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Vertical, horizontal, and temporal changes in temperature in the Atlantis II and Discovery hot brine pools, Red Sea

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In October 2008, we measured temperature and salinity in hot (68°C), hypersaline (250 psu) brine filling the Atlantis II and Discovery Deeps on the Red Sea spreading center near 21°N. In agreement with previous observations in the Atlantis II Deep, we found a stack of four convective layers (in which temperature is vertically uniform) separated by thin interfaces with high vertical temperature gradients. Compared with the last observations in 1997, temperature in the thickest, deepest convective layer in the Atlantis II Deep continued to slowly increase at 0.1°C/yr. Based on earlier data extending back to the 1960s, we found that the temperature of all four convective layers increased at the same rate, from which we infer that diffusive vertical heat flux between convective layers is rapid on time scales of 3-5 yr and, thus, heat is lost from the brine pools to overlying Red Sea Deep Water. Heat budgets suggest that the heat flux from hydrothermal venting decreased from 0.54 GW in 1966 to 0.18 GW in 2008. A towed CTD survey found that temperature in the upper convective layers changes about 0.2°C over 5-6 km, whereas the temperature in the lower brine layer remains constant. Compared to previous surveys, temperature in the lower convective layer in the Discovery Deep remains unchanged at 48°C. To explain these results, we hypothesize that heat flux from a hydrothermal vent in the floor of the Discovery Deep has been stable for 40 years, whereas temperature of the brine in the Atlantis II Deep is adjusting to a decrease in hydrothermal heat flux from the vent in the Southwest Basin. We found no changes in the upper transition layer at 1900-1990 m depth that appeared between 1976 and 1992. Our data are consistent with this layer originating from a seafloor vent elsewhere in the rift.