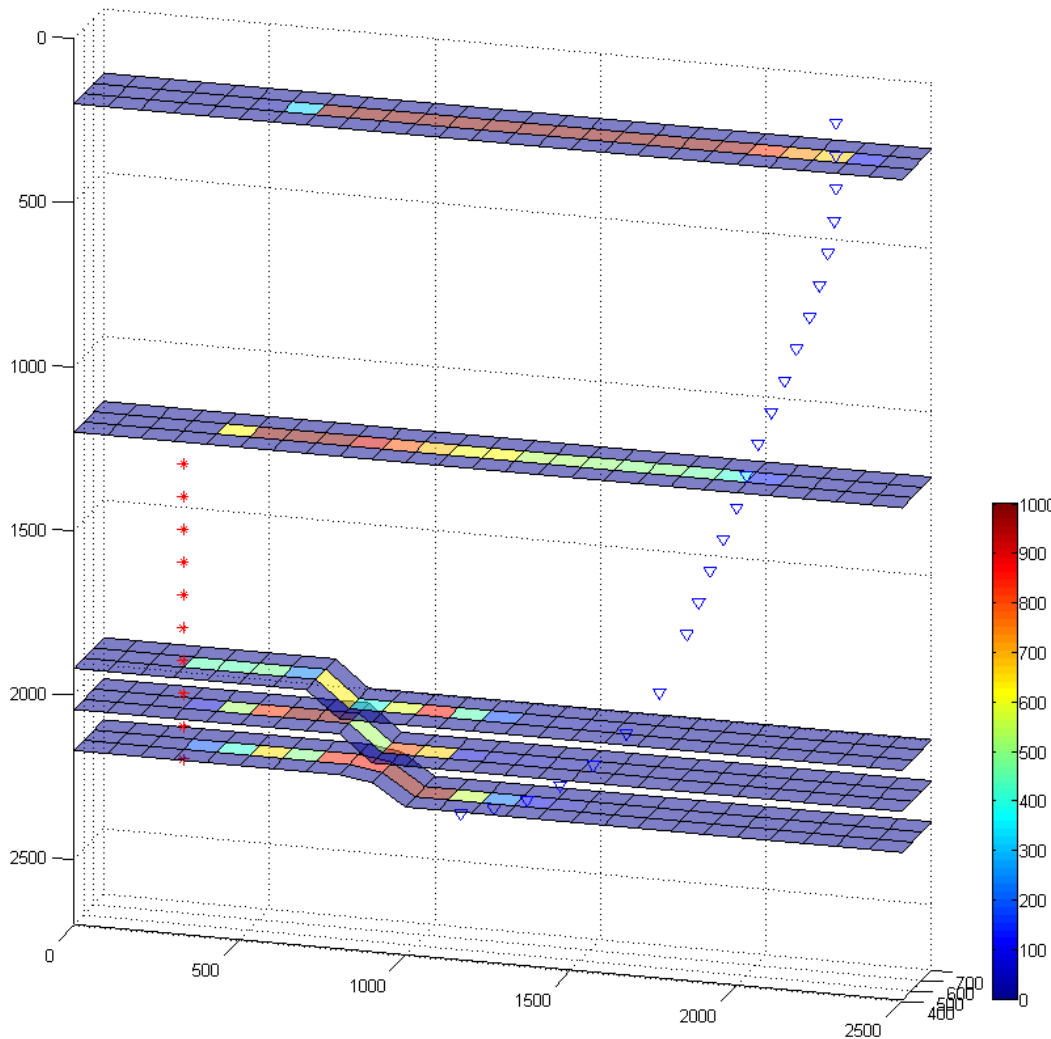
Multi-offset VSP



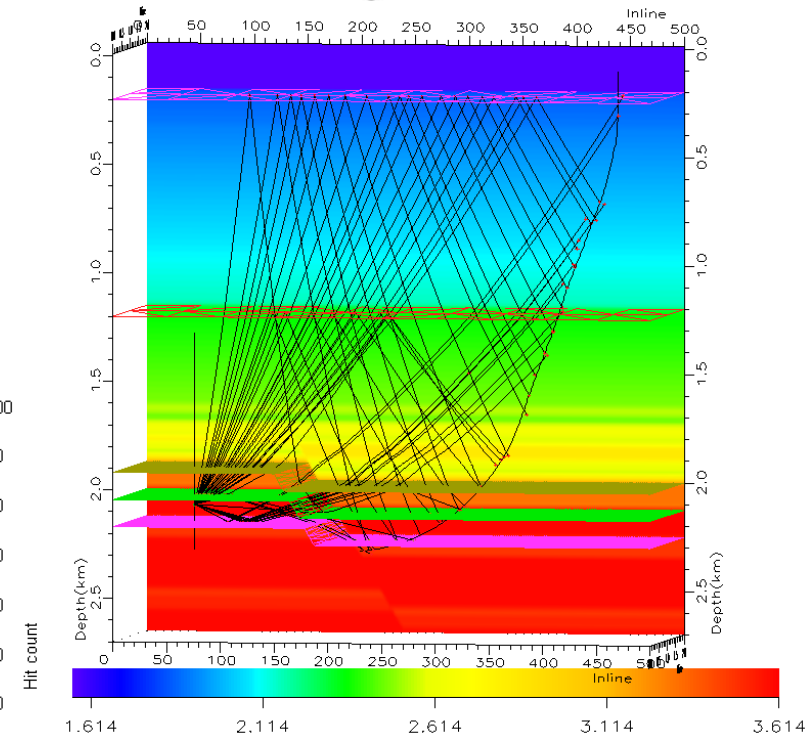


