Appendix A: Identification System for Blocks and Glyphs of the Hieroglyphic Stairway

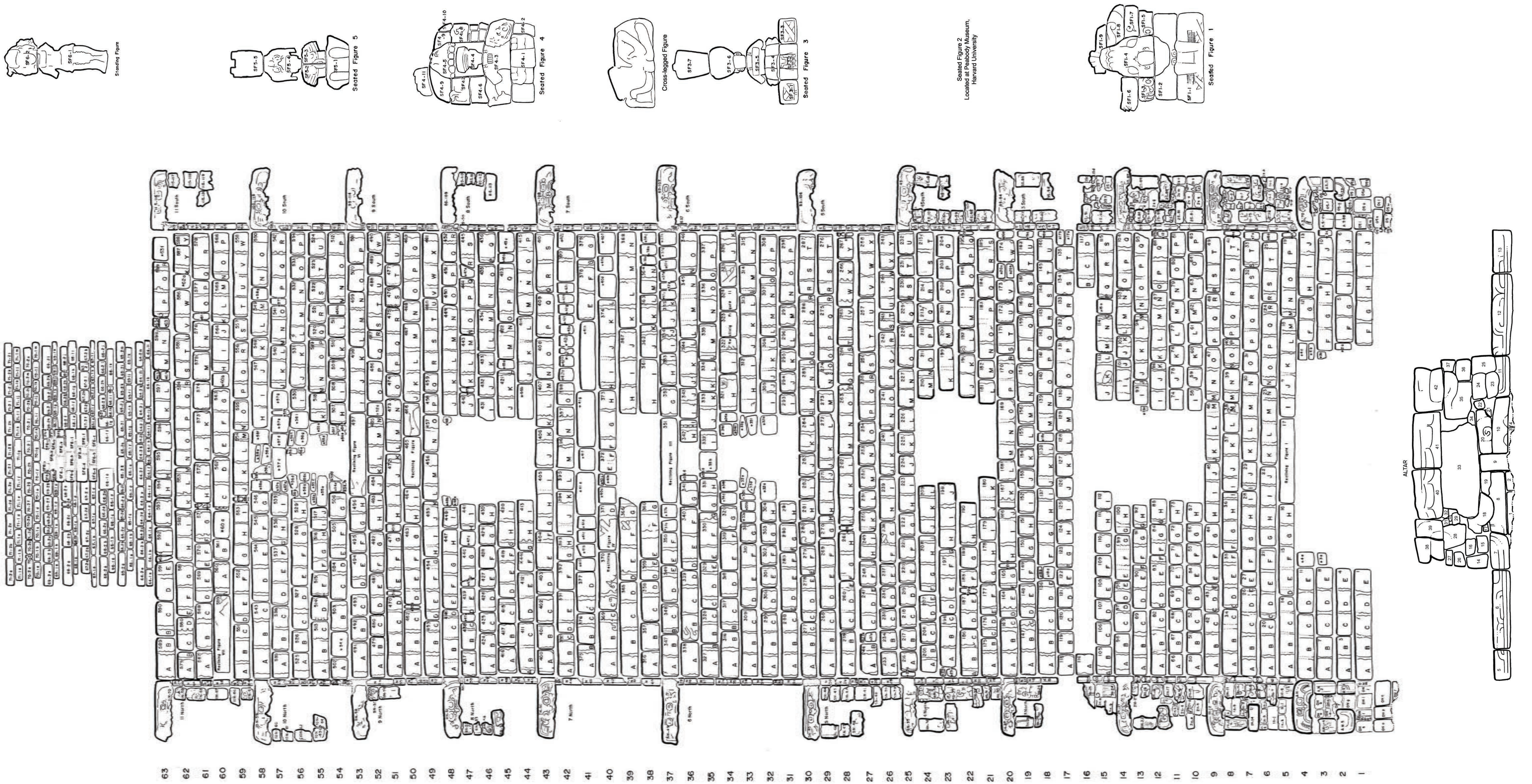


Figure A.1 Identification system for blocks and glyphs of the Hieroglyphic Stairway, based on a system developed by Barbara Fash.

Appendix B: Chronological Summary of the Stairway Conservation History

1885

Discovery of the Hieroglyphic Stairway by Alfred Percival Maudslay. The part of the Stairway visible at the time is the section of steps that slid down together from a higher elevation on the pyramid.

December 1892–January 1893

The second Peabody Museum expedition to Copán clears the Stairway mound (Structure 26) from vegetation, and its director, John G. Owens, starts its excavation. The hieroglyphic blocks from the fallen section are fully uncovered, and the in situ steps are discovered under more than four meters of debris; they are partially excavated.

May 1893

The second Seated Figure, sawed into pieces, and a number of hieroglyphic step blocks, sawed off to four- to five-inch slabs for transportation, are brought back to Boston among the season's finds.

December 1894–June 1895

Under the direction of George Byron Gordon, the hieroglyphic blocks of the fallen section, as well as other loose blocks found in the debris, are cleaned and lowered to the Plaza level, where they are placed on stone supports and photographed. Most of them are paper-molded.

March–May 1900

Gordon fully uncovers the lower steps found in situ, revealing a total of fifteen steps, as well as the first Seated Figure. All of the in situ steps and all loose blocks not already molded are then paper-molded and photographed in detail.

1910–11

American archaeologist Sylvanus Griswold Morley visits Copán on behalf of the School of American Archaeology, along with Dr. Edgar L. Hewett and Jesse L. Nusbaum. The group clears the in situ steps again, removing debris that had partially recovered them.

January–June 1935

The Carnegie Institution of Washington starts work in Copán under the direction of Norwegian engineer Gustav Strømsvik. The Stairway mound is cleared of vegetation, and the Altar at the base of the Stairway is stabilized.

January–May 1937

The reconstruction of the Stairway begins with the stabilization of the in situ steps. The blocks of the upper four in situ steps are lowered, photographed, and, along with the first Seated Figure, reset in cement mortar. The space behind the blocks is filled with rubble set in lime mortar, while the block joints are repointed with cement mortar.

The new support stairway, on which the hieroglyphic blocks will be placed, is dug out and built up to the level of step 43. The hieroglyphic blocks of the fallen section are placed from steps 29 to 43. Uncarved stones, set back a few centimeters, are used to fill areas of missing stones. On the top of the last replaced step, a channel is built to divert rainwater to the sides of the Stairway. Cracks and joints of the blocks are filled with cement. The lowest inclined balustrade panel on the south side is reconstructed.

January–May 1938

A few more balustrade panels are reconstructed on both sides, and a half dozen hieroglyphic blocks are reset on the north side of steps 18–21. Repairs are made to the first Seated Figure.

March–May 1939

The area between the in situ and fallen sections is filled with carved stone blocks—the most deteriorated stones with unrecognizable glyphs. Several elements of the balustrade are also reset. The Seated Figure, set the previous year in the middle of steps 31–36 (now Seated Figure 4), is removed and replaced by Seated Figure 3. Fewer than a dozen support steps (and only their central parts) are also built further up the slope, but no hieroglyphic blocks are placed on them.

ca. December 1939–May 1940

Support stairway steps are constructed up to step 63, then the hieroglyphic blocks are reset on them with cement mortar. Both sides of the balustrade are rebuilt, and finally, the narrower upper plain steps are constructed and Figure 6 is installed. Cracks and faults in the stone blocks are filled with cement.

December 1940–July 1941

A few missing balustrade elements are found and placed on the north balustrade.

March 1946

The Stairway may have received a "cement wash" after a thorough and careful cleaning.

