SIGNIFICANCE OF TERMITE MOUNDS IN GOLD EXPLORATION

E. A. V. PRASAD, M. JAYARAMA GUPTA† and COLIN E. DUNN*
Department of Geology, Sri Venkateswara University, Tirupati 517 502, India.
**Geological Survey of Canada, 601 Booth Street, Ottawa, Ontario, K1A OE8, Canada.*

ABSTRACT

The *Brihat Samhita* of Varahamihira (6th Century A.D.) points out that termite mound is an important bioindicator of groundwater and ore deposits. It has been found to be an ideal indicator, with its biological absorption coefficient (BAC) as a significant parameter, in gold exploration, thus confirming the ancient Indian observation.

INTRODUCTION

THE *Brihat Samhita* (Sanskrit) of Varahamihira (A.D. 505–587), pointed out that termite mound is an important bioindicator of groundwater[1–3] and economically important mineral deposits[4,5] in the tropical lands generally covered by thick soil mantle. In such areas, prospecting for minerals is difficult owing to the scarcity of outcrops; hence Harris[6] pointed out that termite mounds, with their high proportion of unweathered subsoil, are especially suitable for mineral exploration. On the basis of these observations in the ancient and modern scientific literature, recent biogeochemical studies described these mounds in the tropics as an important tool in the exploration for chromium and copper[7] and lead[8] in India; and for gold in Zimbabwe[9–11], and copper and nickel in Mozambique[12] in the African continent.

AREA OF STUDY

In the present study, an attempt has been made to test the efficacy of the termite mound as a bioindicator in gold exploration in the Ramagiri gold field (Long. 77°30′E–77°33′E and Lat. 14°17′–14°22′, Survey of India toposheet No. 57 F/11), in Anantapur District, Andhra Pradesh. The geological formations of this area (figure 1) consist chiefly of meta-volcanics and the associated meta-sediments of Precambrian Dharwar system. In this, the main auriferous formation is a quartz vein traversing the light and grey phyllites, about 150 metres in width, with the N–S strike distance of more than 8 km extending from the Jibutil mine in the south, through the Yeppamanu mine in the central region, up to the Chennebhavi mine in the north. Geological aspects of this area have been studied by Krishnamurthy[13] and Prasad[14]. There are a few old mine workings located in this area; and, since the last few years, Bharat Gold Mines Limited (BGML), a public sector undertaking of the Government of India, has been carrying out the mining and extraction of gold from the Yeppamanu mine.

SAMPLING AND ANALYSIS

In and around this gold field, there are several termite mounds, ranging from 1.0 m to 1.8 m in base diameter and 0.6 m to 1.5 m in height. Amongst them, eleven mounds occur conspicuously in a profile along a stream course near the Chennebhavi mine (figures 1 and 2).

Composite samples of soils, from each termite mound and its adjoining surface soils, were collected. Thus, a total of 38 samples, consisting of 19 pairs of termite and surface soils, including those occurring in a profile, were collected from different parts of this area (figures 1 and 2). The moisture from these samples was eliminated by heating at 100°C in a hot air oven; these samples were then passed through 2 mm sieve and were finely powdered for trace element analysis.

Gold content at very low concentration of parts per billion (ppb) level (involved in biogeochemical prospecting) is estimated by neutron activation analysis[15,16]. Accordingly, this analytical technique, following a lead sulphide fire assay extraction[17], was adopted for the gold estimation in these soils and termite soils (table 1 and figure 3).

RESULTS AND DISCUSSION

From the data, it may be seen that the termite mounds generally contain higher concentration of gold than their adjoining surface soils. Thus, D'Orey[12] detected copper mineralization only by geochemical analysis of termite soils but not by the conventional geochemical methods of the surface soils.

† For correspondence.

