

Understanding the creation of small conical cupules in Daraki-Chattan, India

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Abstract

The present paper is in continuation of our efforts to understand the creation of cupules in Daraki-Chattan by the process of cupule replication, started in 2002. Daraki-Chattan is one of the richest Palaeolithic cupule sites in the world, and has been studied under the EIP Project. We have identified four categories of cupules in Daraki-Chattan. Circular cupules with about 30 to 40mm diameter and conical depth of more than 5mm represent category 2. We really need to show how hard it is to make a small cupule of 30 to 35mm diameter with conical depth of 9mm. It is incredibly hard; it requires immense skill, precision and dedication. The present paper presents our endeavour to replicate such small cupules on hard quartzite rock and observations made particularly in 2008-09.



Fig. 1. Daraki-Chattan Cave (DC) in the quartzite buttresses of Indragarh hill near Bhanpura in district Mandsaur, Madhya Pradesh in Chambal basin.

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Daraki-Chattan is one of the richest Palaeolithic cupule sites in the world (Fig. 1). It is situated in the quartzite buttresses of Indragarh hill near Bhanpura, district Mandsaur, Madhya Pradesh in Chambal basin (Kumar 1996). It bears more than 500 cupules executed on its both the vertical walls (Fig. 2). For scientific study and establishing the antiquity of the cupules in Daraki-Chattan, excavations have been carried out here under the EIP Project in the direction of Giriraj Kumar from 2002 to 2006. EIP project is a joint venture by RASI and AURA under the aegis of IFRAO, and has been carried out with the support of ASI, ICR and Australia-India Council, Canberra since 2001. It is still going on. The excavations at Daraki-Chattan yielded 28 cupules and some hammer stones from Lower Palaeolithic cultural strata (Kumar *et al.* 2005; Bednarik *et al.* 2005).



Fig. 2. Southern wall of Daraki-Chattan (DC) bearing cupules. Exfoliated slab scars devoid of cupules can be seen in the front.

1. Cupule categories in Daraki-Chattan

The archaic cupules in Daraki-Chattan Cave have been classified broadly in to four categories with their sub-categories as follows:

1. Big circular cupules with saucer shaped or deep round depth
 - a. Big circular cupules with more than 50mm diameter and smooth saucer shaped depth of more than 5mm
 - b. Big and deep Cupules with about 30 to 50mm diameter and 7 to 12mm smooth and round depth. Sometimes the depth is more than 12mm
2. Cupules with conical depth
 - a. Circular cupules with about 30 to 40mm diameter and conical depth of more than 5mm
 - b. Oval or elongated Cupules with oblique and conical-receding depth, deep side always down wards (Fig. 3-4)



Fig. 3. An oval shape cupule on northern wall in DC.



Fig. 4. Small cupule with oblique depth on southern wall in DC.

3. Small cupules with smooth depth

- a. Small circular cupules with shallow smooth depth. These appear to be unfinished left over cupules
- b. Small circular cupules with deep smooth depth

On northern wall (rock)

NR In the lower side before Group 1a: 18.3 x 17.6 x 5.7mm

NR N° 144: 24.65 x 27.0 x 11.35mm, deep conical cupule

NR N° 162: 24.5 x 23.8 x 8.83mm

On southern wall (rock)

SR N° 195b. 32.3 x 24.6 x 8.4mm

4. Small cupules with angular periphery and deep angular depth

There are only two examples

- a. NR In the lower side before Group 1a: 18.3 x 17.6 x 5.7mm is with roughly triangular periphery and angular depth
- b. SR N° 23: 27.3 x 24.6 x 8.4mm, with triangular periphery and triangular depth (Fig. 5). It is the only case of its kind and appears to be a marvel of technological achievement in archaic cupule production

Category 1 and Category 2 form the major bulk of the cupules in Daraki-Chattan Cave. Category 3 forms only a small part, while cupules of Category 4 are rare (only two in the Cave). Cupules of Category 2 have been found from the excavations at Daraki-Chattan.



Fig. 5. Ram Krishna on work of cupule replication in June 2009.

2. Replication of cupules

Our study of early cupules on hard quartzite rock is a pioneering research. In the global literature (Bednarik 1998:23-35), on rock art we do not have any reference to refer to for replication work that could have helped us in understanding the techniques used, intelligence and skill required and complexities involved to produce the cupules under study, so archaic on hard quartzite rock. Hence, in order to understand the creation of cupules and their significance in Daraki-Chattan we have been experimenting on the replication of cupules on the vertical wall, the experimental rock, in a rockshelter closely associated with and located by the left side (south) of Daraki-Chattan (Fig. 6). It is a continuation of the same quartzite bedrock of Daraki-Chattan. The rock shelter, 660cm in breadth, 175cm deep and 275cm in height at present, faces west. The experimental rock faces west. It runs 210cm from north to south, than turns to a southeast direction covering an additional distance of 140cm. It is 200cm in height from the present floor surface.

