

# Natural radionuclides in the environment

Cosmogenic radiation



Terrestrial radiation



Radionuclides from volcanic activity



Radionuclides on materials

238U decay chain  
235U decay chain  
232Th decay chain

238U decay chain  
235U decay chain  
232Th decay chain

Terrestrial radionuclides (rock)

Terrestrial radiation



Terrestrial radiation

238U  
235U  
232Th

Radionuclides in water (groundwater and surface water)

238U decay chain  
235U decay chain  
232Th decay chain

# Radionuclides In The Environment

**International Commission on Radiation  
Units and Measurements**



## **Radionuclides In The Environment:**

*Radioactive Releases in the Environment* John R. Cooper, Keith Randle, Ranjeet S. Sokhi, 2003-05-07 This text brings together in one single comprehensive reference the fundamentals of radioactivity It uniquely fills the gap in the market as no other books deal with environmental radioactivity to this degree Timely and invaluable as the studies of environmental processes and the awareness of the impact of human activity on our environment are increasing Links all three main aspects of environmental radioactivity Principles Transport and Measurement Useful to a wide readership students lecturers researchers companies and environmental consultants

*Radionuclides in the Environment* Clemens Walther, Dharmendra K. Gupta, 2015-10-30 This book provides extensive and comprehensive information to researchers and academicians who are interested in radionuclide contamination its sources and environmental impact It is also useful for graduate and undergraduate students specializing in radioactive waste disposal and its impact on natural as well as manmade environments A number of sites are affected by large legacies of waste from the mining and processing of radioactive minerals Over recent decades several hundred radioactive isotopes radioisotopes of natural elements have been produced artificially including  $^{90}\text{Sr}$   $^{137}\text{Cs}$  and  $^{131}\text{I}$  Several other anthropogenic radioactive elements have also been produced in large quantities for example technetium neptunium plutonium and americium although plutonium does occur naturally in trace amounts in uranium ores The deposition of radionuclides on vegetation and soil as well as the uptake from polluted aquifers root uptake or irrigation are the initial point for their transfer into the terrestrial environment and into food chains There are two principal deposition processes for the removal of pollutants from the atmosphere dry deposition is the direct transfer through absorption of gases and particles by natural surfaces such as vegetation whereas showery or wet deposition is the transport of a substance from the atmosphere to the ground by snow hail or rain Once deposited on any vegetation radionuclides are removed from plants by the airstream and rain either through percolation or by cuticular scratch The increase in biomass during plant growth does not cause a loss of activity but it does lead to a decrease in activity concentration due to effective dilution There is also systemic transport translocation of radionuclides within the plant subsequent to foliar uptake leading the transfer of chemical components to other parts of the plant that have not been contaminated directly

**Behavior of Radionuclides in the Environment III** Kenji Nanba, Alexei Konoplev, Toshihiro Wada, 2022-03-14 This book the third in the series Behavior of Radionuclides in the Environment is dedicated to Fukushima Major findings from research since 2011 are reviewed concerning the behavior of radionuclides released into the environment due to the Fukushima Dai ichi Nuclear Power Plant accident including atmospheric transport and fallout of radionuclides their fate and transport in the soil water environment behavior in freshwater coastal and marine environment transfer in the terrestrial and agricultural environment Volume III discusses not only radionuclides dynamics in the environment in the short and mid term but also modeling and prediction of long term time changes Along with reviews the

book contains original data and results not published previously It was spearheaded by the authors from the Institute of Environmental Radioactivity at Fukushima University established two years after the Fukushima accident with their collaborators from Japan Russia and Ukraine The knowledge emerging from the studies of the environmental behavior of Fukushima derived radionuclides enables us to move forward in understanding mechanisms of environmental contamination and leads to better modeling and prediction of long term pollution effects in general

