# FORMATION AND IMPLICATION OF THE TITANIUM-RICH SHOCK MELT POCKETS IN EUCRITE NORTHWEST AFRICA 8003

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**Introduction:** Shock-induced melts can be categorized as shock melt veins (SMVs) and pockets (SMPs) based on their geometries [1–3]. SMPs are either irregularly isolated or interconnected by SMVs. They are results of localized concentrations of stress and temperature [1]. Processes such as shock-wave collisions, frictional heating, and collapse of open fractures (e.g., cracks and vesicles) have been proposed to account for the formation of SMVs [4–5]. Collapse of open spaces has also been suggested as the formation mechanism of SMPs [3–4]. High P-T excursion (e.g., 60–80 GPa, 1600–2000 °C) has been suggested to interpret the formation of SMPs in martian meteorites [2,3,6]. However, high P-T excursion was not always inferred in some shocked meteorites. Therefore, how SMPs formed remain unclear. Here, we report a novel type of Ti-rich SMP (simply as Ti-SMP) in eucrite NWA 8003, which are morphologically and chemically disctinct from the SMPs in previous studies. The formation condition and formation mechanism of the Ti-SMPs are discussed.

**Results and discussions:** The Ti-SMPs (<50 μm) in NWA 8003 occur exclusively within the rock fragments that are entrained in SMVs. In most cases, Ti-SMPs are isolated and have no direct contact with SMVs. Occasionally, some off-shoots of Ti-SMPs intrude into their host phases and the SMVs nearby. The presence of off-shoots of Ti-SMPs into SMVs indicate that Ti-SMPs postdate the formation of the SMVs. Ti-SMPs exhibit sharp boundary with the surrounding phases. Relicts of primary ilmenite are observed in some Ti-SMPs, indicating in-situ melting.

Various mineral assemblages are observed in different Ti-SMPs, consisting of Ti-dominant oxides, Ti-rich silicates and some other phases (corundum, kyanite, and silica). In some of the Ti-SMPs, a new mineral vestaite $(TiFe)Ti_3O_9$ was found [7–8]. Subhedral-euhedral grains of corundum, vestaite, and kyanite are usually embedded in a fine-grained intergrowth. The typical texture is fine-grained intergrowth of secondary ilmenite and silicate in the Ti-SMPs. The enrichment of Fe and Ti in Ti-SMPs substantiate the preferentially melting of ilmenite at the grain boundaries to adjacent silicates (e.g. plagioclase, pyroxene). Therefore, the temperature must be above the melting point of ilmenite (1470 °C). A lower limit of pressure of ~2.7 GPa can be inferred based on the kyanite-sillimanite equilibrium boundary at a temperature of 1500 °C [9]. The cooling time of Ti-SMPs (<50 μm) might be less than 1 ms [10], which can account for the preservation of high-pressure assemblages.

The absence of Ti-SMPs outside the SMVs and the off-shoots of SMPs show that Ti-SMPs and SMVs are genetically related but Ti-SMPs probably formed slightly later than SMVs. The high density and the low melting point of ilmenite might be the essential properties to form Ti-SMPs. Discontinuous propagation of a shock wave at interfaces with strong density differences (e.g., ilmenite vs. plagioclase) and impedance contrasts (shock velocity × density) will cause local shearing and friction [11–12]. In addition, after the formation of SMVs by the primary shock wave, reflected shock waves may have provided additional shearing to finally melt the pre-heated ilmenite-silicate interfaces while the rock was still pressure-loaded which could explain the off-shoots of the Ti-SMPs into SMVs.

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