We really need to show how hard and intelligent it is to make the above mentioned different types of cupules. It is incredibly hard and requires immense skill and precision. Secondly, we also need to understand and justify the nature and types of

hammer stones discovered in the excavations at Daraki-Chattan and correlate them with the cupules in the cave.

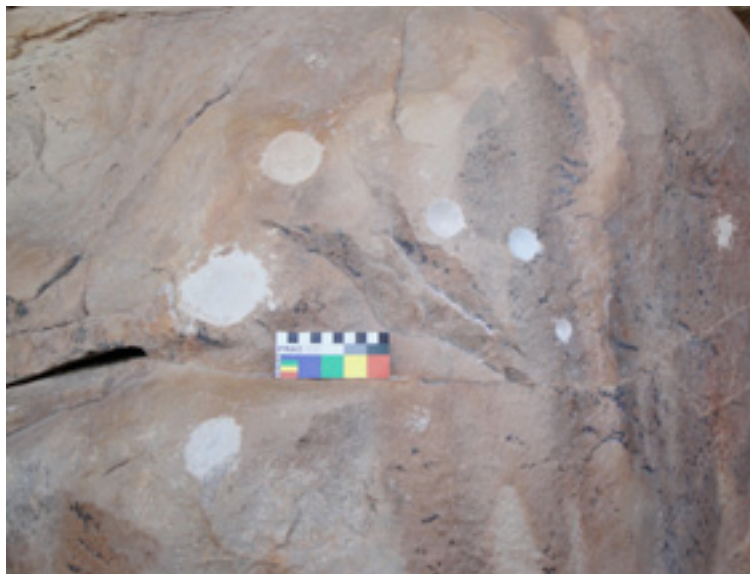


Fig. 6. Replicated cupules on the quartzite vertical rock-face in a small rock shelter in the left side (south) of and close to Daraki-Chattan.

Experiment with replication of cupules was started by Giriraj Kumar in 2002, the year of beginning the excavation at Daraki-Chattan. Ram Krishna joined the replication project in 2004. It is still continuing.

3. Hammer stones used for practical

Pebbles and cobbles from Patasighati, with purple-red colour core, are very hard and are most suitable for using as hammer stones for cupule production and also for making artifacts. They were similarly used at this place by hominins of the Lower Palaeolithic. Those on chert, chalcedony and other igneous rock are not suitable because of their fragile nature.

Patasighati is between Indragarh hill and Chanchalamata hill. It contains highly cemented thick boulder conglomerate of river deposit in a palaeochannel. So far we could not trace any stone artifact or fossil remain from this palaeochannel deposit. It must have been a very powerful stream of very high intensity, as the boulders up to 50cm diameter have become almost round, some are flat round, hence the local name Patasighati (valley of boulders, cobbles and pebbles like sugar cakes) derives.

4. Technique used

From the study and observation of cupules in Daraki-Chattan, Kumar was convinced from the very beginning that they were produced by a direct percussion technique. So we used the same technique for cupule replication unless mentioned otherwise.

4.1. Replication of small cupules with conical depth

So far we have replicated nine cupules on this experimental rock from 2002 to 2009 (Fig. 6). In 2002 and 2004 we were able to produce cupules of Category 1a, i.e. big circular cupules with more than 50mm diameter and more than 5mm smooth saucer shaped depth (Fig. 7-9; Kumar 2007). Small cupules with conical depth of Category 2a, with less than 40mm diameter and more than 5mm depth, were produced in 2008 and 2009. Initial results and observations were presented in 2008-09 in the Global Rock Art Congress, Sao Raimundo Nonato, Capivara, Brazil in 2009 (Kumar & Ram Krishna 2009). The study is going on. We are presenting here a brief summary of the replication work and our observations made in 2008-09.

