Oldest sky-chart with Supernova record

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Summary:

Mankind has been curious about heavens above and the heavenly bodies since a very long time. The most common form of early expression of this date back to almost 20,000 years is in the form of cave paintings and stone etchings. The rock carving found in Burzahama region in Kashmir, India, depicts what is conventionally believed to be a hunting scene along with two very bright objects in the sky. The two objects in this scene have been interpreted as either the Sun and the Moon or two bright stars in close proximity. Here we investigate the possibility that this could be a record of a guest star or supernova in the sky. We search the supernova catalogue to look for a possible supernova that could have had the brightness comparable to that of Sun or Moon and close to ecliptic between 2000 BC and 10,000 BC since the etching is believed to have been done prior to 2000 BC and be visible from Burzahama. Only one Supernova remnant HB9 satisfies this condition. In addition to being dated to 4,600 BC, its apparent magnitude at peak must have been close to that of the Moon. We then plot this object in the sky along with the rest of the scene and show that the whole hunting scene along with the Moon and the Supernova fits quite well into the pattern of stars in the sky. Thus we suggest that this is probably the oldest record of supernova and sky chart found in the Indian Subcontinent.

Introduction

The oldest human art is substantially earlier than normally assumed and carved human female forms have been dated to seventy five thousand years or more. Cave paintings have also been dated to well over twenty thousand years old (Henshilwood et al., 2002). It is known that humans have been fascinated about the skies and could discern basic star patterns since a very long time. The cave paintings and stone carvings are subject to interpretation but claims of records of basic star patterns like Orion date back to thirty thousand years. The Lascaux caves were discovered in 1940 showing lunar ephemeris fifteen thousand years old and in last few years similar cave arts have been identified from other sites in France and Spain, some of them predating Lascaux caves (Rappenglueck, 1999). From that period, till the more historic period, there have been only a few records of any pre-historic reports of astronomical observations.

In Burzahama, where oldest settlements date back to about 4325(+/-115) BCE (Sharma, 2000), a stone carving has been unearthed (Khazanchi, 1969). The carving is on an irregular stone slab with size of about 48 cm by 27 cm. The plate is chipped at one corner, leaving a possibility that a part of the carving may be missing. The slab was

recovered from phase Ib of the site reutilized for a larger structure with inscribed surface facing interior of the structure (Pande, 1971; Agrawal and Kusumgar, 1965). The photograph of the stone plate along with its sketch is presented in figures 1a and 1b. The figure shows two bright objects in the sky with rays of light coming out of them and a hunter spearing an animal below the first object. There is another animal to the left of the hunter drawn above the hunter's spear. It has been suggested that this represents a hunting scene and the two objects are pair of bright stars at the local zenith at the beginning of the hunting season. Few such candidate pairs of stars have also been suggested. However, the possibility of it being a record of supernova is not considered even though it is mentioned (Kameshwar Rao, 1995).

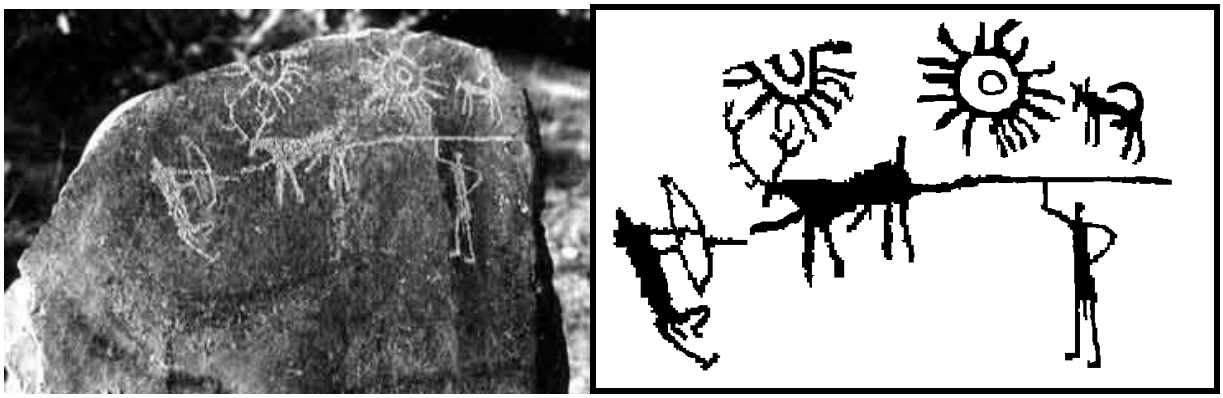

Figure 1: Photograph of stone Carving from Burzahom (Courtesy IGNCA) along with a sketch of the same.

