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BOOK REVIEW

THE PHYSICS OF EXPLOSIVE VOLCANIC ERUPTIONS. Edited by J.S. Gilbert and R.S.J. Sparks. Geological Society, London, Special Publication No. 145, 1998. 186 p., £59.

A review, consisting of 8 papers with 120 illustrations, this book aims to present an outline of the editors' current understanding of several aspects of the physics of volcanic eruptions. The aspects covered include the physical characterization of silicic magma relevant to explosive volcanism, vesiculation of silicic magmas, conduit flow and fragmentation, gas loss from magmas during eruption, observations and models of eruption columns, tephra dispersal, pyroclastic density currents, and future research directions. By no means a complete outline nor one that reflects all important issues regarding explosive volcanic eruption physics, the papers in this book reflect the research interests of the group of writers chosen for this review. As such there is a notable bias towards eruption of silicic magmas, which is fair considering that these magmas are perhaps the most common in explosive magmatic eruptions. Readers will find this book to be a useful guide to issues that have been recent topics of considerable attention in volcano physics. Because of the generous citation of background research, each paper in itself is an excellent starting point for students and professionals to rapidly grasp the salient topics, those that have experimental and theoretical as well as observational basis for discussion.

The book begins with a discussion of future research directions in the physics of explosive volcanic eruptions by the editors, J.S. Gilbert and R.S.J. Sparks. The authors present a useful table outlining research topics and important problems to solve. They address these research topics with respect to material properties and parameters, the contributions of theoretical and computer modeling, dynamical system experimentation, and seismicity. This introductory paper reflects a point of view about computer modeling that once dominated other disciplines (e.g., mechanical engineering, atmospheric sciences, and geophysics), a stance that such modeling is to be viewed with skepticism. If volcanology follows the evolution of other disciplines, then researchers will eventually regard computer modeling on equal grounds with more traditional research approaches. Still, it is to the authors' credit that they recognize the contributions of this burgeoning research technique. In citation of experiments, a notable deficiency is present: little mention of dynamical experiments on the interaction of magma with water (*fuel-coolant interaction*). In many cases, the interaction of magma with water dominates the physical processes that govern eruption behavior, both physically and chemically. As such, this book would have benefited greatly form a paper(s) covering observations, theory, and ongoing experiments in this area.

One of the most complete reviews contained in this book is the paper by D. Dingwell on the physical description of silicic magma and experimental progress. Readers will find this paper extremely useful as a quick reference for the physical properties of magma, including rheological, thermodynamic, and mechanical properties. The subject matter has considerable interdisciplinary interest for geophysicists and geochemists. As much as glass is an interest to mineralogists, this paper focuses on its character with changing physical and chemical conditions but only discusses molecular diffusion in glass with respect to eruption-relevant water.

Vesiculation is perhaps one of the most notable processes in eruption of silicic magmas, and the paper by O. Navon and V. Lyakhovshky presents a concise review that takes the reader through the evolution of gas bubbles from the stage of supersaturation through nucleation, growth, and coalescence. While the topic of supersaturation is treated very sparsely, this paper is noteworthy in that it clearly presents classical nucleation and bubble-growth theory, but little experimental evidence is cited, perhaps reflecting its relative dearth. With respect to bubble coalescence, the authors discuss the formation and deformation of foams in terms of characteristic times for melt-film failure and restoration of bubble sphericity, properties applicable to textural features but as of yet poorly linked to eruption processes.

Conduit flow and fragmentation, discussed by H. Mader, emphasizes vesiculation, which the author correlates most closely with composition and viscosity but not with discharge rate, a correlation that seems to contradict the thesis of the following paper about gas loss from magma through conduit walls. Theoretical considerations focus on moments of the bubble size-distribution function and methods for interpretation. Following a review of conduit flow models and the unanswered problem of whether fragmentation is of a brittle or ductile type, the author reviews the application of shock-tube experiments to study of conduit flow and fragmentation. The chapter may leave one with the belief that the topic is still beyond grasp.

The dominating control of volatile content on explosive eruption has been strongly debated in recent years. In discussion of gas loss from magmas through conduit walls during eruption, C. Jaupart elegantly reviews observational, textural, petrologic, and isotopic evidence that supports the contention that gas loss, sensitive to eruption rate and chamber pressure, determines whether an eruption will be explosive or not. The

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author shows that *open-system* degassing is promoted by the fractured nature of conduit walls and that textural features such as microlites and obsidian clasts provide important clues to the nature of gas evolution during eruption.

Eruption columns provide a wealth of information from direct and remote observation as well as the deposits of tephra they produce. Summarizing recent observations and field measurements, A. Woods summarizes theoretical models, based largely on the theory of turbulent buoyant plumes, that address column height and structure with considerations of the effects of surface water and craters. This paper also briefly reviews experimental and numerical models of eruption columns. The brevity of this paper understates the extensive literature available on these subjects, and readers may not recognize that this topic is perhaps the most studied of any presented in this book.

Following a logical progression, the next paper by M. Bursik gives a very thorough review of tephra dispersal, discussing the important controls of pyroclast settling speed and atmospheric turbulent advection-diffusion. A theory for proximal dispersal of the eruption column, umbrella cloud, plumes and their downwind development, and pyroclast fallout is developed and shown to be robust and well supported by field measurements. On the other hand, the transition from proximal dispersal by the plume to distal transport by the atmosphere is poorly understood, but the author does a remarkable job of integrating the approaches used by atmospheric scientists to show how downwind trajectories can be calculated and monitored.

The final paper in this book deals with the most destructive feature of explosive eruptions, pyroclastic density currents. The physics of these currents is still undeveloped by volcanologists, so the author, T. Druitt, focuses mainly on characterizing their complex nature, a characterization that suggests several theoretical approaches, including the theories of high-speed multiphase flow, stratified flow, and sedimentological flow regime. What the paper lacks in physics is greatly overshadowed by the richness of descriptions given, making the paper stand out from the others in this book as perhaps the most readable.

Overall, this may be the first book a student or professional will grab from the shelf when a quick study on explosive eruption physics is needed. A similar book, entitled *From Magma to Tephra, Modelling Physical Processes of Explosive Volcanic Eruptions*, edited by A. Freundt and M. Rosi and recently published by Elsevier (ISBN 0-444-82959-8), focuses more on large-scale processes of explosive eruptions and thus is a complimentary text. The strength of this present book lies in its review format and citation of experimental data. Much of the theory discussed will no doubt evolve quickly over the next decade and some will be completely replaced.

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