Chapter 5

Conclusions and Discussions

5.1 Conclusions

Seismic data are useful to shallow sea exploration for deposits of heavy minerals, gemstones and construction aggregates. The shallow sea survey activities commonly deal with the investigation of the Quaternary sequences underlying the shelf areas. Although Quaternary sequences on continental shelves are among the most complex and variable environment accumulation in the world, seismic interpretation could well assist in sedimentary sequence analysis.

The principle of seismic stratigraphy are applied to study the Quaternary strata underlying the eastern offshore areas of the Gulf of Thailand. Geological concepts of depositional environments, lithofacies, sedimentary features and processes, and history of sealevel changes are interrelative subjects contributing to seismic stratigraphic analysis of the Quaternary sequences in the study area. With an application of seismic stratigraphic concept in conjunction with the analysis of sealevel change history in Quaternary period, the Quaternary sequences of the study area in the northeast of the Gulf of Thailand (Area 1) can be regionally categorized into 3 major sequences, as follows.

The lowermost sequence A : It was deposited on weathered bedrock/regolith and parts of old piedmont fans along the coast. The sequence was probably deposited from early Pleistocene to middle Pleistocene. It comprises numerous depositional facies, *i.e.* regolith, piedmont fans and estuarine deposits. On seismic profiles, the sequence generally shows a few channel cut and fill, drape parallel and some chaotic patterns. Environments of deposition are mainly the combination of fluvial/drainage system and estuarine deposits. It is interpreted to be deposited in the transitional zone of terrestrial and estuarine. However, the sequence is dominated by terrestrial environment. The sequence A usually disappears at topographic highs of bedrocks in the east of the area (sub-areas 1-C and 1-E).

The middle sequence B : It is overlying the sequence A, and old piedmont fans or weathered bedrocks near the coast. Its dominant characteristic is a channel cut and fill feature associated with chaotic, parallel, sub-parallel and acoustically transparent patterns. It was probably deposited from late middle Pleistocene to late Pleistocene. In between this period, the sealevel curve models exhibit numerous sealevel fluctuations in the Quaternary. Depositional and erosional events during this period are so complicated to be interpreted individually. This sequence also comprises numerous depositional settings. The middle sequence B is interpreted to be deposited in the transitional zone of terrestrial and estuarine environment when sealevel fluctuations maintained at range from -10 to -80 m relative to the present sealevel.

The uppermost sequence C : The sequence is interpreted to be deposited during late Pleistocene to Holocene. It consists of two subsequences, including a) the lower subsequence LC (early Holocene) and the uppermost subsequence UC (late Holocene). The lower subsequence is interpreted as a dominant estuarine setting, exhibiting chaotic pattern with moderate to weak parallel and subparallel reflections and locally acoustically opaque zone. The uppermost sequence UC is recently deposited, comprising marine mud and sandy mud. It exhibits acoustically transparent pattern with relatively weak to strong parallel reflectors.

The boundaries between sequences are generally identified by regional erosional truncation and partly correlative conformity. The two major unconformities "A" and "B" are identified on the upper surface of sequence A and B, and believed to be developed in late Pleistocene glaciation (*c.* 120,000 years BP.) and last glaciation (*c.* 17,000 years BP.) respectively. At lowstands, upper surfaces of sequences would have substantially experienced subareal exposure and soil erosion would have been developed across the surfaces. The subareal exposed surfaces were preserved as unconformity surfaces "A" and "B" over the study area. On the seismic profiles, they extensively show relatively high reflection amplitudes and relatively moderate to high continuity. The unconformity surface B was interpreted as a hard ground which was exposed to subareal and altered to be lateritic soil with hard surface. It was proved by results of drilling that the upper part of sequence B contains iron oxide and siderite nodules.

Lithofacies concept is most useful in exploration for detrital minerals, because economic heavy minerals, gemstone and aggregates are chiefly concentrated in specific lithofacies or associated lithofacies. Eventually, an attempt to be made for detrital mineral exploration is able to focus on the most prospective area by reconstructing past geological environments and locating the lithofacies of interest. Lithofacies can be indirectly inferred from seismic facies analysis. The most interesting lithofacies in the study area are fluvial channel deposits in the sequence B in which it exhibits chaotic pattern, partly associated with subparallel reflections and obliquely dipping fills. The thickness of the observed chaotic pattern generally ranges from 4 m to 15 m. Distribution of the chaotic seismic facies is likely inferred favorable targets for deposition of heavy minerals and aggregates in the study area.

