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Magnitude of Cenozoic erosion from mean sonic transit time, offshore Taiwan

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Abstract

Mean sonic transit times from eight stratigraphic units in forty-four wells in western and northern offshore Taiwan were plotted against depth. Apparent erosion (displacement on the depth axis from the normal compaction) was determined for each unit in each well. Cretaceous and Eocene units show greater apparent erosion than Miocene and Pliocene units in the same well, which in turn show more erosion than Pleistocene units. Apparent erosions derived from two different units are plotted against each other for correlation analysis. Based on the analysis, the main periods of erosion were during the Oligocene and Plio-Pleistocene.

The timing of erosion inferred from sonic interval transit is consistent with recognized unconformities, and its areal distribution is consistent with the observed structural evolution of the region. The maximum true erosion (corrected for post-erosion burial) at the Oligocene unconformity was 3500 m on the Penghu Platform. Approximately 2500 m of true erosion occurred on the Kuanin Ulift and the Pengchiahsu Platform. Due to moderate-to-minor erosion and a great amount of post-erosion burial, true magnitude of erosion is masked at the Miocene unconformity in most of the area.

Erosion of up to 500 m on the eastern side of the Penghu Island at the Pleistocene unconformity defines the shape of the present-day Penghu Waterway. In the northern offshore area up to 1000 m of Plio/Pleistocene, true erosion occurred in the Taiwan–Sinzi folded zone where Miocene folds are observed. The magnitude of true erosion decreased west of the Taiwan–Sinzi folded zone to 500 m in the Pengchiahsu Basin. A maximum of 500 m of true erosion is also observed in the west offshore area along Hsing-Chu to Miaoli coast.

Keywords: Cenozoic erosion; Mean sonic time; Offshore Taiwan

1. Introduction

Burial history and paleo-thermal gradient are two of several important factors for sedimentary basin and petroleum system modeling (Waples, 1994). The distribution of oil windows through geological time gained from modeling depends tremendously upon the two input factors. Yet their determinations are usually highly uncertain, resulting in an outcome of generally of low confidence. True erosion at an unconformity is crucial for the determination of the burial history once the age of strata is determined. Hu, Chou, Yuan, Lin, and Chi (1981) estimated locally, using a few sonic and gamma logs, the magnitude of erosion at the Oligocene unconformity in Peikang–Wangkung and Western Taiwan foothill area. Other works conducted previously by the CPC staff are all single well based. The areal distribution of erosion for the regional unconformity in the offshore Taiwan area has not been consistently mapped and understood. Although by adjusting the paleo-thermal gradient in basin modeling, the quantity of erosion analysis can fit approximately to the present-day kerogen maturation profile, which is analyzed from cuttings or core samples. Yet, the resultant erosion and paleo-thermal gradient may not be consistent with the paleo-tectonic mechanism shown in the map. The objective of this study is to analyze the true magnitude of erosion, consistent in the sense of paleo-structure, at regional Cenozoic unconformities in offshore Taiwan areas. It will serve as a database to assist the further basin modeling of petroleum systems.

Quite often, sonic, gamma ray and kerogen maturation profiles show a remarkable difference above and below an unconformity and are offset right at the unconformity. The magnitude of erosion at unconformity for a single well has been discussed in previous studies. It has been resolved through projecting upward the trend in older strata underneath the unconformity to match the log values in younger strata above the unconformity (Dow, 1977; Hu et al., 1981; Magara, 1976). Depth shift on shale transit time curve of uplifted and over-compacted strata to match that of the normally compacted shale has also been applied to estimate

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