Problem of Shale Oil(Tight Oil) Resources Evaluation of Onnagawa Formation in Japan

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List of Japanese Neogene and Paleogene Sedimentary Basins (Uncompleted)

No.	Basin name	Geologic age of the bottom sediment
	Tsushima Basin	Neogene
	San'in-Hokuriku Basin	Neogene
7	Toyama Basin	Neogene
1	Akita-Yamagata Basin	Neogene
6	Niigata Basin	Neogene
2	Okushiri Basin	Neogene
3	Oshima Basin	Neogene
5	Teshio Basin	Upper Mesozoic-Paleogene
4	Ishikari Basin	Upper Mesozoic-Paleogene
	Tokachi Basin	Neogene
	Joban-Sanriku Basin	Upper Mesozoic-Paleogene
	Kanto Basin	Neogene
	Tokai-Kumano Basin	Neogene
	Tosa Basin	Neogene
	Miyazaki Basin	Neogene
	Fukue Basin	Neogene
	Danjo Basin	Neogene
	Okinawa Trough Basin	Neogene
	Shimajiri Basin	Neogene

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Shale Oil (Tight Oil) Target in Japar Siliceous Hard Shale

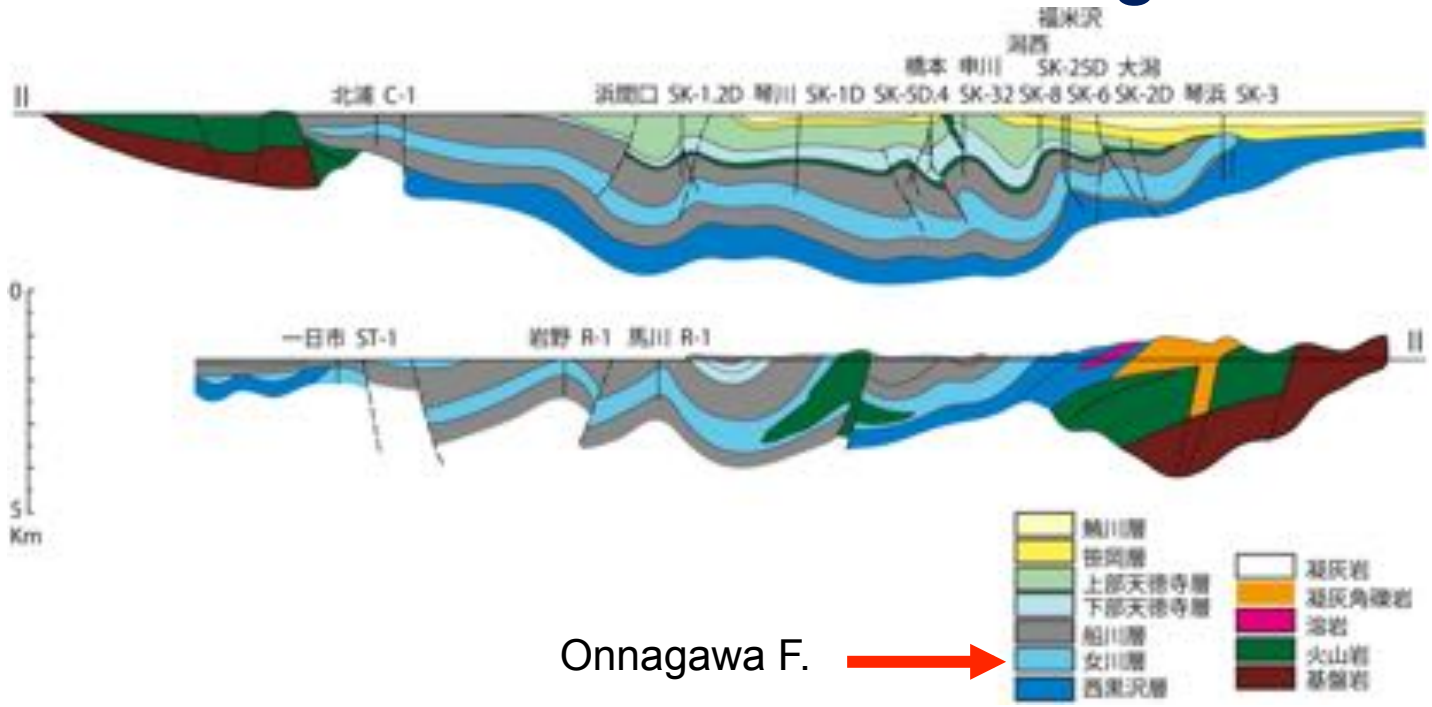
- Akita-Yamagata Basin has highly potential for shale oil (tight oil) and shale gas.
- Siliceous shale of Onnagawa Formation is main target formation.
- Equivalent or similar lithologic formations are extended and distributed in Niigata, Okushiri, Oshim, Ishikariand Teshio basins.

