

Archaeological experiment at Balnuaran of Clava NE cairn on the 20th. and 22nd December 1997 by Ronnie Scott and Tim Phillips

Method

We covered the cairn with two large tarpaulins under which were placed lengths of 2 x 1 inch. timber at approximately 1m intervals which we laid across the top of the passage orthostats, and one 4 x 2 timber across the chamber to support the tarpaulin. Ropes at the corners of the larger tarpaulin, which covered chamber and most of passage, were attached to trees at rear of cairn and loosely to stones on the cairn surface. The stones were not disturbed by this. The second tarpaulin was placed over the passage and overlapped the first tarpaulin did and not need ropes to hold it in place as it was quite stiff.

Though the tarpaulins were made of heavy weight cloth and plastic coated light could permeate the fabric.

As far as possible Tim and I felt that we had recreated the position of the missing roof of the passage, and had enough room to stand upright in the chamber.

This operation did not take long and was easily accomplished by five people. The same procedure was done by three people on the 22nd. December 1997 without any problem. Two on the top of the cairn and one in the passage under the tarpaulin guiding it as it was dragged into place.

If the experiment has to be repeated then it was felt that, instead of a tarpaulin lying on top of timber lathes placed at intervals, plywood or similar sheets cut to lie on top of the orthostats of the chamber would recreate the original dimension of the passage more accurately. All light needs to be excluded and black plastic polythene sheeting laid over the tarpaulin, on the 22nd. December, showed that this would be a cheap method of achieving this, though the sheet that was used then was not quite large enough. to exclude all light

The position of the light from the setting sun coming down the passage and striking the interior of the chamber was recorded by Tim on his photomosaic plan of the interior of the chamber. He also took notes. I spent my time between viewing what was happening in the chamber and taking videos of the exterior appearance of the cairns and sunset, and recording my thoughts onto the tape. Photography was considered difficult as the value of the light was minimal for photography though the human eye was sensitive enough to observe clearly within the chamber. On the 22nd. of December time exposures of various lengths were tried and colour print film was used.

Tim was not present on the 22nd. December as he had to return south.

Observations on 20th December

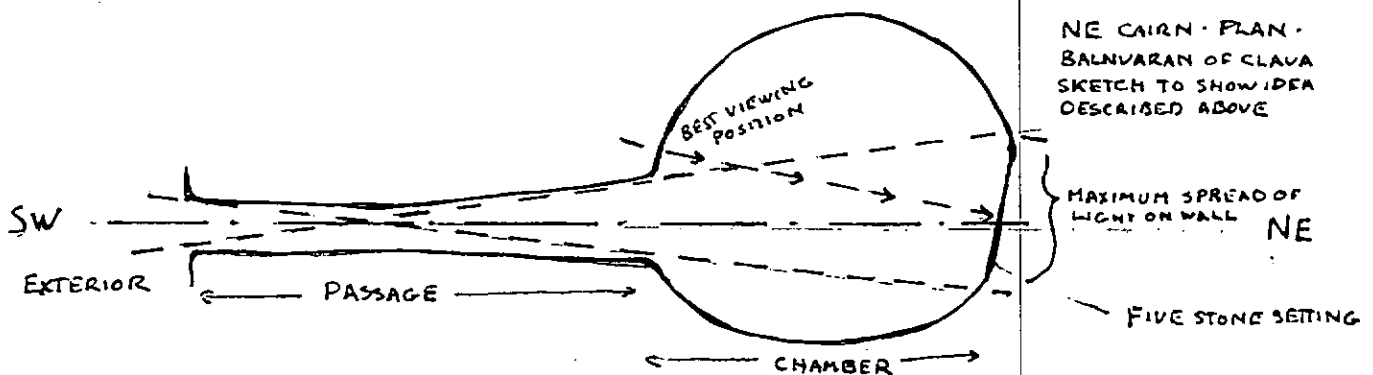
Observation started about 14.45. Local sunset at this latitude is about 15.20 and sunset proper 15.40.

