PRODUCTION OF MULTI-PURPOSE MOLDS FOR VERSATILE, DETAILED REPLICATION OF LARGE-SCALE FOSSILS: THE *BASILOSAURUS ISIS* CASTING PROJECT AS AN EXEMPLAR

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Reasons for Molding and Casting

Public whale evolution exhibit

--protection of originals from handling

--archiving copies

--dissemination of copies

--educational exhibition

--generation of research copies

Constraints on choices of molding and casting methods and materials

Constraints:

--quality of fossil material

--intended use of casts

--project budget, etc.

Materials:

--latex, silicone rubber, polyurethane rubber, etc.

--plaster, urethane, polyester resin, epoxy, etc.

Methods:

--solid pour molds

--laminar molds

--multipiece molds

--mothermolds

--solid casts

--hollow casts

--fiberglass

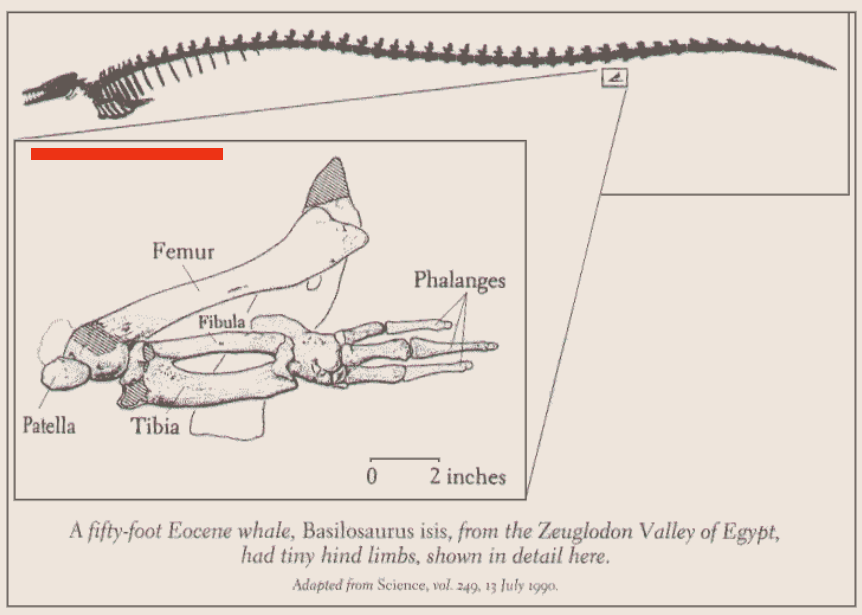
--foam-filled, etc.

--rotational

Step One:

GET A BIG FOSSIL WHALE

Basilosaurus isis replication project



A fifty-foot Eocene whale, Basilosaurus isis, *from the Zeuglodon Valley of Egypt, had tiny hind limbs, shown in detail here.*

Adapted from Science, vol. 249, 13 July 1990.

