Tight Oil Potential in Neogene Monterey-Like Biosiliceous Shale of Japan*

Satoru Yokoi1 and Takashi Tsuji1

Search and Discovery Article #51119 (2015)**
Posted August 3, 2015

*Adapted from poster presentation given at Pacific Section AAPG, SEG and SEPM Joint Technical Conference, Oxnard, California, May 3-5, 2015

**Datapages © 2015 Serial rights given by author. For all other rights contact author directly.

1Japan Petroleum Exploration Co., LTD., Chiyoda, Tokyo, Japan (satoru.yokoi@japex.co.jp)

Abstract

We have proposed a diagenetic hydrocarbon trap model in Monterey-like biosiliceous shale formation called Onnagawa (Tsuji et al, 2011), which is the main source rock of Japan and has similar potential as that of Upper Monterey. We however have much and continuous oil shows in the Onnagawa shale far below the trap, which is indicative of a shale oil system. We have reviewed the Yuihara-Ayukawa field in Akita of Japan mainly from geochemical aspect, where commercial oil and gas production from the Onnagawa Shale with a conventional trap is ongoing. In the field, various producing reservoirs in the Onnagawa shale seem to have a common gas-oil system. In addition, the maturity of the hydrocarbon is much higher than that of source rocks close to these reservoirs, which indicates normal migration process from the kitchen. We also have non-commercial oil production or intense oil shows from tight reservoirs, typically porcelanites, and the maturity of oil, however, is lower than that of commercial oils and close to that of early-matured source rocks around. In summary, we have two different hydrocarbon accumulations in one filed. One is productive, mature and probably migrated, and another is non-commercial so far, less mature and indigenous. Now we think the latter is a part of a shale oil or tight oil system. Although not enough data are available so far, we expect basin-wide shale oil potential with the order of 100 million bbl without risk factor, where our fields are located in the upper transition zone of oil generation window. To confirm the existence of shale oil system, we started The Onnagawa Tight Oil Project with support of JOGMEC in 2012. Firstly, we tried acid treatment on naturally but weakly fractured shale reservoir of an existing deviated-well of the Yuihara-Ayukawa field to testify the productivity of Onnagawa tight oil. We had a success with over 50 times improvement in terms of Productivity Index. Starting from with rate of over 300bbl/D, the oil production is ongoing with over 100bbl/D after 10-month production, and its cumulative production is getting over 60,000bbl. We also have started the first multi-stage fracturing project in Japan to optimize fracturing operation in Onnagawa shale. The operation was completed for a newly drilled horizontal well of another oil field last year, and we are waiting for flow-back. As the next step to the current fracturing project, a pilot test in Yurihara-Ayukawa field with higher potential is being planned.
The Onnagawa is Monterey-like biosiliceous shale of Middle Miocene age and the main source rock in Japan, with fairly high source-rock potential and average thickness of 500m (Fig. 1).

We have a commercial oil & gas production from Onnagawa shale in the Ayukawa-Yurihara field, and we have proposed a diagenetic trap model* (Fig. 2-4).

* opal-CT porcelanite as a seal and Qz porcelanite as a reservoir (Tsuji et al., 2011, AAPG)

We also have much and continuous oil shows in the Onnagawa shale far below the trap, which is indicative of a shale oil system (Fig. 5-7).

The Onnagawa shale is under review in the light of tight/shale oil, as for the Monterey shale.

---

**Fig. 1** Source Rock Potential of the Onnagawa Formation

- TOC: 2% in average, up to 5% in part
- type II ~ type II-S kerogen

**Fig. 2** Locality Map

- Commercial production since 1985
- black band: clay rich, better source rock
- white band: reservoir property (~30% 1md)

**Fig. 3** Porcelanite reservoirs of the Onnagawa formation

**Fig. 4** Diagenetic Trap Model in Porcelanite
Fig. 5 Ayukawa Field 
Structure: top of Onnagawa

Fig. 6 Geological Cross Section

Commercial production
- From Dolerite, Tuff and Qtz-Porcelanite partly fractured
- Common gas-oil contact → one pressure system

Fig. 7 Distribution of oil & gas

Where are “tight oils” stratigraphically? Close to the best source rock horizon

Fig. 8 Geochemical characterization of oil in Ayukawa field

We have two oil groups in terms of maturity:

Higher maturity: commercial oils

Lower maturity (same as source rocks around): low-productive oils (in tight reservoirs)

(Yokoi, Waseda and Tsuji, 2013)
Two different hydrocarbon system:
- Productive, mature and migrated
- Sub-commercial or non-productive so far, relatively immature and indigenous

We understand the latter is a part of basin-wide tight oil system, possibly with continuous accumulation.

1st Pilot test in Japan
As the 1st step, we tried acid stimulation in an existing deviated hole.

Success!
A multi-stage hydraulic-fracturing project with a horizontal well is on going in another field (Fukumezawa). (under flow-back)
* those tests are supported by JOGMEC*

We recognize two different hydrocarbon system

Study conclusion

Fig. 9 Tight Oil model in Ayukawa field

Fig. 10 Acidizing Concept
Preflush: 15% HCL (10,000 gal)
Main Acid: 12%HCL+3%HF (a/a) for 40m interval

Targeting “tight oil” with weakly-fractured porcelanite in Kurosawa well
Stimulating non-conductive fractures cemented with soluble minerals, with acid & over fracture-opening pressure

Fig. 11 Acidizing Result

Performed in 2012-2013:
10 BOPD (intermittent) ⇒ 300 BOPD
0.02 md ⇒ 5~9 md
Production is ongoing with moderate decline, getting over 60,000bbl in cumulative production

Changing our mind as “hybrid” shale?

What’s next?

Next pilot test in Ayukawa field is being planned.
We will go to basin center (kitchen), expecting much more potential with an order of 100 MMbbl.

May I ask you what have you found in “Qtz Tight” zone?