induces an increase in contraction of small and large intestines[19], and inhibits the transit of material through gastrointestinal tract[9,10,20]. Our observations on the enzyme activities and absorption of ^{14}C glucose and ^{14}C glycine in codine-treated rat intestine also add further evidence for such adverse effects of codeine. The observed reduction in absorption could be due to the cumulative effects of codeine on the enzyme systems and on the intestinal motility.

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TITANIUM-BEARING GARNETS FROM ALKALINE ROCKS OF CARBONATITE COMPLEX OF TIRUPPATTUR, TAMIL NADU

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SIX types of Ti-bearing garnetiferous alkaline rocks occur as intrusive bodies, plugs, veins and dykes amidst riebeckite syenites within the carbonatite complex of Tiruppattur (N 12°15′–12°30′ and E 78°25′–78°35′)[1,2] along the southern margin of a structural basin[3] marked by pyroxenites and granitic gneisses. The garnets are black in colour and their composition approaches that of melanite which normally[4] possesses 1–5% of TiO_2. The mineral proportion (table 1) within a single intrusive body varies widely. In the outcrop, the syenite containing the fine-grained riebeckite ($2V_\gamma = 85°$, $(\gamma-\alpha) = 0.013$, $\alpha:(001) = 8°$, N_γ 1.678; X = blue; $Y = Z$ = yellowish green) grades to a coarse-grained melanite-orthoclasite which includes high temperature orthoclase[5,6] with $2V_\alpha = 81°$, $\alpha:(001) = 15°$, $(\gamma-\beta) = 0.002$. The latter grades into a very coarse-grained melanite-aegirine-wollastonite orthoclasite and then to a monomineralic wollastonite rock. The fine-grained melanite-microcline containing high temperature iron rich microcline[6] $2V_\alpha = 39°$, $\alpha:(001) = 19°$ is an ultrapotassic syenite ($K_2O - 16.5\%$) which is in sharp contact with coarse-grained melanite-orthoclasite and wollastonite rock. Syenite porphyries and melanite-

Table 1 *Modal composition of Ti-garnet bearing rocks of Tiruppattur (vol. percentage)*

	Melanite-orthoclasite (6)	Wollastonite rock (5)	Melanite-microcline-syenite (7)	Melanite-scapolite-syenite (5)	Melanite-syenite-porphyry (5)	Melanite-sovite (4)
Quartz	—	—	—	0.5	—	—
Potash feldspar	95.0–84.0	2.0	97.0–88.0	73.0–58.0	90.0	2.0
Plagioclase	1.0–0.5	0.5	—	17.0–10.0	—	—
Melanite	9.0–1.0	1.0	5.0–1.0	3.0–1.0	1.0	4.0
Diopsidic augite	—	—	—	10.0–5.0	—	—
Aegirine-augite	3.0–0.5	0.7	1.0–0.1	3.0–2.0	1.0	2.0
Riebeckite	—	—	1.0–0.2	0.3	3.0	1.0
Biotite	—	—	3.0–1.0	3.0–2.0	3.0	0.5
Sphene	1.0–0.5	0.1	0.5–0.1	0.2	0.1	1.5
Scapolite	—	—	—	4.0–1.0	—	—
Apatite	0.5	0.1	0.5–0.3	0.1	0.3	2.0
Magnetite	—	—	—	—	0.5	—
Calcite	0.5	0.1	1.0–0.3	0.9	0.5	85.0

Numbers of samples studied are given in brackets

scapolite syenites occur as discordant dykes and veins amidst riebeckite syenites in the northern portion of the basin.

The chemical analyses of Ti-bearing garnets (table 2) show that the silica deficiency in tetrahedral site is compensated by substitution of Al^{iv} in the site. Al^{iv} substitution depends on temperature and an increment of Al^{iv} content in tetrahedral site indicates a progressive rise in the temperature of formation of the garnet[7]. Since sufficient Al^{iv} is available to bring Si to the theoretical value of 6.00, Ti in the trivalent state may occupy Si-site. Melanite separated from melanite-aegirine-wollastonite-orthoclasite is subjected to trace elemental analyses. Quartz grating spectrograph was used. The results are; Cu 8 ppm, Ni 10 ppm, Zn 100 ppm, Ba 200 ppm, Zr 200 ppm, V 300 ppm and Y 30 ppm. This trace element concentration level in the garnet suggests carbonatitic affinity[8].

