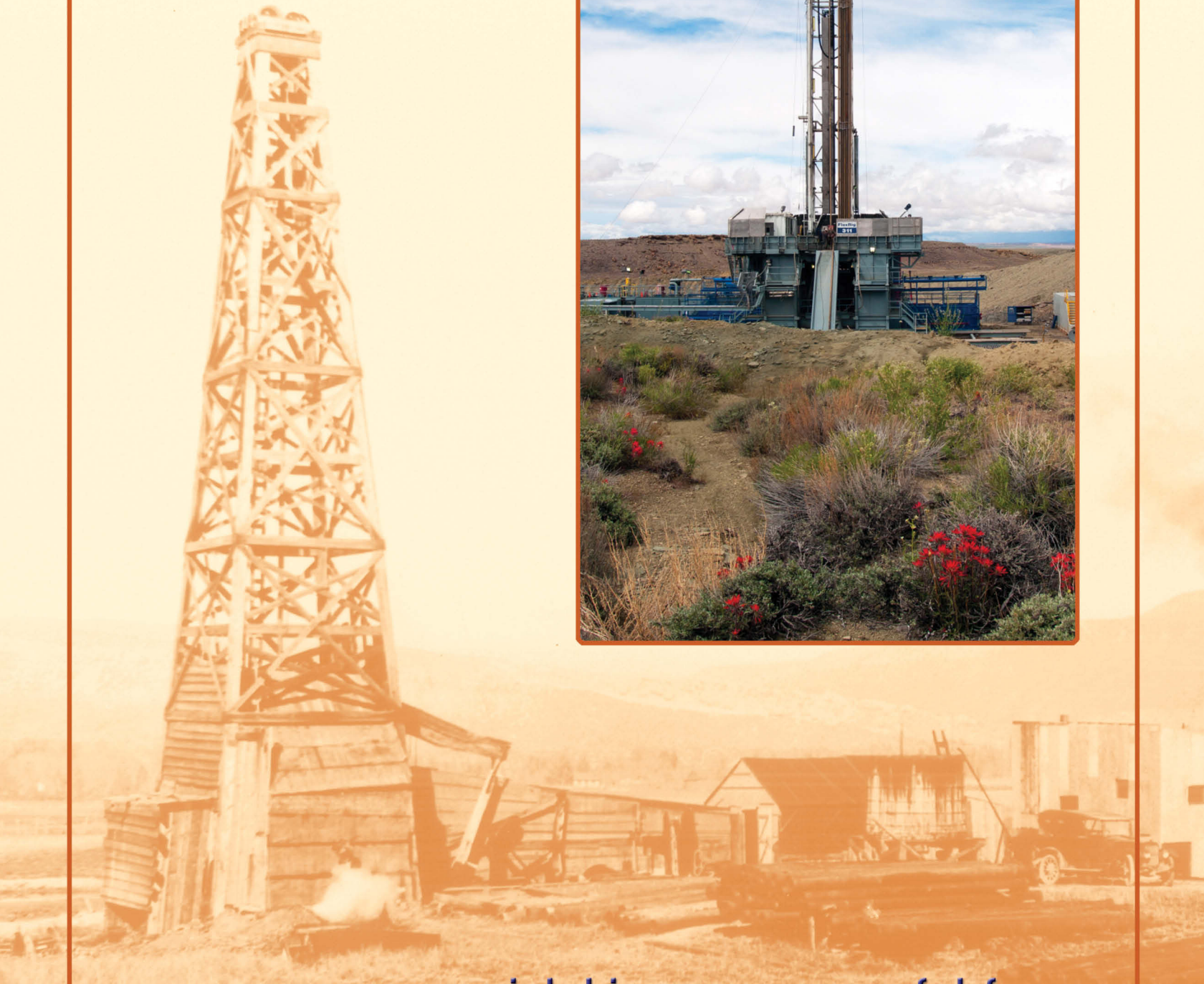
UTAH
Oil and Gas



...a rich history, a powerful future

Contact Information

For information about oil and gas programs, geophysical well logs, publications, geological samples, regulations and permitting, production, and leasing of state lands, contact the following:

Utah Geological Survey

1594 W. North Temple, Suite 3110
P.O. Box 146100
Salt Lake City, UT 84114-6100
801-537-3300, Fax: 801-537-3400
geology.utah.gov

Petroleum Geology
Thomas C. Chidsey, Jr.
Petroleum Section Chief
801-537-3364/801-537-3300
tomchidsey@utah.gov

Library
Robyn Keeling, Librarian
801-537-3333
robynkeeling@utah.gov

Natural Resources Map and Bookstore
801-537-3320 or 888-UTAH-MAP
mapstore.utah.gov
geostore@utah.gov

Utah Core Research Center
Peter Nielsen, Curator/Geologist
240 North Redwood Road
Salt Lake City, UT 84114
801-537-3359
peternielsen@utah.gov

Division of Oil, Gas, and Mining

1594 W. North Temple, Suite 1210
P.O. Box 145801
Salt Lake City, UT 84114-5801
801-538-5340
ogm.utah.gov

Vicky Dyson
Public Information Center
801-538-5279/801-538-5283

John Rogers
Associate Director for Oil and Gas
801-538-5349
johnrogers@utah.gov

School and Institutional Trust Lands Administration (SITLA)

675 East 500 South, Suite 500
Salt Lake City, UT 84102-2818
801-538-5100
trustlands.utah.gov

LaVonne J. Garrison
Assistant Director/Oil and Gas
801-538-5197
lavonnegarrison@utah.gov

Jim Davis
Field Supervisor/Oil and Gas
801-538-5156
jimdavis1@utah.gov

Advisors to the Governor

Utah Governor's Office
governor.utah.gov
Cody Stewart
Energy Policy Adviser
801-538-8802
codystewart@utah.gov
324 South State Street, Suite 500
Salt Lake City, Utah 84111

Office of Energy Development
energy.utah.gov
Samantha Mary Julian
Director, Utah Office of Energy Development
801-538-8726
sjulian@utah.gov
60 East South Temple, 3rd Floor
Salt Lake City, Utah 84111

Cover Photo: *Drilling operations, Natural Buttes field targeting "tight" gas in the Tertiary Wasatch Formation and Cretaceous Mesaverde Group, Uinta Basin.*
Background Photos: *Utah's early oil exploration drilling, development operations, pipeline construction, and Utah State Capitol. Used by permission, Utah State Historical Society, all rights reserved.*

Message from the Governor

Gary R. Herbert

As Governor, I am pleased to invite energy exploration, development, and investment companies to the State of Utah. Our state offers tremendous natural resources and the prospect to develop many unexplored areas that have the geological potential for containing ample oil and gas reserves. Moreover, businesses will benefit from our favorable regulatory environment, streamlined well-permitting process, educated workforce, and excellent infrastructure.

Utah is endowed with a wealth of diverse natural energy resources that enable us to contribute significantly to meeting the nation's energy needs. Our oil and gas production is growing, with Utah being ranked 11th for oil production and 9th for natural gas production in the United States. Our state's rich oil shale and tar sand resources have attracted attention from investors, innovators, and businesses worldwide.

Energy is, in fact, a crucial cornerstone of Utah's prosperity. Recognizing the importance of energy to all aspects of our economic vitality, I created a *10-Year Strategic Energy Plan* for the State of Utah. It outlines recommendations to position Utah among the top energy producers in the country. I invite you to view the plan at www.energy.utah.gov.

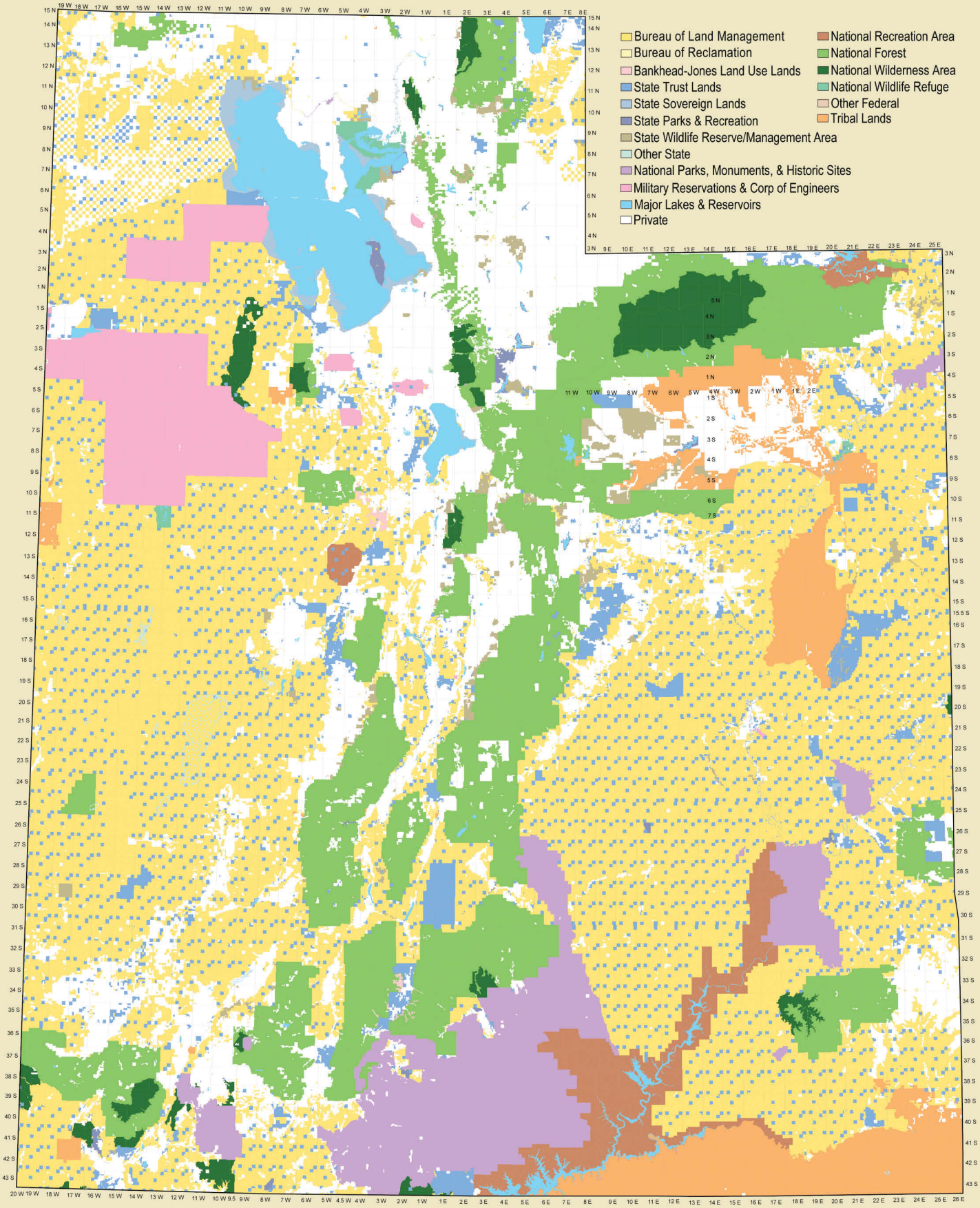
This brochure on Utah's hydrocarbon resources will help you learn about investing in our promising energy future. In addition, I encourage you to contact the Utah Geological Survey; Division of Oil, Gas, and Mining; School and Institutional Trust Lands Administration; and Utah Office of Energy Development for further information about energy exploration and development opportunities in our great state. Utah's energy industry is ready to grow and prosper now and far into the future.