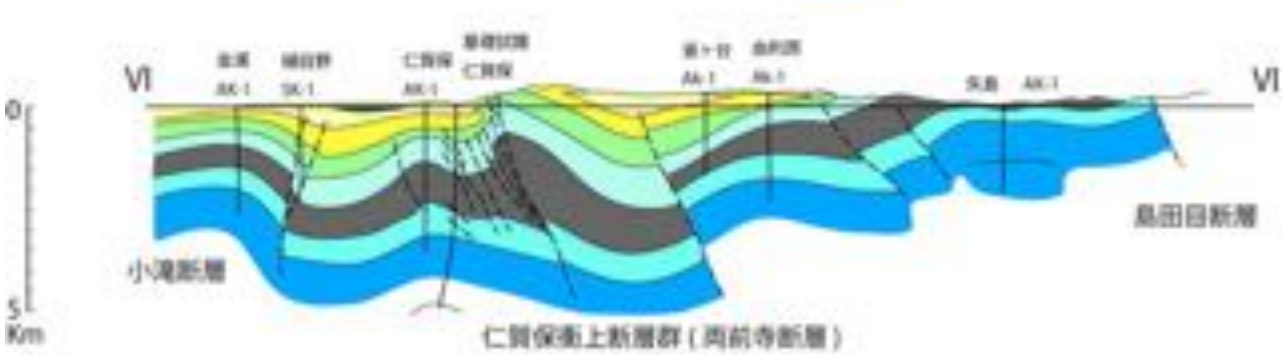
Onnagawa Formation
(siliceous hard shale)

Onagawa Formation in the Akita-Yamagata

Isopack Map
(excluding volcanics)

About Onnagawa Formation





Cross Section of Akita-Yamagata Basin

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Lithological Variation in Onnagawa Formation by well log data

(after Takayama & Kato, 1995)

- Takayama&Kato analyzed lito-type in the Onnagawa formation by well log data
- High resibility(HR) and low gamma-ray(LG) show silica(SiO2) rich rocks