The volume per cent of garnets decreases from coarse-grained members to fine-grained members from 10 to 1. The sizes of garnets from coarse-grained rocks range from 7 mm to 2 mm and among fine-grained rocks the sizes of garnets range from 2 mm to 0.1 mm. Garnets in the coarse-grained melanite-orthoclasite and melanite sovite are subhedral to euhedral in form. Some garnets in these rocks have overgrowth with aegirine augite ($2V_\alpha = 82°$, $\alpha : Z = 11°$, $(\gamma - \alpha) = 0.048$, N_m 1.770, X = dark brown, Y and Z are yellow). The garnets intimately associate with aegirine augite, wollastonite and sphene. The composition of co-existing sodic pyroxenes ranges from sodic augite ($2V_\gamma = 62°$, $\gamma : Z = 50°$, $(\gamma - \alpha) = 0.023$) to aegirine ($2V_\alpha = 68°$, $\gamma : X = 11°$, $(\gamma - \alpha) = 0.048$, N_m 1.780, X and Y are green, Z = pale green)[4,5]. Similarly the composition of Ti bearing garnets varies from andradite to melanite. Garnets from coarse-grained melanite syenites have lower content of titanium than garnets from fine-grained syenites. From field and petrographical study, it is concluded that garnets from highly differentiated late magmatic alkalic rocks have higher content of Si, Ca and Ti and a lower content of Mg than the garnets of alkaline rocks of relatively early magmatic ones. Highly differentiated agpaitic magma is usually enriched with incompatible elements like Ti, P and Zr in their mafic minerals[9]. Augite ($2V_\gamma = 60°$, $\gamma : Z = 42°$, $(\gamma - \alpha) = 0.025$, $(\beta - \alpha) = 0.008$) from agpaitic-alkalic rocks are calcic-rich and they have higher content of Fe^{3+} and Ti and both in 4 and 6-fold coordination and with higher Mg/(Mg + Fe) ratios[4]. At late magmatic stages Mg content decreases in the residual liquid owing to fractional crystallization and removal of relatively early formed mafic minerals which were enriched with Mg. At low-pressure conditions, ferric content increases due to increase of P_{O_2} in the agpaitic fluid. At this stage, augite transforms into aegirine-augite by incorporation of soda and ferric iron from the residual fluid and the co-existing aegirine-augite accommodates more CaO SiO_2 by breakdown of sphene[10]. Further, the aegirine-augite transforms to Ti-andradite (melanite)[11], in highly differentiated

Table 2 *Chemical compositions of Ti-garnets from alkaline rocks of Tiruppattur*

Oxides (Wt%)	572		584		39		990	
SiO_2	33.83		34.78		34.07		34.70	
Al_2O_3	3.90		5.39		3.43		4.07	
Fe_2O_3	22.03		22.64		nd		22.47	
FeO	2.90		0.90		21.96*		2.30	
MnO	0.69		0.82		0.81		0.22	
MgO	2.25		0.64		0.51		1.81	
CaO	31.00		30.29		33.05		30.52	
Na_2O	0.45		0.34		0.04		0.84	
K_2O	0.07		0.36		nd		0.23	
TiO_2	1.61		2.58		5.49		1.80	
Cr_2O_3	nd		nd		0.02		nd	
LOI	0.78		0.62		nd		0.92	
Total	99.51		99.36		99.38		99.88	
	Number of ions on the basis of 24 (0)							
Si	5.723	6.00	5.799	6.00	5.709	6.00	5.819	6.00
Al^{IV}	0.277		0.201		0.291		0.181	
Al^{VI}	0.496		0.859		0.381		0.623	
Fe^{3+}	2.807	3.51	2.841	4.02	2.374	3.45	2.835	3.69
Ti	0.204		0.324		0.692		0.227	
Cr	nd		nd		0.002		nd	
Mg	0.569		0.116		0.127		0.452	
Fe^{2+}	0.407		0.125		0.438		0.322	
Mn	0.103	6.86	0.159	6.00	0.115	6.63	0.031	6.61
Na	0.142		0.110		0.012		0.274	
Ca	5.621		5.411		5.934		5.483	
K	0.020		0.076		nd		0.048	
Almandine	7.1		2.1		7.5		5.5	
Andradite	77.4		73.0		83.4		79.9	
Grossular	4.3		20.1		5.1		6.5	
Pyrope	9.5		2.6		2.1		7.6	
Spessartine	1.7		2.2		1.9		0.5	

