Structural aspects of magmatic rocks: Comparison between outcrop and seismic data interpretation from central Western Iberian Margin (WIM) and relevance for oil and gas, CCS and natural hydrogen.

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Historically, magmatic processes and related geological record have been considered a burden and source of complexity while exploring for hydrocarbon resources. Abnormal and episodic thermal gradient modelling, source rock overmaturation, trap destruction and abrupt reservoir property changes are some of the ghosts that haunt any oil and gas exploracionist. Nonetheless, recent exploration examples indicate that, when properly constrained, magmatism can be an additional booster for what-else could only considered as marginal petroleum systems (e.g. Taranaki Basin (New Zealand), Faroe-Shetland Basin (Faroe Islands), Yayo Basin (Ethiopia)).

Contrastingly, unravelling the complexity of magmatic processes is paramount for the successful exploration of mineral resources. Structural controls, geochemical reactions, pressure versus temperature, pH, oxidation-reduction potential and timing are key parameters to properly delineate mineralization zones.

Currently, with the ongoing energy transition process and the emerging decarbonising technologies, magmatic rocks are being re-looked with new eyes that combine both oil and gas and mining approaches. These technologies require a methodology that goes from the basin scale to the reservoir and mineral scale, in order to find areas suitable for basalt carbonation or natural hydrogen generation in ultra-mafic rocks.

To fully understand these geological systems, high quality seismic data together with potential fields data must be used, not only to enable the characterisation of the large scale structure and basin infill, but also to interpret in detail the interplay between magmatic rocks and their structure within the hosting rocks. In addition, geochemical analysis, fracture network development and modelling type, and timing of mineralization processes need to be assessed to constrain available storage/ production volume and rates.

This study uses examples from post-rift magmatic bodies interpreted from high resolution broadband seismic data from offshore Portugal (central West Iberian Margin), to compare with the onshore sector where similar structures of the same age outcrop (Late Cretaceous (94-69 Ma). The aim is to highlight the implications of magmatism in the regional and local structural framework for hydrocarbon maturation, reservoir properties distribution, trap creation and/or destruction. The study also emphasises potential consequences for the generation of natural hydrogen accumulation and CO_2 sequestration and mineralization via basalt carbonation.

The WIM post-rift magmatic event left excellent exposures along coastal and inland areas, both of intrusive and extrusive nature, where sub-seismic resolution structures can be studied. Recent 3D seismic acquisition campaigns, together with high resolution gravity and magnetic data, allowed further identification and characterisation of offshore magmatic structures related with this event. The result is that currently the West Iberian Margin, particularly its central part constitutes a natural laboratory to compare between outcrop and seismic data allowing the interpretation of the structural styles and mineralization processes associated to magmatism at different scales.