

Quantifying massive hydrogen (H₂) potential resources associated with mantle serpentinization during the final stages of the South Atlantic opening using seismic data

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The Santos and Campos basins, offshore Brazil, have been the focus of intense hydrocarbon exploration through past decades, especially since Petrobras' discovery of supergiant oilfields in the Pre-salt sequence in 2006. This petroleum system comprises exotic lacustrine carbonate reservoirs sealed by very thick salt layers, which are believed to have formed syn-mantle exhumation [1] and concomitant with continental breakup. Interpretation of ION-GXT deep seismic lines and gravimetric inversion suggests that the exhumed mantle section between the Santos and Campos basins is highly serpentinized [2]. Mantle serpentinization consumes enormous amounts of water and may have been a key factor in the formation of the South Atlantic giant salt deposit [3].

Here, we reinterpret ION-GXT lines of the distal ultra-wide margin of the Santos basin with clear indications of hyperextension and mantle exhumation. Based on crustal geometry, structural mapping, gravimetric inversion, and flexural backstripping, we interpret that deep sinusoidal reflectors likely correspond to major rheological boundaries within and at the base of the hyperextended continental crust (Moho). Multi-1D thermal modelling using >500 offshore wells suggests that the temperature of the top mantle was between 200-350°C during late Aptian (112 Ma), hence favoring serpentinization circa breakup time.

The serpentinization degree of the exhumed mantle was calculated in geobodies extracted from the seismic, applying a linear correlation factor with compressional wave velocity (Vp) [4]. Initial peridotite volume was backcalculated employing a linear rock volume expansion versus serpentinization degree equation [5]. Finally, adopting Atlantic abyssal peridotite average mineralogy and Fe²⁺ content [6] and serpentinite bulk-rock Fe³⁺/ΣFe [7], the best-estimate H₂ generation potential reaches 153 ±12 Gt. Since hydrogen production was syn-salt and possibly continued after its deposition, it is plausible that part of it was/is trapped in Pre-salt reservoirs, either mixed with hydrocarbons/CO₂ or not. H₂ resource calculation methodology is patent pending.

References

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