LABORATORY REPORT

FOR: Inca Stone, Inc.

SUBJECT: Salt Analysis

SAMPLES SUBMITTED:

Sample Size: 2” x 2” x 2”
(1) sample of “Alpaca” travertine
(1) sample of “Cremino” travertine
(1) sample of “Kello” travertine
(1) sample of “Siena” travertine

PURPOSE OF TEST:
• To determine the quantity of salts on the submitted samples.

TEST METHOD: Salt Analysis

A quantity of the sample is crushed, put into a water solution, and then agitated for one minute. The sample is then injected through an ion-chromatograph, using the EPA 300.1 test method to determine chloride, nitrate, nitrite, and sulfate levels. EPA test method 200.7 is used to determine calcium and sodium levels, and EPA test method 365.3 is used to determine phosphate content of the samples.

Chloride, Nitrate, Nitrite, Sulfate, Calcium, Sodium and **Phosphate** levels are reported as mg/Kg (mg of ion per Kg of sample).

CONCLUSIONS:
The levels of salts in each of the samples tested are extremely low except for calcium, which is to be expected in a calcium based stone such as travertine. Chloride, sulfate, nitrate, nitrite, sodium, and phosphate are all extremely low in each of the submitted samples.

Courtney A. Murdock

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Project Testing Director

LABORATORY REPORT

SAMPLES SUBMITTED:

Sample Type Color Size
“Alpaca - Unfinished” Travertine Brown/Tan/White 8” x 12” x 1” and five 2” x 2” x 2” cubes
“Alpaca - Honed” Travertine Brown/Tan/White 8” x 12” x 1”
“Cremino - Unfinished” Travertine Tan/White 8” x 12” x 1” and five 2” x 2” x 2” cubes
“Kello - Unfinished” Travertine Tan/White/Brown 8” x 12” x 1” and five 2” x 2” x 2” cubes
“Siena - Unfinished” Travertine Gold/Tan/White 8” x 12” x 1” and five 2” x 2” x 2” cubes

PURPOSE OF TEST:

- To determine the dry compressive strength of the submitted “Unfinished” travertine samples.
- To determine the mineralogical composition of the submitted “Unfinished” travertine samples.
- To determine the water vapor transmission characteristics of all five of the submitted travertine samples.
- To determine the slip resistance characteristics of all five of the submitted travertine samples.

TEST METHODS: ASTM C 170 Standard Test Method for Compressive Strength of Dimension Stone

Five 2” x 2” x 2” cubes of the “Alpaca - Unfinished”, “Cremino - Unfinished”, “Kello - Unfinished”, and “Siena - Unfinished” were submitted by Inca Stone, Inc. for testing.

The samples were first placed in an oven at approximately 140° F for 48 hours. The samples were then removed and allowed to cool at room temperature.

The samples were then placed in the testing machine and the test was performed. The compressive strength of each sample was calculated as follows:

$C = W/A$

where:
C = compressive strength of the specimen, psi
W = total load, lbf, on the specimen at failure
A = calculated area of the bearing surface in $in.^2$
Each individual result was rounded to the nearest 100 psi

PHOTOGRAPH: Samples for Compressive Strength Before Testing

TEST RESULTS: ASTM C 170 Standard Test Method for Compressive Strength of Dimension Stone

SUMMARY

ASTM C 170
SUMMARY FOR COMPRESSIVE STRENGTH OF DIMENSION STONE

Specimen Identification	Alpaca	Cremino	Kello	Siena
Cure Condition	dry	dry	dry	dry
Average Width (in.)	2.03	2.15	2.06	2.06
Aveage Length (in.)	2.07	1.96	2.00	1.95
Average Height (in.)	1.97	2.03	1.92	1.91
Average Area (in.)	4.21	4.20	4.12	4.02
Average Maximum Load (lb)	54,520	53,140	51,160	48,600
Average Compressive Strength (psi)	**12,960**	**12,670**	**12,420**	**12,155**

"ALPACA - UNFINISHED"

ASTM C 170
COMPRESSIVE STRENGTH OF DIMENSION STONE

Specimen Identification	Alpaca 1	Alpaca 2	Alpaca 3	Alpaca 4	Alpaca 5	**Average**
Cure Condition	dry	dry	dry	dry	dry	**n/a**
Width (in.)*	2.07	2.00	2.01	2.10	1.99	**2.03**
Length (in.)**	2.00	2.12	2.09	1.99	2.16	**2.07**
Height (in.)	1.99	1.96	1.96	1.94	2.02	**1.97**
Area (in.)	4.14	4.24	4.19	4.18	4.30	**4.21**
Maximum Load (lb)	54,000	53,400	49,400	63,400	52,400	**54,520**
Compressive Strength (psi)	**13,050**	**12,600**	**11,780**	**15,180**	**12,200**	**12,960**

Notes: * Average width from the top and bottom of the specimen.
** Average length from the top and bottom of the specimen.
Alpaca 4 had a 1/2 inch chip at one corner and a 1/4 inch void.

