

JACKETING THE DESERT SANDS

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Abstract

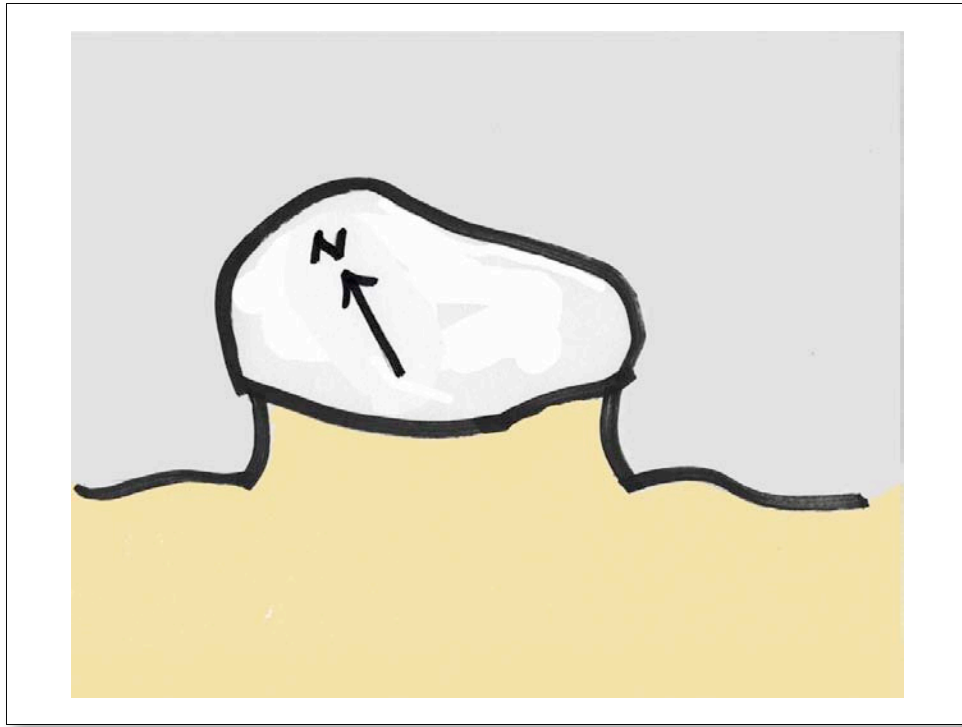
In December of 2007, a team from the Yale Peabody Museum of Natural History traveled to Abu Dhabi, United Arab Emirates, to work in conjunction with the Abu Dhabi Authority for Culture and Heritage. The team prospected in Miocene age deposits of the Baynunah Formation along the Persian Gulf coast, and discovered and excavated specimens that included an elephantid jaw and a partial ratite, while a crocodylian skeleton remains for future excavation. While Abu Dhabi is truly a sand desert, coastal sites are quite humid, slowing plaster drying times significantly. The excavation of bone that was fractured apart by evaporites and weathering, lying in soft and loose sand, presented several issues that were considerably different from those presented by the more usual siltstones or mudstones. The typical pedestal method for jacketing is less than successful in such sand, because the partially capped jackets usually slump prior to flipping. One answer is to heavily consolidate the specimen and surrounding sand, but again, due to the humidity, consolidant drying time is slowed. Overzealous consolidation in the field, furthermore, creates later challenges to preparation. Butvar B76 or PVA B15 in acetone, as less viscous consolidants, proved to be more appropriate than thin Paraloid B72 in acetone, while an attempt to use Aquazol 200 in water proved ineffective. Another technique is to jacket far more of the matrix than is needed for the stability of the specimen and cut away the extraneous plaster and matrix after the jacket is flipped over. This paper will discuss some of the logistics involved with this and other international fieldwork, as well as considerations of methods and materials for consolidation and excavation of fragile specimens in loose sands.



