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A Proposal on Ultimate Safety Disposal of High Level Radioactive Disposal

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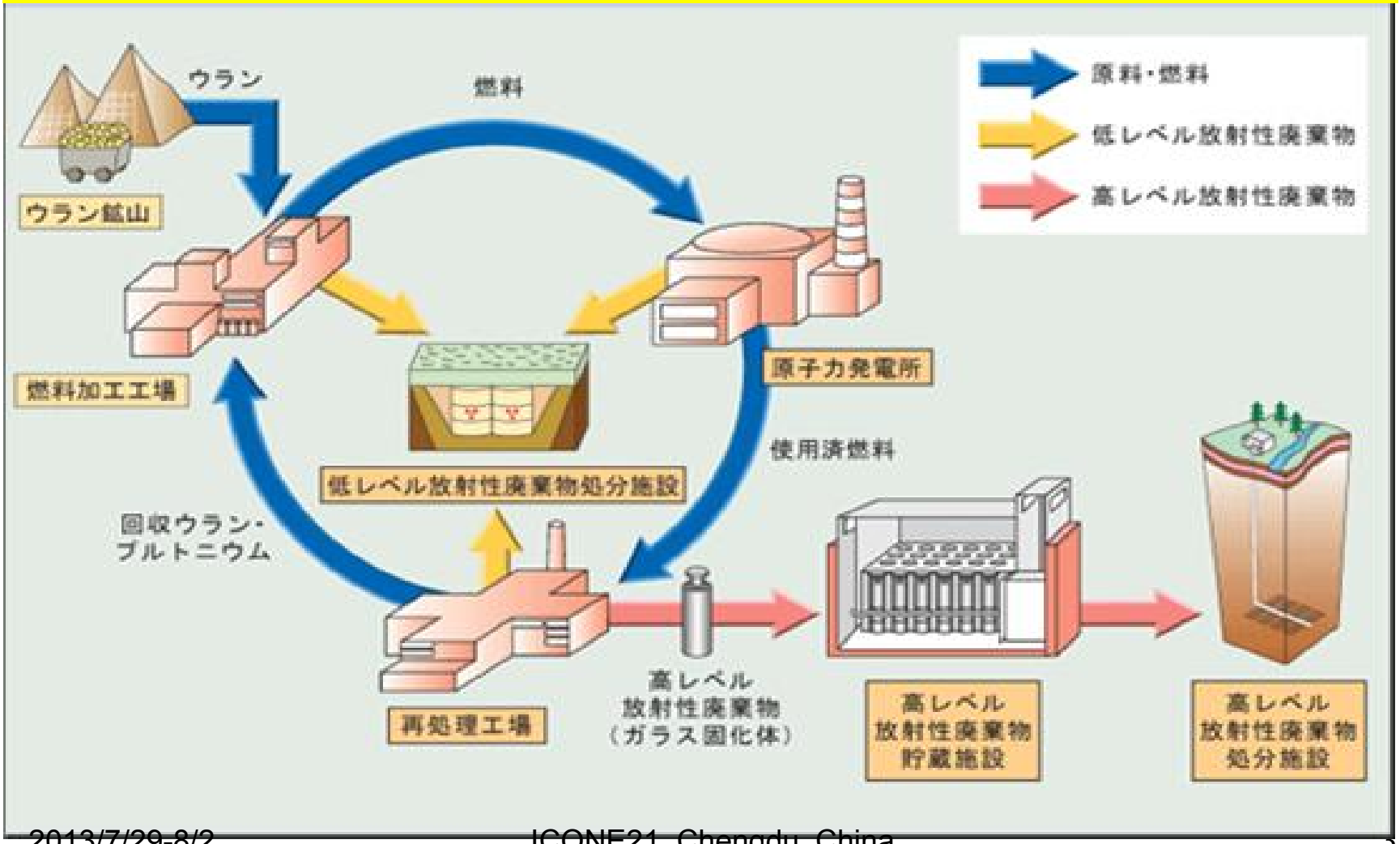
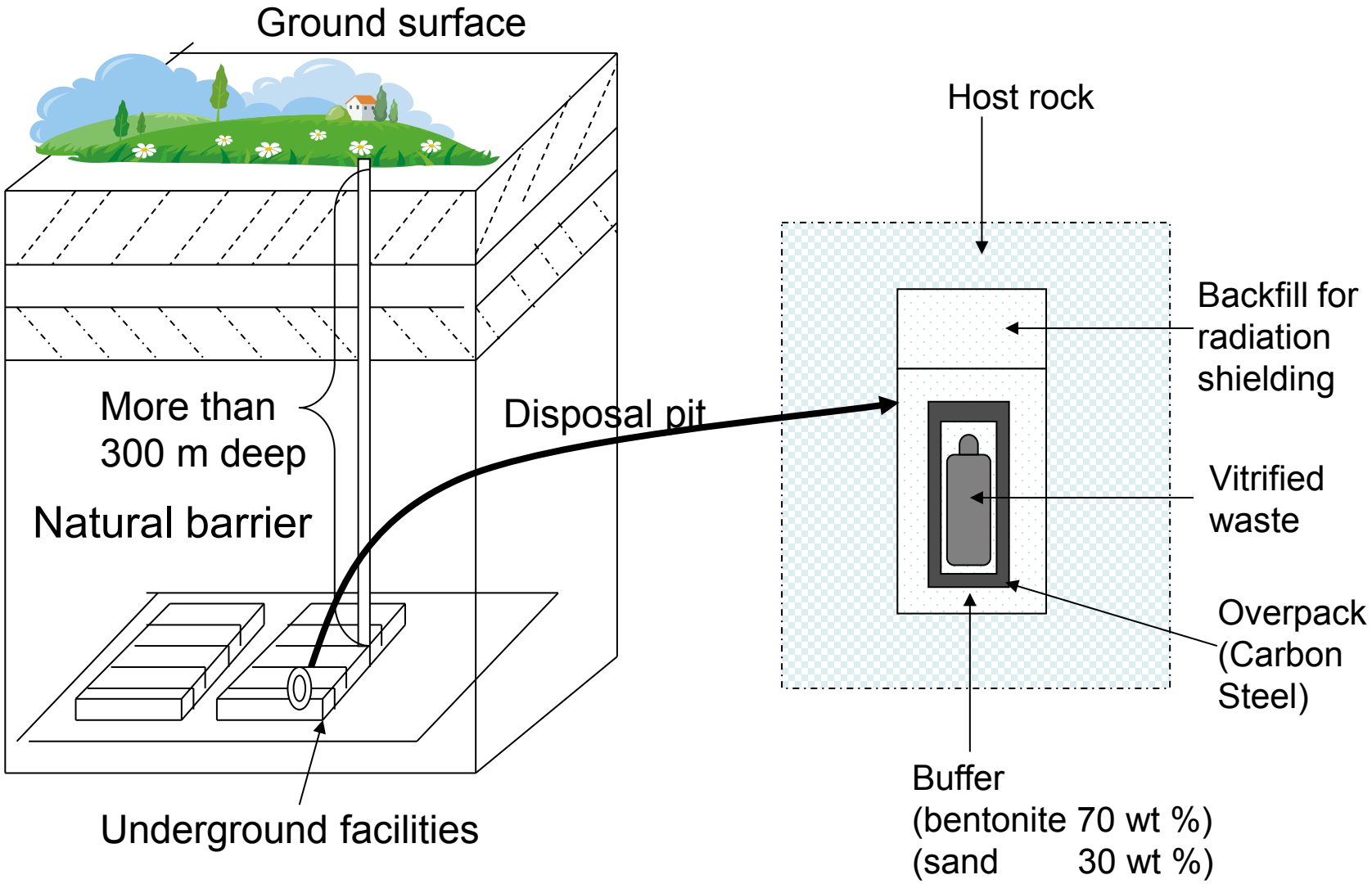
Nuclear fuel cycle and high level radioactive wastes



