

## Lithology of Cambrian to Ordovician radiolarian chert in Kazakhstan with special reference to trace fossils

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### Introduction

Trace fossils have been examined in the upper Cambrian to upper Ordovician radiolarian bedded cherts in Australia, Scotland and Newfoundland to clarify both the evolution of benthic animals and the change in environment of pelagic realm (Kakuwa and John, 2001; 2010; Kakuwa, 2014a; Kakuwa, 2014b). The result is summarized that Darriwilian is the age when benthic animals colonized widely on the pelagic deep ocean bottom. The other important and well-dated successions of radiolarian bedded chert (ribbon radiolarite) in Kazakhstan are studied to verify the result.

Examined bedded chert belongs to the Burubaital Formation that exposed in the southwest of Lake Balkhash, southern Kazakhstan. Age constraints of the examined two successions of bedded chert are given by Tolmacheva et al. (2001; 2004; unpublished data) who studied conodont fossils in detail.

### Outline of the examined successions

#### Locality 89101

Upper Cambrian and Lower Ordovician chert is measured as thick as 36 meters. The succession is divided into three. The lower part consists of pale gray crystalline chert of upper Cambrian. The middle part consists of red chert of Tremadocian, and the upper part consists of pale gray, red and black cherts of Tremadocian to Floian. Radiolarians and sponge spicules are observed under the microscope. Thin laminations consistently develop in the cherts of this locality.

#### Locality 9706

Lower to Middle Ordovician bedded chert continuously exposed as thick as 70 meters. The lower half of the section consists of pale to dark gray, black and red cherts. The upper half of this succession, Dapping and Darriwilian in age, consists of red chert with some intercalations of white crystalline chert.

Characteristic knobby bedding planes that are considered as trace fossils by Tolmacheva et al. (2001) develop in the middle to upper part of the section. Several beds and laminations of sandstone and oligomitic conglomerate (breccia) occur in the same horizon. The grains of sandstone and conglomerate are composed of angular to subrounded chert, and are cemented by microcrystalline quartz. Sponge spicules are closely associated with the clastic rocks.

### Trace fossils

No convincing trace fossils are found in the Upper Cambrian to Tremadocian chert of the locality 89101, while trace fossils are found in the Darriwilian red chert of the locality 9706. Trace fossils found are horizontal tunnel on bedding planes. They are as long as 10 cm and a few millimeters in diameter. Some tunnels are bifurcated and some are sinuous. Curious tubes are densely crowded in cherts of some limited horizons. They run oblique, parallel and vertical to the bedding plane. The tubes are 3 to 8 mm in diameter and as long as 2 cm in compacted length. The tubes are filled with chalcedonic quartz. Various relieves on the knobby bedding planes include probable trace fossils and diagenetic deformations.

### Implications of trace fossils

Trace fossils are found in the radiolarian bedded chert of Darriwilian in Kazakhstan. This result is common to the other examined areas of Australia, Scotland and Newfoundland, but the trace

fossils found in Kazakhstan are different from those found in the aforementioned areas.

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