Proceedings of the
Latin-American Geothermal Congress 2025
LGC 2025
San Salvador, El Salvador
22–26 Sept. 2025

Identification of potential geothermal targets for retrofitting in abandoned oil wells in the offshore region of the Campos Basin, Southeastern Brazil.

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Keywords: renewable energy, geothermal energy, offshore, abandoned wells, geothermal potential, retrofitting.

ABSTRACT

Geothermal energy is considered a reliable, sustainable and abundant source of energy with minimized environmental impact. This geoenergy can be used both directly, which is the case with outcropping hot springs, and indirectly to generate electricity. One of the main challenges in exploiting this type of resource is access to it, which involves drilling wells. One of the solutions to this conflict is to use disused oil wells and adapt them to geoenergy exploitation, since they reach sufficient depths for this viability or can be adapted by deepening them using modern deep drilling techniques. The abandonment of oil wells is commonly considered an essential measure to guarantee the safety and integrity of these wells, generating enormous costs and concerns for the industry. By converting abandoned or unactivated oil and gas wells into geothermal wells, it is claimed to be possible to produce geothermal energy and generate power. In this context, we sought to identify potential targets with high heat flow values that reveal high temperatures at depths accessible to oil wells in the offshore hydrocarbon exploration region of the Campos Basin, southeastern Brazil. This region is known worldwide as one of the most important oil and gas producing regions in Brazil and on the South American platform.The heat flow calculated using geothermal information from BHT wells showed that in the regions of structural highs that delimit the basin, the values vary between 65 and 80 mWm-², which classifies it as an exploratory geothermal target. The temperature variation in these regions reaches values above 150°C at depths of 2-2.5km. Oil exploration in the basin began in the 1970s and was a pioneer for offshore oil and gas exploration, however, the exploration success rate has plummeted in the last 10 years, which may indicate the maturity of the basin. This fact,

combined with the large-scale oil and gas exploration in the pre-salt region, suggests that mature fields could be decommissioned and we therefore suggest retrofitting them.

1. Introduction

The Campos Sedimentary Basin is one of the main hydrocarbon producing regions in Brazil. This basin has already gone through all the stages of the typical production cycle of oil reservoirs, starting with the discovery of reserves, passing through peak production and progressing to the stage of decline and abandonment of wells [1-3]. The production dynamics followed in the Campos Basin are a good illustration of the classic oilfield life cycle model, as described in the Hubbert curve [3]. A significant number of wells in the Campos Basin have been designated as abandoned, either temporarily or permanently, according to data from the National Agency of Petroleum, Natural Gas and Biofuels (ANP).[4]. It is possible to sustainably reuse these abandoned structures, either by reactivating them for oil production or by converting them to generate geothermal energy. An economically interesting solution is to repurpose them for geothermal energy recovery, since drilling costs represent most of the total investment [5]. Geothermal energy can therefore contribute not only to the identification of new promising areas for hydrocarbon exploration, but also to the reuse, through retrofitting, of abandoned wells, increasing sustainability and efficiency in the use of underground resources [5,6].

2. Methodology

The applicability of retrofitting depends on adapting existing wells to improve production or convert them to exploit geothermal energy. To do this, it is necessary to evaluate the available wells and the region in which they are located. From this initial assessment, it becomes possible to select the technology that best suits the new purpose of exploiting the well.The evaluation is carried out on the basis of well data available from the National Petroleum, Natural Gas and Biofuels Agency (ANP). These files contain important information, such as the temperatures measured at the bottom of the well (BHT) during drilling and their respective depths. With this data, it is possible to calculate the geothermal gradient, estimate the thermal conductivity based on the lithology and thus determine the heat flow. For this study, nine wells were selected from the Campos Basin, classified as abandoned by the ANP, in order to assess their potential for geothermal reuse. In this way, the analysis of the study area will enable future simulations to be carried out, projects to be developed and installations to be set up for energy reuse.

3. Results

BHT temperatures above 85 °C significantly increase the potential for generating heat or electricity, which reinforces the feasibility of retrofitting wells for geothermal use [7][8]. The results obtained indicated high temperatures, reaching up to 172.3 °C.

However, the depths associated with these values, greater than 3km, can represent operational and economic limitations for the implementation of geothermal systems [9]. Deep wells located in areas with a geothermal gradient equal to or greater than 40 °C/km and heat flow above 60 mW/m² are considered favorable for retrofitting, due to the significant increase in the potential for generating heat or electricity [7]. The results obtained in this study indicated an average geothermal gradient of 31.4 °C/km, with minimum and maximum values of 23.5 °C/km and 42.1 °C/km, respectively, while the heat flux showed an average of 67 mW/m², ranging from 50.4 mW/m² to 90.6 mW/m².

