Name: John W. Pritchett

Position: Senior geothermal reservoir engineer

Technical Expertise: Reservoir engineering, numerical simulation, software design and development, field data interpretation, resource evaluation.

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EXPERIENCE SUMMARY

After completing his formal education in physics at the University of California at Berkeley in 1964, Mr. Pritchett was employed by the Naval Radiological Defense Laboratory (NRDL) in San Francisco where he specialized in experimental hydrodynamics and the development and application of large computer programs for solving unsteady multidimensional hydrodynamics problems. After NRDL was closed by the Defense Department in 1969, he moved to the private sector with Information Research Associates of Berkeley, which was acquired by Systems, Science and Software (S-Cubed) of San Diego in 1972. S-Cubed was acquired by Maxwell Technologies of San Diego in 1982, and Maxwell's Systems Division was sold to Science Applications International Corporation (SAIC) in 2000. SAIC spun off Leidos Inc. in 2013. Mr. Pritchett left Leidos and joined Geologica in January 2019.

EXPERTISE

Mr. Pritchett's primary expertise is the development and application of sophisticated computerized simulators to describe processes such as geothermal reservoir behavior, thermal oil recovery, deep well waste injection, in-situ mineral leaching, underground greenhouse-gas sequestration, geophysical survey interpretation, rock fracturing, and air and water pollution transport. He has developed a multi-gas two-phase miscible simulator for natural-gas storage applications and a simulator to describe the formation and dissolution of natural-gas hydrates in sea-bed sediments.

He has personally developed several state-of-the-art simulation programs to describe geothermal reservoir dynamics and related phenomena that are now in use worldwide. These include three-dimensional compositional unsteady multi-phase mass and heat flow simulators that may be used for "natural-state" studies, history-matching, and/or future performance predictions. The simulators are adjoined with various mathematical representations for the fluids occupying the void spaces in the rock, ranging from pure liquid water to complex multicomponent mixtures with several immiscible phases.

In addition to conventional reservoir simulators, Mr. Pritchett has developed software for computation of flow within geothermal wells and has coupled mathematical models for geothermal power stations to underground reservoir simulators using the well models. He has extended the capabilities of conventional reservoir simulators by developing "geophysical postprocessors" to compute temporal changes in quantities observable by time-lapse surface geophysical surveys caused by production-induced changes in subsurface conditions. These "postprocessors" calculate changes in microgravity, DC resistivity, magnetotelluric response, electrical self-potential, and seismic properties, and are particularly useful for reservoir history-matching.

He has undertaken extensive reservoir engineering studies of numerous geothermal fields both in the U.S. and overseas and has been an active participant in geothermal R&D continuously since 1974. Much of his experience with reservoir modeling, simulation, resource estimation and forecasting has involved geothermal systems in Japan, including the fields at Hatchobaru, Sumikawa, Ohnuma, Wasabizawa, Mori and Onikobe among others. In the U.S., he carried out a multi-year study of the Coso geothermal system for the Navy Geothermal Program Office in 2004-2006 and has since been engaged in smaller-scale examinations of other domestic geothermal prospects.

MEMBERSHIPS, AWARDS AND RECOGNITION

Mr. Pritchett is a member of the Geothermal Resources Council (GRC), the International Geothermal Association (IGA), and the Geothermal Research Society of Japan (GRSJ). He served on the Board of Directors of the Geothermal Energy Association (GEA), the U.S. geothermal industry's trade organization, from 1997 until GEA's merger with GRC in 2015.

Awarded U.S. Navy NRDL Gold Medal for Scientific Achievement, 1967.
Geothermal Resources Council Special Achievement Award, 2000.
Geothermal Resources Council Geothermal Pioneer Award, 2010.
Geothermal Energy Association Honors Award, 2012.
Geothermal Resources Council Ramey Reservoir Engineering Award, 2015.

