# COASTAL SYSTEMS AND CONTINENTAL MARGINS

# Natural Gas Hydrate

in Oceanic and Permafrost Environments

Edited by Michael D. Max



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# Natural Gas Hydrate In Oceanic And Permafrost Environments

M D Max

#### **Natural Gas Hydrate In Oceanic And Permafrost Environments:**

Natural Gas Hydrate M.D. Max,2012-12-06 1 THE BEGINNINGS OF HYDRATE RESEARCH Until very recently our understanding of hydrate in the natural environment and its impact on seafloor stability its importance as a sequester of methane and its potential as an important mechanism in the Earth's climate change system was masked by our lack of appreciation of the vastness of the hydrate resource Only a few publications on naturally occurring hydrate existed prior to 1975 The first published reference to oceanic gas hydrate Bryan and Markl 1966 and the first publication in the scientific literature Stoll et al 1971 show how recently it has been since the topic of naturally occurring hydrate has been raised Recently however the number of hydrate publications has increased substantially reflecting increased research into hydrate topics and the initiation of funding to support the researchers Awareness of the existence of naturally occurring gas hydrate now has spread beyond the few scientific enthusiasts who pursued knowledge about the elusive hydrate because of simple interest and lurking suspicions that hydrate would prove to be an important topic The first national conference on gas hydrate in the U S was held as recently as April 1991 at the U S National Center of the U s Geological Survey in Reston Virginia Max et al 1991 The meeting was co hosted by the U s Geological Survey the Naval Research Laboratory and the U S

Natural Gas Hydrate in Oceanic and Permafrost Environments M D Max, 2000-11-30 **Exploration and Production** of Oceanic Natural Gas Hydrate Michael D. Max, Arthur H. Johnson, 2018-10-24 This second edition provides extensive information on the attributes of the Natural Gas Hydrate NGH system highlighting opportunities for the innovative use and modification of existing technologies as well as new approaches and technologies that have the potential to dramatically lower the cost of NGH exploration and production Above all the book compares the physical environmental and commercial aspects of the NGH system with those of other gas resources It subsequently argues and demonstrates that natural gas can provide the least expensive energy during the transition to and possibly within a renewable energy future and that NGH poses the lowest environmental risk of all gas resources Intended as a non mathematical descriptive text that should be understandable to non specialists as well as to engineers concerned with the physical characteristics of NGH reservoirs and their production the book is written for readers at the university graduate level It offers a valuable reference guide for environmentalists and the energy community and includes discussions that will be of great interest to energy industry professionals legislators administrators regulators and all those concerned with energy options and their respective Natural Gas Hydrate - Arctic Ocean Deepwater Resource Potential Michael D. Max, Arthur advantages and disadvantages H. Johnson, William P. Dillon, 2013-10-11 The book is an up to date basic reference for natural gas hydrate NGH in the Arctic Ocean Geographical geological environmental energy new technology and regulatory matters are discussed The book should be of interest to general readers and scientists and students as well as industry and government agencies concerned with energy and ocean management NGH is a solid crystalline material that compresses gas by about a factor of about 164 during

crystallization from natural gas mainly methane rich pore waters over time NGH displaces water and may form large concentrations in sediment pore space Its formation introduces changes in the geotechnical character of host sediment that allows it to be distinguished by seismic and electric exploration methods. The chemical reaction that forms NGH from gas and water molecules is highly reversible which allows controlled conversion of the NGH to its constituent gas and water This can be achieved rapidly by one of a number of processes including heating depressurization inhibitor injection dissolution and molecular replacement The produced gas has the potential to make NGH a valuable unconventional natural gas resource and perhaps the largest on earth Estimates for NGH distribution concentration economic targets and volumes in the Arctic Ocean have been carried out by restricting the economic target to deepwater turbidite sands which are also sediment hosts for more deeply buried conventional hydrocarbon deposits Resource base estimates are based on NGH petroleum system analysis approach using industry standard parameters along with analogs from three relatively well known examples Nankai Japan Gulf of Mexico United States and Arctic permafrost hydrate Drilling data has substantiated new geotechnical level seismic analysis techniques for estimating not just the presence of NGH but prospect volumes In addition to a volumetric estimate for NGH having economic potential a sedimentary depositional model is proposed to aid exploration in the five different regions around the deep central Arctic Ocean basin Related topics are also discussed Transport and logistics for NGH may also be applicable for stranded conventional gas and oil deposits Arising from a discussion of new technology and methodologies that could be applied to developing NGH suggestions are made for the lowering of exploration and capital expenses that could make NGH competitive on a produced cost basis The basis for the extraordinarily low environmental risk for exploration and production of NGH is discussed especially with respect to the environmentally fragile Arctic region It is suggested that because of the low environmental risk special regulations could be written that would provide a framework **Economic Geology of Natural Gas Hydrate** Michael D. Max, Arthur H. for very low cost and safe development Johnson, William P. Dillon, 2006-07-09 This book is a companion to Natural Gas Hydrate in Oceanic and Permafrost Environments Max 2000 2003 which is the first book on gas hydrate in this series Although other gases can naturally form clathrate hydrates referred to after as hydrate we are concerned here only with hydrocarbon gases that form hydrates The most important of these natural gases is methane Whereas the first book is a general introduction to the subject of natural gas hydrate this book focuses on the geology and geochemical controls of gas hydrate development and on gas extraction from naturally occurring hydrocarbon hydrates This is the first broad treatment of gas hydrate as a natural resource within an economic geological framework This book is written mainly to stand alone for brevity and to minimize duplication Information in Max 2000 2003 should also be consulted for completeness Hydrate is a type of clathrate Sloan 1998 that is formed from a cage structure of water molecules in which gas molecules occupying void sites within the cages stabilize the structure through van der Waals or hydrogen bonding Oceanic Methane Hydrates Lin Chen, Sukru Merey, 2021-01-10

