RECENT SEDIMENTATION RATES AT LAGUNA DEL PLATA (CORDOBA, ARGENTINA) USING THE Pb-210 DATING METHOD

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Keywords: Pb-210 dating method, lacustrine sediments, sedimentation rates.

INTRODUCTION

The Laguna del Plata (62°51'45"–30°54'38"; Córdoba, República Argentina) is a small saline lake connected to the Laguna Mar Chiquita. The Suquía River is the only tributary and produces a dilution in the water salinity, as compared to the main lake. The lake probably originated about 30.000 years B.P. (Martinez, 1991).

The most striking feature of the system is its marked water level fluctuations, which define low level (LLP) and high level periods (HLP). For example its surface area increased from 1,960 km^2 in 1977 to 5,772 km^2 in 1982 (Reati et al., 1992). During LLP the Laguna del Plata could become isolated from the Laguna Mar Chiquita.

In this paper we are presenting the study of a sediment core obtained in the Laguna del Plata. These results are a part of a wider research project that includes the whole Mar Chiquita lacustrine system.

MATERIALS AND METHODS

An 80-cm long sediment core was extracted in November 1997, using a Beeker-type sediment sampler (Eijkelkamp), at a water-depth of 3.6-m. Bottom sediment grab samples were also collected using a Van Venn-type dredge.

Sedimentary structures were identified in X-ray radiographs of the cores, which were then split in two halves in the laboratory. Inverted tonalities in the X-radiograph were measured using a densitometer.

Grain-size analyses of sediments were performed using a ZM model Coulter Counter particle analyzer. Textural parameters are those of Folk and Ward (1957).

The measurement of the radionuclides ^{226}Ra and ^{210}Pb were used to determine the dates and sedimentation rate.

Those radionuclides were determined in each slice of the core (García-Tenorio, 1986). The samples of sediments were dried at 60°C and sifted in sieves of 0,065 mm after dry. Then the samples were dissolved in mineral acids, HNO_3conc., HF 40%, H_2O_2 30%, in microwave digestor and submitted to the radiochemistry procedure for the determination of Ra and Pb.

This procedure consists in an initial precipitation of Ra and Pb with H_2SO_4 3M, dissolution of the precipitate with nitrilo-tri-acetic acid at basic pH, precipitation of $Ba(^{226}Ra)SO_4$ with ammonium sulfate and precipitation of $^{210}PbCrO4$ with sodium cromate 30%.

The ^{226}Ra concentration was determined by gross alpha counting of the precipitate of $Ba(^{226}Ra)SO_4$ (Oliveira 1993) and the ^{210}Pb concentration through its decay product ^{210}Bi, by measuring the gross beta activity of the precipitate of $^{210}PbCrO_4$ (Moreira, 1993). Both radionuclides were determined in a low background gas flow proportional detector.

The dates were calculated by the model CRS by Ivanovich and Harmon (1992).

CHARACTERISTICS OF SEDIMENTS CORE AND RESULTS (Fig. 1)

Sediments exhibit very fine parallel lamination. Grain sizes are dominantly silt and clay, indicating the prevalence of settling processes. Fine sand content is sparse in few levels of the core, and its provenance is related to Río Suquía stream. Mean grain-size ranges from 4.5 phi to 10.6 phi (Table 1). According to the classification proposed by Pejrup (1988), flocculated sediments are dominant with subordinated mechanic silt (Table 1 and Fig. 1a). Those core levels where finer grain-sizes are dominant are also enriched in organic matter. This is illustrated by dark laminae in the inverted color X-ray radiograph (Fig. 1b).

Isotopic ages are listed in Table 1. The ^{210}Pb profile (Fig. 1c) depicts a well-defined linear trend from level 0 cm (year 1997) to level 36 cm (year 1941). These results indicate an accumulation rate of 0.6 cm.y^{-1}. The lowermost dated level (52-cm) yields a sedimentation rate of 0.7 cm.y^{1}. Both rates are minimum theoretical rates because no subaerial-exposures of the lake floor were considered.

Water level values of the lake were took into account for years corresponding to ^{210}Pb data (Fig.1d). Departures from the mean lake water level (66.5 m a.s.l.) are expressed as positive values during HLP (levels above the mean) or negative values during LLP (levels below the mean). Water levels were obtained from a report made in by the Universidad Nacional de Córdoba (1988).

Although water level data is reliable for the 1967-1997 period, a LLP could have occurred during 1936-1954 (partially supported by local knowledge). Parts of these years are represented in the core below 36 cm, thus matching with the ^{210}Pb anomalous values. This fact could be attributed to lead enrichment due to long-time subaerial exposure of the lake floor during extreme dry periods. This hypothesis will be tested.

Two sedimentation rates can be defined when considering present-day HLP and the last LLP of the lake. The HLP is represented from 0 cm (1997) to 12 cm (1978) and has a sedimentation rate of 0.6 cm.y^{-1}.

The LLP is represented from 14 cm (1972) to 20 cm (1964), and has a higher accumulation rate than the previous one, in the order of 1.0 cm.y^{-1}.

