An ice-free Northwest Passage: What are the consequences for exploration and exploitation of mineral resources and other raw materials in Greenland and in the Canadian Arctic?

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Routes of the the Northwest Passage

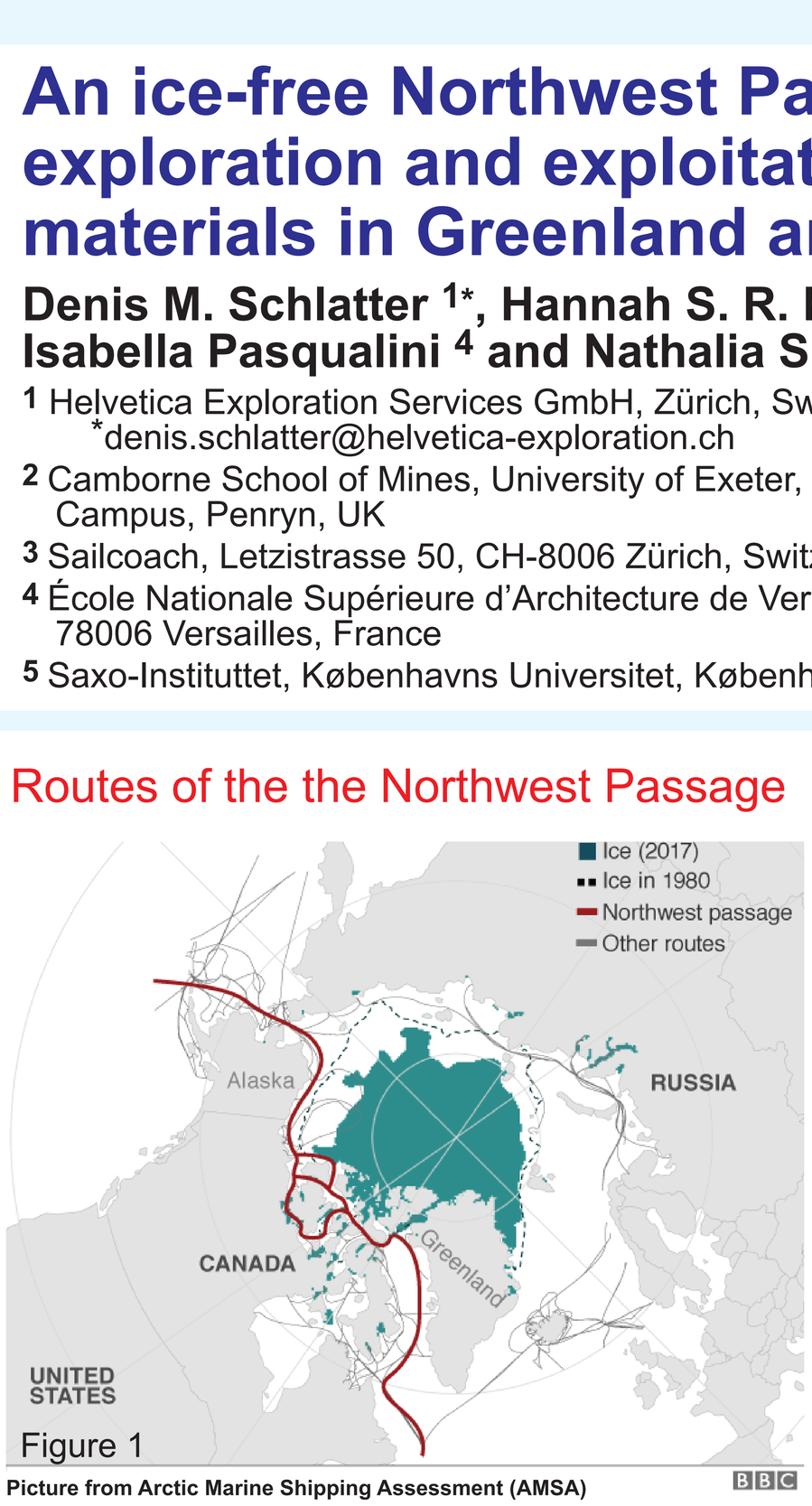
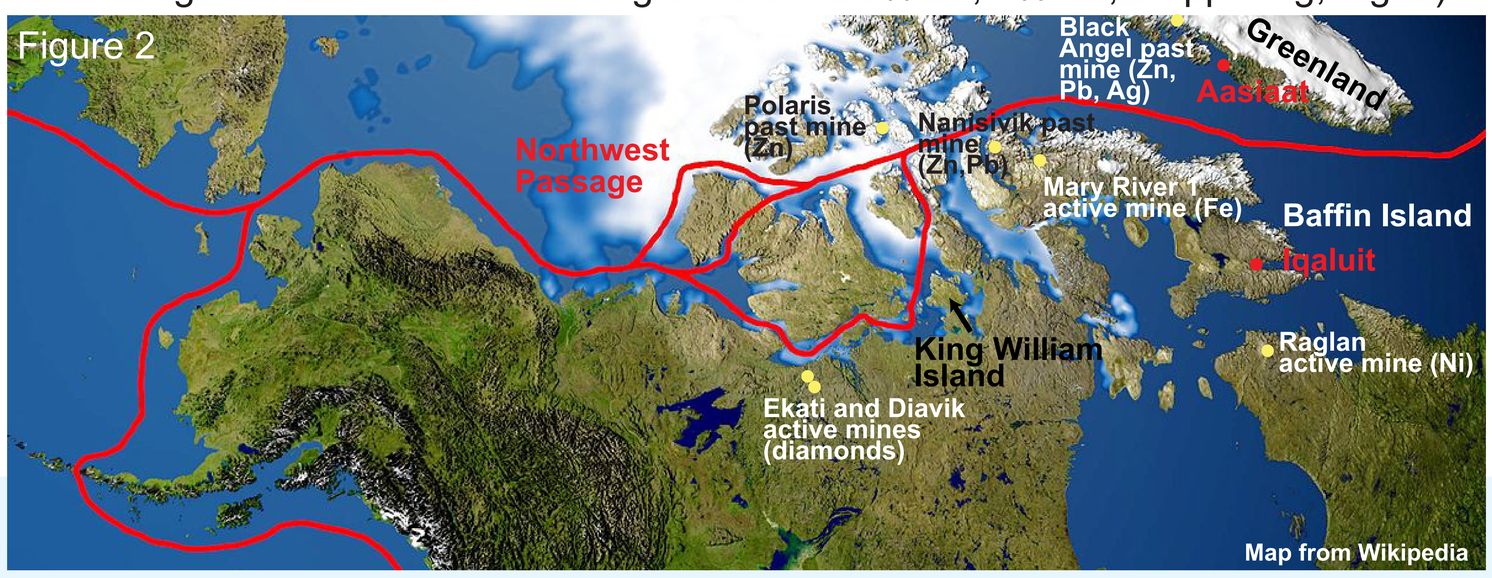


