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利用InSAR短基线技术估计洛杉矶地区的地表时序形变和含水层参数

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Application of small baseline subsets D-InSAR technology to estimate the time series land deformation and aquifer storage coefficients of Los Angeles area

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摘要 美国南加州洛杉矶地区是自然和人为活动引起的地质构造活跃、石油及地下水抽取和回灌频繁的区域.本文利用19景ENVISAT ASAR降轨影像生成了71幅垂直基线小于300 m、时间间隔小于3年的解缠差分干涉图,并基于短基线集技术(SBAS),GPS和地下水水位数据估计了该区域2003年9月~2009年8月的地表时序形变及含水层贮水系数等物理参数.研究结果表明:(1)在InSAR干涉图中可以清楚的识别多处沉降明显的区域.例如,主要由于含水层地下水的抽取与回灌引起地表沉降的Pasadena盆地(~-2.5 cm/a)、San Gabriel流域(~-2 cm/a)、San Bernardino盆地(~-2.5 cm/a)、Pomona-Ontario盆地(~-4 cm/a)和Santa Ana盆地(~-2.5 cm/a),以及由石油抽取引起地面形变的Santa Fe Springs区域(~-1 cm/a)和Wilmington区域(~-1 cm/a)等;(2)InSAR时间序列形变与GPS投影在雷达视线方向上的形变结果具有较高的一致性,平均形变速率差异的均方差为0.39 cm/a;(3)InSAR时间序列形变与含水层地下水位的变化基本一致,并基于相关理论计算出了含水层的弹性贮水系数和非弹性贮水系数,分析了含水层的形变机理.

关键词 InSAR, 短基线集, 地表形变, 地下水, 含水层贮水系数, 洛杉矶

Abstract: The Los Angeles area is a tectonically active region with a combination of natural and anthropogenic deformations, such as, fault related tectonics, oil and groundwater recharge and discharge. In this paper, we process a dataset of 19 descending ENVISAT ASAR images acquired between September 2003 and August 2009 over Los Angeles and generate 71 differential interferograms, which are characterized by perpendicular baseline smaller than 300m and time interval less than 3 years. Based on Small Baseline Subsets (SBAS) D-InSAR technique, we estimate the time series land deformation of this area. With the additional GPS and groundwater data, we further estimate the aquifer storage coefficients. The results show that: (1) a couple of deformation evident regions can be easily identified from the interferogram, including the aquifers compaction related subsidence area such as Pasadena basin (~-2.5 cm/a), San Gabriel valley (~-2 cm/a), San Bernardino basin (~-2.5 cm/a), Pomona-Ontario basin (~-4 cm/a) and Santa Ana basin (~-2.5 cm/a), and the oil extraction related area such as Santa Fe Springs (~-1 cm/a), Wilmington (~-1 cm/a) and so on; (2) InSAR-derived and LOS-projected GPS deformation velocity show a very good consistency, with a RMS difference of 0.39 cm/a; (3) InSAR deformation time series and groundwater level variations are in good agreement. Based on the theory of poroelasticity, we calculate the elastic and inelastic skeletal storage coefficient and analyze the deformation mechanisms of aquifer system.

Keywords InSAR, SBAS, Ground Deformation, Groundwater, Aquifer Storage Coefficient, Los Angeles Keywords

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