The light from the outside coming down the passage struck the rear wall of the chamber defined in the main by a setting of five stones (see Tim Phillips plan). We observed that two of the left hand stones appeared to sparkle as quartz particles on the surface of the stones caught the light, then as the sun set lower and became more red in colour this affect disappeared and the

five stones were lit up by a rosy pink glow. By this time there were several other observers apart from Tim and myself all commenting on the sparkle and then the glow as being more intense and interesting than expected. In the dark of the chamber the features on the surface of the stones appearing to be enhanced by the quality of the light. One observer, a History teacher (Don Esson) said he could imagine a leaping animal form on one of the stones, this was partially created by iron staining on the stone. Others said they could as well but it was generally accepted that ones imagination was stimulated as the patterning on the surface of the stones was enhanced by the quality of the light.

Outside the cairn the sun was obscured by clouds though there was quite a good sunset effect. There was no direct sunlight on the site only a sky glow (see video). The previous year (1996) the site was completely lit by direct sunlight creating a warm gold red effect over the cairns and standing stones. (Ronnie Scott present 1996).

As when building a house the foundation appears small in comparison to the final enclosed space, this was felt in the now enclosed chamber, and covered the interior appeared to be larger and more accommodating than in the unroofed cairn. The fact that the original chamber was probably covered by a corbelled dome approximately eight feet high the chamber was probably designed to accommodate people standing. The interior of the chamber was clearly divided by the light into two halves and observers found that the left hand side of the chamber (looking NE) was by far the larger, the conclusion reached was that this was the natural side for observation for most observers. Though this appears an obvious conclusion it was only under experimental conditions that the full implications of this were made very obvious as the path of light from the passage clearly delineated two halves of the chamber, and that the larger could hold quite a number of people, where the right side felt cramped. A further feature of the architecture was noted. Where the light from the passage fell on rear of the chamber, at the five stone setting, these were observed to be not perpendicular to the axis of the passage but were skewed to face just left of the entrance to the chamber. It appeared that this was deliberate and was checked against the SW cairn where a similar alignment was observed. Taking a perpendicular line from the rear of the chamber of the SW cairn, where the light would fall, one would face the cup marked stone to the left of the entrance to the chamber in this cairn. It was at this spot that it was felt that the 'best' viewing position, of the light from the passage on the rear of the chamber, could be observed in both the SW and NE chambers. It was felt significant that both the NE and SW cairns showed similarities in the shape of the chambers. It would appear that the fact that the passage is offset to the centre of the chamber and that, far from having a circular shape to the chamber, the odd interior shape is quite deliberate. This gives a 'best' viewing position facing directly the spot where the light from the passage hits the rear wall, without obstructing the light from the passage and accommodating a number of people to the left of the chamber. The best analogy I can make is a slide show with the screen tilted down to face the audience with the projector light above their heads, put that idea on its side and that is the effect that was observed (see sketch below).



In the passage it was noticed that the light from outside appeared to just brush the edges of the upright stones of the passage from where there was a slight kink in the alignment of the orthostats. Under the experimental conditions we had created this construction now seemed deliberate, as was the architectural design of the chamber. The purpose appeared to be to enhance the spread and amount of light entering the chamber. Further tests would have to be done to substantiate this hypothesis. It would appear that the passage is taking an optimum shape between focusing the light, by the narrow entrance, and between increasing the light capturing properties by increasing the area of spread. The analogy would be an early bellows camera where the bellows increases in width towards the rear and the plate.

Once the sun had set experiments were done with torches and candles placed at the entrance to the passage. It was surprising how much light from one candle reached the rear wall of the chamber. Torches obviously gave more light but did not enhance the features of the stone in the chamber as did the candle.

Summary of observations on the 20th. December

What the experiment showed was that certain aspects of the passage and chamber became apparent during the experiment and appear to be intentional in design. Previously some of these had been put down to lack of care of construction by the original builders of the cairns but now seemed to be deliberate architectural features. That is the straight alignment within the setting of the five stones at the rear of the chamber and the kinks in the alignment of the orthostats in the passage. The larger area to the left of the chamber designed to accommodate a number of people. The purpose for this and how it was used is of course speculation.

22nd. December Ronnie Scott and Annette Jack

Method

The cairn was covered as before with the addition of a large sheet of black polythene sheet placed on top of the tarpaulins. This arrangement excluded most of the light permeating the tarpaulins.

Annette remained outside the cairn and kept me in touch with the state of the external lighting conditions.

Several photographs were taken of the rear wall of the chamber using slow shutter speeds and camera on tripod F3.5 1sec - 1/30th, 400 ISO colour print film

Observations started at 14.45 and were completed at 15.50.

