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SOME EARLY ASTRONOMICAL SITES IN THE KASHMIR REGION

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Abstract: We discuss a number of early rock art sites in the Kashmir Valley in northern India and neighbouring Pakistan, and suggest that some of these contain depictions of astronomical objects or events. The sites are in the Srinagar and Sopore regions and in or near the Ladakh region, and date to Neolithic or Upper Paleolithic times. Our studies suggest that during this period some of the ancient astronomers recorded supernovae, meteorite impacts, the Sun, the Moon and the seasons in their rock art.
Key words: Ancient astronomy; stone carvings; supernovae; meteorite impacts.

1 INTRODUCTION

Archaeoastronomy is the study of ancient or traditional astronomies in their cultural context, utilizing archaeological evidence. The subject uses historical records of heavenly events to infer the astronomical knowledge of our ancestors. Archaeoastronomy also uses monuments and written records to evaluate astronomical traditions. The importance of archaeoastronomy is that it allows us to understand something about prehistoric times and the knowledge of astronomy that flourished. In other words, archaeoastronomy can be used to identify prehistoric astronomical practices. There are a number of ways of studying archaeoastronomy, including through

1) the architecture of ancient monuments (e.g., see Menon, 2007);
2) simulations of ancient observatories and situations (e.g., see Hrishikesh et al., n.d.);
3) Harappan script pattern recognition (e.g., see Yadav and Vahia, n.d.); and
4) stone carvings (e.g., see Masood, 2007).

The Kashmir region of India (Figure 1) is rich in stone carvings. Stone carvings often have abstract representations, and large numbers of poorly-understood stone carvings raise interesting issues about the history of civilization. These mysteries pose important questions and lead to new answers about the people of the ancient world, including their culture, language, architecture, astronomy and religion. Ancient people viewed heavenly objects as unknowns and sometimes expressed their state of knowledge through their stone carvings.

Figure 1: Map showing the locations of Kashmir and Ladakh in northern India (blue and purple), and the neighbouring regions of Pakistan (green).

Various carvings found in Kashmir and in the areas of Drass in Ladakh and Chillas (bordering Ladakh, in Pakistan) indicate that there was a tradition of recording astronomical events in prehistoric times. In this paper, we discuss sites in three different areas of Kashmir that appear to present evidence of this type.

2 ANCIENT ASTRONOMICAL ROCK ART SITES

On the basis of visiting various sites and studying their astronomical aspects, we believe that the following sites were used by ancient peoples from time to time for astronomical observations and therefore are the oldest 'observatories' in Kashmir.

Figure 2a: Stone carving located at Bomai Sopore in the Baramulla District of Kashmir.

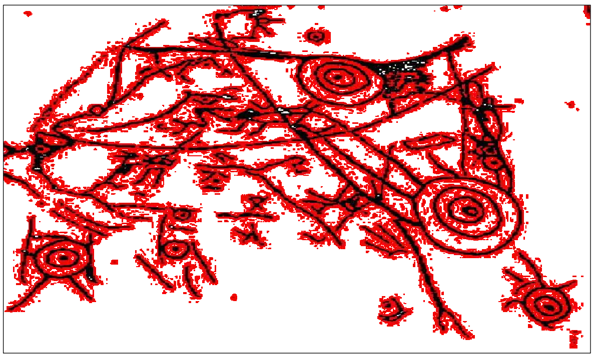

Figure 2b: Drawing showing the concentric circles of different sizes in Figure 2(a).

2.1 Bomai Sopore (Baramulla-Kashmir)

In northern Kashmir there is a place called Bomai Sopore ~70km northwest of Srinagar. This region was occupied during the Upper Paleolithic period, from ~20,000 to 6,000 BP. There is a conspicuous rock carving in this area situated at 74° 30′ longitude and +34° 22′ latitude, at the northwest end of a 3,000m high plateau with peaks to the southeast rising to ~3,500m. The rock surface has multiple concentric circles (Figures 2a and 2b), and is situated on the side of a mountain ~100m from the fields, and overlooking the eastern side of the famous Wular Lake. We believe that this rock carving depicts a meteorite impact that occurred some time between 40,000 BP and 6,000 BP (Vahia et al., n.d.). It has already been observed that when it impacts a meteorite can deform the surface on which it lands. Such fractures can take the form of concentric rings around an impact crater. The impact of a massive meteorite or a small asteroid can also induce volcanic activity if the area it strikes contains hot lava that can rise up through the crust (Gibilisco, 2003). We believe that the astronomical interpretation of this stone carving is consistent with this interpretation because the carving has multiple concentric circles distributed across the entire picture (see Figure 2a and 2b). Vahia et al. (n.d.) have already postulated that a single meteoroid may have splintered into several pieces as it penetrated the atmosphere and that if any of the larger fragments landed they would have formed craters or pits.

