Numerical modelling and simulation optimization of geothermal reservoir

Ester Maria Vasini, Paolo Berry, Stefano Bonduà, Villiam Bortolotti, Carlo Cormio
Department DICAM, University of Bologna
Bologna, Italy

Introduction
Numerical modelling and simulation of geothermal reservoirs are essential tools in order to better optimize exploitation and characterization of geothermal resources. Among other things, in general, the simulation permits:

- to study natural state modelling, i.e. the reservoir before exploitation (that provides information serving as the basis to create the model to be used to evaluate the exploitation of the geosystem);
- to predict the possible future exploitation scenarios.

My Ph.D. project consists mainly in the use of the numerical simulator TOUGH2 (Pruess et al., 1999), for the modelling of high enthalpy geothermal system and for the improving of simulation tools, such as TOUGH2GIS (Cormio et al., 2012), TOUGH2Viewer (Bonduà et al., 2012), T2Well (Pan and Oldenburg, 2013). In order to optimize numerical modelling and simulation process, particular attention has been dedicated to T2Well, a TOUGH2 based wellbore-reservoir coupled simulator, and to its use in high enthalpy geothermal system.

TOUGH2
One of the most popular software for geothermal numerical modeling is TOUGH2, a numerical simulator for non-isothermal flows of multicomponent, multiphase fluids in one, two, and three-dimensional porous and fractured media. It is characterized by a modular structure (see fig.1), in which there is a core module dedicated to assemble and iteratively solve the flow equations and several Equation of State (EOS) modules, each of which focused on specific thermophysical properties of fluid mixtures involved in the problems.

TOUGH2 is written in Fortran 77 and requires as input a set of ASCII files (whose management is not very easy without specific pre-processor software, especially in the case of full field simulations) describing the numerical model and its use in the simulation process.

T2Well
T2Well, is a numerical simulator for non-isothermal, multiphase and multicomponent flows that permits to simulate a wellbore-reservoir system. The simulator is based on TOUGH2 and couples reservoir heat and mass transport equations, with the thermodynamic described by means of the EOS ECO2N (mixtures of water, NaCl and CO2), with wellbore flow equations (the Drift Flux Model - DFM) (Pan et al, 2013). Up to now T2Well has been mostly used for carbon storage problems (Hu et al., 2012), which are characterized by low temperature (not more than 110°C).

Objective
To extend T2Well code coupling with EOS modules different than ECO2N, dedicated to high enthalpy geothermal reservoir simulation.

My research progress
- Learning the use of T2Well and verify the goodness of T2well code by reproducing some published results;
- Analysis of the T2Well code to individuate the subroutines that possibly have to be modify in order to work with other EOS modules.

Expected results:
By means of the new T2Well it will be, for example, possible the interpretation of the flowing P&T logs and the deliverability trend, thus to well calibrate the hydraulic properties of the reservoir.

Conclusion
In its preliminary stage the research has given promising results, in fact it has been assessed that T2Well code can be modified and these efforts will improve numerical model and simulation of geothermal resources.

References
- Pruess, K., Oldenburg, C., Morris, G., 1999, TOUGH USER’S GUIDE, VERSION 2.0, Earth Sciences Division, Lawrence Berkeley National Laboratory, University of California, Berkeley, California 94720.