

# Preface

Do we actually understand geologic processes? New technology brings new information and perceptions, which sometimes overturn imaginations based on simple observation and estimation, in conjunction with common sense inference. In 1902–1904, Pierre Curie and Ernest Rutherford first formulated the idea of using radioactive transformation of nuclides as a geologic chronometer. After a century of working with such tools, geology has advanced from a descriptive science to an analytic science that formulates conclusions based on exact values. The technology of radiogenic isotope geology has created a branch of science that considers the Earth as a planet generated within a Solar system and studies the subsequent evolution of geologic processes that has resulted in the present formation of our planet's continents and oceans.

The physicist Vitaly Ginsburg, Nobel Prize laureate, wrote recently: “If Kepler had been given information on orbital parameters of planets with modern precision, he would not have been able to formulate his laws”. Indeed, after development of laws of celestial mechanics, methods of measurements became so advanced and such numerous secondary distortion effects were found that to describe an orbit of a cosmic body by a curve of the second order would appear impossible. But it does not mean that Kepler's laws are “cancelled”; they still occupy an honorable place in courses on celestial mechanics. A reasonable division into basic and secondary phenomena is accepted and the latter are entered as variations in the basic equations.

Application of radiogenic isotopes for study of geologic processes showed that accumulation of daughter substances, according to the Rutherford–Soddy Law of Radioactivity, in some cases was interfered with by other circumstances. Authors often gave only “verbal explanations” of these phenomena without appropriate differential equations. Present-day radiogenic isotope geology, however, expresses results in values that can claim a high degree of accuracy. Similar to the study of celestial mechanics, understanding of natural isotopic systems requires a deliberate selection in geologic processes of the main and secondary effects.

New data, technological breakthroughs, and changes of paradigms inevitably result in changes of approaches in geochronology and isotope geochemistry. Only the requirements for selection of material for an isotope analysis remain constant from the geologic point of view. A geologist aspires to obtain data most appropriate to

satisfactory geochronological interpretations using isochron or Concordia–Discordia diagrams. Additional complexities arise in cases of deviations from the statistically substantiated models. Factually, every isotopic measurement is to some degree a compromise between a strict model and the probabilities of alternatives. In this book, we designate, therefore, results based on the principle approaches and on interpretations on a level of more or less approximate constructions.

Achievements of radiogenic isotope geology have been highlighted in several monographs (Faure 1989, 2001; Geyh and Schleicher 1990; Dickin 1997; McDougall and Harrison 1999; Ozima and Podosek 2002 etc.). Monographs that were published in Russian on this topic were listed by Shukolyukov in introductory comments to the Russian edition of the book on principles of isotope geology by Gunter Faure (1989). A few books have been published recently (Kotlyar et al. 2001; Titaeva 2005 etc.). Our Russian book “Radiogenic isotope geology in problems and examples” (Rasskazov et al. 2005a) was intended for students and geologists interested in modern approaches to applications of the principle geochronometric systems.

Respectively, comprehensive information on the theory, experiments, models and methods is presented in the first three chapters of this book, exhibiting modified compilations from the Russian monograph mentioned above. In the further chapters, some aspects of radiogenic isotope behavior are developed for understanding geologic processes. On the one hand, we substantiate theoretically the geochronological consequences of (1) possible fractionation of argon isotopes in the terrestrial atmosphere, (2) distribution of radiogenic argon in a mineral grain, (3) particularities of Ar–Ar spectra, (4) radiogenic isotope losses in an exocontact zone of an intrusive body and in a terrane affected by long-term elevated temperatures provided a Laplace regime, (5) decreasing isotope losses in a cooling dike with transition from an open to a closed isotope system, and (6) separation of leads in ore deposits according to the Concordia–Discordia model. On the other hand, we highlight geochronological data on processes of (1) the early Earth, (2) important Phanerozoic boundaries, and (3) the late Phanerozoic.

The book was prepared at the laboratory for isotopic and geochronological studies of the Institute of the Earth’s crust, Siberian branch of the Russian Academy of Sciences, with the ultimate goal of establishing a special course on radiogenic isotopes in geologic processes for students of the Irkutsk State University, Irkutsk. The help of our colleagues occasionally contributed to this work is highly appreciated.

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