





### **ESS302 Applied Geophysics II**

Gravity, Magnetic, Electrical, Electromagnetic and Well Logging

### Well Logging (Borehole Geophysics)

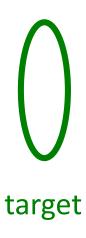
Instructor: Dikun Yang Feb – May, 2019

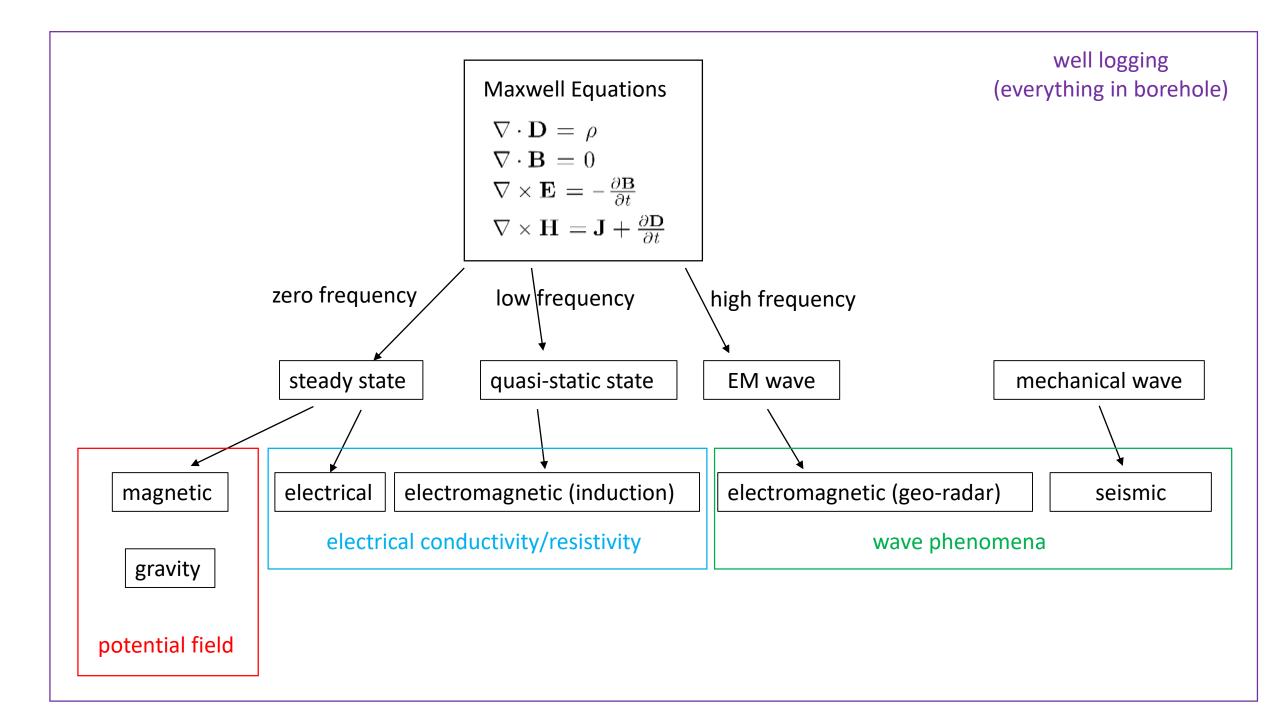


# Quiz: Draw the Magnetic Field Lines and Determine the Sign of Data



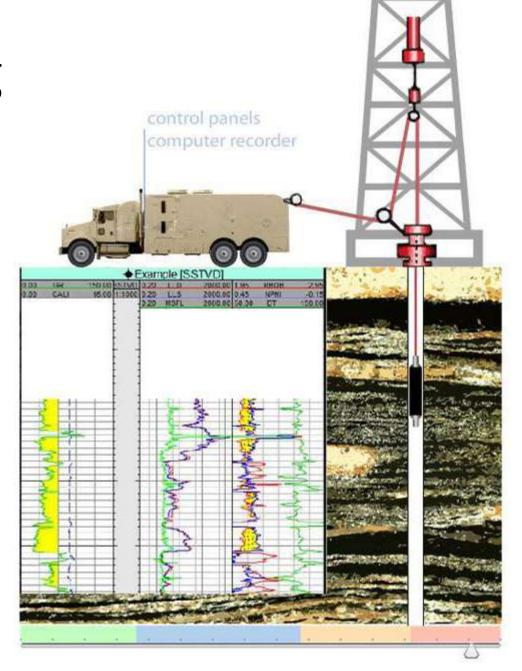






## Well Logging





#### **Electrical logging**

- Normal log
- Lateral log
- Microlog
- Induction log

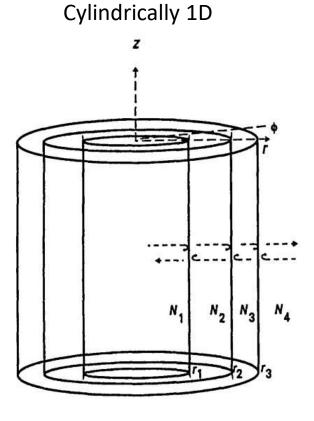
Acoustic logging

#### Radiometric logging

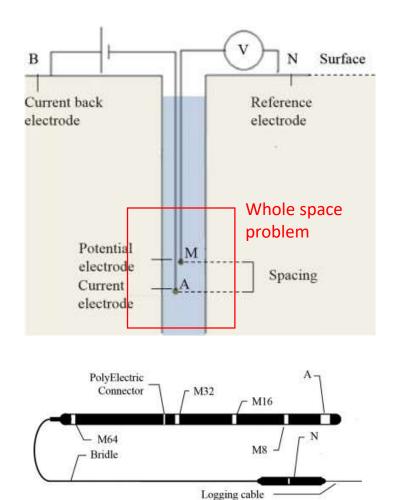
- Gamma ray
- Gamma gamma
- Neutron gamma

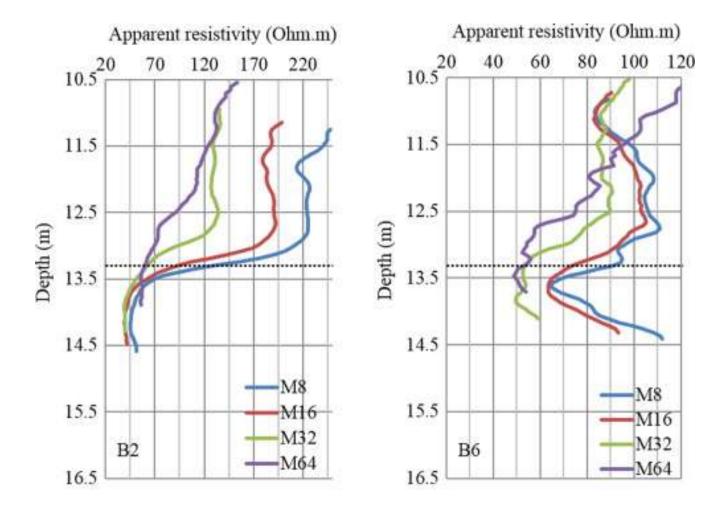
### Fluid Distribution Around a Well

Formation water Uninvaded: Oil > Water Mixture of mud filtrate and formation water Яm Transition: Flushed Zone Oil ≈ Water ☐ Water Flushed: Mud filtrate Oil < Water Flushed zone

