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Economic non Metallic Mineral Resources in Quaternary Sediments of Tehran and its Environmental Effects

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Abstract Air pollution in Tehran is widely recognized as a serious environmental challenge, posing significant threats to the health of the resident population. As one of the most evident natural hazards and significant environmental issues, the dust phenomenon has raised significant concern within the research community. In light of the negative effect of dust mass in urban areas, robust and effective early warning systems are necessary; continuously enhanced monitoring of dust aerosols are a critical step in developing such systems. Tehran plain in general is of alluvial fan accumulation. The Quaternary of Tehran plain has up to 1100 m of sediments belongs to four lithostratigraphic units. They contain both non-metallic resources. Non-metallic resources of Quaternary strata include construction aggregates for the residential, industrial and transportation segments of the population, ceramic clays and laterites. Tehran region can be divided into 4 geological units as follows: Hezardareh F., Kahrizak F., Tehran alluvial F. and Holocene alluvium. The quaternary sand and gravel mines of Tehran have been exploited widely and this exploration is one of the causes of the environmental pollution. The over-exploitation of construction material mines in southern Tehran has become a source of dust particles, adding to air pollution problems in the Iranian capital.

Keywords: *quaternary, sand and gravel mines, Tehran plain, environmental pollution*

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1. Introduction

Air pollution in Iran has significant natural and anthropogenic sources. Cold season and temperature inversion, dust, particles released from construction work in the city, emissions from old cars, underdeveloped public transportation, too many cars in the streets, drought, lack of enough rain and wind due to special location of Tehran are among the other elements lie behind air pollution in Tehran.

The primary anthropogenic sources are industrial activities and transportation, both of which are centered in urban areas, while the main natural source is wind-blown dust. Cars account for 70 to 80 percent of the normal air pollution in Tehran due to the large number of automobiles, heavy traffic congestion, and petrol with a sulfur content 2-3 times greater than legally permissible levels [1]. Tehran's air pollution is responsible for thousands of deaths and costs millions of dollars each year [2]. Mining activity is one of the new causes of pollution in Tehran. Yet the country is one of the most important mineral producers in the world, ranked among 15 major mineral-rich countries [3], holding some 68 types of minerals, 37 billion tons of proven reserves and more than 57 billion tons of potential reservoirs. Mineral production contributes only 0.6 per cent to the country's GDP [4]. Add other mining-related industries and this figure increases to just four per cent (2005). Many factors have contributed to this, namely lack of suitable infrastructure, legal barriers, exploration difficulties, and government control over all resources.

The most important mines in Iran include coal, metallic minerals, sand and gravel, chemical minerals and salt. Khorasan has the most operating mines in Iran. Other large deposits which mostly remain underdeveloped are zinc (world's largest), copper [5], iron (world's ninth largest), [6] uranium (world's tenth largest) and lead (world's eleventh largest) [7-13].

Iran with roughly 1% of the world's population holds more than 7% of the world's total mineral reserves [14,15].

Tehran has developed on recent sediment and quaternary. Geological maps confirm that quaternary and Pliocene alluviums and moraine deposit have developed in Tehran desert.

The Quaternary deposits comprising semiconsolidated to unconsolidated gravel, sand, silt and clay occupy the greatest part of Tehran plain. These deposits use in construction aggregates for the residual, industrial and

transportation segments of the population, ceramic clays, and laterites. The Construction sand and gravel can be classified into two types of deposits:

1-Alluvial fan sands and gravel

2-River sand and gravel

Much of the ground water essential to agriculture and human existence emanates from aquifers in quaternary sedimentary environments.

Air pollution in Tehran is widely recognized as a serious environmental challenge, posing significant threats to the health of the resident population. Improving air quality will be difficult for many reasons, including climate and topography, heavy dependence on motor vehicles for mobility, and limited resources to reduce polluting emissions.

2. Materials and Methods

2.1. Study Area

Tehran Province is one of the 31 provinces of Iran. It covers an area of 18,909 square kilometers and is located in the north central plateau of Iran.

Coordinates of Tehran in decimal degrees

The study area consists of the 22 municipal districts of Greater Tehran (Figure 1). This area is about 1100 km^2 wide and is located between 51° 15′ and 51° 33′ Eastern longitude and 35° 32′ and 35° 49′ Northern latitude. Tehran plain starts near the city center with an elevation of 1250 meters above sea level, and stretches over to the southern parts of Rey in a mild slope. The elevation declines in a mild west-east slope.

Tehran is located on relatively recent alluvial deposits extending toward the south from the foothills of Alborz Mountains range. These deposits are the result of river activity and seasonal inundations.

