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Near-surface velocity structure study using surface waves and first breaks in the middle segment of the Bangong-Nujiang suture zone, Tibetan Plateau

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Outline



- > 1. Introduction
- 2. Model data
 - 1) Forward modeling with an irregular topography
 - 2) F-K spectrums stack in common receiver domain
 - 3) Fundamental and higher mode surface wave inversion
- > 3. Field data example nearby Bangong-Nujiang suture zone, Tibetan Plateau

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Introduction

This study makes full use of surface waves and first breaks to obtain near-surface P- and S-wave velocities based on a 2D deep seismic reflection survey data which was acquired by SinoProbe project in 2009. We adopt the method of superposition of surface waves in common receiver domain to generate high quality F-K spectrum which enables us to obtain fundamental-order and high-order dispersion curves.

Forward modeling with an irregular topography



A 2D layered model with an irregular topography was built and the 2D elastic finite difference modeling was executed to generate 161 synthetic seismic shot gathers which mimicking the actual acquisition geometry. These gathers contain surface waves, refractions, reflections and multiples energy, and the maximum offset is about 18 km.

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F-K spectrums stack in common receiver domain



the F-K spectrum quality has been improved for each receiver station using superposition of surface waves in the F-K domain by adding more shots.

F-K spectrums at irregular topography location A (a): using one shot of 625m offset with A; (b): using one shot of 1625m offset with A; (c): using one shot of 2625m offset with A; (d):using one shot of 3625m offset with A; (e): using one shot of 4625m offset with A; (f): using one shot of 5625m offset with A; (g):using one shot of 6625m offset with A; (h): using one shot of 7625m offset with A; (i): using one shot of 8625m offset with A; (g): using one shot of 9625m offset with A; (g): using one shot of 9625m offset with A; (g): using one shot of 9625m offset with A;

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Fundamental and higher mode surface wave inversion





The S-wave velocity inverted from dispersion curves showed good agreement with the synthetic model

Left: Picked and Inverted dispersion curves at irregular topography location A

Black: picked fundamental dispersion curve, blue: picked 1stmode dispersion curve, purple: picked 2ndmode dispersion curve. (a): orange line is dispersion curve of initial model; (b): red line is inverted dispersion curves using fundamental mode dispersion curve; (c): cyan line is inverted dispersion curves using fundamental mode dispersion curve; c): green line is inverted dispersion curves using fundamental mode, 1stmode and 2nd mode dispersion curve

Right: Inverted S wave velocity structure at irregular topography location A

gray: S wave velocity structure from Synthetic model as listed in Tab.1. (a): initial S wave velocity structure model; (b): red line is inverted S wave velocity structure using fundamental mode and 1st mode dispersion curve; (c): cyan line is inverted S wave velocity structure using fundamental mode and 1st mode dispersion curve; d): green line is inverted S wave velocity structure fundamental mode, 1st mode and 2nd mode dispersion curve. All rights are reserved.

Field data example nearby Bangong-Nujiang suture zone, Tibetan Plate



F-K spectrums at different receiver locations topography line: black is receiver elevation, red is shot elevation.



Picked and inverted dispersion curves at different receiver locations



Inverted S wave velocity at different receiver locations along deep seismic reflection profile gray: initial S wave velocity model; red: inverted S wave velocity model

High quality F-K spectrum generated from the above method enabled us to pick dispersion curves from the SinoProbe field data. Results show that using higher order dispersion curves can generate a more reliable near-surface model. *All rights are reserved.*

Tomography using First Break Time and Vp, Vs, Results



First breaks were also picked up to 18 km offset and diving wave tomography was applied to derive near-surface P-wave velocity from abundant first break information. There is an excellent correlation between P- and S-wave velocities, the bottom of basin is clearly revealed, and over-thrusts are identified accordingly which is consistent with field geological survey in the middle segment of Bangong-Nujiang suture zone.

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