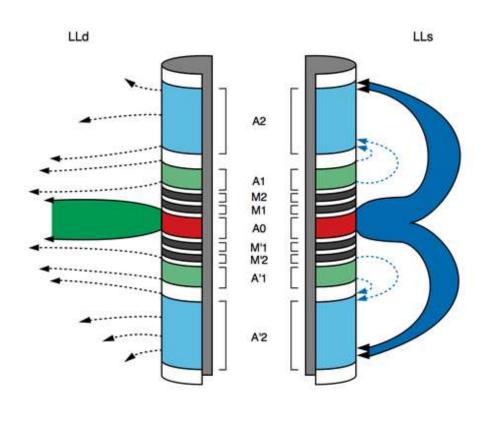


### Normal Log

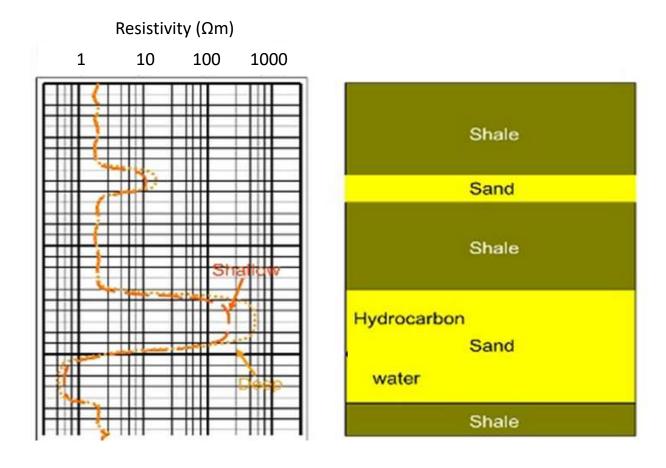




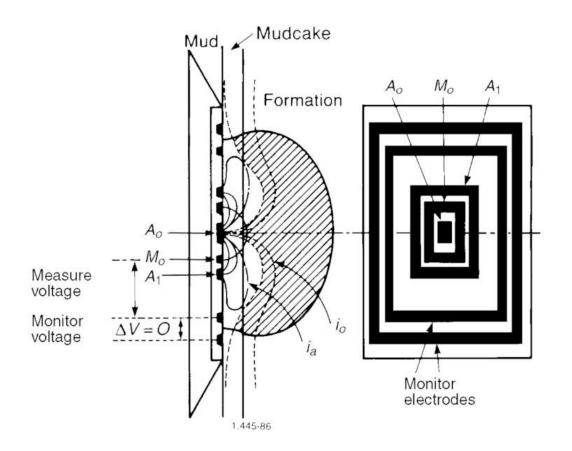
### Lateral Log



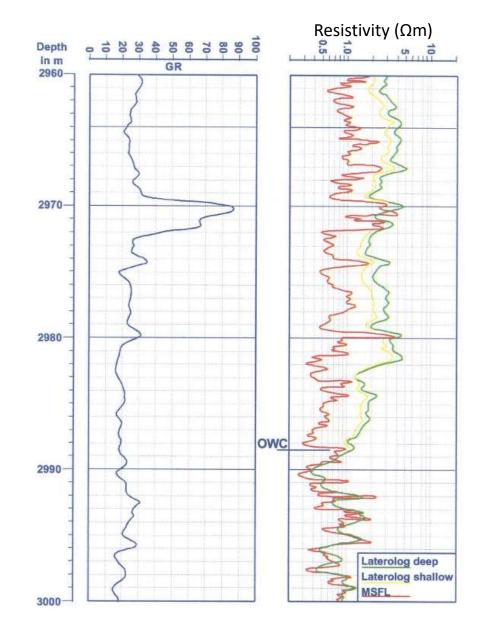
Dual Laterolog sonde electrode distribution and current path shape.



