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RESEARCH ARTICLE

Luminescence and radiocarbon chronology of Bhagatrav: A Sorath Harappan camp site in South Gujarat

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Abstract
Excavation at the site of Bhagatrav yielded four layers of cultural deposits: the lowermost being the Sorath Harappan, the upper two are medieval, and layer three caps the Sorath Harappan layer. A horn-deity painted dish was found in a stratified context at the lowest level. The medieval deposit includes turquoise glazed and celadon wares, followed by an abundance of Monochrome Glazed Ware, which is otherwise known as Khambhat ware. The date of the Sorath Harappan layer of the site, the time and space of the horn-deity motif in the Harappan world, and the date of Khambhat ware have long been subjects of discussion. With the help of a series of absolute dating (radiocarbon and luminescence), this paper attempts to place the site, horn-deity motif, and the Khambhat ware in the cultural chronology of Gujarat.

1. Bhagatrav

The site of Bhagatrav (21°29′N; 72°42′E) is located 2 km south of the village Jetpur, Hansot Taluka, which is about 60 km southwest of Bharuch district of Gujarat, India. The archaeological mound falls on the south of Narmada, on the northern estuary of a small navigable creek Kim, which flows to the Arabian Sea at a distance of 2 km (Figure 1).

After the excavation at Lothal (22°19′0″N, 72°24′0″E), S.R. Rao representing the Archaeological Survey of India (ASI), took trial trenches at three satellite sites to corroborate the evidence in 1957–1958. One of those sites was Bhagatrav, which he claimed to be contemporary to Lothal and a Mature Harappan port site.

ASI excavation at Bhagatrav revealed an 8 ft high mound with a 7 ft cultural deposit of two cultural periods, Period I and II, assignable respectively to the Harappan and medieval times. Period I was further divided into two sub-periods, 4 and 1/2 ft thick I-A (Mature Harappan) and 2 ft thick I-B (Late Harappan), representing respectively the Urban[1] and Post-Urban[2] phases of Harappan culture (IAR 1957–1958, 15)[3]. Between period I-A and period I-B there is an eroded surface consisting of sand and silt due to a flood. Period I-A yielded ceramic types similar to those from Lothal and Rangpur-IIA, while I-B revealed Post-Urban phase pottery forms like a dish with a short projected rim and a small jar with a

[1] Mature Harappan period is considered as the urban phase of Harappan culture.
[2] Late Harappan period is termed as post-urban phase.
[3] Mature Harappan, Urban Harappan, Classic Harappan, Late Harappan, Early Harappan, Pre-Urban Harappan, Post-Urban Harappan etc., are terminologies used to describe specific features of the Harappa culture or Harappan civilization. Often, some of these terms are interchangeable but do have nuanced meanings.

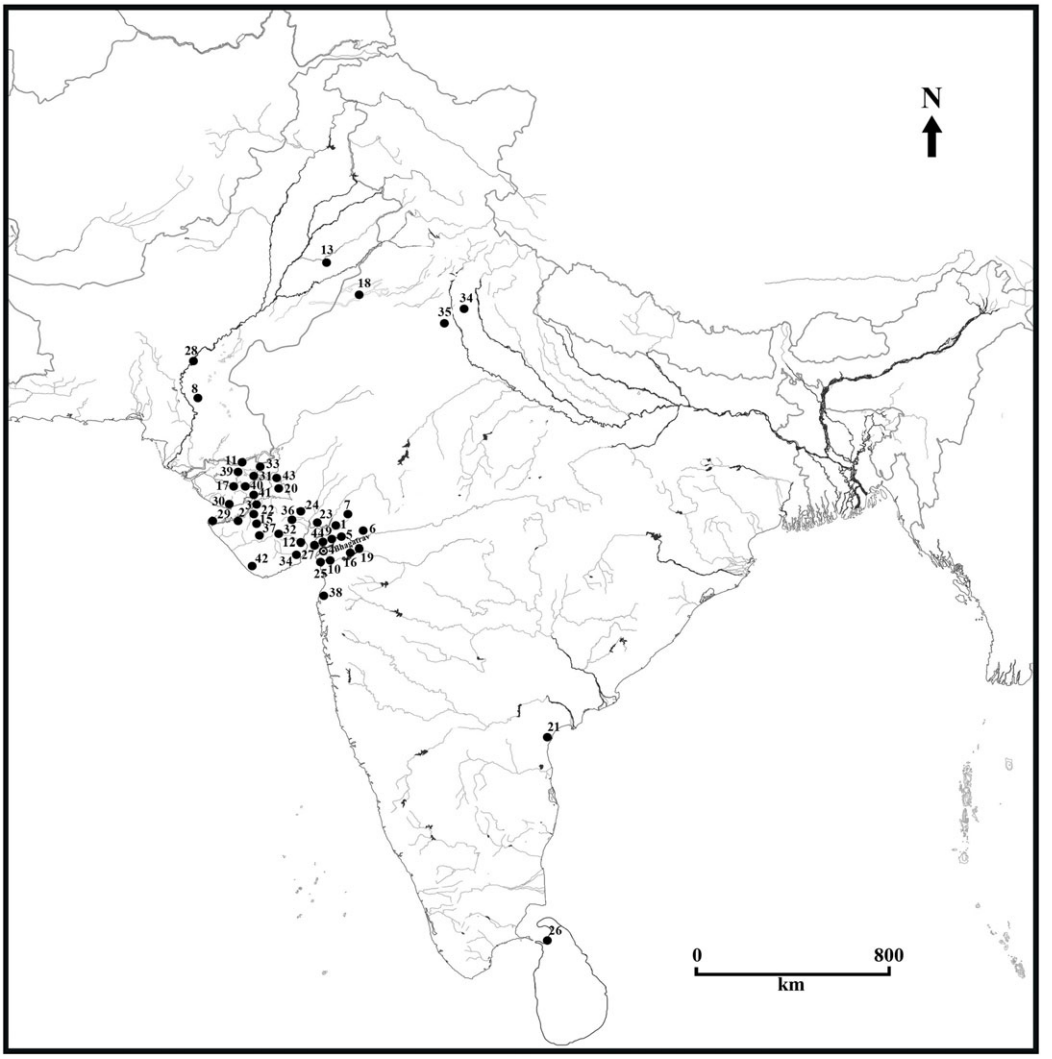

Figure 1. *Location of Bhagatrav and other referred sites in the paper (1. Akota, 2. Amara, 3. Bagasra, 4. Bhagatrav, 5. Bharbhut, 6. Bharuch, 7. Champaner, 8. Chanhudaro, 9. Chawaneswari, 10. Dhatva, 11. Dholavira, 12. Gogha, 13. Harappa, 14. Hastinapur, 15. Jaidak, 16. Jokha, 17. Juni Kuran, 18. Kalibangan, 19. Kamrej, 20. Kanmer, 21. Kottapatanam, 22. Kuntasi, 23. Lashkarshah, 24. Lothal, 25. Malvan, 26. Mantai, 27. Mehgm, 28. Mohenjo-daro, 29. Nageshwar, 30. Navinal, 31. Ner, 32. Oriyo Timbo, 33. Pabumath, 34. Padri, 35. Purana Qila, 36. Rangpur, 37. Rojdi. 38. Sanjan, 39. Saran, 40. Sevakiya, 41. Shikarpur, 42. Somnath, 43. Surkotada, 44. Telod).*

slightly elongated neck (Rao 1963, 190). Rangpur[4]-IIA and IIB are placed under the Urban phase, and Rangpur-II C and Rangpur-III are under the Post-Urban (Possehl 1980, 1992; Possehl and Mehta 1994; Rao 1963). Later many scholars disagreed with the flood theory and opined that Bhagatrav is erroneously compared to Rangpur-IIA because of this misconception (Herman 1996, 84).

In 2015, National Institute of Oceanography (NIO) led by A.S. Gaur took a trial trench measuring 2.5 × 5 m on the margin of the site and close to a channel of Kim creek (Gaur and Sundaresh 2016, 84–87). Two cultural period deposits are noticed down to 2 m from the surface of the trench, out of

[4] The site of Rangpur has been the index site of the region from the time it was excavated.

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which the bottom 60 cm revealed evidence of Protohistoric settlement, and the remaining is of the medieval period. There is no mention of fluvial deposit. The first period yielded 25 shapes of pottery, which are very different from other protohistoric settlements of Saurashtra and Kachchh; the complete absence of typical Protohistoric bowls of Saurashtra sites; no influence of Harappan except some paintings; and shapes and paintings found are similar to those reported from the early phase of Malvan[5]. However, a few antiquities of the Protohistoric period, including a chert blade, a carnelian bead, and a spindle whorl are found. The second period is identified as the medieval; majority of pottery is black ware, and the main shape is carinated *handi* (pot).

