31 October 1986; Revised 24 March 1987

1. Kershbawn, A. and Bellets, A., *J. Am. Med. Assoc.*, 1964, **187**, 32.
2. Pozner, H. and Billimoria, J. D., *Lancet*, 1970, **1**, 1318.
3. Hammond, E. C., *Natl. Cancer Inst. Monogr.*, 1966, **19**, 127.
4. Nestel, I. and Zimmet, S., *Atherosclerosis*, 1981, **1**, 257.
5. Weime, R. J., *Arscia vitgaren brussels*, (ed.) N. John, New York, 1959, p. 25.
6. Kannel, W. B., Dawber, T. R. and Friedman, G. D., *Ann. Int. Med.*, 1964, **61**, 888.
7. Miller, N. E., Thelle, D. S. and Forde, D., *Lancet*, 1977, **1**, 965.
8. Eisenberg, S., *J. Lipid. Res.*, 1984, **25**, 1017.
9. Mjos, O. D., Rao, A. and Honden, T., *Atherosclerosis*, 1974, **39**, 75.

REDLICHIID TRILOBITES FROM THE TAL FORMATION, LESSER HIMALAYA, INDIA

GOPENDRA KUMAR, ASHUTOSH JOSHI and V. K. MATHUR

Himalayan Geology Division, Geological Survey of India, Lucknow 226 020, India.

THE note records the discovery of redlichiid trilobites and associated brachiopods from the Phulchatti Member (Upper Tal) of Tal Formation exposed in the western part of the Nigalidhar Syncline on southern slopes of the ridge about 800 m N.70°E. of Ganog, Sirmur District, Himachal Pradesh, India (figure 1). So far, no trilobites were recorded from the Lesser Himalaya, though there were recent finds of other fossils from the Tal Formation from the adjoining Mussoorie and Garhwal synclines in the eastern part of the Krol belt which includes earliest skeletal microfauna[1–4], stromatolite[5], archaeocyatha and calcareous algae[6], microgastropod and brachiopod[7] mainly from the 'Lower Tal' (Chert-Phosphorite to Calcareous members[8]). These fossils, in addition to records of varied type of trace fossils[7,9–11] and trilobite impressions[12], have helped in fixing the age of the 'Lower Tal' to Precambrian—Early Cambrian (Meishchucunian to Qiongzhusian Stages) in contrast to well entrenched a probable Mesozoic age[13] and more recent Cambro-

