Chapter 7


El Paso
Oklahoma
Rio Grande
Dallas
Austin
Houston
MEXICO
Chihuahua
Durango
San Antonio
Monterrey
Gulf of Mexico
Gulf of California
California

Chapter 7

Challenge Theme 5. Current and Future Needs of Energy and Mineral Resources in the Borderlands and the Effects of Their Development

By Floyd Gray, William R. Page, Peter D. Warwick, and Martín Valencia-Moreno

Introduction

Exploration and extraction activities related to energy and mineral resources in the Borderlands—such as coal-fired power plants, offshore drilling, and mining—can create issues that have potentially major economic and environmental implications. Resource assessments and development projects, environmental studies, and other related evaluations help to understand some of these issues, such as power plant emissions and the erosion/denudation of abandoned mine lands. Information from predictive modeling, monitoring, and environmental assessments are necessary to understand the full effects of energy and mineral exploration, development, and utilization. The exploitation of these resources can negatively affect human health and the environment, its natural resources, and its ecological services (air, water, soil, recreation, wildlife, etc.). This chapter describes the major energy and mineral issues of the Borderlands and how geologic frameworks, integrated interdisciplinary (geobiologic) investigations, and other related studies can address the anticipated increases in demands on natural resources in the region.

Lavender Pit copper mine near Bisbee, Arizona

Porphyry Copper Resources

Copper is the most economically important mineral resource in the Borderlands. It occurs dominantly as porphyry copper systems: copper orebodies that are associated with intrusive rocks and the fluids that accompany them during the transition and cooling from magma to rock. These copper deposits occur along a belt oriented northeast-southwest, exposed along most of the western edge of North America. About 15 major deposits have been recognized in this belt, and almost all are located in the Borderlands. The combined large deposits of southern Arizona, western New Mexico, and northwestern Mexico constitute one of the most prominent copper provinces on Earth (fig. 7–1) (Titley, 1993). This province, commonly referred to as the "great cluster" of porphyry copper deposits of Arizona, Sonora, and New Mexico (Keith and Swan, 1996), includes about 12 economically important mines, some of which have been

Aerial view of the Cananea copper mine, Sonora

classified as being of giant size (greater than 2.5 million metric tons copper [2.8 million short tons]; Clark, 1993; Laznicka, 1999). The most productive locations, which are considered to be of global importance, are the Safford and Morenci deposits in Arizona and the Cananea and La Caridad deposits in northeastern Sonora (fig. 7–1). The importance of these deposits is shown by the fact that approximately 60 percent of all copper production in the United States and 95 percent of all copper production in Mexico comes from the Borderlands. In addition, production from the border region of Mexico represents approximately 3.3 percent of all porphyry copper produced in the world and 18.1 percent of the potential estimated for the "great cluster" (fig. 7–1). The majority of occurrences south of this rich province are of marginal importance.

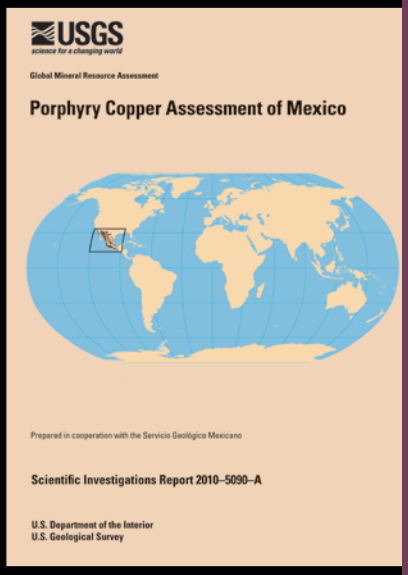


Figure 7–1. Map (left) and comparative charts (right) of the porphyry copper–rich region of the southern United States and northwestern Mexico. The map shows the "great cluster" of porphyry copper deposits in the western cordillera of North America (shaded area) and the location of individual deposits. The most significant deposits are named. The charts show Mexican porphyry copper resources in the context of the "great cluster" (top) and compared to world resources (bottom). Modified from Valencia-Moreno and others (2007); chart data estimated from data in Singer and others (2003).

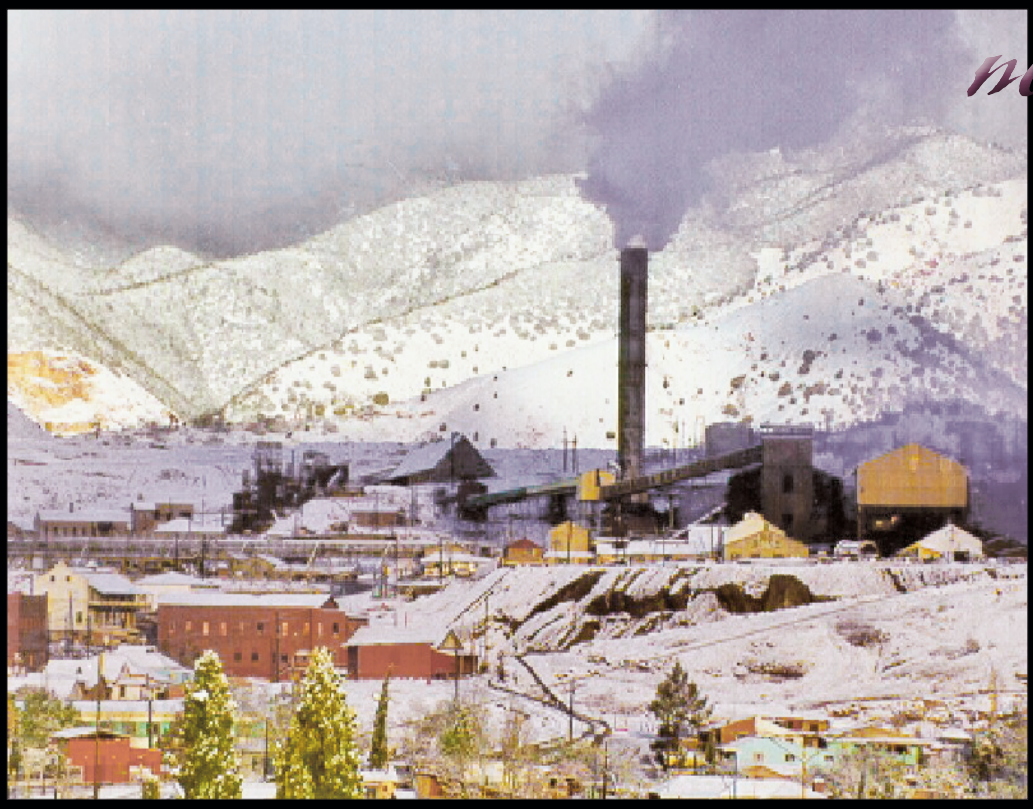
Metals Transport from Abandoned Mine Lands, Smelter Emissions, and Metal Solute Migration in Groundwater

The mid-1800s marked the beginning of a long and colorful history of mining in the western United States and Mexico. That history left a legacy of approximately 11,000 abandoned hard-rock mine sites. At many of these sites, historical mining activities—including random dumping, unfiltered smelter emission, and unrestricted metal-laden tailings leachate—resulted in adverse effects on the quality of water and sediment and on the health of humans and other biota. For example, the Cananea Consolidated Copper Company has operated a copper smelter in Cananea in Sonora, Mexico, since the late 1800s. Today, Cananea is a densely populated urban environment whose economy is based on the copper smelting industry. It is the copper capital of Mexico, but atmospheric pollution from the smelter degrades the quality of the local environment.