1949

As a stone conservation trial, Strømsvik carefully cleans and dries the six lowest steps of the Hieroglyphic Stairway; using a brush he applies the DuPont clear lacquer no. 1234, sent to him by Robert Eliot Smith, fellow Mesoamerican archaeologist and a member of the Carnegie staff.

1952

Creation of the Instituto Hondureño de Antropología e Historia (IHAH), the institution responsible for the site.

ca. 1975

IHAH no longer allows visitors to walk on the Stairway.

January 1977, July 1977, and January 1978

Three trial areas of the Stairway are treated with biocides by Mason Hale: step 2, an approximately 1.5-meter riser section from the south side; step 28, a 2-meter riser section from the north side; and step 53, a 2-meter riser section from the south side. The treatment consists of an application of Clorox, followed a day later by an application of Borax in January and July 1977; Clorox alone is used in January 1978.

September 1978, December 1978, and March 1979

The entire Stairway is treated three times with Clorox, followed by a treatment with Borax on the following day. The microflora on the horizontal surfaces, as well as 95% of the larger lichens on the vertical risers, are eliminated. Against Hale's recommendation, mechanical brushing may have been used on the Stairway to remove the remains of microflora.

ca. 1979–1980

Biocide (Thaltox Q) treatments may have been carried out on the Stairway.

1980

The archaeological site of Copán is declared a World Heritage Site by UNESCO.

March–April 1982

A treatment trial with Paraloid B-72 is carried out on a small, five-glyph-wide area of the Hieroglyphic Stairway, on the center portion of steps 6 and 7. The stone surface is cleaned and the detached flakes are re-adhered with a 20% solution of Paraloid B-72 in acetone. Then Paraloid B-72 at 5% in acetone is applied to the entire surface of the risers. Nothing is applied on the step treads.

Summer 1982

By this date, Paraloid B-72 is used on site for regular stone surface treatments. Three principal types of treatments are carried out: consolidation of fragile stone surfaces with a low-concentration solution (1%–5% in acetone) of Paraloid B-72, re-attachment of stone flakes with a 15%–20% Paraloid solution as an adhesive, and edging repairs of stone flakes with a mix of Paraloid B-72 and Copán stone powder.

May 1985

The Stairway shelter is put into place, initially only during the rainy season (May–October). At the same time, a lip of cement mortar is built above step 63 to keep rainwater off the Stairway.

August 1986

A work program specifically includes a proposal for surface conservation treatment on the Hieroglyphic Stairway with Paraloid B-72 at 12% mixed with Copán stone powder for edging repairs, and Paraloid at 5% as a surface consolidant.

1987

The south terraces of Structure 26 are excavated and restored.

ca. 1987

The Stairway shelter is kept in place throughout the year.

Late 1980s

Mowilith 30 partially replaces Paraloid B-72 as the edging repair binder, including for the Stairway.

Spring 1991

The canvas tarpaulin is changed for the first time.

Spring 1998

The third tarpaulin is installed. This tarpaulin is both wider and longer than the previous two, and it protects the three top steps of the Stairway from rain. All surface treatments on the Stairway are stopped.

2000

All other conservation and maintenance activities at the Stairway, including the semiannual brushing of the risers and treads, are discontinued.

February 2001

The fourth tarp is installed (its dimensions are identical to those of the previous one).

April 2003

The fifth tarp is installed (its dimensions are identical to those of the previous one).

September 2006

The sixth tarp is installed.

Appendix C: Photographic Documentation of Stairway Blocks Chosen for Condition Monitoring

	Peabody Museum	***Carnegie Institution of Washington***	***Raúl Pavón Abreu***	***Maya Bracher***	***Jean-Pierre Courau***	***Photarc Surveys Ltd. / GCI***	***GCI***	***Photarc Surveys Ltd. / GCI***
	1891–1901	***1915–1953***	***1946–48***	***June–August 1979***	***May 1987***	***June 2000***	***April–July 2003***	***December 2004***
Step number / block number	*Negative number*	*Negative number*	*Roll number - negative number*	*Roll number - negative number*	*Contact sheet number - negative number*	*Negative number*		*Negative number*
1/2	1872	H-15-93, 40-13-54	55-10, 55-11, 55-12	Does not exist*	1522-11	23–25, 1308–1309	Yes	1–16
11/71	1869	37-13-133	51-14	Does not exist	1519-3a	1313	Yes	17–20
12/83	1868	37-13-133	51-5, 51-6	Does not exist	1518-24, 1518-25	1320–1321	Yes	21–28
12/86	1867	37-13-133	51-8, 51-9	Does not exist	1518-29	1328–1329	Yes	29–36
23/203	No	No	45-2	Does not exist	1514-36	248	Yes	37–42
23/204	No	No	45-2	Does not exist	1514-36	248	Yes	37–42
36/342	414	No	39-11	404-28	1510-42	360	Yes	43–45, 47–49
36/343	414	No	39-11	404-29, 404-30	1510-42	361	Yes	44–46, 48–50
41/375	403	No	37-5	Does not exist	1507-42	1373	Yes	51–53, 56–58
41/376	403	No	37-5, 37-6	Does not exist	1507-42, 1507-43	1374–1375	Yes	52–55, 57–60
43/409	401	No	36-16, 36-17	403-12, 403-13	1506-10, 1507-21	1356–1357	Yes	61–68
43/410	401	No	36-17, 36-18	403-13, 403-14, 403-15	1507-21, 1507-24	1359–1361	Yes	69–76
45/422	No	No	35-17	402-24	1506-30	462	Yes	77–82
50/462	No	No	33-12, 33-13	Does not exist	1504-28, 1504-29	1378–1380	Yes	83–87
52/483	377	No	9-29	379-22	1503-41a	510	Yes	88–93
58/549	No	No	13-6	335-31a	1500-42a	578	Yes	94–96
59/551	381	No	13-1	358-27, 358-28, 358-29	1500-25a	584	Yes	97–100
61/575	386	No	12-26	357-12a	1499-19	1383	Yes	101–103
61/576	386	No	12-26, 12-27	357-13a	1499-19	1384	Yes	102–104
61/578	386	No	12-28	357-15a, 357-16a	1499-21	1386, 1388	Yes	105–108
63/592	294	H-15-89	12-4	354-3	1496-32	633	Yes	109–110
63/594	388	H-15-90, 37-13-145	12-5, 12-6	338-20a	1496-33	1391	Yes	111–113
63/595	388	H-15-90, 37-13-143	12-6	338-19a	1496-34	1392	Yes	112–114

*There is no Bracher photograph, but a 1979 photograph of block 1/2 was found in the IHAH archives in Tegucigalpa. Roll labeled “Copán Ruinas. Microflora. 2 febrero 1979.” Negative no. 28.

Appendix D:
Illustrated Glossary of Stairway Stone Conditions

Material characteristics

Vein

Geological feature of the stone, appearing as a thin irregular layer of a different mineral composition, color, and/or texture in relation to the surrounding stone.

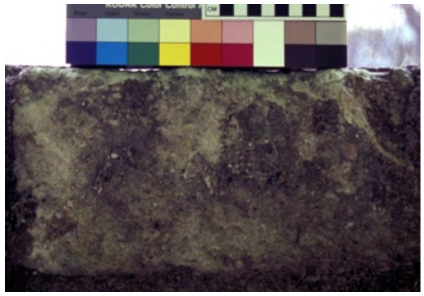
Current conditions

Detachment

Intact surface section of stone separated from the underlying substrate, a condition that can be detected by tapping the surface and listening for a hollow sound. Detachments can be blind (no visual sign of their presence) or open.

