

OFFICE OF FOSSIL ENERGY

2009 WINTER NEWS

ROCKY MOUNTAIN OILFIELD TESTING CENTER



ORMAT UPDATE

GEOHERMAL ELECTRICAL GENERATION HOLDS PROMISE FOR OLDER OIL FIELDS

In October, Rocky Mountain Oilfield Testing Center (RMOTC) and Ormat Inc. of Reno, Nevada, announced the first successful generation of electricity using geothermal hot water from a producing oil well. This project is unique in its production of on-site renewable power and has the potential to increase the productivity and longevity of existing U.S. oil fields. Harnessing hot water produced during oil production to power the oil field could lead to more economical access to reserves, especially in older, depleted fields.

The 12-month test started in September 2008 at Naval Petroleum Reserve No. 3 (NPR-3). The power system is a commercial standard design Ormat Organic Rankine Cycle (ORC) power plant. The binary power unit uses produced hot water as the heating fluid for a heat exchanger in the Ormat Energy Converter (OEC). In the heat

exchanger, a secondary working fluid, an organic fluid with a low boiling point, is vaporized. That vapor is then used to spin a turbine coupled to a generator to produce electricity.

The cooled geothermal fluid can then be reinjected into the reservoir or discharged, depending on the location. Previously, the 190°F water produced from the Tensleep sandstone formation at NPR-3 was a waste stream and was treated before being safely discharged into an adjacent stream. The ORC captures the water's heat and makes use of it before the water is treated and discharged. The Ormat power unit is connected to the field electrical system to power production equipment and the produced energy is metered and monitored for both reliability and quality. It has been producing 150-250 gross kilowatts of power since it was first started in early September.

The unit at NPR-3 is similar to a 250

kilowatt Ormat unit that has been producing electricity from 210°F geothermal water at an Austrian resort for more than six years. Similar units have also been in continuous commercial operation since the 1980s in Nevada and Thailand.

There are a large number of oil and gas wells in the United States that produce hot water as well as hydrocarbon products. These wells, which generally produce fluids at temperatures below 220°F, have been estimated as being capable of generating upwards of 5,000 megawatts of power.

Some 8,000 similar wells were identified in Texas by the U.S. Department of Energy (DOE) Geothermal Research Project Office. Ormat is now assessing the feasibility of utilizing these wells to support on-site power generation by employing its sub-megawatt geothermal power units which have been field proven in 1,000 installations worldwide.

Ormat's Organic Rankine Cycle generator has been running at full capacity since early September at NPR-3.





FRACTURE MODELING FIELD COURSE

RMOTC, SCHLUMBERGER PARTNER TO OFFER FIVE-DAY, HANDS-ON CLASS

Geoscientists, engineers, and Petrel modelers from several companies all over the world participated in a class held in June in Casper. The Petrel fracture modeling course was held in cooperation with RMOTC and Schlumberger Information Solutions. Petrel is a Schlumberger software package used for seismic interpretation, reservoir analysis, and geologic modeling of the subsurface in oil fields.

The five-day course combined field and classroom training sessions that integrated model building in Petrel along with field observations. Much of the field portion of the class took place at RMOTC's test facility at NPR-3 about 35 miles north of Casper. The historic field, also known as Teapot Dome Oil Field, is a 10,000-acre DOE facility used for testing energy-related technologies in a real-world setting.

The field portion of the course consisted of short excursions to view the oil-field facilities at NPR-3 and other surface geology and outcrops in the area. The group also spent time in other areas near Casper including Alcova Lake about 30 miles southwest of Casper, where reservoirs

found in the subsurface at Teapot Dome are exposed in surface outcrops displaying similar structures, fracturing, and reservoir characteristics. "The field visits were first-class," said one student in the course. The mix of field and classroom training appealed to the students over a traditional all-classroom approach.

