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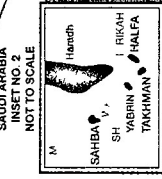
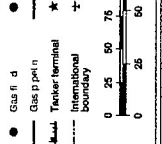
# TWILIGHT IN THE DESERT

THE COMING  
SAUDI OIL SHOCK  
AND THE WORLD ECONOMY

MATTHEW R. SIMMONS

# THE PERSIAN GULF

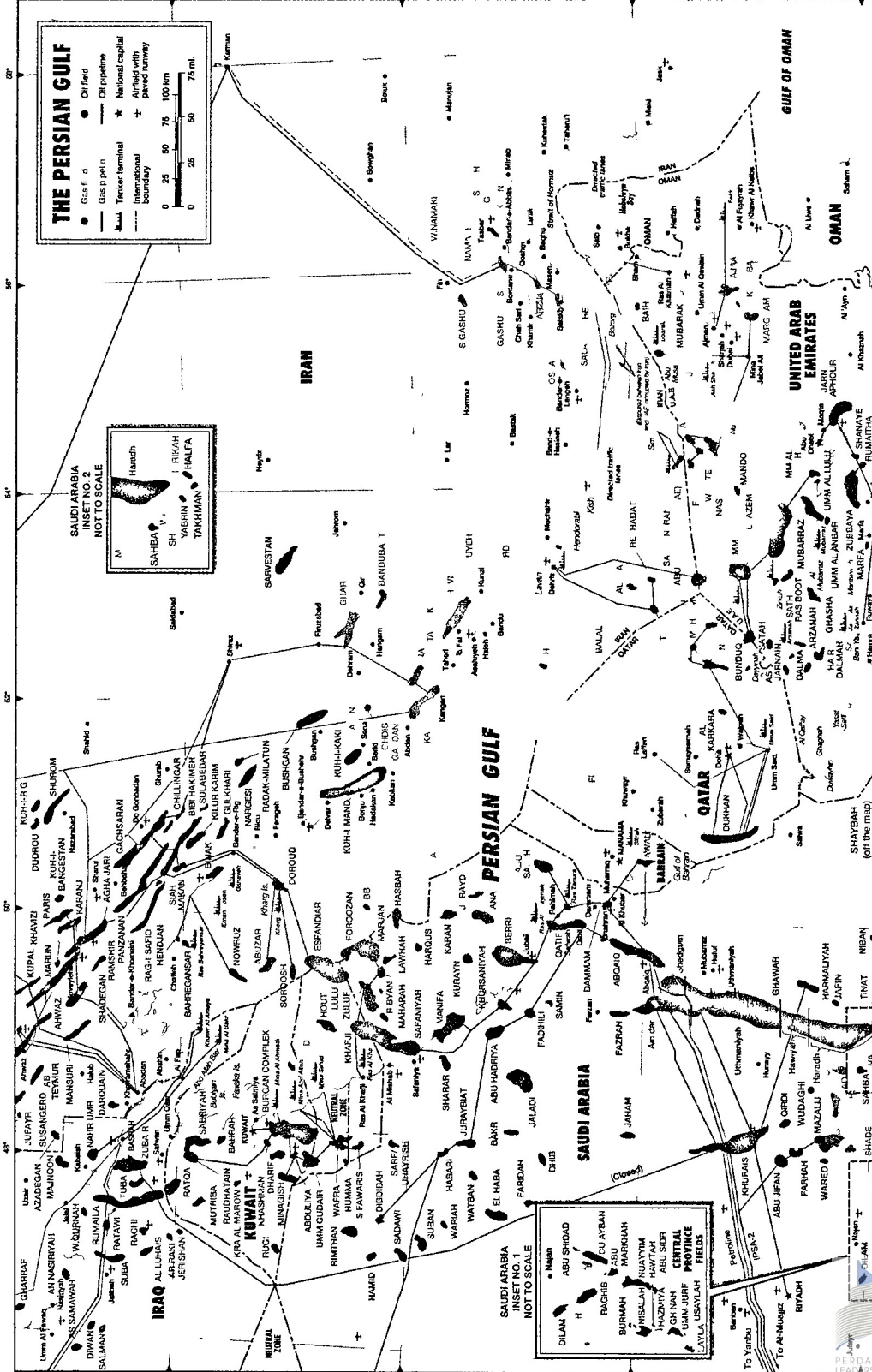
- Gas field
- Oil field
- Oil pipeline
- National capital
- Alfined with paved runway
- Trailer terminal
- International boundary



SAUDI ARABIA  
INSET NO. 2  
NOT TO SCALE



SAUDI ARABIA  
INSET NO. 1  
NOT TO SCALE



AREA OF DETAIL NO. 1

AREA OF DETAIL NO. 2

## Acclaim for *Twilight in the Desert*

“Simmons has authored a compelling warning to the world . . . the Saudi oil miracle is coming to an end. The days of easily recoverable oil are giving way to increasingly complicated technical solutions for smaller amounts of oil. Our oil-fueled world isn’t sustainable much longer.”

—*New Statesman*

“Saudi Arabia takes it on the chin in *Twilight in the Desert*. Simmons examines mountains of data and concludes that the House of Saud’s vaunted oil reserves are vastly overstated.”

—*Financial Times*, “Best Books on Politics and Religion for 2005”

“Oil prices have been blamed for practically every twitch of the stock market . . . The provocative Matt Simmons . . . suggests there is worse to come.”

—*Barron’s*, “The Best Books of 2005”

“Bull markets often have a guru who helps crystallize a belief that prices have nowhere to go but up. Mr. Simmons has played such a role in the oil boom.”

—*Wall Street Journal*

“If Simmons is right, then the global economy has a shock coming . . . His basic points are right on target. Saudi Arabia’s giant fields are old. Two of its three biggest, Abqaiq and Ghawar, by far the world’s largest, were discovered in the 1940s . . . Eventually they will run dry.”

—*BusinessWeek*

“The answers he provides in *Twilight in the Desert* are nothing less than alarming—all the more so because of his pro-industry sympathies and the prodigious research and fair-minded reasoning he brings to the task.”

—*Washington Post*

“Simmons doesn’t think energy-intensive countries like the United States should take Saudi Arabia at its word. He contends that the country’s official oil reserve count could be overstated and the kingdom’s oil production could decline, throwing the world’s supply-and-demand balance off-kilter and jacking up prices for years to come.”

