The underbelly of ice sheets - studying the basal zone of ice sheets

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The build up and decay of ice sheets lowered and raised global sea level throughout the Quaternary as global climate cooled or warmed. Intense research since the last IPY revealed that ice sheets not only grow or shrink in response to climatic changes but also that ice sheets develop an internal dynamic, which itself interacts with the Earth’s ocean and climate system. This internal dynamic is highly influenced by the interaction of the ice sheet with subglacial geology and changing conditions at the ice sheet base as an ice sheet builds up or decays. In particular basal water interacting with the glacial bed plays a key role in facilitating fast ice streaming. Basal water flowing through a subglacial hydrological system not only reduces basal resistance and lubricates the ice sheet bed; it also provides an environment for life beneath the ice sheet. In return biogeochemical processes in the subglacial environment as well as the refreezing of basal water to the ice sheet base in some areas enable us to study subglacial hydrological processes despite the inaccessibility of the ice sheet bed.

Encouraged by preliminary results from limited basal ice, subglacial water and sediment samples obtained from the base of a West-Antarctic ice stream, we propose to study the subglacial environment and processes therein.

In a truly interdisciplinary effort, at the frontier of science, we will use, among others, biogeochemical tracers and direct visual observations to further our understanding of the subglacial hydrological system as well as life in this extreme environment. Using geochemical analyses of subglacial sediment and rocks as well as direct measurements of geothermal fluxes after sediment or rock core retrieval, we will further improve our knowledge about the nature of subglacial geology and its ice sheet interaction. This will address, among others, such important questions as the magnitude of geothermal heat responsible for basal melting; the existence of subglacial volcanic activity modulating regularly supplied geothermal heat and the origin, distribution and availability of subglacial sediment.

Boreholes from ice coring in Greenland and Antarctica already allow access to the subglacial environment for bedrock coring and limited subglacial samples retrieval. Incorporation of these studies in the design of new ice coring initiatives could allow the retrieval of pristine subglacial water and sediment samples in the future. Special sampling methods and sampling handling to obtain pristine samples are in particular important for the study life in this environment.

We believe that the study of the subglacial environment and processes therein are particularly suited for the IPY initiative, as these studies will revolutionize our view of ice sheets by turning them upside down, revealing their underbelly.