

Deposition of Oil spilled from A Russian Tanker on Coasts

by

Fuminori Kato¹⁾ and Shinji Sato²⁾

ABSTRACT

Heavy oil spilled from a Russian tanker deposited on coasts facing the Japan Sea in January 1997. Especially, coasts in Fukui Prefecture and Ishikawa Prefecture were attacked by disastrous oil deposition. On the basis of detailed field reconnaissance, the behavior of deposited oil was described for sandy beaches, pebble beaches and rocky coasts. Impacts of oil deposition on coastal environment were also estimated.

Key Words :Coastal Environment,
Oil Deposition, Oil Spill,
Winter Storm

1. INTRODUCTION

The Russian tanker "Nakhodka" sank in the Japan Sea off Oki Islands on January 2, 1997. Huge amount of 6,240 kl heavy oil was spilled from the tanker. The amount ranks with the worst oil spill accident in Japan, that is, the accident at Mizushima oil plant of Mitsubishi Petroleum Corporation in 1971 in which 7,500 - 9,500 kl of C heavy oil was spilled. The spilled oil from the Russian tanker polluted the coasts facing the Japan Sea from Yamagata Prefecture to Shimane Prefecture. Deposited oil on coasts was removed with the help of many volunteers. Oil removal activities were performed under severe weather conditions and greatly influenced by winter storms. Since the long-term impacts of oil deposition on coastal environments were anticipated, field observation was conducted on the behavior of the deposited oil on coasts and its impact on coastal environments.

2. MOVEMENT OF SPILLED OIL AND EFFORTS FOR RECOVERY

The oil spill accident occurred when the Russian tanker "Nakhodka" was traveling in the Japan Sea from Shanghai to Petropavlovsk in the Kamchatka Peninsula, Russia. The tanker was carrying 19,000 kl of C heavy oil. On January 2, 1997, the tanker was accidentally broken into two pieces by storm off Oki Islands. The bow drifted in Japan Sea and the rest of the body sank onto the sea bottom of 2,500 m depth. A total amount of 6,240 kl of oil was spilled from the two pieces of the tanker. Part of the oil deposited the coasts facing the Japan Sea from Yamagata Prefecture to Shimane Prefecture.

After drifting on the sea surface, the bow stranded on the coast of Mikuni Town, Ishikawa Prefecture, on January 7. Photo 1 illustrates the stranded bow and deposited sludge-like oil on the coast. In the town, oil deposited on the beach intermittently for about two months from the accident. Sludge-like oil drifted toward the coast in the beginning of the time. About one month after the first oil deposition, only oil grain deposited on the beach. Oil in the stranded bow was completely removed on February 25, but oil grain occasionally deposited on the coast even after that.

Figure 1 shows the date of the first oil arrival on the coast and the total amount of removed oil. From Kaga Coast in Ishikawa Prefecture to Tottori Coast, the first arrival date was January 7-9. As the spilled oil was transported by the strong Tsushima currents and wind-driven currents, the arrival of oil delayed

1) Research Engineer, Coast Division, River Department, Public Works Research Institute, Ministry of Construction, Tsukuba, 305-0804 Japan

2) Head, Coast Division, ditto

on the northern coasts.

The amount of oil deposited on the coasts was not estimated, however, it can be inferred from the amount of oil removed by March 28 which includes not only oil but also sand, gravel and sea water. The total amount of removed oil was 38,000 kl. The removed oil in Fukui Prefecture was about 18,000 kl, and that in Ishikawa Prefecture was about 13,000 kl. The total amount of oil removal was especially large in the area around Mikuni Town, eastern part of Wakasa Bay, and northern part of outer side of Noto Peninsula.

Figure 2 shows the temporal variation of significant wave height and average wind velocity recorded at Tokumitsu oceanographic observation station in Mattou City, Ishikawa Prefecture (see Fig.1). A ultrasonic-type wave gage is fixed on the sea bottom at the point of 15 m depth, 1,500 m off the coast. A wind meter is installed at about 15 m above the ground. Significant wave height in January and February 1997 was mostly over 1 m, sometimes exceeded the highest significant wave height 4.93 m between 1988 and 1996. Wind speed in the period was frequently over 10 m/s. Prevailing wind direction was from northwest. Such winter storm made oil removal quite difficult.

