Preface

In recent years, the increasing demand for oil and gas resources has driven the rapid advancement of oil and gas exploitation technologies. Consequently, the focus of oil and gas field development has shifted from easily accessible medium to high-quality reservoirs towards more challenging low-quality reservoirs.

China is endowed with abundant low permeability and tight sandstone oil and gas resources. Significant discoveries have been made in various basins across the country. Notably, the Cretaceous Qingshankou-Quantou Formation in the Songliao Basin, Xujiahe Formation in the Sichuan Basin, He 8 Member of the Permian Shihezi Formation in the Ordos Basin, Permian Lucaogou Formation in the Junggar Basin, and Bashijiqike Formation in the Tarim Basin are among the important reservoirs holding promising potential. These low permeability and tight sandstone resources serve as realistic alternatives for China's future energy requirements. As conventional reserves decline, these unconventional resources become increasingly vital for sustaining the country's energy needs. Emphasizing their exploration and development will contribute to achieving energy self-sufficiency and promoting the long-term energy security of China.

Low permeability and tight sandstone reservoirs exhibit distinct characteristics, including significant compaction, low porosity and permeability parameters, a high ratio of micropore throats, and pronounced heterogeneity. These reservoirs deviate from the conventional seepage mechanism governed by Darcy's law. Consequently, the exploitation of hydrocarbons in such reservoirs faces challenges like low production rates, rapid decline in production, and low recovery efficiency. To address these challenges effectively, it is crucial to thoroughly understand the unique characteristics of low permeability and tight reservoirs and formulate development technology policies accordingly. By doing so, several key objectives can be achieved.

This book focuses on the study of low permeability and tight sandstone reservoirs within fluvial delta facies found in the Ordos Basin, Songliao Basin, and Sichuan Basin. It systematically examines the superimposed patterns, geometric forms, and scale characteristics of sedimentary sand bodies within the fluvial delta system. Additionally, it analyzes the impact of seepage barriers such as interlayers and closed faults on fluid flow. The book establishes a sedimentary model for sand bodies in typical sedimentary environments, considering the

differences in separation and connectivity caused by the shape, scale, direction, and spatial overlap of different reservoir units and seepage barriers. It investigates the mechanisms of fluid flow controlled by interlayer, plane, and intralayer heterogeneity to understand the fluid flow within the reservoir architecture unit affected by different flow types. To evaluate the fluid properties in low permeability and tight sandstone reservoirs, the book proposes fluid characteristic identification standards using lateral to induced resistivity ratio, transverse to transverse wave velocity ratio, and resistivity to porosity intersection. It identifies the distribution characteristics of different types of fluid and determines the main controlling factors of fluid distribution while verifying the quantitative scale and heterogeneity of effective reservoirs. Using multidisciplinary knowledge from geology, mathematics, and computer science, the book establishes 3D geological models of underground oil and gas reservoirs. These models characterize the dynamic changes occurring in the reservoirs, providing a basis for developing oil and gas reservoir development plans and exploring remaining reserves. By analyzing the production characteristics of single wells in typical low permeability and tight gas reservoirs in China, the book selects a scientific and reasonable development method. Through the analogy of experience and economic evaluation, it determines an appropriate development pace for low permeability and tight oil and gas reservoirs and formulates a scientifically sound production system. The book also aims to elucidate the production decline patterns of single wells, blocks, and entire oil and gas reservoirs. Selecting stable production replacement modes and establishing a reasonable development strategy can maximize the development life of low permeability and tight oil and gas reservoirs while improving development outcomes.

It is important to acknowledge that the river-delta depositional system is complex and diverse, with various types of rivers and deltas. While there are many similar research methods that can be applied to different types, it is crucial to focus on new research methods and approaches in order to provide valuable insights. Given the limitations of space and the need to avoid redundant repetition, it was not possible to fully cover the same research content for different types of rivers and deltas. This limitation is acknowledged, and the readers' understanding is appreciated. Furthermore, despite differences in fluid properties and development processes observed among reservoirs within fluvial delta systems with low permeability and tight formations, there are significant similarities in reservoir characteristics and formation mechanisms. As a result, the study process does not completely segregate these aspects but considers them together due to their interconnected nature. By recognizing both the complexity and similarities within the field of study, this book aims to provide val-

uable knowledge and understanding of low permeability and tight sandstone reservoirs in fluvial delta systems.

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However, it is important to acknowledge that despite the author’s best efforts, there may be certain areas within the book that require improvement. Therefore, the author humbly invites experts and readers to provide valuable criticism and corrections, which will greatly contribute to enhancing the book’s quality and accuracy.