THERMAL MODELING OF LOS HUMEROS SUPER-HOT GEOTHERMAL FIELD , MEXICO

Paromita Deb[1], Xiangyun Shi[1] ,Dominique Knapp[2], Alfonso Aragón Aguilar[3], Christoph Clauser[1], Gabriele Marquart[1]

[1] Institute for Applied Geophysics and Geothermal Energy, RWTH Aachen University (Germany),
[2] Geophysica Beratungsgesellschaft mbH, Germany
[3] Instituto Nacional de Electricidad y Energías Limpias, Mexico

RWTH AACHEN UNIVERSITY
E.ON Energy Research Center
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Geological Settings

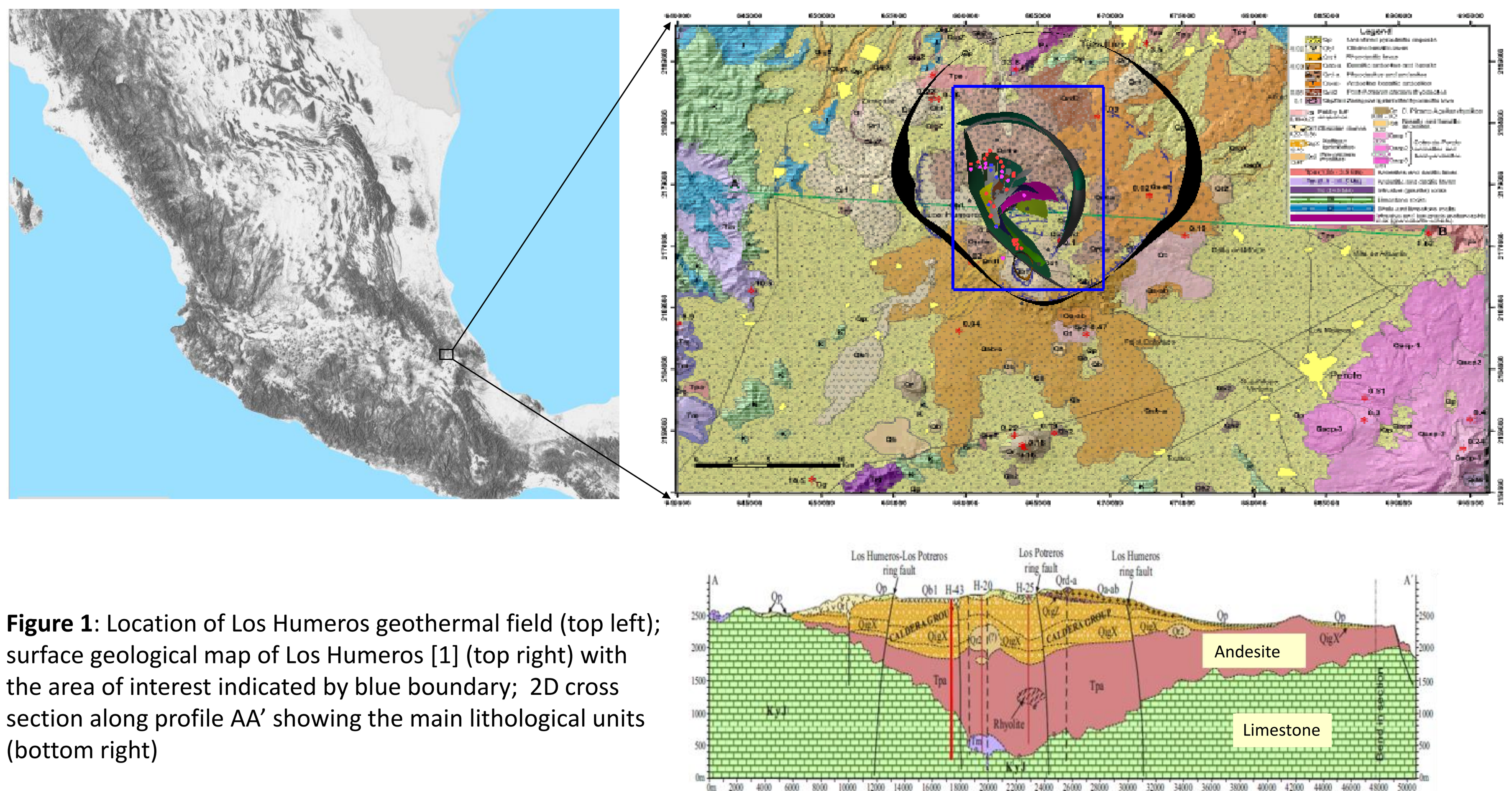


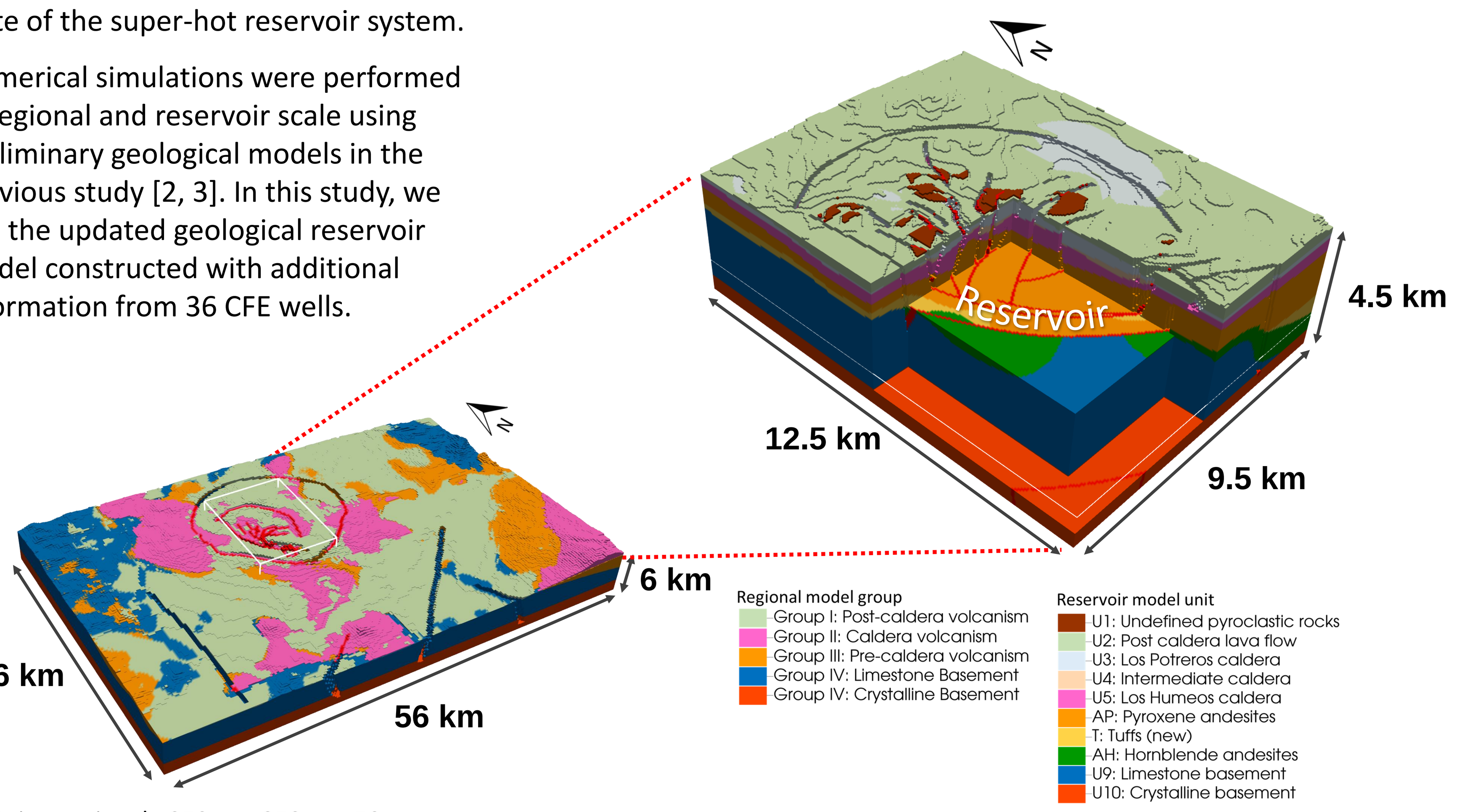
Figure 1: Location of Los Humeros geothermal field (top left); surface geological map of Los Humeros [1] (top right) with the area of interest indicated by blue boundary; 2D cross section along profile AA' showing the main lithological units (bottom right)

