

**Long-term growth of the Himalaya inferred from interseismic InSAR measurement**

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The rise and support of the ~5000m topographic scarp at the front of Indian-Eurasian collision in the Himalaya involves long-term uplift above a mid-crustal ramp within the Main Himalayan Thrust (MHT) system. Locking of the shallower portion of the flat-ramp-flat during the interseismic period also produces transient uplift above the transition zone. However, spatial and temporal relationships between permanent and transient vertical deformation in the Himalaya are poorly constrained, leading to an unresolved causal relationship between the two. Here, we use synthetic aperture radar interferometry (InSAR) acquired within the framework of the Dragon-2 program (project ID 5305) to measure interseismic uplift velocity on a transect crossing the whole Himalaya in Central Nepal. The uplift velocity, which reaches up to 7mm/yr at the front of the Annapurnas, can be explained by a 18-21mm/yr slip rate on the deep shallow-dipping portion of the MHT, with full locking of the mid-crustal ramp underlying the High Range. Furthermore, the transient uplift peak observed by InSAR matches spatially with the long-term uplift peak deduced from the study of trans-Himalayan river incision patterns, although models of the seismic cycle involving thrusting over a ramp of fixed geometry predict a ~20km separation between the two peaks. We argue that this coincidence indicates that today's mid-crustal ramp in Central Nepal is located southward with respect to its average long-term location, suggesting that mountain growth proceeds by progressive frontward migration of the ramp driven by underplating of material from the Indian plate under the Himalaya.

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# 由震间InSAR测量推测喜马拉雅的长期增长过程

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喜马拉雅地区印度-欧亚板块碰撞边界~5000m地形山脉的增长和支撑，包含了主边界带（MHT）内中地壳以上部分的长期抬升。震间期flat-ramp-flat结构的浅部锁定也产生了转换带以上部位的暂态隆升。然而，喜马拉雅地区永久变形和暂态垂直变形的时空关系缺乏观测约束，导致两者的因果关系不清楚。我们利用Dragon-2项目获得的InSAR数据（项目编号5305）测量尼泊尔中部，与整个喜马拉雅相交截面的震间抬升速率。其抬升速率在Annapurnas地区达到7mm/y，这可以被解释为MHT深部浅倾部位存在18-21mm/y的滑动率，高海拔地区以下中地壳坡面的完全锁定。另外，InSAR观测的暂态抬升峰值与trans-Himalayan河流切割模式研究推测的长期抬升峰值在空间上匹配，尽管以固定断层坡面上的逆冲作用为基础的地震周期模型预测了两个峰值间存在~20km的空间距离。我们认为这种一致性表明，现今尼泊尔中部中地壳坡面相对于其平均长期位置偏南，说明山脉生长开始于中地壳坡面逐步向喜马拉雅前端迁移过程中，其被印度板块材料向喜马拉雅下插所驱动。