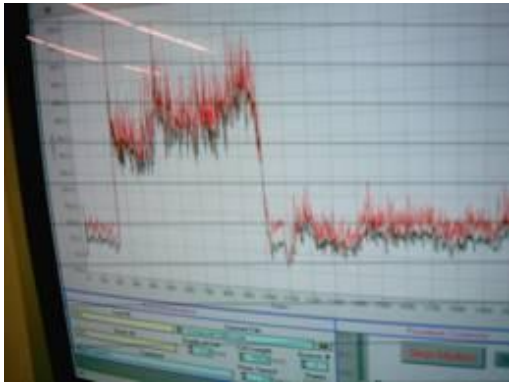
GeoNeurale

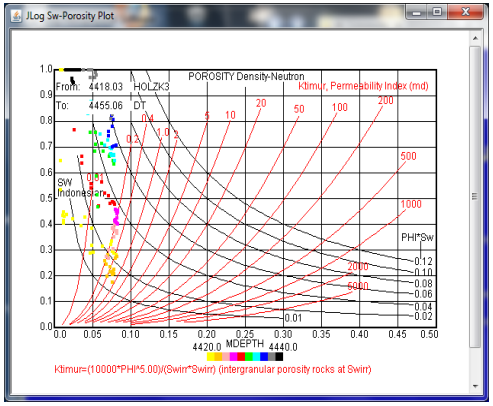
INTRODUCTION TO GEOTHERMAL AND PETROLEUM EXPLORATION

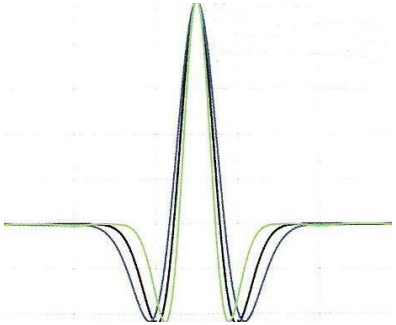
J.R. Fanchi , A. Piasentin

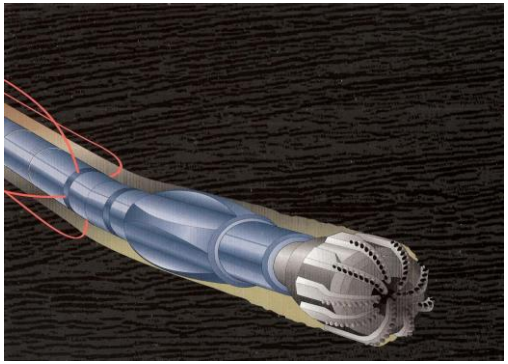
28 July – 03 August 2014

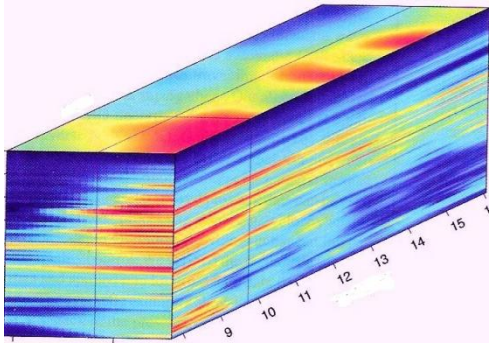
GeoNeurale - Munich

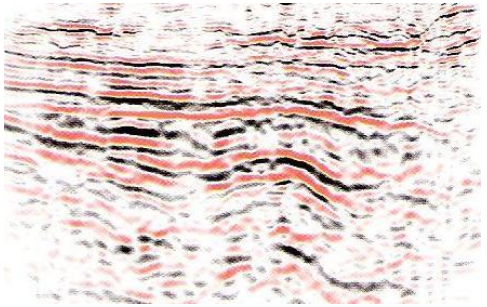












INTRODUCTION TO GEOTHERMAL AND PETROLEUM EXPLORATION

J.R. Fanchi , A. Piasentin

28 July – 03 August 2014

GeoNeurale – Munich

Registration Deadline: 25 June 2014

7 DAYS COURSE

INSTRUCTORS: J. R. Fanchi, A. Piasentin

A BASIC COURSE FOR GEOTHERMAL PROFESSIONALS

AUDIENCE: geologists, engineers, managers, economists, insurance brokers for geothermal projects, investors, political authorities. This course is particularly suited for geothermal professionals and authorities involved in decision-making responsibilites wishing to deepen their knowledge and understanding of geothermal and petroleumexploration systems. Any individual planning to enter into the deep geothermal exploration business.

LEVEL: Basic

PROPEDEUTICAL:

Basic mathematics and physics. No previous knowledge of reservoir technologies is required, All concepts are introduced schematically with images and conceptually simple without extensive use of complex mathematical concepts.

COURSE FEES: 3650 Euro + 19% VAT (Non german private companies can be exempted from VAT tax)

ONLINE REGISTRATION: www.GeoNeurale.com

COURSE PROGRAM IN ENGLISH

The course material will be in english.
Most of the technical dictionary terminology will be
in english as normative of the international conventions.

The course can be offered also in the following languages:
German, French, Italian.

Course material comprises books, DVD´s videos and
animations.