Figure 1

Picture from Arctic Marine Shipping Assessment (AMSA)

The opening of the Northwest Passage could represent an efficient Europe - Asia shipping trade route linking the Atlantic Ocean with the Pacific Ocean through the Arctic Ocean (Figs. 1, 2). Whilst the route may become navigable (indeed, commercially viable) as a result of climate change, it has a hazardous history - Sir John Franklin's expedition met a tragic end in 1948 on King William Island (Fig. 2) after becoming trapped in the ice, ending in the loss of the ships "Erebus" and "Terror" (Fig. 5). Shown on figure 2 are also locations of mines in the vicinity of the route of the Northwest Passage. This would open up further exploration for mineral resources and other raw materials in the Arctic. Some of the ore resources are world-class deposits (e.g. the past Black Angel mine with 13.6 Mt with grades of 12.3% Zn, 4% Pb, 29 ppm Ag, Fig. 2).



Retreat of glaciers in West Greenland

Since the days when the father of plate tectonics, Alfred Wegener carried out his West Greenland expedition and established his station "Eismitte" on the inland-ice in the early 1930s, the effects of climate change has caused the melting of sea-ice and most tangibly the retreat of glaciers. Glaciers in the Qaamarujuk Fjord that once extended to the sea (Fig. 3a) are now melting and have retreated for several hundred meters (Fig 3b). See figure 4 for location of Qaamarujuk.