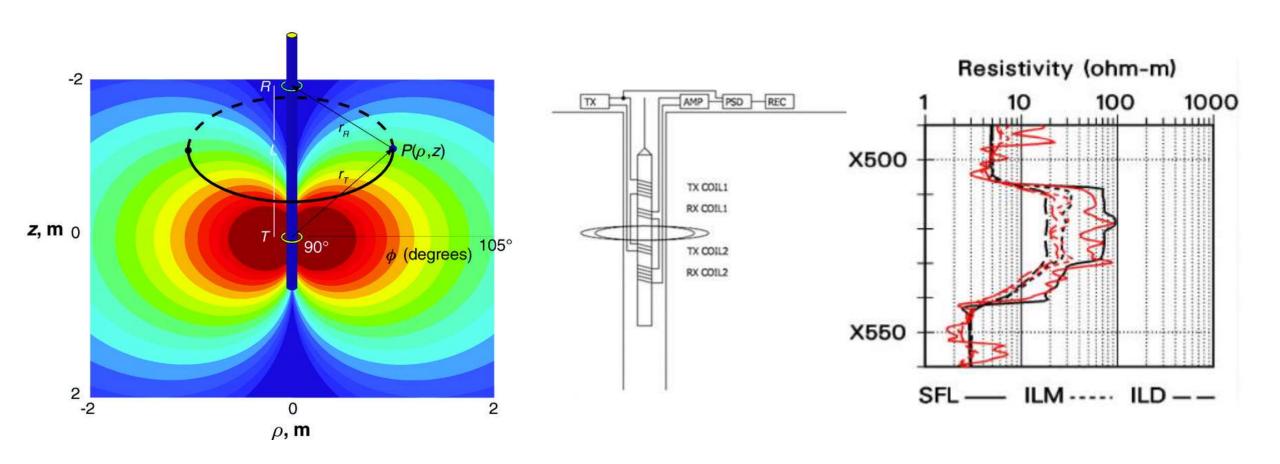
### Microlog



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

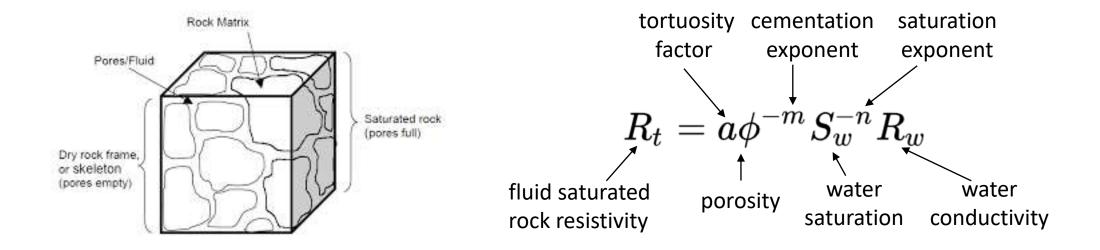


### Induction Log



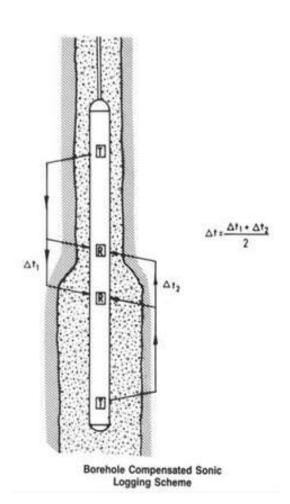
### Archie's Law

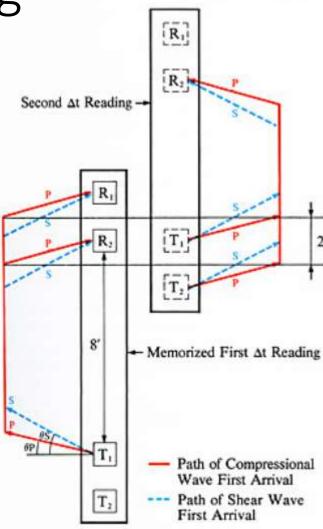
Relates the in-situ electrical conductivity of a sedimentary rock to its porosity and water saturation

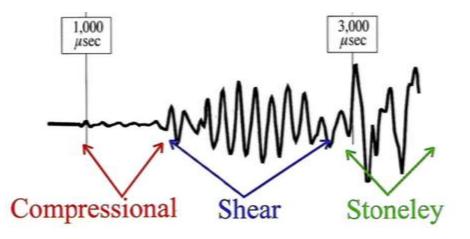


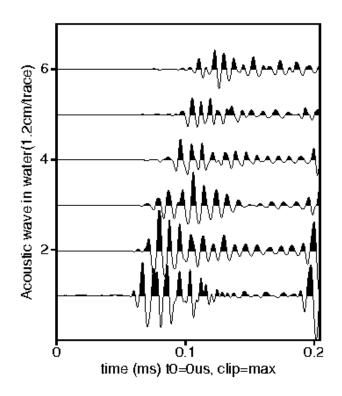