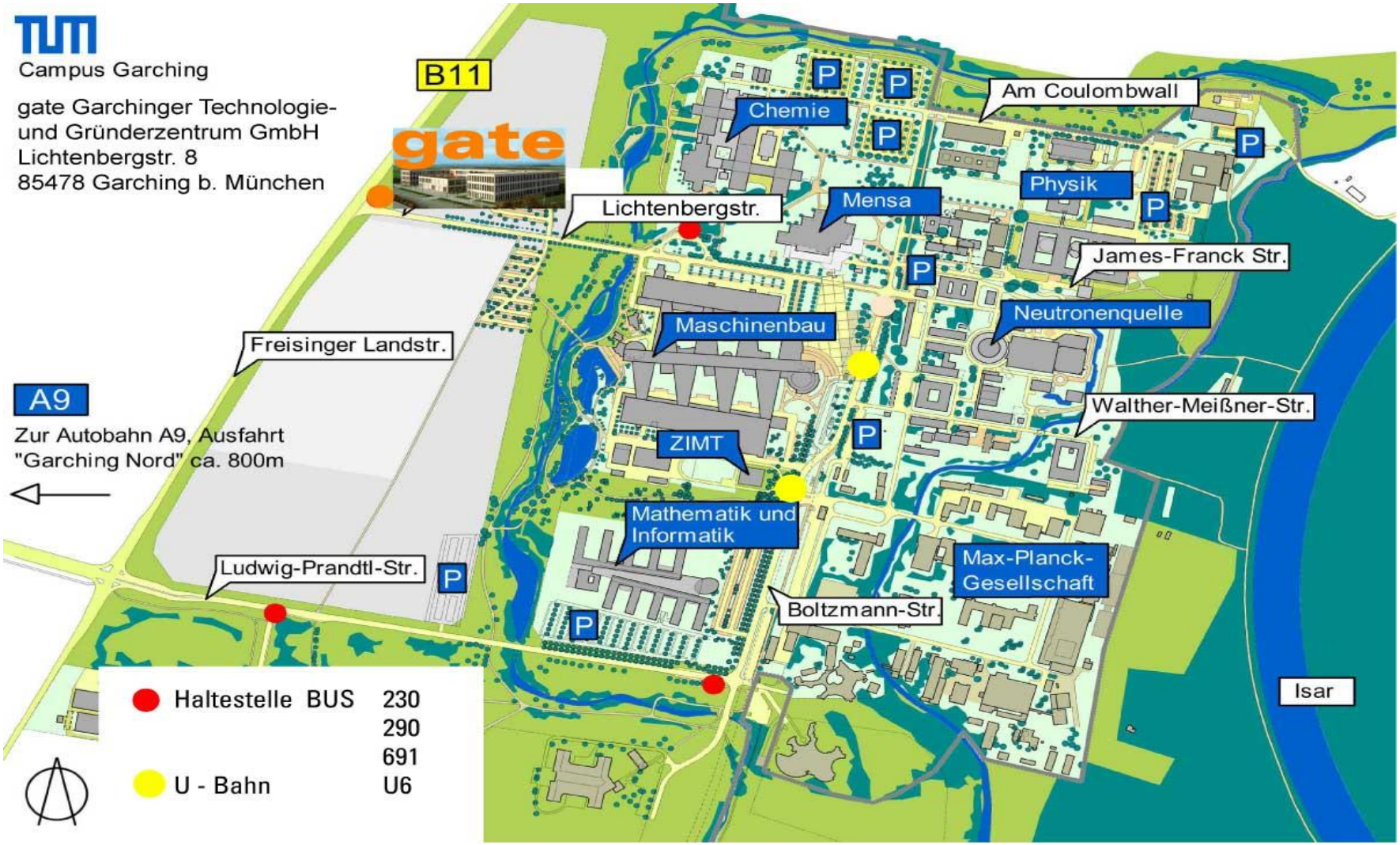
COURSE PREPARATION

Online Propedeutical course preparation is available at request
and comprises the following topics:

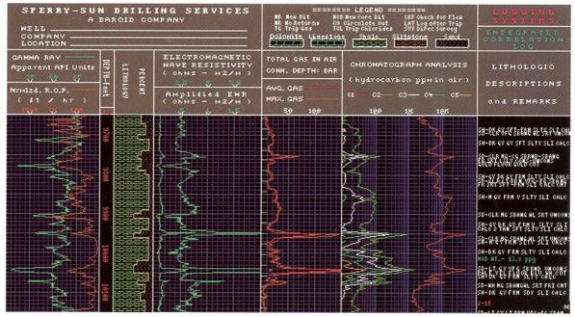
-Basic Algorithms
-Introductory elements of Petrophysics
-Introductory elements of Seismology

