Geochronological Dating of Sediments from Pallanza Bay

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Introduction: using methods developed by Goldberg (1963), Krishnaswami (1971) and Robbins et al. (1978), lead-210 (^{210}Pb), and cesium-137 (^{137}Cs) geochronology measurements were used to examine environmental changes over the last 50 to 100 years and to develop historical records of chemical loading to sediments. These sediment and chemical dating techniques have been applied successfully in aquatic systems in Europe and North America (Callender and Robbins 1993, Albrecht et al. 1998, Van Metre et al. 1997).

As part of a series of investigations being carried out by ENVIRON in Lake Maggiore (Italy), ^{210}Pb and ^{137}Cs analysis was undertaken to better understand the sediment accumulation rate in the Pallanza Bay area of Lake Maggiore, and well as to examine historical trends in the accumulation rate of DDT and mercury in Lake Maggiore sediment. The assessment of linked geochronology and chemical data improve understanding of sedimentation behavior in Pallanza Bay, as well historical trends in chemical loading to the Bay.

Methods: In 2009, ENVIRON collected sediment cores from 9 stations in Pallanza Bay (Lake Maggiore, Italy). These stations were chosen to span a range of likely sediment accumulation rates. Coring relied on alightweight sediment-water interface gravity corer. . For each station, the sediment accumulation rate was determined based on the activity of ^{137}Cs and ^{210}Pb in 2-4 cm depth increments of each core. Cores recovered for assessment of sediment accumulation rate were also analyzed for the organic chemicals of concern DDT and HCB.

Results and Discussion: Based on the depth profile of ^{137}Cs, a peak corresponding to 1986 is apparent in all 9 cores, at a depth that varies from 9 cm to 86 cm. A ^{137}Cs peak corresponding to 1963 is apparent in 7 of the 9 cores, at a depth that varies from 20 cm to 78 cm. The 1954 horizon, marking the initiation of atmospheric weapons testing, is apparent in 5 cores, at a depth that varies from23 cm to 89 cm. Overall, the sediment accumulation rate in Pallanza Bay, as determined from ^{137}Cs activity, ranges from 0.4 cm/y to 3.7 cm/y, depending on station location in the Bay.

For ^{210}Pb analysis, as defined by the relationship between unsupported ^{210}Pb activity and depth, sediment accumulation rates range from 0.4 cm/y to 3.1 cm/y, and are generally consistent with sediment accumulation rates as determined by ^{137}Cs activity. Moreover, as is also evident from the both the ^{137}Cs and ^{210}Pb data, the accumulation rate of sediment within each core can vary significantly across discrete depth sections.

Coincident with determination of ^{137}Cs and ^{210}Pb activity in geochronology cores, ENVIRON also collected samples for analysis of DDT and mercury concentrations in sediment. In these cores, concentrations of DDx and mercury have overall declined significantly relative to both the highest measured concentrations of each analyte at depth, as well as relative to concentrations measured contemporaneous with the 1986 peak in ^{137}Cs activity. For DDT, the most significantly elevated DDT concentrations occur in the general period of the mid-1960s; in sediment deposited prior to the mid-1960s, DDT concentrations are significantly lower and approach the analytical detection limit in the interval prior to the 1954 inflection point in ^{137}Cs activity.

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