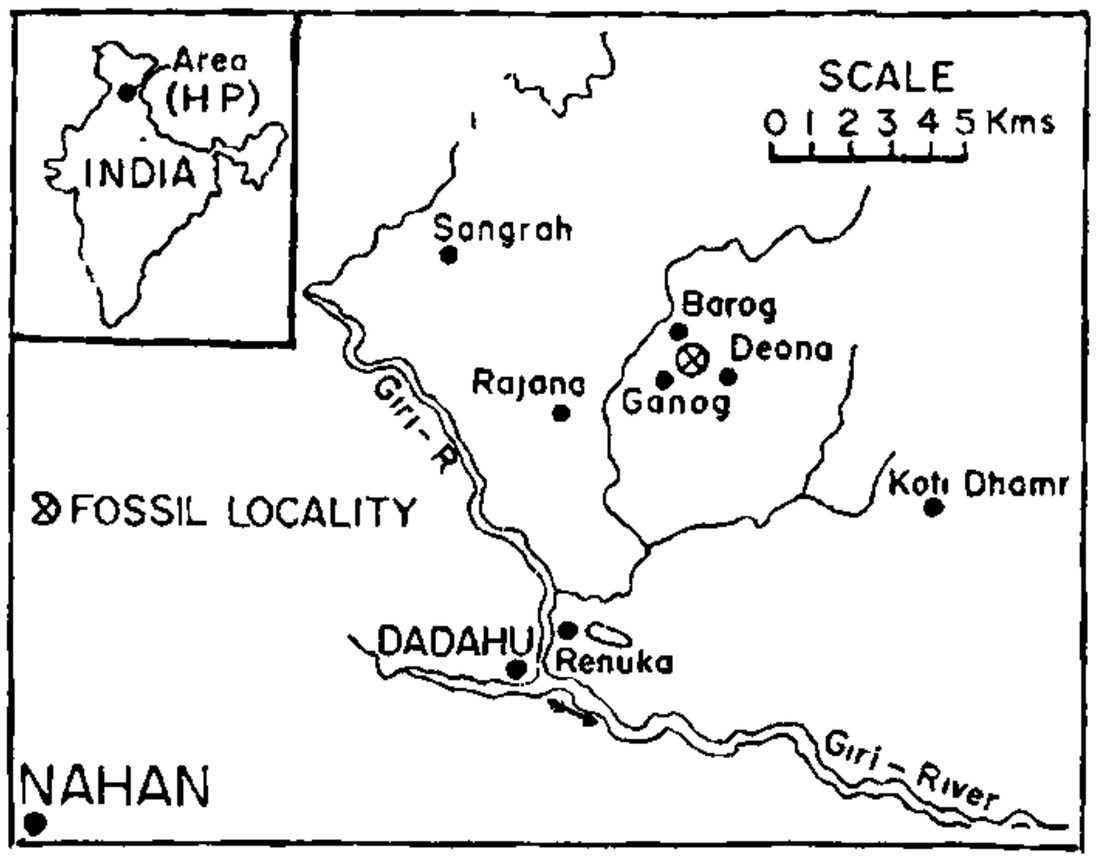


Figure 1. Location of fossiliferous horizon.

Ordovician[14,15]. The other fossil records are of rich brachiopod fauna from the basal part of the Phulchatti Member (Upper Tal) referable to the Botomian Stage of Early Cambrian[16,17]. Though this brachiopod-horizon was chronostratigraphically favourable and lithostratigraphically correlatable to the trilobite bearing Tsanglangpuian (? = Botomian) Stage of China[18], no trilobites were recorded from it till now.

The trilobites and the brachiopods occur in a grey to greenish grey flattened-nodular rusty weathering shale with intercalated thin greyish white arenite bands (Shale Member[19,20]) 245 m above the base of Phulchatti Member (figure 2). The preservation of individual elements of the fauna is excellent. The trilobite fossil remains are dominated by cranidium (figure 3). Some of the trilobites show broken but well-preserved thoracic parts (figures 4a, b). Complete carapaces, though not common, are also present (figure 4d). The brachiopod fossils form similar clustered facies as has been reported from Mussoorie area[16,17] with identical elements. The brachiopod fossils have not been studied in detail for the present.

Trilobites: *Redlichia noetlingi* (Redlich) (figures 3a, c, f) and *Redlichia* sp. (figures 3b, d, e and 4a, b), trilobite gen et sp. Indet. (figures 4c, d).

Brachiopods: *Obolella* sp. and *Lingulella* sp.

The present find of redlichiid trilobites (*Redlichia noetlingi*) in fair abundance proves beyond doubt an Early Cambrian (Tsanglangpuian Stage) age for the lower part of the Phulchatti Member of Tal Formation as assigned earlier on the basis of brachiopod

