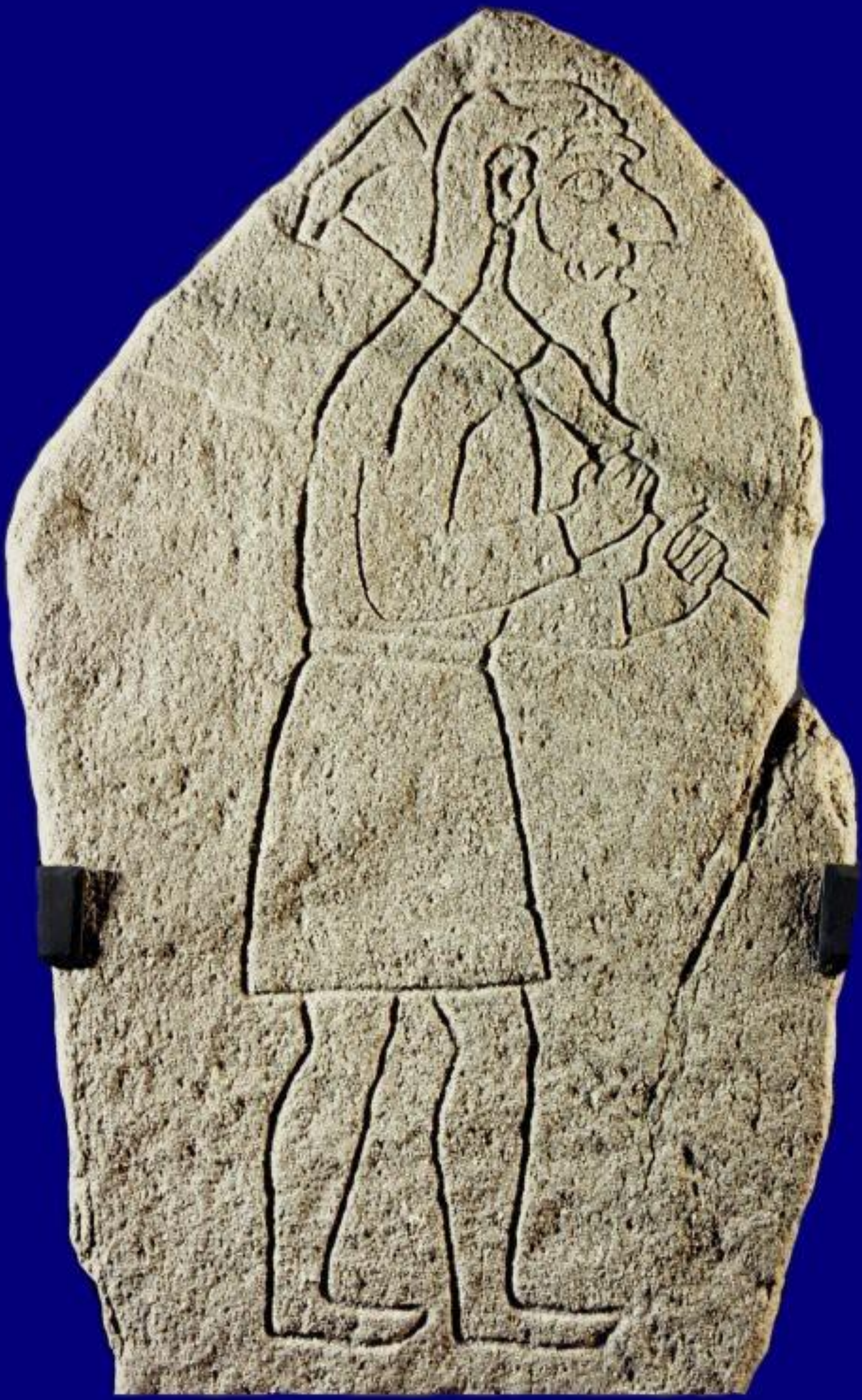


Image 1 Pictish stone known as the Rhynie Man Stone found buried face-down in a field in the village of Rhynie, Aberdeenshire. Here is a man carved on a six-foot tall stone hiding the plans of an Ancient Telescope. Perhaps one of the most important ancient artefacts and greatest works of art ever found.

The Search for a Pictish Telescope

The Rhynie Man stone was found whilst ploughing a field in 1978 at Barflat in the village of Rhynie, Aberdeenshire and currently stands at the reception to the council building of Woodhill House in Aberdeen. The carving is well preserved probably due to the fact that the stone had toppled face down and become buried by topsoil so that only limited weathering of the carved surface occurred over the many centuries it lay buried. The Rhynie Man stone is unlike most of the other Pictish Class I stones as its surface is carefully finished to a high degree of flatness and smoothness and it depicts a single human figure. The figure himself is rather intimidating, not a handsome or rugged warrior, but a peculiar ugly peasant figure. The carved stone depicts a kilt-clad, balding man or tonsure hairstyle with ferocious teeth and a big hooked nose carrying an axe over his shoulder. Who was this strange and slightly menacing figure? Considering the elegant artistry of the other Pictish animal symbols, this is an unlikely representation of a god-like or even human figure. What on earth could this strange stone fellow tell us? Surely if this man was an astronomer, he would have had a telescope over his shoulder and not an axe.

Looking at the Class I Pictish stones we found that a common way of hiding images of the Great God, the Cat-Head god guardian of the winter Sun, otherwise identified as the constellation of Capricorn, was to carve a half-image of a cathead cleverly concealed as part of the design of one of the Pictish Symbols. The Cathead image could only be seen for what it was when a mirror was used to reflect the unnoticeable half-image carved pattern in an axis to complete the image of a cat's head. Looking at the carved image of Rhynie Man we wonder where an axis might be drawn to produce a reflection that transforms the image of a strange man into something else. Similarly, Crom Dubh the god of the start of the Pictish year at the beginning of winter was likewise hidden in the Pictish symbol of the flower, or kelp that when reflected produced an image of Crom Dubh as a menacing crooked stack of seaweed with eyes representing the constellation of Crater and heralding the beginning of winter festival of Samhain.

Rhynie man has a very large nose and has very sharp teeth, teeth unlike that of a man, the teeth of a cat perhaps. A vertical axis serves the purpose of cutting the man's nose down to size and when the left side of the carved image is reflected in this axis, the man's head is transformed into that of a lion or lioness where the strange human teeth now appear more at home in a feline mouth. But something else happens where the space between the man's body and the axis, when reflected, takes on the form of a woman's body, with a long dress and rounded hips. The left hand and arm of Rhynie Man takes on the appearance of a belt around the reflected woman's waist. There is even the hint of the shape of a vulva beneath the dress formed by shallow indentations carefully carved in the otherwise flat stone surface, subtle marks which may be coincidental or lightly made for this purpose. Finally, the line of Rhynie Man's beard when reflected in the vertical axis takes on the form of a Pharaoh's beard aided by the curved tip of his own beard to complete its form.

Rhynieman is thus transformed into the Ancient Egyptian lion-headed goddess Sekhmet. How a stone found in Scotland with the carved image of what seems to be a local man has come to also have a concealed image of an Egyptian goddess carved on the stone is a mystery. But if we can find Sekhmet carved in such unusual circumstances then perhaps there is hope in our search to find a concealed telescope.

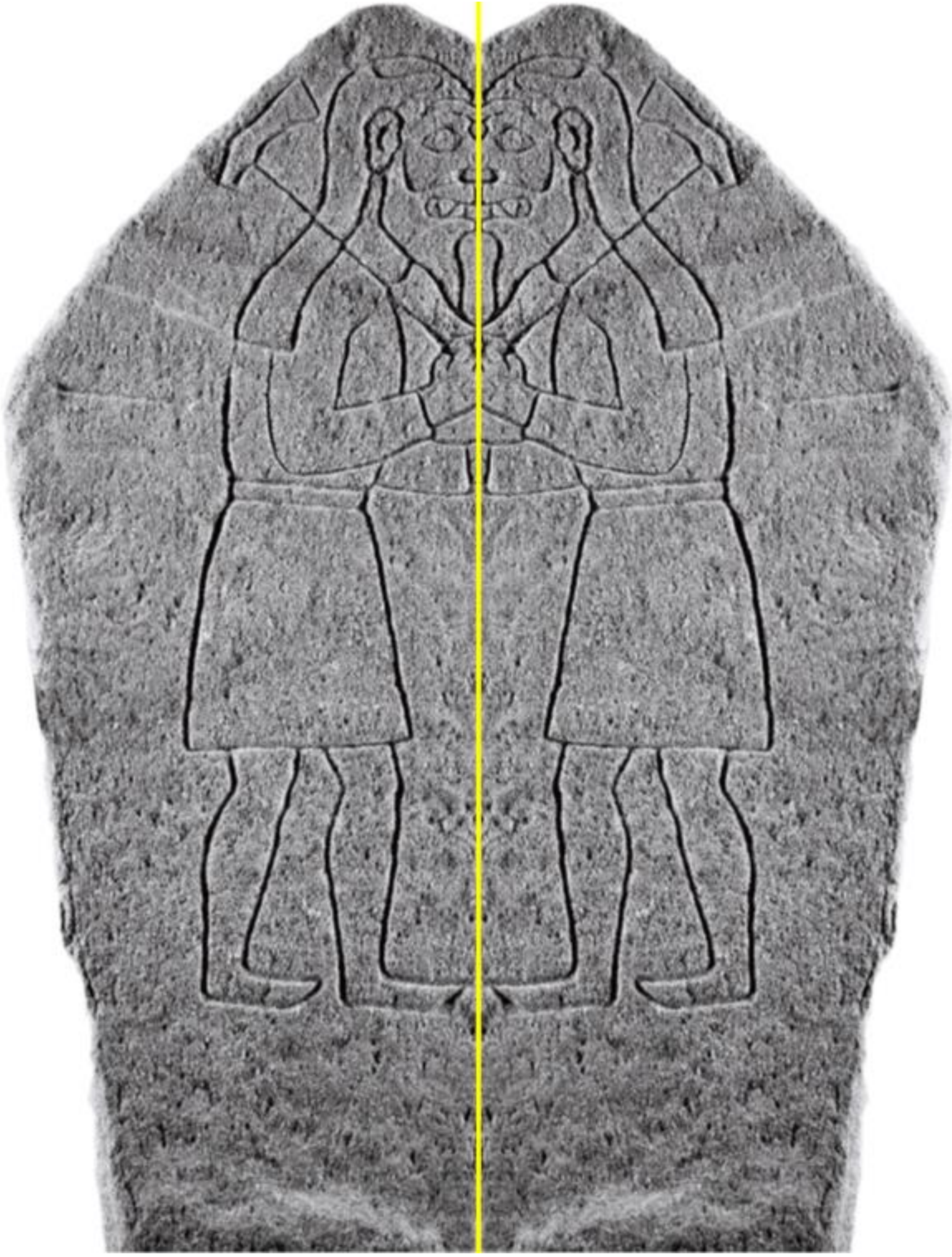


Image 2 Axis of reflection changes Rhynie Man into Rhynie Woman. A faint image of a deer's head is also apparent just beneath the belt

Image 3 Reflection in the vertical axis cutting through Rhynieman's nose, touching his lips and tip of his beard creates the image of a female with a lion's head otherwise known in Ancient Egypt as the goddess Sekhmet. The surprising connection with Egypt is supported by the appearance of a pharaonic beard.

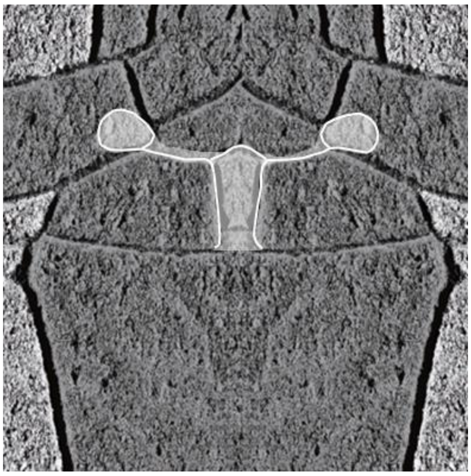


Image 4 Lightly carved womb to confirm the transformation of Rhynie Man into the female deity Sekhmet

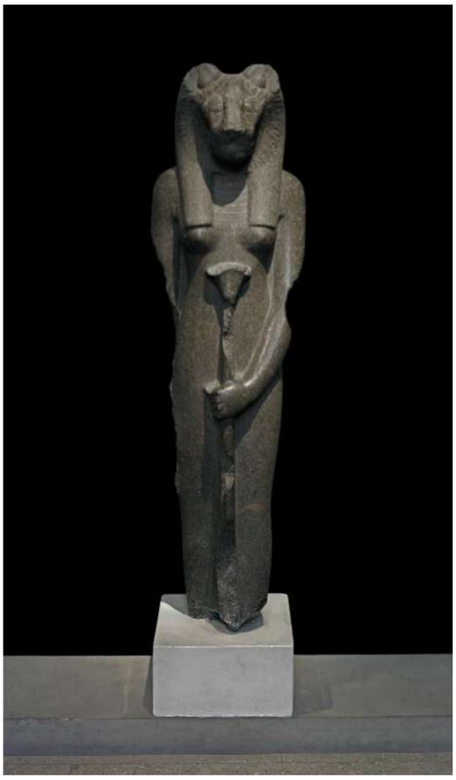


Image 5 Statue of the Ancient Egyptian Goddess Sekhmet in the British Museum

The next step is perhaps to find another axis which can be used to form a reflected image of a telescope. The carver of the stone in ancient times has left us a huge clue in the way he has carved the stone or in this case what he has omitted from carving in the stone.

Looking closely again at the image of Rhynie Man we are struck by the strange appearance of his axe which has a very long and fine shaft, consisting of a single carved line. The shaft as carved would be totally useless as an axe shaft and has the appearance of missing a line and being unfinished. This portrayal of a single line shaft however has been interpreted by others as representing an iron axe shaft that might have been used in sacrificial ceremonies, because it would be unsuitable for use for conventional chopping applications. However even an iron axe shaft would have a physical thickness which would better be represented by two closely positioned parallel lines to define that thickness however slender that may have been rather than a single carved line.

There is another consideration in that the Rhynie Man stone is considered to be a Class I Pictish symbol stone. If so then it shares a common date of carving with the other Class I stones which has been proposed by the author to have been around 1200BC based on considerations of the precession of the equinox relating to both the alignment of stars on the festival days proposed as forming a Pictish calendar and the angle of declination for deep space objects indicated by the angles of the V-Rod on the Crescent and V-Rod symbol, proposed as representing a Pictish quadrant tool. In this case the date of carving the Class I stones predates the known Iron Age in Scotland by over four hundred years (750BC-500AD).

We are left to consider that the absence of the carved line may have been an intentional device to indicate the position of an axis of reflection. If the missing axe shaft line is drawn as an axis, then the following image can be revealed.

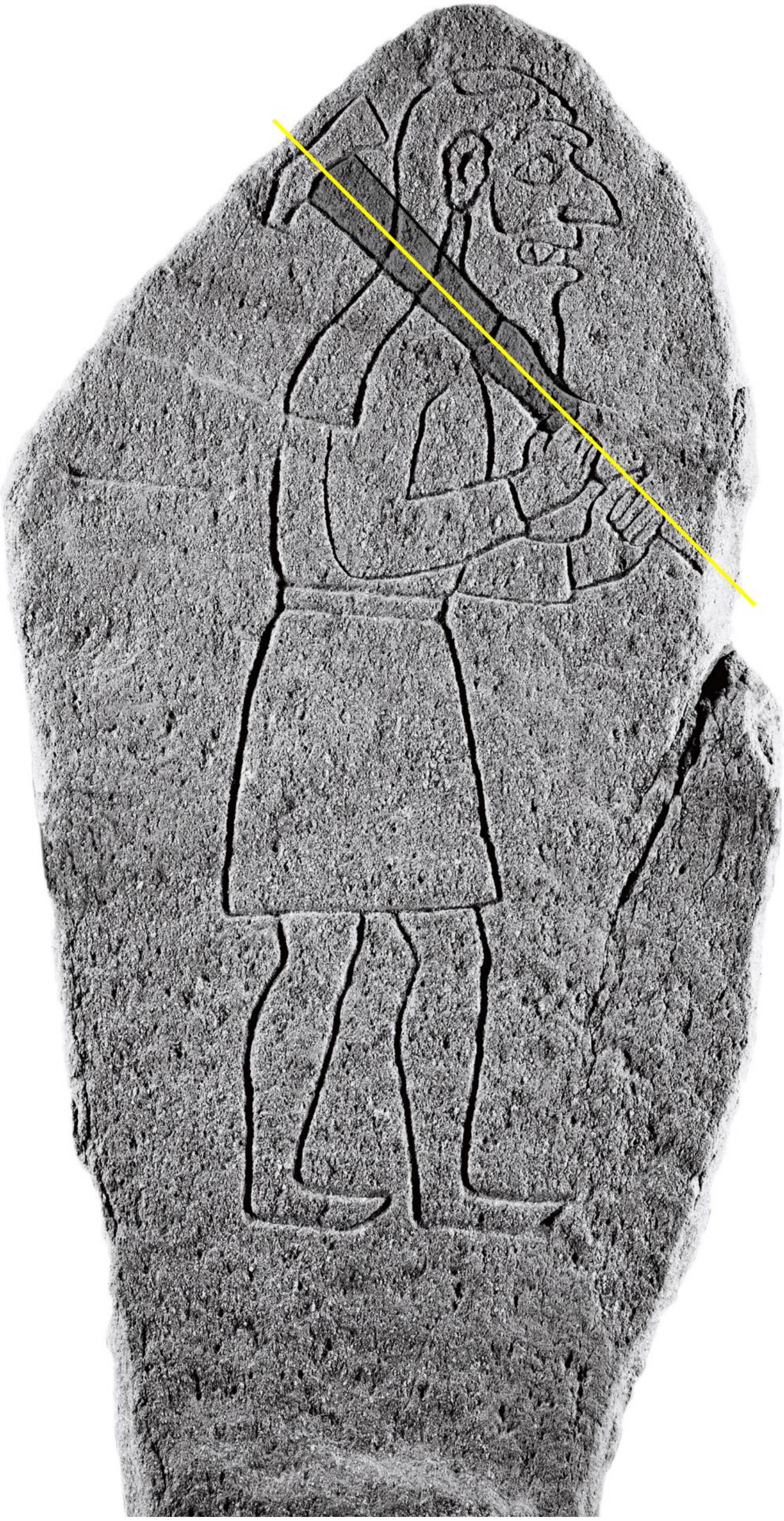


Image 6 The axis in Yellow represents the missing axe shaft carved line. The lower axe shaft line reflected in the axis creates an object (in dark grey) that has the general appearance of a refractor telescope

Could this be the concealed telescope we were looking for? It seems a little too convenient that a refractor telescope is revealed so easily but there is a bigger issue namely the telescope revealed is more akin to a terrestrial telescope than an astronomical telescope. A small refractor telescope in itself would be a remarkable discovery as the idea of a terrestrial telescope being available at the time the Pictish stones were carved would represent a very significant technology before its time. However, a telescope of this size would have insufficient magnification and light gathering capability to be able to view deep space objects such as galaxies and nebulae and being able to allow their appearance to be faithfully represented in stone. The idea that we are actually saying that we are looking for a telescope powerful enough to view nebulae hidden on a stone carved around 1200BC does sound like something that would be immediately dismissed as complete nonsense by any self-respecting archaeologist, or astronomer for that matter, but then again without the discovery of the physical remains of the Antikythera mechanism, the same would have been said about the suggestion of a geared mechanism that could describe the movements of the planets in the solar system and predict not only solar and lunar eclipses in the future but also the apparent colours of the eclipses as being red or black in a device now recognised by academics as being "the first computer" made 2000 years before the time when geared clocks are believed to have first been constructed.

Antikythera geared wheel artefact

Perhaps there is more mileage to be had from the missing line axis of the Rhynie Man stone. Whilst we have reflected the carved lines below the axis upwards in the axis there is also the possibility of reflecting the carved line above the axis downwards in the same axis. When we do that, we obtain the following reflected image.

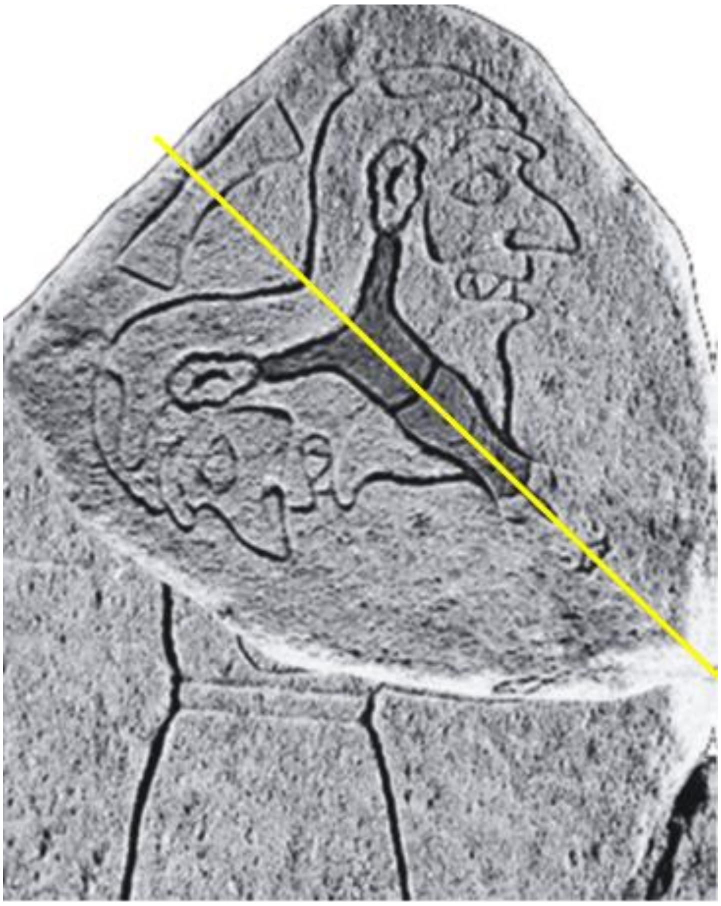


Image 7 obtained by reflecting Rhynie Man's beard and hairline in axe shaft Axis B.

The image obtained in dark grey taken together with Rhynie Man's "ears" has the vague appearance of fallopian tubes. However, looking at the grey shaded area, what looks like the sliding eyepiece of the previously revealed refractor telescope is seen again but now attached to a short section of tube that flares out to form a curved end. The shape is reminiscent of the eyepiece of a different sort of telescope, namely a reflector telescope that relies on mirrors to produce an image that is focussed at a small lens in the eyepiece. Unfortunately, this only represents a small part of a telescope and without the other parts of the telescope the appearance of the eyepiece can be considered as nothing more than coincidental. It is also interesting that the curved line denoting the underside of Rhynie Man's axe forms a circular arc which when combined with the circular arc opposite it, from Rhynie Man's hair line has a circular form and together with the area shaded grey might be interpreted as a mirror but not the mirror we would need in order to form a reflector telescope.

In order to find the other components of a telescope of the complexity of a reflector telescope, would require other axes of reflection and at first sight it seems unlikely that there could be hidden axes that might be found, at least not in the same obvious way as the missing axe shaft axis was suggested. However, when we look more closely, it can be seen that Rhynie Man's nose and end of hair create near straight lines that form two parallel lines that intersect the diagonal axis at the axe head and the left thumb of Rhynie Man's left hand. When drawn on the image of Rhynieman, the three possible axes form a mirror-image "Z". Whilst this may not seem particularly significant to our way of thinking, the mirror image "Z" in Pictish symbology was very important as it represented the “Z-Rod” symbol, a bent Z-Shaped Pictish spear with its characteristic apple shaped terminal that was the representation of a ceremonial compound pendulum that allowed the different pendulum lengths used by the Picts to measure both time and length to be represented in one device by suspending the Z-Shaped pendulum from a series of hooks at the spear end of the pendulum.

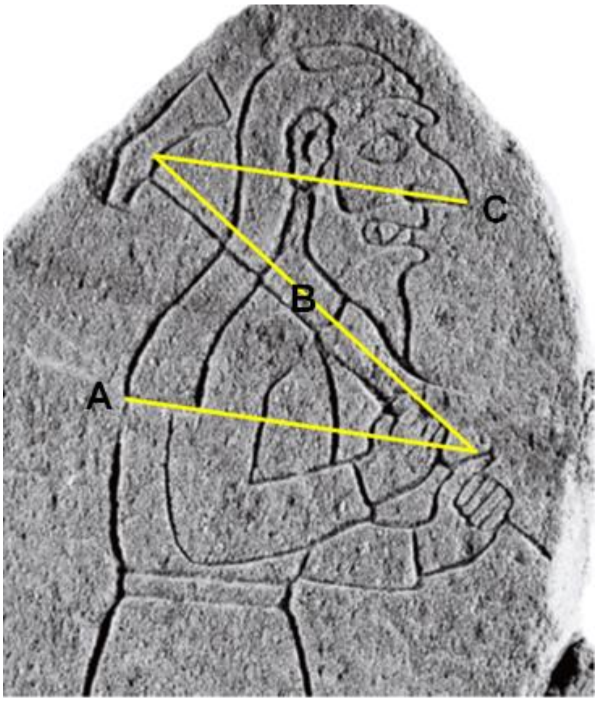


Image 8 The missing carved line on the Axe handle forms a Z-shape when Rhynieman’s nose and end of hair are considered which is reminiscent of the Pictish Z-Rod symbol. Three axes labelled as A, B and C forming a Z-Shape

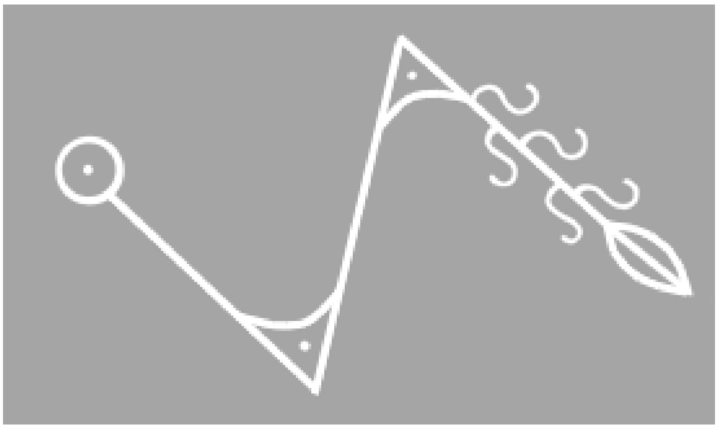
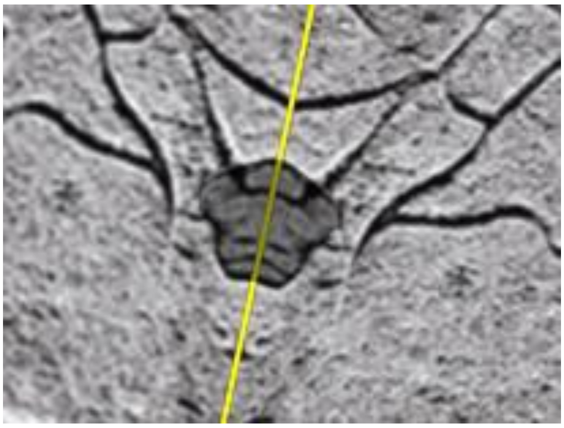


Image 9 The Pictish Z-Rod Symbol is usually found in combination with either the Double Disc, the Serpent or the Notched Rectangle symbols which are believed to represent the constellations of Cetus, Draco and Vela respectively which have star pairs that are separated by Hour Angles that can be used to calibrate the Pictish pendulums; the Z-Rod being a compound pendulum that can oscillate at the required periods for several of the important pendulum lengths by suspending the Z-Rod on each of the hooks present at the spear-head end; in the case above, 5 different hooks where the effective length of the pendulum is the distance between the point of suspension on the hook and the centre of gravity of the very heavy bob, that may have been lead filled.

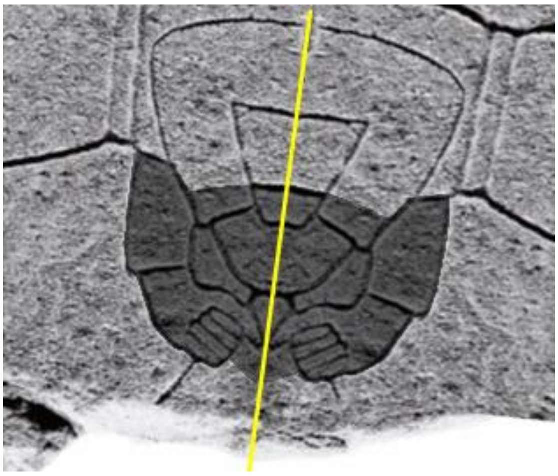
Determining whether such a series of three axes was intentional and the precise position for each axis of reflection intended by the stone carver is subjective but we have the diagonal axis and the other two axes are parallel with each other to guide us. However, before looking at the images produced by reflections in the three axes, there may be another clue to help support the idea that they were both intentional and that their positions can be established by the secondary guiding images that reflections make when the axes are correctly aligned. It has already been seen how cathead images can be revealed by reflection in the Class I Pictish stones and again Cat heads and Snake heads have been used as a device to show the precise intended position of axes of reflection when looking for the component parts of the telescope, consisting most critically of curved mirrors and a small lens for the eyepiece. That is because when the axis is correctly located, a reflected image of a cathead and/or snakehead will be revealed whose appearance looks “right”.

A snake’s head appears out of the stone when Rhynie Man’s right hand is reflected downwards in Axis A whilst a Cat’s head appears when his left hand is reflected upwards. The snake, ancient symbol of wisdom and knowledge and capable of a fixed stare was a perfect indicator of where to make our axis of reflection but this is confirmed when the opposite reflection is made in the same axis which produces the image of what looks like a cat’s head when the other side of the axis is reflected in the mirror.



A

Image 10 Snake head which appears from the reflection of Rhynieman’s fingers on his right hand when reflected downwards in Axis (A). The shaft line cutting across Rhynie Man’s Right thumb forms the snake’s eye.

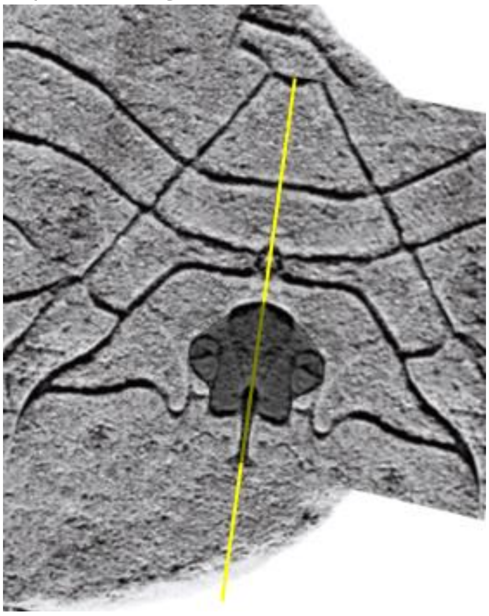


A

Image 11 Cat’s head which appears from the reflection of Rhynieman’s left hand and arm together with the space between his hands and his right wrist upwards in Axis A.

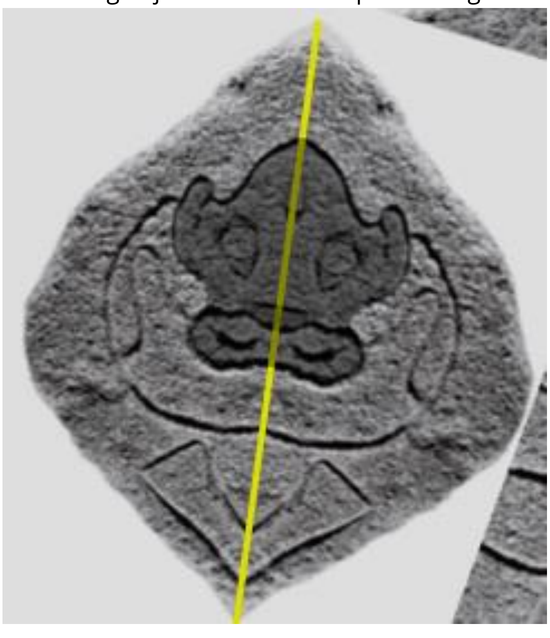
This way of revealing images of what appear to look like a snake's head from a reflection in one direction and a cat's head in the opposite direction is a clever device for establishing the precise position of the axis of reflection because it only works to give both those identifiable snake head and cat head reflections within quite narrowly defined limits.

Looking at the top Axis C representing the "horizontal" arm of the "Z"



C

Image 12 Reflecting Rhynie Man's mouth area upwards in Axis C produces a snake's head complete with forked tongue just to confirm its precise alignment.



C

Image 13 Reflecting Rhynie Man's Eye, bridge of his nose and ear downwards in Axis C produces what looks like a lion cub's head

It appears therefore that we have two parallel approximately horizontal axes whose positions correspond to the bottom of Rhynie Man's nose and the bottom of his long hair. When reflections in each axis are made in both directions an image that appears like a snake's head and another that appears like a cat's head is produced for each axis.

