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Original Article

Microstructural and Magnetic Characterization of Dust Storms in the Province of Sistan and Baluchestan in Iran

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Abstract

Sistan and Baluchistan is a province in eastern Iran and is one of the most active regions for dust storms in the country. The dust storms originate from the dry lakebeds of Hamoun in the northern part of the province. The present study analyzed the aerosol characteristics of dust in the atmosphere over the city of Zabol. X-ray diffraction pattern analysis showed that the samples contained SiO2, CaCO3, NaCl, feldspar, kaolinite, illite, and clay. Scanning electron microscopy revealed that the dust was an agglomeration of micro-sized particles. The elements detected by energy dispersive x-ray spectrometry were Fe, Ca, K, Cl, S, Si, Al, Mg, Na and O. The magnetic properties were studied using a vibrating sample magnetometer and the hysteresis loops of the sample showed it possessed ferromagnetic properties.

Key words: Dust, Structure, Magnetic, SEM, EDX

INTRODUCTION

Pollutants are serious threats to the environment and are responsible for altering the ecosystem [1]. Dust storms are major sources of mineral aerosols. They occur frequently in arid and semi-arid regions of the globe and are regarded as a serious environmental hazard. Each year, several billion tons of soil/dust is entrained into the atmosphere affecting solar irradiance attenuation, marine environments, atmospheric dynamics, and weather [2]. Severe sand/dust storms strongly affect human activities such as transportation and telecommunications [3].

It is necessary to detect and monitor dust storms and determine their temporal and spatial variation [4]. Strong winds are major factors affecting weather conditions in the province of Sistan and Baluchistan. The winds blow intermittently in winter and continuously in spring and summer, mostly to the north-northwest.

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Hamoun Lake is located in northern Sistan and Baluchistan. The lake dried up after the 1999 drought in response to changes in land use from fallow to agricultural land. The lake bed soil is sensitive to erosion; a large area of the region is subject to soil erosion which results in dust storms. During a severe dust storm, wind speed increases and massive amounts of dust particles are suspended in the air [5].

The present study examined the micro-structural and magnetic properties of dust storms in Sistan to provide information about hazardous pollutants contained in the dust. The results may serve to better understand the physical nature of these pollutants and their effect on the health of residents and on electronic instrumentation.

MATERIALS AND METHODS

The samples were collected during the summer of 2011. The wind speed was measured at over 20 m/s. The city of Zabol in the province of Sistan and Baluchistan lies between 60°15' E and 61°50' E longitude and 30°5' N and 31°28' N latitude.

Physical characterization of the dust samples were measured using various physical techniques. The crystal

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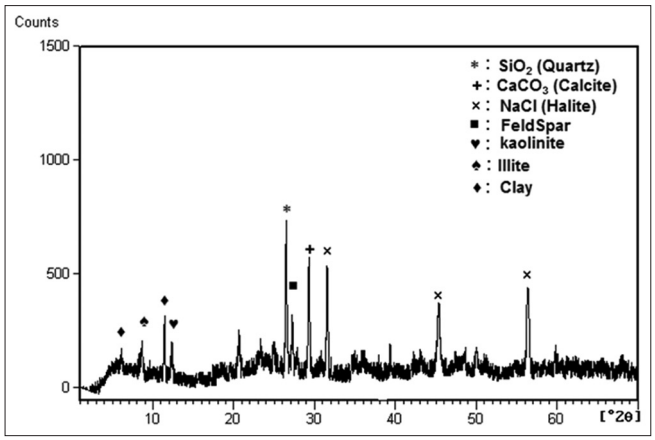

Figure 1: X-ray diffraction pattern of the dust storm sample

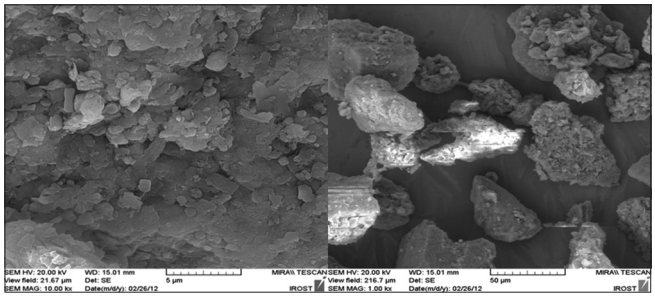

Figure 2: SEM micrographs of the dust storm sample

structural properties of the sample were measured using x-ray diffraction (XRD). The morphology and compositional analysis of the samples were done by scanning electron microscopy (SEM) and energy dispersive x-ray spectrometry (EDX). The magnetic measurement of the sample was carried out using a vibrating sample magnetometer (VSM).