Gaur and Sundaresh placed the site under Post-Harappa on the basis of morphological features and the presence and absence of certain shapes and paintings. However, the Protohistoric potteries illustrated in their publication are morphologically close to the potteries reported from Jokha (Mehta et al. 1971) and Dhatva (Mehta et al. 1975), the two Harappan affiliated Chalcolithic sites (dated to Post-Urban Harappan period) excavated by the Maharaja Sayajirao University of Baroda (MSU).

2. Excavations 2015—IITGN

In April–May 2015, another archaeological investigation for a single season was carried out by Indian Institute of Technology Gandhinagar (IITGN) under the field directorship of the first author of this paper, with two-fold objectives: first, to place the site scientifically in the cultural time and space of the region and second, to evaluate the functional role of the site. This paper deals with the date of the occupation at the site.

The mound now survives to a size of 100–150 m, which is perhaps only the periphery of the original mound; a larger part has been eroded as a result of the Kim River and backwaters of the sea entering the creek. Due to high tides, the mound remains surrounded by water for half of the year. A thorough survey of the existing mound revealed that the Sorath Harappan cultural artifacts distribution is restricted to the western end of the mound, whereas the celadon and Khambhat wares of the medieval period are found across the mound.

3. Stratigraphy

Out of three trenches (OA1, CX7 and DY9) excavated by IITGN at different locations, the trench DY9 (21°28′42.4″N; 72°42′0.89″E), which is 30 cm down the datum line, revealed both Sorath Harappan and medieval deposits in four individual cultural layers (Figure 2). Layers 1 (until the depth of 63 cm from datum) and 2 (following 30 cm) are assigned to the medieval period. The pottery assemblage is represented by red, grey, and glazed wares. In the early level of this period, a few pieces of celadon and turquoise glazed wares are found. Red ware is dominated by jars and pots, followed by bowls and basins, whereas grey ware has a variety of jars/pots, *handis* and basins. In the case of glazed ware, only fragments of plates, bowls, and small pots were observed. The glazed ware has three surface colors: white, green and blue. Layer 3 (25 cm thick) is a break between medieval and Sorath Harappan deposits. Though the cultural deposit of this layer is mixed in nature, no evidence of fluvial activity in the form of sand and silt is noticed. There is every possibility that this mixed nature is a result of the reworking of the sediments by the medieval occupants. However, finding of a number of clay storage-bin's base (see Ansari 2000) suggests there was occupation at this level (Figure 3). Layer 4 (lowermost 75 cm) is assigned to the Sorath Harappan period, on the basis of pottery and artifacts, including a terracotta miniature bull and a bichrome dish sherd with a painting of a horn-deity (Figure 4, Kanungo 2021). Ceramic assemblages included sturdy and well-treated fine red ware (both slipped and unslipped) and a few coarse red and buff wares. A very small quantity of pottery was treated with red or cream slip. The painting is executed in black over red and chocolate over buff. The assemblage is dominated by jars/

[5] Malvan is a post-Harappan site in Valsad district of the Gujarat.

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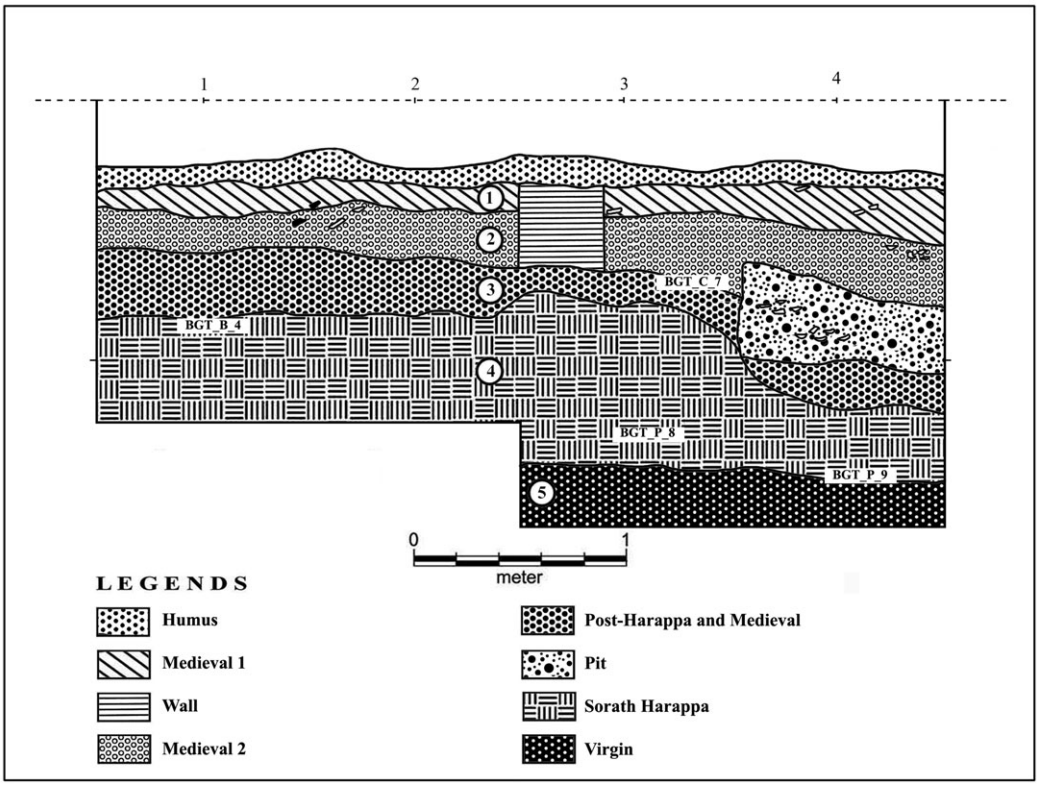

Figure 2. *Stratigraphy of Bhagatrav, trench DY9 section facing north.*

pots, followed by dishes, bowls and basins. A majority of jars have high and concave necks, indicating the late Urban phase. Characteristic types, such as step-sided dishes, perforated jars, basins, convex-sided bowls and goblets were recovered in considerable numbers (Figure 5).

Trench CX7 (21º28′39.2″N; 72º42′11.2″E) is placed on the highest point of the mound; thus the datum is set on the NW peg of this trench. OA1 (21º28′24.4″N; 72º42′09.2″E) is 40 cm down the datum. On the basis of soil color, composition and cultural contents of the layers, Layers 1 and 2 of trenches OA1 (40 and 34 cm thick) and CX7 (38 and 42 cm thick) are similar to what has been found at respective layers of 1 and 2 in trench DY9. Layer 3 in both OA1 (dug up to 36 cm) and CX7 (dug up to 30 cm) gave percolating artifacts consisting of small flakes and few beads of layer 2 due to the visible cracks in the black cotton soil than any habitation deposits.

4. Gujarat Harappan port settlements

Gujarat has a long coastline and, being in maritime contact from the time of first urbanization, has developed several ports. There are a number of sites very close to the shore, and most are linked with the sea or Gulf by a river or an estuary. The excavation at Lothal in the 1960s brought to light a "dockyard" (Rao 1979, 1984). Kuntasi on the southern shore of the Gulf of Kachchh and Saran, near Dholavira on the shore of the Great Rann, yielded remains of jetties. The ancient city of Kuntasi was established to develop it as a port (Dhavalikar 1996, 25).

Nageshwar, Amara [Amra] and Bagasra on the Saurashtra coast, and Navinal, Sevakiya, Shikarpur, Kanmer, Surkotada, Pabumath, Ner and Juni Kuran, all on the Kachchh/Rann coast, have been claimed as small local ports involved in short-distance trade through both overland and sea routes (Rawat 2015:208). Rawat further opined that these sites might have been associated with a greater chain of trade

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Figure 3. *Clay storage-bin bases in layer 3, trench DY9 (the East Section of the trench is in the background).*

