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A STUDY OF THE GRANITIC ROCKS OF THE ICHADAG AREA IN RANCHI PLATEAU IN EASTERN INDIA

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ABSTRACT

The Ichadag area forms the northern extremity of Ranchi plateau in the Chotanagpur region of eastern India and is dominated mainly by the Precambrian lithounits. It is represented by a vast expanse of granitic rocks with metasedimentaries and amphibolites occurring in close association. The Precambrian metamorphites and the associated granitic rocks of the region have been subjected to repeated tectonism and associated metamorphism.

The metasedimentaries in the area are the remnants of argillaceous, arenaceous and calcareous primary rock materials, which have been subjected to various phases of tectonism and metamorphism and they comprise of biotite schist, biotite- muscovite schist, phyllites, quartzites, calc- silicate rocks, crystalline limestone etc. The granitic rocks of the study area include granite gneisses, anatectic granites, migmatites, pegmatites and associated quartzo-felspathic veins. They differ widely in mineralogy, texture and field relationship.

The granite gneisses possess an alternations of lepidoblastic and granoblastic fabric, whereas nonfoliated granites are typically hypidiomorphic and crystalline in nature.

The granites of the Ichadag area are peraluminous, their silica percentage lies between 70 – 74% and CaO % is less than 3.7%. The geochemical study of these granitic rocks establishes their S-type lineage. There are enough indications that points towards the contribution of pelitic schists in generation of anatectic melt for the evolution of granitic rocks of the study area.

INTRODUCTION

The Ichadag area forms an important segment of the Chotanagpur Granite Gneissic Complex (CGGC), which bears the signature of the various tectonic, intrusive and metamorphic activities and is composed essentially of Precambrian rocks. The predominance of granite gneisses has imparted a more common nomenclature for this region as CGGC. The present area of study forms the northern segment of Ranchi plateau and is a depository of almost all representative lithounits of CGGC. The study area occupies the southeastern and southwestern sections of Survey of India Toposheet number 73 E/6 and 73 E/10 respectively. It is located at the boarder of Ranchi and Hazaribagh districts of Jharkhand. The area is almost rectangular in shape lying between the latitude 23^0 32' to 23^0 36" N and longitude 85^0 25" to 85^0 32' E.

The Ichadag area is a vast expanse of granitic rocks occurring in association with amphibolites and metasedimentaries. The granitic rocks are the type representatives of CGGC. In the present project, emphasis has been given to the problem of compositional variations in the granites and their petrogenesis.

GEOLOGICAL SETTING

The Geological investigation of the area reveals that the Ichadag area represents a highly metamorphosed and deformed terrain in the CGGC. The lithounits are composed of pelitic metasediments, confirmably interlayered belts of quartzites, and small isolated exposures of calcareous metamorphites, ambhibolites and different variants of granites. The granitic rocks and metamorphites constitute the bulk of the area. The granitic rocks include granite gneisses, grey and pink granites, pegmatites, migmatites and associated quartzo-felspathic veins. The various metamorphites are represented by biotite schists, biotite-muscovite schists, phyllites, calc silicates and crystalline limestones, quartzites and amphibolites.

The area is a hilly and densely forested terrain, thus it is very difficult to get the exposures of different lithounits, and their contact is also obscure. However the same can be studied in nala cuttings and streams flowing in the area. Large numbers of stone chip quarries have also come up in the area, which

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provide very good exposure of the rocks. The rock formations met within the area mostly belong to the Precambrian era. Detail and systematic study of the area reveals the occurrence of three facies- argillaceous, calcareous and arenaceous in a epicontinental sea environment (Sarkar et al.,1985; Tiwary et al., 1982). The pelitic schists represent the first phase of sedimentation. These metasediments occur as inclusions, having diverse shapes and sizes in vast expanse of granitic rocks. A series of tectonic disturbances and igneous activities seem to have taken place after the first period of sediementation. The argillaceous metasediments are represented by biotite schists, biotite- muscovite schists and phyllites. The pelitic metasediments are followed by quartzites of varied types, which represent the psammitic metasediments in the Ichadag area. The calcareous facies is the youngest of the three sedimentaries in the area. Crystalline limestones and calc-silicate rocks representing the calcareous facies occur as small isolated outcrops in this granitic country. The metamorphosed sedimentary sequence is followed by the amphibolites, which occur as large and small massive bodies, concordant bodies and as inclusions in granitic rocks.