Understanding the processes that influence the distribution, concentration, and bioavailability of potentially toxic metallic elements is critical for the successful management of chronically affected ecosystems where the total remediation of environmental problems is not economically feasible. The USGS is coordinating with the Mexican government and other Federal agencies to ensure all of the issues of this ongoing problem are taken into account.

then

Circa 1906–1910



now

Circa 2007

The town of Cananea in Sonora (left) is the copper capital of Mexico and home to the Cananea Consolidated Copper Company. Note the number of stacks in operation in the early 1900s (top) and the single main stack operating in 2007 (bottom). The smelter stack has since been torn down.

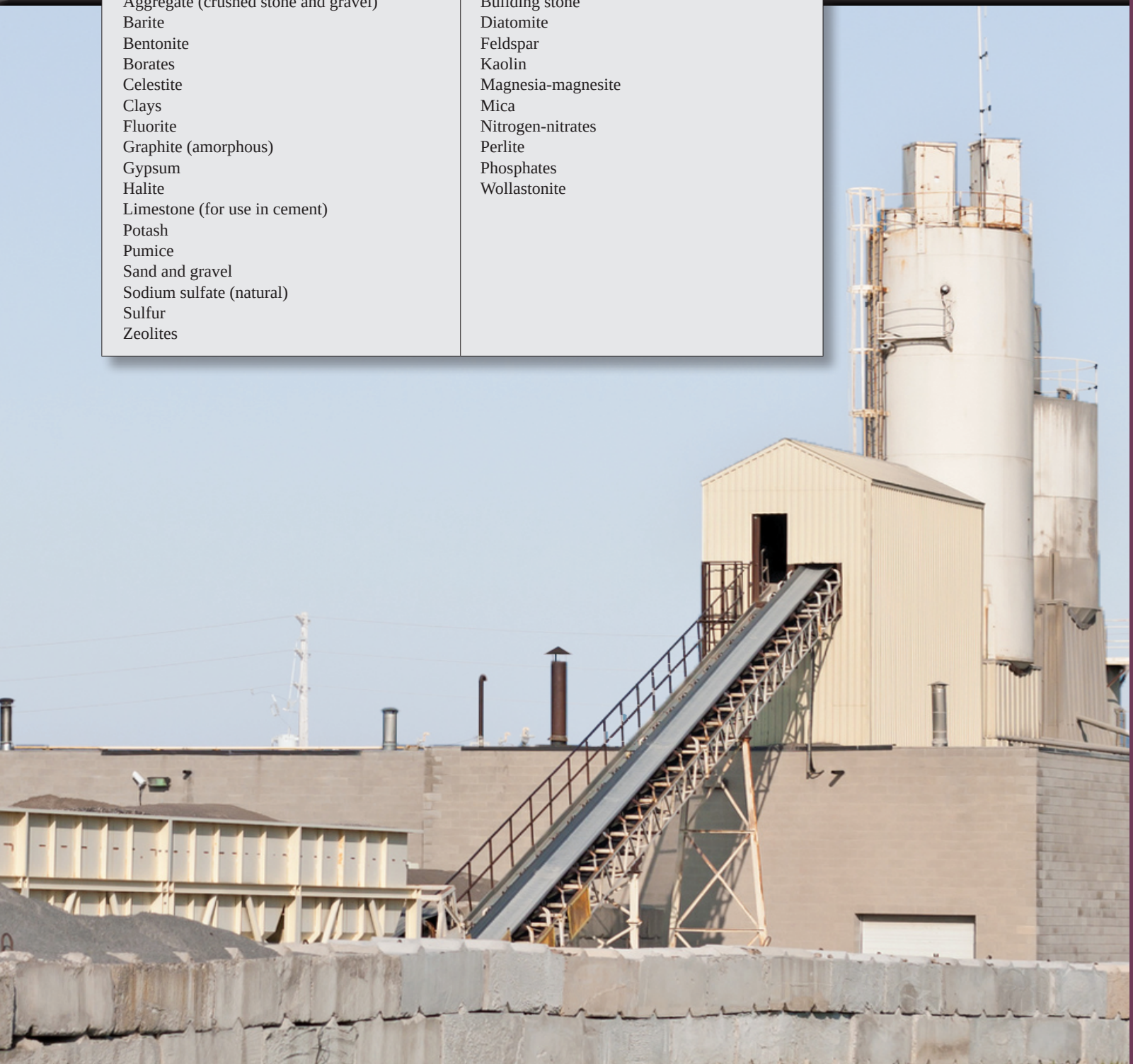
Other Mineral Deposits and Resources

Mexico is one of the world's largest producers of silver, much of which is imported across the border to the United States, but the most significant deposits are in the southern Mexican states, including Zacatecas, far from the Borderlands. For gold and silver, the distribution of major mines, prospects, and occurrences indicates that both placer and lode deposits were mined historically in the Borderlands (fig. 7–2). Precious metals, such as gold and silver, were the dominant commodities of interest in the Borderlands until the mid-19th century, when lead, zinc, and copper deposits began to be mined, eventually dominating metal production in the region. The distribution of precious metals indicates the western part of the area is richer in gold and the southeastern part of the area is richer in silver. There are no reported major gold occurrences in Nuevo León, Tamaulipas, or Coahuila, Mexico, although a few small occurrences have been reported. Figure 7–2 also shows the distribution of known mines, prospects, and occurrences where copper, lead, and zinc are the main commodities; most of these locations have since been abandoned. Lead and zinc deposits appear to be more abundant in the eastern part of the Borderlands, particularly in Chihuahua, Coahuila, and Tamaulipas. The level of ongoing modern exploration indicates that the Borderlands will continue to be a source of considerable wealth in precious metals in the foreseeable future (Orris and others, 1993).

In addition to precious and base metals discussed above, other mineral commodities are produced in the Borderlands (table 7–1). The Mexican cement company CEMEX (formerly Cementos Mexicanos) is one of the three largest cement producers in the world. Mexico is a major supplier of cement for the United States and has major limestone mining and processing operations along the border, such as those in and around the El Paso–Ciudad Juárez sister city area (Texas-Chihuahua).

Table 7–1. Mineral commodities produced in the United States–Mexican border region. Data from the Mineral Resources Data System (*http://tin.er.usgs.gov/mrds/*).