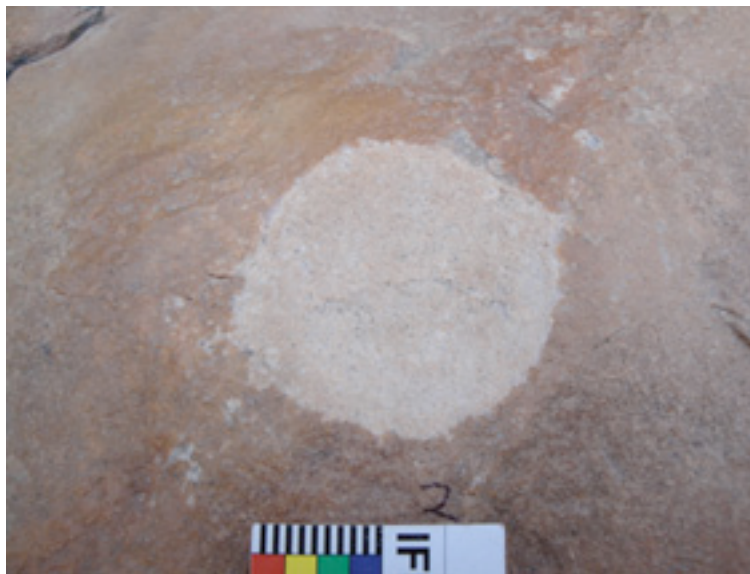


Fig. 7. Replicated broad cupule, RC 2 executed in 2002.



Fig. 8. One of the hammer stones with broad striking head used in replication of replicated cupule RC 2.



Fig. 9. A quartzite hammer stone with broad striking head obtained from layer 6 in the excavations at DC.

4.2. Replication of cupules–2008

The authors resumed the work of replication of cupules from December 25 to 27, 2008. P.K. Bhatt and D. Kumar helped us in this mission. This time our objective was to replicate small cupules with conical depth (i.e. cupules of Category 2a).

We re-observed Daraki-Chattan Cave carefully, specially comparatively small cupules with conical depth. We were convinced that latter appear to be a work of patience and could have been produced by steady and consistent strokes with precision.

Ram Krishna and Dinesh Kumar collected suitable small pebbles from Patasighati to be used as hammer stones in cupule replication. Ram Krishna started work on Replication Cupule-6 (RC-6) at 3:40 pm on 25 December and continued the experiment for the next two days. Details of his work are given below:

Table 1. Details of work done on Replication Cupule, **RC-6** by Ram Krishna.

Date	Phase of striking RC-6	Time	N° of Strokes	HS N°	Remarks
25 Dec 3:40 pm	1	1 mt	56	HS1	HS-1, flat dark brown quartzite cobble, 140.4 x 95.0 x 50.5mm. Rejected because of its fragile nature
	2	4 mt	317	HS2	Patinated, quartzite cobble with purple colour core, 118 x 75 x.....mm
	3	2 mt	173		
	4	2 mt	194		Started going deep in to the cupule leaving third stage surface towards periphery
	5	2 mt	169		Going deep
	6	2 mt	250	HS3	
	7	2 mt	206		
	8	2 mt	203		
	9	2 mt	185		RC-6 dimension: 26.4 x 25.7 x 2.4mm

26 Dec 11:30 am	10	2 mt	217	HS4	HS-4, quartzite pebble with hard purple core, 87 x 67 x 48mm in dimension, striking end flat, 11mm wide, broken from three sides, retaining cortex on one side only.	
	11	2 mt	208		Light stokes	
	12	2 mt	162			
	13	2 mt	174			
	14	2 mt	234		Light stokes	
	15	2 mt	214		Light stokes	
	16	2 mt	268		Light stokes	
	17	2 mt	315		Light stokes	
	18	2 mt	268		Light stokes	
	19	2 mt	341		Light stokes	
	20	2 mt	298		Light stokes	
	21	2 mt	280		Light stokes	
	22	2 mt	286		Dimension of RC-6: 28.0 x 27.9 x 3mm, Striking surface of HS-4-19.5 x 11mm	
	23	2 mt	213	HS-4-5	The stone of HS-4 is very good, hence we reused it as HS-4-5. To get pointed striking head we flaked off certain portion from its used striking head. After a lot of effort we obtained a string head of the dimension- 19.5 x 3mm.	
	24	2 mt	430		Light stokes executed by G. Kumar	
	25	2 mt	228			
	26	2 mt	241			
	27	2 mt	193			
	28	2 mt	189			
	29	2 mt	167	HS-4-5	Dimension of RC-6: 28.0 x 27.9 x 4mm, only depth is increasing. Dimension of the striking head of HS-4-5 – 19.5 x 4mm, only width of striking head is increasing Took a break	
	30	2 mt	195			
	31	2 mt	209			
	32	2 mt	212			
	33	2 mt	187			
	34	2 mt	162			
	35	2 mt	226		Dimension of RC-6: 29.0 x 28.0 x 4.6mm, depth is increasing and slightly diameter also.	
	36	2mt	177	HS-4-5-6	We again modified HS-4-5 to get pointed striking head. HS-4-5-6 dimension - 69.4 x 65.8 x 47.4mm	
	37	2 mt	218			
	38	2 mt	160			
	27 Dec 10:25 am	39	2 mt	130		
		40	2 mt	156		Dimension of RC-6: 29.0 x 28.0 x 5.0mm, only depth is increasing. Have to discard HS-6 having dimension: 69.4 x 65.8 x 47.4mm
		41	2 mt	136	HS-7	A quartzite pebble from Patasighati, with hard, purple colour core and nearly onemmm thick weathered rind. It has a hard pointed head with 13mm wide base. Dimension: 101.0 x 67.8 x 53.0mm.
		42	2 mt	148		
		43	2 mt	122		
		44	2 mt	142		
		45	2 mt	137	HS-7-8	HS-7 was modified to HS-7-8, dimensions-86.3 x 67.8 x 53.0mm. It is with blunt point and broad base.
		46	2 mt	202		Dimension of RC-6: 32.5 x 30.6 x 6.0mm. A slight change in striking angle making the lower side of HS touched with the periphery of the cupule, resulting in increasing its diameter HS-7-8 broke down while modifying it for further use, hence discarded.
		47	2 mt	540	HS-9	Light stokes by G. Kumar. HS-9 is a quartzite pebble.
48		2 mt	535		Light stokes by G. Kumar	
49		2 mt	538		Light stokes by G. Kumar	
50		2 mt	534		Light stokes by G. Kumar	

