CALIFORNIA STATE SCIENCE FAIR
2003 PROJECT SUMMARY

Name(s)
Cameron J. Shepherd

Project Number
S1521

Project Title
Beta and Gamma Scintillation Detection and Assessment of Fluvial Radioactivity

Abstract

Objectives/Goals
My project evaluated liquid and solid scintillation to determine the feasibility of using these methods to detect trace levels of fluvial radioactivity. After doing research, I decided liquid scintillation could detect minute traces of weak radioactivity that might be present from natural or man-made sources.

Methods/Materials
I made a radiation and light-shielded apparatus out of lead and cloth. Using a photomultiplier tube, I built a scintillation photodetector. I compared the effectiveness of liquid scintillation detection to a plastic scintillator and a sodium iodide (NaI) scintillator. I also visually investigated the response of several solid scintillators and phosphors to radiation from radioactive ore. I created dissolved ore samples with varying pH to simulate fluvial radioactivity that might come from weathered rocks.

Results
I analyzed 85 fluvial samples from the Pacific Ocean, rivers of the Northwestern US, and the dissolved ore. My liquid scintillation photodetector was more sensitive than the NaI. I detected tritium showing that it could detect low energy beta and alpha particles that could not penetrate the aluminum housing of the NaI detector. I discovered radioactivity in Pacific Ocean samples taken near Russia and China at about six times background levels with a 99 % confidence level. Samples from eastward and westward voyages across the Pacific showed reproducible detection. Use of dissolved ore showed that scintillation molecules seemed to be affected by pH. The less sensitive plastic scintillator was able to provide satisfactory detection at pH extremes.

Conclusions/Discussion
Short 15 minute counts using liquid scintillation detected low levels of low energy radioactive materials in oceans and rivers with high statistical confidence. Using the NaI detector, there was no ability to detect radioactivity from the same samples even with seven hour counts and 20 times more sample. There were interesting trends in the fluvial samples from the Western US, further supporting my hypothesis that detection of extremely low level radioactivity might help to provide insight into geologic processes.

Summary Statement
This project evaluates scintillation as a method to detect varying levels of radioactivity in fluvial environments.

Help Received
The LA Section of the American Nuclear Society loaned me a sodium iodide detector. My grandparents and uncles helped collect samples (Pacific Ocean, Columbia River, and Lassen drainage). My parents bought the components I wanted and provided critical review of my report and board.