CHAPTER - 8

SEDIMENTARY EVOLUTION AND PALEOGEOGRAPHY

The entire data and interpretation generated so far i.e. in respect of microfacies, biofacies, paleoenvironments, sedimentary cycles etc. have been integrated together to evolve detailed sedimentation model in relation to paleogeographic setting, total sediment produce, subsidence history, sea level change etc. Rey (1985) carried out similar studies to infer the sedimentary evolution in early Cretaceous of the Algrave, Portugal. Detailed figures depicting such interpretation for each section, paleogeologic crosssections and ultimately three - dimentional sedimentary models have been prepared to understand the precise geological history. Such precedure has also been adopted by many workers including Grosso et.al. (1984), for reconstructing paleogeography of Malta - Regusa platform, Sicily.

8.1 SEDIMENTARY EVOLUTION

The sedimentary evolution in relation to individual sections on the basis of intergrated and correlation data is as follows.

8.1.1 Ratipal Section

Figure 8.1 shows the bio and lithostratigraphic correlation along with age and geologic time in relation to lithological section observed along Ratipal section. The lower Ramania stage indicates low energy, open shelf environments with paleobathymetry ranging upto 20 metres. The total sedimentary thickness during 3.6 million years is only 25 feet indicating stable platform conditions with little subsidence. The sequence shows one sedimentary cycle.

After a minor diastem, the upper Ramania stage sediments were orginally deposited under moderate energy, open shelf conditions having bathymetry of the order of 10 to 15 metres. However, the environment changes to low energy giving rise to diagenetic dolomite. In the course of only three millon years 40 feet of thickness was accumulated indicating greater subsidence in comparison to lower part. Butt (1982) has also arrived at similar conclusions for the Cretaceous sequence of western Morocco. The strata experienced only one sedimentary cycle.

The Waior stage sediments were deposited in low energy open shelf conditions with varying depths of burials. The paleobathymetry ranged from 20 metres at the base to 35 to 40 metres during the central part, and 10 to 15 metres during the depostion of upper part. The total sedimentary thickness is of the order of only 40 feet, possibly deposited during 3.6 million years indicating very little subsidence. The Waior section also shows only one major sedimentary cycle.

8.1.2. Bermoti Section

The lower Ramania section which was mainly deposited under low energy, shallow open shelf conditions having bathymetry ranging between 10 to 30 metres (from base to top) indicates 45 feet thick sediments possibly accumulated in 3.6. million years (Figure 8.2). This may indicate greater amount of subsidence in comparision to other sections. This lower Ramania stage experienced three sedimentary cycles in quick succession. High energy, intertidal environments with bathymetry ranging between 15 to 20 metres prevailed at the time of upper Ramania stage depostion. In a span of about 3 million years only 20 feet of sediments were resulted indicating much stable deposition condition showing only one sedimentary cycle.

The Waior stage sediments also experienced only one sedimentary cycle, under open shelf, low energy conditions, having gradual upward shallowing of depth of burial i.e from about 40 metres at the base in central part to only 10 metres to the top. The sedimentary product is only of 40 feet in 6.3 million years suggesting comparable stable conditions which prevailed during the deposition of upper Ramania.

8.1.3. Bernani Section

An interesting fact noted during the deposition of lower Ramania is presence of minor diastem at the base of Lumpy Clay

Member (Figure 8.3). The entire lower Ramania section was subjected to high to low energy, open shelf deposition conditions with paleobathymetry ranging around 10 to 15 metres in lower part and 30 to 35 metres in the upper. There is definite evidence of a sedimentary break. The geological records of the Basal Member indicates two transgressive and one regressive phase. No regressive phase is observed at the top of Basal Member and data suggest a short - lived withdrawal of sea. The Lumpy Clay Member also experienced one complete sedimentary cycle. The lower Ramania sequence generated 45 feet of thickness indicating moderate subsidence.

The upper Ramania stage representing Coral Limestone Member was deposited under high energy intertidal conditions having bathymetry around 20 metres. It represents two sedimentary cycles possibly during 3 million years.

