Deep Oil Spills

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Facts, Fate, and Effects

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Foreword and Dedication

Eric Brown, a British aircraft engineer, described structural engineering as "*the art of molding materials we do not really understand into shapes we cannot really analyze, so as to withstand forces we cannot really assess, in such a way that the public does not really suspect*" (quote from Broad 2010). There is much to learn from engineering failures regarding the fragility of such structures and systems (Love et al. 2011), no more so than those of oil rig blowouts such as *Deepwater Horizon* (DWH) and Ixtoc 1, the two largest accidental blowouts in world history.

While the forensics of engineering and systems failures in the *Deepwater Horizon* case are well documented (National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling 2011; Boebert and Blossom 2016), perhaps less well understood were the failures of regulators, legislative oversight, and science to anticipate, plan for, and understand the risks involved in such a catastrophic failure. Quantifiable risk is the product of both the probability of events happening and the consequences of such an event should it happen. In the case of deepwater blowouts, the event has an exceedingly low probability of occurrence but a very large potential consequence. A system subject to a critical single point of failure combined with the inability to contain the ensuing blowout for 87 days points to systematic breakdown in regulatory as well as industrial oversight systems for risk reduction. Doubtlessly, the oil and gas industries have learned from these spectacular engineering failures and put in place what they believe to be appropriate risk reduction measures. Similarly, additional government regulation, inspection, and oversight have been forthcoming.

The DWH event also clearly pointed out the dearth of scientific information necessary to make informed decisions once the blowout occurred, including deciding on appropriate response measures and calculating the impacts of that event in the milieu that is the Gulf of Mexico. Previous research was insufficient to confidently evaluate the risks and trade-offs of, for example, using chemical dispersants injected into the stream of oil and gas emanating from the blown-out well. Likewise, the lack of systematic contaminant baselines for nearly all biota and habitats in the Gulf of Mexico made assessing the damage from that disaster more difficult than it needed to be if such baselines had been available. The lack of specific information points to

a larger failure of science and science administration to adequately assess the risks involved in deepwater oil and gas production and to organize a research program of sufficient rigor and scope to have answers – or at least a plausibly narrow set of outcomes – that would guide such a response. The science necessary for informed decision-making regarding oil spills is well documented in the "wish lists" of government agencies (ICCOPR 2015), but the industry, various federal and state administrations, and government agencies were unable to muster the political will and resources to close these gaps.

Much changed in the funding and direction of oil spill-related research following DWH. Through a $500 million grant from BP (British Petroleum, for whom the Macondo well was being drilled), the Gulf of Mexico Research Initiative was established. This ambitious 10-year program has produced an enormous body of research spanning the physical, geological, chemical, engineering, biological, and human health sciences. Additionally, significant funding spent by the Natural Resources Damage Assessment (NRDA), the Gulf Restoration Council, and the National Academy of Sciences Gulf Research Program (GRP) is also contributing to the wealth of new science informing oil spill risk reduction, preparedness, and assessment. The scope of the research programs supported by these funds has been both broad and deep, with many of the fundamental uncertainties of what, how, and why of oil spill science being addressed. As with any science portfolio, the GoMRI-funded research spanned the theoretical to applied science continuum and that of high risk-high reward to incremental.

This volume synthesizes a considerable portion of GoMRI-sponsored research and that commissioned by government, industry, and other entities. Many of the chapter authors are members of the Center for Integrated Modeling and Analysis of Gulf Ecosystems (C-IMAGE) and a number of other GoMRI-funded science centers (ADDOMEx, ECOGIG, RECOVER). Additional authorship includes researchers working for the federal government, in academia, and in private industry. The goal of this book is to synthesize what has been learned from these research investments and to identify additional or as yet unanswered research questions going forward. Given the considerable wealth of new information generated during the 9 plus years after DWH, it is contingent on researchers and regulators to put this information into practical application. The challenge will be for the industry and regulators to assimilate and use this information to devise more risk-averse oil and gas exploration and exploitation strategies and to implement more agile, targeted, and effective response strategies in the event of future accidents. One of the particular barriers for more complete integration of new science into the current industrial regulatory frameworks supporting oil and gas production will be that much of the new, relevant research has been generated by academics not traditionally affiliated with industry or government. The aversion to research "not invented here" by those outside the historical institutional relationships supporting the industry is thus a concern. However, while academic scientists may not understand the history or details of industrial applications, science conducted by independent researchers has

the positive attribute of being unencumbered by dogma. New, more expansive, and more productive working relationships among the tripartite science community (industry-government-academia) need to be nurtured.

