OBLIQUE IMPACT INDUCED MICROTEXTURES IN ORDINARY CHONDRITE: EVIDENCES FROM SHYTAL L6, DACCA, BANGLADESH. S. Ghosh (sombhunath.ghosh@gmail.com) and D. Ray (dwijesh@prl.res.in), Physical Research Laboratory, Ahmedabad 380 009, India.

Introduction: Shytal chondrite (fell: 11th August, 1863) is a pyramid shaped fragment (13.5cm x 10.4cm x 9.5cm) of), fully covered with numerous deep elongated compound regmaglypts and shallow simple regmaglypts. Breccia texture and anastomosing shock veins are partly exposed underneath the brownish gray fusion crust which is 0.3 mm thick, close textured, and locally showing radiating streaks.

In this communication, we have carried out a detail investigation on primary and secondary properties through mineralogy and bulk chemistry and shock-thermal history through the microtextures.

Analytical Techniques: Petrography was carried out on polished thin sections under transmitted- and reflected- light microscope. Textural studies are documented with high- resolution backscattered images and mineral compositions are precisely determined by Electron Probe Micro Analyser equipped with Wavelength Dispersive Spetrometers (Cameca SX 100). An accelerating voltage of 15 kV, sample current 15-20 nA and 1 micron beam were used during analyses. Natural and synthetic standards were employed to check instrument calibration and the obtained data were internally PAP corrected [1]. Bulk chemistry has been carried out using a 5g fresh piece following the gravimetric- AAS technique [2].

Textures and Mineral Chemistry: It is an equilibrated ordinary chondrite comprising several poorly defined relict clasts of porphyritic olivine (PO) and radiating pyroxene (RP) chondrules in a coarsely recrystallised matrix of olivine (mean Fa 25.2), low- Ca pyroxene (mean Fs 21.3) and secondary ternary non-stoichiometric feldspar (mean catsum: 4.512), the latter in a dress of diaplectic plagioclase glass (after solid-state transformation) and maskelynite (quenched plagioclase melt). High Ca pyroxene (mean $En_{6.0}$ $Fs_{34.9}$ $Wo_{59.1}$), kamacite (mean Ni: 6.54 wt%), taenite (mean Ni: 27.3 wt%), troilite (with Ni <0.5 wt%), spinel, and merrillite (mean Ca_{45} $Na_{2.5}$ $Mg_{3.5}$ $Fe_{1.0}$ $P_{47.5}$) are other minor accessories. Considerable replacement of Mg^{2+} by Fe^{2+} in chromite is indicated from excess Fe-enrichment. At places, large troilite grains penetrate into the silicates following fractures. We assigned the chondrite to L group based on mean composition of olivine and low Ca pyroxene [3] and petrologic type 6 based on compositional homogeneity of major silicates with <2% PMD, thermally equilibrated matrix including coarse interstitial grains of feldspar and high Ca-pyroxene [4].

Bulk Chemistry: We present the bulk composition (major and minor elements) and some significant parameters of Shytal chondrite to confirm and compare with average L- group [5]. Shytal is slightly Mg depleted and total Fe- enriched mainly because of silicate iron and it is also evident from Fe- rich olivine, Fe-rich pyroxene and Fe- rich chromite. Mg/Si, Al/Si, Ca/Si and Fe_t/Si ratios are 0.80, 0.06, 0.08 and 1.24 respectively and well corresponds with the average data of L group.

Shock metamorphism: Impact signatures to well-equilibrated polymineralic aggregate of Shytal chondrite are available in different forms and in different scales. Brecciation and fracturing in silicate rich aggregate is ubiquitous down to submicron level. Both irregular and regular planar fractures (pf) frequently in olivine and less commonly in pyroxene represent brittle deformation of variable shock impedance. Local heating at the shock pressure spikes has caused brittle-ductile deformation in the form of lattice structure damage at submicron scale and the effect is planar deformation features (pdf) especially in olivine grains. Similar nature of deformation is also noticed in low density silicate or plagioclase as solid state transformation of plagioclase into diaplectic plagioclase glass (Fig. 1) [6]. Most localized shock induced ductile deformations in Shytal are identified as Maskelynite (Fig. 1) [6] and Silicate darkening (Fig. 2) [7].

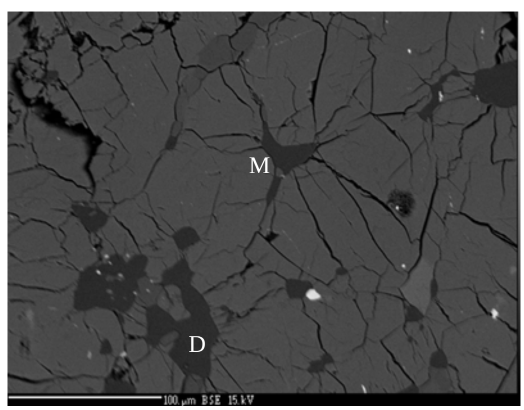

Fig. 1 Shock induced Diaplectic plagioclase (D) and localized development of Maskelynite (M). Note that fracturing (radiating cracks) also developed at the surrounding silicate minerals. Fine specs of metals are also noticed.

