Analele Universităţii din Oradea, Seria Geografie, Tom XIX, 2009, pag. 233-238

NUMERICAL TYPES OF MODELING OF GEOTHERMAL RESOURCES

Elena ZIERLER[1], Maria DURGĂU[2]

Résumé: ***Types de modélisation numérique des ressources géothermiques.*** Les modèles numériques sont différentes, selon le degré de complexité, à savoir les modèles localisés paramètre du distribués complexes, chacun ayant la possibilité de représenter les conditions physiques uniques et des propriétés. Lumped modèle paramètre peut effectuer un suivi précis des indices de production.

Mots-clés: les modèles numériques, lumped modèle, indices de production.

1. Introduction

Different approaches have been applied in assessing high-temperature geothermal resources in Iceland, for example, in areas of volumetric, analytical and numerical approaches. The volumetric approach recoverable reserves are estimated as a fraction of energy in the original place. Essential weakness of the method is the assumption of fixed factor of recovery, while strong energy recovery depends on the actual physical conditions and properties of the reservoir. These numerical models can take into account the physical, - which can be matched to the response of production and other observational data. Complex physical methods of analysis were also developed as based on description of geothermal resources.

Numerical models are different, depending on the degree of complexity, namely, lumped parameter more complex distributed models, each having the opportunity to represent the unique physical conditions and properties. Lumped parameter model can accurately track production indices.

2. Modeling and validation

Svartsengi model used to measure a given geothermal field in SW Iceland is well suited for testing of operating models and numerical modeling. This model was studied in 1976 and was used to study the exploitation of geothermal waters, which are then transported by pipeline in the towns and villages nearby space heater. Geothermal waters are also used for power generation. In 2006, model Svartsengi have an installed power of 46.4 MW of electricity.

3. The conceptual Svartsengi

Svartsengi system conceptual models, describing conditions and development of natural characteristics. It should be noted that the depth of 2500 m down warm salt water is in a buoyancy force due to the development of convective cells developed in the water. This convectivitate is considered to be hampered by the porosity of the rock to a depth of

[1] University of Oradea, Faculty of History, Geography and International Relations, No. 1 University Street, Oradea, Bihor, România, E-mail: elenavasii@yahoo.com

[2] University of Oradea, Faculty of IETI, No. 1, University Street, Oradea, Bihor, România, E-mail: mariadurgau@yahoo.com

300-500 m. The phenomenon formed by filling the pores with mineral changes is evident when salinity of geothermal water is cooling down. Strata of sedimentary rocks at lave Svartsengi consist mainly of basalt. High permeability geothermal systems are primarily associated with sedimentary strata boundaries, fractures, and limits intrusion.

The study presents a conceptual Svartsengi over 250 journals temperature leading to a better determination of formation temperature. The analysis identifies three different aquifer systems in reservoir Svartsengi namely:

- a system of groundwater depth of 30 - 300 m,
- a principal in more than 600 m deep and
- one chimney which allows the correlation between two geothermal aquifers.

