

## A TECHNIQUE TO CREATE FORM-FITTED, PADDED PLASTER JACKETS FOR CONSERVING VERTEBRATE FOSSIL SPECIMENS

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### ABSTRACT

In many cases, vertebrate fossils lying on storage shelves are in danger of falling to pieces - whether it is from ancient glues and hardeners, ambient vibration, or handling. Many methods have been tried to reduce the wear and tear on specimens, though few seem to fully protect them. The Smithsonian Institution has developed a multi-step process of protecting fossil vertebrates with foam-padded, plaster jackets made of hydrocal gypsum cement, surmat fiberglass cloth, and ethafoam padding. Custom-fit, two-piece jackets with handles and feet on both sides that bolt together are created to fully encase the specimens. These enable a person to lift off a side, fully examine one side of even the most delicate specimen, and then flip it over to examine the other side. This eliminates excessive handling, and reduces the chances for breakage. An active program has been implemented to jacket all of the Smithsonian's vertebrate paleo specimens. So far, many of the titanotheres skulls, toothed and baleen whale skulls, *Plesippus* skulls, *Teleoceros* skulls, turtle shells and sauropod bones have been jacketed. Many jacketed bones have already been safely shipped to our Museum Support Center storage facility in Suitland, Maryland, with more of the collections targeted for jacketing and relocation.

### RESUMO

Em muitos casos os fósseis de vertebrados armazenados encontram-se em perigo de deterioração, quer seja devido a antigas colagens e restaurações, manuseamento, ou à vibração ambiental. Existem muitas formas de tentar reduzir a utilização e a danificação de espécimes, no entanto, são poucos os métodos que os conseguem proteger totalmente. O Smithsonian Institution desenvolveu um processo de protecção de fósseis de vertebrados com casacos feitos de gesso, tela de fibra de vidro e reforçado com espuma de poliuretano. O revestimento é composto por duas peças com pegas em ambos os lados que, quando aparafusadas, envolvem totalmente o espécimen. Isto permite que se possa virá-lo e examinar de ambos os lados, mesmo nos espécimes mais delicados. Assim, elimina-se o manuseamento excessivo e reduzem-se quaisquer outros riscos.

Foi implementado um programa de forma a revestir todos os espécimes de vertebrados do Smithsonian Institution. Até agora muitos dos crânios de titanotheres, cetáceos, *Plesippus*, *Teleoceros*, carapaças de tartarugas e ossos de saurópodes encontram-se protegidos. Muitos ossos revestidos foram enviados para o nosso armazém (Museum Support Center) em Suitland, Maryland, juntamente com outras peças das colecções destinadas a serem revestidas e recolocadas.

## INTRODUCTION

Many fossil vertebrate specimens are at risk of deterioration over the course of time. Among the causes of this common problem are the deterioration of old consolidants and adhesives, inadequate support for the weight of the specimen, ambient building vibrations, and the handling of the bones by staff and researchers. (Figure 1) Though there are few papers written on this subject, the many versions of support



Figure 1: Failure of an ancient plaster bond on a sauropod tibia lying on inadequate support in the collections.

systems found in research collections can be studied and further improved upon. For instance, those that incorporate wood or burlap do not meet current safety standards because of the combustibility of their components. Non-archival foams will off-gas and break down into a pile of dust. Lining a jacket or cradle with latex rubber as a protective surface may have seemed like a good idea at the time, but the specimen will eventually adhere to rubber, causing problems when the jacket is removed. Also, the latex rubber eventually breaks down, off-gasses and turns brittle. Some plaster jackets are lined with plastic or foil, which do not provide an adequate cushion on which the specimen rests. Some are loose fitting and do not offer 100% support, or are made of soft plaster that easily breaks and leaves white streaks on shelf if it is moved. The list goes on.

## DISCUSSION

The Smithsonian Institution's National Museum of Natural History (NMNH) has developed a multi-step procedure to construct two-sided, padded jackets to fully protect and hold fragile vertebrate fossils. The process is similar to that described by Dan Chaney (1992), but with some modifications. In general, hydrocal gypsum cement, surmat fiberglass cloth, and ethafoam

padding are used to create two-sided jackets that bolt together to fully encase the specimens. Handles and feet on either side of the jacket enable a person to lift off a side, fully examine one side of even the most delicate specimen, recap it and then flip it over to examine the other side. This eliminates excessive handling while the jacket uniformly supports the specimen and reduces the chances for breakage. The technique has enabled NMNH to repair and jacket many vertebrate fossils in our collections, and all newly prepared specimens automatically get a jacket.

