Estimation of depression cones of Los Humeros

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Sustainable development means meeting the needs of the present generation without compromising the ability of future generations to meet their needs (UN, 1987). Geothermal projects are usually planned to not only meet energy generation needs, which means to maintain the production rate of the field, but also to be profitable. As the production rate is iconnected to sustainability use, this study aims at detecting if the proximity of the wells and their rate of production has a negative impact on the performance of the electric generation from Los Humeros, Mexico. We analyzed the productivity data from three wells in the southern part of the geothermal field in Los Humeros (H-6, H-12, and H-39) was calculate the productivity index for each well.

The resulting PI trends changed 3 times in the entire production period. The first notable change appeared after 10 years of production, when the PI of the wells H-6 and H-12 fell simultaneously. Furthermore, we calculated the equivalent area corresponding to the mass and heat extracted considering the effective thickness of the reservoir (Limberger et al. 2018) and applying the "Heat in Place" linear model (Muffler and Cataldi, 1978; Garg and Combs, 2015;). These results could be an appealing baseline for profitability calculations and therefore for an assumption of sustainability.

Reservoir pressure

The well logs reported by the CFE show the location of the high permeability zones. We interpreted these zones as the feed zones of the wells.
In these intervals we assumed the average pressure reported in the well-logs after drilling by the CFE.

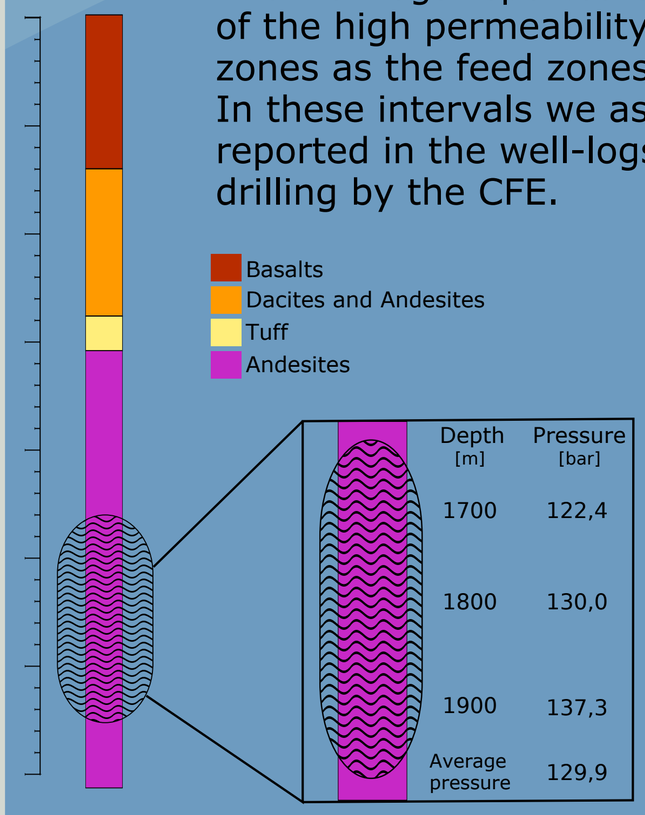


Figure 1: well H-12 stratigraphic and pressure profile.

We calculated the pressure difference from the reservoir value and the the wellhead measurements.
With this difference and the mass extraction rate we could calculate the productivity index (figure 2).
Finally we looked for the correlation between the resulting PI value of the 3 wells.
The correlation was above 60% for some time intervals.

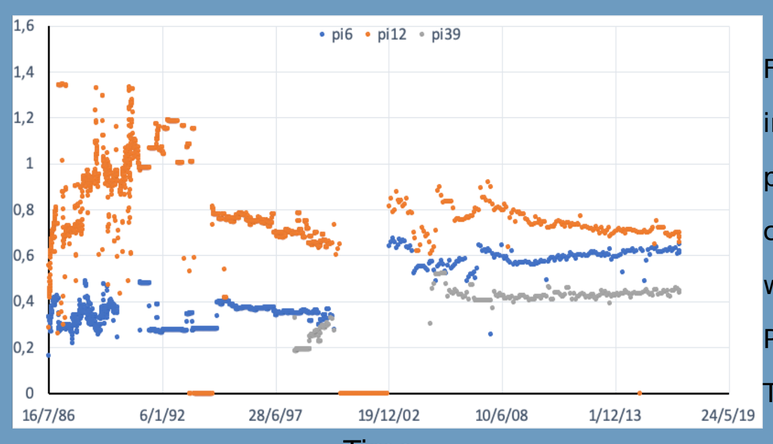
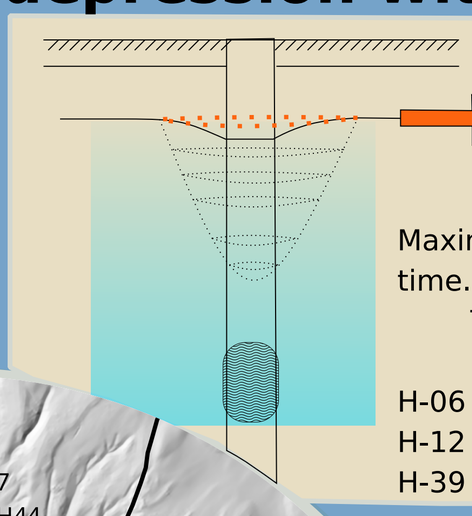


Figure 2: historic productivity index. The general trend of the points shows similarity at certain time. This similarity was measured with the Pearson correlation coeficient. The productivity index is

$$PI = \frac{\dot{m}}{\Delta P}$$

Productivity Index

Estimation of cones of depression with the Heat in place



Maximum radius and time.

