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Surveying Boulders at the Sacred Site of the Birdman

Lost in the vastness of the southern Pacific Ocean, Easter Island is the most isolated inhabited place on the face of the earth.

To its original Polynesian settlers, this was simply "the land," the center of the world, Te Pito te Henua. The first European to set foot on the island was the Dutch admiral, Jacob Roggeveen, who paid it a single day's visit on Easter Sunday in 1722. An expedition dispatched by the Spanish viceroy of Peru rediscovered the island in 1770, calling it San Carlos. Today it is called Isla de Pascua in the Spanish of Chile, the country that annexed it in 1888, or Rapa Nui in its natives' language.

By any name, Easter Island is known today for the ring of enormous stone statues, or moai, that dot its coastline (see Figure 1).

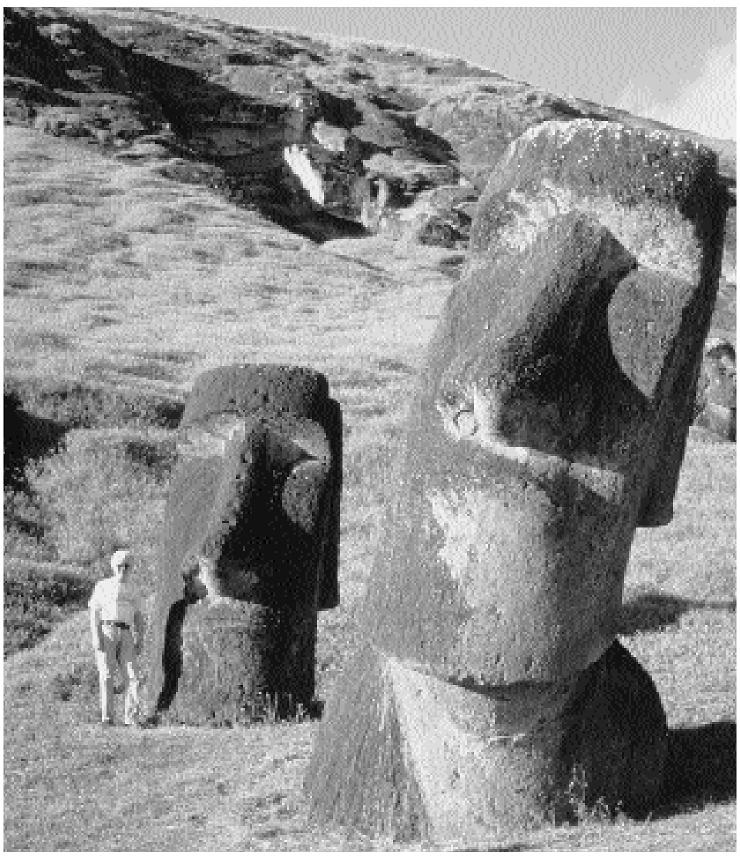


Figure 1: Rano Raraku, the moai (statue) quarry.

Though occupied by humans for only 1,600 years, this short period of habitation produced significant cultural remains that rival the monuments of older and more established societies.

The island's abundant archeological sites give the impression of a vast outdoor museum in a setting of breathtaking beauty. Three mountains rise nearly 2,000 feet. Between the mountains, smaller volcanic cones create a rolling, hilly, rugged landscape. On these cones are found the distinctive stone of the island, the brownish tuff of the stone quarry at Rano Raraku, the red scoria of Puna Pau where the topknots or pukao for statues were obtained, and the spectacular boulders at the ceremonial site of Orongo.

The Birdman of Orongo

Perched high above the South Pacific surf on a promontory formed by the partially collapsed wall of the volcanic crater Rano Kau, 1,785 petroglyphs are carved into the boulders of Orongo. Symbols of the life and culture of the people of Easter Island, 375 of these carvings are associated with the Birdman cult and show a praying man with a bird's head.[1]

As Alan Drake says in his book, "Easter Island, the Ceremonial Center of Orongo":

> This new myth and cult of birdman which replaced Rapa Nui's traditional religious practices and beliefs, contains powerful symbolic elements of death and rebirth. These include the symbolism inherent in birds, eggs, figures in praying or fetal positions, descent into the great ocean, re-climbing the cliff with a sacred egg, spring renewal rites, the shaving of the head, taking on a new name, undergoing ordeal and confinement. The motif of Birdman appears to be an archetypal symbol which arose from necessity out of the collective unconscious of the Rapanui, a response to extreme societal stress and the deeply felt needs of the island's population.[2]

At the scared precinct of Orongo known as Mata Magaru, the Birdman ceremonies took place.

