A KYANITE-GARNET-MICA SCHIST FROM SAIDAPURAM, NELLORE

By N Jayaraman

The kyanite rock studied in this work occurs as many fine scattered exposures in the western part of Gudur Taluk (Nellore District, Madras) The main exposure, a small hill, lies about half a mile to the due west of Saidapuram village It forms the highly mineralized zone of the mica schist complex of the Nellore Dharwars, being closely associated with scattered outcrops of garnetiferous schists rich in well crystallised garnets[1]

It is interesting to note that this region of the schist complex is charged with numerous intrusives of granite and pegmatite masses which seem to be closely related to the adjoining mica pegmatites Even though the appearance and mineral content of this exposure of the schist is impressive it has not attracted much attention from mineralogists A short description of the kyanite with two analyses of the same was previously made by Swaminathan[2]

The matrix of the rock carrying the kyanite is a micaceous schist having a light to dark grey colour It is composed of mica, kyanite, quartz, garnet and staurolite This schist has undergone good deal of weathering on the surface, the resulting rock being coloured deeply by hydrous iron oxide Weathering has left good crystals of garnet, staurolite and kyanite loose on the surface and in the red soil where they can be easily collected

The unaltered rock is dark in colour and highly schistose It is mostly composed of kyanite in large bladed crystals, muscovite mica and large masses of quartz The following other minerals are also commonly met with, garnet, staurolite, hornblende, biotite, tourmaline, magnetite, ilmenite and sphene Though igneous rocks occur abundantly in the vicinity it is observed that their contacts with the schist seldom show any marked metamorphic effect The rock shows a more or less uniform structure throughout The presence of isolated crystals of tourmaline in the schist is rather interesting to note

Goldschmidt and Peters have shown that it is possible to expect tourmaline in boron containing schists which have undergone some degree of dynamo metamorphism. Still in the rock under study, considering the closeness of the intrusive granite and pegmatite masses and the absence of tourmaline in similar schists occurring far removed from the granite intrusives, it is possible to ascribe the origin of the tourmaline to the escaping boron bearing gases from the original magma of the intrusives.

Kyanite - This mineral forms the main bulk of the rock mass and some times even exceeds 80 per cent. Its distribution is rather widespread. It is found in good crystalline condition and judging from the following chemical analysis it seems to be sufficiently pure. The usual colour is green but it is very often blended with an intense blue colour. When examined under a microscope, the green portions are found to hold only a very few inclusions while the blue portions are rather rich in minute mica like inclusions. These inclusions are purplish blue in colour and are pleochroic. Under sufficiently high magnification, these inclusions present a bladed and rod-like appearance the blades being hexagonal in outline. These inclusions are arranged lengthwise, viz., end to end and therefore exhibit a flow phenomenon. The individual blades show almost straight extinction. They vary in size from very minute forms 0.02 mm. long and 0.006 mm. wide to those with a length of 0.1 to mm. and a width of 0.09 mm. In addition to these inclusions the kyanite also holds a few grains of a titanium inclusion, most probably sphene.

Chemical composition of the kyanite

SiO	Al_2O_3	FeO	Fe_2O_3	MgO	CaO	TiO	Total
36.55	62.72	0.29	0.36	trace	0.31	0.20	100.43

Garnet – The dark red almandite is the common variety. It occurs both as well defined crystals and as massive crystalline material. Excepting for the iron and calcium content, the composition is found to vary from crystal to crystal. The amount of calcium is rather low in all the specimens. The quantity of magnesium and manganese show considerable variations. Crystals rich in spessartite are found to be poor in pyrope and vice versa. It is interesting to note that the

percentage of total iron is remarkably uniform Further, it is strikingly shown that specimens found in highly schistose areas and in close proximity to other ferric minerals showed a high percentage of magnesium, while the distribution of garnets containing large amounts of manganese is uniform throughout the exposure The size of the garnet crystals vary from 10 cms in diameter to microscopic forms Forms with unmodified dodecahedral habit are alone met with

These garnets, especially those containing a large amount of spessartite molecule, display a marked parting effect This parting occurs parallel to the dodecahedral faces and it is so developed that a projecting pyramid with step-like arrangement is produced on all the twelve faces of the crystal with the result that the ridges on the crystals appear as deep grooves The index of refraction varies from 1 79 to 1 81 The garnet has developed numerous cracks in which limonite has been deposited Limonite films are also commonly found in the body of the garnet away from cracks

