The Payne Institute for Public Policy
COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

PAYNE COMMENTARY SERIES: **COMMENTARY**

How Artificial Intelligence Can Accelerate Geothermal Investment

By Sebnem Düzgün, Elsa Barron, and Morgan Bazilian

In the midst of the global energy transition, geothermal operations promise to provide stable, renewable energy, so why aren't more investors taking the bait? One of the major roadblocks for geothermal investment is the high level of uncertainty that accompanies the subsurface resource. It is impossible to know exactly what the productivity of a geothermal site will be until the drilling has been done. The high costs of such exploration on the outset, coupled with uncertain rewards for the future, means that risk-averse investors have been shy about jumping into geothermal opportunities. However, with the application of new technologies, the fog of uncertainty is beginning to dissipate.

Geothermal energy is a powerful addition to the renewable energy cocktail because of its reliability. When tapped, geothermal wells can provide a consistent, uninterrupted flow of energy in the form of heat from the Earth's core, which can then be translated into electricity and distributed across the grid. By providing a consistent base for renewable energy supply, geothermal makes a clean grid more feasible. The key is to find the right places with feasible resources.

In the past, three main indicators have been used to predict potential geothermal sites: faults, indicator minerals, and surface temperature. Data on all three of these parameters are accessible through a variety of satellite images. Today, artificial intelligence (AI) is making it possible to integrate all of this data and create a new, more accurate method for predicting geothermal productivity. Correlating these observable metrics on the surface with knowledge of subsurface conditions can create powerful, predictive maps for identifying areas of likely opportunity.

Predictive capabilities can attract investors to future geothermal projects by mitigating risk. Yet, mobilizing the funding for subsurface exploration isn't where the challenges end for geothermal development. These projects can cause serious concerns among neighboring communities who are some of the most important stakeholders and partners in such developments. Community concerns may revolve around the significance of existing landscapes in their current form or the risk of future shifts in land stability or seismicity caused by the operation. Providing a full report of the scope and associated risk of geothermal projects to the neighboring community is critical.

It's rare for decision-makers and community stakeholders to have a background in technical or scientific areas, so it is crucial to create accessible ways to communicate the complex data contained in AI-generated surface maps and subsurface predictions. Visualization through virtual reality technology is a tool that can empower communities to fully understand the impacts of future energy projects on their environment and make an informed decision on whether to partner on such developments. A virtual reality environment allows stakeholders including investors, policy-makers, and community members to immerse themselves in the physical environment and visualize its properties. They can witness complex data come to life and make judgments about the proposed developments for themselves.

For example, research at the Colorado School of Mines is using Artificial Intelligence methods to help better understand the geothermal resources. Artificial Intelligence (AI) is a promising area for managing the challenges of geothermal exploration, specifically, reducing the time and cost of a large number of field data collection and analysis of vast data sets with a broad range of experts. Due to the extensive coverage of the exploration areas, AI can decrease the size and provide targeted sites for further investigation, which is eventually beneficial for reducing the cost and managing the risks related to geothermal projects.

Energy Resources Intelligence (ERI) developed by the Düzgün`s Lab with the funding from DOE, is an AI-based prediction system that supports investment decisions in geothermal. The ERI system produces accurate footprints of potential subsurface geothermal resources using deep-learning algorithms, multimodal big data analytics, statistical- and machine-learning methods. An accurate resource potential leads to the cost reduction in geothermal discovery and application via a delineation of the potential geothermal area. ERI has three major components, namely data pre-processing and curation, pattern analysis, and prediction. The pre-processing data component curates satellite images (hyper/multispectral and SAR images) and geological data (faults and lithology) used by the pattern analyses module. The pattern analysis module consists of machine and statistical learning algorithms. The last module is a new convolutional neural network architecture, uniquely designed to incorporate geothermal indicators, namely, mineral maps, fault intensity, and land surface temperature. The system was tested for a blind geothermal site, which has very limited or no surface manifestation. It was able to delineate 75 % of the footprint of the geothermal resource. This allows a significant reduction in uncertainty in geothermal exploration and a considerable risk reduction in investment.

Some worry that virtual reality technologies will disconnect people from the real world, yet that doesn't have to be the case - the key lies in the application of technology. In the context of geothermal energy, artificial intelligence and virtual reality technologies can be applied to develop more inclusive and comprehensive consultation processes for all relevant stakeholders- from community members to investors. These new opportunities can help lower the risk of geothermal development as well as create stronger community investments and partnerships in new developments toward a sustainable world.

The Payne Institute for Public Policy

COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

ABOUT THE AUTHORS

H. Sebnem Düzgün
Fred Banfield Distinguished Endowed Chair and Professor, Mining Engineering, Colorado School of Mines

Dr. H. Sebnem Düzgün, was born in Nazilli, Turkey, and graduated the second in the class of 1992 from the Department of Mining Engineering at Middle East Technical University (METU), Ankara, Turkey. She started her graduate studies in the Department of Mining Engineering. She got her M.Sc. and Ph.D. Degrees in 1994 and 2000, respectively, from the same department. She was a visiting scholar in the Department of Civil and Environmental Engineering at MIT from 1998 to 1999 with an award given by the Turkish Scientific and Technical Council (TUBITAK). She was appointed as an assistant professor in the Geodetic and Geographic Information Technologies Program at METU in 2001. She performed research as a postdoctoral fellow from 2004 to 2005 at Norwegian Geotechnical Institute and International Center for Geohazards with a grant from the Norwegian Research Council. She then returned to the Department of Mining Engineering at METU in 2006 as an associate professor and became a full professor in 2010. Dr. Düzgün was awarded the Alexander von Humboldt Foundation's experienced researcher fellowship in 2014 and used it to research at the Geophysical Institute at Karlsruhe Institute of Technology in Germany between 2015 and 2016. She has been over 20 years of experience in research and teaching in mining engineering on mine closure and reclamation, quantitative sustainability assessment for mining projects, risk and safety analysis for coal mines, mine environmental monitoring using remote sensing, reliability-based design and analysis of rock slopes, uncertainty modeling in rock engineering, and interdisciplinary topics including geographic information systems, remote sensing, spatial and spatio-temporal data mining, landslide and earthquake risk assessment, critical infrastructure resilience.

Elsa Barron
Communications Associate, Payne Institute for Public Policy

Elsa Barron is an Environmental Journalist at the Payne Institute for Public Policy. Her writing has been published in the Wall Street Journal, the Hill, and the Chicago Tribune, amongst others.

Morgan Bazilian
Director, Payne Institute and Professor of Public Policy

Morgan Bazilian is the Director of the Payne Institute and a Professor of public policy at the Colorado School of Mines. Previously, he wD.as lead energy specialist at the World Bank. He has over two decades of experience in the energy sector and is regarded as a leading expert in international affairs, policy and investment. He is a Member of the Council on Foreign Relations.

The Payne Institute for Public Policy

COLORADO SCHOOL OF MINES
EARTH • ENERGY • ENVIRONMENT

ABOUT THE PAYNE INSTITUTE

The mission of the Payne Institute at Colorado School of Mines is to provide world-class scientific insights, helping to inform and shape public policy on earth resources, energy, and environment. The Institute was established with an endowment from Jim and Arlene Payne, and seeks to link the strong scientific and engineering research and expertise at Mines with issues related to public policy and national security.

The Payne Institute Commentary Series offers independent insights and research on a wide range of topics related to energy, natural resources, and environmental policy. The series accommodates three categories namely: Viewpoints, Essays, and Working Papers.

For more information about the Payne Institute please visit:
https://payneinstitute.mines.edu/

or follow the Payne Institute on Twitter or LinkedIn: