PETROGRAPHIC SERVICES REPORT

DESCRIPTION OF CAST STONE
GRAND STAIRCASE
EASTERN OREGON UNIVERSITY
ONE UNIVERSITY BOULEVARD
LA GRANDE, OREGON 97850

STANDARD PRACTICE FOR PETROGRAPHIC EXAMINATION OF HARDENED CONCRETE ASTM C 856-20 (NORTH RETAINING WALL, BALUSTER, RAILING AND TOP CAP)

Prepared for:

Mr. Peter Meijer, AIA Principal
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Prepared by:

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June 10, 2022
DCI Project No. 890-4

Dominion Consulting, Inc.
Petrographic Examination of Concrete Products and Earth Materials

June 10, 2022

Mr. Peter R. Meijer AIA, Principal
Peter Meijer Architect, PC
2232 SE Clinton Street
Portland, OR 97202

Grand Staircase Investigation
Eastern Oregon University
One University Boulevard
La Grande, Oregon 97850

Dear Peter,

We collected two concrete retaining wall cores, one baluster sample, a top cap and a piece of railing from on-site May 24, 2022. You requested that we describe the historic cast stone layer present on baluster, top cap and railing samples and the concrete present in retaining wall cores. In order to due this we used applicable methods stated in ASTM C856-20, *Standard Practice for Petrographic Examination of Hardened Concrete.* We understand that the main goal of this analysis is to provide you with the information required to duplicate the cast stone layer for a total staircase re-construction project.

Sample Preparation and Examination Methods

The samples were measured and photographed upon receipt and prepared for microscopic examination in accordance with the stated ASTM. Original and laboratory sawed/polished surfaces were viewed with the unaided eye and stereomicroscope (16-80X) to note overall aggregate and paste characteristics of the cast stone layers and wall concrete.

Thin-sections ground to 25 microns were made from the cored wall concrete and each sample containing a cast stone layer and studied using a polarizing microscope (40-400X) to determine degree of binder type(s), carbonation, void characteristics and microcracking. Paste scratch hardness was tested by observing the reaction of binders to probing with steel dental tools under microscopic observation. Water drops were placed with a surgical needle on lapped surfaces and relative absorption rates were noted.

Discussion and Conclusion

The cast stone layer in the baluster, railing and top cap samples consists of approximately 65 percent limestone (calcite) chips, 33 percent crushed quartz and 2 percent feldspar grains by volume. This composition is not typical of local made concrete products. The closest limestone is approximately 70 miles south of La Grande. The overall pinkish white color (fresh) is due to a binder additive, not identifiable by this microscopic method. This cast stone pre-dates air-entrainment, so the void systems are due to consolidation. Cement paste is locally carbonated. The portland cement observed in thin-section analysis is relatively large compared to modern more finely ground cement. Estimated overall proportions of the historic cast stone examined is 1 part coarse ground portland cement to 4 parts sand. Refer to Table 1 in the Appendix for additional details of our examination.

Table 1, job-site photographs and laboratory photographs and photomicrographs are included in the Appendix. The above observations and comments specifically apply to the samples as received for examination and analysis. This report may be copied only in its entirety without prior written approval from this office. Remnants of the samples will be kept in our laboratory storage for three months than discarded unless notified.

Please call (541) 962-7430 or email me at dick@dominionconsulting.biz if you have any questions concerning this report. We appreciate the opportunity to serve your petrographic needs.

