

Geochronology of the Indian Precambrian*

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Abstract: Precambrian geochronology of India is now known with greater precision because of the dating of samples carefully selected, in respect of geological consideration and set up, from several areas in the past decade. Vestiges of older nuclei dating more than 3000 m.y. have been identified in southern, eastern and western India. The Charnockite-Khondalite supergroup (c.2900–2600 m.y.) is now considered to be older than the Dharwar supergroup; the Eastern Ghats (*sensu stricto*) rocks are now considered belonging to the Charnockite-Khondalite supergroup proper but with impress of events at 1650 m.y. and 1400 m.y. at about the same time as events in Cuddapah Basin, Nellore Schist Belt and Amgaon group. The Aravalli, Bailadila, Bengal and Iron Ore groups are correlated with the Dharwar and range in age from c.2500–c.2000 m.y. The Delhi supergroup appears to be coeval with the lavas of the Gwalior 'series'.

Vindhyan sedimentation which started at c.1400 m.y. continued into Cambrian (?) unlike the Cuddapah supergroup where sedimentation ended by about 1300 m.y. The successively younger dates for the mobile belts from south to north, with respect to the southern nucleus, indicates a migration of geosynclines in the same direction. The Satpura 'group' despite valid evidences for its abolition as a supergroup appears to indicate the reactivation of the Narmada-Son lineament at 950/1000 m.y. in part of eastern India. The manifestation of carbonatite and anorogenic granites dating 725 m.y. in southern India, high-level granites in western India, dating 730 m.y., Myllem granite at 765 m.y. in eastern India and carbonatite in Rajasthan at 960 m.y. appear to be related to reactivation of lineaments in these areas at these dates. The overprint of mineral ages at c.500 m.y. along the east coast is also suggestive of activity of lineaments but further studies are necessary to confirm this view.

INTRODUCTION

Dates on less than a score of minerals were available when Arthur Holmes (1955, p. 81) presented the first account of the geochronology of the Precambrian tectonic cycles in the Indian Shield. At present, nearly six hundred dates are available representing a much wider spectrum of the Indian Shield: (Aswathanarayana, 1956; 1959; 1962 and 1964; Sarkar *et al.*, 1964; 1967 and 1969; Venkatasubramanian *et al.*, 1968 and 1971; Crawford 1969a, 1969b and 1970; Crawford and Compston, 1970). A review of the stratigraphy and geochronology by Sarkar (1968) has been supplemented by a review by Chatterji *et al.*, (1971). Even fission track methods have been applied for pegmatite minerals (Mehta *et al.*, 1968 and 1970). At present many institutions in India, including the Geological Survey of India, have commissioned mass spectrometers and a wealth of data will be flowing from these institutions in the years to come.