Environmentally, the climate of Tehran province in the southern areas is warm and dry, but in the mountain vicinity is cold and semi-humid, and in the higher regions is cold with long winters. The hottest months of the year are from mid-July to mid-September when temperatures range from 28°C (82°F) to 30°C (86°F) and the coldest months experience 1°C (34°F) around December–January, but at certain times in winter it can reach −15°C (5°F). Tehran city has moderate winters and hot summers. Average annual rainfall is approximately 200 millimeters (7.9 in), the maximum being during the winter season. On the whole, the province has a semiarid, steppe climate in the south and an alpine climate in the north.

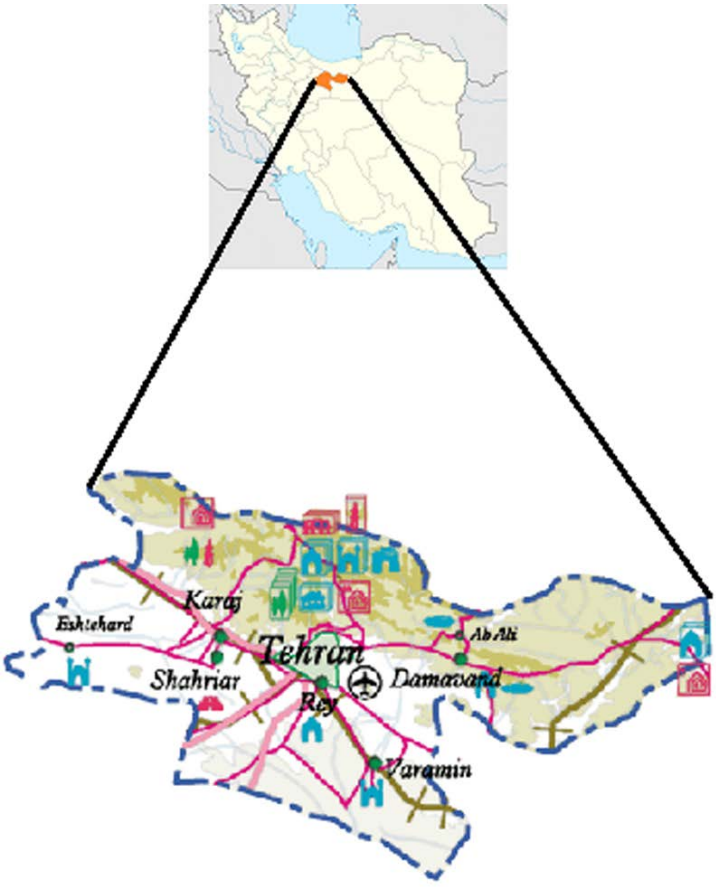

Figure 1. Study area in Iran

2.2. Methods

The main propose of this paper is the study of the new source of air pollution in Tehran, due to increase licensing of mining activities. New environmental pollution source in Tehran is dust particles, produced from mine exploration. Dust particle pollution have been produced from mine activities in the south and southeast of Tehran city.

Growing of dust pollution is due to the increasing number of mines in the area.

The Quaternary stratigraphy of Tehran is discussed in some detail. The following procedures were adopted in the data analysis:

-Preparation of geological maps.

-Field studies: The base of this study was the original geological information's of the upper plains including the properties of structure, petrology of geological outcrops in studied areas.

2.3. Bibliotheca Studies

The collection of data for this study was carried out using resources review.

3. Results and Discussion

Stratigraphy

Tehran has developed on recent sediment and quaternary. Geological maps confirm that quaternary and Pliocene alluviums and moraine deposit have developed in Tehran desert.

Bed rock: The bed rock of Tehran is the Tertiary formations, mostly Eocene lava, showing in the mountainous areas in the north of the city. The younger sediment has formed on this bed rock. The bed rock of the eastern heights in Sehpayeh and Bibi Shahrbanoo mountains have been formed from the dolomite limestone from Triassic and Cretaceous ages.

The Quaternary sediments of Tehran region were studied during the recent 15 years. On the basis of the stratigraphical and sedimentological development of the Quaternary deposits, the region can be divided into 4 Formations as follows [16,17,18]:

1- Hezardareh Formation

The name of the formation, literally "Bad land morphology" has been inspired by the geomorphologic properties of its surface and the existence of the multitude of its erosional valleys of great density. The oldest and most important of the four units. The Hezardarreh formation consists of materials that had source like the overlaying B and C units, mainly in the Eocene formation. The average grain size is between one centimeter to one decimeter. A characteristic of this ancient alluvium is the regularity of its bedding. Unregulary it displays beds of sandy gravel which is cemented by lime carbonate. An angular unconformity was observed by Rieben [16]. Further study by revealed three unconformity in A (Hezardarreh) formation. This unit is folded and dissected by numerous faults.

