

**TOWARDS THE MINAMATA BAY ANTI-MERCURY POLLUTION PROJECT  
(KUMAMOTO PREFECTURE, JAPAN)**

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The existence of Minamata disease was officially recognized by the Government of Japan in 1956. This problem is related to industrial emissions of methylmercury. Source of contamination was Japanese chemical company «Chisso Corporation». It is an important supplier of liquid crystal used for liquid crystal display (LCDs), but is better known for the leading role in the 34-year-long contamination of the water supply in Minamata, Japan that led to thousands of deaths and victims of disease. The main symptoms of this disease is a sensory impairment, ataxia, concentric narrowing of the field of vision and hearing disorders.

The Minamata Bay Anti-Mercury Pollution Project is considered to be the largest Anti-Pollution Project in the world. It began in 1974, although the first premise of Minamata Disease appeared in 1956.

At that time mercury was not being discharged from the factory. But there were several fish species that were contaminated with mercury exceeding safety levels recommended by the Ministry of Health and Welfare of Japan (total mercury – 0.4 ppm, and methylmercury – 0.3 ppm). Unfortunately, the mercury in seawater of Minamata Bay was detected only in inorganic form, not methylated.

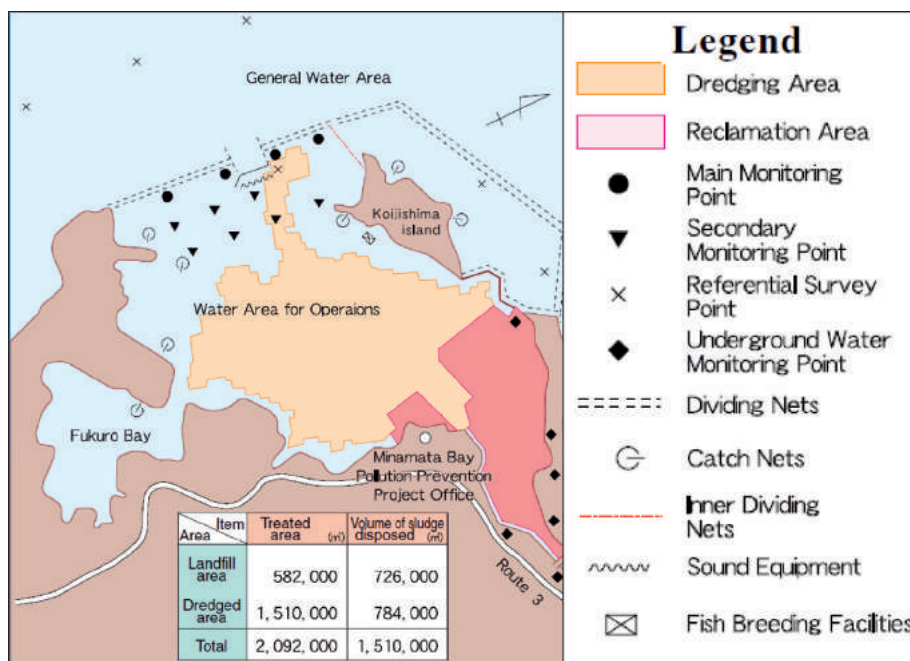
Dr. Fujiki and Dr. Tajima (Medical School of Kumamoto University) found that inorganic mercury in the mud of Minamata Bay had reacted with organic compounds such as acetic acid and turned into methylmercury by the influence of sunlight (ultra-violet radiation) under the aerobic condition.

Organisms converted mercury into methylmercury in their metabolism. This compound is more toxic and has a stronger head for accumulation in organisms, whereby its concentration in the tissues of organisms increases with their position in the food chain. Thus, methylmercury content in fish was 8-36 ppm, in oysters – up to 85 ppm, whereas in water its concentration was less than 0.68 mg/l.

So, Kumamoto Prefectural Government decided to implement Anti-Pollution Project. In 1973, “Provisional Regulatory Standards for Mercury Contaminated Sediment Disposal” were issued to be 25 ppm by the Environmental Agency, and in 1974 Kumamoto Prefecture Pollution Countermeasures Committee approved it.

The amount of discharged mercury from Chisso Minamata Factory was estimated between 70 and 150 tons. In certain localities the sludge depth with the mercury content more than 25 ppm reached to 4 meters. Therefore the total area of sludge treatment reached the size of 2.09 mln m<sup>2</sup>. The investigation showed that zones with mercury content more than 1000 ppm were situated in the deepest part of the bay, and the concentrations decreased with the distance.

After many discussions, the decision was chosen: to dredge the sediments with low mercury concentration, and remove them in the deepest part of the bay. The sludge to be dredged was estimated of 1.5 million m<sup>3</sup>, the dredging area is of 151 ha and reclamation area is of about 58 ha.



