THE NEOM BRINE POOL – THE FIRST DISCOVERY IN THE GULF OF AQABA

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PROJECT OBJECTIVES

- To characterize the physical and chemical characteristics of this new type of pool.
- Based on coring and radiometric dating, our second aim is to quantify its stratigraphic setting.
- Our final aim is to describe the eukaryote and prokaryote life which thrives in the harsh brine environment.

PROJECT RATIONALE

Deep sea brine pools are formed by the dissolution of buried evaporites and the stable accumulation of these hypersaline solutions in seabed depressions. Earth has three classic venues for such accumulations – the Gulf of Mexico, the Mediterranean, and the Red Sea. Of these, the Red Sea boasts the most numerous pools and, prior to this study, they fell into one of two categories.

In the first category, there are at least 25 complexes of brine pools developed along the axial trough of the Red Sea (Fig. 1). These 'axial' pools are all anoxic, and, being associated with the hydrothermal system of the basin's spreading axis, are 'hot', meaning that they are substantially warmer than ambient seawater. To date, there are only two examples in the second category, which encompasses pools located away from the axial trough on the coastal shelf. Both examples situate offshore Saudi Arabia – the Thuwal Seeps at 860 m water depth and the Afifi Brine Pool at 350 m. Like the axial pools, this pair are both anoxic, but their hypersaline waters are not substantially warmer than ambient. Colloquially, these are termed 'cold' pools.

Here, we report our discovery of the NEOM Brine Pool (Fig. 2), named eponymously after the NEOM-facilitated 2020 research cruise with OceanX. Different to all previous discoveries, the NEOM pool situates in the Gulf of Aqaba. The first discovery outside the Red Sea proper. As for the axial pools, the NEOM pool is situated at abyssal depth (1770 m), yet like the much shallower Afifi pool and Thuwal seeps, the discovery is cold (its waters are only 1 °C warmer than ambient; Fig. 3). The final feature that sets the NEOM pool apart is its 2 km proximity to the coast. Of all the other Red Sea pools, the most shore-proximal is the Thuwal Seeps which situates 25 km offshore. Based on these differences, we propose our discovery constitutes a meaningful variation on the category of cool coastal-shelf pools, but arguably represents an altogether new category of Red Sea brine pool.

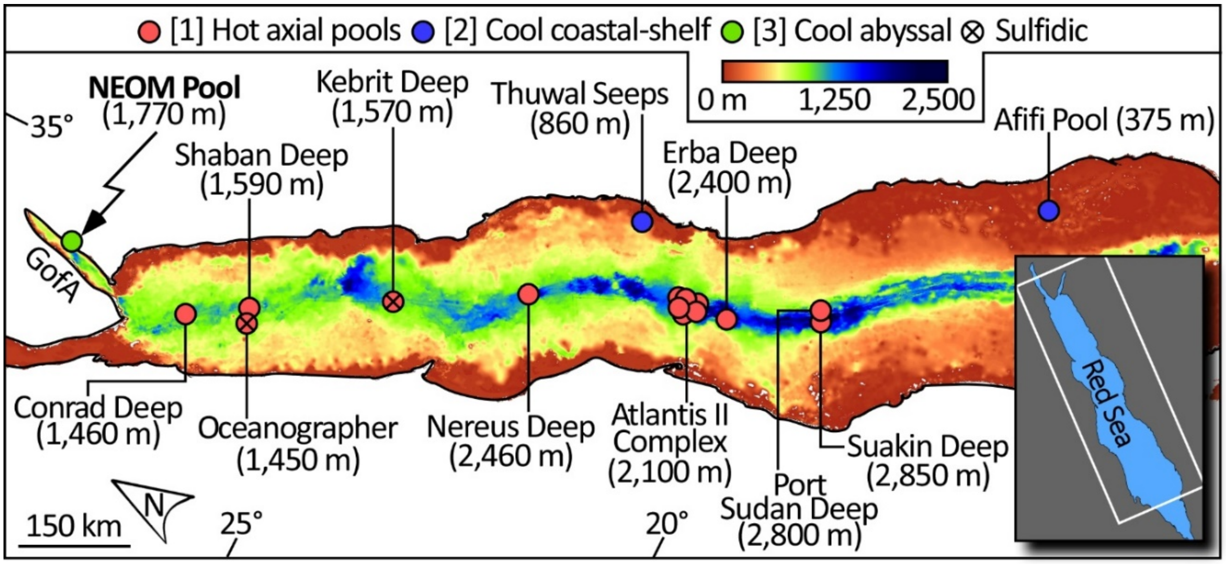

Figure 1: Brine Pools of the Red Sea. Based on the depths at which the brine pools locate and their temperature, the basin's population of pools logically split into three categories. [1] Hot pools in the deep axial trough associated with hydrothermal flow at the rift spreading axis (red dots). [2] Cold pools, meanwhile, situate on the shallow coastal shelf (blue dots). [3] The NEOM Brine Pool, the first discovery in the Gulf of Aqaba (GofA), is cold, and neither located on the spreading axis nor the continental shelf (green dot). Two hot axial pools, Oceanographer and Kebrit, are sulfidic, meaning their brines contain stable measurable concentrations of dissolved sulfide.

