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Environmental effects and characterization of the Egyptian radioactive well logging calibration pad facility

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HIGHLIGHTS

- Location of well logging calibration pad facility in Egypt is a very suitable site.
- Top layer radioactivity is less than the background radioactivity.
- The radioactive dose rate reaches 1.26 mS/y.
- Soil covers the area surrounding pad must buried in suitable landfills.

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ABSTRACT

A set of ten radioactive well-logging calibration pads were constructed in one of the premises of the Nuclear Materials Authority (NMA), Egypt, at 6th October city. These pads were built for calibrating geophysical well-logging instruments. This calibration facility was conducted through technical assistance and practical support of the International Atomic Energy Agency (IAEA) and (ARCN). There are five uranium pads with three different uranium concentrations and borehole diameters. The other five calibration pads include one from each of the following: blank, potassium, thorium, multi layers and mixed. More than 22 t of various selected Egyptian raw materials were gathered for pad construction from different locations in Egypt.

Pad's site and the surrounding area were spectrometrically surveyed before excavation for the construction process of pad-basin floor. They yielded negligible radiation values which are very near to the detected general background. After pad's construction, spectrometric measurements were carried out again in the same locations when the exposed bore holes of the pads were closed. No radioactivity leakage was noticed from the pads. Meanwhile, dose rate values were found to range from 0.12 to 1.26 mS/y. They were measured during the opening of bore holes of the pads. These values depend mainly upon the type and concentration of the pads as well as their borehole diameters. The results of radiospectrometric survey illustrate that the specification of top layers of the pads were constructed according to international standards.

1. Introduction

Radioelement baseline data sets are essential components for many research applications in the earth and life sciences. The benefits of radioelement data baselines include the effective use of radioelement data for uranium exploration and mining, geological mapping, mineral “including hydrocarbon” exploration, and regolith mapping. Radioelement baseline data sets are, thus, crucial for the setting of good public policy in relation to uranium resource discovery and development (IAEA, 2010). Geophysical well logging processes play a very important role in mineral exploration especially radioactive minerals. Any geophysical radioactive instrument must be calibrated before data acquisition process, to get accurate measurements for radioactive mineral concentrations. An appropriate location was selected for constructing geophysical well logging calibration pads in one of the sites of the Egyptian Nuclear Materials Authority at 6th October city, Geizah, Egypt. The excavation process in the site reached 6 m depth. The main objective for well logging pad construction is to facilitate calibration of the well logging tools, especially the gamma-ray spectrometric ones, beside the nuclear density and neutron tools.

The selected location of the constructed pads is very suitable for this project, because the underground water in this location is deep due to the presence of basaltic sheets in this area. Besides, these basaltic sheets prevent any radioactive pollution from to reaching the underground water, according to its high density. The environmental radioactive background for this location is very low, because the basic mineral composition of the basaltic rocks in the area is characterized by their very low radioactivity.

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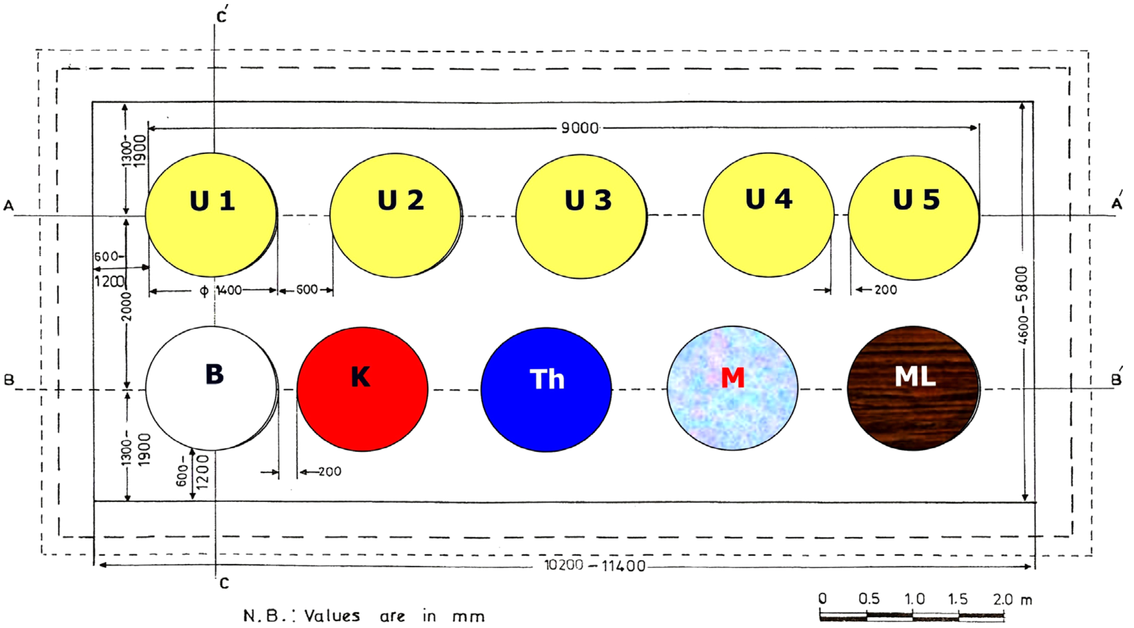
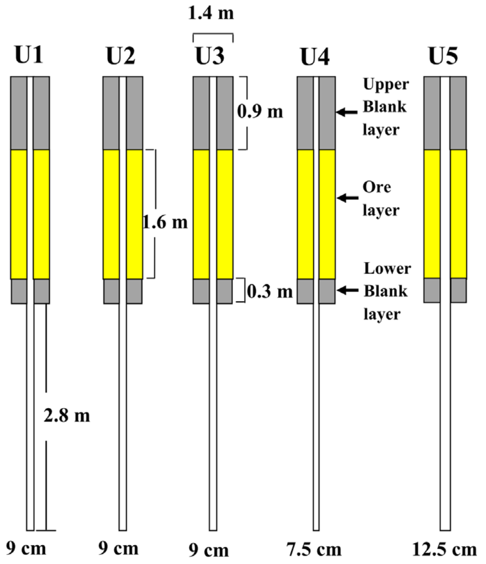


