

Geology, Mode of Occurrences and X-Ray Diffraction Studies of Cretaceous Phosphatic Nodules, Nambakuruchi Block of Tiruchirappalli District, Tamil Nadu, India

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ABSTRACT

The Cretaceous phosphatic deposits of Tiruchirappalli district Tamil Nadu is one of the critical exposers in the world. The present studies revealed that the geological set-up, mode of occurrence and mineralogical character based on X-Ray diffraction studies. The basement of the Cretaceous phosphatic deposits is Archean, which is overlain by the Upper Gondwana, followed by the Uttatur, Tiruchirappalli, Ariyalur, Niniyur, Cuddalore, and Alluvium. The phosphatic deposits consist of the Uttatur Group in Karai formation. The type of occurrence of the phosphate is in nodular form exposed on the land with Maruvattur Clay or Karai Shale showing badland topography. The size of nodules varies from sizes 2 to 5 cm width and 6 – 20 cm length with different shapes like circular, cylindrical, conical, rectangular, and elliptical. The surface colour is yellow to ferruginous. The XRD revealed that the CFA is the main phosphate mineral and calcite, quartz, montmorillonite, and hematite are the gangue minerals present in phosphatic nodules.

KEYWORDS: XRD, Cretaceous, Phosphatic Nodules, Mineralogy, Occurrence, Tamil Nadu.

INTRODUCTION

Cretaceous phosphorite deposit is one of the significant deposits in the world. The Uttatur group of the Cretaceous period in this district is one of the vital sources of rock phosphate in India. The average content of phosphorous in the Earth's crust to be 0.23% P₂O₅, Ronovand Yaroshevsky (1969). The onshore Cretaceous marine sedimentary sequence of the phosphatic nodules exposed in the Tiruchirappalli district of Tamil Nadu. The

mineralogy and composition depend on the types of origin, whether sedimentary or igneous. The origin of the sedimentary deposits is many sources. The phosphatic nodules in the Nambakuruchi are the part of the Cauvery basin of South India, which lies in the Uttatur group of the Karai formation. The phosphatic buds reported by Worth (1893). Numbers of the authors worked on the lithostratigraphy, biostratigraphy, paleoceanography, phosphatic nodules, flora, and fauna; V. P Rao (2002, 2007), Banerji et al.

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(1986), Sundram and Rao (1979), Rama Rao (1958), Blanford (1862). The purpose of this work is to describe the mineral composition and their mode of occurrence of phosphatic nodules in the Nambakuruchi block of Tiruchirappalli district Tamil Nadu India with the help of X-ray diffraction studies.

GEOLOGY OF THE STUDY AREA

The Nambakuruchi Varagupadi block of Tiruchirappalli district, Tamil Nadu India, is a part of the Cauvery basin that lies in the Southern part of India. The geographic location of the Nambakuruchi (Latitude $11^{\circ} 5' 30''$; Longitude $78^{\circ} 52' 15''$ and Varagupadi

(Latitude $11^{\circ} 8' 50''$, Longitude $78^{\circ} 54' 00''$). The study area of phosphatic nodules covers an area of about 27.52 Sq. kms. The most extensive exposure of Cretaceous rocks in Tamil Nadu has been found in Tiruchirappalli district, extending over 400 sq. km. The basement rock of the Cretaceous succession of the Cauvery basin is the Precambrian basement overlain by Uttatur, Tiruchirappalli, Ariyalur, and Niniyur groups. The phosphatic nodules have been marked in the Uttatur group of Nambakuruchi Varagupadi block of Tiruchirappalli district Tamil Nadu. The buds are generally white with calcareous encrustation.

