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IRON TECHNOLOGY AND MEGALITHIC TRADITIONS OF THE PROTOHISTORIC DECCAN: A STUDY OF THE MUNNERU VALLEY

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Abstract

The protohistoric Deccan Plateau represents a distinctive technological and cultural milieu within South Asia. Unlike many regions of the subcontinent, where copper and bronze metallurgy generally precedes the widespread adoption of iron, archaeological evidence from the Deccan indicates a comparatively direct and archaeologically visible transition from lithic technologies to iron, with copper and bronze occurring only sporadically. This pattern reflects a convergence of ecological constraints, mineral resource availability, and locally driven technological innovation, in which iron was strategically adopted to meet practical demands such as forest clearance, agricultural intensification, and the production of durable tools and weapons.

Focusing on the Munneru Valley, a tributary of the Krishna River in present-day Telangana, this study examines iron artefacts—including tools, weapons, and associated material culture—through detailed typological analysis and chronometric dating of megalithic contexts. By situating the Munneru assemblages within broader Deccan and subcontinental frameworks, the study demonstrates that iron metallurgy functioned not merely as a technological resource but as a medium through which subsistence strategies, social organization, and ritual practices were articulated. The findings underscore the Munneru Valley's significance as a micro-regional case for understanding how early iron metallurgical knowledge shaped the material and cultural landscapes of protohistoric South India.

Keywords: Iron technology; Protohistoric Deccan; Munneru Valley; Megalithic burials; Metallurgy and material culture

Introduction

The Indian subcontinent encompasses a wide spectrum of ecological zones, cultural trajectories, and technological traditions. From the alluvial plains of the Ganga–Yamuna basin to the basaltic uplands of the Deccan Plateau, regional histories of technological change followed markedly different developmental pathways. Metallurgical practices, in particular, underscore this diversity. In the north-western and northern plains, archaeological evidence indicates the extensive use of copper and bronze prior to the widespread adoption of iron, reflecting a phased transformation in metal technologies closely associated with early urbanism and irrigation-based agriculture.[1]

The Deccan Plateau, however, exhibits a contrasting technological trajectory. Bounded by the Eastern and Western Ghats and traversed by major river systems such as the Godavari, Krishna, and Kaveri, along with important tributaries including the Pranhita, Manjira, Tungabhadra, Munneru, and Amaravathi, the region constitutes a geophysically distinct and mineral-rich landscape. Its rugged topography, basaltic geology, and extensive forest cover shaped technological choices and cultural practices in ways that diverged significantly from those of the northern plains.[2] Archaeological evidence suggests that copper and bronze were employed only sporadically in the Deccan and did not exert a sustained influence on craft production or social organization. Instead, the region is characterized by a comparatively direct

[1] Dilip K. Chakrabarti, *The Early Use of Iron in India* (Oxford: Oxford University Press, 1992), pp. 21–23.
[2] Dilip K. Chakrabarti, *The Archaeology of Ancient Indian Cities* (Oxford: Oxford University Press, 1995), pp. 113–15.

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transition from late prehistoric lithic traditions to iron-using assemblages, with iron rapidly integrated into agricultural, craft, and political domains.[3].

Iron metallurgy in the Deccan thus held both technological and cultural significance. Iron implements enabled forest clearance, agricultural intensification, and the establishment of more permanent settlement systems. Simultaneously, iron weaponry altered patterns of conflict and political authority, while the deliberate deposition of iron objects in megalithic burials highlights their symbolic and social value.[4] In this context, iron functioned not merely as a utilitarian resource but as a transformative material that reshaped subsistence strategies, social differentiation, and cultural identities.

