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EASTER ISLAND'S "SUN STONES": A RE-EVALUATION

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Introduction

The most publicized evidence for the suggestion that prehistoric peoples of Easter Island had sophisticated knowledge of astronomy is the group of so-called "sun stones" at the ceremonial site of Orongo, first described by Ferdon (1961). According to his measurements, pairs of four man-made depressions pecked in exposures of bedrock point to the rising sun at the June and December solstices and at the March and September equinoxes.

Owing to the attention they have received in the literature and their potential importance as an indication of advanced calendrical development, we made independent azimuth measurements of these stones based on astronomically-determined directions. In part, this reevaluation was made because many of the rock deposits in this area, as well as in other parts of the island, are strongly magnetized, making any compass reading highly suspect. Indeed, the Chilean Armada map of Easter Island warns navigators that in some locations, compass readings can be significantly in error.

The Island

Easter Island is virtually isolated in the vast seas of the South Pacific. The closest inhabited island is Pitcairn, 2,000 km to the west; the coast of South America is 3,200 km to the east. The island was probably settled sometime in the first few centuries A.D. and it appears that after that time, no contact was made with other groups. Thus, without any outside influences for some 1300 years, this Polynesian culture developed many special features including large stone statues, called *moai*, megalithic ceremonial platforms (*ahu*), an undeciphered script (*rongorongo*), and according to some scholars (McCoy, 1979: 158; Mulloy, 1975: 2; Goldman, 1970: 104), a sophisticated system of solar observation. This latter feature of the society is based upon findings of the Norwegian Archaeological Expedition of 1955, and is the subject of this paper.

Some have questioned the presence of a solstice observatory (Bellwood, 1979: 367), and most have done so on the basis of the lack of evidence for any such device elsewhere in Polynesia and the fact that no mention of solstice watching is made in the ethnographic data collected for Easter Island. Evidence for observing the solstices by sighting on mountain peaks or other landscape features has, however, been recorded for other Polynesian island societies,[1] as well as considerable star lore, which is to be expected from a seafaring people who navigated by the stars.

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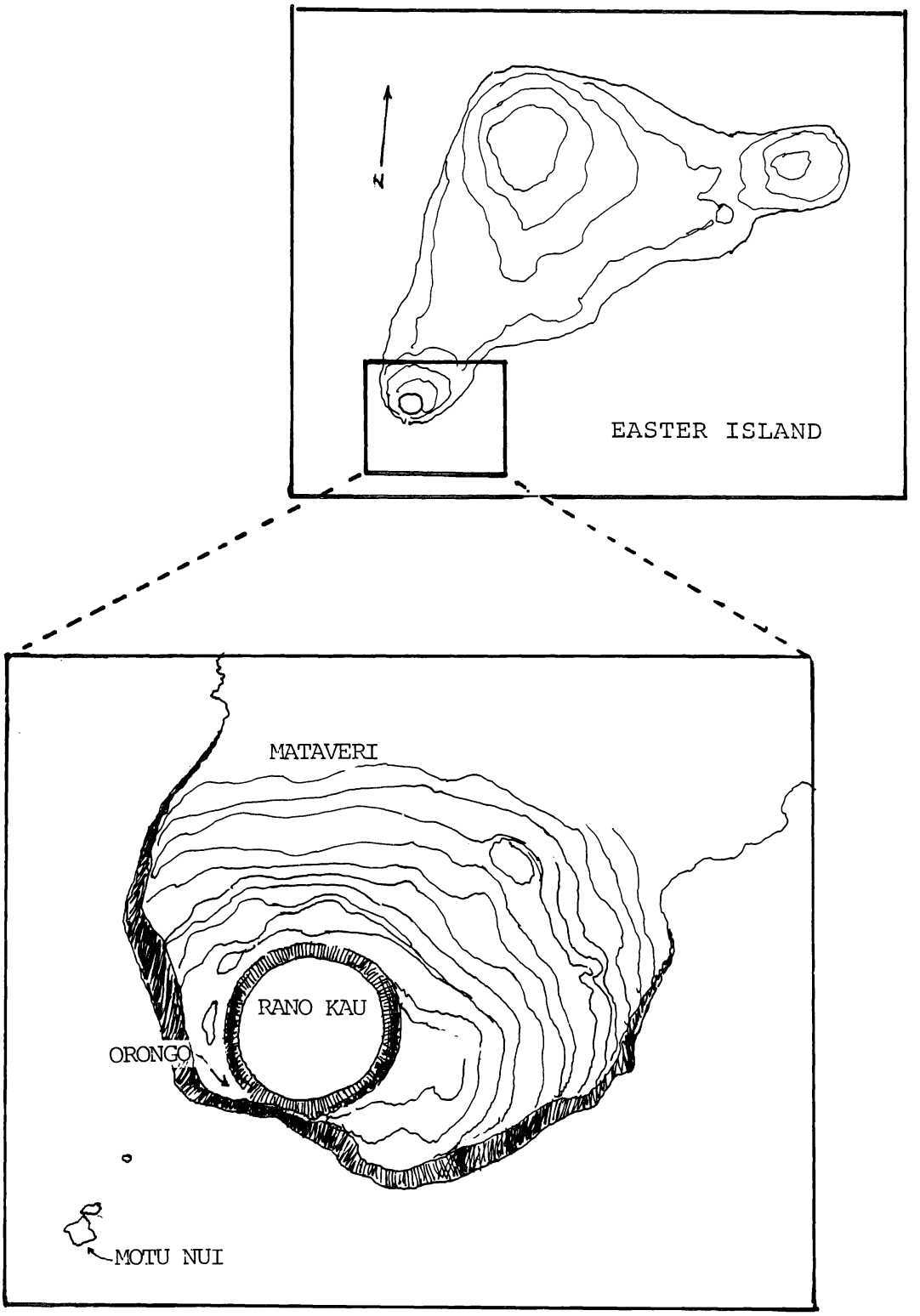

