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Vesicles and Sulfide globules in mid-ocean ridge basalts (MORB): A comprehensive study from the Carlsberg Ridge basalt glasses

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A total of 25 basalt glass samples covering the entire length of the Carlsberg Ridge (CR) were analysed to understand the compositional heterogeneities. Here, we present a detailed study of the vesicles containing sulphide-rich spherules in the glasses revealed through the use of scanning electron microscopy (SEM) and Energy Dispersive Spectrometry. Vesicles from the basaltic glasses range from 10 µm to several millimetres. Several of these vesicles also contain sulphide-rich spherules ranging in size from 0.2 to 2.5 µm in diameter. Scanning electron microscopy (SEM) images reveal that the spherules have a high degree of spherical symmetry and are located approximately halfway within the vesicle walls. The dimensions of the vesicles exhibit variability with in a single sample as well as across different samples. However, spherules in a particular vesicle exhibit a strikingly consistent size and arrangement. The dimensions and arrangement of the spherules appears to have been influenced by various factors, including the dimensions of the host vesicle, the depth at which they have erupted, as well as the chemical composition and presence of volatile substances within the melt.

Larger sulphidic globules up to 50 µm in diameter were also found in glass matrix compared to the smaller spherules entrapped in the vesicles. Fe, S, Cu, and Ni are the distinctive components found in both smaller spherules and larger globules. The presence of sulphide-rich globules within the plagioclase phenocrysts indicate magmatic source for sulphur. It is unlikely that the spherules were formed through a straightforward condensation process on the vesicle walls from a portion of the volatile phase within the vesicle. Considering the differential abundance of such features from different ridge locations, this study further places constraints on the heterogeneity, mantle redox conditions, volatile phase composition as well as possible linkages to the hydrothermal vent system in the CR.