Methane hydrates are still a complicated target for today s oil and gas offshore engineers particularly the lack of reliable real field test data or obtaining the most recent technology available on the feasibility and challenges surrounding the extraction of methane hydrates Oceanic Methane Hydrates delivers the solid foundation as well as today s advances and challenges that remain Starting with the fundamental knowledge on gas hydrates the authors define the origin estimations and known exploration and production methods Historical and current oil and gas fields and roadmaps containing methane hydrates around the world are also covered to help lay the foundation for the early career engineer Lab experiments and advancements in numerical reservoir simulations transition the engineer from research to practice with real field core sampling techniques covered points on how to choose producible methane hydrate reservoirs and the importance of emerging technologies Actual comparable onshore tests from around the world are included to help the engineer gain clarity on field expectations Rounding out the reference are emerging technologies in all facets of the business including well completion and monitoring economics aspects to consider and environmental challenges particularly methods to reduce the costs of methane hydrate exploration and production techniques Rounding out a look at future trends Oceanic Methane Hydrates covers both the basics and advances needed for today s engineers to gain the required knowledge needed to tackle this challenging and exciting future energy source Understand real data and practice examples covering the newest developments of methane hydrate from chemical reservoir modelling and production testing Gain worldwide coverage and analysis of the most recent extraction production tests Cover the full range of emerging technologies and environmental sustainability including current regulations and policy outlook **Sediment-hosted Gas Hydrates** D. Long, 2009 There is much interest in gas hydrates in relation to their potential role as an important driver for climate change and as a major new energy source however many questions remain not least the size of the global hydrate budget Much of the current uncertainty centres on how hydrates are physically stored in sediments at a range of scales This volume details advances in our understanding of sediment hosted hydrates and contains papers covering a range of studies of real and artificial sediments containing both methane hydrates and CO2 hydrates The papers include an examination of the techniques used to locate sample and characterize hydrates from natural methane rich systems so as to understand them better Other contributions consider the nature and stability of synthetic hydrates formed in the laboratory which in turn improve our ability to make accurate predictive models <u>Exploration of Gas Hydrates</u> Naresh Kumar Thakur, Sanjeev Rajput, 2010-10-08 Gas hydrates are ice like crystalline substances that form a rigid cage of water molecules and entrap hydrocarbon and non hydrocarbon gas by hydrogen bonding Natural gas hydrate is primarily composed of water and methane These are solid crystalline ice like substances found in permafrost areas and deepwater basins around the world They naturally occur in the pore space of marine sediments where appropriate high pressure and low temperature conditions exist in an adequate supply of gas mainly methane Gas hydrates are considered as a potential non conventional energy resource Methane hydrates are

