

E.I. Tolstykh · M.O. Degteva · V.P. Kozheurov
E.A. Shishkina · A.A. Romanyukha · A. Wieser
P. Jacob

Strontium metabolism in teeth and enamel dose assessment: analysis of the Techa river data

Received: 19 July 1999 / Accepted: 5 May 2000

Abstract People living on the banks of the Techa river were exposed to ^{90}Sr in the early 1950s. Data obtained by radiochemical measurements of extracted permanent teeth, ^{90}Sr autopsy measurements in bone and tooth samples, in vivo measurements of surface beta activity of the anterior teeth and whole-body counter (WBC) measurements of ^{90}Sr in the skeleton have been analyzed. Surface beta activity measurements indicate a biological half-life of ^{90}Sr of about 35 years in enamel. The WBC measurements have been performed since 1974 and a model for the age-dependent strontium retention in human bone has been used to extrapolate to previous time periods when the other measurement results were obtained. For the first decade after the intake, the ratio of the ^{90}Sr concentrations in teeth and bones were found to decrease with age at the time of major intake, from about 10 for 1-year-old children to about 0.3 for adults. There was a considerable variability of individual data within each age group. For adults, the correlation between ^{90}Sr in skeleton and teeth was not high at 0.47 according to radiochemical data for posterior teeth (molars and premolars) and 0.43 according to measurements of surface beta activity for anterior teeth. For children and adolescents there was no correlation between individual measurements in the skeleton and teeth. The absorbed dose in enamel due to ^{90}Sr in dentine has been calculated by Monte Carlo simulations of the electron transport. The results are in agreement with EPR measurements of the absorbed dose in the enamel of persons exposed, mainly due to ^{90}Sr ingestion.

Introduction

The Techa river (Southern Urals, Russia) was contaminated as a result of radioactivity released from the Mayak plutonium complex. The major ^{90}Sr intake by inhabitants of the area occurred between 1950 and 1951 and on average about 3000 kBq of ^{90}Sr was ingested with river water by the adult residents of the upper and mid-Techa region [1]. Extensive monitoring of the environment and of the population began in 1951. The Techa river cohort (about 30,000 persons) has now been studied for several decades by the Urals Research Center for Radiation Medicine (URCRM) [2]. A data base has been established including personal data, residence history and results of medical and dosimetric examinations for each cohort member. The data base is used to address different dosimetric and epidemiological tasks related to environmental exposure.

The database contains measurement results of ^{90}Sr in bones, teeth and in the whole body for more than 15,000 persons in total, and over a period of more than 45 years (Table 1). Methods of experimental dosimetry have changed since the early 1950s and the database includes information on the various methods. Initially, radiochemical methods (based on the sedimentation of ^{90}Sr with nitrates) were applied to autopsy and bioassay samples [3] and the average ^{90}Sr concentration in the skeleton was calculated on the basis of measurements of several samples of trabecular and compact bones.

Measurements of ^{90}Sr in extracted permanent teeth from the Urals residents were performed in 1959–1964 (Table 1). The teeth under investigation were extracted according to medical indications. The radiochemical method described by Gussev et al. [3] was used and methods were derived to estimate the ^{90}Sr whole-body burden. A similar program was created at the same time in the Soviet Union within the framework of an environmental monitoring project [4].

In vivo measurements of surface-beta activity on front teeth have been performed since 1959 (e.g., tooth beta counting, TBC). For these measurement, detectors

E.I. Tolstykh · M.O. Degteva · V.P. Kozheurov · E.A. Shishkina
Urals Research Center for Radiation Medicine, Medgorodok,
Chelyabinsk, 454076, Russia

A.A. Romanyukha
Institute of Metal Physics, S. Kovalevskoy St.,
Ekaterinburg, 620219, Russia

A. Wieser · P. Jacob (✉)
GSF—National Research Center for Environment and Health,
Institute of Radiation Protection, 85764 Neuherberg, Germany

Strontium Metabolism

Terry C. Jones



Strontium Metabolism:

Strontium Metabolism: Proceedings of the International Symposium on Some Aspects of Strontium Metabolism Held at Chapelcross, Glasgow and Strontian, 5-7 May, 1966 J. M. A. Lenihan, 1967 *Handbook of Stable Strontium* Stanley Skoryna, 2013-06-29 Nearly two hundred years ago Crawford and Cruickshank surgeons and chemists in the Royal Artillery reported the occurrence of a new earth in the mines at the Scottish village of Strontian Humphrey Davy following the advice of Berzelius isolated stable strontium in 1808 along with other alkali earth metals It was not until 1883 that physiological effects of stable strontium were first recognized by none other than Sidney Ringer in his experiments on frog heart The medicinal use of strontium salts was first described in Squire's Companion in 1894 Subsequently strontium was introduced into the Pharma copeias of Great Britain United States France Germany Spain Italy and Mexico and was used in treatment of a variety of disease s clearly without detailed knowledge of its actions It is hoped that this handbook will provide a sound basis for further research on stable strontium and the establishment of the levels of intake necessary or desirable in different pathophysiological conditions The objective of this publication was to assemble a comprehensive collection of essays on stable strontium which review the respective areas of research as well as present original data I consider myself fortunate to have been able to work with the contributors of these essays It is obvious that this type of book should be interdisciplinary in nature owing to the necessity of examining each subject from the viewpoint of different disciplines *Toxicological Profile for Strontium* ,2004 **Nuclear Science Abstracts** ,1973 **Combined Subject and Author Indexes to Radiobiology Bibliographies** U.S. Atomic Energy Commission. Division of Technical Information, 1967 *The Effects of Radiation and Radioisotopes on the Life Processes* Charles M. Pierce, U.S. Atomic Energy Commission, 1963 **The Effects of Radiation and Radioisotopes on the Life Processes: Index** ,1963 *AECU* ,1953 *Biominerals* F.C.M. Driessens, R.K. Verbeeck, 1990-09-26 This book provides a comprehensive analysis of biominerals in particular phosphates and carbonates of calcium The book begins with a discussion of the theories of solid state chemistry and thermodynamics of ionic solid solutions and applies these theories to show how physiological constituents like sodium magnesium carbonate chloride fluoride lead or strontium influence the formation stability and solubility of calcium phosphates The results of this discussion are then applied to a critical evaluation of data regarding minerals in bone dentin and tooth enamel their formation during growth and turn over their stability under physiological conditions and their breakdown under pathological conditions These principles are also applied to pathological calcifications such as renal calculi arterial wall calcifications chondrocalcinosis dental calculus and salivary stones A similar approach is used as the authors discuss carbonations such as calcite dolomite and aragonite The book also includes an extensive analysis of the advantageous effects of magnesium supplementation The wealth of knowledge in this extensive treatise of biominerals is valuable to medical dental and ecological biologists as well as scientists and clinicians in the fields of osteoporosis bone diseases caries renal stone disease parodontology and nutrition Atomic

Energy Research, Life and Physical Sciences, Reactor Development, Waste Management, 1961, Special Report U.S. Atomic Energy Commission, 1962 **Fundamental Nuclear Energy Research** U.S. Atomic Energy Commission. Division of Plans and Reports, U.S. Atomic Energy Commission, 1963 Scientific Careers in the Agricultural Research Service John Martin Miller, William Crawford Kennard, Frederick Paul Keen, H. F. Winters, 1959 This publication reviews the results of research on the western pine beetle up to July 1 1952 It shows the progress that has been made in over a half century of study of this one bark beetle It also records the trials and errors the research that ran into blind alleys The record of this pioneer effort in the field of forest entomology in the United States should be of great help to research workers who are faced with similar problems Isotopes ,1958 **Nuclear Power Reactor Instrumentation Systems Handbook** Joseph M. Harrer, James G. Beckerley, 1973 **Miscellaneous Publication** ,1961 **50 Years of Service Through Wood Research** ,1960
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