There are four lakes in this region—which appear to correspond to the four circles in the drawing—and several smaller water bodies, all consistent with a multiple impact event. Also, the orientation of the lakes indicates that the meteoroid entered the region from the northwest and fell in a southeasterly direction. Three of the circles in Figure 2a are collinear and three of the lakes are also aligned in the same direction. In this scenario (see Iqbal et al., 2008 for details), Wular Lake (the largest in India) can be associated with the top-most circle; the second circle relates to Manasbal Lake; the third circle to Dal Lake; and the fourth circle to Hokerser Lake. The small circle between the two larger circles corresponds to the small water bodies which exist between these lakes. We believe that the line adjacent to the three collinear circles indicates the flight path of the meteoroid, or the associated (smoke) trail, and the relative sizes of these three circles indicate the changing brightness of the object. All this seems consistent with a meteorite impact. In order to examine this hypothesis, we reviewed the relevant geological literature and also carried out our own research around Dal Lake. We found the following evidence that, in our view, supports a meteorite impact:

1. Dal Lake was originally a basin-like structure, but has been deformed through erosion since its formation.
2. Coulomb excitation measures of different samples taken from Dal Lake revealed the presence of those same elements found at Lonar Lake, which is known to be associated with a meteorite impact (see Chowdhury and Handa, 1978). About 70% of the Dal Lake samples matched the elemental abundance levels obtained at Lonar Lake.
3. Wadia (1953) reports evidence of shock metamorphism in the vicinity of Dal Lake.
4. Jeelani and Shah (2006) report the presence of basalts and breccias in the vicinity of Dal Lake.
5. The pH value of the water at a depth of 2m in the Lake, and from the surrounding mountains averages >9.7.

2.2 Burzahama (Srinagar-Kashmir)

The site of Burzahama is located in the Kashmir Valley at 74° 54′ longitude and +34° 10′ latitude and is 17km northeast of Srinagar. To its east is the glaciated peak of Mahadev Mountain, while the glittering waters of Dal Lake lie to the south; there are also mountain ranges to the west. Among dozens of flat rectangular stones found at Burzahama are two bearing engravings. One of these has a base width of 70cm and contains a really impressive example of Neolithic art. The engraved portion is divided into two parts. The upper part shows an animal on the right and on the left depictions of two Suns, one with sixteen radiating lines while the other is somewhat damaged. Below these three elements are another animal (with antlers) and two hunters (see Figure 3a). It would seem that the picture depicts a hunting scene, but Hrishikesh et al. (n.d.) postulate that this is not a terrestrial hunting scene but actually represents a sky map and the locations of prominent constellations and the Moon on the night when a supernova (SN) was observed (see Figure 3b). In this scenario, the hunter on the left in the figure represents Orion, the central animal is Taurus, the hunter on the right may have been formed from stars in Cetus, and the other animal on the right may be Andromeda or Pegasus.

The latitude of Burzahama (34° N) and its geographical setting in the foothills of the Himalayas constrained the number of possible SNe that would have been visible in the past, given the presence of mountains up to 4,000m high both to the north and the east. A further constraint is the age of the site, which on the basis of radio-carbon dating we know to have been utilized between about 5,000 BP and 3,500 BP (Agrawal and Kusumgar, 1965; Pande, 1971). A search of the relevant literature (Green, 2004; Xu et al., 2005) revealed the existence of five different SNe closer than ~5 kpc[1] (and therefore conspicuous at maximum light) that erupted during this period,[2] but three of these had southern declinations and were not easily observed from Burzahama. This left just two viable candidates, HB9 and G182.4+4.3, and these are compared in Table 1.

This Table shows that G182.4+4.3 erupted around 3,800 BP, and at a distance of ~3 kpc would have reached an apparent magnitude of between –7 and –5 at maximum (see Kothes et al., 1998). The other candidate, HB9, exploded some time between 7,000 and 4,000 BP. The distance of this SN is given as 1.1 kpc by Touhy et al. (1979) and 0.8 ± 0.4 kpc by Laehy and Tian (2007), so at maximum it would have reached between –10 and –7.5 apparent magnitude (Laehy and Aschenbach, 1995; Xu et al., 2005).

Both SNe would have been readily visible from Burzahama and very conspicuous to naked eye observers, so which SN is more likely represented on the rock engraving? If one of the concentric circles represents the Moon and discloses the location of the ecliptic, we believe that the positioning of the various elements in the drawing better supports HB9. If HB9 is indicated by the damaged concentric circles in the upper left part of Figure 3b and the Moon's position is marked by the larger concentric circles to the right, then the long curved line in the carving—traditionally interpreted as a spear—is actually an arc of bright stars, and the figure on the left is Orion. To check on this assumption, the relative distances of various stars in the rock engraving were compared with the actual angular separations of the stars in the sky, and there was a reasonable fit (Hrishikesh et al., n.d.). On the basis of the accumulated evidence we suggest that the rock engraving depicts a major astronomical event which took place more than 4,000 years ago.

