



THE GREAT PYRAMID DEBATE



**EVIDENCE FROM
DETAILED PETROGRAPHIC EXAMINATIONS OF
CASING STONES FROM THE GREAT PYRAMID OF KHUFU,
A NATURAL LIMESTONE FROM TURA, AND
A GEOPOLYMERIC LIMESTONE**

**DIPAYAN JANA
Construction Materials Consultants, Inc. &
Applied Petrographic Services, Inc.**



THE EGYPTIAN PYRAMID ENIGMA

CARVE – AND – HOIST THEORY

Pyramid blocks are quarried, carved, and hoisted limestone

MYSTERY = HOW??

- The Great Pyramid of Khufu
- 2.3 million blocks
- Average 2.5 tons/block
- Built in 26 years
- Close fit



Dr. JOSEPH DAVIDOVITS'

CAST-IN-PLACE GEOPOLYMERIC CONCRETE THEORY

Pyramid blocks are cast-in-place concrete made by mixing disintegrated kaolinitic, nummulitic limestone with lime and natron



“GEOPOLYMERIC” LIMESTONE

“RECONSTITUED” LIMESTONE CONCRETE CEMENTED BY ALKALI-ACTIVATED ALUMINOSILICATE GLUE

- ❖ “EASILY DISAGGREGATED” SOFT, MARLY LIMESTONE
 - ❖ LIME + NATRON = ALKALI HYDROXIDE
 - ❖ KAOLINITIC CLAY IN LIMESTONE
- ALKALI-ALUMINOSILICATE (ZEOLITIC) “GLUE” [GEOPOLYMER]

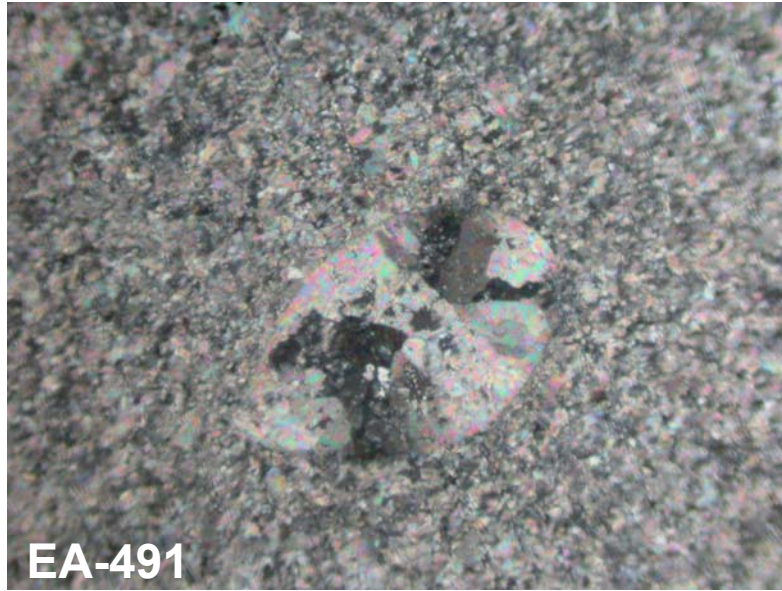
STUNNING VISUAL RESEMBLANCE TO NATURAL LIMESTONE

BUT WHAT ABOUT TEXTURE & MICROSTRUCTURE?

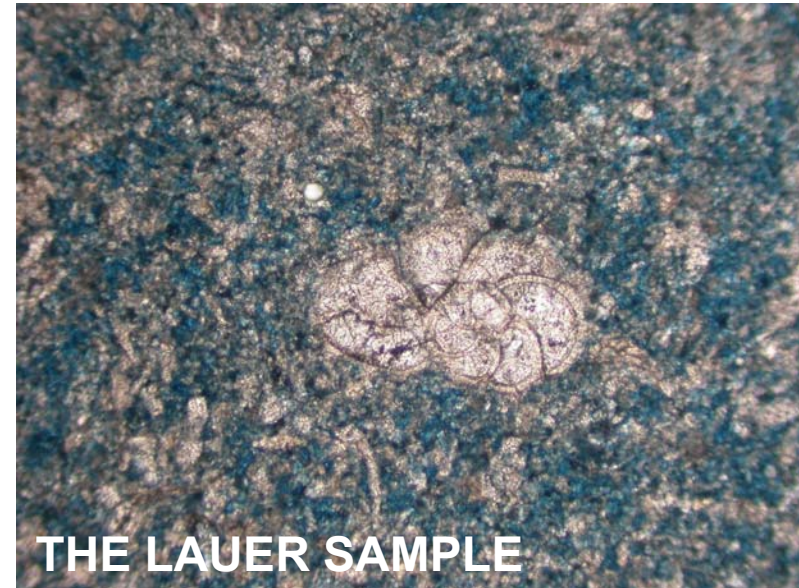


LIMESTONE – GEOLOGIC OR MAN-MADE?

A



EA-491



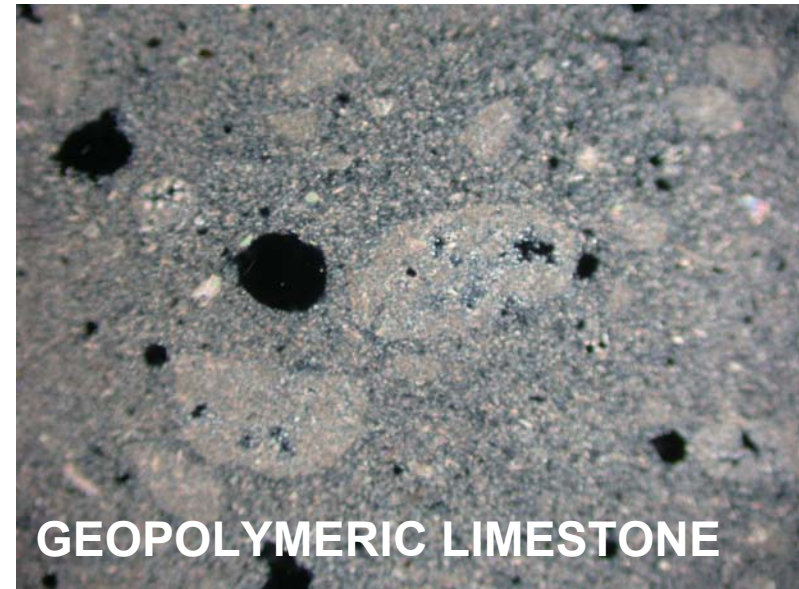
THE LAUER SAMPLE

B

C



TURA LIMESTONE



GEOPOLYMERIC LIMESTONE

D

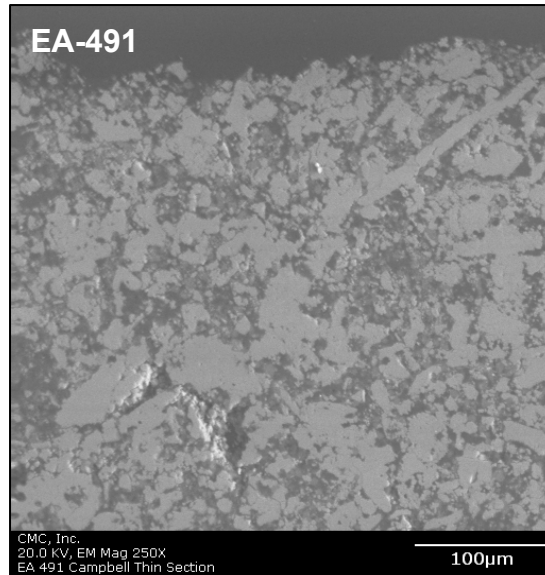
FW
=
1.4 mm

Significant Textural Difference Between Pyramid/Quarry Limestone & “Man-Made” Limestone

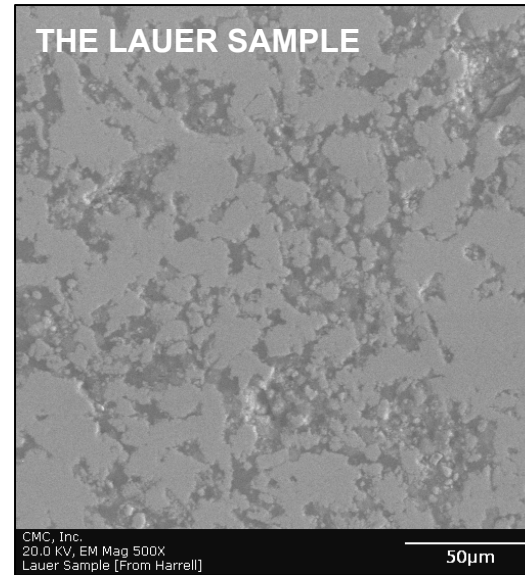


LIMESTONE – GEOLOGIC OR MAN-MADE?

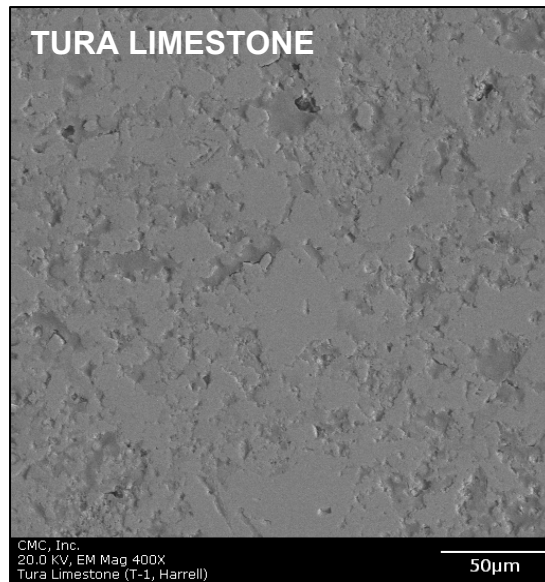
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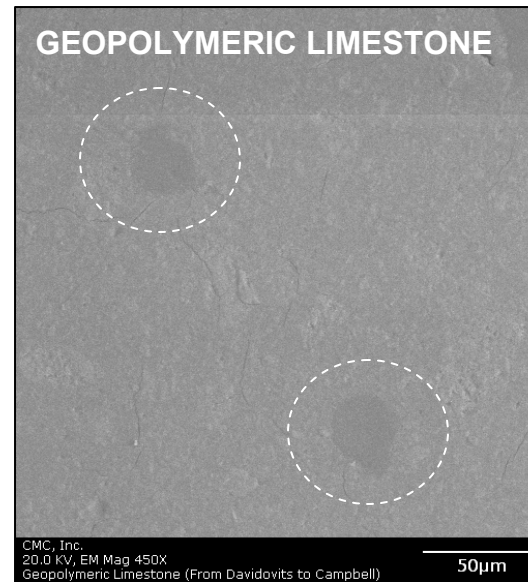
B



C



D



Significant Microstructural Difference Between Pyramid/Quarry Limestone & “Man-Made” Limestone



WHERE IS THE HARD SCIENTIFIC PROOF?

No Published Textural & Microstructural Data of
a Geopolymeric Limestone showing
Resemblance to Natural Limestone



WHERE IS THE HARD SCIENTIFIC PROOF?

**Davidovits' "Hard Scientific Proof"
Came from Laboratory Studies of:**

Pyramid Casing Stones & Natural (Quarry) Limestone

His hypothesis is based on finding:

**"Unusual" Composition/Phases in the Pyramid Blocks
Reportedly Not Found in Quarry Limestone**

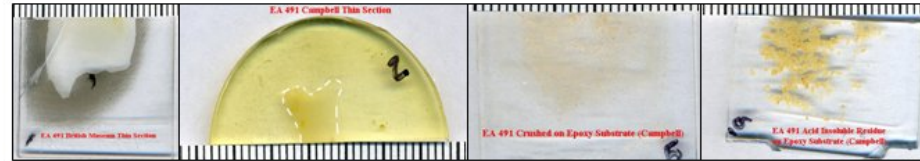




SAMPLES OF THIS STUDY

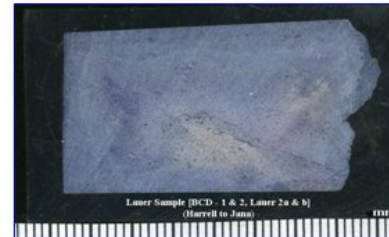
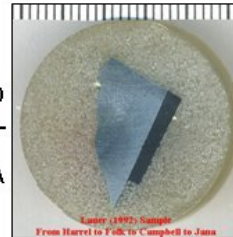
PYRAMID SAMPLES

**EA-491: CASING STONE FROM THE CHEOPS PYRAMID
- FROM BRITISH MUSEUM TO CAMPBELL**



**THE LAUER SAMPLE: INNER CASING STONE FROM THE CHEOPS PYRAMID
- FROM J.P. LAUER TO DAVIDOVITS TO MORRIS TO HARRELL/CAMPBELL**

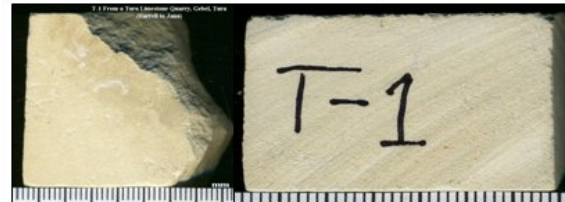
HARRELL
TO
CAMPBELL
TO
JANA



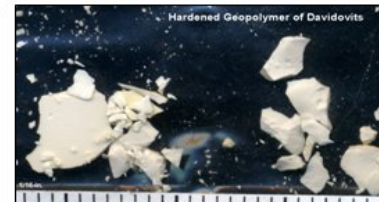
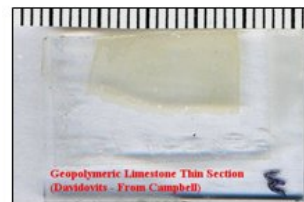
HARRELL
TO
JANA

The sample, which played a crucial role in the man-made theory of pyramid construction

**TURA LIMESTONE: NATURAL LIMESTONE OF GIZA REPORTEDLY USED IN
THE CASING STONES - FROM JAMES A. HARRELL**



**GEPOLYMERIC LIMESTONE (LEFT) & PURE GEPOLYMER (RIGHT)
A MAN-MADE LIMESTONE - FROM DAVIDOVITS TO CAMPBELL**

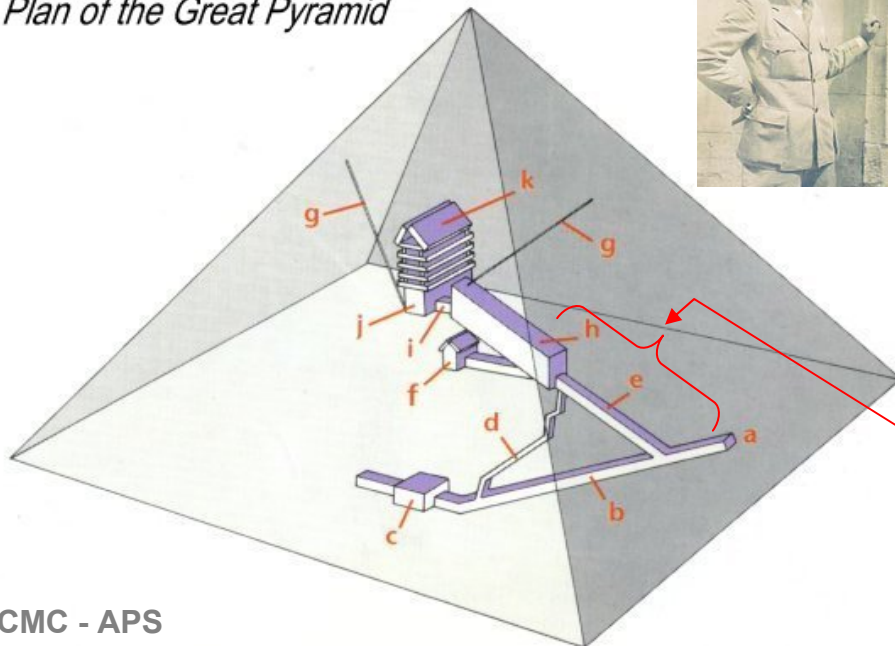


NATURAL & MAN-MADE LIMESTONE

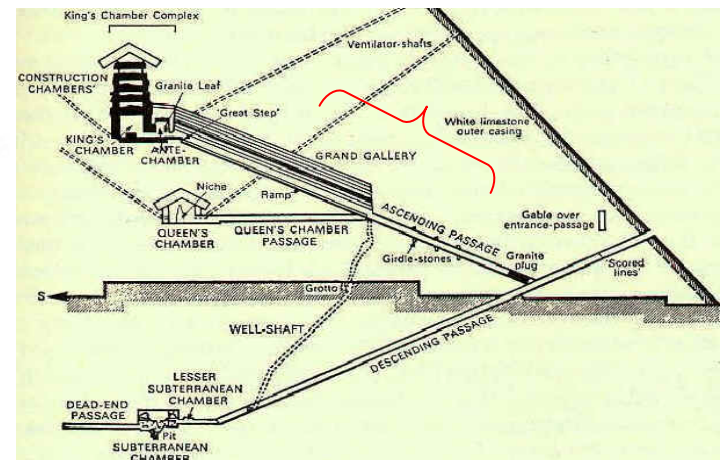
CASING STONES FROM THE GREAT PYRAMID OF KHUFU



Plan of the Great Pyramid



- AXONOMETRIC VIEW OF THE PYRAMID OF KHUFU
- a. Entrance
 - b. Descending corridor
 - c. Underground chamber
 - d. Service corridor
 - e. Ascending corridor
 - f. Queen's room
 - g. Air shafts
 - h. Great Gallery
 - i. Antechamber
 - j. King's chamber
 - k. Weight relief chambers



POSSIBLE LOCATION OF THE LAUER SAMPLE

29th ICMA CONFERENCE, QUEBEC CITY, CANADA



DAVIDOVITS' "HARD SCIENTIFIC PROOF"

Unusual Minerals in Pyramid Blocks?

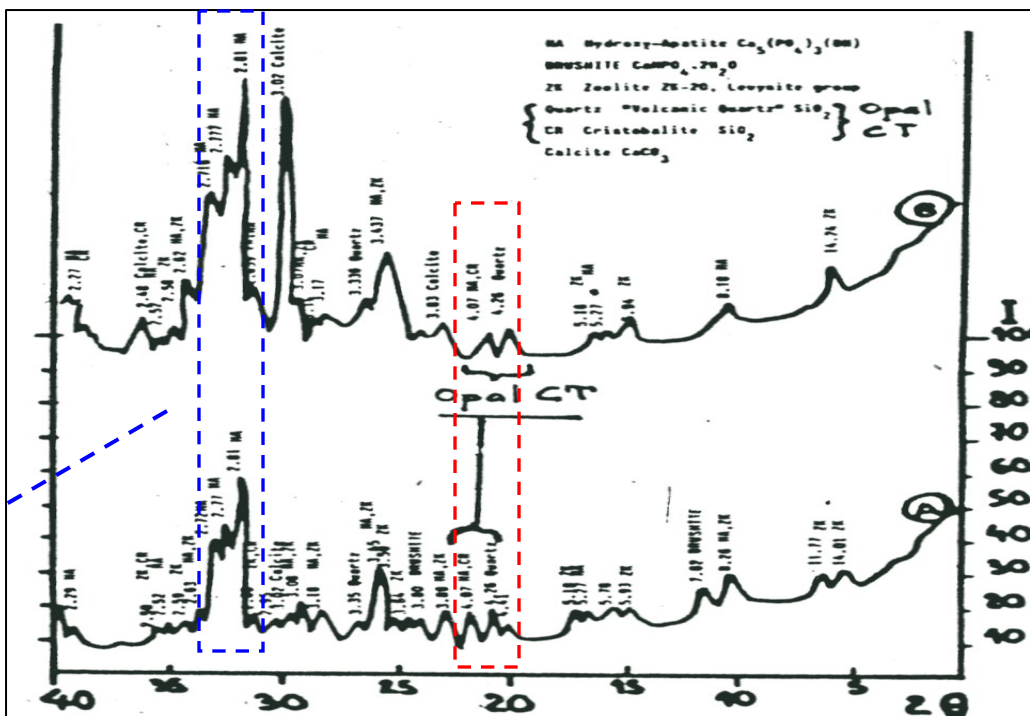
XRD Analysis Of Pyramid & Quarry Samples

Calcium Phosphate In Khufu Casing Stone

But not in Quarry Limestone

Ca-Phosphate

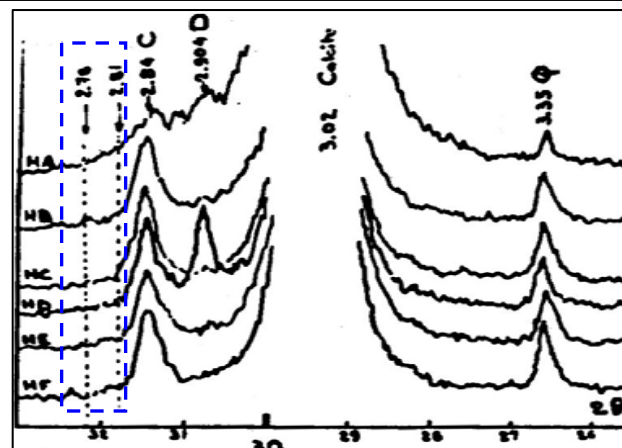
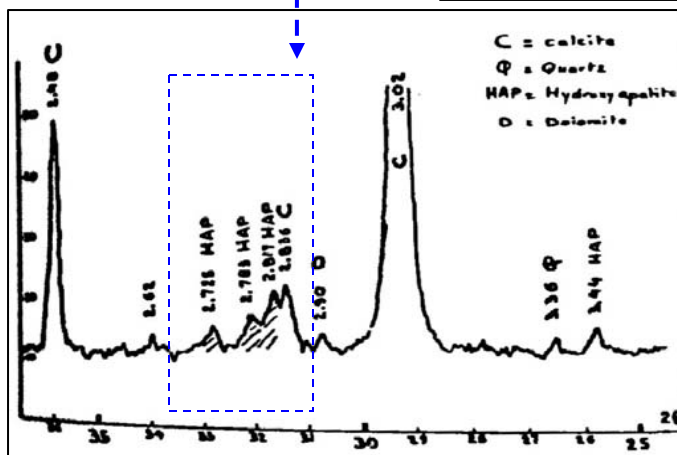
LAUER SAMPLE – "RED COATING" (Davidovits 1986)



COATING "POLLUTED" WITH CALCITE FROM THE CORE

RED COATING

KHUFU CASING STONE



QUARRY LIMESTONE

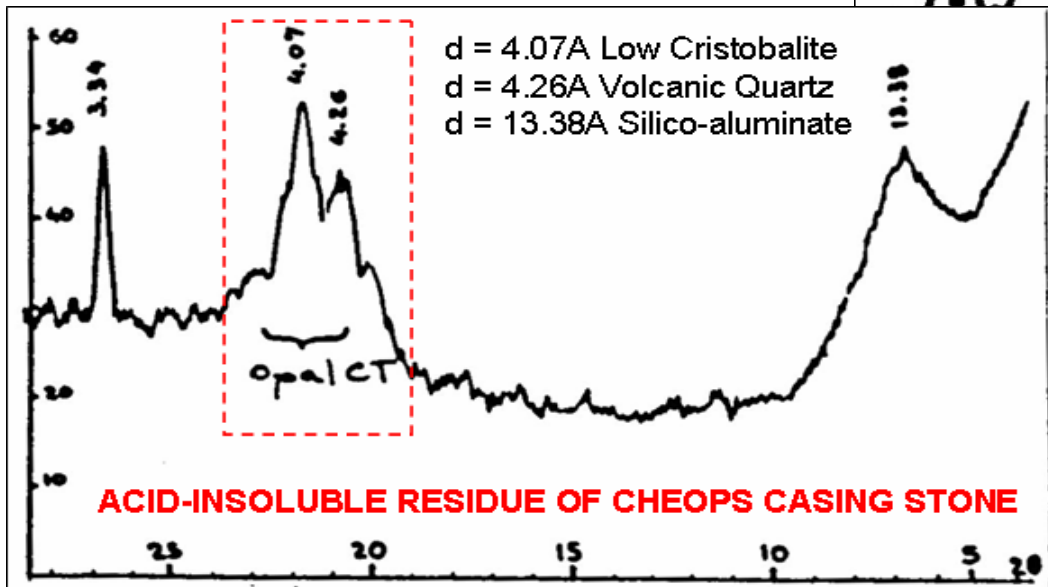
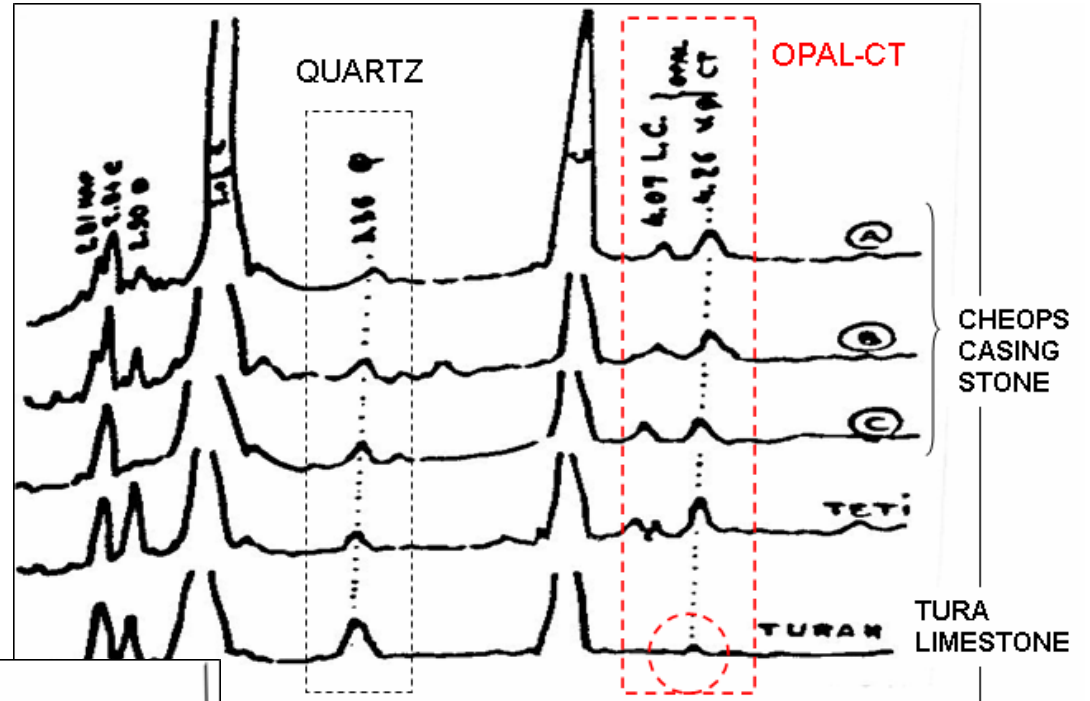


DAVIDOVITS' "HARD SCIENTIFIC PROOF"

Unusal Minerals in Pyramid Blocks?

XRD Analysis Of Pyramid & Quarry Samples

Opal-CT In Khufu Casing Stone



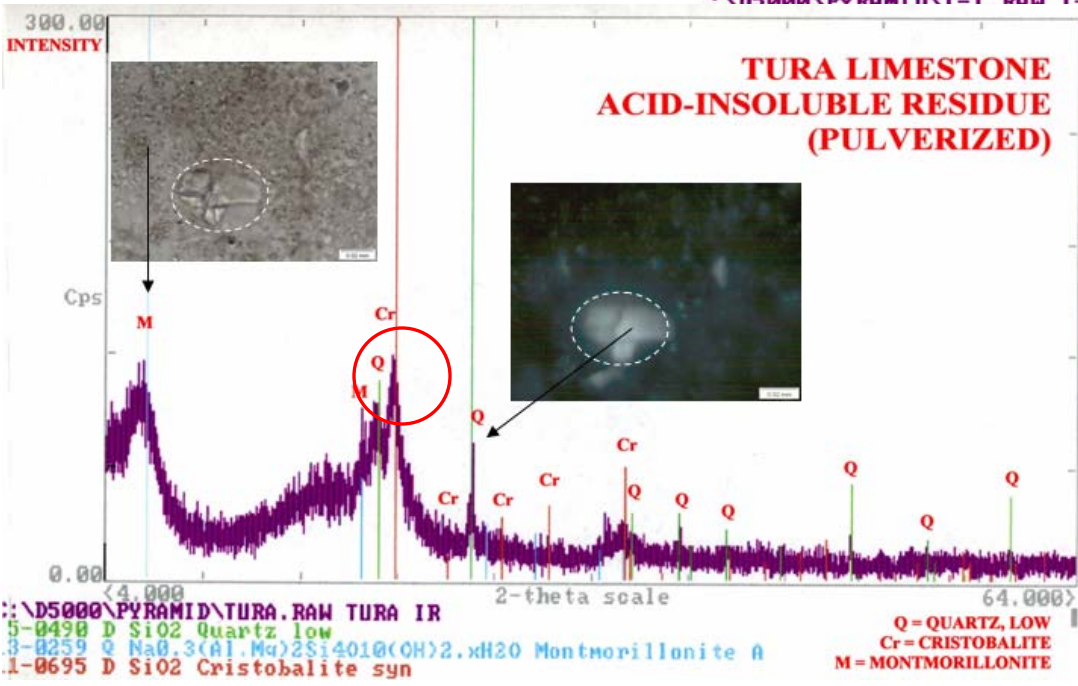
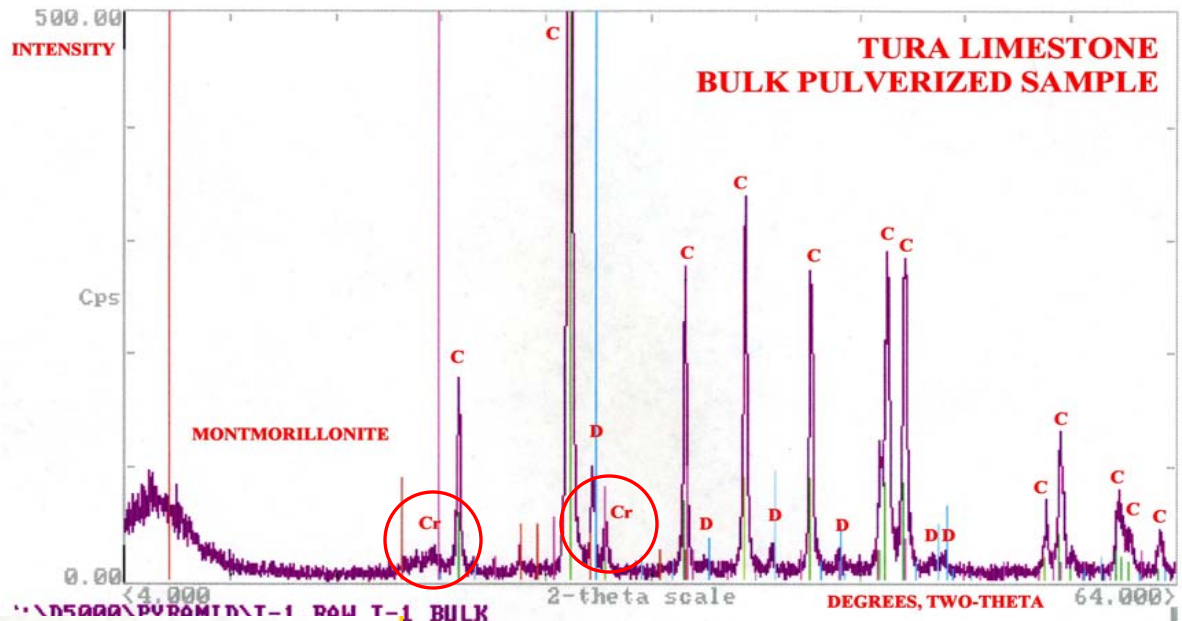
But not found in Quarry Limestone



JANA'S "HARD SCIENTIFIC PROOF"

**Opal-CT is
Not Unusal!**

**OPAL-CT IS PRESENT
IN THE QUARRY
LIMESTONE
AS WELL!**

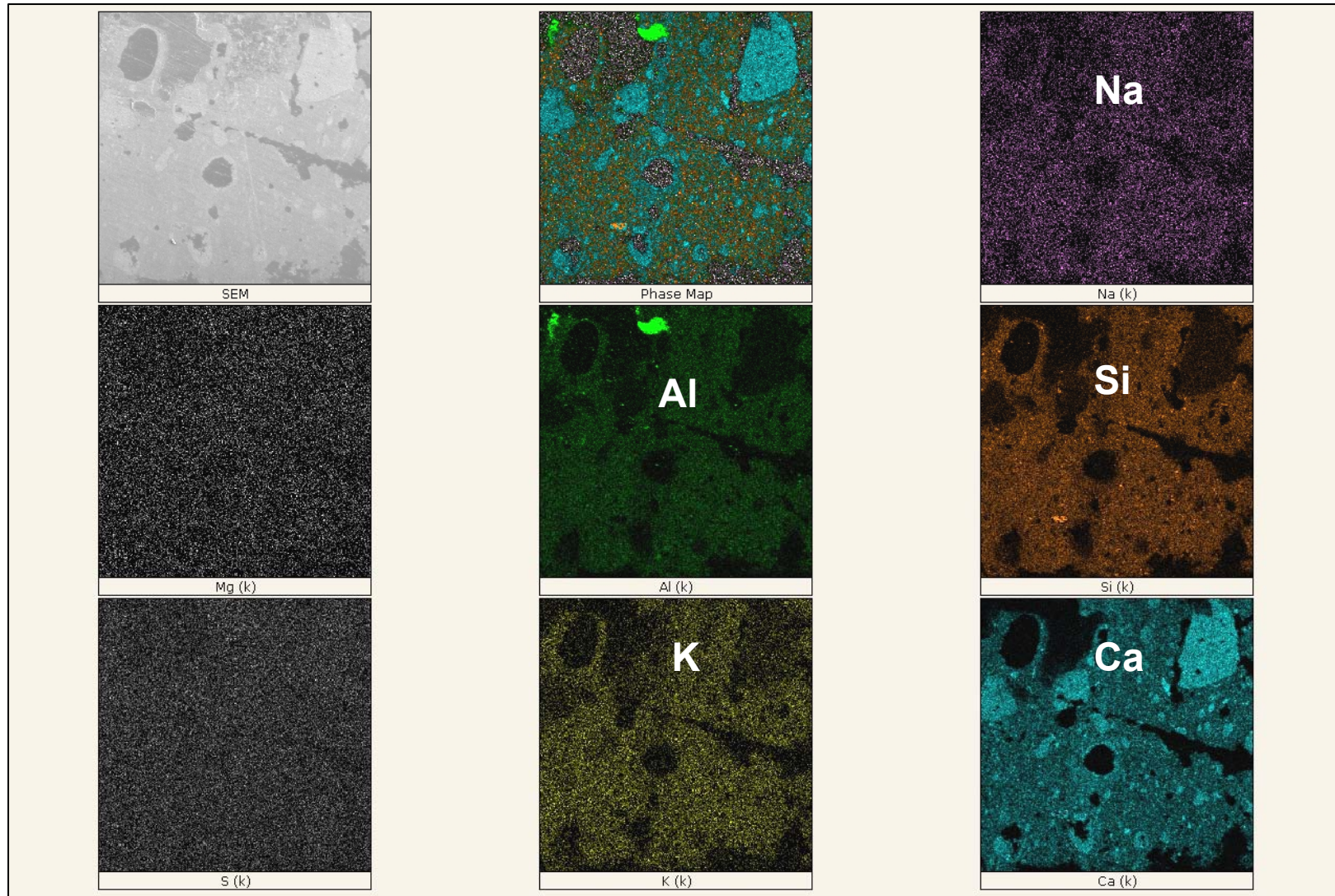


**Finding Opal-CT in Pyramid
Casing Stones does not
Indicate a "man-made" origin**



GEOPOLYMERIC “GLUE”

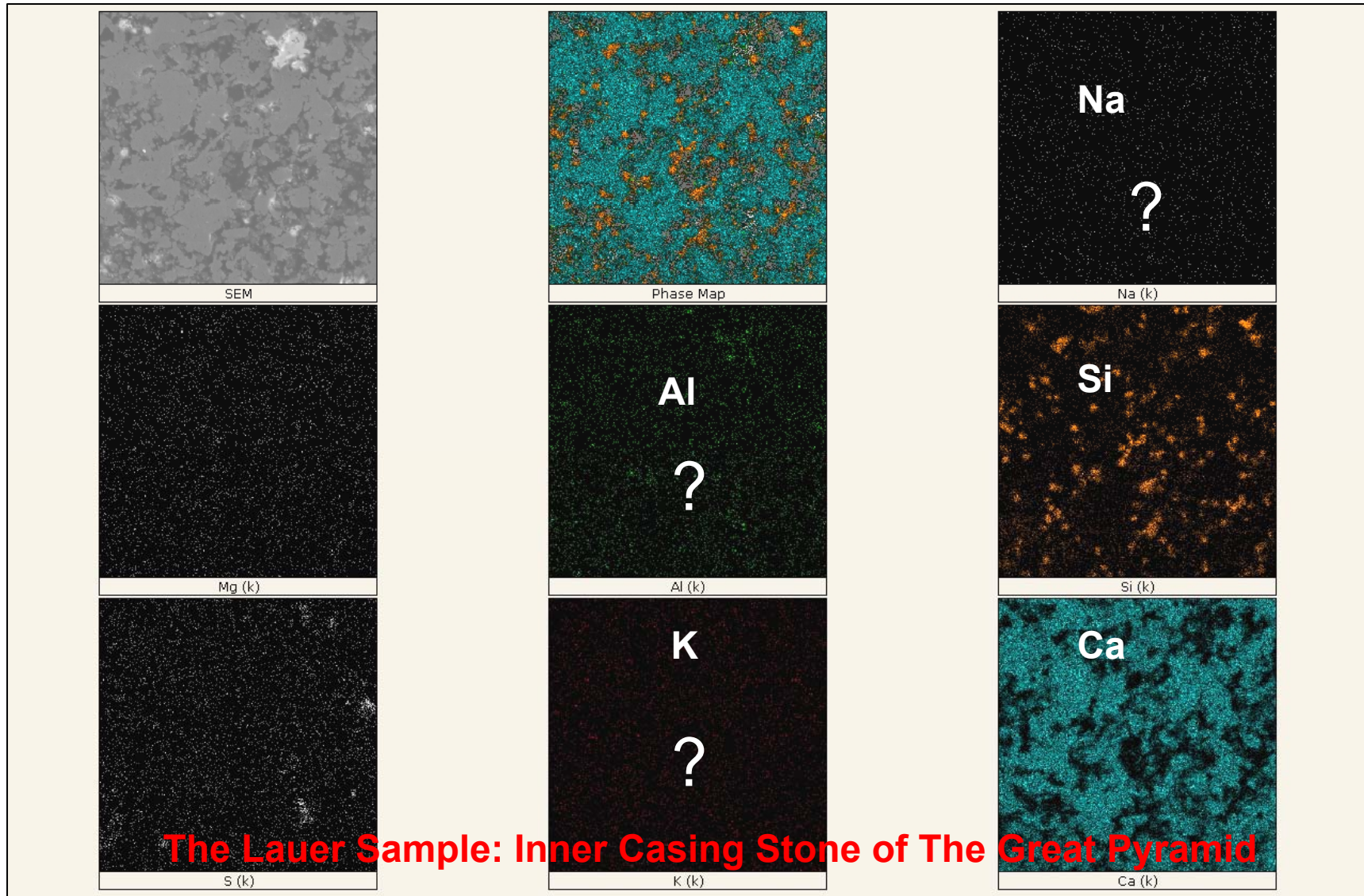
ALKALI-ALUMINOSILICATE COMPOSITION OF GEOPOLYMERIC LST.





