



ISSN: 2347-8314

Int. J. Modn. Res. Revs.
Volume 3, Issue 7, pp 731-734, July, 2015

ORIGINAL ARTICLE

XRD INVESTIGATION ON CLAY MINERALS OF THE TERTIARY FORMATIONS OF TRIVANDRUM AND KOLLAM DISTRICTS OF KERALA STATEDISTRICTS OF KERALA INDIA

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Article History: Received 20TH June,2015, Accepted July 30th 2015, Published 30th July,2015

ABSTRACT

The clay minerals of the tertiary formation occurring Trivandrum and Kollam District of Kerala has been investigated by XRD. The clay mineral assemblages present in these formations are Kaolinite, Muscovite and Illite. The non-clay minerals identified are quartz, and siderite. Overall clay mineral assemblages of the study area reveals moderately intense weathering chemical decomposing and mechanical fragmentation of the source rocks in humid to semi-humid climate. The most probable sources of the clay mineral derivation were predominantly igneous metamorphic and pre-existing sedimentary rocks of the formation.

Keywords: XRD, Clay minerals, Trivandrum and Kollam of Kerala State.

1.INTRODUCTION

The continuing and expanding interest in the clay mineral investigations in the recent years has been paid much attention on the study of various depositional environments, diagenetic changes and a correlation among the sources rocks, weathering climate drainage and topography with the clay mineral suite has been tried by geologists (Das et.al., 1998). Most of the clays are inherited by weathering of parent rocks and by the removal of clay fraction from soils (Sarmin Akther et.al. 2008). Clay minerals are mainly of detrital origin and reflect the characters of the source rocks, although they are liable to be altered during the process of transportation and deposition. Variations in the clay minerals may result from the source rock modifications related to tectonism (Chamley, 1989). The purpose of the present study is to identify the occurrence, source rock characteristics of the clay- rich sediments in Tertiary formations of Trivandrum and Kollam districts based on the XRD studies.

GEOLOGICAL SETTING

Kerala state lies between north latitude 8° 17 30 and 12° 27 40 and east longitudes 74° 51 57 and 77° 24 47 , covers an area of 38,863 km². Geologically the major part of Kerala is occupied by Pre-Cambrian crystalline rocks.

These crystalline rocks are fringed on the west by sedimentary formations, belonging to Tertiary and Quaternary period. The associations of various rock types, their stratigraphy along with their mineralogy are briefly discussed. Geologically, Kerala forms part of the Precambrian shield. The major rock types include granulites and associated gneisses belonging to Precambrian age. Late Precambrian – early Palaeozoic granites and associated pegmatites and Mesozoic- Cenozoic dykes intrude these rocks. The Precambrian rocks of North Kerala varies in composition when compared to those of South Kerala.

South Kerala (south of Achankovil shear zone) comprises an assemblage of migmatized metasedimentary and metaigneous rocks i.e. khondalite- charnockite assemblages. Khondalite Group has been ascribed to the rock assemblage containing garnet-sillimanite-graphite gneiss, garnet- biotite gneiss and garnetiferous –quartzofeldspathic gneiss.

Patches of charnockites are associated with this khondalite group of rocks. Massive charnockites with granoblastic texture are also noticed outcropping in some regions. Their mineralogical association includes hypersthene, garnet, plagioclase, microcline, microperthite and quartz. Ilmenite, rutile, apatite and zircon occur in minor quantities. A few patches of calc – granulites also occur.

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TERTIARY FORMATION

Most of the major residual and sedimentary deposits including kaolinite deposits are associated with the Tertiary sedimentary formations. This great sedimentary deposit is spread over a major part of the western margin of Kerala. The sequence consists of both marine and non-marine rocks in the on-land part (King, 1882; Foote, 1883), and are distributed in two major basins of deposition 1) between Trivandrum and Ponnani in the south and central Kerala with a maximum width of 16 km between Quilon and Kundara and 2) between Cannanore and Kasargode in north Kerala with a maximum width of 10 km at Cheruvattur (Paulose and Narayanaswami, 1968).

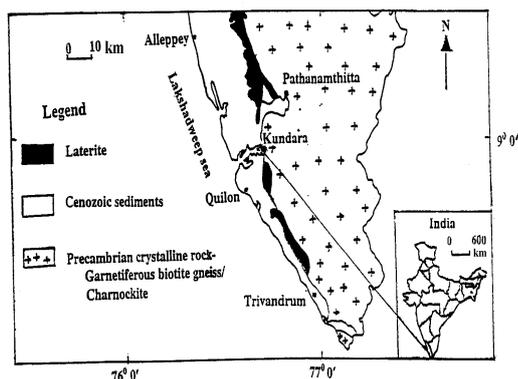


Fig.1 Location map of the study area

2.MATERIALS AND METHODS

The clay minerals of the Tertiary formations of Trivandrum and Kollam area of Kerala States were analysed by X-ray diffraction (XRD) technique. The representative samples were collected from study area, gently disintegrated by applying finger pressure. The clay and silt grade particles (finer than 40) were separated following Krumbein and Pettijohn (1983) and was centrifused several times by which the clay fraction was allowed to dry in room temperature followed by making powder in agate mortar and made homogeneous slurry. From this homogeneous slurry, oriented mounts were prepared with the help of a pipette keeping the thickness of the mount about 0.07 to 0.12 mm. Then the slides were dried at room temperature without disturbing them.