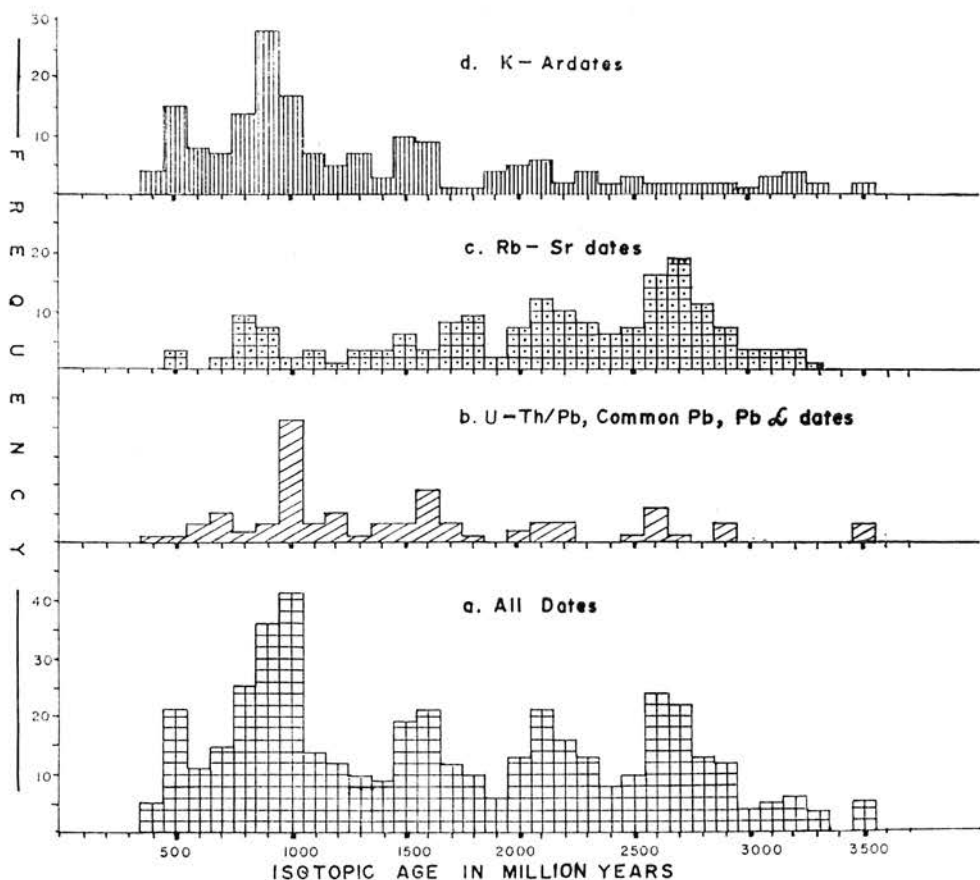
PRECAMBRIAN DATES

General

Fig. 1 depicts the histograms of isotopic ages of the Indian Precambrian Shield. Even though it will be hazardous to interpret the average of dates or the histograms (Cahen and Snelling, 1966, p. 16), it is now fairly well established that peaks of histograms do reflect orogenies (Clifford, 1968, p. 302). An attempt is made here to focus attention on the dates of major tectonic events and also elucidate the concordance or discordance between different methods of dating in the same group of rocks.

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Fig. 1. Indian Precambrian Dates (Histograms)

Histograms a, b, c and d of Fig. 1 represent respectively the dates available i) by all the methods ii) by U-Th/Pb method, lead alpha method and common lead method and iii) by Rb/Sr methods pertaining to single whole rock analysis with initial ratio at 0.7 and mineral dates and iv) K/Ar method on whole rock basic igneous rocks and mineral dates. The histogram 'a' represents major events at 500 m.y., 950–1000 m.y., 1500–1600 m.y., 2100 m.y., 2600 m.y., 3100–3200 m.y. and 3500 m.y. matched by U-Th/Pb date peaks at 1000 m.y., 1600 m.y., 2600 m.y. and 3500 m.y. The lack of other dates is possibly due to lack of datable material only. The peaks of Rb/Sr dates are at 500 m.y., 800 m.y.–900 m.y., 1500 m.y., 2100 m.y., and 2600 m.y.–2700 m.y. However Rb–Sr whole rock isochrons (Fig. 2) are concordant to the peaks of U-Th/Pb at 1000 m.y., 1700 m.y., 2000 m.y. and 2600 m.y., indicating that these pertain to major plutonic activity. The K/Ar dates with peaks at 500 m.y., 900 m.y., 1500–1600 m.y., 2100 m.y., 2300 m.y., 2500 m.y., and 3200 m.y., based as they are mainly on mineral dates, tend to reflect the metamorphic and uplift dates in general.

- (v) a 2600 m.y. plutonic event of crystallisation of charnockites under granulite facies conditions in the region *pari passu* with regional migmatisation resulting in the evolution of Peninsular Gneisses of Mysore-Hyderabad region.
- and (vi) a 3000 m.y.-3100 m.y. plateau and a peak at 3500 m.y. revealing nuclei in southern India, eastern India and western India.

The periodicity of the events is similar to those in other continents, particularly similar to the geochronology of Africa (Clifford, 1968, p. 303) except for the event at 1400 m.y. which is recorded insignificantly in India.

Classification into supergroups

Fig. 3 details the stratigraphy and geochronology of the different supergroups in the Indian Precambrian. The approximate time range in the tectonic and post tectonic evolution of these are also detailed together with histograms of dates pertinent to the supergroups shown. The Dharwar supergroup is shown separately from that of the Charnockite-Khondalite supergroup; the Eastern Ghats formations belong to the Charnockite-Khondalite group, but certain dates have attributes of the adjoining Cuddapah supergroup also and hence shown alongside for comparison of dates. Earlier views that the Charnockites represent metamorphosed Dharwar and that they belong to two periods (Pichamuthu, 1962) and they intrude the Dharwar (Rama Rao, 1936) are now questionable hypotheses. Evidences have been presented by Narayanaswami (1963), Iyengar and Banerji (1971) and Balasundaram and Balasubrahmanyam (1971) that the Charnockite-Khondalite supergroup forms a craton to the Dharwar. On the basis of isotopic age data, the east coast Eastern Ghats rocks have been thought to be of a younger age (Crawford, 1969b), in relation to their southern equivalents. The status of the Nellore Schist Belt, which is now included in the Dharwar supergroup, will be subjected to review perhaps on more modern geological data and isotopic age, as suggested by Crawford (1968). The data for central India groups of Khairagarh, Sausar, Sakoli, Amgaon and as those of the Singhbhum region are tentative and will have to await Rb/Sr studies as the present data rely on K/Ar dates only. The events in the Aravalli and Delhi supergroups together appear to span the time range from 3000 m.y. to 700 m.y. and future work will throw much light on the detailed correlation of the region. Thus Fig. 3 is partly based on existing data as such and partly on reinterpretation of such data by the authors, well supported by other workers, as already referred to.

