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基于PSInSAR技术的海原断裂带地壳形变初步研究

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The PSInSAR technique and its application to the study on crustal deformation of the Haiyuan fault zone

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摘要 常规差分干涉测量(DInSAR)受时间、空间失相干的严重制约和和大气延迟等相位误差的影响,难以实现对长期累积微小地壳形变场的有效探测.PSInSAR技术克服了常规DInSAR的局限性,能够高精度监测微小地壳形变.本文首先介绍了PSInSAR技术的算法模型和处理方法.该方法通过二维线性相位模型,对时序干涉图象上相干点目标的差分干涉相位进行回归分析,逐次消除大气延迟、轨道残余和地形残余等相位误差,提取出准确可靠的形变相位,进而得到相干点目标上的累积形变量和形变速率.在此基础上,以祁连山海原断裂带为实验研究区,利用2003~2009年的21景ENVISAT ASAR数据,采用上述相干点目标处理方法进行了海原断裂带地壳微小形变的探索性研究,得到海原断裂东段绝大多数高相干点的形变速率在6~7 mm/a,2003~2009年共6.3年累积位移平均值约为4.2 cm,运动性质为左旋走滑.这一结果与GPS,库仑应力反演和地质学方法得到的结果基本一致,说明PSInSAR技术在长期累积微小地壳形变探测中具有广阔的应用前景和巨大发展潜力,有望成为探测震间微小形变,获取地震形变异常的有效途径之一.

关键词: PSInSAR 失相干 点目标 回归分析 地壳形变

Abstract: Because of serious constraints from the phase decorrelations in time and space and the phase errors due to atmospheric delay, the current differential interferometric synthetic aperture radar (DInSAR) technique cannot work well in mapping the long-term accumulated small crustal deformation. To solve this problem, a new method called PSInSAR (Permanent scatterer InSAR) has been developed recently. In this paper, we introduce the principle, algorithm and data processing procedures of PSInSAR. Using a two-dimensional linear model of phase, this method makes regression analysis of differential interferometric phases at coherent point targets on images of time serial interferograms, eliminates phase errors from atmospheric delay, orbit residuals and topographic influence, and yields real phases associated with deformation. Finally it acquires the accumulated deformation and its rates at the coherent points on images. Then we take the Haiyuan fault zone as the experimental area to test this technique. We use 21 scenes of ENVISAT ASAR data from 2003 to 2009 and the PSInSAR technology presented above to examine the small crustal deformation on this fault zone. The result shows that most coherent point targets display a left lateral slip rate about 6~7 mm/a, the average cumulated displacement of these points in 2003~2009 is about 4.2cm, which is roughly in agreement with that from GPS measurements and geological investigations. This suggests that the PSInSAR technique is capable of detecting long-term accumulated crustal deformation on active faults.

Keywords: PSInSAR Decorrelation Point target Regression analysis Crustal deformation

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