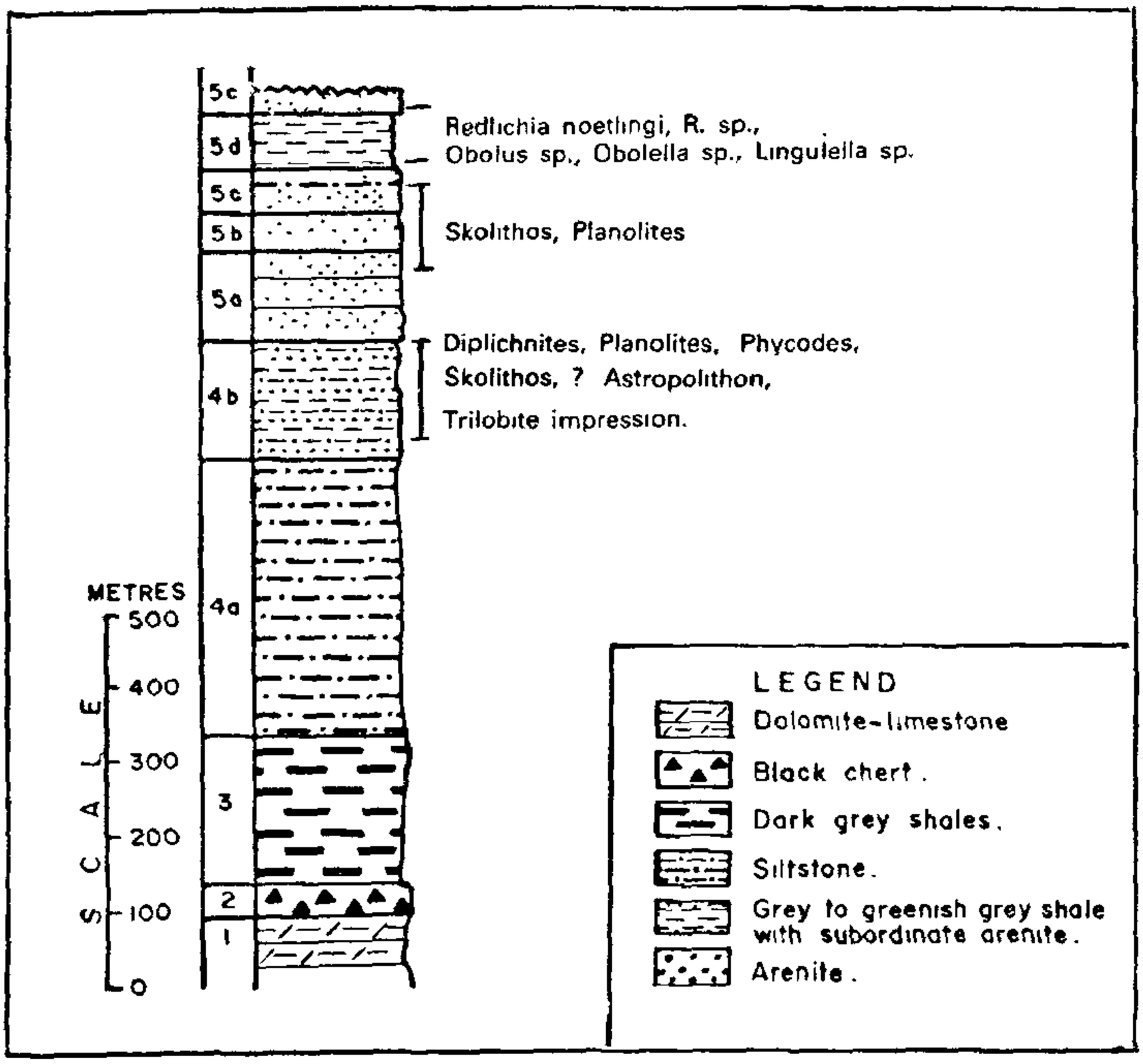
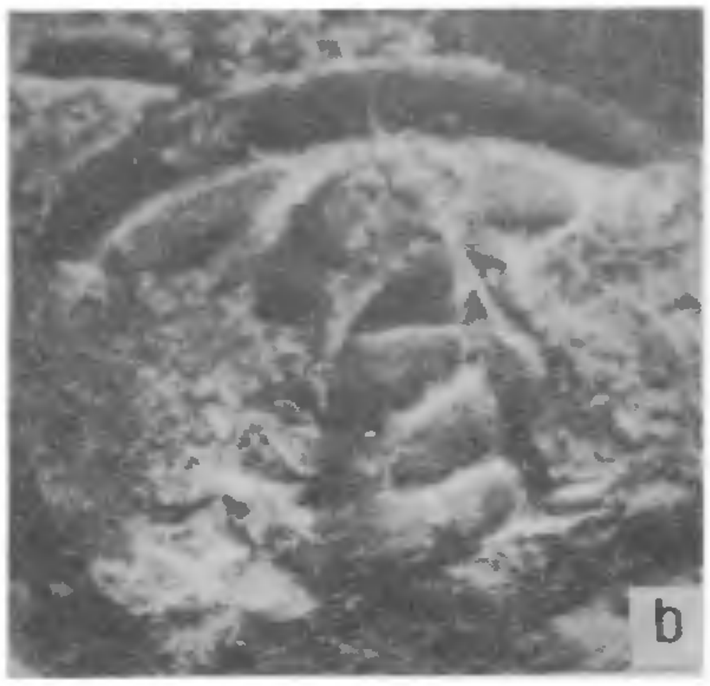
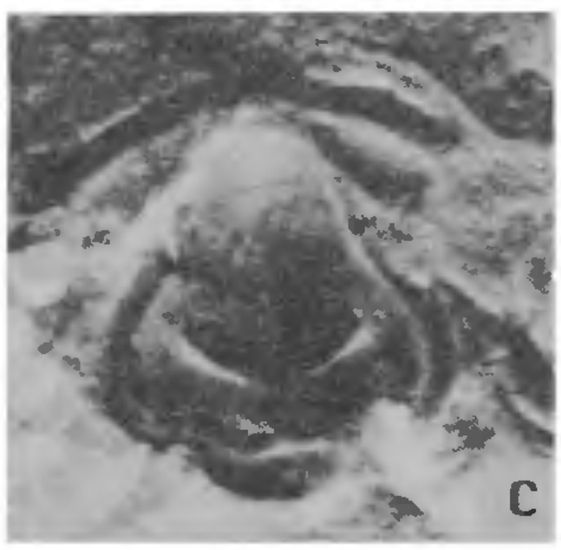