The ritual revolved around the competition to obtain the first egg upon the return of great

Figure 2: Mata Ngarau showing the steep slope that drops over 300 yards to the sea.

flocks of sea birds to the islet of Motu Nui each September. Contestants were men of importance, men who probably selected servants called hopu to represent them. The hopu descended Orongo's sheer cliffs and using reed bundles for floats swam to Motu Nui where they secreted themselves in hiding places to await the laying of the egg. The hopu would scoop the egg into a small reed basket tied to his neck, swim back, climb the cliff, and present the egg to his employer who would then become the new Birdman.

The news of the event would be signaled with fires that marked the start of a celebration. The new Birdman shaved his head, eyebrows and eyelashes, and painted his head white. Taking the egg in his palm on a piece of tapa cloth, the Birdman and his companions danced down the mountain to Rano Raraku, near the statue quarry, his home for the coming year. Living under strict tapu, the Birdman was not allowed to associate with his family, wash, shave, or cut his nails for a full year until there was a new Birdman. At the end of his tenure, the Birdman returned to ordinary life[3] but was considered sacred throughout his lifetime and given special honors at death.[4]

The boulders that tell the Birdman story are on the southwestern end of the island and the petroglyphs are completely exposed to erosion by wind and rain. Situated on the very edge of a sheer cliff (see Figure 2), the boulders also are threatened by any weakening of the underlying soil, which could send them tumbling into the sea.

Over the years, since work was done on this site by the archeologist William Mulloy, concern has arisen about the stability of some of the carved boulders at the Mata Ngarau ceremonial center. Surveys of the site were conducted in August and December 1995 and in March 1996.[5]

In 2001, the World Monuments Fund sponsored an expedition by members of U.S. National Committee of the International Council on Monuments and Sites to Easter Island. One objective of the expedition was to establish the exact location of the boulders using a system of measurements that could be replicated to determine any movement. The work was conducted under an agreement between the National Park Service and its Chilean counterpart, the Corporación Nacional Forestal, El Servicio Forestal de Chile.

The survey team consisted of an engineer in private practice, Michael Schuller with Atkinson-Noland & Associates, and two architects from the National Park Service's Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER), Raul Vazquez and the author. We brought digital cameras and the total station system necessary to record accurately the positions of the carved boulders deemed most susceptible to movement.[6]

Conducting the Survey

To locate precisely the positions of the selected boulders and to be able to measure any future displacement, at least two points on each boulder had to be located with three spatial coordinates. Also, several points, or benchmarks, were needed in positions not subject to movement so that the points on the boulders could be related to stable points of reference in a future survey.

Since the island did not have its own total station system, the points on the boulders also had to be located so that hand tape measurements – slope dimensions – could be taken. In addition, the points had to be placed so that they could be located in the future.

With these parameters in place, the method of establishing points on the soft alkali basalt boulders was addressed.[7] The Mata Ngarau site is unprotected, subject to weathering, and visited by tourists. This meant that the points needed to be permanent. Also, because the boulders containing the petroglyphs are of great cultural importance and could not be marred or have the carvings damaged, the material used to establish the points had to be unobtrusive and benign.