Concept of geological disposal of HLW



1. HLW disposal policy in Japan

- This nuclear energy policy had been supported by the majority of Japanese people before Fukushima Daiichi accident, in order to attain national energy security and to prevent global warming by CO_2 emission with the abundant use of fossil energy.
- However there were already many problems existed in this nuclear fuel cycle policy before Fukushima accident. Especially the selection of HLW disposal site was difficult to decide for these ten years or so.

2. Effect of Fukushima accident

- As the result of Fukushima Daiichi accident in March 2011, final disposal of HLW has become more serious issue than before.
- The amount of HLW to be processed and disposed has surely increased than before.
- In addition to the crushed nuclear fuels in the damaged Fukushima Daiichi plants which should be retrieved and processed after the decomposition of the plants, not a few nuclear power plants will be forced to decommissioned because of the danger of big earthquake in the vicinity of the nuclear reactor in the future.

2. Effect of Fukushima accident

- There are not a few people in Japan who want complete nuclear phase-out. But will nuclear phase-out solve this issue?
- There are significant amount of spent fuels in such reactors even if they are not in operation.
- Even if all reactors in Japan are shutdown, there will be the risk of radioactive release accidents in Japan where strong earthquakes may occur so frequently.
- Then what should they do with HLW disposal?

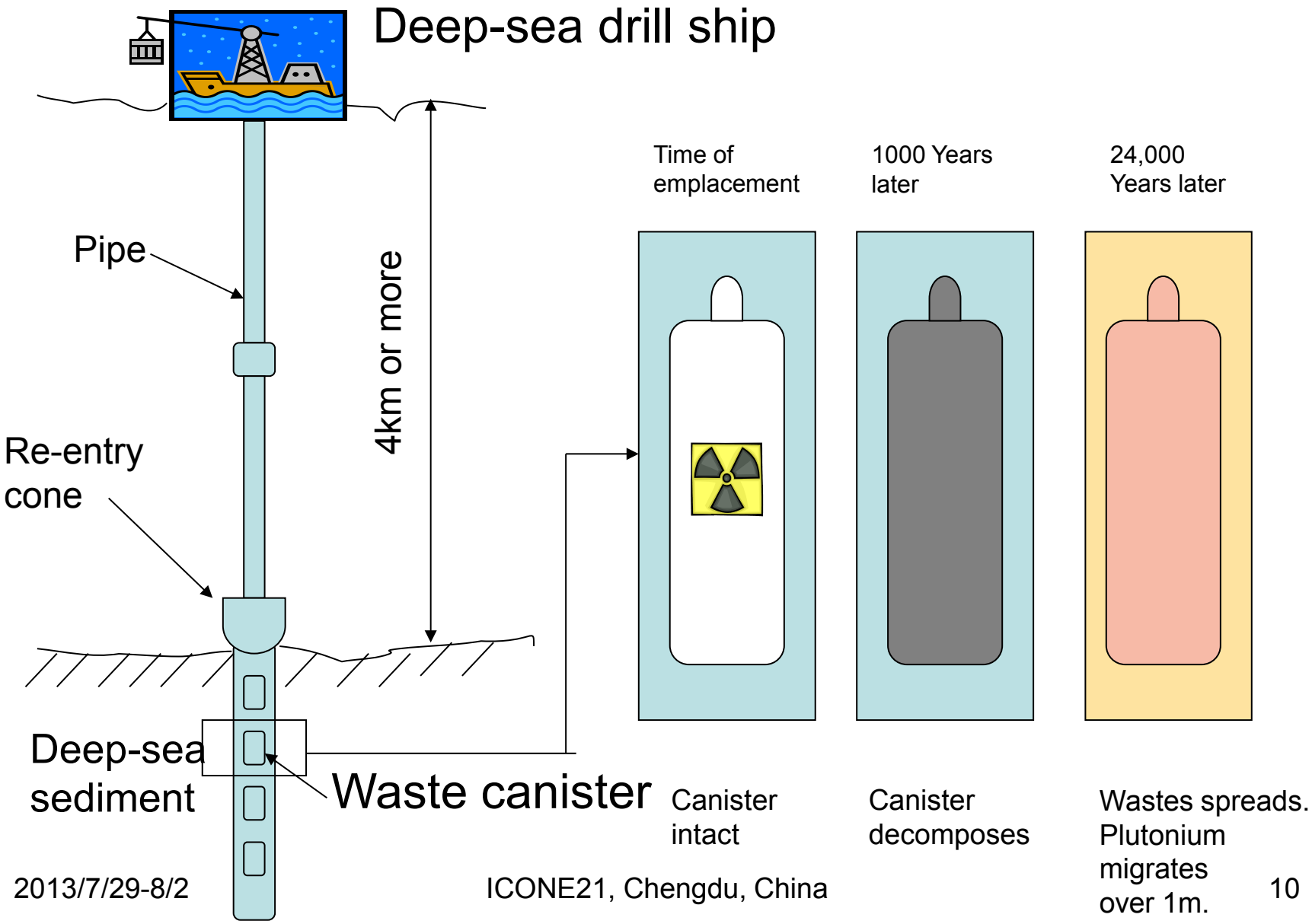
3. Seafloor disposal of HLW

- The author of this paper proposes to re-consider the old idea of sea bed disposal of HLW deep in Pacific Ocean which had been studied in US until 1990s .
- This old idea was abandoned internationally since 1986 by London Convention which banned radioactive waste dumping in public sea. But the author would like to point out that the HLW disposal in seabed is not ocean dumping.
- The sea-bed disposal of HLW deep in Pacific Ocean is not only a safer ultimate disposal of HLWs than by underground disposal, but also it has the possibility of synergetic effect of rare-earth resource exploration from deep sea-beds .