The Waior stage sediments experienced only one sedimentary cycle and represent 55 feet of sediments deposited in about 6.3 million years. This shows very stable, low, energy, open shelf conditions of deposition.

8.1.4. Waior Section

The lower Ramania sediments experienced two sedimentary cycles under low energy, open shelf and fluctuating conditions (Figure 8.4). The upper Ramania stage coral limestones were deposited under high energy, intertidal conditions having bathymetry

around 15 to 20 metres. It experienced only one sedimentary cycle and generated 30 feet of sediments which are comparable to lower Ramania stage, thus, similar tectonic conditions prevailed during their deposition.

The sediments of Waior stage, experienced three sedimentary cycles in quick succession under overall low energy, open shelf lagoonal conditions. The sediment product of 35 feet during the course of about 6.3 million years indicate very stable conditions and little subsidence.

8.2 FACIES AND PALEOGEOLOGICAL SECTIONS

In order to understand further geological history through time, three paleogeological sections in relation to microfacies are prepared unfolding three datums, viz.

1) Top of lower Ramania stage,
2) Top of upper Ramania stage, and
3) Top of Waior stage.

Similar exercise was done by Conerst (1986), for the sedimentary evolution of the Cretaceous sequence of North African Atlantic and Neotethysian margins.

The paleogeologic sections at the top of lower Ramania stage, indicates a central depression around Bernani and Bermoti and shallowing of the basin at either ends ie. Waior and Ratipal (Figure