Charnockite-Khondalite Supergroup

In lithology, regional structure and metamorphism, the rock formations in the Charnockite Province of Fermor (1936) are similar. The province comprises the eastern coastal tract of Eastern Ghats group of Andhra Pradesh and Orissa and the southern extensions in Tamil Nadu and Kerala proper. Subramaniam (1959, 1967) adduces evidences for revising the nomenclature of the granulitic hypersthene bearing rocks into a genetically connected magmatic *charnockite suite* emplaced in a basement of khondalite, magnetite-quartzite, calc-granulite and amphibolite association within which occur lenses of pyroxene granulite ("basic-charnockite") all of which have been retrograded to amphibolite facies rocks. Merh (1962) invoked two periods of folding in the area and related the development of biotite and hornblende to the second folding period. In Orissa, Prasada Rao (in Krishnan, 1954) and Chatterjee *et al.*, (1964) have indicated that the Charnockite-Khondalite association of rocks is older than the Iron Ore Series of rocks, which are equivalent to Dharwar. Pichamuthu (1962) describes an older gneissic charnockite with conformable strike to the gneisses intruded by a coarse

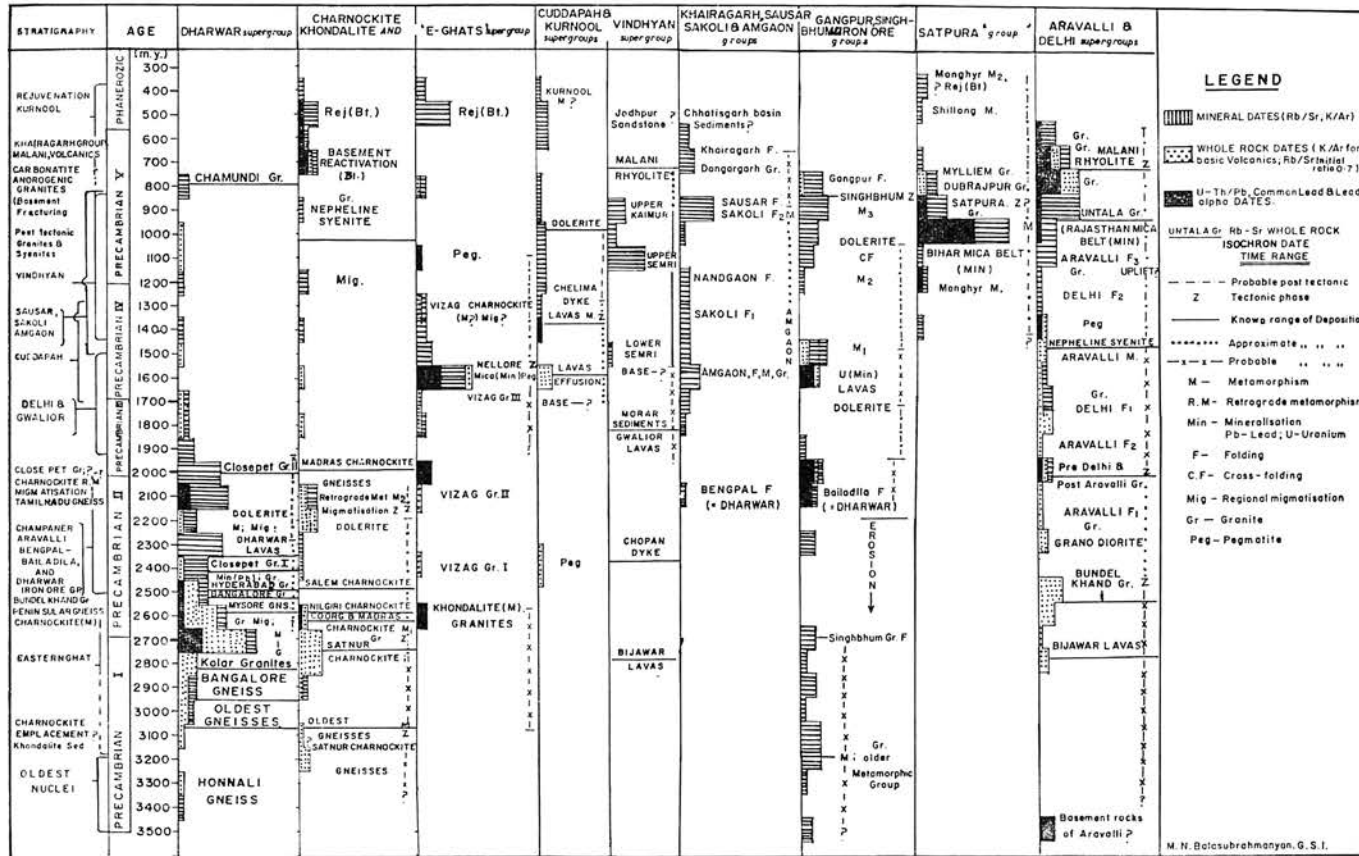


Fig. 3. Chronology of Indian Precambrian

grained granitic charnockite. All these data indicate a complex polymetamorphic history for this supergroup of rocks. Narayanaswami (1966) has envisaged a geosynclinal assemblage of origin followed by granulite facies metamorphism giving rise to two-pyroxene granulites and subsequent migmatization by alaskitic granites giving rise to acid and intermediate charnockites. The folding is polyphased; the earlier with E.-W. axis, followed by N.E.-S.W. cross-folding and shearing.

Interpreting the isotopic age data in both the areas of the Charnockite Province, herein called as the Charnockite-Khondalite supergroup, the authors suggest the sequence of events in the following lines. The minimum age of the basement rocks would be c.2900-c.3100 m.y. (age of the hornblende of the charnockite terrain —P.R.J. Naidu in Sarkar, 1968; age of the oldest gneisses at 3065 m.y., Crawford 1969b). The possibility of an older age at 3200 m.y. seems to be emerging in some areas from unpublished data with one of the authors (M.N.B.). The concordant zircon age of Madras city (Type Area) acid charnockite and the placer monazite of Vizag (Vinogradov, *et al.