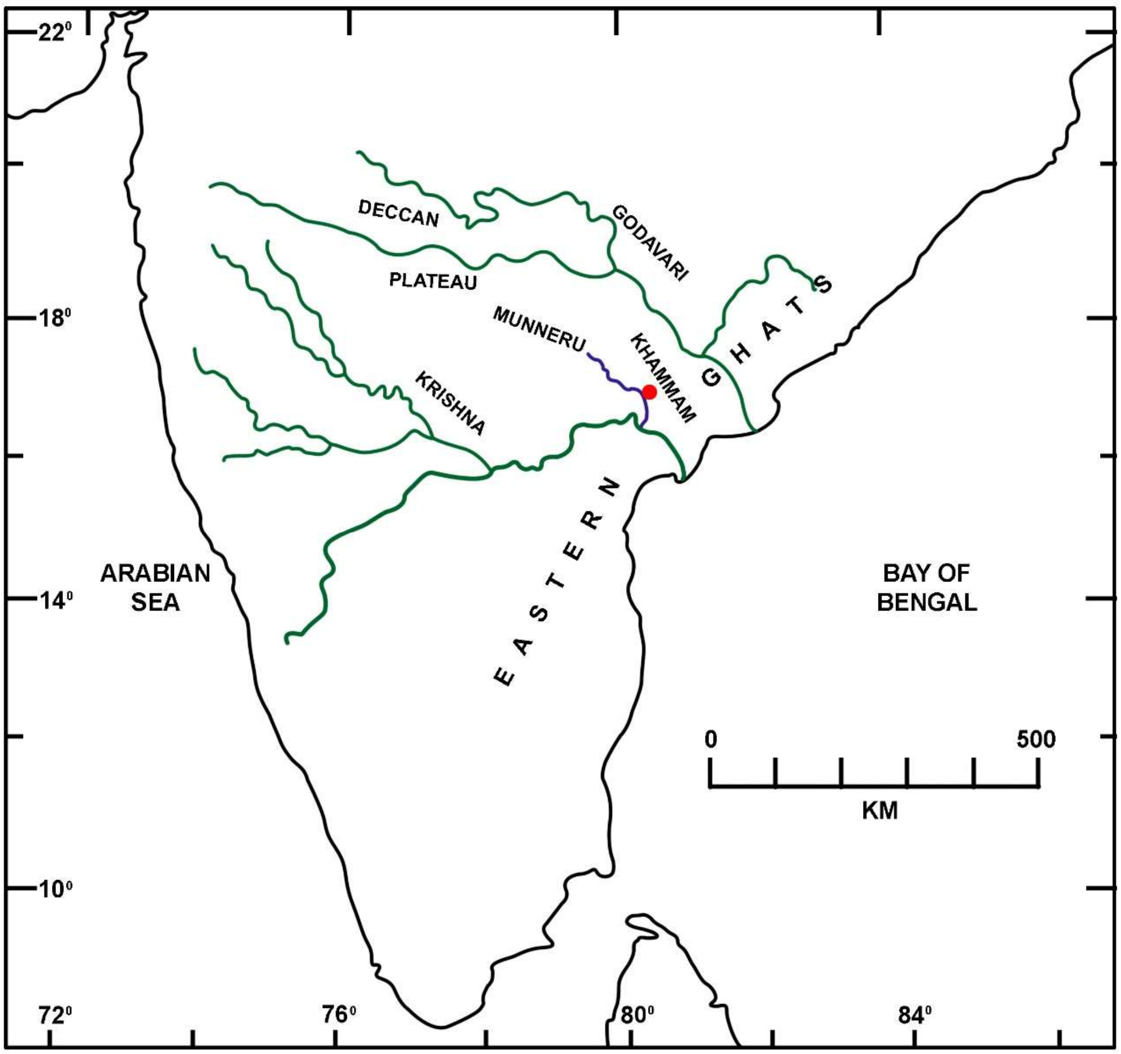

Figure-1: Map showing the course of the Munneru River in the Eastern Deccan region.

[3] V. Tripathi, "The Emergence of Iron in India: Archaeological Perspective," in *Metallurgy in India — A Retrospective* (Proceedings of the Seminar, National Metallurgical Laboratory, Jamshedpur, 26 Nov. 2000), **pp. 44–46.**

[4] Lawrence S. Leshnik, *South Indian Megalithic Burials: The Pandukal Complex* (Wiesbaden: Franz Steiner Verlag, 1974), pp. 112–14.

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Within this broader regional framework, the Munneru Valley emerges as a critical micro-regional locus for examining the intersection of iron technology and megalithic traditions. A tributary of the Krishna River, the Munneru traverses present-day Telangana, linking upland ecological zones with riverine landscapes. Excavations and systematic surface surveys in the valley have documented iron artefacts in association with megalithic architectural features, indicating both domestic production and ritualized deployment of iron. By situating the Munneru assemblages within the wider Deccan tradition, this study examines how localized ecological conditions and cultural practices shaped regionally distinctive systems of iron production, use, and meaning in protohistoric South India.

2. Diffusion and Indigenous Innovation in South Asian Iron Metallurgy

The emergence of iron technology in South Asia has long been a subject of scholarly debate, framed broadly by two paradigms: **external diffusion** and **indigenous innovation**. The external diffusion model posits that knowledge of iron smelting and forging was introduced to the subcontinent through contact with West Asia, either via the Achaemenid Empire in the fifth century BCE or through Indo-Aryan migrations from regions with early ironworking traditions. Proponents of this view, including R.E.M. Wheeler, N.R. Banerjee, and F.R. Allchin, argue that such contact explains the relatively rapid dissemination of iron artefacts across northern India, particularly in association with the Painted Grey Ware (PGW) culture in the Ganga-Yamuna Doab. Wheeler's excavations at sites like Charsadda suggest a diffusionist model in which iron technology entered India through interactions with Achaemenid administrative and military networks, providing both technical knowledge and the impetus for its widespread adoption.[5] Banerjee, in his seminal work *The Iron Age in India* (1965), similarly attributes the introduction of iron to Aryan migrations from West Asia, linking the appearance of iron artefacts to the PGW culture and emphasizing the role of incoming populations in shaping early Iron Age socio-technical organization.[6]

F.R. Allchin further elaborates that the distribution of iron artefacts and the technological uniformity observed in early Iron Age contexts in northern India are difficult to explain solely through indigenous innovation, suggesting that **cross-cultural interaction** played a significant role.[7] Scholars such as R. Thapar and D. Gupta also note that the chronological alignment of PGW settlements with the broader West Asian Iron Age implies a diffusionist element in the early technological repertoire of northern India, although they caution that such models must be tempered with evidence of localized experimentation and adaptation.[8]

In contrast, the indigenous innovation model, advocated by D.K. Chakrabarti, V. Tripathi, K.T.M. Hegde, and M.D.N. Sahi, emphasizes local experimentation and adaptation in the development of iron technology in South Asia. Archaeological excavations across the subcontinent indicate that iron ores suitable for smelting were widely available, particularly in central India, eastern India, and the Deccan, allowing communities to develop smelting and forging techniques independently[9]. Chakrabarti, in his seminal work *The Early Use of Iron in India* (1992), argues that the evidence of iron artefacts and slag at sites such as Dadupur and Malhar suggests an indigenous origin for iron technology in the region. He contends that the technological sophistication observed in these sites points to local innovation rather than external diffusion.

