

# THE LABORATORY OF EXPERIMENTAL TAPHONOMY (LET)

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**Scientific coordination: Research Team of Taphonomy of the MNCN**

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This is an emergent laboratory that offers diverse programmable equipments to test and monitor mechanical processes such as compression and abrasive experiments, as well as atmospheric and early bone diagenesis agents in action.

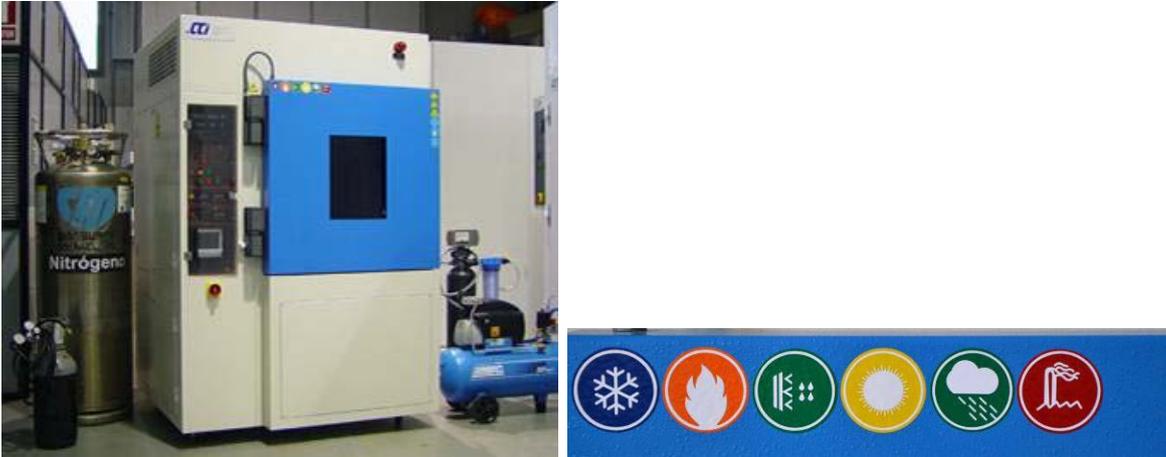


The Laboratory of Experimental Taphonomy, at the National Museum of Natural Sciences (Madrid, Spain), is the first laboratory worldwide of these characteristics. This laboratory has been created by the Research Team of Taphonomy of the Museo Nacional de Ciencias Naturales. The objective of this laboratory is the simulation of taphonomic processes mainly referred to mechanical and environmental experiments. This laboratory simulates processes that occurred in the past based on highly controlled experiments and monitoring today. Simulation of standard climates and extreme environmental conditions can be performed controlling atmospheric parameters that can be varied independently or creating climatic cycles.

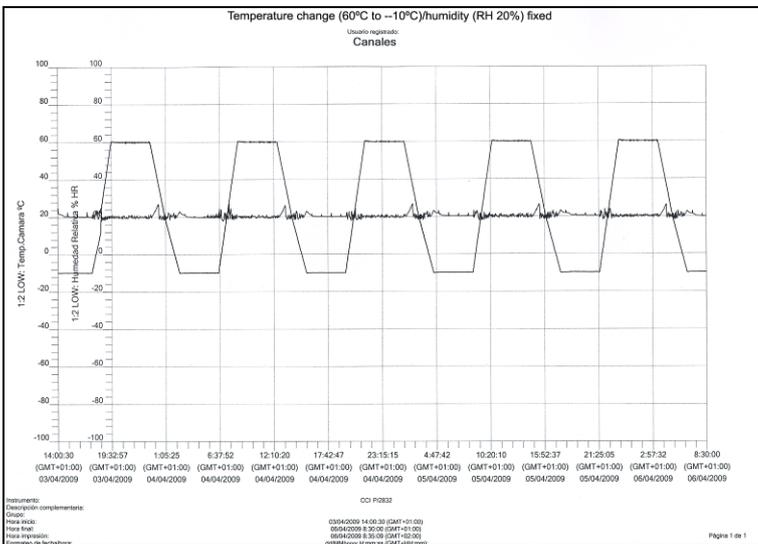
The origin of the laboratory is the taphonomic study of macro- and microvertebrates, but we have already experienced with pollen and can work with samples of different nature such as shells, seeds, coal, lithic artefacts or even construction materials or paper. The laboratory may have an interest, not only for goals and archaeo-paleontological samples, biological, geological and / or forensic but also for preservation of specimens that are stored in basements or singular deposits.