"Taking us to the outcrop and showing us the actual geology of the field and modeling the same thing in Petrel gave us the actual feel of modeling Teapot Dome live," another student said. The data used in the Petrel course was actually collected at NPR-3, giving students an opportunity to see tangible examples of the conceptual models they use and create in their day-to-day work. The students also did exercises using core from RMOTC's core storage and examination facility located in Casper.

Schlumberger plans to further develop this concept of learning with another Petrel fracture modeling class tentatively scheduled for 2009. It also plans to add other courses in the future, expanding on the successful partnership with RMOTC initiated in 2008.



GREENING THE OIL FIELD

RMOTC RESEARCHES ALTERNATIVES TO POWER THE OIL FIELD

Wyoming has long been known for its abundant natural resources – oil, gas and especially coal. In recent years, the renewable energy push has revealed yet another important energy resource Wyoming has, and in no short supply. Wind.

Construction of new wind farms has increased throughout the state in 2008 and generation capacity is expected to increase to a total 787 megawatts by year end. RMOTC recently partnered with Casper College to investigate how wind could be used to power oil fields.

Roping the wind

In 2007, Casper College and RMOTC began discussing the possibility of designing a wind power system that would be housed at NPR-3. A wind turbine would be installed to supplement grid power in the field while also serving as a research laboratory for students. After nearly two years of planning and securing funding from several sources, the project began to take shape. One Proven 6 kilowatt wind turbine was installed in the field in October.

High oil prices along with environmental concerns and government incentives have made the United States the fastest growing wind market in the world. In recent years, many large oil companies

in the United States and abroad have begun expanding their energy portfolios, and this has meant diving into the renewable energy sector. Shell and BP, for example, have made significant investments in wind farms and say that their goal is to make money while reducing their carbon output.

While using wind technology in the oil field is not unheard of, it is not common either. The wind industry is now seen at energy conferences and events traditionally reserved for the oil and gas industry. Proven Energy turbines have gone through rigorous testing offshore and are currently being used on an offshore Shell rig and BP's petrol stations. In another offshore application, wind turbines and cable have been installed east of Scotland to test the viability of using offshore wind turbines to power Beatrice Oil Field.

At NPR-3, RMOTC and Casper College are testing the feasibility of using a wind-diesel generator hybrid system to power remote small industrial applications. The project will be accomplished in phases. In the first phase which started in early November, the small-scale 6 kilowatt turbine was installed and connected to RMOTC's customer operations center. Grid power continues to supplement the

wind power in the building. According to Proven, the turbine being installed is able to meet the power needs of a home with four to six bedrooms, excluding heat. Any excess energy could be exported to the grid, although that will not be done in this case. In Phase 2, a meteorological tower and wind turbine-diesel backup system will be connected off-grid to a load source. One of the goals of the pilot project is to provide wind-derived electricity to power one or more small electric oil pumping units. The power will be directed to a battery pack and then to the pumping units.

The effective coordination of oil extraction and wind power is not an easy process. The goal of the RMOTC project is to gain a greater operational knowledge to effectively manage the energy contributions from the wind turbines and their effect on oil extraction activities. RMOTC estimates that offsetting conventional electrical power with a renewable energy source could reduce costs by up to \$300,000 over 10 years if 5% of electrical costs could be replaced by wind turbines. The same or similar savings percentage could be achieved in oil fields worldwide.

Educational access

In addition to testing the application of wind power generation in oil fields, Casper College and RMOTC will be involved in a certification process for small wind turbines of less than 200 kilowatts electrical generation capacity. Casper College's partnership with RMOTC will serve as a significant part of the school's training program for renewable energy technicians, but also as a site for research and development activities. The college's program with the University of Wyoming allows students to complete coursework in renewable



PAGE 4: A ribbon-cutting ceremony was held in conjunction with Casper College and Rocky Mountain Power in November at NPR-3. The wind turbine was raised during the event. The turbine is currently producing power at full capacity.

