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# Geochemistry of Termite Mounds: A Study from Barite Mineralized Zone, Andhra Pradesh, India

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**ABSTRACT:**

*Termite mounds are abundant components of Velpula barite mineralization of Kadapa District of Andhra Pradesh, India. The systematic research has been carried out on the application of termite mound sampling to mineral exploration in this region. The distribution of chemical elements Ba, Sr, Cu, Pb and Zn, were studied both in termite soils and adjacent surface soils. In the study area it is observed that generally, concentration of Ba and other elements Sr, Pb, Zn and Cu are higher in termite soils than that of their adjacent surface termite free soils. The concentration of ore element Ba in termite soils is from 1200 to 4013 ppm, and that of soils it is from 147 to 571 ppm reflecting the barium element in termite soils. A biogeochemical parameter called "Biological Absorption Coefficient" of the termite mounds indicated the termite affected soils contained huge amounts of BAC values than the adjacent soils. BAC values of Ba element in all termite mounds are classified as positive reflecting the enrichment of the Ba element in the termite mound with reference to the surface soil. Amongst all the elements, Ba concentration was much greater in the termite mounds reflecting the enrichment of barium .Similarly the maximum BAC value (17.14) for Ba element in termite mounds is attributed to the influence of barium mineral zone in the study area. Therefore, termite mounds are useful indicators in mineral exploration.*

**Key words:** Termite mound, Biological Absorption Co-efficient, Barite area, Andhra Pradesh

## 1. INTRODUCTION

Termites are common biological agents that produce significant physical and chemical modifications to tropical and subtropical soils .Termites always live in communities. There main function primarily is to maintain a constant high humidity, which is an essential requirement for the very survival of the termites especially for those of that live in arid and semiarid regions (Lee and Wood, 1971). Termite's activity increases the amount of organic matter and changes the composition of clay mineral in soils that used for building their nests (Nriagu, 1992). The mounds are made with materials from underlying soils. Termites decent through subterranean galleries ramified over wide tract, and sample the sub surface geological formations for their construction material. In a mineralized area, termites bring up partly dissolved mineralized water from the water table to maintain the required high humidity and they precipitate the mineral matter carried jaws to the site and cemented with a mixture of clay and saliva for the construction of the mounds (Watson, 1972). They constitute

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an important of soil fauna in tropical and tropical regions. Varahamihira's Brihat Samhita describes termite mound as one of the important bioindicators in exploration for ground water (Prasad, 1980) and mineral resources (Prasad and Vijayasaradhi, 1985; Prasad *et al.,* 1987). In Russia, geochemical features of termite mounds have been studied (Glazovskaya, 1984). Biogeochemical studies have demonstrated that in tropical parts of India these mounds can be used as tool in the exploration for lead (Prasad and Sankaranna, 1987), tin (Suryaprakash Rao and Raju, 1984), barite (Raghu, 2007), chromite (Chandrasekhar Reddy, 2014) and gold (Gopalakrishnan,1993). Termite mounds in the study area are generally found in association with different types of vegetation and soil. They have varied shapes as conical, elongated, bald and rounded. In the present study, termite soils and their adjacent surface soils were studied in the barite mining area of Velpula, Kadapa district, Andhra Pradesh to examine the potential of the termite mounds as an indicator in mineral exploration.

## 2. AREA OF THE STUDY

Velpula barite area (Lat, $14^0$.37" N; Long. $78^0$.32" E) is located in Kadapa/ Cuddapah District, Andhra Pradesh. The study area is about 60 Km from Kadapa, the district headquarter and 10 Km from Plivendula, the mandal headquarter. This study area forms part of the Lower Cuddapah super group comprising Papaghni and Chitravati Groups (Nagaraja Rao *et al.,* 1987). This area chiefly consists of shales, dolomites, basalts and dolomitic limestones. Barite is a naturally occurring $BaSO_4$ mineral. The barite occurrences in the traps are most productive and the thickness of the veins from a few centimeters to as much as 3-5m. These barite deposits associated with basic intrusives occurs within the vempalli stage of the Lower Cuddapah in the southeren part of Cuddapah sub-basin (Prasad and Prasannan, 1976). Earlier workers have carried out mineralogical (Krishna, 1953), petrogenetical (Prasad and Prasannan, 1976; Gangadhar *et al.,* 1983) and geochemical (Chakrapani Naidu, 1962) aspects on some parts of Cuddapah basin.

## 3. SAMPLING AND ANALYTICAL TECHNIQUES

Termite mound samples were collected from 10 spots from different parts of the mound and were combined to form a composite sample. Similarly the adjacent surface soils were also collected and combined to represent a composite sample. Thus, a total of 12 pairs of termite soils and their adjacent surface soils were collected in and around the barite mining area. All the samples were oven dried at 110$^o$C to expel moisture. These dry soils were lightly disintegrated with porcelain mortar and pestle to break lumps if any and were then sieved to pass through 2mm sieve mesh. From this material required quantity of each representative sample was obtained by coning and quartering. These samples thus obtained were finely powdered in an agate mortar and ignited at 500$^o$C in a muffle-furnace for six hours. Then the samples were digested in aquaregia and analyzed for Ba, Sr, Pb, Zn and Cu by atomic absorption spectrophotometry (AAS) and the elemental data is shown in Table 1.

