学　位　論　文　内　容　の　要　旨
Abstract of Doctoral Dissertation

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Basin and petroleum system modeling of the northern Mannar Basin, offshore Sri Lanka
(スリランカ沖北部マナー堆積盆地の堆積盆石油システムモデリング)

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ABSTRACT

Gulf of Mannar extending in0-3000m water depths between Sri Lanka and India is a Mesozoic rift basin that has been evolved as part of multiphase break up of Gondwana. The Sri Lankan sector of the Gulf of Mannar is commonly referred to as Mannar Basin, which is an exploration frontier. In 2011, three exploration wells were drilled in the northern part of the Mannar Basin and discovered natural gas from two wells. This was the first hydrocarbon discovery in Sri Lanka. The discoveries confirmed the existence of an active petroleum system in the Gulf of Mannar. However, Petroleum system in the basin is relatively unknown. In this study geology, geological history and petroleum system of the northern part of the Mannar Basin was investigated based on geochemical analyses of cutting from wells drilled in 2011, interpretation of seismic data and basin and petroleum system modelling using the SIGMA-2D modelling software.

The results show that the basin has Recent to probably Late Jurassic or older sediments. The sediment thickness ranges from around 4km in the shallow water areas to more than 7km in the deep water areas towards the south. The basin has rift basin architecture. Rifting between Indo-Lanka landmasses might have lasted for about 50Ma from the latter part of the Aptian Epoch to the end of Cretaceous period. After the end of rifting, the basin followed a thermal sag phase. In Maastrichtian epoch, there has been a massive lava flow in the basin. Towards the latter part of the thermal sag phase, the basin seems to have undergone inversion, which created pop up structuresappear on the seismic data. The geothermal gradient in the northern part of the Mannar Basin is around 24.3^{o}C/km. The present day heat flows in the shallow areas is around 40 mW/m^2, and it rages 35.5-38 mW/m^2 in the deep water areas towards the south. Mannar Basin's heat flow history follows a typical heat flow patter of a rift basin. The heat flow and formation temperatures increases from north to south of the basin. This may be related to increasing crustal extension from north to south of the basin due to counter clockwise rotation of Sri Lanka during rifting of Indo-Lanka landmasses. If source rocks in the Albian and older sections in the shallow water

areas have 0.5% or higher TOC content they might have the potential to expel oil and gas during Maastrichtian to Miocene period. In addition, Santonian to Turonian sections could expel hydrocarbons during Miocene Epoch. In deep water areas, if potential source rocks in Albian to older sections in the northern Mannar Basin have 0.5% or higher TOC content they could have expelled most of the generated oil and gas during the Late Cretaceous period. Due to increasing formation temperatures related to increasing burial, oil generated from potential source rocks in Valanginian to older sections might have started to thermally crack into natural gas in Campanian Epoch. Hydrocarbon generation and expulsion timing seems independent from the source character. Potential source rocks in the Mannar basin could probably be marine sediments. Therefore, they might have at least 1% TOC and 10-15% contribution from type II kerogens. In such a scenario, the Mannar Basin may have oil deposits in additions to natural gas. Cretaceous sandstones could be the most potential hydrocarbon plays in the Mannar Basin. Potential hydrocarbon traps may include tilted/rotated fault blocks, anticlinal closures and stratigraphic pinch outs. In addition to horizontal hydrocarbon migration, the fault system may provide ample pathways for vertical hydrocarbon migration creating a vertical drainage system in the Mannar Basin.