The Oil Drum: Australia & New Zealand
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Queensland Shale Oil Billions in The Balance ?

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The Australian Financial Review today has a report on a plan by the Ziff brothers to revive Queensland's defunct shale oil industry (subscription required) - "a mining project worth as much as $14 billion near the Great Barrier Reef Marine Park". The report predicts the development would bring 16,000 new residents to the Whitsundays region and is already facing opposition from local groups like "Save Our Foreshore" concerned about damage to the environment and the tourism industry.

Bloomberg has a much smaller version of the story - "Ziff Seeks to Develop Australian Oil-Shale Project, Review Says".

> Queensland Energy Resources Ltd., a closely held company backed by Ziff Brothers Investments, is seeking to develop an Australian oil-shale project valued at A$14 billion ($12 billion), the Australian Financial Review reported.
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> Consultants from New-York based Ziff recently met the Queensland government to discuss development of the project, which would require the relocation of a nearby airport, the paper said, citing government documents. The project, located in Queensland state near the Great Barrier Reef Marine Park, may contain as much as 9.7 billion barrels of oil resources, the Review said, citing a document lodged with the state's government.
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> Queensland Energy is scheduled to complete an initial study into possible development of the project within six months, the Review said, citing Simon Eldridge, the company's director of corporate affairs. The company acquired the project from Southern Pacific Minerals NL in 2004, the report said.

The original Stuart shale oil development in the area was done by Southern Pacific Petroleum.

Gareth Walton at Online Opinion made the following comments about the project before it collapsed for economic and environmental reasons after a Greenpeace campaign against the plant:

> The Stuart Project, operated by Southern Pacific Petroleum (SPP), is an experimental attempt to produce oil from shale rock. The plant has significant environmental problems, such as releasing highly toxic dioxins and making local people sick with

> noxious fumes.
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> Greenhouse pollution from the production of shale oil is nearly four times higher than from normal oil and SPP refuses to publicly release any evidence to prove its claim that it can reduce shale oil's greenhouse pollution to 5 per cent below normal oil. Even if SPP could reduce shale oil's greenhouse pollution to the level it claims, if SPP developed all of its shale oil deposits in Australia, as it wants to do, it would at least double Australia's greenhouse emissions.

Another company that seems to be in the Queensland shale oil game is the soon-to-list Blue Ensign Technologies - though there seems to be some controversy about one of the individuals involved.

> Blue Ensign Technologies Ltd., the company that said it's found a way to extract oil from Australia's outback, filed an amended prospectus today to disclose the checkered past of the inventor of the process.
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> John Rendall, developer of the technology Blue Ensign plans to use to produce oil from shale, misled investors in Solv-Ex Corp. from 1995 to 1997 with claims that he had devised a method to exploit Alberta's oilsands, Double Bay, Australia- based Blue Ensign said in today's filing with the Australian Securities & Investment Commission.
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> Rendall, 73, and Herbert Campbell, his general counsel at Solv-Ex, were sued by the U.S. Securities and Exchange Commission in 1998 for lying to shareholders about their efforts to extract oil from tar-soaked sand in Alberta.

In his book"The Control Of Oil", John Blair was very optimistic that significant amounts of shale oil could be economically produced in the western US once the price of oil reached a certain level.

As a result, I had a look into this several years ago but decided that shale oil was probably better renamed snake oil - the prospects of producing large amounts of oil from shale seem to be bleak (or pleasingly low, if you are more concerned about global warming) - the extraction processes are energy intensive, and there are huge problems with water availability and waste disposal to overcome.

Green Car Congress had an explanation of why Shell abandoned some of its shale mining permits in Colorado a little while back, which demonstrates just how energy intensive the extraction process is.

> Shell has withdrawn an application for a mining permit on one of its three oil-shale research and demonstration leases for economic reasons. Shell has been working on its In-Situ Conversion Process (ICP) for oil shale for more than two decades—ever since the collapse of the first run at oil shale in the 1980s.
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> Under the in-situ process, Shell drills holes into the resource, inserts electric resistance heaters, and heats the subsurface to around 343° C (650° F) over a 3- to 4-year period. During this time, very dense oil and gas is expelled from the kerogen and undergoes a series of changes, including the shearing of lighter components from the dense carbon compounds, the concentration of available hydrogen into these lighter compounds, and the changing of phase of those lighter more hydrogen rich compounds from liquid to gas.

