Journal of Asian Earth Sciences 65 (2013) 75–85

Contents lists available at SciVerse ScienceDirect

Journal of Asian Earth Sciences

journal homepage: www.elsevier.com/locate/jseaes

Structural evolution of Bondoc–Burias area (South Luzon, Philippines) from seismic data

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A R T I C L E I N F O

Article history:
Received 31 March 2010
Received in revised form 6 October 2012
Accepted 11 October 2012
Available online 15 November 2012

Keywords:
Seismic horizons
Seismic sequences
Multiple folding events
Strike-slip tectonics
Tectonic inversion

A B S T R A C T

Recently acquired 2-D seismic profiles in the offshore area between Bondoc Peninsula and Burias Island, South Luzon, Philippines, are interpreted in the context of known structural styles observed onshore and in relation to paleo- and neo-tectonic regimes in the region. Two distinct seismic sequences can be distinguished relative to their structural style and tectonic significance. The top of a lower sequence shows strongly reflective properties. This unit, correlative to Late Oligocene to Early Miocene limestone bodies observed onshore in Bondoc Peninsula and Burias Island, is affected by intense to moderate superposed folding and thrust faulting. An upper sequence, correlative to a two-member turbiditic and shallower marine clastic deposit widely exposed in Bondoc Peninsula, is affected by thrust faulting and deformation associated with overturned tight folding. The onshore equivalents of these two seismic sequences form the core of a bent anticlinorium that twists from a NW–SE axis in onshore Bondoc into a N–S axis southwards into the southern tip of the peninsula, then back to a NW–SE axis in the offshore region further to the south. Overlying this structural core is a relatively less deformed sequence where syn-sedimentary half-grabens are still preserved in places. This complex structural style is the result of a series of several tectonic events occurring from the Eocene to the Present, involving carbonate build-up, deep water turbidite deposition, consequent compression (folding and faulting), and late-event half graben-controlled deposition. Some resulting structures are indicative of tectonic inversion processes (positive and negative) which may prove to be potentially favorable in the search for structural plays in the area.

1. Introduction

Published materials in studies of offshore areas in inter-island seas of Luzon in the Philippines are generally few and sporadic. If any, these studies have been based on regional geophysical data such as gravity and magnetics gathered through air-borne techniques (e.g. Pineda and Aurelio, 1990; Bischke et al., 1990). In 1986, the then Bureau of Energy Development of the Philippines published a comprehensive summary of the sedimentary features of Philippine basins, based primarily from regional data. Detailed studies have been confined to areas surveyed by independent workers, mostly from the petroleum industry. In 1989, studies more specific to the Visayan Sea area were published by Porth and Von Daniels (1989).

This paper presents recent 2-D seismic profiles acquired in the offshore area between Bondoc Peninsula and Burias Island in Southern Luzon, Philippines. The offshore data is integrated with onshore observations to gain a comprehensive understanding of the structural geology and tectonic character of the region. A preliminary effort to understand the implications of this structural and tectonic nature to petroleum exploration is attempted.

2. Methodology

Offshore data (seismic profiles and bathymetry) acquired in 2007 (complemented with older profiles) were processed and interpreted, then correlated with onshore field observations.

2.1. Data acquisition and processing

Seismic data were acquired in 2007 offshore south of Bondoc Peninsula (Fig. 1). Shots were triggered in distance intervals of 18.75 m using a Single Tuned Point-Source Airgun Array with air pressure of 1971 PSI and 3200 cubic inch-volume at 5 ± 0.5-m depth. The source array consisted of two sub-arrays using a

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1367-9120/$ - see front matter
http://dx.doi.org/10.1016/j.jseaes.2012.10.039

