AN IDEA ON EXTRACTION OF URANIUM FROM SEAWATER USING THE DRIFT OF ICEBERGS

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Abstract: On recovering uranium from seawater, one of the most radical problems awaiting solution is how to contact economically an enormous quantity of seawater with absorbents. In this paper a new method of mechanical cable-bucket system combined with the drift of icebergs is discussed. In order to determine the amount of recoverable uranium, an iceberg of 1 km in length and drifting at 1 kt was chosen. Then, a 5-km loop with absorbent buckets attached at 3 m intervals was hung over the iceberg. Assuming an absorption efficiency is 30% and a desorption efficiency 90%, the amount of uranium produced by this recovery process was estimated to be 77 t a year.

A major assessement was to be made of the uranium resources in seawater. One of the most radical problems to be overcome was how to economically contact an enormous quantity of seawater with absorbents, because of the quite low concentration of uranium, about 3.3 ppb in seawater. Several concepts for processing seawater to recover uranium were investigated. They included pumping the seawater and using natural ocean currents or tides directly. But a new mechanical method combining linked buckets and using drifting icebergs was suggested. A similar continuous line bucket system as a technique for mining deep-sea manganese nodules is also now being tested (MERO, 1977). In a test made in 1972, some 10 t of nodules from the ocean floor off the Hawaiian Islands were reported to have been recovered by this system (JAPAN RESOURCES ASSOCIATION, 1980).

Numerous icebergs are drifting in the Antarctic and the Arctic Oceans. The icebergs are spread over an area of 63×10^6 km^2, or 18.7% of the world's oceans (SCHELL, 1966). In the Antarctic region, icebergs are fragments of an ice shelf and usually have a flat-topped, tabular shape. However, the icebergs in the Arctic region, which are of a glacial origin, are pinnacled, domed, winged or horned in shape. The average size of the tabular icebergs is 576 m long and 40–50 m above sea level. The ratio of the height of an iceberg above the surface to the submerged portion is 1 : 7, with one giant iceberg measuring 175 km in length, 75 km in width and 20 m above water. The mean life of icebergs is about 12–14 years in the Antarctic, and 4 years in the Arctic. It is observed that the speed of an iceberg drift, due to the effect of wind and current forces, is 0.1–0.2 kt at a windless place, and 0.4–0.8 kn at a windy location in the vicinity of the coast, 1–2 kt at an offshore location (KUSUNOKI, 1973).

The Antarctic water masses consist principally of three waters, namely surface water, intermediate water and bottom water. In general, the surface and bottom

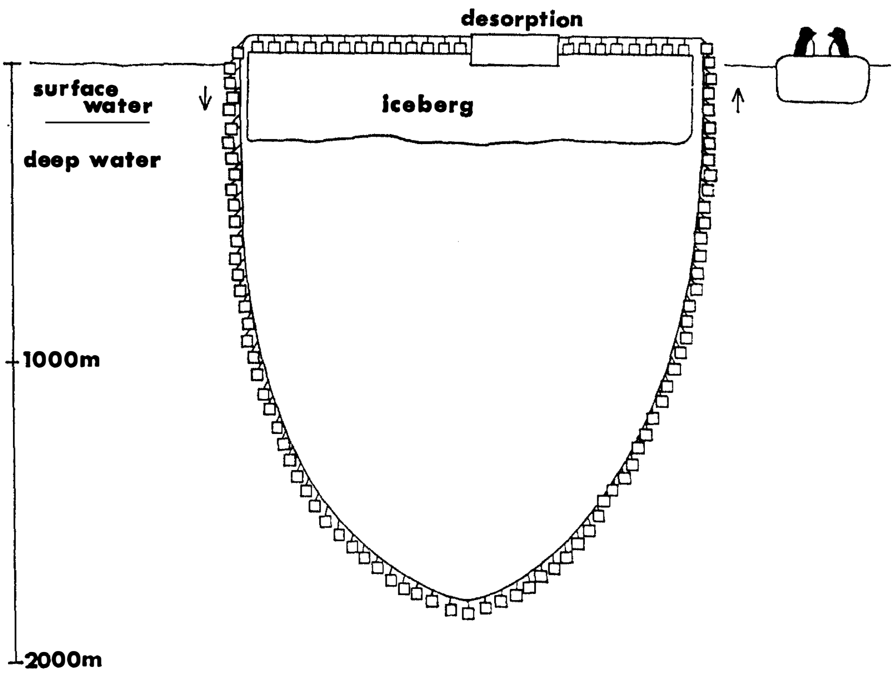

Fig. 1. The continuous line bucket system for contracting the seawater with the adsorbent by the use of the iceberg drift.

waters are carried towards the north, and then the intermediate water from low latitudes is drawn into the system in order to replace the lost portions. The intermediate water, which has a salinity above 34.5% and a temperature higher than 2°, climbs from a depth of about 3000 m to within 200 m of the surface in a vertical direction (SVERDRUP *et al.*, 1942).

Based on recent studies of various adsorbents of uranium, hydrous titanium oxide and hexaketone are considered to be the best adsorbent materials (CAMPBELL *et al.*, 1979; TABUSHI *et al.*, 1979).

The continuous line bucket system for contacting the seawater with the adsorbent using the iceberg drift is shown in Fig. 1. A long continuous loop of rope, to which adsorbent buckets are attached, is hung over the platform (an iceberg). The buckets descend to the ocean along one side of the loop, and return to the platform on the other side of the loop. As the iceberg drifts, the sea water passes through the adsorbent buckets. When they return to the surface of the iceberg uranyl ion is liberated from the adsorbent. The essential energy to rotate the loop is very small, because the tensions of both sides of the loop are approximately balanced. Compared with previous methods for recovering uranium from seawater, the capital cost of this system is minor owing to its simplicity.

In order to determine the amount of recoverable uranium, an iceberg of 1 km in length and drifting at 1 kt will be chosen. Then, a 5-km loop with adsorbent buckets ($2\times2\times2$ m) attached at 3 m intervals will be hung over the iceberg. It is possible that this plan allows 86.5×10^9 m^3 per year of seawater to contact the adsorbents. Assuming that the adsorption efficiency is 30% and desorption efficiency 90%, the amount of uranium produced by this recovery process is estimated to be 77 t a year.

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