> To keep groundwater away from the process (which would affect the heating), and to keep byproducts of the process away from the groundwater flow, Shell proposes to freeze the groundwater to create a subsurface ice barrier. (The creation of subsurface ice barriers to prevent water flow is a mining technique).
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> Shell spokeswoman Jill Davis said the withdrawal of a permit on one of its three oil-shale research and demonstration leases was done for economic reasons: Costs for building an underground wall of frozen water to contain melted shale have "significantly escalated."
> ...

Dan Denning at The Daily Reckoning also had a look at the economics of this process and some of the companies active in the region.

> The Bureau of Land Management recently received ten applications (by eight companies) for a pilot program to develop Colorado's shale reserves. The program allows the companies access to public lands for the purpose of testing shale-extraction technologies. You see below an interesting mix of large, publicly traded oil giants and small, privately held innovators.
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> * Natural Soda, Inc. of Rifle, Colorado.
> * EGL Resources Inc. of Midland, Texas.
> * Salt Lake City-based Kennecott Exploration Company.
> * Independent Energy Partners of Denver, Colorado
> * Denver-based Phoenix Wyoming, Inc.
> * Chevron Shale Oil Company.
> * Exxon Mobil Corporation.
> * Shell Frontier Oil and Gas Inc
>
> There is dispute within the industry over how long, if ever, demonstration extraction technologies can become commercially viable. I've spoken with some of the smaller companies that have applied for leases from the BLM. Some of them will have to raise money to conduct the project. And some of them have been less than forthcoming about how exactly their extraction technology is different or better than previous methods.
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> How will it all unfold? Well, for starters, it could all utterly fail. To me, Shell's in-situ process looks the most promising. It also makes the most sense economically. There may be a better, less energy-intensive way to heat up the ground than what Shell has come up with. But Shell, Chevron, and Exxon Mobil clearly have the resources to scoop up any private or small firm that makes a breakthrough.

A more recent report from Fortune (which is both optimistic and the most comprehensive news article I've come across on the subject) indicates that some alchemists from Shell are still dreaming about turning this shale oil into gold (The Oil Drum's Gail the Actuary also reported on Shell's enthusiasm during her recent visit to one of their offshore oil platforms).

> Haold Vinegar is the energy industry's leading expert on the complex petroscience of transforming solid oil shale into synthetic crude - a liquid fuel that can be refined into diesel and gasoline. The breakthroughs this 58-year-old physicist has achieved could turn out to be the biggest game changer the American oil industry has seen since crude

was discovered near Alaska's Prudhoe Bay in 1968.

If that sounds like hyperbole, then consider this: Several hundred feet below where Vinegar is strolling lies the Green River Formation, arguably the largest unconventional oil reserve on the planet. ("Unconventional oil" encompasses oil shale, Canadian tar sands, and the extra-heavy oils of Venezuela - essentially, anything that is not just pumped to the surface.)

Spanning some 17,000 square miles across parts of Colorado, Utah and Wyoming, this underground lakebed holds at least 800 billion barrels of recoverable oil. That's triple the reserves of Saudi Arabia.

The reason you probably haven't heard about the Green River Formation is that most of the methods tried for turning oil shale into oil have been deeply flawed - economically, environmentally or usually both. Because there have been so many false starts, oil shale tends to get lumped with cold fusion, zero-point energy, and other "miracle" fuels perpetually just over the horizon.

"A lot of other companies have bent their spears trying to do what we're now doing," Vinegar says of his 28-year quest to turn oil shale into a commercial energy source. "We're talking about the Holy Grail."

Unlike the Grail, though, Shell is convinced that oil shale is no myth and that after years of secret research, it is close to achieving this oil-based alchemy. Shell is not alone in this assessment. "Harold has broken the code," says oil shale expert Anton Dammer, director of the U.S. Department of Energy's Office of Naval Petroleum and Oil Shale Reserves.