The samples were analysed using a Philip X ray diffractometer (PAN analytical X Pert) in the Department of Earth Sciences, Pondicherry University. The samples were scanned within 20 range of 2 to 30 degree. The samples were analysed in untreated as well as after glycolation (ethylene glycol) at 60°C following the methods of Carroll (1970). The clay minerals were identified from the diffractograms with the help of values in the powder diffraction file (JCPDS).

3.IDENTIFICATION OF CLAY MINERALS

X-ray diffractograms (fig.2) of the representative clays of the Tertiary formations around Trivandrum & Kollam area reveal the presence of Kaolinite, montmorillonite, chlorite, muscovite and Illite. The non clay minerals identified are quartz, orthoclase and siderite.

KAOLINITE

It is not possible to differentiate mineral kaolinite from several other members of the kaolinite group, because the clay is nearly monomineralic. Therefore, kaolinite is used here; refer to the kaolinite group of clay minerals. Kaolinite is a major and abundant clay mineral in the tertiary formations of Trivandrum and Kollam area of Kerala State. A more reliable indication of Kaolinite is recognized by the presence of the reflections at 2.38A°, although weak in intensity. Kaolinite is characterized by basal reflections at 7.14A°- 7.19A° and reflection at 3.57A°. Kaolinite is also shown by reflections at 4.46A°, 2.49A° and 2.29A°.

BIOTITE

Biotite is identified by the reflections at 3.47A° in few samples.

Non Clay Minerals

The most important minerals in the non clay fraction are quartz, feldspar and siderite. The mineralogical composition of non clay minerals is described below:
Quartz

Quartz is the most abundant non clay mineral in all the studied samples and it is recognized by the characteristic reflections at 4.24A°, 3.34A°, 2.28A°.

SIDERITE

The next important non clay mineral is siderite and by using reflections at 3.59A° and 2.34A°.

Table 1. Semiquantitative mineralogical analysis by XRD (raw clay, fines and heavy fraction)

Sample	Raw	Fines	Heavy
K1	K, Q, B, I	K [#] , Q	B [#] , I [#] , A, Pr
K2	K, Q	K [#] , Q	A [#] , R, Pr, S, Go
K3	Me [#] , Q, K, P [#] , J, A	-	-
K4	K, Q, A	K [#] , Q	R [#] , A [#] , Pr
K5	Gi, Q, K, A	Gi [#] , K [#] , O, A, R	Ma [#] , R [#] , A [#] , J, S
T6		Gi [#] , K [#] , R, Q, A	A [#] , R [#] , J, Go, S
T7	Gi, KR, Q	Gi [#] , K [#] , Q, R	A [#] , R [#] , S
T8	Q, Gi [#] , R, K, A	K [#] , Gi [#] , Q, R	Ma [#] , A [#] , R [#] , S
T9	K [#] , Q [#] , He	K [#] , Q	A [#] , R [#] , He, S, Go, K
T10	Q, K	K [#] , Q	S [#] , R [#] , A
T11	Q [#] , K, He	K [#] , Q, R	R [#] , S, He, K

K- kaolinite, Q- quartz, B- biotite, Gi- gibbsite, I- ilmenite, Pr- pseudorutile, A- anatase, R- rutile, S- sillimanite, Me- melanterite, P- pyrite, Ma- marcasite, J- jarosite, He- hematite, Go- goethite

-major, - minor and trace

The sequence of minerals from left to right is in the decreasing order of concentration