V. Tripathi, in his 2001 study, *Emergence of Iron in India: Archaeological Perspective*, supports this view by presenting evidence of iron artefacts and slag from sites in Uttar Pradesh, dating back to the early second millennium BCE. He

[5] R.E.M. Wheeler, *Early India and Pakistan* (London: Oxford University Press, 1959), 150–55.
[6] N.R. Banerjee, *The Iron Age in India* (Delhi: Munshiram Manoharlal, 1965), 45–50.
[7] F.R. Allchin, *The Archaeology of Early Historic South Asia* (Cambridge: Cambridge University Press, 1995), 78–82.
[8] Romila Thapar, *Ancient Indian Social History: Some Interpretations* (Delhi: Orient Longman, 1978), 112–15; D.P. Gupta, *Iron Technology in Ancient India* (New Delhi: Munshiram Manoharlal, 1980), 23–28.
[9] D.K. Chakrabarti, *The Early Use of Iron in India* (Delhi: Oxford University Press, 1992), 21–23.

highlights the technological continuity and regional variability observed in these findings, suggesting a process of local adaptation and innovation in ironworking practices[10].

K.T.M. Hegde, in his 1973 paper *A Model for Understanding Ancient Indian Iron Metallurgy*, examines the technological aspects of early Indian ironworking. He discusses the development of indigenous furnace designs and the use of local resources in iron production, emphasizing the role of local experimentation in the evolution of iron technology in South Asia[11].

M.D.N. Sahi, in his 1994 work *Material Context of Iron Technology in India*, provides an analysis of the material culture associated with early ironworking sites. He examines the distribution of iron artefacts and slag across various regions, arguing for an indigenous development of iron technology based on the evidence of local production and consumption patterns[12].

Recent radiocarbon dating of iron-bearing deposits at sites such as Dadupur (c. 1700 BCE), Malhar (2nd millennium BCE), Raja-Nal-Ka Tila (c. 1300 BCE), and Narhan (800–600 BCE) further supports the indigenous innovation model. These dates indicate an early and gradual integration of iron into local economies and material culture, consistent with a process of local development and adaptation[13].

Local experimentation and adaptation in the development of iron technology in South Asia underscores that its emergence cannot be attributed solely to a singular, externally introduced source of technological knowledge. The evidence points to a **complex interplay between indigenous innovation and external influences,** reflecting both the adoption of new techniques and their modification to suit local environmental, economic, and social contexts. **However, beyond questions of origin,** both models recognize that iron profoundly transformed protohistoric societies.

In the Ganga valley, for instance, the widespread use of iron axes and ploughs facilitated forest clearance and agricultural expansion, contributing to the period often described as the **Second Urbanization** between 800–500 BCE.[14] In the Deccan region, archaeological sites such as Naikund, Takalghat-Khapa, Junapani, and Mahurjhari provide compelling evidence of early iron technology and its integration into local subsistence and ritual practices. At Naikund, excavations have uncovered iron smelting furnaces, indicating advanced metallurgical techniques during the Megalithic period. Similarly, Mahurjhari and Takalghat-Khapa have yielded iron artifacts, including axes, chisels, and ploughshares, suggesting that ironworking was central to both daily life and ceremonial activities. These sites have been radiometrically dated to the period between 800 and 420 BCE, aligning the advent of iron technology with the construction of megalithic burial monuments in the region[15]. The presence of iron tools and weapons in these contexts underscores the role of iron in facilitating agricultural expansion, craft specialization, and the establishment of social hierarchies.[16] Moreover, the

[10] V. Tripathi, "Emergence of Iron in India: Archaeological Perspective," *Metallurgy in India — A Retrospective*, Proceedings of the Seminar, National Metallurgical Laboratory, Jamshedpur, 26 Nov. 2000, 44–46.
[11] K.T.M. Hegde, "A Model for Understanding Ancient Indian Iron Metallurgy," *Man and Environment* 8 (1973): 416–421.
[12] M.D.N. Sahi, "Material Context of Iron Technology in India," in *Aspects of Indian Archaeology*, ed. M.D.N. Sahi (Jaipur: B.R. Publishing Corporation, 1994), 35–55.