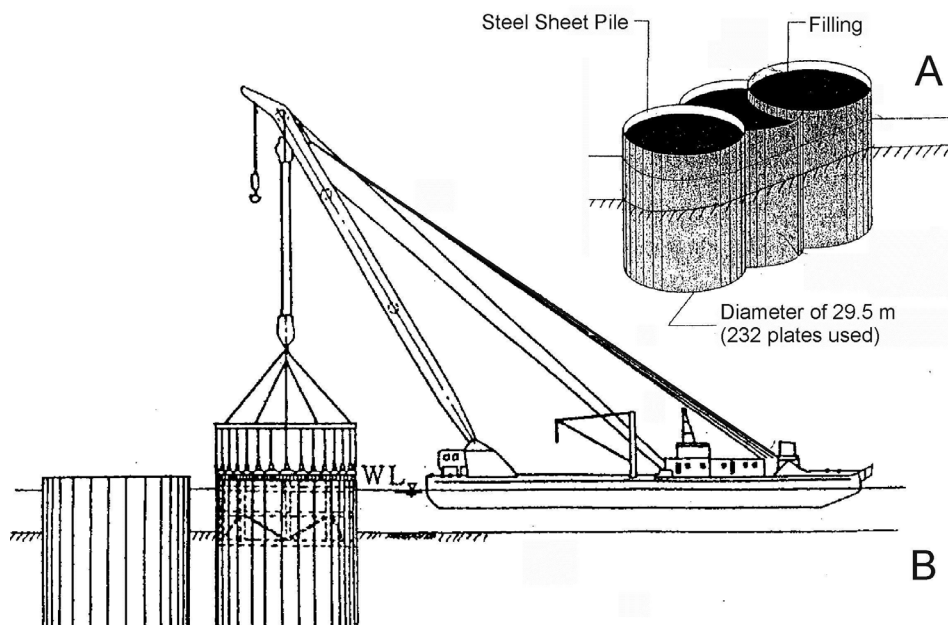
*Fig.1 Map of Minamata Bay Dredging Operations [2]*

The first thing to do was to set the dividing net at the edge of the bay. This was done to shut the polluted fishes in the bay during the dredging operation. The length of the double net was 3,600 m and maximum depth was about 30 m. Moreover, big loud speakers were set at the inlet, where the dividing net was not installed, to shut the polluted fishes in

the bay.

After this step the temporary close-off bank was set up and combined Myoujinzaki and Koijishima islands. The purpose was to weaken the tidal flow inside Minamata Bay and to prevent sediment from flowing out of the bay.

Next step was the bank construction for land reclamation. The bank was constructed by driving cylindrical steel cell pile into the seabed. The diameter of the pile was about 20-30 m and was filled with sand. Such method was called "Steel Sheet Cell Pile Method". It was done to prevent any mercury or polluted water from leaking out of the bank.



**Fig.2 Bank for Reclamation Area Using the Steel Pipe Cell Method (A) and Setting of Steel Sheet Pile Cell (B)**

Dredging activity was done using dredging ship with cutter-less pumps. To minimize the sludge disturbance, cutterless pumps were used. In addition, underwater TV cameras and turbidity meters were equipped at the underwater drawing inlets. Dredging operations were carefully continued with the observation of the seawater turbidity condition. Reclamation operations were carried out to keep water more than 50 cm in depth inside the reclaimed land, to shield from the air and sunlight. Of course, the outlet for discharging was also installed underwater to keep them away from the air. Top-layer seawater of the reclaimed land was processed by the wastewater treatment systems. Combined methods of coagulation and filtration were applied. The turbidity and mercury concentration of the processed seawater were checked and then processed water released.

After the dredging, in order to shield mercury-contained sludge from air and sunlight, it was necessary to confine it with mountain soil immediately. However, the sludge in the landfill was so soft that it was difficult to use ordinary methods. Therefore, at first, the reclaimed land was covered with synthetic cloth and then pressed with a net of ropes. Then the surface was treated with 80-cm-thick layer of sand by spreading suspension of sand in water. After the leveling process, mountain dirt or mud was spread by small and big bulldozers.

In 1977, Monitoring Committee of Minamata Bay Anti-Pollution Project was organized to monitor the clean-up operations. It consisted of related administrative organizations, academic experts, local citizens and some others. The committee was authorized to abort or terminate clean-up operations and to change the methods when necessary. The committee held meetings 69 times in 17 years and there reviewed and discussed about the results of monitoring.

As the result of longstanding monitoring during the operation and after completion, mercury concentration in all water samples were kept below the limits of detection (0.0005 ppm), while the permissible level is 25 ppm. In 1994, after 5 years from the completion of operation, the average of mercury concentration in fish was below the Japanese safety level.

All dividing nets were removed in August, 1997. It took 8 years to start the fishery in Minamata Bay since the end of the Anti-Pollution Project. Additional survey of mercury levels was continued for another 3 years.

#### References

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