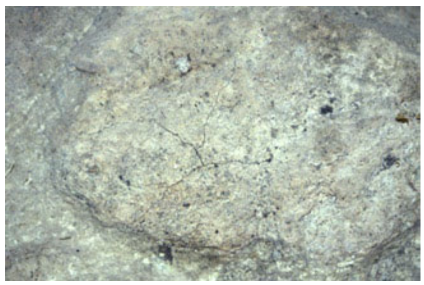
Disaggregation

Loss of cohesion of stone surface, which has disintegrated into powder or small particles.



Fissure

Fine linear break (crack) of the stone surface.

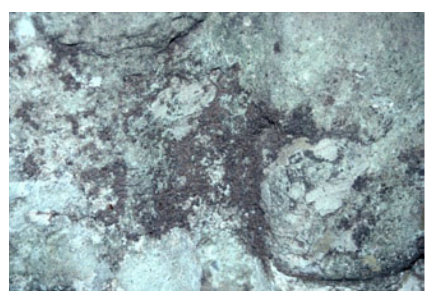


Flaking

Total or partial detachment of small, flat, thin stone elements (flakes) of irregular form or thickness, following the profile of the stone surface.

Microbiological organisms

Colonization by fungi, algae, lichens, mosses, and/or bacteria.



Mortar loss

Area where the pointing mortar is missing.

Superficial loss

Area where stone surface is missing, as compared to the remaining outermost surface of a stone block (not to the conjectural original surface).

Previous interventions

Fill/edging repair

Stabilization treatment done to fill areas of loss or edges of flakes with a binder-aggregate mixture.

Surface consolidation

Stabilization treatment of the stone surface with a liquid binding material.

Mortar 1

Weak, cementitious pinkish gray mortar.

Mortar 2

Hard cementitious mortar with large river sand aggregate.

Mortar 2 bis

Hard cementitious mortar with large river sand aggregate, similar to Mortar 2 but containing less aggregate.

Mortar 3

Hard cementitious pink mortar with fine aggregate.

Mortar 4

Soft, lime-based mortar with fine sand and soil mix.

Mortar 5

Hard, white cementitious mortar with fine aggregate.

Appendix E: Additional Environmental Monitoring Data

Inventory of equipment at the Escalinata and Jaguar environmental monitoring stations in Copán, and at the base station, located at the Centro Regional de Investigaciones Arqueológicas (CRIA), northeast of the site.

Escalinata Environmental Monitoring Station

Serial Number	*Description*
5795	Campbell Scientific Inc. (CSI) SI CR10X measurement and control module with wiring panel and 2 M memory
11969	CSI AM416 16-channel (4-wire) relay multiplexer with thermally insulated enclosure
2719	CSI AM25T 25-channel solid-state multiplexer for thermocouples
H5071	Met One 024 wind direction sensor
H2233	Met One 012 anemometer (wind speed)
20392-1297	Texas Electronics TE525 tipping bucket rain gauge
T1730017	Vaisala HMP45C temperature and relative humidity probe (ambient)
PY32300	Licor LI200X pyranometer
	Li-Cor LI210SZ photometric sensors (Stairway illumination)
	Omega E-type thermocouples and wires (Stairway surface temperature)
	Stainless steel pins (2) soldered onto wiring (Stairway perimeter time of wetness)
69272 to 69288	Rotronic temperature and relative humidity sensors (Stairway subsurface)
519FQW3030	Motorola FM radio
1223	RF95 RF modem
23052	Yaga unidirectional antenna
F10004051625431	Solarex SX20U 20-watt solar panel
2949	CSI CH12R 12 V charger/regulator
	Yuasa 12 V lead-acid battery
E3040	CSI CSM1 card storage module
6JA	CSMC4M 4 M PCMCIA card
	CSI thermally insulated equipment enclosure
	CSI CM6 6-foot steel tripod with grounding kit

Jaguar Environmental Monitoring Station

Serial Number	*Description*
5794	CSI CR10X measurement and control module with wiring panel and 2 M memory
11968	CSI AM416 16-channel (4-wire) relay multiplexer with thermally insulated enclosure
2710	CSI AM25T 25-channel solid-state multiplexer for thermocouples
H5068	Met One 024 wind direction sensor
K2561	Met One 012 anemometer (wind speed)
	Model 257 soil moisture sensor
20661-198	Texas Electronics TE525 tipping bucket rain gauge
T2130014	Vaisala HMP45C temperature and relative humidity probe (ambient)
PY32301	Licor LI200X pyranometer
	Omega E-type thermocouples and wires (stone experiment surface and subsurface temperature)
	Stainless steel pins (2) soldered onto wiring (stone experiment time of wetness)
	CSI CS615 water content reflectometers (Jaguar Plaza soil moisture)
519FQW3028	Motorola FM radio
1097	RF95 RF modem
14310	Yaga unidirectional antenna
F10004061627686	Solarex SX20U 20-watt solar panel
2948	CSI CH12R 12 V charger/regulator
	Yuasa 12 V lead-acid battery
E3041	CSI CSM1 card storage module
6GA	CSMC4M 4 M PCMCIA card
	CSI thermally insulated equipment enclosure
	CSI CM6 6-foot steel tripod with grounding kit

Base Station

Serial Number	*Description*
	RF232 RF base station
519FQW3029	Motorola FM radio
14303	Yaga unidirectional antenna
	CSI CM6 6-foot steel tripod with grounding kit
NS0037244324	APC Smart-UPS
11001	CSI CR10KD keypad