The third axis is the original axis, the diagonal section of the "Z-rod" formed by the three axes which was indicated by the fact that it was a missing carved line, a line that would complete the carved image of the axe shaft held in the hands of Rhynie Man but carved only as a single line.

Having established three possible axes it is now possible to see what images appear when the carved areas below and above each axis are reflected in each axis in both directions.

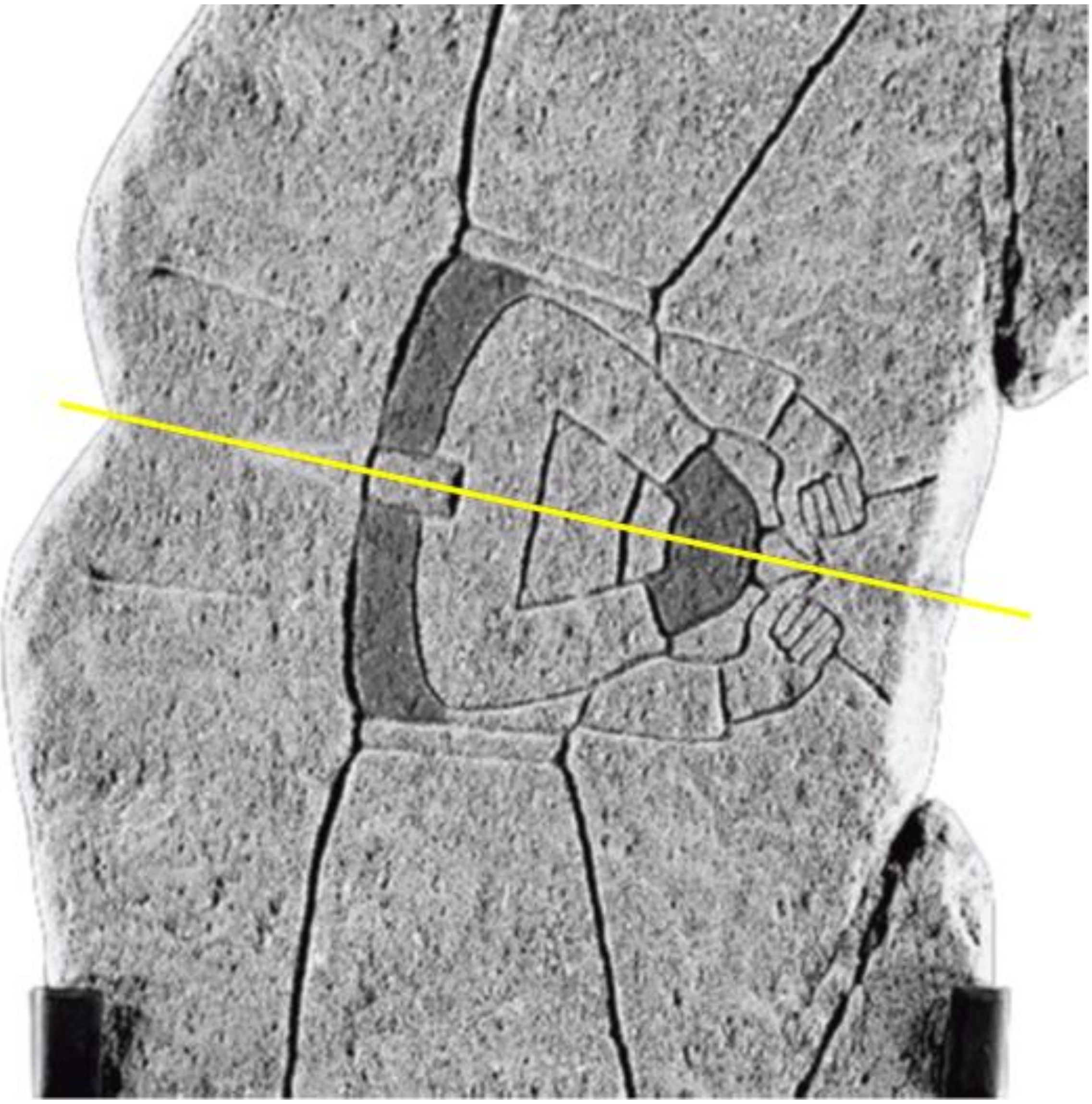


Image 14 Reflecting this elbow curve upwards in Axis A gives us a well-defined curve that is a parabola and perfectly suited for use on a reflector telescope as the primary mirror.

The actual curvature is analysed later and its focal length calculated. Furthermore, there is a vague appearance of a sort of hole and tube formed from the end of the man's hair sitting in the central hole. This happens to also be a design feature shared with some modern reflector telescopes where the eyepiece is located beneath the primary mirror.

To find the secondary mirror we now need a smaller, curved mirror that can reflect incident light from the primary mirror down through the central hole and tube in the primary mirror to an eyepiece located on the other side, below the primary mirror. This secondary mirror would be expected to be positioned centrally above the primary mirror. We notice that the heel of the hand of Rhynie Man has a curve that produces a convex curve when reflected in the same axis of approximately the right size and at the correct approximate distance from the primary mirror.

When we reflect the carved lines above Axis A downward, we obtain what appears to be a bowl to contain the primary mirror and also what appears to be a snake's body and head. In this case we can imagine a bowl consisting of perhaps three snakes wound around the bowl with their heads sitting out proud beyond the bowl. Perhaps the heads could have been made from bronze to give weight and stability to the telescope. The interpretation of the bowl consisting of three entwined snakes is one possible design for the telescope and is appropriate given that snakes can remain motionless and stare unblinkingly at their prey and symbolised wisdom and knowledge. The reason for suggesting that there may be three snakes is that their tails may have been the way in which the secondary mirror was supported above the primary mirror and three supports gives the best way of balancing and holding a mirror whilst minimising the area of shadow created on the mirror by their presence.

Image 15 Scottish Adder. Note the similarity of the black head markings with the shape made by Rhynie Man's hairline

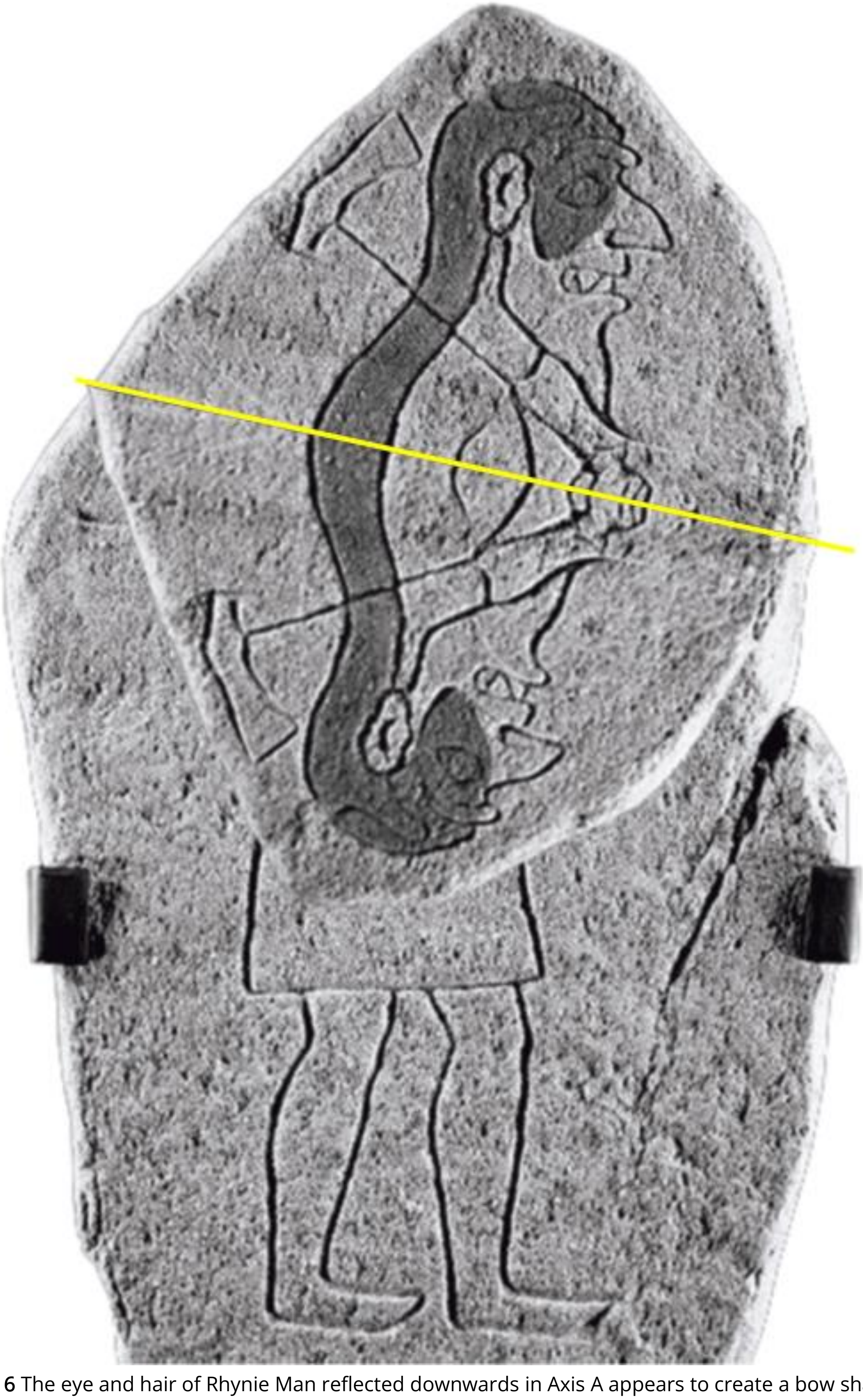
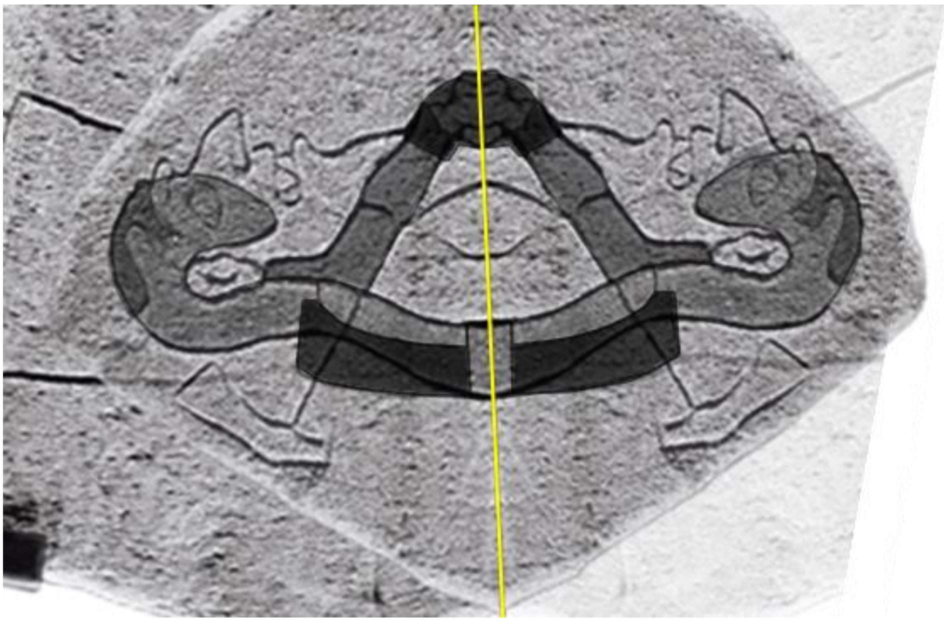


Image 16 The eye and hair of Rhynie Man reflected downwards in Axis A appears to create a bow shape that can be interpreted as a bowl with what appear to be snakes decorating it



A

Image 17 Composite reflections in both directions in Axis A revealing possible parabolic primary mirror sitting in a bowl with a secondary curved mirror suspended above the primary mirror

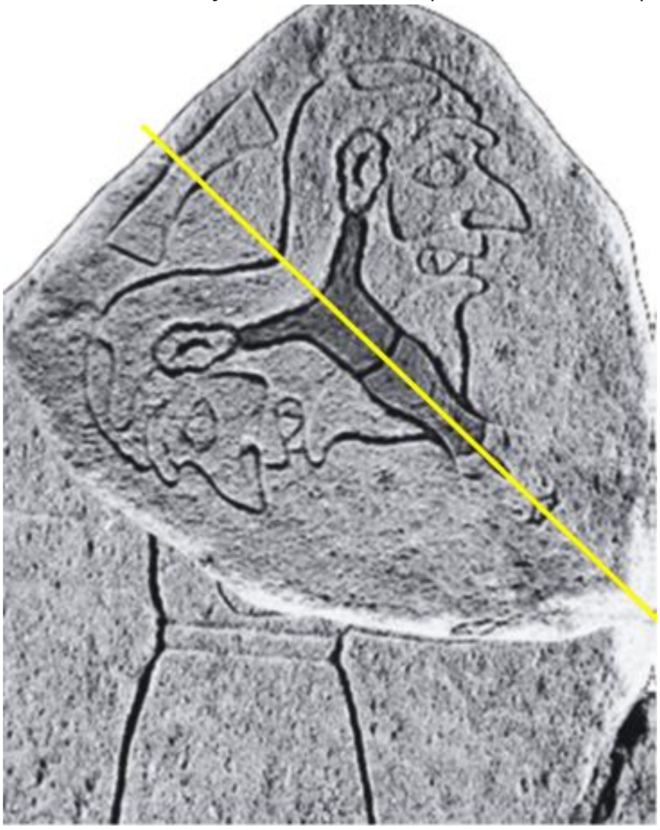


Image 18 Diagonal Z-Axis Reflection from above to below produces what looks like an eyepiece with a possible sliding sleeve containing the lens for focussing

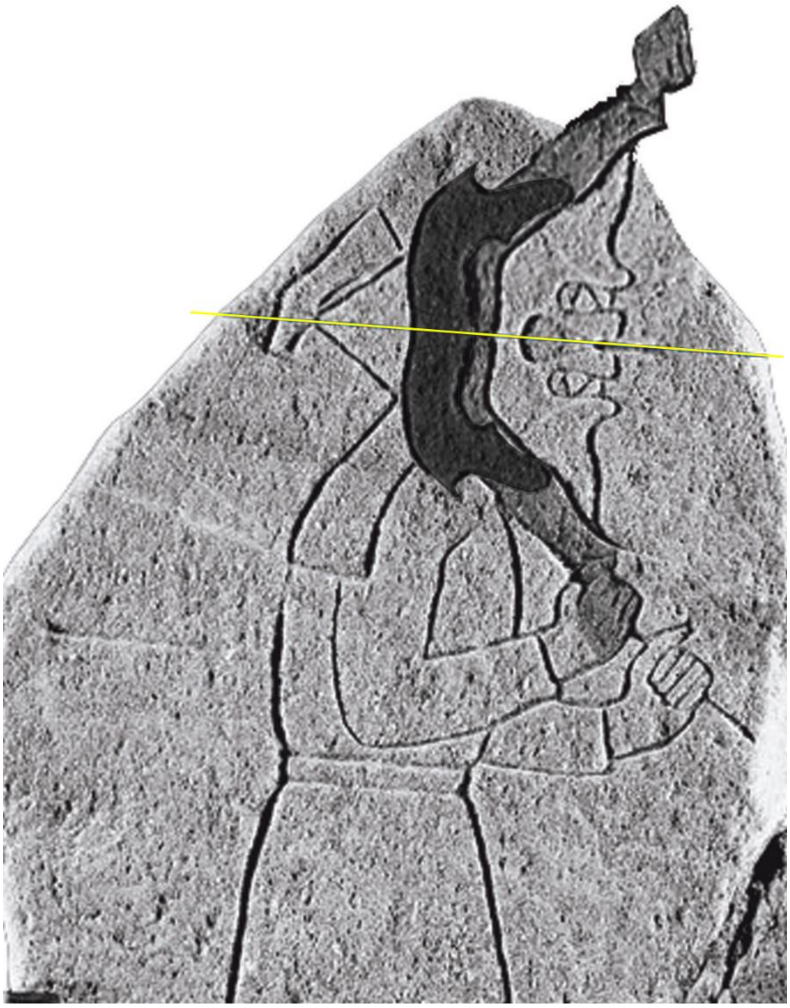


Image 19 Upper Axis A Reflection from below to above gives rise to Horse legs and horse heads that may have formed a stand or tripod to support the telescope.

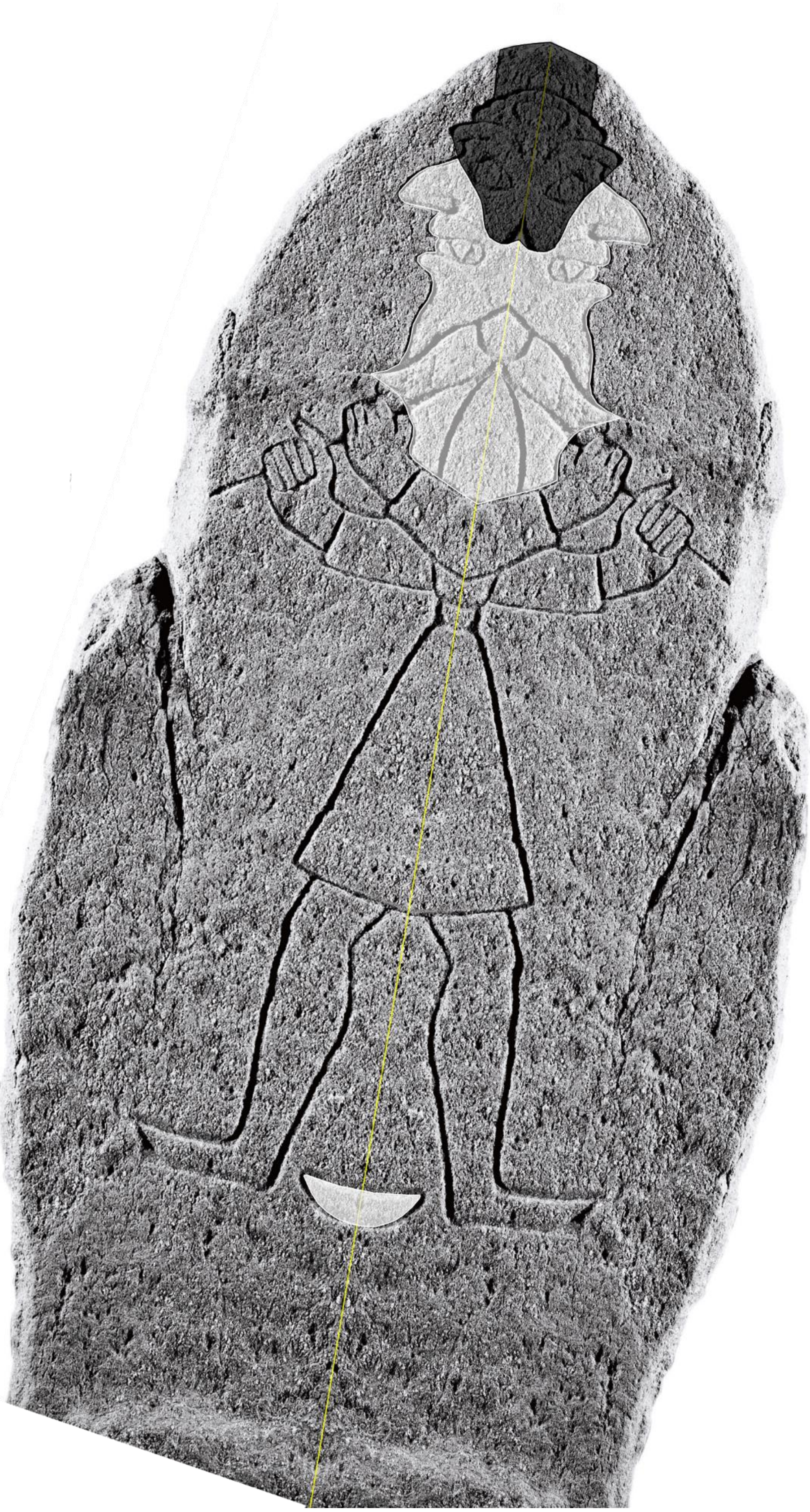


Image 20 Axis that produces a Lion's head (in white) and Snake's head (dark grey) above, that reveals an enlarged curved object that might represent either an eyepiece lens or the secondary mirror from Rhynie Man's right foot as the curvature of the central area of the curve corresponds to a hyperbola.

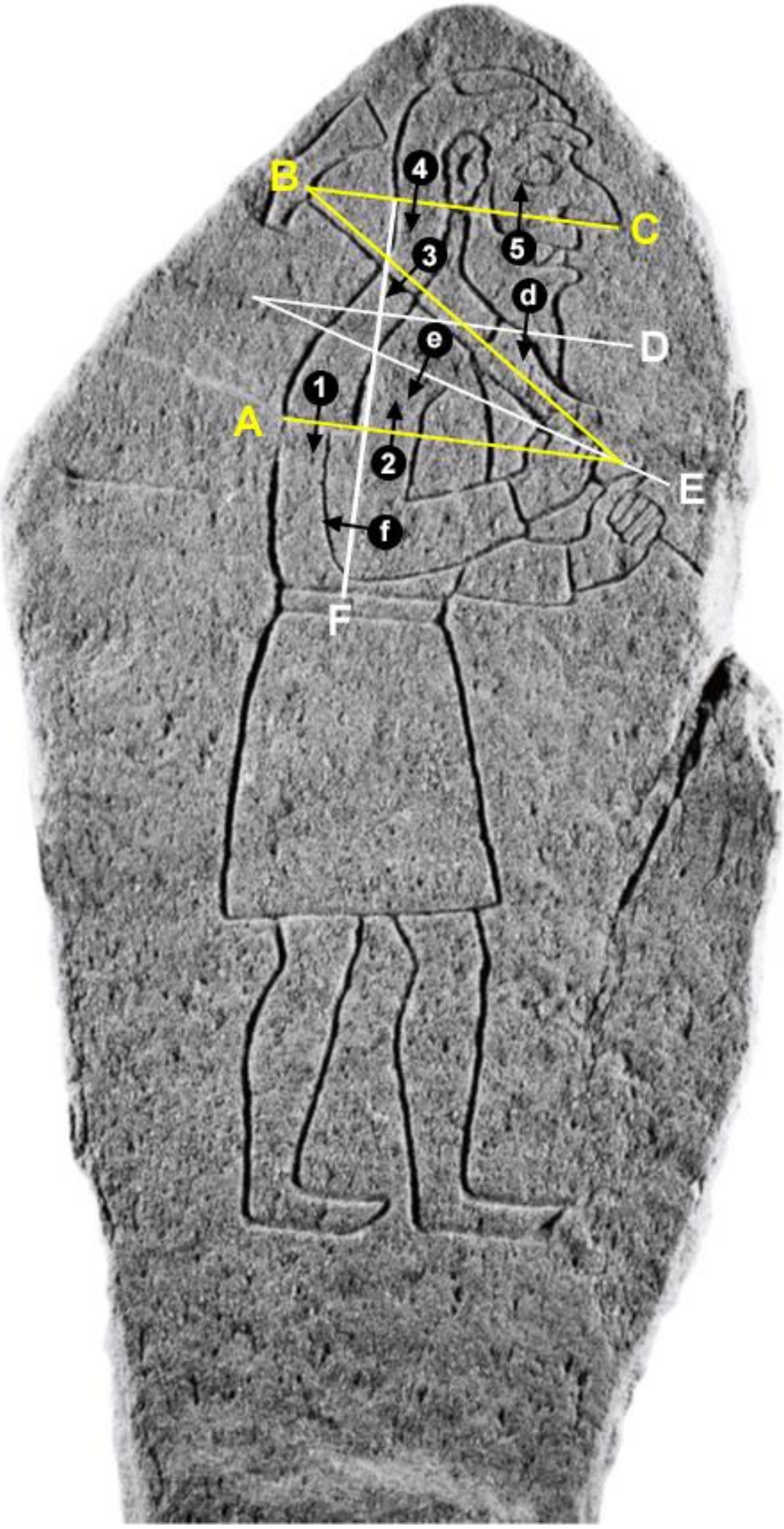


Image 21 There are three main axes of reflection shown in yellow as A, B and C which adopt the shape reminiscent of the Z-Rod Pictish Symbol. These three axes allow the component parts of the reflector telescope to be revealed by carrying out reflections in the axes in the directions shown by the black arrows 1-5.

The three white lines are axes labelled D, E and F which allow the optical components revealed by the reflections in A, B and C to then be reflected in these secondary axes to assemble the components together to form a functioning reflector telescope.

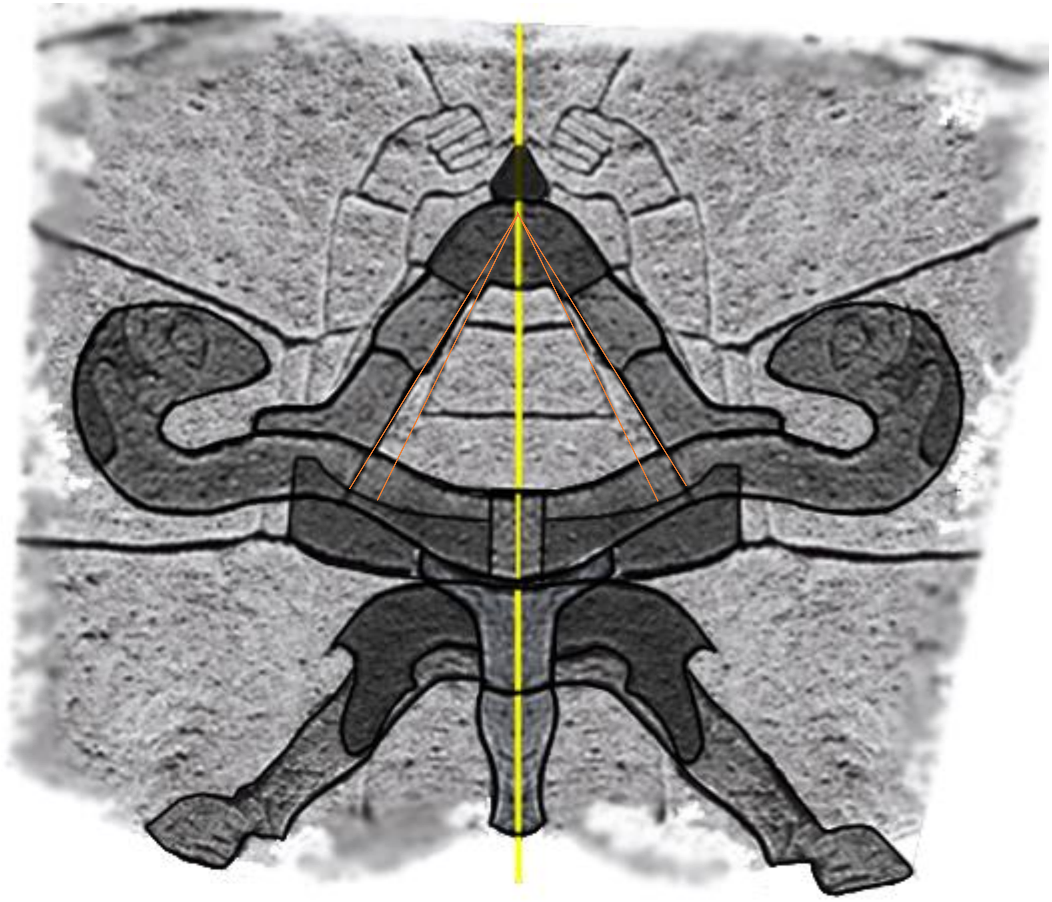


Image 22 Combining the reflected images from axes A, B and C we obtain an image of what may have been an ancient Reflector Telescope which remarkably despite its zoomorphic form, shares its arrangement of optical components with a modern Cassegrain Reflector telescope which consists of a parabolic primary mirror and a secondary hyperbolic curved mirror positioned above, which then focuses light through a central hole in the primary mirror to the eyepiece lens situated beneath the mirror assembly.

Locations where Pictish Symbol Stones bearing the Image of a Man have been Found that may Hide the Plans to Pre-historic Telescopes

To find or some may say manufacture a reflector telescope from multiple reflections using a mirror may be a step too far for many. However, there are a few other Pictish stones such as the Bullion stone from Dundee, the Collessie stone from Fife and the Golspie stone in Sutherland where the figure of a man has been carved on megaliths and maybe if they also can be shown to conceal the plans for a telescope in a similar way to the way in which it was revealed on the Rhynie stone from Aberdeenshire, using the same devices then that would help to support the idea that the presence of what looks like a reflector telescope is not coincidental or something that has been made to appear by someone wanting to find a telescope by whatever means necessary.

The Bullion Stone Telescope

Image 23 The Bullion Stone, found just outside Dundee at Invergowrie in 1933 whilst digging a road is now on display in the National Museum of Scotland in Edinburgh.

Like the Rhynie Man, Bullion Man also has a large nose but his is hidden inside his large drinking horn decorated with an eagle's head. He is somewhat comically gross in appearance, which perhaps is only right in a stone carved in Dundee; the home of the Beano and Dandy comics, but ugliness is truly only skin deep and when this stone is properly observed it again shows us its secret plans that are so cleverly concealed. It is as if our ancient ancestors are playing a game with us, their distant simple descendants, who have failed to see what was under our noses all along. When we reflect the simply carved images, the reflected images reveal incredibly beautiful multiple images in complete contrast with what appears at first glance to be nothing more than a rudimentary comical image. As with the Rhynie stone, where we found that a simple reflection transformed Rhynie Man into Sekhmet, we can find an axis of reflection which converts the drunk man on a horse into an entirely different image. In this case, the Bullion Man has already had his nose cut off by his drinking horn and as if to celebrate the difference with this stone in not using this device that was used for the Rhynie stone and the Golspie and Collessie stones, the stone carver from Dundee instead chooses to cut off the horse's out of proportion "long nose" with an axis that runs along his reins. A hidden image of the mythical Cauldron of Plenty is revealed by reflection in this axis. A reflection in the axis along the (unusually straight) reins reveals the cauldron of plenty, famed in Celtic mythology, this cauldron seems to replicate the idea of the horn of plenty, the rider is drinking from, but in this case the cauldron has two horses boiling away in it, as the back legs of the horses are sticking out of the cauldron! The cauldron is on a fire with the sticks of the fire represented by the front legs of the horse whilst the right leg of the rider may represent supports for the cauldron. One final amazing astronomical touch is that this so-called cauldron is actually a representation of the constellation of Coma Berenices. The cauldron decorated with what looks like an eye, as we will show later probably represents the "Black Eye Galaxy" of Coma Berenices. Furthermore, the almost comical position of the horse's legs, sticking out of the cauldron, incredibly coincides with the appearance of a twin galactic collision that has created a deep space image very similar to the horses back legs that is now known as NGC 4676, "The Mice". The presence of this remarkable hidden image revealed by the use of the mirror confirms that using a mirror on this stone is a reasonable operation to reveal further hidden images. This imagery is supported by the association of the cauldron of plenty with the festival of Beltane in folklore, which as we have seen, is indicated by the alignment of Coma Berenices and more specifically the stars Alpha and Beta Comae, due South at dusk on this day (May 6th around 1200BC) and when the alignment is used as an axis of reflection, allows the cauldron of plenty to be formed.

Image 24 Cauldron axis which cuts the horse's nose down to size

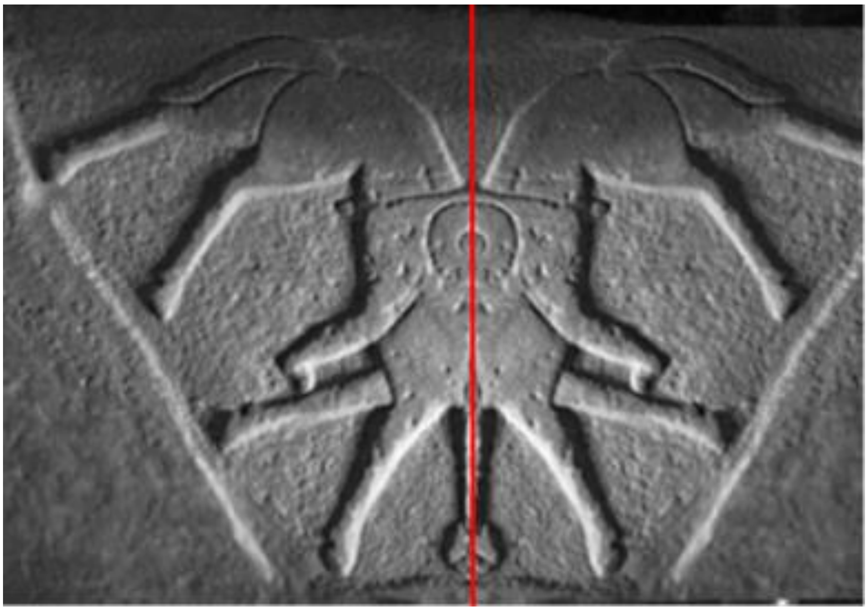


Image 25(i) Cauldron of Plenty formed from a reflection in the Bullion Stone along the horse's reins.

