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LITHOSTRATIGRAPHY, STRUCTURE AND SEDIMENTATION OF THE KUTI SHALE (FORMATION) OF THE TETHYAN SEQUENCE IN PARTS OF MALLA JOHAR REGION KUMAUN, HIMALAYA

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ABSTRACT

The paper incorporates an account of the Kuti shale (Formation) as studied during an expedition to the Tethys Himalaya of the Milam—Topidhunga—Lapthal section in the Malla Johar region of the Kumaun Himalaya. Here, the Kuti Formation, which is prominently exposed in the Unta Dhura-Jandi Dhura Pass, conformably overlies the Kalapani Limestone and underlies the Passage Formation. The upper half of the Kuti is folded into an ESE-WNW trending open anticline and a corresponding open syncline. This formation is dominantly argillaceous and shows the development of two prominent members—a lower with grey micaceous shale with some biomicrite flags, and an upper, constituted mainly of biomicrite, biocalcarenite and intraclast, together with some shale. Fossils are distributed throughout the formation and include those of ammonites, brachiopods, corals and bryozoans. Record of bryozoans and corals from the Kuti Formation, is being made for the first time.

The Kuti Formation appears to have been deposited under normal marine conditions. The environmental framework might have witnessed shelf mud conditions in the beginning, but in the later part, it witnessed transition to subtidal conditions. The basin was characterised by marked subsidence to accumulate a rather huge pile of sediments (approx. 500 metres) in a relatively very short span of time (Noric), i.e., about 4 to 5 m. y.

INTRODUCTION

The paper incorporates an account of the Kuti Shale as studied during an expedition (June-July, 1977) to the Tethys Himalaya of the Milam-Lapthal section in the Malla Johar region of Kumaun Himalaya. This section, though highly hazardous and quite uninviting, unravels good exposures of the mighty pile of Tethyan sequence. The Kuti Shale unit, as prominently exposed in the Unta Dhura-Jandi Dhura Pass along the Indo-Tibetan border, constitutes the subject matter for the present paper.

The area exposing the Kuti Shale, as studied here, falls in the northwestern Pithoragarh District and parts of the northwestern Chamoli District of Uttar Pradesh. From the Tanakpur rail-head, the area is approached, first up to Mansiari through Pithoragarh, by road, and then from Mansiari by mule or bridle path.

Excepting the work of G. Kumar, *et al.*, (1972), no other geological information is available for this section. However, in some other selected sections of the Tethys Himalaya, some work is available, as mentioned below.

Strachey (1851) was the first to present a geological account of the Malla Johar area. Later on, Griesbach (1891) mapped parts of Malla Johar and Spiti areas and established a detailed stratigraphy for the Tethyan sequence. It was followed by the work of von Krafft (1902) on the 'Exotic Blocks' of Malla Johar.

In the wake of the above, come the work of Heim and Gansser (1939) in Central Himalaya extending from Malla Johar to the Kali river. Later on, Gansser (1964) reviewed the general stratigraphy of the Tethyan sequence and provided a nomenclature for the constituting rock units. Aspects of biostratigraphy were studied by Valdiya, *et al.*, (1971) and Valdiya and Gupta (1972) in the Kali and Kuti valleys. S. Kumar, *et al.*, (1977) studied lithostratigraphy, structure, depositional environment and trace fossils in the Sumna-Lapthal section, falling mostly in north-eastern Garhwal region.

GEOLOGICAL AND STRATIGRAPHIC SETTING

In the section studied, the mighty pile of the Tethyan sediments physically overlie the Central Crystalline Zone of the Greater Himalaya. The former and the latter constitute two prominent but separate lithotectonic-physiographic subdivisions of the Kumaun Himalaya. According to the classical view of Heim and Gansser (1939), the contact of the Tethys sequence with the Central Crystalline Zone is unconformable, and marked by the presence of the Ralam conglomerate unit. However, the present author is of the opinion that the contact of these two lithotectonic subdivisions is faulted—marked by the Martoli Fault—as distinctly seen along the Lhaspa Nala, south of the Martoli village. Similar opinion was also put forward by G. Kumar, *et al.*, (1972), for the Dar area and by S. Kumar *et al.*, (1978) for the Sumna area, both in the adjoining Garhwal Himalaya.