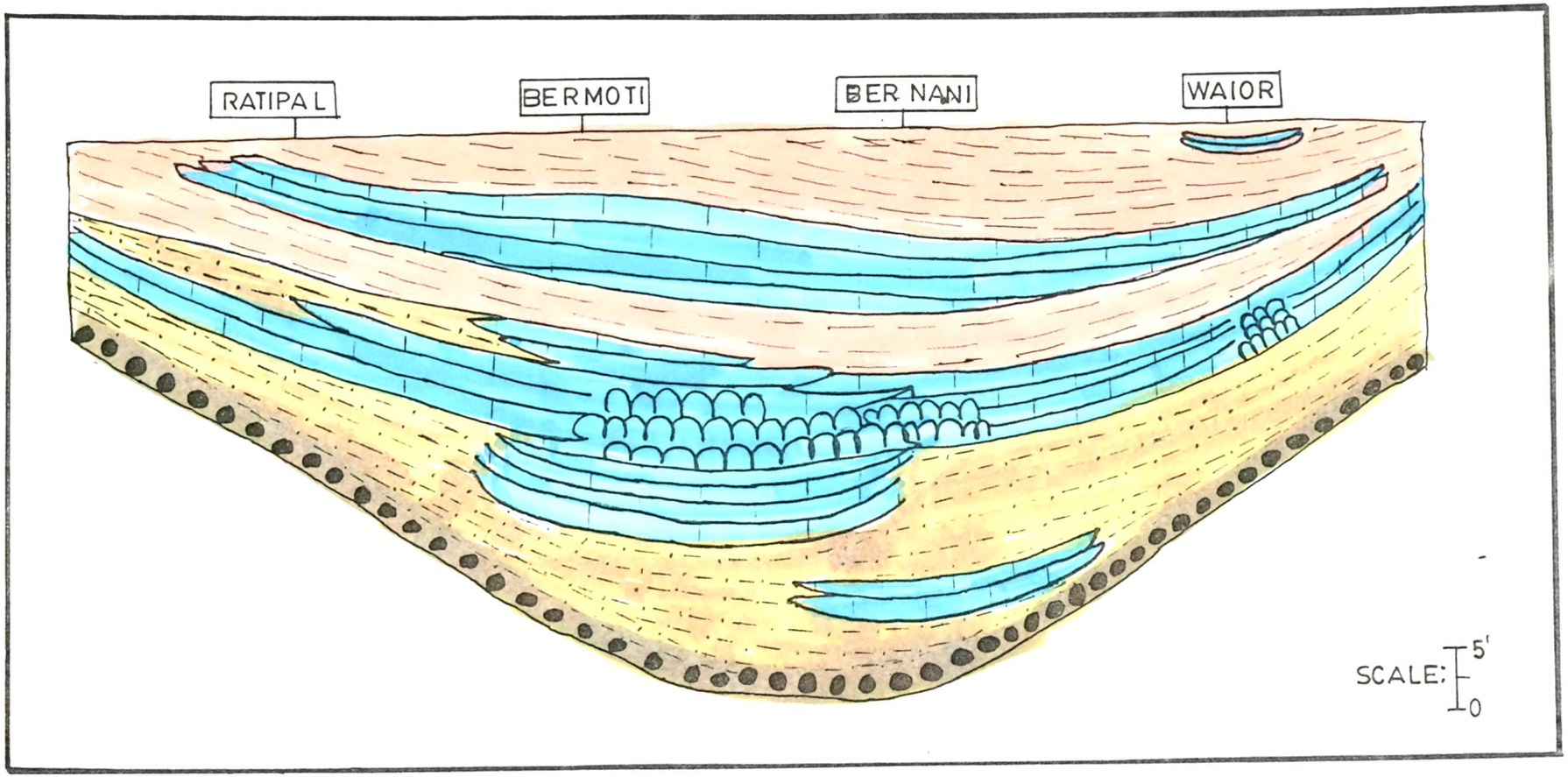


FIG.8·5 GENERALISED STRATIGRAPHIC CROSS SECTION, DATUM - TOP OF LOWER RAMANIA STAGE

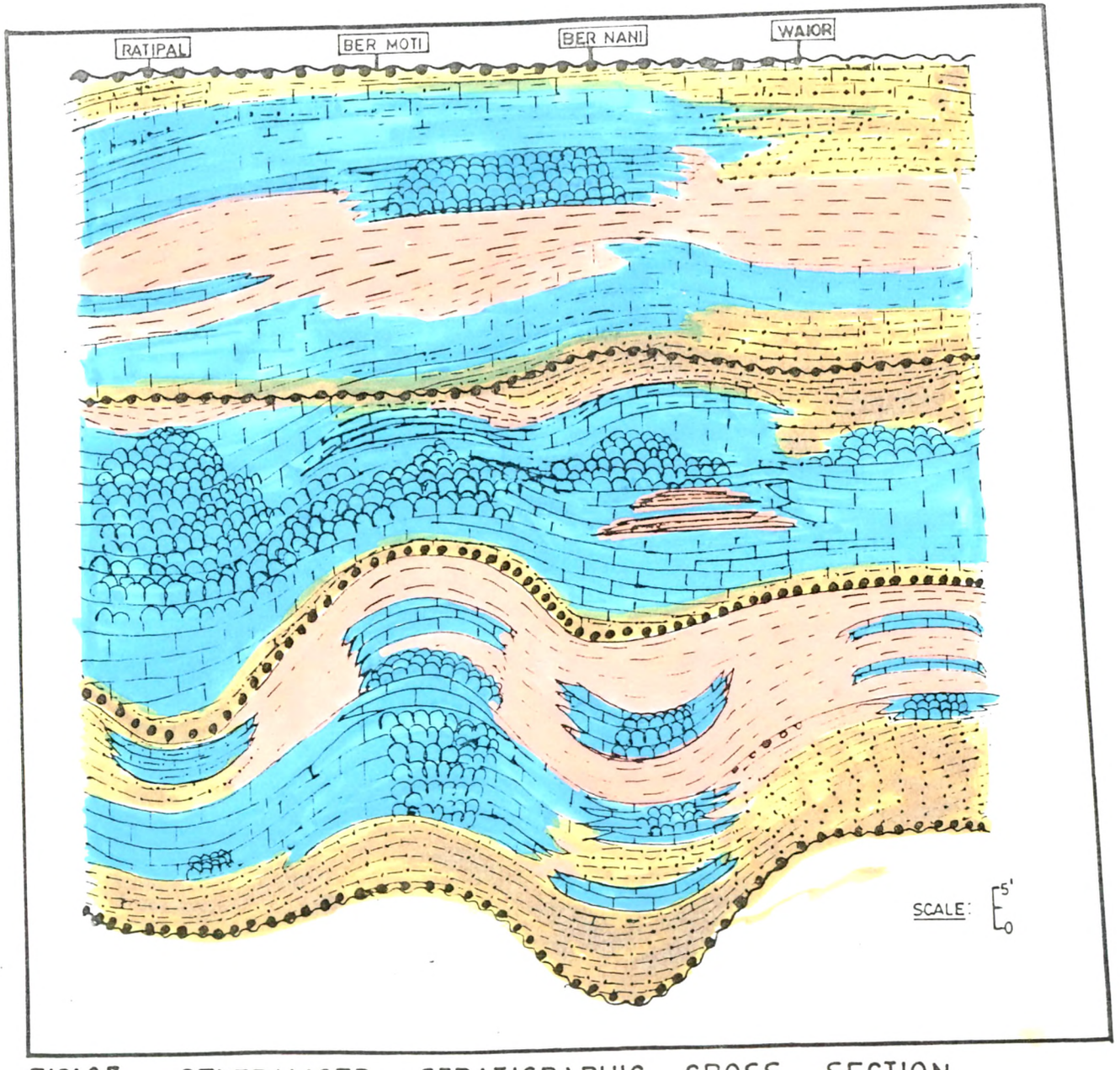


