Abstract

Developing improved methods to better characterize fractures in Enhanced Geothermal System (EGS), new methodologies to characterize geothermal reservoir northwest part of The Geysers, and gain better knowledge of their porosity, permeability, fracture size, fracture spacing and reservoir discontinuities (faults and shear zones) is the main objective of this article. In addition, soft computing is used for processing and analyzing the microseimic events. Some of these fracture systems are created by injecting water, and stimulating fracture development in hot wet rocks, and hot dry rocks. The fractures thus created enhance the permeability of the hot rock formations, enabling better circulation of water for the purpose of producing the geothermal resource. Better understanding of the mechanisms for fracture stimulation leads to a better exploitation of geothermal resources. Our initial test bed for the newly developed methods will be The Geysers field located in Sonoma County, California to be followed by application to other fields with similar sub-surface characteristics. Careful analysis of the MEQ data in The Geysers field by unleashing the power of neuro-fuzzy approach for the processing of the MEQ data can provide us with a mathematical framework to develop a more practical velocity field. Further, we demonstrate that utilizing various neural-network-based approaches also leads to a better understanding of the fracturing system. This will be accomplished by adapting some of the attributes of the conventional seismic data used in the oil and gas exploration and production to E&P in geothermal fields. Some of such seismic attributes we would like to examine include similarity (coherency), eccentricity, and curvature to carry out fracture modeling analysis and interpretation. Micro-earthquake (MEQ) data analysis both for compressional waves and shear waves, with the aid of soft computing and fractal techniques, demonstrate the versatility and flexibility of the methods. This enables us to analyze and interpret subtle micro-seismic data effectively. We also show the use of Neuro-fuzzy approach for a hybrid MEQ event picking. Finally, hybrid neural network and fuzzy logic approach is used to create a more reliable reservoir map. This approach extended to examine and analyze the microseismic data acquired in this article and develop an accurate fracture map for the area. Handpicked events in selected seed points are used as the training set for the neuro-fuzzy auto-picker. Our hybrid approach becomes superior in both ability to pick the subtle events and the efficiency of the process.