Of considerable interest is the occurrence of linear, steepened magnetic gradients which are especially pronounced. They are east-west in direction and extend as much as several hundred miles in length. Just south of San Francisco, an east-west lineament that is 400 miles long and extends eastward from the San Andreas fault may be related to the Mendocino fracture.

We suspect that these east-west lineaments may be related to fractures or fracture zones, some of which originate deep in the earth's crust, and that they may be genetically related to the system of east-west fractures which have been discovered over the oceans in the past decade.

To investigate the deeper part of the earth's crust, an aeromagnetic map which effectively filters out the magnetic anomalies of short wavelength has been compiled. Except for the continental margins, there is an east-west grain over most of the continent. It may be that the emplacement of magnetic material causing these anomalies may be controlled by an east-west system of fractures located in the deeper part of the earth's crust.

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Biochemical Test of the Operon Model

A cell-free system for DNA-directed peptide synthesis has been developed; the system chosen for study was the enzyme β-galactosidase of *Escherichia coli*. Previous attempts have been made to synthesize this enzyme, but the incorporation systems were comparatively poor and the evidence was lacking in rigor, so that these attempts can be discounted. β-Galactosidase has a molecular weight of 535,000 and is known to be a tetramer containing 1170 amino acid residues. Because the monomer is so large, systems were sought in which only a fragment of this long polypeptide chain could be detected. Such a system is available which will allow for detection of the first portion of the chain called α. This is accomplished by intracistronic complementation—one mixes an extract containing α with an extract from a mutant containing a deletion of α. The complemented product, unlike either of the components, displays enzymatic activity. The critical macromolecular components in the synthetic system include DNA from the virus ϕ80dlac and a subcellular extract prepared from a mutant of *E. coli* containing a deletion of the lac operon and its *i* gene repressor. The synthesis of the α-fragment is detected by the complementation scheme referred to above.

The α-fragment is adjacent to the operator which is believed to be the primary site of action of repressor. This system has been used to study the action of repressor. Partially purified repressor prepared from an *E. coli* mutant containing two copies of the repressor gene have been used to inhibit 80 percent of the synthesis of α. This inhibition is largely reversible by $10^{-3}M$ isopropyl-β-D-thiogalactopyranoside (IPTG), which is a most potent inducer of the lac operon in vivo. The inhibition of α-synthesis is greater if repressor is mixed with the DNA before RNA and protein synthesis are allowed to proceed. This demonstrates unequivocally that the primary site of action of repressor is the DNA and not the messenger RNA.

This is the first time that it has been possible to demonstrate DNA-directed synthesis of a naturally occurring peptide in a cell-free system, and also the first time it has been possible to demonstrate the effect of repressor in a cell-free system. The results tend to support the operon model for regulation of protein synthesis.

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MEETINGS

Radiation Protection

Protection for atomic workers against radiation hazards has been a major concern of health physicists ever since the splitting of the atom over 20 years ago. Various work procedures and dosimetry systems have been developed to guard against and monitor exposure. Research on such methods and equipment was reported at the Symposium on Neutron Monitoring for Radiological Protection (Vienna, Austria, week of 29 August 1966) and the First Congress of the International Radiation Protection Association (IRPA) (Rome, Italy, week of 5 September 1966). At the Vienna symposium 151 delegates from 26 countries attended; at the Rome meeting 800 full members represented 40 countries.

Symposium on Neutron Monitoring for Radiological Protection

One of the major topics of interest was the Andersson-Braun dosimeter. Attention was directed toward reducing the size and weight of this portable neutron survey meter, which otherwise was much favored by the participants. Accordingly, two sequels to the Andersson-Braun dosimeter were described by J. W. Leake (Atomic Energy Research Establishment, Harwell, United Kingdom).

