

## Preface

This book is intended as a reference book for advanced graduate students and research engineers in shale gas development or rock mechanical engineering. Globally, there is widespread interest in exploiting shale gas resources to meet rising energy demands, maintain energy security and stability in supply and reduce dependence on higher carbon sources of energy, namely coal and oil. However, extracting shale gas is a resource intensive process and is dependent on the geological and geomechanical characteristics of the source rocks, making the development of certain formations uneconomic using current technologies. Therefore, evaluation of the physical and mechanical properties of shale, together with technological advancements, is critical in verifying the economic viability of such formation. Accurate geomechanical information about the rock and its variation through the shale is important since stresses along the wellbore can control fracture initiation and frac development. In addition, hydraulic fracturing has been widely employed to enhance the production of oil and gas from underground reservoirs. Hydraulic fracturing is a complex operation in which the fluid is pumped at a high pressure into a selected section of the wellbore. The interaction between the hydraulic fractures and natural fractures is the key to fracturing effectiveness prediction and high gas development. The development and growth of a hydraulic fracture through the natural fracture systems of shale is probably more complex than can be described here, but may be somewhat predictable if the fracture system and the development of stresses can be explained. As a result, comprehensive shale geomechanical experiments, physical modeling experiment and numerical investigations should be conducted to reveal the fracturing mechanical behaviors of shale.

The book is divided into three parts. The first part, Chapters One, Two, Three and four, concerns the geomechanical properties of shale subjected to different stress paths, including uniaxial compression, triaxial compression and indirect tension. The macroscopic and mesoscopic fracturing behaviors of Longmaxi shale are investigated in detail. The second part, Chapters Five and Six, concerns the effects of natural fracture on hydraulic fracturing, the interaction between

the natural fractures and hydraulic fractures, and the optimism of multiple hydraulic parameters on fracturing effectiveness. The studies of these two chapters are focused on the mechanics of hydraulic fracturing from the laboratory scale. The third part of the book, Chapter Seven, applies the result from important experiments conducted in laboratories. The hydraulic fracturing technique was used to a Longmaxi shale formation and silty laminae shales in China. Effort has been made to include a list of comprehensive literature citations in each chapter. However, it is impractical to list all available literature. I apologize sincerely for any omissions.

I am fortunate for having the opportunity to work with a group of excellent scholars, Prof. X. Li, C. H. Li, B. Zhang, Z. H. Zhao, T. Q. Mao, B. Zheng. In fact, most of the materials presented in this book are collections from my published papers. I wish to acknowledge Prof. C. A. Tang from the Dalian University of Technology to provide me the RPFA-FLOW software. I wish to acknowledge the support and guidance of my friends, Drs. It was Prof. X. Li who introduced me to gas shale geomechanics study when I was a doctoral student when I was in Institute of Geology and Geophysics, Chinese Academy of Sciences.

As mentioned at the beginning, the book is intended as a reference book and not as a text. Thus, the description of phenomena and derivation of equations may not be in depth or in detail as the reader may wish. However, if the reader obtains a clear picture and understanding of the shale geomechanics and mechanics of hydraulic fracturing, I would consider the book a success. It is my sincere hope that this book may inspire further research and development into this fascinating subject.

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