JANA'S "HARD SCIENTIFIC PROOF"

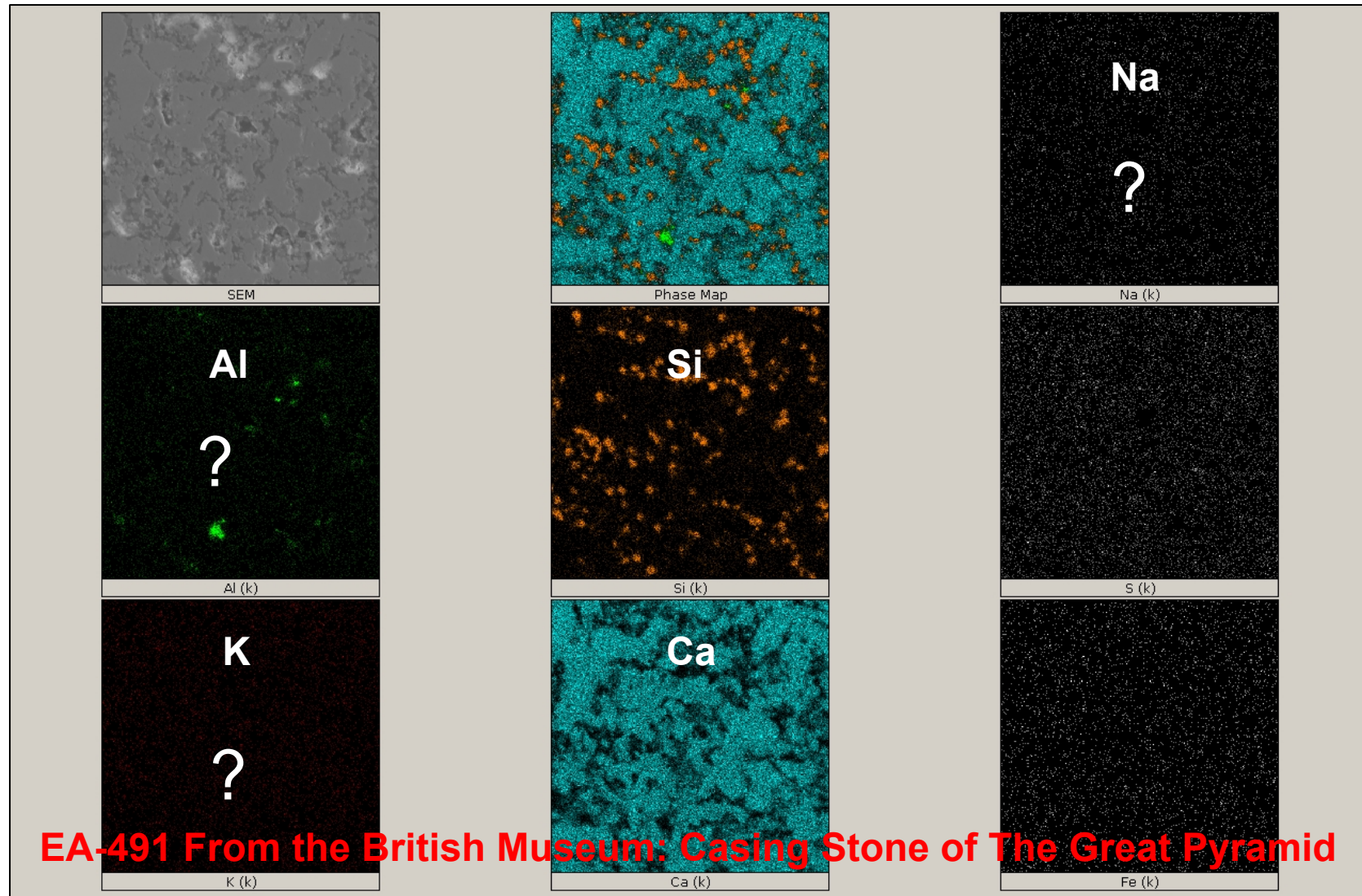
NO GEOPOLYMERIC "GLUE" IN PYRAMID BLOCKS – NONE!





JANA'S "HARD SCIENTIFIC PROOF"

NO GEOPOLYMERIC "GLUE" IN PYRAMID BLOCKS – NONE!



EA-491 From the British Museum: Casing Stone of The Great Pyramid

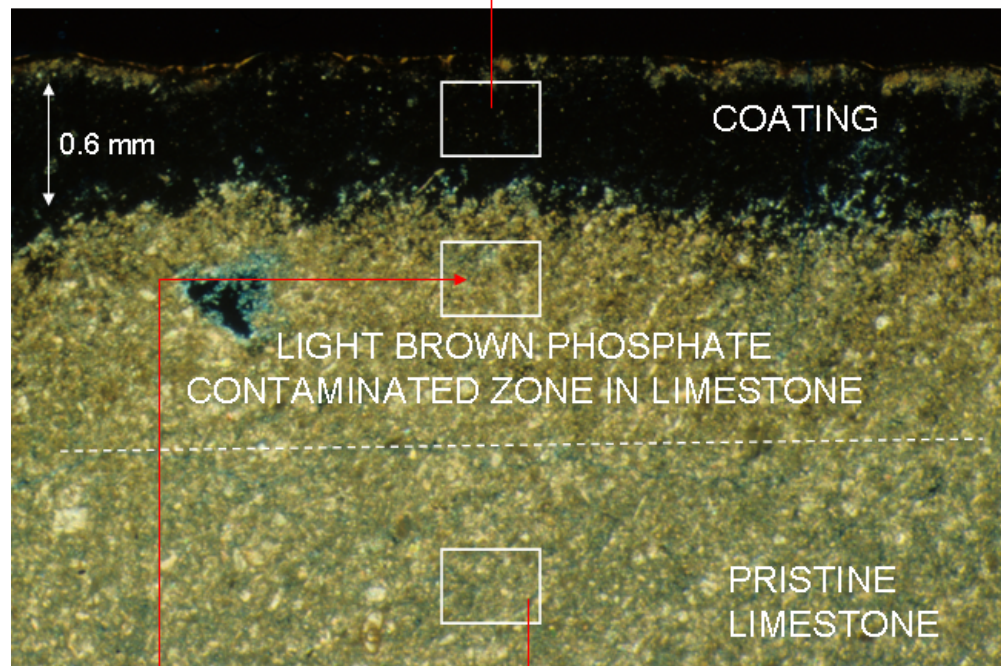


JANA'S "HARD SCIENTIFIC PROOF"

PHOSPHATE CONTAMINATION IN THE LAUER SAMPLE

PHOSPHATIC ZONE IN COATING

Ca	55.60	58.46	58.10	At. %
P	40.37	40.83	40.41	



No
"Unusual"
Phosphate
In Casing
Stone!



No
Unusual
Ca-Phosphate
Minerals
in Pyramid
Blocks

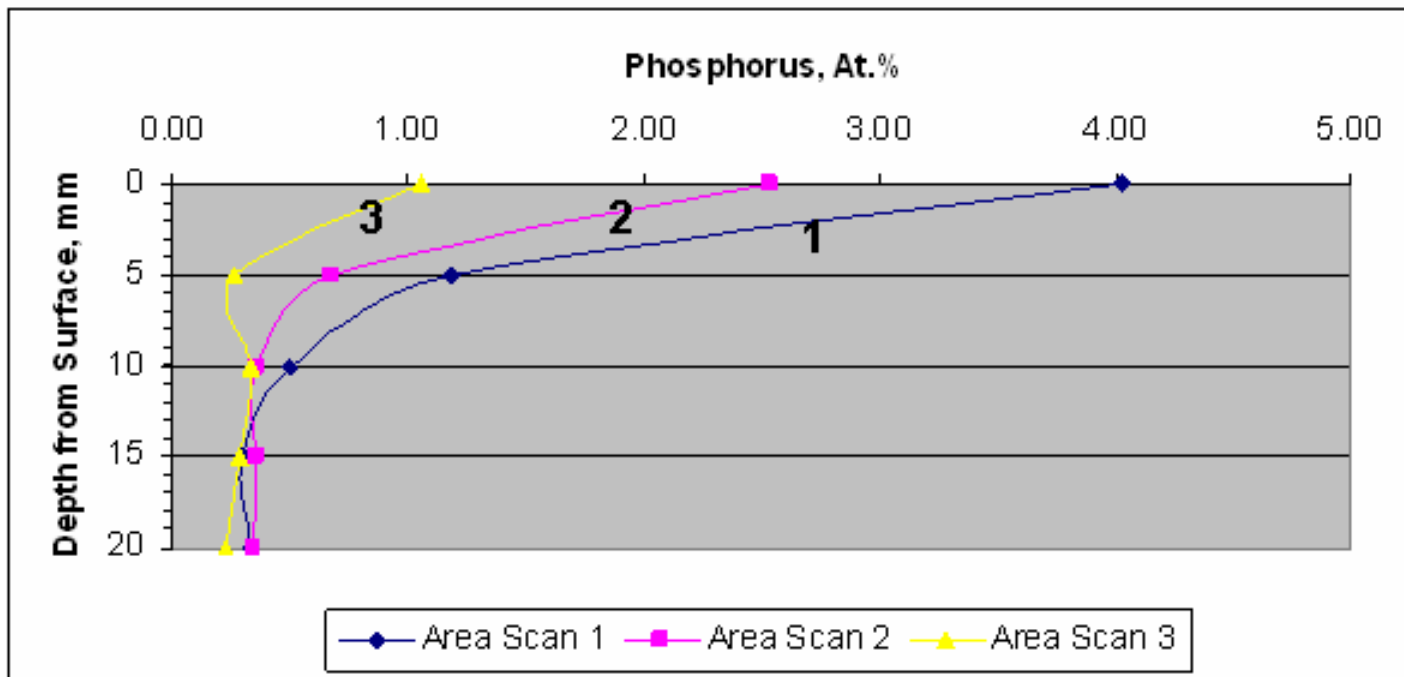
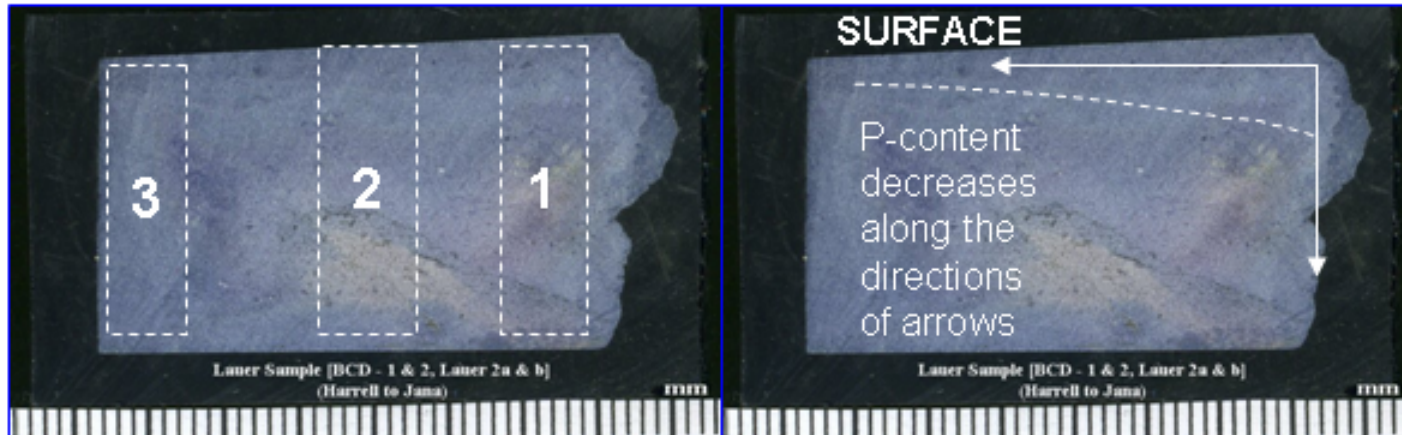
Ca	95.22	Ca	98.03	At. %
P	3.21	P	0.21	