Welcome to Utah!

Sincerely,

Gary R. Herbert
Governor

Map of Land Ownership



SITLA: Managing 4.5 Million Acres of Mineral Trust Lands in Utah

The School and Institutional Trust Lands Administration (SITLA) is an independent state agency managing 4.5 million acres of Utah mineral trust lands exclusively for the benefit of Utah's schools and 11 other beneficiaries.

While over one million acres of trust lands are already leased for oil and gas exploration and development, more than three million acres are yet to be evaluated for oil and gas potential.

Advantages to working with SITLA

- Fast and easy to commit lands to a lease or exploration agreement
- Competitive bidding and Internet offerings
  - Sealed bid oil and gas lease offerings in January, April, July and October. Contact us to join our bid mailing list or visit trustlands.utah.gov and follow our *Current and Prior Lease Offering* link.
  - Select parcels listed for bid at energynet.com
- Flexible business arrangement options and special development terms for selected parcels, such as:
  - Exploration and development agreements
  - Farmouts
  - Seismic options
- Attractive royalties
- Streamlined state permitting process through the Division of Oil, Gas, and Mining

Pump jack - Drunkards Wash field, Carbon County

CONTACT US

LaVonne Garrison	801-538-5197	lavonnegarrison@utah.gov
Jim Davis	801-538-5156	jimdavis1@utah.gov

For more information or to download our ownership map, visit trustlands.utah.gov.

OGM: Utah's Regulatory Environment

The Oil and Gas Regulatory Program within the Division of Oil, Gas, and Mining (OGM) regulates exploration for, and development of, oil and gas resources in Utah.

The Oil and Gas Regulatory Program incorporates important conservation principles derived from the historical exploitation of petroleum resources in the United States. It is our obligation to promote the wise development of oil and gas, preventing waste and maximizing ultimate recovery, while protecting the environment so that the public might realize the greatest possible good from these natural resources.

It is also our duty to protect correlative rights of all owners of oil and gas resources, controlling the proper participation and sharing of the various owners within an oil and gas pool.

OGM issues permits for all wells whether they are on private land, SITLA lands or the vast expanse of Federal (Bureau of Land Management, Tribal, or Forest Service) lands in Utah.

Through roughly 50 years of existence, the oil and gas conservation program has evolved into a user-friendly system for effective regulation of the state's oil and gas industry.

Drilling operations, Greater Aneth field, San Juan County

- **Permits** – The Division provides timely processing and approval of various permits involving drilling, workover and recompletion operations, underground injection, well plugging, and waste management.

- **Monitoring** – An experienced field staff monitors operations with regular inspections, enforcement, and database tracking of field operations.

- **Record Keeping and Public Information** – Basic well data, well histories, injection data, production reporting, operator statuses, and bonding are electronically stored and easily retrieved in our public information room or on our Web site.

- **Reporting Compliance** – An audit staff conducts reviews of industry compliance reports to ensure accurate and timely documentation.

- **Other Services** – Technicians provide expertise relating to tax credit qualification, royalty payment disputes, mapping, and abandoned well plugging.

Providing technically current, timely, and quality regulatory services—
The Utah Division of Oil, Gas, and Mining.

Exploration History

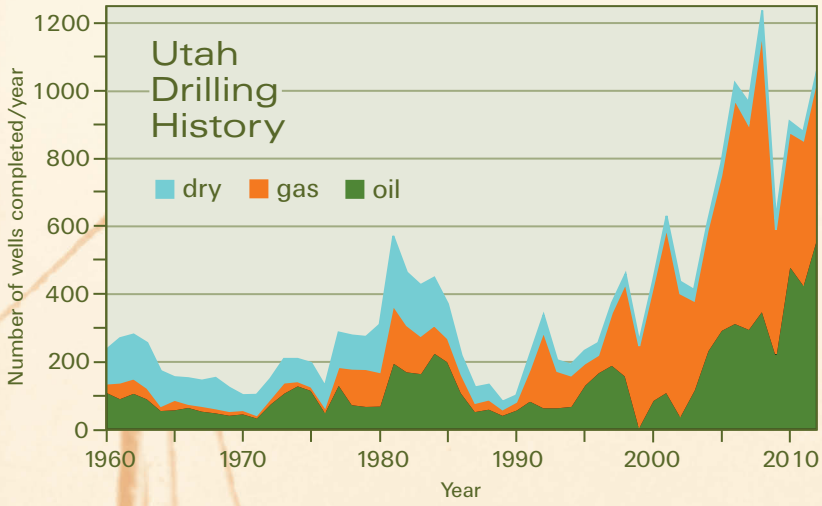
Utah's oil and gas exploration history extends back over 100 years. In 1891, natural gas was accidentally discovered at a depth of 1000 feet in Farmington Bay on the eastern shore of Great Salt Lake during the drilling of a water well. Between 1895 and 1896, gas from several wells near this location was transported to Salt Lake City in a wooden pipe, marking Utah's first use of local oil or gas. The first oil shows were encountered in wells drilled during the early 1900s at Rozel Point (northern Great Salt Lake), Mexican Hat (near Monument Valley, southeastern Utah), and near the town of Virgin (near Zion National Park). Although oil shows were also found at several other eastern Utah locations in later decades, it was not until 1948 that Utah's first large-scale commercial oil well, Ashley Valley No.1, was drilled near Vernal. By 1960, Utah was the 10th largest oil-producing state in the country, and it has remained in the top 15 since then. Today there are over 11,000 producing oil and gas wells.

Exploring beneath Great Salt Lake in 1978

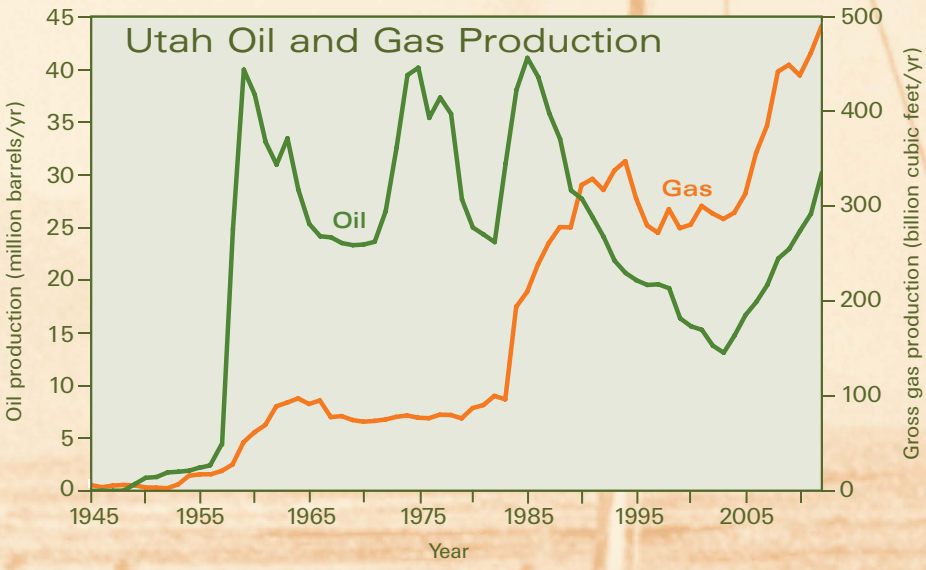
First central Utah "Hingeline" discovery, Covenant field, Sevier County, in 2004

First thrust belt discovery, Pineview field, Summit County, in 1975

Utah's drilling history has fluctuated greatly due to discoveries, oil and gas price trends, and changing exploration targets. During the boom period of the early 1980s, activity peaked at over 500 wells per year. After slowing in the 1990s, drilling activity has again increased, averaging 940 well completions between 2005 and 2012, peaking in 2008 at 1238 wells. This increase in activity has been spurred by high prices for both oil and natural gas, and perceptions that Utah is highly prospective and under-explored. In recent years, the proportion of new wells exploring for oil has increased greatly. The success rate of exploration drilling for both oil and gas has also improved, with very few dry holes being reported compared to the 1980s drilling boom. Sustained high oil prices are likely to entice less risk-averse exploration investment (more wildcats), resulting in new discoveries.