* Total FeO, FeO determined by wet gravimetric analysis – 3.12%. Other analyses by A. W. Groves method[13]. Purity of mineral separates ranging from 95 to 100%; For 572–95%, 990–95%, 584–98%, 39–99 to 100%. Fe_2O_3 calculated from total FeO by using FeO 3.12% is 18.92% (min) for the sample 39. Garnets from 572–Melanite orthoclasite; 584–Melanite-aegirine-wollastonite-orthoclasite; 39–Melanite-microcline syenite; 990–Melanite sovite.

late magmatic fluids. Melanite may also grow as a reaction product between wollastonite and aegirine-augite[12]. Field and textural evidence indicates that melanite grew at the expense of aegirine-augite at late magmatic stages under high degree of oxidation potential. The paragenetic assemblages of melanite are similar to the ones described by Le Bas[12] from the alkaline rocks of Usaki carbonatite complex of Western Kenya. The parageneses of melanite have been subjected to several and superimposed alkali magmatic and metasomatic processes.

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BODY AND TRACE FOSSILS FROM THE ROHTAS FORMATION (VINDHYAN SUPERGROUP) EXPOSED AROUND AKBARPUR, ROHTAS DISTRICT

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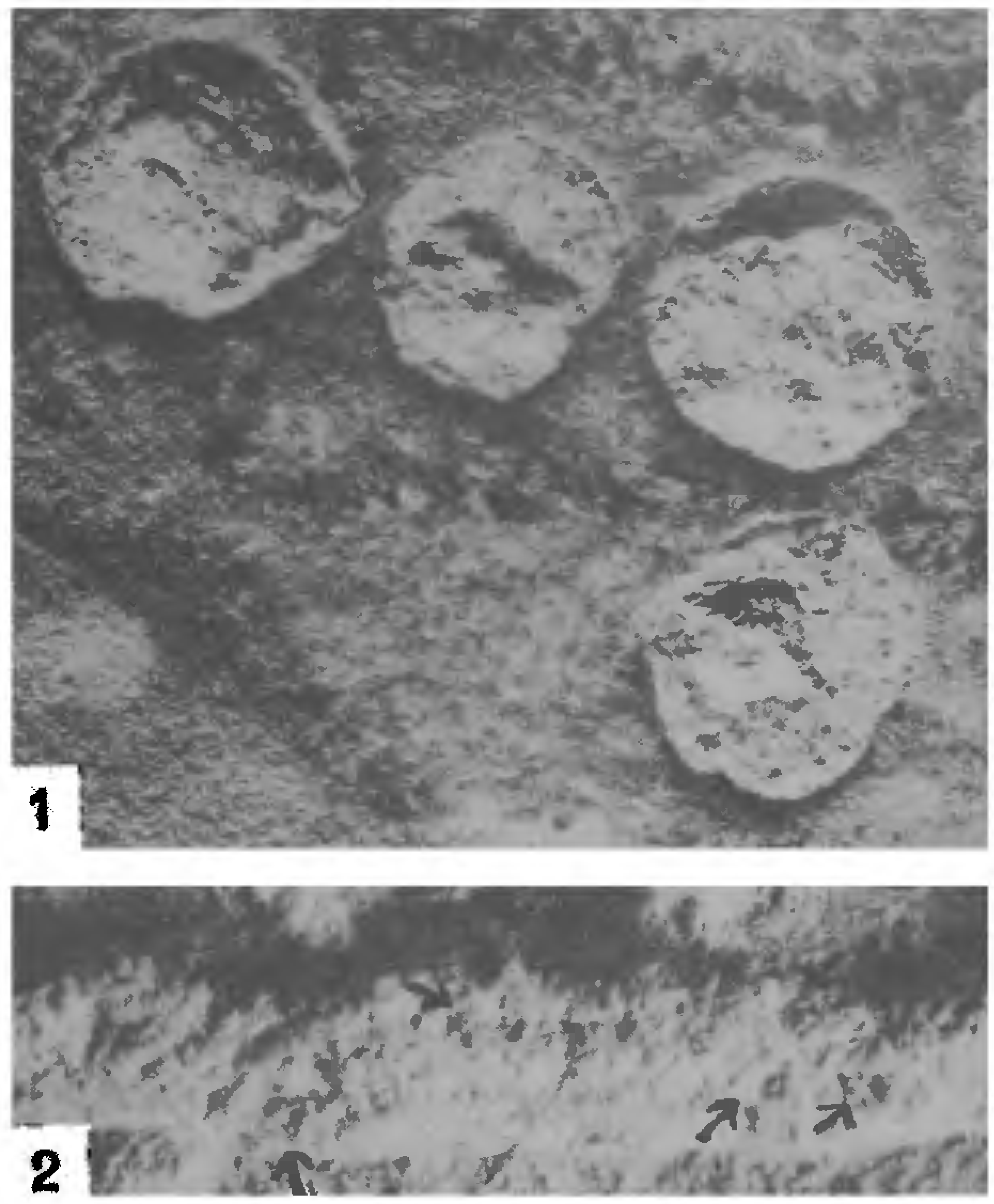
THE present note records spheriodal casts of fossils which resemble *Sekwia excentrica* and annelid trace fossils preserved in the uppermost horizon of the Rohtas Formation (Vindhyan Supergroup) exposed in the limestone quarries around Akbarpur (24° 38′:83° 58′) Rohtas District, Bihar.