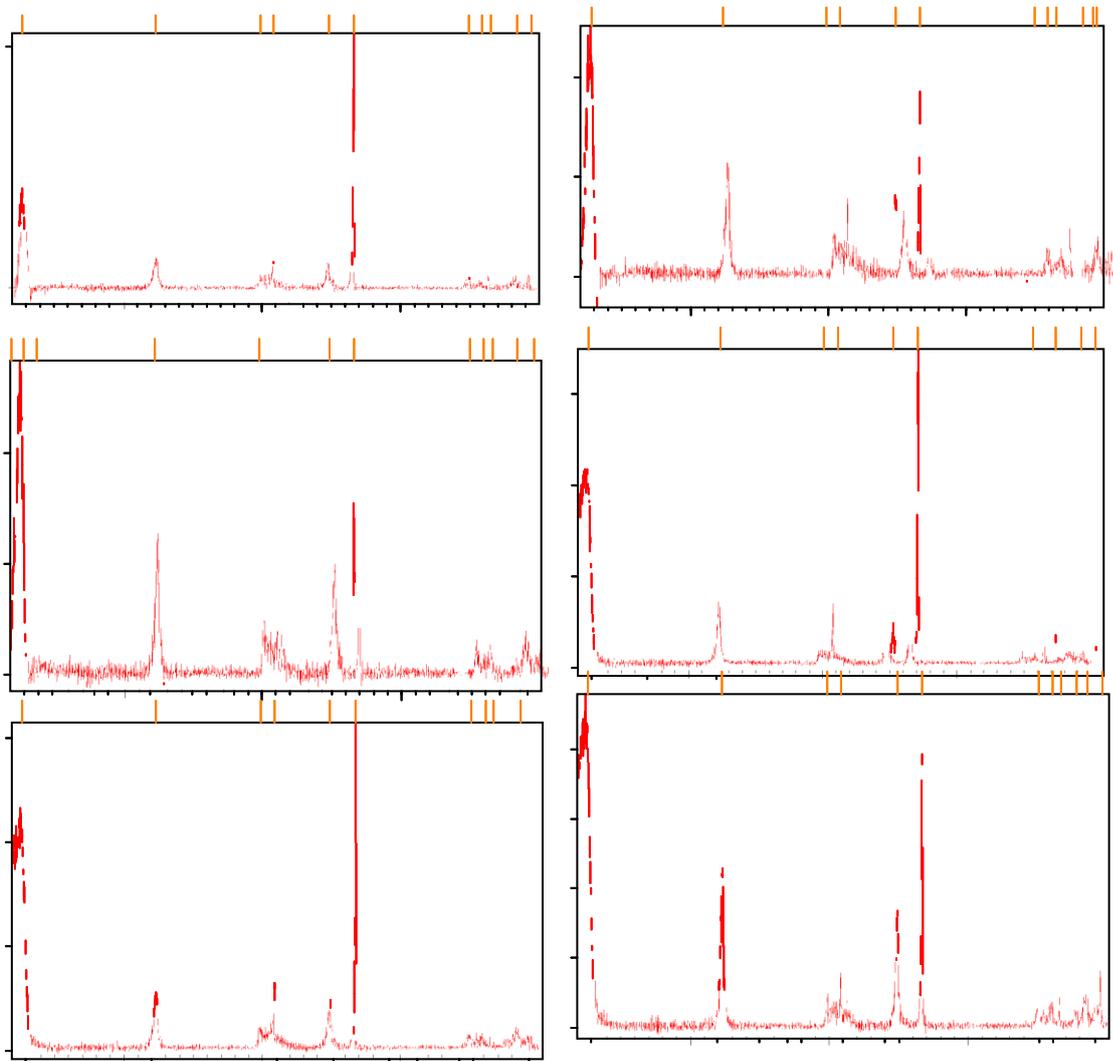


Fig.2 XRD diagrams for clays of Trivandrum and Kollam Districts of Kerala State.

4.DISCUSSION AND CONCLUSIONS

The results of qualitative analysis of the clay minerals in the Tertiary formation around Trivandrum and Kollam Districts of Kerala State district are given in the table.1. Kaolinite, is the dominant clay minerals followed by Muscovite.

Bahl (1964) studied the sedimentary clay beds within the upper Gondwana (Jabalpur series) in the Jabalpur area of the Satpura basin and observed that the clay fractions are essentially kaolinite together with traces of Montmorillonite and illite. The kaolinite is originated from the weathering of crystalline rocks in the source area and deposited in a freshwater of the basin. Kaolinite is possibly derived from pre-existing igneous rocks (Granitic rocks) as a product of weathering in acidic environment (Das et.al, 1998).

Kaolinite is considered to be abundant in regions of intense weathering under tropical (low pH and warm temperature) conditions (Biscaye, 1965, Suraj, 1996). According to

Murray (1954) acidic to neutral pH conditions are more suitable for the formation of kaolinite. Presence of kaolinite is indicative of a continental or near shore environment of deposition (parhem,1966).

Kaolinite is the abundant mineral in the shales of Dupi Tila formation and primarily a weathering product of feldspars and other silicates produced in lower pH environments (Segali and Kuehl, 1992). A major proportion of Kaolinite owes its origin to weathering of granite and basic rocks. Presence of Kaolinite represents sub-aerial weathering for the sediments (Eslinger and Peaver, 1988) Chlorite is the notable clay mineral in the study area. Chlorite is favoured by an alkaline environment (Chaudhri and Grewal, 1988). The parent material from which chlorite is generated are metamorphosed schist of Precambrian age and sandstone, shale of Mesozoic-Cenozoic age (Roy et.al.2004a). Chlorite in soils is mostly inherited has primary mineral from metamorphic and igneous rocks, but it may form by the alteration of ferromagnesian mineral, particularly biotite. According to Brown and Ingram (1954) both Kaolinite and Montmorillonite decrease towards marine water. Muscovite

is highly resistant to weathering and destruction during transportation. A part of muscovite may be of diagenetic origin. Illite, under increased pressure and temperature attains a gradual approximation to the composition of muscovite (Millot, 1970, Chaudhri and Grewal, 1988).

From the above studies carried out, it can be concluded that the Tertiary clays of Trivandrum and Kollam Districts of Kerala State are dominated by Kaolinite originated by the weathering of crystalline, Granitic rocks prevailing warm, humid tropical conditions. Occurrence of Kaolinite and montmorillonite along with illite and chlorite indicates that the sedimentation probably took place off the marine basin under fluvial deltaic conditions.

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