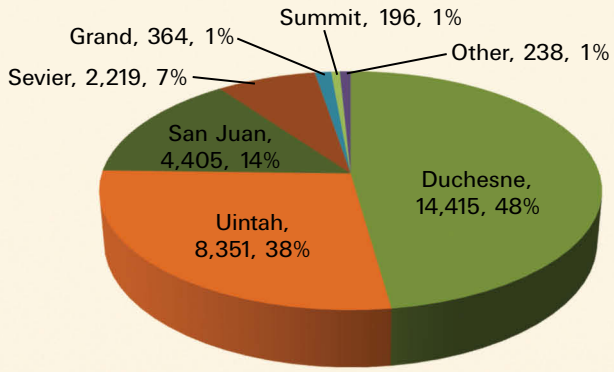
Utah oil fields have produced a total of 1.5 billion barrels (bbl). Although annual production decreased from a peak of 41 million bbl in 1985 to 13 million bbl in 2003, the trend has reversed and 2012 production reached 30 million bbl. Two components of this turn-around are the discovery of Covenant field in a region known as the "Hingeline" or central Utah thrust belt, and increased drilling along the Monument Butte trend in the central Uinta Basin. Despite over 50 years of production at rates that have varied by a factor of three, proven oil reserves during this time have risen to 582 million bbl, indicating significant oil remains to be produced. Higher oil prices, horizontal drilling technology, more elaborate completion techniques (such as hydraulic fracturing or "fracking"), and secondary and tertiary recovery techniques should collectively result in a continued boost in production rates and ultimate recovery from both known fields and new discoveries. There is also resurgence in interest in Utah's substantial oil shale and tar sand resources, which received brief attention during the 1970s oil supply crisis.



Total natural gas production from Utah fields now exceeds 11 trillion cubic feet (Tcf), with sold production close to 8 Tcf. The difference in these two volumes is mainly due to reinjection of produced gas and nitrogen at Anschutz Ranch East field as part of a pressure maintenance program to prevent retrograde condensate loss. Total proven reserves of gas are over 7 Tcf, and annual sold production is close to 0.3 Tcf. Gas production is at an all-time high despite low prices. Although gas production from some fields declined during the late 1990s, two factors caused overall gas production to increase. Deeper exploration drilling in the eastern and southern Uinta Basin during the past ten years has led to discoveries of substantial gas accumulations in Mesaverde, Entrada, and Wingate reservoirs. Also, the development of coalbed methane accumulations in the Ferron play, in particular Drunkards Wash field, has added 10% to the total annual gas production. Significant potential exists for other coal fields around the Uinta Basin to yield coalbed methane, and the extent of deeper conventional, and unconventional tight sand and shale gas plays remains to be explored.

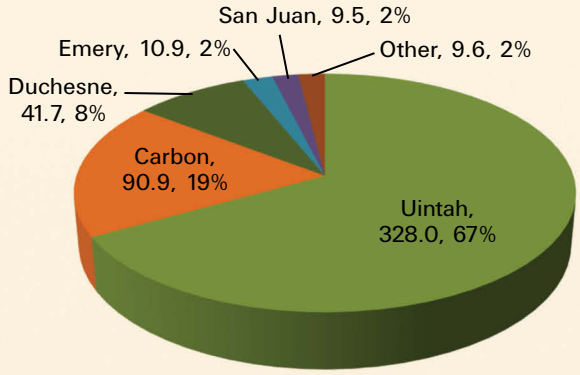
Crude Oil Production by County, 2012

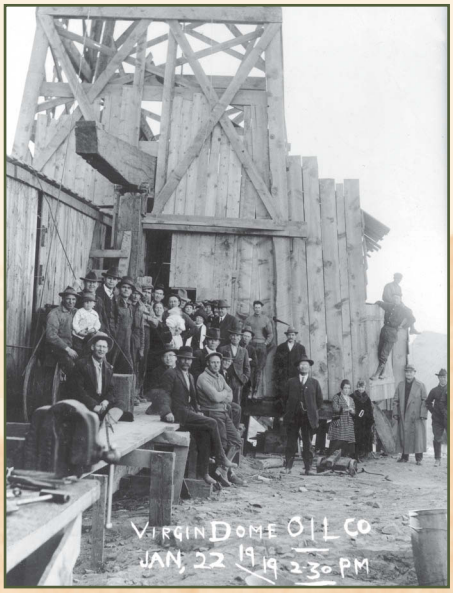
(thousand barrels)



Natural Gas Production by County, 2012

(billion cubic feet)





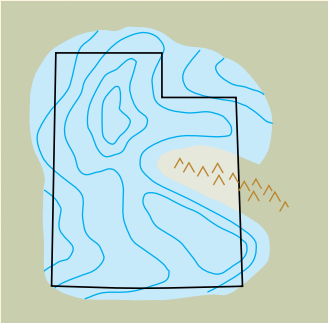
Virgin oil field - Utah's first oil production (only minor production realized)

General Geologic Setting

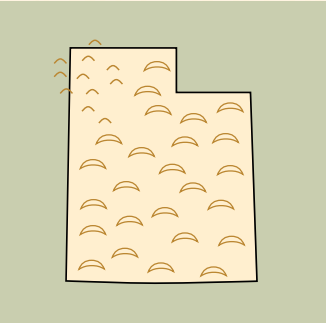
The ages of the rocks exposed in Utah include every geologic eon, era, period, and epoch. Many of these rocks have the qualities necessary to create the oil and gas reservoirs, sources, and seals that make Utah a petroleum-producing state with large, relatively unexplored areas of hydrocarbon potential. Because of Utah's world-class rock exposures, every producing formation and type of trap in the state can be examined in outcrop analogs. Many of these serve as outcrop analogs for oil and gas fields outside of Utah as well as providing a natural laboratory for study.

A combination of depositional and structural events created the major petroleum-producing provinces in Utah: Paradox Basin, Ferron coalbed methane fairway, thrust belt, Uncompahgre uplift, and Uinta Basin.

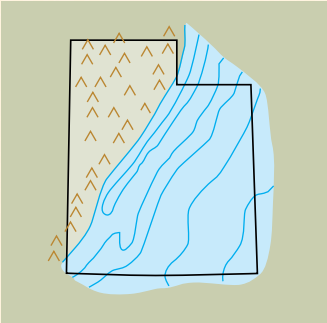
During the Pennsylvanian, the Paradox Basin developed in southeastern Utah where cyclic organic-rich shales, carbonates, and evaporites accumulated under restricted marine conditions in the rapidly subsiding basin. The Paradox Basin contains Utah's largest oil field, Greater Aneth and many small fields, productive in reef-like buildups of algae. Renewed movement on deep, older basement faults in the basin formed structures productive in Mississippian-age carbonates.



Permian - Pennsylvanian
(240-330 mya)



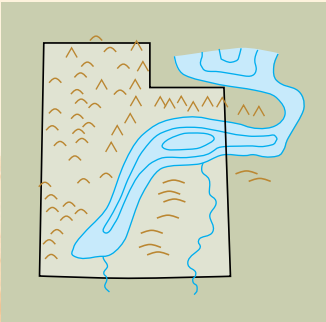
Early Jurassic
(187-205 mya)



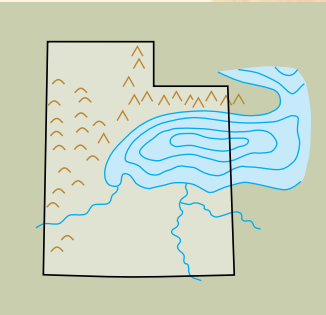
Cretaceous
(66-138 mya)

In Early Jurassic time, Utah had an arid climate and lay 15 degrees north of the equator. It was then that the most prolific reservoir in the thrust belt, the Nugget/Navajo Sandstone, was deposited in an extensive dune field comparable to the present Sahara. Correlative rocks form many of the spectacular canyons in the parks of southern Utah.

During the Cretaceous, compressional forces of the Sevier Orogeny produced highlands in western Utah and the Western Interior Seaway covered most of eastern Utah. Extensive coal-forming swamps and marshes near the coastline (Emery, Book Cliffs, and Sego coal fields) and fluvial and wave-dominated deltas migrated eastward



Paleocene
(55-66 mya)



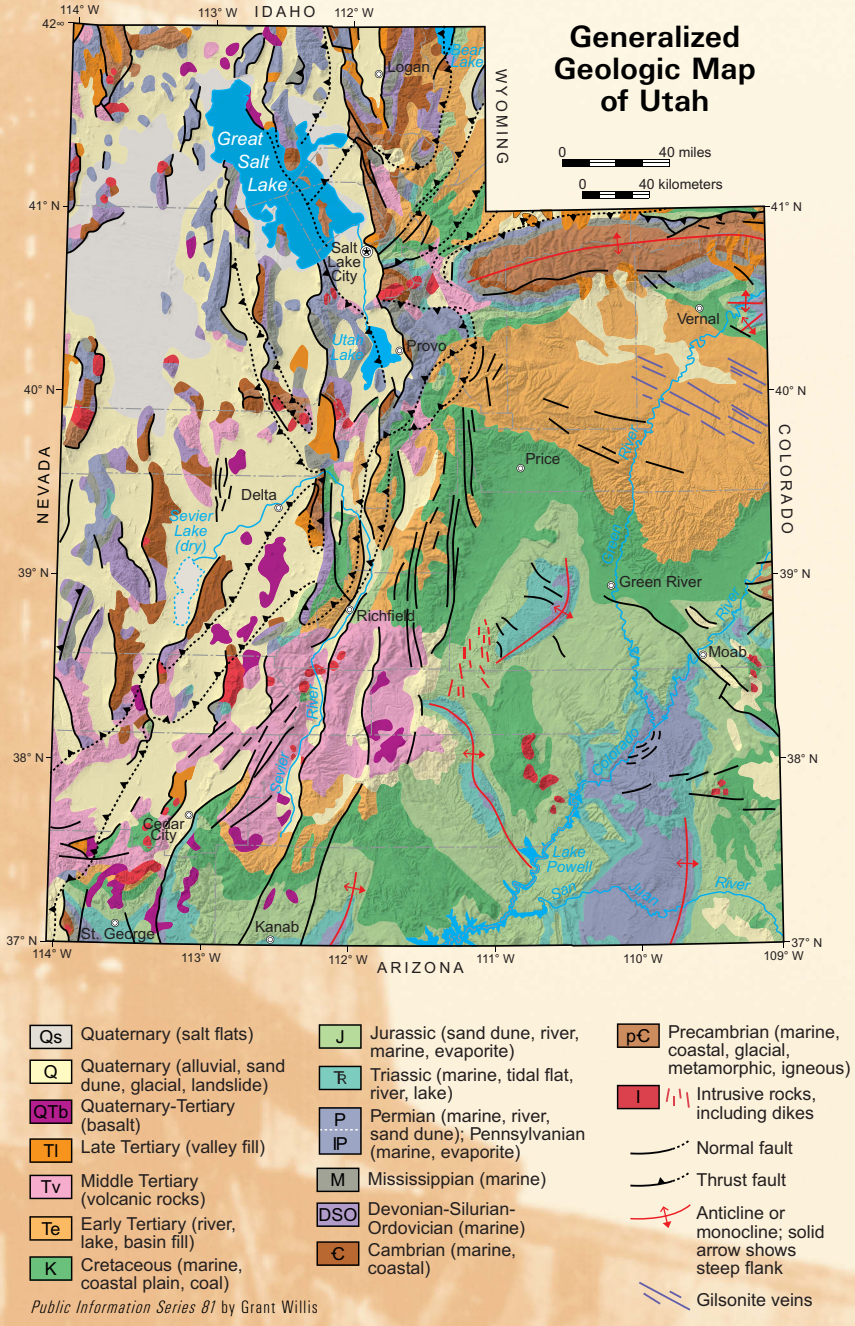
Eocene
(38-55 mya)

