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Uncovering the impact of Gokceada Volcanic Zone on pressure and temperature conditions of Thrace Basin in the Northern Aegean Sea using 1D basin modelling and seismic velocity extraction

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Tectonic evolution of Thrace Basin in the offshore area surrounding the Gokceada island has been widely studied except for pressure and temperature conditions. This study aims to fill this scientific gap while introducing the discovery of NW-SE oriented Gokceada Volcanic Zone, represented by extinct volcano geometries and chaotic seismic facies on seismic sections. Presence of such a significant heat source causes inevitable effects on pressure-temperature behaviour that might manifest itself as abrupt changes and makes the understanding of petroleum system essential. Hence, an integrated workflow involving seismic & well log interpretation, post-drill ppfg & temperature analysis, conversion of interval velocities into a 3D pore pressure model and 1D basin modelling has been conducted for the first time. 1D models focus especially on the oldest sedimentary unit of gas prone Thrace Basin, known as Early-Mid Eocene aged Karaagac Formation in the Northern Aegean region.

Basin analysis has yielded unique results by providing clues to better understand pore pressure mechanism and maturity rate of the Karaagac Formation, including type-III Eocene shales. The shallower parts of the Karaagac Formation, dominated by the Eocene deltaic succession, is in main oil window. On the other hand, between 4-5 km. depth at where the Eocene shales exist, maturity rate reaches late oil-wet gas. Maturity profile also suggests that entrance to the early oil window is at 38-35 Ma, corresponding to the Oligocene. It can be claimed that high burial rates caused fast maturation which can also be supported by the sedimentation rates, calculated approximately as 450 m/Ma. The post-collisional extensional regime in the Early-Mid Eocene, characterised by wedge-shaped growth strata on seismic sections, can be considered as the main reason for the high sedimentation rates. Thus, it can be proposed that the main causes for increasing pore pressures are disequilibrium compaction and possibly hydrocarbon generation process.

Gokceada Volcanic Zone can be suggested as another driving force of fast maturation. Temperature profiles of two wells exhibit a significant increase towards the volcanic zone. In terms of geothermal gradients, the abrupt changes resulted with temperature fluctuations. Gradient values change between 35-45 ^{0}C/km during Eocene-Oligocene at when the basin has experienced severe volcanism due to the crustal thinning. By the ongoing burial, values decrease and approach present-day conditions, ranging between 25-35 ^{0}C/km. Present day temperatures reach at least 150-160 ^{0}C interval for the deepest part of the basin.

Unlike the temperatures, pore pressures slightly decrease along the volcanic zone. This trend can be related to low porosities of products of intrusions and extrusions. For a better comparison of pressure conditions, a pore pressure cube has been reflected on the seismic sections. According to the model, present-day pressure values range between 5000-12000 psi in the Karaagac Formation. A very similar pressure profile has been illustrated by burial history charts and post-drill ppfg graphs as well. Although different inputs were used, outcomes of all methods validate each other. Therefore, findings of this study can act as a reliable foundation for pore pressure prediction and static temperature prognosis in the area.