—*Houston Chronicle*

“An important new book . . . *Twilight in the Desert* persuasively argues that high-profile estimates of key Saudi oil reserves are wildly inflated . . . When the source is someone as establishment-friendly as Matthew Simmons, it’s hard to dismiss.”

—Emagazine.com

“A page turner . . . like a Tom Clancy novel . . . Simmons has assembled a devastatingly convincing case that Saudi Arabia is at or beyond peak.”

—*Washington Post*

“Mr. Simmons is not an alarmist. Instead he has presented an informed, well-documented argument that output will soon decline in the world’s most prolific oil-producing nation.”

—*Dallas Morning News*

“Simmons has created a compelling case that Saudi Arabia production will soon reach an apex, from which its production will decline and the world will be confronted with an immense and potentially catastrophic oil shortage.”

—Solar Living Institute

“He (Simmons) fears Saudi oil output could soon start to fall. A drop could destabilize the kingdom, already under attack from Islamic radicals, and send world oil prices shooting to unprecedented heights.”

—*San Francisco Chronicle*

“Matthew Simmons has been the secret card on the Rolodex of most energy reporters for more than 20 years . . . Mr. Simmons dismisses the Swearingen-style optimists who argue that the new higher prices will produce discoveries and development of other new reserves.”

—*Washington Times*

# TWILIGHT IN THE DESERT

THE COMING SAUDI OIL SHOCK  
AND THE WORLD ECONOMY

MATTHEW R. SIMMONS

PUSTAKA PERDANA



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*To my mentor and friend, Professor C. Wickham Skinner,  
who taught me that great teaching comes from  
preparing thoroughly, challenging the students,  
listening carefully and respectfully,  
constantly learning as you teach,  
and including in every class  
a clear, insightful, new concept.*





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## *Preface*

**T**his is a book about Saudi Arabia's oil. It analyzes the present condition of the Saudi Arabian oil exploration and production industry, and it details the real story about the small number of rapidly aging giant and super-giant fields that account for almost all the oil produced within the Kingdom. It asks, as a matter of greatest urgency, whether Saudi Arabia will be able to deliver over the next several decades the oil supplies that the world's consuming nations have come to depend on.

For years, every important energy supply model has assumed that Saudi Arabian oil is *so plentiful* and can be produced *so inexpensively* that its supply is expandable to any realistic demand level the world might need, at least through the year 2030. Many widely respected supply models (such as those used by United States government energy planners and the International Energy Agency) assume that Saudi Arabia will be producing as much as 20 to 25 million barrels of oil a day within the next two to three decades. In reality, the Kingdom's demonstrated production capacity in 2004 was on the order of 10 million barrels a day—in other words, one-half of the estimate.

Saudi Arabian officials have enthusiastically encouraged their oil-consuming customers to believe this plentiful supply scenario, while at the same time they have resisted third-party *verification* of their ability to

deliver. At the end of 2004, Saudi Arabia's petroleum minister announced that the Kingdom could increase its oil reserves in a few years by almost 77 percent, to top 461 billion barrels, through a combination of new discoveries and increased recovery from known deposits. This announcement came as a new oil-producing facility was inaugurated. Saudi Aramco, the Kingdom's national oil company, claims that this new facility will boost Saudi Arabia's production capacity to 11 million barrels a day, restoring a production cushion of two million barrels a day. If all this is true, then Saudi Arabia could theoretically produce at a rate of nine million barrels a day for another 140 years before its recoverable oil is gone.

To its great credit, Saudi Arabia has always made good on its commitments to provide the oil needed to prevent supply shortages in the marketplace. The Kingdom has done its part (and at times more than its part) to manage the supply and price of crude oil for the general benefit of both producing and consuming nations. It has been a responsible participant and leader in the world oil markets. Based on past behavior, there would seem to be good reason to believe Saudi assurances about the future availability of its oil. There are, however, crucial differences between past and present realities that require more careful examination of the claims that Saudi oil officials have been making. Oil demand has grown to unprecedented levels, and the main Saudi Arabian oilfields grow older every year.

That Saudi Arabia's oil is important to the world is beyond any dispute. But this is one of the *few* facts, claims, and assumptions about the Saudi oil industry that requires no further scrutiny. Despite the importance of Saudi Arabia's oil to the well-being of the global economy, amazingly little is known about the details of the Kingdom's exploration and production industry, details urgently needed to support its seemingly extravagant resource claims. Field-by-field production reports disappeared behind a wall of secrecy over two decades ago. Information about the contribution that each field makes to the reported 261 billion barrels of proven Saudi Arabian oil reserves is treated as a state secret. It is not even clear how much oil Saudi Arabia actually produces, since announced surges and cutbacks in production in recent years have rarely shown up in reports of oil imports from the Kingdom made by the member nations of the Organization for Economic Cooperation and Development (OECD), the recipients of by far the greatest bulk of the oil produced by Saudi Arabia and the other petroleum exporters.

This book tells a story about Saudi Arabia's oil that differs sharply from the official Saudi version. Instead of the oil abundance of the official ver-

sion, it argues that Saudi Arabian production is at or very near its *peak sustainable volume* (if it did not, in fact, peak almost 25 years ago), and is likely to go *into decline* in the very foreseeable future. There is only a small probability that Saudi Arabia will ever deliver the quantities of petroleum that are assigned to it in all the major forecasts of world oil production and consumption. Crucial to the story this book tells is a body of technical information about Saudi Arabia's aging giant oilfields that explains the real nature of the threat to the Kingdom's oil production capability. This in turn exposes the risk that the world might soon witness the fading of Saudi Arabia's oil supply, an event that would also mark the ultimate peaking of global oil supplies, just as demand is beginning to increase substantially in many countries.

The "twilight" of Saudi Arabian oil envisioned in this book is not a remote fantasy. Ninety percent of all the oil that Saudi Arabia has ever produced has come from seven giant fields. All have now matured and grown old, but they still continue to provide around 90 percent of current Saudi oil output. The Kingdom's three most important fields have been producing at very high rates for over 50 years. High-volume production at these key fields, including the world's largest, has been maintained for decades by injecting massive amounts of water that serves to keep pressures high in the huge underground reservoirs and also to sweep the mobile, more easily recoverable oil toward the producing wells. When these water injection programs end in each field, steep production declines are almost inevitable.

