

THE GOLDEN HERITAGE OF KARNATAKA

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I) INTRODUCTION

Historical perspectives of a nation or a region can be viewed from many angles. The rise and fall of empires is the most conventional one. Alternatively one can look at the religious and cultural streams. Yet another view is through the prism of materials, as they are intimately linked to the progress of human civilization. It is this view that is emphasised in this article. The state of Karnataka was the region where the Badami Chalukyas (500-750 A.D), the Rashtrakutas (750- 970 A.D) the Hoysalas (1100-1400 A.D) and the Vijayanagar empires flourished. These regimes were followed by the remarkable rise of Hyder Ali & Tipu Sultan and the Wodeyar family of the princely State of Mysore. After independence in 1947, the amalgamation of the Mysore State with the Indian Union took place with rechristening as Karnataka. The rich geography of the region has been admired. The rivers Krishna and Kaveri make it a green and pleasant land. The Western ghats boast of an extraordinary bio-diversity. The Coorg plantations waft the fragrance of coffee. The literary tradition in Kannada is redolent as well. The architecture of Cheennakesava temple at Belur makes it a jewel among temples. The graceful faces of the Kannadigas are frozen as friezes in the Madanika brackets. But the stone sculptures come alive, even as we behold them. The religious streams of Hinduism Buddhism, Jainism, Christianity and Islam flow in harmony. However, it is perhaps in the mastery of materials that Karnataka presents an extraordinary and most luminous picture. Among materials gold and silk have fascinated mankind almost from the beginning. Iron and steel came in much later. Today the age of information technology is founded on yet another material, silicon. It is no exaggeration to say that the association of Karnataka with gold, silk, steel and silicon is full of splendour and significance. We shall trace the contribution of Karnataka to these four materials in the national context.

II) GOLD

The fascination that gold holds for Indians borders on the obsessive. Even though India produces two tons of gold per annum, the consumption is around 500 tons, nearly 20% of the global production. This is the only metal that India uses in proportion to its population. Early reference to gold is to be found in the Rig Veda Samhita. In all the sacrificial rites golden vessels were used. The arthashastra refers to gold having "the colour of lotus, soft, lustrous and not producing any type of sound". The Harappan civilization had many gold objects. The admixture of gold with silver suggests that this gold might have originated in Kolar in Karnataka. Silappadikaram, the Tamil Classic, makes a reference to golden anklets. In the epic Ramayana, the golden deer, though it was an illusion, was sufficient to distract Sita and provide a fateful twist to the story of the Ramayana. It has been stated that the Indian conquest of South Asian regions in the distant past was driven by the desire for gold. The tradition of mining gold started at least as early as the first millennium B C. The Champion reef at the Kolar gold fields was mined to a depth of 50 m during the Gupta period in the fifth century A.D. The metal was continued to be mined by the eleventh century kings of South India, the Vijayanagar empire from 1336 to 1560 and later by Tipu Sultan. It is estimated that the total gold production in Karnataka to date is

1000 tons. Renewed interest in the Kolar Goldfields occurred towards the end of the nineteenth century. The ancient gold workings, which may be 200 years old and the workings of Tipu Sultan were located by Captain Warren in 1802 and started in 1864 by Michael F. Lavelle. John Taylor & Company did much of the prospecting. A gold medal at the Indian Institute of Metals was instituted by them in the name of John Taylor. The Kolar gold fields and the other mineral deposits of the state of Mysore appealed to Professor William Ramsay, Nobel Laureate and discoverer of noble gases and tilted his opinion for the location of the Indian Institute of Science at Bangalore rather than Roorkee. The Kolar and Hutti gold mines are under continuous, if somewhat chequered, development. However as the ores are more refractory compared to those mined in earlier days, novel methods of extraction become desirable. Among them bacterial leaching holds great promise. The bacterium *ferrobacillus thiooxidans* has been well studied from this point of view. The research group at I I Sc is doing pioneering work in this area and is engaged in genetic engineering of this bacterium to produce superior varieties. An industrial scale bioreactor is on the anvil. The ancient craftsmanship, for which India was famous, has taken a new birth in the design of gold jewelry. The Tanishq designs of the Titan Industries of Bangalore have captured the imagination of the jewellery buyer. It has happened before with diamond. In spite of very little local production a large quantity is imported, cut, polished and exported with value addition. This may still happen with gold in India.