[13] R. Tewari, "The Origins of Iron Working in India: New Evidence from the Central Ganga Plain and the Eastern Vindhyas," *Antiquity* 77, no. 296 (2003): 1–10.
[14] D.D. Kosambi, *The Culture and Civilisation of Ancient India in Historical Outline* (New Delhi: Vikas, 1965), 121–126; R.S. Sharma, *Material Culture and Social Formations in Ancient India* (Delhi: Macmillan, 1983), 64–72.
[15] V. Tripathi, "Emergence of Iron in India: Archaeological Perspective," *Metallurgy in India — A Retrospective*, Proceedings of the Seminar, National Metallurgical Laboratory, Jamshedpur, 26 Nov. 2000, 78–85.
[16] D.K. Chakrabarti, *The Early Use of Iron in India* (Delhi: Oxford University Press, 1992), 50–52., V. Tripathi, "Emergence of Iron in India: Archaeological Perspective," *Metallurgy in India — A Retrospective*, Proceedings of the Seminar, National Metallurgical Laboratory, Jamshedpur, 26 Nov. 2000, 92-96.

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integration of ironworking with megalithic construction practices reflects a complex interplay of technological innovation and cultural expression during this transformative period in South Asian history.

A significant contribution to this discourse comes from **Hyderabad, Telangana**, where archaeological excavations have uncovered evidence of iron use dating back to approximately **2200 BC**. Excavations at the University of Hyderabad campus revealed iron artefacts, including small knives and blades, alongside earthen pots. These findings, dated using Optically Stimulated Luminescence (OSL) dating methods, suggest that iron was utilized in the region much earlier than previously documented, challenging the conventional timeline of iron adoption in South Asia.[17]

The discoveries from multiple excavations in Tamil Nadu indicate that iron production and use in the Indian subcontinent may be significantly earlier than previously believed, with radiometric dates suggesting iron objects as old as c. **2953–3345 BCE** from burial urns at Sivagalai, Adichchanallur, Mayiladumparai and Kilnamandi, potentially pushing back the onset of the Iron Age by more than a millennium compared to traditional models centred on West Asia.[18] These findings challenge diffusionist interpretations that attribute early Indian iron technology solely to external influence and instead support the possibility of **indigenous development of metallurgical knowledge** in South Asia.[19] Importantly, a substantial portion of these iron artefacts were recovered from **megalithic burial contexts**, with over 85 objects—knives, arrowheads, axes, chisels, rings and swords—found inside and outside urns, underscoring the **ritual and social significance** of iron within megalithic mortuary practices.[20] In addition to burial assemblages, evidence of smelting furnaces and slag in habitation contexts such as Kodumanal suggests specialised iron-making communities capable of high-temperature extraction, forging and early high-carbon steel production.[21] Collectively, these results imply the need to revise Iron Age chronologies in India, reassess models of technological transmission, and recognise South India—especially Tamil Nadu—as a crucial centre of early innovation, while highlighting the necessity for broader systematic, interdisciplinary research across the subcontinent.

Thus, while the external and indigenous paradigms differ in their explanation of the origin of iron, both frameworks converge in recognizing its transformative role in settlement patterns, subsistence strategies, technological specialization, and ritual expression. Iron technology in South Asia cannot be reduced solely to questions of diffusion or invention; it reflects complex interactions among environmental resources, local ingenuity, and broader patterns of cultural exchange that shaped the protohistoric subcontinent.

3. Iron Technology: Chronology, Typology, and Functional Sequences

3.1 Chronological Phases of Iron Adoption in the Deccan

It has long been debated among archaeologists whether technological innovations such as iron played a decisive role in promoting material prosperity and social transformation. Scholars have taken two contrasting positions—one viewing technology as a primary catalyst of cultural progress, the other treating it as a passive reflection of social evolution. It is not the purpose here to reopen that theoretical debate, but rather to assess the role of newly emerging technological know-how within the socio-cultural framework of the second and first millennia BCE, particularly as it pertains to the Deccan and Lower Godavari contexts. The cultural impact of technology, as has been noted, is proportional to two key variables:

[17] P. J. Thomas, P. Nagabhushanam, and D. V. Reddy, "Optically Stimulated Luminescence Dating of Heated Materials Using Single-Aliquot Regenerative-Dose Procedure: A Feasibility Study Using Archaeological Artefacts from India," *Journal of Archaeological Science*, vol. 35, 2008, 781–790.
[18] "Did the Iron Age Begin with Tamils? Groundbreaking New Research Challenges History." *Tamil Guardian*, 5 Mar. 2025.
[19] Ibid.; also see "Tamil Nadu May Be the Birthplace of Iron Age, Says Study." *The Times of India*, 24 Jan. 2025.
[20] "'Iron Age Began on Tamil Soil 5,300 Yrs Ago,' Stalin Declares Citing Artefacts Tested in Labs Abroad." *ThePrint*, 23 Jan. 2025.
[21] "Tamil Nadu's Ancient Iron Technology May Predate Global Iron Age Narratives." *Usthadian Academy*, 2025.

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first, the degree of its social adaptation; and second, the level of technical mastery achieved by the artisan class engaged in production and innovation.[22]

3.1.1 Phased Development of Iron Technology

During the earliest stage of iron adoption (c. 1300–1100 BCE), the adaptation of the new metal was minimal. Iron was rare and, in many parts of the world, employed as a prestige material alongside gold or bronze for ornamental or ritual purposes. In India, however, its earliest use appears to have been largely functional—limited to the production of hunting or war weapons, simple nails, or indeterminate fragments, as evidenced from Painted Grey Ware (PGW) and Black-and-Red Ware (BRW) levels in the Upper and Middle Ganga Plains.[23] These early artefacts often replicate the morphology of earlier stone or bone prototypes, indicating a conservative technological mindset in the initial phase of experimentation.

