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基于弯曲元技术的含水合物松散沉积物声学特性研究

胡高伟[1,2], 业渝光[1,2], 张剑[1,2], 刁少波[1,2], 刘昌岭[1,2]*

1. 国土资源部海洋油气资源与环境地质重点实验室,青岛 266071;
2. 青岛海洋地质研究所,青岛 266071

Acoustic properties of hydrate-bearing unconsolidated sediments based on bender element technique

HU Gao-Wei[1,2], YE Yu-Guang[1,2], ZHANG Jian[1,2], DIAO Shao-Bo[1,2], LIU Chang-Ling[1,2]*

1. Key Laboratory of Marine Hydrocarbon Resources and Environmental Geology, Ministry of Land and Resources, Qingdao 266071,China;
2. Qingdao Institute of Marine Geology, Qingdao 266071, China

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摘要 含水合物松散沉积物的声学特性对海上天然气水合物地球物理勘探和资源评价具有重要意义.研制了适用于高压条件下含水合物沉积物声学特性探测的纵横波一体化新型弯曲元换能器,提出利用频谱分析(FFT)和小波分析(WT)相结合的方法获取纵横波速度,并进行了多个轮次的水合物声学特性模拟实验研究.结果表明,新型弯曲元技术可以灵敏探测松散沉积物中水合物的生成和分解,随着水合物饱和度(*Sh*)的增大,纵横波速度呈规律性增长:当*Sh*<25%时,纵横波速度增长较快,水合物可能胶结沉积物颗粒生成;25%~60%之间,声速增长较为缓慢,水合物可能与沉积物颗粒呈接触关系;在*Sh*>60%时声速随着水合物饱和度增加又快速增长,表明水合物可能重新胶结沉积物颗粒生成.

关键词 天然气水合物, 弯曲元, 松散沉积物, 声学特性, 饱和度

Abstract: The acoustic properties of gas hydrate bearing unconsolidated sediments have significance on marine gas hydrate exploration and resources evaluation. In this paper, a new type of bender elements was proposed to measure both compressional wave velocity (V_p) and shear wave velocity (V_s) of hydrate bearing unconsolidated sediments simultaneously under certain pressure and temperature conditions. Combination of Fast Fourier Transform (FFT) and Wavelet Transform (WT) was thought to be an effective method to analyze both V_p and V_s data, based on which several runs of experiments were conducted. The results show that the new bender element technique is efficient in detecting gas hydrate formation and dissociation in unconsolidated sediments. The acoustic velocities of hydrate bearing unconsolidated sediments increase with hydrate saturation (*Sh*) as follows. When *Sh* is less than 25% or more than 60%, V_p and V_s increase fast with *Sh*, which indicates that hydrate may cement sediment particles. However, when *Sh* is between 25% and 60%, V_p and V_s increase little, which indicates that hydrate may partly contact with sediment particles.

Keywords Gas hydrate, Bender elements, Unconsolidated sediments, Acoustic properties, Saturations

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Corresponding Authors: 业渝光,男,1946年生,研究员,博士生导师,长期从事海洋地质学实验研究工作.E-mail:yeyug@public.qd.sd.cn Email: yeyug@public.qd.sd.cn

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