also recognized as an influence on offshore platform stability a major factor in climate change contributing to global warming and a significant contribution to the ocean carbon cycle The proposed book treats various geophysical techniques in order to quantify the gas hydrate reserves and their impact on environment The primary goal of this book is to provide the state of art for gas hydrate exploration The target audiences for this book are non specialist from different branches of science graduate students and researchers Natural Gas Hydrates Timothy S. Collett, Art Johnson, Camelia C. Knapp, Ray Boswell, 2010-01-14 Hardcover plus CD Charting the Future of Methane Hydrate Research in the United States National Research Council, Division on Earth and Life Studies, Board on Earth Sciences and Resources, Ocean Studies Board, Committee to Review the Activities Authorized Under the Methane Hydrate Research and Development Act of 2000,2004-11-14 Methane hydrate is a natural form of clathrate a chemical substance in which one molecule forms a lattice around a guest molecule with chemical bonding In this clathrate the guest molecule is methane and the lattice is formed by water to form an ice like solid Methane hydrate has become the focus of international attention because of the vast potential for human use worldwide If methane can be produced from hydrate a reasonable assumption given that there are no obvious technical or engineering roadblocks to commercial production the nation's natural gas energy supply could be extended for many years to come This report reviews the Department of Energy's DOE Methane Hydrate Research and Development Program the project selection process and projects funded to date It makes recommendations on how the DOE program could be improved Key recommendations include focusing DOE program emphasis and research in 7 priority areas incorporating greater scientific oversight in the selection initiation monitoring and assessment of major projects funded by the DOE strengthening DOE s contribution to education and training through funding of fellowships and providing project applicants with a set of instructions and guidelines outlining requirements for timely and full disclosure of project results and consequences of noncompliance Clathrate Hydrates of Natural Gases E. Dendy Sloan Jr., Carolyn A. Koh, 2007-09-07 Hydrate research has expanded substantially over the past decade resulting in more than 4 000 hydrate related publications Collating this vast amount of information into one source Clathrate Hydrates of Natural Gases Third Edition presents a thoroughly updated authoritative and comprehensive description of all major aspects of natural gas cla Chemical Thermodynamics for Industry Trevor M Letcher, 2007-10-31 Chemical Thermodynamics for Industry presents the latest developments in applied thermodynamics and highlights the role of thermodynamics in the chemical industry Written by leading experts in the field Chemical Thermodynamics for Industry covers the latest developments in traditional areas such as calorimetry microcalorimetry transport properties crystallization adsorption electrolyte systems and transport fuels It highlights newly established areas such as multiphase modeling reactive distillation non equilibrium thermodynamics and spectro calorimetry It also explores new ways of treating old technologies as well as new and potentially important areas such as ionic liquids new materials ab initia quantum chemistry nano particles polymer recycling clathrates and the economic value of applied

thermodynamics This book is aimed not only at those working in a specific area of chemical thermodynamics but also at the general chemist the prospective researcher and those involved in funding chemical research **Advances in Natural Gas Technology** Hamid Al-Megren, 2012-04-11 Natural gas is a vital component of the world's supply of energy and an important source of many bulk chemicals and speciality chemicals It is one of the cleanest safest and most useful of all energy sources and helps to meet the world's rising demand for cleaner energy into the future However exploring producing and bringing gas to the user or converting gas into desired chemicals is a systematical engineering project and every step requires thorough understanding of gas and the surrounding environment Any advances in the process link could make a step change in gas industry. There have been increasing efforts in gas industry in recent years. With state of the art contributions by leading experts in the field this book addressed the technology advances in natural gas industry **Arctic** Mark Nuttall, 2005-09-23 With detailed essays on the Arctic's environment wildlife climate history exploration resources economics politics indigenous cultures and languages conservation initiatives and more this Encyclopedia is the only major work and comprehensive reference on this vast complex changing and increasingly important part of the globe Including 305 maps This Encyclopedia is not only an interdisciplinary work of reference for all those involved in teaching or researching Arctic issues but a fascinating and comprehensive resource for residents of the Arctic and all those concerned with global environmental issues sustainability science and human interactions with the environment Geological Controls for Gas Hydrates and Unconventionals Sanjeev Rajput, Naresh Kumar Thakur, 2016-04-27 Geological Controls for Gas Hydrate Formations and Unconventionals tells the story of unconventional hydrocarbon resources especially gas hydrates tight gas shale gas liquid rich shale and shale oil to future generations. It presents the most current research in unconventionals covering structural constituents of continental margins and their role in generating hydrocarbons Additionally this book answers basic questions regarding quantifications and characterizations distributions modes of occurrence physical and chemical properties and more in essence all the information that is necessary to improve the models for precision prediction of the enigma of gas hydrates and other unconventionals Blending geology geophysics geomechanics petrophysics and reservoir engineering it explains in simple language the scientific concepts that are necessary to develop geological and reservoir models for unconventionals Serving as a focal point for geoscientists and engineers conducting research that focuses on reservoir characteristics of unconventionals Geological Controls for Gas Hydrate Formations and Unconventionals is a useful resource for a variety of other specialiststies including physicists geochemists exploration geologists and petroleum and reservoir engineers It details the key factors for successful exploration and development of unconventional reservoirs including discovery data evaluation full field development production and abandonment along with a vivid description of the worldwide occurrence of unconventional hydrocarbons Includes a range of datasets that provide detailed workflows for geological modeling Presents theoretical and real data analysis from different parts of the world