FIG: 8·7 GENERALISED STRATIGRAPHIC CROSS SECTION, DATUM – TOP OF WAIOR STAGE

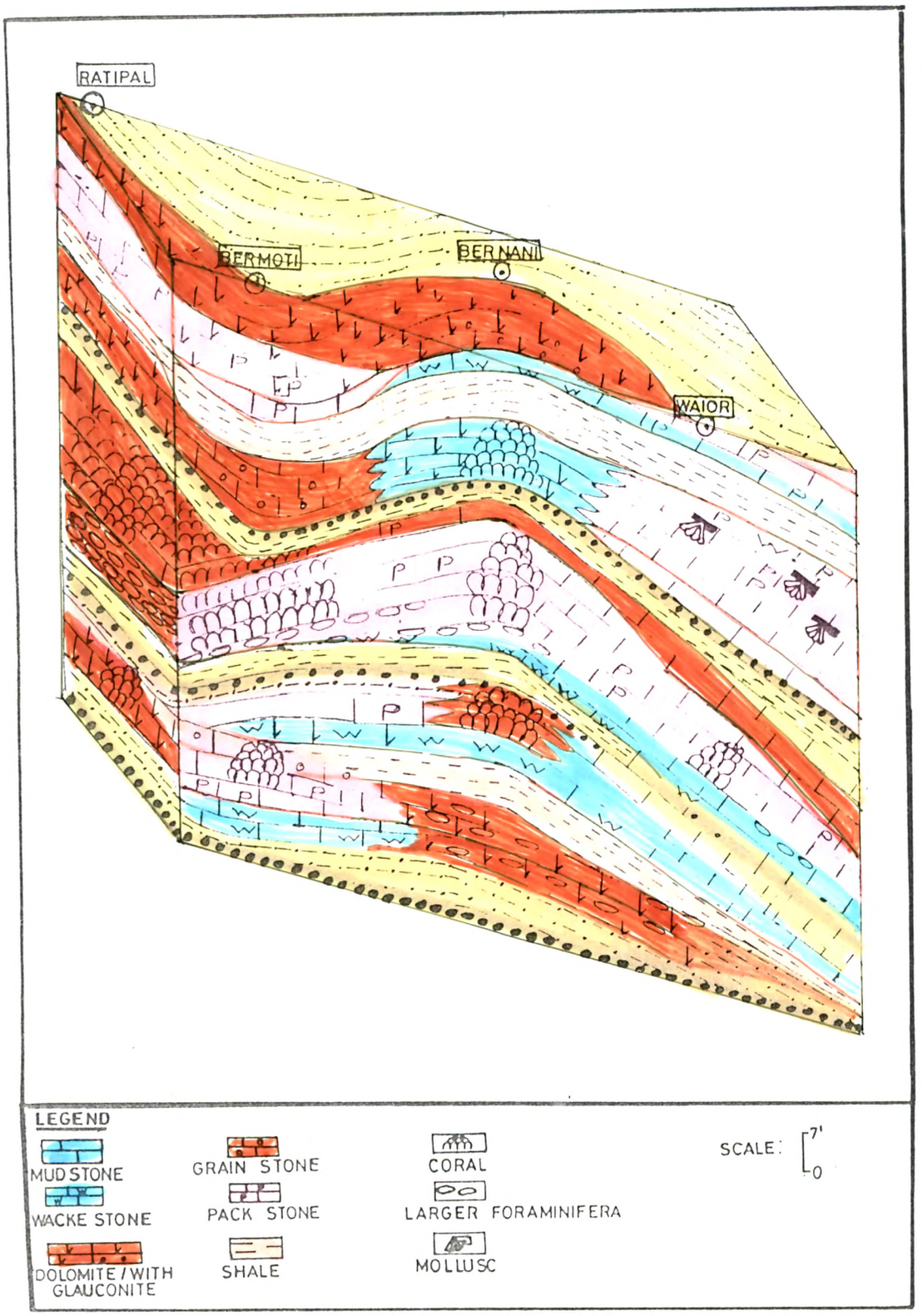


FIG. 8·8 THREE DIMENTIONAL PRESENTATION OF MICROFACIES