The fossils occur in a bed which constitutes the uppermost horizon of the Rohtas Formation (Semri Group) exposed at the right embankment of the nala descending from the Amjhore Pyrite Mine. The lower portion is thick bedded and laminated, upper 10 to 15 m is stromatolitic and the top part enclosing these fossils is made up of thinly bedded, flaggy and argillaceous limestone. The fossil (figure 1) occurs as spheroidal casts measuring 1–8 mm in diameter and 1–2 mm in thickness, with thickened distinct margin; slightly displaced circular fold from the centre of the specimen is observed with a protuberance at the central part. The fossils are similar to *Sekwia excentrica* Hofmann[1] recorded from the late Precambrian of Mackenzie Mountains of north-western Canada. The resemblance to *Sekwia* is debatable though Hofmann[1] states that the "most likely phylogenetic position is with Coelentrates". The remains of Coelentrates medusoids have been described earlier from the homotaxial beds in Nimbahera Limestone of Rajasthan[2] and Suket Shale Formation Ramapura[3].



Figures 1–2. 1. *Sekwia excentrica* Hofmann (×4). **2.** Trace fossils (×2.5).

In addition some trace fossils have been located in the Murli Sandstone Formation (Kaimur Group) of Murlipahar (24° 39′:83° 59′). they have elongated cylindrical structure (figure 2) measuring 5 cm in length with a central ridge and rows of deep furrows, ± circular on either sides of the ridge. These trace fossils may be referred to as annelids.

The presence of Coelentrate *Sekwia* and trace fossils support the idea that an assemblage of metazoan was present during the end of the Rohats and the beginning of Kaimur periods. Therefore, an examination of these beds in different areas will be necessary to establish definite existence of life during the Vindhyan era, which was hitherto considered as barren of megascopic biota.

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