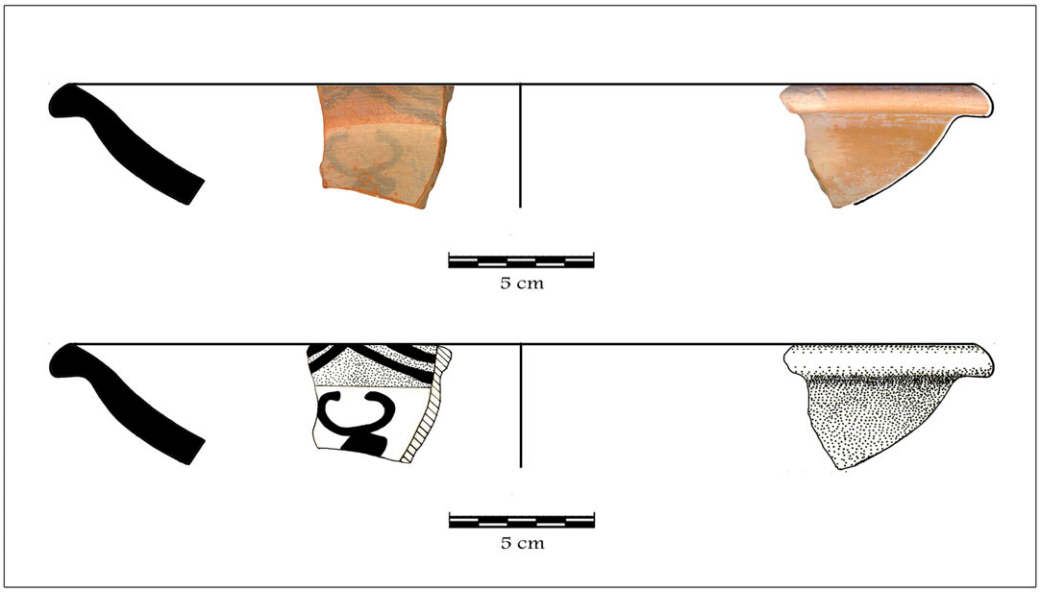

Figure 4. *Horn-deity painted dish, layer 4, trench DY9.*

networks or resource management mechanisms. Bhagatrav has been interpreted as a port site involved in procuring minerals and forest products for trading to contemporary cities (IAR 1957–1958). In relation to questionable identification of Dilmun, Magan and Meluhha, Thapar (1983) proposed that Bhagatrav possibly played the same role as Lothal (center for processing and commodity production)

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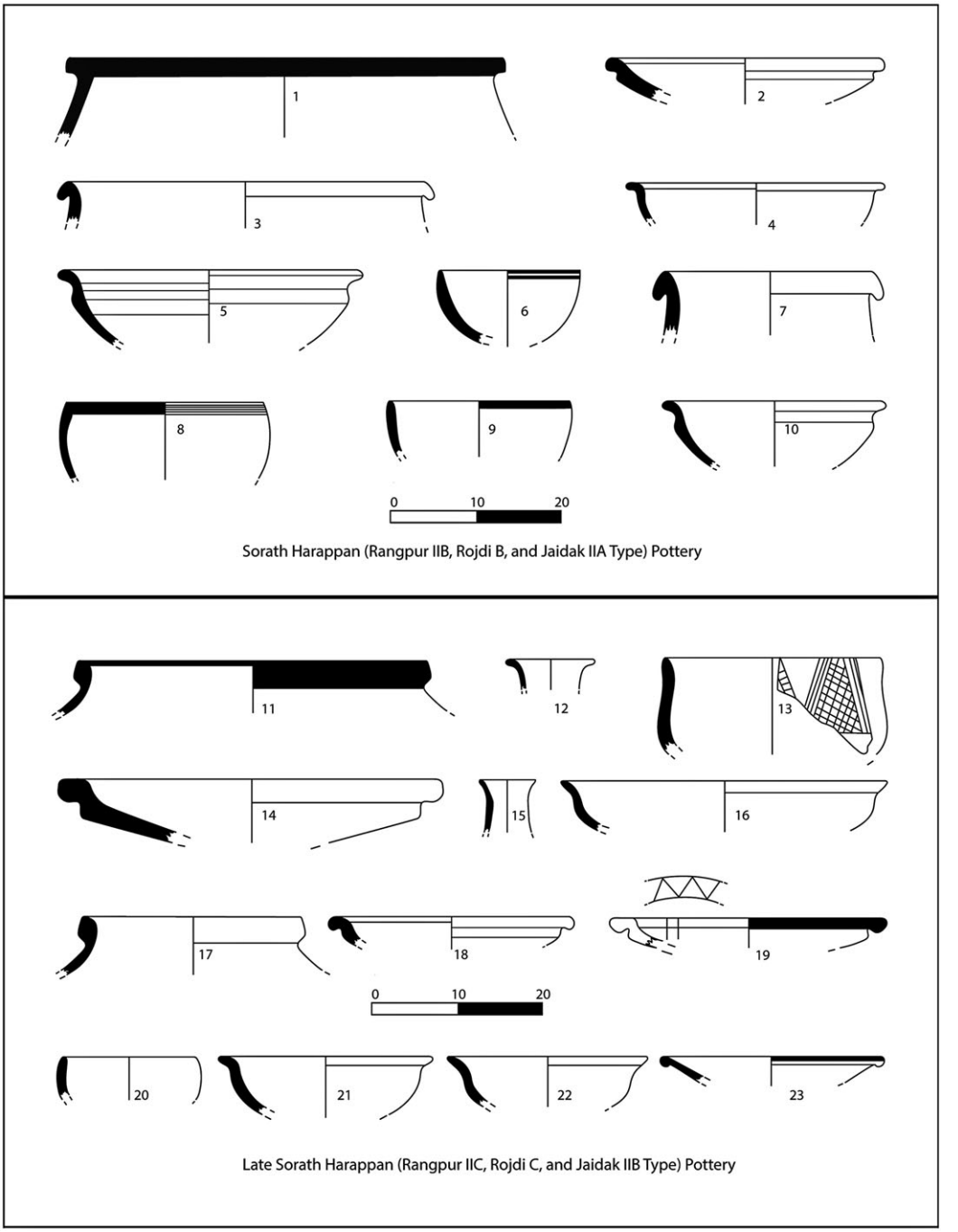

Figure 5. *Sorath and late Sorath Harappan period ceramics from Bhagatrav.*

for the products of the Narmada valley, such as timber, agate and carnelian. To substantiate her claim for a site which did not yield any structural evidence, she argued that a trade involving the collection of raw materials would not necessitate complex urban centers, but locations for the collection and packaging of cargo with marginal commodity production.

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Even if it was a packaging center and a respective portion of the site had been washed out, it would have yielded a few structures. The only evidence we have is a few circular features (perhaps related to storage facilities) in the Harappan level and a broken anchor on the surface, which was reused as a crusher. Neither of these can be taken as important criteria for trading, let alone port.

5. Sorath Harappa

Though S.R. Rao did not use the term Sorath Harappan but, the Harappan site of Lothal yielded a distinct regional variation in pottery, which are nothing but Sorath Harappan pottery.

Excavations at Rojdi (Possehl 1989, 1) established Sorath Harappan as a distinct regional manifestation in terms of settlement, subsistence, and material culture and Sorath Harappan as contemporary with the urban phase of the Harappan civilization of Kutch and Sindh regions[6].

Except for Pithad/Jaidak, which is 15 hectares in size (Ajithprasad 2008), most Harappan sites in Saurashtra are generally quite small; the average site size is estimated at 5.3 hectares (Possehl 1980, 65). The other two excavated sites, Rojdi and Padri, with approximately 7 hectare each, are relatively large (Possehl 1980, 65; Shinde 1998, 173). Kuntasi is 3.3 hectares (Dhavalikar et al. 1996, 25). Sorath Harappan settlement plans are different from the large Classic Harappan settlements such as Mohenjo-daro, Harappa, Kalibangan, Dholavira, and Lothal. Public architecture, including a town plan characterized by a citadel and lower town, is absent. Most sites were expected to fulfil a specific function. Kuntasi (bead and ceramic manufacture), and Lothal (bead and metal ware making) were industrial establishments (Dhavalikar et al. 1996, 31–32). Likewise, Bagasra gave ample evidence of shell cutting and ernestite nodules (used for drill bits). Crafts played a major role in the then economy—one of the reasons for the spread of civilization to the Saurashtra region and fortifications.

There are fortifications around some settlements, including Kuntasi, Rojdi, and Pithad/Jaidak but none are close to what we get in Classic Harappan sites. Lothal and Bagasara, the two Classic and Sorath Harappan sites, have large fortifications.

Characteristic Harappan objects such as long tubular carnelian beads, seals and sealings, cubical chert/agate weights and Harappan script are absent in the entire regions of Sorath Harappa, with a few exceptions, like an inscribed sherd is found at Rojdi.

6. Radiocarbon dates of Sorath Harappan sites

While it appears that most of the occupation at Rojdi falls within the Urban phase, the material inventory of the site is clearly not of the Mature/Classic Harappan (Table 1), at least as we know it from Mohenjo-daro, Chanhudaro and other sites in Sindh, or even Lothal and Surkotada. However, the material inventory of Rojdi A and B does seem to be shared with a number of other sites in Saurashtra. Many, possibly most, of the Rangpur II B-C sites would fall into this category (Possehl 1989, 13).

Rojdi phases A and B are identified as Sorath Harappan. The dates compare well with those from Lothal A and the three phases of occupation at Surkotada are fully congruent with the chronological data for the date of the Urban phase in Sindh and Punjab (Agrawal 1982a, 1982b; Possehl 1989, 12). Taking Rojdi phase B dates ranging between 2283–1836 BCE (Possehl 1989), Dhavalikar et al. (1996, 32) placed Rojdi B phase to ca. 2200–1900 BCE range, which is considered as late Urban Harappan phase.

