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The Katol (L6-7): A unique chondrite with evidences for shock-induced melting and post-shock annealing

D. Ray, S. Ghosh and **A.D.Shukla**[#]
Physical Research Laboratory, Ahmedabad 380 009, India (dwijesh@prl.res.in)
[#]presenting author

Abstract

Troilite-metal nodules (TMN) bearing Katol chondrite is classified as L6-7(S2). Its complex thermal-shock history includes highly thermal metamorphism in the host chondrite and extreme shock metamorphism and subsequent post-shock annealing in the TMN. The latter exhibits numerous shear melt veins (SMV) with quenched metal sulphide melt (QMSM) textures, maskelynite and ringwoodite. Subsequent healing in response to post-shock annealing induces degenerated plessites and undulose extinction of olivine grains which are intensely fractured and filled with QMSM.

1. Introduction

The Katol chondrite is one of the recent meteorite showers (May 22, 2012) in India. This unique chondrite hosts an unusual piece of TMN [1,2]. The silicate part of the chondrite is highly recrystallised and hardly any relict chondrule is discernible. Based on homogenetity of olivine (Fa 25.1, PMD: 2.37), low-Ca pyroxene (Fs 21.2, PMD: 0.82) and coarse plagioclase grains (generally > 100μ), Katol resembles to highly equilibrated petrologic type. There are no significant shock features except impact induced fracturing in olivines and pyroxenes and diaplectic plagioclase are recorded. In contrast, TMN is an impact melt product of mainly troilite and metal including high pressure silicate polymorphs. In this communication, we will discuss the nature of newly identified SMVs, microstructures of plessite within Fe,Ni alloy in order to understand the TMN shock history and post-shock annealing.

2. Microstructures

2.1 Quenched Metal-Sulphide Melt

QMSM is the major component of the TMN (Fig. 1).Texturally it looks like a metal-sulphide mosaic due to quenched droplets and irregular blebs of metals within the troilite host (Fig. 2). The SMVs with different scales and in bifurcating pattern are the preferred sites of such quenched melts. (Fig. 1,2).

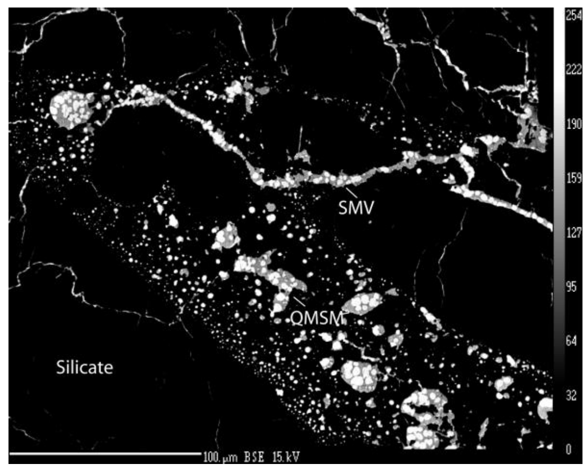

Figure 1: BSE image of QMSM and veins of SMV.

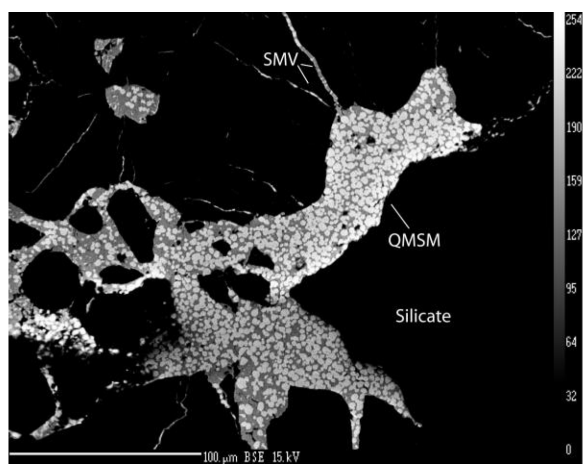

Figure 2: Irregularly branched SMVs showing caught-up silicate fragments in QMSM.

2.2 Metallography

Apart from isolated grains, a few coarse kamacite-taenite assemblages are found to occur adjacent to shock melt vein. The most interesting feature is the finely crenulated taenite bands within kamacite in the plessite regions (Fig. 3,4) with well developed outer-taenite rim. The Ni content of kamacite within the plessite is comparatively low (Ni: 3.5-5.35 wt%), where as the outer taenite rim shows high Ni content (Ni:48.11 wt%).