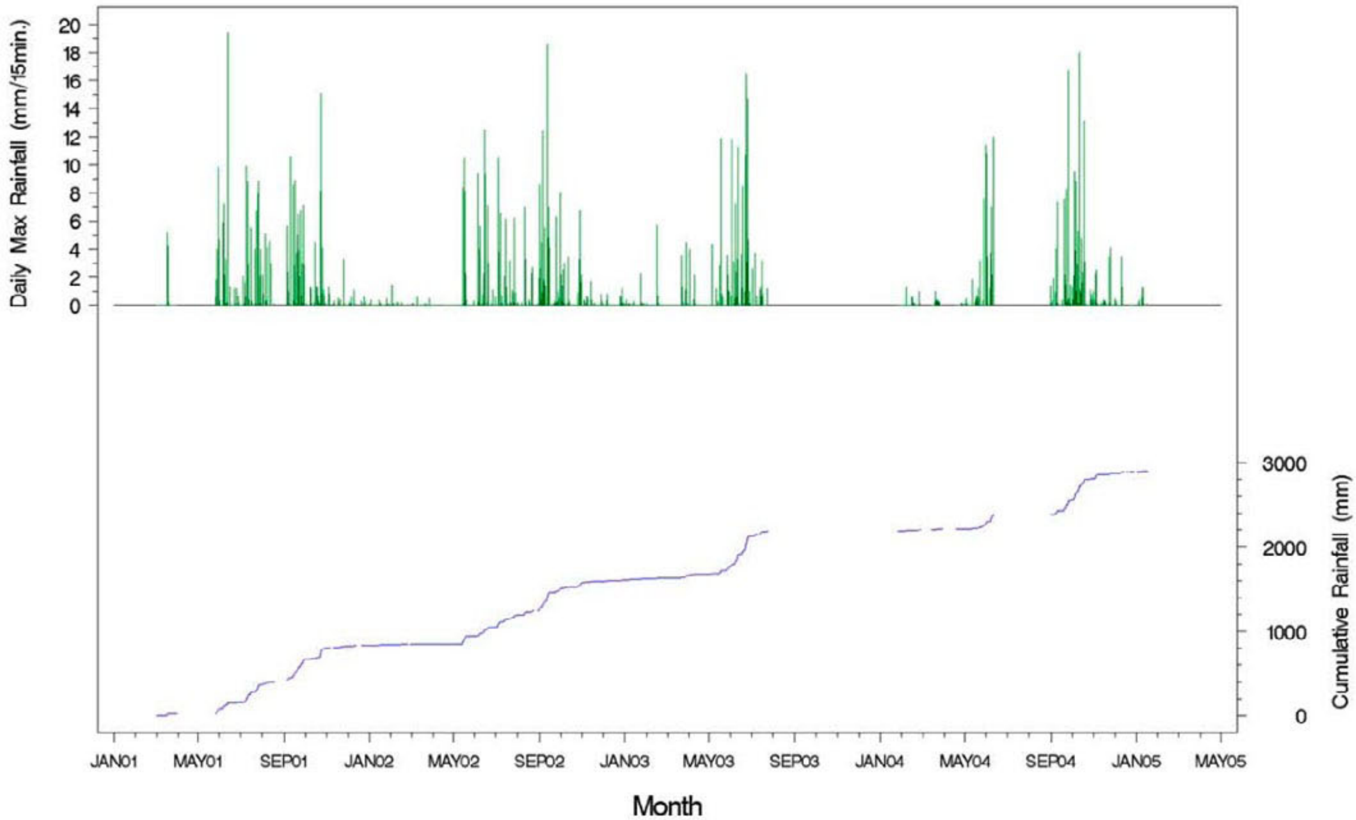
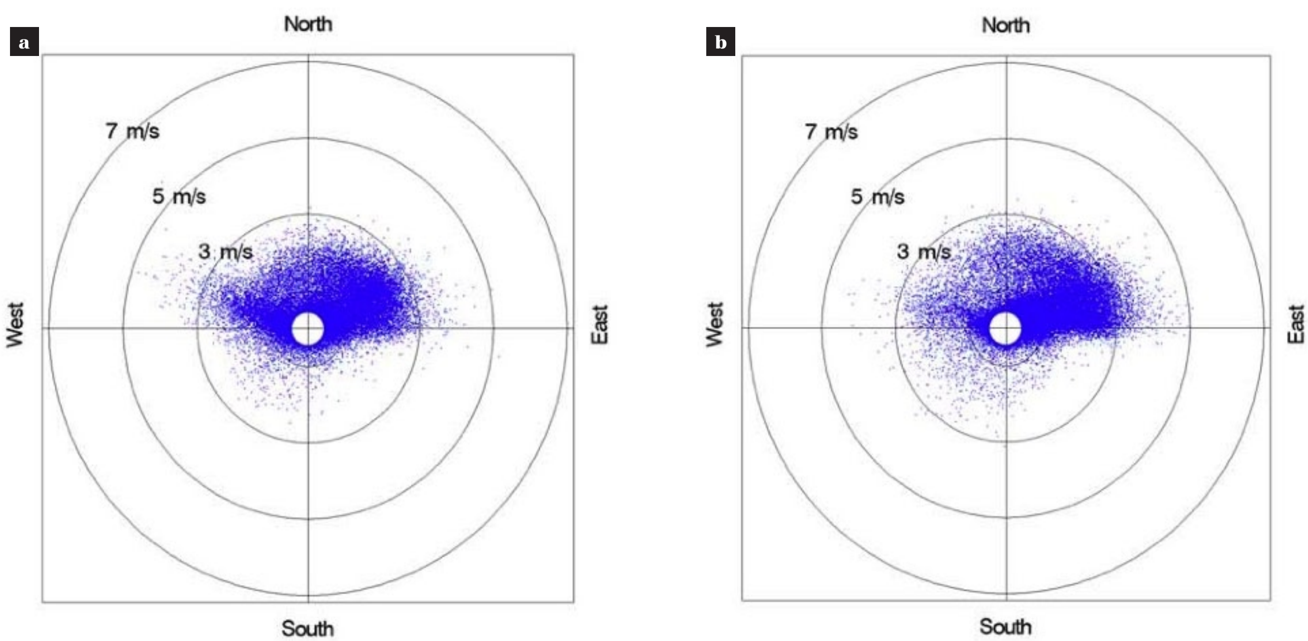


Figure E.1 Daily maximum 15-minute rainfall (upper left axis) and cumulative rainfall (lower right axis), collected at the Jaguar environmental monitoring station from March 2001 to January 2005. Interruptions in the plot of cumulative rainfall indicate periods of missing data.



Figures E.2a and b Wind roses depicting wind speed and direction (15-minute vector average) during the wet season, May to October (a), and the dry season, November to April (b), at the Jaguar environmental monitoring station from March 2001 to January 2005.

a

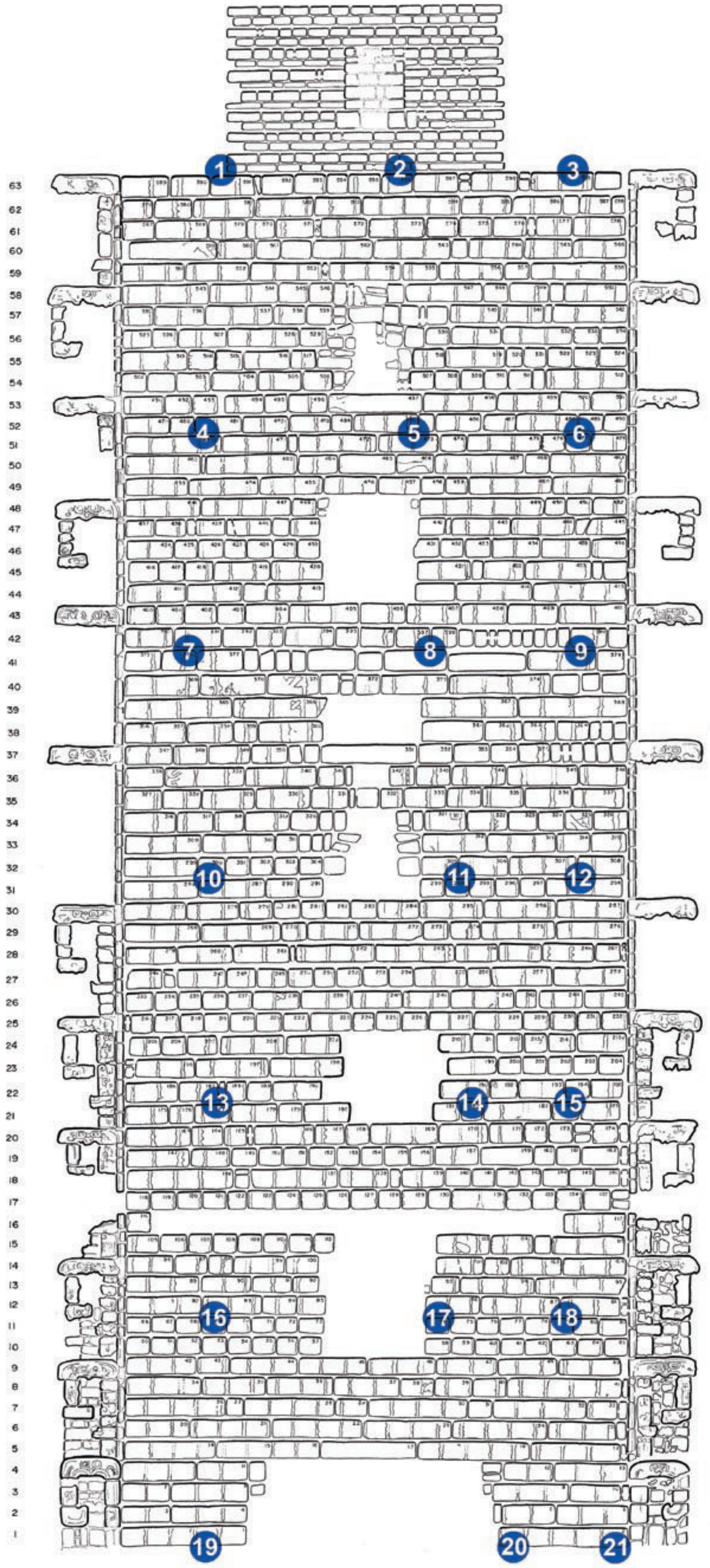


Figure E.3a Sensor map displaying the locations of surface temperature sensors (ST) across the Hieroglyphic Stairway. The Stairway sensors were installed in March 2001.

