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ORIGINAL RESEARCH PAPER

Investigation of Geological and Environmental Factors of Airborne Suspended Particles from Sand and Gravel Quarries in The West of Tehran, Iran

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ABSTRACT

Introduction: Particulate matter (PM) is known as the most common cause of air pollution in the world. Activities of sand quarries are known as one of the emission sources in Tehran. This study aimed at investigating the geological and environmental factors of airborne particles in an active quarry in the west of Tehran.

Material and Methods: Three methods of dust sampling were used. totally, 32 samples were analyzed by Scanning Electron Microscope-Energy Dispersive X-ray (SEM-EDX). The data were analyzed through Principal Component Analysis (PCA), Enrichment Factor (EF) and Geo-accumulation Index (Igeo).

Results: The results showed the presence of Si, Ca, Al, Na, Fe, K, Zn, Pb, P, S, Mg, Cu, Ti, Mn, Cl and V in dust of the quarry. Also, the elements of Mn, V, Zn, Cu and Pb were shown to have moderate to extremely enrichment and contamination from anthropogenic origin. The silicon and potassium were found to have a natural source originated from igneous and alluvial rocks.

Conclusion: In this study, it was shown that fugitive dust generated from sand quarries and related activities have higher concentration of elements than those in the Earth crust due to anthropogenic activities. Further studies on transfer of fugitive dust from sand and gravel quarries to Tehran and assessment of its health impact are suggested.

Keywords: *Airborne suspended particles, Sand and gravel quarries, Geo-accumulation Index, Enrichment Factor, Principal Component Analysis*

1. INTRODUCTION

Today, particulate matter is considered as the most important cause of air pollution in Tehran with a population of more than 12 million people. Anthropogenic sources such as vehicles, some industries and activities of sand and gravel quarries have been introduced as the most important sources of particulate matter in Tehran atmosphere. Mining, especially on the surface, leads to the release of particles extracted from rocks and minerals, as well as other pollutants from the operation, transportation and extraction [1]. The effects of mining operations seem to be local, but various studies have shown that fine and very fine particles from various mining processes can move over long distances in the air and act as adsorption cores for other aerosols. Accordingly, they will affect not only the workers in the mines, but also the surrounding residents and even kilometers away [2]. Crystalline silica is an abundant compound on Earth crust, known as the main pollution of sand and gravel quarries with the capability of causing silicosis and lung cancer upon inhaling large and chronic doses in course of occupational exposure. There isn't enough research on other pollutants with health risk potential in these quarries [3]. This study, therefore, aimed at evaluating the airborne suspended particles in an

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active quarry in the west of Tehran.

2. MATERIAL AND METHODS

This study was conducted in one of the active sand and gravel quarries in the west of Tehran Greater City for one week in November (in rainless conditions). In this study, three methods were used for collecting airborne particulate matter including two passive methods (DF and SPHS) and one active method of sampling (APS-MN). The dust fall (DF) sampling was made based on the ASTM D1739. Two new devices (SPHS and APS-MN) have been designed and manufactured. SPHS was used for sampling from 6 different elevations (from 6m to 21m); APS-MN was used for size selective sampling of airborne particles (from micro to nano) with a flow rate of 8.5 L/m. Thirty-two dust samples were analyzed using Scanning Electron Microscope-Energy Dispersive X-ray. The results were assessed using Enrichment Factor (EF), Principal Component Analysis (PCA) and Geo-accumulation Index (Igeo) [4]. In this study, aluminum was selected as the reference element and the average concentration of elements in the upper Earth crust was used as required criteria for comparison [5].

3. RESULTS AND DISCUSSION

The statistical analysis of the results showed that the collected dust consisted of silicon, calcium, aluminum, iron, sodium, potassium, zinc, lead, phosphorus, sulfur, magnesium, copper, titanium, chlorine and vanadium. Classifications of elements based on two indicators (Geo- accumulation Index and Enrichment Factor) are shown in Tables 1 and 2.

Concentration of Mn, V, Zn, Cu, and Pb indicates both moderate to extremely enrichment and contamination classes. Variance of data obtained by PCA analysis can be explained using four factors. First, variances in aluminum, copper, zinc, and titanium are related with the correlation of terrestrial aluminium elements in aluminosilicate minerals enabled to carry anthropogenic elements of zinc and copper with high enrichment due to their airborne innate. Second, silicon and potassium are linked to albite as a predominant mineral in fugitive dust of sand as well as in the soil. In fact, Si and K are originated from the alluvial deposits from igneous rocks sited in the quarries of the west of Tehran. Third, they are related to vanadium and manganese and the fourth to lead which is assumed to be a single component with a separate source. Vanadium and manganese are attributed to the type of consumed fuel and heavy truck activities. Some studies have suggested lead and zinc sources from the residual of previous mining activities accumulated throughout the years. In addition, lead and zinc induced contamination can be also emitted through other sources i.e., engine,

Table 1. Geo- accumulation Index Classification for the most important identified elements in dust sample from a sand mine in west of Tehran.

