

# A REAPPRAISAL OF THE STRATIGRAPHIC POSITION OF THE AGASTMUNI FORMATION, GARHWAL HIMALAYA, UTTARANCHAL

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## ABSTRACT

Stratigraphic position of Agastmuni Formation exposed in the Mandakini valley, Garhwal Himalaya, is reappraised. Present studies reveal that Agastmuni Formation forms the lowermost part of Garhwal Group. It has a tectonic contact with the rocks of Central Crystalline Group exposed in the northern part of the area. Agastmuni Formation is a tectonised, granitised and metamorphosed sequence of pelitic, arenaceous and calcareous rocks and has undergone both acid and basic magmatism. Three phases of deformation are inferred on the basis of deformational structures. This unit occupies the core of an isoclinal anticline related with  $F_1$  phase of deformation and is flanked by quartzo - volcanic sequence of the Rudrapryag Formation. The core of the anticline is imtruded by a granitic body named as Kharpatiyakhali Granite. Polymictic pebbly bed occurring at the contact zone of Agastmuni and Rudrapryag formations is repeated in both the limbs of the anticline. The gneissic bodies occurring within Agastmuni Formation may be the product of alkali metasomatism of metasedimentaries.

**Key words:** Agastmuni Formation, Isoclinal anticline, Mandakini valley, Uttaranchal.

## INTRODUCTION

The Agastmuni Formation exposed in Mandakini valley in Chamoli and Tehri districts, Uttarnchal has a very controversial stratigraphic position in the geological set-up of Garhwal Himalaya. Lithologically, it is lowgrade metamorphic sequence of pelitic, semipelitic, psammitic and calcareous rocks, which have profusely witnessed both acid and basic magmatism. These litho units were included in both Central Crystalline and Garhwal groups by different workers over a period.

In this area, Tiwari and Setti (1959) took traverses in Mandakini and Alaknanda valleys and proposed a generalized tectonic sequence. Subsequently, the rocks of Mandakini valley were studied by Phukan (1972), Chakravarti and Das (1974), Sinha and Das (1975), Dungarkoti *et al.* (1976), Rao and Das (1976), Dungarkoti

and Raina (1977), Rao (1979), Agarwal and Kumar (1980), Safaya and Lahiri (1981).

Phukan classified the rocks of the area into Garhwal Group in the south and Central Crystallines in the north and located Main Central Thrust (MCT) near Bogwa in Mandakini valley; Chakravarti and Das marked the MCT near Tilwara in Mandakini valley; Sinha and Das marked the MCT near Tilwara and placed the schistose rocks occurring north of MCT in Central Crystalline Group; Dungarkoti, Raina and Das classified the rocks into Central Himalayan Crystalline Group and Deoban Group, they marked the position of MCT between Kund and Guptakashi and considered Agastmuni Formation as lower part of Deoban Group; Rao and Das considered Agastmuni Formation as lower part of Garhwal Group, having faulted contact with Rudrapryag Formation and gradational contact with

Ghansyali Formation; Dungrakoti and Raina classified the rocks into Rudrapryag Formation towards eastern part and schistose rocks occurring north of Tilwara as Agastmuni Formation in Mandakini valley; Rao opined that Agastmuni Formation is the lower part of Garhwal Group and probably represents the lower limit of Garhwal Group; Safaya and Lahiri clubbed the rocks into quartzite-volcanic association, meta-argillite and gneisses with subordinate schist. Later, Agarwal and Kumar opined that Agastmuni Formation may either represent the basement of Garhwal Group or it is more metamorphosed, granitised and tectonised equivalent of Uttarkashi Formation.

In view of the controversial and debatable stratigraphic status of Agastmuni Formation detailed lithological as well as structural studies

were conducted in between Rudrapryag – Mohankhal and Rudrapryag – Agastmuni areas in Mandakini and Alaknanda valleys to establish the stratigraphic position of this Formation. On the basis of the studies carried out during the field investigations, the following stratigraphic set up of this formation has been established (Table 1).

### Central Crystalline Group

Central Crystalline Group comprising garnetiferous mica schist, augen gneiss/porphyroblastic gneiss and streaky biotite gneiss with bands of quartzite and marble of Guptakashi Formation, are exposed north of Kundchatti. It has tectonic contact with underlying Agastmuni Formation. The contact zone shows marked pulverization and mylonitisation.