*, 1964) with the whole rock isochron age of Madras city charnockite and leptynite at 2600 m.y. (Crawford, 1969b) point to the date of plutonic crystallisation of charnockite under granulite facies conditions. The age of 2600 m.y. for zircon of Khondalite of Orissa is interpreted by Vinogradov *et al.*, (1964) to be its 'earliest' metamorphic age, which means that the khondalite is older to charnockite proper and the sedimentation date of khondalite is much earlier and the granulite facies metamorphism has been imprinted on the older zircons in the khondalite, pertaining to lead loss at that age.

The age of retrogression is tentatively assigned a date on 2100 m.y. based on the age of biotite (Balasubrahmanyam, 1971) and also on several gneisses with the same age in central Tamil Nadu, Kerala and to north and south of Godavari valley (Crawford, 1969b). The ages of 1650 m.y. and c. 1400 m.y. for the Vizag charnockite as well as for sillimanite gneiss in the area are difficult to interpret as they are all single whole rock dates (Crawford 1969a; Aswathanarayana, 1964). The specimen dated by Aswathanarayana has been reported to show myrmekitisation and is associated with granites nearby. Rb/Sr biotite ages of 1490 m.y. and 1400 m.y. for Bastar and Vizag have also been reported in the region by Venkatasubramanian and Krishnan (1960). Thus these dates of 1650 and 1400 m.y. appear to be related to migmatization of the charnockite in Vizag and also a metamorphic event respectively as indicated by the biotite ages. It is pertinent to note that the time of effusion of lavas in the nearby Cuddapah basin is as old as 1700 m.y. and subsequent strontium isotope homogenisation is at 1400 m.y. These would indicate that these events which are contemporaneous appear to be controlled by some major tectonic process perhaps common to both. This requires further investigation. Though alpha helium dates are of doubtful value for interpretation, it is significant to note that such ages at 1050-1250 m.y. have been reported for the quartz-magnetite rocks in the charnockitic province by Venkatasubramanian and Krishnan (1960), which are nearer the Vijayan metamorphism event in Ceylon (Crawford, 1969a).

