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Persistence of methane seepage from pockmarks in the Storegga Slide region

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The Storegga Slide complex is a three-stage slope failure where the most recent stage occurred 8.1 kya. The mechanisms and consequences of these slope failures are likely linked to deglaciation, sediment overpressurization, and/or methane hydrate instability. The northern flanks of the Storegga Slide complex on the Norwegian continental margin contain pockmark features that are inferred to be related to shallow methane deposits and gas venting, based on bottom simulating reflectors and chimney structures present in seismic reflection profiles. Three jumbo piston cores (JPC), two taken from separate pockmarks and one core taken near the pockmarks on the northern flank of the Storegga Slide (800m water depth), were sampled at 10 cm resolution. Radiocarbon ages indicate typical sedimentation rates of 40-70 cm/ka at these sites. Concentrated layers of *Bathymodiolus* mussels, an indicator of methane-rich environments, are dated to 18.2 and 22.2 ka (calendar years before present; 670-710 cmbsf and 780-790 cmbsf, respectively) in one core. Oxygen and carbon stable isotope analysis on planktonic foraminifera, *Neogloboquadrina pachyderma sinistral*, and benthic foraminifera, *Melonis barleeanum* and *Islandiella norcrossi*, from pockmark region sediment provide a high-resolution record of temperature change and methane activity in the Storegga Slide area. Oxygen isotopic results show a clear glacial/deglacial transition ($-1.95\text{‰ } \delta^{18}\text{O}$), including Heinrich Event 1 and Terminations 1 with the Younger Dryas. Multiple negative excursions in the planktonic carbon isotope record (as much as $-7.59\text{‰ } \delta^{13}\text{C}$) indicate methane-derived carbon is episodically available within the pockmark sediments. However, these isotopic shifts do not occur during the Storegga slide event and are instead concurrent with the

timing of deglacial warming. Carbon isotope values from benthic foraminifera suggest frequent exposure to methane seepage. Together the planktonic and benthic data from these cores show that these pockmarks have been sites of methane seepage since at least the last glacial maximum, and that seepage rate has varied.

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