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Uranium remobilization and migration evaluation through aerial spectrometric gamma technique in Syrian Desert (Area-1), Syria

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HIGHLIGHTS

- Airborne γ-ray spectrometry data are used to compute uranium migration trends of Syrian Desert (Area-1).
- Approaches are used to evaluate the redistribution of radioactive elements in Area-1.
- Possible traps for uranium accumulations are located in Area-1.

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ABSTRACT

Uranium remobilization and migration in the Syrian Desert (Area-1) has been evaluated through analyzing the data of aerial spectrometric gamma technique and examining different radioactive geophysical approaches. The ten geological units identified on the already established scored map have been well characterized through analyzing their contents of eU, eTh, and K%, and studying the mutual relationships between those elements and their ratios. This is done in order to define the regional variation trends of the uranium migration in Area-1, and to evaluate the degree of uranium remobilization. The uranium potential in the studied Area-1 has been explained by applying and analyzing two prospecting indicators of the uranium favorability index U_I and alteration-F. It was demonstrated that uranium remobilization took place in all the described lithological units, but to different degrees. The uranium migration and its haloes redistributions have been explained by establishing different plausible geological model interpretations. Several localities such as wadi Ratka are found to be favorable possible traps for uranium accumulation, which necessitate more further detailed uranium exploration.

1. Introduction

An airborne gamma-ray spectrometric survey was undertaken in Syria during a project conducted in 1987 on some Syrian regions in cooperation with the International Atomic Energy Agency and Riso National Laboratory SYR/86/005 (Riso, 1987, and Jubeli, 1990).

The region covered by this airborne survey consists of the following areas shown in Fig. 1:

1. The Syrian Desert (7189 line km at 4 km line spacing).
2. Ar-Rassafeh Badyieh (2240 line km at 4 km line spacing).
3. The Northern Palmyrides (1600 line km at 3 km line spacing).

The main objective of this survey was originally to assist uranium exploration. It was found that gamma ray anomalies are mainly associated with phosphate deposits encountered in Central Syria. The richest phosphorite outcrops are in central southern Palmyrides, where they have been economically mined from two mines for many years, Khneifis and Al-Sharquieh, which are located 65 km and 45 km southwest of Palmyra respectively, Fig. 2.

Airborne gamma-ray spectrometric data of the Syrian Desert (Area-1) has been recently interpreted by using a factor analysis technique, in order to reconstruct a scored lithological map of outcropping units for Area-1, (Asfahani et al., 2015). A model of four factors (F1, F2, F3 and F4) was adapted for representing the acquired data, where 86% of the total data variance is explained. Ten lithological units have been identified by using this technique, and establishing the scored lithological map.

In this paper, efforts are concentrated on the clarification of the regional uranium migration trends and its remobilization in Area-1 through analyzing, explaining and interpreting the airborne gamma-ray spectrometric data of the Syrian Desert (Area-1). Similar methodological research has been carried out, where