## ENVIRONMENTAL TEST EQUIPMENT

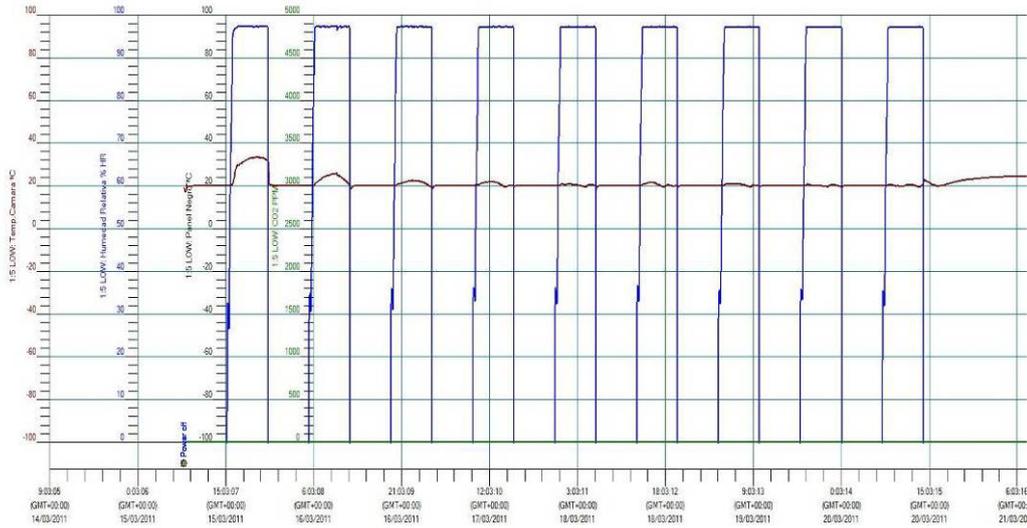
**THE CLIMATIC CHAMBER (MQ/ESP-CCI)** has been designed to control individually temperature, relative humidity, solar radiation, rain and pollution by CO<sub>2</sub>. The equipment is also designed to test climatic cycles by programming specific values of atmospheric parameters to reproduce desert, savannah, tropical forest, Mediterranean climates.



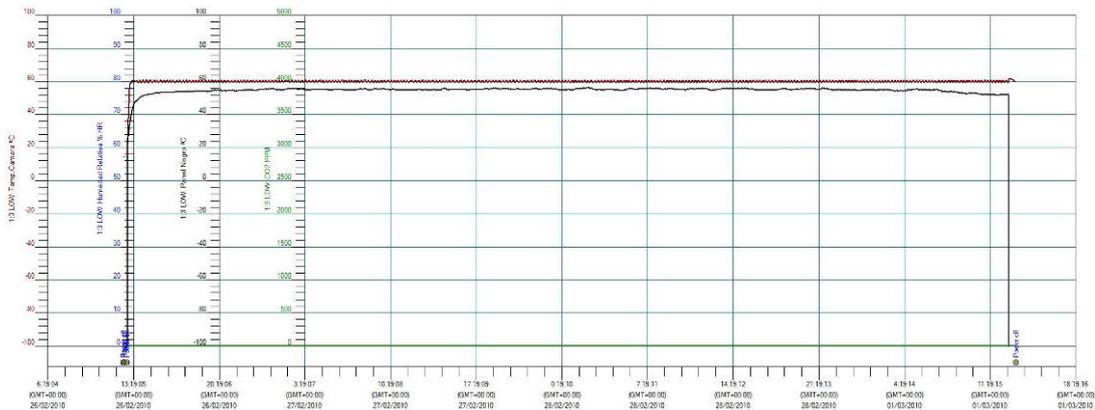
**Function Temperature-** environmental temperatures vary between - 20 °C and +80°C. Maintaining *critical relative humidity* at 20% can be programmed constant with custom-built software that dries at low temperatures up to -10°C.



**Function of Relative Humidity-** Values of relative humidity while using cryogen cannot be maintained fixed. The equipment, however, has the capacity of programming environmental relative humidity in conventional mode between +10 %RH + /- 1 %RH, until saturation.



