Bringing deep-sea ichnology into the classroom using IODP Expedition 339 core digital images

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Introduction
Although the most known ichnospecies are vertebrate footprints (particularly dinosaurs), ichnology encompasses the study of all trace fossils such as burrows produced by marine organisms in soft sediments. Several authors have conducted trace fossil research analyzing deep-sea cores obtained during Ocean Drilling Program (ODP), Deep Sea Drilling Project (DSDP), Integrated Ocean Drilling Program, and International Ocean Discovery Program (IODP) expeditions.

These international scientific ocean drilling programs have now operated over 50 years resulting in a huge collection of high-quality deep-sea sediments cores. IODP Expedition 339 had two inter-related objectives to recover continuous sedimentary sequences for (i) studying the Contourite Depositional System (CDS) formed by the Mediterranean Outflow Water (MOW), and (ii) reconstructing North Atlantic climate variability on orbital and suborbital time scales.

Methods
We present an adaptation of the three step methodology proposed by Droser et al. (2014a,b) that included some image adjustments to improve the trace fossils visualization (B1). Next we propose the determination of the degree of bioturbation (B2), and finally the identification of ichnotaxonomic structures (B3).

This methodology is really easy to implement even by non-specialists, such as secondary school students and teachers.

B1 | Enhancing the colours of the high-resolution core photos and digital images

Using GIMP (GNU Image Manipulation Program) - there is a great variety of adjustments such as balance, brightness-contrast, threshold, levels, curves to enhance the colours of the high-resolution core photos and digital images GIMP - We propose a sequence of adjustments (levels, brightness and saturation) to increase the visibility of the trace fossils (Figure 1).

B2 and B3 | Bioturbation quantification and identification of trace fossils

To estimate the degree of bioturbation ichnologists commonly use indices such as bioturbation and ichnofabric indices (e.g. Droser and Benzer, 1998; Taylor and Goldring, 1993). This approach has become a very useful tool in paleoenvironmental reconstruction studies. Several authors (Weisbrod and Uchman, 2012; Knaust, 2017) have detailed descriptions of the most common trace fossils in marine cores.

Some examples

The Zoophycos ichnocoenosis (Figure 5). Trace fossils include: Chiocodina (C), Canavalia (N) – commonly use index (A), Phycosiphon (Pb), Planolites (A), Scorches (S), Uvigerina (U), Thiolarthrus (T), and Zoophycos (Z).

Cross-cutting relationships

Bringing deep-sea ichnology into the classroom

Methods

Fig. 1. IODP Expedition 339 core in the Gulf of Cadiz sediment core, shown yellow solid circles

IODP Expedition 339 recovered 5447 m of core (Figure 1). Once the 0.5-meter long cores arrived from the seafloor, the technicians labeled and cut them into 1.5-meter sections. Next, they split the cores into two halves, the “working half”, which scientists sample and use aboard the drilling platform, and the “archive half”, which is kept in unscothched condition after being visually described and photographed with a digital imaging system (Figure 2).

This work presents some examples of how high-resolution IODP Expedition 339 core digital images, available through the LIMS online database, can be used to explore the 19th of bioturbation in marine sediments.

Methods

A | Looking for info and downloading the core photos and digital images

Reading the Expedition Proceedings Volume (Figure 3) is always a good way of starting collecting information about it. Then, it is time to download the cores photos and digital images from the LIMS online database (Figure 4). There are several types of photos and images that can be downloaded, such as whole-core photos, digital images of core sections and close-up photographs.}

Fig. 1. IODP Expedition 339 Proceedings Volume

Fig. 2. Section half Imaging Log (sIL) aboard the JOIDES Resolution

Fig. 3. IODP Expedition 339 Core Database

Fig. 4. LIMS database Online Reports