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Dating Quaternary raised coral terraces along the Saudi Arabian Red Sea coast

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ABSTRACT

Late Pleistocene raised coral reef terraces form extensive outcrops up to 5 km wide along the Saudi coast. *Porites* coral were dated using U/Th while clastic sediment from Jeddah was dated using thermoluminescence. The pooled mean age for the coral samples is 121.5 ± 0.2 ka suggesting MIS 5e, even for the uplifted 16–20 m high terrace in the north at Haql. In Jeddah the MIS 5e back-reef succession is overlain by fluvial sediment that gave a TL age of 66 ± 13 ka. The structure and faunal composition of the coral terraces suggests that they accumulated in broad shallow embayments following the last interglacial transgression. The consistent elevation of these terraces suggests that the central and southern Saudi coast has been tectonically stable for at least the past 125,000 years and the coral reef terraces (at 3.5–5.5 m elevation) are consistent with the MIS 5e sea level high-stand that peaked at 6–9 m above present sea level. The Saudi coastal coral terrace north of Duba shows progressive uplift to 16–20 m near Haql since 108–120 ka as a result of ongoing transform faulting in the Gulf of Aqaba.

1. Introduction

Late Pleistocene raised coral terraces are well preserved along much of the Red Sea coast (Fig. 1) varying in width from 500 m to 5 km with heights up to 25 m above present sea level (apsl). Due to the complex relationship between eustatic sea-level changes and local tectonics, numerous geological and geomorphogical studies on these Red Sea coral terraces have concentrate on either sea level history (Behairy, 1983; Dullo, 1990; Sheppard et al., 1992; Scholz et al., 2004) and/or neotectonic activity (Gvirtzman and Buchbinder, 1978; Sneh and Friedman, 1980; Jado and Zotl, 1984; Plaziat et al., 2008).

Most of the early studies were concentrated in the northern region of the Red Sea (north of latitude 27 N, Fig.1) where the Red Sea is divided into the Gulf of Aqaba and the Gulf of Suez. This is because of the presence of abundant coral reefs and terraces, tectonic instability and easy access to the region. Farther south, both the Saudi Arabian and Egyptian margins are rimmed by several levels of Pleistocene and Holocene terraces, but they do not show significant uplift and generally suggest relative vertical stability (Plaziat et al., 1998, 2008).

Studies from the northern region of the Red Sea have assigned a wide range of ages to the raised coral terraces: from 4 to 150 ka for terraces with heights between 1 and 100 m (Friedman, 1965; Gvirtzman and Friedman, 1977; Dullo, 1984; Al-Rifaiy and Cherif, 1988; Dullo, 1990; Hoang and Taviani, 1991; Gvirtzman et al., 1992; El-Asmar, 1997; Dullo and Montaggioni, 1998; Scholz et al., 2004; Vincent, 2008; Parker et al., 2012).

A few coral reefs were dated from the west coast of the Red Sea before 1980 (Berry et al., 1966; Butzer and Hansen, 1968; Veeh and Giegengack, 1970; Faure et al., 1980) while more published dates have appeared within the last three decades. These ages ranged from 50 to 150 ka for the lower raised reefs (1–9 m) previously referred to late Pleistocene times (Gvirtzman et al., 1992; Gvirtzman, 1994; El-Moursi, 1992; El-Moursi et al., 1994; Walter et al., 2000).

The eastern coast of the Red Sea (the coastline of Saudi Arabia) is about 1840 km long, accounting for 79% of the eastern seaboard of the Red Sea (Fig. 1). Early ^{14}C dating (Nesteroff, 1959; Behairy, 1983) provided a minimum age for the raised coral terraces because the sequence is beyond the limits of radiocarbon dating. Later U/Th dating for two raised (6–10 m) coral reef samples north of Duba gave an age of 95–120 ka (Jado et al., 1989) while Dullo (1990) dated a terrace 4–6 m above present sea level (apsl) near Umm Lajj (105 ka), a terrace 8–12 m apsl south of Aqaba (96 ka) and a terrace at 18–25 m apsl north and south of Maqna (118 ka). Despite the paucity of geochemical and mineralogical evidence for possible diagenetic modification of the corals, these ages reflect MIS 5 reefs or terraces. Dullo (1990) considered that the terrace consisted of three on-lapping reef cycles representing Marine Isotopic Stage (MIS) 5e, 5c and 5a sea level high stands that were significantly higher than the currently accepted global MIS 5 high-stand, thus indicating a strong tectonic uplift in the Aqaba area. A more recent study by Scholz et al. (2004) using *Porites* corals determined an age of 121–122 ka for a 7–10 m apsl terrace and 106 ka for a