b

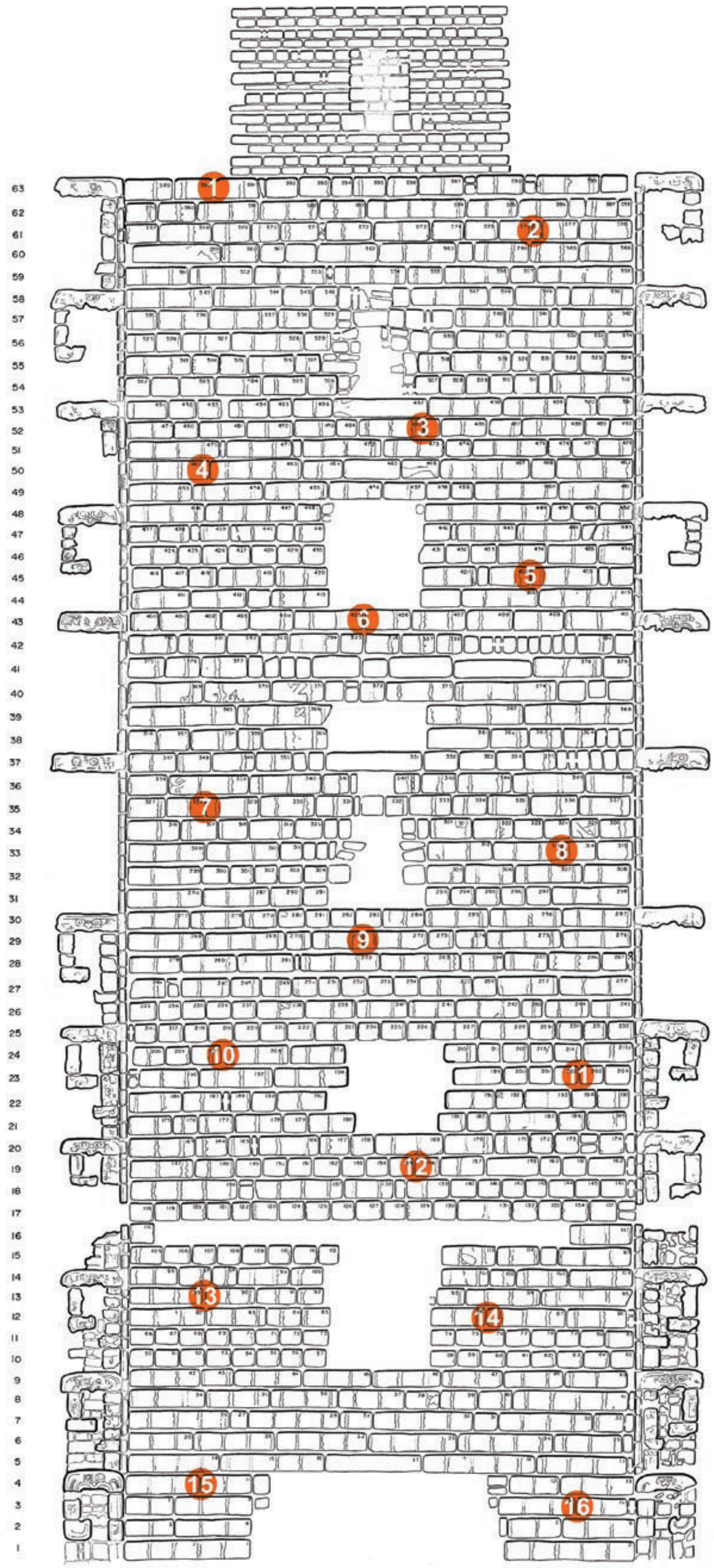


Figure E.3b Sensor map displaying the locations of subsurface temperature and relative humidity sensors (TBS/RHBS) across the Hieroglyphic Stairway. The Stairway sensors were installed in March 2001.

c

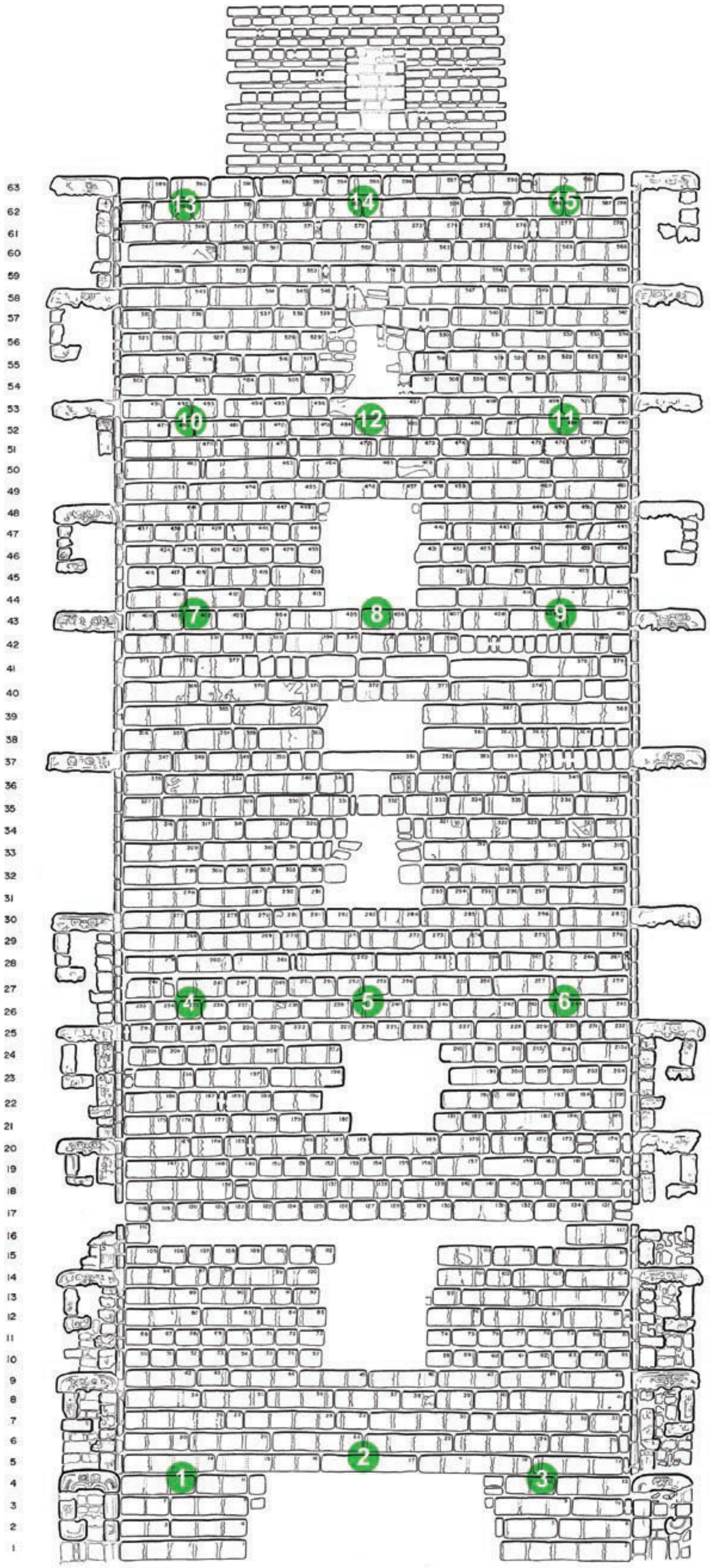


Figure E.3c Sensor map displaying the locations of light sensors (LUM) across the Hieroglyphic Stairway. The Stairway sensors were installed in March 2001.

