Permedia MPath – Fluid Flow Simulators

Modeling flow

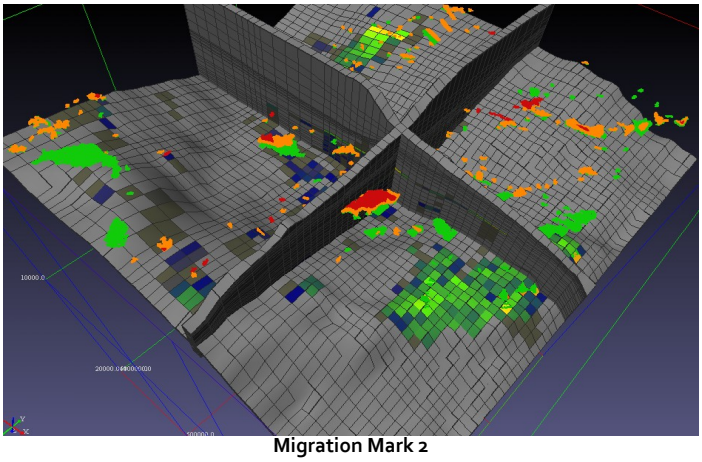
Permedia MPath includes a full suite of fluid flow simulators for any modeling project, be it migration in a full basin model or pressure simulations in reservoirs.

Basin simulators

For basin modelers, MPath's basin tools provide the ideal toolkit for quantifying volumes and fluid properties, and evaluating petroleum containment potential and emplacement patterns. And the same set of tools can be used to evaluate petroleum flow and emplacement ranging from core to basin scales. Easy to use, with similar workflows at each scale of investigation, MPath can model 3D, multi-scale, multi-million gridcell petroleum transport in a matter of minutes.

Migration Mark 2

Permedia's second generation Migration simulator, Mark 2 was released in spring of 2008. It models the flow of petroleum fluids under the assumption of a low capillary-number ($<10^{-4}$) regime, and runs natively on basin modeling meshes.



Migration Mark 2

Some of Mark 2's features include:

- fast performance
- ability to run on any basin mesh without re-gridding
- n-Component, multi-phase
- mass conservation
- handles downward migration
- reactions (e.g., secondary cracking, biodegradation)
- downscaling with "conditioning fabrics"
- advanced post-processing
- custom PVT Plugin framework
- custom Reaction Plugin framework, which allows users to define their own fluid and rock-fluid reactions

Typical uses:

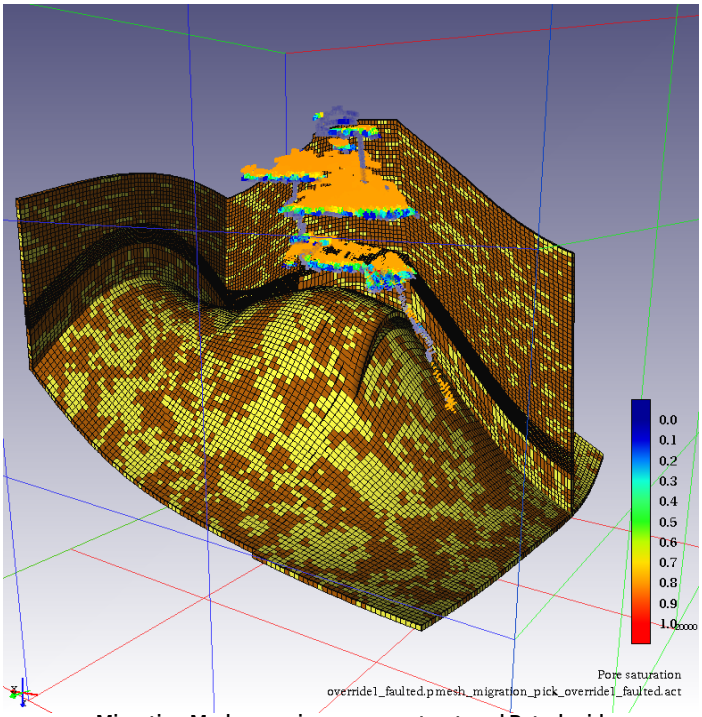
- basin-scale petroleum migration
- reservoir filling
- column height analysis

Migration Mark 3

Migration Mark 3 is Permedia's third generation migration simulator. It shares the same features as Mark 2 and adds additional features:

- multi-core processing
- runs on any structured or unstructured mesh both at basin and reservoir scales
- adaptive gridding around fault surfaces
- handles tilted fluid contacts, even within elements