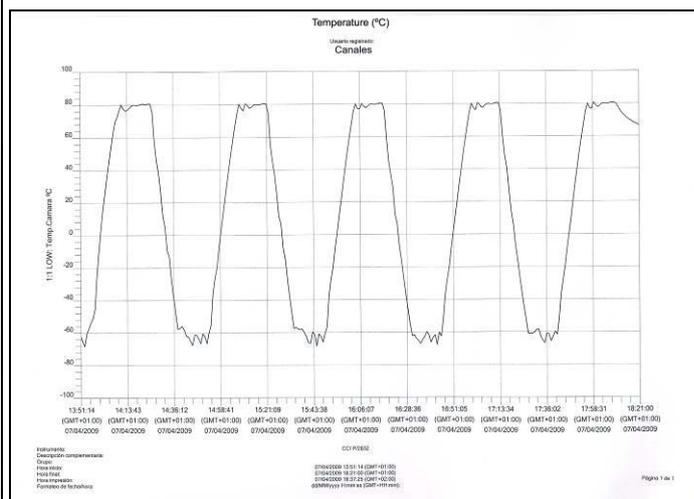
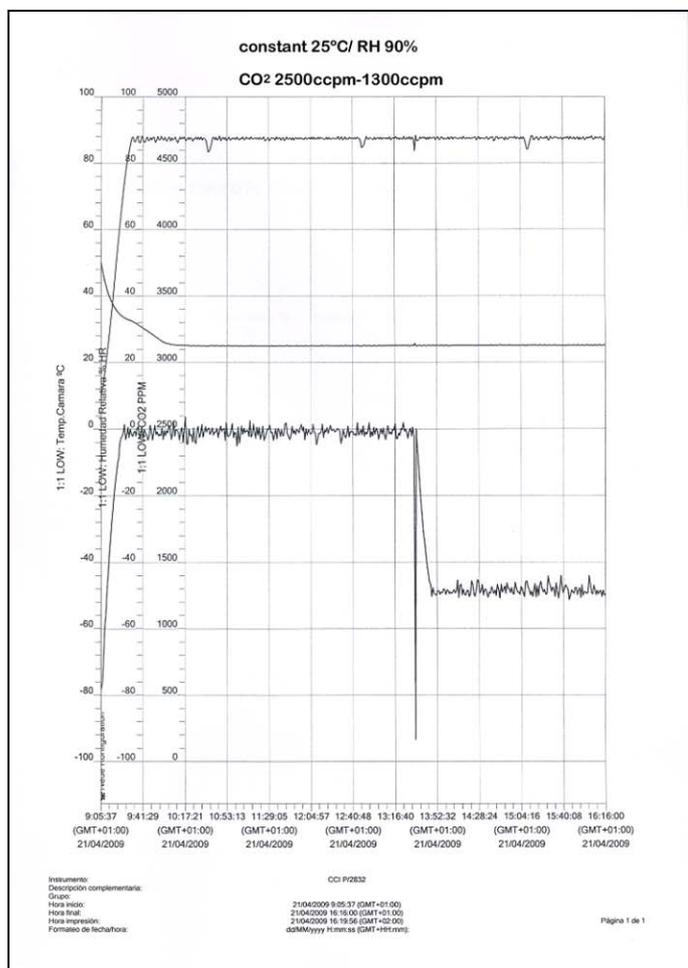
**Function of Solar Radiation-** Radiant spectrum lamps (UV radiation, visible and near infrared) similar to the radiation emitted by the sun, based in ionisable gas at high pressure in quartz glass and a spiral of tungsten incandescent, (average power radiated of approx. 800 W/m<sup>2</sup>, with an installed power of approx. 5 KW/m<sup>2</sup>, without glass filters of insulation) equivalent to the radiation recorded in Ecuador in the peak of solar (at noon). The total installed power of radiation is obtained by four bulbs of 300 watts each, totalling 1200 W



**Function of Rain-** using sprinklers of approximate an angle of 60 degrees in the centre of symmetry of the test chamber. Like the rest of the functions, the time and the time of entry of the role of rain is commanded by the program. The chamber will prevent perform this function in incompatible conditions such as spraying corresponded with programs of freezing temperature, although simulation of the formation of ice can be obtained using a program of cold after the rain.