Image 25(ii) Carved image of a cauldon on a Class II Pictish stone from the Manse at Glamis. Whether the legs sticking out of this cauldron, in the same manner as the reflected Bullion Stone, are animal legs is doubtful as they appear to have knees and human feet.

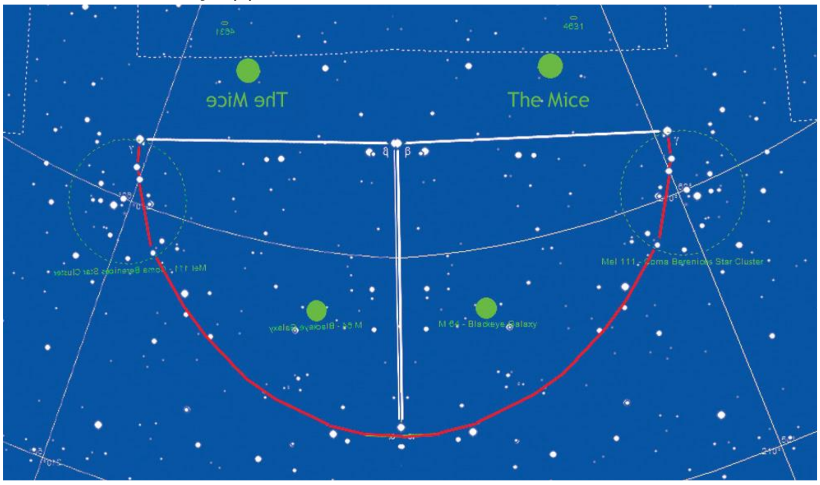


Image 26 Coma Berenices reflection along axis connecting α-β Comae

Image 27 The Mice, NGC 4676, within Coma Berenices that has the appearance of the hind leg of the horse

Image 28 The Black Eye Galaxy in Coma Berenices M64 Represented as Bullion Man’s Shield

The Bullion Stone Telescope

The Bullion stone gives us clear clues for the design of its large reflector telescope because here the dimensions and positions of the mirrors and lenses are made more obvious and their use as optical mirrors is substantiated by the presence of straight, angled finely carved lines that give us both the axes of reflection required to reveal the second half of the various mirrors and lens but also indicate the focal points of the primary and secondary mirrors. Furthermore, this telescope is truly impressive, whilst the primary mirror of the Rhynie telescope was around 10-11 inches in diameter, the Dundee telescope has a primary reflector measuring 15 inches across a potentially powerful reflector telescope at the maximum end of the size scale for a good modern- day amateur/semi-professional telescope.
The first axis of reflection “A” is shown on the image in red, this is indicated by the straight line representing the front of the rider’s arm which continues above the image as a lightly carved “scratch” in the rock. This line is our primary line of reflection and is important in that it establishes the curvature of all the mirrors and lenses. The reflection in the opposite side of the axis converts the man’s head into what looks like a snake’s head (upside down).

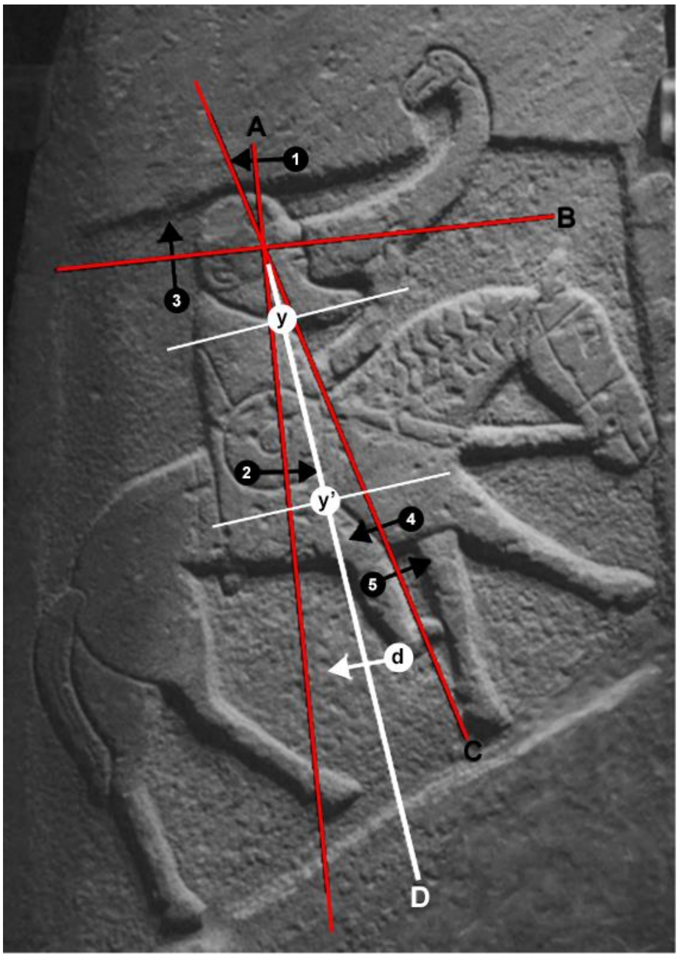


Image 29 Axes of Reflection required to transform Bullion man into Bullion telescope

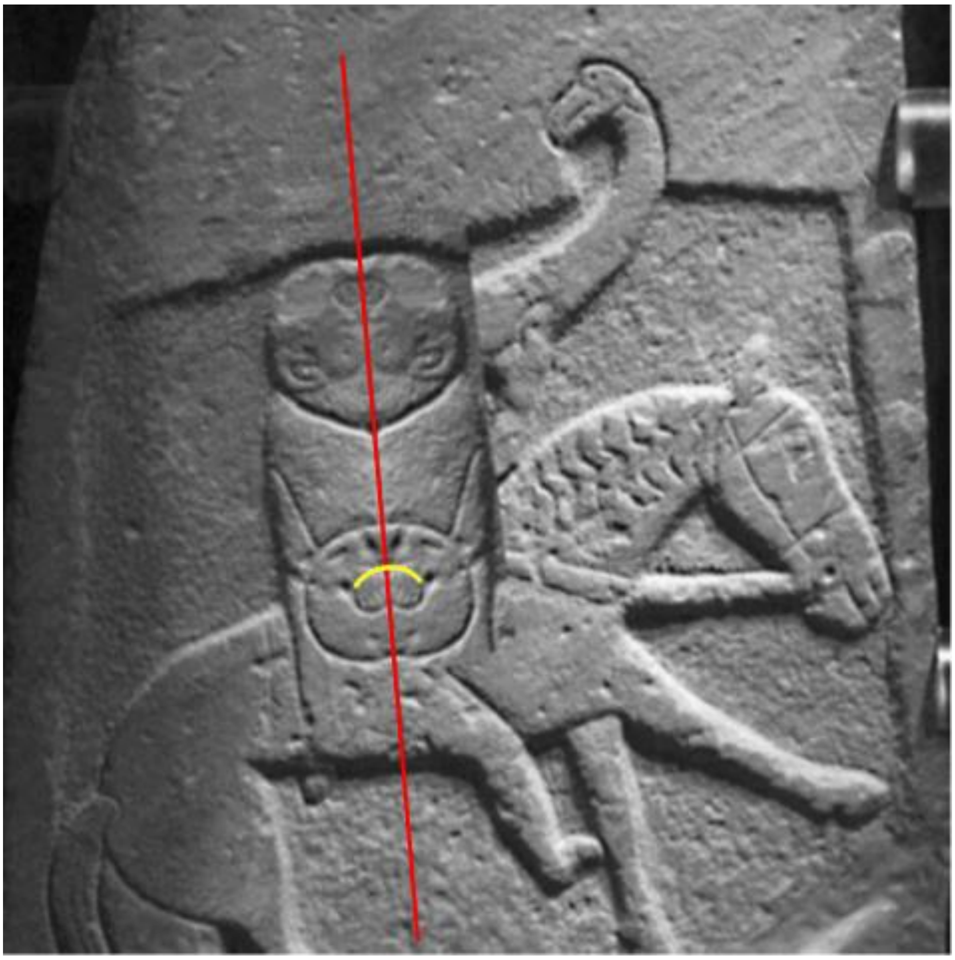


Image 30 Right hand side reflection in Axis A

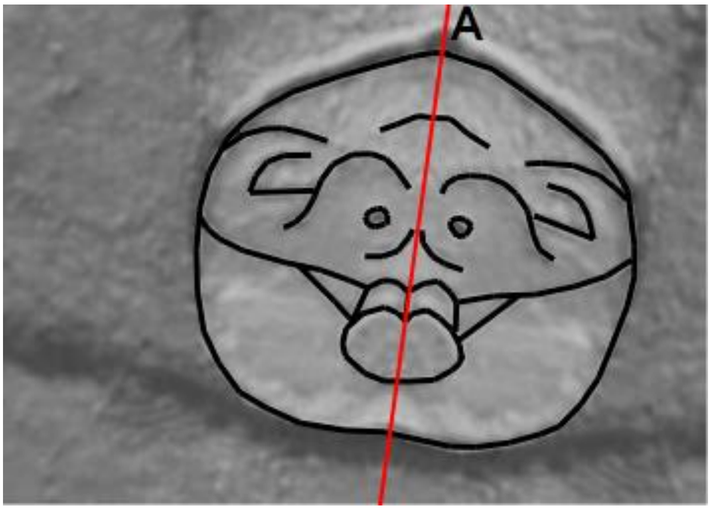


Image 31 Bullion Man's head is transformed into a snake's head when reflected in the primary axis and inverted

The Primary Mirror is now revealed (below) as the upper curve of the drinking horn and once again appears to have a centrally located hole as we would expect from a technologically advanced reflector telescope.

Image 32 Reflection of the drinking horn in the primary axis gives the primary parabolic mirror

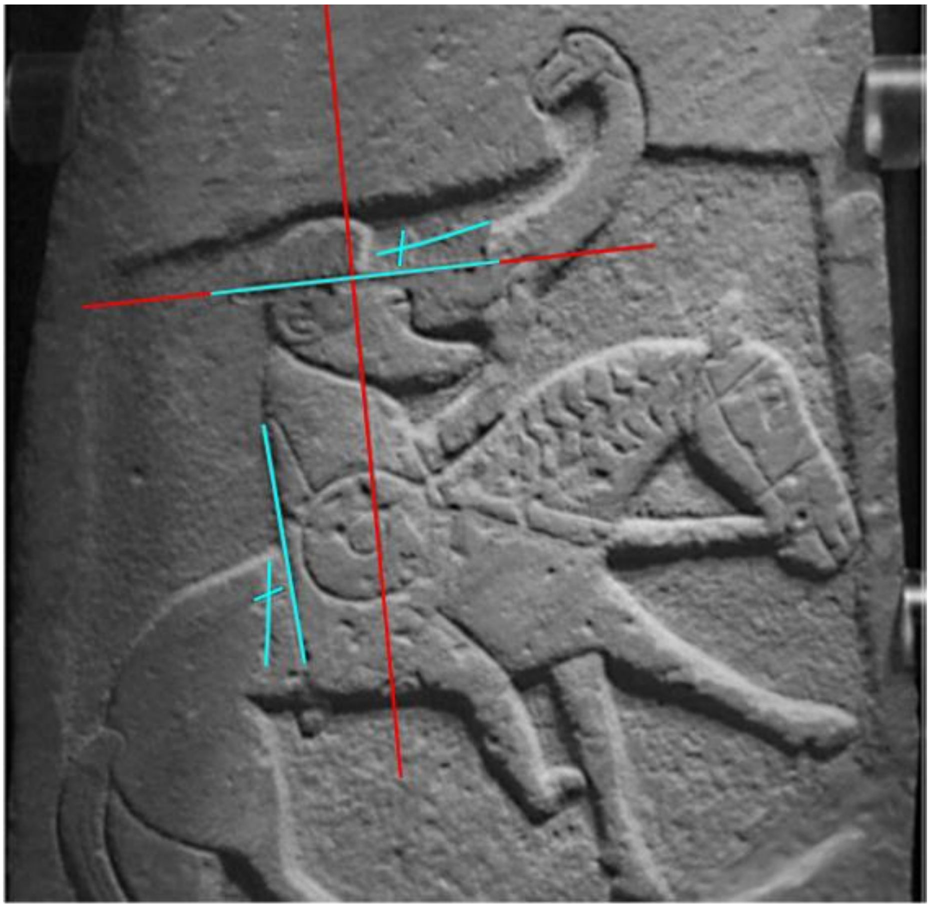


Image 33 The second axis of reflection, B is perpendicular to the first. The point at which it crosses the first axis is indicated by the straight carved underside of the rider's nose that meets the primary axis at 90 degrees. But before we go on, this position is more accurately represented by the strange markings on the horse behind the rider shown in blue. Here we see both a representation of the primary mirror's curvature and the straight-line axis of reflection.

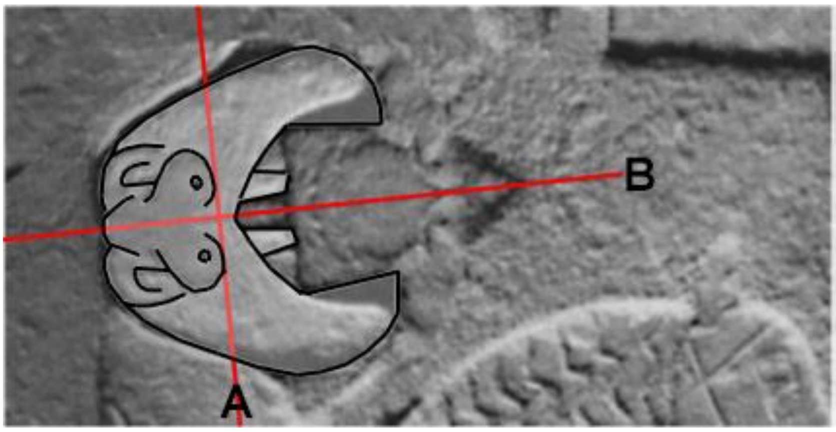


Image 34 Reflection of Bullion Man's beard and Ear upwards in the second axis B produces the head of another snake, a cobra perhaps.

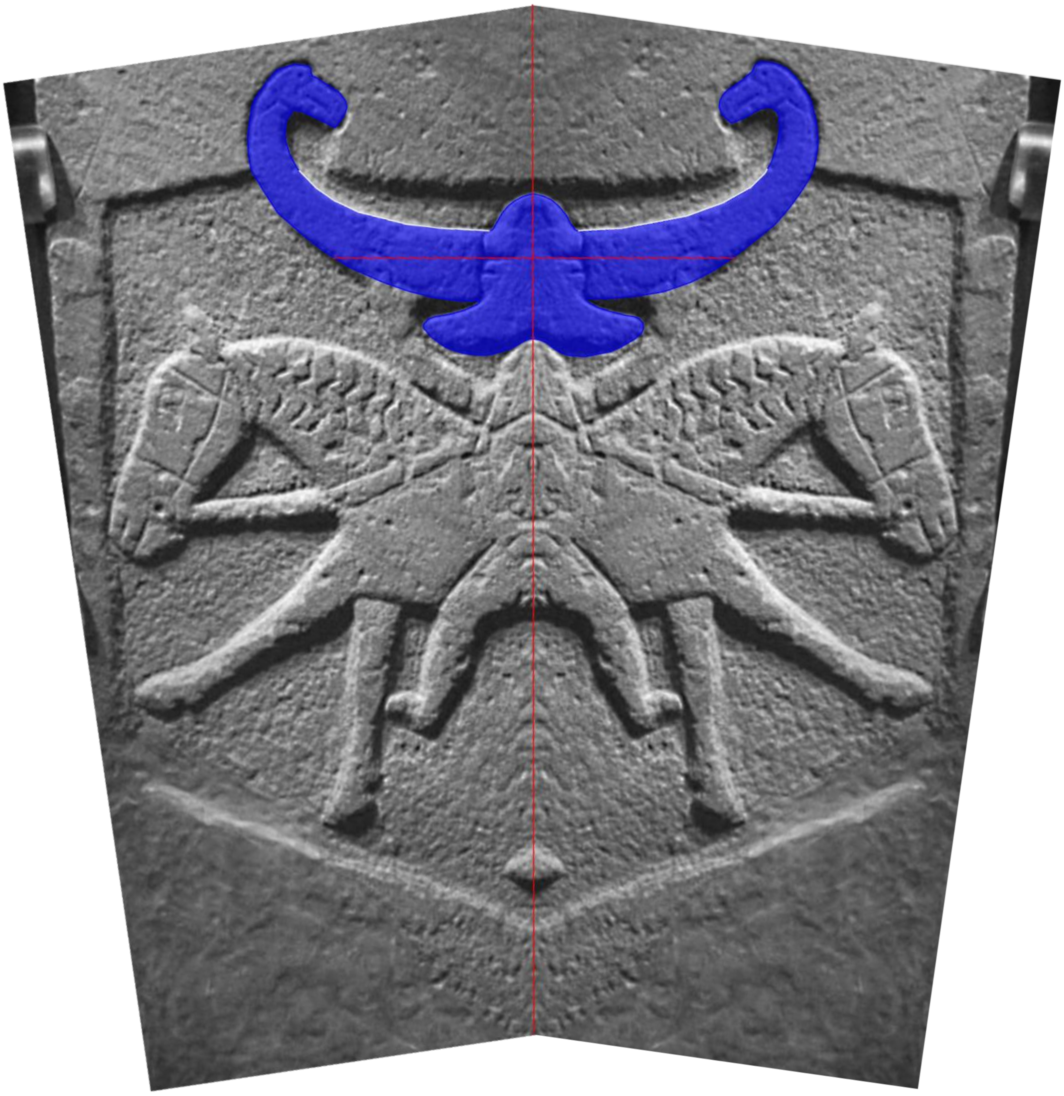


Image 35 Primary Mirror obtained by reflecting right hand side in Axis A. Axis B is shown under the primary mirror, perpendicular to the vertical axis A.

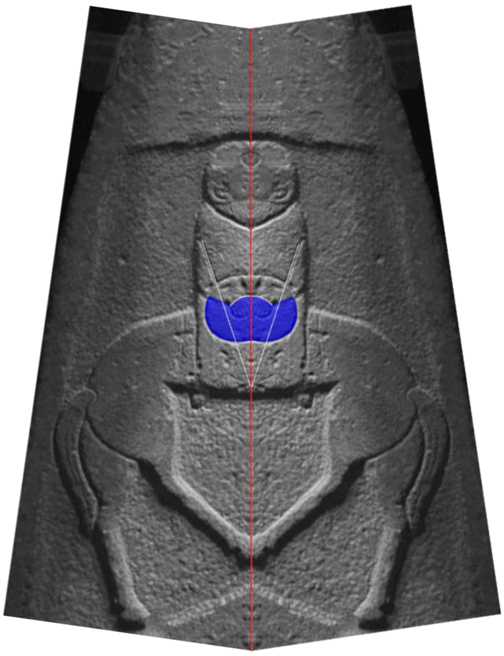


Image 36 Inverted secondary mirror obtained by reflecting left hand side in Axis A is shown as a white curve. The straight radial fine carved lines indicated in white may serve to indicate the focal point of the Primary mirror

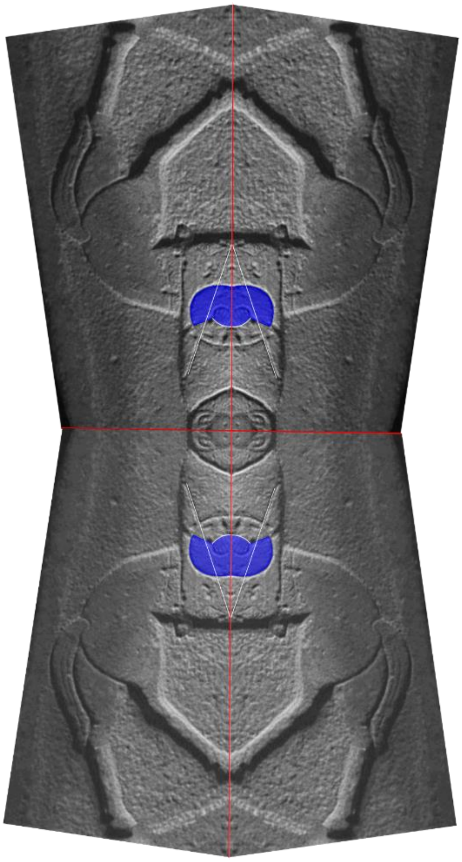


Image 37 The correct orientation of the secondary mirror is obtained by reflecting the inverted image of the mirror in Axis B which is perpendicular to Axis A and goes through the underside of the Bullion Man's nose.

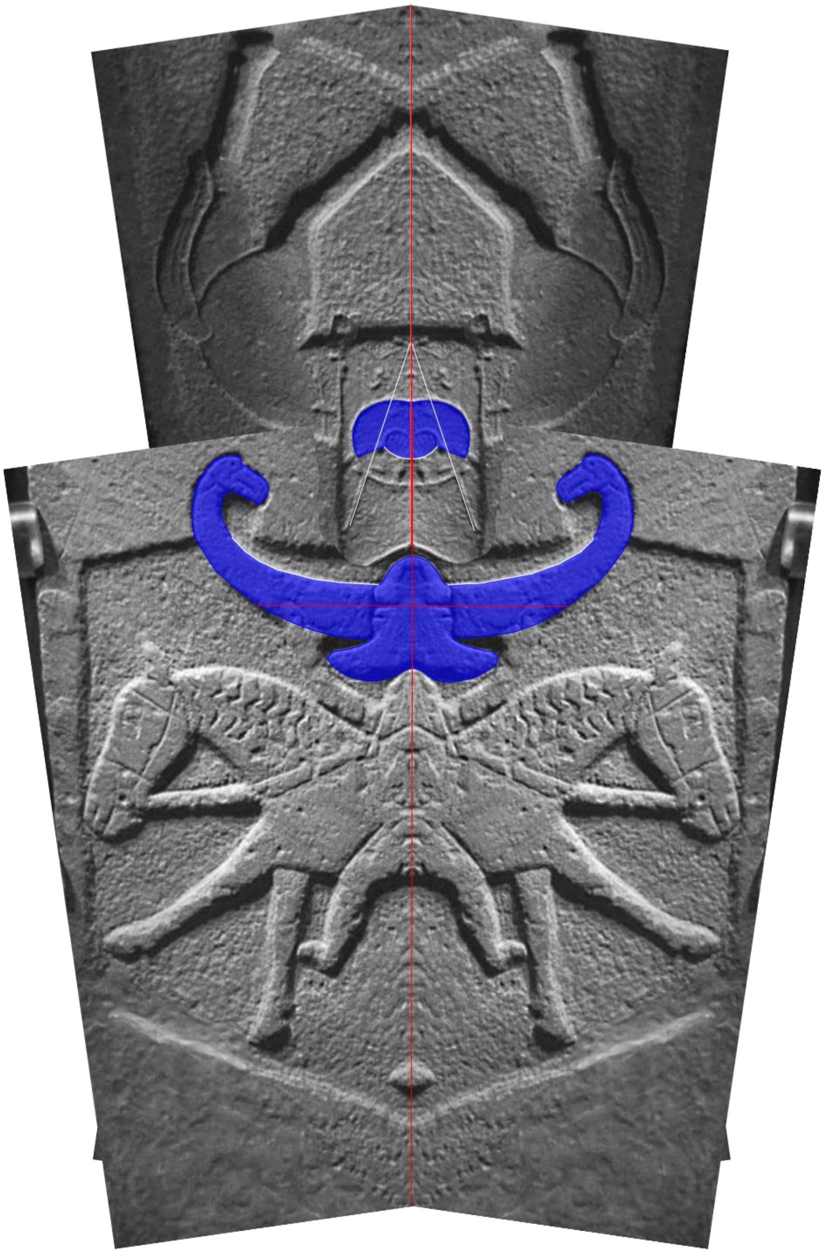


Image 38 Combining the Primary and Secondary mirrors obtained by reflections in Axis A and Axis B.

The focal point of the primary mirror can be calculated by determining the equation that describes the curvature of the carved primary mirror obtained by reflecting the upper edge of the drinking horn in Axis A.

In order to locate the eye-piece we need to find a third axis for reflection. This time the lens and eyepiece are located by Axis C indicated by the straight line incised at an angle to the right and cutting into the primary axis.

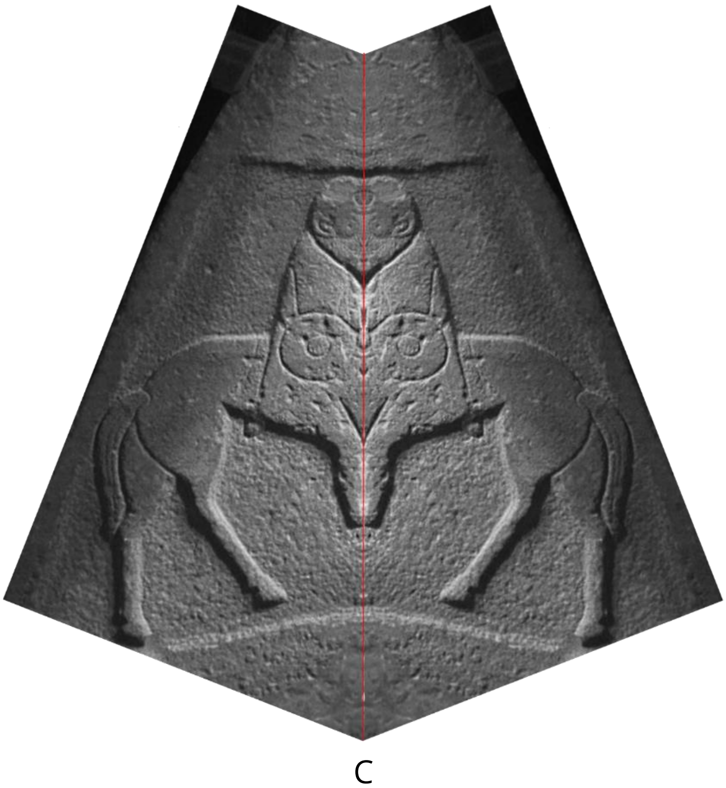


Image 39 Left hand side reflection in Axis C produces the outer appearance of the eyepiece. An inverted snake's head appears from the Bullion Man's head where his ear becomes the snake's eye and his eye is transformed into the snake's tongue. A dimple on Bullion Man's cheek is transformed into the snake's nostrils. A cat's head also appears where Bullion Man's arms are transformed into the cat's ears and his shield becomes the cat's eyes.

Image 40 Inverted snake head above cathead produced by reflection in Axis C

The eyepiece itself formed from Bullion Man's leg has the appearance of a snake's head but these features are subtle indentations which may or may not have been intentionally carved which is the common problem when using mirrors to reveal reflected images and the reason why the whole idea of concealing images as half patterns is controversial. The piece extending vertically downwards between the horse's legs has the appearance of an eyepiece.

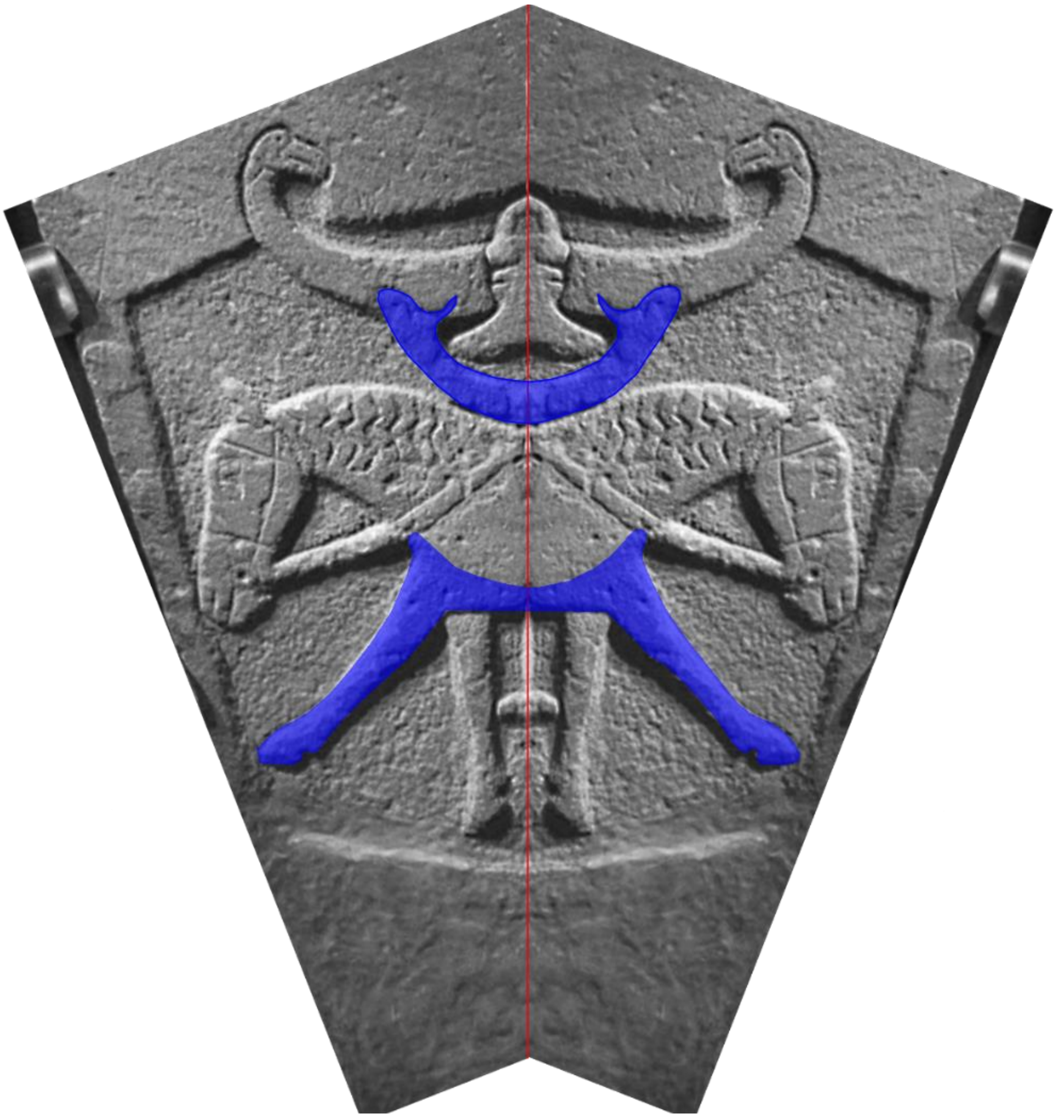


Image 41 When the right-hand side of Axis C is reflected in the axis, a plano convex lens is formed from the rider's foot, within a tube formed by one of the horse's front legs.

Image 42 This may represent a magnified plan of the eyepiece but the lens is displaced above the notch that is formed by the gap between the hoof and the fetlock. The reflection of the Horse's front leg, shaded blue in Image 41, could represent a stand for the telescope, whilst the reflected arm and hand holding the drinking horn may have represented the bottom of the bowl holding the primary mirror. The component parts of the proposed telescope obtained from reflections in Axes A, B and C can be assembled to show the Primary mirror in its bowl with an eyepiece extending beneath the bowl and the secondary mirror positioned above.