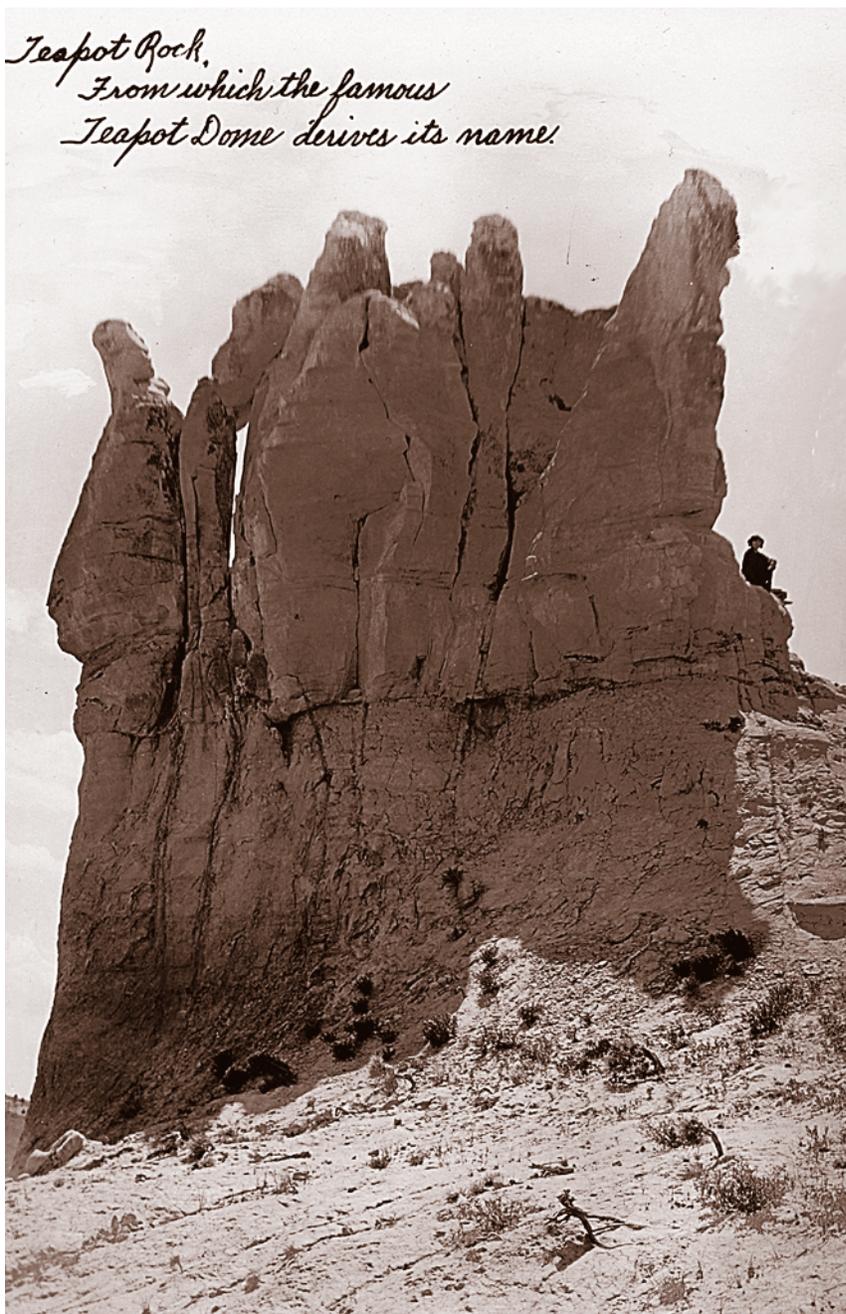
RIGHT: Students from nearby Midwest attended the wind turbine ribbon-cutting event to learn more about alternative energies. RMOTC also offers educational outreach programs for schools at its Science Center, which is often visited by students and teachers in Casper and Midwest.

resources or mechanical engineering leading to advanced degrees.

As Wyoming continues to invest in wind energy, the need for trained technicians in the field will increase. Casper College's Renewable Energy Program is designed to investigate the feasibility of interconnected wind electric power production and remotely located wind-diesel electric power generation that might be used in the oil and gas industry, agriculture, and other rural applications. NPR-3's proximity to Casper and its remote location make it a good fit to supplement the program.