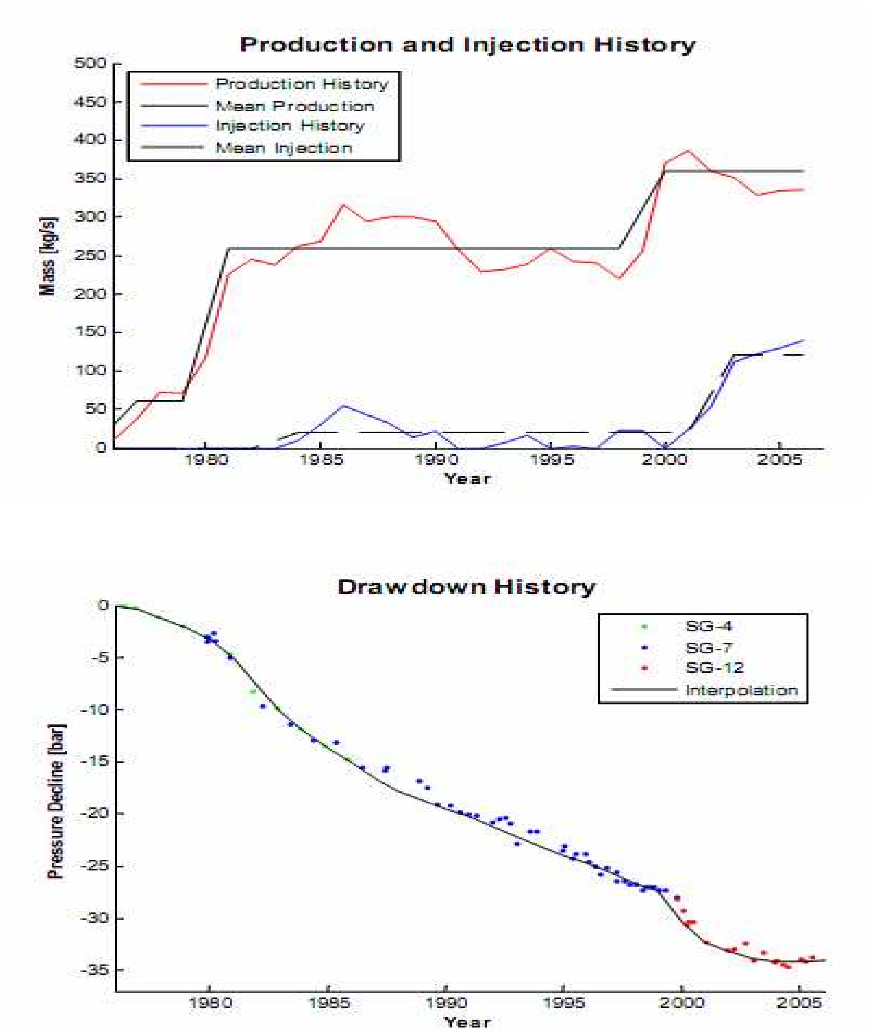

Fig. 1. (**a**) Svartsengi model of production and injection. (**b**) History Svartsengi model for withdrawal. Interpolation is shown with black lines.

Solving the model was developed after Svartsengi in a study monitored by thirty years, in the period 1976-2006. The average estimated annual production and use of injection is a chart in steps of data. As shown in Fig. 1 (a) production history is captured in three steps. Similarly injection is rendered with two lines. Interpolation pressure, history of withdrawal based on data from three wells, is shown in Fig. 1 (b) using a spline interpolation curve that consists of selected data by points. This simple approach to production, injection and pressure history believe that withdrawal can significantly affect the modeling results, as it is well known that changes in production rates are average pressure function.

4. The number model

Model Svartsengi use mesh layer 169 known elements covering a horizontal layer volume of dimensions 100x100 km and 2700 m depth seen in Fig. 1. Therefore meshes have 1521 items in total, of which 338 are inactive from the beginning and know the basic layers that have a constant physical conditions. Initial physical conditions are determined by a temperature gradient 1000C/km, with a corresponding hydrostatic pressure gradient.

This is a common approach, as seen. Limit physical conditions can be seen in Fig. 1 for lateral faces allowing fluid into the model based on pressure, the geothermal area. A low permeability layer surrounds two sides of the chimney type 300-600 m as indicated by simulation. Properties used as physical constants in Svartsengi model is based on linear relative permeability curves that are used for water and water vapor with a saturation of 4 to 5%.

5. Numerical Results

A geothermal aquifer of high permeability with isotropic permeability of 100 md was selected as an initial depth of 2100 m thick section. Around the reservoir is the isotropic permeability of 5 md where it was selected an initial depth of 1800 m thick section. Injection of 93 MW heat is refilling the tank.

