STUDY ON DAMAGE AND RECOVERY OF COASTLINES FOR THE THREE YEARS AFTER THE NAKHODKA OIL SPILL

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Outline

- 1. Degree of oiling of coastlines, based on visual observation that were made during the 2-year period following the oil spill.
- 2. Recovery of the coastlines by monitoring PAHs for 2-3 years.
- 3. Characteristics of both the coast and the oil affecting on the degree of oiling and the recovery from oiling.

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- 1. The viscosity and the concentration of polycyclic aromatic hydrocarbons (PAHs) of C-heavy oil are much higher than those of crude oil.
- 2. In spite of the large differences such as viscosity and chemical composition between crude and C-heavy oils, little information is available on C-heavy oil spills.

Nagahashi Beach, Suzu, Jan. 18, 1997.



Katano Beach, Kaga, Jan. 9, 1997.



Visual observations of coastline

- 1. (1) March 21 and 22 and April 17 and 18, 1998; (2) April 17 and 18 and May 15, 1999.
- 2. 170 km, from Suzu, Ishikawa Prefecture to Mikuni, Fukui Prefecture, except for steep coasts.
- 3. 176 zones: bedrock, boulder/ cobble/pebble, gravel/sand and man-made material.

Sampling

- 1. Beached oil
- 2. Sand (beach and bottom)
- 3. Seawater
- 4. Fishes (greenling and globefish)

Persistence of C-heavy oil

- I. Not covered with oil and oil lumps were not found (not oiled).
- II. Not covered with oil but oil traces or lumps less than 5/m² were found (lightly oiled).
- III. No more than 5% of the surface was covered with oil or oil lumps between 5 and 100/m² were found (moderately oiled).
- IV. More than 5% of the surface was covered with oil or oil lumps more than 100/m² were found (heavily oiled).

Relationship between Oiling Level and Habitat of Ishikawa and Fukui Coastlines

| Habitat | n | Afer 1 Year % After 2 Year % | | | % | | | | |
|--------------------------------|----|------------------------------|----|----|----|----|----|----|----|
| | | Α | В | С | D | Α | В | С | D |
| Rock | 60 | 29 | 9 | 15 | 47 | 13 | 62 | 17 | 8 |
| Bould/cobble/ pebble/gravel | 34 | 12 | 21 | 21 | 47 | 44 | 27 | 18 | 12 |
| Sand | 53 | 59 | 19 | 16 | 6 | 68 | 22 | 4 | 6 |
| Man-made | 29 | 31 | 7 | 12 | 50 | 38 | 37 | 25 | 0 |

Observations: (after 1 year) March 21, 22 and April 17, 18, 1998; (after 2 years) April 17, 18 and May 5. Oiling levels: A, not remained; B, light; C, moderate; D, heavy.









Kawaura Beach, March 5, 1998.

Shape of Coast



Relationship between Oiling Level and Shape of Ishikawa and Fukui Coastlines

| Habitat | Shape | After 1 year % | | | After 2 years % | | | | |
|--------------------------------|-----------|----------------|----|----|-----------------|----|-----|----|----|
| | | Α | В | С | D | Α | В | С | D |
| Rock | exposed | 38 | 0 | 19 | 43 | 11 | 66 | 11 | 11 |
| | pocket | 33 | 16 | 11 | 39 | 0 | 100 | 0 | 0 |
| | sheltered | 16 | 11 | 11 | 61 | 14 | 56 | 21 | 7 |
| Bould/cobble/ pebble/gravel | exposed | 9 | 9 | 18 | 64 | 62 | 19 | 5 | 14 |
| | pocket | 25 | 17 | 33 | 25 | 0 | 100 | 0 | 0 |
| | sheltered | 0 | 36 | 9 | 55 | 17 | 33 | 42 | 8 |

Observations: (after 1 year) March 21, 22 and April 17, 18, 1998; (after 2 years) April 17, 18 and May 5. Oiling levels: A, not remained; B, light; C, moderate; D, heavy.

| Chemical | Fomulae | b.p. (°C) | |
|----------------------------------|--|------------|--|
| Paraffins | | | |
| Methane | CH4 | -161 | |
| Ethane | C2H6 | -88 | |
| Propane | СзНв | -42 | |
| Butane | C4H10 | 1 | |
| n-Hexane | C6H14 | 69 | |
| n-Octane | C8H18 | 126 | |
| Naphthenes | | | |
| Cyclopentane | C5H10 | 49 | |
| Cyclohexane | C6H12 | 81 | and the second s |
| Methylcyclohexane | C6H11CH3 | 100 | a all a second and a second a |
| Olefins | | | ·* |
| Ethylene | CH2=CH2 | -104 | |
| Propylene | CH ₂ =CHCH ₃ | -48 | |
| 1-Hexene | CH2=CHC4H9 | 64 | |
| Aromatic hydrocarbons | | | |
| Benzene | C6H6 | 80 | |
| Toluene | C6H5CH3 | 111 | |
| o-Xylene | C6H4(CH3)2 | 144 | |
| <i>m</i> -Xylene | C6H4(CH3)2 | 139 | |
| <i>p</i> -Xylene | C6H4(CH3)2 | 138 | |
| Ethylbenzene | C6H5C2H5 | 136 | |
| Polycyclic aromatic hydrocarbons | and a second | | |
| Naphthalene | C10H8 | 218 | |
| Anthracene | C14H10 | 341 | |
| Pyrene | C16H10 | 404 | |
| Benzo[a]pyrene | C20H12 | 495 | |
| Others | | | |
| 1,3-Butadiene | CH2=CHCH=CH2 | -4 | |
| Acetylene | CH≡CH | -84 | |
| Resins | 1. | | |
| Asphaltenes | a sub- | | |
| | <u>si</u> | | |



Chromatograms of PAHs in the Nakhodka C-heavy oil and the oil lump collected from a bedrock at Nagahashi, Suzu on April 17, 1999. Conc. (x 100, µg / g)





Time Courses of BaP Concentrations in Sea Water



Comparison of BaP concentrations in sea water at Nagahashi, Suzu, Kaiso, Monzen and Sunsetbeach, Mikuni to those of several other beaches in Japan



Time courses of BaP Concentrations in Edible Tissues of Greenling and Globefish Collected at Kaiso, Monzen

Sample number: n = 4 (***), 3 (**), 2 (*), 1 (others). Each plot and bar indicate mean \pm SD.

Conclusions

- The beached C-heavy oil tended to remain for a long time on coastlines of bedrock and boulder/cobble/pebble. Wave energy appeared to be the main force to remove the oil from sandy beaches.
- 2. Concentrations of BaP in seawater were high one month after the accident. The concentrations fell to sub ng/l level after three years, which were as low as those on unpolluted coastlines in Japan.
- 3. Concentrations of BaP in the edible parts of greenling during only the first two months were higher than the normal level.



Concentrations of Several PAHs in Sand at Kaiso Beach, Monzen



PAH Concentrations in Reached Oil Lumps Collected on Bedrocks at Nagahashi, Suzu



Nap Z Ant = Pyr N BaP = BPer - n-hexane extract

Time Courses of n-Hexane Extract Amount and PAH Concentrations in Sand at (A) Kaiso, Monzen and (B) Sunsetbeach, Mikuni