FIG. 1. Map of study area.

The Site

The sun stones are located at Orongo, on the top of the southwestern lip of the crater of Rano Kau (Figure 1), 310 metres above sea level. This fairly even and grassy area contains scattered boulders and rock outcroppings and undoubtedly is one of the most dramatic locales on the island. A precipitous cliff defines the southern perimeter and the crater edge drops steeply into the caldera with its dark lake, forming the eastern side of the site. To the south is a breathtaking view of the ocean. The area known as Orongo Village, where stone structures housed those persons involved in the annual birdman cult activities,[2] lies on the rim of the crater.

That portion of Orongo designated as Complex A by Ferdon (1961) contains the sun stones plus remains of an ancient *ahu* and other cultural features. As the existence of the site was not known in historical times, it appears to have some claim to antiquity. The sun stones are on exposed sections of bedrock directly west and in front of the *ahu* (Figure 2), and are associated with rock carvings (petroglyphs), one of which is on one of the sun stones. Three of the sun stones have cup-shaped holes (cupules) and lie in a nearly straight line running NE-SW (Figure 3). They measure 10 × 12 cm; 7 cm diameter; and 12 × 13 cm. Depth varies from 2 to 5 cm. The fourth has a much larger hole which appears to us to be natural. It measures 35 × 45 cm at the rim, and is 20 to 25 cm deep. The west edge of this latter hole is composed of poorly fitted loose stones, and other small stones line part of the bottom. The size of this fourth hole presents a problem in that a gnomon could be placed within it in one of several positions and have a leeway of some 30 cm in order to cast a shadow over a designated cupule. This lack of precision appears to us to be crucial, although Ferdon (personal communication, 1986) states that "...a bit of variation was not that important"; and "...don't expect so much from a simple device and a simple society". However, without reasonable accuracy, there is little point in making a solsticial observatory (Edwin Krupp, personal communication, 1986).

Cupules are not a rarity in the rock art of Easter Island. They are worked into both horizontal and vertical surfaces at numerous sites around the island. At Orongo, over 75 of them have been recorded, and all of them are in association with petroglyphs. Some of the larger cupules on horizontal surfaces could have been used in the preparation of pigments or dyes for tattoo.

