TROILITE-METAL NODULE IN KATOL CHONDRITE - ROLE OF IMPACT AND NOBLE GAS EVIDENCES

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Introduction: Katol, a troilite-metal nodule bearing strongly equilibrated L6-7 chondrite, is a recent fall in India (May, 2012) [1]. Origin of the troilite-metal nodules, largely in L chondrites remain least understood although role of shock melting, impact-induced vaporisation or sub-solidus diffusion are proposed [2,3,4]. Present study focuses on formation mechanism of troilite-rich, Fe, Ni-metal nodule (~2 cm across) that includes a large variety of shock-induced melt-dominated micro-textures. We have also studied noble gases in the nodule to discern preferential gas loss due to shock, if any, compared to the bulk [5].

Mineral and textural studies: Katol nodule is essentially an immiscible submicron scale intergrowth of Ni- rich troilite (mean (wt%) Ni:1.81, S: 32.63 wt%), S-bearing kamacite (S:0.55, Ni: 6.18) and taenite (S:0.64, Ni:8.65). Metal-troilites are juxtaposed with intensely fractured silicate minerals, mainly olivine (Fa: 25.0), low-Ca pyroxene (Fs:21.2) and large volume of maskelynite. Moderate shock evidences are clearly imprinted in chondritic silicates (PDF in olivine, diapletctic plagioclase crystal and glass), while compression shock wave and subsequent shear-stress resulted in several ductile-brittle micro-textures (swiss cheese, fizz troilite, sheared troilite, metal-droplets and globules, shear melt veins, melt pockets including high pressure phases, maskelynite-I that quenched under high pressure [Raman bands, 510 and 580 cm^{-1}], wadsleyite [Raman bands, 716, 918 cm^{-1}] and ringwoodite [Raman bands, 799, 841 cm^{-1}]) within the nodule. Post-shock decompression textures were identified as melt breccias, metal dendrites, secondary melt veins and pockets and maskelynite-II [Raman bands, 508, 516, 587 cm^{-1}] that quenched under low pressure.

Noble gas isotopes: Ne is purely cosmogenic but all other noble gases are a mixture of cosmogenic, radiogenic and trapped components. Cosmogenic (^{3}He, ^{21}Ne) and radiogenic (^{4}He, ^{40}Ar and ^{129}Xe) amounts are comparable in this nodule with the bulk sample [5], though $(^{22}Ne/^{21}Ne)_c$ are different, indicating different depths of sample location. If U, Th and K are similar in both samples, it indicates gas losses due to shock effects are similar in both samples, and the major shock event occurred, prior to cosmic ray exposure.

Discussion: Based on the complexly intergrown troilite-metal texture, the nodule formation is likely a localised event by a high energy impact which facilitates spatially focused frictional heating at the structural and compositional discontinuities. Our results correspond to calibrated peak shock pressure of ~ 45 GPa with peak shock temperature between 900°C to 1500°C. However, peak shock pressure locally exceeds the shock facies S_6 (> 45 GPa). Furthermore, Cu and Zn in the nodule confirm the path of metal migration through the melt phase while sulphides through both metal and vapour phase. Overall shock-thermal history of the Katol nodule is dissimilar from those of host chondrite as the latter had been subject to equilibrium moderate shock pressure without any shear deformation.

References: [1] Ray D. et al. 2014. *LPSC* 45, #1300. [2] Widom E. 1986. *GCA* 50:1989-1995. [3] Kong P. et al. 1998. *MAPS* 33:993-998. [4] Rubin A. E. 1999. *JGR* 104:30799-30804. [5] Murty S.V.S. et al. 2014. This conf.