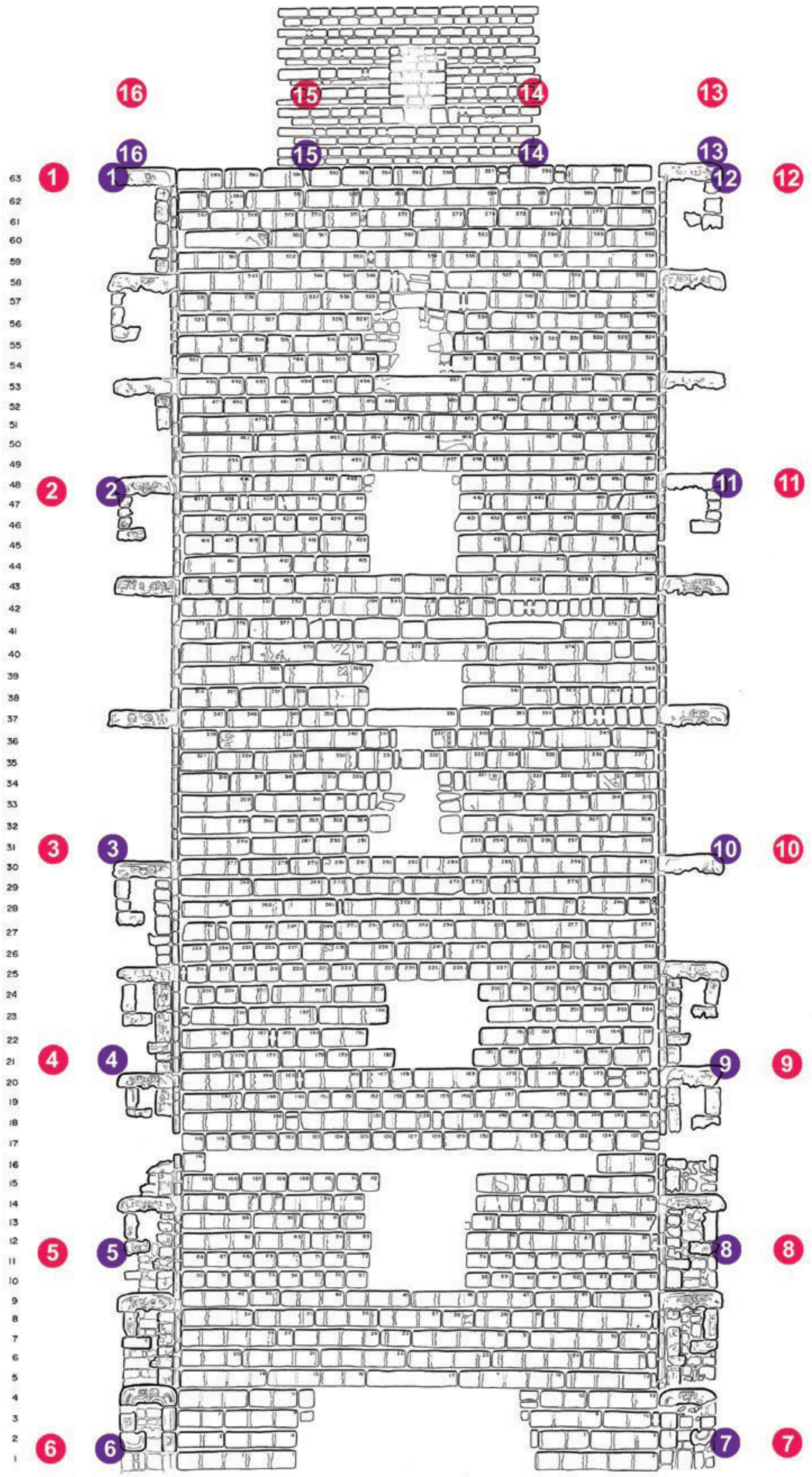
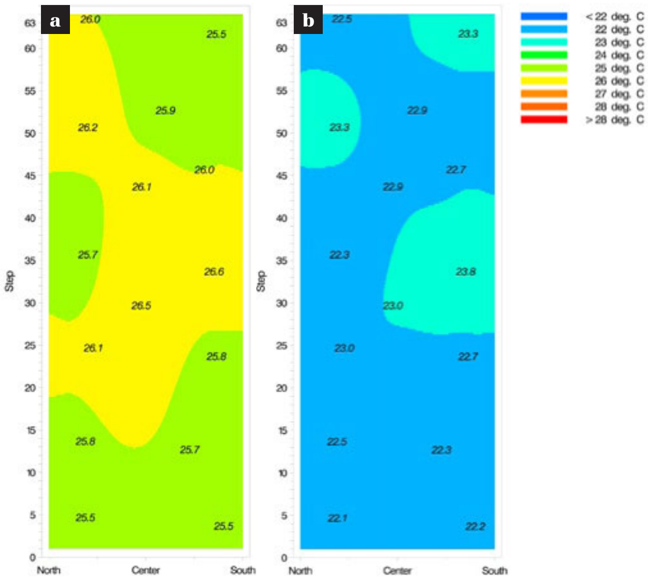
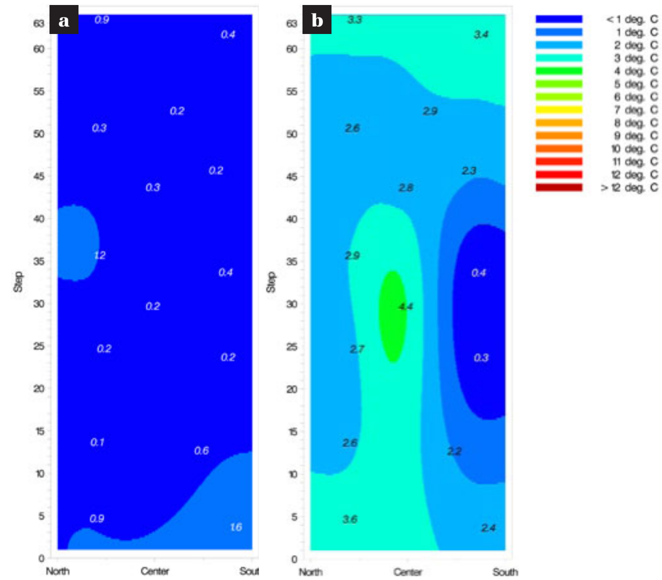


