

PALEOENVIRONMENT OF CARBONIFEROUS CONGLOMERATES, BLACK MARMOT VALLEY, KHARKHIRRA UUL, MONGOLIA

JO NISSENBAUM
Whitman College
Sponsor: Patrick Spencer

INTRODUCTION

The Black Marmot Conglomerate, located in the eastern Kharkhirra Uul in western Mongolia, is ≈ 500 m thick, not including an unknown thickness of coal in the middle, and crops out in stream cuts and on steep slopes of the Y Valley (Fig. 1). The steeply-dipping

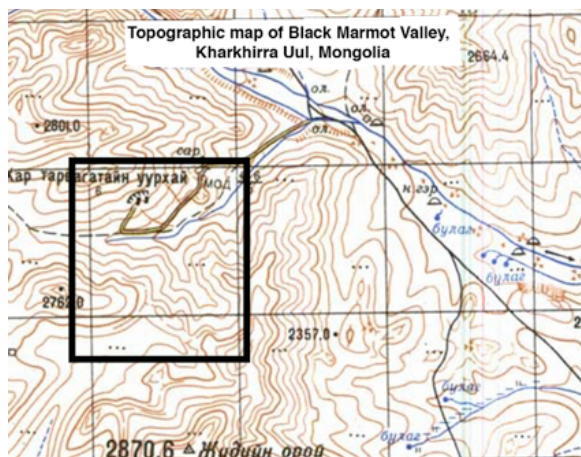


Figure 1. Topographic map showing Y-Valley study area.

beds contain conglomerate types of both shallow marine and fluvial origins. The clasts are a variety of lithologies, including quartzite, quartz, sandstone, greenstone, conglomerate, limestone, and volcanics. There are also numerous interbeds of organic-rich shales, coarse-grained sandstones, coals, and tuff-rhyolites (Fig. 2). Regional stratigraphic context, conglomerate texture (including grain size, fabric, and rounding), sedimentary structures, cement and matrix, stratification, and tectonic setting differentiate depositional environments for each unit, though the entire

unit is interpreted as a high-energy fanglomerate that represents both shallow marine and fluvial deposition, indicating a transgressive/regressive marine series.

The main purposes of this study are to determine the paleogeographic context of the formation; to constrain the age of the various units; to establish the depositional environment of the various conglomerate units; and to determine the paleoenvironmental context of the conglomerate exposures and relate it to the geologic history of Mongolia and east-central Asia.



Figure 2. An exposure of the Black Marmot Conglomerate.

Paleogeography

The late Paleozoic was marked by the continental collision of a number of small

microcontinents that came together as convergent tectonics dominated their margins. As the Siberian craton and the North China block converged, ancient continental crust was thrust onto the continental margin and small island arcs, subduction wedges, and ophiolitic belts were accreted as preexisting basement rock was deformed and faulted, and uplift initiated. This boundary, known as the Mongolian-Okhotsk Mobile Zone, is represented by 8 distinct and varied orogenic belts, or superterranes, making Mongolia similar to that of a complex accretionary-collision system (Misar, 1997).

The northeastern portion of the Kharkhirra Uul area is located near the border of two of these 8 large orogenic superterranes, the North Mongolian Early Caledonides and the Mongolian Altai Caledonides. The smaller subterrane that the Black Marmot study area straddles are the Hovd Turbidite Terrane and the Ölgii Oceanic Terrane. Combined, these subterranes represent a transgressive sequence of Lower to Upper Paleozoic marine tuff-terrigenous sediments with synorogenic-postorogenic molasse sediments and local continental volcanics (Tomurtogoo, 2003; Misar, 1997). Based on geochemical and petrologic data of these continental volcanics, it is probable that the Black Marmot strata were deposited in an extensional back-arc basin formed at the time the island arcs of the Mongolian Altai Caledonides were colliding with the North Mongolian Early Caledonides.

Regional Stratigraphy

The regional stratigraphy of the Black Marmot coal mine is a complex of middle Paleozoic marine-terrestrial rocks that overlie the Early Paleozoic Lakes Island Arc Terrane. Douglas (cf., this volume) found that this 10-km² region consists of five distinct lithologic units. The oldest units are turbidites and organic-rich shale, interbedded with dolostone, mudstone, and limestone. These units are overlain by a lithic sandstone and conglomerate series, and capped by a conglomerate with prominent interbeds of shale, sandstone, coal, and tuff-rhyolite. In a regional context, the stratigraphy appears to represent a transitional

system that fluctuated between a deeper marine environment, in which the turbidites were deposited, and progressively shallower environments, in which the limestones, shales, and sandstones were deposited, which graded into an estuarine-terrestrial setting, in which the conglomerates were deposited. The system therefore contains lithologic units that were deposited during the rise and fall of sea level. This oscillation of sea level may be due to glaciation in Gondwanaland as well as isostatic change resulting from the impact of the North China block and the Siberian craton.

