

The Great Pyramids of Giza; Evidence for Cast Blocks

by

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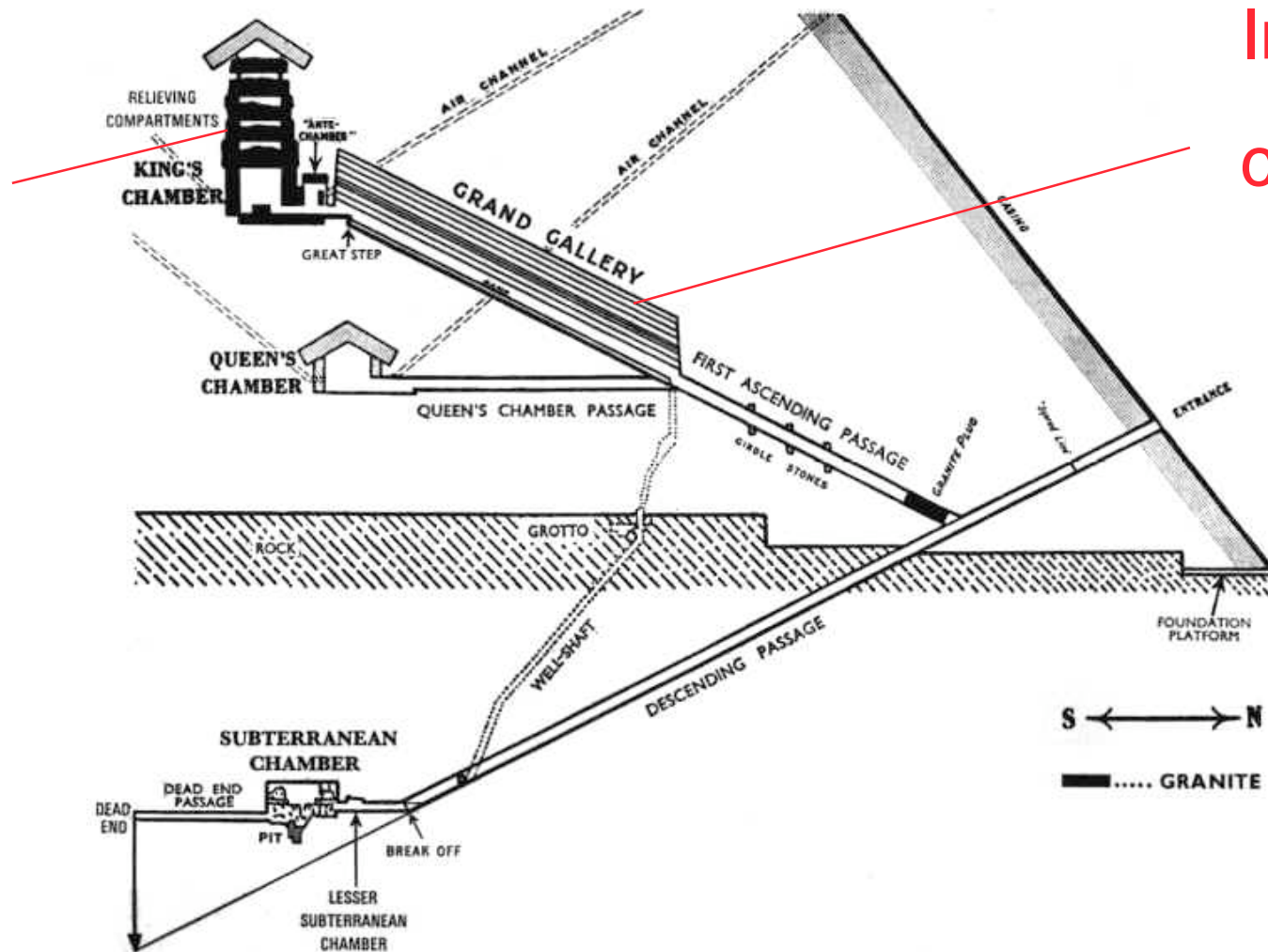
Short History

- *The Great Pyramids of Egypt were built roughly 5000 yrs ago.*
- *They are the only remaining of seven wonders of antiquity.*
- *The established theory of how they were built is that limestone was carved with rocks and copper chisels and carried up ramps.*
- *In the early Eighties, Joseph Davidovits came up with the radical but inspired idea that the pyramids blocks were cast using a mixture of limestone, clay, lime and water. These ingredients reacted and formed a concrete that he termed geopolymers.*
- *His idea was rejected by the Egyptological community because he did not have irrefutable scientific evidence.*
- *Four years ago, A. Ganguly, my graduate student, Dr. G. Hug, a colleague in France, and I, obtained some stone samples from the outer and inner casings of the Great Pyramid of Khufu. It took us 3 years, but we finally managed to prove beyond a shadow of doubt that indeed the inner and outer casing stones were NOT natural. This evidence is technical and is summarized at the end of this presentation.*

Cross-section of the Great Pyramid

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70 ton
granite
beams



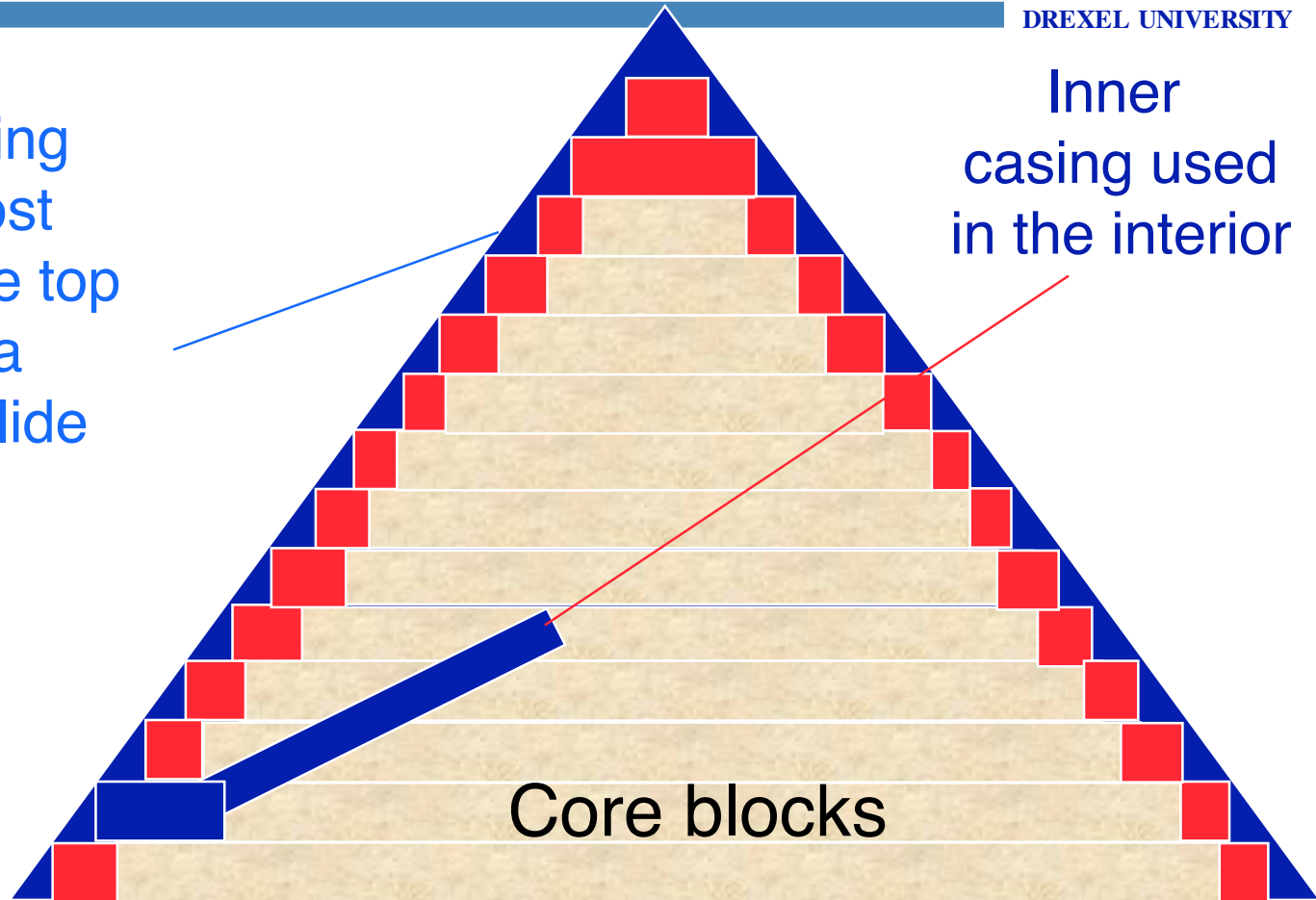
Inner
casing

Types of Stones in the Pyramid

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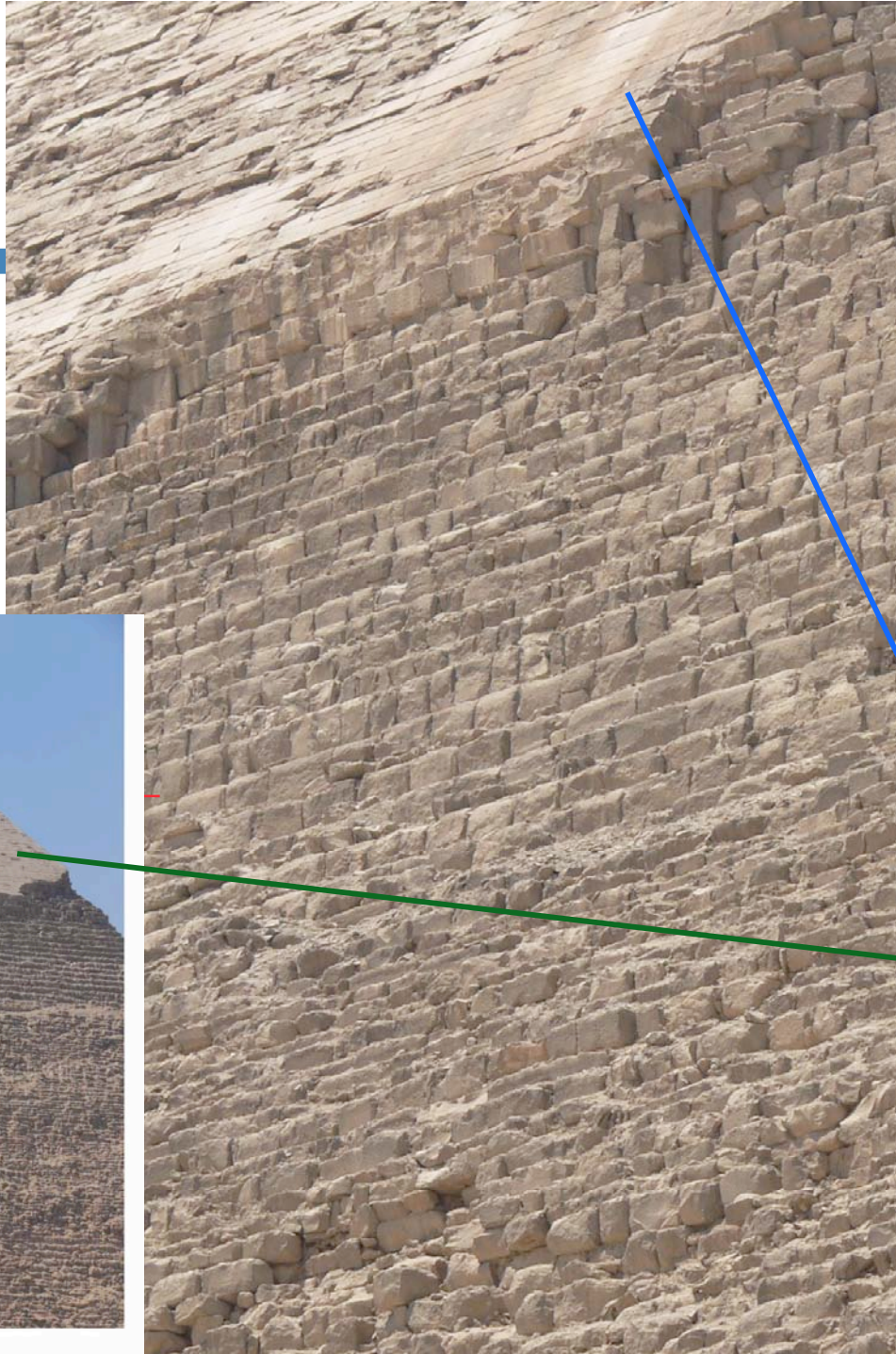
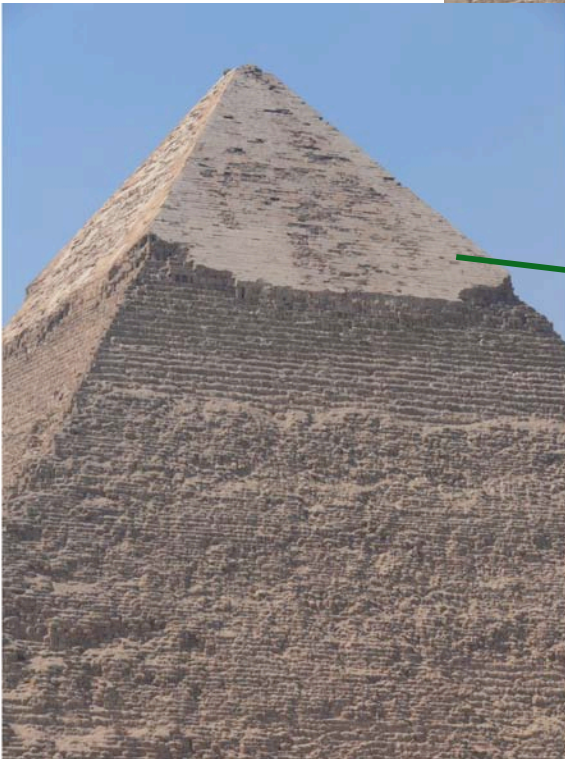
Outer casing
Largely lost
except at the top
of Khafra
See next slide