Kuntasi, period I (layers 20–7, 2400–1900 BCE) begins from the end of the early Mature phase and covers the entire late Mature Harappan phase, whereas the period II (layers 6–1, 1900–1700 BCE) is identified as Late Harappan (Dhavalikar et al. 1996, 27). Three AMS dates were obtained from the charcoal samples of different layers. One from layer 12 (middle level of period I), which marks the structural phase B is dated to 2291 BCE, the second sample is from layer 5 (period II), dated to 2145

[6] "Sorath Harappan" represents the regional manifestation of the Urban/Mature phase Harappa Culture in Saurashtra and the 'Late Sorath Harappan' is the Post-Urban phase.

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Table 1. *Radiocarbon determinations for Sorath Harappan phases of different sites*

Lab code	Radiocarbon age (yr BP)	Calibrated date[7]	Reference
Lothal B			Possehl 1989, 10
TF-19	3759±135 BP	2315–1865 BC	
TF-23	3816±105 BP	2320–1959 BC	
Average 2275, 2210 and 2307 BC			
Lothal A			
TF-135	3507±125 BP	1950–1570 BC	
TF-29	3850±110 BP	2340–1980 BC	
TF-133	3850±110 BP	2340–1980 BC	
TF-26	3945±120 BP	2425–2195 BC	
TF-27	3955±110 BP	2425–2160 BC	
TF-22	3960+110 BP	2430–2165 BC	
TF-136	4032+130 BP	2655–2185 BC	
Average: 2452, 2427, 2395, 2374 and 2366 BC			
Rojdi Main Mound (Trench 45K), Middle level (Rojdi B?)			Possehl 1989, 12
PRL-1088	3770±125 BP	2420–1980 BC	
Rojdi Main Mound (Trench 45 K), Lower levels (Rojdi A)			
PRL-1089	3865±115 BP	2640–2150 BC	
PRL-1093	3920±105 BP	2645–2310 BC	
PRL-1087	4010±105 BP	2680–2515 BC	
PRL-1085	4020±105 BP	2680–2515 BC	
Average for lowest level: 2469 BC			
Rojdi Main Mound (Trench 46L), Middle Level (Rojdi B)			
PRL-1282	3470±140 BP	2000–1665 BC	
PRL-1281	3520±110 BP	2015–1710 BC	
Rojdi Main Mound (Trench 46L), Lower Level (Rojdi A)			
PRL-1285	3740±140 BP	2410–1945 BC	
PRL-1284	3810±100 BP	2415–2135 BC	
PRL-1283	3980±100 BP	2660–2385 BC	
Rojdi South Extension (Trench 76L), Upper Level (Rojdi C?)			
PRL-1084	3700±145 BP	2350–1890 BC	
Rojdi South Extension (Trench 76L), Lower Level (Rojdi B?)			
PRL-1083	3875±125 BP	2640–2160 BC	
Rojdi Trench B, Period I, Phase B, 1962/63 season			Possehl 1989, 12
TF-200	3810±110 BP	2415–2135 BC	
Rojdi Trench C, Period I, Phase B, 1962/63 season			
TF-199	3590±110 BP	2160–1850 BC	
Kuntasi Period I			
PRL-1370	3820±170 BC	2291 BC	Dhavalikar et al.
BS-567		2451–2356 BC	1996, 41
Average 2451, 2433, 2392, 2384 and 2356 BC			
Kuntasi Period II			
PRL-1371	3750±140 BC	2145 BC	
Average 2191, 2181 and 2145 BC			
Padri Uppermost level of Mature Harappan Phase			Shinde 1992, 82
PRL-1536		2300 BC	

(*Continued*)

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Table 1. (*Continued*)

Lab code	Radiocarbon age (yr BP)	Calibrated date[7]		Reference
Somnath Period II, Lustrous Red Ware Period				Possehl 1989, 14
PRL-19	3100±160 BP	1590–1230 BC		
PRL-20	3340±105 BP	1775–1550 BC		
PRL-91	3860±165 BP	2560–2145 BC		
Average 1733, 1722 and 1695 BC				
Somnath Period II, Prabhas Period				
TF-1284	3465±95 BP	1955–1695 BC		
TF-1286	3595±90 BP	2160–1850 BC		
PRL-92	3830±95 BP	2425–2155 BC		
Average 2026, 1995 and 1986 BC				
	68% probability	95% probability	Intercept age	Ajithprasad 2014, 645
Bagasra Phase III Late Urban				
	2310–2200 BC	2430–2140 BC	2280 BC	
	2460–2290 BC	2470–2210 BC	2390–2340 BC	
Bagasra Phase IV Post Urban				
	2020–1920 BC	2120–1880 BC	1960 BC	

BCE and the third sample is from the middle level of the period I, which is dated to 2451–2356 BCE (Dhavalikar et al. 1996:41).

Of the four phases of Harappan cultural development at Bagasra, Phases III (late Urban) and Phase IV (Post-Urban) phases in Bagasra are attributed to Sorath Harappan (Rangpur-II A–B and Rojdi A–B) and Late Sorath Harappan (Rangpur IIC and Rojdi C) respectively. Phase III is contemporary to the last state of Classic/Urban Harappan culture (Sonawane et al. 2003, 25).

Both the Classical Harappan artifacts and the Sorath Harappan convex and straight-sided bowls, large globular pots with tapering flat bottoms, dishes, and jars with distinct rim features resembling Rojdi-B types are found together in Phase III. Rojdi-B has been dated by ^{14}C to 2200–1900 BCE (Possehl and Raval 1989, 12). Comparing with material culture and identical pottery of this phase, Sonawane et al. (2003, 49), ascribed 2100–1900 BCE to Phase-III of Bagasra. The Post-Urban, Phase-IV assemblage at the site has been equated with Rangpur-IIC and Rojdi-C due to the presence of blunt carinated bowls, dishes with drooping rims, pots/jars with elongated necks and beaded rims, etc. It can also be equated with Lothal-B from where a similar artifacts assemblage has been reported by Rao (1979). The date of Rojdi-C has been estimated on the basis of ^{14}C determinations and other chronological considerations to be between 1900 to 1700 BCE (Dhavalikar et al. 1996, 32). This suggests a date of 1900–1700 BCE for Phase-IV of Bagasra. Later on, the AMS radiocarbon dates obtained for Bagasra matched with the dates proposed on the basis of ceramic chronology. Bhagatrav has no distinct stratum corresponding to Bagasra IV or Rojdi C, but has ceramics belonging to that Phase. An overlying phase to Sorath Harappan in the form of layer 3 exists, and a bone from the undisturbed context from the uppermost portion of the preceding layer 4 is dated to 3454 BP with the AMS radiocarbon method.

Padri is nearly 2 km from the Gulf of Cambay. The site is interpreted as a salt processing and trading center (Shinde 1992, 79). On the basis of the ceramic assemblage, which is comparable to Rojdi B, the Mature Harappan level—period II (layers 4–10) is dated to ca. 2200–2000 BCE (Shinde 1992, 82). A ^{14}C date from the uppermost levels of this phase is dated to 2300 cal. BCE. It is, therefore, reasonable to assume the date of ca. 2500 BCE as the time for the beginning of this period.

Period II at Somnath ceramic is comparable to Rojdi A and B, whereas, Rojdi-C and Rangpur IIC ceramic assemblages are comparable to the Post-Urbanization phase of the Sorath Harappan and

[7] The calibrated dates are as in the original references and not recalculated.

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Bhagatrav IA [layer 4] (Rao 1963). Prabhas assemblages (Period II at Somnath) include Sorath Harappan ceramics in addition to Prabhas pottery. Period III at Somnath includes Rojdi-C pottery and lustrous red ware of Late Sorath Harappan. At Oriyo Timbo, lustrous red ware using occupation layer has been compared with Rangpur-III (Rissman and Chitalawala 1990, 140).

7. Inhabitant, function, and time period of Bhagatrav proposed by earlier scholars

Rao (1963) claimed Bhagatrav: (1) to be the southernmost Harappan site having a port contemporary with Lothal; (2) served as a stone raw material supply point to the Harappan settlements of the Saurashtra and Kachchh region; (3) on the basis of ceramic and other evidence, Bhagatrav-IA is placed slightly earlier than Rangpur-IIA and is perhaps contemporary with Phases II and III of Lothal-A; (4) Bhagatrav IB yields Late Harappan wares, especially the dish and jar, similar to those from Mehgam and Rangpur-IIB; and (5) Bhagatrav Period II yielded jar and knobbed lid of coarse grey ware, assignable to the medieval times (10–11th century CE) on the basis of the evidence obtained elsewhere, e.g. at Akota.