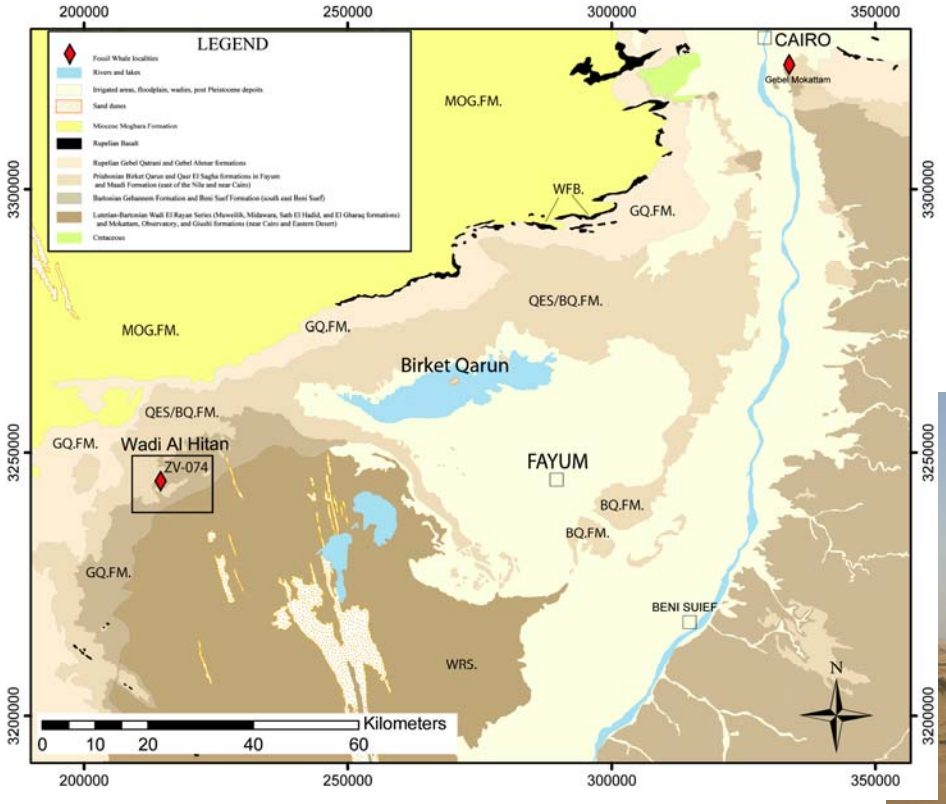
Skeletal aspects of *Basilosaurus isis*

38 million years old

Archaeoceti, Cetacea

Artist's reconstruction of *Basilosaurus isis*

Wadi Hitan, Egypt: Excavation site



Wadi Hitan: World Heritage site

Visitor's Center

Univ. Michigan Research Facility

Exhibit Created Around Exposed Vertebrae of *Basilosaurus*

Basilosaurus excavation and plaster jacketing

Step Two:

An infinite number of students with an infinite number of airscribes will eventually prepare a 65-foot-long whale out of matrix

(we had 20 students, 5 airscribes, and it took a year)

Airscribing vertebral endplate

. . . sometimes, things got a little out of hand in the lab . . .

. . . But eventually, we processed four tons of sediment to extract nearly all elements of the *Basilosaurus* specimen (WH 074), including toes, hyoids, and auditory bullae

Student assistant with part of the skeleton arrayed on long tables

Approach

--expense a concern: molding in polyurethane rubber, using laminating technique and backing with fiberglass and resin mothermolds

--hire students from work-study program and Undergraduate Research Opportunity Program, and take on volunteers

--cast in polyester resin mixed with talc; laminar hollow-cast method backed with fiberglass or filled with foam (weight a concern for casts to be used in mounts)

--time a concern: hire LOTS of students

Step three: molding

--clay blocking: divide up specimen into parts

--angled, low clay rims to create edges which lock into mothermolds

--use of insulation foam and hot glue to build support platforms for clay walls around specimen

--lock tabs, positive and negative, to ensure proper alignment of mold sections

--3 to 4 coats of polyurethane rubber are laminated on, about one an hour; a waxy separator is necessary between the specimen and first coat

--the clay wall is extended past the low clay rim to form a flange beyond the mold, onto which the mothermold will extend; this provides a place to drill bolt holes for reassembly later

--mold parts are flexible and supported by external mothermolds made of fiberglass and resin

--bolt holes are easily drilled through mated mothermold pieces, which are internally aligned by lock tabs.

--molds are typically about a centimeter in thickness and "flow" around the morphology

--dimensional stability seems good and fidelity of detail is reasonable

Step three: create and add plugs

--plugs useful to make molds versatile: molds can be used to make hollow, laminar casts lined with fiberglass and resin (lightweight) OR to make urethane foam-filled casts inside of laminated polyester coats (even more lightweight

--fiberglass hollow casts are typically 1/15th the weight of the original specimens

--foam-filled casts are typically half that in weight, making them ideal for mounting

--plugs are sculpted onto dixie cups, molded in RTV silicone rubber, and cast in polyurethane rubber, with a plaster inner plug insert

--one surface of a fossil is prepared with a clay ring, and polyurethane rubber is applied; the plug is pushed down into that ring to adhere to the specimen (temporarily)

--a clay wall is built around the section with the plug, with lock tabs and a low clay rim

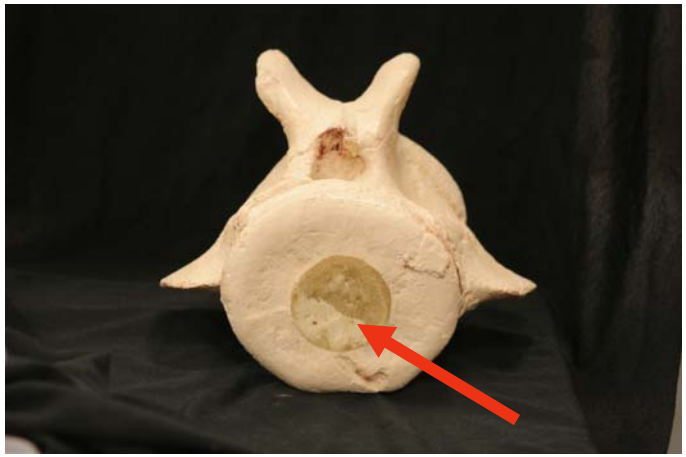
--polyurethane rubber is layered on around and onto the plug (the plug is first sprayed with a waxy separator