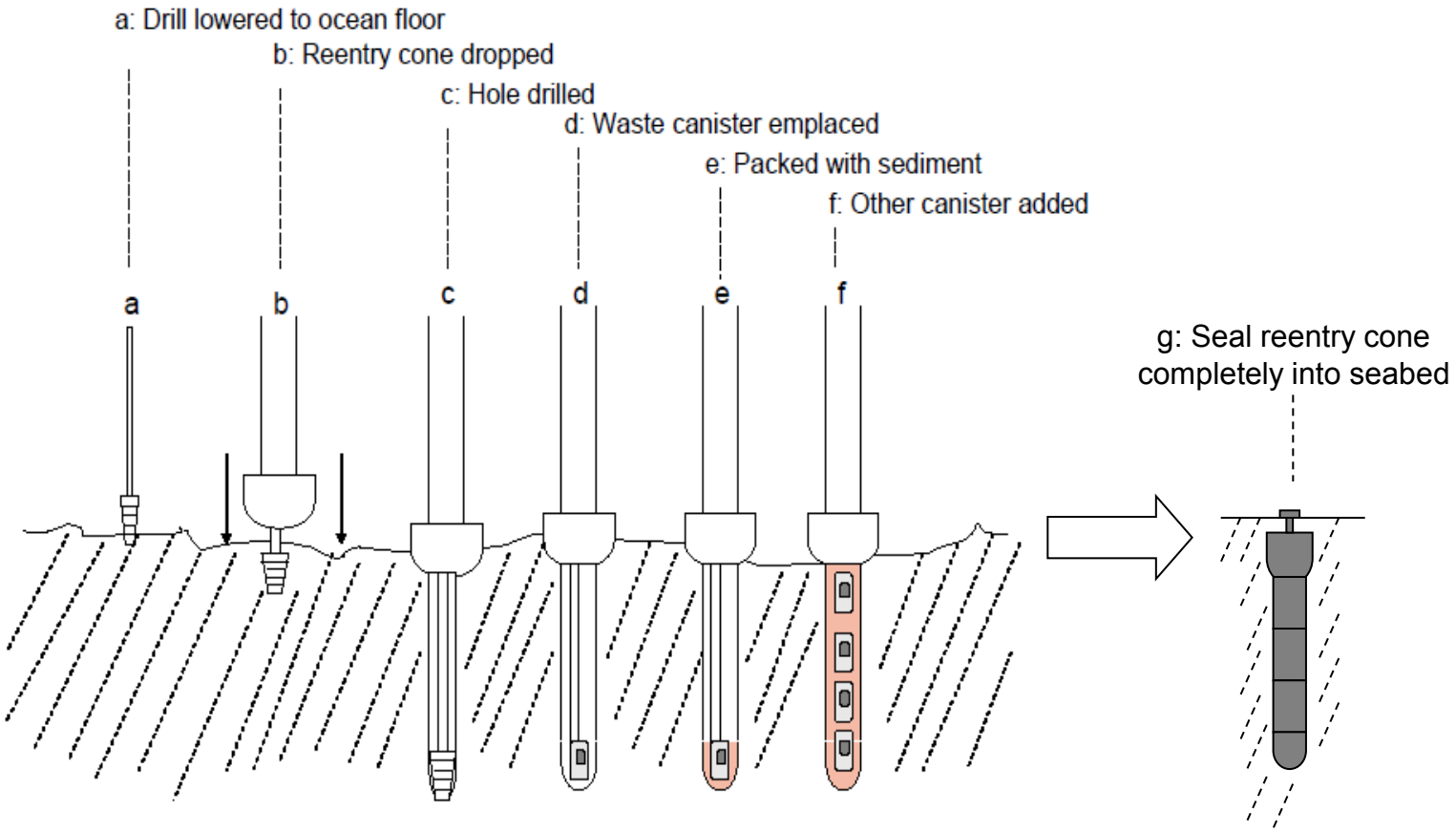
Hollster, C.D. and Nadis,S. : Burial of radioactive waste under the seabed, Scientific American, January 1998, pp.60-65.

- A feasibility study of confirming the possibility of disposing HLW on the sea-bed had been conducted between 1976 and 1986 as an international research project which was called as “Seabed Working Group (SWG)”.
- This SWG had conducted on the research project with 120 million U.S. Dollars by the support of U.S. government and OECD/NEA with the participation of 200 research institutions from ten countries.

General concept of sea-bed disposal of HLW.

