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Tiwanaku Masonry

The prehistoric city of Tiwanaku is noted for its impressively consistent and accurate masonry. Ninety degree angles, absolutely flat, smooth planes, and repetitive measurements and patterns make this ancient site unique. From first impressions it would seem that sophisticated technology must have been used to create the city, but as the heyday of Tiwanaku was probably between A.D. 500 and 950, available technology was presumably very limited.

Of the known and possibly relevant Tiwanaku technologies, we have plenty of evidence of stone tool manufacture[1], we know they also cast bronze and gold, therefore they also knew how to smelt ore and heat the metals and stone moulds to extreme temperatures for casting. As they were herders, there is also a good possibility that they could skin animals for leather.

It was my purpose to continue an exploration of probable techniques of stone carving that could have been used to build this city. The guides and new age literature tells the credulous that the stones were cut by lasers using technology from another planet and other far-fetched stories that are leading people astray[2]. In denying authorship to the Tiwanaku craftspeople, they not only disregard an incredible (albeit extinct) culture, but also effectively state that such achievements are impossible without the trappings of technology.

There has been very little research into the methods of the Tiwanaku masons, specifically. For this reason my study of the subject has been frustrating. Needless to say, research on the methods of *other cultures* has been useful for finding research directions, but conversely they may also be misleading. It is, after all, highly improbable that several cultures that were isolated from one another in both time and space actually had anything to do with one another. (It should be noted that there is plenty of dubious research in print on the subject of these unlikely connections!) How likely is it that there was a singular bronze-age 'toolbox' spanning millennia and continents? And if there was such universal knowledge, then why have we 'lost' it? If there are similarities between the techniques of Tiwanaku, Easter Island, Messopotamia and Ancient Egypt, is it not highly likely that any similarities are due to the absolute simplicity of the methods and universal availability of the required 'tools?' I like to think that there was never communication between the Tiwanaku and the Egyptians, and that the only reason we have 'lost' these simple technologies is that we have 'out-technologized' ourselves, reaching sooner for tungsten tipped chisels and diamond cutters than for handy stones lying around in the meadows that we, ourselves, abandoned hundreds of years ago.

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[1] The manufacture of stone tools seems to have been ubiquitous. Evidence indicates that a very large part of society (if not everyone) was involved in knapping stone tools. (**Kolata, Alan** (ed.); *Tiwanaku and its Hinterland: Archaeology and Paleoecology of the Andean Civilisation)*

[2] **Nair, Stella**; *Stone against Stone*, p.72

There have been several studies that reveal the likely contents of the basic 'toolbox'[3]. It is worth noting that most academics involved in this research don't include bronze or copper tools on the list – at least for working hard stone. And it is encouraging that Dr. Jean Pierre Protzen's rediscovery of stone hammers was in the same mountain range as Tiwanaku, and that identical tools have been found in Tiwanaku itself. For such a discovery implies, beyond reasonable doubt, that the Tiwanaku and the Inca shared tools and methods for at least part of their masonry process.

The Inca stone hammers (re)discovered by Protzen make the working of even enormous monoliths possible and there is evidence that they were used in Tiwanaku at least to 'rough out' the Tiwanaku masonry. The idea that this technique might have been more widespread than the Inca is also convincing[4]. But this may be where the connection ends: after all, there are characteristics of Tiwanaku stonework that Dr. Protzen's masonry technique doesn't lend itself to. The regularity and sharp geometry of Tiwanaku is distinctly different from the naturalistic style of the Incas.

Of course, similar studies by Alexei Avranich and Paul Harmon in Costa Rica show that Dr. Protzen's technique can be used for incredibly regular geometry[5]. However, the stone that Avranich and Harmon's team carved was a sphere, and being curved, doesn't address the problems raised by straight lines, flat planes, grooves, incredible regularity of measurements and perfect right angles.

In fact, as far as I can establish, the only useful specific research into the Tiwanaku masonry is the thesis of Stella Nair – 'Stone Against Stone.'

