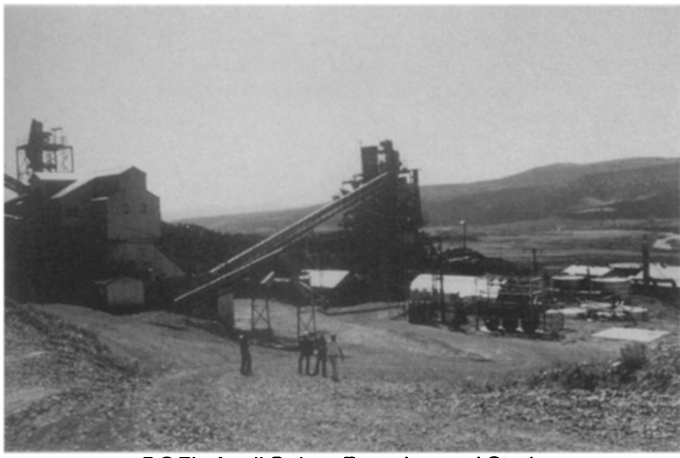
Squeezing Oil out of Stone

Plentiful petroleum has driven the oil shale industry into hibernation, leaving behind just a shadow of the industry's original promise

By IVARS PETERSON


I. Peterson

DOE's Anvil Points Experimental Station

ANVIL POINTS, COLO.—A restless stillness hovers over the Anvil Points Experimental Station. No rattle of machinery, no rumble of trucks, no workers' shouts break the silence of a once-busy research center waiting for better times—just a wind whispering past a jumble of iron skeletons, frameworks for massive rock-cooking ovens, hanging in the fierce sunlight. Quiescent, corrugated metal buildings perch on the edge of a bluff that barely brushes the Colorado River far below.

For almost 40 years, the station has seen the ebb and flow of interest in the oil shale that permeates the upper levels of the bluff and extends in a thick sheet into Wyoming and Utah. At the station, researchers, at first from the U.S. Bureau of Mines and later from the Department of Energy (DOE), devised and refined methods for mining the rock and for prying the "oil" loose from its stony trap. Now the work has stopped, caught in the economic squeeze created by seemingly plentiful and cheap petroleum from more conventional sources.

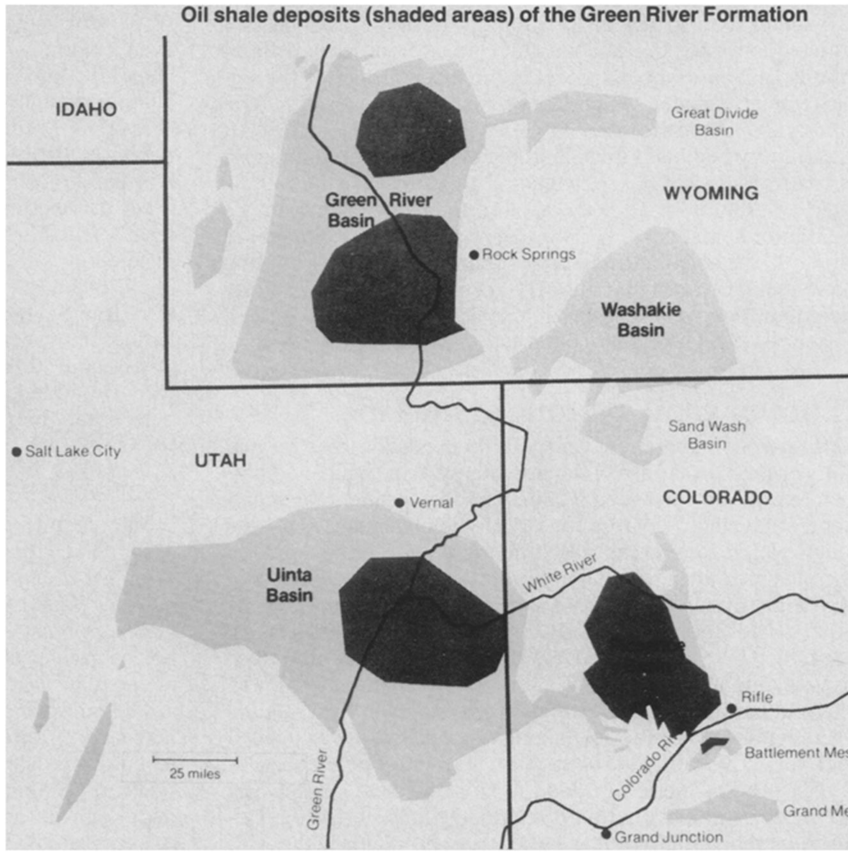
A few dozen miles away, near Parachute Creek, sits the partially completed, but now abandoned, Colony Oil Shale Project. There, the Exxon Corp., together with Tosco Corp., planned a $5 billion complex for blasting oil shale out of what was to be the world's largest underground mine, intensely heating the mined rubble to extract a thick, oily fluid and refining the product into useful liquid fuels. The companies designed and started to build the model community of Battlement Mesa to house the thousands of workers needed for the Colony project. But, a little more than a year and a half ago, the boom suddenly ended when Exxon abruptly withdrew from the project. The lifeless streets and empty houses of Battlement Mesa now wait for better times, too.

