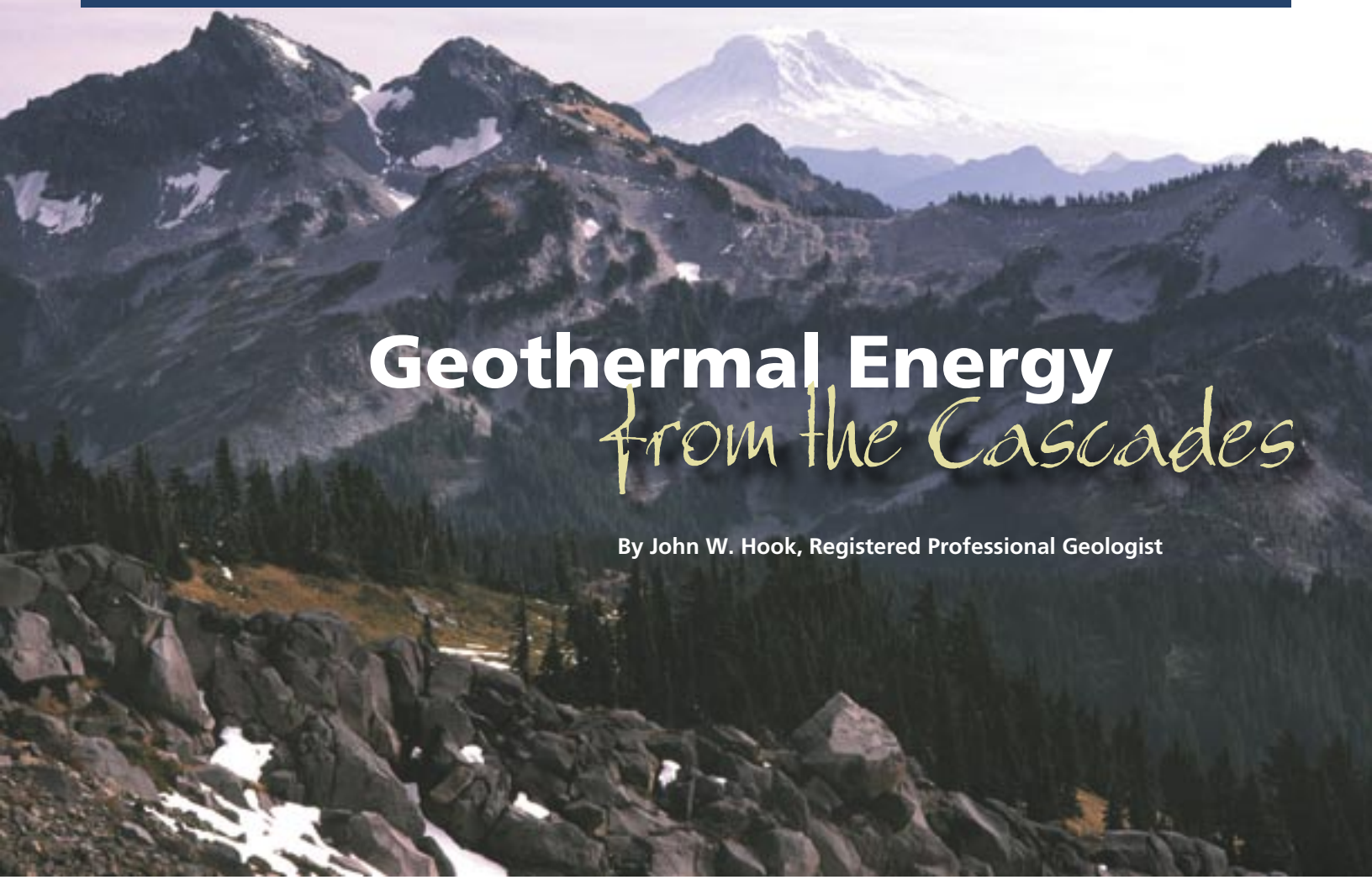

Geothermal Energy from the Cascades

By John W. Hook, Registered Professional Geologist

Editor's Note: The following was written in the 1990s by the late John W. Hook, a registered geologist who took a special interest in the geothermal potential of the vast Cascades Range in Oregon and Washington states. Though some of the facts have changed since this piece was written, his ideas still ring true, as geothermal developers across the West seek viable resources for power generation. Born on June 11, 1922, Mr. Hook passed away on May 17, 2003. His son, James, gave the Geothermal Resources Council special permission to reprint this insightful commentary.

