SHORT COMMUNICATIONS

GEOTHERMOMETRY OF ULTRAMAFIC ROCKS AROUND TERAKANAMBI, SOUTHERN KARNATAKA

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ULTRAMAFIC to mafic layered igneous intrusions form an integral part of the Archaean terrain of southern Karnataka[1,2]. This note records for the first time the temperature estimate data for the ultramafic rocks of the Terakanambi area, which forms the southern extension of the Sargur high-grade terrain in Karnataka. The area around Terakanambi (lat. 11°47'N and long. 76°47'E) is predominantly composed of tonalitic to trondhjemitic gneisses which have enclaves of sillimanite-bearing pelites, manganiferous horizons, banded iron formations, amphibolites and various components of the ultramafic layered complex. The supracrustal rocks are considered to be older than 3.4 BY as the enclosing gneisses yield an Rb/Sr age of 3.4 BY (Janardhan and Vidal, pers. comm.). The lithologies show evidence of four deformational episodes and upper amphibolite facies metamorphism.

The ultramafic rocks of the present study include the various components of the layered complex and late gabbroic anorthosites, which now occur as tectonically interleaved patches within the Peninsular gneisses. Mineralogically the ultramafic rocks of the Terakanambi area can be broadly classified into six important groups, viz. (i) orthopyroxene + clinopyroxene + olivine + tremolite + talc + green and brown spinel + green hornblende ± carbonate-bearing rocks; (ii) orthopyroxene + clinopyroxene + anthophyllite + green spinel + sapphirine + corundum + phlogophite + cordierite-bearing rocks; (iii) hornblende + clinopyroxene + plagioclase-bearing rocks; (iv) serpentine + olivine + magnesite + chromite-bearing rocks; (v) plagioclase (An_{80-90}) + clinopyroxene + hornblende + scapolite + clinozoisite-bearing meta-anorthosite; and (vi) plagioclase (An_{30-40}) + hornblende + clinopyroxene + quartz-bearing late gabbroic anorthosite.

Results of chemical analysis of the coexisting orthopyroxene, clinopyroxene, hornblende and spinel from group (i) rocks are given in table 1. Minerals were analysed using an ARL electron microprobe at the Department of Geological Sciences, University of Chicago, USA. Operating voltage was 15 kV and sample current 10^{-7} amp; the beam spot was one micrometre.

Orthopyroxene is enstatite ($X_{Mg} = 0.81$) with relatively high Al content. Tschermak's component is high with $Al_{tot} = 0.09$ atom p.f.u., indicating that it is an aluminous orthopyroxene. Clinopyroxene is diopsidic in composition and shows high X_{Mg} (0.88) relative to the associated orthopyroxene. Al_{tot} is 0.068 atom p.f.u. and this total is relatively low compared to the reported Al_{tot} for the clinopyroxenes of ultramafic rocks from the Sargur area[2]. Hornblende exhibits pale green colour and this is mainly due to the presence of low TiO_2 (0.95%). The chemistry of hornblende indicates that it belongs to

Table 1 *Microprobe analysis of orthopyroxene, clinopyroxene, hornblende and spinel from an ultramafic rock of Terakanambi*

	Opx	Cpx	Hbl	Spinel
SiO_2	54.37	53.52	47.12	—
Al_2O_3	2.21	1.58	10.76	57.90
TiO_2	—	—	0.95	—
FeO	12.61	4.09	6.60	21.91
MnO	0.32	—	0.21	0 30
MgO	29.94	16.16	17.53	14.44
CaO	0.54	24.70	12.70	—
Na_2O	—	—	0.61	—
K_2O	—	—	0.19	—
Cr_2O_3	—	—	0.33	5.68
Total	99 99	100.05	97.00	100.23
No. of oxygen atoms	(6)	(6)	(23)	
Si	1.934	1.961	6.74	
AlIV	0.066	0.039	1.26	
AlVI	0.027	0.029	0.54	
Ti	—	—	0.10	
Fe	0.375	0.125	0.78	
Mn	0.096	—	0.01	
Mg	1.588	0.881	3.76	
Ca	0.020	0970	1 89	
Na	—	—	0 14	
K	—	—	0.34	
Cr	—	—	0.05	
X_{Mg}	0.81	0.880		

the magnesio–hornblende type. Spinel is an aluminium-rich Fe–Mg type and its chemistry is comparable with that of the spinels of the ultramafic rocks from the Sargur area[2].

