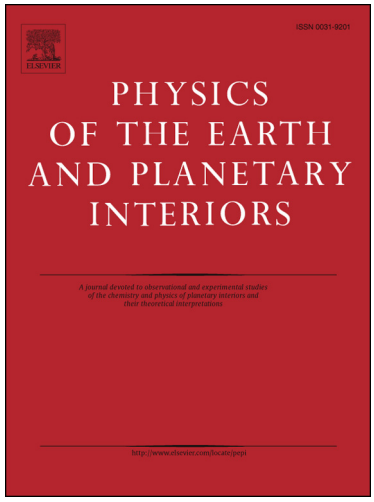

Melting efficiency of troilite-iron assemblages in shock-darkening: insight from numerical modeling

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Melting efficiency of troilite-iron assemblages in shock-darkening: insight from numerical modeling.

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Abstract

We studied shock-darkening in ordinary chondrites by observing the propagation of shock waves and melting through mixtures of silicates, metals and iron sulfides. We used the shock physics code iSALE at the mesoscale to simulate shock compression of modeled ordinary chondrites (using olivine, iron and troilite). We introduced FeS-FeNi eutectic properties and partial melting in a series of chosen configurations of iron and troilite grains mixtures in a sample plate. We observed, at a nominal pressure of 45 GPa, partial melting of troilite in all models. Only few of the models showed partial melting of iron (a phase difficult to melt in shock heating) due to the eutectic properties of the mixtures. Iron melting only occurred in models presenting either strong shock wave concentration effects or effects of heating by pore crushing, for which we provided more details. Further effects are discussed such as the frictional heating between iron and troilite and the heat diffusion in scenarios with strongly heated troilite. We also characterized troilite melting in the 32-60 GPa nominal pressure range. We concluded that specific dispositions of iron and troilite grains in mixtures allow for melting of iron and explain why it is possible to find a wide textural variety of melted and unmelted metal and iron sulfide grains in shock-darkened ordinary chondrites. We finally observe shock-melting of albite within a few iron and troilite grain models, and investigate the effects of higher porosity within the olivine matrix in the single iron and troilite grain models.