III) THE SILKEN THREAD

India is well known for its silk products. It ranks fifth amongst the silk producing countries after Japan, China, Korea and Russia. Karnataka leads by producing nearly 75% of the country's raw silk amounting to an annual production of 6000 tons of yarn. The founder of the Indian Institute of Science, J. N. Tata had befriended the Dewan of Mysore Sir K Seshadri Iyer in his efforts to develop a silk farm at Bangalore. He was well aware of the famous Mysore silk, the production of which was encouraged by Tipu Sultan the dynamic ruler of Mysore. In 1895 Tata started a farm. A successful venture, Bangalore silk was regarded as the best silk even in the European market. It was this silken bond that led the Dewan to offer free land for the proposed Institution. The nutrition, physiology and pathology of silk worms have been investigated at I I Sc. The glow of the silkworm has also attracted the attention of scientists and its molecular genetics has been elucidated.

IV) STEEL

Karnataka has the richest resources of iron ores of the order of 1000 million tons of Karnataka and 25000 million tons of magnetic ores. Major deposits occur in Bellary, Chickmagalur and Chitradurga districts. Some of the richest deposits analyzing to more than 62 per cent iron ore occur in Bellary. Among the four most outstanding metallurgical achievements of antiquity, the production of Wootz steel is the most dazzling one. The development of this steel occurred in Karnataka and allied regions. Wootz is the anglicized version of ukku in the languages of the state of Karnataka, and Andhra Pradesh, a term denoting steel. Literary accounts suggest that the steel from the southern part of the Indian subcontinent was exported to Europe, China, the Arab world and the Middle East. Though an ancient material, wootz steel also fulfills the description of an advanced material, since it is an ultra-high carbon steel exhibiting properties such as super-plasticity and high impact hardness and held sway over a millennium in three continents - a feat unlikely to be surpassed by advanced materials of the current era. Wootz deserves a place in the annals of western science due to the stimulus provided by the study of this material in the 18th and 19th centuries to modern metallurgical advances, not only in the metallurgy of iron and steel, but also to the development of physical metallurgy in general and metallography in particular. It is a dream of India to recapture this primacy in steel. A reference must be

made to the pioneering role of Sir M Visvesvaraya in establishing in 1923 the Mysore Iron and Steel Limited at Bhadravathi, as the first public sector steel plant in the country. The company started with a miniature charcoal blast furnace and was gradually transformed into an alloy and special steel plant. LD , electric furnace and continuous casting were introduced at various stages . A diversification into production of ferroalloys has taken place. Today the plant is known as Visvesvaraya Iron and Steel Limited. The major consideration for locating the Jindal Vijayanagar Steel Plant at Torenagallu in Bellary District is the presence of extensive high grade iron ore deposits in Bellary -Hospet region. This plant is to make use of the Corex process. Currently scientists at I I Sc are modelling the corex process. Kudremukh means the face of a horse, as the profile of the mountain near Mangalore resembles it. This is no ordinary mountain but a rich lode of iron ore. It is one of the largest iron ore deposits of the world and the largest in Asia. Average daily production of ore is 70,000 tons.

V) THE SILICON VALLEY

The advances in materials science have been most spectacular in the last five decades. In particular the development of electronic materials has proceeded in an extraordinary manner. Indeed it is this aspect which led to the coining of the label Materials Science by John von Neumann, one of the pioneers of the computer. The discovery of zone refining led to the development of semiconductor materials such as silicon and germanium. The miniaturisation of devices through ICs and VLSI has led to the modern revolution of information technology. The emergence of the personal computer and the networked computer has led to the "Global Village". Indian record in the development of electronic materials has been at best patchy. The establishment of the semiconductor complex limited at Chandigarh and Gatech at Hyderabad are not adequate measures. The production of silicon by IISc scientists is a landmark in indigenous development of materials. With the Sanmar group IISc entered into a joint venture to establish Metkem silicon in 1969. The research and development of gallium arsenide films at IISc in a cooperative project with Bharat Electronics Limited and the Indian Space Research Organisation is worthy of mention.

While the nation has been lagging behind in hardware, it has emerged on a major player in software industry. Bangalore leads the nation in this effort earning for itself the sobriquet "Silicon Valley of India". While the debt of information technology to materials technology is enormous, it appears that this is being repaid. The tools of information technology can be used to access the vast storehouse of information on materials. Indeed the modern metallurgist must be as skilled in data mining as he must be acquainted with traditional mining. The establishment of " the Wootz File " at IISc with the ambitious objective of an universal materials library with emphasis on the Indian context may be pointed out.

V) SUMMING UP

The State of Karnataka is rich in mineral, material and human resources. This brief article has tried to bring out the mosaic of mineral and material production. It also indicated the pioneering role of IISc in these areas. However, it does not do justice to the many other facets of development such as Aeronautics and space. If the skies over Bangalore are alight with the Advanced Light Helicopter and tingle with the expectation of the Light Combat Aircraft in the horizon or the Indian satellites streaking across the globe, it will require a volume. In all these accomplishments the metallurgists of India, and the Indian Institute of Metals have played a decisive role.