

Dionisos 4 and Extension

A Joint Industry Project

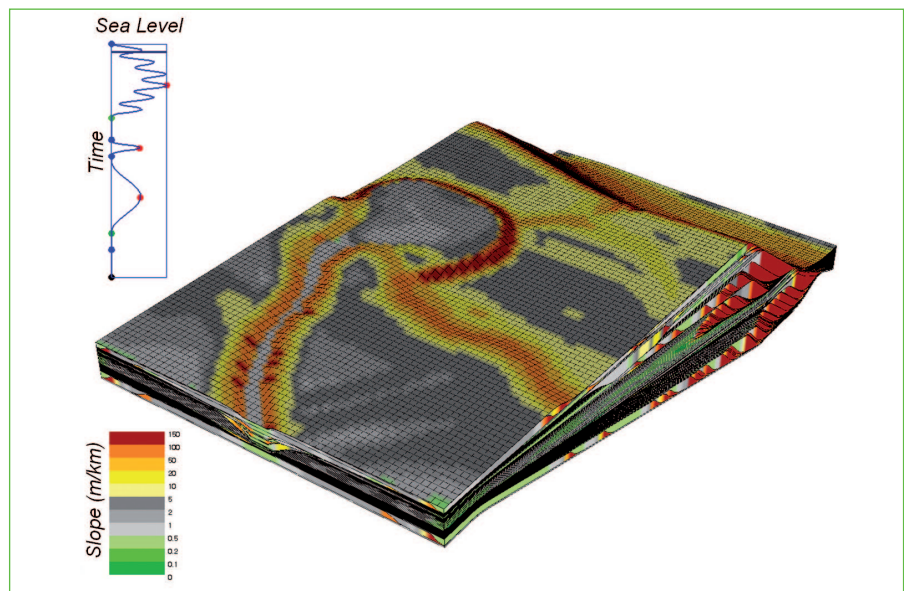
Advanced basin-scale 3D stratigraphic modeling

Objectives and technical challenges

Dionisos™ is a 3D stratigraphic forward model based on a basin-scale deterministic approach, designed to simulate the evolution of sedimentary systems at basin to prospect scales. Recent applications of Dionisos™ in subsurface case studies have illustrated the robustness and utility of this approach in:

- deltaic systems (e.g. Cenozoic Fm. along the Mahakam and Niger Deltas);
- carbonate (e.g. Permian isolated platforms in the Caspian Sea, Natih Fm. in Oman, Khuff Fm. in Saudi Arabia);
- turbiditic environments (e.g. Pab Fm. in Pakistan);
- complex tectonics settings (e.g. with salt diapirs, such as along the Brazilian margin, or with growth faults such as in the Gulf of Mexico).

The greatest challenge is now to use stratigraphic modeling not only to predict geometries but also facies distribution, and thus better estimate large-scale reservoir and source rock properties. The main objective of this Joint



3D stratigraphic modeling of the evolution of a clastic passive margin.

Industry Project (JIP) is thus to improve and validate basin deformation, carbonate and evaporite production and sediment transport modules used in Dionisos™.

Background

Dionisos™ has been developed at IFP Energies nouvelles over the past 12 years. From the definition of key structural and sedimentary parameters, such as basin deformation, sediment supply and

sediment transport, Dionisos™ performs a simulation of sedimentary processes and provides a 3D numerical grid that represents the basin structure and stratigraphy, yielding quantitative insights into reservoir properties. Facies and paleobathymetry maps can then be exported to a basin model to constrain the simulation of HC genesis, migration and trapping, leading to better basin to prospect evaluations.

The main principles of Dionisos™ are the following:

- basin deformation is defined as the sum of user-defined vertical subsidence, eustatic curve, hydrostatic compaction and elastic flexure. To simulate more complex tectonics, a growth fault can be introduced to study compressive/extensive domains, and several salt layers can be taken into account;
- sediment supply is defined as the sum of user-defined in/out flows, a maximum weathering rate and a carbonate production function of water depth, wave energy and ecological rules;
- sediments are then transported using a water-driven diffusion equation. The sediment discharge carried by water, waves or gravity is assumed to be equal to the transport capacity of each transport agent, under the constraint that erosion cannot exceed the maximum erosion rate defined by weathering processes.

Program

The first two years of the Dionisos 4 JIP have focused on improvement of the sediment production and transport laws:

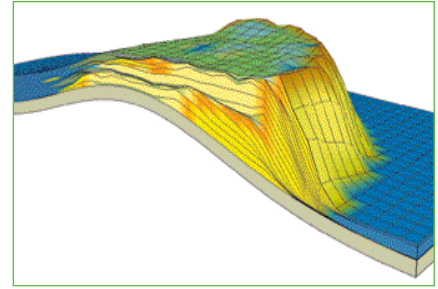
- water mass balance between runoff, rainfall and evaporation is computed in order to define lake levels and estimate the potential precipitation rate of evaporites;
- sediment transport is simulated using a non-linear water-driven diffusion equation in continental and marine environments, linked to a diffusive suspended plume equation in shallow marine realms.

The next step aims to provide a detailed physical and theoretical formulation for the basic equations in Dionisos™, including the testing of these equations with data from published literature, subsurface and flume experiments. The goal is to replicate the large-scale dynamics of these experiments and basins, in particular the formation and evolution of incised valleys, changes in slope gradient in space and time and all feedbacks with depositional thicknesses along the profile and the resulting distribution of sand and mud.

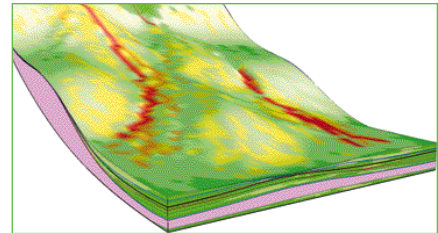
The last step of the extension will focus on the validation and calibration of Dionisos™ on case studies in a broad range of tectonic settings and sedimentary environments, such as the Suez Rift and the South Pyrenean Foreland. The ability of Dionisos™ to reproduce (or propose new) fundamental stratigraphic principles will be tested on the basis of the published geological and structural models for these basins.

Deliverables

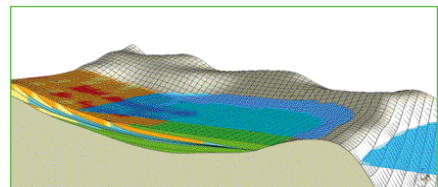
New members will receive five permanent licenses and all the partners will receive regular upgrades. A Dionisos™ user meeting will be held every 6 months to present and train partners in the latest functionalities of Dionisos™ and to discuss the ongoing work program.



Example of a reef-lagoon system.



Interaction between salt diapirs and turbiditic systems.



Simulation of lacustrine environments.

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