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Source and Reservoir Rock Distributions in Coal-Bearing Non-Marine Sediments within A Sequence/Tectono-Stratigraphic Framework: Implications for Non-Marine Rock Exploration

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Abstract

Coal-bearing non-marine sediments are one of major targets of hydrocarbon exploration, as it contains high source- and reservoir-rock potential. Since non-marine sediments are more heterogeneous in general than marine sediments, this paper attempted to construct a realistic and practical model for source and reservoir rock distributions in non-marine sediments within a sequence/tectono-stratigraphic framework, which focuses on controlling factors on the distribution patterns. This study selected 3,000 m-thick Eocene coal-bearing non-marine sediments in Hokkaido, Japan as a case study field to collect basic data for constructing and testing the source- and reservoir-rock distribution model. In addition to sedimentological field analysis, geochemical source-rock potential analysis was conducted, and relevant published data were also considered to obtain a comprehensive model.

The obtained non-marine sequence stratigraphic model indicates that a sequence boundary (SB) of a non-marine depositional sequence can be recognized at the bottom of an incised valley. A depositional sequence can be divided into lower half (Lowstand Systems Tract, Transgressive Systems Tract) and upper half (Highstand Systems Tract). The boundary between two is a maximum flooding surface (MFS), which is recognized in a marine incursion interval within fluvial sediments. Fluvial channel sandstones, which are major reservoir rocks in non-marine sediments, occur frequency in LST, lower TST and upper HST, whereas occur rarely in upper TST and lower HST. Coals and coaly mudstones, which show the highest organic geochemical potential and are considered as the major source rocks of non-marine sediments, occur dominantly in upper TST, if there is no large-scale marine incursion bed. With regard to spatial variation, high potential coal seams dominantly to occur at an area where sediment accumulation rate and accommodation rate related to basin subsidence are balanced within a basin. On the other hand, coal potential tends to be low in a highly subsiding area, where flooding and clastic dilution events are common, and in a subtle subsidence area, where coal preservation potential is low.

Introduction

Coal-bearing non-marine sediments are on the spotlight in recent hydrocarbon explorations, as it contains high source- and reservoir-rock potential. In Southeast Asia, coal-bearing non-marine sediments dominantly occur as syn-rift to early post rift sediments, and they are regarded as one of the major targets of hydrocarbon explorations. Since non-marine sediments are more heterogeneous in general than marine sediments, non-marine rock explorations commonly require a special model for source- and reservoir-rock distributions. In 1990's, some researchers tried to apply sequence stratigraphic concepts to non-marine sediments as a new genetic stratigraphic method, and proposed fundamental non-marine sequence models[1-6]. Although these studies presented general trend of source- and reservoir-rock distributions, especially in a vertical succession, it seems that we still need more case studies to construct a precise and practical model for the three-dimensional distributions of non-marine source and reservoir rocks, as actual distribution patterns tend to be more complex and variable in various tectonic settings. Since non-marine sedimentation is strongly controlled by various factors such as tectonics, climate and sea-level change[2], reexamination of the precise distribution model requires consideration of sedimentation controlling factors during source- and reservoir-rock deposition.

This study selected 3,000 m-thick Eocene coal-bearing non-marine sediments in Hokkaido, Japan as a case study field to collect basic data for constructing and testing the source- and reservoir-rock distribution model. In this case study field, we conducted a) sedimentological field survey for obtaining information on depositional sequence identification criteria and channel sandstone distributions, b) geochemical source-rock potential analysis for examining source rock distributions, c)