Oil removal works on the beach was started immediately after the first oil arrival. The total amount of oil removal in Mikuni Town reached 2,170 kl by January 20 and 2,520 kl by March 28. It included sand, gravel and sea water which were collected with oil. At a gravel beach in Mikuni Town, pebbles were wiped out with a piece of cloth steeped by kerosene in March. In Hamaji Coast, a sandy beach in the town, thorough oil removal was conducted even after oil removal on the surface. The removal of oil from the sand layer was conducted by two ways; one was sand sieving by hand and the other was pushing out oil-mixed sand into the sea expecting for the stir by waves.

3. FIELD RECONNAISSANCE ON REMAINED OIL

Field reconnaissances on remained oil

were conducted several times on coasts in Fukui, Ishikawa and Kyoto Prefectures. The result shows sediments in the coast influenced oil deposition.

On sandy beach, Sand accretion after the oil deposition resulted in the confinement of oil in sand. Photo 2 illustrates typical oil deposition on sandy beach. Lumps of oil were scattered on the surface. In order to investigate the presence of oil underground, sand in an area of 12 m by 1.5 m was excavated to the depth of 1.5 m. Figure 3 and Photo 3 illustrate an oil layer in the ground of Hamaji Coast, Mikuni Town, Fukui Prefecture, observed on February 6, 1997. Depth of the layer was over 1 m. Oil concentration in the layer was 20,000 mg/kg (oil weight per 1 kg of sand). Since there were no traces of oil penetration above the underground oil layer, it was considered that the oil was remained underground owing to the rapid accretion of sand.

On gravel beach, oil penetrated into the void space among the gravels. Photo 4 shows oil in the space among gravels near the stranded bow. The gravels were coated thickly by oil. Photo 5 illustrates a gravel beach adjacent to Hamaji Coast on the other side of Imazu River, observed on June 11, 1997. There were gravels covered with oil on the surface. Figure 4 shows oil concentration in sediments was 72.7-415 mg/kg in 50-70 cm depth, 15 mg/kg in 90-100 cm, 0 mg/kg in 130-150cm on March 6. The thickness of the gravel layer was up to 1m. The deeper part is consisted of only sand. This means that oil has penetrated into the border of the sand layer.

On rocky coast, oil has filled rock cracks. Photo 5 and 6 illustrates oil deposition on rocky coast in Shiga Town, Ishikawa Prefecture. Deposited oil was seen in rock cracks even in splash zone.

4. IMPACT OF REMAINED OIL ON COASTAL ENVIRONMENTS

(1) Remained Oil on Coasts

Oil deposition on coasts have a serious impact on coastal environments. Field

observation of the impact was conducted in Mikuni Town.

Figure 5 shows oil concentration in seawater taken at Hamaji Coast. Line 1 is across the zone in which detached breakwaters is built. Line 2 is out of the zone. Onshore point is 50 m off the coastal line. Offshore point is 150 m off the coastal line. Oil was detected on February 2, February 25, June 11 and November 21, 1997. It shows oil was detected intermittently. Leveling on the beach for sea bathing may push sand into sea on June 11. Oil in sand on the beach can be washed away by big waves.

Figure 6 shows oil concentration in sand on the beach of Hamaji Coast. Although sand on the surface has contained oil by March, it has rarely contained oil since May. On the other hand, oil was detected in the ground even in November. It indicates that oil is scattered in the ground of the sandy beach although oil on the surface has been removed by removal activities.

Figure 7 shows oil concentration in marine sediments on Hamaji Coast. Oil in marine sediments was detected only on February 25. It indicates oil-mixed sand may deposit on the sea bottom.

(2) Impact on Coastal Organisms

Observation of macrobenthos on the beach was conducted at Hamaji Coast. Species and number of macrobenthos in 30 cm square, 30cm in depth, was measured. Table 1 shows the result. Macrobenthos were found to be rare before the end of February. Species and the number of macrobenthos increased after March. It is considered that macrobenthos will not be present in surface sediments during winter since vigorous sediment movement will occur under winter storms. It is still uncertain whether the variation of macrobenthos was due to seasonal change or due to the impact of oil deposition.

