Using a dense array and HVSR to obtain the shallow structure of the Binchuan Basin

Tianwei Sun[1], Weitao Wang[1], Baoshan Wang[1]

[1]Key Laboratory of Seismic Observation and Geophysical Imaging, Institute of Geophysics, China Earthquake Administration, Beijing, China, damaisuntianwei@sina.cn

The Binchuan Basin is located in the western part of Yunnan Province, China. It is driven by the Chenghai Fault in the "Dianxibei" rift belt which has large number of active faults and high seismicity. The loose sediments of the basin can aggravate the damage of earthquakes by an amplification effect (Tape et al. 2017). The populated Binchuan basin is covered by thick sediments, and seismic hazards are a great concern. Therefore, the detection of the detailed distribution of sedimentary layers is highly necessary.

In order to study the underground structure of the Binchuan area, we deployed a 20x20 km dense array in the Binchuan area that operated from March to May, 2017, with interstation distance of ~2 km, covering the Binchuan and Binju sag of the Binchuan Basin. Based on background noise data collected during the observation, we obtained a peak resonant frequency by the horizons–to-vertical spectral ratio (HVSR) method.

We calculated the HVSR curves for all stations in the array, but only stations located in the Binchuan and Binju sag have significant peak frequencies. The results show that the peak frequency is between 0.1 and 1.5 Hz, revealing a significant impedance interface at the depth of 500-1000 m which we consider to be derived from the strong wave velocity contrast between unconsolidated sediments and bedrock of the basin. Taking 500 m/s as the average S-wave velocity of the shallow sediments, we obtained a sedimentary basement depth shown in Figure 1 by frequency-depth conversion. The sedimentary thickness of the Binchuan sag is ~600 m, and the sedimentary thickness of the Binju sag is ~1000 m, which is consistent with the geological survey results (Tan, 1999). To obtain the detailed basin structure, we selected a profile across the basin (Fig. 2a). The original H/V curves of these stations are shown in Figure 2c. Because there is no significant pick frequency in the gray area where is corresponds to the middle part of the two sags, these curves are not involved in the calculation. Figure 2d is the basin structure image after frequency-depth conversion. It can be seen that there is a two-layer impedance interface in the Binchuann sag area with one depth of ~300 m and the other varies from 300 m to 600 m. The depth of the sedimentary layer in the Binju sag varies drastically from 600 m to 900 m.

This study demonstrates that the combination of the dense array and HVSR methods can obtain a detailed shallow structure of the basin, and the calculation cost is low.

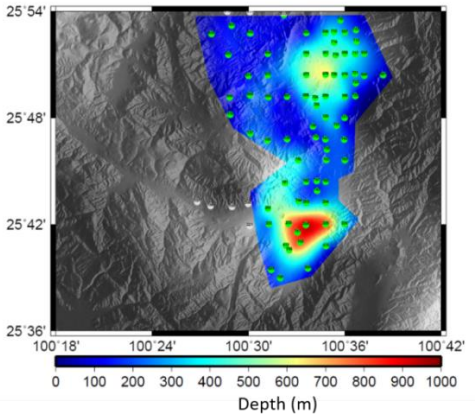

Figure 1. Spatial distribution of sedimentary depth in the basin, green dots are stations participating in the calculation

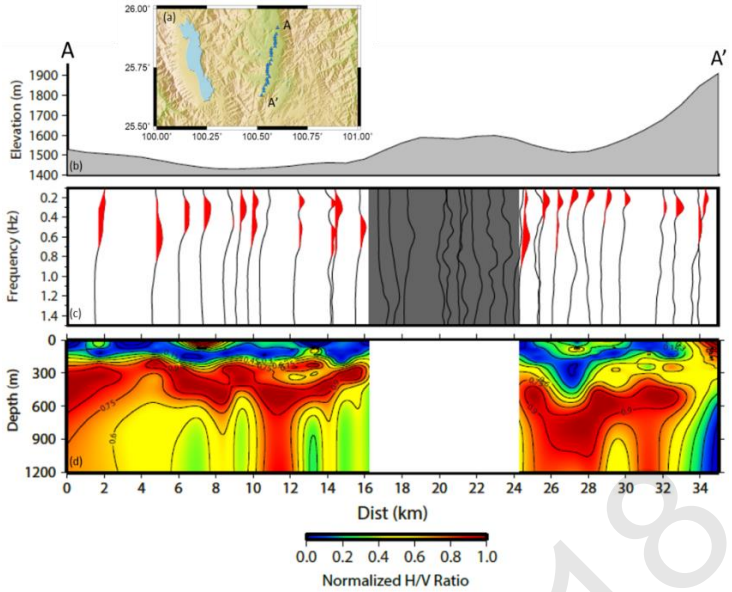

Figure 2. (a) profile AA'; (b) topographic of profile AA'; (c) self-normalized H/V curves of the stations from profile AA', the H/V curves of the stations in the gray area has no obvious peak frequency; (d) structure of the sedimentary layer..

References

C Tape, D Christensen, MM Mooredriskell, J Sweet, K Smithm, 2017, Southern Alaska Lithosphere and Mantle Observation Network (SALMON): a seismic experiment covering the active arc by road, boat, plane, and helicopter, Seismological Research Letters, 88 (4) :1185-1202.

Yuhong Tan, 1999, Characteristics and formation mechanism of the Cenozoic tectonic basin in the Sanjiang area, western Yunnan, Yunnan Geology, 18(2): 112-121.