

**Characteristics of Sedimentary Basins around
Japanese Islands**

Yoshihisa OKUDA

**Institute for Geo-Resources and Environment,
Geological Survey of Japan, AIST**

2005/11/30
APEC Symposium

Characteristics of sedimentary basins around Japanese Islands

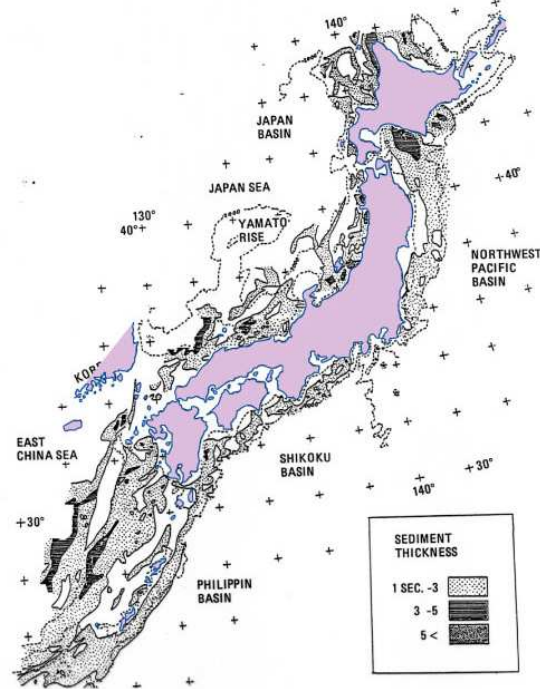
**Institute for Geo-resources and Geo-environment
GSJ, AIST
Yoshihisa OKUDA**

Content

- Distribution of sedimentary basins around Japanese Islands.
- Distribution of methane hydrates around Japanese Islands.
- Characteristics of offshore sedimentary basins around Japanese Islands.
- Scale of sedimentary basins on the estimate of the hydrocarbon resource potential.
- Sedimentary basins in the East China Sea.
- Sedimentary basins with high potential of hydrocarbon resources originated from coal source rocks.
- Unconventional oil and gases
- Summary

Distribution of Sedimentary Basins around Japanese Islands

Okuda (1984)

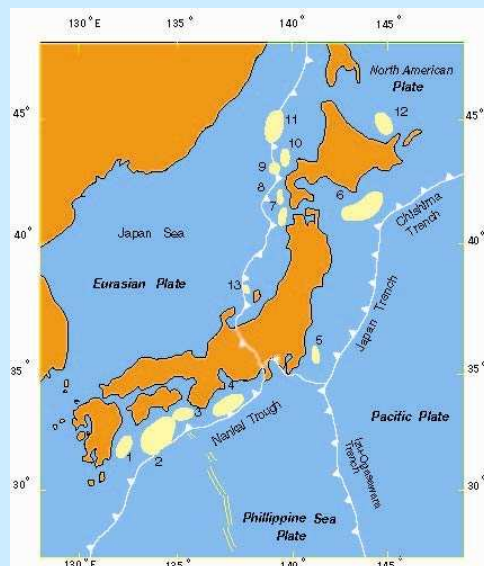


Distribution of Methane Hydrate around Japan

Subsiding Basins along the Trenches

- Nankai Trough
 - Southern part of Japan Trench
 - South of Hokkaido
- Eastern rim of Japan Sea
Okhotsk Sea

- Low Heat-flow
- Compression
- BSR → Natural Gas in deep



Characteristics of Hydrocarbon Sedimentary Basins					
Area	Age of Sediments	Basin Characteristics	Volcano	HY/potential	HY Resources
Okhotsk	Paleogene, Neogene	Shelf basin / Pull apart sinking basin	○	○	oil
Western Hokkaido	Paleogene, Neogene	Shelf basins from onshore	○	○	Oil & Gas
Southern Hokkaido	Paleogene, Neogene	Shelf basins from onshore	○	○	Oil & Gas
Japan Sea side of NE Honshu	Neogene	Shelf basin from onshore	○	○	Oil
Japan Sea side of SW Japan	Neogene	Shelf basins	○		Oil & Gas
Pacific Ocean side of NE Honshu	Paleogene, Neogene	Warping-sinking basins			Gas
Kanto	Neogene	Shelf from onshore basin / warping-sinking		○	Gas
Pacific Ocean side of SW Honshu	Neogene	Warping-sinking basin		○	Gas
Ryukyu Islands	Neogene	Shelf from onshore basin / warping-sinking basin	○	○	Gas
Okinawa Trough	Neogene	Rift Basin	○		Gas
East China Sea	Paleogene, Neogene	Shelf Rift Basins		○	Oil & Gas
Izu-Ogasawara Arc	Paleogene, Neogene	Sinking/ Median/Rift basin	○	?	Gas ?