According to Rao, it is a "certainty that the Harappans came to Lothal for trade or colonizing in 2450 B.C." (1962, 15) and that when their settlement was destroyed, along with the Indus Valley cities in the wake of a great deluge, they moved to Rangpur and Bhagatrav. Latter was echoed by Kirk (1975). This would have been sometime after 2000 BCE (Rao 1962, 17, 1963, 204). Later scholars discarded the flood theory (Herman 1996, 84).

While discussing the whereabouts of Lothal occupants, Kirk (1975) opined that by 2000 BCE, the prosperity of Lothal was waning. A destructive flood about that time was not followed by customary rebuilding. Some of its people appear to have moved to Rangpur, 48 km to the southwest, and it is possible that at about the same time, a [Sorath] Harappan colony was established at Bhagatrav.

On the basis of excavated finds at Malvan and a comparative ceramic (including lustrous red ware) study with Bhagatrav and Mehgam, Allchin and Joshi (1995) opined all these are broadly comparable to Rangpur IIB-C, and III.

In light of these observations, though Rao referred to the early phase of Bhagatrav (IA) as "Harappan" [Mature/Urban Harappan], Allchin and Joshi did not observe any definitively Harappan objects in coastal south Gujarat, which led them to doubt the existence of the Mature Harappan phase to the east of the Gulf of Cambay. Rao also referred to a "second wave of migration from the Indus Valley" as responsible for the late Harappan settlements of Bhagatrav-IB, Mehgam and Telod. In Allchin and Joshi's view, there is scarcely any evidence of a wave of migration, and certainly not from the nuclear sites of the Indus region. According to them, even as the culture which represents protohistoric, Bhagatrav developed contemporarily with Rangpur IIB-C, and survived until Rangpur-III, it should rather be referred to as Post-Harappan than Late Harappan.

The claim that Bhagatrav is the southernmost Harappan site has been accepted (Thakran 1993) and as a port for stone raw materials has been cited by many in the following periods (Dayalan 2015; Rawat 2015). Gaur and Sundaresh (2016) opined that the sites on the Narmada estuary on the west coast are very close to the stone raw material, which were in great demand in Saurashtra and Kachchh through the entire Protohistoric and Historical periods. Further, their exploration along the Narmada estuary on the west coast, which included the site reported by Allchin and Joshi (1970), Bharuch, Bharbhut, Chawaneswari and Bhagatra [Bhagatrav] did not reveal any remains of Harappan elements. That led them to question the earlier claim of extension of the Harappan domain in the Narmada region. Finding a few lustrous red ware sherds at the site and taking into account the earliest habitation date at Malvan, i.e., 15th century BCE, and interpreting Bhagatrav and Mehgam to have actively participated in maritime during the same time period, Gaur and Sundaresh (2016) placed Bhagatrav under Post-Harappan time period.

Incidentally, in the Lothal excavation report (1984), S.R. Rao corrected the chronology of lustrous red ware and placed it under the Late Harappan phase.

Prof. Ajithprasad of the MSU explored the region and the site of Bhagatrav once in 2004 and again in 2011 and found pottery resembling Rangpur-IIB and a few Rangpur-IIC periods and the characteristic

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Sorath Harappan bowls. He believes lustrous red ware finds of Gaur and Sundaresh need closer examination, even though this ware is part of the Post-Urban Harappan phase (personal communication 21.05.2021).

8. Monochrome Glazed Ware–producing medieval Bhagatrav

The finding of celadon and turquoise glazed ware in the lower level of layer 2 indicates that after a gap of about 2500 years, the site was reoccupied during the celadon and turquoise glazed ware using people in the 10th–12th century CE. As per present data, this early occupation of the medieval period is restricted to the western side of the mound. A carbon sample (BGT_C_7) from the floor level between layers 3 and 2, trench DY9 is dated with AMS radiocarbon to 863 BP. This period gave ample evidence of lapidary activity in the form of agate (carnelian) roughouts and stages of bead production. It also yielded a number of otoliths—fishing activities. The 14th–17th centuries Monochrome Glazed Ware (MGW) predominates the assemblage. Some of these are painted. The littered wastes of MGW indicate that the site could have been a production center of the same. The evidence is in the form of numerous glazed wares of blue, green and white color with unglazed and unpolished blemish (Figure 6), slags, setters, and stone crusher. Setters are refractory support used to keep wares separated in the stack in the kiln. Another contemporary production site of MGW is reported at Lashkarshah (Bhan 2006). This type of pottery is also found in other sites on the Gulf of Khambhat, including, Gogha (Gaur et al. 2008). 16th century Champaner has yielded a number of such sherds (Sonawane 2018). On the east coast, 10th–14th century Kottapattanam (Sasaki 2004; personal communication, K.P. Rao 16.07.2023) and Mantai (Yamamoto 2004) yielded a number of MGW. This glazing tradition is known to be West Asian. Since when the production started in India and who brought the knowledge is not known. However, Mohammed (1984-85:105) claimed that in India, glazed ware of the type discussed here (made by applying glass-like material to an earthenware base) came along with the medieval invaders from West Asia. At Hastinapura, it was found in levels contemporary with and posterior to the coins of Balban (1206–87 CE). Excavations at Purana Qila reported MGW in association with the coins of Balban and Muhmmed Tuglak. In Bhagatrav, two Sultanate of Gujarat coins are found from medieval layer 2, one of Nasir ud Din Ahmad Shah I (1411–1442 CE), and another of Qutb ud din Ahmad Shah II (1451–1458 CE). At Kamrej there was a respectable number of MGW, dated to the 9th–10th century CE (Gupta 2004) and, Sanjan (9th–12th century CE) yielded a small quantity of MGW (Gupta et al. 2004). The ware is distributed in the coastal region of the western coast, Kerala, Southeast Asia through sea trade. How far Bhagatrav has played a role in the trade and culture contact in this area is a subject of further investigation. Non-glazed pottery at Bhagatrav is dominated by black ware, and the main shape is carinated *handi* (pot).

Since MGW has been associated with varied time periods at various sites, establishing dates of the same at Bhagatrav required absolute dates. We carried out AMS radiocarbon date of two carbon samples of layer 2, one collected from the lower level of layer 2 of trench CX7 (BGT_C_1), which yielded a date of 506 BP and another from the middle level of layer 2 of trench AO1 (BGT_C_2), that resulted in a date of 468 BP.

9. Luminescence and radiocarbon chronology of Bhagatrav

The Sorath Harappan period (layer 4) neither yielded carbon nor collagen could be extracted from the bones of lower levels for AMS radiocarbon date. Thus, optically stimulated luminescence (OSL) ages of two stratified potsherds, including one found in association with a sherd with horn-deity painting, were estimated. However, collagen could be extracted from a homogeneously found bone (BGT_B_4) from the uppermost level of layer 4, for AMS date. A respectable amount of carbons from medieval hearth were collected from layer 2 of all three trenches, and three AMS dates from this period are obtained. All dates are carried out at Physical Research Laboratory, Ahmedabad.

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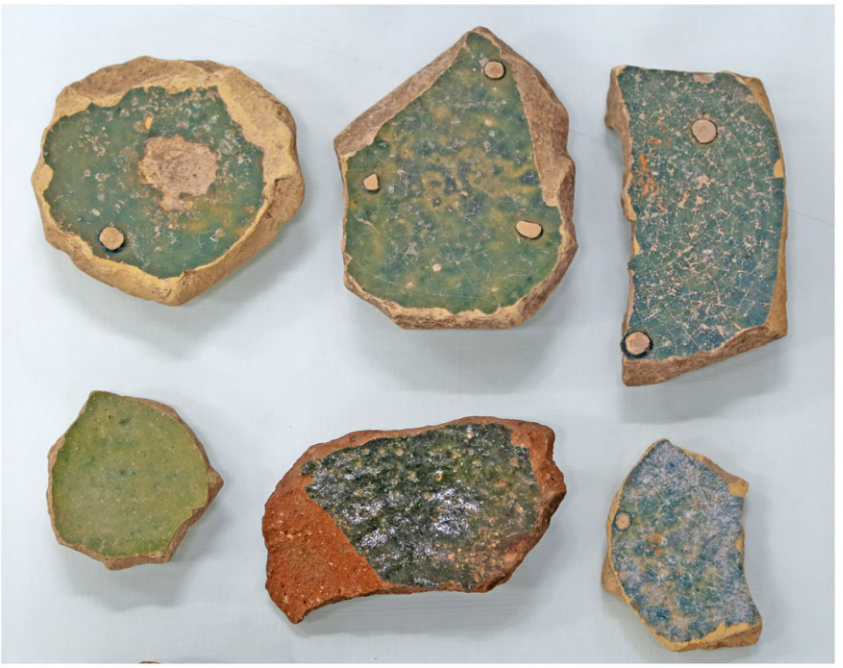

Figure 6. *Monochrome Glazed Ware with blemish.*

9.1 Luminescence dates of Harappan Pottery

Material and methods

9.1.1. Sample collection procedure

Two Harappan-identified thick potsherds were collected from the undisturbed context in layer 4 for Luminescence date processing, one from a depth of 1.80 m (BGT_P_9) and another from 1.65 m depth (BGT_P_8). It is to be noted that sample BGT_P_9, dated to 4200 BP was found in association with a rim sherd with a horn-deity painted motif.

