Oldest sky-chart with Supernova record[1]

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Summary:

When did the humans begin astronomical observations? The oldest of the human observations are scattered through various Palaeolithic epochs. These observations are seen in the form of the cave paintings at various sites in France and Spain and include the phases of moon leading to ephemeris, bright stars and basic constellations (Rappenglueck, 1999). In India, a stone carving is excavated from a site in the Kashmir region, where permanent settlements are dated to a period around 3000 - 1500 BC (IAR, 1964). The stone slab shows two bright objects in the sky with a hunting scene in the foreground. These have been assumed to be a depiction of a double star system (Kameshwar Rao, 1995). We propose that this is the first record of a supernova. From the manner of drawing of the two objects, they both seem to be brighter than other stars and planets. We show that one of the objects is likely to be near-full moon and other is a probable supernova. We have searched the records of supernovae (Green, 2005; Xu et al., 2005) and suggest that the supernova drawn in the rock painting is HB9 (Xu et al. 2005; Damashek et al., 1978; Laehy and Aschenbach, 1995) which exploded in 5700 BC and had an estimated apparent magnitude of -9.6. We then reinvestigate the entire hunting scene and show that the drawing of the hunter and the stag seem to be correlated to Orion and Taurus in the vicinity of HB9. We scale this picture and find that all the drawings can be correlated to astronomical sky patterns. Hence we suggest that this picture is not only the first record of a supernova, but also a sky-chart from 5500 BC making it by far the oldest such record.

Astronomical references amongst ancients in prehistoric period are sketchy and have relied largely on the stone carvings and etchings. The cave paintings and stone carvings are subject to interpretation but some authors have claimed that prehistoric man identified basic star patterns like Orion as early as 30,000 BC. The Lascaux caves were discovered in 1940 showing lunar ephemeris 15,000 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.

However, at a site in Burzahom in Kashmir (about 10 km north east of Srinagar in north India), a peculiar stone carving has been unearthed (IAR, 1964). The carving is on an irregular stone slab with rough size of 48 cm x 27 cm. The plate is chipped at one corner, leaving a

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possibility that a part of the carving may be missing. The slab was recovered from phase Ib of the site (roughly 2125 B.C.E.) 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 figure 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 (Kameshwar Rao, 1995).

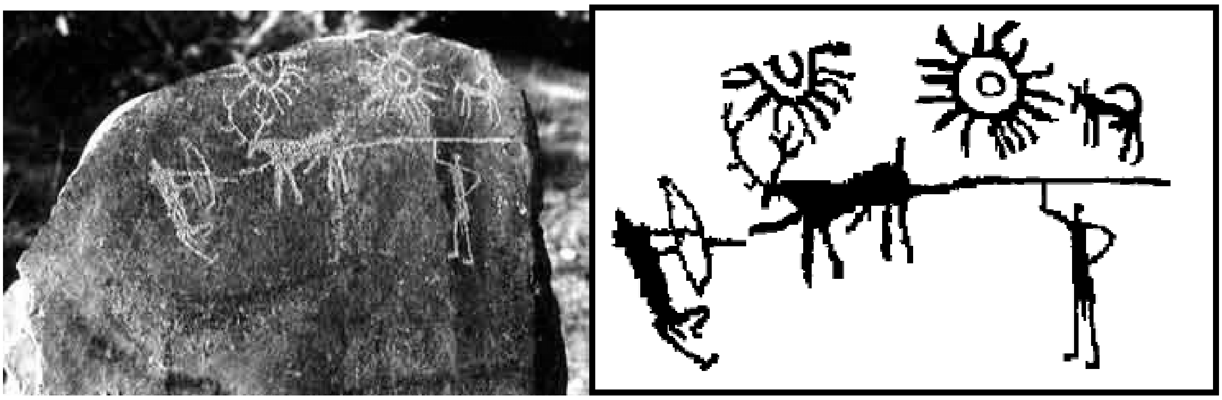


Figure 1: Photograph of stone Carving from Burzahom (Courtesy IGNCA) along with a sketch of the same.

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 the (near) full moon and second object is relatively close to the first. If we assume one of the objects is the Sun then the second object cannot be the moon, since, with such proximity to the Sun, the moon would be in a partial phase around the new the moon and cannot be very bright. We propose 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[1]. Further, brightness of stars or even the planets is not of the class which requires depiction of light beams coming from the same. 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 conclude that the observed object is a supernova.