The first of these dosimeters, now available in commercial form from Isotopes Development Company (U.K.), utilizes a LiI (Eu) detector in place of a BF_3 tube. The crystal separated by a cadmium shield is surrounded by a double polyethylene moderator system. Although the weight of the instrument is reduced from 11.4 to 6.4 kg, the response is changed appreciably, especially for neutrons below 200 kev, where the dose is overestimated. The overestimate is by a factor of 3.5 for 5-kev neutrons and 3.25 for thermal neutrons. The instrument can also be used in pulsed fields where the pulse rate in pulses per second does not exceed the dose rate in millirems per hour.

The second instrument described by Leake contains a mean-current ionization chamber filled with $^{10}BF_3$ gas. The Andersson-Braun-type moderator is used, so that there is no reduction in weight. However, this instrument can be used around pulsed radiation sources. In mixed neutron-gamma fields, two readings are required to assess both neutron and gamma dose.

One interesting concept with regard

to the Andersson-Braun meter involved reducing the weight by using a spherical moderator in place of a cylinder. The sphere is then cut in half; the body of the person doing the monitoring serves as the other half of the moderator.

Neutron monitoring by photographic methods has been severely criticized in recent years. However, there is apparently a renewed interest in these methods. E. I. Zeinalov *et al.* (U.S.S.R.) discussed both theoretical and experimental studies of a film badge useful for monitoring both thermal and intermediate neutrons. The detector uses the activation principle to expose ordinary x-ray film, but two filters of pair-resonance detectors are used instead of a single activation material. These filters consist of Cd + In and Cd + Sn. The dose of neutrons of intermediate energy is determined by the density difference under these two filter pairs. The scheme was successfully used to monitor thermal and intermediate-neutron doses around a power reactor station and a fast reactor. Lower limits of detectability are claimed to be 5 mrem for thermal neutrons and 3 mrem for intermediate-energy neutrons.

However, use of nuclear emulsions for personnel monitoring is still the preferred choice. While there were no major or new points discussed, one comment that a holder for the polypropylene-film badge could increase the response to fast neutrons by about 15 percent indicated a need for calibration in the holders.

Neutron dosimetry of fission fragments appears to be a promising new technique for use on personnel. A system utilizing both natural uranium and plutonium in contact with mica foil was discussed by C. O. Widell (AB Atomenergi, Sweden). After exposure, the mica is etched in 40 percent HF for 100 hours, and the resultant tracks are counted. In 1 month, this system detects 0.002 to 1 rem of thermal neutrons, 0.010 to 50 rem of intermediate neutrons, and 0.200 to 50 rem of fast neutrons. The detector is insensitive to alpha, beta, and gamma radiation, and the latent tracks do not fade with time.

Similar results were obtained by C. M. Unruh *et al.* (Battelle, Northwest), who used a variety of fission foils and Lexan polycarbonate plastic. The plastic is etched in hot caustic and hence is slightly less convenient to use than mica. Mica and plastic appear to be superior to silver metaphosphate glass, although the latter can be used for both fast-neutron and gamma dosimetry. Of all fission foils used, ^{237}Np provided the best results; this nuclide has a fission cross section of about 1.5 barns and a threshold of 0.5 Mev.

Although several other systems were discussed, none was as promising as the one that used the fission-fragment methods. Both LiF and $Li_2B_4O_7$:Mn were found to have significant response to thermal neutrons but required thick moderation for fast-neutron dosimetry, obviating their use as a personnel dosimeters. However, if the body of the wearer can be utilized as a moderator, these systems may be adapted for limited use. Similar comments apply to alumophosphate glass, which is doped with Li or B to provide response to thermal neutrons.

There have been no fundamental breakthroughs with respect to personnel monitoring, and routine monitoring is still being accomplished by nuclear emulsion and radiography of materials activated by Cd. One participant suggested that this may be caused by complacency, but the papers on neutron dosimetry by fission-fragment methods tend to belie this suggestion. However, it is apparent that no really satisfactory substitute for photographic mehods is in current use.

