

# TECHNICAL SPECIFICATIONS



## TemisFlow™

Petroleum System Modeling

### Software Presentation

TemisFlow™ is the next-generation solution for multi-dimensional basin modeling, offering all the functionalities required to understand and model oil and gas generation, migration and accumulation processes. Built upon 30 years of R&D for numerical modeling of petroleum systems, it enjoys a unique reputation for scientific rigor and sound physical basis.

TemisFlow™ unified workflow offers the following key stages:

- Present day model building (1D, M1D, 2D, 3D)
- Restoration through time
- Simulations (temperature, maturity, expulsion, pressure, migration)
- Calibration
- Post-Processing

TemisFlow™ applicability ranges from regional resources evaluation and play assessment, prospect generation and ranking to pre-drill risk assessment, including pore pressure prediction and drilling optimization in overpressured areas.

### Functionalities & Algorithms

#### SCENARIO MANAGER

- Step by step workflow
- Tracking of the modifications and hypothesis through a Scenario Tree
- No duplication of unmodified data

#### GEOLOGICAL FRAMEWORK AND GEOGRID

- Geological Framework concept to gather all available data (horizons interpretation, facies and kerogen distribution) and describe basin history (erosion, salt movement...)
- Data can be of heterogeneous domain and meshing
- 1D, M1D, 2D or 3D
- User-defined extractions to build consistent simulation grids
- Task manager for quality control and automatic corrections
- Interactive 2D and 3D edition
- Easy to update

#### BACKSTRIPPING

- Interactive backstripping decoupled from simulation
- Visualization of the grid evolution through time in pre-processing

#### ADVANCED RESTORATION PROCESS

- Hiatus
- Multiple erosion events
- Multi-layers thickness variations
- Multiple lithology changes through time
- Easy and interactive definition

#### SALT RESTORATION

- Multi-layer Thickness Variations and/or Lithology Changes Events for salt diapirism and canopies development
- Direct volume computation from thickness maps for QC
- Automatic routine based on basin regional tectonics and accounting for sediment loading effect on diapirism

#### MAP EDITOR

- Handles horizons, property maps, clouds of points and grids
- Multi map visualization
- Regular or scottish meshes
- Interactive drawing and painting
- Interactive mesh edition
- Multiple variable operations
- Attributes and mapping computations: interpolation, smoothing, normalization, gradient, curvature...
- Fault digitalization as polylines or polygons

#### STRUCTURAL CLOSURE AND DRAINAGE AREAS COMPUTATION

- Very fast and direct computation on maps (structured or unstructured horizons)
- Accounts for reservoir porosity and thickness, as well as faults
- Filtering and reporting on traps of interest
- Possibility to export as polylines all generated traps and drainage areas

#### LITHOLOGY MANAGEMENT

- IFPen databank with reference lithologies
- Creation of user-defined or mixed lithologies
- Possibility to tune and define:
  - Depth-compaction curves
  - Permeability (thanks to Kozeny Carman, log(K) or user defined laws)
  - Thermal conductivity and radiogenic production
  - Relative permeabilities and capillary pressure curves

#### DIAGENESIS

- Chemical compaction for sandstone and chalk through pressure-dissolution phenomenon
- Chemical compaction for mudstone with dissolution of kaolinite or smectite, transport and mineral precipitation of illite

#### GEOCHEMICAL INFORMATION

- Definition of laterally variable Initial TOC, Initial HI and Net to Gross for each Source Rock layer
- IFPen or BP schemes with their associated databank
- Definition of all kinetics parameters for HC fractions and Source Rocks (viscosity, thermal reactivity, phase behavior...)
- User-defined multi-compositional HC systems and kinetic schemes
- Primary and secondary thermal crackings
- User-defined Vitrinite-Transformation Ratio law

#### UNCONVENTIONAL RESOURCES

- Computation of adsorbed HC quantities controlled by TOC evolution, pore pressure, temperature, kerogen kinetic, carbon mass balance and HC density
- Organic porosity calculated according to kerogen cracking
- Both processes fully coupled with expulsion and Darcy's migration simulations

#### BIOGENIC GAS

- Definition of labile (available to microbial activity) and labilizable (requiring a preliminary maturation) organic matter to assess biogenic gas generation
- Adsorption, dissolution and free transport of the biogenic gas
- Fully coupled with thermogenic processes

#### BIODEGRADATION

- Biodegradation process fully coupled with Darcy's migration
- Sensitivity to biodegradation definition for each component
- Bacterial activity controlled by temperature and pore space
- HC phase composition and viscosity affected throughout migration process

## HYDRATES AND TSR OCCURENCE RISK

- Risk given in residence time in the favorable window
- Post-processing computation
- Computed for all cells and at all ages of the grid

## THERMAL BOUNDARIES

- Several conditions: surface temperature, temperature at base upper mantle, temperature gradient, heat flow at base sediments or base upper mantle
- Automatic computation of surface temperatures from paleobathymetry and paleogeographic position during continental drifting
- Extraction of heat flow values at base of sediments from a simulation with advanced basement to remove the crust and reduce computation time