Yet the sagebrush-strewn scene throughout the Green River geologic formation, where the oil shale lies, isn't completely desolate. This fall on a cliffside ledge near Parachute, Colo., the Union Oil Co. finished building a $620 million plant that will extract about 10,000 barrels of oil from 13,000 tons of shale every day. The Department of Defense (DOD) has already signed up as a customer for the refined product at a guaranteed price of $42.50 per barrel. The $10 to $15 premium is justified, DOD says, because of the product's superior quality for conversion into jet fuel.

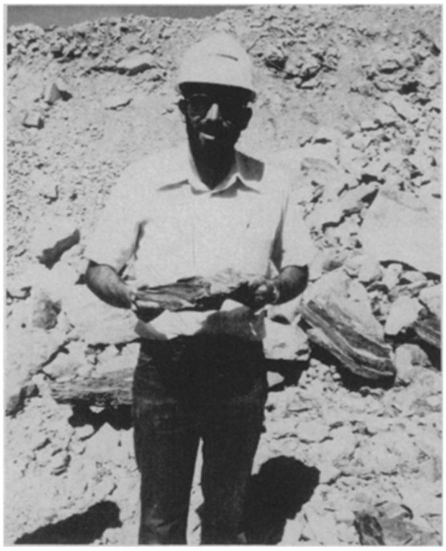
Meanwhile, the U.S. Synthetic Fuels Corp. (SFC), the independent federal body responsible for handing out billions of dollars in aid for promising synthetic fuel projects, will decide this month which of about half a dozen oil shale development proposals will receive support (SN: 1/8/83, p. 24). The SFC has already offered $2.19 billion in loan and price guarantees to the Cathedral Bluffs shale oil project, located deep in the oil shale country of Colorado's Rio Blanco county.

The object of this wavering attention is not, strictly speaking, shale, nor is the extracted product really oil. The Green River beds began forming about 50 million years ago. For 10 million years, trillions of aquatic organisms (like the algae and pond scum that thickly blanketed surface waters) settled into the mineral silt at the bottom of two great freshwater lakes. Eventually, the minerals solidified into a form of limestone. Sandwiched between the limestone layers, the organic matter congealed into a rubbery hydrocarbon known as kerogen. Impervious to solvents and intimately entwined with the rock, this complex hydrocarbon mixture emerges as

Oil shale deposits (shaded areas) of the Green River Formation



Colorado Energy Research Institute/Colorado School of Mines


I. Peterson
Joseph Virgona holds a chunk of streaked, kerogen-bearing shale.

a slow-flowing liquid only from strongly heated rock.

The Green River formation is rich in kerogen. Patches of rock sometimes catch fire when lightning strikes. Pioneers of the 1800s, striking out across the plains, learned about "the rock that burns" from the Ute Indians, fueled their campfires with chunks of shale and greased their wagon axles with its oily exudate. The Piceance Basin portion — little more than 1,500 square miles of northwestern Colorado — is one of the richest single hydrocarbon deposits in the world. If it could be completely recovered, this resource alone would be enough to supply the United States at 1980 oil consumption levels for at least 60 years.

In fact, all of the world's inhabited continents have impressive oil shale deposits, and hydrocarbons have been recovered from these kerogen-containing rocks for at least 600 years. In the fourteenth century, oil shale was the source of medicinal ointments in Austria and Switzerland. Throughout the 1800s, important commercial processes for extracting oil from shale existed in a few countries: Australia, France, Brazil, Scotland and the United States. But the discovery of vast petroleum reserves smothered interest in oil shale except during crises when reports of potential petroleum shortages surfaced or when a country felt that its fuel supply was threatened.

One would expect that after 600 years of experience with oil shale, a satisfactory recipe exists for cooking the shale (at twice the temperature achievable in a home oven) to drive out the kerogen. Indeed, hundreds of retorts, as these oil shale "ovens" are called, have been invented over the years, but most never left the drawing board. "It's not difficult to get oil from shale," says an oil company executive. "The problem is doing it economically."

