SUSTech Southern University of Science and Technology

南方科技大学 SOUTHERN UNIVERSITY OF SCIENCE AND TECHNOLOGY

地球与空间科学系 DEPARTMENT OF EARTH AND SPACE SCIENCES

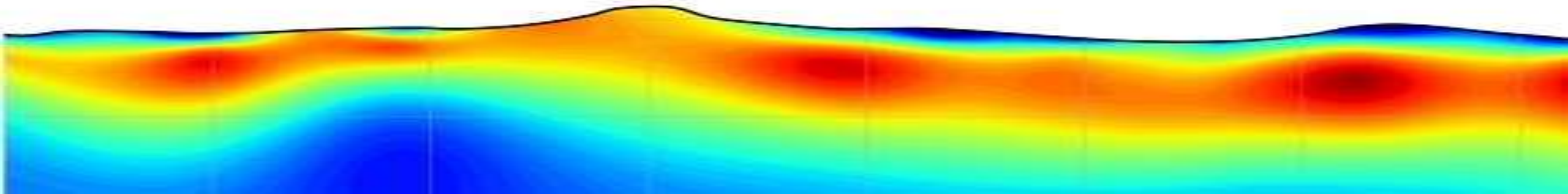
ESS302 Applied Geophysics II

Gravity, Magnetic, Electrical, Electromagnetic and Well Logging

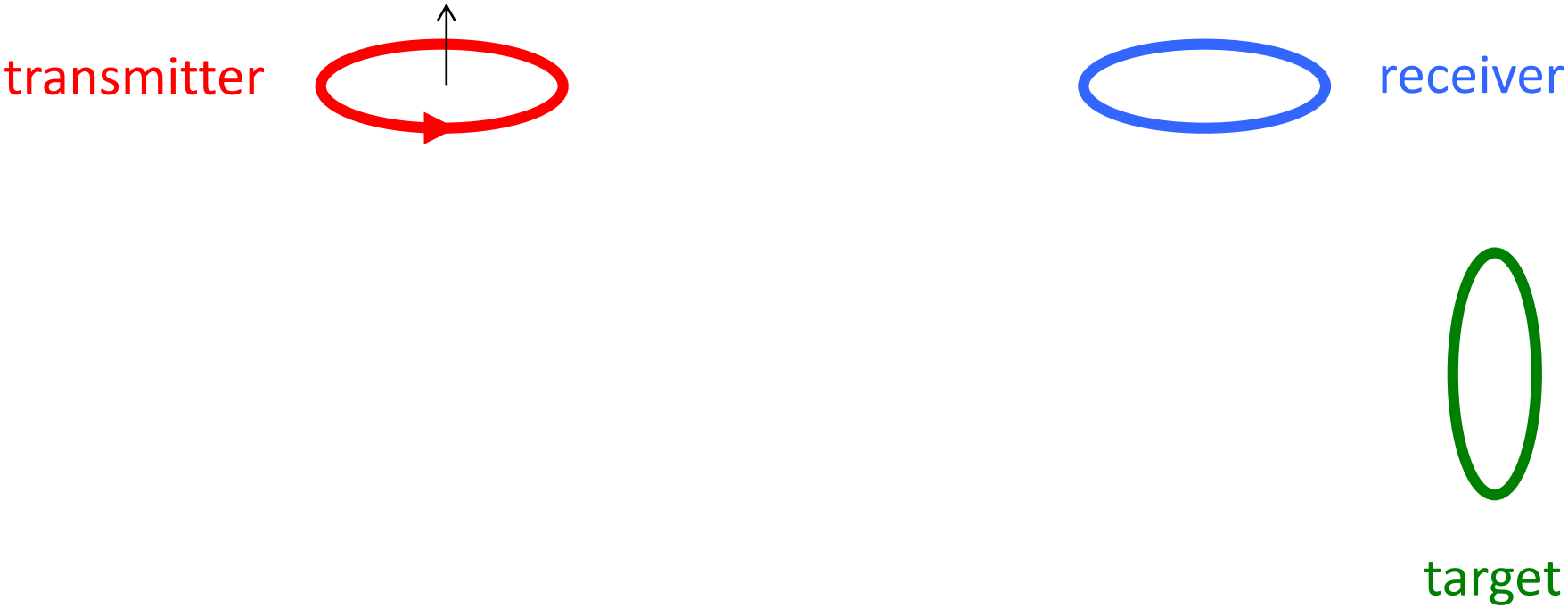
Well Logging (Borehole Geophysics)

Instructor: Dikun Yang

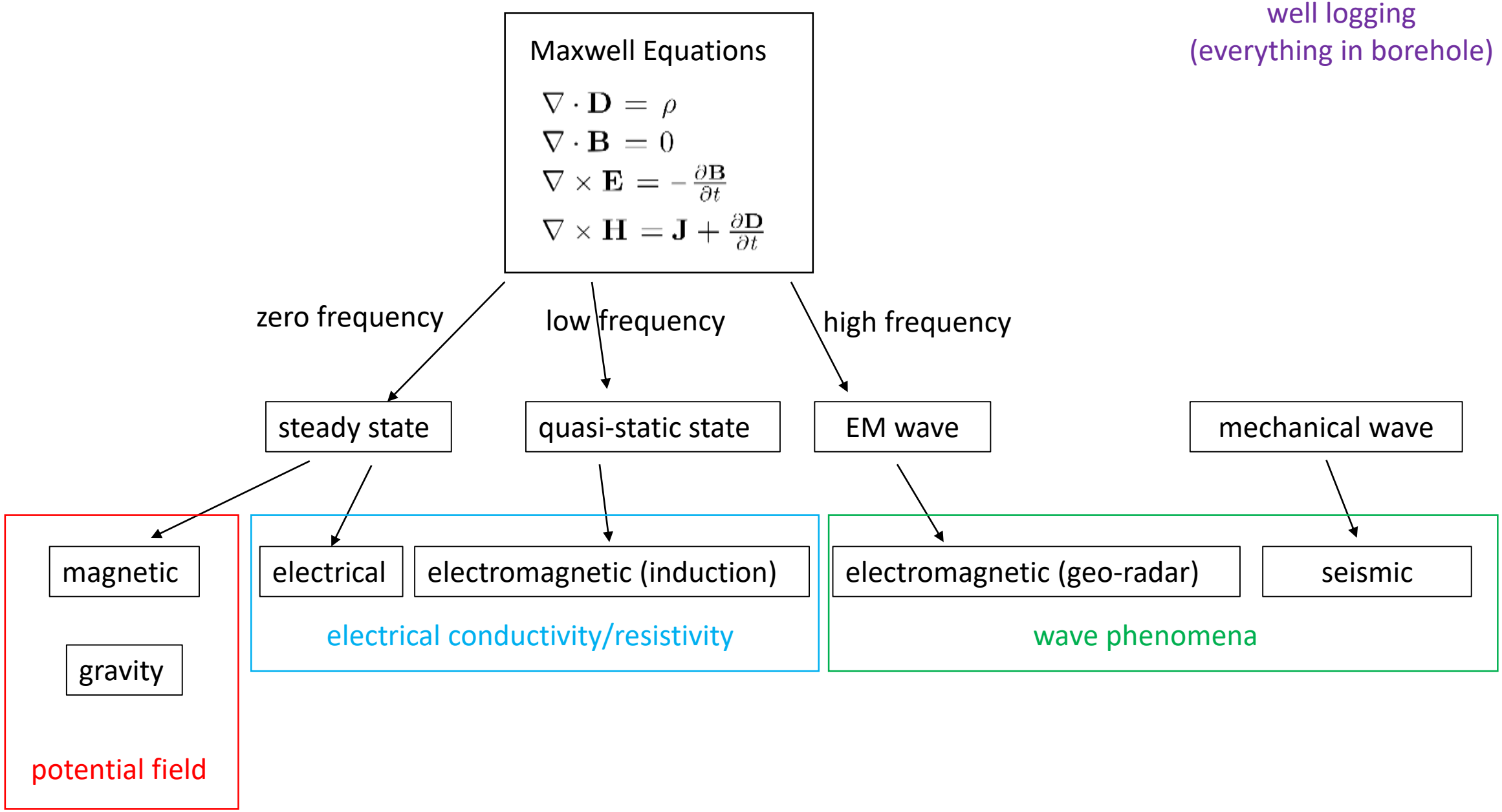
Feb – May, 2019



Quiz: Draw the Magnetic Field Lines and Determine the Sign of Data

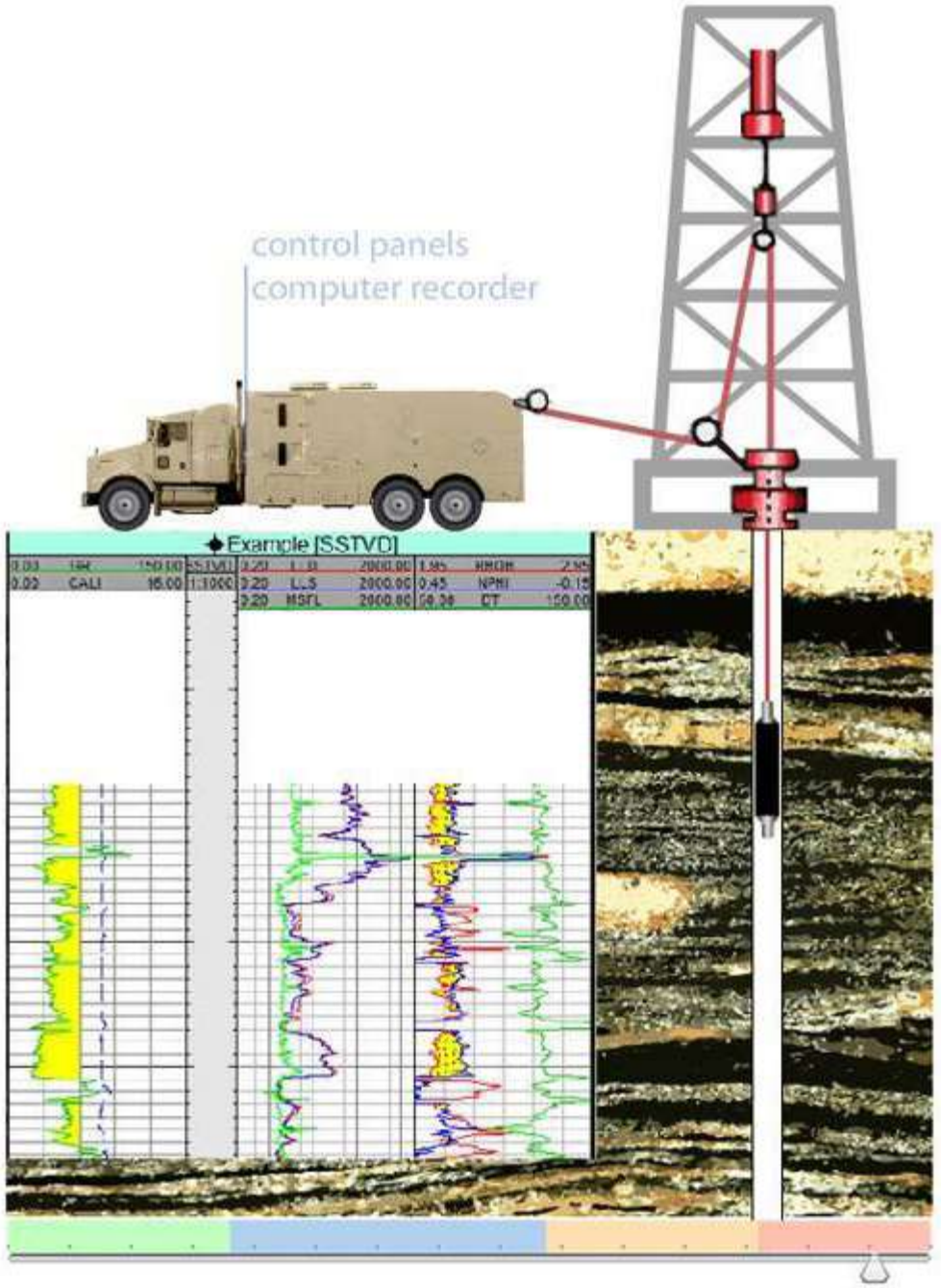


well logging
(everything in borehole)