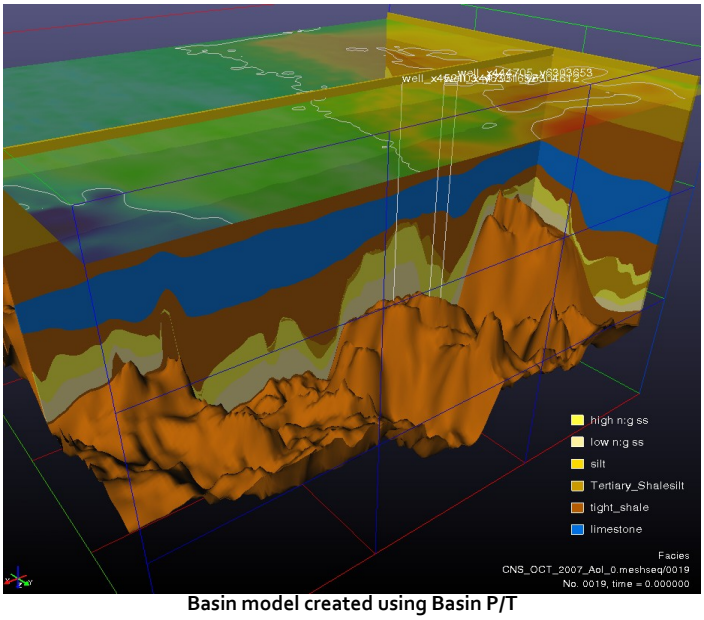
Mark 3 is used in MPath Reservoir Filling. Currently in development, Mark 3 will ultimately replace Mark 2 and be deployed both for basin-scale migration and reservoir filling studies.



Migration Mark 3 running on an unstructured Petrel grid

Basin P/T

Basin P/T forward models a sedimentary basin, solving for pressures and temperatures (not unlike the basin simulators in PetroMod and Temis). It uses a finite volume technique and interfaces onto different linear solvers.



Basin model created using Basin P/T

Features include:

- flexible, time-based boundary conditions
- link with different lithology property schemes
- runs on models built in packages like Gocad and Petrel, requiring only simple handshaking of variables

Typical uses:

- calculate basin temperature and pressure evolution
- calculate petroleum generation and expulsion on the basin results and migrate fluids using Migration

Reservoir simulators

MPath's reservoir simulators provide insights into observed composition variations, fluid continuity assessments, and pressure/fluid property compartmentalization.

All of MPath's reservoir simulators share the following characteristics:

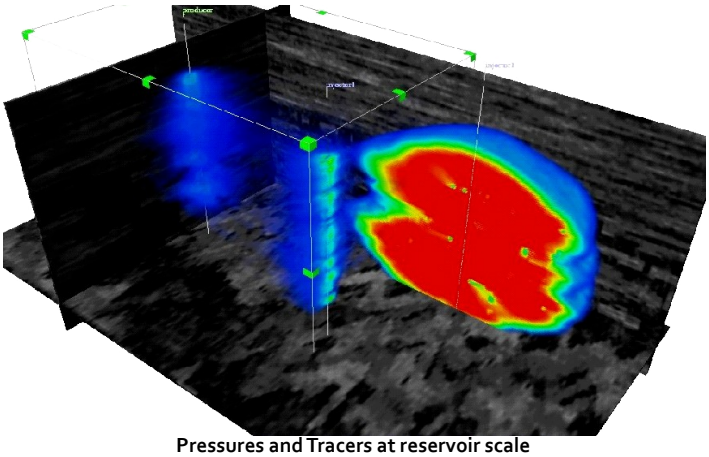
- founded on classical Darcy flow formulations
- use finite volume discretization
- conserve mass
- special handling to ensure optimized runtimes on volume and mesh inputs
- work with all volume and mesh formats supported by the Permedia platform
- have flexible boundary conditions
- well-based sources and sinks
- interface with different linear solvers including ones that use OpenMP, MPI and soon CUDA

Pressures and Tracers

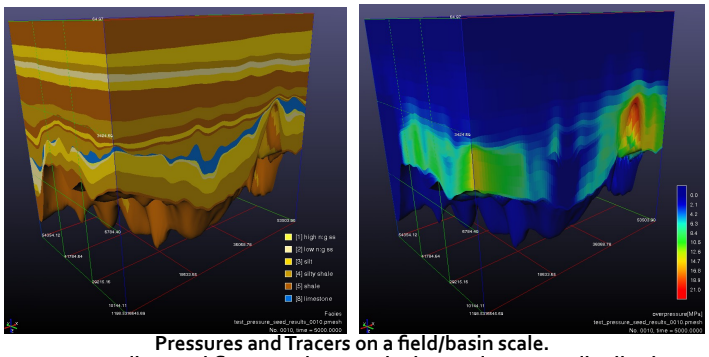
Pressures and Tracers is a single-phase compressible and incompressible fluid simulator that can also model the transport of any number of inert tracers.