Recently several regional lineaments have been identified in the Peninsular Shield by Eremenko and Gagelgantz (1966) and Grady (1971). It is significant that the lineaments identified by Grady are the loci of carbonatite, dunite, alkali syenite and granites as well as zones of mineralisation. These lineaments appear to have been active at about 720 m.y. This is indicated by the age of biotite in the biotite-pyroxenite associated with the carbonatite in a fault at 720 m.y. (Deans and Powell, 1968); by the age of Ramanathapuram 'granite' at 720 m.y. and the Madurai gneisses at 700 m.y. (Vinogradov *et al.*, 1964) perhaps associated with another lineament. It is apparent that the

geological history of the shield in this area is connected with the reactivation of major lineaments. This view appears to be strengthened by the overprint of c.500 m.y. mineral ages in this supergroup (not yet identified in the Dharwar supergroup) which is attributable to the activity of northeasterly lineament (Crawford, 1968) resulting in uplift of the Cuddapah group also, (Aswathanarayana, 1964) and (?) metamorphism of the Kurnool group. The identification of some dates indicating the role of reactivation of lineaments is put forward here for the first time. It is thus hoped that by proper identification of such lineaments in the shield and by dating rocks related to it, the complicated geochronology of the shield will emerge more clearly. This would also prove the nonexistence of any orogeny with a date of 1650 m.y. as suggested by Aswathanarayana, which has been a stumbling block in the interpretation of the geology of the region proper.

Peninsular Gneiss

The Peninsular Gneiss was originally described from Mysore in the region where Dharwar supergroup of rock formations have been described by Rama Rao (1936). Subsequently all the gneisses in the whole of southern India have been attributed to this unit and as such the term Peninsular Gneiss has now become a sack-term. This has been due to the mistaken correlation of all the schistose rocks associated with magnetite quartzites in the Charnockite-Khondalite supergroup and the Dharwar supergroup as belonging to the Dharwar supergroup only. With such a correlation, any and all the gneisses in both these supergroups have been mistakenly called the Peninsular Gneiss. Radhakrishna (1968) even suggested the possible description of the Peninsular Gneiss as a group term. However, as several gneissic units are exposed in the Dharwar group region with different ages and significantly differ from the gneisses of the charnockitic region, it is suggested that the term Peninsular Gneiss be restricted to the migmatite gneisses in the Mysore-Hyderabad region and the term Tamil Nadu Gneiss be given to the migmatitic gneiss in the Charnockite-Khondalite region. The Peninsular Gneiss *sensu stricto* has been dated to be 2585 m.y. (Crawford, 1969b) and is thought to be older than the Dharwar lavas. Several other gneissic units in the Dharwar region have also been dated; at 2420 m.y. (Venkatasubramanian *et al.*, 1971) and 2480 m.y. (Ramamurthy and Sadashivaiah, 1967) in the Kolar area; at 2830 m.y. for Honnali Gneiss in Shimoga District (Crawford, 1969b), and at 2900 m.y. for the Bangalore area by Venkatasubramanian *et al.*, (1971). The variation in age of these gneissic units appear to be related to repeated magmatism resulting in the Sr isotope homogenisations of these gneisses. A few of the granites identified so far have been dated—at 2520 m.y. at Bangalore (Venkatasubramanian, 1971) at c.2700 m.y. in the west coast (Balasubrahmanyam, *et al.*, 1971) and at 2400 m.y. and 2600 m.y. for some granites within the Chitradurga area of the Dharwar supergroup (Crawford, 1969b).

Dharwar Supergroup

The three-fold classification of the Dharwar supergroup postulated by Rama Rao (1936) has largely been replaced by others. Radhakrishna (1968) has described a number of Series in this supergroup with Peninsular Gneiss as the basement, while a four-fold classification has been proposed by Srinivasan and Sreenivas (1968) and Iyengar (1971). However, the isotopic age data for this supergroup is surprisingly poor in contrast to the large number of dates available for the Peninsular Gneiss. These pertain to the Rb/Sr isochron date for the Dharwar lavas at 2345 m.y. (Crawford, 1969b) and the model age to galena for the same area at 2450 m.y. The other dates are K/Ar hornblende dates of hornblende schists from different schist belts which appear to be meta-lavas. The ages of 3295 m.y. for the Hutti area and 2900 (Lead isochron) date of Kolar