<i>Id.</i>	51	2 mt	211		Striking resumed by Ram Krihsna
	52	2 mt	198		
	53	2 mt	201		
	54	2 mt	156		Dimension of RC-6: 32.5 x 32.5 x 6.6mm. HS-9 discarded at this stage, Its head, 19 x 13mm in size, little bit of chips came out of stroking
1:50 to 2:05 pm	55	15 mt	2170	HS-10	HS-10 is a small, flat quartzite pebble. 76.6mm length and 48.0mm breadth
2:10 to 2:25 pm	56	15 mt	2168		
2:35 to 2:50 pm	57	15 mt	2162		HS-10 after 45 mt of its use: 76.6 x 48.0 x 20.4mm. Dimension of RC-6: 32.5 x 30.6 x 8.0mm, only depth is increasing (out of it 10 minutes, 1,222 strokes were of indirect stroking)
	58	2 mt	240	HS-11	HS-11 is a flake naturally came out of a quartzite pebble with hard purple core from Patasighati. Its dimension: 56.0 x 57.0 x 28.6mm.
	59	2 mt	180		
	60	2 mt	130		Striking head of the HS-11 became quite blunt, hence discarded.
	61	12 mt	2100	HS-10-12	Used HS-10 was modified to HS-12, dimensions after 12 mt use, 58.4 x 46.7 x 21.2mm. (12 mts, 2100 strokes were of indirect percussion). Dimension of RC-6: 33.5 x 32.5 x 9.0mm. It is with conical depth.

Table 2. Details of work done on Replication Cupule, **RC-7** by Dinesh Kumar on December 26 and 27, 2008. Number of strokes not counted in this case.

Date	Phase of striking RC-7	Time	HS N°	Remarks
26 Dec 12:00 Noon	1	15 mt, 12:00-12:15 pm	HS-1	HS-1. It is a patinated pebble from Patasighati with purple colour core. 81.7 x 59.7 x 44.7mm
	2	15 mt, 12:20-12:35 pm		
	3	15 mt, 1:00-1:15 pm		
	4	05 mt, 3:10-3:15 pm	HS-2	HS-2 dimension: 91.7 x 69.7 x 45mm. It is a flat quartzite pebble, dark brown in colour
	5	15 mt, 3:25-3:40 pm		
	6	15 mt, 3:45-4:00 pm		
	7	10 mt 4:00-4:15 pm	HS-3	HS-3 is a hard quartzite cobble, 138 x 84 x 80mm in dimension, used from two stout opposite ends.
	8	15 mt, 4:20-4:35 pm		
	9	15 mt, 5:00-5:15 pm	HS-4	HS-4 is a quartzite pebble. Dimension of RC-7 at stage-9: 34 x 30 x 5mm
27 Dec 10:30 am	10	15 mt, 10:30-10:45 am	HS-5	
	11	15 mt, 10:50-11:05 am	HS-5-6	HS-5 has to be modified to HS-5-6. New dimension: 118.8 x 77.0 x 42
	12	15 mt, 11:10-11:25 am		
	13	15 mt, 11:35-11:50 am		
	14	15 mt, 12:00-12:15 pm		
	15	10 mt, 12:20-12:30 pm		After stage-15, HS-5-6 has to be modified to HS-5-6-7
	16	15 mt, 12:45-1:00 pm	HS-5-6-7	After stage-16 dimension of RC-7 is 38.4 x 32.3 x 6.4mm. After stage-16, HS-5-6-7 was again modified to HS-5-6-7-8

Id.	17	15 mt, 2:15-2:30 Pm	HS-5-6- 7-8	
	18	20 mt, 2:35-2:55 pm		Striking head of the HS has become round, 21.8 x 20.0mm. After stage-18 dimension of RC-7 is 49.0 x 32.5 x 6.5mm.