**Function of CO2 pollution.** This function is controlled by an infrared sensor driven from the program. This function is selected by a selector switch that activates the additional control from the program. The system needs external connection of CO2 to the chamber reaching concentrations between 0 and 3000ppm at the interior of the chamber. When using this function, a red light on top of the chamber switches on warning to open the door while the experiment is running. The mean duration of these CO2 experiments may be one to two weeks depending on the nature of the sample and experiment objective.



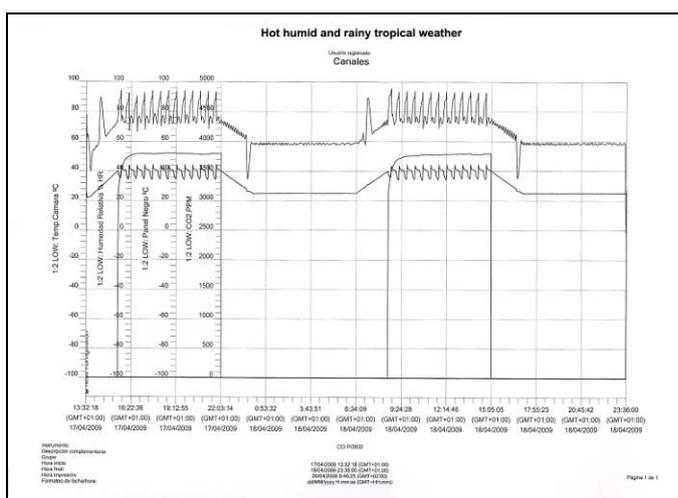
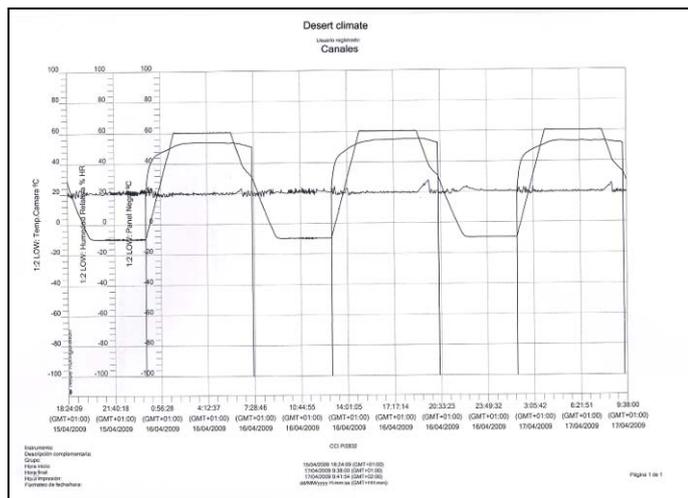
Left: diagram of CO2 concentration (2500ccpm/10ccpm) right: diagram of cryogen from -60°C to +80°C

**Function of cryogen** - Extreme temperatures to reach -60 °C or to accelerate fast temperature oscillations from +80 to -60°C can also be programmed connecting liquid nitrogen to the chamber. The transit speed recommended is 20 to 30 minutes, a fast ramp to allow a fast temperature alternation.

**Automatic programming system of climatic cycles and of functional variables** - Programming up to 9 different climatic programs, nineteen segments per program (ramps or maintenance) and repetition up to 999 cycles or infinity. - Maximum time possible by segment programmable up to 99 hours 59 minutes. - Minimum time programmable for segment 1 minute or 1 hour.

The mean duration of standard climatic chamber experiments can be 1 to 3 months or more depending on the nature of the sample and the objective of the experiment. The mean duration of the CO2 experiments may be one to two weeks depending on the nature of the sample and experiment

objectives. Finally, the mean duration of experiments using criogeny can be days depending on the nature of the sample and the experiment objective.