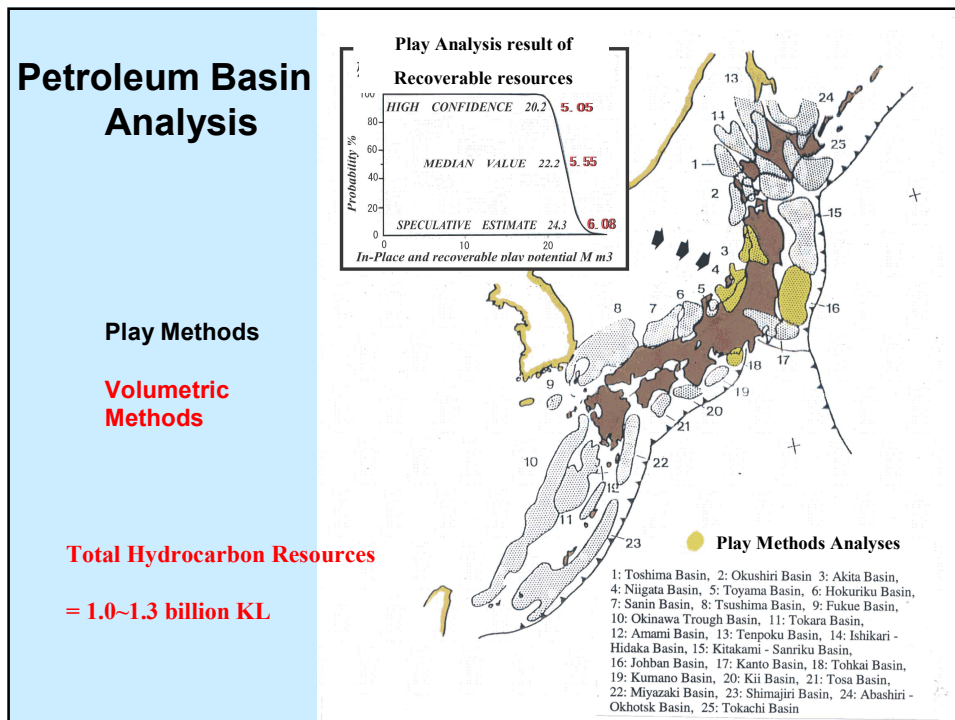
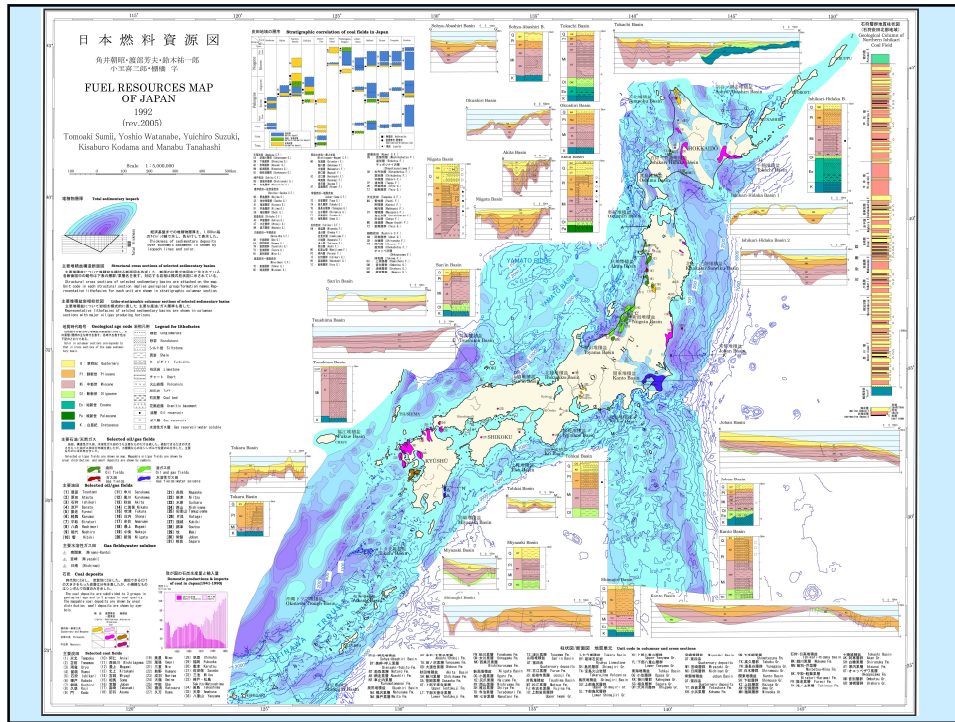
Characteristics of two types of Sedimentary basins

