Geophysical Research Abstracts
Vol. 16, EGU2014-7405-2, 2014
EGU General Assembly 2014

The relationship between magnetic mineralogy and redox conditions in Baldeggersee

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Many factors contribute and later influence the iron mineralogy in lake sediments, such as catchment geology, climate, and redox conditions in the water and sediment column. Reidar Lovlie was one of the earliest paleomagnetists to examine these factors. Local redox conditions especially play an important role when magnetotactic bacteria are the main source of ferromagnetic grains in the lacustrine sediments. Baldeggersee, a mid-sized lake, which formed in the Molasse Basin of Switzerland during the last glacial retreat, has been shown to undergo extreme anoxia in the past century due to eutrophication. A reliable indicator for anoxic conditions is the preservation of seasonal varves. Previous studies using core transects confirmed that the anoxia intensified during the first half of the 20th century affecting shallower lake areas until oxygen was pumped into the lake as part of a lake restoration program that started in 1982. Two short sediment cores were taken at two different water depths in fall, 2010 to investigate how magnetic mineralogy is affected by the anoxic conditions, which have a different timing at the two coring sites. Both the magnetic properties of sediments and their remanent magnetization were determined. Core BA10-04 was taken from the deepest part of the lake, with a water depth of 61 m. The 85 cm core records the anoxia from its onset around 1910 until the restoration measures in 1982. The second core, BA10-01 is 58 cm long and was taken from intermediate water depth of 35m. At this depth it is postulated that anoxic conditions did not affect the shallower water depth until ca. 1935. A total of 75 samples were taken from BA10-04 and 50 samples from BA10-01. Rock magnetic experiments show that magnetite is the only ferromagnetic phase in both cores. Before 1900 analysis of first-order reversal curves indicate that magnetite is biogenic in origin. After 1900 there is a rapid decrease in the concentration of magnetite, and it occurs as clusters of grains rather than in chain configuration. There is also an increase in paramagnetic iron minerals as the anoxic conditions persist. Although anoxic conditions start later at shallower water depth, the magnetic properties of the lacustrine sediments in BA10-01 show a decrease in magnetite concentration before a decrease is seen in BA10-04. Deposition of paramagnetic iron, however, only starts with the appearance of varves. These results suggest that there is not a simple correlation between the presence of biogenic magnetite and redox conditions.