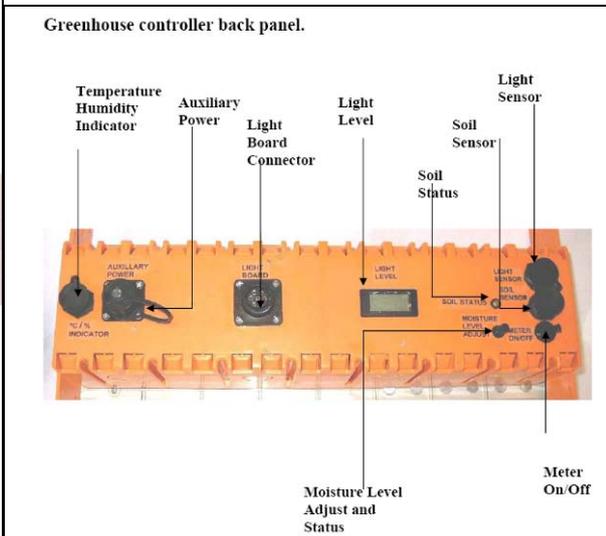
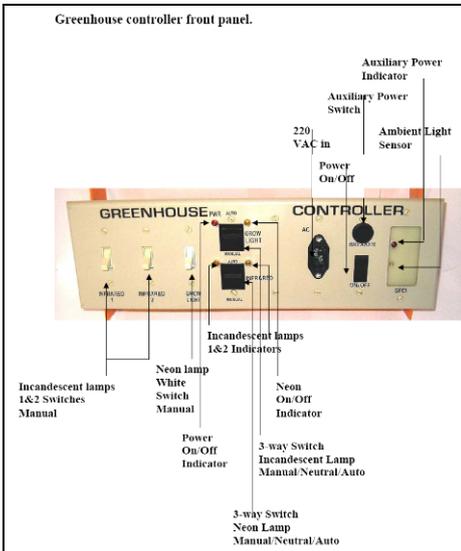
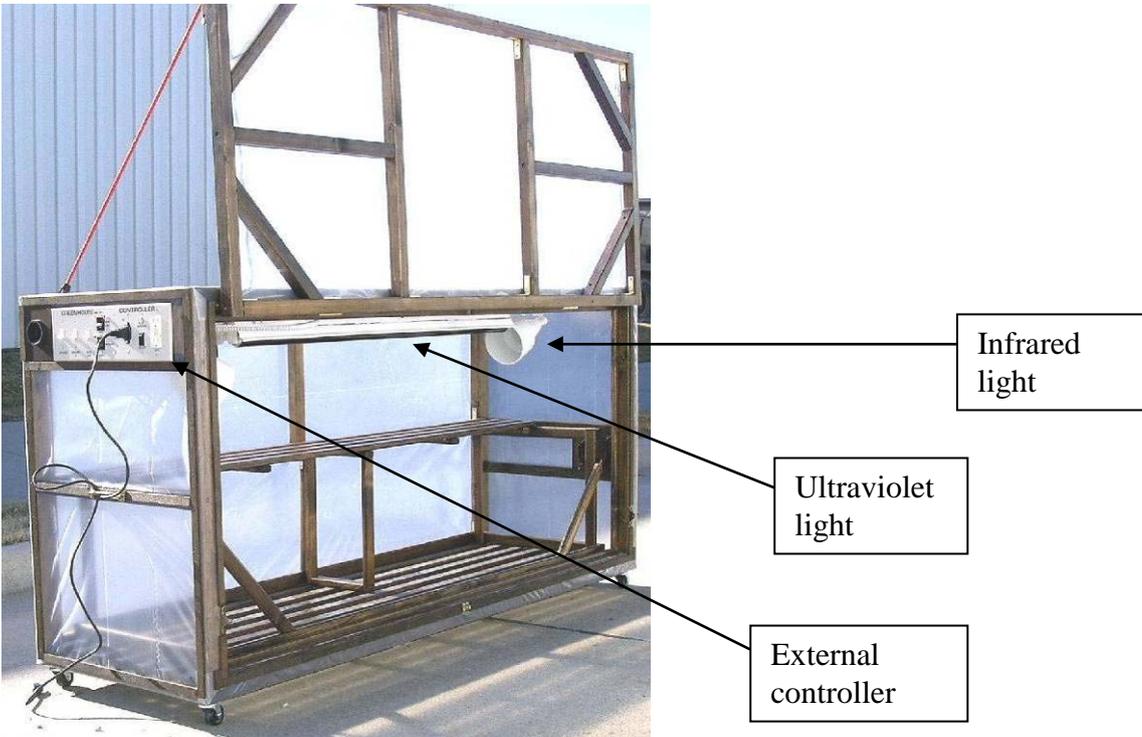
The structures, the automation and control systems and programming have been custom-built to meet the requirements of the laboratory. The specimens are placed on a grill adjustable in height. The interior dimensions of the test chamber are 600mm high x 600mm wide x 600mm depth\*.