The granitic rocks of the area are younger than amphibolites. These rocks are most prominent and cover large portion of the area. Based on field observations, broadly two types of granites have been identified, viz, the strongly to weakly foliated and lineated type and the massive, equigranular and crystalline variety. The foliated ones are characterized by distinct gneissose structure, in which alternate bands of quartzo-felspathic and mafic minerals show strong foliation along E – W. The light coloured bands are dominated by quartz and plagioclase feldspar, showing granulose structure; whereas biotite and hornblende displaying schistose fabric is abundant in mafic layers. The granite gneisses have suffered migmatisation varying from incipient to advanced stages. The massive granites of the study area are leuco to grey in colour, medium grained, holocrystalline, equigranular and nonfoliated rocks. They are intrusive into metasedimentaries, amphibolites and even granite gneisses, thus they are younger to all these rocks and probably represent last phase of intrusive activity (Sarkar et al., 1985).

The area seems to have witnessed three phases of deformations, i.e. F1, F2 and F3. Each phase of tectonism has modified the previous structure and presents a new and overprinted structural pattern.

THE GRANITIC ROCKS

The granitic rocks of ichadag area differ mainly in mineralogy, texture and nature of ferromagnesian constituents. Following types of granites have been identified in the area:

1. Granites possessing gneissic bandings called Granite gneisses
2. Granites without gneissic bandings called Massive granites
3. Migmatites
4. Pegmatites, aplites and quartz veins

Granite gneisses

The granite gneisses of the study area are characterized by heterogeneity in mafic mineral composition and structure. They show distinctive gneissosity and strong mineral lineations and most of them have suffered migmatisation. They are characterized by alternate felsic and mafic bands, which is exceedingly prominent and sharply divided. These rocks show large scale variations in terms of size and shape of the bands, the width of the band is seen to vary from about 1 cm to 3 cms. The individual bands are seldom straight and are often found to be contorted and folded. In the banded gneissic granites, the leucocratic and melanocratic bands are distinctly of different age. The melanocratic bands seem to be reconstituted and recrystallised and are distinctly older than the leucocratic layers and may be regarded as palaeosomes. The leucocratic band is medium to coarse grained, dull white to grey in colour and is not uniform in thickness. At times, it is found to pinch and swell abruptly. The effect of spheroidal weathering is quite visible in these rocks, as they out crop in the form of rounded to elliptical dome like bosses and hills. These gneissic rocks enclose numerous xenolithic inclusions of biote schists and amphibolites. These rocks are profusely intruded by younger pegmatites and quartz veins along the foliation planes.

Massive Granites

They are white to pink and grey coloured, hard, compact, massive and medium grained rock. Massive granites have limited occurrence in the area and they are found in small pockets. These rocks are nonfoliated and leucocratic in nature and are charcterised by their intrusive nature. They also occur as small veins and stringers in the older country rocks. Cross joints are prominent in them and at few places inclusions of older rocks like amphibolites and mica schists are found to be present as small lenticular bodies in these rocks. They consist essentially of quartz, k-felspar and plagioclase, biotite, hornblende and iron ores are the common mafic accessories. These rocks show two sets of joints viz. NE – SW and NW – SE.

Migmatites

Migmatites are also called mixed rocks. The formation of migmatites may take place in one of the two ways. The metamorphic rock may be heated enough to partially melt, but not completely. The

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molten material resolidifies within the metamorphic rock, producing a rock that incorporates both igneous and metamorphic features. Migmatites can also form when metamorphic rocks experience multiple injections of melt that solidify to form a network of cross cutting dykes. These are the mixed rocks that is veined or streaked with granites. Migmatites of Ichadag area are composed leucosomes of quartzo-felspathic material, which is intimately admixed in varying degrees with the dark coloured minerals called melanosomes. The major trend of foliation in these migmatites is NW – SE. The leucocratic bands frequently pinch and swell out. The thickness of both the types of bands is variable. The migmatites of the area are characterized by numerous crosscutting veins of quartz and quartzo-felspathic materials.

Pegmatites, Aplites and Quartz veins

Numerous corcordant and discordant veins of pegmatites are widely distributed in the area. These veins are often found crosscutting the regional foliation of the host rock. The pegmatite veins in turn have been traversed by quartz veins. The pegmatites and quartz veins have invades practically all the older rocks in the area and thus are the youngest intrusive in the area. NNE – SSW and WNW – ESE are the two major regional joints in the area and the crystallization of pegmatite and quartz has taken place along these regional joint planes. Pegmatite veins upto 50 cm in thickness and of at least two generations have been observed traversing the granite gneisses. The pegmatites are very coarse grained, however their grain size is found to decrease along the walls. White to light grey rectangular crystals of feldspar, quartz and muscovite are the essential mineral constituents of these rocks, while tourmaline, biotite and garnet occur as accessories. The pegmatite veins exhibit a highly contorted nature and ptygmatic folding.

