3D biomechanical simulation of a fossilization process of a bone structure
New perspectives for the retrodeformation of paleo-anthropological fossils

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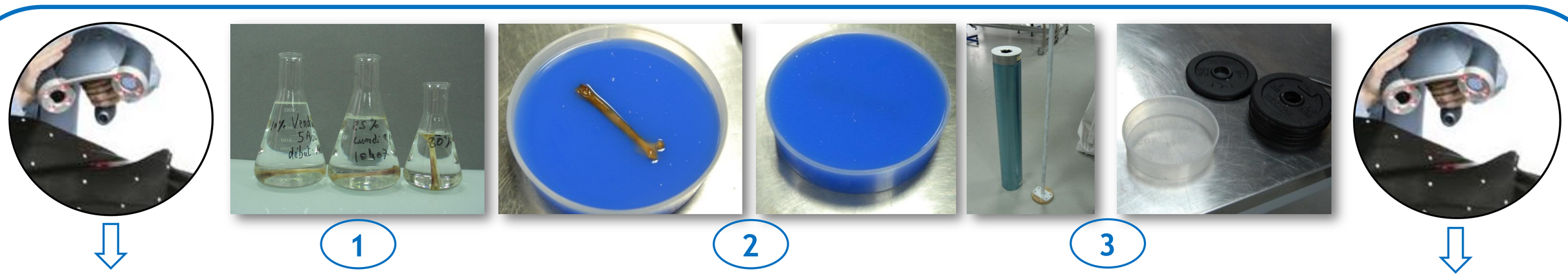
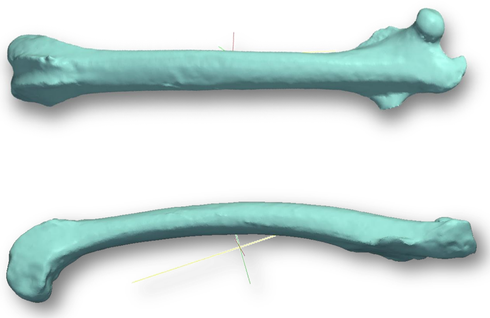
1. Designing a testbed to simulate the plastic deformation of a fossil bone structure
with the help of B. AIELLO[2] and B. GRANSAC[2]

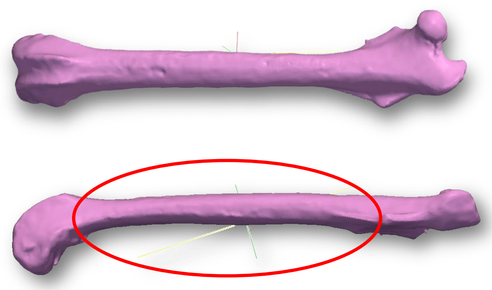


1. The bone structure (a rabbit femur) is plunged in a controlled acid solution. As a result, the dissolution of the mineral part **softens** it.
2. The bone structure is then placed in the middle of a cylinder filled with silicon elastomer which simulates the **surrounding sediments**.
3. A vertically controlled **mechanical load** is applied to the surface of the silicon cylinder during several days

→ **plastic deformation due to the weight of overlying sediments**

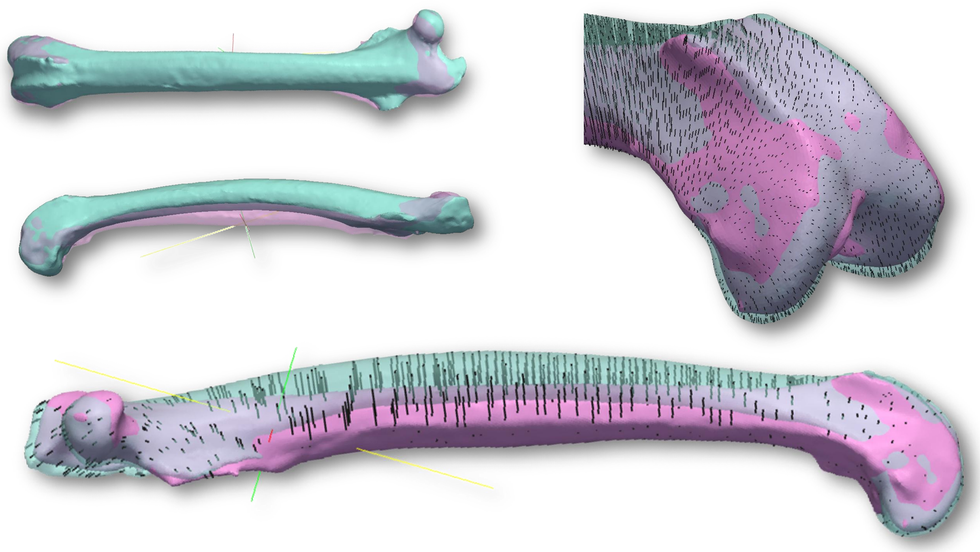


Original 3D data



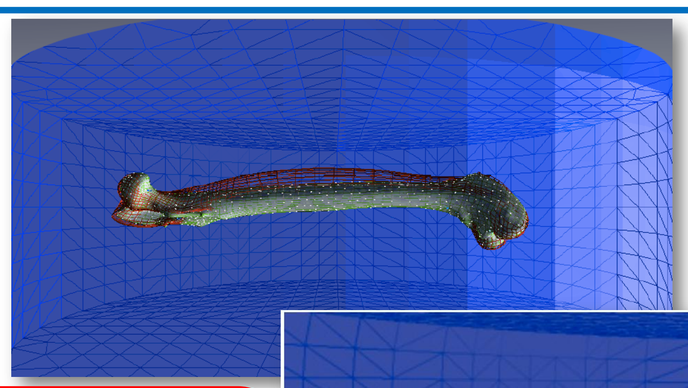
After deformation

2. Developing algorithms to simulate and assess the 3D plastic deformation of a fossil bone structure
with the help of B. COMBES[7] and S. PRIMA[7]



A **3D registration algorithm** automatically makes the correspondence between the surface points before and after deformation.

