

Massive abiotic methane production in eclogite during cold subduction

LIJUAN ZHANG AND LIFEI ZHANG

Peking University

Presenting Author: lijuanzhang@pku.edu.cn

Methane (CH₄) is a critical but overlooked component in the study of deep carbon cycle. Abiotic CH₄ produced by serpentinization of ultramafic rocks has received extensive attention, but its formation and flux in mafic rocks during subduction remain poorly understood. Here, we report massive CH₄-rich fluid inclusions in well zoned garnet from eclogites in the Western Tianshan, China. Petrological characteristics and carbon–hydrogen isotopic compositions confirm the abiotic origin of this CH₄. Reconstructed P–T–*f*O₂–fluid trajectories and Deep Earth Water modeling imply that massive abiotic CH₄ was generated during prograde HP–UHP metamorphism at depths of 50–120 km, whereas CO₂ was produced during exhumation. The massive production of abiotic CH₄ in eclogites may result from multiple mechanisms during prograde HP–UHP metamorphism. Our flux calculation proposes that abiotic CH₄ formed in HP–UHP eclogites in cold subduction zones may represent one of the largest, yet overlooked, sources of abiotic CH₄ on Earth.