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Phil Manning, geologist of Manchester University

“Scanning dinosaur prints allows us to study them in the greatest detail”

Phil Manning, Lecturer at the University of Manchester, visited the Universitat Autònoma de Barcelona to present, together with researchers from the Catalan Institute of Palaeontology (ICP), a summary of the results obtained during the first phase of the *Iberian Dino Track Tour*. This is a tour of the Iberian Peninsula (Spain and Portugal) in which palaeontologists from both institutions document and use laser technology to scan ichnite fossils left by dinosaurs millions of years ago, and which are now candidates for World Heritage sites. But the interesting thing about this project is that once we have the scanned footprints of these creatures we can tell what height they were, the way and the speed at which they moved. They even show that in Catalonia lived one of the largest species of dinosaur: the Titanosaur. Dr. Manning tells us that the scanning and recording technique LiDAR (Light Detection and Ranging) has revolutionised the study of footprints and the conservation of traces of the past.

Dr. Phil Manning leads the Palaeontology Research Group in the School of Earth, Atmospheric and Environmental Sciences (SEAS) at the University of Manchester. His research includes international projects in Europe, New Zealand and North America. The breakthroughs of the research group have attracted attention worldwide, especially those involving the palaeontology of vertebrates and invertebrates from a multidisciplinary perspective. They have adapted existing techniques to the analysis of locomotion, biomechanics, paleobiology, proteomics, and the forms and function of muscular-skeletal disorders in extinct vertebrates. The current research programme in the palaeontology of vertebrates began in October 2000 with the LiDAR Project at Fumanya (Berguedà, Barcelona). This project is based on 3D digital photography of field discoveries.

Let's talk about your technology. What is LiDAR?

LiDAR is based on laser scanning technology. It works in the same way as a photocopier but in this case it obtains the image of an object in 3D. By scanning specific area of ground it not only localises two or three point in space, but also hundreds of thousands every second, which are combined to form geo-referenced images. Thanks to the high quality obtained we have been able to localise dinosaur footprints. Previously, the use of classical photography was a problem because it obtained only two-dimensional images of objects, while ichnites were three-dimensional! It is therefore the most advanced technological system today for making recordings of the ground and everything in it.

Originally, LiDAR had a geological application centred on petroleum prospection. But now, the palaeontologists have found it to be extremely useful. Why?

LiDAR has been extremely useful in many disciplines for years. For example, the police have used it to record crime scenes and meteorologists have used it for their forecasts. In the case of palaeontologists, they have been able to scan the ground and the ichnites within it, as well as entire skeletons which would have taken an extremely long time to do in the past. Now we can scan a whole dinosaur in 15 minutes, with the corresponding analysis of its body mass using the computer. I sincerely believe that we still do not know the full potential of LiDAR fro palaeontology. It is a very useful tool, but just like any other, if you use it properly and broadly, you can obtain very valuable information. And we are currently engaged in that learning curve...

And that is how *The Iberian Dino Track Tour*. What is the role of LiDAR in this project?

The important thing about LiDAR is that it does not just allow you to scan and record land in three dimensions, but it also allows you to analyse it in detail. In other words, in the case of fossilised footprints found throughout the Iberian Peninsula, it is very normal to find two or three thousands prints in very close proximity to one another, making the task of understanding exactly what happened there very difficult. That is why our technology allows us to extract a single print, analyse it, and obtain results which otherwise – in a joint analysis – could be confusing. LiDAR also allows us to work at a distance, which is an essential characteristic for working in difficult terrain. If we take the locality of Fumanya (Berguedà, Barcelona) as an example, and we go back to the time when Africa collided with Europe, we can understand that is what caused the

inclination of the land. That is very interesting but it also presents a problem: it forces us to use a climber to study the prints located in the high part of the mountain. Climbing Fumanya is risky because the rock is very delicate and the ichnites could become damaged. This means we have to have a remote system of observation and recording.

What led you to start up this project?

When I began working at Manchester, I realised that I could make a valuable contribution to the work of the palaeontologists. So 4 years ago, after having attended a conference in Fumanya and observed the prints, I thought that I could and should bring Fumanya and LiDAR together. That is how our work with the Catalan Institute of Palaeontology (ICP) began and it has turned out to be a very fruitful working relationship. . However, I must admit that it was also a stroke of luck: we were there at the right time, with the right people – Bernat Vila, Albert Oms… - and above all, we have received great support for the project. Also, given the quantity and great value of your ichnites and I didn't hesitate in joining the project for a moment.

Why are the fossilised footprints in the Iberian Peninsula so valuable? What distinguishes them from those found in other places in the world?

You are simply very lucky. To study dinosaurs, the first thing you need are rocks which are still exposed from a specific period – Triassic, Jurassic or Cretaceous. And here you have all that. Moreover, you also need to know the terrestrial habitat in which these animals' lives, and although the bones give you this information, it is very common that they become displaced from their original sites over time. With prints this does not happen, and this offers us reliable information about where these creatures lived. In the Iberian Peninsula environmental conditions have enabled conservation of the prints for hundreds of thousands of years, in different ways. I have travelled around the world – to Africa, North America, South America, Asia... – and I have had the opportunity to see high quality ichnites, but the ones that here are undoubtedly the best in the world.

And what kind of information do we obtain through the study of ichnites?

We can study the locomotion of the animals, understand how they moved their limbs and at what speed. In fact, from the shape of the ichnite it is possible to establish a relationship between the bones and find out the animal's height, as well as the relative positions between them. It is incredible the amount of information you can get from a single footprint, given it takes you back to a time millions and millions of years ago when these creatures were still living.

I imagine, though, that the added value of these footprints and your technology is the capacity from documentation...

In the past, when many scientists went to certain location sin Fumanya and took photographs, there was the danger of returning with little material. For example, a photograph taken at a poor angle meant that you had to go back and do the work again. That doesn't happen with LiDAR. You can even exaggerate the dimensions and analyse them in greater detail. And most important of all, you can do it when and wherever you like. It is a very powerful tool. That is why we are

hoping to be able to scan and record all the prints in the Iberian Peninsula that we possibly can, and guarantee their preservation. You have to remember that all this information could disappear as a result of erosion over the years, and that is terrible! The most fascinating thing about this technology is that it allows you to freeze time and history.

And what have the first results been like?

The first results that we have obtained have been incredibly exciting; in particular those from Fumanya have shown us a great deal about the Titanosaurs – a really huge species that lived during the late Cretaceous period (65 million years ago). In fact, we have already published three articles about the locomotion of these animals and today, not only do we know the speed at which they travelled, but also they way in which they did so.

And what will be the next step in your research?

We have an article that is about to be published in which we have discovered how to use the computer to generate the movement of the dinosaurs and see how the skeleton moves. It's amazing. We can therefore create virtual footprints with the computer and compare them with those we have observed on the ground (in Fumanya and other locations in Spain). Using both types of footprint we cab understand the functions of the bones and obtain an even more complete image of the movement of the dinosaurs.

What future applications will all this information have?

Dinosaurs are very complex creatures that allow us to resituate ourselves in space and understand a little more about certain fields of science. For example, studying how the bones have survived in extreme conditions can perhaps enable us to understand our own bones. In fact, we are currently working with biologists, engineers, physicists and chemists – different disciplines that apply the technology developed in the study of dinosaurs to other area of science. If we want to understand the past, we need to start by understanding why the dinosaurs became extinct 65 million years ago. They lived during 165 million years and were the most successful group of vertebrates that has ever lived on earth. So if we want to understand what is happening with our own species in the 21st century, with mass climate changes, we need to take a look at our past. Because is really the key to the future.

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