Los Humeros (LH) is the third largest geothermal field in Mexico in view of both installed capacity and electricity generation. It is a caldera complex situated in the eastern part of Trans-Mexican Volcanic Belt (TMVB) at an elevation of approximately 2800 m. The field is operated by Comisión Federal de Electricidad (CFE). The first exploration well was drilled in 1982 but commercial exploitation began only in 1990.

Objectives

Within the framework of GEMex, a Horizon 2020 project (Grant Agreement No. 727550), we model the initial steady-state of the super-hot reservoir system.

Numerical simulations were performed in regional and reservoir scale using preliminary geological models in the previous study [2, 3]. In this study, we use the updated geological reservoir model constructed with additional information from 36 CFE wells.



Grid size: regional- **250 m × 250 m × 50 m**
Grid size: reservoir- **50 m × 50 m × 50 m**

Figure 2: Geological models: regional (left) and reservoir (right)

Petrophysical data

- **Temperature and pressure data analysis of CFE geothermal wells**

  - ❑ Corrected steady state temperature is calculated for the bottom hole depth of every well.
  - ❑ Feeding zones/ advection zones are identified in the well data
  - ❑ Pivot points are identified from the well data
  - ❑ Wells which shows pure conductive trend are identified

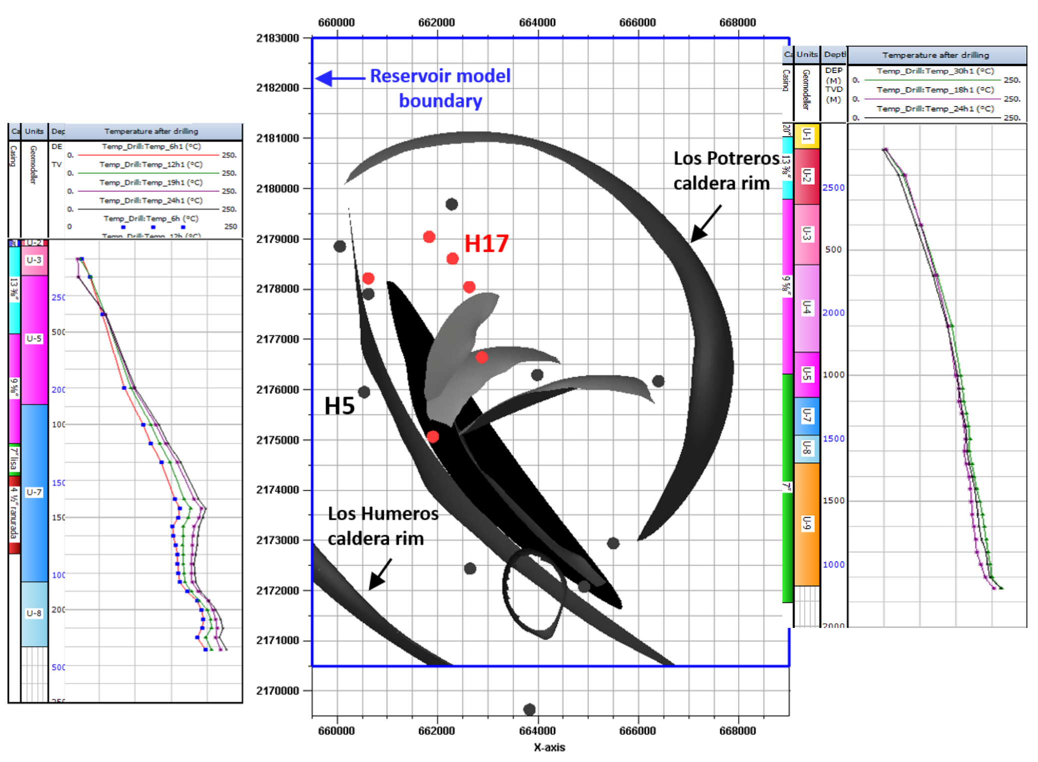
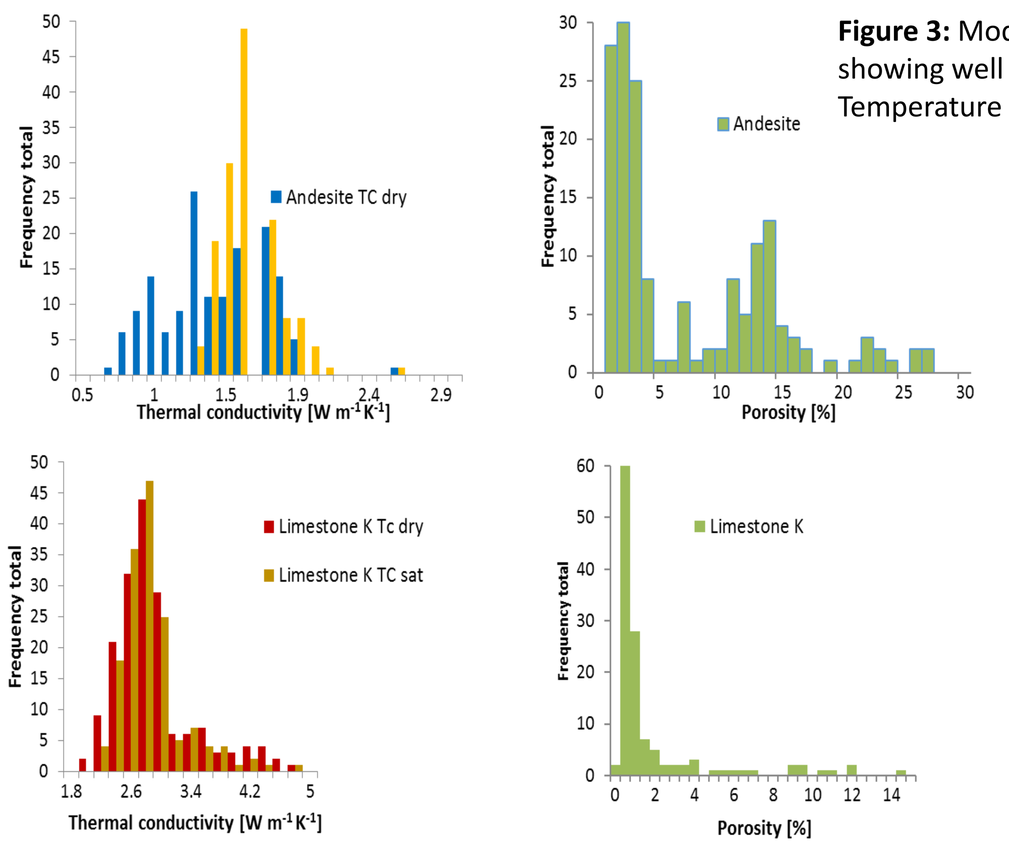


Figure 3: Modelled fault network (center) with Los Potreros (LP) caldera rim showing well locations, black (non-economic) and red (productive) wells. Temperature log examples from geothermal wells H17 (left) and H5 (right)



- **Laboratory measurements on outcrop samples and cores from CFE wells**

  - ❑ Laboratory data, petrophysical wells logs and literature data were combined to assign appropriate property values to the model units [4]