In her paper, Nair attempts to prove that the Tiwanaku people used a similar technique to the Inca, but with some additional techniques to flatten, gouge and cut the stone. To demonstrate these methods, Nair attempts to replicate a typical artefact from the field. Whilst she definitely had a great deal of success, she also came across some frustrations.

Whilst she did demonstrate that stone tools could be used to gouge and roughly flatten the typical andecite stone, she failed to get the smoothness and flatness that the Tiwanaku achieved. It is in this area that I focussed my attention.

I attempted a similar project to Nair's, but without a great deal of success. Having said that, there were some techniques I came across that could be of value. Curiously, I failed in the very same areas that Nair succeeded. In an attempt to 'pick up' from where Nair left off, I attempted to work using a local (Californian) 'close match' in place of andecite. Unfortunately, whilst both rocks looked reasonably similar, the Californian granophire[6] is

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[3] Though these studies have been numerous, they reveal a very limited set of tools.

[4] A tool such as a stone hammer is incredibly basic and it stands to reason that it should be invented and reinvented as is needed by disparate populations. Alexei Avranich and Paul Harmon in Costa Rica, for example use the technique successfully in Costa Rica to research the Mayan masonry. (**Harmon, Paul**; in correspondence)

[5] **Harmon**; ibid.

[6] I was told that this stone was rhyolite by its distributors, but have subsequently found otherwise.

much harder than andecyte, (Moh 7 vs. Moh 6) and is more porphrytic, meaning that it has larger crystal grains in its structure. It isn't especially well suited to the Protzen technique, because the larger crystal grains tend to shatter with impact, leaving pits deeper than the area being worked. Granophire is also so hard that one can only work the stone with very large and heavy pounding stones. And this prevented me from pounding out the narrow mortise I needed to test some of my theories[7].

Nair discussed using fractured obsidian and flint to cut into edges to make sharp angles. I also attempted to use fractured hard stones, although neither obsidian nor flint was available to me at the time of experimentation. As it happens, this technique simply didn't work on the granophire. The tools became blunt whilst the stone showed no noticeable marks.

Surprisingly, the granophire ground flat quite well. In fact, in spite of the hardness of my stone, I suspect I may have had better success with grinding than Nair, and here I may possibly make a valuable contribution to her study.

I started the experiment by flattening a couple of surfaces of the stone with stone hammers. My intention was to grind it flat before cutting a mortise. Once I had achieved an adequate flatness with the hammers, I found that I could grind my stone down with any other flattish rock. I tried using granophire that I had already pounded to a reasonable level of flatness and I also tried using a naturally flat sandstone. The sandstone, though much softer, was more effective, although both minerals did the job.

I worked with the stones both dry and wet. I have no doubt that the wetter the stones were, the faster they would grind down: in fact, when both rocks were fully submerged, I was working faster than ever as the grey rock slurry would wash away quickly, and rather than aid the process (as I originally anticipated,) the slurry appeared to slow it down.

Over the grinding process the stone developed a slight curve over the flat surface. Obviously there's no curve in the Tiwanaku stones, but they are much larger stones, and I suspect that this is an instance where scale matters. (I believe the test I was doing was too small.) With larger stones – typical of those found on the site, this problem should not occur.

In fact the size and flatness of the Tiwanaku masonry raises other issues. If the masons were to use hand held grinding stones, how could they have achieved this level of flatness over such a huge area? The answer to this question, I believe, is in having very large grinding stones. And, I feel quite sure after my experimentation, that some answers lie at the bottom of Lake Titicaca.

I think it is likely that the monoliths 'took turns' in doubling as grinding stones, as both rocks get polished in the process. But to aid the process, it's also probable that the grinding was done in shallow water. Not just would the grinding be facilitated by the

[7] To add to this frustration I was also simultaneously diagnosed with wrist inflammation from the repetitive pounding (not to mention use of crutches,) which meant that all further pounding experiments had to be cancelled.

presence of water, but the monolith's mass would be displaced by the water, making it an easier task overall.