RELATIONSHIP, DURING MANIYARA FORT FORMATION

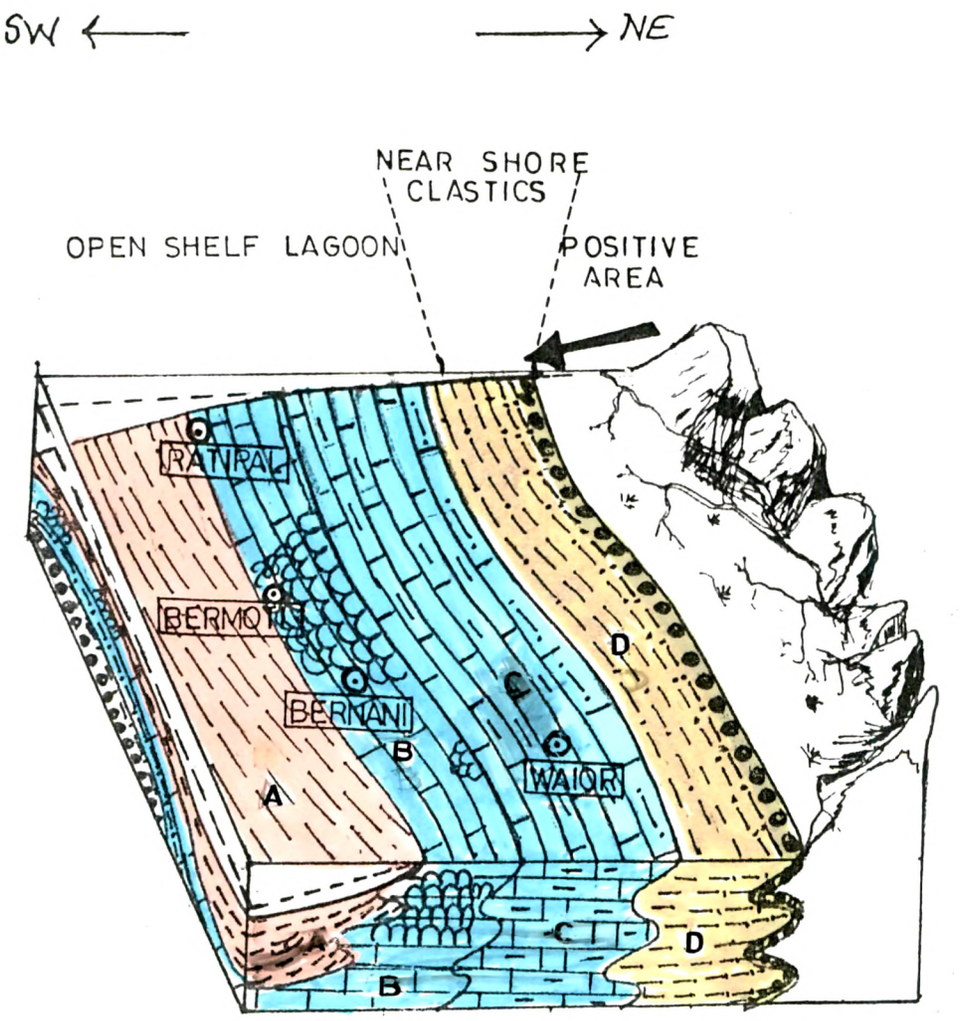
8.5). The deeper, possibly subtidal, depositing conditions around Bernani indicates more argillaceous sequence and relatively poor development of reefal growths. However, further shallowing of the basin resulted in development of better carbonate facies in Bermoti area.

