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Ionic composition of wet precipitation in the Petra Region, Jordan

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Abstract

The results of chemical analysis of precipitation samples collected in Petra between October 2002 and May 2004 are presented. All samples were analyzed for major cations (NH_4^+, Na^+, K^+, Ca^{2+} and Mg^{2+}), major anions (Cl^-, NO_3^-, HCO_3^- and SO_4^{2-}), conductivity and pH.

The daily sample pH values ranged from 5.71 to 8.15 with an average value of 6.85 ± 0.5. Rainwater quality is characterized by low salinity and neutralized pH. Generally, the pH is high due to dust in the atmosphere, which contains a large fraction of calcite. Factor analysis was used to identify the factors that affect the presence of ions in wet precipitation; these factors permitted the identification of three source groups, namely crustal dust, sea-salt spray and combustion products.

In general, the results of the present study suggest that the atmospheric composition in the Petra region is strongly influenced by natural sources rather than anthropogenic sources.

Keywords: Chemical element; Factor analysis; Jordan; Major ions; Precipitation chemistry

1. Introduction

The chemical composition of rainfall is strongly affected by the chemical composition of the atmosphere. The study of the chemical composition of atmospheric eolian dust and

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aerosols is especially important and significant, because of the immediate influence on human health and the ecosystem. The composition of metals emitted into the atmosphere in the form of eolian dust or aerosols is mainly from anthropogenic activities, these are taken away by dry or wet deposition and cause damage to the surface water and organisms. The chemical composition of eolian dust and precipitation in the Mediterranean region and the factors affecting these compositions are fairly well established through many studies performed since the 1990s. The analysis of ionic and heavy metals in atmosphere particles and precipitation is very important because certain species are emitted from particular source types and they can be used as tracers for these sources (Rahn and Lowenthal, 1985). There are two main sources that strongly affect the composition of atmospheric aerosols and precipitation in the Mediterranean area. One of these is the eolian dust transported from North Africa (Kubilay and Saydam, 1995) and the other is the pollution aerosol transported from Europe (Bergametti et al., 1989; Gullu et al., 1998).

The chemistry of wet and dry precipitation in both rural-continental and urban areas has been the subject of intense research and study in the in the last two decades, especially in developing and industrial countries. Jordan is situated 80 km to the east of the Mediterranean Sea, the climate of Jordan is predominantly of the Mediterranean type. Petra, (rose-red city), now a UNESCO World Heritage Site (population 60,000) is one of the great archaeological treasures in the world. It is the most important famous attraction of Jordan. This city is located in the southern part of Jordan and is located to the eastern side of the Mediterranean weather regime. The investigated area is in general considered as a very arid to semiarid area, it is marked by sharp seasonal variation in both temperature and precipitation. It is about 80 km from the sea and the annual rainfall is about 298 mm/year (Department of Meteorology, 2003). The winter season in Jordan is the principle season of rainfall, the water year starts in early October–May. The prevailing wind direction is from westerly to northwesterly, this wind bringing cold wet air during winter and spring from Europe and the Mediterranean Sea and from the east and south bringing hot dry air during summer and autumn from Saudi Arabia, Africa and India (Department of Meteorology, 2003). Water resources in Jordan mainly depend on rainfall, which is subject to great variability. Meanwhile, there is an observed population growth, so there is high demand for water. This paper presents 2-year study of precipitation contents carried out on a daily basis in Petra city. The objective of this study is to find out the ionic composition of precipitation in this city, to study the variation in the chemical composition of rainwater samples and to explain the reason of the concentration of major ions for the period between October 2002 and May 2004.

2. Materials and methods

Precipitation samples were collected from the Petra area approximately 250 km to the south of the capital of Jordan, Amman. The station was located inside the region, which is about 1115 m above sea level (Fig. 1). Twenty-eight rainwater samples were collected in the investigated area between the period October 2002 and May 2004. Two samplers were used in this study; both consist of a polyethylene funnel with a 25-cm diameter opening