Oil and Gas Well Enigmas Point to Future Green Resources in the Middle East

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Abstract

Borehole aquifers that are “too hot” or “too cold” can be evidence for geothermal convection systems. Some deep-seated faults in the Afro-Arabian Plate are dilated by Late Tertiary tectonic and thermal stresses, allowing aquifers to circulate to depths of many kilometres, where they heat up, and hence reduce in density and viscosity, before returning buoyantly towards the surface.

This is spectacularly demonstrated along the seismically active Dead Sea Rift in Jordan, but locally elevated temperatures occur in spring waters and sub-surface aquifers across the region. Unsurprisingly, given the high level of seismicity, very variable temperatures are also encountered along the coastal plains of the Red Sea and Gulf of Aden, and in their offshore wells.

Temperatures in excess of 200ºC are known, or can be inferred from fluid inclusions and mineralogy, in shallow- penetrating research wells close to the rift axis in the Red Sea. Although no industry wells have been drilled close to the rift axis, the very high palaeotemperatures implied by thermal maturity indicators in petroleum wells drilled closer to shore suggest that similar temperatures were reached prior to spreading, when the rift axis was much closer to those wells.

Our thermal modelling indicates that the best geothermal prospects will be encountered in relatively deep water, on the flanks of the rift axis, where sediment seals prevent heat loss to the seabed, and where modern seismic imaging can optimise the placement of geothermal wells. These sites will therefore necessarily be away from the most environmentally sensitive coastal areas along the Red Sea and Gulf of Aden.

By analogy with onshore geothermal fields, such temperatures would yield large quantities of “always on” green power and would also deliver, by condensation of the produced steam, huge volumes of fresh water. Whilst the power could be used to produce hydrogen from the fresh water by electrolysis, hence providing a route to green fuels, our calculations suggest that there will be much more fresh water than can be electrolysed by the geothermal power produced. In the Middle East context, solar or wind power could be coupled to the offshore geothermal system to generate green fuels from the co-produced geothermal fresh water without the need for a desalination process.

The Red Sea to the Gulf of Aden is one of five geographical areas that we have high-graded for offshore geothermal pilot studies and is the area that in our view shows the greatest potential for progression from the pilot phase to a series of full-scale commercial projects. This potential arises from the combination of expertise in engineering and Earth science available across the Middle East, along with its optimal geological location on the Earth’s Global Rift System. Progress can be rapid, because no “blue skies” technology is required: this novel combination leverages high-TRL technologies from the petroleum and geothermal industries, offering a green fuel “off ramp” for Middle East petroleum expertise.

In ten to twenty years, the offshore section of the Earth's Global Rift System could be viewed as the next generation source of green fuels. The region that first marshals its expertise to prove the viability and magnitude of this resource would be well-placed to become the world leader in green fuel production. In the case of the Middle East, this would represent a natural, manageable, transition from its present leadership role in petroleum fuels.