JOURNAL OF HISTORY AND ARCHAEOLOGY
ISSN: 3107-734X, Vol. 1, No. 2, 2025, pp. 117-150

URL: http://www.arfjournals.com
Publisher of Open Access Journals
Peer Reviewed Journal

A Report on Excavation at Badmal Asurgarh: An Iron Age-Early Historic Fortified Settlement in the Middle Mahanadi Valley Region, District Sambalpur, Odisha, India

PRADEEP KUMAR BEHERA[1], SAKIR HUSSAIN[2], PRANAB K. CHATTOPADHYAY[3] AND NEENA THAKUR[1]
[1]*Qrs. No. A/4, Jyoti Vihar, Sambalpur University, Jyoti Vihar Campus, Burla-768019, Odisha, India.*
E-mail: pradepkbehera53@gmail.com, neenat1@gmail.com
[2]*Government Autonomous College, Sundargarh, Odisha, India. E-mail: sakirhussain303@gmail.com*
[3]*Mission Palli Near P.G. Garden, Sonarpur, Kolkata-700150 , India. E-mail: pranab.chattopadhyay@gmail.com*

Abstract: The site of Badmal-Asurgarh, located in the middle Mahanadi valley of the Odisha highlands, represents a significant fortified settlement dating from the Iron Age to the Early Historic period (c. early 1st millennium BCE to 2nd century BCE). Strategically positioned on the left bank of the Harihar stream, the site spans approximately four hectares and is demarcated by a lozenge-shaped earthen rampart and a wide moat with three entry points, indicating planned defensive architecture. Excavation remains supported by radiocarbon dating, stratigraphic analysis, and ceramic typology, indicate two distinct phases of occupation. The Iron Age phase was marked by a subsistence economy based on limited agriculture, animal husbandry, and foraging, with minimal but definitive use of iron, primarily for utilitarian tools. A subsequent occupational hiatus is followed by reoccupation during the Early Historic period, when the site witnessed significant socio-economic transformation. Of particular importance is the emergence of Badmal as a major bead manufacturing centre during this later phase. The presence of raw materials such as banded hematite, red jasper, and agate, alongside imported cowry shells, coral, and onyx, suggests long-distance trade networks. Iron, crucial to bead production, appears to have been both locally used and possibly imported in higher-quality forms, pointing to complex exchange systems. Despite its archaeological importance, the site suffers from severe disturbances due to modern activities, including road construction and illegal gem mining. Nevertheless, the relatively intact northern sector offers valuable insight into early industrial specialization in eastern India. This paper presents a broad picture of our excavation conducted during the 2000-2001Season's.

Keywords: Fortification, Precious/semi-precious beads, Ceramics, Iron Age, Faunal remains, Odisha.

Received : 13 September 2025
Revised : 19 October 2025
Accepted : 28 October 2025
Published : 30 December 2025

TO CITE THIS ARTICLE:

Pradeep Kumar Behera, Sakir Hussain, Pranab K. Chattopadhyay and Neena Thakur (2025). A Report on Excavation at Badmal Asurgarh: An Iron Age-Early Historic Fortified Settlement in the Middle Mahanadi Valley Region, District Sambalpur, Odisha, India. *Journal of History and Archaeology,* 1: 2, pp. 117-150.

INTRODUCTION

Archaeological investigations conducted during the last few decades in various parts of Odisha have brought to light several Early Historic settlements, some of which are fortified (Lal 1949; Das 1990; Basa and Mohanty 2000; Yule 2006; Patra 2007; Mohanty and Smith 2008; Hussain 2018). From the available literature, it appears that by the 6th-5th century CE there was a proliferation of urban centres of various dimensions and styles in Odisha. These have been reported from three environmental zones: the hilly terrain of the Eastern Ghats and Chhottanagpur Plateau, the coastal plains comprising the alluvial stretch of the Mahanadi delta and the Rusikulya river system in south Odisha, and the alluvial stretch of the highland areas. Thus, the region of Odisha included distinct environments to which the Early Historic settlers very well adapted. The distribution pattern of these settlements appears to suggest that, in addition to the latter two environmental zones, highlands were also preferred, obviously due to the availability of rich and varied mineral resources and a wide spectrum of subsistence-related forest products. Our survey in the Middle Mahanadi Valley region of Odisha, which stretches from the Hirakud Dam Reservoir to roughly the Tikaraparah gorge (Singh 1971: 754-775) identified thirty-four Iron Age-Early Historic sites on both the banks of Mahanadi and forty on its major and minor tributaries (Behera *et al.* 2019: 95-134; Hussain and Mahakur 2023: 337-345), associated with black-and-red ware pottery and other exotic/non-exotic artefacts (Fig.1). Most of these also contain Iron Age deposits suggesting cultural continuity in the region (Behera 2002-2003). However, compared to other regions of India where extensive structural remains belonging to the pre and post Gupta period sites have been brought to light, unfortunately in the study area most of the structural sites are either washed away by the Mahanadi or due to anthropogenic intervention, these have been completely destroyed.

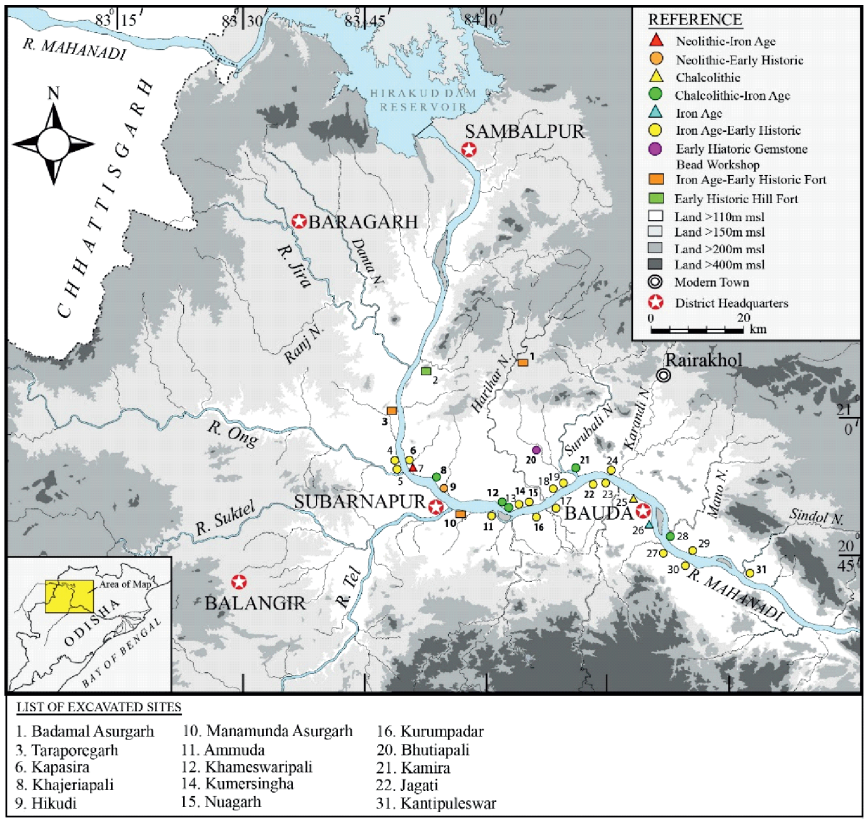


Fig. 1: Iron Age-Early Historic Settlements (Excavated and Explored) in the Middle Mahanadi Valley

As stated above, our intensive exploration in the Middle Mahanadi region have brought to light a large number of Iron Age-Early Historic settlements in the region. Some of these are fortified, while others are open-air mounds of varied dimensions and in varied state of preservation. In the mid-first millennium BCE, the middle Ganga plains witnessed the emergence of the Early Historic period due to various factors, including natural conditions and earlier cultural developments *i.e.* Iron Age (Ghosh 1973, 1989: 130-151; Allchin 1995; Dhavalikar 1999: 1-16). During this initial phase, early historical growth extended across and beyond the middle Ganga plains, to the Ganga-Yamuna doab, Northwest India, and parts of Central India and also Eastern India, including Odisha and West Bengal. Archaeological evidence suggests that by about the 5th-4th century BCE, there was a efflorescence of early historic centres of different sizes and styles in Odisha (Yule 2006; Mohanty and Smith 2008; Mishra and Behari 2019: 1-33; Mishra 2005: 135-148; Patnaik 2022-23: 363-384; Behera *et al.* 2019; Hussain 2020: 69-90). The distribution pattern of these settlements indicates that, in addition to the Coastal Plains, the highland areas of Odisha, were also favoured due to the abundance of rich mineral resources and a wide range of forest products as well as wild and domesticated animals for subsistence. This part of highland region of Odisha is identified as a gemstone belt having more than 150 pegmatite deposits alone in the Harihar stream and its adjacent areas with evidence of occurrence of emerald, ruby, sapphire, aquamarine, heliodor, chrysoberyl, tourmaline, zircon, topaz, moonstone, amethyst, smoky quartz, and garnet, among others, associated with the iron ore and pegmatite deposits of the Eastern Ghats (Mishra and Mohanty 1995: 185-202). The renowned geographer Ptolemy of the 1st century CE also mentioned diamond mines at *Sambalaka* (probably modern Sambalpur in Western Odisha) and referred to the river *Manada* (probably identified with the Mahanadi River) as rich in gemstone resources (Majumdar 1927: 169). Thomas Motte, a British diamond merchant, corroborated the existence of gemstone deposits in the region and praised the quality of diamonds available at Sambalpur (Acharya 1955). He also described trade activities, the use of boats in the Mahanadi River and its tributaries, as well as the fortified settlements along its banks. In view of the above the site of Badmal Asurgarh located in the upper course of the river Harihar, a northern tributary of the Mahanadi River becomes immensely significant.

IRON AGE-EARLY HISTORIC CULTURE OF HIGHLAND REGIONS OF ODISHA

Unfortunately, compared to other regions of India where extensive structural remains belonging to the early historic period have been unearthed through systematic excavations, no such effort has yet been undertaken in Odisha. The first excavation in this region was conducted at Narla Asurgarh in Kalahandi district by N. K. Sahu in 1973 (Behera 1982). Now, the question of location of *Mahakantara* mentioned in line nineteen of the Allahabad pillar inscription (Gupta 2013: 8), which says king Samudragupta invaded this country subjugated the reigning ruler *Vyaghyararaja*. While scholars widely differ in their opinion about its exact location (Pandey Sharma 1947: 176), N.K. Sahu of Sambalpur University ascertained on the basis of his excavations carried out inside the fort in 1973 at Narla Asurgarh that the massive rectangular shaped fort was under the possession of king *Vyaghyararaja* whom Samudragupta defeated during his southern Indian campaign (Behera 1982: 7). The two trial trenches laid by Sahu inside the fort yielded two phases of structural remains, *i.e.*, Mauryan and post-Mauryan (Gupta) periods. The size of bricks used in the structures varies widely, like 44×29×7 cm, 43×27×7 cm, 38×20×7 cm and 27×21×7 cm. The excavations yielded a large variety of artefacts which included a hoard of 50 pieces of silver punch-marked coins, which belong to pre-Mauryan, Mauryan and post-Mauryan or

Gupta period. According to Sahu these coins were minted at the site and were in circulation as late as 5th century CE in this area. It seems probable that this part was under the control, at least economically or administratively, under the Mauryans. Significantly, during the excavation of *Kurumpadar* (District-Baudh) in the middle Mahanadi River an imperial variety of silver coated copper punch marked coin was also recovered along with evidence for large scale glass bangle production in the upper level with scores of slags and numerous finished and unfinished glass bangles and other byproducts. (Behera and Khamari 1998-99: 205-210; Singh and Behera 2001-02: 173-176).

According to N.K. Sahu, as per *Terasingha* copper-plate inscription found near the Narla Asurgarh fort, King *Vyaghyararaja* was succeeded by the next important king, named *Tushtikara*, who held sway over the fort for some time and by about 5th-6th century CE the site was deserted. Unfortunately, except a brief note of seven pages and a very few artefacts, like brick pieces and very few pottery pieces now stored in the N.K. Sahu Museum of the Post-Graduate Department of History, Sambalpur University, we do not have any other detailed information on this important excavation.

Subsequently, small scale excavation was conducted by S.C. Behera in 1982 at another very important and massive early historic fortified site *i.e.* Manamunda-Asurgarh, located near the confluence of the Mahanadi and the Tel in the district Baudh (Behera 1982: 16-22), which revealed an early historic fortified settlement with the extensive material remains of Iron Age-early historic period. During the subsequent period in 1989-90 the site was again subjected to excavations by the P.G. Department of History, Sambalpur University, under the supervision of C.R. Mishra and S. Pradhan (IAR 1989-90: 80-86, IAR, 1991-92: 86). This year's excavation also yielded extensive structural remains, like soak pits, terracotta ring wells, foundations of houses, square-shaped brick-lined tanks, besides a large variety of variety of ceramic wares, beads of precious and semi-precious stones, copper

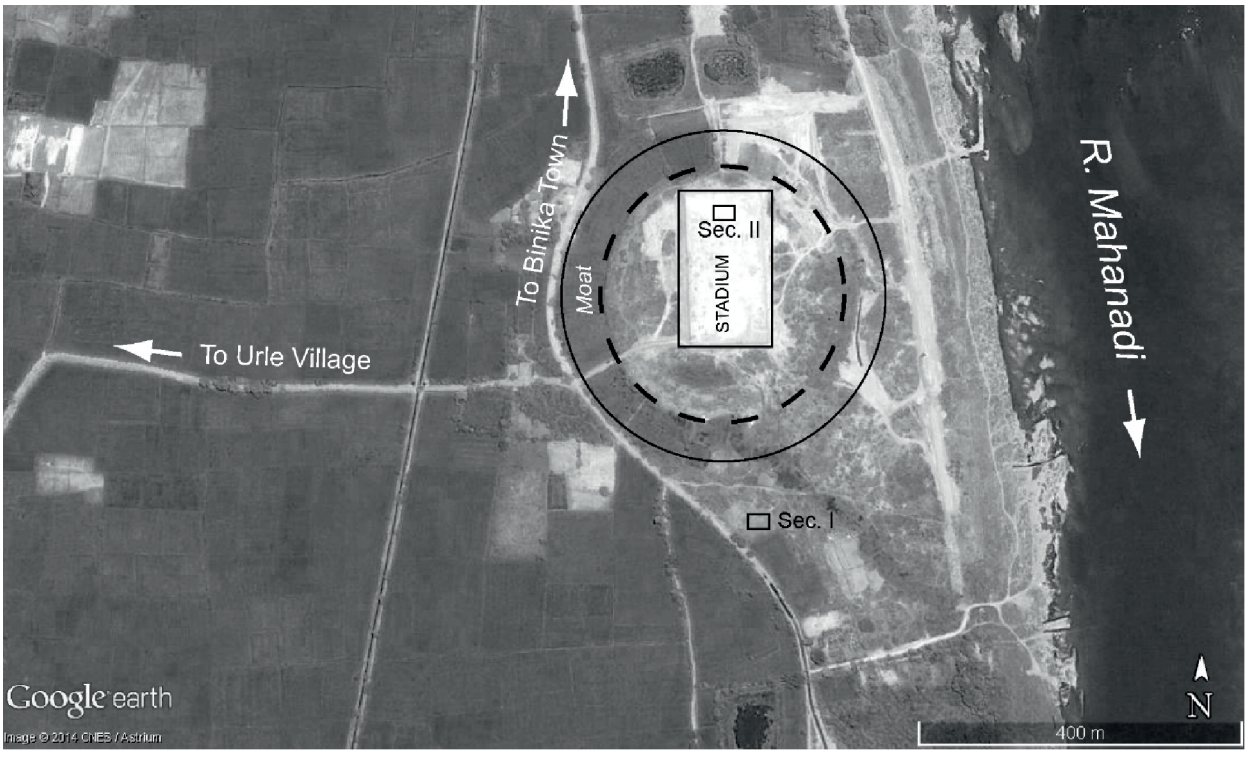


Fig. 2: Circular Fortified site with moat on the right bank of the Mahanadi near Binka, Dist-Subarnapur, recently build up stadium in the center of the mound

and glass bangles, several specimens of imperial variety of silver punched marked coins (Pradhan 1992: 26-28), and numerous iron objects and other artefacts. Unfortunately, except a brief note published by S. Pradhan in the *Indian Archaeology: A Review* almost nothing is available, not even the photographs and material remains recovered and extensive remains of structural remains unearthed during the excavation. Ironically, except a small part of the southern rampart wall, the entire fortification area has already been washed away by recurrent flood in the Mahanadi and its tributary the Tel. Had the site and its cultural remains been systematically documented and analyzed for posterity, it would have greatly benefited to the future generation of young archaeologists in understanding the processual aspects of urbanization in this part of Odisha. Unfortunately, it seems none of the proper archaeological methods and techniques have been followed by the excavators while excavating this very important multi-period (From Iron Age through the Mauryan to the Gupta Period) fortified settlement.

