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Geochemical provenance of soils in Kerman urban areas, Iran: Implications for the influx of aeolian dust

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ABSTRACT

The investigation of the interaction of aeolian dust with residual soils has not been fully explored in the Kerman urban areas, Iran. To assess the geochemical influence of aeolian dust on the residual soils of the Kerman urban areas of Iran, 27 samples were studied petrogeochemically. The arid–semi-arid climate of the area together with the southwest–northeast prevailing wind, have deposited aeolian sands over the residual soils. Residual soils reflect similar mineral compositions to that of the underlying bedrock and include mostly calcite and quartz. However, the minor occurrences of pyroxene, amphibole, olivine, plagioclase and volcanic clasts in urban soils and aeolian dust are attributed to volcanogenic inputs transported by aeolian dust. Urban soils and aeolian dust show different geochemical signatures from the local carbonate rocks. All samples contain trace element concentrations that are higher than the carbonate bedrock. Discrimination diagrams indicate that immobile trace elements have geochemical affinity to the detrital ferromagnesian dust inputs and are different from the local carbonate bedrock. Based on the elemental bivariate and ternary diagrams, the soils and aeolian dust are derived from the interaction of carbonate and volcanic rocks. This highlights that the urban soils in the Kerman urban areas have been formed by interactions of the aeolian dust with the primitive residual soils.

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1. Introduction

1.1. Previous works

The importance of dust inputs in determining petrogeochemical properties of soils can range from subtle in the case of remote archipelagoes to dominant in the case of loess accumulation (Kurtz et al., 2001). Addition of minerals from atmospheric resources challenges traditional assumptions of weathering in soil environments. Geochemically, the soils are assumed to be formed from the weathering of the underlying parent rock materials under different climates and vegetation (Jenny, 1980). Continuous low-level addition of aeolian mineral dust to the residual soils complicates the geogenic process of the weathering and affect physiochemical as well as ecological nature of the soils (Brimhall et al., 1988, 1992).

In some cases, the aeolian dust provides nutrients needed for plant growth (Swap et al., 1992; Drees et al., 1993) and influences hydrology by altering soil texture (Young et al., 2004). Marine aerosols in the form of sea spray are also a significant source of nutrient elements to modern and buried soils (Whipkey et al., 2000). It is now known that Asian dust plays an important role in the genesis of soils on many Pacific islands (Kurtz et al., 2001). Similarly, African dust influences the development of soils around many parts of the Mediterranean basin (Muhs and Budahn, 2009).

Geochemical and mineralogical methods have been used to identify the presence of aeolian dust in soils and surficial deposits in deserts and archipelagoes (Kurtz et al., 2001).

Despite the variety of works on "aeolian contamination" of soils, nevertheless, little is known regarding the interaction of aeolian dust and bedrock with residual soils in the urban areas. The study of Beckett (1958) was the pioneer research on the soil formation in Kerman urban areas in southeast of Iran (Fig. 1a). He mapped and classified the soils into residual skeletal soils, soils on alluvium and rock debris, soils on fine outwash alluvium and sand dunes. Other research studies on the soils around the Kerman urban areas include Banaei (2000), Nadimi et al. (2009), Yamani et al. (2010), Hamzeh et al. (2011) and Atapour (2015).

1.2. Scope

Little is known about the composition of soils and the role of relative contributions of aeolian dust in soil formation in the