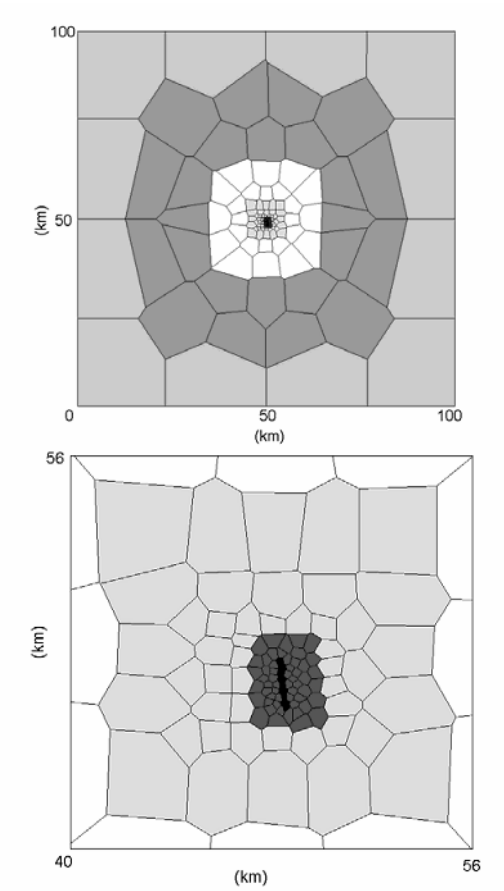

Fig. 2. Horizontal distribution of material elements mesh Svartsengi. Central area of a geothermal deposit is shown in the bottom of Figure

If we use as indicators of decreased five observations:

- by subject;
- withdrawal pressure of 1 bar for misconduct,
- enthalpe produced with a 20 kJ / kg of misconduct,
- temperatures from 1050 and 1350 m and
- perimeter surrounding the departure of 2°C.

Note that using indicators calculation of pressure and withdrawal of aquifer temperature can be seen in Figure 3. We have for this case four parameters of optimization; injected hot water temperature, energy flow, permeability and productivity index of tenofovir and exloatat perimeter. The main features of the model and the best parameter estimation are presented in Figure 3.

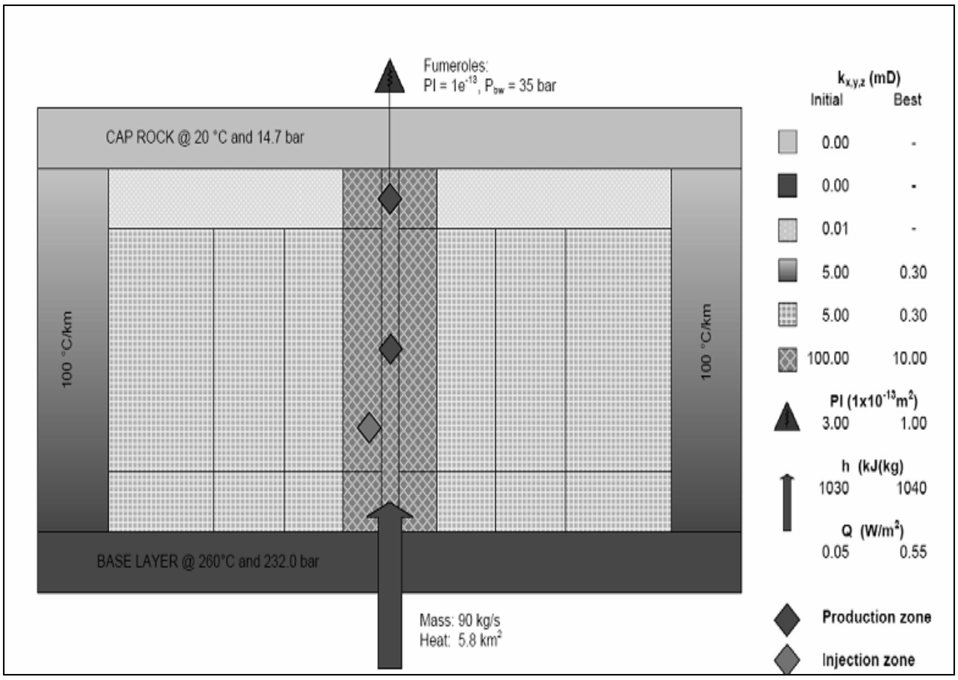

Fig. 3. The physical characteristics of the model Svartsengi. The five best values of parameters are presented in the right

In general, the contribution from each observation indicates that the reservoir pressure and temperature are the most sensitive. The contribution of each parameter of the objective function, measured by the disturbance, indicating that the injected water temperature is contributing to the permeability of the perimeter, whereas other parameters did not contribute significantly. Parameter indicates how the relative sensitivity is sensitivity. Sections of vertical and horizontal geothermal deposit in 1976 and 2006 are presented in Figures 3 and 4, illustrate the effect of production.