"CREMINO – UNFINISHED"

ASTM C 170
COMPRESSIVE STRENGTH OF DIMENSION STONE

Specimen Identification	Cremino 1	Cremino 2	Cremino 3	Cremino 4	Cremino 5	**Average**
Cure Condition	dry	dry	dry	dry	dry	**n/a**
Width (in.)*	2.16	2.12	2.17	2.11	2.17	**2.15**
Length (in.)**	1.95	1.96	1.96	1.96	1.96	**1.96**
Height (in.)	2.04	2.08	2.00	2.05	1.98	**2.03**
Area (in.)	4.21	4.15	4.24	4.13	4.25	**4.20**
Maximum Load (lb)	50,600	54,400	53,400	58,100	49,200	**53,140**
Compressive Strength (psi)	**12,010**	**13,120**	**12,590**	**14,050**	**11,580**	**12,670**

Notes: * Average width from the top and bottom of the specimen.
** Average length from the top and bottom of the specimen.
Cremino 1 had a 1/4 inch chip at one corner.

"KELLO – UNFINISHED"

ASTM C 170
COMPRESSIVE STRENGTH OF DIMENSION STONE

Specimen Identification	Kello 1	Kello 2	Kello 3	Kello 4	Kello 5	**Average**
Cure Condition	dry	dry	dry	dry	dry	**n/a**
Width (in.)*	2.06	2.20	2.00	2.02	2.03	**2.06**
Length (in.)**	2.01	2.00	2.00	1.98	2.00	**2.00**
Height (in.)	1.86	1.91	2.02	1.88	1.90	**1.92**
Area (in.)	4.12	4.41	3.99	4.00	4.06	**4.12**
Maximum Load (lb)	59,600	53,800	52,400	44,000	46,000	**51,160**
Compressive Strength (psi)	**14,460**	**12,210**	**13,120**	**11,010**	**11,320**	**12,420**

Notes: * Average width from the top and bottom of the specimen.
** Average length from the top and bottom of the specimen.
Kello 1 and 2 had a 1/4 inch void on the surface.
Kello 3 had a 1/4 inch chip at the corner.
Kello 5 had a 1/4 inch chip and void at the corner.

“SIENA - UNFINISHED”

ASTM C 170
COMPRESSIVE STRENGTH OF DIMENSION STONE

Specimen Identification	Siena 1	Siena 2	Siena 3	Siena 4	Siena 5	**Average**
Cure Condition	dry	dry	dry	dry	dry	**n/a**
Width (in.)*	2.10	1.98	2.09	2.08	2.04	**2.06**
Length (in.)**	1.95	1.96	1.96	1.95	1.95	**1.95**
Height (in.)	1.59	1.98	1.99	1.99	2.01	**1.91**
Area (in.)	4.09	3.88	4.09	4.06	3.98	**4.02**
Maximum Load (lb)	37,400	51,000	46,000	45,800	51,600	**48,600**
Compressive Strength (psi)	**9,140†**	**13,150**	**11,240**	**11,270**	**12,960**	**12,155**

Notes: * Average width from the top and bottom of the specimen.
** Average length from the top and bottom of the specimen.
†Value was excluded from the average based on a statistical T-test.
Siena 3 had a 1/4 inch chip.
Siena 5 had a 1/4 inch chip at the corner.

TEST METHODS: Petrographic Examination

Identification of the mineralogical composition of the masonry sample is initially determined using powder X-ray diffraction analysis. Confirmation of the XRD results, and textural characterization of the sample, as well as identification of trace components and any suitable stain or microchemical tests, are conducted using polarized light microscopy. The methods used largely follow ASTM procedures recommended for concrete petrography.