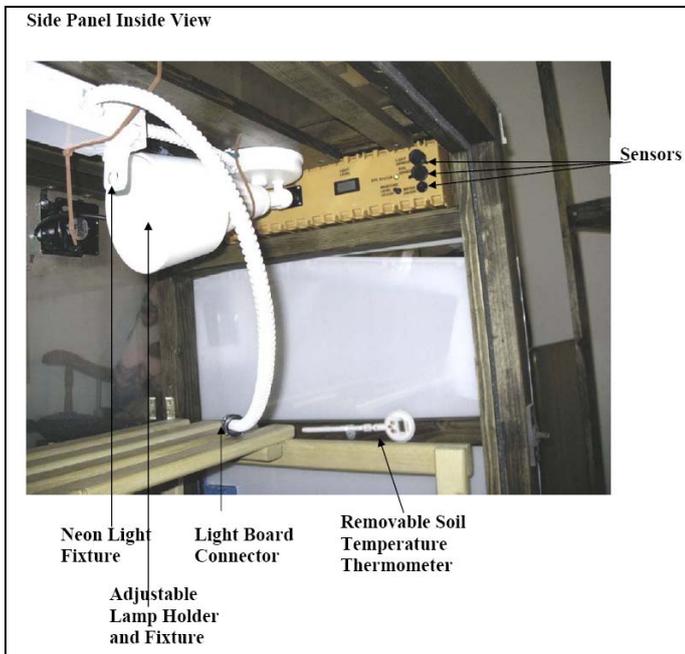
Courtesy of Xiomara Cantera (MNCN)

\*Samples of relative large size can be placed at the interior of the chamber. When the experiment needs pre-post- microscopic studies to observe textural/compositional modifications, small sized samples is advised to reduce the observation.

**EQUIPMENT ENVIRONMENTAL CHAMBER** Built by the MRSE company, LLC (Canada) specialized in outdoor programmable greenhouses for development of plants at temperatures below 0 °F (-18 °C). The greenhouse was built to operate in interior and allow the programming of temperature, humidity and soil, with infrared and ultraviolet light (simultaneous and/or independent) to simulate longer days with values of tropical, temperate or more extreme climates. Greenhouse electronic programming, temperature, humidity and ventilation, with ultraviolet and infrared light. Experiments simulate early diagenesis situations of superficial burial under different soil quality or growing different types of plants to obtain root marking on the samples exposed.



Courtesy of Xiomara Cantera (MNCN)



The mean duration of these experiments can be 1 to 3 months or more depending on the nature of the sample and the experiment objective.

### MECHANICAL TESTING EQUIPMENT

**TESTBED (ZWICK-5kN ROELL GROUP):** The equipment has a single column to test loads and high accuracy measurements. This compression instrument simulates processes of compaction by sediment, subaerial compression, deformation efforts and impact fractures of static materials at high speed range.

The equipment is connected to a standard PC to measure the strength, time of experimentation to fracture and values and diagrams of deformation/microfracture and fracture. Different tools and accessories are available for compression and bending efforts that can be programmed from 5 grams to 500 kilograms-force along a variable time and speed of compression.



Courtesy of Xiomara Cantera (MNCN)



Leyenda	Nr	Identificación de la probeta	Fecha/Hora	L <sub>c</sub> mm	h <sub>0</sub> mm	L <sub>0</sub> mm	F <sub>x1</sub> N	F <sub>max</sub> kN	dL en F <sub>max</sub> mm
1	1	mandibula 1 30N ling	25/06/2010 17:07:34	3,00	3	3,00	2,77	0,0302	1,5
2	2	mandibula 2 25N ling	25/06/2010 17:12:43	3,00	3	3,00	0,848	0,0251	1,5
3	3	mandibula 3 25N ling	25/06/2010 17:18:33	3,00	3	3,00	0,759	0,0250	1,5
4	4	mandibula 4 27N ling	25/06/2010 17:24:16	3,00	3	3,00	1,13	0,0270	2,0
5	5	mandibula 5 23N ling	25/06/2010 17:31:03	3,00	3	3,00	1,18	0,0231	0,6
6	6	mandibula 6 23N ling	25/06/2010 17:36:20	3,00	3	3,00	1,12	0,0232	0,9
7	7	mandibula 7 23N bucal	25/06/2010 17:41:07	3,00	3	3,00	0,769	0,0231	1,0
8	8	mandibula 8 23N bucal	25/06/2010 17:45:48	3,00	3	3,00	4,01	0,0230	0,6
9	9	mandibula 9 23N bucal	25/06/2010 17:49:47	3,00	3	3,00	2,99	0,0230	0,7