The well established stratigraphic classification of the Tethys sequence, as proposed by Heim and Gansser

(1939), has, in general, been followed in the paper. The only major difference, however, is that a definite status of "Formation" has been given to each constituting rock-unit, instead of the classical "Series", in accordance with the Code of Stratigraphic Nomenclature in India (1977) and the International Stratigraphic Guide (Hedberg, 1976). A similar suggestion has also recently been made by S. Kumar, *et al.*, (1977) for the adjoining Sumna—Lapthal section, where they have proposed a Malla Johar Supergroup for the entire Tethyan sequence. In the Milam-Topidhunga-Lapthal section, as studied in this paper, due to structural complications, the Tethys sequence is disturbed. For example, due to the presence of faults, the Ralam and Garbyang are repeated twice and the chocolate Formation is missing between the Kuling and the Kalapani units. The stratigraphy for this section has been summarised in Table 1.

The Kuti Shale, redesignated here as the Kuti Formation, is constituted of an argillaceous assemblage of rocks. The outcrops are typically exposed along the highest ridge of the area, i.e., Unta Dhura-Jandi Dhura, rising up to 19,000 ft. and also along its slope up to the gorgeous Girthi Ganga.

Table 1. Stratigraphy of the Tethys sequence in the Milam-Topidhung-Lapthal Section, Kumaun Himalaya

North		
	Giumal Formation	
	Spiti Formation	
	Lapthal Formation	
T	Kioto Formation	
E	Passage Formation	
T	Kuti Formation	
H	Kalapani Formation	
Y	——Fault——	(Chocolate Fm. concealed due to fault)
S		
	Kuling Formation	
Z	Muth Formation	
O	Variegated Formation	
N	Shiala Formation	
E	——Fault——	
	Garbyang Formation	
	Ralam Formation	
	——Fault——	
	Martoli Formation	
	——Fault——	
CENTRAL CRYSTALLINE ZONE		
South		

STRUCTURAL SETTING

In the area under study, the Kuti Formation conformably overlies the Kalapani Formation and is again conformably overlain by the Passage Formation. The strata of the Kuti unit have been prominently folded (Fig. 1) into an open anticline on an ESE-WNW axis passing along the Girthi Ganga, designated here as the *Girthi Ganga Anticline*. The northern beds show dip of 20° NE, while the southern beds dip 15°-20° S/SSW. Corresponding to this, the strata show, further to the south, an open syncline around Topidhunga, designated here as the *Tonidhunga Syncline*. The strata around Topidhunga which constitute the upper part of the Kuti Formation, show marked deformation on local scale—development of open, upright as well as isoclinal folds being more common. The axes of all such local folds trend ESE—WNW. At places, development of shear planes, dipping 20°-30° S/SSW, is also noticed.

The lower part of the Kuti Formation, on the other hand, practically remains underformed and shows a consistent dip of 30°-40° NNE. The constituent strata also do not show much crumpling, corrugation or flexures.

The available data on the fold axes show a general N/NNE—S/SSW trend for the compressional forces, which were later on released along some selected direction (S/SSW) to give rise to the development of shear planes

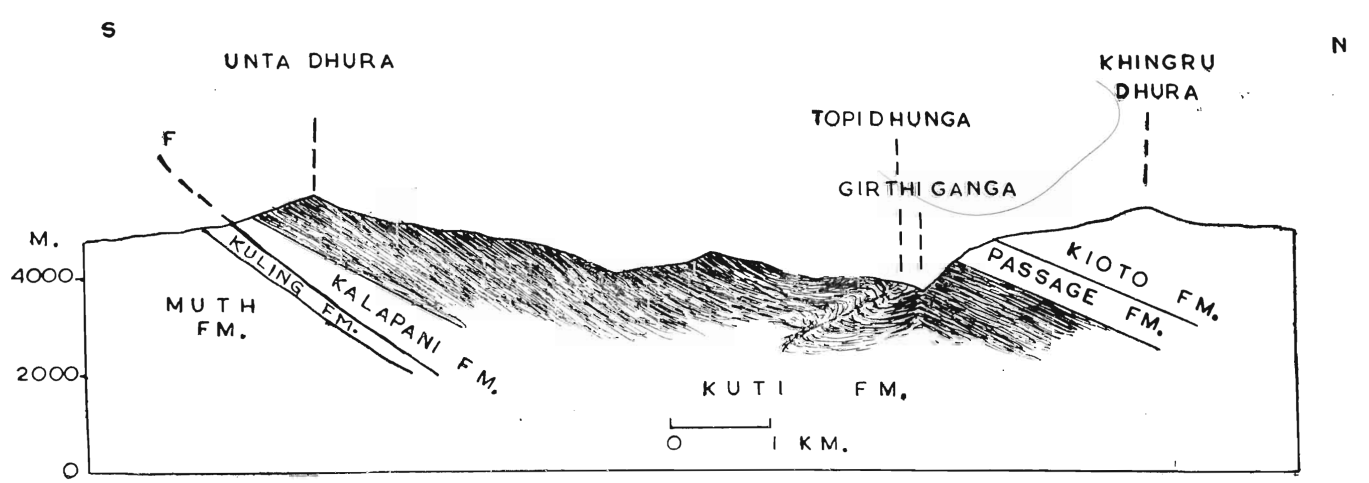

Fig. 1. Section across the Kuti Formation to show its structure.

within the Kuti domain of deformation. Further, the marked absence of recumbent/reclined folds of any scale, as well as complete absence or involvement of such folds in the meso and other small folds, indicate that horizontal translation, as a mode of deformation, did not take place during the tectonic deformation of the Kuti Formation.