	Time yrs	Radius m
H-06	30	99
H-12	30	120
H-39	18	72

$$Q_R = A \cdot h_e \cdot \delta\bar{C}_p \cdot (\Delta T)$$

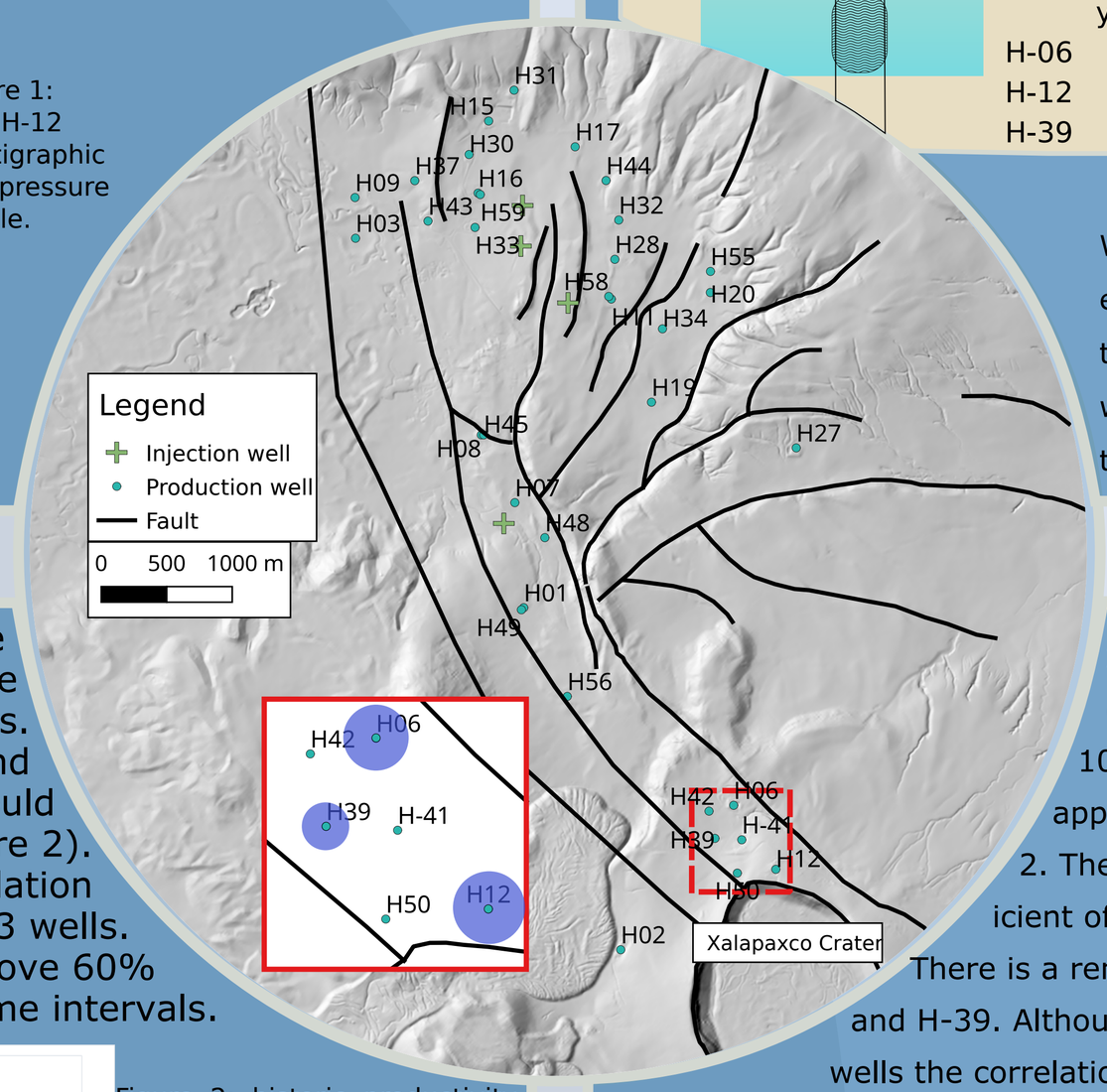
$$\dot{Q} = \dot{m} \cdot \Delta H$$

$$\dot{Q} \cdot t = Q_R$$

$$\dot{Q} \cdot t = A \cdot h_e \cdot \delta\bar{C}_p \cdot (\Delta T)$$

$$A = \frac{\dot{Q} \cdot t}{h_e \cdot \delta\bar{C}_p \cdot (\Delta T)}$$

We took a monthly average of the mass extraction. With this values we fed the model to find the radius of the cones. The target wells were H6, H12 and H39. These wells are in the southern zone of the system.



1. After 30 years of production the depression cones of wells H-6 and H-12 reached 99 and 102 m of radius respectively. For the well H-39 apperture was 52m after 18 years of production.
2. The PI of H-06 and H-12 correlates with a coeff-icient of 60% between H-12 and H-39 it was 20%. There is a remarkable correlation between the wells H-06 and H-39. Although there is not clearly a fault that links these wells the correlation value was 58% for certain periods of time.

The results do not give a clear sustainable state for the reservoir. As Geothermal systems are dynamic, sustainability should be treated as a dynamic function based on the system features and should be of a dynamic nature as well.

Future work

This analysis will be extended to all the wells in the area. Aditionally, we plan to carry out a transient analysis of the thermodynamic state at the bottom zone of the wells. These results might help to define a basis for the key parameters that define the dynamic sustainability of the system.

Conclusions

Objective: Calculate the historic productivity index for 3 wells in Los Humeros and estimate the radius of influence that each well has on the reservoir.

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