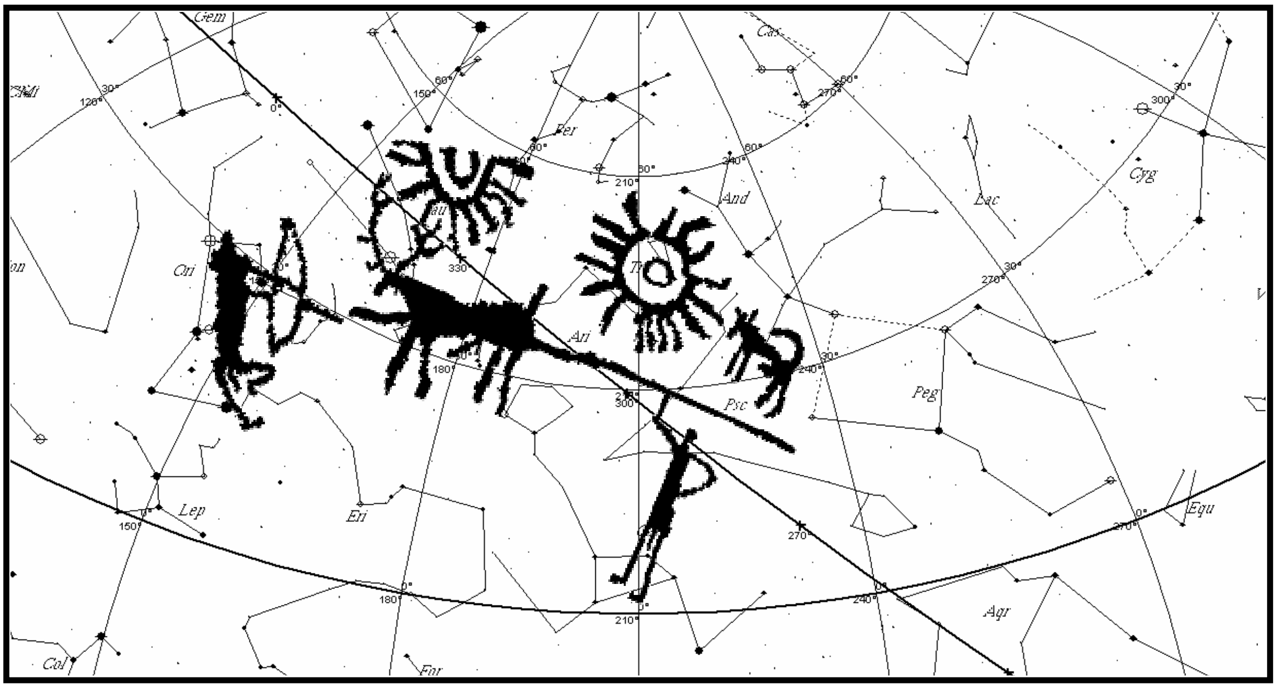
We searched for galactic supernova records (Green, 2005; Xu et al., 2005) of ancient supernovae for a possible candidate. Since supernovae catalogues give only the current observational details, we calculate the apparent magnitude of these objects based on the assumption that their absolute magnitude is -19.6, which is typical for a type IIa supernova. We then calculate the apparent magnitude using geometric consideration. The active period of the site has been dated to between 3,000 BC and 1,500 BC by Carbon dating (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. One is G182.4+4.3 (Xu et al., 2005) with Galactic coordinates λ = 91.79 and β = 5.57 degrees, and apparent magnitude of -7.21, rough age of 3800 years (1800 BC) and distance of 3000pc. The other is HB9 (Xu et al. 2005; Damashek et al., 1978; Laehy and Aschenbach, 1995) with its λ = 78.99224 and β = 23.78943 degree, apparent magnitude of -9.6, age of 7700 years (5700 BC) and distance of 1000 pc. Typical error in the determination of age can be taken to be $\pm$ 1000 years since the age estimates depend on the canonical interstellar medium conditions, expansion rates etc. It should be noted that no data of the apparent brightness of these supernovae at their peak exists. We assume that these are canonical supernovae with an absolute magnitude of -19.6 and then derive their apparent magnitude from their distance. Both these objects would have been visible from the site. The age of these SNRs is determined by measuring their radii and thermal temperatures. The typical error in the process is about ten percent or more. Archaeological data of settlements is in line with the Supernova G182.4+4.3 as being the correct supernova. However, some authors have argued that the astronomical data are known to predate formal dated settlements in several areas (Baity, 1973). If we assume that the humans make serious astronomical observations well before they settle down (Baity, 1973) then the latter supernova is more likely. Also HB9 is much brighter and more in line with the drawing than G182.4+4.3. Further, the fact that the stone plate had lost importance by 2100 BC and was reused for another structure, goes against G182.4+4.3. At this point, we select HB9 as the most promising candidate supernova for the pictograph.

