COMPLEX TRACE ANALYSIS APPLICATIONS TO THE SOROKHIN TROUGH SEISMIC DATA, THE NORTHERN BLACK SEA

Derman Dondurur [1], Mustafa Ergün [2] * and Günay Çifçi [3]

[1] Dokuz Eylül University, Department of Geophysics, Buca-Izmir, Turkey
[2] Yasar University, Alsancak, Izmir, Turkey - * mustafa.ergun@yasar.edu.tr
[3] Dokuz Eylül University, Institute of Marine Sciences and Technology, Izmir, Turkey

Abstract

Complex trace attribute analysis was used to determine the acoustic anomalies from gas accumulations on the high resolution seismic data from Sorokhin Trough in the Northern Black Sea. In bright spot zones, envelope of the single channel seismic data shows strong acoustic anomalies. Phase and polarity reversals are observed on instantaneous phase and polarity sections, and the gas saturated zones are observed to have much lower frequencies on the instantaneous frequency sections.

Key Words: Single Channel Seismic, Integrated Instantaneous Attributes, Gas Accumulation.

Introduction

The Sorokhin Trough, the western submarine termination of the Great Caucasus is situated within the eastern Black Sea basin on the continental slope and rise. The basin is mainly filled by the Maikopian (Oligocene-Lower Miocene) deposits that make up numerous clay diapirs and fluid related features at the seafloor.

Detailed seismic investigations were carried out across faults, hydrocarbon fluid escapes, and fields of gas hydrates in the Sorokhin Trough during the UNESCO-TTR 6 (Training Through Research) cruise in 1996. High resolution seismic reflection profiling was carried out along five lines (PS256 to PS260) at water depths of 600 2100 m to define the faults, diapirs, mud volcanoes, hydrocarbon fluids and bright spots. The diapirs seem to have been produced by a lateral tectonic compression from the south (1).

A single channel seismic system was used during the survey with a recording length of 3 s. An airgun of 120 atm was used with a shot interval of 10 s (about 40 m). The receiving length of streamer was 75 meters with 6 active units.

Complex Trace Analysis

Complex trace attribute analysis is based on the computation of time-dependent envelope, phase and frequency variations of the seismic trace (2), which allows a better definition of the reflections from water-gas/oil or gas-oil interfaces. The applications of the complex trace analysis are generally restricted to the areas where large-scale bright spots occur (3, 4, 5). In these zones, the envelope of the seismic data shows strong acoustic anomalies because of the high velocity contrast between gas accumulated zone and the overlying sediments. Since the velocity of the gas saturated zone is lower than the sedimentary layers, polarity reversals are observed on the instantaneous phase and polarity sections, and the gas saturated zones are observed to have much lower frequencies on the instantaneous frequency sections because of the absorption of the seismic energy.

In complex trace analysis, the recorded seismic trace S(t) is supposed to be the real component of the complex (or analytical) signal and the imaginary component Q(t) is computed using Hilbert transform of S(t). Then the envelope R(t), instantaneous phase θ(t) and frequency φ(t) of the trace are given by (6, 2),

$$R(t) = \sqrt{[S(t)]^2 + [Q(t)]^2} \quad (1)$$

$$\theta(t) = \tan^{-1}[Q(t)/S(t)] \quad (2)$$

$$\varphi(t) = \frac{\partial\theta(t)}{\partial t} \quad (3)$$

Applications to the Sorokhin Through Data

The Sorokhin Through area shows many diapirs, most of which is crowned by mud volcanoes. The complex trace attribute analysis was applied whole seismic data to determine the acoustic anomalies (gas accumulations or bright spots). Bright spots are especially observed above the tops and slopes of the diapiric structures. This is especially evident on line PS256 in which a number of diapiric folds are observed. Fig. 1 shows the envelope section of the PS256 showing several diapiric structures and very high-amplitude reflections (bright spots) near the diapirs. Fig. 2 shows a small part of envelope, instantaneous frequency and polarity sections from slope of a diapiric uplift from PS256. Envelope section shows very strong reflection event between 3.1-3.2 s. Polarity section shows that this reflection has negative polarity and frequency section indicates very low frequency zone below this strongly reflective interface. These indications clearly state a localized gas accumulation located at the side of the diapir. On the other hand, some gas uplifting structures as low frequency transparent columns with strong reflections at both sides are also observed in PS258, whereas some localized and horizontal gas accumulation anomalies are observed on envelope section of line PS257.

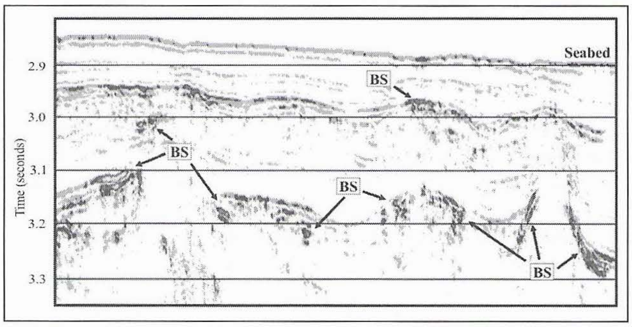

Fig. 1. Envelope of line PS256 showing several diapiric structures and a number of bright spot anomalies (BS) near the diapirs.

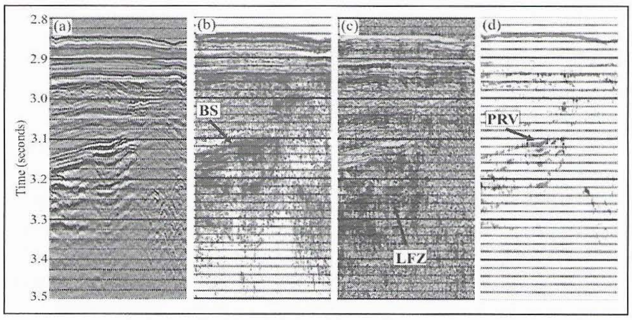

Fig. 2. Complex trace application to a part of line PS256. (a) Original data, (b) envelope, (c) instantaneous frequency and (d) instantaneous polarity sections. The bright spot anomaly (BS) in (b), the low frequency zone (LFZ) in (c) and the polarity reversal (PRV) in (d) indicate a localised gas accumulation.

The application of the complex trace analysis showed the presence of shallow accumulations of hydrocarbon gases. These negative polarity, high amplitude, and relatively short reflections are distributed 250-800 ms interval below the sea floor.

References

1 - Limonov A.F., Ivanov M.K., Kozlova E.V., VanWeering T.C.E., Meisner L.B., Woodside J.M., 1998. The structure of the sedimentary cover and active fluid venting in the Sorokhin Trough (Northern Black Sea), *Rapp. Comm. int. Mer Médit.*, 35: 80-81.

2 - Taner M.T., Koehler F., Sheriff R.E., 1979. Complex seismic trace analysis. *Geophysics*, 44: 1041-1063.

3 - Morozov I.B., Smithson S.B., 1996. Instantaneous polarization attributes and directional filtering. *Geophysics*, 61: 872-881.

4 - Yılmaz Ö., 1987. Seismic Data Processing. Society of Exploration Geophysicists, Tulsa.

5 - Ampilov I.P., and Arts R.J., 2000. Seismic multi-attribute analysis techniques for reservoir characterization. 62nd EAGE Meeting.

6 - Farnbach J.S., 1975. The complex envelope in seismic signal analysis. *Bull. Seism. Soc. Am.*, 65: 951-962.