It even occurred to me that the rocks may have been lashed to Totora reed rafts to further displace their mass, but after further research this seems unlikely, to say the very least- a team of archaeologists headed by Paul Harmon is currently researching totora reed boats for the transport of large andicite monoliths from one bank of Titicaca to the other. (Qala Yampu project[8]) They theorise that totora reed boats were used to carry the stones, and that the pathway to Tiwanaku led right through Titicaca. As they succeeded in their demonstration, I proposed to Harmon that the boats may have been used for another purpose also: It was my hypothesis that the reed boats may have been used for more than just transport: I thought it may have been possible that the rock cargo of these reed boats was lashed underneath, rather than stowed aboveboard. I imagines the 'handles' that I have heard so much about, may have been used to lash these stones, and that, if this were the case, then the boats could have buoyed the stones through an underwater grinding process (see fig 1.) Unfortunately, this hypothesis seems improbable because, as far as I know, the handles were not carved into the stones until they were at the site, and that they were impractical for use in transportation[9]: Furthermore, Harmon assures me that the conditions at Titicaca would make a stone on the underneath of the hull a real liability, as seas are often big and the winds strong[10].

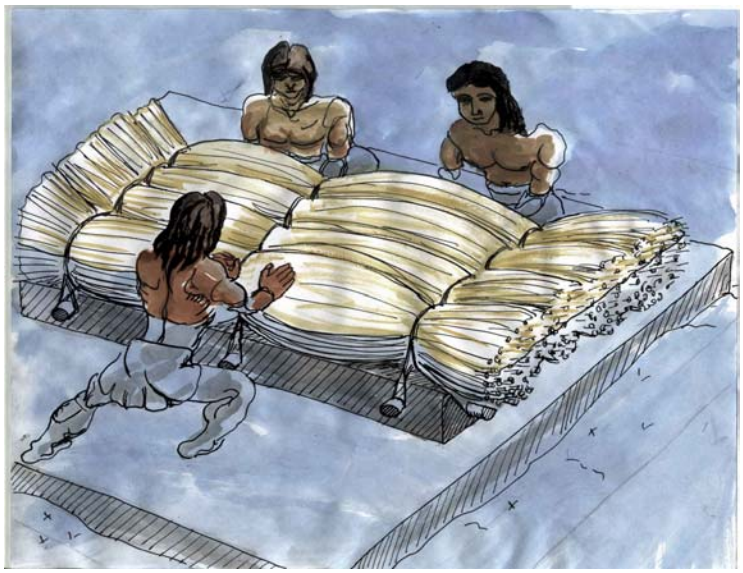

Fig 1

There are apparently huge Andecite stones in the shallows beneath the surface of Lake Tiwanaku.[11] Known as 'tired stones,' or 'piedras cansadas,' it is generally assumed that these rocks were on their way to Tiwanaku but never made it. Is it possible that some of

[8] **Harmon, Paul** and **Vranich, Alexei;** *www.reedboat.org*, **Knutson, Chris;** *The Use Of Totora Reed Boats In The Transport Of Monoliths To Tiwanaku*.
[9] **Alex**, *The Rock Files, 2003*
[10] **Harmon, Paul** (in correspondence)
[11] ibid.

these were deliberately placed there and used temporarily as grinding stones, before before they were refined further and eventually used in the construction of the city? I should add here that I discovered that any flatish stones will work as grinding stones, but andecite looks especially useful[12].

I would love to see these stones and look for evidence of grinding on either the underside or above. If my theory is correct, then a smooth lower face (deliberately ground rather than streaked, because of dragging) would indicate that the stone was accidentally drowned, but a polished upper face could indicate that the submerged stone was probably used in situ.

The sample stone from the field, lent to me by Dr. Protzen, lends evidence to this theory. One face is highly polished, and the other is still heavily pitted.

Obviously only a more thorough knowledge of the site and the stones of the Titicaca shallows could demonstrate this theory more adequately. Unfortunately I couldn't locate any thorough catalogue of these stones that wasn't in Spanish or German, so my efforts in this area were thwarted.