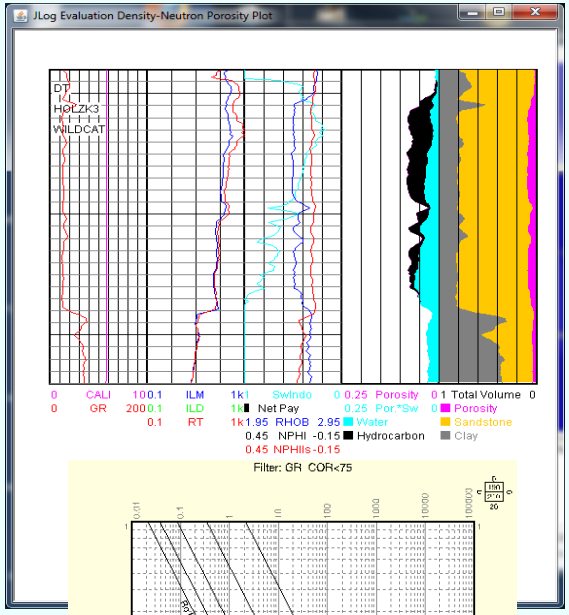
gate GeoNeurale Training Center

at the Munich-Garching Research Center



SHORT COURSE PROGRAM





PLANNING A GEOTHERMAL EXPLORATION PROJECT AND TECHNOLOGIES OF THE PETROLEUM INDUSTRY

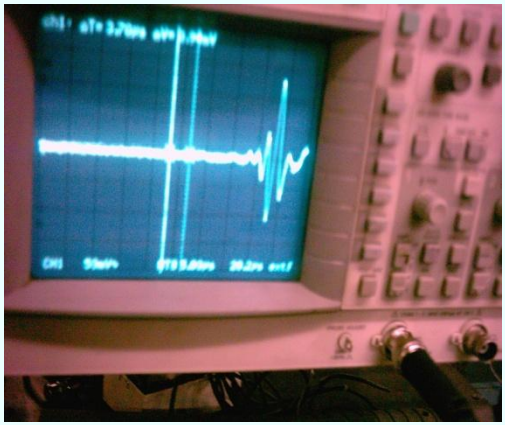
SHORT PROGRAM INDEX

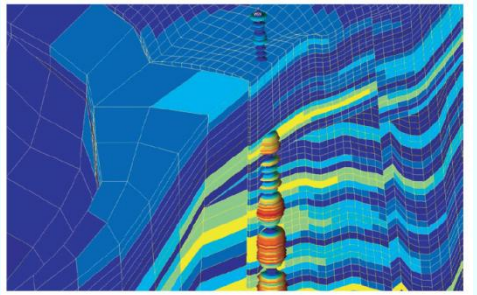
THE STUDIES
THE MACRO-FIELD
REGIONAL STUDIES
GEOPHYSICAL PROSPECTING
SEISMIC EXPLORATION
AQUISITION
ANALYSIS:
- PROCESSING
- INVERSION
- INTERPRETATION

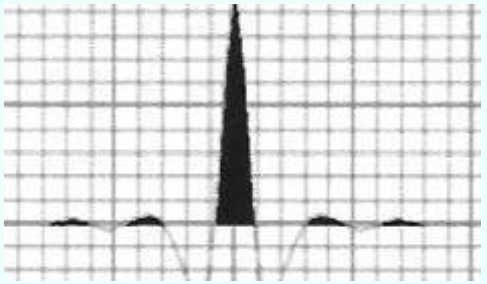
PETROPHYSICS
THE MICRO FIELD
PHYSICS OF THE TOOLS AND MEASUREMENTS
LOG-INTERPRETATION
UPSCALING
RESERVOIR ANALYSIS
INTEGRATED STUDIES
RESERVOIR CHARACTERISATION
STATIC SIMULATION
DYNAMIC SIMULATION
TARGET DEFINITION

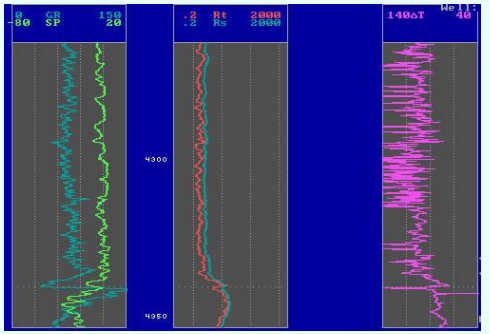
OPERATIVE PHASE

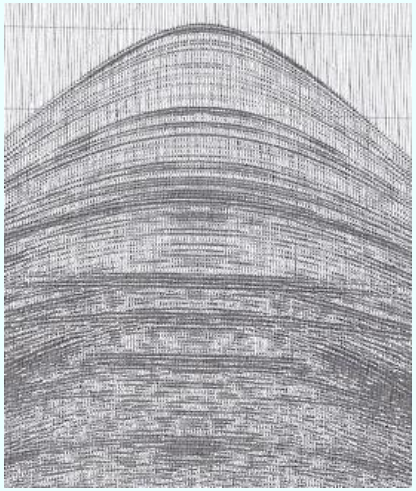
THE PLANNING PHASE
DRILLING PROJECT PLANNING
DIRECTIONAL PLANNING
THE DRILLING RIG
DATA LOGGING AND DRILLING DYNAMICS
PHYSICAL UNITS AND CONVERSIONS IN THE OIL INDUSTRY
DIRECTIONAL DRILLING METHODS
MWD/LWD SYSTEMS
WIRELINE LOGS
REALTIME LOGS AND ANALYSIS
REALTIME RESERVOIR CHARACTERIZATION
TESTING AND PRODUCTION METHODS
STIMULATION: FRAC OPERATIONS, COILED TUBING, ACIDIZING, CO2
WELLTEST

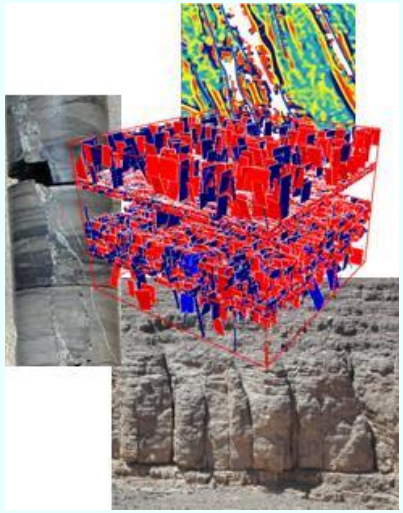












DETAILED PROGRAM
REGIONAL STUDY
The reservoir concept: Oil, Gas,Unconventionals, Geothermy
Geology and Plays
Geophysical studies:
Gravitational, Magnetotelluric, Seismic