Observation of macrobenthos in marine sediments was conducted at Hamaji Coast. Table 2 shows species and number of the macrobenthos. There were few macrobenthos on the sea bottom in the beginning of February as well as on the beach. The same reason can

be considered. Impact of oil deposition is also unknown.

Observation of sessile creatures was conducted on a gravel coast and a rocky coast in Mikuni Town. Species and number of sessile creatures in 30 cm square was measured. Table 3 shows the result. No significant changes in their species and number are recognized. Creatures of low activity have never been observed between 1 month and 11 months after the first oil arrival. To conclude, impact of oil deposition on sessile creatures was not recognized.

Observation of seaweeds was conducted on the same coasts as sessile creatures observation. Species and weight of seaweeds in 30 cm square was measured. Table 4 shows the result. Extreme changes in their species is not recognized. It indicates seaweeds was not influenced by oil deposition so much.

Totally speaking, impacts of oil deposition on coastal environments have not been clearly detected yet. Further monitoring survey will be necessary for a few years.

(3) Impact on Beach Utilization

Inquiry from the sea bathing people on the beaches in Fukui Prefecture and Ishikawa Prefecture was conducted on August 8-9. The result shows that they had no reluctance for past oil deposition.

Laboratory experiments on remained oil recognition were conducted. The result suggests the guideline for recreational beaches, that is, there should be no visible oil on the surface and oil concentration in sand should be less than 20 mg/kg.

5. Conclusion

Field surveys were conducted in order to understand the effects of vast deposition of spilled oil on coastal environments. Main conclusions are summarized as follows:

(1) The behavior of deposited oil on coasts varied among sandy beach, pebble beach and rocky coast.

(2) Further long-time monitoring will be necessary to understand the impacts on ecological system.

