A TRITIUM STUDY OF ENEWETAK ATOLL

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ABSTRACT

Nuclear weapons tests were conducted at Enewetak Atoll from 1948 through 1958. In 1964 Koranda (1965) conducted studies of tritium levels in the atoll ecosystem with particular emphasis in the vicinity of Cactus Crater, a 1958 fission event crater at the north end of Runit Island. As part of a continuing study of atoll groundwater radiochemistry, geochemistry and hydrology (Marsh et al., 1975; Noshkin et al., 1975; Buddemeier and Holladay, 1976) similar microenvironments in the same locations were sampled, providing information on the long-term behavior of local fallout tritium and the soil-groundwater system which it labels.

Materials sampled in both studies included soil, dominant plants, leaf litter, rain, seawater and lagoonwater. The present study has also analyzed groundwater from a number of island test wells. For solid samples, tritium analyses were performed on both the "loosewater" (extracted by freeze-drying) and "boundwater" (water produced by combustion of the freeze-dried sample) fractions. N. Runit vegetation, litter, and soil loosewater activities were about 135, 135, and 400 T.U., respectively; boundwater activities were about 10^3, 10^3, and 10^6 T.U., respectively. Tritium leaching rates, about 2.7 $\pm$ 0.6 T.U./day, were determined for the soil samples. The tritium activity of the freshwater component, ranging from 5 to over 10^3 T.U., of the brackish groundwater was calculated from the chloride content (assuming no aerosol contribution of salts) and the average tritium activity of ocean water, about 4.5 T.U.

Groundwater and the soil loosewater fractions show reasonably consistent activity relationships and permit conclusions to be made about recharge mechanisms and residence times; vegetation activities are much less satisfactory as predictors or indicators of the soil-water system activities, presumably because of physiological and microenvironmental variability.

Although uncertainties about sample site equivalence and the activity variations within each class of samples make precise calculations difficult, it is clear that the biogeochemical half-life of the "boundwater" soil fraction is well in excess of the radiological half-life of tritium. The data plus observations elsewhere in the atoll, indicate that the soil "boundwater" is the dominant reservoir of excess tritium and that it contols directly, by a slow exchange and equilibration process, the tritium activities of the soil "loosewater", the groundwater, and those plants which draw much of their water requirement from the soil.

The leaching of tritium from the soil by loosewater of meteoric origin and the eventual downward displacement of this water to the groundwater has been modeled.

Enewetak rainfall, 4.1 $\pm$ 0.9 T.U., lagoonwater, 5.5 $\pm$ 2.0 T.U., and groundwater, 5 to over 360 T.U., tritium contents have been characterized. There is some evidence of deep groundwater storage dating back to periods of high activity rainfall (1950's and early 1960's). The limited number of samples taken at Bikini Atoll have shown no appreciable excess ^{3}H at the locations sampled.