**Radionuclides in the Environment** E. C. Freiling,1970 Radionuclides in the environment ,1968 *Radionuclides in the Environment* Clemens Walther,Dharmendra K. Gupta,2015 This book provides extensive and comprehensive information to researchers and academicians who are interested in radionuclide contamination its sources and environmental impact It is also useful for graduate and undergraduate students specializing in radioactive waste disposal and its impact on natural as well as manmade environments A number of sites are affected by large legacies of waste from the mining and processing of radioactive minerals Over recent decades several hundred radioactive isotopes radioisotopes of natural elements have been produced artificially including  $^{90}\text{Sr}$   $^{137}\text{Cs}$  and  $^{131}\text{I}$  Several other anthropogenic radioactive elements have also been produced in large quantities for example technetium neptunium plutonium and americium although plutonium does occur naturally in trace amounts in uranium ores The deposition of radionuclides on vegetation and soil as well as the uptake from polluted aquifers root uptake or irrigation are the initial point for their transfer into the terrestrial environment and into food chains There are two principal deposition processes for the removal of pollutants from the atmosphere dry deposition is the direct transfer through absorption of gases and particles by natural surfaces such as vegetation whereas showery or wet deposition is the transport of a substance from the atmosphere to the ground by snow hail or rain Once deposited on any vegetation radionuclides are removed from plants by the airstream and rain either through percolation or by cuticular scratch The increase in biomass during plant growth does not cause a loss of activity but it does lead to a decrease in activity concentration due to effective dilution There is also systemic transport translocation of radionuclides within the plant subsequent to foliar uptake leading the transfer of chemical components to other parts of the plant that have not been contaminated directly

**Radionuclide Concentrations in Food and the Environment** Michael Poschl,Leo M.L. Nollet,2006-08-21 As radiological residue both naturally occurring and technologically driven works its way through the ecosystem we see its negative effects on the human population Radionuclide Concentrations in Food and the Environment addresses the key issues concerning the relationship between natural and manmade sources of environmental radioactivity

**Radionuclide Behaviour in the Natural Environment** Christophe Poinssot,Horst Geckeis,2012-09-20 Understanding radionuclide behaviour in the natural environment is essential to the sustainable development of the nuclear industry and key to assessing potential environmental risks reliably Minimising those risks is essential to enhancing public confidence in nuclear technology Scientific knowledge in this field has developed greatly over the last decade Radionuclide behaviour in

the natural environment provides a comprehensive overview of the key processes and parameters affecting radionuclide mobility and migration After an introductory chapter part one explores radionuclide chemistry in the natural environment including aquatic chemistry and the impact of natural organic matter and microorganisms Part two discusses the migration and radioecological behavior of radionuclides Topics include hydrogeology sorption and colloidal reactions as well as in situ investigations Principles of modelling coupled geochemical transport and radioecological properties are also discussed Part three covers application issues assessment of radionuclide behaviour in contaminated sites taking Chernobyl as an example estimation of radiological exposure to the population performance assessment considerations related to deep geological repositories and remediation concepts for contaminated sites With its distinguished editors and international team of expert contributors Radionuclide behaviour in the natural environment is an essential tool for all those interested or involved in nuclear energy from researchers designers and industrial operators to environmental scientists It also provides a comprehensive guide for academics of all levels in this field Provides a comprehensive overview of the key processes and parameters affecting radionuclide mobility and migration Explores radionuclide chemistry in the natural environment Discusses the migration and radioecological behaviour of radionuclides Technical Peer Review Report American Society of Mechanical Engineers,Asme,2003-01-01 The scope of this plan of the Office of Nuclear Regulatory Research is the overall research of radionuclide transport in the environment RTE from the place and time of release to the place and time of exposure of a member of the public The RTE research program provides data and models for use in assessing the effect on public health and safety and the environment from nuclear materials that enter the environment from U S Nuclear Regulatory Commission USNRC licensed activities The technical issues examined include 1 source term characterization 2 the effectiveness of engineered and natural containment systems surrounding the radioactive material 3 multi phase flow of water including episodic infiltration into and through contaminated systems 4 the transport of radioactive material through the geosphere 5 the transport of radioactive material through the biosphere and 6 exposures of members of the public to radiation from these materials Excluded from consideration are biological effects of ionizing radiation and the associated modeling and assumptions Results from the RTE research program are intended to be generically applicable to USNRC licensing activities including the decommissioning of facilities disposal of uranium mill tailings low level radioactive waste disposal and high level radioactive waste disposal The RTE research program includes the conduct of independent confirmatory and anticipatory research and analyses to provide data and models and other technical information that will support 1 credible realistic and defensible estimates of risk to the public from alternative courses of action at decommissioning and nuclear waste disposal facilities and 2 agency decisions regarding decommissioning and waste disposal