PUBLICATIONS AND PRESENTATIONS

Mr. Pritchett has authored over 100 technical publications in his areas of expertise and has conducted numerous short courses and seminars for the Geothermal Resources Council and other organizations. He is in demand worldwide as a lecturer on geothermal reservoir engineering and simulation.

RECENT REPRESENTATIVE PROJECT EXPERIENCE

Client: U.S. Department of Energy
Period of Performance: 2014-2018
Place of Performance: USA
Project Description: Geothermal energy production by water circulation in natural and/or man-made fracture systems is referred to as enhanced or engineered geothermal systems (EGS). The permeable zones of an EGS must be created by stimulation, a process which involves fracture initiation and/or activation of discontinuities such as joints by pore pressure and stress perturbations. The stimulation of a rock mass is often accompanied by multiple microseismic events (micro-earthquakes, or MEQs) which are responsible for detectable acoustic emissions (AE). To study this process on a laboratory scale, Prof. A. Ghassemi and his students at the University of Oklahoma with support from Mr. Pritchett and Dr. Garg performed reservoir stimulation using 13x13x13 inch pre-heated cubical rock samples under representative *in-situ* stress regimes. The data collected were then analyzed to develop a better understanding of the fractures and the induced fracture permeability and fluid/heat flow.

Client: U.S. Department of Energy
Period of Performance: 2010 – 2013
Place of Performance: USA
Project Description: The principal objective of this project was to develop an advanced simulator for (1) predicting the response of an EGS reservoir to hydraulic stimulation, and for (2) modeling the behavior of the reservoir to long-term injection and production operations. Secondary objectives included the development of interpretation techniques for characterizing fractures based on tracer test data, and

various surface and downhole measurements. The resulting HeatEx simulator software was delivered along with documentation to DOE in January 2013.

Client: Idaho National Laboratory (U.S. Department of Energy)
Period of Performance: 2004 – 2007
Place of Performance: USA
Project Description: The utility of electrical surveys for geothermal reservoir characterization was tested using existing reservoir and exploration data sets from the Beowawe geothermal field, located in north-central Nevada. A geothermal reservoir simulator was used to model the quasi-steady natural state, and the DC, MT and SP response corresponding to available survey data. The results support the view that a suite carefully designed of electrical surveys (DC, MT, and SP) may be employed to infer subsurface geothermal reservoir characteristics.

Client: Contact Energy, New Zealand
Period of Performance: 2007 – 2010
Place of Performance: New Zealand
Project Description: Contact Energy is considering additional development of the Wairakei-Tauhara geothermal field. Leidos performed Peer Reviews of the resource data and reports provided by Contact, and provided an independent opinion on the adequacy of the geothermal resource to provide hot fluid for the new power plants.

Client: Mighty River Power, New Zealand
Period of Performance: 2006 – 2009
Place of Performance: New Zealand
Project Description: Leidos was retained to perform Peer Reviews of the resource data and reports for several projects. In each case, Leidos provided an independent opinion on the adequacy of the geothermal resource to supply the power plant.

Client: J-Power, Tokyo, Japan
Period of Performance: January 2009 – December 2009
Place of Performance: Japan
Project Description: J-Power and Mitsubishi Materials Corporation have formed a joint venture to develop the Wasabizawa-Akinomiya geothermal field, Japan. Reviewed the existing dataset (geological, geochemical and geophysical surveys, exploration well drilling and testing), and developed conceptual and detailed numerical models of the geothermal field. The numerical model has been used to forecast the electrical generation capacity of the geothermal field.

Client: Geological Survey of Japan (AIST), Japanese Government Agency
Period of Performance: 2008 –present
Place of Performance: Japan
Project Description: Providing software support to the Geological Survey of Japan, including upgrading and modifying geothermal reservoir simulation software and conversion to permit simulation of underground greenhouse-gas storage facilities using essentially the same simulation programs. Also includes development and elaboration of history-matching geophysical postprocessors for both geothermal and greenhouse gas sequestration applications.