We reinterpret the picture with emphasis on the two extremely bright celestial bodies shown in the picture. There is clear indication that the two celestial objects drawn are very bright. One of the objects is either the Sun or bright Moon and second object is relatively close to the first. They cannot be Sun and Moon since, with such proximity to the Sun, the Moon would be in a partial phase around the new and hence not very bright. We investigate the possibility that the observed object is not a star pair as even in other prehistoric drawings from European caves, stars are never shown as large disks. Further, brightness of stars or even the planets is not of the class which requires depiction of light beams coming from the same. Also, the so called hunting activity shown below is a daytime activity when stars would not be seen. In view of its nearly circular shape and same horizontal position of the two objects, comets, halos and terrestrial events also seem unlikely. We therefore consider the possibility that the observed object is a supernova.

We have searched for galactic supernova records (Green, 2005; Xu et al., 2005) of ancient supernovae for a possible candidate. Since supernovae catalogues give only the current observational details, we calculate the apparent magnitude of these objects based on the assumption that their absolute magnitude is -19.6 at the time of explosion, which is typical for a type IIa supernova. We then calculate the apparent magnitude based on the distance to the object.

The active period of the site has been dated to between 5,000 BC and 1,500 BC by Carbon dating (Sharma, 2000, Pande, 1971; Agrawal and Kusumgar, 1965). We narrow down the search to the young Supernova remnants with estimated ages between 2,000 to 10,000 years and supernovae of known distance. We ignore the supernovae with distance greater than 5000 pc since their apparent magnitudes will be less than -5 which is much smaller than that of the Sun or the Moon. As both the objects in the picture are shown close to each other, we assume the supernova to be close to the ecliptic. Thus, we eliminate the supernovae which are situated beyond $\pm$25 degrees from the ecliptic. This gives 5 possible candidates.

The site at Burzahom has latitude of about 34 degrees. It is also surrounded by Himalayan foothills, except on the west side. The eastern and northern side particularly have taller mountains with some peaks crossing 4,000 meters. Out of 5 candidates, 3 are in the approximate direction of the centre of the Milky Way and have the declinations of less than - 40^{o}. This region of sky is poorly visible from the site and hence we ignore those. This leaves only two possible candidates that are listed in table 1.

Table 1: Two possible supernovae that can be associated with the Buraraham

No	Name	Location (galactic cords α, β)	Distance (parsecs)	Age (BC)	Peak Apparent magnitude in Earth sky	Reference
1	G182.4+4.3	91.79, 5.57	3,000 pc	1,800	-7.1	Kothes et al. (1998)
2	HB9	79.0, 23.79	800 pc	4,600	-9.6	Leahy and Tian (2007)

G182.4+4.3 (Kothes et al., 1998, Xu et al., 2005) is dated to 100 BC and has an apparent magnitude of -7.21. HB9 (Xu et al. 2005; Damashek et al., 1978; Kothes et al., 1998, Laehy and Aschenbach, 1995) has an apparent magnitude of -9.6, age of 6600 years or 4600 BC (with a margin of 2000 to 5000 years BC).

The stone painting was found in a rock wall with the stone facing inside in site dated to 2100 BC, suggesting that its importance had been lost to the people by then and the stone had been reused for another structure. This makes it unlikely that G182.4+4.3 was the supernova depicted in the drawing. Astronomical data are known to predate formal dated settlements in several areas (Baity, 1973) and rock art is known to be the earliest form of human expression and it seems possible that the stone carving was made much earlier than the end period of the civilisation. This suggests that HB9 is the most promising candidate supernova for the pictograph.

We therefore investigate the possibility that the rock drawing is the record of the supernova HB9. We suggest that the partially drawn object is HB9 since it would be irregular and that the second bright object is Moon since the apparent magnitude of HB9 is closer to that of the Moon.

