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Supporting Information for

[Experimental Investigation on the Transport of Sulfide Driven by Melt-rock Reaction in Partially Molten Peridotite]

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Contents of this file

Text S1 to S2
Figures S1 to S9
Tables S1 to S6

Additional Supporting Information (Files uploaded separately)

Tables S1. The statistical results of grain sizes of olivine and clinopyroxene in the upper partially molten peridotite of run PC520, PC528, and PC545.
Tables S2. The statistical results of grain size of sulfide droplets in these experiments of this study.
Tables S3. The composition of starting materials.
Tables S4. EPMA data of olivine, Cpx, and Opx for Figures 6-7.
Tables S5. EPMA data of silicate melt and sulfides for Figure 8.
Tables S6. The results of the thermodynamically-constrained model for Figures 6-8.

Text S1. The methodology for the measurement of grain sizes of olivine and clinopyroxene

In this study, grain sizes of olivine and clinopyroxene in the partially molten peridotite were measured by mapping analyses of electron backscattered diffraction (EBSD) using a Quanta 450 FE-SEM equipped with an HKL Nordlys EBSD detector at the State Key Laboratory of Geological Processes and Mineral Resources (GPMR) of China University of Geosciences. Measurements were performed under the conditions of an accelerating voltage of ~ 20 kV, ~ 0.8 µm step size, a beam current of ~ 6 nA, a tilt angle of ~ 70°, and about ~ 20-25 mm working distance. The smallest detectable grain size was about ~ 4 µm. EBSD patterns of different crystal minerals are determined by the orientations of the grains being examined. By scanning the beam in a grid pattern, a map of the grain orientations can be produced. When a discontinuous change in the orientation occurs, this indicates that a grain boundary has been crossed. The misorientations of greater than 15° were recorded as being distinct grains. Then, orientation maps of different crystal minerals can be built using the commercially available software channel5© to obtain grain sizes of different minerals.

Text S2. The methodology for the measurement of water content in silicate melt using Fourier transform infrared spectroscopy (FTIR)

We used the FTIR to determine the water content of silicate melt in experiments PC520 and PC528 at the State Key Laboratory of Geological Processes and Mineral Resources (GPMR) of China University of Geosciences. Before the FTIR measurements, the samples were double polished to a thickness of 100 µm and kept in a vacuum stove at 400 K for at least 12h to preclude the grain boundary water in samples. The water content can be calculated by using the Beer-Lambert law:

$$C_H = \frac{A \times 18.0152}{d \times \rho \times \varepsilon}, \quad (1)$$

where C_H is the total H_2O content (wt.%), A is the measured absorbance of the peak at 3550 cm^{-1}, after linear baseline correction (≤1), d is the sample thickness (cm); ρ is the density ($g\ L^{-1}$) of silicate melt, ε is the molar absorptivity (62.8 ± 0.8 $L\ mol^{-1}\ cm^{-1}$) (Mercier et al., 2010).