Well Logging

Sonde



Electrical logging
- Normal log
- Lateral log
- Microlog
- Induction log

Acoustic logging

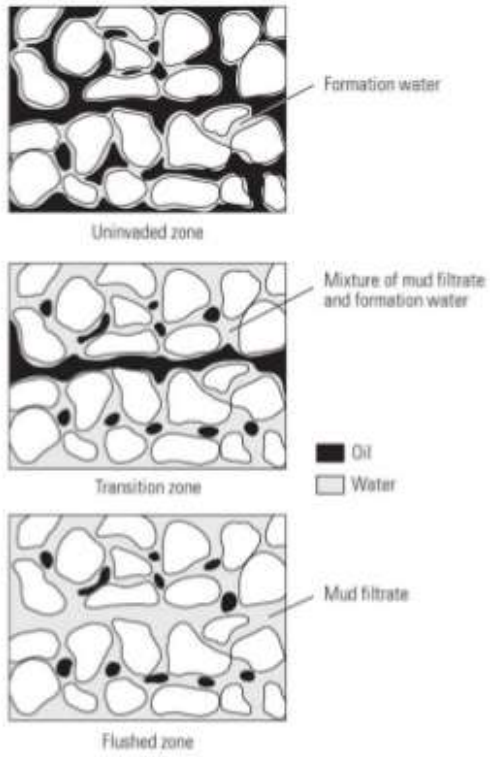
Radiometric logging
- Gamma ray
- Gamma gamma
- Neutron gamma

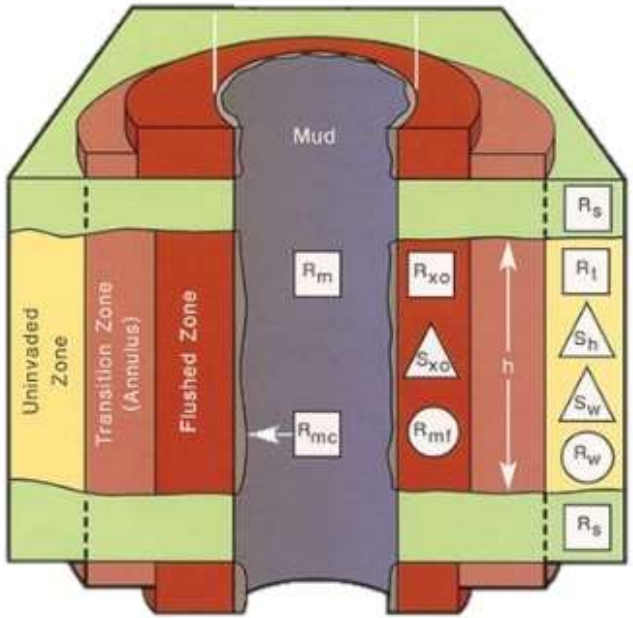
Fluid Distribution Around a Well

Uninvaded:
Oil > Water

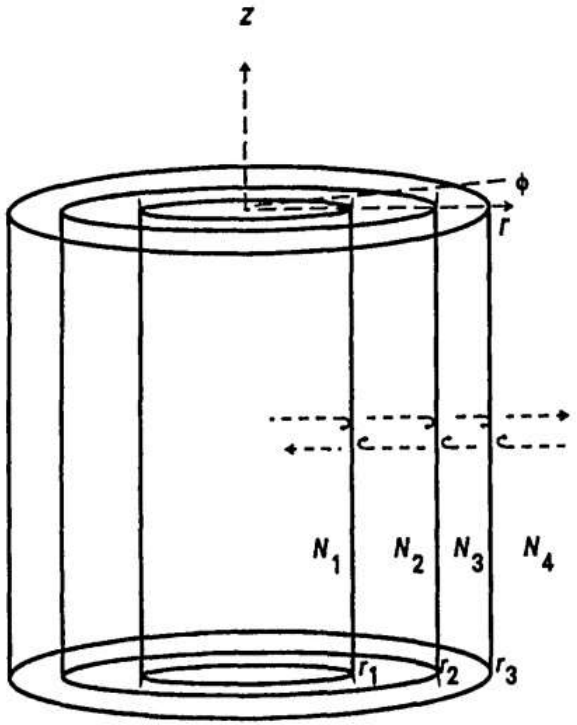
Transition:
Oil ≈ Water

Flushed:
Oil < Water

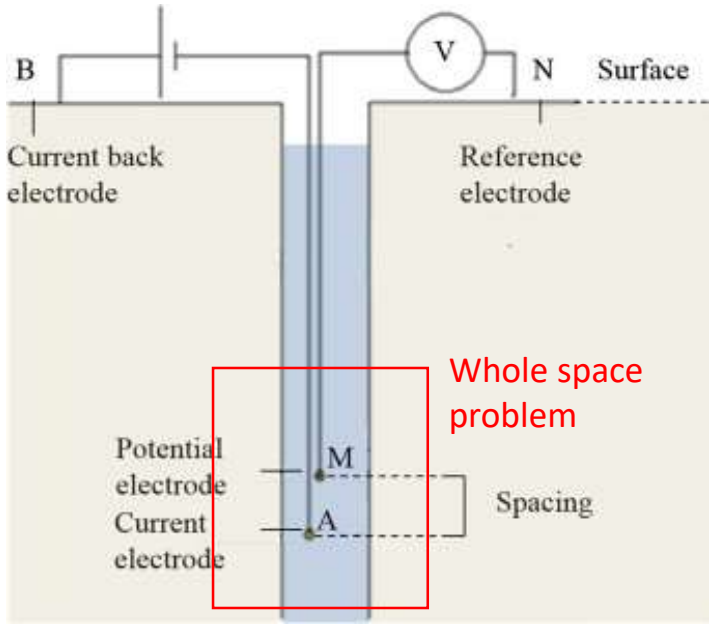


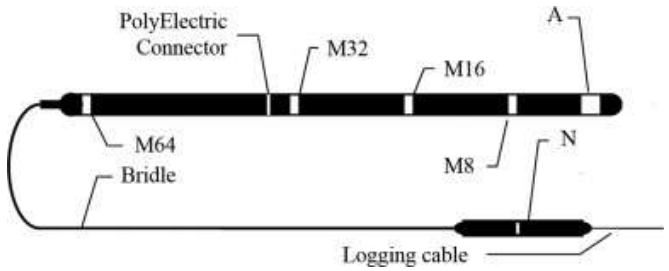


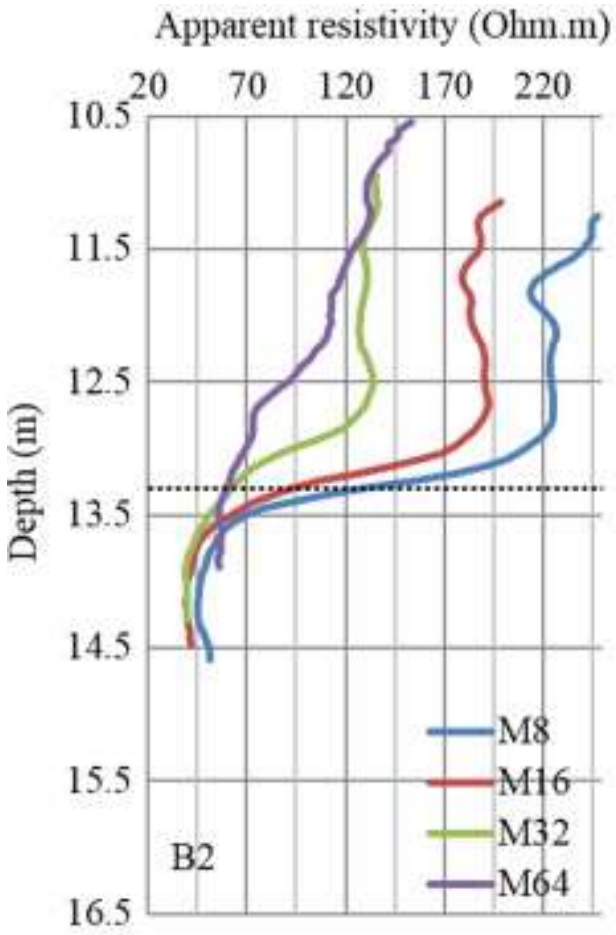
Cylindrically 1D

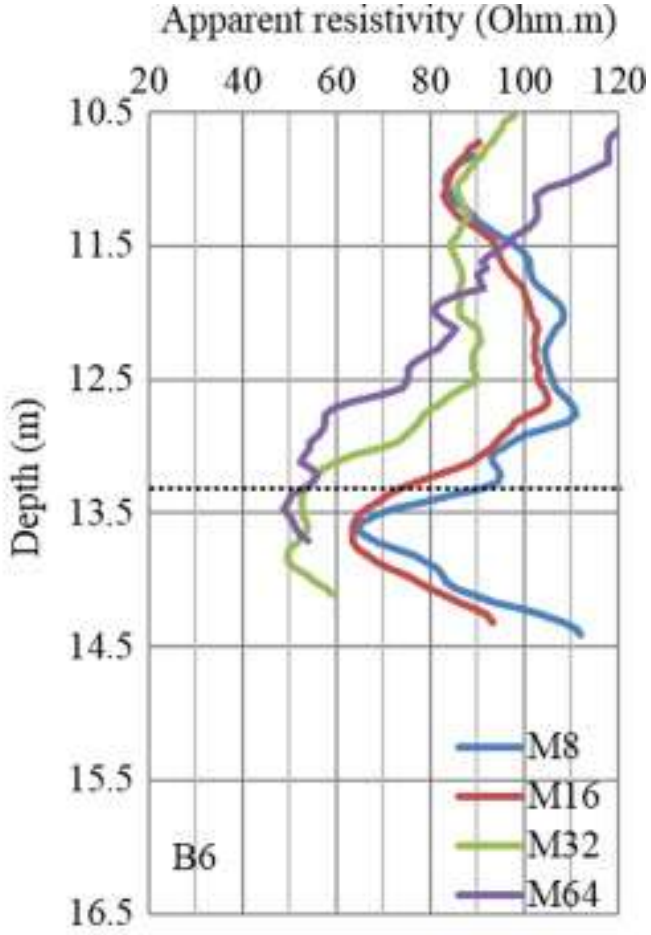


Normal Log



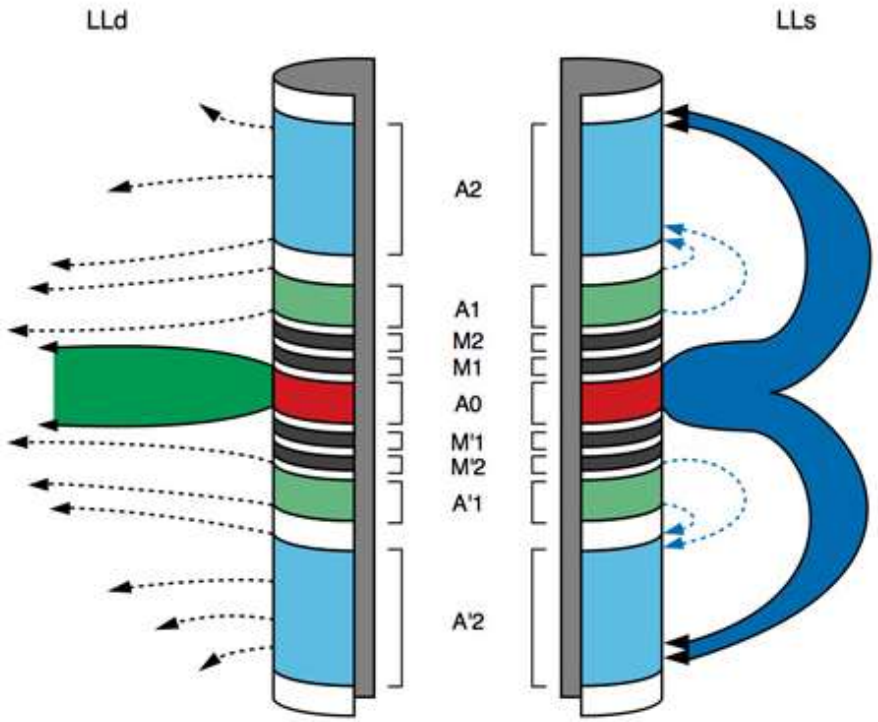




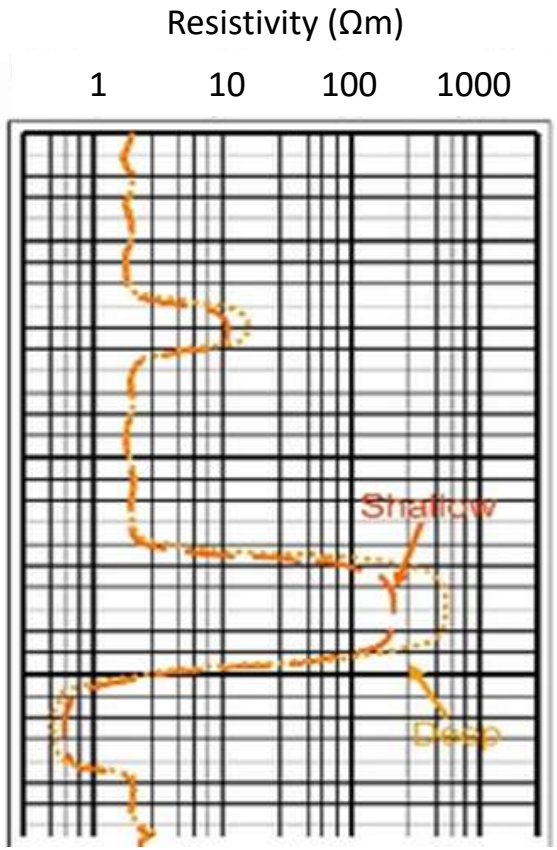


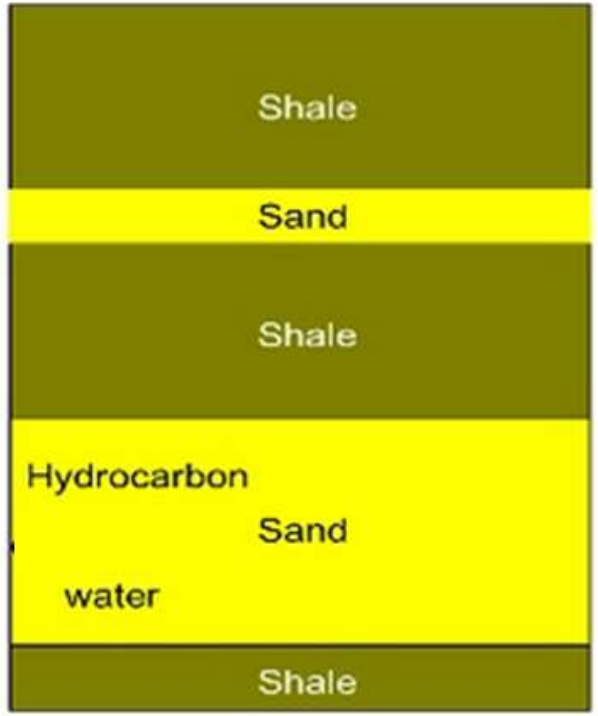
Taillet et al. 2014 (https://www.sciencedirect.com/science/article/pii/S096386951400005X)