The future

Renewable energy can be expensive and payout can take a long time, but in a time where grid-supplied power is becoming more expensive, renewable energy systems are becoming more economical and attractive to general consumers as well as the oil and gas industry. As renewable energy technologies become more robust and reliable, offsetting the cost of electricity while reducing CO2 emissions will become more common.



*Teapot Rock,
From which the famous
Teapot Dome derives its name.*

LOOKING BACK

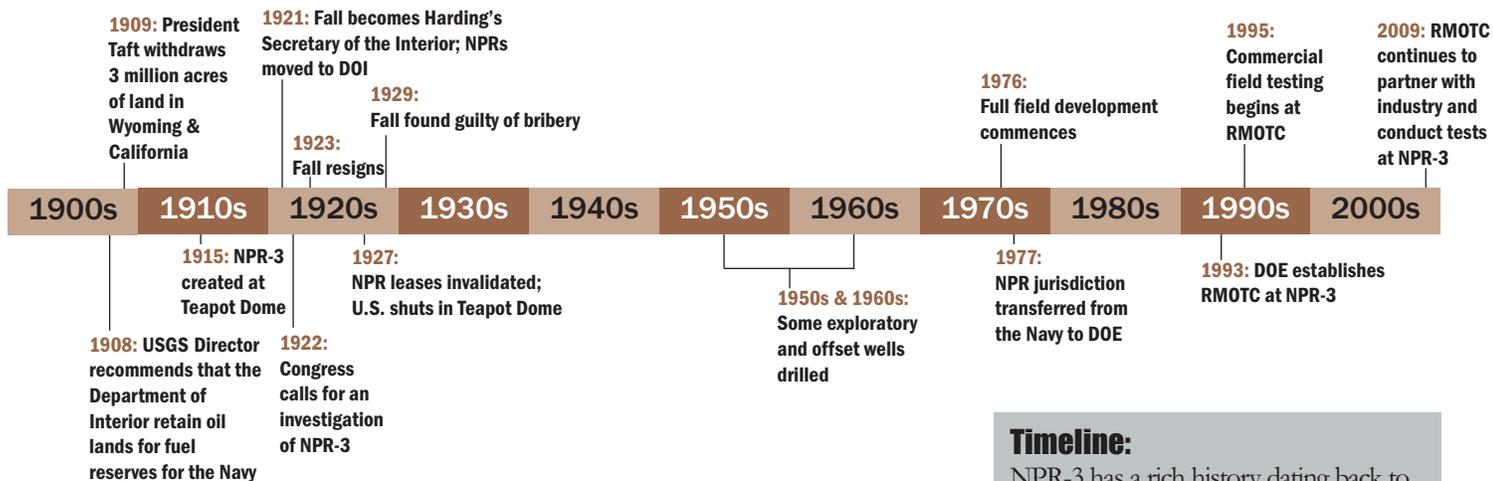
PHOTO ARCHIVE PROJECT REVEALS CHANGES AT NPR-3

These days it's not very easy to tell why Teapot Rock is so named, but a look back in time gives us some insight. The famous rock was named in 1911 by C.H. Wegemann, a government geologist, because of its resemblance to a teapot (see photo on left). Teapot Dome, Teapot Creek, and Teapot Ranch were also named after the small, isolated sandstone butte located about six miles west of Teapot Dome Oilfield.

Many more changes have taken place in the old stripper field also known as NPR-3. Recently, RMOTC's chief scientist Tom Anderson sought to reveal the differences by taking photos from the same viewpoints as historical photos from the 1920s-1940s. A lot has changed ...



Teapot Rock's soft sandstone composition has been eroded away by weather over the years. Since losing its "handle" and "spout" in a storm in 1962, it bears little resemblance to the rock named in the early 1900s.



Timeline:
NPR-3 has a rich history dating back to the early 1900s.



