

grained, and has cloudy and twinned plagioclase (An 63), and shows typical intergranular and ophitic texture. Fine, equant hornblende grains are found coronated along their outer periphery, by pyroxene and almandine garnet, in that order (figure 2).

Rocks along the contact zone are fine-grained and show evidence of intense crushing. Occurrence of crushed pyroxene (augite) within the bent polygonized plagioclase can be interpreted to have been mechanically derived from the peripheral crushed pyroxene granules during deformation. Scapolite might have been formed due to the alteration of plagioclase feldspar under a condition of shearing and temperature difference.

Chemical analyses show (table 1) a decrease in  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  $\text{Fe}_2\text{O}_3$ ,  $\text{FeO}$ ,  $\text{K}_2\text{O}$  and  $\text{P}_2\text{O}_5$ , and an increase in  $\text{Al}_2\text{O}_3$ ,  $\text{MnO}$ ,  $\text{CaO}$  and  $\text{Na}_2\text{O}$  in rocks from the contact zone compared to tonalite gneiss, indicating basification of the acidic country rock as a result of intrusion. Release of Na, Ca and Mg from the dolerite body possibly facilitated the formation of more hornblende and augite in the contact zone. Corona structure (figure 2), formed by reaction between already crystallized phenocryst and intrusive dolerite melt; high content of  $\text{SiO}_2$ ,  $\text{TiO}_2$ ,  $\text{FeO}$ ,  $\text{P}_2\text{O}_5$  and  $\text{K}_2\text{O}$  in tonalite; and similar type of enrichment of  $\text{SiO}_2$ ,  $\text{MgO}$  and  $\text{CaO}$  in dolerite of the study area compared to their average compositions<sup>6</sup> (table 1) indicate thermochemical mobilization of elements across the contact zone.

The temperature of metamorphism (almandine-amphibolite facies) must have been appreciably high, as indicated by the presence of higher amount of garnet and its coexistence with hornblende<sup>7</sup>, and preservation of relict minerals and texture<sup>3</sup>. However, the younger metadolerites experienced comparatively short-duration metamorphism, which

