

The Promise and Peril of Shale Oil

New technologies and high oil prices are sparking renewed interest in shale oil. But can it be extracted economically - and without devastating environmental consequences?

By Hal Herring

On a 160 acre parcel near Meeker, Colorado, Shell Energy Corporation is trying to efficiently extract the hydrocarbons from a layer of rock known as the Mahogany Shale. It's been tried before, many times, dating back to when cowboys noticed that if you used certain dark rocks in your fire ring, they'd catch fire. But Shell is taking the effort to a new level, spurred by record energy prices, accommodating federal land managers, and a willingness to radically evolve the technologies for extracting fossil energy from



The new extraction apparatus.
All photos courtesy of Shell Oil.

the earth.

It will take ten to fifteen years to discover if the experiment will produce economically viable amounts of oil and natural gas, or if the EROEI -- the energy returned on energy invested -- will balance out, but the technologies involved in the experiment are so new that in the course of operations, some entirely different process may yet reveal itself, drawing the elusive genie of energy from the thousands of square

miles of ancient seabed algae.

Shale oil conjures images of vast, highly destructive mining processes, and of the massive, government-subsidized projects that came to a crashing halt on so-called Black Sunday, May 2nd, 1982, when cratering oil prices led Exxon pull out of its operations in Colorado.

The Shell experiment, though, is very different. It doesn't involve moving the earth to reach the shale. Instead, the earth is heated, in situ, to allow the hydrocarbons to vaporize and drain from the stone to pools where they can be collected and pumped to the surface. According to Tracy Boyd, Shell's communications manager for the Mahogany Project, the new in-situ heating process can recover 60% of the available hydrocarbons in the shale, whereas the traditional mine and retort processes recovered only 28-30%.

"And those produced a gooey, low grade crude oil," Boyd explains. "The in-situ process produces a 700 degree hydrocarbon vapor, and as it cools, it condenses, and the products -- the liquids -- are diesel, jet fuel, naphtha, and natural gas." Boyd says the technology is evolving quickly. "On our last test, our most successful -- we heated an area 30 by 40 feet and produced 1700 barrels of liquid. You get a lot out of a relatively small area."

The test required the area to be heated for about one year, Boyd said, using long electrical resistance heaters inserted deep into the earth. The heaters radiate enough heat that the rock expands around them, creating a kind of seal that boosts heating efficiency.

First, the area to be heated must be isolated, not only to prevent the hydrocarbons from escaping, but also, as Shell emphasizes in their communications, to protect groundwater. To isolate the area, a "freeze wall" is constructed. Shell's literature describes the process in its experimental stages: A series of

1800 foot deep holes are drilled, spaced eight feet apart, to enclose the rectangular area to be heated. A "closed loop pipe system" is installed in the holes, and ammonia is circulated through the pipes to refrigerate and freeze the rock around the pipes, creating a barrier. Groundwater is then pumped out of the area to be heated. Heating the shale enough to vaporize the kerogen and recover the fuels can take as little as one year, or as long as three years, using the current resistance heaters.

As it currently stands, the process consumes enormous amounts of electricity. "Energy in versus energy out balance is still not understood," said Boyd. "We don't have hard and fast numbers that we can talk about on a commercial scale. But we believe that eventually we will have a positive energy balance. We are not going to waste our time on something that we don't think will work out."



Boyd says Shell is well aware that the only way this development can work is if it "balances the economic with the environmental with the social." Even if Shell's bold experiments prove that oil and gas can be extracted without mining the shale, that balance will be difficult to find. The Green River formation, which holds the most potential (60% of the world's oil shale) for economically viable energy development, underlies some of the West's most iconic and empty landscapes and watersheds: Wyoming's Green River basin, already in the midst of one of the most profitable -- and most controversial -- energy booms in history; Colorado's White

River country; or south to the Roan Plateau, a current flashpoint, as the Bureau of Land Management offers over 55,000 new acres of leases to natural gas developers, over the objections of Colorado's Governor Bill Ritter and other regional leaders.

Energy analyst Randy Udall, drawing on studies by the RAND Corporation, has estimated that the production of as few as 100,000 barrels of oil per day (enough to supply the US demand for seven minutes) from the richest deposits of oil shale near Grand Junction, Colorado, using the current Shell experimental technology, would require the construction of a \$3 billion dollar power plant, burning 5 million tons of coal per year. To produce one million barrels of oil per day, about one twentieth of US demand, would require ten such new power plants, along with new coal mines and the infrastructure -- housing, water, roads, etc. -- to support them.