Figure 4: Histograms of thermal conductivity (TC) (left) and porosity (right) measurements on outcrop samples: andesite (top) and limestone (bottom)

Numerical Simulations

Different scenarios were simulated in regional and reservoir scale to investigate the following:

- ❑ basal heat flow boundary conditions
- ❑ impact of intrinsic permeability of formations (tuffs, andesites and limestones)
- ❑ effect of fault permeability contrasts on the temperature and flow field

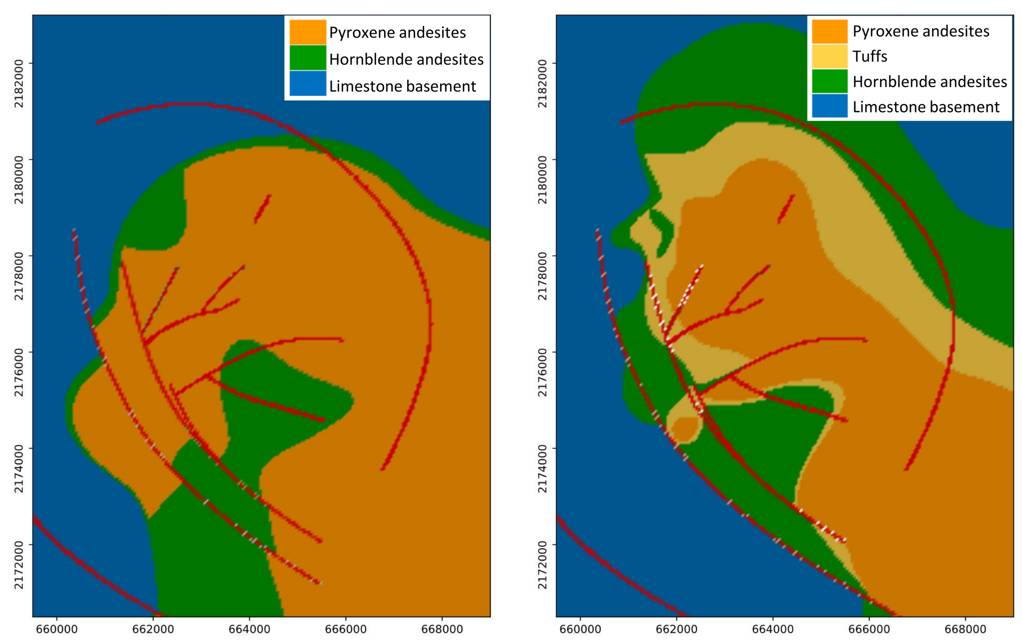


Figure 5: Geological maps at 1800 m below surface of the preliminary (left) and updated (right) reservoir structural models The red lines are faults.

