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An evaluation of the Early Cretaceous of Spitsbergen: new insights into stratigraphy and palaeoclimate

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During the Early Cretaceous, Spitsbergen was located at a palaeolatitude of ∼60°N. Abundant fossil wood derived from conifer forests, dinosaur trackways, enigmatic deposits such as glendonite horizons and rare outsized clasts, and stable isotope data from the Early Cretaceous formations of Spitsbergen suggest that the climate at that time was much more dynamic than the traditional view of "invariant greenhouse" conditions on Earth. The purpose of this study is to test the veracity of using such proxies as climate indicators, and to evaluate the climatic character of Arctic Svalbard during the Early Cretaceous. To these ends, the sedimentological and sequence stratigraphic context of glendonites and outsized clasts within the Rurikfjellet, Helvetiafjellet and Carolinefjellet formations are being documented. This is being achieved through high resolution sedimentary logging (bed-scale) of the Early Cretaceous succession at multiple locations, documentation of glendonites, outsized clasts, together with sampling (every < 0.5m) for stable isotope analysis, in order to constrain and elucidate the nature of environmental and possible climatic variations during this time.

The Early Cretaceous succession at Festningen is 750m thick and is considered to have been deposited between the Berriasian and late Aptian/early Albian. The basal Rurikfjellet Formation comprises a normally regressive water to wave/storm dominated shoreface. A forced regression (expressed as a regional unconformity) marks the base of the overlying Helvetiafjellet Formation. The Helvetiafjellet and overlying Carolinefjellet Formation represent a strongly aggradational, weakly transgressive succession characterised by delta plain deposits, containing abundant terrestrial woody material and with ornithopod footprints, passing upward into deep water mudstones and rare storm beds. Abundant glendonites occur within the shoreface deposits of the upper Rurikfjellet Formation, and in the Carolinefjellet Formation.

The expanded nature of the sedimentary deposits in the Carolinefjellet Formation suggest high subsidence rates and high sedimentation rates, implying that the main signature here is that of higher rates of tectonic subsidence, rather than a eustatic control possibly evident in the lower part of the succession.

Stable isotope results from the Valanginian - Barremian part of the succession (the upper Rurikfjellet and Helvetiafjellet formations) are also be presented. These data are being used to both improve the resolution of dating of the succession (carbon-isotope stratigraphy), and to shed light on how global perturbations in the carbon cycle, particularly during the Valanginian, may have been expressed in the northern high latitudes. This study aims to improve our understanding of the global climatic and sequence stratigraphic context in which these rocks were deposited.