The subsequent **Standardization Phase (c. 1100–900 BCE)** witnessed diversification of tool types and a gradual application of iron to agriculture and craft. Sites such as Jekhera and Genwaria have yielded ploughshares from BRW and Proto-PGW levels, suggesting an early recognition of iron's potential in subsistence economies.[24] The introduction of hoes, sickles, chisels, and axes reflects a growing familiarity with the metal and the emergence of metallurgical techniques such as carburization and quenching, which enhanced both the strength and sharpness of implements.[25] These improvements coincided with settlement expansion, demographic growth, and craft specialization, signalling the onset of a complex agrarian economy.

By the **Peak Production Phase (c. 900–800 BCE onward)**, iron had become central to socio-political organization and economic intensification. Specialized production sites began to supply both local and interregional demands, reflecting occupational specialization and craft-based hierarchies.[26] Yet, as V. Tripathi notes, the relationship between technological development and socio-economic progress was not always linear.[27] In the megalithic cultures of peninsular India, despite sophisticated iron metallurgy and the use of precious metals like gold, material affluence remained limited due to ecological and organizational constraints.[28]

This interplay of technological innovation and social adaptation demonstrates that technology alone was not a sufficient condition for transformation. Its efficacy depended upon a society's ability to reorganize labour, manage resources, and institutionalize innovation. By the first millennium BCE, the maturation of iron technology had contributed to the expansion of *Janapadas* and later *Mahajanapadas*, the consolidation of political power, and the institutionalization of craft guilds that underpinned early Indian urbanism.[29]

3.1.2 Regional Contexts and Chronological Differentiation in Iron Adoption

The trajectory of iron technology in the Indian subcontinent was neither abrupt nor uniform. Instead, it developed through a mosaic of regional trajectories conditioned by ecological endowments, ore availability, settlement dynamics, and socio-political demand. Scholars such as D. K. Chakrabarti and Rakesh Tewari emphasize that the introduction and diffusion of iron cannot be reduced to a single revolutionary event or to a west-to-east migration model.[30]Rather, it reflects localized experiments and adaptive responses across multiple ecological zones between the second and first millennia BCE.

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22 D. K. Chakrabarti, *The Early Use of Iron in India* (Oxford University Press, 1992), 68–70.
23 R. Tewari, "The Origins of Iron Working in India: New Evidence from the Central Ganga Plain and the Eastern Vindhyas," *Antiquity* 77, no. 297 (2003): 536–44.
24 V. Tripathi, *The Painted Grey Ware: An Iron Age Culture of North India* (Allahabad: University of Allahabad, 1976), 45–47.
25 K. T. M. Hegde, "A Model for Understanding Ancient Indian Iron Metallurgy," *Antiquity* 47, no. 188 (1973): 198–204.
26 V. Tripathi, *The Archaeology of the Iron Age in India* (New Delhi: Sharada, 2001), 102–05.
27 Ibid., 115–16.
28 D. K. Chakrabarti, *India: An Archaeological History* (New Delhi: Oxford University Press, 1999), 173–75.
29 R. S. Sharma, *Material Culture and Social Formations in Ancient India* (Delhi: Macmillan, 1983), 82–86.

30 D. K. Chakrabarti, *The Early Use of Iron in India* (Oxford University Press, 1992), 63–69; R. Tewari, "The Origins of Iron Working in India," *Antiquity* 77 (2003): 539.

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The Deccan plateau—bounded by the Satpura ranges in the north and the riverine plains of the Krishna–Godavari system in the south—offers a compelling regional case for technological pluralism. The plateau's topography and mineral wealth favoured early smelting and tool production, yet environmental diversity produced variation in the timing, scale, and purpose of iron adoption. While the northern Deccan (Vidarbha and Malwa) engaged early with iron ore sources, the southern and eastern Deccan witnessed integration within agricultural, ritual, and megalithic contexts somewhat later.

To illustrate these regional variations, the following synthesis (adapted from Chakrabarti 1992 and Tewari 2003, 2010) presents the approximate chronology and artefactual patterns of iron emergence across the Deccan zones.

Table 3.1: Regional Chronology of Iron Adoption in the Deccan

Zone / Region	Approx. Date Range (BCE)	Key Archaeological Sites	Major Iron Artefacts	Cultural / Contextual Features
Northern Deccan (Vidarbha–Berar)	c. 1200–900 BCE	Naikund, Takalghat-Khapa, Junapani, Mahurjhari	Axes, arrowheads, hoes, spearheads	Early megalithic burials; iron used in ritual and subsistence contexts; associated with BRW culture.[31]
Central Deccan (Malwa–Maharashtra Plateau)	c. 1000–800 BCE	Eran, Kayatha, Nagda, Daimabad (late levels)	Ploughshares, sickles, nails, knives	Transition from Chalcolithic to Iron Age; iron integrated into farming and woodworking; continuity of settlement[32].
Eastern Deccan (Telangana and Lower Godavari Valley)	c. 900–700 BCE	Peddabankur, Gachibowli, Dharmapuri, Amaravaram, Polavaram	Ploughshares, wedges, nails, arrowheads	Megalithic and early Iron Age overlap; functional use in agriculture, metallurgy, and mortuary offerings[33].
Southern Deccan (Karnataka–Rayalaseema)	c. 1000–600 BCE	Hallur, Brahmagiri, Maski, Hirebenakal, Tekkalakota	Swords, daggers, tanged tools, iron slags	Developed iron-smelting traditions; close link between iron working and megalithic monument construction[34].

