

RAMAN SPECTROSCOPIC STUDY OF DERGAON H5 AND MAHADEVPUR H4/5 CHONDRITES.

Bhaskar J. Saikia¹, G. Parthasarathy², R. R. Borah³ and R. Borthakur³, ¹Department of Physics, ADP College, Nagaon, India, ²National Geophysical Research Institute (CSIR-NGRI), Hyderabad, India, ³Department of Physics, Nowgong College, Nagaon, India. (vaskaradp@gmail.com)

Introduction: Raman spectra are produced by molecular vibrations and provide direct means for studying and identifying minerals. It is mainly sensitive to short-range effects on the mineral structure and to a lesser extent to long-range effects. Minerals are identified by their spectral patterns and mineral compositions can be inferred from the peak positions. Meteorites are the only physical materials available on the Earth that allow direct study of the original dust from which the Solar System formed. Many reports have described the Raman spectra of Olivine in meteorites [1-5]. The chemical composition for olivine is in a narrow range for all the meteorites. The well-known doublet for the Si-O vibration of olivine can be seen at constant average values of 820–852 cm^{-1} . Infrared spectroscopic studies of these two meteorites have been reported by many authors [6-9]. The study intends to determine the vibrational characteristics of olivines and pyroxenes in Dergaon H5 [10] and Mahadevpur H4/5 [11] chondrites which are structurally deformed by shock metamorphism.

Methods: The Raman spectra are collected using a Ar^+ excitation source having wavelength 488 nm coupled with a Jobin-Yvon Horiba LabRam-HR Micro Raman spectrometer equipped with an Olympus microscope with 10X, 50X and 100X objectives and a motorized x-y stage and using 1800 gr./mm grating in the range from 100 to 4000 cm^{-1} . The investigated Raman spectra, only wavenumbers between 200 cm^{-1} and 1100 cm^{-1} were accounted here, because we are not investigating the bands of the minerals observed between 1100 cm^{-1} and 4000 cm^{-1} . Spectra were generally collected with counting times ranging between 10 and 60 s.

Results and Discussions: The Figure 1 and Table 1 reveals Raman spectra corresponding to olivine, pyroxene and plagioclase in Dergaon H5 and Mahadevpur H4/5 chondrites. Generally olivine has 81 numbers of optic modes, out of which 36 numbers are Raman-active [5,12-14]. Raman active modes in olivine are divided into three spectral regions: peaks below 400 cm^{-1} are attributed to the translational and rotational lattice modes. Peaks between 400 cm^{-1} and 800 cm^{-1} can be assigned to the internal bending of the SiO_4 tetrahedron (ν_2 and ν_4) and Si and Mg dis-

placements, peaks between 800 cm^{-1} and 1100 cm^{-1} are associated with the internal stretching of the SiO_4 tetrahedron (ν_1 and ν_3). The reported peaks in Mahadevpur H4/5 chondrite between 800 and 1100 cm^{-1} are attributed to SiO_4 internal stretching vibrational modes, the dominant feature in this region is a doublet with peaks near 823.21, 856.13, 936.95 and 1009.78 cm^{-1} . In this region only two peaks at 935.21 cm^{-1} and 1006.57 cm^{-1} is observed in Dergaon H5 chondrite. The relative heights of these peaks are a function of crystal orientation. The observed peaks at 823.21, 856.13 and 936.95 cm^{-1} in the Mahadevpur H4/5 chondrite spectrum is indicative to forsterite. In olivine spectrum, generally, five apparent peaks are denoted as peak 1 (826–819 cm^{-1}), peak 2 (858–849 cm^{-1}), peak 3 (883–881 cm^{-1}), peak 4 (920–914 cm^{-1}), and peak 5 (967–951 cm^{-1}). For forsterite, peak 1, peak 2, and peak 5 are assigned to the A_g symmetry, peak 3 to B_{2g} symmetry, and peak 4 to B_{3g} symmetry. Peak 1 and peak 2 are assigned respectively to the coupled modes ν_3 and ν_1 ; the other peaks are the ν_3 modes [15].

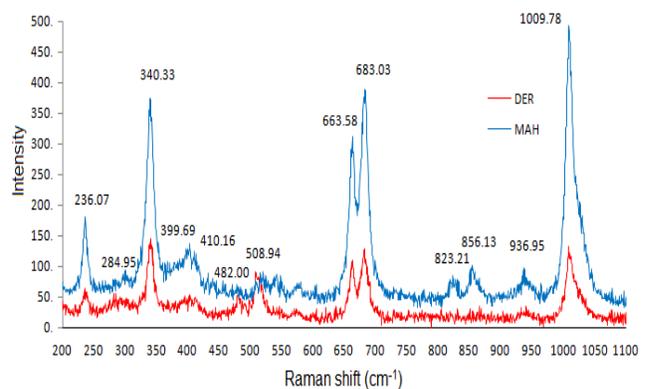


Figure 1. Raman spectra of the studied chondrites (in between 200-1100 cm^{-1})

The peak observed at 410.16, 482.21, 520.41, 541.86, 573.34, 605.21, 663.58, 683.03 cm^{-1} and 508.94, 573.79, 661.25, 681.54 cm^{-1} in Mahadevpur H4/5 and Dergaon H5 chondrites respectively were arises due to the internal bending of the SiO_4 tetrahedron (ν_2 and ν_4) and Si and Mg displacements. The most intense bands of the Raman spectra at 1006.57 – 1009.78; 661.25 – 663.58 and 681.54 – 683.03 cm^{-1} have been assigned to the stretching $\nu(\text{Si-O}_{nb})$ and $\nu(\text{Si-O}_b\text{-Si})$,

respectively, where O_{nb} and O_b mean non-bonded oxygen and the chain-bonded oxygen of the SiO_4 tetrahedron, respectively, in the two oxygenshared SiO_4 tetrahedra of inosilicates [12-18]. The major peaks below 400cm^{-1} region are 236.07, 284.94, 340.33 and 399.69 cm^{-1} for Mahadevpur H4/5 and the peaks at 226.69, 279.47 and 340.33 cm^{-1} are for Dergaon H5 chondrite. These peaks are mostly contributed by lattice modes: rotations and translations of SiO_4 units and translations of octahedral cations in the crystal lattice. The observed peaks around 330, 658, 676 and 1004 cm^{-1} are attributed to characteristic magnesian types of pyroxene. The plagioclase feldspars exhibit a characteristic A_g vibrational mode between 500 and 510 cm^{-1} which is observed in the spectrum of Dergaon H5 chondrite at 508.94 cm^{-1} . Another band observed at 482.21 cm^{-1} in the Mahadevpur H4/5 chondrite have been assigned to a mixed Si-O-Si (or Si-O-Al) band/stretch [19]

Table 1. Main peaks measured in the Raman spectra.

Sample	olivine	pyroxene	chromite	plagioclase
Mahadevpur	236.07	340.33	683.03	482.21
	284.94	399.69		573.34
	410.16	520.41		
	541.86	663.58		
	605.21	936.95		
	823.21	1009.78		
	856.13			
Dergaon	226.69	340.33	681.54	508.94
	279.47	661.25		573.79
		935.21		
		1006.57		

Conclusions: The studied Raman spectra reveals the orthopyroxenes and plagioclase are the major mineral phases identified in the studied chondrites, followed by olivines. The presence of mid intensity band around 935 cm^{-1} in both chondrites suggests a partially polymerized silicate framework.

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