The cluster of exposed bedrock that comprises the site in question contains petroglyphs of faces (Figure 4). One, representing an 'eye-mask' (outlined eyes), is a common design on Easter Island, and is placed directly next to one of the cupules. The others — two of which are double faces — are on adjoining pieces of rock and one is carved on a corner of rock so that as the viewer changes position, the face changes. This, too, is a common feature in the rock art of Easter Island, and is a form of visual punning in that it reflects a play on meaning and is typical of the complex metaphors that are found throughout Eastern Polynesia (Lee, 1986: 127).

Easter Island has a profusion of petroglyphs. Yet, Orongo stands out, for it is here that an intense concentration occurs: 1,369 have been documented in a relatively confined area. This can be explained as the result of ritual activity, and is supporting evidence for the ethnohistorical data that describe Orongo as one

FIG. 2. Map of Complex A (after Ferdon 1961).

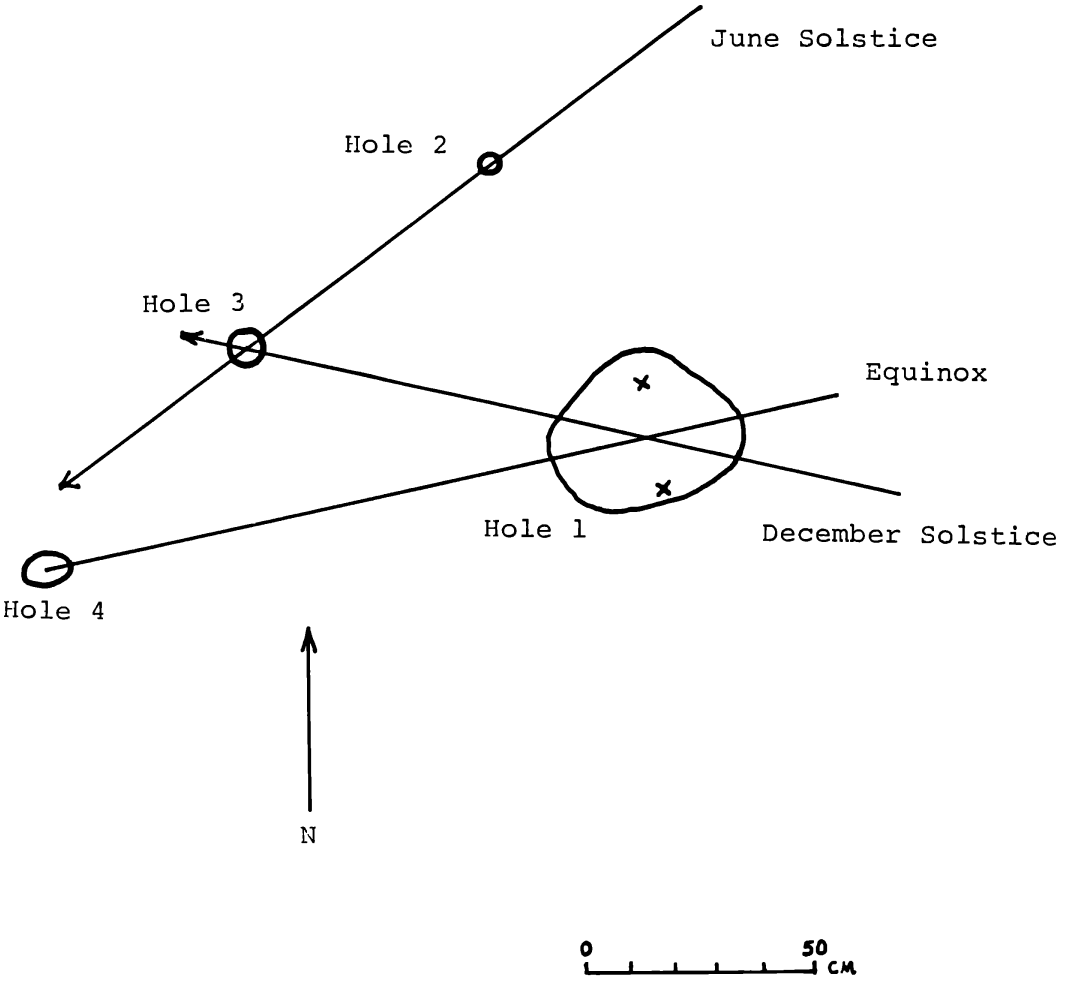

FIG. 3. Detail of sun stones at Complex A (after Ferdon, 1961). $x = 5°$ deviation points for equinox line.