Regards,

Dick M Glasheen

Dick M. Glasheen, R.G.
President/Principal Petrographer

DCI Report No. 890-4

APPENDIX

Includes

Jobsite Photographs

DCI Laboratory Photographs
and
Photomicrographs

APPENDIX

DCI REPORT NO. 890-4 (Grand Staircase)

Table 1 – Summary of Microscopic Observations and Testing

Item	North Retaining Wall Cores (3" x 1¼" dia.)	Baluster (22¾" high x 8"dia.)	Railing (8" x 8" x 2-3" thick)	Top Cap (14¼" square x 2")
As Received	2 & 3 pieces; no embedded steel.	½ of a longitudinal piece; 3/16 dia. rebar longitudinally through center of sample, some corrosion; cast stone ranges from ½-1½" thick; fresh color is pinkish white, Munsell® Soil Color Chart HUE 2YR 8/2; relatively smooth textured exterior surface; interior material medium-dark gray.	One broken piece; a lightly corroded 3/6" dia. rebar "hooked through" lower part of sample; cast stone ranges ½" at crest to 1-3/8" thick at edges; fresh color similar to Baluster; rough textured exterior surface; interior material color similar to Baluster.	One piece; cast stone ranges ¼-3/8" at crest to ½-3/8" thick at edges; fresh color similar to Baluster; rough textured exterior surface; interior material color similar to Baluster.
Aggregate	Coarse: mostly dark gray & brown clean sound basalt gravel; Fine: crushed basalt fragments, feldspar & quartz grains. Overall grading roughly similar to ASTM C33 No.467 (1½"-#4).	Cast Stone: sand clean crushed limestone (calcite) 65%, quartz 33% & feldspar 2% by volume, gap graded largest ASTM #7 (2.80mm max). Interior Material: mostly clean crushed basalt, feldspar & mafic minerals; #4 grading (4.75mm max.)	Cast Stone & Interior Material sand similar to Baluster.	Cast Stone & Interior Material sand similar to Baluster.

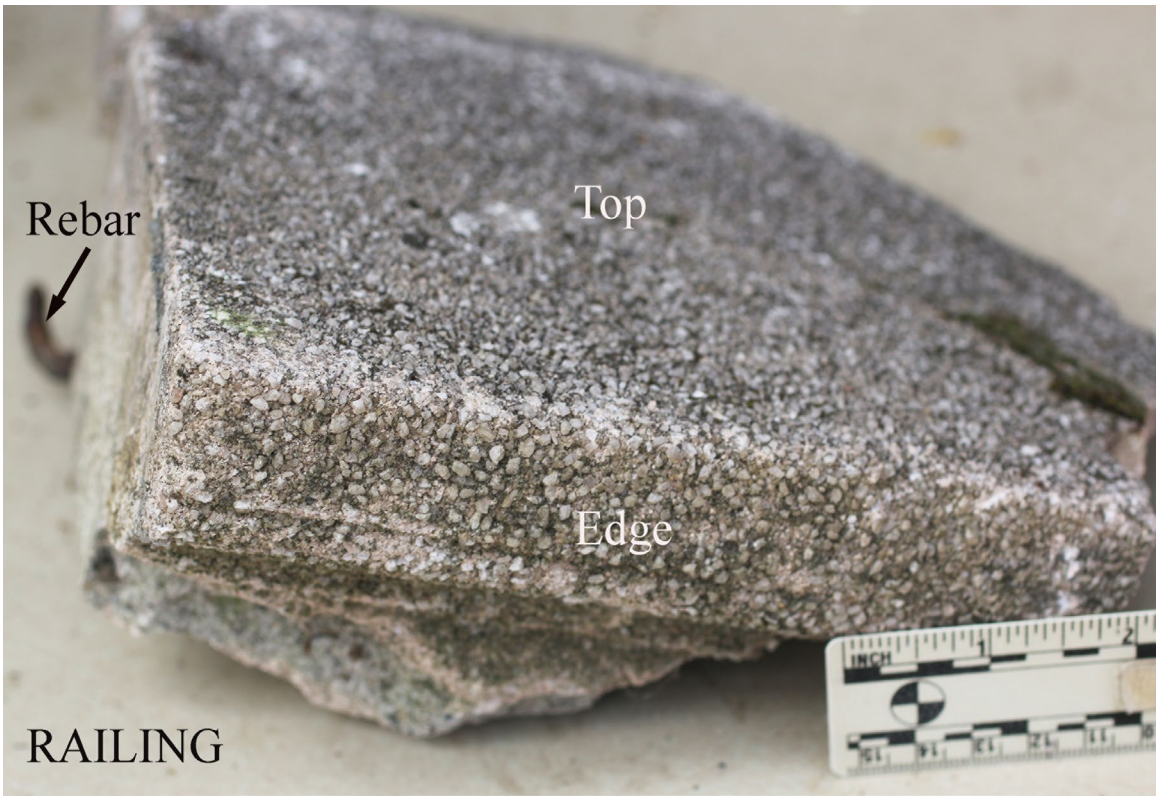
APPENDIX (continued)