Replication Cupule, RC-8, measures 19.6 x 19.2 x 8.8mm. It is the smallest cupule replicated so far and is the only replicated cupule produced by indirect percussion at Daraki-Chattan. Hence, we are not discussing it here.

4.3. Replication of cupules-2009

In order to get the desired conical shape of RC-6, Ram Krishna used direct percussion technique for most of the time. But he also used indirect percussion technique for a little time of 22 minutes, stroking 3322 strokes in 22 minutes during the last phase (N° 55-57 and 61) of cupule creation

But, Kumar was of the firm belief that we can produce a small cupule with conical depth by using direct percussion technique only. We need not to use indirect percussion technique at any stage of cupule replication. Hence, we went back to replicate small cupule RC-9 by using direct percussion technique only (Fig. 5). The details of the work done on RC-9 are as follows:

Table 3. Details of work done on Replication Cupule, **RC-9** by Ram Krishna on 16 and 17 June 2009.

Date	Phase of striking RC-9	Time	N° of Strokes	HS N°	Remarks
16 June 2009 9:10 am	1	5 mt	0400	HS1	HS1, flat dark brown quartzite cobble, 140.4 x 95.0 x 50.5mm. Very few microchipping, smooth head after striking of first phase, 35 x 40 mm,
	2	5 mt	300		Striking head after second phase, 45 x 43mm. HS-1 was discarded because of its fragile nature
	3	5 mt	628	HS2	HS2. Quartzite pebble from Patasighati Measuring 90 x 50 x 25mm. It is with thin weathered rind of patina. Strokes light and fast.
	4	5 mt	405		
	5	5 mt	396		
	6	5 mt	353		Dimensions of the striking head after use, 18 x 14mm. Very smooth surface, microchipping of the rind,
	7	5 mt	379	HS3	HS3. 100 x 57.6 x 36.6mm. Flat, triangular pebble from Patasighati with a single point end. It is with CaCO ₃ encrustation.
	8	5 mt	394		
	9	5 mt	398		After striking, heavy chipping from three sides, hence could not be used further. Dimensions of the striking head of HS3 after use, 13 x 10mm.
	10	15 mt	1180	HS4a	HS4a is a flat, pentagonal pebble on quartzite, measuring 92.4 x 67.8 x 17mm, used for four times from its angular points(HS4a-d). Used light and precise strokes. Dimensions of the striking head of HS4a after use 24 x 19 mm.
	11	15 mt	1176	HS4b	HS4b, left side angular head of the pebble (when rotated clockwise), used for phase 11 of 15 mts. Dimensions after use 10 x 8mm. Microchipping on both sides.
	12	15 mt	1190	HS4c	HS4c. Lower left corner of the pebble. Triangular striking head with chipping only on lower side and a little bit on upper side. Dimensions of the striking head after use for phase 12 of 15 mts, 9mm, straight.
	13	15 mt	1172	HS4d	HS4d, 4d. Right lower head of the pebble. Heavily flaked from both sides leaving straight sharp edge at the head, hence could not be used further. Dimensions of the striking head after use, 11 x 9mm.

