ANAS Transactions **Earth Sciences** **Special Issue / 2023**

http://www.journalesgia.com

INVESTIGATION OF GAS HYDRATE RELATED STRUCTURES IN THE EASTERN BLACK SEA AND STUDIES RELATED WITH ACOUSTIC AND PHYSICAL PROPERTIES OF SHALLOW GAS IN THE GWANGYANG BAY

Özel S.[1], Çifçi G.[1], Okay S.[1], Kım D.C.[2], Bae S.-H.[2]

[1]Dokuz Eylül University, Institute Of Marine Sciences And Technology, İnciraltı, İzmir, Turkey: sevinc.ozel@deu.edu.tr

[2]Department Of Energy Resources Engineering, Pukyong National University, Busan 608-737, Korea

Keywords: *Eastern Black Sea, gas hydrate, BSR, Bright spot, Multichannel seismic reflection*

Summary. Free gas and gas hydrate areas, which the existences have been known through the determination of acoustic and physical characteristics of sediments in two different regions (Offshore of Turkey in the eastern Black Sea and the Gwangyang Bay at the south Korea) having geological histories and formations, were mapped with the utilization of high resolution acoustic and seismic methods. Technical as well as scientific collaboration were realized between Institute of Marine Sciences and Technology (IMST) and Pukyong International University(PKNU) based on the marine seismic studies. In this context in both of regions, the Eastern Black Sea and the Gwangyang Bay at the south of Korea, shallow gas and gas hydrate formations, various hydrocarbon indicators (pockmarks, mud volcanoes, faults causing seepages) are mapped and sampling was done with piston coring method. Also two mud volcanoes were found in the region and they were named as İzmir and Pusan respectively. This situation supports the probability of existing gas accumulations in this environment.

Introduction

The Black Sea was formed as a back-arc basin as a result of the northward subduction of the Thetis Ocean. This wide basin is divided into two by the Andrusov and Archangelsky ridges, namely the Middle Black Sea Ridge. The Eastern Black Sea Basin and the Western Black Sea Basin have different characteristics. The Black Sea is a closed basin in the form of an east-west trending elliptical depression that has an area of 436,400 km^2, with maximum depth of 2,212 m and it is one of the world's largest inland seas.

In the exploration studies carried out in the shelf, open sea and international waters on the coasts of our country, gas hydrate and shallow gas reserve related structures like BSRs, mud volcanoes, mud diapirs, gas seeps etc. were observed and the presence of gas hydrate was proved by samples taken at some locations.

The BSR level refers to the strong seismic reflection surface from the bottom of the gas hydrate containing sediments. Free gas is usually found below the BSR level, and the world-wide production of gas from gas hydrates today is the extraction of this free gas from below the hydrate.

The aim of the study is to investigate the acoustic and physical properties of the sediments in two different seas of the World, the Eastern Black Sea and in the Gwangyang Bay located in the south of Korea.

Survey area in the Eastern Black Sea covers the continental slope, apron and abyssal plain (Figure1). BSR, bright spots and gas columns were observed on the seismic profiles that collected at the farthest east of the survey area. Also two mud volcanoes were found in the region and they were named as İzmir and Pusan respectively. Slump features were observed on the continental slope. Seismic attribute analyses, instantaneous frequency, envelope and apparent polarity, were applied on the sections where showing strong reflections in the seismic profiles. Low frequencies are observed on the instantaneous frequency sections which supports the probability of gas accumulations in this environment.

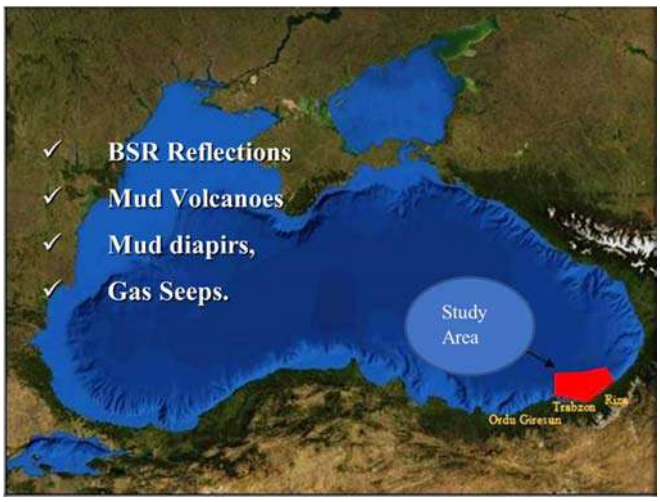


Fig. 1. Study Area at the southeastern Black Sea offshore Turkey. With the high resolution seismic reflection method shallow gas accumulations are observed below BSR (Bottom Simulating Reflector) structures which are the seismic indicators of gas hydrates. Also mud volcanoes, mud diapirs and gas seeps were observed

