tion. The shank of the catheter is grasped with jeweler's forceps and the tip is first plunged through the chorioallantoic membrane, and is then introduced into the blood vessel from below, in a separate motion. The vessel may be steadied by grasping the membrane with another pair of forceps. Finally, the shaft of the catheter is secured to the egg shell with cellophane tape, and the window is sealed with tape. The egg, catheter, and syringe assembly are mounted on the syringe drive in a standard incubator.

Previously available methods permit short-term injection into or withdrawal of samples from the vascular compartment (*4*). The present technique can be utilized for the short term or long term delivery of a wide range of fluids and particulate suspensions at known rates during given periods of development of the chick embryo. We have infused 6- to 17-day-old incubated embryos at a rate of 0.01 ml per hour for a period of up to 4 days; many of these embryos subsequently hatched successfully.

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Sodium Iodide Crystal Dosimeters for Use in Surveys of Regions of High Background Radiation

Abstract. In a study of selected regions of high background radiation in Brazil, thallium-activated NaI crystals were used as density amplifiers for dosimeter film badges. Calibration experiments were made, and the field results are summarized.

In a recent survey of background radiation in Brazil (*1*), extensive field use was made for the first time of phosphors as density amplifiers for film badges. While a combination of an ionization chamber and a portable scintillometer can be used to map an external gamma ray field, such a device is needed to integrate the dose received by people as they move through the variable field.

Recently O'Brien, Solon, and Lowder (*2*) have developed the use of a thallium-activated NaI phosphor for low intensity gamma fields with a density amplification of about 1000. A 1⅝- by 2-inch crystal is mounted in a small aluminum can; a small x-ray film (DuPont 508) together with an unopened control film is placed over the crystal, and the can is sealed. Ordinary film badges are sensitive to doses in the order of a fraction of roentgen, but the crystal film pack is sensitive to doses in the order of a fraction of a milliroentgen.

A characteristic feature of the monazite region of Brazil is that the radiation levels vary widely and abruptly. In Guarapari, where most of the measurements were made, the levels vary from a low 10 μr/hr, through street values of 50 to 200 μr/hr, to levels in homes up to 600 μr/hr. Monazite sand spots on the beach can have levels as high as 2 mr/hr, while levels in the monazite plant can reach 5 to 7 mr/hr.

These levels determined two types of procedure in the field and two sets of calibration experiments. For most of the population, the crystal film packs could be carried 24 hours a day. For workers receiving dose rates in the order of 1 mr/hr, the range of levels was first measured with a scintillometer, and the crystal film packs were given to them for periods of an hour or less.

In the first set of calibration experiments, films were exposed for 24 hours in a low background room at different distances from a standard milligram radium source. The background was first measured with an ionization chamber. The spread of the selected doses was slightly broader than those encountered in the city of Guarapari. Data for these calibration experiments are presented in Fig. 1.

In order to interpret the density readings of films exposed for shorter times at higher radiation levels, a second set of calibration films was exposed. In Fig. 2 the data are presented giving lines of constant doses and showing the dependence of density on dose rate.

The field data for the dose rates received by a sample of the populations of the three monazite towns of Guarapari, Meaipe, and Cumuruxatiba are given in summary form in Table 1.

Since this was the first time the crystal film packs had been used extensively in field work, certain precautions were taken. Several repeated measurements were made. One man working in a low-radiation section of Guarapari was measured on 3 successive days; the results showed levels of 25, 25, and 26 μr/hr, respectively. In a house where the ionization chamber indicated levels from 200 to 230 μr/hr, the married couple were given film packs on 2 successive days. The housewife measured 200 and 205 μr/hr, while the husband, who worked in a bakery with a lower level of radiation, measured 135 and 140 μr/hr. In addition, some film packs were left in locations measured with the ionization

Table 1. Summary of crystal film pack data. Dose rate received by people in monazite sand region, towns of Guarapari, Meaipe, and Cumuruxatiba, Brazil.

Range of dose rate (μr/hr)	Number of persons
> 1000	3
300–1000	3
200– 300	7
100– 200	6
60– 100	7
20– 60	6
10– 20	2

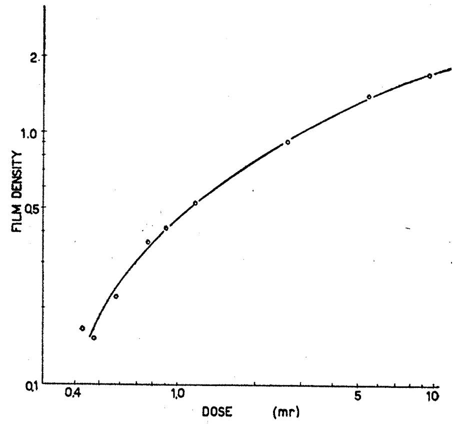

Fig. 1. Film calibration curve for constant time (24 hours), showing dependence on dose.

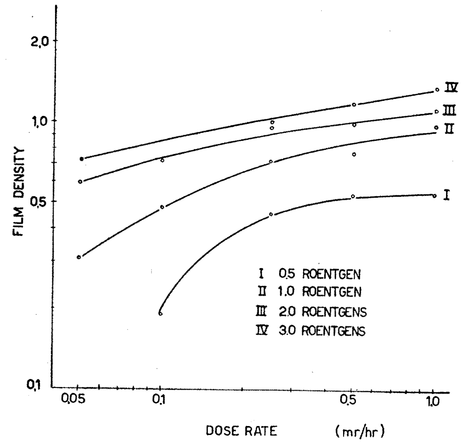

Fig. 2. Film calibration curve for constant dose, showing dependence on dose rate.

chamber, and excellent agreement was reached.

