

FIRST PALYNOLOGICAL RECORD FROM THE WINNIPEG SHALE (UPPER ORDOVICIAN) IN THE NORTHERN BLACK HILLS OF SOUTH DAKOTA, U.S.A.

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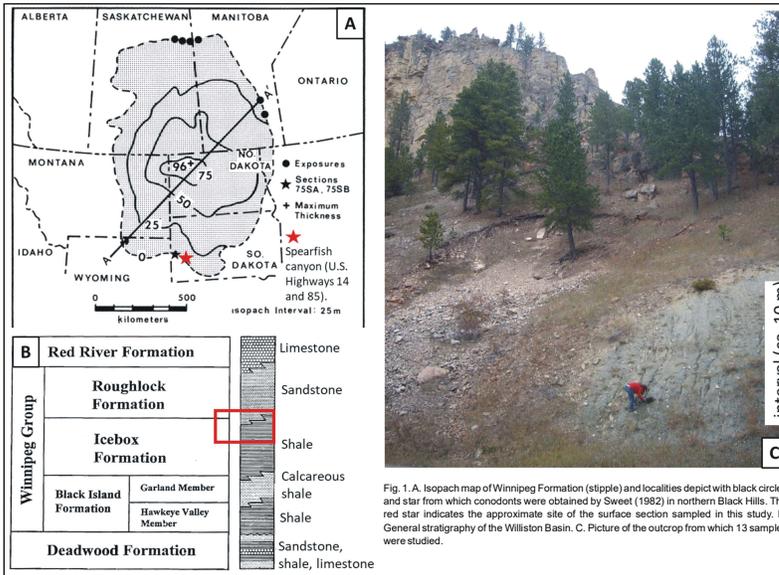


Fig. 1. A. Isopach map of Winnipeg Formation (stippled) and localities depicted with black circles and star from which conodonts were obtained by Sweet (1982) in northern Black Hills. The red star indicates the approximate site of the surface section sampled in this study. B. General stratigraphy of the Williston Basin. C. Picture of the outcrop from which 13 samples were studied.



Fig. 2. Distribution of the taxa and their global ranges present in the Icebox and Roughlock Formations in Spearfish canyon, South Dakota. Range of species (meaning of colors): Three species in green with L/landoverian. Four species in red with FAD/LAD in Hirnantian. The remaining species in light blue are Late Ordovician. In orange is the most probable age of the assemblages. *Calpichitina* (=Desmochitina) *lenticularis*, *Euconochitina* (=Jenkinochitina) *tanvillensis*

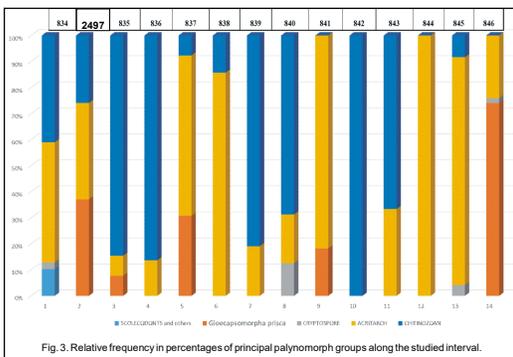


Fig. 3. Relative frequency in percentages of principal palynomorph groups along the studied interval.

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INTRODUCTION

The marine Winnipeg Formation exposed in the northern Black Hills of South Dakota is composed of the Icebox and Roughlock members, which represent the southern extension of transgressive episodes documented in the northern Great Plains (Williston Basin) of the USA and Canada. The typically dark green to black shales of the Icebox grade up into argillaceous carbonates of the Roughlock. The first palynologic analysis of the Icebox and lower Roughlock members includes a well-preserved and diverse palynoflora from fourteen unweathered samples collected from Spearfish Canyon (U.S. Highways 14 and 85). Figs. 1A-B

MATERIALS

The lower ten samples were taken approximately every meter from the 9 meters of Icebox shales and three additional samples from thin transitional layers into the calcareous shale of the Roughlock (1 m), from which another sample was collected. (Fig. 1C).

RESULTS

The fourteen assemblages are variably composed of chitinozoans (25 species) and acritarchs (23 species), with fewer cryptospores, cyanophycan *Gloeocapsomorpha prisca*, and five scolecodonts. Figures 2-4.

