

21 days GEOPOLYMER EXPERIMENT

OF THE ANCIENT SITES IN PERU

WALLACE

CUSCO, PERU

April-May 2022

PREPARATION!

1. I flew from Mexico to Bolivia April 1. New adventure!
1. I went and visit TIWANAKU + PUMAPUNKU and I went to collect some “weathered” sandstones at a little town called CALLAMARCA.
1. Took a bus from LA PAZ, BOLIVIA to YUNGUYO, PERU stopping at the “CERRO KHAPIA” to collect some Andesite sand.
1. Continued my way up to PUNO, PERU where I bought some GUANO that came from ILO.
1. Took a bus from PUNO to CUSCO (had to walk 7h30*) where I had a airbnb waiting for me with a lot of space to conduct the experimentation.
1. I found some LIME POWDER quite easily since the locals use it to peel the “maiz” and I bought some baking soda + table salt in order to make my own NATRON.



Material collected: Weathered sandstone / Andesite sand / Guano / Lime powder / Natron

Material for molding: Clay / wood / Latex / Metal

PREPARATION!

WHY did I go collect the materials at those sites?

Because of all the research done by Joseph Davidovits and associates.

Because I have watch his youtube videos on the subject 4 times and felt it was the BEST theory.

I wanted to continue his theory and actually try with the materials he mention to replicate the masonry of the ancient sites.

<https://www.geopolymer.org/archaeology/tiahuanaco-monuments-tiwanaku-pumapunku-bolivia/>



CERRO KHAPIA



CALLAMARCA

MANY QUESTIONS

1. What were the molds made out of?
2. What is the purpose of the “knobs”?
3. What was the construction technique used?
4. Artificial stones or natural stones?
5. Where did they source the materials?
6. If Artificial stones... what was their recipe?





But nobody has the answers!

So it is time to experiment and let the universe teach us! Hopefully giving us the answers to all the unanswered questions.

Before the experiment!

Let's resume what we "know" or can observe.

Small polygonal



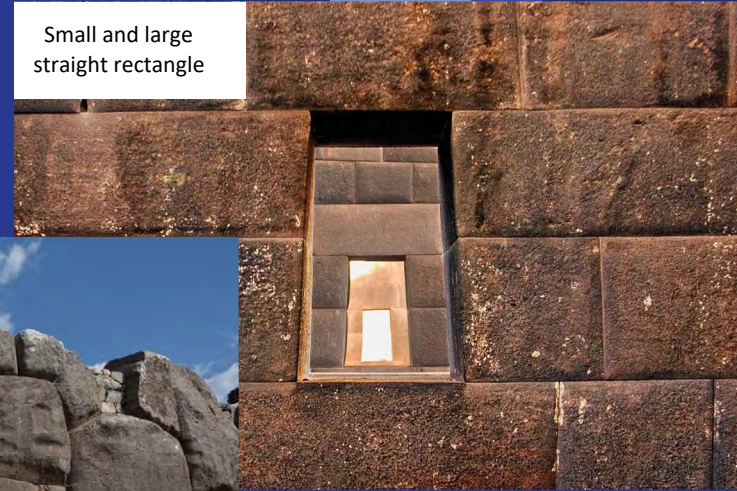
Megalithic



Small bubble rectangle



Small and large straight rectangle



(Maybe more)

1. We can see 4 different types of Masonry / Molding techniques



EXPERIMENTATION.

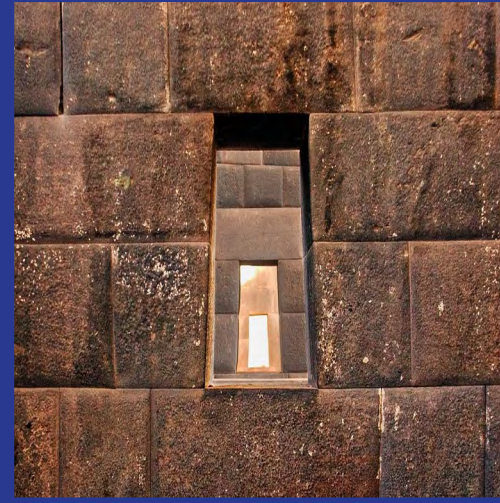
Replicating the 4 different styles of masonry that we find at the temples in Peru. Using materials that the ancient builders had access to, using very simple tools.



Creating HUGE stones



No gap in between



Finding the molding technique

GEOPOLYMER RECIPES

What did the ancient builders/chemists mix together? To build those temples...
What do they had access to?