Various geothermometers[3-5] are employed to determine the temperature conditions of metamorphism using the miscibility data of coexisting ortho- and clinopyroxenes. Temperature calculation using the model of Wells[4] for the pyroxene pairs from an ultramafic rock of the Terakanambi area yielded 690°C (corrected for −60°, cf. Raith *et al*[6]). However, the temperature estimate based on Powell's geothermometer[5] is higher (764°C/7 kb) than that obtained from the Wells model. The present temperature estimate of 690°C for the ultramafic rocks is consistent with the reported temperature of 700±20°C for the ortho- and clinopyroxene pairs from the ultramafic rocks of the Sargur area[2]. The estimated metamorphic temperature of 690°C for the ultramafic rocks of the Terakanambi area clearly indicates imprints of upper amphibolite facies metamorphism.

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A NOTE ON THE CRYSTALLIZATION OF FOOT-AND-MOUTH-DISEASE VIRUS

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ANIMAL viruses, regarded as biological macromolecular assemblies, have kindled provocative pursuits in different scientific disciplines. A significant lead is to examine the possibility of these viruses forming crystals and to study the conformation of the immunogenic sites in their proteins and glycoproteins.

Foot-and-mouth-disease virus is a member of the genus *Apthovirus* in the family Picornaviridae[1]. It is icosahedral with an approximate diameter[2] of 300° A, and contains a single, unsegmented strand of positive-sense RNA (M_r 2.6×10^6), 60 copies of each of the four polypeptides designated VP_1, VP_2, VP_3 and VP_4, and one to two copies of VP_2 and VP_4 present as an uncleaved precursor molecule, VP_0. Crystalline virus structures have been described for representatives of three of four genera of Picornaviridae, namely human rhinovirus[3] 14, poliovirus[4] and mengovirus[5]. These show a startling similarity in both tertiary and quaternary structures. We report in this communication our preliminary effort to crystallize foot-and-mouth-disease virus serotypes O, A, C and Asia-I.

Foot-and-mouth-disease virus types were grown in BHK_{21} cell monolayers overnight at 37°C and purified in sucrose or cesium chloride density gradients[6, 7]. The recovered virus was concentrated by pelleting through 30% sucrose containing a mixture of 10 mM sodium phosphate (pH 7.6) and 150 mM sodium chloride (pH 7.6) at 200,000 *g* for 3 h. Pellets were resuspended in 50 mM potassium phosphate buffer (pH 7.6) containing 100 mM ammonium sulphate and a trace of NaN_3 to obtain a virus concentration of 10–15 mg/ml. Any debris was removed in a microcentrifuge. Uninfected BHK_{21} cells were subjected to the same procedure and used as control. The crystallization set-ups of siliconized glass haemagglutination wells, were placed inside sealed petri dishes that were saturated with 50 mM potassium phosphate (pH 7.6) containing 100 mM ammonium sulphate and 1% PEG (PEG 4000, Sigma) and used for vapour diffusion. Crystals formed when 10 µl of purified virus (10 µg/µl) and 10µl of 50 mM potassium phosphate buffer (pH 7.8) containing 100 mM ammonium sulphate and 1% PEG were allowed to reach equilibrium at room temperature (24 C) for 15 to 21 days. No crystals developed in the control preparations. The virus crystals formed disintegrated when repeatedly forced through a glass capillary tube, a characteristic feature of crystals of biological macromolecules. The crystals were washed thrice with 50 mM potassium phosphate buffer (pH 7.8) containing 100 mM ammonium sulphate and then dissolved in cold 50 mM