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Determination of ^{137}Cs activity in soil from Qatar using high-resolution gamma-ray spectrometry

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HIGHLIGHTS

- A baseline for the radionuclide ^{137}Cs in soil samples collected from Qatar was established.
- 129 soil samples collected across the landscape.
- Samples were collected before the most recent accident "the 2011 Fukushima Dai-ichi NNP accident".
- The highest activity concentration was found to be $15.41 \pm 0.67_{\text{Stat.}}$ and $0.11_{\text{Syst.}}$
- The relatively high concentrations can be attributed to rain washout.

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ABSTRACT

With interest in establishing baseline concentrations of ^{137}Cs in soil from the Qatarian peninsula, we focus on determination of the activity concentrations in 129 soil samples collected across the State of Qatar prior to the 2011 Fukushima Dai-ichi nuclear power plant accident. As such, the data provides the basis of a reference map for the detection of releases of this fission product. The activity concentrations were measured via high-resolution gamma-ray spectrometry using a hyper-pure germanium detector enclosed in a copper-lined passive lead shield that was situated in a low-background environment. The activity concentrations ranged from 0.21 to 15.41 Bq/kg, with a median value of 1 Bq/kg, the greatest activity concentration being observed in a sample obtained from northern Qatar. Although it cannot be confirmed, it is expected that this contamination is mainly due to releases from the Chernobyl accident of 26 April 1986, there being a lack of data from Qatar before the accident. The values are typically within but are sometimes lower than the range indicated by data from other countries in the region. The lower values than those of others is suggested to be due to variation in soil characteristics as well as metrological factors at the time of deposition.

1. Introduction

The State of Qatar occupies a total area of 11,437 km^2, extending approximately 235 km north-south and 95 km east-west. It is situated between (25.30) north latitudes and (51.15) east longitudes. It shares a geographical border with the Kingdom of Saudi Arabia towards the south. The surface of Qatar lies over a

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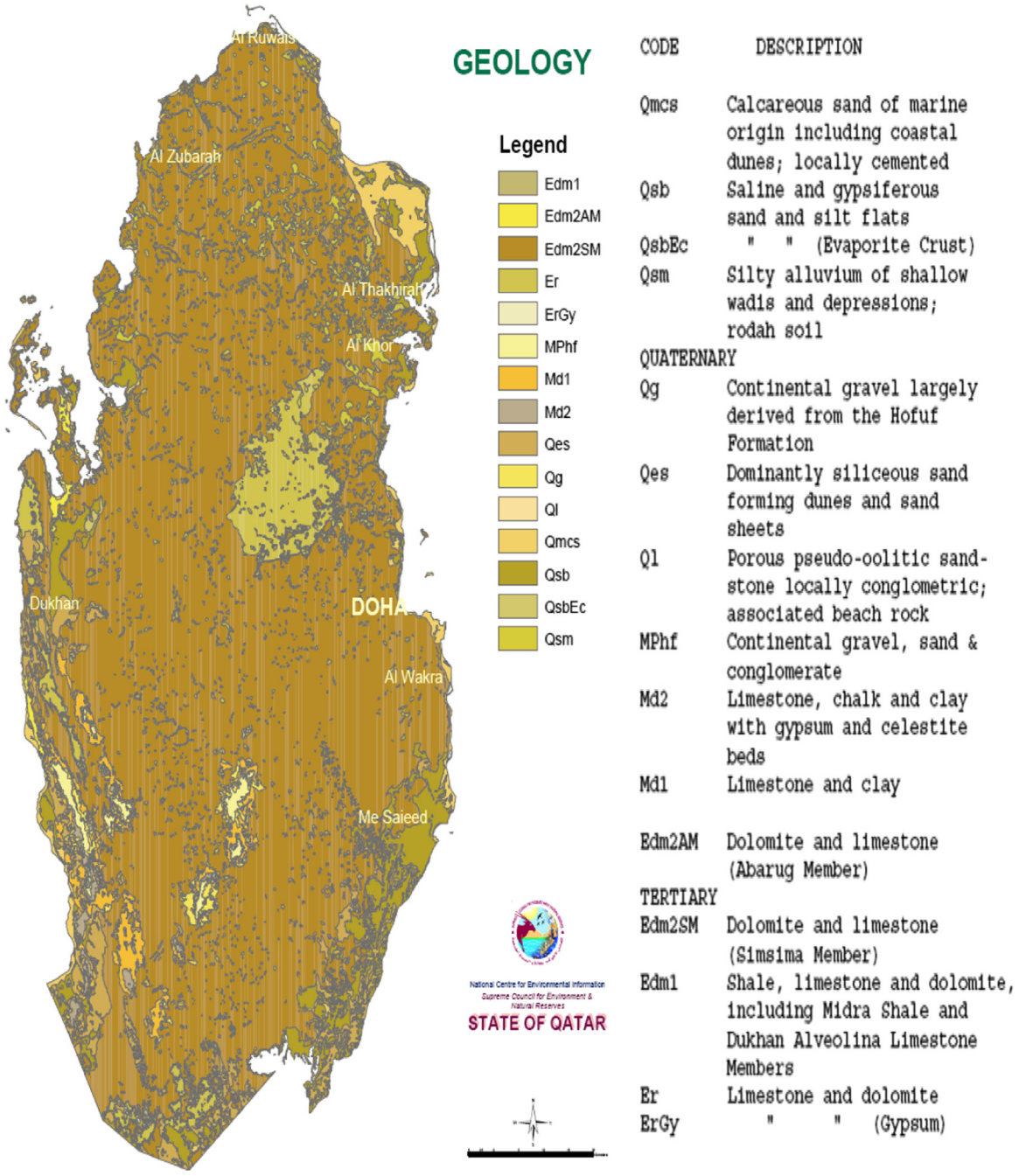

Fig. 1. Geological map of Qatar (taken from the Ministry of Environment, Doha, Qatar (EIC). A description of the legend is given above.

geological formation comprising a sequence of limestone, chalk, clay and gypsum (DAWR, 2005). This formation forms the largest part of Qatar's surface geology as shown in the geological map of the State of Qatar in Fig. 1.

The topography of the land is an almost low and flat to wavy desert with a declination in the northern areas towards the sea as illustrated in Fig. 2. The highest altitude is about 103 m in southern Qatar which is notable for its rocky hills and sand dunes. The northern and eastern areas are known for their lower altitudes that permit the growth of limestone young colluvial deposits in depressions, known locally as rodah. The soil of rodah constitutes about 2.44% of the total area of the state and is considered as the best arable soil in the country, tending to be more in the northern areas. Besides the permanent crops, mainly dates, agricultural land use is mainly limited to the production of seasonal green fodder, cereals and vegetables (Al Yousef et al., 2000). Domestic and industrial water demands are vitally depend on the desalinization of sea-water. Surface fresh waters are very rare and are limited during the winter season in depressions (rodahs). The only source of freshwater in the country is ground-water which is basically used for irrigation (NRMED, 1997).

The average annual rainfall in Qatar is about 100 mm per year limited to the autumn and winter seasons, with a higher rainfall tendency towards the northern and eastern areas that sustain limited plant and animal life (see Fig. 3). Summer months, which roughly start from June and extend until October, are characterized by extreme heat, dryness, relatively alternating humidity and irregularly violent wind and sand storms. These increase the rate of soil erosion and movement (particularly sand) in the upper layer of soil especially in a dry, hot desert where there is no scrub