When a specimen is to be jacketed, the first step is to conserve it through cleansing, consolidation, and restoration as much as possible. Broken specimens also need to be repaired. (Figures 02, 03) Cleaning can be done just with a dry brush and compressed air or in combina-



Figure 2: The broken carapace of *Amyda* cf. *aequa*, a soft-shelled Eocene turtle collected in 1930 by George Sternberg

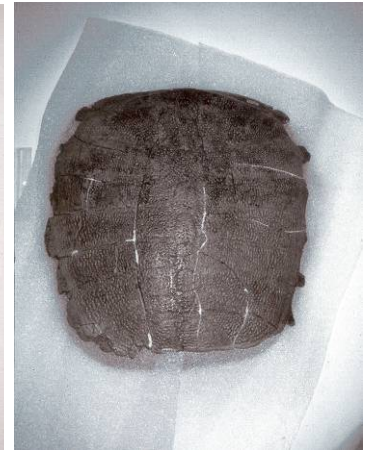


Figure 03: The cleaned, repaired and consolidated carapace of *Amyda* cf. *aequa*.

tion with damp cotton swabs if the specimen can withstand moisture. Occasionally old plaster bases and armature may have to be removed from the fossil before it can be jacketed. Newly prepared specimens should be in a stable state before the jacketing begins.

After the conservation of the specimen is completed, it is necessary to locate a good dividing line to separate the specimen into imaginary halves. This determines the size and shape of the two sides of the jacket. One detail to look for in a dividing line is a natural separation in the specimen, such as the top and bottom of a turtle shell. It is best to keep any diagnostic elements, like teeth, fully exposed, and the size and weight distribution of the jacket also have to be considered. Once a dividing line is determined, a two- to three-inch wide flange must be made along this line around the specimen using a ma-



Figure 4: The turtle carapace on its original plaster base, sunken into a sandbox to create the flange along the dividing line.

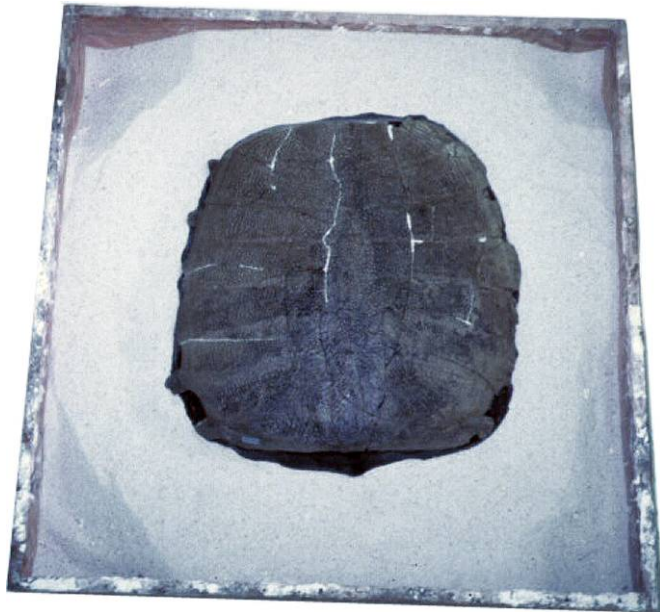


Figure 5: Plan view of the flange.

terial such as sand or cardboard. The quickest and easiest way to do this is to sink the fossil half-way deep in a sandbox, and use the sand surface as the flange. (Figures 4, 5) Otherwise, it must be constructed out of cardboard or some other material. If necessary, block out any overhangs or vertical walls of the specimen with newspaper or foil. There can be no "undercuts" that the rigid jacket will get hung-up on when it is removed. It's the same principle as making a plaster mother-mold.



Figure 6: The specimen and flange covered in foil and ready for the clay layer.

Once the flange and any undercuts are taken care of, the entire surface is covered with foil. (Figure 6) The foil acts as a separator between the specimen and the clay layer that will be applied next.

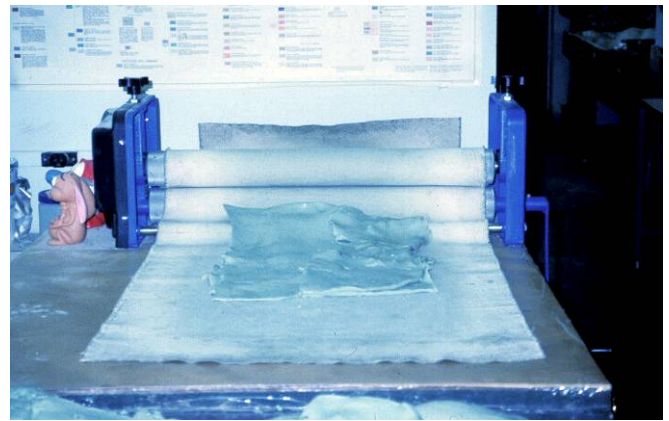


Figure 7: A clay roller that is used to roll out clean clay to 3/16-inch to act as a spacer for the foam in the jacket.



