Geophysical Research Abstracts
Vol. 21, EGU2019-4787, 2019
EGU General Assembly 2019

Facies characterization based on physical properties from downhole logging data: a case study for the ICDP drilling project Lake Junín, Peru

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The key objective of most lake drilling projects is to retrieve drill core for reconstruction of paleoenvironmental conditions based on the sedimentation history. Such studies help to define past climate changes in space and time in order to understand current environmental processes and to provide input parameter for modelling future climate scenarios. The type of sedimentation and geophysical properties of lacustrine lithological units can be investigated with different measurement techniques on core samples and by downhole logging data. However, downhole logging data are rarely used to contribute to specific scientific research tasks in lacustrine projects, although they allow the determination of lithological, mineralogical and stratigraphic properties of the rocks and sediments especially in sections with larger lithological gaps or poor core recovery. Additionally, a well-log cluster analysis allows to construct a lithological profile, called the electrofacies log, which commonly has a higher vertical resolution than an initial visual core description and is valid even in long and frequent core gap sections. The purpose of this cluster analysis is to look for similarities/dissimilarities between data points in the multivariate space of logs and to identify zones with uniform values in each log, in order to group these features into electrofacies classes. In the framework of the International Continental Scientific Drilling Program, ICDP, a scientific drilling campaign in Peru has been supported during summer 2015. The ICDP Lake Junín Drilling Project aims to obtain high-resolution paleoclimate records from lacustrine sediments, to reconstruct the history of the continental records covering the glacial-interglacial cycles. Lake Junín (known also as Chinchaycocha) is located at 4000 m a.s.l. in the tropical Andes of Peru and is characterized by a thick sediment package (> 125 m) deposited at a high rate (0.2 to 1.0 mm/yr). Drill cores were recovered from three drill sites. After the completion of each coring operation, a full suite of downhole geophysical logging was performed in five of the 11 boreholes (1A, 1C, 1D, 2A and 3B) by the Operational Support Group of ICDP. Characterization of the physical properties of the lithologies by the use of cluster analysis allows to reconstruct a continuous lithological profile of the sedimentary record of Lake Junín. An electrofacies represents a unique set of log responses, which characterizes the physical and chemical properties of the rocks and fluids contained in the volume investigated by the logging. The downhole logs have been divided into cluster units determined by a dendrogram. Three major groups (carbonate-silt, peat and silt) have been identified by spectrum gamma ray, magnetic susceptibility, and p-wave velocity logs. With this method we are able also to attribute the lithology in correspondence of core gaps. By the end the properties of the clusters are analyzed and converted into lithological units according to the lithological information from the visual core description.