Goldschmidt 2021 Abstract
https://doi.org/10.7185/gold2021.5926

Formation of abiotic CH_4 in UHP eclogites from S.W. Tianshan subduction zone: Implications for redox state of subducting slabs and deep carbon cycle

CHAO WANG[1,2], LIFEI ZHANG[1], JESSE B. WALTERS[3] AND RENBIAO TAO[4]

[1]Peking University
[2]School of Earth and Space Sciences, Peking University
[3]Goethe Universität
[4]Center for High Pressure Science & Technology Advanced Research

Presenting Author: wangchao1996@pku.edu.cn

Subduction links carbon cycle between Earth's surface and deep interior through geological time. Besides P and T conditions, redox condition (i.e. oxygen fugacity) also plays significant role in deep carbon cycle in subduction zones. In this study, we observed CH_4-rich fluid inclusions in UHP eclogites (with coesite) and CO_2-rich fluid inclusion in HP eclogites (without coesite) from Chinese southwestern (S.W.) Tianshan orogenic belt, respectively. Further phase equilibrium modellings for the CH_4-beairng UHP eclogites indicate that they recorded a cold subduction path, evolving from 420 ℃, 26 kbar to 505 ℃, 29 kbar then to metamorphic peak temperature of ~600 ℃, 19.5 kbar during exhumation. CH_4 fluid inclusions are only observed in garnet core and mantle and omphacite core area, which were formed during prograde process at pressure above 2.7 GPa. Thermodynamical modellings of fluid evolution in spaces of P-T-fO_2-X show CH_4-beairng UHP eclogites would have experienced a reducing process by decreasing intrinsic oxygen fugacity along with adjusting their mineral and fluid composition, and further resulted in production of CH_4 when its fO_2 was lower than the C-H_2O buffer. CH_4 is the dominant C-bearing aqueous specie in fluids in UHP eclogites, which are weakly carbonated. In contrast, CO_2-bearing HP eclogites are strongly carbonated, and inherited high initial redox condition (high carbonate contents and high $Fe^{3+}/\sum Fe$) from oceanic oxidation front. Based on geological observation and relevant thermodynamical modelling, we proposed that ultra-deep, ultra-cold subduction of palaeo-Tianshan oceanic crust offered all kinds of advantage conditions (high-pressure, low oxygen fugacity, rich carbon and water source) for formation of abiotic hydrocarbon (e.g. CH_4) in S.W. Tianshan subduction zone. We further discussed redox evolution of subducting slab (e.g. S.W. Tianshan) and its significance on deep carbon cycle.