УДК: 550.34.06

СЕЙСМИЧЕСКАЯ СЪЕМКА С УЗЛАМИ ОКЕАНСКОГО ДНА (OBN): ТЕХНИКА ЗЕРКАЛА

SEISMIC IMAGING WITH OCEAN-BOTTOM NODES (OBN): MIRROR TECHNIQUE

Абделаал Мохамад Эссам Сайед
Abdelaal Mohamad Essam Sayed
г. Санкт-Петербург, Санкт-Петербургский государственный университет
Saint-Petersburg, Saint-Petersburg State University,
mohamad.essam2099@gmail.com

Аннотация: в работе изучается новая методика сейсмической визуализации. В соответствии с ограничениями в традиционных морских сейсморазведочных работах, таких как съемка сложной геологии в глубоководных районах, поиск новых и альтернативных технологий, таких как OBNs (узлы океанического дна), мотивирован.

Abstract: In this paper a new technique in seismic imaging is studied. According to the limitations in conventional marine seismic surveys such as imaging of complicated geology in deep water, a quest for new and alternative technologies such as OBNs (ocean-bottom nodes) motivated.

Ключевые слова: сейсмическая съемка, узлы, зеркальные методы, восходящая волна, нисходящая волна

Key words: Seismic Imaging, nodes, Mirror techniques, up-going wave, down-going wave

The ocean bottom is a much quieter environment than the surface. The surface is subject to weather, waves and swells. These noises contaminate the seismic data and can be particularly problematic for deep reflections.

In recent years a new generation of OBS equipment has become available, and a growing number of surveys are being acquired in deep water using OBS techniques.

There are two main methods used to acquire ocean bottom seismic, cable based and node based systems. Cable based systems were the first to gain popularity, and in the early days these were simply waterproofed land systems and had limited deep water viability. Nodes can be split into two further categories. The first are autonomous and un-connected. These are the type used commonly in deep water exploration. [2]

The wavefield recorded by hydrophones, P, and vertical component geophones, Z, can be decomposed into up-going and down-going components: U and D.

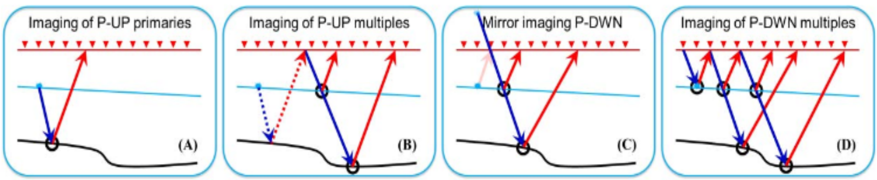

Figure 1 Schematic ray diagrams for imaging using OBS data: (A) imaging of primaries using P-UP wavefield; (B) imaging of multiples using P-UP wavefield; (C) mirror imaging using P-DWN wavefield; (D) imaging of multiples using P-DWN wavefield. The blue arrows are source wavefield and red arrows are receiver wavefield. Black circles are imaging points.

High-quality data from the sea floor can be acquired with ocean-bottom node acquisition techniques which can provide wide-azimuth data set with sparse receiver interval and dense source interval.

OBS systems inherently have the potential for broad bandwidth and lower frequencies than towed streamer systems. A hydrophone is a pressure sensor that has no knowledge of the direction from which the pressure comes. There is no distinction between 'up-going' or 'down-going' energy. Due to the negative reflection coefficient at the sea-air interface, down-going energy from this interface is opposite in polarity to the up-going energy, resulting in notch filtering of frequencies of certain wavelengths that include Zero Hertz. [4]

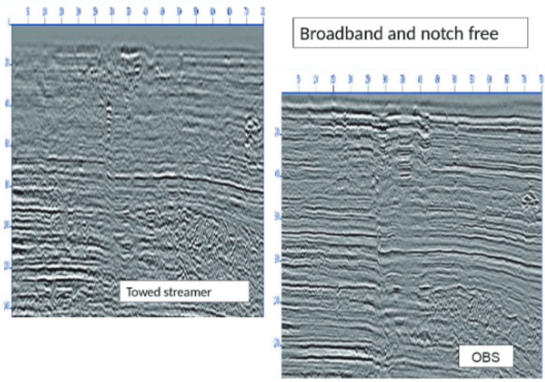

Figure 2. OBS image (right) has considerably higher bandwidth compared to towed streamer data (left).