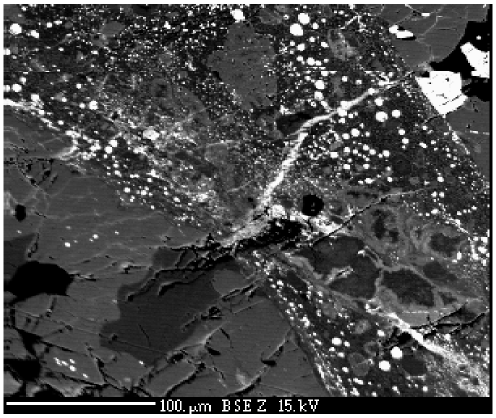

Fig. 2 Silicate darkening showing immiscible metal-sulphide- silicate emulsion texture in Shytal chondrite

The former exhibits a few micron sized quenched plagioclase melt with radiating cracks and the latter shows curvilinear trails of troilite melt pervasive from megascopic to the submicroscopic level and traverse silicate interiors either cutting across or, following grain boundaries and shock- induced fracture planes. This melt often carries tiny metal grains, droplets and globules, metal- troilite eutectic texture (Fig. 3), fragments and sludge of silicates. Shock- induced small scale chemical transformation is also recorded within the ductile zone as Fe enrichment (Fa_{32-34}) of olivine grain margin caught up in shock melted troilite (Fig. 4).

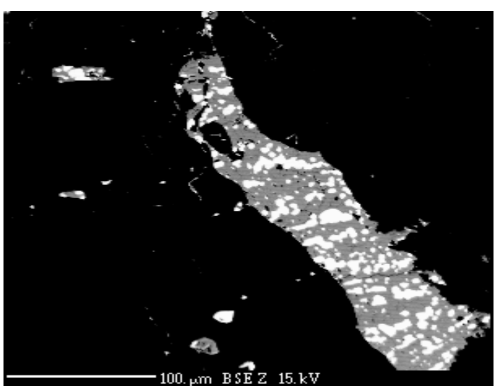

Fig. 3 Metal-troilite eutectic texture in Shytal Chondrite

Discussion: Shock textures are spatially distributed because of the development of innumerable shock pressure spikes at structural and compositional discontinuities during shock pressure excursion across grain boundaries and their spontaneous re-equilibration through local heating in micro- and nanoseconds. Brecciation and planar fractures with limited pdf especially in olivine are shock-induced mechanical transformation or brittle deformation caused by impact or first order directed stress.

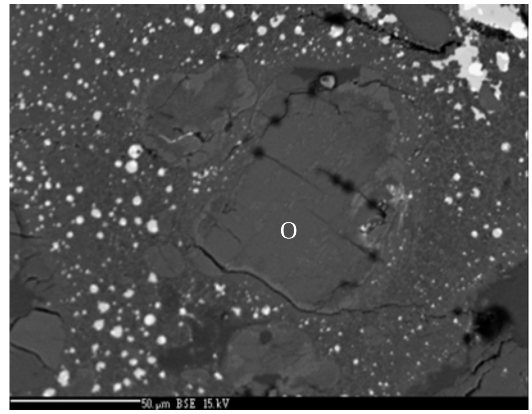

Fig. 4 Marginal Fe enrichment at olivine (O) grains within the shock vein

Heating associated with this stress was not high enough to cause melting of low density silicates or, metal-troilite and that is why we record the textures of diaplectic plagioclase glass (formed by solid-state transformation), monocrystalline troilite and unshocked kamacite and taenite all of which are spatially distributed with respect to shock vein. It seems that the ‘low shock- high strain’ oblique impact generated shear stress or shock veins within which we note ‘silicate darkening’ due to immiscible metal droplets in melted troilite, metal- troilite eutectic texture and in the immediate vicinity small size quenched plagioclase melt with radiating cracks. Frictional melting in the high strain zone of shock veins is also preserved in partial chemical transformation of a few subrounded olivine grains. It is envisaged that the P-T regime for Shytal shock vein formation was within ~25 GPa and ~1500^{o}C considering low peak shock pressure for oblique impact, and > 988^{o}C for metal-troilite eutectic and partial alteration of olivine.

References: [1] Pouchon J. L. and Pichoir F. (1991) New York, Plenum Press, 31–75. [2] DasGupta, S.P. et al. (1978) *Min. Mag*. 42, 493- 497 [3] Keil K. and Fredriksson K. (1964) *J. Geophy. Res.*, 69, 3487- 3515 [4] Van Schmus W.R and Wood J.A. (1967) *Geochim. Cosmochim. Acta* 31, 747- 765 [5] Dodd, R.T. 1981 Cambridge Univ. Press, 368p. [6] El Goresy et al. (2013) *Geochim. Cosmochim. Acta* 101, 233- 262 [7] Rubin A.E. (1992) *Geochim. Cosmochim. Acta* 56, 1705- 1714.