Vinegar has developed a cutting-edge technology that, according to Shell, will produce large quantities of high-quality oil without ravaging the local environment - and be profitable with prices around $30 a barrel. Now that oil is approaching $90, the odds on Shell's speculative bet are beginning to look awfully good.

Shell declines to get too specific about how much oil it thinks it can pump at peak production levels, but one DOE study contends that the region can sustain two million barrels a day by 2020 and three million by 2040. Other government estimates have posited an upper range of five million. At that level, Western oil shale would rival the largest oilfields in the world.

Of course, considering the U.S. uses almost 21 million barrels a day and imports about ten million (and rising), even the most optimistic projections do not get the country to the nirvana of "energy independence." What oil shale could do, though, is reduce the risk premium built into oil prices because energy traders could rest easy knowing that the flow of oil from Colorado or Utah won't ever be cut off by Venezuelan dictators, Nigerian gunmen or strife in the Middle East. In a broader sense, U.S. energy security lies in diversity of supply, so enhancing domestic sources is appealing.

Oil shale has one other big appeal: It's not vulnerable to the steep depletion rates that have afflicted other big oilfields. Alaskan oil production is now 775,000 barrels a day, down from its peak of two million in 1988. In contrast, there's enough oil shale to maintain high production levels for hundreds of years. "Companies just aren't discovering new Prudhoe Bays anymore," says Bear Stearns oil analyst Nicole Decker, who thinks Shell has hit on a breakthrough technology. "This could be very significant - certainly bigger, to our knowledge, than any new discoveries that might be available globally." ...

With some 200 Shell (Charts) oil shale patents already filed and approvals needed from Colorado and the U.S. Department of the Interior to proceed with commercial production, Shell knows it has to make the public case for developing the country's oil shale potential.

So after months of negotiations, Shell and Vinegar agreed to give FORTUNE an exclusive look at a new technology - inelegantly dubbed the In Situ Conversion Process, or ICP - that could vindicate Shell's 28-year, $200 million (at least) bet on oil shale research.

In a nutshell, ICP works like this: Shell drills 1,800-foot wells and into them inserts heating rods that raise the temperature of the oil shale to 650 degrees Fahrenheit. To keep the oil from escaping into the ground water, the heater wells are ringed by freeze walls created by coolant piped deep into the ground; this freezes the rock and water on the perimeter of the drill site. Eventually the heat begins to transform the kerogen (the fossil fuel embedded in the shale) into oil and natural gas. After the natural gas is separated, the oil is piped to a refinery to be converted into gasoline and other products. ...

Attempts to commercialize oil shale began in the early 20th century and accelerated during the 1970s Middle East oil crisis, when the Carter administration began pouring big money into synthetic fuels. Problem was, the prevailing production process - known as surface retorting - was dirty and inefficient. Federal subsidies masked the problems, encouraging companies to build businesses they never would have created on shareholders' dimes. When oil prices collapsed, so did the economic rationale for shale oil. The day Exxon left town in 1982, turning some communities into ghost towns, is still remembered in northwestern Colorado as "Black Sunday."

The basic problem with surface retorting was that shale had to be mined, transported, crushed and then cooked at 1,000 degrees Fahrenheit. Not only were there toxic waste byproducts, but the oil thus produced had to be purified and infused with hydrogen before it could be refined into gasoline and other products. Vinegar may be a physicist by training, but he thinks like an MBA, and to him such a labor- and energy-intensive process reeked of bad economics.

Wouldn't it be better, he thought, if Shell could extract a liquid that could be pumped and pipelined instead of a solid that had to be mined and trucked? Upon visiting a Shell surface-retorting site for the first time in 1979, he came to a quick, life-changing conclusion: "Wow, we're going to have to do this in situ." ...

"Shell continued doing research, even in the 1980s when most everyone else quit," says Glenn Vawter admiringly. Vawter, a veteran of Exxon's failed oil shale operation, is now an executive with an oil shale startup, EGL Resources. In 1998 - when the price for West Texas crude crashed to less than $15 a barrel - Shell spent $799 million on R&D; by comparison, the larger Exxon Mobil spent $549 million.