The section at the top of Ramania stage indicates (Figure 8.6) gradual deepening of the basin from Waior to Ratipal with a prominent high around Bermoti. This has obviously resulted in generation of a high energy intertidal zone around Bermoti, in turn, giving rise to good biohermal growths. The gradual reduction of clastic sequence from Waior to Ratipal, ie. from SE to NW, is observed. The prominent high around Bermoti was subdued during the deposition of Waior sediments (Figure 8.7). However, the area around Bernani experienced a minor mound in relation to neighbouring areas. This phenomenon has generated relatively moderate energy carbonate facies around Bernani. The gradual reduction in clastic sequence is observed from Waior to Ratipal. The basin paleoslope, however, remained towards west showing gradual thickening from Waior to Ratipal.

Figure 8.8 represents block diagram, taking a top of Bermoti, series as a horizontal plane, depicts detailed microfacies in three dimension.

8.3. PALEOGEOGRAPHIC SETTING AND SEDIMENTATION

Generalised block diagrams indicating land and sea



A — LUMPY CLAY– LOW ENERGY

B — CORRALINE LIMESTONE– HIGH ENERGY

C — ARGILLACEOUS LIMESTONE– LOW ENERGY

D — GLAUCONITIC SILTSTONE BAND– MODERATE ENERGY

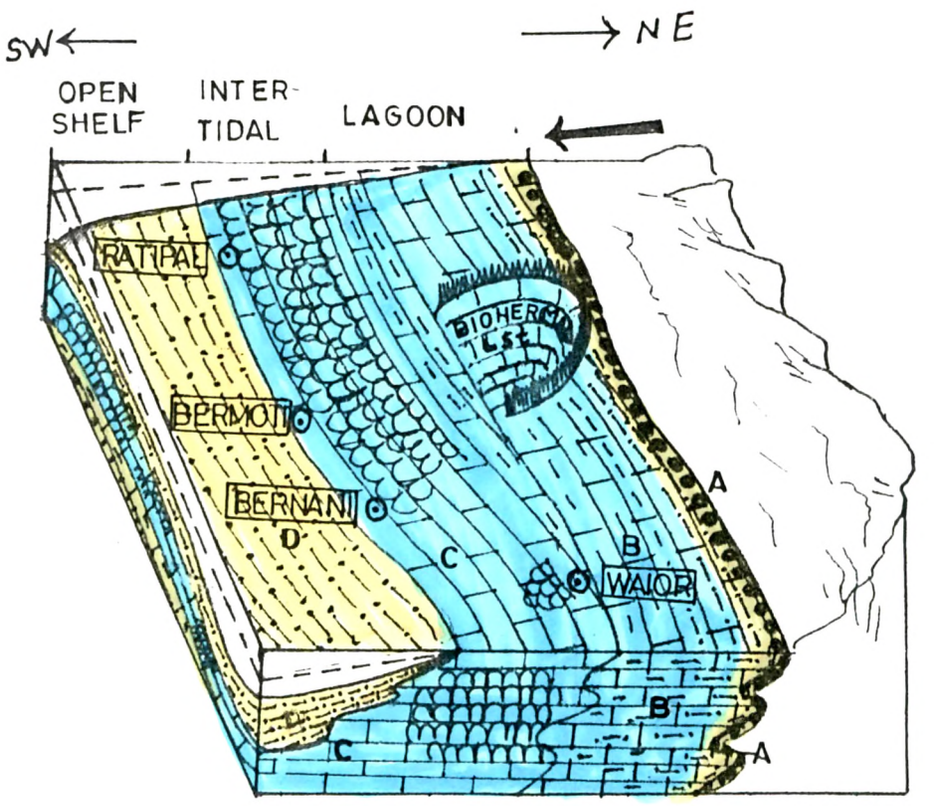
FIG. 8·9 THREE DIMENSIONAL SEDIMENTATION MODEL, LOWER RAMANIA STAGE

distributions, as well as, various parts of the marine setting in relation to facies have been prepared, viz. lower Ramania, upper Ramania and Waior stages . Similar methodology of depicting paleogeograpy and sedimentation have been adopted by several workers including Turner, et. al. (1981), Kocurek (1981), Hiller et. al. (1984), Carbone, et. al. (1986), etc.

8.3.1. Lower Ramania stage

As mentioned earlier, (Chapter 1) the main tectonic episode in Kutch basin took place in upper Cretaceous times and most of the uplifts including high hills of Deccan Trap already existed at the commencement of Oligocene sedimentation. Oligocene sea in the area, was necessarily shallow and could transgress only the peripheral, low lying areas encircling Deccan Trap hills. The main Deccan Trap mass occurs northeast of the present area. The preceding Eocene sedimentation also took place under similar conditions. The Oligocene sea possibly transgressed partly over the Eocene strata. The area in the northeast, thus, remained a positive one (Figure 8.9).

The Deccan Trap provenance being hard and fine grained, could supply only minor clay and silt as detritus to the nearby depositing area. The general, clastic supply was also very poor because of the very hard and dense nature of the Deccan Trap. This situation favoured generation of carbonate sedimentation. A thin linear belt of nearshore clastics occurs close to the strand line. The open shelf lagoon to the south west of this was the site of



D — SILTSTONE– LOW ENERGY
C — CORALLINE REEFAL LIME STONE–HIGH ENERGY
B — SILTY ARGILLACEOUS LIMESTONE–MODERATE ENERGY
A — FERRUGINOUS GLAUCONITIC PELOIDAL BAND–MODERATE ENERGY

FIG. 8·10 THREE DIMENSIONAL SEDIMENTATION MODEL, UPPER RAMANIA STAGE

partly carbonate and partly finer clastic deposition. The finer detritus was obviously brought in the suspension from the nearby Deccan Trap provenance.

8.3.2. Upper Ramania stage

The strand line appears to have shifted slightly southwest as compared to lower Ramania time (Figure 8.10). A linear high existed possibly east of Ratipal and Bermoti giving rise to high energy, intertidal environments, in turn resulting in development of coralline reefs. Further southeast, towards Bernani and Waior, the effect of this high was possibly greatly reduced. Subtidal open shelf conditions prevailed west and southwest of this high. Mixed carbonate and shale facies developed in the subtidal zone.

8.3.3 Waior Stage

The strandline shifted further southwest, during Waior sedimentation (Figure 8.11). The prominent high which existed during upper Ramania also ceased. Thus excepting a minor siltstone deposits near the shoreline, most of the area was the site of low energy, shallow, open shelf sedimentation resulting in both carbonate and shale facies. A local shoaling conditions around Bermoti and Bernani possibly gave rise to moderate energy conditions in turn resulting in development of patchy coral reef. The area around Waior was a site of tidal flat deposition characterised by high content of ichnofossils.

