Experimental measurements and numerical analyses about the temperature change of rocks with stress chang

*Xiaoqiu Yang[1], Weiren Lin[2,3], Osamu Tadai[4], Xin Zeng[1]

1. South China Sea Institute of Oceanology, Chinese Academy of Sciences, 2. Graduate School of Engineering, Kyoto University, 3. Kochi Institute for Core Sample Research, Japan Agency for Marine-Earth Science and Technology (JAMSTEC), 4. Marine Works Japan Ltd.

The temperature responses of rocks to stress changes are key to understanding temperature anomalies in geoscience phenomena such as earthquakes. We developed a new hydrostatic compression system in which the rock specimen center can achieve adiabatic conditions during the first ~10 s following rapid loading or unloading, and systematically measured the representative lithologies of several sedimentary, igneous and metamorphic rocks sampled from two seismogenic zones (the Longmenshan Fault Zone in Sichuan, and the Chelungpu Fault Zone (TCDP Hole-A) in Taiwan), and several quarries worldwide. And we built a finite element model of heat conduction to confirm the measured results of temperature response of rocks to stress change. The results show that: (1) the adiabatic pressure derivative of the temperature (β) for most crustal rocks is ~1.5 to 6.2 mK MPa^{-1}, (2) the temperature response of sedimentary rocks (~3.5 to 6.2 mK MPa^{-1}) is larger than that of igneous and metamorphic rocks (~2.5 to 3.2 mK MPa^{-1}), and (3) there is a good linear correlation between β (in mK MPa^{-1}) and the bulk modulus K (in GPa): $\beta=(-0.068 \cdot K+5.69)\pm0.4$, $R^2=0.85$. This empirical equation will be very useful for estimating the distribution of β in the crust, since K can be calculated when profiles of crustal density (ρ) and elastic wave velocities (V_p, V_s) are obtained from gravity surveys and seismic exploration.

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