Maps from W.L. Stokes, *Geology of Utah*, 1986

across the state as the sea eventually retreated. The resulting deposits are now the targets for gas production aggressively being pursued in eastern Utah and in the Ferron coalbed methane (CBM) fairway of central Utah. The Sevier Orogeny continued into the Paleocene producing the "thin-skinned" folds and faults of the thrust belt that have been such prolific producers in northern Utah, and now in the "Hingeline." Concealed, deep exploration targets beneath the Sevier thrusts offer frontier drilling opportunities in the poorly explored western half of Utah.

The Laramide orogeny, between latest Cretaceous and Eocene time, produced numerous basins and basement-cored uplifts in the Rocky Mountain states. In Utah, the Uinta Basin and Uncompahgre uplift are the major petroleum contributors. The northwest-trending Uncompahgre uplift represents a reactivation of ancient highlands of the Pennsylvanian-Permian Ancestral Rockies. Numerous subsidiary structures formed along the uplift and produce mainly gas. During the Paleocene and Eocene, lakes Flagstaff and Uinta formed in the Uinta Basin where over 11,000 feet of alluvial, marginal lacustrine (fluvial, deltaic, beach, etc.), and open lacustrine sediments accumulated in an intertonguing relationship. The eastern Uinta Basin is Utah's most prolific producer of non-associated (dry) gas; recent horizontally drilled wells, state-of-the-art hydraulic fracturing completion techniques, and waterflood projects have been very successful in increasing oil production in the southern part of the basin.

The principal source rocks for these provinces were deposited during the Pennsylvanian, Permian, Cretaceous, and Tertiary as marine and lacustrine shale, and coal. The reservoir rocks were deposited in a variety of environments including deltas, shallow-shelf marine, eolian dunes, coastal-plain, and river-floodplain settings.



Public Information Series 81 by Grant Willis

Utah Core Research Center

- The Utah Core Research Center (UCRC) occupies a 12,000-square-foot warehouse managed by the Utah Geological Survey (UGS). It contains the region's only publically available and most complete collection of geological samples, drill cuttings, and core from Utah.

- UCRC holdings include cuttings from more than 4100 wells, core from approximately 980 wells, samples from major tar sands and oil shale deposits, and historical type oils from all major producing oil reservoirs in the state. The holdings catalogue is available on the UGS website.

- Collection highlights include:
  - Fluvial-dominated deltaic sandstones from the Cretaceous Ferron Sandstone of east-central Utah
  - Shallow-shelf carbonates from the Pennsylvanian Paradox and Mississippian Leadville Formations of the Paradox Basin in southeastern Utah
  - Eolian sandstones from the Navajo/Nugget Sandstone of the "Hingeline" and thrust belt
  - Lacustrine and associated fluvial-deltaic deposits from the Eocene Green River Formation

- The UCRC is available for academic and energy-industrial research, workshops, and short courses.

- Samples of cuttings and core may be examined on-site using the laboratory facilities and sampled for analytical destructive testing with advanced notice and permission.

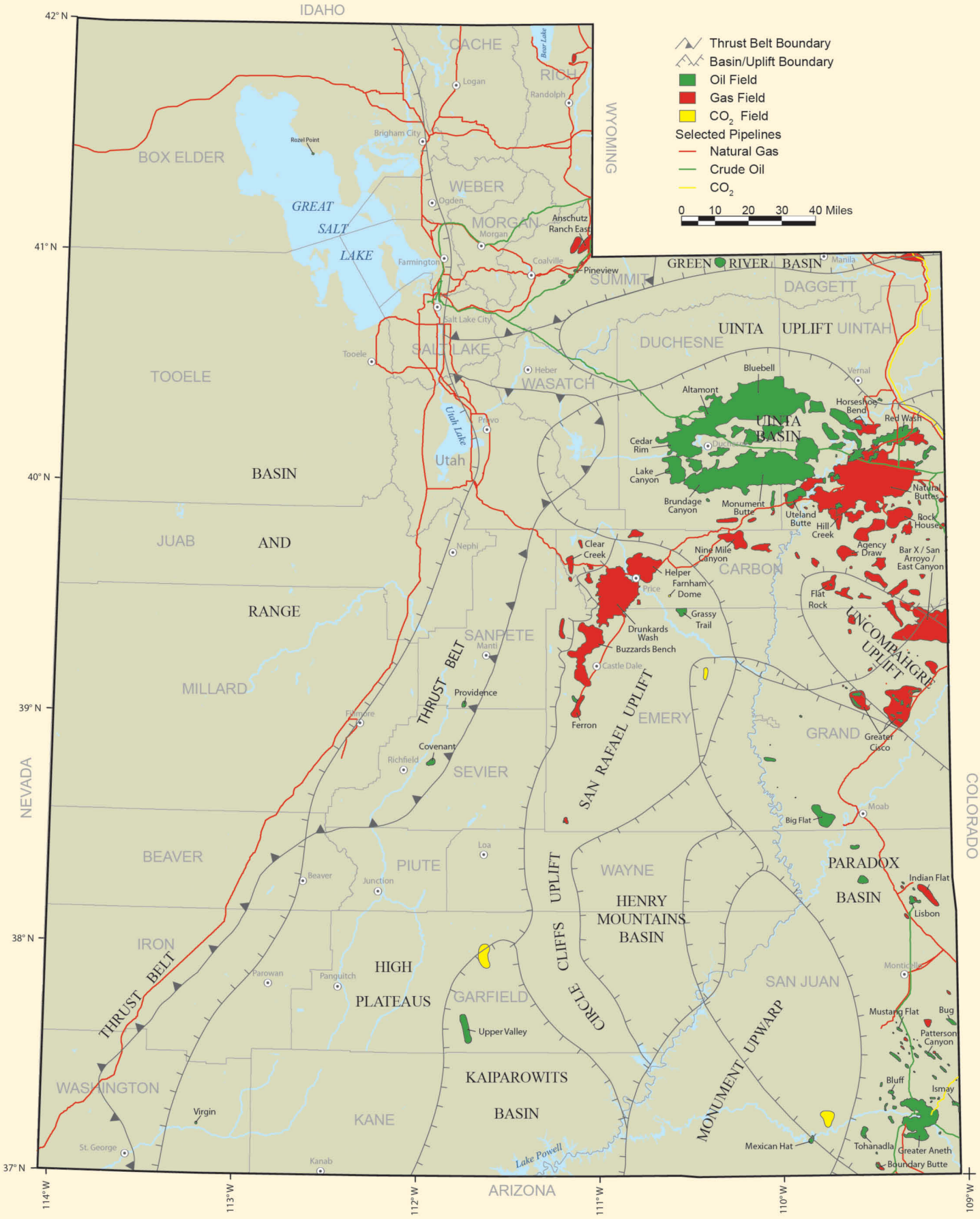
- The UCRC has equipment to slab cores to facilitate descriptions, sampling, and plugging to prepare samples for thin sections, petrophysical and geomechanical testing, and geochemical analysis.

- The UCRC has a fully functional white- and black-light, high-resolution digital photographic system, stereographic binocular and petrographic microscopes.

- Laboratory capabilities include X-ray fluorescence geochemistry, X-ray diffraction mineralogy, and gamma-ray surveying of outcrops, hand samples, and core sections.

- Utah Geological Survey contact:
  Peter Nielsen, UCRC Curator
  (801) 537-3359
  peternielsen@utah.gov

Utah's Oil and Gas Fields



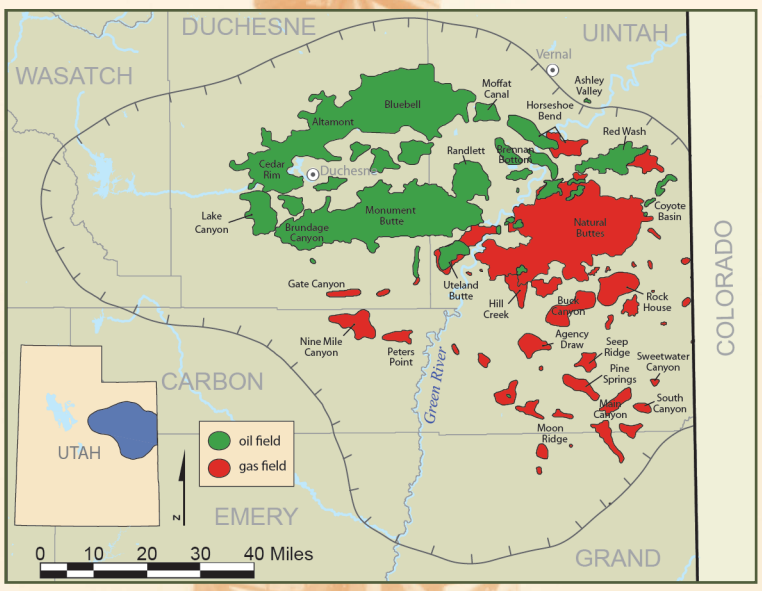
Uinta Basin

- Major reservoirs: Eocene Uinta, Green River, and Colton/Wasatch Formations, lacustrine to alluvial channel and bar sandstone; Cretaceous Mesaverde Group, fluvial and littoral sandstone; Jurassic Entrada and Wingate eolian sandstone; Permian Park City Formation, shallow marine limestone and dolomite; and Pennsylvanian Weber Sandstone, coastal eolian and littoral sandstone.

