

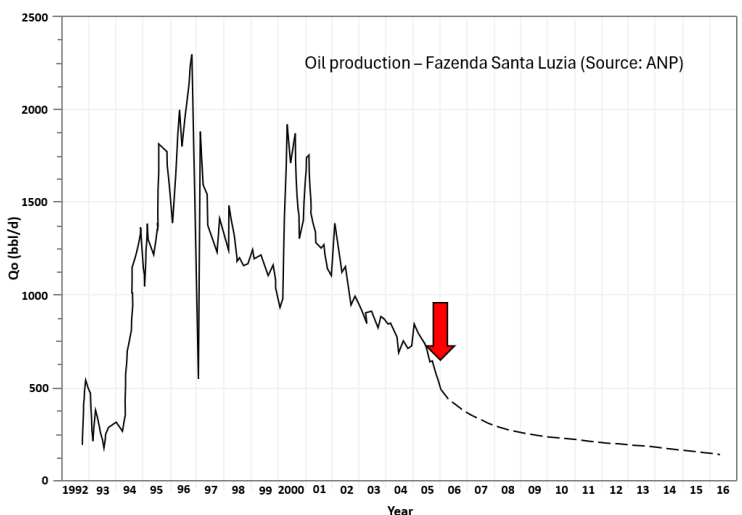
Success Story

Rejuvenation of Fazenda Santa Luzia oil field increases recovery factor from 10% to 20% and generates USD24 millions/year

The onshore Fazenda Santa Luzia oil field, located in the Espírito Santo Basin, Brazil, contains 54.4 MMbbl VOIP, an area of 10 km² and 79 wells spaced 200 m apart, of which 31 are producing oil between 21 to 28° API. The Albian reservoirs from the São Mateus Formation are laterally-disconnected, multilayered, mixed-coastal sandstone overlain by shallow-marine shale and carbonate occurring at depths between 1600–1900 m⁽¹⁾. Production began in 1992. The oil recovery factor is 20%, with cumulative production of 10.7 MMbbl and daily production of 630 bbl⁽²⁾. This success story was developed at Petrobras thanks to the work of E. Bento-Freire and D. Dargan⁽¹⁾ but later incorporated the advances presented here.

CHALLENGE: How can the decline in oil production be reversed?

In 2005, Fazenda Santa Luzia faced a **sharp decline in oil production, reaching its economic cut-off (300 bbl/d) in 2006**. BSW was increasing significantly, and water injection had no impact on production. The last wells drilled **crossed "unforeseen zones", with or without hydrocarbons**, which were not aligned to the established reservoir zonation. The Brazilian National Agency then demanded a recovery plan. **The field was about to be abandoned in 2006 if the current concepts and practices for its management were maintained⁽¹⁾.**



SOLUTION: The better the geology, the better the result

Our approach is developed based on updated reservoir geology concepts:

Step 1: Reservoir zonation and characterisation are some of the key factors impacting oil production. Zone boundaries act as effective barriers that impede the vertical fluid flow (zonation), and the lateral connectivity of reservoirs within a zone (characterisation) determines the horizontal fluid flow. **Stratigraphic and sedimentological analysis**, based on cores, well logs, production, and seismic data, **unveil the reservoir's spatial distribution and heterogeneities**. Well correlation based on **high-resolution sequence stratigraphy (HRSS) allows the recognition of washed zones due to production and target oil zones**. Applying updated geological concepts enables accurate reservoir characterisation and a clear understanding of both vertical and lateral connectivity.

(1) Magalhães *et al.*, 2020. High-resolution sequence stratigraphy applied to reservoir zonation and characterisation, and its impact on production performance—shallow marine, fluvial downstream, and lacustrine carbonate settings. *Earth-Science Reviews*, 210, 1–36. <https://doi.org/10.1016/j.earscirev.2020.103325>