3D SEISMIC EXPLORATION
GENERAL CONCEPTS
SEISMIC WAVES
The Wave Equation
MAIN ELASTICITY PARAMETERS
Young,Poisson,Rigidity,Bulk Modulus, Lame constants (Static and Dynamic domains)
P-S WAVES PROPAGATION PARAMETERS
Velocity, Frequency,Wavelength,Phase, Energy, Intensity, Attenuation, Absorption, Spherical Divergence, Acustic Impedance, Elastic Impedance, Reflection and Transmission Coefficients

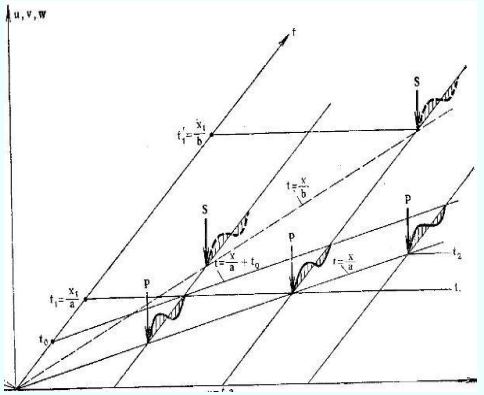
IMPORTANT LAWS FOR WAVE PROPAGATION:
Snell,Huygens, Zoeppritz

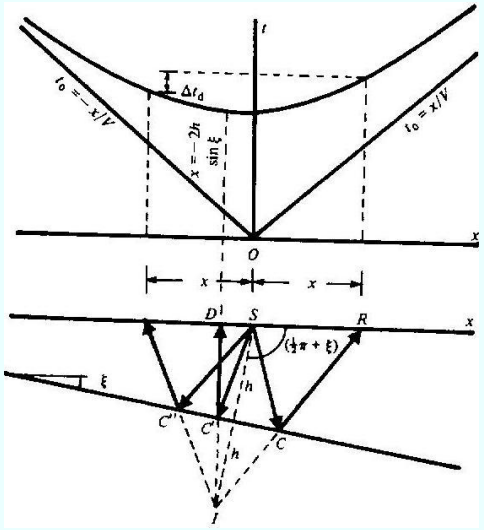
WAVE PROPAGATION MODELS
Ray Tracing, Diffraction Modeling, Exploding Reflectors, Huygens Model, Kirchhoff,
Wave Equation, Eikonal Equation

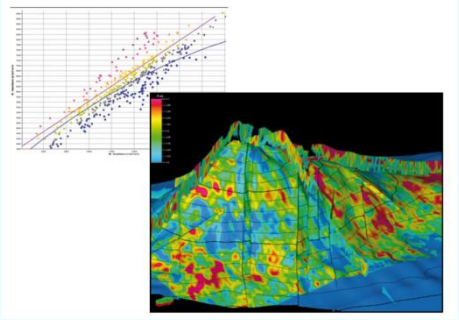
GEOMETRY OF SEISMIC WAVES PATH – RAY PROPAGATION GEOMETRY / PHENOMENA
NMO, DMO, Offset, Velocity, Raypath, Reflection, Refraction, Transmission, Conversion, Polarization, S-Waves Splitting
Diffraction, Multiples, Sideswipes, Dispersion, Anisotropy

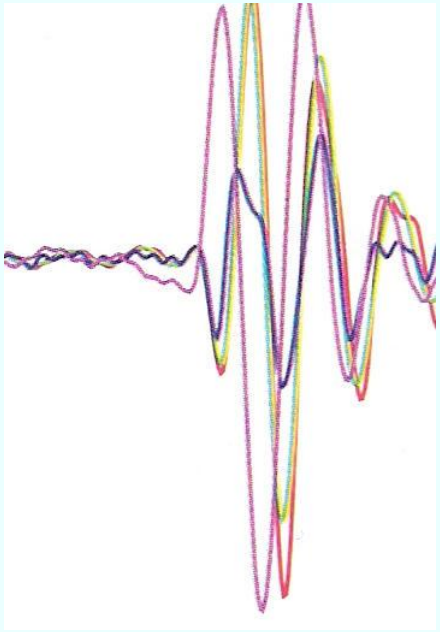
VERTICAL AND HORIZONTAL RESOLUTION
Tuning Thickness, Fresnel Zone

SOURCE MODELS
The Dirac Impulse, Zero and Minimum Phase Wavelet, Sweep, Sweep Design (Bandwidth, Frequency , Taper)









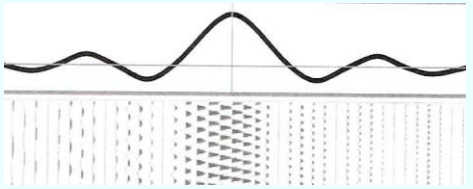
THE UPCOMING SEISMIC EVENTS
Event Signatures , Basic Wavelets, Integral, First and Second Derivatives, Polarity

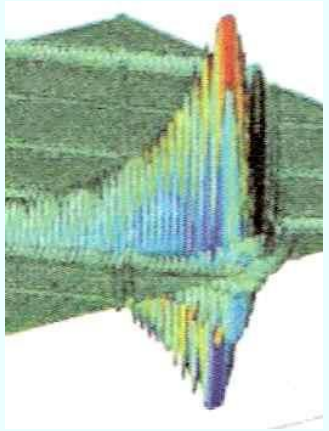
SOURCES
Vibroseis, Explosives, Waterguns

