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Environmental factors of urinary stones mineralogy, Khouzestan Province, Iran

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ABSTRACT

Urinary stone diseases in the Khouzestan province (southwest Iran) are growing in number and it required extensive studies on various factors of the urinary stones formation in this province. In this research, in addition to distribution of urinary stones in different areas of province, the role of bioenvironmental (race), climate (temperature) and geology (water hardness) factors in urinary stones diversity has been studied. Mineralogical studied using X-ray diffraction showed that uricite and whewellite are the most frequency mineral phases. Struvite, Cystine, hydroxyapatite, weddellite, and Niahite can be observed as urinary stones, too. These data show that the urinary stone in the Khouzestan province can divide into 7 groups: calcium oxalate, phosphate, calcium oxalate/ phosphate, Urate, Urate/calcium, Urate/calcium oxalate/phosphate, Cystine/calcium oxalate. Also the results which attained from temperature effect investigation on the mineralogy of urinary stones, confirms that from Mediterranean sub-humid climates (northeastern area) to warm and dry climates (south and southwest area), calcium oxalate stones and urate stones concentration decreases and increases respectively. Comparison of data related to the drinking water hardness and mineralogy of urinary stones in different areas of Khouzestan province show that the combination of drinking water (especially water hardness) affects mineralogy of urinary stones in some areas (such az Ramhormoz and Hendijan). Finally, the data suggest that frequency of calcium oxalate in women is more than that of men. Moreover, there is direct relationship between the age (>45 years) and the increase in frequency of Urate minerals.

1. Introduction

Urinary stones are the third most common disease of human urinary tracts (Qaader et al., 2006) and they exist in all altitudes, countries and races (Aloisi, 2008). Urinary stones are hardened masses (called calculi) of insoluble substances formed in urinary tracts (Gray et al., 1982). These substances may be organic or inorganic (Abboud, 2008b). In other word the composition of Urinary stones can be classified into two parts. The first part is represented by organic matrix containing mainly proteins, lipids, carbohydrates, and cellular components. The other part is biomineral component (Giannossi and Summa, 2012). Urinary stones can form in different parts of the urinary system such as the kidney, bladder, ureter, and urethra (Singh et al., 2009), among which the kidney is where urinary stones are most frequently formed (Kerr and Laing, 1992; Hesse et al., 2009). In terms of mineralogy, calcium oxalate stones are the most common with a frequency of 70–80% (Singh et al., 2009; Frackowiaka et al., 2010). The minerals whewellite and weddellite comprise ca. 63% of calcium oxalate urinary stones; however, calcium oxalate monohydrate (whewellite) is much more frequent than calcium oxalate dihydrate (weddellite) (Chelfouh et al., 1998). Other important urinary stone minerals are struvite (magnesium ammonium phosphate), uricite (commonly called uric acid), and cystine (Basiri and Shakhssalim, 2010), whose frequencies of occurrence are ca. 15%, 5–10%, and 1%, respectively (Singh et al., 2009). It should be noted Struvite stones are less common and formed by infections in the urinary tract. In addition, Cystine stones are rare (Giannossi et al., 2013).

The average lifetime prevalence of urinary stones may be as high as 20% in the general population (Singh, 2008). The percentage of people suffering from urinary stones varies between 20% and 30% in different parts of the world (Safarinejad, 2007). In addition, men suffer more from urinary stones than women (Sood et al., 2010). The increasing number of people suffering from urinary stones around the world, especially in developed countries, and

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its geographical correlation with industrial development (Fazil Marickar and Vijay, 2009), has raised concerns about this disease in the last couple of decades. For example, because urinary stones cause some irreparable renal damages (Chandrajith et al., 2006), mineralogical studies of the physico-chemical features of urinary stones have been undertaken in various countries (Ancharov et al., 2005; Qaader et al., 2006; Abboud, 2008b). Those studies show that occurrence of urinary stones is influenced by a series of biological and environmental factors, whereas other studies cannot determine a single special factor as the main agent of this disease (Kerr and Laing, 1992; Al-Eisa et al., 2002; Basiri and Shakhssalim, 2010).

A recent research has revealed that people in the 'Afro-Asian urinary stone belt', which includes the Middle East, suffer more from urinary stones than people in other parts of the world (Abboud, 2008b). The Khouzestan province (southwestern Iran) is located in this belt. Because of its predominant warm and dry climates, various types of drinking water, and reports of urinary stone prevalence, this province offers opportunity to contribute to knowledge about urinary stones in the Afro-Asian stone belt. The study described in this paper focuses on the possible influence of environmental (race), climatic (temperature) and geological (water hardness) factors on variety and mineralogical characteristics of these stones in this province. In this way distribution of mineralogical of urinary stones (such as calcium oxalate, urate) in various climate and race has been studied. In addition, comparison between hydrological data and distribution of urinary minerals in the various areas of the Khouzestan province was conducted.