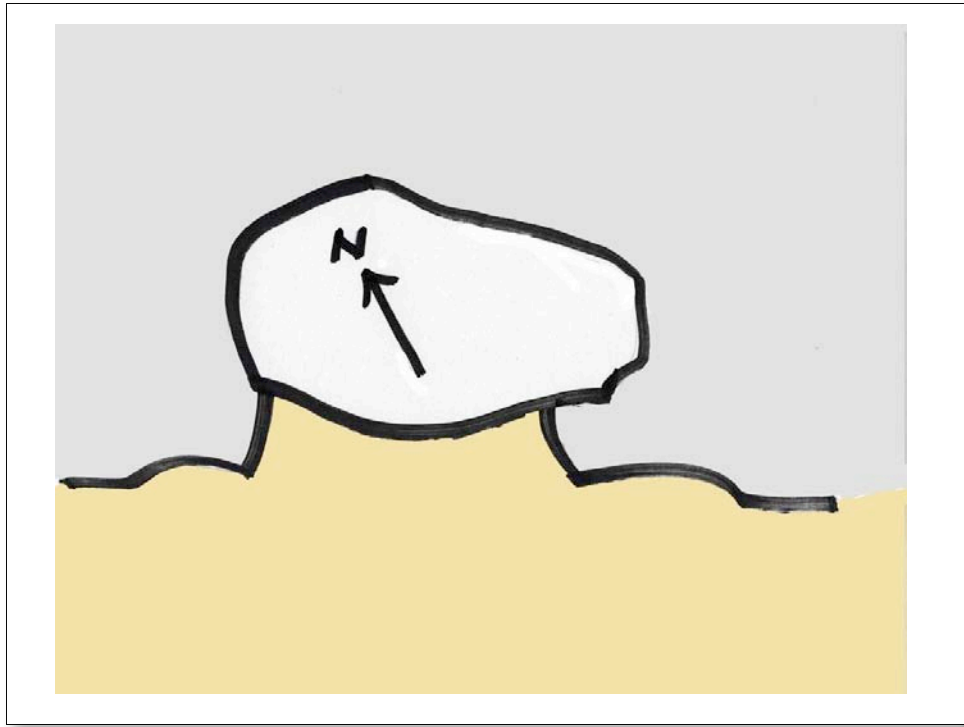
A typical prospecting scene in Abu Dhabi

In December of 2007, I accompanied Faysal Bibi, a Yale graduate student and Walter Joyce, Peabody Collections Manager, to Abu Dhabi. I was there primarily to help with the collection of a raitite synsacrum discovered by Faysal about four years previously. We were working with Dr. Mark Beech from the Abu Dhabi Authority for Culture and Heritage (ADACH). Yale Professors Andrew Hill and David Evans, and another Geo grad student Dan Peppe formed a second team to the trip.

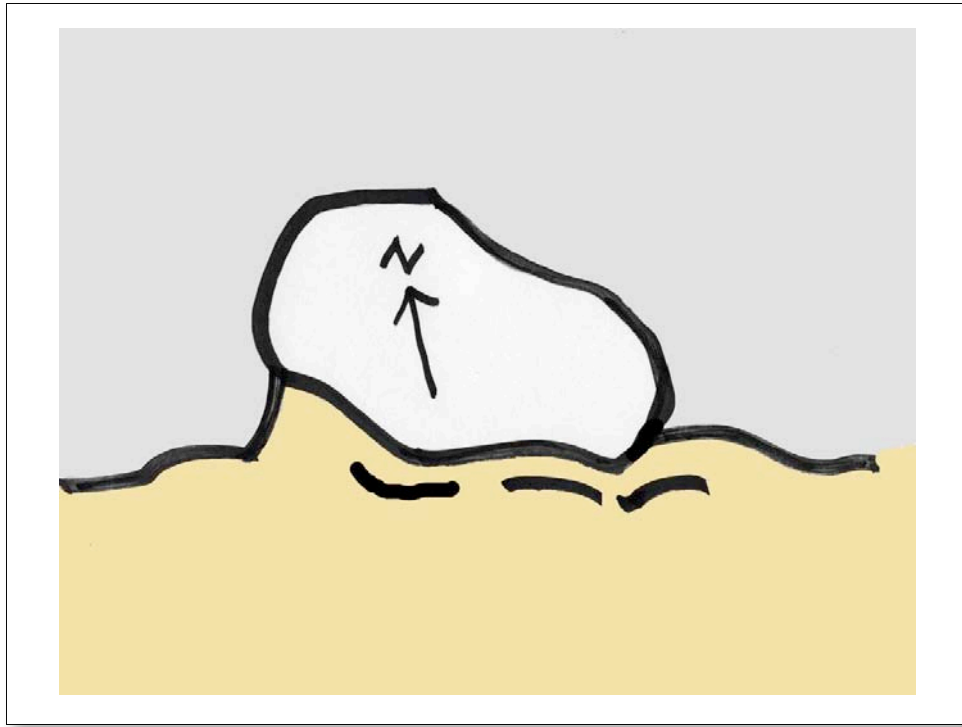
This is really a talk about how preconceived notions may not serve you very well when you go to new locations. I thought I'd divide this talk into two parts - my first trip to Abu Dhabi, problems that arose and how I dealt with them at that time. The second part will include a report on the second trip in December of 2008, and adhesive and other tests performed to improve my ability to work in these locations, as well as notes on logistics.