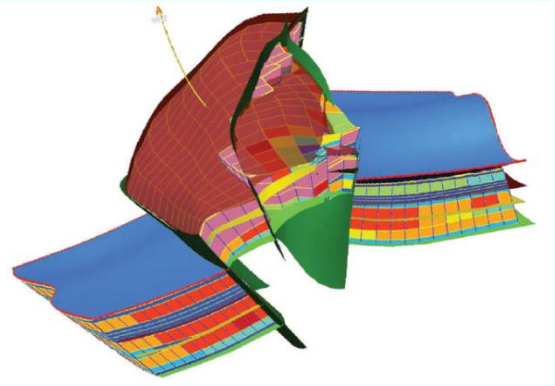
RECORDERS
Geophones, Geophones Arrays, Marine Streamers

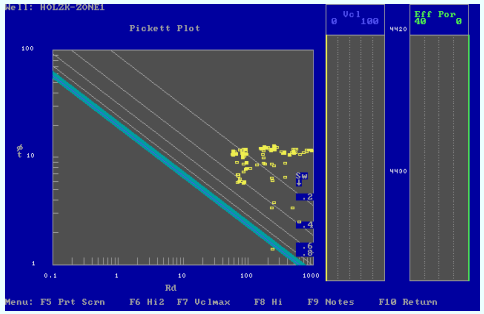
3D SEISMIC PLANNING
3D Seismic Layout Parameters:
Main Concepts: (Inline, Crossline, CMP, Bin, Fold, Taper, Patch, Scattering angle, Template, Xmax, Xmin, Migr-Apron, S/N Ratio)

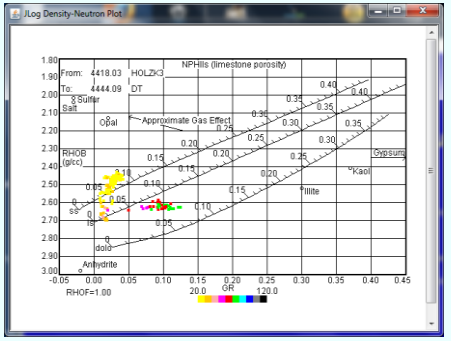
ELEMENTARY SEISMIC DATA PROCESSING SEQUENCE
-Geometry
-Amplitude recovery
-Deconvolution
-Statics
-Noise attenuation
-Velocities
-Stacking
-Migration
-Inversion , AVO





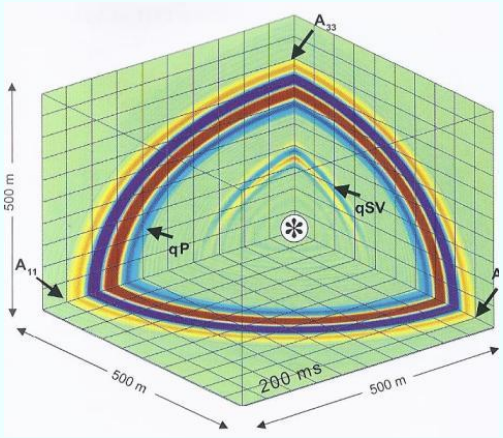


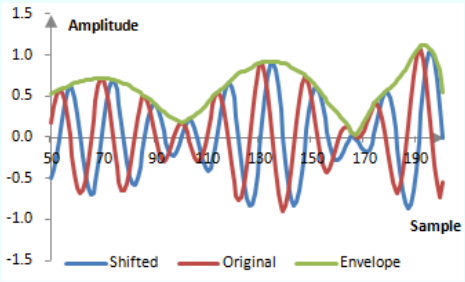




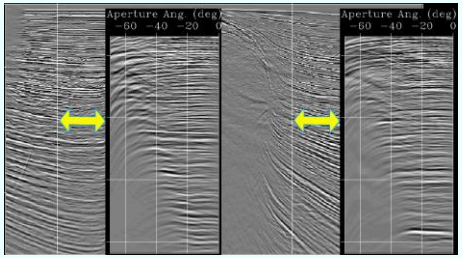
GENERAL CONCEPTS IN THE PROCESSING WORKFLOW

- ELEMENTS OF DIGITAL ANALYSIS OF ANALOG SEISMIC SIGNALS
The Raw Signal, Ricker Wavelet and Spectrum, Zero Phase and Minimum Phase, Fourier transform, Frequency and Phase Spectra, the Sampling Theorem, Aliasing, Nyquist Frequency,the Convolution Theorem, Comb, Sinc, Boxcar,
Hilbert transform, Z Transform, Laplace Transform and Transfer Functions, Convolution/Deconvolution,Filters , S/N Ratio,
Autocorrelation,Crosscorrelation, Coherence, Semblance,
Function Shift/Spectral Changes, Spectral Shift/Function Changes



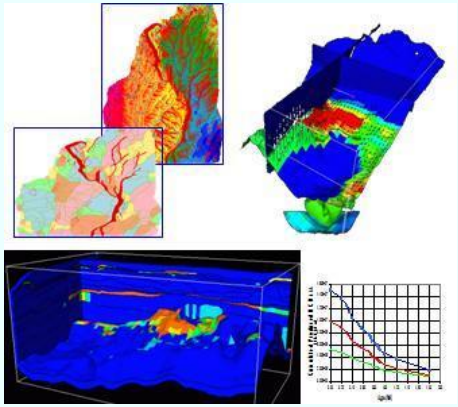


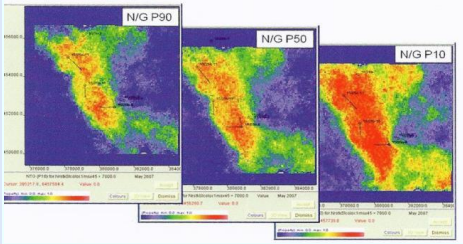
THE ANISOTROPY PROBLEM
Micro and Macro-Anisotropy, Anisotropy Systems, the Stiffness Tensor, Parametrization of Anisotropy, Polarization. qP and qS Waves.
Weak Anisotropy. The Thompsen Parameters. VTI and HTI media. AVAZ.