For a number of years two groups have paid close attention to the message that oil supplies might peak and start declining. The first group comprises various oil company executives. They tend to welcome this message, even if they do not firmly believe it will ever happen, as it gives them hope that oil prices will then rise—always "music to the ears" of any oil producer. The second group tends to be made up of environmentalists, some of whom seem to relish the thought that oil might peak. There are those who look forward gleefully to the day when fossil fuels of all types finally vanish to be replaced by the renewable slate of energy sources: wind, solar, biomass, and, ultimately, hydrogen. These two small audiences, for totally opposite reasons, were the only groups that expressed much interest in the argument that oil supplies will someday peak. Over the last year or two, however, the peak oil topic has suddenly mushroomed, spurred by the dramatic unpredicted rise in oil prices.

Those who express the most vocal public skepticism about a medium-term peak in oil supply tend to be economists. Among this community, the

most biting scorn comes from those economists specializing in energy. There is still widespread agreement among many of the world's most respected energy economists that all energy supplies, and particularly oil, will remain plentiful for at least another 20 to 30 years. A few even argue we will have more oil in 2100 than we do today. As a group, these energy economists tend to spend far more time worrying that demand for oil might soon start to wane, than spending any serious analytical time on the supply side of the oil equation.



The suspicion that Saudi Arabia's oil resources might fall short of the claimed proven reserves and production capacity began to take shape for me during a visit to the Kingdom in 2003 as a guest of Saudi Aramco. My doubts drove me into a research project involving the intense study of over 200 technical papers about Saudi Arabia's petroleum resources and production operations. These papers were written by engineers and scientists closely familiar with the key Saudi oilfields and were published by the Society of Petroleum Engineers (SPE). The problems documented in these technical papers confirmed my initial suspicions and led to the conclusions presented in this book. These problems are detailed in the book so that readers may judge for themselves whether or not my conclusions are warranted. A jury examining this evidence would, I believe, find it difficult not to share my concern about the future sustainability of Saudi Arabia's high-volume oil output.

Saudi Arabian oil officials occasionally admit that their older fields are declining, but they quickly note that reduced output from older fields can be made up with oil from an inventory of discovered but yet-to-be-produced fields and anticipated new discoveries in the many unexplored areas in the Kingdom. Such sources, they claim, could sustain production rates of as much as 15 million barrels a day for at least 50 additional years. Unfortunately, these officials have never provided any information to substantiate these claims. Most of the fields Saudi Aramco lists in its inventory of discoveries have never produced substantial quantities of oil for a sustained period of time. Further, very few areas of the country have not been explored rather intensively.

Saudi Arabia and the other major oil-producing nations have refused for over two decades to provide data to verify and substantiate either their reserve claims or their production levels. Given the rapid growth in oil

demand that is now underway and the shortage of spare production capacity outside of Saudi Arabia, the lack of verifiable data must soon be addressed by some international forum. It is imperative that we create a credible and reliable worldwide system for collecting and reporting energy data.

It is impossible to predict with any certainty just when the problems afflicting Saudi Arabia's oilfields will finally become insurmountable and send the Kingdom's daily oil output into an irreversible decline. Access to more detailed information about Saudi resources and production would make more accurate estimates possible. But this event is not a far-fetched fantasy, and it is not so distant in the future that it deserves no concern today. Moreover, the many consequences of such an event, some clearly predictable and others quite unforeseen, are of such monumental importance to the world economies that to ignore the eventuality of this occurrence is naïve.

Sooner or later, the worldwide use of oil must peak, because oil—like the other two fossil fuels, coal and natural gas—is non-renewable. The main reason that many oil experts have scoffed at claims that peak oil might occur sooner rather than later is their belief in the super-abundance of Saudi Arabia's oil resources. *Twilight in the Desert* challenges this belief through a lengthy review of the all-too-real oilfield problems occupying the time and talents of some of the best technical oil experts in the world. In passing, the book should also demonstrate to both technical and non-technical readers that oil is by no means simply “another commodity.” The enterprise that supplies the oil the world consumes so lavishly is everywhere a highly complex business, even in the Middle East and Saudi Arabia, where conventional wisdom has always assumed that oil was easy to find, cheap to produce, and almost inexhaustible in its supply. The risk is high that twilight may soon descend on oil production in Saudi Arabia.

## How This Book Is Organized

The unique contribution of *Twilight in the Desert* is the analysis of the Saudi Arabian oil and gas industry based on the technical papers published by SPE (Society of Petroleum Engineers). This analysis occupies Parts Three and Four of the book. Petroleum industry professionals who have some familiarity with Saudi Arabia will be able to go directly to Part Three (the true heart of this book) and get right into the series of individual field

assessments. For all other readers, Parts One and Two establish the background and context for understanding the technical discussions of the Saudi oilfields and appreciating the implications for the Kingdom's future oil output and the world's energy supplies.

Part One first reviews the brief national history of Saudi Arabia and its rise to a position of global prominence as the world's largest oil producer. Chapters 2 and 3 detail the origins and growth of Saudi oil production and the key events that influenced and shaped it from World War II to the Iranian revolution. Chapter 4 discusses the mature decades of the Saudi petroleum industry and introduces the issues and problems that began to occupy more and more of the attention of Saudi Aramco from the mid-1970s.

Part Two first provides an overview in Chapter 5 of the Saudi oil and gas industry and the organization that operates and manages it, Saudi Aramco, the world's largest oil company. It then introduces, in Chapter 6, the principal technical challenges Aramco has been facing as its main fields have grown increasingly mature, and that now are perhaps the main focus of the company's activities.

Part Three examines each of the mainstay giant and super-giant fields that have been the source of the greatest volumes of Saudi Arabia's oil production, as well as the lesser fields that have contributed and the new projects that are expected to sustain future production. Part Three also discusses oil and gas exploration in Saudi Arabia over the past 35 years and Aramco's attempts to secure additional new sources of natural gas to meet the Kingdom's surging domestic energy needs.