Observations

Though the skies were completely clear of cloud and the sun was shining brightly the Strath was filled with a light mist and the sunlight at the cairn was white and diffuse. The quality of light entering the chamber was quite different than on the 20th. Whiter, stronger and sharper even though it was coming through local mist and not partially obscured by clouds as on the 20th.

The sun at times was almost clear of mist early on before it reached the local horizon. At these times a sharply defined area of light corresponding with the inner edge of passage where it entered chamber being projected onto rear wall of chamber, A-A. (see diagram 3). Masking of light in passage could be taking place further in the passage at points C-C (see diagram 3) as it appeared to brush the edges of the orthostats from this point inwards hitting them only where they protruded slightly from their alignment. My impression is that the area illuminated on the chamber wall on the 22nd was further to the left than on the 20th. Could this be that the position of the sun had already moved along the horizon further west? If that was the case then one would expect that it would be showing further to the right on the rear wall except if the passage was acting like a pinhole/lens and inverting some of the light rays, interesting? If the position on the horizon has such an effect on the position of the light shining into the chamber, would this mean that in 2000BC that the area illuminated on the chamber wall was slightly different? Could it be that the chamber was now totally dark and on the 20th we could not observe the total spread of the sun's rays down the passage as extraneous light was spoiling the effect? Could it be that on the 22nd the colour of the light was different and as you know different wavelengths of light bend differently through different substances, i.e. mist, cloud or direct sunlight? Also different atmospheric conditions will cut out some of the spectrum therefore we get red skies at sunset and the more so through dust particles at high altitude. Was there any major volcanic eruptions around 2000BC giving dramatic sunsets?

As the sun set nearly to the horizon then most of the light fell on B-B corresponding approximately to where the reddish glow was observed on the 20th.

The overall effect of the light coming down the passage onto the chamber, as has already been described, was different on the 22nd. The diffuse reddish light on the 20th enhanced the features on the surface of the stone in the chamber. On the 22nd no sparkle of the quartz was observed and the whitish light did not enhance the features on the surface of the stone.

Summary and thoughts

The contrast of the effects of the light in the chamber between the 20th and the 22nd beg some questions. It was clear on the 22nd that light would enter the chamber at all times of the year and day. Why then was the alignment with the winter solstice so significant? Was it quantity of light shining directly down the passage as at Newgrange or was it quality of light and the enhancement of the features as on the 20th, or a combination of quantity and colour? Was there some other reason for the winter alignment, for early Bronze Age people, than to project light into the chamber? How important is the shape of the passage to the effect of the light in the chamber? Was the rear wall of the chamber the area of interest or the floor of the chamber? Was the Chamber lined in anyway, with clay perhaps? Was it painted or decorated in any way?

Two analogies came to my mind after the experiment. In early medieval churches the altar was placed behind a rood screen behind which the congregation sat/stood in the dimly lit nave. Light from a south facing window flooded down onto the altar. Taking into account the use of incense and the separation of the congregation by the rood screen from the mystery, light was used for dramatic effect to enhance the rituals that were being performed round the altar. Secondly when I visited Padua a few years ago the medieval hall between the Piazza della Frutta and the Piazza della Erbe had a hole high up on the south facing wall. A metal strip was inset in the tiled floor and at certain times the diffuse image of the sun was projected along this metal strip. Could a similar arrangement be the reason for the winter solstice alignment? I once made pinhole cameras with

my pupils and know how good an image they can project, though the smaller the pinhole the less light can enter the camera, but the sharper the image becomes. A door placed over the entrance of the passage with a small hole in it might project the sun's image onto the rear of the chamber, especially direct sunlight which would be intense. Being an inverted image, as with a lens, the sun's image would appear to rise from the floor of the chamber and finally disappear as the sun set. An image of the sun may even be able to appear to travel down the passage before rising up the rear wall and disappearing. What a spectacle that would be in a society dominated by the seasons and thereby the cycle of the sun and with life and death. Obviously there is no evidence at present to support this but it is an interesting thought. Perhaps some controlled experiments could be conducted to see if it was possible at all. The principals of the early camera obscuras were discovered probably when an inverted image of the outside was projected into the interior of a dark room through a small hole in a curtain or shutter.