- Trapping mechanisms: anticlinal at Ashley Valley and Peters Point fields, stratigraphic conventional and basin centered, tight oil (Uteland Butte Limestone Member of the Green River Formation).

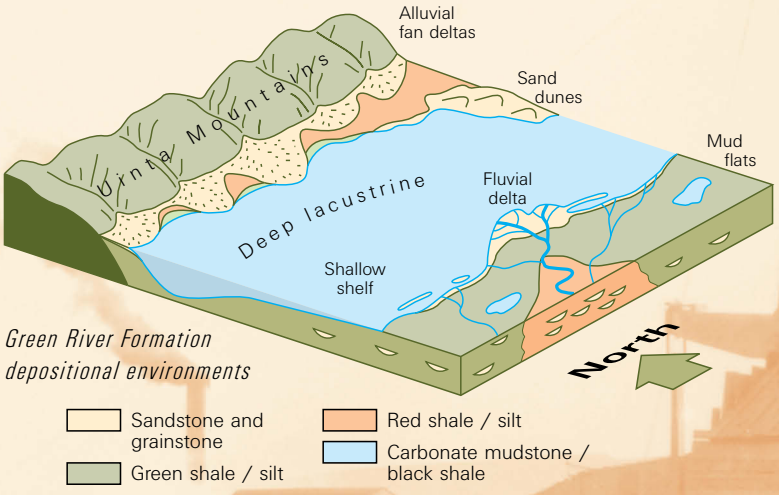
- Source rocks: Cretaceous coals and shale, Eocene lacustrine shale.

- First commercial discovery: gas at the Ashley Valley field, 1925, and oil at Roosevelt field, 1949.



Uinta Basin fields

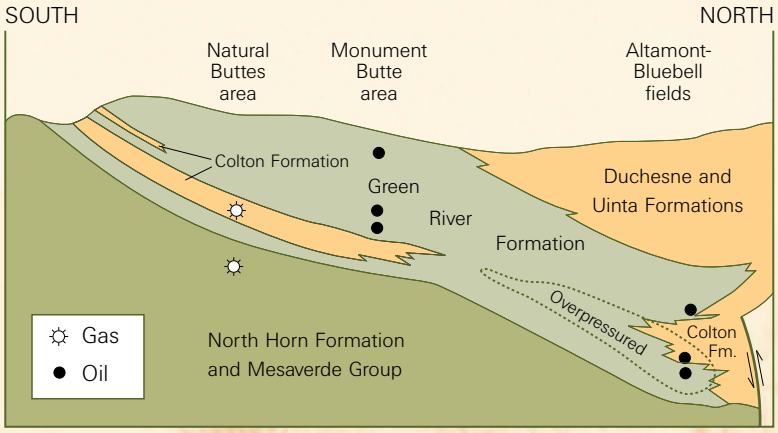
Drill rig - Natural Buttes field, Uintah County



Green River Formation depositional environments

- Number of active fields/wells: 76 fields/10,219 wells.
- Recent monthly production: 2.5 million bbl of oil, 30 billion cubic feet (Bcf) of gas.
- Cumulative production: 642 million bbl of oil, 4.9 Tcf of gas.
- Types of enhanced oil recovery projects: waterflood in the Green River Formation.
- Land ownership: 80% BLM, 7% National Forest, 6% Native American, 5% Private, 1% SITLA, 1% Wildlife Refuge.
- Outcrop analogs in Utah: Book, Roan, and Badlands Cliffs, and Raven Ridge.
- Utah Geological Survey contact:
  Craig D. Morgan
  (801) 537-3370
  craigmorgan@utah.gov

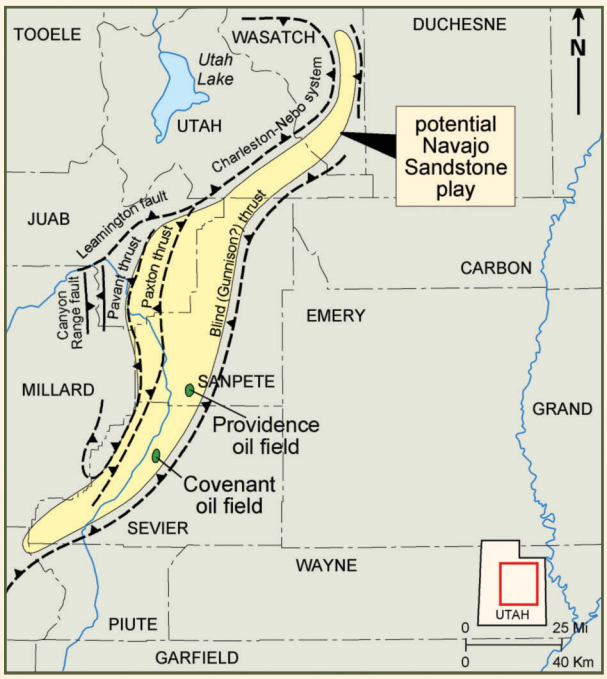
Willow Creek overlook, Green River Formation



South-north cross section through Uinta Basin

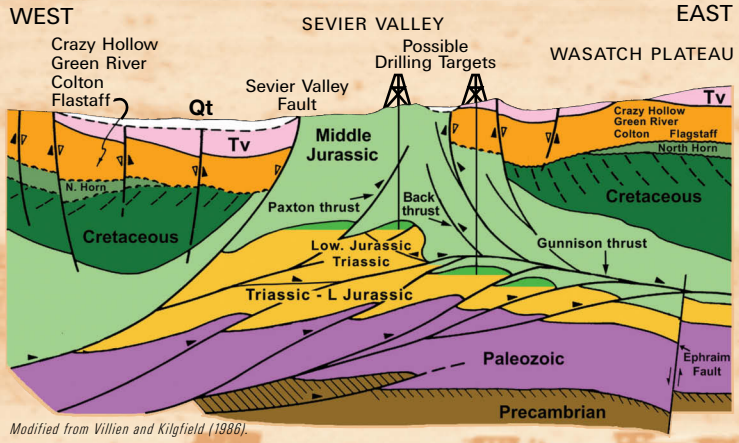
Hingeline

- Major reservoirs: Jurassic Navajo Sandstone, eolian dune sandstone; Jurassic Temple Cap Formation, coastal eolian dune sandstone.
- Trapping mechanisms: anticlines in the hanging walls of detached (not involving basement rocks) thrust systems created by thrust imbricates, or imbricate fans above, and antiformal stacks of horses forming duplexes below the major thrusts.
- Source rocks: organic-rich marine shale within the Mississippian Manning Canyon Shale, Delle Phosphatic Member of the Deseret Limestone, Doughnut Formation, or Chainman Shale; possibly Permian Park City/Phosphoria Formation.
- First commercial discovery: Covenant field, 2004.
- Number of active fields/wells: two fields/26 wells.
- Average monthly production: 165,000 bbl of oil.
- Cumulative Production: 17.9 million bbl of oil, 0.6 Bcf.
- Types of enhanced oil recovery projects: possible future carbon dioxide/nitrogen injection.
- Land ownership: 47% Private, 25% National Forest, 17% BLM, 11% School and Institutional Trust Lands Administration.
- Outcrop analogs in Utah: San Rafael Swell, Pavant Range, southern Wasatch Range, and throughout the Colorado Plateau of southern Utah.
- Utah Geological Survey contact:
  Thomas C. Chidsey, Jr.
  (801) 537-3364
  tomchidsey@utah.gov



Hingeline oil play area, central Utah (Covenant and Providence fields shown in green)

Eolian dune sandstone, Jurassic Navajo Sandstone, San Rafael Swell, east-central Utah

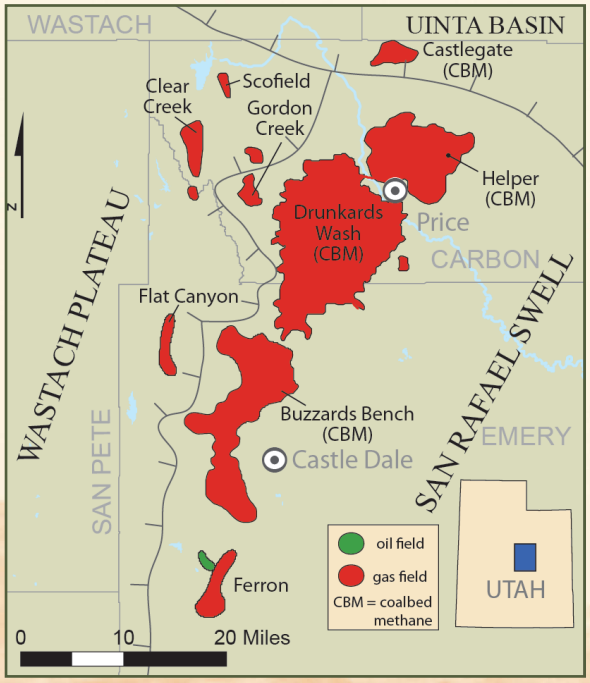


Modified from Villien and Kilgfield (1986).