LIMESTONE AWAY FROM COATING



JANA'S "HARD SCIENTIFIC PROOF"

PHOSPHATE CONTAMINATION IN THE LAUER SAMPLE



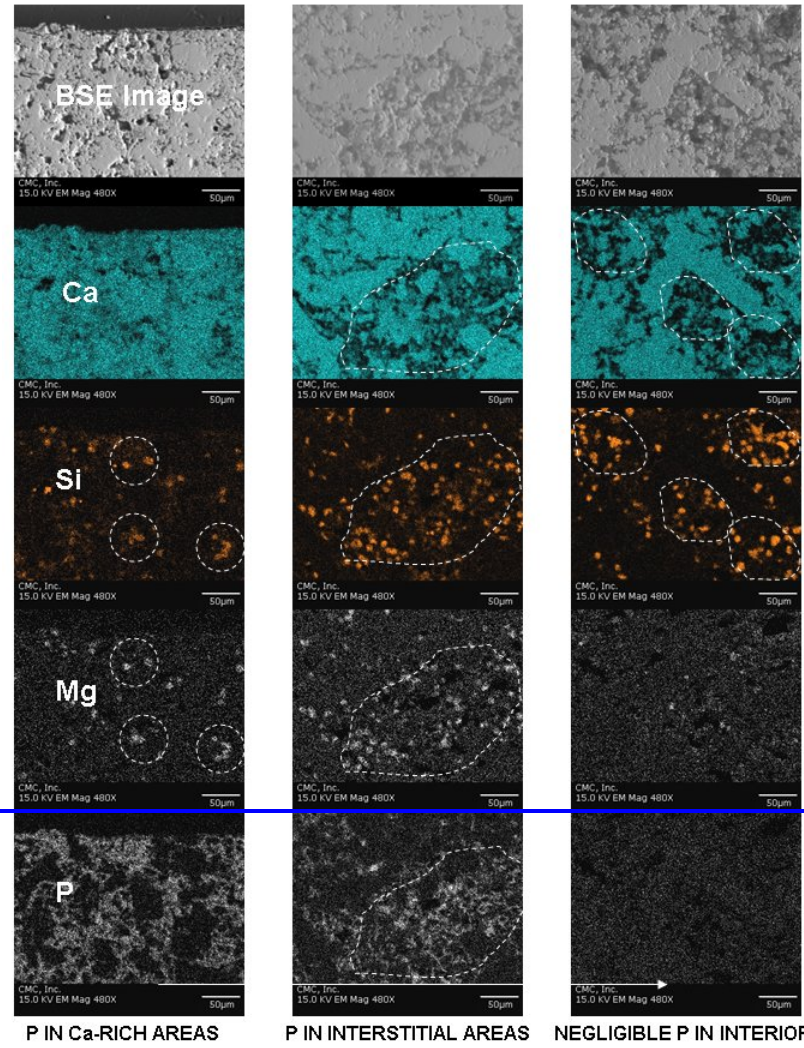


JANA'S "HARD SCIENTIFIC PROOF"

PHOSPHATE CONTAMINATION IN THE LAUER SAMPLE

THE LAUER SAMPLE
EVIDENCE OF PHOSPHATE CONTAMINATION – MAP SCANS

NEAR COATING → AWAY FROM COATING

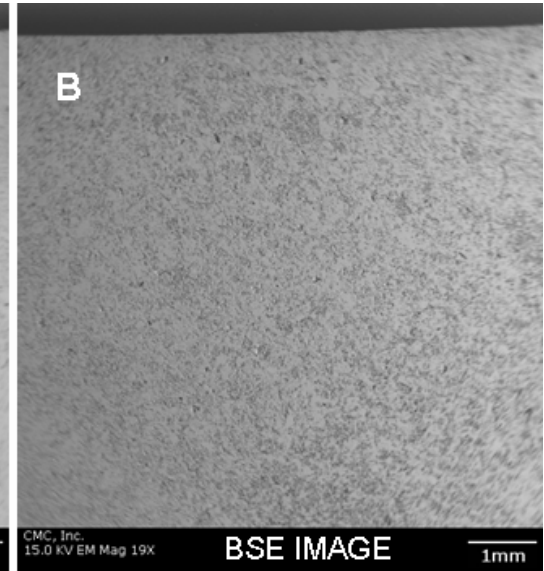
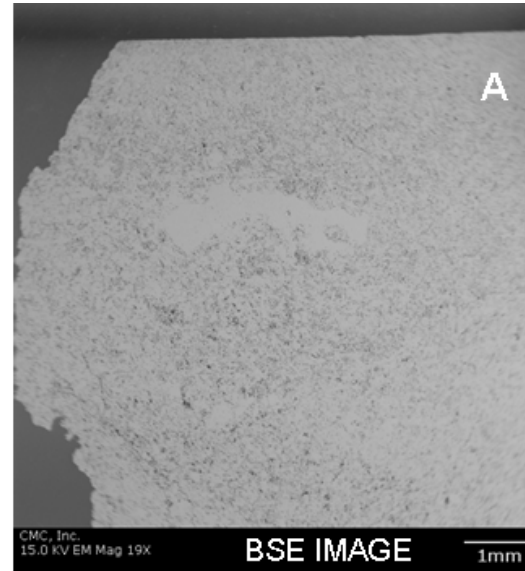
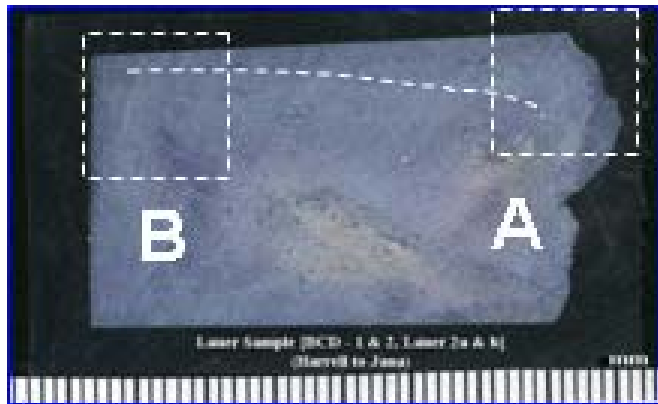


**No
Unusual
Ca-Phosphate
Minerals
in Pyramid
Blocks**

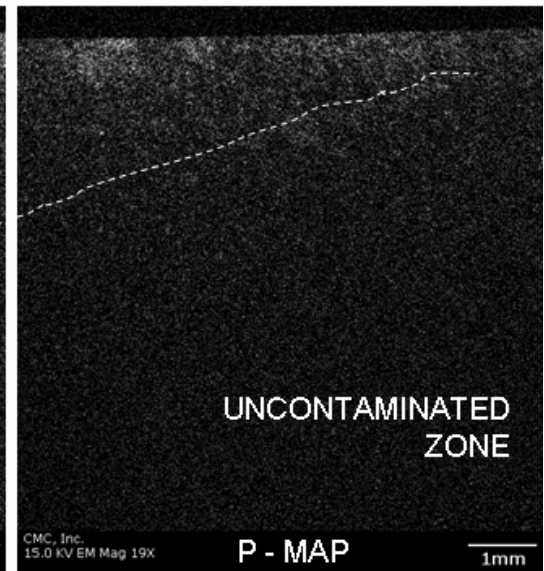
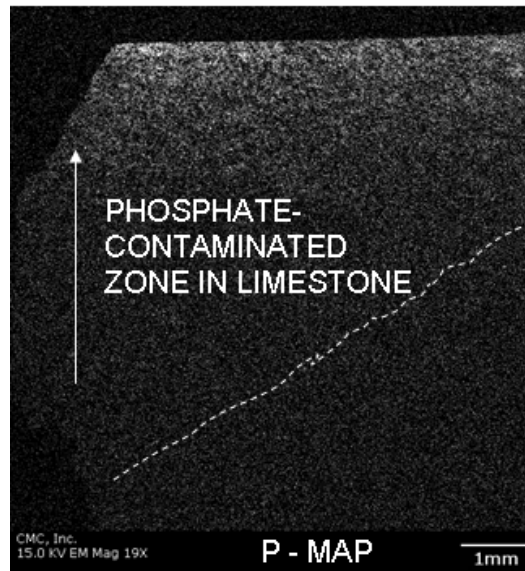


JANA'S "HARD SCIENTIFIC PROOF"

PHOSPHATE CONTAMINATION IN THE LAUER SAMPLE



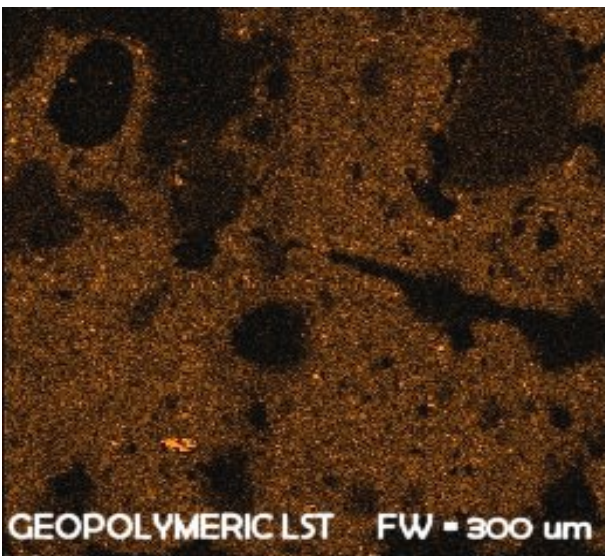
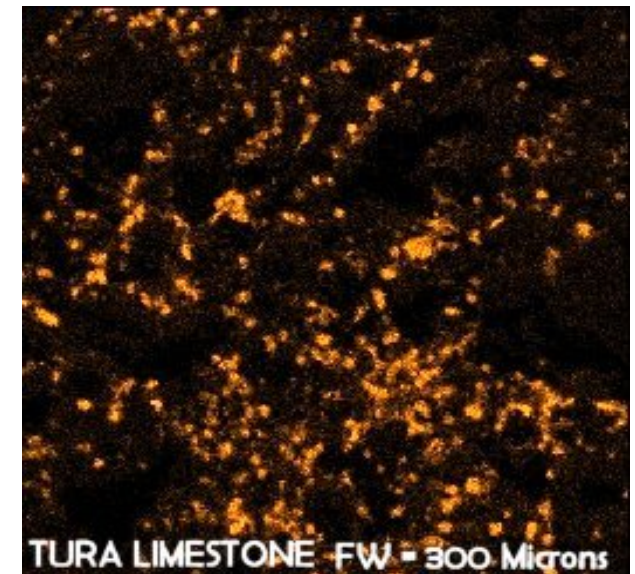
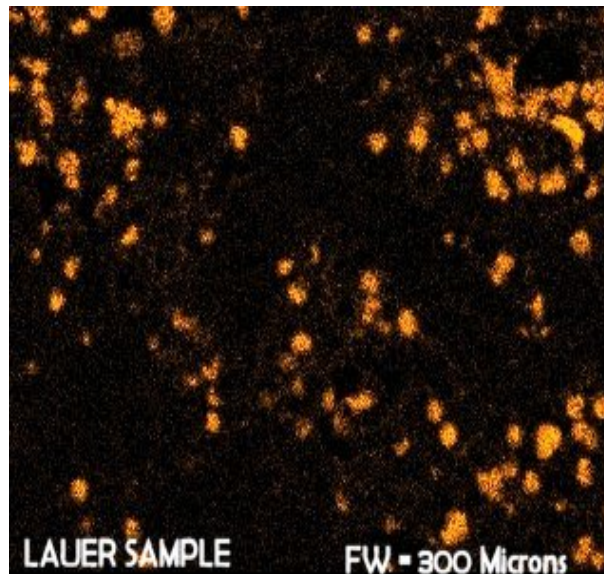
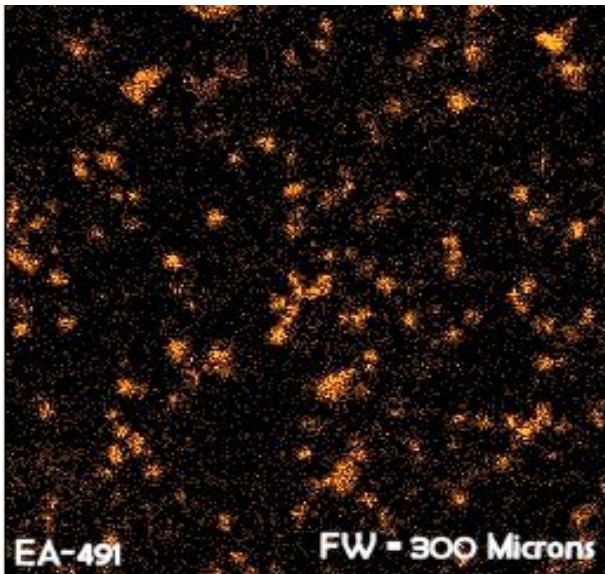
**No
Unusual
Ca-Phosphate
Minerals
in Pyramid
Blocks**





JANA'S "HARD SCIENTIFIC PROOF"

