Radioactive sinkers

Can we devise high-temperature, rock-melting probes, fuelled with the radioactive wastes from reactors, both to dispose of those wastes effectively and to tell us more about the Earth's interior? There are many difficult problems, but the gains in knowledge about the deep regions of the terrestrial mantle could be considerable

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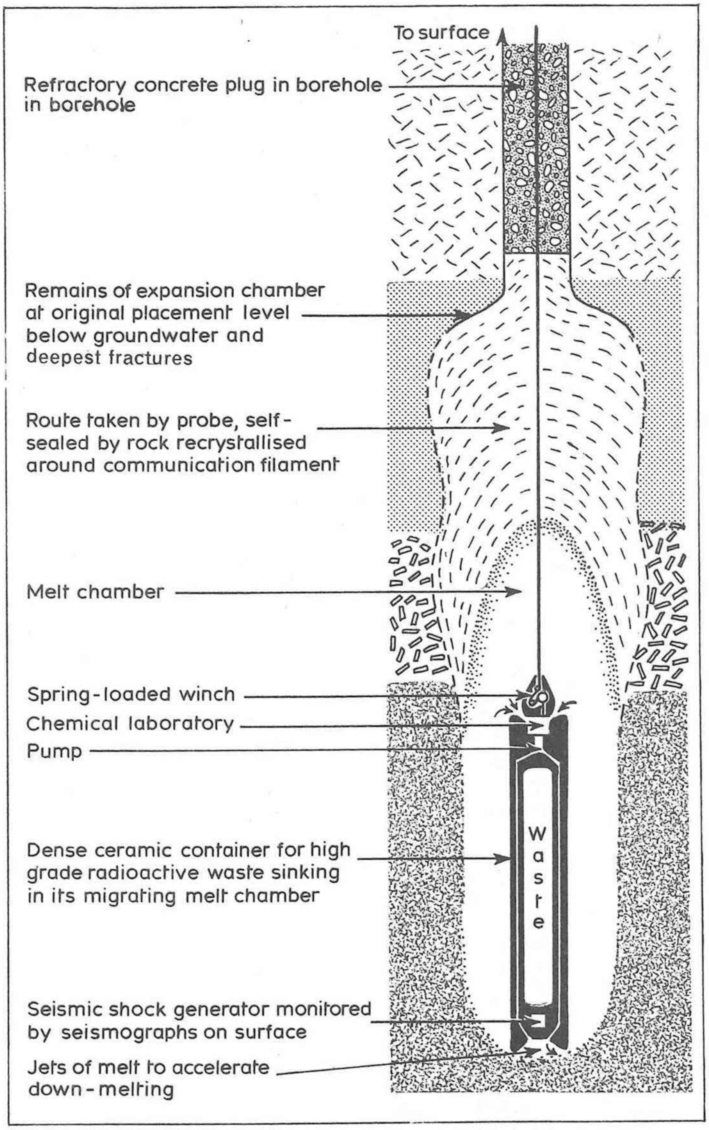
The waste produced by man's future nuclear generated energy will produce such heat and biologically dangerous radiation that, apart from the world's ocean floors (*New Scientist*, vol 73, p 709) there are few areas on the surface of the Earth where it can be disposed of (rather than stored) safely. Actual disposal of such waste into space towards the Sun has been proposed but would be too costly, and involve too many unknowns, to be acceptable. Another suggestion has been to dump or bury the wastes in submarine trenches in the hope that they would disappear into the Earth's mantle along the subduction zones where one of the Earth's lithospheric plates slides under another. However, the plates move at rates of only a few centimetres a year; it would be difficult to guarantee that the wastes would disappear downwards safely without profoundly affecting the column of ocean water above.

The general philosophy behind most suggestions so far has been that the wastes should be stored indefinitely at large sites deeper than 400 m beneath the surface. The Americans have been exploring the possibilities of storing such waste for 20 years in bodies of buried rock salt, as have the Germans for less time. The British and other national groups have started more recently doing the same for hard crystalline rocks such as granite. From confident beginnings the American "salt-vault" publications appear to have become more wary with time and US workers are now looking at other soft rocks as candidates for storage. One of the areas of stable bedded rock salt they were considering as a federal repository for high-grade radioactive waste turned out to be so full of exploratory boreholes dating from early searches for oil that it might have been dangerously permeable.

Impermeable and highly conductive

One of the great advantages of rock salt is that it is potentially so impermeable at comparatively shallow levels that circulating water in the ground is not likely to reach, and be contaminated by, the extensive storage areas required. Tiny pockets of fossil brine do exist in rock salt. They would migrate up the temperature gradients induced by the waste and vent into the storage areas as superheated steam but the expected volumes (no more than 2 to 3 litres annually) could be drawn off by a ventilation system. Apart from its radiation effect (which embrittles salt and turns it deep blue) high-grade radioactive waste is particularly unpleasant because of the enormous quantities of heat it generates for so long. Another advantage of rock salt therefore is its remarkably high thermal conductivity compared to other rocks. Only clean quartzites have comparable conductivities among the most indurated rock types.

Buried 10 m apart, the waste canisters would accumulate at a rate to fill almost half a square kilometre of storage space each year if all the US electrical energy requirements were met by nuclear power. Each of the stainless steel canisters of concentrated waste currently planned for storage by the Americans would raise the temperature of any immediately surrounding rock. This increase would be 1900°C in a few months if individual canisters were buried one year after removal from the reactor and about 700°C if they were buried after three years. In salt the thermal front would reach an approximate maximum 100 m above and below the permanent ventilated storage level 40 years after emplacement. Thereafter it would retreat as the thermal energy in the waste became spent (*Scientific American*, vol 276, p 21). Packed more closely the thermal energy of a few canisters would be sufficient to melt pockets of any rocks for long periods. Great effort has gone to ensuring that this could not happen because significant volumes of molten rocks (magma) developing in a large permanent repository would not be safe at shallow levels. If, on the other hand, melting of comparatively small volumes of rock at any one time were encouraged it could be used both to dispose of small batches of canisters to great depths, while at the same time exploring the Earth's interior.



A hypothetical model of a radioactive Earth probe

The construction of appropriate containers capable of

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NOT Acknowledged by

1. M. I. Ozhovan, F. Gibb, P. P. Poluéktov and E. P. Emets (August 2005), “Probing of the Interior Layers of the Earth with Self-Sinking Capsules”, Atomic Energy 99 (2): 556-562
2. M. I. Ozhovan and F. Gibb (2008), “Exploring the Earth’s Crust and Mantle Using Self-Descending, Radiation-Heated, Probes and Acoustic Emission Monitoring”, Nuclear Waste Research: Siting, Technology and Treatment, Edited by: Arnold P. Lattefer, pp. 207-220- “Probing of the Interior Layers of the Earth with Self-Sinking Capsules” (2005) and “Exploring the Earth’s Crust and Mantle Using Self-Descending, Radiation-Heated, Probes and Acoustic Emission Monitoring” (2008),

or other recent references to nuclear probes