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Research Papers

"Biogeochemical study of aquatic mosses in chromite mineralized zone of Byrapur, Karnata, India"

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Abstract

In view of the ecological, mineral exploration and environmental significance of aquatic mosses, a biogeochemical study of mosses was undertaken in the chromite mineralized zone of Byrapur area, Karnataka. The objective of the present work is to determine the metal accumulation in the aquatic mosses for Cr and other associated metals. Samples of aquatic mosses from mine pits in chromite mineralized zone were collected. The aquatic mosses were analyzed for mineral elements namely Cr, Co, Ni, Pb, Zn, Cu, Mo, Mn, V and Fe. Analysis of aquatic mosses show that the concentration of Cr ranges from 1820 ppm to 2564 ppm; Zn ranges from 430 ppm to 620 ppm; Co ranges from 24 ppm to 59 ppm; and for the Vanadium it ranges from 20 ppm to 48 ppm, whereas other metals are not in much higher concentration.

The concentration of Cr is significantly high (2564 ppm) in aquatic mosses of the study area reflecting the enrichment of ore element. Aquatic mosses collected from mine water pits contained significantly higher concentrations of ore element Cr and other heavy metals viz., Zn, Co ,Pb, Cr and Mn. In view of the unusually high absorption and accumulation of ore element and heavy metals in aquatic mosses from the water bodies, these species may be suggested as indirect indicators of mineralization in the catchments areas of the drainage system Further these studies can be ideally used as tools for their possible application in biogeochemical reconnaissance surveys, biomonitoring of the pollution levels of aquatic environment and water treatment. The aquatic moss appears to be a valuable sampling material for geochemical prospecting of Chromium in the study area.

Key words: Heavy metals, aquatic mosses, Chromite mineralized zone

INTRODUCTION

Biogeochemistry dealing with chemical analysis with emphasis on trace elements in various biological materials for application in mineral prospecting (Malyuga, 1964; Brooks, 1972, 1983; Kovalevskii, 1979), regional geochemical reconnaissance applied to agriculture (Joyee,1975) and in applied to environmental geochemistry to tackle various problems of practical importance (Thornton,1983). Chemical analysis of systematically sampled traces and shrubs for traces of ore metals was one of the first geochemical methods to be investigated (Rose et al., 1979). Biogeochemistry has grown enormously to include several geological and biological factors influencing the sources, dispersion, and distribution of elements in surficial environment their pathways into food materials and water supplies and their possible effects on health and disease in plants, animals, and man. The use of vegetation as guide to mineralization is considerably more complex than soil geochemistry, since it involves the response of plants to their environment. Geochemical prospecting for minerals consists of systematic measurement of chemical properties of natural materials: soil, vegetation, water sediment etc., (Rose et al., 1979). The purpose of geochemical method is discovering of abnormal chemical patterns, called anomalies, related to mineralization. Vinogradov (1964) has designated the term 'biogeochemical provinces' to the regions where an excess or deficiency of a particular element or group of elements in soils, rocks and waters result in variations in the health, form, vitality of plants and animals by the fauna and flora. Such provinces may be zonal or intrazonal. The intrazonal provinces are often influenced by local enrichment of metals due to the occurrence of ore bodies and their associated dispersion halos; and such a province represents an obvious target area for biogeochemical prospecting procedure. The geochemical interest for aquatic mosses as sampling in their ability to absorb chemical elements that are dissolved in water in which they grow. It is assumed that the elemental contents in their tissues is proportioned to the average concentration in water during their growth

The biogeochemical cycles of the majority of the heavy metals are in constant modification as a consequence of human activities, originating an increasing concentration in water bodies and terrestrial or aquatic ecosystems. Aquatic plants (bryophytes), such as mosses, water lilies, water hyacinth, duckweed, etc., are very important components of the aquatic ecosystems throughout the earth. Aquatic bryophytes are especially affected due to their sensitivity to organic; and chemical (Kosiba and Sarosiek, 1995; Papp and Rajczy, 1995) pollution and their sensitivity to changes in nutrient status (Frahm, 1975, 1976; Daniel and Haury, 1996). Nevertheless, the ecology of aquatic bryophytes remains poorly known. Aquatic bryophytes is usually regarded as one of the most pollution-tolerant species (Frahm, 1974; Hussey, 1982; Kelly and Huntley, 1987).These mosses in general seem to be sensitive to temperature (Glime, 1992), and are primary producer and provide habitats for a variety of organisms in fresh water ecosystem (Lopez and Carballeira, 1993).