APPROACH

A comprehensive geophysical dataset acquired in the Gulf of Aqaba will be interrogated to examine the syn-rift carbonates of the northern Red Sea and the brines that accumulate in the basin's abyssal deeps. Geochemistry, genomics, and sequence stratigraphy will be used to divine the source of the brine, the microbial life which thrives in the harsh brine environment, and the unique sedimentary record which deposits beneath the brine (Fig. 4). Emphasis will be placed on disentangling the controls on plan-view morphology of rift carbonates and internal stratal patterns of the deposits, with a view to developing a modern analog to Tertiary rift basins in the South China Sea and Mesozoic basins of the South Atlantic.

SIGNIFICANCE

Syn-rift carbonate platform strata can form important petroleum reservoirs within syn-rift basins. They also provide critical records for understanding the tectonic evolution and depositional history of rift systems. This unique dataset from the Red Sea has the potential to provide enhanced understanding in such settings.

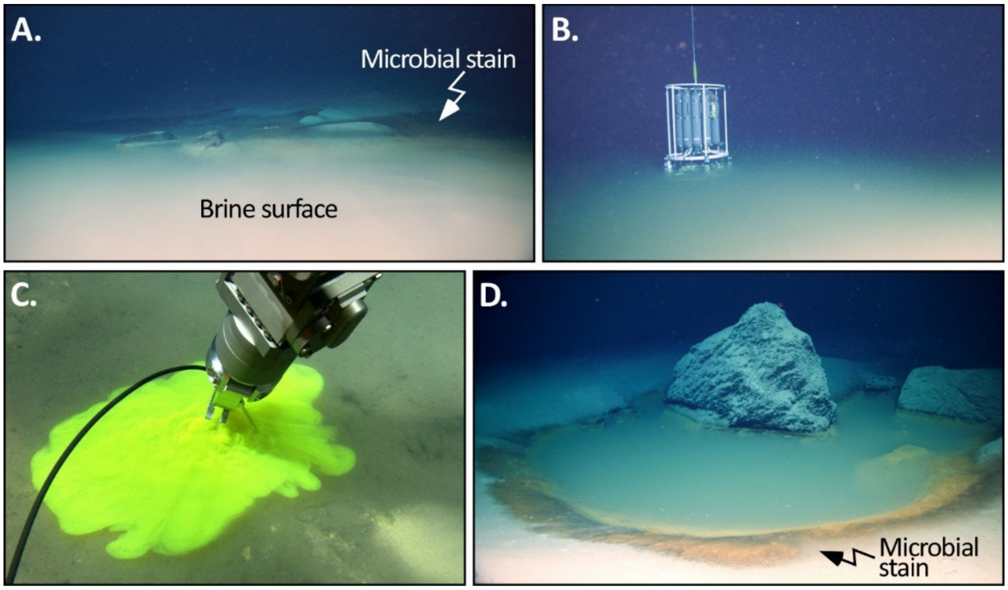

Figure 2: Photographs of the NEOM Brine Pool. (A) Brine surface in the foreground onlaps the 'beach' which is characterized by a rich microbial community (orange-to-gray in color). In (B) the Sea-Bird CTD system is lowered through the brine-seawater interface, a transition which can be emphasized via injection of biodegradable dye (C). (D) Shows a small brine pool situated 50 m to the west of the main pool. Boulders shed from the nearby reef slope have excavated a seabed depression on the abyssal plain that has subsequently filled with brine. As for the main pool, the microbial community stains the beach around this diminutive pool.

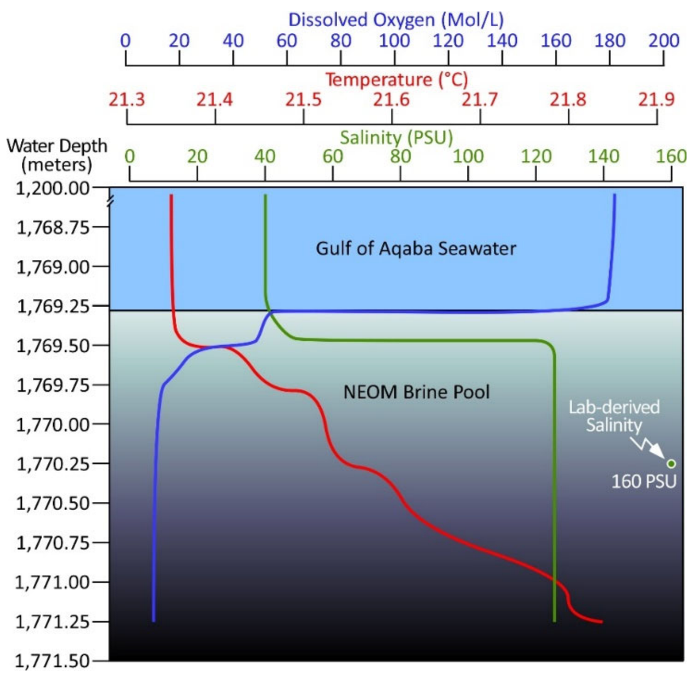

Figure 3: Dissolved oxygen, temperature, and salinity profiles into the NEOM brine pool. The brine-seawater interface situates at 1769.26 m water depth, demarked by the abrupt decrease in dissolved oxygen concentration and increase in salinity. Note that the CTD conductivity probe saturated at 120 PSU and the true brine salinity was determined in the lab to be 160 PSU. The temperature differential between the brine and overlying seawater is modest at 1 °C.