DCI REPORT NO. 890-4 (Grand Staircase)

Item	North Retaining Wall Cores (3" x 1¼" dia.)	Baluster (22¾" high x 8"dia.)	Railing (8" x 8" x 2-3" thick)	Top Cap (14¼" square x 2")
Hardened Paste	Light gray to white color overall; firm scratch hardness; estimated 5-8% consolidation voids; some remnant portland cement grains; outmost ½" carbonated (pH 5-6).	Cast Stone: estimated 12-18% consolidation voids; some remnant portland cement grains; pH 9-10, locally carbonated pH less than 7. Interior Material: estimated 9-12% consolidation voids; some remnant portland cement grains; mostly pH 7-9, spots of 10-11 pH.	Cast Stone: estimated 8-12% consolidation voids; some remnant portland cement grains; pH 10-11, locally carbonated pH less than 8. Interior Material: estimated 14-18% consolidation voids; some remnant portland cement grains; mostly pH 7-9, spots of 10-11 pH.	Cast Stone: estimated 7-10% consolidation voids; some remnant portland cement grains; pH 10-11, locally carbonated pH 5-6. Interior Material: estimated 6-8% consolidation voids; some remnant portland cement grains; mostly pH 8-9, spots of 11-12 pH.

FIGURE 1 **Core #1 from wing wall at east side of North Retaining Wall.**