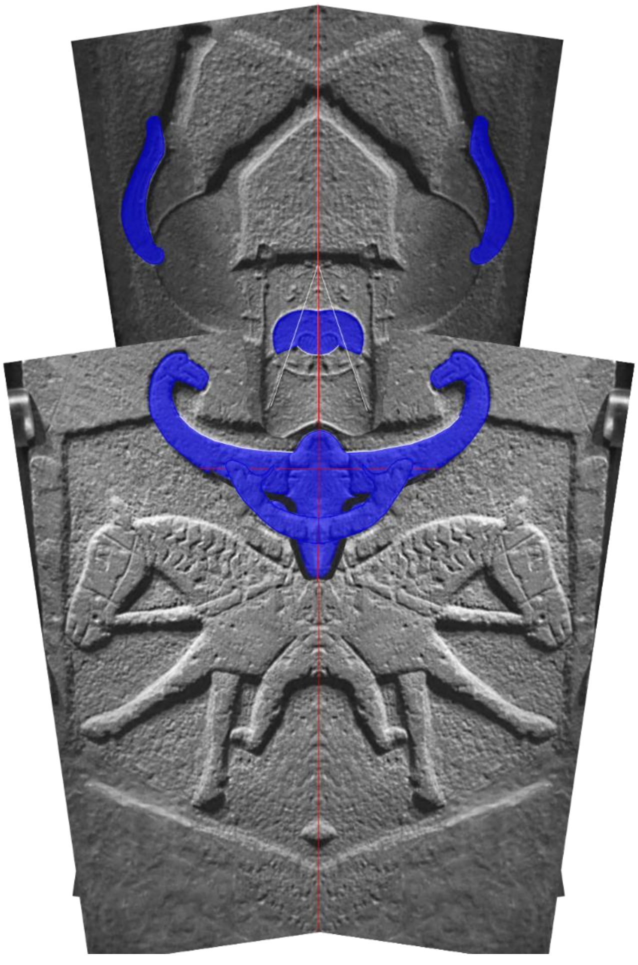


Image 43 The reflected horse's tail obtained from reflections in Axes A and B could represent supports for the secondary mirror

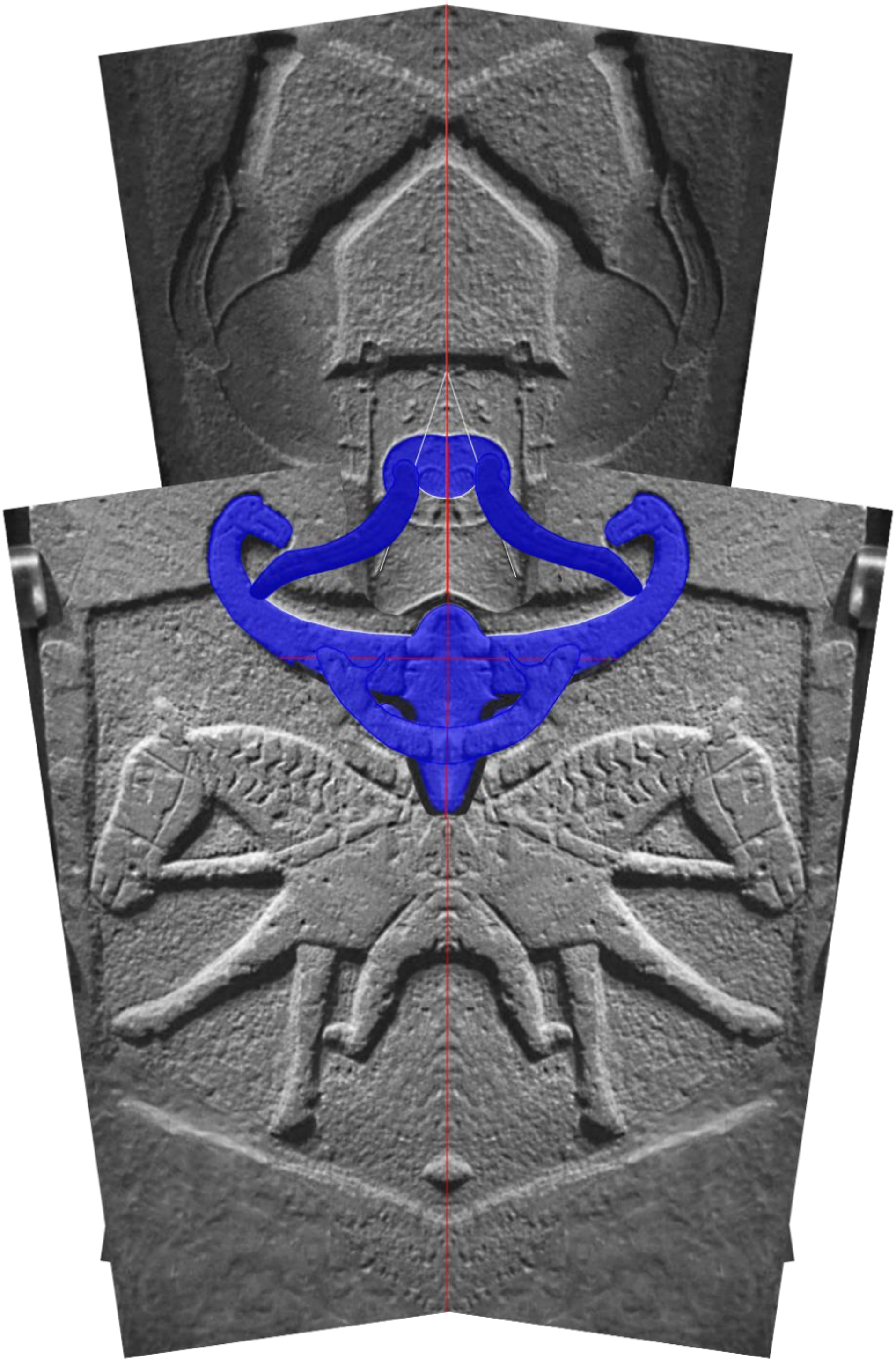


Image 44 When the horse tail supports are added to the other components they again take on the appearance of snakes

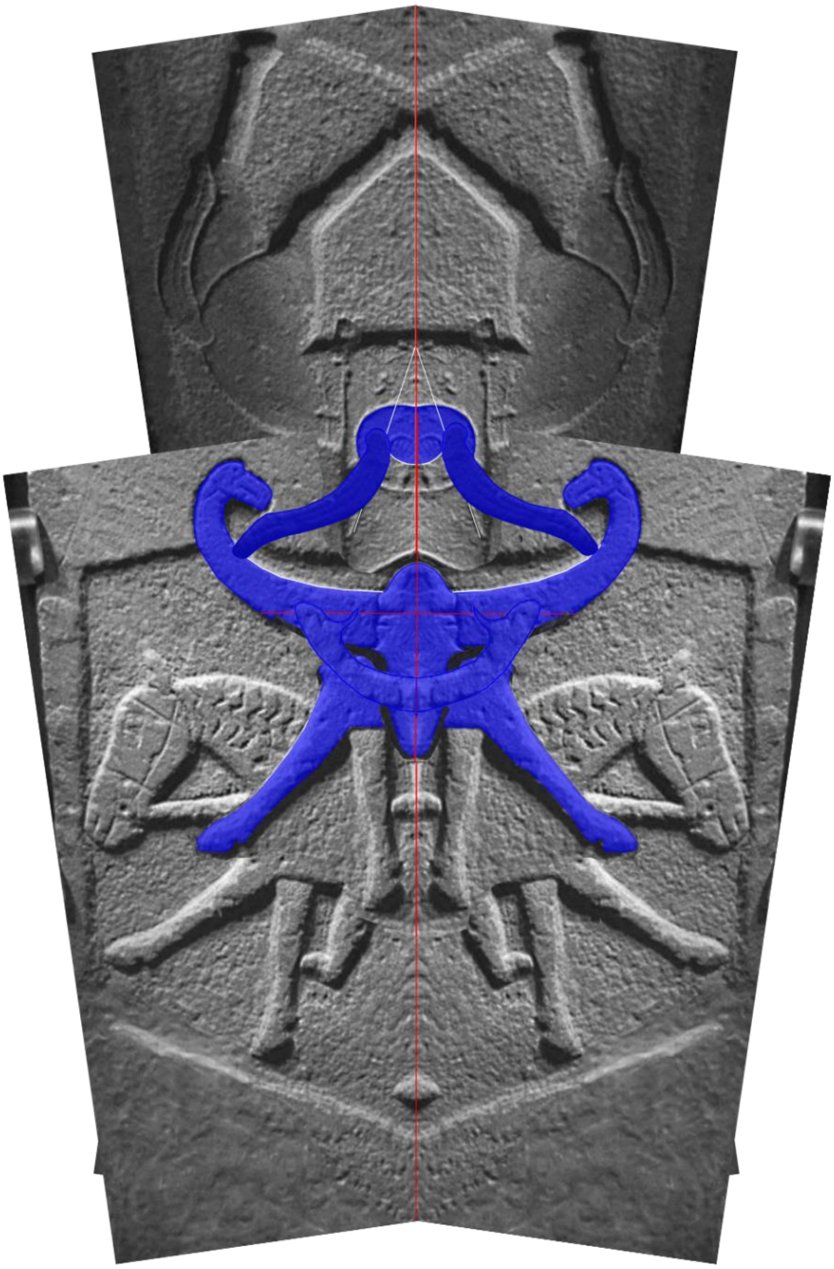


Image 45 The telescope components formed by the reflections in Axes A, B and C and then aligned by reflection in Axis D and a translation from y to y′

Transformations used to obtain the Bullion Telescope
Primary mirror Axis A direction of reflection 1
Secondary mirror Axis A direction of reflection 2
Followed by reflection in Axis B
Eyepiece Axis C direction of reflection 5
Followed by reflection in Axis D
and translation y to y′
Stand Axis C direction of reflection 4
Followed by reflection in Axis D
and translation y to y′

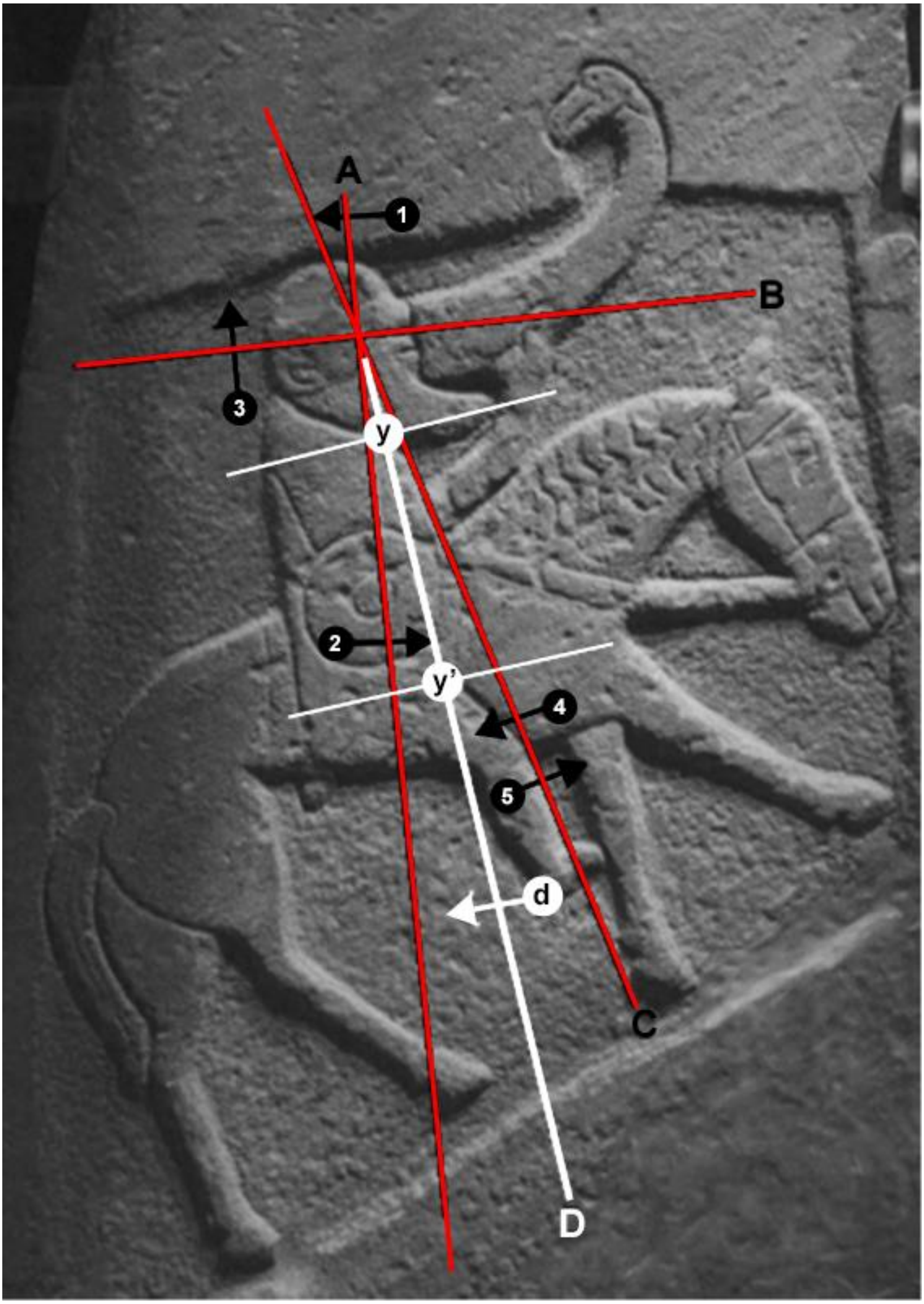


Image 46 Axes of reflection and direction of those reflections required to reveal the components of an ancient reflector telescope

The Golspie Stone

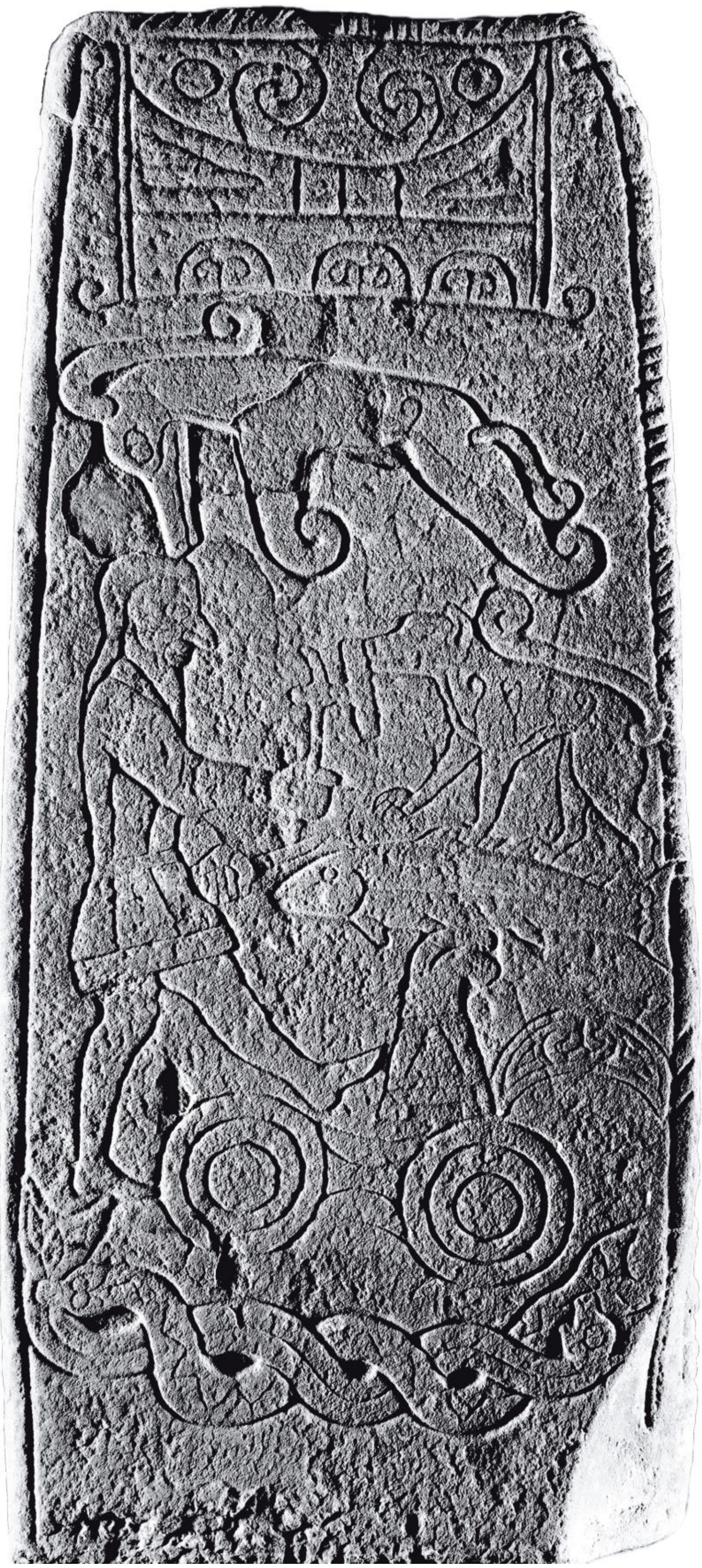


Image 47 The Golspie Stone

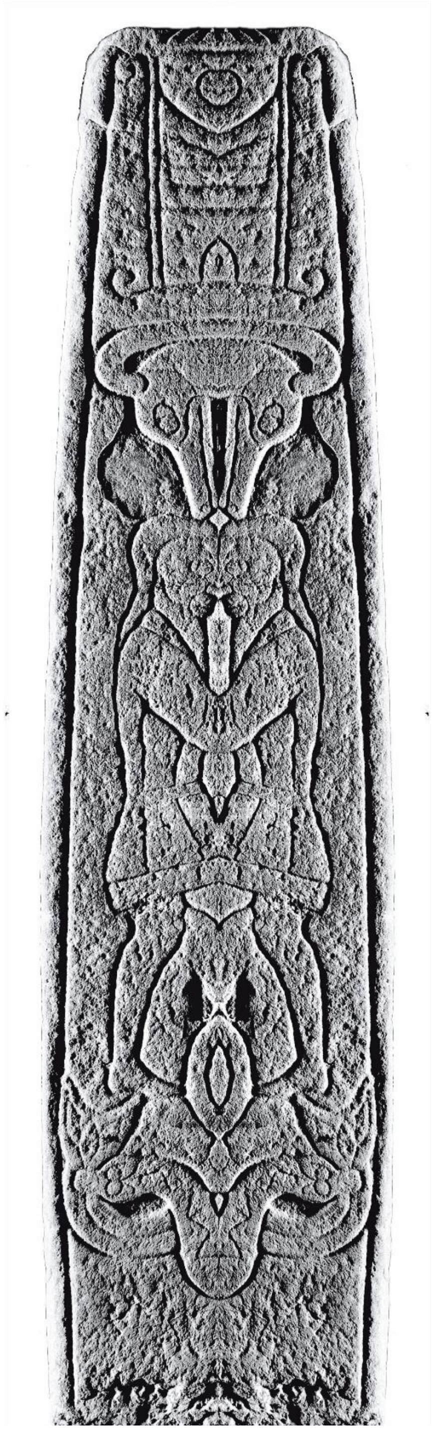


Image 48 Reflection obtained through the axis that cuts off Golspie man’s nose

When an axis is drawn from the centre of the circle in the rug symbol downwards, cutting off Golspie Man’s nose, as was done with the Rhynie stone, once again the image of the man seems to be transformed into the lioness headed Sekhmet. This time though there is also the appearance of a horned skull above, that may mirror the image of Cernunnos obtained from the Collessie stone reflection seen later.

With the previous telescope “plans”, we found that three axes of reflection were required in order to reveal the functional components of a reflector telescope;

namely the primary mirror, the secondary mirror and the eyepiece lens, together with the telescope stand, the eyepiece assembly, the bowl to hold the primary mirror and the supports to hold the secondary mirror above the primary mirror.

The Upper symbol on the Golspie stone is the Pictish Rug which represents the constellation of Gemini. The two brightest stars in Gemini, Castor and Pollux are represented by the two circles carved at the top left and top right of the Rug pattern. It is interesting that whilst stars are usually portrayed as a circle with a central dot, only the top right circle has a carved central dot. This may suggest that in order to reveal two stars depicted as dotted circles requires the top right hand dotted circle to be reflected in an axis. Though on closer inspection the dot appears to be elongated and has the appearance of a cat’s eye. Two axes can be drawn through straight lines in the central rug pattern which bisect the eye of the fish. A third axis goes from the centre of the Water Horse’s eye, through the man’s eye and bisects the strangely shaped shoe of the man.

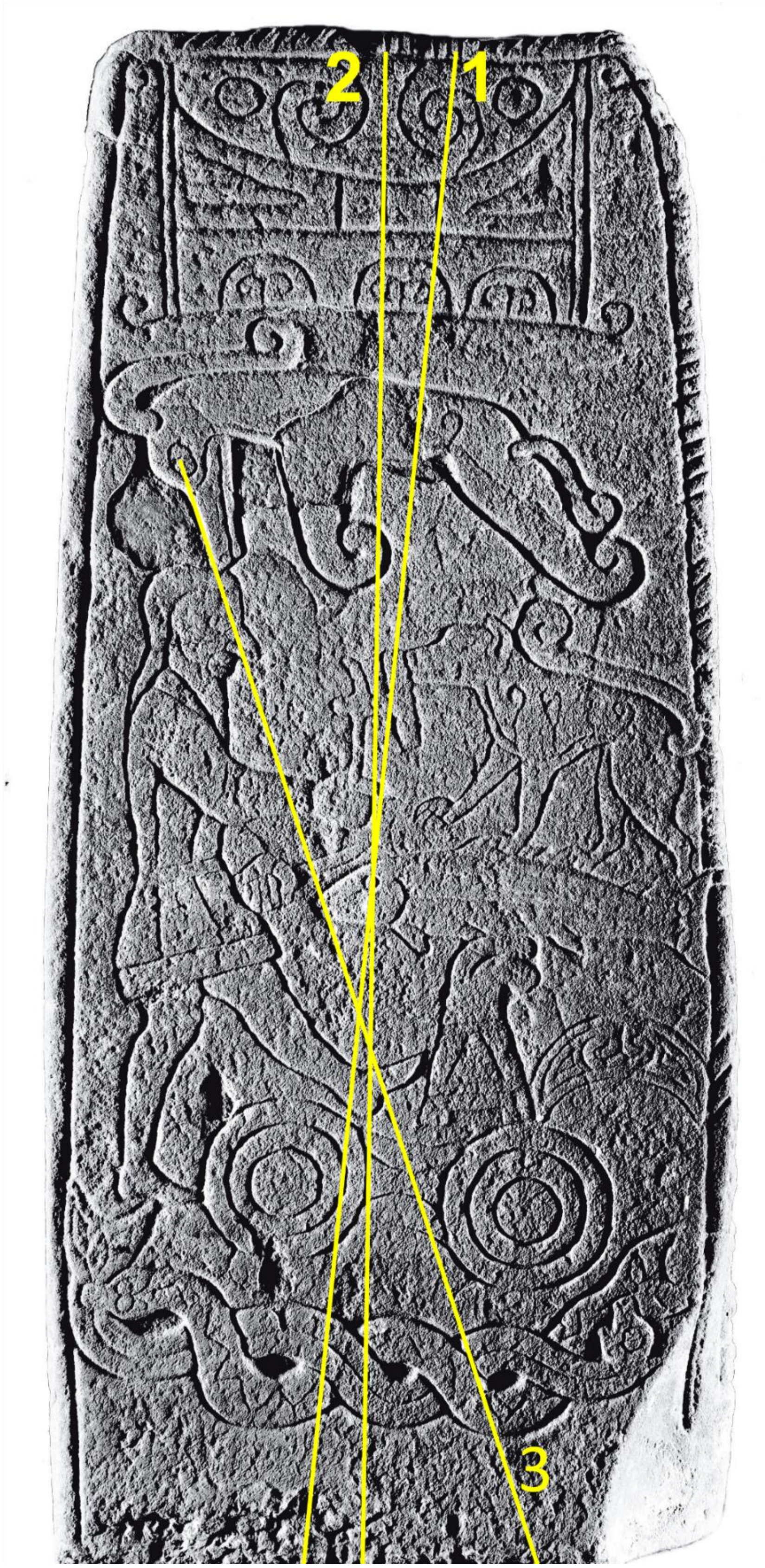


Image 49 Three possible axes of reflection indicated by the three carved lines; two in the Rug symbol (Gemini) through the eye of the Salmon (Pisces) and one from the eye of the Kelpie (Monoceros) through the middle of the Double Disc (Cetus)

Image 50 Taking each axis in turn, Axis 1 reflection of right hand side in the axis reveals a Cats head in the top right-hand corner of the Rug

In fact, there are two Cats heads obtained by a reflection in Axis 1. The one below in the middle of the stone has the appearance of an impressive lion's face.

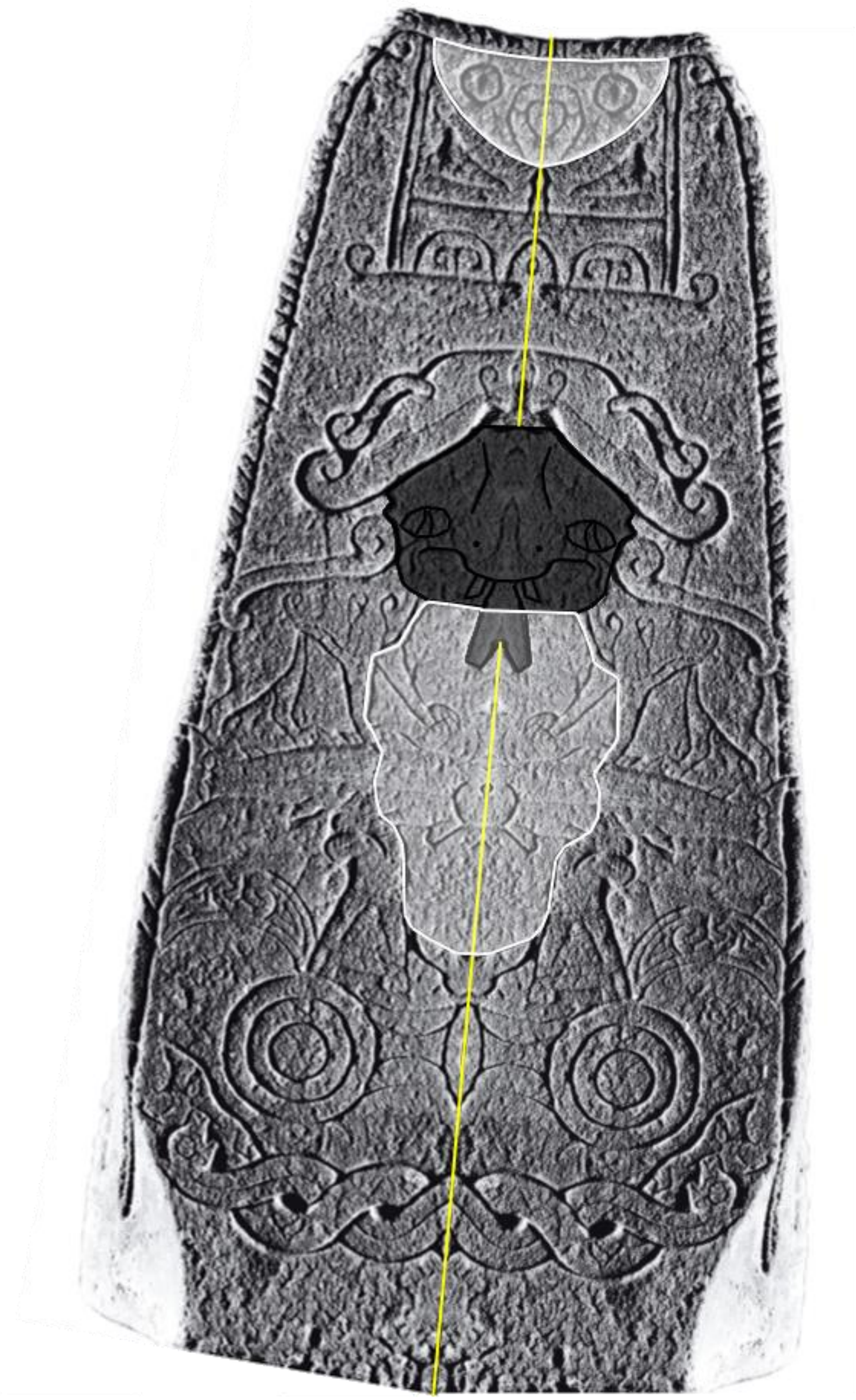


Image 51 In addition to the two cats' heads (shaded white), there is also the appearance of a snake's head (shaded dark grey) sitting on top of the lion's head. This is remarkably similar to the way in which cats' heads and snakes' heads were hidden in the carved pattern on the Rhynie stone. The appearance of a snake head and cat head confirms the position of the axis

A reflection in Axis 1, reveals the secondary mirror on the upper curve of the dog's nose where the incident rays reflected from the primary mirror are indicated as radiating lines represented by the folds of skin on the dog's snout. The dog's tail could possibly provide supports for the secondary mirror.

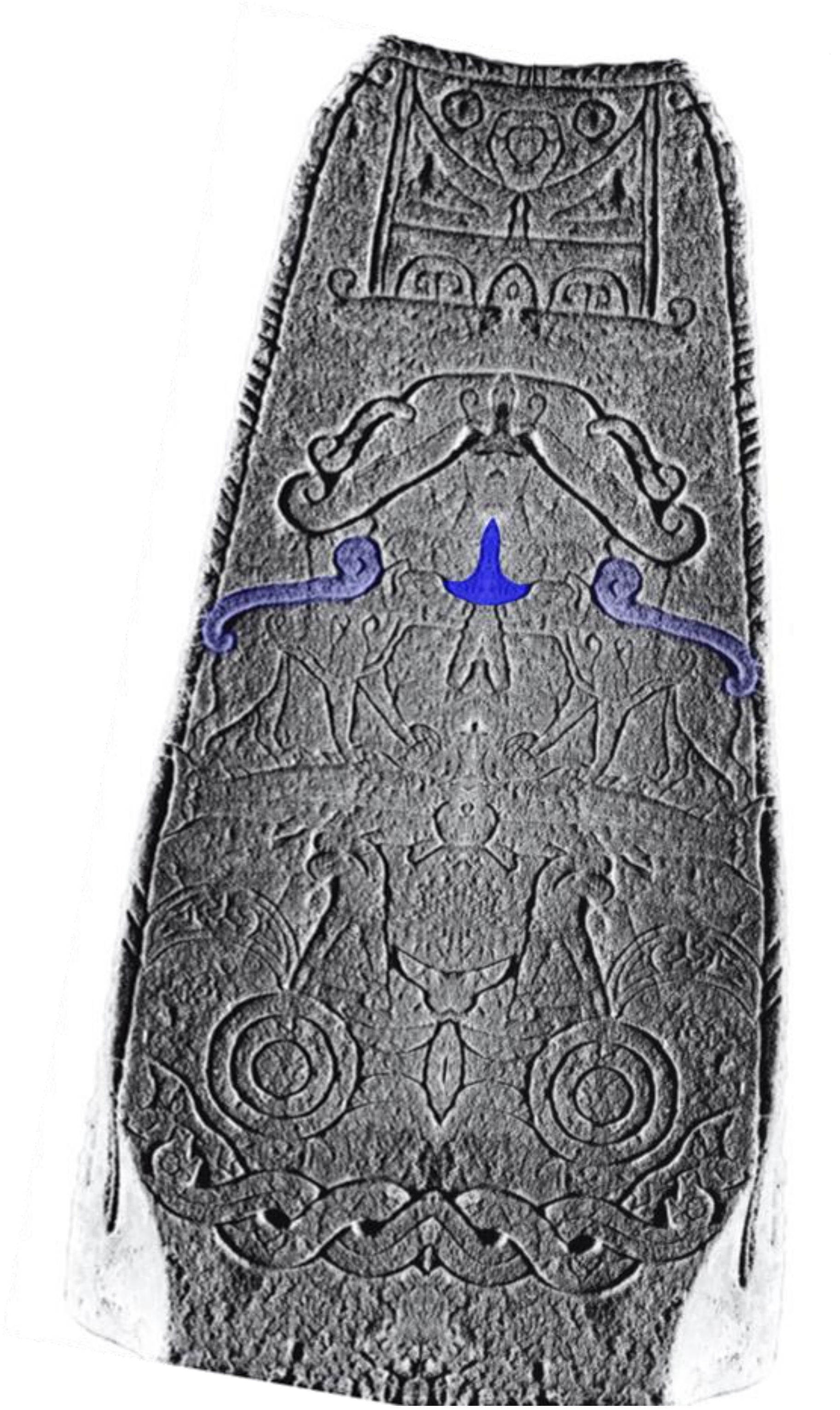


Image 52 Right hand side reflected in Axis 1. Reflection A in Image   Reveals the Secondary mirror

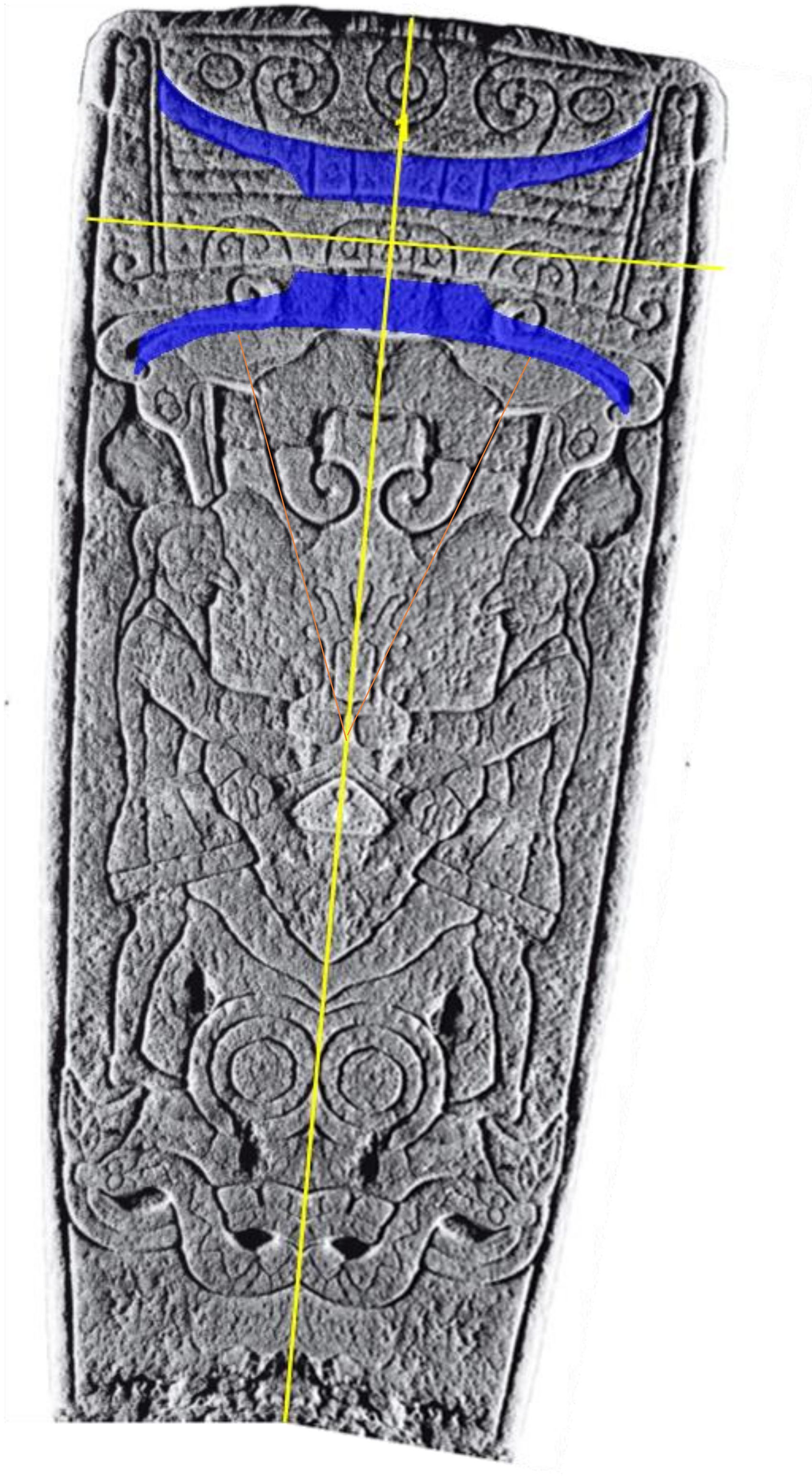


Image 53 Left hand side reflected in Axis 1 reveals the Primary Mirror.The primary mirror is revealed by the reflection of the left-hand side of Axis 1 in the axis. Reflection B in Image   The mirror needs to be inverted by reflecting the upper curve in the axis perpendicular to Axis 1 so that the primary mirror sits along the back of the reflected kelpie.