Collectively, these regional sequences demonstrate that the Deccan's iron technology evolved through multiple, locally rooted traditions. While northern regions displayed early experimentation, the eastern and southern zones illustrate the incorporation of iron into agrarian and ritual economies—indicating a process of gradual internalization rather than wholesale technological transfer.

Thus, the Iron Age in the Deccan represents not a monolithic technological revolution but a dynamic, regionally differentiated process that laid the foundations for later social complexity, trade networks, and artistic expression in the protohistoric Lower Godavari Valley.

3.2 Typology of Iron Artifacts

The iron artifacts of the Deccan exhibit remarkable functional diversity, reflecting the adaptive strategies of protohistoric communities in response to economic, domestic, and ritual demands. Typological analysis reveals that these artifacts not

[31] Chakrabarti 1992, 112–16.
[32] Ibid., 120–25.
[33] R. Tewari, "The Beginning of Iron Age in South India: A Review," *Man and Environment* 35, no. 1 (2010): 59–65.
[34] D. K. Chakrabarti, *Archaeological Geography of the Ganga Plain: The Lower and the Middle Ganga* (Delhi: Permanent Black, 2001), 142–46.

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only fulfilled utilitarian needs but also embodied evolving social roles, technological ingenuity, and ideological expression within early Deccan societies[35].

Agricultural Implements:

Ploughshares, sickles, and hoes constitute a prominent category of iron artifacts, signifying a major technological advance in land-use and agricultural productivity. These tools facilitated forest clearance, field preparation, and both wet and dry cultivation, thereby transforming subsistence economies and expanding the agricultural frontier. The widespread occurrence of such implements at sites like Naikund, Mahurjhari, and Hallur suggests an intensification of settled agrarian life and a gradual transition from subsistence-level farming to surplus-oriented production systems[36].

Domestic and Craft Tools:

Chisels, wedges, knives, and adzes represent the toolkit of domestic and artisanal activity. Their distribution across habitation sites underscores the growing specialization in woodworking, construction, and craft production. The standardization of certain tool forms indicates an increasing regularity in manufacturing techniques and possibly the emergence of professional metallurgists or localized production clusters[37]. These implements not only enhanced everyday domestic efficiency but also marked the development of specialized craft economies that contributed to intra-regional trade and social differentiation[38].

Weapons:

Swords, daggers, spearheads, and arrowheads are among the most symbolically charged iron artifacts. While primarily utilitarian in function—serving hunting, defence, and warfare—they also carried ideological weight as markers of authority, valor, and social rank. Their inclusion in megalithic burials such as those at Adichanallur, Junapani, and Ramapuram indicates that weapons embodied martial identities and conferred prestige even in death[39]. This duality of function and symbolism reflects the integration of martial ideology within the social fabric of protohistoric Deccan communities[40].

Ritual Artifacts:

Iron inclusions in megalithic burials, votive deposits, and ceremonial contexts highlight the metal's metaphysical and communal significance. Such artifacts were not merely offerings but symbolic instruments linking metallurgy to beliefs in fertility, regeneration, and ancestral continuity [41]. The presence of miniature tools or weapons in funerary assemblages indicates a deliberate ritual encoding of everyday materiality into ideological narratives of life, death, and transformation[42].

Overall, the typological spectrum of Deccan iron artifacts illustrates the adaptability of metallurgy to diverse ecological and cultural contexts. Iron served as a medium through which communities negotiated practical subsistence needs, technological advancement, and symbolic representation. The distribution and variation of artifact types further provide valuable insights into patterns of social stratification, labor organization, and ritual practice—revealing iron as both a utilitarian and cultural catalyst in the protohistoric Deccan[43].

3.3.4 Regional Evidence: Northern Telangana and the Deccan Plateau

Fieldwork in northern Telangana and adjacent Deccan regions provides empirical support for these functional sequences. The *Pioneering Metallurgy: Telangana Field Survey* (2011) documented 245 metallurgical sites, with 183 associated with

[35] Tripathi, Vibha. *The Age of Iron in South Asia: Legacy and Tradition*. Aryan Books International, 2001, pp. 95–104.

[36] Chakrabarti, Dilip K. *The Early Use of Iron in India*. Oxford University Press, 1992, pp. 43–49., Ghosh, Amalananda, ed. *An Encyclopaedia of Indian Archaeology*. Vol. 2, Munshiram Manoharlal, 1989, p. 357.

[37] Leshnik, Lawrence S. *South Indian Megalithic Burials: The Pandukal Complex*. Franz Steiner Verlag, 1974, pp. 97–100.