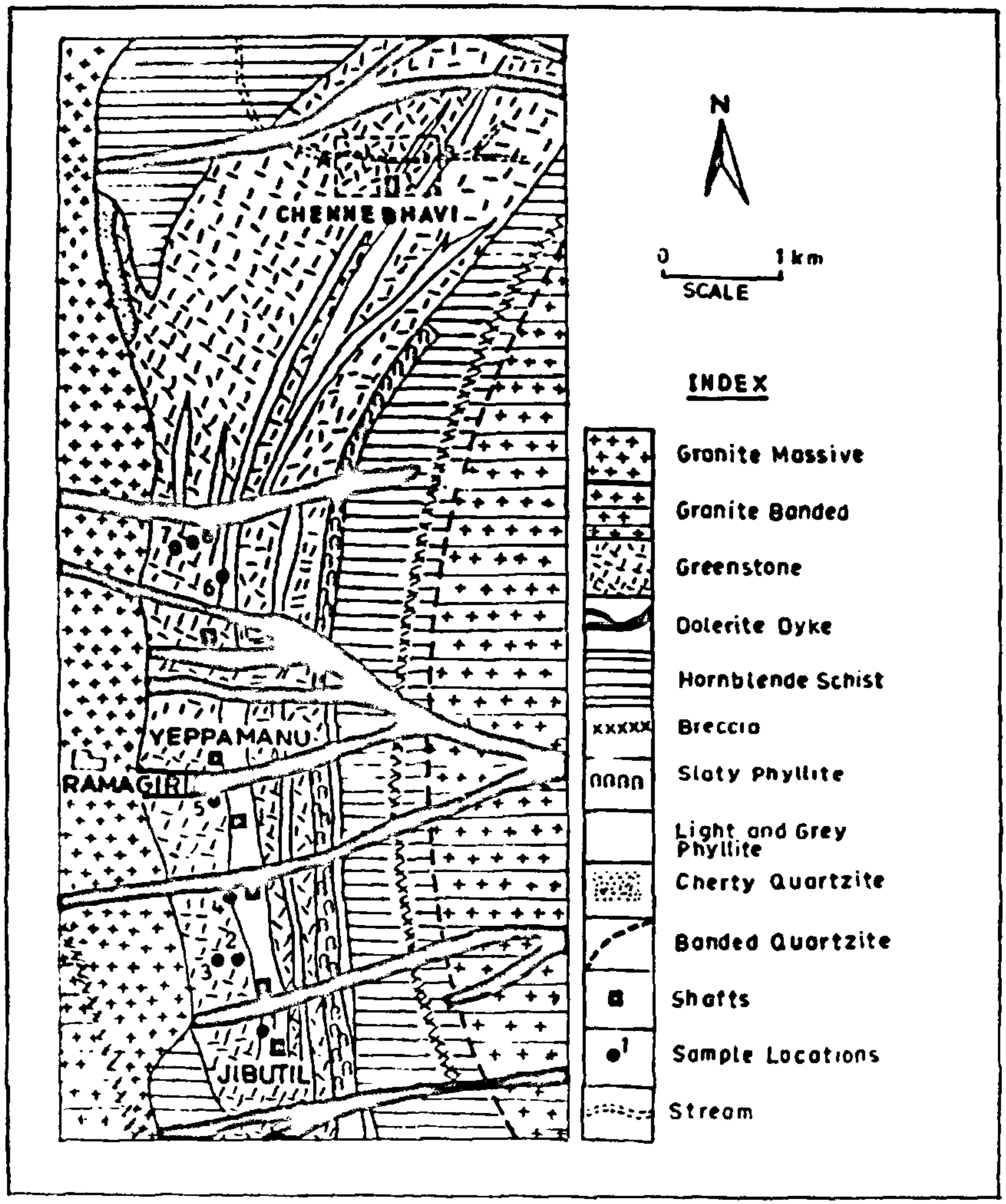

Figure 1. Geological map of the Ramagiri Gold Field showing the distribution of the termite mounds. The rectangular part of the stream course A–B is enlarged and shown in figure 2.

There is an unusually high concentration of gold in the surface soils at site 5 (figure 1), and at sites 11 and 12 (figure 2) due to the contamination from the mine workings in their vicinity. Biogeochemical studies[18] of plants and animals, also showed anomalously high elemental concentrations due to contamination of the adjacent old mine workings.