Japan Sea Side

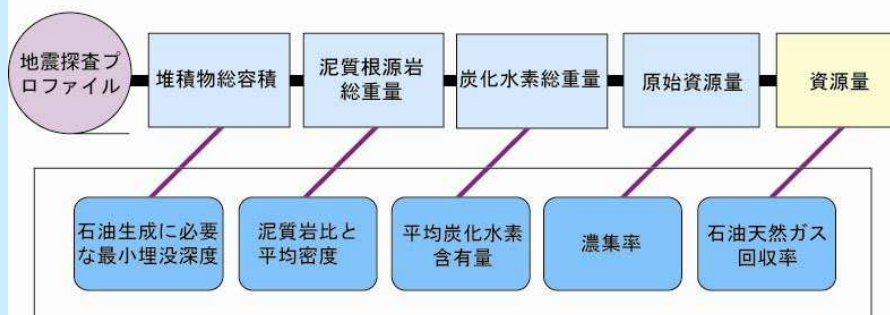
- Marginal Sea
- Back Arc Basin
- Rifted Basin
- High Heat Flow
- high TOC Content (=~2%)
- Type I Kerogen

Pacific Ocean Side

- Open Sea
- Fore Arc Basin
- Accretionary Prisms
- Low Heat Flow
- Low TOC Content (=~0.5%)
- Type III Kerogen



堆積物に基づく地化学物質収支法



地化学パラメータ

0~200m in water depth

Basins	Ultimate Recorable resources (oil equivalent)		Ultimate Recorable resources	
	10 ⁶ ton wt	10 ⁶ kl vol	Crude Oil (10 ⁶ kl)	Gases (10 ⁹ m ³)
Ihikari~Rebun	16	19	6	13
Soya~Abashiri	28	33	11	22
Hidaka	4	5	0	5
Shimokita~Kuji	1	1	0	1
Tokachi~Kushiro	2	2	0	2
Oshima~Nishitsugaru	0	0	0	0
Akita~Yamagata	28	32	10	22
Niigata	27	33	11	22
Noto~Oki	1	1	0	1
Oki~Tsushima	25	29	9	20
Fukue	3	4	1	3
Amakusa	0	0	0	0
Miyazaki	1	2	0	2
Kitakami	0	0	0	0
Joban	15	17	0	17
Boso	1	1	0	1
Tokai~Shikoku	9	11	0	11
Nansei Islands	0	0	0	0
Okinawa Trough	37	44	14	30
East China Sea	210	247	80	167
Izu~Ogasawara	0	0	0	0
Yamato Bank	0	0	0	0
Total	408	481	142	339

