Assessing Gigaton-Scale Geologic Hydrogen (H_2) Generation Potential from Mantle Serpentinization in the Final Stages of the South Atlantic Opening Through Deep 2D Seismic Data

Yuri de Melo Portella[1*], Frank Cenci Bulhões[1], Nolan Maia Dehler[1], and Cleriston Ferreira Silva[1]

Search and Discovery Article #42616 (2026)**
Posted April 14, 2026

*Adapted from extended abstract based on oral presentation given at AAPG International Conference and Exhibition (ICE) Rio de Janeiro, 30 September - 3 October, 2025.
 DOI:10.1306/42616Portella2026

[1]Petrobras – Petróleo Brasileiro S.A., Avenida Henrique Valadares 28, Centro, Rio de Janeiro (RJ) 20231-030, Brazil (*e-mail: yuriportella@petrobras.com.br)

Abstract

The Santos and Campos basins, located offshore Southeast Brazil, have been central to hydrocarbon exploration for decades, particularly after Petrobras discovered supergiant oilfields in the Pre-salt sequence in 2006. This petroleum system comprises unique lacustrine carbonate reservoirs sealed by thick salt layers, believed to have formed during mantle exhumation [1] and the continental breakup. Interpretation of ION-GXT deep seismic lines and gravimetric inversion indicates that the exhumed mantle section between the Santos and Campos basins is highly serpentinized [2]. Mantle serpentinization, which consumes vast amounts of water, may have played a crucial role in forming the South Atlantic's extensive salt deposits [3].

This study reinterprets ION-GXT seismic lines from the distal ultra-wide margin of the Santos Basin, revealing clear evidence of hyperextension and mantle exhumation. Using crustal geometry, structural mapping, gravimetric inversion, and flexural backstripping, we identify deep sinusoidal reflectors as major rheological boundaries within and at the base of the hyperextended continental crust (Moho). Multi-1D thermal modeling, based on data from over 500 offshore wells, suggests that the top mantle temperature ranged between 200–350ºC during the late Aptian (112 Ma), conditions favorable for serpentinization around the time of the breakup.

The degree of serpentinization in the exhumed mantle was calculated using geobodies extracted from seismic data, applying a linear correlation with compressional wave (Vp) velocity [4]. The initial peridotite volume was reconstructed using a linear rock volume expansion equation based on the degree of serpentinization [5]. By adopting the average mineralogy and Fe^{2+} content of Atlantic abyssal peridotites [6] and serpentinite bulk-rock $Fe^{3+}/\Sigma Fe$ ratios [7], the minimum best-estimate hydrogen (H_2) generation potential was calculated at 146 ±9 Gt. Since serpentinization and hydrogen production occurred during salt deposition and possibly continued afterwards, it is plausible that some hydrogen was or remains trapped in Pre-salt reservoirs, either mixed with hydrocarbons/CO_2 or as a standalone resource. In this scenario, even if only 0.1% of the potentially generated hydrogen is preserved, multiple Mali-sized accumulations could be hiding in the South Atlantic Pre-salt

reservoirs, characterizing a potential future exploratory frontier. The proposed quantitative methodology for geologic hydrogen resource generation potential is patent pending (BR 10 2025 010557 8; PCT/BR2025/050492).

References

[1] Epin et al. (2021) MarPetGeo 128, 105005 https://doi.org/10.1016/j.marpetgeo.2021.105005

[2] Zalan et al. (2011) *AAPG Conference #30177*

[3] Debure et al. (2019) *SciReports* 9:11720 https://doi.org/10.1038/s41598-019-48138-9

[4] Miller & Christensen (1997) *Proceedings of the ODP, Scientific Results*,Vol. 153

[5] Portella et al. (2024) GSF 15, 101763 https://doi.org/10.1016/j.gsf.2023.101763

[6] Warren (2016) *Lithos* 248–251, 193–219 https://doi.org/10.1016/j.lithos.2015.12.023

[7] Debret et al. (2024) *Earth-Science Reviews* 258, 104910 https://doi.org/10.1016/j.earscirev.2024.104910