FRONT RANGE INFRASTRUCTURE RESOURCES PROJECT
Energy Resources Activities

Introduction—Energy Resources

Oil, natural gas, and coal (energy resources) have been produced from rocks in the Front Range of Colorado and Wyoming for more than a century, and significant quantities of oil and gas continue to be developed in the study area of the U.S. Geological Survey (USGS) Front Range Infrastructure Resources Project (fig. 1). As an infrastructure resource, energy resources helped to fuel past development of (1) urban areas in the Front Range as well as (2) some of the manufacturing and mining upon which the urban centers were built and thrived. At present, much of the oil and gas extracted from rocks beneath the Front Range urban corridor is used locally; the people living in the urban area provide a need and viable marketplace for these commodities.

How long oil and gas will continue to be developed from rocks along the Front Range depends largely on economics, particularly the closeness of the marketplace and availability of quality resources. The oil and gas market is a function of the worldwide supply and demand of these resources (Seba, 1998), so whether or not oil and gas will continue to be developed along the Front Range is largely controlled by the level and stability of worldwide oil and gas prices. Nevertheless, with a nearby marketplace for produced energy resources (principally Front Range urban centers) and with estimates of significant additional resources in the region (see Gautier and others, 1995), the oil and gas industry likely will continue to operate in the area, assuming stable prices and continued demand.

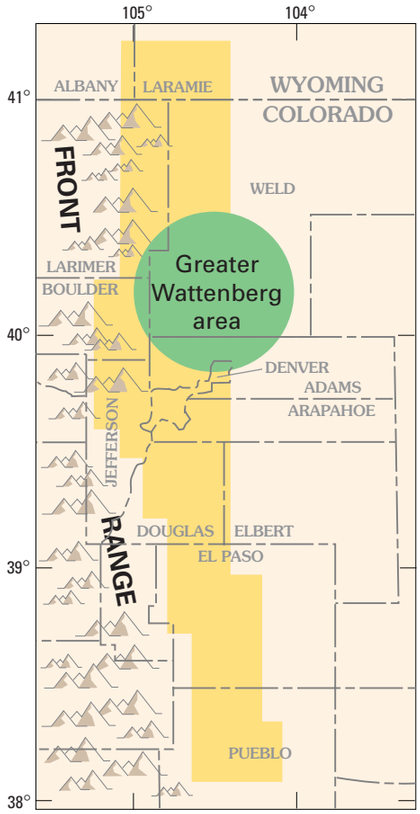

Figure 1. *Map showing the locations of the Front Range Infrastructure Resources Project study area (yellow) and the greater Wattenberg area.*

USGS Oil and Natural Gas Research

Because intense growth is occurring throughout the Front Range urban corridor, questions remain as to how urbanization will affect the future availability of oil and gas. USGS scientists on the Front Range Infrastructure Resources Project, using geologic and engineering data to model processes leading to oil and gas generation and accumulation, are focusing research efforts on estimating how much additional oil and gas can be developed and on identifying areas in the Front Range urban corridor where oil and gas resources are likely to be found in the future. Although oil and gas have been extracted in many places along the Front Range (fig. 2), current interest lies within the greater Wattenberg area, which lies just north of the Denver metropolitan area and extends through-out much of the northern part of the Front Range Infrastructure Resources study area (fig. 1).

Figure 2. *Photograph of an oil-well pump, one of many in the study area.*

Most of the oil and gas in the area is being developed from Cretaceous rocks that range in age from 68-95 million years. Oil generation probably began about 65 million years ago, and gas was generated subsequently (Weimer, 1996). Formations from which most production occurs in the greater Wattenberg area (fig. 1) include the Muddy ("J") Sandstone (Dakota Group), the Codell Sandstone Member and "D" sandstone (Benton Shale), Niobrara Formation, and sandstones in the Pierre Shale (Weimer, 1996). Depths to oil and gas reservoirs generally range from about 4,000 to more than 9,000 feet. The apparent association of faults with accumulations of natural gas (Higley and others, 1997) suggests that faulting may control, in a regional sense, sites favorable for gas production.

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Additional USGS Energy-Related Studies

U.S. Geological Survey scientists also are studying the effects on the environment of past extraction of energy resources. For example, studies are underway to determine whether saline waters produced along with oil and gas may have been a source of saline minerals deposited in soils in small (typically < 10 acres) areas (fig. 3) scattered throughout the Front Range. Detailed mapping of salts in addition to water and soil studies will help to establish if there is any causal relationship between produced waters and salty soils. Another example of USGS research on topics related to past energy extraction is the study of coal mining in the Front Range, including the Boulder-Weld coal field, the Foothills district, and an area near Colorado Springs. Given that much of the coal was mined from depths of < 500 ft beneath the surface, post-mining problems, including subsidence, can affect how land is used in the future. USGS scientists, along with colleagues from the Colorado Geological Survey, are creating digital maps that will be used to readily determine where coal mining took place and the depth to old coal mine workings. Finally, USGS scientists are estimating the area of land used for the infrastructure required for oil and gas production (pumps, access roads, tank batteries, etc.). While producing oil and gas, this land cannot be used for other purposes (e.g., agriculture, urbanization, extraction of other infrastructure resources). With more than 6,000 oil and gas wells in the study area, the necessary access roads, pumps, and storage tanks cover a large amount of land and can significantly restrict its use for other purposes, including agriculture—this is especially important in the greater Wattenberg area, which includes some of the most productive agricultural land in Colorado.

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Figure 3. *Photograph, taken in the spring, of a plowed field in the study area where salt minerals have formed on the soil surface. Photograph from Jim Otton, USGS.*

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