Another important fortified Early Historic site in the area is Taraporegarh, situated on the right bank of the Mahanadi, nearly two kilometers east of the town of Binika, in the district of Subarnapur. Significantly, four copperplate inscriptions ascribed to the *Somavamsi* ruler Mahashivagupta Yayati-I of 9th-10th century CE issued from *Vinitapura*, have been reported from this area. In terms of historical geography the place name *Vinitapura* has been identified by some historians with the modern town of Binika (Mishra 1933: 68-69). Situated on the right bank of Mahanadi, the site is almost circular on plan, enclosed on all sides with a massive earth rampart which rises to a height of about four meters from the surrounding plains (Fig.2).

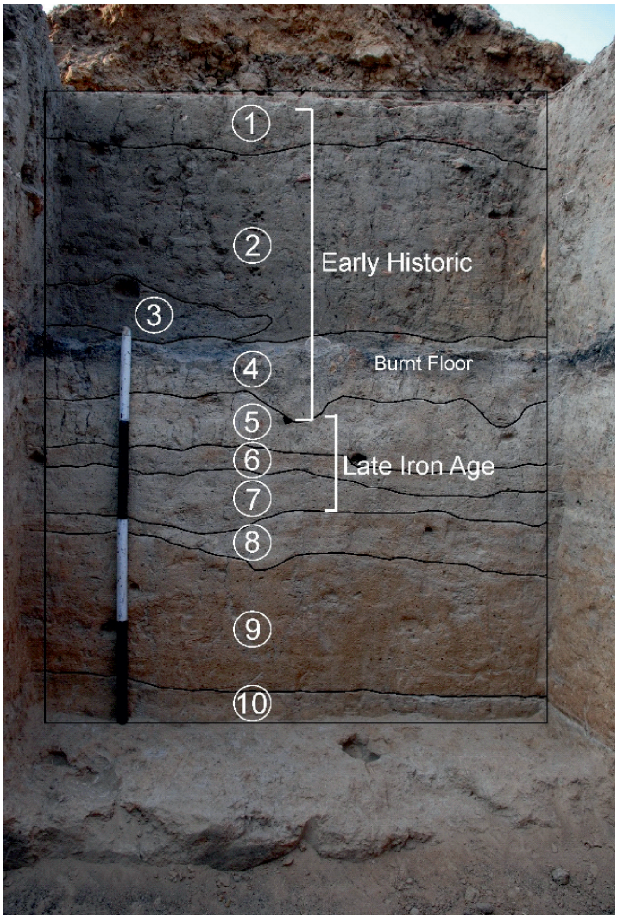


Fig. 3: Scrabed Section-II inside the fortified settlement representing different cultural phases

Interestingly, other than Taraporegarh no other such circular fort has been recorded in the state of Odisha so far. The debris of the rampart suggests that it was made out of clay and rubbles dug out from outside the periphery of the site. The fortification wall measuring about 20 m in width at the base and rounded at the top, is encircled on all sides by a 60 m wide moat, which is now converted into agricultural fields by the present villagers. The fort covers an area of about four hectares (200 m x 180 m). While the north-western, western and south-western prominences of the wall are to some extent better preserved, other parts including the inner area have already been destroyed by natural and anthropogenic agencies. Recurrent floods in the Mahanadi have severely eroded the eastern parts of the site. Flood water regularly enters the fortified area on the eastern side. Significantly, the site of Taraporegarh represents the easternmost extension of circular fort, which has a wide distribution in the eastern part of Chhattisgarh region (Pandey 2010). Here also, first a Government funded *Panthanivas* (Rest House) constructed during 1996-97 towards the north-eastern part inside the fort, which caused severe damage to almost 200 sq. meter area of the fort. Subsequently, recently, a public stadium was constructed which covers a substantial part of the habitation area inside the fort. This has seriously impaired the preservation of the site giving very little scope for future archaeological investigations. Despite local protests nearly more than two meters thick habitation deposit inside the fort was bulldozed and levelled plain revealed scores of iron object and other artefact were found scattered across the site. Earlier, towards the north-western part of the settlement a huge pit was dug by using JCB the workers of the construction project. Later the exposed section of this ditch was thoroughly scrapped by us to at least to record different cultural levels represented at the site (Section-II: Fig.3).

About 80 m outside the southern wall of the Taraporegarh fort lies another mound of moderate height (about 3-5 m from the surrounding plains). The mound measures about 205 m in length and 140 m in width. While a substantial part of this mound lying towards the east has already been washed away by the floods in the Mahanadi, the western part is under active cultivation.

The eroded section inside the fort was scrapped (Section-II) and exposed a 195 cm thick deposit divisible into 10 layers, identified on the basis of colour and composition of soil sediment, besides cultural materials., which yielded different ware types and antiquities. The scrapping was carried on to the natural soil. The clearing of the section revealed Habitation remains *viz*., pottery fragments of highly polished Black Slipped, Red Slipped, black-and red ware and plain red ware, besides lot of faunal remains, etc., recovered from Layers-1 to 7, while Layers 8, 9 and 10 were found to be sterile. A burnt and rammed floor of about 10-15 cm thickness occurred in the upper level of Layer 5. The floor is made of charred cereal grains mixed with burnt earth, mainly represented by carbonized grains of rice (domesticated coarse type, belonging to *Oryza sativa* Linn; (*pers. comm.* with M. D. Kajale of Deccan College, Pune) and potsherds of various types and fabrics. Large quantity of potteries, mostly in rolled condition from the upper deposits and sparse faunal remains, but floral remains were recovered from different stratigraphic levels. Soil sediments sampled from different levels were put to floatation method for complete recovery of depth-wise vegetation remains, which recovered were submitted to the Deccan College, Pune for identification, but still awaiting the results. The section scrapping (Section-I) which was carried out outside the fort revealed a 140 meter-thick habitation deposit divisible into four distinct layers overlying the natural soil, composed of yellowish red coloured sandy-silty-clay. The excavation yielded huge quantity of potteries of different ware types and faunal remains, most of which were in charred condition. The fauna recovered included medium sized cattle (*Bos indicus*), sheep/goat (*Ovis/Capra*), horse (*Equus*

caballus), pig *(Sus scrofa*), molluscan shells (gastropods and lamellibranches), etc., (Behera *et al.* 2015: 178-196). While levelling the ground inside the fort for constructing the public stadium scores of iron objects of different types, ceramics, brick structures and a complete terracotta/brick-lined ring well were also brought to light. The size of the bricks used in the structural remains varies from 30×20×7 cm to 25×18×5 cm.

Recently, the Archaeological Survey of India, excavation branch, under the supervision of D.B. Gadnayak conducted systematic excavations at the Narla Asurgarh site (20o 04' 54" N; 83o 21' 8" E, MSL- 226 m), located on the left bank of the *Sandul* stream, a tributary of the river Tel which is a major southern tributary of the Mahanadi. Though no detailed report of the excavation is available, but a brief research article is available on the site (Gadnayak 2020: 353-377). Excavation revealed broadly three phases of human occupation, out of which the earliest phase belonged to two Iron Age phases *i.e.* Period I and II (9th century BCE to 4th century BCE}, while two others belonged to the pre (3rd -4th century BCE to 2nd century BCE} and post rampart phases (2nd century BCE to 1st century CE) and the site was deserted by about 2nd century CE to 3rd -4th century CE. However, except a few Black-and-Red Ware sherds, the ceramic assemblage comprise mainly fine and polished red slipped and black slipped wares, besides beads of semi-precious stones, terracotta figurines, terracotta roof tiles and several iron objects and silver punch-marked coins. Brick structural activities appeared during the Periods-II and III. The chronological scheme does not seem to differ much from the earlier excavations conducted by N. K. Sahu.

Besides the above, recent excavations carried out at Kharligarh (Pradhan 2003: 51-61) and Budhigarh (Mishra 2016: 21-28) forts located in the Tel river system also yielded extensive brick structures and other antiquities belonging to the pre-Gupta and Gupta periods, but no detailed reports are available. The most well preserved and intact Early Historic fort is Jamsaragarh (Hussain 2020: 132-135), located in the Jhirpani area of Rourkela town in the district Sundargarh, and situated on the left bank of the river South Koel, a tributary of the river Brahmani. This site was first studied by the first author while conducting prehistoric investigation in the upper Brahmani river valley in 1985. Subsequently it was mapped and documented in the year 2002 (Yule *et al.* 2005: 307-318). Here huge structural remains of Sunga-Gupta period are exposed towards the river bank. However no detailed work has yet been initiated at Jamsaragarh. Similarly, Gupta period structural remains have also been recorded at Nehna **(**Mishra, 2011) in the Nuapada district, Deuli in Subarnapur district (Hussain *et al.* 2017: 59-63), and Deundi and Kachchhimdola **(**Hussain and Joshi 2014: 259-262), Budhigarh (Mishra 2016: 21-28) and Sirpur (Mishra 2011) in the Kalahandi district, all located in the Tel river system, besides an extensive hill top Gupta period structural site was discovered at Sindhol in the district Subarnapur (Behera 2023: 81-93) . Though extensive excavations were carried out at Budhigarh in Kalahandi no detailed report is available on this site (Mishra 2016). In view of the above, here an attempt has been made to provide an insight on the available details of the excavations carried out at the Iron Age-Early Historic fort of Badmal Asurgarh.

THE SITE OF BADMAL ASURGARH

The fortified site of Badmal-Asurgarh (Long. 21° 07' 84" N; Lat. 84° 04' 42" E) is roughly lozenge/rhombic-shaped and spreads over an area of about four hectares (180 x 120m). The site is protected on all sides by a massive earth rampart, which rises to a height of about six to seven meters above the surrounding plains and is approximately 20-25meters wide at the base. Besides the main fortification,

two supplementary small earth ramparts are also located on the north-western side of the site, towards the stream, presumably to protect the settlement from seasonal flooding (Fig.4).

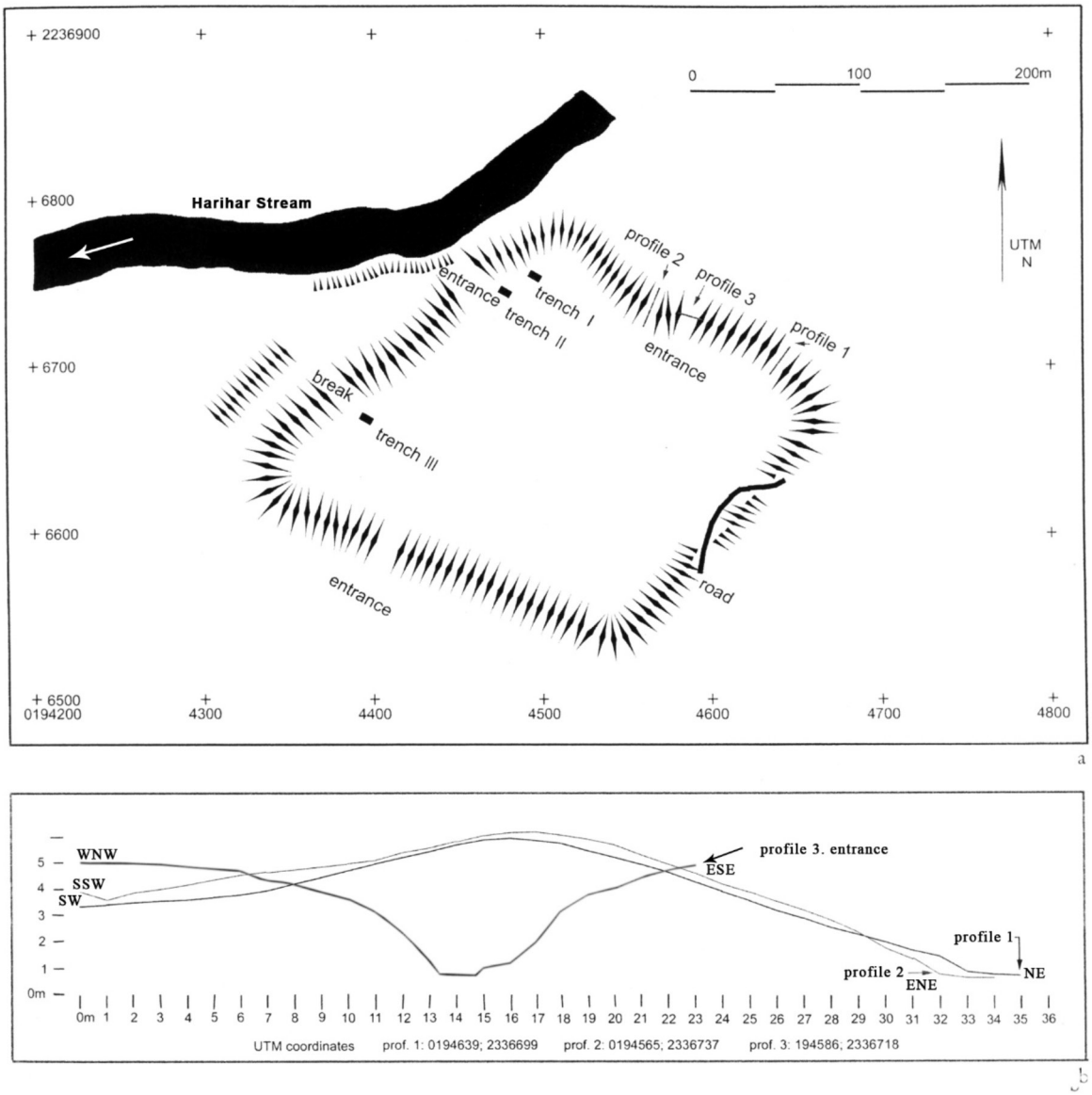


Fig. 4: Plan of the Badmal Fortified site with the elevation of the rampart wall (after Yule *et al*., 2005, p. 311)

