RADIATION SAFETY IN SEDIMENT STUDIES

by

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The use of radioactive materials has proved to be invaluable to science and industry. However, attendant with the benefits are potential hazards if radiation safety practices are ignored. Radiation safety practices, like other safety practices, are based on common sense and an understanding of the nature of the hazard. Because radioactive materials are being used for many different purposes within the Geological Survey, it is important that Survey personnel become familiar with radiation safety and with the elementary nature of radioactivity and its relation to the human body.

Radioactivity is the emission of particles and (or) waves from unstable atomic nuclei that are spontaneously altering their structure. In humans, these emissions, whether particulate (alpha and beta radiation) or electromagnetic (gamma radiation) produce ionization and consequent damage to body cells. Humans are continuously subjected to radiation from their surroundings. Even the human body contains radioactive materials. However, humans can tolerate without measurable detrimental effects certain amounts of radiation. For safety, the level of permissible total body exposure, or dose as it is called, has been established on the basis of available clinical information. For people who use radioisotopes, the permissible dose has been set at 100 millirems per week [1]. As long as exposures are maintained below this dose rate, the use of and exposure to radioactive materials presents no hazard.

Three factors can be utilized to reduce exposure to radiation. These factors are distance, time, and shielding (see fig. 1). Radioactive materials emit in all directions radiations that are essentially straight line trajectories. Thus, the further away a body of given size is from the radioactive source, the fewer will be the trajectories that strike the body. In fact, geometry can be used to show that the intensity of radiation from a point source which impinges on a body varies inversely with the square of the distance from the body to the source. In other words, if a body is exposed to a certain amount of radiation when it is one foot from a source, it will be exposed to only one-fourth as much when it is 2 feet from the source and only one-ninth as much when it is 3 feet from the source. Time is involved in radiation exposure simply because the longer a body is exposed to radiation, the more radiation it will absorb. Shielding material between the body and the source also reduces radiation to the body. All material, even air, absorbs radiation; however, some materials are better absorbers than others. With alpha and beta radiation, the denser the material, the more radiation it will absorb; in general, this is also true for gamma radiation. Alpha radiation is absorbed entirely by relatively thin materials such as aluminum foil, regardless of the strength of the source. Beta radiation

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[1] The dose in rems (roentgen equivalent man) closely approximates, in human tissue, the dose in roentgens times the RBE (relative biologic effect). RBE is a factor that depends on the type of radiation; for beta and gamma radiation RBE = 1, for alpha radiation RBE = 10. Comprehensive information on allowable dose rates is given in Handbook 69.

is also absorbed entirely, regardless of the strength of the source, if the thickness of the absorber is great enough; 2 inches of aluminum will absorb most beta radiation. Gamma radiation, on the other hand, varies with the strength of the source and is never completely absorbed; although, the intensity is reduced exponentially as it passes through progressively greater thicknesses of material.

In our project on the distribution and concentration of radioactive waste in streams by fluvial sediment, the movement of sediment in natural and artifical channels is being studied with the aid of natural sediment that is "tagged" with radioactivity. The radiation safety practices observed during project studies characterize, to some degree, those necessary for other hydrologic investigations in which radioactivity is released to the environment.

When radioactive material is released to the environment, the primary concern is that proper precautions are taken to insure the safety of the general public. To this end, experiments are designed so that (1) the concentration of radioactivity in the flow is less than the maximum permissible concentration for drinking water at all places where the stream is accessible to the public and (2) the radioactivity taken up by inorganic and organic material, including the biota, is insufficient to be harmful if consumed by humans or other life. To meet these requirements, only the minimum amount of radioactivity necessary to give significant data is used. Also, to insure public safety, radiation warning signs are posted. Radiation signs should never be ignored, for without radiation detection equipment, the signs are the only indication of a potential hazard. Remember, none of the human senses warn against radiation.

For the safety of project personnel a number of practices are followed. Before radioactive materials are handled and before areas containing radioactivity are entered, the radiation is monitored so that exposures can be kept within a safe level (see fig. 2). When radioactive materials are handled one or more of the personnel monitoring devices and protective clothing are worn. Convenient personnel monitoring devices are pocket dosimeters and film badges, both of which measure total dose. Dosimeters are read frequently to determine the extent of radiation exposure, and records are kept on all personnel so that total exposures can be evaluated at any time. Radioactive materials are handled remotely and distance, time, and shielding are used as much as possible to reduce body exposure. With particulate activity, the particles are handled only in or over trays so that in case of an accidental spill the particles will not be scattered over a large area. After radioactive materials are handled all personnel are monitored completely to determine if any bodily parts or clothing have become contaminated. If contamination is found the affected area is washed thoroughly. Work areas are monitored frequently and the results are posted after each survey.

Accidental spills and contaminated areas are cleaned immediately. Contaminated solid waste material is disposed in specifically designated facilities that are separate from noncontaminated waste facilities, and radioactive waste is not washed or dumped into the public sewer systems unless the activity will be diluted sufficiently to insure public safety.

Radioactive materials are useful and safe in both the laboratory and the field provided they are handled carefully and in accordance with prescribed practices.

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