**Electrical well log interpretation**: Borehole electrical conductivity  $\rightarrow$  hydrocarbon saturations

# Acoustic Log









### Radiometric Log

Caprock and anhydrite

Coal

Salt

Dolomite

Limestone

Sandstone

Sandy limestone and limy sandstone

Greenish-gray sandstone

Shaly sandstone

Shaly limestone

Sandy shale

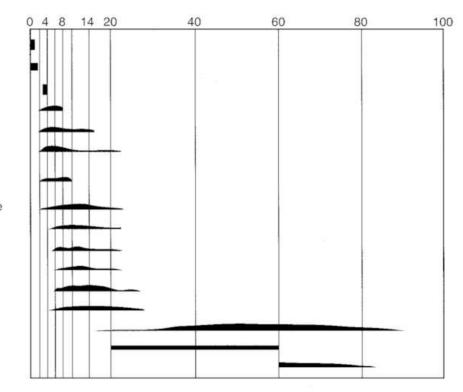
Calcareous shale

Shale

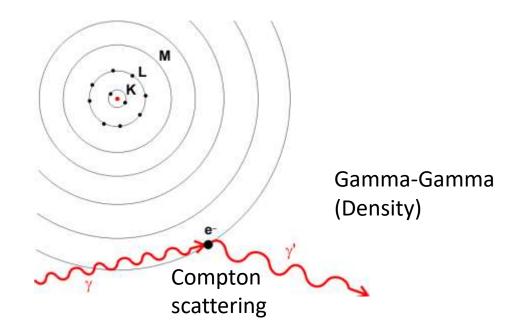
Organic marine shale

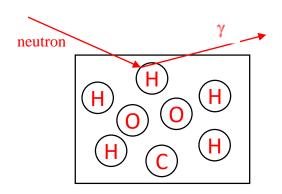
Lean potash beds

Rich potash beds



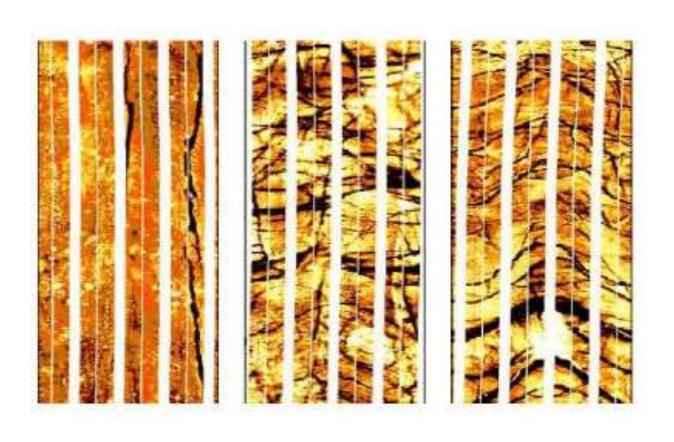
Natural gamma (Lithology)

