An Oregon cure for Bikini Island? First results from the Zeolite Immobilization Experiment

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INTRODUCTION

Bikini Island, a part of Bikini Atoll in the Marshall Islands, was the home of the Bikinians prior to nuclear testing in the area from 1947 through 1958. In 1969, debris from the testing was removed, and plantations were established to prepare the island for resettlement. However, studies in 1978 showed that the settlers had accumulated unacceptable amounts of cesium-137 from food grown on Bikini. The Bikinians again had to leave their homeland until a solution could be found.

The Bikini Atoll Reclamation Committee (BARC) was established by Congress to study the cost and feasibility of rehabilitating Bikini, with decontamination of the island a primary goal. Studies have concentrated on reducing cesium uptake by plants, though excavation of the contaminated topsoil is a possible alternative. Other radionuclides are present on Bikini but do not pose a significant hazard.

I work primarily on development of environmental and agricultural applications for clinoptilolite zeolite. In 1986, I read in the *National Geographic Magazine* (Ellis, 1986) about the cesium-137 uptake by plants on Bikini Atoll and immediately realized that clinoptilolite zeolite might provide an attractive alternative to the possible remedies under discussion. Clinoptilolite occurs in large sedimentary deposits as an alteration product of volcanic tuff (Hay, 1977), and Teague Mineral Products mines three deposits of clinoptilolite in Oregon and Idaho.

Zeolites are hydrous aluminosilicate minerals with a porous framework structure. The pores within the structure contain exchangeable cations and account for the high cation-exchange capacity. The cation-exchange characteristics of clinoptilolite provide the basis for most environmental applications, and the mineral can selectively absorb (or adsorb—both terms hereafter subsumed under "sorb") many radionuclides, heavy metals, ammonium, and organic compounds, immobilizing them sufficiently to reduce uptake by plants.

I contacted Dr. W.L. Robison at Lawrence Livermore National Laboratories, and after he and BARC received background information from me on the ability of clinoptilolite to selectively sorb cesium and on its value as a soil amendment, they decided to test my hypothesis with the Zeolite Immobilization Experiment, which was soon started.

THE EXPERIMENT

In 1986, 15 plywood frames were built for the Zeolite Immobilization Experiment 1.5-m² test plots and installed on Bikini. Clinoptilolite (Feed Grade CH Zeolite), provided by Teague Mineral Products, was mixed by a concrete mixer with the surface foot of soil in three different amounts (9, 18, and 36 tons per acre). Corn and Chinese cabbage were initially planted, and sweet potato was planted later. Two control plots were established, one using excess potassium fertilizer, because previous tests had shown that extra potassium inhibits cesium uptake.

Results from the first crop grown in clinoptilolite-amended soil indicate that cesium-137 uptake was significantly less than in the untreated and potassium-treated controls (Figure 1). However, since a high-potassium clinoptilolite was used, it is unknown how much of the effect was due to cesium sorption by the clinoptilolite and how much was due to the effect of potassium released by the clinoptilolite's cation exchange. Successive cuttings and possibly other tests will be used to determine how much of the reduction was actually due to sorption by the clinoptilolite.

Problems will still have to be solved, no matter what approach is finally taken for the rehabilitation of Bikini. Though excavation

