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Study of soil-fern transfer of naturally occurring alpha emitting radionuclides in the Southern Region of Cameroon

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ABSTRACT

This study was carried out in the localities Melondo and Ngombas located in the Southern Region of Cameroon where there are known to be uranium-bearing and high background radiation areas. Activity concentrations of naturally occurring radionuclides ^{210}Po, ^{238}U, ^{235}U, ^{234}U, ^{232}Th, ^{230}Th, ^{228}Th and ^{226}Ra were determined in soil and fern (filicophyta) samples collected at 10 points in both localities. In soil, the average values of these activity concentrations (in $Bq.kg^{-1}$ d.w.) were ^{210}Po(130 ± 10), ^{238}U(126 ± 11.6), ^{235}U(5 ± 1), ^{234U}(131 ± 10), ^{232}Th(400 ± 22), ^{230}Th(145 ± 11), ^{228}Th(381 ± 21) and ^{226}Ra(154 ± 28) at Melondo; and ^{210}Po (228 ± 1), ^{238}U(170 ± 11), ^{235}U(9 ± 2), ^{234}U(179 ± 12), ^{232}Th(200 ± 18), ^{230}Th(184 ± 18), ^{228}Th (228 ± 22) and ^{226}Ra(416 ± 7) at Ngomba. In fern the average activity concentrations were: ^{210}Po(35 ± 3), ^{238}U(0.68 ± 0.05), ^{235}U(0.042 ± 0.01), ^{234}U(0.90 ± 0.05), ^{232}Th(1.2 ± 0.2), ^{230}Th(0.7 ± 0.1), ^{228}Th (39 ± 3) and ^{226}Ra(14 ± 3) at Melondo and ^{210}Po(24 ± 2), ^{238}U(0.82 ± 0.06), ^{235}U(0.046 ± 0.01), ^{234}U (0.92 ± 0.06), ^{232}Th(0.8 ± 0.2), ^{230}Th(0.9 ± 0.2), ^{228}Th(15 ± 5) and ^{226}Ra(14 ± 3) at Ngomba. The soil-fern transfer factors (TF) (in $kg.kg^{-1}$) were respectively ^{210}Po(1.64×10^{-1}), ^{238}U (5×10^{-3}), ^{235}U(7×10^{-3}), ^{234}U(6×10^{-3}), ^{232}Th(3×10^{-3}), ^{230}Th(5×10^{-3}), ^{228}Th(7.9×10^{-2}), and ^{226}Ra(5.1×10^{-2}). The highest TF for fern was for ^{210}Po, probably because of atmospheric deposition. The TFs of uranium and thorium were comparable to those given in the IAEA handbook for grass.

1. Introduction

There is a great interest in the study of natural environmental radiation as well as radioactivity in soil and plants because the population is exposed to natural radioactivity at different levels depending on the natural radioactive minerals in each region in the world (Akhtar et al., 2005). In fact, higher concentrations of radioactivity in environmental media are associated with higher radiation damage and risk to human such as kidney damage, mutagenicity, bladder and kidney cancer, leukemia, testis cancer, lung cancer, etc.(Guogang et al., 2009; Meinrath et al., 2003; Veronique et al., 2005). Apart from ^{40}K, natural radioactivity arises mainly from ^{238}U and ^{232}Th and their daughter products which form the main two natural radioactive decay chains. Radioisotopes from these natural decay chains are present in ground formations with concentrations varying within a wide range of different geological setting (Patra et al., 2013).

Plant contamination by these radioisotopes can result from deposition of radionuclide from the atmosphere to the above-ground parts and from sorption of radionuclide from the soil by the root system. Root absorption of uranium is dependent on the same parameters that determine its mobility in soils, such as the content of organic matter and the presence of phosphates, sulphates and carbonates (Cuney et al., 1992; Gueniot and Munier-Lamy, 1988). Generally, the transfer soil-plant of radionuclides is assessed in terms of transfer factor (TF) which is defined as the ratio of radionuclide concentration in dry plant to that in dry soil per unit mass (IAEA, 1994). The highest values of uranium TF are often measured in root vegetables, particularly in potato tubers (Sheppard and Sheppard, 1985). Thorium is adsorbed very well by the roots but is very little translocated in the leaves. The ability of the plant to accumulate thorium is correlated with its growth characteristics. Thus, high-growth plants dilute thorium in their dry matter (AEC, 1988). An important pathway for plant contamination may be the re-suspension of soil particles. Thus, washing of the vegetation before measurement can decrease by a factor of 10 the TF (Zararsiz et al.,