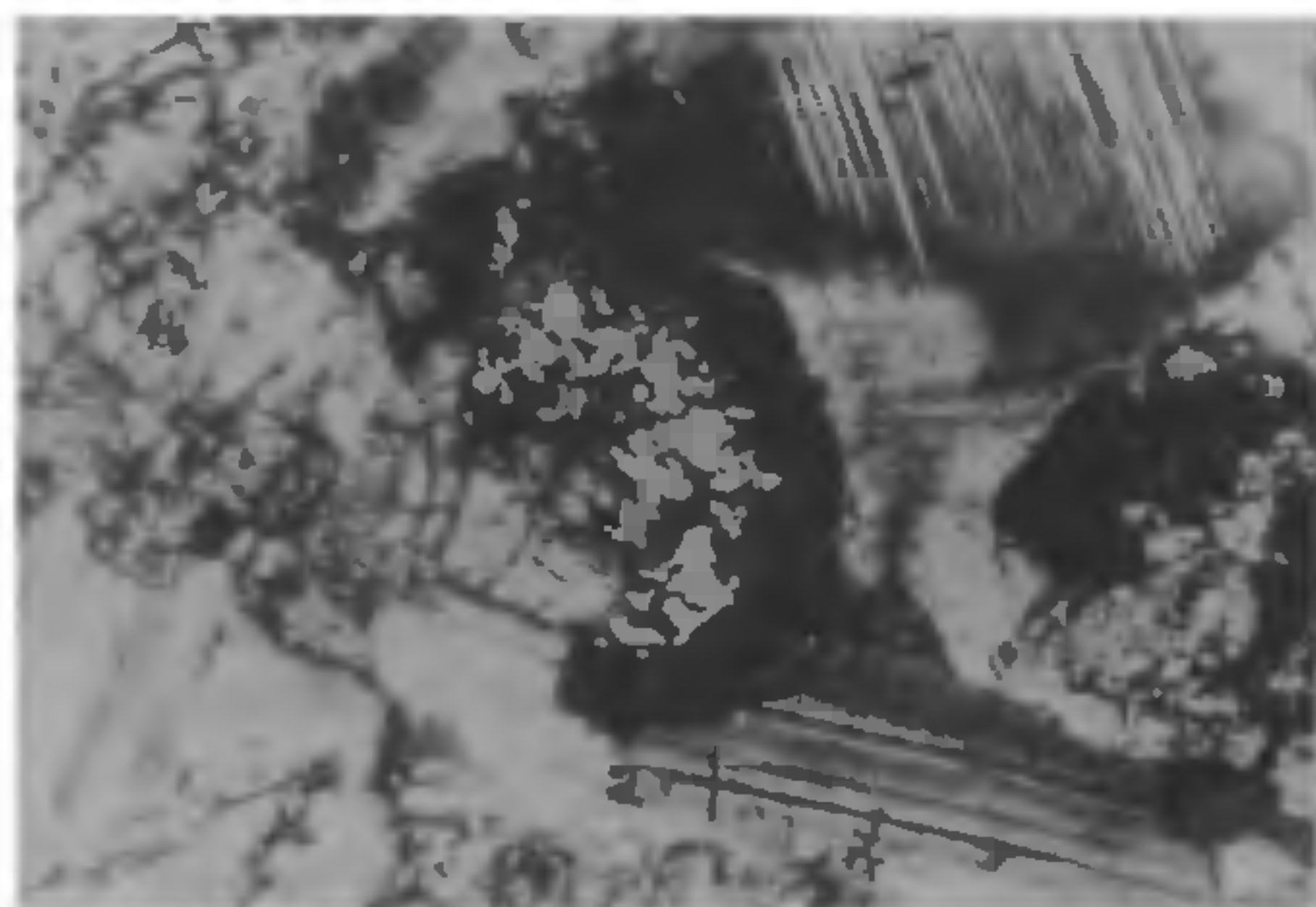


Figure 2. Corona structure with garnet rim enclosing the granular pyroxene grains (crossed  $\times 40$ ).

Table 1 Chemical analyses of some major elements (wt %)

Oxides	A	B	Bl	C	D	DI
$\text{SiO}_2$	68.29	66.94	61.52	53.07	51.81	50.18
$\text{TiO}_2$	0.42	1.53	0.73	0.42	0.36	1.14
$\text{Al}_2\text{O}_3$	15.81	13.72	16.48	13.76	15.14	15.26
$\text{Fe}_2\text{O}_3$	0.64	1.51	1.83	1.31	1.26	2.86
$\text{FeO}$	2.30	4.05	3.82	3.46	4.89	8.05
$\text{MnO}$	0.03	0.04	0.08	0.10	0.19	0.19
$\text{MgO}$	0.99	2.65	2.80	9.37	8.81	6.78
$\text{CaO}$	4.34	4.21	5.42	15.89	14.97	9.24
$\text{Na}_2\text{O}$	4.35	2.18	3.63	2.29	2.26	2.56
$\text{K}_2\text{O}$	1.97	2.46	2.07	0.26	0.24	1.04
$\text{P}_2\text{O}_5$	—	0.28	0.25	0.03	0.03	0.27

A, Granodiorite; average of 3 samples. B, Tonalite gneiss; average of 6 samples. Bl, Average composition of tonalite, (Cox *et al.*<sup>6</sup>). C, Contact zone; average of 5 samples. D, Central part of the sill; average of 4 samples. DI, Average composition of dolerite, (Cox *et al.*<sup>6</sup>).

commenced at the peak of the regional metamorphic episode.

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1. Hunday, A. and Banerjee, S., *Mem. G. S. I.*, 1967, 97.
2. Saha, A. K., *J. Geol. Soc. India*, 1979, 20, 375.
3. Mukhopadhyay, R., M.Sc. thesis, Calcutta Univ., 1979, p. 81.
4. Sarkar, S. N., *Indian J. Earth Sci.*, 1980, 7, 12.
5. *J. Mines Met. Fuels*, Geological Survey India, 1977, p. 25.
6. Cox, K. G., Bell, J. D. and Pankhurst, R. J., *The Interpretation of Igneous Rocks*, George Allen & Unwin, London, 1979, pp. 450.
7. Yoder, H. S., *Geol. Soc. Am.*, 1955, 62, 505.