(2) Agência Nacional do Petróleo <https://www.gov.br/anp/pt-br>

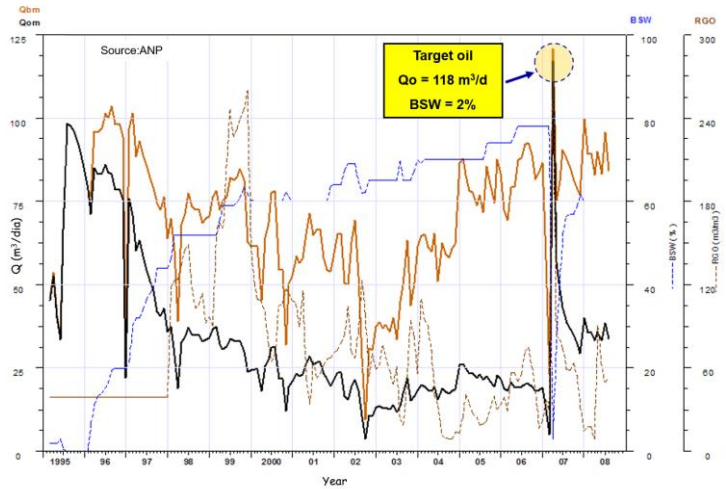
Step 2: Workovers, isolating water-saturated intervals and **opening new zones with target oil**, significantly increase the field's production.

The **fine-tuned adjustment between the models (static, numerical and geomechanical) is essential** for the most realistic representation of facies distribution and their petrophysical properties in 3D geocellular models ⁽¹⁾. This enables a more reliable estimation of VOIP and reserves and **effective reservoir management**.

The adjustment of simulated production with historical data allows a reliable production forecast. The geomechanical study establishes the operational limits (minimum and maximum reservoir pressures – depletion due to production or increase in pressure due to injection) to prevent environmental problems or other factors that affect production.

Step 3: Infill drilling is necessary if the lateral extent of the reservoirs is less than the well spacing. The study through **High-Resolution Sequence Stratigraphy** carried out in step 1 is decisive in this stage.

Step 4: Water injection should be evaluated after the study. The injection scheme depends on the reservoir characterisation (lateral and vertical connectivity).

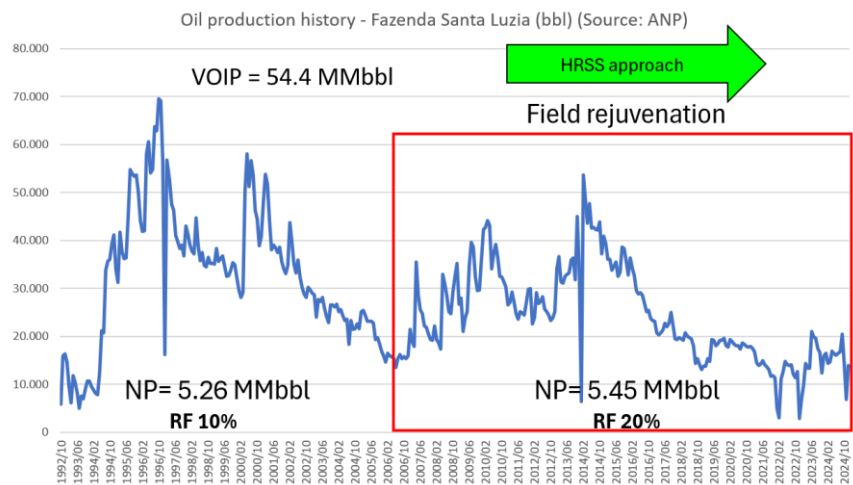


Flowing well after opening a target oil zone.

VALUE: Field rejuvenation

Our approach established a new geological model, a new zonation and an understanding of reservoir connectivity. The following results were achieved with an accurate reservoir representation and the fine-tuning between the static, fluid flow, and geomechanical models:

- The new zonation **supported several workovers and infill drilling, which increased oil production and reduced water production.**
- Most newly opened intervals allowed **wells to flow naturally**, although with rapid decline.
- By the end of 2024, the field had cumulative oil production of 10.71 MMbbl, more than double the field's production up to 2006. **Our approach increased the oil recovery factor from 10% to 20% without water injection. The production gain between 2006 and 2024 was 5.45 MMbbl, equivalent to an average revenue of USD435 millions or USD24 millions annually.**



Let's repeat this success story!

Partnership