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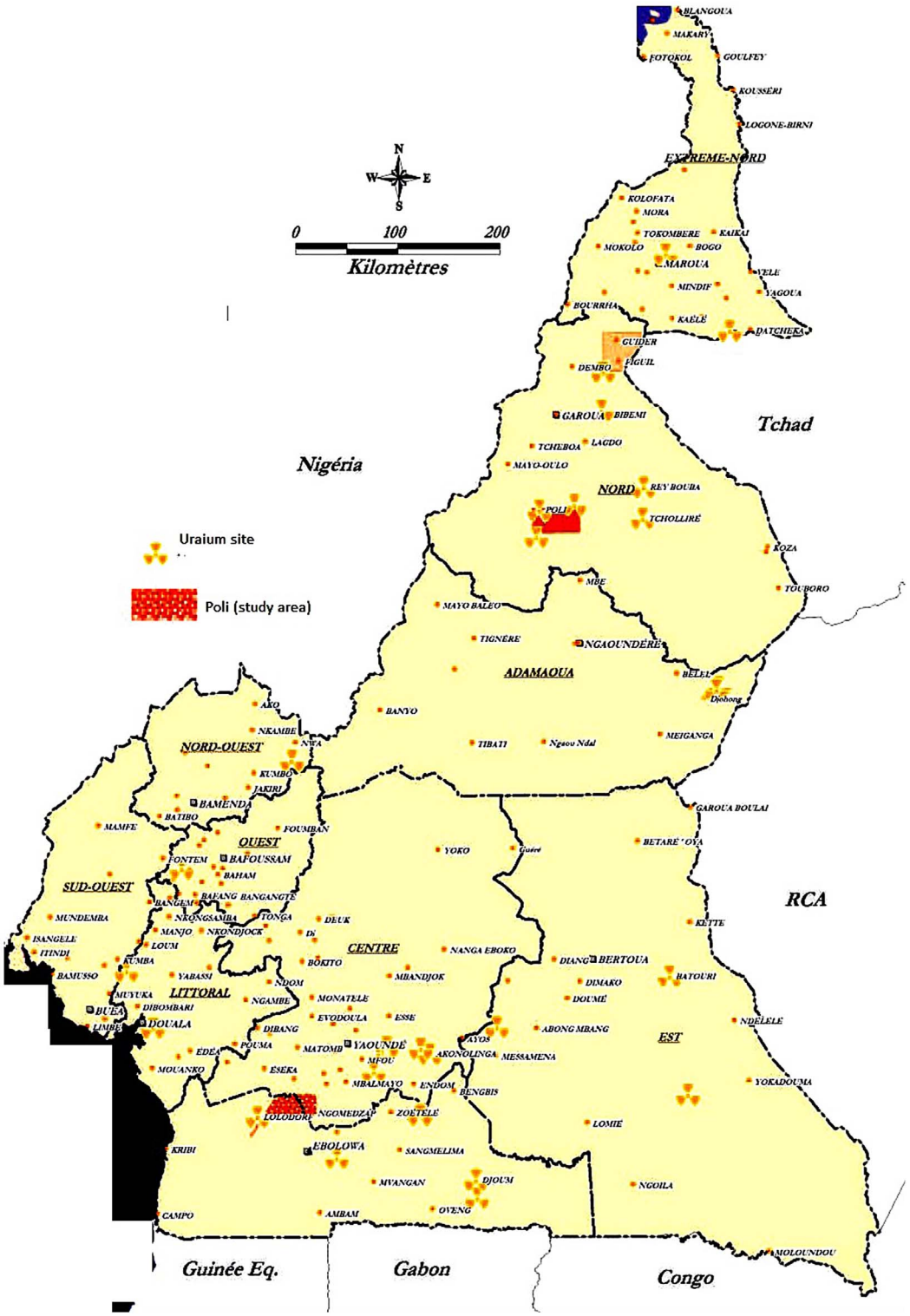

Fig. 1. Uranium projects map of Cameroun showing the sampling area (Nguepjouo, 2010).

1997).

Particular attention must be paid to natural ^{210}Po (T1/2 = 138d) which is ^{238}U radioactive daughter in radiation protection because of its high degree of toxicity estimated to be 500 to 2000 times higher than that of plutonium for the same activity concentration in soil (Pradel et al., 2001). ^{210}Po is considered to be one of the most important environmental radionuclides due to its wide distribution and potential for human radiation exposure through ingestion and inhalation (Martin and Ryan, 2004).

The present study is carried out in two rural localities (Ngombas and Melondo) in the Lolodorf subdivision in the Southern Region of Cameroon. These areas are located on the Lolodorf syenitic axis extending about 75 km in the South West of Cameroon, from the Precambrian geological period. Radiometric anomalies are concentrated along the Lokoundje River Basin which dissects through radioactive syenite sources (Ele et al., 2010; Maurizot et al., 1986). Fig. 1 shows the uranium exploration projects and identifies the studied area. Since 2009 several investigations have been made around these