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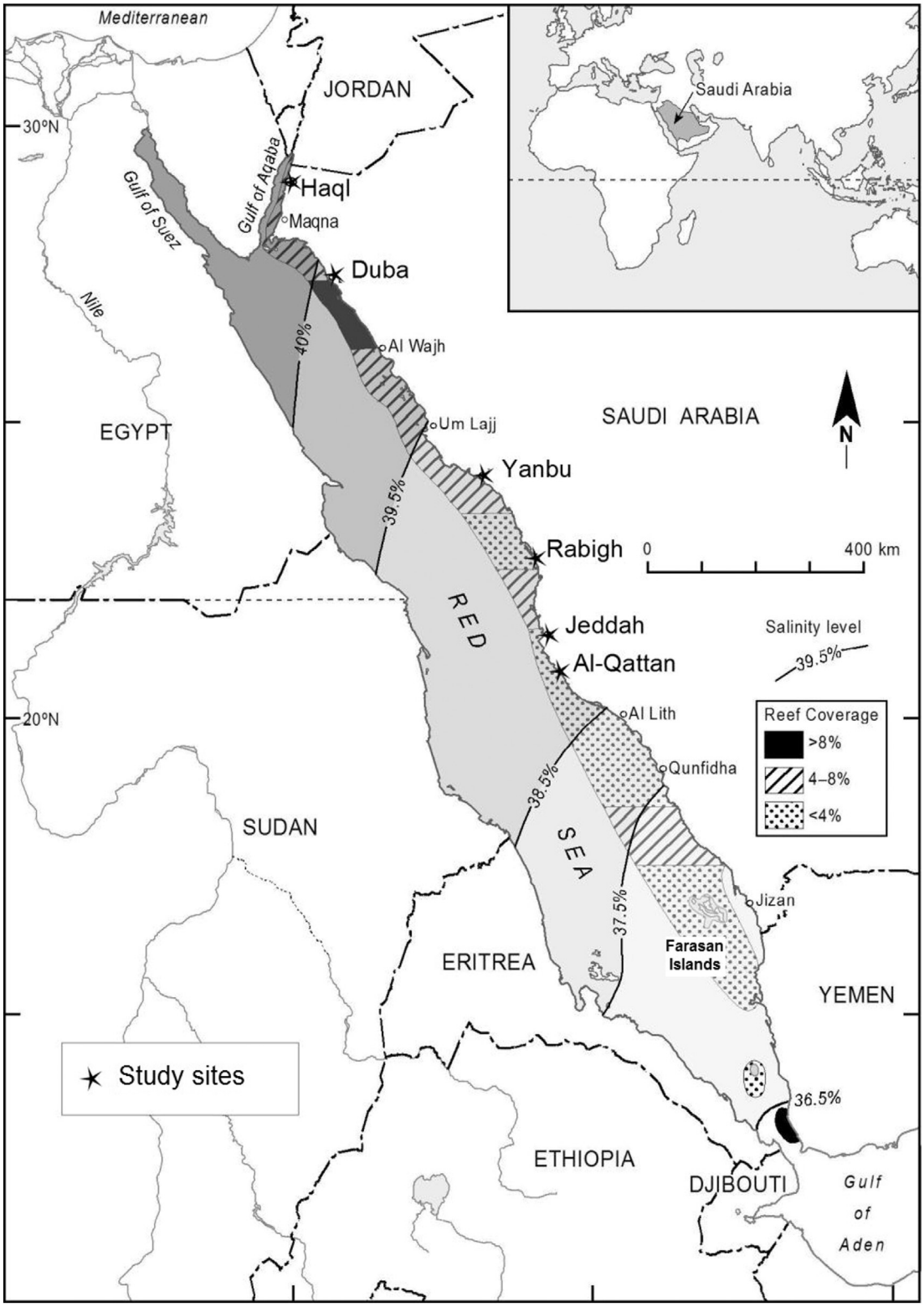

Fig. 1. Map of the Red Sea showing the location of the principal study areas along the Saudi Arabian coast, salinity profiles and coral reef densities: shading represents areas of 500 m × 500 m quadrat reef coverage.
Modified from Saifullah (1996) and PERSGA/GEF (2003).

4–5 m apsl terrace at the north end of the Gulf of Aqaba. They noted that diagenetic addition of uranium was an important factor in this area and based their conclusions on isochron ages.

In contrast to determining the age of the terraces in the northeastern Red Sea region, dating on the central Saudi coast is sparse and suggests a wide range of ages for the terraces. Dawood et al. (2013) applied the alpha-counting U/Th dating method to three whole rock samples within a single terrace 3–4 m high in the Rabigh area, resulting in ages ranging from 235 ± 1 to 128 ± 0.2 ka while Bantan et al. (2015) dated a 5 m high reef terrace on the Jeddah coastal plain that revealed a range of