In 2006, Shell spent $855 million on R&D to Exxon's $733 million. Both Vinegar and Shell Vice President for Unconventional Production John Barry confirm that oil shale is now the biggest piece of the company's R&D budget, though neither will specify exactly how much has been spent. One source briefed by Shell officials puts the total oil shale R&D investment at north of $200 million.

Shell has long been known for its science. It invented the first semi-submersible offshore drilling rig and pioneered the use of steam flooding to maximize oil well production; it's also the industry leader in natural-gas-to-liquids (GTL) technology. Much of its research originates at its Bellaire Research Center in Houston, where Vinegar has spent

most of his career.

The lab's most famous alumnus is the late M. King Hubbert, of Hubbert's Peak fame. Hubbert was the first geologist to understand the mechanics of oilfield depletion and the first to make a reasonably accurate assessment of recoverable oil reserves - initially for the U.S. and later for the world. The founding father of peak-oil theory, Hubbert predicted that U.S. production of conventional oil would peak around 1970 (he was right) and that global oil production would taper off after 2000 (he was wrong, though by how much is the topic of heated debate).

Neither Vinegar nor Barry wants to get drawn into a discussion of peak-oil theory. They simply state that the rapid growth in worldwide oil demand necessitates the development of unconventional oils. (Shell has also invested in biofuels and solar power.)

That said, it's no coincidence the oil company Hubbert once called home is the one now making the biggest bet on unconventional oil - not only oil shale but GTL and Canadian tar sands too. Jim Spehar, a former Colorado community-relations consultant for Shell, remembers company scientists and executives talking at length about peak oil - and about oil shale as a potential "bridge" between conventional oil and renewable energy - when he worked for Shell in the late 1990s.

"They definitely believed that the conventional stuff being pumped out of the ground was a declining resource," Spehar says.

Vinegar and the Shell team of chemists, engineers and physicists eventually figured out why the oil they collected early in that 1981 field test was so light and clean and the later samples so dark and dirty. They found that a slower, lower-temperature process - 650 degrees Fahrenheit, versus the 1,000 degrees required in the retorting process - allows more of the hydrogen molecules that are liberated from the kerogen during heating to react with carbon compounds and form a better oil.

This was a crucial discovery, because one of the hallmarks of a light oil - the most valuable kind because it costs less to refine - is its elevated hydrogen content.

Best of all, Shell was able to replicate the lab results in several field tests; the most recent one, in 2005, yielded 1,700 barrels of light oil. In that test, carefully engineered heating rods were inserted several hundred feet into the ground in order to gradually raise the temperature of the oil shale to 650 degrees Fahrenheit. Now Shell had a proven technology that it believed could produce a barrel of oil for $30. ...

Because there's no mining and because most of the action occurs underground, ICP is more environmentally benign than surface retorting or even tar sands production in Canada. But one big challenge is preventing the oil from leaching into ground water. Vinegar's solution was to create an impenetrable "freeze wall" of frozen rock and ice around the perimeter of the heating and production wells.

On a football-field-sized parcel of its own land, Shell is spending an estimated $30 million on a test that involves drilling 150 well bores and filling them with coolant in order to freeze surrounding rock and water to a temperature of minus-60 degrees Fahrenheit. "I do realize," says Vinegar, "that the whole idea of heating an area [to 650 degrees Fahrenheit] and simultaneously freezing around the circumference to keep the water out sounds almost like science fiction." Regardless, the freeze wall passed a smaller-scale test in 2004, and Vinegar says everything is proceeding as expected with the latest one.