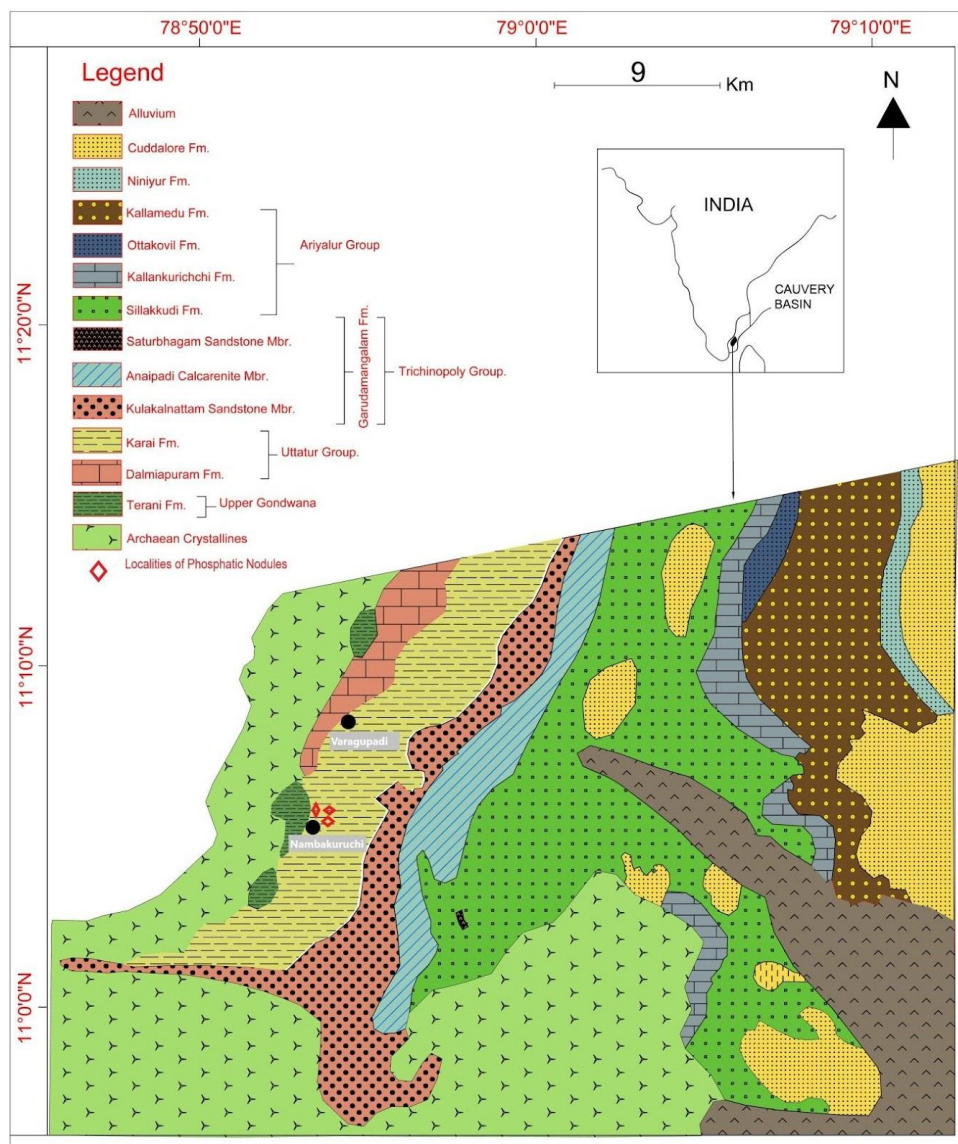


Figure 1: Geological Map of Nambakuruchi Varagupadi block of Tiruchirappalli district, Tamil Nadu India (After R. Nagendra et al, 2017).