2. Geography and general geology of the study area

The province of Khouzestan, which occupies an area of 63,213 km^2 in southwestern Iran, has ca. 4 million inhabitants. It is located between 48° and 49.5° E longitudes and between 31° and 32° N latitudes (Fig. 1). Its capital city is Ahvaz. Topographic elevations in the province vary between 0 and 3740 m. Izeh is its highest city at 760 m above sea level, whereas Hendijan is its lowest city at 2 m above sea level. Because of its plain and mountainous geomorphology, the province has different climatic conditions, with warm and dry (to ultra-dry) conditions in the plains and sub-humid to sub-dry conditions in the mountainous areas (Fig. 1). The northern parts of the province experience cold weather, whereas the southern parts experience tropical weather. Summer is from April to September, whereas winter is from October to March. The annual average means of maximum summer temperatures in the province is about 50 °C (in July) and minimum winter temperatures is 9 °C (in March). The annual amounts of rainfall are 150–260 mm in the south and 990–1100 mm in the north, and about 70% of annual rainfall events occur from February to April. The annual evaporation is 2000–4000 mm.

Sedimentary rocks consisting of chemical–biochemical limestone's and clastic sandstones-conglomerates, with ages ranging from Cretaceous to Quaternary, occupy the central and northern parts of the Khouzestan province as mountains. Geomorphologically, Khouzestan province is located in a basin occupied by Cenozoic-quaternary alluvial sediments mostly derived from the chemical and mechanical erosion of the Zagros Mountains. Rapid erosion in the Zagros area is accompanied by high water flow resulting in large stream load. Rock and mineral fragments are transported by streams toward south of the province and are deposited on alluvial and sedimentary plains (e.g., Ahvaz city). Deposits of sediments show diverse layers and mixtures of sand, silt and hard mud. The area of the province's capital city is characterized by the predominance of alluvial and sedimentary rocks of both chemical and detrital origins. The sand and much of the coarse silt fractions of alluvial deposits are typically composed of quartz, whereas the fine silt and clay fractions are dominated by clays. Mineral fragments in the alluvial deposits are sorted by size due to differences in specific gravity and to some chemical dissolution during transport. Mineralogically, Most important mineralogical composition of semi-desert and desert areas of Khouzestan (warm and dry and ultra-dry conditions) are Illite, kaolinite and Montmorillonite (clays groups), alkali feldspar, quartzic sand,

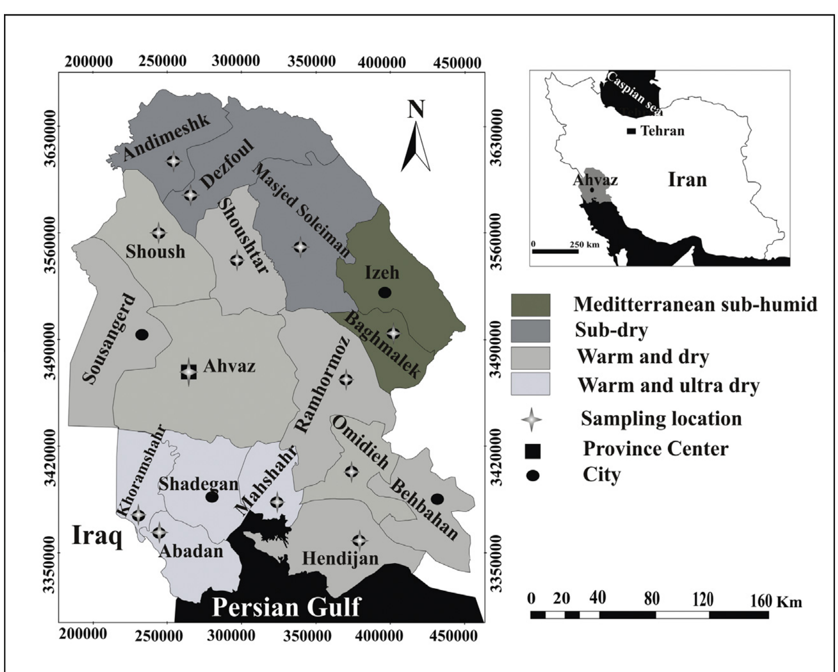

Fig. 1. Location of the Khouzestan province (Iran) and collected samples.