A METHODOLOGY FOR ASSESSMENT OF GEOTHERMAL ENERGY RESERVES ASSOCIATED WITH VOLCANIC SYSTEMS

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ABSTRACT

The potentially exploitable geothermal energy reserves associated with an active or dormant volcano can be estimated using a methodology that combines principles of conductive heat transfer and volcanology to calculate temperature distribution in time and space following magma emplacement, then calculates recoverable geothermal reserves using principles of thermodynamics combined with reasonable values for rock and fluid properties and "recovery" and "utilization" factors. Four principal magma characteristics must be estimated for the calculation: volume, depth, age and temperature of emplacement. Since these four parameters and the recovery factor are the most important uncertain parameters in the reserve calculation, a probabilistic simulation is done by assigning to each a reasonable maximum and a reasonable minimum value and a probability distribution - usually triangular (if a most-likely value can be defined) or uniform (all values between the minimum and maximum being equally likely).
The mean, standard deviation and most-likely values of reserves are then calculated statistically through Monte Carlo sampling of the uncertain parameters. The bases for assigning these maximum and minimum values are discussed, and an example of application of this methodology to a volcano in Nicaragua is presented. In a nationwide assessment of geothermal prospects in Nicaragua, this methodology has been applied to 14 different volcanoes, ranging in volume from 4 to 220 cubic km, depth from 3 to 7 km, age from 5,000 to 500,000 years, and temperature from 900°C to 1,100°C. With a uniform distribution of 0.05 to 0.1 for the recovery factor, and a typical utilization factor of 45%, the mean calculated reserves per volcano ranged from 61 MW to 676 MW for 30 years. In the absence of detailed exploration and drilling, this methodology provides a perfectly general, rigorous and internally consistent method of geothermal reserves estimation in the volcanic environment.

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