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Multidisciplinary research of geothermal modeling

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INTRODUCTION

In times of global warming renewable, green energies are getting more and more important. The development of application of geothermal energy as a part of renewable energies in Germany is a multidisciplinary process of fast growing research and improvements.

Geothermal energy is the energy, which is stored below earth's surface. The word geothermal derives from the Greek words geo (earth) and thermos (heat), so geothermal is a synonym to earth heat. Geothermal energy is one of the auspicious renewable energies. In average the temperature increases 3°C every 100 m of depth, which is termed as geothermal gradient. Therefore 99 percent of our planet is hotter than 1.000°C, while 99 percent of that last percent is even hotter than 100°C. Already in a depth of about 1 kilometer temperatures of 35 – 40°C can be achieved.

While other renewable energies arise less or more from the sun, geothermal energy sources its heat from the earth's interior, which is caused mostly by radioactive decay of persistent isotopes. This means a possibility of a base-loadable form of energy supply. Especially efficient is the use of deep geothermal energy of high-enthalpie reservoirs, which means a high energy potential in low depths.

In Germany no high-enthalpie reservoirs are given. To use the given low-enthalpie potential and to generate geothermal power efficiently inventions and improvements need to be performed. An important part of geothermal progresses is performed by universities with multidisciplinary research of geothermal modeling. Especially in deep geothermal systems numerical calculations are essential for a correct dimensioning of the geothermal system. Therefore German universities and state aided organizations are developing numerical programs for a detailed use of application on geothermal systems.

The history of this multidisciplinary research of geothermal modeling performed by German universities is shown in this paper. Outstanding geothermal research programs of German universities and state aided organizations (BGR, LBEG, GGA) are pointed out. Actual geothermal modeling programs based on the Finite-Element-Method or the Finite-Differences-Method as well as analytical programs are introduced. National and international geothermal projects supported by German universities and state aided organizations are described. Examples of supervised shallow and deep geothermal systems are given.

Actually the Technical University Darmstadt is performing a research program supported by a national organization, the Ministry of Economics and Technology (BMWi).

Main aim of this research program titled experimental investigation for the verification of a Finite-Element-Multiphase-Model is to analyze the subsoil as a three-phases-model with separated consideration of conduction, convection and advection and their subsequent interaction.

The latest developments of numerical projects as well as the actual state of the before mentioned research program are pointed out in the paper.

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