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现代大地测量学——地壳形变场

2008年汶川地震断层北川段的几何学与运动学特征及地震地质灾害效应

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摘要 2008年5月12日M_S8.0 汶川大地震的主要发震断层是龙门山断裂带的映秀—北川断裂.本研究通过地震后的实地调查和地震前后高空间分辨率航空与卫星影像的解译，对映秀—北川断裂带北川段（擂鼓镇—曲山镇）同震地表破裂带的几何学与运动学特征及相关地震地质灾害进行了详细分析.研究结果表明5·12汶川大地震沿映秀—北川断裂带产生的地表破裂带正穿过北川县城—曲山镇中心，并在曲山镇周围诱发了一系列大型滑坡和岩崩等地质灾害，致使北川县城遭到毁灭性破坏.野外考察表明北川段最大逆冲量和右旋走滑量都达8~10 m，这也是映秀—北川地表地震破裂带中位移量最大的地段.同时，值得注意的是曲山镇一带正是地震断层几何学和运动学特征改变的转换地带：曲山镇及其南西部断层倾向北西，呈现以逆冲为主兼右旋走滑的特征；在曲山镇北东断层倾向南东，表现为右旋走滑分量与垂直分量相当，走滑活动特征更明显.研究结果还表明，逆冲-走滑型（或斜向逆冲型）同震地表破裂带的几何学和运动学特征直接影响地震地质灾害及其破坏程度，地震地质灾害的分布表现出明显的不对称性：断层NW盘（上盘）远远强于SE盘（下盘）.地震断层的几何学特征与断层运动的应力及坡向的自由面之间相互作用，加强了滑坡、岩崩等地质灾害的破坏力.因此，汶川大地震为我们研究逆冲-走滑型同震地表破裂的几何学、运动学特征及其地震地质灾害效应提供了契机.

关键词 汶川大地震 同震地表变形 高精度遥感 地质灾害效应 映秀—北川断裂

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Geometry and kinematics of the 2008 Wenchuan earthquake surface ruptures around the Qushan Town of Beichuan County, Sichuan: Implications for mitigation of seismic and geologic disasters

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Abstract The NE-trending Yingxiu-Beichuan and Guanxian-Anxian faults in the Longmen Shan fault zone are responsible for the 12 May 2008 M_S8.0 Wenchuan earthquake. Based on the interpretation of post-quake high-resolution remote sensing imagery and field geologic observations, the geometry and kinematics of co-seismic surface rupture as well as the seismic and geologic hazards along the Beichuan segment between Leigu Town and Qushan Town, Beichuan County, are analyzed in detail. Results indicate that surface deformation appears as an oblique thrusting with near equal vertical and right-lateral displacements ranged from 2 to 10 m, in which the largest displacement occurred along this segment in the Yingxiu-Beichuan fault. A notable distribution feature of geologic disasters and building damages induced by this earthquake shows strong hanging wall effects across the surface rupture zone: the highest density of landslides, rock falls, debris flows and building damages occurred on the northwest (hanging wall) side of the fault, but few geologic disasters developed on the southeast (foot wall) side of the fault. These effects are caused directly by the asymmetric fault geometry and the stress interaction between the fault motion and free surface of the slopes. Other factors such as material heterogeneity and spatial variation in frictional properties along the fault strike may further affect the rupture and slip patterns of oblique thrust faulting with a right-lateral strike-slip component.
From view of disaster mitigation, the geometry and kinematics of surface rupture zone associated with the M_S8.0 Wenchuan earthquake also taught a realistic lesson to how to mitigate potential seismic and geologic disasters associated with future great earthquakes in highly populated region through pre-earthquake analysis and evaluation of active faults using

remote sensing technique combined with field reconnaissance.

Key words M_S8.0 Wenchuan earthquake; Coseismic surface rupture; High-resolution remote sensing; Effects of seismic and geologic disaster; Yingxiu-Beichuan fault

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