This was one of my most frustrating problems. I didn't actually get any pictures of a jacket falling over. But basically it was a lesson to me in not making assumptions that all collecting events will happen as planned. I've usually worked in places where there are harder and more consolidated mudstones or siltstones. These have some cohesion and you can excavate accordingly. The problem here was that this was really like digging at the beach. I could start normally, excavate down a bit and begin the top of the jacket.



The sand would stay together for a while and I could begin undercutting as normal.



Then without warning the pedestal would give way dramatically and the whole thing would slump over. It's always a matter of speed and timing to successfully flip a jacket, so this falling over was really rather a problem for me.



As I mentioned in the abstract, one way around this is to include more matrix around the specimen than would normally be desired. This extraneous matrix can be jacketed. The extra matrix can be removed and jacket cut away after the jacket has been flipped.



On smaller jackets this worked pretty well, a sort of pancake flipping procedure. But it would only work with smaller jackets or for well-preserved single bones of medium size. It would not work for a large or disarticulated specimen.



It wouldn't work with this mandible of an elephantid. You'll notice the puzzling whitish crust.



This was actually the remainder of a plaster bandage wrapping that was done in 1991. You'll note the green tube from the inside of the plaster bandage roll. One thing to note is that while the plaster remains, the gauze has completely degraded. Plaster bandage does not hold up that well over time.



Because the specimen was already lying at an angle in the bed I was worried to begin with about it slumping before I was prepared to turn over the jacket.



Particularly as there were some pretty fractured teeth inside the jaw. The jaw needed to be pretty completely wrapped before flipping was attempted.



So I used some sticks to support it and keep it from rolling while the jacket was completed. This has led me to a solution for the problem that was still awaiting me in December of 2008.



This is a pretty disarticulated but still rather complete crocodile. Crocs are known from this area, but mainly from isolated elements, so we thought it would be useful to collect this.

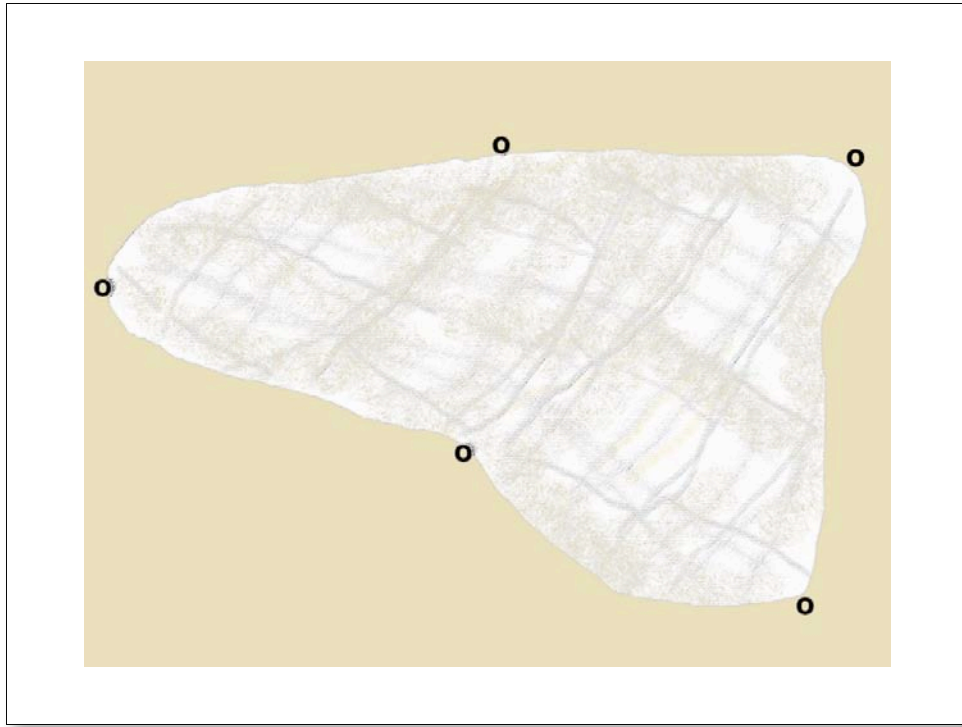


The bone is not really infilled at all, so the specimen is very broken and fragile. Because of the disarticulation and fragility of the bone this is a specimen where it will really matter if it slumps while being jacketed. In fact, I could probably count on the whole thing falling out of the jacket if the plaster wasn't thoroughly wrapped around the bottom of the specimen before it was flipped over. It's not going to be effective to make a bigger excavation and include more matrix. And although the specimen was consolidated prior to capping with a temporary "winter" jacket, I doubt if that consolidation will be enough to keep it together.

