Shale Oil Potential in Neogene Siliceous Shales of Japan*

Satoru Yokoi[1], Amane Waseda[1], and Takashi Tsuji[1]

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[1]Japan Petroleum Exploration Co., Japan (satoru.yokoi@japex.co.jp)

Abstract

We have proposed a hydrocarbon trap model in the Monterey-like bio-siliceous shale Onnagawa Formation. The trap is associated with diagenetic transformation of silica mineral from opal-CT to quartz, and across the boundary, the overlying opal-CT porcelanite layer forms a seal and underlying clay-poor quartzose porcelanite forms a reservoir (Tsuji et al 2012 in this poster session, Figure 1). The Onnagawa Formation is the main source rock in Japan, particularly in the Akita Basin, with high potential. It averages 500 m thick and has a total organic carbon (TOC) ranging from 2% up to 5%, and HI of 500 (Figure 2).

Introduction

As the first step, we have reviewed the Ayukawa Field (Figure 3), where the largest commercial oil and gas production from the Onnagawa Formation is ongoing. In the field, various reservoirs, including dolerite, tuff and quartzose porcelanite are probably fractured and seem to have a common gas-oil contact. In other words, they constitute one pressure system. In addition, the maturity of the hydrocarbon in this system is much higher than that of source rocks close to the reservoirs, which indicates normal migration processes. We also have sub-commercial production or intense oil shows from relatively tight reservoirs that is typically alternation of porcelanite and tuff, and the maturity of oil, however, is lower than that of commercial oils and close to that of early-matured source rocks (Figure 4 and Figure 5).

Conclusions

In summary, we have two different hydrocarbon accumulations in one field. One is productive, mature and probably migrated from adjacent areas; the other is sub-commercial or non-productive so far, relatively immature and indigenous (Figure 6). Now we think the

latter is a candidate for shale oil or tight oil exploration with horizontal drilling and massive stimulation treatments and the first pilot test is being planned. In addition, we have other similar examples in this basin, although not enough data are available to confirm (Figure 7). We also expect much more potential with an order of 100 million bbl in deeper and matured areas, following the Bakken-type continuous shale oil accumulation model, where our field is located in the transition zone just above the oil generation window.