0~200m in water depth

Basins	Ultimate Recoverable resources (oil equivalent)		Ultimate Recoverable resources		area	Age of Sediments	Basin Characteristics
	108ton wt	108kl vol	Crude Oil (108kl)	Gases (108m3)			
Ihikari~Rebun	16	19	6	13	Okhotsk	Paleogene, Neogene	Shelf basin / Pull apart sinking basin
Soya~Abashiri	28	33	11	22	Western Hokkaido	Paleogene, Neogene	Shelf basins from onshore
Hidaka	4	5	0	5	Southern Hokkaido	Paleogene, Neogene	Shelf basins from onshore
Shimokita~Kushiro	1	1	0	1	Japan Sea side of NE Honshu	Neogene	Shelf basin from onshore
Tokachi~Kushiro	2	2	0	2	Japan Sea side of SW Japan	Neogene	Shelf basins
Oshima~Nishino	0	0	0	0	Pacific Ocean side of NE Honshu	Paleogene, Neogene	Warping-sinking basins
Akita~Yamagata	28	32	10	22	Kanto	Neogene	Shelf from onshore basin / warping-sinking
Niigata	27	33	11	22	Pacific Ocean side of SW Honshu	Neogene	Warping-sinking basin
Noto~Oki	1	1	0	1	Ryukyu Islands	Neogene	Shelf from onshore basin / warping-sinking basin
Oki~Taushima	25	29	9	20	Okinawa Trough	Neogene	Rift Basin
Fukue	3	4	1	3	East China Sea	Paleogene, Neogene	Shelf Rift Basins
Amakusa	0	0	0	0	Izu-Ogasawara Arc	Paleogene, Neogene	Sinking/ Median/Rift basin
Miyazaki	1	2	0	2			
Kitakami	0	0	0	0			
Joban	15	17	0	17			
Boso	1	1	0	1			
Tokai~Shikoku	9	11	0	11			
Nansei Islands	0	0	0	0			
Okinawa Trough	37	44	14	30			
East China Sea	210	247	80	167			
Izu~Ogasawara	0	0	0	0			
Yamato Bank	0	0	0	0			
Total	408	481	142	339			

200~500m in water depth

Basins	Ultimate Recoverable resources (oil equivalent)		Ultimate Recoverable resources		area	Age of Sediments	Basin Characteristics
	108ton wt	108kl vol	Crude Oil (108kl)	Gases (108m3)			
Ihikari~Rebun	2	2	1	1	Okhotsk	Paleogene, Neogene	Shelf basin / Pull apart sinking basin
Soya~Abashiri	6	7	2	5	Western Hokkaido	Paleogene, Neogene	Shelf basins from onshore
Hidaka	2	2	0	2	Southern Hokkaido	Paleogene, Neogene	Shelf basins from onshore
Shimokita~Kushiro	1	1	0	1	Japan Sea side of NE Honshu	Neogene	Shelf basin from onshore
Tokachi~Kushiro	1	1	0	1	Japan Sea side of SW Japan	Neogene	Shelf basins
Oshima~Nishino	0	0	0	0	Pacific Ocean side of NE Honshu	Paleogene, Neogene	Warping-sinking basins
Akita~Yamagata	1	1	0	1	Kanto	Neogene	Shelf from onshore basin / warping-sinking
Niigata	22	28	9	18	Pacific Ocean side of SW Honshu	Neogene	Warping-sinking basin
Noto~Oki	7	8	3	5	Ryukyu Islands	Neogene	Shelf from onshore basin / warping-sinking basin
Oki~Taushima	14	16	5	11	Okinawa Trough	Neogene	Rift Basin
Fukue	0	0	0	0	East China Sea	Paleogene, Neogene	Shelf Rift Basins
Amakusa	0	0	0	0	Izu-Ogasawara Arc	Paleogene, Neogene	Sinking/ Median/Rift basin
Miyazaki	0	0	0	0			
Kitakami	1	1	0	1			
Joban	3	3	0	3			
Boso	0	0	0	0			
Tokai~Shikoku	2	2	0	2			
Nansei Islands	0	1	0	1			
Okinawa Trough	65	64	21	43			
East China Sea	3	4	1	3			
Izu~Ogasawara	0	0	0	0			
Yamato Bank	0	0	0	0			
Total	120	139	41	88			