Lateral Log

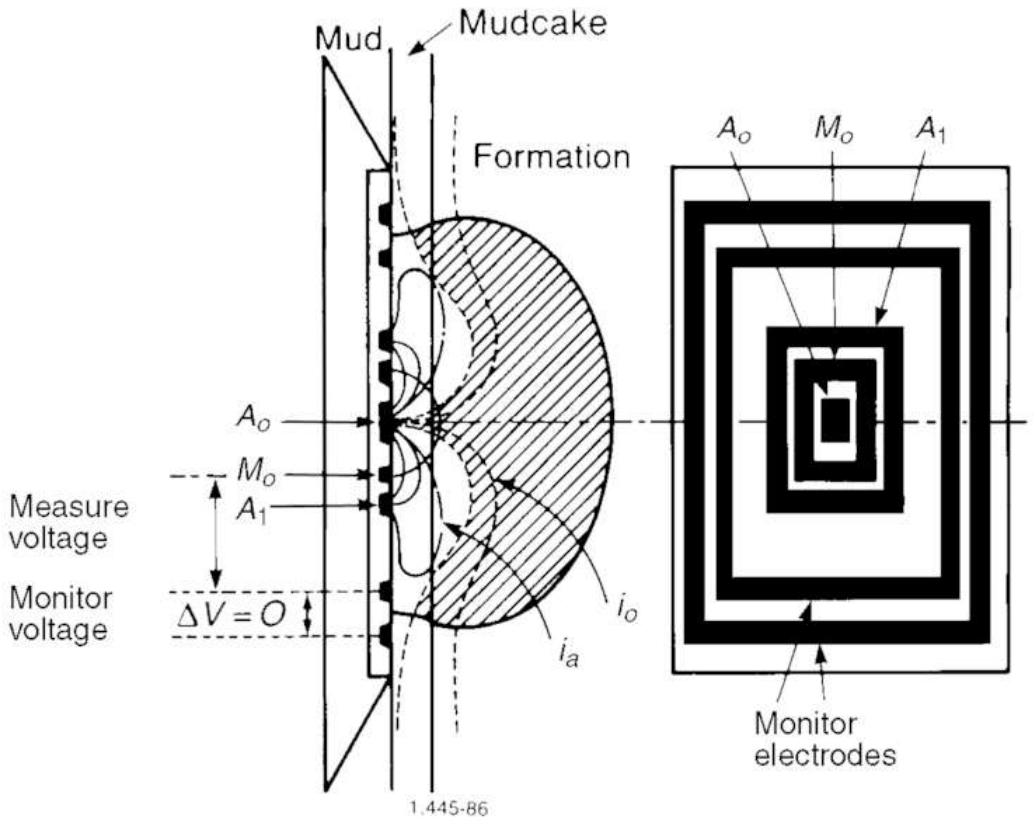


Dual Laterolog sonde electrode distribution and current path shape.

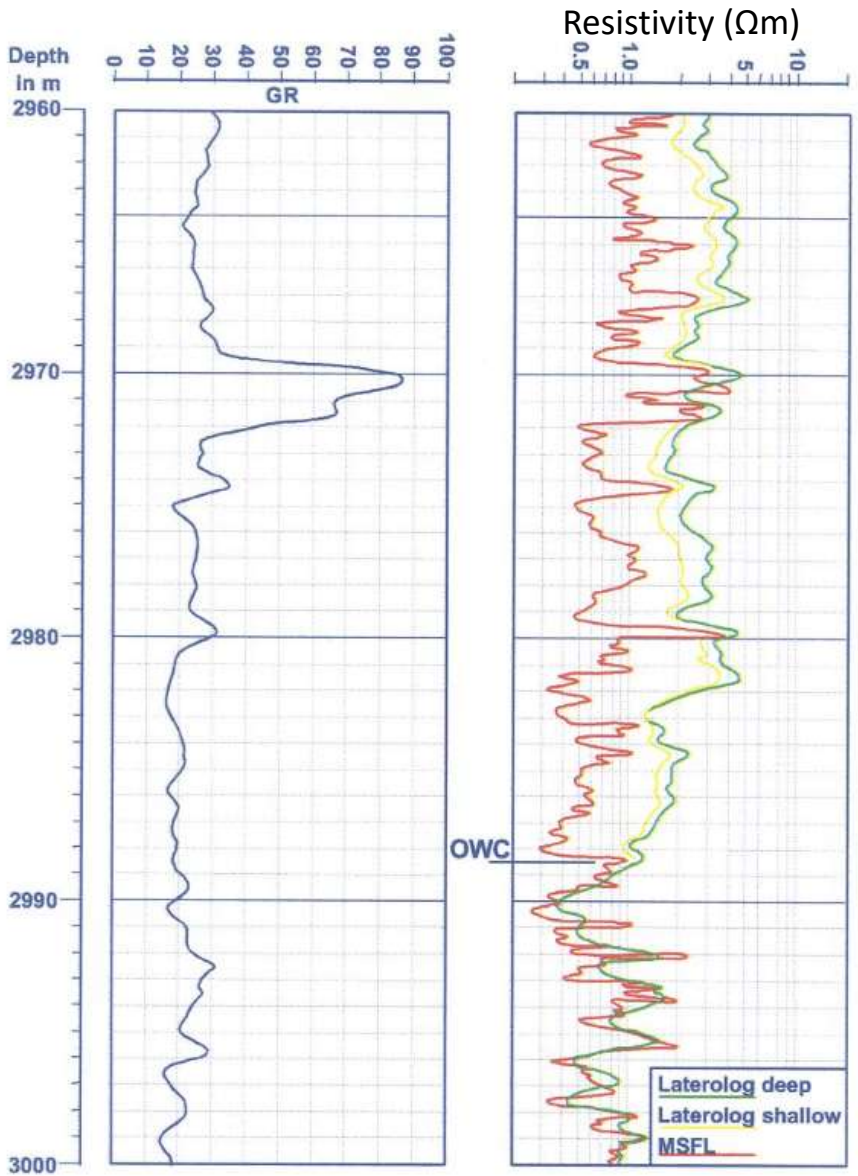




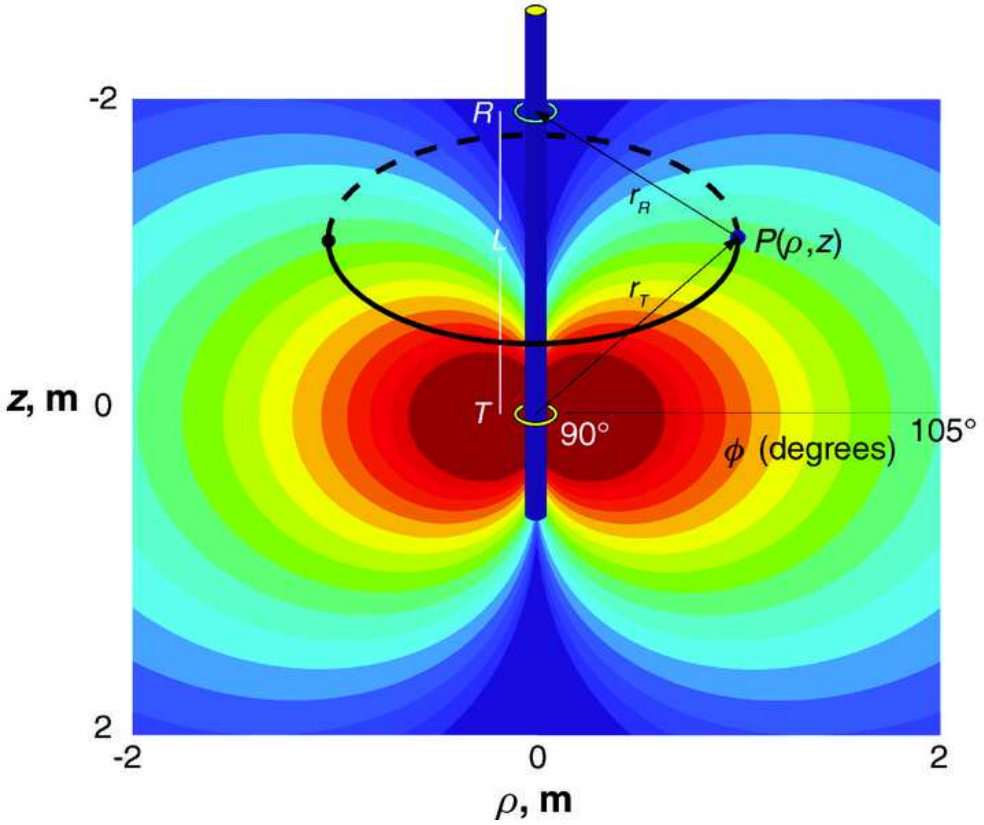
Microlog

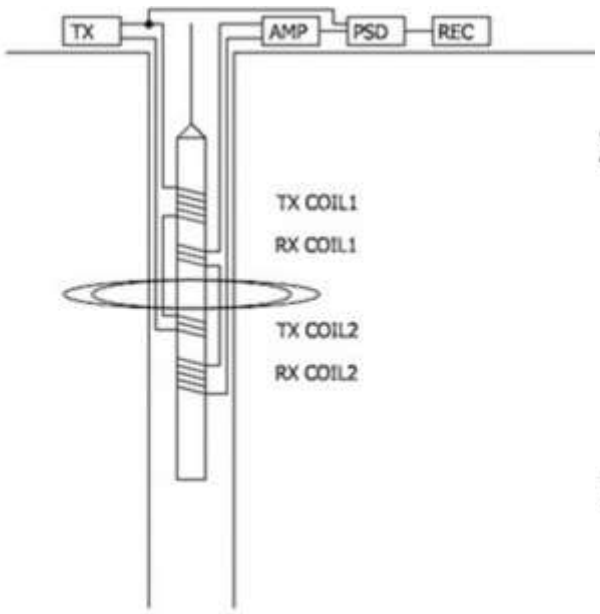


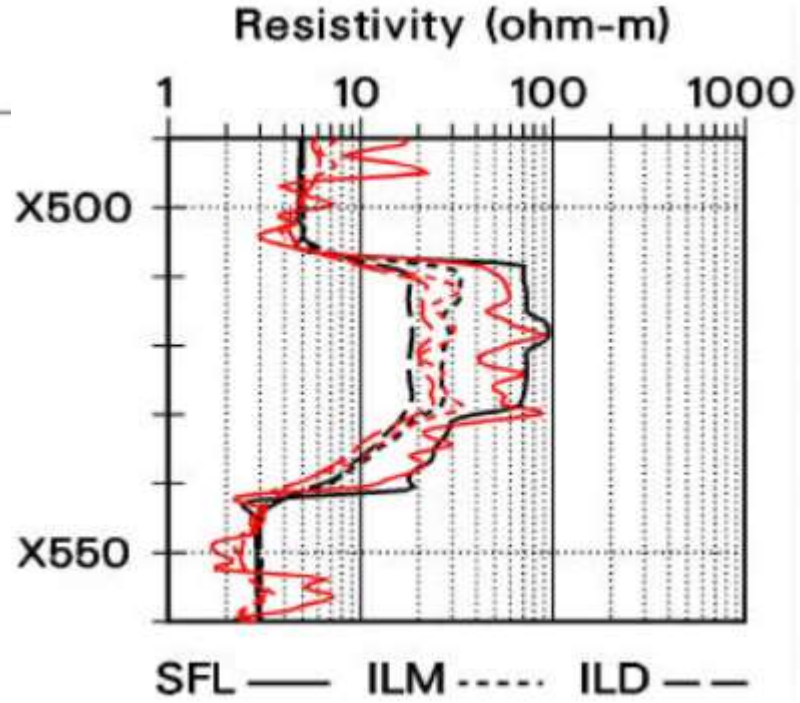
Micro-spherically Focused Log (MSFL)
(Firmly pressed against the wallrock)