All this cooling and heating, of course, consumes energy. Can it possibly be worth it? Yes,

> says Vinegar, who estimates ICP's ratio of energy produced to energy consumed will range from 3-to-1 to 7-to-1, depending upon the scale of the project. Moreover, the power needed to perform the heating and cooling will be generated entirely from natural gas produced onsite by the ICP process. Shell plans on building its own large power plant and is exploring ways to sequester any CO2 produced. ...
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> Shell insists that it has no beef with Governor Ritter's desire to proceed slowly. Even so, it's not leaving anything to chance. Shell has a public relations team devoted to oil shale and, in a shrewd move, the company has hired former U.S. Secretary of the Interior Gale Norton as an in-house lawyer. The stakes are huge. Assuming only $20 in profit for each barrel produced (at today's inflated oil prices, it would be more like $50), 300,000 barrels per day would add $2.2 billion to Shell's annual pretax profits. And three million barrels a day would be worth $22 billion.
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> It could be decades before Shell hits the really big numbers, if it happens at all. The logistics are daunting. It has taken the tar sands industry of Canada almost 30 years to reach its current production of about a million barrels a day (although it could be double that by 2010). ...
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> While it waits for its latest freeze wall to freeze and for the BLM to grind its way toward some sort of commercial leasing program, Shell is exploring other applications for ICP. It is negotiating with Jordan to test it on that country's oil shale reserves and investigating whether ICP can produce oil from Canadian tar sands - in which Shell also has major investments - more efficiently than current methods.

The Aspen Daily News has a report on some of the local politics revolving around the amount of water required for the shale oil industry, as does the Glennwood Springs Post Independent.

> Battling viewpoints on oil shale were presented on Friday at a water seminar sponsored by the Colorado River District. The theme of the conference was "Water: Fueling the Future?" and much of that question pertains to how much water it might take to extract oil from the vast oil shale deposits in Western Colorado, eastern Utah and southeastern Wyoming. "Half of the world's oil shale is within 100 miles of this room," Randy Udall of the Community Office for Resource Efficiency told the audience at the Two Rivers Convention Center in Grand Junction.
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> And he thinks the oil shale should stay in the ground. "We have one energy boom in our region and that's plenty," he said. He said that oil shale has low energy content and it is not worth the environmental degradation, water use, and intense electricity use that would go along with intense oil shale production.
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> Udall believes that pursuing energy efficiency measures makes far more sense than developing elaborate and technically complex schemes to heat the oil shale in the ground as part of the process of turning it into fuel. "I do think there are better ways to address our energy needs than oil shale," he said. "The way we are using petroleum right now in the United States today is a tragedy and it's kind of a bad joke and we will not use it this stupidly and this wastefully in the future. So oil shale will have to compete with all kinds of ways to save this precious fluid we call oil or 'black magic.'"
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> But Tony Dammer, the director of the Office of Naval Petroleum and Oil Shale Reserves with U.S. Department of Energy, said the federal government is bullish on oil shale development and that the potential exists for 2 trillion barrels of oil to be extracted from the oil shale in the Green River Basin region.

The Wikipedia article on shale oil notes that the oil produced is high in sulphur content and thus not a direct substitute for crude oil in some applications. It also notes that some countries (notably Estonia) use shale for power generation, much like coal (presumably with even worse emissions characteristics). The article also makes the following comments on the economics of shale oil production, considering both cost and EROEI.

> The various attempts to develop the world's oil shale deposits, over a period of over 150 years, have experienced successes when the cost of shale oil production in a given region was less than the price of crude oil or its other substitutes. According to a survey conducted by the RAND Corporation, a surface retorting complex (comprising a mine, retorting plant, upgrading plant, supporting utilities, and spent shale reclamation) is unlikely to be profitable in the United States until crude oil prices range between US$70 to US$95 per barrel (in 2005 dollars). Once commercial plants are in operation and experience-based learning takes place, costs are expected to decline in 12 years to US$35–US$48 per barrel. After production of 1,000 million barrels, costs are estimated to decline further to US$30 – US$40 per barrel. Royal Dutch Shell has announced that its in-situ extraction technology in Colorado could be competitive at prices over US$30 per barrel, while other technologies at full-scale production assert profitability at oil prices even lower than US$20 per barrel. To increase the efficiency of oil shale retorting, several co-pyrolysis processes have been proposed and tested.
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> A critical measure of the viability of oil shale as an energy source is the ratio of the energy produced by the shale to the energy used in its mining and processing, a ratio known as "Energy Returned on Energy Invested" (EROEI). A 1984 study estimated the EROEI of the various known oil shale deposits as varying between 0.7-13.3. Royal Dutch Shell has reported an EROEI of three to four on its in-situ development, Mahogany Research Project. An additional economic consideration is the water needed in the oil shale retorting process, which may pose a problem in areas with water scarcity.