The major interest was in the area of standards and calibration. Off-the-record conversations indicated a general dissatisfaction with terminology used to describe neutron energy groups, and at least two participants commented in this regard for the record. About one-fifth of the program dealt with intercomparison of neutron dosimetry systems in addition to calibration and standardization.

John Auxier (Oak Ridge National Laboratory) reported on a timely and interesting study (from seven U.S. nuclear installations) of dosimetry systems used for neutron accidents. For an unmoderated reactor spectrum, the comparisons were generally good, having a spread of ± 25 percent from the mean. When the reactor spectrum was modified with 20 cm of paraffin, there were discrepancies greater than ± 50 percent. In the latter case, the initial interpretations, made 2 days after the exposure, showed a factor of nearly 3 between the estimates of the greatest and smallest fast-neutron dose. Subsequent revision reduced this to about a factor of 1.5. Gamma-dose estimates and also estimates of total neutron fluence varied by a factor of 2.

Moderated systems with thermal neutron detectors yield too great a response in the regions from a few ev to 300 kev, while nuclear emulsions and diode systems give too low readings. A combination of both moderated thermal neutron detectors and nuclear emulsions or diodes could be used to give a rapid estimation of the neutron exposure in relation to a fission spectrum. If the neutron spectrum involved were softer than a fission spectrum, then an average of the two systems would be better than either one alone, and would provide for direct establishment at approximate error limits.

The British interest in neutron standardization was evidenced in a presentation by E. J. Axton (National Physical Laboratory, U.K.). He described a 3-Mev, positive-ion Van de Graaff accelerator facility with low-scatter environment. A minimum of about 6 m of free air space is provided. The facility features a unique method for attaining thermal-neutron flux, accomplished by oscillating the charged particle beam rapidly between two targets. The targets themselves are situated in a graphite pile, and a flux chamber (100 cm^3) will provide a standard flux of 10^7 n/cm^2 per second, about a thousand times greater than conventional methods. A standard beam of 10^3 n/cm^2 per second is also provided, as well as a high intensity flux of 10^7 to 10^{10} n/cm^2 per second. Another report indicated that an accuracy of 1 to 2 percent could be achieved with the $MgSO_4$ bath by circulating the liquid.

Of special interest was a point brought out in the panel discussion: currently there are only three agencies providing sources for intercalibration of neutron detectors. These agencies are: Health Physics Research Reactor (ORNL), U.S.); a 3-Mev Van de Graaff accelerator (Saclay, France); and a thermal flux facility and 3-Mev accelerator (Berkeley Nuclear Laboratories, U.K.). Perhaps this was a pessimistic view of existing facilities; several participants commented that other laboratories might make their facilities available. In any event, other laboratories would probably be desirous of participating in incalibration studies, and one suggestion was directed toward extension of intercalibration data by the International Atomic Energy Agency.

The symposium was sponsored by the International Atomic Energy Agency (IAEA).

International Radiation Protection Association Congress

Opening ceremonies of this congress included two invited papers: one, an historical paper by K. Z. Morgan outlining the development of health physics as a profession; and the other by E. E. Pochin outlining the concept of permissible dose rates for tissues and organs with respect to genetic and neoplastic effects, and pointing out how these, rather than other impairments, might be limiting with respect to establishment of permissible concentrations of radionuclides in specific tissues.

A detailed report was made on a criticality at the Venus reactor at Mol, 30 December 1965. The reactor is a D_2O-moderated nuclear model of the Vulcan reactor. The criticality supposedly occurred when a technician failed to follow verbal instructions given him shortly beforehand. Of interest were the orders themselves, for these were in violation of the written operating procedures of the reactor. The criticality spike consisted of about 15 Mw-sec (4.5×10^{17} fissions), and resulted in no special damage to the reactor. The technician involved in the accident was pulling out one of eight hand-regulated control rods when the prompt criticality occurred; he noted the Cerenkov glow and heard the criticality alarms. By dropping the rod, he effectively halted the prompt criticality. He was the only person exposed.