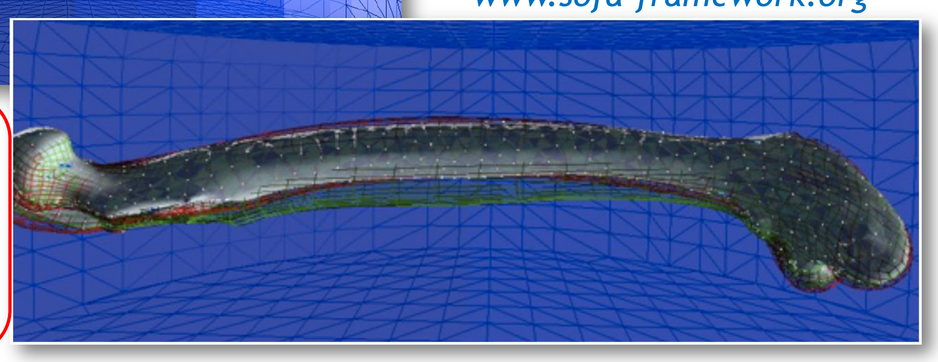
→ **3D actual deformation vector field**



SOFA
Simulation Open Framework Architecture

J. Allard et al. "SOFA - an Open Source Framework for Medical Simulation". Medecine Meets Virtual Reality, 2007. www.sofa-framework.org

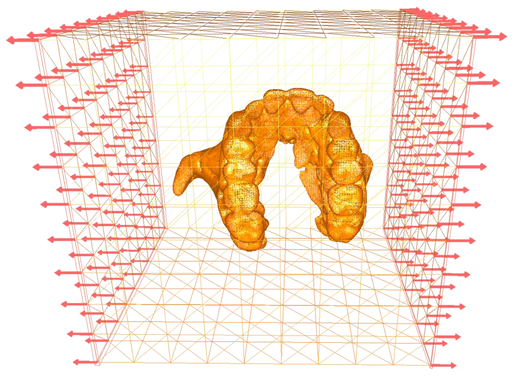
- *2 elements:*
  - *bone*
  - *silicone elastomer*
- *Linear elasticity*
- *Vertical constraint*



A **computer simulation** is used. A virtual force is applied and the software efficiently calculates the 3D deformation.

→ **3D simulated deformation vector field**

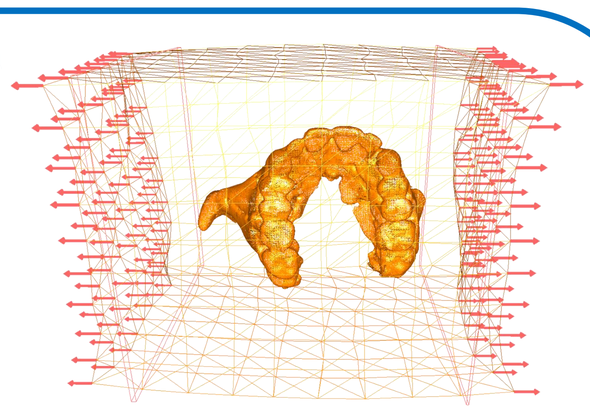
3. Retrodeforming a fossil by 3D biomechanical simulation: a preliminary experiment
with the help of B. GILLES[1], S. POTZE[8] and F. THACKERAY[9]

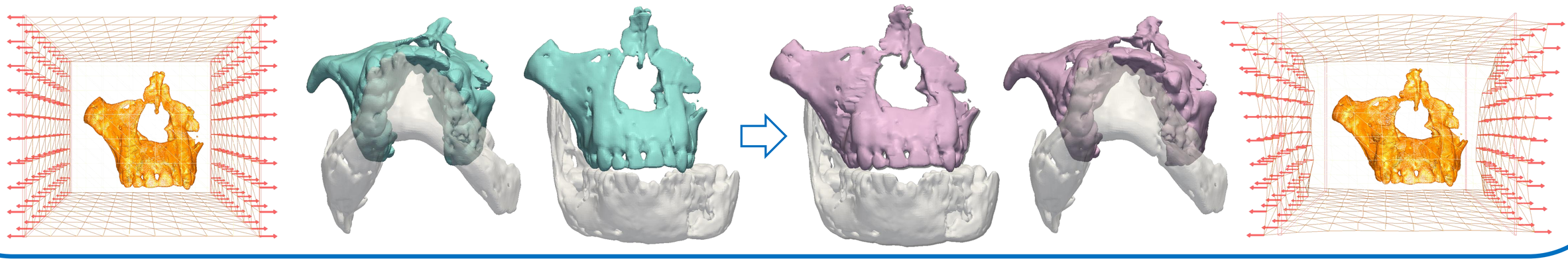


STS52 (*Australopithecus africanus*, ~2.5 mya) is composed of a laterally compressed partial lower face and part of a mandible. The two parts do not fit one another.

- *2 elements:*
  - *bone (151,478 triangles)*
  - *sediments*
- *Linear elasticity*
- *Parameters roughly estimated*
- *Unique lateral constraint*

→ **fast 3D plastic retrodeformation**





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