The widespread occurrence of these plants and their ability to accumulate metals has led to their use in environmental monitoring programs (Claveri and Mouvet, 1995). Aquatic bryophytes have been referred to in literature as being able to shut off, retain and accumulate pollutants such as nutrients, toxic organics and heavy metals, leading to a concentration in their tissues several times higher than in the surrounding environment (Nimptsch et al., 2005). Elemental accumulation by aquatic bryophytes from polluted mine streams was studied by Mc Lean and Jones (1975) and Burton and Peterson (1979).The ancient Sanskrit text of Ayurveda, (the science of longevity), suggest the use of the aquatic plants, such as mosses and the roots of the water lilies for water treatment (Prasad, 1987b,1987c). These plants are capable of absorbing and accumulating the heavy metals from the water bodies to large extent (Brooks, 1972, p.117). Such enrichment of metals in plants, in comparison with water, increases the sensitivity of detection (Whitten, 1985) by analytical technique such as inductively coupled plasma emission spectrometry (I.C.P) (Thomson, 1983, p. 85).Hence these aquatic species are more commonly employed specifically for monitoring the heavy metals in waters (Dietz, 1973; Empain, 1976; Wehr and Whitten, 1983) and for waste water treatment (Nasu and Kugimoto, 1981; Nasu et al, 1984). These mosses have been also successfully used as biological indicators of surface waters contaminated by heavy metals or radioisotopes (Nimis et al., 2002, Mouvet, 1985 and Vincent et al., 2001).Hence, in view of the, ecological, mineral exploration and environmental significance of aquatic mosses, a biogeochemical study of mosses was undertaken in the chromite mineralized zone of Byrapur area, Karnataka. The objective of the present work is to determine the metal accumulation in the aquatic mosses for Cr and other associated elements.

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GEOLOGY OF THE STUDY AREA

Byrapur (Lat.13 06' 20" to 13 06' 56"; Long 76 24' 30" to 76 20' 40") is located in Hassan District, Karnataka(Fig 1) and is included in the Survey of India toposheet No. 57 C/8. Byrapur chromite mineralized zone comes under Nuggihalli schist belt, one of the ultramafics rich ancient belts in the Dharwar craton (Bidyananda et al., 2003). Sporadic occurrence of sulphide mineralelzation has been known from this belt (Radhadkrishna et al., 1973). The texture as well as the nature of silicate minerals associated with the chromite throws significance light on the genesis of the ore (Sahu and Nair 1982). The chromite ore bodies in and around Byrapur is a linear and narrow band of metamorphic basic and ultrabasic rocks and occur as lensoid bodies. The ore bodies are the result of magmatic segregation. The important rock types in the study area are amphibolite, serpentinite talc, tremolite schist, dunite and peridotite. The soil in the study is greenish grey and coarse textured. Earlier workers studied the oxidation character of chlorite (Tapan et al., 1993), and chemical studies of chromo chlorite (Damodaram and Somasekhar, 1976 and Laphan, 1958) of Byrapur chromite area. Geomorphologically, this area has an undulating, moderately elevated terrain surrounded by plains, ridges, and valleys. This area witnesses subtropical climate. The average annual rain fall is about 900 mm and most of this rain fall receives during the northeast monsoon period.