# Illumination maps & ray paths

Hit Map for Crosswell

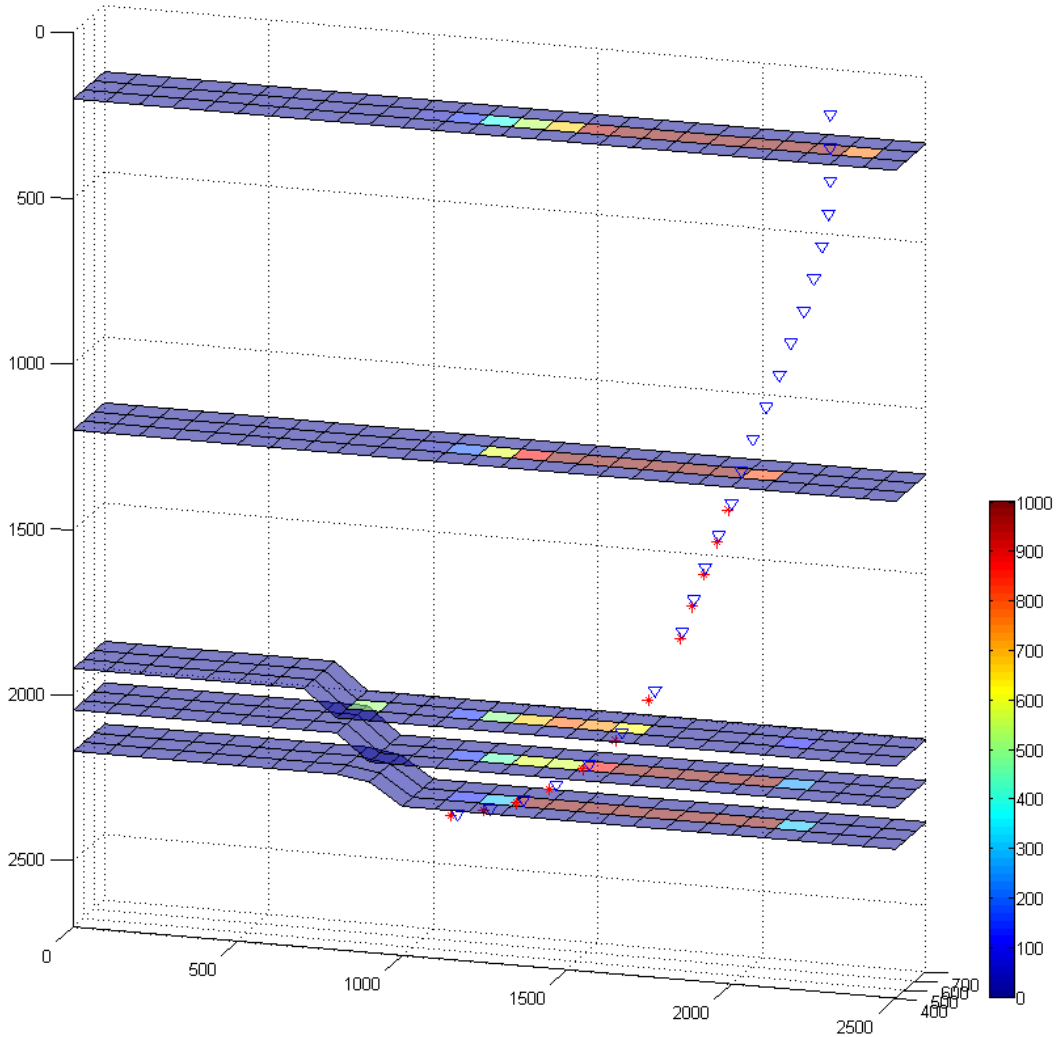


Cross-well VSP