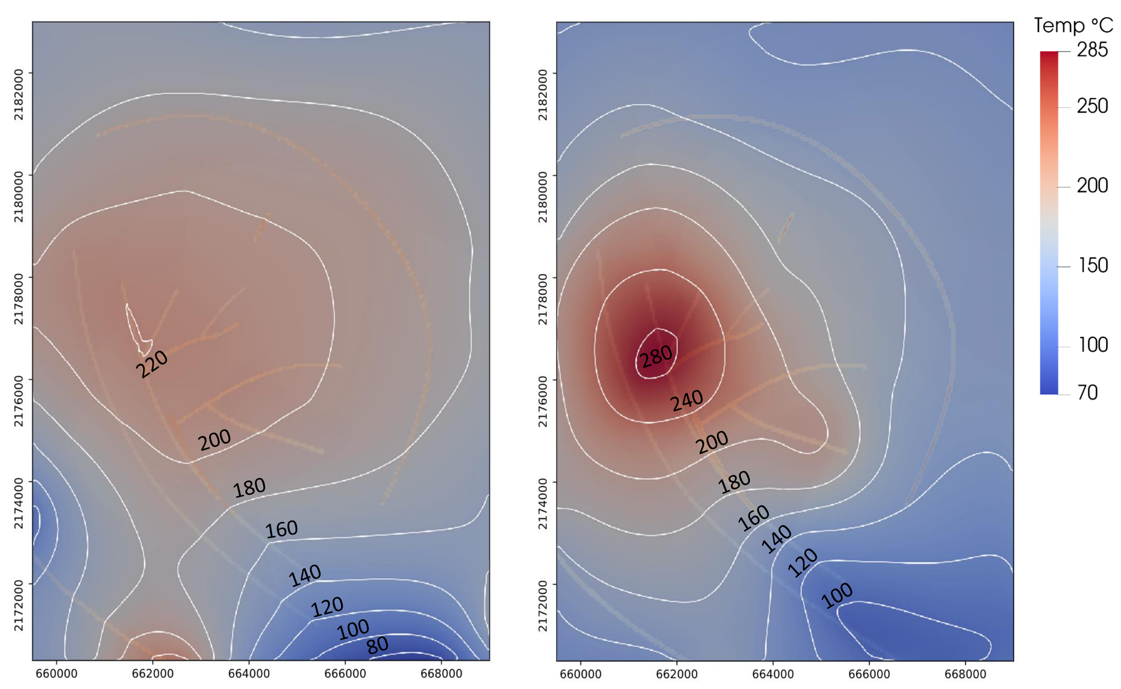


Figure 6: Temperature maps extracted at 1800 m below surface from the preliminary (left) and updated (right) reservoir structural models