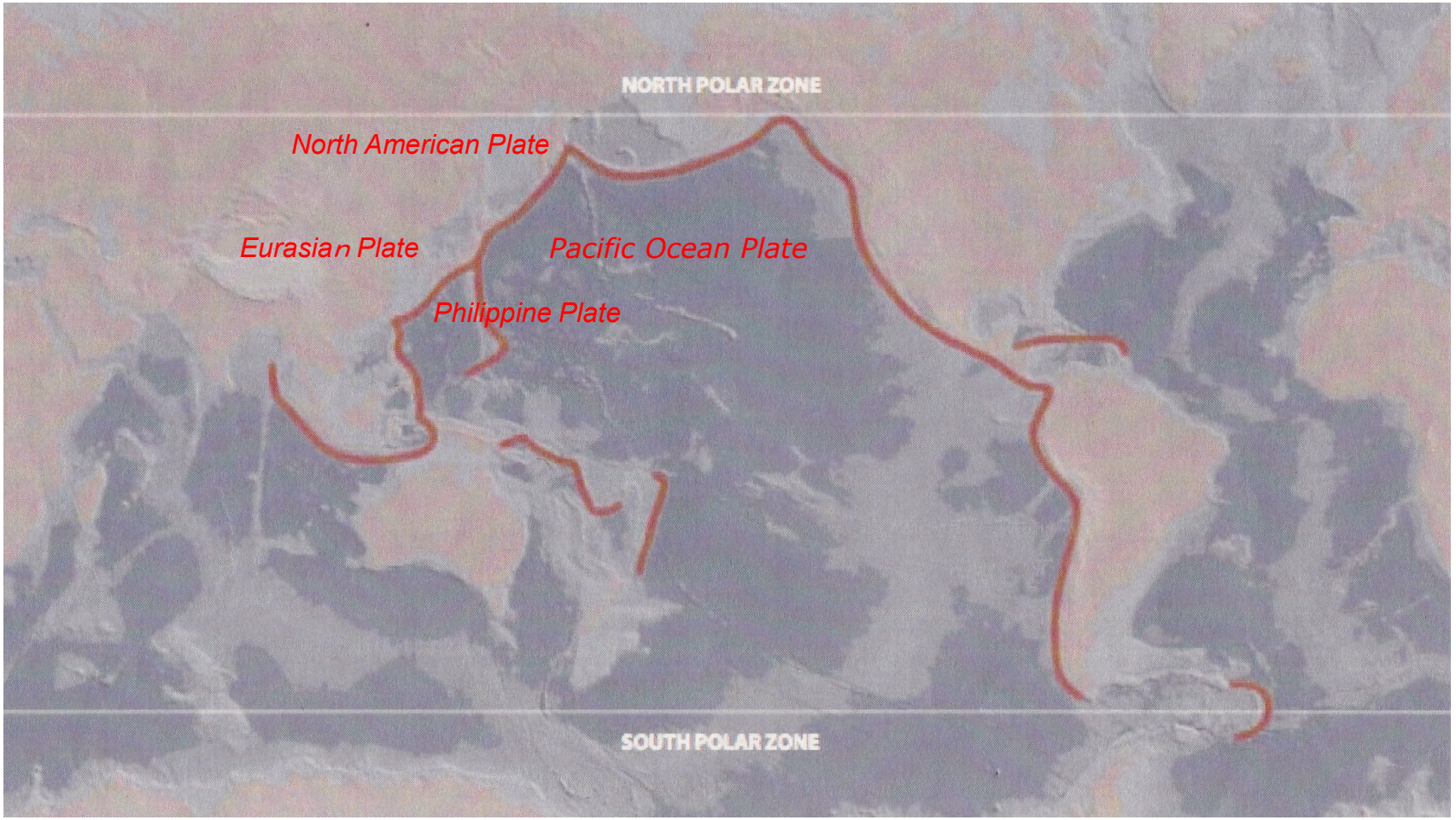


Detailed procedure to dispose HLW.



Deep-Sea Drill Ship used in Ocean Drilling Program

Plate tectonics of earth



Explanation of the figure

- The stable sea floor (part of dark blue color) would expand to 20 % of whole surface of earth, and this is suited for deep-seabed disposal.
- However, those regions such as (i) plate boundaries (red color belt zones) and (ii) rather shallow sea-floor regions such as spots where plumes would pour out from mantle and many under-sea volcanoes line up in row, and (iii) the south and north polar zones (light blue color part) are classified as inappropriate place for sea-bed disposal because of the instability of the sea-bed layers.

Hollster, C.D. and Nadis,S. : Burial of radioactive waste under the seabed, Scientific American, January 1998, pp.60-65.

- However, this SWG project was interrupted in 1986 by the U.S. government. It was because that year the U.S. government decided Yacca Mountain as the candidate site for HLW disposal repository to start HLW disposal from 2015. (However, the construction of Yacca Mountain HLW repository was cancelled by President Obama.)
