Geochemical analyses of termite mounds as a prospecting tool for tin deposits in Bastar, MP—a preliminary study

K SURYA PRAKASH RAO and S V RAJU*

Department of Geology, Osmania University, Hyderabad 500 007, India.

*Present address: Geological Department, Oil India Limited, Shahid Nagar, Bhubaneswar 751 007, India.

MS received 29 April 1983; revised 28 February 1984

Abstract. Tin deposits in the form of cassiterite occur in precambrian zoned pegmatite bodies intrusive into Archean metabasic and metasedimentary rocks in Bastar, MP. The associated economic minerals include columbite-tantalite, lepidolite, beryl etc. As a major part of the area is covered by a thick overburden, termite mounds have been used as geochemical sampling medium in view of their significant potentiality in tropical areas with overburden, and also because of the low cost and ease of sampling. Though many elements have been used as pathfinders for tin, tin itself acts as the best indicator of its deposits.

The present work has given encouraging results, and therefore can be applied for tin prospecting and possibly for heavy metals like Nb, Ta, W, etc., in this and other areas where termite mounds have a good spatial distribution.

Keywords. Geochemical prospecting; termite mounds; Bastar tin.

1. Introduction

One does not often come across instances where geochemical prospecting has been attempted using termite mounds as a sampling medium and hence literature pertaining to this aspect is scanty. This is probably because of two factors: (i) Unlike soils which are found in almost all regions of the world, termite mounds are not ubiquitous and therefore cannot be applied as a universal method and (ii) the formation, geochemical characters, and related aspects of soils have been extensively studied, and are therefore well understood whereas termite mounds are less understood, these being samples of unusual nature. However, where termite mounds occur in sufficiently large numbers, particularly in tropical areas with overburden, their efficacy as a prospecting tool assumes importance (Levinson 1974). They are easy to sample and need very little preparation. Termites are known to burrow up to depths of 40 m in desert regions where these mounds have been used in prospecting.

In India, economic deposits of tin do not exist. However, in the Bastar district of MP, significant reserves of cassiterite ores occur in pegmatites which are intrusive into the Bengpal metasediments of Archean age. Apart from cassiterite, pegmatites contain workable quantities of columbite-tantalite, lepidolite, and at places beryl. Minor accessories include pyrochlore, triphylite, galena, etc. Cassiterite occurs in the quartz core of the pegmatite and as some authors (Deshpande 1976; Deshpande *et al* 1981; Ramaswami *et al* 1981) believe, the productive hydrothermal zones of cassiterite may have been completely eroded leaving only the root zones of cassiterite. Another view proposed by Schuiling (1983) is that the primary cassiterite mineralization zones are yet

to be discovered. Both the situations are possible, but if there has been deep erosion, there must be areas where alluvial cassiterite has been concentrated as placers covered by an overburden. It is in this context that analyses of overburden, in the form of soils, termite mounds vegetation, etc., assume significance. Shallow drill holes can also provide valuable information on such occurrences. But of all these methods, termite mound sampling is the easiest to execute and the least expensive and it is due to these reasons that these have been adopted as sampling medium. However, as Brooks (1972) has pointed out, biogeochemical prospecting methods are not expected to be a universal panacea for the prospector in his search for minerals. This method has been applied on a preliminary, reconnaissance basis and more effort has to be put in so as to assess the overall potentiality of this method and the possibility of its application on a large scale in other areas.

2. Location and physiography

The mineralized area ($18^{\circ}39'$ – $18^{\circ}42'$ latitude and $81^{\circ}47'$ – $81^{\circ}56'$ longitude) falls in the Konta tahsil of Bastar district and lies about 70 km South of Jagdalpur. The main villages in the area where pegmatites are partly exposed are Tongpal, Govindpal, Chitalnar, Mundval, Madkamiras, Chiurwada and Nama. The pegmatites lie in a major valley surrounded by hill ranges some of which are over 600 m high. The drainage which is dendritic, forms an elaborate network and has no particular orientation. The principal rivers of this region are Indravati and Kolab (Sabari) and their tributaries, Jherum, Bhimsen, Barunadi, and Chakabuka. All these streams finally empty into the Godavari in the South. The streams have low gradients and carry large quantities of boulders and sand. A major portion of the valley is covered by thin sandy loam and consequently the outcrops of rocks are scarce. While a major part of the hilly areas supports dense forest growth the Sal (*Shorea robusta*) and mixed forest, the valley has suffered much denudation and is under cultivation.