of the most sacred sites on the island. Therefore, the occurrence of three cupules on an outcrop of rock in this area is neither surprising nor particularly unusual, and likely had ceremonial importance unrelated to solstice watching. The larger hole, which does not contain any traces of having been worked by man and probably is a natural feature, may simply be fortuitous.

The Measurements

Our procedure was, first, to determine true (astronomical) north using a precision theodolite, and then to measure the azimuth of the sun stone pairs relative to true north by means of a transparent plane table (a large sheet of glass) placed over the stones. To determine true north, we established the local sidereal (star) time using the tables of the *Astronomical almanac* of the U.S. Naval Observatory and the longitude of the site, measured from the excellent geodetic map published by the Instituto Hidrográfica de la Armada de Chile (1970 edn). The latter quantity was found to be 109°26′.8W (latitude

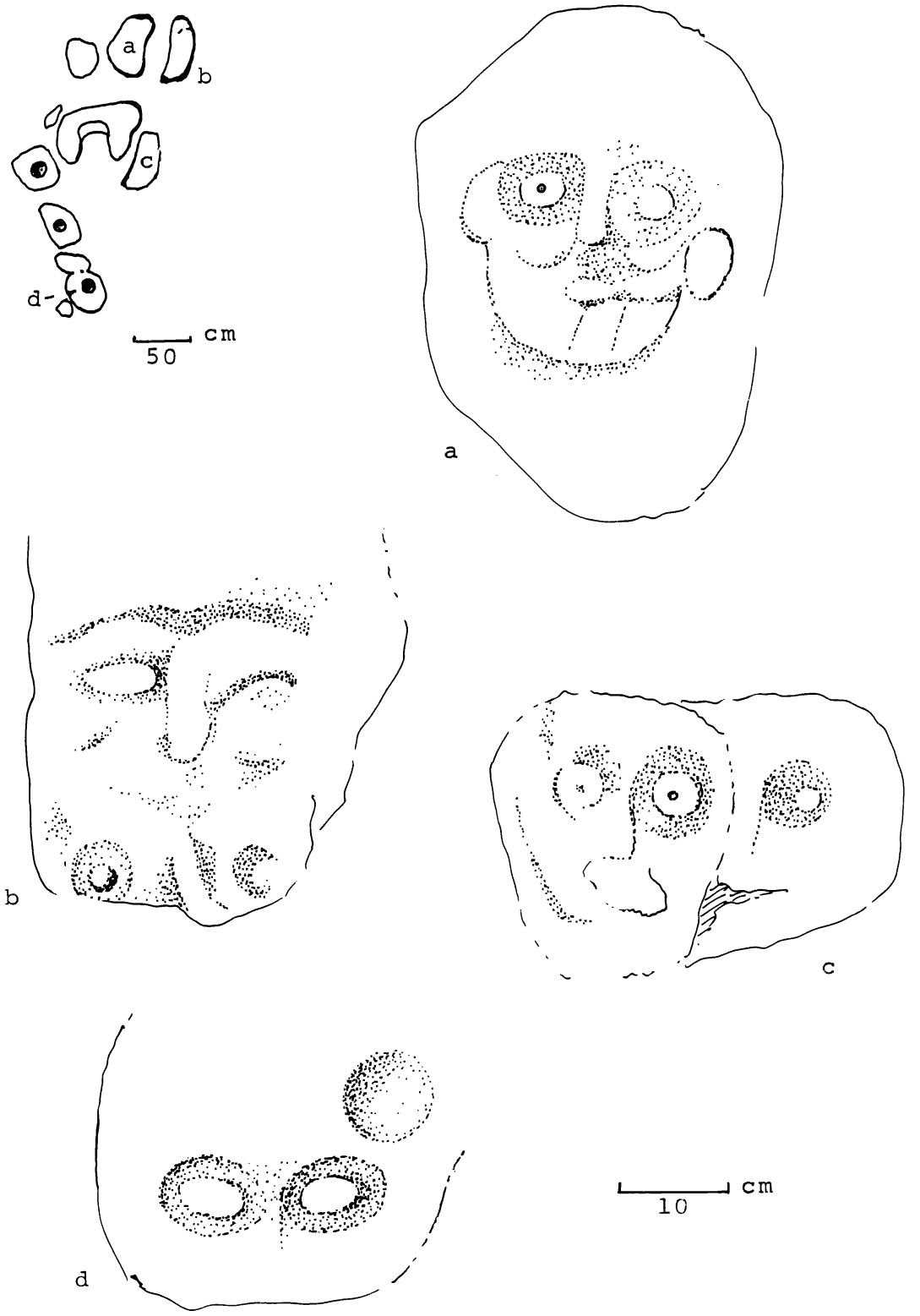

FIG. 4. Motifs on, or associated with, the sun stones at Complex A. *c* is an example of visual punning where face changes depending upon position of viewer (116).

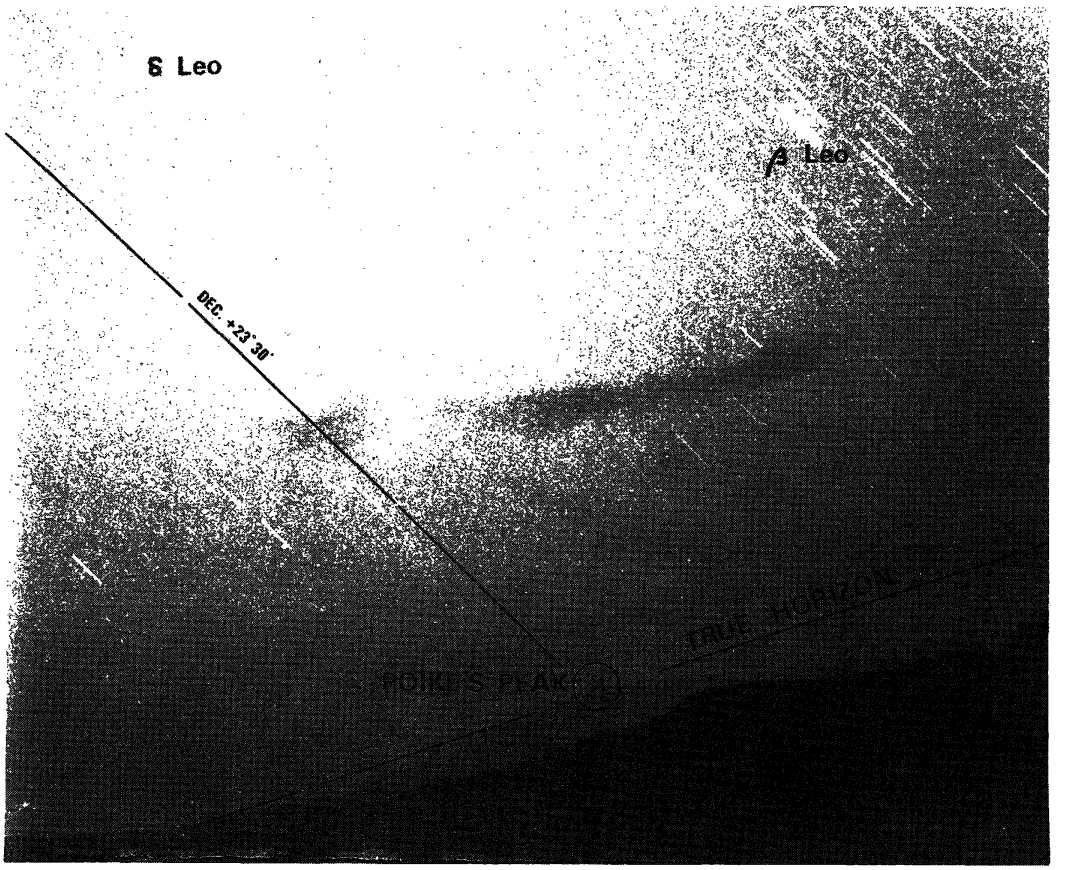

FIG. 5. Star trails over Poike's Peak.