Inner
casing used
in the interior



Backing blocks

Not to scale and
does not include the granite



Outer
casing
still
present
at the top
of Khafra.

Current Understanding

- *Egyptologists maintain that the entirety of the pyramids are made of carved stones.*
- *J. Davidovits claims that they are made entirely of cast stones.*
- *In this presentation I will show the pyramids are actually a **hybrid**, where the outer casing, backing blocks - i.e. outer skin - inner casing and architecture and the top half are probably cast. I say probably because I do not have backing block or upper tier samples.*

Basic Premise

I submit that the human eye can almost immediately differentiate between cast stone blocks and those which are carved and hoisted into place. I also show that NOT all the stones are cast.

Introduction

- *3 unanswered questions in Egyptology.*
 - *How do you get ramps to the top?*
 - *How can some of the massive backing blocks be so perfectly mated to the outer casing and to each other?*
 - *Why, despite millions of tons of stone carved, presumably with copper chisels, not one copper chisel was ever found on the Giza Plateau.*
- *Our work answers these 3 basic questions.*

Major results of our paper

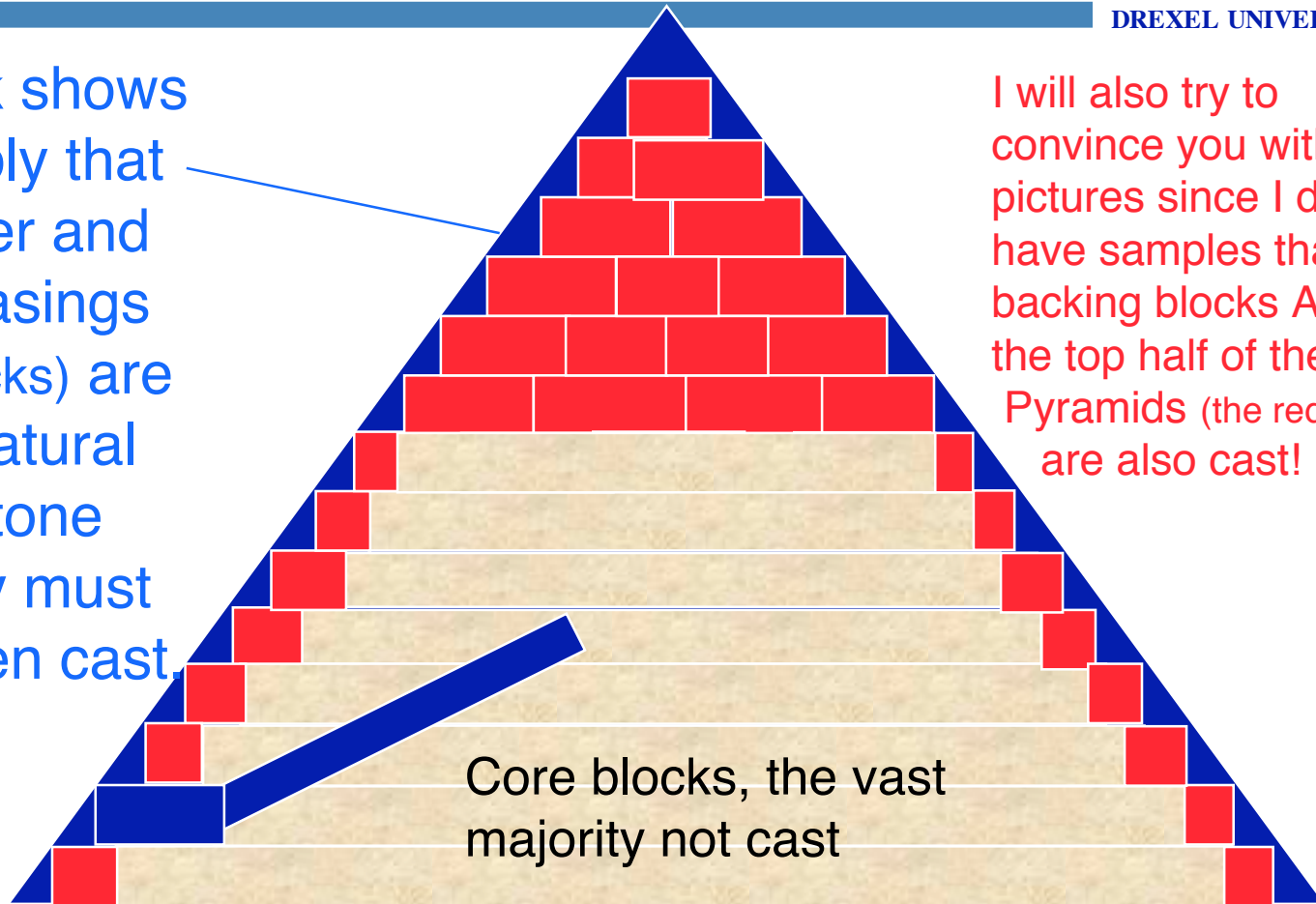
- *The inner and outer casing stones of the Great Pyramid are not natural.*
- *The microstructure is consistent with a reconstituted limestone where the cementing phase is either silicon dioxide or a Ca-Mg-silicate.*
- *The starting materials are believed to be diatomaceous earth, dolomite and lime.*
- *In other words, some of the blocks must have been cast in place.*

So, how do you build a Great Pyramid?

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Our work shows
irrefutably that
the outer and
inner casings
(blue blocks) are
NOT natural
limestone
i.e. they must
have been cast.

I will also try to
convince you with
pictures since I do not
have samples that the
backing blocks AND
the top half of the
Pyramids (the red blocks)
are also cast!



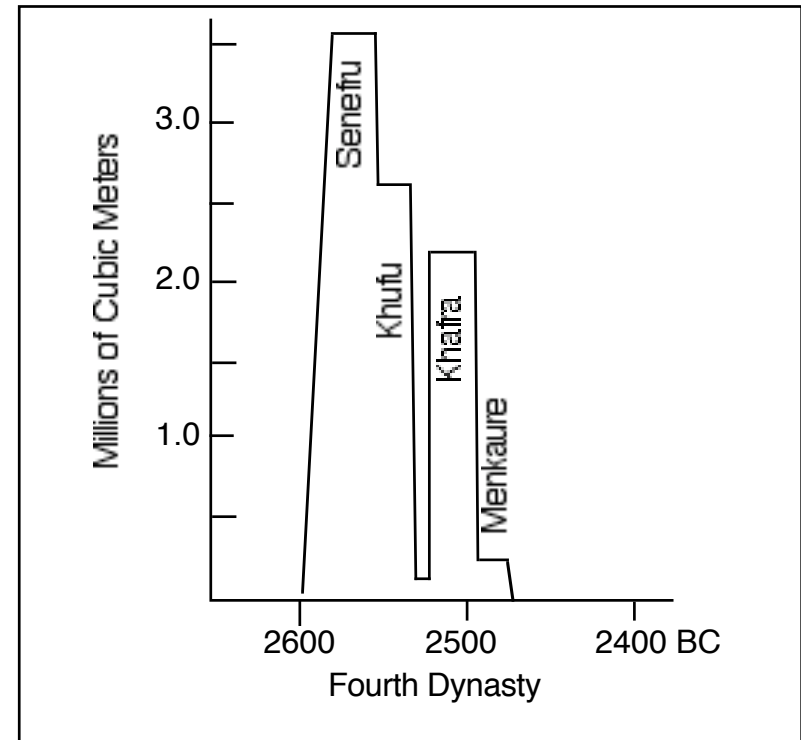
Probably cast

Not to scale

Volume of Stone Moved

This graph shows that a huge amount of stone was moved during the 4th dynasty of the Old Kingdom. Senefru, Khufu's father built 3 pyramids, whose volume was > the Great Pyramid of Khufu or Khafra.

In the coming slides I show that most of the stones in the Senefru pyramids were clearly carved and hoisted into place, while SOME of those in Khufu and Khafra were clearly cast.