FIGURE 2 **Core #2 from east side of North Retaining Wall.**



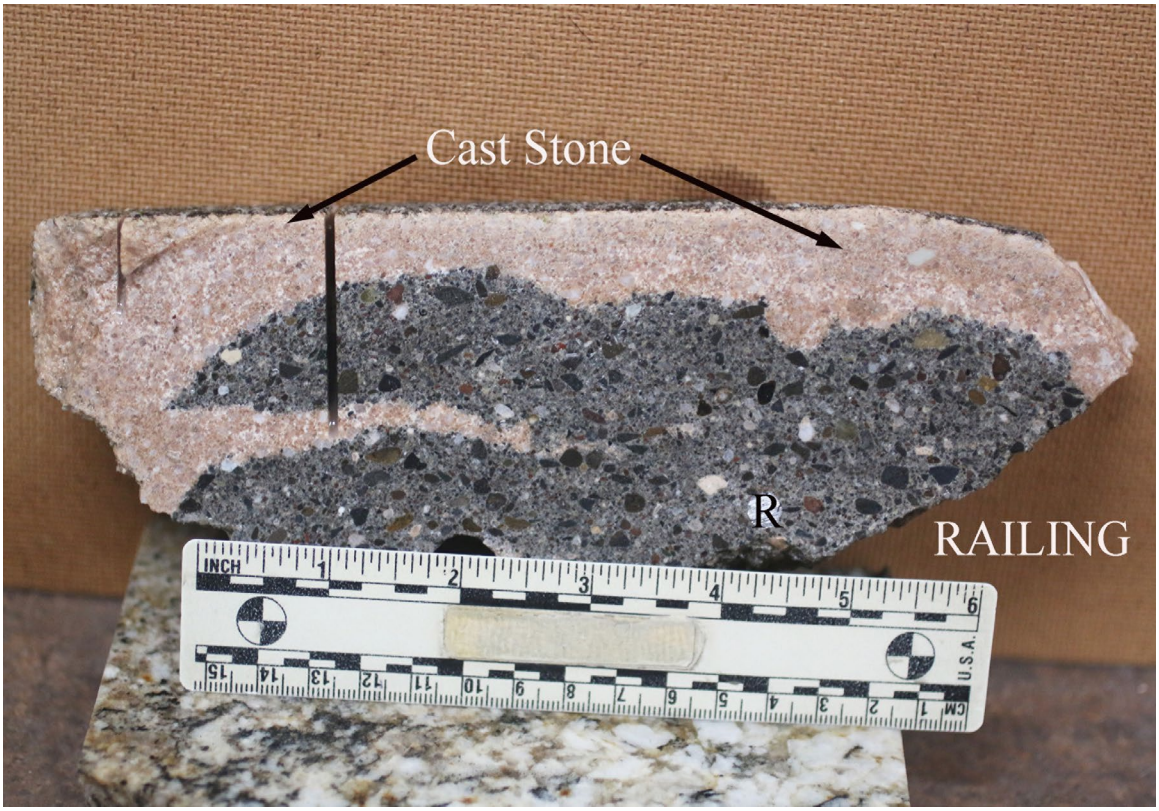


FIGURE 3 **Railing sample.**

FIGURE 4 **Sawed cross-section through railing shows cast stone layer.**

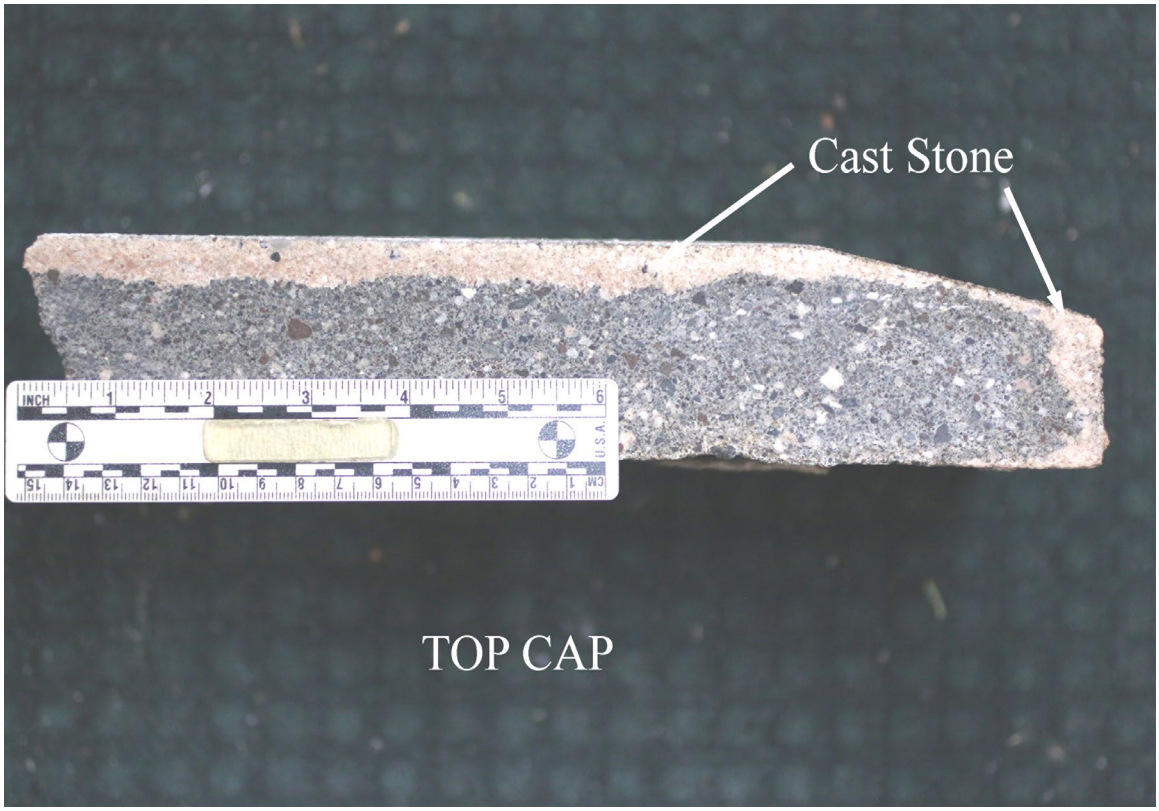


FIGURE 5 **Face of Top Cap sample.**

FIGURE 6 **Sawed cross-section through top cap shows cast stone layer.**

FIGURE 7 Face of Baluster sample.

FIGURE 8 Interior of Baluster sample.

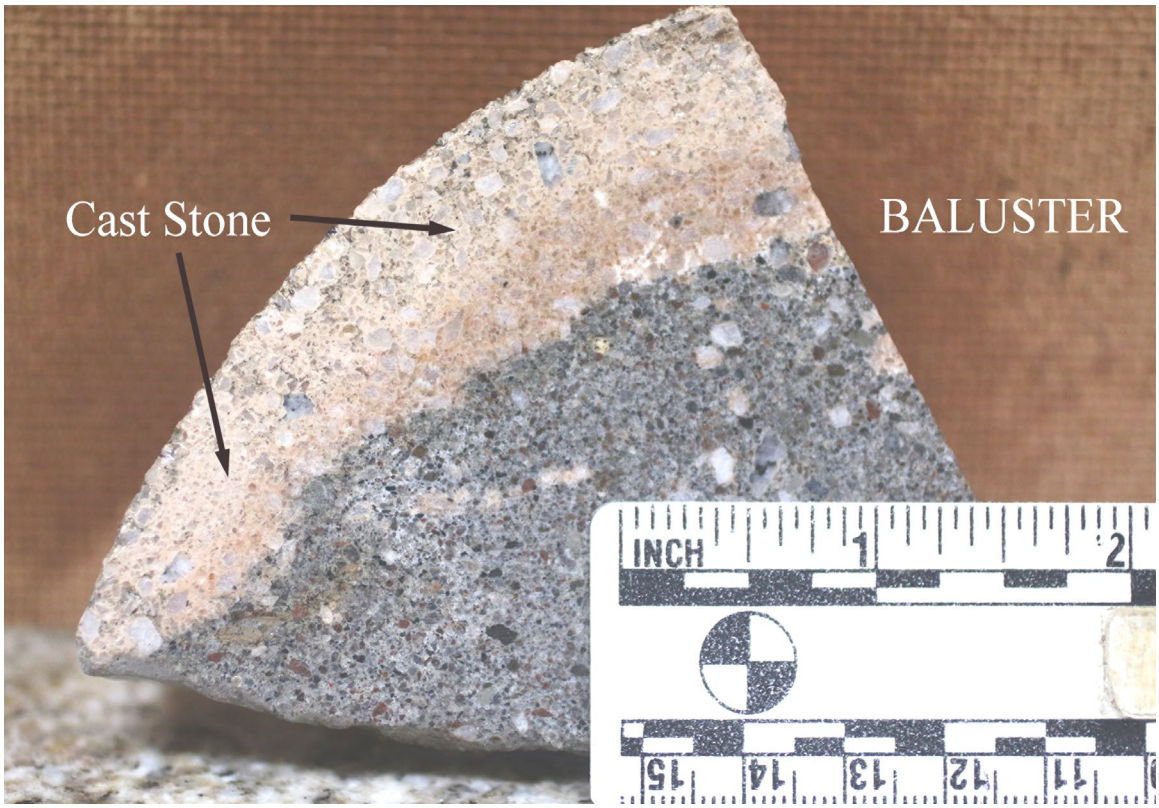


FIGURE 9 Sawed cross-section through baluster shows cast stone layer.