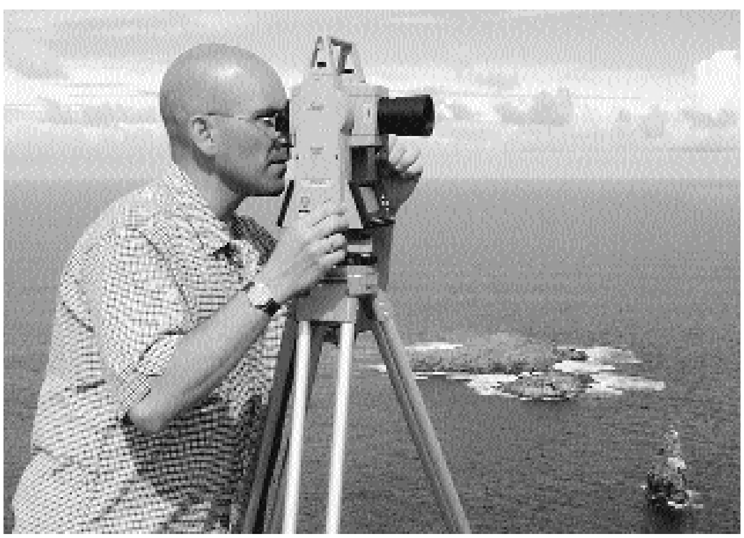
Several approaches were considered. Any topical application would rely on the surface condition for permanence. Since this surface was granular and friable, any adhesive-applied target would need a large surface area to achieve permanence — approximately 1 square inch — and would still be subject to being peeled off by hand. Smaller targets were tested when the points were being measured but were easily removed by wind as well as by hand. An applied liquid marker faced the same problems of surface condition and would have to be large enough to be distinguished from the variations in the boulder surface. The ultimate solution was to place small pins in the boulder surface that would be permanent, distinguishable from the surrounding stone, and as noninvasive as possible.

The survey team determined that small, 0.12-inch-diameter austenitic stainless steel pins could be inserted into an area of the boulder void of petroglyphs without causing future damage to the surface. The pins would be permanent, held in place with epoxy, and nearly imperceptible. Reference points of larger 0.25-inch diameter stainless steel pins would be installed within approximately 200 yards in stable ledges and other large rock formations devoid of petroglyphs. Also, it was anticipated that unobtrusive concrete posts containing steel pins could be used as reference points if installed in stable locations. (A number of these were placed along the edge of the soil slope to monitor erosion of the soil and movement of the slope inward.)

Field Work

Prior to drilling any holes, the team tested the procedures at a site across the crater Rano Kau where there are similar boulders that have no petroglyphs and are not located in a culturally sensitive context. Drilling was done with cordless electric drills using masonry bits of the same diameter as the pins. No flaking or spalling occurred when the stone was drilled; and neat, clean holes resulted. A small amount of epoxy was placed on the end of the pin before inserting the pin in the hole.[8]

Figure 3: Theodolite in operation.



Measurements taken of the test pin locations with the theodolite and compared to hand measurements taken with a steel measuring tape showed that, by using reflectors on the pins, measurements precise to within a few millimeters were possible.

On site at Mata Ngarau, station points for the theodolite were determined beforehand (Figure 3) so that pin positions avoided the petroglyphs, were visible from at least one station point (or two if possible), and had unobstructed slope dimensions (line-of-sight) in the majority of positions allowing park staff to take periodic hand measurements.

Drafting tape was placed on the boulder surface and a mark seen through the theodolite put on the tape to indicate were the hole was to be drilled. The holes were drilled through the drafting tape with a 0.125-inch drill, and pins of the same diameter were epoxied into the hole.

Two pins were placed in each of five selected boulders. In two cases, three pins were set; and in one boulder, only one pin was placed. It was felt that a minimum of two points was needed to determine any displacement or direction of movement in the boulder. Three pins were also placed in the surrounding non-culturally-sensitive ledge to act as reference points. These pins were larger — 0.25 inch in diameter — so that they could be found more easily in the future.

After all the pins were installed, the location of each was surveyed with total station and its position located in space using the pins placed in the ledge. In addition, the concrete monuments were also surveyed with the same points of reference. To take these readings accurately, small pieces of reflecting tape were adhered to the top of each pin. However, after taking readings from all points it was discovered that the oblique angle at which the laser sometimes hit the reflector was causing distortion. A second set of readings was made using a small hand-held reflector placed perpendicular to the surface of the pin and at its center so that the laser hit the reflector surface more directly at its point of contact with the pin. This second method increased the accuracy of the measurements.