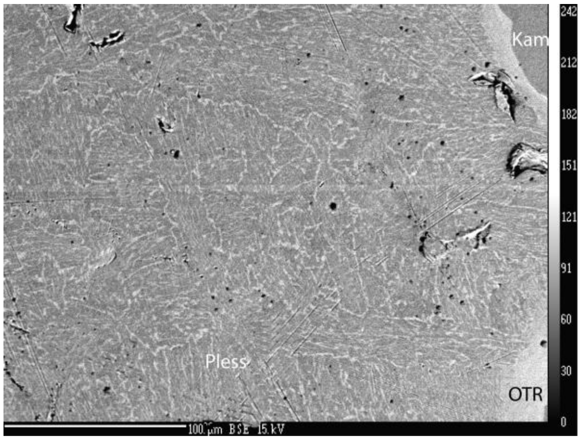

Figure 3: Fine crenulations within plessite (Pless). OTR:Outer taenite rim, Kam: Kamacite

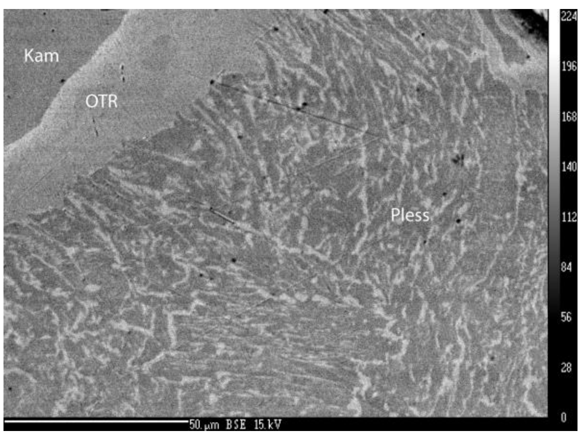

Figure 4: Degenerated plessite (in high mag) OTR:Outer taenite rim, Kam: Kamacite.

2.3 Post-shock annealing

Annealing is a slow recovery process through cooling of the shock-induced heat generated in the target rocks. Effects of post-shock annealing are more common in ordinary chondrites and commonly represent low shock stage despite previously experienced relatively higher shock [3]. Presence of shock-melted plagioclase glass, numerous shock-melt veins, high pressure polymorphs suggest that Katol attained a maximum shock pressure up to S6. Subsequent annealing developed polycrystalline troilite, degenerated plessites and part healing of crystalline damage in olivine grains in the form of undulose extinction.

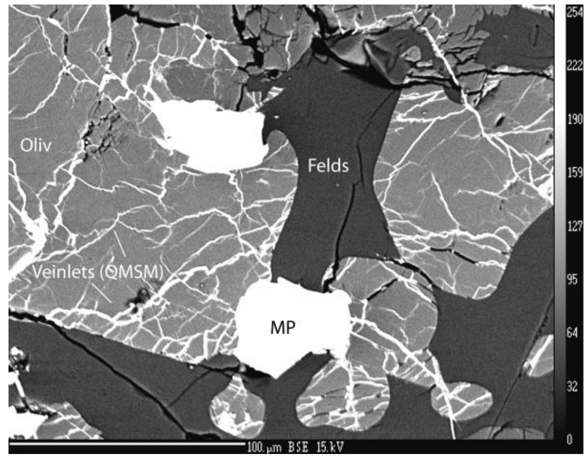

Figure 5: Fractures filling within olivine (Oliv) by QMSM. MP: Melt pockets, Felds: Feldspar

3. Summary and Conclusions

Based on microstructures, it appears that the impact generated hot, molten metal-troilite (Fe-Ni-S) melt was injected into the major shear veins and adjoining fractured silicates. TMN comprising SMVs filled with QMSM is a product of high energy, localised impact. Post-shock annealing lowered down the shock stage (S2) in silicates and degenerated the plessite. Finally, annealing healed and sealed the fractures in olivine grains by QMSM (Fig. 5).

References

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[3] Rubin, A.E. Postshock annealing and postannealing shock in equilibrated ordinary chondrites: Implications for the thermal and shock histories of chondrite asteroids. Geochimica et Cosmochimica Acta, Vol. 68, pp. 673-689, 2004.