The Anvil Points Experimental Station, situated at the edge of one of several tracts (Naval Oil Shale Reserves) set aside in the 1920s as future emergency energy sources, was founded in 1944 in response to wartime oil shortages. There, Bureau of Mines engineers blasted gigantic rooms into the rock and came up with the first safe, low-cost, large-scale oil shale mining techniques. Others worked on the towering retorts in which shale fragments, licked by hot gases, released their oil as they fell. Later, several of the project engineers ended up profitably exporting their Anvil Points expertise to nations like Brazil, which wanted to exploit their own oil shale resources.


I. Peterson
Ashby McMullan, Colorado School of Mines graduate student, shows the dark brown "oil" that condenses from the operation of a small-scale, experimental retort.

In May 1972, a consortium of 17 energy companies and engineering firms, under the name Paraho Development Corp., leased the Anvil Points site to develop further the technology for oil shale processing that had its origin in those early Anvil Points experiments. The Paraho retorting process produced more than 100,000 barrels of crude shale oil, some of which was used in Energy and Defense Department oil refining experiments.

In 1982, DOE, as one critic put it, "pulled the plug on Paraho." Paraho was forced to leave the site when legal technicalities prevented the lease from being renewed. A new Paraho pilot plant, processing about a ton of shale per hour, now operates a few long steps down the slope from Anvil Points.

The Paraho effort depends on SFC support (which hasn't come yet) for building a commercial-scale plant in Vernal, Utah, and on creating a technology that it can export to other countries. However, it faces competition from Japan, which has no oil shale reserves of its own but where a powerful consortium of about 30 major companies including Mitsubishi and Nippon Steel is poised to take the lead in oil shale technology.

Paraho's Charles F. Metzger says that Japan's determined development bid, in joint projects with countries like Australia, may surpass U.S. know-how this year. When the next oil crisis hits the United States and shortages stir up panic again, some industry analysts fear that the only proven technologies for building large-scale oil shale plants will belong to Japan.

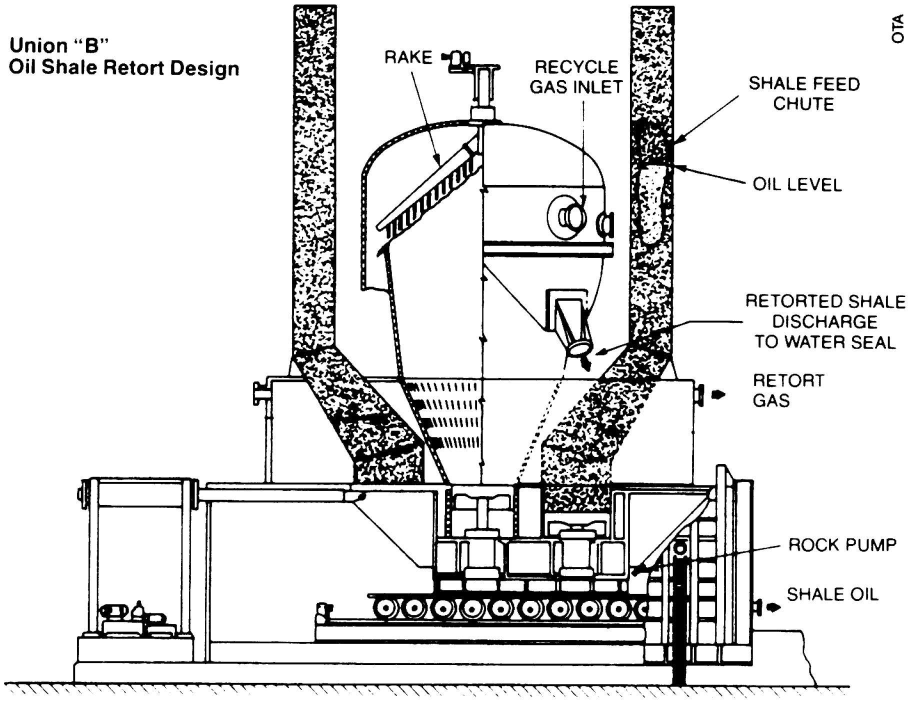
Attorney and environmental consultant Roger P. Hansen of Englewood, Colo., says that Japan's emphasis on long-term, harmonious planning and its ability to integrate public and private industries means that Japan's approach is likely to be more successful than U.S. efforts. "If Japan owned the Piceance Basin, we would have an oil shale industry today," says Hansen.

Not everyone is sorry that U.S. shale development has slowed. Some Colorado government officials say that the chance of developing better oil shale processing schemes as the result of further research and development is worth the delay. They worry that rushing into commercialization too early will result in expensive mistakes and more abandoned towns.