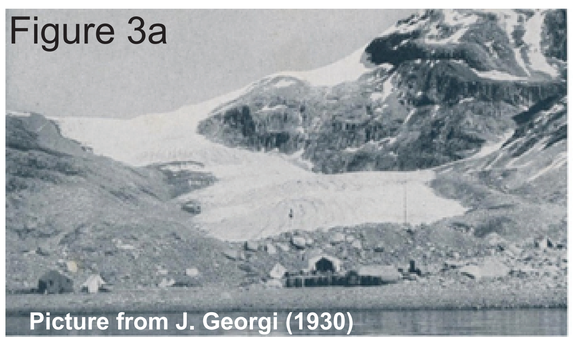


Figure 3a

Picture from J. Georgi (1930)

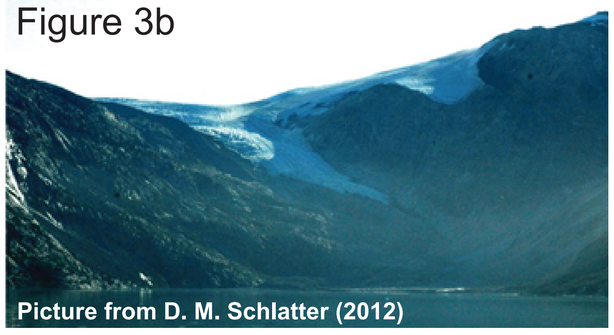


Figure 3b

Picture from D. M. Schlatter (2012)

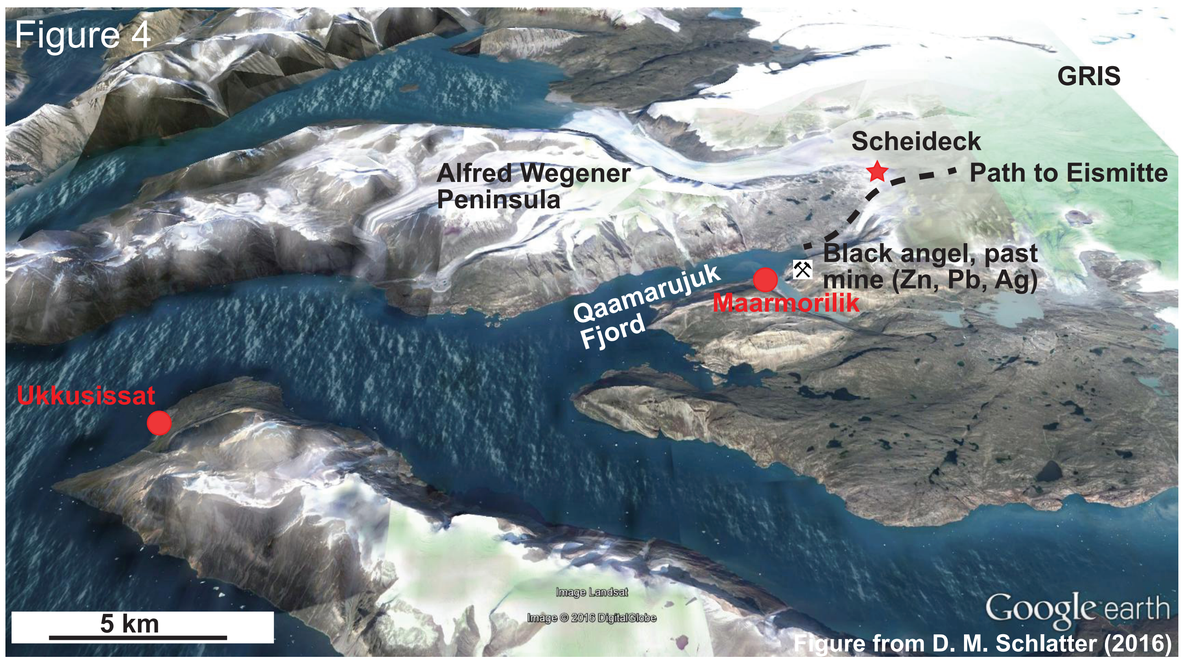


Figure from D. M. Schlatter (2016)