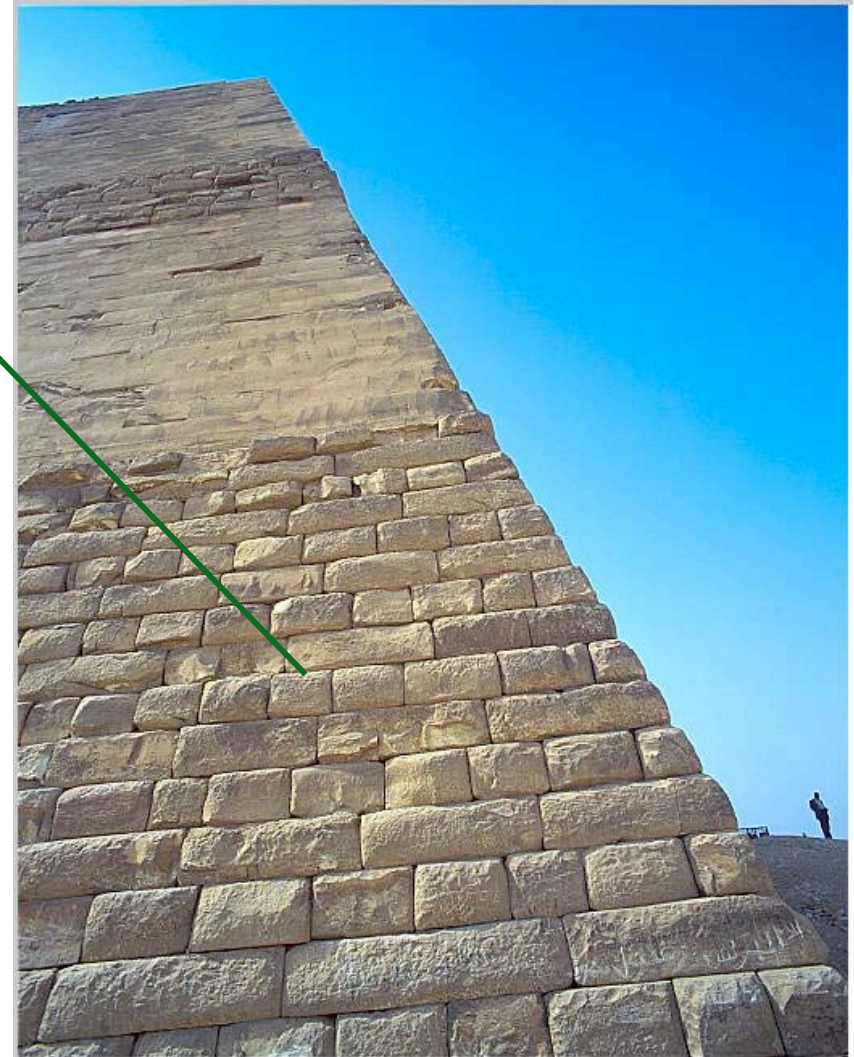


Maidum or Collapsed Pyramid of Senefru

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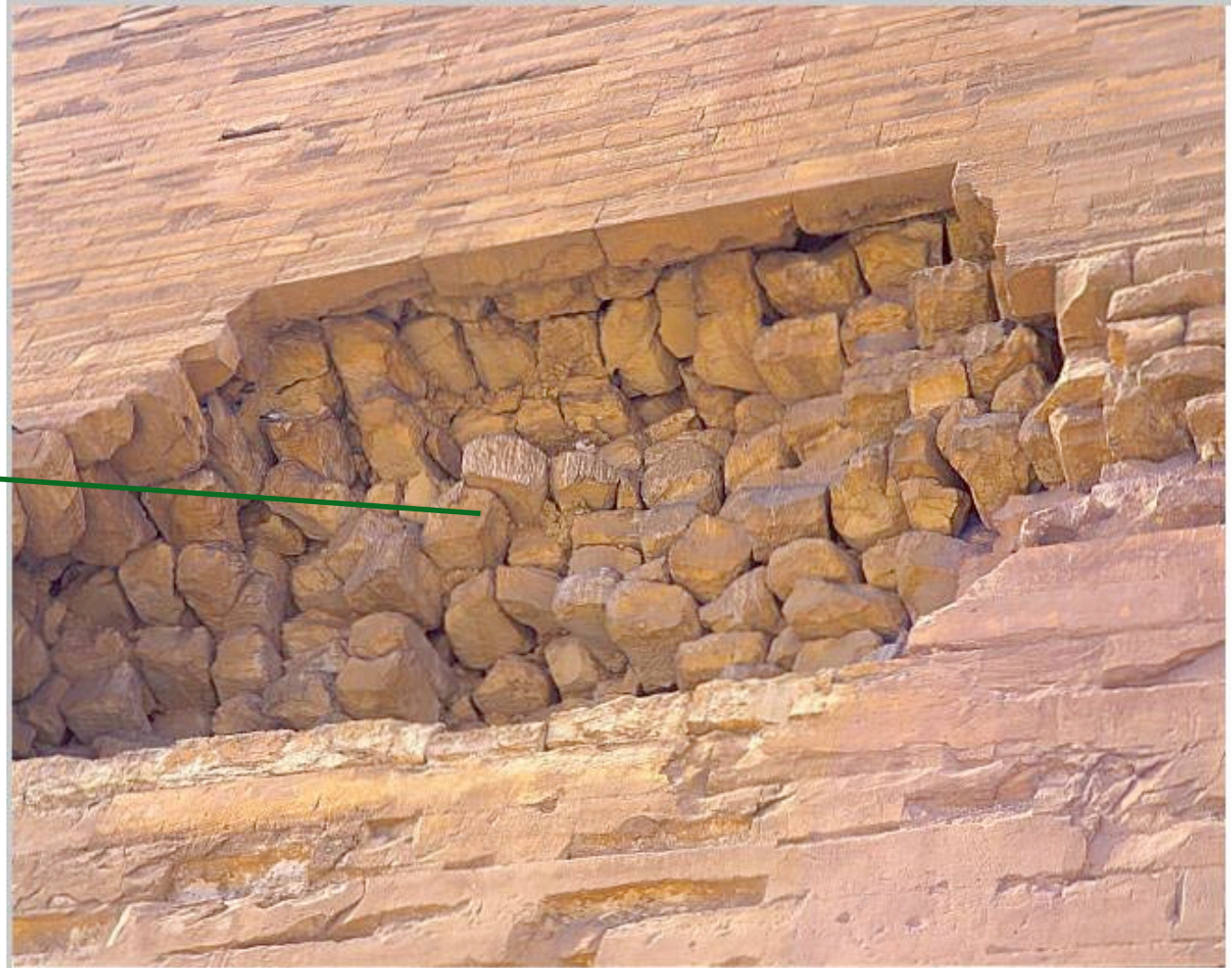
Built by
Khufu's
father
Senefru

Carved
or cast?



Closer Picture of Gash Denoted by A in previous slide

Carved
or cast?



Close-up of edge of gash

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Outer layer
is probably cast!



Interior appears carved

Bent Pyramid of Senefru

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Carved
or cast?



North or Red Pyramid of Senefru

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Cast or carved?

Khafra Quarries

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If the pyramids were totally cast, then why go to the trouble of carving out large blocks?



Conclusion I

Some - most ? - of the blocks of the 3 Senefru Pyramids appear to have been cut and hoisted into place.

The volume of stone in the 3 pyramids of Senefru is > Great Pyramid.

Senefru reigned for 24 yrs; Khufu, 23. Thus the Ancient Egyptians were able to move millions of tons of blocks fairly rapidly.

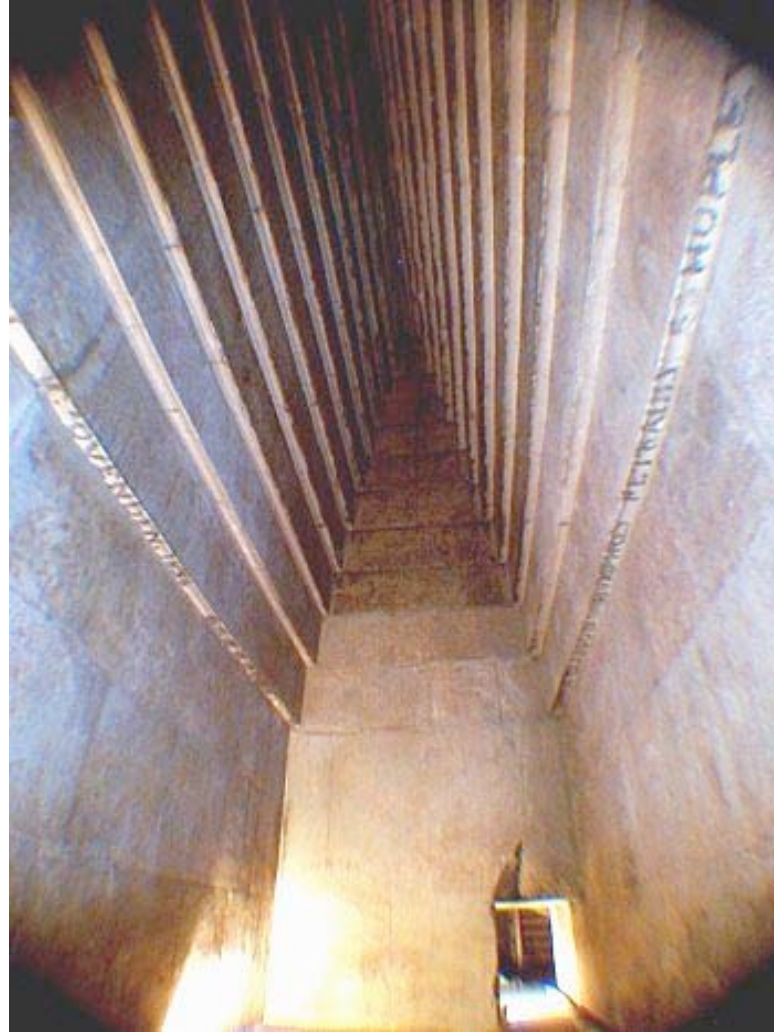
This does not imply that the entirety of the Senefru pyramids are made from carved stone (see next slide).

Interior of Senefru's Red Pyramid

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50 ft corbelled
ceilings

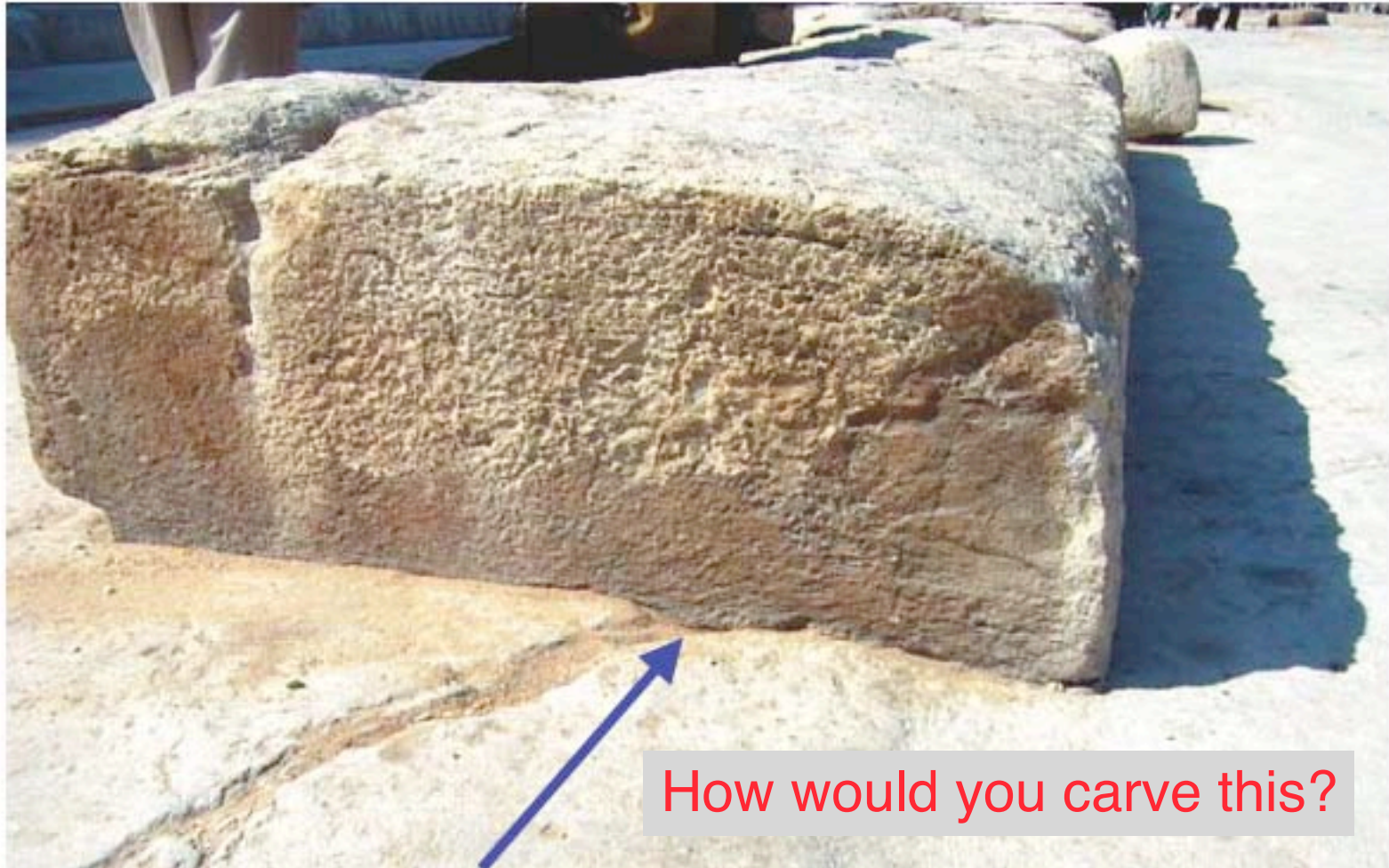
The stones of the interior
gallery of the
Red Pyramid appear
to have been cast. They
are massive, with no
gaps between them.
Note the interior gallery of the
Great Pyramid is even
more impressive



<http://www.guardians.net/egypt/meidum/meidum2.htm>

Stone in Vicinity of Khufu's Pyramid; Cast of carved?

