ABNORMAL PRESSURES IN HYDROCARBON ENVIRONMENTS

Edited by

B.E. Law
G.F. Ulmishek
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ABNORMAL
PRESSURES
IN
HYDROCARBON
ENVIRONMENTS

An outgrowth of the AAPG Hedberg Research Conference
Golden, Colorado, June 8–10, 1994

Edited by
Ben E. Law
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AAPG MEMOIR 70

Published by:
The American Association of Petroleum Geologists
Tulsa, Oklahoma, U.S.A.
Printed in the U.S.A.
AAPG wishes to thank the following for their generous support to:

*Abnormal Pressures in Hydrocarbon Environments*

**Hydrocarbon Management International, Ltd.**

Contributions are applied against the production costs of publication, thus directly reducing the book's purchase price and making the volume available to a greater audience.
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ABOUT THE EDITORS

Ben E. Law was born in Drain, Oregon. He earned B.Sc. and M.Sc. degrees in geology from San Diego State University. Ben has had an interest in abnormal pressures since his employment with Texaco, Inc. in 1969–1971, as an exploration geologist in the Rocky Mountain region. He has been employed with the U.S. Geological Survey since 1971. His interest in abnormal pressures became more focused in 1977 when he became involved in research on low-permeability gas reservoirs. Ben has written several papers on abnormal pressures, particularly in unconventional gas reservoirs, and is currently involved in abnormal pressure studies in the Appalachian Basin, the Timan-Pechora Basin of Russia, and the Dnieper-Donets Basin of Ukraine. He is the Regional Coordinator for South Asia in the USGS World Energy Program. Ben was co-editor of AAPG Studies in Geology No. 38, Hydrocarbons from Coal, and co-convenor of the AAPG 1994 Hedberg Research Conference on Abnormal Pressures in Hydrocarbon Environments.

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PREFACE

This book had its beginnings during an AAPG Hedberg Research Conference entitled “Abnormal Pressures in Hydrocarbon Environments” convened June 8–10, 1994, in Golden, Colorado. During the conference geoscientists from 18 countries presented papers on different aspects of abnormal pressure. It became apparent that there were very diverse opinions concerning the nature and integrity of pressure seals, causal mechanisms, transient nature of pressure systems, the global distribution of abnormal pressures, pressure modeling, detection of abnormal pressuring, drilling and completion techniques in abnormal pressure environments, and the association of abnormal pressures with hydrocarbon accumulations.

The subject of abnormal pressures encompasses a wide spectrum of topics, and an attempt to cover all aspects of abnormal pressure in a single volume would be woefully inadequate. Therefore, in an attempt to narrow the scope and provide new information, this book focuses on abnormal pressures in hydrocarbon environments. More specifically, the objectives are to provide information concerning the global distribution of abnormal pressures in petroleum provinces, relate occurrences of abnormal pressures to hydrocarbon accumulations, provide an overview of the causal mechanisms of abnormal pressures, bring into question some long-held pressure paradigms, and provide examples from a few select regions in the world of the utilization of abnormal pressures in the exploration for hydrocarbons. We are aware that we will have offended some individuals by omitting some aspects of abnormal pressure that they consider to be of extreme importance, such as abnormal pressures caused by hydraulic head.

Abnormal pressures, pressures above or below hydrostatic pressures, have been the subject of investigation for many decades. The first description of abnormal pressure known to us was by Gulishambarov in 1878. He described oil fountains (geysers) and discussed abnormally high pressures in the Balakhany oil field near Baku, Azerbaijan. We are uncertain when the first study on abnormal pressures in the western world was published. However, the work of Dickinson (1953) in the U.S. Gulf Coast initiated an era of investigation of abnormal pressure that has continued to this day. In the 1950s in the former Soviet Union there was also a surge of investigations of abnormal pressure coinciding with an increase in the number of deeply drilled wells. In China, studies of abnormal pressure were largely introduced from western countries in the late 1970s.

As a consequence of the wide interest in abnormal pressures, there has been a large number of comprehensive works on abnormal pressures. Some of the more notable overview publications in western countries include those by Fertl (1976), Fertl et al. (1994), Hall (1993), Mouchet and Mitchell (1989), and Sahay et al (1988). In the former Soviet Union, the more significant publications on abnormal pressure include those by Aleksandrov (1987), Anikeev (1964, 1971), Buryakovskiy, Dzhevanshir, and Alnyarov (1986), Dobrynin and Serebryakov (1978, 1989), Kucheruk and Lyustikh (1986), Slavin, Sheverdyayev, and Khimich (1987), and Zkhus and Bakhtin (1979).

The early investigations of abnormal pressure in North America were driven by a concern for drilling and completion problems in abnormally overpressured rocks. During that time some of the earlier proposals for the cause of abnormal pressure included tectonics, mineral transformations, and hydraulic head. While these mechanisms are still important, compaction disequilibrium and hydrocarbon generation have gained prominence within the last 20 years. It is now quite apparent that many of the processes involved in the generation, expulsion, migration, entrapment, and preservation of hydrocarbons are, in some cases, the same processes involved in the development of abnormal pressure. Therefore, knowledge of the processes involved in the development of abnormal pressure may also be used as a hydrocarbon exploration tool.
Although our knowledge of pressure systems has considerably advanced during the last 20 years, there remains much work to be done. In our view, problems that warrant additional study include causal mechanisms of abnormally underpressured systems, the nature and integrity of pressure seals, dynamic vs. static pressure systems, the transient nature of pressure systems, the prediction of abnormal pressures, and the application of abnormal pressures to the exploration for hydrocarbons.

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