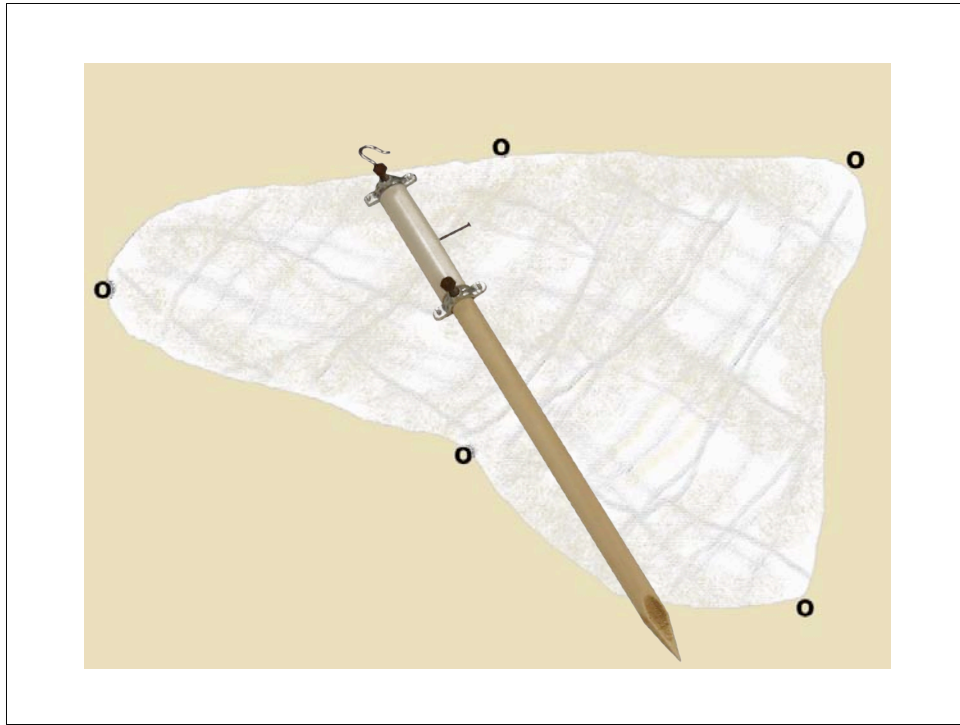
I pondered this for almost a year, while, hopefully, the specimen remained safe under its winter jacket. And I came up with a plan.



To start everything will proceed normally. After the edges of the specimen are delineated and the sediment cut down about 6-8", a coat of plaster and either burlap or AC filter media (if I can either compress it enough to carry it or purchase it there) will be used to cover the entire specimen.



PVC pipe pieces cut about 6" long will be attached with plaster and burlap at about 4-6 places around the specimen.



Through these collars I plan to drive stakes, 2-3 feet deep into the sand, in effect making legs for the specimen. Pipe clamps or nails driven into the stake will prevent up and down movement. In this way I can safely undercut the specimen bit by bit, wrapping it as I go, and the specimen will be held from tipping. Once the jacket is complete enough to keep the sand from falling out when the jacket is flipped the legs can be easily removed, by pulling them back up through the collars. This is probably a wheel that has already been invented, but I think it'll work for this project.



Report from Field Season 2008



Report from Abu Dhabi field season, December 2008. We returned to the site where the crocodile was winter jacketed and re-buried last year. All was intact, a worry since the area, adjacent to the shore, is used by local people on ATVs.



We were able to remove some parts of the total specimen in small jackets, reducing the size of the block. This was important because it was necessary to wrap the jacket underneath almost the whole specimen before attempting to flip it over.



With the aid of ADACH conservator Ibrahim K. Lababidi and archeologist Mohammed Mater al Adhere, we used the stakes discussed at the 2008 SVP meeting. After an initial toilet paper and plaster bandage inner jacket, the stakes were driven into the sand at the edge of the jacket. The lower locking clamps were slid onto the stake and locked, the collars were then slid down and firmly attached onto the jacket with plaster and burlap. The top section of the jacket was then completed with plaster and burlap, including two sticks for extra support. The jacket was then gradually undercut and covered, using strips of plaster bandage. It was important that the undercutting not be at an angle to the plane of the jacket as this would have allowed the sand to sift out and not have closed in the jacket from below.



These photos show the legs just prior to flipping the jacket. As you can see the legs supported the jacket, allowing the block to be undercut and plastered without allowing the block to slump. The top locking clamp was loosened and removed before the jacket was lifted. I will note that the legs could have been driven deeper into the sand. The jacket was pulled up off the legs, and while that was not difficult, it would have been easier if the tops of the stakes were close to the tops of the collars.



The completed jacket, flipped over, with plaster, burlap and additional sticks on the second side. The collars could be cut off but this is not necessary. Much of the plaster bandage that was used to cover the specimen from below was cut away. This does waste some plaster bandage but it is a necessary waste.

