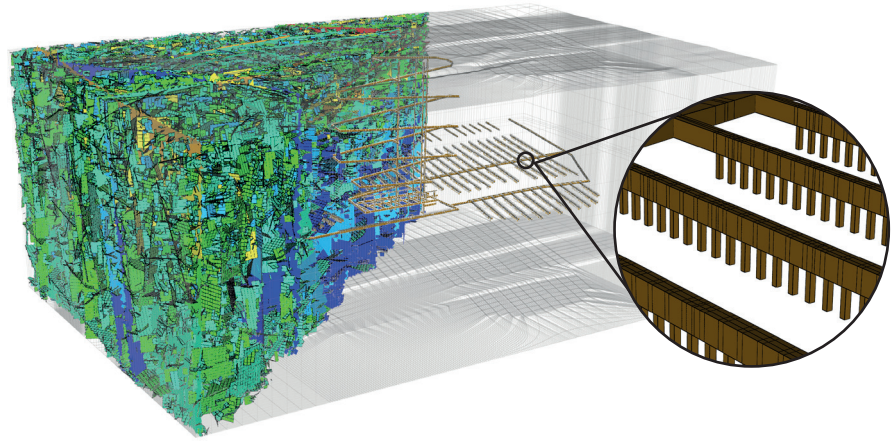
ConnectFlow®
Hydrogeological Modelling Suite



Geological disposal facility, with CPM tunnels embedded within a site-scale DFN model of fractured bedrocks

ConnectFlow® provides a flexible, multi-scale modelling environment for simulating the migration of fluids and solutes through fractured and porous rocks, enabling the integrated assessment of structural geology, engineering, hydrogeology, hydro-geochemistry and contaminant transport processes.

Overview

ConnectFlow offers industry-leading capabilities in the representation of fractured rock hydrogeology and hydrogeochemistry. The software provides a discrete representation of rock fractures and their role as fluid conduits, as well as the more classical porous medium representation of geology. A variety of physics are supported to address a wide range of subsurface issues relating to geological disposal of radioactive waste, rock engineering, well performance, and assessing the migration and remediation of contaminants.

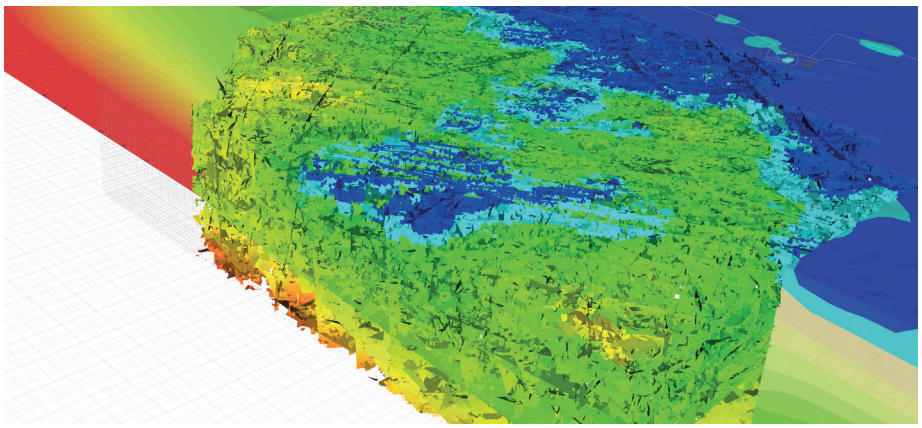
ConnectFlow is developed under a QA programme that conforms to the ISO 9001 international standard.

DFN module

The Discrete Fracture Network (DFN) concept is a computational approach in which rock fractures are explicitly represented in the model, with individually-assigned geometric and hydraulic properties. The technique is well suited to modelling geological regimes in which flow and transport is predominantly confined to the void-space of an interconnected network of fractures.