The rampart was quite possibly originally encircled by a 15-20m wide moat, which has now been converted into agricultural land. The site is surrounded on all sides by low to high hills rising above 400 meters above mean sea level with abundance of wild lives and woodland lust forest cover. The eastern part of the site is now active cultivation by the modern villagers. The south-eastern part of the mound is badly disturbed by the construction of a village road, which passes through the fort. Besides, the southern part of the mound is almost honeycombed by the local villagers in search of gem stones including beads and their waste products, particularly during rainy seasons. Moreover, the locals regularly carry out illegal mining activities in the nearby hills also. However, the northern part of the mound is somewhat well preserved and intact and located at a higher part of the

mound than the southern part. The present population largely depend upon seasonal rains, besides lift irrigation for crop cultivation. In addition to limited agriculture, local population depend largely upon the vast natural resources available in the area to meet their day-to-day requirements, such as large and small game animals, aquatic resources like fishes and turtles available in the Harihar stream, besides wood for house construction and fencing, tubers, etc., from the forest. The climate of the area mostly supports tropical moist deciduous, riverine and tropical dry deciduous types of natural vegetation. As per the geological formation, the rocks of the area mainly belong to the Achaean series to the Quaternary period, represented by thin to thick deposits of secondary laterite, colluvium and alluvium of variable extent and thickness. However, the most significant geological feature of this belt is its rich gem stone deposits (Mishra and Mohanty 1995). Most of the gemstones in this area occur in secondary as well as primary contexts and become an easily amenable source for good quality gems. Gemstones to be found within this area include beryl, aquamarine, topaz, garnet, heliodor, ruby, sapphire, tourmaline and amethyst. For manufacturing beads, amulates and pendants, the Early Historic settlers of Badmal-Asurgarh exploited some of these gemstones, as well as other semi-precious stones, such as chalcedony, agate, banded-hematite-red- jasper (BHRJ) amygdaloidal basalt and chert from other sources, probably from the bed of the Mahanadi and beyond. Besides, the local clandestine interference, the Odisha Mining Corporation also extensively surveyed this area by taking several prospecting trenches. They not only ascertained huge deposits of primary as well as fluviatile occurrence of gem stones but they also admitted illegal mining activities by the local villagers.

EXCAVATED TRENCHES

Two trial trenches were taken in the northern undisturbed sector of the mound while only one trench was laid out in the southern part, which was badly disturbed by gemstone seekers. The northern sector provided us a complete cultural succession right from the early Iron Age to the Early Historic periods, with a 15 centimetre gap between the two cultural phases. Further, the Iron Age phase, on the basis of stratigraphy, changes in the ceramic assemblages and associated technology, besides radiocarbon dates (Behera *et al.* 2007: 41-46, 2019: 1-19), it is divided into three sub-phases, namely IA, IB and IC (Fig.5 & 6). In the southern sector of the mound only Early Historic ceramic assemblages besides finished, semi-finished beads as well as numerous waste products were recovered. A detailed study of these is underway and will be published later on. It seems from the available evidence that, while the northern sector was occupied for residential area, the southern sector was exclusively used for beads and other associated tool kits for making them. It is very interesting to note that, several bead polishers including one two-legged quern with drilling marks have been brought to light from the southern sector, which unequivocally prompt us to presume that the site during the Early Historic period was a large scale industrial centre for bead manufacturing activities.

Another such open-air bead manufacturing site was discovered and excavated in small scale at Bhutiapali located in the *Ghungni* stream (Lat. 20° 57′ 02.3″ N; Long. 84° 05′ 05.6″ E), district Subarnapur, near Birmaharajpur the sub-divisional headquarters in Odisha (Behera and Hussain 2017: 269-282). Here also the local villagers illegally honeycombed the entire site in search of gem stones. Fortunately, we got a very small area for excavation and our goal was achieved. A few sherds of Black-and Red Ware and other potteries were also found along with several precious and semi-precious beads besides bead polisher and other bead making tool kits.

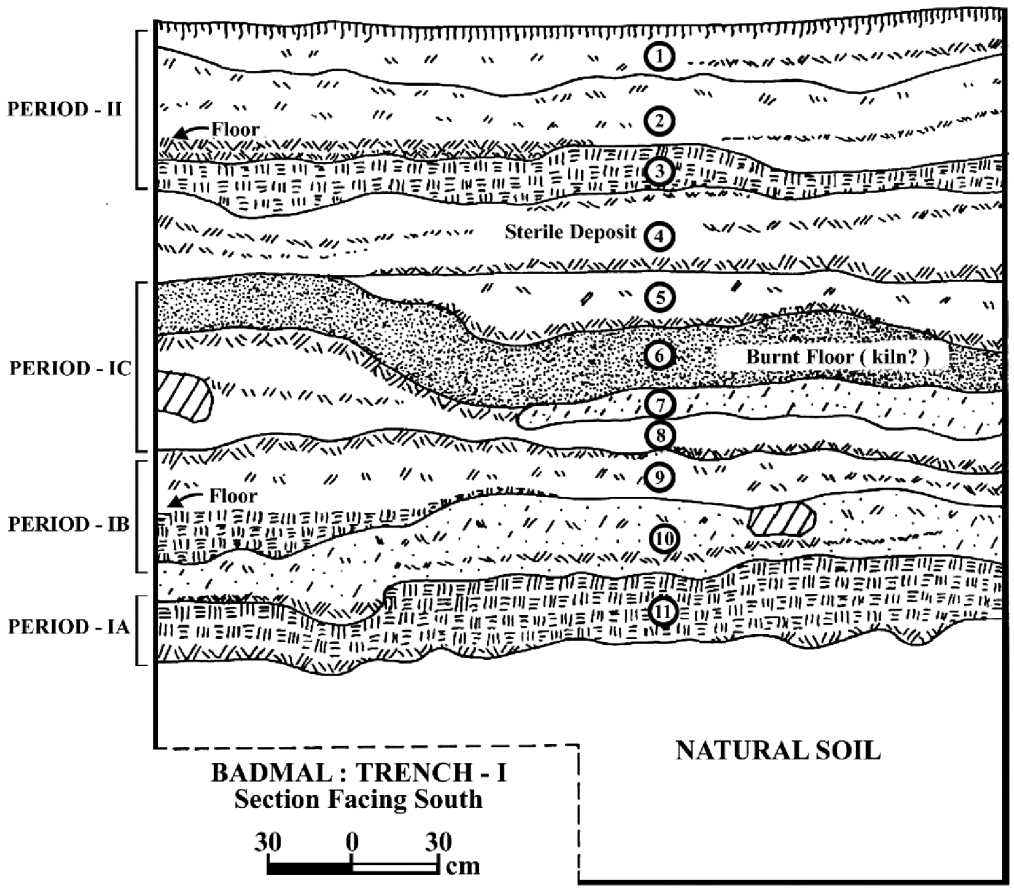


Fig. 5: Excavated Section Trench-I, taken on the northern sector of Badmal-Asurgarh Site

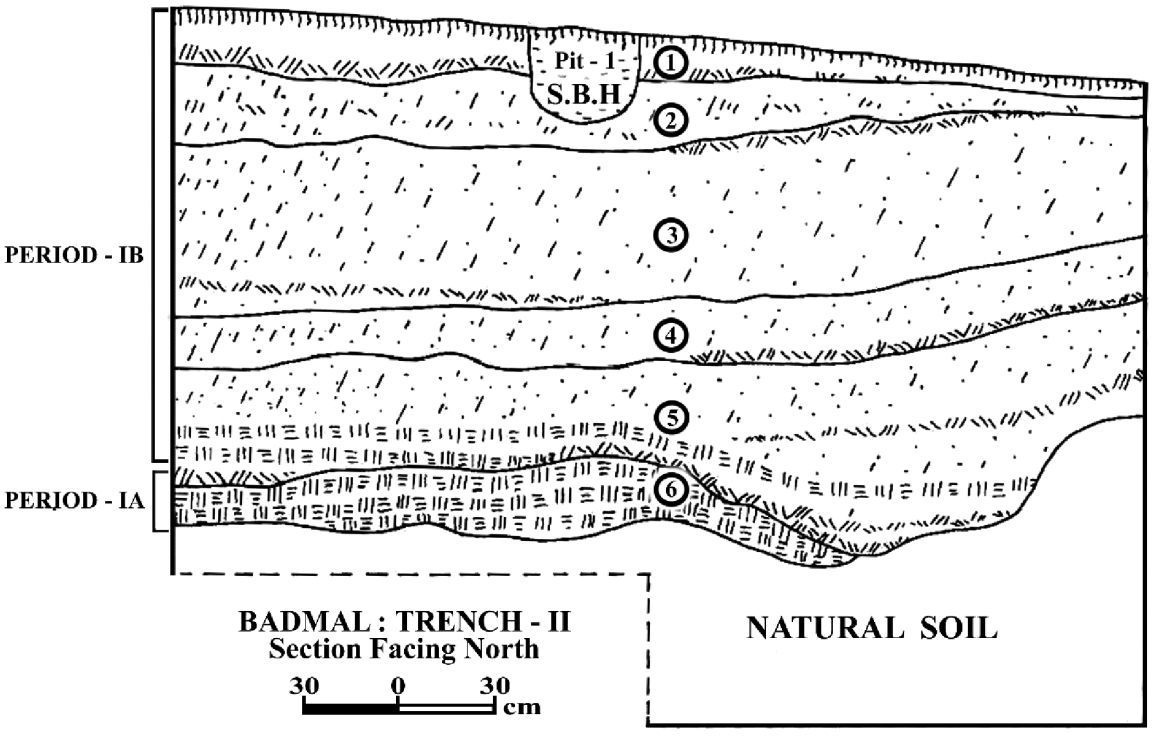


Fig. 6: Excavated Section Trench-II, taken on the northern sector of Badmal-Asurgarh Site.

THE CERAMIC ASSEMBLAGES

As referred to earlier two broad cultural phases can be delineated, on the basis of stratigraphy, changes in the ceramic assemblage and chronology, *i.e.* Iron Age and Early Historic Periods with a cultural hiatus 10-20 cm gap between them. The ceramic assemblages from both the cultural periods are briefly described below, starting from Early Iron Age to the Early Historic periods.

Period-IA: Early Iron Age

During this period the settlement was confined to a limited area, situated towards the highest north-western part of the mound, and probably lacked any fortification wall. The inhabitants lived in wattle-and-daub houses. They used a variety of materials, including iron spears and arrow-heads and copper bangle, bone and antler tools, sling balls of stone, pottery discs and a variety of earthen wares. Although they were exposed to locally available precious and semi-precious stones, none of these materials were found during the trial excavations. The early settlers presumably subsisted on limited agriculture and domestic as well as wild animals. The deposit of this period yielded a large quantity of charred and un-charred skeletal remains of wild and domesticated animals bearing distinct butchery marks. The ceramic assemblages, which demonstrate close affinity with those from contemporary Iron Age settlements of the middle Mahanadi Valley, and are represented by black-and-red ware pottery of fine to medium fabric, black slipped ware, red slipped ware and plain red ware pottery. Important shapes in the black-and-red ware include flat and round-based convex-sided bowls, dishes and medium-sized vases (Fig.7&8).

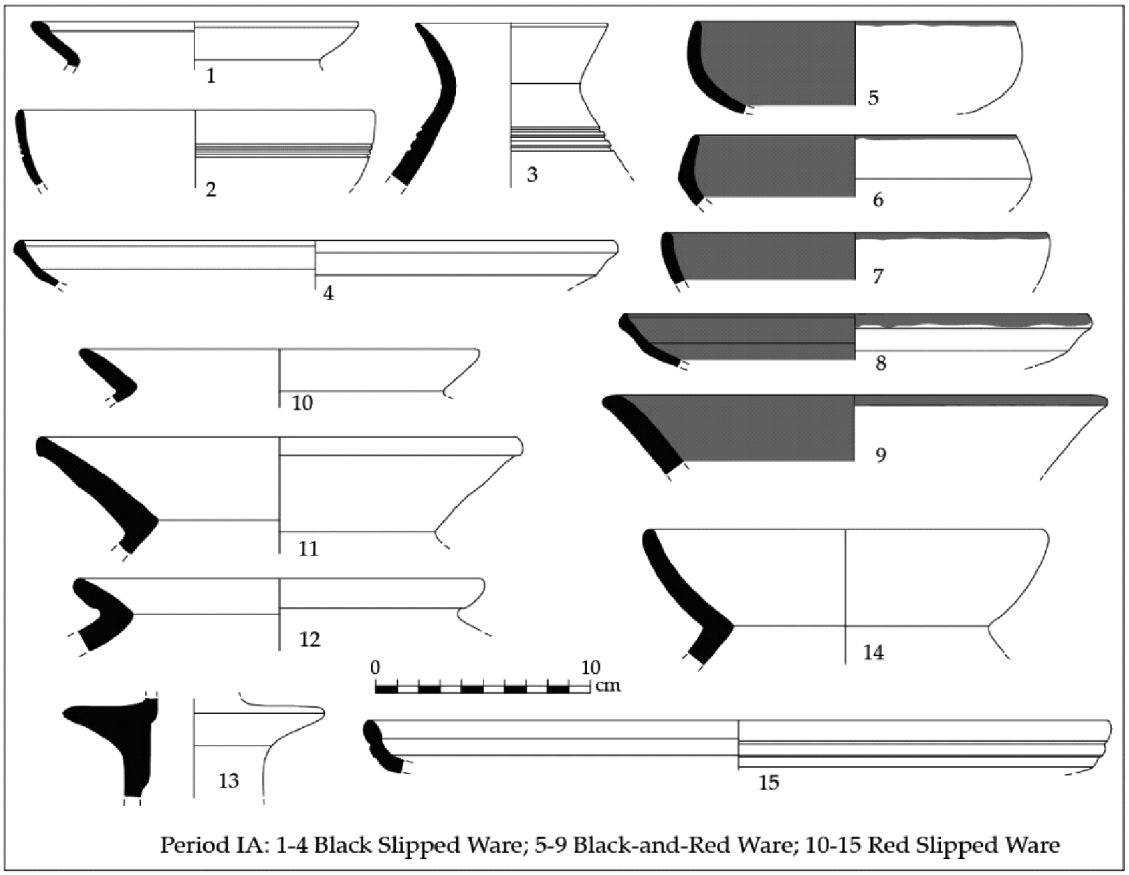


Fig.7: Pottery shapes from Period-IA.