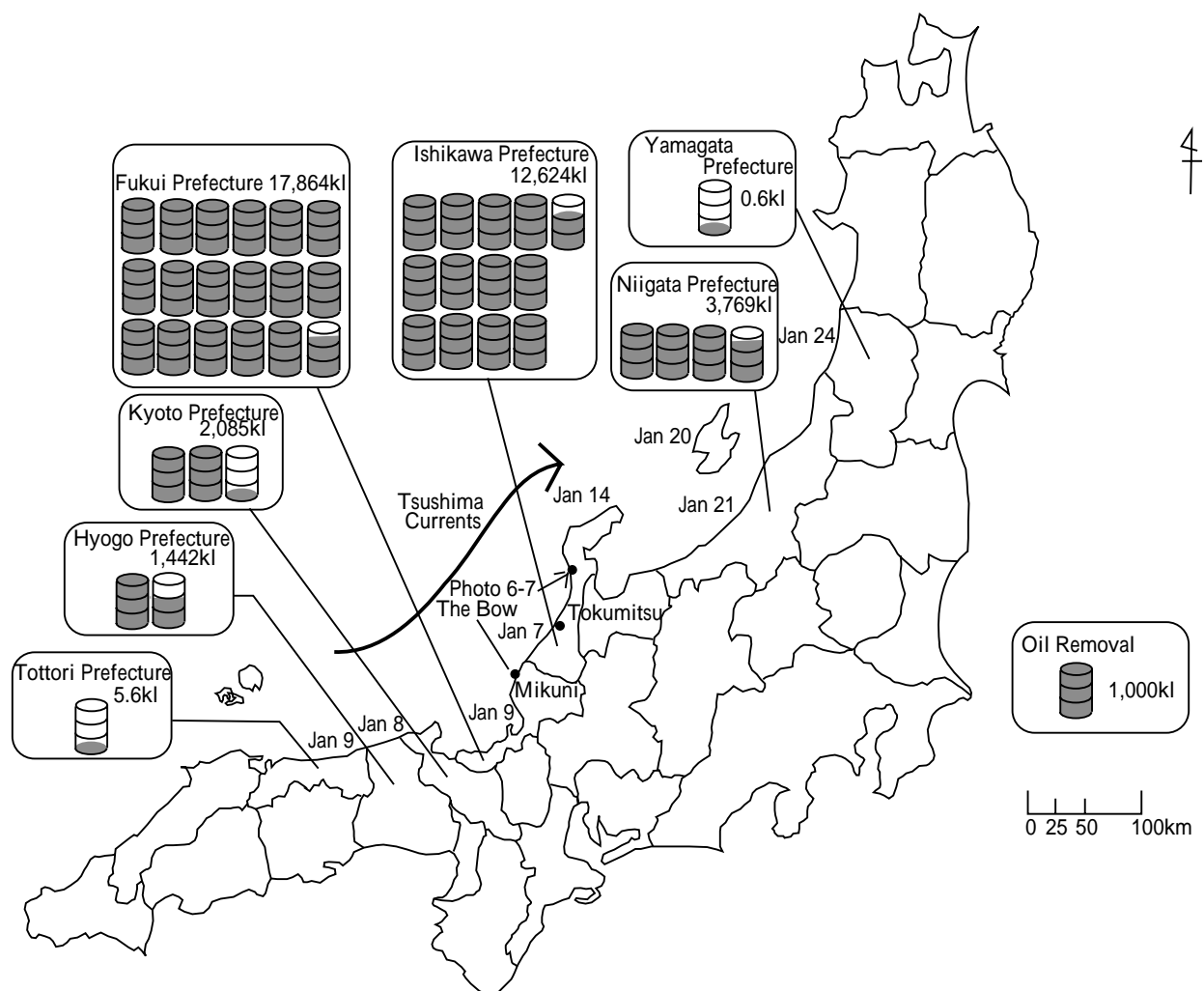


Fig.1 The first oil arrival date and the total amount of removed oil by March 28, 1997.