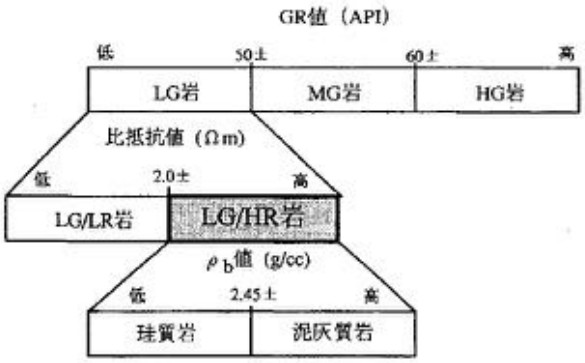
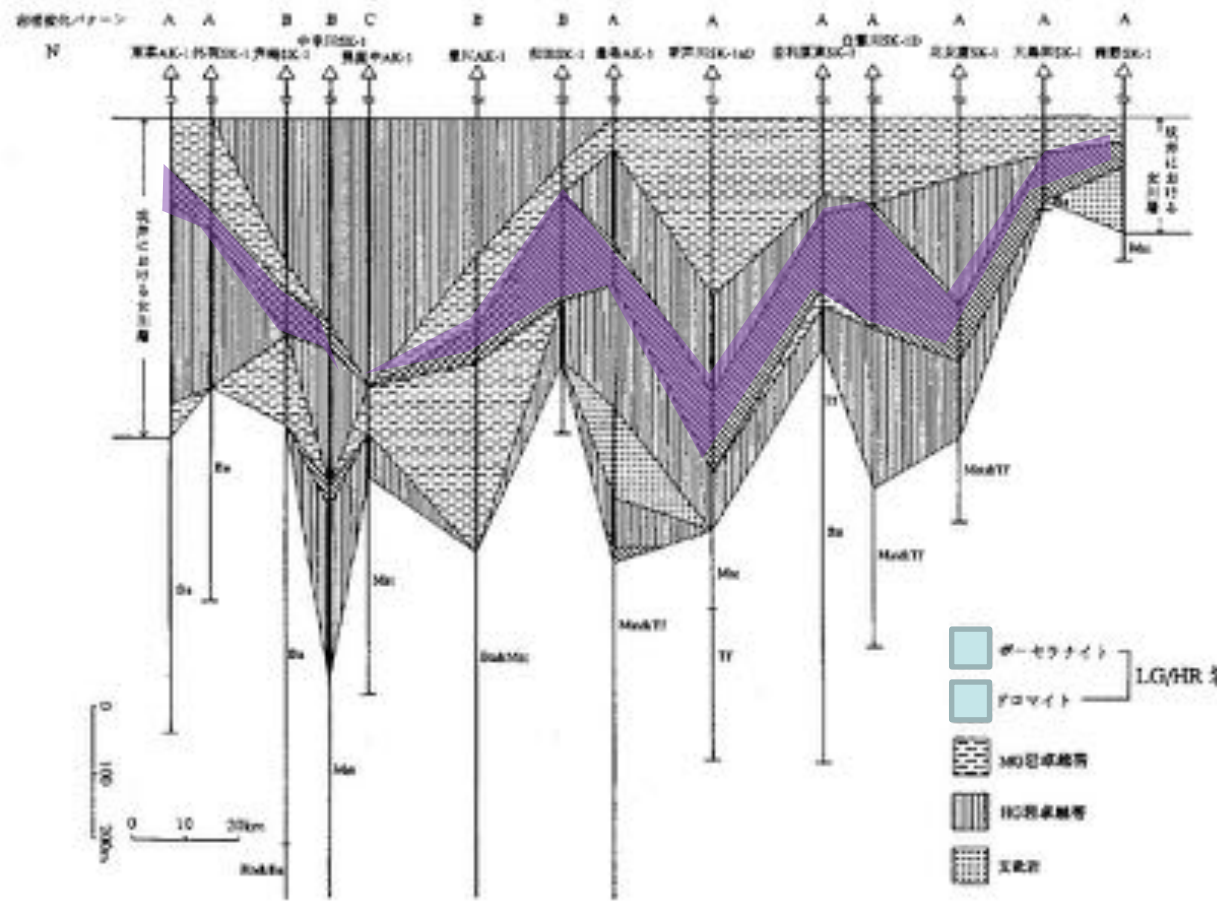


図 3　物理検層のレスポンスによる泥質岩の分類



Detail study of Onnagawa Formation

(after Waseda et al.,1995)

- Waseda et al.(1995) studied the Onnagawa formation in Yurihara area.
- Over 30 samples (actuary over 200) from outcrops were analyzed