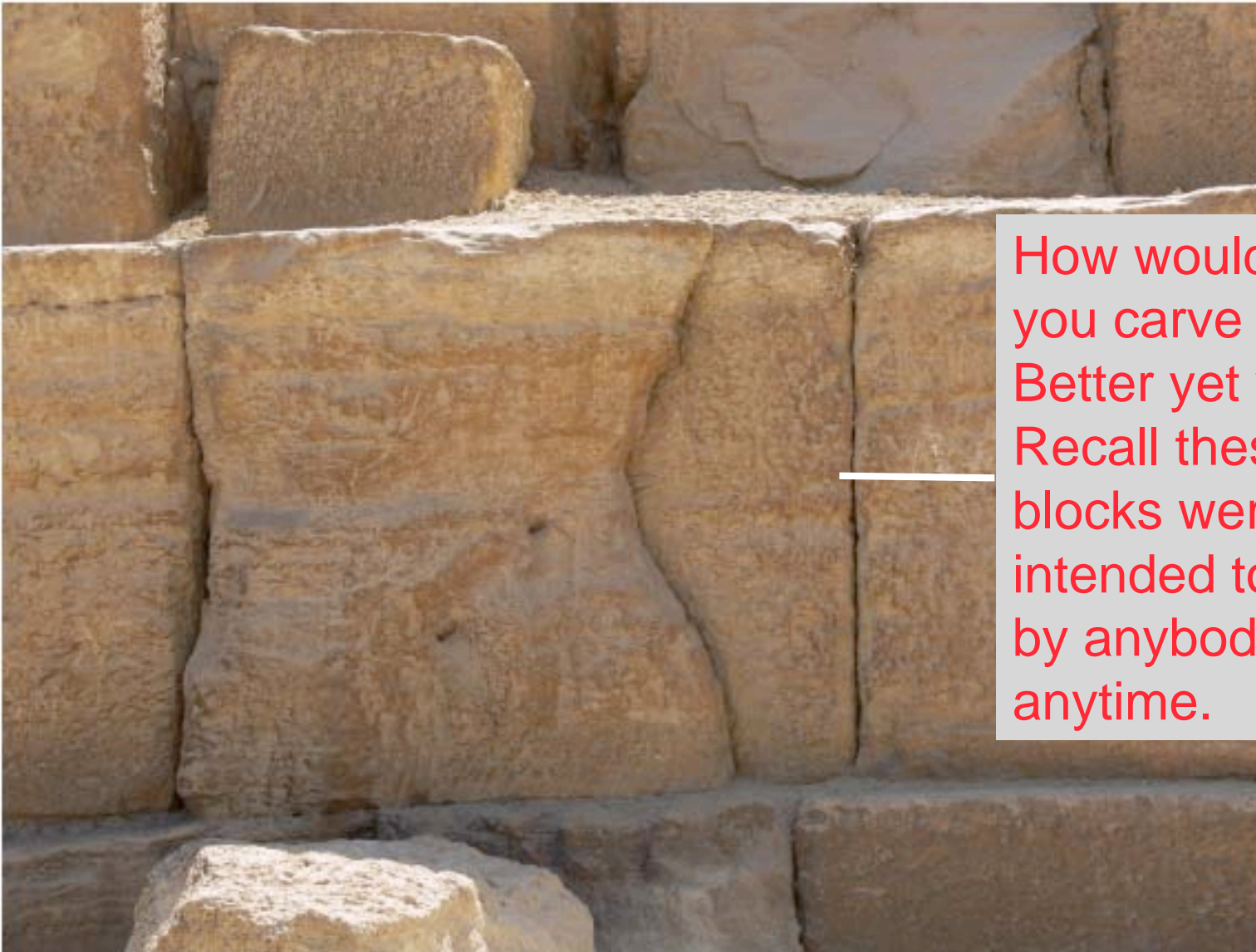
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J. Davidovits and M. Morris, *The Pyramids: An Enigma Solved*, Hippocrene, NY, (1988).

Khufu. West side, lower courses

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How would you carve this?
Better yet why?
Recall these backing blocks were never intended to be seen by anybody, anytime.



Khufu
lower
courses



Senefru

Compare
the two
stones

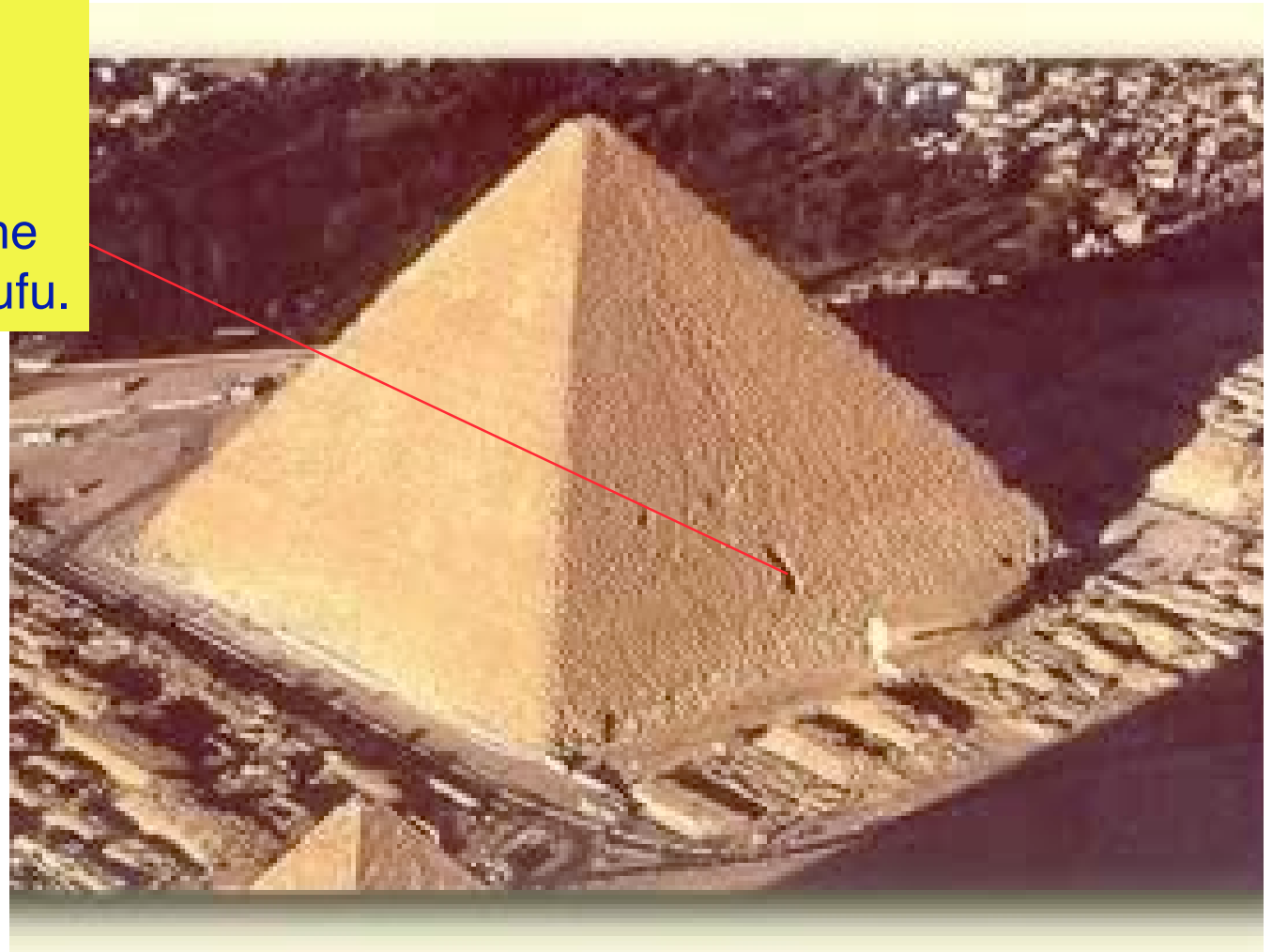
Recall these backing blocks were never meant to be seen. Then why go to the trouble of making the joints so perfect? Also note that not all the seams are perfect because of erosion. See better pictures later.

The Vyse Gash in the South Side of Khufu.

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In 1837, Vyse, an Englishman used gunpowder to blast a large gash in the south side of the Great Pyramid of Khufu.

In the following I show pictures from inside and around the gash.



First a historic picture.

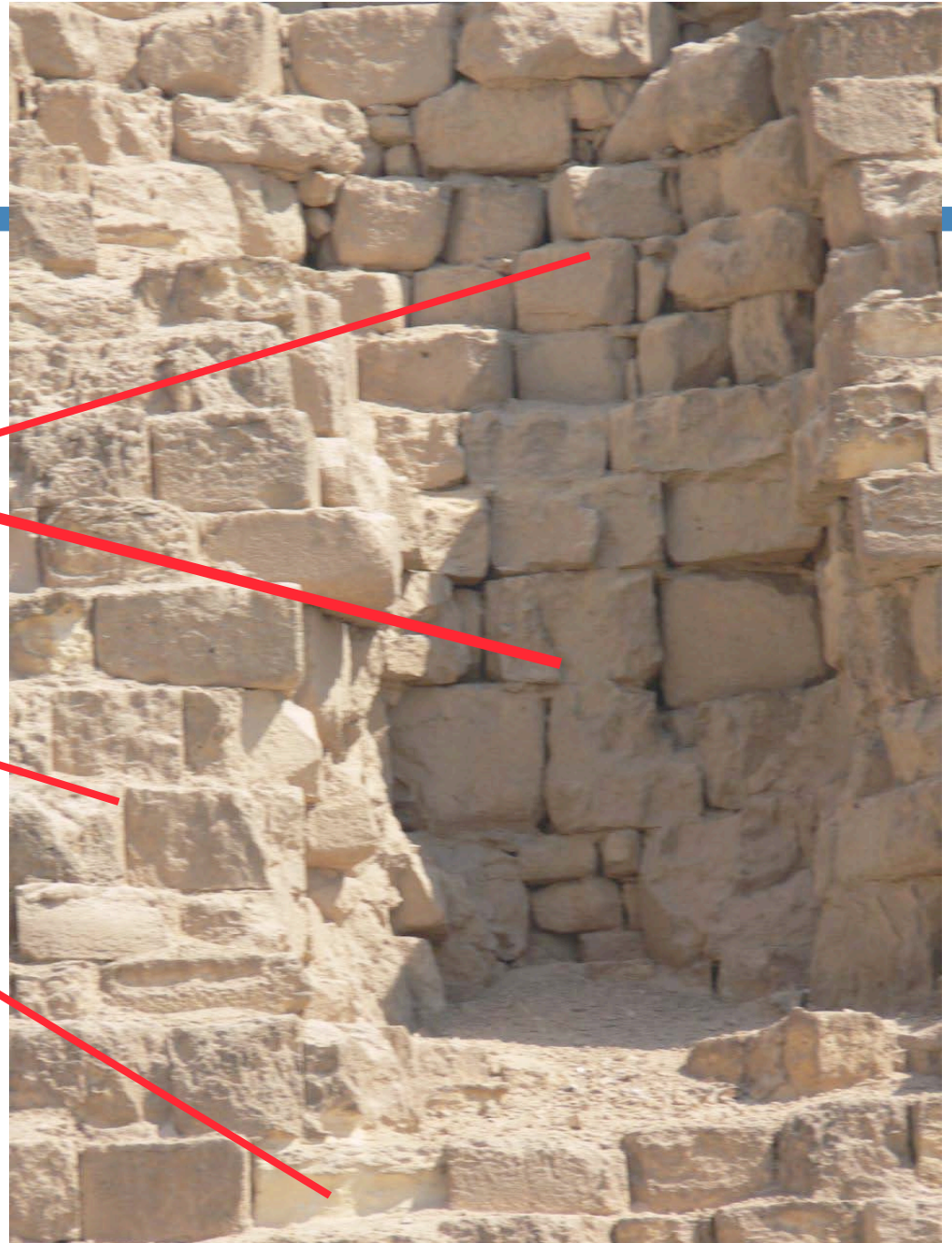
Blocks
in Khufu
inside of the
casing/backing
stones.
These blocks
are clearly
carved.