This volume is dedicated to our mentors, C-IMAGE colleagues, and friends Drs. John W. ("Wes") Tunnell, Jr., John E. Reynolds, and Benjamin ("Ben") Flower.

John W. ("Wes") Tunnell, Jr. Wes had many roles during his illustrious career in marine research, focusing on Gulf of Mexico studies. Working from his home institution at Texas A&M-Corpus Christi, Wes conducted wide-ranging and important studies of the natural history of the Gulf. As a young researcher, Wes was literally on the spot of the Ixtoc 1 oil well blowout in 1979–1980 along the Campeche coast of Mexico. His studies located oil deposition centers along the Campeche, Veracruz, and Tabasco coasts, northward to south Texas. He and his students and collaborators revisited these locations over the next 30 years. In 2016, the C-IMAGE-II consortium undertook the "Tunnell Trek" visiting these deposition locations to apply new methods for understanding oil weathering over a nearly 40-year interval.

Wes was a central figure in conceiving the "OneGulf" concept to encourage multinational research among scientists from Cuba, Mexico, and the United States. Without his enthusiasm, patience, and sense of purpose, the international collaborations sponsored by GoMRI – many documented in this volume – would not have occurred. We are forever grateful to our friend and colleague for his humor, generosity, dedication, and sage advice.

John E. Reynolds Dr. John Elliott Reynolds, III, was an icon in the world of marine mammal science and conservation. The volume and value of his science, and his rare ability to understand, inspire, and lead those around him, will ensure his lasting legacy. At the very young age of 36, John was appointed by President George H. W. Bush as Chair of the US Marine Mammal Commission and was retained under Presidents Clinton, G. W. Bush, and Obama. He had a keen interest in helping to recover the health and integrity of the Gulf of Mexico ecosystem after the *Deepwater Horizon* spill, using sound conservation decisions that came both from the head and the heart. John was the epitome of a "gentleman scholar" with his humor and gentle nature integrated with his incredible knowledge and experience. The conservation world, and indeed the world in general, is a lesser place without him.

Benjamin P. Flower We also dedicate this volume to our friend, mentor, and colleague Benjamin ("Ben") P. Flower. Ben's paleoceanographic research focused on the role of ocean circulation in past global climate change on decadal through orbital timescales. He was a pioneer in recognizing the value of pairing foraminifera to determine the past oxygen isotopic composition of seawater. Despite his propensity for seasickness, Ben participated in eight oceanographic research cruises, including expeditions in the Gulf of Mexico following the DWH oil spill. He was a key player in early work to assess the impact of the *Deepwater Horizon* oil spill on the sediments and deepwater communities of the West Florida Shelf and Slope. He coined the terms "flocculent blizzard" and "dirty bathtub ring" referring to two mechanisms for oil residue sedimentation. He also initiated a high-resolution sediment sampling approach, which proved to be essential for detecting the *Deepwater Horizon* in the sediments of the northern Gulf of Mexico. Although his scientific accomplishments were substantial, Ben was also a loving and involved father and an accomplished athlete. He played tennis competitively at Brown, was an avid soccer and ultimate Frisbee player, and was a member of the National Champion Santa Barbara Condors ultimate team. In ultimate, players are responsible for playing fairly, refereeing themselves, and upholding the "spirit of the game." Ben was a special person: kind, caring, hardworking, honest, and dedicated to his family, friends, and colleagues. In Ben's personal and professional life, he truly embodied the "spirit of the game."

Wes, John, and Ben were ardent scientists with a passion for the natural world. Their contributions to GoMRI and C-IMAGE and to science and society were significant and long lasting. They will be missed.

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References

Boebert E, Blossom JM (2016) *Deepwater Horizon*: a systems analysis of the Macondo disaster. Harvard University Press, Cambridge, MA, 290 pp

Broad WJ (2010) Taking lessons from what went wrong. New York Times, July 19, 2010

Interagency Coordinating Committee on Oil Pollution Research (ICCOPR) (2015) Oil pollution research and technology plan: fiscal years 2015–2021, 270 pp. https://www.bsee.gov/sites/bsee_prod.opengov.ibmcloud.com/files/bsee-interim-document/statistics/2015-iccopr-research-and-technology-plan.pdf

Love PED, Lopez R, Goh YM, Tam CM (2011) What goes up, shouldn't come down: learning from construction and engineering failures. Procedia Eng 14:844–850

National Commission on the BP *Deepwater Horizon* Oil Spill and Offshore Drilling (2011) Deep water: the Gulf oil disaster and the future of offshore drilling. Report to the president, 398 pp. https://www.gpo.gov/fdsys/pkg/GPO-OILCOMMISSION/pdf/GPO-OILCOMMISSION.pdf

Contents