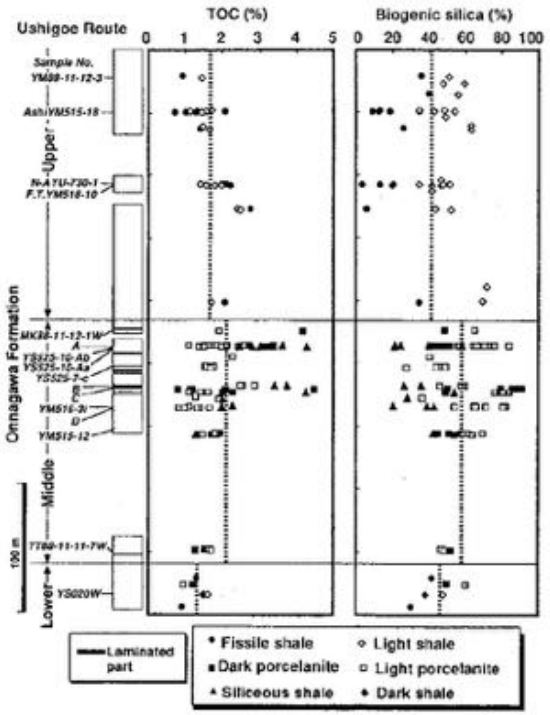


Fig. 8 TOC and biogenic silica contents in the Onnagawa Formation. Average values for upper, middle and lower members are shown as dashed lines. Sampling points of Samples A to D (Table 1) and samples for biomarker analyses (Table 2) are also shown.

Table 1 Inorganic components, TOC, Rock-Eval, kerogen carbon isotope compositions for outcrop samples of the Onnagawa Formation in Ushigoe area. Subsamples are collected at millimeter- to centimeter-scale stratigraphic intervals.