Reflection in Axis 1 therefore reveals both the Primary and Secondary mirrors of a telescope.

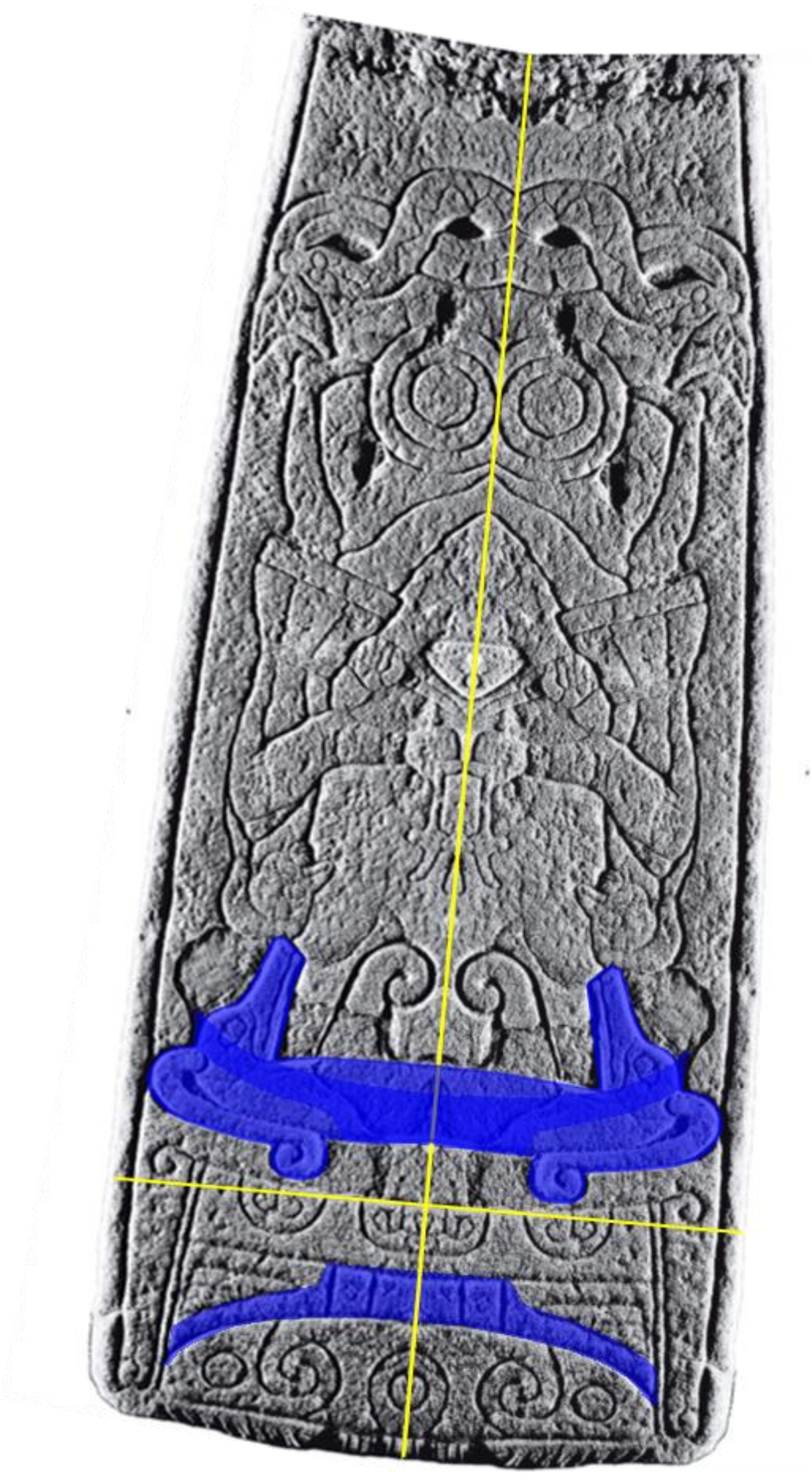


Image 54 Inverted stone reflection in Axis 1 shows the primary mirror in what might serve as a bowl to contain the mirror that has the appearance of the Water Horse or Kelpie.

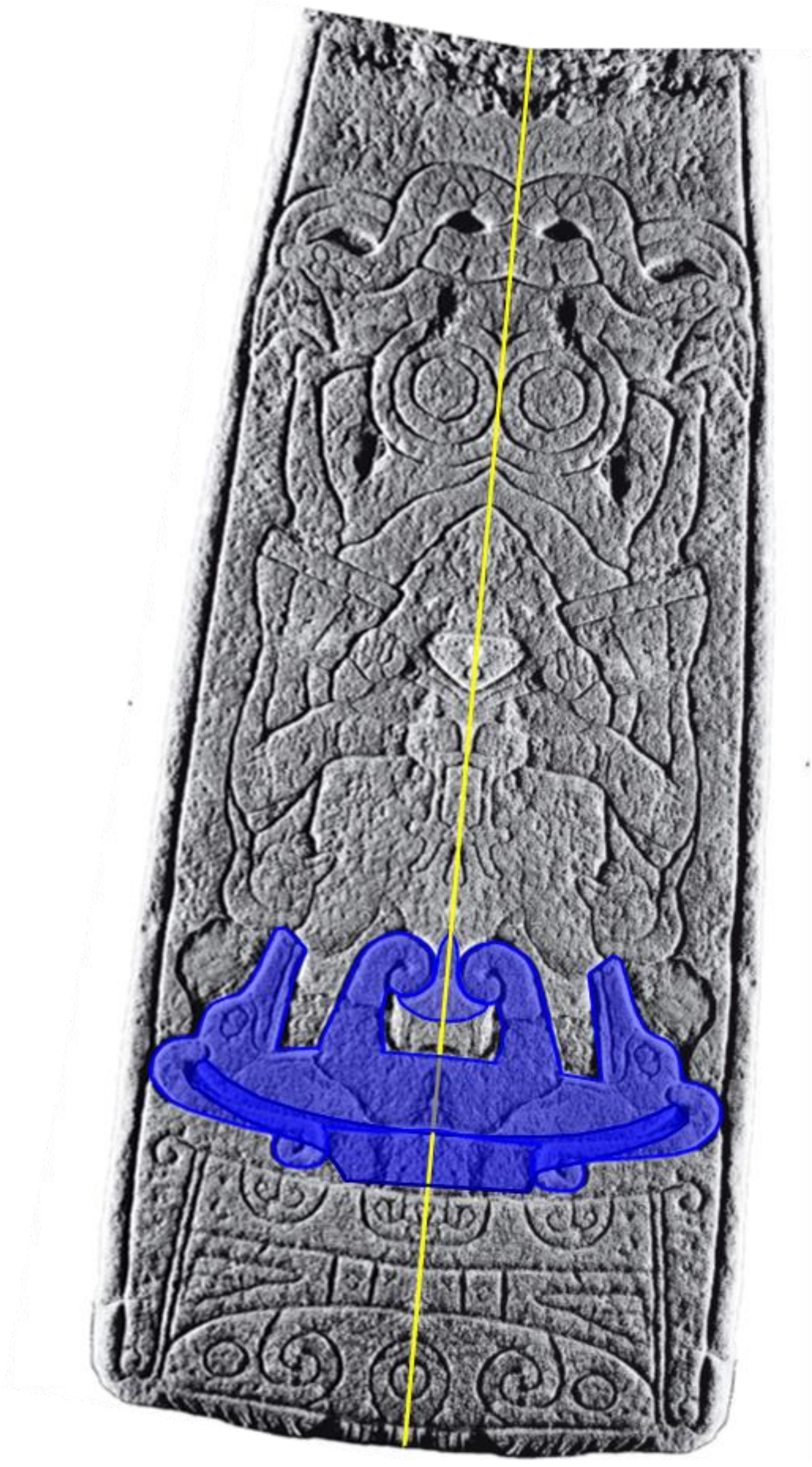


Image 55 of the Kelpie bowl containing the primary mirror and the front flippers of the Kelpie form a perfect fit as supports for the Secondary mirror though the flipper supports may have been telescopic to allow adjustment of the distance between the primary and secondary mirrors

It can be seen how the kelpie's body is being transformed into a telescope and how the head and front flippers are incorporated into a zoomorphic yet functional design for a reflector telescope.

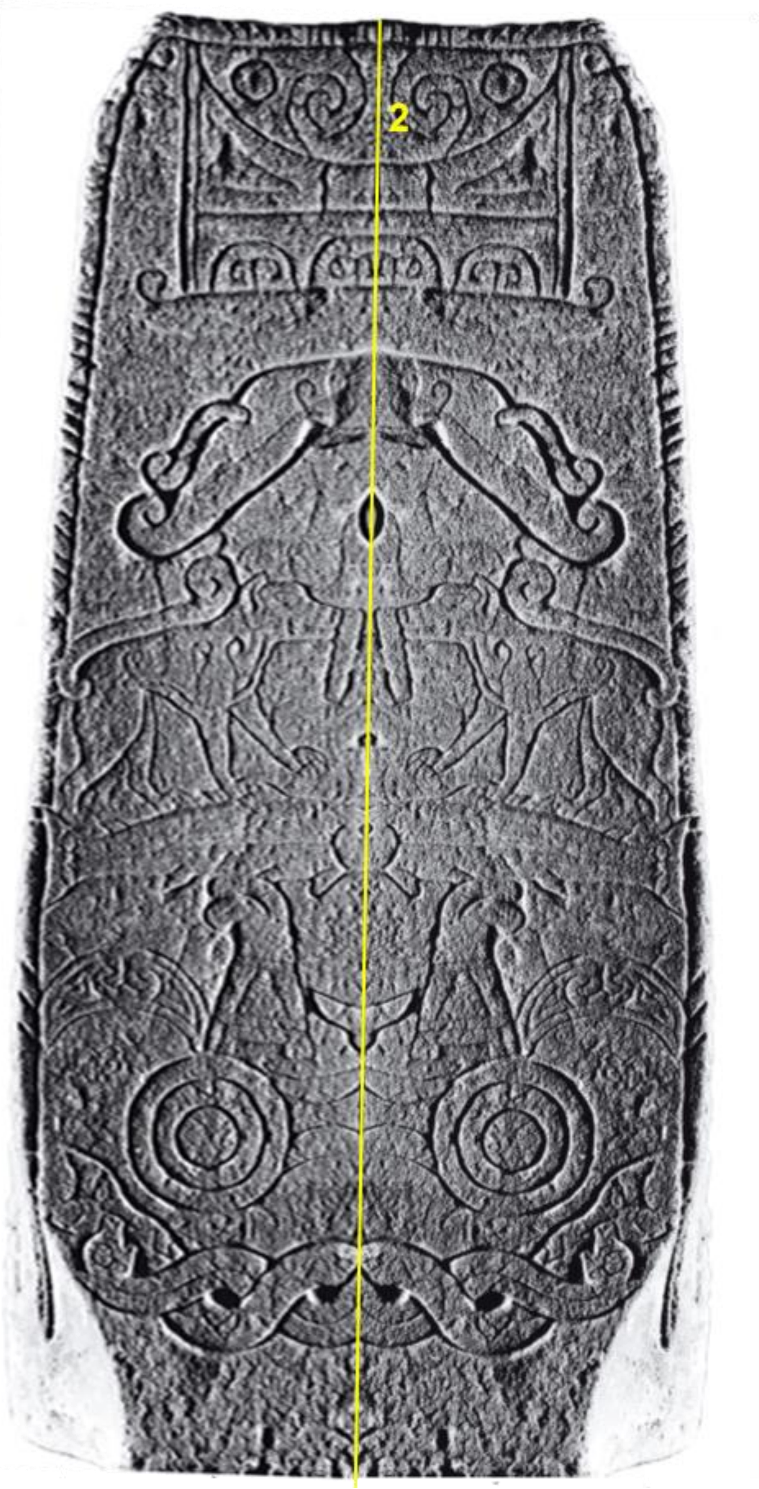


Image 56 Reflection of the Right-hand side in Axis 2 appears to reveal the back flipper and tail of the kelpie as a possible stand for the telescope.

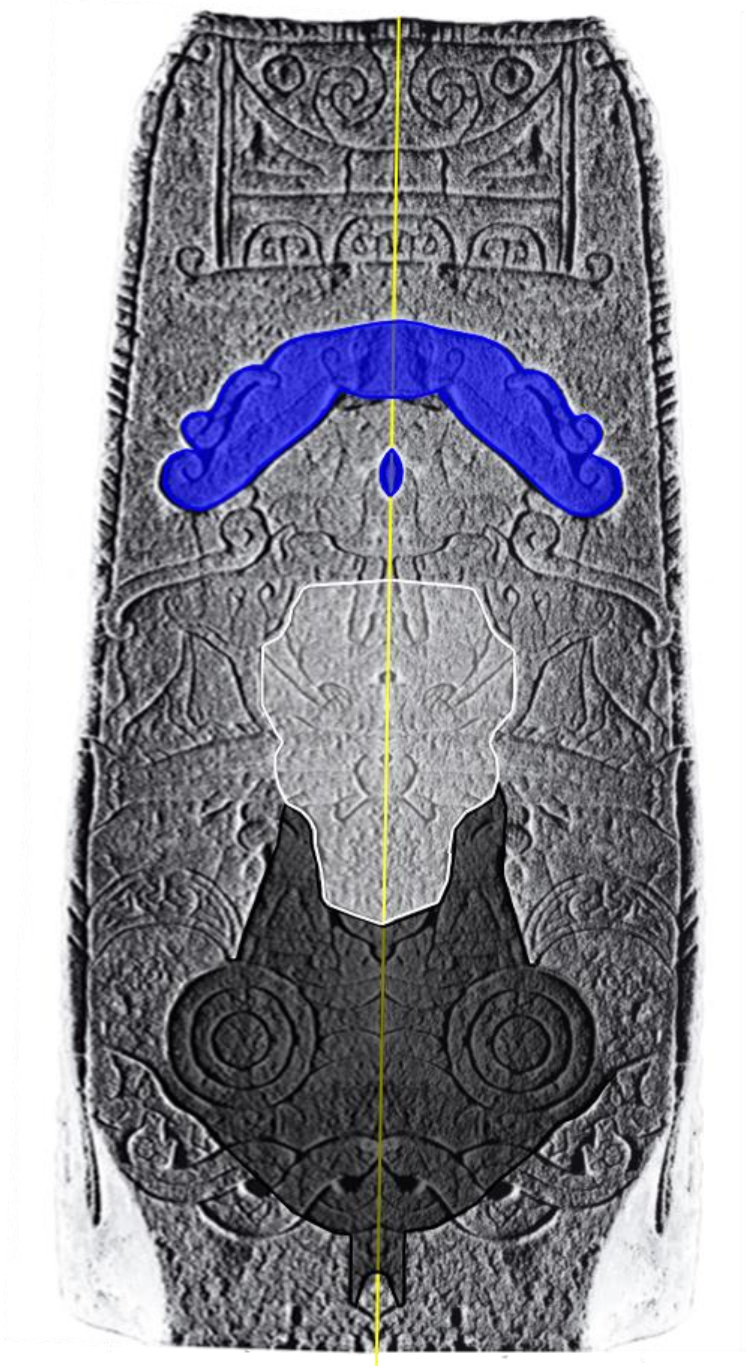


Image 57 Reflection in Axis 2 produces a possible stand for the telescope (shaded blue) along with what looks like a lens shape (blue) where the eyepiece might be located. A Lion's face again appears in the centre of the stone (shaded white) along with a snake's head below it (grey).

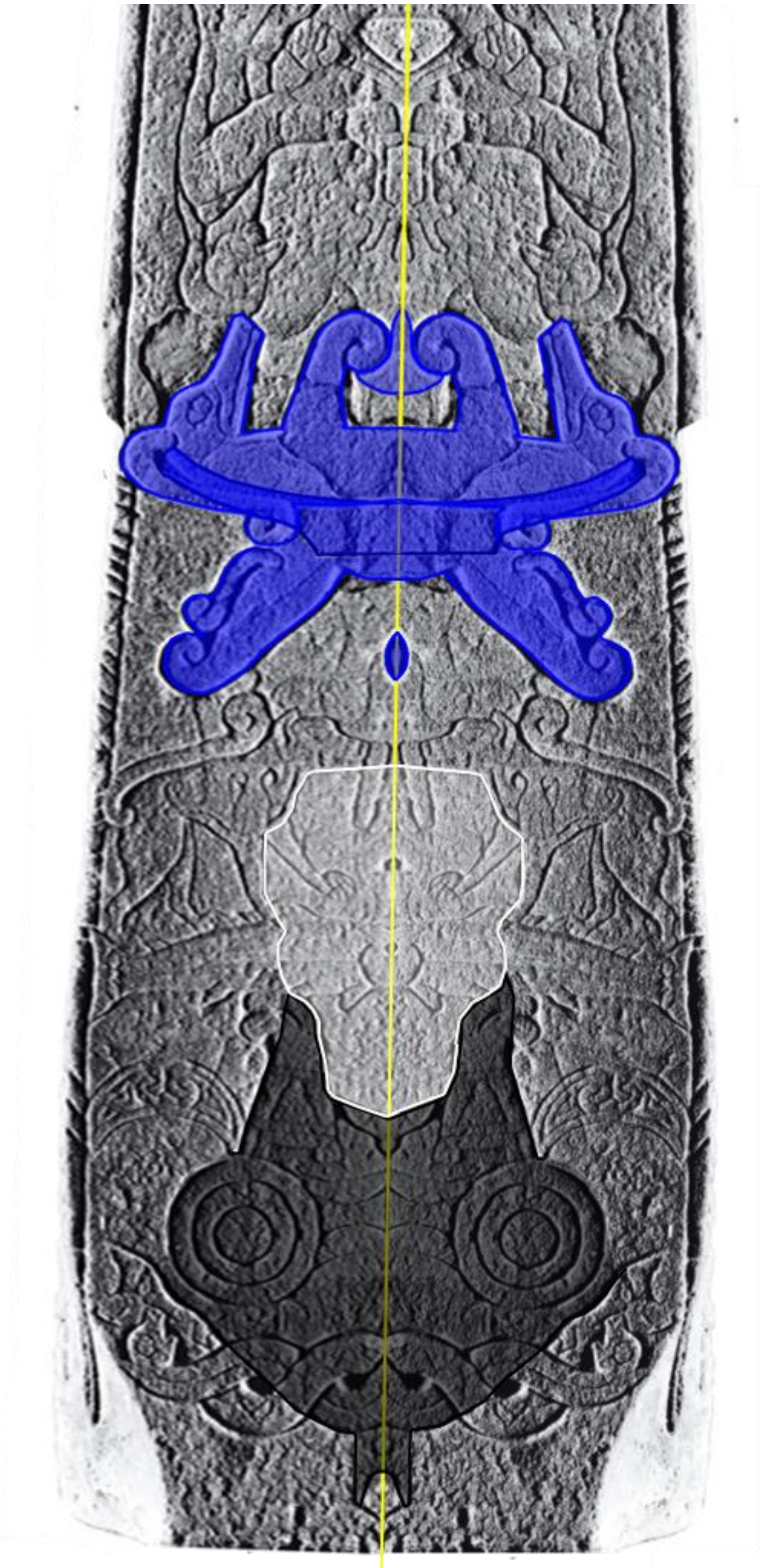


Image 58 Combined Reflections from Axis 1 and Axis 2 to give Kelpie Stand, Bowl and primary and Secondary Mirrors. The Kelpies now appear complete with arched backs, riding the waves and supporting the primary and secondary mirrors of the telescope.

The entire body of the carved kelpie seems to have been transformed into two kelpies that form a telescope bowl and stand that can support the primary and secondary mirrors. It is likely that in order to obtain a stable stand and supports that three Kelpies were used to provide tripod legs and tripod flipper supports for the secondary mirror. The missing component is the eyepiece and this might be obtained from the eye of the Kelpie carved on the stone by looking at the reflected image obtained when Axis 3 is examined.

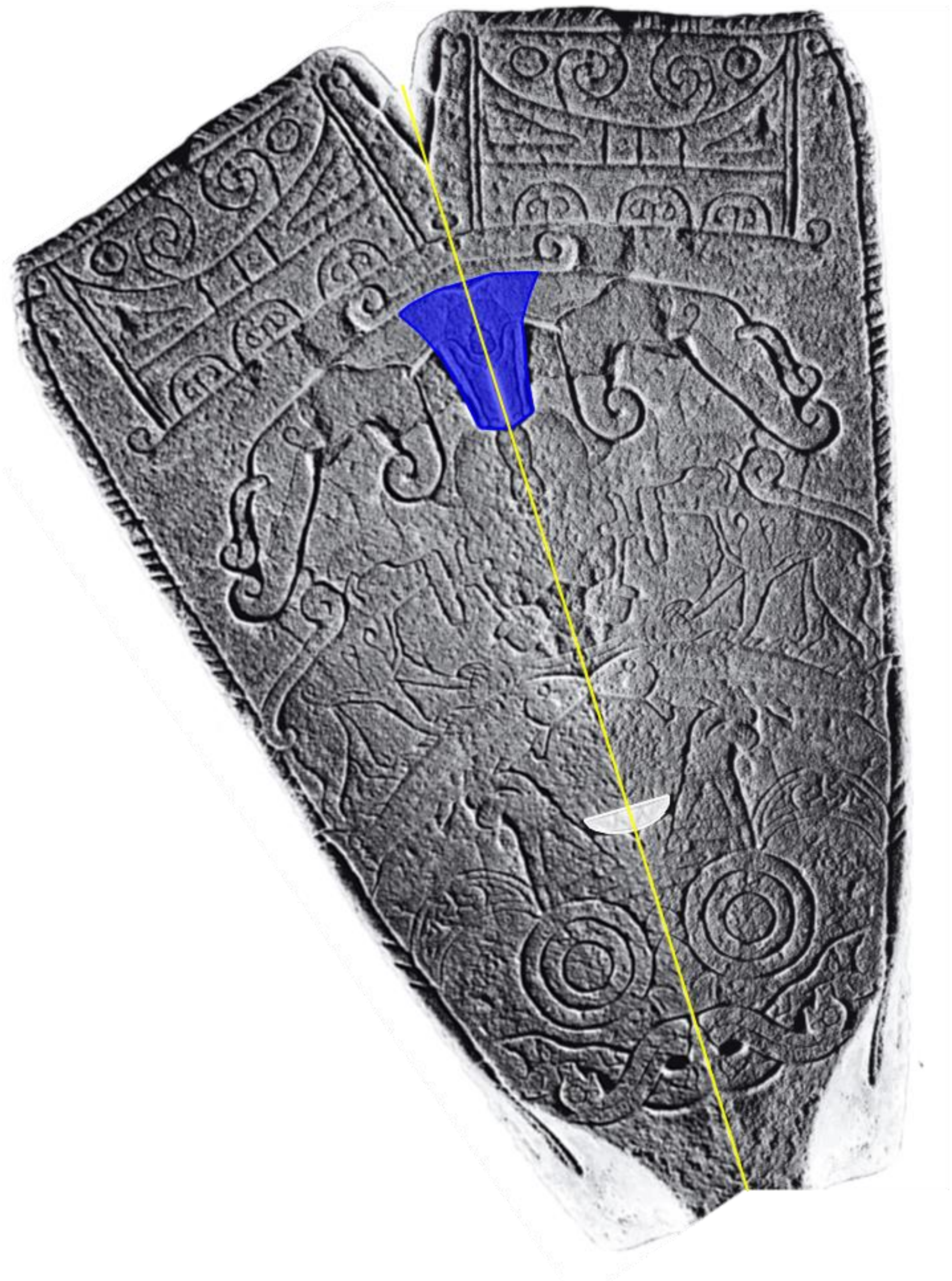


Image 59 A Reflection in Axis 3 from right to left along the line of the snout of the kelpie forms what looks like a possible eyepiece (blue) and further down the axis a plano convex lens is formed (shown in white) from the reflection of the man's shoe.

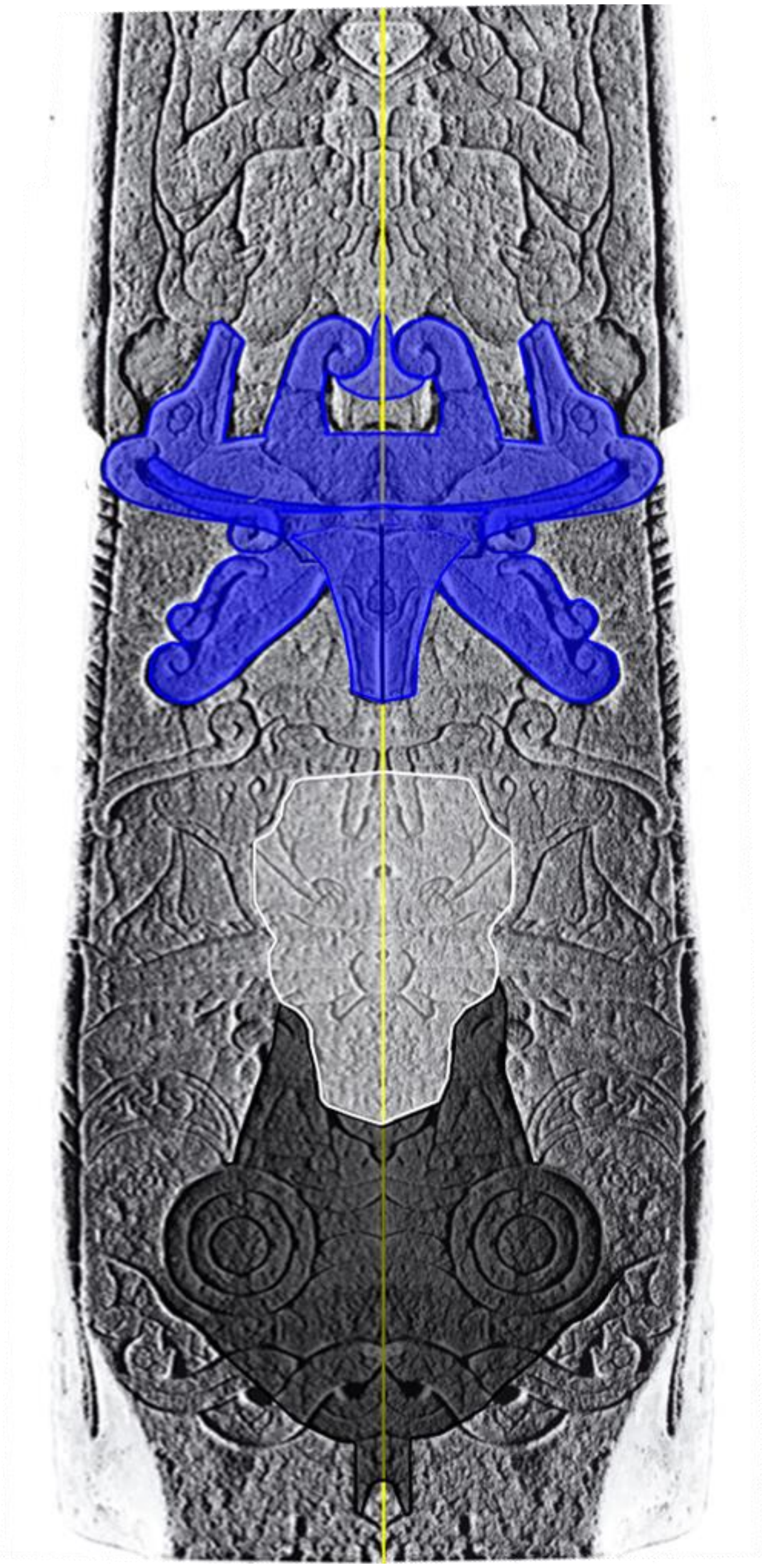


Image 60 The component parts revealed through reflections in the three axes can be assembled to form what looks like a tool that could function as a Reflector Telescope, similar to the proposed Rhynie stone and Bullion Stone telescopes. The incorporation of a kelpie into the design of the telescope results in a truly beautiful zoomorphic telescope that (if it existed and survived as an artefact) would arguably surpass the greatest finds from the ancient world both in terms of beauty and technology.

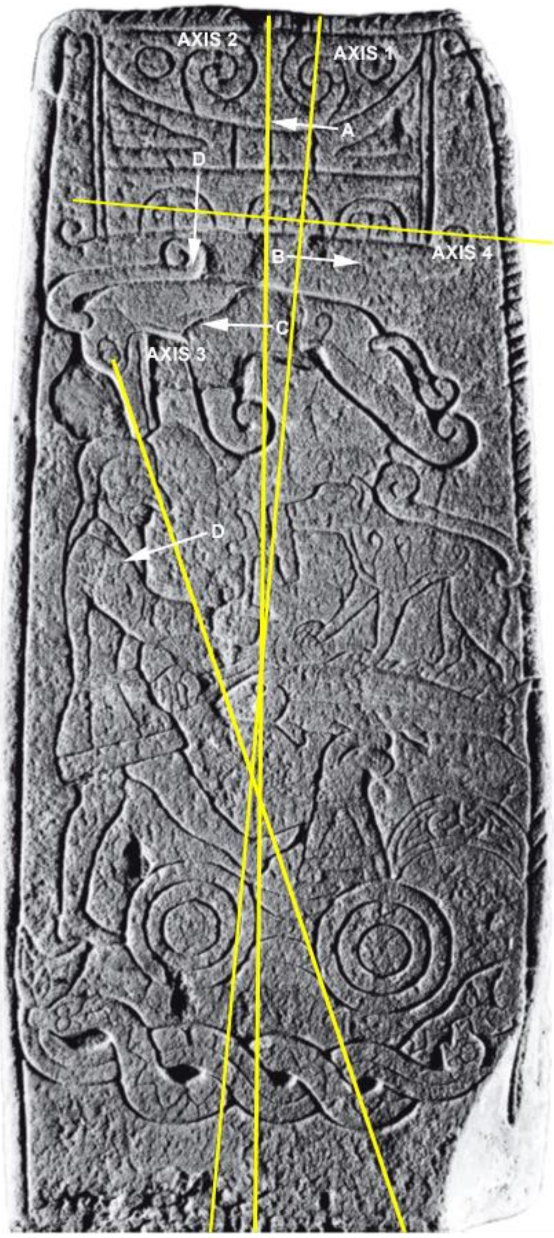


Image 61 Axes and reflections that reveal the components of a reflector telescope in the Golspie stone.

AXIS	Reflection	Component
1	A	Secondary Mirror
1	B	Primary Mirror Kelpie Bowl Secondary Mirror support
2	C	Telescope stand
3	D	Eyepiece Lens
4	E	Correct orientation of Primary Mirror

Table 1 Reflections in Axes on the Golspie stone that reveal the various component parts of a reflector telescope

Collessie Stone

There is another Class I Pictish stone from the village of Collessie in Fife which also has the image of a man carved on it. The stone is much more weathered than the stone from Rhynie, and the stone's surface not prepared to the same level before carving, making interpretation a bit more difficult.

