THE ORIGIN OF CHONDRULES AND CHONDRITES

Chondrites are the largest group of meteorites. They can provide unique insights into the origins and early evolution of our Solar System, and even into the relationships between our Solar System and other stars in the vicinity of our Sun. The largest structural components of most chondrites are the glass-bearing chondrules, and there are numerous theories for their origin. This clear and systematic text summarizes the ideas surrounding the origin and history of chondrules and chondrites, drawing on research from the various scientific disciplines involved. With citations to every known published paper on the topic, it forms a comprehensive bibliography of the latest research, and extensive illustrations provide a clear visual representation of the scientific theories. This text will be a valuable reference for graduate students and researchers in planetary science, geology, and astronomy.

Derek Sears was born in England and obtained a bachelor's degree in chemistry at the University of Kent at Canterbury, and a Ph.D. in Astronomy and Geology at the University of Leicester. He is now Professor of Chemistry and Director of the Arkansas–Oklahoma Center for Space and Planetary Sciences. He teaches chemistry and performs meteorite research, and is currently involved in creating new research and graduate teaching programs in space and planetary sciences. Professor Sears is probably best known for his pioneering studies on the use of thermoluminescence to characterize primitive meteorites and to determine the thermal and radiation history of Antarctic meteorites. In 1999 he received the University of Arkansas' highest award for research and service, and asteroid 4473 Sears was named in his honor. This is his third book on meteorites.

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Preface

Rocks falling from the sky have a long and colorful history. I mean this both in a socio-economic sense and, perhaps more obviously, in a scientific sense. Stories of stones from the heavens have been with us for as long as humans have left traces of themselves. In ancient tombs and burial sites, in their earliest writings and during the faltering steps of the industrial revolution and the creation of modern science, people wrote about rocks from the sky now known as meteorites. In many respects the history of modern science instrumention is inextricably linked with the history meteorite studies.

Meteorites are major witnesses of the history of our Solar System. Everyone agrees that meteorites are ancient materials from the earliest stages in the history of the Solar System. Their age, composition, and texture clearly point to this conclusion. Everyone also agrees that meteorites are fragments from near-Earth asteroids, which occasionally threaten us with impact, and it seems that such asteroids largely come out of the Main Asteroid Belt between Mars and Jupiter although a small fraction of them are probably related to comets. These rocks are fascinating to study. They are sufficiently like terrestrial rocks that similar techniques and approaches can be used, yet they present a whole new range of physical and chemical processes to consider, processes that take the researcher from petrologist, mineralogist, and geochemist to the astronomer and the astrophysicist. But while they reward us with many new observations and insights, much about them remains covered in a veil of obscurity "of truly delphic proportions." For example, what is the origin of the chondrules from which chondrites get their name? What processes have given rise to the differences in the accumulation of metal and silicates that characterize the various classes?

This book emerged from a paper I was invited to give at the annual conference on Antarctic meteorites hosted by the National Institute for Polar Research (NIPR) in Tokyo. I am very grateful to K. Yanai and H. Kojima for the invitation and their extraordinary hospitality. In an age of endless specialization and highly focussed expertise, I wanted to present a discussion of the big picture – laying out the variety of ideas that have been published and trying to stimulate some new thoughts. I wanted to give an overview of both where we have been in our thinking and where we are now, whilst remaining very aware that many major issues in the study of these precious rocks have not yet been resolved. I also wanted to do this in an easily digestible form. So throughout the book appear lists of theories, cartoons, and figures. Lists can be dull, but they can be read easily, used for reference, and they give an idea of real constraints that exist on some of our theories. I also wanted to collect together in one place as many literature references as possible, because many good ideas are becoming lost in the explosion in recent literature. I wonder how many of our new ideas are restatements of old ideas and I wonder how many good ideas were prematurely interred.

In addition to my NIPR hosts, I am grateful to a number of people for helping me assemble this book. Simon Mitton of Cambridge University Press persuaded me to finish what had become a decade-long project. Four anonymous reviewers gave me an objective perspective on what I was proposing to do that encouraged me to finish and helped me improve the project. The University of Arkansas has provided the means for me to achieve much that I have done, including this book. Hazel Sears helped in the mechanics of book assembly and proofed the final product. To them all my thanks, and I hope they feel I have justified their efforts.