Subsample Number	Lamination*	Rock Type**	Inorganic component (%) Biogenic Silica	Detritus	TOC (%)	Rock-Eval Tmax (°C)	S1 (mg/g)	S2 (mg/g)	S3 (mg/g)	HI (mg/g)	OI (mg/g)	S2/S3	S1/S1+S2	δ13C (‰) Kerogen
Sample A														
YM514-5d	NO	H-W	64.4	34.9	1.54	402	0.34	4.32	1.20	281	78	3.60	0.07	-21.8
YM514-5c	NO	H-B	46.9	51.7	3.40	422	0.71	13.61	2.49	400	73	5.47	0.05	-21.8
YM514-5b	NO	H-W	72.1	27.6	1.54	412	0.46	4.91	1.68	319	109	2.92	0.08	-21.9
Ushigoe SK-6j	NO	H-W	75.0	24.3	1.70	405	0.68	6.40	1.56	376	92	4.10	0.10	-22.0
Ushigoe SK-6i	NO	H-B	65.5	33.5	2.13	402	0.62	8.46	1.62	397	76	5.22	0.07	-21.8
Ushigoe SK-6h	NO	H-W	72.5	26.9	1.88	400	0.58	7.38	1.50	392	80	4.92	0.07	-21.8
Ushigoe SK-6g	NO	H-B	57.7	41.2	2.70	409	0.69	10.26	1.89	380	70	5.43	0.06	-21.8
Ushigoe SK-6f	NO	H-W	56.5	42.6	2.60	401	0.74	11.14	1.32	428	51	8.44	0.06	-22.0
Ushigoe SK-6e	NO	S	40.3	58.9	3.65	405	1.13	17.12	1.77	469	48	9.67	0.06	-22.0
Ushigoe SK-6d	NO	H-W	69.2	30.4	1.59	402	0.41	6.05	1.29	380	81	4.69	0.06	-22.1
Ushigoe SK-6b	NO	H-W	72.6	27.1	1.43	416	0.50	6.18	1.20	432	84	5.15	0.07	-22.3
Ushigoe SK-7f	NO	H-W	74.2	25.7	1.40	410	0.32	4.08	1.26	291	90	3.24	0.07	-22.1
Ushigoe SK-7e	NO	H-W	76.3	23.5	1.38	413	0.41	4.46	1.32	323	96	3.38	0.08	-22.2
Ushigoe SK-7d	NO	S	58.4	41.1	2.48	401	0.65	9.14	1.65	368	67	5.54	0.07	-22.2
Ushigoe SK-7c	NO	S	22.4	77.2	3.05	415	0.76	12.47	1.62	409	53	7.70	0.06	-22.0
Ushigoe SK-7b	NO	H-W	66.6	33.3	1.52	400	0.39	5.48	1.20	361	79	4.57	0.07	-22.0
YS525-10-Af	NO	H-W	72.2	27.1	2.10	408	0.56	10.61	1.02	505	49	10.40	0.05	-22.0
YS525-10-Ae	NO	H-B	52.0	46.7	3.09	406	0.56	7.86	0.93	254	30	8.45	0.07	-21.7
YS525-10-Ac	NO	H-B	56.1	42.5	3.25	396	0.76	7.84	1.11	241	34	7.06	0.09	-21.6
YS525-10-Ab	NO	H-W	70.6	28.9	2.00	393	1.09	14.26	1.89	713	95	7.55	0.07	-21.6
YS525-10-Aa	NO	H-B	50.6	48.0	3.39	407	0.36	10.46	1.38	309	41	7.58	0.03	-21.7
Sample B														
Ushigoe SK-4m	YES	H-B	50.8	48.3	4.47	402	2.02	21.32	1.92	477	43	11.10	0.09	-20.7
Ushigoe SK-4l	YES	H-B	79.8	19.4	2.11	405	0.70	6.96	1.68	330	80	4.14	0.09	-21.2
Ushigoe SK-4k2	YES	H-B	87.8	11.2	1.21	410	0.46	4.43	1.38	366	114	3.21	0.09	-21.5
Ushigoe SK-4k1	NO	H-B	90.3	7.8	0.83	405	0.35	2.45	1.32	295	159	1.85	0.13	-21.7
Ushigoe SK-4j	YES	H-B	85.7	9.8	1.16		0.39	4.56	1.35	393	116	3.30	0.07	-21.5
Sample C														
YM514-4g	NO	H-W	76.2	24.0	1.62	398	0.80	5.22	0.90	322	56	5.80	0.13	-22.4
YM514-4f	YES	H-B	77.1	23.1	2.01	400	0.84	7.36	0.99	366	49	7.43	0.10	-21.8
YM514-4a	YES	S	54.2	47.5	4.27	404	1.67	17.09	1.32	400	31	12.95	0.09	-21.2
Ushigoe SK-5b	YES	H-B	83.9	16.0	1.48	405	0.57	4.12	1.26	278	85	3.20	0.12	-22.1
Sample D														
YM516-3h	NO	H-W	64.5	36.7	1.32	414	0.47	3.66	0.87	278	66	4.21	0.11	-21.7
YM516-3f	NO	H-W	82.0	18.7	0.84	418	0.31	2.22	0.78	264	93	2.84	0.12	-22.2
YM516-3e	NO	H-W	81.1	19.8	0.98	410	0.35	2.80	0.72	286	73	3.89	0.11	-22.2
YM516-3d	NO	S	43.4	58.0	2.00	403	0.68	5.99	1.32	300	66	4.54	0.10	-21.7
YM516-2c	NO	S	39.5	62.2	2.00	410	0.54	5.56	1.59	278	80	3.50	0.09	-21.6
YM516-2b	NO	S	39.3	62.4	2.01	408	0.59	5.80	1.17	289	58	4.96	0.09	-21.7
YM516-2a	NO	H-W	65.7	35.2	1.01	417	0.22	2.18	0.84	216	83	2.60	0.09	-22.0

