3D joint interpretation of magnetotelluric, seismic tomography, gravity and magnetic models in La Palma volcanic island

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SUMMARY

We performed a comprehensive 3D joint interpretation of magnetotelluric, seismic velocity, gravity and magnetic data models for the volcanic island of La Palma. Our methodology involved the application of the Fuzzy Cluster Method (FCM) at various depths to derive multiple clusters or classes. This analysis allowed us to infer the presence of a geothermal system in the southern region of the island.
The fuzzy cluster method, also known as fuzzy c-means clustering, divides the input data set into m fuzzy clusters. Each cluster is considered a fuzzy set characterized by ill-defined and possibly overlapping boundaries. Consequently, any given data point may partially belong to multiple fuzzy clusters, each with a specific degree of membership. This method is particularly useful in geophysical studies where the data points have inherent spatial and physical continuity.

The implementation of FCM involved generating four-dimensional vectors for the spatially coincident cells, incorporating values of electrical resistivity, seismic velocity, density, and magnetic susceptibility. By examining these vectors at different depths, we were able to detect the complex subsurface structures of La Palma. The fuzzy clustering approach allowed us to handle the ambiguities and uncertainties associated with the geophysical data, providing a nuanced interpretation of the island's subsurface properties.

Our results suggest that the southern part of La Palma may have a potential geothermal system, as indicated by distinct patterns in the fuzzy clusters. The study highlights the effectiveness of FCM in jointly interpreting multiple geophysical data, providing valuable insights into the geothermal potential of volcanic regions.

Keywords: 3D joint interpretation, Fuzzy-Logic, Geothermal, Volcanic Island

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