Part Four draws further conclusions from the findings of the analysis in Part Three with regard to the present state and future prospects of Saudi Arabia's oil and gas production. Chapter 12 offers a critical assessment of Saudi claims to have some 260 billion barrels of proven oil reserves, as well as vast volumes of natural gas. Chapter 13 assembles information about giant and super-giant oilfields from other petroleum provinces under the assumption that the production histories of these great fields offer a paradigm for what is likely to happen in Saudi Arabia. Chapter 14 reviews the significant number of technical papers that have been presented by Saudi Aramco authors at major SPE conferences during the later part of 2003 and 2004. Chapters 15 and 16 use the analytical findings to speculate about the likely future of oil production in Saudi Arabia. The final chapter, "Aftermath," raises a number of critical issues that must be addressed if the nations of the world are to cope with the impacts of dimin-

ishing oil supplies and make a successful transition to an economy based on alternative fuels and energy sources.

The SPE papers are the most significant body of information for this book and the basis of its unique value: An appendix describing my methodology in studying more than 200 of these papers is provided at the end of the book. In addition, there are, of course, a great many other sources that contributed to my research. Chief among these are the general knowledge and array of more detailed information that I have acquired as a keenly interested observer and historian of the international energy industry—and an avid participant in the financial side of it—since the early 1970s. Other information comes from earlier research projects I have conducted, most notably a study titled “The World’s Giant Oilfields” completed in 2000. I have also made judicious use of more general literature published by Saudi Aramco—brochures, periodicals, and reports. What I observed during the visit that I made to Saudi Arabia in 2003 and the information presented by Saudi Aramco officials has been invaluable. And finally, I have benefited greatly from information gained through personal correspondence and conversation with many expert authorities on various aspects of petroleum technology, and also with a number of retired former Aramco employees who generously shared their insights with me.

I hope you find the information gathered in this book equally valuable.



## *Acknowledgments*

I would like to thank scores of professional friends in the oil industry and a number of industry organizations for the assistance they have given me in writing this book. At the top of the list is the Society of Petroleum Engineers (SPE), which made available to me its remarkable library of technical papers, including the more than 200 written by engineers and managers working at Aramco and then Saudi Aramco once the original company was nationalized. The detailed information about oil production operations in each key Saudi Arabian oilfield and the challenges and problems they presented proved invaluable in creating this book. Some of the world's best technical experts and petroleum analysts helped me refine my knowledge of oil exploration, geology, and reservoir management practices, the problems encountered in handling water injection and water incursion, and gas issues in oil-producing wells—the issues that make reservoir management such a complex task, even in 2005. Among these experts, I would particularly like to single out Dr. David Donohue and his colleagues at the International Human Resources Development Corporation (IHRDC), Professor Kenneth Deffeyes, Carl Thorne, Herbert Hunt, Bruce Hunt, Darab (“Rob”) Ganji, George Spaid, Dr. Tom Hamilton, Dr. Richard D. Chimblo, Michael Lynch (former Senior Drilling Engineer at Aramco), Dr. Ali Bakhtiari (Senior Expert in

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Two individuals deserve special recognition: my executive assistant, Judy Gristwood, who tirelessly converted my hand-scribbled notes into what finally became a draft manuscript and managed the complicated process entailing several rounds of revision and editing; and Dr. Charles McCabe, retired editor of Gulf Publishing Company's *Ocean Industry*, who served as my chief editor. Chuck probably had no idea what he was getting into when I recruited his help in the spring of 2004. His broad knowledge of the oil and gas industry, editor's skills, and alert critical eye have been invaluable. Without Chuck and Judy, I could never have produced this book.

I also had the tremendous good fortune to attract the interest of John Wiley & Sons as I was completing my book. They quickly decided not only to publish the book, but to fast-track the publication schedule. Working with the team at Wiley has been a pleasure, particularly since I had prepared myself to go through the tedious process of self-publication to get this message to the world's energy planners while there is still time to manage the coming adjustment to the post-petroleum world.

Finally, I would like to acknowledge the patience and encouragement I received from my dear wife, Ellen, and from Wheeler, Abby, Emma, Winnie, and Lydia, our five lovely daughters, as I spent two and a half years struggling through the exhaustive process of researching and writing this book.

## *Introduction*

**I**t is hard to believe that I am writing an introduction to the paperback edition of *Twilight in the Desert* only six months after the book was first released. Many significant energy events have transpired in that short time, and I have received an enormous amount of feedback from knowledgeable people who read the book carefully. I am thus glad to have this opportunity to comment on what has happened in energy circles and what I have learned from my readers.

This paperback edition expands the account of the Senate committee hearings of 1974 and 1978–1979 (spelled out in Appendix C) that looked into Saudi Arabian oil reserves and production capabilities. These important investigations, buried in forgotten archives for almost three decades, were remarkable because the data they disclosed provided the first hints that Middle Eastern oil resources might not be adequate to supply ever-increasing demand in energy consuming nations. Our global economy might be quite different today had we understood in the early 1980s that the record Middle Eastern oil production of 1981, based as it was on peak output from a handful of giant fields, would not reach that magnificent level again in the next 25 years.

I also rewrote Chapter 17, the important “Aftermath,” that concludes the book. As I was finishing the original manuscript, I wanted to avoid writing about how our global economy might cope in a post-peak oil

world; the topic is very complex and needs a thorough exploration by a genuine authority on this subject. However, I did attempt to think through the consequences of oil production peaking in Saudi Arabia—the Kingdom’s oil twilight will effectively mark the transition to a world of diminishing oil supplies.

In the six ensuing months I spent a great deal of time pouring over data on oil demand and discussing the status and prospects of the various strategies and solutions that have been proposed for coping with energy needs as oil becomes an increasingly scarce commodity. The ideas I first began exploring in order to finish *Twilight* on a positive note grow clearer with every hour I spend on the topic. The more information I assemble on aftermath possibilities, the more convinced I am that we can find workable solutions that will sustain a healthy global economy once peak oil has passed. These more developed ideas are now incorporated in a newly written Chapter 17.

## A Contrarian Path to Energy Enlightenment

The publication of *Twilight in the Desert* propelled me into a frenzied schedule of talks and media interviews about the book’s message and the serious energy issues it raises. On these occasions, I have been asked repeatedly to explain what led me to write the book.

The story is quite simple. The seeds were planted about 15 years ago when I first became concerned that our oil-based global energy course was leading us rapidly down a blind alley. My concerns grew as I gathered more and more information and analyzed what was happening in the worldwide oil and gas industry. The more I dug into the best data available, the more convinced I became that we were drifting into a serious energy crisis.