In a recent study of this site we noted a number of additional points of interest:

1. Two of the stones are still *in situ* but are leaning (see Figure 4) while the rest have fallen, but all can be categorized as 'megaliths'.
2. When all of the fallen and standing stones at this are considered together, they form a rough circle which may also have astronomical connotations.
3. There seems to be more to these monuments than local people attribute to them now. Of particular interest is a mound located due east of the stones.
4. Some of the stones seem to have been erected on artificially-constructed mounds, judging by the placement of rocks as a sort of retaining structure exposed in one of the excavations.

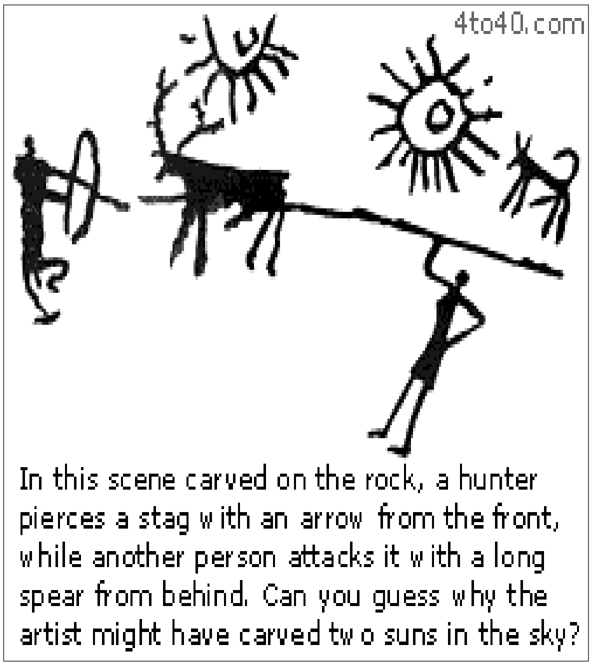

Figure 3a: Rock carving found at Burzahama.

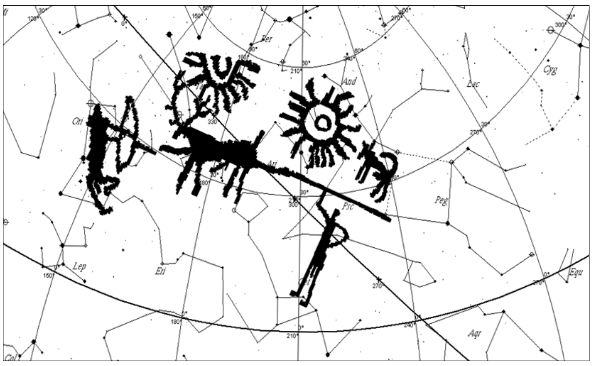

Figure 3b: Sky map showing the region of HB9 in 5,000 BP. To facilitate easy comparison with the drawing, rough patterns are drawn in the map. The large circle in the centre is the full Moon in the month of August in roughly 5,000 BP, and the smaller damaged circle to its left marks the position of HB9.

5. 'Cup marks', which are known to have astronomical connotations elsewhere (Ruggles, 1999), were observed on two of the fallen stones.
6. A view of the eastern horizon is blocked to a large extent by mountains, but the western horizon is largely unobstructed.

Table 1: A comparison of the two SN candidates.

SN Name	l (°)	b (°)	Date (BP)	Dist. (kpc)	Max. m_v
HB9 (G160.9+2.6)	160.9	+2.6	7,000 - 4,000	0.8 – 1	–10 to –7.5
G182.4+4.3	182.4	+4.3	3,800	3	–7 to –5

Figure 4: Panoramic view of the Burzahama from the north-west.

2.3 Chillas and Drass (Ladakh)

Chillas is a small town located near the Drass belt in the Ladakh region. It is at 74° longitude and +35° latitude, on the upper reaches of the Indus River, under the shadow of the famous Nanga Parbat, the ninth highest mountain on Earth. Archaeological surveys have revealed the existence of ~20,000 rock art sites and petroglyphs along the Karakorum Highway in northern areas of Pakistan, left by various invaders, traders and pilgrims who passed along this popular trade route.

