Source dimension of AE during frictional sliding

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Since AE during stable sliding is unstable slip in a small part of a fault, we can understand microscopic process of frictional sliding by AE. The purpose of this study is to find the control factor of AE source size. From topography of the fault and mineral distribution, we find quartzes exist at center of projections of some mm in length and several decade micron in height, implying fault topography of intermediate scale depends on the mineral distribution. When the fault surfaces are brought together, the projections may contact to each other. Since AE should be generated by unstable slip between projections in contact, AE source size may depend on the mineral distribution on the fault. The distribution of the real contact spots on the fault may correlate with the mineral distribution.

We need to understand the microscopic process of friction law established by the laboratory experiments to apply it to the natural fault. It is known that acoustic emission (AE) occurs in laboratory experiments of frictional sliding, even if the sliding mode is stable. On the basis of the hypocentral distribution and the focal mechanism solution of AE events, we consider that they are unstable slip in the small parts of the fault. The source dimensions of AE events are estimated to be from a few mm to about 1cm from the analyses of spatio-temporal cluster and pulse widths of the P-wave first motion, being almost equivalent to the grain size of rock sample used in our experiments. In addition, change in the pulse widths of the P-wave first motion with the sliding is small, involving that the source dimension of AE is nearly independent of the sliding distance. On the other hand, roughness of the fault surface varies with the sliding, as is known from the comparison of the fault topography before and after sliding. These suggest that the source dimension of AE event should not be strongly affected by the roughness of the fault surfaces. The main purpose of this study is to clarify the control factor of AE source dimension through investigations of mineral distribution on the fault and of fault surface topography.

The topography of a fault surface ground with #60 abrasive is measured along a profile line to find that (1) projections of about 1cm in length and of several decade micron in amplitude exist on the fault. From the examination by the eye of minerals on the fault surface, we find that (2) the projections coincide with quartz grains, (2) valleys or troughs of about 0.1 mm in depth exist at grains of biotite, and (3) topography at feldspars depend on minerals in the circumference.These observations suggest that fault surface topography of intermediate wavelength depends on mineral distribution on the fault.

The correlation of the distribution of the minerals and the surface topography can be understood by hardness of the minerals. When the fault surfaces are brought together, it is probable that only the projections contact to each other, involving that the source dimension of AE should be affected by the sizes of the projections on the fault surface. That is, the source dimension of AE should be controlled by grain sizes on the fault plane.

In most cases of the past studies on AE events during frictional sliding, it is assumed that the real contact spots are uniformly distributed on the fault plane. Our results, however, suggest that the distribution of the real contact spots is spatially non-uniform, but correlates with the mineral distribution on the fault plane.