Metals	
Major	**Minor**
Copper	Iron
Gold	Mercury
Lead	Molybdenum
Silver	Rhenium
Zinc	Tungsten
Industrial Minerals and Materials	
Major	**Minor**
Aggregate (crushed stone and gravel)	Building stone
Barite	Diatomite
Bentonite	Feldspar
Borates	Kaolin
Celestite	Magnesia-magnesite
Clays	Mica
Fluorite	Nitrogen-nitrates
Graphite (amorphous)	Perlite
Gypsum	Phosphates
Halite	Wollastonite
Limestone (for use in cement)	
Potash	
Pumice	
Sand and gravel	
Sodium sulfate (natural)	
Sulfur	
Zeolites	



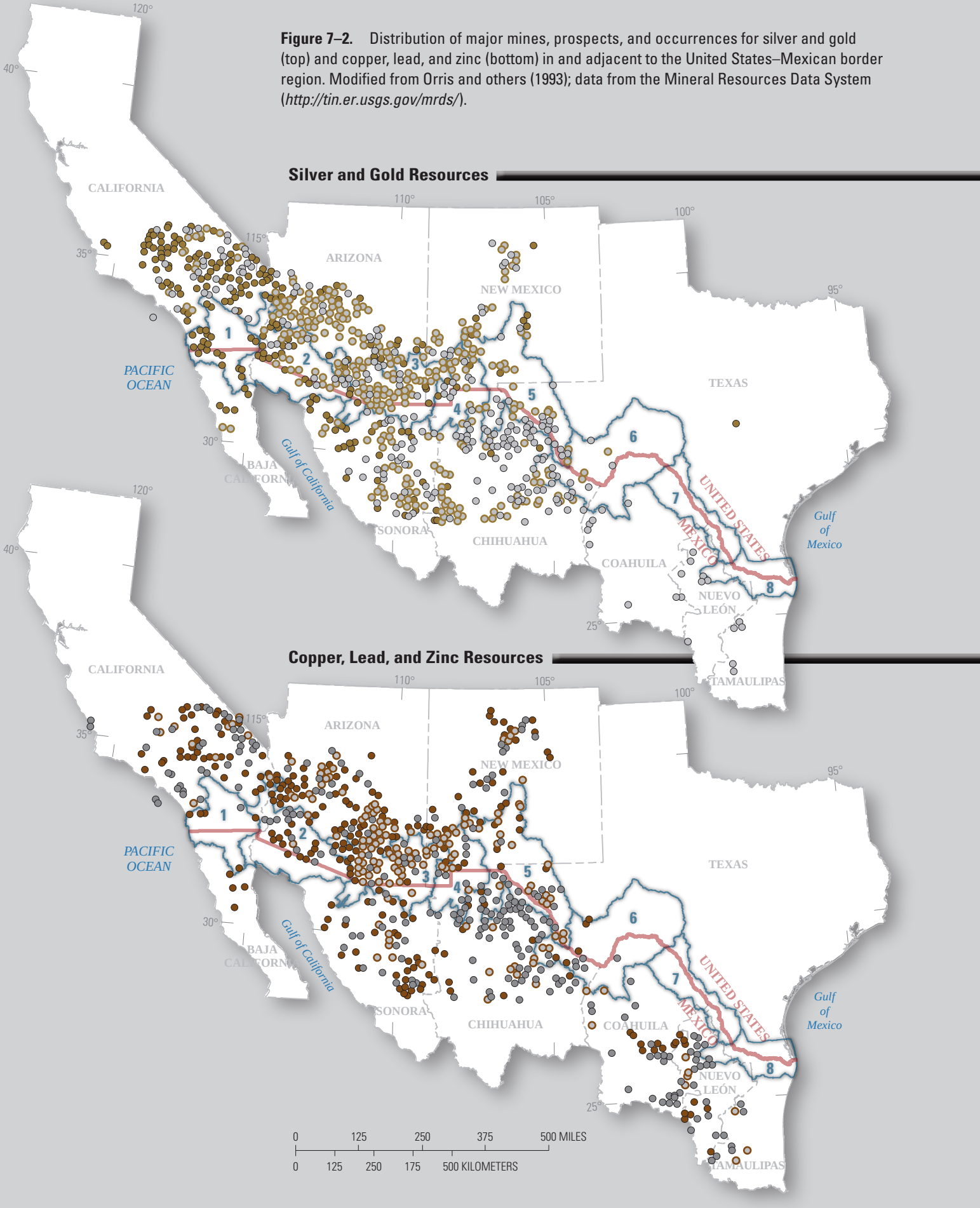


Figure 7–2. Distribution of major mines, prospects, and occurrences for silver and gold (top) and copper, lead, and zinc (bottom) in and adjacent to the United States–Mexican border region. Modified from Orris and others (1993); data from the Mineral Resources Data System (*http://tin.er.usgs.gov/mrds/*).

EXPLANATION

1

Subareas of the border region

- **1** Pacific Basins–Salton Trough
- **2** Colorado River–Gulf of California
- **3** Mexican Highlands
- **4** San Basilio–Mimbres
- **5** Rio Grande West—Elephant Butte Reservoir to Rio Conchos
- **6** Rio Grande Central—Rio Conchos to Amistad Reservoir
- **7** Rio Grande East—below Amistad Reservoir to Falcon Reservoir
- **8** Lower Rio Grande Valley

International boundary

Silver and gold resources

- Silver
- Gold
- Silver and gold

Copper, lead, and zinc resources

- Copper
- Lead and (or) zinc
- Copper and lead and (or) zinc

Acid Mine Drainage in the Patagonia Mountains

Iron-stained acid rock drainage (left side of image) converging with a neutral stream.

The Patagonia Mountains and southern Santa Rita Mountains in southeastern Arizona were mined for silver, lead, copper, and zinc intermittently from the 1600s to the mid-1960s. Studies carried out by the USGS in the Harshaw Creek and Alum Gulch watersheds examined the transport and chemical behavior of metals in several arid to semiarid watersheds containing these abandoned mine lands (see Balistrieri and others, 2007) with the goal of evaluating how climate and other conditions influence metal cycling in mining-affected ecosystems. Such knowledge is vital for developing robust models that describe the potential effects on the environment of mining activity in different climate settings.

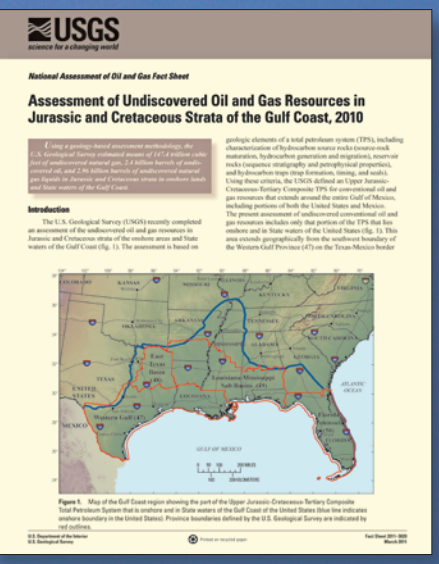
Seasonal precipitation and acid mine drainage, which contains dissolved metals such as cadmium, cobalt, copper, nickel, lead, and zinc, are the dominant sources of water to a variety of downstream habitats. During dry periods, acid rock drainage evaporates and readily soluble metal sulfate salts are deposited on rocks and in stream sediment. During storm events, these salts dissolve and release acid and metals back into solution. Downstream decreases in acid and metal concentrations after a storm event depend on the ability of the ecosystems to neutralize or buffer the acid produced during salt dissolution and on the volume of water from the storm event. If the buffering capacity of the ecosystem is small, acid and metals are transported far downstream in the dissolved phase. If the ecosystem has large buffering capacity, neutralization results in the precipitation of aluminum-iron-oxyhydroxide minerals, adsorption of metals, and release of carbon dioxide gas.

Apart from the complex biogeochemical processes affecting dissolved metals at near-neutral pH in degraded, semiarid watersheds in the Southwest, stormflow causes significant transport of aluminum, iron, zinc, copper, cadmium, and uranium associated with suspended aluminum-iron-oxyhydroxides and oxyhydroxysulfate minerals. The settling of suspended particles and precipitates in streams may result not only in the introduction of metal toxins to the streambed sediments but also in changes in the phototropic levels and in the amount of oxygen available to bottom-dwelling organisms and fish species.