The stratigraphic sequence of the Cauvery basin, the basement is Archean overlain by upper Gondwana, followed by Uttatur, Tiruchirappalli, Ariyalur, and Niniyur groups. The phosphatic nodules demarcate the Uttatur group of Karai formation. The Uttatur group consists of Arogyapuram, Dalmiapuram, Karai, and Maravattur formations. The Arogyapuram formation consists mainly of the conglomerate and medium to very coarse-grained sandstone. Lithologically, the Dalmiapuram formation contains grey shales, coral limestone, bedded limestone, pebble conglomerates, siltstones, and marls. The

uppermost Karai formation contains clays, silty clays, sandy clays, siltstones, sandstones, and occasionally phosphatic nodules and gypsum. The composition is further subdivided into two members, the lower odiyam and the Upper Kunnam members. The Odiyam member is argillaceous, composed of clay with abundant phosphatic nodules and gypsiferous mudstone, and occasionally intercalated with sandstone and siltstone. The Kunnam member is arenaceous, composed of silty to sand clay with dispersed phosphatic nodules, inter layered mudstone, siltstone, and fine grain sandstone.

Table 1: Lithostratigraphic classification of Cauvery Basin of Tiruchirappalli Tamil Nadu India, (Venkateshwarlu et al., 2016)

Period	Epoch	Group	Formation	Member	Age
Cretaceous	Upper	Ariyalur	Kallamedu	Kallamedu Sandstone	Maastrichtian
			Ottakkovil	Ottakkovil Sandstone	
			Kallankurichchi	Kallankurichchi Limestone	
			Sillakkudi	Sillakkudi Sandstone	Campanian
		Tiruchirappalli	Saturbugam	Saturbugam Sandstone	Santonian
			Anaipadi	Anaipadi Sandstone	
			Garudamangalam	Kulakkalnattam Sandstone	Coniacian
		Uttatur	Karai (Phosphatic nodules)	Karai Shale/ Maruvattur Clay	Turonian
					Cenomanian
					Albian
			Dalmiapuram	Kallakkudi Limestone	Aptian
			Arogyapuram	Gray Shale	
		Upper Gondwana	Terani	Terani Beds	Neocomian
	Boulder Conglomerate				
Precambrian			Basement		

MATERIAL AND METHODS

The samples were collected from the Nambakuruchi block of Karai Formation, Uttatur Group Tiruchirappalli Tamil Nadu (fig.1). The sampling was carried out in different locations with different shapes and sizes. The representative samples were used for XRD studies. The phosphatic nodules were cut in two halves; one part was used for X-ray diffraction. The powder scanned from 3° to 60° 2θ at 0.5° 1/min, using nickel filtered Cu Kα radiation at the department of Mechanical Engineering AMU Aligarh. The X-ray

diffraction data have identified by 2θ to d values tables of the National Bureau of Standards, ten series of US Department of Commerce, and also the uses JCPDS cards and Match3 for the identification of minerals.

RESULTS AND DISCUSSION

Mode of Occurrence

The most substantial exposure of the Cretaceous rock in Tamil Nadu state has been found in Tiruchirappalli district. The Uttatur group of the Cretaceous period in this district is one of the essential sources of rock

phosphate in India. The Cretaceous system here has been divided into four groups viz., Uttatur, Tiruchirappalli, Ariyalur, and Niniyur, based on the lithological, faunal, and stratigraphic characteristics (Gonindan et al., 1998). The Cretaceous belt of the Tiruchirappalli district has revealed that the occurrences of phosphatic nodules are mostly confined to the lower and the middle sub-stages of the Uttatur stage. The smaller and middle sub-stages of the Uttatur stage predominantly consists of gypsiferous, fossiliferous clays, faint greenish blue to brown in colour, with some intercalations of thin sandy, fossiliferous limestones and a few tiny bands of sandstones. The clays assume buff to brown colour on weathering. The clays show weak signs of bedding, and the sandstones in places are red in color. The clays generally contain thin veins of gypsum besides some veinlets of calcite and barite, and phosphatic nodules are sporadically distributed in clay. Towards the base of the lower substage of the Uttatur coralline limestones is orient in places viz., in the vicinity of Tiruppattur, Moykulam, Uttatur, Karai, Varagupadi, Kalpadi, and Maruvattur.

