Geophysical Research Abstracts
Vol. 13, EGU2011-1946, 2011
EGU General Assembly 2011

NMR Magnetic Resonance Sounding, a New Approach to Assess Englacial and Subglacial water content: A Pilot Study on Hansbreen Polythermal Glacier (SW Spitsberguen, Norway)

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Introduction: Polythermal glaciers are widely spread on sub-polar regions and middle latitude mountains, where water content data is needed to know ice dynamics.

Method: Magnetic resonance soundings (MRS) were done following a 3 Km profile on Hansbreen front. Data shows different signals amplitude on the Larmor frequency according to depth (loop surface related).

Results: For small loops (30 m square loop) amplitudes around 50 nV are common as well as some decay time (T^*_2) above 300 ms. Enlarging the loop size (60 m square loop) a decrease of the signal amplitude and decay time are observed (E_0 $<$ 20 nV; 100 ms $>=$ T^*_2 $>$40 ms). Increasing loop sizes (90 and 120 m square loops), an amplitude increase and very high decay time are recorded (30 nV; T^*_2 $>$500 ms) interpreted as subglacial free water (drainage tunnel or subglacial lake). Avaiable GPR data (Moore *et al*. 1999) show a water content of 2,5% on the cold-ice layer (the first 35 m depth) and 2% of water content on the tempered-ice layer but a 4% of water content can also be detected.

Discussion: Both geophysical methods are not convergent because some water content on ice is undetectable has relaxation times too short to be detectable with conventional MRS devices. In that sense the low T^*_2 time decays data from large MRS loops elucidates that at the tempered-ice layer water flows by seepage through veins and microfractures at a very low rate toward the glacier bottom and a large amount of free water is close to the cold/temperate transition surface. In the cold-ice layer large T^*_2 time decays are common because water flows through fissures or karstic like conduits. In summary, combining the MRS and GPR techniques gives glaciologists a powerful toolkit to elucidate water flow-paths on glaciers, supercooled meltwater content and subglacial water or aquifers.

Acknowledgements: To Piotr Glowacki Polish Academy of Sciences (Polar and Marine Research department of the Institute of Geophysics). To Jacek Jania and Mariusz Grabiec (Silesia University). To Doug Benn from the UNIS (Svalbard). To Anatoly Legchenko for his prudent conclusions. Many thanks for all those persons that directly or indirectly make that project possible.

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