I am really happy with the way this method worked and will use it again in any similar situation. I am confident that this specimen could not have been collected without this support.

Consolidant



I tend not to favor consolidation in the field unless absolutely needed, it only makes preparation more complicated. But these specimens tended to be rather fragmented, so some consolidation was necessary. In 2008, I brought a selection of adhesives - Paraloid B-72, PVA B-15, Butvar B-76 and an adhesive that I've been playing with called Aquazol 200.

Basically, I wanted to use the weakest adhesive, one that was only strong enough to hold the specimen together while it was being excavated, but one that could be easily removed in the lab, preferably mechanically and not by dissolution. I did, however, want a consolidant that would remain soluble in either acetone or ethanol. My feeling in the field was that PVA B-15 and Butvar B-76 were preferable, while Paraloid B-72 was too strong and Aquazol was ineffective.

Consolidant tests



I thought I'd try to illustrate why I believe that PVA B-15 (Vinac) and Butvar B-76 are preferable as field adhesives. I did a series of samples on three different sands that I had in the lab, sand from Abu Dhabi, Montana and Mongolia. The results were interesting, and not always what I expected.

I set these up as small forms made of screening with a filter paper on the bottom. I wanted the consolidant to flow completely through and penetrate the sand, without contaminating the sample with the supporting sand below. I wet each sample completely with water and then allowed the samples to completely dry. Sand in the lab is loose sand removed from prepared specimens. I wanted, as much as possible, to recreate sand as it might be in the field, where it has some cohesion from exposure to weather. These are the samples after drying and prior to adhesives being added. The sand from Mongolia and Montana appear as expected, hard little bricks. The Abu Dhabi sand however behaved differently.



It expanded rather than compressing and formed these crystals. They seem to be saline crystals, and I'll discuss that further later.



I mixed the adhesive at 5% by volume in acetone. I began by mixing the adhesives in acetone at 5% by weight. But because Butvar B-76 is much lighter than the other adhesives this resulted in an uneven consistency to the mixtures. Therefore, I chose to mix it by volume rather than by weight. I hoped that a volume ratio would more closely represent an equal amount of adhesive to solvent with all four adhesives. I even broke up the beads of B-72 to make a more consistent volume.

I chose a weak dilution of 5% because as I said before I wanted the weakest useful consolidant.

I poured 100ml of consolidant onto each sample, saturating it completely, until the consolidant flowed out of the block. This was allowed to dry completely. Of course, in the field that might not happen, we all know that we can't wait a day or so for consolidant to completely dry.

Paraloid B-72



After the consolidant had dried I opened the wire baskets and examined the consolidated blocks. Then I broke each one as a quick test of its strength and ability to hold together.

Paraloid B-72. At least at this dilution it was too weak and the evaporation of the acetone pulled the adhesive noticeably to the top of the block. This was especially noticed on the Abu Dhabi sand, perhaps because it was looser to being with. But even with the sand from Montana and Mongolia the consolidant was pulled to the top of the block. In the lab I have used B-72 at greater concentrations, 10 or 15%. At that dilution it seemed to me to be too strong as a consolidant, it is often necessary to soften the adhesive with acetone or ethanol in order to proceed with preparation.

Butvar B-76



Butvar B-76 on the other hand made nice sturdy blocks with all the samples, yet the samples were not so hard that the matrix would be difficult to remove.

PVA B-15 (Vinac)



PVA B-15 also made good blocks, and again was not so hard that the matrix would be difficult to remove, even without the use of solvents to re-wet the adhesive.

Aquazol 200



This adhesive is interesting to me because it's soluble in water, alcohol and acetone and it's a very weak adhesive. At least at this dilution, it's actually much too weak. As with the B-72 the adhesive was pulled back to the surface by the evaporation of acetone from the block. The Abu Dhabi sand was also very fragile and crumbled easily.

Of course trying varying concentrations of acetone and adhesive could be interesting, but until I do that Butvar B-76 or PVA B-15 will be my field consolidants, while Paraloid B-72 will remain my adhesive of choice. Aquazol, while I've had success with it as a bulked adhesive for gap filling, probably won't be going with me in the field.

It was mentioned to me that it might be possible that the sand filtered out the Paraloid and Aquazol rather than the adhesive being pulled back to the surface through evaporation of the solvent. This is an intriguing idea and needs to be explored further.



Salt



As I said the sites we were visiting were along the coast. Some of the sites were about 20 meters above the sea. And some were not far from areas known as sabkha, an Arabic name for a salt-flat. They are flat and very saline areas of sand or silt lying just above the water-table.