The initial dosimetry evaluation was made by the criticality badge worn by the technician. The film portion of this badge indicated an exposure of about 700 roentgens to the trunk; the threshold foils indicated a fast-neutron dose, based on sulfur, of 55 radiation absorbed doses (rad). The thermal- and intermediate-neutron dose was far lower than the latter value. Final dosimetric data revealed the following: Entry dose, thorax: 400 rad; exit dose, thorax: 275 rad; midsection dose: 700 rad; gonadal dose: 1000 rad; marrow dose: 500 to 1000 rad to 48 percent of marrow; and maximum dose to left foot: 4700 r. These dose estimates are for electromagnetic radiation only; the neutron contribution was an additional 10 percent. The necessity for phantoms for duplicating exposure conditions was particularly emphasized; also, the film badge was shown to be a reasonable means of quickly estimating the whole-body exposure.

The medical aspects of this case were presented in detail. The patient followed the classical radiation syndrome and was hospitalized for 120 days, primarily because of the damage to his foot. A frank burn resulted shortly after the exposure, and in spite of all efforts, it was necessary to amputate the foot 25 weeks after exposure. Less than 9 months after the accident, the patient could not be located and was believed to have left the area. Attempts to find him have not been successful, although the presumption is made that he is still living and in reasonably good physical condition. Thus, future study of this individual was precluded.

External personnel dosimetry was a subject of prime interest during the technical sessions. Two comparisons of the film badge and thermoluminescent dosimeters (TLD) were cited. Generally, the only conclusions that were reached regarding the use of TLD (LiF) for personnel monitoring were that this system is not yet ready for widespread operational use and that it probably should be used in conjunction with other systems. It was felt that the systems of thermoluminescence dosimetry need additional study.

Papers on film dosimetry emphasized sophisticated instrumentation for calibration and readout. Such instrumentation implies that film dosimetry is still firmly entrenched as the primary personnel dosimeter. Surprisingly, no one specifically pointed out errors and inaccuracies associated with film dosimetry.

More significant were the papers dealing with internal dosimetry. C. R. Richmond and J. E. Furchner (Los Alamos Scientific Laboratory) compared differences between species with respect to radionuclide metabolism. They related the retention integral (or equilibrium factor) for a given radionuclide to body weight, basal metabolic rate, and the calories per gram per day. In all cases, smooth curves were obtained, implying that data from smaller mammalian species could be extrapolated to humans. Of particular importance was the statement that young animals have faster metabolic rates, and hence shorter effective residence time. If this can be extrapolated to humans, then a better quantification of the effects of internally deposited nuclides can be obtained, particularly for the accident situation involving a mixed population.

The dosimetry of β-emitters deposited in bone was discussed by F. W. Spiers (Leeds University, U.K.). In view of the fact that the relevant tissues lie within or close to the trabeculae, the importance of an accurate dosimetric

model was cited. By using such a model, it was shown that Maximum Permissible Body Burden (MPBB) for critical tissues may be too restrictive in several cases; specifically mentioned were Ca^{45} and Sr^{90}.

Two noteworthy presentations regarding pulmonary clearance of PuO_2 were made. L. J. Casarett (University of Rochester) showed how retention time varies as a function of particle size. As an example, the Mass Median Diameter (MMD) of particles within rat alveoli was cited as being log-normal with time, with 0.14-μ particles being retained the longest. For dogs, the comparable value was 0.11 μ.

The translocation from lung and excretion of Pu were greater by an order of magnitude for PuO_2 prepared by calcination at 350°C as opposed to 950°C, according to a study made by W. J. Bair (Battelle). Similarly, metals oxidized at 123° and 450°C showed greater translocation than the PuO_2 prepared by calcination at 950°C. Fecal excretion was greatest for the oxide calcined at 350°C, and least for that calcined at 950°C; the two directly oxidized metals were intermediate. Urinary excretion varied by nearly two orders of magnitude for the four materials studies. The results of this study point out that large errors in estimates of lung burden can be made on the basis of excretion data unless the chemicophysical state of the material and the physiology of the material in that state are known.

