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EVOLUTION OF THE CONTINENTAL CRUST OF INDIA: GROWTH OF KNOWLEDGE, 1900-1980 – A REVIEW

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By today's standards, the knowledge on the structure and manner of evolution of the continental crust of India in the year 1900 was most rudimentary, but more or less at par with the global state of knowledge at that time. The absolute age of the Earth was still unknown – but as in other countries, it was recognised in India that there was an early era of earth history (Archaean) during which life did not exist, followed by an era with rudimentary forms of life (Proterozoic, but the term *PURANA* was used in India), and then followed an era with abundance of various forms of life (Phanerozoic). Much earlier, in 1854, Archdeacon Pratt of Calcutta put forward the concept of *Isostasy*, which implied that the continental crust is thicker than the oceanic crust. A broad outline of the surface geology of India and the relative ages of some of the major groups in the Indian shield were already known by 1900, as summarised in R.D. Oldham's *Manual of the Geology of India* (1893).

After the propounding of the hypothesis of Continental Drift by A. Wegener (1912), the geologists in India (mostly European at that time) generally accepted the idea that during Palaeozoic and early Mesozoic, the continental masses of India, Australia, South Africa, South America and Antarctica together formed a super-continent (Gondwanaland); beginning from Triassic, this supercontinent broke apart and moved in different directions like shallow rafts over a sea of basalt. It was believed that the Indian continent drifted northward from near the South Pole, and that the sediments deposited along its northern border were pushed along with the moving continent and folded up to give rise to the Himalaya when the Indian continent collided with the Central Asian Continent.

During the first half of the 20th century, there was no significant addition to our knowledge of crustal evolution of India. A breakthrough came in the early fifties, when Arthur Holmes (1955) recognised on the basis of a few isotopic ages of radioactive minerals that Indian shield represents a series of mobile belts which developed successively throughout the Precambrian time. He recognised four such major belts or 'provinces' – Dharwar Province, Eastern Ghat Province, Satpura Province and Aravalli-Delhi Province – whose successive development led to the framework of the Indian continental crust.

Subsequent detailed studies (cf Sarkar 1968) have indicated that relics of Archaean rocks occur in almost all the provinces demarcated by Holmes, and that in each province, a series of orogenic cycles (two to three major ones) have operated; undisturbed sediments (viz. Cuddapahs, Vindhyans, etc.) of appropriate ages occur in association with some of these provinces. Naqvi *et al.* (1974) put forward the concept that the Indian shield has grown around three 'proto-continents' (i.e. continental nuclei), viz. Dharwar, Singhbhum and Bundelkhand nuclei, which joined together in late Precambrian. Sarkar and Saha (1969, 1977) discovered that a wedge-shaped crustal block in eastern India (the Singhbhum-Orissa Iron ore craton) contains the oldest known relics of the continental crust of India (*c.* 3.8 billion years) – this crustal block has been shown to have grown through three major diastrophic cycles, closing *c.* 3.8 b.y., 3.0 b.y. and 1.6 b.y. ago.

Gravity surveys by the Survey of India in the early part of the century indicated the existence of abnormally light or heavy subcrustal rocks underneath the Indian shield – one ridge of heavy rocks runs roughly WNW-ESE through Nagpur (called Burrard's Hidden Range). Subsequent systematic gravity surveys along with seismic data (including the DSS programme of the National Geophysical Research Institute) have indicated that the crust under the Indian shield is 30-40 km thick, but some of the mountain ranges, such as the Aravallis, the Vindhyans, the Satpuras, and the Eastern Ghat, are characterised by gravity highs, suggesting that the underlying crust has higher than normal density; in the case of the Eastern Ghat, the crust is considerably thicker than under the adjoining Dharwar Belt to the west. Geobarometric studies based on application of thermodynamics to chemical composition data of metamorphic minerals have indicated that some of the rocks now exposed in Eastern Ghat Belt recrystallised during the Archaean times at depths of the order of 35-40 km – this disproves the contention of many earth scientists that the Archaean crust was much thinner than at present.

With the introduction of the theory of Global Plate Tectonics in the late sixties, the emergence of the Himalaya has now been elegantly explained as the result of collision of the northward-moving Indo-Australian plate against the Eurasian plate, whereby the thickness of the crust under the Himalaya has doubled (70-80 km) with the subduction of the Indian continental crust underneath the Eurasian plate. A number of Indian scientists are trying to study the Precambrian crustal evolution of the Indian shield in terms of Plate Tectonics, e.g. Sarkar and Saha (1977) in Singhbhum region and Sen (1981) in Rajasthan.*

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*One highly significant result of recent geophysical studies has been the finding of K.K. Roy *et al.* (1989) that the lithosphere under the Precambrian Singhbhum Granite batholith of Eastern India is abnormally thin (average thickness 40 km against global average of 100 km).

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