<i>Id.</i>	14	15 mt	1270	HS5	HS-5. Triangular quartzite pebble from Patasighati, with stout triangular striking head and more than 1mm thick rind . The head became quadrangular on striking because of microchipping from three sides. Dimensions of the striking head after use, 23 x 11mm. Dimensions of HS5 after use, 82.5 x 66 x 39.5mm.
	15	15 mt	1210	HS6a	HS6 was used for two times as HS6a and HS6b. It is an Acheulian artefact on purple quartzite with patination, measuring 104 x 68.7 x 29.4mm.
	16	15 mt	1223		
	17	15 mt	1209		
	18	15 mt	1218		Dimensions of RC-9 after phase 18 at the end of the working day: 25 x 23 x 5mm.
17 June 2009 7:50 am	19	5 mt	450		One end of the striking head chipping from two sides making it elongated, measuring 19 x 7mm.
	20	5 mt	455	HS6b	
	21	10 mt	920		
	22	10 mt	928		HS6b. When the hammer stone is hard-fine grained, the striking head becomes smooth after use. Striking head, 23 x 13mm. Cupule dimensions after phase 22: 25.4 x 26 x (5 h and 5.3 v)
	23	20 mt	1862	HS7a	HS7 is a Lower Palaeolithic artefact on crescent shaped hard, purple quartzite cobble, measuring 123 x 60.4 x 52.4mm. Used two times from two opposite ends as HS7a and HS7b. Striking head triangular and almost no chipping after use. Striking head after use 28 x 23mm.
	24	15 mt	1376	HS-7b	
	25	5 mt	458		
	26	5 mt	460		
	27	5 mt	456		Striking head after use 16 x 12mm. Cupule dimensions after phase N° 27: 35 x 32 x h 6.4, v 7mm.
	28	15 mt	1378	HS8a	HS8. It is an Acheulian artefact on flat pebble of purple quartzite measuring 99.8 x 55 x 22mm. Used for two times as HS8a and HS8b. HS8a. A big flake came out on striking, making the dimension of the striking head 8 x 5mm.
	29	5 mt	453	HS8b	HS8b. Dimension of the striking head 11mm. Cupule dimensions after phase N° 29: 31.8 x 31.4 x 6.7 h and 7.4 v mm.
	30	10 mt	920		
	31	15 mt	1362	HS9	HS9 is a triangular pebble on quartzite in two layers, upper light red and lower one purple red. Dimensions: 80.5 x 56.2 x 28mm. It was used for three phases N° 31, 32 and 33 of 15 mts each.
	32	15 mt	1376		
	33	15 mt	1358		Striking head smooth and stought, after use measuring 12 x 14mm.
	34	7 mt	636	HS10a	HS10 is a light red quartzite pebble, patinated and pyramidal shape, measuring 85 x 85 x 51mm. It was used for two times as HS 10 a and 10b. HS10a. Striking head after use 16 x 10mm.
	35	30 mt	2715	HS10b	HS10b. Striking head after use 12 x 8mm. Final dimensions of RC-9 (after phase N° 35): 32.0 x 31.5 x 9mm.

5. Discussion

Ram Krishna created RC-6 in comparatively soft 21 661 strokes, in actual work of 172-minute in three days. For most of the time he used direct percussion technique except for 3322 strokes in 22 minutes of indirect percussion. So created RC-6 is with conical depth and measures 33.5 x 32.5 x 9.0mm in dimension. To produce it we maintained the time of striking phases mostly of 2 mt duration except phase N° 55, 56 and 17 of 15 minutes each and phase 61 of 12 minutes. We properly recorded the process. Ram Krishna used pebbles of different size as hammer stones, which were generally collected from Patasighati and are having highly metamorphosed hard, purple-red colour core and a thin weathering rind around them. They were also

having a stout point and a broad base, suitable for holding with a firm grip while using them as hammer stones. He used 12 hammer stones to produce it, out of which pebble of HS-4 was used three times as HS-4, 5 and 6, and that of HS-7 and HS-10 for two times as HS-7 and 8 and HS-10 and 12 respectively, as the quality of hardness of their stone was superior. To obtain a stout point on the used striking-head we have to modify it by taking out some flakes from it.

Table 4. Comparative summary of the cupule replication experiment.

Year and dates	Person replicating cupule	Quality of the person at work	N°, shape and dimension of replicated cupule	N° of strokes used	Duration of actual work in minutes	N° of days of work	Comments
2002 June 12-13	Janakilal Gujjar	A young Shepherd Boy from village	RC-2 , Saucer like big cupule, 55.7 x 55.0 x 9mm	17,300 strokes	138 mt	2 days	It is a work more of strength and commitment, and less of mind. Hammer stone has to be lifted up to the level of shoulder (28 to 30cm) to exert great power and strength to it while striking. Use of big cobbles as HS.
2004 June 19-20	Ram Krishna	Hr Sec Student from city	RC-5 Broad, deep Cupule with irregular Periphery. 77.7 x 59.0 x 6.7mm	21,730 strokes	240 mt, in one phase of 15 mt duration	2 days	Produced by untrained hands with enthusiasm. Hammer stone (HS) has to be lifted up to the level of shoulder to exert great power and strength to it while striking. Use of big cobbles as HS.
2008 Dec 26-27	Diniesh Kumar	Hr Sec pass villager	RC-7 , Deep saucer like small cupule, 49.0 x 32.5 x 6.5mm	Strokes not counted	255 mt, in one phase of 15 mt duration	2 days	Number of strokes not recorded to get the result fast. Used both pebbles and cobbles as Hammer stones, and lifted it up to 15 to 17cm to exert pressure and power on it. It is a work of patience.
2008 Dec 25-27	Ram Krishna	Student of III yr Eng from city	RC-6 , Small cupule with conical depth, 33.5 x 32.5 x 9.0mm	21,661 strokes (out of these 18,339 strokes by direct percussion and 3,322 strokes by indirect percussion technique)	172 mt, in 61 phases, one phase mostly of 2 mt duration (Out of these 150 minutes of direct percussion and 22 minutes of indirect percussion)	3 days	Steady work with precision and concentration, with recordings at short intervals. It is a work of comparatively soft strokes made by small hammer stones, by lifting them only up to a height of 5 to 6cm. Out of the 21,661 strokes, 3,322 strokes were made by indirect percussion in 22 minutes.
2009 June 16-17	Ram Krishna	Student of IV yr Eng from city	RC-9 , Small cupule with conical depth, 32.0 x 31.5 x 9mm	28,327 strokes	372 mt, in 35 phases	2 days	Steady work with precision and concentration, with recordings at intervals ranging from 5 to 15 mts, mostly of 15 mts. It is a work of comparatively soft strokes made by small hammer stones, by lifting them only up to a height of 5 to 6cm. It is circular in shape except a few wrong strokes on left and right sides.