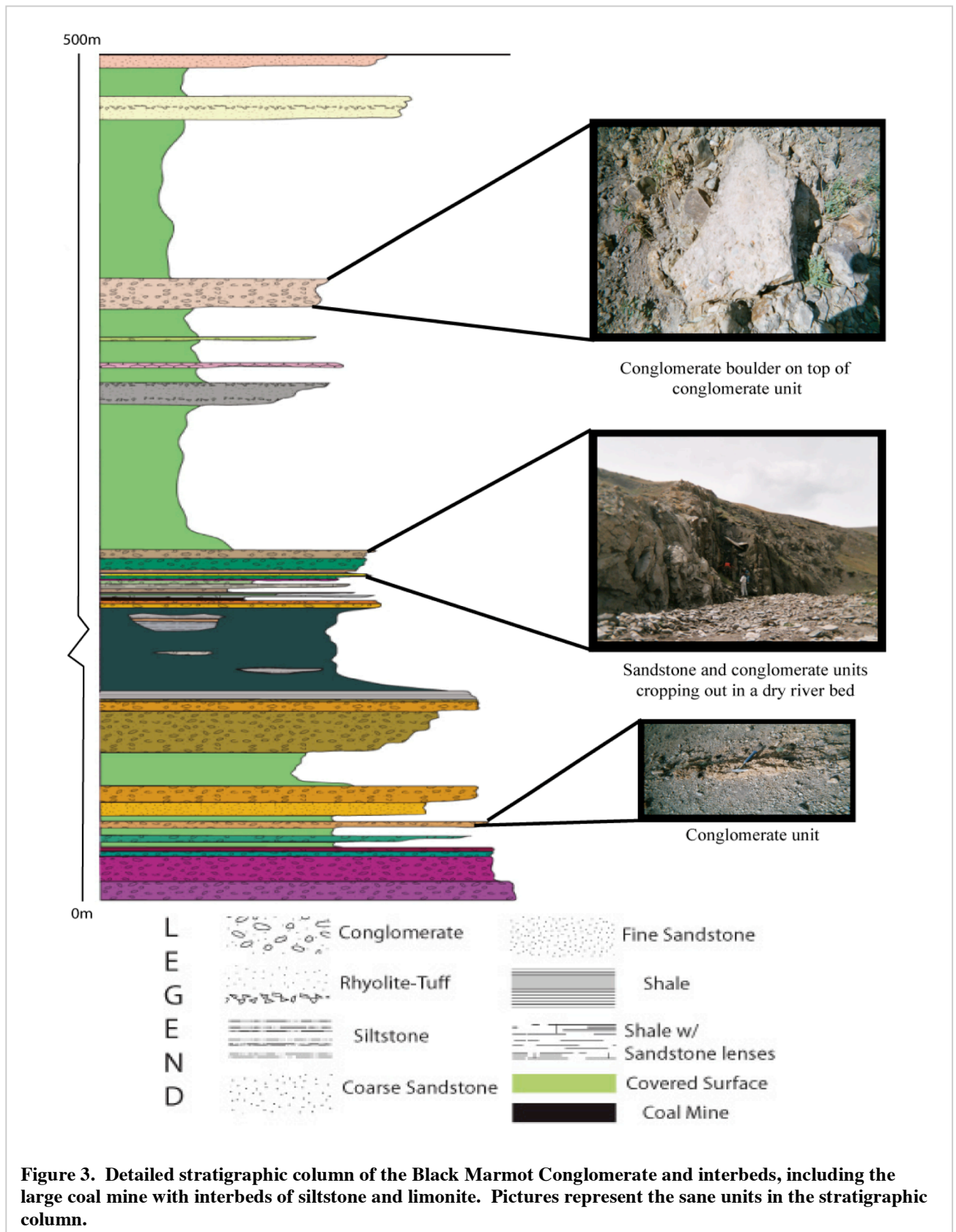
Age And Correlation

The Black Marmot Conglomerate has not been previously mapped, and therefore there is no age determination for this section. It was hoped that there would be fossils within the strata; however, few were found. Fragments of a fossil questionably assigned as *Sphenopsida*, or Horsetail, were the only fossils present, found within shale and coal interbeds. Unfortunately, no age constraints were established since the *Sphenopsida* range from the middle Devonian to present. However, during the early Carboniferous, a greater diversity of distinctly sphenopsid plants became more prominent which suggests that a Carboniferous age for the conglomerates is appropriate (Stewart and Rothwell, 1993).

