Press Releases

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JAMSTEC

Quartz Melting Point Depresses on Fault Plane
- A big step in understanding large earthquake mechanism -

Overview

High velocity friction experiments on quartzite mimicking an earthquake demonstrated that quartz could melt by rapid frictional heating at temperatures of 1350 to 1500 degrees C, 220 – 370 degrees C lower than generally expected, according to a research by Takehiro Hirose at the Fault Mechanics Research Group of the Japan Agency for Marine Earth Science and Technology (JAMSTEC; President Asahiko Taira) carried out in collaboration with Seoul National University, Gyeongsang National University and Andong National University. The research result suggests that frictional melting of quartz could facilitate the fault slip, which is likely to trigger large earthquakes.

During earthquakes, fault moves rapidly at high velocity of meters per second, inevitably leading to generation of frictional heat on fault plane. The heat often melt rocks and subsequently lubricates a fault. The melt lubrication of faults during earthquakes has been considered as one of the mechanisms of earthquake generation. However, quartz, a major component of crustal rocks, has not been expected to melt easily during seismic slip because of a high melting temperature of about 1,726 degrees C. If quartz melt at lower temperatures, however, it means that faults can slip easier, which will lead to large earthquakes. These research results are a big step to understand how earthquakes are generated.

In addition, the result implies that larger amount of frictional melts along faults can be produced by smaller magnitude of fault slip than expected. The results can help estimate more precisely the magnitude of past large earthquakes if any sign of frictional melting is found along a fault by deep seismogenic fault drilling such as the Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) Project[*1] by JAMSTEC.

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*1 The Nankai Trough Seismogenic Zone Experiment (NanTroSEIZE) : It is a complex ocean drilling project that has been conducted over several years with multiple expedition teams of scientists from all around the world. NanTroSEIZE attempts for the first time to drill, sample, and instrument the earthquake-causing, or seismogenic portion of Earth's crust, where violent, large-scale earthquakes have occurred repeatedly throughout history.

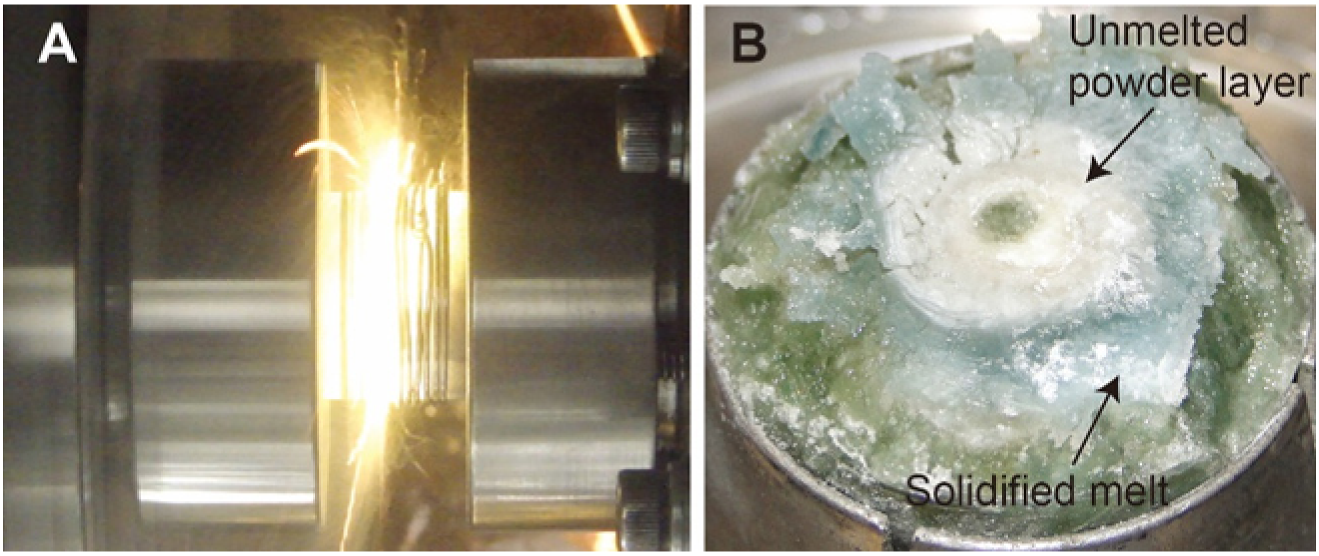

Figure 1. A: A snapshot of the frictional melting of quartzite during a high velocity friction experiment at a velocity of 1.3 meters per second, nearly earthquake velocity conditions.
B. Samples collected after the experiments. They show solidified melt (pale blue) and powder layer at the central portion of the slip zone (white).