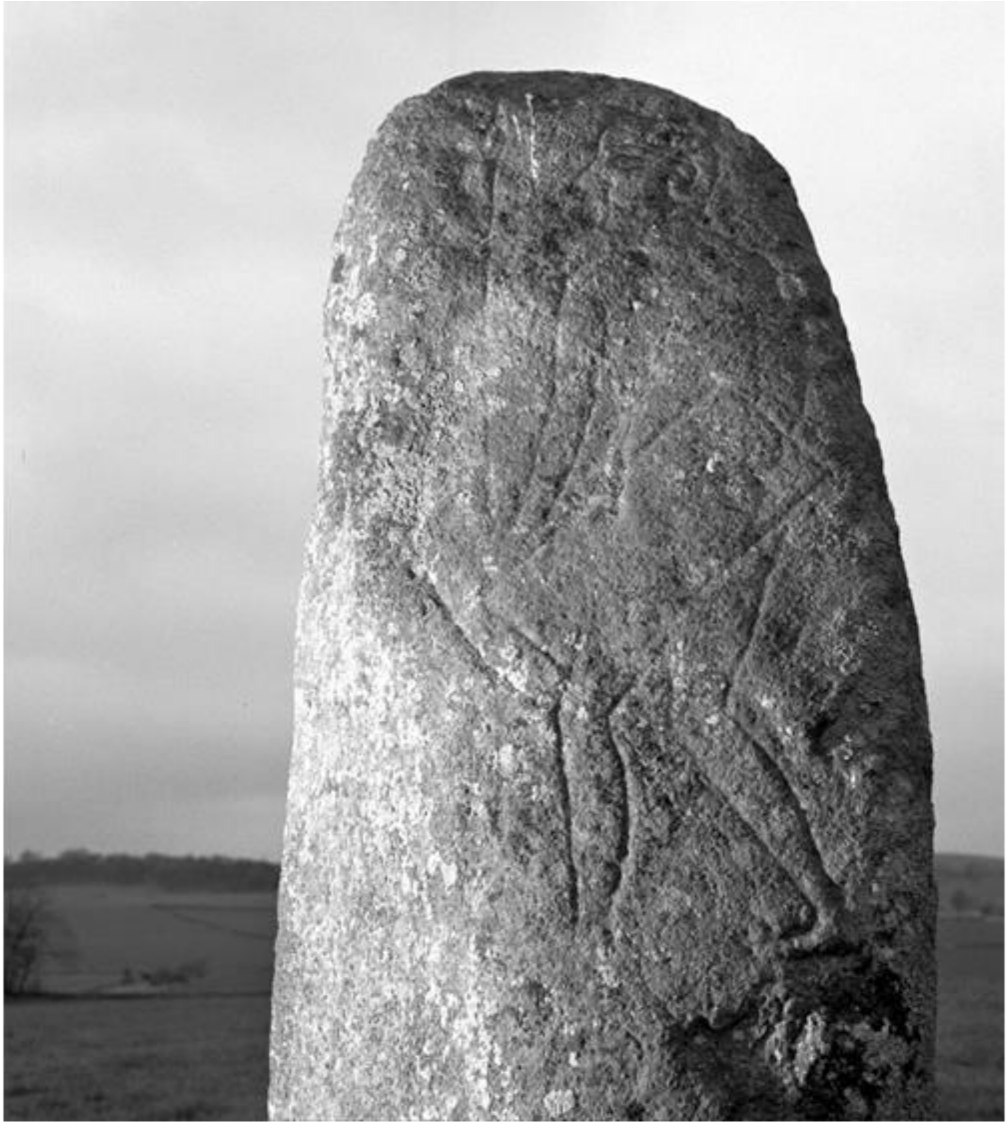


Image 62 Pictish Class I stone from Collessie, Fife carved with the image of a Pictish warrior

Collessie Man, in common with Rhynie Man, Golspie Man and Bullion Man has a large nose (a nose that is too large, though this may have been a characteristic of the people). He is carrying a large rectangular shield on his left arm and a spear in his right hand that has the typical Pictish Apple knob on its end that, according to Roman accounts, made a ringing sound when the spear was shaken. The Picts seemed to have been well versed in the practise of intimidating their opponents with a wall of sound including their rattling, ringing spears and their Boar-headed "trumpets" called Carnyxes which may, contrary to the accepted view, have actually been reed blown instruments, whose terrible sound may have imitated the screams and grunts of ferocious wild boar, a truly frightening cacophony of noise when a phalanx of carnyxes were blown together, a tradition of emboldening the fighters and intimidating their foes that was later continued in Scotland by the playing of bagpipes and drums as kilted warriors entered more recent battles.

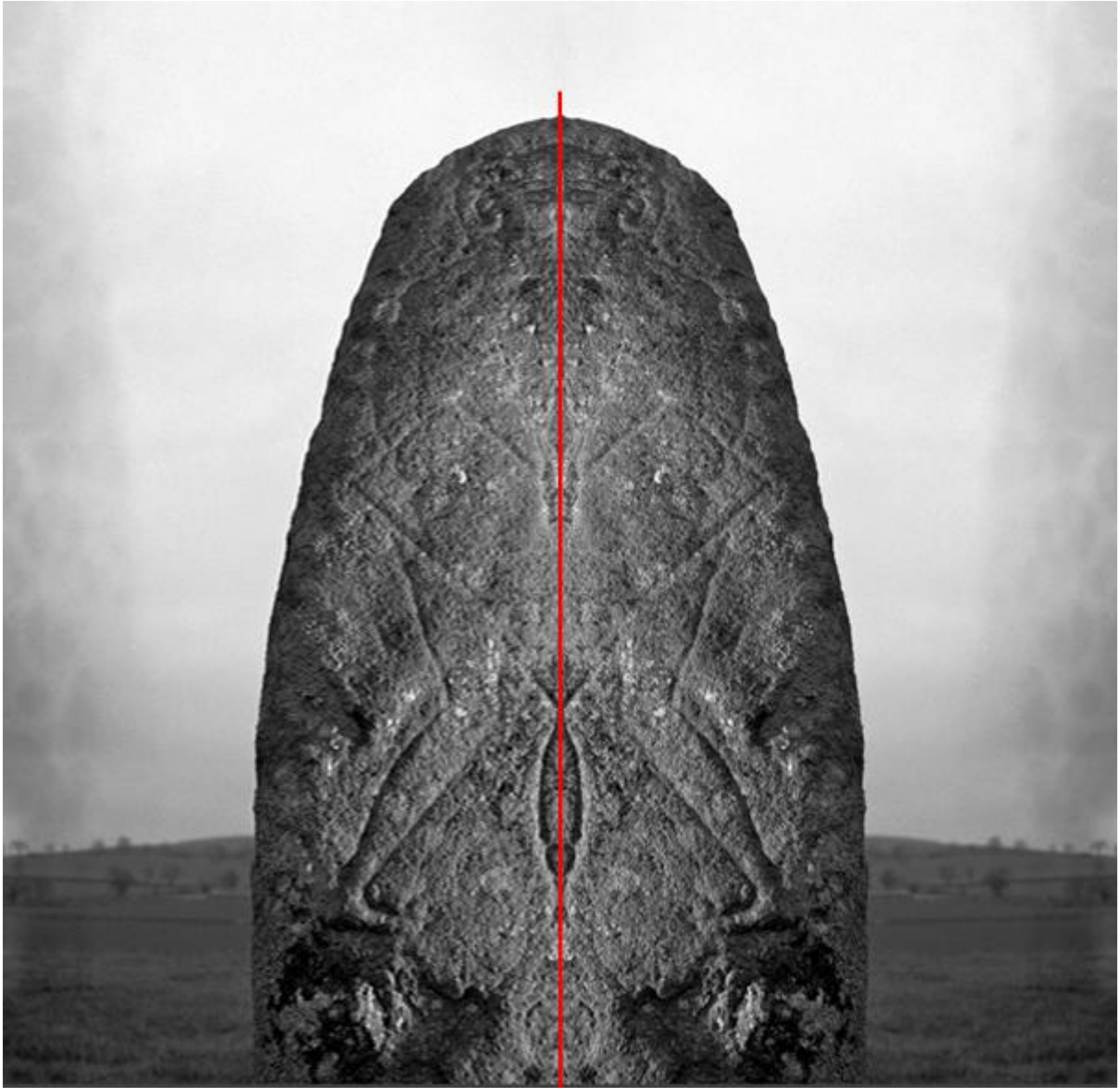


Image 63 A vertical axis through Collessie man's nose allows the right-hand side of the stone to reveal the god Cernunnos when reflected in the axis.

The Collessie Man is most similar in style of carving to the Rhynie Man stone and in the same manner of examination, we should perhaps first look at the possibility of choosing an axis of reflection that converts the man into a deity. In the case of Rhynie Man a vertical axis that chopped his nose down to size resulted in the transformation of the man into the lion headed goddess Sekhmet. When the same

process is carried out on Collessie Man, with a vertical axis running through the man’s nose the image above is formed.
There is the appearance of a snake’s head when the reflection is made when Collessie Man’s ear is seen as a pair of snake eyes and an indentation below the neck becomes a pair of nostrils. But the main feature of the reflected image is the transformation of a man’s head in profile into that of a Man/Horned beast hybrid looking forward where Collessie Man’s ears have been transformed into what look like ram’s horns. This reflected image is consistent with known portrayals of Cernunnos.

Another image is created by carrying out this reflection; a very large "V” shape which may be significant as this symbol represented the feminine, the vulva, the mother of all living things that gives birth to all creatures on earth. When inverted it represents the masculine form and when joined with the V, the shape of the hexagram is formed which is the symbol of procreation, divine union and harmony. However here in this image we have the feminine V symbol and the image of Cernunnos standing behind as one of the most important deities in the pantheon of ancient deities, a god of male animals, fertility and the wilderness. Whilst this might seem strange to our modern sensibilities, this imagery may give us an insight into the more earthy, nature-centred beliefs of our distant ancestors some three millennia ago where procreation of animals and people was central to their survival.

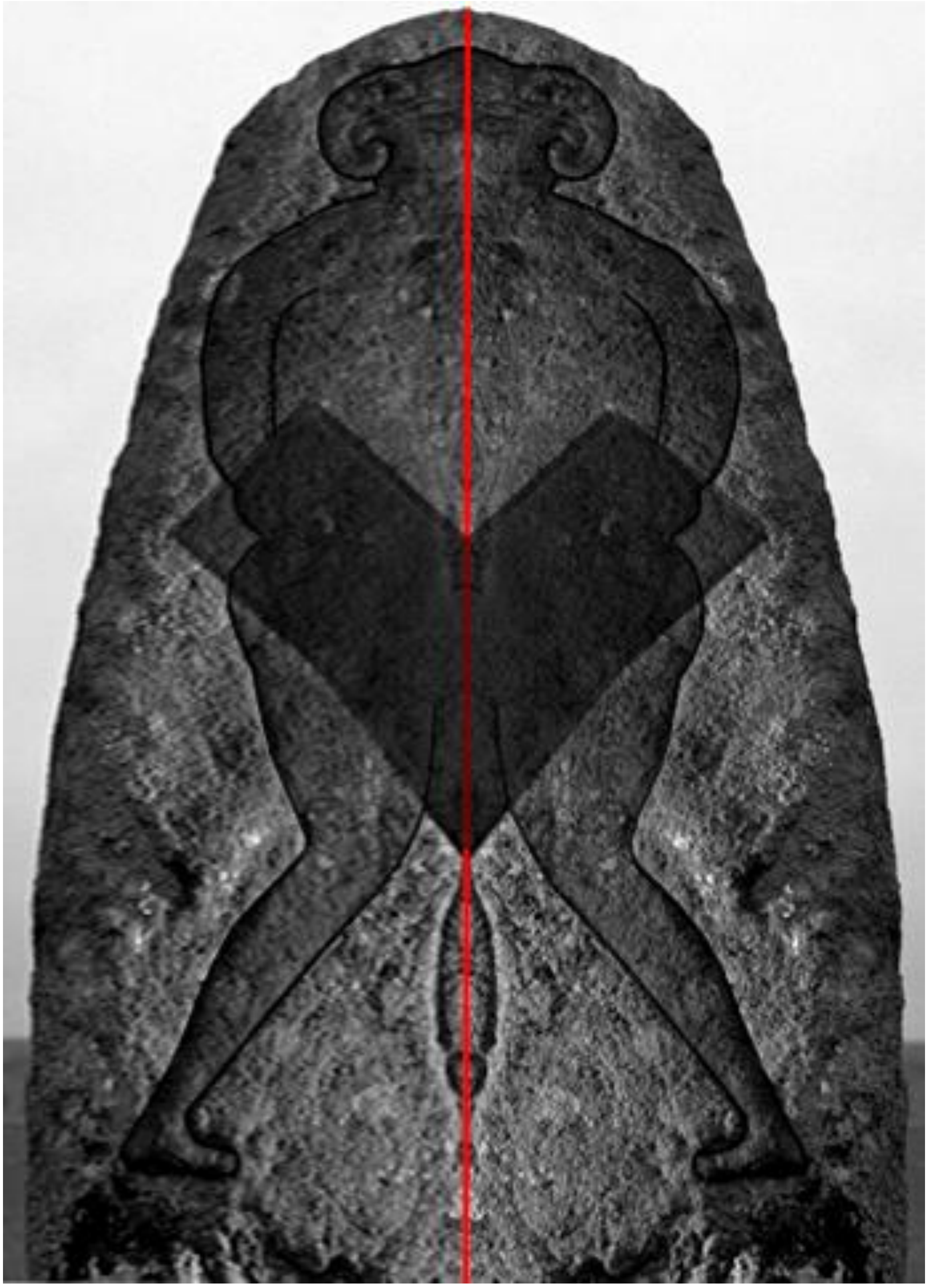


Image 64 The upper half of the God Cernunnos is consistent with the way in which this Celtic God of the Woods was represented usually with deer antlers but sometimes with ram's horns and a beard.

The god Cernunnos was associated with fertility and regeneration and the master of wild animals. The Romans identified the Celtic God Cernunnos with Mercury and it is interesting that there are faint, possibly intended, indentations seen in the stone behind Collessie Man's heels that have the appearance of small wings.

Image 65 Possible winged heel of Cernunnos as with the later Roman God Mercury with whom Cernunnos was later identified

Image 66 Cernunnos carved in stone with antler horns and torcs over the antlers.

Image 67(i) Gundestrup cauldron from Denmark, 150-1BC, Interior panel A

Image 67(ii) Gundestrup cauldron Interior panel C

It is interesting that the deity known as Cernunnos is often represented holding a torc and a ram horned serpent. The Collessie stone apart from having a carved image of a Pictish Spear-holding Man, has two other Pictish symbols carved on it. These symbols now are quite worn and difficult to see clearly but are the Kelpie symbol carved above the Horseshoe symbol. This is interesting because the horseshoe has the same shape as a torc and the Kelpie symbol that was identified with the constellation of Monoceros has a strange beast that has what appears to be either a spout of water emanating from his head or a curly horn. After the Picts, the constellation was identified with the Unicorn another mythical creature with a single horn positioned on its head that maybe not coincidentally is replicated by the position of a nebula above the head of Monoceros, the Unicorn, called The Cone Nebula (NGC 2264).

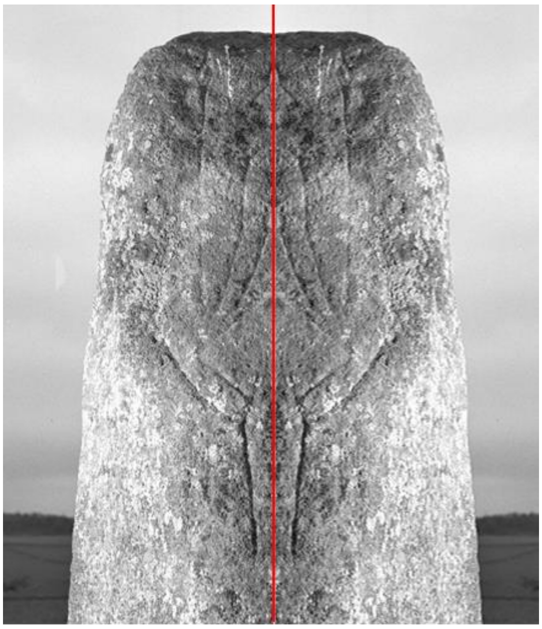


Image 68 Reflection of left-hand side in the axis going through the man's nose

The opposite direction reflection in the same axis produces legs that are vertical with outward pointing feet though the feet themselves are so lightly carved or weathered that they are barely visible. However, there is another interpretation of the image as there is a similarity in appearance of the reflected image with female genitalia including the appearance of faintly carved fallopian tubes. There is also the appearance of a "V" and "A" as representing the female and male respectively.

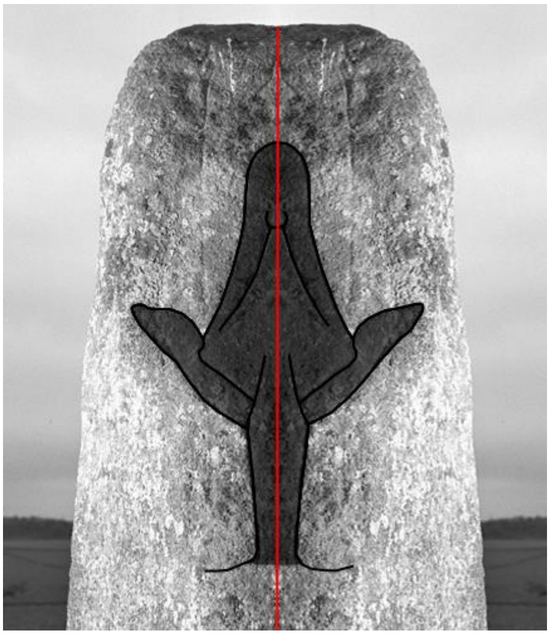


Image 69 Shaded area of Image 68 shows the possible portrayal of a female genital on the same vertical axis that produces the image of the fertility god Cernunnos. The representation is similar to that observed on the Rhynie stone on the Sekhmet reflection.

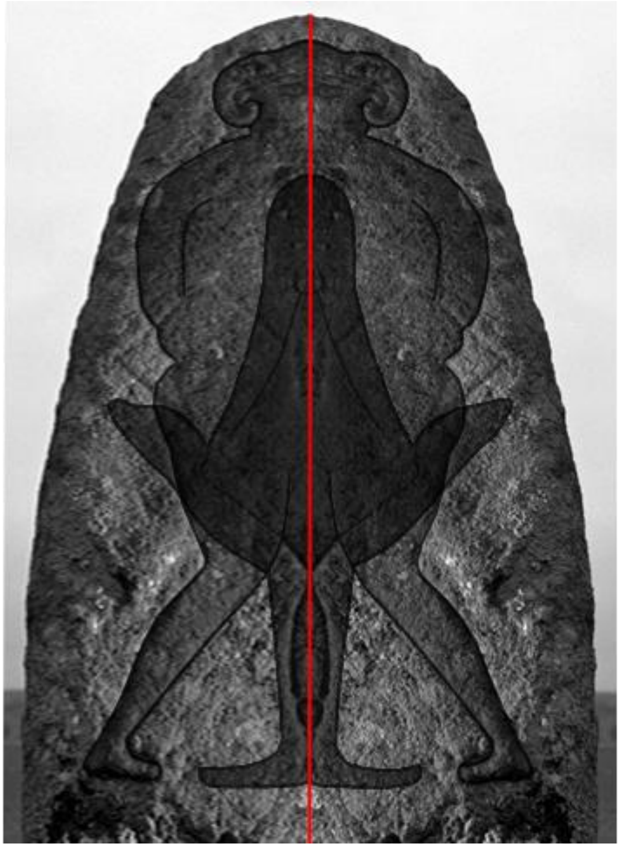


Image 70 Combining the reflections from both sides of the vertical axis produces an image where the head and upper torso of Cernunnos can be seen and below there appear to be two pairs of legs one set spread apart with in-pointing feet, the other standing straight with, out-pointing feet.

It may be that the straight legs are those of Cernunnos and the splayed legs are those of a female. The subjective interpretation of the pattern of reflection from the left-hand side to the right is that it represents the female form which may be consistent with the association of the deity Cernunnos as a male god of fertility. In any event the transformation of Collessie Man into the god Cernunnos appears to be quite convincing and replicates the transformation seen in the stone from Rhynie where the image of a carved man was similarly transformed into a deity, in that case the lion-headed female deity Sekhmet.

The Search for the Collessie Telescope

Given the similar manner of carving of the Collessie and the Rhynie stones and the fact that a vertical axis through the nose of the carved man on each stone produced a reflection of an ancient deity, perhaps the three axes required to produce the component parts of a reflector telescope are also similarly arranged for the Rhynie and Collessie stones. The Rhynie stone was found to have three axes arranged as a "Z" or rather the horizontally flipped image of a "Z" just as it usually appears on the carved Z-Rod Pictish symbol. In the case of the Rhynie Man Stone, the diagonal axis was marked by the absence of a carved line where it should have completed the shaft of the axe, in the case of the Collessie stone there is no such missing carved line but the shin of the left leg of Collessie Man appears to be unnaturally straight and was selected as the potential diagonal axis.

Image 71 Shows Axis 2 as an extension of Collessie Man's straight left shin

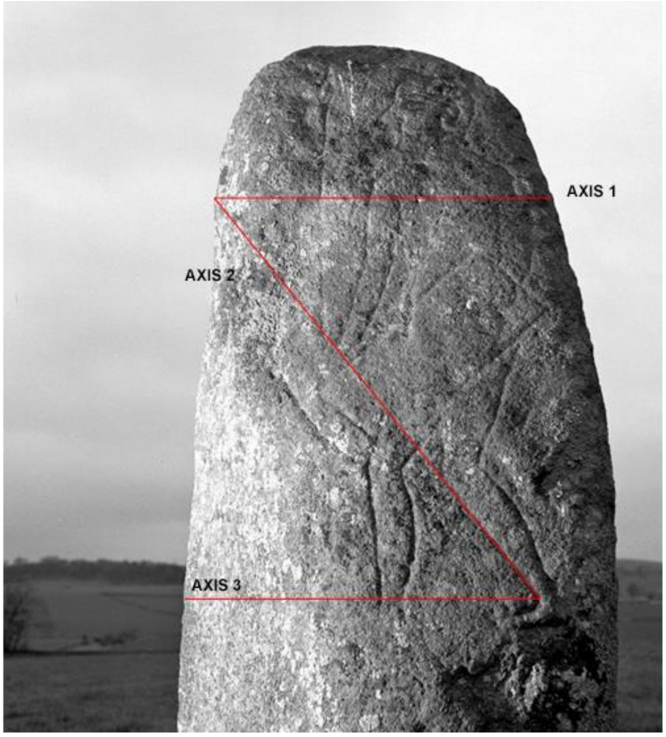


Image 72 Proposed “Z-Rod” arrangement of three axes of reflection on the Collessie Stone similar to that used on the stone from Rhynie, where Axes 1 and 3 are parallel and form an acute angle of 52 Megalithic Degrees (4x13MD) with the diagonal Axis 2 which is an extension of the straight line forming Collessie Man’s left shin.

Image 73 Left hand side reflection of Collessie Stone diagonal Axis 2 (Reflection C Image 89). The legs appear to form what may have been either the stand for the telescope or perhaps more likely given the relative dimensions, the support for the secondary mirror situated above the primary mirror.

Image 74 Possible support for the secondary mirror (shaded in grey). The support may have consisted of three narrow arms for maximum stability and to minimise the area of mirror shaded by the mirror support.

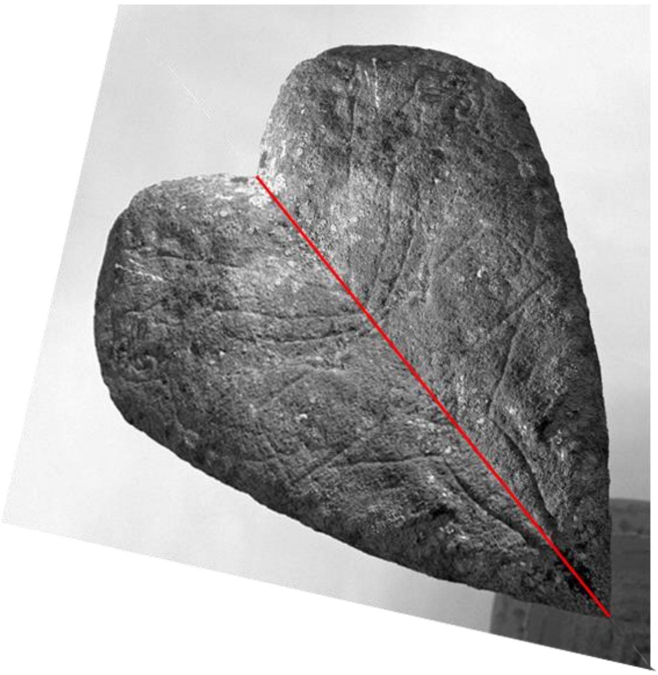


Image 75 Reflection in the diagonal Axis 2 from the opposite right-hand side produces something that has the appearance of an eyepiece. Reflection D in Image 89)

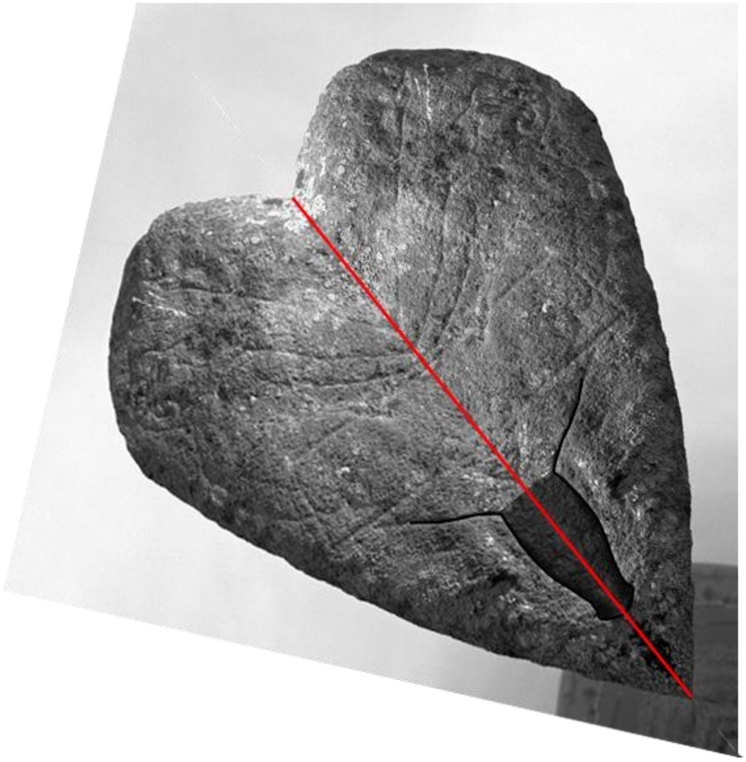


Image 76 The eyepiece from the reflectiom in Axis 2 has been shaded grey. The shape of the eyepiece is similar to that seen on the Rhynie Man telescope.

The eyepiece on the Rhynie stone also is revealed from a reflection in the diagonal axis, the difference being that in the case of the Collessie stone the eyepiece is formed from the shape of Collessie Man's calf whereas on the Rhynie stone the eyepiece is formed from the reflection of Rhynie Man's beard which shares the same pattern of curvature.

If the axes form a "Z-Rod" then we would expect to find two parallel axes that are perhaps perpendicular to the vertical axis that cut through Collessie man's nose in whose reflection appeared the deity Cernunnos.

The Collessie Stone has Three axes of reflection in the form of a Z-Rod as was the case for the stone from Rhynie. This coincidence is further supporting evidence that the images of telescope components are unlikely to occur simply by chance. It is also interesting to consider the angles between the horizontal parallel arms of the Z-Rod and the diagonal arm. If this was an intentionally carved Z-Rod carved then we might expect the angles to be expressed as megalithic degrees and to be either one of the Pictish important numbers or a multiple of one of those numbers. For instance, it might be expected that if carved intentionally, the angles chosen to represent the "Z" might be the special Pythagorean triplet hypotenuse numbers and the special megalithic degrees used to calibrate pendulums. Especially as the Z-Rod was a ceremonial compound pendulum that could be used to calibrate other pendulums by suspending the Z-Rod pendulum on one of the different hooks at the spear end. The special numbers used by the Picts in their measurement system were 13, 16, 17, 23, 27,29, 32, 34,37 and 41. The acute angle between the diagonal and the horizontal arms on the Z-Rod axes in the case of the Collessie stone is 52 Megalithic degrees which is 4x13MD. In the case of the Rhynie Man Z-Rod the angle was measured as 34MD. Therefore, in both cases whilst they are different, both angles are integer values of Megalithic degrees and can be regarded as consistent with respect to representing the special Pictish angles.

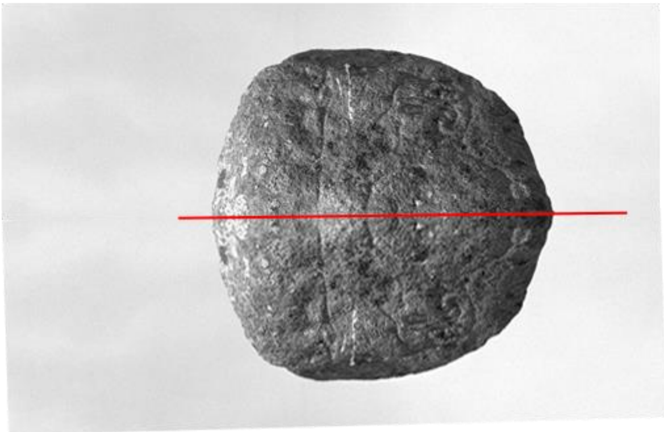


Image 77 Collessie Reflection from above downwards in Axis 1 Reflection B in Image 89.

Head of Collessie Man reflected in Axis 1 comprising the upper horizontal arm of the Z-Rod trio of axes.

The Circular shape which appears below Collessie man's chin may represent a secondary mirror

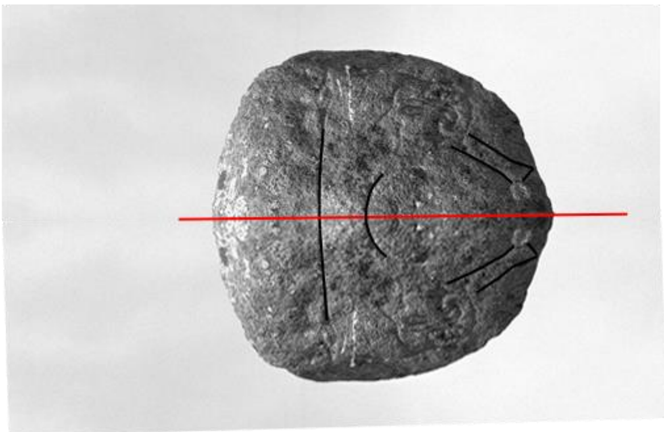


Image 78 Possible curved secondary mirror in black beneath Collessie Man's nose.

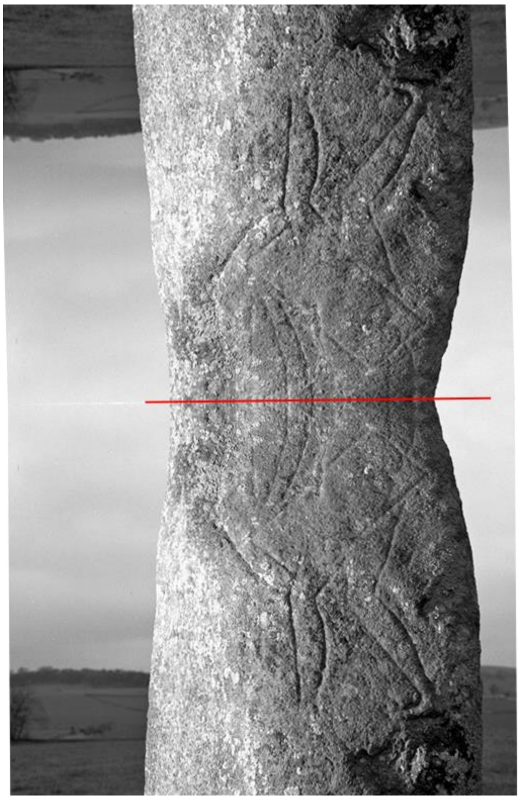


Image 79 Upwards Reflection from below Axis 1. Reflection A in Image 89

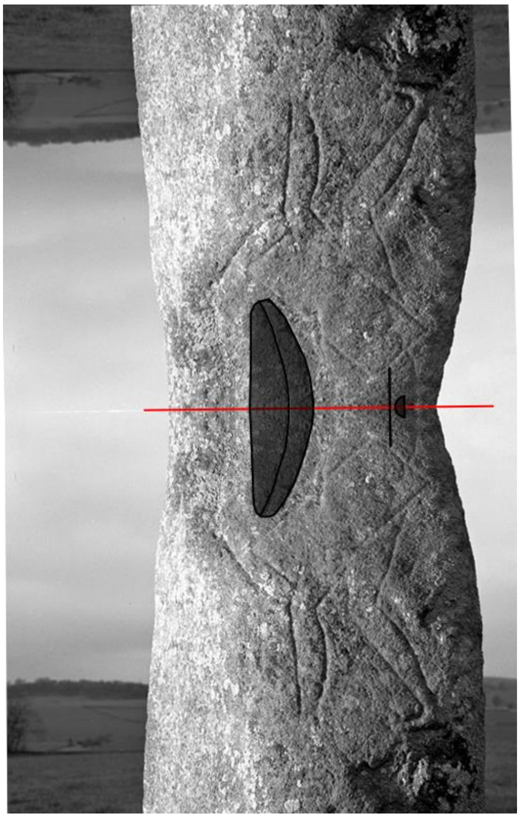


Image 80 Reflection in Axis 1 from below the axis upwards shows what looks like a bowl and a small curved arc to the right which may be the secondary mirror that fits into the supporting arms seen on the opposite reflection in the same axis. The perfectly straight-line reflection seen to the left of the curve may be a simple device for showing when the precise location and orientation of Axis 1 has been achieved.