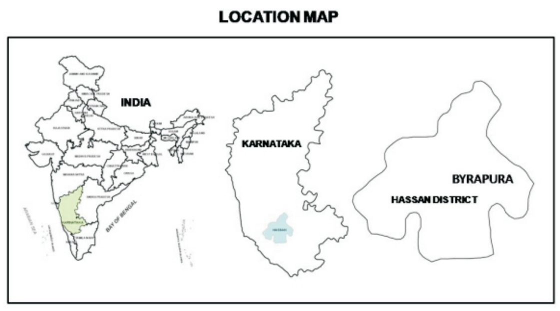

Fig 1. Location Map of the Study area, Byrapur

MA

Samples of aquatic mosses from mine pits in chromite mineralized zone of Byrapur area were collected. The plant samples/aquatic mosses were thoroughly washed with distilled water and air-dried. Moisture was eliminated by keeping the samples in a hot air oven at 110oC. The oven dried material was ignited into ash in a muffle furnace at 500oC for six hours and then dissolved in 2M HCl (Brooks, 1983). These plant species samples were analyzed for Cr, Co, Ni, Pb, Zn, Cu, Mo, Mn, V and Fe by atomic absorption spectrophotometry (Table 1). In the present work, an attempt has been made to study the behavior of ore elements together with their associated trace elements in the aquatic mosses of chromite mineralized zone.

RESULTS AND DISCUSSIONS

Anasysis of aquatic mosses (Table 1) show that the concentration of Cr ranges from 1820 ppm to 2564 ppm with the mean value 2186 ppm; Zn ranges from 430 ppm to 620 ppm with the mean value 530 ppm; Co ranges from 24 ppm to 59 ppm with the mean value 42 ppm; and for the Vanadium it ranges from 20 ppm to 48 ppm with the mean value 35 ppm, whereas other metals are not in higher concentration. The concentration of Cr is significantly high (2564 ppm) in aquatic mosses of the study area reflecting the enrichment of ore element. The concentration of the other trace elements like Zn,Co and V in the mosses can be utilized to monitor the levels of water pollution. The mosses of aquatic environment absorb and accumulate unusually high concentration of certain elements whether toxic or non-toxic. From the data (Table 1), it may be noted that there is a striking element enrichment of Cr, Zn, Co and V in Byrapur chromite mining area. In view of the unusually high absorption and accumulation of heavy metals and ore element in aquatic mosses from the water bodies, these species may be suggested as indirect indicators of mineralization in the catchments areas of the drainage system (Brooks, 1972, p. 178). The trace element study involved in agricultural reconnaissance (Kilmer, 1979; Thornton, 1983) as well as the geochemical reconnaissance is similar (Joyce, 1975). Hence biogeochemical study of the mosses can be successfully employed for such surveys of the aquatic environment. Whitten (1985, p. 53) has emphasized the most urgent priority for a standard approach for biological monitoring for potentially toxic concentrations of heavy metals. The trace element analysis of mosses provides one of the standard methods for this purpose. Utilization of water from mineralization zone leads to human health problems due to heavy metal contamination. Mosses are ideally suited for purification of water particularly for the elimination of toxic heavy metals. The widespread occurrence of these plants and their ability to accumulate metals has led to their use in environmental monitoring programs (Claveri and Mouvet, 1995). Welsh and Denny (1976) stated that many aquatic macrophytes accumulate heavy metals and play an important role in biogeochemical cycling of these elements.

Table 1. Concentration of trace elements (in ppm) in aquatic mosses from chromite mineralized zone

Sample No	Pb	Zn	Cu	Cr	Co	Ni	V	Fe	Mn	Mo
1	10	520	4	2275	54	7	20	1260	210	2
2	6	430	3	1980	46	12	42	1130	190	6
3	15	575	5	2410	40	8	37	1500	85	4
4	4	620	1	2070	59	11	40	1470	175	3
5	7	485	2	1820	32	14	26	800	74	1
6	3	553	7	2564	24	10	48	950	56	2

CONCLUSIONS

It may be noted that there is a striking element enrichment of Cr, Zn, Co and V in Byrapur chromite mining area. In view of the unusually high absorption and accumulation of heavy metals and the ore element, chromium in aquatic mosses from the water bodies, these species may be suggested as indirect indicators of mineralization in the catchments areas of the drainage system. Mosses are ideally suited for purification of water particularly for the elimination of toxic heavy metals. Prasad et al, (1989) stated that many aquatic plants accumulate heavy metals and play an important role in geochemical and agricultural reconnaissance surveys. Further these studies can be ideally used as tools for their possible application in biogeochemical reconnaissance surveys, biomonitoring of the pollution levels of aquatic environment and water treatment. Aquatic mosses accumulate heavy metals and play an important role in biogeochemical cycling of the elements. The aquatic moss appears to be a valuable sampling material for geochemical prospecting of chromium in the study area.

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