THE VELOCITY MODEL
V-Analysis, Vrms, Vinterval, Vstack, Dix Equations, Dispersion and Frequency dependency

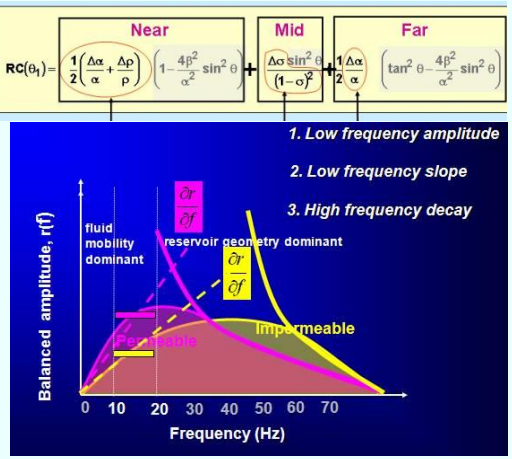
IMAGING
Pre and Post-Stack Migration
NMO, DMO, Zero Offset, Ray Tracing, Diffraction Modeling, Fourier, Exploding Reflectors, Huygens, Wave equation, Eikonal equation,
Kirchhoff Migration, Tomography, Beam Migration, RTM, WEM

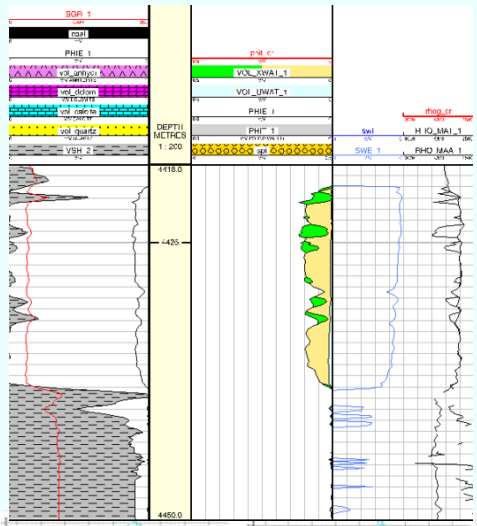




INVERSION
Pre and Post-Stack Inversion.
Linearization of the Zoeppritz Equation. The Aki-Richards Equation.
Elastic Impedance, LMR, Simultaneous Inversion.
Convolutional Model, Recursive Inversion, Colored Inversion, Sparse Spike Inversion. Stochastic Inversion.

INTERPRETATION
Amplitude, Signature, Seismic Stratigraphy, Noise, Multiples, Side-Swipes, Diffraction, Seismisc Attributes Analysis , Amplitude Interpretation, modern Workstations Interpretation programs Workflows





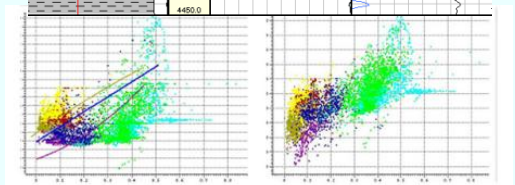


TABLE 4.1—EQUATIONS FOR FRACTURE LENGTH, MAXIMUM FRACTURE WIDTH, AND INJECTION PRESSURE FOR CONSTANT INJECTION RATE

PKN Model

$L(t)$	$w(0,t)$	$p(0,t)-\sigma_H$
$C_1\left[\frac{Gq_0^3}{(1-\nu)\mu h_f^4}\right]^{1/5} t^{4/5}$	$C_2\left[\frac{(1-\nu)q_0^3\mu}{Gh_f}\right]^{1/5} t^{1/5}$	$C_3\left[\frac{Gq_0^3\mu L}{(1-\nu)^3}\right]^{1/4} \frac{1}{H_f}$

GdK Model

$C_4\left[\frac{Gq_0^3}{(1-\nu)\mu h_f^3}\right]^{1/6} t^{2/3}$	$C_5\left[\frac{(1-\nu)q_0^3\mu}{Gh_f^3}\right]^{1/6} t^{1/3}$	$C_6\left[\frac{Gq_0\mu h_f^3}{(1-\nu)^3 L^2}\right]^{1/4} \frac{1}{2H_f}$

Observe that p_0 increases with fracture length and thus treatment time for PKN models and decreases with fracture length for GdK-type models.