Currently, there are knowledge gaps concerning the bioavailability of metals from streambed/soils, the mineralogy and speciation of metals, and the remobilization potential of adsorbed or precipitated metals associated with suspended solids under a variety of conditions in arid to semiarid regions. A major outcome of our research has been an improved understanding of the connections among weather conditions, landscape, mineral precipitation and dissolution, and metal transport. The U.S. Forest Service and the Arizona Department of Environmental Quality (*http://www.azdeq.gov/*) use this information to develop remediation plans for this mining-affected area.

Energy Resources

The Borderlands have plentiful energy resources used primarily for power generation (fig. 7–3). These resources include conventional oil and natural gas, offshore natural gas hydrates, coal and coalbed methane, oil sands, and uranium (Masters and others, 1998; USGS World Energy Assessment Team, 2000; Dyni, 2003; Dubiel and others, 2007, 2011; Meyer and others, 2007; Tewalt and others, 2008). Though it would be inaccurate to characterize Mexico as energy rich, it by no means lacks energy resources. About 92 percent of the country's energy needs are met through hydrocarbon sources (oil, gas, and coal) and about 8 percent through hydroelectric, nuclear, and renewable energy generation (U.S. Energy Information Administration, 2011). Nuclear, geothermal, wind, and solar energy are minor contributors to an economy with growing energy demands.



USGS
science for a changing world

National Assessment of Oil and Gas Fact Sheet

Assessment of Undiscovered Oil and Gas Resources in Jurassic and Cretaceous Strata of the Gulf Coast, 2010

Using a geology-based assessment methodology, the U.S. Geological Survey estimated means of 147.4 trillion cubic feet of undiscovered natural gas, 2.4 billion barrels of undiscovered oil, and 1.96 billion barrels of undiscovered natural gas liquids in Jurassic and Cretaceous strata in onshore lands and State waters of the Gulf Coast.

Introduction

The U.S. Geological Survey (USGS) recently completed an assessment of the undiscovered oil and gas resources in Jurassic and Cretaceous strata of the onshore areas and State waters of the Gulf Coast (fig. 1). The assessment is based on geologic elements of a total petroleum system (TPS), including characterization of hydrocarbon source rocks (source-rock maturation, hydrocarbon generation and migration), reservoir rocks (sequence stratigraphy and petrophysical properties), and hydrocarbon traps (trap formation, timing, and seals). Using these criteria, the USGS defined an Upper Jurassic-Cretaceous-Tertiary Composite TPS for conventional oil and gas resources that extends around the entire Gulf of Mexico, including portions of both the United States and Mexico. The present assessment of undiscovered conventional oil and gas resources includes only that portion of the TPS that lies onshore and in State waters of the United States (fig. 1). This area extends geographically from the southwest boundary of the Western Gulf Province (47) on the Texas-Mexico border

Figure 1. Map of the Gulf Coast region showing the part of the Upper Jurassic-Cretaceous-Tertiary Composite Total Petroleum System that is onshore and in State waters of the Gulf Coast of the United States (blue line indicates onshore boundary in the United States). Province boundaries defined by the U.S. Geological Survey are indicated by red outlines.

U.S. Department of the Interior
U.S. Geological Survey

Printed on recycled paper

Fact Sheet 2011–3020
March 2011

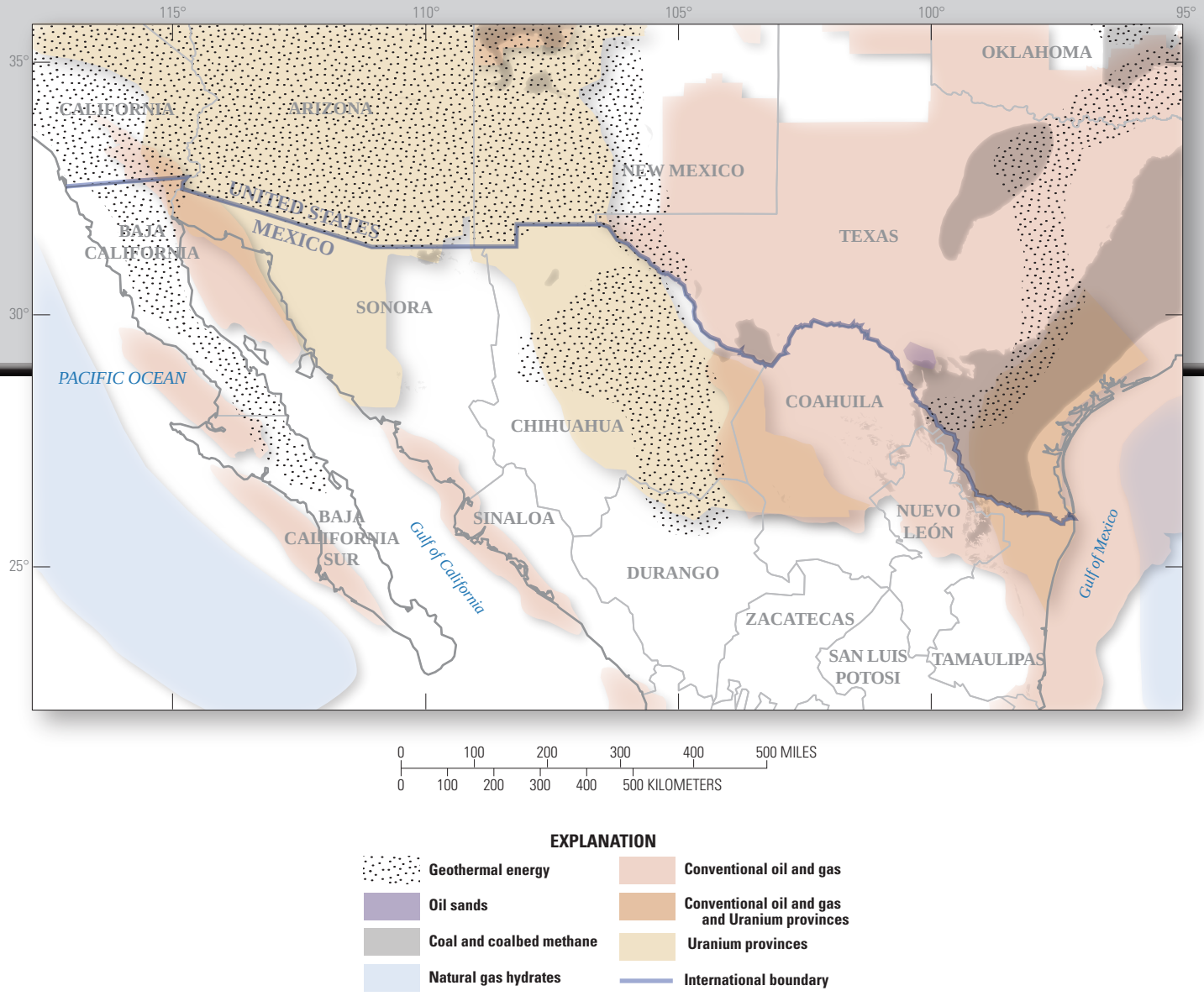


Figure 7–3. Potential energy resources along the United States–Mexican border. For potential areas for solar and wind energy development in the western United States–Mexican border region, see fig. 10–6. Compiled from Masters and others (1998), USGS World Energy Assessment Team (2000), Dyni (2003), Meyer and others (2007), and Tewalt and others (2008).