In 1927, a garage, office, and warehouse occupied the land where RMOTC's parts warehouse and offices are currently located.



While a bridge across Teapot Creek remains in the same place at NPR-3 today, it has been replaced to accommodate heavy equipment traffic.

MLEF INTERNS

INTERNSHIPS AVAILABLE FOR SUMMER 2009

The Mickey Leland Energy Fellowship (MLEF), a summer internship program sponsored by the DOE's Office of Fossil Energy, supports minority students studying academic disciplines related to the Fossil Energy mission. For several years, RMOTC has sponsored and hosted one or two students each summer, in both geoscience and engineering disciplines.

Last summer, the program provided funds for two interns to join the RMOTC team for a few months to further their research. Check out the work they accomplished at RMOTC.

Delphine Tsinajinnie

Delphine is a U.S. Bureau of Reclamation Fellow at Central Washington University conducting research in aquatic toxicology to contribute to global sustainability. As a



Yorke Bannard Scholar, Delphine studied linguistics at the University of Arizona. She holds a Bachelor of Science degree in Biology with researchships in ocular physiology and cancer genetics from Arizona State University. She has been inducted into Gamma Beta Phi and Gamma Theta Upsilon. She has interned at Procter & Gamble's

Baby Care Division and Barrow Neurological Institute's neuropathology department. Her research focuses on the relationship between water quality and human health.

Over the summer, Delphine worked with Project Manager Kenny Colina and Environmental Specialist Steve Shire to develop a "Use Attainability Analysis," a structured scientific assessment of physical, chemical, biological, and economic factors affecting water quality.

"I am thrilled to be working on a project at the only facility in the nation that fosters partnerships between government, industry, and academia to develop and test sustainable energy technologies," she said. "I wholeheartedly welcome all that I can learn from everyone at RMOTC, so that I may develop the skills necessary to help guide the way to a more sustainable global future."

Desiree Coles

Desiree Coles (Dez) was RMOTC's first Mickey Leland intern to arrive last summer. She spent most of her summer assisting Mark Milliken with his geological surveys.



Dez was born and raised in central Wyoming, mostly Casper and Jeffrey City. In college she discovered she had a passion for the earth sciences. While enrolled in a paleontology class, she and two classmates found a triceratops outside of Lusk, Wyoming. Their find is currently being worked on in the Tate Geological Museum at Casper College.

She is working to earn a bachelor's degree through the University of Wyoming with the ultimate goal to work in a field involving structural geology and tectonics. She enjoyed her internship to gain hands-on experience to supplement her classroom work.

Summer 2009

For more information on MLEF internship opportunities, visit fossil.energy.gov/education/leland_fellowships.



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RMOTC BRIEFS

RMOTC partners receive federal tech transfer award

Two RMOTC partners were honored at the 2008 Federal Laboratory Consortium (FLC) Mid-Continent Region meeting in Denver in September. WhisperGen LLC of New Zealand and BP America shared an Excellence in Technology Transfer award for their combined efforts in testing Stirling Cycle electrical generators for use at remote well sites and the wide dissemination of those test results to the oil and gas industry.

WhisperGen partnered with BP America to develop and commercialize the Stirling Cycle generator before approaching RMOTC in 2006. The technology has been running artificial lift equipment at Teapot Dome using raw natural gas.

The Stirling Cycle generator has been running

a low kilowatt motor (3 hp) motor on a shallow (500-foot depth) well at the site since February 2007. The test results demonstrate that the system is highly reliable and requires little maintenance.

Where to see RMOTC this spring

RMOTC is gearing up for its spring trade show season. There will be plenty of opportunities to catch up with RMOTC staff at the following events:

- SPE/IADC Drilling Conference
Amsterdam, March 17-19, 2009
- Offshore Technology Conference
Houston, May 4-7, 2009
- AAPG Annual Convention
Denver, June 7-10, 2009

Check out www.rmotc.doe.gov for more details on RMOTC's conference plans.