We suggest that this is not a terrestrial hunting scene but is actually a sky-map giving location of prominent constellations and the Moon on the day the supernova was first observed. Figure 2 shows sky-map of the region around HB9 for 4,500 BC (using

Skymap Pro sky mapping software) . The striking similarity of the patterns drawn on the sky map with the original drawing is clearly visible.

On the sky chart if we put the partially drawn object at the location of HB9 (indicated by circle on the top), the image of one of the hunters coincides with the Orion; the central stag is same as the Taurus. The hunter on the right may have been formed from stars of Cetus and other animal on the right may be Andromeda and Pegasus. The long, curved line in the carving, traditionally interpreted as spear, may well be an arc of bright stars. These sky patterns account for all the bright stars in the region and look consistent with then prevalent culture. As the constellations had iconographic importance in primitive cultures, exaggerated male organs of the four figures may have represented fertility. However, some of these male organs can also be traced in the star patterns.

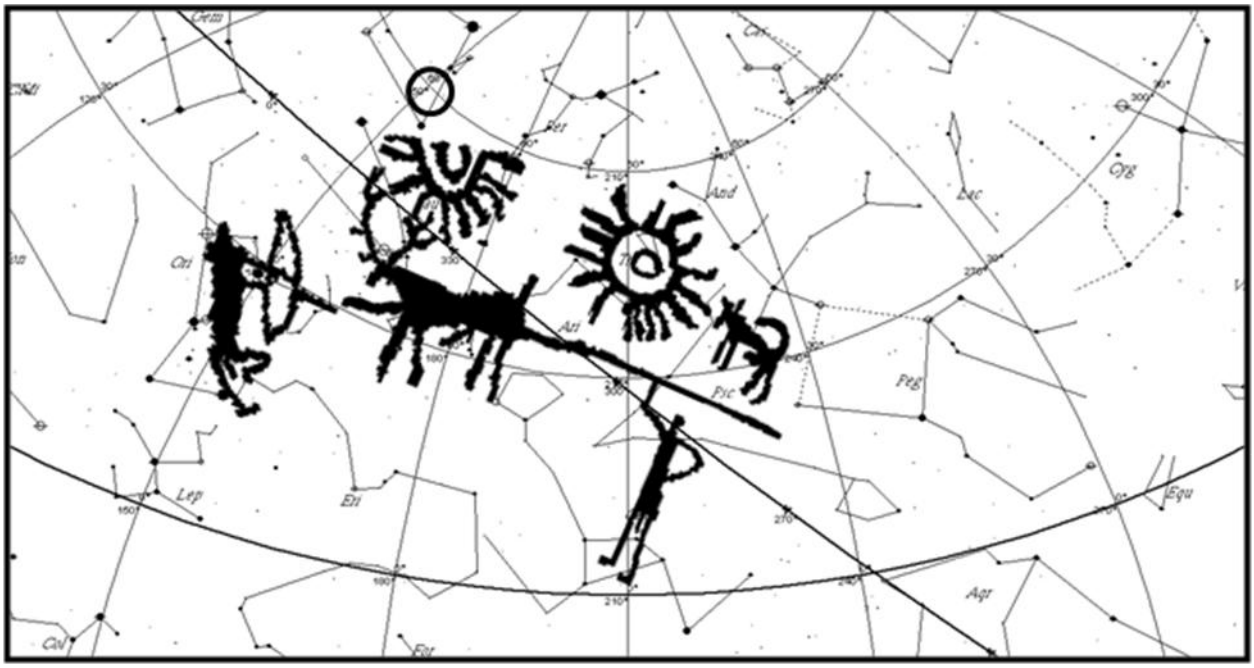

Figure 2: Skymap of the region of HB9 in the sky chart for 5700 BC. To facilitate easy comparison with the drawing, rough patterns are drawn in the map. The constellation names as per current identification are given. The big spot at the center is the full Moon in the month of August in roughly 4500 BC, and the circle on the right indicates the position of HB9.

The location of HB9 just beside Capella fits perfectly with the left object in the picture. Obviously, with a supernova of -9.6 magnitude in the close vicinity, Capella may have disappeared in its glow and is absent from the carving. In order to check this we attempt to scale the drawing. We assume that the figure on the left is Orion. We therefore measure the relative distances of various star locations in the figures with the angular separation of the stars in the sky. The result is given in table 2.