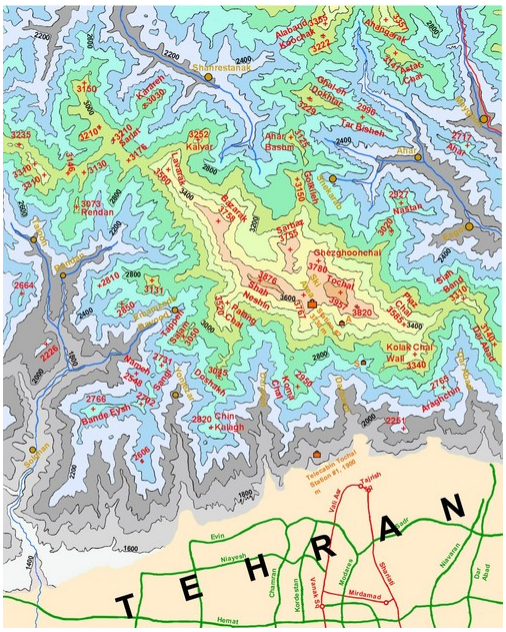

Figure 2. Topographical map of Tehran plain

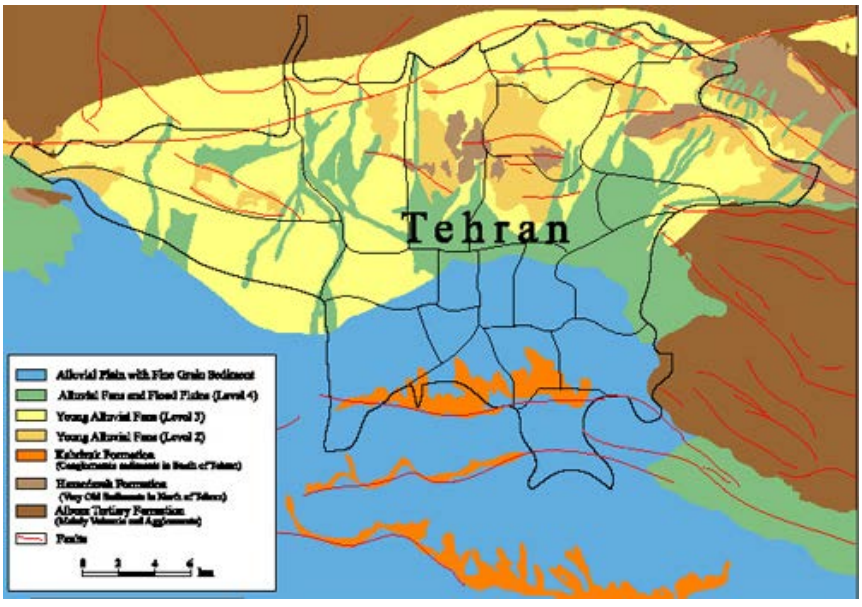

Figure 3. Geological map of Tehran [21]

The distinguished characters of Hezardareh Formation are:

-High thickness, Homogeneous, Regular stratification, Pebble with medial size, Advanced grade of weathering, Grey in color, High slope of layers.

-There are semi rounded grain results from Karaj Formation (90%) and other rocks (10%).

Which indicate during of Hezardareh Formation sedimentation uplift and erosion of Alborz Mountains. Hezardareh alluvial Formation overlaying Upper red Formation (Pliocene), gradually in the Ivanaky region. In the upper part of Upper red Formation, which composed of marl and red sandstone, with much conglomeratic layers, which indicated existence of torrential environments and

came up Alborz Mountain and deposition of Hezardareh Formation begun. Hezardareh Formation is divided in two members. The first member of Hezardareh Formation has much little porosity, high erosion of pebble and strongly cementation. The second member of it has highly porosity respect of first member and less grade of erosion of pebble. Hezardareh Formation after folding, faulting and intense alternation, overlaying by Kahrizak Formation.

Age: Plio-Pleistocene

2- Kahrizak Formation

Kahrizak Formation in the type section overlaying Hezardareh Formation unconformitily that corresponding to tectonic phase of Passadenian and has been covered by Tehran alluvium. This unit is made of sandy or clayey loam. the colore is pale brown and overlay the A beds with a angular unconformity. In contrast to A beds it is not consolidated. The size of pebels in a matrix of sand and clay differ considerably in dimensions.