Results of studies by B. A. J. Lister (Harwell, U.K.) on the practical evaluation of inhaled radioactive materials were based primarily upon actual data. He found a correlation between alpha activity in nose blowings and in fecal samples after inhalation of insoluble α-emitters. These data suggest that lung burden can be predicted on the basis of nose blowings or nose wipes immediately after the exposure. According to Lister, the ratio of the nose blow to lung burden would be 500, or 80 microcuries on a nose blow sample would correspond to 0.16 microcurie in the lung, which was considered the maximum permissible lung burden. (This latter consideration would be correct only if the material is assumed to remain in the lungs, and if it is uniformly distributed in a mass of 10^3 g. New data would imply that this level is too great by a factor of 8, since a portion of these insoluble particles ultimately deposit in the pulmonary lymph nodes, with a much smaller mass.)

Lister also pointed out that a better estimate of lung burden could be made on the basis of fecal excretion, in the so-called plateau region of the excretion curve. This occurs from 10 to 50 days after exposure. The ratio of retained lung burden to average daily fecal excretion was found to be 2000.

Support for the very recent lung model of the International Congress of Radiation Protection (ICRP) was presented by P. L. Zeimer and co-workers (Purdue University) who studied two cases of inhalation exposure to europium oxide. The observed somewhat more rapid excretion from the first compartment, but in general their data agreed quite well with that of the ICRP Task Group. Excretion followed a $t^{-0.9}$ power function (t, days).

A report of an accidental exposure of three men to an insoluble mixture of Pu-Am was reported by A. Brodsky and N. Wald (University of Pittsburgh). Whole body counts, based on the 60-keV Am^{241} x-ray, were used to estimate the lung burden. Diethylenetriamine-pentaacetic acid (DTPA) was ef-

fective only in removing the soluble portion of the contaminant from the lung.

Perhaps the most valuable single presentation was the invited paper of F. D. Sowby (ICRP representative, U.K.) entitled "The 1965 Recommendations of the ICRP." In a rather candid presentation, Sowby pointed out certain changes in philosophy which led to the 1965 recommendations. Such changes are:

(i) a more general concept (in recognition of the growing number of experts in the field of radiation protection); (ii) the assumption of linearity, rather than (as previously) a threshold; (iii) the concept of dose limit, as applied to members of the population, and inclusion of population exposures in the general fabric of the recommendations; and (iv) a redefinition and more encompassing definition of occupational exposure.

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Calendar of Events

Courses

Built-In Test Equipment for the **Maintenance** of **Complex Electronic Systems**. New York, N.Y., 24–28 July. Tuition, $225. (D. M. Goodman, School of Engineering and Science, 401 W. 205 St., New York 10034)

Cancer Chemotherapy. Memorial and James Ewing Hospitals and Sloan-Kettering Institute for Cancer Research, New York, N.Y., 23–28 October. Designed for physicians; limited to 100 participants. Tuition, $100. (D. A. Karnofsky, Memorial Hospital, 444 E. 68 St., New York 10021)

Coelenterate Ecology. University of Hawaii, 19 June–8 Sept. Designed for 15 students fulfilling minimum requirements for graduate division at the University. Participants will receive $300 stipend and round-trip airfare from place of residence in United States. Six graduate credits in Zoology 600. *Deadline: 1 May*. (P. Helfrich, Summer Training Program, Hawaii Inst. of Marine Biology, Univ. of Hawaii, 2538 the Mall, Honolulu 96822)

Color Measurement. Clemson Univ., 31 July–4 Aug. For participants with background in colorants and basic knowledge of physics and mathematics. Tuition, $125. (H. J. Keegan, Color Measurement Seminars, School of Industrial Management and Textile Science, Clemson Univ., Clemson, S.C. 29631)

Ecological Approach to Study of Life. Humboldt State College, 26 June–4 Aug. (Summer Sessions Office, Humboldt State College, Arcata, Calif.)