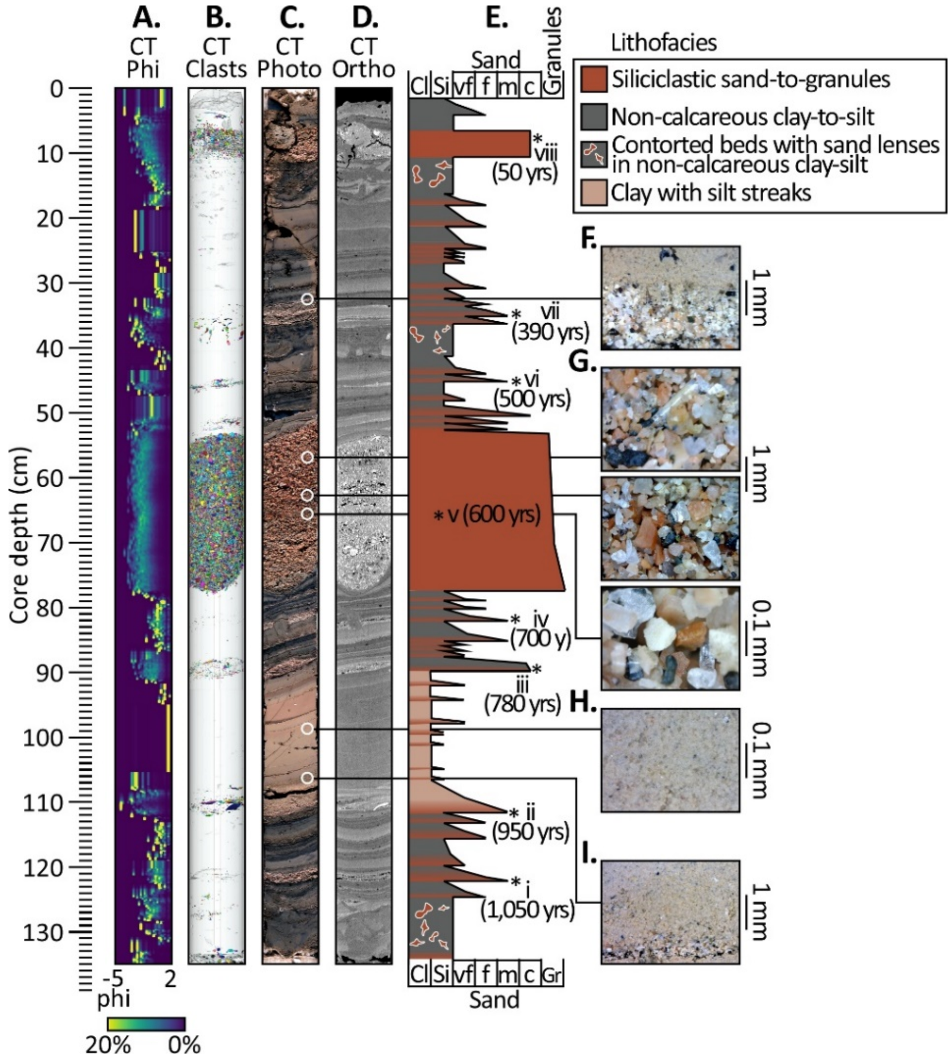

Figure 4: Stratigraphy of the long core pushed into the bed of the brine pool. (A) Clast size analysis derived from computed tomography (CT) scanning of the core computed at 1 cm intervals via a moving window. In this histogram plot, the left border is -5 phi (i.e., coarse clasts) and the right border is 2 phi (fine clasts). The color scale varies from 0% occurrence of a given phi in each 1 cm interval in blue, up to 20% by volume in yellow. Using random colors, (B) identifies the occurrences of individual clasts which could be separated in the CT scan. This 3-D visualization excellently emphasizes the eight prominent siliciclastic intervals. (C) Is a high-resolution digital photo-scan of the archive half of the split core and (D) is the equivalent grayscale orthoslice reconstructed from CT. (E) Is the core description capturing grainsize and lithofacies. Asterisks demark the eight prominent siliciclastic intervals recorded in the cores and their ages as derived from the Bayesian age model. Of these, the most prominent is 'v' which dates to ~600 yrs. BP. (F) through (I) are photomicrographs which detail the fining-upwards arrangement of the turbidite deposits (F), the coarse siliciclastic interval (G), and the clay deposit with silt streaks during times of uninterrupted deposition (H) and also interspersed with fining-upwards turbidite deposits (I).