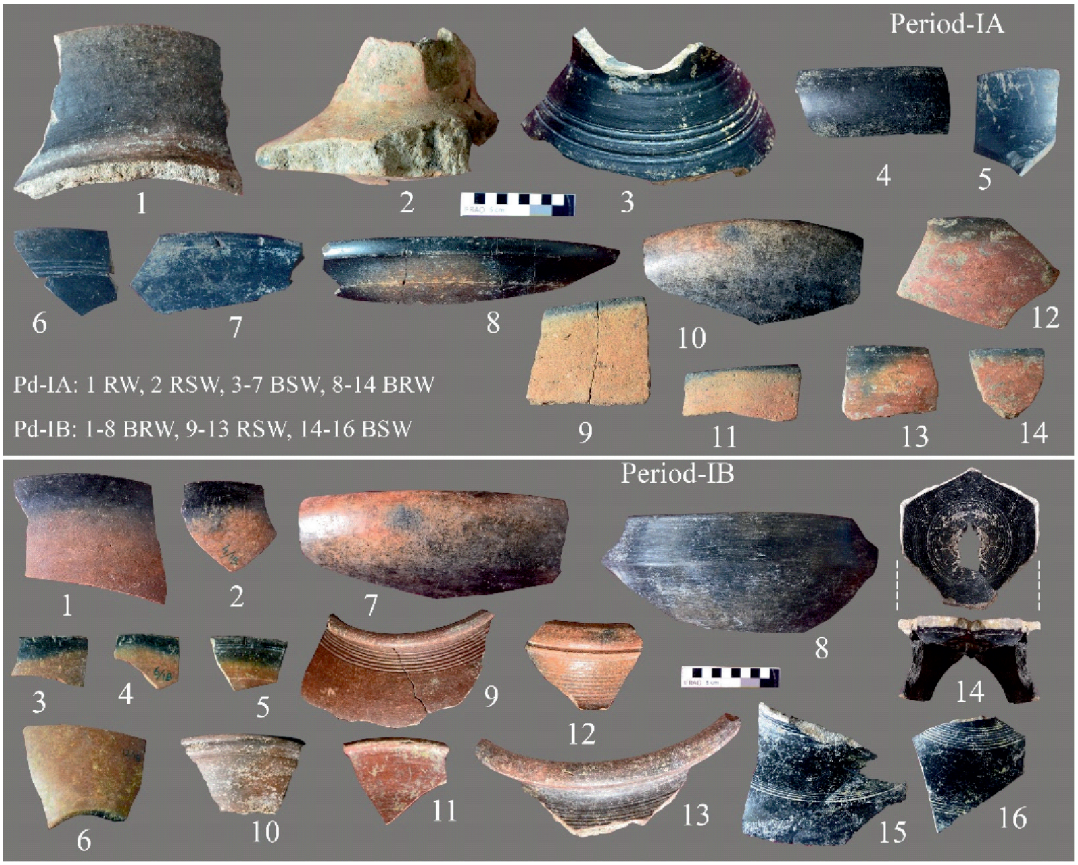


Fig. 8: Representative pottery specimens from Period-IA & IB.

While vases of different sizes and forms predominate in the red slipped ware group, large sized storage vessels of coarse fabric are almost rare and confined to the plain red ware. The ceramic assemblages from period-IA mostly represented by Red Slipped Ware (RSW), plain as well as white painted Black-and-Red Ware (BRW), plain Red Ware (RW) and Black Slipped Ware. Except the plain RW, all other ware types are thoroughly burnished and of medium to course fabric with organic and inorganic inclusions. In the case of white-painted BRW, painting is done on the inner surface of a bowl. The painted design is unique as similar pattern has been encountered in graffiti but never recorded in any painted sherds of the earlier Chalcolithic period in the region. As only small fragments of RW are found from this phase, it is difficult to give any description about the shape of this ware type. Shapes in the BRW are mostly represented by convex as well as carinated bowls with round base, medium-sized vases/*handis* with flaring rim, and dishes. On the basis of Mansell soil colour chart, while the outer surface exhibits a good deal of colour variation from red (7.5R 4/6, 4/8, 5/8; 10R 5/6, 5/8) and dark red (7.5R 3/6) to reddish brown (5YR 5/4), the inner surface is mostly black (2.5YR 2.5/1, 5YR 2.5/1) in colour. The Red Slipped ware occur in different colour variants as red (7.5R 4/6, 4/8, 5/8; 10R 5/6, 5/8) and dark red (7.5R 3/6) to light reddish brown (2.5YR 6/4). In RSW dominant shapes comprise vases/*handis* with flaring rim, gourd-shaped vases which have been documented almost every Iron Age sites in the middle Mahanadi River valley, besides convex-sided bowls, basins, dishes, *surehi* with constricted and elongated neck, and miniature pots. BSW comprises vases/*handis*, bowls with convex sides and round base, dishes, etc. From this phase, we could not register evidence for large storage jars, indicating non-intensification in the agricultural process.

Period IB: Middle Iron Age (Period of affluence)

The pyrotechnology during this phase undergoes a marked improvisation, with a substantial reduction in the cultural continuation of the preceding phase. This is particularly noticeable in the ceramic industry in which new forms with mostly developed surface treatments appeared and there is decrease in the use of burnishing technique and medium to coarse fabric potteries. White painted BRW is completely absent. However, pots of medium fabric were decorated with appliqué bands and those with incisions, impressed and punctured design patterns. Red Slipped Ware potteries pre-dominate the assemblages, followed by BSW, BRW and plain Red Ware. Among the most diagnostic shapes appeared during this phase, mention may be made of highly polished and flat-based convex-sided bowls of BRW of fine fabric, shallow dish-on-stand of fine fabric with concentric grooves on the inner surface of the flaring dishes in BSW and RSW, gourd-shaped RSW potteries of medium fabric with parallel and shallow comb-like horizontal marks on the outer surface of the in-turned rim and vertical such marks from the shoulder to the lower part of the body, besides several verities of sagger-based dishes in BRW, BSW and RSW. Besides, lids and fragments of lid handles of RSW, BSW and RW. Sherd fragments of large-sized, hand-made storage vessels of course fabric in Red Ware have also been recorded for the first time from this phase, indicating intensive agricultural activities (Fig.8&9). Surprisingly, the limited excavations at both the Periods I and II did not yield any beads tough entre excavated deposit was wet sieved.

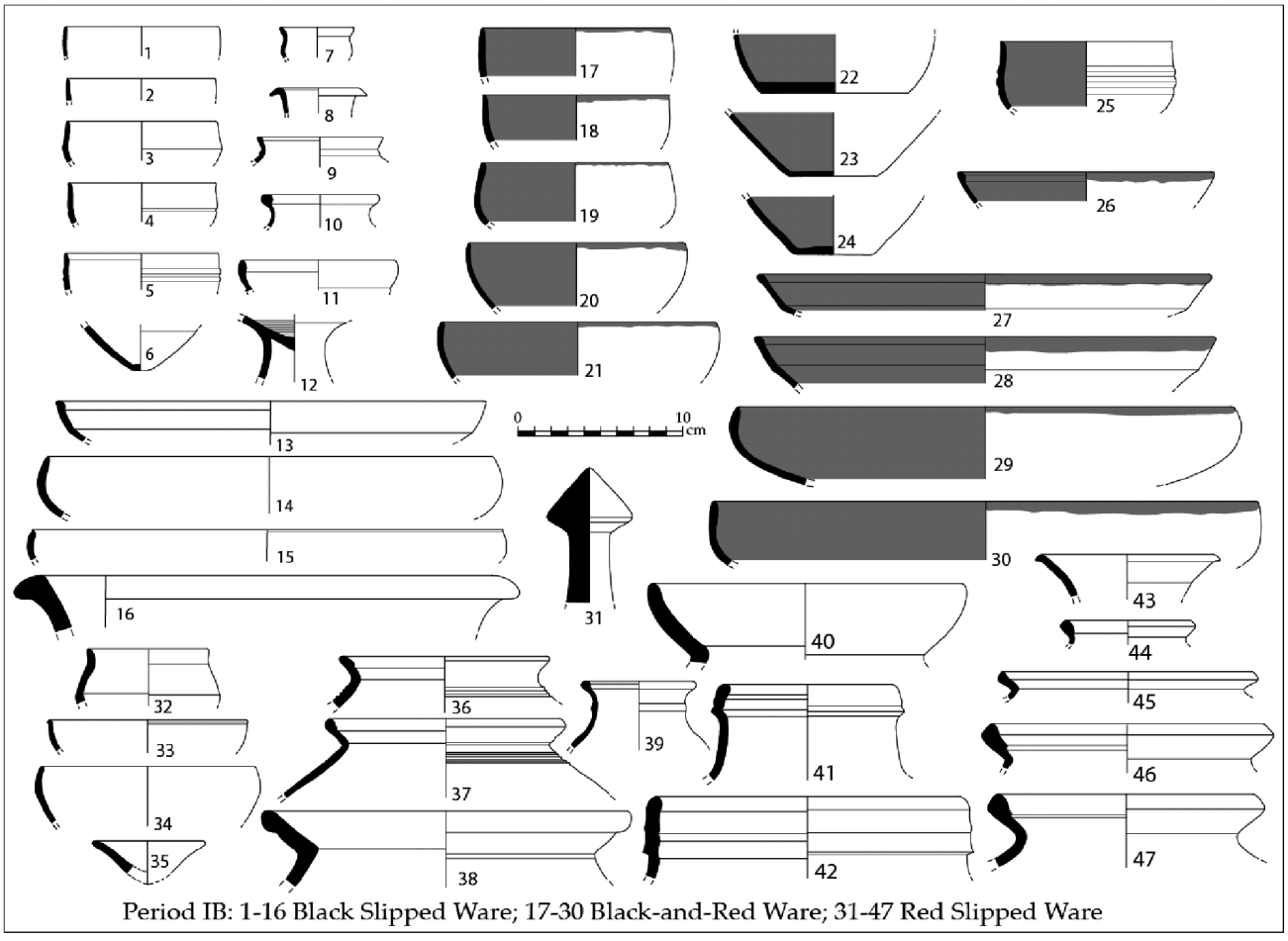


Fig. 9: Pottery shapes from Period-IB.

Potteries with Graffiti Marks

The Iron Age deposits from this phase have yielded a good number of pot sherds and shapes with post-firing graffiti marks on them. These marks occur normally on the outer surface of the pots, *viz.* on the base, shoulder, neck, stand and body parts and lid handles. Among the ware types these marks occur frequently on the BRW and RSW potteries. While a few of these marks resemble those with early *Brahmi* alphabets others represent geometric and non-geometric shapes *viz*., ladder, boat, floral, arrowhead, sun, animal, insects, etc., (Fig.10). Almost similar graffiti marked potteries have also been recorded several Iron Age-Megalithic sites of Southern parts of India (Yazdani 1916: 56-79; Lal 1960: 4-24; Athiyaman **1999: 1087-1091;** Rajan and Bopearachchi 2002: 97-105; Boivin *et al.* 2010: 21-33).

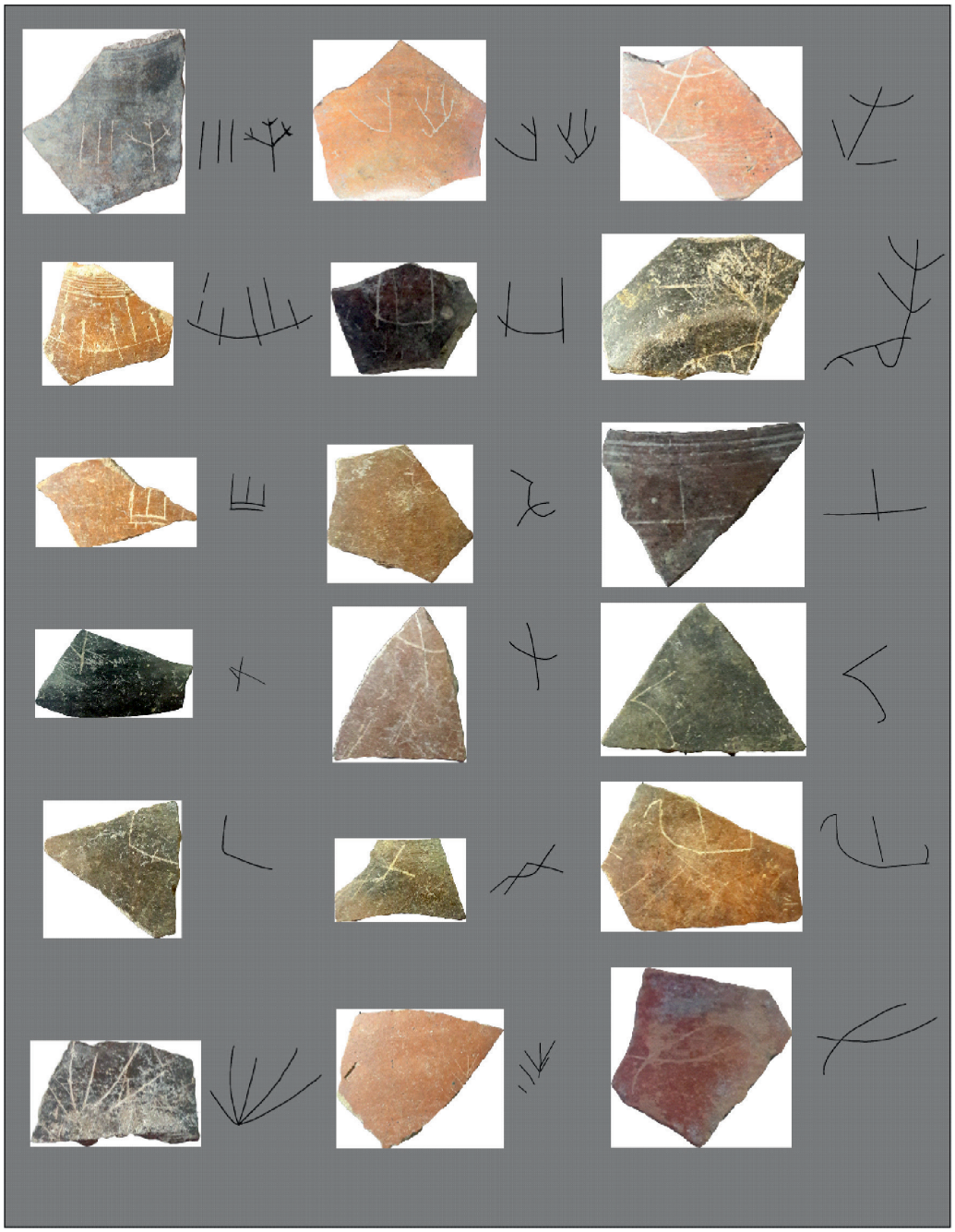


Fig. 10: Gaffiti Marked Potteries from Period-IB

Period-IC: Late Iron Age

The ceramic industry of this phase is dominated by mostly RW and RSW, followed by BRW and BSW. The typical dish-on-stand of BSW and RSW of the preceding cultural phase and the gourd-shaped vases are completely replaced and many new varieties were introduced during this phase. Potteries are decorated mostly with appliqué and incised design patterns. For the first time, knobbed dishes/bowls with a flat base appeared in BSW during this phase. The fabric of the available pots varies between fine to medium, except large storage vessels. Shapes mostly comprise vases, bowls, dishes, basins, storage jars and lids of different types. Very few pots in BRW and RSW bear graffiti marks (Fig.11&12).

