氯化鈉溶液對氯滲入蛇紋岩的影響

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摘要

氯在蛇紋石礦物中的結合對俯衝帶中氯的循環具有重要意義。天然蛇紋岩的流體包裹體中氯含量可高達 50 wt%，但氯化鈉溶液的鹽度對蛇紋石礦物中氯分佈的影響尚未明確。在本研究中，使用來自台灣利吉層的天然蛇紋岩樣品（實驗初始顆粒大小為 100–177μm），將其在氯化鈉溶液（2.93 wt%、8.78 wt%、19.30 wt% NaCl）中，在環境溫度和壓力下平衡反應，反應持續時間為 18 至 43 天。利用電子微探儀（檢測限為 33ppm）分析蛇紋石礦物中的氯濃度。實驗前，蛇紋石的氯含量非常低，為 0.017 ± 0.009 wt%。相比之下，與氯化鈉溶液平衡的蛇紋石中氯含量約為實驗前的三倍，例如，與 2.93 wt% NaCl 平衡 18 天後的蛇紋石，其氯含量為 0.077 ± 0.033wt%。為了檢驗氯是否以弱結合或結構型鍵合形式存在，將蛇紋石在純水中重新平衡約 24 小時。對於與低鹽度溶液（2.93 wt%和 8.78 wt% NaCl）平衡的蛇紋石，重新平衡於純水後，其氯含量損失約 40%。儘管如此，蛇紋石中的氯含量仍高於實驗前水平，這表明氯化鈉溶液可以增加蛇紋石礦物的結構型鍵合氯。這種效應在高鹽度溶液（19.30 wt% NaCl）中更為顯著，重新平衡於純水中的蛇紋石氯含量與在氯化鈉溶液中平衡的水平基本一致。我們的實驗結果表明，氯化鈉溶液可以顯著改變蛇紋石中的氯含量，且結構型鍵合氯可能不一定提供天然蛇紋岩的溫壓（T-P）信息。

關鍵字：氯、蛇紋石化、蛇紋岩、流體鹽度、隱沒帶。

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Effect of saline fluids on chlorine incorporation in serpentine

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Abstract

The incorporation of chlorine in serpentine minerals is crucial for the recycling of chlorine in subduction zones. Fluid inclusions of natural serpentinites have up to 50 wt% Cl, but effect of fluid salinity on chlorine distribution in serpentine minerals is poorly constrained. In this study, natural serpentinites (Lichi Melange, Taiwan) with starting grain sizes of 100–177 μm were equilibrated in saline solutions (2.93 wt%, 8.78 wt %, and 19.30 wt% NaCl) at ambient temperature and pressure for experimental duration from 18 to 43 days. The concentrations of chlorine in serpentine minerals were analyzed using electron microprobe with a detection limit of 33 ppm. Serpentine before experiments has very low chlorine, 0.017 ± 0.009 wt%. In contrast, serpentine equilibrated in saline solutions contains chlorine around three times higher, e.g., serpentine equilibrated in 2.93 wt% NaCl has 0.077 ± 0.033 wt% Cl after 18 days. The serpentine was re-equilibrated in pure water for around 24 h in order to testify chlorine is hosted in a weak-bound or structurally-bound position. For serpentine minerals equilibrated in low-salinity solutions (2.93 wt% and 8.78 wt% NaCl), they lost ~40% of Cl after re-equilibrated in pure water. Despite such release, chlorine in serpentine minerals is still higher than that of serpentine before experiment, which indicates that saline solutions increase structurally-bound chlorine of serpentine minerals. This is more efficient for high-salinity solution (19.30 wt% NaCl), and chlorine in serpentine re-equilibrated in pure water is essentially the same as that of serpentine equilibrated in the saline solution. Our experimental results suggest that chlorine in serpentine can be greatly modified by saline fluids. The structurally-bound chlorine may not necessarily reflect the T-P information of natural serpentinites.
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Keywords: Chlorine; Serpentinization; Serpentinites; Fluid salinity; Subduction zones