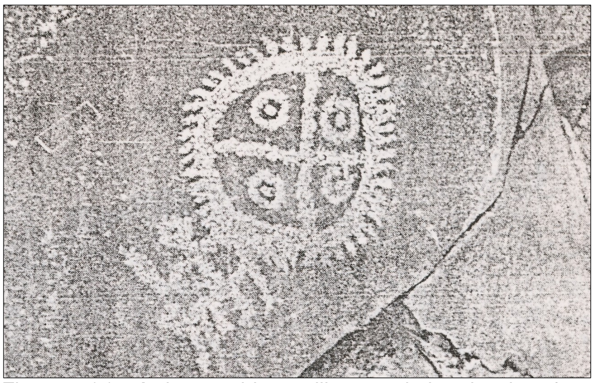

Figure 5(a): A horse rider pulling a circle showing four seasons.

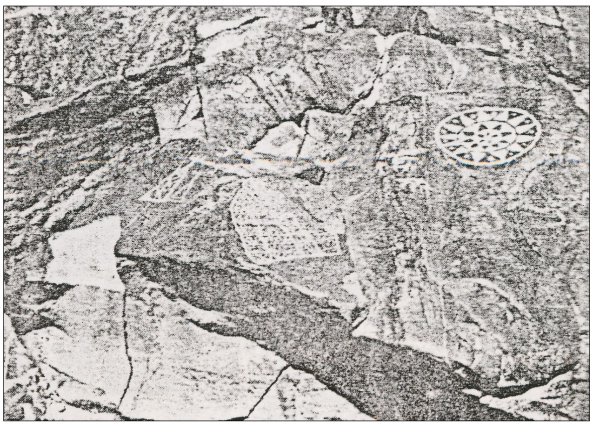

Figure 5b: Solar symbol that has in it 12 triangles possibly showing 12 months.

The earliest sites date between 7,000 and 3,000 BP, and include pictures of animals as well as circular motifs. These latter carvings were pecked into the rock with stone tools, and some may have astronomical significance. Figures 5a and 5b show two different kinds of circular motifs, and as an initial interpretation we propose that they may represent the changing of the seasons, the calendar and radiating objects. These interesting rock engravings clearly warrant further investigation.

3 CONCLUDING REMARKS

The overall investigations in this paper are summarized briefly as follows. Observation of the sky and astronomical bodies has been of worldwide interest since prehistoric times, irrespective of the cultures involved. Kashmir, too, was an important place for celestial observations during the Paleolithic and Neolithic periods. In this paper we discussed the northwestern part of Kashmir, and gained the impression that the ancient inhabitants definitely noted different celestial events, despite the fact that they were merely hunters and gatherers and could only use stone tools to record their observations.

Two of the sites we discussed, Sopore and Burzahama, have already attracted international attention because of their archaeoastronomical features, but some of the sites near Chillas also need to be carefully investigated from an archaeoastronomical point of view. Collectively, these Kashmir sites appear to depict meteorite impacts, a supernova, various constellations, and possibly the changing of the seasons. This northwestern sector of Kashmir offers a route that was popular with ancient travelers, and some of them made astronomical observations and left records of these in their rock art. Water would have been essential for the survival of these early 'astronomers', and when the various sites were studied in detail we noticed that all of them were situated on the banks of lakes, rivers or other bodies of water. Those sites that we have identified appear to provide a new perspective on the archaeoastronomical potential of Kashmir.

4 NOTES

1. Distances to supernova remnants (SNRs) can be estimated from (1) optical expansions and proper motions, (2) 21cm H-line absorption spectra, (3) neutral hydrogen column densities, (4) association with neutral hydrogen or CO features in the surrounding interstellar medium, or (5) associations with other objects of known distance. But Green (2004: 348) reminds us that each of these "… is subject to their own uncertainties …" Consequently, astronomers tend to rely

> … on the surface-brightness/diameter, or 'Σ–D' relation to derive distances for individual SNRs from their observed flux densities and angular sizes. For remnants with known distances (d), and hence known diameters (D), physically large SNRs are fainter (i.e. they have a lower surface brightness) than small remnants. Using this correlation between Σ and D for remnants with known distances, a physical diameter is deduced from the distance-independent *observed* surface brightness of any remnant. Then a distance to the remnant can be deduced from this diameter and the observed angular size of the remnant. (Green, 2004: 350).

Thus, since

$$\Sigma \propto S/\theta^2 \text{ and } L \propto Sd^2 \qquad (1, 2)$$

then

$$\Sigma \propto L/(\theta d)^2 \ \ or \ \ \Sigma \propto L/D^2 \qquad (3, 4)$$

where Σ is the surface brightness, S is the flux density, θ is the angular size and L is the luminosity.

2. As Green and Orchiston (2004: 111) stress, "… it is not easy to definitively determine the age of an SNR from available observations." Physical size, surface brightness and morphology can all be used as indicators, but each has its inherent problems. Meanwhile, the age of an SNR containing a pulsar can be calculated from the pulsar period and time derivative of the period (Dickel, 2006: 62). However, HB9 and G182.4+4.3 are shell-type SNRs (see Green, 2004: 367) and as such lack pulsars.

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