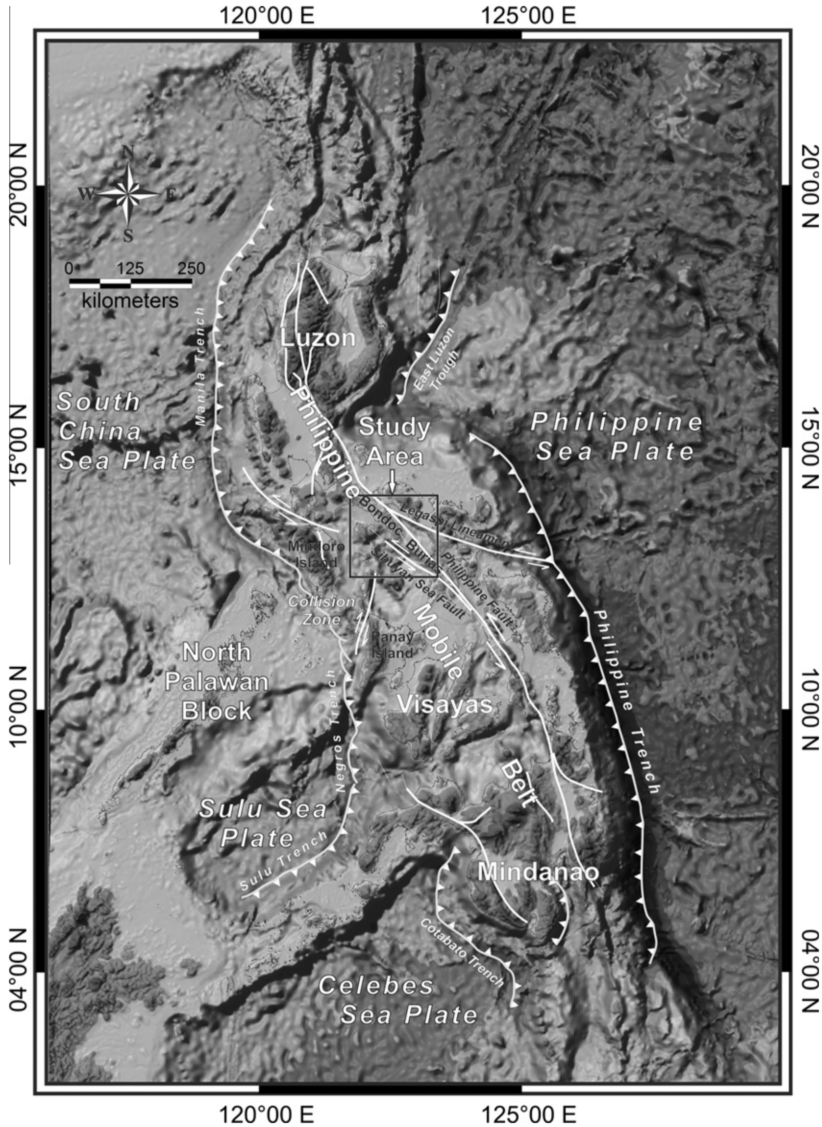

Fig. 1. Simplified tectonic map of the Philippines situating the setting of Bondoc Peninsula, Burias Island and the intervening sea in between (inset box indicates coverage of study area shown in Fig. 2) in a complex deformational zone affected by strike-slip faults in the near field and subduction and collision zones in the far field. See text for discussion.

20-gun (10 guns per sub-array and streamer) configuration. The streamer type used was a digital 396 channel streamer with 4950-m length consisting of 396 groups, wherein each 75-m long active section of the streamer had six groups with an interval of 12.5 m each, towed at 6 ± 1-m water depth. Recorded length for each survey was 4.5 s at a sampling rate of 2 ms. A total of 320 line kilometers of 2-D seismic data were gathered for this work (Fig. 2).

Final flow of data processing proceeded from transcription of SEGD 8058 format seismic lines with 2 ms sample rate, trace editing, gain recovery with T 2.0 applied, and pre-filtering with band pass frequency 3–250 Hz, to processing series of de-convolution, velocity analysis, stacking and migration. De-swell Noise Attenuation was applied using less than 1.3 NOISE3 value, with Time Frequency De-Noise (TFDN) from 200 to 4500 ms. Shot interval was interpolated from 18.75 m to 12.5 m to make group and shot interval consistent. Surface Related Multiple Elimination (SRME) was applied to cut water bottom multiple of noise, prior to Radon De-multiple. FK Filter on shot and receiver was used with 1400 ms. Pre-stack de-convolution parameters were obtained from trials conducted to the shot record data in the TAUP Domain using −3500 ms to 3500 ms dip of DELTA-T values. The parameters selected were 480 ms operator with 48 ms predictive gap. Data output was transformed back into T-X shot domain for further processing. For some remaining typical long and short period multiples, a Time Variant velocity dependant mute of multiple zone was employed on the first run using parabolic ray path de-multiple. The pre-stack time migration using the Kirchoff diffraction summation migration was applied with 3750 m aperture distance. Velocity analyses were employed on the data in between the abovementioned processes before the final normal moveout (NMO) correction and stacking in the order of the following intervals: 2.0, 1.0, and 0.25 km, after determining time corrections and sorting. The data were stacked at one over root N (1/root N) mute compensation, where N is the fold of stack at any specific time, with final stacking velocities. To compensate for the shot and streamer depths, a static correction of 7 ms shift to final datum was applied right after stacking. Data produced consisted of panels of varying types of equalization: single window AGC and dual window AGC with different percentage application of equalization.