SILICA-RICH MICROCONSTITUENTS – A COMMON "GEOLOGIC" OCCURRENCE



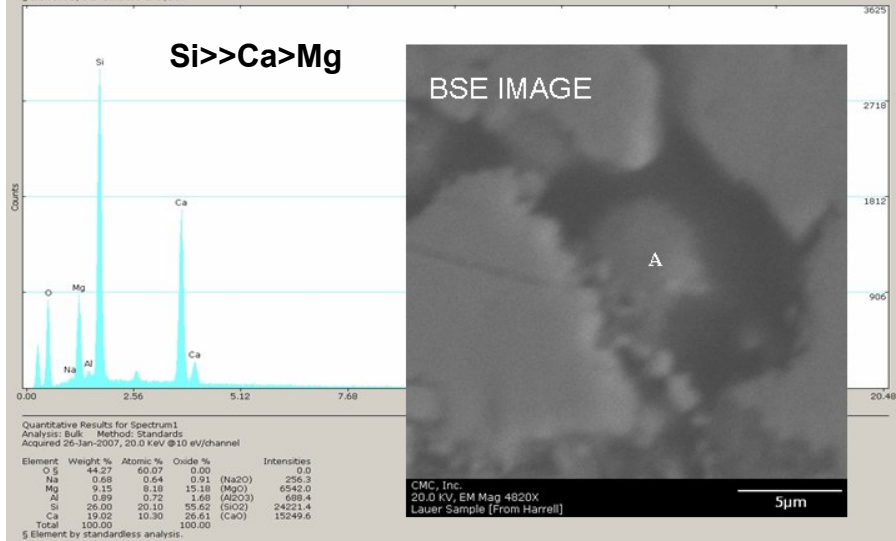
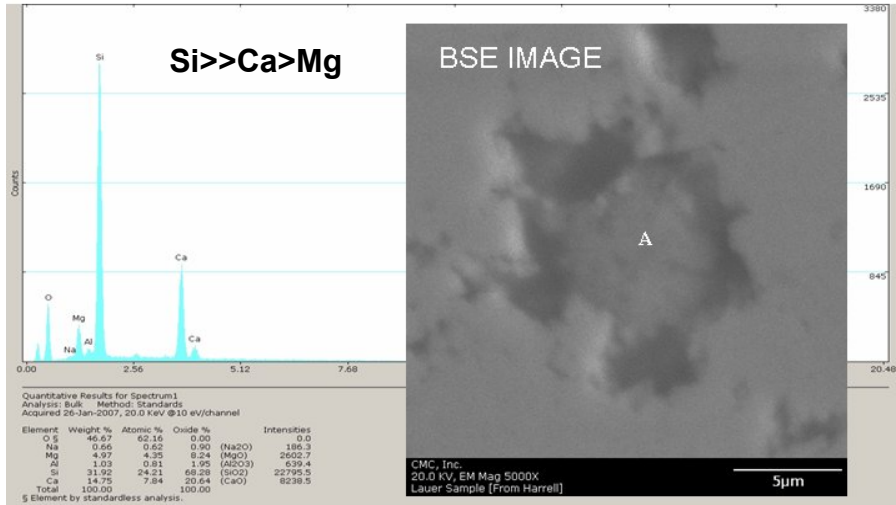
Si - Maps

- Silica-rich Microconstituents – Spherical to Irregular
- Both in Casing stones and Natural Limestone
- No such constituents in Geopolymeric Limestone
- Lepispheres of Opal CT – "Impure" as any Mineral!



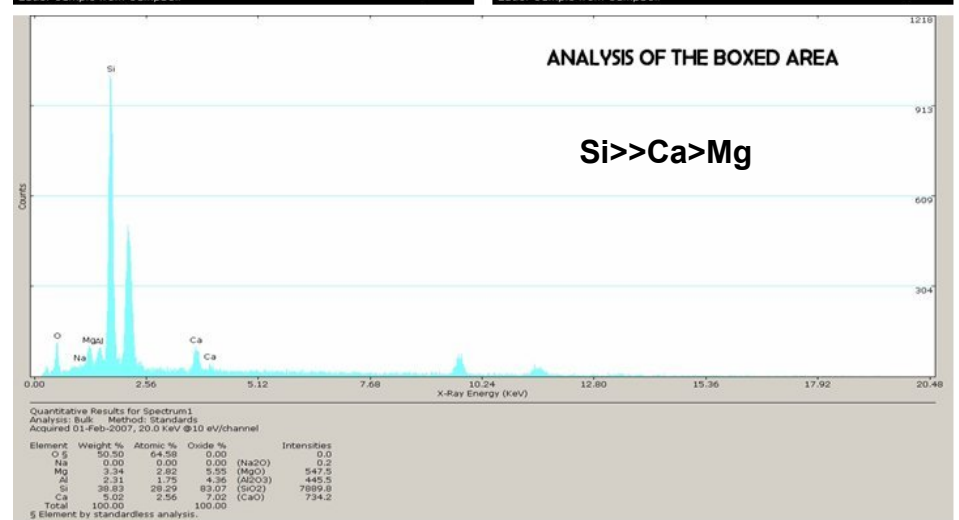
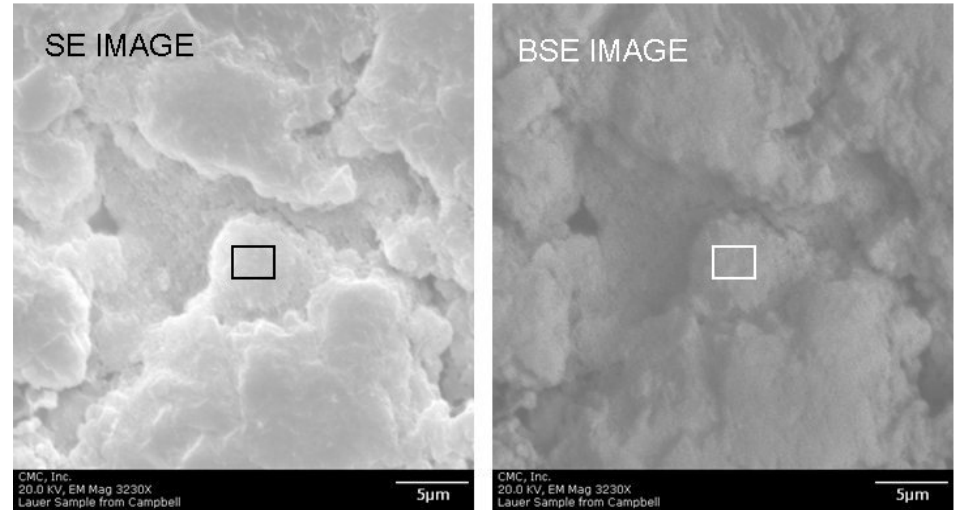
LEPISPHERES IN LAUER SAMPLE

THE LAUER SAMPLE – SILICA-RICH MICROCONSTITUENTS



The Lauer Sample from Harrell CamScan Series II SEM – Robinson BS Detector – 20Kv

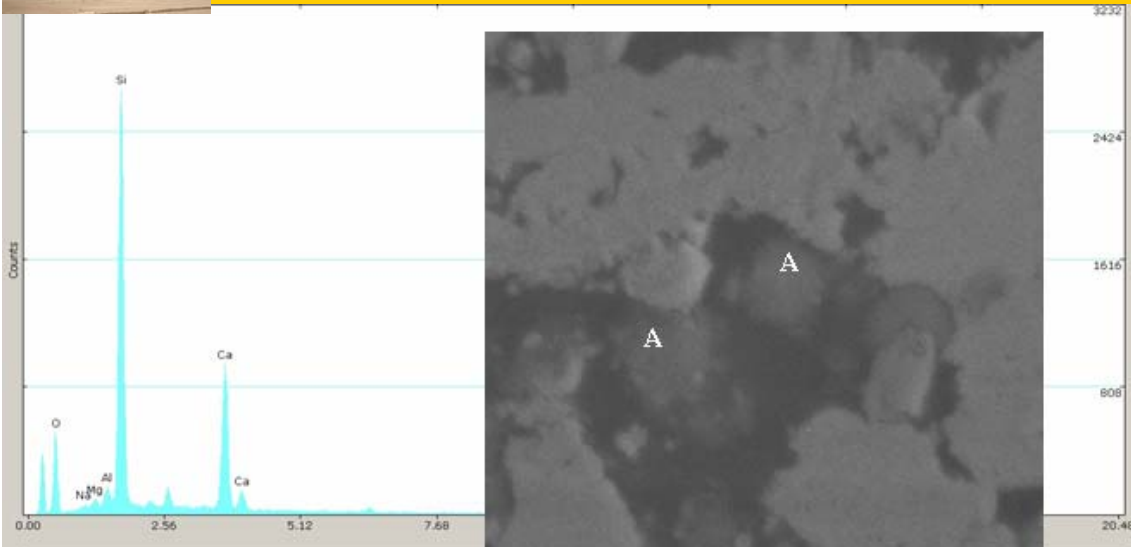
THE LAUER SAMPLE – SILICA-RICH MICROCONSTITUENTS



The Lauer Sample from Campbell CamScan Series II SEM – Robinson BS Detector – 20Kv



LEPISPHERES IN EA-491



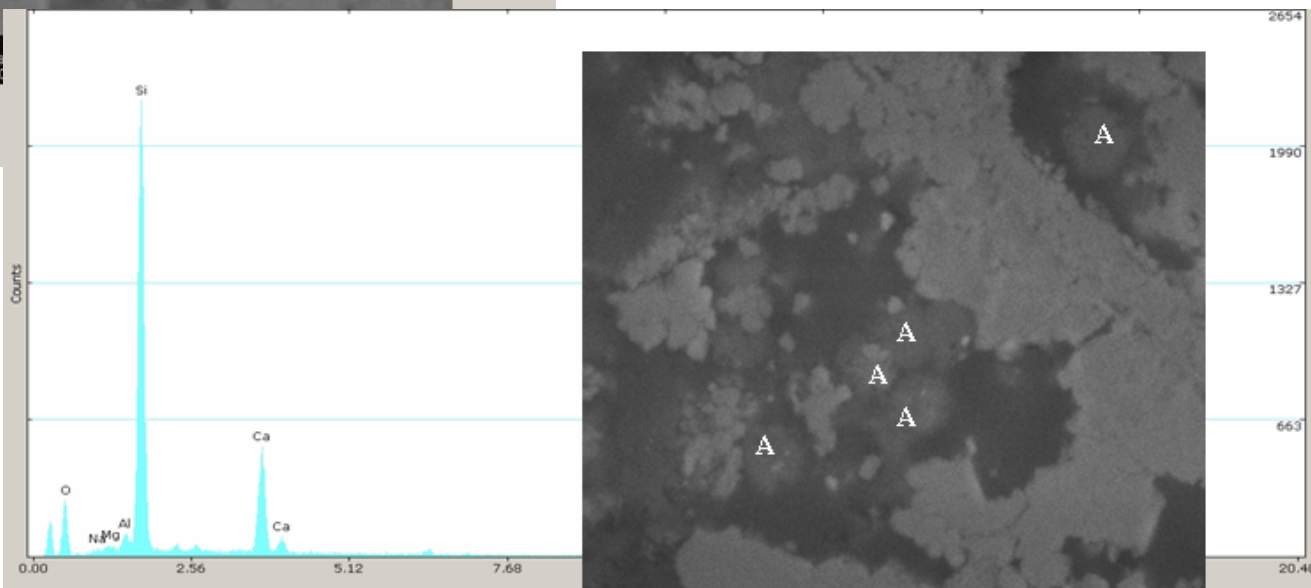
Quantitative Results for Spectrum1
 Analysis: Bulk Method: Standards
 Acquired 26-Jan-2007, 20.0 KeV @10 eV/channel

Element	Weight %	Atomic %	Oxide %	Intensities
O \$	46.55	62.91	0.00	0.0
Na	0.00	0.00	0.00 (Na2O)	0.2
Mg	0.89	0.79	1.48 (MgO)	393.0
Al	1.60	1.28	3.03 (Al2O3)	949.9
Si	32.70	25.17	69.95 (SiO2)	21248.1
Ca	18.25	9.84	25.54 (CaO)	8827.0
Total	100.00	100.00		

§ Element by standardless analysis.