9.1.2. Pottery sample preparation

The two pottery sherds are processed under the subdued red-light conditions. The thicknesses of pottery sherds were ~8 mm. The outer part ~2 mm was removed from all sides with the help of a flat metal file while continuously spraying alcohol to avoid any heating while rubbing the sample. The remaining inner parts of the pottery sherds are gently crushed in a metal vice. As pottery is mostly made of fine silt, therefore, we applied luminescence fine grain technique (Zimmerman 1971) for establishing the chronology of the pottery sherds. The details of the geochemistry procedure are provided in supplementary file.

9.1.3. Instrumentation and equivalent dose measurement using fine-grained poly-mineral sample

All luminescence measurements were performed with automated Riso-TL/OSL reader model DA-20 (Botter-Jensen et al. 2010) equipped with a $^{90}Sr/^{90}Y$ beta source delivering ~0.047 ± 0.001 Gy s^{-1} to the sample. Polymineral sample aliquots formed by depositing sample on aluminium discs in presence of alcohol were stimulated with the IR LEDs (~870 nm) and IRSL signals were detected through a BG-3+BG-39 (blue pack filter, 320–520 nm) filter combination. Normally luminescence emission takes place in several emission windows (Devi et al. 2022), but the emission selected by mentioned

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Table 2. *Summaries of the IRSL SAR protocols used for this study*

Step	IRSL protocols
1	Preheat at 200°C for 60 s, 2°C/s
2	IR stimulation at 50°C for 100 s
3	Test dose (90 s)
4	Preheat at 200°C for 60 s
5	IR stimulation at 50°C for 100 s
6	Dose and return to step 1

combination of filter packs is preferred in several earlier studies (Auclair et al. 2003; Buylaert et al. 2009). Luminescence signals were detected by bialkali EMI-9235QB photomultiplier tube (PMT). More details about the instrument are explained in the Botter-Jensen et al. (2010) and Lapp et al. (2015).

For the palaeo doses estimation (De), the single aliquot procedure (SAR; Murray and Wintle 2000) was used for dose estimation using IRSL measurements on the polymineral fine fractions (Table 2). IRSL measurements were done for 100 s at 50°C (IR50). The initial 2s was used as signal while last 20s averaged signal of the decay curve was used for background. Background subtracted signal is then used for growth curve and D_e estimation (Figure. 7). Aliquots having recycling ratio greater than 10% of unity and recuperation within 5% of natural signal were rejected. The final D_e is calculated based on 20 accepted aliquots. Figure 8 shows the radial plots of the samples, the overdispersion for the two samples (Table 3) was found to be 6% and 2.6% respectively. As the distribution is quite compact, the central age model is used for dose estimation (Bailey and Arnold 2006; Chauhan and Morthekai 2017).

The radionuclides ^{238}U, ^{232}Th and ^{40}K concentrations by gamma spectrometry using high-purity germanium detector and the environmental dose rates were estimated by using conversion factors given by Adamiec and Aitken (1998). The cosmic ray's contribution was taken from the method by Prescott and Hutton (1994). For the internal potassium contribution of K-feldspar was assumed to be 12.5±0.5% (Huntley and Baril 1997). Further, the alpha efficiency "a-value" (Aitken and Bowman 1975; Singhvi and Aitken 1978) was measured using the vacuum alpha irradiator containing Americium-241 ($^{241}_{95}Am$) source. The $^{241}_{95}Am$ of half-life of 432.2 yr has a strength of 0.084 $\mu m^{-2} min^{-1}$ and emitting 5.443 MeV alpha particles. The samples were bleached by Vitalux Sunlamp irradiated with alpha source under vacuum for a fixed time and doses were recovered by beta source. "a" value was estimated for 5 aliquots per sample and averaged values are provided in Table 3. The alpha efficiency for samples BGT_P_9 and BGT_P_8 is 0.042±0.002 and 0.038±0.002 respectively.

For fading rate estimations, bleached aliquots were given known doses and delayed luminescence signals were measured for variable delay times (Huntley and Lamothe 2001; Auclair et al. 2003; Devi et al. 2022). The fading rates (g_{2days}-values) were estimated from the slope of measured delayed luminescence signal vs delay time graph. The mean g-values of the samples BGT_P_9 and BGT_P_8 are estimated as 1.22±0.16%/decade and 1.46±0.27%/decade respectively. The fading corrected ages were obtained following Huntley and Lamothe (2001) and are given in Table 3. The fading corrected ages were finally estimated using measured estimated dose rates, equivalent doses and fading rates following the method suggested by Auclair et al. (2003). The date calculated for sample BGT_P_9 is 4.2 ±0.4 and for BGT_P_8 is 4.2±0.3 thousand years BP (Tables 2–3).

9.2 AMS dates of bone and charcoals

Methods

9.2.1 Bone sample preparation

Bone collagen was extracted by demineralization of bone. Bone chunk (~1.0 g) was rinsed with Milli-Q to remove surficial contamination. The sample was put in a glass vial in 0.2M HCl at room temperature.

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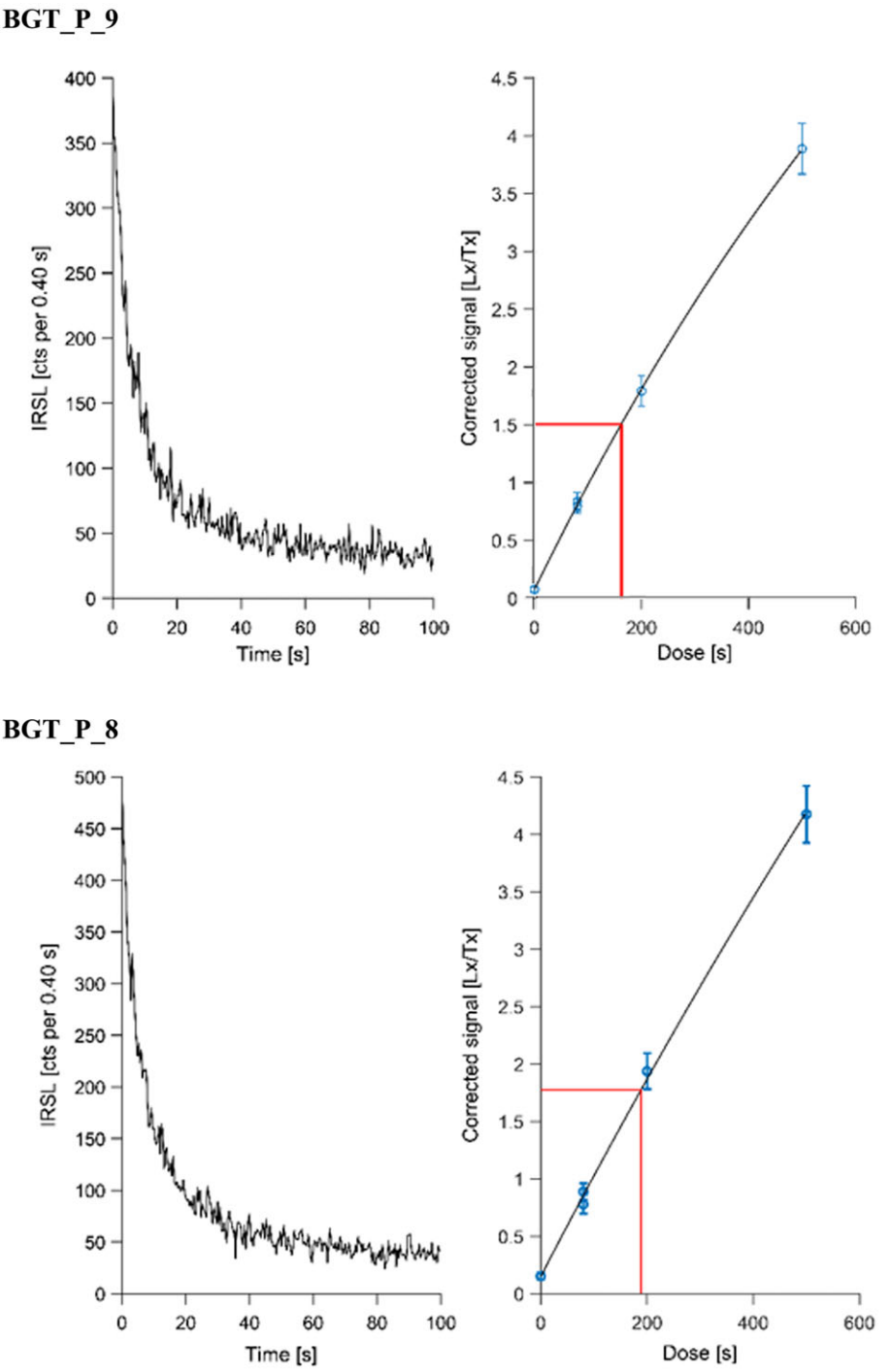