Conventional oil and natural gas resources in Texas have been exploited since the late 1800s, and the Texas oil boom of the early 20th century gave the state status as the leading oil producer in the Nation. Texas has produced more oil and natural gas than any other state to date; it remains the country's largest daily producer, and its refineries remain the most active in the United States. Natural gas production in Texas peaked in the 1970s, and production has remained steady because of increases in the number of producing wells, which are at an all-time high. In fact, most new exploration and production activities in Texas are related to natural gas, not oil.

The greatest potential petroleum resource in the Borderlands is the Burgos Basin province along the northeast border of Mexico in Tamaulipas and Nuevo León, south of Texas (fig. 7–4). The most recent U.S. Geological Survey (USGS) assessments of the hydrocarbon resources of the Burgos Basin (Schenk and others, 2004) give estimates of 20 trillion cubic feet of natural gas, 6.2 billion barrels of oil, and 0.52 billion barrels of natural gas liquids (0.57 trillion, 0.99 billion, and 0.08 billion cubic meters, respectively). Obviously, development of this basin will critically affect the economy and environment in the eastern Borderlands.

Commercial coal mining in Texas began in the 1880s, and most of the coal resources in the Borderlands are in an area extending southward from the Eagle Pass–Piedras Negras sister city area (Texas-Coahuila) to the Laredo–Nuevo Laredo sister city area (Texas-Tamaulipas). Most coal in Texas is lignite, but some bituminous coal is mined in the Piedras Negras area. The coal is used principally for steam generation at nearby power plants. All of Mexico's coal reserves are in northern Coahuila, located near the state's major coal-burning power plants in Piedras Negras, Coahuila. Because Mexico does not produce sufficient amounts of coal to meet its smelting and power demands, the rest of the country's coal needs are met through imports, primarily transported from the United States by train. Recent investigations by the USGS and others have identified coalbed methane resources in basins that span or are near the Borderlands in southeastern Texas and northeastern Mexico (Barker and others, 2003; Eguiluz de Antuñano and Amezcua Torres, 2003; Warwick and others, 2007, 2011).

Uranium resources have been mined in the South Texas uranium district since the 1960s. The closest uranium mines to the Borderlands are in Karnes County, Tex., about 60 kilometers (37 miles) southeast of San Antonio, but uranium-bearing rock formations extend southward to the border and into northern Mexico (Bureau of Economic Geology, 1981). Uranium mining increased in the district in the 1970s, but production dropped off after 1980 because of decreased demand and price. Today, most uranium resources in Texas are produced from in-place mining operations.

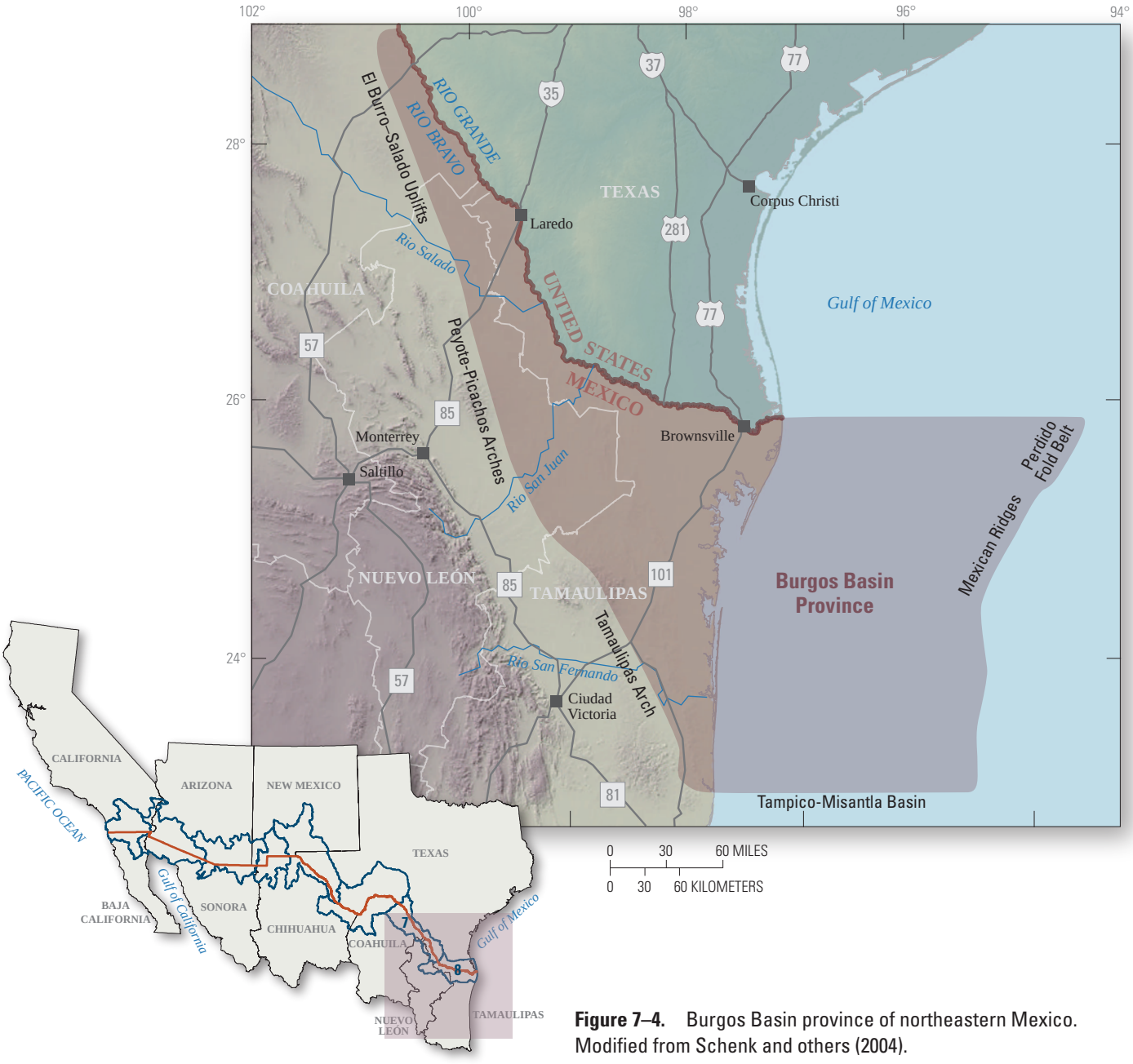
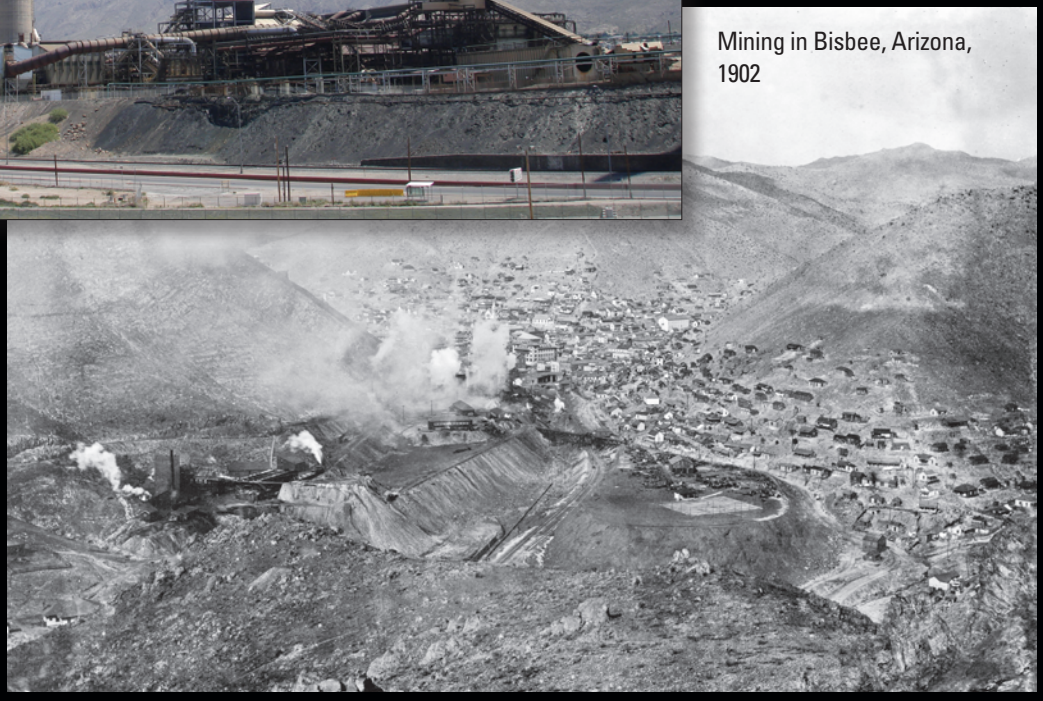