Figure 8: The specimen and the flange, layered with the rolled clay.

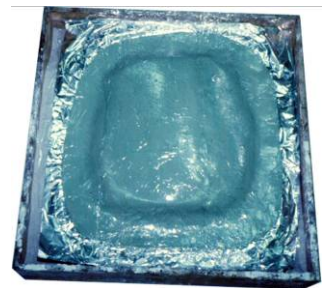


Figure 9: Plastic wrap is applied to the specimen and flange as another separator.

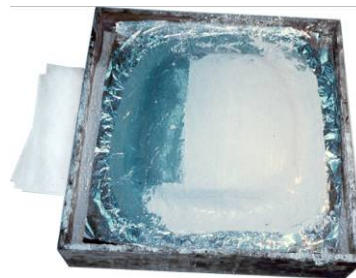


Figure 10: Fiberglass cloth and FGR-95 Hydrocal Gypsum cement being applied to the specimen.



Figure 11: The completion of the fiberglass and hydrocal application.

Sheets of clean clay are rolled to 3/16-inch, and the entire surface of the specimen is covered with it - including the flange. (Figures 7, 8) The clay acts as a spacer for where the foam padding will go in the jacket. All of this is covered with plastic wrap, which acts as another separator. (Figure 9)

The whole thing is then layered with 10 or 15 mil fiberglass cloth and liberal amounts of FGR-95 Hydrocal Gypsum Cement. There must be at least four fiberglass / hydrocal layers on the specimen, and five layers around the flange. More layers may have to be applied for large specimens. (Figures 10, 11)



Figure 12: A jacketed mysticete whale skull illustrating the conduit handles used to lift the jacket off the skull.

After the layering is completed, it is necessary to ensure that the final product will not rock back and forth while on a flat surface. This is done by constructing feet on which the jacket will stand - along with handles to lift it off. The handles are usually made from electrical conduit and built into the feet. (Figure 12) A typical way to install the handles is to first figure out where they will best serve their purpose, based, in part, on the contours of the jacket. The handles should be as low profile as possible, but far away enough from the jacket to keep it off the ground and to get fingers between the handle and the jacket. Creative placement of the handles can help with structural support on long jackets. Flattening the ends of a handle may make it easier for it to conform to the shape of the jacket. Once it is determined where the handles go, measure and cut the lengths of conduit needed and set them in place on pieces of clay of the correct height to level them. The clay should not be in the area where the handles will be attached to the jacket. Remember to first thoroughly wet the attachment areas on the plaster jacket surface with water so the fresh hydrocal is not dewatered by a dry under-surface. Pieces of fiberglass cloth are soaked in hydrocal and folded and stacked under the conduit until they make contact with it. Strips of fiberglass and hydrocal are then applied over the top of the conduit and attached to the jacket. Plywood or another flat surface can be placed over the feet while they are drying to ensure that they are level. In

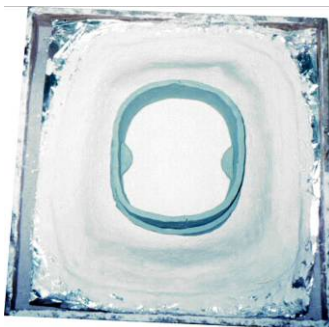


Figure 13: Hydrocal cement will be poured into this clay dike to make a solid pad, with finger holds, on which the jacket will rest.



Figure 14: The finished resting pad.

some cases, as with a smaller, simple-shaped specimen, it is easier and more efficient to just make a solid plaster pad with finger holds to lift the jacket off. (Figures 13, 14) The jacket surfaces, including the feet and handles, must be

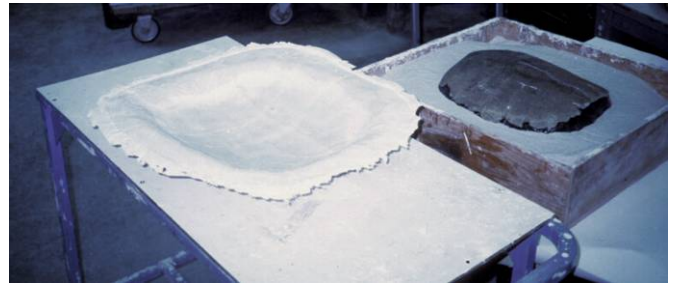


Figure 15: The fresh plaster jacket is removed and set aside to completely dry.

smooth for comfortable handling. Remove the clay immediately after the hydrocal is set.