Figure 7. *Decay curve and dose response curves. (A) Sample BGT_P_9 and BGT_P_8 show the decay curves for the natural signals from the fine-grained polymineral feldspar. (B) Dose-response curve for the fine-grained polymineral BGT_P_9 and BGT_P_8 sample.*

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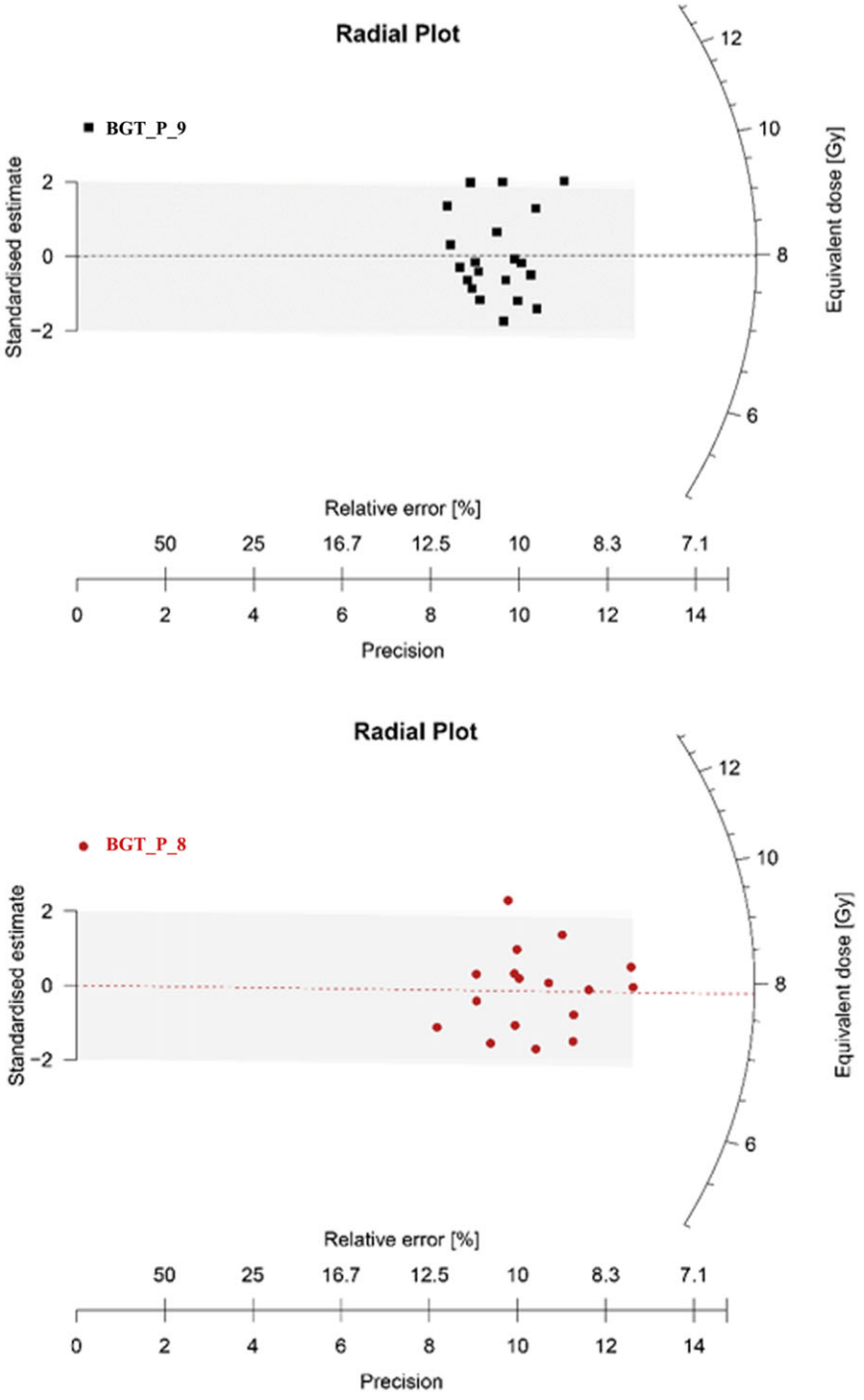

Figure 8. *Radial plots show the distribution of equivalent doses of the sample BGT_P_9 and BGT_P_8.*

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Table 3. *Radioactivity concentration and age estimates of the fine-grained polymineral obtained by the IRSL single aliquot along with fading correction*

Trench	Sample ID	Altitude (m)	U (ppm)	Th (ppm)	K (%)	a value (alpha efficiency)	g-values (%/decade)	OD %	CAM D_e (Gy) IR_{50}	Dose rate (Gy/ka)*	Age (ka) IRSL age (IR_{50})	Age (ka) #Fading corrected age (IR_{50})
DY9	BGT_P_9	9	1.91±0.08	4.70±0.13	0.85±0.02	0.042±0.002	1.22 ±0.16	6	7.99±0.22	2.1±0.167	3.8±0.1	4.2±0.4
DY9	BGT_P_8	9	2.07±0.09	5.71±0.16	0.79±0.02	0.038±0.002	1.46±0.27	2.6	7.88±0.18	2.12±0.07	3.7±0.1	4.2±0.3

*Water content is assumed to be 4±2 % of the surrounding sediments of the pottery sherds in which it was buried. The surrounding sediment around pottery exhibits minimal water content, attributed to the dry nature of the material.

Table 4. *AMS date from bone of intermediary level*

Trench	Sample ID	Lab ID	Radiocarbon age (years)	Calibrated age range (1 Sigma) years BP*	Median age (years) BP
DY9	BGT_B_4	AURIS-05016	3235 ± 67	3378–3550	3454

*Calibration done by Calib 8.2 (INTCAL20) (Reimer et al. 2013; Stuiver and Reimer 1993; Bhushan et al. 2019a, 2019b).

The acid was changed every day until the sample demineralized (appeared as translucent and flexible) which took nearly 10 days. The sample was then rinsed with Milli-Q water until a neutral pH was obtained. Sample was put in 0.1N NaOH for 24 hours at room temperature to remove humic acid/lipids. Collagen was then rinsed with Milli-Q several times until a neutral pH was obtained. The samples were then dried and the necessary graphitization procedure was followed for radiocarbon dating.

9.2.2 Graphitization

Organic samples were graphitized with AGE3 (Automated Graphitization Equipment-3). Samples were flash combusted with Elementar make EA, and Carbon dioxide from combustion was transferred to AGE3 reactor with pre-filled Fe powder (used as a catalyst) through Xeolite trap. Hydrogen was then added to the reactor at 2.3 times of volume of CO_2. This reactor was put in a preheated reactor oven (570 degree) for 120 mins during which CO_2 was reduced to Graphite. Graphite powder was pressed in a 1mm Aluminium cathode target and loaded in AMS carousel.

The graphitized samples along with standard (NBS Oxalic Acid II), anthracite blank and check standards were analyzed with 1MV Accelerator Mass Spectrometer (PRL AURiS) for radioisotope measurements as per procedures described in Bhushan et al. (2019a, 2019b). Radiocarbon ages thus obtained from Accelerator Mass Spectrometer (AMS) were calibrated using Calib 8.2 (Reimer et al. 2020). The date derived following this method is 3454 BP (Table 4, Figure 9).

9.2.3 Carbon sample preparation

The sediment samples were homogenised and checked for visible contaminants (roots, stones, twigs, paper, fibers etc). Contaminants are picked out and separated. The dry samples were crushed and homogenized. ~1 g of sediment was washed with 10 mL 1N HCl in 15 mL centrifuge tubes. Samples were centrifuged and acid removed. 10 mL 1N HCl was again added and mixed with samples, put in the hot water bath (~85 deg) for 60 min. Samples were then washed with deionized water repeatedly until pH got neutral. Samples were dried, powdered and graphitized.

The AMS date for the carbons of Layer 2 yielded two dates 506 and 468 BP whereas of floor level between layers 2 and 3 turned out to be 863 BP (Table 5, Figure 9). All these dates corroborate with the stratigraphy and associated finds of the site.