The down-going wavefield contains unique information, which can usefully contribute to the subsurface image using a technique known as 'mirror imaging'. The benefits of mirror imaging stem from the larger subsurface illumination cone offered from the 'virtual' receiver location. These include improved shallow imaging, reduced acquisition footprint, improved signal to noise and improved velocities. As water depth increases the uplift from mirror imaging becomes greater.

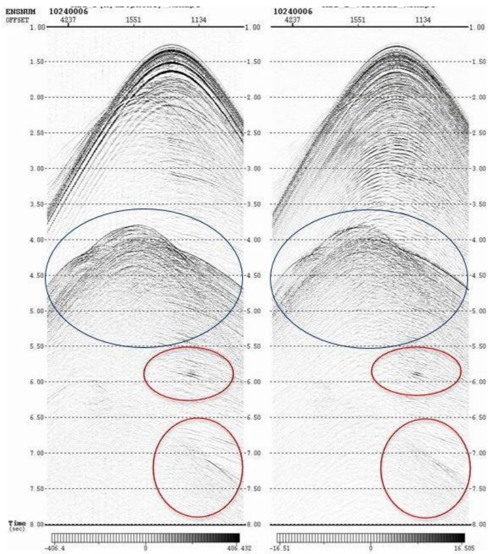

Figure 3: Up-going and down-going wavefields after PZ summation. The left side shows down-going data, the right side shows up-going data. The blue circles indicate the first water bottom multiples. The red circles indicate multiples.

The main challenge with the ocean-bottom nodes is now processing and imaging of the data. The mirror migration technique is an effective solution for this challenge by separation of the seabed hydrophone and geophone data into up-going and down-going waves. Applying the mirror migration method on a real OBN dataset and demonstrate that using multiples to image the shallow sea bottom improves the continuity and image quality, which is very important for subsurface depth/velocity model derivation. [3]

It`s so clear that the image from the ghosts is better than the image from the primaries (Figure 4). The main reason is that the illumination is wider, especially for shallow targets. In addition, the ghosts are less susceptible to velocity variations just under the seabed, which cause scattering, amplitude variations, and statics on OBS and OBC. [1]

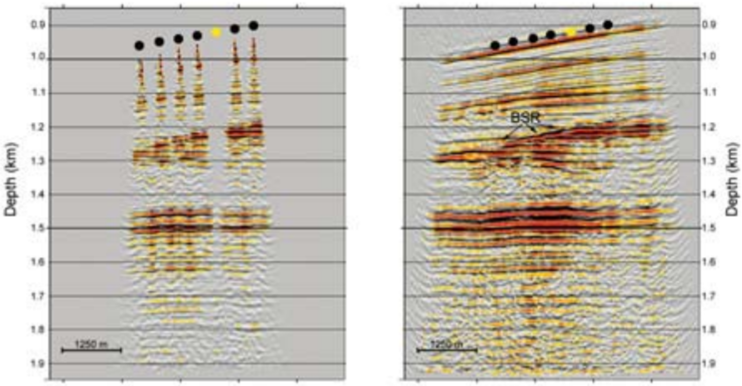

Fig.4. Up-going (left) and mirror (right) migrated image from the Storegga Slide, offshore Norway. Data acquired with seven OBS nodes 400 m apart. The location of the nodes is marked in black.

References:

[1] Barr, F. J. and Sanders, J. I. [1989] Attenuation of water-columnreverberations using pressure and velocity detectors in a water-bottom cable. 59th SEG Annual Meeting, 653-655.

[2] Berg, E., Svenning, B., and Martin, J. [1994] Sumic - a new strategic tool for exploration and reservoir mapping. 56thEAGE Conference & Exhibition, G055.

[3] Amal, R., Bertram, N., and Herron, D. [2005] An experi-mental nodal OBS acquisition from the Thunder Horse field, Gulf of Mexico. The Leading Edge,24, 410-412.

[4] Berkhout, A.J. and Verschuur, D.J. [1994] Multiple technology: Part 2, migration of multiplereflections.64th Annual International Meeting, SEG Expanded Abstracts, 23, 1497-1500.