Physical Characteristics of the Massive Meteorite of Saudi Empty Quarter

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Abstract

The meteorite found in the Empty Quarter of the KSA is the largest meteorite and has the shape of an irregular ellipsoid of semi axes (0.65 × 0.38 × 0.27) and density of 6400 kg/m^3 and mass of 2550 kg. It is a massive piece belonging to the category of iron–nickel meteorites with an occurrence (or fall) of only 5% of total showers. The present report was on the physical characteristics (elemental composition and structural) of this piece using laser break down spectroscopy (LIBS), X-ray fluorescence (XRF) and Energy dispersive X-ray spectrophotometer (EDX), Scanning Electron microscope (SEM) Xray diffraction (XRD) etc. Our investigation indicated that this piece consists of 91% iron, 5% Ni, 1.51% P, 0.3% Co, and a host of others; most of them exist as oxides. Since the measured density is only 6400 kg/m^3 the meteorite is porous (approximately about 19%) which is confirmed by the micro hardness. Based on these physical measurements, it is very likely that this meteorite would have "escaped" from the belt around Mars and Jupiter and unlikely from the moon or elsewhere. This could be the first investigation, employing the above sophisticated instruments, on that massive Saudi meteorite.

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Keywords

Physical characteristics • Massive meteorite • Saudi empty quarter • Modern analytical methods

1 Introduction

The last two decades have seen a very powerful research activity for the development, advancement and achievement of laser-induced break-down spectroscopy (LIBS) as a practicable and effective analytical tool that can be used for the study of air, water, and solid materials [1–4] plus geo-materials [5–7].

In the current study, the physical characteristics of meteorite samples were studied using laser break down spectroscopy (LIBS), X-ray fluorescence (XRF) and Energy dispersive X-ray spectrophotometer (EDX), Scanning Electron microscope (SEM) and Xray diffraction (XRD) etc.

2 Materials and Methods

The following instruments were used LIBS (Applied Spectra, USA), XRF (S8 Tiger, Brucker), EDX, SEM (JSM-6380 LA, JEOL) to study the meteorite samples (Fig. 1).

3 Results and Discussion

3.1 LIBS Analysis

We have recorded the meteorite sample LIBS spectra at different points and with altered laser energy, delay time and gate width in air atmosphere. The experimental results show highest abundance in the sample with Ni and P etc. in different proportions as shown in Fig. 2. In order to estimate the different elements concentrations, the revealed elements

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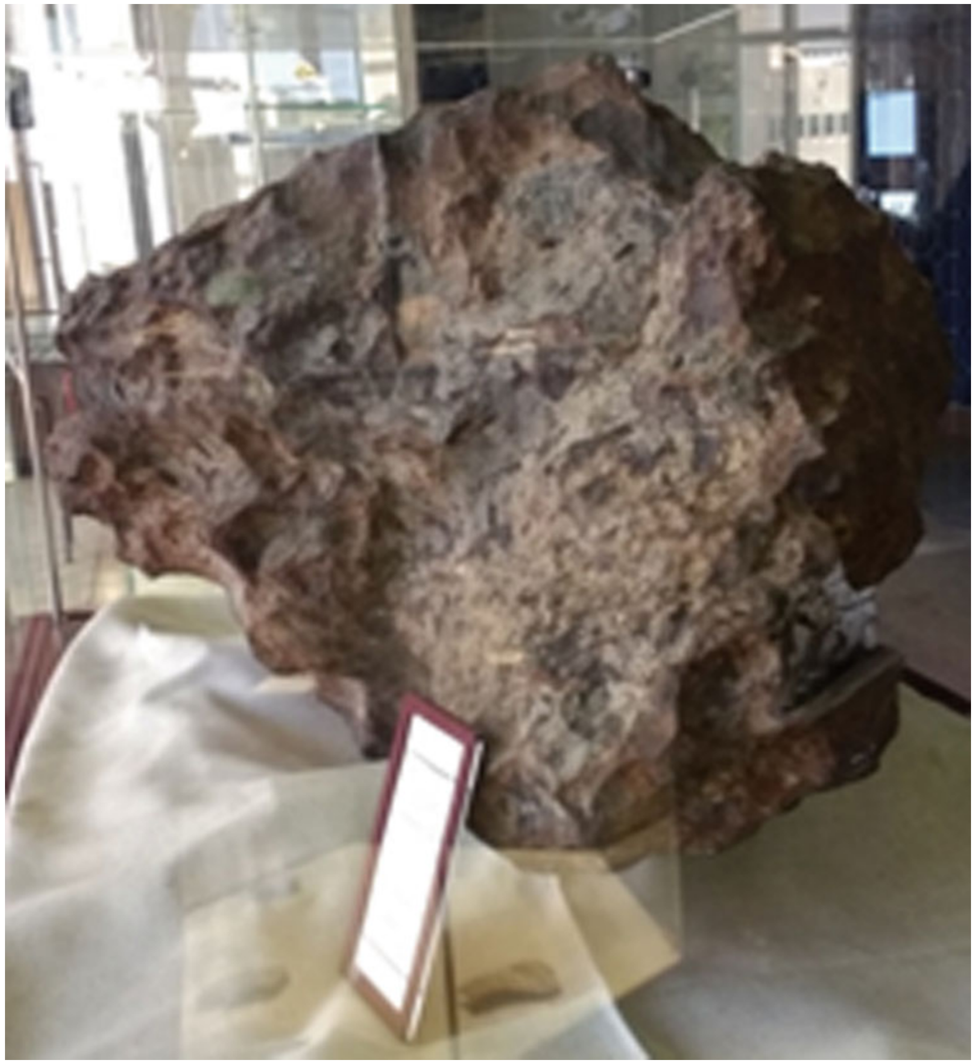

Fig. 1 A photograph of the massive meteorite

were compared to those found in the LIBS from calibration curves drawn for the corresponding elements [8].