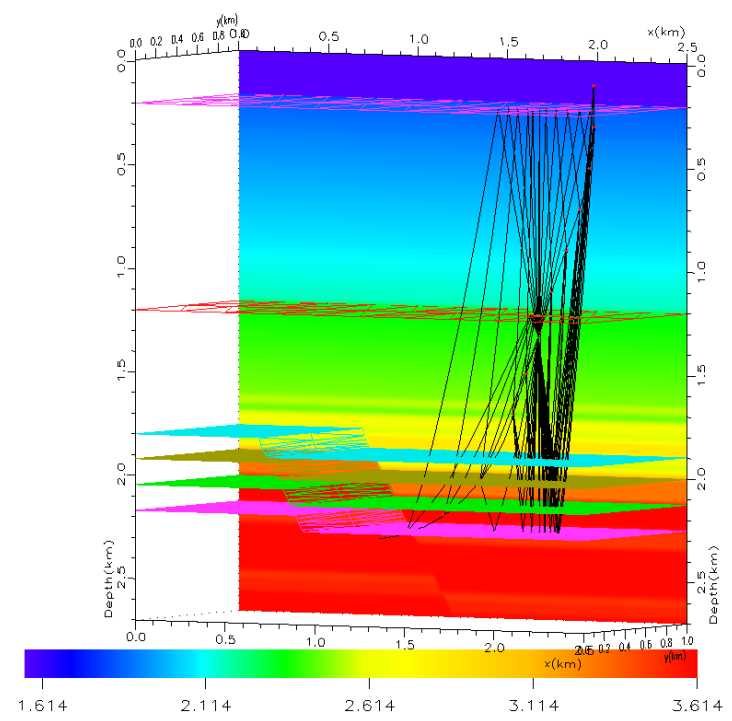


# Illumination maps & ray paths

Hit Map for Borehole

