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Time constraints on the evolution of southern Palawan Island, Philippines from onshore and offshore correlation of Miocene limestones

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ABSTRACT

The link between the deformation of southern and central Palawan Island, Philippines and the deformation of the adjacent offshore wedge is investigated. The wedge is a continuation of the Palawan fold and thrust belt and bounds the Borneo–Palawan Trough to the Dangerous Grounds and to Palawan Island. Key parameters for the understanding of the formation and development of this wedge are two limestone formations: The Oligocene to Middle Miocene Nido limestone and the Upper Miocene to Lower Pliocene Tabon limestone.

The initiation of the thrust belt formation is constrained by the Nido limestone, which was deposited from shortly before the breakup of the eastern South China Sea (~35 Ma) until the Early Miocene. Age data available from wells offshore central Palawan gives an age of Early Miocene close to the base of the Nido limestone. While cropping out onshore north Palawan, these limestones were overthrusted by the wedge in southern and central Palawan. Seismic images show gently east dipping carbonates below the wedge. The seismic data show that these limestones are only mildly affected by the wedge formation.

The end of the wedge development can be constrained by the Tabon limestone. With an age of ~9 to ~4 Ma, this limestone sequence overlies unconformably the offshore wedge. A detailed biostratigraphic correlation of the Tabon limestone along the southwest Palawan shelf, using well data, combined with multichannel seismic data and investigations onshore southern and central Palawan, shows a time- and space-transgressive development of these limestones. They are progressively younging towards the west. We propose that the formation of the Tabon limestone is directly linked with the development of the wedge that tectonically controls the formation of this carbonate platform. This constrains the time for the final phase of the formation of the Palawan thrust belt. After the final compressional phase and wedge formation in the lower Early Pliocene the wedge underwent a phase of subsidence.

Based upon the detailed correlation of these limestones we propose that the wedge did not form in the southern Palawan area prior to ~18 Ma. Using the sealing Tabon limestone as time constraint we suggest that the development of the wedge in the south Palawan area started in the lower Middle Miocene (~15 Ma) and continued developing towards the west until the upper Late Miocene to Early Pliocene (~5 Ma).

After the wedge propagation stopped, the wedge front collapsed in several places due to gravitational sliding.

Southern and central Palawan were uplifted above sea level during a second phase of compression in the Late Pliocene. Onshore outcrops give indications to a working spleothem since ~1.2 Ma.

1. Introduction

The island of Palawan, is located between the South China Sea and the Sulu Sea in the southwestern part of the Philippines. It stretches about 600 km in NE–SW direction and consist of at least two major tectonostratigraphic blocks (McCabe, 1985; Schlüter et al., 1996). Northern Palawan is dominated by rocks of a continental margin affinity thought to have rifted from mainland China. It is also referred as North Palawan continental block (Holloway, 1982). It is commonly assumed that this block drifted from mainland China to the present position during the Oligocene to Early

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Miocene seafloor spreading stage of the South China Sea. In contrast, central and south Palawan are considered to be emerged imbricated thrust belts (Hinz and Schlüter, 1985), which were overthrusted by an ophiolitic formation. The N–S trending Ulugan Fault Zone (Fig. 1) divides Palawan Island and its western shelf. The offshore position of this structure is speculative; however, its proposed position marks the eastern boundary of the thrusted wedge (Pulute Formation), which is confined to only the central and southern part of the shelf (Figs. 1 and 8).

For simplicity and orientation we subdivide the island of Palawan into three parts as indicated in Fig. 1. When we refer in the following to northern Palawan this comprises the island to the north and east of the Ulugan Bay and the Ulugan Fault Zone (10°N 118°50′E). Central Palawan, to the south and west of the Ulugan Bay ranges as far south as to the City of Quezon (09°14′N, 118°E). Finally, southern Palawan is south of Quezon City and includes Balabac Island (Fig. 1).

The general change in the onshore geology (Fig. 3) between North Palawan on the one hand and central and south Palawan on the other hand coincides with remarkable variations in bathymetry. The most striking bathymetric feature offshore Palawan is the Borneo–Palawan Trough. As shown by Hinz and Schlüter (1985) and pointed out by Hutchison (2010) there is no northern extension of the Borneo–Palawan Trough between the Reed Bank and the NW Palawan microcontinental block. The trough thus may be a collisional foredeep.