making its content practical and implementable in a range of gas hydrate exploration and extraction scenarios Features more than 200 figures and illustrations to highlight key concepts **Fundamentals of Materials for Energy and** Environmental Sustainability David S. Ginley, David Cahen, 2011-11-30 How will we meet rising energy demands What are our options Are there viable long term solutions for the future Learn the fundamental physical chemical and materials science at the heart of renewable non renewable energy sources future transportation systems energy efficiency and energy storage Whether you are a student taking an energy course or a newcomer to the field this textbook will help you understand critical relationships between the environment energy and sustainability Leading experts provide comprehensive coverage of each topic bringing together diverse subject matter by integrating theory with engaging insights Each chapter includes helpful features to aid understanding including a historical overview to provide context suggested further reading and questions for discussion Every subject is beautifully illustrated and brought to life with full color images and color coded sections for easy browsing making this a complete educational package Fundamentals of Materials for Energy and Environmental Sustainability will enable today s scientists and educate future generations Giavarini, Keith Hester, 2011-09-06 Gas hydrates are both a huge energy resource and an environmental challenge They have a significant impact on society because of their applications to the future of energy protection of the environment and fuel transportation Gas Hydrates opens up this fascinating multidisciplinary field to non specialists It provides a scientific study of gas hydrates that considers their potential as an energy source while assessing the possible risk to the environment The authors also examine the feasibility of using these natural compounds for storing and transporting gases such as methane and carbon dioxide Diagrams and photos are used throughout Gas Hydrates to help readers understand the scientific and technical content Each section has been designed so it can be read independently by academics and professionals in the oil and gas industry as well as by all those with an interest in how hydrates combine to be an energy resource an industrial challange and a geological hazard Marine Policy and Economics Porter Hoagland, John H. Steele, Steve A. Thorpe, 2010 This title is an important reference on current knowledge and expertise in one convenient and accessible source The selected articles all written by experts in their field fall into several categories Investigating Seafloors and Oceans Antony Joseph, 2016-12-08 Investigating Seafloors and Oceans From Mud Volcanoes to Giant Squid offers a bottom to top tour of the world's oceans exposing the secrets hidden therein from a variety of scientific perspectives Opening with a discussion of the earth's formation hot spots ridges plate tectonics submarine trenches and cold seeps the text goes on to address such topics as the role of oceans in the origin of life tidal bore thermal effects ecosystem services marine creatures and nutraceutical and pharmaceutical resources This unique reference provides insight into a wide array of questions that researchers continue to ask about the vast study of oceans and the seafloor It is a one of a kind examination of oceans that offers important perspectives for researchers practitioners and academics in all marine related fields Includes chapters addressing various

scientific disciplines offering the opportunity for readers to gain insights on diverse topics in the study of oceans Provides scientific discussion on thermo tolerant microbial life in sub seafloor hot sediments and vent fields as well as the origin of life debates and the puzzles revolving around how life originated Includes detailed information on the origin of dreaded episodes such as volcanic eruptions earthquakes tsunamis internal waves and tidal bores Contains information on the contribution of the oceans in terms of providing useful nutraceutical and pharmaceutical products *The Status of Natural Resources on the High-seas* Southampton Oceanography Centre, A. Charlotte De Fontaubert, International Union for Conservation of Nature and Natural Resources, 2001

Reviewing **Natural Gas Hydrate In Oceanic And Permafrost Environments**: Unlocking the Spellbinding Force of Linguistics

In a fast-paced world fueled by information and interconnectivity, the spellbinding force of linguistics has acquired newfound prominence. Its capacity to evoke emotions, stimulate contemplation, and stimulate metamorphosis is actually astonishing. Within the pages of "Natural Gas Hydrate In Oceanic And Permafrost Environments," an enthralling opus penned by a very acclaimed wordsmith, readers embark on an immersive expedition to unravel the intricate significance of language and its indelible imprint on our lives. Throughout this assessment, we shall delve into the book is central motifs, appraise its distinctive narrative style, and gauge its overarching influence on the minds of its readers.

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## Natural Gas Hydrate In Oceanic And Permafrost Environments Introduction

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