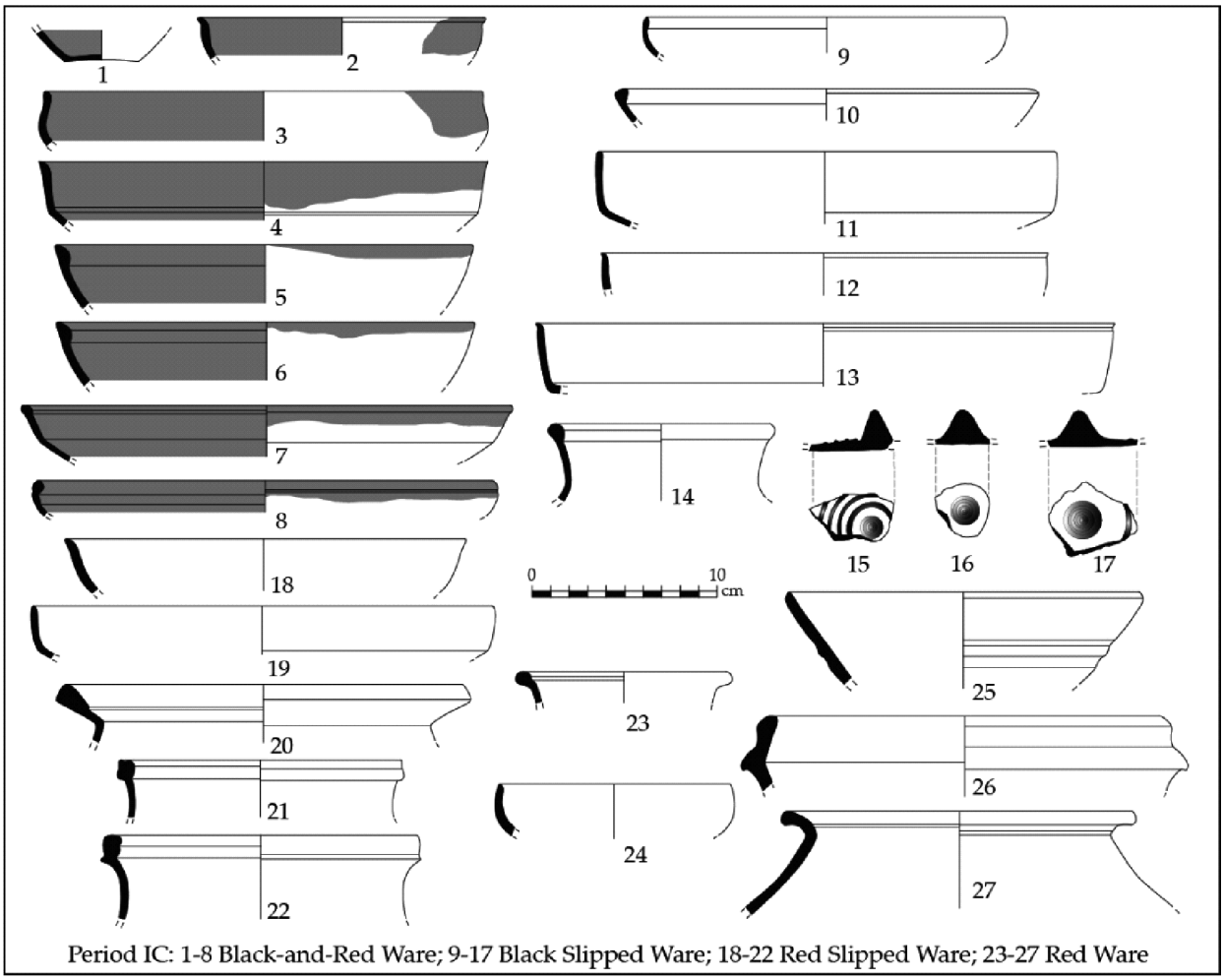


Fig. 11: Pottery shapes from Period-IC

Period-II: Early Historic

With a settlement gap of about 10-20 cm the site was again reoccupied during the Early Historic period. It is also stratigraphically revealed in particularly discerned in the Trench-I. Detailed studies of different ceramic assemblage from this period with other associated materials suggest that RSW and RW are the dominated varieties followed by BSW and BRW. Black-and-red ware was confined to a few fine varieties of sherds of bowls, whereas black slipped ware represents fine to medium fabric bowls and dishes, and medium to coarse fabric vases. Red slipped ware and Red ware have occurred with minor typo-technological changes from preceding Iron Age period. Black slipped bowls/dishes

Fig. 12: Representative pottery specimens from Period-IC & II

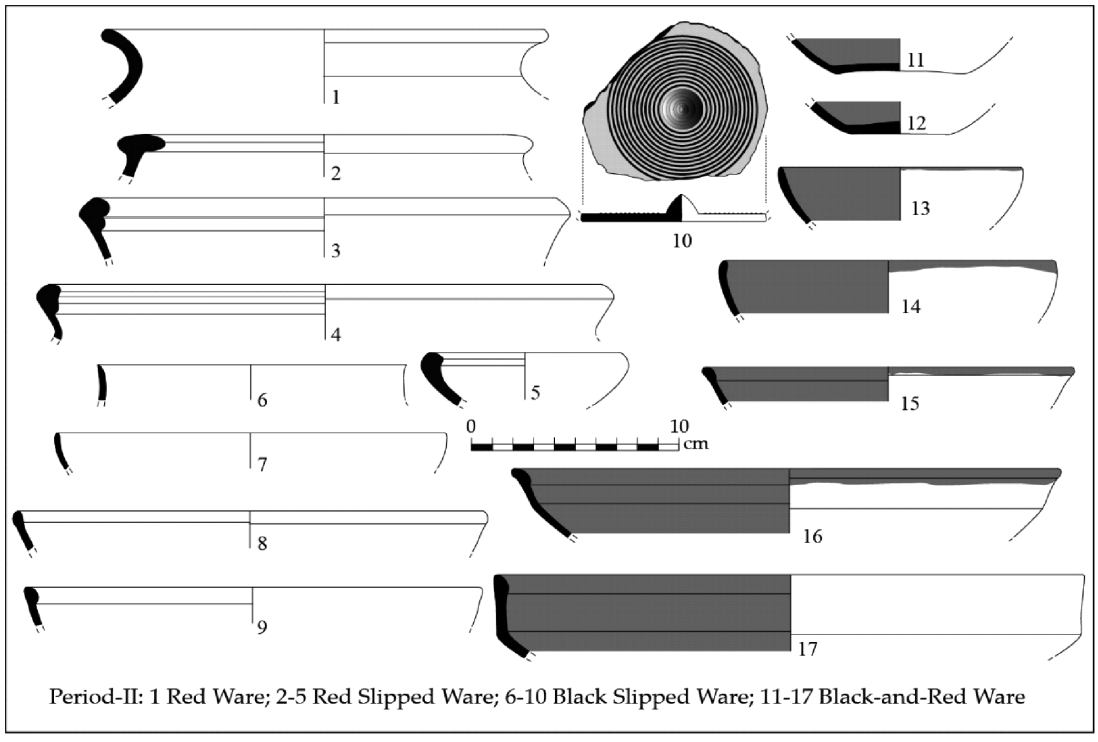
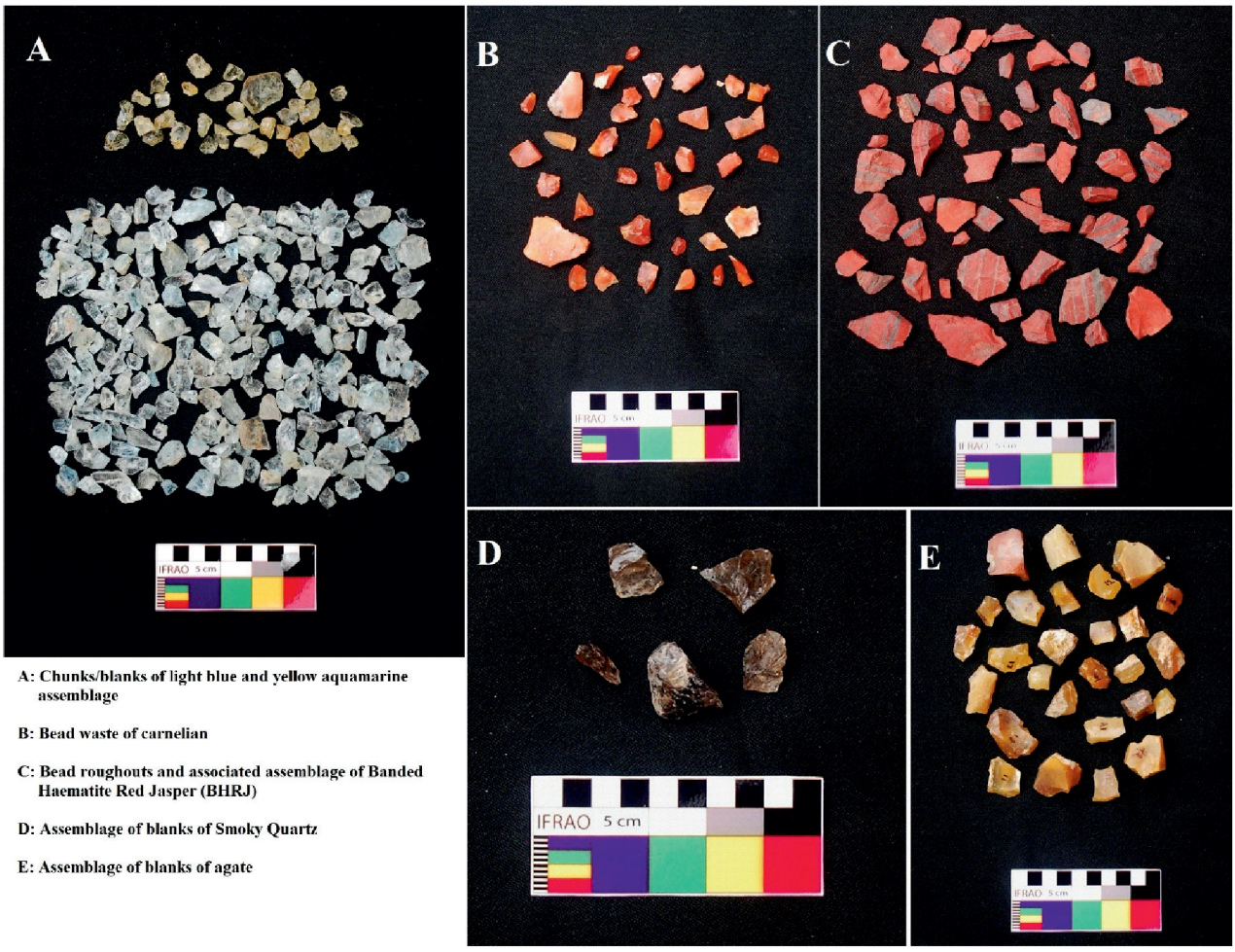


Fig. 13: Pottery shapes from Period-II

with a central knob surrounded by multiple rings are also representing the ceramic assemblage of the early historic period (Fig.12&13). Compared to the earlier phases, mostly potteries not so fine and demonstrate decadence in fabric and dominated by Red Ware.

OTHER MATERIAL FINDS

On the northern part, except a few iron objects and a broken part of a polished stone axe of basalt and potteries from the Period-II, no other artefacts could be recovered from Period I and II. However the southern sector yielded hundreds of beads and few amulets of precious and semi-precious stones showing different stages of manufacturing process (Fig.14-18), besides, numerous bead roughouts of different raw materials and scores of waste products. Most probably the raw materials used for manufacturing beads were brought to the site from alluvial as well as from primary sites. Other raw materials like Banded Haematite Red Jasper (BHRJ) was imported to this site from hundred kilometres away from Bonaigarh area, located in the southern part of Sundargarh district of Odisha. Similarly, a lump of chromite ore was also found on the southern sector, which is available some more than hundred kilometre away in the Keonjhar district of Odisha. In addition, beads of coral coloured glass, which were directly imported from outside the region, have also been found.



A: Chunks/blanks of light blue and yellow aquamarine assemblage

B: Bead waste of carnelian

C: Bead roughouts and associated assemblage of Banded Haematite Red Jasper (BHRJ)

D: Assemblage of blanks of Smoky Quartz

E: Assemblage of blanks of agate

Fig. 14: Bead waste of aquamarine, Carnelian, BHRJ, Smokey Quarzt and Agate of trench-III from southern sector of Badmal-Asurgarh Site

Obviously, for manufacturing beads, iron drill bits become an inevitable and significant tool. In Odisha, iron ore deposits are found east of the Brahmani river valley, in the northern and north-eastern highland zones, comprising the Bonai-Keonjhar, Gandhamardan, Tomkadaitari and Gorumahisani-Badampahar regions of Maurbhanj district. The parent rocks of these deposits are represented by Banded iron Formation (BIF) and ferruginous shales. The iron bands are also represented by magnetite, marmite, goethite and magnetite, although hematite constitutes the predominant band in the layered BIF (Mohanty 1995: 229-251). Iron objects include Spear head, arrow head, drill bit, nail, flattened ring, toothless saw, net sinker, clamp, etc., (Fig.19).

Fig. 15: Representative samples of Bead roughouts of trench-III from southern sector of Badmal-Asurgarh Site

Fig.16: Unfinished beads of various material recovered from trench-III of southern sector of Badmal-Asurgarh Site

Fig. 17: Finished beads of various material recovered from trench-III of southern sector of Badmal-Asurgarh Site. (1-5 Glass and 6-57 Stone)

Other important materials recovered from southern sector consist of craft tools like bead polishers, several small-sized pestles with sub-triangular cross-section, anvils, hammers, mulers, and two-legged querns bearing drill marks on its surface, and several pottery discs/scotches of various sizes (Fig.20).