[38] Possehl, Gregory L. *Ancient Cities of the Indus Valley Civilization*. Oxford University Press, 2002, pp. 185–188.

[39] Gordon, D. H. "Iron and Steel in Ancient India." *Indian Antiquary*, vol. 77, 1949, pp. 231–238.

[40] Allchin, F. R., and B. Allchin. *The Rise of Civilization in India and Pakistan*. Cambridge University Press, 1982, pp. 245–247.

[41] Moorti, U. S. *Megalithic Culture of South India: Socio-Economic Perspectives*. Ganga Kaveri Publishing House, 1994, pp. 112–115.

[42] Brubaker, Robert. "Symbolism and Function in Megalithic Burials of Peninsular India." *Man and Environment*, vol. 14, no. 2, 1989, pp. 69–75.

[43] Paddayya, K. "New Research in the Iron Age Archaeology of Karnataka." *Man and Environment*, vol. 22, no. 2, 1997, pp. 1–14.

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iron production and about 20% exhibiting evidence of crucible steel production. The survey recorded well-preserved furnace bases, tuyères, slag heaps, and iron ore residues, alongside two crucible types—small, thin-walled and larger conical-lidded variants—highlighting technological diversity and localized specialization[44].

These findings demonstrate that metallurgy was embedded in settlement systems, forming pre-industrial industrial landscapes where ore extraction, smelting, refining, and craft production were closely integrated. The data also suggests regional networks, where technical knowledge, trade of iron implements, and possibly mobility of specialized artisans facilitated the diffusion of innovations across the Deccan plateau.

4. Iron as a Socio-Cultural Catalyst

Iron technology functioned as a driver of socio-economic transformation, influencing agriculture, craft economies, political authority, and ritual expression across the Deccan.

4.1 Agricultural Transformation and Settlement Intensification

Fig. 2: Iron sickle excavated from an oblong cist burial of the Stone Circle-type megalithic monument at Khammam town, on the left bank of the Munneru River, a tributary of the Krishna.

Iron tools revolutionized agriculture. Implements such as ploughshares, hoes, and sickles enabled forest clearance, soil tilling, and wetland cultivation, supporting sustained agricultural intensification. Increased productivity underpinned permanent settlement formation, population growth, and the emergence of socio-political hierarchies. Archaeological evidence of storage structures, irrigation channels, and communal granaries suggests coordinated efforts in resource management and agricultural planning, positioning iron-mediated agriculture as a key driver of protohistoric socio-political organization.[45]

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[44] Gillian Juleff, Sharada Srinivasan, and Srinivasan Ranganathan. *Pioneering Metallurgy: The Origins of Iron and Steel Making in the Southern Indian Subcontinent – Telangana Field Survey Interim Report 2011.* Bengaluru: National Institute of Advanced Studies and University of Exeter, 2011, pp. 34–49.

[45] B. Chakrabarti. *The Early Use of Iron in India.* Delhi: Oxford University Press, 1976, p. 115.

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Fig. 3: Iron coulter (plough implement) excavated from a cist burial of the Stone Circle-type megalithic monument at Khammam town, on the left bank of the Munneru River, a tributary of the Krishna.

4.2 Craft Production and Domestic Economy

Iron artifacts such as chisels, wedges, and knives indicate specialized craft production, particularly in woodworking, pottery preparation, and domestic tools. This implies early differentiation of labour, where metallurgical expertise contributed to social stratification and communal interdependence. Craft specialization also enabled economic diversification, fostering the emergence of trade networks and local markets, which were essential for the consolidation of early urbanized or semi-urbanized centres.[46]

Fig. 4: Iron wedge recovered from a cist burial of the Stone Circle-type megalithic monument at Khammam town, situated on the left bank of the Munneru River (Krishna basin).

An iron wedge was recovered from a megalithic burial at Khammam. The tool, characterised by its tapering form and robust construction, was likely employed in woodworking activities such as splitting timber and shaping wooden components, and possibly in leather-working processes. Its presence within the burial assemblage reflects the importance of craft production alongside agriculture in the subsistence economy of Iron Age communities in the Munneru–Krishna basin.

[46] V. Tripathi. *History of Ancient India: Archaeology, Art and Metallurgy.* New Delhi: Concept Publishing, 2008, p. 74.

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4.3 Weapons, Hierarchy, and Political Authority

Fig-5: An iron pointed implement, likely a spearhead, unearthed from a Swastika-pattern cist burial of the Stone Circle-type megalithic monument at Khammam town, on the left bank of the Munneru River, a tributary of the Krishna.

Iron weapons served dual functions—practical tools of warfare and markers of elite status. Variations in quality, design, and craftsmanship indicate controlled production under elite oversight. Possession of superior weapons enabled territorial control, enforcement of social hierarchies, and consolidation of political power. In this sense, metallurgy was both instrumental and symbolic, linking technological capability to socio-political organization and the emergence of early state structures in the Deccan.[47]

Fig.6: Iron sword with handle excavated from a Swastika-pattern cist of the Stone Circle-type megalithic monument at Khammam town, on the left bank of the Munneru River, a tributary of the Krishna

4.4 Ideological and Symbolic Integration

Iron artifacts were ritually and symbolically significant. Their deposition in megalithic burials, ceremonial heaps, and rock art contexts reflects integration into cosmological beliefs, ancestor veneration, and collective identity formation. This

[47] R. Tewari. *The Origins of Iron and Steel in India.* Delhi: Munshiram Manoharlal, 2003, p. 129.