While Shell has drawn attention recently for buying up water rights in the oil shale basins of Colorado, the volumes of water needed to support a commercial oil shale development are unknown. In April of 2008, Tracy Boyd told the Denver Post, "We've been acquiring land and associated water rights for a long time..." "We're just situating ourselves so that when the time comes, we'll have the resources we need." Boyd said in a more recent interview (with me) that the process Shell is using actually "produces water rather than uses it, by dewatering the shale." But, as reported in the Denver Post story, many Colorado officials have concluded that Shell will need enormous amounts of water to keep its operations running. "On the upper end, we're looking at potentially several hundred thousand acre-feet of water -- more than people think is commonly available to develop in the Colorado River," Dan Birch, deputy general manager for the Colorado River Water Conservation District, told the Post.

Boyd said that a commonly used figure regarding water use in oil shale development was "three barrels of water to one barrel of oil." "Hopefully, we'll do a little better than that." Boyd also points out that the water required to produce an acre of ethanol is probably much higher than that.

The Energy Policy Act of 2005 directed the Bureau of Land Management to create a Research, Development and Demonstration (RD&D) Program that granted 160 acres of public land to energy companies willing to invest in new technologies to extract oil and gas from shale. The companies hold the leases for ten years, with an option to extend, and with the agreement can be extended for an eight square mile area around the RD&D site.



Shell was granted three of the leases, and the Mahogany Project is well underway on one of them. All of the leases involve experiments in in-situ extraction, but one, held by the Oil Shale Exploration Company (OSEC), which operates the White River Mine in northeastern Utah. This RD&D operation re-opens a 1970's era mining operation for oil shale, and will "retort" the mined shale to extract the oil. Although OSEC is currently the only RD&D operation on public land using the older technologies of mining and retorting, the process may become viable on a much larger scale in the future if oil prices remain high.

Certainly the US Department of Energy believes the older process to be viable, given the right incentives from the fed-

eral government. A Department of Energy report in 2004 estimates a recoverable reserve of oil in the Green River Formation of 2 trillion barrels of oil, utilizing both in-situ and mining and retort technologies. Such an operation, according to the DOE report, would involve enormous mining, retorting and electrical production operations, create 100,000 new jobs, and utilize the .8 million acre feet of water that the Colorado Basin received in an October, 2003 agreement with California. In return, the DOE estimates that the region can offer up 2 million barrels of oil per day by 2020. The report does not estimate the square miles necessary to produce this amount of oil, although it does suggest that a billion tons of shale per year could be retorted.

The potential of oil shale to produce actual oil has long been disputed. The DOE, as pointed out above, claims 2 trillion barrels of oil is possible. The Bureau of Land Management recently released a study that claims a potential of "800 billion barrels of oil" on federal land in the West. This figure was also quoted by Newt Gingrich and other prominent Republican political leaders in the recent campaign called "Drill Here, Drill Now, Pay Less."

But for most people who are actually involved in energy production or analysis, such figures are difficult to understand. Tracy Boyd said that he was not sure how the BLM arrived at its figures. Analyst Randy Udall notes that "on paper, you can prove anything," and also notes that if the policies called for by the DOE report were instituted it would be a "disaster," for Colorado. The most strident promises made about the potential for oil shale development to help solve US energy needs are made by men like Newt Gingrich, not by energy engineers or even CEOs.

"Industry is nowhere near knowing what is feasible," said Dave Alberswerth, a senior policy advisor for the Wilderness Society. "This is all at an

embryonic stage.” Alberswerth said that the struggle right now involves Western political leaders like Colorado’s Democratic Senator Ken Salazar, who is on record as supporting the oil shale research efforts, but is cautious about the impacts the industry will have on the state, and a Presidential administration that wants to “set up an industry favorable set of regulations now.”

With the current turmoil in energy development -- fury over leasing of the Roan Plateau, lawsuits against the BLM from New Mexico Governor Bill Richardson over natural gas leasing on the Otero Mesa, lawsuits against the Bureau of Land Management in Wyoming over its failure to protect the sage grouse and other resources in the face of energy development, lawsuits between Montana and Wyoming over the discharge of salty “produced water” from coal bed methane wells into rivers and streams, and on and on -- the only certainty in the oil shale future is probably conflict. The engineers and workers on Shell’s Mahogany Project, deeply involved in solving a complex and fascinating series of technical challenges, may inhabit the calmest place in the Western energy country.