The Uttatur stage extends over an area of about 153 sq. kms. (60 sq. miles) and is exposed along a belt trending roughly NE -SW of approximately 25.76 kms. (13 miles) between Uttatur village on the south and Chitalai village on the north, overlapped by the Tiruchirappalli stage on the east and flanked on the west by the Archaeans comprising the gneisses and charnockites by the Upper Gondwana. There is, however, a tongue-like extension of the belt at the southern end extending eastward for about 3.05 kms. (5 miles). The belt is broadest between Karai and Kulakkalnattam, where, it is approximately 3.05 kms. (5 miles) wide. Away from this, the belt gradually narrows down along the northern and the southern extensions and clones down between the Tiruchirappalli stage and the Archaeans. The occurrences of phosphatic nodules have been found mostly confined to an area extending between Nambakuruchi village on the south and Varagupadi village on the north, covering parts of Nambakuruchi, Uttatur, Varagupadi area (Blanford 1862, Rao et al. 2002 and R. Nagendra et al. 2016).

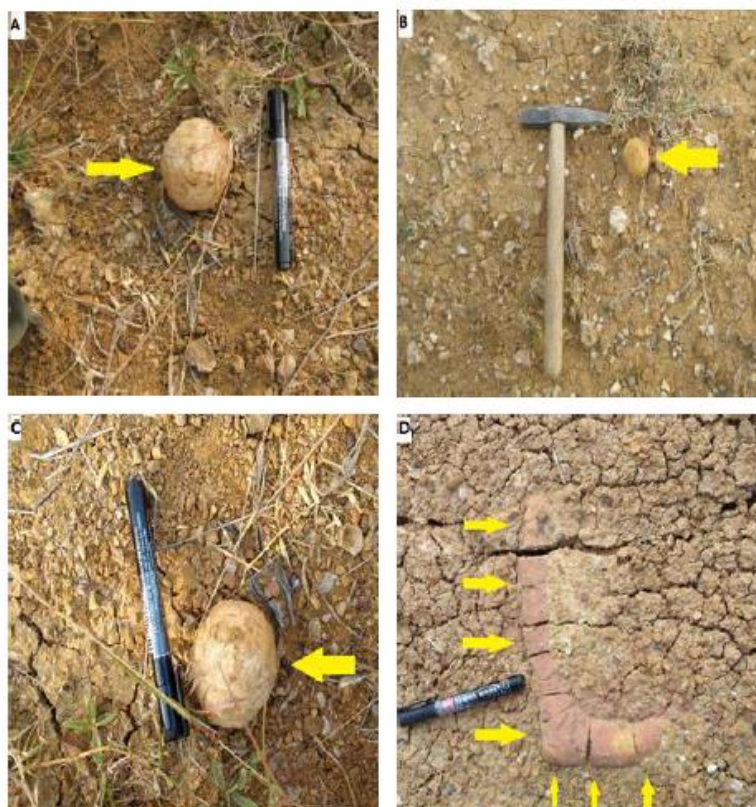


Figure 2: Mode of occurrence of Phosphatic Nodules of the Nambakuruchi block of Tirichinapalli district, Tamil Nadu India.

The phosphatic nodules are a sedimentary rock which occurs in the nodular form of various shapes and sizes. Mostly in size, the buds vary in length from 6 cm to 20 cm and are 2 cm to 5 cm larger and smaller sizes are occasionally present. They are generally

encased in a chalky shell rich in calcium carbonate, or they bear encrustation of ferruginous and calcareous matter. The nodules are hard, and when broken reveal a deep brown to a dark amorphous interior with cracks traversed by veins (Figure 3).