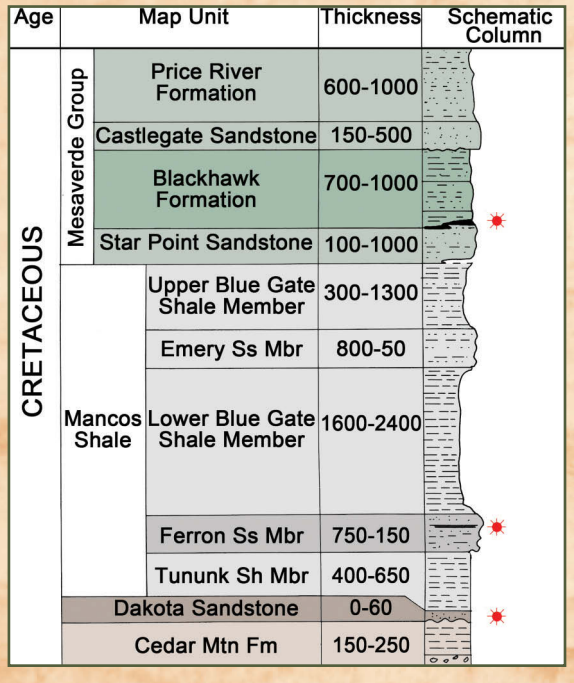
East-west structural cross section through Hingeline area

Wasatch Plateau and Coalbed Methane (CBM) Fields

- Major reservoirs: Dakota Sandstone, beach and nearshore sandstone; Ferron Sandstone Member of the Mancos Shale, fluvial-deltaic sandstone and coal; and the Blackhawk Formation, wave-dominated deltaic sandstone and coal.
- Trapping mechanisms: self-sourcing coaly reservoir beds and some migrated gas trapped by structures and updip stratigraphic pinchout of sandstone reservoir beds.
- Source rocks: coal and organic shale beds in the Tununk, Ferron Sandstone, and Blue Gate Members of the Mancos Shale, and the Blackhawk Formation.
- First commercial discovery: Clear Creek, 1951 (Ferron); Drunkards Wash field, 1983 (Ferron); Castlegate field, 1993 (Blackhawk); Helper, 1993 (Ferron).
- Number of active fields/wells: 8 fields/1040 wells.
- Recent annual production: 0 bbl of oil, 55.7 Bcf of gas.
- Cumulative production: 57,946 bbl of oil, 1.3 Tcf of gas.
- Types of enhanced oil recovery: none at present.
- Outcrop analogs in Utah: exposures of the Ferron Sandstone Member of the Mancos Shale along the western flank of the San Rafael Swell to the southeast of Emery, Utah, exposures of the Blackhawk Formation along the Book Cliffs.
- Utah Geological Survey contact:
  David E. Tabet,
  (801) 537-3373
  davidtabet@utah.gov



Trend of thick net coal and fields in the Ferron Sandstone CBM play



Stratigraphic section; red star indicates gas production

Paradox Basin

- Major reservoirs: Devonian McCracken Sandstone Member of the Elbert Formation, subtidal to supratidal dolomite to delta-front sandstone; Mississippian Leadville Limestone, shallow-shelf marine limestone and dolomite; Pennsylvanian Paradox Formation, shallow-shelf marine limestone and dolomite in the Desert Creek and Ismay zones, and fractured units in the Cane Creek shale (with potential in the Hovenweep, Gothic, and Chimney Rock shales); Pennsylvanian Honaker Trail Formation, beach and deltaic sandstone; Permian Coconino Sandstone, eolian sandstone.

- Trapping mechanisms: stratigraphic – carbonate buildups (algal mounds, shoals, islands) sealed by anhydrite, salt, or organic-rich shale; structural – fracture zones faulted and asymmetrical anticlines; diagenetic – dolomitization and dissolution.

- Source rocks: black, organic-rich marine shale within the Pennsylvanian Paradox Formation.

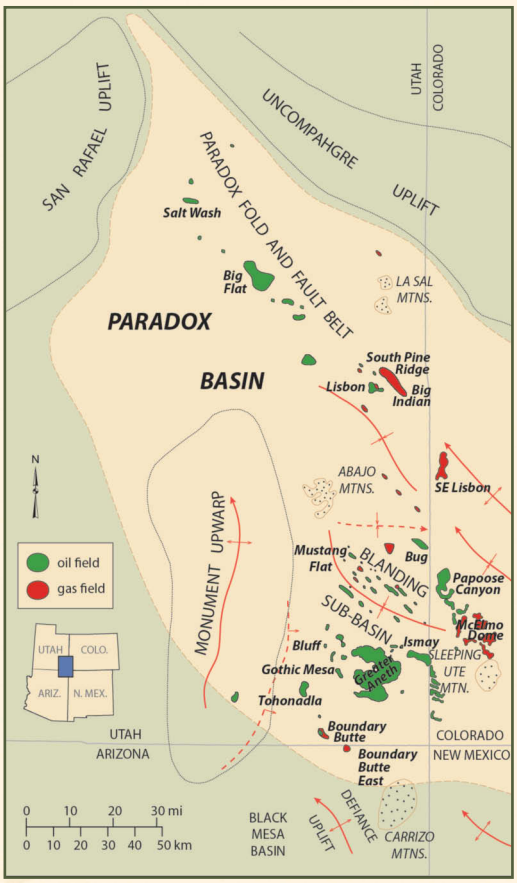
- First commercial discovery: Boundary Butte field, 1947.

- Number of active fields/wells: 89 fields/785 wells.

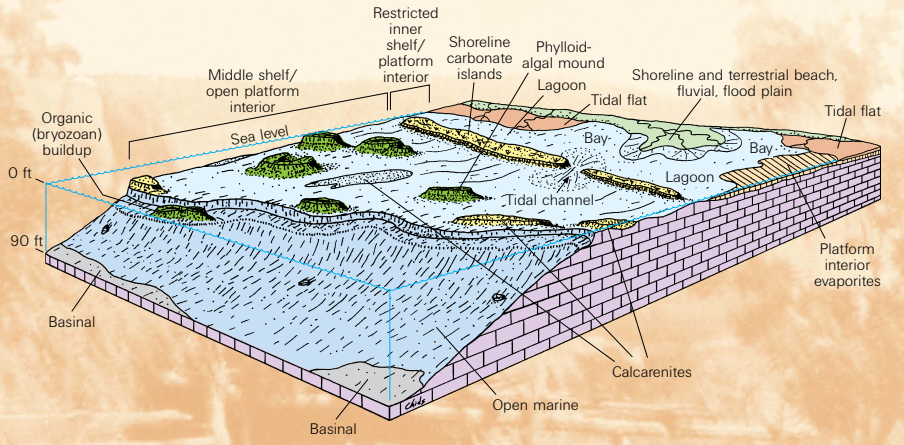
- Average monthly production: 410,000 bbl of oil, 0.7 Bcf of gas.

- Cumulative production: 578 million bbl of oil, 1.4 Tcf of gas.

- Types of enhanced oil recovery projects: waterflood, CO_2 flood (CO_2 provided by pipeline from McElmo Dome in Colorado), gas injection using horizontal wellbores.



Paradox Basin fields



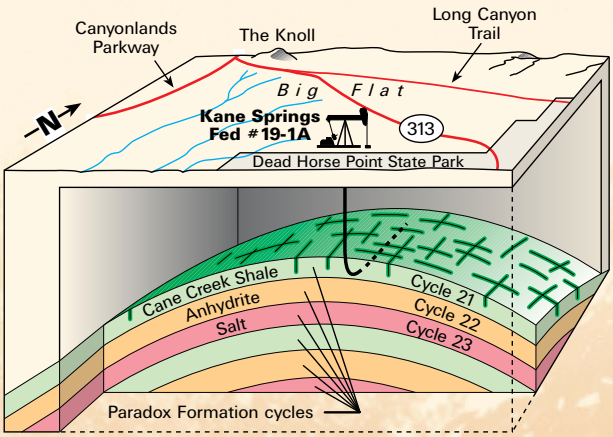
Pennsylvanian Paradox Formation depositional environments

Pennsylvanian Paradox Formation algal mound, San Juan River Canyon

- Land ownership: 56% BLM, 11% National Park, 9% Native American, 8% School and Institutional Trust Lands Administration, 8% Private, 7% National Forest, 1% Wilderness.

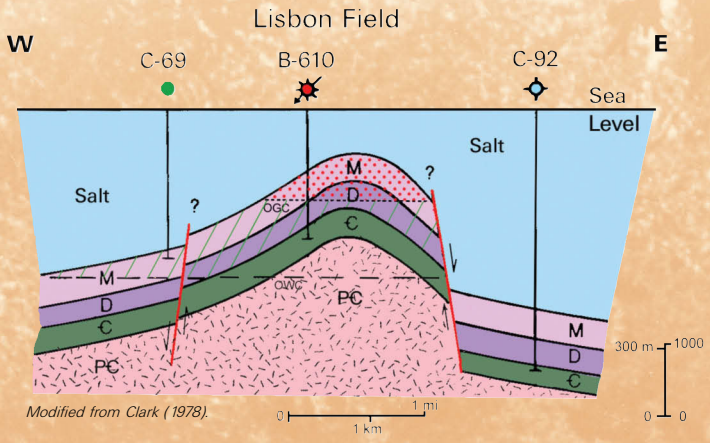
- Outcrop analogs in Utah: shallow-shelf carbonates and karst features, Mississippian Madison and Deseret Limestones, south flank of the Uinta Mountains; Ismay and Desert Creek algal mounds, Pennsylvanian Paradox Formation, exposed along the San Juan River in southeastern Utah; deltaic and eolian sandstone, Pennsylvanian Honaker Trail Formation and Permian White Rim Sandstone, respectively, Canyonlands area.

- Utah Geological Survey contact:
  Thomas C. Chidsey, Jr.
  (801) 537-3364
  tomchidsey@utah.gov



Schematic of horizontal drilling targets, Cane Creek shale, Park Road field

Gothic shale along the Honaker Trial, San Juan River Canyon



West-east structural cross section through Lisbon field that produces from the Leadville Limestone

Thrust Belt

- Major reservoirs: Mississippian Madison Group, open-marine to supratidal limestone and dolomite; Pennsylvanian Weber Sandstone, coastal eolian and littoral sandstone; Permian Phosphoria Formation, shallow marine limestone, dolomite, phosphatic shale, and chert; Triassic Dinwoody Formation, tidal-flat dolomite; Jurassic Nugget Sandstone, eolian dune sandstone; Jurassic Twin Creek Limestone, shallow marine limestone.

- Trapping mechanisms: anticlines in the hanging walls of detached (not involving basement rocks) thrust systems, and untested subthrust structures (beneath detached and basement-cored faults).

- Source rocks: Cretaceous Mowry Shale; possibly Permian Phosphoria Formation.

- First commercial discovery: Pineview field, 1975.

