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Separation of ^{3}He and CH_4 signals on the Mid-Atlantic Ridge at 5°N and 51°N

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Abiogenic methane may be produced in submarine hydrothermal systems by degassing of basalts or serpentinization of ultramafic outcrops. The latter process presumably releases little primordial helium and is therefore implicated by high $CH_4/^{3}He$ ratios in vent fluids from the ultramafic-hosted Rainbow field and in methane plumes near ultramafic outcrops. We report the existence of depth-separated CH_4 and ^{3}He plumes in two segments of the Mid-Atlantic Ridge, at 5.4°N and 51°N. In both cases, the helium plume was deeper, near the valley floor, and the methane carbon isotope ratio was heavy ($\delta^{13}C \approx$ -14‰). The plumes may issue from separate vents, where the helium is discharged near the volcanic axis and the methane is generated by serpentinization higher on the valley wall. However, at the present time the locations of the vents that produce these plumes are not known. Using a one-pass model, we investigated whether separate venting could arise from heat conduction from a primary, helium-carrying, hydrothermal circulation to a second, shallower fracture loop intersecting ultramafic rock. The model results indicate that the flow rate through the secondary loop would have to be relatively low in order for it to stay warm enough for serpentinization to proceed. In this case, some of the exothermic heat production is lost by conduction, and the temperature increase in the circulating fluid is only a fraction of that expected from a water/rock ratio of 1:1.