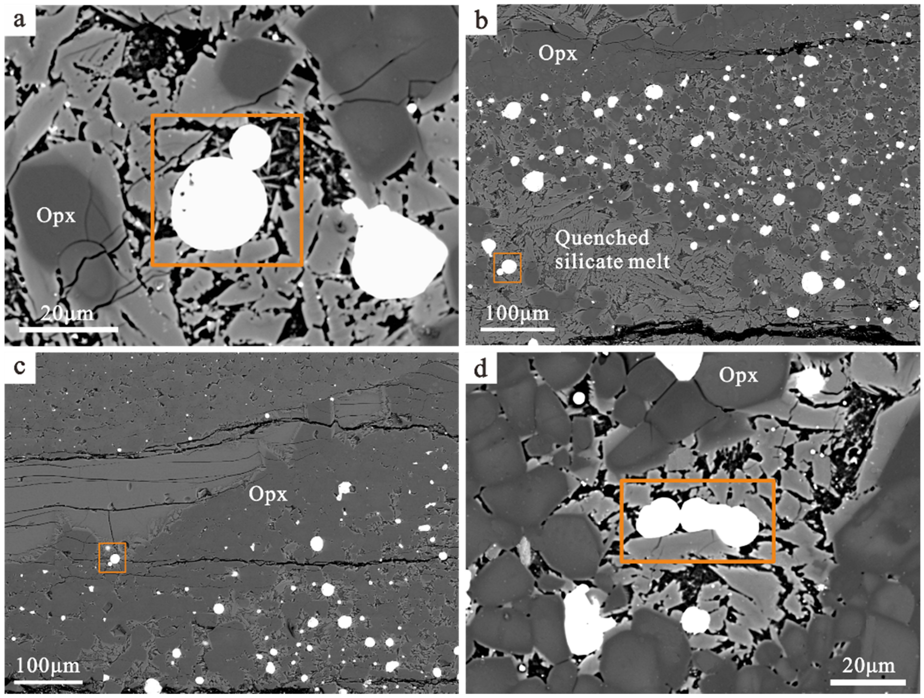

Figure S1. Microstructures of two sulfide droplets contacting each other from experiments PC527 (a-b), PC528 (c), and PC545 (d). Yellow squares denote that two sulfide droplets are contacting and coalescing with each other. Opx-orthopyroxene.

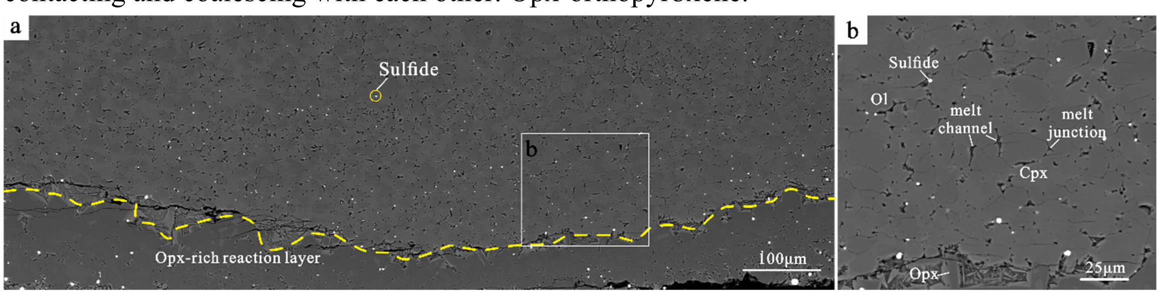

Figure S2. Microstructures of the peridotite and the Opx-rich reaction layer from experiment PC520 (~ 1.5 GPa, ~ 1,250 °C, ~ 12h). The dashed yellow line denotes the top of the Opx-rich reaction layer. The bright white spots in the peridotite are sulfide droplets entrained by the reactive melt flow from the lower melt source. Melt junctions and channels are also designated in (b). Ol-olivine; Opx-orthopyroxene; Cpx-clinopyroxene.