Now the plaster jacket, plastic wrap, clay and foil are removed from the specimen, and the jacket left to dry completely. (Figure 15) The edges of the jacket are trimmed and sanded smooth. It is also advisable to take a propane torch and burn off any fiberglass along the edges.

The foam padding can now be adhered to the jacket. Pieces of 1/4-inch, high-density ethafoam are trimmed to tightly fit onto the interior surface and flange of the jacket. A coating of contact cement, such as 3M Hi-Strength 90 Spray Adhesive or MISTY Heavy Duty Adhesive Spray, is applied to the interior surface of the jacket and flange and to the contact surfaces of

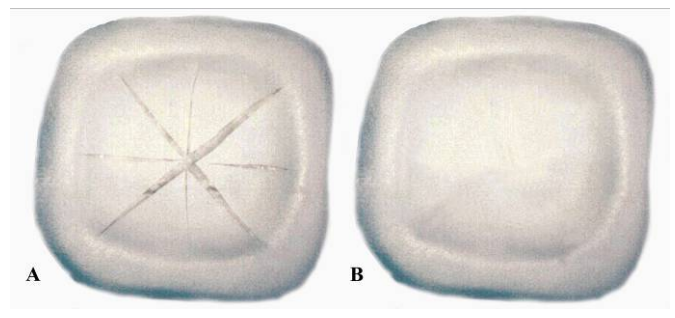


Figure 16: (A) The foam is adhered to the inside of the jacket and any air spaces are slit open so the foam completely rests against the plaster. (B) The slits are then filled in with foam.

ethafoam. It is advisable to always work in a well ventilated area, or wear a respirator with organic vapor filters when applying the contact cement. After waiting the prescribed amount of time, the ethafoam is carefully pressed into the jacket and the surfaces worked completely down. (Figure 16) If possible, the jacket can be put back on the specimen and weighted down

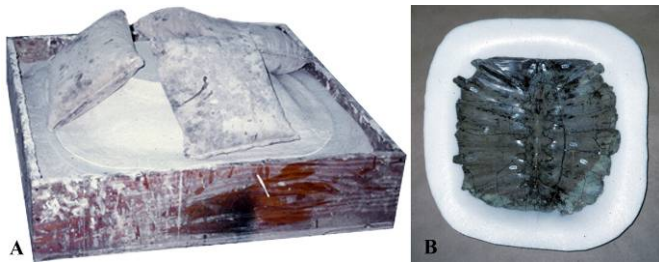


Figure 17: (A) The jacket can be placed back on the specimen and slightly weighed down so the foam conforms to the shape of the specimen. (B) The jacket and specimen are then flipped over.

until the cement dries to make sure everything stays in place. The foam edges are then trimmed, the contact cement allowed to completely off-gas, and the specimen is put back into the jacket and flipped. (Figure 17)

Now, the same general procedures are performed on this side of the specimen. It is layered with a foil separator, then 3/16-inch of clean clay - but the clay is not applied around the flange on this side of the jacket. Foam will not

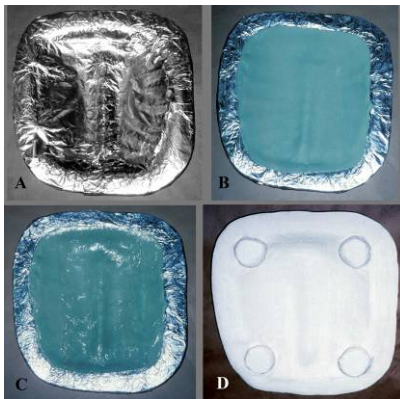


Figure 18: The process - (A) foil, (B) clay, (C) plastic wrap, (D) fiberglass cloth and hydrocal gypsum cement, and feet as handholds - are repeated on the second side, except there is no clay or foam on the flange.



Figure 19: The finished, labeled jacket showing the bolts and washers that hold it together, and the original catalogue labels in a plastic bag.

be applied to the flange on this side either as it isn't necessary to have both flanges with foam on both sides of the jacket. An extra layer of foam makes it easier for the jacket to be over-compressed if the bolts are over-tightened, possibly resulting in damage to the underlying specimen. Plastic wrap is applied as another separator, and then surmat and hydrocal. The jacket is trimmed and sanded, and the feet and handles are constructed for this side. (Figure 18) Ethafoam is then adhered to the inside of this jacket - but not around the flange.