TEST RESULTS: Petrographic Examination

“Alpaca”, “Cremino”, “Kello” and “Siena” Travertines

Four 48 x 48 x 5 mm samples of travertine (Fig. 1) were provided for X-ray diffraction and petrographic analysis to determine the mineralogy of the travertines. The samples were unfinished as received, so one side of each sample was polished so that textural details could be observed, and to better reveal the color of each sample. The four samples include “Alpaca”, which is a rich, medium brown, “Cremino”, a light tan mottled with touches of gray patches and a few pores, “Kello”, a mottled beige with gray and black patches, and “Siena”, a gold, fairly uniformly-colored stone with strings of small pores.

Figure 1: Travertine samples described in this report. The samples were polished and dampened to enhance color and textural differences between samples. Scanned image.

TEST RESULTS: Petrographic Examination (cont.)

X-ray Diffraction Analysis

X-ray diffraction analysis (Figs. 2 and 3) of the samples indicates that all four samples are essentially 100% calcite ($CaCO_3$). The distinct color variation among the samples is therefore not simply due to mineralogical differences.

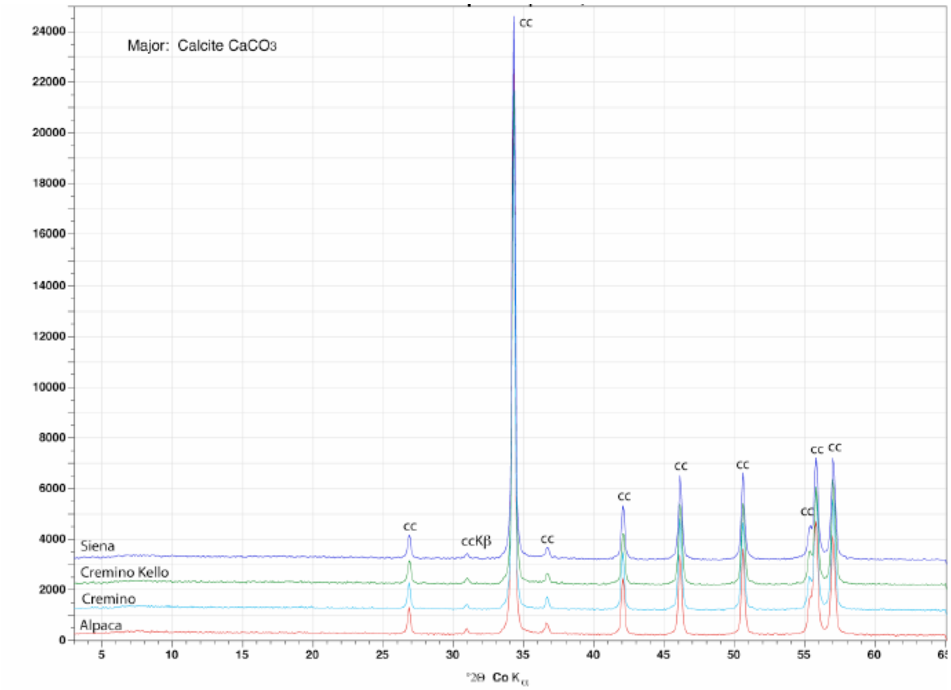


Figure 2: Powder X ray diffractogram of travertine samples. Calcite is the only phase detected.

Petrography

Petrographic examination of each sample was conducted to characterize trace components, and textural features that might contribute to the color variations among the samples.

“Alpaca” Travertine

Alpaca is relatively coarse, transparent tan calcite. It is uniformly-textured with few pores and only slight mottling. The individual calcite grains are transparent, though slightly colored, and the contacts between grains are very tight. The result is little scattering of light at grain boundaries, producing a richly-colored stone. The coloring agent is probably a trace of iron oxyhydroxides, at the parts per million level, within the calcite grains. The color is quite common for coarse calcite.

TEST RESULTS: Petrographic Examination (cont.)

Figure 4: 20 x 20 mm close-up views of the travertines. The Alpaca is very uniformly-textured with few pores and only slight mottling. The Cremino has transparent, sparry calcite crystals lining vugs, producing the gray patches in the light tan travertine making up most of the stone. The Kello contains fine grained calcite, with very small drusy calcite crystals lining the pores. Dendrites and spots of a black mineral, possibly a manganese oxide, add a trace of dark color to the buff, cemented granular bulk of the stone. The Siena is very fine-grained and uniformly textures, with strings of small pores outlining calcite granules. Scanned images.