In biological prospecting for mineral deposits[19,20], the "biological absorption coefficient" (BAC), also known as "plant-soil coefficient" (PSC), is used as an important biogeochemical parameter; and it is equal to the ratio between the concentration of the element in plant ash and in the substrate soil. In the present study, the same

Table 1 *Distribution of gold in ppb in termite mounds and their adjoining surface soils. The sample numbers correspond to those shown in figures 1 and 2*

Sample and Sl. No.	Gold in ppb: Termite soil (C_{ts})	Gold in ppb: Surface soil (C_{ss})	Biological absorption coefficient BAC = C_{ts}/C_{ss}
1	309	43	7.18
2	18	34	0.53
3	19	52	0.37
4	20	< 4	> 5.00
5	1040	1120	0.93
6	19	< 4	> 4.75
7	7	4	1.75
8	< 4	4	< 1.00
9	25	472	0.05
10	146	160	0.91
11	265	542	0.49
12	838	542	1.55
13	159	128	1.24
14	322	128	2.52
15	79	21	3.76
16	174	39	4.46
17	88	39	2.26
18	66	44	1.50
19	159	160	0.99

parameter is also employed for the termite mound and computed from:

$$BAC = C_{ts}/C_{ss}$$

indicating the ratio of the concentration of the element in the termite mound (C_{ts}) and that of its surrounding surface soil (C_{ss}). These values (table 1) are found to vary from 0.05 to 7.18 and a majority

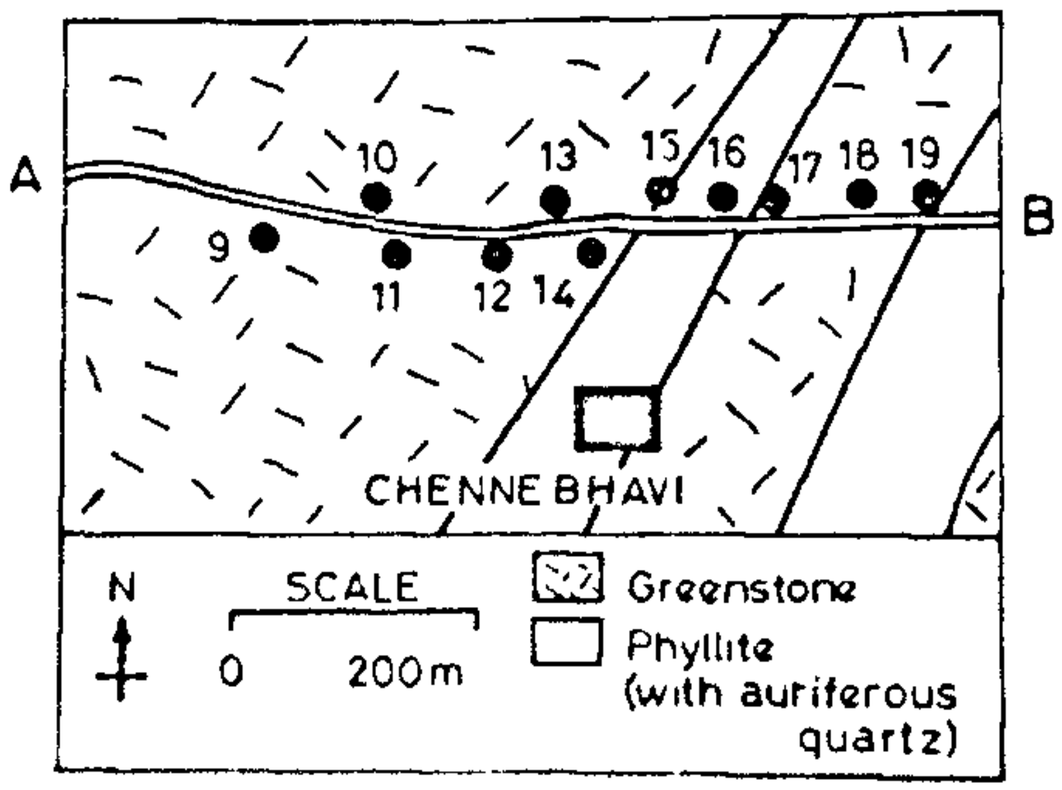

Figure 2. Rectangular part of figure 1, enlarged to show the distribution of termite mounds in a profile A–B along the stream course.

