Seismic Features of Marine Gas Hydrates in Offshore Northwest Africa

LIU Shuang1,2,*, LU Shuangfang1, YANG Jinxiu1 and ZHANG Yanian1,2

1 Research Institute of Unconventional Petroleum and Renewable Energy, China University of Petroleum, Qingdao, Shandong, 266580, China
2 School of Geosciences, China University of Petroleum, Qingdao, Shandong, 266580, China

1 Introduction

Gas hydrates are also called methane hydrates or clathrate hydrates, commonly known as “combustible ice”, which are present in permafrost, continental slope, shallow sea, platform, etc. Gas hydrates (clathrate hydrates) are crystalline solid structures consisting of water and small molecules such as CO₂, N₂, CH₄, H₂, etc. which are formed under conditions of low temperature and specified (generally high) pressure (Esilamimanesh A et al., 2012). Gas hydrates are characterised by high energy, wide distribution, shallow burial depth, clean and environmental protection, which are ideal alternative energy for oil and gas. Seismic exploration technology is an effective method to detect natural gas hydrates and the study of seismic features of gas hydrates is essential. This paper mainly describes the seismic features of gas hydrates in offshore northwest africa.

2 Seismic Features of Gas Hydrates

Bottom* simulating reflections (BSRs) are obvious seismic features of the base of gas hydrate system on continental margins, which are strongly amplitude seismic reflection of polarity inversion and parallel to the seabed topography in seismic profile. A hydrate-related BSR is a useful seismic indicator to detect the base of gas hydrate stability zone. It is caused by acoustic impedance contrast between the overlying hydrate-bearing sediments and the underlying free gas-charged sediments (Shipley T H et al., 1979; Bünz S et al., 2003). There are obvious BSRs in offshore northwest africa and have four types of distinct seismic reflection features (Fig.1): (1) on the shallower slope, the BSR crosses isochronous stratigraphic and intersects seabed at about 880 ms in TWT time. The BSR is parallel to the seabed depth and the burial depth of BSR decreases as the seabed depth gets shallower. (2) In the mud diapir, the BSR is up-domed and the morphology is similar to the strata in the diapier structural belt. (3) In the canyon area, the BSR has obvious concave shape and deepens when the BSR gets close to the canyon wall. (4) In the slide block near the submarine canyon, the BSR is less obvious and discontinuous. This phenomenon may be caused by the migration and truncation of BHSZ caused by the sliding.

The seismic characteristics of BSR suggest the distribution of the base of gas hydrate system, which is influenced by many factors and should be analyzed from the perspective of the forming conditions of gas hydrates. The formation and distribution of gas hydrates are controlled by the nature of natural gas, temperature, pressure and salinity (Fan Shuanshi et al., 2004). Temperature and pressure play decisive roles in the distribution of gas hydrates, especially the temperature. Other gases contained in gas hydrates have an effect on the stability of gas hydrates, such as the increase of N₂ content will reduce the stability of gas hydrates and the increase of other gases will enhance the stability. The increase of salinity will reduce the stability of gas hydrates. In general, according to the hydrates phase diagram, we analysis the distribution of BSR and the range of hydrates stability zone comprehensively. The hydrates stability curve and the heat flow profile together determine the depth of BSR. Since hydrates are unstable in seawater, only the area between seabed and BSR is generally believed to hydrates stable zone. The seismic characteristic of BSR in Fig.1 can be explained by the hydrate phase diagram (Fig.2). With the increase of seawater depth, the temperature of seawater decreases gradually, the intersection depth of the hydrates stability curve and the heat flow profile moves down, therefore the BSR gets deeper as well. When the mud diapir formed later than the gas hydrates, the massive heat flow released during the formation of mud diapir will lead to the upward

* Corresponding author. E-mail: 15621015471@163.com
migration of the BSR. When the diapir is salt diapir, the fluid and gas generated during the formation of salt diapir will flow into the overlying strata and the salinity will increases, which will lead to the upward shift of the BSR. However, if the formation of diaper was earlier than that of gas hydrates, it will not affect the BSR.

References