Tertiary carbonate sedimentation and response to sea-level changes: A case study from Sarawak

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Central Luconia Province is the largest carbonate province in Malaysia. As a result of extensional tectonics at the end of the early Miocene, submarine topographic highs were formed, whereupon reef growth took place. The period of prolific carbonate production corresponds with local and global sea-level rise in the mid- and late Miocene.

Sedimentological studies of a selected reef buildup in the province has been carried out to in order to understand the controlling factors that were involved in the reef development. Extensively cored intervals, and a wealth of well data have allowed a detailed study of the carbonate buildup to be undertaken. Based on seismic characters and well data, the buildup has been subdivided into four units (Units I to IV) which are interpreted to reflect sea-level changes. Deposition of each unit commenced with accumulations of argillaceous carbonates during the initial deeper phase (trangressive period). As the rate of sea-level rise decreased and reef growth caught up with sea-level, an aggradational growth developed. In an almost static and shallow sea-level setting (during the highstand period), the reef prograded laterally and formed an 'expansion reef'. A subsequent drop in sea-level subjected large parts of the reef to subaerial exposure. The demise of both the buildup was caused by an influx of terrigeneous clastic sediments.

As in modern reef sediments, the bulk of the carbonate sediments of the buildup was composed of metastable aragonite and Mg-calcite. Diagenetic changes into stable calcite and dolomite, occurred at an early stage in the diagenetic history under surface-related physico-chemical conditions. Investigation of the textures and geochemical analyses of the carbonate suggest the following sequence of early diagenetic events:

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1. Early marine diagenesis: This process involved micritization and early marine cementation that was dominated by the formation of fibrous/bladed circumgranular and circumvoid rim cements.
2. Fresh water stabilization: This process occurred predominantly during periods of emergence. This involved stabilization of carbonate comprising dissolution of metastable grains and precipitation of stable calcite cements.
3. Dolomitization: Dolomitization predominantly affected reef and protected facies. The process developed within regressive sequences. Although dolomite is associated locally with anhydrite and halite (recognized here for the first time in the Malaysian Miocene), some dolomitization was a by product of evaporite formation. Geochemical data suggest that dolomitization was mainly caused by the mixing of fresh and marine waters.

These early diagenetic processes were of utmost importance for the development of porosity in the buildup. Diagenetic processes which affected the buildup during the burial stage were less effective and occurred primarily within the present water zone in the buildup.