Induction Log

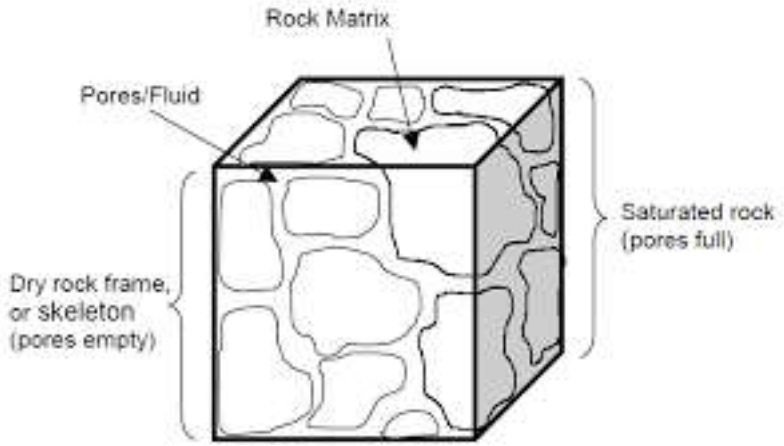






Archie's Law

Relates the in-situ electrical conductivity of a sedimentary rock to its porosity and water saturation



tortuosity factor

cementation exponent

saturation exponent

$$R_t = a\phi^{-m} S_w^{-n} R_w$$

fluid saturated rock resistivity

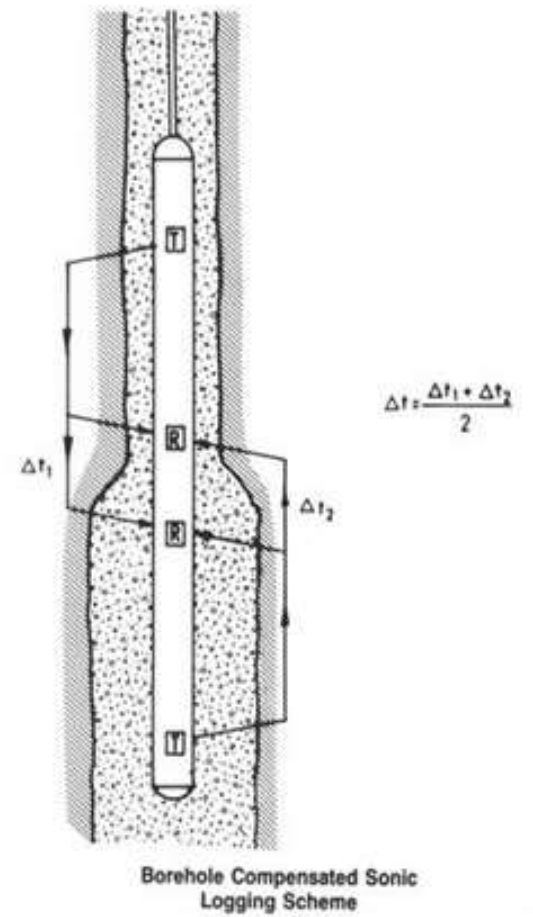
porosity

water saturation

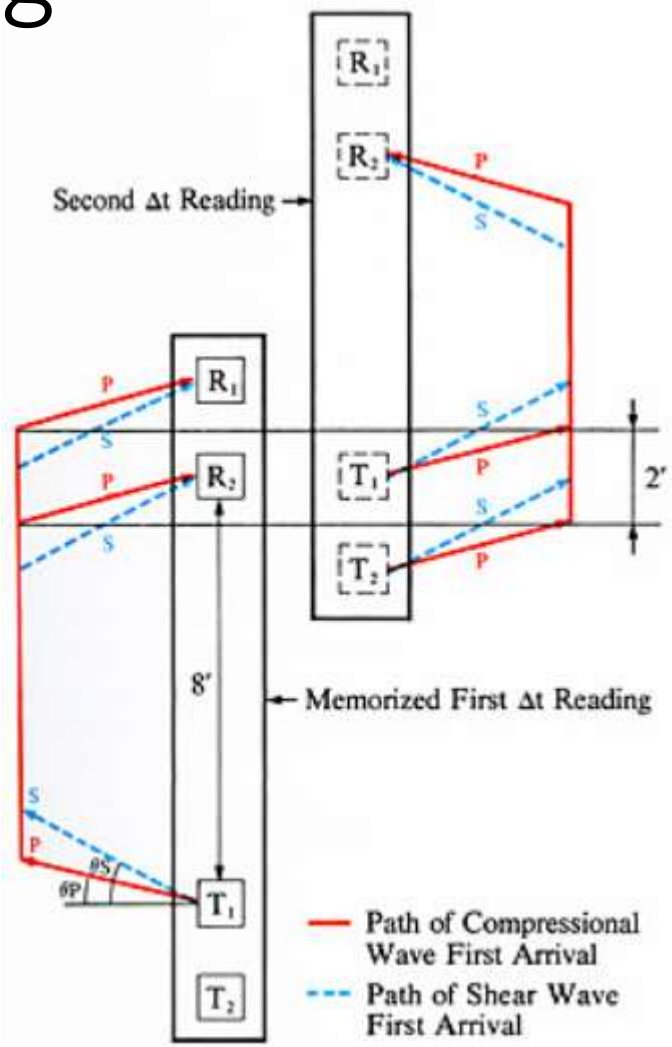
water conductivity

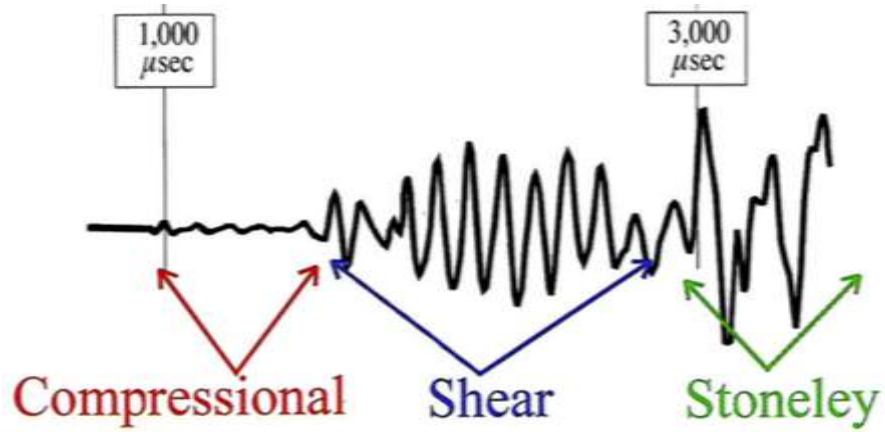
Electrical well log interpretation: Borehole electrical conductivity → hydrocarbon saturations

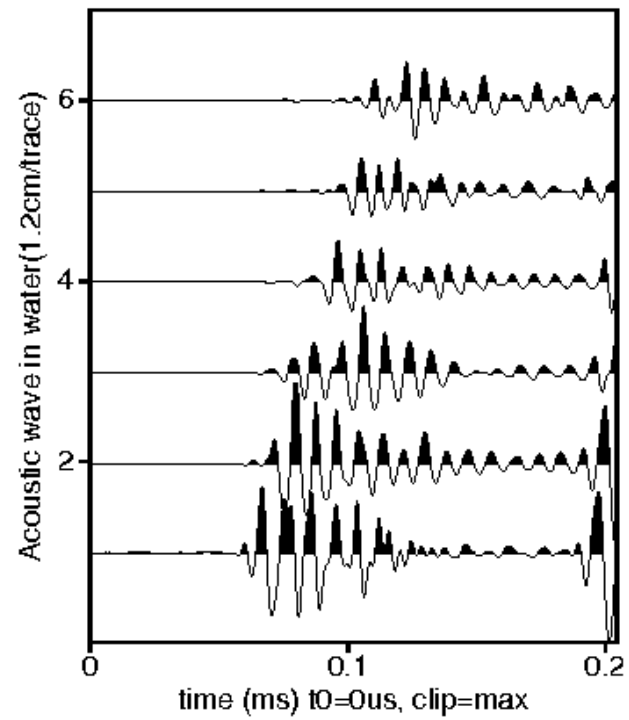
Acoustic Log



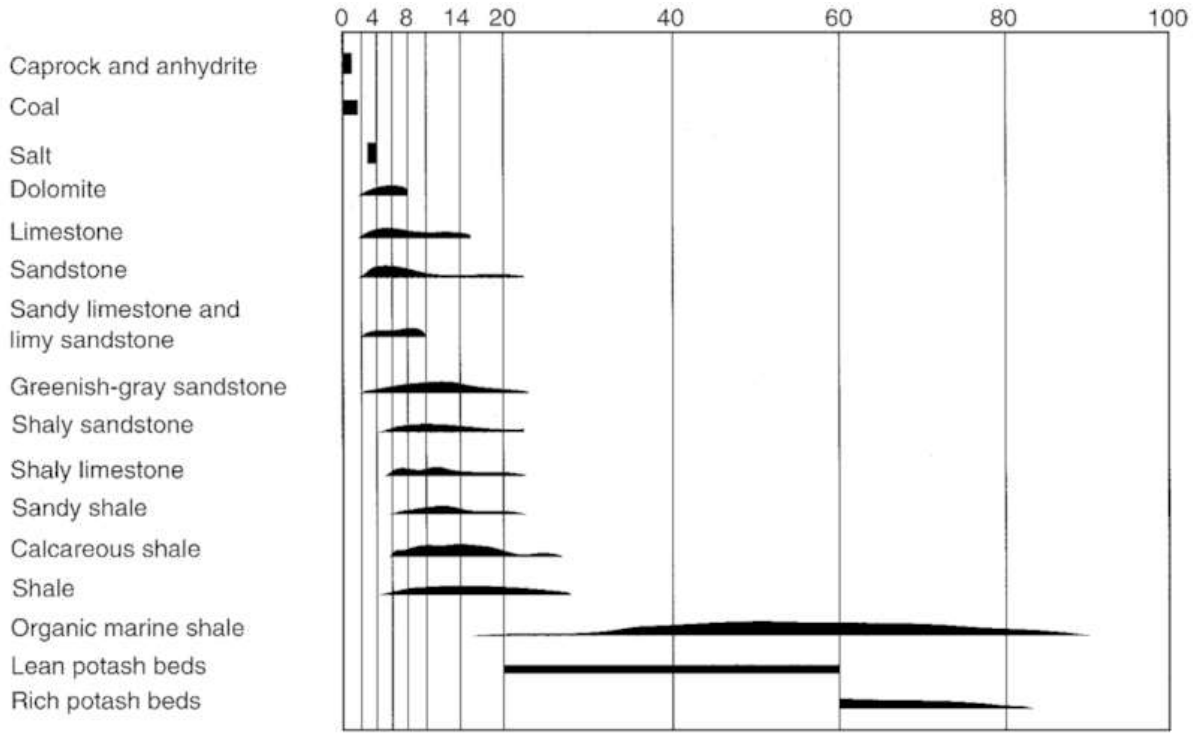
Borehole Compensated Sonic Logging Scheme



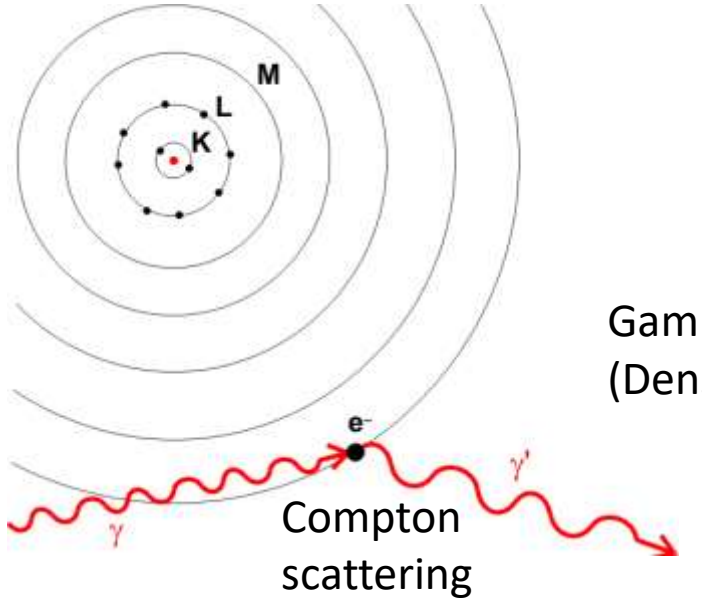




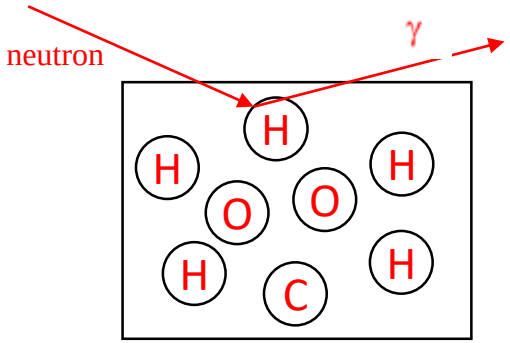
Radiometric Log



Natural gamma
(Lithology)