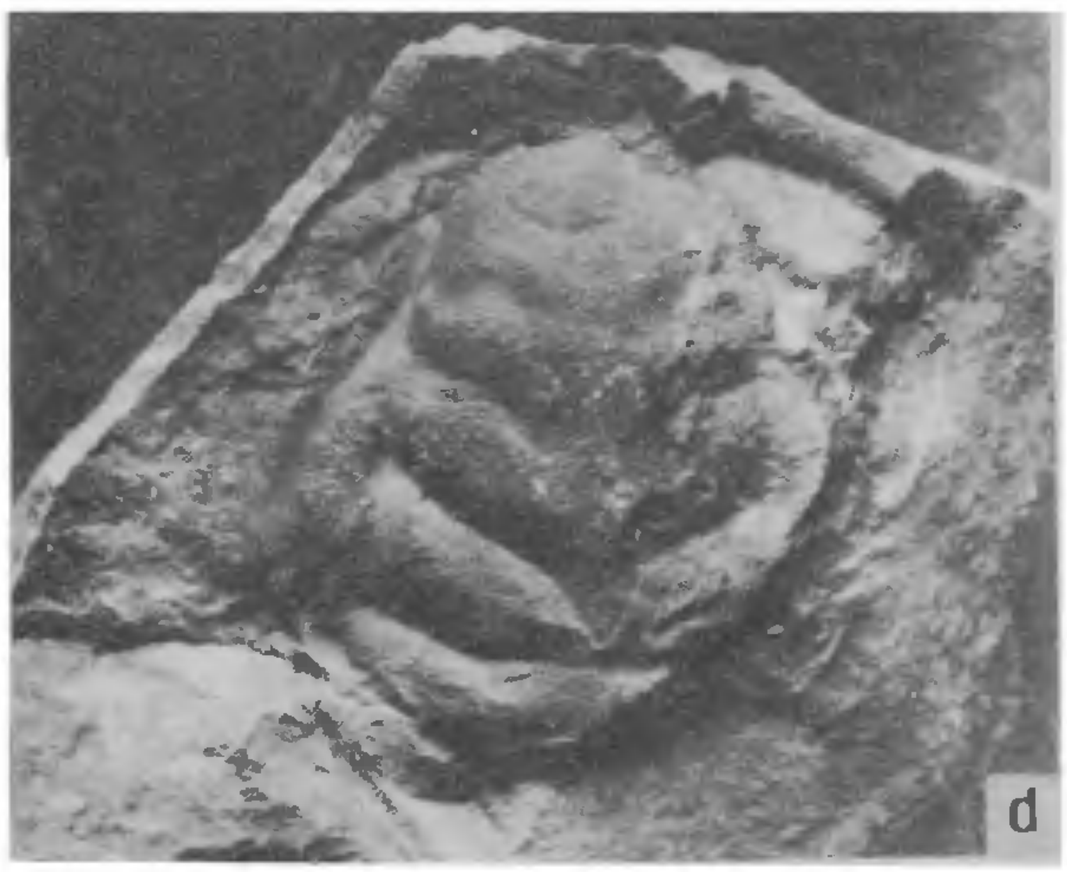
Figure 2. Generalized lithocolumn of part of Tal Formation in Rajana-Ganog section, Nigalidhar Syncline, Sirmur District, Himachal Pradesh showing fossiliferous horizon. 1. Krol Formation (E Member); 2–5 Tal Formation–2, Chert-Phosphorite Member—interbedded black chert and shale; 3– Argillaceous Member — dark grey shale with minor calcareous bands; 4– Arenaceous Member – 4a, grey siltstone; 4b, alternating greyish green, purple siltstone, finely laminated at places, white arenite; 5– Phulchatti Member ('Upper Tal') 5a, white coarse-grained, cross-bedded quartz arenite with dark grey shale near the base; 5b, light grey green to purplish siltstone, laminated at places, and bands of white arenite; 5c, White, cross-bedded to dark grey coarse-grained arenite with dark grey shale, bioturbation towards top; 5d, grey fossiliferous, flattened- nodular, rusty weathering shale with intercalated thin bands greyish white arenite; 5e, white, grey, purple arenite with laminated grey shale yielding *Cruziana*.

