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Genesis of non-annual laminae in Holocene sediments from the southern Gulf of California: Their relation with ENSO events

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The sediment sequence of Alfonso Basin in the Bay of La Paz, southern Gulf of California spanning the last 8000 years is characterized by a laminated structure, consisting of alternating millimeter to sub-millimeters layers of olive gray shades. Microfossil (radiolarians), geochemical (major elements and organic-chemical parameters) and magnetic mineral analyses are used to characterize the laminae and investigate on their genesis. Radiolarian assemblages suggest that light laminae represent episodic pulses of high productivity in the Alfonso Basin. Changes in radiolarians composition in dark laminae record penetration of warm waters (Equatorial Surface Water) into the Bay of La Paz, most probably during ENSO events. Dark and light laminae show similar chemical compositions and magnetic minerals properties. Silica correlates with terrigenous elements (Al, Fe, K and Mg) supporting an origin related to the volcanic siliceous tuffs around the Bay of La Paz. Dark laminae contain relatively more silica and aluminium that support formation when terrigenous input increases. Calcium content is higher in light laminae and mostly represents biogenic input. Measures of total organic carbon and hydrogen index suggest good quality and preservation of marine organic matter in both laminae, as a result of low bottom water O_2 contents. Hysteresis ratio parameters show samples fall in the PSD region, indicating mixtures of SD and MD particles. Variations in hysteresis saturation magnetization parameters for dark and light lamina reflect changes in relative mineral concentration, with magnetic signal dominated by low coercivity fine-grained low-titanium titanomagnetites and magnetite. We propose that dark/light lamina result from paleo-oceanographic

and paleoclimatic cyclic processes, with main terrigenous input variation associated to ENSO forcing pluvial influx. Then, the laminated sequence of Alfonso Basin formed a non-annual depositional system with ENSO cyclicity, in contrast to the varve seasonal laminated sediments characteristic of the central Gulf of California basins.