"Cremino" Travertine

The Cremino contains fine-grained calcite and has a fairly uniform texture with a faint granular texture. The sample displays one diffuse, medium gray spot (Fig. 4) consisting of transparent, colorless sparry calcite lining a vug. The clarity of the sparry calcite allows light to enter the crystal and get trapped, rather than being scattered and re-emitted, giving the calcite a dark appearance. The surrounding fine-grained calcite scatters light, producing a lighter color.

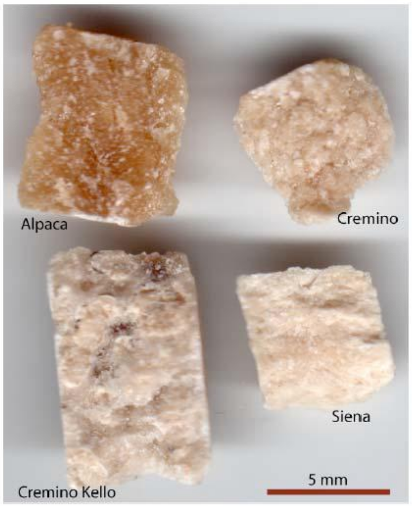


Figure 5: Fractured surfaces of the travertines, showing differences in texture and grain size. The Alpaca is relatively coarse, transparent tan calcite. The Cremino and Kello are both fine-grained buff calcite, but the Kello has a granular, "cottage cheese-like" texture whereas the Cremino has a more uniform texture. The Siena is very fine-grained beige calcite with a slightly fibrous texture (visible in the lower right portion of the chip) and uniform color. Scanned image.

TEST RESULTS: Petrographic Examination (cont.)

"Kello" Travertine

The most noticeable feature of the Kello travertine is its granular, "cottage cheese"-like texture (Fig. 4). Light-colored, subangular to rounded granules ranging from 0.5 to 5 mm across are cemented together with fine-grained calcite. Where cementation is incomplete, pores lined with very small drusy crystals of calcite are preserved. Where the drusy calcite is coarser and transparent, the cement has a darker appearance (Fig. 5). A trace of presumed manganese oxides form clusters and strings of tiny black spots (Fig. 4), but those do not have much effect on the overall color of the stone. Most of the color variation in the sample is due to variation in light-scattering between the light clasts and the more transparent cement and drusy calcite.

"Siena" Travertine

Nearly all the calcite in the Siena sample is very fine-grained, with little variation in the light-scattering characteristics of the calcite clasts and cement (Fig.4). The sample is thus nearly uniformly light in color, with only subtle variation in tone. On the fractured surface of the sample (Fig. 5) some of the calcite appears to have a fibrous fracture that might be a relict of calcite precipitation on fibrous nuclei, such as algal or bacterial strands.

Summary

The four travertine samples are all essentially pure calcite (<<1% non-calcite phases). The color variation among the samples is primarily due to variation in the light-scattering characteristics of calcite with different textures between the samples, and within individual samples. The only other mineral detected in the samples is a trace of manganese oxides in the Kello travertine, but the oxide is not an important coloring agent compared to the various types of calcite in the sample.

Respectfully submitted by

J. B. Murowchick

James B. Murowchick, Ph.D.
Consulting Mineralogist

TEST METHODS: Water Vapor Transmission (ASTM E 96 – Water Method - Modified)
The samples were cut with a wet masonry saw into appropriate size test specimens. The samples were then rinsed with water under a sink and allowed to dry for at least 24 hours. The travertine samples were placed on laboratory test cells partially filled with distilled water. The sides of the samples were sealed to the top rim of the test cell so that no water vapor could escape. Cells were then weighed and placed in a room maintained at approximately 73°F (23°C) and 30% relative humidity.

The total weight loss of the individual cells was calculated after the second day and daily thereafter for a total of ten days. Weight loss was calculated as a factor of g/m_2 per 24 hours.

CALCULATION:

WVT = g/m_2/24 hours

TEST RESULTS: Water Vapor Transmission (ASTM E 96 - Modified)

Sample	**Water Vapor Transmission Rate**
“Alpaca - Unfinished”	6.830 g/m_2/24 hours
“Alpaca - Honed”	11.917 g/m_2/24 hours
“Cremino - Unfinished”	6.707 g/m_2/24 hours
“Kello - Unfinished”	21.967 g/m_2/24 hours
“Siena - Unfinished”	13.937 g/m_2/24 hours

PHOTOGRAPH: Water Vapor Transmission (ASTM E 96 - Modified)

TEST METHODS: ASTM C 1028 Slip Resistance Evaluation

The samples were tested for wet and dry static coefficient of friction using procedures and materials in accordance with ASTM C 1028.

