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# ACCUMULATION OF URANIUM IN *RAPHANUS* SP.

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**Abstract**

An appreciable amount of uranium was accumulated by *Raphanus* sp., growing on heap piles of uranium mine wastes and overburdens in the mining area. About 40% of the plant samples contained ≥5 μg $U_3O_8$ / g on dry weight basis. The descending order of average U content in various plant parts was: leaves > roots > stems.

## Introduction

Plants growing on heavy metal-rich soil have been described as accumulators, excluders or indicators, depending on metal concentrations (Legittimo *et al.*, 1995. The basis of the biogeochemical method of prospection is that the presence of anomalous concentrations of metals in the soil or underlying rocks will be reflected by the high concentration of metals in the vegetation (Butcher, 1992; Kabata-Pendias & Pendias, 1992; Badri & Springuel, 1994). Therefore, the use of certain plant species as bioindicators of heavy metals is well documented in literature (Ernst, 1993; Malyuga, 1964). *Rosa rugosa* and *Thuja accidentalis* are capable of absorbing the flying dust so that U and Th can be detected in their leaves for prospection of these precious metals (Kovacs & Podani, 1986).

The purpose of present study was to investigate the uptake of U in *Raphanus* sp., growing on heap piles of mine wastes and overburdens of sandstone ores in the mining areas.

## Materials and Methods

**Sample collection:** Thirty six plant samples of *Raphanus* sp., growing on heap piles of mine wastes, overburdens, low- and high-grade sandstone ores, and root-zone soil/ ore (0-20 cm depth) for each plant sample were collected from the mine site.

**Sample preparation and analysis:** The attached foreign particles from plant materials were removed carefully with the help of fine plastic forceps. The plant samples were washed thoroughly with running double -deionized water and were separated into various parts (leaves, stems and roots). These plant materials were separately oven-dried at 60-80 °C for 2-days to constant weight, and then pulverized with a mortar and pestle. An accurately weighed (1 g) sub-sample of each plant part was digested in 10 ml

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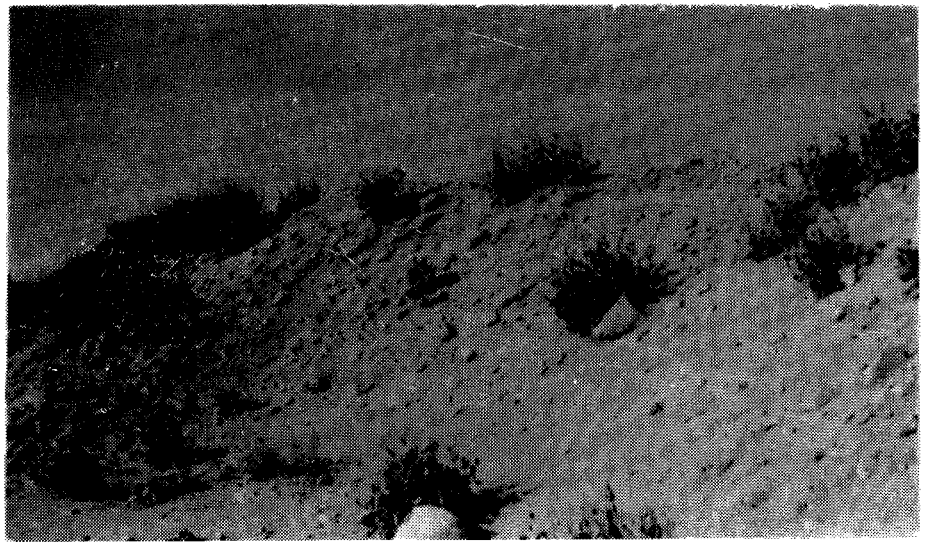

Fig. 1. A view of *Raphanus* sp., growing in the field.

conc. $HNO_3$ at 100°C for 4 hr. The extract was filtered through Whatman No. 41 filters and the filterate volume was made to 25 ml with double-deionized water. The filterates were analyzed for U concentration in plant parts using fluorimetric method (Mateen *et al.*, 1989). The oven-dried soil/ ore samples were analyzed for their U content using a standard radiometric method (Bone & Porritt, 1970). Slurry of soil/ ore samples in double deionized water (1:1 ratio) was prepared and analyzed for pH and electrical conductivity (EC).