This heterogeneous formation overlay the surface of strongly eroded A-formation. The heterogenity of this formation was for Riviere [12] an indication for to take it as a moraine. The tilting of this unit exceed max 15 degree. The observation of an angular unconformity in B-beds leaded Rieben [5] to distinguish a lower and a upper B-formation.

Kahrizak Formation has different characters from layer to layer because of heterogeneous, mechanical resistance and changeable porosity.

Distinguished characters from Hezardareh Formation were:

-Unsolidificate, heterogeneous and poorly sorted conglomerate, Gravel size ranging from several cm to several meters which has been situated in sandstone cement, Low feeble cement and little mechanical resistance, Slope of layers (maximum of 15), Darkness color of Formation.

Age: Middle Quaternary.

3- Tehran alluvial Formation

Formation (Tehran plain alluvium) - it forms from gravels, pebbles and sands in the cement of sands and silts. The permeability and the strength of the formation are high. The volume of Tehran alluvium fans consists mainly of C formation. As to more thickness and permeability, it forms a suitable groundwater resource in Tehran.

Tehran alluvium Formation includes younger alluvial fans which from southern pediments of Alborz Mountains continue to south and spread part of Tehran city building on it.

This formation in general created by alluvial and streams sedimentation. The thickness of them is up to 50 m. The homogeneous sediments were composed of gravel, sand, silt and boulders. On the unconsolidated sediments species of stratification were seen. The presence of red conglomeratic layers laterizaed and weathering surface indicated the suspension of sedimentation. This formation is divided into two different stratigraphical alluvial plain units:

A) Khorramabad alluvial Formation. This formation has covered the formation of the older alluvial fans in the south of Tehran, forming a fairly smooth plain. In the northern and eastern parts, the sand is richer. The southwest of the plain is dominated by fine grain material such as clay and silt.

B) River alluviums unit. The most recent alluviums of alluvial levels in Tehran are formed by the deposits of the flood plain of rivers consisting Grave land pebble size clasts. These materials have an alluvial origin and are not very hard.

The layers of this Formation had horizontal aspect, which did not support tectonic movements. Tehran alluvium Formation overlaid Kahrizak Formation and covered by Holocene alluvium. These alluvium sediments were formed of erosion and resedimentation of Kahrizak Formation.

Age: Upper Quaternary

4- Holocene alluvium (Recent alluvium)

Formation (Recent alluvium) - the most recent riverbeds, alluvium terraces and the young fans consist of the D formation. It includes gravel and pebble, by the weak cements in the north, which gradually convert to silt and clay toward the south. Due to weathering, a layer with the thickness of 2-3 m is formed on the surface of the formation (Figure 4 and Table 1)

Age: Holocene

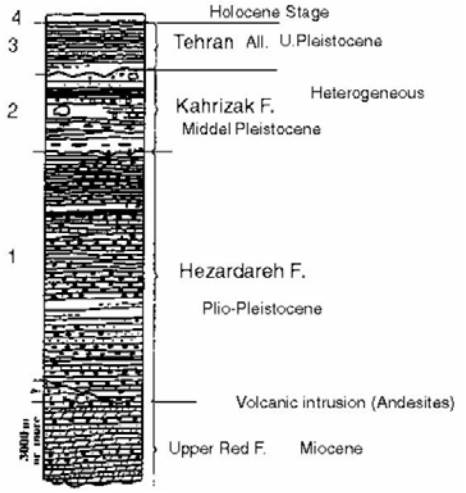

Figure 4. General stratigraphical section of Tehran alluvium, by [16]

Table 1. Alluvial groups in Tehran [17]

Bed	Geological name	Thickness (m)
D	Recent Alluvium	Up to 20
C	Tehran Formation	Up to 100
B	Heterogenous Formation (Kahrizak F.)	Up to 300
A	Hezardarreh Formation	Up to 500

Mineral resource potential

Tehran province structurally belongs to two structural zone of Iran namely, Alborz and central Iran zones. Based on its geological and structural characters such as existence of magmatism (intrusive and extrusive), alteration, thrusting, and faults and hydrothermal, it contains diverse type of mineral resources like:

- Robatkarim manganese deposits 45 NW of Tehran.
- Sabou refractory clay deposit.
- Hovir feldspar and dolomite (Damavand).
- Keripton-Ah kaolin deposit.
- Silica sand and refractory sand in Masklu, Mobarakabad, Sarneza, Mosha and Damavand.
- Celestite in Mikabad.
- Talc and asbestos 48 north of Karaj (Sierra).
- Magnesite and huntite 75 km SE of Varamin.