Typical uses:

- connectivity analysis
- ranking and qualifying different geostatistical models
- pressure studies
- pressure assessment via "pressure seeding" workflows



Pressures and Tracers at reservoir scale



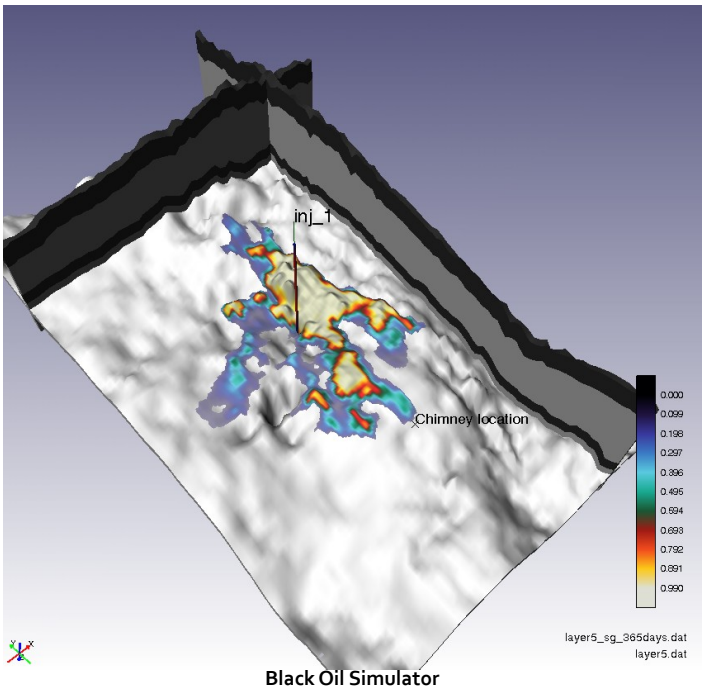
Pressures and Tracers on a field/basin scale.
Pressure seeding workflows used to match observed pressure distributions.

Black Oil Simulator (BOS)

A fully implicit, three phase, classical black oil production simulator, BOS has similar features to Eclipse and CMG Imex. Independent tests show that it is currently ~5x faster than Eclipse.

Typical uses:

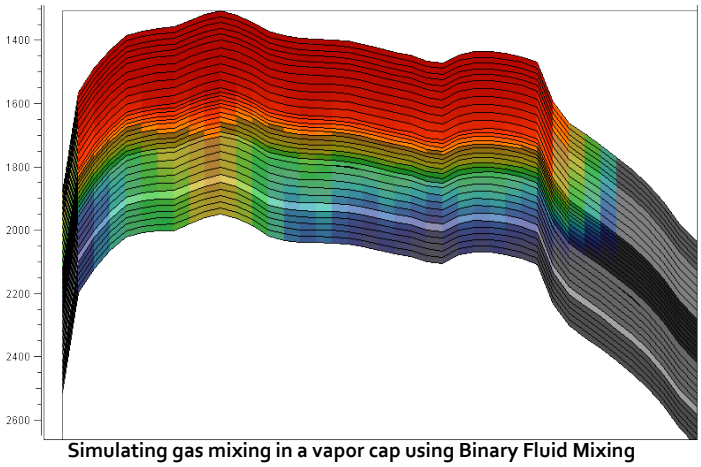
- modeling oil and gas production where the effects of fluid phase composition on flow behavior do not need to be considered
- two component (oil-gas) reservoir filling



Black Oil Simulator

Fluid Mixing (Binary Fluids)

Binary Fluid Mixing can take any two end-member fluids and mix them under the effects of convection, diffusion and dispersion. Density and viscosity are set via user defined equations, where density and viscosity are a function of end-member fluid concentration and pressure. The fluids are assumed to be miscible, but may be compressible.



Simulating gas mixing in a vapor cap using Binary Fluid Mixing

Typical uses:

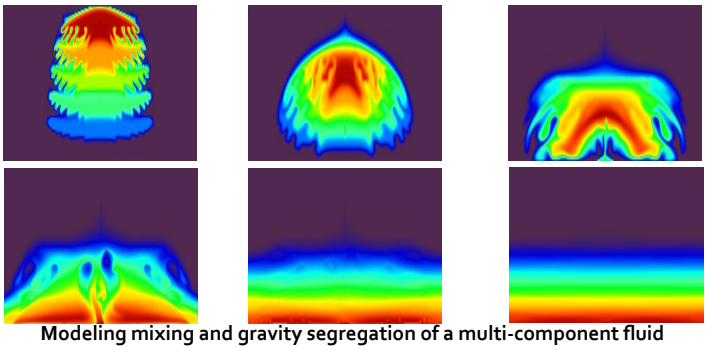
- charging a reservoir with two distinct oils or gases
- quantifying reservoir fluid mixing times
- assessing the impact of reservoir geometries and properties on filling and mixing

Fluid Mixing (n-Comp Single Phase)

n-Component Single Phase Fluid Mixing models the flow of a multi-component fluid in a single phase.

Features include:

- fluid properties derived from an equation of state (EOS) module
- EOS implemented as a plugin allowing end-user customization
- component information can be imported from PVT-Sim
- models temperature effects, diffusion, convection, gravity segregation of components


Modeling mixing and gravity segregation of a multi-component fluid

Typical uses:

- modeling compositional reservoir charging and mixing

Fluid Mixing (n-Comp Multi Phase)

n-Component Multi-Phase Fluid Mixing adds multi-phase capabilities to the n-Comp Single Phase simulator.

Fluid Mixing (Binary Fluid / n-Comp Single Phase + water)

Adds a separate water phase to the n-Comp Single Phase and Binary Fluid simulators. All fluid mixing occurs in the non-water phase.

Platforms

Permedia MPath runs on Windows (XP/Vista/7) and Linux (32 and 64).

For more information

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