Holes are drilled through the flange, and 1/4-inch bolts, washers, and wing nuts are inserted and tightened just until they are snug to hold

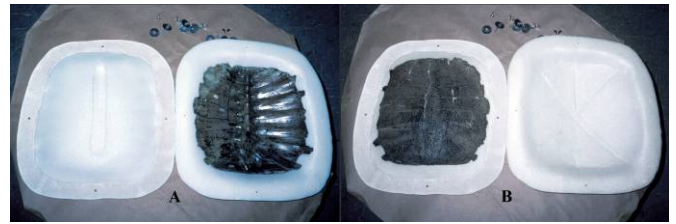


Figure 20: The finished jacket, opened to show the (A) ventral and (B) dorsal views of the turtle carapace.



Figure 21: A well-designed jacket will take up little more space on the shelf than the specimen itself.



Figure 22: A view of the conserved turtles in the USNM collections.

the jacket together. The appropriate data to identify the specimen is written on the outside of the jacket. (Figure 19) A photograph of the specimen may be attached to the jacket for easier identification. Now the specimen can be studied, and any unnecessary handling is eliminated. (Figure 20) It is also ready to be transported and placed into the collections.

(Figures 21, 22)

**Modifications:**

As always, there can be any number of variations on this theme. The procedures can be, and are, continually modified for specific specimens and conditions. A couple of common concerns are addressed below.

**Non-Metal Handles:**

There may be the occasion when the specimen being jacketed will be x-rayed or CT scanned or MRI scanned. Metal handles in a storage jacket will interfere with these processes. If the specimen is scheduled for scanning, or if there is a chance it will be, the handles must be made of an inert substance such as PVC pipe.

**Lightweight, Delicate Specimens:**

If the specimen is very light - 15 pounds or less - one-eighth inch thick foam can be used instead of the 1/4 inch thick material. Also, the clay must be rolled out to 1/8 inch thickness to get the right spacing. The plaster and fiberglass making up the jacket does not have to be as thick as for a heavier specimen, either.

**Fragile Projections:**

Thinking in terms of negative space, projecting teeth, such as those on a *Eurhinodelphis* rostrum, can be protected by making the clay layer over the teeth slightly thicker. Adding a little more clay over the normal layer will create a slightly larger air space around the teeth once the jacket is made. After the jacket is lined with foam, the teeth should just barely come into contact with it (or possibly just miss making contact - it's better to err on the side of caution within reason) and eliminate the potential to break because of too much pressure. However, because the teeth will then be, in effect, "floating", it is essential that there are areas of bone that contact the jacket foam to act as the load bearers for the weight of the jacket. The palate or the rostrum or the sides of the mandibles are all areas to consider. Make sure the normal thickness of clay for the jacket you are making still contacts them. The larger or longer the contact area is, the better it will disperse the weight.

Fragile processes can be taken care of in the same way. Make the clay on those areas slightly thicker than normal so that when the specimen sinks down into the foam it will not create too much pressure on the processes and break them off. The weight and the shape of the specimen must be taken into consideration as to how far it will sink into the foam. The processes shouldn't be floating in the air, though, because there is risk of breakage when the jacket is flipped or jostled.

Finally, if a jacket is constructed for a fragile specimen or one that has delicate features, be sure not to crank down too hard on the wing

nuts and bolts holding the jacket together. Too much pressure could be created on those features inside the jacket and break them. Write "FRAGILE" on the outside of the jacket.

**CONCLUSIONS**

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The National Museum of Natural History has been utilizing custom fit padded jackets for over 10 years and they have worked well. In addition to protecting the specimens, it is easier to find specific individuals because of the large specimen numbers printed on the sides of the jackets. As a matter of continued safety of the collections, an institution that elects to use any type of conservation jacket should develop protocols for the handling of specimens while in their jackets, and for handling the jackets themselves. Instances of specimens being pried out of their jackets and breaking are not uncommon. The jacket handles are only for lifting that side of the jacket off and not for lifting the entire specimen; the jacket should be gripped at the flanges if it is to be moved. And while storage space may not be significantly saved by the use of support jackets, it is space that is being put to better use. Innovative designs of the jackets can make them 'nest' better without risk to the fossils. Specimens originally stored upright can be stored flat and take up less vertical space, possibly increasing the number of shelves in a rack.

**REFERENCES CITED**

- Chaney, D. S. 1992.** Encapsulating Supports for Large Three Dimensional Fragile Specimens. in: *Workbook for the Storage of Natural History Collections.* eds. Carolyn L. Rose and Amparo R. de Torres. Society for the Preservation of Natural History Collections. Washington, D.C. pages 95-98.

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