- Moreover in 1996, International Maritime Organization (IMO) made the resolution that the deep sea-bed disposal of HLW corresponds to ocean dumping which is prohibited by London Dumping Convention.

Hollster, C.D. and Nadis,S. : Burial of radioactive waste under the seabed, Scientific American, January 1998, pp.60-65.

- Since then the sea-bed HLW disposal has been forgotten, but only underground HLW disposal within each countries has been taken in nuclear developing countries for HLW disposal, also because of the restriction of Basel Convention which became effective in 1992 to prohibit transport of harmful wastes over the national boundaries.
- However according to London Convention, it is possible to re-evaluate the deep sea-bed disposal of HLW after 25 years of IMO resolution. Therefore, it is possible to reconsider deep sea HLW disposal from 2021 internationally.

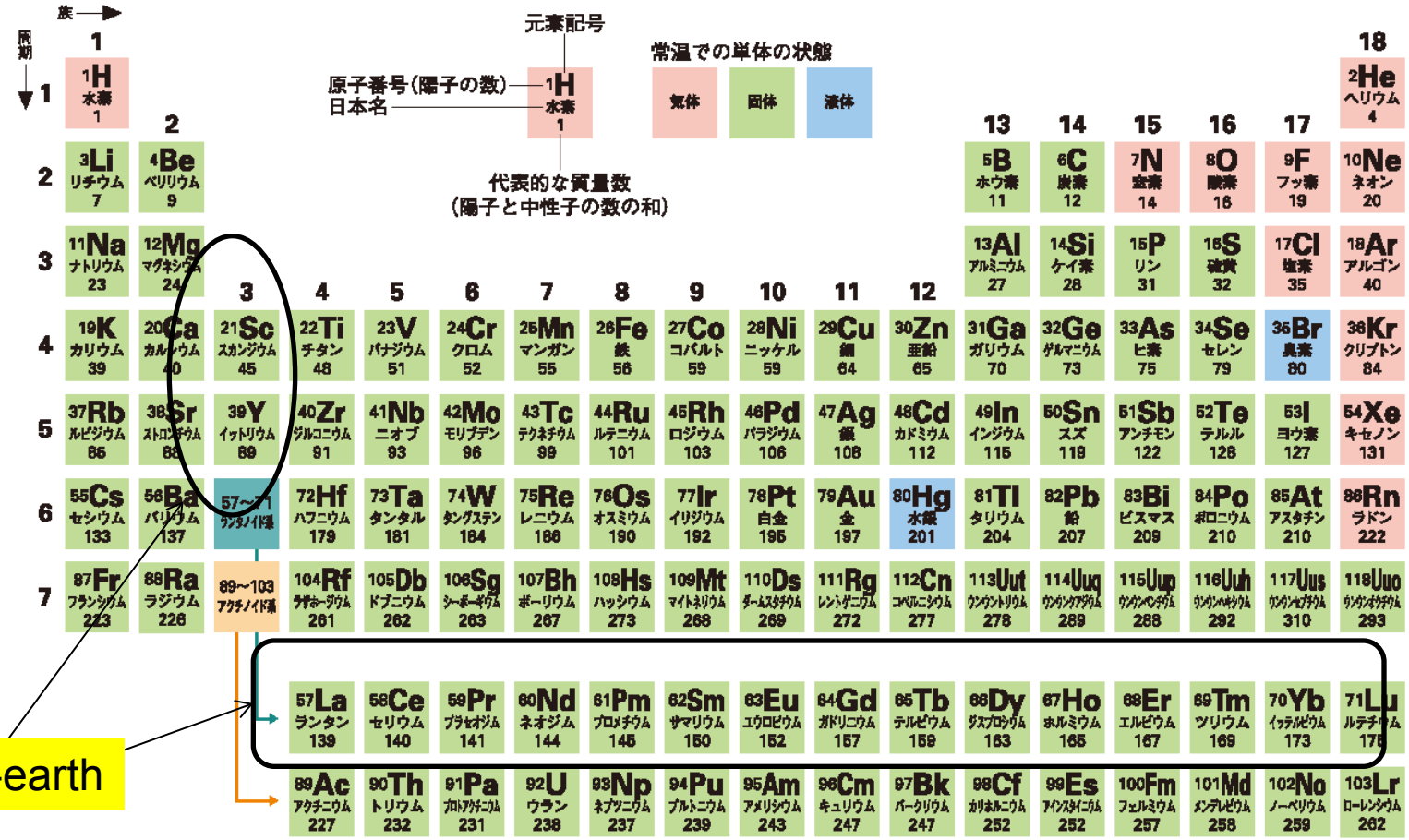
4.Proposal of deep sea-bed HLW disposal repository system