fauna[16,17]. It further substantiates the lithostratigraphic correlation of the Blaini-Krol-Tal succession of the Krol belt with the Sinian Precambrian—Early Cambrian sequence of China[18] and provides a clear evidence to correlate the lower part of Phulchatti Member of the Tal Formation with other redlichiid trilobite bearing horizons known from Salt Range[21,22], Kashmir[23,24] and Spiti[25] in the Indian subcontinent. This find extends southwards the limit of the 'redlichiid province' than known so far in the subcontinent, which until now was considered to be limited largely to the north of the Great Himalayan Range i.e. the Tethyan realm.

The authors are grateful to Dr C. Tripathi, for encouragement and guidance. They are also thankful to Drs D. K. Bhatt, V. D. Mamgain and Gopal Singh for their help in the preparation of the manuscript.







Figures 3a-f **a.** *Redlichia noetlingi* (Redlich) cranidium, (× 2), [20208]; **b.** *? Redlichia* sp. cranidium, (× 1.5), [20209]; **c.** *Redlichia noetlingi* (Redlich) cranidium, (× 2.5), [20210]; **d.** *Redlichia* sp. cranidium, (× 2), [20211]; **e.** *Redlichia* sp. cranidium, (× 1.5), [20212]; **f.** *Redlichia noetlingi* (Redlich) cranidium, (× 2.5), [20213]. Figures in square brackcts represent GSL type nos.

Figures 4a-f **a.** ?*Redlichia* sp. cranidium, (× 2), [20214]; **b.** *Redlichia* sp. cast of cranidium, (× 2), [20215]; **c.** Trilobite gen. et sp. Indet. cranidium with thoracic segments. Lower right hand part of fossil is covered with part of cephalon of another specimen, (× 1.5), [20216]; **d.** Trilobite gen. et sp. Indet. part of carapace, (× 2.5); [20217]; **e.** Trilobite gen. et sp. Indet, a part of thorax, (× 1.5), [20218]. and **f.** Trilobite gen et sp. Indet, a part of thorax (× 2), [20219]. Figures in square brackets represent GSL type nos.

