Massive production of abiotic methane during subduction zone HP-UHP metamorphism in SW Tianshan, China

LIJUAN ZHANG[1], XIAO WANG[2], LIFEI ZHANG[1], RENBIAO TAO[1] & FENGXIA TIAN[2]

[1]The Key Laboratory of Orogenic Belt and Crustal Evolution, MOE; School of Earth and Space Sciences, Peking University Beijing 100871, China and e-mail address lijuanzhang@pku.edu.cn; lfzhang@pku.edu.cn

[2]School of Earth Sciences and Resources, China University of Geosciences, Beijing, China

Most natural gas reservoirs found in the world are biogenic genesis, whereas more and more methane (CH_4) was found to be abiotic. Abiotic methanogenesis at shallow conditions is well documented, whereas the *P-T-f*O_2 conditions and formation genesis at greater depths are still poorly understood. CH_4 could move upward via mantle wedge, return to the surface by degassing at arc volcanoes and further influence the gas accumulation, climate and environment. Here we first identify massive abiotic CH_4 -bearing fluid inclusions (FIs) in garnet and omphacite, in ultrahigh-pressure (UHP) eclogites from the Western Tianshan cold subduction zone in China. We assess the geochemistry of CH_4-bearing FIs and find that they contain CH_4 and variable minor N_2 in vapor, H_2O in fluid phase, with/without solid phase of calcite, graphite, rutile and quartz. Petrological study and phase equilibrium modeling indicate that the massive CH_4 could be produced in HP-UHP conditions during subduction. The CH_4-bearing FIs in garnet record that they occurred from the prograde metamorphic stage at P-T conditions of 21–23 kbar, 520–530°C and oxygen fugacity condition of FMQ - 2.4 log units, to UHP peak condition of 32-34 kbar, 540–560°C and FMQ - 3.4 log units. Thus, we documented the first natural case of massive reduced carbon (CH_4) liberation by deep subduction fluids at *P-T* conditions of sub-arc depth. The UHP eclogites may represent an important source of abiotic CH_4, with significant implications for deep carbon cycle and gas accumalation. Cold subduction zone is a most important factory for abiotic CH_4.