In addition, environmentalists and others are concerned about the impact of oil shale projects on the air, water and land. A typical oil shale plant will require thousands of gallons of scarce water and will generate thousands of tons of spent shale every day. This waste material is several times larger in volume than the initial unprocessed shale, keeping it from being returned to where it was mined. Dumping the spent shale in canyons, as proposed, can leave behind blemished landscapes and water contamination problems. Extensive development could also affect wildlife, including several endangered species and the White River deer herd, which is probably the largest migratory deer herd in North America.

Although the Anvil Points facility is in a "standby mode," says Joseph Virgona, a DOE chemist at Grand Junction, Colo., the federal government is still funding oil shale research. At the Los Alamos National Laboratory in New Mexico, for example, scientists use sophisticated computer models and the results of blasting experiments at Anvil Points to track rock cracks. One aim is to see if explosively fracturing rock will create the right conditions underground for igniting the rubbled shale and for recovering the oil and gases produced instead of having to haul the shale to surface retorts.

Union "B"
Oil Shale Retort Design

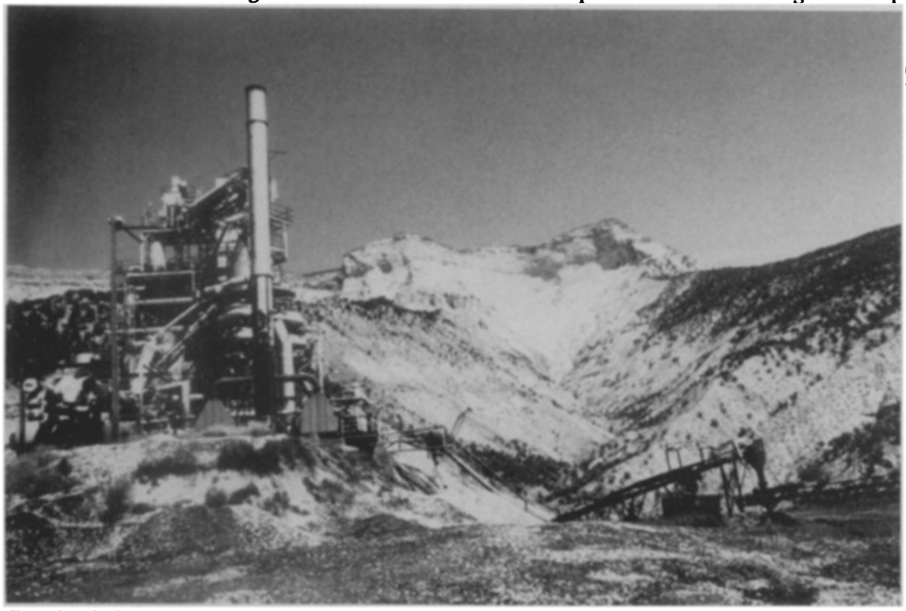


Testifying before a Congressional subcommittee recently, Jan W. Mares, DOE's assistant secretary for fossil energy, said, "We believe the government should help ensure that a small but adequate base of commercial synthetic fuels experience is available and that new ideas and innovations are channeled into the industrial development pipeline." The rest is up to industry and the "free market," Mares said.

However, Metzger says that U.S. oil and energy companies, which own most of the privately held oil shale land, are notoriously short-sighted. Right now, most of these companies are scrambling for cheap oil anywhere they can find it, he says, and forgetting about long-term planning.

Thomas A. Sladek of the Colorado School of Mines Research Institute in Golden hesitantly predicts that by the year 2010, the shale oil industry may reach an output of 1 million barrels per day. This is a far cry from the days, only a few years ago, when politicians and many others optimistically called for million-barrel outputs within 10 years.

This year, if all goes well, Union will be producing the first 10,000 barrels of that total — just a drop in the bucket, as the saying goes. But even Union's plans for expanding its plant to 50,000 barrels per day by 1988 depend heavily on more government aid from DOE and the SFC.



I. Peterson

Crushed shale, conveyed down from mines blasted into the bluff's upper layers, releases its store of kerogen as it tumbles through the heated retort (left). Blackened spent shale fills the foreground.

Many people in industry and government are watching Union closely. The Union "B" retort is the first large-scale test of the company's innovative retorting scheme. In this version, crushed raw shale is pumped upward in the vessel and heated by gases introduced at the top. The resulting oil mist condenses, and the liquid product collects in a pool at the bottom of the retort. The spent shale spills out from the top, to be disposed of eventually in nearby canyons. The weak link may be the mechanical rock pump, which must keep the shale moving upward, but so far, company engineers appear satisfied with its performance.

Much rides on the success of Union "B." One keenly interested watcher is Capt. Myron E. Smith Jr., of DOE's Naval Petroleum and Oil Shale Reserves office, which now is responsible for the Anvil Points Experimental Station. "I hope Union 'B' is a big success," he says. "Then maybe something will start happening again at Anvil Points." □