3. Geology

The area was first mapped in 1938 (Crookshank 1963), later by Ghosh in 1941 and more recently, by geologists (Deshpande *et al* 1981; Ramaswami *et al* 1981) and the state Department of Mines and Geology of MP. The geological sequence in the Govindpal Mundval area in Bastar district is as follows: (figure 1).

A	Recent	Soil and laterite,
	late Precambrian	conglomerate, arkose,
R		orthoquartzite
C	----- Unconformity -----	
H	Intrusives	quartz veins
E		dolerite
A		pegmatites and quartz veins
N		granites, metabasic rocks
	Bengpals	quartz sericite schists
		sericite quartzites
		andalusite schists, etc.
	----- Base not exposed -----

Figure 1. General geological map of the study area showing major formations and exploration target (toposheets Nos. 65 F/13, F/14).

A brief description of the Archean lithotypes is given below.

3.1 Bengpals

The Bengpal metasediments are represented by quartz-sericite schists, sericite quartzites, andalusite gneisses and schists and represent low grade metamorphosed

sediments due to the intrusion of granites. The quartz-sericite schists and sericite quartzites are friable, soft, and yellowish-brown to purple in colour. The quartzite is interbedded with ochre and olive green shale/phyllite occasionally. The andalusite gneisses and schists vary in colour from grey-white to buff. At places, large crystals of andalusite occur. The sericite quartzites consist of fine to medium grained equigranular quartz, albite, microcline, muscovite, biotite and sericite in clayey matrix. The Bengpals are closely associated with the basic rocks. These vary in composition from metadolerite to amphibolites and at places metadioritic also.

3.2 Granites

These are exposed in the South Western part of the area around Paliyam (Paliyam granite), Darba, and also at Sukma. The granite at Paliyam which has been studied is fine to medium grained, non-foliated, biotite granite traversed by veinlets or ribbon-like pegmatites of two generations. A few quartz veins and dolerite dykes also cut across the granites. The ribbon-like pegmatites contain crystals of magnetite and recrystallised flakes of biotite. At places these granites carry fluorite indicating perhaps pneumatolytic zones. At a few places, caught up patches of quartz sericite schist (Bengpals) are noticed near the granite periphery. Near the contact of granite with the Bengpal metasediments, development of andalusite schist is very characteristic. This contact metamorphism, perhaps as an effect of thermal aureole and the absence of gneissosity in the granite, indicates its magmatic nature.

3.3 Pegmatites

Pegmatites have been emplaced in the Bengpal group of rocks along parallel fractures and also in the granites. Some of the pegmatites have a width of 4–8 m and extend over a strike length of 200–400 m. About 90 pegmatite bodies have been mapped by GSI geologists, in the Bengpal metasediments. The pegmatites appear to be the final phase of Paliyam granite activity and have been emplaced wherever conditions were favourable for pneumatolytic solutions to crystallize the tin into discrete crystals of cassiterite in the quartz core and lepidolite feldspar zone. The pegmatites in the granite body itself are devoid of cassiterite. Alternatively, it is possible that the granite has been eroded away with the mineralized portions of the pegmatites leaving only the barren roots now exposed (Deshpande *et al* 1981). Some of the pegmatites in the metabasics exhibit indistinct zoning with quartz core, lepidolite albite zone, spodumene zone, quartz green mica zone, etc and contains cassiterite as fine disseminations, discrete crystals and also as small veinlets of pure cassiterite. Besides, the pegmatites are associated with magnetite, beryl, and fluorite. The unzoned pegmatites do not contain any cassiterite mineralization. The pegmatites which have been exposed by trenches made by the State Department of Mines and Geology, were studied for their mineralogy.

4. Mineralization

Cassiterite occurs as small lenticular veinlets in the quartz core of the pegmatites. In the zoned pegmatites the core is normally occupied by white to grey smoky quartz which

shows tiny black disseminations of cassiterite. The outer zones consist usually of quartz, feldspar, and green mica. In between lie the lepidolite, albite, fluorite constituting the greisenized zones with irregular contacts. The cassiterite crystals have stunted growth with poor development of prismatic faces. They are dark grey with submetallic to adamantine lustre and give white, pale-yellowish to brown streak. The other accessory minerals in the pegmatites are beryl, amblygonite, triphylite, galena etc. Other economic minerals present in workable quantities in the pegmatites are columbite-tantalite and lepidolite. The intrusive granites at Paliam do not contain any significant tin concentrations. However, Sn values ranging from 1 to 15 ppm have been reported by Schuiling (1983) and values up to 60 ppm in biotite granite near pegmatite contact were reported by Deshpande *et al* (1981).