I went back to Balnuaran of Clava on the 25th and further thoughts occurred to me. There are other straight alignments of stones in the chambers of the NE and SW cairns. Are these also significant? It is clear that in daylight, without the chamber covered, my speculation about the best viewing position was not obvious thereby reinforcing how useful the experiment was. The offset alignment of the passage to the chamber could also be an attribute designed to create an area within the chamber to avoid being seen from outside creating a private area. Taking Connor McCarthy's paper in PSAS 1996 on board were the cairns being used at this period for public exterior ritual and private more intimate ritual within the chamber.

The back wall alignment of stones that receives the light through the passage is only significant if it can be shown to be a deliberate 'Skewed setting and not just an attribute of building a megalithic structure and this can be done by making comparisons with other passage graves and the one or two we looked at on the evening of the 20th. seemed to suggest we are onto something in the shape of the chamber in that it is designed to perform some function. If the light from the passage hitting the rear of the chamber is significant, then why are the lower setting of stones here smaller than to the south west? To our modern way of thinking a large flat surface for the sun to hit would seem more likely. Is the variety of stone important? The use of an iron stained stone, mentioned earlier, was also observed on the rear wall at Corrimony though higher up the rear wall and was unique within that chamber.

Obviously our observations are subjective so far, especially judging quantity and quality of light and we need now to make a scientific study of what we have observed.

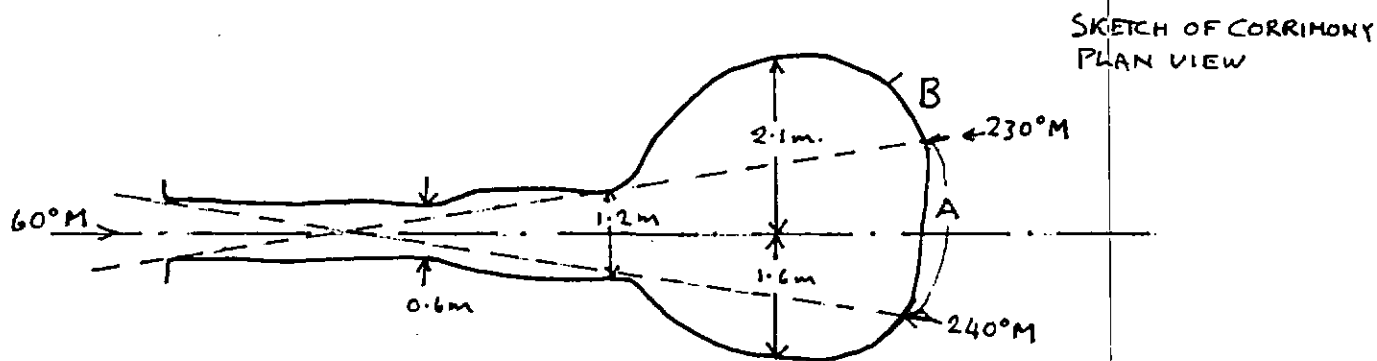
Observations at Corrimony 4.1.98

Aubrey Burl gives comparisons of four Clava type cairns as Midwinter sunset (declination -24.0°) Balnuaran of Clava NE -24.0° Balnuaran of Clava SW -24.0° Minor southern moonrise (declination -18.9°) Corrimony -18.9° , Dalcross -18.9° . Though Corrimony is aligned with the moonrise I felt that as it's chamber and passageway are so complete it would be worth looking at. The question arises about moonrise. Is there enough light from the moon to shine into the chamber. I expect so. I visited Balnuaran on the 12th of January and there was a full moon. There was adequate light from a full moon to light up the rear of the chamber, but is this significant? Could it be that the the alignment is enough as with most Christian churches and Mosques. Newgrange is the strongest argument that light shining into the chamber at some stage in the history of Neolithic tomb builders was important. Also with a south west orientation of the passage, winter sunsets would shine down the passage, though not at the solstice.

I am not sure though if any reconstruction at Corrimony has affected the interior alignments of the basal course of stones of the chamber or disturbed them when it was excavated in 1952. Certainly some of the standing stones were re-erected in 1874 and 1882 but I do not know if the chamber was disturbed then either.

The survey was a field survey and notes sketches and photographs were taken.