## ADVANCED THERMAL BASEMENT

- McKenzie or user-defined approach
- Complete description of the lithosphere accounting for heterogeneities both in structure and nature
- Homogeneous or heterogeneous rifting events (geometric and thermal beta factors)
- Lithology changes through time
- Coupling of the lithosphere with the sedimentation of the model
- Strong thermal conductivities heterogeneities handling
- Blanketing effect modeling

## LATERAL BOUNDARIES

- User-defined boundaries to assign specific pressure and temperature conditions at the model edges through time
- Several pressure types to define: No Flux, Hydrostatics, Water-Head, Constant Pressure or Overpressure

## PIEZOMETRIC SURFACES

- Definition at each time step of the water table depth
- Reference surface for the pressure regime computation
- Possibility to define specific cases : water table below Sea Level (arid areas) or above Top Sediment (lakes)

## FULLY COUPLED AND PARALLELIZED SIMULATIONS

- Temperature, Pressure, Expulsion, decoupled or full Darcy Migration
- Non-compositional or multi-compositional simulations
- PVT computation through time
- Tuning of time steps and simulation control criteria
- Parallelization on several processors

## MAP BASED RAY TRACING SIMULATION

- Traps and drainage areas computation through time
- Runs on surfaces, structured and unstructured grids
- Accounts for basin deformation history
- Multiple source rocks and multiple reservoirs
- Accounts for petrophysical properties, lateral variations, stratigraphic trapping and faults
- Based on expulsion or migration simulation to predict trapped Gas/Oil volumes with API degree, GOR and column height
- Upward or downward migration from source rock layers

## Results Analysis

### THERMAL AND MATURITY PROPERTIES

- Temperature regime
- Maturity indicators: Vitrinite Reflectance, Tmax, S2
- Various TOCs: Rock-Eval TOC, Current TOC, Residual Solid TOC
- Source Rock Maturity Timing

### PRESSURE PROPERTIES

- Water Pressure and Overpressure
- Mud Weight
- Effective Stress
- Hydraulic Fracturing

### EXPULSION AND MIGRATION PROPERTIES

- Adsorbed and retained masses
- Expelled and Migrated masses
- HC Phase Saturation
- Biodegradation Index
- PVT properties: Volumes, API Degree, BO, BG...

### BUNCH OF VISUALIZATION TOOLS

- 3D Viewer
- Map Viewer
- Cross Plot Viewer
- Cross Section Viewer
- Log Viewer
- Statistics Viewer

## DATA EXTRACTION & CALIBRATION

- Map extractions
- Well extractions
- Burial analysis
- Log pressure analysis
- Cell history
- Section extractions

## FILTERING & REPORTING

- Filtering capabilities on simulated output
- Synchronization between viewers
- Statistics and quantitative report on areas of interest

## Data Management

### DATA IMPORT/EXPORT

The following formats are available:

- Horizons in ASCII cloud of points, CPS3 ASCII and binary, Fraca, GMap, gOcad Tsurf and Z-Map+
- Property maps in ASCII cloud of points, CPS3 ASCII and binary, Fraca, GMap and Z-Map+
- Cultural data in shape files and .leg format
- Polylines in ASCII, CPS3 and Z-Map+
- Well paths and logs in ASCII, LAS 2.0 and 3.0, and OBDAT2
- Faults in CPS3 ASCII and binary, Fraca, EarthVision, gOcad Tsurf and Z-Map+
- 2D section templates in .ext format and flat file
- Lithology and geochemical libraries in .xml and .ltds formats
- Stratigraphic scales in .temis format
- Temis Suite studies (1D, 2D, and 3D)
- Seismic in XML and SEG-Y
- 3D grid in GRDECL and RESQML
- Templates, preferences and color scales from OpenFlow™
- Groovy scripts and packages
- Data exchange between OpenFlow Suite projects

### DATABASE

- MySQL or Oracle database
- Improved data security and integrity, reduced data storage
- User and project administration

### OTHER PLATFORM FACILITIES

- Colorscale & unit system management
- Remote machines or cluster simulation launcher
- Simulation monitoring
- Online & contextual Help

## Extensions & Customization

- Direct link with CougarFlow® for sensitivity and risk analysis
- Direct link with DionisosFlow® for elaborated facies, kerogen, and paleobathymetry maps
- Direct link with KronosFlow for advanced 2D restoration in structurally complex environment
- Petrel link for direct maps, wells, faults and grids exchange
- Scripting facility based upon Groovy language

## System Requirements

- **Operating Systems:**
  - Windows 10
  - Linux Red Hat 7 for calculators only (unavailable GUI)
- **RAM:** 32 Gb or more recommended, 16Gb minimum
- **Minimum free disk space:** 5 Gb (for installation files)
- **CPU:** x86-64 processors (Opteron, CoreDuo, Core2Duo, Xeon & EMT64, Nehalem, Westmere, Sandy Bridge, Core i3, i5, i7)
- **Dualcore or Quadcore:** 2 GHz or more recommended
- **Graphics board:** NVIDIA (except Quadro FX 1000, Quadro FX 3500, Quadro NVS 110 M and Quadro NVS 280 SD) with recent driver (at least OpenGL 3.3 -driver 330 or later)
- Openmotif rpm package must be installed on Linux
- **Database:** MySQL 5.5, 5.6.X (with X superior to 22), 5.7 or 8.0 and Oracle 11g, 12c, 18c or 19c
- FlexLM 11.13.1.3 server for licensing



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