The Eyepiece obtained from reflection D in Axis 2 can be added onto the primary mirror bowl.

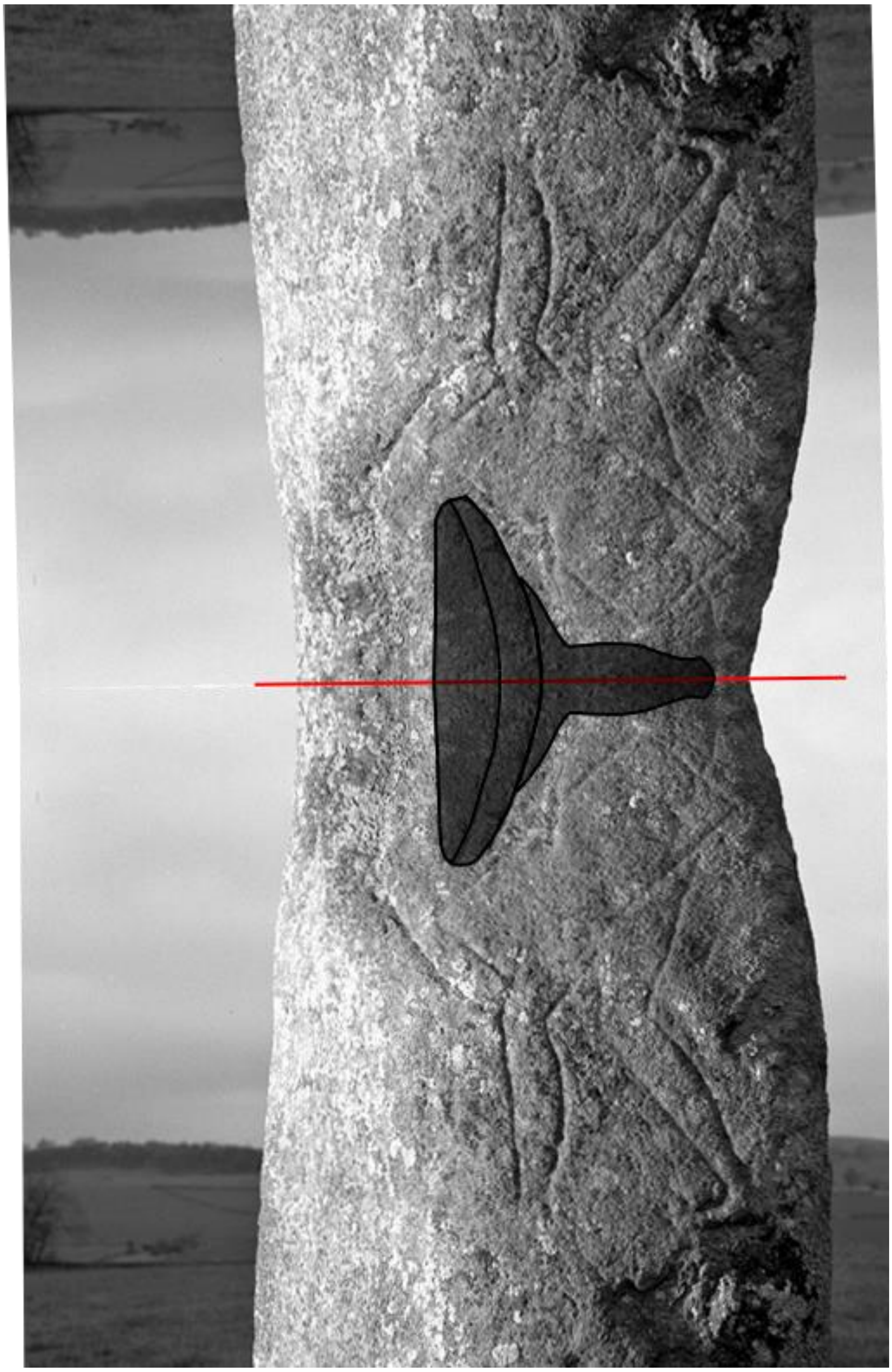


Image 81 The bowl containing the primary mirror and the eyepiece

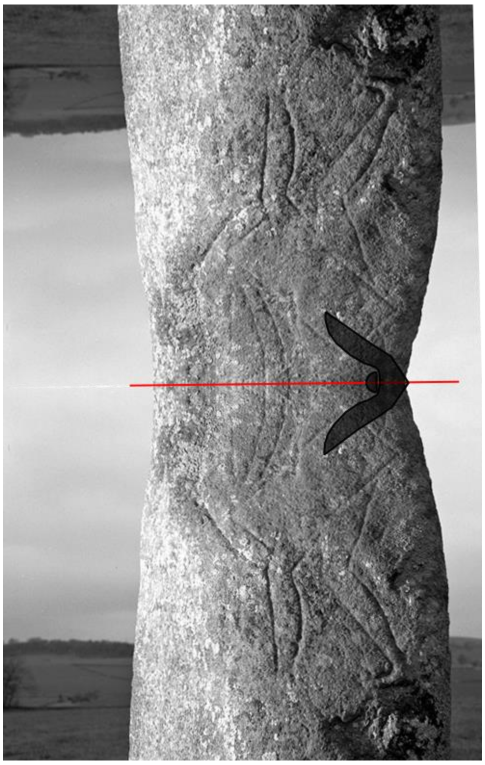


Image 82 Reflection A in Axis 1 and Reflection C in Axis 2 combined to show possible arrangement of Secondary Mirror and its support.

Combining the Secondary mirror and supports with the Bowl and Eyepiece produces the following image.

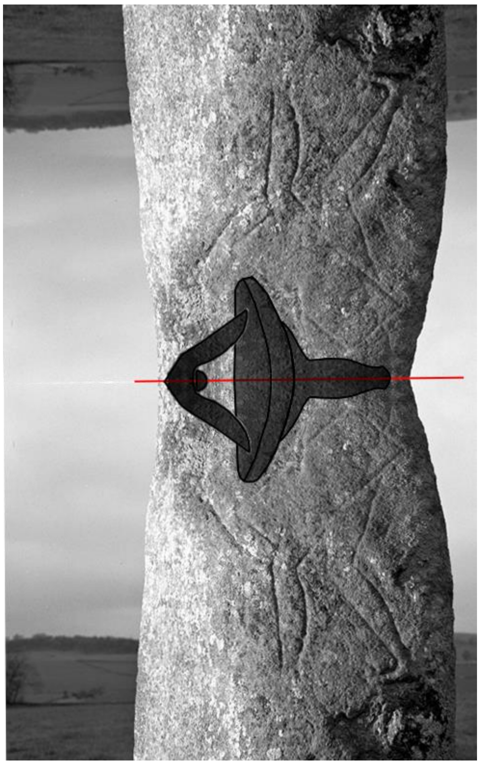


Image 83 Reflections A, C and D combined to give the secondary Mirror, the primary mirror bowl, the Eyepiece and the Secondary Mirror supports.

Reflection in the third axis gives a parabolic carved curve that transforms the same line marking Collessie Man's calf into what could be the primary mirror of the telescope, furthermore the curve at the heel makes a central gap in the curve which would provide the hole in the primary mirror for light rays from the secondary mirror to be reflected back through the hole to the eyepiece.

Image 84 Reflection of the top of the stone in Axis 3 reveals a parabolic curve formed from the calf of Collesie Man's left calf. Reflection E in Image 89

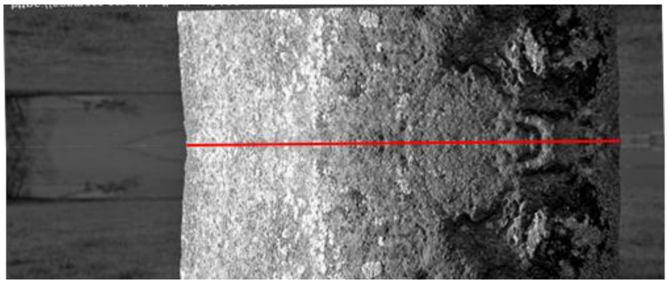


Image 85 Reflection of the bottom of the stone upwards in Axis 3 may show the central hole in the primary mirror

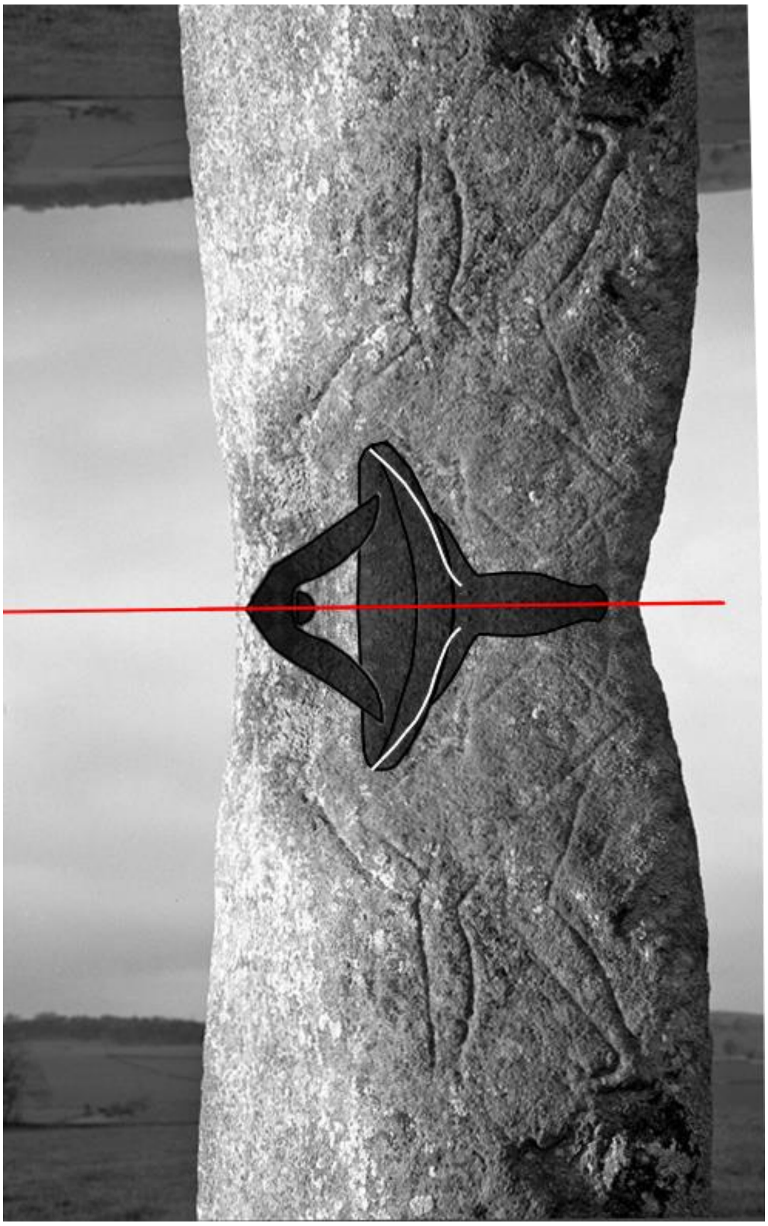


Image 86 The Primary Mirror from Reflection E in Axis 3 shown in white can be combined with the Secondary Mirror, the supports, bowl and eyepiece to obtain a functional reflector telescope. The only missing part is the stand on which to mount the telescope.

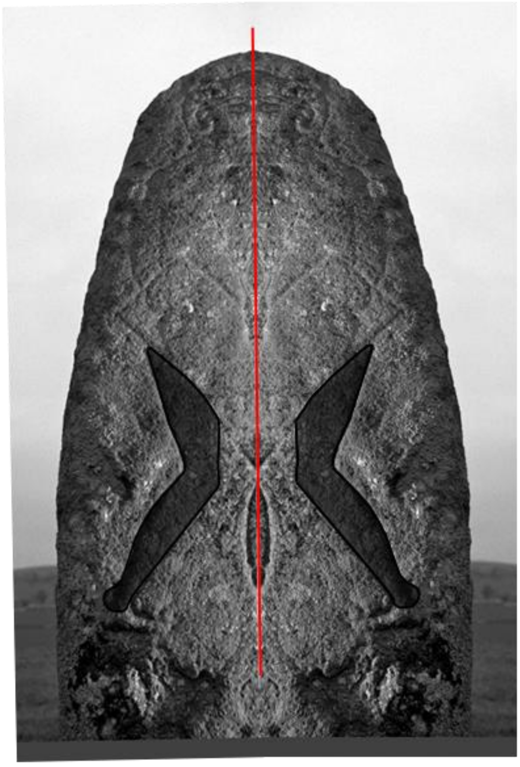


Image 87 The original axis that converted Collessie Man into Cernunnos can be used to obtain the stand that was used to support the telescope. Reflection F in Image 89.

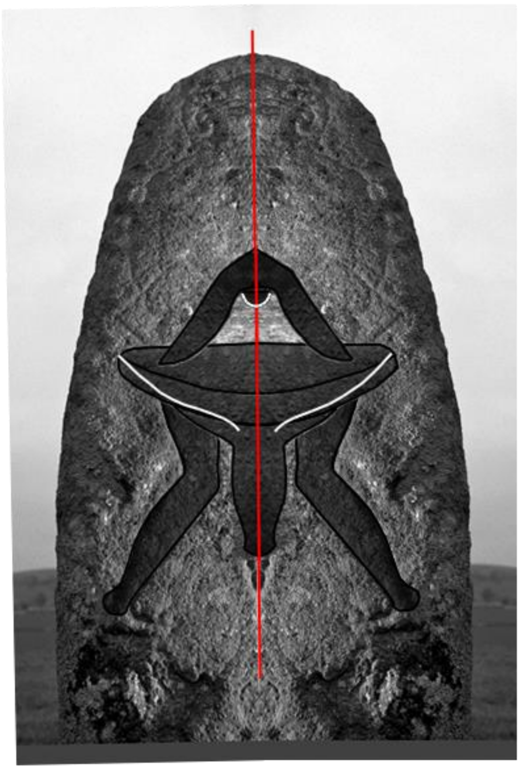


Image 88 The component parts of the telescope obtained by reflections in three axes can be assembled to form a reflector telescope with Cernunnos standing over it.

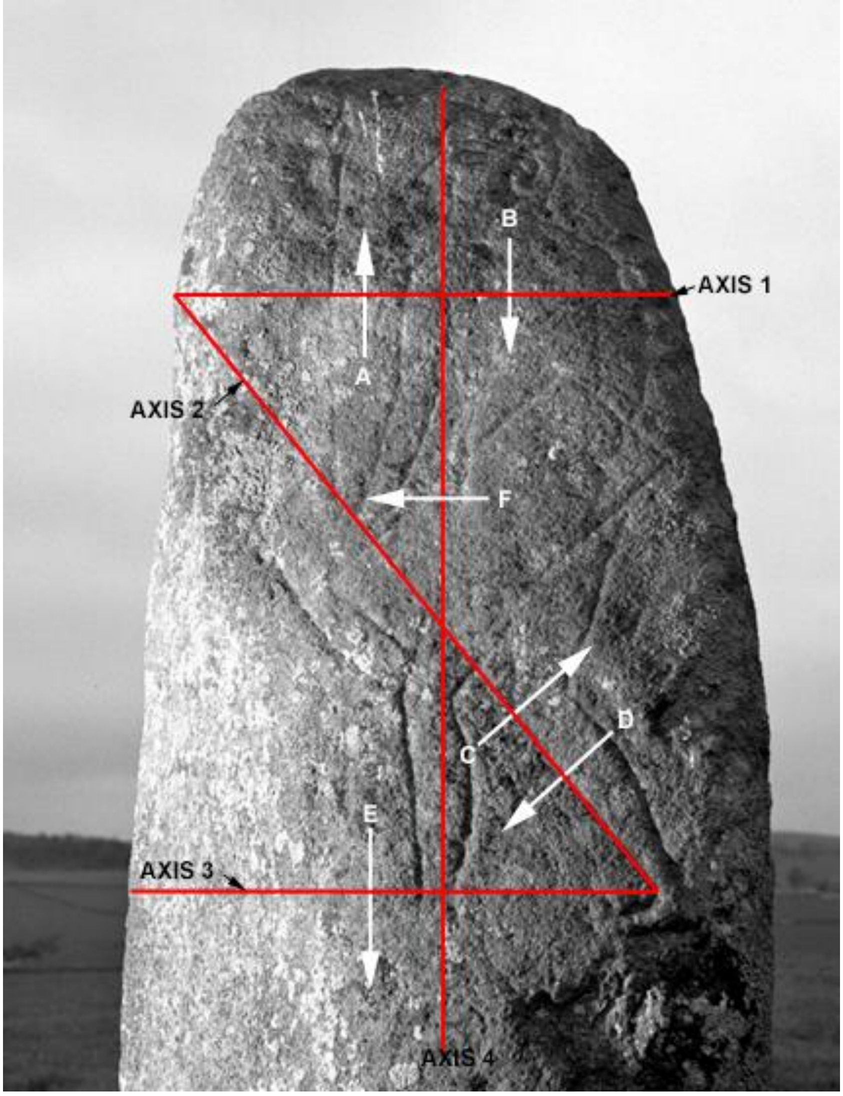


Image 89 Collessie Stone Axes and reflections A-F required to form the component parts of a reflector telescope.

AXIS	Reflection	Component
1	A	Bowl for Primary Mirror and Eyepiece Lens
1	B	Secondary Mirror
2	C	Secondary Mirror Support
2	D	Eyepiece
3	E	Primary Mirror with Central hole
4	F	Telescope Stand

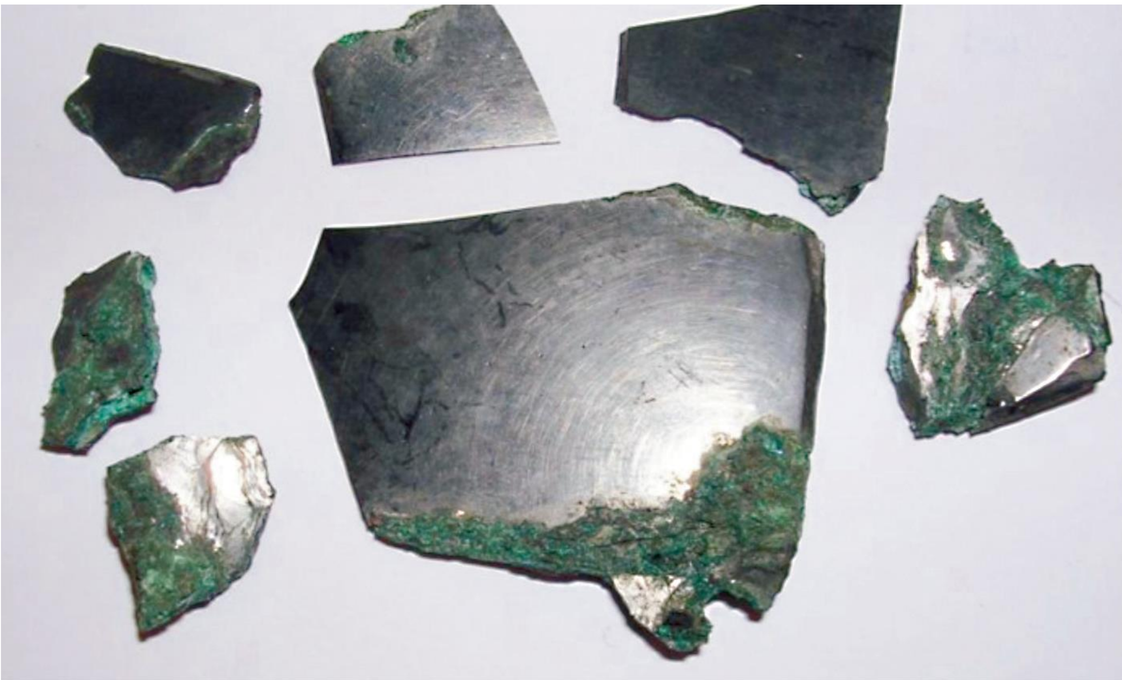
Table 2 Summary of the components produced by the various reflections in the four axes shown above in Image 89.

Physical Evidence for a Prehistoric Telescope

There is of course the issue that the only evidence that a prehistoric telescope must have existed are the carved patterns in stone that resemble deep space objects together with a carved quadrant symbol that gives a declination that is consistent with a known galaxy or nebula that shares a similar appearance to the carved image. For these carved images of deep space objects and their declination to be known, the conclusion is that a telescope must have already been developed by the time that Picts carved these Class I stones. The telescopes that can be made to appear from carved stones using a mirror to produce a series of reflections may be considered by many as a step too far but it is interesting that it can be done is a way that is consistent and produces four telescopes from four stones carved with the image of a man.

The search for evidence

If the proposal that the broch was an ancient observatory is correct, then perhaps, this would be a good place to look for artefacts that may have formed some part of an ancient telescope. A variety of artefacts have been found inside brochs including evidence that bronze making activities were common place inside brochs, where clay moulds for casting a variety of bronze objects have been found together with querns and other materials that may have been utilised in grinding and polishing operations. However, the most important artefacts that would help to support our ideas, those that could be identified in some way as component parts of a working telescope, are sadly lacking. Whilst it might be expected that a telescope built from wood would not survive millennia in the ground and that a small rock crystal eyepiece would be easily lost, the two metal mirrors proposed for a reflector telescope would have a chance of surviving for a considerable time but it might also be expected that the valuable metal used to form the mirrors would be recycled to form other useful items once they became redundant rather than being left to slowly corrode away. There is also the consideration that an instrument involved in the observation of the heavens might be considered as a dangerous object to have in your possession given the way in which later, the church considered the old worship of stars and deep space objects and telescopes may have been destroyed to avoid any danger of being accused of witchcraft. Despite our low expectations that artefacts associated with a telescope had been found by archaeologists but not recognised as such, we searched through the catalogued artefacts obtained from brochs during various archaeological digs. Scanning through lists of artefacts stored at the Hunterian Museum in Glasgow, there, amongst the usual pieces of bone, pins, lead weights and combs retrieved from a dig at Leckie Broch in Stirlingshire, were some shiny metallic fragments. In the archaeologist Euan MacKie's Interim Report on the excavations carried out at Leckie Broch in Stirlingshire between 1970 and 1978, he describes a **"*shattered mirror is of first century manufacture*"** The broch itself is considered by archaeologists to have come to an abrupt and violent end sometime in the first century AD and perhaps this explained the presence of so many artefacts. The possible mirror fragments stood out from all the other artefacts due to the brilliance of the metal and remarkable state of preservation of the albeit broken fragments.



Mirror Fragments recovered from Leckie Broch in Stirlingshire, during excavations between 1970-78 now stored at the Hunterian Museum. (The largest fragment in this magnified image is less than an inch long).

The author visited the museum store in Glasgow in October 2007 and was kindly given access to the fragments to determine whether the fragments could have once formed a telescope's primary mirror. The appearance of the metal fragments was very unusual in that they were highly polished and there was only a relatively small amount of green copper oxide corrosion product evident along the broken edges. Indeed, a reflection can still be seen in the ancient mirror that was supposed to date from 100AD. In other words, here was a mirror that despite having been buried in soil exposed to the Scottish elements for over 1900 years, still gave a reflection. This was a fortuitous discovery but something was strange about these fragments because they would be expected to have completely corroded a long time ago. A laser beam was used to determine the angles of reflection of the incident beam from the surfaces of the mirror fragments. A series of parallel incident rays were shone onto the largest mirror fragment placed vertically in a small stand formed from "blue tac". The reflected rays were marked on a graph paper base. A plane mirror should give parallel reflected rays but here we saw the unmistakable convergence of the rays to a single point.

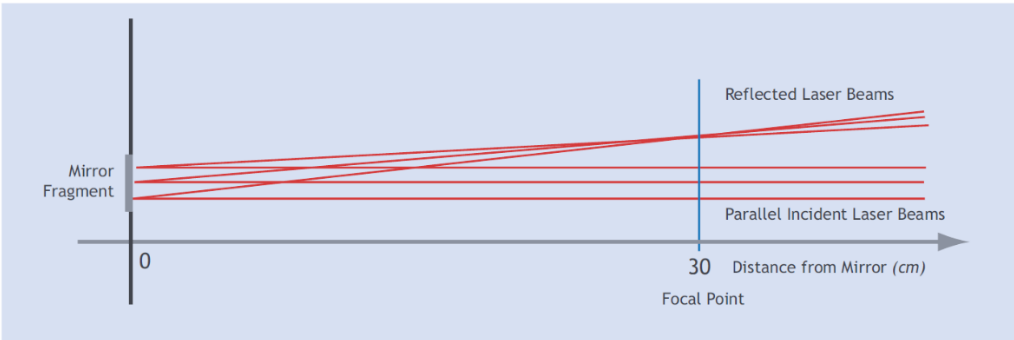


Diagram to show convergence of incident rays reflected from a mirror fragment from Leckie broch stored at the Hunterian Museum, Glasgow.

This is not a straightforward operation because the largest fragment was no more than about an inch square and it was not clear from what part of the larger original mirror it came from and what angle the incident light should be directed from. The approximate focal point was estimated to be around 30cm, that is the same as that found in the plan for the Bullion telescope. The curator Dr Sally-Anne Cooper very kindly supplied a tiny broken fragment to study in order to determine its metallurgy and surface structure. The remarkable thing about the mirror was the relative lack of corrosion.

The tiny piece of mirror was taken to the MacAulay Institute in Aberdeen for various analytical investigations. The first investigation involved the use of a Scanning Electron Microscope. The surface was examined for scratches and evidence of polishing. The pictures below show that there appear to be two types of straight scratches some fine striations that run parallel to each other to deeper marks that run in random directions on top of the finer parallel scratches.

SEM Analysis
Image Report
25 January 2008

Sample ID: **Archaeological Artifact**

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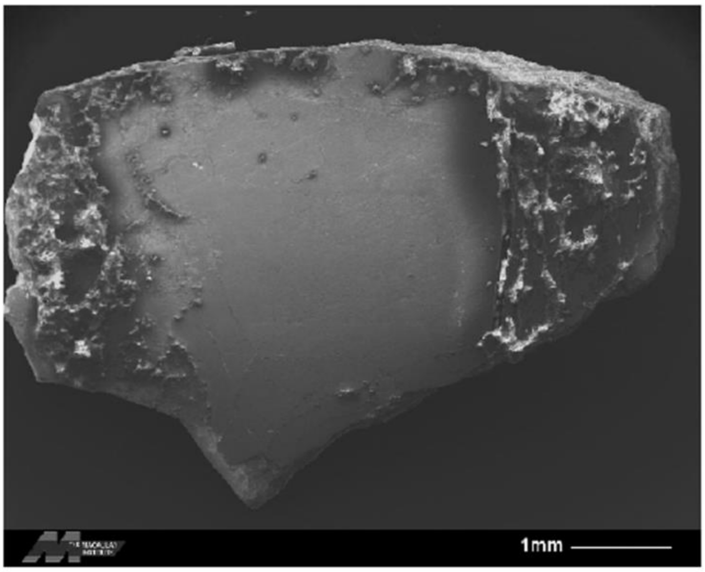
Collected: January 25, 2008 16:29:48



Width(µm):	7009.43	Height(µm):	5257.07	µm/pixel:	6.845

Scope magnification: 35X

Plate 1: SEM image of whole fragment

This might represent a mirror that has been turned during polishing. The deeper random "top" scratches might represent later attempts at hand polishing where small particles of grit have caused some deeper scratches to form. In any event the presence of two sets of distinct "polishing" marks might suggest that the mirror was used before it was broken. In other words, the mirror was useful and did not represent a failed attempt at moulding a mirror.

SEM Analysis
Image Report
25 January 2008

Sample ID: **Archaeological Artifact**

File: D:\MACAULA...lfield Mineral Solutions\2008-5997c\919600-b1_Img1.tif
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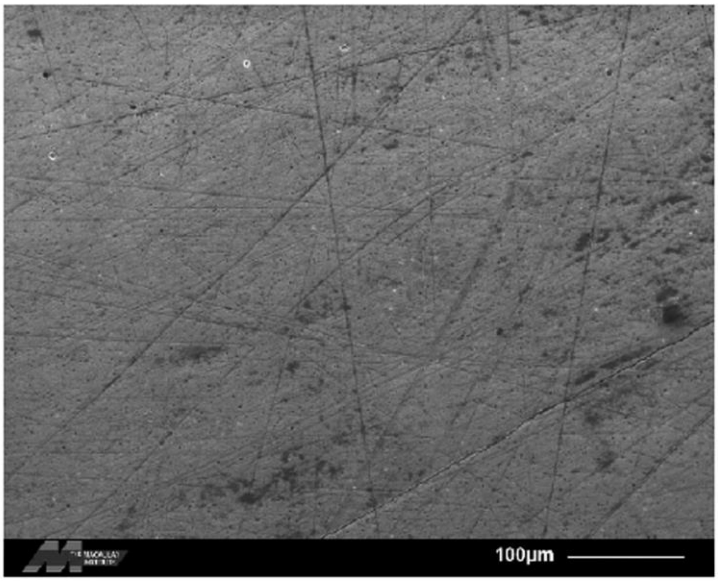


Width(µm):	607.88	Height(µm):	455.91	µm/pixel:	0.594

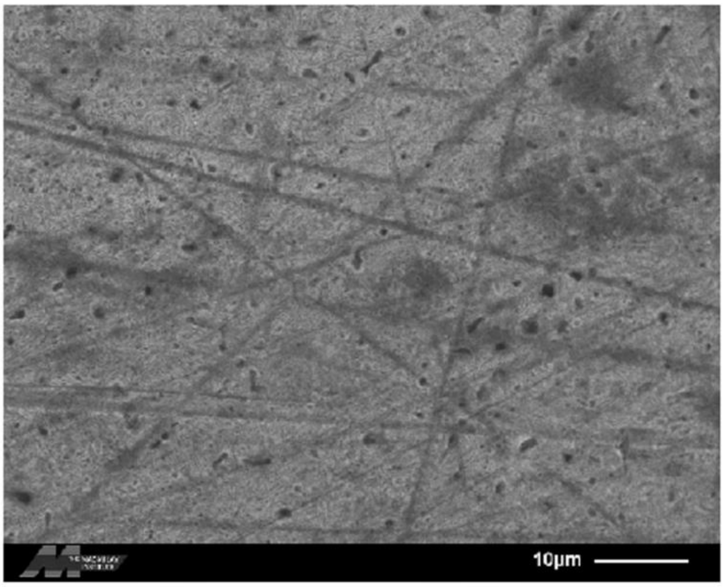
Scope magnification: 400X

Plate 3: SEM image of area 1

SEM Analysis
Image Report
25 January 2008

Sample ID: **Archaeological Artifact**

File: D:\MACAULA...ilfield Mineral Solutions\2008-5997c\919600-d_Img1.tif
Collected: January 25, 2008 17:10:08



Width(µm):	77.59	Height(µm):	58.19	µm/pixel:	0.076

Scope magnification: 3200X

Plate 5: SEM image of area 1

The SEM analysis of the surface shows that the metallurgy consists of Copper, Tin, Lead and Iron. This is what we might expect for an ancient bronze mirror from this period but doesn't tell us the relative proportions of these metals. The first reported mirrors manufactured in the seventeenth century for reflector telescopes were made of speculum, a bronze alloy consisting essentially of 68% copper and 32% tin. The next test involved the digestion of a small fragment of the mirror in nitric acid before analysing the dissolved metal ions using plasma emission spectroscopy.

The results showed that only 49% of the mirror fragment was soluble in Nitric acid. The acid soluble metal was composed mainly of copper, with trace amounts of tin, lead and iron. The most surprising result came from the discovery that the insoluble properties of the mirror came from the incorporation of silica into the mirror matrix, in other words the mirror seems to be a mixture of metal and glass but unlike modern mirrors where the metal (usually silver) is coated onto the glass surface, here the metal and glass appeared to form a homogenous mixture. Perhaps white sand and the different metals were put into the furnace together and melted to form a homogenous mixture of glass and metal that was then poured or blown into a mould to give the required mirror curvature. Or flat sheets of the mirror were made that were then placed on a surface of the required curvature and reheated to a temperature that allowed the sheet to adopt the required curved shape by reaching a plastic rather than liquid state.

The analysis of the metal fragments gives the final composition (see appendix) and reveals that the ancient mirror consisted mainly as a mixture of Tin, Copper and lead (29%, 29% and 11%) within a glass matrix that protected the mirror from oxidation. Pictish man by the start of the first millennium appears to have had a very advanced level of metallurgical technology.

