Geodynamics Seminar

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The role of mineral phase transition during high pressure faulting

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主催：愛媛大学地球深部ダイナミクス研究センター
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場所：総合研究棟 4F 会議室

Abstract

Intermediate and deep focus earthquakes (100 -700 km) occur in a pressure and temperature regime where rocks are expected to deform plastically. The idea that they may be triggered by phase transformations in cold subducting lithosphere is appealing. However, the relationship between phase transformation and faulting remains unclear.

Coesite has been recognized as a reliable marker of ultrahigh-pressure (UHP) metamorphic environments in continental collision zones. Recent careful relocation of subduction-zone earthquakes have also shown that at depths of 100–250 km, seismicity occurs in the uppermost part of the slab, where the former oceanic crust has already been converted to eclogite, In the mantle transition zone, olivine undergoes two phase transformations while deep focus earthquakes locate inside the coldest part of slab, where metastable olivine bodies have sometimes been identified.

Here, we provide experimental evidence that, under differential stress at high pressure and temperature conditions P=2-5GPa and T=1150±50K), shear fractures nucleate and propagate at the onset of the olivine -> spinel transition in the Mg2GeO4 analogue system. Similar observations were performed for quartz -> coesite (P=3-4GPa and T=1300±50K) in samples of Arkansas novaculite. In both cases, fracture propagation is sufficiently rapid to radiate energy in the form of intense acoustic emissions. These follow the Gutenberg-Richter law over 4 orders of moment magnitudes and like intermediate and deep-focus earthquakes, require no volumetric strain.

Microstructural analysis shows the development of macroscopic faults, filled with a gouge composed exclusively of the HP polymorph (spinel or coesite). Within the gouge, the material is so fine (1-50 nm) that diffusion accommodated grain boundary sliding may have provided a mechanism viable at “coseismic” strain rates (>104 s-1). Our results seem to indicate as a rule that HP polymorphic transformations are mechanically unstable under stress, simply because they are exothermic and induce large negative DV. This clearly opens the prospects of revisiting a large number of phase transitions to assess their role in the triggering of deep seismicity.

詳細は当センターホームページ: http://www.ehime-u.ac.jp/~grc/をご覧ください
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