

# Modeling lithological heterogeneity

## Enhanced realism

Geomodelers looking to enhance the realism in their models can use Permedia™ Petroleum Systems modeling software to get truly heterogeneous lithology assignments in basin models. The software offers unique lithology proportion technology and a lithology mixing engine that allow modelers to obtain far more geologically realistic results while reducing subjectivity and complexity.

Traditional basin modeling provides regional-based pressure and temperature prediction. These predictions are based primarily on the lithology assignment and relative ages of each layer. In classic models, layers are assigned a uniform lithology, or a category map is used to describe lithology regions per layer. Providing heterogeneous lithologies using these crude assignments is a challenge. The facies boundaries are typically highly quantized – for any given element, there is one lithology assignment. Modelers must make decisions about where one lithology stops and another starts. This subjectivity can have significant consequences, particularly for petroleum systems analysis.

## Lithologies in proportion

Using Permedia software's lithology proportion technology and lithology mixing engine, modelers can build regional models with true lithological heterogeneity. Rather than having unrealistic discrete facies boundaries, proportion maps and volumes allow modelers to specify the percentage of each lithology in the model, retaining all the geological subtleties of seismic data. The results are much more geologically realistic, removing subjectivity about boundaries, such as where a shale ends and a siltstone begins, and allow for much more natural modeling of stratigraphic traps.

The technique works as follows: modelers assign any number of end-member lithologies to a map or volume, along with a fraction identifying the proportion of the lithology. For example, a map of the sand and shale proportions can be used to assign rock properties for a layer. The model then dynamically assigns lithologies based on user-defined mixing rules.

Proportion maps can be created by extracting a processed seismic property (e.g., semblance) from a seismic volume at a given map layer. Dark values might correspond to regions higher in shale, and lighter elements to those higher in sand. By normalizing the map to create a shale fraction map, it can be applied to a layer in the Earth model as a shale proportion map.

Even better, lithology proportion volumes allow modelers to assign lithology proportions across the entire model, obviating the need to create maps for each layer. For example, a Vshale

volume can be used to provide a shale proportion within the lithology definition of the entire basin model. Proportion volumes can be created using seismic facies modeling routines, geostatistics, and other techniques. Once added to the model, the software automatically creates lithology "maps" in the area where the volume is defined. And to define different proportions for specific layers, modelers can combine lithology maps and volumes – layer assignments take precedence over volume assignments, giving precise control over lithology assignment across the entire model.

## Dynamic assignment

Because the volume assignments are dynamic, the modeler can change the volume and the lithologies are automatically updated in the model. So if the modeler updates the seismic velocity model, there is no need to regenerate maps for each layer. The reverse is also true. As the lithology mixture for each layer is based on the geometric intersection of the volume and layer, modelers can change the layer geometries and new lithologies will automatically be calculated from the proportion volume.

Another benefit of the proportion assignment of lithologies is that it allows the use of pure end-member lithologies. The mixing is handled by the Permedia mixing engine, avoiding the need for lithology libraries with hundreds or even thousands of lithologies as in classic modeling systems.

Modeling lithological heterogeneity is essential for geological realism, and with its lithology proportion technology and mixing engine, Permedia software delivers in a way that is dynamic, flexible and easy-to-use.