Frequency trends from the last four samples, corresponding to the transition of Icebox to Roughlock, show chitinozoans dominating the lower sample with a lesser proportion of acritarchs that dominate in the next two samples. *Gloeocapsomorpha prisca*, Ordovician colonial marine microorganism, was found intermittently through the entire interval but is especially abundant in the sample from the Roughlock; hence interpreted as blooms related to environmental changes.

AGE

Although many chitinozoans and acritarchs are long-ranging Ordovician species, the chitinozoans *Calpichitina lenticularis*, *Euconochitina (Jenkinochitina) tanvillensis* and *Belonechitina robusta*, documented from the base up to the mid-upper Icebox, support a correlation of our studied interval with the mid-Caradocian (equivalent to North American Trentonian and current Sandbian-Katian stages) homonymous palynozones of North Gondwana. Figure 5

The acritarchs *Elektriskos aktinotos* and *Peteinosphaeridium accintulum* and *Sylvandium paucibrachium*, known from the Ashgillian of Missouri, and *Peteinosphaeridium septuosum* from the Caradocian and Ashgillian of Kansas, Missouri and Oklahoma, and *Belonechitina punctata* (recorded in the upper Icebox), reinforce this age.

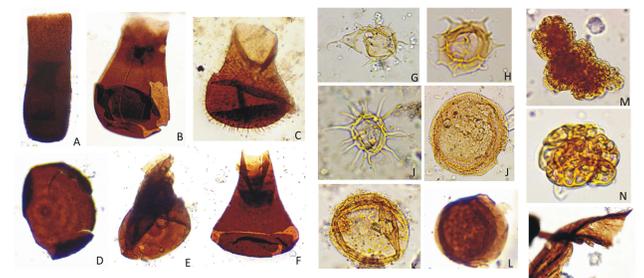
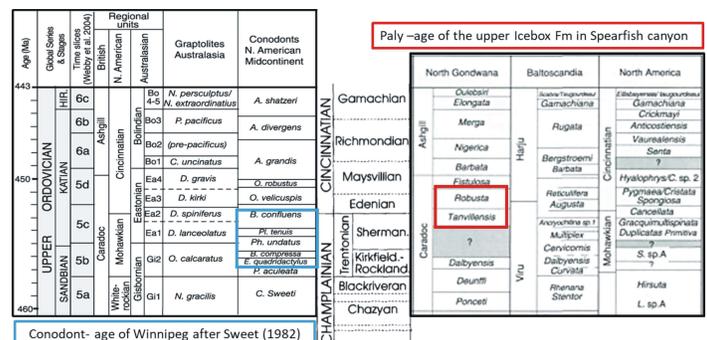


Fig. 4. Chitinozoans. A. *Belonechitina robusta* (160 µm). B. *Belonechitina punctata* (110 µm). C. *Fungochitina* cf. *F. merrelli* (82 µm). D. *Desmochitina jugandiformis* (80 µm). E. *Calpichitina lenticularis* (78 µm). F. *Jenkinochitina tanvillensis* (112 µm). G. *Sylvandium paucibrachium* (45 µm). H. *Acritarch G. Elektriskos aktinotos* (40 µm). I. *Dicomopalla* sp.1 (70 µm). K. *Peteinosphaeridium accintulum* (50 µm). L. Cryptospore. *Pseudodiyadyspora ?petasa* (28 µm). Cyanophycan. M-N. *Gloeocapsomorpha prisca* (105 µm and 40 µm). O. Graptolite cuticle (175 µm). P. Scolecodont (*Staurcoephalites*) (150 µm).

FINAL CONSIDERATIONS

The age obtained with palynomorphs (Fig. 5) is in concordance with previous studies of conodonts from upper Icebox and Roughlock at Icebox Gulch and Whitewood Creek in the Black Hills (Sweet, 1982), where lower and mid-Caradocian species documented (*Belodina (Panderodus) compressa*, *Chirognathus duodactylus (=delicatula)*, *Distacoda insculptus*, *Falodus prodentatus*, *Oulodus serratus*, *Plectodina dakota*, *Plectodina tenuis*, *Ptiloconus gracilis*, *Scyphiodus priscus*, and several species of *Panderodus*).

A preliminary paleobiogeographic affinity indicates a close relationship to Northern Gondwanan, Baltic and Laurentian chitinozoan assemblages during the late Ordovician. Figure 5 (based on Webby et al., 2004; Paris and Verniers, 2005).



Conodont- age of Winnipeg after Sweet (1982)