Figure 7–4. Burgos Basin province of northeastern Mexico. Modified from Schenk and others (2004).

Energy and Mineral Resource Issues

Land managers and government officials in the Borderlands are continually faced with decisions that involve the supply and use of raw materials, the substitution of one resource for another, competing land uses, and the environmental consequences of resource development. Informed planning and decisionmaking processes require integrated information from a broad area. To help supply some of the information necessary to this approach, the USGS collaborates with cooperators in unbiased, accurate scientific assessments of undiscovered energy and mineral resources based on knowledge of identified resources and an understanding of the processes that influence the distribution, concentration, and bioavailability of potentially toxic elements. For Federal, State, and local agencies charged with minimizing the effects of toxic elements on human health and the environment, investigations carried out in this way provide the scientific foundation needed to make decisions, develop strategy, and assess mitigation and remediation alternatives (Balistrieri and others, 2007).

ASARCO copper smelting plant

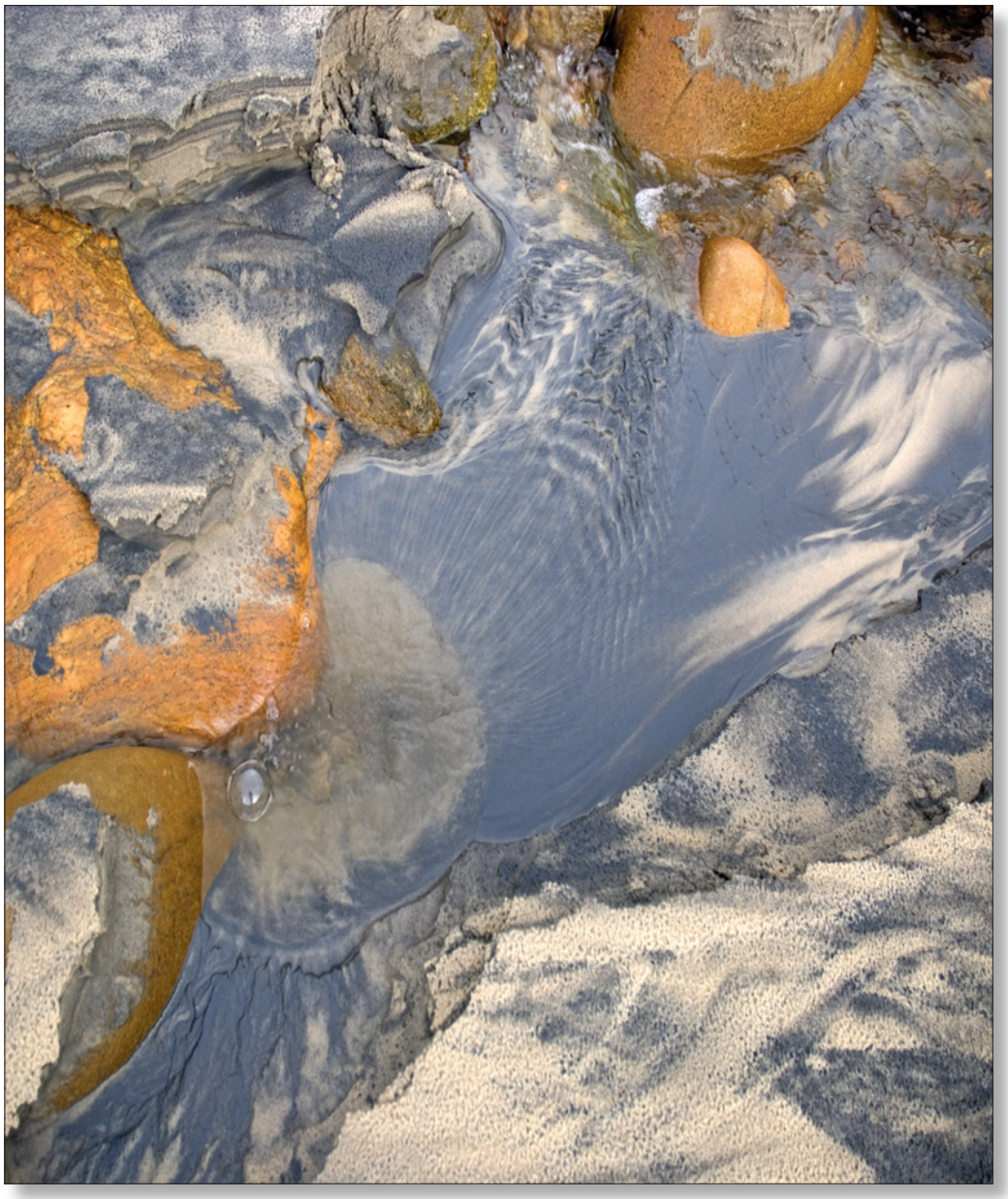


Mining in Bisbee, Arizona, 1902

After more than a century of industrialization, agriculture, and urbanization as a significant source and processing area for the Nation's energy and mineral needs, the Borderlands have a legacy of disturbed land—much of it damaged prior to the regulatory oversight of the mid to late 20th century. The mineral and fuel deposits in the Borderlands, however, remain important to domestic and international users, so interaction with resources still plays a potentially key role in the geoenvironmental status of the area. Geologic studies are crucial in understanding the issues associated with the thousands of abandoned mines on Federal lands, such as the effects of metals dispersion in air and water and the occurrences and cycles of toxins and pathogens in soils (see the USGS Abandoned Mine Lands Initiative, *http://amli.usgs.gov/*). Geologic research in these areas develops precision techniques and instrumentation used to identify sources of contamination and the processes that interact to create the biogeochemical cycles that ultimately affect human and habitat health. An important example of environmental effects of past mining activities in the Borderlands is the ASARCO[1] metals smelter in El Paso, Tex., where the U.S. Environmental Protection Agency is currently investigating soil contamination in the smelter area and planning future clean-up operations in populated neighborhoods adjacent to the smelter. The smelter processed lead and copper from Arizona and the western United States until the 1990s. Other metal smelters historically were active in the Borderlands, such as the Cananea copper smelter in northern Sonora, Mexico, and smelters in the Laredo, Texas, area. Several other examples of the effects of past mining activities in Arizona and Sonora are discussed in the "*. . . facing the challenge*" sections on pages 160–161 and 166–167.