Behavior of Radionuclides in the Environment II Alexei Konoplev,Kenji Kato,Stepan N. Kalmykov,2020-05-19 This is Volume II in a three volume set on the Behavior of Radionuclides in the Environment focusing on Chernobyl Now so many

years after the Chernobyl accident new data is emerging and important new findings are being made The book reviews major research achievements concerning the behavior of Chernobyl derived radionuclides including their air transport and resuspension mobility and bioavailability in the soil water environment vertical and lateral migration in soils and sediments soil to plant and soil to animal transfer and water to aqueous biota transfer The long term dynamics of radionuclides in aquatic ecosystems are also discussed in particular the heavily contaminated cooling pond of the Chernobyl Nuclear Power Plant which is in the process of being decommissioned Lessons learned from long term research on the environmental behavior of radionuclides can help us understand the pathways of environmental contamination which in turn will allow us to improve methods for modeling and predicting the long term effects of pollution This book features a wealth of original data and findings many of which have never been published before or were not available internationally The contributing authors are experts from Ukraine Russia and Belarus with more than 30 years of experience investigating Chernobyl derived radionuclides in the environment The content presented here can help to predict the evolution of environmental contamination following a nuclear accident and specifically the Fukushima Dai ichi nuclear power plant accident

**Behavior of Radionuclides in the Environment I** Kenji Kato,Alexei Konoplev,Stepan N. Kalmykov,2020-02-18 The 3 volume set highlights the behavior of radionuclides in the environment and focusing on the development of related fields of study including microbiology and nanoscience In this context it discusses the behavior of radionuclides released in areas of Lake Karachai in Ural and those released as a result of Chernobyl accident 1986 and in Fukushima 2011 Volume I presents the experiences gained in South Urals Mayak plant Lake Karachai providing a scientific basis for more precise understanding of the behavior of radionuclides in complex subsurface environments On the basis of monitoring data it examines the pathways of radionuclide migration and the influence of the geological environment and groundwater on the migration with a particular focus on particles from the nanoscale to microscale It also discusses the function of microbes and microscale particles from their direct interaction with radionuclides to their ecological role in changing the physicochemical condition of a given environment Lastly the protective properties of geological media are also characterized and mathematical modeling of contaminant migration in the area of Lake Karachai is used to provide information regarding the migration of radionuclides

**Environmental Radionuclides** Klaus Froehlich,2009-09-23 Environmental Radionuclides presents a state of the art summary of knowledge on the use of radionuclides to study processes and systems in the continental part of the Earth's environment It is conceived as a companion to the two volumes of this series which deal with isotopes as tracers in the marine environment Livingston Marine Radioactivity and with the radioecology of natural and man made terrestrial systems Shaw Radioactivity in Terrestrial Ecosystems Although the book focuses on natural and anthropogenic radionuclides radioactive isotopes it also refers to stable environmental isotopes which in a variety of applications especially in hydrology and climatology have to be consulted to evaluate radionuclide measurements in terms of the ages of groundwater and

climate archives respectively The basic principles underlying the various applications of natural and anthropogenic radionuclides in environmental studies are described in the first part of the book The book covers the two major groups of applications the use of radionuclides as tracers for studying transport and mixing processes and as time markers to address problems of the dynamics of such systems manifested commonly as the so called residence time in these systems The applications range from atmospheric pollution studies via water resource assessments to contributions to global climate change investigation The third part of the book addresses new challenges in the development of new methodological approaches including analytical methods and fields of applications A state of the art summary of knowledge on the use of radionuclides Conceived as a companion to the two volumes of this series which deal with isotopes as tracers Low-level Measurements Of Man-made Radionuclides In The Environment - Proceedings Of The 2nd International Summer School M Garcia-leon,G Madurga,1991-03-22 This volume gives an up to date account of the methods used in the detection of artificial radionuclides and their spread in the environment *Radioactivity in the Terrestrial Environment* ,2007-03-02 The Radioactivity in the Environment Series addresses the key aspects of this socially important and complex interdisciplinary subject Presented objectively and with the ultimate authority gained from the many contributions by the world s leading experts the negative and positive consequences of having a radioactive world around us is documented and given perspective In a world in which nuclear science is not only less popular than in the past but also less extensively taught in universities and colleges this book series will fill a significant educational gap Radioactivity in the Terrestrial Environment presents an updated and critical review of designing siting constructing and demonstrating the safety and environmental impact of deep repositories for radioactive wastes It is structured to provide a broad perspective of this multi faceted multi disciplinary topic providing enough detail for a non specialist to understand the fundamental principles involved Contains extensive references to sources of more detailed information Provides a detailed summary of radioactivity in terrestrial ecosystems providing a substantial and essential reference on the subject Discusses lesser known sources of radiation exposure that provide useful information for those seeking to place environmental radioactivity into perspective Sampling for Radionuclides in the Environment International Commission on Radiation Units and Measurements,2006 Man-Made and Natural Radioactivity in Environmental Pollution and Radiochronology Richard Tykva,Dieter Berg,2013-03-14 Radioactivity can be detected at different levels in almost all objects all over the world including the human body This omnipresence of naturally occurring radioactivity is of immediate and crucial concern to people who work in the nuclear industry to state and local authorities responsible for environmental protection and control of nuclear weapons and to researchers as physics e g interaction in scientific and technological disciplines such of radiation with matter chemistry e g management of radioactive wastes biology Ce g radiation bioeffects and risks ecology e g remediation of environmental pollution electronics e g measurement instruments etc Unlike other environmental pollutants such as heavy metals and pesticides some other scientific disciplines

