行政院國家科學委員會專題研究計畫　成果報告

子計畫四：三維模組反算聲速分布之模式建立(2/2)

計畫類別： 整合型計畫
計畫編號： NSC92-2611-E-002-006-CCS
執行期間： 92 年 08 月 01 日至 93 年 07 月 31 日
執行單位： 國立臺灣大學工程科學及海洋工程學系暨研究所

計畫主持人： 陳琪芳

計畫參與人員： 林穎聰、謝力文

報告類型： 完整報告
報告附件： 出席國際會議研究心得報告及發表論文
處理方式： 本計畫為 A2 級列管案件，97 年 12 月 31 日後可公開查詢

中　華　民　國 93 年 12 月 2 日

行政院國家科學委員會專題研究計畫 成果報告

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UAL-NTU TR 0405
中 華 民 國 93 年 11 月 8 日

行政院國家科學委員會專題研究計畫成果報告

子計畫四：三維模組反算聲速分布之模式建立(2/2)

Acoustic Inversions from an Explosive Source in the ASIAEX-SCS Experiment

UAL-NTU TR 0405

計畫編號：NSC 92－2611－E－002－006－CCS

執行期限：92 年 08 月 01 日 至 93 年 07 月 31 日

執行單位：國立臺灣大學工程科學及海洋工程學系暨研究所

主持人：陳琪芳 教授

計畫參與人員：林穎聰、謝力文

Abstract

Acoustic inversions using an explosive source are presented for the South China Sea component of the Asian Seas International Acoustics Experiment (ASIAEX-SCS). These include source localization and geoacoustic inversion for the sound speed in a bottom model, and an equivalent transform method for evaluating the effect of watercolumn mismatch on geoacoustic inversion. In the source localization, horizontal beamforming is adopted to obtain source bearing; the pulse arrival time in frequency range of 50Hz–150Hz is used for source ranging. To perform the bottom model estimation, a broadband geoacoustic inversion is performed by using the two most dominant points, the Airy phase and modal cutoff frequency, in low-frequency group velocity measurement and also matching other low-frequency data points (< 50Hz). As regards the equivalent transform method, it is derived from perturbative inverse formulations and is illustrated with two test cases, in which linear and nonlinear internal waves are considered as the cause of the watercolumn mismatch, respectively. In conclusion, a range-dependent multilayer model of the bottom compressional wave speed is obtained, and error estimates for this model are shown. The effect of watercolumn mismatch is introduced as well.

Keywords: Inversion, Localization, Internal wave, ASIAEX, Equivalent transform method

1. Asia Seas International Acoustic EXperiment, ASIAEX

The Asian Seas International Acoustics Experiment (ASIAEX) was one of the most successful and largest oceanographic collaborations in the Asian marine region. The major experiments of ASIAEX, which included physical oceanography, geology and geophysics and acoustics components, were conducted from April to August in 2001. The main scientific goal was to study the shallow-water acoustics. There were two main experiments in ASIAEX. One was the bottom interaction experiment in the East China Sea (ECS), and the other was the volume interaction experiment in the South China Sea (SCS), which this dissertation will focus on and which is abbreviated as the "ASIAEX- SCS" experiment.

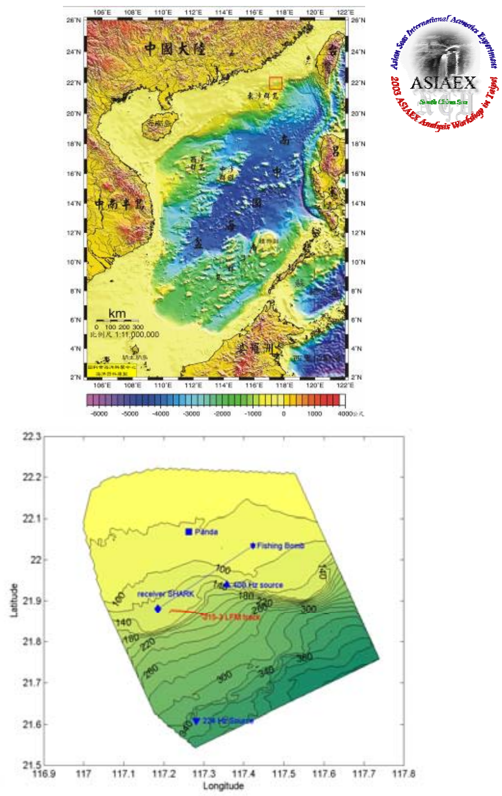

Fig. 1 Schematic showing the experiment site.

