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Variations of marine pore water salinity and chlorinity in Gulf of Alaska sediments (IODP Expedition 341)

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Pore waters of marine sediments usually have salinities and chlorinities similar to the overlying sea water, ranging around 34-35 psu (Practical Salinity Units) and around 550 mM Cl-, respectively. This is because these parameters are conservative in the sense that they do not significantly participate in biogeochemical cycles. However, pore water studies carried out in the frame of the International Ocean Discovery Program (IODP) and its predecessors have shown that salinities and chlorinities of marine pore waters can substantially deviate from the modern bottom water composition in a number of environmental settings, and various processes have been suggested to explain these phenomena. Also during the recent IODP Expedition 341 that drilled five sites in the Gulf of Alaska (Northeast Pacific Ocean) from the deep Surveyor Fan across the continental slope to the glaciomarine shelf deposits, several occurrences of pore waters with salinities and chlorinities significantly different from respective bottom waters were encountered during shipboard analyses. At the pelagic Sites U1417 and U1418 ($\sim$4,200 and $\sim$3,700 m water depth, respectively), salinity and chlorinity maxima occur around 20-50 m sediment depth, but values gradually decrease with increasing drilling depths (down to 30 psu in $\sim$600 m sediment depth). While the pore water freshening at depth is most likely an effect of clay mineral dehydration due to increasing burial depth, the shallow salinity and chlorinity maxima are interpreted as relicts of more saline bottom waters that existed in the North Pacific during the Last Glacial Maximum (Adkins et al., 2002). In contrast, the glaciomarine slope and shelf deposits at Site U1419 to U1421 ($\sim$200 to 1,000 m water depth) are characterised by unexpectedly low salinitiy and chlorinity values (as low as 16 psu and 295 mM Cl-, respectively) already in very shallow sediment depths ($\sim$10 m), and their records do not show systematic trends with sediment depth. Freshening of pore waters in continental margin settings has been reported in association with dissociating gas hydrate deposits (Hesse, 2003), but neither seismic profiles nor sediment records showed any indications for the presence of gas hydrates at the Gulf of Alaska sites. An alternative and intriguing explanation for these almost brackish waters in the glaciomarine shelf and slope deposits is the presence of glacial meltwater that could either be "fossil" (stored in the glaciomarine sediments since the last glacial termination) or "recent" (i.e. actively flowing from currently melting glaciers of the St. Elias Mountain Range along permeable layers within the shelf deposits). As these relatively fresh waters are found at three distinct drill sites, it can be assumed that they are distributed all along the Gulf of Alaska shelf and slope, and similar findings have been reported at other glaciated continental margins, e.g., off East Greenland (DeFoor et al., 2011) and Antarctica (Mann and Gieskes, 1975; Chambers, 1991; Lu et al., 2010). While a recent review has highlighted the importance of fresh and brackish water reservoirs in continental shelf deposits worldwide (Post et al., 2013), we suggest that climatic and depositional processes affecting glaciated continental margins (e.g., the release of huge amounts of fresh water from ice sheets and glaciers during glacial terminations, and the rapid deposition of unconsolidated sediments on the adjacent shelf) are particularly favourable for the storage and/or flow of meltwater below the present sea floor.

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