for example archaeology hydrology and geology profit by the environmental radionuclides using methods based on their application in radiochronology The basic goal of this book is to examine the complex state of radioactivity in the environment including its sources and applications In principle there are two sources of environmental radioactivity namely man made and natural The authors of this book set out to analyze mainly empirical aspects of the activities of both groups On one hand a detailed analysis of the sources releasing radionuclides into the environment by human activities should while describing environmental pollution and its dangers contribute to its decrease in the future

**Radionuclide Contamination and Remediation Through Plants** Dharmendra Kumar Gupta, Clemens Walther, 2014-07-14 This book focuses on the mechanistic microscopic understanding of radionuclide uptake by plants in contaminated soils and potential use of phytoremediation The key features concern radionuclide toxicity in plants how the radioactive materials are absorbed by plants and how the plants cope with the toxic responses The respective chapters examine soil classification natural plant selection speciation of actinides kinetic modeling and case studies on cesium uptake after radiation accidents Radionuclide contaminants pose serious problems for biological systems due to their chemical toxicity and radiological effects The processes by which radionuclides can be incorporated into vegetation can either originate from activity interception by external plant surfaces either directly from the atmosphere or from resuspended material or through uptake of radionuclides via the root system Subsequent transfer of toxic elements to the human food chain is a concrete danger Therefore the molecular mechanisms and genetic basis of transport into and within plants needs to be understood for two reasons The effectiveness of radionuclide uptake into crop plants so called transfer coefficient is a prerequisite for the calculation of dose due to the food path On the other hand efficient radionuclide transfer into plants can be made use of for decontamination of land so called phytoremediation the direct use of living green plants for in situ removal of pollutants from the environment or to reduce their concentrations to harmless levels

*Analysis of Environmental Radionuclides* Pavel P. Povinec, 2011-07-28 The purpose of this book is to present a state of art summary of current knowledge of methods of assessment of radionuclides in the terrestrial and marine environments It covers the traditional methods of radioactivity measurements such as radiometrics techniques but also recent developments in the mass spectrometry sector The book starts with a short preface introducing the subject of the book summarising content and philosophy of the book as well as the most important historical achievements The scientific topics are introduced by description of sampling methods optimisation of sampling sites and sampling frequency The recent developments in radiochemical separation methods using chromatography resins for the treatment of actinides transuranics and other groups of radioelements are also described No other book is available covering all aspects of environmental radioactivity measurements although remarkable progress has been made in detection techniques over the last ten years At present the new methods enable to carry out investigations which were not possible before either because of lack of sensitivity or because of the fact that they required too large samples

**Behavior of**



**Radionuclides in the Environment** ,2020 The 3 volume set highlights the behavior of radionuclides in the environment and focusing on the development of related fields of study including microbiology and nanoscience In this context it discusses the behavior of radionuclides released in areas of Lake Karachai in Ural and those released as a result of Chernobyl accident 1986 and in Fukushima 2011 Volume I presents the experiences gained in South Urals Mayak plant Lake Karachai providing a scientific basis for more precise understanding of the behavior of radionuclides in complex subsurface environments On the basis of monitoring data it examines the pathways of radionuclide migration and the influence of the geological environment and groundwater on the migration with a particular focus on particles from the nanoscale to microscale It also discusses the function of microbes and microscale particles from their direct interaction with radionuclides to their ecological role in changing the physic chemical condition of a given environment Lastly the protective properties of geological media are also characterized and mathematical modeling of contaminant migration in the area of Lake Karachai is used to provide information regarding the migration of radionuclides

*Radionuclides and Heavy Metals in Environment* Marina V. Frontasyeva,Vladimir P. Pereygin,Peter Vater,2001-09-30 Proceedings of the NATO Advanced Research Workshop on Monitoring and Man Made Radionuclides and Heavy Metals Waste in Environment Dubna Russia 3 6 October 2000

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