Biogeochemistry and subglacial meltwater limnology in East Antarctica: insight from microbial response with subglacial silica input in a perennially ice-covered lake at Rundvagshetta

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Since the discovery of subglacial Antarctic lakes by radio-echo sounding in the late 1960s, numerous subglacial lakes including extensive networks of subglacial meltwater channels (e.g., Anderson et al., 2002; Wingham et al., 2006) have been identified during the past two decades (e.g., Priscu et al., 1999; Christner et al., 2006). To date, Siegert and co-workers compiled an inventory of 145 subglacial lakes beneath the East and West Antarctic Ice Sheet (Siegert et al., 2005). The subglacial water, which is initially derived from melting due to geothermal heat (heat flow rates, ~50 mW m^{-2}; Siegert et al., 2012), is involved in various water-rock interaction processes beneath the ice sheet, and these interactions play important roles in the supply of nutrients, including trace metals, to organisms in Antarctic environments.
Firstly, silicon (Si) is one of the critical elements limiting the growth of Antarctic diatoms (e.g., Nelson and Treguer, 1992), likewise nitrogen and other elements (e.g., Hutchins and Bruland, 1998). Moreover, glacial Fe inputs including particulate and dissolved Fe are significant as a biologically essential element to the Southern Ocean (Raiswell and Canfield, 2012). In addition to nutrient input by seasonal snowmelt, subglacial meltwater flowing through channels may influence the productivity and diversity of microbial communities by controlling the concentrations of nutrients and the physico-chemical conditions of glacial environments. Secondly, glacial lakes affected by subglacial water input can be observed at the retreating margins of the Antarctic ice sheet. In the Rundvågshetta area on the Soya Coast of Lützow-Holm Bay, East Antarctica, fresh water flows from subglacial drainage channels of the EAIS.
The objective of this study is to examine the interaction between the limnology of subglacial water input and microbiological responses in the perennially-ice covered glacial lake in Rundvagshetta (i.e., Lake Maruwan) over the last 6000 years. Greenish-grayish organic-rich laminations in sediment cores from the lakes indicate continuous primary production affected by inflow of subglacial meltwater containing relic carbon, nitrogen, sulfur and other essential nutrients. Biogenic silica, amorphous hydrated silica, and DNA-based molecular signatures of sedimentary facies indicate that diatom assemblages are the dominant primary producers supported by the input of inorganic silicon (Si) from the subglacial inflow.This study highlights the significance of subglacial water-rock interactions during physical and chemical weathering processes for an important source of bioavailable nutrients.
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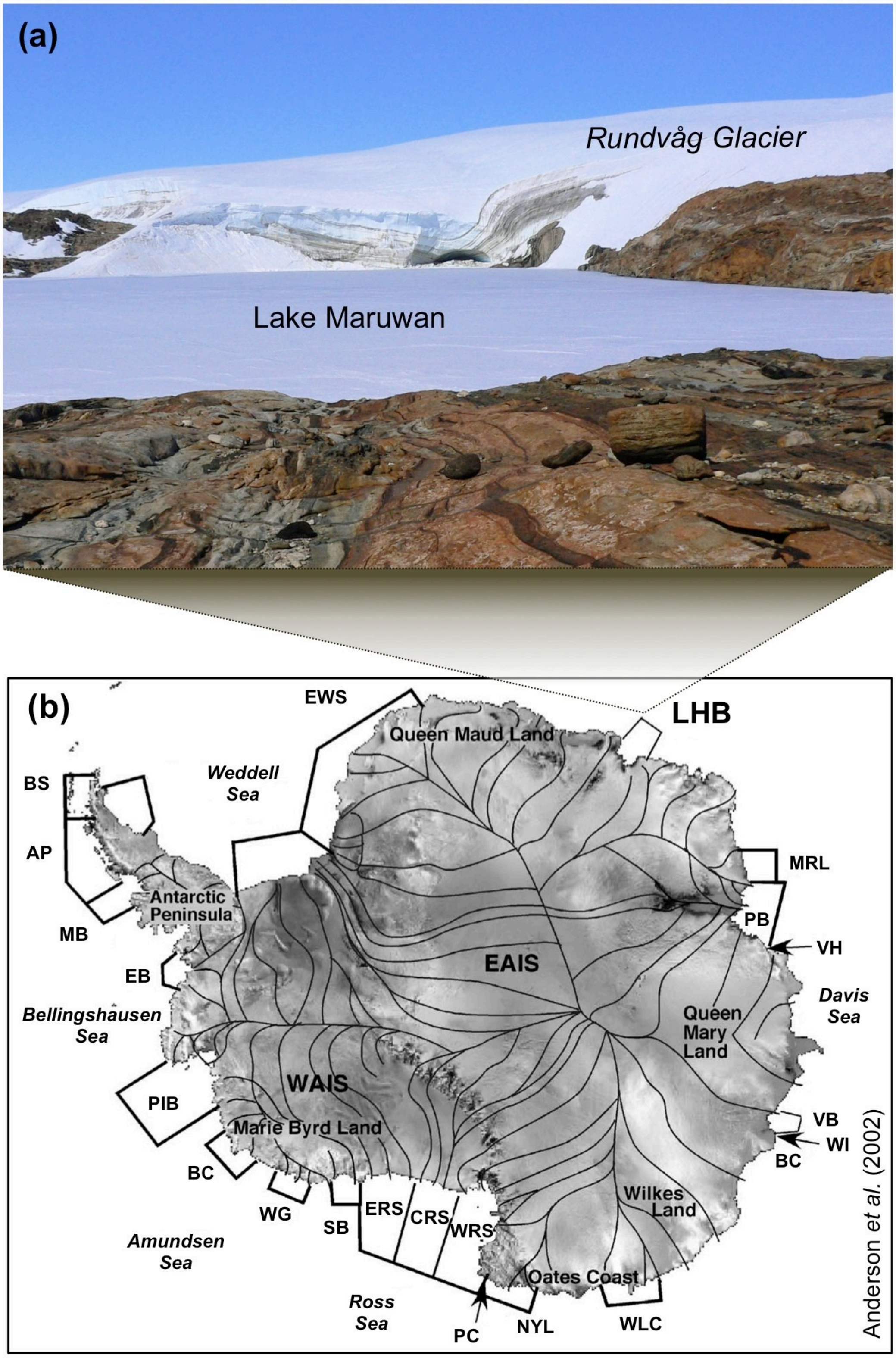

(a) Lake Maruwan, a perennially ice-covered glacial lake at the Rundvågshetta on the Soya Coast of Lützow-Holm Bay (LHB), East Antarctica. **(b)** a drainage map of the Antarctic ice sheet. Modified after Anderson *et al., Quaternary Sci. Rev.*, 2002 and Takano *et al.*, this study.