Thermal maturity of carbonaceous materials as a new indicator for frictional heat recorded in fault zones during earthquakes

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Most of the total energy budget released during earthquakes is converted into frictional heat in slip zones. Because the amount of frictional heat is directly related to earthquake slip parameters such as shear stress and slip distance, quantitative estimation of earthquake-induced maximum temperature recorded in the fault rocks has been one of the most important issues. Recent multiple laboratory experiments and fault-rock analyses suggested several temperature indicators, including mineral reactions such as thermal decomposition of carbonate minerals and dehydration of clay minerals and anomalies in concentration of fluid-mobile trace elements and Sr isotope ratio due to fluid-rock interaction.
Carbonaceous material (CM), which changes its organochemical characteristics irreversibly with increasing ambient temperature, has been received a marked attention as a new temperature proxy for fault zones since more than 10 years ago. The amount of frictional heat recorded in CM was traditionally investigated by vitrinite reflectance measurement, and recently by IR/Raman spectroscopies, CHO elemental analyses, and biomarker indexes. On the basis of temperatures estimated from these indicators, some studies conducted numerical simulations to infer slip behaviors during earthquakes. However, thermal maturation reaction of CM contains some uncertainties caused from changes in reactivity owing to coseismic shearing, kinetic effects of heating rate, and cumulative effects by earthquake repeating. Understanding how much these effects could affect on CM thermometer is necessary for establishing more accurate temperature indicator. In this presentation, we track the history of CM as a useful thermometer for fault rocks and introduce our recent works investigating effects of coseismic shearing and heating rate on CM thermometer.

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