CMC, Inc.
 20.0 kV, EM Ma
 EA-491 [From C

Si>>Ca>Al, Mg



Quantitative Results for Spectrum1
 Analysis: Bulk Method: Standards
 Acquired 26-Jan-2007, 20.0 KeV @10 eV/channel

Element	Weight %	Atomic %	Oxide %	Intensities
O \$	48.29	63.93	0.00	0.0
Na	0.00	0.00	0.00 (Na2O)	0.2
Mg	0.60	0.53	1.00 (MgO)	203.4
Al	1.46	1.14	2.75 (Al2O3)	656.8
Si	36.17	27.28	77.38 (SiO2)	17545.6
Ca	13.48	7.12	18.86 (CaO)	4652.3
Total	100.00	100.00		

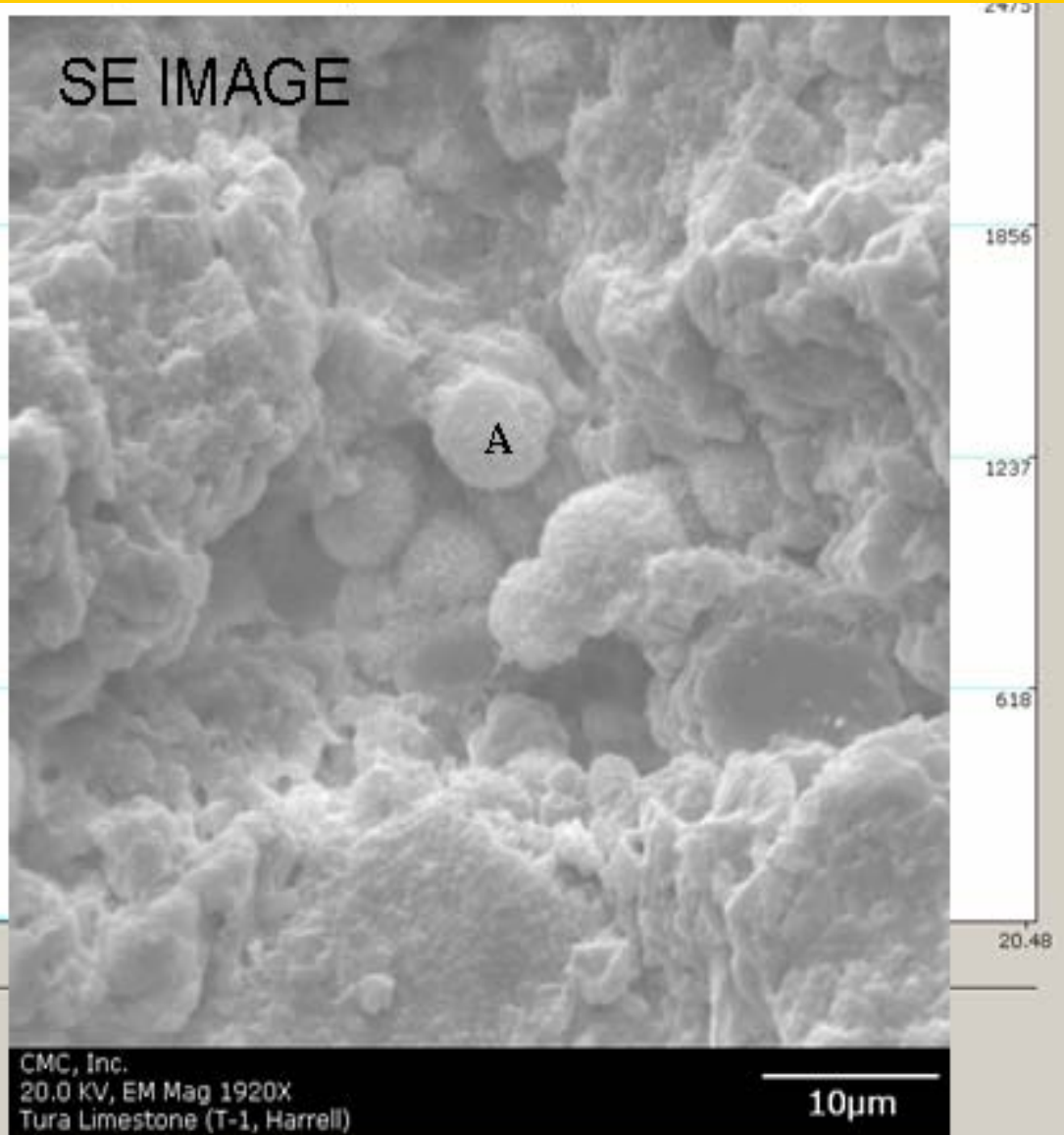
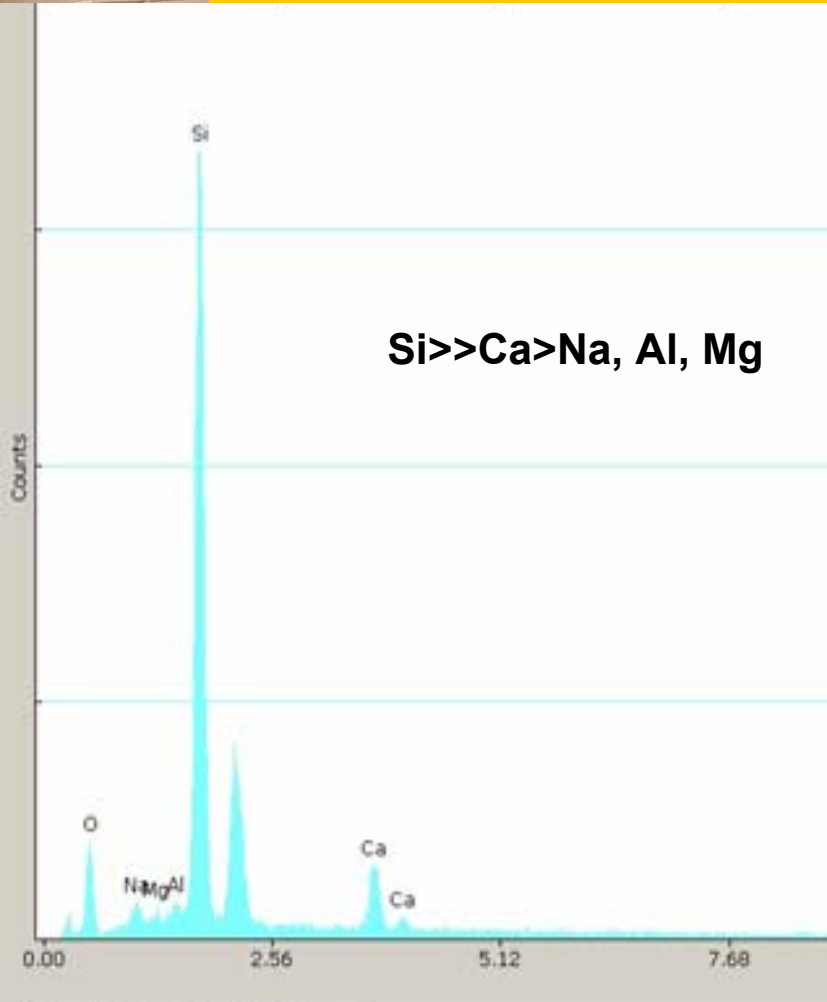
§ Element by standardless analysis.

CMC, Inc.
 20.0 kV, EM Mag 1910X
 EA-491 Campbell Thin Section

10µm



LEPISPHERES IN TURA LIMESTONE



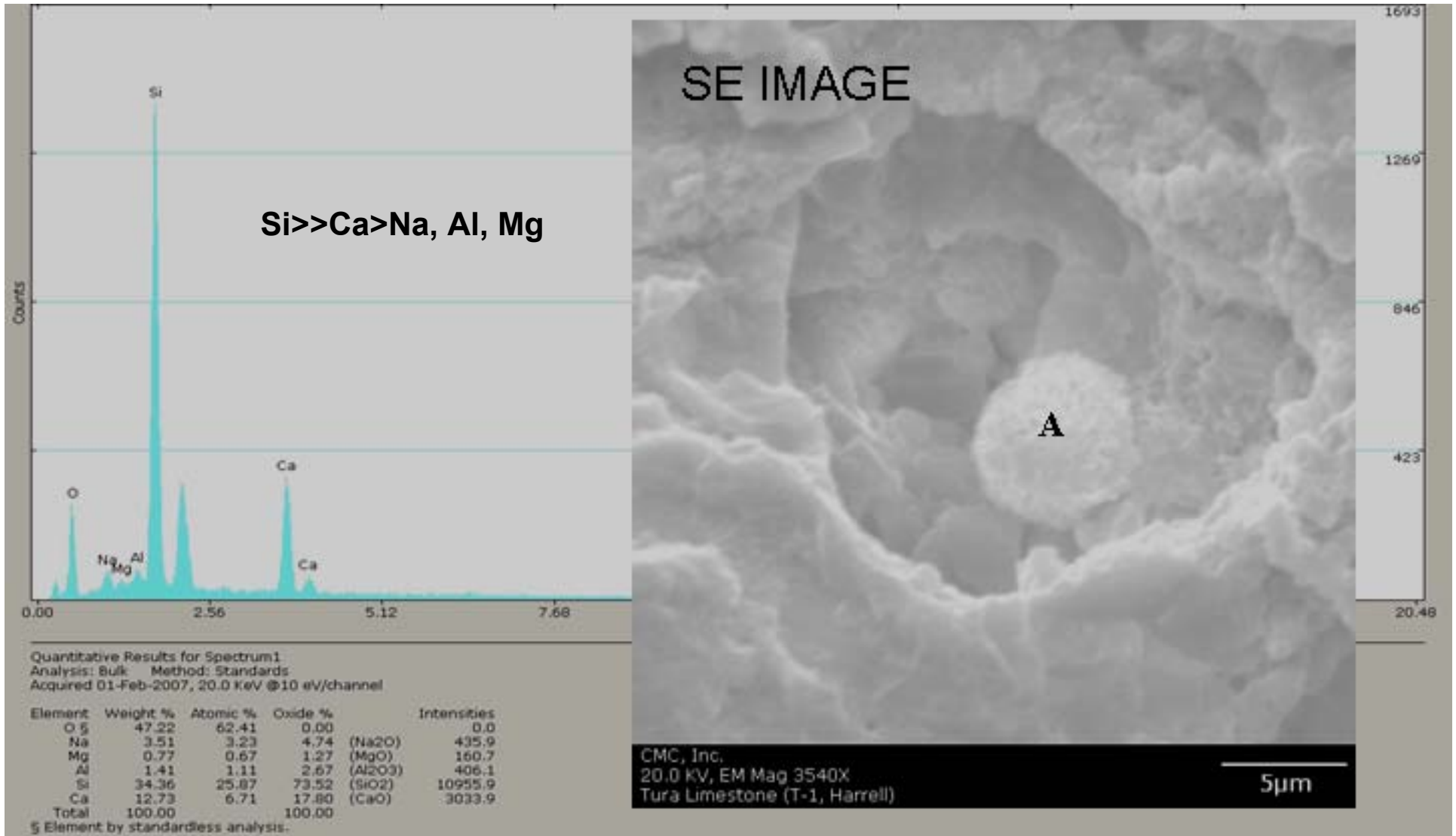
Quantitative Results for Spectrum1
Analysis: Bulk Method: Standards
Acquired 01-Feb-2007, 20.0 KeV @10 eV/channel

Element	Weight %	Atomic %	Oxide %		Intensities
O §	50.00	64.18	0.00		0.0
Na	2.72	2.43	3.66 (Na ₂ O)		466.1
Mg	0.58	0.49	0.97 (MgO)		167.3
Al	0.96	0.73	1.81 (Al ₂ O ₃)		370.9
Si	39.94	29.20	85.45 (SiO ₂)		16658.7
Ca	5.80	2.97	8.11 (CaO)		1665.8
Total	100.00		100.00		

§ Element by standardless analysis.



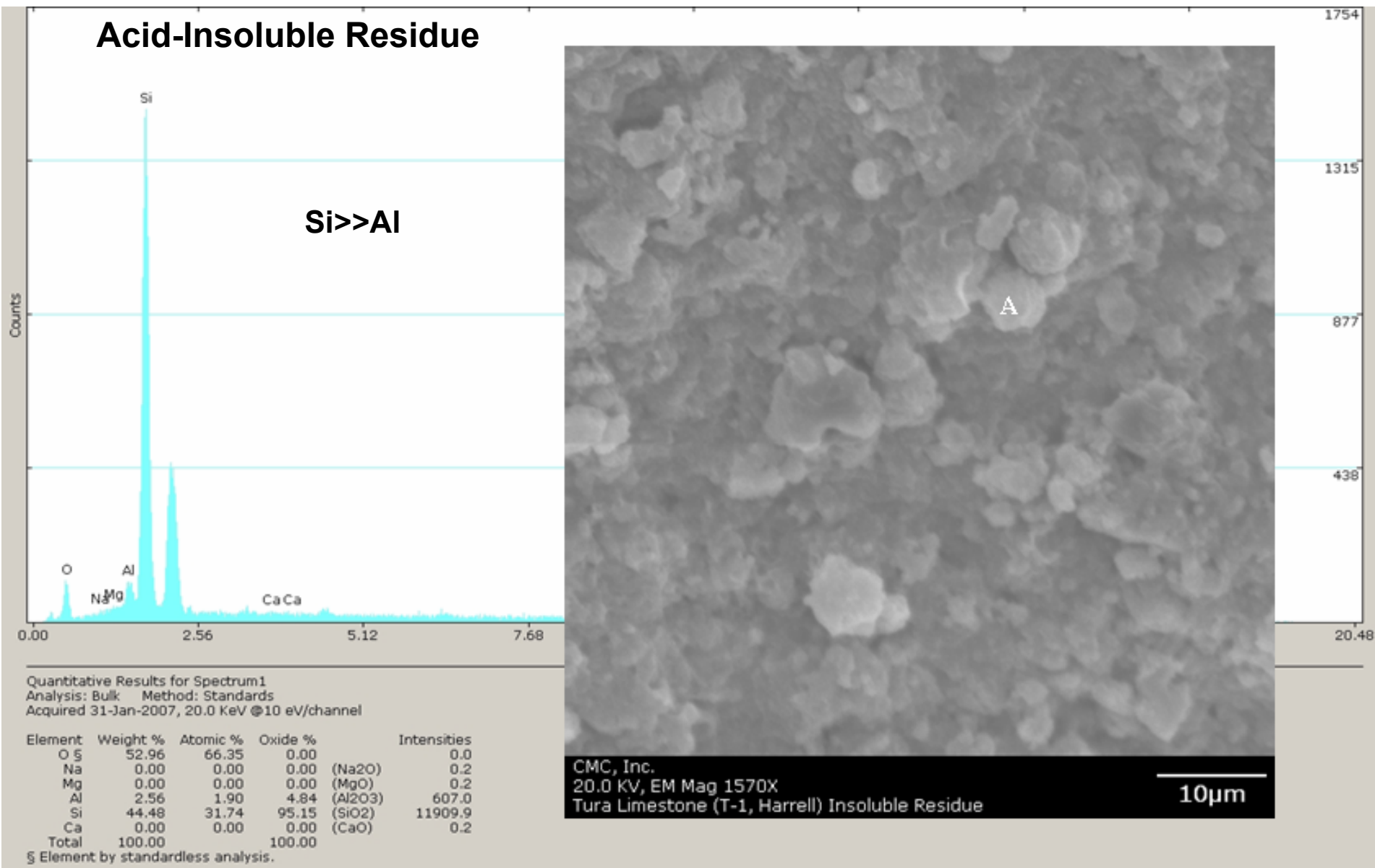
LEPISPHERES IN TURA LIMESTONE



Nano-lepispheres of Opal CT = Nanobacterial Precipitates in Limestone? – Folk et al., 1995