It thus appears that the Kuti strata (of course, together with other Tethyan units) were first subjected to an epeirogenic movement which first caused the filling and upheaval of the sedimentary pile, and later on, were deformed in response to the Himalayan orogeny. Now, since the Kuti shows conformable relation with the overlying Passage Formation and, likewise all the topmost formations, viz., Kioto, Lapthal, Spiti and Giumal, show conformable relation with respect to each other, indicating thereby a normal and continuous sedimentation in the Tethys sea, it is, therefore, suggested that at least one epeirogeny affected the Tethys palaeotectonic domain during or after the Cretaceous.

LITHOSTRATIGRAPHY

The Kuti Formation is dominantly an argillaceous rock unit. The major constituent rock type is micaceous shale of grey, greyish black and olive grey colours, together with limestone interbeds. The shale and limestone beds contain ammonites, gastropods, lamellibranchs, brachipods, corals and bryozoans. The thickness of this formation in the section studied is about 500 metres, and, on the basis of lithology, has been divided informally into two members—a lower and an upper (Fig. 2).

LOWER KUTI

This member is about 300 metres thick and is characterised by its typical argillaceous content alongwith some intercalation of limestone flags. Grey micaceous shale is the dominant rock type, showing regular and prominent layering for several metres without any marked disruption. It is usually friable and sometimes shows rhythmic alternation with thin, but relatively hard, calcareous shale and biomicrite. Individual shale laminae are up to 5 mm thick. Locally, the development of brown shale as well as black shale is noticed. Primary sedimentary strucstructures are rare and include, besides parallel bedding, faintly developed ripples in some of the shale beds. Fossils are usually confined to shales only and include those of bryozoans, ammonites and brachiopods.

UPPER KUTI

This member is about 200 metres thick and is characterised by the dominance of calcareous content over the argillaceous. The former is represented by biomicrite, biointraclast, micrite and intraclast. These rocks are quite hard as compared to the shales which are rather subordinate in this member and occur as interbeds of