amphibolite (Vinogradov, 1964) are interesting in contrast to the dates of 2631 m.y. for Channagiri area, 2477 m.y. for the Kudremukh area and 2407 m.y. for the Karighatta area by Sarkar (1968), which can only be resolved by detailed Rb/Sr studies in the region. Balasubrahmanyam *et al.*, (1971) have given a metamorphic date of 2285 m.y. for the amphibolite (metalava) of Agumbe area based on K/Ar date of a hornblende. Except for the old dates of 3295 m.y. of Hutti hornblende, and of 2631 m.y. of Channagiri, the rest of the K/Ar dates indicate at least minimum ages for the later tectonism in the Dharwar group to be around 2400 and 2300 m.y. respectively. Even this is a tentative approach and except for the Agumbe sample the details pertaining to other dated samples are not mentioned in the literature cited.

The granitic activity associated with orogeny of the Dharwar supergroup pertains to the dated granites of Closepet (2380 m.y.) and Chitradurga (2400/2450 m.y.) by Crawford (1969b). These will be late to post orogenic granites if the date of 2345 m.y. for the Dharwar is to be interpreted as a folding event (Sreenivas and Srinivasan, 1968). A younger age of 2050 and 2000 m.y. for the Closepet granite adduced by Ramamurthy and Sadashivaiah (1967) and Venkatasubramanian (1971) respectively are interpreted by Crawford to be a 'migmatization' event which affected the Closepet granite. The youngest rock in the Dharwar supergroup area relates to the anorogenic Chamundi granite at 790 m.y. (Crawford, 1969b), which is also reflected in a mineral date of 800 m.y. in the Closepet granite (Venkatasubramanian, *et al.*, 1971) which indicates that the Closepet granite has perhaps several age components. In analogy with Tamil Nadu area where the lineaments are associated with carbonatites and granites, it is particularly necessary to examine Chamundi Hill area for any such lineament and also possible carbonatites etc., associated with them, indicating manifestations of activity of the upper mantle in that period.

Aravalli and Delhi Supergroups

The Aravalli is now tentatively correlated with the Dharwar, the former with a possible source of rocks in a craton as old as 3500 m.y. (Vinogradov *et al.*, 1964). It was thought that the Banded Gneissic Complex formed the basement to the Aravalli supergroup. However, with the isotopic age data revealing several age components (2580, 2220, 2040, 2000 and 955 m.y.) none of which are very much older than the age of 2500–2000 m.y. assigned to this supergroup (Crawford, 1970a), this tenet has not been accepted. The craton to this group appears to be the Bundelkhand granite and Berach granite (2550 m.y.) as discussed by Crawford and Compston (1970). Then the Bijawar lavas, also resting on the Bundelkhand granite, will be the equivalent of Aravalli lava, thereby indicating that the younger age limit of the Bijawar date of 2780 ± 365 m.y. is to be preferred. Dates on basal Aravalli conglomerate components (Crawford, 1970) would give the maximum age of 1970 m.y. However, the conglomerate is from a region correlated with Delhi supergroup by earlier workers and thus the approximate span of 2500–2000 m.y. for the Aravalli is itself indicative for the necessity of further studies in this area to resolve the time range properly.

The Delhi supergroup is thought to be the geosynclinal analogue of the Gwalior platform sediments within which the lavas occurring have a date at 1830 ± 200 m.y. The span of the Delhi sedimentation appears to range in time from at least 1900 m.y. with two cycles of folding and a younger metamorphism at 900 m.y. (Crawford, 1970). The western region of India, where these groups are exposed, has been subjected to repeated granitic activity at 1660 m.y., 1010 m.y., 950 m.y., 790 m.y. and 735 m.y., with the Malani phase (volcanic) at 745 m.y. The last of these events is contemporaneous with emplacement of anorogenic granites in eastern and southern India, where the

role of reactivation of basement fractures have been causative for the emplacement. These dates by Crawford (1970) have to a great extent refined the earlier belief that the Delhi has an age of 735 m.y. (Holmes, 1955) and the Aravalli has a maximum age of 1020 m.y. (Sarkar *et al.*, 1964; Sarkar, 1968). However, an intensive programme of isotopic dating of these supergroups is to be carried out in the future to define their tectonic history and correlation of similar rocks in the area south of Bundelkhand region. An interesting possibility pertains to the possible location of Bijawar equivalents in Son valley where the shales are intruded by Chopan dyke dated at 2370 ± 460 m.y.

