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温度－拉应力共同作用下砂岩破坏的断口形貌

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摘要 通过扫描电镜研究温度－拉应力共同作用下砂岩破坏的断口形貌。通过研究不同温度影响后的解理断口、准解理断口、疲劳断口、非主断裂面的二次裂纹和碎裂断口、局部延性断口、沿晶断口及一些奇特的断裂花样，证实温度对砂岩断裂的微观机制产生了影响，随着温度的升高，砂岩的断裂机制由以局部脆性断裂机制为主向局部脆性和延性耦合断裂机制转变。低温下的断口较为光滑平坦，高温下的断口较为粗糙，表明发生过塑性变形，并且高温断口形貌更为多样和更为复杂，这主要是受到高温影响后，岩石内部矿物颗粒、晶体和原子热运动加剧，当岩石受到外部载荷作用时断裂就有可能出现在更大范围的位置。通过一些简单的断裂机制示意图对部分断口形貌进行解释，并报道了一些特殊的岩石断口形貌。综合认为金属断口学研究中所发现的微观断口形貌特征几乎都可以从岩石断口形貌中找到，但由于岩石是多晶体地质材料，高温影响下岩石的断口形貌还将更为多样和更为复杂。

关键词 岩石力学；砂岩；温度－拉应力共同作用；断口形貌；扫描电镜

分类号

FRACTOGRAPHY OF SANDSTONE FAILURE UNDER TEMPERATURE-TENSILE STRESS COUPLING EFFECTS

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Abstract

The scanning electron microscope(SEM) is employed to study sandstone fractography under thermo- mechanical coupling effects. Through several fracture morphologies at different temperatures，such as cleavage，quasi-cleavage，fatigue，secondary and fragmentary，local ductile，intercrystalline fracture and some special fractographies，the temperature has been confirmed to influence actually micro fracture mechanism of sandstone. The fracture mechanism will transfer from brittle fracture mechanism to brittle-ductile coupling fracture mechanism with the increasing temperature. At low temperatures，the fractography of sandstone is quite smooth；but at high temperatures，the fractography is rougher，and a great deal of plastic deformation is observed obviously. Therefore，the fractography is more various and complicated after high temperature effects. The reasons can be summarized as follows. The thermal motion of mineral particle，crystals and atom will be strengthened after temperature effects；and sandstone will fracture at more widely positions. Several fracture mechanism models had been used to interpret some failure phenomena. In addition，some novel rock fractographies were reported. At last， it is concluded that any micro fractographies which has been reported in metallic fractography can also be found in rock fractography. Moreover，rock fratography is more various and more complicated because of rock own characteristics and thermal-mechanical coupling effects.

Key words rock mechanics；sandstone；temperature-tensional stress coupling effects；fractography；scanning electron microscope(SEM)

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