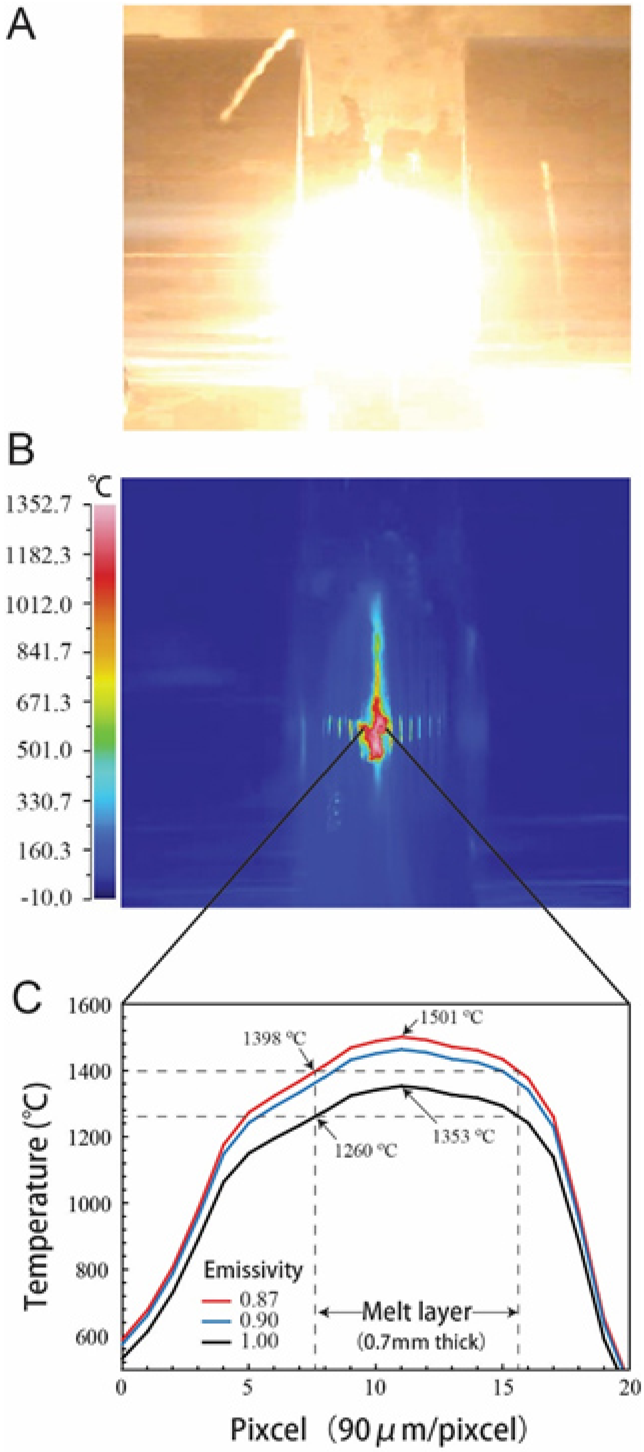

Figure 2. A. An image of frictional melting of quartzite. B. Temperature distribution across the melting zone recorded by an infrared thermographic camera. An emissivity of 1.0 is assumed. C. Temperature profiles across the melting zone. Three emissivities are assumed. It indicates that the temperature of frictional melt reaches 1,353 -1,501 degrees C.

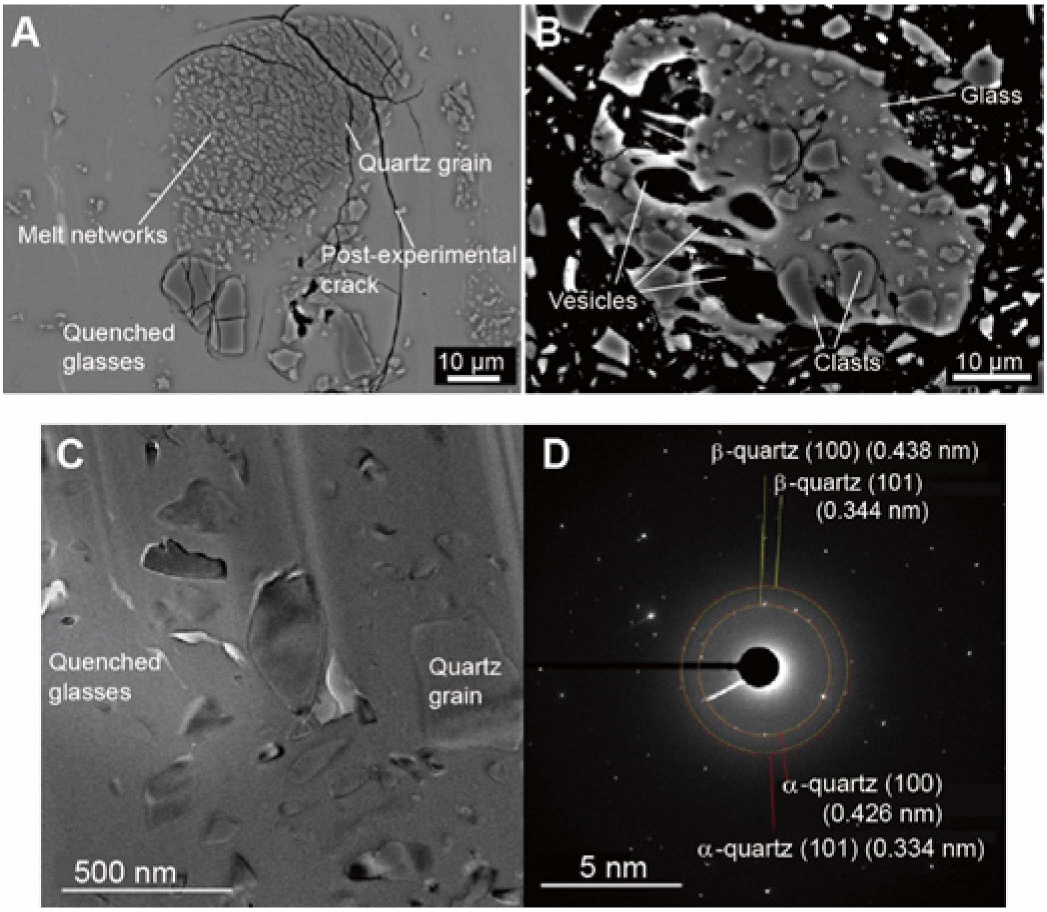

Figure 3. A & B: Backscattered-electron (BSE) images of the recovered products from frictional melting experiments. They show the melt network within quartz clasts. A gray area in B is melted quartz (quenched glass). C & D: High-resolution transmission electron microscope images of a glass matrix in frictionally melted quartzite and electron diffraction pattern for crystalline silica

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