Table 1 shows a comparison of dimensions between points taken by hand measurement and with total station. Table 2 is a comparison of

Table 1						
(Note: Point designations are based on the numbering system developed for the Mata Ngarau petroglyphs as found in "The Rock Art of Easter Island," by Georgia Lee, p. 137.						
Measurements Between Points (meters)						
Points	**X Diff**	**Y Diff**	**Z Diff**	**Slope Distance**	**Diff. in mm.**	**Measured Slope**
4N - 18N	1.208	9.506	0.043	9.582	0.084	9.582
22N - 18S	0.558	2.730	1.985	3.421	16.269	3.437
22S - 18S	2.371	3.188	2.165	4.524	15.771	4.540
4aN - 6aS	0.509	1.526	0.255	1.629	0.863	1.630
4aW - 6aS	1.197	0.892	0.420	1.551	0.865	1.550
6aW - 16	1.613	2.178	0.485	2.753	2.071	2.755
6aW - 9E	0.270	2.788	0.601	2.864	5.539	2.870
9W - 22N	1.185	5.376	1.797	5.791	3.376	5.794
BM5 - BM3	7.718	6.600	1.005	10.205	15.064	10.220
BM2 - BM1	1.700	9.034	0.543	9.208	2.817	9.211

slope measurements (point-to-point) of those points surveyed from more than one station point (not all points could be seen from more than one station point). As can be seen from Table 2, these measurements have standard deviations of less than 0.25 inch. The comparison of hand measurements with those taken using the instrument, Table 1, shows that most are quite close, differing less than 6 millimeters. Three of the measurements differ by about 16 millimeters or, about 0.64 inch. Because of the close correlations found in Table 2, it is assumed that these differences result from tape curvature (sag) in the hand measurement or from the fact that the pins in the bench marks did not have the center points marked and, therefore, could have a variance of about a centimeter — the diameter of the pin.

In addition to the total station measurements, the scenes in several photographs taken by Mulloy in 1974 and found at the local museum were replicated.[9] Comparable views were obtained for nine of the photographs. No major displacement is evident in their position from 1974 to 2001. It should be noted that while the photos do not offer evidence of any appreciable displacement over 27 years, small changes might not be detectable in the scale of the photographic images given the differences in focal length, lens type, camera elevation, and shadow.

The survey team recommended taking measurements every 6 months; to date, this has not revealed any movement. If these measurements begin to vary by 0.75 inch, then a new total station survey should be done. The three-dimensional coordinates for each pin can be compared with the benchmark coordinates to determine the direction of movement. Absent the need for it earlier, a second total station survey should be undertaken in 2006.

Conclusion

No evidence has been uncovered of discernible movement in the boulders of Mata

Table 2						
Slope Distance from Pin 1, 0 at Pin 2, to Points with Common Station Points (in meters)						
Point	**SP 1 data**	**SP 2 data**	**SP 3 data**	**Average**	**S D in mm.**	**Mean Var in mm**
Pin 2	93.011	93.011	93.010	93.011	0.615	0.454
Pin 3	182.179	182.180	182.176	182.178	1.843	1.370
4N	17.108		17.115	17.111	4.408	3.117
18N	21.829	21.825	21.831	21.828	2.866	2.081
18S	22.343	22.339	22.343	22.341	2.295	1.767
22S		26.167	26.175	26.171	5.218	3.690
4aW	20.520		20.525	20.522	3.052	2.158
4aN	19.675		19.678	19.676	1.653	1.169

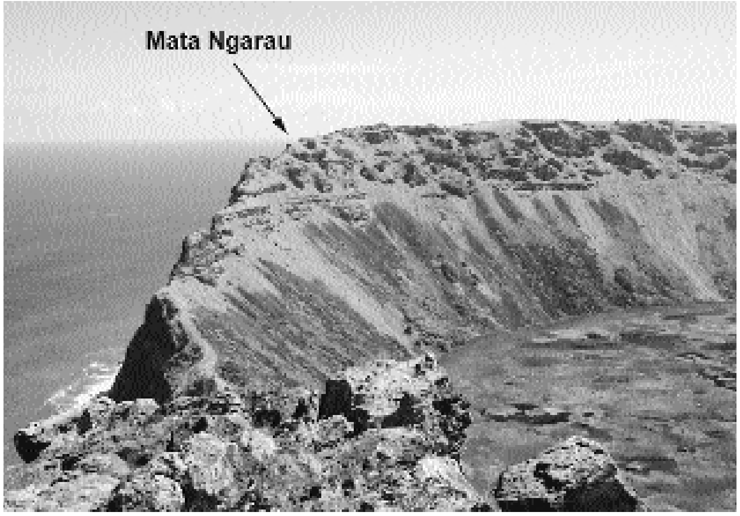


Figure 4: The volcanic ridge at Orongo.