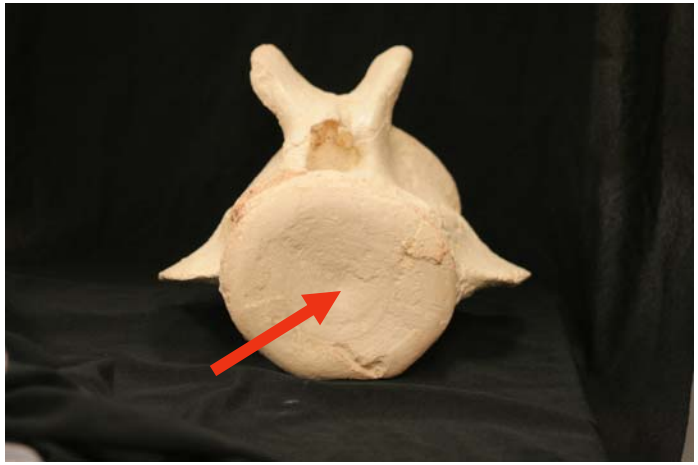
--note the extended clay flange to later accommodate a mothermold flange for bolt holes

--once the mold section is ready and the plug is firmly in place, a two piece mother mold can be constructed around it, permitting demolding later

--two part mothermolds for single mold sections are often desirable to prevent damage to the specimen during demolding

--we apply clay buttons under the first of two mothermold parts to accommodate bolt heads later (to hold the pieces together)





--Foam-filled cast vs. fiberglass-lined cast

--if used for a mount, the obvious plug part will be unobtrusive

--if to be used as an isolated specimen, the plug part can be painted over and will be barely noticeable

--the foam-filled cast is literally light enough to float (the mount could be truly aquatic again!)

Step four: casting

--casting in polyurethane molds can be done using a variety of media (resins, plaster, urethanes, metals)

--we chose to work with a high quality, low shrinkage polyester resin, and mixed it with talc (for control of lamination) and pigment (to provide a base color)

--this material works well with fiberglass, is easy to paint, generates less heat and damage to molds than epoxy, and is dimensionally stable over time (and quite strong for handling)

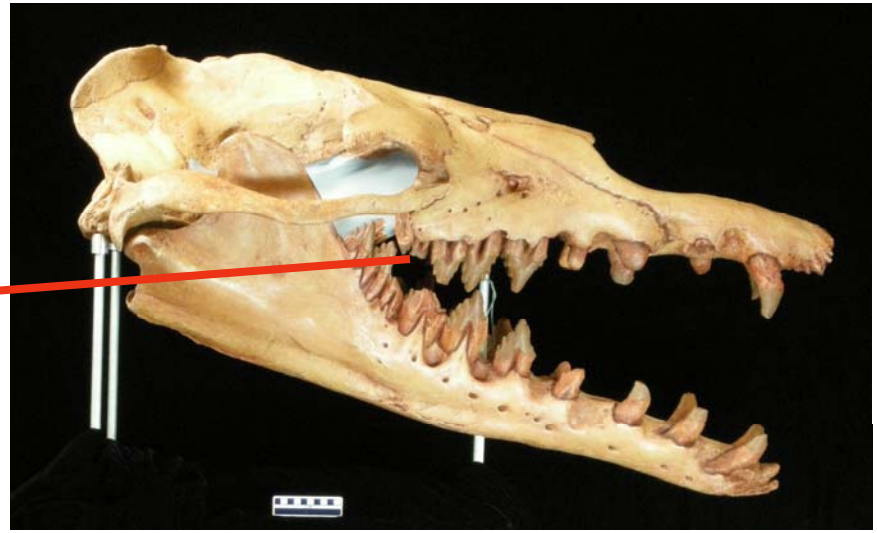
--we generally applied three layers of talced resin, a final layer of talced resin with fiberglass (to tack the fiberglass in place), and finished the cast internally with (appropriately) finishing polyester resin

--mold parts were then bolted together and rotated by hand for even distribution of excess material

--students laminating talced, pigmented polyester resin into rib mold halves for casting

The finished rib cast, prior to painting

--student assistant with completed casts arrayed next to original specimens



--painted casts of the skull for display in educational exhibit case

(bonus whale cartoon)

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