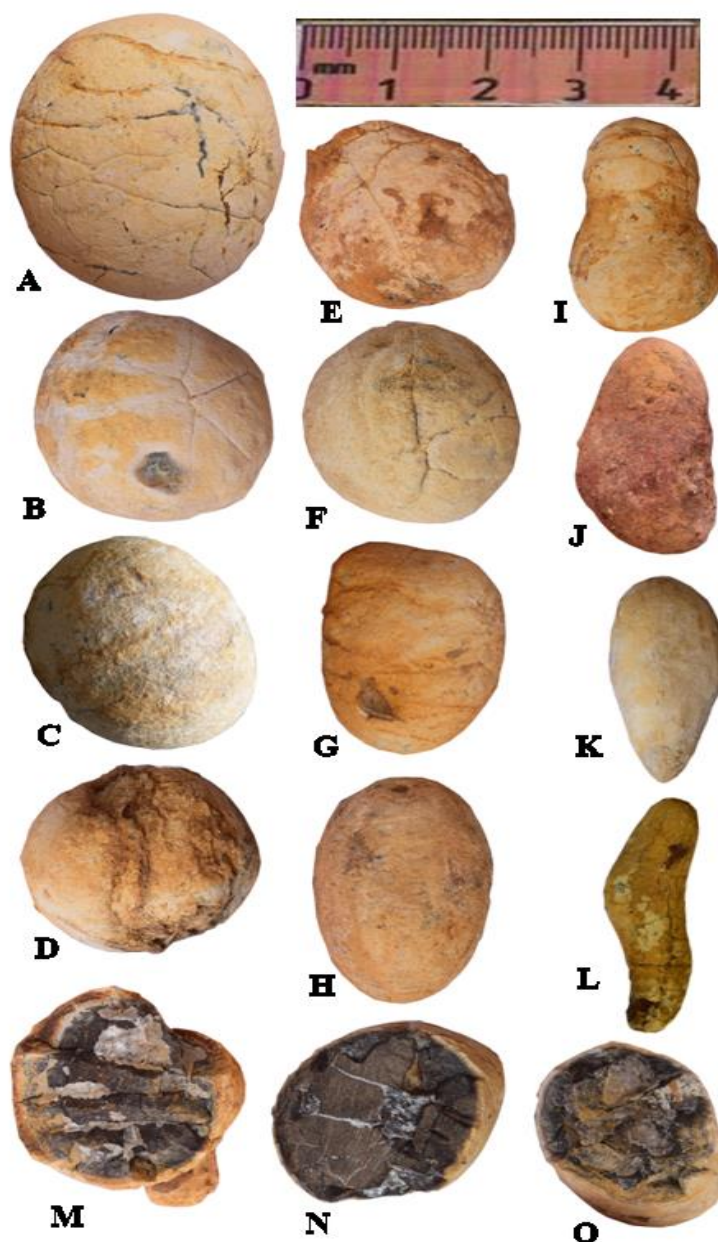


Figure 3: Sample photograph of the Hand Specimens of Phosphatic Nodules of Nambakuruchi block of Tiruchirappalli district, Tamil Nadu India (A – L) shape and size variation, (M – O) contact veins.

Mineralogy

The phosphatic nodules of the Nambakuruchi are different shapes and sizes, and the surface is yellow or white to reddish colors with different veins consist of crystal contact (figure 3). The X-ray diffraction studies revealed that the Carbonate Fluorapatite (CFA) is the major phosphate minerals in the nodules of

Nambakuruchi block of Tiruchirappalli district Tamil Nadu India and the secondary minerals like calcite, quartz, hematite and montmorillonite (Figure 4 NK-01, NK-02, NK-04, NK-06). Similar work has been reported by Rao et al. (2007).