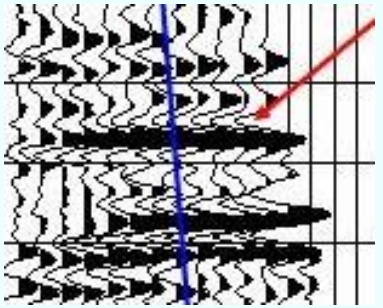
AVO INTERPRETATION AND ROCK PHYSICS
Concepts of Space-Statistics, Heterogeneity , Anisotropy, Variographic Functions and Structure (Lag, Nugget, Range, Sill), Variogram Models, Covariant and Fractal Models, REV (Representative Effective Volume) and Measurements Resolution.
The Effektive-Volumes: Gassmann, Hertz-Mindlin,Voigt, Reuss, Hill, Hashin-Strickman, CCT, SCA,DEM Models,
Sonic-Sampling ln - Field
Seismic-Sampling ln - Field
Velocity Models and Anisotropy
Linearized Models of the Zoeppritz Equation, Shuey Equation, Angel-Stacks, Cube-Stacks,
NI and Poisson Reflectivity
Reservoir-Impedance , AVO Classes 1,2,3 , Seismic Signatures, AVO Attributes Analysis

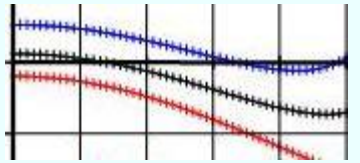
SEISMIC ATTRIBUTES ANALYSIS
Interpretive Processing for Seismic Attributes, Amplitude, Time and Complex Attributes, Spectral Decomposition. Multiattributes Interpretation

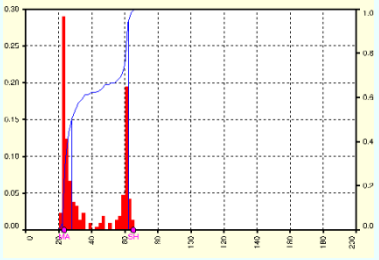
CLASTIC AND CARBONATE PETROPHYSICS
The Archie´s Equation and Archies Parameters: (a,m,n,F), Porosity Partitioning, Vsh and Sw Determination, Saraband Model, Dual Water Model, Sw Equations for Shaley-Sands Analysis, Lucia Classification, Porosity /Secondary Porosity classification and m-Dependency, Saturation Zones, Capillary Pressure Curve, Winland / Fock and Munn theories,
The General Parallel Conductor Model, the Dual-Porosity Model , Special Core Analysis

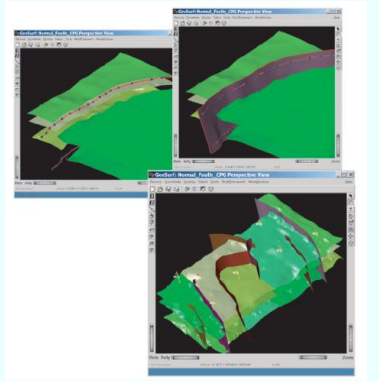
STATIC SIMULATION
SEISMIC AND PETROPHYSICAL RESERVOIR CHARACTERIZATION, STATIC SIMULATION IMPLEMENTING MODELS
3D Seismic Visualization, 3D Modeling, the Seismic Impedance, Coherence, Steering Cube, Inline/Crossline Sections, the Attributes Cube, Structural Models,
Fault Modeling, Pillar Gridding, Zonation and Layering, Facies Modeling,
Petrophysical Modeling, Upscaling, Variogram Modeling, Kriging Algorithms, Sequential Gaussian Simulation, Multiple Realizations Models, Neural Networks Estimation Models
Electrofacies concepts, Volume Calculation, Target Definition, Well Design

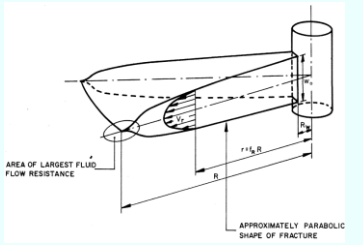
TARGETS
Oil and Gas Targets, Hot Dry Rock , Hydrogeothermal , High Entalpy Targets







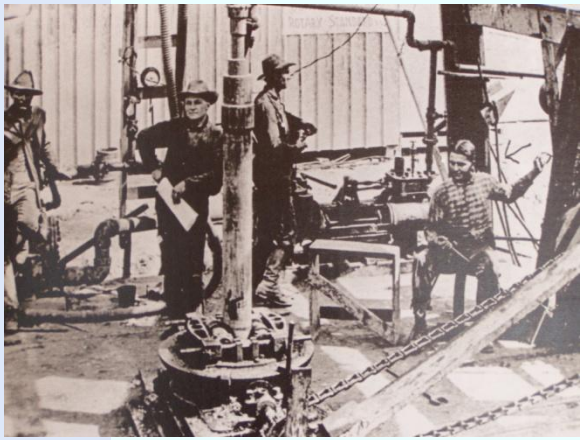


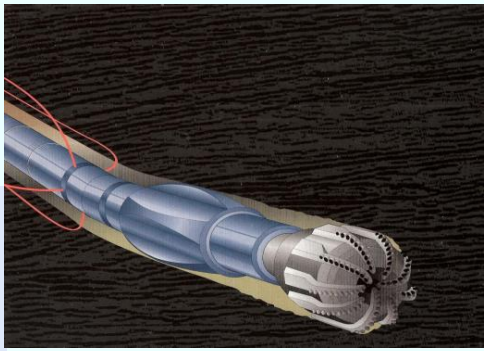


DRILLING PRIMER
History of Drilling Methods
Types of Wells and Well Patterns
The Drilling Process
Drilling Rights
Drilling a Well
Production Performance Ratios
Well Productivity
Modern Drilling Methods
Activities

DRILLING AND COMPLETIONS
Rotary Drilling
Casing
Completions
Formation Damage and Stimulation
Typical Drilling Problems
Activities

SURFACE FACILITIES
Onshore Facilities
Offshore Facilities
Fluid Transport Facilities
Pipe Flow
Refineries
Urban Operations – The Barnett Shale
Activities