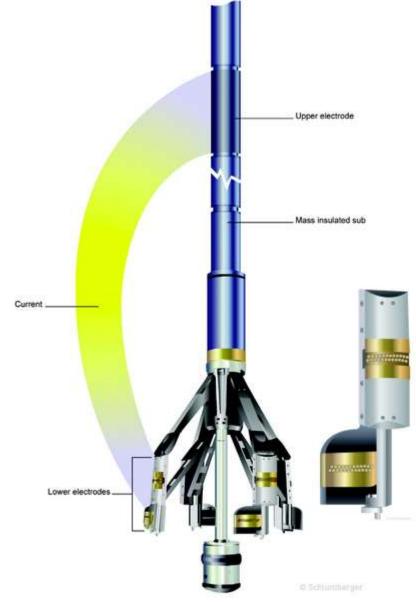




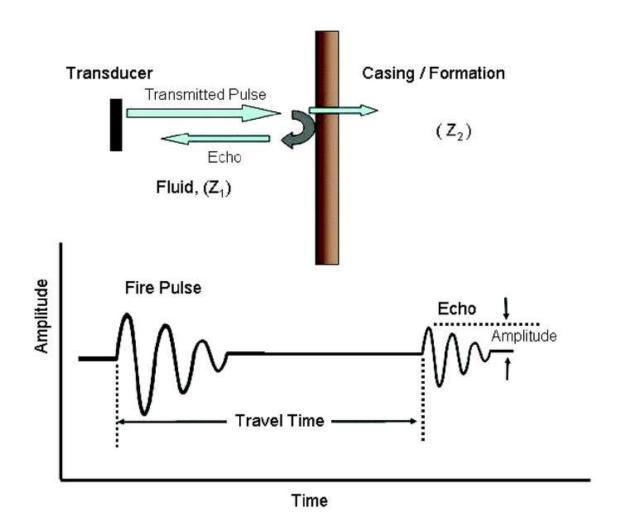
Neutron Gamma (Porosity)

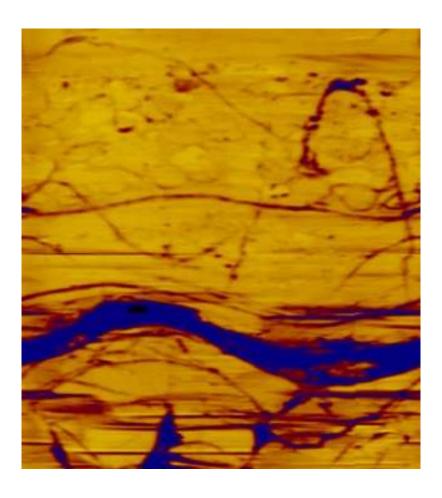
# Imaging Log (Electrical)



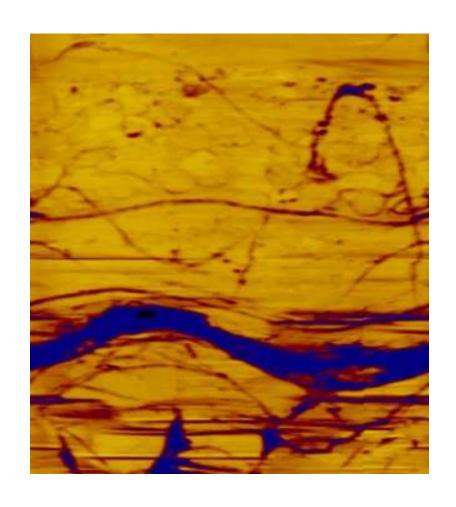


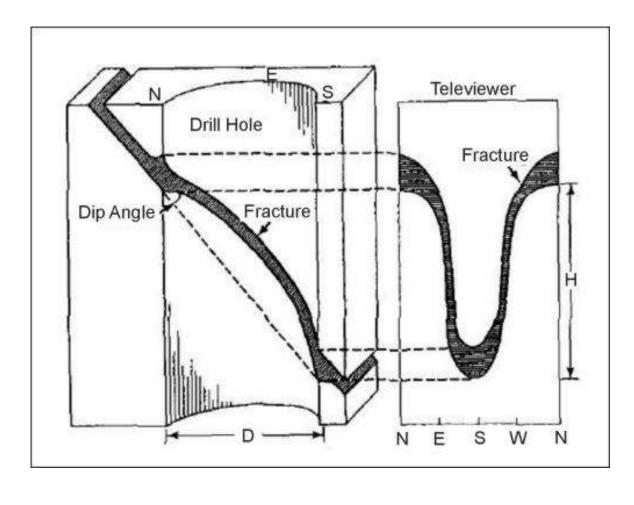
## Imaging Log (Acoustic)