In this study, the application of seismic stratigraphic concepts for re-interpretation of shallow seismic profiles together with correlation to drilling results has provided more accurate geological information, *e.g.* sedimentary structure and sequences, depositional system, and buried geological interests. The revision of geological analyses, based on information of depositional system, stratigraphic sequences, lithofacies models and chronostratigraphic correlation can provide possible geological models of the study area. Moreover, the results of the study can contribute to the search for favorable locations of economic placers and aggregates in the study area.

5.2 Discussions

The seismic stratigraphic concept has largely contributed to the study of Quaternary sequences in the study area since the area is situated in the coastal zone and inner shelf where it preserved the very complicated records of deposition and erosion. Major regional unconformities can be identified the on the seismic profiles. Where most Quaternary shelf sequences have limited number of absolute dating data available, age can, be presumably assigned to the underlying sequences based on a knowledge of regional and global unconformities related to the major lowstands during those periods.

The difficulty is that the minor fluctuation in the eustatic sealevel may produce local unconformities within the Quaternary strata. These may be confused with the major cycles of sealevel change. The potential of preservation of the Quaternary sequences on the continental shelf depends upon sediment supply and tectonic subsidence. The Quaternary sequences underlying the study area are believed to be greatly influenced only by eustatic sealevel changes since the Gulf of Thailand is mostly stable during the Quaternary. The complexity of more regional extensive sequence boundaries may be difficult to be used for a local scale. This study cannot correlatively provide more accurate age of sequences due to a lack of dating data and palynological analyses. The accurate ages of the sequences in the study area are still not known. However, seismic stratigraphic interpretation in conjunction with the study of Quaternary sealevel curve models can much assist to evaluate ages of Quaternary sequences correlatively.

Determination of ages of the sequences was based only on the correlation of events from Quaternary sealevel curve models to geological records of the sequences, *i.e.* unconformities, lithofacies, depositional environments, erosional and depositional events, sedimentary structures *etc.*, which were obtained from interpretation of seismic profiles and study of drilling results. Hence, the evaluated ages of the Quaternary sequences in the study area may be all incorrect. It would be suggested that to obtain reliable results of stratigraphic analysis, dating of peat samples and palynological analyses should be carried out to obtain more accurate age correlation of sequences, and related time of unconformities occurring at two major lowstands during glaciation stadials.

Where the primary source rocks are available, to determine the locations for deposits of aggregates (in sub-areas 1-A and 1-C), and sapphire and ruby (in Area 1-E), mapping of seismic facies related to known lithofacies favorable for such deposits in the study area should be carried out in details. It should be restricted to relatively high energy of depositional environments which their seismic facies seen on seismic profiles are chaotic pattern, channel fill with prograded obliques, a series of oblique divergent seaward dipping and mounded deposit like dune (drowned barriers) with low continuity of internal reflectors. Mapping of such seismic facies may facilitate to determine more prospective locations in the study area and the known lithofacies favorable to the deposits may be applied to the other areas around the Gulf and this region.

Limitation for the interpretation of high resolution seismic profiles in this study depends on the seismic data quality. The difficulty is that the seabed multiples and noisy records mask the deeper part of the seismic sections. If digital seismic data acquisition and processing techniques are available, multiple reflections mask can, therefore, be removed and data quality may be satisfactorily improved. Subsequently, more accurate interpretation can be accomplished.

Conducting digital seismic survey for shallow sea mineral exploration may not be a cost-effective program since digital seismic system is very costly and the analogue recording technique can still provide appropriately readable information when all operational settings can be optimized. So, digital seismic system is not conventionally employed in shallow sea mineral exploration programs. But in unsuitable survey conditions and parameter settings, analogue seismic system always generates less fair to poor quality seismic records from time to time. If survey programs cannot afford digital seismic system, less fair to poor quality analogue seismic records will still be troublesome to more accurate seismic interpretation, as faced in this study.