Ngarau at Orongo—at least not within the past 25 years. However, this does not mean the site is not in danger. Sitting precariously as it does above the sea, Orongo is a site waiting for a landslide (see Figure 4).

The stability of the petroglyphs at Mata Ngarau is endangered by the weathering and erosion of the supporting rocks and soil that make up the crater rim. Clearly portions of the crater have already collapsed, reducing the height of the rim. This weathering of the rock formations has produced a 30-degree slope (see Figure 2) that comes to within 3 feet of the lower boulders.[10]

An earlier expedition evaluating the hydrogeology of Mata Ngarau reported that the site was threatened by erosional processes of both wind and wave action more than 300 yards below, causing the cliff face to fall away at an angle of 70 degrees:[11]

> A secondary erosion mechanism is creep and sliding of surface soils (about 30 to 60 cm thick) on which the boulders rest. Repeated wetting and drying of soils can result in a gradual movement down the 30º slope towards the cliff face. Periods of heavy rain could, however, saturate the thin soil layer, which could lead to sudden slides and rapid movement.[12]

Moisture collects on site in puddles where foot traffic compacts the soil or soaks in underneath the boulders and exits at the cliff face. Increasing the vegetation throughout the area would increase soil stability as well as the ability of the area to carry and release moisture back to the atmosphere.[13]

The petroglyphs are carved into the boulders that have eroded and will continue to do so until they no longer exhibit evidence of the Birdman. Stabilization of the site through the use of concrete shoring is possible but such intervention can be as destructive as a landslide to the integrity of the site. We should enjoy the petroglyphs and the austerity and seclusion of Orongo as it is for now. Ultimately, relocating the boulders to a museum might be a better fate than their loss. In this way, the petroglyphs would be protected in a way they never would be in situ.

Notes

1 Georgia Lee, *An Uncommon Guide To Easter Island,* (Arroyo Grande, CA: International Resources, 1990), 69.

2 Alan Drake, *Easter Island, The Ceremonial Center of Orongo,* (Old Bridge, NJ: Cloud Mountain Press, 1992), 31.

3 Ibid., p. 41.

4 Lee, *op.cit.*, 44.

5 See reports: K. Hall Nicholas, "Observations and Preliminary Assessment of the Stability of the Mata Ngarau Area, Orongo Ceremonial Village"; Raúl Marchetti Salazar, "Pre Informe Visita de Inspeccionamiento"; J. Vouvé and B. Clement, "Summary of the Final Report of the Mission to Orongo, Easter Island."

6 Total station is a system consisting of a theodolite with laser distance-measuring capacity.

7 A.E. Charola, "Summary of the Final Report of the Mission to Orongo, Easter Island," submitted by Profs. J. Vouvé and B. Clement to World Monument Fund, March 1996, p. 2.

8 In the tests, a small amount of epoxy had oozed onto the boulder surface. This was addressed in the final placements by leaving the drafting tape in place until the pins were set and the epoxy had begun to harden. When the tape was removed, the excess epoxy went with it.

9 W. Mulloy, "Investigations and Restoration of the Ceremonial Centre of Orongo, Easter Island," Bulletin 4, Easter Island Committee, International Fund for Monuments Inc., 1975.

10 Raúl Marchetti Salazar, "Pre Informe Visita de Inspeccionamiento," prepared for World Monuments Fund Mission, November 1995.

11 Charola, op.cit., p. 2.

12 Michael Schuller and Elena Charola, "Soil Erosion Issues, 2001" prepared for World Monuments Fund (Mission of April 2001).

13 Ibid.

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Photos by the author.