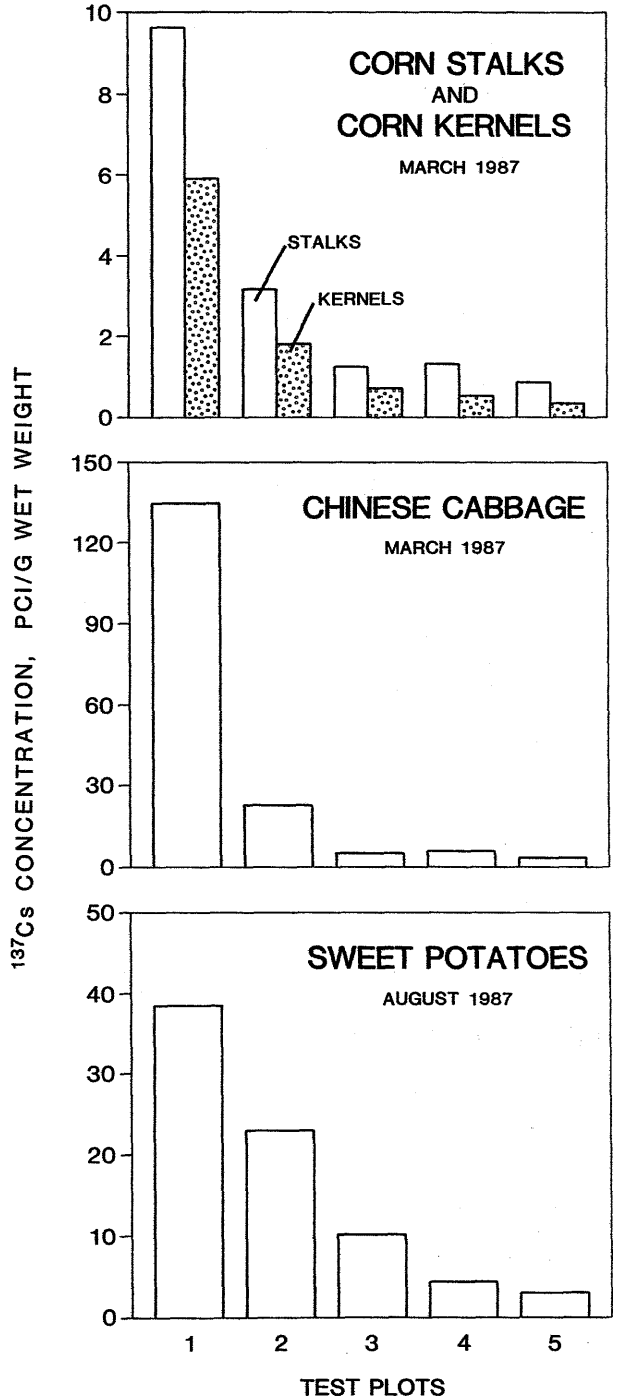

Figure 1. Zeolite Immobilization Experiment, November 1986-March 1987, showing cesium-137 concentrations in corn stalks and corn kernels, Chinese cabbage, and sweet potatoes grown in control plots and plots treated with clinoptilolite zeolite. Test plots were treated in the following ways: 1. Control plot, native potassium (K) only. 2. Control plot, plus 20 gm/m² K (178 lbs/acre). 3. Zeolite-treated plot (2 kg/m²). 4. Zeolite-treated plot (4 kg/m²). 5. Zeolite-treated plot (8 kg/m²).

of the topsoil removes the contamination from the island, revegetation without topsoil may be difficult, and the problem of what to do with the contaminated soil remains. Application of large amounts of potassium may be effective, but repeated applications would be necessary every five years or so for the next 75 years.

Assuming that further testing will support the initial results, incorporation of clinoptilolite into the soil may provide an attractive alternative to and avoid some of the problems associated with the other approaches. Ultimately, a combination of treatments may be the most efficient and cost-effective way to decontaminate the island and finally allow the Bikinians to return home.

REFERENCES CITED

Ellis, W.S., 1986, A way of life lost, Bikini: National Geographic Magazine, v. 169, no. 6, p. 810-834.

Hay, R.L., 1977, Geology of zeolites in sedimentary rocks, *in* Mumpton, F.A., ed., 1977, Mineralogy and geology of natural zeolites: Washington, D.C., Mineralogical Society of America, p. 53-64.

Robison, W.L., and Stone, E.L., 1988, Bikini Atoll Reclamation Committee summary report: Washington, D.C., BARC Report No. 6, p. A5, A45-47. □

NWMA announces 94th annual convention

The Northwest Mining Association (NWMA) will hold its 94th annual convention in Spokane, Washington, from November 30 to December 3, 1988, under the title "Working Together—Exploring Mining's Future." Early registrations and a trade show that sold out by September 1 have raised hopes for an unusually well-attended and successful convention.