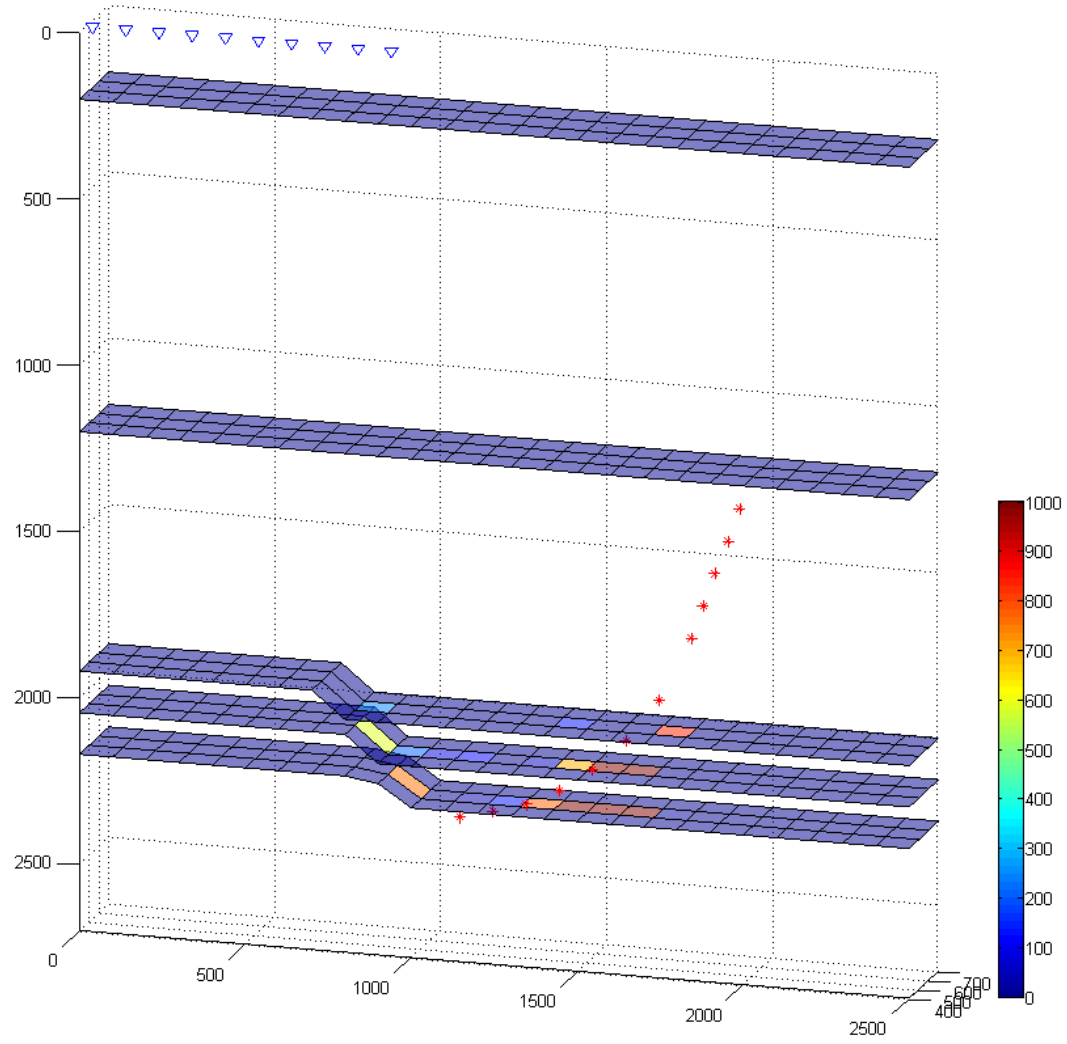


In-wellbore VSP

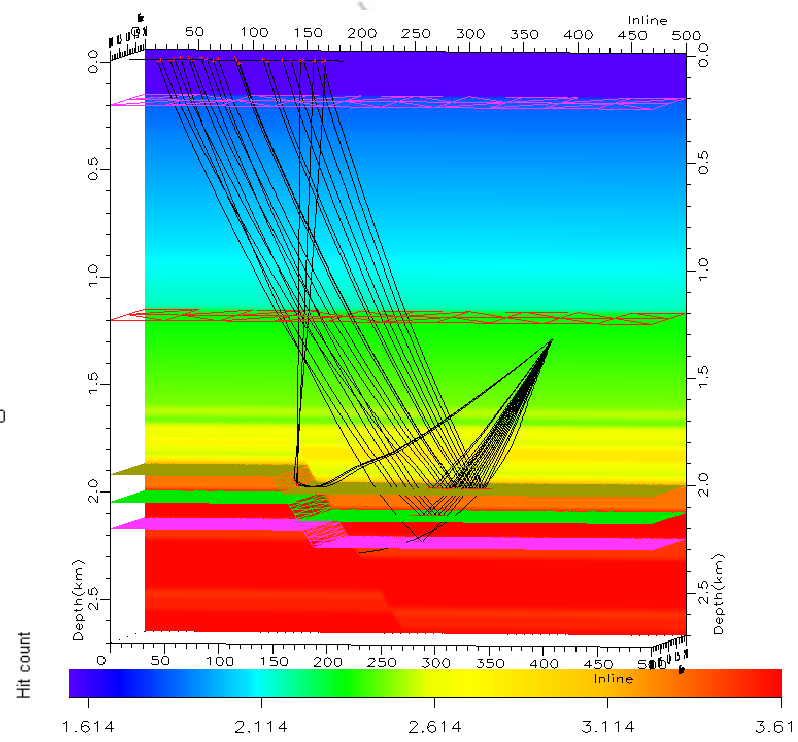


# Illumination maps & ray paths

Hit Map for RVSP

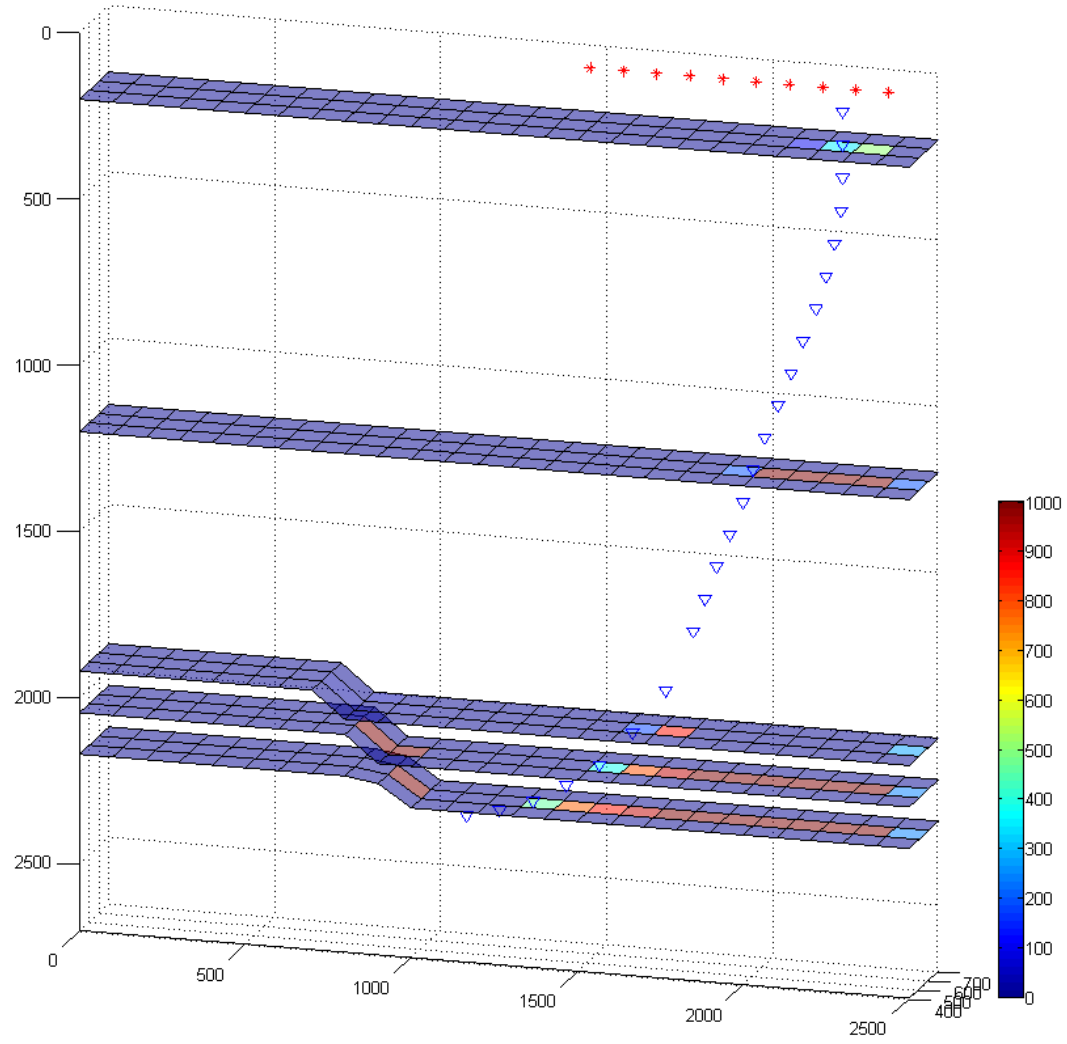


Wellbore-to-surface seismic (RVSP)