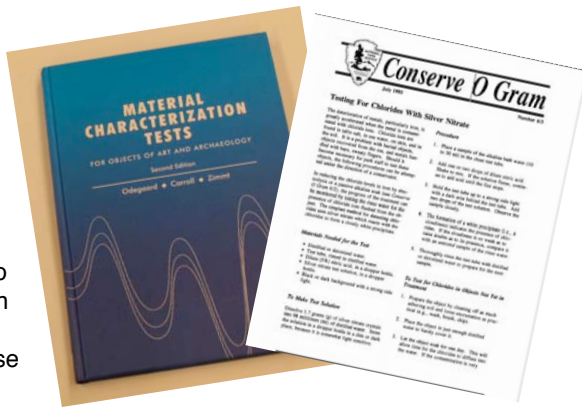


To make sure that these crystals were indeed saline crystals I decided to perform a simple test for chloride ions. Chloride ions are found in table salt, and in sea water. The test was performed only on the sand from Abu Dhabi, not on bone. I think one could safely assume that if salts were evidently present in this sand test, the salts would also have migrated into the bone. It should be noted that the annual rainfall in these areas of Abu Dhabi is about 3 inches, so it unlikely that these sands would ever be soaked with water as they were in my adhesive tests.

Salts within fossils can cause extreme degradation if the humidity and temperature in which the specimens are stored is not controlled. High humidity can cause the salts to react and expand, as seen in the consolidant sample. Unintuitively, though, high temperatures can have the same effect. The humidity in December was about 70%. Daytime temperatures can range from the 60's to over 100. This means that for the best preservation all fossils collected should be stored in a humidity and temperature controlled storage space.

Silver Nitrate Test Procedure

1. Place the sample in deionized water. In this case 10gm of sand.
2. Let the object soak for one day. This will allow time for the chlorides to diffuse into the water. If the contamination is very great, a detectable amount of chlorides can diffuse in minutes.
3. Place a sample of the alkaline bath water (10 to 30 ml) in a clean test tube.
4. Add one or two drops of dilute nitric acid. Shake to mix. If the solution fizzes, continue to add acid until the fizz stops.
5. Hold the test tube up to a strong side light with a dark area behind the test tube. Add two drops of the silver nitrate solution. Observe the sample closely.

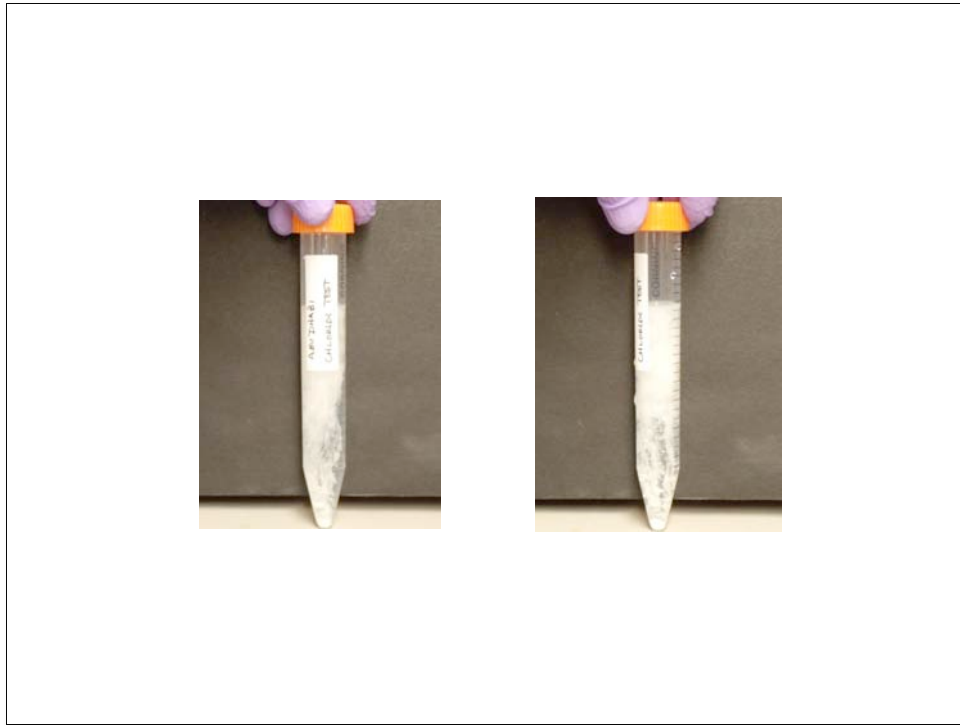


My procedure was adapted from these two publications. Chloride ions are dissolved and acidified in a solution of nitric acid and then reacted with silver nitrate. I used a purchased pre-prepared silver nitrate solution. If chloride ions are present the silver nitrate will form silver chloride, a white precipitate.

