Meteorite fall at Karimati village, Hamirpur, Uttar Pradesh

We report here a recent meteorite fall that occurred on 28 May 2009 at around 12:00 noon, in Karimati village, Tahsil Hamirpur (25°57′N, 80°09′E/25.95°N, 80.15°E), Uttar Pradesh (Figure 1 *a* and *b*). According to the eye witness, a roaring sound was heard and a blackish stone (Figure 1 *c*) fell near a wall in his house, 1.5 m away from him. Out of fear, villagers put the stone in a water tank for about 72 h. When the local authorities came to know about it, they took the material in their custody. One of the authors (H.C.V.) visited the place on 2 June following a newspaper report and took possession of the stone from Tahsil office for research purposes. He also visited the fall site to examine the crater. There was a heavy rain on 30 May 2009 and the crater was little altered due to water. The examination revealed that the ~8 cm deep crater was nearly of oval shape with a maximum diameter of 18 cm and a minimum diameter of 15 cm (Figure 1 *d*).

The stone itself was covered with a black crust except at one corner where the local people had broken a small part of it out of curiosity. As seen in Figure 1 *c*, the surface has a number of regmaglypts. The weight was about 1 kg and had specific gravity of around 3.3, typical of stony meteorites. A small part coming out from the broken area was used to do Mössbauer spectroscopy, SEM-EDAX analysis and other experiments, and the main stone was transferred to Physical Research Laboratory, Ahmedabad.

All meteorites have iron-bearing minerals and Mössbauer parameters of these minerals give important information about the meteorites. Our group has explored the potential of this technique in the field of meteorite classification. Each broad class of meteorite has its own characteristic Mössbauer pattern and the absorption area ratios give finer details of the classification.

A small piece was crushed and 50 mg of this was sandwitched between two layers of a transparent tape in the circular area of 12 mm diameter. This sample was subjected to transmission Mössbauer spectroscopy with ^{57}Co source in a standard constant acceleration spectrometer set up.

Figure 2 *a* shows the Mössbauer spectrum of this meteorite recorded at room temperature and Table 1 gives the Mössbauer parameters. The main iron bearing minerals are olivine, pyroxene triolite and kamacite. This confirms that the meteorite under consideration is an ordinary

Figure 1. ***a***, Location of the meteorite fall, Karimati village in India map, denoted by the green balloon; ***b***, Detailed location in Hamirpur District, denoted by the balloon marked 2; ***c***, The whole meteorite piece, and ***d***, Oval shape crater (of about 18 cm longer diameter, 15 cm shorter diameter and 8 cm deep).

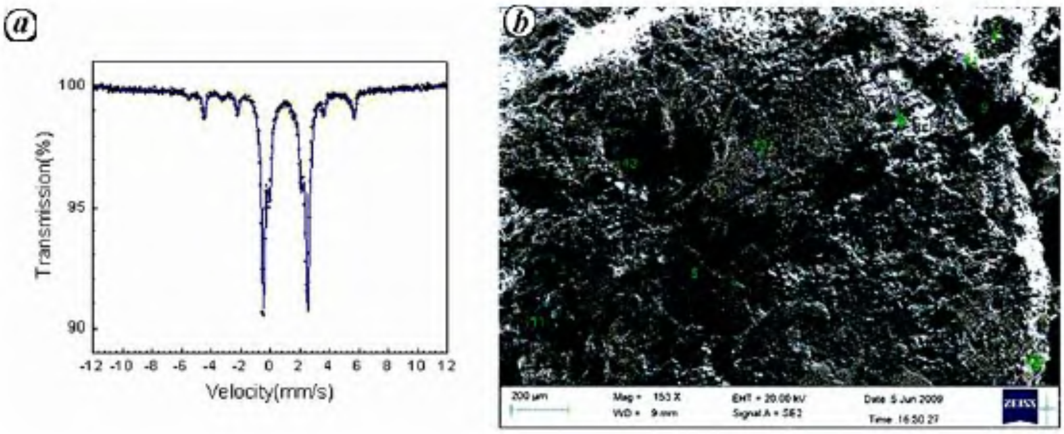

Figure 2. ***a***, Room temperature Mössbauer spectrum of the meteorite fallen at Karimati. Black circles are the experimental points and solid blue line is the least square fit; ***b***, Scanning electron microscopy image of the polished piece cut from the meteorite.

Table 1. Mössbauer parameters of different phases present in the meteorite

Mineral	IS (mm/s)	QS (mm/s)	LWD (mm/s)	B_{hf}(T)	Area (%)
Pyroxene	1.13	2.12	0.33	–	23.0
Olivine	1.13	2.99	0.30	–	59.5
Troilite	0.76	–0.06	0.25	31.4	12.7
Metallic	–0.02	0.04	0.46	33.4	4.7

Table 2. Average composition of main elements found in Karimati meteorite using EDAX analysis. The rest is oxygen and some other trace elements

Element	Atomic %
Carbon	10.21
Sodium	2.80
Magnesium	7.93
Aluminum	2.57
Silicon	10.14
Sulphur	4.29
Potassium	0.26
Calcium	0.50
Titanium	0.02
Chromium	0.153
Iron	8.04
Nickel	0.34

chondrite[1,2]. All unweathered meteorites of the class ordinary chondrites show these four iron-bearing minerals, the Mössbauer absorption areas were in different ranges for the three subclasses H, L and LL of this class. Verma *et al.*[3] have studied Mössbauer parameters of a large number of meteorites and reported certain systematic characteristics of H, L and LL chondrites. For example, when the pyroxene absorption area is plotted against olivine absorption area, the H-chondrites fall in a certain region of the plot and L, LL fall in certain other region. Similar separation occurs when absorption area for metallic phase is plotted against that for silicate phase. Another criterion for looking into the sub-classification is based on absorption area of olivine to that of pyroxene, which is <1.9 for H-chondrites, between 2.0 and 2.4 for most of the L-chondrites and above 2.6 for most of the LL-chondrites. On the basis of the Mössbauer parameters obtained in the present study, the meteorite is either L or LL-chondrite.

We have also done SEM-EDAX analysis on a polished section and Figure 2 *b* shows a typical micrograph. The EDAX analysis was done at 26 spot scans, one line scan and two frame scans. On the basis of this, the average main elemental abundances are shown in Table 2. The olivine and pyroxene grains are largly Mg rich. In kamacite, Ni is found to be less than 4%. However, a possible tenite phase was also identified where the nickel content was about 25%. Apart from this, feldspar plagioclas was observed in abundance. Carbon, known to be present in ordinary chondrites, was also found to be abundant.

In conclusion, the meteorite has all the characteristics of an ordinary chondrite, of either L or LL type. The main minerals present are Mg-rich olivine and pyroxene, plagioclase, feldspar, triolite and kamacite. Carbon is quite abundant in the matrix. The SEM picture also suggests a high metamorphism and a higher petrologic grade.

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