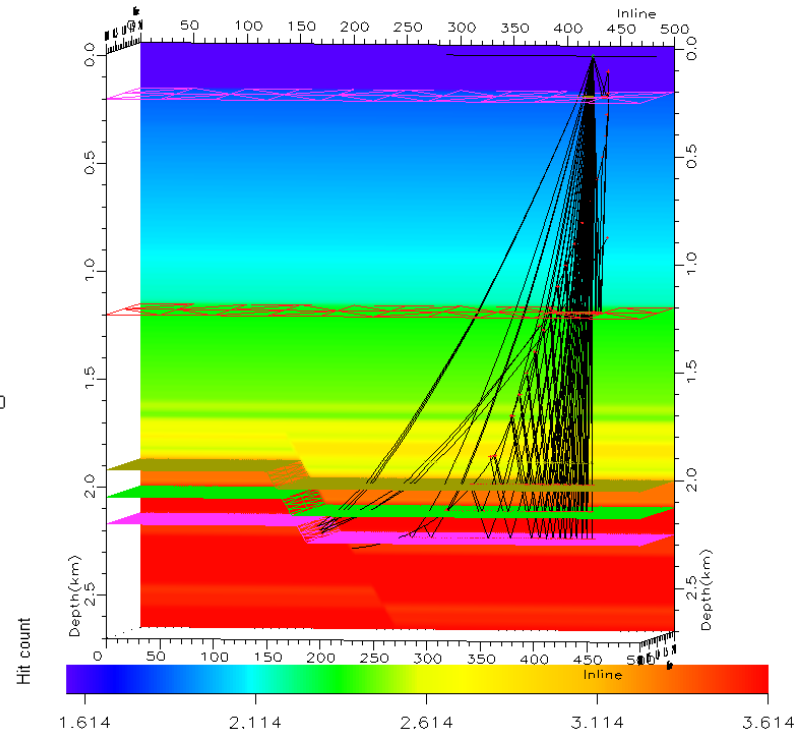


# Illumination maps & ray paths

Hit Map for VSP

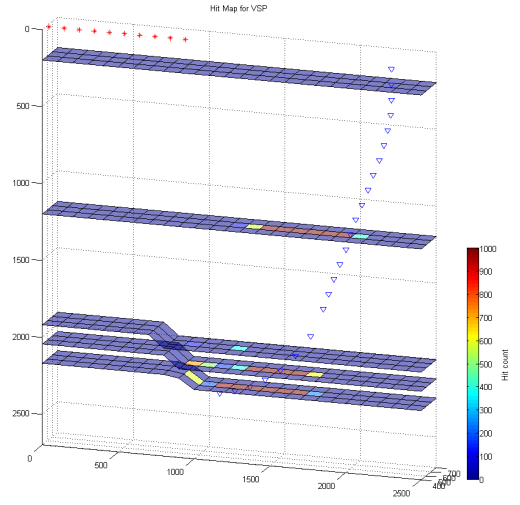


Multi-offset VSP No.2

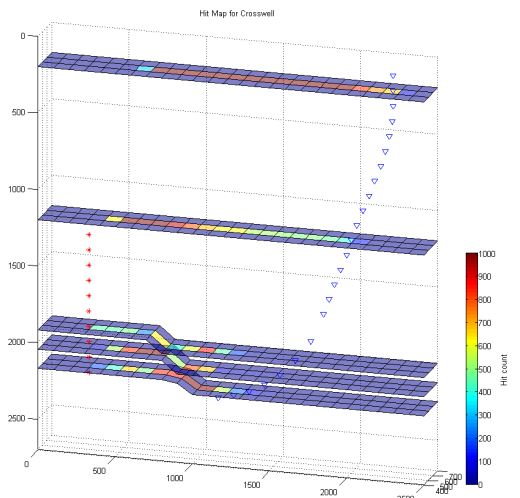


# Comparison

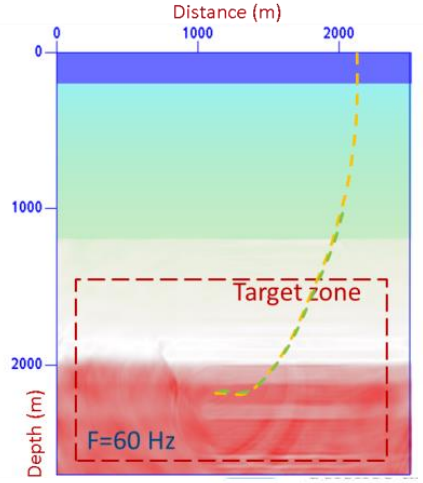
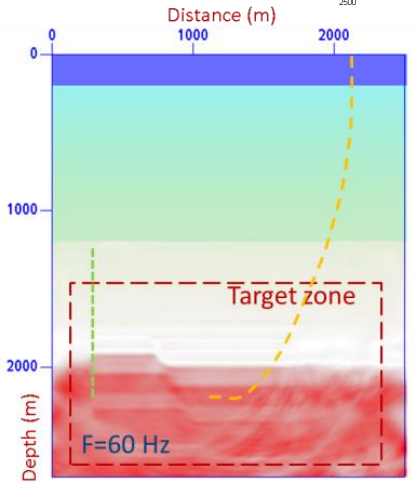
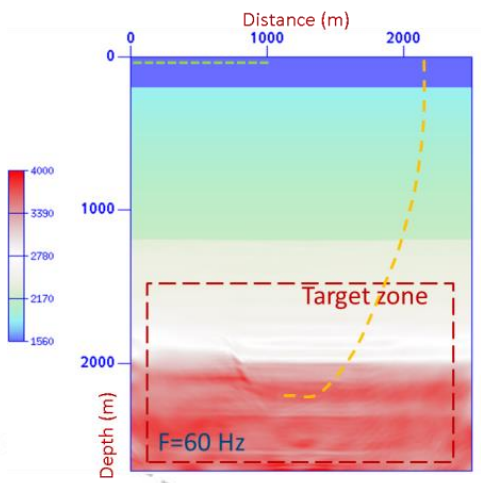
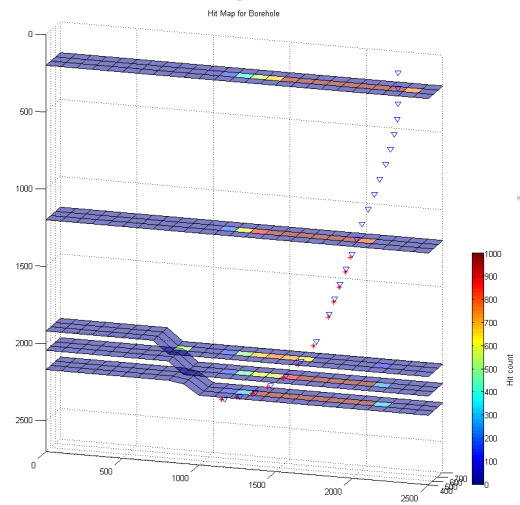
## Multi-offset VSP