FIGURE 10 Typical appearance of in-place/missing balusters and damaged railing.

FIGURE 11 North end of the Grand Staircase.

FIGURE 12 Some of the samples collected from the staircase.

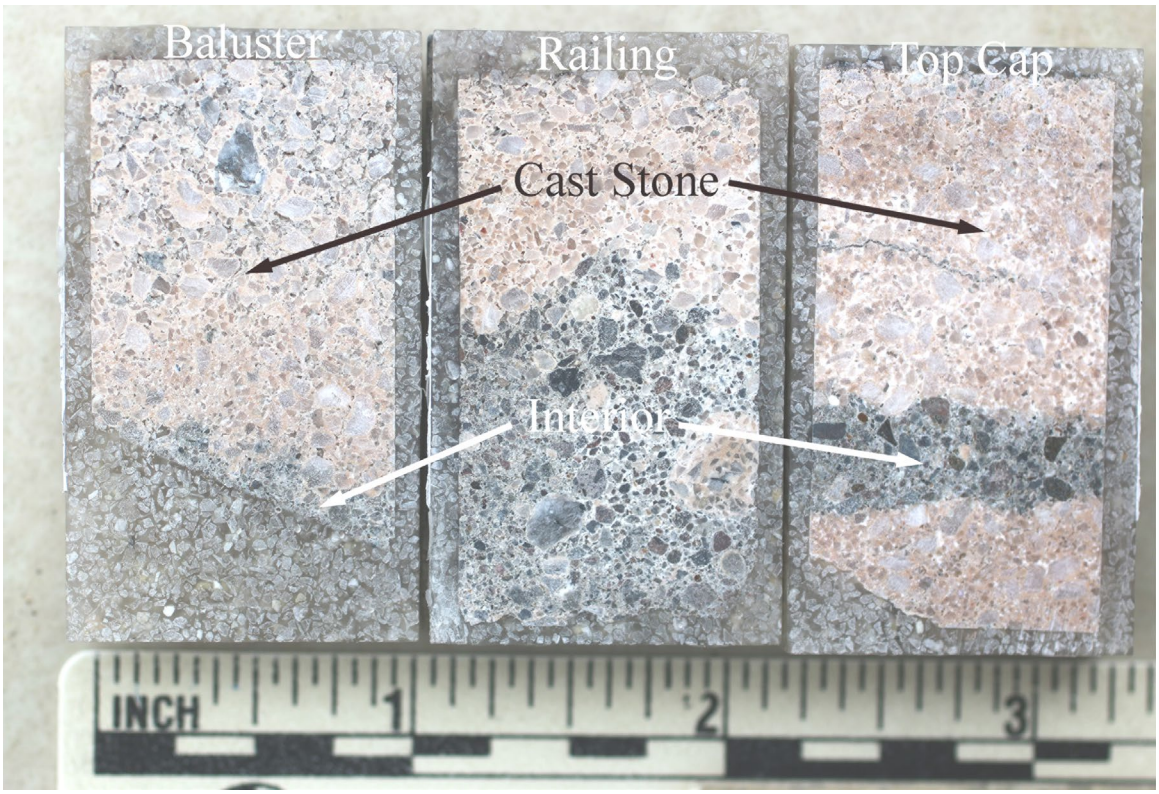


FIGURE 13 Epoxy cemented blocks of cast stone containing samples from which thin-sections fabricated.

FIGURE 14 Comparison of typical cast stone fresh color to Munsell Chart.