1. ANDESITE in ACIDIC MEDIUM:

- Andesite sand from Cerro Khapia
- Guano from Ilo
- Oxalic or/and Phosphoric acid



50ml water
1g of Guano
3g of acid
90g of Andesite sand

2. SANDSTONE in ALKALINE MEDIUM:

- Weathered Sandstone from Callamarca
- Natron salt
- Lime powder



50ml water
1g of Natron
3g of Lime powder
90g of weathered Sandstone

*Many recipes will be tried and documented in order to find the best one.

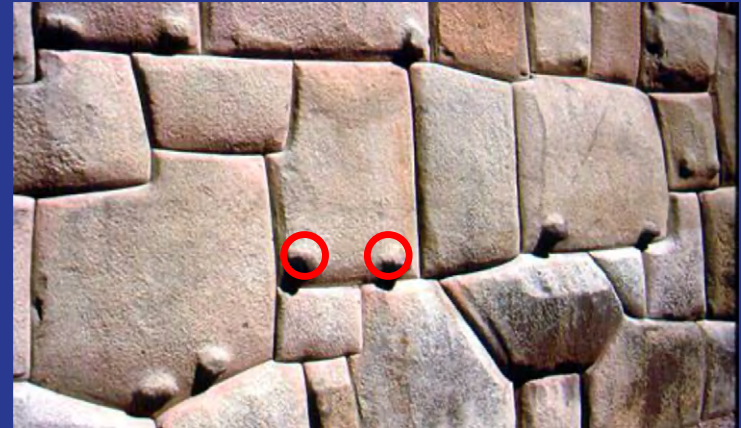
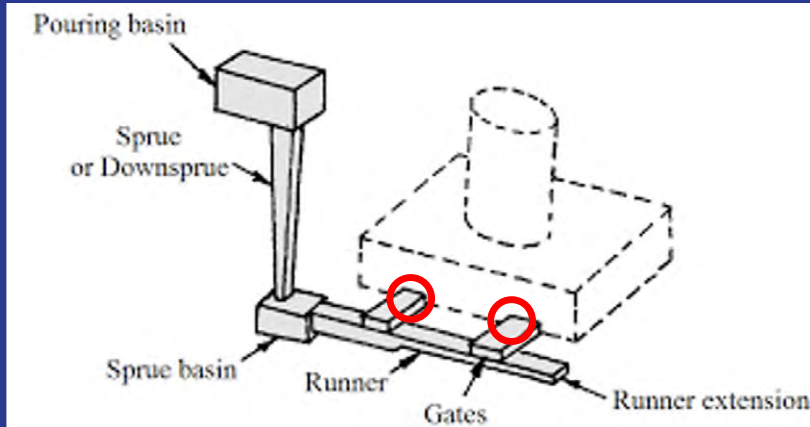
THEORIES TO TRY

What is the purpose of those “knobs”?

Why some are negative? Why we find so many different style of “knobs”?

“KNOBS”

1. They are the remains of the injection “gates” from the mold.



THEORIES TO TRY

Why we find those “knobs” around the world?

Why so many civilizations used them?

“KNOBS”

2. They were used to move the stones. (But why not all of them have some?)
3. They were steps to climb up the wall for construction.
4. They were made to anchor wooden support during construction.



THEORIES TO TRY

When you finally have your geopolymer recipe ready... how do you do the molds?
(For all those unique shapes)

MOLDING TECHNIQUE

Are the snakes on the walls of Cusco giving us some clues on how to build them?



LET'S START

April 23 / 2022

First I had to make my own NATRON because you can't buy it.

So in a pot I boiled 1L of water and added 500g of table salt + 500g of Baking soda. Mix it and waited until most of the water evaporates.

Then I spread it on a plate to let it dry completely.

Finally when all dried, I crush it and VOILA we have our NATRON salt for the experimentation.

Vous n'avez pas fait de natron, carbonate de soude Na_2CO_3 , mais un mélange de bicarbonate de soude (baking soda) et de sel ClNa , cela ne conduit pas chimiquement au natron.



LET'S START

April 24 / 2022

Why those quantities?

Now I wanted to try some different Sandstone and Andesite geopolimer recipe to find the best one for the experiment.

Since I had no help, I had to watch the video of Joseph Davidovits and his team replicating the Egyptian blocks and estimate the quantity of NATRON + LIME POWDER they used for their Limestone geopolimer recipe.

I estimated:

500L water
10kg NATRON
30kg LIME POWDER
900kg Limestone rubble

So I used this recipe as my starting point. I reduce the quantity of each elements and I then tried different recipes for SANDSTONE and ANDESITE.