500~2000m in water depth

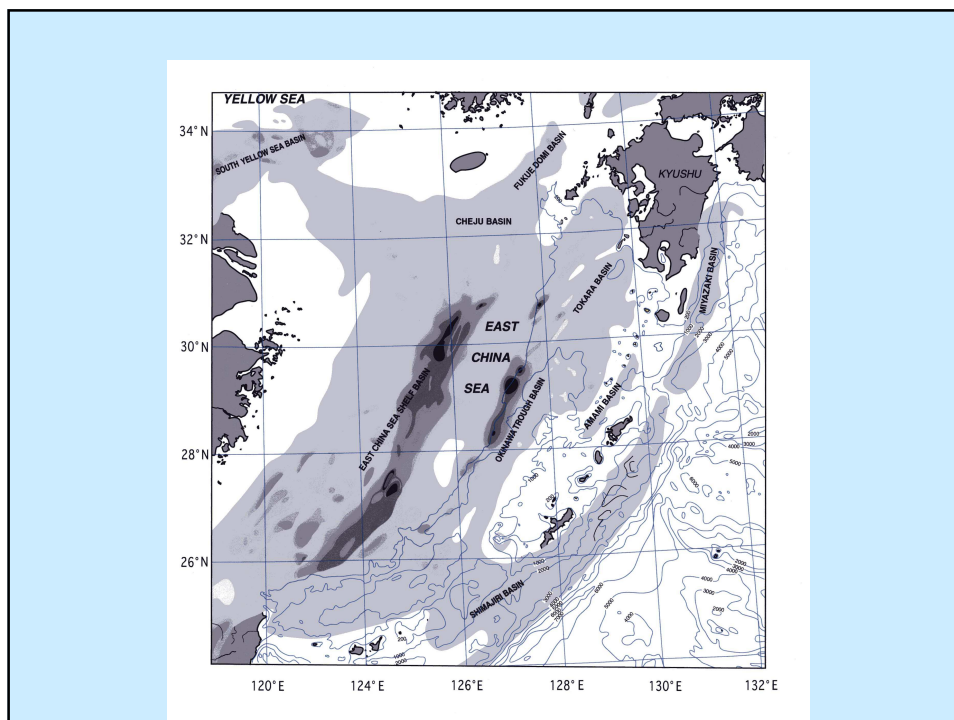
Basins	Ultimate Recoverable resources (oil equivalent)		Ultimate Recoverable resources	
	106ton wt	106kl vol	crude Oil (106kl)	Gases (109m3)
Ihikari~Rebun	1	1	0	1
Soya~Abashiri	38	45	14	31
Hidaka	4	5	0	5
Shimokita~Kuii	44	52	1	51
Tokachi~Kushiro	1	1	0	1
Oshima~Nishitsi	0	0	0	0
Akita~Yamagata	0	1	1	0
Niigata	48	56	18	38
Noto~Oki	32	39	12	24
Oki~Izushima	7	7	2	5
Fukue	1	1	0	1
Amakusa	0	0	0	0
Miyazaki	1	1	0	1
Kitakami	8	10	0	10
Joban	6	8	0	8
Boso	0	0	0	0
Tokai~Shikoku	11	13	0	13
Nansei Islands	4	4	0	4
Okinawa Trough	130	153	49	104
East China Sea	1	1	0	1
Izu~Ogasawara	3	4	0	4
Yamato Bank	1	2	1	1
Total	341	403	98	305

area	Age of Sediments	Basin Characteristics
Okhotsk	Paleogene, Neogene	Shelf basin / Pull apart sinking basin
Western Hokkaido	Paleogene, Neogene	Shelf basins from onshore
Southern Hokkaido	Paleogene, Neogene	Shelf basins from onshore
Japan Sea side of NE Honshu	Neogene	Shelf basin from onshore
Japan Sea side of SW Japan	Neogene	Shelf basins
Pacific Ocean side of NE Honshu	Paleogene, Neogene	Warping-sinking basins
Kanto	Neogene	Shelf from onshore basin / warping-sinking
Pacific Ocean side of SW Honshu	Neogene	Warping-sinking basin
Ryukyu Islands	Neogene	Shelf from onshore basin / warping-sinking basin
Okinawa Trough	Neogene	Rift Basin
East China Sea	Paleogene, Neogene	Shelf Rift Basins
Izu-Ogasawara Arc	Paleogene, Neogene	Sinking/ Median/Rift basin

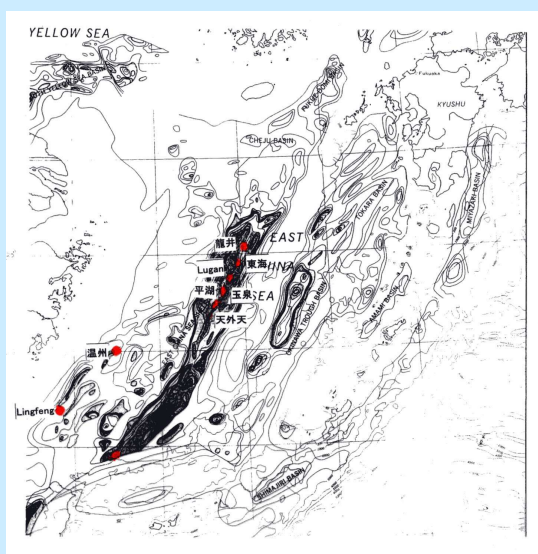
Estimated hydrocarbon Resources
around Japanese Islands