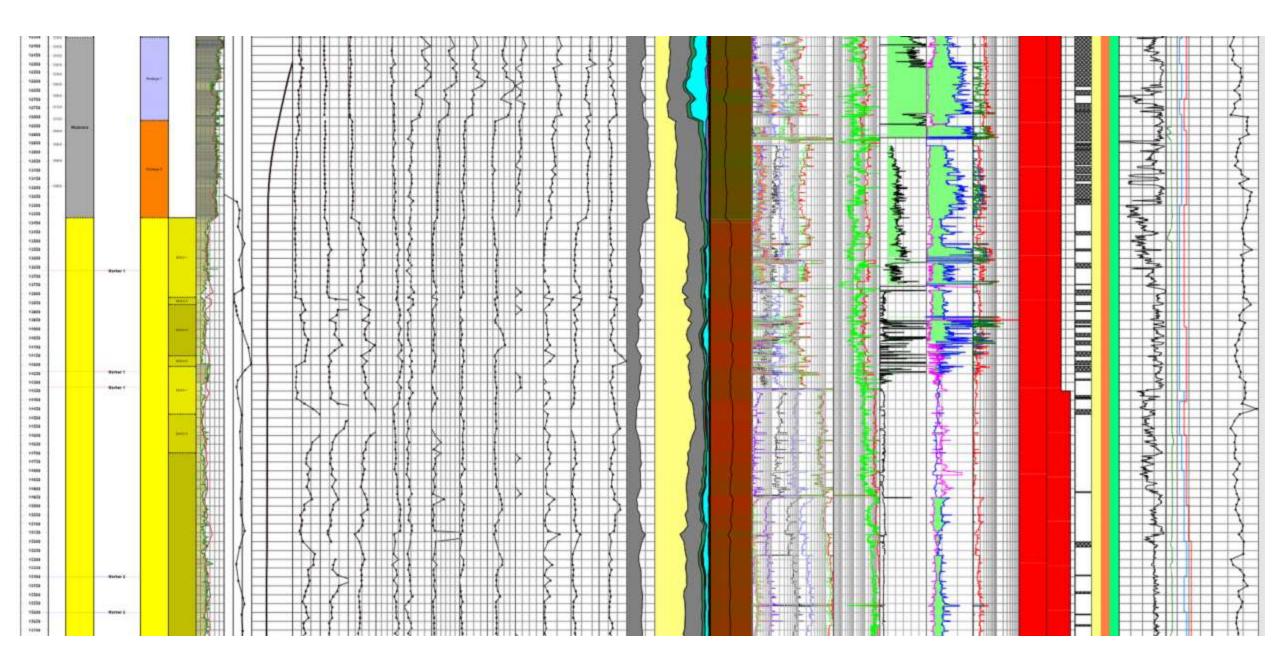




### Fracture in Imaging Log







# Logging While Drilling (LWD)

#### **FALCON MWD**

High Speed and High Temp MP and EM options available

#### SCI-QUEST™

Sci-Quest Resistivity available for precision wellbore placement

#### SCI-DRIVER™

The Sci-Driver - Near Bit Smart Motor provides High Accuracy azimuthal gamma and continuous inclination 1.83-2.74m (6-9ft) from the bit

#### MagTracer'

A stand alone Active Ranging solution which provides accurate magnetic ranging measurements between wellbores without requiring additional electronics

#### SCI-GAIN™

Provides API Natural Gamma & Inclination

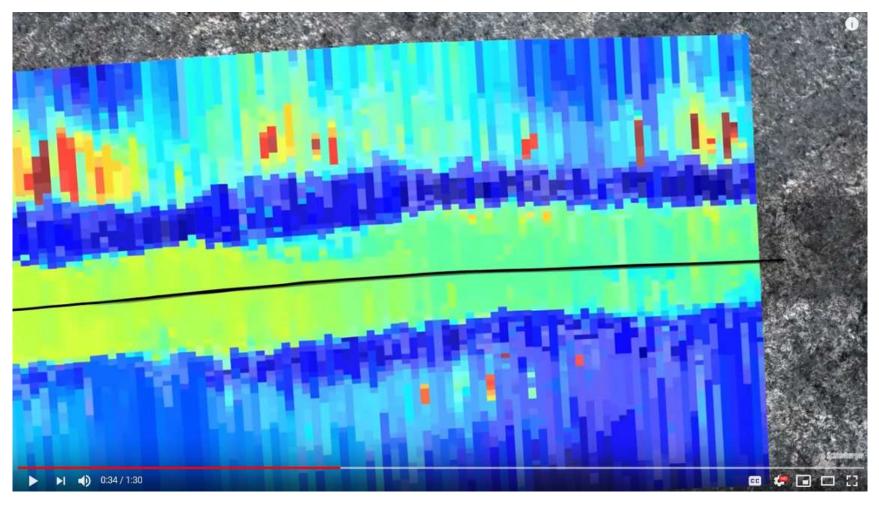
#### **Titan Motor Series**

Performance Drilling Motors engineered to handle the toughest drilling environments