2. Acoustic Inversion (I): Source Localization of the Explosive Signal

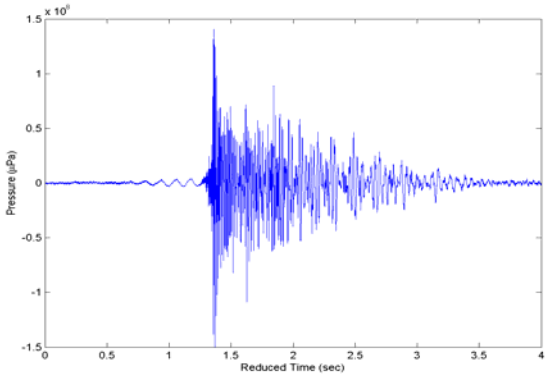

Fig. 2 Explosive "source of opportunity" signal

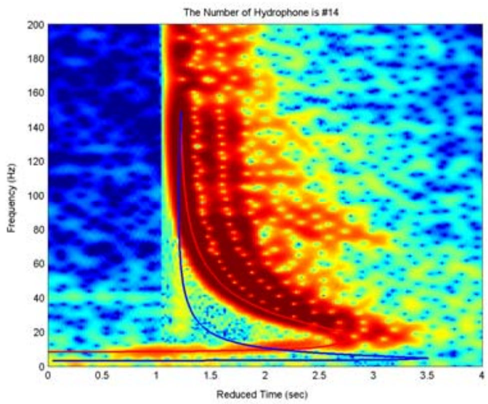

Fig. 3 Spectrogram of the source of opportunity explosion

2.1. HLA Beamforming

The result of HLA beamforming on the explosion signal shows the direction to be 55 degrees relative to north.

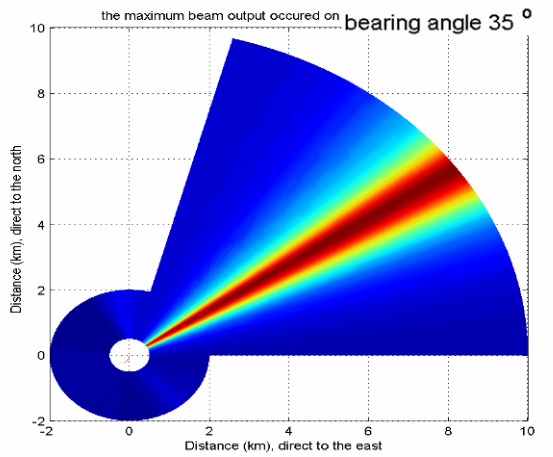

Fig. 4 HLA beamforming results

2.2. Source Range

The source range inverted from the adiabatic modal arrival, which is 29.3km and σ_R=0.852km, agrees with the measurement.

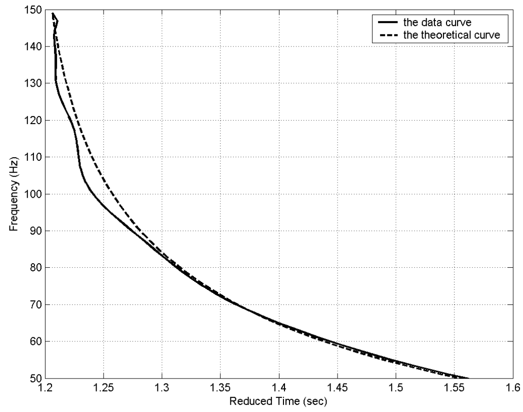

Fig. 5 Inverted source range.

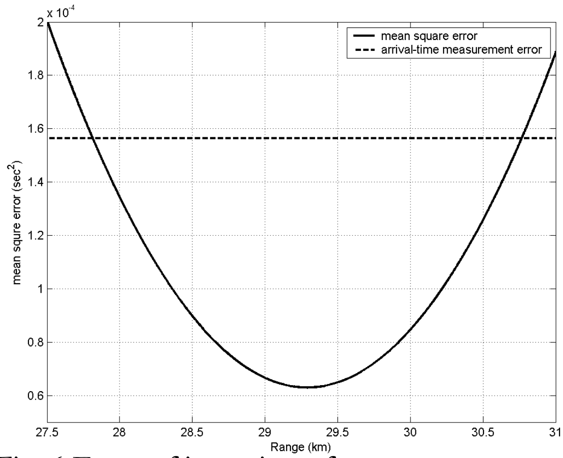

Fig. 6 Error of inversion of source range

3. Acoustic Inversion (II): Perturbative Inversion for Bottom Model from the Explosive Signal

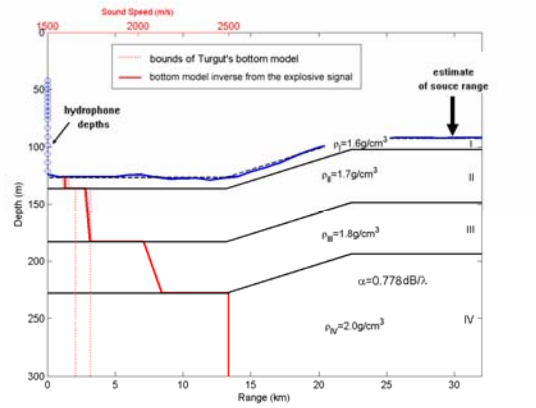

Fig. 7 The resolved range-averaged bottom model

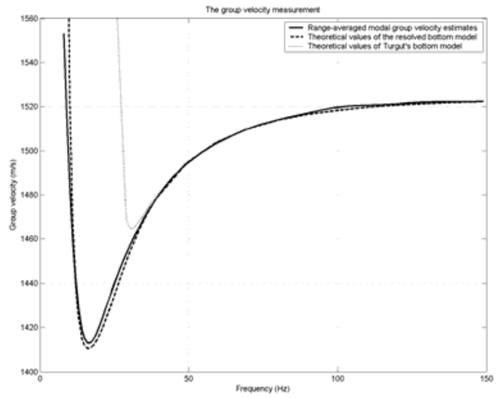

Fig. 8 Comparison between the theoretical modal group velocities of second mode in the resolved bottom model with data.