It is interesting to note that these garnets, unlike those from an adjacent garnetiferous schist previously examined by the author, are entirely free from inclusions of any type Only occasionally are a few grains of quartz met with Chemical analysis of these garnets shows that titanium is entirely absent

Specimen No 1 which was rich in magnesium and specimen No 2 which was rich in manganese were analysed and the results obtained are given in table I and II

Staurolite —This mineral occurs in the schist as good individual crystals and it is found in the groundmass also The crystallographic features of the crystals of staurolite are quite normal It presents the normal form flattened parallel to orthopinacoid (100) which form is absent on the crystal The crystals exhibit the common forms and the prominent form is the unit prism The unit macrodome is also well developed There are only three forms present on the crystal, viz, the unit prism, the unit macrodome and the brachy pinacoid Almost all the crystals are found to contain numerous cavities The colour is brownish-black. Specific gravity = 3.9683. Axial ratio = 0 4751.1 0 6836

As the reflecting power of the faces were very poor the interfacial angles could not be measured with any great accuracy, and therefore the axial ratio is only a rough estimate. Refractive indices α 1.7357 β 1.7402 γ 1.7448 $\gamma - \alpha$ 0.0091

A chemical analysis shows the following percentage composition, SiO_2 27.81, Al_2O_3 51.97, Fe_2O_3 2.16, FeO 12.67, MnO 0.31, MgO 0.23, CaO 0.12 and H_2O 1.57, total 99.84

A thin section of the mineral examined between parallel nicols shows fairly strong pleochroism, dark orange red to orange yellow. The section as a whole presents a spongy texture owing to the inclusion of numerous grains of quartz

TABLE I

Chemical Composition, per cent

Specimen No.	1	2
SiO_2	37.51	36.50
Al_2O_3	22.29	20.71
Fe_2O_3	5.13	1.68
FeO	21.92	23.97
MnO	3.49	13.03
CaO	1.15	1.33
MgO	7.52	0.20
Total ...	99.31	100.97

TABLE II

Mineral Composition per cent

Specimen No	1	2
Garnets		
Almandite	61 93	65 13
Pyrope	25 17	0 67
Grossularite	3 08	3 57
Spessartite	7 33	27 35
Total garnet	97 51	96 72
Specific gravity	3 9928	4 1256
Refractive index	1 7961	1 8147

Hornblende —This mineral is not so abundant as either garnet or staurolite It is dark-brown in colour and in hand specimens of the rock it is rather difficult to distinguish it from the associated staurolite Good crystals of this mineral are not usually met with Generally it is found as corroded crystals with a faint prismatic outline Specific gravity = 3 2931 $Z \wedge c = 19.5^{\circ}$

Tourmaline.—Crystals of tourmaline are not very common and they are found only occasionally They are of the black variety with the characteristic crystal habit They are also found to occur as minute prisms in the groundmass and sometimes in the body of other minerals A well crystallised almandite was found to hold three or four such prisms of tourmaline In a few cases its presence was also noticed in kyanite.

Generally the crystals of tourmaline vary in size from microscopic specimens to crystals having a length of 1 cm and a thickness of about 0·1 cm Specific gravity 3·1116

No chemical analysis of this mineral was carried out but its jet black colour suggests a high percentage of iron in the mineral

Muscovite.—This is a white silvery mica It strongly resembles paragonite and occurs both as fairly large books measuring 2 to 3 inches in diameter and also as minute flakes which together with quartz and kyanite make up the groundmass for the other constituents of the rock

Quartz.—This mineral is one of the main constituents of the rock and it occurs both as large shapeless masses and as fine grains in the groundmass It is clear and free from inclusions

Magnetite, sphene, ilmenite and zircon occur as minor constituents Excepting magnetite, the others are present only as microscopic grains The magnetite is found to be titaniferous and its titanium content varies from 1 to 4 per cent Sphene is present in the kyanite crystals and so is responsible for the titanium shown in the kyanite analysis

Summary.—1 A short description is given of Kyanite garnet-mica schist from Sadapuram and the presence of tourmaline in this rock is discussed

2 The occurrence and mineralogical characteristics of the kyanite, garnet, staurolite, hornblende and tourmaline are described and chemical analyses of the first four minerals are also given

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