All the films were sent for development and measurement to the New York Health and Safety Laboratory of the U.S. Atomic Energy Commission. Accompanying each exposed film was an unopened film with the same history of humidity and temperature. The films were compared on a densitometer. (*3*).

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Evaluation of Isotope Exchange by Chromatography

Abstract. The study of exchange reaction kinetics between sulfur-35 and organic compounds which contain sulfur can be made much easier by use of radiochromatography. Activity ratios of the components of the reaction mixture can be estimated by use of very small amounts of radioactive materials. The reaction need not be halted and individual components need not be isolated. Any degradation of reacting substances can be measured quantitatively at the same time.

Much attention has been devoted recently to the development of methods for labeling biological materials with radioactive isotopes. In addition to chemical synthesis and to a much lesser extent biosynthesis, extensive use has been made of exchange reactions between inactive organic substances and simple inorganic active isotopes (*1*). Properly employed, this method permits easy labeling of highly complicated molecules, even those that are difficult to synthesize (*2, 3*).

In order to obtain the best results from exchange reactions, it is necessary to know rather precisely the most favorable experimental conditions. Exchange reactions are controlled by temperature, time, concentration of components, catalysis, and the type of reaction medium. The rate of degradation of the substance being labeled also has an effect. A series of time-consuming assays must be carried out to measure the effects of these factors on the exchange reactions. The step-by-step exchange reactions of radioactive sulfur have been estimated on the basis of the increase in specific activity of the organic substance or by measuring the decrease in specific activity of radioactive sulfur. The exchange reaction must be halted, however, to make these assays (*4*).

In our studies of the most efficient use of elemental S^{35} in exchange reactions (*2*), we have used radiochromatography as a rapid means for following and evaluating the course of exchange and the rate of degradation of the substances being examined. The technique is easier and simpler than the assay procedure.

The technique provides a rapid means for following step-by-step exchange without having to stop the reaction. In addition, it substantially reduces the number of experiments and also the amount of radioactive material needed. If a suitable chromatographic system is used, only a few milligrams of the substance to be labeled and only about 1 μc of S^{35} are needed to study the exchange and any degradation that may occur.

At specified time intervals, small samples are taken out of the homogeneous reaction mixture with a capillary tube. The samples are spotted directly on a sheet of chromatograph paper. The paper is then developed by means of a system which separates the source of radioisotopes from both the substance being labeled and from any degradation products. In most systems—for example, in water-saturated butanol—elemental sulfur has rather high R_F values. The developed chromatograms can be used with adequate accuracy and reproducibility (*5, 6*) for estimating activity ratios of individual components at the instant of sampling. Our method deals with the estimation of radioactivity *ratios* only. The measuring instrument need not be calibrated with standard samples. Chromatograms are resolved by planimetric determination of the areas outlined by graphic recording of activity distribution. Radioactivity is measured by means of an automatic device (Frieseke-Hoepfner) for continuous scanning of radioactive chromatograms.

By determining activity ratios of exchange reaction components when the system is at equilibrium one can determine the exchange equilibrium constant, the exchange coefficient α, and the percentage exchange. For example, the simple exchange between elemental S^{35} and an organic compound can be expressed by the equation

$$SS^* + OS \rightleftharpoons SS + OS^*$$

where SS^* is the radiosulfur molecule (the asterisk denotes a radionuclide) and OS is an organic compound. The equilibrium constant K of the exchange is

$$K = \frac{[SS]\ [OS^*]}{[SS^*]\ [OS]}$$

and the exchange coefficient α is

$$\alpha = \frac{[S^*]}{[S]_{OS}} : \frac{[S^*]}{[S]_{SS}}$$

In this case the numerical value of K equals α and it can be expressed by the relationship

$$K = \alpha = \frac{a}{b}\left(\frac{x_0 - x}{x}\right)$$

where a is the total concentration of the compound in the reacting mixture $[OS^*] + [OS]$, b is the total concentration of the organic compound in the reacting mixture, x_0 is the ratio $[SS^*]/[SS^* + SS]$ at the start of exchange, and x is the same ratio, but at a point when equilibrium is reached (*7*).

At the early stage of reaction the concentration SS equals zero (no radioactive sulfur has yet entered from the reacting mixture into the organic compound) and $x_0 = 1$. To compute K or α it is necessary only to determine from the chromatograms the value of x, because

$$\alpha = \frac{a}{b}\left(\frac{1 - x}{x}\right)$$

The value of x denotes the unreacted portion of S^{35} at the equilibrium point. This value can be readily obtained from the recorder diagram as the quotient of the radioactivity value of the area belonging to S^{35} divided by the sum of the radioactivity of this area and the radioactivity of the area belonging to the organic compound. The radioactivity of the organic compound comes exclusively from the exchange reaction with elemental S^{35}.

Radiochromatographic evaluation of exchange reactions or of components of a reacting mixture can also be applied to carbon-14 and even to tritium (*6*) if the physical properties of the reacting substances are appropriate.

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