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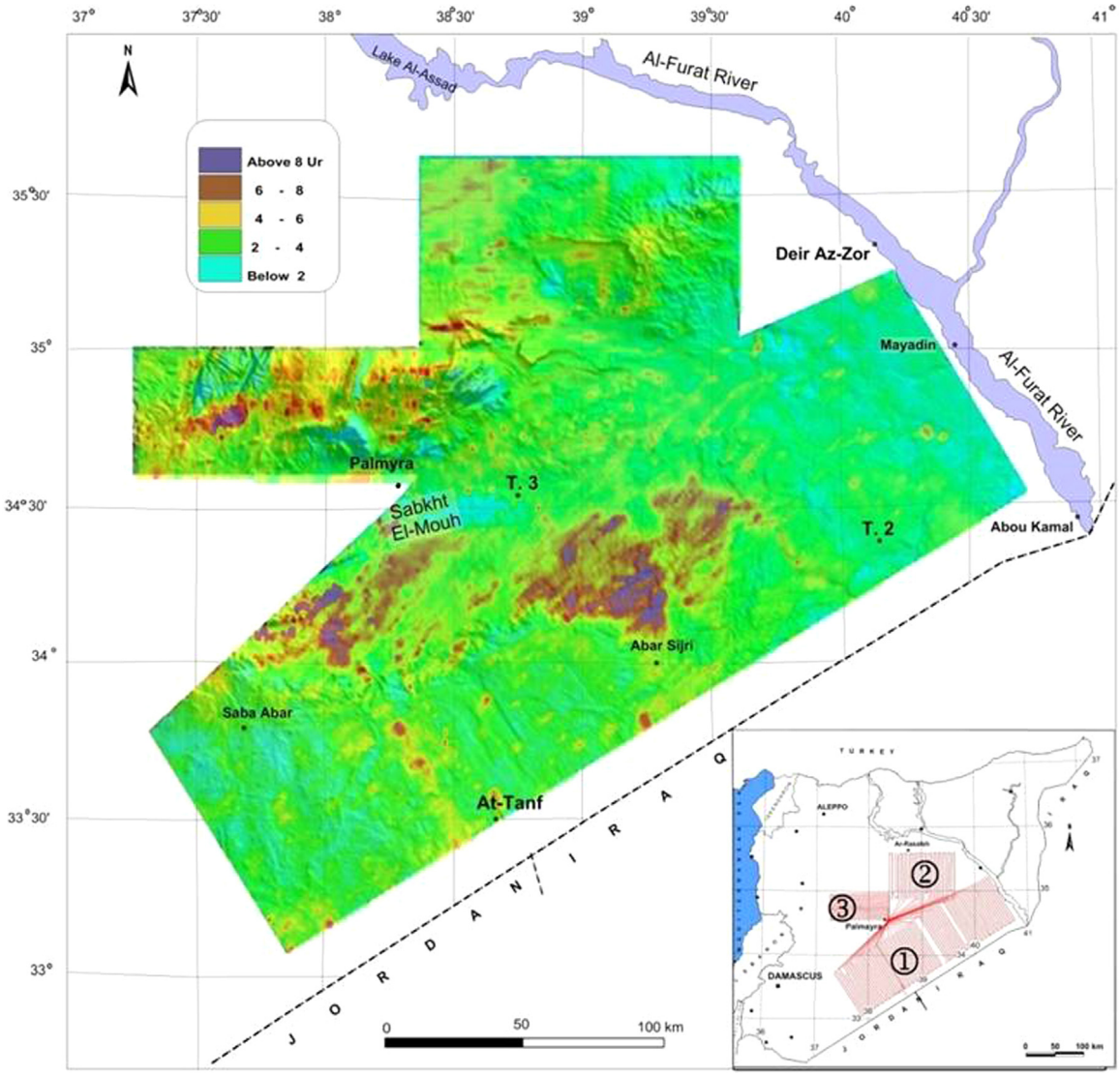

Fig. 1. A: Total areas covered by airborne gamma-ray spectrometry. B: Radiometric map resulting from spectrometric survey (Riso, 1987).

uranium migration has been determined for the first time through an original approach of benifiting from the airborne spectrometric data of the Area-3 in northern palmyrides in Syria, where different regional maps explaining the uranium migration behavior have been established (Asfahani et al., 2005, Asfahani et al., 2010).

The main objective of the present paper is therefore to achieve the following:

1. Identify the radioactive characteristics of the ten lithological units already outlined by using the factor analysis technique (Asfahani et al., 2015) and consequently define the distribution pattern of the radio-elements in those units and their radioactive signatures.
2. Determine the mutual relationships between the different outlined lithological units in the studied Area-1.
3. Analyze the trends and the behavior of eU, eTh, and K% with their ratios as an indicator of uranium remobilization to evaluate the redistribution of radioactive elements in the studied region.
4. Explain the regional uranium migration trends in Area-1, and its haloes redistributions through establishing different plausible geological model interpretations.
5. Propose some locations as favorable possible traps for uranium accumulation.

2. General setting

2.1. Geology

The exposed sequence in the desert region (area-1) ranges from cretaceous up to pliestocene, Fig. 3, with several regional and local unconformities intervening the stratigraphic column (Technoexport, 1967, Bender, 1975).

2.1.1. Cretaceous system

occupies the north western mountainous tract of the research area. These rocks consist of limestone, dolomitic, marly-clayey limestone, with phosphate intercalations. The phosphate deposits are actually in the Al-Sharaquieh locality. Cretaceous sequences are thinned or wholly disappear in boreholes struck in the extreme south and southeast, with long period depositional hiatus, where a Paleogene sequence directly lies on Triassic rocks (Technoexport, 1967; Al-Bassam et al., 2006).

2.1.2. Paleogene system

covers widely the surveyed territory. It is composed of a litho-sequence of marine, shallow marine facies, where are gradually changed to a continental nature toward the northeast and east.