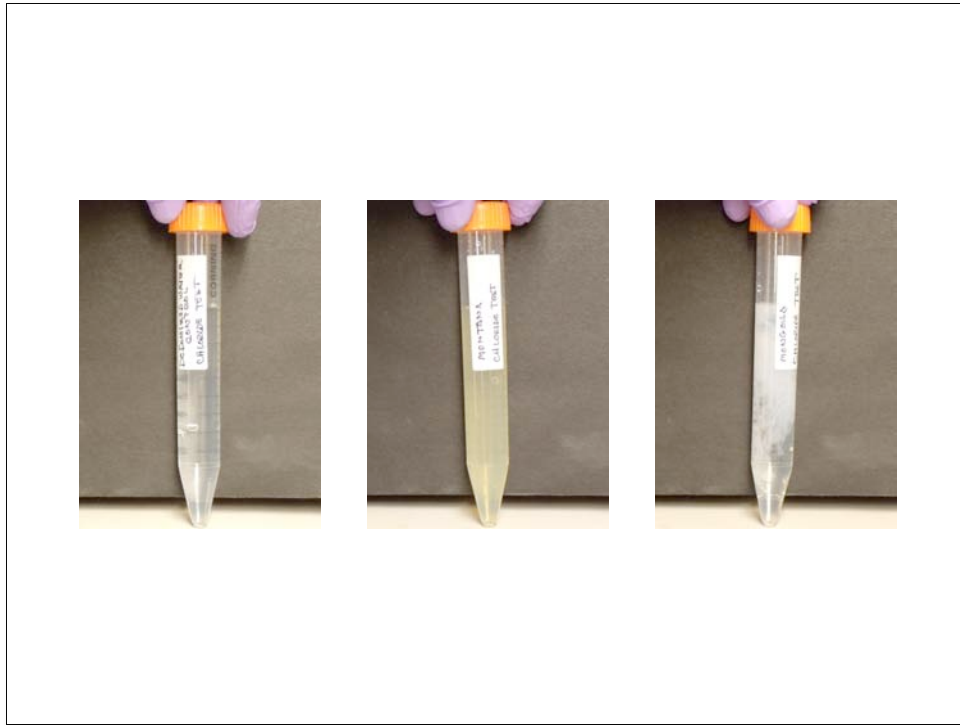


Samples were produced by adding 10 grams of sand to 100ml of deionized water . The samples were mixed and allowed to settle so that floating particulates would not interfere with the test. I decided to try this test on sand from Montana and Mongolia for comparison with the sand from Abu Dhabi. The test was also performed on plain deionized water as a control.

10ml of the sample was removed by pipette for testing and placed in clean test tubes.



As expected the sample with sand from Abu Dhabi clearly formed a white precipitate, indicating the presence of chloride ions. A taste test of the same deionized water/Abu Dhabi sand sample prior to the chloride test had a strong salt flavor as well.



The deionized water showed no change, the same was true of the sand from Montana (the yellowish cast was present in the sample before testing) However, the sample from Mongolia also showed the presence of chloride ions. I can't account for this result. It might warrant further exploration.



Local suppliers



One of the ever present issues with doing fieldwork anywhere but near your home base is obtaining supplies. Some supplies, like acetone, are impossible to take on airplanes and can be impossible to obtain in small towns even in the US. Other materials, like plaster, can be of varying quality in other countries and it's difficult to carry enough to make more than a couple of small jackets. We were extremely lucky to find local shops that carried not only plaster, but burlap, tools, buckets, and other supplies. When working in the US, I always obtain acetone at the largest town en route, here we were able to obtain it from a taxidermy facility.