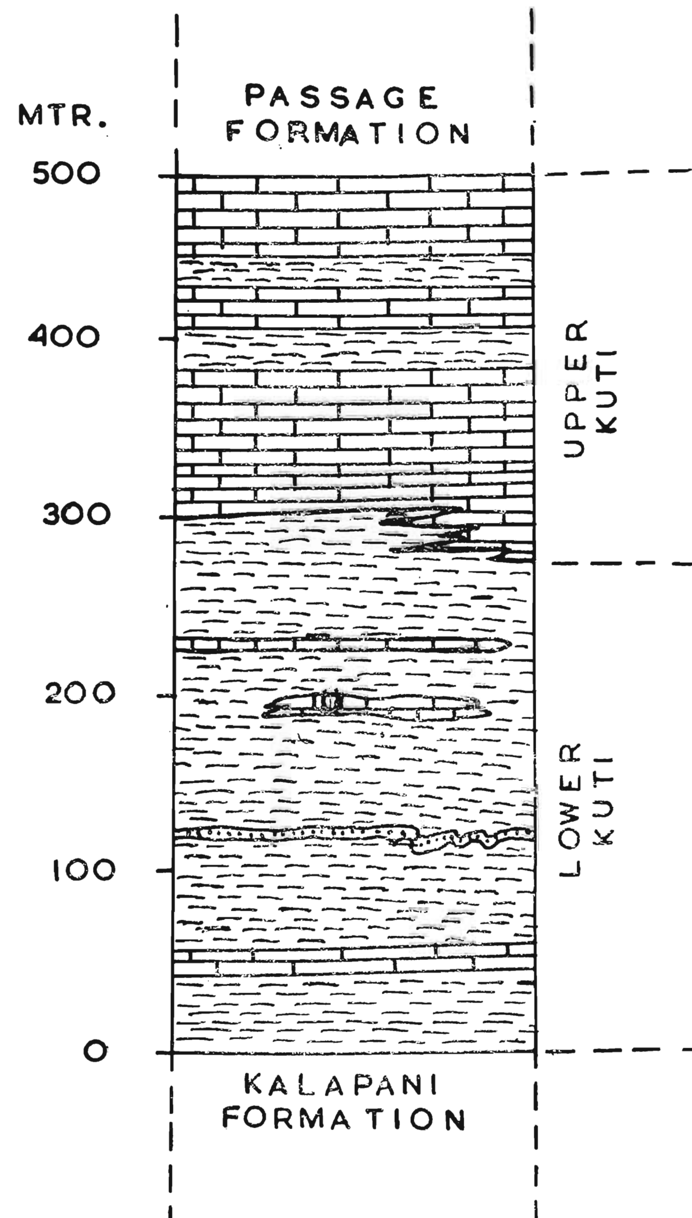

Fig. 2. Litholog of the Kuti Formation showing the two constituent members: Lower Kuti Member (typically argillaceous with some limestone flags) and Upper Kuti Member (showing the dominance of calcareous content over the argillaceous).

5-10 metres thick. Individual limestone beds are 1-75 cm thick, while those of shale are up to 5 mm thick. At places, shaly limestone and silty shale are quite common. Rhythmic alternation of limestone and shale within a maximum thickness of one metre is also occasionally noticed. Bedding features are not much prominent and regular in contrast to those of the Lower Kuti. Fossils are seen in both the limestone and shale beds and include those of ammonites, corals, bryozoans and palecypods.

On the basis of the fossil assemblage, Heim and Gansser (1939) and Gansser (1964) have assigned a

Noric age for the Kuti unit. Since, the palaeontological aspects have not been studied here, the Noric age has been directly accepted in the paper. However, the bryozoans and corals are being recorded from the Kuti Formation for the first time.

The Kuti Formation, in the section studied, shows only two prominent lithological sub-divisions (members) —a lower argillaceous and an upper calc-argillaceous. However, in the Sumna-Lapthal section, further west in Garhwal, where this formation is almost equally thick, S. Kumar, *et al.*, (1977) have distinguished three members, viz., a lower Kuti A (black friable shale and shaly limestone), a middle Kuti B (greyish black friable shale with hard calcareous shale) and an upper Kuti C (silty shale and sandy limestone). Apparently, this is an interesting case of facies change, i.e., while the Kuti sedimentation, during its later part, was witnessing a high energy arenaceous facies in the western part of the Malla Johar region, it was witnessing a relatively low energy calcareous facies in the eastern part of the region.

ENVIRONMENTAL AND TECTONIC CONTROL OF SEDIMENTATION

Before discussing the environmental and tectonic control of sedimentation, it is necessary to first investigate some relevant features of the Kuti Formation in the present area.

The thickness of the Kuti Formation is about 500 metres. In general, it shows a persistence of individual lithotypes as well as the litho-assemblages (i.e. shale-limestone). Further, parallel bedding and lamination are prominently marked. Individual layers of shale are very thin—only up to 5 mm in thickness—but this nature of layering is remarkably very regular and quite persistent laterally. Limestone interbeds, or flags, though rare in the lower part, are typically represented by fine, but uniformly textured, micrite and biomicrite and, further, such beds are also, in general, thin. Rhythmic alternation of shale-limestone beds, both of thin nature, is occasionally present in both lower and upper members. The upper member, however, is dominated by limestones which are relatively thickly bedded and are quite uniform and persistent in their lithology. Fossils—as represented by various forms of ammonites, brachiopods, corals, bryozoans and palecypods—are distributed throughout the formation and become abundant at places.

On the basis of above mentioned features, it may, therefore, be said that the Kuti Formation is the product of normal marine conditions. The environmental framework might have witnessed shelf mud conditions in the beginning, but in the remaining later part it witnessed transitional to subtidal conditions. In other words, while relatively deeper water conditions prevailed during the first part, the basin appears to have become relatively shallower in the later part. Apparently, the basin initially witnessed relatively slow subsidence in response to vertical variability in negative basin tectonism which has controlled both the lithology and fauna. Thus, mildly unstable shelf conditions might have prevailed in the first part of the basinal history with continuous supply of fine detritus interrupted by intrabasinal chemical sedimentation. However, tectonic stability was restored, to some extent, in the later part of basinal history giving rise to the development of the chemical realm, though interrupted by frequent supply of fine detritus. That is why we find two major lithotopes in this formation. Further, deposition of a rather huge pile of some 500 metres sediments in a relatively very short time span (Noric) of about 4 to 5 million years only, (See Kummel, 1968), clearly implies that the depocentre was in a state of rapid subsidence to accumulate such a massive pile. Consequently, the source area or the surrounding positive area might have been mildly epeirogenic in its tectonic behaviour.

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