Data and Methods

This study was carried out as a bilateral TUBITAK Project with the collaboration of Institute of Marine Sciences and Technology and South Korea Pukyong National University. In the scope of the Project cruises were carried out in the Gwangyang bay in 2009 and in the Eastern Black Sea in 2010. In Eastern Black Sea high resolution multi-channel seismic reflection and CHIRP data were collected by the researchers from Dokuz Eylül University(DEU) Marine Sciences and Technology Institute onboard R/V Koca Piri Reis vessel (Figure 2) and CHIRP data were collected in the South Korea in Gwanyang Bay on board R/V Tam Yang.

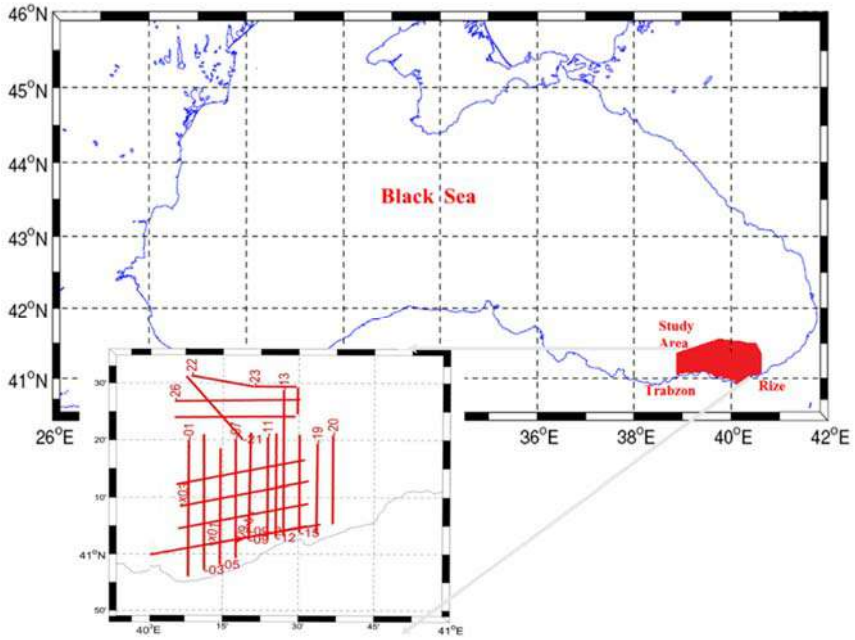


Fig. 2. Map showing the study area and locations of collected multi-channel seismic reflection lines

12 scientific researchers from DEU and many researchers from Pukyong National University joined the survey. Approximately 1700 km of high resolution multi-channel seismic data were collected in the study area The streamer length was 1350 km with 216 channels, the soruce was a Generator-Injector (GI) gun with 2x(45+45) cubic inch volume. The ferquency of subbottom profiler(CHIRP) system is 3.5 kHz. The applied seismic data processing flow includes band pass filtering, automatic gain control (AGC), F-K filter, velocity analysis, NMO, stack and migration.

Results and Discussion

A fold zone is observed in the west of the study area which is associated with the left-lateral strike-slip Trabzon fault. In the north of the line DK 10-11, which exits in the easternmost part of the study area, the exensions of continental canyons system are observed on the apron part (Figure 3). On the N-S trending seismic profile DK10-11, this fold structure with Trabzon faults is observed in the middle part of the profile. Chaotic features on the slope are interpreted as slumps. Towards north uniform parallel sediments exists at the upper part of BSR structure.

BSR reflections were observed at a depth of approximately 1800-2700 ms from the sea floor and their average width was calculated between 2000-4000 m. Figure 4 shows an example for BSR structure. In some areas shallow gas do not exist under the BSR reflections on some seismic sections but some areas show acoustic masking or acoustic turbidity indicting shallow gas under BSR structure.

A mud volcano is discovered and named as Busan mud volcano (Figure 4b). Acoustic masking is interpreted as gas accumulations. Feeding channel of mud volcano is observed as acoustic masking. Sediments are dipping because of velocity pull down. High amplitude reflections are shown by yellow circles. AVO is applied for BSR analysis.

Figure 4 is an example section which shows BSR structure in the middle part of the mud volcano and high amplitude reflections at the northern part of the mud volcano.