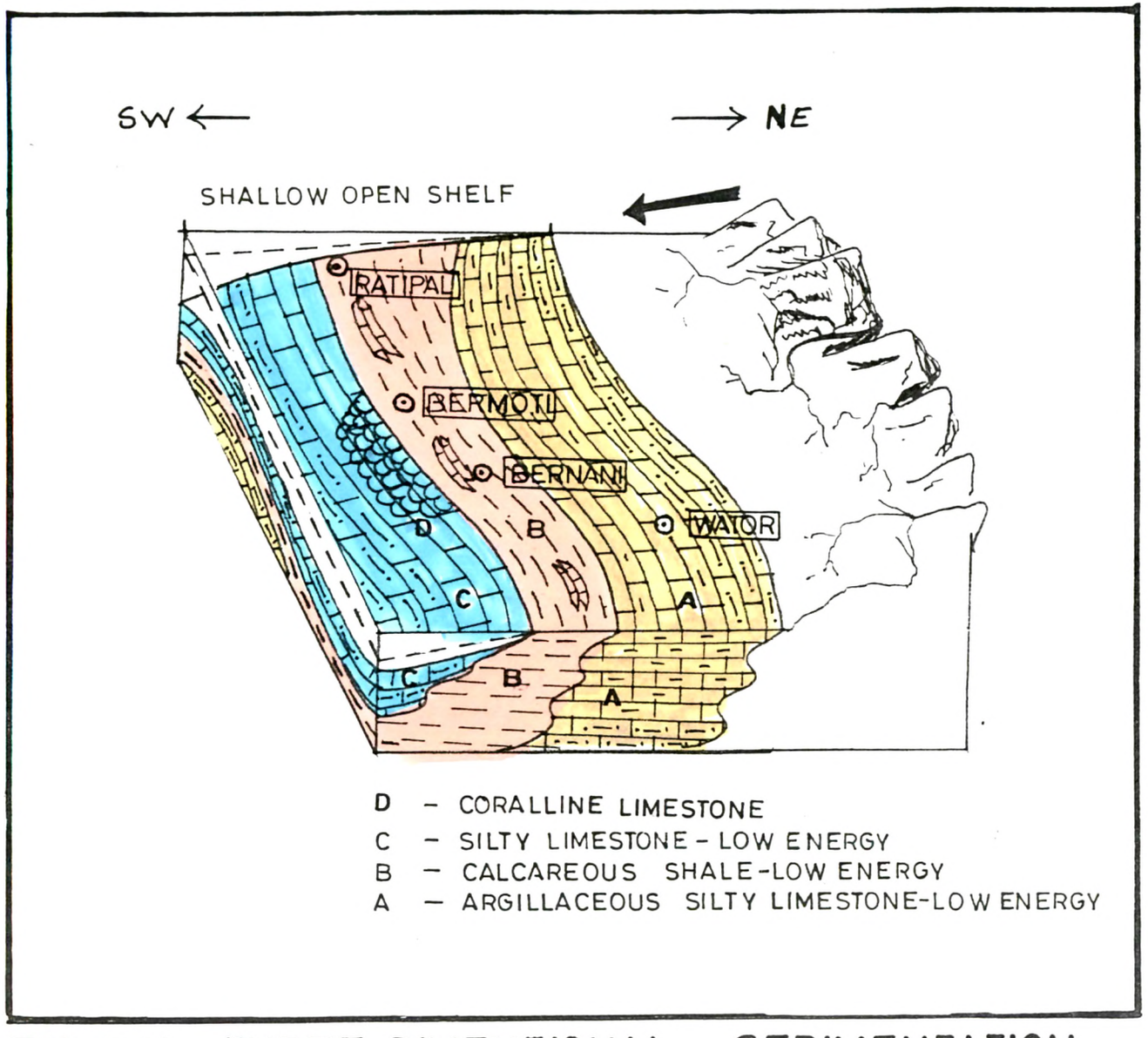


FIG. 8·11 THREE DIMENTIONAL SEDIMENTATION MODEL, WAIOR STAGE

Comparing the three figures, there is a definite shift of the strandline from northeast to southwest. Intermittant and localised development of high energy facies took place particularly during upper Ramania deposition. The development of minor undulations in Oligocene time and changes in the bathymetric positions coupled with episodic supply of finer clastic gave rise to carbonate and shale alternations.