SANDSTONE:

50ml water + 1g Natron + 3g LIME + 90g S

50ml water + 1g Natron + 3g LIME + 180g S

20ml water + 3g Natron + 9g LIME + 180g S

ANDESITE:

50ml water + 1g Acid + 3g Guano + 90g A

50ml water + 1g Acid+ 3g Guano + 180g A

20ml water + 3g Acid + 9g Guano+ 180g A

LET'S START

April 25 / 2022

NEW RECIPES

Recipe #3



Right after

30min after

LET'S START

April 26 / 2022

RESULTS + NEW RECIPES

Recipe #3

Samples April 26



LET'S START

April 30 / 2022

I am missing some geopolymer knowledge I think. Because not one samples is rock solid yet... WHAT TO DO NOW?

Changing the focus of the experiment.
Now I will focus on the molding techniques.

LET'S START

May 2 / 2022

Starting the molding techniques experiment

"I have different styles of masonry to replicate and I think they each used a unique technique of molding. So I will try many theories."

THEORY #1 (Sacsayhuaman masonry)

The unique and giant polygonal stones were prepared on the ground and then placed in the same order vertically using "block and tackle" pulley system to create the wall structure.

LET ME EXPLAIN MORE IN DETAILS!!!

*This theory come from Alex Gonzalez. He is an architect from the United-states. He saw I was experimenting so we start chatting a week ago. Having done my school studies in architecture, we immediately connected. Alex has a lot of experience with concrete, physics and engineering on the field so it was a pleasure working with him to make this theory more complete.

Molding on the ground





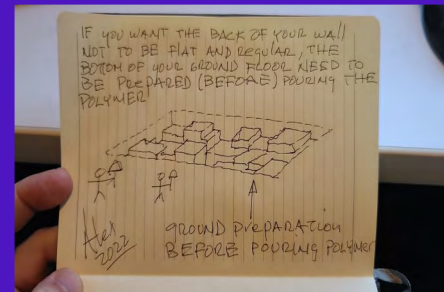
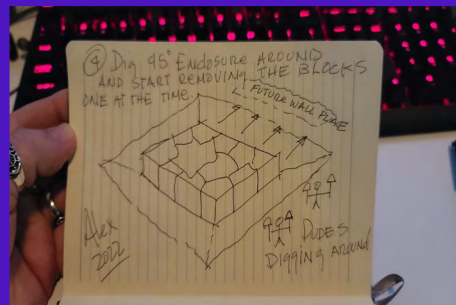
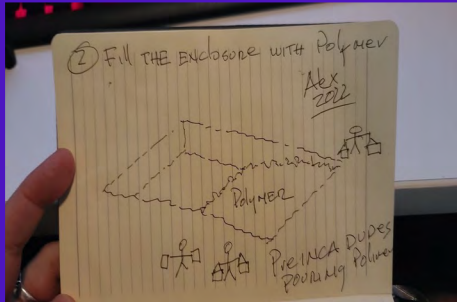
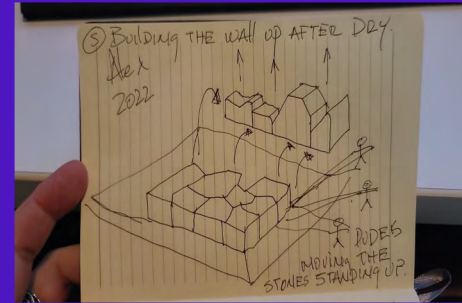
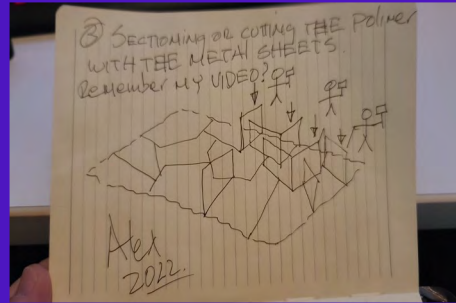
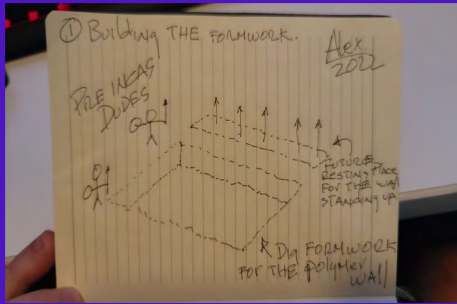
Sacsayhuaman Masonry

LET'S START

Polygonal Megalithic

May 2 / 2022

THEORY #1 (Ground preparation)



<https://youtu.be/C43Qhcd6lx8>

3D mock up made by Alex Gonzalez

Molding experiment #1



Looking good.