The grain-size record of a lake may be a proxy of past climate changes. In the core, those levels with high percentage of flocculated material and high sedimentation rates represent LLP. Well known are dust storms in the area during dry periods that rise the amount of wind-transported sediment that settles down in the lake. Otherwise, during LLP the Laguna del Plata may become disconnected from the main lake, disabling the fluvial fine sediments dispersion to the main lake.

The sand increase in the first centimeters of the core is related to the movement of fluvial sandbars in the mouth.

Depth (cm)	^{210}Pb age	Depth (cm)	Sand	Mechanic silt	Flocs	Mz
0	1997	3	57.5	14.4	28.2	4.4
2	1996	10	6.0	24.9	69.1	7.2
4	1991	20	1.7	19.4	78.9	8.1
6	1986	30	1.3	31.7	67.0	7.1
8	1979	37	1.6	16.0	82.4	9.3
12	1978	39.5	1.3	24.6	74.1	7.9
14	1972	44	0.0	4.1	95.9	10.1
16	1969	48	0.0	1.3	98.7	9.7
18	1968	49.5	0.0	3.2	96.8	10.6
20	1964	51	0.0	5.1	94.9	10.2
22	1962	55	0.0	8.2	91.8	9.4
24	1960	58	0.0	18.4	81.6	7.8
26	1957	61	4.5	13.1	82.3	7.0
28	1959	70	0.0	13.5	86.5	6.5
30	1952	71	0.0	33.5	66.5	6.0
32	1950					
34	1943					
36	1941					
38	1950					
40	1960					
42	1966					
44	1967					
46	1966					
48	1957					
50	1935					
52	1923					

Table 1: ^{210}Pb ages and textural compositions (%) for core levels.

CONCLUSIONS

Although a sedimentation rate at Laguna del Plata is estimated to range between 0.6-0.7 cm.y^{-1}, rates differ according to the water level of the lake. During LLP sediment accumulation is fast and finer than during HLP. This could be a consequence of direct settling to the lake of fine sediments transported by eolian processes. Moreover, the disconnection of the Laguna del Plata from Mar Chiquita during LLP hinders the

dispersion of silt and clay to the main lake. These periods are also characterized by an increase in the organic matter content that helps in floc formation.

The presence of fluvial sand may be related to the growing of bars in the river mouth during wet periods. An striking ^{210}Pb anomaly (38 to 50 cm) is probably produced by the subaerial exposure of the lake floor.

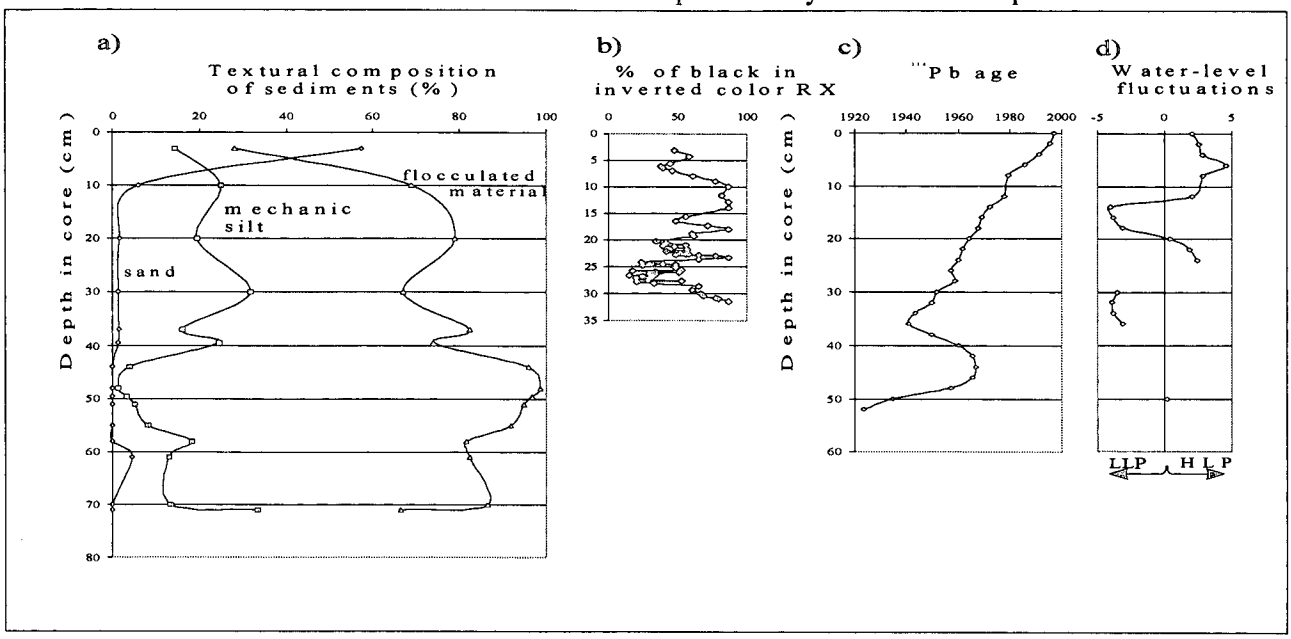

Fig.1: a) Textural variation of sediments along the depth core; b) percentage of black measured with a densitometer; c) age-depth relationship for the core; d) water level fluctuation, zero value corresponds to mean lake level

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