In the final map, possible shallow gas accumulations, BSRs and mud volcanoes are shown on the approximate bathymetry map (Figure 5).

Sesimic attribute analysis are applied on the targeted structures on the seismic sections and especially on the indicators known as direct indicators (bright-spot, dim-spot, flat-spot etc.) in hydrocarbon exploration. The applied attributes are envelope, apparent polarity and instantaneous frequency. Areas with strong reflections with negative polarity in the envelope and apparent polarity sections, show themselves with low frequency content in the same region in the instantaneous frequency section.

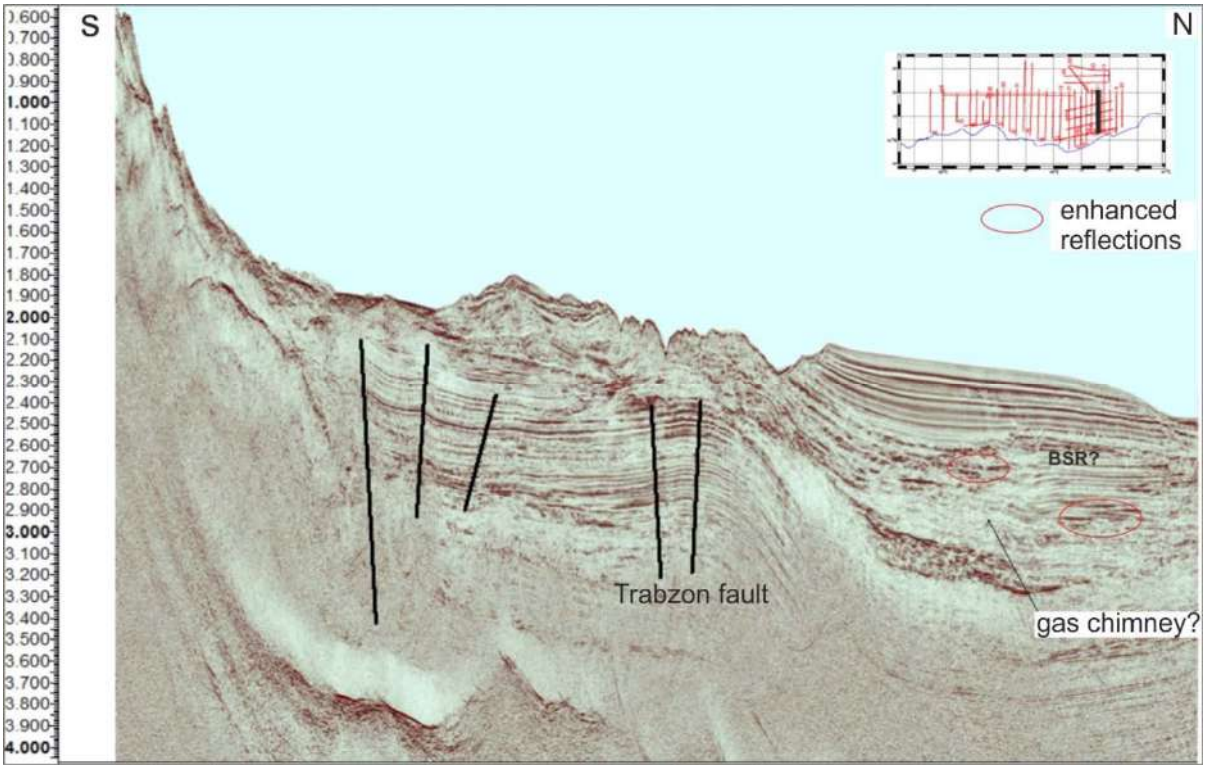
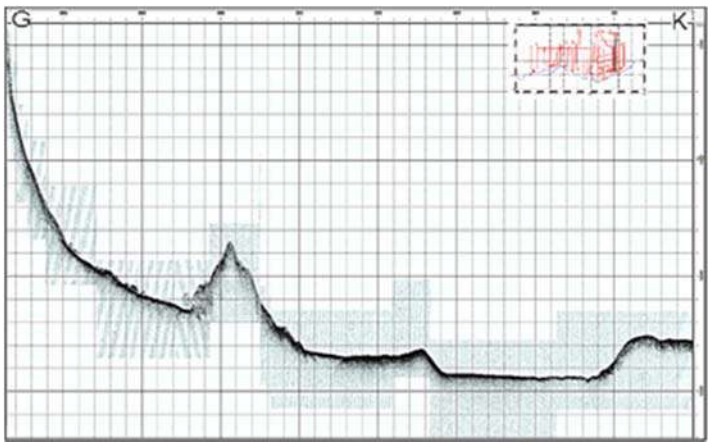


