石油ポテンシャル評価のための三次元地質・堆積相モデリングワークフロー：仁賀保亜堆積盆女川層モデリングの例
Principal workflow of 3D geologic and facies modeling for petroleum potential evaluation: a case study of the Onnagawa Formation in the Nikaho subbasin, Akita, northeast Japan

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This paper presents principal workflow of three-dimensional (3D) geologic and facies modeling for the purpose of petroleum potential evaluation. Because the petroleum system factors are so complex, the modeling procedure tends to be various depending on the modeling purpose and geologic settings. This case study adopts the structural geological, sedimentological, sequence stratigraphical and geostatistical methods in the modeling to obtain precise results on the reservoir facies distributions, connectivity and volumetrics. The example modeling target is the Onnagawa Formation, which mainly consists of hybrid source and reservoir rock-type siliceous shale, distributed in the Nikaho subbasin of the Akita basin, northeast Japan. The major data sources are from exploration well and 2D/3D seismic survey data sets. This study conducted modeling mainly utilizing software on a workstation.

The first step starts with the 3D structural modeling using major stratigraphic surfaces, such as formation boundaries, which are derived from seismic horizons and well stratigraphic marker data. All these source data are interpolated and extrapolated to create a 3D horizon surface. In case 3D seismic survey data exists, horizon picking automatically leads to horizon surface creation.

The second step focuses on facies determination on the well logs (log facies) and seismic sections (seismic facies) to associate the rock property type with sedimentological framework. If needed, facies association, which is a group of associated facies, can be determined. In the case of the Nikaho subbasin, three facies associations were recognized. All the divided facies information is plotted on a map to create conceptual depositional model.

The third step conducts sequence stratigraphic division to create sedimentologically meaningful finer layers, by which basic modeling layers are created and detailed depositional system/facies distribution maps are created. In the case of the Nikaho subbasin, four depositional sequences were recognized in the Onnagawa Formation. The depositional process as a controlling factor of facies distributions is also discussed at this step.

The fourth step is the geostatistical integration of well-log petrophysics data and seismic attributes to determine reservoir properties of each facies class.

In the final step, geostatistical facies modeling is conducted for each depositional sequence unit. At this step, facies are distributed using stochastic simulation methods with well data as hard data and seismic attributes as soft data. Stochastic simulation method can be selected depending on the data condition

and ultimate purpose of the modeling. In the case of the Nikaho subbasin, sequential indicator simulation was selected for facies distribution simulation. Depositional trend in accordance with the estimated depositional systems and processes was also given as soft data to control facies distributions.

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