## Cross-well VSP

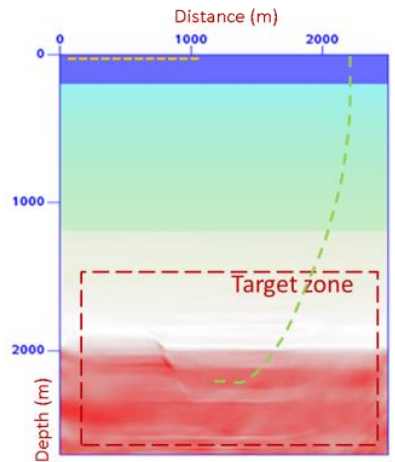
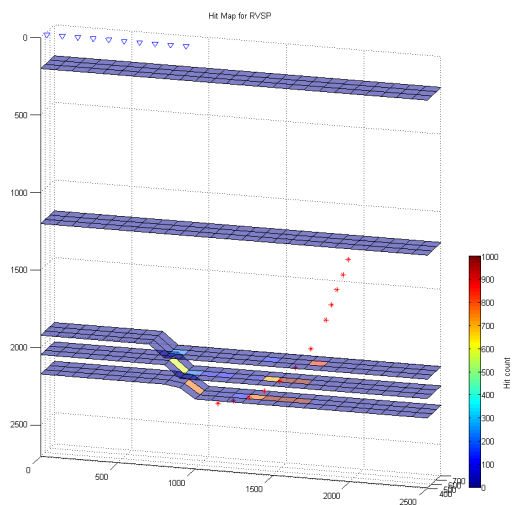


## In-wellbore VSP

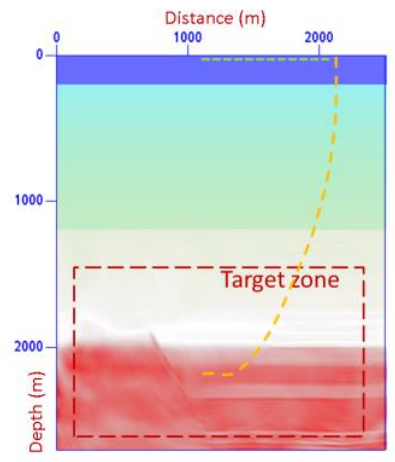
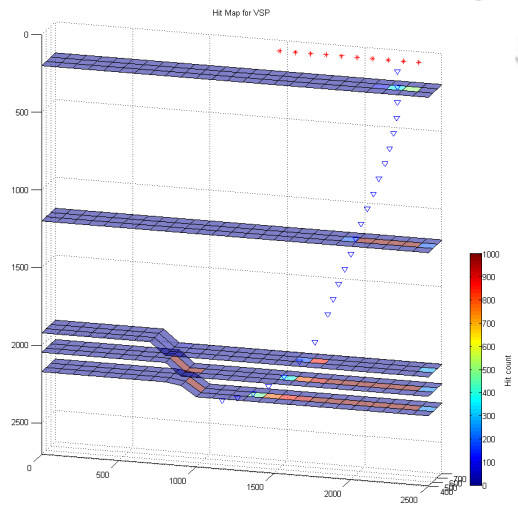


