GeoNeurale-Wavefields
Neural-Geophysics Lab - Augsburg

TRAINEESHIP WINTER 2020
1st October – 31st December 2020

CONVOLUTIONAL AND RECURRENT NEURAL NETWORKS APPLICATIONS FOR 3D SEISMIC / PETROPHYSICS AND GENERAL APPLICATIONS

AUDIENCE:
Geophysicists, Geoscientists, Petrophysicists, Engineers, Physicists, Mathematicians, Chemists

Sciences and Technologies of the Petroleum and Geothermal Exploration
Petrophysics, Geostatistics, Seismic Integration, Scientific Programming

MAXIMAL PROGRAM - WINTER STAGE 2020 - NEURAL-GEOPHYSICS LAB – AUGSBURG

ELEMENTS OF GENERAL AND CLASTIC PETROPHYSICS

-Archie law for F, Sw in clean sands

-BiLog Diagram of F-Phi – mathematical significance of a and m

-Surface drilling parameters ROP, RPM, WOB, HKLD, TOR/DRIVE AMPS, SPM, Chromatography C1,C2,C3,nC4,iC4,nC5,iC5

-Crossplots (xplots) of Surface parameters and interpretation, xplots of chromatography to interpret hydrocarbon types, correlations with downhole parameters

-Conversion units in oil exploration

-Well profile

-MWD/LWD systems:

- Cartrige assemblies: D&I , TAA, SCA, TCA, Modulator

- Electronic block systems, logical gates

- LWD communication protocols, binary system, bytes, words, frames of LWD measurements, D&I frame, ToolFace frame, MWD frame, Sync words

BULK DENSITY AND PHOTOELECTRIC ABSORPTION CROSS-SECTION LOG

- Petrophysics of density, photoelectric absorption cross-section (Pe) and porosity tools: hardware and measurements physics
- Density calibration, "Spine-Rib" plot
- Spectrum of the density-Pe measurement: Compton scattering region and Pe region
- Standoff correction
- Standoff measurement with LWD density tool in rotary and sliding mode
- Interpretation of bimodal sampling distribution
- Photoelectric absorption cross-section (Pe) and volumetric photoelectric absorption cross-section (U) and respective units (barns/electron, barns / cm3)
- Volumetric equations for porosity, density and volumetric photoelectric absorption cross-section

NEUTRON POROSITY LOG

- Neutron porosity
- Hydrogen index
- Excavation effect and gas correction of porosity-density crossplot

SONIC LOG

- Sonic log hardware and measurements physics
- Velocity of longitudinal waves Vp, velocity of transversal waves Vs
- Application of sonic tool measurements to geomechanics: hydraulic fracturing optimization
- Determination of dynamic elastic parameters from sonic tool measurements: Young modulus, bulk compressional modulus, Poisson number, earth stress tensor parameters sigma1, sigma2, sigma3 from Vp, Vs, density.
- Comparison of dynamic and static elastic parameters
- Dipole sonic tool, hardware and measurements physics
- Vs wave polarization due to anisotropy and deviatoric earth stress field.
- Applications of Rayleigh waves for permeability and anisotropy detection

RESISTIVITY LOG

- Resistivity tools, hardware and measurements physics
- Normal and lateral device
- Focusing electrode devices, Laterolog
- Induction log
- Integrated geometrical factor
- Conductivity equation and geometrical factor
- Skin effect correction
- Microresistivity tools: microlaterolog, microSFL, FMI
- Electromagnetic Wave Resisitivity EWR
- Resistivity from Phase Delay and Amplitude attenuation
- Interpretation of measurements,
- Polarization horn
- Application of EWR LWD tool in geosteering drilling operations

NMR LOG

- Nuclear Magnetic Resonance log hardware and measurements physics
- Proton spin polarization in the static Bo magnetic field
- B1 RF 90 and 180 flipping pulse, precession of proton spins, Larmor frequency
- CPMG (Carr-Purcell-Meiboom-Gill) sequence
- T1 and T2 relaxation time
- Surface, bulk and diffusion relaxation
- Surface relaxation as porosity and permeability indication
- Diffusion relaxation as fluid viscosity indication
- Bimodal T2 spectrum
- T2 free fluid and irreducible saturation cutoff
- NMR log presentation

PETROPHYSICAL INTERPRETATION

- Petrophysical interpretation crossplots
- density-porosity xplot (Saraband model)
- MN Mid-Plot Rho-maa, t-maa
- Mid-Plot Rho-maa, U-maa
- Equation of petrophysical volumetric balance
- Saraband density
- Complex lithology mixture 2 and 3 components
- Sand and laminated shales conductivity equation
- Dual water model equation
- Waxman-Smith model equation
- Regional empirical Non-Archie models equations: Indonesia, Nigeria

CARBONATE PETROPHYSICS

The Lucia classification.
Wellbore proximity sectors on carbonate formations.
Vp-Porosity and parameters controlling Vp.
NMR and porosity partitioning.
Pc curves in the context of Lucia carbonate classification.
Winland R35 in the context of Lucia carbonate classification.
Swirr and flow units in the context of Lucia carbonate classification.
Pc curve, NMR, R35, Ka-PHI: reservoir system quality and performance.
Petrofacies and NMR T2 distribution.
Vuggy porosity.
m structural parametrization: VPR and Brie model.
Porosity partitioning in the m Dual Porosity equation.
The modified Myers model.
m and porosity type.
n exponent, Wettability and NMR porosity typing.

PICKETT PLOT INTERPRETATION

Effects of petrophysical parameters on the Pickett plot:
Sw, m, Rw
Buckle plot
BVW,Sw,K,m.

ELEMENTS OF GEOSTATISTICS

Reservoir Heterogeneity and measurement scales: Micro, Macro, Mega, Giga
The representative elementary volume and the support effect
Statistical distributions of static and dynamic properties
Concepts of reservoir modeling
Review of general statistics
Spatial statistics
Moving window statistics
Spatial declustering of data
Bivariate distributions
Linear regression
Covariance
Spatial Covariance
Random variables, Gaussian distribution function, cumulative distribution function
Mathematical Expectation
Derivation of probabilistic functions as expected values relationships
Calculation of probability from normal and log-normal distributions
Concepts of Spatial Stationarity
The First and Second Order of Stationarity
Spatial Covariance and Variogram
Spatial Covariance and Variogram numerical calculations
Variogram parametrization: Lag Distance, Lag, Sill, Range
Measures of uncertainty
Variogram models: Nugget Effect, Spherical model, Exponential model, Gaussian model
Cross Covariance and Cross Variogram
Spatial correlation algorithms: Markow-Chain and Multipoint Histogram
Conventional spatial estimation
Simple Kriging, Ordinary Kriging, Universal Kriging
Cokriging
Non-linear Kriging
Grid-based spatial simulation Methods
Sequential Gaussian Simulation
Upscaling petrophysical properties into the Static Reservoir Model

ELEMENTS OF PETROPHYSICAL-SEISMIC INTEGRATION
Overview of Post and Pre-Stack Seismic Inversion methods
Reservoir Static modeling
Upscaling of static and dynamic properties in the seismic cube
Introduction of petrophysical properties in the seismic inversion
Correlation of elastic parameters from petrophysical and seismic measurements

ELEMENTS OF GEOTHERMAL EXPLORATION
Concepts of thermodynamic modeling of the Geothermal Reservoirs