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Seismic Velocity, Stratigraphy and Acoustic Study of the South China Sea

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LONG-TERM GOAL

Our long term goal is to understand the tectonic processes that govern the formation of rifted passive margins, in particular the role of upper crustal faulting versus lower crustal flow. In addition we hope to understand what governs the accumulation of sediment on the shelf and upper slope and specifically in the case of the South China Sea how this is related to growth and erosion of the Himalayas and Tibet.

OBJECTIVES

We wish to establish the nature of the stratigraphy on the South China Shelf and upper slope through interpretation of multichannel seismic lines and tie in age information from existign petreolume exploration wells. Most importantly we have mapped the structure of the basement and sedimentary cover in three dimensions using the stacking velocities derived from released MCS profiles, which have been used to map the depth to crucial velocity intervals over the width of the shelf. This data was then merged with the existing data set of Dennis Hayes to provide a comprehensive survey of the region.

APPROACH

We retyped the velocity information available on released oil industry multichannel seismic profiles and recalculated the intervals velocities and the depths to natural breaks in the velocity structure of the shelf. The data was entered in to a UNIX database system and after interpolatign between the control point using a routine written for MATLAB the GMT program was used to plot maps contouring different velocity increases. Although any velocity contour can be plotted we chose to concentrate on those that formed natural breaks in the velocity structure, following the example of Dennis Hayes earlier OBS and sonobuoy work.
In order to under the dynamic evolution of the Pearl River Mouth Basin and associated slope the lithology and age information from petroleum wells was entered in a computer and subsidence analysis performed in one dimension at each sites, as well as in two dimensions along interpreted seismic lines.

WORK COMPLETED

The stated project is now fully complete. The compiled data is now delivered together with a hard copy report to the Naval Oceanographic Office. Velocity maps have been created and included with the report. A scientific paper (Clift and Lin, in review) on the subject of the basin extension and the partitioning of strain during continental break-up has been completed.

RESULTS

The South China Sea, formed by seafloor spreading in the Late Oligocene at ~30 Ma, is bounded to the north by the South China Shelf and to the south by the Palawan margin. In this study we documented the timing, distribution, and amount of extension in the lower and upper crust, as well as the mantle lithosphere, on the China shelf during the rifting process. Applying a one-dimensional backstripping modeling technique to industry well data from the Pearl River Basin, Beibu Gulf and other areas in the South China shelf, we calculated subsidence rates of the wells and examined the timing and amount of extension. The subsidence results for regions east of Hainan Island suggest relatively high rates of post-rift thermal subsidence, implying higher degrees of mantle lithospheric than crustal extension, as measured by the amounts of syn-rift subsidence. In the Beibu Gulf, west of Hainan Island, however, extension of crust and mantle appears to be similar in magnitude. We also applied a two-dimensional flexural modeling technique to model crustal extension along four interpreted multichannel seismic profiles across the South China Shelf east of Hainan Island. The results show that the predicted post-rift subsidence due to upper crustal normal faulting and assumed uniform mantle extension alone is insufficient to explain the observed subsidence especially in the outer rise area. Thus, substantial extension in the lower crust, that must exceed that in the upper crust and possibly the mantle lithosphere, is required to explain the degree of subsidence experienced. These results are compatible with a model in which the South China Shelf east of Hainan Island forms the upper plate of a simple shear system during continental break-up, where extension of the weak lower crust is greater than in the stronger upper mantle lithosphere.

IMPACT/APPLICATION

The work has implications for our understanding of continental break-up and suggests follow-up studies, especially on the southern margin of the basin, i.e., offshore Palawan to test models of deformation using conjugate margin data sets. Specifically it raises questions about the applicability of simple shear models to passive margin studies.

RELATED PROJECTS

Seismic stratigraphy and sedimentary history of the Indus Fan. Preparation for ODP drilling on the fan to document erosion history of Southern Asia.

REFERENCES

PUBLICATIONS

Clift, P.D., and Lin, J., Variations in Extensional Deformation with Depth during Continental Break-Up in the South China Sea, *Journal of Geophysical Research*, in review.

Clift, P.D., and Lin, J., 1998. Timing and Distribution of Extension Prior to Seafloor Spreading on the South China Margin, *EOS*, Transactions of Spring meeting.