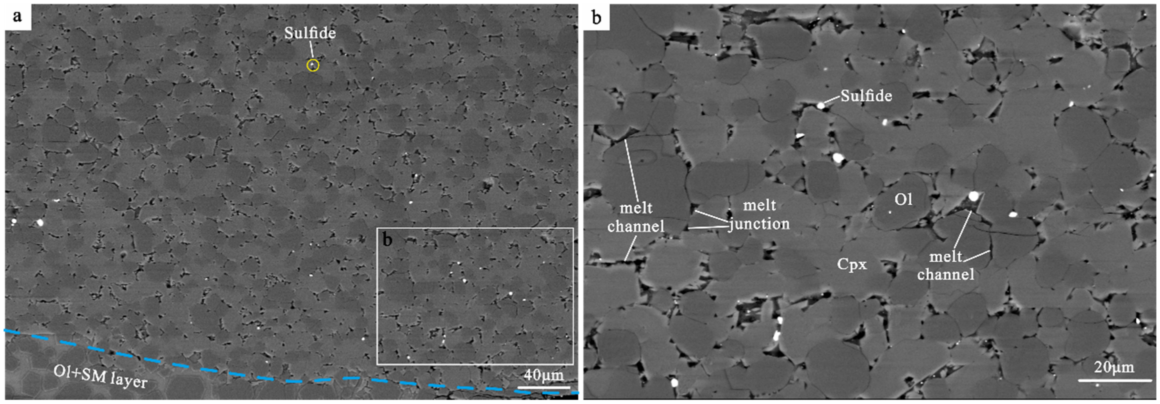

Figure S3. Microstructures of the peridotite and the olivine-melt layer (the Ol+SM layer) from experiment PC527 (~ 1.5 GPa, ~ 1,300 °C, ~ 12h). The dashed cyan line denotes the top of the olivine-melt layer. Symbols are the same as in Figure S2. Ol-olivine; Cpx-clinopyroxene; SM-silicate melt.

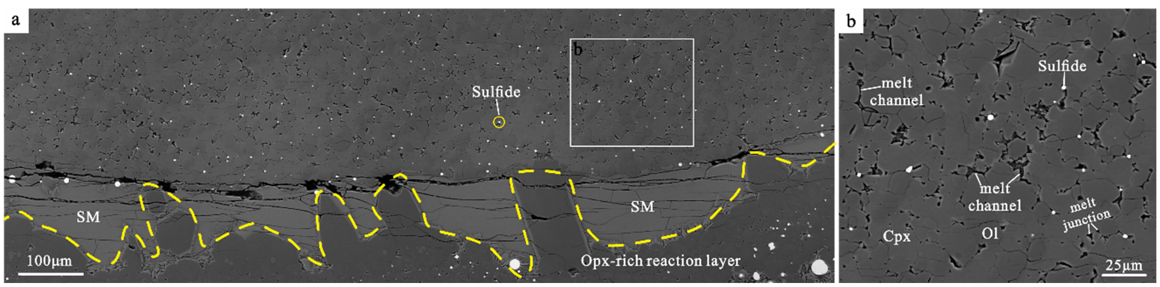

Figure S4. Microstructures of the peridotite and the Opx-rich reaction layer from experiment PC528 (~ 1.5 GPa, ~ 1,250 °C, ~ 48h). Symbols are the same as in Figure S2. Ol-olivine; Cpx-clinopyroxene; Opx-orthopyroxene; SM-silicate melt.

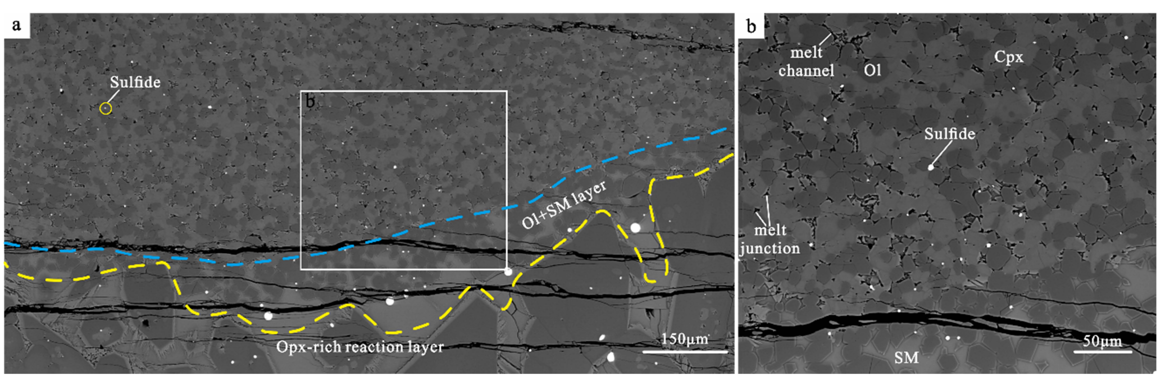

Figure S5. Microstructures of the peridotite, the olivine-melt layer, and the Opx-rich reaction layer from experiment PC545 (~ 1.5 GPa, ~ 1,250 °C, ~ 72h). The dashed blue and yellow lines denote the tops of the olivine-melt layer and Opx-rich reaction layer, respectively. Symbols are the same as in Figure S2. Ol-olivine; Opx-orthopyroxene; Cpx-clinopyroxene; SM-silicate melt.