* YES: Laminated NO: Nonlaminated

** H-B: Dark-colored porcelanite H-W: Light-colored porcelanite S: Siliceous

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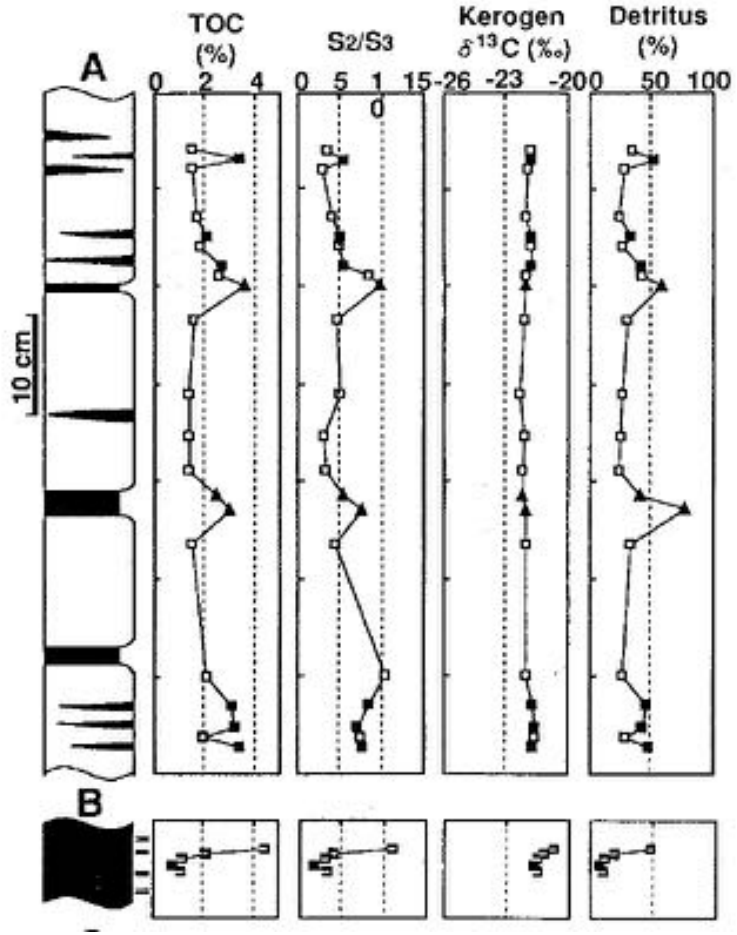
Vertical Variation at narrow area

- TOC and S2/S3 are varied in a narrow area
- Sweet spot zone is important for resources evaluation



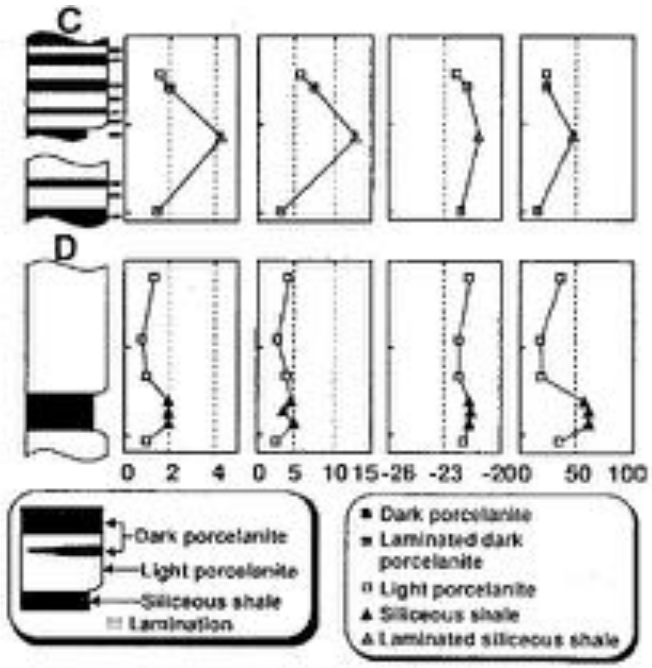


Fig. 9 The millimeter- to centimeter-scale variation of TOC, S_2/S_3 of Rock-Eval, kerogen carbon isotope compositions and detritus contents in 4 samples in the Onnagawa Formation.