[1] Formerly the American Smelting and Refining Company.

Although energy resources (coal, oil, and natural gas) are the foundation for modern industrial society, aspects of the extraction, processing, and utilization of these resources can potentially impair human and wildlife health. For example, energy resources can contain chemical substances that, if mobilized into air, water, and soil, can be harmful to humans and wildlife. Toxic substances from coal found in some water supplies in areas of southeastern Europe have been connected to kidney disease and cancer (Orem and others, 2010), and coal-fired power plants in Texas and Coahuila release large amounts of CO_2, which increase rates of greenhouse gas emissions and thus contribute to climate change and global warming. Coal-burning plants are also major point sources in the Borderlands (Martinez and Deshpande, 2009) for emissions of particulate matter that includes toxic mercury and arsenic. Chemical plants, petroleum refineries, and oil and gas production facilities in southern Texas and northern Mexico can introduce harmful substances into the environment, including volatile organic compounds, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), sulfur dioxide, benzene, and toluene. The recent Deepwater Horizon oil spill in the Gulf of Mexico (*http://www.usgs.gov/oilspill*) exemplifies the vulnerability of Borderlands society and its economy and ecosystems to similar potential disasters in the Tamaulipas and Texas coastal areas of the Borderlands.



Fire boat crews responding to the blaze on the Deepwater Horizon offshore rig

Areas of dark brown and red emulsion oil near the convergence zone of the Deepwater Horizon oil spill, May 2010

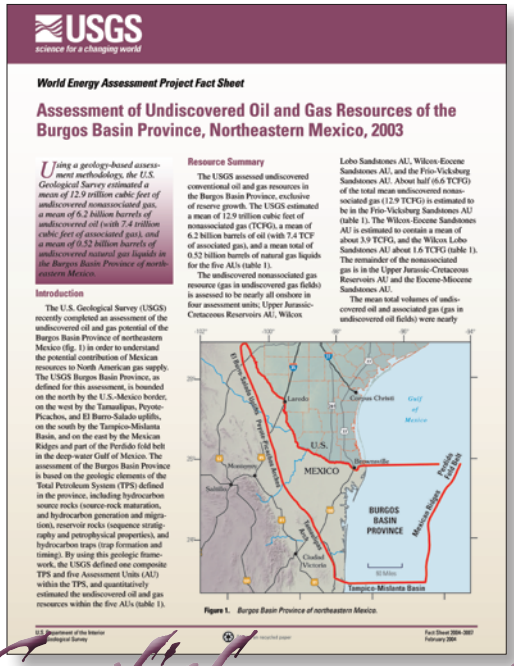
USGS Capabilities

The USGS is currently engaged in several projects that have the potential to respond to the growing need for international mineral information, such as the evaluation of concealed mineral deposits, the geoenvironmental modeling project, and the Global Mineral Resource Assessment Project. In addition, the existing project objectives can be tailored to integrate and coordinate with the regional and binational aspects of the Borderlands.

Because the Borderlands host several world-class mineral belts, its ability to supply many basic minerals to industries within and outside of its boundaries contributes to the prospect of a dynamic economic future for the region. Initial compilation of nonfuel mineral resource data—precious metals, base metals, and mineral commodities used in infrastructure, agriculture, and environmental improvement—yields approximately 9,300 known deposits and occurrences in the Borderlands. In the near future, with increased demand for metals and hence higher commodity prices, the exploration for and exploitation of mineral deposits are likely to experience significant growth. Preliminary assessment of the geological terranes indicates that further exploration in northern Mexico could augment the known deposits of many metallic and industrial minerals, including copper, silver, zeolites, and clays, as well as aggregate, sand, and gravel.

Silver Bell mine, Arizona

The USGS already has carried out assessments of the undiscovered but technically recoverable oil and gas resources throughout the United States Gulf Coast and northeastern Mexico (Schenk and Viger, 1995 a, b; USGS World Energy Assessment Team, 2000; Pollastro and others, 2001; Schenk and others, 2004; Condon and Dyman, 2006; Dyman and Condon, 2006; Dubiel and others, 2007; Pittman and others, 2007; Warwick and others, 2007). These assessments are based on geologic elements such as the presence of hydrocarbon source rocks, suitable reservoir rocks, and hydrocarbon traps within the total petroleum systems identified in the region. Assessment of undiscovered oil and gas potential in basins in the Borderlands is necessary to understand the potential contribution of Mexican resources to the North American gas supply (Schenk and others, 2004). In 2004, a USGS assessment of the Burgos Basin in northeastern Mexico (fig. 7–4) was undertaken to understand this basin's potential contributions to the regional gas supply (Schenk and others, 2004); detailed oil and gas assessments of other basins in Mexico have also been reported (Schenk, 2012). Recent assessments of geothermal energy resources (Williams and others, 2008) and ongoing investigations into offshore natural gas hydrates (National Energy Technology Laboratory, 2008) and uranium resources (USGS Energy Resource Program, 2008) will add to a better understanding of the energy resource base in the Borderlands.



USGS
science for a changing world

World Energy Assessment Project Fact Sheet

Assessment of Undiscovered Oil and Gas Resources of the Burgos Basin Province, Northeastern Mexico, 2003

Using a geology-based assessment methodology, the U.S. Geological Survey estimated a mean of 12.9 trillion cubic feet of undiscovered nonassociated gas, a mean of 6.2 billion barrels of undiscovered oil (with 7.4 trillion cubic feet of associated gas), and a mean of 0.52 billion barrels of undiscovered natural gas liquids in the Burgos Basin Province of northeastern Mexico.

Introduction

The U.S. Geological Survey (USGS) recently completed an assessment of the undiscovered oil and gas potential of the Burgos Basin Province of northeastern Mexico (fig. 1) in order to understand the potential contribution of Mexican resources to North American gas supply. The USGS Burgos Basin Province, as defined for this assessment, is bounded on the north by the U.S.-Mexico border, on the west by the Tamaulipas, Peyote-Picachos, and El Burro-Salado uplifts, on the south by the Tampico-Misantla Basin, and on the east by the Mexican Ridges and part of the Perdido fold belt in the deep-water Gulf of Mexico. The assessment of the Burgos Basin Province is based on the geologic elements of the Total Petroleum System (TPS) defined in the province, including hydrocarbon source rocks (source-rock maturation, and hydrocarbon generation and migration), reservoir rocks (sequence stratigraphy and petrophysical properties), and hydrocarbon traps (trap formation and timing). By using this geologic framework, the USGS defined one composite TPS and five Assessment Units (AU) within the TPS, and quantitatively estimated the undiscovered oil and gas resources within the five AUs (table 1).

Resource Summary

The USGS assessed undiscovered conventional oil and gas resources in the Burgos Basin Province, exclusive of reserve growth. The USGS estimated a mean of 12.9 trillion cubic feet of nonassociated gas (TCFG), a mean of 6.2 billion barrels of oil (with 7.4 TCF of associated gas), and a mean total of 0.52 billion barrels of natural gas liquids for the five AUs (table 1).