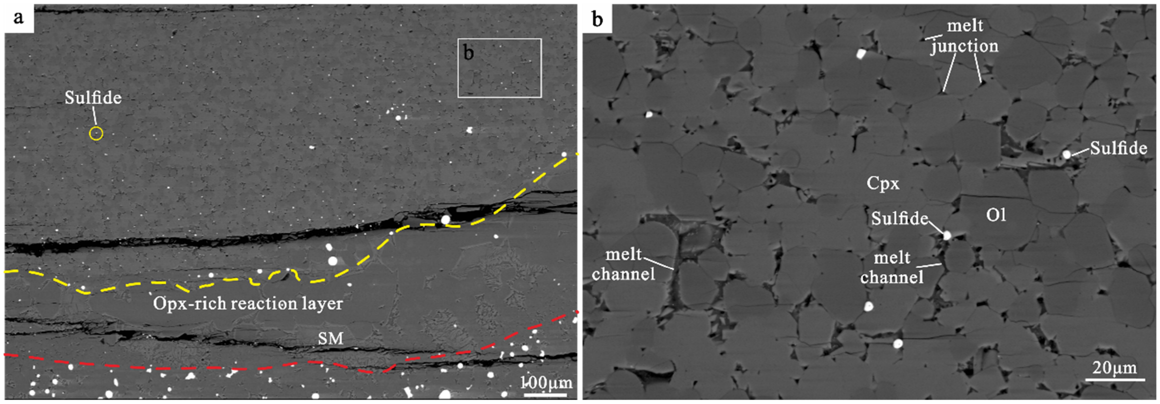

Figure S6. Microstructures of the peridotite and the Opx-rich reaction layer from experiment PC548 (~ 1.5 GPa, ~ 1,250 °C, ~ 48h). The dashed yellow and red lines denote the top of the Opx-rich reaction layer and the original interface between the melt source and peridotite before the melt-rock reaction, respectively. Symbols are the same as in Figure S2. Ol-olivine; Opx-orthopyroxene; Cpx-clinopyroxene; SM-silicate melt.

