地球物理学报
CHINESE JOURNAL OF GEOPHYSICS

地球物理学报 » 2010, Vol. 53 » Issue (11) :2671-2680

引用本文:
缪阿丽, 马胜利, 周永胜.硬石膏断层带摩擦稳定性转换与微破裂特征的实验研究[J] 地球物理学报, 2010,V53(11): 2671
5733.2010.11.014

MIAO A-Li, MA Sheng-Li, ZHOU Yong-Sheng.Experimental study on frictional stability transition and micro
fault zones.Chinese J.Geophys. (in Chinese),2010,V53(11): 2671-2680,DOI: 10.3969/j.issn.0001-5733.20

硬石膏断层带摩擦稳定性转换与微破裂特征的实验研究

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Experimental study on frictional stability transition and micro-fracturing characteristics for

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摘要 断层带摩擦稳定性转换及其对应的微破裂特征对于地震成核条件和慢地震机理研究具有重要的意义.本文利用双轴实验
了硬石膏断层带摩擦稳定性的转换及其对应的应变变化、微破裂特征,并分析了实验标本的微观结构.实验结果表明,σ_2和加
断层滑动稳定性具有显著影响.在低σ_2条件下,硬石膏断层带出现不稳定滑动,变形以局部化的脆性破裂和摩擦为主;随σ_2的增
不稳定滑动向稳定滑动转换,断层带变形方式逐渐转变为分布式的破裂.在低σ_2条件下,硬石膏断层带在较低加载点速度下表
化且滑动稳定,在中等加载点速度下表现为速度弱化并伴有准周期性的黏滑,在较高加载点速度下又有转向速度强化的趋势,σ
得速度弱化的范围逐渐减少,滑动趋于稳定.上述两次转换对应不同的微破裂特征,在较高速度下从速度弱化转换为速度强化时
伴有能量较小但频度很高的微破裂活动,而在较低速度下从速度弱化转换为速度强化时,断层滑动伴有间歇性的微破裂,这与
观结构特征有较好的对应关系,表明其转换机制是不同的.

关键词: 摩擦滑动 稳定性转换 速度依赖性 微破裂特征 硬石膏 慢地震机制

Abstract: Study on frictional stability transition of the fault zone and the corresponding micro-fracturir
characteristics has great significance for understanding earthquake nucleation condition and mechanism
earthquakes. In this paper, using biaxial experimental apparatus, we studied the frictional stability transi
anhydrite fault zones and the corresponding change in strain and micro-fracturing characteristics, and ar
microstructure of the fault zones after experiments. The results show that σ_2 and loading point velocity
significant impact on the stability of fault sliding. At low σ_2, anhydrite fault zone behaves as unstable fri
sliding, and the deformation is predominated by localized brittle fracturing and frictional sliding. As the σ_2
increases, transition from unstable sliding to stable sliding of the fault zone occurs, and the deformation
gradually transforms to distributed fracturing. Anhydrite fault zone shows velocity strengthening and stab
at lower loading point velocities, and velocity weakening accompanied by quasi-periodic stick-slip at mod
velocities. At higher velocities, frictional sliding tends to turn into velocity strengthening again. With incr
σ_2, the scope of velocity weakening gradually decreases and frictional sliding becomes stable. Moreover,
micro-fracturing characteristics corresponding to the two transitions are different. At higher velocities, f
sliding is accompanied by micro-fracturing activity with small energy but high frequency when friction tra
from velocity weakening to velocity strengthening. While at lower velocities, fault sliding is accompanied
episodic micro-fracturing when friction transforms from velocity weakening to velocity strengthening. Thi
coincides with the characteristics of the microstructure of fault zones, indicating that the mechanism of
transitions is different.

Keywords: Frictional sliding Stability transition Velocity dependence Micro-fracturing Anhydrite
Mechanism of slow earthquakes

Received 2010-02-05;