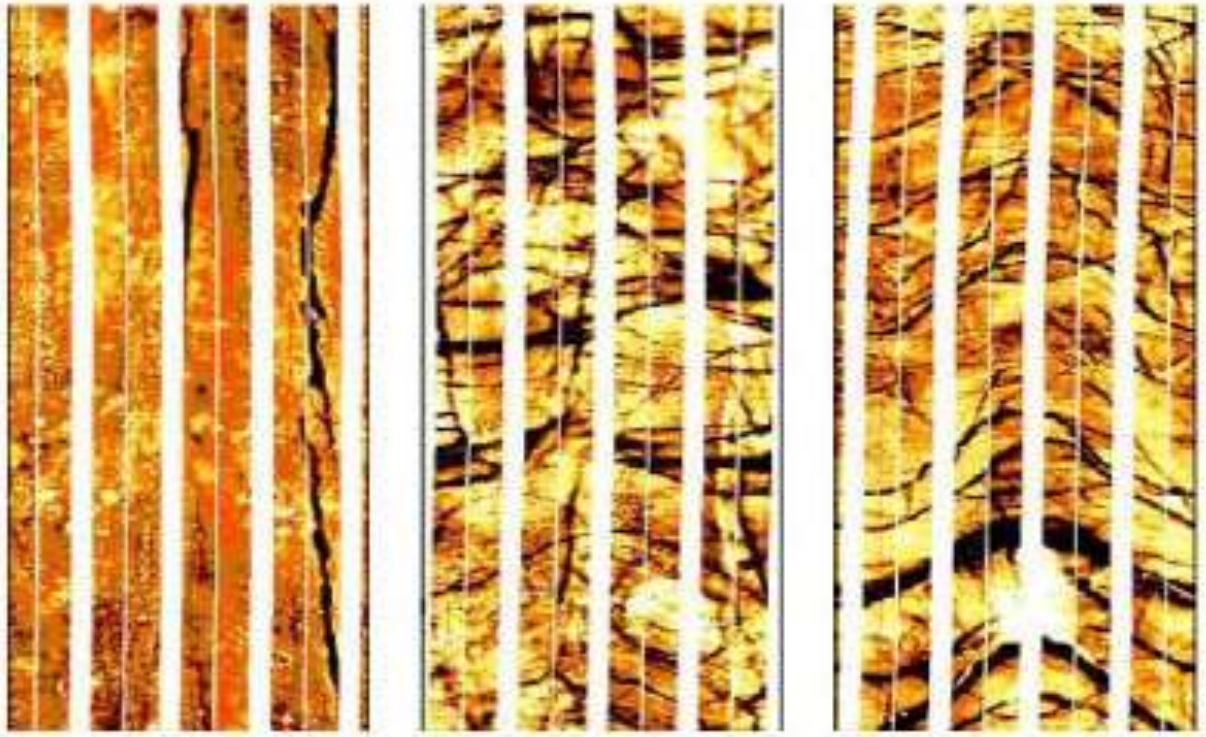


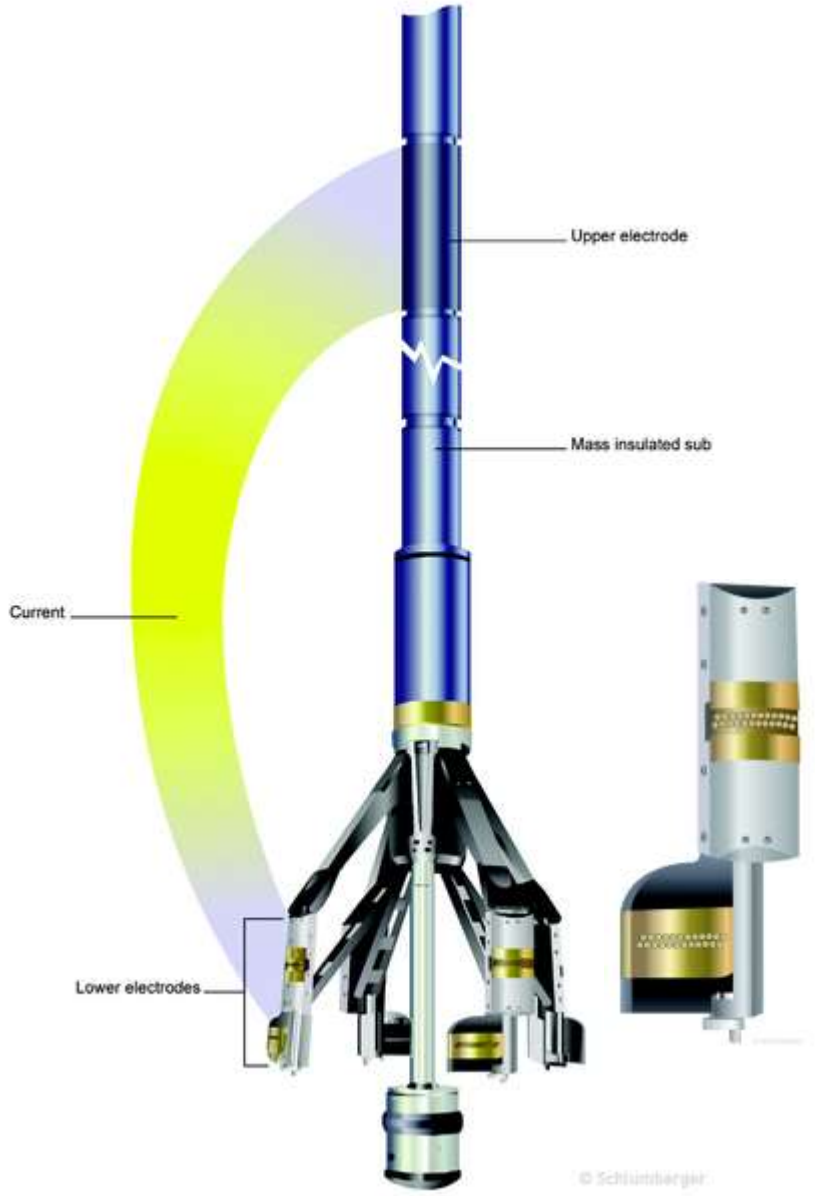
Gamma-Gamma
(Density)



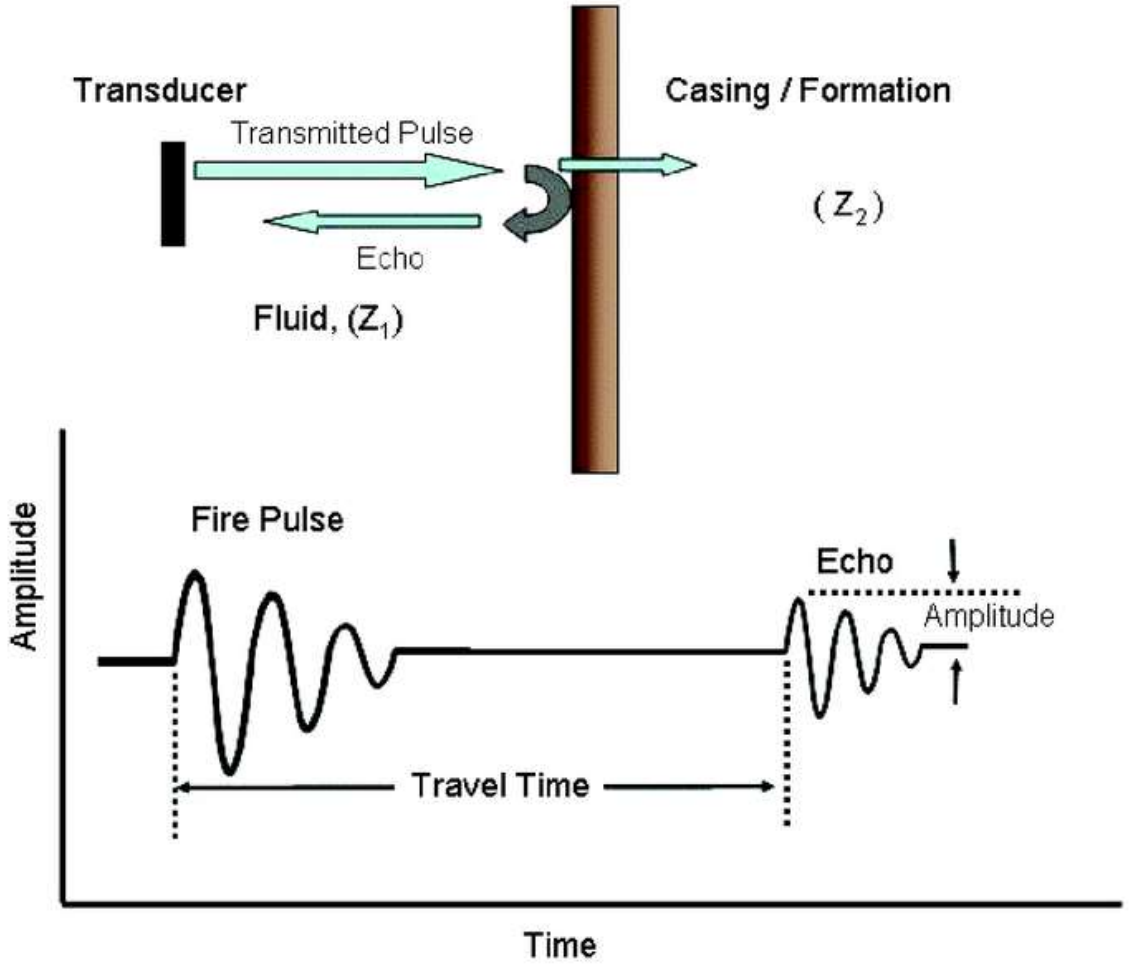
Neutron Gamma
(Porosity)

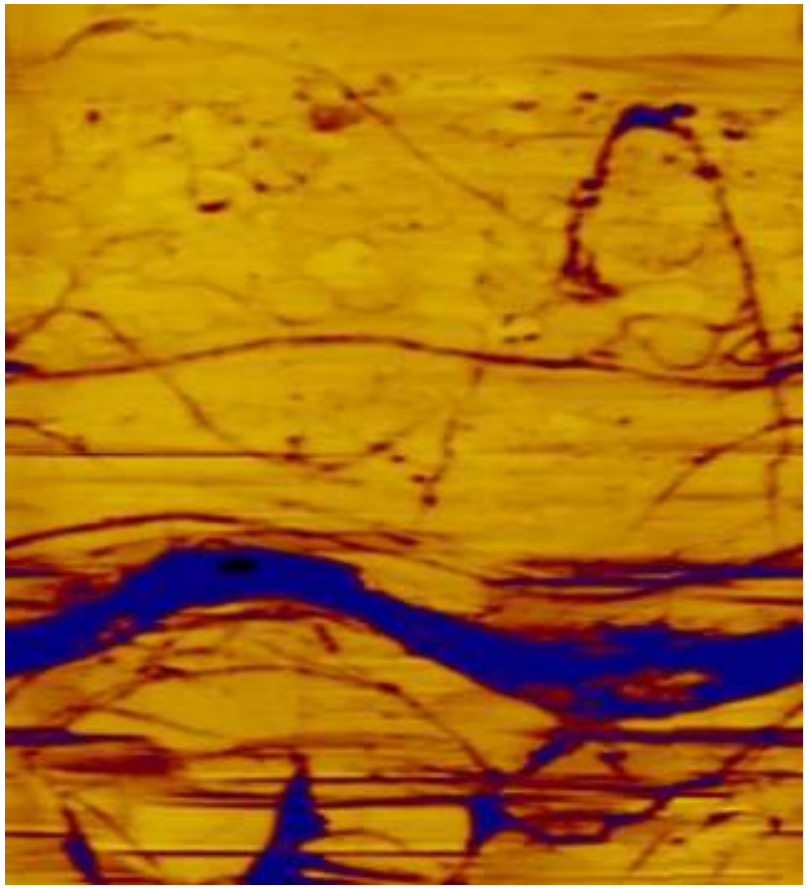
Imaging Log (Electrical)