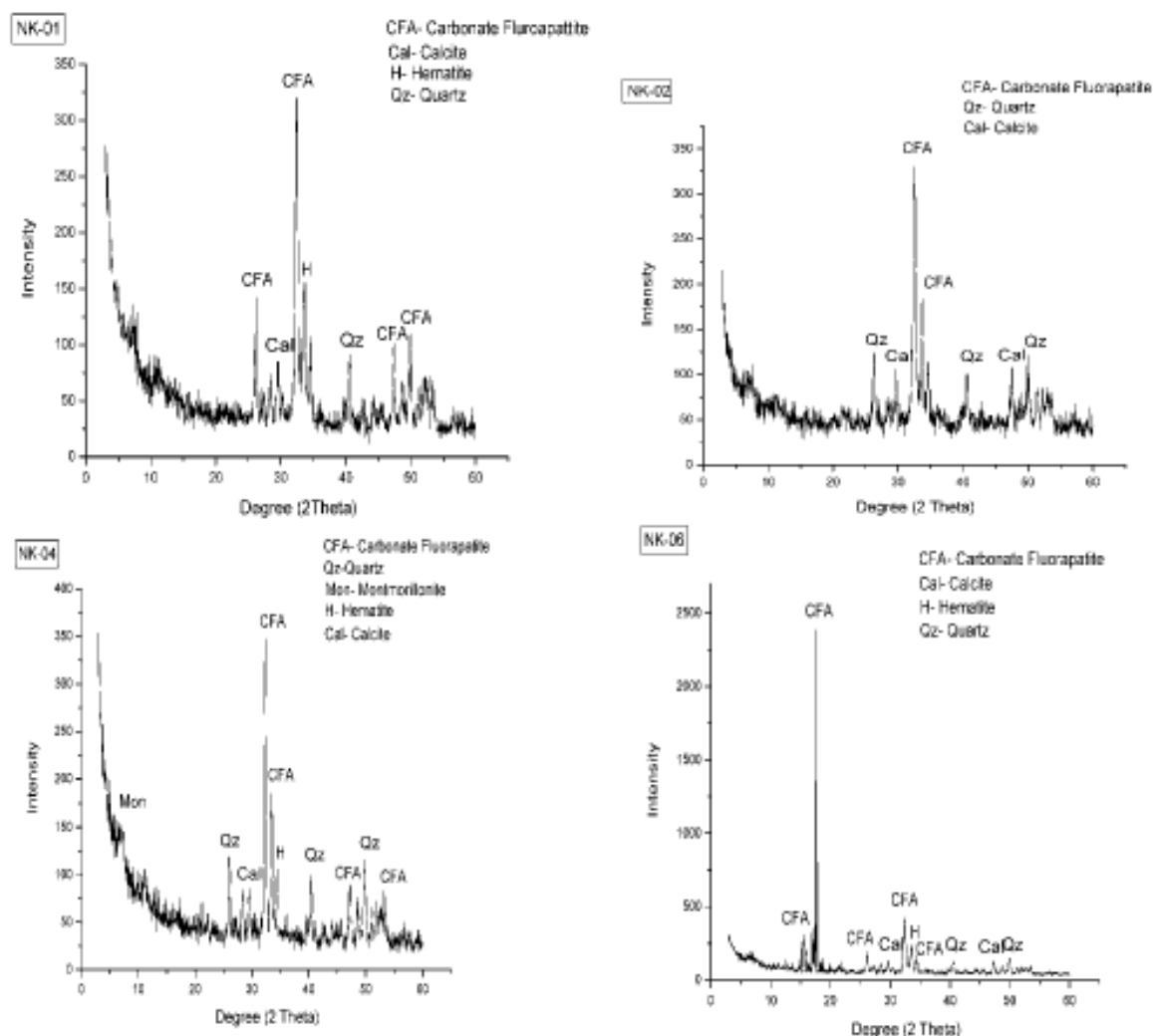


Figure 4: X-ray diffraction (XRD) pattern show the CFA (Carbonate Fluorapatite), Qz (Quartz), Cal (Calcite), H (Hematite), Mon (Montmorillonite).

CONCLUSION

The Cretaceous phosphatic deposits Nambakuruchi block of Karai formation, Tiruchirappalli Tamil Nadu shows in the

nodular form on badland topography. These nodules are associated with Karai Shale having different shapes and sizes. The X-ray diffraction studies refer to the mineralogical constituents of phosphate is carbonate

fluorapatite as a significant and calcite, quartz, hematite and montmorillonite as gangue constituents.

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