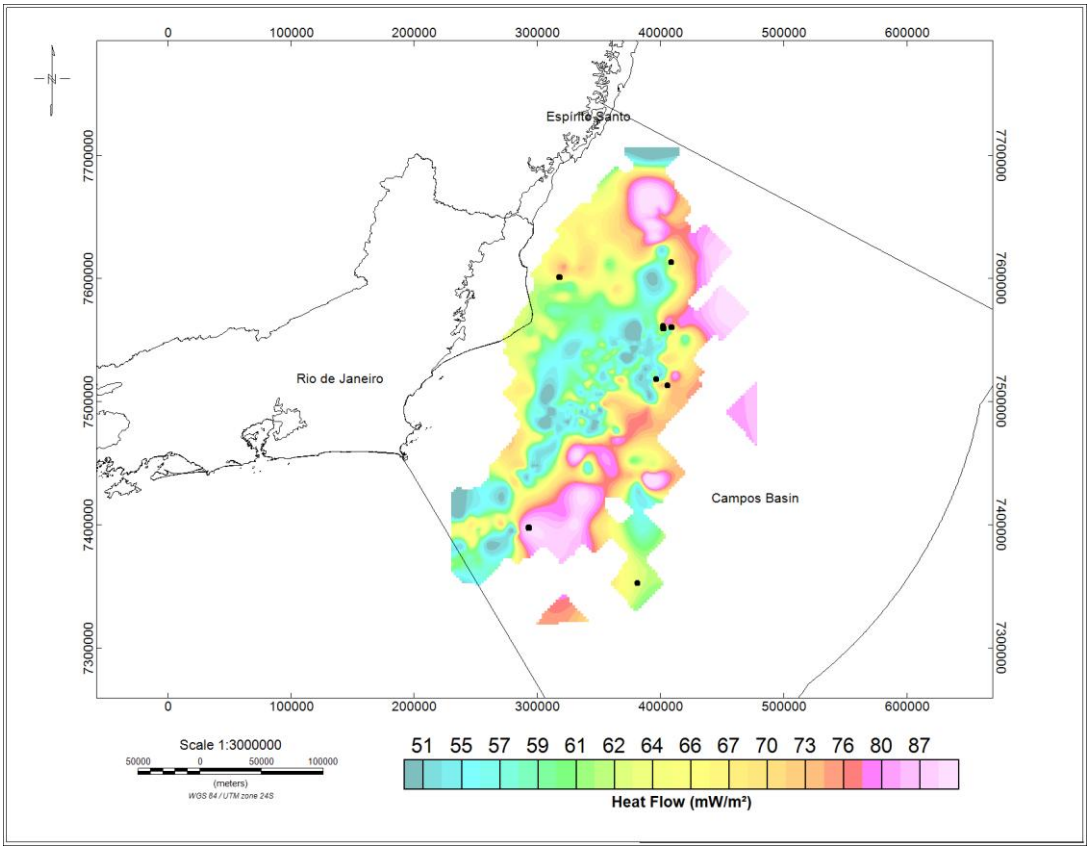
4. Discussion

Despite the existence of points with geothermal gradient and heat flow values below the ideal parameters, the general average of the parameters in the area indicates adequate thermal potential for geothermal exploitation. This suggests that, although not all wells are equally favorable, the region as a whole has promising conditions for retrofitting, provided there is careful selection of wells, focusing on those with the best thermal characteristics to ensure the technical and economic efficiency of the project. The greatest difficulty observed is the distance to the end user and the availability of economically viable technologies for exploration at depths greater than 3,000 meters, a situation common to the nine wells analyzed.

5. Conclusions.

The calculated geothermal parameters confirm that the area studied has favorable thermal conditions for geothermal exploitation by retrofitting existing wells. Although some wells have a low geothermal gradient, the Campos Basin as a whole has a vast extension with an average heat flow of approximately 59.8 mW/m², which is close to the ideal value for this type of application. However, the variation observed in the parameters reinforces the need for individualized assessments of abandoned wells in order to select those with the greatest technical and economic suitability for retrofitting. In addition, in order to guarantee efficient reuse, the distance to the end user and the technological adaptations required must also be taken into account, which are relevant factors that directly impact the total cost of the project.

Figure 1. Distribution of heat flow in the Campos Basin based on 1.350 measurements. The locations of the nine wells classified as abandoned by the ANP are indicated by



the black dots

Acknowledgment: The first author gratefully acknowledges the financial support provided by Petronas, the Carlos Chagas Filho Foundation for Research Support of the State of Rio de Janeiro (FAPERJ), and the Graduate Program of the National Observatory (ON).

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