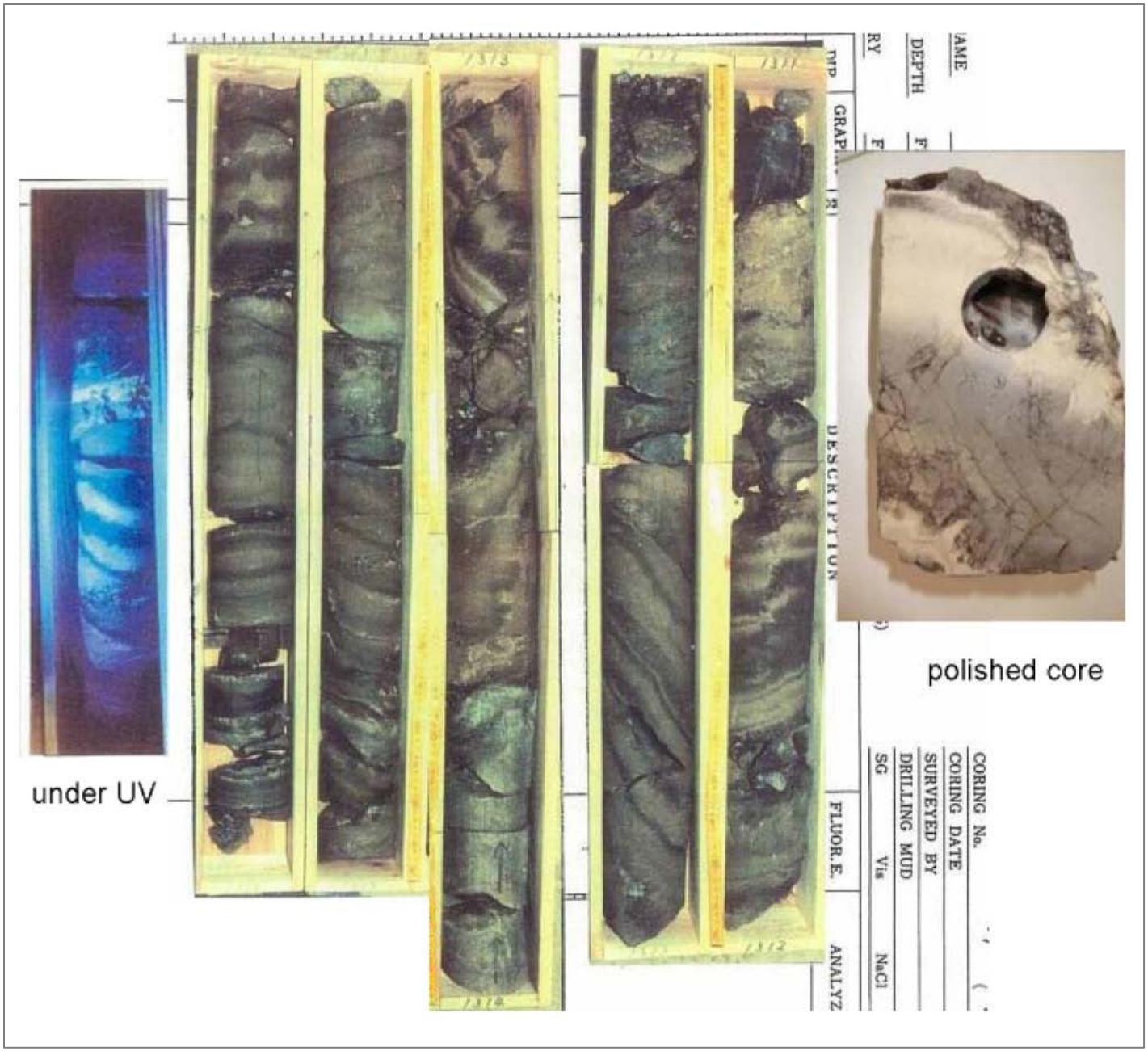

Figure 1. Porcelanite reservoirs of Onnagawa Formation.