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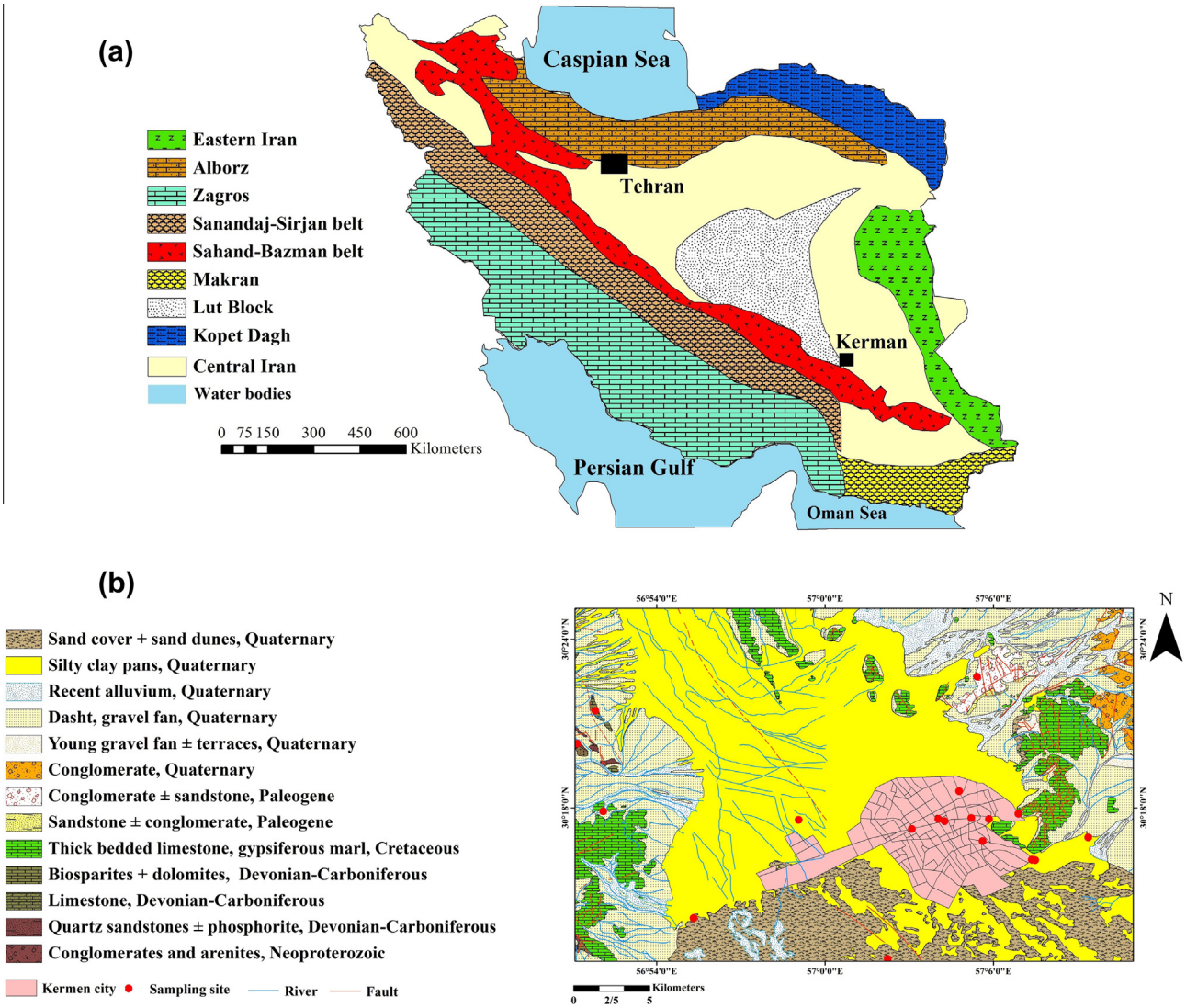

Fig. 1. (a) Lithostructural zone of Iran (modified after Stöcklin, 1977); (b) location and regional geological map of Kerman urban areas (modified after Sabzehei, 1999 and Djokovic and Dimitrijevic, 1973).

Kerman urban areas. The purpose of this study is to examine (1) the processes of soil formation in the Kerman urban areas; (2) mineralogical and geochemical compositions of the soils; and (3) geochemical provenance and interactions of aeolian dust with the residual soils. If the soils are derived from weathering of local bedrock, their composition should be similar in composition to the local Cretaceous carbonate bedrock. By contrast, if the soils have an aeolian source, they will likely have a composition that differs from the local bedrock and their derived residual soils.

2. Geology and site characteristics of the Kerman urban areas

2.1. Geology

The study area is situated in Kerman province in southeast of Iran. Lithostructurally, Kerman urban areas are located in Central Iranian Microcontinent and Lut Block in Southwest of Iran (Fig. 1a). Geologically, the studied area is dominated by weakly metamorphosed Neoprotrozoic and Paleozoic conglomerate and arenite, Devonian–Carboniferous arenite and limestone, Lower Cretaceous limestone, Upper Cretaceous–Paleocene conglomerate, Neogene conglomerate and Quaternary deposits (Huckriede et al., 1962; Dimitrijevic, 1973; Djokovic and Dimitrijevic, 1973; Atapour and Aftabi, 2002) (Fig. 1b). According to Dimitrijevic (1973) and Atapour and Aftabi (2002), Quaternary units in the area are composed of four subdivisions: (1) Older Dasht (bajada), which is composed mainly of old dissected alluvial fans, gravel fans, and terraces. (2) Younger Dasht (bajada), which includes younger undissected gravel fans (boulder, sand, and silt). (3) Recent Dasht (bajada), which is composed of recent alluvium (subgranular to rounded pebble and sands) transported from the neighboring bedrocks. (4) Very recent distal Kavir (silty–clayey salt plain), which represents very recent distal alluvial deposits. The Kerman urban areas were built on silty–clayey pans and aeolian sand dunes which cover a vast area in the south and southeast of the study area.

The major volcanic and metamorphic belts near the study area are the Urumieh–Dokhtar volcanic belt or the Sahand-Bazman magmatic belt and Sanandaj-Sirjan Zone (Schroder, 1944; Alavi, 2004). The Urumieh-Dokhtar is a 150 km wide magmatic belt which is composed mainly of andesitic–rhyolithic Eocene extrusive and Oligo-Miocene granitoid rocks (Alavi, 1994). The Sanandaj-Sirjan Zone is characterized by the metamorphosed and complexly deformed volcano–plutonic rocks (Azizi and Jahangiri, 2008).

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