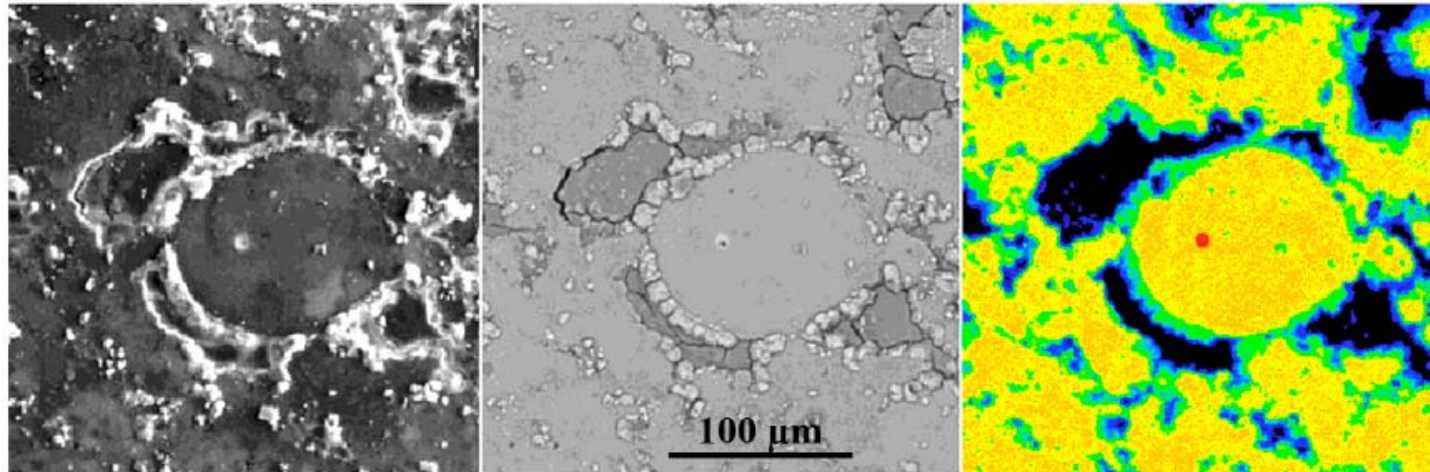
LEPISPHERES IN TURA LIMESTONE





BARSOUM'S STUDY OF THE LAUER SAMPLE

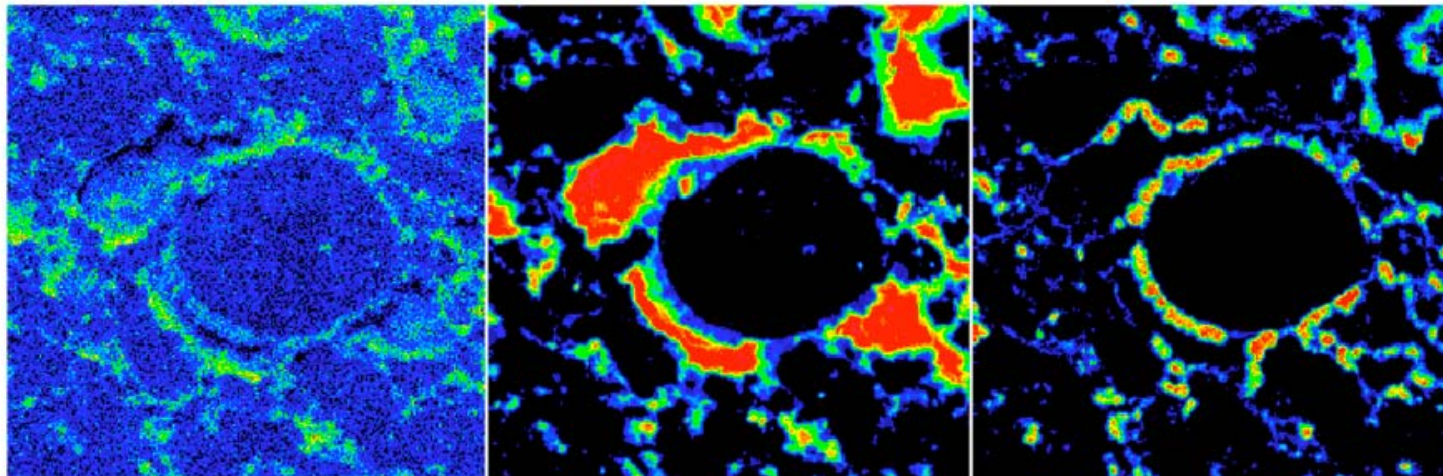
From Barsoum et al. 2006



Secondary

Backscattered

Ca-map



Na-Map

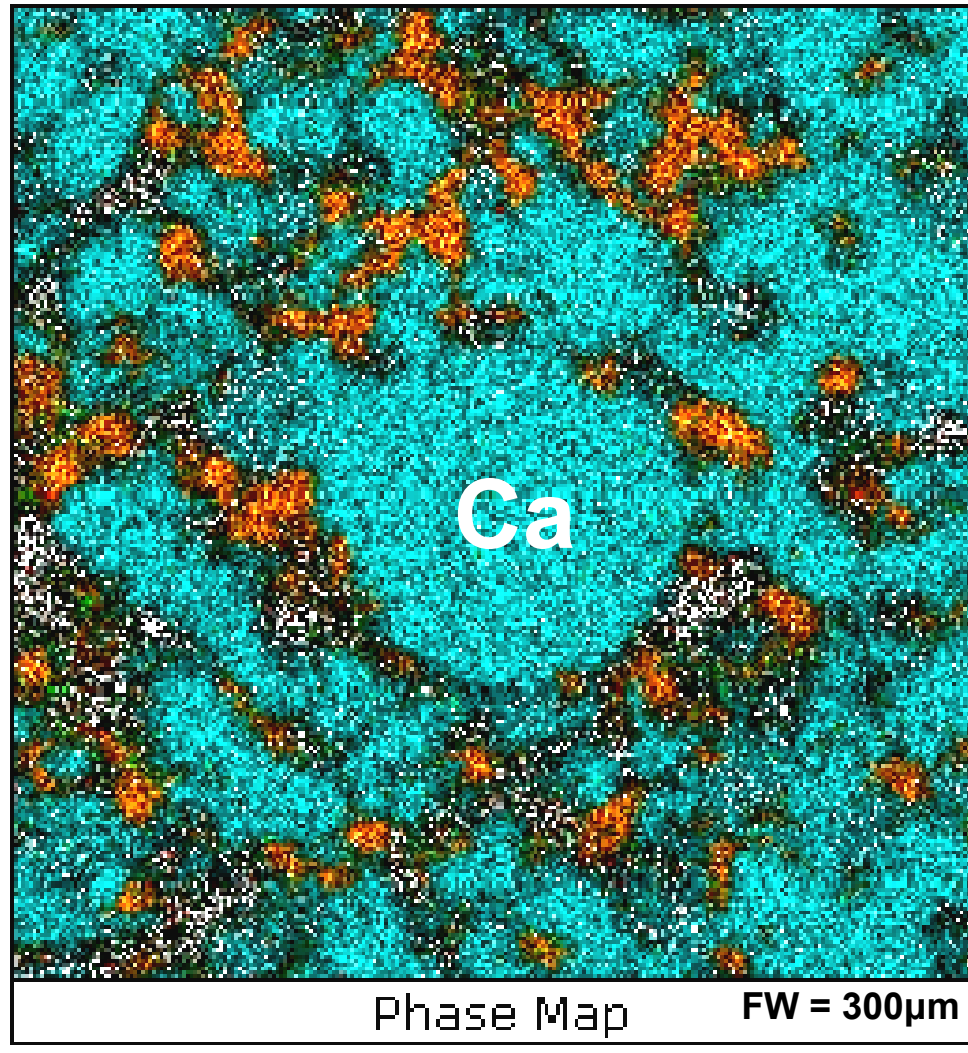
Si-Map

S-Map

Silica in the interstitial spaces between calcite grains



JANA'S STUDY OF A QUARRY (TURA) LIMESTONE



Blue = Ca
Orange = Si
White = Mg

**Silica in the interstitial spaces between calcite grains
- In Tura Limestone = Similar to those found in the Lauer Sample**



BARSOUM'S "CEMENT" PHASE

RAW MATERIALS = DIATOMACEOUS EARTH + DOLOMITE + LIME

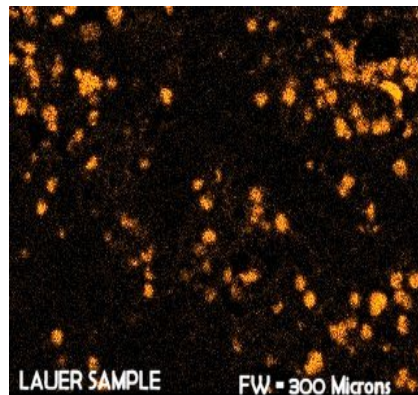
SILICATE CEMENT? = SILICON DIOXIDE OR CA-MG-SILICATE

NOT AN ALKALI-ALUMINOSILICATE GLUE – NOT A "GEOPLYMER"

WHERE IS THE ACTUAL SCIENTIFIC EVIDENCE ?

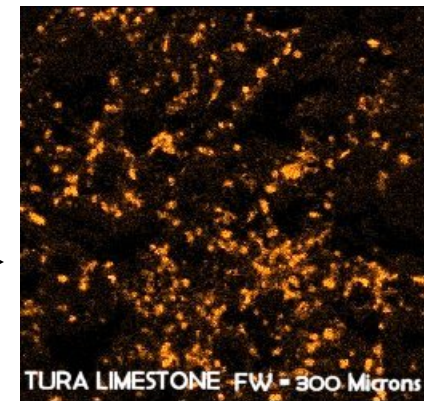
- **DIAGNOSE IN THE PYRAMID SAMPLES**
- **COMPARE PYRAMID SAMPLES WITH AN "EXPERIMENTAL" SAMPLE**
- **RESEMBLANCE IN TEXTURE, MICROSTRUCTURE, & MICROCHEMISTRY**

**Pyramid
Sample**



**SILICA IS NOT A "CEMENT"
IN EITHER
PYRAMID SAMPLE
OR IN QUARRY LST**

**Natural
Sample**



**Barsoum's Silica-rich Microconstituents are Opal-CT (Lepispheres) – SEM-EDS & XRD
-A Common minor phase in the "matrix" of Pyramid Blocks and Quarry Limestone
-NOT A "CEMENT"**



CONCLUSIONS

- ❖ **Quarried – versus – “Man-made” Limestone
Significant Textural and Microstructural Difference**
- ❖ **No “Geopolymeric” Signature in the Casing stones**
- ❖ **No “Unusual” Constituents in the Casing Stone**
- ❖ **Coating Contamination in the Lauer Sample**
- ❖ **Silica-rich Microconstituents – Natural Not Rare,
Not “Cement”**

**Cast-in-place concrete hypothesis remains a “hypothesis”
with no scientific evidence in the actual pyramid samples**

**The Great pyramid of Giza was built with Quarried Limestone Blocks
- As everyone, except Davidovits et al. always thought!**



ACKNOWLEDGMENTS

A big thanks to.....

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