By sighting along either side of the passage from the entrance I produced a rough diagram of where the light from outside might hit the rear of the chamber and floor (see diagram below)



From the central axis through the passage the chamber is 2.1m wide to the left and 1.6m wide to the right, thereby showing a similarity with Balnuaran. There are two straight alignments of the basal course of stones in the chamber at (A) and (B) (see diagram above). At (A) these consist of three stones in straight alignment and at (B) two stones in alignment. (A) corresponds with the area in which the light from the passage would strike the rear wall and corresponds to my measuring staff including the edges of two stones to the right and left of (A) (see Photographs). There is an iron stained stone within this setting (see Photographs). Setting at (A) is slightly skewed to left side of chamber but not nearly so pronounced as at Balnuaran.

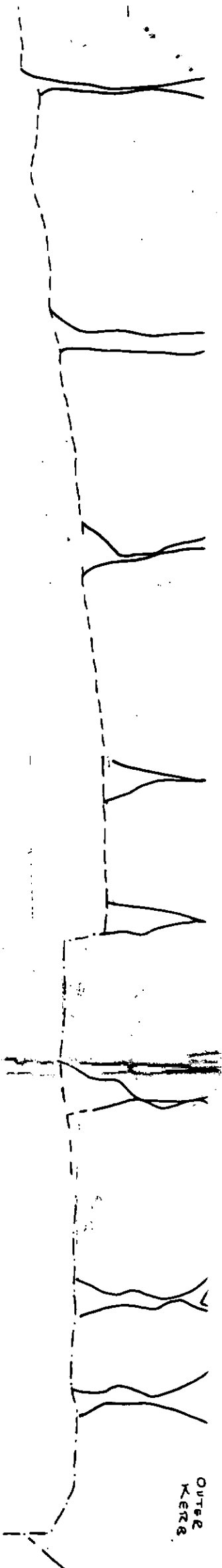
The dimension of the passage as it meets the chamber is 1.2m wide and 1.0m high. The way the passage widens at the west as it enters the chamber seems a bit odd though as if a stone is missing, as the lintel is still in place I think it may be intentional. If there was a missing stone there then surely the lintel would have collapsed. The passage widens, as at Balnuaran, and is much more pronounced almost creating a narrow anti-chamber. By Squatting at the rear wall and looking down the passage the sky, is visible, but would only correspond with light hitting the rear wall up to two courses of stone. All of the floor and passage within the dashed lines in the sketch are in view of the sky.

Here then we have a cairn showing some of the features found at Balnuaran. A straight alignment at the rear of the chamber where light coming down the passage would strike, a passage offset to the central axis of the chamber, the larger side to the left and a passage that starts with parallel sides that opens towards the chamber.

The amount of light that a moonrise could provide worries me about my hypothesis about the architectural design of the chamber to provide a theatre for viewing the effect of the light on the rear wall of the chamber and may have to be modified when considering lunar and solar events and the construction of the tombs. Could it be that instead of the effect of light within the chamber being observed a person could sit or lie and look back along the passage and view either the moonrise or

sunset. This might explain why quantity of light would not be significant. It would not be also, if it were the resting place for a corpse, be necessary to have an actual sunrise or sunset, the ritual alignment would be enough. This would also fit my concern over the smaller size of stones to the rear of the chamber and the short distance, two course up the rear wall, that the light at Corrimony could be projected down the passage and at Balnuaran the focus of light low down on the rear wall of the chamber.