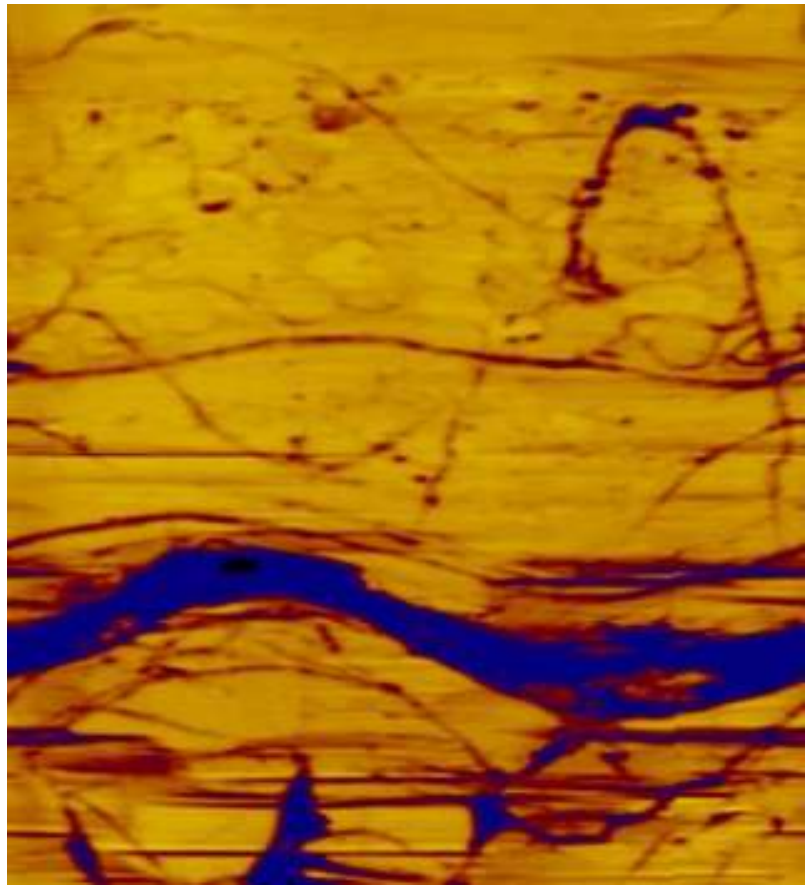


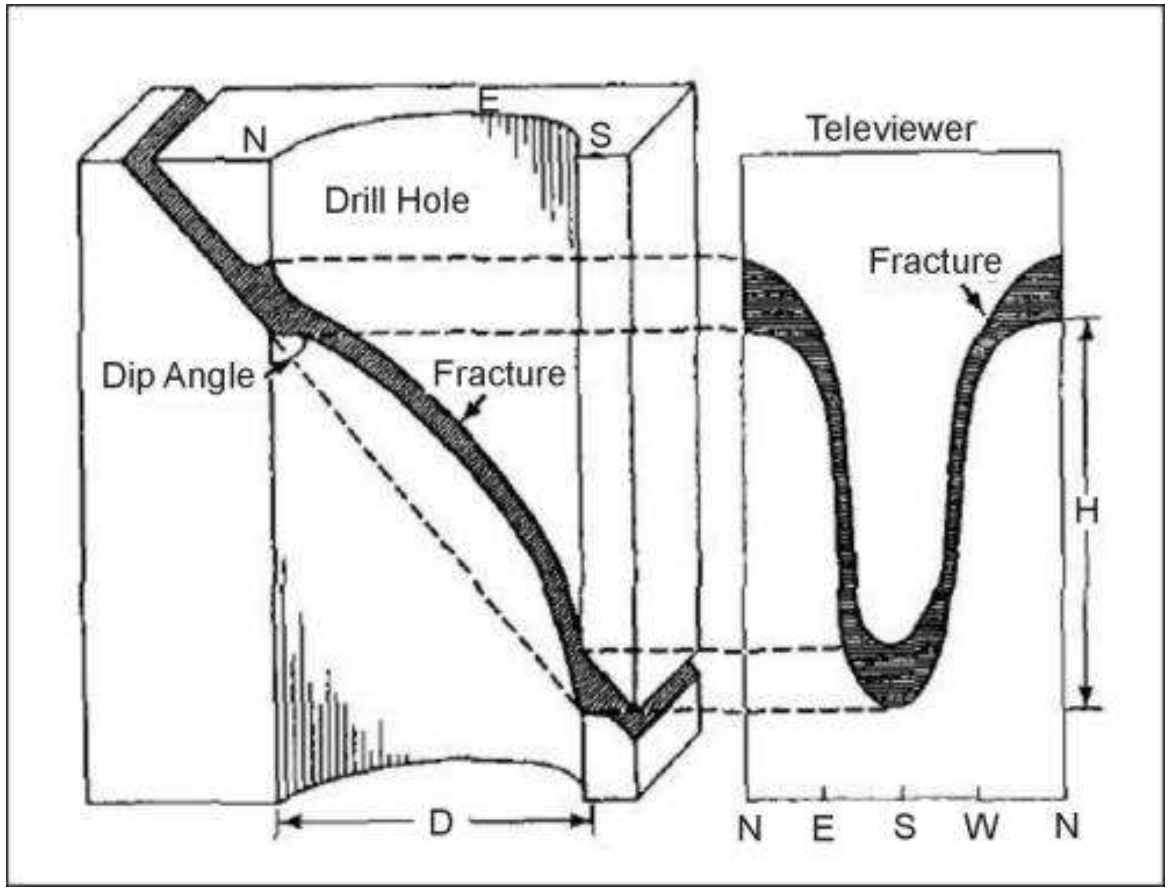
Imaging Log (Acoustic)

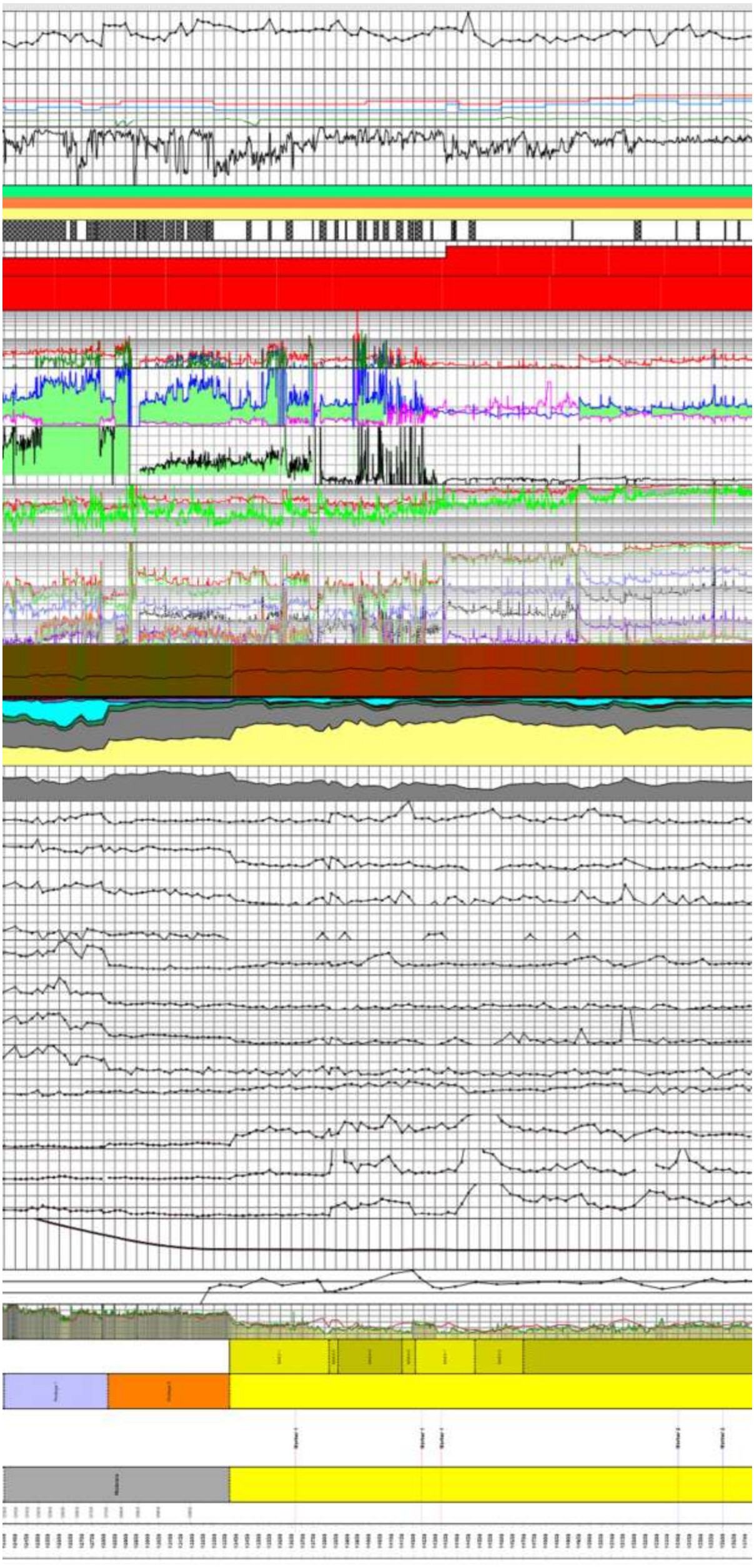




Fracture in Imaging Log

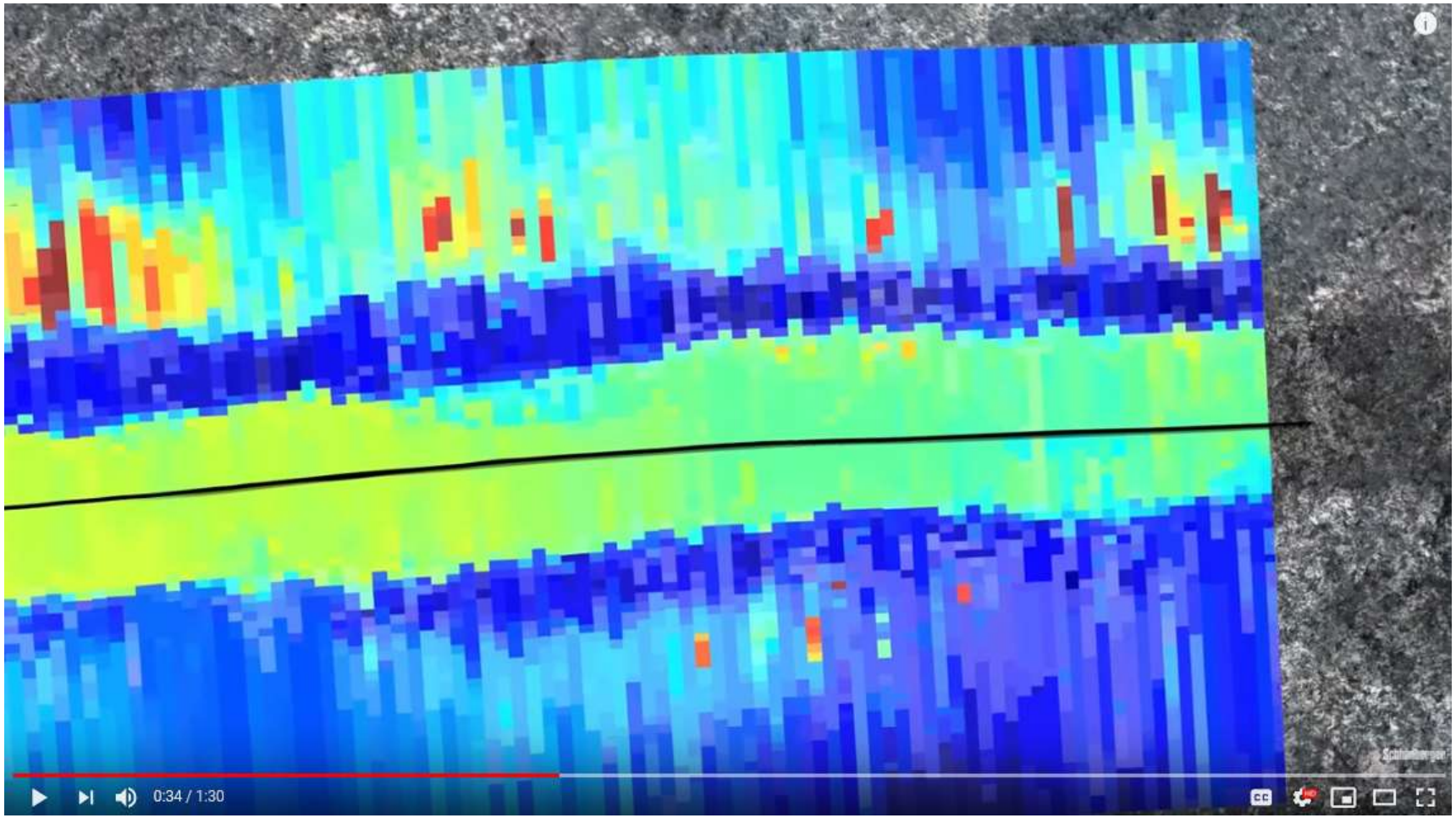






Logging While Drilling (LWD)