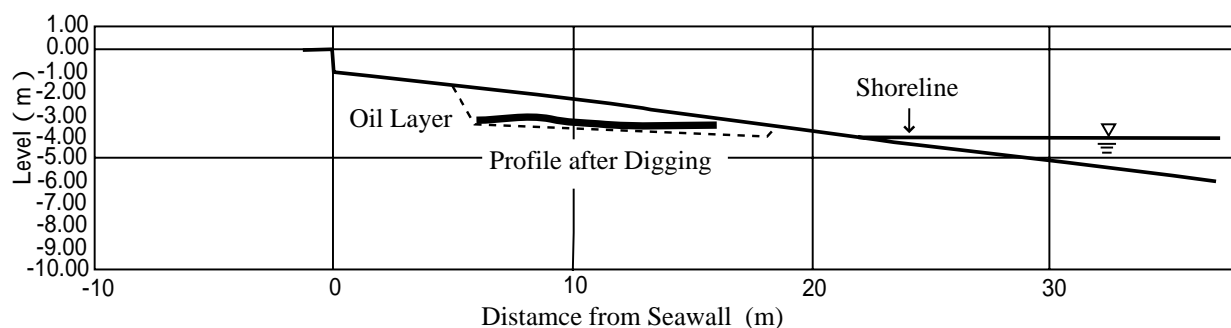


Fig.3 Oil layer in the ground of Hamaji Coast

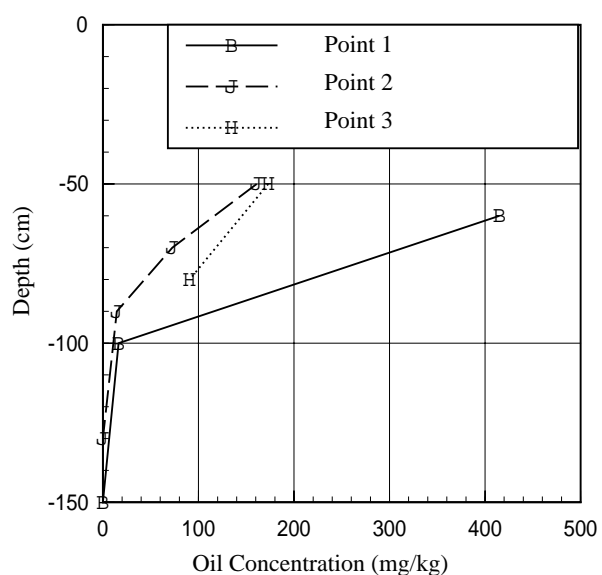


Fig.4 Oil concentration in gravels

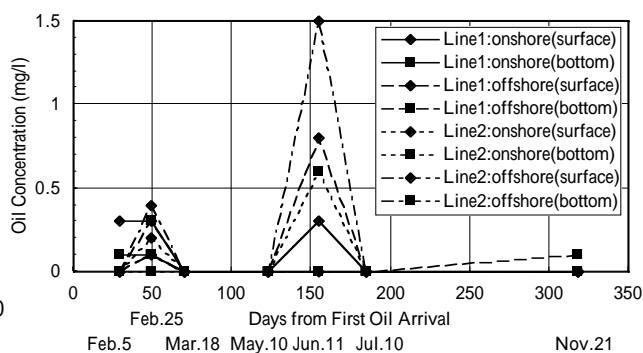


Fig.5 Oil concentration in seawater of Hamaji Coast

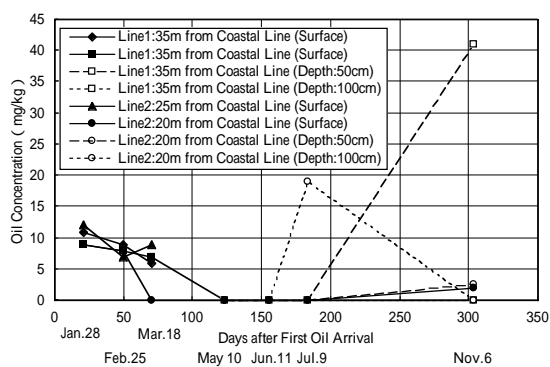


Fig.6 Oil concentration in sand on the beach of Hamaji Coast

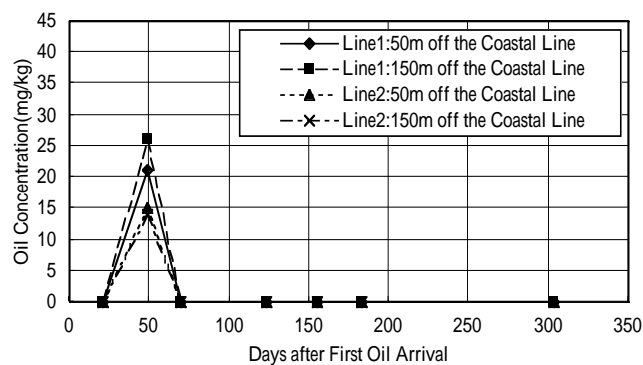


Fig.7 Oil concentration in marine sediments on Hamaji Coast

Table 1 Species and number of macrobenthos on Hamaji Coast

Unit: /0.09m²

Line	Distance from the coastal Line	January 28		February 25		March 18		June 11		November 6	
		Species	Number	Species	Number	Species	Number	Species	Number	Species	Number
1	35m	0	0	1	1	3	49	-	-	-	-
	20m	0	0	1	1	3	13	5	27	6	421
2	25m	0	0	0	0	3	5	-	-	-	-
	20m	0	0	0	0	1	2	6	89	2	11

Table 2 Species and number of macrobenthos in marine sediments of Hamaji Coast

Unit: /0.1m²

Line	Distance off the Coastal Line	February 6		February 25		March 18		June 11		November 21	
		Species	Number	Species	Number	Species	Number	Species	Number	Species	Number
1	50m	2	4	4	48	6	48	7	185	8	118
	150m	0	0	6	124	4	22	6	173	13	29
2	50m	2	10	5	69	7	50	7	46	13	347
	150m	2	9	6	34	11	127	9	179	15	167

Table 3 Species, number and weight of sessile creatures on the coasts in Mikuni Town

Unit: /0.09m²

Point	Item	Jan.28, Feb.5	Feb.25	Mar. 18	Jun.11	Dec.6
Gravel Coast	Species	22	37	40	64	63
	Number	61	101	287	368	346
	Weight(g)	3.29	9.6	9.26	56.01	16.5
Rocky Coast	Species	61	74	44	61	30
	Number	247	299	125	206	242
	Weight(g)	27.41	28.61	8.61	40.62	18.7