## Results and Discussion

*Raphanus* sp., a member of the family *Brassicaceae*, is a xerophytic shrub at maturity. It was a characteristic species of the vegetation in the uranium mining area (Fig. 1). The relationship of this species with uranium mineralization as a tool for biogeochemical prospection of uranium ore-bodies is yet unclear. The soil/ ore samples were alkaline in nature due to high calcite content. Quartz was the most abundant constituent of the sandstone ores. The water slurries of these samples had pH in the range of 7.5 to 7.9; a great variation was observed in the values of their EC (Table 1). Uranium concentration in various samples of bed rock, overburdens and sandstone ores were in the range of 20 to 1000 ppm $U_3O_8$ (Table 1). The main uranium mineral was identified as tyuyamunite $[Ca(VO_4)_2(UO_2)_2 \cdot 5\text{-}8H_2O]$ in which uranium was present in the hexavalent state $[U^{6+}]$ (Mahmood, 1994).

A significant amount of uranium was accumulated in *Raphanus* sp., growing in the mining areas of sandstone uranium ores. The uptake of this metal may occur as soluble $U^{6+}$ state from the soil/ ore by roots which is then translocated from root to other plant

**Table 1. Characteristics of soil/ore samples collected from root-zones of plants.**

| Sampling site | pH of Slurry | EC ($\mu Scm^{-1}$) | $U_3O_8$ (ppm) |
|---|---|---|---|
| Rock Bed | 7.80 | 200 | ≤20 |
| Overburden | 7.90 | 190 | ≤50 |
| Cut-off grade ore | 7.50 | 600 | 200 |
| Medium-grade ore | 7.80 | 150 | 500 |
| High-grade ore | 7.80 | 130 | 1000 |

The values are means of three replicates.

parts. High U content was accumulated in leaves and roots of the plant (s). The concentration of U ranged from 4.5 to 7.7 g/g in leaves, 2.7 to 3.7 g/g in stems and 2.2 to 6.2 g/g in roots on dry weight basis. Relatively higher U content was observed in leaves and roots of plants growing on heap piles of overburdens and low- and high-grade sandstone ore followed by high-grade ore (Fig. 2).

About 40% of the plant samples contained ≥5 $gU_3O_8$/ g dry weight. It could be due to difference in age of the plants and the availability of soluble uranium in the root zone. The soluble $U_3O_8$ content may find way into roots, stems and leaves through different pathways of nutrient cycling. This is a universal characteristic of plant

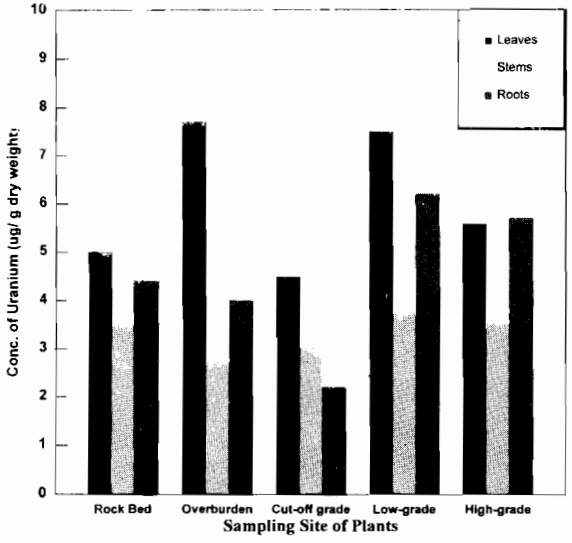


Fig.2. Histogram showing the accumulation of uranium in leaves, stems and roots of *Raphanus* sp., growing on heap piles of mine wastes, overburdens, low- and high-grade sandstone ores in the mining areas. Values shown are means of three replicates.

community growing in the mineralized areas that the plants have a high metal content in their ash. Generally, leaves had higher $U_3O_8$ content as compared with roots and stems.

The plants growing on mineralized soil or rocks would accumulate anomalous amounts of heavy metals and could be used as a tool for biogeochemical prospection or phytoremediation of the particular areas (Kovacs & Podani 1986). In the present study, however, accumulation of uranium in plants had no correlation with the uranium concentration in the soil/ ore samples and thus the root zone (rhizosphere).

These preliminary studies have shown that *Raphanus* sp., accumulated an appreciable amount of $U_3O_8$ through root uptake. There is need for further studies to identify the plant species and establish the relationships between plant species and uranium mineralization in the area. *Raphanus* sp., can be used as phytoremediation of soils contaminated with uranium.

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