27°11′.15S). Using a modern theodolite generously loaned to us by the meteorologists of the Dirección Aeronáutica of the Mataveri Airport, we measured early on the night of 10 March 1986, the relative azimuths of four stars as they crossed the north-south meridian. The tripod of the theodolite was centred over a large stone located about 5 metres northwest of the sun stones; a metal washer, now epoxied to the stone, marks the precise location of the tripod.

Both before and after the meridian measurements, we determined the azimuth of a 1-inch metal pipe driven deeply into the ground approximately 15 metres from the theodolite on a line extending from the theodolite through the sun stone area.

Additional twilight measurements were made of the left-hand peak of Maunga Terevaka, the highest point of the island, and the central peak of Poike, the conspicious mountain on the northeast corner of the island. The summit of the latter is well defined by a grove of trees which grow in the small central crater of this long-extinct volcano.

The vernier scales of the theodolite are intended to be read to $\pm 0°.1$, but all measurements were made to $\pm 0°.01$. The agreement of the four meridian crossings indicates an accuracy of $\pm 0°.08$ (mean error).

TABLE 1. Azimuths measured at Orongo, Easter Island.

Object or Direction Measured	Azimuth	Remarks
True North	0°	Mean error of determination ±0°.08
L.H. Peak, Terevaka	28.56	
Poike Peak	63.81	Centre of grove of trees 0°.3 wide
Sun Stones		
Line 1-3*	100.4	Solstice ** 116°.71; Ferdon 105°
1-4	77.7	Equinox ** 90°.00; Ferdon 81°
2-3	55.5	Solstice ** 63°.29; Ferdon 56°.5
1-2	153.3	
2-4	49.7	
3-4	43.8	
metal pipe	124.26	

* See Figure 3 for identification of holes.
**Calculated for the year A.D. 1000. When a correction for atmospheric refraction is applied, these azimuths are appropriate to an altitude for the sun's centre of approximately 0°.5.

On the same night we also made time exposures on fine-grained film (Kodak 2415 Technical Pan) with a 135mm lens. They clearly show the central peak of Poike and numerous stars (Figure 5). Knowing the precise astronomical declinations of the stars, we can derive the azimuth of Poike, thereby giving us a good check on our results. A photograph of the moon rising near Poike taken on 22 April 1986 added further weight to the azimuth determinations, as did measurements made directly on the Armada map of the island.

The Results

In Table 1 we list the azimuths (north = 0°, increasing through east) of the various points of interest described above. We note that the four depressions, taken two at a time, define six orientations (actually twelve if we consider the directions 180° away); we list all values (< 180°). The depressions, identified by Ferdon's numbering system, are shown in Figure 3.

Before beginning a discussion of the results, we shall make several comments. First, the angular width of the grove of trees on Poike, some 21 km distant, is 0°.3, and while measuring the centre of the grove is not difficult, there could be a small variation (several hundredths of a degree) with time or seasons. However, this grove shows clearly in aerial photographs taken in 1960, and at that time, as now, it was very nearly centred in the small crater.

The metal pipe was located such that a nylon line, stretched between the pipe and the metal washer-marker, crossed through the centre of the group of sun stones, making it a simple matter to establish the azimuths of the sun stone pairs. A large sheet of glass was placed under this line and over the stones, the lines of interest were carefully drawn with narrow-tip pen, and the orientations measured later with a precision protractor.

While we took every precaution to measure the sun stone azimuth relative to the precise centre of the depressions, the stone with the largest concavity presented problems owing to its size and oval shape. In Figure 3 we have indicated with crosses the points where the equinox azimuth would differ by ±5° from the value listed in the table.

TABLE 2. Azimuths measured at Orongo, Easter Island.

Solstice or Equinox	Angular Altitude of Crater Lip	Azimuth* of Sun at Crater	Sun Stone Azimuths: Ferdon	Sun Stone Azimuths: This Paper
June	5°.5	60°.7	56°.5	55°.5
Mar-Sept	8 .9	85 .4	81	77 .7
December	6 .6	113 .1	105	100 .4

*Calculated for the year A.D. 1000.