#### Lodestone"

An Active Ranging solution which generates accurate and consistent ranging results at the bit, so steering decisions can be made sooner and with greater confidence

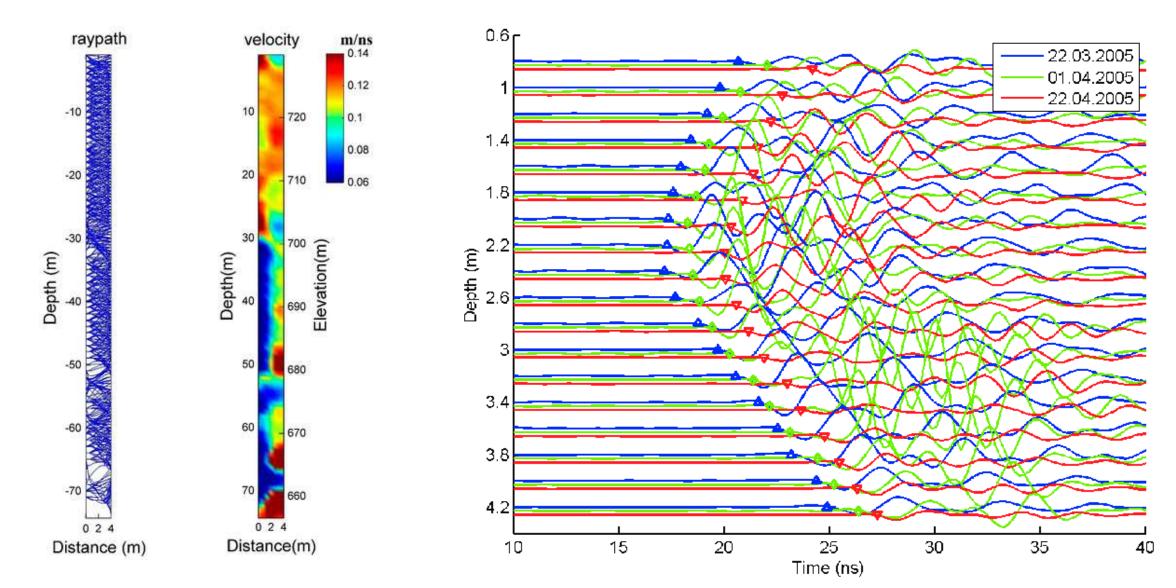
## Logging While Drilling (LWD)



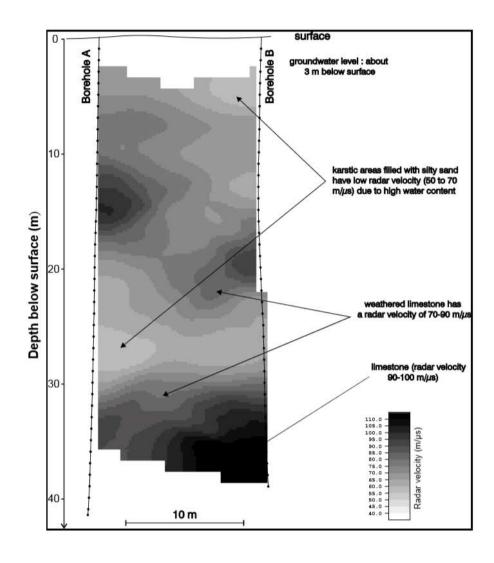
# Logging While Drilling (LWD)