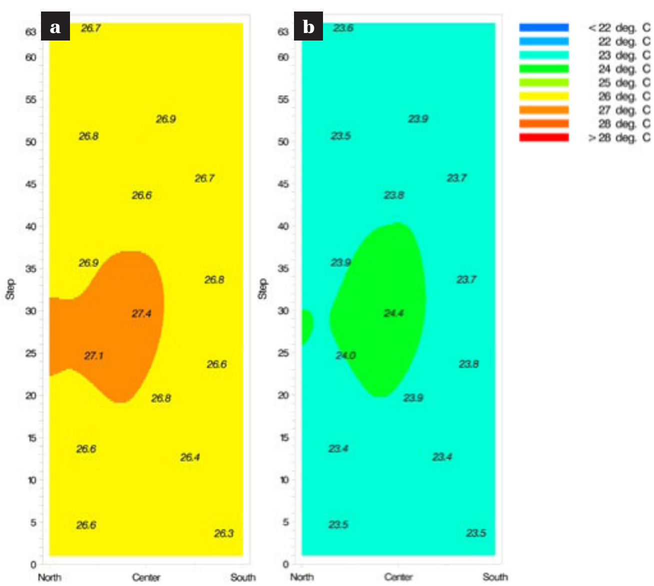
Figure E.4 Sensor map displaying the locations of time of wetness sensors around the perimeter of the top step of the Hieroglyphic Stairway and the north and south edges of the Stairway balustrade. Time of wetness sensors were not placed across the base of the Stairway. The Stairway time of wetness sensors were installed in March 2001.



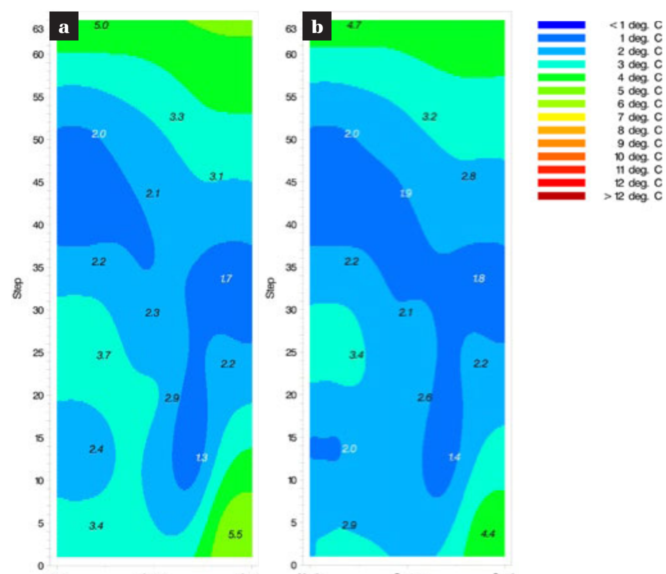
Figures E.5a and b Contour maps displaying the mean subsurface temperature (°c) at a depth of 30 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from March 2001 to approximately January 2002.



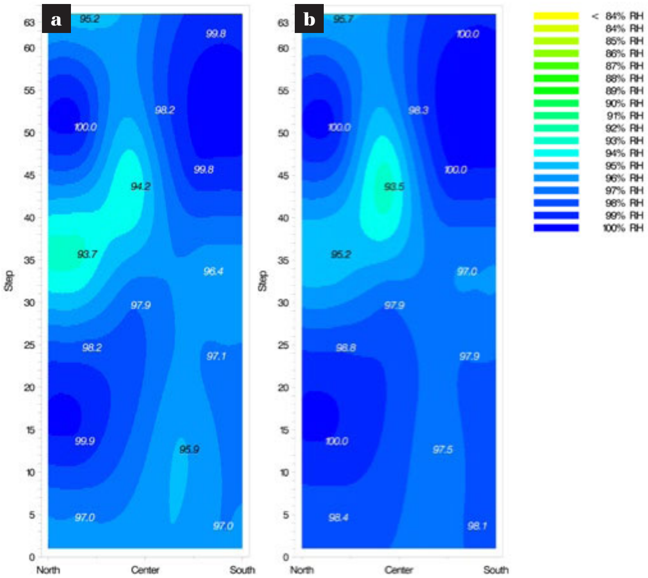
Figures E.7a and b Contour maps displaying the mean daily variation of subsurface temperature (°c) at a depth of 30 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from March 2001 to approximately January 2002.



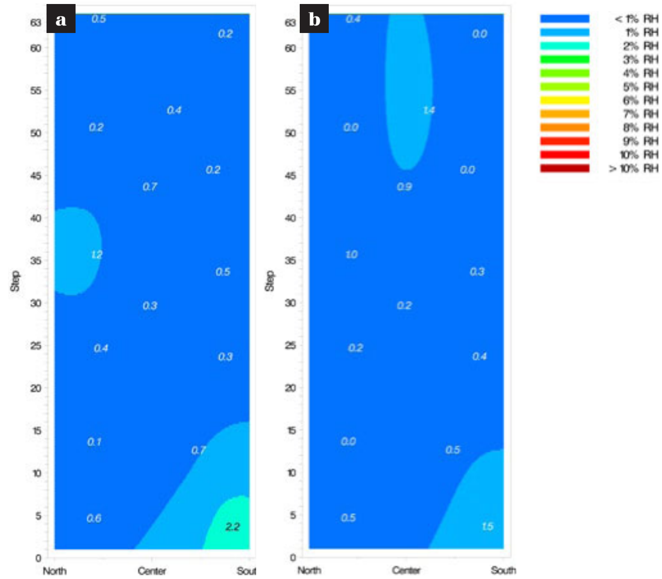
Figures E.6a and b Contour maps displaying the mean subsurface temperature (°c) at a depth of 12 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from approximately January 2002 to August 2004 (known dates of shelter removal are excluded).



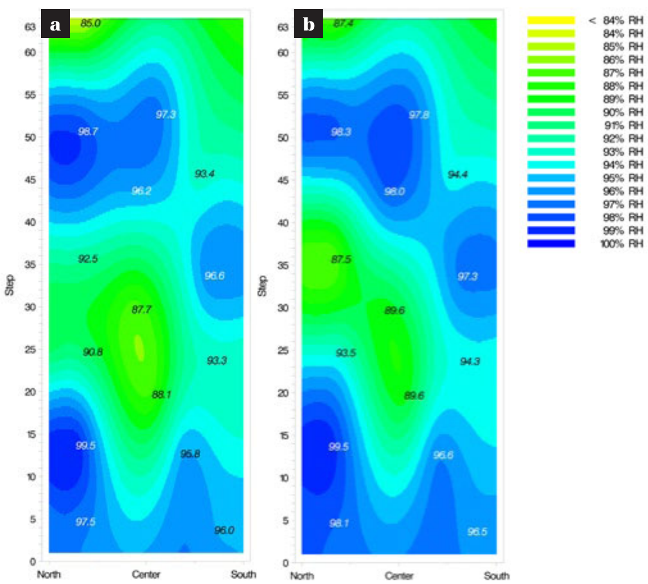
Figures E.8a and b Contour maps displaying the mean daily variation of subsurface temperature (°c) at a depth of 12 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from approximately January 2002 to August 2004 (known dates of shelter removal are excluded).



