CHAPTER I

INTRODUCTION

Palghat Gap is a prominent geomorphic feature in the landscape of South India (Fig. 1). This low level landform having a width of about 30 km and a length of over 80 km in an east-west direction and bordered by the Nilgiris to the north and the Anaimalai massif to the south, constitutes the only major break in the Western Ghats. The Gap proper has a subdued profile (Fig. 2a & b) with an average elevation of 60 m in the western part and 120 m in the eastern part, with well-defined scarp faces towards southern and northern flanks. Origin of this interesting geomorphic feature is still a controversy with the present day discussions centering around apparently conflicting hypotheses:

(1) Fluviatile action model of Jacob and Narayanaswamy (1954) attributed the origin of the Gap to a large easterly flowing and a probable westerly flowing drainage systems with their source very close to the Palghat region. Absence of strike trends and other structural features indicative of faulting were taken as supporting evidences in favour of a fluviatile origin.

(2) Supported by the geomorphological and structural evidences in favour of uplift of the Nilgiris flanking the Palghat Gap to the north, through large-scale faulting and
Fig. 1 Landsat (MSS band 4) image of Palghat Gap. Scale: 1:1 million.
Fig. 2(a) A view of a part of the Palghat Gap close to the northern flank.

Fig. 2(b) View of the northern flank from the Malampuzha reservoir site.
the suggested presence of a wide shear zone in the Mangalam (10° 34'; 70° 31') and Walayar (10° 51'; 76° 51') dam sites within the Gap (Balasundaram, 1953; 1954), Arogyaswamy (1962) emphasised the role of structural control and marine erosion subsequent to the uplift of the mountains in sculpturing of the 'Gap' area. Presence of terraces at an elevation of 375 m in the Gap was taken as an indication of large-scale block faulting (Arogyaswamy, 1962), coinciding with that of the west coast, resulting in horst and graben like structures. Presence of bedded concretionary 'tuffaceous limestones' and black clays typical of backwaters and estuarine lagoons close to the Gap, in Coimbatore Dist., was taken as indication of shallow marine conditions.

The unlikely possibility of river erosion being the sole cause for the formation of the Gap was furthered by Ahmed (1966), Bose and Kartha (1977), Rao (1978) and others. The possibility of upheaval of the plateau landforms on either side of the Gap by tectonic processes was considered by Demongeot (1975) while Vaidyanandhan (1977) viewed it as due to repeated uplifts along major fault zones.

Fluviatile or marine erosion as the sole cause for the reduction of the order of 1900 m of land masses was also ruled out by later workers (Subramanian et al., 1980; Subramanian & Muraleedharan, 1985). Absence of structural features indicative of faulting (Jacob &
Narayanaswamy, 1954), paucity of mylonites (Mani, 1975) the tectonically undisturbed character of the rocks of the Gap area (Venkata Rao & Subramanian, 1979) and consideration of the steep northern scarp faces as probable escarpment slopes (Gopalakrishnan, 1979), rule out major faulting and uplift of the Jurassic plateau landform. Absence of displacement features in limestone bands traceable from Madukkarai in Tamil Nadu to Walayar in Palghat Gap (Subramanian & Muraleedharan, 1985) and continuity of structural trends of the Pre-cambrian crystalline from the north-eastern part of the hills into the Gap (Gopalakrishnan, 1981), were taken as substantiating evidences of this hypothesis.

(3) Following the model of King (1962), the possibility of upward doming of the lithosphere in this region as a result of vertical thermal plumes with related volcanic activity (Wyllie, 1976) and the passing of Indian plate near a mantle thermal plume around 65 m.y ago (Dietz & Holden, 1970) were taken as supplementary arguments by Subramanian & Muraleedharan (1985) to postulate a 'crustal upwarp' theory. Arogyaswamy's (1962) emphasis on marine erosion as a dominant sculpturing agent of 'Gap' was also ruled out since, the bedded concretionary limestones and black clays containing gypsum occurring near the Gap, on which his theory was mainly based, were shown to be nothing but kankar and desiccated inland lake clays by later workers. Crustal upwarp of the surface in Post Jurassic times along an E-W axis and consequent development of joints and fractures
in the weak rocks such as hornblende and biotite gneisses exposed in the area were explained to have facilitated speedy erosion by fluviatile agents. Their model also explained the same level of elevation of high lands on either side as due to the proximity of these hills to the axis of upwarp. The elevation of Jurassic surface was attributed to be a consequence of the accumulation of thick lithic sediments in taphrogenic basins such as that of the Cauvery, leading to crustal imbalance and isostatic adjustments by way of elevation of the continental crust. Presence of a thinner crust in the Gap area has also been suggested by the reported positive Bouger anomaly over the Gap and negative Bouger anomaly over the elevated areas (Subramanian, 1978).