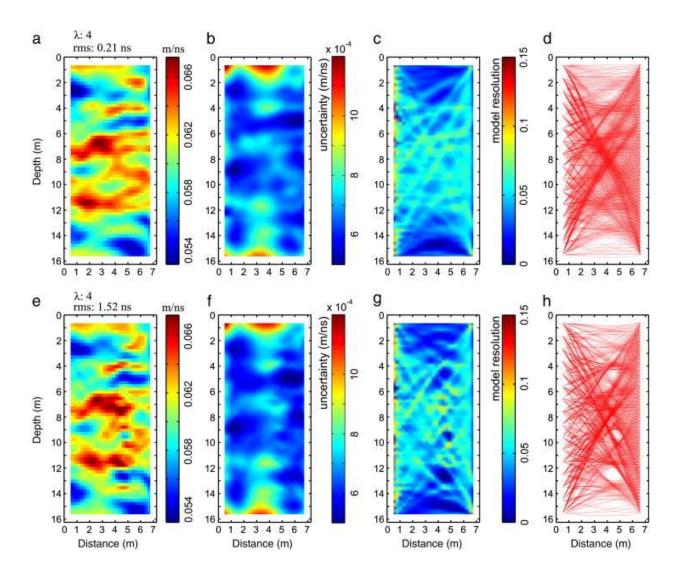


### Cross Well Radar

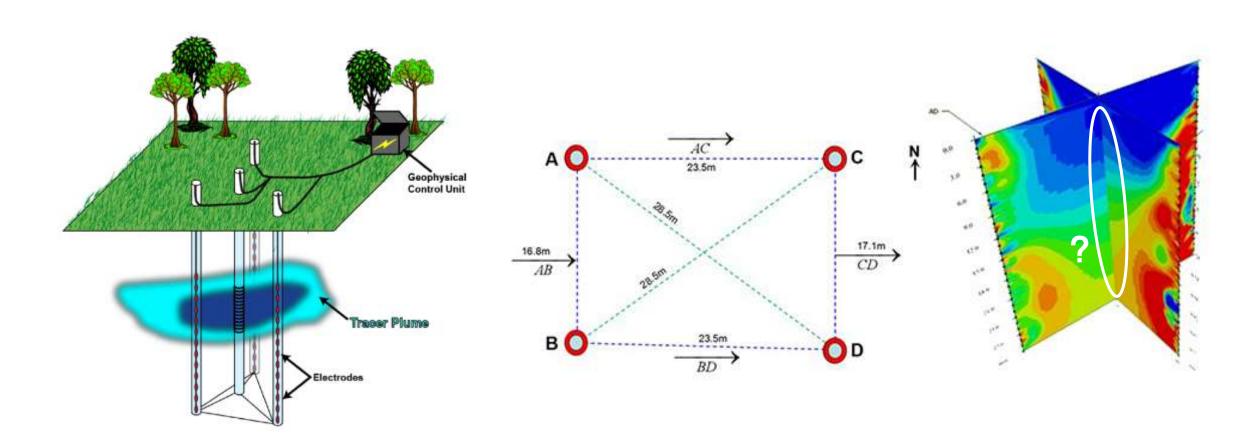


### Cross Well Radar

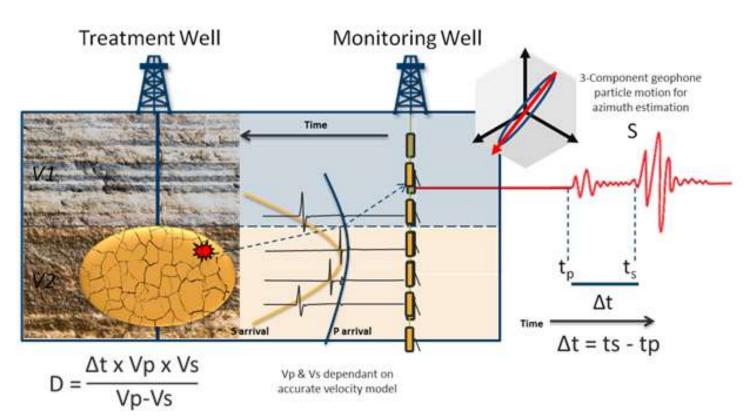




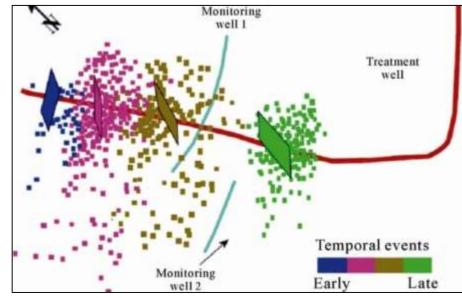
### Cross Well ERT



# Fracturing Monitoring Using Borehole Geophones

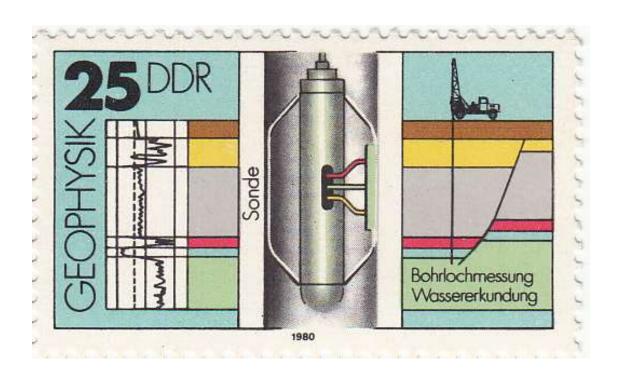


#### Micro-seismic Imaging



### 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?