Simulation vs Measured data

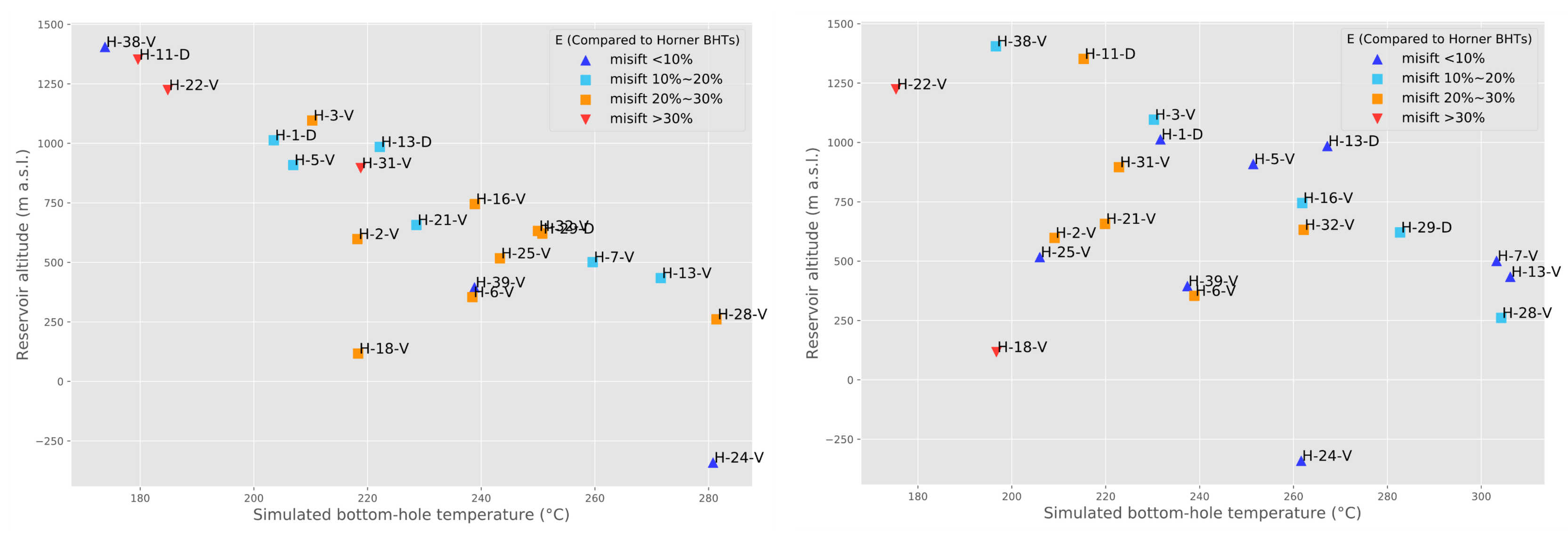


Figure 7: Comparison of simulated BHTs extracted from the preliminary (left) and updated (right) reservoir structural models with respective altitudes. Well is colored according to the degree of misfit between simulated and measured BHTs.

Conclusion and Way forward

We simulated the steady-state fluid flow and heat transport under natural conditions (i. e. prior to production) for Los Humeros using the updated geological reservoir model (WP 3). Compared to the preliminary geological model, the updated reservoir model provides better simulation results when compared to the measured temperature data of the CFE geothermal wells, but still with certain under-estimation of the temperature field. In the next step we investigate the possibility of shallow magma pockets as localized heat sources based on the volcanological study conducted by WP 3.

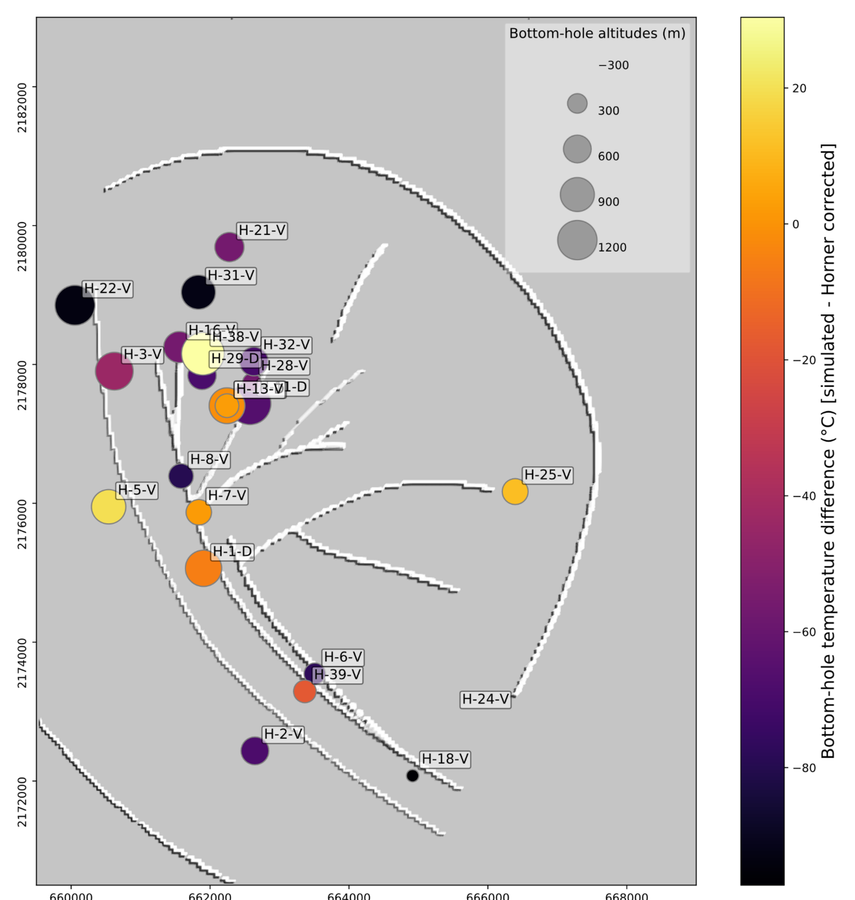


Figure 8: Well locations, with color gradient indicating the temperature difference between the simulated and the measured BHTs, plotted on fault structure map. Dot sizes refer to bottom-hole altitudes.

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For further information, the first author can be contacted following email address: pdeb@eonerc.rwth-aachen.de

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