**Table 1: Stratigraphic position of the Agastmuni Formation**

Group	Formation	Lithology
		Basic Intrusives; Amphibolite / epidiorite and dolerite Acid Intrusives; leucocratic granite, medium to coarse grained occasionally porphyritic grey granite (Chirpatiyakhal/Kharpatiyakhal Granite)
Lameri Formation		Stromatolite bearing dolomitic limestone, black shale and splintery shale
Rudrapryag Formation		Coarse to fine grained, white to ferruginous quartzite with penicontemporaneous basic volcanic and partings of quartz mica schist, talc schist and polymictic pebbly bed at base
Garhwal Group	Agastmuni Formation	Greyish white, gritty, coarse to fine grained schistose arenite and mica schist and associated metabasic volcanics Quartz mica schist, sericite schist, chlorite schist with associated meta basic volcanic and bands/lenses of crystalline limestone. Porphyroblastic and augen gneiss with partings of quartz mica schist
Central Crystalline Group	Guptakashi Formation	Augen gneiss, streaky biotite gneiss, garnetiferous mica schist and interbands of quartzite and marble

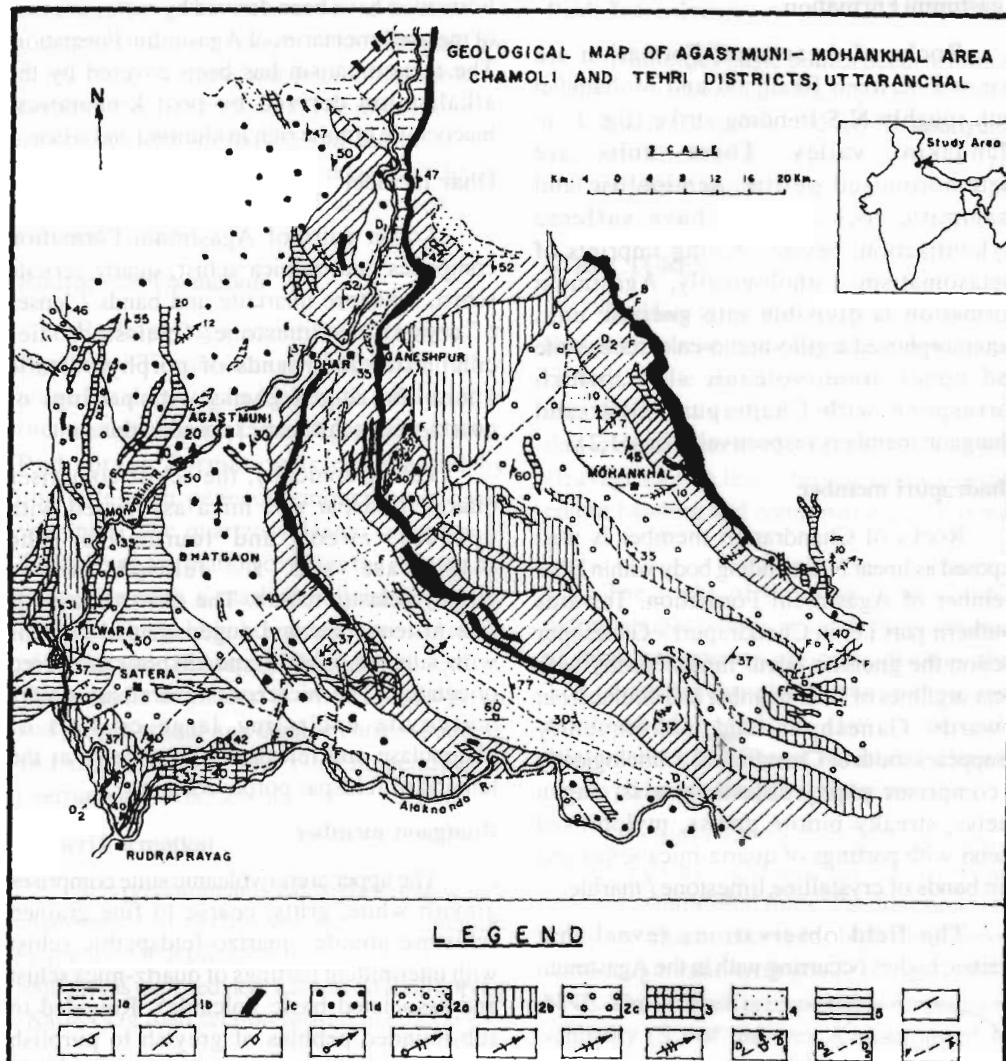


Fig. 1. 1a to 1d : Agastmuni Formation : 1a-Porphyroblastic and augengneiss with partings of quartz-mica schist; 1b-Sericite schist/chlorite schist and schistose quartzite with associated basic volcanics; 1c-Bands/lenses of crystalline limestone; 1d - Gritty; coarse to fine grained schistose arenite and quartzofeldspathic schist with basic volcanics; 2a to 2c: Rudraprayag Formation : 2a-Polyimictic pebbly bed; 2b- Coarse to fine grained ferruginous quartzite; 2c- Basic volcanics; 3 : Lameri Formation : Stromatolite bearing dolomitic limestone, blacks and splintery shale; 4 : Chirpatiyakhal and Kharpatiyakhal Granite; 5 : Amphibolite/epidiorite and dolerite.

