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# Chemical projectile-target interaction during hypervelocity cratering experiments (MEMIN project).

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The detection and identification of meteoritic components in impact-derived rocks are of great value for confirming an impact origin and reconstructing the type of extraterrestrial material that repeatedly stroke the Earth during geologic evolution [1]. However, little is known about processes that control the projectile distribution into the various impactites that originate during the cratering and excavation process, and inter-element fractionation between siderophile elements during impact cratering.
In the context of the MEMIN project, cratering experiments have been performed using spheres of Cr-V-Co-Mo-W-rich steel and of the iron meteorite Campo del Cielo (IAB) as projectiles accelerated to about 5 km/s, and blocks of Seeberger sandstone as target. The experiments were carried out at the two-stage acceleration facilities of the Fraunhofer Ernst-Mach-Institute (Freiburg).
Our results are based on geochemical analyses of highly shocked ejecta material. The ejecta show various shock features including multiple sets of planar deformations features (PDF) in quartz, diaplectic quartz, and partial melting of the sandstone. Melting is concentrated in the phyllosilicate-bearing sandstone matrix but involves quartz, too. Droplets of molten projectile have entered the low-viscosity sandstone melt but not quartz glass. Silica-rich sandstone melts are enriched in the elements that are used to trace the projectile, like Fe, Ni, Cr, Co, and V (but no or little W and Mo). Inter-element ratios of these “projectile” tracer elements within the contaminated sandstone melt may be strongly modified from the original ratios in the projectiles. This fractionation most likely result from variation in the lithophile or siderophile character and/or from differences in reactivity of these tracer elements with oxygen [2] during interaction of metal melt with silicate melt. The shocked quartz with PDF is also enriched in Fe and Ni (experiment with a meteorite iron projectile) and in Fe, Cr, Co and V (experiment with the steel projectile). An enrichment of W and Mo in the shocked quartzes could not be observed. It is suggested that two types of geochemical mixing processes between projectile and target occur during the impact process: (i) After shock compression with formation of PDF in Qtz and diaplectic quartz glass, up to about 1 % of projectile matter is added to these phases without detectable fractionation between the meteoritic tracer elements (except W and Mo). We suggest that projectile material was introduced to shocked quartz from a metallic vapour phase, which was formed near the projectile-target interface. The lack of W and Mo enrichment in shocked target material probably results from the relatively high melting and boiling points of these elements. (ii) In addition heterogeneous melting of sandstone and projectile and subsequent mixing of both melts inter-element fractionation occurred according to the chemical properties of the elements. Fractionation processes similar to our type (ii) are known from natural impactites [3].

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References:

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