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Impact Stratigraphy

The Italian Record

With 174 Figures

Springer

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This volume is dedicated to
Walter Alvarez and Jan Smit,
whose studies on the K/T boundary started it all.

Preface

In this volume, we hope to bring together a general introduction to the study of impact structures and ejecta deposits, and a detailed description of how and where to find such impact deposits (for example, in the form of so-called impactoclastic layers) in the field. The marine sedimentary rocks of the Umbria-Marche (U-M) basin in Italy provide a remarkably complete and continuous stratigraphic record from the Late Triassic to the Pleistocene. Several major impact events happened during this time period, and the signatures of these impact events can be recognized in the field in the U-M sequence. It was in this region of Italy, near the town of Gubbio, where, in 1979, a team of researchers from Berkeley discovered extraterrestrial signal in the Cretaceous-Tertiary (K/T) boundary layer. It was this discovery that led to the hypothesis that the major extinction event, which occurred at the end of the Cretaceous, was caused by the impact of an asteroid or comet on Earth. The resulting vigorous scientific debate gave great publicity (not only among geoscientists) to impact research, which had been pursued for several decades by planetary geologists, cosmochemists, and mineralogists/petrologists who were interested in shock metamorphism.

The wider geological community had not been aware of their work, which led to misunderstandings and heated debates that could have been avoided if the data and evidence on impact research would have been more widely known. The last two decades have seen great progress. The findings of shocked minerals at the K/T boundary and the identification of the (buried) Chicxulub impact structure in Mexico as the K/T source crater led to a wide acceptance of the reality of an impact event at the K/T boundary among researchers. Nevertheless, no textbook is currently available that reviews impact processes and their deposits, and how to find them in the field. We hope that the present book will help to fill this gap.

The impetus for writing the present volume came from two different sources. First, an enormous amount of studies has been done over many decades on the U-M sequence (including work by one of us [A.M.], impact-related or not), and nowhere was this work summarized or discussed, especially with respect to the well-preserved impact signatures in this record. Second, in 1998, the European Science Foundation (ESF) launched a new scientific program on "Response of the Earth System to Impact Processes" (IMPACT), with one of us (C.K.) being the chairman of this program, and one of the first activities within the IMPACT program was the organization of a (probably annual) short course on "Impact Stratigraphy" in Coldigioco, to study the impact record of the U-M sequence. The idea of this book grew out of the need to produce course notes for this class, which

was held for the first time in May 1999. The present volume is the result of a year-long gestation period following the preparation of this course.

The book is organized in two major parts and several chapters. Chaps. 1–3 set the stage on impact cratering and provide background information on the study of shock metamorphism, impact ejecta, and descriptions of distal ejecta from around the world. Chap. 4 introduces the geology of the Umbria-Marque sequence, and Chap. 5 gives detailed descriptions of the rock units in the U-M sequence, especially of those that have been found to contain impactoclastic layers. Chap. 6 discusses a few pertinent sampling and analysis techniques. Detailed location and outcrop maps and photographs should allow the reader or student to locate the discussed layers in the field. Almost all locations are easily accessible. Thus, the book will hopefully serve as both, an introduction into impact stratigraphy, and a field guidebook.

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