Dinesh Kumar created RC-7 in actual work of 255 minute in two days. It is 49.0 x 32.5 x 6.5mm in dimension and looks like a deep saucer. To create this cupule in comparatively short period we did not count strokes, and each pahse of striking lasted for 15 mt instead of 2 mt of Ram Krishna.

Dinesh used eight hammer stones to produce it, out of which cobble of HS-5 was used for four times as HS-5 and 6, 7 and 8 by using it at different points and modifying it again and again. He generally used quartzite cobbles of different size from Patasighati as hammer stones. They were having at least one or more stout point and are suitable for holding with a firm grip while using them as hammer stones.

While replicating a RC-6 Ram Krishna also used indirect percussion technique, though for 3322 strokes in 22 minutes only. Actually we should have not used indirect percussion technique for any moment. Hence we returned to the site in June 2009. This time Ram Krishna succeeded in creating RC-9 by using soft strokes and direct percussion technique only. In the light of experience we gained while creating RC-6 and RC-7 we used mostly small pebbles with angular heads as hammer stones. We became successful to produce a small cupule with conical depth (RC-9), measuring 32.0 x 31.5mm in diameter and 9mm in depth (Fig. 10). It was created in 28,327 strokes in 372 minutes in two days. Seventeen striking heads on ten hammer stones of hard quartzite were used for this purpose (Fig. 11).



Fig. 10. Replicated conical cupule, RC 9 executed in 2009.



Fig. 11. Close up of the pointed striking head of one of the quartzite hammer stones used in replication of cupule RC 9.

RC-9 is the smallest cupule with conical depth we have produced. The comparatively longer duration and greater number of strokes were obvious. In order to go deep in to the cupule while keeping its diameter under control we have to maintain the striking end of the hammer stone at right angle to the striking surface. It required a great concentration and changing of striking head/hammer stone at proper time.

5.1. Replication of rare small cupules

It is a great challenge to replicate small cupules with smooth depth of Category 3b with diameter of less than 25mm and depth more than 5.7mm. Such cupules are rare in Daraki-Chattan. Our experience of cupule replication shows that such small cupules cannot be produced by using direct percussion technique. Hence, Ram Krishna tried alternate technique of indirect percussion. He was able to produce a small cupule RC-8, measuring 19.6 x 19.2 x 8.8mm in 2008. It was a great success. But we have to justify that the rare small cupules in Daraki-Chattan have been produced by using indirect percussion. We must have to get picks used in this method from the excavated material, which we have not found so far. We have to restudy the excavated material, even the debris has to be sieved and carefully observed if necessary.

Comparatively short duration used in the creation of the cupule RC-6, than RC-9 is because in the former case out of the 21 661 strokes, 8 600 strokes were made by indirect percussion in 57 minutes.

5.2. Observation

1. The processes of battering of the hammer stone head and chipping on its sides occur simultaneously. When the hammer stone is struck forcefully small to big chips chipped off, resulting in an elongated battered surface with chipping marks on its both sides, while on striking normally and rhythmically only small chips came out, and chipping remains minimum.
2. Cupule creation on a hard quartzite vertical rock is a tough job. It requires involvement, commitment, great patience, consistency, devotion, strength, concentration and dedication. Small cupules with an average diameter of 25 to 28mm and depth of 6 to 8.4mm are the work of immense skill and great patience with steady and consistent strokes executed with precision.
3. Most of the cupules in Daraki-Chattan Cave are perfect in terms of regular form, design and execution. Hence, they appear to have been produced with controlled and perfect strokes. Not a single stroke has gone out side. Sometimes even two or more cupules have been made side by side, even then their edges are perfect, and not mixed up with each other. It means strokes were very much precised and were executed with sharp focus and total concentration.
4. Our practical experience shows that even if we work with total concentration, it is not possible to remain so for long time. During the process some moments come when for a fraction of a second we loose the concentration and stroke becomes uncontrolled. Such uncontrolled strokes result in the increase in diameter, specially when we are working on a small cupule. It means perfect small cupules were not made in a short duration. Rather, it appears to be the result of a long process of working in many phases of short duration.