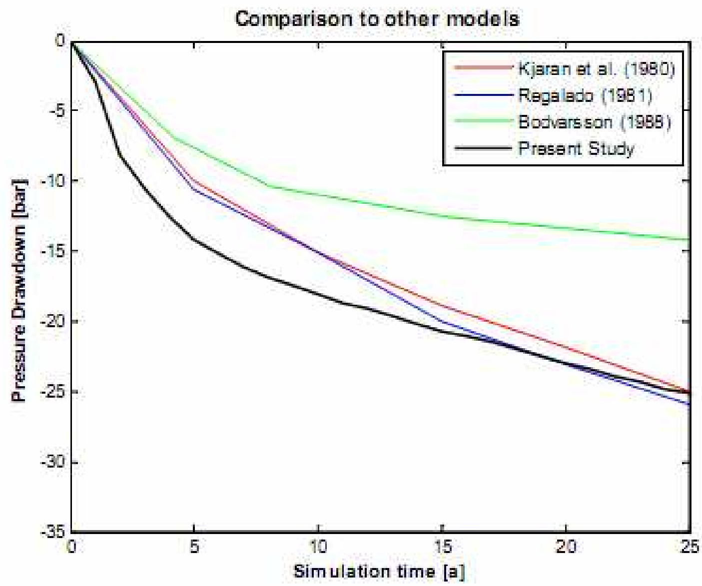

Fig. 4. Comparison of constant pressure for a withdrawal from production of 200 kg/s for different models Svartsengi

6. Conclusion

SVHeat 2D or 3D provides SVHeat more advanced tools to create geothermal simulation models, which would be difficult or impossible to create using key frames for individual sedimentary layers. The conclusion of this chapter is the acquirement of the fundamentals and techniques related to the following possibilities:

- ♦ Creating hierarchies of geothermal areas;
- ♦ Types of spatial distortions and their effects on the exploitation of geothermal resources;
- ♦ Areas of mesh deformation using the tools of transformation;
- ♦ Areas of mesh deformation using the Skin modifier and Flex;
- ♦ Setting up and solving the dynamic simulation.

REFERENCES

Abbado D., Orlando V., Minisale A., Tassi F., Magro G., Seghedi I., Ioane D., Szakacs AL, Coradossi N. (1998), *Origin and evolution of the fluids from the Eastern Carpathians*, Proceed. XVI-th Carpathian-Balkan Geological Association Congress, p 37, Viena.

Panu D., Mitrofan H., Codrescu L., Militaru O., Preda M., Radu C., Stoia M., Şerban F., (2002), *Atlas of Geothermal Ressources in Romania*, plates 61-66 as part of: *Atlas of Geothermal Ressources of Europe*. Comm. Europ.Commun. 17811.

Schiau/Drapa Ana, Adela Martin (2008), *Valorificarea surselor regenerabile de energie în România*, Referate master FIF.IM.

Tărăpoancă M. (2004), *Architecture, 3D Geometry and Tectonic Evolution of the Carpathians Foreland Basin*, Vrije Universiteit, 119 p, ISBN 90-9017847.

Zierler Elena (*2008*), *Geothermal energy, an alternative for Romania*, în „Analele Universității din Oradea, Seria Geografie", Tom VIII, pag. 140-143, ISSN 1221-1273.

W. Cunningham si B. Saigo (1999), *Environmental Science*, McGraw-Hill, Boston.

*** *Readings from American Scientific*: Energy for Planet Earth, 1991.

*** Refocus, *The International Renewable Energy Magazine*, International Solar Energy Society - ISES, Ian/Feb 2003.

*** *Scheme suport pentru utilizarea surselor regenerabile de energie în țările candidate la aderare în Uniunea Europeană (R. Cehă) European Union Policy Renewable Energy Resources – Energy for the Future: Renewable Energy Sources, 2003.*

*** *Trattato sulla Carta dell'Energia*, 1995, Programma Synergy dell'Unione Europea Fiscal Policies for Improving Energy Efficiency (Taxation, Grants & Subsidies), 2001 - UE Energy Charter Secretariat.

*** http://www.geothermie.de/egec-geothernet/geo_tech/geothermal_technologies_annex.htm15.10.2001