The 1st pilot test for shale oil in Japan, Operated by JAPEX and sponsored by JOGMEC

- **Ayukawa Oil-field**
  As the 1st step, we tried acid stimulation in a existing deviated hole
  - ➡ Success!

- **Fukumezawa Oil-field**
  A multi-stage hydraulic-fracturing project with a horizontal well.

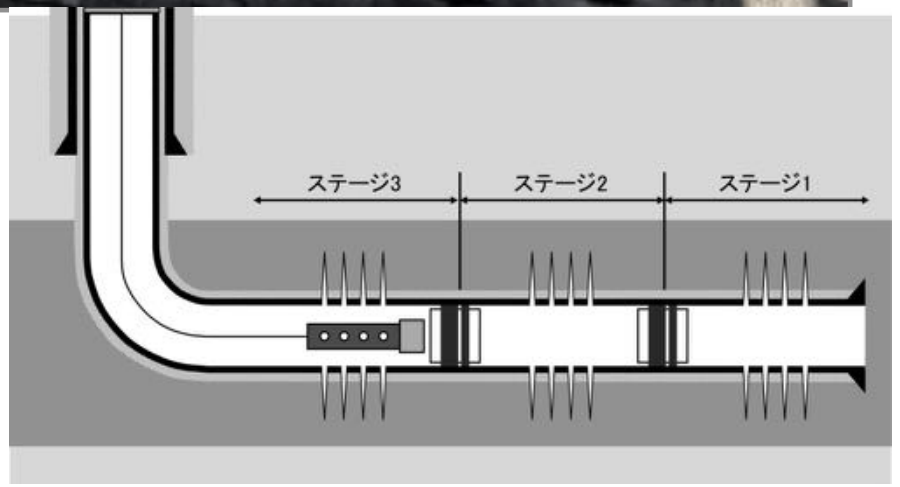
The 1st pilot test for shale oil in Japan, Operated by JAPEX and sponsored by JOGMEC (2013～2017)