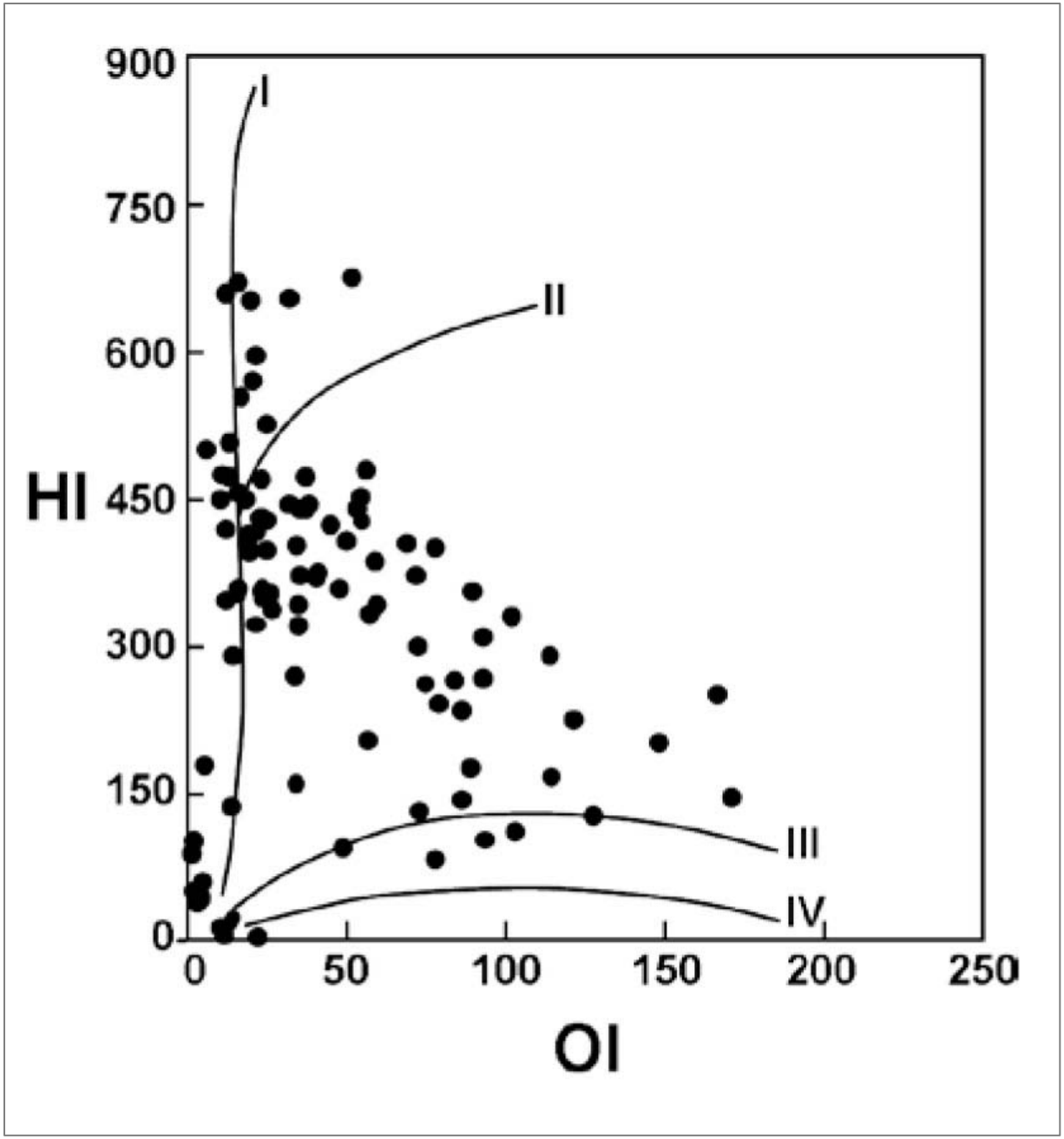

Figure 2. Rock eval analysis of Onnagawa.