Ashraf Abd al-Aziz stands in the gash made by Howard Vyse in the south face of the Khufu Pyramid during his 1836-38 explorations.

Compare and contrast
the stone blocks
inside the gash
and those outside
the gash.

The difference
is clear; the
former are carved,
the latter are
probably cast.





These blocks are just below the gash. They are clearly different than the ones inside the gash and appear cast.

So, what's going on?

The Ancient Egyptians realized that if you cast huge backing blocks on the outside, then the core blocks would not have to be that carefully cut.... This explains the blocks inside the Vyse gash.

Why not cast the entire pyramid?

For a primitive society, producing lime from limestone to make the concrete is expensive because it is energy intensive, and crushing millions of tons of limestone is also non-trivial...

So, they cast the big backing blocks around the perimeter and filled the center with carved blocks!

Major Implications

Ramps were used.

But not to the top; probably half-way (see below).

So the tops of the pyramids should also be cast.

Volume of top half of pyramid is 12 % of total.

Center of pyramids is full of uneven stones, debris and other fillers.

Historic Evidence

- *One of the conclusions of the Stanford Research Institute Electromagnetic Sounder Experiment on the Giza plateau in 1975 was: “Observation of construction practices made visible by the digging efforts in various forced entrances disclose a much more common use of irregular blocks and debris fill, particularly in Chephren's and Mycerinus' pyramids, than is commonly appreciated.”*
- *This experiment failed because the Pyramid stones absorbed the EM radiation as a result of their high water content. The researchers estimated that the Great Pyramid contained 100 million gallons of water!*
- *For more details go to: <http://www.ldolphin.org/egypt/egypt1/index.html>.*

Evidence for Water

At the time of the opening of the Great Pyramid by Caliph Al Mamun in AD 820, after it had been sealed for many centuries, the interior chambers were found to be “mysteriously encrusted with salt as much as one-half inch thick,” consistent with rock that is by nature damp and porous.‡

This is very important because the natural limestone on the Giza plateau is quite dry.

This water was added to the limestone and other minerals to make the concrete. In our limestone concretes we can only drive off 25 % of the water. The rest is trapped in the cement.

‡ P. Tompkins, *Secrets of the Great Pyramid*. Harper & Row, San Francisco, 1971.

The Complete Pyramids, M. Lehner, 2004

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“... the quality of the core stone (in Khufu) becomes gradually finer in the last several courses that are preserved before the top, until it almost matches that of the Turah limestone casing”

This is extremely important because we have shown that the limestone casing is not only NOT from Turah, but as important is synthetic.

The Complete Pyramids, M. Lehner, 2004

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“Just beneath the lowest surviving course of casing stones (in Khafra), a band of regular stepped core stones is visible. The rest of the surface down to the base – the greater part of the pyramid – consists of very rough, irregular loose stone”.

What is this loose lower band? Is it packing between the core and casing exposed when the casing was stripped away? That seems likely until, climbing the corners of the pyramids, one sees that this irregular masonry seems to continue for some some depth into the pyramid body”.

“The discontinuity might indicate different building styles, perhaps even a hiatus and then resumption of building. Alternatively, the core masonry may simply have been laid in a more regular fashion towards the top in order to allow the builders greater control”

We submit that the difference comes because the lower blocks are carved and the top layers are cast!

The Band

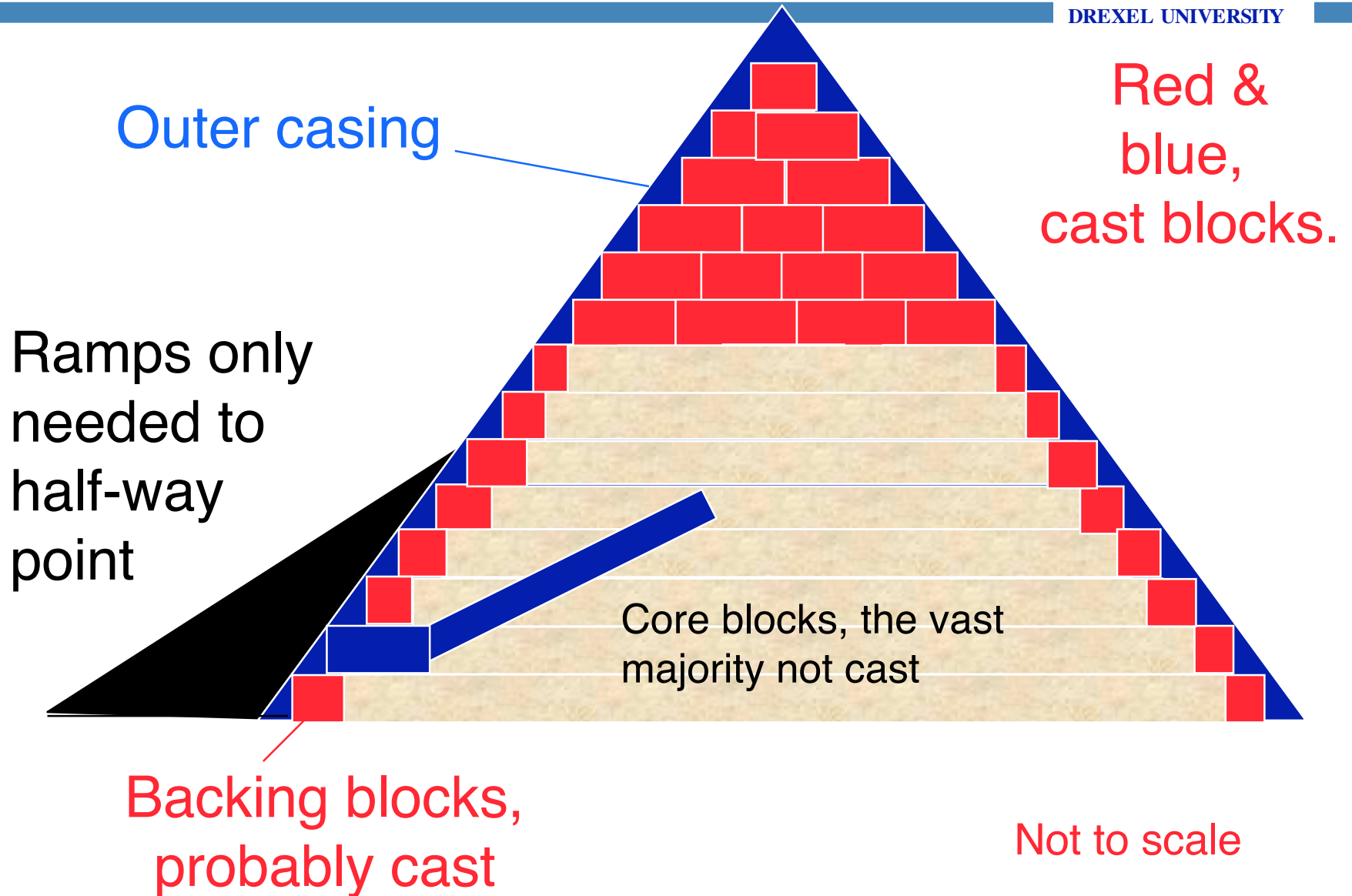
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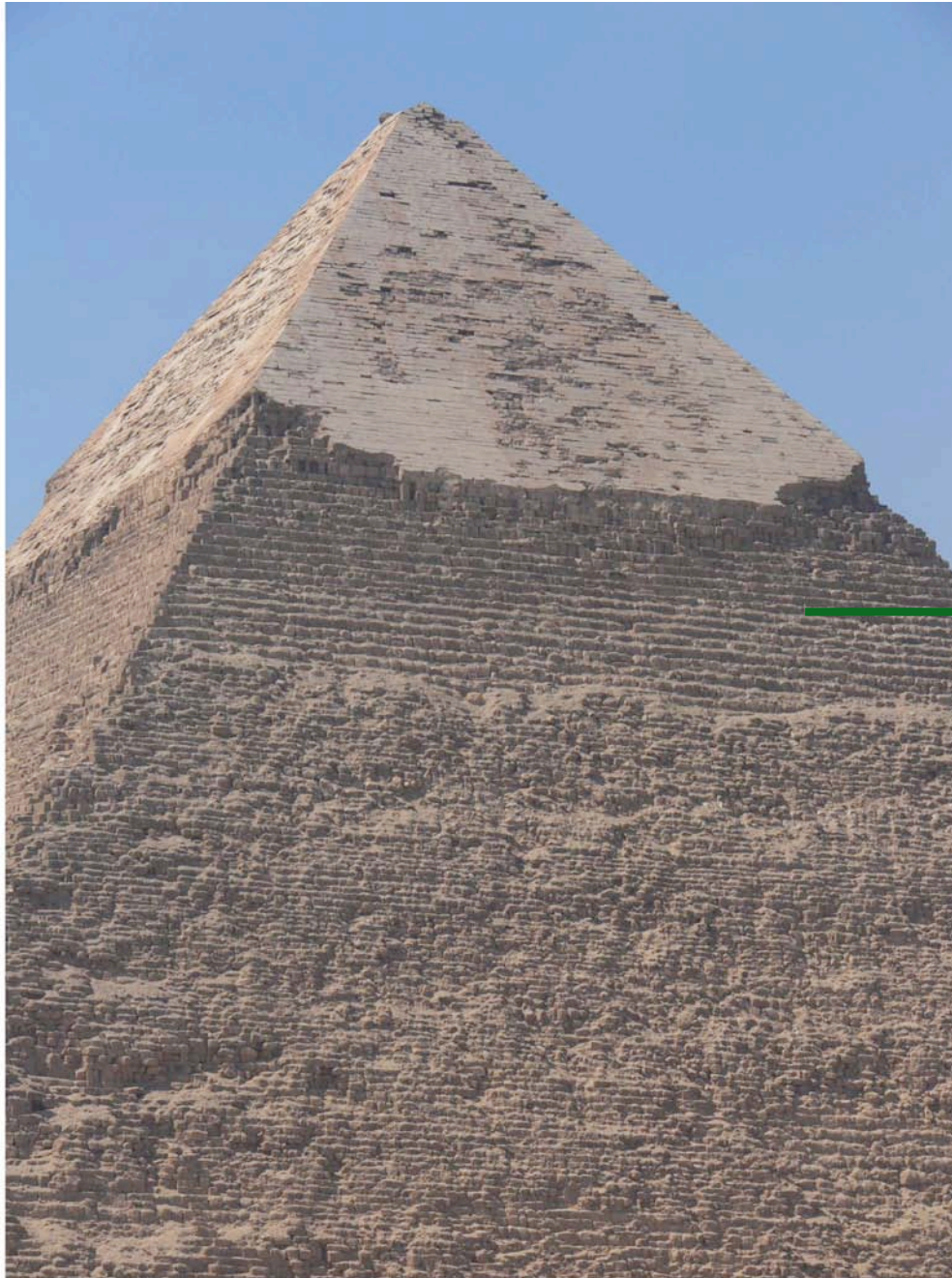
From here up
The blocks
were probably
cast!

So, how do you build a Great Pyramid?