The young volcanic areas of the Cascade Mountains offer the possibility of abundant clean electrical power. Geologic studies to date indicate that the geothermal energy equivalent of 400 Trojan-size nuclear plants probably exists in the Cascades—outside of Wilderness Areas and National Parks. (This estimate was by the Oregon Department of Geology and Mineral Industries in 1983 in Special Paper 15.) Many other similar estimates of a vast power reserve were made in the 1970s and 1980s, based on thermal gradient drilling, geophysical and geological explorations. Yet for the past 10 years almost nothing has been done to follow up this promising work with the deep drilling needed to prove this resource.

In California, Nevada and many other places around the globe, geothermal has proven to be an economical source of energy, for both direct use and for the generation of electricity. It is the most economical of the "green" energy resources such as solar or wind. Geothermal energy is a "baseload" type of power, which is there full time—not just when the sun shines or the wind blows. In the long-run the economics of geothermal power may even exceed those of the fossil fuels. It would likely prove to be a sustainable low-cost source of power, such as the Northwest has been realizing for many years from the hydropower it developed in the 1930s and 1940s.

Geothermal energy is one of our renewable resources—it is environmentally benign compared to hydropower, nuclear energy or fossil fuels. It does not dam streams, produce nuclear wastes or pump vast quantities of carbon dioxide (greenhouse gas) into the air. Geothermal energy from the Cascades would be a reliable domestic resource. It would not be dependent on the foreign political regimes of some of the most unstable areas in the world. It would not be subject to an OPEC embargo.

So, why are we not using it? That is a long story.

The young volcanic areas of the Cascade Mountains offer the possibility of abundant clean electrical power. Geologic studies to date indicate that the geothermal energy equivalent of 400 Trojan-size nuclear plants probably exists in the Cascades—outside of Wilderness Areas and National Parks. Photo: TJC / GRC

Money

Unlike the California "49ers" grubstaking with a mule and a gold pan, being a geothermal prospector involves more than buying a few cans of beans. Instead of showing a few nuggets or some gold dust, the geothermal prospector must show steam economically capable of turning electrical turbines to claim a discovery. The real "Catch 22" of this is that until he shows steam coming out of a drill hole, he can't attract the millions of dollars it takes to drill the hole deep enough to find the steam.

Unfortunately the petroleum industry, which has the financial resources and the drilling expertise needed to prospect for geothermal energy, has much better short-term risk factors in prospecting for more petroleum. Their prospectors drill a well and if it is successful, they start pumping almost immediately. They often get a full return on their investment in less than a year, then sit back and rake in the gravy. The geothermal prospector has to drill a discovery hole, then prove a large reservoir with multiple development holes, build a power plant, and string the wires before he can sell the first kilowatt of electricity. This return on investment is seldom less than 10 years.

Utility companies with distribution systems to sell power are not risk oriented. They are often prohibited by regulations from taking the kind of gamble that exploration requires. This is not totally true, considering the Northwest Natural Gas and the Eugene Water and Electric Board on geothermal exploration projects in the 1970s. These projects were heavily endowed with government funds and/or joint ventures with petroleum companies. I consulted on both.

In brief, we no longer take a long-range view of our natural resources, with planning for the future, like we did following World War II. We found that we were dependent on some badly needed mineral and energy supplies that were now in hostile territory. The War Production Board gave a high priority to the development of more hydro power and building more aluminum production plants.

Following the war, the same men responsible for these developments saw the need to explore for adequate strategic energy and mineral reserves. Unfortunately, many of the companies with the foresight to discover and develop large reserves were the same ones that takeover artists preyed upon in the 1980s, selling their assets for a quick profit. The name of the game seems to be the next quarter's income, not where we will be 10 or 15 years down the road. We are dangerously dependent on petroleum, more than 50 percent of which is imported. We are much too dependent on OPEC for comfort.