Ronnie Scott 11.1.98

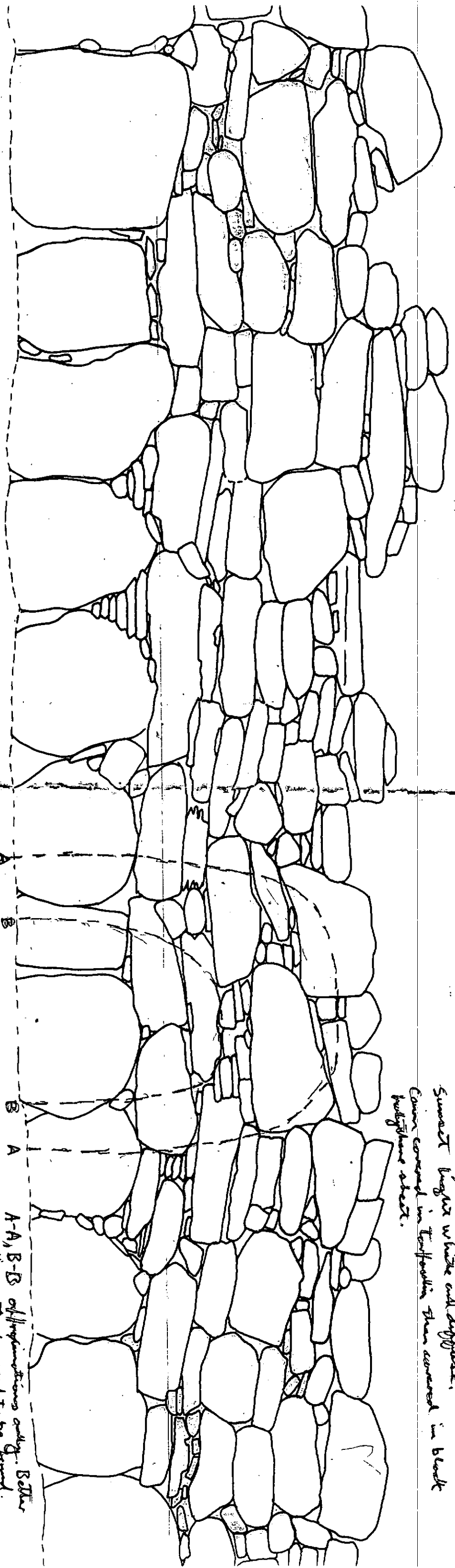


OUTER
KERR

100

Diagram 3

PHOTODUPLICATION



NE Cairn Bohannon
Observations on 22nd December 1997
Naim Valley filled with mist
clear sky.
Sunset lighter white and diffuse.
Cairn covered in turf-like than covered in bank
hydrostone sheet.

22nd December 1997

A-A Full extent of 1st cairn on near wall of chamber
B-B West illuminated area

White light from sun observed but mist did not burn out
in the stone, mist was sparkle observed from gully
on the 20th December 97

Experiments started 14.45
completed 15.50

A-A, B-B of alignments only. Both
reaching upwards need to be found.

Light mist? Light mist also pointing to NW then in 2000C down
Sun near side pointing to NW then in 2000C down
This was A-A B-B are developed to left.

White light from sun observed but mist did not burn out
in the stone, mist was sparkle observed from gully
on the 20th December 97

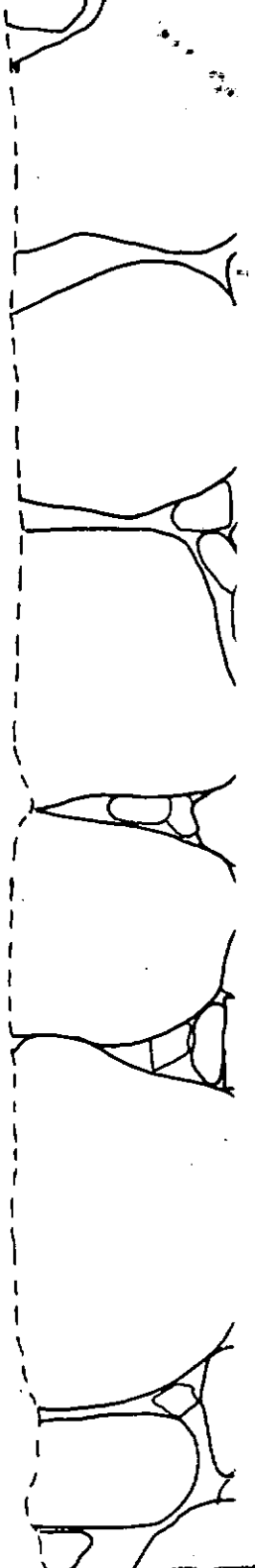
Sun's at times almost clear of mist early on before
it reached horizon. At these times a sparkling light
area of light was seen with the inner edge of passage
illuminated rear wall of chamber A-A. Working of
some light could also have taken place pointing
down the passage but this change in direction of the
chamber where it enlarges (see sketch)

↑ Kinks in line of passage appear to be deliberate
and smallest appear to be rough along the line of
stones of the inner part of alignment.

Smallest appears to run parallel to the surface.
C/A (changes in alignment of passage) appear to be significant

Entrance

Chamber



SW Cassia Bahadur
 12.1.98 R.S.
 Experiment with Trench as requested

(From Protoplasts, not mechanically accurate)