Iron Ore, Singhbhum and Gangpur Groups

Sarkar *et al.*, (1967) have identified the oldest nuclei in the Peninsular Shield at c.3200 m.y. in this region, forming the basement of the Iron Ore group of rocks dated to have an orogeny closing at c.2700 m.y. with the emplacement of Singhbhum granite. The subsequent orogeny (the Singhbhum Orogeny) closed at c.850 m.y. having several age components in the area south of the copper-belt thrust zone. The Singhbhum and Gangpur groups are now correlated with each other; but with age data reflecting the Satpura 'cycle' event. The geology of the region and the radiometric data by Sarkar have been questioned by Dunn (1966) and a different interpretation given by Iyengar and Alwar (1965). It may be stated here, that until the area receives attention by geochronologists utilising Rb/Sr methods, the controversies will not be resolved. The salient features pertaining to the geology of the region as detailed by Sarkar *et al.*, appear to relate to the revival of the Older Metamorphic Group, confirmation of a possible younger age of the Kolhan Series at 1500 m.y.–1600 m.y. (cf. Dunn and Dey, 1942), renaming the Iron Ore Stage lying to the north of the thrust as Dhalbhum Stage and equating it with the lower part of the Dhanjori group (Sarkar and Saha, 1968). Their data are based entirely on K/Ar dating. The age of the uranium mineralisation appears to be 1600 m.y. (Vinogradov *et al.*, 1964).

Khairagarh, Sausar, Sakoli and Amgaon Groups

Even though the geology of this region in central India is known in considerable detail, our knowledge of geochronology of this area is restricted to the K/Ar method only (Sarkar *et al.*, 1964). The Dongargarh Belt is thought to have a three event tectonism at 1444–1730 m.y., 1200 m.y. and 600 m.y. whereas the Sakoli group has two tectonic phases at 1530 m.y. and 862 m.y.–950 m.y. The younger event is also the main folding event in Sausar group. The date of Khairagarh folding at 670 m.y. indicates it to be the youngest event in the Indian Precambrian. It is possible that Sausar and Singhbhum cycles are coeval and the Amgaon and Sakoli first folding are nearly of the same age as Aravalli metamorphism and second folding of Delhi group.

Satpura group

The rock formations in Palamau-Bankura areas of the eastern India originally described as belonging to the Satpura orogeny are now thought to have no such attribute. However, the name appears best to be retained, in as much as the trend is that of the Satpura mountains in Deccan Trap having the Narmada-Son lineament direction which is a significant feature in the Peninsular India; the possible role of reactivation and developments of this lineaments in the evolution of this segment of the Indian Shield is also significant, especially as the major rocks of the area are akin to granulitic rocks of the Charnockite-Khondalite supergroup. The important mica belt of Bihar in this region has been responsible for the prolific dating of uranium minerals by Holmes (1955) and Vinogradov *et al.*, (1964) at 950 m.y. and 1000 m.y. respectively.

With this several K/Ar dates of Sarkar, (1968) are concordant. Granites at 765 m.y. and 795 m.y. in West Bengal and Shillong Plateau appear to be coeval with Singhbhum orogeny, Sausar folding and post-Delhi granites. The possible role of this lineament in shaping events in this region at different dates become significant when it is realised that the pyroxene in melanite-nephelinite rock in Amba Dongar has been dated at 38 m.y.

Cuddapah supergroup

The geology of the Cuddapah supergroup first described by King (1872) has been revised by Narayanaswami (1966) and Sen and Narasimha Rao (1968). It is now believed that in the eastern margin of the Cuddapah basin, the Nallamalai rocks are equivalent to gently folded Cheyair rocks. The deposition started not earlier than c. 1700 m.y. (Crawford, in Balasundaram and Balasubrahmanyam, 1971), and ceased by the time Chelima dyke intrude at 1225 m.y. The Cuddapah lavas were metamorphosed at c. 1400 m.y. as revealed by the strontium isotope homogenisation at c. 1400 m.y. suggested by Crawford, (1969a) which is also the model age of the galena in Cumbum shales of the Nallamalai Series (Aswathanarayana, 1962). Post-Cuddapah dolerites intruded at 980 m.y. and the overprint of mineral and whole rock K/Ar date of shales at c. 500 is thought to be an uplift date. The possibility of this being related to north-easterly lineament of the east coast has to be visualised. The Kurnool being younger than the post-Cuddapah dolerite at 980 m.y. are therefore correlated with Upper Vindhyan group.