ConnectFlow's DFN module has been developed over a period of more than 25 years and has been extensively verified in international comparison exercises. The software employs a highly efficient implementation of the finite-element method, allowing it to handle models comprising tens of millions of fractures. The DFN module incorporates options for:

- Deterministic and stochastic fracture generation
- Steady-state and transient groundwater flow simulation
- Generation of regular and irregular meshes (e.g. ZMap, VIP, FEMGEN and CAD formats)
- Multi-component solute transport through fracture networks, with support for rock-matrix diffusion
- Reactive transport, via an interface with the USGS geochemical modelling software PHREEQC
- Upscaling of DFN models to equivalent CPM (ECPM) models



Site-scale DFN nested within a regional CPM model

CPM module

Continuous Porous Medium (CPM) models are appropriate for certain types of rock and porous materials, in which flow is transmitted through the connected pore-space between the solid grains of the rock matrix. Examples include sandstones, soils, clays and unconsolidated deposits.

ConnectFlow's CPM module supports a range of facilities for specifying the geometry of the model domain, the properties of rocks, fluids and solutes and the physics to be included in the system.

It incorporates options for:

- Steady-state and transient flow in saturated and unsaturated conditions
- Saline groundwater flow with variable density
- Coupled salt and heat transport
- Multi-component solute transport with chemical reactions, via interaction with PHREEQC
- Contaminant transport, including the effects of advection, dispersion, sorption, rock matrix diffusion and solubility limitation
- Radioactive decay chains, including interacting chains linked by solubility limitation of a common radionuclide
- Sensitivity to model parameters, using the adjoint method

Combined models

Uniquely among subsurface flow modelling software, ConnectFlow also offers the option to construct embedded models that integrate one or more sub-models of different types. That is, the model can be divided into separate domains that use either the CPM or DFN concepts, nested within one another. Internal boundary conditions are created at the domain interfaces to ensure continuity of pressure and conservation of mass. This affords the user far greater flexibility in the construction of subsurface models, allowing them to, for example:

- Model detailed flow-fields in fractures around tunnels, shafts or boreholes, using localised DFN models embedded within a CPM rock volume
- Apply the CPM concept to a backfilled tunnel or shaft, nested within a larger, site-scale DFN model of a fractured rock mass
- Include continuous representations of deterministic faults and fractured zones through DFN and CPM sub-models

User interface

Powered by the VTK graphics library, ConnectFlow's graphical user interface (GUI) provides users with advanced visualisation tools that can be applied to a wide range of 3D subsurface data formats. Examples include visualisation of fracture networks, colouring data by physical attributes and analysis of model results, such as particle tracking pathlines. The GUI can also be used to construct and run ConnectFlow models from within the graphical environment.

Support for interacting with familiar external subsurface modelling packages is also included, for example GOCAD® file formats, ECLIPSE grids, ESRI™ surfaces, and many others.

Consultancy

Our multi-disciplinary team consists of professional scientists and engineers, many of whom are internationally recognised within their fields. From our offices in Harwell, Oxfordshire (UK), we apply years of experience in scientific consultancy to deliver bespoke, tailored solutions to a global customer base.

We work closely with our clients to provide links between data and understanding in diverse geoscience disciplines: from geology, hydrogeology and geochemistry to geophysics and reservoir engineering.

Case studies

ConnectFlow is used by a number of international organisations and academic institutions.

Recent examples include:

- Site characterisation and safety-assessment modelling for construction licensing of spent nuclear fuel repositories in Finland (Posiva) and Sweden (SKB)
- Site-descriptive modelling, engineering optimisation and environmental safety modelling at Low Level Waste Repository (LLWR), in Cumbria, UK
- Assessment of contaminated land at Sellafield, Cumbria, UK
- Site-descriptive modelling for the Japanese radioactive waste disposal siting programme
- Fractured reservoir modelling of oilfield assets in the Middle East
- Hydrostructural modelling of geothermal reservoirs in Australia and Indonesia

Contact

ConnectFlow is available to license from Wood. For more information on ConnectFlow pricing, our consultancy services, or for technical support, please contact:

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