Tectono-Sedimentary Evolution of the Porto Basin (NW Offshore Portugal): Implications for Hydrocarbon Exploration

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Abstract

This study reassesses the evolution and petroleum potential of Porto Basin, based on Basin and Petroleum Systems modeling to evaluate the margin maturity and complemented with new insights in the prediction of lithology variations on the unexplored deep offshore area, consequently contributing to the future hydrocarbon exploration. The Meso-Cenozoic Porto Basin is a rift-type basin located in the NW Iberian margin that evolved into a typical non-volcanic passive margin. It corresponds to the conjugate margin of the Canadian Flemish Pass Basin, where significant commercial discoveries recently occurred. The basin area extends from the shallow offshore platform, westwards beyond the continental slope into the deep offshore (water depth up to 3000 m) and, although with few published data, it had been explored twenty years ago. Good volumes of oil and gas-prone Early and Late Jurassic source rocks (present-day TOC values: 0.5-1.6 wt%), as well as different types of reservoirs (e.g. channel-lobe siliciclastics, reef buildups, karstified dolomites) are considered to be present in this basin. Rifting was initiated in the Late Triassic, with the Hercynian structural fabric playing a crucial role in controlling basin architecture. The basin margin's geometry, in which the Porto-Tomar main border fault plays a significant role, has been shaped mainly by Mesozoic extensional tectonics. Some extension-related features such as ENE-WSW trending fault zones evolved into major transfer faults during the second (Late Jurassic) and third (Early Cretaceous) rifting stages. The newly formed transfer faults reactivated Hercynian structures visible in the onshore domain and most likely controlled the rift shoulder sediment bypass, leading the sediment input from the onshore/proximal to the distal domains. The basin marginal and internal architecture suggests the existence of several relay-ramp structures that also controlled sediment pathways into the basin's depocenters. Alpine-related orogenies (Pyrenean and Betics) were responsible for late tectonic inversion, inverting normal faults and reversing strike-slip transfer faults as well as creating new structural traps and ultimately destroying pre-existing ones. The Porto Basin tectono-sedimentary evolution had an important impact on petroleum systems, affecting crucial parameters such as subsidence and maturation, siliciclastic accommodation space and depocenters, structural traps and seal integrity.