Class	Parameters	The value of each class
Uncontamination	Na, AL, Mg, Si, K, Ti, Cl, S, Fe, P	$I_{geo} \leq 0$
Uncontaminated to moderately contamination	-	$0 < I_{geo} < 1$
Moderate contamination	Ca, Mn	$1 < I_{geo} < 2$
Moderate to heavy contamination	V	$2 < I_{geo} < 3$
Heavy contamination	Zn	$3 < I_{geo} < 4$
Heavy to extremely contamination	-	$4 < I_{geo} < 5$
Extremely contaminated	Pb, Cu	$I_{geo} > 5$

Table 2. Enrichment Factor classification for the most important identified elements in dust samples from a sand mine in west of Tehran.

Class	Elements	The value of each class
Minimal enrichment	Na, P, Cl, Mg, Si, K, S, Ti	EF<2
Moderate enrichment	Fe	2<EF<5
Significant enrichment	Ca، Mn ،V	5<EF<20
Very high enrichment	Pb، Zn	20<EF<40
Extremely high enrichment	Cu	EF>40

brake, and tire wear as well as fuel additives, and car engine oil. Moreover, the sources of copper emissions in urban air could include car brake pads, tire wear, fuel additives and car oil, from which copper nanoparticles are sometimes used. In some studies, manganese originated from tire wear and brake pads has been estimated [6]. In a study, the elements lead, zinc, arsenic and aluminum were shown to be in the dust around porcelain, sand and gravel queries and non-metallic industries [7]. The study of Tehran street dust is in good agreement with the results of this study regarding the presence of lead, zinc and copper elements. Researchers have evaluated these elements from resources such as fossil fuel combustion, transportation systems, and some industrial activities.

Because of the geographic location of Tehran and the direction of the dominant winds (west to east), there is high possibility of transferring fugitive dust from sand and gravel quarries to the neighboring area of Tehran.

The amount of transferring dust is expected to be high as there are about 60 mines and quarries in the west of Tehran.

Several worldwide epidemiological studies suggested an association between respiratory impairment and occupational exposures to mine-originated dust. A high prevalence of silicosis, asthma, and adverse respiratory symptoms like cough, chest pain, and dyspnea has been reported among workers working in related quarrying. Specific adverse health effects (or health issues), also, have been reported by residents of nearby quarry sites include nasal infection, cough, and asthma [8].

4. CONCLUSIONS

In this study, it was shown that fugitive dust generated from sand and gravel quarries activities has higher concentration of elements than those in the Earth crust. It is concluded the differences found in the mineral concentrations are due to anthropogenic activities in sand and gravel mines. Further studies on the transferring process of fugitive dust from sand and gravel quarries dust to Tehran are recommended with an emphasis on health risk assessment.

5. REFERENCES

1. Blodgett S. Environmental Impacts of Aggregate and Stone Mining New Mexico: Case Study. Center for Science in Public Participation; 2004.
2. Knippertz P, Jan-Berend W. Stuut. Mineral Dust: A Key Player in the Earth System. London: Springer; 2014.
3. Kalantary S, Golbabaei F, Yazdanirad S, Farhang Dehghan S. Review of literature on occupational exposure to the dusts in Iran over the past 14 years. JHSW. 2019;9(1):1-12. [Persian]
4. Javidaneh Z, Zarsevandi A, Rast Manesh F. Determination of Geo-Environmental Factors and Source of Heavy Metals in Street Dust, Masjed-e-Soleiman City, Khouzestan Province. IJHE. 2016;9(2): 155-170
5. Wedepohl, K. H. The composition of the continental crust. Geochimica et cosmochimica Acta.1995;59(7):1217-1232.
6. Zereini F. Wiseman C. Urban Airborne Particulate Matter: Origin, Chemistry, Fate and Health Impacts. New York: Springer; 2010
7. Kamani H, Hoseini M, Safari G, Mahvi A, Zarei H. Factors affecting the concentrations of heavy metals in precipitation of Tehran using factor analysis method. Iranian Journal of Health and Environment. 2016;8(4):401-10.
8. Nemer M, Giacaman R, Husseini A. Lung Function and Respiratory Health of Populations Living Close to Quarry Sites in Palestine: A Cross-Sectional Study. Int. J. Environ. Res. Public Health. 2020;17:6068.