**was this the technique
they used?**

LET'S START

Polygonal Megalithic

May 2 / 2022

THEORY #1 (Ground preparation)

Very
interesting
first try!

After removing the molds



After removing the excess



LET'S START

Polygonal Megalithic

May 2 / 2022

THEORY #1 (Ground preparation)



FINAL RESULT:

-The “bubble effect” as been created by the insertion of the metal plates when the geopolymer is semi dry.

-The joints are too large due to my thick cardboard compare to the scale of the experiment and I moved the molds too much.

explanation in large scale

-Can replicate the shapes and we have beautiful straight line + smooth corners like we see.

LET'S START

May 2 / 2022

Starting the molding techniques experiment

“I have different styles of masonry to replicate and I think they each used a unique technique of molding. So I will try many theories.”

THEORY #2 (Sacsayhuaman masonry)

The unique and giant polygonal stones were prepared directly on the wall by very skillful artistic stones masons. Using very simple metal tools to shape and smooth + the perfect consistency of the geopolymer recipe.

LET ME EXPLAIN MORE IN DETAILS!!!

*This theory come from WALLACE. After visiting many temples, I observed that they didn't look for perfection those giant stones. All are uniques with very weird shapes, completely unequal in depth and “3D effect”. I observed that no pattern was followed and I thought it had a more artistic look.



LET'S START

May 2 / 2022

THEORY #2
(Directly on the wall masonry)

THEORY #2 demonstration

-The cardboard represent an incline hill of earth that we just prepared in order to build the wall on it.

-I feel like doing this technique on a larger scale would be even easier for the creation of the stones because my "tools" were not small enough for the details and "smoothing"

-This geopolymers recipe dry/solidify very quickly so we create one recipe, make 1-2-3 stones and make another recipe after. This allow a good flow.



***The geopolymers dry very fast
but still fun to play with.***

LET'S START

Polygonal Megalithic

May 2 / 2022

THEORY #2 (Directly on the wall masonry)

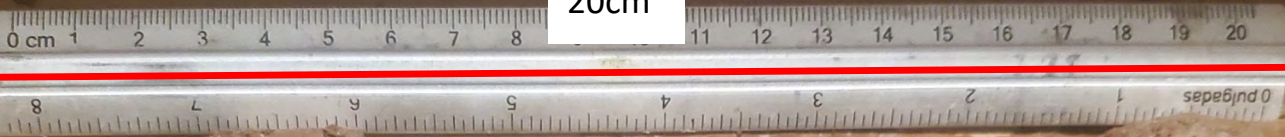
THEORY #2 result



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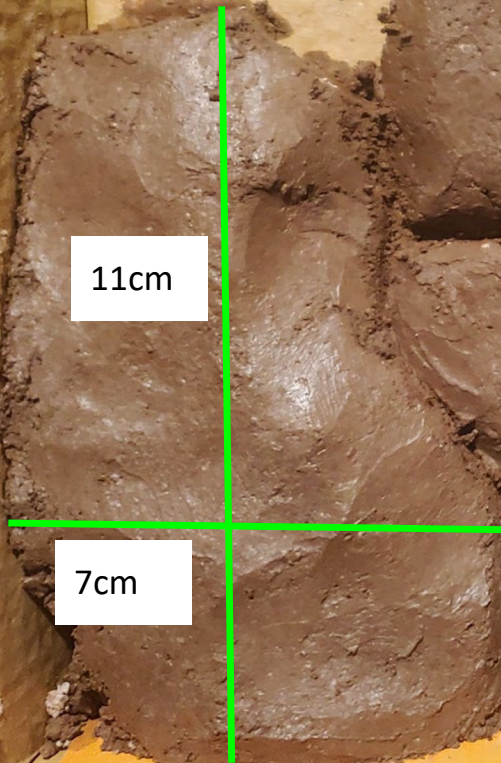
*I think this looks very similar. Can be reproduce on a large scale... BUT... Still doesn't explain the "knobs" :)

20cm



11cm

7cm



LET'S START

May 8 / 2022

THEORY #1

(Ground preparation)

*With metal plates

I still need to improve the recipe and learn more about Geopolymer. The insertion of the metal plates actually create a small "3D effect" that would be more intense on larger scale. The yellow cardboard could be replicated by digging in the ground OR by building wood/metal mold on the ground.



Update from today



This is the best theory so far.

