

GOAL EDUCATIONAL RESOURCE

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TITLE OF THE CASE	A geoethical conflict in " <i>Lo Hueco</i> " fossil site
SHORT CASE DESCRIPTION	The exceptional Late Cretaceous site of <i>Lo Hueco</i> in Central-East Spain has yield an enormous, new and unusual unexpected concentration of dinosaurs in 2007 as a result of works in infrastructure development, and constitutes one of the best world- case examples of how to solve a conflict between infrastructure construction and the preservation of the fossil heritage, with benefits either for the administration and to the scientific community.
KEYWORDS	Agreement; Fossils; Geoethical conflict; Geoheritage; Paleontology.
PRIOR KNOWLEDGE	Dinosaurs; Fossils; Geodiversity; Geoheritage.
AIM	Develop knowledge and awareness about geoethical conflicts between works of infrastructures and the geoconservation of paleontological sites, and the discovery of new fossils.
OBJECTIVES	<ul style="list-style-type: none"> • To understand that the value of fossils is based on sound scientific knowledge produced by the geoscientific community. • To examine the solutions found in this real-case study for the conservation of the paleontological heritage from a geoethical perspective. • To discuss the cultural value of the paleontological heritage and the impact of its conservation on society, in environmental, cultural and economic terms. • To debate the need for a proper balance between development of infrastructures and development of works, with preservation of heritage. • To relate the conservation of the paleontological heritage with the sustainability of the Earth. • To raise citizens' awareness of geoethics.

CASE

In May 2007, a small hill named "Lo Hueco", near the village of Fuentes (Cuenca, Central-East Spain), was excavated in the frame of the works under the construction of the Madrid-Levante high-speed railway by the company ADIF (*Administrador de Infraestructuras Ferroviarias*) (http://www.adif.es/en_US/index.shtml) (Fig.1). The archaeologists discovered an unexpected and extraordinary amount of large bone remains assigned to Upper Cretaceous (70-80 million years) sauropod titanosaurs (Barroso-Barcenilla et al., 2009; Ortega et al., 2008;). Preliminary fieldworks revealed a rich and varied fossil assemblage in the outcrop, works on the railway stopped, and an urgent and systematic paleontological excavation started. Given that there was no preliminary evidence on the surface that indicated the presence of a deposit of these characteristics, it was necessary to rethink the strategy of action in the section. The railway works were paralyzed in the area to facilitate the location, documentation and protection of the fossils. The excavation forced to introduce a modification in the construction works of the Madrid-Levante high-speed line, already in service, at the location of the site, where a tunnel was planned, and in order to preserve it, the section in trench was built. All this gradually involved more than 60 paleontologists and 100 manual workers from diverse public institutions and private companies and continued until December 2007.



Fig. 1 – Aerial view of the palaeontological site of *Lo Hueco* (right) and detailed picture of the works. (Adapted from Barroso-Barcenilla et al., 2009, p. 1269).

Lo Hueco is located at a short distance from two other very important paleontological sites: *Las Hoyas*, with fauna and flora remains from the Lower Cretaceous (about 130 million years ago), and *Portilla*, with a same age as *Lo Hueco*, which constitutes an area enriched in remains of dinosaur eggs attributable to titanosaur dinosaurs.

Lo Hueco is considered to be a Fossil-Lagerstätten (as exhibits extraordinary fossils with exceptional preservation—sometimes including preserved soft tissues) sedimentary deposit (Fig.2), and the fossil collection excavated (with more of 14.000 remains) constitutes one of the largest and most relevant collections (mainly of fishes, turtles, lizards, crocodiles, dinosaurs and vegetal remains) not only in the Iberian record

but also in the European one of the upper-most stages of the Upper Cretaceous (see Ortega et al., 2008; Barroso-Barcenilla et al., 2009; Cambra-Moo et al., 2012). Apart from this scientific value, the paleontological record of *Lo Hueco*, specially that concerning the dinosaurs, contains all the necessary elements to be a reference for the social culture as well.



Fig. 2 – Zone of excavation (left) near the railway works and example of square (right) showing the unusual concentration of fossil (specially sauropod titanosaur) remains including articulated bones. Retrieved from: <http://www.adifaltavelocidad.es/>.

The Science Museum of Cuenca was not being able to accommodate all the tons of fossils and sediments excavated that resulted from *Lo Hueco*. As such, ADIF financed the rental of a warehouse where the deposit and laboratory of the collection were installed. Thanks to this discovery, the current museum was expanded, a new center was created (Fig.3) and man and researchers were hired.



Fig. 3 – Sauropod titanosaur vertebrae remains exposed in the Interpretation Center in Fuentes. Retrieved from: https://www.dinosauriosdecuenca.es/storage/contents/fichas/vertebrados_2-.jpg.

Thanks to the works carried out in *Lo Hueco*, in where there were no signs of any fossil site of such characteristics, new heritage has recently come to light. Without any other information, this can pose a very important geoethical conflict between the need of a new infrastructure construction and the preservation of a newly found fossil heritage of unique characteristics. However, the protection of the geoheritage (including the paleontological heritage) and geoconservation along the route of high-speed works is one of the essential principles of ADIF within its policy of Corporate Social Responsibility. This not only evidences that infrastructure works of a very high value for the economic and social progress of a

	<p>country and other companies can help to the discovery of new paleontological heritage, but also that they can invest money to help to recover and promote this heritage.</p>
QUESTIONS	<ol style="list-style-type: none">1. What must prevail: the economic and social benefit of a new (necessary) infrastructure or the conservation of the nature (which is indeed a social benefit as well)?2. How can be predicted the location of new fossil sites?3. Why are the works on infrastructure usually considered a threat to paleontological heritage?4. What is the effect of having temporary works on infrastructure construction in parallel with excavations?5. How can the works of infrastructures contribute positively to the paleontological heritage?6. What are the possible consequences of human activities, carried out in "Lo Hueco", in the geosphere and, consequently, in the Earth system?7. What is the consequence for the local community to have an excavation and a railway work in the same place?8. To what extent can geoethics values and principles help to solve this conflict?
PROCEDURE	<ol style="list-style-type: none">1. The preparation for this activity should use the information available in scientific publications and media (newspapers, photos, TV videos, and others) most of them provided in the section references and links.2. Watch the video pill: "GOAL: Geoethics issues and geoethical dilemmas" – https://youtu.be/1KBFAqMMnpo.3. Virtual fieldtrip:<ol style="list-style-type: none">a) Use _____ of _____ the _____ website (https://www.dinosauriosdecuenca.es/centro-expositivo-fuentes/vertebrados) of the interpretation center in Fuentes for a virtual fieldtrip.b) Start a plenary debate with students facilitated by the teachers about the Late Cretaceous fossil site of "Lo Hueco". The plenary debate will start with the participation of all students and teachers and, if possible, with paleontologists and personnel from the Administration (these latter related with this real case as much as possible).c) The debate should finalize with only the presence of the students and the teacher to discuss ideas in an environment with no external pressure. <p>Important links:</p> <ul style="list-style-type: none">• https://www.diariosur.es/20071106/sociedad/descubierto-cuenca-mayor-yacimiento-20071106.html• https://www.20minutos.es/noticia/300060/0/cementerio/dinosaurios/fuente/

- <https://www.europapress.es/castilla-lamanca/noticia-yacimiento-hueco-fuentes-cuenca-mas-importante-dinosaurios-peninsula-iberica-20071031160450.html>
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