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More Photographic Evidence



A

Close-up of Band A Shown in Previous Slide



Compare the blocks on the left from the Upper Courses of Khafra and those of one of Senefru's pyramid.

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These are not very clear
because they were taken with
a regular camera from
the bottom of the pyramid



Senefru pyramid

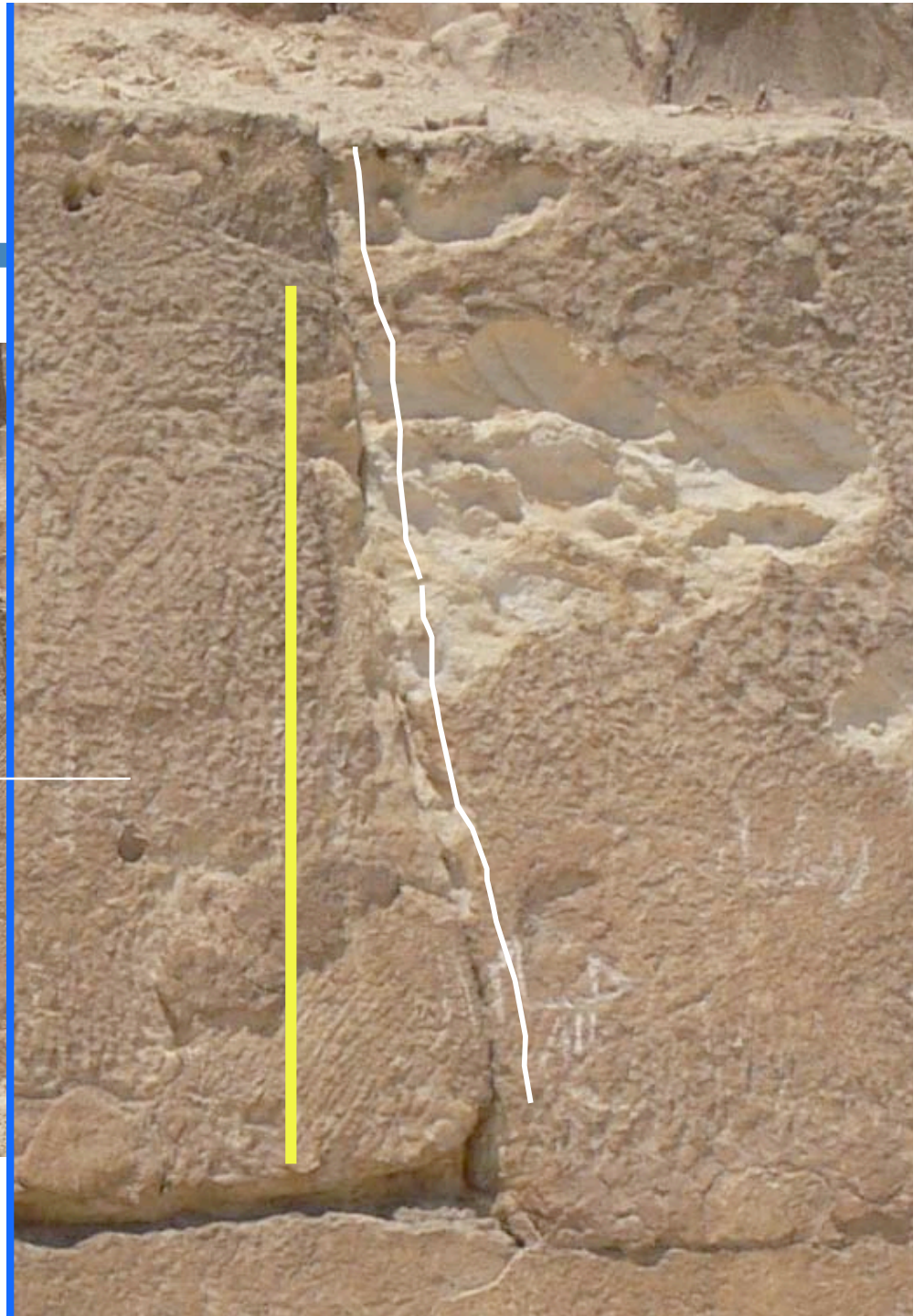
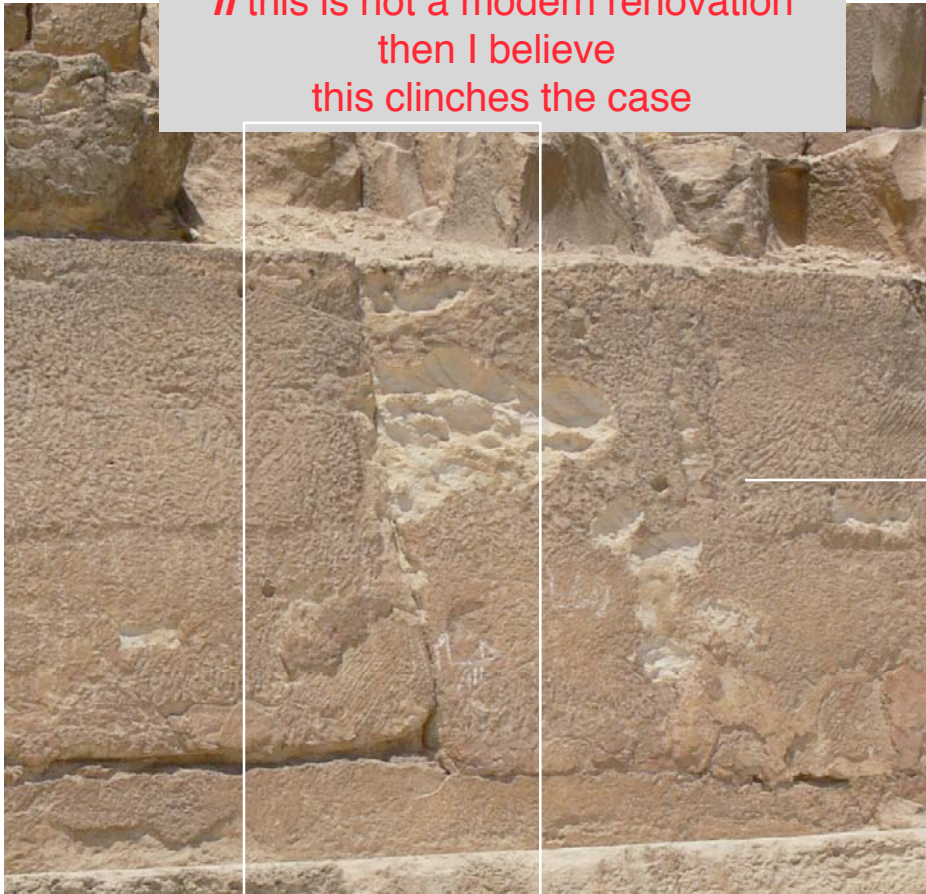
Lowest Courses of Khufu, E-side

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In the next
slide I
magnify
this
seam.

The seam between
these two massive blocks
is neither straight no smooth!
IF there is **NO** mortar between these
roughly **60** ton blocks, and
if this is not a modern renovation
then I believe
this clinches the case

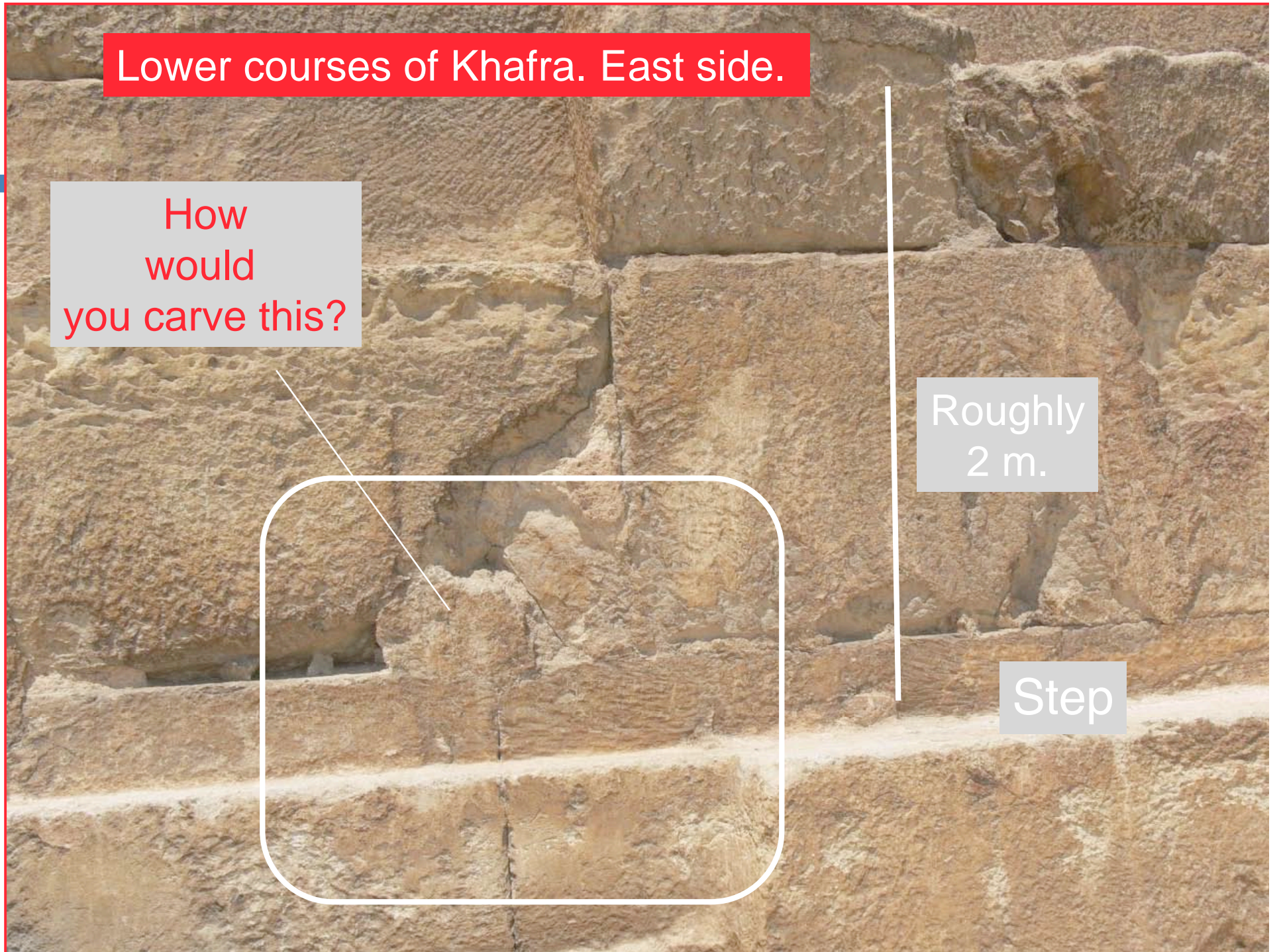


Lower courses of Khafra. East side.

How
would
you carve this?

Roughly
2 m.

Step



At even higher magnification.

Recall these massive blocks
were not meant to be seen.

Here again ***IF*** there is **NOT** mortar and
if this is **NOT** a modern renovation
then I believe this again clinches the case



Lowest course in Khufra.

Note the excellent
but irregular
molding of the
limestone
blocks to the
Granite blocks.

Here again ***IF*** there is **NOT** mortar between
the granite and limestone and ***if*** this is **NOT**
a modern renovation then I believe here
again is strong evidence for casting the limestone
The granite is **REAL**! (see later).





How would one carve this?

Top view of a lower course on the south side of Khufra showing a granite block perfectly mated to the limestone block behind it.