Ironically, my concerns began just as the Great Oilfield Depression of the 1980s and early 1990s was finally ending. The massive spare energy capacity industry-wide that caused this awful Depression was rapidly shrinking. Demand for both oil and gas was on the rise once again, fueled by the extremely low prices in conjunction with increasing consumption in developing countries. It was clear to me that unless oil and gas prices rose to levels sufficient to stimulate more drilling for new supplies and drive expansion of the global pipeline and refining systems, we would someday find ourselves with a greater demand for energy than even the huge existing systems could meet.

As I began speaking out on the need to expand our efforts to increase petroleum supplies, I was repeatedly told by scores of supposed energy experts that modern oilfield technology was ushering in an era of steadily cheaper and more abundant oil and gas. A high percentage of the industry's key opinion setters began believing that oilfield technology was making dry holes a thing of the past. Perceived energy authorities soon embraced the thesis that a drilling rig in the 1990s could drill the same number of productive wells as eight rigs could drill a few years earlier. The same optimists confidently asserted that growth in energy demand was also slowing down or, even worse, possibly peaking. I was told by hundreds of well-positioned analysts and forecasters that the threat of high oil prices had ended. Oil prices would stay low or fall even lower. Anchoring this "low energy prices forever" thesis was the strong belief that the Middle East had virtually limitless oil that could be produced so cheaply that it was essentially free.

I knew that the claims that modern oilfield technology had made oil and gas far easier to find and produce cheaply were greatly overhyped. I had spent a great deal of time throughout the 1980s working on investment banking projects with the key companies that invented all this technology, and I understood what these new systems and techniques could and could not do. I was quite sure that whatever temporary benefits they might bring, these new technologies were not the long-term salvation for our energy needs.

As my concerns for supply grew, I as yet had no sense about the real story of Middle Eastern oil resources because the data needed to properly analyze them were extremely inadequate. Over the past three decades, I had heard numerous experts opine repeatedly on the boundless volumes of cheap oil that still lay beneath Middle Eastern sands. Therefore, until the end of 2001, I assumed they must be correct. As I now think back on the evolution of my energy views over 30 years of increasingly intense analysis of our global oil and gas business, I cannot recall anyone challenging the assumption of the boundless abundance of Middle Eastern oil. My friends and oilfield associates universally believed that Middle Eastern oil was so vast and easily produced that it would effectively last forever.

If I was uneasy about Middle Eastern petroleum supplies, it was only because I questioned whether this small cadre of oil-producing countries would refuse to spend the capital needed to get 50 to 100 percent more oil out of the ground, process it to export standards, and then transport it to consuming markets. It never dawned on me at that time that the whole

structure of certitude about Middle Eastern oil might be based on mere assumptions instead of solid facts.

By the mid-1990s, I had become a serious student of the accelerating rates of decline in the world's oil and gas fields. As I delved deeper into this problem, I became convinced that the same technology that was making it easier to find and produce oil and gas was, in fact, a double-edged sword. While the technology did make it possible to extract oil and gas reserves far faster, it simultaneously created far higher decline rates in existing production areas. The accelerating decline rates were an unintended consequence of the new technology. Since it was very difficult to get factual data about field-by-field production rates and declines, most analysts simply ignored the issue. This key failure tilted almost all models forecasting future oil supply far too sharply toward optimism.

In the fall of 2001, I started creating a list of the world's highest-producing oilfields. The end product of this research was a white paper titled "The World's Giant Oilfields" that I circulated widely among knowledgeable oil industry people. Three startling findings emerged from this work (some details appear in Appendix B). First, the world had only 120 oilfields producing at rates over 100,000 barrels of oil each day. These fields accounted for half of the world's oil supply. Second, the 14 largest oilfields accounted for 20 percent of global oil supply, yet the average age of these 14 super-giant oilfields was about 50 years. The third and for me most astonishing finding was that the five main Middle Eastern oil-producing countries were keeping the oil-consuming world afloat with production from only a handful of aging fields. Until embarking on this research, I had naively assumed that Middle Eastern oil came from hundreds, if not thousands, of individual oilfields.

This newfound enlightenment about the sources of the Middle Eastern oil supply was invaluable when I finally had the opportunity to visit Saudi Arabia in early February 2003. As the small U.S. delegation of which I was a member listened to presentations about current operations in the Saudi Arabian oilfields, my knowledge that so few fields were involved in producing the world's largest national oil output made me acutely aware of the importance of an immense field like Ghawar.

We were also shown illustrations to impress upon us how few wells were required to extract the vital Saudi oil supply and how intensively oil from this handful of oilfields was being produced. With these lessons in mind, I came back from Saudi Arabia intrigued by a few unanswered questions and interested in unraveling the mystifying secrets of Saudi

Arabia's oil system. My observation that a great many of the wells in Ghawar, the world's largest oilfield, were tightly bunched into the field's north end turned out to be a significant smoking gun. I now know that this small area, only about 25 miles long and 12 miles wide, contributed about 4.5 to 5 million barrels per day of Ghawar's total peak output of over 5.8 million barrels per day from 1979 to 1981. Listening to Saudi Aramco presentations in early February 2003, I had hastily sketched a dense cluster of dots—the wells of North Ghawar, spaced at one well per kilometer. This was Ghawar's true sweet spot which is now rapidly being depleted. What remains for future exploitation is the rest of Ghawar, a large but less promising area, with far less favorable reservoir rocks and with thicker, more viscous oil.

Within weeks of my return from Saudi Arabia, my curiosity had become a powerful appetite. To satisfy it, I began a lengthy study of technical papers about Saudi Arabia's oilfields filed in the library of the Society of Petroleum Engineers (SPE). The more I studied, the more I realized that the universal assumption that Saudi Arabian oil resources could last indefinitely was not true. This led ultimately to writing *Twilight in the Desert*. The project took the better part of the next two years.

## Reception, Reactions, Responses

As 2004 was drawing to a close, I finally began to see some light at the end of this long research and writing tunnel. I began contacting publishers but was quite willing to self-publish the book to get its serious message into the public domain as soon as possible. Only one book publisher had any interest in tackling this controversial book. From the feedback I received, the book was “too technical,” too narrowly focused, or not explicitly dire enough to draw much of a reading audience. I also began learning from friends who had published books that it takes about a year and a half to progress from an acceptable manuscript to a formally published book.