10. Conclusion

The site of Bhagatrav was first occupied during the late Urban Harappan phase of Sorath Harappans, starting from 2200 BCE, which is supported by two Luminescence dating of contextual potsherds from the lower level. Finding a horn-deity-painted dish at this level attests that the tradition of horn-deity was prevalent among the Sorath Harappans, too (for details, see Kanungo 2021). Bhagatrav pottery analysis confirms that the potteries align with both the Sorath Harappan and Late Sorath Harappan. A good number of sherds from the lowest level have parallels with the late Urban levels of Lothal, Rojdi B, Rangpur IIB, Surkotada, Kuntasi, Padri, Bagsra, Kanmer and Jaidak IIA. A respectable number of

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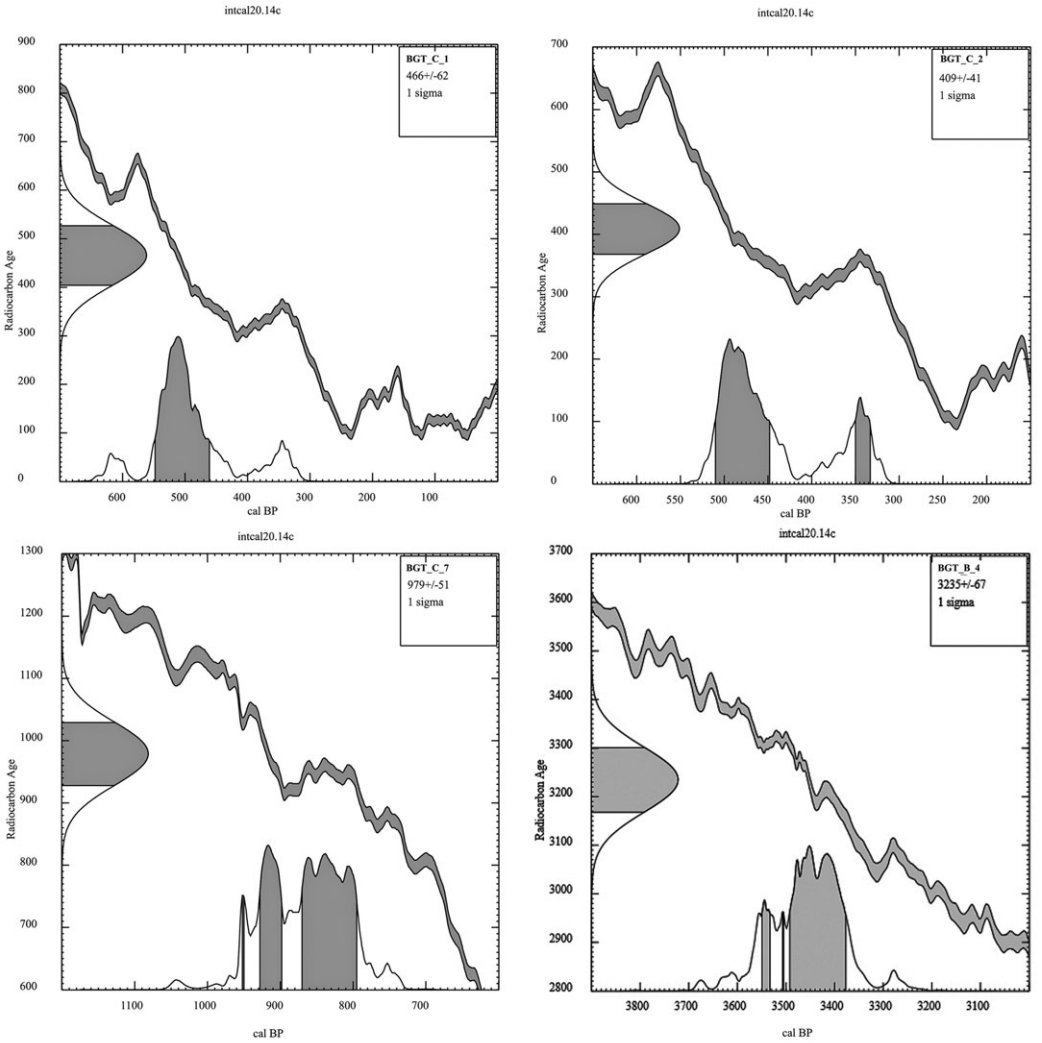

Figure 9. *Radiocarbon measurement plots for charcoal and bone samples.*

signature pottery shapes and compositions of Late Sorath Harappan, like that of concave-sided bowls and thick, gritty red ware, are noticed in the middle and upper levels of layer 4. The above facts support the ceramic finds by Rao, which indicated that the site was occupied by the [Sorath] Harappan in the later stage of the Urban phase and continued to be occupied in the Late [Sorath] Harappan times. The percentage of Rangpur IIC, Rojdi C and Jaidak IIB-type potteries became prominent from the middle level and dominant in the uppermost level in layer 4. It is during this time that the site incorporates a good number of ceramics that show features similar to the chalcolithic remains reported from Jokha and Dhatva in the assessment of Allchin and Joshi (1995). Finding Jokha-Dhatva type ceramic in the excavation, Gaur and Sundaresh (2016) assigned the site to Post-Harappan. However, illustrations of their ceramic assemblage attest to the presence of Sorath and Late Sorath Harappan ceramic types of the Rangpur IIB and IIC along the Jokha-Dhatva types. These essentially are Post-Urban Harappan-affiliated cultural developments in South Gujarat, and their association with the lustrous red ware at some of the sites establishes the chronological range of Post-Urban Harappan in South Gujarat. It is important to mention that our excavation did not yield lustrous red ware, though the type was reported by both Gaur and Sundaresh (2016) and Allchin and Joshi (1995).

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Table 5. *AMS date from charcoal from medieval deposit*

Trench	Sample ID	LAB ID	Radiocarbon age (years)	Calibrated age range (1 sigma) years BP*	Median age (years) BP
DY9	BGT_C_7	AURIS-03420	979±51	795–952	863
CX7	BGT_C_1	AURIS-03418	466±62	461–549	506
OA1	BGT_C_2	AURIS-03421	409±41	334–510	468

*Calibration done by Calib 8.2; IntCal 20 calibration curve (Bhushan et al. 2019a, 2019b; Reimer et al. 2013; Stuiver and Reimer 1993).

So, it appears the occupation at the site started from the late Urban/Mature Harappan (Sorath Harappan) stage and continued in the Post-Urban or Late Sorath Harappan times as well. All these occupations, starting from the Urban phase onwards, must have been small campsites confined to discrete pockets at the site; some such pockets may also have laterally overlapped. That is very much possible in a campsite, where people from nearby urban centres come for fishing or other natural resources exploitation seasonally. This has accounted for the diversity of cultural materials in the three excavations. The best example of this sort of scenario is the Rangpur site itself, where Rangpur IIA, IIB, IIC and III occupations are found at different parts of the large site. It is also significant that the bone sample from the topmost level of layer 4 is dated by AMS estimation to 1504 BCE. Layer 4, therefore, has a date ranging from 2200 BCE to 1500 BCE. This would cover the last phase of the Urban Harappan (in this case, the Sorath Harappan, Rangpur IIB) and the Post-Urban/Late Sorath Harappan (Rangpur IIC) and probably the final stages of Late Sorath Harappan (lustrous red ware, 1500 BCE) and the association of local ceramics (Jokha-Dhatva types).

Most of the Harappan settlements in Sorath regions have been interpreted as centers for procurement of nearby natural resources, craft(s), and supply to major regional centers. However, the finds at unfortified Bhagatrav neither gave any evidence of structures nor large-scale crafts. Our excavation did not yield any major deposit of raw stone materials or workshop at the site to substantiate the claim that Bhagatrav played a major role in transporting stones (materials) to the mainland Harappan regions. Nevertheless, it can be argued that most part of the site on the bank of the river has been washed away since its abandonment, and a center for processing and export need not have the deposits. Exporting of raw materials does not results in the formation of huge habitation either. On the ploughed field, the raw stone materials are found more with medieval potsherds than the Sorath Harappan materials.

Shereen Ratnagar (1981:231) opined, "many of the sites of Harappan or latter periods on Gujarat coast were some kind of 'refuelling stations' or anchorages if not actual ports." This may be true for the fortified settlements situated on the shore, but the small rural settlements seem to have been occupied by the people subsisting on fishing and other such activities (Rawat 2015). Perhaps the site of Bhagatrav falls under the latter category, supported by the absence of structures and the presence of a large number of fish bones.

Contrary to Rao's (1963) claim, layer 3, DY9 did not yield sand and silt deposits but three clay storage-bin's bases. Thus, concluding that there was a hiatus period without large scale excavation is premature. After a break of more than 2500 years, the site was reoccupied by the celadon ware using people in about the 12th century CE (layer 2), then continuously occupied by Monochrome Glazed Ware–producing craftsmen from the 14th century until about 17th century CE (layers 2–1). Three radiocarbon dates from the layer 2 of all three trenches authenticate this chronology.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/RDC.2024.119

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