## AN EMPIRICAL MODIFICATION TO HIGASI'S EQUATION FOR THE EVALUATION OF DIPOLE MOMENT OF A POLAR SUBSTANCE IN A NON-POLAR SOLVENT

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SEVERAL methods are available<sup>1-6</sup> for the evaluation of dipole moment of a polar molecule in a non-polar

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solvent from static dielectric measurements in dilute solutions. According to the method of Higasi<sup>5</sup> the dipole moment is given by

$$\mu = B(a_0 - a_\infty)^{\frac{1}{2}} \quad (1)$$

where

$$B = \frac{1}{2(\epsilon_1 + 2)} \sqrt{\frac{27 MKT}{\pi N d_1}} \quad (2)$$

$a_0$  is the slope of the graph  $\epsilon_{12}$  vs  $W$ ,  $a_\infty$  the slope of the graph  $n_{12}^2$  vs  $W$ ,  $\epsilon_{12}$  the dielectric constant of the

solution,  $n_{12}$  the refractive index of the solution,  $W$  the concentration of the dilute solution,  $M$  the molecular weight of the solute,  $K$  Boltzmann's constant,  $N$  Avogadro's number,  $T$  the absolute temperature in Kelvin,  $d_1$  the density of the solvent, and  $\epsilon_1$ , the permittivity or dielectric constant of the solvent.

To employ the method the concentrations are to be so chosen that they conform to the idea of dilute solutions, to which Debye's theory is applicable. For such low concentrations the variation in values of

**Table 1** Dipole moment determination by the Higasi method and by using the proposed equation for polar compounds

Compound	$a_0$	$a_\infty$	$\mu$ by Higasi method (D)	$\mu$ by proposed equation (D)
*Methyl anthranilate	1.150	0.220	1.14	1.20
*Butyl isovalerate	1.970	-0.116	1.75	1.67
*Butyl formate	3.100	-0.260	1.78	1.68
5-Bromopyrimidine	4.000	0.100	1.89	1.87
*Amyl benzoate	2.058	0.057	1.89	1.88
*Methyl benzoate	2.198	0.094	1.90	1.90
*Isopropyl benzoate	2.501	0.061	1.93	1.91
*Ethyl cinnamate	2.720	0.216	2.01	2.05
*Isobutyl benzoate	2.546	0.028	2.03	2.01
*Dimethyl malonate	4.700	-0.100	2.42	2.35
*Methyl salicylate	4.423	0.239	2.42	2.43
*Diacyl adipate	2.932	0.130	2.45	2.45
Indole	6.820	0.100	2.51	2.48
*Dipropyl adipate	2.934	-0.107	2.55	2.45
*Ethyl lactate	5.960	-0.225	2.60	2.50
*Dimethyl phthalate	4.008	0.115	2.63	2.62
*Ethyl salicylate	4.782	0.114	2.67	2.65
*Isobutyl salicylate	4.089	0.045	2.69	2.65
*n-Amyl salicylate	3.950	0.091	2.73	2.71
2,3-Dimethylindole	6.860	0.470	2.92	2.95
2,5-Dimethylpyrazine	11.430	0.500	3.08	3.08
3-Methylpyridazine	13.650	0.500	3.15	3.14
Ethyl 5-ethoxy-3-methyl-indole-2-carboxylate	5.330	0.620	3.26	3.39
Ethyl 1-cyanomethyl-5,7-dimethyl-3-phenyl-indole-2-carboxylate	5.080	0.170	3.26	3.25
Ethyl 1-cyanomethyl-5-chloro-3-methyl-indole-2-carboxylate	7.270	0.290	3.31	3.31
1,2-Dimethylindole	9.300	0.360	3.45	3.45
2,5-Dimethylindole	9.500	0.320	3.49	3.48
3-Phenylindole	10.450	0.910	3.72	3.80
5-Bromoindole	9.180	0.440	3.96	3.98
Ethyl 3,5-dimethyl-indole-2-carboxylate	8.640	0.500	4.02	4.05
N-(2-methyl-5-nitro)phenylsydnone	12.59	1.200	4.49	4.62
2-Acetylbenzimidazole	17.140	-0.500	4.56	4.40
N-(3,4-dimethyl)phenylsydnone	34.170	1.530	4.83	4.84
2-(1-Hydroxyethyl)-benzimidazole	26.000	5.000	5.22	5.69
2-Acetyl-1-methylbenzimidazole	29.000	0.530	6.30	6.23
N-(2,5-dimethyl)phenylsydnone	16.410	1.000	7.03	7.10
N-(4-methoxy)phenylsydnone	46.400	3.940	8.12	8.26

Solvent: Benzene for compounds marked \*. 1,4-dioxane for the rest.

refractive index from one concentration to another is generally found to be only in the fourth decimal place. Hence a very sensitive refractometer is needed for accurate measurement of  $n_{12}$ . A simple empirical modification of equation (1) is proposed, which eliminates refractive index measurement.

