Geophysical Research Abstracts, Vol. 8, 06595, 2006
SRef-ID: 1607-7962/gra/EGU06-A-06595

Preliminary analysis of water balance of an ice-contact lake: the Miage case (Italian Alps).

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Miage Lake (Mont Blanc, Italy) is the oldest known Italian calving ice margin with over two centuries of historical observations, iconography and field surveys, dating from the time of De Saussure (1786). This rich record allows lake evolution to be reconstructed and calving processes to be understood. Miage is an ice -contact lake on the right-lateral side of debris-covered Miage Glacier (Mont Blanc Massif), at 11 km2 the third largest Italian glacier by area. The calving margin is 200 m long and averages 30 m high, a vertical surface of c. 6,000 mˆ2. The lake surface area is c. 36,000 mˆ2. On the last four years field surveys were performed and they permitted to identify the main processes leading to iceberg production and quantified the calving losses. The lake is also famous for its periodic emptying episodes, which occurred several times in the XX century. The last one occurred in September 2004 and it offered the occasion to observe and the lake floor; in addition it has given a unique opportunity to study the hydrological and hydrogeological characteristics of an ice-marginal lake. The investigations performed in the lake area embraced both glaciological and hydrological -hydrogeological surveys with the following aims:

-to quantify the lake volume and the floor morphology for contributing to the knowledge of calving phenomena;

-to evaluate the dynamics of water fluxes entering the lake, according to its multipond structure;

-to determine the hydraulic connection between each pond;

-to determine water discharged by the glacier in the lake and water discharges exchanged through the ponds;

-to test fine materials layering at the bottom of the ponds to determine water loss through it.

During the last emptying was possible to investigate the lake floor and to map by DGPS its morphology. Moreover in spring-summer 2005 several field surveys have been done, in particular: a) double ring infiltrometer tests on the fine soils at the bottom of the ponds to determine their hydraulic characteristics; b) laboratory tests to determine main physical properties of fine soils; c) water level monitoring at three ponds to control the filling phase of the lake occurring during the study period; d) tracer test to check groundwater fluxes among the basins and to determine hydraulic properties of glacial interbasins material. The lake system have registered an average incoming discharge of about 1700 m3/d, with a maximum of more than 5000 m3/d. deriving from glacier melting. These discharges are almost completely due to glacier melting because of the lack of precipitation in the monitoring period. Through a numerical modelling, water losses have been estimated of about 180 m3/d. These losses are not high and insufficient to cause the complete drainage of the lake, also in long lasting period of low glacier melting; in this situation only few meters of drawdown could eventually occurs. Water level monitoring and tracer test shown a strong underground hydraulic connection through the main ponds, up to 3500 m3/g,. This fact avoid the formation of great hydraulic head difference between ponds and the consequent development of high seepage pressures on their boundaries, formed by morenic materials, which maintain a general good stability. The activities have also allowed to accurately define the dynamics of lake filling, with the reconstruction of flow path from the glacier to the surficial emissary of the lake, and to obtain important information also on fast lake drawdown. Moreover the contribution of calving losses to the lake volume has been quantified and compared with the other inflow water discharges.

This work is supported by the Italian Ministry of University and Research through the funds for the Research COFIN 2005.