Monitoring Crustal Deformation and Man-made Infrastructure in China Using InSAR Observations

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Objectives:

1. Develop an optimal procedure to monitor man-made infrastructure such as Qinghai-Tibet railway, highway, and transmission lines;

2. For targeted locations on selected major faults in and around Tibet, measure the inter-seismic strain accumulation, and hence the slip rates, using InSAR with ERS-1/2, Envisat and Sentinel-1radar images;

3. Determine regional deformation and strain map for the Tibetan plateau using InSAR and GPS observations;

4. Investigate post-seismic deformation for the 2008 Wenchuan and 2010 Yushu earthquakes. Initiate InSAR studies of post seismic motion for any large earthquakes in China that may occur during the lifetime of the project.

Scientific issues:

1. Qinghai-Tibet railway, highway, transmission line and other national key projects and its ancillary buildings have the characteristics of strong reflection and long distance continuous distribution. How to use these features to monitor the deformation of a long linear region, and how to reveal the movement of Qinghai-Tibet Plateau block patterns with the deformation of these major projects' network.

2. Multi track data can cover the whole block in combination while single track data cannot meet the need of deformation monitoring of large blocks. The multi-track data can be either both in ascending or descending tracks or in ascending and descending tracks. How to develop a method for reasonable splicing and merging is one of the most significant studies since the PSI multi-track results are different with each other in tracks (ascending and descending), incidence angles, and even sensors.

3. Not all of the coseismic deformation can be detected by InSAR. Whether InSAR can detect coseismic deformation successfully is restricted by the quality of SAR data and earthquake magnitude, focal depth and mechanism. In general, InSAR can only detect shallow earthquakes with medium to high magnitudes. Which earthquake can be detected by InSAR in Qinghai-Tibet block? The directly- determined earthquake source parameters, slip distributions, and the rupture histories, will add to the growing data base for large earthquakes that will enable the controls on earthquakes to be established, e.g. the role of geological structure in segmenting faults, the influence of heterogeneity and initial stresses.

4. What are the slip rates for the major faults in the Qinghai-Tibet Plateau? The estimates of rates of strain accumulation and slip rates for the major faults will discriminate between different models of continental deformation and improve the assessment of seismic hazard. The availability of rates of deformation at a regional scale will reveal

unexpected features in the deformation field and lead to further enquiry and, integrated with GPS data, will provide further tests of large-scale deformation models.

5. What are the mechanisms for post seismic motion after large earthquakes? InSAR post-seismic time series will discriminate between different mechanisms for post-seismic motion and, with observations for any new earthquakes, will constrain the mechanical structure of the fault zones used in modelling the earthquake cycle.

基于InSAR技术监测中国境内的地壳和人工建（构）筑物形变

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目标：

1.发展监测青藏铁路、公路、输电线路网等青藏高原国家大型工程变形的最优流程；
2. 利用ERS-1/2，Envisat和Sentinel-1雷达影像监测青藏高原重点区域的地震震间形变以及断层滑动速率；
3. 基于InSAR/GPS获得青藏高原区域形变和应变率图；
4. 调查2008汶川地震和2010玉树地震震后形变情况；在项目执行期间，利用InSAR技术初步研究中国境内可能发生的大地震的震后形变。

科学问题提出：

1.青藏铁路、公路、输电线路等国家重大工程及其附属建（构）筑物具有强反射、长距离连续分布的特性，如何利用这种特性来监测长线状区域的变形，以及如何通过这些重大工程网络的变形监测揭示青藏高原各块体的运动模式？
2.利用单一Track数据无法满足大块体的形变监测，而多Track 数据的联合应用能够覆盖整个块体。多track的 PSI结果可能具有不同的轨道模式（升轨、降轨以及两者兼有）、不同的入射角，甚至不同的传感器，如何构建最优数学模型进行合理的拼接和融合以达到监测大块体形变的目的？
3. 目前并非所有的地震同震形变场都能用InSAR来获取，InSAR能否成功探测同震形变信息除了受数据质量限制外，还取决于地震的震级、震源深度和滑动机制。一般来说InSAR容易探测到浅源、倾滑、震级较大的地震，那么在青藏地块，InSAR能探测到的临界地震如何来界定？反之，利用InSAR确定出大地震的震源参数、滑动速率以及断裂演化过程也可以有效的约束断裂的产状，分析计算过程中非均匀介质假设对结果的影响，以及确定应力初始状态等。
4. 青藏高原大型活动断裂的滑动速率是多少？估算这些大型活动断裂的累积应变速率和滑动速率有助于理解不同大陆变形模型的特征，从而可以提高地震危险性评估的质量。另外，InSAR得到的区域形变速率与GPS结果相结合可以进一步的约束大块体形变模型。
5. 大地震震后形变的驱动机制是什么？InSAR震后形变序列分析有助于理解不同地震的震后形变驱动机制；利用这些地震的观测数据可以有效约束断裂带的流变结构以建立准确的地震周期模型。