Logging While Drilling (LWD)

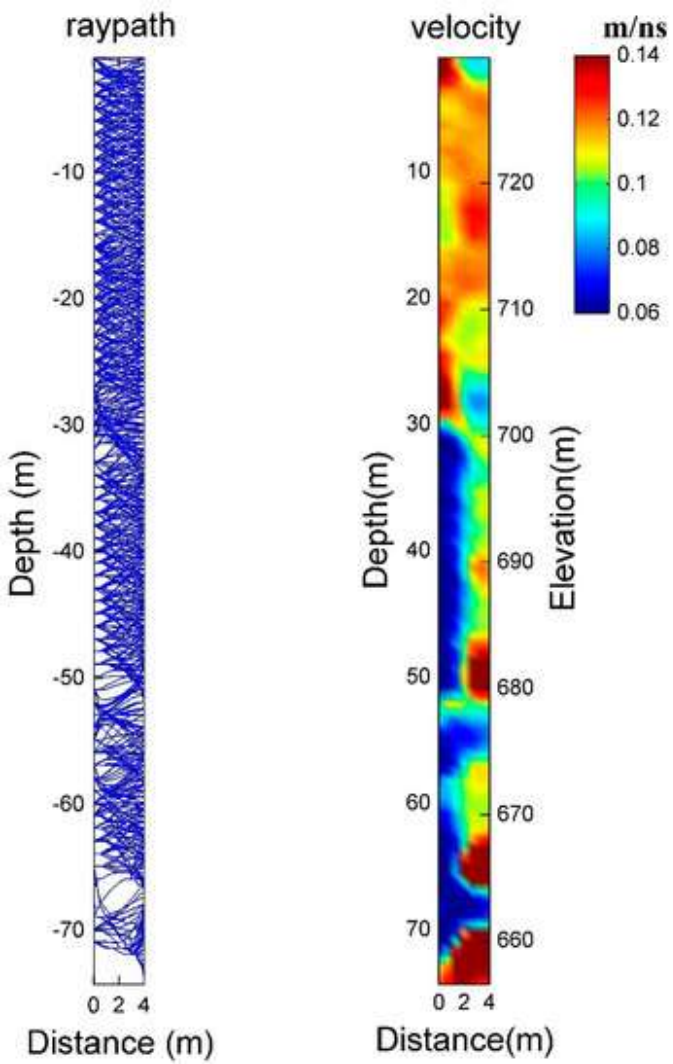


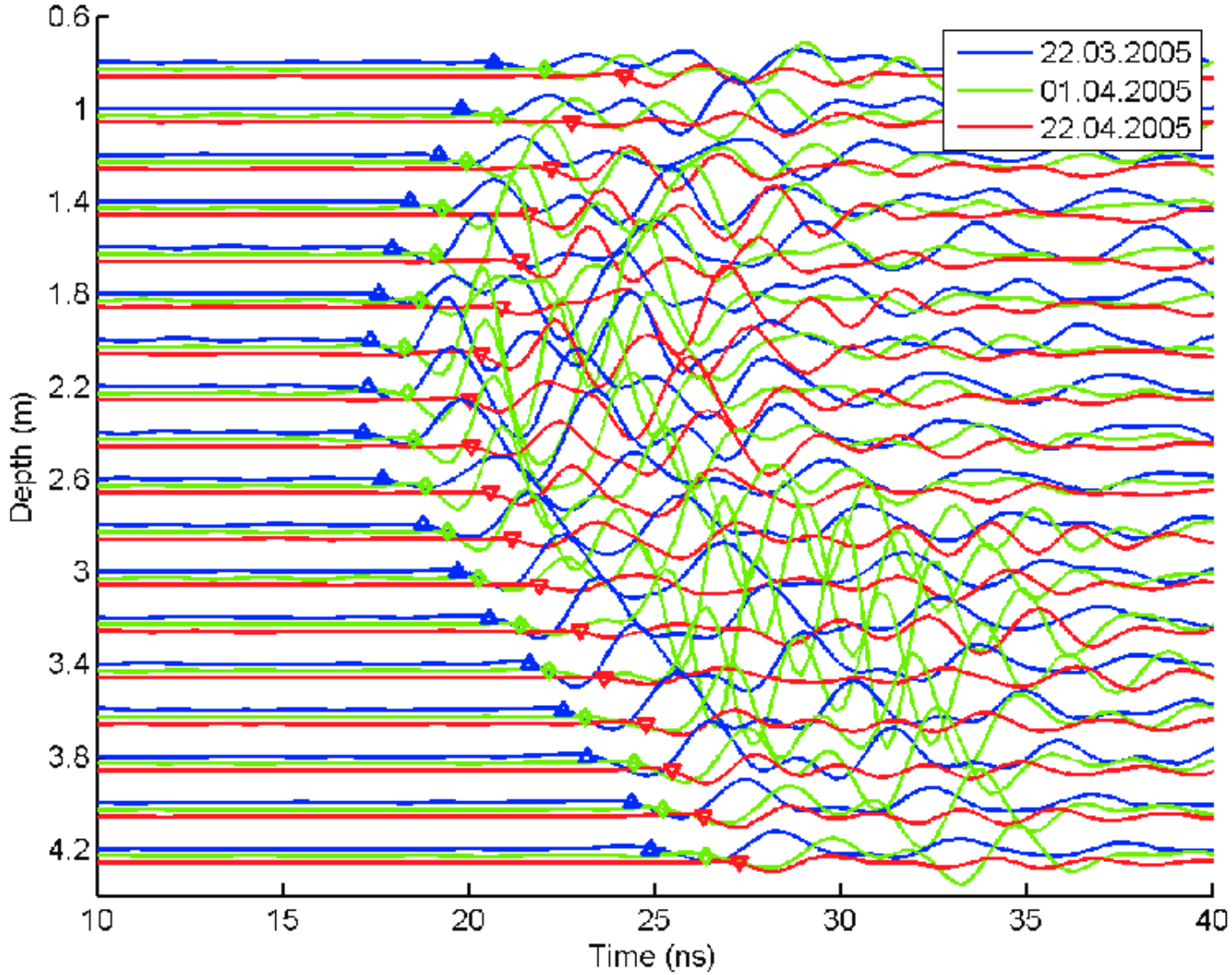
https://youtu.be/ApZGdju4CFA

Logging While Drilling (LWD)