We estimate the accuracy of fit by superposing the original drawing to the sky chart. We coincide the centre of the image and measure the distance between various objects in the sky chart and the drawing. Some sample results of measurement of

objects at large angular separation in the drawing and in the sky are given in table 3. In table 3. The average scaling between the drawing and the sky chart is 4.15 $\pm$ 0.57 based on the original drawing and sky chart available with the authors. Hence the absolute number are not significant, but the fact that we get consistent scaling which ever two objects we take, suggests that the drawing was to the scale of the sky observation. Part of the error in fit must arise from the fact that the drawing is a visual image of the sky and part of the error arises from the fact that the artist has sketched the constellations rather than plot the stars. Within these constraints, we suggest that the fit is exceptionally good.

Table 2: Scaling of stone carving with angular separation of stars in Orion Constellation

Object	**Location**	**Probable Stars**	**Apparent magnitude**	**RA**	**Dec**
Left Hunter	Head	Betelgeuse	0.5	88.75	7.40
Left Hunter	Left foot	β Orionis	0.12	78.50	-8.20
Stag	Head	γTauri		64.75	15.62
Stag	Left horn	β Tauri		81.50	28.60
Stag	Right Horn	ε Tauri		67.25	19.18
Stag	Left feet	μ Tauri		64.00	8.88
Stag	Right Feet	5 Tauri		52.75	12.93
Stag	Tail	η Tauri		56.75	24.10
Right Hunter	Head	η Pisces		22.75	15.35
Dog	Head	β Andromeda		17.50	35.62
Moon	Along Ecliptic		-12.74 (mean)	30.00	30.87
SN HB9	Near α Auriga		- 9.6 (max)	75.25	43.82

Discussion and conclusion

We have attempted to check if the rock art found at Burazahama is associated with a supernova. Based on the date of the site (6000 to 2000 BC) we search for possible supernovae in the modern astronomical catalogue. We put the condition that a) the supernova should have been bright enough to attract the attention of early sky grazers at Burazahama, b) should be close to the path of the Sun and the Moon and c) should have gone off during between 6000 and 2000 BC. We find that only one Supernova remnant HB9 meets all these criteria and it exploded around 4500 BC with a brightness comparable to the brightness of the Moon.

We plot the sky chart of the time and the rock drawing on each other and find that the other objects in the chart coincide very well with other objects in the sky close to where HB9 exploded. The scaling between different parts of the sky chart and the drawing is constant to about 15%. Based on this we re-calculate the separation of Betelgeuse from the star γ Tauri which forms the head of Taurus (stag) close to which

HB9 exploded. The predicted value of the location of HB9 as per this chart matching, come out to be at the locations predicted on the calibration given in table 2. We therefore suggest that the stone drawing is a complete sky chart of the night on which the Supernova was first observed by unknown observers around 4,500 (± 1000) BC.

There is no certain positive identification of a supernova prior to 352 BC (Hellemans and Bunch, 1988) , and hence this stone carving predates previous record of a supernova by far. Also, this would be first record of a sky map drawn to record a peculiar event.

Table 2: Scaling of the drawing to the sky chart.

To	**From**	**Distance(Sky) (Degrees)**	**Distance (Map) (arb units)**	**Factor (Degrees/unit of magnification)**
Stag's Head	Dog's Head	46.51	11.59	4.01
Right Hunter's Head	Stag's Head	40.41	11.62	3.48
Right Hunter's Head	SN's Location	52.64	11.99	4.39
Left Hunter's Head	Right Hunter's Head	64.97	17.11	3.80
Left Hunter's Head	Moon's Location	59.49	14.90	3.99
Stag's Left horn	Right Hunter's Head	55.53	12.81	4.33
Stag's Left horn	Moon's Location	44.38	10.03	4.43
Left Hunter's Left foot	Right Hunter's Head	60.04	15.19	3.95
Left Hunter's Left foot	SN's Location	52.10	11.55	4.51
Left Hunter's Left foot	Moon's Location	60.67	15.13	4.01
Stag's Right Horn	Right Hunter's Head	42.56	11.12	3.83

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