Conclusions

We find that the true azimuth of the solstice and equinox 'pointers' differ by 8°, 12°, and 16° from the corresponding astronomical azimuths. The estimated uncertainties in these values arising from the difficulty in locating the central points of the depressions, especially Hole 1, are 1°, 1°.5, and 2° respectively.

Of course, there always exists the possibility that the positions of the sun stones have been altered over the years owing to weathering or disturbances by man, but we think this to be extremely unlikely as the three cupules are carved pecked in what appears to be exposed bedrock; the larger hole appears to be a natural feature.

Ferdon, also aware of these discrepencies, notes that the eastern horizon is obscured by the lip of the crater beside Orongo, and that a vertical rod placed in the centre of the largest hole would, on the December solstice, cast a shadow across Hole 3 as the sun rose *over the crater lip* (emphasis ours), and similarly for the other dates and holes. To check this possibility, we measured the angular altitudes of the crater lip as seen from the sun stones and calculated the azimuths that the sun would have on the mornings of the solstices and the equinoxes as it first appeared over the crater lip. The results, listed in Table 2, show that these corrections still fall far short of making up the differences.

Further confirmation of these conclusions has recently come from Edmundo Edwards of the Departmento de Archeologia of the University of Chile who writes in an informal report: "On the 21st and 22nd of December 1983 the author was able to observe personally that neither during sunrise nor sunset did a post located in [the appropriate] orifice project its shadow over any of the other orifices as Ferdon claimed."

We have noted that lying approximately 5 metres to the east of the sun stones, between these and the crater lip, are the remains of an *ahu*, a ceremonial stone platform that may once have supported a *moai*, one of the well-known Easter Island statues. Oriented roughly in a north-south direction, it appears to be some 10 metres long and 2 or 3 metres wide. Conceivably, the original platform presented a higher apparent horizon to the sun stones than the crater lip. If, at 5 metres distance, the platform heights above the level of the sun stones were 1.4, 2.1, and 2.6 metres, the sun stones could have been used in the manner Ferdon suggests. However, the *ahu* today is the same as when Ferdon conducted his research in 1955.

It seems particularly strange to us that morning sightings with a badly obscured horizon would be so important to the early Islanders when to the west, there is a perfectly clear (and spectacular) view of the ocean and western horizon where the azimuths of the setting sun could be measured far more precisely. In

addition, because of the position of the stones below the nearby ridge, the rising sun on the solstice does not clear the rim until 45 minutes after sunrise, which considerably lessens the possibility for a dramatic shadow effect on the stones (Linda King, personal communication, 1983). Moreover, within just a few metres of the site, there exists a perfectly unobscured view of the eastern horizon.

Finally, we must point out what seems to us to be a far more significant alignment, namely that the azimuth of the summit of Poike,[3] as seen from Orongo, is within a fraction of a degree of the rising solar azimuth on the June solstice. To the early Easter Islanders, this remarkable coincidence must have seemed god-given. Indeed, this alignment may be, at least in part, the reason why Orongo became such an important centre on the island (Clark, n.d.).

Therefore, we most emphatically cannot subscribe to Ferdon's conclusion that "...it can be definitely stated that the complex of four holes ... constituted a sun observation device". We feel it far more likely that the stones served some other purpose, probably ceremonial in nature.

Acknowledgements

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1. Buck (1938: 414-15) states that the north and south passages of the sun were noted in Mangareva and Hawaii by observing its position at dawn in relation to natural topographical features.
2. The birdman cult was a late development on Easter Island, probably beginning around A.D. 1550. The stated purpose of the spring ritual was to obtain the first egg of the sooty tern from the off-shore islet of Motu Nui. The contestant (or his servant) who obtained the egg and successfully brought it back to Orongo was declared birdman of the year, an important status position. This cult was under the control of a powerful warrior class who wrested power and status from the traditional hereditary chief (Lee, 1986: 257).
3. Buck (1938: 415) translates the word 'Poike' as "...to be seen just above the horizon, to rise in connection with stars".