We suggest that the second bright object is moon rather than the Sun. The magnitude of the brightest full moon never exceeds -12.5. This makes it nearly comparable to HB9 and would explain why both the objects were drawn similar. This was rebuked earlier on the basis of the hunting scene drawn just below the two objects. It was argued that hunting scene would indicate daytime activity. Here, we propose to reinterpret this part of the picture as well. We argue 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 5700 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 (figure 2).

One of the hunters is same as 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. HB9's position is indicated by a spot in the upper part of the picture and Moon's likely position, as seen in the carving, is indicated by a bigger spot at the centre of the picture. 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 comparision with the drawing, rough patterns are drawn in the map. The constallation names as per current identification are given. The big spot at the center is the full moon in the month of August in roughly 5700 BC, smaller spot on the right of Capella is 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 1.

In table 2 we have given the fit of these stars to the images in figure 2. As can be seen from the table, the fit of various stars to different points in the figure is reasonably accurate with an expansion factor around 4.15. 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 1: Scaling of stone carving with angular separation of stars in Orion Constellation

Object	**Location**	**Probable Stars**	**RA**	**Dec**
Left Hunter	Head	Betelgeuse	88.75	7.40
Left Hunter	Left foot	Beta Orionis	78.50	-8.20
Stag	Head	Gamma Tauri	64.75	15.62
Stag	Left horn	Beta tauri	81.50	28.60
Stag	Right Horn	Epsilon Tauri	67.25	19.18
Stag	Left feet	Mu Tauri	64.00	8.88
Stag	Right Feet	5 Tauri	52.75	12.93
Stag	Tail	Eta Tauri	56.75	24.10
Right Hunter	Head	Eta Pisces	22.75	15.35
Dog	Head	Beta Andromeda	17.50	35.62
Moon	Location		30.00	30.87
SN	Location		75.25	43.82

Discussion and conclusion

As can be seen from the table, we get a conversion factor of 4.86 $\pm$ 0.25. Based on this we calculate the separation of Betelgeuse from Gamma Tauri which forms the head of Taurus (stag) a well as to the SNR HB9. These come out to be at the locations predicted on the calibration given in table 1. 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 5,500 ($\pm$ 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/cm)
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
Right Hunter's Head	Moon's Location	16.88	5.55	3.04
Dog's Head	Right Hunter's Head	20.80	3.62	5.74
Dog's Head	Moon's Location	11.47	2.88	3.98
Moon's Location	Stag's Head	35.18	9.39	3.74
Moon's Location	Right Hunter's Head	16.88	5.55	3.04
Moon's Location	SN's Location	37.70	7.72	4.88
Left Hunter's Head	Stag's Head	24.88	5.61	4.44
Left Hunter's Head	Right Hunter's Head	64.97	17.11	3.80
Left Hunter's Head	SN's Location	38.28	8.50	4.51
Left Hunter's Head	Moon's Location	59.49	14.90	3.99
Stag's Left horn	Left Hunter's Head	22.28	4.92	4.53
Stag's Left horn	Right Hunter's Head	55.53	12.81	4.33
Stag's Left horn	SN's Location	16.02	3.98	4.02
Stag's Left horn	Moon's Location	44.38	10.03	4.43
Left Hunter's Left foot	Stag's Left horn	36.91	7.71	4.79
Left Hunter's Left foot	Stag's Head	27.44	6.93	3.96
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
Stag's Right Horn	Moon's Location	35.52	8.45	4.20

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