On Thanksgiving weekend of 2004, *Barron's* published a two-page story titled “Field Research” about my research and the pending book. Several days later, I was contacted by Kevin Commins, one of the senior editors of John Wiley & Sons, inquiring about the book and why I seemed determined to self-publish. Within weeks, Wiley not only committed to publish the book but also agreed to put it on a fast-track schedule for release the coming spring. From the start of 2005 until around the

first of May, I had little time to do anything but rush to get the book into final shape.

During the year prior to the book being published I gave many talks at key energy conferences about the issues that *Twilight in the Desert* would ultimately spell out. These speeches began with presentations in Kuwait and Qatar in mid-February 2004, followed by a pivotal debate at the Center for Strategic and International Studies (CSIS) in Washington, D.C. There, in an hour-long presentation, I laid out the case for my doubts about Saudi Arabia's future oil production. After my presentation, two senior executives from Saudi Aramco made the official Saudi Arabian rebuttal, arguing that no unusual production problems existed in any of their oilfields. Throughout 2004 and early 2005, some 45 PowerPoint presentations were posted on the Simmons & Company web site summarizing the basis of my concern that Saudi Arabia lacked the resources to grow its production to the levels assumed by most long-term oil supply models, and even worse, that each key super-giant Saudi oilfield could soon begin to decline.

From these beginnings in early 2004, the debate over the true story of Saudi Arabia's oil grew to significant proportions long before the book was available. Saudi Arabia's Petroleum Ministry and senior Saudi Aramco executives unleashed a steadily increasing barrage of public presentations refuting that the Kingdom of Saudi Arabia had any oil problems and affirming, in fact, that they could produce 10 to 15 million barrels a day for another 50 years without significant new discoveries.

I knew that the debate would intensify to far higher levels once the book was published. No longer would my conclusions be summarized on several dozen PowerPoint slides. Instead, some 400 pages of detailed facts would be available for anyone to scrutinize.

By the start of May 2005, there was nothing more I could do to improve the book's content or clarity. I would soon see the results of my efforts, for better or worse, in stark black and white. I spent a quiet month-long interlude wondering how severely the book's thesis would be attacked, and how I would react to negative reviews. After all, no one was more aware than I was of the challenge the book makes to conventional energy wisdom.

Having studied almost 300 technical papers about Saudi Arabia's key oilfields, I was confident I had honestly and correctly interpreted their implications for future Saudi production. I also knew, however, that my field of expertise was financial, not technical, and it would be easy for

petroleum scientists and engineers to cherry-pick various conclusions for criticism and heap scorn upon the way I interpreted some extremely technical data.

By the time *Twilight* finally hit bookstores in the middle of June 2005, its thesis was being widely discussed in energy circles around the world. Many media sources had written stories about the book and my views of Saudi Arabian oil before seeing the book's details. At the same time, oil prices were surging from one new record to another, despite a growing chorus from many experts that high oil prices were unsustainable and would soon fall. Forty-dollar oil soon became \$50 oil. By the time Rita, the second hurricane disaster to hit the U.S. in Sept., 2005, oil prices exceeded \$71 a barrel. This directed even more media attention to world oil markets. My questions about the sustainability of Saudi Arabian oil production, as well as the risk of a sudden production decline, seemed to be on everyone's radar screen.

The barrage of negative reviews I had expected never materialized. This was my first pleasant surprise. The second was the book's commercial success. By the end of November 2005, over 80,000 copies of *Twilight* had been sold around the globe. The book has been reviewed by many leading newspapers and magazines and has been selected as one of the top books of 2005 by *Barron's* and the *Financial Times*. I have been honored to receive thousands of letters and e-mails from people who have read the book carefully. Some letters were from people who knew little about how oil was produced but read *Twilight* from cover to cover. Other praise came from some of the world's best oil technology experts, ranging from senior exploration professionals to the heads of some of the world's finest petroleum engineering schools.

The book also rekindled memories for some key players involved in the events of the 1970s when U.S. government officials were struggling to assess charges that Saudi Arabian oilfields were being overproduced. The publication of detailed data on each key Saudi Arabian super-giant oilfield also started to crack the code of silence among Saudi Aramco employees and retirees. These are the people most familiar with Saudi oil operations, and they began speaking more openly about problems they had struggled to overcome in these maturing oilfields.

By the end of 2005, a surprising number of senior Saudi Aramco employees have officially or unofficially contacted me to applaud the manner in which I reported the real story of Saudi Arabia's oil challenges. More importantly, several senior Saudi Arabian government officials have told me

that I might emerge as one of the best friends the Kingdom of Saudi Arabia has ever had, since *Twilight* raises public awareness of the risks the Kingdom faces of exhausting its fields if it tries to produce as much oil as global consumers demand. By the same token, there are still many senior Saudi Aramco oil officials who strongly deny the existence of any problems in their oilfields. I know now, however, that this hopeful position is really more “hypeful,” and is not widely held within the senior Saudi Aramco camp.

Not surprisingly, *Twilight* also received a few negative reviews. Almost every unfavorable review, though, has attacked the erroneous interpretation that the book predicts an imminent, steep, and irreversible drop in Saudi Arabia’s oil output. Such an event is offered as one possibility, but the actual thesis is more qualified. The book asserts that every oilfield, whether super-giant or ordinary, will begin to decline at some reasonably predictable time. The risk that the oil-consuming world faces is that Saudi Arabia’s oilfields will begin declining sooner rather than later.

What the book puts to rest, one hopes, is a totally false impression that Saudi Arabian oil can easily grow to 15, 20, or even 25 million barrels a day and sustain this production rate for decades. This is a pure myth. Unfortunately, for reasons that the book also spells out, the imminent-decline scenario cannot be dismissed as impossible. It is not, however, a foregone conclusion that Saudi Arabia’s total production will collapse, let alone soon. What the book does try to lay out clearly is how unrealistic it is for the world to assume that Saudi Arabia’s oil output could virtually double over the next 10 to 25 years. The book also makes it clear that even the scenario of maintaining steady production for several more decades is by no means risk-free.

Nothing I have seen, heard, or learned from the book’s negative reviews has altered these conclusions. To the contrary, every solid new data input I receive underscores my initial concerns.