Mirror Analysis Results

In conclusion it appears that the mirror fragments represent an unusual type of mirror that we have not seen before in any other mirror artefact from any time, having a composition of glass, copper and tin present as a homogenous blend. As the broch was destroyed by fire around the first century, the artefacts recovered from the archaeological excavation are believed to date from this time as there is no evidence of subsequent habitation of the broch. The mirror could of course have been brought to the broch at a later date and broken but as we have seen the nature of the mirror is unlike any mirror that we know about from a later time and it therefore seems more likely that the mirror fragment dates from before the time when the broch was destroyed. The fragments recovered represent only a small fraction of the size of mirror that would have been required to provide a primary mirror for a reflector telescope and perhaps there are still other fragments of this mirror buried at the site. There is evidence that the mirror has a shallow parabolic curvature in-keeping with its proposed function as a primary mirror for a telescope but to date this is the only hard physical evidence we have for a prehistoric telescope.

Conclusions

Four megaliths carved with the Pictish symbol of a Man can all be transformed from a man to something else. The Rhynie Man stone from Rhynie, Aberdeenshire is transformed into the lioness headed goddess of Ancient Egypt called Sekhmet, the Bullion man stone from Dundee and horse is transformed into the Cauldron of Plenty, the Golspie Man stone from Dunrobin is transformed into the head of a lion whilst Collessie man, from Fife is transformed into the horned god Cerrunnos.

The component parts of a reflector telescope can be revealed on each of the four Pictish stones by reflections of the carved lines in three or four axes. The Rhynie man stone and Collessie Man stone axes form three axes in the shape of a Pictish “Z-Rod” symbol. manipulated by choice of 3 or four axes to produce component parts of a reflector telescope. The precise position of the axes of reflection seem to be indicated by the appearance of a cathead and snake head when a reflection is made at the correct place

Appendix I

ANALYTICAL REPORT

Analysis of an Archaeological Artifact

Test Methods

1. SEM/EDS
2. XRD
3. ICP-OES

Introduction

A small fragment of a possible two thousand year old telescope mirror was forwarded to the Institute to observe it under the Scanning Electron Microscope (SEM) and to try and determine its elemental composition in an attempt to understand how it had been manufactured. In addition to SEM, the sample was analysed using Energy Dispersive Spectroscopy (EDS), X-Ray Diffraction (XRD) and Inductively Coupled Plasma-Optical Emission Spectroscopy (ICP-OES).

Results

SEM/EDS Analysis

A portion of the sample was mounted, shiny surface uppermost, onto a standard aluminium SEM stub using a double-sided carbon tab as the adhesive. The prepared sample was analysed using a Philips XL20 SEM operating at an accelerating voltage of 20kV. Characterisation of the material analysed was aided by EDS, which provides an elemental composition of the material analysed. The EDS detector is equipped with an ultra thin window allowing qualitative analysis of elements down to carbon.

Digital SEM photomicrographs (Plates 1 to 7) were acquired at an accelerating voltage of 20kV. The uncertainty associated with quoted measurements is ±5%. SEM Plates are presented in the Appendix.

The shiny surface is scarred with perfectly straight scratches. They are best observed in the x400 images (Plates 3, 6, 7), which cover three different areas of the sample. In area 3, there are a couple of additional scratches which are not so straight and terminate with an imprint feature. These are thought to have occurred after the polishing process whereas the straight lines may relate to the polishing process.

An EDS spectrum (Figure 1) representing a qualitative elemental composition of the mirror was also collected. This reveals that the main detectable elements consist of tin (Sn) and copper (Cu). The alloy also contains some lead (Pb) and iron (Fe), these probably in much smaller amounts.

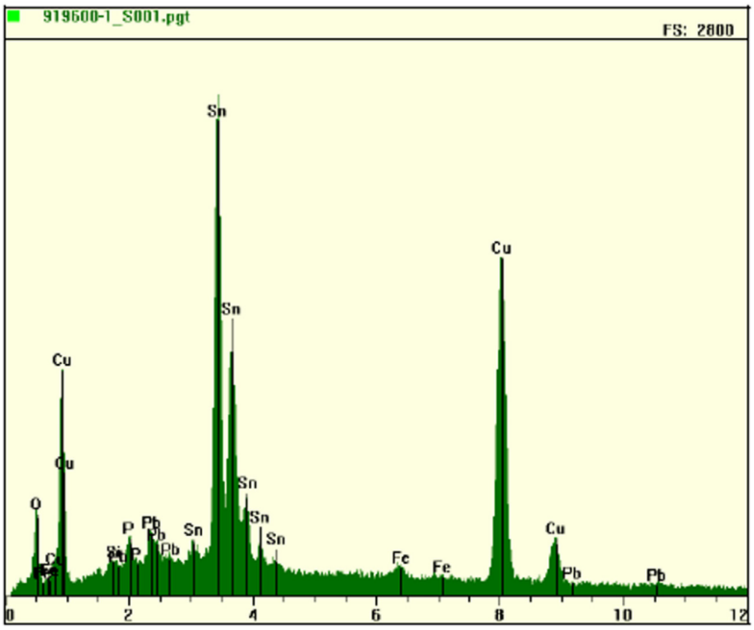


Figure 1: EDS spectrum of shiny surface

XRD Analysis

An XRD pattern was obtained by placing the object on a glass slide positioned so that the flat surface of the object was on the focusing circle of the diffractometer. A small amount of NBS silicon 640a was dusted onto the surface of the object to act as a d-spacing standard. A diffraction pattern was obtained, and the peaks from silicon are in the expected positions indicating that the specimen was correctly placed. Aside from the added silicon the other peaks in the pattern appear to provide satisfactory matches to some form of copper-tin alloy, three examples of which are illustrated (Figure 2).

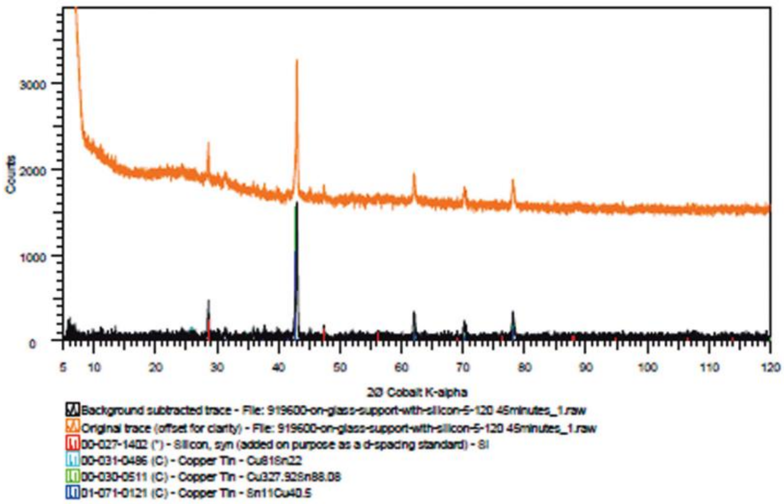


Figure 2: XRD Patterns

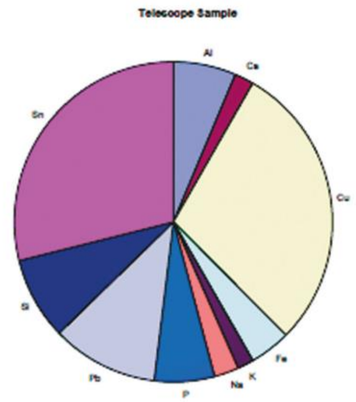
ICP-OES Analysis

A small fragment of the sample (2.7mg) was dissolved completely in hydrofluoric acid (HF). The HF solution was then evaporated to dryness and the residue was dissolved in nitric acid. It is possible at this stage that some of the silicon present in the sample could have evaporated as silicon tetrafluoride (SiF_4), but without the facility to analyse HF samples directly, no alternative means were available.

The residue was dissolved in nitric acid and analysed quantitatively by ICP-OES. It was found to consist of the 10 elements listed below and in their respective concentrations. It cannot be ruled out that the sample was not contaminated from the ground in which it lay for 2000 years and it must be noted that XRD analysis was carried out prior to ICP-OES analysis and the sample was coated with NBS silicon 640a. Although the sample was cleansed by rinsing with deionised water prior to dissolving in acid, the small size of the sample meant that this may not have been wholly effective and that it may have been contaminated.

Results expressed as percentage

Sample	Al	Ca	Cu	Fe	K	Na	P	Pb	Si	Sn
Telescope sample	6	2	29	4	2	2	6	11	8	29



Appendix II

Rhynie Man Telescope Calculations

In order to accurately examine the curves, a photographic image of the Rhynie Man stone was blown up to its full size with the carved man's height of 103 cm. The points on the reflected image of the Primary mirror were plotted on a graph and then the best fit polynomial curve calculated.

The following measured points were determined on the curve of the arm but the curvature has to change as it approaches the elbow, changing from the shallow parabolic curve to a tighter curve.

The standard form equation describing the parabola is y=a(x-h)^2 + k

However, we can simplify this by drawing our grid reference over the curve such that the curve goes through the origin (0,0) such that the x or y-axis (depending on the orientation of the parabola bisects the curve. This in effect removes the terms h and k so that the parabolic curve can be described by the equation y = ax^2

The tangent to the curve becomes y' = 2ax which describes the gradient m_t at each point (x,y) on the curve. The line that is perpendicular to the tangent then has a gradient that can be described as m_p = -1/2ax
The line perpendicular to the tangent to the curve can be used to determine the path a ray of incident light takes when it is reflected at the surface of a parabolic mirror as the angle of incidence equals the angle of reflection. So that the angle of any in10cident light perpendicular to the directive of the parabolic mirror

X(cm)	Y(cm)
13	1.81
11	1.29
9	0.87
7	0.52
5	0.27
0	0
-5	0.27
-7	0.52
-9	0.87
-11	1.29
-13	1.81

The parabolic nature of the carved line changes at a radial distance of about 13cm we have assumed therefore that the functional diameter of the primary mirror is just over 10".
The mirror's curve describes a parabolic function that can be represented by the equation:

$$f(x) = 0.0107x^2$$

The tangent to this parabolic curve has a gradient that can be described by m=0.0214x. Taking the point (13,1.81), the gradient of the tangent to the curve at this point is 0.2782. The line going through this same point perpendicular to this line is the line that is "normal" to the surface of the parabolic mirror. It can be calculated since its gradient equals -1/0.26 = -3.5945. The gradient is equivalent to the tangent of the angle alpha between a horizontal incident ray of light and the line normal to the surface. This angle can be calculated by subtracting the value of the angle from 90 degrees. The angle of reflection equals the angle of incidence and by doubling the angle calculated (15.5465) we obtain the value 31.093 degrees. Since the angle of reflection from the primary mirror forms an alternate angle with the axis that bisects the primary mirror, we can calculate the focal point by firstly determining the tangent of 29.15 degrees to be 0.603075. The focal point x' = 13/0.5577 = 21.556 plus 1.81cm equals 23.366cm.

The secondary mirror has a curvature that appears to be hyperbolic the points measured on the reflected carved curve were as follows:

X(cm)	Y(cm)
3	0.43
2	0.73
1	0.86
0	0.9
-1	0.86
-2	0.73
-3	0.43

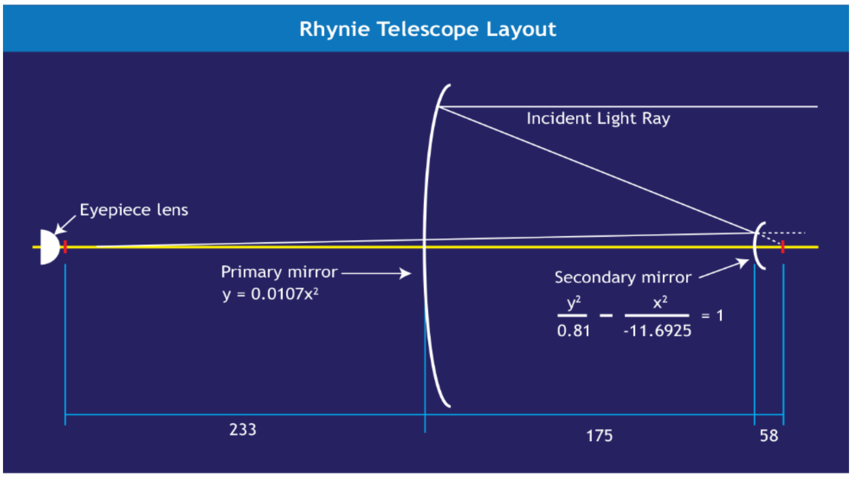
The secondary mirror curve can be described by

$$y^2/a^2 - x^2/b^2 = 1$$

To determine a^2 we simply substitute the value x=0 to calculate a^2=0.81 (0.9 squared). To find b^2 we can take the value x=2 for instance to obtain a value of -11.69252977 for b^2. The internal or "virtual" focus of this hyperbolic curve can be calculated by first considering the gradient of the tangent to the reflective surface by differentiating the hyperbolic function to obtain.

$$y' = ax/ (b^2(1+(x^2/b^2))^{1/2})$$

The normal to the surface can then be calculated in the form y = mx + c where
m = -1/y' and c can be obtained by substituting the known values of x and y such as (2, 0.73).
The angle of incidence of a ray of light can be determined by considering the gradient of the normal line since the incident ray is horizontal. The gradient of the normal is equivalent to the tangent and the angle of incidence i = 90 – atan(m) in this case
y' = -0.18979, m = -5.26885, i = 10.747 deg, angle = 21.493 deg, tan alpha = 0.39377 virtual focal point = 5.07+.73 = 5.8cm



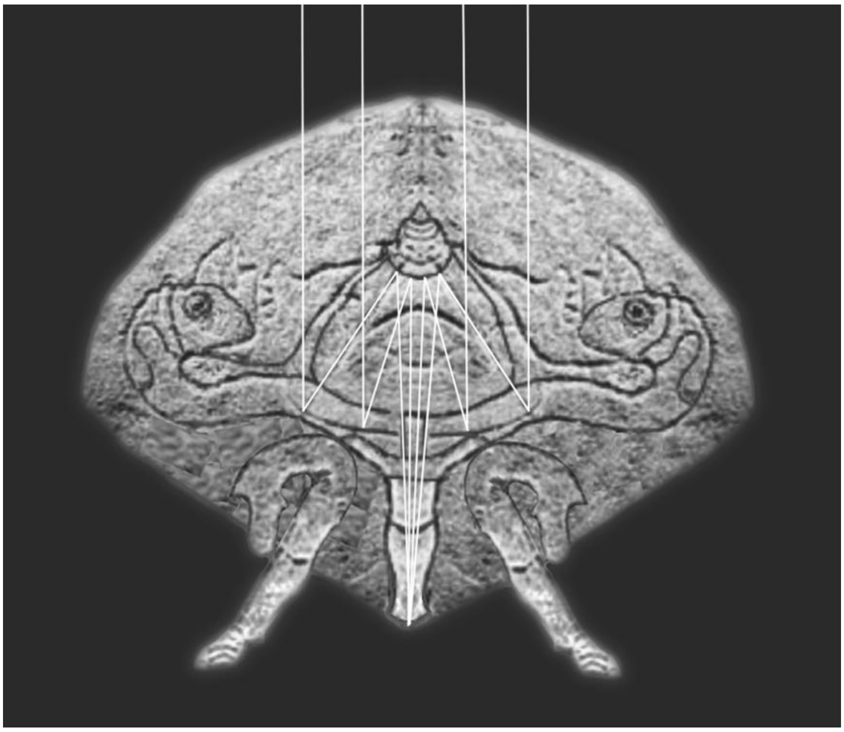


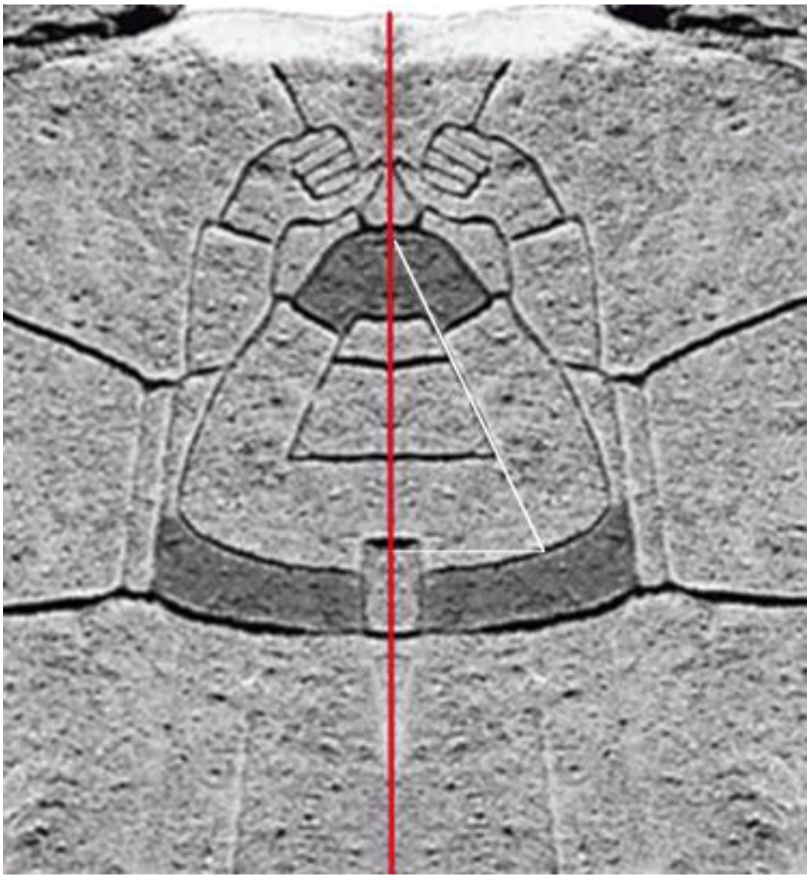
Image 23 Combined reflections forming a reflector telescope with the pathways of light shown in white

Image 24 Rhynie reflector telescope revealed from reflections in the Pictish stone

For the proposed telescope to function as a reflector telescope, several conditions have to be fulfilled. Firstly, there needs to be two mirrors and an eyepiece lens. Secondly the curvature of the mirrors needs to be correct, so that the primary mirror has a parabolic curvature and the secondary in this case where the primary has a central hole, needs to have a hyperbolic curvature. Thirdly, the mirrors need to be aligned at the correct separation from each other so that the primary and secondary mirror have a common focal and virtual focal point. The eyepiece also needs to be aligned at approximately the correct distance below the primary mirror but there is some flexibility here in that the eyepiece may be adjustable through sliding the outer upper sleeve up or down to focus an image.
It appears that in the case of the proposed telescope revealed by mirror reflections on the stone from Rhynie that these conditions are met. However, this is just one carved stone and perhaps we have made what is merely a set of coincidental reflections into what we were keen to find! The search for other examples of embedded telescopes was required.

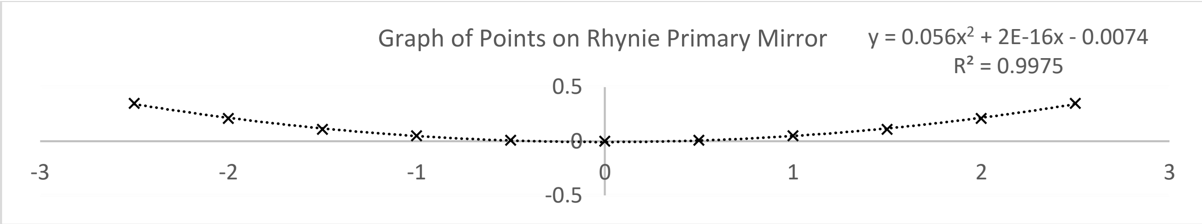
Calculating the curvature and focal point of the Rhynie Primary Mirror

The coordinates of points on the carved curve line that is transformed into a concave bowl by reflection in an axis can be determined by overlaying a grid on an image of the curve. The co-ordinates can then be plotted as a graph and analysed to determine the equation that describes the shape of the curve



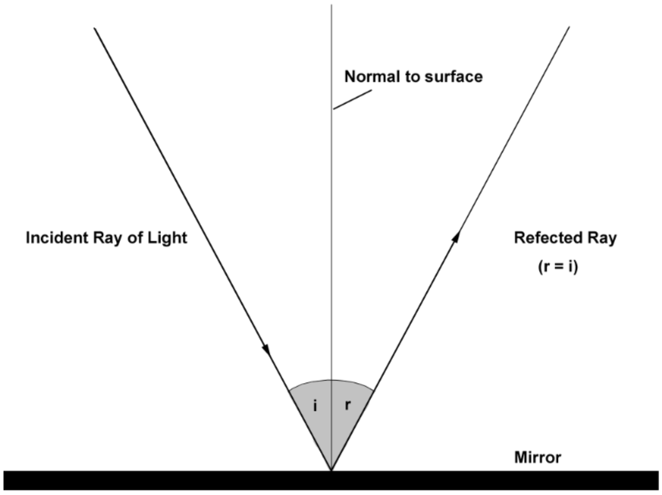
Co-ordinates of points on the curve

x	y
-2.5	0.35
-2.0	0.21
-1.5	0.11
-1.0	0.05
-0.5	0.01
0	0
0.5	0.01
1.0	0.05
1.5	0.11
2.0	0.21
2.5	0.35



The points on the curve describe a curve that is extremely close to a perfect parabolic curve that can be described by the equation **$y = 0.056x^2$**

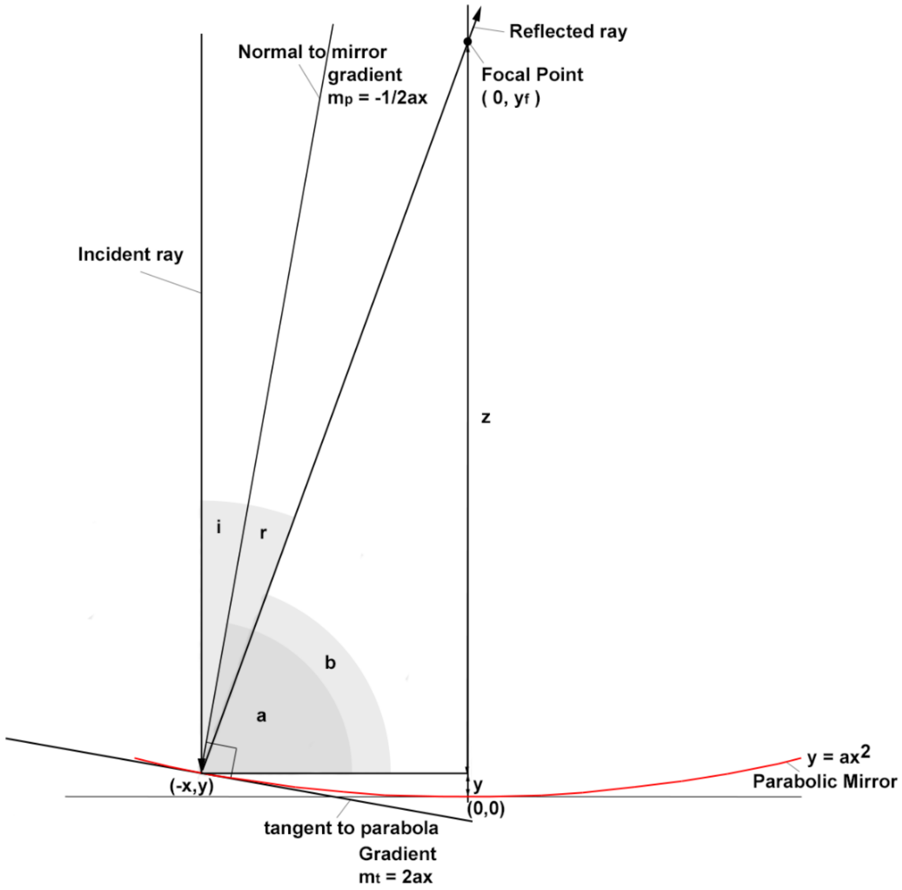
The focal point of this parabolic mirror can be calculated by considering that a ray of light is reflected from a flat mirror such that the angle of reflection equals the angle of incidence.



The angle of incidence (i) equals the angle of reflection (r). On a curved mirror surface the same principle applies and the angle of reflection can be determined by calculating the gradient of the tangent to the curve at the point of incidence on the mirror surface and then determining the normal to the tangent, that is the line that is perpendicular to the tangent.

In the case of the Rhynie parabola the gradient of the tangent to the curve **$y = ax^2$** can be determined by differentiating to obtain **$y' = 2ax$** (in the case of the Rhynie parabola the gradient of the tangent $y' = 0.112x$ and can be simply calculated for each point along the curve by substituting the value of x at that point).

The Normal to the mirror surface can then be calculated as the line that is perpendicular to the tangent as the gradient of the Normal **$m = -1/2ax$**



Angle of reflection (**r**) equals the angle of incidence (**i**)
Gradient of the tangent to the curve $y = ax^2$ is the derivative $y' = 2ax$. The normal to the parabolic curve is the line perpendicular to the tangent and has a gradient $m_p = -1/2ax$. Light rays from a distant source such as the stars are effectively parallel to each other and reflect off the surface of the mirror and in the case of a parabolic mirror are focussed as a common focal point.

Angle a

tan **a** = m_p = -1/2**a**x

a = atan(-1/2**a**x)*180/PI()

Angle i

i= 90 – **a**

Angle b

b = 90 – 2**i** (as **i** = **r**)

Focal Point (0, y_f) where $y_f = z + y$ and $y_f = x\tan(2i - 90) + y$

For the parabolic curve $y=0.056x^2$ that is a close fit to the curve carved on the Rhynie stone.
At a point on the curve (-2.5, 0.35), mt = -0.28. The gradient of the Normal to the mirror surface at this point is that of the line that is perpendicular to the tangent and can be described as mp = -1/2ax = -1/-0.28 = 3.571429
Angle a = atan (3.571429)*180/pi() =74.35776 degrees
Angle i =90 – 74.35776 = 15.64224 degrees
Angle b = 90 – (2* 15.64224) = 58.71552 degrees
z = xtanb = 2.5*tan((90-(2*15.64224))*PI()/180) = 4.114288
yf =z + y = 4.114288 + 0.35 = 4.464288
focal point = (0, 4.464288)

The point at which the angle carved line intersects with the axis of reflection or y-axis was estimated to be (0, 4.5). In other words, the carved straight line appears to indicate the focal point of the mirror. It is also apparent that the angled straight line representing the upper carved line of Rhynie Man’s right arm may represent the limit for a reflected ray hitting the secondary mirror positioned above the primary mirror. It is interesting that the curvature of the primary mirror described by the outer line of Rhynie Man’s upper right arm, changes from a parabolic curve as it reaches the elbow. The effective diameter of the Primary mirror can be taken as the length between the extrapolated angled line from the straight line of the lower section of the right arm where it intersects with the parabolic mirror and its reflected position on the other side of the axis.
The other proposed telescopes on the Bullion, Golspie and Collessie stones can be similarly analysed to see whether they too have angled lines that correspond with the focal points of the mirrors carved as curved lines on each of the stones but the condition of these stones is not of the same quality as the Rhynie stone due to erosion of the surface caused by centuries of weathering.

Appendix III

The Bullion Slab calculations of curvature

The curvature of the primary mirror was determined using a curve fitting program on Excel as a polynomial function the curve is described as:

$y= 0.0019\ x^2 + 37.3$ ($R2 = 0.99$)

This again is the equation of a parabolic curve which is needed for a mirror to bring parallel rays from distant light emitting objects to a single focal point.

The determination of the focal point is easily achieved mathematically, because the gradient of the tangent to the curve of a parabola of the form $y = ax^2 + c$, is 2ax. The line perpendicular to this has the gradient -1/2ax and we can calculate the centre of curvature by considering the equation for this line which always has the form y=mx+c. As m is the gradient (-1/2ax) and we have individual values of (x,y) from the curve all we need to do is substitute these values into the equation and we can obtain the value c (c = y-mx) this is the point on the y-axis where all the parallel lines perpendicular to the mirror intersect and is the centre of curvature. Once we know this point we can calculate the focal point of the mirror. This is easily achieved by converting the gradient (tangent) to its equivalent angle. We then subtract this angle from 90 degrees, double the angle as this is the angle between the incident and reflected ray. We then can work out the gradient of this reflected ray again by considering the tangent of the reflected angle and again substitute this value into the equation of form y = m1x+c1 where m1 is the newly obtained gradient and c1 is the focal point.

As this is the primary mirror, light from say a galaxy will essentially be hitting the mirror as a series of parallel rays (since the light source is so far away). These parallel rays will be reflected at the surface of the mirror in the way that governs all mirrors, that is, the angle of reflection equals the angle of incidence. Now we know the centre of curvature of the mirror all we need to do is draw a ray of light parallel to the axis of symmetry of the parabolic mirror (y-axis), the point at which it hits the curve of the mirror surface is then connected through an imaginary line to the centre of curvature and that incident ray is reflected in this axis to give the reflected rays position. In practical terms we simply measure the angle between the incident ray and the line going through the centre of curvature and draw a reflected line with the same angle the other side of the axis. We repeat this for several points on the curve and we can obtain the focal point of the parabolic mirror. Because it is parabolic all parallel rays will be focussed at one single point.

The centre of curvature of the primary mirror is calculated to be (0,305) for a point x=50mm from the origin (0,0) on the y-axis of the mirror the focal point is (0,168.9). We now need a secondary mirror above the primary mirror so we will need to reflect a curve from below the horn so that it is above the horn. The curve of the secondary mirror is indicated by the reflection obtained from the centre of the shield. We can obtain the full position of secondary mirror by first reflecting the left hand curve in the first axis.We then need a second axis of reflection in order to reflect the secondary mirror onto the correct side, above, the primary mirror.

The curve described by the secondary mirror is a hyperbolic function of the general form $(y^2/a^2) - (x^2/b^2) = 1$

Using the origin this time as the intersection of the Primary and secondary we obtain the curve with equation

$(y^2/16641) – (x^2/10221.) = 1$

The virtual centre of curvature can be calculated on the "wrong side", or dull side, of the mirror by integrating the equation to first obtain the gradient going through each individual point on the hyperbolic curve

$y' = ax/ (b^2(1+(x^2/b^2))^{1/2})$

The focal point or virtual focal point is again calculated by working out the gradient of the line perpendicular to y', that is -1/y' and substituting the individual (x,y) data points into the equation y = mx + c where m = (-1/y'). The focal point found is (0,168) which corresponds almost exactly with the focal point of the primary mirror (0,168.9). This configuration of mirrors and their curvature are perfect for a Cassegrain reflector telescope. The coincidence of the two focal points means that a ray of light from a star is reflected from the primary mirror to the secondary mirror and is again reflected to the second focal point situated at (0, -168). This position is marked by the small circle at the centre of the shield. Could this represent the lens?

Bullion Stone Primary Mirror

X Co-ordinate (mm)	Y Co-ordinate (mm)
190	106
180	99
160	86
140	74.5
120	64.7
100	56.3
80	49.5
50	42
35	39.7
0	37.3

Secondary Mirror

X Co-ordinate (mm)	Y Co-ordinate (mm)
50	150
40	142
30	136
20	131.5
0	129

The curves appear to satisfy the curvature of mirrors to make a reflector telescope. The mirrors of the Bullion Telescope are of the same general curvature as the Rhynie telescope but the telescope is a bit larger and potentially more powerful. The final piece of the jigsaw is the eyepiece lens. We can see half of a lens shape at the foot of the Bullion man. When we reflect the foot in the axis running up the leg we obtain a Plano-convex lens.

The focal point of the lens is given by the equation
$f = R / (n - 1)$
Where f = focal point (mm)
R = Radius of curvature (mm)
n = Refractive index of quartz (Rock crystal =1.544)
The curve of the lens from the foot was plotted onto graph paper and analysed using Excel.

Lens

X Co-ordinate (mm)	Y Co-ordinate (mm)
-20	8
-15	13
-10	16.5
-5	19
0	19.7
5	19
10	16.5
15	13
20	8

The equation for the curve that fits these data points is
y = - 0.0292 x2 + 19.607
The radius of curvature is determined by considering first the gradient of the tangent to the curve (-2*0.0292x) and then the axis perpendicular to this (1/0.0292x). The Radius of curvature is calculated by reflecting parallel incident rays in the perpendicular axis at each point and working out where each ray crosses what is our y-axis by considering c = y – mx where m is the gradient of the reflected ray. The Radius of curvature was calculated as 10.98mm giving a focal point of 20.186mm. The rays reflecting from the outer edge of the secondary mirror (150,50) pass through the central hole in the primary mirror and cross the central axis at (-168,0). The angle of this ray is 8.936 degrees. The plano-convex lens is positioned 20.186mm behind this point. The size of lens required can be calculated using simple trigonometry. The lens could be as small as about 8.4mm in diameter but the likely diameter would be about 12.7mm so that only the central two-thirds of the lens is used. This represents a scaled down version of the carved foot lens by a factor of pi. The rays from the two mirrors entering this shaped lens at this position would exit the lens as parallel rays completing the telescope.
When we extend the “rays” from the secondary mirror through the hole they meet the surface of the lens perfectly and would give the correct focussing properties to allow the rays to exit the lens as parallel rays to be observed by the astronomer