Another area that frustrated Nair was the pattern she used for accuracy, which she had to repaint with gesso regularly throughout the carving process. She guessed that the pattern was printed onto the rock surface with a carved template. And she became frustrated, because her paint ran under the edge of the template giving an inaccurate line[13]. Though this problem is obviously surmountable, she also had other problems with the edges: She also sometimes worked too close to her edges, accidentally breaking them[14].

To get around this problem I glued a leather template to the already smooth stone, using animal skin size. This worked beautifully as a template and also protected the delicate edges of the pattern very well. Although I was using a very large pounding stone, and even the granophire I was carving was very hard, I still did not damage the edges of my stone, as Nair had. As the Tiwanaku people evidently did herd deer and Llamas, it's not unreasonable to assume that hide was available, as was the size (bones, tendons and skin soup!) We also have evidence that hide was used in the region, albeit by the Incas, hundreds of years later[15].

The leather I used was quite well tanned and soft, but I could imagine a thicker, harder leather being used repetitively over several stones, thereby guaranteeing a high level of consistency in manufacture, which is one of the staggering features of the Tiwanaku site.

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[12] Unfortunately I had no samples that I could experiment with, but andecite has a sandy texture with excellent hardness. As the surface or the grinding stone would become too smooth to use as a grinder, it would be ready to use as masonry.

[13] Nair, Ibid. p.31

[14] Ibid.

[15] **Protzen,** *Inca Architecture and construction at Ollantaytambo*, p.179 (I have been unable to find any archaeological evidence of hide use by the Tiwanaku specifically.)

Other areas I wished to explore included the cutting and drilling techniques that there is some evidence for, but as Nair points out, those techniques don't appear to have been used for the stone carving, but for other tasks (such as gold inlay) The incomplete Kantatallita stone shows as much[16].

There are many other areas of study in this subject that interest me, but I have found it very frustrating working with little or no direct evidence, ploughing through reams of fanciful material, or books written in languages I don't understand, not to mention the trials of experimental archaeology, when I also had to deal with my own very significant physical disabilities. But even those frustrations are merely just the beginning. The site has been so spoiled by academics 'with the best intentions' and by centuries of looting, that the very fabric of the site is so fractured it's really hard to draw any firm conclusions from the physical evidence. Looting has been so extreme, that one academic writes of the 'tired stones,' concluding that it's impossible to say whether they were travelling to or from Tiwanaku[17]. In addition, the Bolivian government has a reputation for obstreperous interference with any such research.

Areas that beg for greater understanding abound, but alas, it is unlikely that anyone will ever get an absolutely clear picture of the architectural practices of the Tiwanaku. Even with the first Western contact the Tiwanaku were already extinct, described only in Inca legends. Time and change muddy the picture more every day. There is so much more to learn – an area that interests me, for example, is to pursue Nair's exploration of the stone chisels and cutters. But even with access to the site – would complete, uncontestable research ever be possible? Petrie argues (in his case for the cut granite in Egypt) that beryl, topaz, chrysoberyl, condinum, sapphire and diamonds were the only stones hard enough to cut Egyptian granite effectively[18]. While Nair was successful cutting andecite with flint and obsidian, and chiselling with greywhakes, it is possible that beryls such as emerald were used by the Tiwanaku, as the Andes is a known and relatively abundant source for the crystal, (examples have been found up to 5 meters long!) But stones such as emeralds were given a new value after the arrival of Christopher Columbus, and became commodities rather than hard stones that could potentially be used as tools. Moreover, archaeological evidence pointing to possibilities such as this would presumably have been looted with the gold inlays, in the recent centuries. Obviously this suggestion that they used emeralds as tools is pure speculation, and is probably absurd, but even if the site were more accessible, there is no doubt that the world has changed, and aspects of the lives and crafts of the ancient Tiwanaku will remain a mystery, always.

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[16] op.cit. Nair; p. 117
[17] Harmon; Ibid
[18] Petrie, *The Pyramids and Temples of Gizeh*

Bibliography

I read through a lot of books and papers on related subjects, but most of these are either unreliable in their evidence or have little to say about the specifics I discuss here. I have chosen, therefore, to exclude these works from this bibliography.

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