multi-stage fracturing in a horizontal well
in FUKUMEZAWA

⇒ application of the standard technology
to Japanese Monterey-type shale

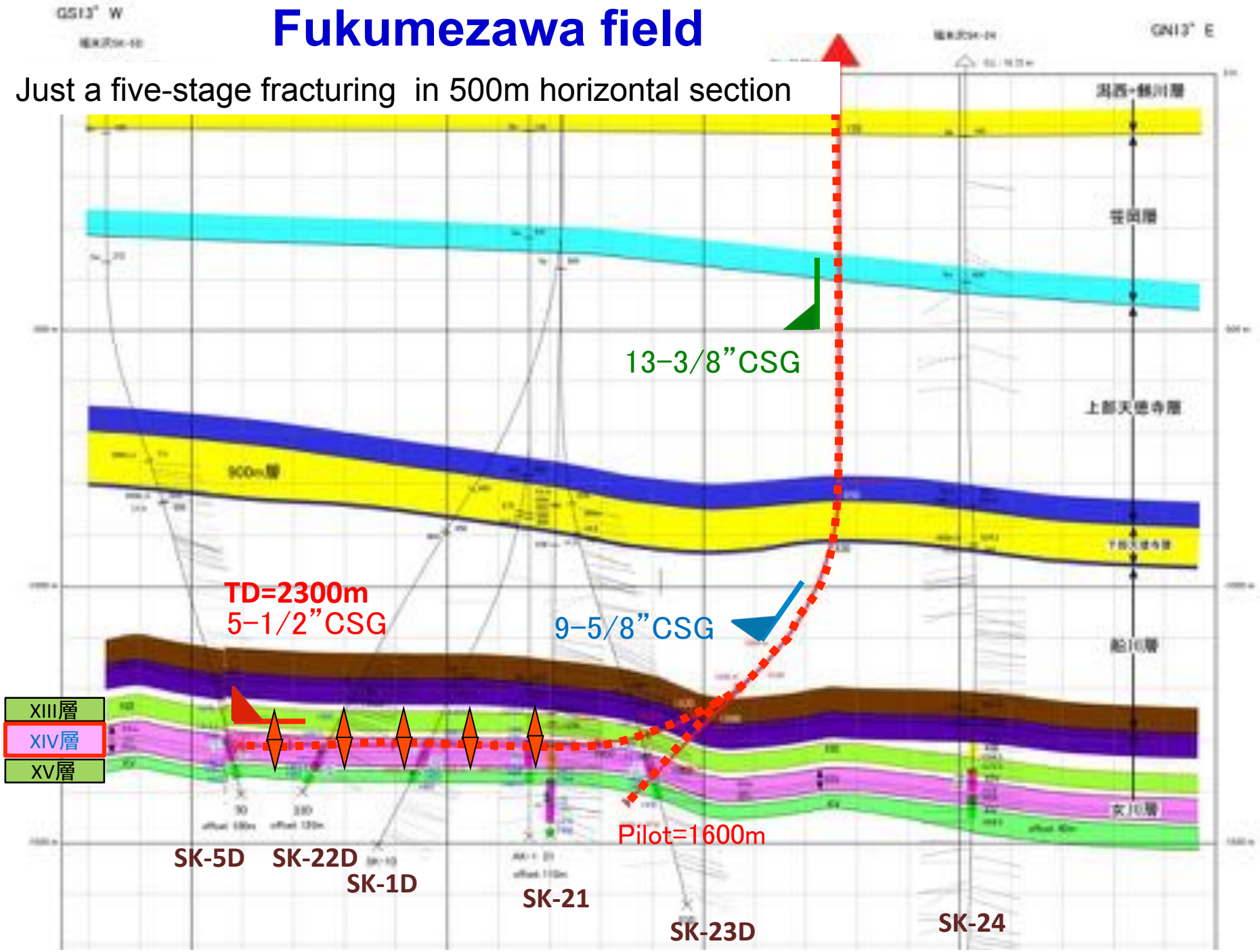
Hydro-fracturing using Coiling Tube (CT)

methoed：
plug & perfo.



Fukumezawa field

Just a five-stage fracturing in 500m horizontal section



The 1st pilot test for shale oil in Japan, Operated by JAPEX and sponsored by JOGMEC

- **Ayukawa Oil-field**
  As the 1st step, we tried acid stimulation in a existing deviated hole
  ➡ Success!

- **Fukumezawa Oil-field**
  A multi-stage hydraulic-fracturing project with a horizontal well.
  (under flow-back)
  Test was Finished in 2017 (Success?)

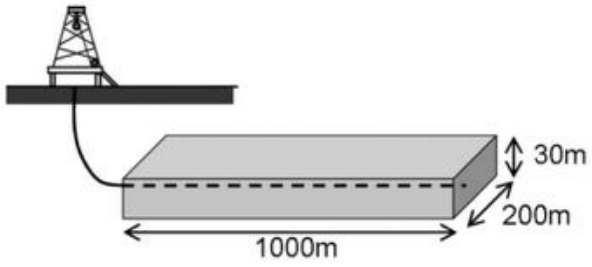
Current Producion

Production (1 well) : Oil : 10kl/day (62.9bbl/day)
Gas : 2,000m^3/day

Estimation of Tight Oil Reserves (after Dr. S.Yokoi, JAPEX)

Ayukawa Area :

simply 2 million bbl



GRV	NGR	ϕ	S_w	B_o
6,000,000 m^3	1	20%	70%	1.2

図 14　鮎川地域におけるタイトオイル埋蔵量計算モデル

Mature Area near Ayukawa-Yurihara :

- No Commercial tight oil product
  -> difficult to estimate proven play
- Adapting Rock-Eval Using Downey et al.(2011) Method(S1 based method)
- Based Sirayukigawa SK1D well data
  area: 10km, thickness: 100m, average S1: 6mg/g, etc
- Simply estimated : 100million bbl
- All basin: 1 billion bbl ?

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Thank You
for your attention

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