Using local supplies



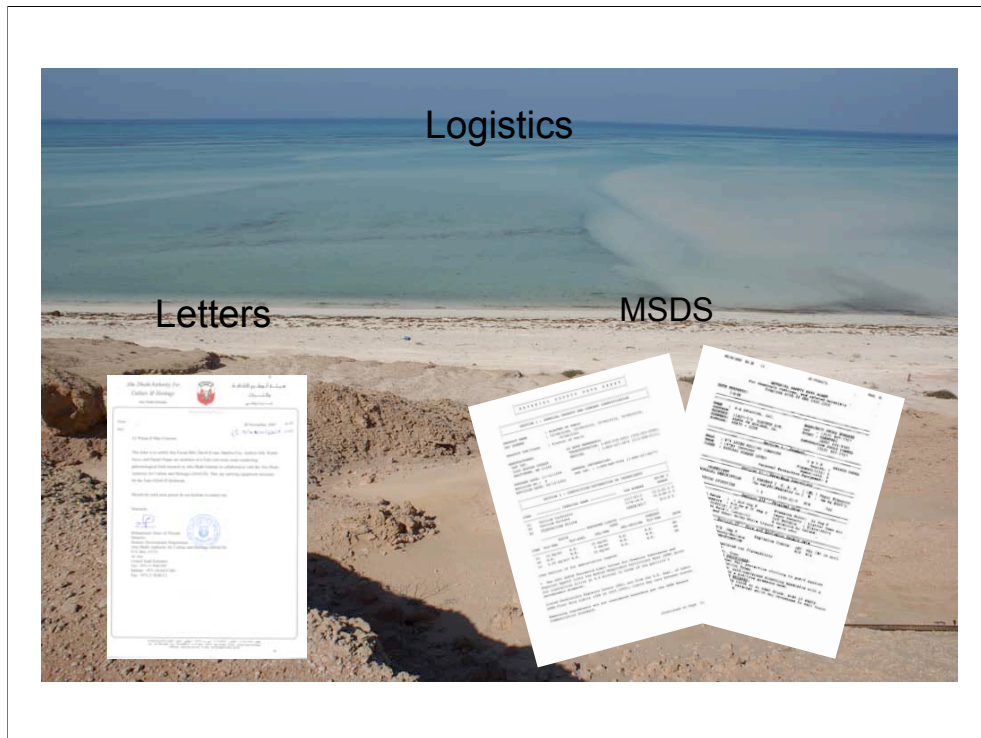
One of my tasks was to make molds of elephant and antelope trackways. Latex #74 rubber was brought from the US, but other supplies were purchased locally, including dish soap and talc as separators, and local burlap and plaster for jackets.



While the local dish soap was a bright yellow and the talc quite perfumey, both worked well as separators for the latex.



We found a supply of local burlap. Burlap is getting more difficult to find in the US, as it can be usually only be purchased from a landscaping supply, a supplier not often seen in most small towns. After a quick test to make sure it would work properly and be strong enough we were able to use local plaster for jackets.



Even within the US, flying with paleontological preparation materials and tools can be an issue. I've adopted a few methods that help me to get through airport security with as few problems as possible.

When traveling internationally I always try to have a letter, in the language of that country if possible, stating that I am there on official business. I carry copies of this letter with me, and also put one in my luggage and in each container of materials that will be carried as baggage.

Letters should also be obtained, as well as all appropriately signed permits for any material carried out of the country. I brought back some sand samples, and had a letter to the effect that they were geological samples for research.

I always include a packing list, and MSDS for any suspicious-looking product, no matter how innocuous, especially white powdery substances like plaster and Butvar. These will also be shipped within an original, unopened container, if possible. This might be a good reason for taking PVA B-15 rather than Butvar, as the beads are less like a white powder than Butvar.

Packing



Any container used to pack materials or tools should be easy to open and reclose. Straps placed around containers should also be easily removed and replaced. Luggage straps, made to be easily opened for inspection may be a good choice. Small items should be enclosed in smaller containers that are also easy to open and reclose. If these internal containers are clear it will help security officers see that the contents are not dangerous.

Acknowledgements

I'd like to thank Jacques Gauthier, the ADACH-Yale Project, directed by Professor Andrew Hill (Department of Anthropology & Yale Peabody Museum) and PhD student Faysal Bibi (Yale Department of Geology & Geophysics) for giving me the opportunity to work in Abu Dhabi.

I'd also like to thank Dr Mark Beech of the Abu Dhabi Authority for Cultural Heritage (ADACH) (Head of Division: Cultural Landscapes) especially, for his great assistance and for providing us with new ways to say burlap. Members of ADACH's Historic Environment Department Dr Walid Yasin (Head of Division: Archaeology), and Ali El-Meqbali (Archaeologist) joined us in 2007. Drs. Yasin, and Beech rejoined us in 2008, and as well as Ibrahim K. Lababidi (ADACH Conservator), Mohammed Mater al Adhere (Archaeologist).

The 2007 field team also included Walter Joyce (Collections Manager), of the Division of Vertebrate Paleontology of the Yale Peabody Museum of Natural History, Professor Ali Haidar, a geologist from the American University of Beirut, Lebanon. Professor David Evans and PhD student Daniel Peppe, of the Yale Department of Geology & Geophysics, participated in the second half of the trip.

I'd also like to thank Alana Gishlick for her many helpful ideas during discussions held on the way back from the field this fall, and Vicki Fitzgerald for drawing a slumping jacket.

For further information on the Miocene Vertebrates From the Emirate Of Abu Dhabi, United Arab Emirates Project of Andrew Hill and Peter Whybrow, see: <http://www.adias-uae.com/fossils/index.html>

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