Leyenda	Nr	Deformación nominal en F <sub>max</sub> mm	W hasta F <sub>max</sub> Nmm	tensayo s
1	1,5	14,00	179,09	
2	1,5	9,29	179,24	
3	1,5	11,80	183,90	
4	2,0	11,74	245,08	
5	0,6	6,53	71,48	
6	0,9	7,87	104,60	
7	1,0	7,15	119,14	
8	0,6	6,60	78,69	
9	0,7	4,21	84,98	

**Estadística:**

Serie	L <sub>c</sub> mm	h <sub>0</sub> mm	L <sub>0</sub> mm	F <sub>x1</sub> N	F <sub>max</sub> kN	dL en F <sub>max</sub> mm	Deformación nominal en F <sub>max</sub> mm	W hasta F <sub>max</sub> Nmm	tensayo s
n = 9									
x	3,00	3	3,00	1,73	0,0247	1,1	1,1	8,80	138,47
s	0,00	0,000	0,00	1,20	0,00247	0,5	0,5	3,15	60,40
v	0,00	0,00	0,00	69,38	10,00	44,16	44,16	35,84	43,62

These experiments need the technician attendance, and the rate is calculated per hour.

Long term compression/deformation using a **Hydraulic shop press**. This equipment is not automated or computer controlled, only maintains a constant weight (up to 30 tons) for the time needed.



**ABRASION: sand-blasting cabinet:** basic sandblasting to simulate the erosion in deserts sand-wind. These experiments need the attendance of the technician (1<sup>st</sup> day rate), but are performed during the day, so there is not fee of subsequent days. Air guns that project sand by means compressed air. Exterior Dimensions (Width x Height x Depth): 660 x 490 x 500mm Dimensions cab interior (Width x Height x Depth): 575 x 450 x 280 front-350 fund Weight: 20Kg. Made in steel and equipped with a pistol, four nozzles, gloves, lighting and 5 protector sheets of the window.



**Polishing motorized tumblers** to simulate friction of different sediment size grain (clay to gravel) in water currents or dry friction. These experiments use to be running along a time range of weeks-months.

- Ultrasonic baths, manual micro-cutter, microscopes adapted to the study of large format or small dimension samples and magnifier lamps, experiment glass containers, refrigerators and freezers.





Glass containers for monitoring specimens buried in different types of soil or water immersion.

**SAMPLES ARE PHOTOGRAPHED BEFORE AND AFTER THE EXPERIMENTS USING OPTICAL MICROSCOPES WITH AUTOMATIZED FOCUS IN Z AND HIGH RESOLUTION CAMERA.**



EQUIPMENT	1st day and programming / experiment revision		Non-attended subsequent days*		
	Euros	Research centre	Private Enterprise	Research centre	Private Enterprise
CLIM.CHMB.STD/day		57€	88€	12€	18€
CLIM.CHMB.CO2/day		105€	162€	61€	94€
CLIM.CHMB.CRIO/day		346€	533€	200€	308€
GREEN HOUSE/day		60€	93€	7,5€	12€
ABRASION/day		35€	50€	3,5€	7€
HYDRAULIC PRESS/day		35€	50€	3,5€	7€
COMPRESSION/hour		54€	90€		
MICROSCOPE/hour		54€	90€		
* Experiments exceeding the day. The first day consists of programming and start of the experiment as the above rates. The maintenance of the experiment corresponds to 'non-attended subsequent days', although supervised by the technician (half rate).					

- Reports and data processing of experiments including interpretation and all the artwork and results has a separate fee (40€ /page for MNCN; 60€/page other users and sources). Complete taphonomic studies may also be done, but they must be budgeted according to the amount of sample provided for the study and whether the study exceeds 40 working days.