Geophysical Research Abstracts, Vol. 8, 10146, 2006
SRef-ID: 1607-7962/gra/EGU06-A-10146

3D modelling of the Tortin glacier (Switzerland) using gravity and georadar data

P. Chasseriau, V. Lattion, D. Hammami, F. Marillier, R. Olivier
(pierreeric.chasseriau@unil.ch)

For many years, a significant retreat of alpine glacier is observed. Some of them, located in touristic areas, are of special interest for ski resorts. The Study area is located at an altitude of 3000 m on north face of Mont Fort in Valais canton (Switzerland). The purpose of this work was to determine variations of the Tortin glacier (glacier tongue orientation: South-North) with time and space. Gravity and DGPS surveys were carried out in 2000, 2001, 2004 and 2005, and several in-line and cross-line profiles were acquired along the lower part of the glacier tongue. A total of 226 gravity stations were occupied, covering the entire northern part of the glacier. Because each measurement requires very accuracy positioning, altitudes were determined by DGPS with centimetric accuracy. This allows comparing the ice surface altitudes obtained over period of 5 years and also comparing the data with glacier altitudes deduced from existing topographic maps. One gravity survey in the summer of 2005 required a helicopter in order to estimate the regional gravity effect of peaks surrounding the glacier. More than 2 km of Ground Penetrating Radar (GPR, with frequencies of 50 and 100 MHz) profiles were acquired along some of the gravity profiles. Standard processing was applied to the GPR data (band-pass filter, gain, elevation static and migration). Common Mid Point (CMP) GPR data were also acquired to determine the velocity of electromagnetic waves of the ice. This velocity (0.18 m/ns) was used to convert the time profiles to depth. The bottom of the glacier is clearly visible on GPR profiles in spite of many diffraction hyperbola caused by trapped rocks, lodgement till or cavities within the ice. A Bouguer anomaly was calculated using a reduction density of 2800 kg.m-3 that represent the average density rock outcrops in the area. Terrain correction was calculated up to 3 km around the gravity stations using a 25 m DEM grid completed with our own DGPS data on the glacier. A regional anomaly was deduced using gravity data from mountains tops and valleys that surround the glacier. This regional

anomaly was calibrated with depth values obtained by the GPR sections. Because of a strong contrast between the ice density (900 kg.m-3) and the density of the bedrock (2800kg.m-3), a strong negative anomaly of 4 mGals is observed. Thus, rock and ice densities are accurately determined and the combined gravity and georadar surveys provide and efficient tool to estimate the ice thickness, our 2D density models are well constrained. The 3D bedrock was then interpolated under the glacier using several 2D profiles perpendicular to the glacier tongue. Preliminary results show a maximum ice thickness of 55-60 meters whereas DGPS surveys indicate ice melting of 1 meter/year. Once the geometry of the glacier is modelled, and estimation of the melted ice volume and of the remaining ice volume can be established.