RAMAN SPECTROSCOPIC STUDIES OF SHOCK INDUCED DIAMONDS FROM ORDINARY CHONDRITIC METEORITES. A. Bhattacharya[1] and A. Dutta[1], [1]Meteorite and Planetary Science Division, Geological Survey of India, 15, A & B Kyd Street, Kolkata-700016, India, Email: anindya.gsi@gmail.com.

Introduction: Extraterrestrial microdiamonds of diverse polytypes from ordinary chondrites along with other sensitive shock indicators can be used as an important marker for calibrating meteoites under different shock stages. Diamond is an abundant phase in space and exists in the meteorites, inside the planets, interplanetary dust particles, comet dusts and stars [1]. The present abstract is aimed at presenting the incidence of extraterrestrial diamond and diamond diversity in ordinary chondrites with an observation on the origin of the microdiamonds. The extraterrestrial nanodiamonds are believed to be formed before or during the formation of our solar system because of the isotopic anomalies and can be found in the most primitive meteorites, mostly in carbonaceous chondrites [2].

Methods: Raman Spectroscopy aided by Cathodolumineascence study (CL) had been the most useful tool for identifying the different carbon phases along with different polytypes of diamond in the studied ordinary chondrites. The different diamond polytypes and shock features were identified by the Renishaw Invia Reflex Micro-Raman instrument with 514 nm edge Ar-laser and 785 nm edge laser using ~ 1 µm beam diameter and focus energy ~ 15 – 18 mW to acquire the Raman signal.

Results: The rare presence of extraterrestrial diamonds in ordinary chondrites determined by Raman Spectroscopy is being reported in this abstract. The ordinary chondrites in general contain less than 0.2 wt % carbon [3]. The chondritic meteorites (e.g., Bori, Mirzapur, Kuttippuram and Chainpur) of varying chemical and petrologic types (LL3 – L5 – L6) with different shock grade (S5 – S6) display the presence of different diamond polytypes and other carbon phases with a wide range in Raman shifts from 1306 cm^{-1} to 1385 cm^{-1}. Thus diamonds have been reported form different meteorites under varied shock stages.The studied chondritic meteorites are essentially composed of olivine + orthopyroxene + Na-plagioclase ± clinopyroxene ± apatite ± merrillite + magnetite ± chromite ± troilite ± Fe and Fe-Ni metal. The shock features in the studied meteorites have been established from fracturing of olivine and pyroxene phenocrysts, presence of isotropic shock veins and melt pockets, melting of plagioclase and pyroxene to glass and presence of high pressure polymorphs of olivine (ringwoodite) due to high intensity impact induced shock deformation. Raman spectrum measured from shocked olivine grains gives the Raman fingerprint bands at 796,797,799 cm^{-1} and 844, 845, 846 cm^{-1} respectively, corresponds to ringwoodite occurring as fine lamellae within the host olivine. Presence of ringwoodite indicates escalation of impact pressure at about 18 - 20 GPa and temperatures range from 900 - 1100°C [4]. Disordered olivine structure observed from the meteorites with doublet peak position shifts towards higher wavenumbers suggests to shock pressure at about 50 GPa [5]. Moreover presence of plagioclase melt glass occurring along the interstitial/intergranular spaces of olivine and pyroxene and within the matrix suggests to shock pressures at above ~ 45 GPa [6].

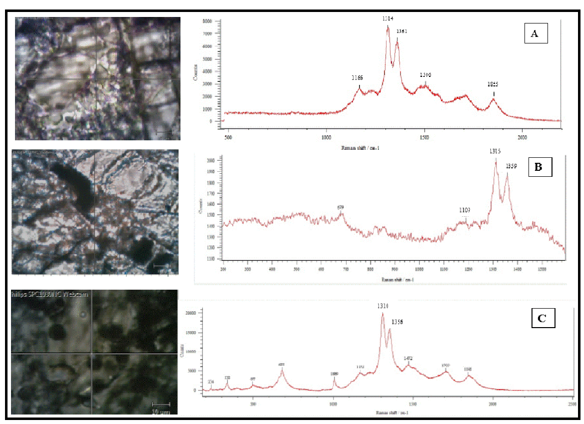

Figure 1: Raman spectroscopic signature of difffernt polytypes of microdiamonds (A) Lonsdalite occurring in matrix in Mirzapur meteorite, (B) 8H polytype occurring in shocked vein in Bori meteorite (C) 8H polytype occurring as inclusion in clinopyroxene in Kuttippuram meteorite.

The micro-diamonds present from the shocked chondrites (Bori, Mirzapur, Kuttippuram and Chainpur) have bimodal occurrenece and are mainly present in the shock veins and rarely as inclusions within shocked olivine and pyroxene. The intergranular spaces and matrix are being occupied by amorphous carbon and graphitic material. Different diamond polytypes were identified from characteristic Raman peaks at 1308 cm^{-1}, 1314 cm^{-1}, 1315 cm^{-1}, 1318 cm^{-1}, 1322 cm^{-1}, 1332 cm^{-1}, 1333 cm^{-1}, 1359 cm^{-1} 1360 cm^{-1}, 1379 cm^{-1} & 1393 cm^{-1}, 1504 cm^{-1},1585 cm^{-1}, 1588 cm^{-1} corresponding to different polytypes of diamond like 6H, 8H, B-C phase, lonsdaleite - 2H. The Raman shift towards smaller wavenumber at 1315 cm^{-1} indicates to the presence of lonsdalite with more ordered carbon form and hexagonal symmetry. The presence of microdiamonds within the shock veins indicates to High Pressure High Temperature (HPHT) impact genesis at 45 GPa and 2230 ± 140 K. The Raman shifts at 1580 cm^{-1} and 1469 cm^{-1} corresponds to graphitic phase and fullerene present within the shocked induced veins.

Conclusion: Though there are many existing theories which explains the origin of extraterrestrial microdiamonds, the presence of different microdiamond polytypes in the ordinary chondrites (Bori, Mirzapur, Kuttippuram and Chainpur) within shocked veins and as inclusions within shocked olivine (ringwoodite) and pyroxene may indiacate to its origin from (HPHT) impact processes.

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