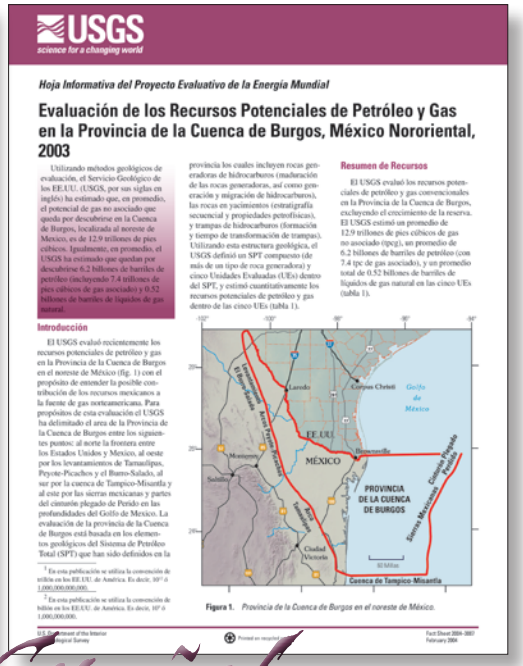
The undiscovered nonassociated gas resource (gas in undiscovered gas fields) is assessed to be nearly all onshore in four assessment units; Upper Jurassic-Cretaceous Reservoirs AU, Wilcox Lobo Sandstones AU, Wilcox-Eocene Sandstones AU, and the Frio-Vicksburg Sandstones AU. About half (6.6 TCFG) of the total mean undiscovered nonassociated gas (12.9 TCFG) is estimated to be in the Frio-Vicksburg Sandstones AU (table 1). The Wilcox-Eocene Sandstones AU is estimated to contain a mean of about 3.9 TCFG, and the Wilcox Lobo Sandstones AU about 1.6 TCFG (table 1). The remainder of the nonassociated gas is in the Upper Jurassic-Cretaceous Reservoirs AU and the Eocene-Miocene Sandstones AU.

The mean total volumes of undiscovered oil and associated gas (gas in undiscovered oil fields) were nearly

Figure 1. *Burgos Basin Province of northeastern Mexico.*

U.S. Department of the Interior
U.S. Geological Survey
Printed on recycled paper
Fact Sheet 2004–3007
February 2004

English



USGS
science for a changing world

Hoja Informativa del Proyecto Evaluativo de la Energía Mundial

Evaluación de los Recursos Potenciales de Petróleo y Gas en la Provincia de la Cuenca de Burgos, México Nororiental, 2003

Utilizando métodos geológicos de evaluación, el Servicio Geológico de los EE.UU. (USGS, por sus siglas en inglés) ha estimado que, en promedio, el potencial de gas no asociado que queda por descubrirse en la Cuenca de Burgos, localizada al noreste de México, es de 12.9 trillones de pies cúbicos. Igualmente, en promedio, el USGS ha estimado que quedan por descubrirse 6.2 billones de barriles de petróleo (incluyendo 7.4 trillones de pies cúbicos de gas asociado) y 0.52 billones de barriles de líquidos de gas natural.

Introducción

El USGS evaluó recientemente los recursos potenciales de petróleo y gas en la Provincia de la Cuenca de Burgos en el noreste de México (fig. 1) con el propósito de entender la posible contribución de los recursos mexicanos a la fuente de gas norteamericana. Para propósitos de esta evaluación el USGS ha delimitado el área de la Provincia de la Cuenca de Burgos entre los siguientes puntos: al norte la frontera entre los Estados Unidos y México, al oeste por los levantamientos de Tamaulipas, Peyote-Picachos y el Burro-Salado, al sur por la cuenca de Tampico-Misantla y al este por las sierras mexicanas y partes del cinturón plegado de Perdido en las profundidades del Golfo de México. La evaluación de la provincia de la Cuenca de Burgos está basada en los elementos geológicos del Sistema de Petróleo Total (SPT) que han sido definidos en la provincia los cuales incluyen rocas generadoras de hidrocarburos (maduración de las rocas generadoras, así como generación y migración de hidrocarburos), las rocas en yacimientos (estratigrafía secuencial y propiedades petrofísicas), y trampas de hidrocarburos (formación y tiempo de transformación de trampas). Utilizando esta estructura geológica, el USGS definió un SPT compuesto (de más de un tipo de roca generadora) y cinco Unidades Evaluadas (UEs) dentro del SPT, y estimó cuantitativamente los recursos potenciales de petróleo y gas dentro de las cinco UEs (tabla 1).

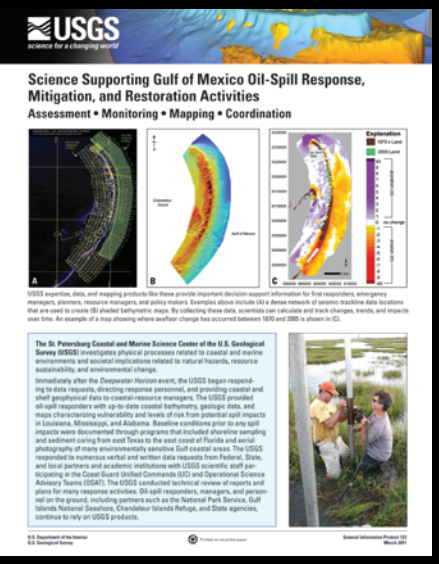
Resumen de Recursos

El USGS evaluó los recursos potenciales de petróleo y gas convencionales en la Provincia de la Cuenca de Burgos, excluyendo el crecimiento de la reserva. El USGS estimó un promedio de 12.9 trillones de pies cúbicos de gas no asociado (tpcg), un promedio de 6.2 billones de barriles de petróleo (con 7.4 tpc de gas asociado), y un promedio total de 0.52 billones de barriles de líquidos de gas natural en las cinco UEs (tabla 1).

Figura 1. *Provincia de la Cuenca de Burgos en el noreste de México.*

Publicado en papel reciclado
Hoja Informativa 2004–3007
Febrero 2004

Español


USGS
science for a changing world

Science Supporting Gulf of Mexico Oil-Spill Response, Mitigation, and Restoration Activities

Assessment • Monitoring • Mapping • Coordination

On the environmental side of oil and gas production, the USGS is playing a critical role in assessing the effects of the Deepwater Horizon oil spill, and it continues to gather scientific data on the environmental effects of the spill on nearby coastal habitats. In the days after the spill, USGS scientists responded by collecting samples from Texas, Louisiana, Mississippi, Alabama, and Florida before the oil could make landfall in order to establish baseline conditions for water chemistry, bottom sediments, and aquatic invertebrates. They also collected samples from barrier islands and coastal wetlands; these areas are critical to fish and wildlife in the Gulf of Mexico and could have suffered severe environmental damage had oil from this spill come ashore.

In addition, USGS scientists collected satellite imagery to assess the spill's effects on wetlands and coasts, developed maps showing projections by the National Oceanic and Atmospheric Administration of spill trajectory with respect to lands owned by the U.S. Department of the Interior (DOI), collected samples to ascertain source and levels of toxicity to soils and water systems, conducted tests to determine cause of mortality of wildlife, and developed models that depict how local tidal and current conditions interact with seafloor bathymetry to carry oil over barrier islands. Many of these projects are ongoing. The USGS also provides decision support tools to land managers with the DOI to help mitigate the effects of the oil spill and assist in restoration efforts.

References cited in this chapter are listed in chapter 12.

U.S. Geological Survey scientist collecting sediment core samples on the Gulf Coast in response to the Deepwater Horizon oil spill, October 2010