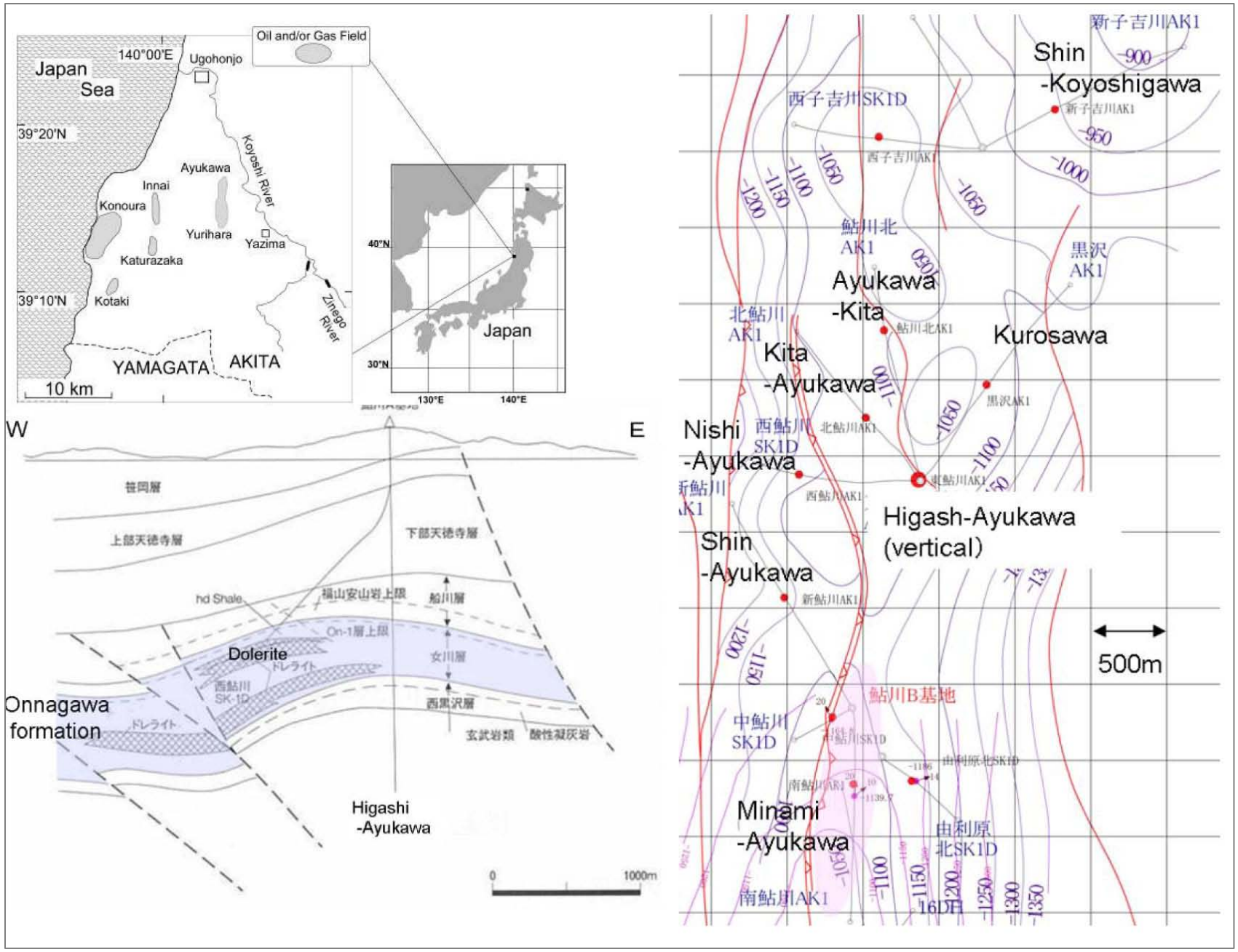

Figure 3. General information of Ayukawa Field (location, geologic section, structural map of top Onnagawa).