Table 4 Species and weight of seaweeds on the coasts in Mikuni Town

Unit: /0.09m²

Point	Item	Jan.28, Feb.5	Feb.25	Mar.18	Jun.11	Dec.6
Gravel Coast	Species	32	24	36	20	25
	Weight(g)	43.51	214.66	133.31	398.36	221
Rocky Coast	Species	34	31	29	22	26
	Weight(g)	82	92.01	165.09	86	198

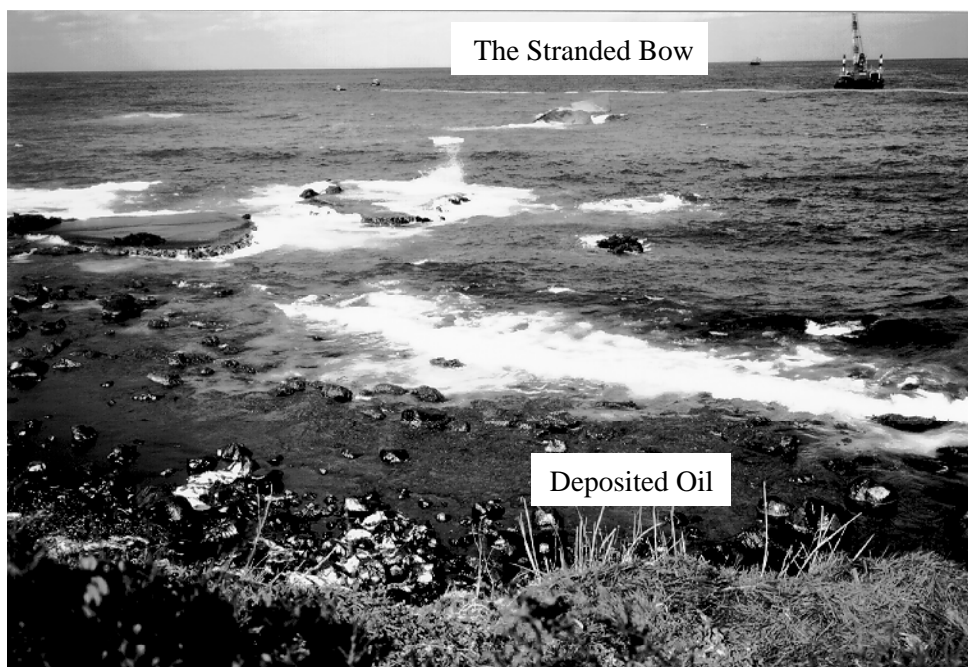


Photo 1 The stranded bow near the coast (January 11, 1997)



Photo 2 Oil deposition on sandy beach (Sunset Beach in Mikuni Town, January 11, 1997)



Photo 3 Oil layer in the ground of Hamaji Coast, Mikuni Town (February 6, 1997)

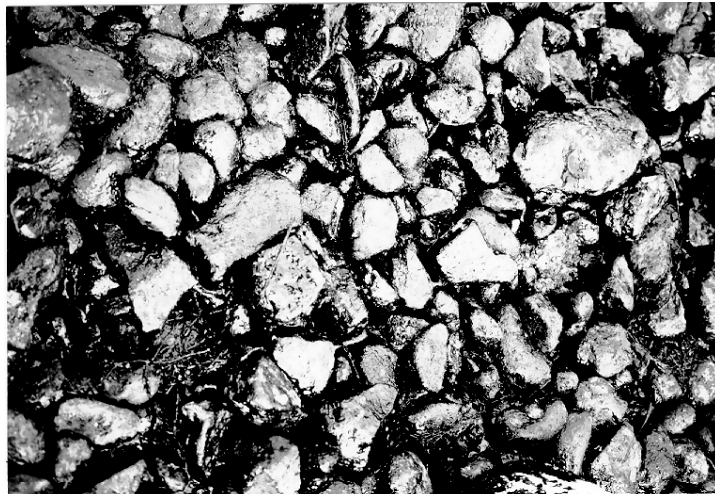


Photo 4 Deposited oil in the space among gravels near the stranded bow (February 6, 1997)



Photo 5 Gravel beach adjacent to Hamaji Coast, Mikuni Town (June 11, 1997)



Photo 6 Rocky coast in Shiga Town, Ishikawa Prefecture (February 10, 1997)



Photo 7 Oil deposition around a tide pool (February 10, 1997)