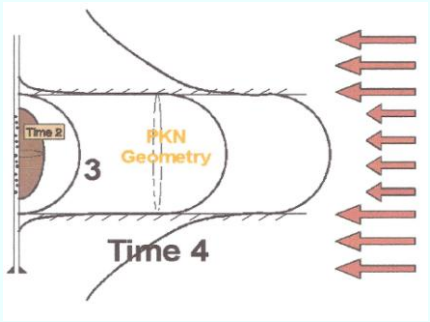
WELL LOGGING
Well Logging Principles
Direct Measurement Logs
Lithology Logs
Porosity Logs
Resistivity Logs
Other Types of Logs
Reservoir Characterization Issues
Activities

TRANSIENT WELL TESTING
Pressure Transient Testing
Oil Well Pressure Transient Testing
Gas Well Pressure Transient Testing
Gas Well Deliverability
Summary of Transient Well Testing
Activities

PRODUCTION EVALUATION TECHNIQUES
Decline Curve Analysis
Probabilistic Decline Curve Analysis
Material Balance
Production Performance Ratios and Drive Mechanisms
Wellbore-Reservoir Coupling
Tracer Tests
Activities

RESERVOIR FLOW MODELING
Field Performance Data
Data Management
Reservoir Characterization
Green Field Flow Modeling
Brown Field Flow Modeling
Activities

RECOVERY AND RESERVES
Recovery
Reserve Definitions
Reserve Determination Methods
Decline Curve Analysis



INTERPRETATION WITH PROFESSIONAL SOFTWARE

SEISMIC INTERPRETATION
Data Loading: SEGY, Creation of a Steering Cube, Horizon Cube etc, Well-Tie, Visualization of Horizons Slices, Inline , Xline, Transverse, Horizontal Sections, Autotracking, Anttracking, Attributes Analysis, Volume Rendering, Spectral Decomposition, Properties Crossplotting, Velocity Analysis, Sequence Stratigraphy

LOG INTERPRETATION
Data loading: LAS, DLIS, ASCII, Format Logs, Merge/Shift, SCAL.
Calculation of PHI,Vsh, PHIeff, Frequency Plots, RHOB-NPHI Xplot, Pickett Xplot, Complex Lithology Xplots, Sw, Shy,K, Pay Volume determination.
Single Well and Multi-Well Interpretation

STATIC MODELING SOFTWARE
Fault Modeling, Pillar Gridding, Zonation and Layering, Facies Modeling, Petrophysical Modeling, Upscaling, Well Design

DYNAMIC SIMULATION SOFTWARE
Overview of the Modeling Process, Conceptual Reservoir Scales, Reservoir Structure, Fluid and Rock-Fluid Interaction, Reservoir Simulation, Reservoir Architecture, Data Preparation, History Matching, Predictions
Dynamic Simulation using "IFLO" software.
Reservoir Flow Modeling:
Input Data
Green Field Model Workflow
Brown Field Model Workflow
Integrated Flow Model (IFLO) Demonstration

Course Books:

- J.R. Fanchi - Nontechnical Guide to Petroleum Geology, Exploration, Drilling and Production (3rd Edition) by Norman J. Hyne (PennWell, 2012)
- GeoNeurale
-Introduction to Geothermal and Petroleum Exploration
-Course Notes

Instructor's Biography

John R. Fanchi is a Professor in the Department of Engineering at Texas Christian University in Fort Worth, Texas. He is holder of the Matthews Chair of Petroleum Engineering. He has taught petroleum and energy engineering courses at TCU and at the Colorado School of Mines, and worked in the technology centers of four energy companies. He co-edited Volume 1 General Engineering of the SPE Petroleum Engineering Handbook (with L. Lake, SPE, 2006), and is the author of several books, including Integrated Reservoir Asset Management (Elsevier, 2010), Energy in the 21st Century, 2nd Edition (with C.J. Fanchi, World Scientific, 2010), Principles of Applied Reservoir Simulation, 3rd Edition (Elsevier, 2006), Math Refresher for Scientists and Engineers, 3rd Edition (Wiley, 2006), Energy: Technology and Directions for the Future (Elsevier-Academic Press, 2004), Shared Earth Modeling (Elsevier, 2002), Integrated Flow Modeling (Elsevier, 2000), and Parametrized Relativistic Quantum Theory (Kluwer, 1993). Dr. Fanchi was Director of the Consortium for Integrated Flow Modeling at CSM and has a Ph.D. in physics from the University of Houston.

Angelo Piasentin, leads since 2007 the scientific course administration at GeoNeurale - Munich.
He graduated in Geosciences with Internato in Geophysics at the University of Padua. He worked with all major oil service companies as a Mud-Logging, Data Logging Engineer, MWD-LWD Engineer in oil exploration operations in 4 continents in projects for Agip, BEB, BP, Chevron, Ciepsa, Coastal Oil and Gas, Deutsche Texaco, Elf, Enterprise Oil, Ina, Maersk Oil, MND, Mobil, NAM, Norsk Hydro, Pennzoil, Repsol, Shell, Sonatrach, Statoil,Texaco, Vermilion, Wintershall.
He progressed in the Geothermal and Oil Exploration working as a Petrophysicist and Geoscientist.
He was involved alltogether in more than 60 operations projects in the Oil/Gas and Geothermal Exploration.
He participated to the course development of Neural Network Applications for the Petrophysical and Geophysical Analysis and Integrated Geostatistical and Petrophysical Applications.
Authored papers and publications and presented three patents for new geothermal exploration Systems and new methods to integrate Petrophysical Analysis in the Pre-Stack Seismic Inversion with distribution of Petrophysical properties in the 3D Seismic Volume.

REGISTRATION FORM

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