A Cost-Effective Approach to Geothermal Resource Discovery: Principal Component Analysis and Clustering

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Geothermal resource exploration is expensive and highly uncertain. Improving success rates and lowering exploration costs are high priorities for energy scientists worldwide. Our work is aimed at better understanding the hydrologic, geologic, geochemical, and geophysical factors that control the presence/absence of geothermal resources within New Mexico to guide exploration efforts. We use advanced statistical learning tools, trained with information from known geothermal resources, to identify regions of high geothermal potential. The main two statistical methods used in this study are principle component analysis and Euclidean clustering. We considered eight predictors, which are readily available for most of the State: heat flow, elevation, crustal thickness, silica geothermometer temperature, dike density, volcanic vent density, seismicity, and fault density. We found a clear separation between geothermal systems located in volcanic, active, and stable tectonic regimes, which allows us to predict where these types of geothermal systems are likely to occur. As part of this work, we performed a detailed variable selection analysis to determine which measurable parameters make the best predictors for geothermal activity. The results suggest that high heat-flow, low elevation, and low crustal thickness are key controls on the location of classic forced-convection geothermal systems within the State. Finally, the method can be used to locate unexplored portions of New Mexico that have similarities to known geothermal resources, effectively outlining areas of greater resource potential. Future work will focus on using these statistical methods to determine data-driven weights to more accurately construct statewide geothermal prospectivity maps.

Keywords: geothermal exploration, statistical learning, principal component analysis, clustering