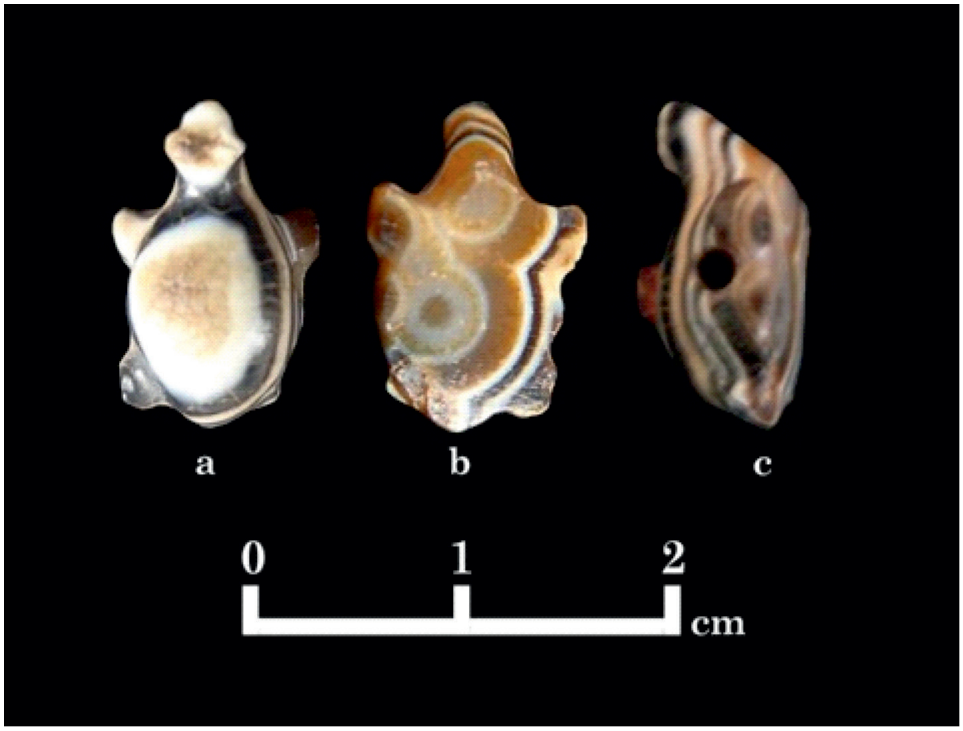


Fig. 18: Obverse, reverse and profile views of a highly finished turtle amulate of banded agate from Badmal Asurgarh site.

Fig. 19: Different iron objects recovered from the Early Historic deposit from Badmal Asurgarh site.

As stated above, the limited excavations at Badmal did not yield any direct evidence pertaining to on-site iron smelting activities. However, during our exploration in the downstream of Harihar stream (Behera *et al.* 2019; Hussain and Mahakur 2023) (Fig.21), was brought to light a few sites associated with Iron Age-Early Historic sites some of which with iron smelting activities, which included tuere, iron slags and other waste products (Fig.22).

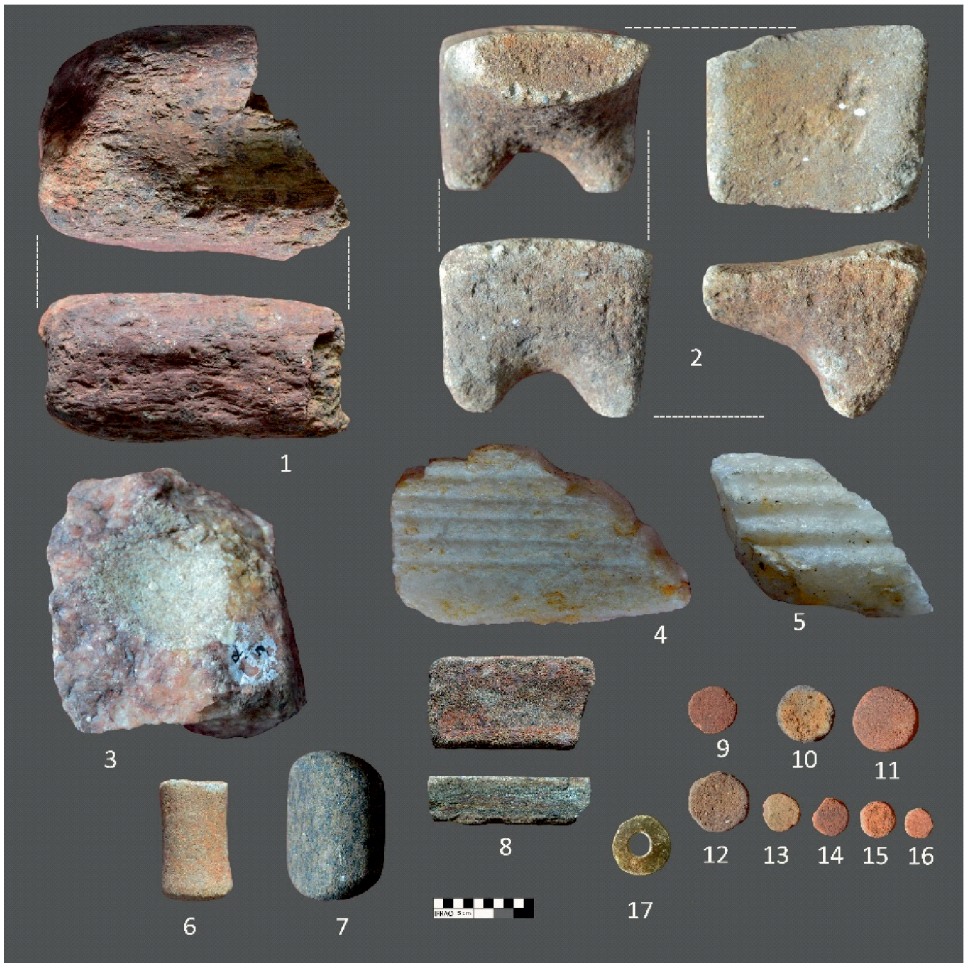


Fig. 20: Tools used in bead manufacturing at Badmal and Pottery discs

During the excavations, a lump of chromite ore was retrieved from Trench-III at Badmal, located in the southern sector of the mound. In order to determine the source of the iron and the technology used in manufacturing the iron objects found at the site of Badmal , four iron artefacts—one from Period IA and the remaining from Period II—were analysed using external Particle Induced X-ray Emission (PIXE) at the Institute of Physics, Bhubaneswar. In addition, metallographic examinations were also conducted (Behera and Chattopadhyay 2004-2005: 118-125; Chattopadhyay, *et al.,* 2007: 387-402).

The PIXE analysis was conducted at the institute of Physics, Bhubaneswar, uses a 3ma tandem type Pellet Ron accelerator with proton beam energy of 3 MeV (Vijayan *et al.,* 2003: 772-777). This method is extremely useful for analysing archaeological samples, since it is not only fast, sensitive and capable of simultaneous multi-elemental analysis, but it also ensures that samples of any size can be quantitatively analysed without causing physical damage to the artefacts (Johansson and Campbell

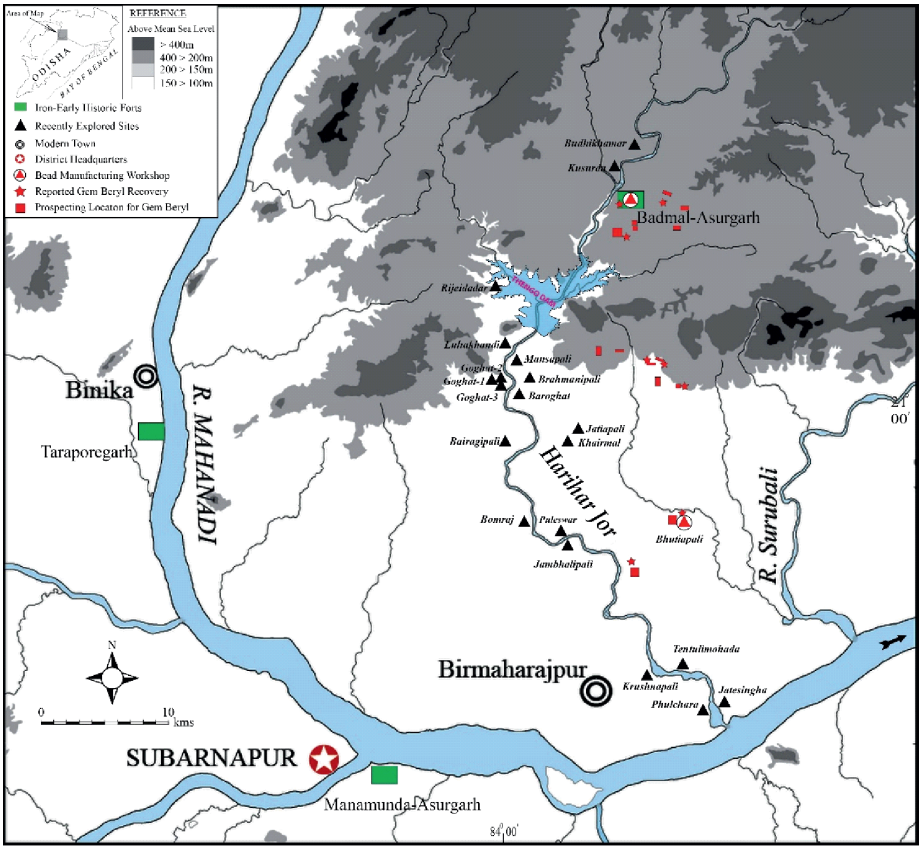


Fig. 21: Recently explored Iron Age-Early Historic Settlements in the lower Harihar *Jor,* along with location of gem deposit recorded by the mining corporation of Odisha

Fig. 22: Tuyere and Iron slag found during exploration from Goghat-3 in Harihar *Jor*

1988; Campbell *et al.,* 1995, 1995: 279-92; Demortier 1997, 2000; Hajivaliei *et al.*, 1999; Govil 2001). However, in PIXE experiments, all the calculations are based on the hypothesis that the material is homogeneous in all the depth of the analysed material (5-10µm). The analysed depth of the irradiated artefact is less than 10µm, even for particles crossing 25 to 30µm in the material, due to the decrease of X-ray production with decreasing energy of the projectiles. Thus, archaeological applications are generally restricted to non-corroded materials or to drillings involving partial destruction of the sample (Mando 1994). in the present analysis, the target areas (1cm^2 surface) of the iron samples were thoroughly cleaned by carefully removing the outer corrosive layer and keeping the original shape intact before the artefacts were irradiated. The results of the analysis are shown in the table-1.

Table 1: Elements detected through external PIXE in weight percent

Sample No.	*Period*	*Object Type*	*P*	*S*	*Ca*	*Ti*	*V*	*Cr*	*Mn*	*Fe*	*Ni*	*Cu*
BDM-18	IB	Spear head	0.15	0.13	-	-	0.13	-	0.70	95.15	0.15	-
BDM-7	II	Drill bit	0.49	0.41	0.41	0.29	0.076	-	0.58	95.76	0.29	0.12
BDM-8	II	Drill bit	0.58	0.40	0.23	-	-	-	0.44	95.71	0.27	-
BDN-16	II	Toothless saw	0.53	0.43	0.12	-	-	0.06	0.56	95.08	0.43	-

Table-1 indicates that the iron objects were possibly produced from multiple ore sources and may well therefore, have been procured from different locations. However, the most interesting result of the analysis is the presence of vanadium and chromium in three of the four samples analysed. Vanadiferous magnetite deposits are found in small pockets near the Nuasahi-Boula area on the eastern boarder of Keonjhar, in the Baripada-Rairangpur belt in Mayurbhanj district, and in the Betei-Rangamatia area in the district of Balasore (Nayak and Das 1995: 288-297). It is known that the addition of even less than 0.1% of vanadium to steel or cast iron can significantly increase strength, toughness and ductility. Whether this characteristic feature of vanadium was known to the early settlers of Badmal cannot be determined with any amount of certainty based on the presently available evidence. Similarly, one of the iron samples also contains chromium, sources of which are located in the Tomka-Daitari belt of Keonjhar district (Sahoo 1995: 108-144). The source lies some 180 km east of the Badmal Asurgarh site. As stated earlier, a lump of chromite ore has also been recovered from the Southern sector of the mound in Trench-III. In addition, the bead workers of Badmal extensively used banded-hematite-red-jasper raw material for bead production. The nearest source for this lies about 140km north-east of Badmal, in the Bonaigarh area of Sundargarh district. The possibility that the early settlers of Badmal imported iron objects from this area cannot therefore be ruled out. Thus, circumstantial as well as scientific evidence appear to suggest that during the Iron Age and early historic periods, iron was procured either as finished goods or in the form of ore by way of trade or exchange from locations at least 140-200km away from the site of Badmal. However, only future investigations using geochemical and other scientific techniques will solve the question of the provenance of iron at Badmal.

METALLOGRAPHIC STUDIES OF IRON ARTEFACTS

For metallographic analysis, small samples were taken from each of the four objects (Table-2) and mounted on perspex using a Buhler Simplimate 2 mounting press. Subsequently, the specimens were

observed in polished and etched conditions. Observations were made using a Leica DMLM microscope in different areas, with different magnifications, ranging from 50 to 1000x. Each of the specimens was heterogeneous in grain size, from large coarse grains of ASTM grain size 1 to very fine ones of ASTM grain size 8. Each sample was also subjected to 2-3 micro-hardness tests using the Leica VMHT at 300gm load for 15 seconds. The average Vickers Hardness Values (HV) is shown in table-3. Slag inclusions were commonly observed in the analysed samples.

Table 2: Analysed Iron Objects

Sl. No.	*Trench No.*	*Sample No.*	*Depth*	*Object*	*Length mm*	*Breadth mm*	*Thickness mm*
1	BDM-I	BDM-18	75 cm	Spearhead	82.0	23.0	7.0
2	BDM-II	BDM-7	15 cm	Drill bit	38.0	6.4	7.0
3	BDM-II	BDM-8	15 cm	Drill bit	62.5	7.3	8.0
4	BDM-II	BDM-16	35 cm	Toothless saw	50.5	19.0	4.2

Table 3: The HV Values of the samples obtained by micro-hardness tests

Specimen No.	*HV at ferrite region*	*HV at other region*
BDM-18	11.37	-
BDM-7	99.0	-
BDM-8	134.8	441.6
BDM-16	110.0	195.6

Sample BDM-18, a spearhead, is chronologically the earliest of the sample range recovered from Trench-I and from the lowest layer.. The microstructure indicates the presence of oxide scale and silica-rich slag inclusions. When etched, the heterogeneous nature of the grains was revealed, with ASTM grain sizes between 3 and 8. No evidence for carburisation was visible and the average micro-hardness obtained was 113.7 HV within a ferrite region.

Sample BDM-8 is a drill bit. At 500x, a heterogeneous microstructure was revealed, including elongated slag inclusions, massive ferrite and ferrite grains with Neumann bands. The latter structure indicates that the tool was forged at low temperatures (below 500°c), which caused a shock to the metal. No evidence for annealing was visible, and the microhardness value obtained was 134.8 HV within a ferrite region.

Sample BDM-7, also a drill bit, was identified as low carbon steel. The microstructure was again heterogeneous, with evidence of partial spheroidisation of the carbides, and Widmanstatten side plates had formed in hypoeutectoid regions.

Finally, sample BDM-16, identified as a toothless saw, and included a fine-grained corrosion layer with ferrite matrix. In the central region, both coarse and fine grain matrices could be observed, along with pearlite grains. A few grains with Neumann bands were also noticed, along with elongated slag inclusions. The micro-hardness value obtained in a ferrite region was 110 HV, while that in a pearlite region was 195.6 HV.

CHRONOLOGY

Table 4: Radiocarbon dates from the Iron Age phase of Badmal Asurgarh in the Middle Mahanadi Valley (Behera et al. 2007: 41-46 , 2019: 1-19)

Sl. No.	*Site Name*	*Trench No./ Depth. (Cm)*	*Cultural affiliation & periods*	*Lab. Code*	*^{14}C age (BP)*	*Cal. ^{14}C age (BC)*
1	Badmal Asurgarh	Tr. I/ 110 cm	Iron Age (Period-IC)	IP – 309	2,657 ± 141	872 ± 130
2	Badmal Asurgarh	Tr. I/ 120 cm	Iron Age (Period-IC)	IP – 275	2,385 ± 66	468 ± 76
3	Badmal Asurgarh	Tr. I/ 120 cm	-	BS-3248	-	2860 ± 90
4	Badmal Asurgarh	Tr. I/ 160 cm	Iron Age (Period-IB)	IP – 274	2,642 ± 90	838 ± 86
5	Badmal Asurgarh	Tr. II/ 45 cm	Iron Age (Period-IB)	IP – 285	2,620 ± 59	803 ± 44
6	Badmal Asurgarh	Tr. II/ 50 cm	Iron Age (Period-IB)	KIA20155	2,511 ± 23	775 – 759 (One sigma range)
7	Badmal Asurgarh	Tr. II/ 50 cm	Iron Age (Period-IB)	BS-3249	-	520 ±180
8	Badmal Asurgarh	Tr. II/ 75 cm	Iron Age (Period-IB)	IP – 287	2813, ± 142	975 ±157
9	Badmal Asurgarh	Tr. II/ 105 cm.	Iron Age (Period-IB)	IP – 289	3,067 ± 122	1,319 ± 132
10	Badmal Asurgarh	Tr. II/115 cm	Iron Age (Period-IB)	IP 291	3,195 ± 156	1,480 ± 189
11	Badmal Asurgarh	Tr. II/ 115 cm	Iron Age (Period-IB)	KIA20154	2,573 ± 22	799 – 776 (One Sigma range)
12	Badmal Asurgarh	Tr. II/125cm	Iron Age (Period-IB)	KIA20153	2,576 ± 22	799 – 766 (One Sigma range)

As revealed from the above list of twelve radiocarbon dates obtained from different institutions (Table-4), except Sl. No. 3 from BSIP, Lucknow, all others are consistent and compatible. In fact, due to lack of datable materials, the deposit of Period IA at Badmal could not be dated. It seems highly probable that the earliest settlers migrated from the main stream of the Mahanadi and occupied the hilly tracts of the Harihar stream in search of wild animals, varied edible and non-edible forest products, besides limited agriculture for their subsistence and sustenance. Though data on vegetative remains from all the phases are still awaited, from the available faunal remains, it may be possible to derive some observations on subsistence economy of the Iron Age people of Badmal.

FAUNAL REMAINS

Very few studies have been made on faunal remains in Odisha *e.g.* Central Odisha (Joglekar and Tripathi 1997-98: 117-120; Joglekar 2015), Kalahandi district (Mohanty *et al*. 1998-99), Gopalpur (Kara and Joglekar 2000: 368–391), Golbai Sason (Sinha 2000: 322-348), Khambeswaripali (Badam *et al.* 2001: 828-30), Badmal Asurgarh (Goyal, *et al* 2014: 52-61), Suabarei (Joglekar and Patnaik 2016: 29-44), Kantipuleswar (Goyal *et al.* 2020a: 78-91), Kapasira (Goyal *et al.* 2020b: 73-99) and Radhanagar (Patnaik 2022-23: 363-384). At the site of Badmal, faunal remains have been recovered

from all the Iron Age deposits and analysed in detail (Goyal, *et al* 2014: 52-61). Among the Iron Age phases maximum faunal materials were recovered from Period-IA, while from Period-II we could not registered any faunal remains. Phase-wise distribution of faunal remains are given in table-5 to 7.

Table 5: Details of the faunal material examined at the site

Cultural Association	*Period-IA*	*Period-IB*	*Period-IC*	*Total*
Number of Identified Specimens (NISP)	83	350	8	441
Unidentified Fragments (UF)	41	144	15	200
Total Fragments (TF)	124	494	23	641
NISP %	66.93	70.85	34.78	68.80

Table 6: Taphonomic Observations of Faunal Remains

Bone Modifications/Cultural Periods	*Period IA*		*Period IB*		*Period IC*	
	Nos.	*%*	*Nos.*	*%*	*Nos.*	*%*
Charred Bones	7	33.33	28	29.17	0	0.00
Completely Charred Bones	2	9.52	6	6.25	0	0.00
Charred and Turned White	9	42.86	15	15.63	3	75.00
Butchering/Cut Marks	3	14.29	39	40.63	0	0.00
Gnawing Marks	0	0.00	3	3.13	0	0.00
Porous Bone	0	0.00	5	5.21	1	25.00
Total	**21**	**100.00**	**96**	**100.00**	**4**	100.00

Table 7: Summary of Identified Species at Badmal.

Species/Cultural Periods	*Period IA*		*Period IB*		*Period IC*	
	NISP	*%*	*NISP*	*%*	*NISP*	*%*
Bos indicus	0	0.00	25	7.14	0	0.00
Bubalus bubalis	1	1.20	7	2.00	0	0.00
Bos/Bubalus	65	78.31	247	70.57	5	62.50
Capra hircus	0	0.00	2	0.57	0	0.00
Ovis aries	0	0.00	1	0.29	0	0.00
Capra/Ovis	12	14.46	40	11.43	2	25.00
Canis familiaris	0	0.00	5	1.43	0	0.00
Boselaphus tragocamelus	1	1.20	2	0.57	0	0.00
Cervus unicolor	1	1.20	0	0.00	0	0.00
Axis axis	0	0.00	2	0.57	0	0.00
Antelope cervicapra	0	0.00	4	1.14	0	0.00
Sus sp.	0	0.00	7	2.00	0	0.00
Panthera pardus	2	2.41	1	0.29	0	0.00
Lepus nigricollis	0	0.00	1	0.29	0	0.00
Hystrix indica	0	0.00	1	0.29	0	0.00
Herpestes edwardsii	0	0.00	1	0.29	0	0.00
Kachuga tecta	0	0.00	0	0.00	1	12.50
General mammal bone	1	1.20	4	1.14	0	0.00
Total	83	100.00	350	100.00	8	100.00

From the faunal analysis it appears that the faunal assemblage at Badmal revealed the presence of several species of domestic and wild animals (Table-7). The domestic animals included mainly cattle (*Bos indicus*), buffalo (*Bubalus bubalis*), sheep (*Ovis aries*), goat (*Capra hircus*) and dog (*Canis familiaris*). The wild animals are represented by *nilgai*/ blue bull (*Boselaphus tragocamelus*), *sambhar* (*Cervus unicolor*), spotted deer/chital (*Axis axis*), panther (*Panthera pardus*), hare (*Lepus negricollis*), porcupine (*Hystrix indica*), and mongoose (*Herpestes edwardsi*). One reptile in the form of Indian sawback turtle (*Kachuga tecta*) was also present in the faunal assemblage. In the case of cattle and buffalo, it was not possible to identify several skeletal fragments up to species level and these have been tabulated as *Bos/Bubalus* (cattle or buffalo) fragments. The same is done for sheep and goat bones and a category called *Capra/Ovis* (goat or sheep) was created. Some of the skeletal fragments have been identified as general mammal bones only. To attain a fine level of identification, published literature have been consulted (Prummel and Frisch 1986: 567-577; Pawankar and Thomas 2001: 109-126; Joglekar *et al.* 1994: 17-20).

All the bone fragments were carefully examined for signatures of bone modifications that can occur due to various human and non-human agents. Observations made on the skeletal elements indicated that a majority had not been subjected to post-depositional trampling and/or displacement. The faunal material however, revealed the evidence of bone modifications mainly in the form of charring, cut/ butchering marks (Fig.23) and a few bones showed the presence of gnawing marks. Charring was one of the most significant pieces of evidence indicating human activity at the site. Faunal material from all the cultural periods has a number of charred bones. The degree of charring has been used to separate these fragments as slightly charred, completely charred, and charred and vitrified. The relative proportion of charred bones was more in Period IA than in the other three cultural periods. Among all the bones having charring marks, skeletal elements belonging to *Bos/Bubalus* are most common. It appears that the early Iron Age settlers used domestic animals for dietary consumption by roasting.

Carcass processing activities in the form of butchering/cut marks were also fairly represented at the site. Several skeletal fragments, particularly those of *Bos/Bubalus* and *Capra/Ovis*, have shown evidence of cutting and butchering marks. Important positions for these marks were the proximal and distal portions of long bones, pelvic fragments, ribs, and vertebrae. The bones of other taxa with such marks were *Sus* sp. and *Boselaphus tragocamelus*. Period IB revealed the largest number of skeletal fragments with these marks, while interestingly Period IC did not reveal even a single fragment bearing such marks, probably change in processing and dietary habit.

From the above observations it appears although the faunal assemblage at Badmal is small in quantity, it represents the remains of animals that were part of a full-fledged protohistoric subsistence system. This subsistence system involved the utilisation of both domestic and wild animals. However, the proportion of wild animals relative to the domestic ones is very minimal. This shows that wild resources may not have played a major role in the subsistence activities of the inhabitants at the site. The small number of bones deterred the analysts from calculating the age and sex ratio of the domestic animals present at the site. This, in turn, precluded looking deeper into the animal-based subsistence activities at the site such as whether or not cattle and buffalo were used for dairy activities and traction purposes.

The faunal remains from Badmal were compared with those recovered from the Iron Age sites of Kantipuleswar (Goyal *et al.* 2020a: 78-91) and Kapasira (Goyal *et al.* 2020b: 73-99), both situated in the Middle Mahanadi Valley. This comparison revealed that the overall pattern of faunal diversity

Fig. 23: Faunal remains from Period IA and IB, showing distinct cut marks

at Badmal closely resembles that of the other two sites. At all three settlements, the animal economy was primarily based on cattle, buffalo, sheep, goat, and pig representing animal husbandry than on wild animals. However, some temporal variations were observed in the relative proportions of these species, likely reflecting differences in the socio-cultural practices and functions specific to each site.

DISCUSSION AND CONCLUDING REMARKS

The foregoing discussion on the Badmal Asurgarh site clearly reveals that the rich bio-habitat and the vast mineral resources of the region have attracted human occupation right from the beginning of the first millennium BCE. It is highly probably that During the Iron Age Phase population moved from the main channel of the Mahanadi to the smaller tributaries, obviously due to inundation in the Mahanadi among other factors. Iron and other mineral resources were imported from different sources for facilitating bead manufacturing at Badmal. For manufacturing beads, the Early Historic population not only exploited the locally available gem stones but they also imported raw materials from as far from Bonaigarh where banded haematite red jasper (BHRJ) is widely found. Though iron smelting activities have been recorded from the site of Kurumpadar (Behera 2002-03: 87-103) and also from

the downstream of Harihar Stream (Hussain and Mahakur 2023: 337-345). But at the present state of our knowledge we are not in a position to know whether the iron produced at these sites might have facilited bead making at Badmal. Though Iron technology had already known to the earliest settlers of Iron Age in the middle Mahanadi valley, but its use was actually widely seen in the Early Historic period.

From the faunal studies it becomes apparent that the two early phases mostly depend upon animal husbandry and less on wild animals for their subsistence. The settlement developed out of the existing Iron Age cultures of the middle Mahanadi Valley, which are very well represented and wide spread, and rose to prominence during the Early Historic period as a bead manufacturing centre in this part of the Odisha highlands. Domestic trade was perhaps one of the important factors in this process of development. This study has revealed that, in addition to locally available gem resources for manufacturing beads for regional and extra regional trade or exchange, the Early Historic bead workers of Badmal also imported *cowry* shells and finished items of onyx and coral coloured glass beads from different places. Besides, terracotta circular discs of different sizes and weight might have been used weighing the beads for export. Iron definitely played a catalytic role in the development of the specialised bead industry at the site, as attested by the iron tools that were employed to craft the beads. Presumably in exchange for finished beads, the settlers were importing iron objects, as well as other raw materials, such as banded-hematite-red jasper, agate, amygdaloidal basalt, amethyst, garnet, carnelian, crystal quartz and other gemstones etc., from alluvial and other primary sources for large-scale bead production. During this period the state of Odisha/*Kalinga* was probably under the subjugation of the Mauryan Empire. From several excavated sites imperial variety of silver punched marked coins have been recovered (Pradhan 1992; Behera and Khamari 1998-99). Though no such evidence recovered from Badmal excavation, but on circumstantial grounds, it may be surmised that during the Early Historic period, the site of Badmal played a very significant role in regional and extra-regional trade and exchange network. Future investigation from multidisciplinary perspective may shed more insight on this site.

ACKNOWLEDGEMENTS

We would like to thank the Archaeological Survey of India for giving us permission to excavate this important site. We also thank the Institute of Physics, Bhubaneswar, and Kiel University, Germany, for providing radiocarbon dating. We also express gratitude to Sambalpur University for administrative and financial support. Finally, we are grateful to the villagers of Badmal for their help and cooperation during the project.

REFERENCES

Acharya, P. (1955). *Sambalpur yatra* (in Oriya): Translations of the account of British diamond merchant T. Motte (1765). Bhubaneswar, India: Utkal University.

Allchin, F. R. (1995). *The archaeology of early historic South Asia: The emergence of cities and states*. Cambridge, UK: Cambridge University Press.

Athiyaman, N. (1999). Graffiti marks from Kodumanal, Tamil Nadu: Spatial distribution analysis. *Proceedings of the Indian History Congress, 60*, 1087–1091.

Badam, G. L., Behera, P. K., & Mishra, J. (2001). Chalcolithic faunal economy at Khameswaripali, Middle Mahanadi Valley, Orissa: A bioarchaeological perspective. *Current Science, 80*(7), 828–830.