5. Only an expert with regular practice can bear the rebound power and pain of the strokes to strike properly in due course of working. An inexperienced person, with out exercise and practice when works on cupule creation, after a short time (with in one or two hours) his hand starts shaking (shivering) with pain. Eyes start becoming stiff because of constant focus. At this moment even the movement of eyelids interrupts the focus.
6. In the process of cupule replication more lifting of hand for striking means much powerful but less controlled strokes. It happens when we use large size hammer stones. Lower the lifting of hand means strokes with comparatively less power, but increased control, hence more precise. It is possible with comparatively small size hammer stones. This observation indicates that big cupules were produced by robust striking, using big hammer stones, with involvement and dedication, but not much use of mind. Reduction in size with increased depth of cupule means proper planning, great involvement, dedication, concentration and patience. It means comparatively high intelligence and skill are essential for producing small-deep cupules.
7. Our experiment shows that after achieving a certain diameter of the cupule by initial striking, it becomes possible to strike in the center of it. Thus, if we are using a hammer stone with a stout head and broad base, in the process of striking depth goes on increasing in the center. But, after a certain point it starts cutting upper side of the cupule because of the broad base of the striking head. Hence, we get almost conical depth of the cupule.
8. It is essential to keep the base of the striking head stout so that the latter can bear the force of direct percussion, otherwise it breaks down.
9. That is why if we want to keep the diameter of the cupule as small as possible while going deep in to it, we have to keep on either changing the hammer stones or modifying the used striking head to get a stout point out of it time to time (Fig. 11). We discovered such a hammer stone with used stout head and broad base from layer 4 in the excavation of Daraki-Chattan (Fig. 12). This provides a solid ground to correlate some of the conical cupules in the Cave to the Acheulian culture of layer four.
10. Strokes produce sound of high pitch, hence continuous striking makes the ears dumb (*sun*) for sometimes.
11. Cupule creation is definitely not a leisure work or not a play work. It might be associated with something specific, deeply related with life. It is also possible that cupule creation might be associated with rhythm of some sort of music and singing. It is apparent from our observation while replicating the cupules. On the second day on 26 December 2008, Ram Krishna resumed working on RC-6. GK also put Dinesh to work on RC-7, close to Ram Krishna. Soon Ram Krishna started losing concentration by the sound produced by arrhythmic strokes of Dinesh. But, after some time strokes of Ram Krishna automatically got synchronized with that of Dinesh. It means cupules in Daraki-Chattan might have been produced either one after the other individually in a peaceful environment, or on the rhythm of some music. The possibility of latter appears strong.
12. Cupule replication should be made at suitable height for convenient striking. If RC-6 might have been 20cm downwards, it might have made difference for better performance. In this regard when we observe the cupules made close to the bedrock of the floor of the cave, the task of their production appears very tough.

13. Oval and elongated cupules with angular depth and also small and deep cupules with angular depth of Category 4 cannot be produced by simple striking. These must have been the product of some refined technology and special skill. We will try for their replication next time.



Fig. 12. A quartzite hammer stone with pointed striking head and broad base obtained from layer 4 in the excavations at DC.

Conclusion

1. In Daraki-Chattan, Cupules of Category 1a, i.e. big circular cupules with more than 50mm diameter and more than 5mm smooth saucer shaped depth, appear to be a work more of strength and commitment and less of mind. They were produced by using a very simple and primitive technology of direct percussion. They appear to represent the earliest stage of cupule production. Our cupule replication experiment indicates that to produce cupules of Category 1a needs two to six hammer stones on cobbles or pebbles to produce such cupules depending on the quality of the stone used and the strength of the person at work. It is a tough and tedious task to produce a cupule on hard quartzite rock. It requires motivation, commitment, strength, endurance and patience for their production. Cupules of Category 1b can be produced similarly by using hammer stones with stout and sturdy striking heads. It needs longer duration of work and high concentration besides all the above-mentioned qualities. At the same time it requires use of multiple hammer stones to achieve deep round and smooth depth.
2. Cupules of Category 2 are comparatively small with conical depth, particularly of Category-2a. We successfully replicated latter ones in December 2008 and June 2009. They appear to be the work of modified technology of direct percussion with small hammer stones of proper shape and size. It requires proper planning, immense skill and great precision and patience to produce such cupules. The person at work on cupule production cannot afford a wrong stroke, even in a thousand ones, as it increases diameter of the cupule by one millimeter.

3. Cupule creation is definitely not a leisure work or not a play work. It is a very tough job and appears to be closely associated with something special and deeply related with life.

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