A new feature was added to this convention: The program was developed jointly by the NWMA and the Association of Exploration Geochemists. Exploration geochemistry is the topic of this year's short course, to be held November 28-30, and related topics are also part of the general program.

The NWMA's address is 414 Peyton Building, Spokane, WA 99201; phone (509) 624-1158; Fax (509) 623-1241.

—NWMA news release

Fellowship available for engineers

The Education Foundation of the National Society of Professional Engineers (NSPE) has announced its fellowship program for engineers pursuing graduate study on management. The program was endowed by the Society's division of Professional Engineers in Government (PEG) and is now in its fifth year. PEG is funding the $1,000 fellowship to encourage registered Professional Engineers (PE) and Engineers-in-Training (EIT) in any field of practice to pursue continuing professional development in the area of management.

Any PE or EIT employed in government, education, industry, construction, or private practice may apply. Qualifications include a minimum undergraduate grade-point average of 3.0; a desire to earn an MBA in management, engineering management, or public administration; and enrollment in, or acceptance to, a program accredited by the American Assembly of Collegiate Scholars of Business or by the Accreditation Board for Engineering Technology. Information and application materials may be obtained from the NSPE Education Foundation, 1420 King Street, Alexandria, Virginia 22314, phone (703) 684-2830, where applications must be received no later than February 1, 1989.

—NSPE news release

ABSTRACT

The Department maintains a collection of theses and dissertations on Oregon geology. From time to time, we print abstracts of new acquisitions that, we feel, are of general interest to our readers.

THE GEOLOGY AND EPITHERMAL VEIN MINERALIZATION AT THE CHAMPION MINE, BOHEMIA MINING DISTRICT, OREGON, by Kurt T. Katsura (M.S., University of Oregon, 1988), 254 p.

The Champion Mine exploits a gold/base-metal epithermal vein system that cuts a Miocene volcanic center in the Bohemia mining district, Oregon. The Champion vein system consists of four steeply-dipping, subparallel veins that are structurally simple at depth and become increasingly complex upward. The epithermal veins show crustification banding, multiple brecciations, vein sediments, and cross-cutting vein relations that cut an earlier porphyry-copper-style mineralization, associated with tourmaline breccia pipes.

Brecciation events are traced throughout the Champion system, providing time-equivalent markers that define four paragenetic vein stages. Gold occurs in two stages: in crustification bands with sphalerite, chalcopyrite, and galena, where it was deposited from boiling of sulfide-deficient fluids; and in kaolinite crustification bands, where it was deposited from mixing of boiled ascending fluids with a descending acid-sulfate water. Intense argillic alteration overprints the veins and is the product of descending acid-sulfate waters. □

(Markers, continued from page 139)

P-6 is at 98th and Stark, near Elmer's Pancake House. Craig Decker, former resident of that area, attached a notice to the stone reading, "Historic stone. If removal is necessary, notify Oregon Historical Society."

P-7 is at 117th and Stark. It was found in a landfill by Mount Hood Community College students and replaced at the southeast corner of Ventura Park. It is flanked by an Oregon Historical Society marker explaining the obelisk-stone mile markers.

P-9 is at 15802 SE Stark, in the front yard of a private residence.

P-11 can be seen near the Stark Street Market at 197th and Stark.

P-13 was rescued from rubble by the Gresham Historical Society. It was kept by that society until road work had been completed and then was reset at 236th and Stark, with a suitable dedication ceremony, on May 13, 1987.

P-14 is on the Mount Hood Community College property, just east of SE Stark and Kane Road.

History buffs of Multnomah County are ever on the lookout for the missing obelisk mile markers. Any persons who might find one of the stones or have any information on them are invited to call the Oregon Historical Society or the Gresham, Troutdale, or David Douglas Historical Societies, or the authors. □

REMEMBER TO RENEW

Some of you will find that the code number on your address label ends in "1288," which means your subscription expires with the December issue of 1988. If so, or if your expiration date is anywhere near this, please use the renewal form on the last page to make sure you will continue receiving *Oregon Geology*. And while you are at it—why not consider a gift subscription for a friend?