Fig. 1. Horizontal distribution of the radiospectrometric well logging calibration pads, (NMA (2002)). Where: U1, Low uranium concentration; U2, Intermediate uranium concentration; U3, High uranium concentration ; B, Blank Pad; K, Potassium, Th, Thorium; M, Mixed Pad; ML, Multi-Layer pad; U4, Intermediate uranium concentration and narrow borehole; U5, Intermediate uranium concentration and wide borehole.

The pads were constructed according to the design models which clarify the horizontal pads distribution as illustrated in Fig. 1, NMA (2002).

A set of ten columns (U1, U2, U3, U4, U5, B, K, Th, M and ML) was constructed, all columns are 2.8 m in height, except the multi-layer (ML) one which reaches 3 m in height. The ore zone thickness is 1.6 m of known radioelement concentration, sandwiched between an upper 0.9 m and a lower 0.3 m barren (background) zones. The borehole diameter of each column is 9 cm, excluding (U4) which reaches 7.5 cm and (U5) which attains 12.5 cm. Three of the columns contain ore zones of different concentrations (low, medium and high) for uranium, with the same borehole diameter 9 cm. Two columns for the same uranium ore (medium) concentration, but with different borehole diameters 7.5 and 12.5 cm. Five other columns include one blanked, one that have only potassium ore, one that contains only thorium ore, one mixed from potassium, thorium and uranium ores, and a final one which contain uranium ore, but separated into three 3 parts. Figs. 2 and 3 illustrate the vertical distribution of blanked and ore zones in the pads.



U1 : Low uranium concentration
U2 : Moderate uranium concentration
U3 : High uranium concentration
U4 : Moderate uranium concentration with narrow borehole
U5 : Moderate uranium concentration with wide borehole

Fig. 2. Vertical distribution of the blank and ore layers in the different five uranium pads of the radiospectrometric well logging calibration facility, NMA, Egypt.

2. Ore materials

Suitable amounts from the Granitic rocks from Gabal Qattar area, Northeastern Desert of Egypt, containing high Uranium radioactive element concentration (U) were collected and crushed to 60 mesh and used as a uranium ores for uranium pads constructions. Monazite ore which contain 54,000 ppm thorium radioactive element is a suitable source for the thorium which can be used in the construction of thorium pads, the monazite ore product is separated from the black sand deposits which located along the north coast of Rosetta branch, Northern coast, Egypt.

On the other hand, the Potassium ores which used in the pads construction were collected from Feldspar mines which located at El Hamrawain area, Central Eastern Desert, Egypt. Fig. 4, illustrates the locations of ore materials in Egypt. All different three types ores after crushing and good blending were analyzed radiometrically and chemically in three international labs in “Egypt, China and France”. Table 1 illustrates the amounts and concentrations of ores, which were used in the construction process.

2.1. Selected samples

Fourty seven samples were selected from different pads after construction to analyze radiometrically, from these 47 samples about 17 samples were analyzed chemically. Figs. 5 and 6, illustrate the samples positions in the different pads. Table 2 illustrates the number of samples from different pads.