The equation proposed is

$$\mu = 0.98 B \sqrt{a_0} \quad (3)$$

Employing a set-up of a crystal-controlled transistor oscillator using a crystal of 1 MHz and a very sensitive variable capacitor (0.250 pF in steps of 0.05 pF), the capacitance of the cell with and without a dilute solution of the polar compound in the non-polar solvent used was found. From the change of capacitance the static dielectric constant of the solution  $\epsilon_{12}$  was calculated. This was repeated for five different concentrations. Refractive index was also measured for each dilute solution using the sodium D line in an Abbe refractometer at room temperature. From the plot of  $\epsilon_{12}$  vs  $W$  the slope  $a_0$  and from the plot of  $n_{12}^2$  vs  $W$  the slope  $a_\infty$  were found. In the present work the slopes were evaluated using computer-aided curve fitting by the least-square method. Using (1) and (3) the dipole moments were calculated for several polar compounds. The results are given in table 1. The solvents used were benzene for some compounds and 1,4-dioxane for the rest. Most of the experimental data are taken from refs. 7-9.

It is clear from table 1 that  $a_\infty$  is small compared to  $a_0$  and the value  $(a_0 - a_\infty)^\dagger$  is empirically found to be more or less equal to  $0.98 (a_0)^\dagger$ .

The proposed equation has been applied to a variety of polar molecules, whose permanent dipole moments range from 1.14 D to 8.12 D. The results obtained agree well with those by the Higasi method. The proposed equation gives equally accurate results but at the same time refractive index measurements are not needed. Thus the method can be used in any laboratory to find dipole moment of a polar molecule from measurements on dilute solutions in a non-polar solvent. The method does not require a costly refractometer but only a simple RF arrangement to measure change in capacitance.

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1. Onsager, L., *J. Am. Chem. Soc.*, 1936, 58, 1482.
2. Syrkin, V. K., *C. R. Acad. Sci. USSR*, 1942, 35, 43.
3. Kirkwood, J. G., *J. Chem. Phys.*, 1939, 7, 911;

*Ann. N. Y. Acad. Sci.*, 1940, 40, 315; *Trans. Far. Soc.*, 1946, 42A, 7.

4. Jatkar, S. K. K., Iyengar, B. R. Y. and Sathe, N. V., *J. Indian Inst. Sci.*, 1946, 28A, 1.
5. Higasi, K., *Bull. Chem. Soc. Jpn.*, 1966, 39, 2157.
6. Guggenheim, E. A., *Trans. Far. Soc.*, 1951, 47, 573.
7. Patil, R. L., Ph.D. thesis, Karnatak University, Dharwad, 1975.
8. Kalihal, G. K., Ph.D. thesis, Karnatak University, Dharwad, 1985.
9. Deshpande, R. L., Ph.D. thesis, Karnatak University, Dharwad, 1985.

## UNRECORDED PATHOGEN ON BAMBOO CAUSING BLIGHT IN INDIA

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*BAMBUSA ARUNDINACEA* (Retz.) Willd. is used for scaffolding in construction of buildings, in agricultural implements and in paper industries in India. Recently, a serious leaf blight was noticed in the forest nursery of the College of Agriculture, Dharwad. The intensity, calculated from per cent leaf area infected, was as high as 38.26%.

Infected leaves showed reddish to dark brown lesions with a grey centre, oval to elliptical in shape. Lesions were longitudinally distributed over the leaf lamina and measured 2-4 × 1-2 mm. Occasionally, they coalesced to give a blighted appearance. Culture of infected leaf bits on potato dextrose agar consistently yielded a species of *Exserohilum*. Colonies were pale greyish brown, later turning to dark brown. Conidiophores cylindrical, simple, geniculate, olivaceous brown, 2-6-septate, 40-180 × 4-8 μm; conidia acrogenous, elliptical or narrowly obclavate-rostrate, brown, thick-walled, subhyaline at the apex, usually straight, 1-15-septate, 29.6-130.0 × 8.0 × 25.0 μm. Cultural and morphological characters of the pathogen were found to agree with those of *Exserohilum halodes* (Drechsler) Leonard and Suggs anamorph of *Setosphaeria rostrata* Leonard. The culture of the fungus has been deposited in CMI, with accession No. IMI 315520.

A-week-old sporulating culture was successfully