Here again ***IF*** there is ***NO*** mortar between The granite and limestone and ***if*** this is ***NOT*** a modern renovation then I believe this again clinches the case

Major Conclusions

- *The inner and outer casings are cast. The backing blocks and the top halves of Khufu and Khafra are also most probably cast.*
- *The Ancient Egyptians invented concrete millenia before the Romans.*
- *In addition to being superb architects, civil and mechanical engineers, they were also brilliant chemists and material scientists.*
- *The fact that this artificial stone has not only survived for almost 5000 years but has fooled generations of Egyptologists and geologists is a testament to the incomparable genius of this ancient civilization!*

Major Implications of Work

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- *This technology is real and almost CO_2 neutral. It should be developed further.*
- *If used instead of Portland cement, it will result in significant reductions in green house gases. The Portland cement industry produces massive amounts of CO_2 every day.*
- *This technology - geopolymers - could be used as a building material for the developing world that is almost free.*

And while our work answers some questions, the mystery is far from solved.

- *How the 70 ton granite beams spanning the ceiling of the King's chamber were carved - with nothing harder than copper - is a true mystery.*
- *How these massive 70 ton beams were hauled into place halfway up the Great Pyramid is also a great unsolved mystery.*

The True and Incomprehensible Mystery

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These are natural granite blocks - used as an external casing for the Menkaure pyramid - that had been partially carved.



We know they are natural because of the veins shown here. How that was Accomplished, with nothing harder than copper, is simply stunning and astounding.



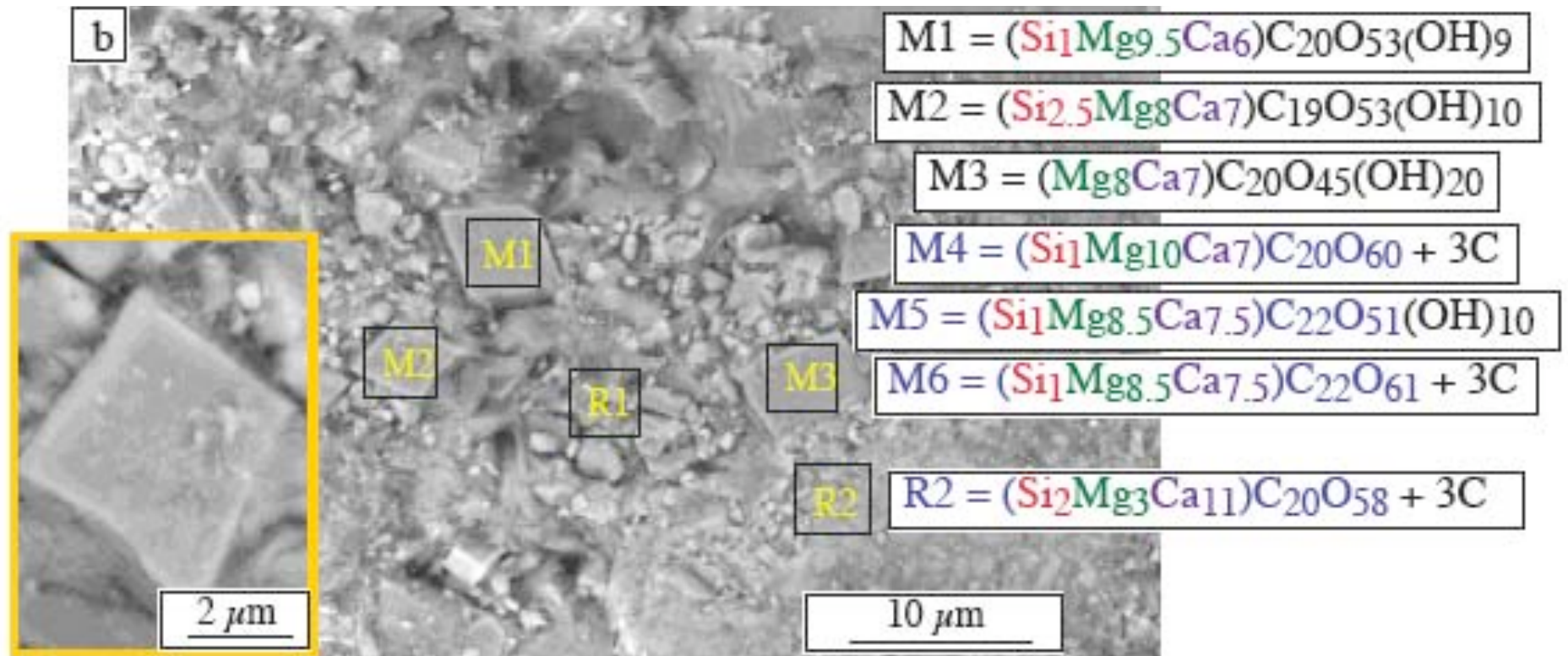
- *Recall that we are not claiming that ALL the blocks are cast. Only a small fraction that we estimate to be about 20 volume %.*
- *Nature is incredibly resourceful and the possibility - even though remote - that the stones we looked at are natural cannot be ruled out. Only more work by others on many more samples can the truth be found.*
- *In the meantime, I strongly believe - and I hope I convinced you - that there is enough of a case here for the Egyptological community to look at this plausible theory more carefully and seriously. It is a fascinating possibility with major implications.*

Scientific Evidence

*For more details see:
M. W. Barsoum, A. Ganguly
and G. Hug, J. Amer. Cer. Soc.
December 2006.*

Outer Casing

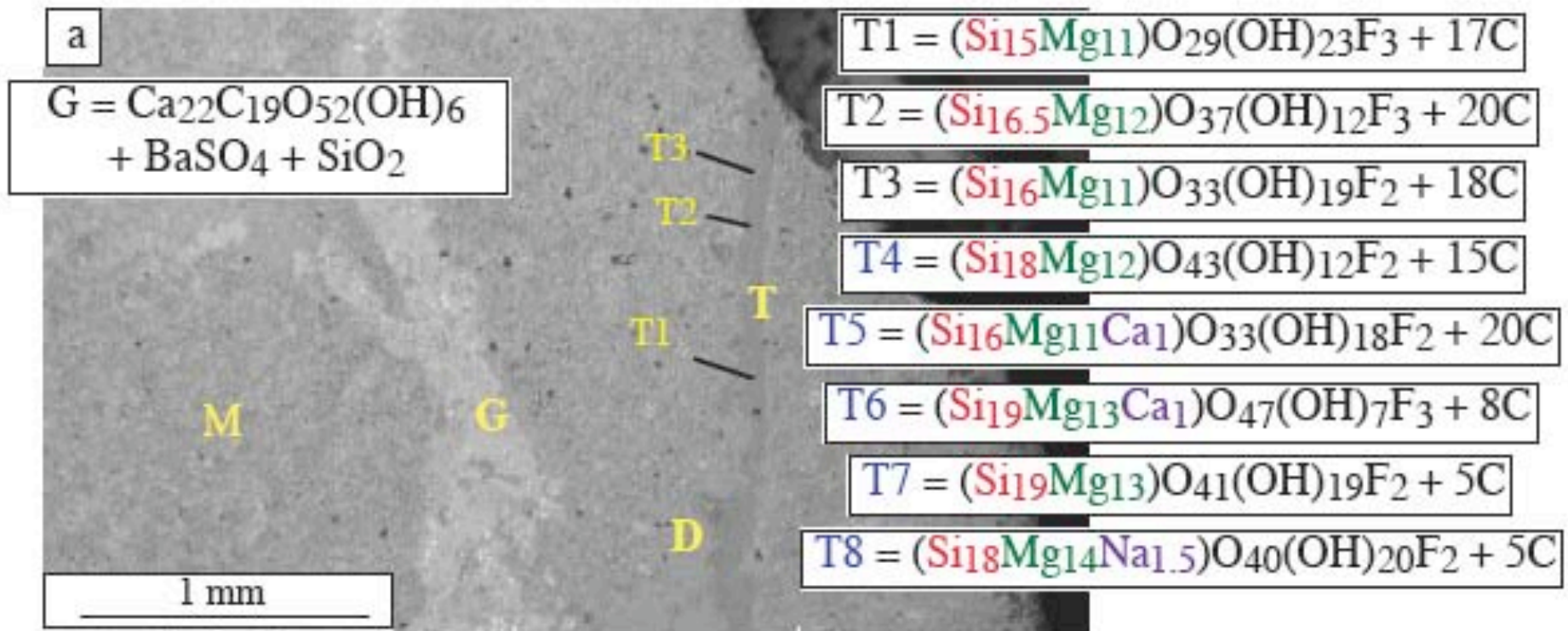
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The M-phase, as far as we are aware, does NOT exist in nature.

Outer Casing

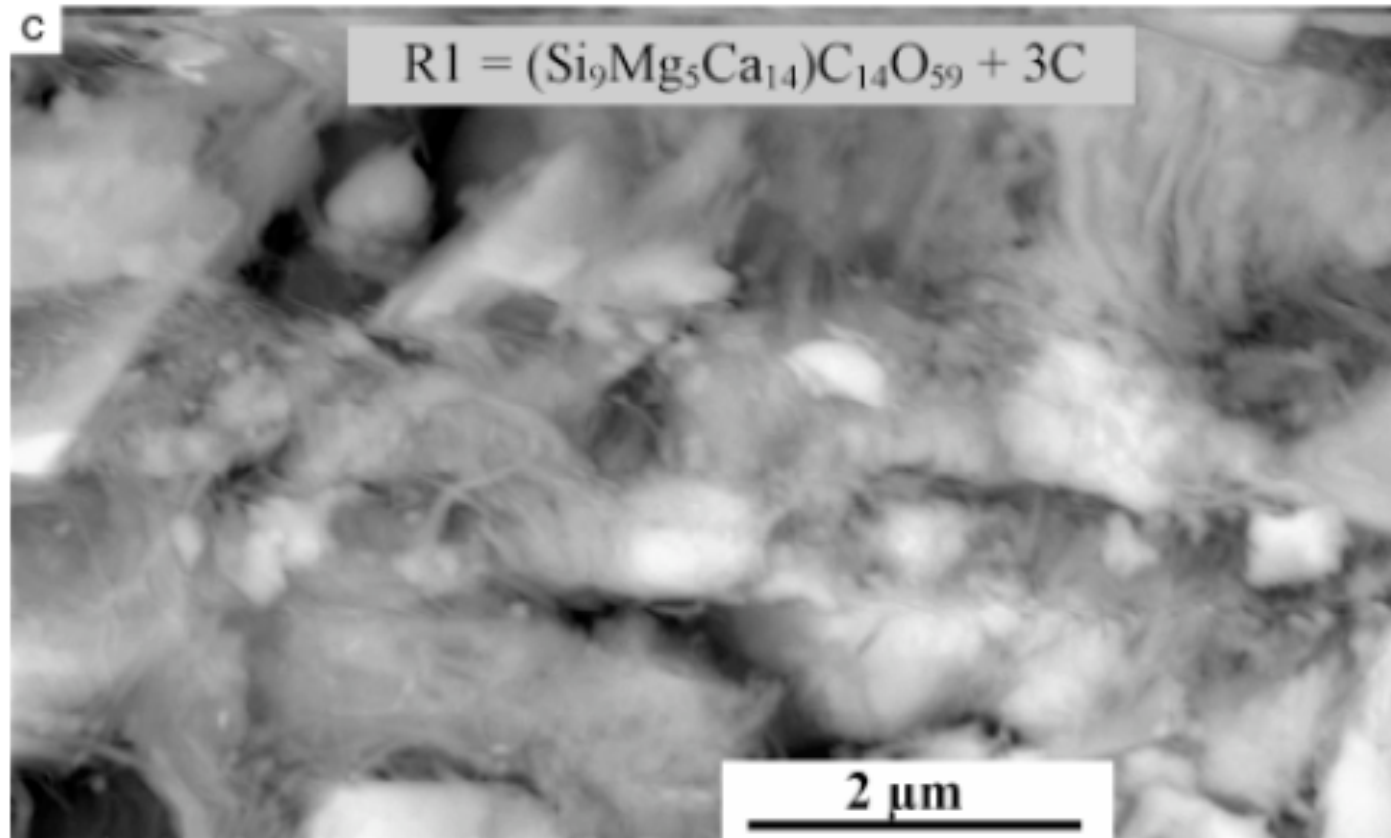
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These results are key because the T-phase composition shown, as far as we are aware, simply does NOT exist in nature.

