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Investigating glacial/interglacial cyclicity from downhole logging data and mineralogical composition: an example from the ICDP drilling project Lake Junín, Peru

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Reconstructing the history of continental records covering the glacial-interglacial cycles was the main objective of the ICDP Lake Junín drilling project. Located at 4000 m above sea level, Lake Junín is characterized by a thick sediment package (>125 m) deposited with a sedimentation rate of 14-15 cm/kyr. In fact, the lake predates the maximum extent of glaciation, and is in a geomorphic position to record the waxing and waning of glaciers in the nearby Cordillera. Drilling was performed in 2015 at three sites and a suite of downhole logging measurements were applied. Downhole logging measurements were used to recognize the glacial and interglacial cycles, to reconstruct an age–depth model, to estimate sedimentation rates and to identify electrofacies. Initially, we investigate the consistency of cyclic sediment behavior and see that the interval from ~30-90 m shows a rather stable cyclicity with a wavelength of ~10 m. Natural and spectral gamma ray data were used for cyclostratigraphic analysis, and the astronomical spectral misfit (ASM) method was used to reconstruct the sedimentation rate. The results indicate a sedimentation rate of about 5-20 cm/kyr in the Lake Junín record. Furthermore, the TimeOpt method was applied to test for a fit of precession amplitude with eccentricity; it results in an average sedimentation rate of 15 cm/kyr. Both ASM and TimeOpt are astronomical testing approaches for untuned stratigraphic data in the depth domain that comprehensively evaluate a range of plausible time scales for the deposition history. This method suggests a good fit of the precession amplitude and an eccentricity filter when applying an average sedimentation rate of 14-15 cm/kyr. Based on these information on sedimentation rate, we establish a correlation of the spectral gamma ray data to the LR04 benthic isotope stack. In addition, the downhole logging data were used for cluster analysis to construct a lithological profile, called the electrofacies log. 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 to attribute the lithology in correspondence of core gaps. Finally, the properties of the clusters are analyzed and converted into lithological units according to the lithological information from the visual core description or mineralogical analysis or core material. To achieve this, 68 samples were taken in total from two core runs, in order to compare and characterize the minerals in the lake sediments at different depths. The mineralogical analyses performed by X-ray diffraction (XRD) show quartz, calcite, feldspar and clay minerals. The clay size fraction (< 2 micron) contains illite, smectite and kaolinite

in different amounts. Linking the abundance and the lack of clay minerals in core samples with the downhole logging data, a relationship between geological history of the lake and climate change processes can be recognized. Consequently, the different mineralogical composition of the sediments, especially the presence or absence of smectite in the clay bulk, reflects a glacial/interglacial climate cyclicality.