Preface

This synthesis draws on the results of a major international scientific workshop held in Pushchino (Moscow Region) in summer 1983, organised jointly by the United Nations Environment Programme (UNEP) and SCOPE, with major financial support from UNEP.

Today one should not discuss the sulphur cycle without reference to isotope data. Isotopes are different nuclear forms of the same element. The number of protons in the nucleus is constant for a given element—16 in the case of sulphur. Different numbers of neutrons in the nucleus correspond to different isotopes: 16 for ^{32}S, 17 for ^{33}S, etc. Some isotopes are not stable and undergo radioactive decay. Radioactive isotopes such as ^{35}S have been used as tracers in biological and agricultural studies. However, variations in the abundances of stable isotopes provide a more universal label for monitoring the global cycling of sulphur. This concept is the basis of this book.

Stable isotope studies are based on the fact that isotopes of an element differ in their masses, e.g. ^{34}S is heavier than ^{32}S. Many physical and chemical processes in nature are mass dependent and hence molecules with different isotopes participate at different rates. When conversions are incomplete, the remaining reactant does not have the same isotope composition as the product, i.e. the isotopes have been 'fractionated'. By measuring isotope abundances of a natural sample, information can be gained about its past geochemistry. In controlled laboratory studies, isotope fractionation can be measured and the data used to interpret natural isotope variations.

There are two extremes in stable isotope investigations. On the one hand, isotopic selectivity provides information about a process. On the other hand, if one wants to use the isotopic composition of an element to follow its fate in the environment, isotope fractionation must either be minimal or capable of being evaluated. Fortunately, there are a number of processes in which sulphur isotope selectivity is small or non-existent. These include certain high-temperature industrial processes, oxidation of H_2S, SO_2, etc. in the atmosphere, solid phase reactions proceeding layer by layer, and assimilation of SO_4^{2-} by bacteria and plants.

A considerable body of stable sulphur isotope data was introduced in *SCOPE 19: The Global Biogeochemical Sulphur Cycle*. The current volume differs from this previous presentation in that it strives to show how stable isotope abundances may be used to differentiate between natural and anthropogenic sulphur in the environment. It is intended to serve as a handbook to anyone interested in this investigative tool. To this end, basic principles and analytical techniques are included as well as documentation of relevant research in different parts of the world.

It is most fitting that the first chapter is an overview by Dr H.G. Thode, the primary driving force in the history of sulphur isotope investigations. Since oxygen isotope abundances in sulphates are also informative for deciphering the sulphur cycle, the second chapter by Dr B.D. Holt reviews the fundamentals of this topic. In turn, the lithosphere, atmosphere, hydrosphere, and biosphere are discussed by teams of international experts. Since sulphur leaving one 'sphere' enters another, it is difficult to avoid duplication. Indeed, a strict adherence to non-overlap would leave serious gaps in individual sections.

The final chapter is devoted to case studies which range from situations where the expertise is well developed to the identification of potential research areas. It is anticipated that the broad spectrum of applications in this chapter will stimulate both the novice and experienced investigator.

Regrettably, the Editors had to delete many details from some manuscripts. Material from contributors who did not attend the workshop were also included to achieve a better balance.

The contributions of the late Dr Charles Edward Rees (1940–84) are especially acknowledged. 'Ted' was a close friend of the editors and well known to the global community of stable isotope researchers for his competent science and gentle manner. His contributions were manifold but he is perhaps best remembered for his numerical modelling of stable isotope phenomena. He not only wrote part of Chapter 3 on preparation techniques for sulphur isotope analyses but he also served as a very effective member of the Editorial Advisory Committee during its meeting at Kananaskis.

In latter stages of preparing this book, the editors and participants of UNEP/SCOPE meetings were also saddened to hear of the passing (1989) of Professor E.T. Degens. As Chairman of the Carbon Unit, he was a welcomed stimulus at Sulphur Unit meetings and provided invaluable input.

The hospitality extended by the Soviet Academy of Science, The Institute of Microbiology, Moscow, and the Kananaskis Centre for Environmental Studies at The University of Calgary during meetings of members of the Editorial Board is gratefully acknowledged.