RESULTS AND DISCUSSION

Figure 1 shows the XRD pattern of the dust storm. This pattern indicates that the major components of the sample are SiO2, CaCO3, NaCl, feldspar ((KAlSi3O8, NaAlSi3O8, CaAl2Si2O8) [6], kaolinite (clay industrial mineralsAl2Si2O5(OH)4) [7], illite(K,H3O)(Al,Mg,Fe)2 (Si,Al)4O10[(OH)2,(H2O)],and clay (clay minerals with traces of metal oxide and organic matter) [8].

Figure 2 shows the SEM images of the morphological and structural characteristics of the dust storm and shows micro-sized amorphous particles with sharp edges.

Figure 3 shows the elements present in the dust storm in the EDX spectrum. The elements detected were Fe, Ca, K, Cl, S, Si, Al, Mg, Na and O. There elements are common to most major dust storms [9,10,11,12]. Si was the

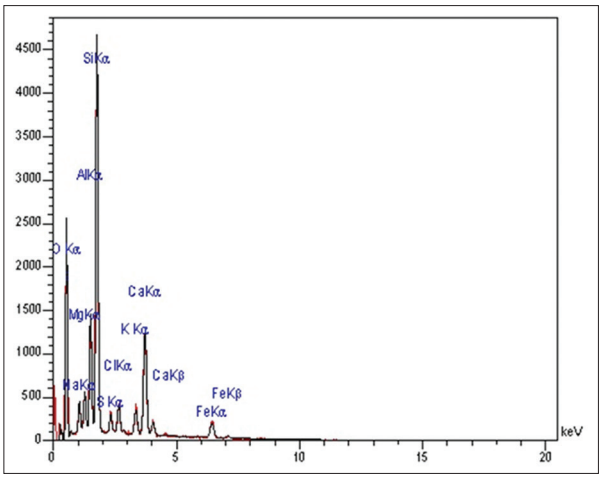

Figure 3: EDX spectra of the dust storm sample

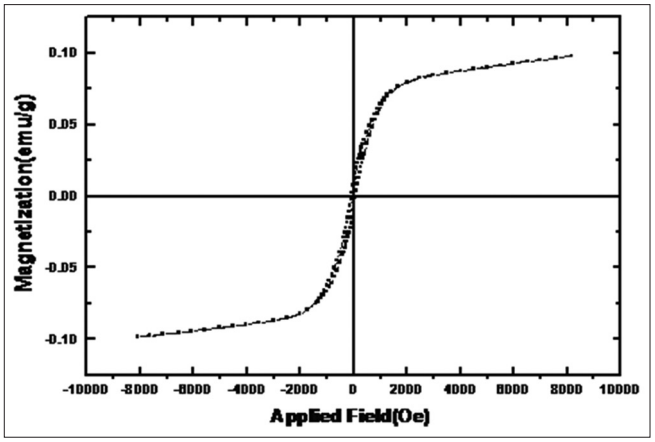

Figure 4: Hysteresis loops of the dust storm sample

most common component and Fe was the only magnetic component in the samples, which is similar to results of previous studies [13,14,15]. These results were confirmed by XRD analysis.

Figure 4 shows the results of magnetic hysteresis and indicates that the behavior was ferromagnetic [16,17].

Table 1 lists the saturation magnetization (M_s), remanent magnetization (M_r) and coercivity (H_c).

The most important minerals are those carrying magnetic remanence at room temperature [18]. The dust storm samples were shown by EDX to be a mixture of two or more magnetic metallic oxides.

CONCLUSION

Samples were obtained from a dust storm in the city of Zabol in the province of Sistan and Baluchistan in Iran. The mineral content of the samples were obtained using

Table 1: Magnetic properties of the dust storm sample

M_s (emu/g)	M_r (emu/g)	H_c (Oe)
0.09836	0.01004	66

XRD analysis. The samples were found to be ferromagnetic and possessed remanence at room temperature.

The present study indicates that the dust storm samples contained fine amorphous particles with sharp edges. Inhalation of such particles can result in physiological damage to humans and wildlife in the region. The present study is a starting point for the development of a methodology to estimate the effects of magnetic pollutants in the air on human heath, electronic instrumentation and microwave systems.

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