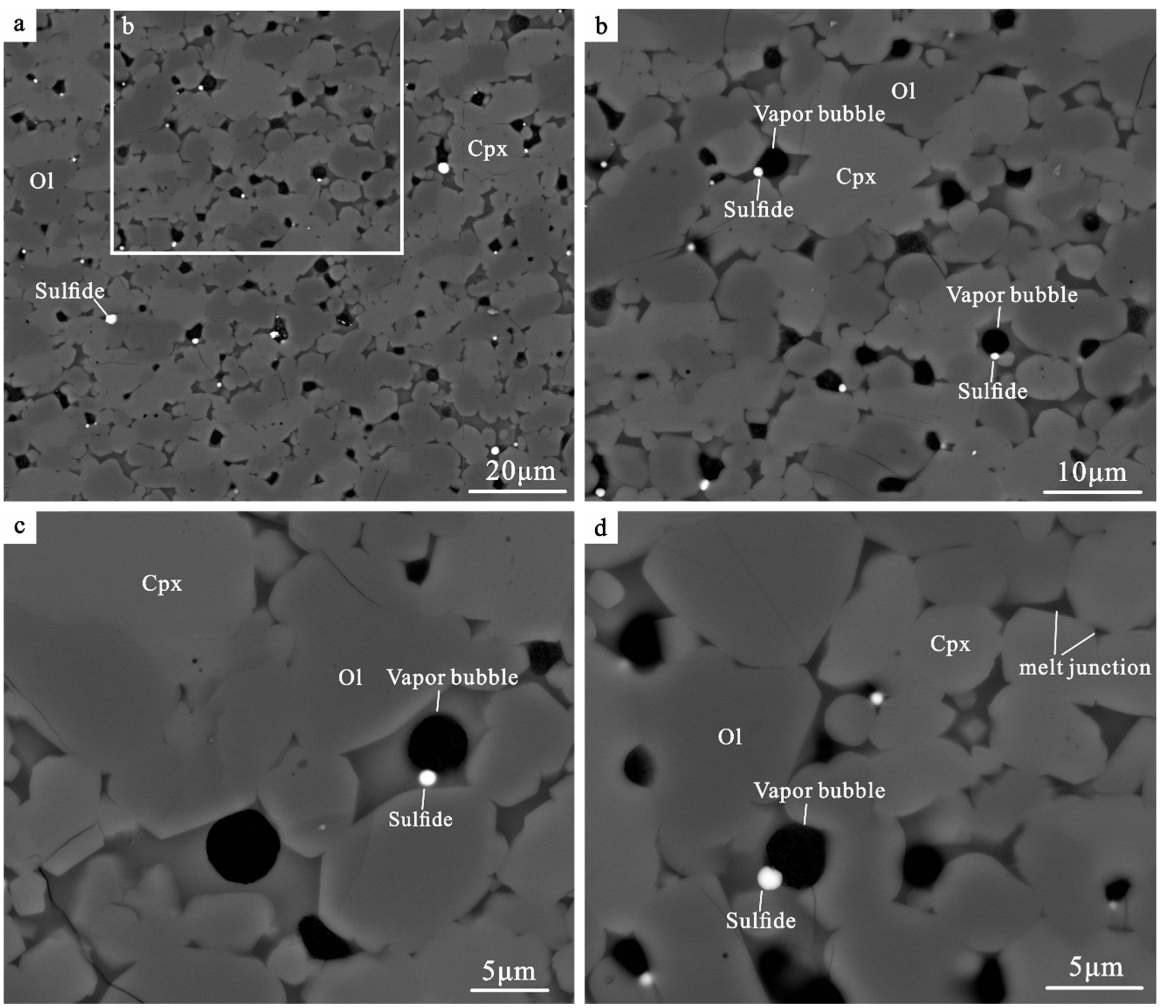

Figure S7. Microstructures of the partially molten peridotite from experiment PC559 (~ 0.5 GPa, ~ 1,200 ℃, ~ 6h). The low pressure (~ 0.5 GPa) potentially leads to the presence of vapor bubbles (mainly H_2O) in the peridotite, forming some sulfide-vapor aggregates. Symbols are the same as in Figure S2. Ol-olivine; Cpx-clinopyroxene.