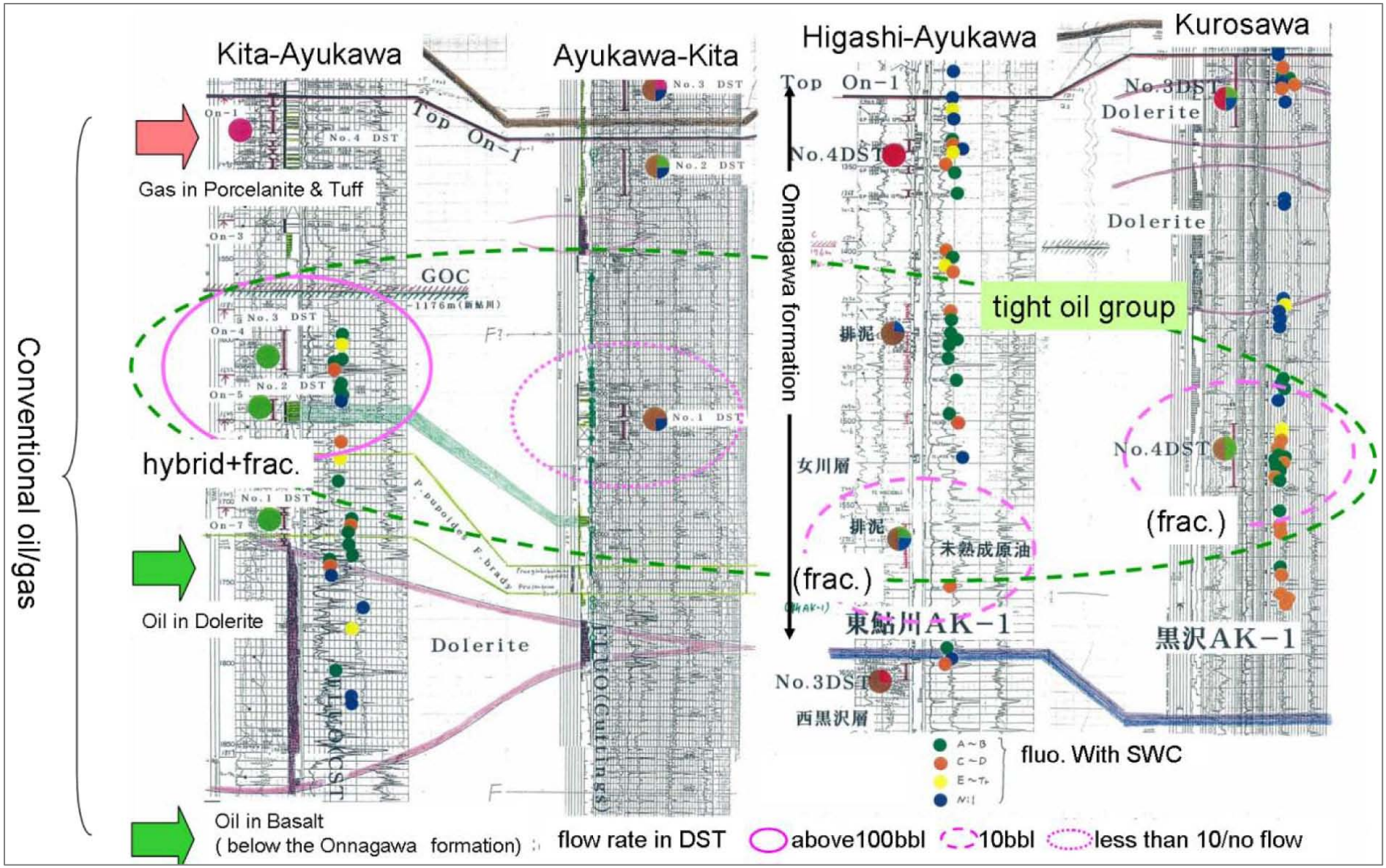

Figure 4. Distribution of oil and gas reservoirs in Ayukawa Field.

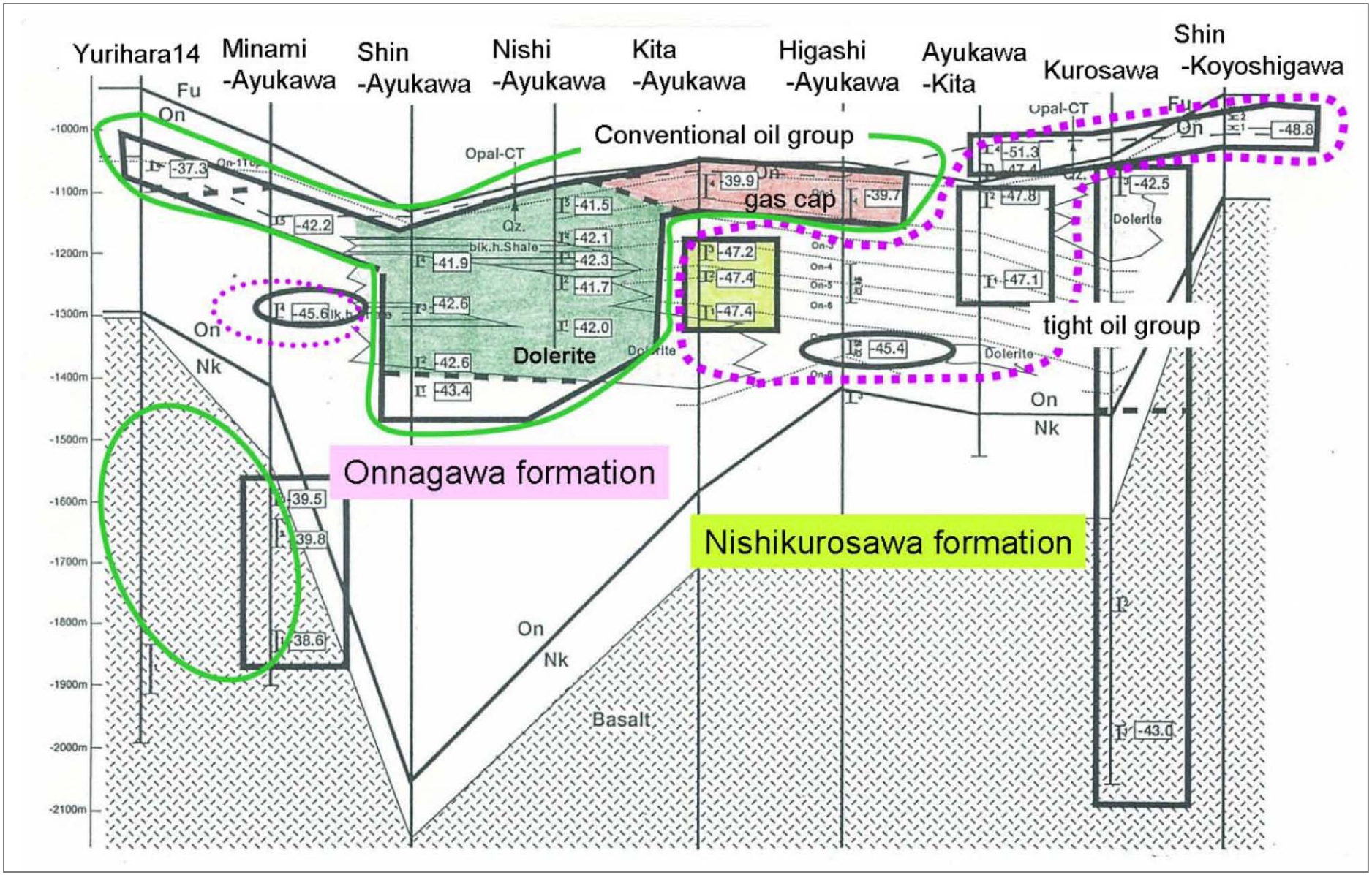

Figure 5. Geochemical characterization of oil in Ayukawa Field in terms of carbon isotopic composition of associated methane. Grouping is made with cut-off of -45, and the conventional group is associated with lower sulfur and higher API.