Basa, K. K., & Mohanty, P. K. (2000). *Archaeology of Orissa*. New Delhi, India: Pratibha Prakashan.

Behera, P. K. (2002–2003). Excavations at Kumersingha and Kurumpadar: The Iron Age settlements in the Middle Mahanadi Valley, Odisha—Results of the first season's work. *Pragdhara, 13*, 87–103.

Behera, P. K. (2023). Contexting Sindhol: A hilltop Gupta period settlement in the district of Subarnapur, Odisha, India. *Journal of Historical, Archaeological and Anthropological Studies, 1*(2), 81–93.

Behera, P. K., & Chattopadhyay, P. K. (2004–2005). Iron objects from Iron Age–Early Historic levels at Badmal (District Sambalpur, Orissa): Archaeometallurgical studies. *Puratattva, 35*, 118–125.

Behera, P. K., & Chattopadhyay, P. K. (2013). Iron Age–Early Historic period in eastern India: A study in material culture and technology—Evidence from Badmal-Asurgarh, District Sambalpur, Orissa, India. In J. Humphris & T. Rehren (Eds.), *The world of iron* (pp. 124–134). London, UK: Archetype Publications.

Behera, P. K., & Hussain, S. (2017). Early Historic gemstone bead manufacturing centre at Bhutiapali, the Middle Mahanadi Valley, Odisha. *Heritage: A Journal of Multidisciplinary Studies of Archaeology, 5*, 269–282.

Behera, P. K., & Hussain, S. (2019). Early Historic gemstone bead workshops at Badmal Asurgarh and Bhutiapali in the Middle Mahanadi Valley region, Odisha, India. *Ancient Asia, 10*(2), 1–16.

Behera, P. K., & Khamari, S. (1998–1999). A note on the discovery of a silver punch-marked coin from excavation at Kurumpadar, District Boudh (Orissa). *Bharati, 25*(1–2), 205–210.

Behera, P. K., Ray, D. K., Dutta, K., Ravi Prasad, G. V., Routray, T. R., & Choudhury, R. K. (2007). Radiocarbon dates from the Middle Mahanadi Valley, Odisha. *Man and Environment, 32*(2), 41–46.

Behera, P. K., Hussain, S., & Badam, G. L. (2015). Taraporegarh: An Iron Age–Early Historic circular fort in the Middle Mahanadi Valley, Odisha. *Puratattva, 45*, 178–196.

Behera, P. K., Hussain, S., & Goyal, P. (2019). Iron Age in the Middle Mahanadi Valley, Odisha: Recent perspectives. *Heritage: A Journal of Multidisciplinary Studies of Archaeology, 7*, 95–134.

Behera, S. C. (1982). Manamunda. In S. C. Behera (Ed.), *Interim excavation reports* (pp. 16–22). Sambalpur, India: Sambalpur University.

Boivin, N., Korisettar, R., & Venkatasubbaiah, P. C. (2010). Megalithic markings in context: Graffiti marks on burial pots from Kudatini, Karnataka. *South Asian Studies, 19*(1), 21–33.

Campbell, J. L., Johansson, S. A. E., & Malmqvist, K. G. (1995). *Particle-induced X-ray emission spectrometry (PIXE)*. New York, NY: John Wiley & Sons.

Campbell, J. L., Teesdale, W. J., & Halden, N. M. (1995). Theory, practice and application of PIXE microanalysis and element distribution maps. *The Canadian Mineralogist, 33*, 279–292.

Chattopadhyay, P. K., Behera, P. K., & Datta, P. K. (2007). From wrought iron to steel: Beginning of steel making in eastern India. *Indian Journal of History of Science, 42*, 387–402.

Das, H. C. (1990). Urban centres in ancient Orissa. In A. Ray & S. Mukherjee (Eds.), *Historical archaeology of India* (pp. 175–193). New Delhi, India: Books and Books.

Demortier, G. (1997). IBA application to ancient metallic items. In M. A. Respaldiza & J. Gómez-Camacho (Eds.), *Applications of ion beam analysis techniques to arts and archaeometry* (pp. 91–114). Seville, Spain: Universidad de Sevilla.

Demortier, G. (2000). Essentials of PIXE and RBS for archaeological purposes. In G. Demortier & A. Adriaens (Eds.), *Ion beam study of art and archaeological objects* (pp. 125–136). Luxembourg: Office for Official Publications of the European Communities.

Dhavalikar, M. K. (1999). *Historical archaeology of India*. New Delhi, India: Books and Books.

Garnayak, D. B. (2020). Excavation at Asurgarh: An Early Historic fortified settlement in Odisha. *Heritage: Journal of Multidisciplinary Studies in Archaeology, 8*(2), 353–377.

Ghosh, A. (1973). *The city in early historical India*. Shimla, India: Indian Institute of Advanced Study.

Ghosh, A. (Ed.). (1989). *An encyclopaedia of Indian archaeology* (Vol. 1). New Delhi, India: Munshiram Manoharlal.

Govil, I. M. (2001). Proton-induced X-ray emission: A tool for non-destructive trace element analysis. *Current Science, 80*(12), 1542–1549.

Goyal, P., Joglekar, P. P., & Behera, P. K. (2014). The Iron Age faunal economy at Badmal, District Sambalpur, Odisha. *Man and Environment, 39*(1), 52–61.

Goyal, P., Behera, P. K., & Hussain, S. (2020a). Continuity and change in animal exploitation at Kantipuleswar, an Iron Age site in the Middle Mahanadi Valley of Odisha. *Man and Environment, 45*(1), 78–91.

Goyal, P., Behera, P. K., & Hussain, S. (2020b). Animal-based subsistence strategies at Kapasira, an Iron Age settlement in the Middle Mahanadi Valley of Odisha. *Heritage: Journal of Multidisciplinary Studies of Archaeology, 8*(2), 73–99.

Geological Survey of India. (2012). *Geology and mineral resources of the states of India*. Kolkata, India: Author.

Gupta, P. (2013). *Prachina Bharata ke pramukha abhilekha* (Part 2). Varanasi, India: Viswavidyalaya Prakashan.

Hajivaliei, M., Garg, M. L., Handa, D. K., Govil, K. L., Kakavand, T., Vijayan, V., Singh, K. P., & Govil, I. M. (1999). PIXE analysis of ancient Indian coins. *Nuclear Instruments and Methods in Physics Research Section B, 150*, 645–650.

Hussain, S. (2018). A note on circular fortified settlements in the Middle Mahanadi Valley, Odisha. *Man and Environment, 43*(2), 103–107.

Hussain, S. (2019). Further archaeological explorations in the Lower Tel River Valley region. *Puratattva, 49*, 169–176.

Hussain, S. (2020a). Early Historic sites of the Middle Mahanadi Valley, Odisha: A preliminary observation on the excavated material remains. In S. Hussain & S. Mendaly (Eds.), *Recent developments in historical and archaeological researches in Odisha* (pp. 69–90). Bhubaneswar, India: Walnut Publications.

Hussain, S. (2020b). A note on the Early Historic fortified settlement of Jamsaragarh in Sundargarh District, Odisha. *Indian Journal of Archaeology, 5*(1), 132–135.

Hussain, S., & Mahakur, A. (2023). Archaeological exploration in the Harihar Jor, District Subarnapur, Odisha, India: A preliminary observation. *Indian Journal of Archaeology, 8*(1), 337–345.

Hussain, S., & Joshi, D. K. (2014). Archaeology of Kalahandi District: Finds from Kachhimdola and Deundi. *Puratattva, 44*, 259–262.

Hussain, S., Jhankar, S., & Purohit, B. (2017). Recent archaeological investigations in the Lower Tel River Valley, Odisha: A preliminary observation. *History Today, 18*, 59–63.

Indian Archaeology: A Review. (n.d.). New Delhi, India: Archaeological Survey of India.

Joglekar, P. P. (2015). *Humans and animals: An archaeozoological approach*. Pune, India: Gayatri Sahitya.

Joglekar, P. P., & Patnaik, J. (2016). Faunal remains from the Chalcolithic contexts at Suabarei, District Puri, Odisha. *Bulletin of the Deccan College Post-Graduate and Research Institute, 76*, 29–44.

Joglekar, P. P., & Tripathi, B. (1997–1998). Archaeological investigation in Central Orissa: A note. *Puratattva, 28*, 117–120.

Joglekar, P. P., Thomas, P. K., Matsushima, Y., & Pawankar, S. J. (1994). Osteological differences between the forelimb bones of ox (*Bos indicus*), buffalo (*Bubalus bubalis*), and nilgai (*Boselaphus tragocamelus*). *Journal of Bombay Veterinary College, 5*(1–2), 17–20.

Johansson, S. A. E., & Campbell, J. L. (1988). *PIXE: A novel technique for elemental analysis*. Chichester, UK: John Wiley & Sons.

Kar, S. K., & Joglekar, P. P. (2000). Gopalpur: A Neolithic–Chalcolithic site in coastal Orissa. In K. K. Basa & P. Mohanty (Eds.), *Archaeology of Orissa* (pp. 368–391). New Delhi, India: Pratibha Prakashan.

Lal, B. B. (1949). Sisupalgarh 1948: An Early Historical fort in eastern India. *Ancient India, 5*, 62–105.

Lal, B. B. (1960). From the Megalithic to the Harappan: Tracing back the graffiti on pottery. *Ancient India, 16*, 4–24.

Majumdar, S. N. (1927). *Ancient India as described by Ptolemy*. Calcutta, India: Baptist Mission Press.

Mando, P. A. (1994). Advantages and limitations of external beams in applications to arts and archaeology, geology and environmental problems. *Nuclear Instruments and Methods in Physics Research Section B, 85*, 815–823.

Mishra, J. (2005). Radhanagar and beyond: Pattern, process and structure of early urbanisation in south-eastern India. In K. K. Chakravarti & G. L. Badam (Eds.), *River valley cultures of India* (pp. 138–148). Bhopal, India: IGRMS; New Delhi, India: Aryan Books International.

Mishra, B. (1933). *Dynasties of medieval Orissa*. Calcutta, India.

Mishra, B. (2011). *Early Orissa: Urbanisation in Tel Valley*. Delhi, India: B. R. Publishing Corporation.

Mishra, B. (2016). Preliminary archaeological investigation at Budhigarh, Odisha. *History Today, 17*, 21–28.

Mishra, B. P., & Mohanty, B. K. (1995). Gemstones. In B. K. Mohanty, N. K. Mahalik, & R. N. Mishra (Eds.), *Geology and mineral resources of Orissa* (pp. 185–202). Bhubaneswar, India: Society of Geoscientists and Allied Technologists.

Mishra, U., & Behari, S. (2019). Understanding nature and attributes of Early Historical Orissa: An archaeological perspective. *Odisha Historical Research Journal, 58*(1–2), 1–33.

Mohanty, P., Joglekar, P. P., & Mishra, B. (1998–1999). Early Historic investigation in Kalahandi District, Orissa: A preliminary report. *Puratattva, 29*, 120–131.

Mohanty, B. K. (1995). Iron ore. In B. K. Mohanty, N. K. Mahalik, & R. N. Mishra (Eds.), *Geology and mineral resources of Orissa* (pp. 229–251). Bhubaneswar, India: Society of Geoscientists and Allied Technologists.

Mohanty, R. K., & Smith, M. L. (2008). *Excavations at Sisupalgarh* (Special Report No. 2). New Delhi, India: Indian Archaeological Society.

Nayak, J. C., & Das, J. N. (1995). Vanadium ore. In B. K. Mohanty, N. K. Mahalik, & R. N. Mishra (Eds.), *Geology and mineral resources of Orissa* (pp. 288–297). Bhubaneswar, India: Society of Geoscientists and Allied Technologists.

Pandey Sharma, L. D. (1947). Mahakantara and its location. *Proceedings of the Indian History Congress, 10*, 176–179.

Patnaik, S. K. (2022–2023). Archaeology of the Early Historic site of Radhanagar, Jajpur District, Odisha: A fresh appraisal. *Heritage: Journal of Multidisciplinary Studies in Archaeology, 10*, 363–384.

Patra, B. (2007). Early Historic urban centres of western Odisha: An archaeological study. *Man and Environment, 32*, 27–36.

Pawankar, S. J., & Thomas, P. K. (2001). Osteological differences between blackbuck, goat and sheep. *Man and Environment, 26*, 109–126.

Pradhan, S. (1992). A note on a punch-marked coin found from Manamunda excavation. *Journal of the Numismatic Society of India, 54*(1–2), 26–28.

Pradhan, S. (2003). Kharligarh: An Early Historic site in western Orissa. *Sambalpur University Journal of Humanities and Social Science, 2*, 51–61.

Prummel, W., & Frisch, H. J. (1986). A guide for the distinction of species, sex and body side in bones of sheep and goat. *Journal of Archaeological Science, 13*, 567–577.

Rajan, K., & Bopearachchi, O. (2002). Graffiti marks of Kodumanal (India) and Ridiyagama (Sri Lanka): A comparative study. *Man and Environment, 27*(2), 97–105.

Sahoo, R. K. (1995). Chromite and nickel ore. In B. K. Mohanty, N. K. Mahalik, & R. N. Mishra (Eds.), *Geology and mineral resources of Orissa* (pp. 108–144). Bhubaneswar, India: Society of Geoscientists and Allied Technologists.

Singh, H. H. (1971). Orissa Highland region. In R. L. Singh (Ed.), *India: A regional geography* (pp. 754–775). Varanasi, India: National Geographical Society of India.

Singh, R. N., & Behera, P. K. (2001–2002). A note on the scientific examination of glass objects from Kurumpadar, District Boudh, Orissa. *Pragdhara, 12*, 173–176.

Sinha, B. K. (2000). Golbai: A Protohistoric site on the coast of Orissa. In K. K. Basa & P. Mohanty (Eds.), *Archaeology of Orissa* (pp. 322–348). New Delhi, India: Pratibha Prakashan.

Vijayan, V., Choudhury, R. K., Mallick, B., Sahu, S., Choudhury, S. K., Lenka, H. P., Rautray, T. R., & Nayak, P. K. (2003). External particle-induced X-ray emission. *Current Science, 85*(6), 772–777.

Yazdani, G. (1916). Megalithic remains of the Deccan: A new feature of them. *Journal of the Hyderabad Archaeological Society*, 56–79.

Yule, P. (2006). *Early Historic sites in Odisha*. New Delhi, India: Pragun Publications.

Yule, P., Behera, P. K., Brandtner, M., Modarressi-Tehrani, D., & Rath, B. K. (2005). Preliminary report of the third field season, 2002: Contexting Early Historic western Orissa. In U. Franke-Vogt & H. J. Weisshaar (Eds.), *South Asian archaeology 2003* (pp. 307–318). Aachen, Germany: Linden Soft Verlag.