Million KL

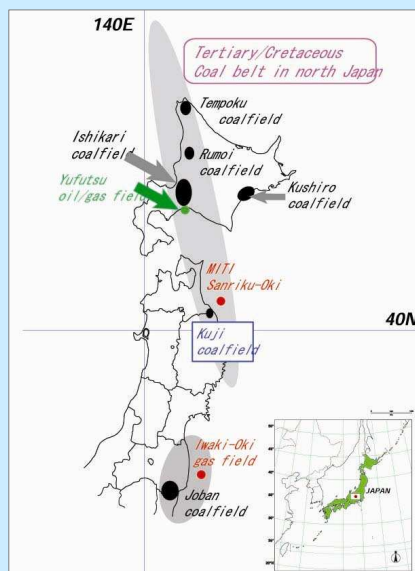
Resources (Ultimate Recoverable resources)				
Area		Offshore	Onshore	Total
Hokkaido	Offshore No : 1, 2, 3-1, 4 Onshore : Hokkaido	123 (12.0) [126 (10.2)]	208 (60.1)	331 (24.2) [334 (21.2)]
Pacific Ocean Side of NE Honshu	Offshore No : 5, 6-1, 6-2 Onshore : Akita, Yamagata, Niigata	149 (14.6) [136 (11.1)]	128 (37.0)	277 (20.2) [264 (16.8)]
Japan Sea side of NE Honshu	Offshore No : 3-2, 11, 12, 13 Onshore : Aomori, Iwate	94 (9.2) [83 (6.8)]	5 (1.4)	99 (7.2) [88 (5.6)]
Japan Sea side of SW Honshu	Offshore No : 7, 8-1, 8-2 Onshore : Toyama, Shimane	102 (10.0) [120 (9.8)]	3 (0.9)	105 (7.7) [123 (7.8)]
Pacific Ocean side of Honshu	Offshore No : 10, 14 Onshore : Shizuoka	29 (2.8) [33 (2.7)]	2 (0.6)	31 (2.3) [35 (2.2)]
NW Kyushu	Offshore No : 8-2, 9	5 (0.5) [8 (0.6)]		5 (0.4) [8 (0.5)]
Okinawa- East China Sea	Offshore No : 15-1, 15-2, 16	518 (50.6) [719 (58.5)]		518 (37.8) [719 (45.6)]
Izu-Ogasawara	Offshore No : 17	4 (0.4) [4 (0.3)]		4 (0.3) [4 (0.3)]
ALL Japan		1,024 (100) [1,229 (100)]	346 (100)	1,370 (100) [1,575 (100)]



Expected geological structures for hydrocarbon accumulation in the East China Sea



Oil and Gases originated from coaly source rocks



Classification of natural gases in sedimentary basins and research issues

Origin	Reservoir	Occurrences	Research Item
Thermogenic Gases (Deep Natural Gases)	Structural Natural Gases		
	Basement rock reservoir Deep reservoir	Low permeability Low permeability	Granite Reservoir, Volcanic Reservoir Tight sand Gases Shale Gases Deep Gases Microbial Gases with subduction
(Natural Gases originated from Coal)		Variable occurrences	Coal Bed Methane Gases from Originated from Coal
Biogenic Gases	Natural Gases dissolved in oil type.		
	Methane Hydrate	Low permeability Solid→Vapor	
	Natural Gases dissolved in water type.	High pressure type Intermittent gas rift type Conventional Type	Mobara Type Geo-pressured Type (Mexico Bay)
Ultra-Deep Gas	?		

Summary

- There are fore-arc, back-arc, median, and rift basins around Japanese Islands.
- Generally speaking, the sedimentary basins on the Pacific Ocean side are mainly expected bearing gas reservoirs including gas hydrate layers, and those on the Japan Sea sides are mainly expected bearing oil reservoirs.
- To generate thermogenic oil and gases in the young strata of Neogene, high heat sources from present and/or past volcanoes are necessary.
- Paleogene from Hokkaido to Kanto along the Pacific coast, which contains coal beds, have high potential to produce thermogenic oil and gases, if they have been under compression stress fields.
- There are giant rift basins beneath the continental shelf of the East China Sea and in the Okinawa trough.
- The rift basins beneath the continental shelf in the southern part of the East China Sea have suffered from thermogenic alternations by tertiary volcanoes, and high potential to produce thermogenic hydrocarbons.