## 4. RESULTS AND DISCUSSION

### 4.1 Trace elements in Termite Soils and Surface Soils

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From the data (Table 1) it is observed that the concentration of Ba and other elements Sr, Pb, Zn and Cu are higher in termite soils than that of their adjacent surface soils. The concentration of ore element Ba in termite soils is from 1200 to 4013 ppm, and that of soils it is from 147 to 571 ppm reflecting the barium element in termite soils. It may be incorporation of the particles from the subsurface geological formation, collected and transported by the termites for their mound construction on the ground surface. The concentration of Sr, Pb, Zn and Cu in termite soils is recorded 650-1900, 16-40, 12-27 and 19-44 respectively. And in surface soils the concentration of Sr, Pb, Zn and Cu is 240-1000, 8-32, 5-18 and 8-32 respectively. Due to biogeochemical cycling of elements, the ore element Ba and other associated elements have migrated into sub-soil horizons depleting the concentration of these elements in the surface soil (Rose et al., 1979). From these subsoil horizons termites bring mineral particles for their mound construction and incorporate in the mound, thus enriching these elemental concentrations in the termite mound (Raghu and Prasad, 1996).

## 4.2 Biological Absorption Co-efficient (BAC)

A biogeochemical parameter, Biological Absorption Co-efficient (BAC), which is the ratio of concentration of the element in termite mound ($C_{Ts}$) to that of its adjoining surface soil ($C_{Ss}$) can be applied while using termite mounds in the mineral exploration (Prasad et al., 1987). It may be written as: $BAC = C_{Ts}/C_{Ss}$

BAC values of elements in termite mounds are classified as positive and negative. The BAC value of unity is taken as the datum line. If the value is more than one it is treated as positive reflecting an enrichment of the element in the mound with reference to its adjacent surface soils; while if the value is less than one it is treated as negative reflecting depletion of the element in the mound. In the present study BAC is calculated for the termite mounds. On this basis BAC of various trace elements viz., Ba, Sr, Pb, Zn and Cu in the termite mounds are classified. Biological absorption co-efficient values for various elements are revealed in Table 2. The BAC values of Ba, Sr, Pb, Zn and Cu in termite soils is recorded 3.53-17.14, 1.50-5.0, 1.20-3.0, 1.33-2.80 and 1.20-3.30 respectively. The distribution of BAC of termite mounds for trace elements in different classes is shown in Table 3. From the data (Table 3), in the study area it is observed that in all the termite mounds, BAC values are consistently positive trend. And also it is noteworthy and interesting to note that Ba is almost dispersed in positive category of the enriched scale. The BAC for the Ba element, majority mounds fall in the 4 and 5 categories and few mounds are also fall in 3 and 6 categories of enrichment. BAC for the Sr element majority of mounds fall in the 2 category and few mounds are in 1 and 3 categories of enrichment.

The elements Pb and Zn fall in 1and 2 categories of enrichment; and Cu fall in 1, 2, and 3 categories of enrichment. It is significant to note that not even single element fall under depletion side. In general, it may be noted that the elements are more mobile in termite soils when compared to those of the surface soils due to the activity of the termites. As the BAC values of Ba element in all termite mounds are classified as Positive reflecting the enrichment of the Ba element in the termite mound with reference to the surface soil. The maximum BAC value of Ba (17.14) in termite mounds is mostly attributed to the influence of barium mineralization in the study area. The other associated elements Sr, Pb, Zn and Cu are less values of BAC compared to barium. Earlier Raghu and Prasad (1996) reported that Ba, Sr, Cu, and Zn showing more than unity in termitemounds.

Table.1 Trace elemental concentration (in ppm) in termite soils (Ts) and surface soils (Ss)