4. Effects of Watercolumn Mismatch on the Geoacoustic Inversion

Linear Internal Waves | Nonlinear Internal Waves

Scenario of Internal Waves

Range-Dependent Inversion Errors

Range-Averaged Inversion Errors

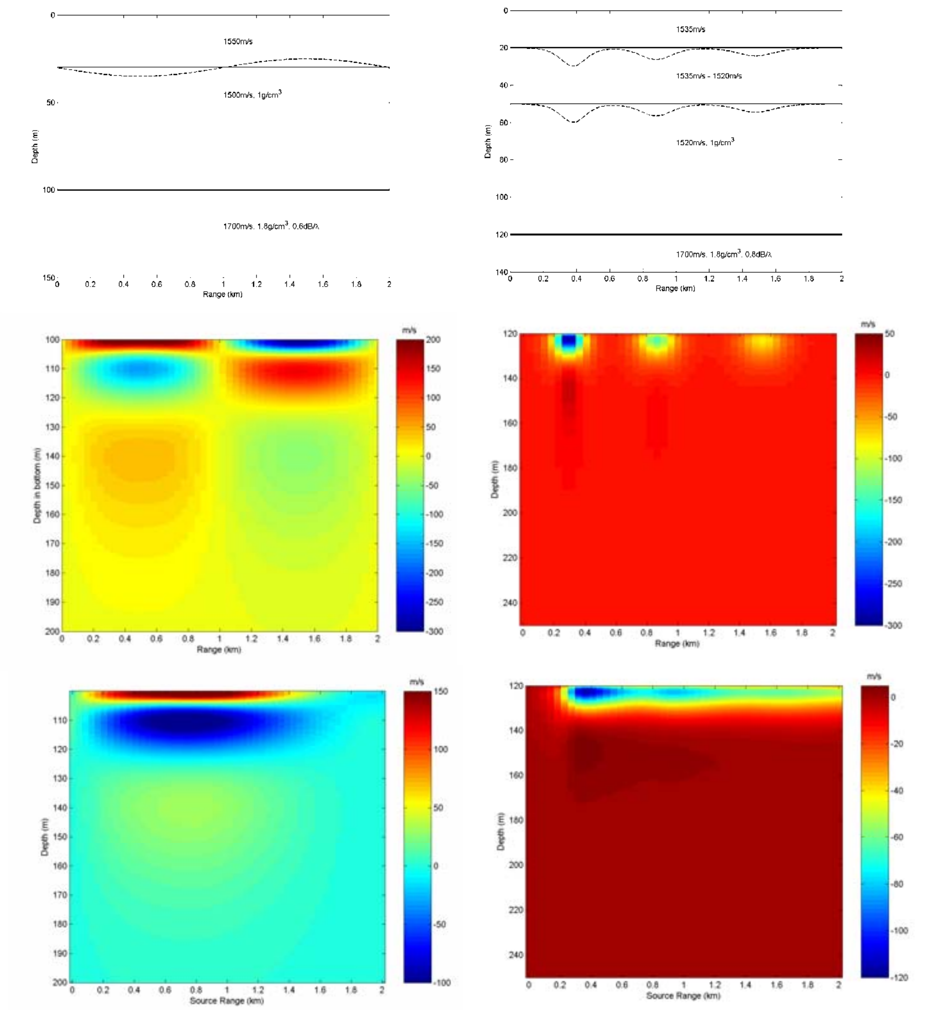

Fig. 9 Comparisons of inversions from Linear and Nonlinear internal waves.

5. Conclusions

The significant contributions this dissertation has supplied to the underwater acoustic research community are as follows:

A. A reliable range-averaged bottom model for the shelf area in the ASIAEX- SCS experiment site is presented, which provides deeper effective depth than the *a priori* model obtained from the chirp sonar and the towed source.

B. This dissertation has clearly demonstrated the usefulness of waveguide dispersion physics to locate a distant broadband source in shallow water by using only single hydrophone data.

C. The dominant role of the modal Airy phase and the modal cutoff frequency in geoacoustic inversion is revealed. Using these allows one to better describe the sub-bottom layering structure and to ascertain a "basement" sound speed. In addition, linear perturbation formulations for both are derived, which enhances the power of linear perturbative inversion schemes.

D. The equivalent transform method is first presented to evaluate the effect of watercolumn mismatch on geoacoustic inversion results. It can be applied to the study of geoacoustic inversion uncertainty due to any type of ocean fluctuations.