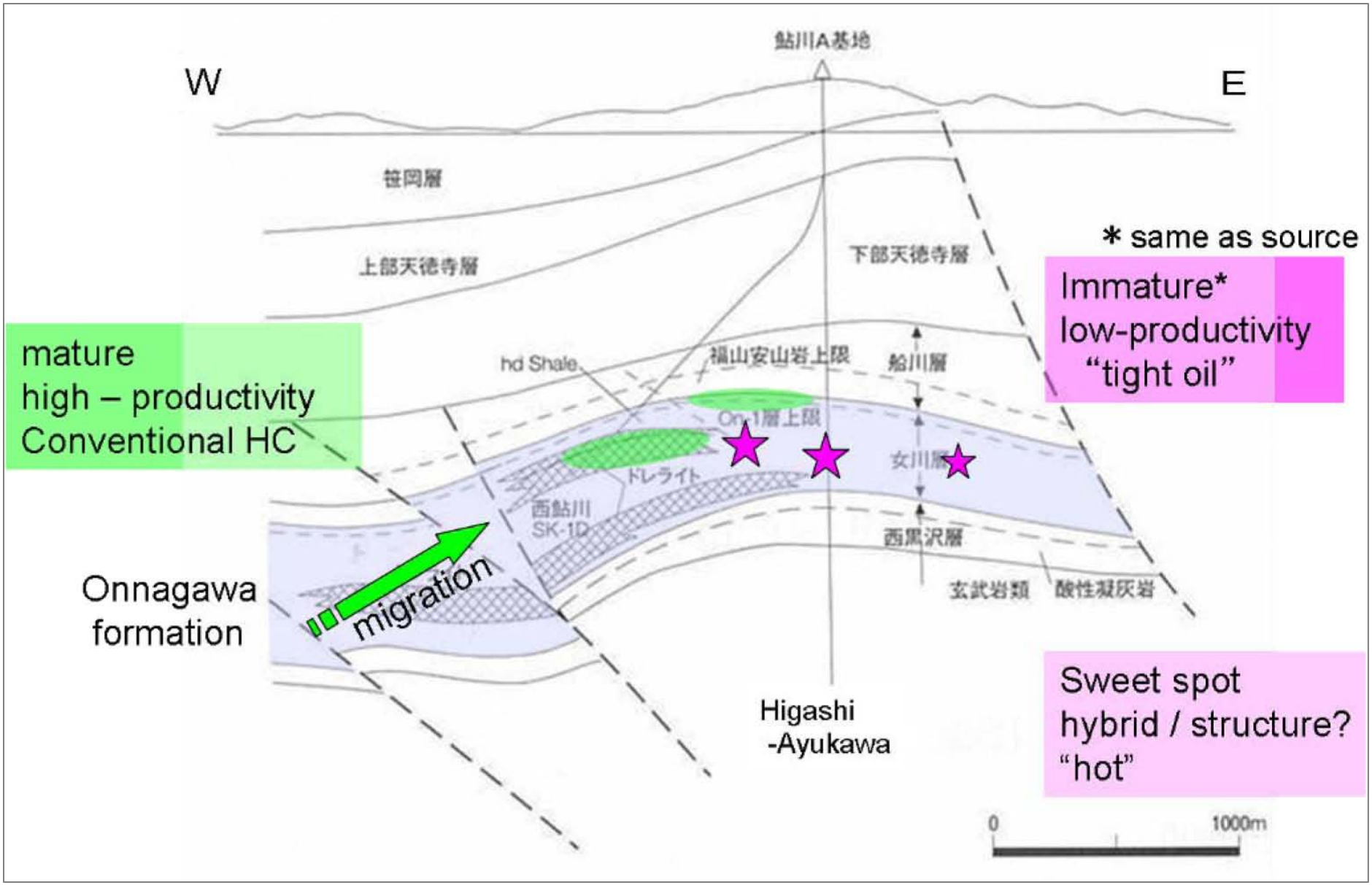

Figure 6. Schematic illustration of oil distribution in Ayukawa Field.