Fine grained varieties of pegmatites are called aplites. They show the characteristic saccroidal texture and they occur in the outer zones of pegmatite walls. Aplite veins have been found traversing both the massive as well as gneissic granites at many places, thus confirming their higher position the stratigraphical sequence.

Chemistry

The greater part of the study area is occupied by the granitic rocks of various types. Presence of enclaves of metasedimentaries and also amphibolites in them makes it hard to believe that all the granites are magmatic in origin.

The chemical analyses of major element chemistry of these rocks have been given in table. I. One of the most popular classifications used in recent studies is the I-type and S-type granite classification. These two contrasting granite types have been recognized by Chappell and White (1974) in the plutonic rocks of southeastern Australia. They proposed a genetic subdivision of the investigated granites into those extracted from sedimentary protoliths as S-type and those derived from igneous source rocks as I-type. Granites were interpreted as being derived by partial melting with composition that directly reflect their source compositions.

	X1	X2	X3	X4	X5	X6	X7	X8
SiO_2	71.06	71.98	70.89	71.23	70.70	72.98	72.85	73.45
TiO_2	0.09	0.13	0.20	0.20	0.23	0.131	0.40	0.35
Al_2O_3	15.14	14.25	14.37	14.44	13.99	14.25	13.25	13.17
Fe_2O_3	0.62	0.70	0.75	0.29	0.38	0.25	0.78	0.80
FeO	0.76	0.84	1.02	1.48	1.53	1.37	1.27	1.32
MnO	0.018	0.04	0.05	0.08	0.051	0.043	0.15	0.16
MgO	0.28	0.22	0.59	0.60	0.59	0.22	0.95	0.78
CaO	1.61	1.29	1.82	1.79	1.82	1.29	1.52	1.27
Na_2O	4.49	4.34	3.80	4.1	3.8	4.34	3.38	3.49
K_2O	4.71	4.97	4.93	4.88	4.93	4.97	4.54	4.26
P_2O_5	0.035	0.03	071	0.07	0.07	0.034	0.15	0.17
LOI	098	1.17	1.35	1.21	1.11	1.27	1.05	0.90
Total	99.79	99.96	100.48	100.37	99.20	101.15	100.29	100.12

Table: 1

Chappell and White proposed several chemical parameters to distinguish S-type and I-type granites. S-type granites have been determined to have a Mol $(Al_2O_3/(Na_2O+K_2O+CaO)$ ratio of greater than 1.1 and I-type less than 1.1.The granitic rocks of the present area are peraluminous, i.e. the value has been found to be more than 1.1, which very well matches with the S-type granite affinity. The CaO percentage in S-type granites should be less than 3.7 wt%. The CaO wt % of granitic rocks of the study area is between 1 and 2, thus supporting the pelitic parentage for these granites. Chappell and White suggest S-type granites are restricted in composition to high SiO_2 types. While I-type granites have a wide composition from felsic to mafic. These characteristics are a consequence of S-type granites having been derived from a more SiO_2 rich source. Therefore, granites containing less than 65% can generally be assumed to be I-type, but the average value of SiO_2 for granites of Ichadag area is more than 71%, thus matching with the standards of S-type granites. I- / S-type compartmentalization of granitic rocks have also been

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attempted using SiO_2 vs CaO variation diagram given by Koble and Taylor (1966). The granitic rocks of the present area are placed very close to S-type field, in fact all the points are far away from that of I-type(Fig. 1), thus indicating their S-type lineage. SiO_2 vs TiO_2 binary diagram (after Koble and Taylor, 1966) has been found to be very effective in parentage categorization of granites. Here the compositional points occupy the S-type field (Fig. 2), thereby suggesting their S-type parentage. S-type affiliation of the granites of study area is further cemented with the help of FeO – Fe_2O_3 (Fig. 3) and K_2O – Na_2O (Fig. 4) variation diagrams. The compositional points religiously occupy the field assigned for S-type granites.