Stratification ( $S_0$ ); Schistosity ( $S_1$ ); Fracture cleavage; Joint; Early lineation; Late lineation; Plunge of  $F_1$  fold, Plunge of  $F_2$  fold, Plunge of  $F_3$  fold. Axial trace of  $F_1$  fold; Axial trace of  $F_2$  fold; Fault.

### Agastmuni Formation

Rocks of Agastmuni Formation are exposed between Bhatgaon and Mohankhal with roughly N-S trending strike (fig. 1) in Mandakini valley. These units are metamorphosed pelitic, semipelitic and psammitic rocks, which have suffered mylonitization, besides having imprints of metasomatism. Lithologically, Agastmuni Formation is divisible into gneissic unit, metamorphosed argillo-arenalocalcereous suite and upper arenalocalcereous suite, which correspond with Chadrupuri, Dhar and Bhatgaon members respectively (figs. 1,2).

#### Chadrupuri member

Rocks of Chadrupuri member is well exposed as linear N-S trending body within Dhar member of Agastmuni Formation. Towards southern part i.e. in Chadrupuri - Ganeshpur section the gneisses occur intermittently with meta-argillites of Dhar member and diminish out towards Ganeshpur and subsequently disappears south of Chadrupuri. Lithologically it comprises porphyroblastic gneiss, augen gneiss, streaky biotite gneiss, mylonitised gneiss with partings of quartz-mica schist and thin bands of crystalline limestone / marble.

The field observations reveal that gneissic bodies occurring with in the Agastmuni

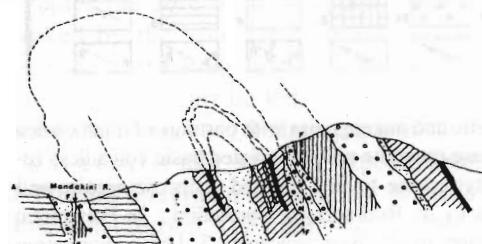


Fig. 2. Geological cross section of the Agastmuni area showing the structure of the Agastmuni Formation along the section line A-B shown in Fig.-1. Legend of litho units same as in Fig.-1.

Formation have been derived by metasomatism of metasedimentaries of Agastmuni Formation. The metasomatism has been covered by the alkalinisation derived by post kinematics leucocratic granite rich in alumina and silica.

#### Dhar member

Lower suite of Agastmuni Formation comprises quartz-mica schist, quartz-sericite schist, schistose quartzite and bands / lenses of crystalline limestone. Gneissic bodies comprising interbands of porphyroblastic gneiss and augen gneiss with partings of quartz-mica schist are exposed in this unit.

Petrographically, the schist comprises quartz, feldspar and mica associated with opaques, zircon and tourmaline. The plagioclase and K-feldspar shows porphyroclastic nature. The quartz occurs as fine to lenticular and augen shaped crystals with sutured margin and display preferred orientation. The micaceous minerals are mainly muscovite encircling large crystals of plagioclase and released silica occurs at the tail end of feldspar porphyroblast.

#### Bhatgaon member

The upper arenalocalcereous suite comprises greyish white, gritty, coarse to fine grained schistose arenite, quartzofeldspathic schist with intermittent partings of quartz-mica schist and associated basic volcanics. Rounded to sub-rounded pebbles of greyish to purplish quartzite embedded in quartzofeldspathic matrix occur occasionally with in this unit. The schistose arenite comprises parallel-arranged crystals of quartz and feldspar wrapped with fine layers of micaceous minerals.

Petrographically, the schistose arenite/quartzofeldspathic schist shows gneissic texture displayed by thin micaceous layers alternating with granoblastic quartz and feldspar. The opaques, zircon and tourmaline are common detrital constituents. The quartz

occurs as fine to lenticular augen shaped crystal displaying sutured margin. The feldspars are plagioclase, perthite and microcline showing porphyroclastic characters. The mica is mainly represented by muscovite but biotite is also common. The muscovite flakes encircle the feldspar porphyroblast and associated with released silica.

### Rudrapryag Formation

Rudrapryag Formation is exposed in Agastmuni-Tilwara section in Mandakini valley, around Rudrapryag in Alknanda valley and in the eastern part of the Agastmuni area. Rudrapryag Formation is represented by quartzite with penecontemporaneous basic volcanics. The quartzo-volcanic sequence of Rudrapryag Formation overlies the Agastmuni Formation with a marked polymictic pebbly horizon. The pebbly horizon is exposed south of Tilwara and in Managu-Mohankhal section. The quartzite in general is white to light green and grey in colour and display current bedding and ripple marks. The current bedding is overturned in Rudrapryag-Satera section.