Considering how vulnerable our present energy supplies are, is it not time to again start planning for the inevitable future when the world's finite petroleum reservoirs are drained or even cut off earlier because political conflict? We have seen rapid increases in the cost of energy in the past few years, and as fossil-fuel resources continue to be depleted they won't become cheaper.

Environment

Active volcanoes have the best prospects for geothermal energy, but all of the major volcanoes in the Cascades are either in National Parks or Wilderness Areas. While these prime prospects are obviously off limits, there are a number of smaller volcanoes that are in multiple use areas. The 400-megawatt (MW) estimate by the state mentioned earlier was for resources outside of the very sensitive areas.

Any source of energy we look at, including wind and solar, will have some environmental impacts. Geothermal is no exception. However, compared to other viable energy resources, the environmental impacts of geothermal development are small indeed. The volatile volcanic gases such as carbon dioxide and hydrogen sulfide often associated with the production of geothermal fluids are very minor in comparison to those produced by the combustion of fossil fuels.

Current geothermal technologies widely in use in California, Nevada, and elsewhere in the world have greatly reduced objectionable gases and steam plumes from geothermal operations. With some of the systems in use today, practically all of the fluids and volatile that comes out of the production wells are returned to the geothermal reservoir through injection wells. Other systems that use flashed steam technology vent it to the atmosphere and produce highly visible plumes when the air is cold. In these systems, scrubbers are used to eliminate sulfur and other objectionable emissions.

The point to be considered here is that we need to assess the adverse impacts of geothermal energy in relation to other viable sources of energy. While geothermal may produce some visible plumes of steam in the mountains, would it not be better to be able to see the mountains, steam plumes and all, than to have them shut off from view by industrial haze from fossil-fuel systems?

We need to weigh our priorities, not give in to the knee-jerk reaction that there can be no energy development in the Cascades. In the same vein, we need to weigh the various risk factors involved with geothermal development compared to other energy resources. Whichever way we turn (or continue to drift) in energy production involves risk. Many prominent scientists now believe that we are at serious risk as we continue to pump more carbon dioxide into the atmosphere from fossil fuels.

Our biggest risk of all may be in not developing alternative energy resources. None will be 100-percent risk free as some seem to demand. Yes, a careful environmental assessment needs to be made. This is required by state and federal laws. But the assessment must involve weighing the negative impacts against the positive impacts. It must involve weighing the results of development against the results of doing nothing. It could even include the risk of our present dependence on OPEC.

Competition

It is human nature, and that of most other life forms, to protect one's own turf. There can be few fields where this is more true than in the energy industry. Oil, gas and coal producers do not welcome anything that cuts their sales. Likewise, there was strong opposition to geothermal development in the 1960s and 1970s from the nuclear industry. Geothermal leasing of federal lands was blocked by a Presidential Order in the early 1960s and not reopened until January 1974.

The stated reason for this was that the government did not know whether to lease geothermal resources as a mineral or gas. It took our National Laboratories, largely funded by nuclear energy studies, a long time to figure this one out. And when leasing was opened, the

nuclear industry and utilities with vested interests in nuclear power plants looked for all kinds of dire environmental impacts and reasons why geothermal energy was a poor idea. For years they pointed to the early geothermal development at Wairakei, New Zealand, where the hot geothermal water was dumped directly into a stream, killing the fish. Despite the later development of injection wells, naysayers continued to point to this disastrous environmental impact.

In the political arena, the infant geothermal industry stood little chance for funding in comparison to studies of nuclear energy. The relatively small amount of funding provided for geothermal went largely to paper studies or computer programs that were either run or directed by the National Laboratories. Various expensive theoretical models were built on some very shaky scientific foundations. Very little was invested in actually drilling holes in the ground to see what was really there.

Geologist John W. Hook as he appeared in a 1975* Oregon Statesman *(Salem) article about geothermal energy potential in the Cascade Range.