Central and south Palawan are considered to be emergent imbricated thrust belts, that developed subsequent to the early

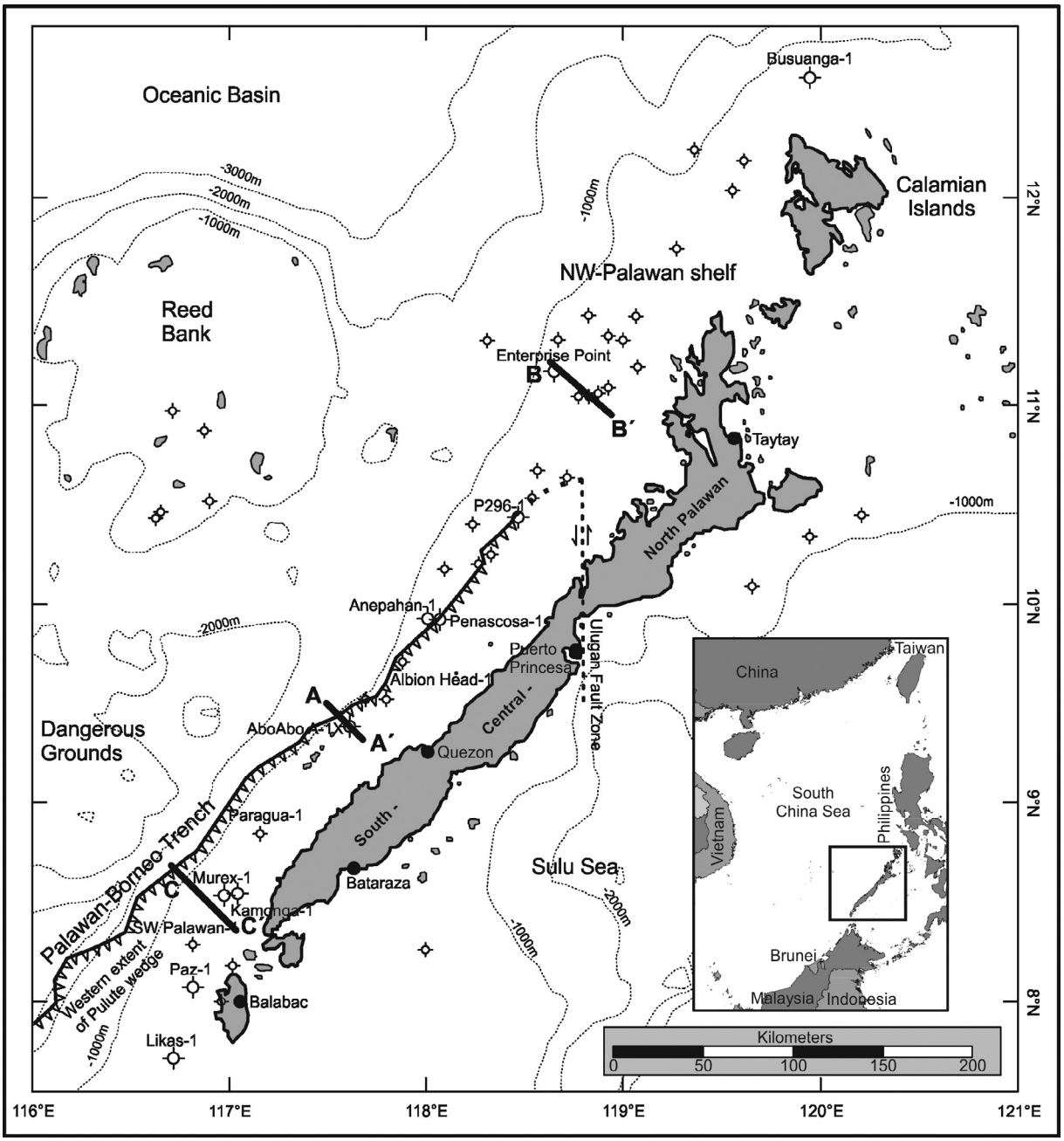

Fig. 1. Regional map showing the locality of Palawan Island and main tectonic features, as well as the location of wells offshore Palawan. Wells which are referred to in the text are enlarged and the names are shown in the map. Solid black lines indicate the locations of the three seismic shown in Figs. 9, 10 and 12. The extend of the offshore accretionary wedge is indicated. The bathymetric data is taken from the General Bathymetric Chart of the Oceans (GEBCOs).