It was recently reported in the international journal of geological science that the mud taken from the deep seabed in Pacific Ocean contained rare-earth resource which become the raw material for high-tech industry.

Possible distribution of rare-earth resource on sea-bed of Pacific Ocean. (Source: Kato, Y., et al.: Deep-sea mud in the Pacific Ocean as a potential resource for rare earth elements, Nature Geoscience 4, 535-539, 2011.)

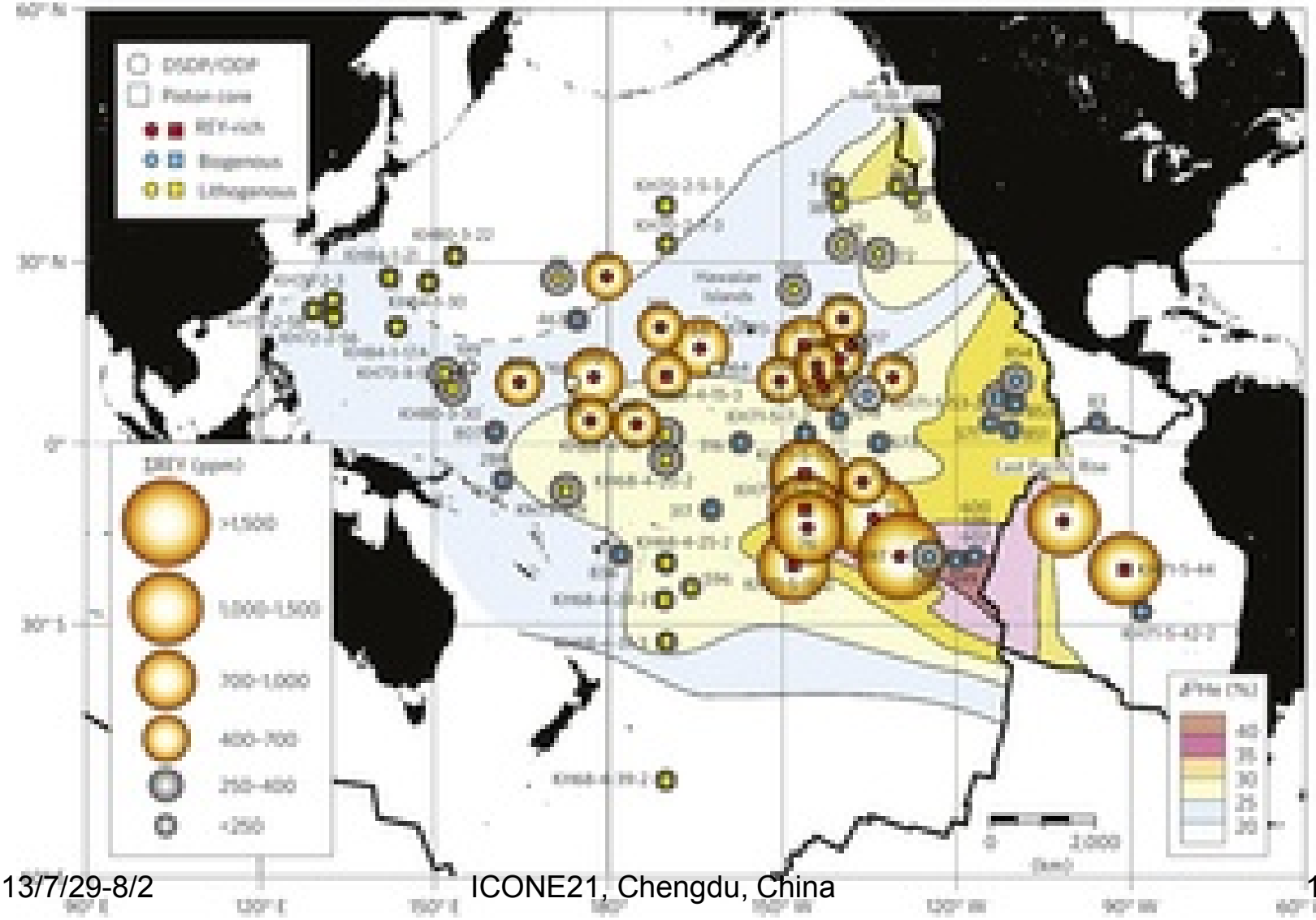
《　元素の周期表　》

原子には多くの種類があります。元素の周期表は、原子の特性のちがいを規則的にならべたものです。

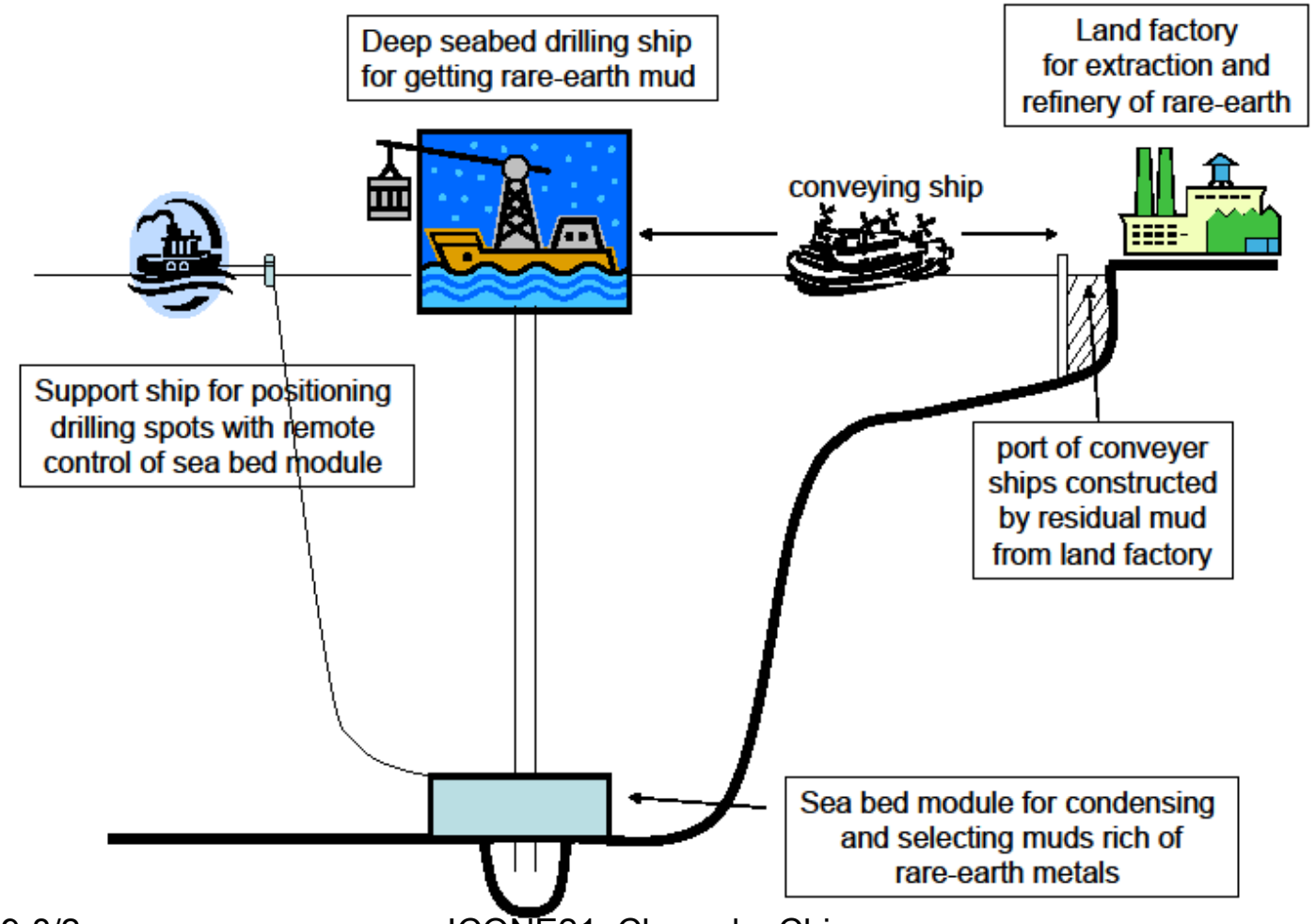


出所：チャレンジ！原子力ワールド

Possible distribution of rare-earth resource on sea-bed of Pacific Ocean.