Outer Casing

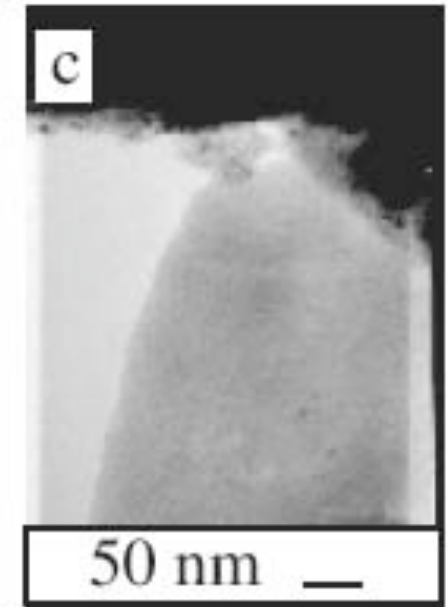
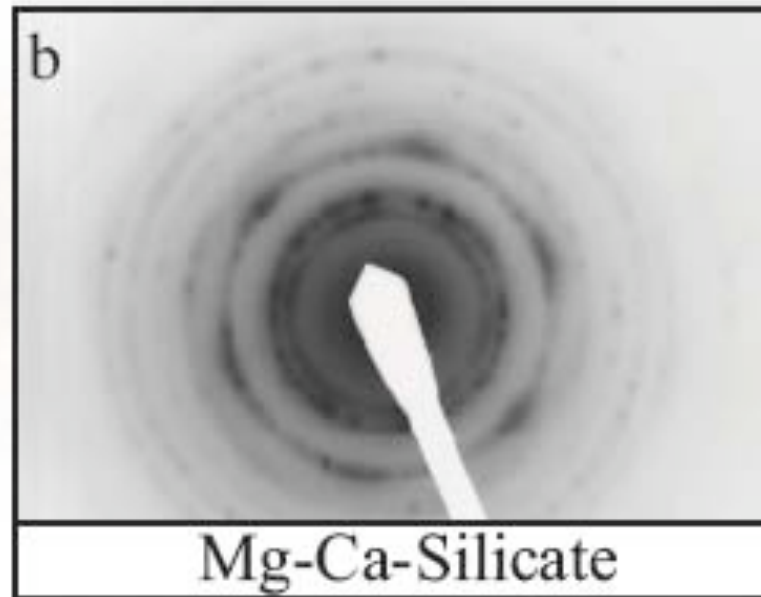
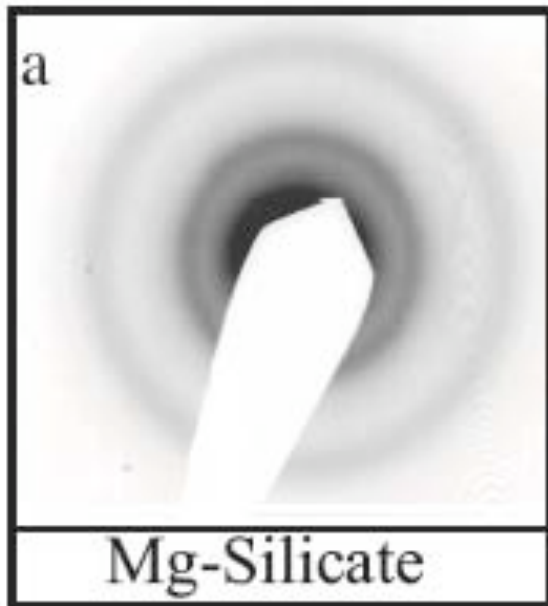
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This composition was not found in the natural limestone that was used as a control.

Transmission Electron Microscopy of Outer Casing

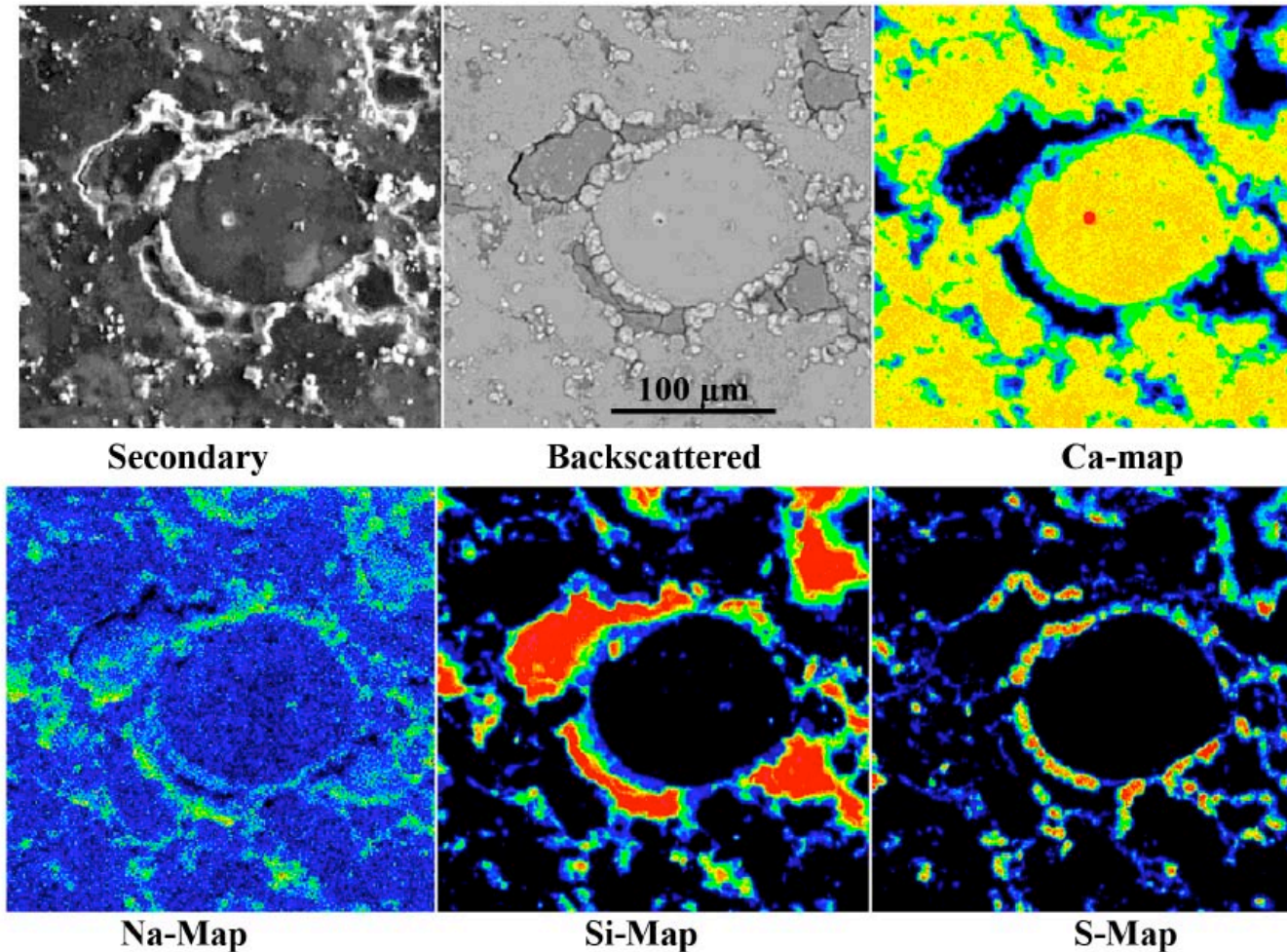
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These results are absolutely crucial to the case, because sedimentary rocks are seldom, if ever, amorphous. As important, the chemistries determined, as far as we are aware do NOT exist in nature.

Bulk of Inner Casing - Lauer Sample

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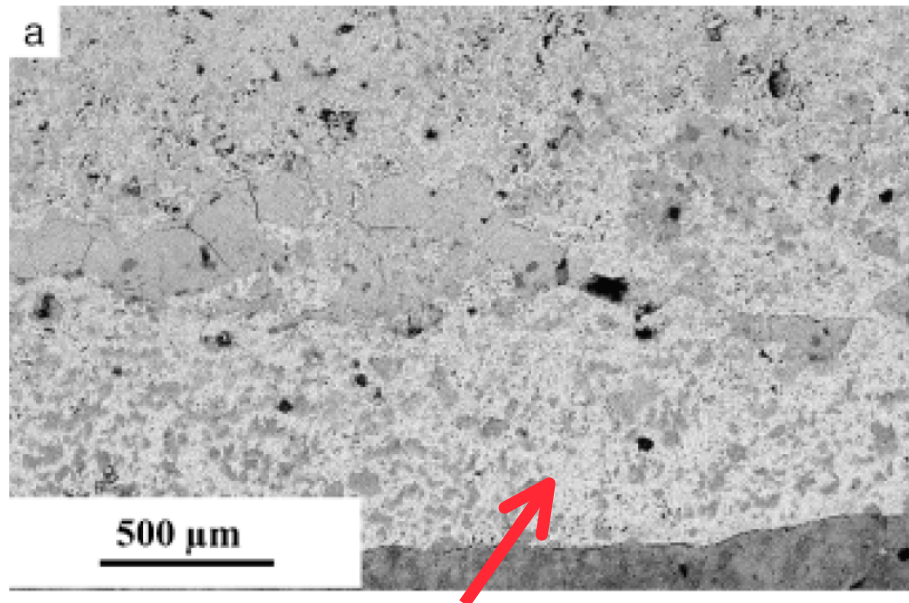
These micrographs more than any clearly show that the limestone aggregate (yellow) surrounded by the silica-based (red) cementing phase.

Micrographs taken by L. Walker at ORNL.

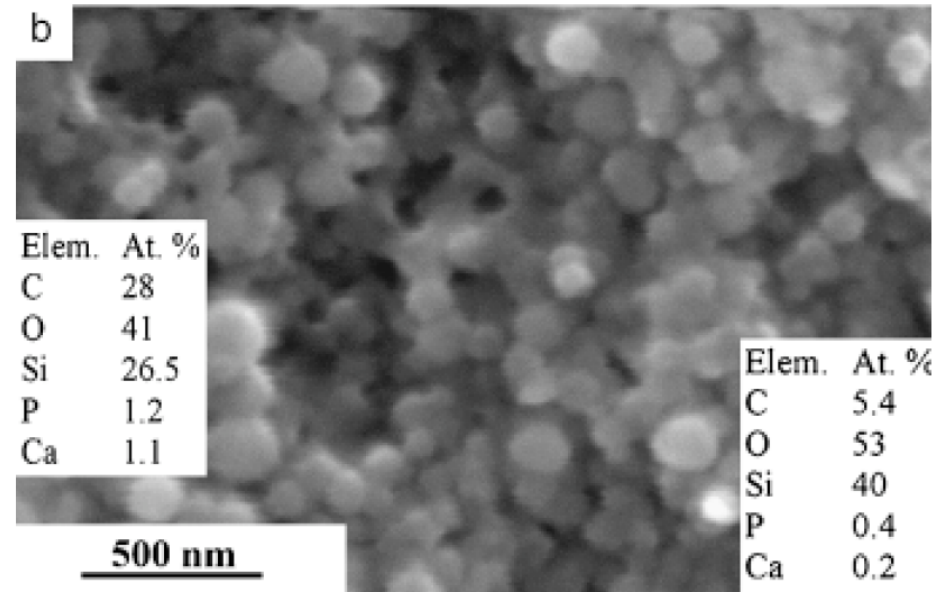
Fig. 3. Scanning electron microscopy micrographs and elemental maps of bulk of Lauer sample showing (a) secondary and (b) backscattered images; the rest of the images represent elemental maps of Ca, Na, Si, and S. Note that the size of the calcite aggregates is 50–500 μm .

Inner Casing - Lauer Sample

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Ca-phosphate!



Silica Nanospheres