Preliminary Ar⁴⁰/Ar³⁹ dating of pillow basalts immediately before the conglomerate units yielded a date of 300 +/- 4 Ma, placing them in the late Carboniferous (Layer and Drake, Geochronology Laboratory, University of Alaska, Fairbanks, 2005). Because these basalts are stratigraphically below the conglomerates, it can be inferred that the conglomerates were deposited after this time, most likely in the later Carboniferous to early Permian. However, excess argon in the samples makes these dates questionable.

Paleoenvironment

The results presented here are based on measured outcrop sections with a cumulative thickness of more than 500-m (Fig. 3). There are noteworthy depositional differences within each of the 35 conglomerate units including clast size, clast composition, imbrication,



sedimentary structures, matrix, and cement. Most of the conglomerates have polymodal clasts, ranging from 30 cm to 1 cm and are angular to sub-rounded; very few have any well-rounded clasts. The majority of the units

are oligomict-orthoconglomerates with little matrix and a grain-supported framework with little to no internally organized fabric (Fig. 4). The fact that most of these rocks are oligomicts implies decomposition and

disintegration of large amounts of rock with a climate and topography that promotes chemical decomposition of all but the most resistant components. The units that are not oligomicts are paraconglomerates with a matrix-supported framework. These units, like the oligomicts, lack any internal organization.



Figure 4
Two beds of conglomerate with an interbed of shale. Note the differences in clast size and color of the conglomerates.

Though several of the conglomerate units show slight imbrication, none of them show any other sedimentary structure. Another difference in the conglomerate beds is the matrix. Approximately 15 of the conglomerates have a carbonate matrix, while the rest are composed of silica. The differences in the depositional environments of these different matrices is unknown.

Based on these observations, the majority of the conglomerates contain clasts that were transported fairly short distances and deposited by processes of mass wasting, such as debris flows, while few of the conglomerate units were deposited by streams into a subtly changing nearshore environment.

The interbeds of the Black Marmot Conglomerate also represent variable settings within a transgressive-regressive sequence. The sandstone interbeds represent shallow, nearshore deposition of compositionally mature and texturally submature sands. The shale interbeds were deposited in slightly deeper water. The coal interbeds indicate a heavily vegetated marginal marine setting in a warm, moist climate where rapid burial of the organics prevented oxidation (Fig. 5). This usually occurs in swampy or boggy settings. The various lenses of siltstone within the coal



Figure 5. Black Marmot coal mine.

and sedimentary structures within these lenses could represent small areas of a marginal marine environment that received variable amounts of additional water that deposited silt as they entered.

DISCUSSION

The Black Marmot conglomerates are rocks, suspected to be Carboniferous, that were most likely deposited in shallow, equatorial seas. The stratigraphy of the conglomerates indicates that relative sea level was oscillating frequently, creating a fluctuating estuarine environment in which deposition likely occurred. This oscillation may have been caused by interactions between glaciation and isostatic change in elevation.

Based on the types of rocks found as well as the regional tectonics of the area, it is likely that the deposition of these conglomerates occurred in an extensional back-arc basin, though more research must be done to gain a more comprehensive understanding of the nature of the tectonic setting.

The research in the summer of 2004 has yielded some evidence in order to determine paleoenvironment of the Black Marmot Conglomerate, however, more research is suggested. In particular, it is suggested that the source area of some of the clasts in the conglomerates is examined. While many of the clasts could have come from the local stratigraphy, a number of clasts, such as quartzite, are not recognized locally. Further, granites, a locally occurring rock, are not found within any of the conglomerates. More research should also be done to further explain the structure of the area, which appears highly folded.

REFERENCES CITED

Misar, Z., 1997, Mongolia, *in* E. M. Moores and R.W. Fairbridge, eds., *Encyclopedia of European and Asian regional geology*: New York, Chapman and Hall, p. 540-544.

Stewart, W. N. and Rothwell, G. W., 1993, *Paleobotany and the evolution of plants*: Cambridge University Press, Cambridge, England.

Tomurtogoo, O., ed., 2003, *Tectonic map of Mongolia*: Mongolian Academy of Sciences, scale 1:1,000,000.