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Mineralogy and geochemistry of Martian meteorite NWA 13250: Constraints on magma evolution

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Northwest Africa (NWA) 13250 is a Martian meteorite discovered in Mauritania in 2019, classified as a poikilitic shergottite based on its mineral assemblage, Sr isotope composition, and rare earth element (REE) characteristics reported herein. Similar to other poikilitic shergottites, it is an ultramafic cumulate rock and can be divided into two distinct components: one of poikilitic texture and another of non-poikilitic texture. The poikilitic component is composed of large pyroxene oikocrysts, which are surrounded by fine-grained olivine and Fe-Cr-Ti oxides. The CaO content of pyroxene oikocrysts increases gradually from ~ 5.52 wt% in the cores to ~14.71 wt% in the rims. The non-poikilitic component is composed of pyroxene, olivine, and maskelynite of similar sizes, and pyroxene is composed of both high-calcium augite and low-calcium pigeonite. Also present in the non-poikilitic component are fine-grained Fe-Cr-Ti oxides. Olivine and pyroxene in the poikilitic and non-poikilitic components are similar in composition. Olivine has Fo values from 61 to 66. The average Mg# values of high-calcium and low-calcium pyroxene are 69-77 and 66-69, respectively. The poikilitic component most likely formed in a deep magma chamber in the early stage of magmatic evolution, representing the original magma components at high pressure. The non-poikilitic component probably formed in a shallow surface layer during the late stage of magmatic evolution, representing more evolved magma at relatively low pressure. This multi-stage and polybaric model has been suggested for other poikilitic shergottites. NWA 13250 is geochemically classified as an enriched poikilitic shergottite with an average $[La/Yb]_{CN}$=0.99, showing significant enrichment in light rare earth elements (LREE). However, the measured ^{87}Sr / ^{86}Sr ratio of maskelynite is 0.710~0.711, which falls within the range of an intermediate source region. Therefore, the parent magma might have originated from mixed zones of enriched and depleted sources. Compared with other shergottites, NWA 13250 has experienced a high degree of shock metamorphism, which is manifested by (1) the presence of impact melt pockets and (2) the total conversion of plagioclase to maskelynite ($An_{60-71}Ab_{28-38}Or_{1-2}$).