Several negative reviews attack the validity of using the SPE papers as the basis of my analysis, on the grounds that these technical papers highlight or even exaggerate localized problems that occur in all oilfields. Some of these critics also advance the notion that a nontechnical person, such as a Harvard MBA investment banker, cannot possibly understand and draw accurate inferences from a set of papers dealing with complex technical issues. If this were true, it would be a sad state of affairs, dissuading analysts from ever trying to grasp technical issues, just because they lack technical training. My 35 years of energy investment banking have repeatedly shown

## Seeking the Future

It would be comforting, to say the least, for all of us now to know the future direction of Saudi Arabia's oil output, particularly since so much of the world's future economic productivity depends on the real answer. Sadly, there is still no way to know accurately. As I spell out in Chapter 16, the main energy stakeholders should structure a genuine oil data reform. To be truly beneficial, this reform should result in quarterly oil production reports for all key oilfields in the world, along with the number of producing wells in each field. With this data, analysts could prepare solid well-productivity trend analyses. Until this occurs, there is no way to begin to estimate the future production of any major oilfield, let alone predict the future production from the five key oilfields that still produce almost 90 percent of Saudi Arabia's oil. It is frightening that a piece of data so important to global economic security is classified as a state secret shared only among a handful of Saudi Petroleum Ministry and Aramco officials.

Unless we get a vastly improved level of field-by-field production data, the world will be subjected to an increasingly strident debate about whether Saudi Arabia's oil production, and thus world oil supply, is peaking. Until we have clear proof the peak has occurred, we will be tempted to entertain the notion that the world will be spared this event through new technology breakthroughs—by then it might just be too late to formulate solutions and strategies to prevent economic chaos as we face an irreversible decline in oil supplies.

In the summer of 2005, at an energy data workshop at the Hart Senate Building in Washington, D.C., I told the audience that it would be less risky for the world to suspend use of traffic lights and air traffic control systems for a couple of years than to let another year go by with no reliable data indicating how close to peak oil supply the world might now be. I truly believe this statement. Energy data reform is an idea whose time has come. It *has to* occur.

I vividly remember the day I made the first official presentation of what were then very tentative conclusions about Saudi Arabia's oil challenges. The presentation was in the boardroom of Kuwait Petroleum Corporation on February 21, 2004. The chairman of KPC assembled a room full of senior Kuwait oil experts. The first question posed as I concluded the presentation was: "How does all this end?" My answer was simple and straightforward. I stated that we needed to start by understanding that the best-case future Saudi Arabian oil production of 20 to 25 million

barrels a day is extremely unlikely. I also told this Kuwait audience that it was not a certainty that Saudi Arabia could even keep producing its current 8 to 8.5 million barrels a day for several decades to come. Finally, I said that there is a genuine but unquantifiable risk, given the lack of data, that one after another of Saudi Arabia's super-giant oilfields could soon begin to experience production declines.

Two years have elapsed since I made this first speech about Saudi Arabia's oil future in Kuwait Petroleum's boardroom. According to recent statistics released by Saudi Arabia's Petroleum Ministry, the Kingdom thus far has continued to deliver the goods. It raised its oil production by almost 1.5 million barrels a day to 9.5 million barrels a day. Moreover, the world has been constantly assured that the Saudis have an additional 1.5 million barrels a day of spare capacity left. Since this spare capacity is all heavy, sour oil, however, there is no refinery capacity left in the world to convert it into light finished petroleum products, so the world will never know if this spare capacity is real or imaginary. As comforting as this production increase sounds, I find it amazing that Saudi Arabia's oil exports have not significantly increased since 2001. It is hard to produce another 2 million barrels a day and boycott the developed economies of the world.

Saudi Aramco also has four massive new projects that are now being fast-tracked in the engineering and procurement stages. These are not new fields, however, but old discoveries that were brought onstream and then abandoned. Hopefully, they will add an additional 2 million barrels a day of new capacity by 2009. The largest and most ambitious of these rehabilitation projects is a program to expand the Khurais oilfield from a current output of around 150,000 barrels a day to as much as 1.2 million barrels a day by the end of 2009. The current cost estimate for this stiff challenge is about \$11 billion. The Petroleum Ministry now openly admits that 800,000 barrels a day of this new capacity are needed to replace declines now under way in mature fields. This seems to imply that total Saudi production is declining by only 2 percent per year. Typical decline rates throughout the oil industry are much higher and increase with each passing year. Is this an example of Saudi exceptionalism?

The drilling rig count in Saudi Arabia has already doubled from the time I visited the Kingdom in February 2003. Further, announced plans envision at least 100 rigs in the Kingdom by sometime in 2006, representing an increase in drilling of three times 2003 levels.

But these ambitious plans are now being openly challenged by a handful of key Saudi insiders, including the leading technical authority within

Saudi Aramco, recently retired executive vice president Dr. Sadad al-Husseini. Dr. al-Husseini has told various journalists that the new projects to increase production will be delayed due to a lack of drilling rigs, and that it is dangerous for anyone to believe Saudi Arabia could produce more than 12 million barrels of oil per day for any extended period of time without risking permanent damage to the reservoirs. The Saudi Arabian Petroleum Ministry has vigorously disputed the alleged oil rig shortfall, although Saudi Arabia's Foreign Minister, speaking at Houston's Rice University in late September 2005, told his audience that it was critical that "international oil companies" not take the drilling rigs that Saudi Aramco needs.

Other key Middle East oil experts are now speaking loudly about the aging of key giant oilfields. In early November 2005, the new chairman of Kuwait Petroleum Corporation stated that the Burgan Complex, the world's number two oilfield, which was producing 2 million barrels per day of Kuwait's 2.5 million barrel per day output, was now "exhausted" and needed to rest by lowering production to 1.7 million barrels of oil each day. Is this the proverbial canary in the coal mine? Only time will tell, but time also marches on and ages old oilfields further.

I have enjoyed the luxury of almost three years to ponder the potential severity and consequences of the pending decline in Saudi Arabia's oil production and to consider what we can begin doing to mitigate the effects of a probable peaking of global oil production. I truly believe that over these three years my grasp of the issues involved has grown by leaps and bounds.

I am now highly confident that it is impossible for Saudi Arabia to produce 20 to 25 million barrels of oil a day for any length of time unless the Kingdom suddenly finds a large number of new giant oilfields. The odds are better for attaining 15 million barrels per day, but believing that this production level could be maintained for a decade requires a real leap of faith. I am also certain that the most productive parts of the key Saudi Arabian oilfields have passed their sustained peak output. Saudi Aramco insiders have confirmed to me that the most productive parts of three key fields, Ghawar, Abqaiq, and Berri, passed their peak supply levels years ago. There are still vast reserves of oil left in Saudi Arabia. However, it is important to know that what has disappeared is the easy-to-produce light grade of oil that is most in demand in consuming nations. The remaining oil is heavier; the reservoir rocks are less porous and have far less permeability. Gone are the days of high volumes of light oil spewing out of the ground at rates of 5,000 to 20,000 barrels a day per producing well.