| Sample No | Ba | | Sr | | Pb | | Zn | | Cu | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Ts | Ss | Ts | Ss | Ts | Ss | Ts | Ss | Ts | Ss |
| 1 | 3200 | 200 | 1750 | 500 | 16 | 8 | 16 | 11 | 19 | 8 |
| 2 | 4013 | 234 | 1200 | 240 | 24 | 10 | 20 | 15 | 24 | 10 |
| 3 | 2800 | 310 | 1900 | 1000 | 30 | 10 | 27 | 18 | 33 | 10 |
| 4 | 1800 | 147 | 850 | 472 | 40 | 32 | 23 | 16 | 44 | 32 |
| 5 | 3650 | 266 | 1020 | 557 | 26 | 21 | 21 | 15 | 28 | 21 |
| 6 | 2200 | 360 | 1470 | 700 | 29 | 24 | 18 | 11 | 32 | 24 |
| 7 | 3800 | 540 | 1290 | 477 | 34 | 24 | 13 | 7 | 36 | 25 |
| 8 | 2700 | 332 | 800 | 275 | 19 | 10 | 16 | 10 | 19 | 10 |
| 9 | 1965 | 245 | 650 | 309 | 22 | 12 | 24 | 14 | 22 | 12 |
| 10 | 3400 | 409 | 890 | 468 | 24 | 16 | 14 | 5 | 20 | 16 |
| 11 | 2020 | 571 | 1360 | 906 | 26 | 20 | 12 | 5 | 24 | 20 |
| 12 | 1200 | 235 | 1235 | 771 | 20 | 15 | 15 | 11 | 20 | 13 |

Table.2. Biological Absorption Co-efficient (BAC) values for various trace elements

| S.No | BAC Value of Ba | BAC Value of Sr | BAC Value of Pb | BAC Value of Zn | BAC Value of Cu |
|---|---|---|---|---|---|
| 1 | 16 | 3.5 | 2.0 | 1.45 | 2.37 |
| 2 | 17.14 | 5.0 | 2.4 | 1.33 | 2.40 |
| 3 | 9.03 | 1.9 | 3.0 | 1.50 | 3.30 |
| 4 | 12.24 | 1.80 | 1.25 | 1.43 | 1.37 |
| 5 | 13.72 | 1.83 | 1.23 | 1.40 | 1.33 |
| 6 | 6.11 | 2.10 | 1.20 | 1.63 | 1.33 |
| 7 | 7.03 | 2.70 | 1.41 | 1.85 | 1.44 |
| 8 | 8.13 | 2.90 | 1.90 | 1.60 | 1.90 |
| 9 | 8.02 | 2.10 | 1.83 | 1.71 | 1.83 |
| 10 | 8.31 | 1.90 | 1.50 | 2.80 | 1.25 |
| 11 | 3.53 | 1.50 | 1.30 | 2.40 | 1.20 |
| 12 | 5.10 | 1.60 | 1.33 | 1.36 | 1.53 |

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Table. 3. Distribution of termite mounds based on classification of Biological Absorption Co-efficient (BAC) for various trace elements

| Category | Class intercals | BAC Range | Ba | Sr | Pb | Zn | Cu |
|---|---|---|---|---|---|---|---|
| | 6. Hyper | >15.59 | 2 | | | | |
| Enrichment | 5.Intensively strong | 9.00-15.59 | 3 | | | | |
| | 4.Very strong | 5.20-9.00 | 5 | | | | |
| | 3. Strong | 3.00- 5.20 | 2 | 2 | | | 1 |
| | 2. Moderate | 1.73- 3.00 | | 8 | 5 | 3 | 4 |
| | 1. Week | 1.00- 1.73 | | 2 | 7 | 9 | 7 |
| -------------- --------------- Datum line----BAC =1 --------------------------------- | | | | | | | |
| Depletion | 1. Week | <1.00-0.58 | | | | | |
| | 2. Moderate | 0.58- 0.33 | | | | | |
| | 3. Strong | 0.33- 0.19 | | | | | |
| | 4.Very strong | 0.19- 0.11 | | | | | |
| | 5.Intensively strong | 0.11- 0.66 | | | | | |
| | 6. Hyper | <0.66 | | | | | |

## 5. SUMMARY AND CONCLUSIONS

In the study area Velpula barite mineralized zone the distribution of various chemical elements viz., Ba, Sr, Pb, Zn and Cu were studied both in termite soils and adjacent surface soils. the concentrations of the elements Ba, Sr, Pb, Zn, and Cu are more in termite soils than that of adjacent surface soils, suggesting indicator characteristics of the mounds for these elements, especially for barium in geochemical prospecting. In the study area, amongst all the elements, Ba concentration (4013 ppm) was much greater in the termite mounds reflecting the enrichment of barium in the study area. Biological absorption co-efficient (BAC) of the termite mounds indicated the termite affected soils contained huge amounts of BAC values than the adjacent surface soils. Similarly the maximum BAC value 17.14 for Ba element in termite mounds is attributed to the influence of barium mineral zone in the study area. Therefore, termite mounds are useful indicators and find application in mineral exploration. The Ba in termite mounds may derive from the soil carried by termites from the sub-soil in the course of construction for their mounds. Thus, the concentration of other elements viz., Pb, Zn, Cu, and Sr may be utilized to monitor the levels of soil pollution. Metal concentration in termite mounds may depends on the chemical speciation of metals in soil and soil solutions. Therefore, based on these geochemical investigations termite mounds can be ideally used as possible application in mineral exploration and agricultural reconnaissance surveys.

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