#GEOPOLYMER

LET'S START

Polygonal Megalithic

THEORY #1 (Ground preparation) *With metal plates

May 8 / 2022

*This is another masonry
molding technique*



#YOURBROTHERWALLACE



**Because of density.
Gravity doesn't exist.**





Quick release wood Molding technique

#GEOPOLYMER



LET'S START

Straight rectangle

May 8 / 2022

THEORY #4 (Quick release wood molding)

Unmolding completely



I am using a composite type of wood for the 2 long pieces. This is not good because the oil goes inside the material and this wouldn't be the type of wood that the ancient used.

My recipe needs improvement and bubbles form in the brick so would need better compaction/vibration technique to eliminate them.

Leaving the first 2 bricks to dry longer would allow us to see the joints between the bricks.

This is not the bubble rectangle.

LET'S START

May 12 / 2022

Straight rectangle

THEORY #4
(Quick release wood molding)



♥ CUSCO, PERU

May 12



**First time going for
second level.**

CON Y
FLUOR

CONCLUSION

Final samples



CONCLUSION

Molding technique for
the Megalithic masonry

Metal plates



Cardboard



Metal plates



Freestyle



CONCLUSION

Molding technique for
the Straight rectangle masonry

Freestyle



Wood quick release



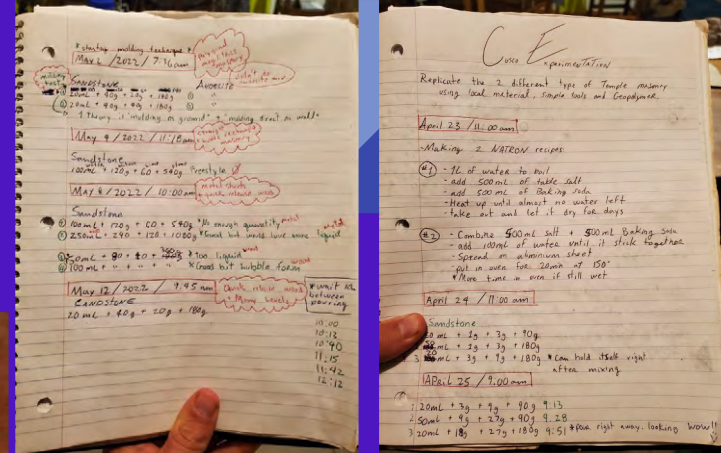
CONCLUSION

Best Sandstone recipe

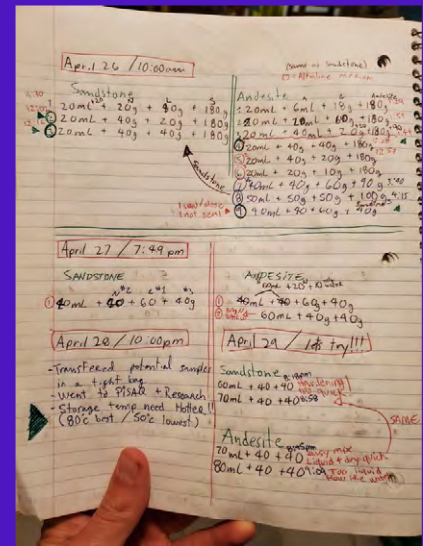
(April 26: 50ml + 20g Natron + 40g Lime + 180g Sandstone)



*The samples that weren't sealed got a lot harder than the sealed ones.



*All my notes during the experiment





WOOD
MAYO 2

FREESTYLE
MAYO 2

METAL
MAYO 3

METAL
MAYO 3

FREESTYLE
MAYO 2

SP2
Ap26
Right After mix

SP2
Ap26
Right After mix



SP2
Ap26
Right After mix

SP2
Ap26
Right After mix

SP2
Ap26
Right After mix

SP2
Ap26
Right After mix

SP2
Ap26
Right After mix

SP2
Ap26
Right After mix

CONCLUSION

#1 I wasn't able to find a good geopolymer recipe and now I know why.


#2 The “ground preparation” theory is by far the best one that can replicate:

-Perfect joints -Bubble effect -Smooth edge -All unique shapes

#3 I wasn't able to replicate the knobs because too small scale, but I still have a theory of their original function

What is next?

LET'S CONTINUE ASKING QUESTIONS AND SCALE UP THE EXPERIMENT!



MERCI
THANK YOU
GRACIAS
SULLPAY
YUUM BO'OTIK
K'AMOJ CHAWE

WALLACE

CUSCO, PERU

April-May 2022



For more knowledge on the ancient sites. Follow
me on youtube at:

WALLACE SPIRIT

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CUSCO, PERU

April-May 2022