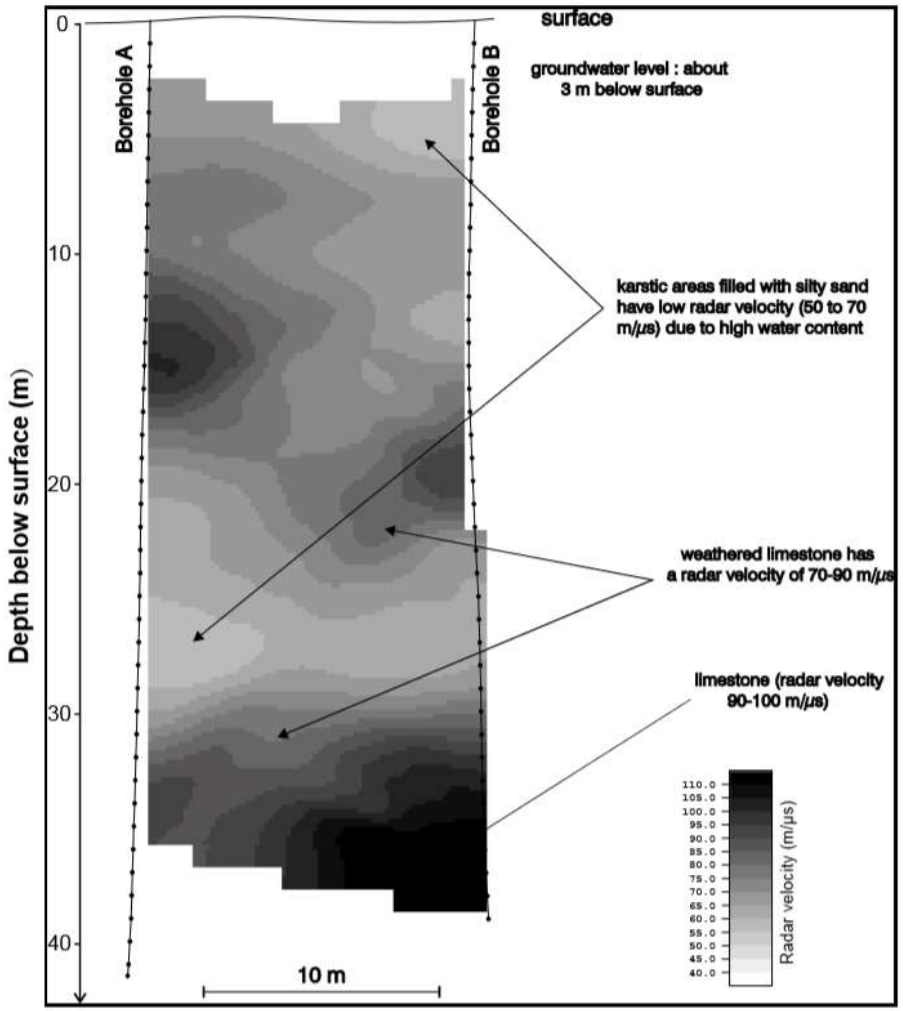
https://youtu.be/VibqM5uykQM

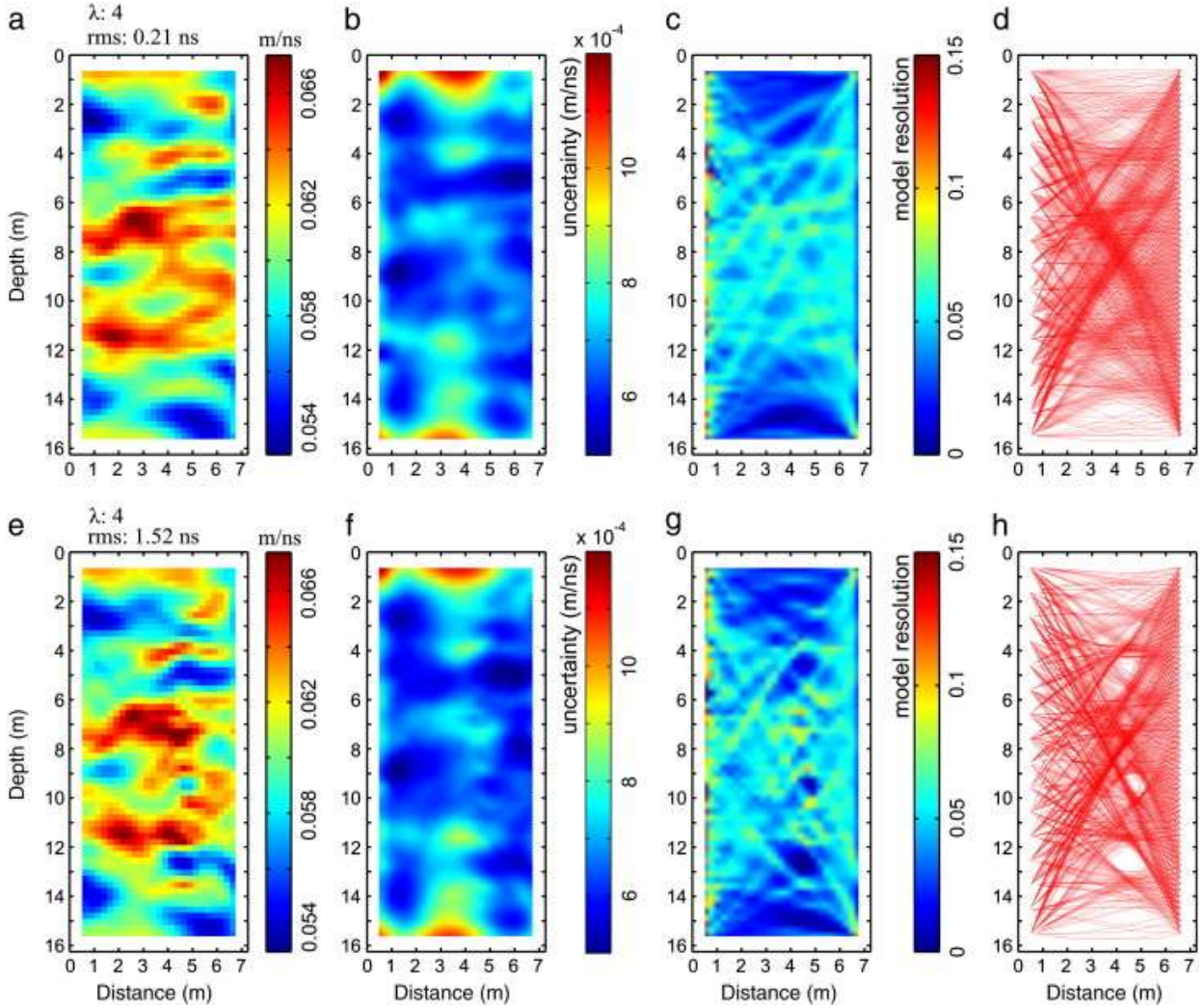
Cross Well Radar



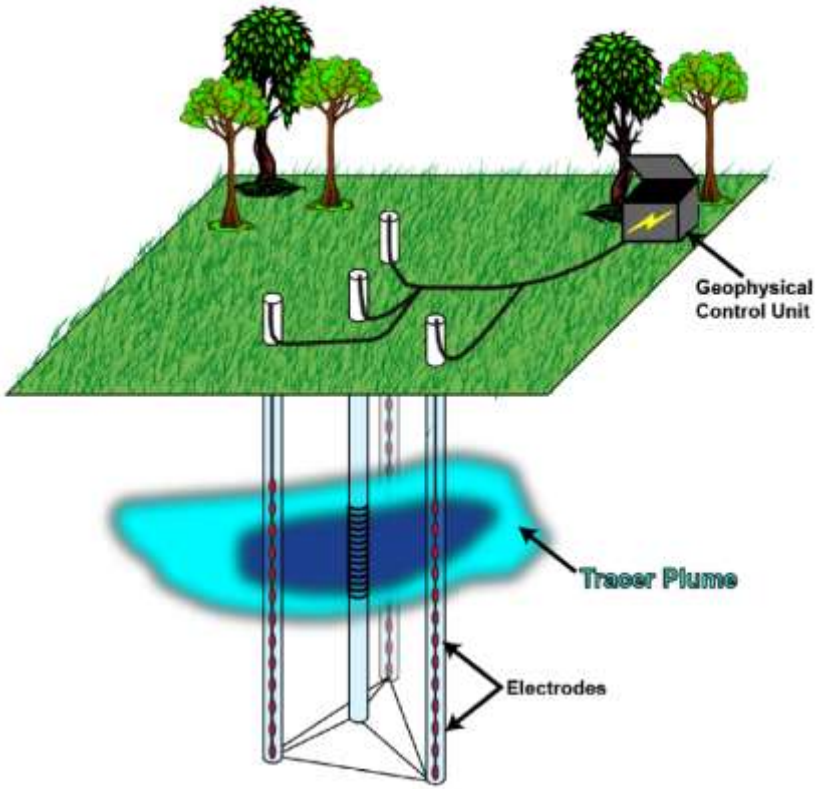


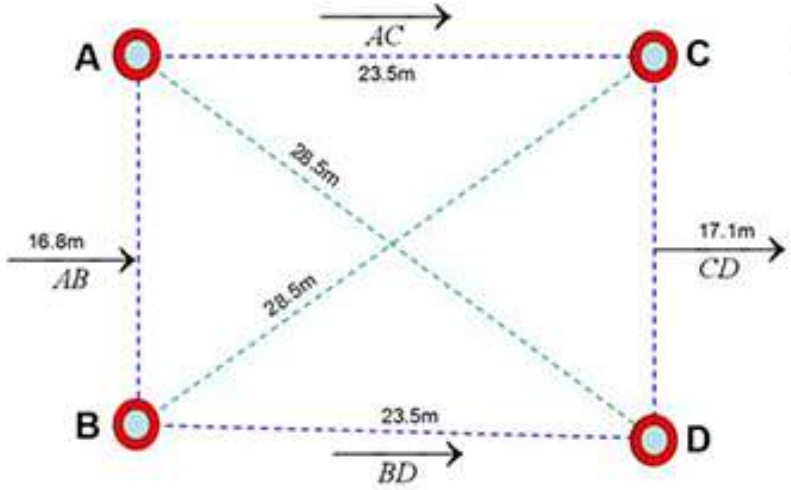
Cross Well Radar

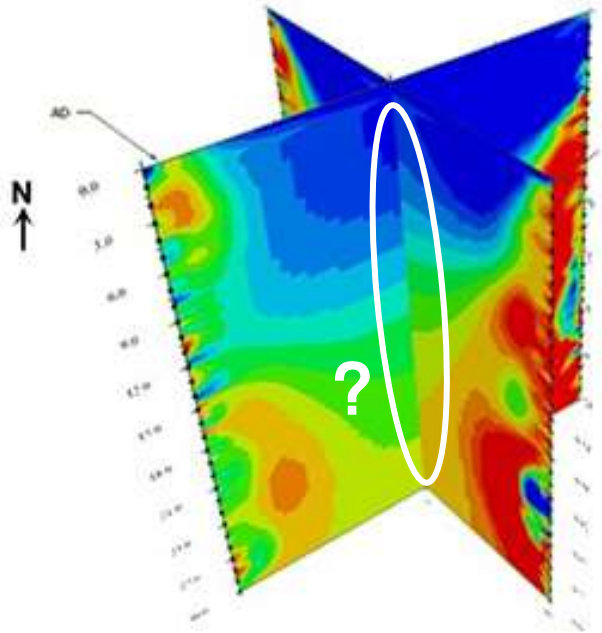




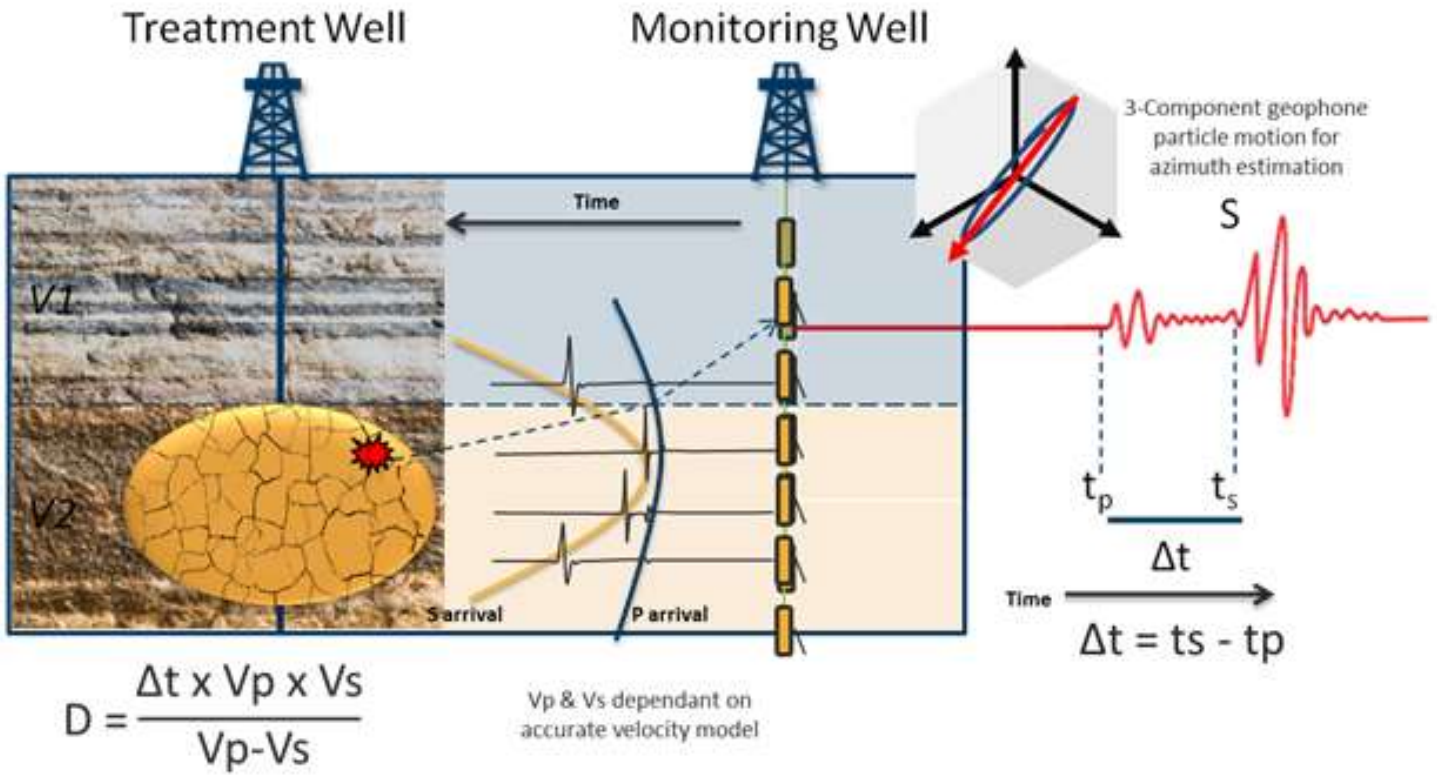
Cross Well ERT



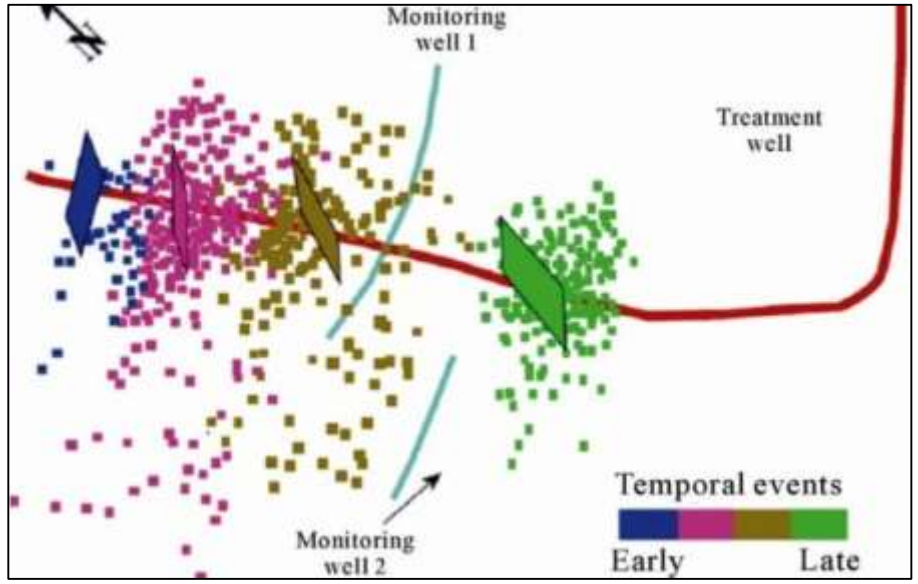




Fracturing Monitoring Using Borehole Geophones

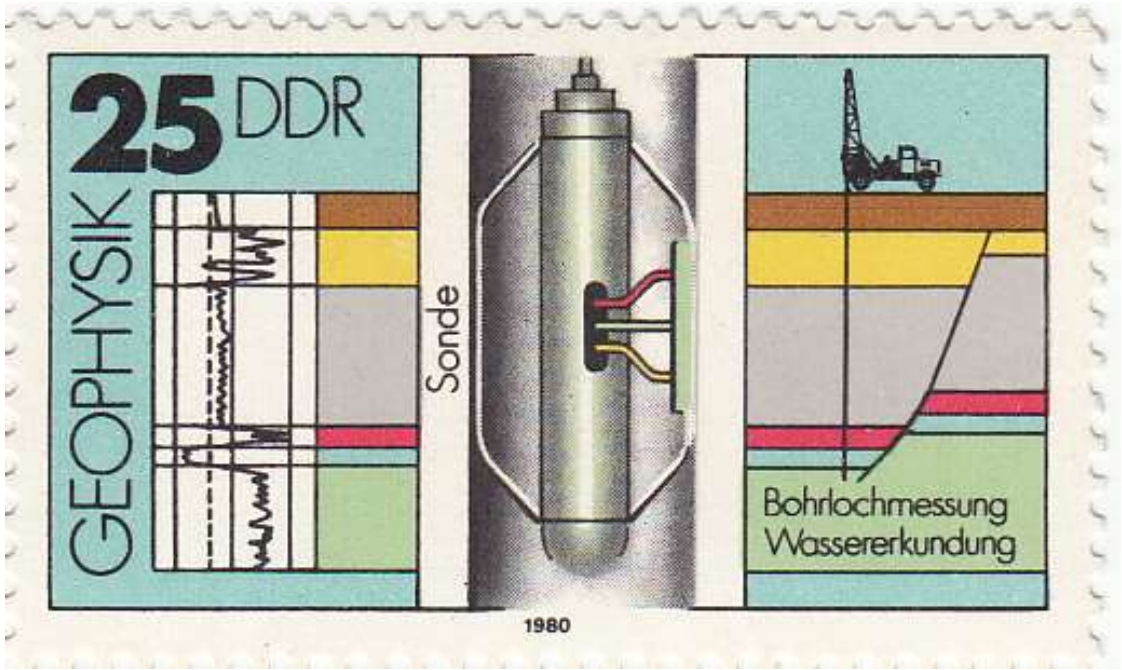


Micro-seismic Imaging



Summary

- Borehole structure
- Electrical (resistivity) log
- Acoustic log
- Radiometric log
- Imaging log
- Logging while drilling
- Cross-well geophysics



Which type of log does this stamp depict?