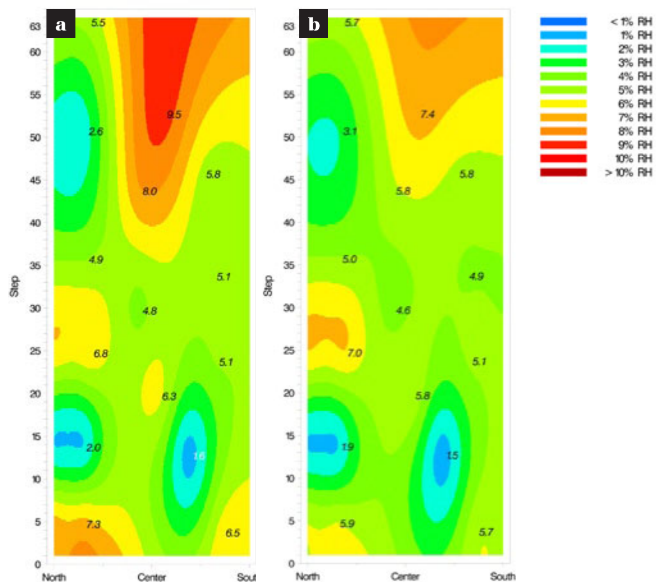
Figures E.9a and b Contour maps displaying mean subsurface relative humidity (%) at a depth of 30 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from March 2001 to approximately January 2002.



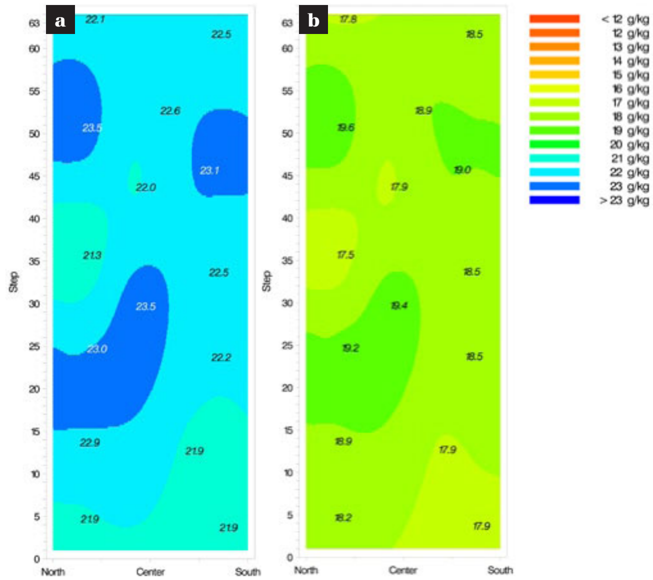
Figures E.11a and b Contour maps displaying the mean daily variation of subsurface relative humidity (%) at a depth of 30 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from March 2001 to approximately January 2002.



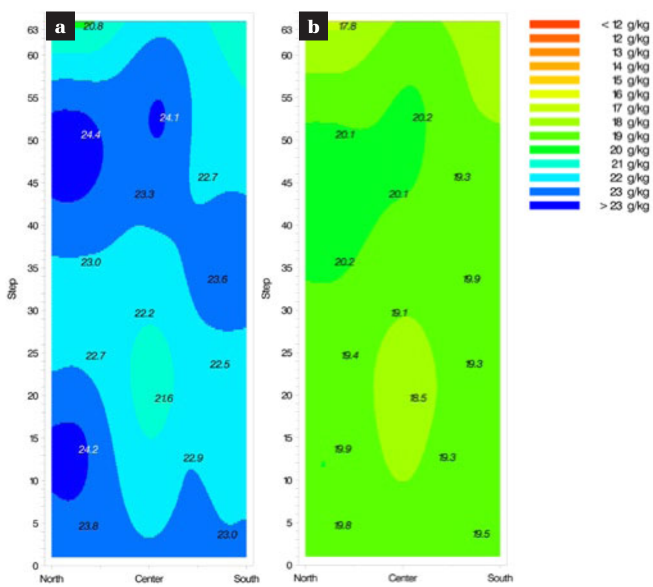
Figures E.10a and b Contour maps displaying mean subsurface relative humidity (%) at a depth of 12 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from approximately January 2002 to August 2004 (known dates of shelter removal are excluded).



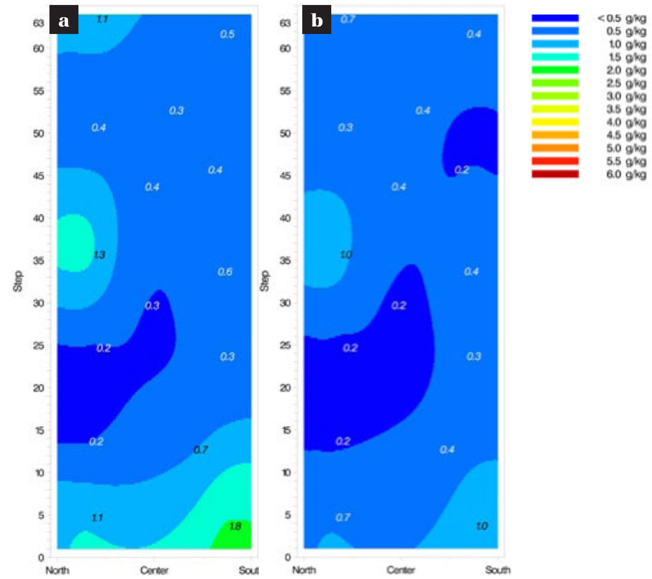
Figures E.12a and b Contour maps displaying the mean daily variation of subsurface relative humidity (%) at a depth of 12 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from approximately January 2002 to August 2004 (known dates of shelter removal are excluded).



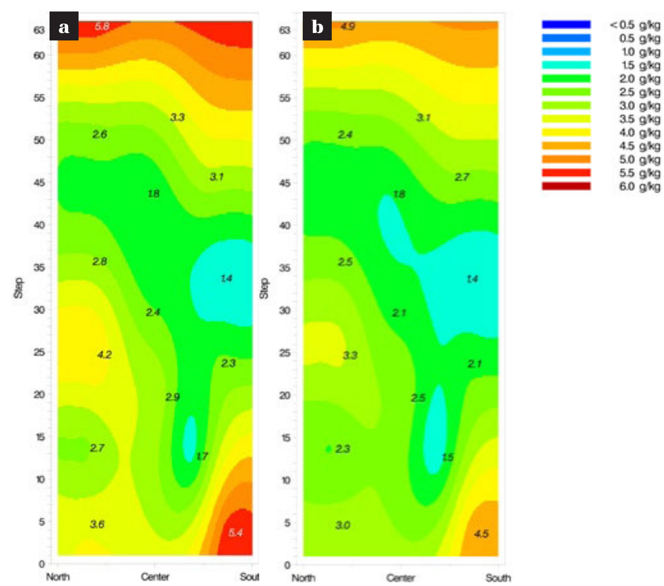
Figures E.13a and b Contour maps displaying mean subsurface humidity ratio (g of water/kg of dry air) at a depth of 30 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Calculated from the subsurface temperature and relative humidity datasets, values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from March 2001 to approximately January 2002.



Figures E.14a and b Contour maps displaying mean subsurface humidity ratio (g of water/kg of dry air) at a depth of 12 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Calculated from the subsurface temperature and relative humidity datasets, values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from approximately January 2002 to August 2004 (known dates of shelter removal are excluded).



Figures E.15a and b Contour maps displaying the mean daily variation of subsurface humidity ratio (g of water/kg of dry air) at a depth of 30 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Calculated from the subsurface temperature and relative humidity datasets, values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from March 2001 to approximately January 2002.



Figures E.16a and b Contour maps displaying the mean daily variation of subsurface humidity ratio (g of water/kg of dry air) at a depth of 12 cm below the surface of the Hieroglyphic Stairway during the wet season, May to October (a), and the dry season, November to April (b). Calculated from the subsurface temperature and relative humidity datasets, values shown indicate the mean seasonal level for specific sensors on the Stairway. The data were collected from approximately January 2002 to August 2004 (known dates of shelter removal are excluded).