

Discussion. Brachiopod zonation and age of the Permian Kapp Starostin Formation (Central Spitsbergen)

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Stemmerik, L. 1988: Discussion. Brachiopod zonation and age of the Permian Kapp Starostin Formation (Central Spitsbergen). *Polar Research* 6, 179–180.

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The following discussion will concentrate on the stratigraphical implications of the brachiopod zonation proposed by Nakamura et al. (1987). No such brachiopod zonation can be recognised in Greenland where in contrast diagnostic species of the upper zones in the Kapp Starostin Formation co-occur throughout the entire section. It is therefore concluded that the correlations proposed by Nakamura et al. (1987) are *not* valid. At best the overall similarities of the East Greenland and Svalbard faunas may indicate a Kazanian–early Tatarian age for the upper part of the Kapp Starostin Formation.

The paper of Nakamura et al. (1987) has wide stratigraphic implications both for local correlation of the Foldvik Creek Group (sensu Surlyk et al. 1986) in East Greenland and for correlation of the Kapp Starostin Formation to the standard Permian subdivision (Nakamura et al. 1987: Fig. 5 and Table 1). The brachiopod zonation is based on work in the Kapp Starostin Formation on Spitsbergen but the interpretation of the zonation as stratigraphic rather than ecologic as previously suggested by Malowski & Hoffman (1979) is entirely dependent on the presumed occurrence of similar distinct brachiopod assemblages in central East Greenland (Nakamura et al. 1987, pp. 212–215).

Nakamura et al. (1987, p. 213) distinguish two brachiopod zones in the Foldvik Creek Group comparable to their *Megousia weyprechtii* Zone and upper *Pterospirifer alatus* Zone based on the work of Dunbar (1955) and Maync (1942). The diagnostic species recognising these zones in East Greenland are *Waagenoconcha payeri*, *Strepto-*

rhynchus kempei, and *Muirwoodia greenlandica* for the *Megousia weyprechtii* Zone and *Pterospirifer alatus*, *Pleurohorridonia scoresbyensis*, *Choristites søderberghi*, and *Odontospirifer mirabilis* for the *Pterospirifer alatus* Zone (Nakamura et al. 1987, p. 213). Furthermore, *Liosotella spitzbergiana*, *Paeckelmannia toulai* and *Kochiproductus plexicostatus* confined to the uppermost zones in the Kapp Starostin Formation are found in East Greenland.

The work of Dunbar (1955) does not imply a two-fold zonation of the brachiopods in the Foldvik Creek Group in East Greenland. As discussed below the different collections described by Dunbar (1955) include a mixture of species diagnostic for the *Megousia weyprechtii* Zone, *Pterospirifer alatus* Zone and possibly even the *Haydene wilczeki* Zone in Spitsbergen.

The brachiopods diagnostic for the *Megousia weyprechtii* Zone are mainly confined to the area north of Kong Oscars Fjord. Exceptions are one collection described from Scoresby Land by Frembold (1931) (in Dunbar 1955) and the frequent occurrence of *Muirwoodia greenlandica* to the south. Only two species diagnostic for the *Pterospirifer alatus* Zone are found in the northern area. Dunbar (1955) found a single specimen of *Pterospirifer alatus* in a collection from Fiskeelv, Clavering Ø. In contrast, *Pleurohorridonia scoresbyensis* was found frequently in the collections from this area. This species, however, co-occurs virtually everywhere with species of the *Megousia weyprechtii* Zone (most commonly *Muirwoodia greenlandica* but also *Streptorhynchus kempei* and *Waagenoconcha payeri*,

(Dunbar 1955, pp. 24, 27, 32, 33, 34)). Also *Kochiproductus plexicostatus*, *Liosotella spitzbergiana* and *Paeckelmannia toulai* occur in these assemblages implying that the Greenland fauna consists of a mixture of that found in the younger parts of the Kapp Starostin Formation but without any zonation. This view is further substantiated by data from Scoresby Land (Dunbar 1955). Here, the fauna is dominated with respect to diagnostic species (sensu Nakamura et al. 1987) by species of the *Pterospirifer alatus* Zone, including *Kochiproductus plexicostatus* and *Liosotella spitzbergiana*. Most collections described by Dunbar (1955) show, however, co-occurrence of this fauna with *Muirwoodia greenlandica* (Dunbar 1955, pp. 16, 17, 20, 21).

Although it is difficult to determine the exact stratigraphical location of many of the collections discussed by Dunbar (1955), enough information is available to ensure that the collections represent the entire depositional sequence of the Wegener Halvø (former Limestone-Dolomite Member) and Ravnefjeld (former Posidonia Shale, here including Productus Limestone and Martinia Limestone) Formations. Surlyk et al. (1986) showed that the Wegener Halvø and Ravnefjeld Formations are partly time equivalent units representing marginal platform and basin sedimentation, respectively. Both formations are overlain by younger Permian clastic sediments. The brachiopods described by Dunbar (1955) occur in beds which are time equivalent to shales dated to be of Kazanian – early Tatarian age based on the presence of a *Vittatina* assemblage (Balme 1979; Piasecki 1984). Diagnostic species of the uppermost three zones in the Kapp Starostin Formation are thus in East Greenland occurring together throughout the entire Kazanian–early Tatarian sequence. This indicates that the zonation of Nakamura et al. (1987) has no stratigraphic significance but rather represents changes in the depositional environment. The reason that a similar ecological zonation is not seen in East Greenland is that all the brachiopod bearing beds are gravity flows containing brachiopods from a wide range of environments.

Although the zonation seen in the upper part of the Kapp Starostin Formation is not stratigraphic, the similarities between the brachiopod fauna of the upper part of the Kapp Starostin Formation and the Foldvik Creek Group may imply overall correlation of the two units, thus dating the upper

part of the Kapp Starostin Formation in very general terms as Kazanian–early Tatarian (for more detailed discussion of the age of the Foldvik Creek Group see Stemmerik & Piasecki 1988). None of the species diagnostic for the *Horridonia timanica* Zone in the lower part of the Kapp Starostin Formation have been found in the Foldvik Creek Group. This may indicate that this fauna is older than that found in the upper part of the formation and in the Foldvik Creek Group in East Greenland. The assignment of the *Horridonia timanica* Zone to the latest Early Permian or the earliest Late Permian (Nakamura et al. 1987) is in agreement with the present view of similar faunas in North Greenland (Håkansson & Stemmerik 1984; Stemmerik & Håkansson 1988).

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