It was about 50 years ago that oil industry observers began assuming Middle Eastern oil was so abundant and so inexpensive to produce that the world would have the luxury of using as much of this energy miracle as it needed for as long as anyone could conceive the need. Over the course of the next five decades, the thesis of boundless Middle Eastern oil underpinned every energy forecast formulated by any serious energy-planning group. This concept raised only two concerns in Western consuming countries. First, we worried that cheap Middle Eastern oil might overwhelm Western oil producers, thus making the world too dependent on one source of oil. Second, we worried about a growing number of geopolitical issues that made the Middle East an increasingly complicated part of the world and threatened continuing oil supplies.

We ignored almost entirely the simple aging of the giant oilfields, the inexorable operation of a natural process concealed in the midst of this shining energy miracle. Saudi Arabia's oil issues are the same as those facing all oil producers in the Middle East. The region has too few giant oilfields, and all are now aging and tired.

It now seems beyond reasonable doubt that oil output in Kuwait, Iran, Oman, Syria, and Yemen is also in decline. Unless a miracle emerges from the ruins of Iraq, its oil production probably peaked decades ago.

How soon the Kingdom of Saudi Arabia passes peak oil production is now finally a seriously debated topic. Twilight is occurring in the Middle Eastern deserts. We have no timetable for the fading of twilight into darkness; nor is there a workable plan showing us how the world adjusts to using less oil, and thus ensuring that there is a new dawn. Given reasonable political stability, world oil production will not plummet, but fade gradually through a twilight. Unfortunately, the world economy is not synchronized to the principles of petroleum geology. A growing gap between energy demand and supply will cause acute, convulsive disruption greatly disproportionate to the actual size of the shortfall.



### The Kingdom of Saudi Arabia and the Middle East Region

SOURCE: Simmons & Company International

# PART ONE

## FROM BEDOUIN TO BOURGEOISIE

**O**f all the many nations that emerged into the harsh light of history and modernity during the twentieth century, none moved so rapidly from obscurity to glaring prominence as Saudi Arabia. Dominated by the Ottoman Turks and warring tribal chiefs in the 1890s, the Arabian Peninsula was in political disarray, and the Saud family, traditional rulers of the area around Riyadh from the mid-1400s, was in exile in Kuwait. The British sought to exercise influence by establishing protectorates among the traditional monarchies along the southern and eastern coasts of Arabia.

The present nation came into being only in 1932 when Abdul Aziz ibn Saud proclaimed the Kingdom of Saudi Arabia after reclaiming the traditional family homeland and battling rival tribes for 25 years to gain control of most of the peninsula. He ruled a largely rural people who followed centuries-old traditional ways as farmers and nomadic herders driving their sheep, goats, and camels across the desert expanses. They practiced Wahhabi Islam, an austere doctrine requiring strict observance of Muslim laws that had been taken up by the Saud family in the mid-1700s and

spread throughout Arabia by their conquests. The new Kingdom was poor and utterly lacking in industrial development.

By the beginning of 1970, less than 40 years after its founding, Saudi Arabia was suddenly thrust into assuming a major role in economic activities and political events that affected the entire world. The world's urgent and virtually insatiable need for more oil catapulted the Kingdom onto the center of the world stage and suddenly made it wealthy almost beyond any historical precedent. The Saudi people were moving into splendid new cities and developing tastes for modern Western goods and entertainments. Its oil industry began diversifying further downstream and gaining world-class technical sophistication.

But Saudi Arabia was by no means a modern state in the early 1970s, nor is it one today. As a monarchy with no elected assembly or parliament, the nation is still dominated by the Saud family and has been ruled for its entire history by Ibn Saud and his hereditary successors—his five eldest sons. These six men have dominated a vast expanse of desert and mountains for 103 years. While oil provided Saudi Arabia great wealth and an enviable array of public services and welfare systems, it has not built an economy that generates enough professional jobs for a rapidly growing population. Saudi society is extremely conservative and, from a Western perspective, restricts the freedom of women severely. The Wahhabist clergy enforce strict Muslim law and impose criminal punishments considered barbaric in the West. The once symbiotic relationship between state and religion appears threatened by rivalries that divide the allegiances of the people. And as the world has recently discovered, the peculiarly Saudi Arabian mix of monarchy, conservative Islam, social restrictions, and economic contradictions has proven to be a fertile breeding ground for discontent, opposition, and terrorism.

Saudi Arabia has also been an extremely reliable proprietor of the world's most critical oil supply. The Kingdom has maintained a very close relationship with the United States and has generally shown a sympathetic understanding of the interests of the Organization for Economic Cooperation and Development (OECD) nations. As the largest producer in the Organization of Petroleum Exporting Countries (OPEC), Saudi Arabia has been a "dove" in policy disputes, working to maintain fair oil prices and safe, reliable oil supplies.

The critical issues facing the Saudi oil industry cannot be properly appreciated without some understanding of Saudi Arabia and its people.

How did a disparate collection of desert tribes come to occupy such a critical position on the world stage? What are the composition and organization of Saudi society today? What are the country's concerns and challenges? What forces are driving the internal dynamics of this desert nation? How do Saudi Arabia's demographics and economic realities impact its oil-producing future? Part I answers these questions, to provide background necessary for understanding the current Saudi oil situation.

Praise for

# TWILIGHT IN THE DESERT

**"This book is likely to be the most important ever written about oil."**

— **The late Richard E. Smalley, PhD, Nobel Laureate in Chemistry, 1996**  
**Former University Professor, Gene and Norman Hackerman Professor of Chemistry,**  
**Former Professor of Physics, Rice University**

**"[Simmons] effectively confronts the complacent notion that there are ample oil reserves in Saudi Arabia. *Twilight in the Desert* should provoke anyone who believes that the recent increase in oil prices reflects either a speculative bubble or short-term supply constraints."**

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**"Matt Simmons's book is a challenge to Middle Eastern oil producers to provide the world with more and better oil field data . . . If Simmons proves directionally correct, we are in for a huge and early challenge to find alternative transportation fuels."**

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