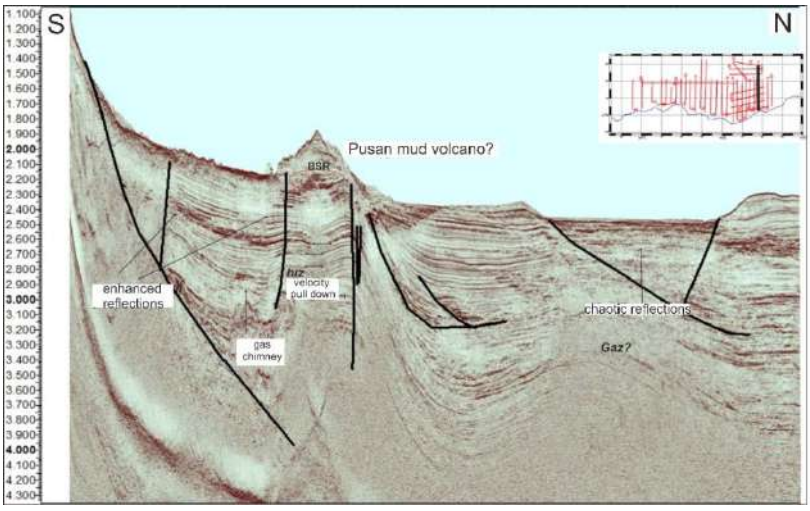
Fig. 3. DK10-11 interpreted seismic reflection line in the study area

Conclusions

In the study area, BSR reflections were observed in the east of the region, indicating the presence of gas hydrate (Figure 5). Two mud volcanoes were discovered and named as Busan and Izmir mud volcanoes. These mud volcanoes are probably formed on the diapiric structures which are formed probably under a compressional tectonic regime. BSR structures are observed at the upper parts of these features. The existence of velocity pull downs and the Seismic attributes, AVO analysis and modeling studies have revealed the presence of gas.



a



b

Fig. 4a. DK10-13 Chirp Line **4b.** DK10-13 Interpreted Seismic reflection line

Gas and BSR mapped as an area of seismic attribute analysis applied to the instantaneous frequency and envelope cross-section, cross section areas of the image appear with a strong polarity of the cross section of low-frequency regions have been identified in areas with a strong negative polarity.

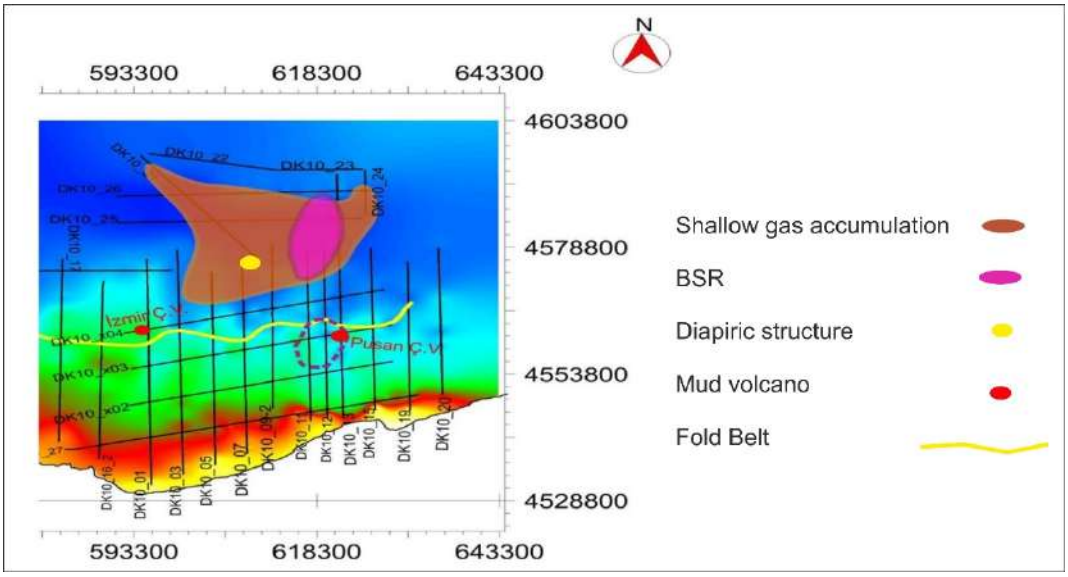


Fig. 5. Map showing possible shallow gas accumulations, BSR area and mud volcanoes on bathymetric map