Rare-earth resource explore system



Rare-earth resource explore system

(i) Land factory for extraction and refinery of rare-earth,

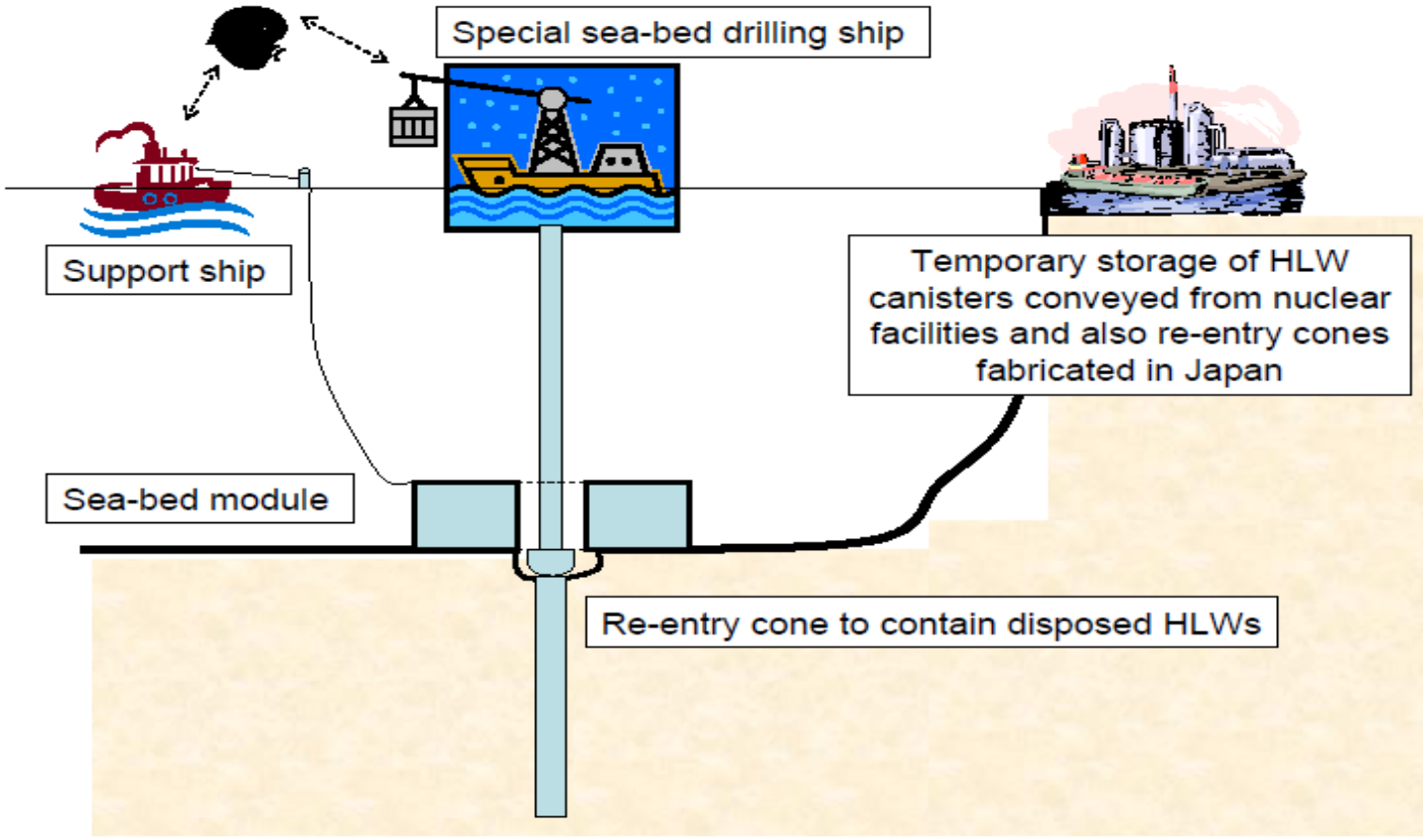
(ii) Conveyer ship and its port which will be constructed by using the residual mud from the land factory,

(iii) Special rare-earth drilling and lifting ship,

(iv) Sea bed module for condensing and selecting mud rich of rare-earth metals,

(v) Support ship for positioning drilling spots with remote control of the sea bed module.

Deep sea-bed HLW disposal repository system



Deep sea-bed HLW disposal repository system

(i) Temporary storage of various types of HLW canisters conveyed from various nuclear facilities and also the re-entry cones fabricated in Japan,

(ii) Special sea-bed drilling ship,

(iii) Sea-bed module, and

Deep sea-bed HLW disposal repository system

(iv)Support ship to support the works of afore-mentioned sea-bed drilling ship and sea-bed module cooperatively, to dig the holes on the sea-bed, place the re-entry cone and then put canisters and fill in the sediment in turn from the bottom of the re-entry cone until its seal off from the sea bed.

Concluding remarks

- The combination of rare-earth resource development and HLW disposal in deep sea-bed is a synergetic project to get high profit from rare-earth materials on one hand and to solve the critical HLW disposal problem which is the negative legacy of nuclear energy utilization amplified by Fukushima Daiichi accident in Japan.

Concluding remarks

- The proposed idea of deep sea-bed HLW disposal repository system is a rough image on how this system will work together with the rare-earth explore system as the synergetic cooperative system.
- Further studies are needed to elaborate the idea not only for technical feasibility study, but also for environmental preservation, and for socio-economical studies such as cost estimation, international agreement, etc.

Thank you very much for your kind attention.