P.S. Rao (1978) indicated that atleast the structural foundation of the Gap was laid in Precambrian times, and its present profile as a compressional graben between two E-W trending shear zones was attributed to repetitive movements along the shear zones in early Tertiary times and subsequent erosion.

(4) Palghat Gap as a possible outcome of repeated differential uplifts of the plateau on both sides and subsequent erosional cycles through the fluviatile action of a westerly flowing stream (Nageswara Rao and Srinivasan, 1980) had its basis on a theory proposed by Medlicott and Blanford (1893) advocating combined headward erosion of two
opposite flowing drainage systems as responsible for the origin of the Gap. The tectonic framework, geomorphic features and development of soil types typical of river valleys in the Gap area as reported by the authors, were cited to reiterate this line of argument. Rejuvenation features observed along the river courses of the three physiographic horizons identified within the Gap area were taken as probable indications of similar rejuvenation of the Gap proper.

Recent investigations point to the lack of correspondence between P-T data on rocks lying south and north of the Palghat-Cauvery 'shear zone' (Harris et al., 1982; Janardhan et al., 1982; Raith et al., 1983; Chacko et al., 1987) facilitating arguments in favour of its being a tectonic boundary between two distinct terranes within the southern shield (Ramakrishnan, 1988), a view which concurs with the gravity data (Mishra, 1988) also.

Drury et al. (1984) envisaged it as a zone of strong E-W striking planar tectonic fabric connected to the N-S thrust system of the Eastern Ghats by many arcuate shears at its eastern extremity (Drury & Holt, 1980). Its relation to the Eastern Ghat mobile belt was also emphasised by curving of the N-S fabric of the northern block into the E-W shear system, which is consistent with an E-W crustal shortening (Mukhopadhyay, 1986; Reddi et al., 1988) and a dextral sense
of movement.

Aeromagnetic data of Reddi et al (1988) also show a conspicuous downfaulted region extending from west of Palghat through Tiruchirappalli region and beyond, in an E-W direction. Contrary to the viewpoint presented by Drury and Holt (1984), a continuity of structural trend lines across Palghat Gap has been cited by Nair (1990), through visual interpretation of LANDSAT imagery, supplemented by aerial photographic data, in support of an absence of a shear zone.

The review of the present status of the origin of Palghat Gap presented above, highlights the diversity of opinions among geologists on its origin and shows that it still offers a subject of debate and challenge to geologists working in the area. The present study attempts to unravel the geologic evolution of the area, through field geological investigations and attendant geochemical, geothermobarometric and geochronological components.

1.1 Location and methodology:

The study area (Fig. 3) comprises part of the Gap proper and a part of its northern flank exposing the metasedimentary sequence. This region, covering an area of 100 km² (falling within longitudes 76° 45' and 76° 50' and latitudes 10° 47' 30" and 10° 52' 30") was chosen after a
Fig. 3 Location map of the study area.
careful perusal of the available geological and geomorphological data. The areal limits of the chosen territory however, has not constrained data collection from areas to its west and east.

Methodology:

(I) Geological mapping in 1:25,000 scale in order to delineate the lithological units outcropping in the area and to bring out the broad structural features.

(II) Systematic collection of representative samples from the various lithological units for:

(a) Petrographic studies (about 120 thin sections)

(b) Geochemical investigations for protolith characterisation of rocks (50 whole rock analyses)

(c) Microprobe analyses of coexisting mineral phases to deduce pressure-temperature conditions of metamorphism/rock formation (about 389 mineral analyses from the garnet-biotite-sillimanite + cordierite gneisses, garnet-biotite gneisses, hornblende-biotite migmatitic gneisses, granites and pegmatites)

(d) Fluid inclusion studies to supplement the mineral P-T data (about 10 quartz and garnet plates from various rock samples) and

(e) Geochronologic investigations (age determinations of biotite and muscovite mineral samples from 5 pegmatites by K-Ar method).