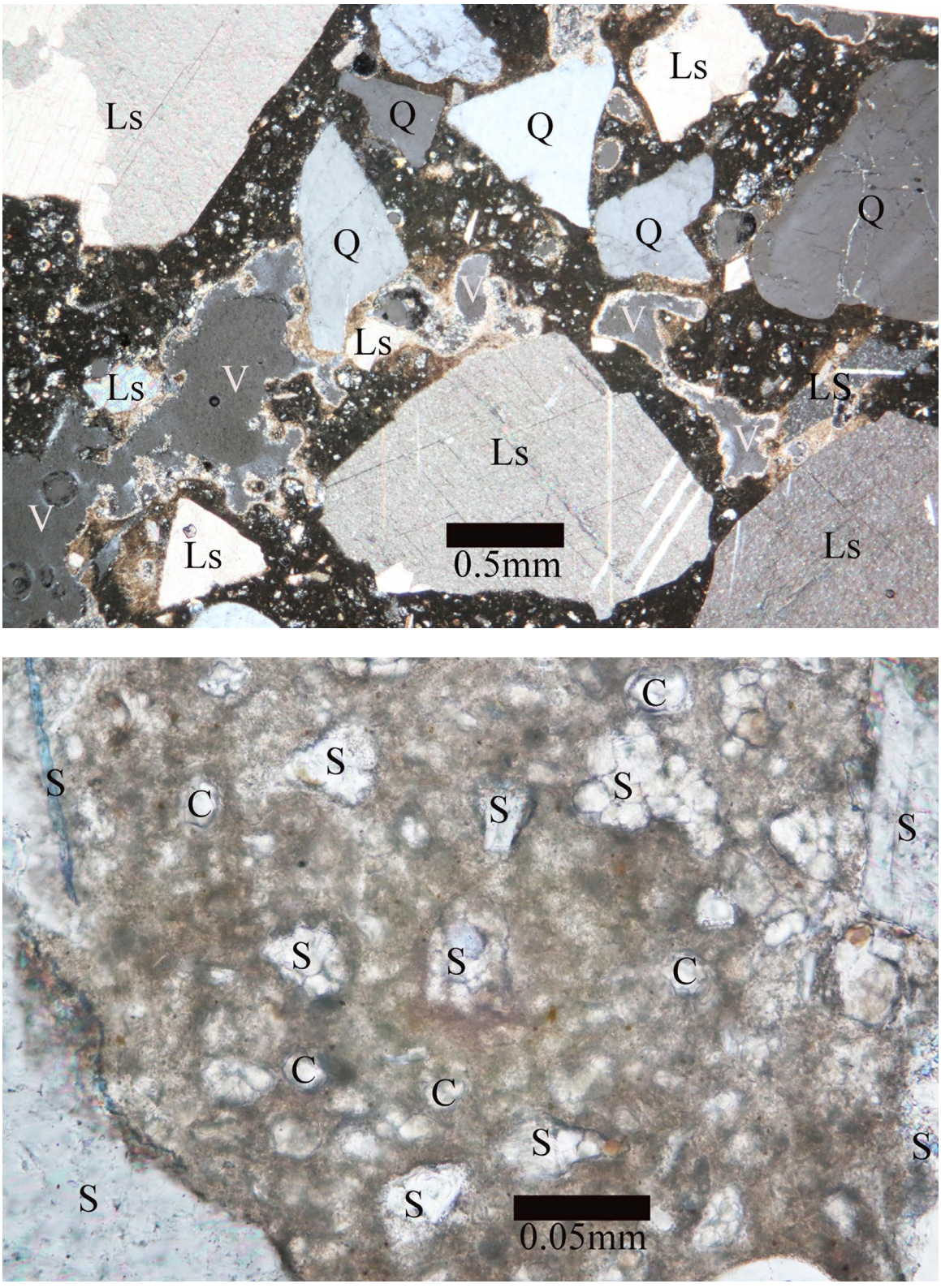


FIGURE 15 Micrograph of cast stone thin-section shows typical limestone (Ls) and quartz (Q) composition. Consolidation voids are marked (V) (X50 polarized light).

FIGURE 16 More highly magnified cast stone thin-section shows some remnant coarse-ground portland cement (C) and sand (S) (X400 plain light).