- Number of active fields/wells: 10 fields/57 wells.

- Average monthly production: 34,300 bbl of oil, 1.3 Bcf of gas.

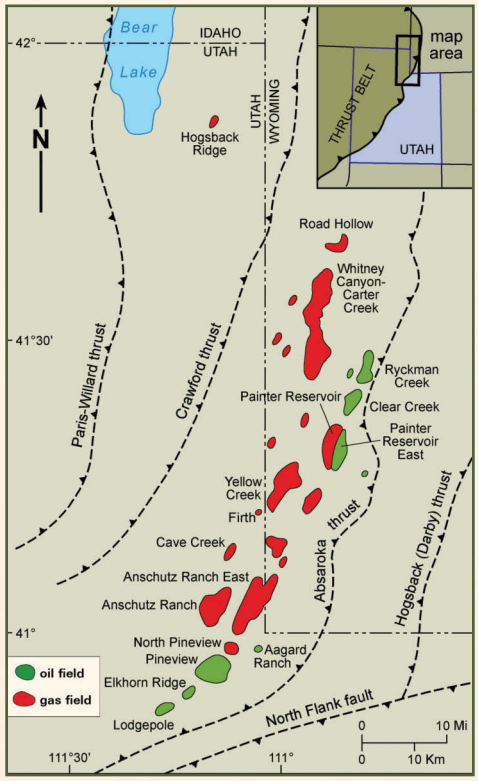
- Cumulative production: 168 million bbl of oil, 3.2 Tcf of gas.

- Types of enhanced oil recovery projects: gas re-injection to maintain pressure, horizontal drilling.

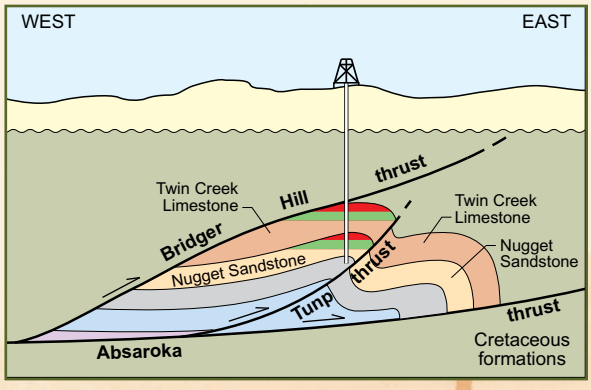
- Land ownership: 70% Private, 16% National Forest, 6% BLM, 3% School and Institutional Trust Lands Administration, 3% Wilderness, 2% Utah Division of Wildlife Resources.

- Outcrop analogs in Utah: northern Wasatch Range, Crawford Mountains, west end of the Uinta Mountains.

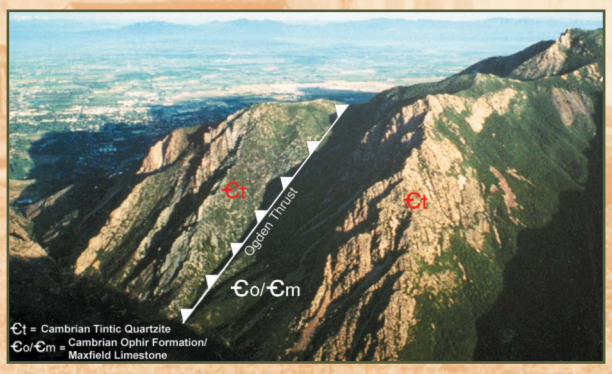
- Utah Geological Survey contact:
  Thomas C. Chidsey, Jr.
  (801) 537-3364
  tomchidsey@utah.gov



Thrust belt fields



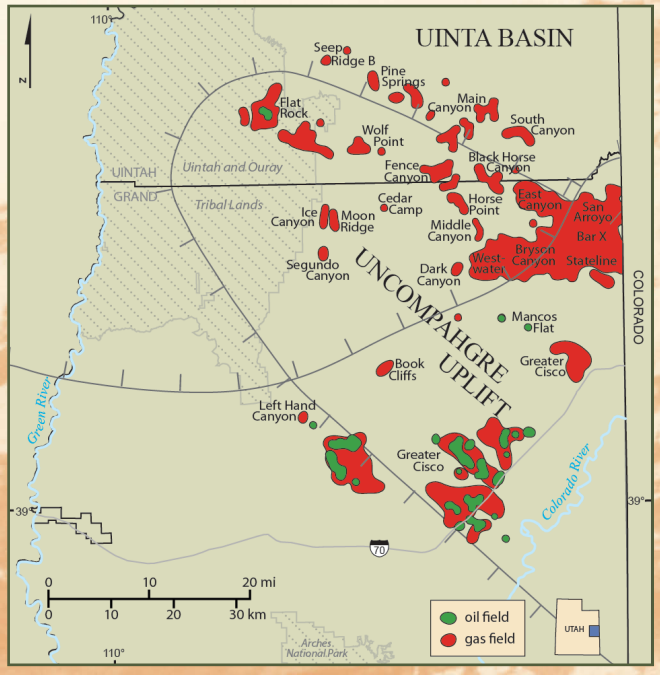
West-east structural cross section



East-dipping Ogden thrust, Ogden Canyon

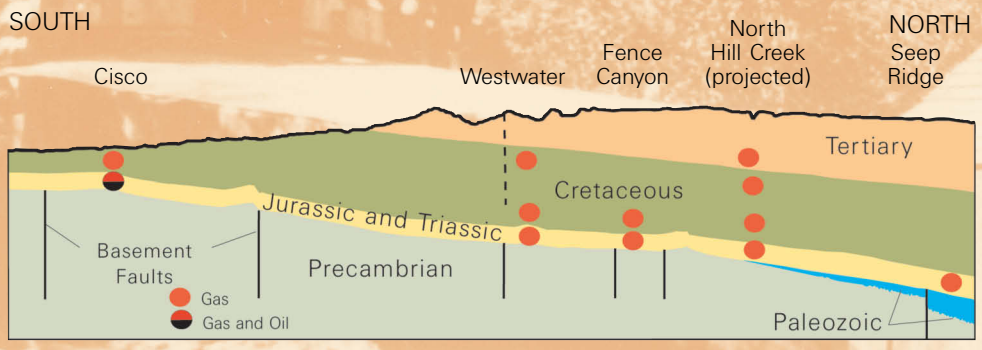
Uncompahgre Uplift

- Major reservoirs: Cretaceous Castlegate Sandstone, braided stream sandstone; Cretaceous Mancos Shale, marine shale; Cretaceous Dakota and Cedar Mountain Formations, fluvial and littoral sandstone; Jurassic Morrison Formation, fluvial sandstone; and Jurassic Entrada and Wingate Sandstones, eolian sandstone.
- Trapping mechanisms: combination structural and stratigraphic.
- Source rocks: Cretaceous shale and possibly Permian and Pennsylvanian shale.
- First commercial discovery: Cisco Dome field, 1925.
- Number of active fields/wells: 34 fields/ 631 wells.
- Recent monthly production: 1,570 bbl of oil, 1.0 Bcf of gas.
- Cumulative production: 3.5 million bbl of oil, 0.5 Tcf of gas.
- Types of enhanced oil recovery projects: one waterflood unit (Calf Canyon) in the Cedar Mountain Formation.
- Land ownership: 98% BLM, 1.6% Native American, 0.6% SITLA.
- Outcrop analogs in Utah: Cretaceous and Jurassic outcrops south and west of the production area.
- Utah Geological Survey contact:
  Craig D. Morgan
  (801) 537- 3370
  craigmorgan@utah.gov



Uncompahgre uplift fields

Jurassic Morrison Formation, San Rafael Swell, east-central Utah



South-north cross section across the Uncompaghre Uplift

Oil Shale

- The largest oil shale deposits in the world are in the Eocene Green River Formation, which covers parts of Utah, Colorado, and Wyoming. Utah's oil shale deposits are found in the northeast corner of the state within the Uinta Basin.

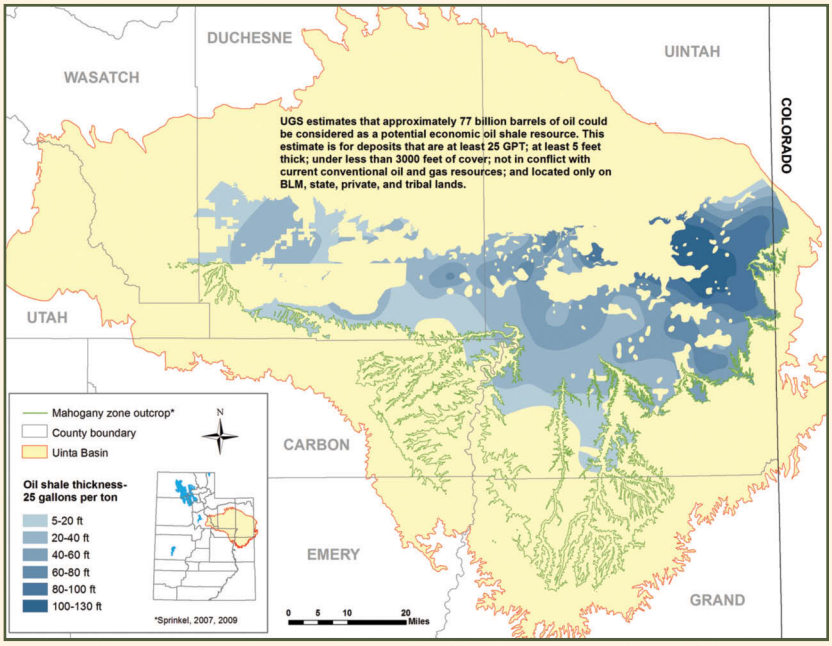
- Organic and lime-rich mud deposited in a large lake about 50 million years ago forms the present-day oil shale.

- The organic material preserved in the oil shale is not oil, but a substance called kerogen that can be heated either at the surface or underground to produce crude oil and natural gas.

- The stratigraphic section with the richest oil shale is the Mahogany zone, which contains beds that can surpass 70 gallons of oil per ton (GPT) of rock. The Mahogany zone typically averages 20–25 GPT and reaches a maximun of about 120 feet thick.

