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紫坪铺水库区域地壳Q_S成像及其与渗透关系研究

王惠琳[1,3], 张晓东[2], 周龙泉[2], 徐晓枫[3], 杨志高[2], 卢显[2], 李智蓉[1,4]*

1. 中国地震局地震预测研究所, 北京 100036;
2. 中国地震台网中心, 北京 100045;
3. 海南省地震局, 海口 570203;
4. 云南省地震局, 昆明 650224

Study on the relationship between fluid infiltration and Q_S tomography of the crust in Zipingpu Reservoir Area

WANG Hui-Lin[1,3], ZHANG Xiao-Dong[2], ZHOU Long-Quan[2], XU Xiao-Feng[3], YANG Zhi-Gao[2], LU Xian[2], LI Zhi-Rong[1,4]*

1. Institute of Earthquake Science, China Earthquake Administration, Beijing 100036, China;
2. China Earthquake Networks Center, Beijing 100045, China;
3. Earthquake Administration of Hainan Province, Haikou 570203, China;
4. Seismological Bureau of Yunnan Province, Kunming, 650224, China

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摘要 利用衰减结构层析成像方法尝试对紫坪铺水库区域地壳Q_S进行成像,获得该区浅层地壳静态及蓄水前、后的Q_S变化特征,结合实验研究成果、岩体岩性、断裂构造、水文地质条件探讨库水的渗透作用及其对地壳介质的影响,对研究区内地震活动类型及发震成因的介质物性变化进行了讨论.研究结果表明:紫坪铺水库区域地壳Q_S横向不均匀变化显著,库区周边近似存在低Q_S值环形区域,主要包括水库东北、东南、西南、西北及库区中段五个区域.其中,水库东北、库区中段、西南低Q_S区域与库水渗透关系密切,初步认为库水可能沿着通济场断裂中段和两端的岩石破碎带及节理、裂隙发育地区向地下渗透,使岩石孔隙中充满流体,内摩擦增大,地震波大大衰减,从而导致Q_S值大幅下降.同时,在西南区诱发了水库小震群,在东北区和东南区诱发了部分水库小震群.另外,紫坪铺水库区域东北、东南、西南三个小震群基本位于高Q_S值(低衰减)和低Q_S值(高衰减)过渡区域,可能由于低Q_S区地震波衰减大,不易积累能量,而高、低Q_S值的过渡区域,介质介于"软"、"硬"之间,有可能积累应变能,孕育地震.当高、低Q_S过渡区域岩石裂纹饱含水或部分含水后,水对裂纹边界起潮湿和润滑作用,降低了发震断层的抗剪强度,使滑动容易产生,从而诱发地震.

关键词 衰减成像, Q_S, 流体渗透, 紫坪铺水库

Abstract: The crustal Q_S values are imaged in Zipingpu Reservoir Area to obtain shallow crustal characteristics of Q_S variation before and after the impoundment of water through two-dimensional seismic attenuation tomography. The infiltration of reservoir water and its impact on the crust are investigated with experimental findings, rocks lithology, faults, hydrological and geological conditions. Simultaneously, we discussed the type of seismic activity and physical variety of medium about the cause of earthquake occurrence in the area. The results show that there is a significant lateral heterogeneity in Q_S distribution in Zipingpu Reservoir Area. Approximately, there are low Q_S value annular regions surrounding the reservoir, namely, the Q_S values are low on the northeast, southeast, southwest, northwest sides and in the middle part of the reservoir. Particularly, the Q_S values variation are most closely related to fluid infiltration in the middle part and on the northeast, southwest sides of the reservoir. We consider that the reservoir water infiltrates through from the middle part and two sides of the rock fracture zones, joints and fractured regions of the Tongjichang faults, filling with fluid in the rock pores, increasing the internal friction, causing significant attenuation of seismic waves, resulting in a substantial decline in the value of Q_S, inducing small earthquake swarms on the southwest and partly on northeast and southeast sides. The small earthquake swarms in northeast, southeast and southwest regions are basically converged to transitional edge regions of high and low Q_S values. This is perhaps a result of accumulation of strain energy in weak and soft zones. After full or partial filling of water in rock cracks,there are wet and lubricating effect on the crack boundary in the high and low Q_S transition region,reducing the shear strength of seismogenic faults,inducing earthquakes.

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徐晓枫
杨志高
卢显
李智蓉

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About author: 王惠琳,女,1982年生,硕士,2011年毕业于中国地震局地震预测研究所,主要从事地震预测、地震层析成像研究.E-mail:huilin95@163.com