# Comparison

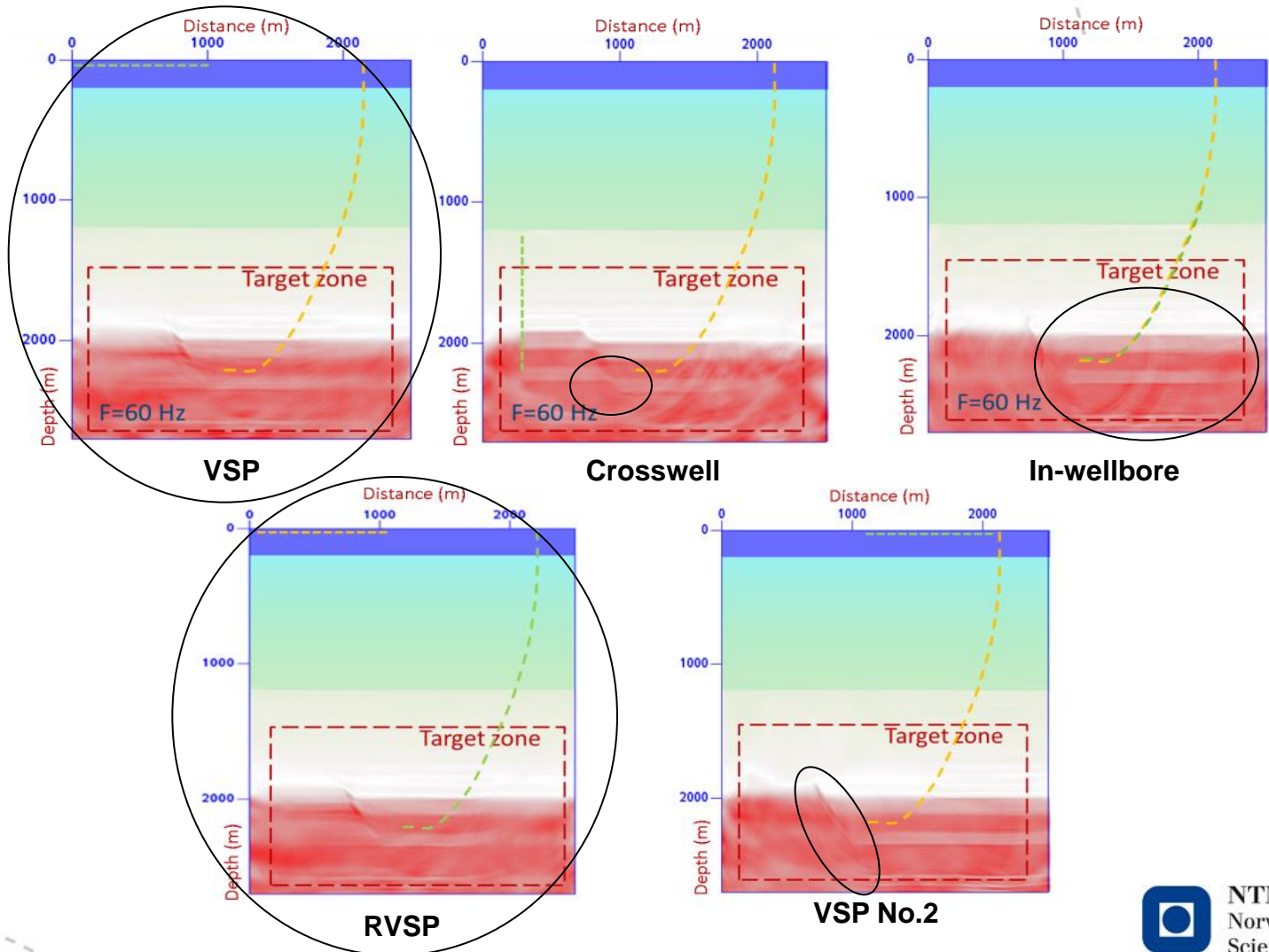
RVSP



Multi-offset VSP No.2



# Comparison





# Conclusion

- The overall incomplete model update from FWI can be attributed to the illumination deficiency resulting from individual acquisition geometry.
- A suitable acquisition geometry for the target area is important in order to obtain a good model update from FWI.
- For this typical fault model, a cross-well geometry gives the best resolution locally around the fault.



# Acknowledgement

- Deep Imaging and Geo-steering project of the Centre for Drilling and Wells for Improved Recovery (SBBU)
- Statoil (operator of the Norne field) and its license partners ENI and Petoro for the release of the Norne-field data
- ROSE consortium



# References

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- Gjøystdal, H, Iversen, E., Laurain, R., Lecomte, I., Vinje, V. and Åstebøl, K. [2002] Review of ray theory applications in modeling and imaging of seismic data. *Stud. Geophys. Geod.*, **46**, 133-164.
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