5. Sampling and analysis

Thirty two termite mound samples (1.5–2.5 m in height) were collected on a reconnaissance scale spread over an area of about 50 km², mostly along the easily accessible parts of the area. The location of the sample points is given in figure 2.

The problems of geochemical sampling and analytical errors in tin determination have been discussed earlier (Yim 1979; Pahlavanpour *et al* 1979; Welsch and Chao 1976).

About 200 g of each sample was finely ground and later homogenised to avoid separation of discrete cassiterite. The samples were digested with 1:1 HCl and the elements Cu, Pb, Zn, Li, Ni, Co, Cr, Mn, determined by flame atomic absorption employing a Perkin Elmer 2380 double beam AAS. Tin was determined by hydride generation (MHS-10) attachment to AAS after sublimation with ammonium iodide (table 1).

The Sn values below 10 ppm are not specified (as anomalous values are above 20 ppm) and therefore do not have much significance. Three USGS geochemical exploration reference samples GXR-1, GXR-4 and GXR-6 were also analysed for accuracy check. The results agree with the international standard values given by Allcott and Laking (1979) and Gladney *et al* (1979).

6. Discussion

Geochemically, the naturally occurring compounds of tin are relatively insoluble, cassiterite being the most stable tin mineral with a marked resistance to chemical attack (Boyle 1974; Lukashev 1970). Cassiterite is extremely sparingly soluble in the weathering zone and concentrates in its endogenous form in eluvial-deluvial and alluvial placers. It is well preserved in alluvial placers and is a typical constituent of heavy mineral concentrates. Because of its high specific gravity (7) and resistance to chemical attack, it is preserved in soils, glacial materials, and sediments in streams, rivers, lakes and the sea. Geochemical prospecting techniques for tin are delineation and interpretation of secondary dispersion patterns in soils and stream sediments. A number of pathfinder elements associated with tin have been mentioned in the literature for the various types of deposits. In the pegmatite environment, Nb, Ta, Li, Rb, Be, etc have been used (Taylor 1979). Cu, Pb, Zn and As have been frequently used

Figure 2. Sample location map indicating block for detailed study.

specially in sulphide-rich terrains. But undoubtedly, tin is the best indicator of its deposits in most cases.

The analytical results obtained indicate that tin anomalies (> 20 ppm) occur in areas where mineralized pegmatites occur and in places where barren pegmatites, basic rocks, and granites are exposed, the Sn values fall below 10 ppm (figures 1 and 2). The elements Cu (15–24 ppm), Pb (10–56 ppm), Zn (12–68 ppm), Li (6–25 ppm), Cr (63–299), Mn (192–1134) and Ni (22–68) do not show any marked correlation with tin. Nb, Ta, may provide valuable information and prove to be useful indicators but their analysis is often expensive and time-consuming and is therefore suggested that with the available data Sn itself can be a useful pathfinder, and its analysis taking suitable precautions in the sampling and analysis stages would be quite illuminating.

Bastar tin deposits fall in the Gondwana tin belt plotted by Schuiling (1983) and

Table 1. Tin values in (ppm).

Sample No.	Sn	Sample No.	Sn	Sample No.	Sn
1	< 10	12	< 10	23	25
2	21	13	< 10	24	26
3	< 10	14	< 10	25	26
4	< 10	15	32	26	31
5	< 10	16	25	27	26
6	< 10	17	27	28	25
7	< 10	18	25	29	30
8	< 10	19	25	30	30
9	< 10	20	23	31	37
10	< 10	21	27	32	27
11	< 10	22	25	GXR-1.	45
				GXR-1*	57

GXR-1*: Standard value after Gladney *et al* (1979).

therefore assumes greater significance in the context of finding extensions of this deposit and locating areas where primary cassiterite zones and also roof zones of productive granite plutons are preserved.

Geochemical prospecting using termite mounds, soils, and possibly vegetation may therefore be of immense help in delineating areas for detailed studies. Based on the results of the present study, an exploration target for detailed geochemical exploration work has been outlined (figures 1, 2).

Acknowledgements

This work forms part of a major research collaboration in Applied Geochemistry between Osmania University, Hyderabad and University of Utrecht, Netherlands. Finances and facilities for this work were provided under this collaboration. Analytical work was carried out in the project laboratory at Osmania University.

The authors have benefited much from field work and discussions with Prof. R D Schuiling. His contribution is gratefully acknowledged. Dr J B de Smeth is thanked for his co-operation in field and laboratory. The authors wish to thank the National Mineral Development Corporation and the State Department of Mines and Geology, Madhya Pradesh for the help extended in the field. Mr K Sudhakar Rao is thanked for his assistance in the field and laboratory.

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