Risk

Exploration by its very nature involves risk. We explore to learn something we don't already know. We may think we know where it will lead us—or simply follow a dream—but until we actually explore we have no sure knowledge. Lewis and Clark hoped to see a major river when they crossed the Great Divide at Lemhi Pass, but they saw another mountain. The Columbia River was out there, but they still had to cross the Bitterroots to reach one of its navigable tributaries.

Exploration risks must be carefully based on what we already know and reasonable projections of this knowledge. We know that some of the volcanoes in the Cascades are still active. The magma chambers under the High Cascades are being renewed by melt from the Cascadia Subduction Zone. We know from the relatively shallow thermal gradient holes drilled during the 1970s and early 1980s that these young volcanic areas have high heat flow. These thermal gradients, when projected to the usual geothermal well depth of 7,000 to 10,000 feet, indicate adequate heat for commercial power generation.

Geothermal power is being produced in some of the other young volcanic areas of the world. We know that certain areas are seismically active, producing the fracture permeability needed for reservoirs. There are excellent targets for exploration, but only deep drilling and testing can discover if they have commercial reservoirs.

Only two deep production test wells have been drilled in the Cascades. The 6,000-ft. test drilled by the U.S. Department of Energy and Northwest Natural Gas in Old Maid Flat near Mount Hood found sufficient heat but insufficient permeability. The 8,000-ft. test near Breitenbush Hot Springs by Sun was in the older volcanic rocks of the Western Cascades rather than the young volcanic areas of the High Cascades, and did not find sufficient heat for electric power generation.

Exploration geologists do not always find what they are looking for with their first well. The first hole in Saudi Arabia did not produce oil. Neither did the second, nor the third, fourth, fifth or sixth. Seven was the lucky number. New Jersey Zinc had good scientific reason to project a high probability that large ore deposits could be found in central Tennessee. It was their 67th hole that found these huge zinc deposits. (Yours truly got lucky with the first hole in a large dome in eastern Tennessee and discovered the world-class Young Mine for American Zinc. My next major discovery was a large vein of fluorspar in western Kentucky that was hit with the 12th hole.)

Exploration is always a gamble. But the Cascades offer some potentially juicy targets. Heat flow studies show abnormal high-temperature gradients for the full length of the High Cascades. The unknown factor is where to find permeable reservoirs with sufficient hot water or steam to drive turbines. Permeability is necessary to allow fluids from a geothermal (or petroleum) reservoir to flow into a production well.

Unlike sedimentary rocks in which oil occurs in permeable silica sands, volcanic rocks carry feldspars in addition to silica, which tend to weather to clay and seal potential reservoirs. The likely reservoirs in volcanic areas are to be zones of fracture permeability. This fracturing along fault zones creates openings in the rock through which the geothermal waters can flow. There are numerous fault zones throughout the High Cascades that would make likely target areas for exploratory drilling.

In at least two places in the Cascades there is evidence that geothermal reservoirs not only existed, but reached critical temperature to create phreatic (steam) eruptions. Blue Lake in the Santiam Pass is a mile-wide crater blasted out by an explosive eruption of steam and other volcanic gases. Rock from this blast only 3,500 years ago is found several miles away along the Metolius River. Fracturing from this eruption, plus an associated fault, likely has created a reservoir of very hot water.

Even more impressive evidence of geothermal reservoirs is a series of five phreatic craters extending from the South Twin Lake to Shukash Butte. The Twin Lakes (near the Wickiup Reservoir) occupy two of these three quarter mile wide explosion craters. Lines of northeast trending cindercones, such as those extending from Lookout Mountain to Mount Bachelor, from the Belknap Crater through the Santiam Pass, from Mount Hood to Mount St. Helens, and many others, show these fissure vents are along zones of relatively recent faulting.

In brief, there are a number of excellent targets for geothermal exploration in the Cascade Range that are outside of Wilderness Areas and the National Parks. The crying need is for the gambling money to test them. It seems too bad that we can't direct our lottery gamblers to a bet that could enrich us all! ■