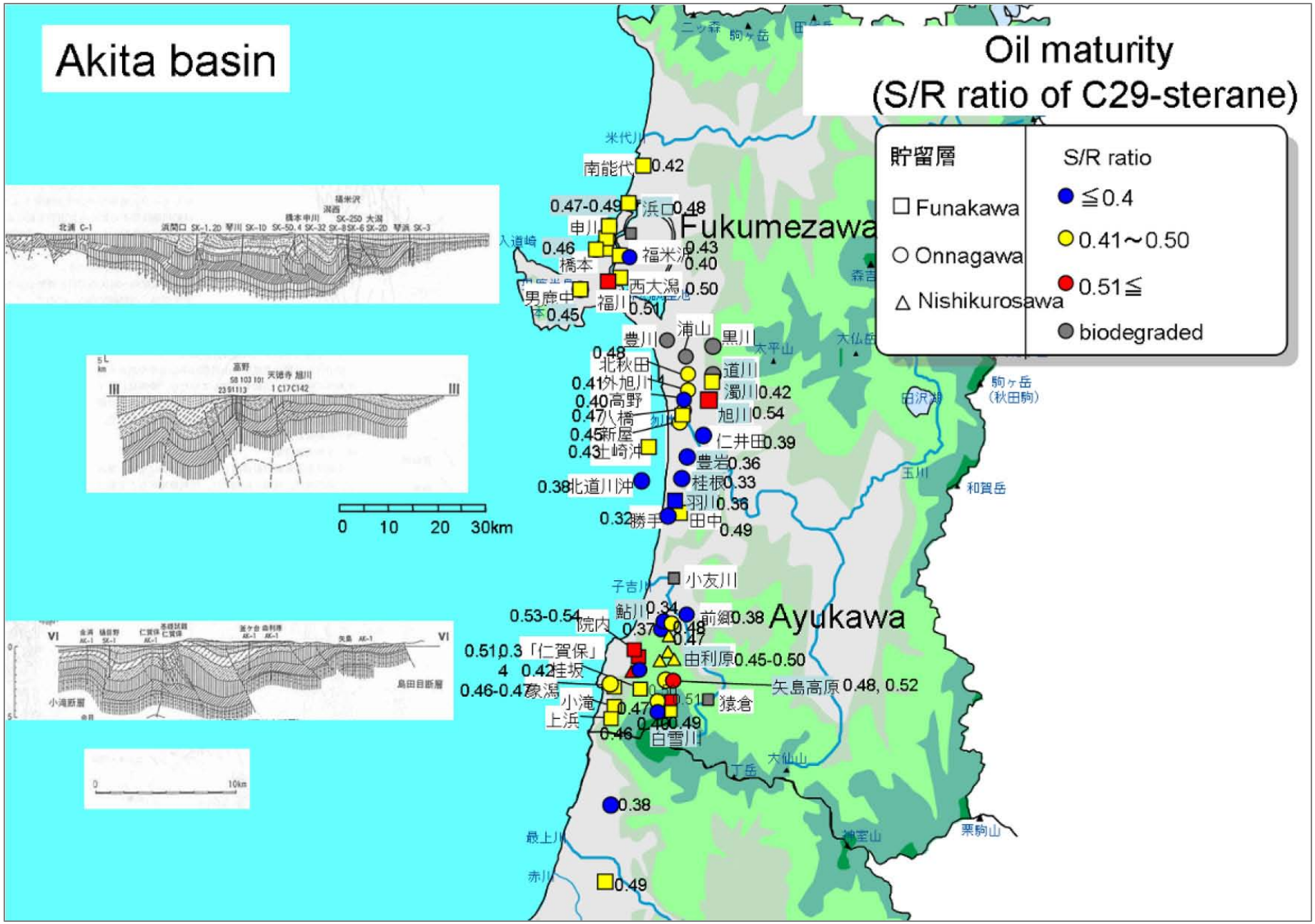

Figure 7. Geochemical characterization of oils in basinal scale in terms of oil maturity.