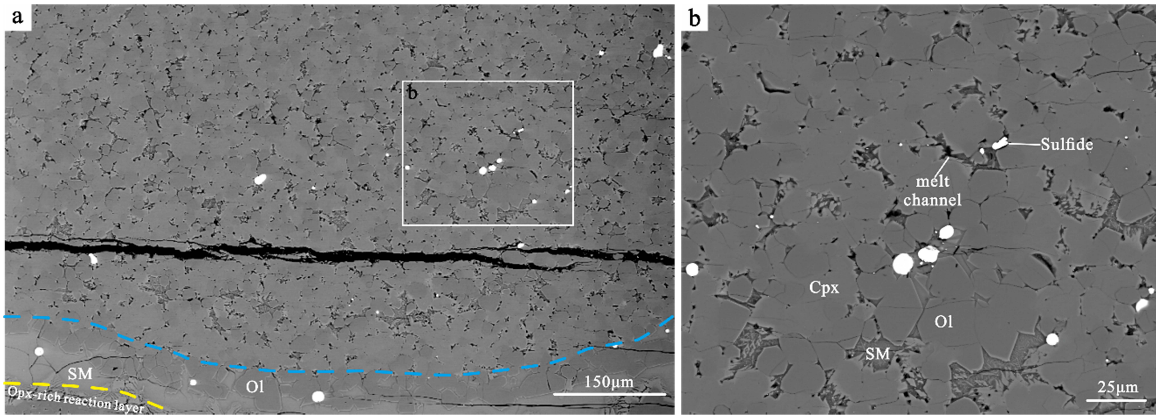

Figure S8. Microstructures of the peridotite, the olivine-melt layer, and the Opx-rich reaction layer from experiment PC560 (~ 1.5 GPa, ~ 1,250 ℃, ~ 24h). Symbols are the same as in Figure S5. Ol-olivine; Opx-orthopyroxene; Cpx-clinopyroxene; SM-silicate melt.

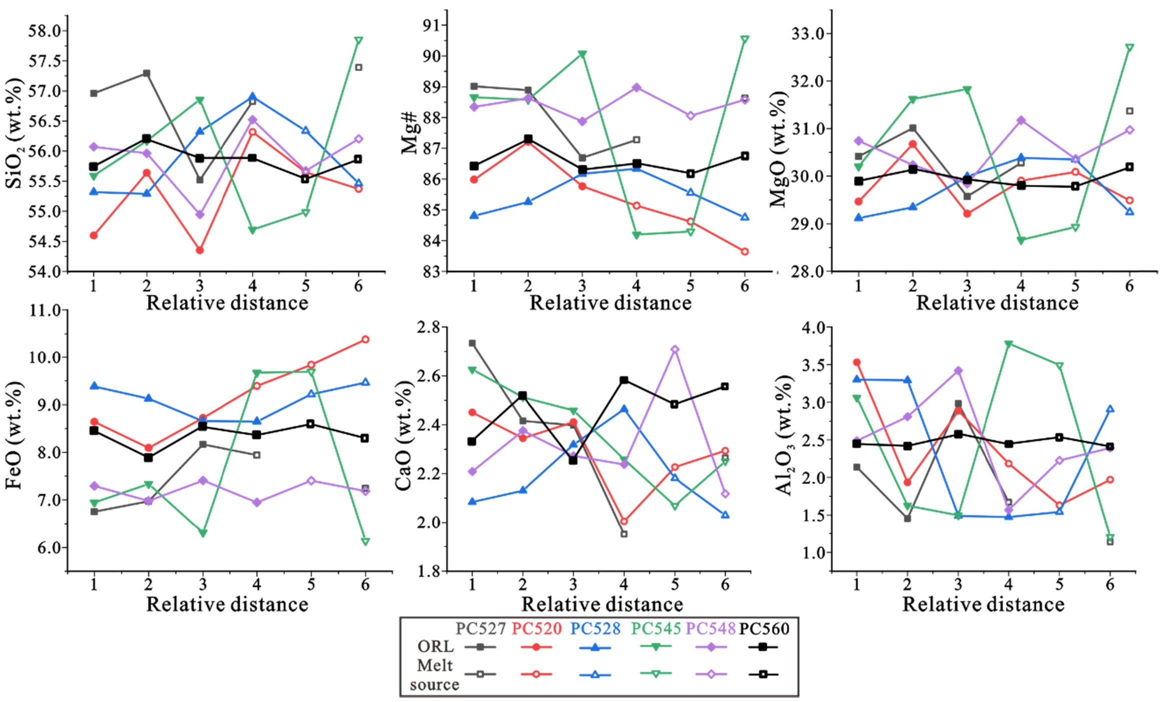

Figure S9. Plots of analyzed oxide abundance (in wt.%) and Mg# of orthopyroxene grains from the ORL to the melt source. The relative distance "1" represents the top of the ORL. The analyzed points are about 50-150 μm apart, depending on the size of orthopyroxene grains and the thickness of ORL.

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