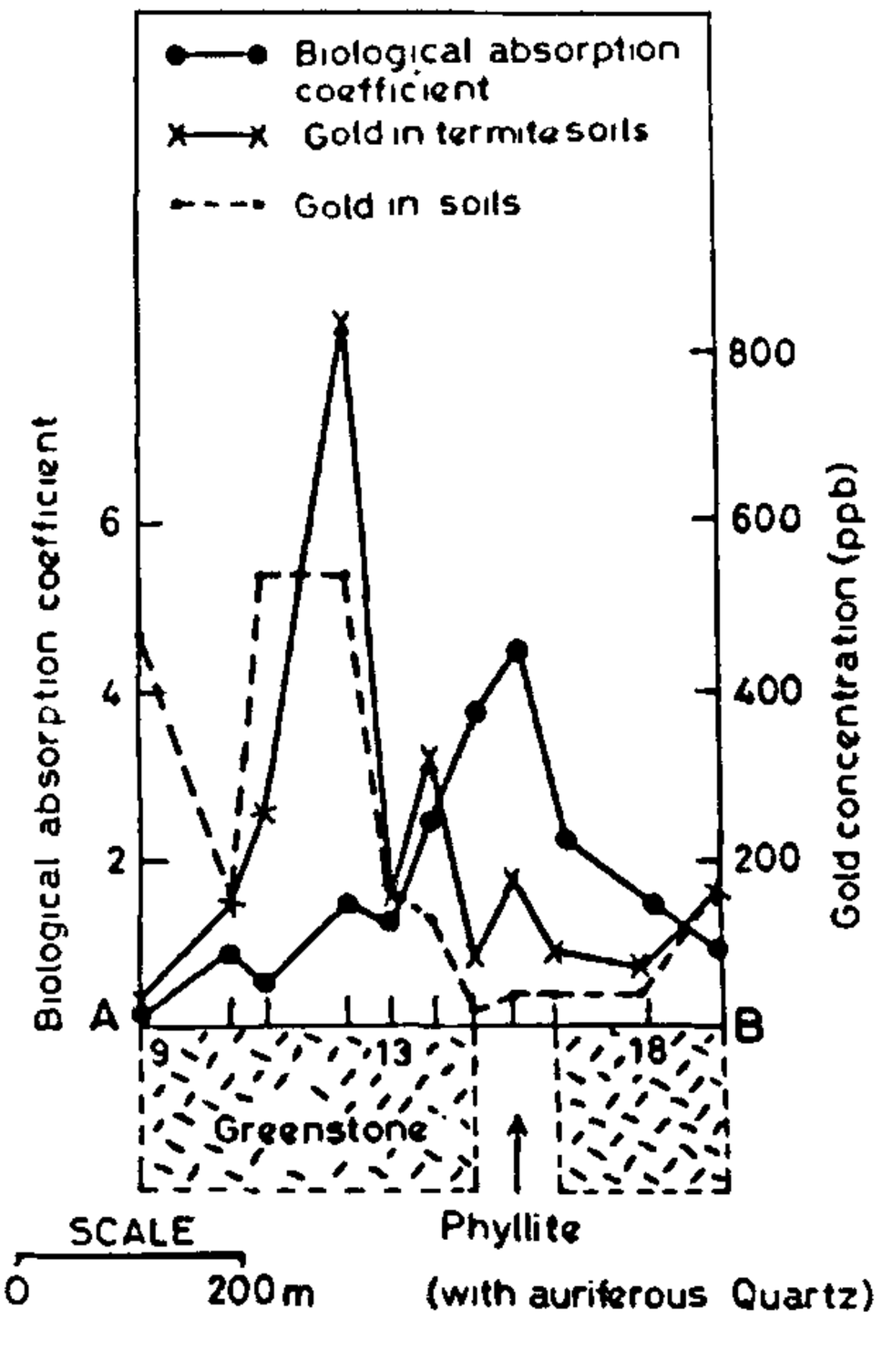

Figure 3. Gold content in termite mounds and in their adjoining surface soil; and the biological absorption coefficient of Gold in these mounds, occurring in the profile A–B (figures 1 and 2) plotted against lithology. The numerals on the 'X' axis correspond to those of the mounds shown in figure 2. Note the peaks with high concentration of gold in soils and termite soils due to contamination. The gold mineralization in phyllite is faithfully reflected by the peak of the BAC values.

of them have more than unity, suggesting that the concentration of gold in termite mound is greater than that of its adjoining surface soil; this trend is also reflected in figure 3.