Calibration

A 50-lb weight with a neolite heel attached on the bottom of the assembly was placed on the standard tile. Using a dynamometer the force required to set the heel assembly into motion was recorded.

A total of four pulls were made with each pull being perpendicular to the previous pull. The following equation was used to determine the calibration factors. The calibration procedure was repeated for both a dry and wet surface.

$X_D = 0.71 - R/NW$ $\qquad$ $X_W = 0.47 - R/NW$

X_D = Dry Calibration Factor
X_W = Wet Calibration Factor
R = Sum of the recorded pulls
N = Number of pulls
W = Weight of the neolite heel assembly

Testing – Dry and Wet

A 50-lb weight assembly with a neolite heel attached on the bottom of the assembly was placed on top of the tile to be tested. Using a dynamometer the force required to set the test assembly in motion was measured.

Four pulls, each perpendicular to the previous pull, on three different surfaces was measured to give a total of four measurements. The following equations were used to determine the static coefficient of friction. The tests were run on both a wet and dry surface.

$F_D = R/NW + X_D$ $\qquad$ $F_W = R/NW + X_W$

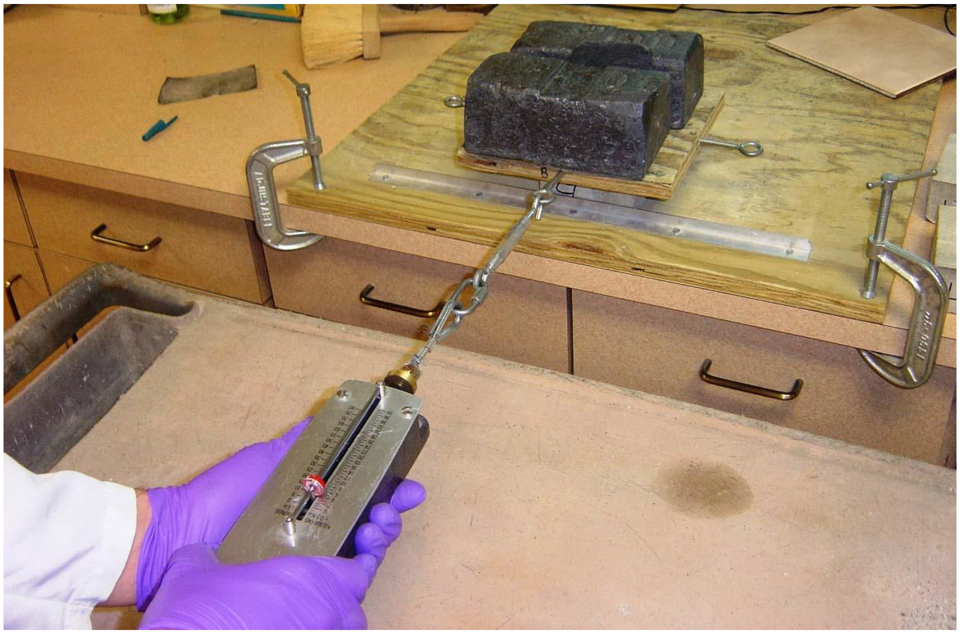
F_D = Static Coefficient of Friction for Dry Surface
F_W = Static Coefficient of Friction for Wet Surface
R = Sum of the 4 force readings
N = Number of Pulls (4)
W = Total Weight of the Neolite Heel Assembly

TEST RESULTS: ASTM C 1028 Slip Resistance Evaluation

SAMPLE	DRY SCOF	WET SCOF
"Alpaca - Unfinished"	0.8071	0.6545
"Alpaca - Honed"	0.7391	0.5719
"Cremino - Unfinished"	0.8314	0.7224
"Kello - Unfinished"	0.7780	0.6059
"Siena - Unfinished"	0.8945	0.6690

Current ADA regulations suggest that horizontal surfaces have a dry static coefficient of friction (SCOF) of 0.6 or greater and a ramped surface have a static coefficient of friction of 0.8 or greater. It should be noted that the larger the SCOF the more resistant the surface is to slipping.

PHOTOGRAPH: ASTM C 1028 Slip Resistance Evaluation



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Recommendations made within this report are based on laboratory test applications and observations. Final determination of the suitability of a product and/or procedure should be made only after thorough job testing on actual surfaces.