浅层有限频率面波成像中的3D灵敏度核分析

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Analysis of 3D sensitivity kernels of the finite frequency surface wave tomography in shallow subsurface

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摘要 本文利用面波散射的模式耦合方法,基于波恩近似和远场假设,研究了有限频率面波三维灵敏度核,针对面波在工程应用中常遇到的水平分层的背景介质模型,计算了介质扰动引起的面波相位和幅度扰动的三维灵敏度核,分析了模式耦合对三维灵敏度核的影响.结果表明,仅考虑模式自身耦合的JWKB近似,介质密度和波速扰动引起的三维灵敏度核可以蜕化为面波相速度扰动的二维灵敏度核,有限频率面波成像和传统基于射线的方法类似,可以分两步进行,只需在纯路径反演过程中将基于大圆路径假设下的一维灵敏度核用二维灵敏度核取代.如果交叉模式耦合的影响不能忽略,在反演时必须引入三维面波灵敏度核,直接对介质参数进行反演.

关键词： 有限频率　面波　灵敏度核　模式耦合

Abstract： In this paper, finite frequency 3D sensitivity kernel is studied using the mode coupling method under the assumption of far field and Born approximation. For the horizontal layered reference media, which is always encountered in the application of Rayleigh waves in geotechnical engineering, 3D sensitivity kernel of the perturbed surface wave amplitude and phase caused by the perturbation of the shear wave velocity is computed. The effects of the mode coupling on the kernel are investigated. Studies show that under the JWKB approximation the 3D sensitivity kernel of the perturbed density and wave velocity is reduced to the 2D sensitivity kernel of the perturbed surface wave phase velocity. That means in the first step for the pure path averaged inversion the finite frequency surface wave tomography is similar to the traditional one based on ray theory, just replacing the 1D sensitivity with 2D sensitivity kernel. If the cross-mode coupling is significant, however, the traditional two-step method breaks down and the shear wave velocity should be directly inverted by introducing the 3D sensitivity kernel in finite frequency surface wave tomography.

Keywords： Finite frequency　Surface wave　Sensitivity kernel　Mode coupling

链接本文:

http://www.geophy.cn/CN/10.3969/j.issn.0001-5733.2011.01.007　　或　　http://www.geophy.cn/CN/Y2011/V54/I1/55

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