Sir Franklin's HMS Terror in the arctic regions, 1837

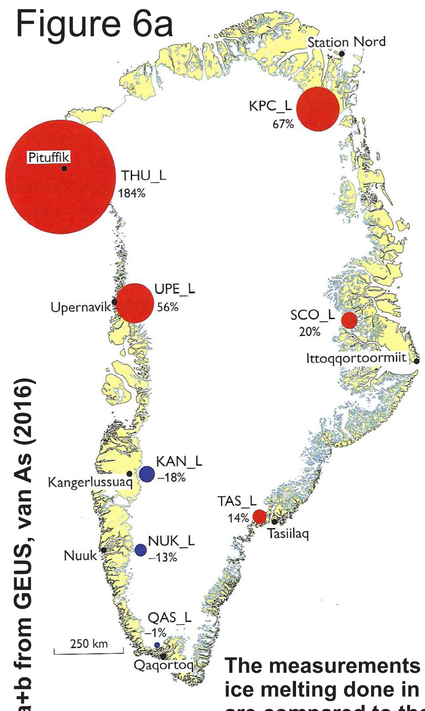
Figure 5

From National Maritime Museum, Greenwich. Catalogue, Sir Franklin exhibtion (2017).

Melting of the Greenland Ice Sheet

The Greenland Ice Sheet (GRIS) has been losing mass at a rate of about 262 Gt/year in the period 2007 to 2011 and this is explained by recent increase in atmospheric and oceanic temperatures. Measurements that were done by GEUS during 2015 showed that for some northern places in Greenland (e.g. the Thule Station, THU, Fig. 6a) the melting in 2015 was 184% larger than the melting recorded in the period 1961 to 1990. Figure 6b shows the rate of ice loss caused by melting for the GRIS vs time for each of the stations shown in figure 6a. An acceleration in ice loss has been recorded e.g. for the Thule Station since about 1995 and the melting has be most notable since the last 150 years (Fig. 6b). A direct consequence of the melting of the GRIS is the substantial fresh water resources that will be released by the ice melting and that may be captured before this water reaches the salty ocean waters, thus the GRIS melting may present future drinking water resources.

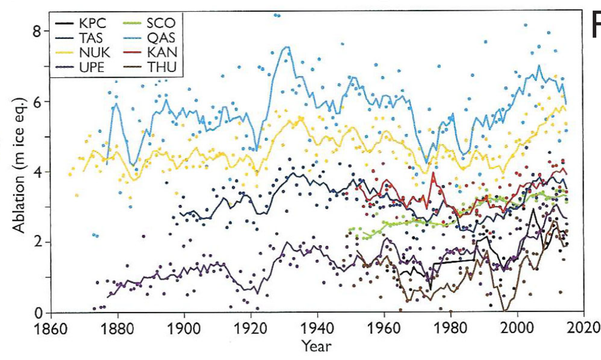
Figure 6a



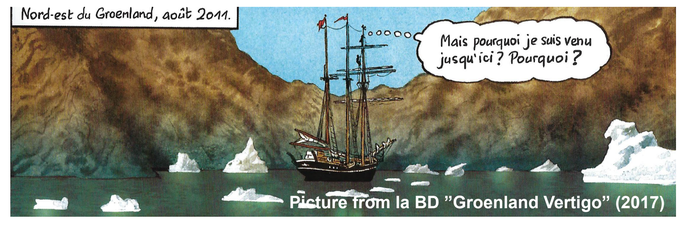
Figs 6a+b from GEUS, van As (2016)

The measurements of the ice melting done in 2015 are compared to the period 1961 to 1990 and the differences are expressed as % changes.

Figure 6b



Estimated yearly (dots) and five-yearly (lines) net losses of ice for each station. van As et al. (2016).



Picture from la BD "Groenland Vertigo" (2017)

Conclusions

Climate change and the related and expected future consequences to the Greenland Ice Sheet and the Arctic ice represent a negative change from a global perspective, yet there are likely to be beneficiaries such as shipping companies that could utilize a sea ice-free Northwest Passage making such routes logistically feasible and profitable. Access via the Northwest Passage and other Arctic sea routes would bring commodities to market and the prospect of wealth to these Arctic areas. But we ask, what are the socioeconomic and environmental factors at play in this scenario?

References:

Sarkar et al. (2018): *Goldschmidt Conference, Boston*
van As et al. (2016): *Geological Survey of Denmark and Greenland Bulletin 35: 71-74*