An alternative method to the underground heaters combined with frozen container walls is a magical microwave device that cooks the oil straight out of the ground, currently being pursued by a company called Global Resource,

> I'm not sure if I'm watching a magic trick, or an invention that will make the cigar-chomping 64-year-old next to me the richest man on the planet. Everything that goes into Frank Pringle's recycling machine—a piece of tire, a rock, a plastic cup—turns to oil and natural gas seconds later. "I've been told the oil companies might try to assassinate me," Pringle says without sarcasm.
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> The machine is a microwave emitter that extracts the petroleum and gas hidden inside everyday objects—or at least anything made with hydrocarbons, which, it turns out, is most of what's around you. Every hour, the first commercial version will turn 10 tons of auto waste—tires, plastic, vinyl—into enough natural gas to produce 17 million BTUs of energy (it will use 956,000 of those BTUs to keep itself running).
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> Pringle created the machine about 10 years ago after he drove by a massive tire fire and thought about the energy being released. He went home and threw bits of a tire in a microwave emitter he'd been working with for another project. It turned to what looked like ash, but a few hours later, he returned and found a black puddle on the floor of the unheated workshop. Somehow, he'd struck oil.

> Or rather, he had extracted it. Petroleum is composed of strings of hydrocarbon molecules. When microwaves hit the tire, they crack the molecular chains and break it into its component parts: carbon black (an ash-like raw material) and hydrocarbon gases, which can be burned or condensed into liquid fuel. Pringle figured that some gases from his microwaved tire had lingered, and the cold air in the shop had condensed them into diesel. If the process worked on tires, he thought, it should work on anything with hydrocarbons. The trick was in finding the optimum microwave frequency for each material—out of 10 million possibilities.
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> Pringle has spent 10 years and $1 million homing in on frequencies for hundreds of materials. In 2004 he teamed up with engineer pal Hawk Hogan to take the machine commercial.
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> Their first order is under construction in Rockford, Illinois. It's a $5.1-million microwave machine the size of small bus called the Hawk, bound for an auto-recycler in Long Island, New York. More deals loom: The U.S. military may use Hawks in Iraq on waste such as water bottles and food containers. Oil companies are looking to the machines to gasify petroleum trapped in shale.

Once again, I think the final word should belong to the prophet of peak oil, King Hubbert, who noted (from Mobjectivist's "Our Petroleum Predicament" post) the following about the original retorting process for extracting oil from shale :

> You read about "oil from shale", right? You heard about 1,000 billion barrels of oil out west? Don't get excited, it's going to stay there. Dr. Hubbert told the Senate Committee on Interior and Insular Affairs it wouldn't work, three years ago this month.
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> It really sounds simple. You "simply" dig up such enormous quantities of shale (1.88 million tons a day,) that it's equal to digging a Panama Canal every week. You crush it fine and heat to 1,100 degrees in a retort to boil off the oil locked in the rock. Then you get rid of the rock. Only now it's turned caustic and has increased in bulk by 20% to 33%. So you back-fill the leftovers, called tailings, into the hole you dug it out of. Since you still have a lot left over, you dump it into the empty scenic canyons of the west. To do this you need to grab off 89% of the undeveloped water of Colorado and Utah and half of Wyoming's. Oh yes, and you turn the Colorado River system into alkaline salts which means you wreck the agriculture in Colorado, Arizona and southern California. What will this get you? 1-1/2 million barrels of oil a day out of the 17 million per day that the U.S. is using!
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> A news item in the Milwaukee Journal of August 29, 1976,25 says that the last of the oil shale development companies, Standard Oil, Gulf, Shell and Ashland, have walked away from the projects in Colorado and Utah, asking the Department of the Interior to release them from paying any more on their leases. Standard and Gulf have already paid $126 million of the $210 million they bid, and Shell and Ashland have paid about $70 million of the $117.8 million they bid. You have to admit they tried, really tried and they spent a big buck to make it work, but it won't.