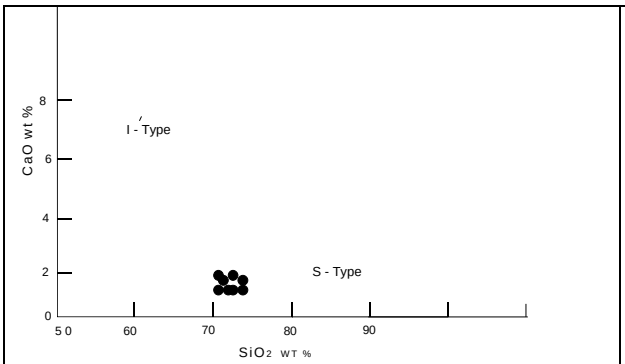


Fig. 1 SiO2 vs CaO binary variation diagram, fields for I- and S- type Granites, after Koble and taylor (1966)

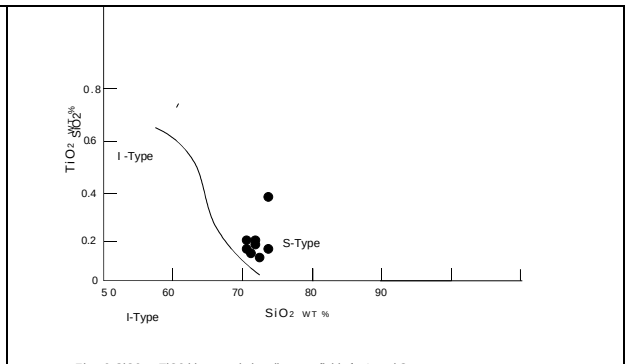
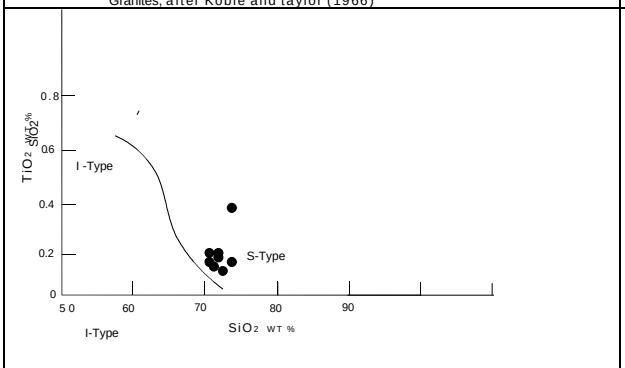


Fig. 2 SiO2 vs TiO2 binary variation diagram, fields for I- and S- type Granites, after Koble and taylor (1966)



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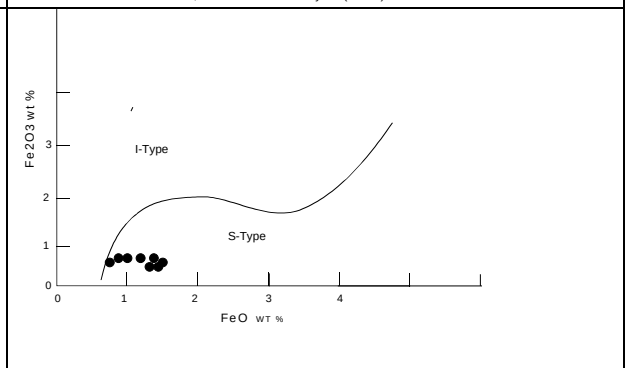

Fig. 3 FeO vs Fe2O3 binary variation diagram, fields for I- and S- type Granites, after Hine et al. (1978)

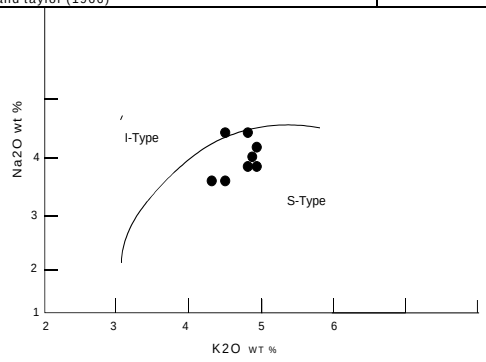

Fig. 4. K2O vs Na2O binary variation diagram, fields for I- and S- type Granites, after Hine et al. (1978)

An amalgamation of all these observations is a clear indication towards the contribution of pelitic schists in the generation anatectic melt, which formed granites of Ichadag area.

CONCLUSION

The Ichadag area is a vast expanse of granitic rocks with metapelites, quartzites, calcareous metasediments and amphibolites occurring in close association. The granitic rocks are most prominent and cover large portion of the area. They show wide scale variations in their fabric and mineral composition. Two major groups of granitic rocks namely, the granite gneisses and massive granites, have been identified in the area. The I- / S-type compartmentalization the granitic rocks have been attempted taking into account various geochemical parameters and the syntheses of all these studies put

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granitic rocks of Ichadag under the category of S-type. It also clearly indicate the effective role of partial melting of pelitic schists in generation of anatectic melt for formation of the granitic rocks of study area.

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