Abiotic methane in HP ophicarbonates from Chinese southwestern Tianshan: Implications for immiscible hydrocarbon fluids in subduction zones

Weigang Peng[1], Lifei Zhang[1], Tingting Shen[2], and Han Hu[1]
[1] SESS, Peking University, Beijing, China
[2] Chinese Academy of Geological Sciences, Beijing, China

Subduction zones play a significant role in the deep carbon cycle – they carry carbon at the surface into the deep mantle, as well as documenting the mechanisms of mobility and precipitation of carbonic fluids from subducted slabs. Previous researches are mainly focused on carbonates to shed light on the behaviours of COH fluids from subducted slabs while investigations of hydrocarbon fluids have long been overlooked. The abiotic methane, uncommonly formed at subduction zones, may control the redox state of the mantle and provide insight into the mechanisms of carbon mobility in the deep [1].

Here, we have recognized numerous dolomite-hosted methane-bearing fluid inclusions in HP ophicarbonates from Chinese southwestern Tianshan. We propose that the massive production of abiotic methane at reduced conditions is responsible for the abnormally high carbon isotopes of dolomites ($\delta^{13}C$ = +9.2‰ ~ +11.5‰) while the olivines from HP ophicarbonates (and surrounding UHP serpentinites [2]) may provide potential H_2 for the reduction. We suggest that the abiotic methane was formed during retrogression, which is also evidenced by the transition of antigorite to lizardite in the hosting HP ophicarbonates. However, the recognition of the decarbonation reaction ($Dol+H_2O \rightarrow Cal+Brc+CO_2$), also documented in HP ophicarbonates without abiotic methane from the same study area, may indicate the increasingly oxidized environments. The transition from reduction to oxidation during exhumation may be attributed to the limited olivines in the ultramafics.

It is the first time to report abiotic methanogenesis during exhumation in subduction zones, contributing to comprehend the redox state and mechanisms of carbon mobility during uplift of the subducted slabs.

[1] Vitale Brovarone, A. et al. Massive production of abiotic methane during subduction evidenced in metamorphosed ophicarbonates from the Italian Alps. *Nat. Commun*. **8**, 14134 (2017).
[2] Shen T.T. *et al*. UHP metamorphism documented in Ti-chondrodite- and Ti-clinohumite-bearing serpentinized ultramafic rocks from Chinese southwestern Tianshan. *J. Petrol.* **7**, 1425-1458 (2015).