COSMOGENIC EXPOSURE DATING ON JAN MAYEN

The effects of bedrock formation age assumptions on ^{36}Cl ages

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Jan Mayen is a small volcanic island situated 550 km north of Iceland in the Norwegian–Greenland Sea (Fig. 1). Its isolated position makes it an interesting location for investigations of the climate history in the North Atlantic. A research campaign to reconstruct the glaciation and climate history of the island was therefore started in 2014 [1].

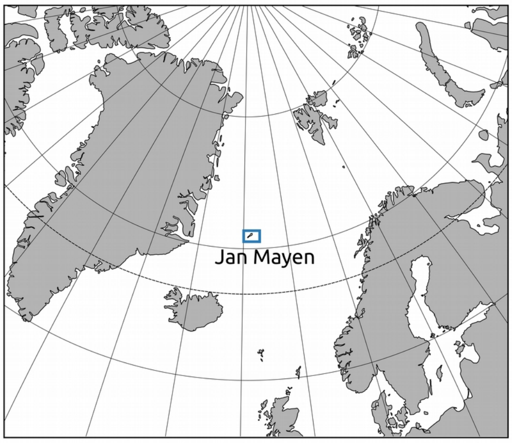

Fig. 1: *Map showing the location of Jan Mayen.*

During that campaign, 89 samples for cosmogenic nuclide exposure age dating (^{36}Cl) were collected with the aim of dating glacial and volcanic events on the island. However, exposure dating in an active volcanic landscape comes with its own challenges. In addition to being created through cosmogenic processes, ^{36}Cl is also created when ^{35}Cl absorbs neutrons produced from fission and (alpha, n) reactions, including uranium and thorium decay (for simplicity, all these reactions are referred to as "background production" herein). To estimate the cosmogenically produced ^{36}Cl in the sample, the background production is subtracted from the measured ^{36}Cl concentration. Standard methods for age calculations assume that the rock is sufficiently old that production of ^{36}Cl from background processes balances radioactive decay i.e., equilibrium conditions have been achieved. However, this assumption is unlikely to be true in areas with young volcanic rocks, such as Jan Mayen.

To quantify the influence the rock formation age would have on the calculated exposure ages on Jan Mayen, all exposure ages were calculated using an updated version of CRONUScalc which allowed us to assume different rock formation ages. Although the formation age assumption did not significantly affect most samples (n = 64), some of the exposure ages changed substantially (n = 25, maximum deviation 6.1 ka) depending on the rock formation age assumed for the sample [2].

Based on these results we recommend not assuming equilibrium conditions when calculating ^{36}Cl ages on rocks that meet the following criteria: (i) known young rock formation ages, and (ii) potentially susceptible composition, specifically high native Cl, or high U and/or Th concentrations that are likely to occur in volcanic rocks. Young exposure age samples will be particularly affected because of the large mismatch between expected equilibrium conditions and measured concentrations [2].

[1] A. Lyså et al., Boreas (2020) https://doi.org/10.1111/bor.12482

[2] J. Anjar et al., Geosciences. (2021) https://doi.org/10.3390/geosciences11090390

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