Tectonophysics

Steady activity of microfractures on geological faults loaded by mining stress

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Abstract

Acoustic Emissions (AE) down to MW ~ –4 were recorded at a site 1 km beneath the surface in the Cooke 4 Mine, South Africa. Several planar AE clusters with lateral extent of 10–100 m were identified. Most of them were located several tens of meters away from the mining front, and exhibited steady activity during the analysis period of about two months. Some of the clusters coincided with mapped faults. The planar-cluster AEs were sharply aggregated within a thickness of several decimeters, likely delineating the fracture interface of the fault and its higher-order morphology such as branches, bends, and stepovers. The composite focal mechanism evaluated for each cluster was consistent with slip events on the fracture interface. These results imply that numerous shear microfractures occur steadily on a natural fault surface subjected to a mining-related stress increase. The planar clusters consist of very small AEs (99.7% were smaller than MW –2), exhibiting high b-values much exceeding unity. This contrasts with the more usual b-values of the stope-cluster AEs, which were aggregated within 20 m of the mining front and exhibited a more scattered distribution. The size distribution of microfractures on a fracture interface may directly reflect fine-scale irregularities of the interface. On the other hand, many other mapped faults near the planar AE clusters were not accompanied by AE activities, despite the fact that these quiet faults were subjected to a similar stress history. The presence or absence of AE activities on a fault may reflect different states of the fault, including stress and strength.