Dr. Amy Bower: Red Sea Hydrography and Circulation

KAUST

An Oceanographic Research Expedition to the Red Sea

The Red Sea is an ocean basin of local, regional and global significance. It is a long and narrow sea, ringed by many Middle Eastern and African countries: coastal development in one country will have a profound impact on the entire region. It is fringed by extensive coral reefs, many in pristine condition, that provide critical habitat for marine life, support several important fisheries and attract tourists. Formed as the African and Arabian plates split apart, the Red Sea remains to this day an active rifting zone, generating earthquakes, volcanic eruptions, as well as deep hypersaline brine pools and valuable mineral deposits at the ocean floor. One of the World's busiest shipping routes and the largest seaport in the Middle East are in the Red Sea.

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from *Oceanus* magazine

In spite of its economic and environmental importance, our knowledge of the oceanographic conditions in the Red Sea, and the important physical, biological, geological and chemical processes remains somewhat limited. For example, the direction and strength of the currents in the Red Sea, and how they change over time, are largely unknown, due mainly to the paucity of oceanographic and meteorological observations. A few oceanographic numerical models have used the available information on prevailing winds, evaporation and heating to predict the circulation of the Red Sea, but there are insufficient oceanographic data to verify the model results. Furthermore, such models have not been designed to resolve the narrow currents and small-scale processes close to the reefs, which are essential to the reef ecosystem.

To advance scientific understanding of Red Sea oceanography, the Woods Hole Oceanographic Institution (WHOI) and King Abdullah University of Science and Technology (KAUST) have joined together to conduct the first comprehensive, multi-disciplinary oceanographic expedition to the Red Sea in October-November 2008. The expedition will be carried out using WHOI's *R/V Oceanus* and it is divided into three legs.

On Leg 1, coastal currents and air-sea interaction will be studied by installing several moorings near KAUST that will measure a full suite of oceanographic and meteorological parameters. In combination with a land-based meteorological tower to be constructed at KAUST prior to the cruise, these moorings constitute the first land-sea observing system in Saudi coastal waters. The observations will provide new information on coastal conditions continuously for two years.

On Leg 2, we plan to conduct the first basin-wide hydrographic survey of the Red Sea, with seven full east-west transects and one axial transect, between the Yemen-Saudi border in the south to just south of Sinai in the north. On this cruise, we will study the physical, chemical and biological properties of the entire Red Sea, top-to-bottom currents and genomics of surface biota. In addition, we will perform an exploratory study of the Red Sea brines, which are sites of extensive mineral deposits and possibly exotic species adapted for life in hot, hypersaline conditions. Brine studies will include bottom imaging, gravity and magnetic measurements, water properties and genomics. Scientists from the American University in Cairo and Hong Kong University of Science and Technology will also participate on this leg.

While the Leg 2 cruise plan is ambitious, and depends on the cooperation of Egypt, Sudan and Eritrea, it represents an unprecedented opportunity to observe the Red Sea in its entirety for the first time. Many oceanographic processes span the width of the Red Sea and therefore cannot be studied without basin-wide measurements. This cruise also sets the stage for KAUST to be a regional and international leader in Red Sea oceanography.

On Leg 3, we plan to use state-of-the-art technology to study small-scale biological and physical processes along the outer reef edge between Rabigh and Jeddah. Several nested, high-resolution surveys will be carried out from *R/V Oceanus* using a suite of sensors attached to an undulating "towfish" pulled behind the ship. This will allow for rapid collection of observations, which is critical to describing exchange processes between the reef and open ocean and understanding how the reef ecology is maintained.

As well as conducting the research activities listed above, the *R/V Oceanus* cruise will demonstrate to KAUST the capabilities of a world-class, fully-equipped oceanographic research vessel. This will help the KAUST leadership select the best research vessel for the new Marine and Ocean Research Center (MORC). A famous late US oceanographer and WHOI scientist, Henry Stommel, once said, " A computer looks pretty impressive on a college campus, but a well-equipped oceanographic vessel is a grander sight and makes a person want to work at sea." The *Oceanus* cruise will also provide important research, training and educational opportunities for KAUST participants.

Manuscripts

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