- The upper Green River Formation in the Uinta Basin holds an estimated in-place resource of 1.32 trillion barrels of oil, with approximately 77 billion barrels as a potential economic resource.

- Utah Geological Survey contact:
  Michael D. Vanden Berg
  (801) 538-5419
  michaelvandenberg@utah.gov



Location of oil shale deposits in Utah

Mahogany zone outcrop

Oil shale sample showing bands of kerogen

Tar Sand Resources of Utah

- Utah's tar sand resources are the largest in the United States. Other states with tar sand resources include Alabama, Alaska, California, Kentucky, New Mexico, Oklahoma, Texas, and Wyoming.

- The Uinta Basin hosts the majority of Utah's tar sands, both in terms of the number of deposits and in-place resources. Other deposits are present in the Tar Sand Triangle, Circle Cliffs, and the San Rafael Swell areas.

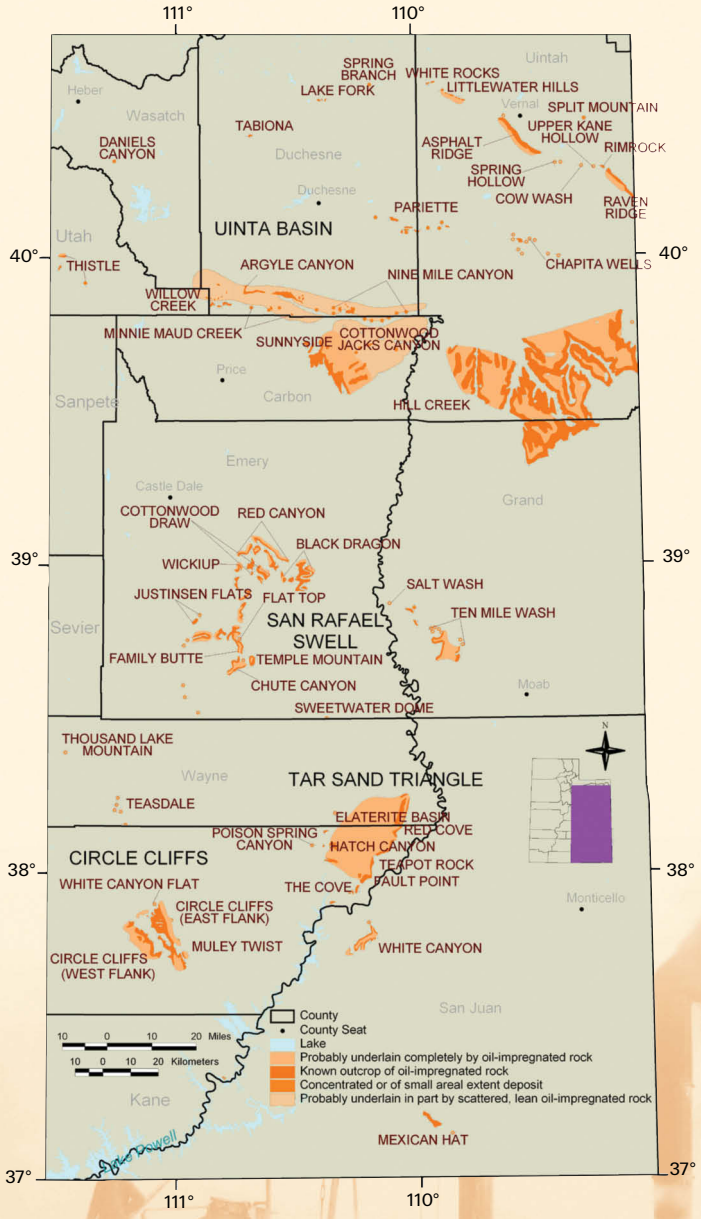
- Utah's measured in-place tar sand resource is nearly 12 billion bbls of oil. The total estimated in-place resource is not well defined but likely includes at least an additional 7 billion bbl.

- The average bitumen content of Utah's tar sands ranges from 4.5% to 14.1%, average API gravity from -3° to 12°, sulfur content (wt%) from 0.3 to 3.8, carbon content from 13% to 24%, and atomic hydrogen/carbon ratio from 1.31 to 1.65.

- Despite the failure of numerous past efforts to develop this heavy-oil resource, recent high oil prices have stimulated renewed interest and at least one company plans to begin production of tar sands in 2014.

- The Utah Geological Survey recently published useful data on Utah tar sands. These publications include information on the P.R. Spring and Hill Creek (OFR-527) and Sunnyside deposits (OFR-566), as well as a comprehensive tar sand bibliography (OFR-503) and strategies for in situ recovery (OFR-551). These resources are available online from the Utah Geological Survey website or at the Natural Resources Map & Bookstore.

- Utah Geological Survey contact:
  Andrew Rupke
  (801) 537-3366
  andrewrupke@utah.gov



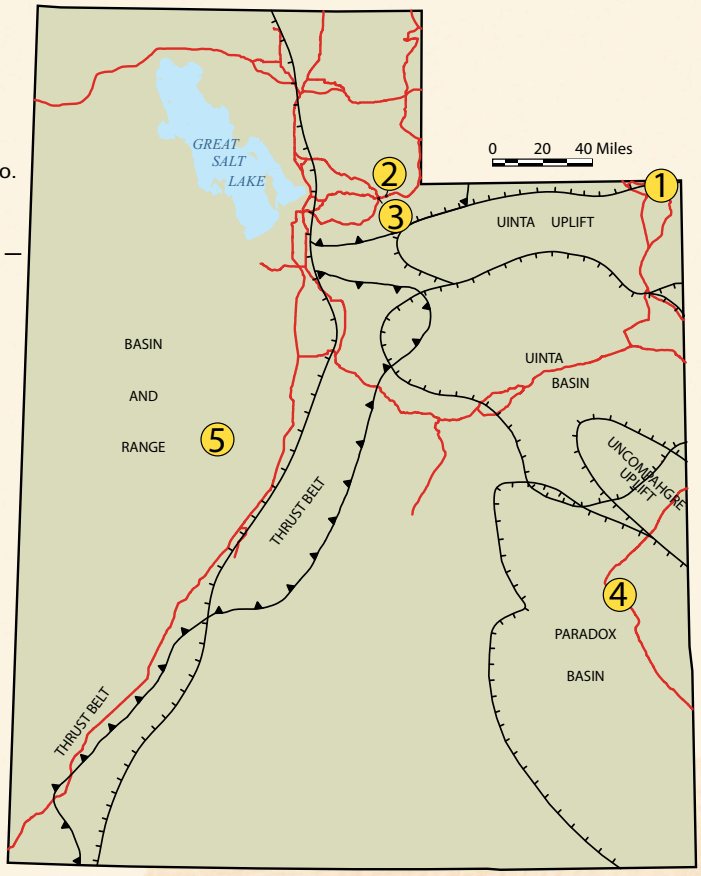
Tar sand deposits

Bitumen (or "tar") seeping from a boulder in the Sunnyside area

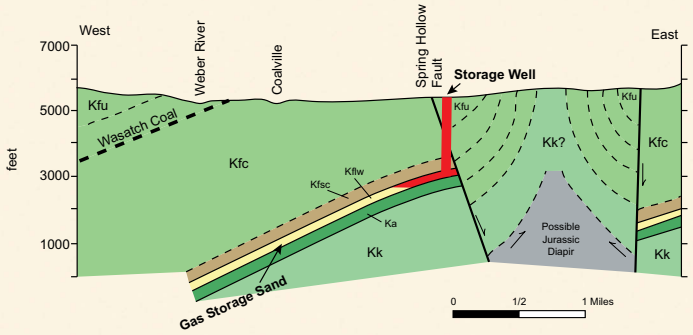
Gas Storage Sites

Thrust Belt Boundary
Basin/Uplift Boundary
Major Natural Gas Pipeline
1 Gas Storage Site

1 Clay Basin — Questar Pipeline Co.
2 Chalk Creek — Questar Pipeline Co.
3 Coalville — Questar Pipeline Co.
4 Moab (salt cavern) — abandoned
5 Western Energy Hub (salt cavern) — Magnum Gas Storage (proposed)



Coalville Gas Storage Structure



Kf Frontier Formation
- Kfu Upper
- Kfc Chalk Creek Member
- Kfsc Spring Canyon Member (sealing shale)
- Kflw Longwall Sandstone Member

Ka Aspen Shale
Kk Kelvin Formation

The Coalville unit holds a maximum 2.8 BCF of gas. Gas can be produced at a maximum rate of 60 million cubic feet of gas per day.

Sources of Utah Oil and Gas Information

- Production, consumption, reserves and price trends for all energy commodities: http://geology.utah.gov/sep/newdata/statpage.htm
- Oil and gas resources, Utah oil and gas map, research reports: http://geology.utah.gov/utahgeo/energy/oilgas/index.htm
- Oil and gas well locator map: http://atlas.utah.gov/oilgaswells2/viewer.htm
- Oil and gas well logs: http://ogm.utah.gov/oilgas/DATA_SEARCH/well_data_search.htm
- Catalogue of oil and gas well cores and cuttings: http://geology.utah.gov/emp/ucrc/index.html
- Production data: http://ogm.utah.gov/oilgas/PUBLICATIONS/Reports/report_list.htm
- Data on permits, drilling starts, completion reports: http://ogm.utah.gov/oilgas/STATISTICS/statindx.htm
- SITLA land lease records, and land and lease digital plat maps: trustlands.utah.gov

UTAH DNR GEOLOGICAL SURVEY

UTAH DNR OIL, GAS & MINING

State of Utah School and Institutional Trust Lands Administration

Public Information Series 71
Utah Geological Survey
a division of
Department of Natural Resources
Updated 2013

Although this product represents the work of professional scientists, the Utah Department of Natural Resources, Utah Geological Survey, makes no warranty, expressed or implied, regarding its suitability for a particular use. The Utah Department of Natural Resources, Utah Geological Survey, shall not be liable under any circumstances for any direct, indirect, special, incidental, or consequential damages with respect to claims by users of this product.

ISBN 1-55791-655-1