20 August 1986; Revised 29 November 1986

1. Bhatt, D. K., Mamgain, V. D., Misra, R. S. and Srivastava, J. P., *Geophytology*, 1983, **13**, 116.
2. Bhatt, D. K., Mamgain, V. D. and Misra, R. S., *J. Palaeont. Soc. India*, 1985, **30**, 92.
3. Kumar, G., Raina, B. K., Maithy, P. K., Prasad Bijai, Babu, R., Bhargava, O. N., Bhatt, D. K. and Srivastava, R. N., *I.G.C.P. Pr. 29—Demarcation of Precambrian—Cambrian boundary, Geol. Surv. India*, 1986, (in press).
4. Kumar, G., Bhatt, D. K. and Raina, B. K., *Geol. Magazine*, 1986, **124**, (in press).
5. Tewari, V. C., *Curr. Sci.*, 1984, **53**, 319.
6. Singh, I. B. and Rai Vibhuti., *Curr. Sci.*, 1984, **53**, 243.
7. Kumar, G., Raina, B. K., Bhatt, D. K. and Jangpangi, B. S., *J. Palaeont. Soc. India*, 1983, **28**, 105.
8. Shanker Ravi, *J. Palaeont. Soc. India*, 1971, **16**, 1.
9. Singh, I. B. and Rai Vibhuti, *J. Palaeont. Soc. India*, 1983, **28**, 67.
10. Singh, I. B., Shukla, V., Rai Vibhuti and Kapoor, P. N., *J. Geol. Soc. India*, 1984, **25**, 102.
11. Bhargava, O. N., *J. Palaeont. Soc. India*, 1984, **29**, 84.
12. Rai Vibhuti and Singh, I. B., *J. Palaeont. Soc. India*, 1983, **28**, 114.
13. Auden, J. B., *Rec. Geol. Surv. India*, 1934, **67**, 357.
14. Azmi, R. J., Joshi, M. N. and Juyal, K. P., *Contemp. Geosci. Res. Him.*, 1981, **1**, 245.
15. Azmi, R. J., *Him. Geol.*, 1983, **11**, 373.
16. Tripathi, C., Jangpangi. B. S., Bhatt, D. K., Kumar, G. and Raina, B. K., *Geophytology*, 1984, **14**, 221.
17. Tripathi, C., Kumar, G., Mehra, S., Bhatt, D. K., Mathur, V. K., Joshi Ashutosh and Jangpangi, B. S., *Curr. Sci.*, 1986, **55**, 585.
18. Kumar, G., V. *Indian Geophytological Conf., Palaeobot. Soc.*, 1984, p. 98.
19. Bhargava, O. N., *Him. Geol.*, 1972, **2**, 47.
20. Ganesan, T. M., *J. Geol. Soc. India*, 1975, **16**, 503.
21. Redlich, K., *Palaeont. Indica*, 1889, 1.
22. King, W. B. R., *Rec. Geol. Surv. India*, 1940, **75**, 1.
23. Raina, B. K. and Razdan, M. L., *Indian Miner.*, 1975, **29**, 64.
24. Shah, S. K., Raina, B. K. and Razdan, M. L., *J. Geol. Soc. India*, 1980, **21**, 511.
25. Reed, F. R. C., *Palaeont. Indica, Ser.*, 1910, 15, 7. 1.

RATE OF INFILTRATION—AN *IN-SITU* MEASUREMENT

S. AVUDAINAYAGAM, K. K. SHARMA, V. RAJAMANI and B. RUKMANGADA REDDI

Department of Applied Geology, University of Madras, Madras 600 025, India.

WHEN water falls on a given formation a small part of it is absorbed by the top thin layer of soil and the excess water moves downward where it is trapped in the free pore spaces to become groundwater. This process of water entering the strata of soil and percolating downward is known as infiltration and the quantity of water infiltrated depends upon the rate of infiltration which is affected by the thickness of saturated layer and the depth of surface detention, soil moisture, soil compaction during recharge, types and properties of vegetative cover, temperature etc.

The rate of infiltration is normally measured by Infiltrometers or rainfill simulators. These two methods have their own limitations; during the present work an attempt was made to utilize easily available soil moisture meter to measure the infiltration rate in the field. Soil moisture meter measures the amount, in percentage, of the moisture present in the soil, and if measured in fixed intervals of time after the onset of rainfall the rate of change of moisture will be the rate of infiltration. Depending upon the requirement and the aim of the study, the infiltration rate in horizontal and (or) vertical directions can be measured by placing the sensors accordingly.

In the present work, the infiltration rate was measured in horizontal and vertical directions by simulating the rainfall conditions in the field. An area in the vicinity of Thiruvanmiyur, Adyar, Madras measuring 90 cm × 90 cm was inundated with water and a water column of 2 cm was maintained throughout the study period. At the central point of this area six sensors were buried at an equal depth interval of 25 cm vertically below the surface of the earth, (water table was seen in the existing nearby open well and the last sensor was just above the water table). These sensors were used to record the moisture at regular intervals of time.