3.2 X Ray Fluorescence Analysis

Figure 3 presents the characteristic X-ray lines of dissimilar elements present in the sample. Note that the sharp lines of different elements arise to different levels of excitation like Fe (91%) to Gallium (Ga).

4 Conclusion

This paper presents some of the preliminary results from the biggest meteorite of the KSA. It is found that the meteorite samples consist of Fe, Ni, P and Co.

Comparing the XRF with the LIBS technique revealed good qualitative analysis in shorter time without any special preparations of the sample.

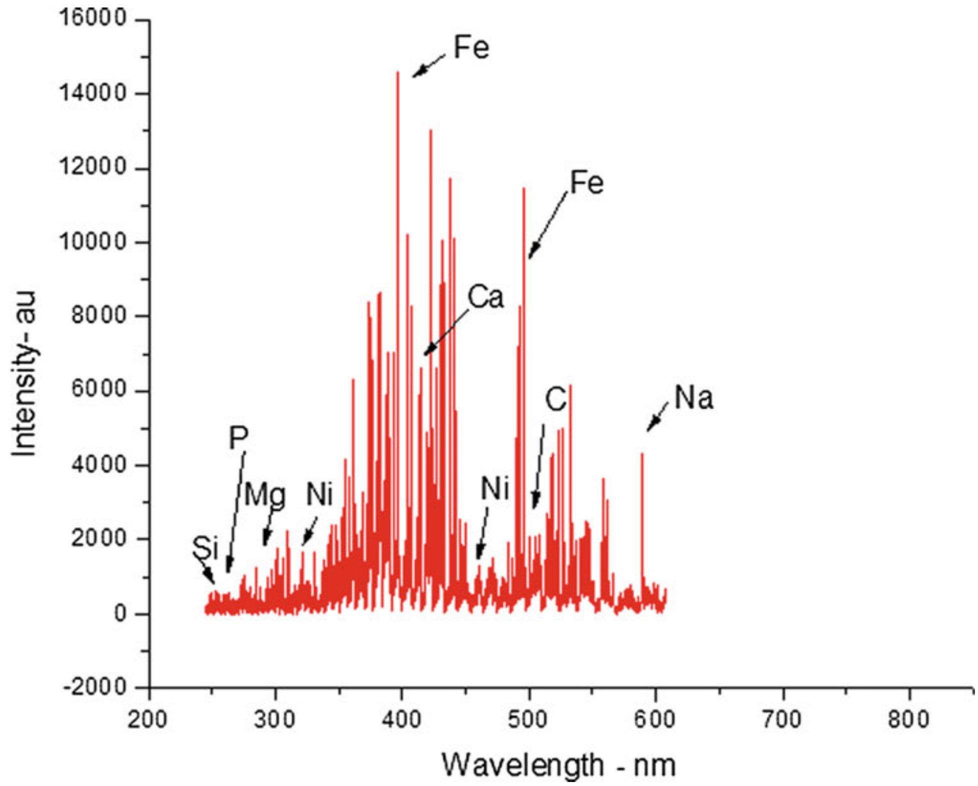

Fig. 2 Laser (266 nm YAG laser) induced breakdown spectra of the sample

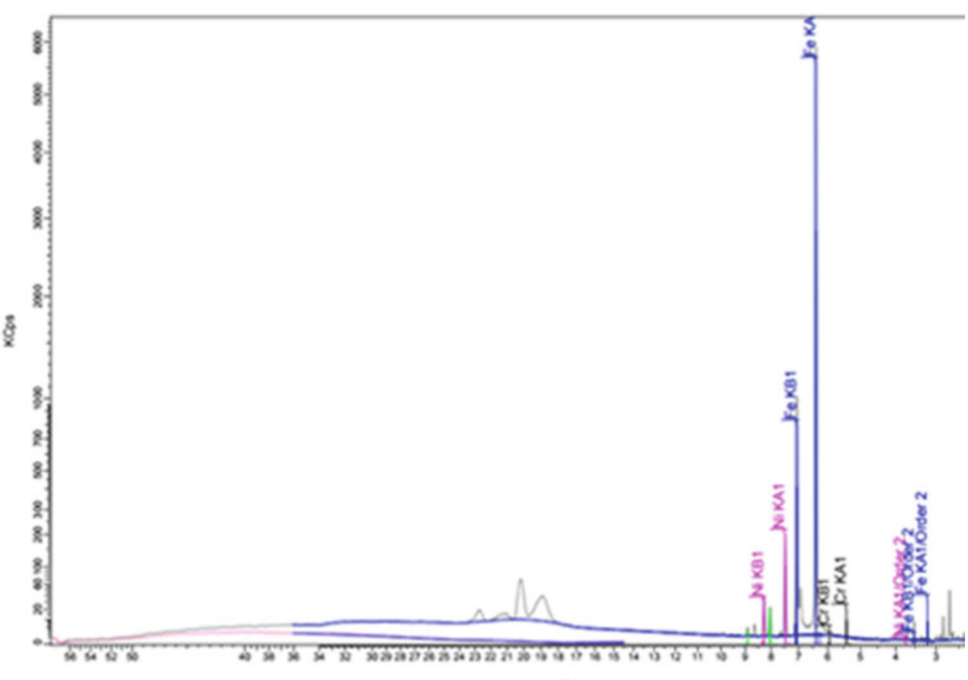

Fig. 3 XRF spectra of the above sample for elemental composition

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