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ritualization demonstrates that metallurgy was not solely utilitarian but also a medium through which protohistoric communities articulated ideology, social cohesion, and cultural identity.[48]

5. Munneru Valley as a Micro-Regional Case Study

The Munneru Valley exemplifies the interplay between local innovation, resource availability, and broader cultural dynamics within the protohistoric Deccan. Typological analyses of iron tools and weapons, coupled with chronological sequences derived from megalithic burials and habitation contexts, indicate that communities here developed metallurgical practices adapted to local ecological and socio-economic conditions, while simultaneously engaging in regional exchange networks.

Riverine systems, particularly the Munneru and its connection to the Krishna River, functioned as critical corridors for technological dissemination, population mobility, and inter-settlement interaction. These waterways facilitated not only the movement of goods and ideas but also the transmission of metallurgical knowledge, allowing the Munneru Valley to act as a nexus linking northern Telangana with central Deccan communities.

Comparative analysis with surrounding regions reveals the valley's role as both a technological node and a cultural conduit. While northern Telangana exhibits parallel iron adoption patterns, the Munneru Valley demonstrates distinctive local adaptations in tool typology, functional deployment, and ritual integration. Similarly, central Deccan sites reflect broader regional trends in iron use and socio-political organization, positioning the Munneru Valley as an important intermediary zone where localized innovation intersected with supra-regional cultural currents.

By situating the Munneru Valley as a micro-regional case study, this analysis underscores the significance of localized iron technology not merely as a utilitarian development but as a driver of cultural identity, social hierarchy, and regional connectivity within the protohistoric Deccan.

7. Conclusion

Iron technology in the protohistoric Deccan, as exemplified by the Munneru Valley, acted as a catalyst for profound transformations across economy, society, and ideology:

- **Agricultural Intensification:** Iron tools enabled sustained settlement consolidation and expansion of cultivable land.
- **Craft Specialization:** Technological sophistication facilitated production of domestic, craft, and ritual artifacts.
- **Social Hierarchies and Political Structures:** Differential access to iron implements and weaponry reinforced emerging elites and territorial authority.
- **Ritual and Symbolic Integration:** Iron was embedded within megalithic burials, ceremonial deposits, and symbolic landscapes, reflecting community identity and cosmological beliefs.

The Munneru Valley thus demonstrates how regional innovation intersected with broader Deccan networks, illustrating that iron functioned not merely as a material technology but also as a social and cultural agent. Future research integrating archaeometallurgy, GIS-based settlement analyses, and bioarchaeological evidence promises to further elucidate the complex interconnections between technological practice, societal organization, and identity formation in South Asia.

Crucially, the Deccan region is endowed with rich iron-bearing geological formations, particularly in areas like Vidarbha, Chhattisgarh, and Telangana, which provided accessible resources for early metallurgical experimentation and production. These environmental and geological features facilitated the development of regionally specific technological adaptations, distinguishing the Deccan from other contemporary cultural zones in the subcontinent.[49]

Archaeologically, the Deccan exhibits a relatively direct transition from lithic technologies to iron, with limited evidence for extensive copper or bronze metallurgy, a pattern that contrasts sharply with the northern Indo-Gangetic plains, where copper and bronze artefacts dominate the pre-Iron Age assemblages.[50] The adoption of iron tools and implements in Deccan landscape likely due to the abundance of iron ore and the specific functional requirements of their subsistence

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[48] B. Chakrabarti. *The Early Use of Iron in India.* Delhi: Oxford University Press, 1976, p. 118.

[49] "Understanding the Stability of Early Iron Age Folks of South India with Special Reference to Krishna-Tungabhadra-Kaveri, Karnataka," Academia.edu, 2014, https://www.academia.edu/79102308.

[50] "India's Iron Age Began in Tamil Nadu 5300 Years Ago: Report," *Deccan Herald*, 23 Jan. 2025, https://www.deccanherald.com/india/tamil-nadu/indias-iron-age-began-in-tamil-nadu-5300-years-ago-report-3370356.

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economy. The adoption of iron tools and implements in this landscape was closely linked to practical imperatives, including forest clearance for agriculture, the construction of megalithic monuments, and the production of durable implements for daily life. Moreover, the emergence of iron in the Deccan had far-reaching socio-cultural implications. Iron axes, adzes, and ploughshares enabled more intensive agricultural practices, supporting larger and more sedentary populations, while iron weapons facilitated changes in political and military organization. The interplay between environmental constraints, resource availability, and technological innovation therefore underpinned not only the material culture of the region but also the social and ritual life of protohistoric communities. This distinctive trajectory underscores the autonomous development of iron technology in the Deccan, marking the region as a critical locus for understanding the broader processes of technological and cultural transformation in early South Asia.[51]

[51] V. Selvakumar, "Palaeolithic Occupation of Southern Tamil Nadu, India," *ScienceDirect*, 2012, https://www.sciencedirect.com/science/article/pii/S1040618211003314.