### Lameri Formation

It is predominately calcareous unit, which conformably overlies the quartzo-volcanic sequence of Rudrapryag Formation. This sequence is exposed near Lameri on Rudrapryag-Karnpryag road section in Alknanda valley.

### Acid Intrusive

Two major acid igneous bodies namely; Chirpatiyakhal Granite and Kharpatiyakhal Granite are exposed in the area. The Chirpatiyakhal Granite is exposed in Lastar gad section. Kharpatiyakhal Granite intruded in the Agastmuni Formation, is exposed around Kharpatiyakhal. It is medium to coarse grained, occasionally porphyritic grey granite and younger leucogranite.

### Basic Intrusives

Numerous basic bodies occur within the rocks of Agastmuni and Rudrapryag formations as well as in Chirpatiyakhal and Kharpatiyakhal granites. These bodies mainly occur as dykes and sometime show branching pattern. These are doleritic to dioritic in composition.

### STRUCTURES

**Bedding ( $S_0$ )** is the only primary structure, besides current bedding and ripple marks present in the metasedimentary rocks of the area. It is mostly obliterated in schistose rocks due to development of a pervasive axial plane cleavage ( $S_1$ ). In less schistose rocks, alternate colour banding and compositional bands mark it.

The rocks of the area show complex deformational history. In small scale, structures of three generations are quite distinguished. The deformational sequence has been established based on the overprinting relationship of different structural elements observed in certain parts of the area.

Structures of the first deformation are represented by tight isoclinal ( $F_1$ ), reclined, rootless to intrafolial folds. The first generation folds are characterized by high amplitude to wave length ratio with gentle plunge in NE or NNE. The  $F_1$  phase is responsible for prominent schisosity ( $S_1$ ) of the area. Lineations of first generation ( $L_1$ ) are parallel to  $F_1$  fold axis.

Structures of the second deformation mainly include folds ( $F_2$ ) represented by open to tight asymmetrical synform and antiform. In majority of instances, these folds are class-1C fold of Ramsay (1967), with thickened hinges and thinned limb. In contrast to  $F_1$  folds, the  $F_2$  folds are mostly upright. The axis of minor  $F_2$  folds show considerable variation, it has a variable plunge towards NW or SE. The

crenulation cleavage ( $S_2$ ) is parallel to axial plane of second-generation fold. Generally, the  $F_2$  minor folds on  $S_1$  cleavage show the dominal fabric in which limb zone have become rich in mica and depleted in quartz in comparison to hinge region. Lineations of second generation ( $L_2$ ) are represented by puckers, which are developed parallel to the axis of  $F_2$  folds.

Structures of the third phase of deformation are less intense than the earlier two phases and represented by the open warps. A set of vertical fractures is formed associated with the  $F_3$  folds. Lineation of the third phase of deformation is represented by puckers, developed parallel to the axis of  $F_3$  fold.

### Megascopic structures

The metasedimentary sequence forming the Agastmuni and adjoining areas roughly extends in NNE-SSW to NW-SE direction. The map pattern showing the orientation of planar and linear structures give clue to deformation history of the area. The stratification and schistosity plane strike NNE-SSW in the northern part of the area, it become NW-SE in the south of Agastmuni. However, in the south of Tilwara it strikes in NE-SW direction.

The area forms the major part of an isoclinal anticline related to  $F_1$  phase of the deformation. The Agastmuni Formation occupies the core of an isoclinal anticline flanked by the younger quartzo-volcanic sequence of the Rudrapryag Formation. The pebbly bed occurring between the contact zone of Agastmuni and Rudrapryag formations acts as a marker unit, which is exposed south of Tilwara and again repeated in Managu-Mohankhal section. The southwestern limb of the anticline is overturned.

### DISCUSSION

Lithological and structural studies reveal that Agastmuni Formation forms the

lowermost part of Garhwal Group and occupies the core of an isoclinal anticline; flanked by the younger quartzo-volcanic association of Rudrapryag Formation. The contact zone between Agastmuni and Rudrapryag formations is marked by the pebbly horizon, which is repeated in both the limbs of the anticline. Agastmuni Formation has a tectonic relation with the rocks of Central Crystalline Group exposed in the upstream of Kundchatti in Mandakini valley. The area suffered three phases of deformation; the major structure i.e. isoclinal anticline related with  $F_1$  phase of deformation. The current bedding indicates that SW limb of the anticline is overturned and NE limb is right side-up.

Kharpatiyakhal Granite intruded in the core of an isoclinal anticline structure. The gneissic bodies occurring within the Agastmuni Formation have been formed by the metasomatism of the metasedimentaries of the Agastmuni Formation. The metasomatism have been covered by the alkalization derived from post kinematics' leucogranite rich in alumina and silica and might have migrated along the privileged path of foliation.

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