Vindhyan supergroup

The base of the Vindhyan could have a minimum age of 1400 m.y. (Tugarinov *et al.*, 1964) whereas the base of the Upper Vindhyan is demarcated at 1140 m.y. The Lower Kaimur host rocks of the Panna Kimberlite has been assigned an age of 940 m.y. Since the K/Ar age of the glauconite in these sediments should be regarded as minimum age, there is no apparent conflict between the Kimberlite date and that of the Lower Kaimur rocks. Crawford has suggested that the Vindhyan probably transgresses the Precambrian/Cambrian boundary. This is based on the possible correlation of Jodhpur sandstones with the uppermost Vindhyan overlying Malani rhyolites (745 m.y.) in Rajasthan. However, the search for datable material in Rewa and Bhandar groups should continue in order to find an acceptable solution to the correlation of Vindhyan.

DISCUSSION

Using the isotopic ages available the probable correlation of different groups and the time range of their evolution are depicted in Fig. 3. The time classification of Semenenko *et al.*, (1968) for the Ukrainian Precambrian have been modified by Sarkar (1968) for the Indian Precambrian. This classification envisages orogenies within the time boundaries defined and do not indicate any rejuvenation dates except the Indian Ocean event etc. at 500 m.y. as quoted by Sarkar (1968).

The oldest nuclei, whose vestiges are discernible in younger formations, are located in southern India in the Charnockite-Khondalite supergroup, Older Metamorphic group in eastern India and perhaps in western India which may be as old as 3500 m.y. The Charnockite-Khondalite supergroup of granulite facies rocks extend from south-western India, eastern India, along the coast; it is also discernible in the area described in old literature as Satpura belt. This had a polymetamorphic history, with a possible

basement of sediments with a minimum age of 2900 m.y. with granulite facies metamorphism at 2600 m.y., later retrograded to amphibolite facies in some sectors at 2100 m.y. *pari passu* with the regional migmatisation of the associated paragneisses to form the Tamil Nadu Gneiss as designated in this paper. The Peninsular Gneiss, restricted to the Mysore-Hyderabad region, was formed at 2550 m.y. is older than the Dharwar supergroup which had sedimentation starting slightly earlier than 2450 m.y. volcanism and folding at 2350 m.y. and a later metamorphism at 2300 m.y. The un-metamorphosed molasse sequence in this supergroup (G.R. Halli Formations) have been assigned a date of 2000 m.y.–1400 m.y. on the basis of microfossils. At about the same time the Iron Ore group, Bengal group, Bailadila group and perhaps Aravalli supergroup too were evolved. The post-orogenic Closepet granite of Dharwar supergroup has two magmatic episodes at 2400 m.y. and 2000 m.y. at slightly younger ages than the evolution of the Bundelkhand granite craton in northern India and its equivalent in northwestern India.

At about 1900 m.y. sedimentation started to form the Aravalli supergroup and Delhi supergroup of rocks and at c. 1700 m.y. in the Cuddapah Basin. The Vindhyan sedimentation is assigned a slightly younger age of 1400 m.y. It could perhaps be older as the Gwalior lavas over which they rest are dated at 1815 m.y. While the sedimentation in Cuddapah basin is supposed to have stopped by 1225 m.y. Vindhyan sedimentation continued beyond 900 m.y. The contemporaneity of the dates of kimberlitic rocks in Cuddapah and Vindhyan supergroups point to the activity of deep faults at that time. The age of the effusion of Cuddapah lavas is also the age of the pegmatites in the Nellore Schist Belt, the mica pegmatites of Rajasthan and the uranium mineralisation in Singhbhum. The metamorphism of the Cuddapah lavas at c. 1400 is reflected with several mineral dates in the adjoining Charnockite-Khondalite supergroup as well as the 1600 m.y. event.

The rocks of the Bihar Mica Belt ('Satpura') at 950–1000 m.y. are contemporaneous with the Singhbhum orogeny date as well as the Aravalli uplift date in western India. This and the subsequent event reflected in the mineral dates of 860–950 m.y. in Sausar, Sakoli, Singhbhum and Gangpur groups indicate the link which these have (?) to the Satpura 'event'. This appears to be due to reactivation of the Narmada-Son lineament at this time, in the opinion of the authors. Similarly the younger dates at 790 m.y., 720 m.y. are also localised along deep main faults and thus point to the anorogenic nature of these events in southern, western and eastern India. It is to be emphasised here that the Indian Precambrian problem is yet to be unravelled in a detailed way with the proper isotopic age data. The scope is indeed vast requiring sustained and intensive work of all geoscientists engaged in this task in a coordinated manner.

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