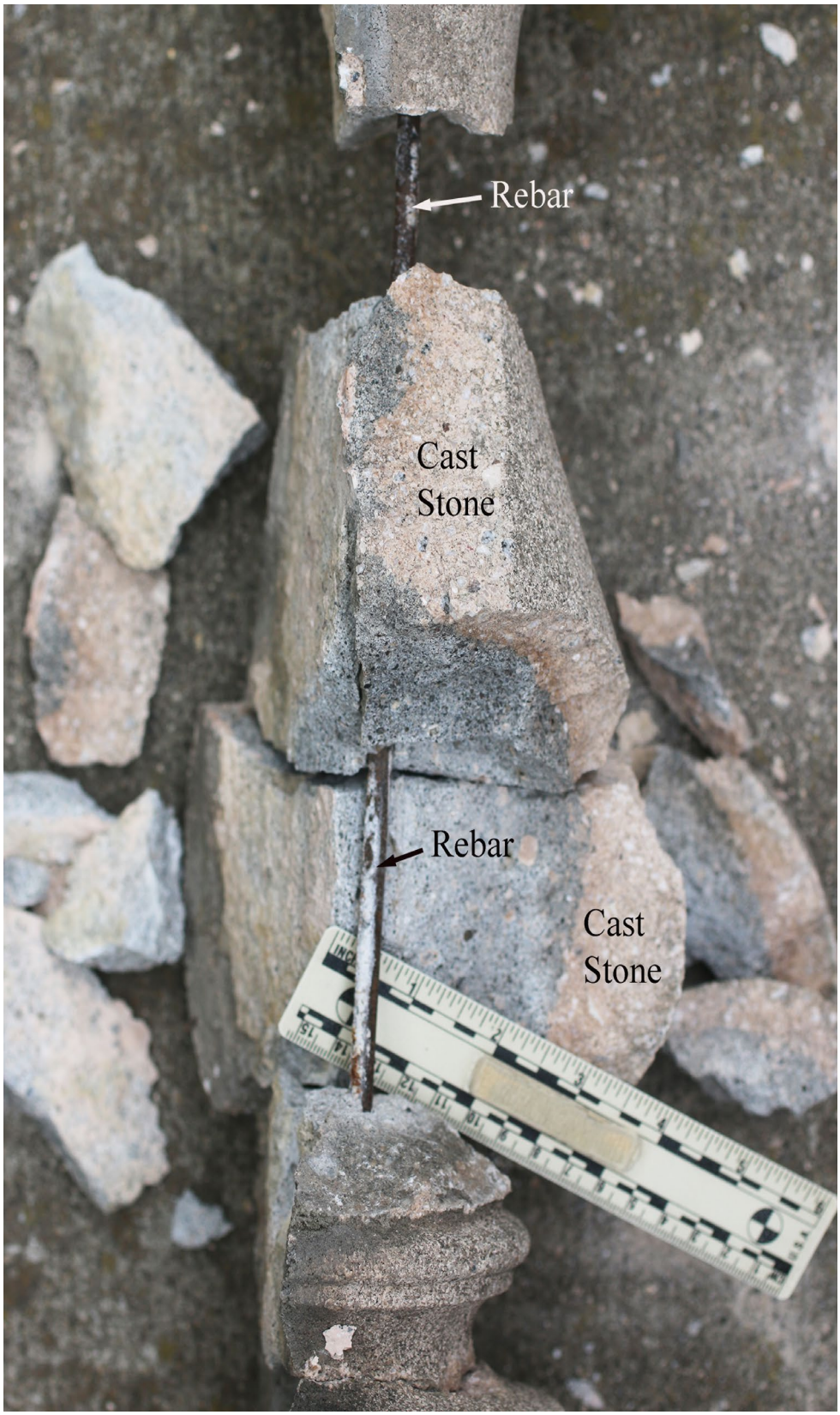


FIGURE 17 Baluster sample "opened up" to show rebar, cast stone layer and interior material.