Other deposit of Tehran province are sand and gravel (110 areas), limestone (14 areas), Gypsum (4 areas), marl

(1 area), industrial clay (4 areas), evaporitic salt (16 areas), copper (2 areas), iron, lead- zinc and coal (3 areas), bauxite (1 area), phosphate (1 area), barite (4 areas), dolomite (2 areas), ornamental stones (41 areas), bentonite (2 areas), dense limestone (2 areas), salt (2 areas) and travertine (1 area).

A large volume of silty clay and clay of economic importance was found lower most of the mapped area.

Aggregate sand and gravel, for construction activities, which are now widely developed in Tehran region. There are abundant sand and gravel deposits along the rivers throughout the western and eastern part of Tehran. Alluvial fan sand and gravel can be excavated from alluvial fan deposits. There are three large alluvial fan deposits in the western (Karaj), central (Kan) and eastern (Jajerud) part of Tehran plain, which are huge suppliers of sand and gravel for construction.

The total numbers of mines in Iran are up to 3200. The numbers of sand & gravel mines throughout Iran are 1174, which totally are open mines Table 2.

Table 2. Number of employees (persons)

Sand and gravel, Ballast and Mineral cartridge (m^3)	Minerals except sand and gravel, ballast and mineral cartridge (Tons)	Contractor	Without wages and salaries	With wages and salaries	Sum	Number of Mines	Province
15747811	16531893	265	78	4029	4372	204	Tehran

Figure 5. Tehran particle dust pollution

There are 204 different mines in Tehran, with ~4372 employees. The numbers of sand and gravel mines are 110, which produce totally 36.500.000 tons annually evaluated more than 109.5 million US dollars. Annual production of sand and gravel in Iran is 63707157 m3. The whole value of annual production is more than 191 million US dollars. The Sand and Gravel business in Tehran shows a growth rate of about 17, 5% in 2013.

Than 110 mines of sand and gravel plays an important role in the economy of the Tehran province. The amount of certain resources of sand & gravel in Tehran evaluated more than one milliard m^3, which in these mines up to 2500 persons are as employees. Sand and gravel extraction in the river areas is 80 percent.

Environmental impact

From an environmental standpoint sand and gravel mines near the Tehran, are one of the pollution sources, which increases the density of air (Figure 5), causing respiratory diseases. From the point of view environmental pollution from mining and its impact on people's quality of life is also very important, mines are indiscriminate exploitation leads to environmental degradation, and land settlement, pollution, etc. are actually some provincial official's dust the storm also caused the famous capital Tehran air pollution from mines knew every day.

Extracted gravel and sand are washed and processed by the factories near the river and transported to the consuming centers. Washed gravel and sand suspend fine sediments like clay and slit in the river. These fine sediments settle in the river and make impermeable layers in the bed and prevent seepage of surface water to groundwater and increase the dangers of flooding and damaging to the adjacent regions of the river and destroy the environment [18].

When we entered the adhesion of particles with diameters less than 2.5 microns in drought periods, and are a breeze to get up from the ground and in space. According to reports, the particles can stay suspended in the air for 15 years. Of course this in mind that external sources of pollution by about 30 percent and 70 percent dust the threat posed by these particles are related to internal resources. Deserts around Tehran as you mention the problem of drought, the main source of air pollution have been Tehran. The head of Iranian Parliament's Environment Commission says the city has been issuing too many licenses for mining construction materials in southern Tehran, and that is now "making Tehran out of breath [22].

4. Conclusion

The Quaternary sediments of Tehran area are drawn considering the geology and other physical processes occurring in the investigated area. Tehran region can be divided into 4 Formations as follows: Hezardareh F., Kahrizak F., Tehran alluvial F. and Holocene alluvium.

-The mapped area consisted of four quaternary geological units. They were:

-Floodplain deposits covered the major part of total mapped area.

-Four geological units (Formation) with different types of vertical section of sediments.

-All the deposits in the area were fluvial in origin.

-The economic non-metallic mineral resources of Quaternary strata include construction materials; consist of clay, sand and gravel.

The main reason for the air pollution in the capital is the vehicles. Tehran is wedged between two mountains that trap the fumes of its bumper-to-bumper traffic. The storm brought with him a message to Tehran: recently painted the sky with a layer of "toxic dust" from standard gasoline vehicles over the sprawling capital had already

elusive yellow, composed of particles produced by sand and gravel mine activities, which also appear turned Inhaled air is several times more dangerous than the old infection. It seems that one way to reduce pollution these licences should be immediately rescinded.

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