The gold content of the termite soils and of their adjoining surface soils, occurring along the profile A–B (figure 1 and 2), and also the BAC values of these mounds (table 1), are plotted against their lithology or parent rock (figure 3). From this, it is evident that the BAC values faithfully reflect the gold anomaly over the phyllite with auriferous quartz. Accordingly, the mounds (Nos: 1, 4 and 6), occurring on the gold-bearing phyllite in other parts of the area (figure 1), have high BAC values. But at these sites, due to contamination by the mine

workings, although the absolute values of gold concentration in the soils and termite soils are extremely high, their corresponding BAC values are very low.

Thus, the biological absorption coefficient of gold in termite mounds, rather than their absolute values, is found to be a more significant biogeochemical parameter as it eliminates the contamination effects in the area. The present study has confirmed Varahamihira's observation made as early as the 6th Century A.D.

17 July 1987; Revised 29 August 1987

1. Prasad, E. A. V., *Groundwater in Varahamihira's Brihat Samhita*, Sri Venkateswara University, Tirupati, 1980, p. 371.
2. Prasad, E. A. V., *Termite mound in Varahamihira's Brihat Samhita*, pp. 61–66. In: *Proc. Sem. Management of environment*, (ed.) B. Patel, BARC, 1980, p. 409.
3. Prasad, E. A. V., *Ground Water*, 1986, **24**, 824.
4. Prasad, E. A. V., *Int. seminar on geobotany and biogeochemistry in exploration for groundwater and mineral resources*, Sri Venkateswara University, Tirupati, 1984, p. 74.
5. Prasad, E. A. V., *11th Int. Geochem. Explor. Symp.*, Toronto, Canada, 1985.
6. Harris, W. V., *Termites: their recognition and control*, Longmans Green and Co. Ltd., London, 1961, p. 187.
7. Prasad, E. A. V. and Vijayasaradhi, D., *Curr. Sci.*, 1984, **53**, 649.
8. Prasad, E. A. V. and Sankaranna, G., *Geobios*, 1987, **14**, 80.
9. West, W. F., *Chamber Mines J. (Rhodesia)*, 1965, **7**, 40.
10. West, W. F., *Termite prospecting*, The Builawayo Symp. Papers. No. 2; *Chamber Mines J. (Rhodesia)*, 1970, **12**, 32.
11. Watson, J. P., *Soil Sci.*, 1972, **113**, 317.
12. D'Orey, F. L. C., *Trans. Inst. Min. Metall.*, 1975, **B84**, 150.
13. Krishnamurthy, M., In: *Gold mining industry in India*, Geological Society of India Memoir No. 1, 1963, p. 97.
14. Prasad, E. A. V., *Igneous and metamorphic complex of Mid Pennar project area, Anantapur District, Andhra Pradesh*, Ph.D. thesis, Sri Venkateswara University, Tirupati, 1966 (unpublished).
15. Razin, L. V. and Rozhkov, I. S., *Geochemistry of gold in the crust of weathering and in the biosphere in the gold deposits of the Kuvanakh type*, Nanka Press, Moscow, 1966.
16. Girling, C. A., Peterson, P. J. and Minski, M. J., *Sci. Tot. Environ.*, 1978, **10**, 79.
17. Dunn, C. E., *J. Geochem. Explor.*, 1986, **25**, 21.
18. Chisnall, K. T. and Markland, J., *J. Assoc. Publ. Analysts*, 1971, **9**, 116.
19. Brooks, R. R., *Biological methods of prospecting for minerals*, John Wiley, New York, 1983, p. 322.
20. Kovalevskii, A. L., *Biogeochemical exploration for mineral deposits*, Oxonian Press Pvt. Ltd., New Delhi, 1979, p. 136.

ANNOUNCEMENT

PAUL NIGGLI COLLOQUIUM

A colloquium to mark the Centennial Year of Paul Niggli's Birth will be held on 27 July 1988 at the Department of Earth Sciences, ETH Zurich, Switzerland. It will focus on the scientific work of Paul Niggli and on modern developments influenced by his work. Lectures will be given by Dr W. T. Eppiecht, Zurich; Dr H. P. Eugster, Baltimore; St. Hafner, Marburg; Dr J. B. Thompson, Harvard University and Dr J. Zemann, Vienna.

Further particulars may be had from: ETH Zurich, Institut fur Mineralogie and Petrographic, Z. HD. Frau Claudia Buchel, ETH Zentrum, CH-8092 Zurich (Switzerland).